Savanna Biome

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Figure 9.1 Late afternoon sun over trees of *Adansonia digitata* dotted amongst *Colophospermum mopane* in Mapungubwe National Park, Limpopo Province.

List of Vegetation Units

1. Introduction: Delimitation and Global Perspective

The savanna vegetation of South Africa and Swaziland constitutes the southernmost extension of the most widespread biome in Africa. It represents 32.8% of South Africa (399 600 km^2) and 74.2% of Swaziland (12 900 km^2). It extends beyond the tropics to meet the Nama-Karoo Biome on the central plateau, the Grassland Biome at higher altitudes towards the east and extends down the eastern seaboard interior and valleys where it grades into Albany Thicket in the Eastern Cape.

More specifically, savanna occupies most of the far-northern part of the Northern Cape, the western and northeastern parts of North-West Province, extreme western parts of the Free State Province, northern Gauteng with more isolated occurrences in the south of this province, almost the entire Limpopo Province, northwestern and northeastern Mpumalanga, most of central and eastern Swaziland, low-altitude parts of the eastern seaboard, inland of the Indian Ocean Coastal Belt in KwaZulu-Natal and the Eastern Cape Provinces, and with the southernmost extension abutting Albany Thicket of the Komga to Albany Districts.

Savannas are largely tropical and occupy the greater area of the southern continents (Huntley & Walker 1982) and also some parts of the northern continents. Most of the savannas are associated with old planation surfaces and are believed to represent a legacy of the vegetation which flourished during the Tertiary and even earlier geological periods when under hot, wet climatic conditions laterisation processes were active (Cole 1982, 1986). Savanna types north of South Africa and Swaziland extend from southern Mozambique in the east and

from the central interior of Namibia in the west through to the coast of central Angola and to the margins of evergreen tropical forest of the Congo Basin and extend further north into eastern Africa. Most of this area of savanna in south-central Africa south of Kenya (and excluding Botswana, Namibia, South Africa and Swaziland) is the miombo woodland or savanna. From Kenya, savanna extends into southernmost Somalia and to the southern and western flanks of the Ethiopian highlands. From here it extends east-west as a great belt between the Sahel to the north and the humid semideciduous forests to the south in West Africa to reach the coast of Senegal (Okigbo 1985, Scholes & Walker 1993). In South America, main savanna forms are the moist cerrado positioned between the Amazon forest and the Atlantic forest in Brazil and the arid caatinga east of the cerrado in northeast Brazil (Eiten 1982, Cochrane et al. 1985) and at least parts of arid chaco mainly in Paraguay and Argentina with parts in Bolivia and Brazil (Bucher 1982). The Orinoco savannas (llanos) occur from the Guaviare River in Colombia to the east coast of Venezuela (Sarmiento 1983, Medina & Silva 1990). Areas of savanna are also found in the Guayana region of Venezuela. Savanna woodlands in Australia are widespread north of the Tropic of Capricorn (Gillison 1983) but also extend southwards in eastern Australia (Lacey et al. 1982, Mott et al. 1985). Savannas on northern continents are limited, and occur mainly in India as well as in various other parts of southeast Asia (Blasco 1983, Pemadasa 1990, Yadava 1990). Savanna is also found in southwest Texas and into northern Mexico (Archer 1990). Savanna can also occur as small isolated areas, e.g. on the Nicoya Peninsula in the extreme west of Costa Rica (Sarmiento 1983). Many dominant grass genera of southern African savanna are shared with savannas of other continents. These include, for example, *Heteropogon* (Africa, India, Australia and America), *Andropogon* (Africa, India and America) and *Themeda* (Africa, India and Australia) (Johnson & Tothill 1985).

More recent major reviews that include southern African savanna are those of Huntley & Walker (1982), Bourlière (1983), Tothill & Mott (1985) and Cole (1986), with other reviews including Furley (2004). For definitions of savanna and considerations for its delimitation in southern Africa see the chapter on Biomes and Bioregions.

2. Climate, Geology and Soils

2.1 Climate

The macroclimatic patterns of the Savanna Biome region are tightly linked to climatic differences between the Atlantic and Indian Ocean coasts of the southern African subcontinent. Among the major macroclimatic traits characterising the Savanna Biome are: (1) seasonality of precipitation (alternation of wet summer and dry winter periods), and (2) (sub)tropical thermal regime with no or usually low incidence of frost. Brief inspection of maps of southern Africa featuring average temperature regime and temperature differences reveal several major trends (see Schulze & McGee 1978), such as (a) an expected overall temperature increase towards the equator (hence the regions of Mopane Savanna bioregion showing the highest yearly temperatures), (b) isotherms being parallel along long stretches of the coast indicating the ameliorating thermal influence of the sea, and along the Indian Ocean coast of the warm Agulhas Current, and (c) the high summer maxima in the Kalahari region as well as increasing differences between minimum and maximum temperatures towards the interior, reflecting the thermal continentality effect.

The steep precipitation gradient spanning the west and east coasts is ascribed to various factors, among which the earth's largest cross-continental zonal asymmetry of tropical convection is supposed to play a major role (Stokes et al. 1997). In the southwestern Indian Ocean, the Inter-Tropical Convergence Zone (ITCZ) reaches its southernmost position at 23° S in the austral summer (Schneider 1996), causing the Indian Ocean to reach temperatures as high as 27.5°C at these latitudes (mid-value for January). In the eastern Atlantic, on the other hand, the ITCZ is seldom found south of 5° S (Stokes et al. 1997). On the other side of the subcontinent, in the southern Atlantic Ocean, the sea surface temperature is almost 6°C lower than at the same latitude in the Indian Ocean—possibly a combined effect of low convection and the cold Benguela Current. The relative position and latitudinal and longitudinal movements of South Atlantic and South Indian Ocean Anticyclones (or cells of high pressure) as well as more to the south, Ferrar lows have been invoked as another, very important source of the precipitation patterns in southern Africa (for detailed discussion of these climatic systems see Tyson 1986). As also noted by the latter author, Streten (1980) and later also Harrison (1986) argued that the anticyclone affecting (eastern) southern Africa in winter is not the South Indian Ocean Anticyclone, but a separate one which owes its origin to anticyclongenesis in a poleward stream of subsiding air originating in the Indian monsoon system of Asia. The regions occupied by the Savanna Biome clearly have a summer-rainfall regime. Stokes et al. (1997) argued that the elevated southern African land mass cools through long-wave emission, thereby providing an interhemispheric sink for Asian monsoon outflow. In summer, the Mascarene Anticyclone propels tropical easterlies—waves of moisture-laden tropical air over the eastern regions of the southern African continent, bringing abundant rain to the Savanna Biome. These waves get blocked in their westward movement by the relatively stable high-pressure system with its core located offshore of the West Coast over the Benguela Current, causing the summer aridity of the western regions of the subcontinent.

Savanna in South Africa and Swaziland does not occur at high altitudes and is found mostly below 1 500 m and extending to 1 800 m on parts of the highveld mainly along the southernmost edges of the Central Bushveld. Temperatures are therefore higher than those of the adjacent Grassland at higher altitudes. The mean daily maximum temperature for February rarely drops below 26°C and exceeds 32°C in the Kalahari region and some low-altitude parts of savanna in the east (Schulze 1997a). In July this temperature remains above 20°C for most of the area, with some temperatures at the highest altitudes dropping to 18°C. The mean daily minimum temperature in February rarely drops below 16°C, with the temperature of substantial parts of lower lowveld remaining above 20°C. The very low occurrence of positive chill units in savanna outside the highveld and Ghaap Plateau area, suggests the irrelevance of a chilling period for breaking dormancy in most savanna plants. Minimum temperatures in winter are much more variable across savanna. In limited areas in the extreme east, the mean daily minimum temperature for July remains above 10°C but drops to below 0°C on the highveld (southern edge of the Central Bushveld) and high-altitude parts of the Eastern Kalahari Bushveld such as the Ghaap Plateau. The average dates of heavy frost are also the earliest (May) and latest (September) in the two last-named areas. In savanna, the Ghaap Plateau shows the longest period in the year when frosts can occur (>120 days). Only lower-lying parts of the Mopane, Lowveld and Sub-Escarpment Savanna Bioregions can be regarded as frost-free. Diurnal temperature ranges (T_{max} minus T_{min}) also differ considerably across savanna from a range of <9°C in Eastern Valley Bushveld to >15°C in

SVkd 1 Gordonia Duneveld in February. Corresponding values for winter (July) are about 12°C and >18°C, respectively. Mean annual temperature varies from about 16°C on parts of the highveld to >22°C in some lower parts of the Lowveld. Summer heat units correlate especially well with savanna, with most of the area with heat units above 2 200 degree days (October–March, base 10°C) falling within savanna. Summer (January) solar radiation is the lowest (< 28 $MJm^{-2}d^{-1}$) in the eastern parts of savanna (Lowveld and Sub-Escarpment Savanna) and highest (>34 $MJm^{-2}d^{-1}$) in the southern parts of Kalahari Duneveld (Schulze 1997b). In July this drops to a low (<13 $MJm^{-2}d^{-1}$) in the southern parts of Sub-Escarpment Savanna (Schulze 1997a).

MAP varies from less than 200 mm in the west in southern Gordonia Duneveld to about 1 350 mm at the highest altitude parts of Swaziland Sour Bushveld in the east. Outside the Kalahari areas, most of the savanna experiences a MAP of between 500 mm and 750 mm. Coefficients of variation in annual precipitation vary from over 35% in the dry west to less than 25% in the more mesic parts of the east (Schulze 1997a). Concentrations of rainfall are generally high in savanna, peaking at a concentration index of more than 65% in the Kalahari Duneveld and northern parts of the Central Bushveld and Mopane regions (Schulze 1997a). A concentration index of 100% implies that the rainfall of a location is very concentrated in a single month, while 0% means that the rain in all months of the year is the same. Most of the savanna has rainfall concentrated in midsummer (January) but in late summer (February) in the Kalahari areas. There are some areas of savanna in the east, especially at higher altitudes, that have rainfall concentration in early summer (December).

Worldwide, savanna has a strongly seasonal rainfall with wet summers and dry winters (Nix 1983). Savanna has a distinct dry season, with most of the area in South Africa receiving less than 5 mm of rain in each of the months of June, July and August. Only in parts of the Sub-Escarpment Savanna is this slightly exceeded (especially in August). Most savanna areas in southern Africa have what is classified as strong summer rainfall or summer rainfall (Bailey 1979, Rutherford & Westfall 1994).

Although savannas have a distinct dry season and, in southern Africa, with a wet season that is essentially unimodal, there are areas of savanna, such as those of northern Tanzania, Kenya and southern Ethiopia, that have very distinctive bimodal rains usually with the 'short rains' peaking around November and the 'long rains' peaking around April, with the dry season centred in July. The summer-rainfall depression (lowest in February) in some of these savanna areas can be considerable, dropping to less than 10% of that of the peak rainfall month of the short rains, effectively creating a second, but shorter dry season (especially in southern Ethiopia and more arid parts of Kenya; Müller 1982). The magnitude of the rainfall in the 'long' and 'short' rainy seasons can be very similar in some areas in the north of the region. There are many species of southern African savanna that also thrive in these strongly bimodal rainfall systems.

The pattern of relative humidity in summer generally approximates the MAP pattern but in winter the relative humidity in the western part of savanna forms a belt of lowest values from around Lephalale (Limpopo Province) to Van Zylsrus (Northern Cape Province) and shows higher humidity into the lower-rainfall area of southwestern Gordonia, possibly due to the influence of cyclonic systems from the west during winter. Nowhere in South African savanna do winter daily minimum relative humidities (i.e. those that typically occur at the hottest period of the day) reach the extremely low levels experienced in savanna some hundreds of kilometres to the north of the country in the central parts of southern Africa where values of close to 0% have been recorded. Potential evaporation in summer (January) is low in parts of the Sub-Escarpment Savanna (<180 mm A-pan equivalent), but increases northwards in the Central Bushveld (200–300 mm) and westwards to high values in Gordonia Duneveld (>360 mm). The extreme variation in potential evaporation in savanna is reflected in the mean annual amounts which vary from less than 1 600 mm in parts of Eastern Valley Bushveld of the eastern seaboard area to more than 3 000 mm in Nossob Bushveld of the Kalahari.

Hail and flash density of lightning on the ground are relatively low compared to that in the surrounding Grassland Biome. Surface winds are generally light in the region of South African savanna, although on the Polokwane Plateau strong winds from the east are sometimes experienced in summer (Schulze 1965). Savanna includes some areas of relatively windless conditions with, for example, Pretoria experiencing a frequency of 41% calms in January and 57% in July.

There has been a long local history of relating the climate of a region to its vegetation, especially in KwaZulu-Natal (Phillips 1983). Climate regions as relating to zones of vegetation have also been proposed at the national level in South Africa (Kruger 2004). Climatic relationships with a number of different savanna species in southern Africa have been established (e.g. Rutherford et al. 1999a, b). By way of but one example, areas where mean annual rainfall of less than 400 or 450 mm intersect with the highest number of heat units (in South Africa) correspond closely to that area of the Limpopo River Basin (and that of some of its tributaries) in which *Adansonia digitata* (Figure 9.2) occurs in South Africa.

2.2 Geology

In South Africa, the Savanna Biome is located mostly in the northeastern part of the country. The geology of this area is dominated by a very stable block of ancient continental crust, known as the Kaapvaal Craton. The Kaapvaal Craton began to form by a process of accretion over 3.5 billion years ago (gya) and has been largely unaffected by crustal processes, except on its fringes, for the last 2 ga. The craton also hosts a number of significant sedimentary basins and igneous intrusions, thus preserving a geological record spanning most of geological time.

The Barberton mountain lands consist of some of the oldest rocks on earth and preserve the first evidence of the assembly of the Kaapvaal Craton (Poujol et al. 2003). This area includes the Barberton Greenstone Belt, a volcano-sedimentary sequence, as well as granitoid and gneissose rocks to the north and south. To the south of the greenstone belt is the Ancient Gneiss Complex in Swaziland which hosts the oldest rocks on the craton, some of which formed over 3.6 gya. Similar, but slightly younger greenstone belts are found elsewhere in the craton such as the Giyani, Murchison, Pietersburg and Kraaipan Greenstone Belts. These belts preserve clastic and chemical sediments as well as volcanic rocks that characteristically include ultramafic extrusives.

The assembled crustal blocks and associated greenstone belts were thickened and stabilised by the intrusion of many large bodies of potassic granitoid rocks that started around 3.1 gya. Such batholiths include the Nelspruit, Mpuluzi and Heerenveen bodies.

This stabilised crust became the basement on which large deposits of sediments could form and be preserved to the present day. The rich gold fields of South Africa formed among the sedimentary rocks of the Witwatersrand Supergroup that were deposited between 3 and 2.7 gya. This thick succession

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Figure 9.2 *Adansonia digitata* (baobab) with shrubs of *Grewia flava* on the edge of a sandstone ridge at an altitude of 555 m in the Mapungubwe National Park in early April. The baobab is one of the earliest savanna tree species to drop its leaves after summer in South Africa.

of quartzite, conglomerate and shale formed the world's greatest gold resource due to a unique set of circumstances on the stable crustal block during the Late Archaean. It was at a similar time that the Pongola Supergroup sediments were deposited to the east.

It is believed that these basins formed during the approach and eventual collision of the Kaapvaal Craton and a similarly stable block, the Zimbabwe Craton. Shortly after the deposition of the Witwatersrand sediments ceased, a phase of rift-related volcanism and associated sedimentation formed the thick Ventersdorp Supergroup. Rocks of this succession cover large areas of the North-West Province. This marked the end of significant tectonic activity on the craton.

During the early Proterozoic, subsidences lead to the development of stable continental platforms on parts of the craton that formed large sedimentary basins. The two large basins were the Transvaal basin, near the centre of the craton, and the Griqualand West basin on the western edge. Hence, the Griqualand West Supergroup correlates both chronologically and genetically to the Transvaal Supergroup. These two successions host similar deposits, most noticeably thick packages of chemical sediments (of the Ghaap and Chuniespoort Groups, respectively), including dolomites and Banded Iron Formations (BIF). The BIFs host important iron and manganese deposits for the country and, interestingly, formed as a result of (cyclically) elevated oxygen levels in the atmosphere and oceans due to the sudden increase of photosynthetic organisms (blue-green algae).

Deposition of the Transvaal Sequence continued for several hundred million years, amounting to a total thickness of accumulated sediment of over 20 km.

At ca. 2 060 mya the intrusion of the Bushveld Igneous Complex (BIC) formed one of the most recognisable features on the Kaapvaal Craton. This enormous structure forms the largest layered mafic intrusion on earth and is also host to the greater part of the world's platinum group metal, vanadium and chromium resources. It is intrusive into the upper part of the Transvaal Supergroup, namely between the Pretoria Group below, and the Rooiberg Group above. The intrusion consists of a mafic part that formed its characteristic compositional layering by means of a settling out of minerals from the melt as they crystallised and is known as the Rustenburg Layered Suite. The other part of the intrusion consists of a voluminous amount of granitic material that lies above the mafic part, in the centre of the structure. This is the Lebowa Granite Suite and it contains some large fragments of older Transvaal Supergroup rocks.

Shortly after the intrusion of the BIC, another event around 2 gya generated the interesting Vredefort Dome. This structure has at its core Swazian Erathem basement gneiss and surrounding this, sediments of the Witwatersrand and Transvaal Supergroups which become younger away from the core. Until recently the reason for this doming and extreme up-warping of the basement and overlying sediments remained enigmatic. The interpretation of shock-metamorphism of the gneiss associated with the doming event is that a meteorite strike was the cause. This catastrophic event resulted in the rebounding of the crust to form what is now called the Vredefort impact structure.

Between ca. 1.9 and 1.6 gya the clastic sediments of the Soutpansberg and Waterberg Groups were deposited in the northern part of the craton. At a similar time the sediments and volcanics of the Olifantshoek Supergroup were laid down on the western edge of the craton. These are all of the Mokolian Erathem.

The next significant sedimentary basin to form on the Kaapvaal Craton was the Karoo Basin, during more recent times. The Karoo was one of several basins on the Gondwana Supercontinent, of which the Kaapvaal Craton formed a part, covering a total area of some 4.5 million km^2 during early Permian times (Smith et al. 1993). Sediments and volcanics of the Karoo cover large parts of the craton and its boundaries with adjacent crustal material.

The boundaries of the craton are in fact the zones of pervasively deformed rocks that represent old orogenic (mountain-building) events that occurred after 2.7 gya. The Limpopo Belt to the north of the craton represents the collision between the Kaapvaal and Zimbabwe cratons beginning at around 2.7 gya. Remobilisation of this orogenic belt occurred at around 2 gya, hence it forms the northern boundary of the craton. To the south and west of the craton, the mesoproterozoic (ca. 1 gya) Namaqua-Natal Metamorphic Belt forms the craton boundary. This belt extends from KwaZulu-Natal, beneath the younger Karoo rocks that cover it in the interior to the Namaqualand region and into Namibia. The Namaqua-Natal Metamorphic Belt is one of several belts of similar age throughout the world.

Although kimberlite pipes occur across large parts of southern Africa, it is only those that intruded into a craton that bear diamonds. Those that intruded into the Namaqua-Natal Metamorphic Belt or further west, are barren. This is consistent with the fact that the conditions for diamond growth are only found beneath old, rigid cratonic crust.

For more detailed accounts of the geology that include savanna areas, see Smith et al. (1993), Thomas et al. (1994), Eriksson et al. (1995), Robb & Meyer (1995), Brandl & De Wit (1996) and Poujol et al. (2003).

2.3 Soils

Since the early 1970s, our knowledge on the distribution and properties of soils has increased significantly, especially in the traditionally uncultivated parts of the country. Careful field observations of soil-plant relationships in the savanna regions by MacVicar (1962), Van Rooyen (1971), Verster (1974), Eloff (1984), Venter (1990) and others, including land type surveys (Land Type Survey Staff 1984a, b, c, 1985, 1986a, b, 1987, 1988, 1989a, b) have made it possible to understand the ecological significance of the soils better. The land type survey programme was initiated by the Department of Agriculture (later the ARC Institute of Soil, Climate and Water) in 1972.

With our improved knowledge of the occurrence and main properties of different soils, we can determine how they are likely to behave under a certain set of given environmental factors. For example, it is now known that there exists a much closer relationship between soils and vegetation in dry regions, such as much of the savanna areas, than in higher-rainfall regions (e.g. the surrounding mesic parts of the Grassland Biome). In low-rainfall areas, where water is the main limiting growth factor, it is mainly those physical factors that determine the rainfall efficiency, that have the greatest influence on the vegetation composition.

Local influences of soil properties (e.g. variation on a scale of as small as 0.25 ha) may have a pronounced influence on the pattern and type of tree-grass coexistence in an area. Such properties may be soil crust formation (Mills 2003) on certain soils (enhancing water runoff and therefore less available soil water in the profile, but possibly raising available nutrient levels; Dougill & Thomas 2004), swelling (cracking) clay soils that formed on basic parent materials (high storing capacity for soil water but with seasonal root pruning taking place), duplex soils with a root-impenetrable clay pan below or skeletal soils (shallow, usually also stony soils, but with fissures and cracks in the saprolite where some water may be stored and roots may penetrate).

Under extreme conditions of a high evapotranspiration and low annual rainfall (e.g. Kalahari), deep soils are needed for the trees and shrubs to survive. As the rainfall increases and the evapotranspiration decreases, shallower soils can also support the growth of trees and shrubs. Where duplex soils with a prismacutanic B-horizon (e.g. Estcourt soil form) dominate within a region, grass will dominate over trees and shrubs. Similarly, where high clay content swelling soils occur, despite favourable climate-soil water conditions, grasses will dominate because they can adapt to seasonal root pruning better than the perennial trees and shrubs. Grass quality, i.e. foliar nutrients, can also be closely related to soil texture (Mutanga et al. 2004).

The contributions of the different soil groups per broad savanna region are given in Box A. In the broad Kalahari area, Van Rooyen (1971) reported that the strongest relation between soil and vegetation was found on the deep red sandy soils (Hutton soil form (Orthic A—Red apedal B); Soil Classification Working Group 1991). The soils are base-saturated and have a considerable water storage capacity. *Acacia erioloba* and *A. haematoxylon* plants serve as distinctive indicators of these soils when they are generally deeper than 1 m. On the same soils but on slightly higher elevations than the former and on northern slopes, dense communities of *A. mellifera* and *A. tortilis* dominate. In contrast to vegetation on the deep red soils, on yellow-coloured, sandy but calcareous soils [Augrabies (Orthic A—Neocarbonate B—Unspecified) and Addo soil form (Orthic A—Neocarbonate B—Soft carbonate B)], treeless grass vegetation dominates. Very little soil covers the dolomite formation of the Ghaap Plateau. The soils are usually calcareous [Coega soil form (Orthic A—Hardpan Carbonate)], with *Tarchonanthus camphoratus*, *Olea europaea* subsp. *africana* and some *Rhus* species. Red, yellow and greyish, excessively drained sandy soils (arenosols according to WRB terminology, where WRB is the World Reference Base for Soil Resources of the International Society for Soil Science (ISSS), the International Soil Reference and Information Centre (ISRIC) and the Food and Agriculture Organization (FAO) of the United Nations) dominate the dune areas (Box A). While these soils are still dominant in the areas where savanna vegetation occurs, deep red weakly structured soils (some of which might be calcareous below) with a slightly higher clay content than the dune sands occupy about one third of the area. It is on these soils (mostly luvisols and some calcisols) where most of the trees and shrubs occur. Shallow soils on rock (mostly leptosols) dominate on the ridges.

In Central Bushveld and including Mopane Savanna the soil variation is quite large (Box A). Although deep red weakly structured soils with a loamy to clay texture dominate on the more level land, soils with a high clay content and swelling properties (mostly vertisols and phaoezems) occupy almost 10% of the area. Where the region borders with the Grassland Biome to the south, the soils are mostly red and yellow, weakly structured with a low to medium base status, reflecting a higher effective rainfall than in the rest of the region. Shallow soils on rock (mostly leptosols) also dominate on the ridges and low mountains, while many rock outcrops occur on some of the mountains. On the shallow gravelly coarse sand of the Wasbank [Orthic A–E—Hardpan ferricrete (broken type)] and Glenrosa (Orthic A—Lithocutanic B—Saprolite) soil forms carry various woody plants including *Combretum zeyheri*, *C. apiculatum* and *Acacia caffra* (Verster 1974). These plants seem to be adapted to soils with a relatively dry soil climate, strong to medium acid conditions and a low inherent soil fertility. On the other hand, no trees (with the exception of a few) have been reported on

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Figure 9.3 *Colophospermum mopane* overwhelmingly dominant on the heavier soils on the plains of Musina Mopane Bushveld with *Sesamothamnus lugardii* in the foreground, uncharacteristically on rock, in the Mapungubwe National Park (Limpopo Province).

the shallow coarse sand of the Wasbank and Dresden (Orthic A—Hardpan ferricrete) soil forms where the ferricrete is hard and solid below. Here grasses (e.g. *Trachypogon spicatus*) dominate. On many imperfectly drained floodplains (e.g. the Nyl River east of Mookgophong) with calcareous moderately structured clay soils [Sepane soil form (Orthic A—Pedocutanic B—Unconsolidated material with signs of wetness)], *Spirostachys africana*, *Acacia mellifera* and *A. tortilis* dominate. These plants therefore can tolerate the seasonally wet conditions, the stronger soil structure and prefer the high base status. In the mopane veld north of the Soutpansberg Mountains, *Colophospermum mopane* seems to be the best adapted to the unfavourable environmental conditions where it occurs on red and dark-coloured loamy and clay soils (Figure 9.3). In contrast, the perennial grasses such as species of *Digitaria*, *Schmidtia* and *Eragrostis* prefer the more sandy soils in this region. Only certain tree and shrub species are present on the black swelling clay ('turf') soils [mainly Arcadia soil form (Vertic A—Saprolite)]. It seems that *Acacia tortilis*, *A. robusta*, *A. nilotica*, *A. tenuispina* and *A. karroo* can tolerate the swelling properties of these soils.

In Lowveld bushveld, Venter (1990) has used the land type concept as basis for his ecological studies and management planning of the Kruger National Park (KNP). He found that a significant correlation existed between geology, landform and soils. Differences in these parameters were well reflected in both species composition and structural features of the vegetation that form the basis for habitat differentiation within the KNP.

The soil variation in this region is also quite large with soils of almost all soil groups present (Box A). However, it is the soils with limited pedological development (mostly leptosols) that dominate the area, with soils with high clay content and swelling properties (mostly vertisols and phaeozems that are associated with the base-rich parent materials, e.g. basalt) that have the highest percentage coverage of all the Savanna Biome groups. Here again, as with the Central Bushveld region, where the region borders on the Grassland Biome to the west, the soils are mostly red and yellow, weakly structured and with a low to medium base status, reflecting a higher effective rainfall than the rest of the region.

Box A. Relative contribution of soil groups within each savanna bioregion.

Bioregion	Soil group (%)											
	A2	A3	A4	A5	AR	B1	B2	C1	D1	E1	G1	H1
Central Bushveld	6	2	38	2	6	3	0	1	9	19	12	2
Mopane	0	0	32	0	16	0	0	4	1	45	0	1
Lowveld	8	1	7	1	5	1	1	2	15	53	3	0
Sub-Escarpment Savanna	6	2	1	0	0	0	1	5	1	83	0	0
Eastern Kalahari Bushveld	0	0	27	1	49	0	0	2	0	17	5	0
Kalahari Duneveld	0	0	1	0	99	0	0	0	0	0	0	0

Soil groups are as follows (classification according to World Reference Base (WRB) soil groups given in brackets):

Red-yellow well-drained soils lacking a strong texture contrast:

A2–Red and yellow, massive or weakly structured soils with low to medium base status (association of well-drained Ferralsols, Acrisols and Lixisols). Land type: Ab.

A3–Red and yellow, massive or weakly structured soils with medium to high base status (association of well-drained Ferralsols, Acrisols and Lixisols and one or more of Regosols, Leptosols, Calcisols and Durisols). Land types: Ac & Ad.

A4–Red, massive or weakly structured soils with high base status (association of well-drained Lixisols, Cambisols, Luvisols). Land type: Ae.

A5–Red, massive or weakly structured soils with high base status (association of well-drained Lixisols, Cambisols, Luvisols and one or more of Regosols, Leptosols, Calcisols and Durisols). Land types: Ag & Ah.

Soils within a plinthic catena:

B1–Red, yellow and greyish soils with low to medium base status (association of Ferralsols, Acrisols, Lixisols and Plinthosols. In addition, other soils with plinthic and gleyic properties may also be present). Land types: Ba & Bb.

B2–Red, yellow and greyish soils with high base status (association of Lixisols, Cambisols, Luvisols and Plinthosols. In addition, other soils with plinthic and gleyic properties may also be present). Land types: Bc & Bd.

Soils with a strong texture contrast:

C1–Soils with a marked clay accumulation (association of Luvisols, Planosols and Solonetz. In addition, one or more of Plinthosols, Vertisols and Cambisols may be present). Land types: Da, Db & Dc.

Soils with a high clay content and swelling properties:

D1–Black and red, strongly structured clayey soils with high base status (association of Vertisols, Phaeozems, Kastanozems and Nitisols. In addition, one or more Leptosols, Calcisols and Cambisols may be present). Land type: Ca.

Soils with limited pedological development:

E1–Soils with minimal development, usually shallow on hard or weathering rock, with or without intermittent diverse soils (association of Leptosols, Regosols, Calcisols and Durisols. In addition, one or more of Cambisols, Luvisols and Phaeozems may be present). Land types: Fa, Fb & Fc.

AR–Red, yellow and greyish excessively drained sandy soils (Arenosols). Land types: Af & Ha.

H1–Soils with negligible to weak profile development usually occurring on recent flood plains (association of Fluvisols, Cambisols, Luvisols and Gleysols). Land type: Ia.

Rocky areas:

G1–Rock with limited soils (association of Leptosols, Regosols, Durisols, Calcisols and Plinthosols). Land types: Ib & Ic.

Within the Sub-Escarpment Savanna, MacVicar (1962) has done some pioneering work on correlating soil with vegetation types in the Tugela Basin. The soil variation in the region is similar to what has been described for the Lowveld, also quite large, with soils of almost all soil groups present (Box A). There is, however, an absence of rocky areas and very sandy (red and greyish coloured, weakly structured) soils and deep soils that occur on large floodplains. Large areas of soils with high clay content that have swelling properties are also very limited. Although the soil group that represents soils with limited pedological development covers about 80% of the whole region, it actually indicates a great variation in the occurrence of soil types (without any of the other soil groups that dominate). One can therefore expect that, besides leptosols, soils such as regosols, cambisols, luvisols, planosols and phaeozems will occur. Again, where the region borders on the Grassland or Afrotemperate Forest Biomes to the west and north, the soils are mostly red and yellow, weakly structured and with a low to medium base status, reflecting a higher effective rainfall than the rest of the region.

3. Biogeography: Origins, Diversity Patterns and Classifications

3.1 Origins of the Savanna Flora and Vegetation

Judging from the wide extent of the Zambezian or Sudano-Zambezian Floristic Region and similarities of broad-leaved woodland and thorn bushland on both sides of the equator (White 1983, O'Brein & Peters 1999), evolution of the southern African savanna must have occurred in a wide African context. Middle and Upper Cretaceous floras are remote in terms of age and therefore have little significance in our assessment of the modern southern African savanna woodland. For instance, late Cretaceous wood from Mahura Muthla, North-West Province (Bamford 2000), and fossil leaves and pollen from Orapa, Botswana (Scholtz in Rayner et al. 1991, Bamford 2000), may have Gondwana features, but the numerous dicotyledonous leaves and other plant remains from Orapa are not identifiable to modern family level (Bamford 2000). We therefore look for clues of the southern African savanna woodland in the Tertiary period rather than the Cretaceous. There is little direct fossil evidence for the origin of savanna vegetation from the Tertiary period in southern Africa, but clues exist of how the vegetation in the current savanna region of southern Africa could have developed during this time.

Pollen of families that are typical in African savanna woodland seems to be present since the early Tertiary (Muller 1981) although they did not at that stage, represent vegetation similar to the current types in Africa. Eocene fossil leaves from Tanzania of *Acacia* and Caesalpiniaceae suggest that woodland elements related to current savanna species were already present in Africa by this time (Herendeen & Jacobs 2000, Jacobs & Herendeen 2004). Fossil Eocene wood in southern Africa at Bogenfels in Namibia indicates the presence of families like Balanitaceae, Burseraceae, and Euphorbiaceae that have members in modern savanna woodland (Bamford 2000). Eocene wood from Mozambique (Bamford 2000) could give similar indications. More tropical conditions in the current savanna region, than at present, are likely to have prevailed for long periods in southern Africa during the Tertiary. We infer this from the observation that subtropical vegetation occurred in the southern and southwestern Cape and Namaqualand regions during the Palaeogene and Early Neogene (Coetzee & Rogers 1982, Scholtz 1985, Scott 1995, Bamford 2000). For example, Bamford (2000) reported on Lower and Middle Miocene wood of Combretaceae from the Namaqualand region indicating wetter and forested conditions. The observation that warmer ocean waters surrounded the subcontinent (Shackleton & Kennet 1975) supports this scenario.

For the Neogene (the Late Miocene and Early Pliocene), Axelrod & Raven (1978) and O'Brein & Peters (1999) envisage scenarios suitable for large expanses of broad-leaved and seasonal and semi-arid woodland in Africa. The development of modern savanna is closely linked with the evolution of C_4 photosynthesis in grasses that took place after 8.5 mya, possibly together with declining atmospheric pressures of CO_2 (Cerling et al. 1997, Ehleringer et al. 1997, Jacobs 2004, Sage 2004). Jacobs (2004) reviewed plant and vertebrate fossil evidence relating to savanna woodland development and suggests that forest changed to open woodland between 12.6 and 6.8 mya in the Tugen Hills, Kenya. The oldest finds of typical savanna components in the southern hemisphere of Africa (*Acacia*, Combretaceae, *Commiphora* and *Dichrostachys* pollen types) are recorded in marine sediment cores along Namibia from the Atlantic Ocean from Deep See Drilling Project cores off Angola and northern Namibia of Late Miocene (Partridge 1978) and Early Pliocene age (Van Zinderen Bakker 1980). Bonnefille (1995) reports the presence of fossil pollen typical of Sudano-Zambezian flora in 4 mya (Pliocene) sediments from East Africa. Several fossil wood fragments from Member 4 in the Sterkfontein Cave include a liana typical of riverine and gallery forest, suggesting that trees were present at the time between 2.8–2.6 mya (Bamford 2000, Partridge 2000). Pliocene uplift in southern Africa and cooling (Partridge et al. 1995) seem to correspond with a transition from closed to more open woodland as inferred from fossil antelope faunas from sediments in South African hominid sites representing the period between 2.6 and 2 mya (Vrba 1985, 1995). Open grassy *Protea* savanna occurred by then on the boundary between the current Savanna and Grassland Biomes as indicated by pollen in deposits from Kromdraai and Sterkfontein (Scott & Bonnefille 1986, Scott 1995). The situation was different from but resembled the contemporary one.

Long-term boundary shifts and changes in floral composition in the Neogene were a characteristic feature of the vegetation history following regular transitions from glacial, stadial and interglacial conditions. These regular cyclic changes are visible in a stalagmite isotope record from Lobatse Cave (Holmgren et al. 1995), and in pollen records over the last 200 000 years from the Tswaing Crater (Pretoria Saltpan) and Wonderkrater (near Mookgophong), suggesting transitions from broad-leaved savanna to other types like montane forests, upland fynbos, thornveld or even karoo-like vegetation (Scott 1982, 1999a, b). During moist phases, for instance ca. 50 000 yr BP montane forests with *Podocarpus/Afrocarpus* and *Olea* must have occupied parts of the interior plateau that is currently under savanna woodland. During coldest Last Glacial Maximum (LGM) times between ca. 30 000 to 16 000 years ago, grassland with fynbos replaced this vegetation, which found refugia at lower elevations. Pollen spectra covering the last 20 000 years at Wonderkrater were presented in a calibrated time scale of radiocarbon dates and reflect the history since the decline of upland fynbos during the LGM. Thornveld developed ca. 10 000 years ago, broad-leaved woodland ca. 7 000 years ago, and more open woodland, associated with Late Holocene cooling, ca. 5 000 years ago (Scott et al. 2003). A nearby stalagmite record (stable isotopes) in the Makapansgat Valley provides a much higher resolution than the pollen record (Holmgren et al. 2003). Apart from the millennial-scale environmental changes

observed in both the pollen and stalagmite records, the stalagmite data show that the savanna vegetation was subject to short-term drought cycles on a decadal scale while the Little Ice Age represented a marked dry event ca. 1750 AD (Holmgren et al. 1999, 2003).

3.2 Diversity and Taxonomic Patterns

The number of species at broad geographical levels (gamma diversity) has been given as 5 788 (Gibbs Russell 1987) for the Savanna Biome in southern Africa, which in turn gives a relatively low species area ratio of 9.2 $10^3/10^6$ km^2 (Van Rooyen & Van Rooyen 1998). For the southern Kalahari part of this biome, the ratio drops even lower to 4.4 $10^3/10^6$ km^2 (Van Rooyen & Van Rooyen 1998). A broad-scale analysis indicates a gradient of sharply decreasing diversity of tree and larger shrub species from east to west within the Savanna Biome (O'Brien 1993, O'Brien et al. 2000). Cowling et al. (1997) found that heterogeneity (length of the temperature gradient) was the strongest predictor of regional species richness in South African savanna and grassland taken together. Savanna is well known for its diversity of mammals but many other animal groups are also well represented, for example dragonflies in the lowveld (Samways 1999).

An analysis of plant species diversity in the Sand River catchment in the lowveld revealed the following diversity patterns (Shackleton 2000b). The total number of species increased with increasing mean annual rainfall across the rainfall gradient, representing about 100 km from the border of the KNP to the eastern escarpment (Figure 9.4). Plant species numbers doubled over this gradient from around 50 to over 100 species per 0.1 ha. Plant species richness was substantially higher on eutrophic bottomlands than on dystrophic toplands. However, species turnover was greater along the rainfall gradient (about 85%) than along the catenal gradient between toplands and bottomlands (about 40%). There were significantly fewer species in protected areas than on the adjacent, highly utilised, communal lands. In the KNP, Whittaker et al. (1984) reported 78 plant species per 0.1 ha in habitat dominated by *Combretum zeyheri* and *Pterocarpus angolensis* and 93 species per 0.1 ha in habitat dominated by *C. zeyheri* and *C. apiculatum*.

In the Central Bushveld in the Nylsvley Nature Reserve, a similar range of plant species richness was found to that in the Lowveld (Whittaker et al. 1984: Table 4). The typical sandy savanna dominated by *Burkea africana* and *Terminalia sericea* had between 80 and 100 species per 0.1 ha, which is indicated to be high compared to diversity in various USA plant communities (Whittaker et al. 1984). The highest set of values were for an area unburned for more than four years. More moderate diversity levels of between 40 and 60 species per 0.1 ha were found on rocky hills dominated by *Diplorhynchus condylocarpon*, and areas with somewhat more clay (than the surrounding sands) dominated by *Acacia tortilis* and *A. nilotica*. This lower range is still ranked as 'moderately high' compared with plant communities in the USA (Whittaker et al. 1984). Cowling & Hilton-Taylor (1997) regard the southern African section of the (Sudano-) Zambesian (Floristic) Region as 'relatively depauperate'. Cowling et al. (1989, 1997) indicate an average of about 67 species per 0.1 ha for South African savanna from a variety of sources.

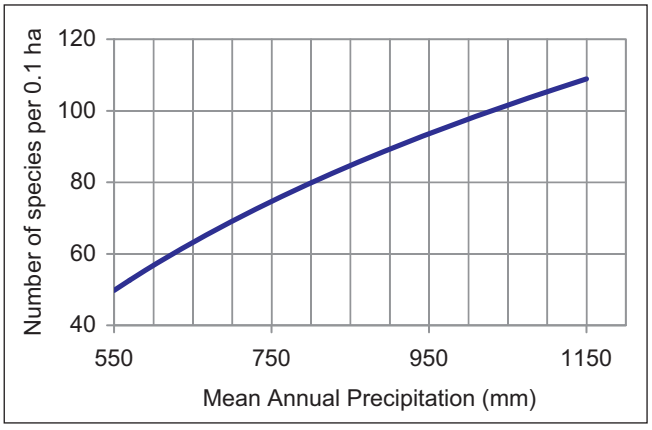

Figure 9.4 Relationship between mean annual rainfall and number of plant species in the Sand River catchment of the Lowveld (Mhala and Pilgrim's Rest Districts). Equation is: Number of species/ 0.1 ha = 80.09 ln(MAP) – 455.57 with $r^2 = 0.67$, $P < 0.00001$ and $n = 40$ (Shackleton 2000b).

Van Rooyen & Van Rooyen (1998) extracted data at a slightly different scale (0.001 ha or 100 m^2) from Leistner & Werger (1973) to show various plant diversity patterns in the southwestern Kalahari. Species number per 0.001 ha was 32 on the red sand interdune valleys and dropped to 23 on the red sand dune tops in the north (with *Terminalia sericea* and *Albizia anthelmintica*), but only to 28 on the other dune tops (with *Stipagrostis amabilis*) common throughout the region. By contrast, the dune crests and slopes covered by red sand had the highest values according to the Shannon-Wiener index (which combines both richness and equitability) from 2.59 to 3.04. Beta diversity (turnover of species along a gradient) is extremely low for the communities of the large and homogeneous sandy areas (excluding riverbeds and pans) in the southwestern Kalahari.

At the point scale (1 m^2) in the Sand River catchment, means of 7.9 and 8.2 species were found for toplands and bottomlands, respectively (Shackleton 2000b). Cowling et al. (1989) indicated a point scale mean of 9 for the Savanna Biome. On a savanna site in Namibia (MAP approximately 520 mm), naturally protected from long-term herbivory or disturbance by larger ungulates and with many plant species in common with South African savanna, point diversity averaged only 5.1 species (Rutherford 1975). Out of 1 200 samples of 1 m^2, there were no empty points; 1.4% had only one species, whereas a similar low percentage of points had 10 or more species (maximum 13).

3.3 Biogeographical and Vegetation Subdivisions

There is no widely accepted and overarching classification system for southern African savannas (Scholes 1997). At a very general phytochorial level, Werger (1978a) considers most of the savanna (and most grassland) in the present work to be part of the Zambezian Domain of the Sudano-Zambezian (Floristic) Region. However, he excluded the Kalahari area, which he placed within the Karoo-Namib Region, as the Southern Kalahari Subdomain. Kalahari has been delimited in many different, and often conflicting, ways (Thomas & Shaw 1991). White (1983) includes this area in the Sudano-Zambesian Phytogeographical Region. The area is, however, transitional between the tree and shrub flora of mainly Sudano-Zambesian affinity and the flora of the lower layers (at least in the Kalahari Duneveld Bioregion), with strong affinities with the Karoo-Namib Region (Werger 1973). The fact that the interdune valleys with mainly lower shrubs are wider than the parallel dunes that carry most of the larger shrubs and trees (Leistner & Werger 1973) was a deciding majority-area consideration in Rutherford & Westfall (1986) placing much of the Kalahari duneveld region in the structurally and climatically defined Nama-Karoo Biome and later extend-

ing it northwards (Rutherford & Westfall 1994: 74, Rutherford 1997) and including only the Nossob Bushveld in the far north in the Savanna Biome. This northern extension was also independently made through recent work on plant structure (Westfall & Van Staden 1996).

Werger & Coetzee (1978) recognised three broad vegetation units in the savanna of our region, namely 'Open *Acacia* savanna of the southern Kalahari' (corresponding to the Eastern Kalahari Bushveld and Kalahari Duneveld Bioregions), '*Colophospermum mopane* vegetation' (corresponding to the Mopane Bioregion) and 'Other woodland, savanna, thicket and bushveld vegetation' (corresponding to the Central Bushveld, Lowveld and Sub-Escarpment Bioregions). Their three units extend farther into Africa to limited degrees. Half of the 'Open *Acacia* savanna of the southern Kalahari' is in South Africa and extends towards Windhoek in Namibia, with a minor extension into southwestern Botswana. The 'Other woodland, savanna, thicket and bushveld vegetation' extends into large sections of central and northern Botswana and parts of central-north Namibia as well as into the far southern part of Mozambique. In this view, the savannas of South Africa and Swaziland are different to much of the rest of savanna (notably miombo) in Africa. The '*Colophospermum mopane* vegetation' does occur farther north, but then only as far as the southwestern corner of Angola and parts of the Zambezi River Valley with the most northerly extension up the Luangwa River Valley in Zambia (Henning & White 1974). Of the eight countries with this vegetation, South Africa is least represented (after Malawi) with only 4% of the total area of *Colophospermum mopane* vegetation (Mapaure 1994). There are, however, floristic elements in some South African savannas that re-occur in most African savannas. For example, the *Burkea africana* tree that occurs in several vegetation units of the Central Bushveld Bioregion is found to varying degrees in most of the African savanna to the north and through West Africa (Rutherford 1982a). The vegetation of the main study site of the South African Ecosystems Research Programme in the Nylsvley Nature Reserve is dominated by *Burkea africana*, and has also sometimes been regarded an impoverished form of miombo vegetation (Scholes & Walker 1993).

Huntley (1982) recognised two broad divisions of savanna (also applying to savannas northwards to the equator). These were moist/dystrophic savanna and arid/eutrophic savanna also called broad-leaved savanna and fine-leaved savanna, respectively (with mopane's broad-leaved being regarded as the exception; Scholes 1997). As mapping units, Huntley's (1982) moist/dystrophic savanna corresponds to the higher-lying areas of the Central Bushveld Bioregion (and to the eastern escarpment slopes west of the Lowveld; Huntley 1984). The arid/dystrophic savanna corresponds to the lower-lying parts of the Central Bushveld Bioregion and to the Lowveld, Sub-Escarpment Savanna, Mopane, Eastern Kalahari Bushveld and Kalahari Duneveld Bioregions. Scholes (1997) introduced a type intermediate between these two major units called 'mixed savanna', which corresponds to most of the Central Bushveld and Lowveld Bioregions (and also occurs in part of central Zimbabwe).

4. Vegetation Structure and Dynamics

4.1 Vegetation Structure and Patterns

Most savanna has a herbaceous layer usually dominated by grass species and a discontinuous to sometimes very open tree layer. 'Savanna grasslands' may grade into 'tree savanna', 'shrub savanna', 'savanna woodland' or 'savanna parkland' (Scholes & Archer 1997). In many savanna areas in southern Africa the term bushveld is appropriate since the woody component does often not form a distinct layer as in miombo vegetation to the north but presents an irregular series of interlocking, often low, canopies with openings and sometimes little distinction between tall shrubs and small trees. This continuum between shrub and tree has been reflected in a 'shrubbiness index' developed for a range of savanna species in the Central Bushveld (Rutherford 1982b). Scholes et al. (2004) referred to 'stemminess' of savanna woody plants and pointed out that the distinction between trees and shrubs along a broad-scale Kalahari transect is somewhat arbitrary with savanna trees being typically multistemmed, but with fewer stems than shrubs. Structure of the woody component of savanna is important to animals—for example tree height which determines the available browse, dense woody entanglements forming impenetrable barriers, availability of shade, and protection against predators or scavengers. In arid savanna, such as the southwestern Kalahari, the configuration of the sparse woody component can also become critical as cover for hunting leopards (Bothma et al. 1994).

Floristically similar vegetation can be structurally different. For example, on black vertic clays, *Acacia tortilis* may form a woodland or occur as low shrubs embedded within grassland and kept low possibly by fire and frost (Van der Meulen & Westfall 1980). Substrate appears to play an important role in differentiating between the tall dominant trees of *Colophospermum mopane* on shale in SVmp 3 Cathedral Mopane Bushveld and the dominant shrubs of the same species in an adjacent vegetation unit (SVmp 4 Mopane Basalt Shrubland) on basalt in the KNP. Substrate also plays a key role in determining structure in the western parts of the Central Bushveld, where on particularly heavy clays (>55% clay in all horizons) most other woody plants are excluded and the diminutive *Acacia tenuispina* dominates at a height of less than 1 m above ground (Figure 9.5). On the sandy clay loam soils (with not more than 35% clay in the upper horizon, but high in the lower horizons) *A. erubescens* at over 5 m tall is the most prominent tree (Pauw 1988) (Figure 9.6). Some other plant relationships with soils are discussed in the section on soils.

The moist and arid savanna types (see Section 3.3) do not only differ predictably with lower woody plant leaf area index (LAI) and canopy cover (Privette et al. 2004) as well as basal cover (Scholes et al. 2002) in the arid savanna type. Finer but distinct structural differences include tree leaves changing from a horizontal orientation to a more random orientation and a strong decline in specific leaf area in arid savanna (Scholes et al. 2004), which, together with decreased LAI, indicates thinner leaves in arid savanna (along a Kalahari transect). Even when rainfall is similar, soil fertility differences result in nutrient-poor savanna (with many properties of moist savanna) and nutrient-rich savanna (with many properties of arid savanna). The nutrient-poor savanna also differs from nutrient-rich savanna in larger leaf size, higher root:shoot ratio, lower grass palatability, greater woody biomass, lower herbaceous water use efficiency and more conspicuous litter layer (Scholes 1990a). In nutrient-poor savanna, woody plant antiherbivore strategy is chemical (tannins, polyphenolics, etc.), whereas it is structural (thorns) in nutrient-rich savanna. Combretaceae and Caesalpiniaceae dominate the former, with Mimosaceae dominating the latter. The soil fauna is high and dominated by termites in nutrient-poor savanna and is low and ant-dominated in nutrient-rich savanna (Scholes 1990a). Both tree and herbaceous layers of nutrient-rich savanna are preferred by kudu over these layers in the nutrient-poor savanna in the Nylsvley Nature Reserve (Owen-Smith 1993). More generally, Owen-Smith (1982) listed 34 large African herbivore species with their preference for either arid/eutrophic or mesic/dystrophic systems; 23 species

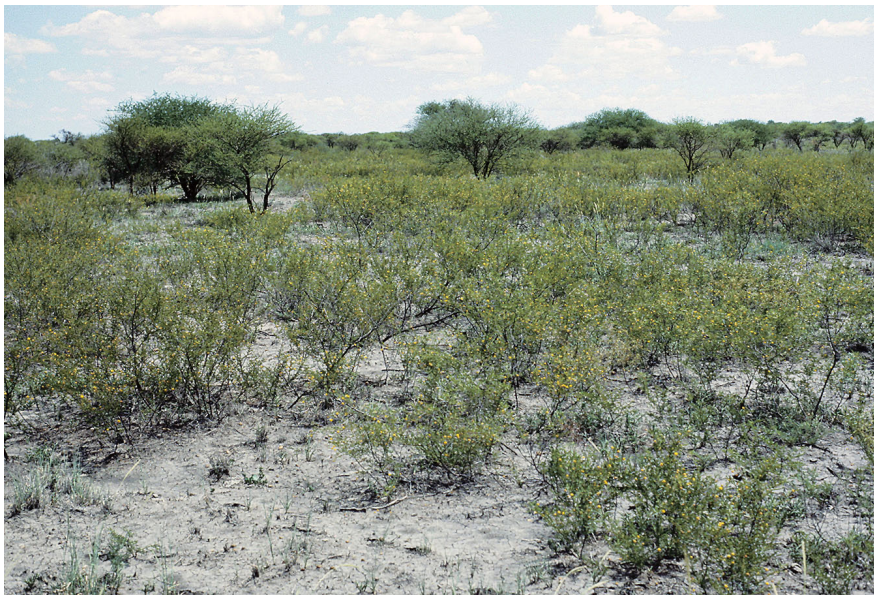

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Figure 9.5 *Acacia tenuispina* dominant in the foreground on soil with a very high clay content west of Thabazimbi, between the Crocodile and Marico Rivers (SVcb 1 Dwaalboom Thornveld).

preferred arid/eutrophic (e.g. the browser black rhinoceros and grazer impala), seven preferred mesic/dystrophic (e.g. the browser grey duiker and the grazer buffalo) and four species fell in both categories (e.g. the grazer and browser Cape eland and the grazer tsessebe). The nutrient-poor systems relate to their position on acid crystalline rocks and old erosional surfaces, while the nutrient-rich systems are on fine-grained sediments and young surfaces (Scholes & Scholes 1997). In some special cases the origin of nutrient-rich patches of *Acacia tortilis* embedded within nutrient-poor broad-leaved savanna has been found to be anthropogenic, arising from Iron Age settlements (Blackmore et al. 1990).

There is often an excellent correlation between vegetation patterns and soil types, as exemplified in the KNP (Venter & Gertenbach 1986, Venter et al. 2003). However, there is much floristic variation along rainfall gradients, even with similar substrate such as demonstrated along the Kalahari gradient in Botswana (Ringrose et al. 2003). Even within the broad group of so-called Kalahari sands a variety of soils occur (Van Rooyen 1984) and the proportion of the coarse sand fraction is associated with the occurrence of certain tree species (Moore & Attwell 1999).

Termitaria are a common feature in many savanna types, also throughout many savannas of the world (Josens 1983). On granite-derived soil in the KNP a density of 111 active termite mounds per km^2 has been quoted (Naiman et al. 2003). Termite mounds form islands of significantly elevated nutrient concentrations and are associated with palatable grasses such as *Cenchrus ciliaris* and are heavily used by herbivores, especially in the dry season (Naiman et al. 2003). In the lowveld, Griffioen & O'Connor (1990) found that the percentage clay, pH, conductivity and sodium of the soil of termite mounds were significantly higher than that of the top soils of the adjacent areas. They point out that the elevated pH is at variance with results from some termitaria elsewhere in Africa. Furthermore, they found that *Cenchrus ciliaris* was only associated with termite mounds in the open and did not occur at all on mounds under the canopies of trees. *Panicum maximum* was far more prolific on termite mounds than off the mounds under the canopies of trees. *Heteropogon contortus* does not occur on termite mounds. In a study in the SVs 6 Eastern Valley Bushveld in KwaZulu-Natal (Gower et al. 1992), woody plants were found to be absent around young, active termitaria, and only started to appear once the termitaria began to degenerate and become recolonised by ants or nongrass-harvesting termite species. *Acacia nilotica* was the first to colonise, followed by species such as *Ehretia rigida* and *Maytenus heterophylla*. The older termitaria had bush clumps with a closed canopy including *Ziziphus mucronata*, *Grewia occidentalis*, *Burchellia bubalina*, *Dovyalis zeyheri* and *Cussonia spicata*. Termitaria can serve as a prominent perch for birds with a greatly increased probability for seed to be dispersed on them (Kemp et al. 2003).

Dambos are seasonally waterlogged bottomlands typically embedded within savannas of south-central Africa (Tinley 1982, Von der Heyden 2004). They are often associated with a catenary sequence (Scholes 1997). Although not as frequently encountered in South Africa as in the savannas further north, there are good examples of this kind of catena such as in the Nylsvley Nature Reserve. Here the catena extends from the hydromorphic grassland of the dambo through the yellow-brown sands of the lower slopes to the yellow-red sands of the midslope to the red-brown sands of the upper slope (Von Harmse 1977), a sequence also broadly associated with a plant species gradient (Scholes & Walker 1993). The catenary pattern of sandy uplands to clayey bottomlands is common in parts of the lowveld (Scholes et al. 2001, Venter et al. 2003), where the

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Figure 9.6 Moderately dense woodland dominated by *Acacia erubescens* on less clayey soils on the Farm Portugal, west of Dwaalboom, Thabazimbi District (SVcb 1 Dwaalboom Thornveld).

catena can include a clear seep zone such as in the Sabi Sand area of the lowveld (see Tinley 1982: Figure 4). Where toplands have been heavily utilised for communal grazing in the lowveld, they become so modified that they classify outside the topland-bottomland dichotomy that characterises this region (Higgens et al. 1999).

Various pattern analyses of plants have been undertaken in southern African savanna vegetation. In the southern Kalahari, both actual and modelled tree spacing tends to be even at small scales, clumped at intermediate scales, and random or clumped at large scales (Jeltsch et al. 1999). Species differences may be important. In a field study in the arid Kalahari, *Acacia erioloba* saplings were found to be aggregated, small trees were randomly or regularly distributed and large trees were randomly spaced. However, in open stands of *A. mellifera* subsp. *detinens* aggregation increased with the size of the shrub (Skarpe 1991b). From a number of sites across a range of conditions on Kalahari sands, Caylor et al. (2003) concluded that small individuals were more aggregated than large ones, and put forward a number of possible mechanisms to explain this pattern. In dystrophic broad-leaved savanna in the Nylsvley Nature Reserve a lack of pattern in the herbaceous layer was attributed mainly to the large number of annual and perennial pioneer and disturbance-indicating species (Theron et al. 1984). Whitaker et al. (1984) concluded that on this site the woody vegetation dominated the pattern. Clearly more studies are needed to elucidate different spatial groupings of plants in the diverse savanna systems.

Roots of savanna plants play a critical role in patterning and function. A well-developed root system allows savanna plants to survive both drought and fire (Menaut 1983). Savanna plants are renowned for their well-developed root systems. A brief summary of the root component and some of its wide variation is given below.

Below-ground plant mass can be considerable. Values such as 29 790 kg ha^{-1} in an area overwhelmingly dominated by small trees of *Colophospermum mopane* are exceptionally high and comparable with that of woodlands elsewhere with much taller trees (Smit & Rethman 1998b). The ratio of below-ground to above-ground parts (root:shoot ratio) in the tall shrub *Ochna pulchra* is still relatively high at a value of about 1 (averaged for the whole population at a site; Rutherford 1982a). Root:shoot ratios of around 5 have been found for shrubby savanna dominated by *Terminalia sericea* (see Rutherford 1982a). The large investment in plant material below ground is believed to be critical for the persistence of the plant under conditions that adversely affect its above-ground parts.

Many savanna woody plants have extensive shallow root systems, but not necessarily to the exclusion of some deeper running roots. The shallow root system enables them to make use of relatively light showers when water does not penetrate far into the ground. The very strongly developed lateral root system can sometimes extend 7–12.5 times that of the canopy radius, and it includes species such as *Terminalia sericea*, *Burkea africana* and *Colophospermum mopane* (Rutherford 1980, 1983, G.N. Smit, personal communication). *Combretum apiculatum* is also reported to have a well-developed shallow lateral root system (Fraser et al. 1987). The high root:shoot ratio and the relatively shallow rooting of *Colophospermum mopane* make it a particularly effective competitor with herbaceous plants (Smit & Rethman 1998b). Some other species have very limited lateral extension such as up to only 1.5 times that of the canopy radius in *Commiphora pyracanthoides* (Jordaan et al. 1998). Contrary to trees of many other savanna systems, this species also has little intergrowth of roots of other tree species. It is also unusual in that, in addition to a tap root system, it has a well-developed fleshy, tuber-like secondary root system that contains a large amount of moisture.

Savanna evergreen trees tend to have deep root systems—at least in dry savanna (Skarpe 1996). *Boscia albitrunca* in the central Kalahari appears to hold the world record for a maximum rooting depth of 68 m (Canadell et al. 1996). In a study in the southern Kalahari dunefield (Gordonia District) Schulze et al. (1998) found downward transport of water in roots (inverse hydraulic lift) with water flow into deeper soil layers. They suggested that inverse hydraulic lift may serve as an important mechanism to facilitate root growth through the dry soil layers underlying the upper profile where precipitation penetrates.

Several low plant species in savanna have stems which are widely interconnected below ground and include geoxylic suffrutices such as *Dichapetalum cymosum*, *Fadogia monticola*, *Lannea edulis*, *Parinari capensis* and *Pygmaeothamnus zeyheri* in the Nylsvley Nature Reserve (Rutherford 1980). In the same reserve several legume species, such as *Elephantorrhiza obliqua* and *Chamaecrista mimosoides*, produce long rhizomes which interconnect widely spaced shoots (Grobbelaar & Rösch 1981); even individuals of *Ochna pulchra* (large shrub, sometimes tree) are sometimes interconnected below ground (Rutherford 1980, 1983).

Leistner (1967) provided an extensive account of the root systems of a wide range of plant species of the southern Kalahari and confirmed that the roots of some species can reach great depths, and that trees can have shallow lateral roots stretching far from the tree. He pointed to several specialist structural features including root sand coats and spongy cortex, succulent roots and contractile roots in monocotyledons and 'deciduous' roots, succulence and wiriness and to suckering in dicotyledons. The ability of plants to sprout from exposed roots is common in species such as *Senna italica* subsp. *arachnoides*, *Heliotropium ciliatum*, *Hermannia tomentosa* and *Lycium hirsutum* and even in adult specimens of *Albizia anthelmintica* (Leistner 1967), and may confer a survival advantage in areas with sometimes unstable sand dunes. Even in deep sandy areas in more humid savanna, the ability of roots to sucker, when exposed and damaged, is very common in *Ochna pulchra* (Rutherford 1983) which, if caused by burrowing animals and small mammals feeding, for example, on soil insects, could result in aerial extension of, and competitive advantage for the plant.

4.2 Plant Interactions

Three major reviews have addressed tree-grass interactions in savannas (Scholes & Archer 1997, Sankaran et al. 2004) or their interaction in the wider context of mixed tree-forb plant systems (House et al. 2003). Here, we emphasise some locally important features of these and other plant interactions that pertain to our region.

Tree-grass mixtures have been regarded as fundamentally unstable, but the simulation models to explore the organisation and dynamics of tree-grass ecosystems are still in their infancy (House et al. 2003). Four classes of hypotheses (models) are recognised for explaining how the woody and herbaceous life forms coexist (House et al. 2003): (1) Niche separation, where woody and herbaceous plants partition resources in space (e.g. preferential access to deep water by woody plants) versus more effective use of shallow soil water by grasses, or in time (e.g. phenological displacement of physiological activity); (2) Balanced composition, where woody and herbaceous plants compete for rather than partition resources, and intraspecific competition (e.g. grass-on-grass and tree-on-tree) dominates over interspecific (e.g. tree on grass) competition; (3) Competitive exclusion,

where the system is driven away from a relatively stable equilibrium and over time the one life form sufficiently pre-empts and monopolises resources so as to virtually eliminate the other. However, disturbances, which have a greater effect on the competitively superior life form, may prevent those plants from achieving or maintaining dominance; (4) Multiple stable states, where the spatial and temporal heterogeneity of resource availability and disturbance is incorporated into equilibrium models so that contrasting tree-grass ratios might exist for a given site at various times. All four the above have elements that should be included (together with many other key factors occurring at various spatial and temporal scales) in a comprehensive model.

By way of example of one of the above, Van Langevelde et al. (2003) suggested the following, based on an interaction between fire and herbivory: an increase in the level of grazing leads to reduced fuel load, which makes fire less intense and, thus, less damaging to trees and, consequently, results in an increase in woody vegetation. The system then switches from a state with trees and grasses to a state with solely trees. Similarly, browsers may enhance the effect of fire on trees because they reduce woody biomass, thus indirectly stimulating grass growth. This consequent increase in fuel load results in a more intense fire and further decline of biomass. The system then switches from a state with solely trees to a state with trees and grasses.

Some locally applied models have shown that rainfall and the competition for water alone were not sufficient to guarantee tree-grass co-existence and to maintain a scattered distribution of Kalahari savanna trees in a cellular automaton model (Jeltsch et al. 1996). In the absence of small-scale heterogeneities (e.g. patches of disturbance), the system is generally driven to a state of either pure grassland or pure woodland. With the introduction of such small-scale heterogeneities, coexistence of trees and grass can occur under a broad range of conditions (Jeltsch et al. 1998). Similarly, Higgins et al. (2000) demonstrated grass-tree coexistence in a model that included fire intensity and its (patchy) variance and its effect on tree recruitment.

The niche separation hypothesis applied locally needs qualification. Contrary to Walker et al. (1981) and Walker & Noy-Meir (1982), grasses do have access to subsoil water, but the two-layer model can still operate, provided each component is the superior competitor in a different layer (Knoop & Walker 1985). Further caution is advised since it has been found that some woody species extract water from a wide range of soil depths, including those near the surface. For instance, whereas *Ochna pulchra* extracts water mostly from above 60 cm depth, extraction of water occurs throughout the whole of the soil profile under *Grewia flavescens* (Moore et al. 1982).

Following an analysis of data from 854 savanna sites across Africa, Sankaran et al. (2005) provide an elegant generalisation of the determinants of co-dominance of trees and grasses in savanna. In savanna with a MAP of less than about 650 mm, water constrains woody cover and permits grasses to exist, while fire, herbivory and soil properties interact to reduce woody cover below the MAP-controlled upper bound. For areas with a MAP above 650 mm, rainfall is sufficient for woody canopy closure, and disturbances (fire, herbivory) are required for the coexistence of trees and grass. They view the latter savanna system as 'unstable'.

Scholes & Archer (1997) suggested that many semi-arid areas on relatively fertile or clayey soils were relatively treeless in pre-colonial times, but were encroached rapidly and apparently irreversibly when grazed continuously by cattle. This is in contrast to semi-arid environments on sandy, low-fertility soils which are seldom treeless. Bush encroachment has long been regarded as a problem for range farmers and wildlife managers (Van der Schijff 1959) and a number of long-term studies have shown a trend for a progressive increase in both tree and shrub cover, e.g. in the Hluhluwe-iMfolozi Park (Watson & Macdonald 1983). Most often woody plant increases have been ascribed to poor land use practices but Bond et al. (2003a) suggested that the general increase in savanna trees in South Africa in more recent times has been assisted by increasing CO_2 concentrations. Ward (2005) contended that causes of bush encroachment are not simple and that bush encroachment, for example, can occur on both heavily grazed areas as well as on areas where grazing is infrequent and light.

The long-term (58 years) increase of woody plant cover on granite substrates and the substantial decline on the basalt substrates in the KNP has been partly ascribed to a difference in competitive intensity of the grasses (Eckhardt et al. 2000). It is thought that the provision of surface water has led to overgrazing of grasses which do not recover rapidly on the granite substrates as opposed to their rapid recovery even after heavy grazing on the relatively nutrient-rich basalts. The sharp decline of woody plant cover on the basalt substrates, however, is more importantly linked to the regular, short-interval prescribed burning over the past 40 years. Bond et al. (2001) demonstrate experimentally at Hluhluwe Game Reserve that both the above-ground and below-ground effects of the herbaceous plants negatively affect both *Acacia nilotica* and *A. theronii*. In Eastern Cape savanna vegetation, removal of the herbaceous layer resulted in an increase in the growth of the *A. karroo* trees illustrating the suppressive effect of the grass-dominated herbaceous layer on woody plants (Stuart-Hill & Tainton 1989). In a broad-leaved nutrient-poor savanna in the Nylsvley Nature Reserve, the effect of the herbaceous vegetation on woody plants was found to be negligible—at least in a period of two years (Knoop & Walker 1985). However, in a nutrient-rich *Acacia* community with seven times more herbaceous biomass, mature woody-plant growth was reduced by the grass-dominated herbaceous layer, especially in a wetter year. Hudak et al. (2003) suggested that soil carbon sequestration may initially increase with bush encroachment, but then it would decline if bush densities become so high that they inhibit understorey grass growth.

There can be major differences in the herbaceous layer under canopies and areas between tree canopies (Scholes & Archer 1997, Smit 2004). Soil nutrient enrichment (N, Ca, K, Mg and Na) and increased soil organic matter is found under trees, especially large ones, due to various mechanisms including leaf litter, stemflow and throughfall of rain and N-fixation under leguminous trees (Smit 2004). In an *Acacia luederitzii*-dominated part of the Kalahari in southern Botswana, significantly higher levels of soil organic carbon and soil organic nitrogen were found under the canopies of the woody vegetation (Feral et al. 2003). Large *A. erioloba* trees in the Kalahari have a close association with animals resting in the shade of the canopy, with the soil enriched with nutrients through faeces, fallen nest material and carcass remains (Dean et al. 1999). In a study in SVk 1 Mafikeng Bushveld near the Molopo, significant development of cyanobacterial soil crusts under the canopies of *A. mellifera* may enable the supply of additional nutrients to the plant (Dougill & Thomas 2004). Despite similar canopy dimensions, soil crust development was found to be greatly reduced under *Grewia flava*, possibly relating to less light reaching the soil surface than with *A. mellifera*. Woody plants can serve as sites of protection for certain grass species, such as for *Themeda triandra* and *Heteropogon contortus* on some heavily grazed areas in the lowveld (O'Connor 1995b).

Acacia karroo trees in the Eastern Cape were found to suppress grass growth up to 9 m away (Stuart-Hill & Tainton 1989). Increasing density of *A. mellifera* individuals strongly depressed herbaceous production in the Molopo area (Rutherford 1978) and grass productivity was strongly inversely related to the LAI of trees in modelling output from the Kalahari (Caylor & Shugart 2004). Scholes (2003) found this a general pattern in savanna where grass declined more steeply per unit increase in tree quantity at low tree cover than at high tree cover. This 'convex relationship' he suggested is explained mainly by the geometry of the spatial interaction between the tree root system and grasses, and the effect of differing phenology (the time course of leaf area exposure) on the acquisition of water and nutrients.

Panicum maximum is a grass commonly associated with under-tree habitats in many South African savanna areas (Griffioen & O'Connor 1990, Smit & Swart 1994, Smit 2004). Tree size is important and *P. maximum* ranged from virtually absent under small trees of *Acacia tortilis*, *A. karroo* and *Dichrostachys cinerea* subsp. *africana* to pure stands under larger trees (Smit & Romburgh 1993). Griffioen & O'Connor (1990) found that *P. maximum* was far more prolific on termite mounds under the canopy of trees. Several species such as *Aristida bipartita* and *Heteropogon contortus* tend to avoid the habitat under the canopy of trees (Griffioen & O'Connor 1990). In some cases the herbaceous species composition under trees in comparison with the open habitat, is not greatly influenced, for example, by the tree layer dominated by *Burkea africana* in the Nylsvley Nature Reserve (Theron et al. 1984), possibly partly relating to the canopy of this species allowing more than 25% light throughfall (Van der Meulen & Werger 1984). Grass species under canopies of woody plants on this site were all C_4 photosynthetic type (Cresswell et al. 1982). However, on the same site, total biomass was significantly greater in the open than under *B. africana* trees while the amount of crude protein was greater under these trees than in the open (Grossman et al. 1980).

Thinning or even total removal of savanna trees is a common practice to counter the apparent suppression of herbaceous plants to improve grazing (Scholes 1990b). However, although thinning of *Colophospermum mopane* confirmed an increase in herbaceous plants, thinning of *Salvadora australis* in the same area appeared to show the reverse on herbaceous plants (Smit 2003b). Scholes's (2003) guideline to thinning suggests that if one needs to keep some trees on the land, the most cost-beneficial pattern of clearing is to remove all the trees in a portion of the landscape, rather than remove a portion of the trees in all of the landscape. In other words, to begin with, the least encroached areas rather than the usual 'intuitive' practice of tackling the most densely treed areas first. This patchy clearing is more easily managed with fire as a clearing mechanism and the dispersal of tree propagules into the cleared area is reduced.

Thinning of *Colophospermum mopane* also reduced inter-tree competition and resulted in a marked increase in the flowering and fruiting of the remaining trees (Smit & Rethman 1998a). Removal of trees closely neighbouring *Acacia nilotica* led to a significant increase of growth when compared with control trees (Smith & Goodman 1986). In bottomland *Acacia* communities in the Pilanesberg Game Reserve, spatial analysis suggested competition among trees as a mechanism controlling their size and density (Smith & Walker 1983). However, of 45 sites spread across the Savanna Biome in South Africa, only at four was the presence of interspecific competition between woody plants indicated (Shackleton 2002). At only 10 of 31 sites tested was intraspecific competition indicated. Despite the limitations of the method used (nearest-neighbour analysis), this does suggest that niche separation between species and within species is generally greater than previously argued. Alternatively, if competition is occurring, its impact is relatively low, both at the level of specific pairs of trees, as well as the community as a whole (Shackleton 2002).

At a site (Vastrap, northeast of Upington) on Kalahari sands, the number of small trees under dominant trees was significantly lower than that expected by chance and is possibly ascribed to limited water supply forcing individuals to disperse away from each other (Caylor et al. 2003). This differed to wetter sites on Kalahari sand in Botswana where the number of small trees under dominant trees was found to be significantly higher than expected. The association with frugivorous birds results in a high frequency of often woody plant species with fleshy fruits (*Boscia*, *Grewia*, *Lycium* and *Solanum*) beneath large trees of *Acacia erioloba* (Dean et al. 1999). Savanna tree species respond differently to shading. Shading reduced survival of *A. tortilis* seedlings in the Nylsvley Nature Reserve (Smith & Shackleton 1988). In the Mkhuze Game Reserve establishment of *A. nilotica* seedlings was restricted to open areas with no woody canopy cover (Smith & Goodman 1987). However, in the same area, seedling establishment of *Euclea divinorum* was limited to areas beneath the canopies of established *Acacia* individuals. *Pappea capensis*, which is widespread in South African savanna, has been shown to perform very poorly in deep shade (Holmes & Cowling 1993). However, in dry years shade may increase moisture availability as evidenced in SVs 7 Bhisho Thornveld where shading dramatically increased survival of seedlings of *A. natalitia* in a drought year (O'Connor 1995a). *Burkea africana* is able to establish under its own canopy and that of some other species (Wilson & Witkowski 2003).

The most commonly observed plant parasites in savanna are mistletoes with a study indicating that mistletoe host preference is negatively correlated with host wood density, which translates in turn to host species preferences (Dzerefos et al. 2003). Thus in lowveld, for example, they found *Sclerocarya birrea* (wood density 560 kg/m^3) was a clearly preferred host species, while *Combretum apiculatum* (wood density 1 230 kg/m^3) was avoided by the woodrose-forming mistletoes *Erianthemum dregei* and *Pedistylis galpinii*. Some species with low wood density were also avoided.

In contrast to the Fynbos, Grassland and Forest Biomes in southern Africa, the most widespread alien invader plants are herbs in the Savanna Biome (Richardson et al. 1997). Most of these are from South America and include *Alternanthera pungens*, *Bidens bipinnata*, *Conyza albida*, *Datura ferox*, *D. stramonium*, *Schkuhria pinnata*, *Solanum elaeagnifolium*, *Tagetes minuta*, *Verbena bonariensis* and *Zinnia peruviana*. Several succulents from the Americas are also important and include *Agave sisalana* and *Cereus jamacaru*. Woody alien invader plants are given in the section on Descriptions of Vegetation Units.

4.3 Rainfall and Temperature Effects

Savanna vegetation structure changes the rainfall that reaches the ground. Studies in areas of the Central Bushveld with a MAP of about 650 mm showed that although the average stemflow of trees per storm was often less than 5% of the gross rainfall; it represented a concentrated application of water to the soil at a point where conditions were ideal for entry (De Villiers 1982). Also interception losses of rainfall are significant and vary mainly between 15% and 20% of the gross rainfall. Stemflow and interception may relate to the sometimes marked ecologi-

cal differences below savanna trees (see section 4.2), but they may also tend to cancel out the net effect of both.

In years of above average rains, savanna deciduous woody species commonly retain their leaves for longer periods, sometimes dropping only a week or two before the new flush of leaves.

Duration of leaf retention into winter as determined by soil moisture is also shown in *Acacia tortilis*. Along a gradient from the Thukela River in midwinter (July) there was 71% leaf retention on the river banks dropping successively to only 10% at 200 m above the river (Milton 1983). A few deciduous savanna woody species characteristically have a particularly long seasonal leaf duration with a very short leafless period (e.g. *Colophospermum mopane*; Dekker & Smit 1996). Many savanna trees produce new leaves before the first rains of the season (Mistry 2000). In some species, the first seasonal activity is flowering, which can start as early as late July in *A. robusta* and *Dombeya rotundifolia*. Slow absorption of water during the leafless period allows for growth to resume before the first rains fall (Van Rooyen et al. 1986). It has also been suggested that the magnitude of shoot growth in a given growth season in certain savanna woody species is influenced by the rainfall of the previous season (Rutherford 1984).

M.C. Rutherford

Figure 9.7 Very low cover of the herbaceous plant layer between and under *Colophospermum mopane* and *Commiphora viminea* trees, east of Pontdrif in Limpopo Province.

In the hyperarid savanna in the southwestern Kalahari periods of drought and the variability of rainfall appear to have a significant influence on herbaceous species in the short term, while there was not much variation in the woody species composition or density (Van Rooyen et al. 1984). In the southern Kalahari after a year of severe drought, Leistner (1967) noted that in contrast to the decimation of all grass species on a particular dune, the survival rate of plants with subterranean storage organs (*Acanthosicyos naudinianus*, *Harpagophytum procumbens* and *Talinum caffrum*) appeared high. Other most obvious survivors were trees and tall shrubs. Herbaceous species composition changed dramatically following a severe drought in savanna of the lowveld east of Acornhoek (O'Connor 1995b). In the Klaserie Nature Reserve after a severe drought, mortality of grasses was very high, but that of woody plants was low (Scholes 1985). Over 80% mortality, for example, was found for *Panicum maximum* and *Schmidtia pappophoroides*. The depauperate state of the herbaceous layer at high densities of *Colophospermum mopane* trees (Figure 9.7) is relatively independent of rainfall (Smit & Rethman 1999).

After some severe drought years in the vicinity of Pontdrif, mortality of *Colophospermum mopane* was most pronounced for individuals less than 1 m tall and with no mortality for individuals taller than 3 m (O'Connor 1998). Dieback of mopane was less on sandier soils in this area (MacGregor & O'Connor 2002). Despite the relatively large leaves of mopane, it is partly protected from desiccation by the oils in its leaves (Venter et al. 2003). In the KNP, after a major drought, 30–40% of mopane were killed in one area while exceptionally high mortality (93%) of *Acacia tortilis* was recorded, but was localised (Viljoen 1995).

In a study replicated in many parts of the KNP, it was found that none of 18 key grass species were lost from the park following the 'severest drought in living memory' (Kennedy et al. 2003). The percentage abundance of these grasses declined during the drought to 87.5% of the pre-drought value. The relative abundance of species such as *Digitaria eriantha* declined while that of *Urochloa mosambicensis* increased, with the latter also spreading to new sites after the drought had past.

Effect of frost on woody savanna plants can be remarkably species-dependent. In the growth season following an unusually cold winter with 11 nights of moderate to heavy frost (–3.5°C measured at 1.5 m above ground: average annual minimum screen temperature of 2.1°C) in SVcb 15 Springbokvlakte Thornveld dominated by *Dichrostachys cinerea* on the Towoomba Research Station, many trees experienced topkill, but with most of these resprouting from the base (Smit 1990). Species significantly damaged by the frost were *D. cinerea*, *Acacia nilotica*, *A. gerrardii* and *A. robusta*. Little affected by the frost were *A. caffra*, *A. karroo*, *A. tortilis*, *Diospyros lycioides*, *Ehretia rigida*, *Grewia flava*, *G. flavescens*, *Rhus leptodictya* and *Ziziphus mucronata*. Of the frost-sensitive *Acacia* species, individuals above a height of 2 m were relatively unaffected by the frost. Smit (1990) observed that fewer of the frost-sensitive species were affected in camps with higher density of woody plants. It was also clear that solitary individuals were damaged more than individuals in groups. Groups of trees taller than 2 m appeared to be more effective in providing protection against frost. Smit (1990) attributed this 'protection' to heat radiated from the earth being reflected downwards by tree canopies. It is perhaps to be expected that almost all the frost-resistant species listed above are distributed farther into colder parts of South Africa than the frost-sensitive species listed.

On Kalahari sand in Hwange National Park in Zimbabwe, strongly species-specific reactions to unusually severe frost were found in a shrubby (height generally 1–2 m) savanna (Rushworth 1975). After frost of –14.4°C measured at ground level (compared to average annual minimum ground temperature of –3.3°C), many woody species experienced 100% (or very close to 100%) death of their main growing stem. These included *Acacia ataxacantha*, *Bauhinia macrantha*, *Burkea africana*, *Combretum collinum*, *C. zeyheri* and *Pterocarpus angolensis*. Data after a different, apparently less severe frost in this area indicated the last two mentioned species to be particularly susceptible to such frost. *A. fleckii*, *Terminalia sericea* and *Ochna pulchra* were remarkably resistant to even the more severe frost.

Individuals damaged by frost usually produced multiple coppice stems following the event.

4.4 Fire

The strong seasonality of rainfall in southern African savanna allows for plant material produced in the wet season to dry and be burned during the dry season. Fire has undoubtedly been an important factor in savanna ever since the ascension of the grass layer to dominance. Fire has long be regarded as a tool for directly influencing the woody plant components of savanna. As a management tool, a popular view is that in the moist savannas fire *per se* can be used to control bush encroachment, whereas in the arid savannas fire has the role of maintaining trees and shrubs at an available height and in an acceptable state for browsing animals (Trollope 1980).

Biomass burning is an important ecosystem process in southern Africa, also with significant implications for regional and global atmospheric chemistry and biogeochemical cycles. Fire is a significant source of trace gases and aerosols from savannas (Korontzi et al. 2003). The seasonal tropospheric ozone enhancement is a result of biomass burning (Scholes & Andreae 2000). At a local level, fire oxidizes organically bound elements in the vegetation and litter and releases them in forms available to plants. Elements that are not volatilised, are added to the soil, but such nutrient increases are usually limited to the surface layers of the soil and after an initial peak, concentration may decline rapidly (Frost & Robertson 1987). Nitrogen loss by fire in the KNP is replenished in burned areas, but the mechanisms by which this is achieved are unclear (Aranibar et al. 2003). In southern Africa, the main fuel is dry grass which burns with high efficiency and produces relatively low emissions of methane, carbon monoxide and aerosols per unit mass of fuel consumed (Scholes et al. 1996).

Studies show that the effect of fires on savanna plants can be highly variable. A study on the effects of fire on populations of *Sclerocarya birrea* in the lowveld showed that although the lower individuals (<2 m tall) were greatly affected by fire, density was unaffected (Jacobs & Biggs 2001). In savanna dominated by *Dichrostachys cinerea* and *Acacia gerrardii* in the Central Bushveld, height of trees less than 3 m was reduced due to severe topkill, but trees higher than 3 m were unaffected by the fire (Jordaan 1995). A very hot fire in *Acacia nigrescens–Combretum apiculatum* in eastern Botswana resulted in topkill of all plants below a height of 2 m and declining degrees of partial topkill with increasing heights (Sweet & Tacheba 1985). Almost all the plants that suffered complete above-ground kill exhibited basal coppice, as did many of those showing only partial topkill. In the Nylsvley Nature Reserve, mortality (total kill) of woody plants after fire was very low and where this occurred often involved plants lower than 25 cm tall (Rutherford 1981). *Grewia flavescens* has one of the highest fuel loads within the plant canopy and many plants are completely consumed by fire yet no mortality was found after fire. Mortality of *Ochna pulchra* was higher (5%) in a faster burn than in a slower burn (1%), where the latter type of fire allows for greater concentration of heat nearer the ground. *A. karroo* is hardly affected by back fires in the Eastern Cape despite the concentration of heat closer to the ground in contrast to that in head fires which cause significant topkill of trees up to a height of 3 m (Trollope 1984). Bond (1997) suggested that the occasional killing of large savanna trees through fire relates to the loss of the insulating properties of their bark.

Average shrub and tree mortality of only 1.3% has been quoted for 43 fires across a broad range of savanna areas in the KNP (Shea et al. 1996). By contrast, in hyperarid savanna of the southwestern Kalahari, where fire occurs infrequently usually after periods of exceptionally high rainfall, a fire killed approximately one third of *Acacia erioloba* trees, with most extensive damage occurring amongst fully grown trees (Van der Walt & Le Riche 1984).

Fire does not necessarily affect production of the grass layer (Grossman et al. 1981). However, grass species may respond differently to fire. In the Nylsvley Nature Reserve, a long-term study indicated that fire resulted in a basal area reduction of *Eragrostis pallens*, an increase of *Heteropogon contortus*, but had no effect on *Digitaria eriantha* (Van Rooyen et al. 1993). Annual burning combined with the effect of fire on soil moisture availability keeps the individual grass plants small, leaving space for the colonisation of opportunistic species such as *Melinis repens*, *Schizachyrium jeffreysii*, *Pogonarthria squarrosa*, *Aristida mollissima* subsp. *argentea*, *A. stipitata* and *A. congesta* (Yeaton et al. 1988).

Exclusion of fire was found to lead to increased biomass of woody plants such as *Acacia nilotica* in the Hluhluwe Game Reserve (Skowno et al. 1999). The large increase in *Dichrostachys cinerea* in Hlane National Park, Swaziland, is due to restricted occurrence of fire (Roques 2004). Possibly related to this is that this park also has an unusual age structure of *A. nigrescens*—the only species above 6 m height in the area (Gertenbach & Potgieter 1978). Using a Dynamic Global Vegetation Model (DGVM), simulations suggest that most of the eastern half of South Africa could support much higher tree cover without fire (Bond et al. 2003b). Savanna in areas with a MAP below 650 mm showed a less compelling trend to woodiness.

The effects of fire on vegetation is very much a function of the behaviour and characteristics of the fire. The intensity and duration of the dry winter season and the frost period (where applicable) determine the degree of inflammability (Edwards 1984). Co-occurrence of independent episodic events, for example a severe late frost coinciding with a high grass fuel load, and followed by a dry summer can result in exceptionally intense fires as occurred in southern Africa in 1968/9 (Walker 1985). The degree of combustion of plant fuels is greater during back fires as compared to head fires (Trollope et al. 1996). However, behaviour of head fires may be more variable than that of back fires, with a greater range in fire intensity in the former (Trollope et al. 1996). Combustion efficiency in savanna was found to be mainly determined by the interaction between the standing grass and litter (see Ward et al. 1996). Fireline intensities and flame lengths were regarded as the best descriptors of the degree of topkill of savanna trees and shrubs (Van Wilgen & Willis 1988). Higher frequency fires on the drier soils in the shrub mopane areas of the KNP had a detrimental effect on the herbaceous vegetation (Gertenbach & Potgieter 1979).

Mean fire return period during wet phases was found to be less than for dry phases in the Hluhluwe-iMfolozi Park (Balfour & Howison 2001). There is a direct positive relationship between grass biomass and probability of fire (Van Wilgen et al. 2003). Lightning fires tend to start at the start of the wet season, during October and November, while anthropogenic fires are usually started during the dry season, between July and August. A long-term study in the *Colophospermum mopane*-dominated Mooiplaas area of the KNP showed that compared to the vegetation with the early-wet season fires, the mid-dry season fires yield a shorter, more scrubby and coppiced savanna (Kennedy & Potgieter 2003). This might be ascribed to fires that occur during the mid-dry season being likely to burn hotter than fires that occur in the early-wet season when the grass layer has

been dampened by the early spring rains, and when there is the possible presence of some new green growth.

Some plants avoid fire by being associated with generally fire-protected habitats in savanna. Examples of such habitats include rocky outcrops (*Cussonia natalensis*), termitaria (*Diospyros mespiliformis*, *Schotia brachypetala*, *Mimusops zeyheri*) and bush clumps (*Ehretia rigida*, *D. lycioides*; Frost 1985b).

Three candidate approaches to fire management have been put forward in the KNP: a lightning fire (letting nature take its course) approach; a patch mosaic burning approach which aims to establish a mosaic of vegetation structure types; and an approach based on the assessment of grass biomass and the species composition of the grass sward. Van Wilgen et al. (1998) compared the advantages and disadvantages of these approaches. A patch-mosaic system of burning is based on the premise that fire pattern is a surrogate for diversity, producing a range of patches in the landscape with unique patch characteristics and fire histories (Parr & Brockett 1999).

4.5 Vegetation-animal Interactions

4.5.1 Impact of Animals

The savannas of Africa are occupied by the earth's richest and most spectacular large mammal fauna. This fauna was even richer in the distant past and it is reasonable to expect that these large animals have long influenced the plants on which they feed and through them the form of the savannas (Cumming 1982, Sinclair 1983). The African Savanna Biome includes more extant ungulate species than any other continent (Du Toit 2003). However, even termites can be the main herbivore resulting in decline of plant cover in places of the lowveld with fairly dense cover of *Grewia bicolor* and *Dichrostachys cinerea* and a relatively low density of herbivores (Braack 1995). In the Nylsvley Nature Reserve, of the annual herbaceous layer production, grasshoppers were estimated to remove over a third of that utilised by all herbivore species (which included a herd of cattle) on the site (Gandar 1982). On occasion lepidopteral outbreaks and subsequent herbivory can result in trees having to replace up to 75% of their leaf biomass in a single season (Frost 1985a).

The dependence of animals on plants has many wide-ranging effects on the plants and vegetation in savanna. O'Connor (1996) reviewed the consequences of browsing of savanna woody plants by ungulates for their physiological functioning, growth, and demographic processes. Many effects are of a generalist nature, i.e. not discriminating between different plants within a given functional guild. Many other effects are species-specific, for instance the dependence of gall-forming insects on a very limited range of plant species in South African savanna (Veltman & McGeoch 2003). Grazers can be bulk grazers, that is, they do not exercise a high degree of selective grazing (for example buffalo and domestic cattle), or can be concentrate grazers which are generally small grazing animals (such as impala and domestic sheep), with very selective grazing (Trollope 1990). However, large herbivores can also avoid certain plants, e.g. *Combretum apiculatum* is not utilised by black rhino in the Ithala Game Reserve (Kotze & Zacharias 1993). Giraffe can have dramatically different effects within the same genus of tree in the Ithala Game Reserve (Bond & Loffell 2001). Populations of *Acacia davyi* have become extinct in areas accessible to giraffe following their introduction some 20 years earlier. By contrast, *A. tortilis* showed no or very low mortality attributable to giraffe browsing. Food preferences can change with season, as was found in the North-West Province. *Ziziphus mucronata* and *Peltophorum africanum* were important food plants for giraffe during the wet season as opposed to *A. tortilis* and *C. hereroense* during the dry season (Sauer et al. 1977). There is a tendency to widen the dietary acceptance range as the overall abundance of favoured food species declines (Owen-Smith 1982). Domestic herbivores are less mobile than many wild species, impeding large-scale selectivity, and are kept at less variable and usually higher densities, preventing small-scale selectivity (Skarpe 1991a).

Elephant have the potential to literally shape African savannas. Savanna woodlands have been changed to wooded grasslands, bushed grasslands or even grasslands in many parts of eastern, central and southern Africa by the activities of elephant (Cumming 1982). Damage by elephants broadly takes three forms: the tearing of leaves and branches, the stripping of bark from the main stem, and the pushing over of an entire tree (Scholes et al. 2003). Elephants clearly affect woody plant population structures. This is dramatically visible, for example, where there are few large trees outside an elephant-proof exclosure in the KNP and a more even spread woody plant structure inside the exclosure without elephant (Trollope et al. 1998). Studies in savanna in western Zimbabwe show that tree species associated with sandy soils are less preferred by elephants than species on more fertile soils such as those associated with termite mounds (Holdo 2003). *Acacia nigrescens* is the tree species most affected by ringbarking by elephant in Hlane Royal National Park in Swaziland (Bowen 2004). In the northern KNP, ringbarking of *A. nigrescens* is more than twice as prevalent than pushing over these trees (Engelbrecht 1979). The pushing over of *A. nigrescens* trees is almost exclusively limited to young adult trees (with shallow root systems). Elephant impact on *Sclerocarya birrea* decreases with distance from roads, with the zone of high impact 10 m from roads and relatively low impact beyond 50 m from roads (Coetzee et al. 1979). Substantially higher impact also occurs along the boundaries of populations of *Sclerocarya birrea*. Utilisation is often highly selective, as for example in the Songimvelo Game Reserve near Barberton, where *Cussonia spicata* and *Pterocarpus angolensis*, despite being less common than other species present, are much selected by elephant (Steyn & Stalmans 2001). In the Sabi Sand Reserve, significantly higher levels of N, Na and Mg were found in the cambium of the species most regularly bark-stripped by elephant (Hiscocks 1999). Some species showed a high level of resilience to elephants, with one study indicating that all elephant-damaged trees survived in an area of the lowveld (Botha et al. 2002).

Using an experimental approach, Capon & O'Connor (1990) showed that predation of grass seed by ants and rodents in lowveld savanna was high and could potentially decimate the input of fresh seed. They suggest that predation is one of the major processes responsible for the well-recorded poor correlation between the abundance of certain perennial grasses (with large seeds) in the vegetation and their virtual absence from the seed bank.

There have been numerous studies in southern African savanna on the nature of the piosphere effect where animals trample and utilise vegetation in the vicinity of water points (Figure 9.8). Introduction of artificial water points in the arid Kalahari, where in earlier times there had only been a few natural water points, has been a concern for multiplying the number of areas of vegetation damaged around water points (Palmer & Van Rooyen 1998). Water points in the Kalahari create trampling gradients where a model indicates negligible recovery even after 100 years after withdrawal of cattle (Jeltsch et al. 1997a). There is an almost complete lack of woody plants in the vicinity of artificial watering points ('sacrifice area') on Satara basaltic soils with

a zone of high utilisation of woody vegetation extending far beyond this area (Brits et al. 2002). Impact around such dams can be species-specific with, for example, more annual grass species with increasing impact (Thrash et al. 1993). Amongst dominant woody plants *Combretum apiculatum* was more sensitive to these impacts than *Colophospermum mopane* (Thrash et al. 1991b), but the woody stratum as a whole was less sensitive to the effect of the dam than the basal cover of the herbaceous stratum (Thrash et al. 1991a). Based on a study on the Klaserie Nature Reserve, Parker & Witkowski (1999) found greater impact on herbaceous plants around seasonal water points than around perennial water points, suggesting preferential utilisation of ephemeral surface water by herbivores during the wet season. In the KNP, borehole closure led to an increase in the relative abundance of decreased grass species, suggesting that here the piosphere effects on herbaceous community composition may be reversible (Gaylard et al. 2003). Around water points in an area of SVk 4 Kimberley Thornveld near Barkly West, change in bare ground and vegetation height within the diminishing grazing gradient was discernible up to 75 m from the water point (Smet & Ward 2005). Abundance of *Schmidtia pappophoroides* increased from very low near the water point and stabilised at about 200 m from the water point. Up to 50 m from a goat kraal in the Thukela Valley, extensive browsing by Boer goats resulted in great mortality of the succulent *Aloe ferox*, with small plants being the most heavily utilised (Breebaart et al. 2002).

Different and complex impact gradients can occur around rural human settlements both as a combination of the effects of local domestic animal stock and use of other resources by people around the settlement. Around rural settlements in the lowveld, at distances up to 450 to 3 100 m from the periphery of the village, woody vegetation decreased (at different amounts according to species), but herbaceous cover increased (Shackleton et al. 1994). Wood is the primary domestic energy source in these settlements.

Grazing pressure elsewhere often has predictable results, but not always. The ratio of unpalatable to palatable grasses depends on the level of grazing pressure and whether this level has been increasing or decreasing (a hysteresis effect with a higher ratio if decreasing for the same given level of grazing pressure; Walker 1987). Shrub encroachment was found to occur in the southern Kalahari by simulating cattle grazing beyond a threshold pressure under all rainfall scenarios (Jeltsch et al.1997b, Weber et al. 1998). Low grazing pressure (33 ha lsu^{-1}) had no effect on shrub cover and distribution. But increasing the grazing pressure to 22 ha lsu^{-1} led to a continuous increase in shrub cover. Reduced grass competition, combined with some years of relatively high rainfall, favour shrub establishment. In arid Kalahari savanna, *Acacia mellifera* shows the greatest increase in response to overgrazing (Skarpe 1990). Woody species richness does not appear to be sensitive to different stocking rates by game and cattle as shown at a wide range of sites in Zimbabwean savannas (Richardson-Kageler 2003). In a lowveld herbaceous sward, the proportion of annuals was highest in communal cattle lands and the proportion of perennial species highest on commercial game farms (Parsons et al. 1997). Communal management appears to markedly reduce densities of most tree species (Shackleton 1993).

4.5.2 *Plant Response Types and Features*

Savanna woody plants have a range of deterrents to browsing. Secondary compounds can be digestibility-reducing, mostly tannins, or contain toxic substances which interfere directly with the physiology of the consumer (e.g. alkaloids, amines; Owen-Smith 1982). Sensitivity can vary according to animal type. For example, in *Burkea* savanna, cattle are susceptible to monofluoracetate poisoning from ingestion of the leaves of *Dichapetalum cymosum* in spring, but wild ungulates seem unaffected (Owen-Smith 1982). Structural repellents such as thorns, spines or twiggy growth form, usually found in plants with highly nutritious foliage, do not prevent feeding on such plants by browsers such as kudu and giraffe, but could affect relative preferences through their influence on bite sizes and biting rates (Owen-Smith 1982). *Acacia mellifera*, with its strong hook thorns, is a preferred food species by black rhinoceros who bite off shoots up to a thickness of 10 mm, with thorns appearing in the dung (Joubert & Eloff 1971). Also kudu, under dry season conditions of food shortage, have been observed eating thorny *Acacia* twig ends (Owen-Smith 1985). Grasses have also evolved grazing deterrents (Stuart-Hill & Mentis 1982). Chemical protection is found in such species as *Bothriochloa insculpta* and *Elionurus muticus*. Physical protection is conferred, for example in *Aristida junciformis*, by the high breaking tension of its leaves which makes it difficult for herbivores to break off the leaves. *Setaria sphacelata* has hairy leaves which collect dust, rendering them unacceptable to the animal.

L. Mucina

Figure 9.8 The piosphere effect around a drinking hole (Kumana Dam, north of Tshokwane) in the Kruger National Park. The piosphere extends well beyond the visibly impacted terrain nearest the water.

As with their response to fire, many savanna plants recover well after removal of plant material (without the heat of fire) and appear to occupy a long-lasting persistence niche. A wide range of woody plants of savannas exhibit a strong coppicing ability following cutting (Shackleton 2000a, Smit 2003a). The longevity of savanna tree species explains the lag between heavy utilisation and species loss (Higgins et al. 1999). It has also been found in the Bushbuckridge part of the lowveld that the taller the potential height of a species, the fewer were the coppice shoots per stump surface area (Shackleton 2000a). *Acacia tortilis* trees in the Central Bushveld were tolerant of damage and continued

to increase in size even when all the current season's shoots were removed (Milton 1988). Coppicing of *Colophospermum mopane* trees from the main stem ('hedging') when broken by elephant, provides these animals with an increased availability of preferred size range of branches of this preferred food species (Smallie & O'Connor 2000). Productivity of woody plants and browse production are reviewed by Smit et al. (1996) and are not repeated here. Many grasses are tolerant of grazing, for instance through tillering. Tillering after removal of the apex of the parent tiller stimulates profuse vegetative reproduction, for example in *Themeda triandra* (Stuart-Hill & Mentis 1982).

Plant species have been classified according to their response to grazing which is in turn used to determine a veld condition score for veld condition assessment. The classification results in various forms of increaser and decreaser plant species. We look at an example of one such classification system. Van Rooyen et al. (1991) recognise five response types with examples from southern Kalahari savanna. (1) Species characteristic of under-utilised veld which decrease in frequency along the grazing gradient. These are usually absent from veld that is moderately to over-grazed (Decreaser species). An example is *Aristida meridionalis*. (2) Species rare or low in frequency in under-utilised veld, but which increase when the veld is lightly grazed. Moderate to heavy grazing decreases their numbers (Intermediate 1 species). An example is *Centropodia glauca*. (3) Species that rarely occur in lightly grazed veld but that increase in frequency when the veld is moderately or selectively grazed (Intermediate 2 species). An example is *Stipagrostis amabilis*. (4) Species that are rare in light to moderately grazed veld but that increase when the veld is fairly heavily grazed (Increaser species). An example is *Schmidtia kalahariensis*. (5) Species that are absent in lightly grazed veld but that become dominant in severely overgrazed veld (Encroacher species). An example is *Chamaesyce inaequilatera*. Van Rooyen et al. (1991) provide useful graphical representations of these five categories with many examples. The concept of decreaser and increaser plant categories has been applied in many other savanna areas (e.g. indicator species for Nylsvley Nature Reserve; Dörgeloh 1999a), also being related to preferred grazing areas (Wentzel et al. 1991).

There are of course also clear-cut benefits of animals to plants. The dependence of plants on animals includes pollinators. For instance in the KNP, honey bees are regarded as key pollinators without which many plant species would be dramatically reduced in abundance and distribution, if not become extinct (Braack & Kryger 2003). In contrast, fig wasps have an extraordinarily narrow and interdependent relationship with fig species (Naiman et al. 2003). Even giraffe are regarded as a pollinator of *Acacia nigrescens* potentially effective through a home range of more than 250 km^2 (Naiman et al. 2003). Dispersal of seeds of some species is effected by birds (Naiman et al. 2003). Mistletoes have a close relationship with birds, depending on them for pollination and for dispersal to suitable establishment sites on host trees (Kemp et al. 2003). Although the floras of the Kalahari savanna are considered to be mainly wind-dispersed, endozoochory is a primary or secondary dispersal mechanism in many plants (Milton & Dean 2001).

4.6 Management

Various tools have been developed to manage savanna, including a decision analysis approach (Norton & Walker 1985), range condition and grazing capacity assessment models (Steenekamp & Bosch 1995), and many others. To various degrees, these tools take into account the relations between trees and grass, tree and tree, animal and plant, and other issues described in the previous sections. However, they usually must add economic and logistical factors for practical application. There is also a bid to account for farming with game in developing these tools. There has been a great increase in game farming in South Africa in recent years following the earlier debates about the extent to which the increase in grass growth after bush clearing offsets the loss in edible and available browse (Walker 1976). Less commonly incorporated as an integrative tool are restoration interventions. Smit (2004) advocates that any restoration programme in savanna (chemical, mechanical or biological) of areas encroached by woody plants should focus on tree thinning rather than on clearing of all woody plants (but see Scholes 2003, section 4.2). It is important to achieve a balanced compromise between the reduction of the competitive effect of the trees on the herbaceous layer and the preservation of the positive influences that the trees may have, but there are divergent views on how to achieve this.

Barnes (1982) summarised various management options for utilisation of savanna in southern Africa for maximising animal production. These include intensifying secondary production through modification of the ecosystem so as to ensure the presence of the most desirable plants, and to create, within the limitations of the local environment, optimal conditions for plant growth. This includes the manipulation of the herbivore population for more efficient utilisation of the vegetation. Matching the animal population and the food supply includes consideration of multispecies herbivore populations or mixing domestic and wild ungulates. Introduction of selected pasture legumes in the herbaceous layer (as opposed to application of fertiliser) is likely to be successful only in higher-rainfall areas of savanna and is obviously one of the management options least compatible with nature conservation objectives. Control of animal distribution and management of grazing involves matters such as drinking water supplies, the feeding of supplements, and consideration of grazing management systems, including rotational grazing. Hadley (1985) gave an overview of resource management in savanna environments, including social perspectives. For further discussion of management issues, often on a biome basis, see extensive contributions by Tainton (1999).

In a situation very different from that of wishing to maximise animal production, the KNP has relatively recently adopted a system of adaptive ecosystem management (Strategic Adaptive Management; Biggs & Rogers 2003). This system embraces spatiotemporal heterogeneity and includes the concept of Thresholds of Potential Concern (TPCs), a set of operational goals that together define the spatiotemporal heterogeneity conditions for which the KNP ecosystem is managed. TPCs are defined as upper and lower levels along a continuum of change in selected environmental indicators. When this level is reached, or is predicted will be reached, it prompts an assessment of the causes of the change and forms a basis for deciding whether management action is needed to moderate the change. Policy has also recently shifted towards burning under diverse rather than fixed conditions (Van Wilgen et al. 2003). Patch mosaic burning is the current view as opposed to the previous quasi-agricultural block burning in KNP (Biggs 2003). Elephants with their possible ultimate 'major simplification of habitats' make management of elephant numbers a major topic of debate in wildlife systems (Whyte et al. 2003).

5. Conservation

There has been a substantial loss of savanna area due to cultivation, more so than other transformational land use practices. Most of the agricultural expansion took place before the 1960s, especially in the wetter eastern parts of the country (Biggs & Scholes 2002). Impacts have been analysed by various sources

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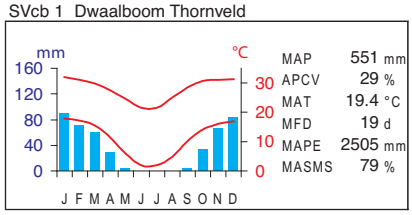
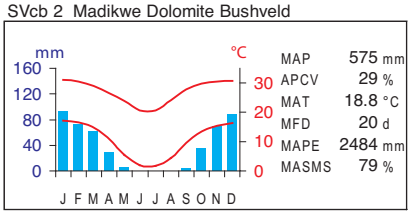
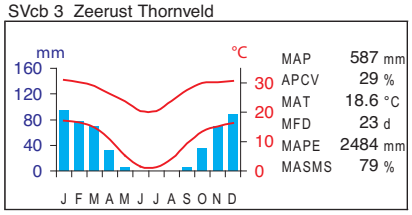


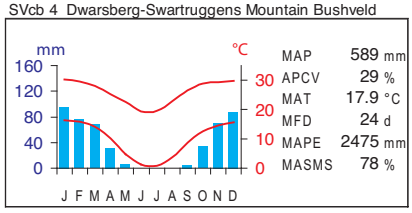
SVcb 2 Madikwe Dolomite Bushveld



SVcb 3 Zeerust Thornveld



SVcb 4 Dwarsberg-Swartruggens Mountain Bushveld



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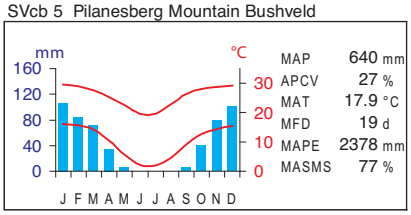

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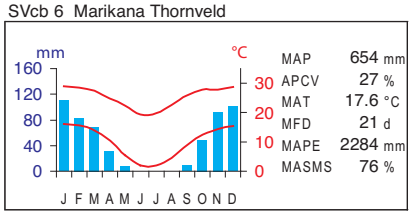
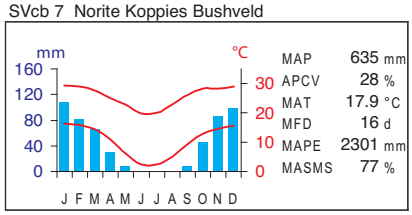


SVcb 7 Norite Koppies Bushveld



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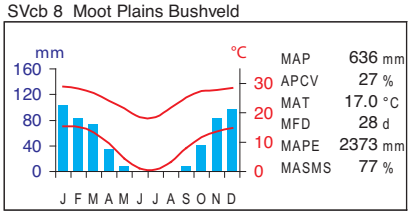

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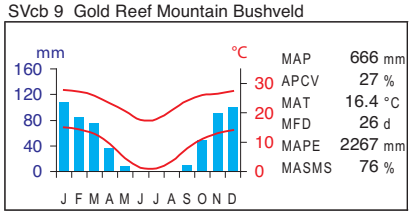

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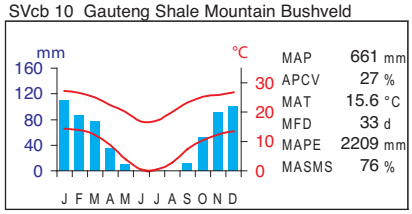

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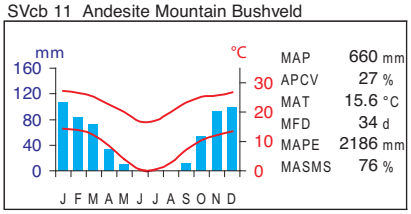

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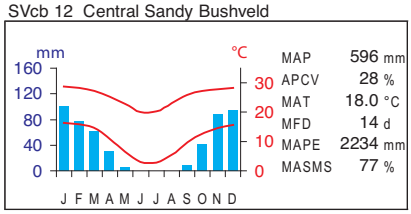

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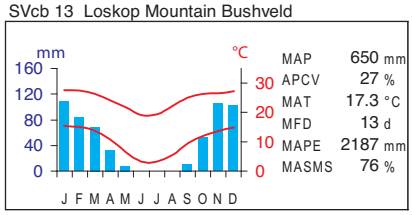

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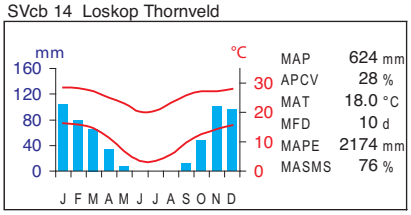

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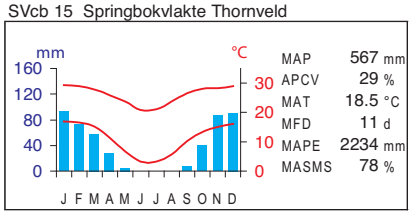

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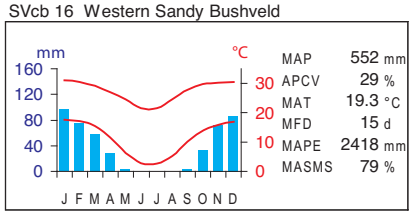

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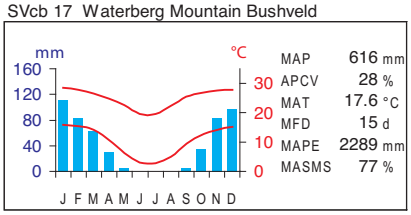

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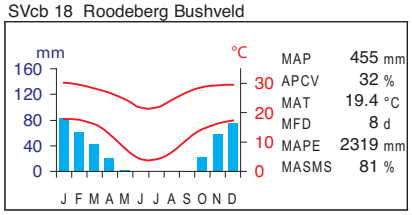

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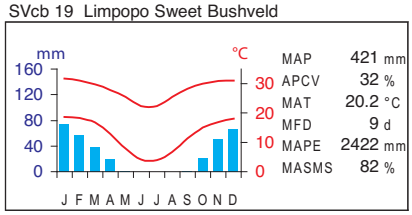
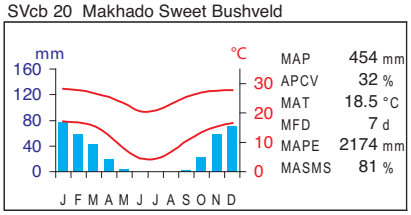
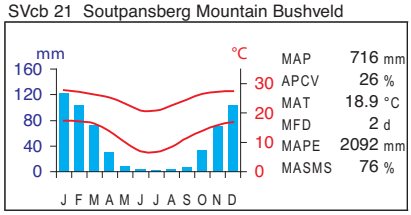


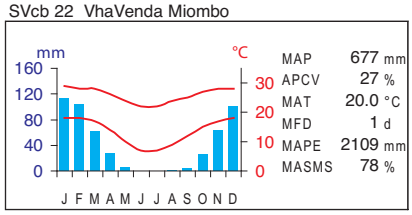
SVcb 20 Makhado Sweet Bushveld



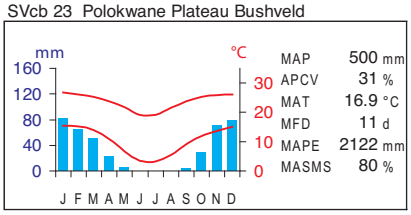
SVcb 21 Soutpansberg Mountain Bushveld



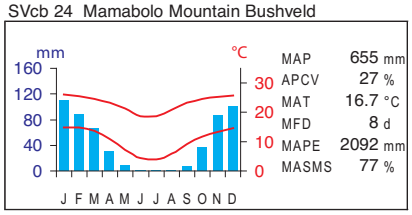
SVcb 22 VhaVenda Miombo



SVcb 23 Polokwane Plateau Bushveld



SVcb 24 Mamabolo Mountain Bushveld



that include the savanna areas (e.g. Thompson et al. 2001). Many aspects relating to conservation in savanna are expanded upon by Huntley (1989) and by Rebelo (1997), and it is clear that substantial progress has been made (also more recently) since the consideration of the state of nature conservation in southern Africa at a meeting held in Skukuza in 1976 (De Graaff & Van der Walt 1977).

Wessels et al. (2003) identified potential conflict areas between land transformation and biodiversity conservation in the north-eastern part of South Africa. This transformation deals with the change from natural vegetation to other land uses, such as crop cultivation and urban development. The analysis included the Lowveld and Mopane Savannas as well as most of the Central Bushveld and Sub-Escarpment Savannas. Potential future agricultural conflict areas include the Waterberg–Dwaalboom–Thabazimbi area where particularly within the valleys of the Waterberg (northern part of SVcb 12 Central Sandy Bushveld) there could be a threat to a unique area of significant conservation importance.

Climate change has been predicted to reduce the area of the Grassland Biome at the cost of expanding savanna vegetation in the northern and eastern sectors (Ellery et al. 1991). Three climate change scenarios (developed from GCMs and modelling a doubling of atmospheric CO_2 concentration) applied to South Africa (Rutherford et al. 1999a) indicated that the Savanna Biome might be less severely impacted than some other biomes further west. Kalahari is possibly the most vulnerable area. Individual species are likely to respond differently and it is possible that *Colophospermum mopane* might expand southwards in the lowveld into newly climatically suitable areas under projected climate change. Rutherford et al. (1999b) assigned the relative vulnerability of individual plant species of two national parks in the Savanna Biome to climate change. The number of species at risk of extinction in the Kgalagadi Transfrontier Park was marginally greater than that in the Vaalbos National Park.

Many plant species are specifically targeted by local communities for a wide range of uses not only for human application, but also for applying to livestock. For example, in a communal area in northern KwaZulu-Natal, farmers use *Cissus quadrangularis* for treating worm infestations and coughs, and *Sarcostemma viminale* for increasing milk production in their livestock (Kunene et al. 2003). Less abundant targeted species are obviously at risk of local extinction with sustained pressure of utilisation.

Alien plant species continue to pose a threat to areas of savanna although in areas such as the KNP (outside riverine habitats) this is sometimes localised, for instance along road verges (Freitag-Ronaldson & Foxcroft 2003). Indigenous woodland in the Kalahari has been found to support a significantly higher diversity of bird species than areas invaded by alien *Prosopis* species (Dean et al. 2002), confirming the conservational need for control of alien species. Threats are usually relative and can (sometimes correctly) divert resources for remedial action. In the Hluhluwe-iMfolozi Park in KwaZulu-Natal, the savanna was reported as less threatened than the adjacent riverine and forest-edge habitats (Macdonald 1983).

Research has included studies that point to specific actions, for example showing that cleared patches covered with grass litter experience the greatest colonisation of grasses (O'Connor 1991). More such explicit results are needed for rehabilitation programmes. But overall, there is a need to reach conservation goals more quickly to minimise losses in biodiversity (Reyers 2004).

For further information relating to conservation in savanna, see the chapters on Ecosystem Status and on Vulnerability of Vegetation Types in this book.

6. Further Research

Although there have been several earlier regional floristic accounts of savanna vegetation (e.g. Van der Schijff 1971, Van der Meulen 1978, Van der Meulen & Westfall 1979) and numerous more detailed surveys given in the references to the descriptions of each vegetation unit, the coverage is still very incomplete. Analysis of diversity patterns is, surprisingly, still in its infancy in savanna. Studies on demography of African savanna grasses are scant (O'Connor 1994), as for other savanna plant forms. Investigation of the full implications of the persistence niche of woody plants in savanna has barely started. We still have no idea of the true age structures of populations of such plants as opposed to the potentially misleading analyses of age (actually size) distributions based on above-ground plant parts only. A comprehensive model that explains both coexistence and the relative productivity of the tree and grass components across the diverse savannas of the world has yet to emerge (Sankaran et al. 2004).

As with many endeavours within the natural sciences, there is a clear need to integrate social and economic spheres into our current biophysical thinking (Biggs 2003) to ensure viable and sustainable systems of biodiversity and their associated ecosystem services in savannas.

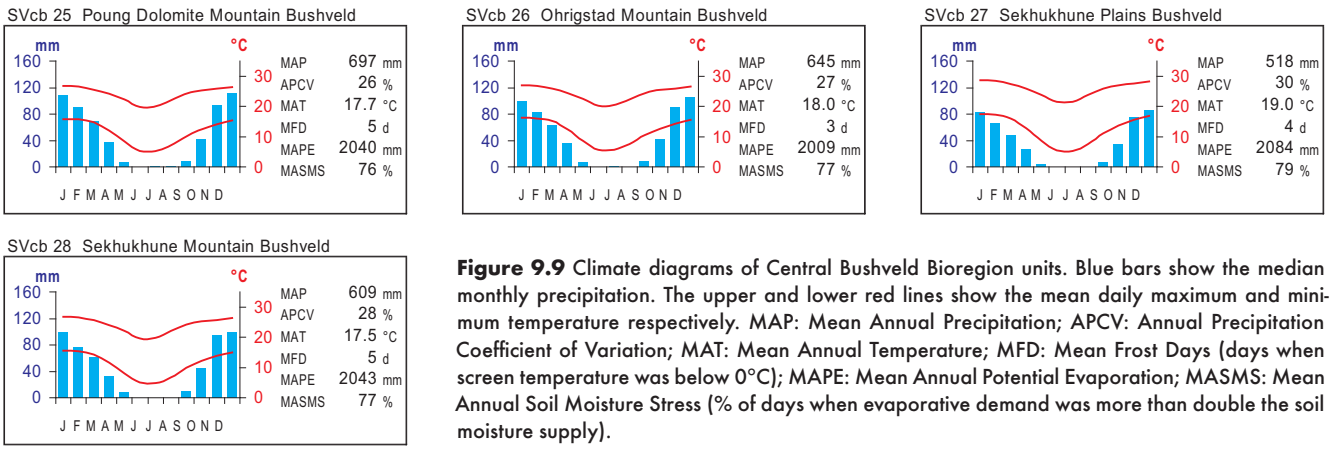


Figure 9.9 Climate diagrams of Central Bushveld Bioregion units. Blue bars show the median monthly precipitation. The upper and lower red lines show the mean daily maximum and minimum temperature respectively. MAP: Mean Annual Precipitation; APCV: Annual Precipitation Coefficient of Variation; MAT: Mean Annual Temperature; MFD: Mean Frost Days (days when screen temperature was below 0°C); MAPE: Mean Annual Potential Evaporation; MASMS: Mean Annual Soil Moisture Stress (% of days when evaporative demand was more than double the soil moisture supply).

7. Descriptions of Vegetation Units

Central Bushveld

SVcb 1 Dwaalboom Thornveld

VT 13 Other Turf Thornveld (58%) (Acocks 1953). LR 14 Clay Thorn Bushveld (48%), LR 18 Mixed Bushveld (43%) (Low & Rebelo 1996).

Distribution Limpopo and North-West Provinces: Flats north of the Dwarsberge and associated ridges mainly west of the Crocodile River in the Dwaalboom area but including a patch around Sentrum. South of the ridges it extends eastwards from the Nietverdiend area, north of the Pilanesberg to the Northam area. Altitude 900–1 200 m.

Vegetation & Landscape Features Plains with layer of scattered, low to medium high, deciduous microphyllous trees and shrubs with a few broad-leaved tree species, and an almost continuous herbaceous layer dominated by grass species. *Acacia tortilis* and *A. nilotica* dominate on the medium clays (at least 21% clay in the upper soil horizon but high in the lower horizons; Figure 9.10). On particularly heavy clays (>55% clay in all horizons) most other woody plants are excluded and the diminutive *A. tenuispina* dominates at a height of less than 1 m above ground (Figure 9.5). On the sandy clay loam soils (with not more than 35% clay in the upper horizon but high in the lower horizons) *A. erubescens* is the most prominent tree (Pauw 1988; Figure 9.6). The alternation of these substrate types creates a mozaic of patches typically 1–5 km across, for example in the unit west of Thabazimbi.

Geology & Soils Vertic black ultramafic clays which developed from norite and gabbro, also locally in small depressions along streams. Some areas have less clay. Some with high base status and eutrophic red soils. Underlying geology is an Archaean granite-gneiss terrane of the Swazian Erathem that is covered in parts by the mainly clastic as well as chemical sediments and volcanics of the Rayton and Silverton Formation, both of the Pretoria Group (Transvaal Supergroup). Mafic intrusive rocks of the Rustenburg Layered Suite, Bushveld Igneous Complex (Late Vaalian) are present in the east and include the Bierkraal Manetite Gabbro. Bronzite, harzburgite, norite and anorthosite are the major mafic rocks of the Rustenburg Suite. Land types mainly Ea and Ae.

Climate Summer rainfall with very dry winters. MAP ranges from about 500–600 mm. This unit has the highest mean annual potential evaporation of savanna vegetation units outside the two Kalahari bioregions. Frost is fairly frequent in winter. See also climate diagram for SVcb 1 Dwaalboom Thornveld.

Important Taxa Tall Tree: *Acacia erioloba*. Small Trees: *Acacia erubescens* (d), *A. nilotica* (d), *A. tortilis* subsp. *heteracantha* (d), *A. fleckii*, *A. mellifera* subsp. *detinens*, *Combretum imberbe*, *Rhus lancea*, *Ziziphus mucronata*. Tall Shrubs: *Acacia hebeclada* subsp. *hebeclada*, *Combretum hereroense*, *Diospyros lycioides* subsp. *lycioides*, *Euclea undulata*, *Grewia flava*, *Tarchonanthus camphoratus*. Low Shrubs: *Acacia tenuispina* (d), *Abutilon austro-africanum*, *Aptosimum elongatum*, *Hirpicium bechuanense*, *Pavonia burchellii*, *Solanum delagoense*. Succulent Shrubs: *Kalanchoe rotundifolia*, *Talinum caffrum*. Herbaceous Climber: *Rhynchosia minima*. Graminoids: *Aristida bipartita* (d), *Bothriochloa insculpta* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Ischaemum afrum* (d), *Panicum maximum* (d), *Cymbopogon pospischilii*, *Eragrostis curvula*, *Sehima galpinii*, *Setaria incrassata*. Herbs: *Heliotropium ciliatum*, *Kohautia caespitosa* subsp. *brachyloba*, *Nidorella hottentotica*.

Conservation Least threatened. Target 19%. Some 6% statutorily conserved, mostly within the Madikwe Game Reserve in the west. About 14% transformed mainly by cultivation. Erosion is very low to low. Main use is extensive cattle grazing.

Remarks Contains some very clayey soils that swell when wet and shrink when dry. On the clays, woody plant biomass is generally low and productivity of woody plants is usually lower than that of herbaceous plants. These areas with ultramafic soils are, contrary to Sekhukhuneland, low in species diversity and in endemic species.

References Coetzee (1971), Morris (1972), Van der Meulen (1979), Van der Meulen & Westfall (1980), Pauw (1988), Rutherford (1993), Winterbach (1998).

SVcb 2 Madikwe Dolomite Bushveld

VT 18 Mixed Bushveld (36%), VT 19 Sourish Mixed Bushveld (27%) (Acocks 1953). LR 18 Mixed Bushveld (78%) (Low & Rebelo 1996).

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Figure 9.10 SVcb 1 Dwaalboom Thornveld: *Acacia tortilis* trees and *Acacia tenuispina* low shrubs on medium clay soil, Steendal west-northwest of Dwaalboom, Limpopo Province.

Distribution North-West and Limpopo Provinces: Extends along the low ridge from the international border at Ramotswa in the west via the Rand Van Tweede Poort, Tlhapitse and Maakane to Modimong in the east. It is also found on dolomite hills between Assen and Northam. Altitude 1 000–1 300 m.

Vegetation & Landscape Features Gentle ridges and low hills up to about 100–150 m above the surrounding plains. Tree and shrub layers often not clearly distinct, especially on steeper slopes; they are dominated by deciduous trees, particularly *Combretum apiculatum* and *Kirkia wilmsii* (especially in the east). Herbaceous layer continuous, dominated by grasses.

Geology & Soils Stony, shallow soils of the Glenrosa and Mispah forms underlain mainly by dolomite, subordinate chert, minor carbonaceous shale, lime-

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Figure 9.11 SVcb 2 Madikwe Dolomite Bushveld: Tall *Combretum imberbe* and *Sclerocarya birrea* trees and smaller trees and shrubs of *C. apiculatum* on the Farm Abjaterskop with the vegetation type extending over the hill of Abjaterskop in the northern Marico District.

stone and quartzite of the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup, Vaalian Erathem). Land type is mainly Fa.

Climate Summer rainfall with very dry winters. MAP from about 520 mm in the west to 650 mm in the east. Frost fairly frequent in winter. See also climate diagram for SVcb 2 Madikwe Dolomite Bushveld.

Important Taxa Tall Tree: *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Combretum apiculatum* (d), *Kirkia wilmsii* (d), *Ozoroa paniculosa* (d), *Rhus lancea* (d), *Combretum imberbe*, *Rhus leptodictya*, *Ximenia americana*, *Ziziphus mucronata*. Tall Shrubs: *Grewia flava* (d), *Tarchonanthus camphoratus* (d), *Vitex zeyheri* (d), *Clerodendrum glabrum*, *Grewia bicolor*, *G. monticola*. Graminoids: *Enneapogon scoparius* (d), *Heteropogon contortus* (d), *Aristida congesta*, *Panicum coloratum*, *P. maximum*.

Conservation Least threatened. Target 19%. Some 17% statutorily conserved in the Madikwe Nature Reserve. Only 1% transformed mostly by cultivation. Erosion is low to very low.

Remarks Some species distributions are associated with the east-west climatic gradient, for example *Kirkia wilmsii* is restricted to the eastern parts of the unit. In contrast to bush encroachment seen on the red clay loams surrounding this unit, the rocky soils of dolomitic origin support a more open canopy structure (Hudak & Wessman 2001).

References Zacharias (1994), Hudak & Wessman (2001).

SVcb 3 Zeerust Thornveld

VT 19 Sourish Mixed Bushveld (56%) (Acocks 1953). LR 18 Mixed Bushveld (55%) (Low & Rebelo 1996).

Distribution North-West Province: Extends along the plains from the Lobatsi River in the west via Zeerust, Groot Marico and Mabaalstad to the flats between the Pilanesberg and western end of the Magaliesberg in the east (including the valley of the lower Selons River). Altitude mainly 1 000–1 250 m.

Vegetation & Landscape Features Deciduous, open to dense short thorny woodland, dominated by *Acacia* species with herbaceous layer of mainly grasses on deep, high base-status and some clay soils on plains and lowlands, also between rocky ridges of SVcb 4 Dwarsberg-Swartruggens Mountain Bushveld.

Geology & Soils Sediments of the Pretoria Group (Transvaal Supergroup) in this area, particularly the Silverton and Rayton Formations, are mostly shale with less quartzite and conglomerate. Carbonates, volcanic rocks, breccias and diamictites also occur in the Pretoria Group. Bronzite, harzburgite, gabbro and norite of the Rustenburg Layered Suite (Bushveld Igneous Complex) are also found. Soils are mostly deep, red-yellow, apedal, freely drained with high base status also with some vertic or melanic clays. Land types mainly Ae and Ea.

Climate Summer rainfall with very dry winters. MAP has a relatively narrow range: 550–600 mm. Frost fairly frequent in winter. Mean monthly maximum and minimum temperatures for Marico-Irr weather station 36.7°C and –0.4°C for January and June, respectively. See also climate diagram for SVcb 3 Zeerust Thornveld.

Important Taxa Tall Trees: *Acacia burkei* (d), *A. erioloba* (d). Small Trees: *Acacia mellifera* subsp. *detinens* (d), *A. nilotica* (d), *A. tortilis* subsp. *heteracantha* (d), *Rhus lancea* (d), *Acacia fleckii*, *Peltophorum africanum*, *Terminalia sericea*. Tall Shrubs: *Diospyros lycioides* subsp. *lycioides*, *Grewia flava*, *Mystroxylon aethiopicum* subsp. *burkeanum*. Low Shrubs: *Agathisanthemum bojeri*, *Chaetacanthus costatus*, *Clerodendrum ternatum*, *Indigofera filipes*, *Rhus grandidens*, *Sida chrysantha*, *Stylosanthes fruticosa*. Graminoids: *Eragrostis lehmanniana* (d), *Panicum maximum* (d), *Aristida congesta*, *Cymbopogon pospischilii*. Herbs: *Blepharis*

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Figure 9.12 SVcb 3 Zeerust Thornveld: Moderately dense bushveld dominated by *Acacia tortilis* in the valley of the Doring River on Rykvoorby north of Zeerust, North-West Province.

integrifolia, *Chamaecrista absus*, *C. mimosoides*, *Cleome maculata*, *Dicoma anomala*, *Kyphocarpa angustifolia*, *Limeum viscosum*, *Lophiocarpus tenuissimus*.

Endemic Taxon Low Shrub: *Rhus maricoana*.

Conservation Least threatened. Target 19%. Less than 4% statutorily conserved, spread between four reserves including the Pienaar and Marico Bushveld Nature Reserves. Some 16% transformed mainly by cultivation, with some urban or built-up. A few areas with scattered plants of the alien *Cereus jamacaru* and several other alien species very scattered elsewhere. Erosion is mainly very low to low.

Remark This unit is somewhat more temperate than the SVcb 1 Dwaalboom Thornveld that borders it to the north.

References Van Wyk (1959), Van der Meulen (1979), Van der Meulen & Westfall (1980), Malan & Van Niekerk (2005).

SVcb 4 Dwarsberg-Swartruggens Mountain Bushveld

VT 19 Sourish Mixed Bushveld (80%) (Acocks 1953). LR 18 Mixed Bushveld (87%) (Low & Rebelo 1996).

Distribution North-West Province: Occurs on hills and ridges east of the Lobatsi River through the Zeerust and the Swartruggens areas to Mabeskraal and the Selons River Valley in the east. Also occurs on the parallel ridges of the Dwarsberge from Witkleigat in the west to the hills of the Dwarsberg area in the east. Altitude about 1 000–1 500 m.

Vegetation & Landscape Features Rocky low to medium high hills and ridges with some steep faces in places. Height above the surrounding plains can reach about 300 m. Variable vegetation structure depending on slope, exposure, aspect and local habitat—various combinations of tree and shrub layers often with dense grass layer. Bush clumps also occur.

Geology & Soils Shales, quartzites and andesites of the Pretoria Group (Transvaal Supergroup) with stony shallow soils of the Glenrosa and Mispah soil forms, with some deep, freely drained soils. Land types mainly Fb, Ib and Ae.

Climate Summer rainfall with very dry winters. MAP from about 550–650 mm. Frost fairly frequent in winter in lower-lying areas, less so on the hills. Mean monthly maximum and minimum temperatures for Lindleyspoort-Irr weather station 35.2°C and –0.4°C for January and June, respectively. See also climate diagram for SVcb 4 Dwarsberg-Swartruggens Mountain Bushveld.

Important Taxa Tall Tree: *Acacia robusta* (d). Small Trees: *Acacia caffra* (d), *A. erubescens* (d), *Burkea africana* (d), *Combretum apiculatum* (d), *Faurea saligna* (d), *Protea caffra* (d), *Combretum imberbe*, *C. molle*, *Cussonia paniculata*, *C. transvaalensis*, *Dombeya rotundifolia*, *Ozoroa paniculosa*, *Pappea capensis*, *Peltophorum africanum*, *Spirostachys africana*, *Vangueria infausta*, *Ziziphus mucronata*. Succulent Tree: *Aloe marlothii* subsp. *marlothii* (d). Tall Shrubs: *Dichrostachys cinerea* (d), *Croton pseudopulchellus*, *Ehretia rigida* subsp. *rigida*, *Grewia flava*, *Mundulea sericea*, *Tarchonanthus camphoratus*, *Vitex zeyheri*. Low Shrubs: *Athrixia elata*, *Pavonia burchellii*, *Rhus magalismontana* subsp. *magalismontana*, *R. rigida* var. *rigida*. Woody Climber: *Asparagus africanus*. Graminoids: *Aristida canescens* (d), *Cenchrus ciliaris* (d), *Chrysopogon serrulatus* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Enneapogon scoparius* (d), *Loudetia simplex* (d), *Schizachyrium sanguineum* (d), *Setaria lindenbergiana* (d), *Bewsia biflora*, *Bothriochloa insculpta*, *Cymbopogon caesius*, *C. pospischilii*, *Elionurus muticus*, *Eragrostis rigidior*, *Fingerhuthia africana*, *Heteropogon contortus*, *Melinis nerviglumis*, *Panicum maximum*, *Setaria sphacelata*, *Themeda triandra*, *Trachypogon spicatus*, *Tristachya biseriata*. Herbs: *Barleria macrostegia*, *Commelina africana*, *Hermannia depressa*, *Senecio venosus*. Geophytic Herbs: *Hypoxis hemerocallidea*, *Pellaea calomelanos*, *Tritonia nelsonii*.

Biogeographically Important Taxon (Central Bushveld endemic) Tall Shrub: *Erythrophysa transvaalensis*.

Endemic Taxon Succulent Shrub: *Euphorbia perangusta*.

Conservation Least threatened. Target 24%. Less than 2% statutorily conserved, mainly in the Marico Bushveld Nature Reserve. Some 7% transformed, mainly by cultivation. Aliens include scattered *Cereus jamacaru* and *Acacia mearnsii* in few areas. Erosion is mainly very low to low.

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Figure 9.13 SVcb 4 Dwarsberg-Swartruggens Mountain Bushveld: Northwestern slopes with *Vangueria infausta*, *Dombeya rotundifolia*, *Acacia caffra* and *Rhus* species in the foreground, on Sephton's Nek, north of Zeerust.

Remarks This vegetation has some similarities with the SVcb 9 Gold Reef Mountain Bushveld to the east but is drier and warmer than this unit. The unit extends into Botswana, for example on the hills around Lobatse.

References Van der Meulen (1979), Zacharias (1994), Bredenkamp (1999).

SVcb 5 Pilanesberg Mountain Bushveld

VT 20 Sour Bushveld (83%) (Acocks 1953). LR 18 Mixed Bushveld (100%) (Low & Rebelo 1996).

Distribution North-West Province: Hills and mountains immediately north of Sun City and west of Heystekrand (Mankwe District). Altitude about 1 100–1 500 m.

Vegetation & Landscape Features A near circular (diameter 23–27 km) complex constituting an intrusive and extrusive massif with the original volcanic caldera almost eroded away leaving a broken ring of hills and low mountains as

L. Mucina

Figure 9.14 SVcb 5 Pilanesberg Mountain Bushveld: Bushveld with *Combretum molle* on south-facing slopes above Mankwe Dam in the centre of the Pilanesberg Game Reserve.

well as the eroded intrusions of the core remaining in the form of many hills and low mountains. Valley floors between the hills and mountains tend to be at most 1–2 km wide. Broad-leaved deciduous bushveld with trees and shrubs with grass layer on slopes of mountains and hills, with mountain summits more grassy and valley floors sometimes less woody but the latter may be related to past disturbance (see section on Conservation below).

Geology & Soils The alkaline complex consists of potassium- and sodium-rich, silica-poor rocks, mainly foyaite, lava and tuff with some syenite. Wide range of elements found, particularly rare earth elements and fluorine in the form of CaF_2 (flourite). Due to the original volcanic actions, subsequent fracturing, emplacement of intrusions, collapse and resurgence of magma and radial emplacement of dykes, a complex geological pattern exists. Pilanesberg is one of the very few large alkaline ring complexes in the world, approximately 1.3 gya old. Soils are shallow, rocky lithosols on the hills and mountains of the Glenrosa and Mispah soil forms, but with deeper soils on the valley floors. Land type is mostly Ib.

Climate Summer rainfall with very dry winters. MAP from about 600–700 mm. Frost fairly frequent in winter in lower-lying areas, less so on the hills. Mean monthly maximum and minimum temperatures for Manyane Gate (eastern entrance to Pilanesberg Game Reserve) 36.7°C and –2.2°C for February and July, respectively. See also climate diagram for SVcb 5 Pilanesberg Mountain Bushveld.

Important Taxa Small Trees: *Combretum apiculatum* (d), *C. molle* (d), *C. zeyheri* (d), *Strychnos cocculoides* (d), *Croton gratissimus*, *Englerophytum magalismontanum*, *Rhus leptodictya*, *Vangueria parvifolia*. Tall Shrubs: *Diplorhynchus condylocarpon* (d), *Elephantorrhiza burkei* (d), *Grewia flava*, *Hibiscus calyphyllus*, *Mundulea sericea*, *Steganotaenia araliacea*, *Vitex rehmannii*. Low Shrub: *Polygala hottentotta*. Graminoids: *Chrysopogon serrulatus* (d), *Elionurus muticus* (d), *Panicum maximum* (d), *Themeda triandra* (d), *Enneapogon scoparius*, *Hyperthelia dissoluta*, *Panicum deustum*. Herbs: *Abutilon pycnodon*, *Chamaesyce inaequilatera*, *Hermannia depressa*, *Nidorella resedifolia*, *Xerophyta retinervis*. Succulent Herb: *Crassula lanceolata* subsp. *transvaalensis*.

Biogeographically Important Taxon (Central Bushveld endemic) Tall Shrub: *Erythrophysa transvaalensis*.

Conservation Least threatened. Target of 24% exceeded, with 96% statutorily conserved in the Pilanesberg Game Reserve. Almost 2% transformed, mainly by urban development on the periphery. Prior to the proclamation of the reserve in 1979 some of the area had been intensively farmed and included some bush-clearing. Some of these areas are still visible, for example high grass cover and low tree cover in the lowlands. A few old mining sites occur. There are some scattered alien plant populations of *Cereus jamacaru*. Erosion is very low.

Remarks This unit is a meeting ground for several species of *Grewia*, for example northwestern limits of *G. occidentalis*, southwestern limits of *G. monticola* and *G. hexamita* and southeastern limits of *G. retinervis*. The vegetation of the southern slopes of this unit is similar to that of the southern slopes of the northeastern end of the Magaliesberg (SVcb 9 Gold Reef Mountain Bushveld) whereas the northern slopes of the two units have distinct physiognomic differences (Van Wyk 1959).

Reference Van Wyk (1959).

SVcb 6 Marikana Thornveld

VT 19 Sourish Mixed Bushveld (46%), VT 13 Other Turf Thornveld (34%) (Acocks 1953). LR 14 Clay Thorn Bushveld (60%) (Low & Rebelo 1996).

Distribution North-West and Gauteng Provinces: Occurs on plains from the Rustenburg area in the west, through Marikana and Brits to the Pretoria area in the east. Altitude about 1 050–1 450 m.

Vegetation & Landscape Features Open *Acacia karroo* woodland, occurring in valleys and slightly undulating plains, and some lowland hills. Shrubs are more dense along drainage lines, on termitaria and rocky outcrops or in other habitat protected from fire.

Geology & Soils Most of the area is underlain by the mafic intrusive rocks of the Rustenburg Layered Suite of the Bushveld Igneous Complex. Rocks include gabbro, norite, pyroxenite and anorthosite. The shales and quartzites of the Pretoria Group (Transvaal Supergroup) also contribute. Mainly vertic melanic clays with some dystrophic or mesotrophic plinthic catenas and some freely drained, deep soils. Land types mainly Ea, Ba and Ae.

Climate Summer rainfall with very dry winters. MAP between about 600 and 700 mm. Frost fairly frequent in winter. Mean monthly maximum and minimum temperatures for Brits-Agr 35.3°C and –3.3°C for January and June, respectively. Corresponding values are 35.3°C and –1.4°C for Rustenberg (November and July) and 32.8°C and –1.0°C for Pretoria University Experimental Farm (January and July). This unit has a relatively more temperate climate than the SVcb 1 Dwaalboom Thornveld. See also climate diagram for SVcb 6 Marikana Thornveld.

L. Mucina

Figure 9.15 SVcb 6 Marikana Thornveld: *Acacia nilotica*-dominated clay thornveld north of Pretoria (near Ga-Rankuwa, Gauteng) after recent fire.

SVcb 7 Norite Koppies Bushveld

VT 19 Sourish Mixed Bushveld (82%) (Acocks 1953). LR 14 Clay Thorn Bushveld (87%) (Low & Rebelo 1996). *Croton gratissimus–Setaria lindenbergiana* Woodland (Van der Meulen 1979).

Distribution North-West and Gauteng Provinces: Embedded in Marikana Thornveld, north of the Magaliesberg, on rocky hills between Rustenburg and Pretoria with the highest hills (e.g. Kareepoortberg) near Brits. Altitude about 1 100–1 350 m.

Vegetation & Landscape Features A low, semi-open to closed woodland up to 5 m tall, consisting of dense deciduous shrubs and trees with very sparse undergrowth on shallow soils, with large areas not covered by vegetation. Tree and shrub layers are continuous. The stands of this unit are found on noritic outcrops and koppies, many appearing as inselbergs above the surrounding plains.

Geology & Soils Mostly gabbro and norite with interlayered anorthosite of the Pyramid Gabbro-Norite, Rustenburg Layered Suite, with a small area of the Rashoop Granophyre Suite (felsic igneous rocks), both of the Bushveld Complex (Vaalian). Large rock boulders and very shallow lithosols occur. Soils are well-drained, Glenrosa and Mispah forms; in some areas vertic, melanic clays are found as well. Land types mainly Ib, with some Ea also occurring.

Climate Summer rainfall with dry winters. MAP from 600–700 mm. Frost fairly frequent around the base of hills in winter but less so on the hills. See also climate diagram for SVcb 7 Norite Koppies Bushveld.

Important Taxa Tall Tree: *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Combretum molle* (d), *Croton gratissimus* (d), *Ficus abutilifolia* (d), *Pappea capensis* (d), *Acacia caffra*, *Bridelia mollis*, *Combretum apiculatum*, *Cussonia paniculata*,

Important Taxa Tall Tree: *Acacia burkei*. Small Trees: *Acacia caffra* (d), *A. gerrardii* (d), *A. karroo* (d), *Combretum molle* (d), *Rhus lancea* (d), *Ziziphus mucronata* (d), *Acacia nilotica, A. tortilis* subsp. *heteracantha*, *Celtis africana*, *Dombeya rotundifolia*, *Pappea capensis*, *Peltophorum africanum*, *Terminalia sericea*. Tall Shrubs: *Euclea crispa* subsp. *crispa* (d), *Olea europaea* subsp. *africana* (d), *Rhus pyroides* var. *pyroides* (d), *Diospyros lycioides* subsp. *guerkei*, *Ehretia rigida* subsp. *rigida*, *Euclea undulata*, *Grewia flava*, *Pavetta gardeniifolia*. Low Shrubs: *Asparagus cooperi* (d), *Rhynchosia nitens* (d), *Indigofera zeyheri*, *Justicia flava*. Woody Climbers: *Clematis brachiata* (d), *Helinus integrifolius*. Herbaceous Climbers: *Pentarrhinum insipidum* (d), *Cyphostemma cirrhosum*. Graminoids: *Elionurus muticus* (d), *Eragrostis lehmanniana* (d), *Setaria sphacelata* (d), *Themeda triandra* (d), *Aristida scabrivalvis* subsp. *scabrivalvis*, *Fingerhuthia africana*, *Heteropogon contortus*, *Hyperthelia dissoluta*, *Melinis nerviglumis*, *Pogonarthria squarrosa*. Herbs: *Hermannia depressa* (d), *Ipomoea obscura* (d), *Barleria macrostegia*, *Dianthus mooiensis* subsp. *mooiensis*, *Ipomoea oblongata*, *Vernonia oligocephala*. Geophytic Herbs: *Ledebouria revoluta*, *Ornithogalum tenuifolium*, *Sansevieria aethiopica*.

Conservation Endangered. Target 19%. Less than 1% statutorily conserved in, for example, Magaliesberg Nature Area. More conserved in addition in other reserves, mainly in De Onderstepoort Nature Reserve. Considerably impacted, with 48% transformed, mainly cultivated and urban or built-up areas. Most agricultural development of this unit is in the western regions towards Rustenburg, while in the east (near Pretoria) industrial development is a greater threat of land transformation. Erosion is very low to moderate. Alien invasive plants occur localised in high densities, especially along the drainage lines.

Remark A few small ridges of SVcb 9 Gold Reef Mountain Bushveld in the Pretoria area have not been mapped separately from this unit.

References Van der Meulen (1979), Van Rooyen (1983, 1984), Panagos et al. (1998).

L. Mucina

Figure 9.16 SVcb 7 Norite Koppies Bushveld: Small norite koppie overlooking plains covered with Marikana Thornveld northeast of Rustenburg, North-West Province.

Dombeya rotundifolia, *Faurea saligna*, *Ficus glumosa*, *Lannea discolor*, *Obetia tenax*, *Peltophorum africanum*, *Rhus leptodictya*, *Vangueria infausta*, *Ziziphus mucronata*. Succulent Tree: *Euphorbia cooperi*. Tall Shrubs: *Triaspis glaucophylla* (d), *Canthium gilfillanii*, *Clerodendrum glabrum*, *Diplorhynchus condylocarpon*, *Euclea natalensis*, *Grewia flavescens*, *G. monticola*, *Gymnosporia nemorosa*, *G. polyacantha*, *Pavetta eylesii*, *Pouzolzia mixta*, *Psydrax livida*, *Vitex zeyheri*. Low Shrubs: *Jatropha latifolia* var. *latifolia* (d), *Abutilon austro-africanum*, *Hermannia floribunda*, *Hibiscus subreniformis*, *Rhus zeyheri*. Succulent Shrub: *Tetradenia brevispicata*. Semiparasitic Shrub: *Osyris lanceolata*. Woody Climbers: *Helinus integrifolius*, *Rhoicissus tridentata*, *Turraea obtusifolia*. Woody Succulent Climber: *Sarcostemma viminale*. Herbaceous Climber: *Cyphostemma lanigerum*. Graminoids: *Chrysopogon serrulatus* (d), *Setaria lindenbergiana* (d), *Aristida congesta*, *Bulbostylis humilis*, *Eustachys paspaloides*, *Heteropogon contortus*, *Loudetia simplex*, *Melinis nerviglumis*, *Panicum maximum*, *Themeda triandra*. Herb: *Hibiscus sidiformis*. Geophytic Herbs: *Pellaea calomelanos*, *P. viridis*, *Scadoxus puniceus*.

M.C. Rutherford

Figure 9.17 SVcb 8 Moot Plains Bushveld: *Rhus lancea* and *Acacia nilotica* dominant on flats at an altitude of 1 325 m at Hekpoort, west of Pretoria.

Conservation Least threatened according to remote sensing data, but ground truthing suggests that it is rather susceptable. Target 24%. None conserved in statutory reserves but 4% conserved in De Onderstepoort Nature Reserve. About 10% transformed (but more recent assessment suggests about 20%), especially at the unit fringes, mainly by mining as well as urban and built-up developments and cultivated areas. Mining is primarily in the form of granite quarries on koppies, but also affects surrounding lower-lying areas. Areas close to human settlements are often severely disturbed and many woody species may have been harvested from these areas for fuel or building materials. Weeds, including a number of declared aliens, are more common in these disturbed sites. Erosion is very low to moderate.

Remarks Vegetation patterns on norite koppies are primarily determined by the amount of rockiness and aspect, warmer north-facing slopes and cooler south-facing slopes bearing floristically distinct vegetation. A number of the woody species, e.g. species of *Ficus*, are typical chasmophytes, penetrating the rocks with their roots (Van der Meulen 1979). The vegetation unit is transitional between xeric lowland bushveld and mesophyllous woodland in cooler more moist upland areas associated with the Magaliesberg and may be considered to be a more xeric phase of these upland areas (Van der Meulen 1979).

References Van der Meulen (1979), Panagos (1996).

SVcb 8 Moot Plains Bushveld

VT 19 Sourish Mixed Bushveld (57%) (Acocks 1953). LR 18 Mixed Bushveld (83%) (Low & Rebelo 1996).

Distribution North-West and Gauteng Provinces: Main belt occurs immediately south of the Magaliesberg from the Selons River Valley in the west through Maanhaarrand, filling the valley bottom of the Magalies River, proceeding east of the Hartebeestpoort Dam between the Magaliesberg and Daspoort mountain ranges to Pretoria. It also occurs as a narrow belt immediately north of the Magaliesberg from Rustenburg in the west to just east of the Crocodile River in the east: also south of the Swartruggens–Zeerust line. Altitude typically about 1 050–1 450 m.

Vegetation & Landscape Features Open to closed, low, often thorny savanna dominated by various species of *Acacia* in the bottomlands and plains as well as woodlands of varying height and density on the lower hillsides. Herbaceous layer is dominated by grasses.

Geology & Soils Clastic sediments and minor carbonates and volcanics of the Pretoria Group (including the Silverton Formation) and some Malmani dolomites in the west, all of the Transvaal Supergroup (Vaalian). There is also some contribution from mafic Bushveld intrusives. Soils often stony with colluvial clay-loam but varied, including red-yellow apedal freely drained, dystrophic and eutrophic plinthic catenas, vertic and melanic clays, and some less typical Glenrosa and Mispah forms. Land types Ae, Ba, Ea, Bc, Ac and less typically Fb.

Climate Summer rainfall with very dry winters. MAP from about 55 mm in the west to about 700 mm in the east. Frost frequent in winter. Mean monthly maximum and minimum temperatures for Pretoria-Pur 33.6°C and –3.1°C for January and June, respectively. See also climate diagram for SVcb 8 Moot Plains Bushveld.

Important Taxa Small Trees: *Acacia nilotica* (d), *A. tortilis* subsp. *heteracantha* (d), *Rhus lancea* (d). Tall Shrubs: *Buddleja saligna* (d), *Euclea undulata* (d), *Olea europaea* subsp. *africana* (d), *Grewia occidentalis*, *Gymnosporia polyacantha*, *Mystroxylon aethiopicum* subsp. *burkeanum*. Low Shrubs: *Aptosimum elongatum*, *Felicia fascicularis*, *Lantana rugosa*, *Teucrium trifidum*. Succulent Shrub: *Kalanchoe paniculata*. Woody Climber: *Jasminum breviflorum*. Herbaceous Climber: *Lotononis bainesii*. Graminoids: *Heteropogon contortus* (d), *Setaria sphacelata* (d), *Themeda triandra* (d), *Aristida congesta*, *Chloris virgata*, *Cynodon dactylon*, *Sporobolus nitens*, *Tragus racemosus*. Herbs: *Achyropsis avicularis*, *Corchorus asplenifolius*, *Evolvulus alsinoides*, *Helichrysum nudifolium*, *H. undulatum, Hermannia depressa*, *Osteospermum muricatum*, *Phyllanthus maderaspatensis*.

Conservation Vulnerable. Target 19%. Some 13% statutorily conserved mainly in the Magaliesberg Nature Area. About 28% transformed mainly by cultivation and urban and built-up areas. Very scattered occurrences to sometimes dense patches in places of various alien plants including *Cereus jamacaru*, *Eucalyptus* species, *Jacaranda mimosifolia*, *Lantana camara*, *Melia azedarach* and *Schinus* species. Erosion is mainly very low to low, moderate in some areas.

References Coetzee (1975), Van der Meulen (1979).

SVcb 9 Gold Reef Mountain Bushveld

VT 61 Bankenveld (50%) (Acocks 1953). LR 18 Mixed Bushveld (44%), LR 34 Rocky Highveld Grassland (43%) (Low & Rebelo 1996).

M.C. Rutherford

Figure 9.18 SVcb 9 Gold Reef Mountain Bushveld: *Protea caffra* and the dominant *Acacia caffra* on the southern slopes of the Magaliesberg at an altitude of 1 655 m in the Magaliesberg Conservation Area, north of Boschfontein and southeast of Rustenburg.

Distribution North-West, Gauteng, Free State and Mpumalanga Provinces: Occurs along rocky quartzite ridges of the Magaliesberg and the parallel ridge to the south, from around Boshoek and Koster in the west to near Bronkhorstspruit in the east. The west-east-trending ridge of the Witwatersrand from around Krugersdorp in the west, through Roodepoort and Johannesburg to Bedfordview (Germiston District). Inner ridges (e.g. Dwarsberg and Witkop) of the Vredefort Dome on the Vaal River northwest of Parys and part of the Suikerbosrand and some other hills around Heidelberg. Altitude 1 200–1 750 m.

Vegetation & Landscape Features Rocky hills and ridges often west-east trending with more dense woody vegetation often on the south-facing slopes associated with distinct floristic differences (e.g. preponderance of *Acacia caffra* on the southern slopes). Tree cover elsewhere is variable. Tree and shrub layers are often continuous. Herbaceous layer is dominated by grasses.

Geology & Soils This area consists predominantly of quartzites, conglomerates and some shale horizons of the Magaliesberg, Daspoort and Silverton Formations (Vaalian Pretoria Group) and the Hospital Hill, Turffontein and Government Subgroups (Randian Witwatersrand Supergroup). Soils are shallow, gravel lithosols of the Mispah and Glenrosa forms. Land types mainly Ib and Fb.

Climate Summer rainfall with very dry winters. MAP about 600–750 mm. Frost frequent in winter (especially in the south), but less common on the ridges and hills. Mean monthly maximum and minimum temperatures for Krugersdorp 30.8°C and –1.8°C for January and July, respectively. See also climate diagram for SVcb 9 Gold Reef Mountain Bushveld.

Important Taxa Small Trees: *Acacia caffra* (d), *Combretum molle* (d), *Protea caffra* (d), *Celtis africana*, *Dombeya rotundifolia*, *Englerophytum magalismontanum*, *Ochna pretoriensis*, *Rhus leptodictya*, *Vangueria infausta*, *V. parvifolia*, *Ziziphus mucronata*. Tall Shrubs: *Canthium gilfillanii*, *Ehretia rigida* subsp. *rigida*, *Grewia occidentalis*, *Gymnosporia buxifolia*, *Mystroxylon aethiopicum* subsp. *burkeanum*. Low Shrubs: *Athrixia elata*, *Pearsonia cajanifolia*, *Rhus magalismontana* subsp. *magalismontana*, *R. rigida* var. *rigida*. Woody Climber: *Ancylobotrys capensis*. Graminoids: *Loudetia simplex* (d), *Panicum natalense* (d), *Schizachyrium sanguineum* (d), *Trachypogon spicatus* (d), *Alloteropsis semialata* subsp. *eckloniana*, *Bewsia biflora*, *Digitaria tricholaenoides*, *Diheteropogon amplectens*, *Sporobolus pectinatus*, *Tristachya biseriata*, *T. leucothrix*. Herbs: *Helichrysum nudifolium*, *H. rugulosum*, *Pentanisia angustifolia*, *Senecio venosus*, *Xerophyta retinervis*. Geophytic Herbs: *Cheilanthes hirta*, *Hypoxis hemerocallidea*, *Pellaea calomelanos*.

Endemic Taxa Succulent Shrub: *Aloe peglerae.* Succulent Herb: *Frithia pulchra*.

Conservation Least threatened. Target 24%. Some 22% statutorily conserved mainly in the Magaliesberg Nature Area and much smaller proportions in the Rustenberg, Wonderboom and Suikerbosrand Nature Reserves. At least an additional 1% conserved in other reserves brings the total conserved very close to target. About 15% transformed mainly by cultivation and urban and built-up areas. Some areas with dense stands of the alien *Melia azedarach* but which is often associated with drainage lines or alluvia (i.e. azonal vegetation) embedded within this unit. Erosion is very low to low.

Remark A few small ridges of this unit in the Pretoria area have not been mapped.

References Van Vuuren & Van der Schijff (1970), Bredenkamp (1975), Coetzee (1975), Bredenkamp (1977), Bredenkamp & Theron (1978), Behr & Bredenkamp (1988), Bezuidenhout et al. (1988), Du Preez & Venter (1990), Coetzee et al. (1993), Bezuidenhout et al. (1994), Coetzee et al. (1994, 1995), Grobler et al. (2002).

SVcb 10 Gauteng Shale Mountain Bushveld

VT 61 Bankenveld (98%) (Acocks 1953). LR 34 Rocky Highveld Grassland (85%) (Low & Rebelo 1996).

Distribution Gauteng and North-West Provinces: Occurs mainly on the ridge of the Gatsrand south of Carletonville–Westonaria–Lenasia. Also occurs as a narrow band along the ridge that runs from a point between Tarlton and Magaliesberg in the west, through Sterkfontein, Pelindaba, Atteridgeville to Klapperkop and southeastern Pretoria in the east. Altitude 1 300–1 750 m.

Vegetation & Landscape Features Low, broken ridges varying in steepness and with high surface rock cover. Vegetation is a short (3–6 m tall), semi-open thicket dominated by a variety of woody species including *Acacia caffra*, *Rhus leptodictya*, *R. magalismontana*, *Cussonia spicata*, *Ehretia rigida*, *Maytenus heterophylla*, *Euclea crispa*, *Zanthoxylum capense*, *Dombeya rotundifolia*, *Protea caffra*, *Celtis africana*, *Ziziphus mucronata*, *Vangueria infausta*, *Canthium gilfillanii*, *Englerophytum magalismontanum*, *Combretum molle*, *Ancylobotrys capensis*, *Olea europaea* subsp. *africana* and *Grewia occidentalis*. The understorey is dominated by a variety of grasses. Some of the ridges form plateaus above the northern slopes that carry scrubby grassland with high surface rock cover.

D.B.Hoare

Figure 9.19 SVcb 10 Gauteng Shale Mountain Bushveld: Typical semi-open bushveld on rocky slope with a variety of woody species, including *Cussonia spicata*, *Euclea crispa* and *Dombeya rotundifolia* in Groenkloof Nature Reserve, Pretoria. The tall grass in the foreground is *Hyparrhenia dregeana*.

Geology & Soils Dominated by shale and some coarser clastic sediments as well as significant andesite from the Pretoria Group (Transvaal Supergroup), all sedimentary rocks. A part of the area is underlain by Malmani dolomites of the Chuniespoort Group (Transvaal Supergroup). Soils are mostly shallow Mispah, but are deeper at the foot of the slopes. Land type is mostly Fb, with some Ib.

Climate Summer rainfall with very dry winters. MAP 600–750 mm, increasing from west to east as well as with higher elevation. Frost frequent, higher in the west and south. See also climate diagram for SVcb 10 Gauteng Shale Mountain Bushveld.

Important Taxa Small Trees: *Acacia caffra* (d), *Dombeya rotundifolia* (d), *Acacia karroo*, *Celtis africana*, *Combretum molle*, *Cussonia spicata*, *Englerophytum magalismontanum*, *Protea caffra*, *Rhus leptodictya*, *Vangueria infausta*, *Zanthoxylum capense*, *Ziziphus mucronata*. Tall Shrubs: *Asparagus laricinus*, *Canthium gilfillanii*, *Chrysanthemoides monilifera*, *Dichrostachys cinerea*, *Diospyros austro-africana*, *D. lycioides* subsp. *lycioides*, *Ehretia rigida* subsp. *rigida*, *Euclea crispa* subsp. *crispa*, *Grewia occidentalis*, *Gymnosporia polyacantha*, *Olea europaea* subsp. *africana*, *Tephrosia capensis*, *T. longipes*. Low Shrubs: *Acalypha angustata*, *Asparagus suaveolens*, *Athrixia elata*, *Felicia muricata*, *Indigofera comosa*, *Rhus magalismontana* subsp. *magalismontana*. Geoxylic Suffrutex: *Elephantorrhiza elephantina*. Succulent Shrub: *Kalanchoe rotundifolia*. Woody Climber: *Ancylobotrys capensis*. Graminoids: *Hyparrhenia dregeana* (d), *Cymbopogon caesius*, *C. pospischilii*, *Digitaria eriantha* subsp. *eriantha*, *Eragrostis curvula*. Herbs: *Dicoma zeyheri*, *Helichrysum nudifolium*, *H. rugulosum*, *Hermannia lancifolia*, *Hibiscus pusillus*, *Selaginella dregei*, *Senecio venosus*, *Vernonia natalensis*, *V. oligocephala*. Geophytic Herbs: *Cheilanthes hirta*, *Pellaea calomelanos*, *Scadoxus puniceus*.

Conservation Vulnerable. Target 24%. Less than 1% statutorily conserved in, for example, the Skanskop and Hartbeesthoek Nature Reserves, Magaliesberg Nature Area and Groenkloof National Park. Additionally, over 1% conserved in other reserves including the John Nash Nature Reserve, Cheetah Park and Hartbeesthoek Radio Astronomy Observatory. About 21% transformed mainly by urban and built-up areas, mines and quarries, cultivation and plantations. Wattles a common invasive plant in places. Erosion very low to low.

Remarks This unit represents the arid western part of the ridges of Rocky Highveld Grassland (Low & Rebelo 1996) or Bankenveld (Acocks 1988). In species composition and vegetation structure it is similar to and positioned adjacent to SVcb 11 Andesite Mountain Bushveld. This unit occurs more frequently on warmer north-facing slopes and is underlain by rocks of sedimentary origin, whereas SVcb 11 Andesite Mountain Bushveld occurs more frequently on cooler south-facing slopes and is underlain by rocks of volcanic origin.

References Coetzee (1972, 1974), Bezuidenhout et al. (1994).

SVcb 11 Andesite Mountain Bushveld

VT 61 Bankenveld (62%) (Acocks 1953). LR 39 Moist Cool Highveld Grassland (45%), LR 34 Rocky Highveld Grassland (37%) (Low & Rebelo 1996).

Distribution Gauteng, North-West, Mpumalanga and Free State Provinces: Several separate occurrences of which the main are: the Bronberg Ridge in eastern Pretoria extending to Welbekend; from Hartebeesthoek in the west along the valley between the two parallel ranges of hills to Atteridgeville; hills in southern Johannesburg; several hills encompassing Nigel, Willemsdal, Coalbrook and Suikerbosrand (in part); and the outer ring of ridges of the Vredefort Dome and some hills to the northwest around Potchefstroom. Altitude about 1 350–1 800 m.

Vegetation & Landscape Features Dense, medium-tall thorny bushveld with a well-developed grass layer on hill slopes and some valleys with undulating landscape.

Geology & Soils Tholeitic basalt of the Kliprivierberg Group (Randian Ventersdorp Supergroup), also dark shale, micaceous sandstone and siltstone and thin coal seams of the Madzaringwe Formation [Karoo Supergroup, and andesite and conglomerate of the Pretoria Group (Vaalian Transvaal Supergroup)]. Weathering of these rocks gives rise to shallow,

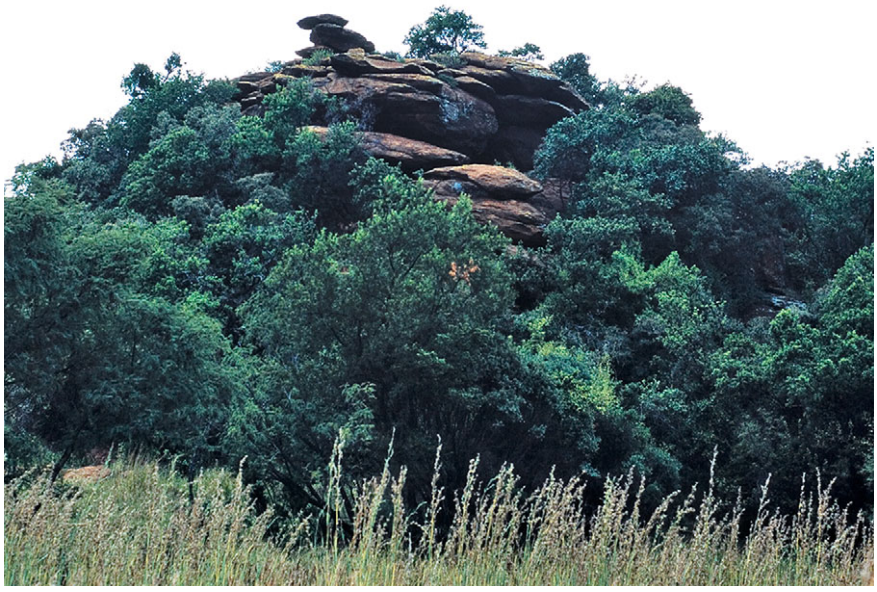

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Figure 9.20 SVcb 11 Andesite Mountain Bushveld: *Acacia caffra* and *Euclea crispa* on a rocky koppie at an altitude of 1 385 m on Hartebeeshoek north of Krugersdorp.

rocky, clayey soils of mainly Mispah and Glenrosa soil forms. Land types mainly Ib and Fb, with some Ba and Bb.

Climate Summer rainfall with very dry winters. MAP from about 550 mm in the southwest to about 750 mm in the northeast. Frequent frost in winter, but less on the ridges and hills. See also climate diagram for SVcb 11 Andesite Mountain Bushveld.

Important Taxa Small Trees: *Acacia caffra* (d), *A. karroo* (d), *Celtis africana*, *Protea caffra*, *Zanthoxylum capense*, *Ziziphus mucronata*. Tall Shrubs: *Asparagus laricinus* (d), *Euclea crispa* subsp. *crispa* (d), *Rhus pyroides* var. *pyroides* (d), *Diospyros lycioides* subsp. *lycioides*, *Gymnosporia polyacantha*, *Lippia javanica*, *Rhamnus prinoides*. Low Shrubs: *Asparagus suaveolens* (d), *Rhus rigida* var. *margaretae*, *Teucrium trifidum*. Soft Shrub: *Isoglossa grantii*. Woody Climber: *Rhoicissus tridentata*. Graminoids: *Eragrostis curvula* (d), *Hyparrhenia hirta* (d), *Setaria sphacelata* (d), *Themeda triandra* (d), *Cymbopogon pospischilii*, *Digitaria eriantha* subsp. *eriantha*, *Elionurus muticus*, *Eragrostis racemosa*, *E. superba*, *Panicum maximum*. Herbs: *Commelina africana*, *Vernonia galpinii*, *V. oligocephala*. Succulent Herb: *Aloe greatheadii* var. *davyana*.

Conservation Least threatened. Target 24%. About 7% statutorily conserved mainly in the Suikerbosrand Nature Reserve and Magaliesberg Nature Area. An additional 1–2% conserved in other reserves mainly in the Hartbeesthoek Radio Astronomy Observatory. Some 15% already transformed, mainly cultivated and some urban and built-up areas. Some of the unit fringes on major urban areas. Erosion is generally very low.

References Bredenkamp (1975, 1977), Bredenkamp & Theron (1980), Du Preez & Venter (1990), Coetzee et al. (1995), Grobler (2000).

SVcb 12 Central Sandy Bushveld

VT 18 Mixed Bushveld (44%), VT 19 Sourish Mixed Bushveld (32%) (Acocks 1953). LR 18 Mixed Bushveld (73%) (Low & Rebelo 1996).

Distribution Limpopo, Mpumalanga, Gauteng and North-West Provinces: Undulating terrain occurs mainly in a broad arc south of the Springbokvlakte from the Pilanesberg in the west through Hammanskraal and Groblersdal to GaMasemola in the east. A generally narrow irregular band along the northwestern edge of the Springbokvlakte (including Modimolle) extending into a series of valleys and lower-altitude areas within the Waterberg including the upper Mokolo River Valley near Vaalwater, the corridor between Rankins Pass and the Doorndraai Dam, and the lowlands from the Mabula area to south of the Hoekberge. Some isolated sandy rises are found on the Springbokvlakte. Altitude about 850–1 450 m.

Vegetation & Landscape Features Low undulating areas, sometimes between mountains, and sandy plains and catenas supporting tall, deciduous *Terminalia sericea* and *Burkea africana* woodland on deep sandy soils (with the former often dominant on the lower slopes of sandy catenas) and low, broad-leaved *Combretum* woodland on shallow rocky or gravelly soils. Species of *Acacia*, *Ziziphus* and *Euclea* are found on flats and lower slopes on eutrophic sands and some less sandy soils. *A. tortilis* may dominate some areas along valleys. Grass-dominated herbaceous layer with relatively low basal cover on dystrophic sands.

Geology & Soils The large southern and eastern parts of this area are underlain by granite of the Lebowa Granite Suite and some granophyre of the Rashoop Granophyre Suite (both Bushveld Complex, Vaalian). In the north, the sedimentary rocks of the Waterberg Group (Mokolian Erathem) are most important. Specifically, sandstone, conglomerate and siltstone of the Alma Formation and sandstone, siltstone and shale of the Vaalwater Formation. Well-drained, deep Hutton or Clovelly soils often with a catenary sequence from Hutton at the top to Clovelly on the lower slopes; shallow, skeletal Glenrosa soils also occur. Land types mainly Bb, Fa, Ba, Bd and Ac.

Climate Summer rainfall with very dry winters. Effectively three seasons, namely a cool dry season from May to mid-August, a hot dry season from mid-August to about October and a hot wet season from about November to April. MAP from about 500–700 mm. Frost fairly infrequent. Mean monthly maximum and minimum temperatures for Goedehoop (in the northern part of this vegetation unit) 35.3°C and –3.1°C for November and June, respectively. See also climate diagram for SVcb 12 Central Sandy Bushveld.

Important Taxa Tall Trees: *Acacia burkei* (d), *A. robusta*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Burkea africana* (d), *Combretum apiculatum* (d), *C. zeyheri* (d), *Terminalia sericea* (d), *Ochna pulchra*, *Peltophorum africanum*, *Rhus leptodictya*. Tall Shrubs: *Combretum hereroense*, *Grewia bicolor*, *G. monticola*, *Strychnos pungens*. Low Shrubs: *Agathisanthemum bojeri* (d), *Indigofera filipes* (d), *Felicia fascicularis*, *Gnidia sericocephala*. Geoxylic Suffrutex: *Dichapetalum cymosum* (d). Woody Climber: *Asparagus buchananii*. Graminoids: *Brachiaria nigropedata* (d), *Eragrostis pallens* (d), *E. rigidior* (d), *Hyperthelia dissoluta* (d), *Panicum maximum* (d), *Perotis patens* (d), *Anthephora pubescens*, *Aristida scabrivalvis* subsp. *scabrivalvis*, *Brachiaria serrata*, *Elionurus muticus*, *Eragrostis nindensis*, *Loudetia simplex*, *Schmidtia pappophoroides*, *Themeda triandra*, *Trachypogon spicatus*. Herbs: *Dicerocaryum senecioides* (d), *Barleria macrostegia*, *Blepharis integrifolia*, *Crabbea angustifolia*, *Evolvulus alsinoides*, *Geigeria burkei*, *Hermannia lancifolia*, *Indigofera daleoides*, *Justicia anagalloides*, *Kyphocarpa angustifolia*, *Lophiocarpus tenuissimus*, *Waltheria indica*, *Xerophyta humilis*. Geophytic

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Figure 9.21 SVcb 12 Central Sandy Bushveld: Open savanna dominated by *Burkea africana* and *Terminalia sericea* on a sandy ridge south of Mookgophong (Naboomspruit).

Herb: *Hypoxis hemerocallidea*. Succulent Herb: *Aloe greatheadii* var. *davyana*.

Biogeographically Important Taxa (Central Bushveld endemics) Graminoid: *Mosdenia leptostachys*. Herb: *Oxygonum dregeanum* subsp. *canescens* var. *dissectum*.

Conservation Vulnerable. Target 19%. Less than 3% statutorily conserved spread thinly across many nature reserves including the Doorndraai Dam and Skuinsdraai Nature Reserves. An additional 2% conserved in other reserves including the Wallmansthal SANDF Property and a grouping of private reserves, which include most of the Nylsvlei freshwater wetlands. About 24% transformed, including about 19% cultivated and 4% urban and built-up areas. Much of the unit in the broad arc south of the Springbokvlakte is heavily populated by rural communities. Several alien plants are widely scattered but often at low densities; these include *Cereus jamacaru*, *Eucalyptus* species, *Lantana camara*, *Melia azedarach*, *Opuntia ficus-indica* and *Sesbania punicea*. Erosion very low to high, especially in some places northeast of Groblersdal.

Remarks *Acacia sieberiana* occurs in the transition zone with grassland in the east, while *A. caffra* and *Faurea saligna* are dominant in the transition zone to SVcb 17 Waterberg Mountain Bushveld in the western parts of this unit. Central Sandy Bushveld is similar to SVcb 16 Western Sandy Bushveld, but the former is generally moister and cooler and generally lacks species such as *A. erubescens* and *A. nigrescens*. The climate seasons described above also apply to many other vegetation units of the Central Bushveld Bioregion. This vegetation unit includes probably the most intensively studied South African savanna field site of the South African Savanna Ecosystem Programme in the Nylsvley Nature Reserve (Limpopo Province).

References Grunow (1965), Coetzee et al. (1976), Van der Meulen (1979), Van der Meulen & Westfall (1980), Lubke et al. (1983), Lubke & Thatcher (1983), Scholes & Walker (1993), Dörgeloh (1998, 1999a, b).

SVcb 13 Loskop Mountain Bushveld

VT 18 Mixed Bushveld (49%), VT 19 Sourish Mixed Bushveld (47%) (Acocks 1953). LR 18 Mixed Bushveld (61%) (Low & Rebelo 1996).

Distribution Mpumalanga, Gauteng and Limpopo Provinces: Occurs on mountains in the vicinity of Loskop Dam extending southwestwards towards Bronkhorstspruit on mountains including the Gouwsberge and westwards to Rust de Winter on mountains including Ditlhabane. Altitude about 1 050–1 500 m.

Vegetation & Landscape Features Low mountains and ridges with open tree savanna on lower-lying areas dominated by *Burkea africana* and a denser broad-leaved tree savanna on lower slopes and midslopes with prominent *Diplorhynchus condylocarpon*, *Combretum apiculatum* and *Acacia caffra*. Herbaceous layer is dominated by grasses.

Geology & Soils Rhyolite of the Selons River Formation (Rooiberg Group, Transvaal Supergroup) and sandstone with subordinate conglomerate and minor shale of the Wilge River Formation (Mokolian Waterberg Group) are most abundant. The Rashoop Granophyre Suite and granite of the Lebowa Granite Suite, (both Bushveld Igneous Complex, Vaalian) are also represented, as are some mudrock, sandstone, conglomerate and volcanic rocks of the Loskop Formation (Vaalian Transvaal Supergroup). Rocky areas with miscellaneous soils

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Figure 9.22 SVcb 13 Loskop Mountain Bushveld: Open broad-leaved woodland occurring on mountain slopes with *Rhynchosia nervosa*, *Mundulea sericea*, *Combretum molle* and *C. zeyheri* in the Loskop Dam Nature Reserve.

ranging from sandy to sandy loams, sandy clays and some clays. Land type is mainly Ib.

Climate Summer rainfall with very dry winters. Frost fairly infrequent. MAP about 600–750 mm. See also climate diagram for SVcb 13 Loskop Mountain Bushveld.

Important Taxa Tall Tree: *Acacia burkei*. Small Trees: *Acacia caffra* (d), *Burkea africana* (d), *Combretum apiculatum* (d), *C. zeyheri* (d), *Croton gratissimus* (d), *Faurea saligna* (d), *Heteropyxis natalensis* (d), *Ochna pulchra* (d), *Protea caffra* (d), *Pseudolachnostylis maprouneifolia* (d), *Terminalia sericea* (d), *Brachylaena rotundata*, *Combretum molle*, *Englerophytum magalismontanum*, *Ozoroa sphaerocarpa*, *Pappea capensis*, *Rhus leptodictya*, *Strychnos cocculoides*, *Vangueria parvifolia*. Tall Shrubs: *Diplorhynchus condylocarpon* (d), *Elephantorrhiza burkei* (d), *Combretum moggii*, *Grewia flava*, *Mundulea sericea*, *Pavetta zeyheri*, *Psydrax livida*, *Vitex rehmannii*. Low Shrub: *Rhus zeyheri* (d). Succulent Shrub: *Aloe castanea*. Graminoids: *Aristida transvaalensis* (d), *Loudetia simplex* (d), *Trachypogon spicatus* (d), *Digitaria eriantha* subsp. *eriantha*, *Enneapogon pretoriensis*, *Heteropogon contortus*, *Setaria sphacelata*, *Themeda triandra*, *Tristachya biseriata*. Herb: *Xerophyta retinervis*.

Endemic Taxa Geophytic Herb: *Gladiolus pole-evansii*. Succulent Herb: *Haworthia koelmaniorum*.

Conservation Least threatened. Target 24%. About 15% statutorily conserved mainly in the Loskop Dam and Mabusa Nature Reserves. About 2% additionally conserved in other reserves. Less than 3% transformed mainly by cultivation and urban and built-up areas. Erosion is mostly very low to low.

Remark The great variation in geology and topography in the area is associated with a wide variety of plant communities.

Reference Theron (1973).

SVcb 14 Loskop Thornveld

VT 18 Mixed Bushveld (91%) (Acocks 1953). LR 18 Mixed Bushveld (71%) (Low & Rebelo 1996).

Distribution Mpumalanga Province and very marginally into Limpopo Province: South of Groblersdal, the valley of the Bloed River towards Stoffberg and the valley of the Olifants River to the Loskop Dam as well as valleys west of Groblersdal to Dennilton. Altitude about 950–1 300 m.

Vegetation & Landscape Features Valleys and plains of parts of the upper Olifants River catchment. Open, deciduous to semideciduous, tall, thorny woodland, usually dominated by *Acacia* species.

Geology & Soils Gabbro, norite and anorthosite of the Dsjate Subsuite, olivine diorite, magnetite gabbro and gabbronorite of the Roossenekal Subsuite (both Rustenburg Layered Suite, Bushveld Igneous Complex), mudstone siltstone, sandstone, andesitic lava and carbonates of the Bloempoort Formation, mudstone, sandstone, conglomerate and volcanic rocks of the Loskop Formation (both Transvaal Supergroup, Vaalian Erathem), and granophyre of the Rashoop Granophyre Suite, also of Bushveld (Vaalian Erathem). Soils are vertic, melanic clays, plinthic catena, eutrophic and widespread red soils. Red-yellow apedal, freely drained soils, high base status. Deep soils with Hutton, Rensburg and Arcadia forms are common. Land types mainly Ea, Bc and Ae.

Climate Summer rainfall with very dry winters. MAP about 550–650 mm. Frost fairly infrequent. Mean monthly maximum and minimum temperatures for Loskop Dam-Irr are 35.7°C and 3.6°C for January and July, respectively. See also climate diagram for SVcb 14 Loskop Thornveld.

Important Taxa Tall Trees: *Acacia burkei*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Acacia gerrardii* (d), *A. sieberiana* var. *woodii* (d), *A. nilotica*, *A. tortilis* subsp. *heteracantha*, *Berchemia zeyheri*, *Combretum zeyheri*, *Pappea capensis*, *Peltophorum africanum*, *Rhus leptodictya*. Tall Shrubs: *Euclea crispa* subsp. *crispa* (d), *Rhus pyroides* var. *pyroides* (d), *Dichrostachys cinerea*, *Euclea undulata*, *Grewia flava*, *Olea europaea* subsp. *africana*. Low Shrubs: *Asparagus suaveolens*, *Leonotis ocymifolia*, *Orthosiphon fruticosus*, *Vernonia poskeana* subsp. *botswanica*. Succulent Shrub: *Kalanchoe paniculata*. Woody Climber: *Clematis brachiata* (d). Woody Succulent Climber: *Senecio pleistocephalus*. Herbaceous Climber: *Rhynchosia minima* (d). Graminoids: *Bothriochloa insculpta* (d), *Digitaria argyrograpta* (d), *Themeda triandra* (d), *Aristida congesta*, *Bulbostylis humilis*, *Cenchrus ciliaris*, *Cymbopogon nardus*, *Enneapogon scoparius*, *Eragrostis trichophora*, *Eustachys paspaloides*, *Setaria verticillata*. Herb: *Kyphocarpa angustifolia*.

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Figure 9.23 SVcb 14 Loskop Thornveld: Deciduous open woodland occurring in valleys with dominant species including *Acacia sieberiana*, *A. tortilis* and *A. theronii*, east of Loskop Dam.

Biogeographically Important Taxon (Broadly disjunct distribution) Small Tree: *Acacia theronii* (d).

Conservation Vulnerable. Target 19%. About 11% statutorily conserved in the Loskop Dam Nature Reserve (with an additional 3.2% represented by the water surface of the reservoir). About a quarter of the area already transformed, mainly for agricultural crops requiring irrigation. The most common crops include maize, cotton, citrus, grapes and wheat (winter crop). There has been a dramatic increase in the establishment of vineyards. Old lands are invaded by *Acacia tortilis* and *Hyparrhenia hirta*. Alien plants, for example *Cereus jamacaru*, *Opuntia ficus-indica*, *Melia azedarach*, *Lantana camara* and *Solanum seaforthianum*, have invaded various parts of this unit. Erosion is generally moderate to very low.

Reference Theron (1973).

SVcb 15 Springbokvlakte Thornveld

VT 12 Springbok Flats Turf Thornveld (48%), VT 18 Mixed Bushveld (42%) (Acocks 1953). LR 14 Clay Thorn Bushveld (55%) (Low & Rebelo 1996).

Distribution Limpopo, Mpumalanga, North-West and Gauteng Provinces: Flats from Zebediela in the northeast to Hammanskraal and Assen in the southwest as well as from Bela-Bela and Mookgophong in the northwest to Marble Hall and Rust de Winter in the southeast. Altitude about 900–1 200 m.

Vegetation & Landscape Features Open to dense, low thorn savanna dominated by *Acacia* species or shrubby grassland with a very low shrub layer. Occurs on flat to slightly undulating plains.

Geology & Soils Rocks are part of the volcano-sedimentary Karoo Supergroup. Most abundant in the area are the mafic volcanics (tholeitic and olivine basalts and nephelinites) of the Letaba Formation, then the mudstones of the Irrigasie Formation and the shale, with sandstone units, of the Ecca Group. Soils are red-yellow apedal, freely drained with high base status and self-mulching, black, vertic clays. The vertic soils, with a fluctuating water table, experience prolonged periods of swelling and shrinking during wet and dry periods, considerable soil cracking when dry, a loose soil surface, high calcium carbonate content and gilgai micro-relief. Land types mainly Ae and Ea.

Climate Summer rainfall with very dry winters. MAP about 500–650 mm. Frost fairly infrequent in winter. Mean monthly maximum and minimum temperatures for Warmbaths–Towoomba are 35.2°C and –2.0°C for October and July, respectively. Corresponding values are 36.8°C and –1.2°C for Marble Hall for January and June, respectively. See also climate diagram for SVcb 15 Springbokvlakte Thornveld.

Important Taxa Small Trees: *Acacia karroo* (d), *A. luederitzii* var. *retinens* (d), *A. mellifera* subsp. *detinens* (d), *A. nilotica* (d), *Ziziphus mucronata* (d), *Acacia tortilis* subsp. *heteracantha*, *Boscia foetida* subsp. *rehmanniana*. Tall Shrubs: *Euclea undulata* (d), *Rhus engleri* (d), *Dichrostachys cinerea*, *Diospyros lycioides* subsp. *lycioides*, *Grewia flava*, *Tarchonanthus camphoratus*. Low Shrubs: *Acacia tenuispina* (d), *Ptycholobium plicatum*. Succulent Shrub: *Kleinia longiflora*. Herbaceous Climbers: *Momordica balsamina*, *Rhynchosia minima*. Graminoids: *Aristida bipartita* (d), *Dichanthium annulatum* var. *papillosum* (d), *Ischaemum afrum* (d), *Setaria incrassata* (d), *Aristida canescens*, *Brachiaria eruciformis*. Herbs: *Aspilia mossambicensis*, *Indigastrum parviflorum*, *Nidorella hottentotica*, *Orthosiphon suffrutescens*, *Senecio apiifolius*.

Biogeographically Important Taxon (Central Bushveld endemic) Graminoid: *Mosdenia leptostachys*.

Conservation Endangered. Target 19%. Only 1% statutorily conserved, mainly in the Mkombo Nature Reserve. Roughly three times this area is conserved in a number of other reserves. At least 49% transformed, including about 45% cultivated and 3% urban and built-up. Dense rural populations in parts of the southern and eastern side of the unit. Very scattered alien plants over wide areas include *Cereus jamacaru*, *Eucalyptus* species, *Lantana camara*, *Melia azedarach*, *Opuntia ficus-indica* and *Sesbania punicea*. Erosion is very low to moderate.

Remark The high clay content of the soil increases soil moisture stress and SVcb 15 Springbokvlakte Thornveld is more xeric than adjacent vegetation units (except for SVcb 27 Sekhukhune Plains Bushveld in the extreme northeast).

References Galpin (1926), Coetzee et al. (1976), Van der Meulen (1979), Van der Meulen & Westfall (1980), Winterbach (1998).

SVcb 16 Western Sandy Bushveld

VT 18 Mixed Bushveld (58%) (Acocks 1953). LR 18 Mixed Bushveld (75%) (Low & Rebelo 1996).

Distribution Limpopo and North-West Provinces: Occurs on flats and undulating plains from Assen northwards past Thabazimbi and remaining west of the Waterberg Mountains towards Steenbokpan in the north. Some patches occur between the Crocodile and Marico Rivers to the west. Mostly at altitudes of 900–1 200 m

Vegetation & Landscape Features Varies from tall open woodland to low woodland, broad-leaved as well as microphyllous tree species prominent. Dominant species include *Acacia erubescens* on flat areas, *Combretum apiculatum* on shallow soils of gravelly upland sites and *Terminalia sericea* on deep sands. Occurs on slightly undulating plains.

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Figure 9.24 SVcb 15 Springbokvlakte Thornveld: Open savanna dominated by *Acacia nilotica*, *A. tortilis* and *A. karroo* on turf flats on Uitzicht northeast of Roedtan at an altitude of 985 m. Cleared land for crops, typically encountered in this unit, is visible in the background.

Geology & Soils Sandstone and mudstone of the Matlabas Subgroup and sandstone, subordinate conglomerate, siltstone and shale of the Kransberg Subgroup (both Mokolian Waterberg Group) are found in the north. Archaean granite and gneiss of the Swazian Erathem and granite of the Lebowa Granite Suite (Bushveld Igneous Complex) are found in the west and southeast of the area, respectively. Soils are plinthic catena, eutrophic, red-yellow apedal, freely drained, high base status, Hutton and Clovelly with some Glenrosa and Mispah soil forms. Several areas have less sandy soil than that of SVcb 12 Central Sandy Bushveld. Land types mainly Bd, Ah, Ae and Fa.

Climate Summer rainfall with very dry winters. MAP from about 450 mm in the north to about 650 mm in the south. Fairly frequent light frost in winter. Mean monthly maximum and minimum tem-

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Figure 9.25 SVcb 16 Western Sandy Bushveld: Open bushveld dominated by *Combretum apiculatum, Acacia nigrescens* and *Sporobolus* species on Ruigtevley, Thabazimbi District.

peratures for Thabazimbi 36.0°C and –3.7°C for February and June, respectively. See also climate diagram for SVcb 16 Western Sandy Bushveld.

Important Taxa Tall Trees: *Acacia erioloba*, *A. nigrescens*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Acacia erubescens* (d), *A. mellifera* subsp. *detinens* (d), *A. nilotica* (d), *A. tortilis* subsp. *heteracantha* (d), *Combretum apiculatum* (d), *C. imberbe* (d), *Terminalia sericea* (d), *Combretum zeyheri*, *Lannea discolor*, *Ochna pulchra*, *Peltophorum africanum*. Tall Shrubs: *Combretum hereroense* (d), *Euclea undulata* (d), *Coptosperma supra-axillare*, *Dichrostachys cinerea*, *Grewia bicolor*, *G. flava*, *G. monticola*. Low Shrubs: *Clerodendrum ternatum*, *Indigofera filipes*, *Justicia flava*. Graminoids: *Anthephora pubescens* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Eragrostis pallens* (d), *E. rigidior* (d), *Schmidtia pappophoroides* (d), *Aristida congesta*, *A. diffusa*, *A. stipitata* subsp. *graciliflora*, *Eragrostis superba*, *Panicum maximum*, *Perotis patens*. Herbs: *Blepharis integrifolia*, *Chamaecrista absus*, *Evolvulus alsinoides*, *Geigeria burkei*, *Kyphocarpa angustifolia*, *Limeum fenestratum*, *L. viscosum*, *Lophiocarpus tenuissimus*, *Monsonia angustifolia*.

Conservation Least threatened. Target 19%. About 6% statutorily conserved, just over half of which in the Marakele National Park. About 4% transformed, mainly by cultivation. Erosion is generally low to very low.

Remark This unit is drier than the SVcb 12 Central Sandy Bushveld vegetation unit and is distinguished from it by the presence of such species as *Acacia erubescens*, *A. nigrescens* and *Combretum imberbe* and general absence of species such as *Burkea africana* and *Ochna pulchra*.

References Herbst (1973), Peel et al. (1991), Brown & Bredenkamp (1994), Brown et al. (1995, 1996, 1997), Winterbach (1998), Winterbach et al. (2000).

SVcb 17 Waterberg Mountain Bushveld

VT 20 Sour Bushveld (73%) (Acocks 1953). LR 12 Waterberg Moist Mountain Bushveld (83%) (Low & Rebelo 1996).

Distribution Limpopo Province: Waterberg Mountains, including the foothills, escarpment and tablelands south of the line between Lephalale and Marken and north of Bela-Bela and west of Mokopane and with outliers in the southwest such as the Boshofsberge and Vlieëpoortberge near Thabazimbi. Altitude about 1 000–1 600 m and generally at a lower altitude than the Gm 29 Waterberg-Magaliesberg Summit Sourveld.

Vegetation & Landscape Features Rugged mountains with vegetation grading from *Faurea saligna–Protea caffra* bushveld on higher slopes (in turn grading into the Gm 29 Waterberg-Magaliesberg Summit Sourveld) through broad-leaved deciduous bushveld (dominated by *Diplorhynchus condylocarpon*) on rocky mid- and footslopes to *Burkea africana–Terminalia sericea* savanna in the lower-lying valleys as well as on deeper sands of the plateaus. The grass layer is moderately developed or well developed.

Geology & Soils Mainly sandstone, subordinate conglomerate, siltstone and shale of the Kransberg Subgroup and medium- to coarse-grained sandstone, conglomerate, trachytic lava and quartz porphyry of the Swaershoek Formation, Nylstroom Subgroup (both Mokolian Waterberg Group). Dystrophic, acidic sandy, loamy to gravelly soil. Glenrosa and Mispah Forms. Land types mainly Ib, Ac, Fa and Ad.

Climate Summer rainfall with very dry winters. MAP from about 500 mm in the lower-altitude northwest to about 750 mm on the higher parts of the main east-west range. Frost fairly frequent in winter. See also climate diagram for SVcb 17 Waterberg Mountain Bushveld.

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Figure 9.26 SVcb 17 Waterberg Mountain Bushveld: West-facing slopes with *Combretum apiculatum, Dichrostachys cinerea* and *Grewia monticola* at 1 235 m within the Marakele National Park, Thabazimbi District.

Important Taxa Tall Tree: *Acacia robusta*. Small Trees: *Acacia caffra* (d), *Burkea africana* (d), *Combretum apiculatum* (d), *Croton gratissimus* (d), *Cussonia transvaalensis* (d), *Faurea saligna* (d), *Heteropyxis natalensis* (d), *Ochna pulchra* (d), *Protea caffra* (d), *Albizia tanganyicensis*, *Combretum molle*, *Englerophytum magalismontanum*, *Ficus burkei*, *F. glumosa*, *Ochna pretoriensis*, *Pseudolachnostylis maprouneifolia*, *Rhus lancea*, *Terminalia sericea*, *Vangueria infausta*, *V. parvifolia*. Tall Shrubs: *Diplorhynchus condylocarpon* (d), *Elephantorrhiza burkei* (d), *Combretum moggii*, *C. nelsonii*, *Dichrostachys cinerea*, *Euclea crispa* subsp. *crispa*, *Gnidia kraussiana*, *Olea capensis* subsp. *enervis*, *O. europaea* subsp. *africana*, *Rhus pyroides* var. *pyroides*, *Strychnos pungens*, *Vitex rehmannii*. Low Shrubs: *Anthospermum rigidum* subsp. *rigidum*, *Barleria affinis*, *Felicia muricata*, *Helichrysum kraussii*, *Protea welwitschii* subsp. *welwitschii*, *Rhus rigida* var. *dentata*. Geoxylic Suffrutices: *Dichapetalum cymosum*, *Parinari capensis* subsp. *capensis*. Succulent Shrubs: *Aloe chabaudii*, *Lopholaena coriifolia*. Woody Climbers: *Ancylobotrys capensis* (d), *Rhoicissus revoilii*. Graminoids: *Loudetia simplex* (d), *Schizachyrium sanguineum* (d), *Trachypogon spicatus* (d), *Brachiaria serrata*, *Digitaria eriantha* subsp. *eriantha*, *Elionurus muticus*, *Enneapogon scoparius*, *Setaria sphacelata*, *Themeda triandra*, *Tristachya leucothrix*. Herbs: *Berkheya insignis*, *Chamaecrista mimosoides*, *Geigeria elongata*, *Hibiscus meyeri* subsp. *transvaalensis*, *Xerophyta retinervis*. Geophytic Herbs: *Haemanthus humilis* subsp. *humilis*, *Hypoxis rigidula*.

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Figure 9.27 SVcb 18 Roodeberg Bushveld: Moderately dense bushveld dominated by *Kirkia acuminata*, *Combretum apiculatum*, *Dichrostachys cinerea*, *Terminalia sericea* and *Acacia* species on the Farm Goedgedacht west of Marken in the Mokopane District.

Biogeographically Important Taxa ([CB]Central Bushveld endemic, [N]Northern Sourveld endemic) Small Tree: *Encephalartos eugene-maraisii*[N]. Tall Shrub: *Erythrophysa transvaalensis*[CB]. Soft Shrub: *Chorisochora transvaalensis*[N]. Graminoid: *Mosdenia leptostachys*[CB].

Endemic Taxa Tall Shrubs: *Grewia rogersii*, *Pachystigma triflorum*. Herb: *Oxygonum dregeanum* subsp. *canescens* var. *pilosum*.

Conservation Least threatened. Target 24%. About 9% statutorily conserved mainly in the Marakele National Park and Moepel Nature Reserve. More than 3% transformed, mainly by cultivation. Human population density is low. Erosion is generally very low to low.

Remark Carrying capacity of the vegetation for domestic stock animals is low, especially during the dry season.

References Coetzee et al. (1981), Westfall (1981), Westfall et al. (1983, 1985), Ben-Shahar (1988), Van Staden (2002), Van Staden & Bredenkamp (2005).

SVcb 18 Roodeberg Bushveld

VT 18 Mixed Bushveld (65%) (Acocks 1953). LR 18 Mixed Bushveld (60%) (Low & Rebelo 1996).

Distribution Limpopo Province: Straddling the Tropic of Capricorn, occurs from Marken and Villa Nora in the south through Baltimore to near Swartwater in the north and to the plains around the base of the Blouberg and Lerataupje Mountains in the northeast. Altitude about 850–1 100 m.

Vegetation & Landscape Features Plains and slightly undulating plains, including some low hills, with short closed woodland to tall open woodland and poorly developed grass layer. *Kirkia acuminata* trees not limited to hills.

Geology & Soils Mainly sandstone, conglomerate, siltstone and shale of the Kransberg and Matlabas Subgroups (Mokolian Waterberg Group). Gneisses, metasediments and metavolcanic rocks of the Malala Drift Group, Beit Bridge Complex (Swazian Erathem) occur in the north. Granite of the Lebowa Granite Suite (Bushveld Igneous Complex) is also present. A variety of soil types, but mostly sandy soils, red-yellow apedal high base status, also dystrophic or mesotrophic. Almost half the area is Ae land type, with remainder divided between mainly Fa, Bc, Ac, Fc, Ia and Fb.

Climate Summer rainfall with very dry winters. MAP 400–550 mm. Frost fairly infrequent. Mean monthly maximum and minimum temperatures for Marnitz 37.1°C and 0.2°C for November and June, respectively. See also climate diagram for SVcb 18 Roodeberg Bushveld.

Important Taxa Tall Trees: *Acacia burkei* (d), *A. nigrescens* (d), *A. robusta* (d), *A. erioloba*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Acacia erubescens* (d), *A. mellifera* subsp. *detinens* (d), *A. nilotica* (d), *A. tortilis* subsp. *heteracantha* (d), *Combretum apiculatum* (d), *Kirkia acuminata* (d), *Acacia grandicornuta*, *A. luederitzii* var. *retinens*, *A. senegal* var. *leiorhachis*, *Albizia harveyi*, *Combretum imberbe*, *Commiphora mollis*, *Rhus lancea*, *Terminalia sericea*, *Ziziphus mucronata*. Tall Shrubs: *Dichrostachys cinerea* (d), *Grewia flava* (d), *Euclea crispa* subsp. *crispa*, *E. undulata*, *Grewia monticola*, *Hibiscus micranthus*. Low Shrubs: *Commiphora africana*, *Melhania acuminata*, *Sida cordifolia*, *Solanum delagoense*. Graminoids: *Aristida canescens* (d), *Chloris virgata* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Enneapogon cenchroides* (d), *Eragrostis rigidior* (d), *Panicum maximum* (d), *Urochloa mosambicensis* (d), *Aristida congesta*, *Brachiaria deflexa*, *Cymbopogon pospischilii*, *Cynodon dactylon*, *Eragrostis rotifer*. Herbs: *Achyranthes aspera*, *Corbichonia decumbens*, *Hemizygia elliottii*, *Kyphocarpa angustifolia*, *Seddera capensis*, *Tephrosia purpurea* subsp. *leptostachya*, *Waltheria indica*.

Conservation Least threatened. Target 19%. Almost 6% statutorily conserved, mainly in the Wonderkop and Blouberg (Malebocho) Nature Reserves. An additional 3% conserved in other reserves, mainly in areas adjacent to the Wonderkop Nature Reserve. About 18% transformed, mainly by cultivation, with very little urban and built-up areas. Erosion is low to high. The area is mostly used for game ranching.

References Schmidt et al. (1993, 1994), Schulze et al. (1994), Winterbach (1998), J.M. van Staden (unpublished data).

SVcb 19 Limpopo Sweet Bushveld

VT 14 Arid Sweet Bushveld (74%) (Acocks 1953). LR 17 Sweet Bushveld (65%) (Low & Rebelo 1996).

Distribution Limpopo Province: Extends from the lower reaches of the Crocodile and Marico Rivers around Makoppa and Derdepoort, respectively, down the Limpopo River Valley including Lephalale and into the tropics past Tom Burke to the Usutu border post and Taaiboschgroet area in the north. Altitude about 700–1 000 m. The unit also occurs on the Botswana side of the border.

Vegetation & Landscape Features Plains, sometimes undulating or irregular, traversed by several tributaries of the Limpopo River. Short open woodland; in disturbed areas thickets of *Acacia erubescens*, *A. mellifera* and *Dichrostachys cinerea* are almost impenetrable.

Geology & Soils The northern half of the area is dominated by gneisses, metasediments and metavolcanics of the Malala Drift Group, Beit Bridge Complex (Swazian Erathem), basalts of the Letaba Formation (Lebombo Group of the Karoo Supergroup) are also found in the northeast. Sandstone, siltstone and mudstone of the Clarens Formation (Karoo Supergroup), as well as of the Matlabas Subgroup (Mokolian Waterberg Group) are found to the south and west. Soils with calcrete and surface limestone layers, brownish sandy (Clovelly soil form) clayey-loamy soils (Hutton soil form) on the plains and low-lying areas, with shallow, gravelly, sandy soils on the slightly undulating areas, localised areas of black clayey soils (Valsrivier or Arcadia soil forms) and Kalahari sand. Land types mainly Ae, Ah and Fc.

Climate Summer rainfall with very dry winters including the shoulder months of May and September. MAP from about 350 mm in the northeast to about 500 mm in the southwest. Frost fairly infrequent. Mean monthly maximum and minimum temperatures for Lephalale 38.2°C and 2.1°C for December and June, respectively. See also climate diagram for SVcb 19 Limpopo Sweet Bushveld.

Important Taxa Tall Trees: *Acacia robusta* (d), *A. burkei*. Small Trees: *Acacia erubescens* (d), *A. fleckii* (d), *A. nilotica* (d), *A. senegal* var. *rostrata* (d), *Albizia anthelmintica* (d), *Boscia albitrunca* (d), *Combretum apiculatum* (d), *Terminalia sericea*. Tall Shrubs: *Catophractes alexandri* (d), *Dichrostachys cinerea* (d), *Phaeoptilum spinosum* (d), *Rhigozum obovatum* (d), *Cadaba aphylla*, *Combretum hereroense*, *Commiphora pyracanthoides*, *Ehretia rigida* subsp. *rigida*, *Euclea undulata*, *Grewia flava*, *Gymnosporia senegalensis*. Low Shrubs: *Acacia tenuispina* (d), *Commiphora africana*, *Felicia muricata*, *Gossypium herbaceum* subsp. *africanum*, *Leucosphaera bainesii*. Graminoids: *Digitaria eriantha* subsp. *eriantha* (d), *Enneapogon cenchroides* (d), *Eragrostis lehmanniana* (d), *Panicum coloratum* (d), *Schmidtia pappophoroides* (d), *Aristida congesta*, *Cymbopogon nardus*, *Eragrostis pallens*, *E. rigidior*, *E. trichophora*, *Ischaemum afrum*, *Panicum maximum*, *Setaria verticillata*, *Stipagrostis uniplumis*, *Urochloa mosambicensis*. Herbs: *Acanthosicyos naudinianus*, *Commelina benghalensis*, *Harpagophytum procumbens* subsp. *transvaalense*, *Hemizygia elliottii*, *Hermbstaedtia odorata*, *Indigofera daleoides*. Succulent Herbs: *Kleinia fulgens*, *Plectranthus neochilus*.

Biogeographically Important Taxon (Central Bushveld endemic) Succulent Herb: *Piaranthus atrosanguineus*.

Conservation Least threatened. Target 19%. Less than 1% statutorily conserved and limited to reserves straddling the southeastern limits of the unit, for example the D'Nyala Nature Reserve. Very little conserved in other reserves. About 5% transformed, mainly by cultivation. Erosion is low to high.

Remark Though limited by low rainfall, this is a good area for game and cattle farming due to the high grazing capacity of sweet veld.

References Bosch (1971), Herbst (1973), Panagos et al. (1986), Pauw (1988), Peel (1990), Van Staden (1991).

SVcb 20 Makhado Sweet Bushveld

VT 18 Mixed Bushveld (51%) (Acocks 1953). LR 18 Mixed Bushveld (44%), LR 17 Sweet Bushveld (43%) (Low & Rebelo 1996).

M.C. Rutherford

Figure 9.28 SVcb 19 Limpopo Sweet Bushveld: Open bushveld dominated by *Acacia senegal* at 740 m on the Farm Kwarel between Maasstroom and Alldays (Limpopo Province).

Distribution Limpopo Province: Straddling the Tropic of Capricorn, occurs on the plains south of the Soutpansberg, east of the Waterberg and on the apron surrounding the Blouberg and Lerataupje Mountains, and north of the Polokwane Plateau and west of the escarpment, with extensions to Mokopane to the south and to the north near Vivo. Altitude about 850–1 200 m.

Vegetation & Landscape Features Slightly to moderately undulating plains sloping generally down to the north, with some hills in the southwest. Short and shrubby bushveld with a poorly developed grass layer.

Geology & Soils The area is underlain by the gneisses and migmatites of the Hout River Gneiss (Randian Erathem) and the potassium-deficient gneisses

of the Goudplaats Gneiss (Swazian Erathem). Sandstones and mudstones of the Matlabas Subgroup (Mokolian Waterberg Group) are also found. Soils include deep, greyish sands, eutrophic plinthic catenas, red-yellow apedal freely drained soils with high base status, clayey in bottomlands. Land types mainly Bd, Bc, Ae and Ia.

Climate Summer rainfall with very dry winters. MAP about 350–550 mm. Frost fairly infrequent. Mean monthly maximum and minimum temperatures for Mara-Agr 36.5°C and –0.8°C for November and June, respectively. See also climate diagram for SVcb 20 Makhado Sweet Bushveld.

Important Taxa Small Trees: *Acacia erubescens* (d), *A. gerrardii* (d), *A. mellifera* subsp. *detinens* (d), *A. rehmanniana* (d), *Boscia albitrunca* (d), *Combretum apiculatum* (d), *Acacia tortilis* subsp. *heteracantha*, *Terminalia sericea*. Tall Shrubs: *Commiphora pyracanthoides*, *Dichrostachys cinerea*, *Grewia flava*, *Hibiscus calyphyllus*, *Lycium shawii*, *Rhigozum obovatum*. Low Shrubs: *Barleria lancifolia*, *Hirpicium bechuanense*, *Indigofera poliotes*, *Melhania rehmannii*, *Pechuel-Loeschea leubnitziae*. Graminoids: *Anthephora pubescens* (d), *Aristida stipitata* subsp. *graciliflora* (d), *Cenchrus ciliaris* (d), *Enneapogon scoparius* (d), *Brachiaria nigropedata*, *Eragrostis trichophora*, *Panicum coloratum*, *P. maximum*, *Schmidtia pappophoroides*, *Urochloa mosambicensis*. Herbs: *Chamaecrista absus*, *Corbichonia decumbens*, *Geigeria acaulis*, *Harpagophytum procumbens* subsp. *transvaalense*, *Heliotropium steudneri*, *Hemizygia elliottii*, *Hermbstaedtia odorata*, *Leucas sexdentata*, *Osteospermum muricatum*, *Tephrosia purpurea* subsp. *leptostachya*.

Endemic Taxon Herb: *Dicliptera minor* subsp. *pratis-manna*.

Conservation Vulnerable. Target 19%. About 1% statutorily conserved, mainly in the Bellevue Nature Reserve. Some 27% transformed, mainly by cultivation, with some urban and built-up areas. The southwestern half of the unit has densely populated rural communities. Erosion is low to high.

Remark This area is transitional between the higher-lying Polokwane Plateau and the lower-lying vegetation units of the Limpopo River Valley.

Reference Peel (1990).

L. Mucina

Figure 9.29 SVcb 21 Soutpansberg Mountain Bushveld: Sour bushveld on steep slopes of the Soutpansberg in the Wyllie's Poort north of Makhado, Limpopo Province.

SVcb 21 Soutpansberg Mountain Bushveld

VT 8 North-Eastern Mountain Sourveld (38%), VT 19 Sourish Mixed Bushveld (34%) (Acocks 1953). LR 21 Sour Lowveld Bushveld (56%) (Low & Rebelo 1996).

Distribution Limpopo Province: Occurs on the slopes of the Soutpansberg Mountain, and Blouberg and Lerataupje Mountains in the west. Extends eastward on lower ridges including Khaphamali and Makonde Mountains. Altitude about 600–1 500 m.

Vegetation & Landscape Features Low to high mountains, highest in the west, splitting into increasing number of lower mountain ridges towards the east. Dense tree layer and poorly developed grassy layer. The topography of the east-west-orientated ridges of the mountain changes drastically over short distances, resulting in orographic rain on the southern ridges, and a rainshadow effect on the northern ridges. Because of this topographic diversity, the Soutpansberg Mountain Bushveld comprises a complex mosaic of sharply contrasting kinds of vegetation within limited areas. The main vegetation variations within the Soutpansberg Mountain Bushveld are subtropical moist thickets (mainly along the lower-lying southern slopes, on steep clayey soils of volcanic origin), mistbelt bush clumps (within the mistbelt of the southern and central ridges of the mountain, on rugged quartzitic outcrops with shallow sandy soils), relatively open savanna sandveld (on both deep and shallow quarzitic sands along the relatively dry middle and northern slopes of the mountain), and arid mountain bushveld (along the very arid northern ridges of the mountain).

Geology & Soils Reddish or brown, sandstone and quartzite, conglomerate, basalt, tuff, shale and siltstone of the Soutpansberg Group (including the Wyllie's Poort, Fundudzi and Nzhelele Formations), Mokolian Erathem. Rocky areas with miscellaneous soils including acidic dystrophic to mesotrophic sandy to loamy soil. Glenrosa and Mispah soil forms are common. Land types mainly Ib, Ab, Fa, Fb, Ae and Ia.

Climate Summer rainfall with dry winters. MAP about 450–900 mm. Frost infrequent. See also climate diagram for SVcb 21 Soutpansberg Mountain Bushveld.

Important Taxa **Subtropical moist thickets:** Small Trees: *Catha edulis* (d), *Acacia karroo*, *Berchemia zeyheri*, *Bridelia mollis*, *Combretum molle*, *Dombeya rotundifolia*, *Dovyalis zeyheri*, *Kirkia acuminata*, *Mystroxylon aethiopicum* subsp. *schlechteri*, *Plectroniella armata*, *Zanthoxylum capense*, *Ziziphus mucronata*. Tall Shrubs: *Flueggea virosa* (d), *Carissa edulis*, *Grewia occidentalis*, *Rhus pentheri*. Low Shrub: *Pavonia burchellii*. **Mistbelt bush clumps:** Small Trees: *Englerophytum magalismontanum* (d), *Mimusops zeyheri* (d), *Syzygium legatii* (d), *Apodytes dimidiata* subsp. *dimidiata*, *Combretum molle*, *Heteropyxis natalensis*, *Maytenus undata*. Tall Shrubs: *Coddia rudis*, *Combretum moggii*, *Euclea linearis*, *Hyperacanthus amoenus*, *Olea capensis* subsp. *enervis*, *Vitex rehmannii*. Low Shrubs: *Rhus magalismontana* subsp. *coddii* (d), *Helichrysum kraussii*, *Heteromorpha stenophylla* var. *transvaalensis*, *Myrothamnus flabellifolius*. Geoxylic Suffrutex: *Parinari capensis* subsp. *capensis* (d). Succulent

Shrubs: *Aloe arborescens*, *Kalanchoe sexangularis*. Graminoids: *Coleochloa setifera* (d), *Setaria sphacelata* (d), *Melinis nerviglumis*, *Trachypogon spicatus*. Herbs: *Fadogia homblei* (d), *Dicoma anomala*, *Felicia mossamedensis*, *Gerbera viridifolia*, *Vernonia natalensis*. Succulent Herbs: *Crassula swaziensis*, *Plectranthus cylindraceus*. **Open savanna sandveld:** Small Trees: *Burkea africana* (d), *Ochna pulchra* (d), *Combretum apiculatum*, *Ochna pretoriensis*, *Pseudolachnostylis maprouneifolia*, *Terminalia sericea*. Tall Shrubs: *Corchorus kirkii*, *Diplorhynchus condylocarpon*, *Elephantorrhiza burkei*, *Strychnos madagascariensis*. Graminoids: *Centropodia glauca* (d), *Enneapogon cenchroides*. Herb: *Xerophyta retinervis* (d). **Arid mountain bushveld:** Tall Trees: *Acacia nigrescens*, *Adansonia digitata*. Small Trees: *Combretum apiculatum*, *Commiphora glandulosa*, *C. mollis*. Tall Shrub: *Tinnea rhodesiana*. Low Shrubs: *Blepharis diversispina*, *Gossypium herbaceum* subsp. *africanum*. Woody Climber: *Acacia ataxacantha*. Herb: *Hibiscus meyeri* subsp. *transvaalensis*. Succulent Herb: *Kleinia fulgens*.

E. van Wyk

Figure 9.30 SVcb 22 VhaVenda Miombo: Hillslopes with savanna dominated by *Brachystegia spiciformis* in the Mbodi River Valley (Soutpansberg), Limpopo Province.

Biogeographically Important Taxa (Soutpansberg endemics) Succulent Herbs: *Aloe vossii*, *Huernia whitesloaneana*, *Orbea conjuncta, Stapelia clavicorona*.

Endemic Taxa Tall Shrubs: *Combretum vendae*, *Vangueria soutpansbergensis*. Low Shrubs: *Blepharis spinipes*, *Dicoma montana*, *Justicia montis-salinarum*, *Tylophora coddii*. Succulent Shrub: *Kalanchoe crundallii*. Herbaceous Climber: *Ipomoea bisavium*. Graminoid: *Panicum dewinteri*. Herb: *Streptocarpus caeruleus*. Succulent Herbs: *Aloe swynnertonii*, *Huernia nouhuysii*.

Conservation Vulnerable. Target 24%. Just over 2% statutorily conserved in the Blouberg, Happy Rest and Nwanedi Nature Reserves. A smaller area is conserved in other reserves. Some 21% transformed, with about 14% cultivated and 6% plantations. High rural human population densities in some of the lower lying parts of the eastern section of the unit. Erosion is very low to moderate.

Remarks This unit is part of the Soutpansberg CE (Van Wyk & Smith 2001). The unit has patches of Northern Mistbelt Forest and Northern Escarpment Afromontane Fynbos embedded in its generally south-facing, upper elevation reaches in the central-western parts. Also embedded are patches of Soutpansberg Summit Sourveld, generally but not always, at elevations higher than the unit. VhaVenda Miombo is also embedded very locally at a lower elevation in the eastern part of the unit. Further research, particularly in the eastern section of this unit, may indicate a revision of this unit.

References Scholes (1979), Van Jaarsveld & Hardy (1991), Van Wyk & Smith (2001), N. Hahn (unpublished data), T.H.C. Mostert (unpublished data), C.H. Verwey (unpublished data).

SVcb 22 VhaVenda Miombo

VT 19 Sourish Mixed Bushveld (100%) (Acocks 1953). LR 11 Soutpansberg Arid Mountain Bushveld (100%) (Low & Rebelo 1996).

Distribution Limpopo Province: As far as is known, it is limited to a small area in the upper reaches of the Mbodi River Valley between Shakadaza and Mafukani within the eastern extension of SVcb 21 Soutpansberg Mountain Bushveld. Altitude about 750–850 m.

Vegetation & Landscape Features Moderately gentle to some steeper slopes with surface stone, in a narrow valley straddling a north-flowing section of the Mbodi River. Fragmented, archipelago of patches with tallest *Brachystegia spiciformis* trees toward the centres of the islands. Tree layer very broken and irregular cover of larger and smaller shrubs. Understorey is species-poor with mainly *Senecio barbertonicus* on deeper soils and *Cyanotis lapidosa* on the shallow soils. Very sparse ground cover with grasses virtually limited to streambanks.

Geology & Soils Sandstone and quartzite of the Wyllie's Poort Formation (Mokolian Soutpansberg Group). Shallow sand with rock and deeper sands in some places. Land type is Ib.

Climate Summer rainfall with very dry winters. MAP about 670–680 mm. Frost very infrequent. See also climate diagram for SVcb 22 VhaVenda Miombo.

Important Taxa Small Trees: *Afzelia quanzensis*, *Albizia adianthifolia*, *Berchemia discolor*, *Bridelia mollis*, *Burkea africana*, *Combretum collinum* subsp. *gazense*, *Englerophytum magalismontanum*, *Erythrina lysistemon*, *Ficus glumosa*, *F. sansibarica*, *F. sur*, *Parinari curatellifolia*, *Peltophorum africanum*, *Plectroniella armata*, *Syzygium cordatum*, *S. guineense*, *Tabernaemontana elegans*, *Ximenia caffra*, *Xylopia odoratissima*, *Zanthoxylum capense*, *Z. leprieurii*, *Ziziphus mucronata*. Succulent Trees: *Euphorbia confinalis*, *E. ingens*, *E. tirucalli*. Tall Shrubs: *Coddia rudis*, *Grewia flavescens*, *Hexalobus monopetalus*, *Lagynias dryadum*, *Strychnos madagascariensis*, *S. pungens*. Low Shrub: *Rhus magalismontana* subsp. *coddii*. Succulent Shrubs: *Senecio barbertonicus* (d), *Kalanchoe lanceolata*, *K. rotundifolia*, *K. sexangularis*. Woody Climbers: *Acacia schweinfurthii*, *Artabotrys brachypetalus*, *Bauhinia galpinii*, *Cissus quadrangularis*, *Tecoma capensis*. Herbaceous Climber: *Senecio tamoides*. Herbs: *Cyanotis lapidosa*, *Portulaca kermesina*. Geophytic Herbs: *Asplenium schelpei*, *Cheilanthes viridis* var. *glauca*, *Cyrtorchis praetermissa*, *Sansevieria aethiopica*, *S. hyacinthoides*. Succulent Herbs: *Aloe aculeata*, *Crassula lanceolata*. Epiphytic Succulent Herb: *Ansellia africana*.

Biogeographically Important Taxon (Southern distribution limit in South Africa) Small Tree: *Brachystegia spiciformis* (d).

Conservation The unit is not conserved. The village of Gundane is in very close proximity to and extends into the southern part of the unit. The vegetation is heavily impacted by grazing (with grass cover virtually zero), wood-collecting (with at least half of the *Brachystegia spiciformis* trees estimated to have been removed, also to allow for a *Eucalyptus* plantation; P.J.H. Hurter, personal communication) and slash agriculture, mainly maize and a type of *Solanum* used as a relish. The alien *Opuntia ficus-indica* is common. A popular ecotourism lodge is situated within the unit.

Remarks *Brachystegia spiciformis* is one of the most important dominant species of miombo woodlands typical of southern, central and parts of eastern Africa, where they cover more than 2.7 million km^2. The occurrence of this species in South Africa was scientifically ascertained only recently (Van Wyk & Hurter 2000). It has been previously known from pollen records dated 19 000 years BP (Scott 1982) and its occurrence in the Soutpansberg (where it totals only a few thousand individuals) might be a relict of former larger distribution of miombo (see also Campbell 1996). Despite the assertion that these *Brachystegia spiciformis* patches do not constitute miombo relict vegetation (Hahn 2002), there are a number of species in the unit that occur in various miombo vegetation types to the north. These include: *Afzelia quanzensis*, *Albizia adianthifolia*, *Burkea africana*, *Combretum collinum*, *Parinari curatellifolia*, *Strychnos pungens*, *Syzygium guineense* and *Tabernaemontana elegans* (Werger & Coetzee 1978). The vegetation unit contains an unusually high proportion of succulent species compared to other miombo types. None of the Soutpansberg endemic species have been recorded in the unit.

References Van Wyk & Hurter (2000), Hurter & Van Wyk (2001), Willis et al. (2001), Hahn (2002).

SVcb 23 Polokwane Plateau Bushveld

VT 67 Pietersburg Plateau Grassveld (50%) (Acocks 1953). LR 18 Mixed Bushveld (88%) (Low & Rebelo 1996).

Distribution Limpopo Province: The higher-lying plains around Polokwane, north of the Strydpoort Mountains and south of the SVcb 20 Makhado Sweet Bushveld. Altitude about 1 100–1 500 m.

M.C. Rutherford

Figure 9.31 SVcb 23 Polokwane Plateau Bushveld: Very open savanna with low *Acacia tortilis* trees at an altitude of 1 250 m on Pilgrimshoop, north of Polokwane.

Vegetation & Landscape Features Moderately undulating plains with short open tree layer with a well-developed grass layer to grass plains with occasional trees at higher altitudes (for example the Mashashane area in the southwest and the south-eastern watershed of the Sand River catchment, such as around Eersteling). Hills and low mountains of SVcb 24 Mamabolo Mountain Bushveld are embedded within this unit.

Geology & Soils Migmatites and gneisses of the Hout River Gneiss and the Turfloop Granite (both of Randian Erathem) are dominant. Some ultramafic and mafic metavolcanics, quartzite and chlorite schist of the Pietersburg Group (Swazian Erathem) are also found. Soils variable, with freely drained soils with high base status, some dystrophic/mesotrophic, eutrophic plinthic catenas. Glenrosa and Mispah soil forms. Land types mainly Ae, Bd, Ah, Ab, Bc and Fa.

Climate Summer rainfall with very dry winters. MAP from about 400 mm in the northwest to about 600 mm where it borders on the foot of mountains to the east and south. Frost fairly infrequent. Mean monthly maximum and minimum temperatures for Polokwane 33.2°C and 0.6°C for October and June, respectively. See also climate diagram for SVcb 23 Polokwane Plateau Bushveld.

Important Taxa Small Trees: *Acacia caffra* (d), *A. permixta* (d), *A. rehmanniana* (d), *A. karroo*, *A. tortilis* subsp. *heteracantha*, *Combretum molle*, *Ormocarpum kirkii*, *Ziziphus mucronata*. Succulent Tree: *Aloe marlothii* subsp. *marlothii*. Tall Shrubs: *Acacia hebeclada* subsp. *hebeclada* (d), *Gymnosporia senegalensis* (d), *Combretum hereroense*, *Diospyros lycioides* subsp. *sericea*, *Euclea crispa* subsp. *crispa*, *Heteromorpha arborescens* var. *abyssinica*, *Lippia javanica*, *Rhus pyroides* var. *pyroides*, *Tephrosia rhodesica*, *Triumfetta pilosa* var. *tomentosa*. Low Shrubs: *Anthospermum rigidum* subsp. *rigidum*, *Gymnosporia glaucophylla*, *Hirpicium bechuanense*, *Lantana rugosa*, *Senecio burchellii*, *Sida rhombifolia*, *Solanum panduriforme*. Succulent Shrub: *Aloe cryptopoda*. Woody Climber: *Asparagus africanus*. Herbaceous Climbers: *Momordica balsamina*, *Rubia petiolaris*. Graminoids: *Aristida diffusa* (d), *Brachiaria nigropedata* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Eragrostis curvula* (d), *Themeda triandra* (d), *Aristida congesta*, *Cymbopogon caesius*, *Cynodon dactylon*, *Digitaria diagonalis*, *Diheteropogon amplectens*, *Elionurus muticus*, *Eragrostis gummiflua*, *E. racemosa*, *E. superba*, *Eustachys paspaloides*, *Panicum maximum*, *Pogonarthria squarrosa*, *Sporobolus africanus*. Herbs: *Felicia mossamedensis*, *Hermbstaedtia odorata*, *Pollichia campestris*. Geophytic Herbs: *Eulophia petersii*, *Hypoxis hemerocallidea*. Succulent Herb: *Aloe greatheadii* var. *greatheadii*.

Biogeographically Important Taxa (Central Bushveld endemics) Graminoid: *Mosdenia leptostachys*. Herb: *Oxygonum dregeanum* subsp. *canescens* var. *dissectum*. Geophytic Herb: *Ledebouria crispa*.

Conservation Least threatened according to remote sensing sources, but with over one third of the remaining vegetation regarded as degraded, would probably be regarded as susceptable. Target 19%. Less than 2% statutorily conserved mainly in the Percy Fyfe and Kuschke Nature Reserves. In addition, 0.7% conserved in other reserves, for example the Polokwane Game Reserve. Some 17% transformed, including about 10% cul-

tivated and 6% urban and built-up. Dense concentration of rural human settlements is found particularly in the eastern and northwestern parts of the unit. In some regions, scattered populations of alien *Agave*, *Jacaranda mimosifolia*, *Melia azedarach*, *Opuntia ficus-indica* and *Ricinus communis* are of concern. Erosion is high to moderate.

Remark Woody plants have increased in parts of the unit in the past few decades.

References Bredenkamp & Van Vuuren (1977), Bredenkamp (1986b), Winterbach (1998).

SVcb 24 Mamabolo Mountain Bushveld

VT 19 Sourish Mixed Bushveld (43%), VT 8 North-Eastern Mountain Sourveld (32%) (Acocks 1953). LR 43 North-eastern Mountain Grassland (53%) (Low & Rebelo 1996).

Distribution Limpopo Province: East and south of the Polokwane Plateau along the foothills of the west-facing part of the eastern escarpment and of the Strydpoort and Makapan Mountains. Also on main isolated hills and small mountains embedded within the Polokwane Plateau as far as Mogoshi Mountain in the west and De Loskop (near Mogwadi) and Renosterkoppies (around Zandrivierspoort) to the north. Altitude mostly 1 200–1 600 m.

Vegetation & Landscape Features Low mountains, lower slopes of Strydpoort and Makapan ranges, and rocky hills. Slopes are moderate to steep, and very rocky, covered by small trees and shrubs. Rock slabs or domes are sparsely vegetated, and then mostly with a mixture of xerophytic or resurrection plants, with several succulents.

Geology & Soils Very varied geology includes basement granite and gneiss, clastic sediments of the Pretoria Group (Vaalian) and ultramafic and mafic metavolcanics of the Pietersburg Group (Swazian). Shallow and skeletal soil (including Mispah and Glenrosa soil forms). Land types mainly Ib and Fa.

Climate Summer rainfall with dry winters. MAP about 450–750 mm. Frost fairly infrequent. With the coolest mean annual temperature of all savanna units apart from the three mountain bushveld units of the Highveld. See also climate diagram for SVcb 24 Mamabolo Mountain Bushveld.

Important Taxa Tall Tree: *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Combretum molle* (d), *Croton gratissimus* (d), *Heteropyxis natalensis* (d), *Acacia caffra*, *A. davyi*, *A. gerrardii*, *A. nilotica*, *Berchemia zeyheri*, *Cussonia natalensis*, *C. transvaalensis*, *Dombeya rotundifolia*, *Erythrina lysistemon*, *Lannea discolor*, *Maytenus undata*, *Pappea capensis*, *Rhus leptodictya*, *Schotia brachypetala*. Succulent Trees: *Euphorbia cooperi* (d), *Aloe marlothii* subsp. *marlothii*, *Euphorbia ingens*. Tall Shrubs: *Clerodendrum glabrum* (d), *Elephantorrhiza burkei* (d), *Acokanthera oppositifolia*, *A. rotundata*, *Buddleja saligna*, *Canthium mundianum*, *Carissa edulis*, *Ehretia obtusifolia*, *Euclea crispa* subsp. *crispa* (short, small-leaved form), *Grewia occidentalis*, *Hibiscus calyphyllus*, *Olea europaea* subsp. *africana*, *Pouzolzia mixta*, *Rhus pentheri*, *R. rehmanniana*, *Scutia myrtina*, *Tarchonanthus parvicapitulatus*. Low Shrubs: *Diospyros lycioides* subsp. *nitens* (d), *Grewia vernicosa* (d), *Barleria rotundifolia*, *Gossypium herbaceum* subsp. *africanum*, *Gymnosporia glaucophylla*, *Hermannia floribunda*, *Heteromorpha stenophylla* var. *transvaalensis*, *Lantana rugosa*, *Myrothamnus flabellifolius*, *Plinthus rehmannii*. Succulent Shrubs: *Kalanchoe sexangularis* (d), *Kleinia longiflora* (d), *Aloe arborescens*, *Cotyledon barbeyi*, *C. orbiculata* var. *orbiculata*, *Kalanchoe paniculata*, *K. rotundifolia*, *Senecio barbertonicus*, *Tetradenia riparia*. Woody Climbers: *Asparagus buchananii* (d), *Jasminum multipartitum* (d), *Acacia ataxacantha*, *Cryptolepis cryptolepidioides*. Herbaceous Climber: *Pentarrhinum insipidum*. Graminoids: *Cymbopogon caesius* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Heteropogon contortus* (d), *Aristida congesta*, *A. diffusa*, *Enneapogon scoparius*, *Eragrostis rigidior*, *Tricholaena monachne*, *Triraphis andropogonoides*. Herb: *Vahlia capensis* subsp. *vulgaris*. Geophytic Herbs: *Boophone disticha*, *Drimia altissima*, *D. robusta*, *Eulophia petersii*. Succulent Herbs: *Aloe greatheadii* var. *greatheadii* (d), *Aeollanthus rehmannii*, *Avonia rhodesica*, *Crassula swaziensis*, *Plectranthus grandidentatus*, *P. hadiensis*.

Endemic Taxa Succulent Shrubs: *Euphorbia clivicola*, *Khadia media*.

Conservation Least threatened. Target 24%. Almost 8% statutorily conserved mainly in the Witvinger and Bewaarkloof Nature Reserves. About 6% transformed, including about 2% each of urban and built-up areas, plantations and cultivated land. Land uses include grazing, wood harvesting and medicinal plant collecting. Alien plants include *Nicotiana glauca*, *Opuntia* species and *Zinnia peruviana*. Erosion is generally moderate to very low, and high in some areas.

References Winter & Hahn (1999), Ndowana Exploration (Pty) Ltd (2003).

L. Mucina

Figure 9.32 SVcb 24 Mamabolo Mountain Bushveld: Granite koppie with abundant *Euphorbia cooperi* near Ga-Mankoeng, east of Polokwane.

SVcb 25 Poung Dolomite Mountain Bushveld

VT 19 Sourish Mixed Bushveld (44%), VT 8 North-Eastern Mountain Sourveld (43%) (Acocks 1953). LR 43 North-eastern Mountain Grassland (96%) (Low & Rebelo 1996).

Distribution Limpopo and Mpumalanga Provinces: Mountain slopes from the area of the Abel Erasmus Pass in the south, more or less continuously northwards along the western rainshadow side of the escarpment, including Poung

Mountain near Penge becoming discontinuous towards the Wolkberg and westwards along the Strydpoort Mountains to Chuniespoort and Mokopane. Altitude about 600–1 500 m extending to about 1 600 m in parts of the west.

Vegetation & Landscape Features Open to closed woodland with well-developed shrub layers. Low to high mountain slopes. Various slope angles, aspects and altitude, especially along the western extension.

Geology & Soils Geology almost entirely Malmani Formation dolomite of the Transvaal Supergroup with chert always interlayered. Soils with high pH, rich in calcium and magnesium, and with low levels of phosphorus. Soils are usually shallow (Mispah soil form) and occasionally deep (Hutton and Griffin soil forms). Land types mainly Ib and Fa.

Climate Summer rainfall with dry winters. MAP about 500–900 mm, lowest in the escarpment rainshadow and peaking near the border, with grassland at higher altitudes on the escarpment, lower on the Strydpoort Mountain part of this unit than on the escarpment. Mist absent and frost infrequent. See also climate diagram for SVcb 25 Poung Dolomite Mountain Bushveld.

Important Taxa Small Trees: *Hippobromus pauciflorus* (d), *Kirkia wilmsii* (d), *Seemannaralia gerrardii* (d), *Boscia albitrunca*, *Combretum hereroense, Croton gratissimus*, *Dombeya autumnalis*, *Vitex obovata* subsp. *wilmsii*. Succulent Tree: *Euphorbia tirucalli* (d). Tall Shrubs: *Pouzolzia mixta*, *Senna petersiana*. Low Shrubs: *Asparagus intricatus* (d), *Barleria rotundifolia*, *Euchaetis schlechteri*, *Rhynchosia nitens*. Geoxylic Suffrutex: *Ozoroa albicans*. Succulent Shrub: *Plectranthus xerophilus* (d). Woody Climbers: *Pristimera longipetiolata*, *Tecoma capensis*. Graminoids: *Bewsia biflora* (d), *Brachiaria serrata* (d), *Eragrostis lehmanniana* (d), *Loudetia simplex* (d), *Melinis repens* (d), *Panicum maximum* (d), *Themeda triandra* (d), *Enneapogon scoparius*, *Heteropogon contortus*, *Melinis nerviglumis*, *Panicum deustum*, *Tragus berteronianus*. Herb: *Stylochaeton natalensis*. Geophytic Herbs: *Cheilanthes dolomiticola* (d), *Sansevieria hyacinthoides*. Succulent Herb: *Plectranthus neochilus*.

Biogeographically Important Taxa ([N]Northern Sourveld endemic, [SK]Sekhukhune endemic) Small Tree: *Lydenburgia cassinoides*[SK] (d). Low Shrub: *Asparagus fourei*[N]. Soft Shrub: *Chorisochora transvaalensis*[N]. Megaherb: *Dracaena transvaalensis*[N] (d). Geophytic Herb: *Haemanthus pauculifolius*[N].

M.C. Lötter

Figure 9.33 SVcb 25 Poung Dolomite Mountain Bushveld: Rocky deciduous woodland, dominated by *Kirkia wilmsii* and *Combretum hereroense* with *Aloe fosteri*, *Sarcostemma viminale* and *Plectranthus xerophilus* northeast of Penge Mine, Limpopo Province.

Endemic Taxa Small Trees: *Encephalartos dolomiticus*, *E. inopinus*. Low Shrub: *Melhania integra*. Succulent Shrubs: *Delosperma vandermerwei*, *Euphorbia grandialata*. Herbs: *Barleria dolomiticola*, *Lotononis pariflora*. Geophytic Herbs: *Brachystelma minor*, *B. parvulum*, *Gladiolus dolomiticus*, *G. pavonia*, *Ledebouria dolomiticola*. Succulent Herbs: *Aloe branddraaiensis*, *A. monotropa*, *Gasteria batesiana* var. *dolomitica*, *Huernia blyderiverensis, Plectranthus dolomiticus*.

Conservation Least threatened. Target 24%. Some 10% statutorily conserved mainly in the Bewaarkloof and Lekgalameetse Nature Reserves. An additional 6% conserved in other reserves including the Wolkberg (Serala) Wilderness Area. About 6% transformed, mainly for cultivation. Erosion is very low to moderate.

Remark Species are often associated with the Wolkberg CE, although some species are also shared with the Sekhukhuneland CE (e.g. *Dombeya autumnalis*, *Orthosiphon tubiformis*) and other northern sourveld units.

References Stalmans (1990), Matthews (1991), Stalmans & De Klerk (1991, 1992), Van Wyk & Smith (2001).

SVcb 26 Ohrigstad Mountain Bushveld

VT 19 Sourish Mixed Bushveld (44%), VT 18 Mixed Bushveld (33%) (Acocks 1953). LR 43 North-eastern Mountain Grassland (52%) (Low & Rebelo 1996).

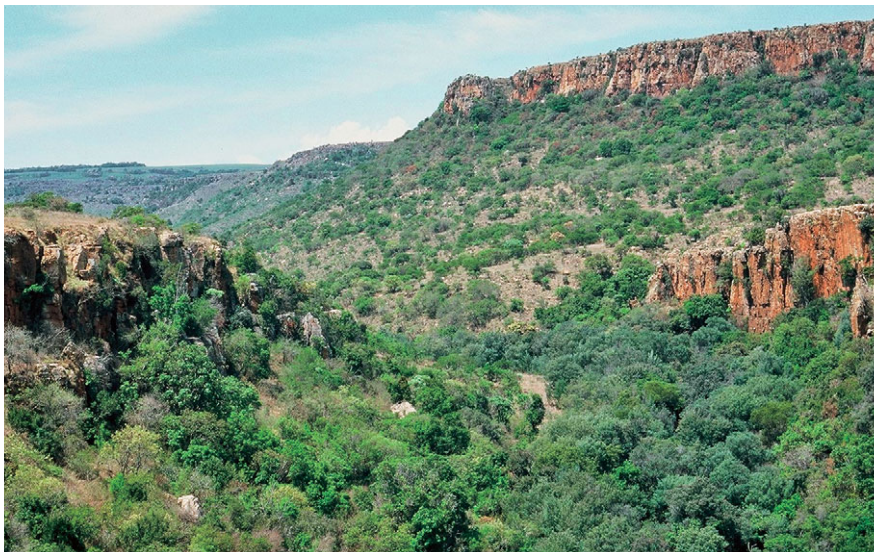
Distribution Limpopo and Mpumalanga Provinces: Mountain slopes and steep valleys from the Blyde River Canyon, Ohrigstad and Burgersfort in the south continuing in the vicinity of the western side of the escarpment northwards to the Mohlapitse Valley and eastwards along the Strydpoort Mountains as far as Chuniespoort. Altitude varies widely from around 500 m (in the Olifants River Gorge) to about 1 400 m.

Vegetation & Landscape Features Open to dense woody layer, with associated woody and herbaceous shrubs and closed to open grass layer. Moderate to steep slopes on mountainsides and sometimes deeply incised valleys; also fairly flat terrain in a few places.

Geology & Soils Primarily on quartzite and shale (Timeball Hill and Silverton Formations of the Pretoria Group), with some chemical sediments of the Chuniespoort Group, weathering to shallow rocky soils of either Glenrosa or Mispah soil forms. Land types mainly Ib, Ae and Fa.

Climate Summer rainfall with very dry winters. MAP about 500–800 mm. Frost infrequent. See also climate diagram for SVcb 26 Ohrigstad Mountain Bushveld.

Important Taxa Tall Tree: *Sclerocarya birrea* subsp. *caffra* (d). Small Trees: *Acacia exuvialis* (d), *A. karroo* (d), *A. tortilis* subsp. *heteracantha* (d), *Combretum apiculatum* (d), *C. molle* (d), *Kirkia wilmsii* (d), *Acacia caffra*, *Berchemia zeyheri*, *Boscia foetida* subsp. *rehmanniana*, *Commiphora mollis*, *Croton gratissimus*, *Englerophytum magalismontanum*, *Hippobromus pauciflorus*, *Pappea capensis*, *Terminalia prunioides*, *Vitex obovata* subsp. *wilmsii*, *Ziziphus mucronata*. Succulent Trees: *Euphorbia tirucalli* (d), *E. cooperi*. Tall Shrubs: *Dichrostachys*



W.L. McCleland

Figure 9.34 SVcb 26 Ohrigstad Mountain Bushveld: Moderately dense woodland on hillslopes with rocky substrate with common species including *Acacia caffra*, *Aloe marlothii*, *Elaeodendron transvaalense*, *Euclea crispa* (blue-leaved form) and *Englerophytum magalismontanum* near Crystal Springs Mountain Lodge, about 10 km from Ohrigstad.

cinerea (d), *Combretum petrophilum*, *Crotalaria monteiroi*, *Grewia bicolor*, *G. monticola*, *Hexalobus monopetalus*, *Karomia speciosa*, *Olea europaea* subsp. *africana*, *Tarchonanthus camphoratus*. Low Shrubs: *Grewia vernicosa* (d), *Psiadia punctulata* (d), *Euclea crispa*. Succulent Shrubs: *Aloe castanea* (d), *A. cryptopoda*, *A. globuligemma*. Woody Climber: *Pterolobium stellatum* (d). Graminoids: *Loudetia simplex* (d), *Andropogon chinensis*, *Aristida congesta*, *Brachiaria nigropedata*, *Eragrostis rigidior*, *Melinis repens*, *Panicum maximum*. Succulent Herb: *Aloe fosteri* (d).

Biogeographically Important Taxon (Central Bushveld endemic) Low Shrub: *Petalidium oblongifolium*.

Endemic Taxa Small Tree: *Encephalartos cupidus*. Woody Climbers: *Asparagus lynnetteae, Rhoicissus laetans*. Succulent Herbaceous Climber: *Ceropegia distincta* subsp. *verruculosa*.

Conservation Least threatened. Target 24%. Almost 8% statutorily conserved, mainly in the Bewaarkloof and Blyde River Canyon Nature Reserves. At least an additional 4% in other reserves, mainly the Wolkberg (Serala) Wilderness Area. At least 9% transformed, mostly by cultivation. Aliens include scattered *Melia azedarach*, *Caesalpinia decapetala* and *Nicotiana glauca*. Erosion is very variable, from very low to very high in parts of the Sekhukhune region.

Remarks Most of the unit is relatively dry mountain bushveld in the rainshadow west of the northern parts of the Drakensberg. The northern area of this unit has been included in the Wolkberg CE (Van Wyk & Smith 2001).

Reference Van Wyk & Smith (2001).

SVcb 27 Sekhukhune Plains Bushveld

VT 18 Mixed Bushveld (71%) (Acocks 1953). LR 18 Mixed Bushveld (97%) (Low & Rebelo 1996). *Acacia tortilis–Dichrostachys cinerea* Arid Northern Dry Bushveld (Siebert et al. 2002a).

Distribution Limpopo and Mpumalanga Provinces: Lowland area from Burgersfort and the lower basin of the Steelpoort River in the south, northwards through the plains of the Motse River basin to Jobskop and Legwareng (south of the Strydpoort Mountains). Continues up the basin of the Olifants River to around Tswaing and the valleys of the Lepellane and Mohlaletsi Rivers. Altitude mostly about 700–1 100 m.

Vegetation & Landscape Features Mainly semi-arid plains and open valleys between chains of hills and small mountains running parallel to the escarpment. Predominantly short, open to closed thornveld with an abundance of *Aloe* species and other succulents. Heavily degraded in places and overexploited by man for cultivation, mining and urbanisation. Both man-made and natural erosion dongas occur in areas containing clays rich in heavy metals. Encroachment by indigenous microphyllous trees and invasion by alien species is common throughout the area.

Geology & Soils Complex geology, with rocks mainly mafic and ultramafic intrusive rocks of the main to lower zones of the Rustenberg Layered Suite on the eastern lobe of the Bushveld Igneous Complex (Vaalian). The zones (subsuites) are dominated by concentric belts of norite, gabbro, anorthosite and pyroxenite, with localised protrusions of magnetite, chromatite, serpentinised harzburgite, olivine diorite, shale, dolomite and quartzite. Most of the area consists of red apedal soils. Deep, loamy Valsrivier soils are characteristic of the plains and shallow Glenrosa soils are found on the low-lying, rocky hills. Patches of erodable black, melanic structured horizons are common around small mountains. Some Steendal soils are underlain by gypsum. Land types mainly Ae, Ib, Ea and Ia.

Climate Summer rainfall with very dry winters. MAP about 400–600 mm, but at the lower end of this range on the central plains increasing to about 500 mm on the plains east of the Leolo Mountains. Frost very infrequent. Mean monthly maximum and minimum temperatures for Tswelopele 37.3°C and –0.9°C for January and June, respectively. Daily temperatures vary considerably at different localities, with higher temperatures on the western plains and lower temperatures on higher-lying plateaus. See also climate diagram for SVcb 27 Sekhukhune Plains Bushveld.

Important Taxa Tall Trees: *Acacia erioloba*, *Philenoptera violacea*. Small Trees: *Acacia mellifera* subsp. *detinens* (d), *A. nilotica* (d), *A. tortilis* subsp. *heteracantha* (d), *Boscia foetida* subsp. *rehmanniana* (d), *Acacia grandicornuta*, *Albizia anthelmintica*, *Balanites maughamii*, *Combretum imberbe*, *Commiphora glandulosa*, *Maerua angolensis*, *Markhamia zanzibarica*, *Mystroxylon aethiopicum* subsp. *schlechteri*, *Ptaeroxylon obliquum*, *Schotia brachypetala*, *Ziziphus mucronata*. Succulent Tree: *Euphorbia tirucalli* (d). Tall Shrubs: *Rhus engleri* (d), *Cadaba termitaria*, *Dichrostachys cinerea*, *Ehretia rigida* subsp. *rigida*, *Grewia bicolor*, *Karomia speciosa*, *Maerua decumbens*, *Rhigozum brevispinosum*, *R. obovatum*, *Tinnea rhodesiana*, *Triaspis glaucophylla*. Low Shrubs: *Felicia clavipilosa* subsp. *transvaalensis* (d), *Seddera suffruticosa* (d), *Gnidia polycephala*, *Gossypium herbaceum* subsp. *africanum*, *Jamesbrittenia atropurpurea*, *Jatropha latifolia* var. *latifolia*, *Lantana rugosa*, *Melhania rehmannii*, *Monechma divaricatum*, *Myrothamnus flabellifolius*, *Pechuel-Loeschea leubnitziae*, *Plinthus rehmannii*. Succulent Shrubs: *Aloe cryptopoda* (d), *Euphorbia enormis* (d), *Kleinia longiflora* (d), *Aloe castanea*, *A. globuligemma*. Woody Succulent

Climber: *Sarcostemma viminale*. Herbaceous Climbers: *Coccinia rehmannii*, *Decorsea schlechteri*. Graminoids: *Cenchrus ciliaris* (d), *Enneapogon cenchroides* (d), *Panicum maximum* (d), *Urochloa mosambicensis* (d), *Aristida adscensionis*, *A. congesta*, *Eragrostis barbinodis*, *Paspalum distichum*, *Schmidtia pappophoroides*, *Stipagrostis hirtigluma* subsp. *patula*, *Tragus berteronianus*. Herbs: *Becium filamentosum* (d), *Phyllanthus maderaspatensis* (d), *Blepharis integrifolia*, *Corchorus asplenifolius*, *Hibiscus praeteritus*, *Ipomoea magnusiana*. Geophytic Herbs: *Drimia altissima*, *Sansevieria pearsonii*.

Biogeographically Important Taxa ([N]Northern Sourveld endemic, [CB]Central Bushveld endemic, [SK]Sekhukhune endemic, [D]Broadly disjunct distribution) Small Tree: *Lydenburgia cassinoides*[SK]. Tall Shrub: *Nuxia gracilis*[D]. Low Shrubs: *Amphiglossa triflora*[D], *Asparagus fourei*[N], *Hibiscus barnardii*[SK], *Orthosiphon fruticosus*[CB], *Petalidium oblongifolium*[CB], *Rhus batophylla*[SK]. Woody Climber: *Asparagus sekukuniensis*[SK]. Herb: *Aneilema longirrhizum*[SK]. Geophytic Herb: *Chlorophytum cyperaceum*[SK]. Succulent Herb: *Piaranthus atrosanguineus*[CB].

Conservation Vulnerable. Target 19%. Nearly 2% statutorily conserved in Potlake, Bewaarkloof and Wolkberg Caves Nature Reserves. Approximately 25% of this area has been transformed and is mainly under dry-land subsistence cultivation. A small area is under pressure from chrome and platinum mining activities and the associated urbanisation. Depending on commodities, this threat could increase in the future. There is a high level of degradation of much of the remaining vegetation by unsustainable harvesting and utilisation. Erosion widespread at usually high to very high levels with donga formation. Alien *Agave* species, *Caesalpinia decapetala*, *Lantana camara*, *Melia azedarach*, *Nicotiana glauca*, *Opuntia* species, *Verbesina encelioides* and *Xanthium strumarium* are widespread but scattered.

Remarks This semi-arid bushveld is a disturbed and degraded system with many erosion dongas. However, much of the erosion can be attributed to inherent edaphic properties. The unit is situated in the Sekhukhuneland CE (Van Wyk & Smith 2001). Several endemic taxa of this unit still require formal description (Siebert et al. 2001). It is related to SVcb 28 Sekhukhune Mountain Bushveld, SVcb 23 Polokwane Plateau Bushveld and SVcb 15 Springbokvlakte Thornveld in terms of floristic diversity, species richness and vegetation structure (Breebaart & Deutschländer 1997, Siebert et al. 2002b).

References Breebaart & Deutschländer (1997), Siebert (2001), Siebert et al. (2001, 2002a, b, d, 2003a), Van Wyk & Smith (2001).

SVcb 28 Sekhukhune Mountain Bushveld

VT 19 Sourish Mixed Bushveld (50%) (Acocks 1953). LR 18 Mixed Bushveld (86%) (Low & Rebelo 1996). *Kirkia wilmsii–Terminalia prunioides* Closed Mountain Bushveld, *Combretum hereroense–Grewia vernicosa* Open Mountain Bushveld, *Hippobromus pauciflorus–Rhoicissus tridentata* Rock Outcrop Vegetation (Siebert et al. 2002a).

Distribution Limpopo and Mpumalanga Provinces: Mountains and undulating hills above the lowlands of the SVcb 27 Sekhukhune Plains Bushveld, including the steep slopes of the Leolo Mountains (except areas of Gm 20 Leolo Summit Sourveld), Dwars River Mountains (except areas of Gm 19 Sekhukhune Montane Grassland) and Thaba Sekhukhune, and a number of isolated smaller mountains (e.g. Phepane and Morone). Also the undulating small hills in the valley of the Steelpoort River up to and along the Klip River flowing past Roossenekal. Altitude about 900–1 600 m.

Vegetation & Landscape Features Dry, open to closed microphyllous and broad-leaved savanna on hills and mountain slopes that form concentric belts parallel to the northeastern escarpment. Open bushveld often associated with ultramafic soils on southern aspects. Bushveld on ultramafic soils contain a high diversity of edaphic specialists. Bushveld of mountain slopes generally taller than in the valleys, with a well-developed herb layer. Bushveld of valleys and dry northern aspects usually dense, like thicket, with a herb layer comprising many short-lived perennials. Dry habitats contain a number of species with xerophytic adaptations, such as succulence and underground storage organs. Both man-made and natural erosion dongas occur on footslopes of clays rich in heavy metals.

Geology & Soils Rocks mainly ultramafic intrusives of the lower, critical and main zones of the eastern Rustenberg Layered Suite of the Bushveld Igneous Complex (Vaalian). Three subsuites (zones), namely Croydon, Dwars River and Dsjate consist mainly of norite, pyroxenite, anorthosite and gabbro, and are characterised by localised intrusions of magnetite, diorite, dunite, bronzitite and harzburgite. Soils are predominantly shallow, rocky and clayey. Glenrosa and Mispah soil forms are common, with lime present in low-lying areas. Rocky areas without soil are common on steep slopes. The Dwars River Valley is characterised by prismacutanic horizons with melanic structured diagnostic horizons. Around Steelpoort red apedal, freely drained soils occur and these deeper soils include Hutton, Bonheim and Steendal soil forms. Land types mainly Ib, Ae, Ic and Fb.

Climate Summer rainfall with very dry winters. MAP about 500–700 mm, but local topography influences rainfall patterns over short distances. Frost fairly infrequent. Daily temperatures vary considerably at different localities, with highest temperatures in lower-lying areas and lowest temperatures on southern aspects of mountains. See also climate diagram for SVcb 28 Sekhukhune Mountain Bushveld.

Important Taxa Tall Tree: *Acacia nigrescens*. Small Trees: *Acacia senegal* var. *leiorhachis* (d), *Combretum apiculatum*

J.P.H. Acocks

Figure 9.35 SVcb 28 Sekhukhune Mountain Bushveld: Moderately open bushveld on upper slopes of the Leolo Mountains, Sekhukhune District, Limpopo Province.

(d), *Kirkia wilmsii* (d), *Terminalia prunioides* (d), *Vitex obovata* subsp. *wilmsii* (d), *Ziziphus mucronata* (d), *Bolusanthus speciosus*, *Boscia albitrunca*, *Brachylaena ilicifolia*, *Combretum molle*, *Commiphora mollis*, *Croton gratissimus*, *Cussonia transvaalensis*, *Hippobromus pauciflorus*, *Ozoroa sphaerocarpa*, *Pappea capensis*, *Schotia latifolia*, *Sterculia rogersii*. Succulent Tree: *Aloe marlothii* subsp. *marlothii*. Tall Shrubs: *Dichrostachys cinerea* (d), *Euclea crispa* subsp. *crispa* (d), *Combretum hereroense*, *Euclea linearis*, *Pavetta zeyheri*, *Tinnea rhodesiana*, *Triaspis glaucophylla*. Low Shrubs: *Elephantorrhiza praetermissa* (d), *Grewia vernicosa* (d), *Asparagus intricatus*, *Barleria saxatilis*, *B. senensis*, *Clerodendrum ternatum*, *Commiphora africana*, *Hermannia glanduligera*, *Indigofera lydenburgensis*, *Jatropha latifolia* var. *angustata*, *Melhania prostrata*, *Phyllanthus glaucophyllus*, *Psiadia punctulata*, *Rhus keetii*, *Rhynchosia komatiensis*. Succulent Shrubs: *Aloe castanea* (d), *A. cryptopoda* (d). Woody Climbers: *Clematis brachiata* (d), *Rhoicissus tridentata* (d), *Acacia ataxacantha*. Woody Succulent Climber: *Sarcostemma viminale*. Graminoids: *Aristida canescens* (d), *Heteropogon contortus* (d), *Panicum maximum* (d), *Setaria lindenbergiana* (d), *Themeda triandra* (d), *Aristida transvaalensis*, *Cymbopogon pospischilii*, *Diheteropogon amplectens*, *Enneapogon scoparius*, *Loudetia simplex*, *Panicum deustum*, *Setaria sphacelata*. Herbs: *Berkheya insignis* (d), *Commelina africana* (d), *Cyphostemma woodii*, *Kyphocarpa angustifolia*, *Senecio latifolius*. Geophytic Herbs: *Hypoxis rigidula*, *Sansevieria hyacinthoides*. Succulent Herb: *Huernia stapelioides*.

Biogeographically Important Taxa ([N]Northern Sourveld endemic, [CB]Central Bushveld endemic, [SK]Sekhukhune endemic, [Z]Link to Zimbabwe) Small Tree: *Lydenburgia cassinoides*[SK]. Tall Shrub: *Rhus sekhukhuniensis*[SK]. Low Shrubs: *Euclea sekhukhuniensis*[SK], *Petalidium oblongifolium*[CB], *Plectranthus venteri*[Z], *Rhus batophylla*[SK]. Woody Climbers: *Asparagus sekukuniensis*[SK], *Rhoicissus sekhukhuniensis*[SK]. Geophytic Herbs: *Chlorophytum cyperaceum*[SK], *Raphionacme chimanimaniana*[Z].

Endemic Taxa Small Tree: *Acacia ormocarpoides*. Succulent Tree: *Euphorbia sekukuniensis*. Soft Shrub: *Plectranthus porcatus*.

Conservation Least threatened. Target 24%. None conserved in statutory conservation areas, but 0.4% conserved in Potlake Nature Reserve. Nearly 15% transformed, mainly by cultivation and urban built-up. Erosion is at moderate to high levels, with donga formation in places. An increasing area along the Dwars River Subsuite is under pressure from mining activities and its associated urbanisation (Siebert et al. 2002d). *Melia azedarach* is currently the most aggressive alien invader.

Remarks This mountain bushveld is part of the Sekhukhuneland CE (Van Wyk & Smith 2001), more specifically the Steelpoort Subcentre. This vegetation unit is not heavily disturbed or degraded and its vast range of habitat still harbours high plant diversity with many endemics, many of which still await formal description (Siebert et al. 2001). It is related to SVcb 27 Sekhukhune Plains Bushveld, SVcb 7 Norite Koppies Bushveld and SVcb 26 Ohrigstad Mountain Bushveld in terms of floristic diversity, species richness and vegetation structure (Siebert et al. 2002b, c).

References Siebert (2001), Siebert et al. (2001, 2002a, b, c, d, 2003b), Van Wyk & Smith (2001).

Mopane

SVmp 1 Musina Mopane Bushveld

VT 15 Mopani Veld (80%) (Acocks 1953). LR 10 Mopane Bushveld (69%) (Low & Rebelo 1996).

Distribution Limpopo Province: Undulating plains from around Baines Drift and Alldays in the west, remaining north of the Soutpansberg and south of the Limpopo River (but also occurring to the north in Zimbabwe), through Musina and Tshipise to Malongavlakte, Masisi and Banyini Pan in the east. Altitude about 300 m (in the eastern Limpopo Valley) to 800 m.

Vegetation & Landscape Features Undulating to very irregular plains, with some hills. In the western section, open woodland to moderately closed shrubveld dominated by *Colophospermum mopane* on clayey bottomlands and *Combretum apiculatum* on hills. In the eastern section on basalt, moderately closed to

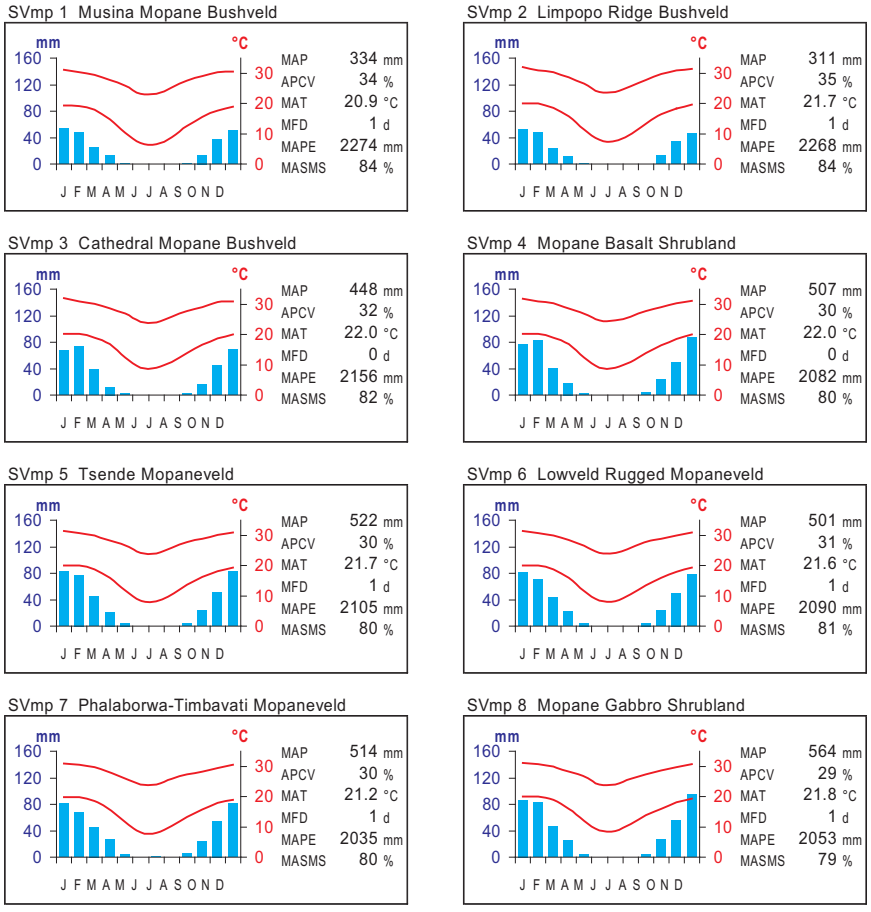
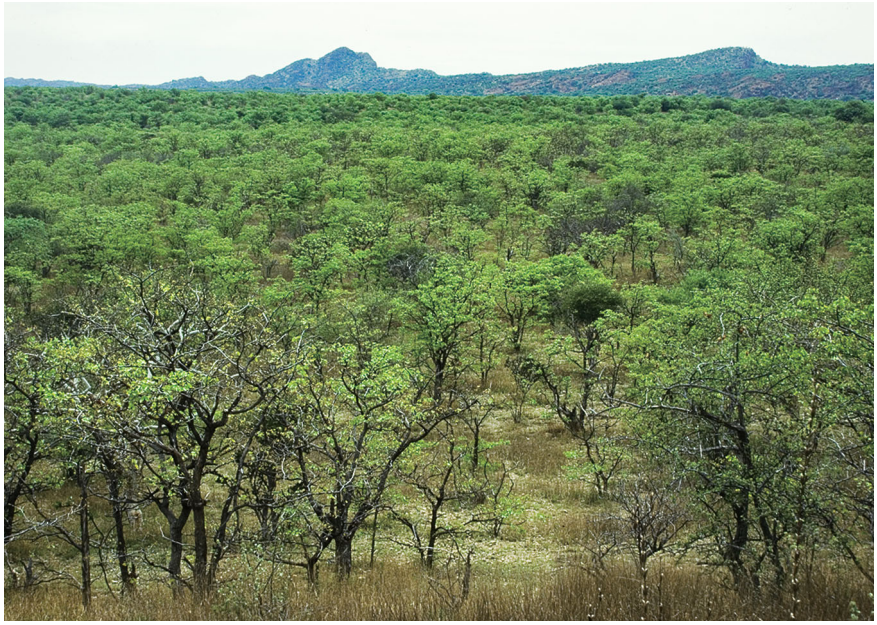


Figure 9.36 Climate diagrams of Mopane Bioregion units. Blue bars show the median monthly precipitation. The upper and lower red lines show the mean daily maximum and minimum temperature respectively. MAP: Mean Annual Precipitation; APCV: Annual Precipitation Coefficient of Variation; MAT: Mean Annual Temperature; MFD: Mean Frost Days (days when screen temperature was below 0°C); MAPE: Mean Annual Potential Evaporation; MASMS: Mean Annual Soil Moisture Stress (% of days when evaporative demand was more than double the soil moisture supply).



L. Mucina

Figure 9.37 SVmp 1 Musina Mopane Bushveld: Bushveld dominated by *Colophospermum mopane* in the Honnet Nature Reserve near Tshipise (Musina District, Limpopo Province).

open shrubveld is dominated by *Colophospermum mopane* and *Terminalia prunioides*. On areas with deep sandy soils, moderately open savanna dominated by *Colophospermum mopane*, *T. sericea*, *Grewia flava* and *Combretum apiculatum*. Field layer well developed (especially on the basalt), open during the dry season; the herbaceous layer is poorly developed in areas with dense cover of *Colophospermum mopane* shrubs, for example, north of Alldays bordering the Limpopo floodplain.

Geology & Soils Most of the area is underlain by the Archaean Beit Bridge Complex, except where it is covered by much younger Karoo sandstones and basalts. The Beit Bridge Complex consists of gneisses and metasediments and is structurally very complex. Variable soils from deep red/brown clays, moderately deep, dark, heavy clays to deep, freely drained sandy soils to shallower types including skeletal Glenrosa and Mispah soil forms. Land types mainly Ae, Ah, Fc and Db.

Climate Summer rainfall with very dry winters including the shoulder months of May and September. MAP about 300–400 mm. Generally frost-free unit. Mean monthly maximum and minimum temperatures for Macuville-Agr (northwest of Musina) 39.9°C and 0.9°C for November and June, respectively. See also climate diagram for SVmp 1 Musina Mopane Bushveld.

Important Taxa Tall Trees: *Acacia nigrescens*, *Adansonia digitata*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Colophospermum mopane* (d), *Combretum apiculatum* (d), *Acacia senegal* var. *leiorhachis*, *A. tortilis* subsp. *heteracantha*, *Boscia albitrunca*, *B. foetida* subsp. *rehmanniana*, *Commiphora glandulosa*, *C. tenuipetiolata*, *C. viminea*, *Sterculia rogersii*, *Terminalia prunioides*, *T. sericea*, *Ximenia americana*. Tall Shrubs: *Grewia flava* (d), *Sesamothamnus lugardii* (d), *Commiphora pyracanthoides*, *Gardenia volkensii*, *Grewia bicolor*, *Maerua parvifolia*, *Rhigozum zambesiacum*, *Tephrosia polystachya*. Low Shrubs: *Acalypha indica*, *Aptosimum lineare*, *Barleria senensis*, *Dicoma tomentosa*, *Felicia clavipilosa* subsp. *transvaalensis*, *Gossypium herbaceum* subsp. *africanum*, *Hermannia glanduligera*, *Neuracanthus africanus*, *Pechuel-Loeschea leubnitziae*, *Ptycholobium contortum*, *Seddera suffruticosa*. Succulent Shrub: *Hoodia currorii* subsp. *lugardii*. Herbaceous Climber: *Momordica balsamina*. Graminoids: *Schmidtia pappophoroides* (d), *Aristida adscensionis*, *A. congesta*, *Bothriochloa insculpta*, *Brachiaria deflexa*, *Cenchrus ciliaris*, *Digitaria eriantha* subsp. *eriantha*, *Enneapogon cenchroides*, *Eragrostis lehmanniana*, *E. pallens*, *Fingerhuthia africana*, *Heteropogon contortus*, *Sporobolus nitens*, *Stipagrostis hirtigluma* subsp. *patula*, *S. uniplumis*, *Tetrapogon tenellus*, *Urochloa mosambicensis*. Herbs: *Acrotome inflata*, *Becium filamentosum*, *Harpagophytum procumbens* subsp. *transvaalense*, *Heliotropium steudneri*, *Hermbstaedtia odorata*, *Oxygonum delagoense*. Succulent Herbs: *Stapelia gettliffei, S. kwebensis.*

Conservation Least threatened. Target 19%. Only 2% statutorily conserved mainly in the Mapungubwe National Park as well as in Nwanedi and Honnet Nature Reserves. Additionally, about 1% conserved in the Baobab Tree Reserve. Roughly 3% transformed, mainly by cultivation. Erosion is high to moderate.

Remarks The unit is the most diverse mopaneveld type in South Africa. The Musina region has the highest species richness—also relative to *Colophospermum mopane*-dominated areas in Namibia and the Save River Valley in Zimbabwe (F. Siebert et al. 2003). The relationship of this unit with the adjacent and often fragmented parts of SVmp 2 Limpopo Ridge Bushveld is spatially complex. It is very dependent on scale and has not been fully captured on the map.

References Louw (1970), O'Connor (1992), Dekker & Van Rooyen (1995), Visser et al. (1996), Du Plessis (2001), Götze (2002), Straub (2002), Jordaan et al. (2004).

SVmp 2 Limpopo Ridge Bushveld

VT 15 Mopani Veld (82%) (Acocks 1953). LR 10 Mopane Bushveld (81%) (Low & Rebelo 1996).

Distribution Limpopo Province: On hills and ridges, such as Madiapala in the lower Mogalakwena River basin in the west through a cluster of hills in the Pontdrif area including Poortjieberg and Tsolwe, eastwards including Mapungubwe Mountain in the Mapungubwe National Park through to the hills and ridges in the vicinity of the Limpopo River further downstream (for example Ha-Tshansi at Musina, Ha-Dowe and Maremani). Also including hills and ridges well away from the river north of the Soutpansberg and generally east of the Sand River (e.g. Tshitangai, Bloukop and Ha-Manenzhe) through to some rugged areas in the far northern Kruger National Park. Altitude from about 300 m in the east to 700 m, with the top of a few hills in the west at around 1 000 m.

Vegetation & Landscape Features Extremely irregular plains with ridges and hills. Moderately open savanna with poorly developed ground layer. Umbrella-shape canopied *Kirkia acuminata* is prominent on some ridge skylines with the often enormous *Adansonia digitata* on shallow calcareous gravel; the shrub *Catophractes alexandri* is dominant on calc-silicate soils. These are particularly striking landscapes with rock walls and passages within areas of sandstone of the Clarens Formation (e.g. within the Mapungubwe National Park).

Geology & Soils Mostly rocks of the Beit Bridge Complex (Swazian Erathem) as well as sediments (including sandstones of the Clarens Formation) and basalt (particularly in the east) of

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Figure 9.38 SVmp 2 Limpopo Ridge Bushveld: *Kirkia acuminata* trees on a rocky hillside at 560 m on Leokwe Hill in Mapungubwe National Park.

SVmp 3 Cathedral Mopane Bushveld

VT 15 Mopani Veld (59%) (Acocks 1953). LR 10 Mopane Bushveld (80%) (Low & Rebelo 1996). KNP 15 *Colophospermum mopane* Forest (99%) (Gertenbach 1983b).

Distribution Limpopo Province: Mapped as a limited area in the Kruger National Park on the flats east of Punda Maria Gate from around Dzundwini Mountain to Gumbandebvu Hills. Also extends northwards in the upper Madzaringwe River Valley and in the Shilahlandonga River Valley to the east. Altitude 350–500 m.

Vegetation & Landscape Features A high, moderately closed tree savanna overwhelmingly dominated by *Colophospermum mopane* 10–15 m tall, often with some shrubs (e.g. *Euclea divinorum*) 2–3 m tall in the understorey, and a sparse herbaceous layer. The upper canopy is seldom closed. Vegetation of this unit occurs on flats and gentle slopes.

Geology & Soils Sandstone and shale of the Karoo Supergroup are most important, with sandstone, basalt and tuff of the Karoo Supergroup. Shallow gravel and sand (Glenrosa and Mispah soil forms) to calcareous clayey soil. Land types mainly Fc, Fb and Ib.

Climate Summer rainfall with very dry winters including the shoulder months of May and September. MAP about 300–400 mm. Generally a frost-free area. See also climate diagram for SVmp 2 Limpopo Ridge Bushveld.

Important Taxa Tall Trees: *Adansonia digitata* (d), *Acacia nigrescens*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Colophospermum mopane* (d), *Commiphora glandulosa* (d), *C. tenuipetiolata* (d), *Terminalia prunioides* (d), *Acacia senegal* var. *leiorhachis*, *A. tortilis* subsp. *heteracantha*, *Boscia albitrunca*, *Combretum apiculatum*, *C. imberbe*, *Commiphora mollis*, *Ficus abutilifolia*, *F. tettensis*, *Kirkia acuminata*, *Sterculia rogersii*, *Ximenia americana*. Tall Shrubs: *Catophractes alexandri*, *Commiphora pyracanthoides*, *Gardenia resiniflua*, *Grewia bicolor*, *G. villosa*, *Hibiscus calyphyllus*, *H. micranthus*. Low Shrubs: *Barleria affinis*, *Blepharis diversispina*, *Neuracanthus africanus*, *Plinthus rehmannii*, *Ptycholobium contortum*. Woody Climber: *Cissus cornifolia*. Graminoids: *Aristida adscensionis*, *A. stipitata* subsp. *graciliflora*, *Digitaria eriantha* subsp. *eriantha*, *Enneapogon cenchroides*, *Panicum maximum*, *Schmidtia pappophoroides*, *Stipagrostis uniplumis*. Succulent Herb: *Tavaresia barklyi*.

Endemic Taxa Low Shrub: *Pavonia dentata*. Herb: *Cleome oxyphylla* var. *robusta*.

Conservation Least threatened. Target 19%. Some 18% statutorily conserved, mainly in the Kruger and Mapungubwe National Parks. An additional 2% conserved in the Baobab Tree Reserve (thus together attaining the target). Only about 1% is transformed, mainly for cultivation and mining.

Remark The correspondence of this vegetation unit with the landscape units of Gertenbach (1983b) and of others below that occur within the Kruger National Park, is given in Table 9.1.

References Louw (1970), Van Rooyen (1978), Gertenbach (1983b), O'Connor (1992), Dekker & Van Rooyen (1995), Visser et al. (1996), Du Plessis (2001), Götze (2002), Straub (2002), Jordaan et al. (2004).

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Figure 9.39 SVmp 3 Cathedral Mopane Bushveld : Tall *Colophospermum* mopane trees outside the mapped unit and associated with the drainage area of the Kolope River in Mapungubwe National Park.

Table 9.1 Correspondence within the Kruger National Park between vegetation types and landscapes (Gertenbach 1983b), with landscapes in decreasing order of area within a vegetation type.

Vegetation Units	Landscapes
SVmp 2 Limpopo Ridge Bushveld	KNP 25 *Adansonia digitata* / *Colophospermum mopane* Rugged Veld
	KNP 26 *Colophospermum mopane* Shrubveld on Calcrete
SVmp 3 Cathedral Mopane Bushveld	KNP 15 *Colophospermum mopane* Forest
SVmp 4 Mopane Basalt Shrubland	KNP 23 *Colophospermum mopane* Shrubveld on Basalt
	KNP 22 *Combretum* / *Colophospermum mopane* Rugged Veld
SVmp 5 Tsende Mopaneveld	KNP 11 Tsende Sandveld
	KNP 12 *Colophospermum mopane* / *Acacia nigrescens* Savanna
	KNP 9 *Colophospermum mopane* Woodland / Savanna on Basic Soils
	KNP 27 Mixed *Combretum* / *Colophospermum mopane* Woodland
SVmp 6 Lowveld Rugged Mopaneveld	KNP 10 Letaba River Rugged Veld
	KNP 7 Olifants River Rugged Veld
SVmp 7 Phalaborwa-Timbavati Mopaneveld	KNP 6 *Combretum* / *Colophospermum mopane* Woodland of Timbavati-area
	KNP 8 Phalaborwa Sandveld
SVmp 8 Mopane Gabbro Shrubland	KNP 24 *Colophospermum mopane* Shrubveld on Gabbro
SVl 1 Makuleke Sandy Bushveld	KNP 34 Punda Maria Sandveld on Waterberg Sandstone
	KNP 16 Punda Maria Sandveld on Cave Sandstone
	KNP 33 *Pterocarpus rotundifolius* / *Combretum collinum* Woodland
SVl 2 Nwambyia-Pumbe Sandy Bushveld	KNP 32 Nwambia Sandveld
	KNP 30 Pumbe Sandveld
SVl 3 Granite Lowveld	KNP 5 Mixed *Combretum* / *Terminalia sericea* Woodland
	KNP 4 Thickets of the Sabie & Crocodile River
	KNP 3 *Combretum collinum* / *Combretum zeyheri* Woodland
SVl 4 Delagoa Lowveld	KNP 13 *Acacia welwitschii* Thickets on Karoo Sediments
SVl 5 Tshokwane-Hlane Basalt Lowveld	KNP 17 *Sclerocarya birrea* subsp. *caffra* /*Acacia nigrescens* Savanna
	KNP 18 Dwarf *Acacia nigrescens* Savanna
	KNP 21 *Combretum* / *Acacia nigrescens* Rugged Veld
	KNP 20 Bangu Rugged Veld
	KNP 14 Kumana Sandveld
SVl 6 Gabbro Grassy Bushveld	KNP 19 Thornveld on Gabbro
SVl 10 Pretoriuskop Sour Bushveld	KNP 1 Lowveld Sour Bushveld of Pretoriuskop
SVl 11 Malelane Mountain Bushveld	KNP 2 Malelane Mountain Bushveld
SVl 15 Northern Lebombo Bushveld	KNP 29 Lebombo South
	KNP 31 Lebombo North

Soutpansberg Group (Mokolian Erathem) also significant. Soils are often deep, with high sodium content. Prismacutanic and/or pedocutanic diagnostic horizons are often dominant. Land types mainly Dc, Fc and Ca.

Climate Summer rainfall with very dry winters. MAP about 400–500 mm. Generally a frost-free area. See also climate diagram for SVmp 3 Cathedral Mopane Bushveld.

Important Taxa Tall Trees: *Colophospermum mopane* (d), *Acacia nigrescens*. Small Trees: *Combretum imberbe*, *Spirostachys africana*, *Ximenia americana*. Tall Shrubs: *Euclea divinorum* (d), *Combretum hereroense*, *Grewia bicolor*, *Hibiscus micranthus*, *Maerua parvifolia*. Low Shrub: *Neuracanthus africanus*. Graminoids: *Enneapogon cenchroides* (d), *Enteropogon macrostachyus* (d), *Aristida congesta*, *Panicum maximum*, *Schmidtia pappophoroides*. Herbs: *Amaranthus thunbergii*, *Seddera capensis*.

Conservation Least threatened. Target 19%. Entirely statutorily conserved in the Kruger National Park. Erosion is low to moderate.

Remarks Forms of this structural type occur unmapped in a number of small areas north of the Soutpansberg, usually forming bands along less major water courses, allied to that on some alluvial soils close to larger streams and rivers (e.g. stretches of the Tsende River north of the Letaba River). The unit is related to the SVl 4 Delagoa Lowveld in moister areas further south.

References Van Rooyen (1978), Van Rooyen et al. (1981b), Gertenbach (1983b).

SVmp 4 Mopane Basalt Shrubland

VT 15 Mopani Veld (90%) (Acocks 1953). LR 9 Mopane Shrubveld (74%) (Low & Rebelo 1996). KNP 23 *Colophospermum mopane* shrubveld on basalt (71%) (Gertenbach 1983b).

Distribution Limpopo and Mpumalanga Provinces: Mainly occurs in a large belt on the plains in the Kruger National Park from around Klopperfontein in the north, southwards and east of the Lebombo Mountain range through the Shingwedzi and Letaba Rest Camp areas to the vicinity of Olifants and Roodewal Rest Camps in the south. Altitude about 200–450 m.

Vegetation & Landscape Features Mainly plains and slightly undulating plains with medium-low (1–2 m) shrubs dominated overwhelmingly by multistemmed *Colophospermum mopane*. Tree forms of mopane are rare. Grass layer is well developed. Vegetation consists of three main variations depending on topographical position (Gertenbach 1983b): (1) lower, middle and footslopes, (2) middle slopes and convex uplands on usually deeper soils, and (3) concave terrain with soils with very high clay content. The unit includes some bottomlands and parts of the Lebombo pediment with a slightly increased proportion of other woody plant species.

Geology & Soils The area is built almost entirely by basalts (tholeitic and picritic) of the Letaba Formation (Lebombo Group, Karoo Supergroup). Soils are often deep and have a high clay content with a dark colour in the lower positions, becoming red on the higher middle slopes. Land types mainly Ea, with some Ia and Fb.

Climate Summer rainfall with very dry winters. MAP about 400–600 mm. Generally a frost-free area. Mean monthly maximum and minimum temperatures for Shingwedzi 40.8°C and 2.4°C for November and June, respectively. See also climate diagram for SVmp 4 Mopane Basalt Shrubland.

Important Taxa Tall Trees: *Acacia nigrescens*, *Philenoptera violacea*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Acacia exuvialis*, *A. tortilis* subsp. *heteracantha*, *Combretum apiculatum*, *C. imberbe*, *Commiphora glandulosa*, *C. mollis*, *Dalbergia melanoxylon*, *Kirkia acuminata*, *Terminalia phanerophlebia*, *T. prunioides*. Tall Shrubs: *Colophospermum mopane* (d), *Combretum hereroense*, *Flueggea virosa*, *Grewia bicolor*, *Hibiscus calyphyllus*, *H. micranthus*, *Maerua parvifolia*, *Tephrosia polystachya*. Low Shrubs: *Clerodendrum ternatum*, *Dicoma tomentosa*, *Neuracanthus africanus*. Woody Climber: *Combretum mossambicense*. Herbaceous Climber: *Rhynchosia totta*. Graminoids: *Aristida congesta*, *Bothriochloa radicans*, *Cenchrus ciliaris*, *Enneapogon cenchroides*, *Fingerhuthia africana*, *Heteropogon contortus*, *Panicum maximum*, *Schmidtia pappophoroides*, *Setaria incrassata*, *Themeda triandra*, *Urochloa mosambicensis*. Herbs: *Heliotropium steudneri*, *Leucas glabrata*, *Phyllanthus asperulatus*. Geophytic Herb: *Sansevieria hyacinthoides*.

Conservation Least threatened. Target 19%, but 100% already statutorily conserved in the Kruger National Park.

Remark The contrast along the interface between the low mopane shrubs of this unit and the very tall mopane trees of the neighbouring SVmp 3 Cathedral Mopane Bushveld is striking.

References Van Rooyen (1978), Gertenbach & Potgieter (1979), Van Rooyen et al. (1981b), Gertenbach (1983a, b), Fraser et al. (1987).

SVmp 5 Tsende Mopaneveld

VT 15 Mopani Veld (77%) (Acocks 1953). LR 10 Mopane Bushveld (92%) (Low & Rebelo 1996).

Distribution Limpopo Province: The main block occurs on undulating terrain west of the basalt plains from the Mphongolo River and Sirheni Bushveld Camp area in the north, southwards across the Shingwedzi River and extending slightly outside the Kruger National Park to include areas near to Malamulele and Mahlathi, through the upper Tsende River catchment area to around Mopani Camp in the south. Another belt occurs further south from the area around the Hans Merensky Nature Reserve in the west to the vicinity of Letaba Rest Camp in the east. It is also mapped as a narrow irregular strip immediately to the east of the basalt plains as far south as the Shingwedzi River area. Altitude about 300–550 m.

Vegetation & Landscape Features Slightly undulating plains with medium-high shrubby savanna, with some trees and dense ground layer dominated by *Colophospermum mopane*, but with the ratio of *C. mopane* to *Combretum apiculatum* decreasing somewhat on the less clayey soils of the uplands. In the northwestern parts the tree cover is greater and, together with the southern and northeastern outliers of the unit, these flatter landscapes include several trees such as *Acacia nigrescens* in addition to the dominant *Colophospermum mopane*.

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Figure 9.40 SVmp 4 Mopane Basalt Shrubland: Open shrubland dominated by *Colophospermum mopane*, approximately 14 km northeast of Mopani Rest Camp, Kruger National Park.

Geology & Soils Three quarters of the area is underlain by potassium-poor, quartz-feldspar rocks of the Goudplaats Gneiss Basement. The northeastern part of the area lies on Letaba basalts of the Karoo Supergroup. Typically clayey soils occur, but with less than 15% clay in the A-horizon on the upland positions. Generally deeper clayey soils are found on the flats; the northeastern outlier area has more sandy soils—weathered products of basalt and Quaternary sand and gravel.

Climate Summer rainfall with very dry winters. MAP about 450–650 mm. Generally a frost-free area. See also climate diagram for SVmp 5 Tsende Mopaneveld.

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Figure 9.41 SVmp 5 Tsende Mopaneveld: Aerial view of the Tsende Mopaneveld on the right in strong contrast to the far less wooded Mopane Basalt Shrubland on the left. North of Mopani Rest Camp, Kruger National Park.

Important Taxa Tall Trees: *Acacia nigrescens*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Colophospermum mopane* (d), *Combretum apiculatum* (d), *Acacia gerrardii*, *A. tortilis* subsp. *heteracantha*, *Albizia harveyi*, *Bridelia mollis*, *Cassia abbreviata* subsp. *beareana*, *Combretum imberbe*, *C. zeyheri*, *Dalbergia melanoxylon*, *Peltophorum africanum*, *Philenoptera violacea*, *Terminalia sericea*. Tall Shrubs: *Combretum hereroense*, *Dichrostachys cinerea*, *Euclea divinorum*, *Grewia bicolor*, *G. monticola*, *Strychnos madagascariensis*, *Tephrosia polystachya*. Low Shrubs: *Clerodendrum ternatum*, *Indigofera schimperi*, *Melhania forbesii*. Woody Climbers: *Cissus cornifolia*, *Combretum mossambicense*. Graminoids: *Bothriochloa radicans* (d), *Digitaria eriantha* subsp. *pentzii* (d), *Heteropogon contortus* (d), *Panicum maximum* (d), *Themeda triandra* (d), *Cymbopogon pospischilii*, *Enneapogon cenchroides*, *Eragrostis rigidior*, *E. superba*, *Panicum coloratum*, *Perotis patens*, *Pogonarthria squarrosa*, *Schmidtia pappophoroides*, *Urochloa mosambicensis*. Herbs: *Blepharis integrifolia*, *Ceratotheca triloba*, *Chamaecrista absus*, *Corchorus asplenifolius*, *Evolvulus alsinoides*, *Heliotropium steudneri*.

Conservation Least threatened. Target 19%. Some 63% statutorily conserved, almost all in the Kruger National Park, with some patches in the Hans Merensky Nature Reserve. About a further 5% is conserved in private reserves, mainly in the Groot-Letaba Wildreservaat. Some 12% of the area has been transformed, mainly through cultivation and some settlement development outside the Kruger National Park.

Remark In most of the main (northern) block of this unit, pans are very common (Gertenbach 1983b).

References Gertenbach (1983a, b), Fraser et al. (1987).

SVmp 6 Lowveld Rugged Mopaneveld

VT 11 Arid Lowveld (55%) (Acocks 1953). LR 10 Mopane Bushveld (87%) (Low & Rebelo 1996).

Distribution Limpopo and Mpumalanga Provinces: Broken veld from the area southeast of Giyani in the west to Shimuwini and Boulders Camps in the east as well as the rugged area of the Olifants River Valley south of Phalaborwa, from Grietjieberg in the west to the Maveni River tributary in the east. Altitude 250–550 m.

Vegetation & Landscape Features Slightly to extremely irregular plains with sometimes steep slopes and a number of prominent hills. The area around the Olifants River has more dissected and steeper slopes than the northern part of this unit. Usually dense shrubs with occasional trees and a sparse ground layer. Woody plants can become particularly dense where fire is excluded by very rocky terrain, such as in the vicinity of the Olifants River. Vegetation is more open in the northeastern parts of this unit outside the Kruger National Park.

Geology & Soils The Goudplaats Gneiss and Makhutswi Gneiss underlie most of this area, with a smaller contribution from the ultramafic metavolcanics (rocks rich in chlorite, amphibole, talc and serpentine) and metasediments of the Giyani Greenstone Belt (all Swazian Erathem). Soils are red-yellow apedal, freely drained, but also shallow and stony, especially in the east. Soil forms are mainly Hutton, Mispah and Glenrosa. Land types Ae, Fb and Fa.

Climate Summer rainfall with very dry winters. MAP about 400–600 mm. Generally a frost-free area, but frost sometimes occurs in the low-lying areas. See also climate diagram for SVmp 6 Lowveld Rugged Mopaneveld.

Important Taxa Tall Trees: *Acacia nigrescens*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Colophospermum mopane* (d), *Combretum apiculatum* (d), *Terminalia prunioides* (d), *Acacia exuvialis*, *A. nilotica*, *Boscia albitrunca*, *Commiphora mollis*, *Dalbergia melanoxylon*. Tall Shrubs: *Combretum hereroense*, *Dichrostachys cinerea*, *Grewia bicolor*, *G. villosa*, *Rhigozum zambesiacum*. Low Shrubs: *Commiphora africana*, *Melhania forbesii*, *M. rehmannii*, *Solanum panduriforme*. Graminoids: *Aristida congesta* (d), *Enneapogon cenchroides* (d), *Melinis repens* (d), *Sporobolus panicoides* (d), *Bothriochloa radicans*, *Digitaria eriantha* subsp. *pentzii*, *Fingerhuthia africana*, *Panicum maximum*. Herbs: *Crabbea velutina*, *Heliotropium steudneri*, *Hemizygia elliottii*, *Hibiscus sidiformis*, *Phyllanthus asperulatus*, *Xerophyta retinervis*.

Conservation Least threatened. Target 19%. Some 34% statutorily conserved, almost all in the Kruger National Park. At least an additional 5% conserved in private reserves, such as Klaserie, Letaba Ranch and Selati Game Reserve. About 20% already transformed mainly by cultivation and some urban and built-up areas. This vegetation occurring outside the conserved areas is under pressure from high-density rural human population and associated urban sprawl and agricultural activities. Some areas experience moderate erosion.

Remark The southern part of this unit in the Kruger National Park contains a number of tree species that are relatively

scarce elsewhere in the park, e.g. *Kirkia wilmsii* and *Hexalobus monopetalus*.

References Gertenbach (1983a, b).

SVmp 7 Phalaborwa-Timbavati Mopaneveld

VT 11 Arid Lowveld (68%) (Acocks 1953). LR 10 Mopane Bushveld (77%) (Low & Rebelo 1996).

Distribution Limpopo and Mpumalanga Provinces: Occurs in a band about 40 km west and east of Phalaborwa and also occurs south of the Olifants River on the boundary between the Timbavati Game Reserve and the Kruger National Park including parts of the Umbabat and Klaserie Nature Reserves. Altitude 300–600 m.

Vegetation & Landscape Features Open tree savanna on undulating plains with the sandy uplands dominated by *Combretum apiculatum*, *Terminalia sericea* and *Colophospermum mopane* trees, with *T. sericea* disappearing and *Combretum apiculatum* becoming less common in the clayey bottomlands, and being replaced by trees such as *Acacia nigrescens* and increased dominance of *Colophospermum mopane*. The field layer is usually well developed. A feature of the northern section of this unit is the large number of termite mounds on the uplands.

Geology & Soils Quartz-feldspar rocks of the Makhutswi Gneiss (Swazian) dominate this area, except in the northwest where they are intruded by the Lekkersmaak Granite (Randian). Sandy soils (usually less than 10% clay in the A-horizon) on the uplands (e.g. Clovelly soil form) and clay soils in the bottomlands (e.g. Valsrivier and Sterkspruit soil forms). The dominant land type mapped is mainly Fb.

Climate Summer rainfall with very dry winters. MAP about 400–600 mm. Generally frost-free. Mean monthly maximum and minimum temperatures for Phalaborwa 38.4°C and 5.7°C for January and July, respectively. See also climate diagram for SVmp 7 Phalaborwa-Timbavati Mopaneveld.

Important Taxa Tall Trees: *Acacia nigrescens*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Colophospermum mopane* (d), *Combretum apiculatum* (d), *Terminalia sericea* (d), *Acacia exuvialis*, *A. tortilis* subsp. *heteracantha*, *Albizia harveyi*, *Cassia abbreviata* subsp. *beareana*, *Combretum zeyheri*, *Dalbergia melanoxylon*, *Ozoroa engleri*, *Peltophorum africanum*, *Pseudolachnostylis maprouneifolia*. Tall Shrubs: *Combretum hereroense*, *Euclea divinorum*, *Grewia bicolor*, *Maerua parvifolia*, *Strychnos madagascariensis*, *Tephrosia polystachya*. Low Shrubs: *Clerodendrum ternatum*, *Commiphora africana*, *Hermannia glanduligera*, *Melhania forbesii*. Woody Climber: *Cissus cornifolia*. Graminoids: *Digitaria eriantha* subsp. *pentzii* (d), *Eragrostis rigidior* (d), *Pogonarthria squarrosa* (d), *Andropogon gayanus*, *Aristida congesta*, *Brachiaria nigropedata*, *Melinis repens*, *Panicum maximum*, *Perotis patens*, *Schmidtia pappophoroides*, *Themeda triandra*. Herbs: *Evolvulus alsinoides*, *Heliotropium steudneri*, *Hemizygia elliottii*, *Ipomoea magnusiana*, *Kohautia virgata*.

Conservation Least threatened. Target 19%. Some 38% statutorily conserved in the Kruger National Park, with a similar proportion in the private Selati Game Reserve and Umbabat, Timbavati, Klaserie Nature Reserves. About 5% has been transformed, mainly by development of human settlements as well as by mining.

Remark This unit contains the most southerly populations of *Colophospermum mopane* in South Africa.

References Gertenbach (1983a, b).

SVmp 8 Mopane Gabbro Shrubland

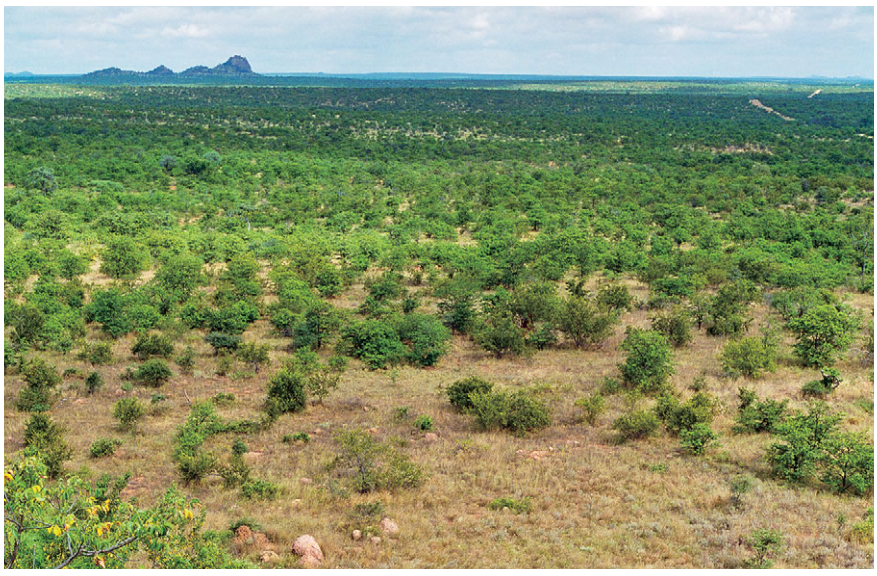
VT 15 Mopani Veld (85%) (Acocks 1953). LR 10 Mopane Bushveld (95%) (Low & Rebelo 1996). KNP 24 *Colophospermum mopane* shrubveld on gabbro (98%) (Gertenbach 1983b).

Distribution Limpopo and Mpumalanga Provinces: Occurs in narrow, irregular and disjunct belts from the Phoda Hills near Bateleur Bushveld Camp in the north, southwards in the vicinity of the Stapelkop Dam and Shimuwini Bushveld Camp, to the Shilawuri Hill area. Also further south in the vicinity of the Shisakashanghondo Dam. Altitude 300–460 m.

Vegetation & Landscape Features Slightly irregular to slightly undulating landscape with numerous outcrops of gabbro. Mainly a low shrub layer with two main structural variations both dominated by *Colophospermum mopane*: a shrubveld with practically no trees and a shrubveld with a few larger shrubs and trees, including *C. mopane* and *Acacia nigrescens*. Species diversity is the highest in the latter variation. The ground layer of both variations is dense.

Geology & Soils The basement rocks of the general area are the Swazian Goudplaats and Makhutswi gneisses. These are intruded by sinuous dykes of Timbavati gabbro that are most significant in this shrubland. Soils are dark, with relatively high clay content. Vertisols occur in areas with concave topography and lithosols on the outcrops. Main soil forms are Milkwood, Mayo, Bonheim and Swartland. Main land types Fa, Ah, Ae, Fb and Ea.

Climate Summer rainfall with very dry winters. MAP about 450–650 mm. Generally a frost-free area. See also climate diagram for SVmp 8 Mopane Gabbro Shrubland.



H.C. Eckhardt

Figure 9.42 SVmp 7 Phalaborwa-Timbavati Mopaneveld: Savanna plains dominated by *Colophospermum* mopane and *Combretum apiculatum* in the Shivulani Kop area of the Kruger National Park, northeast of Phalaborwa.

Important Taxa Tall Tree: *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Acacia exuvialis*, *A. tortilis* subsp. *heteracantha*, *Albizia harveyi*, *Combretum imberbe*, *Dalbergia melanoxylon*. Tall Shrubs: *Colophospermum mopane* (d), *Dichrostachys cinerea*, *Grewia bicolor*, *Tephrosia polystachya*. Low Shrubs: *Commiphora africana*, *Phyllanthus pentandrus*. Woody Climber: *Cissus cornifolia*. Graminoids: *Fingerhuthia africana* (d), *Heteropogon contortus* (d), *Panicum coloratum* (d), *Schmidtia pappophoroides* (d), *Bothriochloa radicans*, *Themeda triandra*, *Urochloa mosambicensis*. Herbs: *Chamaesyce neopolycnemoides*, *Corbichonia decumbens*, *Heliotropium steudneri*.

Conservation Least threatened. Target 19%. Virtually untransformed and about 99% statutorily conserved in the Kruger National Park and the remainder conserved in the private Umbabat Nature Reserve. Erosion is low to very low.

L.W. Powrie

Figure 9.44 SVl 1 Makuleke Sandy Bushveld: Moderately dense bushveld on sandstone ridge east of Mutale, Limpopo Province.

Remarks The vegetation structure is similar to much of that of the SVmp 4 Mopane Basalt Shrubland. The mapped unit follows Gertenbach's (1983b) boundaries. More recent geology maps show the gabbro to be narrower and less continuous than mapped.

References Gertenbach (1978, 1983a, b).

Lowveld

SVl 1 Makuleke Sandy Bushveld

VT 9 Lowveld Sour Bushveld (34%), VT 15 Mopani Veld (21%) (Acocks 1953). LR 21 Sour Lowveld Bushveld (40%), LR 10 Mopane Bushveld (28%) (Low & Rebelo 1996).

Distribution Limpopo and (very slightly into) Mpumalanga Provinces: Flats and hills east of the Soutpansberg, south of Klein Tshipise and Masisi, along the valleys of the Mutale River and mid- to lower Levuvhu River; the Maseya Sandveld and Punda Maria areas of the northern Kruger National Park and as few isolated patches in the park, for example Dzundwini Mountain in the north and a narrow sandstone belt sandwiched between the granite and the basalt reaching the Timbavati Picnic Area in the south. Altitude 300–700 m.

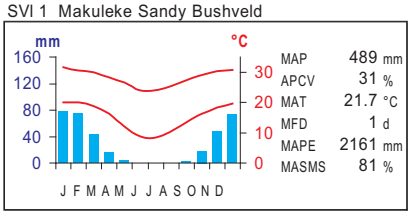
Vegetation & Landscape Features Variable landscapes from low mountains, slightly to extremely irregular plains to hills. A tree savanna (or tall shrub in places) occurs on the deep sands with trees such as *Terminalia sericea*, *Burkea africana*, *Guibourtia conjugata* and *Peltophorum africana* and a moderate to dense ground layer containing, for example, *Andropogon gayanus* and *Digitaria eriantha*. On stony soils the tree savanna includes *Kirkia acuminata*, *Croton gratissimus*, *Combretum apiculatum* and *Diplorhynchus condylocarpon* while the ground layer includes dominant *Digitaria eriantha*, *Panicum maximum* and *Pogonarthria squarrosa*.

Geology & Soils The Soutpansberg Group of sandstones with lesser amounts of conglomerate, shale and basalt is mostly exposed in this area (the Wyllie's Poort, Fundudzi and Nzhelele Formations). Some Karoo Supergroup rocks are also present (Clarens and Letaba Formations). Most of the area has deep sands to shallow sandy lithosols. A few limited areas with heavier soil, particularly in the B-horizon, occur near the western boundary of the Kruger National Park.

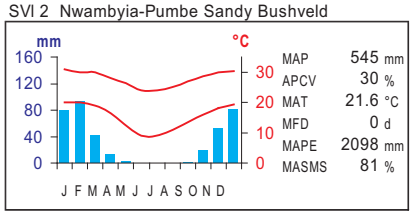
Climate Summer rainfall with very dry winters. MAP about 300–700 mm. Generally a frost-free region, except possibly for higher elevations. Mean monthly maximum and minimum temperatures for Punda Maria 39.7°C and 8.5°C for December and July, respectively. See also climate diagram for SVl 1 Makuleke Sandy Bushveld.

Important Taxa Small Trees: *Burkea africana* (d), *Kirkia acuminata* (d), *Pseudolachnostylis maprouneifolia* (d), *Terminalia sericea* (d), *Afzelia quanzensis*, *Bridelia mollis*, *Combretum apiculatum*, *C. collinum* subsp. *gazense*, *C. zeyheri*, *Croton gratissimus*, *Ficus abutilifolia*, *F. ingens*, *Guibourtia conjugata*, *Hymenocardia ulmoides*, *Lannea schweinfurthii* var. *stuhlmannii*, *Ochna pulchra*, *Ozoroa obovata* var. *elliptica*, *Peltophorum africanum*, *Phyllanthus reticulatus*, *Pterocarpus rotundifolius*, *Stadmannia oppositifolia* subsp. *rhodesica*. Tall Shrubs: *Pteleopsis myrtifolia* (d), *Alchornea laxiflora*, *Boscia angustifolia* var. *corymbosa*, *Dichrostachys cinerea*, *Diospyros lycioides* subsp. *sericea*, *Diplorhynchus condylocarpon*, *Grewia hexamita*, *Gymnosporia mossambicensis*, *Hexalobus monopetalus*, *Monodora junodii* var. *junodii*, *Senna petersiana*, *Steganotaenia araliacea*, *Strychnos madagascariensis*, *Tricalysia junodii*. Low Shrubs: *Agathisanthemum bojeri*, *Hermannia glanduligera*, *Pavetta harborii*. Woody Climbers: *Artabotrys brachypetalus*, *Bauhinia galpinii*, *Cissus cornifolia*, *Rhoicissus revoilii*. Herbaceous Climbers: *Merremia tridentata*, *Rhynchosia totta*. Graminoids: *Andropogon gayanus* (d), *Digitaria eriantha* subsp. *pentzii* (d), *Panicum maximum* (d), *Aristida mollissima* subsp. *argentea*, *A. stipitata* subsp. *graciliflora*, *Brachiaria serrata*, *Bulbostylis hispidula*, *Coleochloa setifera*, *Perotis patens*, *Pogonarthria squarrosa*, *Setaria incrassata*, *Tetrapogon tenellus*, *Tricholaena monachne*. Herbs: *Vahlia capensis* subsp. *vulgaris*, *Vernonia fastigiata*. Geophytic Herb: *Drimia altissima*.

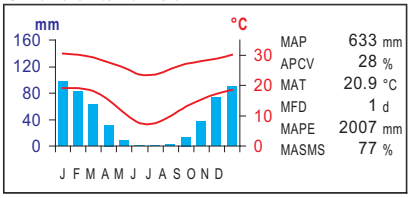
SVI 1 Makuleke Sandy Bushveld



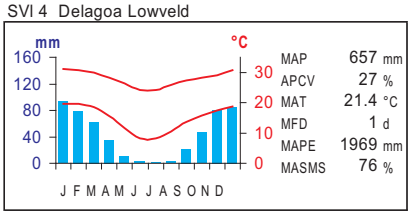
SVI 2 Nwambyia-Pumbe Sandy Bushveld



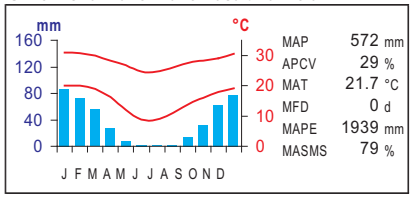
SVI 3 Granite Lowveld



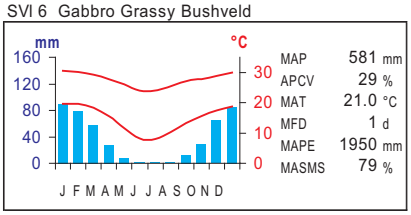
SVI 4 Delagoa Lowveld



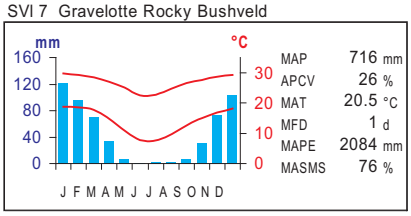
SVI 5 Tshokwane-Hlane Basalt Lowveld



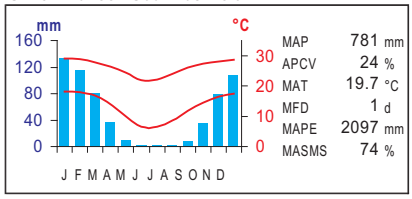
SVI 6 Gabbro Grassy Bushveld



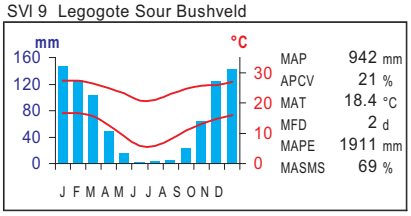
SVI 7 Gravelotte Rocky Bushveld



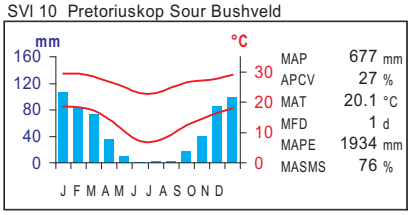
SVI 8 Tzaneen Sour Bushveld



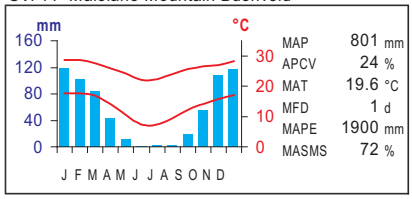
SVI 9 Legogote Sour Bushveld



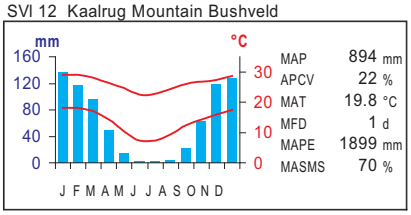
SVI 10 Pretoriuskop Sour Bushveld



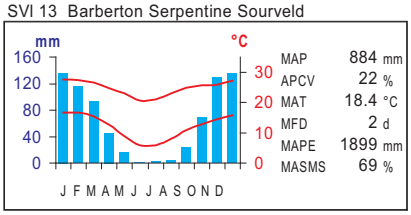
SVI 11 Malelane Mountain Bushveld



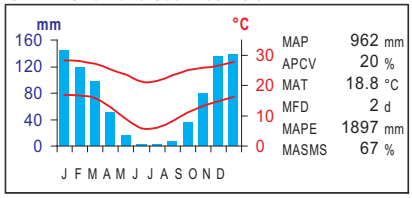
SVI 12 Kaalrug Mountain Bushveld



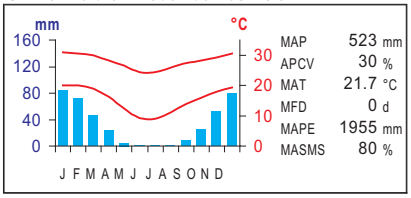
SVI 13 Barberton Serpentine Sourveld



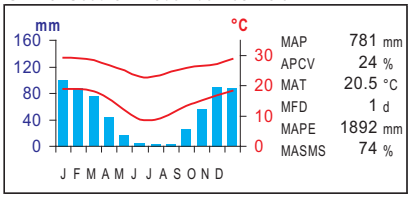
SVI 14 Swaziland Sour Bushveld



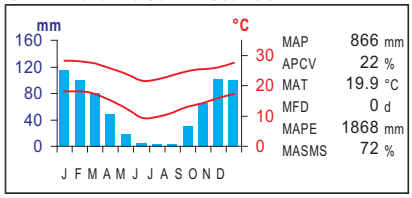
SVI 15 Northern Lebombo Bushveld



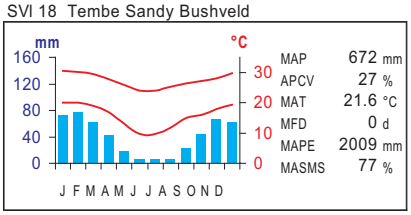
SVI 16 Southern Lebombo Bushveld



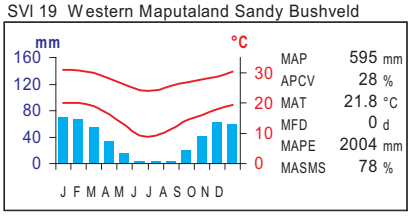
SVI 17 Lebombo Summit Sourveld



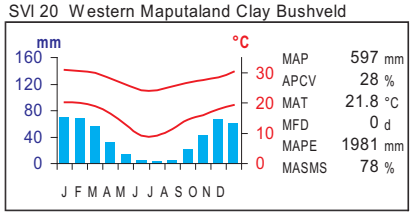
SVI 18 Tembe Sandy Bushveld



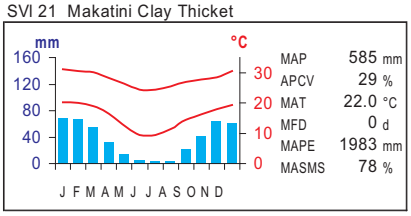
SVI 19 Western Maputaland Sandy Bushveld



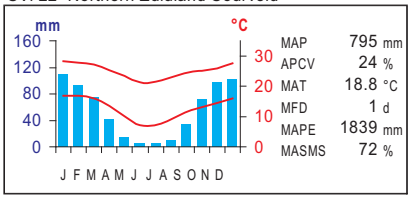
SVI 20 Western Maputaland Clay Bushveld



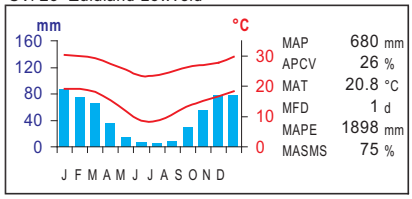
SVI 21 Makatini Clay Thicket



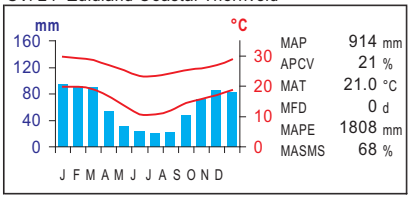
SVI 22 Northern Zululand Sourveld



SVI 23 Zululand Lowveld



SVI 24 Zululand Coastal Thornveld



Biogeographically Important Taxon (Southern distribution limit) Small Tree: *Holarrhena pubescens*.

Endemic Taxa Succulent Shrub: *Euphorbia rowlandii*. Herb: *Ceratotheca saxicola*.

Conservation Vulnerable. Target 19%. About 32% statutorily conserved in the Kruger National Park. Roughly 27% has been transformed, mostly through cultivation. Erosion is moderate to high in places.

Remarks At least two areas of this unit have heavier soil with a clayey B-horizon, and occur on flat to undulating terrain near the western boundary of the Kruger National Park. Despite their heavier soil and that these areas are completely surrounded by vegetation which is overwhelmingly dominated by *Colophospermum mopane*, remarkably few individuals of mopane penetrate these areas. These patches correspond to the *Pterocarpus rotundifolius/Combretum collinum* Woodland of Gertenbach (1983b).

References Van Rooyen (1978), Van Rooyen et al. (1981a), Gertenbach (1983b).

M.C. Lötter

Figure 9.45 SVl 2 Nwambyia-Pumbe Sandy Bushveld: Open to closed broad-leaved woodland, largely occurring on sandy soils with *Strychnos* species, *Crossopteryx febrifuga* and *Xeroderris stuhlmannii* south of Nwambyia, Kruger National Park.

SVl 2 Nwambyia-Pumbe Sandy Bushveld

VT 15 Mopani Veld (81%) (Acocks 1953). LR 10 Mopane Bushveld (55%) (Low & Rebelo 1996). KNP 32 Nwambia Sandveld (84%) (Gertenbach 1983b).

Distribution Limpopo and Mpumalanga Provinces: Flats well to the east of Punda Maria on the border with Mozambique (the Nwambyia part of this unit). A small patch further south, also on the eastern border, in the vicinity of the Pumbe Guard Post northeast of Satara. Altitude 350–550 m.

Vegetation & Landscape Features Flats with several small pans embedded. Conspicuous is the absence of well-defined drainage channels. Moderately open tall shrubland with few trees. The Nwambyia part consists mainly of *Xeroderris stuhlmannii–Combretum apiculatum* tree savanna and *Terminalia sericea–Pogonarthria squarrosa* tree savanna (Van Rooyen 1978), both with field layers better developed than that of the FOz 8 Sand Forest patch embedded in it. The second variation has many floristic links with SVl 1 Makuleke Sandy Bushveld.

Geology & Soils The Cretaceous Malvernia Formation conglomerate and overlying sandstone form deep yellow to red Quaternary sands of the Hutton and Clovelly soil forms (apedal, freely drained, dystrophic and mesotrophic). The Pumbe part also includes some shallow lithosols (Mispah and Glenrosa soil forms). Land types mainly Ac and Fb.

Climate Summer rainfall with dry winters. MAP about 450–650 mm. Generally a frost-free region. See also climate diagram for SVl 2 Nwambyia-Pumbe Sandy Bushveld.

Important Taxa Tall Trees: *Sclerocarya birrea* subsp. *caffra* (d), *Acacia nigrescens*, *Adansonia digitata*, *Philenoptera violacea*. Small Trees: *Baphia massaiensis* (d), *Combretum apiculatum* (d), *C. zeyheri* (d), *Terminalia sericea* (d), *Afzelia quanzensis*, *Balanites maughamii*, *Boscia albitrunca*, *Cassia abbreviata* subsp. *beareana*, *Combretum collinum* subsp. *taborense*, *C. molle*, *Crossopteryx febrifuga, Dalbergia melanoxylon*, *Lannea schweinfurthii* var. *stuhlmannii*, *Ozoroa engleri*, *Ptaeroxylon obliquum*, *Spirostachys africana*, *Vangueria infausta*. Tall Shrubs: *Grewia microthyrsa* (d), *Pteleopsis myrtifolia* (d), *Tephrosia polystachya* (d), *Vitex ferruginea* (d), *Alchornea laxiflora*, *Dichrostachys cinerea*, *Grewia bicolor*, *G. monticola*, *Phyllanthus parvulus*, *Strychnos madagascariensis*. Low Shrubs: *Agathisanthemum bojeri*, *Aptosimum lineare*, *Melhania forbesii*, *Monechma debile*, *Pavetta catophylla*. Woody Climbers: *Cissus cornifolia*, *Combretum mossambicense*, *Rhynchosia resinosa*. Herbaceous Climber: *Merremia tridentata* (d). Graminoids: *Aristida stipitata* subsp. *graciliflora* (d), *Brachiaria nigropedata* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Eragrostis pallens* (d), *Panicum maximum* (d), *Schmidtia pappophoroides* (d), *Aristida congesta*, *Cymbopogon pospischilii*, *Enneapogon cenchroides*, *Eragrostis superba*, *Heteropogon contortus*, *Perotis patens*, *Pogonarthria squarrosa*, *Tricholaena monachne*, *Urochloa mosambicensis*. Herbs: *Vigna unguiculata* (d), *Coptosperma zygoon*, *Euphorbia tettensis*, *Commelina africana*, *C. erecta*, *Heliotropium steudneri*, *Indigofera filipes*, *I. vicioides*, *Kohautia virgata*.

Biogeographically Important Taxa (Southern distribution limit) Small Trees: *Xeroderris stuhlmannii* (d), *Xylia torreana* (d). Woody Climber: *Hugonia orientalis* (d).

Conservation Least threatened. Target 19%. All statutorily conserved in the Kruger National Park.

Remark This vegetation unit is well represented in Mozambique and extends only as far as 10 km into South Africa.

References Van Rooyen (1978), Van Rooyen et al. (1981a), Gertenbach (1983b).

Figure 9.43 Climate diagrams of Lowveld Bioregion units. Blue bars show the median monthly precipitation. The upper and lower red lines show the mean daily maximum and minimum temperature respectively. MAP: Mean Annual Precipitation; APCV: Annual Precipitation Coefficient of Variation; MAT: Mean Annual Temperature; MFD: Mean Frost Days (days when screen temperature was below 0°C); MAPE: Mean Annual Potential Evaporation; MASMS: Mean Annual Soil Moisture Stress (% of days when evaporative demand was more than double the soil moisture supply).

SVl 3 Granite Lowveld

VT 11 Arid Lowveld (40%), VT 10 Lowveld (38%) (Acocks 1953). LR 19 Mixed Lowveld Bushveld (61%) (Low & Rebelo 1996).

Distribution Limpopo and Mpumalanga Provinces, Swaziland and marginally also KwaZulu-Natal: A north-south belt on the plains east of the escarpment from Thohoyandou in the north, interrupted in the Bolobedu area, continued in the Bitavi area, with an eastward extension on the plains around the Murchison Range and southwards to Abel Erasmus Pass, Mica and Hoedspruit areas to the area east of Bushbuckridge. Substantial parts are found in the Kruger National Park spanning areas east of Orpen Camp southwards through Skukuza and Mkuhlu, including undulating terrain west of Skukuza to the basin of the Mbyamiti River. It continues further southward to the Hectorspruit area with a narrow westward extension up the Crocodile River Valley past Malelane, Kaapmuiden and the Kaap River Valley, entering Swaziland between Jeppe's Reef in the west and the Komati River in the east, through to the area between Manzini and Siphofaneni, including the Grand Valley, narrowing irregularly and marginally entering KwaZulu-Natal near Pongola. Altitude 250–700 m.

Vegetation & Landscape Features Tall shrubland with few trees to moderately dense low woodland on the deep sandy uplands with *Terminalia sericea*, *Combretum zeyheri* and *C. apiculatum* and ground layer including *Pogonarthria squarrosa*, *Tricholaena monachne* and *Eragrostis rigidior*. Dense thicket to open savanna in the bottomlands with *Acacia nigrescens*, *Dichrostachys cinerea*, *Grewia bicolor* in the woody layer. The dense herbaceous layer contains the dominant *Digitaria eriantha*, *Panicum maximum* and *Aristida congesta* on fine-textured soils, while brackish bottomlands support *Sporobolus nitens*, *Urochloa mosambicensis* and *Chloris virgata*. At seep lines, where convex topography changes to concave, a dense fringe of *Terminalia sericea* occurs, with *Eragrostis gummiflua* in the undergrowth.

Geology & Soils From north to south, the Swazian Goudplaats Gneiss, Makhutswi Gneiss and Nelspruit Suite (granite gneiss and migmatite), and further south still, the younger Mpuluzi Granite (Randian) form the major basement geology of the area. Archaean granite and gneiss weather into sandy soils in the uplands and clayey soils with high sodium content in the lowlands.

Climate Summer rainfall with dry winters. MAP from about 450 mm on the eastern flats to about 900 mm near the escarpment in the west. In a north-south direction, MAP of the unit appears to peak in Swaziland. Generally a frost-free region. Mean monthly maximum and minimum temperatures for Skukuza 39.5°C and –0.1°C for January and June, respectively. Corresponding values for Hoedspruit 38.0°C and 3.7°C for January and July, respectively. See also climate diagram for SVl 3 Granite Lowveld.

Important Taxa Tall Trees: *Acacia nigrescens* (d), *Sclerocarya birrea* subsp. *caffra* (d). Small Trees: *Acacia nilotica* (d), *Albizia harveyi* (d), *Combretum apiculatum* (d), *C. imberbe* (d), *C. zeyheri* (d), *Ficus stuhlmannii* (d), *Peltophorum africanum* (d), *Pterocarpus rotundifolius* (d), *Terminalia sericea* (d), *Acacia exuvialis*, *A. gerrardii*, *Bolusanthus speciosus*, *Cassia abbreviata* subsp. *beareana*, *Combretum collinum* subsp. *suluense*, *Dalbergia melanoxylon*, *Gymnosporia glaucophylla*, *Lannea schweinfurthii* var. *stuhlmannii*, *Pavetta schumanniana*, *Plectroniella armata*, *Terminalia prunioides*. Tall Shrubs: *Combretum hereroense* (d), *Dichrostachys cinerea* (d), *Euclea divinorum* (d), *Strychnos madagascariensis* (d), *Gardenia volkensii*, *Hibiscus micranthus*, *Tephrosia polystachya*. Low Shrubs: *Abutilon austro-africanum*, *Agathisanthemum bojeri*, *Aptosimum lineare*, *Barleria elegans*, *Clerodendrum ternatum*, *Commiphora africana*, *Gossypium herbaceum* subsp. *africanum*, *Pavonia burchellii*. Woody Climber: *Sphedamnocarpus pruriens* subsp. *pruriens*. Herbaceous Climber: *Rhynchosia totta*. Graminoids: *Brachiaria nigropedata* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Eragrostis rigidior* (d), *Melinis repens* (d), *Panicum maximum* (d), *Pogonarthria squarrosa* (d), *Aristida congesta*, *Bulbostylis hispidula*, *Chloris mossambicensis*, *Enneapogon cenchroides*, *Heteropogon contortus*, *Leptochloa eleusine*, *Perotis patens*, *Schmidtia pappophoroides*, *Sehima galpinii*, *Tricholaena monachne*, *Urochloa mosambicensis*. Herbs: *Achyranthes aspera*, *Aspilia mossambicensis*, *Becium filamentosum*, *Chamaecrista absus*, *Commelina benghalensis*, *C. erecta*, *Cucumis africanus*, *Evolvulus alsinoides*, *Heliotropium strigosum*, *Hermbstaedtia odorata*, *Hibiscus praeteritus*, *Indigofera filipes, I. sanguinea*, *Kohautia virgata*, *Kyphocarpa angustifolia*, *Leucas glabrata*, *Ocimum gratissimum*, *Phyllanthus maderaspatensis*, *Pupalia lappacea*, *Vahlia capensis* subsp. *vulgaris*, *Waltheria indica*. Succulent Herbs: *Orbea rogersii*, *Stapelia leendertziae*.

H.C. Eckhardt

Figure 9.46 SVl 3 Granite Lowveld: Moderately open savanna dominated by *Sclerocarya birrea*, *Combretum apiculatum* and *C. zeyheri* south of Skukuza, Kruger National Park.

Conservation Vulnerable. Target 19%. Some 17% statutorily conserved in the Kruger National Park. About the same amount conserved in private reserves mainly the Selati, Klaserie, Timbavati, Mala Mala, Sabi Sand and Manyeleti Reserves. More than 20% already transformed, mainly by cultivation and by settlement development. Erosion is very low to moderate.

Remark Further research may reveal a need to differentiate the northern from the southern parts of this unit.

References Bredenkamp (1982, 1985, 1986a, 1987), Bredenkamp et al. (1983, 1993), Coetzee (1983), Gertenbach (1983b), Bredenkamp & Theron (1985, 1988, 1990, 1991), Witkowski & O'Connor (1996).

H.C. Eckhardt

Figure 9.47 SVl 4 Delagoa Lowveld: Heavily utilised area surrounded by *Acacia welwitschii* tending towards thickets southwest of Satara, Kruger National Park.

SVl 4 Delagoa Lowveld

VT 10 Lowveld (87%) (Acocks 1953). LR 19 Mixed Lowveld Bushveld (59%) (Low & Rebelo 1996).

Distribution Mpumalanga Province, Swaziland and marginally into KwaZulu-Natal Province: A narrow strip on plains immediately east of the SVl 3 Granite Lowveld from the Nsemani River west of Satara in the Kruger National Park southwards to immediately west of Lower Sabie Camp to the Pomba Guard Post west of Crocodile Bridge Camp to the Strydom Block in the south. Also a band in Swaziland from Mhlume in the north to Onverwacht Border Post in the south, extending marginally into KwaZulu-Natal at Pongola. Altitude 150–450 m.

Vegetation & Landscape Features Dense tree or tall shrub layer dominated by *Acacia welwitschii*, often forming thickets. Herb layer has in addition to grass species a wide variety of forbs. Areas are often heavily grazed which sometimes drastically reduces the grass cover.

Geology & Soils Karoo Supergroup shale and lesser sandstone layers are punctuated by sheets and dykes of Jurassic dolerite. Soils (Sterkspruit, Swartland and Estcourt soil forms) are rich in sodium and very susceptible to erosion. Land types include Dc and Ea.

Climate Summer rainfall with dry winters. MAP about 450–850 mm. Generally a frost-free region. See also climate diagram for SVl 4 Delagoa Lowveld.

Important Taxa Small Trees: *Acacia senegal* var. *rostrata* (d), *A. welwitschii* subsp. *delagoensis* (d), *Albizia petersiana* (d), *Schotia capitata* (d), *Spirostachys africana* (d), *Pappea capensis*. Tall Shrubs: *Euclea divinorum* (d), *Maerua parvifolia* (d), *Boscia mossambicensis*, *Dichrostachys cinerea*, *Ehretia rigida* subsp. *rigida*, *Flueggea virosa*, *Grewia bicolor*, *Rhus gueinzii*. Low Shrubs: *Abutilon austroafricanum*, *Justicia flava*, *Zanthoxylum humile*. Woody Climbers: *Cordia ovalis* (d), *Capparis tomentosa*. Graminoids: *Chloris virgata* (d), *Panicum coloratum* (d), *P. maximum* (d), *Sporobolus nitens* (d), *Aristida congesta*, *Chloris roxburghiana*, *Dactyloctenium aegyptium*, *Tragus berteronianus*. Herbs: *Blepharis integrifolia*, *Kyphocarpa angustifolia*, *Ruellia patula*. Succulent Herb: *Aloe parvibracteata*.

Conservation Vulnerable. Target 19%. About 18% statutorily conserved in the Kruger National Park. Some 33% transformed, almost all by cultivation.

References Coetzee (1983), Gertenbach (1983b).

SVl 5 Tshokwane-Hlane Basalt Lowveld

VT 11 Arid Lowveld (56%) (Acocks 1953). LR 20 Sweet Lowveld Bushveld (69%) (Low & Rebelo 1996).

Distribution Mpumalanga Province and Swaziland (and very slightly into Limpopo Province): On plains immediately west of the Lebombo Mountains from Balule and Satara Camps in Kruger National Park in the north, through Tshokwane, Lower Sabie and Crocodile Bridge Camps, Komatipoort to around Ngwenyeni in the south. In Swaziland it occurs from Vuvulane Settlement in the north, through Hlane Game Sanctuary to a point in the south approximately halfway between Siteki and Big Bend. Altitude 180–400 m.

Vegetation & Landscape Features Usually fairly flat plains with open tree savanna, often dominated by tall *Sclerocarya birrea* and *Acacia nigrescens* with a moderately developed shrub layer and a dense herbaceous layer. On some sloping areas with shallower soils, trees are stunted (e.g. *A. nigrescens*).

Geology & Soils The Letaba Formation basalts of the Karoo Supergroup in this area give rise to black, brown or red clayey soils, usually not more the 1 m deep. Vertisols, such as the Arcadia soil form, occur in low-lying areas and concave plains. Land types mainly Ea with some Dc.

M.C. Lötter

Figure 9.48 SVl 5 Tshokwane-Hlane Basalt Lowveld: Deciduous closed woodland occurring on clay flats with *Acacia gerrardii*, *A. tortilis*, *Combretum hereroense* and *C. imberbe* looking over the Nwanetsi River, Kruger National Park.

Climate Summer rainfall with dry winters. MAP about 400–800 mm in the southernmost part in Swaziland. Mean monthly maximum and minimum temperatures for Satara (in the north of the unit) 40.2°C and 4.2°C for January and June, respectively. See also climate diagram for SVl 5 Tshokwane-Hlane Basalt Lowveld.

Important Taxa Tall Trees: *Acacia nigrescens* (d), *Sclerocarya birrea* subsp. *caffra* (d), *Philenoptera violacea*. Small Trees: *Acacia borleae*, *A. gerrardii*, *A. nilotica*, *A. tortilis* subsp. *heteracantha*, *Albizia harveyi*, *Combretum hereroense, C. imberbe*, *Lannea schweinfurthii* var. *stuhlmannii*, *Peltophorum africanum, Pterocarpus rotundifolius*. Tall Shrubs: *Dichrostachys cinerea*, *Grewia bicolor*, *Gymnosporia maranguensis*, *Rhus gueinzii*. Low Shrubs: *Acalypha segetalis*, *Dicoma tomentosa*, *Hermannia glanduligera*, *Justicia flava*, *J. protracta* subsp. *protracta*, *Seddera suffruticosa*, *Tragia dioica*. Herbaceous Climber: *Commicarpus plumbagineus*. Graminoids: *Bothriochloa radicans* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Panicum coloratum* (d), *P. maximum* (d), *Themeda triandra* (d), *Urochloa mosambicensis* (d), *Aristida congesta*, *Cenchrus ciliaris*, *Eragrostis superba*, *Heteropogon contortus*. Herbs: *Chamaecrista mimosoides*, *Gisekia africana*, *Thunbergia dregeana*. Succulent Herbs: *Aloe zebrina*, *Orbea paradoxa, O. rogersii*.

H.C. Eckhardt

Figure 9.49 SVl 6 Gabbro Grassy Bushveld: Very open low grassy savanna with *Acacia nigrescens* and *Albizia harveyi* near Skipberg southeast of Pretoriuskop, Kruger National Park.

Endemic Taxon Low Shrub: *Boscia foetida* subsp. *minima*.

Conservation Least threatened. Target 19%. About 64% statutorily conserved mainly in the Kruger National Park, but also in the Mlawula Nature Reserve. In addition, over 3% conserved mainly in the Hlane Game Sanctuary. About 17% transformed, almost all by cultivation.

Remarks Different parts of this unit can show different rates of change over years, including some parts with very little change (Coetzee et al. 1977). Mapped as part of this unit is the small area (3% of the unit) east of Kumana waterhole, south of Satara (Kumana Sandveld of Gertenbach 1983b), which is on sandstone, but contains dolerite intrusions with clayey soil as well as some surface shales with sodium-saturated soil.

References Coetzee et al. (1977), Gertenbach & Potgieter (1978), Coetzee (1983), Gertenbach (1983b).

SVl 6 Gabbro Grassy Bushveld

VT 11 Arid Lowveld (60%) (Acocks 1953). LR 20 Sweet Lowveld Bushveld (52%) (Low & Rebelo 1996). KNP 19 Thornveld on gabbro (96%) (Gertenbach 1983b).

Distribution Mpumalanga Province: Flats and hills mainly in the Kruger National Park in isolated patches from Orpen Camp in the north, southwards including Rooigras Vlakte (northeast of Skukuza) and some areas stretching from north of Pretoriuskop to around Afsaal in the south. Altitude 200–550 m.

Vegetation & Landscape Features Open savanna with a dense grass cover (with dominants including *Themeda triandra*) with a few scattered trees and shrubs. Sparser grass cover is encountered on shallow soils.

Geology & Soils The distribution of this bushveld closely follows the sinuous intrusions of the Timbavati gabbro (Mokolian Erathem). The unit is also mapped on surrounding potassic granite and gneiss of Archaean basement and the gneiss and migmatite of the Nelspruit Suite (also Archaean). Dark vertic clay soils (20–50% clay) often swell and shrink. Loose rock is often present on the surface. Some shallow lithosols occur in places. Where gabbro is in contact with the adjacent granite, a mixed soil sometimes develops with a gabbro-derived A-horizon overlying a granite-derived B-horizon. Land types mainly Fb and Dc.

Climate Summer rainfall with dry winters. MAP about 500–650 mm. Generally a frost-free region. See also climate diagram for SVl 6 Gabbro Grassy Bushveld.

Important Taxa Tall Trees: *Acacia nigrescens* (d), *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Acacia tortilis* subsp. *heteracantha*, *Bolusanthus speciosus*, *Dalbergia melanoxylon*, *Lannea schweinfurthii* var. *stuhlmannii*, *Ziziphus mucronata*. Tall Shrubs: *Flueggea virosa*, *Grewia bicolor*, *Ormocarpum trichocarpum*, *Tephrosia polystachya*. Low Shrubs: *Abutilon austro-africanum*, *Seddera suffruticosa*, *Sida rhombifolia*. Graminoids: *Chloris virgata* (d), *Ischaemum afrum* (d), *Setaria incrassata* (d), *Themeda triandra* (d), *Bothriochloa radicans*, *Cenchrus ciliaris*, *Cymbopogon pospischilii*, *Digitaria eriantha* subsp. *eriantha*, *Enneapogon cenchroides*, *Eragrostis superba*, *Panicum maximum*, *Schmidtia pappophoroides*, *Sorghum versicolor*, *Sporobolus nitens*, *Urochloa mosambicensis*. Herbs: *Heliotropium steudneri*, *Ipomoea crassipes*, *Kyphocarpa angustifolia*. Succulent Herb: *Aloe zebrina*.

Conservation Least threatened. Target 19%. Altogether 96% statutorily conserved in the Kruger National Park and the remainder is conserved in private reserves (Timbavati and Manyeleti). Very little transformed and erosion is low.

Remarks The mapped unit follows Gertenbach's (1983b) boundaries. More recent geology maps show the gabbro to be narrower than mapped. A few areas of gabbro just outside the southern Kruger National Park have not been depicted on our map.

References Gertenbach (1978, 1983b), Bredenkamp & Deutschländer (1994, 1995).

SVl 7 Gravelotte Rocky Bushveld

VT 11 Arid Lowveld (59%) (Acocks 1953). LR 19 Mixed Lowveld Bushveld (58%) (Low & Rebelo 1996).

Distribution Limpopo Province: The Murchison Range in the Gravelotte area including surrounding mountains and hills including Ga-Mashishimale north of Mica and Seribana, and extending northwards towards Thohoyandou as isolated hills including Mangombe and Sionwe. Altitude 450–950 m (with the highest peaks reaching 1 025 m).

Vegetation & Landscape Features Open deciduous to semi-deciduous woodland on rocky slopes and inselbergs, contrasting strongly with the surrounding plains.

Geology & Soils The varied geology is largely composed of schist and amphibolite of the Gravelotte and Giyani Groups, with a few quartzitic and granitic hills. Miscellaneous, often shallow, soils with Glenrosa and Mispah forms common. Land types mainly Ib, Fa, Ae and Fb.

Climate Summer rainfall with dry winters. MAP about 500 mm in the east to about 900 mm in the west, with the higher rainfall on the higher mountains. Frost very infrequent. See also climate diagram for SVl 7 Gravelotte Rocky Bushveld.

Important Taxa Tall Tree: *Pterocarpus angolensis*. Small Trees: *Acacia caffra* (d), *Croton gratissimus* (d), *Cussonia natalensis* (d), *Ficus tettensis* (d), *Kirkia acuminata* (d), *Berchemia zeyheri*, *Bridelia mollis*, *Combretum apiculatum*, *C. molle*, *Dombeya rotundifolia*, *Englerophytum magalismontanum*, *Faurea saligna*, *Ficus abutilifolia*, *F. burkei*, *Heteropyxis natalensis*, *Ochna natalitia*, *Pavetta schumanniana*, *Rhus leptodictya*, *Schrebera alata* (woodland form), *Sterculia rogersii*, *Vangueria infausta*. Succulent Tree: *Euphorbia cooperi*. Tall Shrubs: *Steganotaenia araliacea* (d), *Coptosperma supra-axillare*, *Hexalobus monopetalus*, *Mundulea sericea*, *Pouzolzia mixta*, *Psydrax livida*. Low Shrubs: *Barleria affinis*, *B. lancifolia*, *B. saxatilis*, *Psiadia punctulata*. Woody Climbers: *Cocculus hirsutus*, *Sphedamnocarpus pruriens* subsp. *pruriens*. Graminoids: *Brachiaria serrata* (d), *Panicum maximum* (d), *Andropogon schirensis*, *Brachiaria nigropedata*, *Cymbopogon caesius*, *Eustachys paspaloides*, *Heteropogon contortus*, *Loudetia simplex*, *Setaria sphacelata*. Herb: *Vernonia natalensis*. Succulent Herb: *Stapelia gigantea*.

Endemic Taxon Small Tree: *Encephalartos dyerianus*.

Conservation Least threatened. Target 19%. None conserved in statutory conservation areas. Some 7% conserved in a small proportion of the area in the northern part of the Selati Game Reserve. Conservation of this unit is promoted due to the land use of game and cattle ranching and due to its low agronomic potential. About 15% transformed, mainly by cultivation and some development of settlements. Erosion is very low to moderate.

Reference M.C. Lötter & J.E. Burrows (unpublished data).

SVl 8 Tzaneen Sour Bushveld

VT 9 Lowveld Sour Bushveld (80%) (Acocks 1953). LR 21 Sour Lowveld Bushveld (59%) (Low & Rebelo 1996).

Distribution Limpopo Province: A band extending along the footslopes and hills of the northeastern escarpment, from the Soutpansberg Mountains in the north via Tzaneen and narrowing to the Abel Erasmus Pass area in the south. Altitude 600–1 000 m and higher in places.

Vegetation & Landscape Features Deciduous, tall open bushveld (parkland) with a well-developed, tall grass layer, occurring on low to high mountains with undulating plains mainly at the base of, and on the lower to middle slopes of the northeastern escarpment.

Geology & Soils The potassium-poor gneisses of the Goudplaats gneiss (Swazian Erathem) and an Archaean granite dyke underlie most of this area. Shales and quartzite of the Wolkberg Group are present, but not common. Soils are Mispah, Glenrosa or Hutton forms, shallow to deep, sandy or gravelly and well-drained. Land types Fa, Ab, Ae and Ia.

Climate Summer rainfall with dry winters. MAP from about 550 mm on the footslopes of the escarpment in the east to about 1 000 mm, where it borders grassland at higher altitudes to the west. Frost infrequent, but occasional at higher altitude. Mean monthly maximum and minimum temperatures for Tzaneen 36.4°C and 3.9°C for January and June, respectively. Corresponding values for Levubu-Agr 36.4°C and 5.7°C for October and July, respectively. See also climate diagram for SVl 8 Tzaneen Sour Bushveld.

Important Taxa Tall Trees: *Pterocarpus angolensis*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Acacia polyacantha* (d), *Albizia versicolor* (d), *Ficus sansibarica* (d), *Parinari curatellifolia* (d), *Piliostigma thonningii* (d), *Pterocarpus rotundifolius* (d), *Trichilia emetica* (d), *Acacia davyi*, *A. sieberiana* var. *woodii*, *Antidesma venosum*, *Catha edulis*, *Faurea rochetiana*, *F. saligna*, *Ficus*

L Mucina

Figure 9.50 SVl 8 Tzaneen Sour Bushveld: The legendary Modjadji 'Forest' housing thousands of old specimens of *Encephalartos transvenosus*, protected by Her Majesty the Rain Queen of the Bo-Lobedu people near Ga-Modjadji, northeast of Tzaneen.

burkei, *F. petersii*, *Heteropyxis natalensis*, *Peltophorum africanum*, *Terminalia sericea*, *Vernonia colorata*. Tall Shrubs: *Olea europaea* subsp. *africana*, *Pseudarthria hookeri* var. *hookeri*, *Rhus pentheri*, *Triumfetta pilosa* var. *tomentosa*. Low Shrubs: *Agathisanthemum bojeri*, *Barleria elegans*, *Dicliptera clinopodia*, *Flemingia grahamiana*, *Indigofera filipes*, *Polygala producta*. Woody Climbers: *Bauhinia galpinii*, *Pterolobium stellatum*. Graminoids: *Cymbopogon caesius* (d), *C. nardus* (d), *Hyparrhenia cymbaria* (d), *H. poecilotricha* (d), *Hyperthelia dissoluta* (d), *Alloteropsis semialata* subsp. *semialata*, *Andropogon schirensis*, *Bothriochloa bladhii*, *Monocymbium ceresiiforme*, *Paspalum scrobiculatum*, *Schizachyrium sanguineum*, *Themeda triandra*. Herb: *Waltheria indica*.

W.L. McCleland

Figure 9.51 SVl 9 Legogote Sour Bushveld: A particularly open form of this type, namely Short Sparse Woodland with scattered Short Thicket (*sensu* Edwards 1983), extensively represented on crests and slopes. Dominant trees include *Acacia sieberiana*, *A. davyi*, *Dichrostachys cinerea* and *Rhus pyroides* with grasses *Hyperthelia dissoluta*, *Hyparrhenia* species, and shorter grass species such as *Themeda triandra* and *Loudetia simplex*. On the Farm Dingwell southwest of White River.

Conservation Endangered. Target 19%. Only a little over 1% statutorily conserved, almost all in the Lekgalameetse Nature Reserve, and about 2% conserved in private reserves such as the Selati Game Reserve and Wolkberg (Serala) Wilderness Area. About 41% transformed mainly by cultivation (29%) and plantations (9%). The higher-lying parts of this unit have been heavily afforested with tree plantations while the lower-lying areas are under agricultural and horticultural crops. Scattered alien plants include *Solanum mauritianum*, *Melia azedarach* and *Caesalpinia decapetala*. The subtropical climate is conducive to the spread of *Chromolaena odorata*, *Lantana camara* and *Psidium guajava*. Erosion is very variable—from very low to high in some areas.

Remarks This unit has several subtropical elements such as *Acacia polyacantha* and *Trichilia emetica*. It is very similar to SVl 9 Legogote Sour Bushveld, but the latter has a cooler climate and different floristic elements. At places on the footslopes, this vegetation becomes very dense and is transitional to forest in kloofs on the eastern slopes of the Drakensberg. *A. ataxacantha* and *Trema orientalis* are prominent pioneer species here. This unit is also rich in fig species.

References Scheepers (1977), Acocks (1988), Stalmans (1990).

SVl 9 Legogote Sour Bushveld

VT 9 Lowveld Sour Bushveld (56%) (Acocks 1953). LR 21 Sour Lowveld Bushveld (90%) (Low & Rebelo 1996).

Distribution Mpumalanga and Limpopo Provinces: Lower eastern slopes and hills of the northeastern escarpment from Mariepskop in the north through White River to the Nelspruit area extending westwards up the valleys of the Crocodile, Elands and Houtbosloop Rivers and terminating in the south in the Barberton area. Altitude 600–1 000 m and higher in places.

Vegetation & Landscape Features Gently to moderately sloping upper pediment slopes with dense woodland including many medium to large shrubs often dominated by *Parinari curatellifolia* and *Bauhinia galpinii* with *Hyperthelia dissoluta* and *Panicum maximum* in the undergrowth. Short thicket dominated by *Acacia ataxacantha* occurs on less rocky sites. Exposed granite outcrops have low vegetation cover, typically with *Englerophytum magalismontanum*, *Aloe petricola* and *Myrothamnus flabellifolia*.

Geology & Soils Most of the area is underlain by gneiss and migmatite of the Nelspruit Suite, but the southern part occurs on the potassium-poor rocks of the Kaap Valley Tonalite (both Swazian Erathem). The westernmost parts of the distribution are found in Pretoria Group shale and quartzite (Vaalian). Archaean granite plains with granite inselbergs and large granite boulders also occur. Soils are of Mispah, Glenrosa and Hutton forms, shallow to deep, sandy or gravelly and well drained. Diabase intrusions are common, giving rise to Hutton soils. Land types Ab, Fa and Ae.

Climate Summer rainfall with dry winters. MAP from about 700 mm on the footslopes of the escarpment in the east to about 1 150 mm where it borders on grassland at higher altitude to the west. Frost infrequent to occasional at higher altitudes. Mean monthly maximum and minimum temperatures for Nelspruit 35.7°C and 1.6°C for October and July, respectively. Corresponding values for Barberton-Agr 36.0°C and 0.8°C for October and June, respectively. Both weather stations lie at the eastern edge of the unit at lower altitude. See also climate diagram for SVl 9 Legogote Sour Bushveld.

Important Taxa Tall Trees: *Pterocarpus angolensis* (d), *Sclerocarya birrea* subsp. *caffra* (d). Small Trees: *Acacia davyi* (d), *A. sieberiana* var. *woodii* (d), *Combretum zeyheri* (d), *Erythrina latissima* (d), *Parinari curatellifolia* (d), *Terminalia sericea* (d), *Trichilia emetica* (d), *Vernonia amygdalina* (d), *Acacia caffra*, *Antidesma venosum*, *Erythroxylum emarginatum*, *Faurea rochetiana*, *F. saligna*, *Ficus burkei*, *F. glumosa*, *F. ingens*, *F. petersii*, *Heteropyxis natalensis*, *Peltophorum africanum*, *Piliostigma thonningii*, *Pterocarpus rotundifolius*, *Schotia brachypetala*. Succulent Tree: *Euphorbia ingens*. Tall Shrubs: *Diospyros lycioides* subsp. *sericea*, *Erythroxylum delagoense*, *Olea europaea* subsp. *africana*, *Pachystigma macrocalyx*, *Pseudarthria hookeri* var. *hookeri*, *Rhus pentheri*. Low Shrubs: *Diospyros galpinii* (d), *Flemingia grahamiana* (d), *Agathisanthemum bojeri*, *Eriosema psoraleoides*, *Gymnosporia heterophylla*, *Hemizygia punctata*,

Indigofera filipes, *Myrothamnus flabellifolius*, *Rhus rogersii*. Succulent Shrubs: *Aloe petricola*, *Euphorbia vandermerwei*, *Huernia kirkii*. Woody Climbers: *Acacia ataxacantha* (d), *Bauhinia galpinii* (d), *Helinus integrifolius*, *Sphedamnocarpus pruriens* subsp. *pruriens*. Graminoids: *Bothriochloa bladhii* (d), *Cymbopogon caesius* (d), *C. nardus* (d), *Hyparrhenia cymbaria* (d), *H. poecilotricha* (d), *Hyperthelia dissoluta* (d), *Panicum maximum* (d), *Andropogon schirensis*, *Paspalum scrobiculatum*, *Schizachyrium sanguineum*. Herbs: *Gerbera ambigua*, *G. viridifolia*, *Hemizygia persimilis*, *Hibiscus sidiformis*, *Ocimum gratissimum*, *Waltheria indica*. Succulent herbs: *Orbea carnosa* subsp. *carnosa, Stapelia gigantea.* Geophytic Herbs: *Gladiolus hollandii*, *Hypoxis rigidula*.

Endemic Taxon Succulent Herb: *Aloe simii*.

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Figure 9.52 SVl 10 Pretoriuskop Sour Bushveld: Typical savanna dominated mainly by *Terminalia sericea* with *Pterocarpus angolensis* north of Pretoriuskop, Kruger National Park.

Conservation Endangered. Target 19%. About 2% statutorily conserved mainly in the Bosbokrand and Barberton Nature Reserves; at least a further 2% is conserved in private reserves including the Mbesan and Kaapsehoop Reserves and Mondi Cycad Reserve. It has been greatly transformed (50%), mainly by plantations and also by cultivated areas and urban development. Scattered alien plants include *Lantana camara*, *Psidium guajava* and *Solanum mauritianum*. Erosion is very low to moderate.

Remark At places on the footslopes this vegetation becomes very dense and is transitional to forest in kloofs on the eastern slopes of the escarpment.

References Van der Schijff & Schoonraad (1971), Deall (1985), Acocks (1988), Deall et al. (1989).

SVl 10 Pretoriuskop Sour Bushveld

VT 10 Lowveld (94%) (Acocks 1953). LR 21 Sour Lowveld Bushveld (78%) (Low & Rebelo 1996).

Distribution Mpumalanga Province: From around Hazyview and Pretoriuskop Camp in the southwestern part of the Kruger National Park to the Malekutu area. Also in the Crocodile Estates area between Nelspruit and Crocodile Gorge. Altitude 400–700 m.

Vegetation & Landscape Features Mainly uplands with open tree savanna dominated by *Terminalia sericea* and *Dichrostachys cinerea* with relatively few low shrubs, grassy layer dense and dominated by sour grasses such as *Hyperthelia dissoluta*, *Elionurus muticus* and *Hyparrhenia hirta*. Grass composition changes somewhat on the midslopes, and in the narrow bottomlands dominant species include *Acacia nilotica*, *A. gerrardii* and *A. tortilis*, *Digitaria eriantha*, *Eragrostis superba* and *Aristida congesta*.

Geology & Soils Granite and gneiss of the Nelspruit Suite weathering to a shallow, leached, red to yellow-brown sand to sandy loam of the Glenrosa, Hutton and Clovelly forms. Land types Ae, Ab, Ba and Fb.

Climate Summer rainfall and dry winters. MAP about 550–800 mm. Frost infrequent. Mean monthly maximum and minimum temperatures for Pretoriuskop are 37.3°C and 5.2°C for October and July, respectively. See also climate diagram for SVl 10 Pretoriuskop Sour Bushveld.

Important Taxa Tall Tree: *Sclerocarya birrea* subsp. *caffra* (d). Small Trees: *Combretum apiculatum* (d), *C. zeyheri* (d), *Peltophorum africanum* (d), *Piliostigma thonningii (d)*, *Terminalia sericea* (d), *Antidesma venosum*, *Combretum collinum* subsp. *gazense*, *C. molle*, *Ficus petersii*, *Parinari curatellifolia*, *Pterocarpus angolensis, Ximenia caffra*. Tall Shrubs: *Dichrostachys cinerea* (d), *Gymnosporia senegalensis* (d), *Strychnos madagascariensis* (d), *Grewia bicolor*, *G. monticola*, *Strychnos spinosa*, *Turraea nilotica*. Low Shrubs: *Agathisanthemum bojeri*, *Aptosimum lineare*, *Barleria obtusa*, *Gymnosporia glaucophylla*, *Melhania rehmannii*, *Sida chrysantha*. Succulent Shrub: *Aloe petricola*. Woody climber: *Bauhinia galpinii.* Graminoids: *Aristida congesta* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Elionurus muticus* (d), *Eragrostis rigidior* (d), *Heteropogon contortus* (d), *Hyparrhenia hirta* (d), *Hyperthelia dissoluta* (d), *Panicum coloratum* (d), *Pogonarthria squarrosa* (d), *Bothriochloa radicans*, *Diheteropogon amplectens*, *Eragrostis atrovirens*, *E. lappula*, *Hyparrhenia filipendula*, *Melinis repens*, *Perotis patens*, *Setaria sphacelata*, *Urochloa mosambicensis*. Herbs: *Chamaecrista mimosoides*, *Tricliceras glanduliferum*.

Conservation Least threatened. Target 19%. Some 40% statutorily conserved in the Kruger National Park. A very small area is also conserved in the private Mthethomusha Nature Reserve. About 16% transformed by cultivation and by development of settlements. Alien plants include *Opuntia stricta*, *Lantana camara* and *Psidium guajava*. Erosion is very low to moderate.

Remark This vegetation is related to the SVl 9 Legogote Sour Bushveld, but is drier.

Reference Gertenbach (1983b).

SVl 11 Malelane Mountain Bushveld

VT 10 Lowveld (80%) (Acocks 1953). LR 21 Sour Lowveld Bushveld (75%) (Low & Rebelo 1996).

Distribution Mpumalanga Province: High-lying area north of Malelane and Kaapmuiden including Berg-en-Dal Rest Camp area as far north as the area of the hill Sithongwane in the

Kruger National Park. Also includes the Krokodilpoortberge both north and south of the Crocodile Gorge. Altitude from 400 to over 1 000 m in places.

Vegetation & Landscape Features Open savanna on mountains and higher-lying slopes, with an open to dense, short mountain bushveld on rocky outcrops and lower-lying areas. Altitude and aspect are important in determining species composition in this mountainous terrain.

Geology & Soils Granite and gneiss, mostly of the Nelspruit Suite, forming hills with large boulders, with shallow, coarse, sandy lithosols, largely comprised of Glenrosa or Mispah soil types. Land types Fa, Fb and Ib.

Climate Summer rainfall with dry winters. MAP about 600–1 100 mm, increasing with altitude. Mountain tops experience occasional mist. Frost infrequent to occasional at higher altitudes. See also climate diagram for SVl 11 Malelane Mountain Bushveld.

Important Taxa **Low-lying closed savanna:** Tall Tree: *Pterocarpus angolensis* (d). Small Trees: *Acacia caffra* (d), *A. davyi* (d), *Combretum molle* (d), *Dombeya rotundifolia* (d), *Faurea saligna* (d), *Heteropyxis natalensis* (d), *Kirkia wilmsii* (d), *Sterculia murex* (d), *Acacia swazica*, *Combretum collinum* subsp. *suluense*, *C. zeyheri*, *Englerophytum magalismontanum*, *Ficus abutilifolia*, *Maytenus undata* (woodland form), *Mimusops zeyheri*, *Pterocarpus rotundifolius*, *Rhus leptodictya*, *Terminalia sericea*, *Vitex obovata* subsp. *wilmsii*. Succulent Tree: *Euphorbia cooperi*. Tall Shrubs: *Acalypha glabrata*, *Croton madandensis*, *Diospyros lycioides* subsp. *sericea*, *Grewia monticola*, *Olea europaea* subsp. *africana*, *Strychnos spinosa*. Low Shrubs: *Barleria rotundifolia*, *Orthosiphon labiatus*, *Polygala producta*. Succulent Shrub: *Aloe spicata*. Woody Climbers: *Bauhinia galpinii*, *Dalbergia armata*, *Pterolobium stellatum*. Woody Succulent Climber: *Senecio pleistocephalus*. Herbaceous Climbers: *Coccinia rehmannii*, *Rhynchosia caribaea*. Graminoids: *Bothriochloa radicans* (d), *Enneapogon scoparius* (d), *Eragrostis rigidior* (d), *Eustachys paspaloides*, *Heteropogon contortus*, *Themeda triandra*, *Tristachya leucothrix*, *Urochloa mosambicensis*. Geophytic Herb: *Drimia altissima*. Succulent Herb: *Plectranthus cylindraceus*. Epiphytic Succulent Herb: *Ansellia africana*. **High-lying open savanna:** Small Trees: *Acacia davyi* (d), *Combretum molle* (d), *Heteropyxis natalensis* (d), *Hippobromus pauciflorus* (d), *Sterculia murex* (d), *Acacia natalitia*, *Bersama lucens*, *Combretum kraussii*, *Cussonia spicata*, *Ekebergia capensis*, *Faurea rochetiana*, *Ficus ingens*, *Pavetta edentula*, *Rhus leptodictya*, *Vitex obovata* subsp. *wilmsii*. Tall Shrubs: *Olea capensis* subsp. *enervis* (d), *Canthium inerme*, *Rhus pentheri*, *Vernonia myriantha*. Low Shrubs: *Flemingia grahamiana* (d), *Helichrysum kraussii* (d), *Acalypha villicaulis*, *Asparagus virgatus*, *Diospyros galpinii*, *Helichrysum lepidissimum*, *Polygala producta*, *Tenrhynea phylicifolia*, *Vernonia crataegifolia*. Succulent Shrub: *Aloe spicata*. Woody Climber: *Dalbergia armata*. Graminoids: *Bothriochloa radicans* (d), *Enneapogon scoparius* (d), *Eragrostis rigidior* (d), *Andropogon eucomus*, *Eustachys paspaloides*, *Heteropogon contortus*, *Panicum natalense*, *Themeda triandra*, *Tristachya leucothrix*, *Urochloa mosambicensis*. Herbs: *Becium obovatum*, *Indigofera sanguinea*. Geophytic Herb: *Drimia altissima*. Succulent Herb: *Stapelia gigantea*. Epiphytic Succulent Herb: *Ansellia africana*.

Conservation Least threatened. Target 24%. About 39% statutorily conserved in the Kruger National Park and a further 6% conserved in the Mthethomusha Nature Reserve. At least 4% transformed, mainly by cultivation and urban and built-up areas. Scattered alien plants include *Lantana camara*, *Jacaranda mimosifolia*, *Melia azedarach*, *Solanum mauritianum*, *Sesbania punicea*, *Ricinus communis* and *Psidium guajava*. Erosion is generally very low to low.

Remarks This mountainous unit is similar to the SVl 9 Legogote Sour Bushveld, but which has a wetter and cooler climate. Two broad groups of plant communities are recognised, namely the high-lying open savannas and the low-lying closed savannas. The transition between these two community complexes is at an altitude of about 700 m.

Reference Gertenbach (1983b).

SVl 12 Kaalrug Mountain Bushveld

VT 10 Lowveld (73%) (Acocks 1953). LR 21 Sour Lowveld Bushveld (79%) (Low & Rebelo 1996).

Distribution Mpumalanga Province and slightly into Swaziland: Mountain slopes and hills from Barberton in the west continuing eastwards south of the Kaaps River and lower Crocodile River. Also including the lower slopes of Three Sisters and Kaalrug to the area of One Tree Hill and Wilson's Kop in the east. Altitude 350–950 m.

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Figure 9.53 SVl 11 Malelane Mountain Bushveld: General view of here moderately open bushveld near Berg-en-Dal Rest Camp, Kruger National Park.

Vegetation & Landscape Features Open to dense, short mountain savanna or thickets, with a more dense grassy layer at higher altitudes. Often steep or very broken mountain slopes at altitudes lower than the Gm 17 Barberton Montane Grassland.

Geology & Soils Rocky mountains of schists, gneiss, shale and quartzite of the Figtree, Moodies, and Onverwacht Groups of the Barberton Greenstone Belt. Also basaltic lava including the granodiorite of the Salisburykop Pluton. Soils shallow, mainly Glenrosa and Mispah forms, with some areas of vertic, melanic clays along lowest edges. Land types Fb, Fa and Ea.

Climate Summer rainfall with dry winters. MAP from about 650 mm on the footslopes of the mountains to about

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Figure 9.54 SVl 12 Kaalrug Mountain Bushveld. Rocky bushveld with *Olea europaea* subsp. *africana* and *Ficus sur* with some alien *Eucalyptus* species in the centre on Colombo Ranch mine east-northeast of Barberton.

1 200 mm where it borders grassland at higher altitudes. Frost infrequent to occasional at higher altitudes. See also climate diagram for SVl 12 Kaalrug Mountain Bushveld.

Important Taxa Small Trees: *Pavetta edentula* (d), *Sclerocroton integerrimum* (d), *Margaritaria discoidea*, *Tabernaemontana elegans*. Succulent Tree: *Euphorbia triangularis*. Tall Shrubs: *Combretum padoides* (d), *Diplorhynchus condylocarpon*, *Galpinia transvaalica*, *Maerua rosmarinoides*, *Monanthotaxis caffra, Olea europaea* subsp. *africana*. Low Shrubs: *Orthosiphon serratus*, *Pavetta gracilifolia*, *Ruttya ovata*. Succulent Shrub: *Euphorbia transvaalensis*. Soft Shrub: *Metarungia longistrobus*. Woody Climbers: *Combretum woodii* (d), *Caesalpinia rostrata*. Graminoids: *Bothriochloa radicans* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Eragrostis rigidior* (d), *Eustachys paspaloides* (d), *Enneapogon scoparius*, *Heteropogon contortus*, *Panicum maximum*, *Schmidtia pappophoroides*, *Themeda triandra*. Herbs: *Senecio venosus*, *Vernonia natalensis*, *Waltheria indica*. Geophytic Herb: *Cyrtanthus galpinii*. Succulent Herb: *Plectranthus neochilus*.

Endemic Taxa Succulent Shrub: *Euphorbia complexa*. Geophytic Herb: *Ledebouria cremnophila*.

Conservation Least threatened. Target 24%. Some 16% statutorily conserved, almost all in Mountainlands Nature Reserve. A further 9% conserved in the private reserves of Cwantalala and Boondocks. About 12% transformed, mainly by cultivation and plantations. Erosion is generally very low.

Remarks This is a mesic mountain bushveld with some relationships to the mountain grassland, though woody species are most dominant. FOz 8 Scarp Forest patches occur in protected kloofs.

References Bredenkamp & Matthews (1991), De Frey (1999), Van Wyk & Smith (2001).

SVl 13 Barberton Serpentine Sourveld

VT 10 Lowveld (46%), VT 9 Lowveld Sour Bushveld (32%) (Acocks 1953). LR 21 Sour Lowveld Bushveld (86%) (Low & Rebelo 1996).

Distribution Mpumalanga Province: Occurs in fragmented patches on the exposed ultramafic substrates in a triangular region extending from Malelane in the east, to Badplaas, Barberton and eastern Swaziland in the south and to west of Nelspruit in the north. Altitude 350–1 400 m.

Vegetation & Landscape Features Often hilly, but very varied terrain. The southern ultramafic outcrops support herbaceous grasslands with stunted woody vegetation with more woody vegetation apparent within the lower-lying Noordkaap area and towards Malelane.

Geology & Soils Soils derived from ultramafic lavas (including komatiites and serpentinites), predominantly of the Onverwacht Group of the Barberton Supergroup (Barberton Greenstone Belt). The ultramafic geology gives rise to soils with unusually high magnesium: calcium ratios. These soils are associated with high concentrations of heavy metals such as Ni and Cr, which are generally toxic to most plants. Land types mostly Fa and Fb.

Climate Summer rainfall with dry winters. MAP about 600–1 150 mm. Frost infrequent. See also climate diagram for SVl 13 Barberton Serpentine Sourveld.

Important Taxa Small Trees: *Acacia caffra*, *A. davyi*, *Faurea rochetiana*, *Pavetta edentula*. Succulent Tree: *Aloe marlothii* subsp. *marlothii* (d). Tall Shrubs: *Erythroxylum delagoense*, *Tephrosia elongata*. Low Shrubs: *Gnidia caffra* (d), *G. sericocephala*, *Helichrysum kraussii*, *Jamesbrittenia grandiflora*, *Jatropha latifolia* var. *latifolia*, *Pearsonia sessilifolia*, *Rhus rogersii*, *Thunbergia atriplicifolia*. Herbaceous Climbers: *Rhynchosia minima*, *R. totta*. Graminoids: *Loudetia simplex* (d), *Themeda triandra* (d), *Andropogon schirensis*, *Bewsia biflora*, *Cymbopogon caesius*, *Diheteropogon amplectens*, *Eragrostis capensis*, *E. racemosa*, *Heteropogon contortus*, *Panicum natalense*. Herbs: *Helichrysum nudifolium* var. *pilosellum*, *Hemizygia persimilis*, *Rabdosiella calycina*, *Rhynchosia monophylla*, *Senecio coronatus*, *S. venosus*, *Vernonia natalensis*, *V. sutherlandii*. Geophytic Herb: *Cheilanthes involuta*.

Biogeographically Important Taxon (Link to Pondoland) Low Shrub: *Rhus pondoensis* (d).

Endemic Taxa Small Tree: *Protea curvata*. Low Shrubs: *Ozoroa barbertonensis*, *Rhus pygmaea*, *Sclerochiton triacanthus*. Succulent Shrub: *Aloe thorncroftii*. Herbs: *Berkheya coddii* (d), *B. zeyheri* subsp. *rehmannii* var. *rogersiana* (d), *Asystasia subbiflora*, *Berkheya nivea*, *Cyphia bolusii*, *Dicoma swazilandica*, *Inezia speciosa*. Geophytic Herbs: *Brachystelma dyeri*, *Gladiolus serpenticola*.

Conservation Vulnerable. Target 24%. Almost 6% statutorily conserved in the Songimvelo and Barberton Nature Reserves, amongst others. Almost 2% conserved in addition in private reserves including Queensriver and Boondocks. More than one quarter of the area has been transformed, mainly by plantations and cultivation.

Remarks Species richness on some serpentine sites is only slightly lower than that of surrounding areas, but on other serpentine sites the species richness is higher than that of the surrounding vegetation (S. Williamson, unpublished data). This higher species richness is probably due to the heterogeneous nature of these outcrops in terms of altitude, slope and soil conditions. In addition, this vegetation unit is very rich in endemics that have evolved as edaphic specialists. It has been suggested

that these plants could originally have colonised these areas with unfavourable soil conditions as a refuge from competition. There are 31 edaphic specialists known from this vegetation unit at present, of which 10 are still to be described.

References Morrey et al. (1989, 1992), Balkwill et al. (1997), Smith et al. (2001), S. Williamson (unpublished data).

SVl 14 Swaziland Sour Bushveld

VT 9 Lowveld Sour Bushveld (57%) (Acocks 1953). LR 43 North-eastern Mountain Grassland (73%) (Low & Rebelo 1996).

Distribution Mpumalanga Province, Swaziland and marginally into KwaZulu-Natal: From Badplaas, Tjakastad east to Piggs Peak area in the north, southwards through valleys around Manzini and slopes around the Grand Valley, and some isolated mountain outcrops in the lowveld plains, for example the Nkambeni Hills and Bulungu Mountains. Altitude 400–1 100 m.

Vegetation & Landscape Features Open to closed, medium to tall tree layer with closed well-developed grass layer. Very hilly with moderate to steep slopes, positioned at higher altitudes than the adjacent SVl 3 Granite Lowveld to the east.

Geology & Soils Grey soils derived mostly from Randian granites (Mpuluzi and Mswati) and Swazian granites and gneisses (Usutu Suite and Ngwane gneiss). The area reaches to the Onverwacht Group of the Barberton Greenstone Belt in the far north. Soils are dark, very clayey, of the Sterkspruit, Valsrivier, Swartland soil forms. Land types were unclassified in Swaziland, but elsewhere they are mainly Fa, Fb and Ae.

Climate Summer rainfall with dry winters. MAP about 700–1 350 mm. Frost infrequent to occasional at higher altitudes. See also climate diagram for SVl 14 Swaziland Sour Bushveld.

Important Taxa Tall Tree: *Philenoptera violacea*. Small Trees: *Acacia davyi* (d), *A. natalitia* (d), *A. sieberiana* var. *woodii* (d), *A. tortilis* subsp. *heteracantha* (d), *A. gerrardii, Combretum molle*, *C. zeyheri*, *Englerophytum magalismontanum*, *Faurea rochetiana*, *F. saligna*, *Pavetta edentula*, *Vangueria madagascariensis*, *Vitex obovata* subsp. *obovata*, *Ziziphus mucronata*. Succulent Tree: *Aloe marlothii* subsp. *marlothii*. Tall Shrubs: *Dichrostachys cinerea* (d), *Calpurnia glabrata*, *Cliffortia strobilifera*, *Crotalaria monteiroi*, *Elaeodendron transvaalense*, *Heteromorpha arborescens* var. *abyssinica*, *Rhus pallens*, *R. pentheri*, *Tricalysia lanceolata*. Low Shrubs: *Barleria obtusa*, *Crossandra fruticulosa*, *Gnidia splendens*, *Gymnosporia heterophylla*, *Jatropha latifolia* var. *angustata*, *J. latifolia* var. *swazica*, *Justicia flava*, *Passerina filiformis*, *Rhus grandidens*. Woody Climbers: *Helinus integrifolius*, *Putterlickia verrucosa*. Graminoids: *Panicum maximum* (d), *Themeda triandra* (d), *Enteropogon monostachyus*, *Sporobolus fimbriatus*, *S. nitens*. Herbs: *Becium obovatum*, *Gerbera viridifolia*, *Helichrysum miconiifolium*, *Hemizygia pretoriae* subsp. *pretoriae*, *Nidorella auriculata*. Geophytic Herbs: *Eulophia petersii*, *Hypoxis rigidula*.

Biogeographically Important Taxa ([KZN]Northern KwaZulu-Natal endemic, [N]Northern Sourveld endemic) Low Shrub: *Hemizygia gerrardii*[KZN]. Geophytic Herb: *Haemanthus pauculifolius*[N].

Endemic Taxa Geophytic Herbs: *Drimiopsis pusilla*, *D. reilleyana*.

Conservation Vulnerable. Target 19%. About 6% statutorily conserved in mainly the Songimvelo, Ithala and Malalotja Nature Reserves, and a further 0.5% conserved in the Mlilwane Game Sanctuary in Swaziland. Some 21% has been transformed by cultivation and plantations.

Remark In this savanna vegetation unit with the highest MAP, *Philenoptera violacea* is not as restricted to water courses in contrast to its generally close association with water course areas in the drier vegetation units of the Lowveld and Mopane Bioregions.

References Coetzee & Nel (1978), De Frey (1999), Stalmans et al. (1999), Stalmans (2002).

SVl 15 Northern Lebombo Bushveld

VT 11 Arid Lowveld (45%), VT 15 Mopani Veld (27%) (Acocks 1953). LR 13 Lebombo Arid Mountain Bushveld (56%) (Low & Rebelo 1996). KNP 29 Lebombo South (58%) (Gertenbach 1983b).

Distribution Mpumalanga and Limpopo Provinces: Lebombo Mountains south of the Shingwedzi River to the Komatipoort area, including ridge points such as Nhlanguleni. The mountain range forms a natural frontier between Mozambique and South Africa (Kruger National Park). Much of the eastern slopes are in Mozambique. Altitude 200–450 m.

Vegetation & Landscape Features Open bushveld dominated by Combretaceae on rocky slopes and ridges of a linear range of hills reaching about 100 m (and higher in places) above its surrounding basalt plains towards the west. Tree succulents such as *Euphorbia confinalis* and *E. cooperi* are typical on steep, stony slopes.

Geology & Soils Rhyolite of the Jozini Formation and lesser basalt of the Letaba Formation, both of the Lebombo Group (Karoo Supergroup) as well as dykes of granophyre (Jurassic) form ridges with stony, shallow lithosols with very frequent rocky outcrops. Soils are shallow (Mispah) as well as deeper (Swartland and Glenrosa). Land types Fb and Ea.

M.C. Lötter

Figure 9.55 SVl 14 Swaziland Sour Bushveld: Woodland with *Acacia gerrardii*, *A. karroo* and *Euclea schimperi* in Ithala Game Reserve, KwaZulu-Natal.

H.C. Eckhardt

Figure 9.56 SVl 15 Northern Lebombo Bushveld: Short savanna with *Lannea schweinfurthii* and *Combretum apiculatum* northeast of Letaba Rest Camp, Kruger National Park.

Conservation Least threatened. Target 24%. All statutorily conserved in the Kruger National Park and there has been virtually no transformation.

Remark There are *Androstachys johnsonii* 'thickets' embedded within this savanna unit (relate to the FOz 9 Ironwood Dry Forest further north).

References Van Rooyen (1978), Coetzee (1983), Gertenbach (1983b).

SVl 16 Southern Lebombo Bushveld

VT 10 Lowveld (62%) (Acocks 1953). LR 13 Lebombo Arid Mountain Bushveld (69%) (Low & Rebelo 1996).

Distribution Mpumalanga and KwaZulu-Natal Provinces and Swaziland: From Komatipoort, widening southwards into Swaziland, including the Mbuluzi River Gorge, through Siteki and across the Isuthu River Gorge into KwaZulu-Natal, extending east of Mkuze and terminating about 10 km north of Hluhluwe in the south. The high-altitude sourvelds are excluded and are SVl 17 Lebombo Summit Sourveld. Relatively small parts of this unit extend into Mozambique, mainly at the northern end. Altitude 100–600 m. Small patches are unmapped between the Mkuze and Msunduzi Rivers.

Climate Summer rainfall with dry winters. MAP about 350–750 mm. Incidence of fog in river gorges in the Lebombo Mountains supposedly contributes extensively to moisture availability to plants in these areas. Generally a frost-free area. Temperature on the western mountainside can become very high. See also climate diagram for SVl 15 Northern Lebombo Bushveld.

Vegetation & Landscape Features Open bushveld with dominant *Acacia* and *Combretum* species. *Themeda triandra* is the dominant grass on undisturbed sites. On very shallow soils (e.g. slopes of deep gorges or exposed ridges) with *Aloe marlothii*, *Euphorbia confinalis* and thickets of *Olea europaea* subsp. *africana* and *Combretum woodii*. Dry slopes may be dominated by *Androstachys johnsonii* in the northern parts.

Geology & Soils Shallow lithosols developing over rhyolites of the Jozini Formation, Lebombo Group (Karoo). Soils shal-

Important Taxa Tall Tree: *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Combretum apiculatum* (d), *Acacia erubescens*, *A. exuvialis*, *Albizia harveyi*, *Boscia albitrunca*, *Combretum molle*, *Commiphora mollis*, *Croton gratissimus*, *Kirkia acuminata*, *Lannea schweinfurthii* var. *stuhlmannii*, *Manilkara mochisia*, *Newtonia hildebrandtii* var. *hildebrandtii*, *Ozoroa engleri*, *Pappea capensis*, *Sterculia rogersii*, *Strychnos decussata*, *Terminalia sericea*, *Ximenia caffra*. Succulent Trees: *Euphorbia confinalis* (d), *E. cooperi*. Tall Shrubs: *Dichrostachys cinerea* (d), *Croton madandensis*, *Flueggea virosa*, *Grewia bicolor*, *Karomia speciosa*. Low Shrubs: *Barleria affinis*, *Commiphora africana*, *Pavetta catophylla*, *Tragia dioica*, *Tricalysia junodii*. Succulent Shrubs: *Aloe chabaudii*, *A. spicata*, *Kalanchoe rotundifolia*. Woody Climbers: *Adenia digitata*, *A. spinosa*, *Capparis sepiaria*, *Cardiospermum halicacabum*, *Cissus rotundifolia*, *Helinus integrifolius*. Herbaceous Climber: *Cyphostemma subciliatum*. Graminoids: *Aristida congesta* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Enneapogon cenchroides* (d), *Heteropogon contortus* (d), *Panicum maximum* (d), *Andropogon gayanus*, *Bothriochloa radicans*, *Brachiaria nigropedata*, *B. xantholeuca*, *Cymbosetaria sagittifolia*, *Panicum deustum*, *Pogonarthria squarrosa*, *Schmidtia pappophoroides*, *Themeda triandra*. Herbs: *Achyranthes aspera*, *Cleome maculata*, *Crabbea velutina*, *Heliotropium steudneri*. Geophytic Herbs: *Actiniopteris radiata*, *Pellaea calomelanos*, *P. viridis*, *Sansevieria pearsonii*.

L.W. Powrie

Figure 9.57 SVl 16 Southern Lebombo Bushveld: Dense bushveld with *Mundulea sericea*, *Dichrostachys cinerea* and *Peltophorum africanum* at an altitude of 355 m near Ubombo, northeast of Mkuze town, KwaZulu-Natal.

low Glenrosa and Mispah forms. Land types are unclassified in Swaziland and in South Africa the dominant land type is Fb.

Climate Summer rainfall with very little rain in winter. MAP about 550–1 000 mm. Frost very infrequent. See also climate diagram for SVl 16 Southern Lebombo Bushveld.

Important Taxa Tall Trees: *Acacia burkei* (Lebombo form), *A. nigrescens*. Small Trees: *Acacia davyi*, *A. gerrardii*, *Atalaya alata*, *Bridelia cathartica*, *Combretum apiculatum*, *C. molle*, *Commiphora harveyi*, *Croton gratissimus*, *Encephalartos lebomboensis*, *Erythroxylum emarginatum*, *Manilkara concolor*, *Peltophorum africanum, Pterocarpus rotundifolius*, *Strychnos gerrardii*, *Teclea gerrardii*, *Turraea floribunda*, *Vepris reflexa*, *Vitex obovata* subsp. *obovata*. Succulent Trees: *Euphorbia confinalis* (d), *Aloe marlothii* subsp. *marlothii*, *Euphorbia cooperi*, *E. tirucalli*. Tall Shrubs: *Diospyros dichrophylla* (d), *Cassipourea mossambicensis*, *Coptosperma supra-axillare*, *Dichrostachys cinerea, Euclea schimperi*, *Galpinia transvaalica*, *Hibiscus micranthus*, *Karomia speciosa*, *Maerua rosmarinoides*, *Olax dissitiflora*, *Olea europaea* subsp. *africana*, *Pouzolzia mixta*, *Rhus gueinzii*. Low Shrubs: *Barleria saxatilis*, *Jatropha variifolia*, *Mundulea sericea, Polygala producta*. Succulent Shrubs: *Aloe spicata* (d), *A. vanbalenii* (d), *A. chabaudii*, *Euphorbia knuthii* subsp. *knuthii*. Soft Shrub: *Metarungia longistrobus*. Woody Climbers: *Asparagus buchananii*, *Cissus quadrangularis*, *Combretum woodii*, *Pristimera longipetiolata*, *Sphedamnocarpus pruriens* subsp. *pruriens*. Herbaceous Climber: *Coccinia rehmannii*. Graminoids: *Brachiaria xantholeuca*, *Digitaria eriantha* subsp. *eriantha*, *Enneapogon cenchroides*, *Panicum deustum*, *P. maximum*, *Themeda triandra*, *Trachypogon spicatus*. Herbs: *Hibiscus meyeri* subsp. *meyeri*, *H. pedunculatus*, *Pupalia lappacea*. Geophytic Herbs: *Cheilanthes hirta*, *Gladiolus hollandii*, *Pellaea calomelanos*, *Sansevieria hyacinthoides*. Succulent Herbs: *Aloe parvibracteata, Stapelia unicornis*. Epiphytic Geophytic Herb: *Acampe pachyglossa*. Epiphytic Succulent Herb: *Ansellia africana*.

Biogeographically Important Taxa ([KZN]Northern KwaZulu-Natal endemic, [L]Lebombo endemic) Geophytic Herb: *Pachycarpus lebomboensis*[L]. Succulent Herb: *Gasteria batesiana* var. *batesiana*[KZN].

Endemic Taxa Small Trees: *Encephalartos aplanatus*, *E. senticosus*. Succulent Tree: *Euphorbia keithii*. Epiphytic Geophytic Herb: *Polystachya zuluensis*.

Conservation Least threatened. Target 24%. Some 10% statutorily conserved in the Mlawula Nature Reserve, Greater St Lucia Wetland Park, Mananga Cycad Colony as well as in the Ubombo Mountain and Phongolapoort Nature Reserves. A further 1% is conserved in the private Masibekela Wetland. About 9% of the area has been transformed, mainly by cultivation.

Remarks Some of the prehistory of mankind has been revealed in the Lebombo Mountains. The border cave is the site of one of the world's earliest records of *Homo sapiens* (100 000–200 000 BP). This unit is part of the Maputaland CE as defined by Van Wyk & Smith (2001).

References Moll (1978), Smith (2001), Van Wyk & Smith (2001).

SVl 17 Lebombo Summit Sourveld

VT 6 Zululand Thornveld (88%) (Acocks 1953). LR 13 Lebombo Arid Mountain Bushveld (85%) (Low & Rebelo 1996). BRG 15 Moist Lowland Tall Grassveld (83%) (Camp 1999c). Lebombo Grassland (Smith 2001).

Distribution KwaZulu-Natal Province with small parts in Mpumalanga Province and Swaziland: Localised high points on the crest of the Lebombo Mountains from Mbuzini (Mpumalanga) in the north to the Ubombo area immediately north of Mkuze River Gorge in the south. Also occurs in Mozambique in a very limited area north of Namaacha. Altitude mostly from above 600 to 803 m at the summit of Mananga Mountain.

Vegetation & Landscape Features Ridge plateaus and adjacent slightly sloping flanks covered with open, tall, sour, wiry grasslands, often dotted with low bushes and solitary savanna trees.

Geology & Soils Shallow soils of Glenrosa and Mispah forms over Jozini Formation rhyolite lavas (Karoo Supergroup). Heavier soils have developed over dolerite in places. Rocky outcrops are typical. Land types mainly Fa, Ea and Ib.

Climate Summer rainfall with little rain in winter. MAP about 600–1 050 mm. Generally frost-free. See also climate diagram for SVl 17 Lebombo Summit Sourveld.

Important Taxa Small Trees: *Acacia caffra*, *Encephalartos ngoyanus*. Tall Shrubs: *Diospyros dichrophylla*, *Gnidia caffra*, *Grewia monticola*. Low Shrubs: *Crossandra greenstockii*, *Diospyros galpinii*, *D. lycioides* subsp. *nitens*, *Phyllanthus glaucophyllus*, *Polygala producta*, *Ruellia cordata*, *Senecio medley-woodii*. Semiparasitic Shrub: *Thesium jeanae*. Graminoids: *Andropogon gayanus* (d), *Elionurus muticus* (d), *Heteropogon contortus* (d), *Themeda triandra* (d), *Brachiaria serrata*, *Cymbopogon caesius*, *Hyparrhenia filipendula*, *Hyperthelia dissoluta*, *Schizachyrium sanguineum*, *Tristachya leucothrix*. Herbs: *Argyrolobium adscendens*, *Berkheya insignis*, *Blepharis integrifolia*, *Crabbea hirsuta*, *Gazania krebsiana* subsp. *serrulata*, *Gerbera ambigua*, *Helichrysum nudifolium* var. *pilosellum*, *H. rugulosum*, *Indigofera sanguinea*, *Lepidagathis scabra*, *Vernonia oligocephala*, *Zornia capensis*. Succulent Herb: *Australluma ubomboensis*. Geophytic Herb: *Hypoxis hemerocallidea*.

Biogeographically Important Taxon (Lebombo endemic) Geophytic Herb: *Pachycarpus lebomboensis*.

Endemic Taxa Herb: *Cyphostemma barbosae*. Succulent Herb: *Orbea ubomboensis*.

Conservation One of the most endangered vegetation types in KwaZulu-Natal due to alien plant (*Lantana camara*) encroachment, heavy livestock grazing and expanding cultivation. Target 24%. About 4% is statutorily conserved in the Mananga Cycad Colony, Ubombo Mountain, Phongolapoort and Hlatikulu Nature Reserves. Very small portion also conserved in the private Masibekela Wetland Reserve. At least 41% already transformed, almost all by cultivation. Rural settlements are concentrated in these areas. Heavy utilisation and population density may have contributed to the open and less wooded aspect of this vegetation unit. Erosion is very low due to the hard substrate.

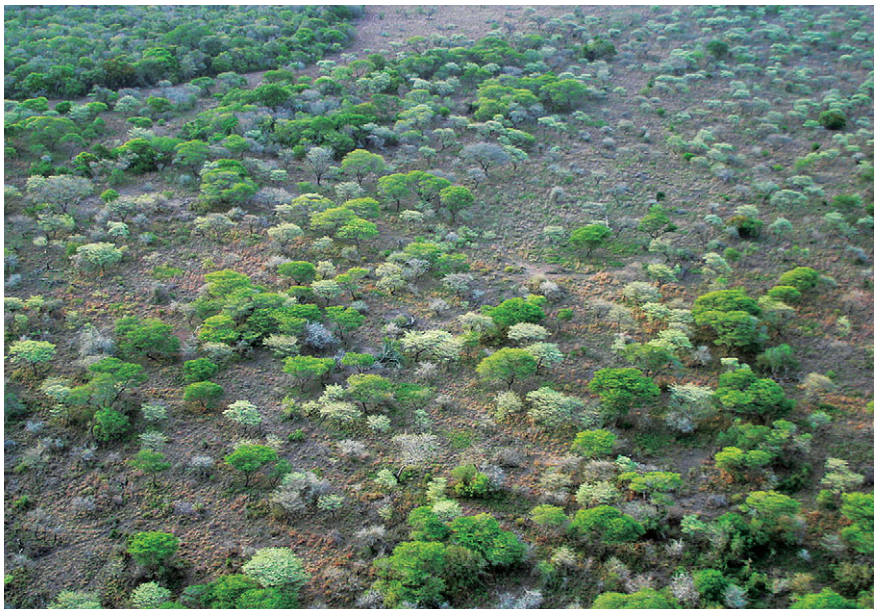
Remark Culturally important Gwaliweni Forest (classified as part of FOz 5 Scarp Forest) borders on this vegetation unit.

References Camp (1999c), Smith (2001), Van Wyk & Smith (2001).

SVl 18 Tembe Sandy Bushveld

VT 1 Coastal Forest and Thornveld (56%) (Acocks 1953). LR 22 Subhumid Lowveld Bushveld (77%) (Low & Rebelo 1996). BRG 23 Sandy Bush & Palm Veld (99%) (Camp 1999e).

Distribution KwaZulu-Natal Province: Part of the Maputaland lowveld, east of the Pongola River. Strip of land between the Mozambique border and the Tembe Elephant Park in the north extending south as far as the surrounds of the confluence of



W.S. Matthews

Figure 9.58 SVl 18 Tembe Sandy Bushveld: An aerial view of the *Terminalia sericea*-dominated sandy bushveld in Tembe Elephant Park in Maputaland.

the Mkuze and Msunduzi Rivers. Sandwiched between the SVl 20 Western Maputaland Clay Bushveld in the west and CB 1 Maputaland Coastal Belt in the east. Isolated patch found east of the town of Hluhluwe. Altitude 40–140 m.

Vegetation & Landscape Features Extensive flat plains to slightly undulating in places with open to closed woodland with canopy 5–10 m tall, dominated by leguminous woody species and *Terminalia sericea*, with species-rich shrub layer and grassy undergrowth (*Panicum*, *Perotis*, *Urelytrum agropyroides*, *Hyperthelia dissoluta* and *Diheteropogon* species).

Geology & Soils System of old (5–3 million years) and younger (125 000 years) grey regic to reddish redistributed sand dunes of marine origin. Nutritionally the sandy soils are very poor and well leached. In some depressions, duplex soils can be found. Land type mainly Ha, with some Ae, Ah and Hb also occurring.

Climate Summer rainfall with some rain in winter. MAP about 550–800 mm. Mist of the warm Indian Ocean contributes to precipitation. No incidence of frost. See also climate diagram for SVl 18 Tembe Sandy Bushveld.

Important Taxa Tall Trees: *Acacia burkei*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Terminalia sericea* (d), *Afzelia quanzensis*, *Albizia adianthifolia*, *A. versicolor*, *Clausena anisata*, *Combretum molle*, *Diospyros inhacaensis*, *Ozoroa engleri*, *O. obovata* var. *elliptica*, *Spirostachys africana*, *Tabernaemontana elegans*, *Vepris lanceolata*, *Zanthoxylum capense*. Tall Shrubs: *Strychnos madagascariensis* (d), *Coddia rudis*, *Crotalaria monteiroi*, *Dichrostachys cinerea*, *Euclea natalensis*, *Gardenia volkensii*, *Grewia caffra*, *Monanthotaxis caffra*, *Rhus gueinzii*, *Strychnos spinosa*. Low Shrubs: *Corchorus junodii*, *Indigofera inhambanensis*. Woody Climber: *Landolphia kirkii*. Herbaceous Climber: *Cissampelos hirta*. Graminoids: *Panicum maximum* (d), *Aristida stipitata* subsp. *graciliflora*, *Digitaria eriantha* subsp. *eriantha*, *Diheteropogon amplectens*, *Eragrostis moggii*, *Hyperthelia dissoluta*, *Perotis patens*, *Pogonarthria squarrosa*, *Urelytrum agropyroides*. Herb: *Oxygonum delagoense*. Succulent Herb: *Aloe parvibracteata*. Semiparasitic Herb: *Striga junodii*.

Biogeographically Important Taxa (Maputaland endemics) Small Tree: *Dialium schlechteri*. Tall Shrubs: *Cussonia arenicola*, *Lagynias monteiroi*, *Synaptolepis kirkii*, *Tarenna junodii*. Low Shrub: *Rhus kwazuluana*. Succulent Shrub: *Aloe marlothii* subsp. *orientalis*. Woody Climbers: *Acridocarpus natalitius* var. *linearifolius*, *Albertisia delagoensis*, *Prionostemma delagoensis* var. *delagoensis*. Herbs: *Aneilema arenicola*, *Pelargonium tongaense*. Geophytic Herbs: *Aspidoglossum delagoense*, *Crinum acaule*. Succulent Herb: *Crassula maputensis*.

Endemic Taxa Low Shrub: *Pavetta vanwykiana*. Herb: *Cleome bororensis*.

Conservation Least threatened. Target 19%. Some 17% statutorily conserved, almost all in the Tembe Elephant Park. The Manqakulane people have established the Tshanini Game Reserve south of Tembe. About 8% has been transformed mainly by cultivation. Erosion is very low.

Remarks The origin of the name relates to the Tembe people living in the area and the Tembe Elephant Park located in the north of this unit in South Africa. The unit extends to the Maputaland part of southern Mozambique. This bushveld unit surrounds most of the Licuati Sand Forests (see Von Maltitz et al. 2003).

References Moll (1978), Camp (1999e), Matthews et al. (2001), Gaugris et al. (2004).

SVl 19 Western Maputaland Sandy Bushveld

VT 10 Lowveld (90%) (Acocks 1953). Red Sand Bushveld (Moll 1980). LR 26 Natal Lowveld Bushveld (99%) (Low & Rebelo 1996). BRG 22 Lowveld (85%) (Camp 1999e).

Distribution KwaZulu-Natal Province: Isolated patches on the coastal plain in the Maputaland region east of the Lebombo Mountains from the Ndumo Game Reserve on the Mozambique border in the north to the Mkhuze Game Reserve (now part of Greater St Lucia Wetland Park) in the south. Altitude 40–180 m.

Vegetation & Landscape Features Comprised of mixed, but mainly simple-leaved, short (5–10 m) bushlands, woodlands and wooded grasslands. Occurring on the mid- and lower midslopes of ancient coastal dune cordons on gently undulating terrain. Extreme variations include open-canopy *Terminalia sericea* sandveld on deeper yellow to orange sands, through to *Combretum molle*-dominated woodlands on the deep red mesotrophic sands.

Geology & Soils Underlying geology comprises the innermost (most westerly) carbonate-rich sandy dune cordon and siltstones formed in the shallow marine and near-coastal environment of the Cenozoic Maputaland and the Mesozoic Zululand Groups. This cordon is poorly preserved with generally well-developed soil profiles which are commonly red to orange. Soils comprise ferruginous arenosols of the Clovelly and Hutton forms. These are well-drained mesotrophic soils with a low clay content (5–14%). Land types typically Ae and Ah.

Climate Summer rainfall with dry winters. MAP about 500–700 mm. Mean daily maximum and minimum temperatures for Mkhuze Game Reserve 32.5ºC and 11.7ºC for January and July, respectively. Mean monthly maximum and minimum temperatures for Ndumo Game Reserve 40.1°C and 6.2°C for January

P.C. Rutherford

Figure 9.59 SVl 19 Western Maputaland Sandy Bushveld: Moderately dense savanna dominated by *Terminalia sericea* on a sandy slope in Ndumo Game Reserve, KwaZulu-Natal.

Distribution KwaZulu-Natal Province: Maputaland region immediately east of the Lebombo Mountains, eastwards to the western edge of the SVl 18 Tembe Sandy Bushveld. From the Ndumo Game Reserve on the Mozambique border, through the Makatini Flats south to Mkhuze Game Reserve, with a narrower extension to just east of the town Hluhluwe. Altitude 20–200 m.

Vegetation & Landscape Features Comprises a mixed but mainly compound leaved short (5–10 m) woodlands and wooded grasslands. It occurs on the crests, upper and midslopes of gently undulating terrain. This vegetation unit is dissected by two large alluvial floodplains associated with the Mkuze and Phongolo Rivers. FOa 1 Lowveld Riverine Forest and woodland dominate these alluvial soils and numerous small floodplains associated with smaller streams.

and July, respectively. Mean annual evaporation (A-pan) 2 100 mm for Mkhuze Game Reserve. No incidence of frost. See also climate diagram for SVl 19 Western Maputaland Sandy Bushveld.

Important Taxa Tall Tree: *Acacia burkei*. Small Trees: *Combretum molle* (d), *Terminalia sericea* (d), *Balanites maughamii*, *Bolusanthus speciosus*, *Boscia albitrunca*, *Commiphora neglecta*, *Ziziphus mucronata*. Tall Shrubs: *Brachylaena discolor*, *Carissa tetramera*, *Catunaregam obovata*, *Euclea natalensis*, *Gardenia volkensii*, *Grewia bicolor*, *G. caffra*, *Mundulea sericea*, *Pteleopsis myrtifolia*, *Rhus gueinzii*, *Strychnos madagascariensis*, *S. spinosa*, *Vitex ferruginea*. Low Shrubs: *Helichrysum athrixiifolium*, *Melhania forbesii*, *Solanum panduriforme*. Graminoids: *Dactyloctenium australe* (d), *Sporobolus fimbriatus* (d), *Aristida congesta*, *Eragrostis ciliaris*, *E. pallens*, *Panicum maximum*, *Perotis patens*, *Tragus berteronianus*. Geophytic Herb: *Drimia altissima*.

Biogeographically Important Taxa (Maputaland endemics) Tall Shrub: *Tarenna junodii*. Woody Climber: *Acridocarpus natalitius* var. *linearifolius*. Herb: *Helichrysopsis septentrionale*.

Endemic Taxon Succulent Herb: *Plectranthus psammophilus*.

Conservation Least threatened. Target 19%. Some 18% statutorily conserved, mainly in the Greater St Lucia Wetland Park (Mkhuze) and Ndumo Game Reserve. Very little (2%) transformed, mainly by cultivation. Erosion is low to moderate.

Remark The sandy patches of this unit are usually elevated above much of the surrounding clay flats.

References De Moor et al. (1977), Moll (1978), Goodman (1990), Camp (1999e).

SVl 20 Western Maputaland Clay Bushveld

VT 10 Lowveld (75%) (Acocks 1953). Mixed Bushveld p.p. (Moll 1978). LR 26 Natal Lowveld Bushveld (74%) (Low & Rebelo 1996). BRG 22 Lowveld (88%) (Camp 1999e).

Geology & Soils Underlying geology comprises Cretaceous shallow-marine and coastal sediments, siltstones and conglomerates of the Zululand Group and minor rhyolites of the Jozini Formation (Karoo Supergroup). Dominant or zonal soils of this vegetation unit are latosols comprising red sandy clay loam to red clay soils (Hutton, Bainsvlei and Shortlands soil forms) and nonduplex brown calcimorphic soils comprising yellow-brown sandy clay, sandy loam to sandy clay loams (Valsrivier and Avalon soil forms). These are generally fertile soils, characterised by a moderate to high clay content (20–60%) in the A-horizon. Land types Ea, Ae, Dc, Ia and Db.

Climate Rainfall occurs in summer with dry winters. MAP about 500–750 mm. No incidence of frost. Mean monthly maximum and minimum temperatures for Makatini-Agr 39.5°C and 3.1°C for January and July, respectively. See also climate diagram for SVl 20 Western Maputaland Clay Bushveld.

Important Taxa Tall Tree: *Acacia nigrescens* (d). Small Trees: *Acacia nilotica* (d), *A. tortilis* subsp. *heteracantha* (d), *Bolusanthus speciosus* (d), *Acacia gerrardii*, *A. grandicornuta*, *A. luederitzii* var. *retinens*, *A. senegal* var. *rostrata*, *Spirostachys africana*, *Ziziphus mucronata*. Tall Shrubs: *Dichrostachys cinerea*

L. Mucina

Figure 9.60 SVl 20 Western Maputaland Clay Bushveld: Typical umbrella thorn (*Acacia tortilis*) in open savanna in the Mkhuze Game Reserve portion of the Greater St Lucia Wetland Park.

(d), *Gymnosporia senegalensis* (d), *Azima tetracantha*, *Cadaba natalensis*, *Carissa bispinosa* subsp. *bispinosa*, *C. tetramera*, *Ehretia rigida* subsp. *rigida*, *Euclea divinorum*, *Galpinia transvaalica*, *Grewia caffra*, *Salvadora angustifolia*. Low Shrubs: *Abutilon austro-africanum*, *Dicliptera clinopodia*, *Maerua edulis*. Graminoids: *Bothriochloa insculpta* (d), *Dactyloctenium australe* (d), *Panicum maximum* (d), *Themeda triandra* (d), *Aristida congesta*, *Digitaria didactyla*, *D. eriantha* subsp. *eriantha*, *Eragrostis rigidior*, *E. superba*, *Panicum coloratum*, *Sehima galpinii*, *Sporobolus fimbriatus*, *S. nitens*, *Urochloa mosambicensis*. Herbs: *Asystasia gangetica*, *Chascanum hederaceum*, *Crossandra greenstockii*, *Hibiscus pusillus*.

Conservation Vulnerable. Target 19%. About 11% statutorily conserved in the Greater St Lucia Wetland Park (Mkhuze) and Ndumo Game Reserve. A significant proportion (34%) has been transformed—almost all by cultivation. Alien plant infestations are locally severe and include *Opuntia* species.

References De Moor et al. (1977), Moll (1978), Goodman (1990), Camp (1999e).

SVl 21 Makatini Clay Thicket

VT 10 Lowveld (63%) (Acocks 1953). LR 26 Natal Lowveld Bushveld (95%) (Low & Rebelo 1996). BRG 22 Lowveld (92%) (Camp 1999e).

Distribution KwaZulu-Natal Province: A number of patches in the Maputaland region, primarily east of the Lebombo Mountains, from Ndumo Game Reserve on the Mozambique border through the Makatini Flats south to just east of the town Hluhluwe. Mostly embedded as varying sized patches within the SVl 20 Western Maputaland Clay Bushveld, where it occurs in bottomland positions. Small unmapped fragments of Makatini Clay Thicket occur west of the Lebombo Mountains, embedded within the SVl 23 Zululand Lowveld. Altitude 40–140 m.

Vegetation & Landscape Features Comprises a mixed, but mainly simple-leaved short bushland and thicket with emergent trees up to 10 m and a generally dense dominant shrub layer 1–4 m tall. It occurs on the lower slopes and bottomland areas of gently undulating terrain. Small clay-bottom, endorheic pans occur commonly at low points in the terrain.

Geology & Soils Underlying geology comprises mostly Cretaceous sandstones, siltstones and conglomerates of the Zululand Group (Mzinene and Makatini Formations). Dominant soils are vertic or melanic clays and clay loams of the Rensburg, Arcadia and Bonheim forms. They are characterised by being poorly drained, with calcium carbonate concretions on the surface or in the A-horizon. Land types mainly Ea and Dc with some Ae and Db.

Climate Rainfall occurs in summer with dry winters. MAP about 500–750 mm. No incidence of frost. See also climate diagram for SVl 21 Makatini Clay Thicket.

Important Taxa Small Trees: *Acacia luederitzii* var. *retinens* (d), *A. grandicornuta*, *A. nilotica*, *Albizia anthelmintica*, *Berchemia zeyheri*, *Ozoroa engleri*, *Schotia capitata*, *Sideroxylon inerme*, *Spirostachys africana*. Tall Shrubs: *Euclea divinorum* (d), *Croton menyharthii*, *Ehretia rigida* subsp. *rigida*, *Erythroxylum delagoense*, *Euclea schimperi*, *Lycium acutifolium*, *Rhus gueinzii*. Low Shrubs: *Barleria elegans*, *Ecbolium glabratum*, *Solanum capense*. Succulent Shrub: *Euphorbia grandicornis*. Graminoids: *Bothriochloa insculpta*, *Chloris mossambicensis*, *Dactyloctenium australe*, *Enteropogon monostachyus*, *Panicum deustum*, *P. maximum*, *Sporobolus nitens*. Herbs: *Blepharis integrifolia*, *Centema subfusca*. Succulent Herb: *Orbea paradoxa*.

Endemic Taxon Geophytic Herb: *Raphionacme elsana*.

Conservation Least threatened. Target 19%. Some 42% statutorily conserved in the Greater St Lucia Wetland Park (Mkhuze) and Ndumo Game Reserve. About 7% already transformed, mainly by cultivation.

References De Moor et al. (1977), Moll (1978), Goodman (1990), Camp (1999e).

SVl 22 Northern Zululand Sourveld

VT 10 Lowveld (31%), VT 6 Zululand Thornveld (24%) (Acocks 1953). LR 26 Natal Lowveld Bushveld (32%), LR 25 Natal Central Bushveld (24%) (Low & Rebelo 1996). BRG 20 Dry Zululand Thornveld (34%), BRG 16 Dry Lowland Tall Grassveld (29%) (Camp 1999c).

Distribution KwaZulu-Natal Province and Swaziland: From the Lusthof area in Swaziland southwards with scattered patches in northern Zululand in the surrounds of Hlomohlomo, east of Louwsburg, Nongoma and the vicinity of Ulundi including Nkandla. In the Hluhluwe-iMfolozi Park it occurs at highest altitudes in the park. Altitude mainly 450–900 m.

P.S. Goodman

Figure 9.61 SVl 21 Makatini Clay Thicket: *Acacia luederitzii* var. *retinens* – *Euclea divinorum* Thicket with emergent *Berchemia zeyheri* on melanic bottomland clay soils of the Makatini Flats, southern Maputaland, KwaZulu-Natal.

Vegetation & Landscape Features The dominant structural vegetation type is wooded grassland, in places pure sour grasslands and rarely also dense bushveld thickets. Terrain is mainly low, undulating mountains, sometimes highly dissected, and also some moderately undulating plains and hills.

Geology & Soils Well-drained and shallow soil forms (Glenrosa and Mispah forms) derived from various lithologies; predominantly, Dwyka Group diamictites, but also shale, siltstone and sandstone from the Madzaringwe and Pietermaritzburg Formations, all of the Karoo Supergroup. Archaean granite and gneiss are also significant. Land types mainly Fb and Fa, with some Ac.

Climate Summer rainfall with a little rain in winter. MAP about 600–1 050 mm

L.W. Powrie

Figure 9.62 SVl 22 Northern Zululand Sourveld: Heavily utilised communal farming area north of Nongoma, KwaZulu-Natal.

reaching a maximum, for example, in the region northwest of Nongoma, towards the mistbelt Ngome Forest. Frost very infrequent to occasional. See also climate diagram for SVl 22 Northern Zululand Sourveld.

Important Taxa Small Trees: *Acacia sieberiana* var. *woodii* (d), *A. natalitia*, *A. nilotica*, *A. tortilis* subsp. *heteracantha*, *Plectroniella armata*. Tall Shrubs: *Gardenia volkensii*, *Gnidia caffra*, *G. kraussiana*. Low Shrubs: *Agathisanthemum bojeri*, *Chaetacanthus burchellii*, *Crossandra fruticulosa*, *C. greenstockii*, *Diospyros galpinii*, *Phyllanthus glaucophyllus*, *Ruellia cordata*, *Syncolostemon argenteus*, *Tetraselago natalensis*. Succulent Shrub: *Aloe vanbalenii*. Woody Climber: *Cryptolepis oblongifolia*. Herbaceous Climber: *Cyphostemma schlechteri*. Graminoids: *Eragrostis curvula* (d), *Hyparrhenia hirta* (d), *Microchloa caffra* (d), *Themeda triandra* (d), *Tristachya leucothrix* (d), *Alloteropsis semialata* subsp. *semialata*, *Digitaria argyrograpta*, *D. tricholaenoides*, *Diheteropogon amplectens*, *Elionurus muticus*, *Loudetia simplex*, *Trachypogon spicatus*. Herbs: *Alepidea longifolia*, *Argyrolobium adscendens*, *Aster bakerianus*, *Berkheya speciosa*, *Chascanum hederaceum*, *Crabbea hirsuta*, *Gazania krebsiana* subsp. *serrulata*, *Gerbera ambigua*, *Helichrysum mixtum*, *H. nudifolium* var. *pilosellum*, *Hemizygia pretoriae* subsp. *pretoriae*, *Hermannia grandistipula*, *Hypericum aethiopicum*, *Lichtensteinia interrupta*, *Pimpinella caffra*, *Senecio glaberrimus*, *S. latifolius*, *Stachys nigricans*, *Vernonia galpinii*, *V. oligocephala*. Geophytic Herbs: *Hypoxis hemerocallidea*, *Pachycarpus concolor*. Succulent Herbs: *Aloe minima*, *A. parvibracteata*, *Senecio oxyriifolius*. Geoxylic Suffrutex: *Salacia kraussii*.

Conservation Vulnerable. Target 19%. Only 4% statutorily conserved, mainly in the Hluhluwe-iMfolozi Park and Ithala Game Reserve. Some 22% already transformed, mainly by cultivation and plantations. Erosion is generally moderate to high.

Remark Northern Zululand Sourveld can be seen as a northern extension of the SVs 4 Ngongoni Veld.

Reference Camp (1999c).

SVl 23 Zululand Lowveld

VT 10 Lowveld (71%) (Acocks 1953). LR 26 Natal Lowveld Bushveld (49%), LR 20 Sweet Lowveld Bushveld (12%) (Low & Rebelo 1996). BRG 22 Lowveld (63%) (Camp 1999e).

Distribution KwaZulu-Natal Province, Swaziland and Mpumalanga Province: Main extent from around Big Bend south to Mkuze, Hluhluwe, Ulundi to just north of the Ongoye Forest. An isolated patch is found on the Swaziland–Mpumalanga border. Altitude about 50–450 m.

Vegetation & Landscape Features Extensive flat or only slightly undulating landscapes supporting complex of various bushveld units ranging from dense thickets of *Dichrostachys cinerea* and *Acacia* species, through park-like savanna with flat-topped *A. tortilis* to tree-dominated woodland with broad-leaved open bushveld with *Sclerocarya birrea* subsp. *caffra* and *A. nigrescens*. Tall grassveld types with sparsely scattered solitary trees and shrubs form a mosaic with the typical savanna thornveld, bushveld and thicket patches.

Geology & Soils Black-clay soils and duplex soils derived from a distinct variety of clastic sediments of the Dwyka, Ecca, Beaufort and igneous rocks of the Lebombo Groups (all of the Karoo Supergroup). Also well-drained soil forms occur especially on stony slopes. Land types Fb and Ea, with some Db and Dc.

L. Mucina

Figure 9.63 SVl 23 Zululand Lowveld: Extensive areas covered by bushveld of this unit at lower altitudes and with SVl 22 Northern Zululand Sourveld visible at higher altitudes in the Hluhluwe-iMfolozi Game Park (Hluhluwe section) in KwaZulu-Natal. Patches of FOz 5 Scarp Forest are visible in the sub-summit positions of the ridges in the background.

Climate Summer rainfall with some rain in winter. MAP about 500–900 mm (highest in the southeast). Generally a frost-free area. Mean monthly maximum and minimum temperatures for Mpila Camp (Hluhluwe-iMfolozi Park) 38.5°C and 7.8°C for February and June, respectively. See also climate diagram for SVl 23 Zululand Lowveld.

Important Taxa Tall Trees: *Acacia burkei* (d), *A. nigrescens* (d), *Sclerocarya birrea* subsp. *caffra* (d). Small Trees: *Acacia tortilis* subsp. *heteracantha* (d), *A. gerrardii*, *A. natalitia*, *A. nilotica*, *A. senegal* var. *rostrata*, *A. welwitschii* subsp. *welwitschii*, *Boscia albitrunca*, *Combretum apiculatum*, *C. molle*, *Ozoroa paniculosa*, *Phoenix reclinata*, *Schotia brachypetala*, *Spirostachys africana*, *Teclea gerrardii*, *Ziziphus mucronata*. Succulent Trees: *Aloe marlothii* subsp. *marlothii*, *Euphorbia grandidens*, *E. ingens*. Tall Shrubs: *Dichrostachys cinerea* (d), *Euclea divinorum* (d), *Coptosperma supra-axillare*, *Crotalaria monteiroi*, *Euclea crispa* subsp. *crispa*, *E. schimperi*, *Galpinia transvaalica*, *Gardenia volkensii*, *Gymnosporia maranguensis*, *G. senegalensis*, *Jatropha zeyheri*, *Lycium acutifolium*, *Olea europaea* subsp. *africana*, *Tarchonanthus parvicapitulatus*, *Tephrosia polystachya*, *Triumfetta pilosa* var. *tomentosa*. Low Shrubs: *Barleria obtusa*, *Crossandra greenstockii*, *Felicia muricata*, *Gymnosporia heterophylla*, *Indigofera trita* subsp. *subulata*, *Justicia flava*, *J. protracta* subsp. *protracta*, *Melhania didyma*, *Orthosiphon serratus*, *Pearsonia sessilifolia*, *Ruellia cordata*, *Sida serratifolia*, *Tetraselago natalensis*. Succulent Shrubs: *Euphorbia grandicornis, E. trichadenia*, *E. vandermerwei*. Soft Shrub: *Pavonia columella*. Herbaceous Climber: *Fockea angustifolia*. Graminoids: *Dactyloctenium australe* (d), *Enteropogon monostachyus* (d), *Eragrostis capensis* (d), *E. curvula* (d), *E. racemosa* (d), *Heteropogon contortus* (d), *Panicum maximum* (d), *Sporobolus pyramidalis* (d), *Themeda triandra* (d), *Aristida bipartita*, *A. congesta*, *Bothriochloa insculpta*, *Chloris mossambicensis*, *Cymbopogon caesius*, *Digitaria natalensis*, *Leptochloa eleusine*, *Panicum deustum*, *Schizachyrium sanguineum*, *Setaria incrassata*, *Sporobolus nitens*, *Trachypogon spicatus*, *Tristachya leucothrix*. Herbs: *Acrotome hispida*, *Argyrolobium rupestre*, *Aspilia mossambicensis*, *Chamaecrista biensis*, *C. mimosoides*, *Corchorus asplenifolius*, *Felicia mossamedensis*, *Gerbera ambigua*, *Helichrysum rugulosum*, *Hibiscus pusillus*, *Kohautia virgata*, *Lotononis eriantha*, *Senecio latifolius*, *Stachys aethiopica*, *Tragia meyeriana*, *Vernonia capensis*. Succulent Herb: *Aloe parvibracteata*.

Biogeographically Important Taxa Small Tree: *Acacia theronii* (Broadly disjunct distribution). Tall Shrub: *Lycium shawii* (Southern distribution limit).

Conservation Vulnerable. Target 19%. Some 11% statutorily conserved mainly in the Hluhluwe-iMfolozi Park and Phongolapoort Nature Reserve. Almost 1% is protected in the private Masibekela Wetland. Much of the area between Magudu, Mkuze and Nongoma is managed as private game farms and lodges. About 26% of the area has been transformed, mostly by cultivation. Erosion is variable from low to high.

Remark Most of the Hluhluwe-iMfolozi Park is covered by tall grassveld and thornveld of this vegetation unit.

References Ward (1962), Downing (1972, 1980), Macdonald (1980, 1981), Watson & Macdonald (1983), Whateley & Porter (1983), Camp (1999e).

SVl 24 Zululand Coastal Thornveld

VT 1 Coastal Forest and Thornveld (71%) (Acocks 1953). LR 23 Coastal Bushveld-Grassland (94%) (Low & Rebelo 1996). BRG 1 Moist Coast Forest Thorn & Palm Veld (100%) (Camp 1999a).

Distribution KwaZulu-Natal Province: Immediately west of Mtubatuba (in the north) and Empangeni (in the south) bisected by the iMfolozi River, extending westwards for 10–20 km. Altitude 40–300 m.

Vegetation & Landscape Features Gently rolling landscapes supporting wooded grassland dominated by *Themeda triandra*. The bush clumps are a strong feature and are more numerous on deeper soils, with *Phoenix reclinata* and *Gymnosporia senegalensis* usually dominant. These plant communities are species-rich relative to the surrounding vegetation units. They grade into dense *Acacia* woodland on dry slopes and riverine bushland thickets and FOa 1 Lowveld Riverine Forest in valley bottoms.

Geology & Soils The area is situated almost entirely on Letaba Formation basalts of the Karoo Supergroup. Soils are mainly black with a high (35–55%) clay content and depth in the range 200–300 mm. Land types mainly Ea with some Fb and Dc.

Climate Summer rainfall but also some in winter (each winter month receiving about 20 mm, which is greater than that of any of the other savanna vegetation units for this period). MAP about 800–1 050 mm, generally higher towards the coast. Frost very infrequent. See also climate diagram for SVl 24 Zululand Coastal Thornveld.

Important Taxa Small Trees: *Acacia natalitia*, *A. nilotica*, *Phoenix reclinata*. Succulent Trees: *Euphorbia tirucalli* (d), *E. ingens*. Tall Shrubs: *Diospyros lycioides* subsp. *sericea* (d), *Euclea divinorum* (d), *Gymnosporia senegalensis* (d), *Abutilon angulatum*, *Clutia abyssinica*, *Euclea schimperi*, *Gymnosporia buxifolia*. Low Shrubs: *Acalypha peduncularis*, *Clutia cordata*, *Sida cordifolia*, *S. dregei*, *Thunbergia atriplicifolia*. Herbaceous Climbers: *Rhynchosia minima*, *R. totta*. Graminoids: *Eragrostis capensis* (d), *Panicum maximum* (d), *Sporobolus pyramidalis* (d), *Themeda triandra* (d), *Tristachya leucothrix* (d), *Aristida congesta*, *Eragrostis curvula*, *E. racemosa*, *Heteropogon contortus*, *Hyparrhenia hirta*, *Schizachyrium sanguineum*, *Setaria sphacelata*, *Trachypogon spicatus*. Herbs: *Berkheya setifera*, *B. speciosa*, *Centella asiatica*, *Eriosema cordatum*, *E. distinctum*, *Gerbera viridifolia*, *Helichrysum nudifolium* var. *pilosellum*, *Hypericum aethiopicum*, *Indigofera hilaris*, *I. sanguinea*, *Pentanisia prunelloides*, *Ruellia patula*, *Senecio erubescens*, *S. inornatus*, *Spermacoce natalensis*, *Vernonia oligocephala*, *Vigna unguiculata*. Geophytic Herbs: *Hypoxis rigidula*, *Pelargonium luridum*.

Conservation Endangered. Target 19%. None of the area is protected in statutory conservation areas. Highly transformed (58%), mostly by cultivation. This is high-potential agricultural land, which is already been much transformed to sugar cane. Most of the area is communal land. Large areas close to towns (e.g. Mtubatuba) are becoming an urban sprawl. Very little of the natural plant communities remains intact. Heavy grazing has depleted the grasslands and wood harvesting has depleted the bush clumps, reducing them to only the resistant and less useful species. Stunted forms of many of the woody species (e.g. *Euclea*, *Diospyros*, *Gymnosporia*, *Maytenus*) invade the grasslands in many places. Currently it is rare to find a site still with its natural plant composition. *Themeda triandra*, a 'decreaser species', has declined to critically low levels. Alien plant invasions are a threat, with *Chromolaena odorata* being the most problematic. Erosion low to moderate.

Remarks Owen Sithole (Cwaka) Agricultural College is a large estate containing SVl 24 Zululand Coastal Thornveld. A distinction from neighbouring SVl 23 Zululand Lowveld is that the latter is often tree-dominated woodland with tall grassveld.

References Camp (1999a), Van der Linden et al. (2005).

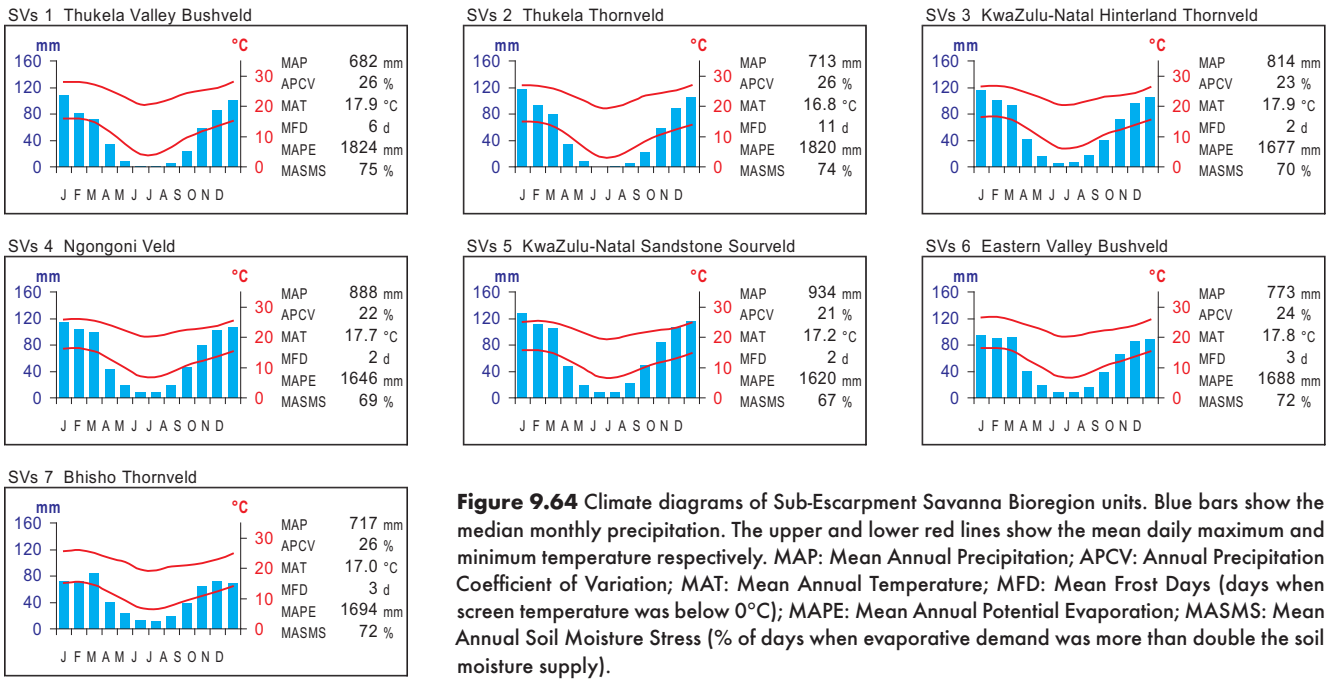


Figure 9.64 Climate diagrams of Sub-Escarpment Savanna Bioregion units. Blue bars show the median monthly precipitation. The upper and lower red lines show the mean daily maximum and minimum temperature respectively. MAP: Mean Annual Precipitation; APCV: Annual Precipitation Coefficient of Variation; MAT: Mean Annual Temperature; MFD: Mean Frost Days (days when screen temperature was below 0°C); MAPE: Mean Annual Potential Evaporation; MASMS: Mean Annual Soil Moisture Stress (% of days when evaporative demand was more than double the soil moisture supply).

Sub-Escarpment Savanna

SVs 1 Thukela Valley Bushveld

VT 23 Valley Bushveld (85%) (Acocks 1953). E 6.3C Semi-deciduous Bush (*Acacia–Boscia–Olea–Schotia* Scrub) (38%), E 6.4C Interior *Acacia karroo–A. nilotica* Thorn Veld (33%) (Edwards 1967). LR 5 Valley Thicket (59%) (Low & Rebelo 1996). BRG 21 Valley Bushveld (99%) (Camp 1999e).

Distribution KwaZulu-Natal Province: Central Thukela River basin upstream of Jameson's Drift, past Tugela Ferry to about 20 km southeast of Ladysmith. Also in valleys of several major tributaries, such as the lower Mooi, Bushmans, Buffels and Sundays Rivers. Altitude about 350–1 000 m.

Vegetation & Landscape Features Often rocky rugged slopes and terraces mainly with deciduous trees of short to medium height (and many large shrubs) including *Acacia tortilis*, *A. nilotica* and *A. natalitia* and prominent evergreen species such as *Olea europaea* subsp. *africana*, *Boscia albitrunca* and *Euclea crispa* in places. Succulent plants, mainly species of *Euphorbia* and *Aloe* occur on shallow and eroded soils. Relatively limited areas are dominated by succulents such as *E. tirucalli* (some hillsides south of the Thukela) and *E. ingens* on steep slopes, but also commonly on the valley floor.

Geology & Soils Shallow soils of Mispah and Glenrosa forms on the slopes, while in valley bottoms, pockets of deep alluvial soils as well as calcareous, duplex soils are found. The major geological formations are sediments of Ecca Group (Karoo Supergroup) and in the eastern part also Archaean granites. Land types mainly Fc and Fb, with some Ae and Ea.

Climate Summer rainfall with dry winters. MAP about 500–850 mm. Frost fairly infrequent and usually on valley bottoms. Mean monthly maximum and minimum temperatures for Muden 36.7°C and 0.2°C and for Weenen 38.1°C and –4.4°C both for December and June, respectively. See also climate diagram for SVs 1 Thukela Valley Bushveld.

B. Forbes

Figure 9.65 SVs 1 Thukela Valley Bushveld: Degraded Thukela Valley Bushveld near Muden showing encroachment by *Euphorbia pseudocactus* and *Blepharis natalensis*.

Important Taxa Tall Tree: *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Combretum apiculatum* (d), *Spirostachys africana* (d), *Acacia tortilis* subsp. *heteracantha*, *Berchemia zeyheri*, *Boscia albitrunca*, *Combretum molle*, *Cussonia spicata*, *Pappea capensis*, *Schotia brachypetala*. Succulent Trees: *Aloe marlothii* subsp. *marlothii* (d), *Euphorbia grandidens* (d), *E. tirucalli* (d), *E. ingens*, *E. triangularis*. Tall Shrubs: *Coddia rudis* (d), *Dichrostachys cinerea* (d), *Euclea crispa* subsp. *crispa*, *E. schimperi*, *Gymnosporia buxifolia*, *Heteromorpha arborescens* var. *abyssinica*, *Olea europaea* subsp. *africana*, *Rhus pentheri*, *Vitex rehmannii*. Low Shrubs: *Barleria obtusa*, *Gymnosporia glaucophylla*. Soft Shrubs: *Hypoestes aristata* (d), *Peristrophe cernua*. Succulent Shrub:

Huernia hystrix subsp. *hystrix*. Woody Climbers: *Asparagus falcatus*, *Jasminum multipartitum*. Woody Succulent Climber: *Sarcostemma viminale*. Graminoids: *Heteropogon contortus* (d), *Melinis repens* (d), *Panicum maximum* (d), *Themeda triandra* (d), *Aristida congesta*, *A. diffusa*, *Cymbopogon pospischilii*, *Eragrostis chloromelas*, *E. curvula*, *Panicum deustum*, *Urochloa mosambicensis*. Succulent Herbs: *Aloe mudenensis*, *Bulbine narcissifolia*, *Duvalia polita, Orbea woodii.*

Biogeographically Important Taxa (Thukela Basin endemics) Small Tree: *Vitellariopsis dispar*. Succulent Herbs: *Aloe prinslooi*, *Orbea woodii*.

Endemic Taxa Small Tree: *Encephalartos cerinus*. Tall Shrub: *Gymnosporia macrocarpa*. Low Shrubs: *Blepharis natalensis* (d), *Barleria argillicola*. Succulent Shrub: *Euphorbia pseudocactus* (d). Succulent Herb: *Gasteria tukhelensis*. Succulent Herbaceous Climber: *Ceropegia cycniflora*.

Conservation Least threatened. Target 25%. Statutorily conserved (less than 200 ha) in the Weenen Game Reserve. This vegetation unit has undergone considerable degradation over almost its entire area. In the many eroded areas, prolonged continuous overgrazing has led to the complete destruction of the grass cover. Often the only ground cover is found under *Acacia tortilis* trees where their root systems retain soil, the trees act as nutrient pumps and provide shade (Camp 1999e). Erosion very variable, ranging from very low to very high. Alien plants include the widely scattered *Opuntia imbricata*.

Remarks Very steep and exposed (well-insolated and dry) rocky habitats support succulent flora including, for example, *Aloe rupestris* and *A. mudenensis*. In the last four decades there has been a substantial increase in woody plant cover, mainly *Acacia tortilis*, at altitudes roughly below 1 000 m in the Weenen/Muden area and possibly related to reduced incidence of fire (Hoffman & O'Connor 1999).

References West (1951), Edwards (1967), Camp (1999e).

SVs 2 Thukela Thornveld

VT 23 Valley Bushveld (58%) (Acocks 1953). E 6.4C Interior *Acacia karroo–A. nilotica* Thorn Veld (61%) (Edwards 1967). LR 25 Natal Central Bushveld (55%) (Low & Rebelo 1996). BRG 18 Mixed Thornveld (98%) (Camp 1999d).

Distribution KwaZulu-Natal Province: Upper Thukela River basin fringing the SVs 1 Thukela Valley Bushveld on its upper border in a series of discontinuous patches. Largest area east of Estcourt–Colenso and including Ladysmith. Also some outliers on slopes south of Dundee. Altitude 900–1 300 m.

Vegetation & Landscape Features The dominant landscape features are valley slopes to undulating hills. Vegetation is *Acacia*-dominated bushveld of variable density (ranging from wooded grassland to dense thickets) with dense grassy undergrowth.

Geology & Soils Broad variety of soils ranging from vertisols and solodised solonetzic soils to transitional fersiallitic soils (Edwards 1967) developing over Karoo Supergroup sediments of the Beaufort and Ecca Groups). Heavy soils are developed over Jurassic dolerite intrusions forming koppies and sills. Land types Fb, Fa, Db, Ea, Fc and Dc.

Climate Summer rainfall with dry summers. MAP about 550–850 mm. Frost fairly infrequent, occurring mainly on the flats. Mean monthly maximum and minimum temperatures for Ladysmith 36.1°C and –3.6°C for January and July, respectively. Corresponding values for Escourt-TNK 34.5°C and –2.3°C for January and June, respectively. See also climate diagram for SVs 2 Thukela Thornveld.

Important Taxa Small Trees: *Acacia natalitia* (d), *A. nilotica* (d), *A. sieberiana* var. *woodii*, *A. tortilis* subsp. *heteracantha*, *Allophylus melanocarpus*, *Boscia albitrunca*, *Clausena anisata*, *Cussonia spicata*, *Dais cotinifolia*, *Ziziphus mucronata*. Tall Shrubs: *Coddia rudis* (d), *Buddleja saligna*, *Clerodendrum glabrum*, *Euclea crispa* subsp. *crispa*, *Heteromorpha arborescens* var. *abyssinica*, *Hibiscus calyphyllus*, *Lippia javanica*, *Pachystigma macrocalyx*, *Rhus pentheri*, *R. rehmanniana*. Low Shrubs: *Barleria obtusa*, *Justicia flava*. Soft Shrub: *Peristrophe cernua*. Woody Succulent Climber: *Senecio brachypodus*. Graminoids: *Eragrostis curvula* (d), *Hyparrhenia hirta* (d), *Melinis repens* (d), *Panicum maximum* (d), *Themeda triandra* (d), *Tristachya leucothrix* (d), *Aristida congesta*, *Digitaria eriantha* subsp. *eriantha*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. superba*, *Heteropogon contortus*, *Setaria sphacelata*, *Sporobolus pyramidalis*. Herb: *Osteospermum muricatum*. Geophytic Herb: *Sansevieria hyacinthoides*. Succulent Herb: *Aloe mudenensis*.

Biogeographically Important Taxa (Thukela Basin endemics) Small Tree: *Vitellariopsis dispar*. Succulent Herbs: *Aloe prinslooi*, *Orbea woodii*.

R. de la Harpe

Figure 9.66 SVs 2 Thukela Thornveld: Open thornveld in the Weenen Game Reserve northeast of Estcourt. *Acacia natalitia* is the prominant tree in the foreground and *A. sieberiana* in the middle distance.

Endemic Taxon Small Tree: *Encephalartos msinganus*.

Conservation Least threatened. Target 25%. Statutorily conserved (less than 1 500 ha) in Weenen Game Reserve and Isandlwana Nature Reserve. About 5% already transformed, mainly by cultivation. Erosion somewhat less than in SVs1 Thukela Valley Bushveld.

Remarks Edwards (1967), echoed by Camp (1999d), claims that an estimated 60% of the thornveld invaded the region this century by an outward migration (encroachment) of *Acacia* species from Thukela River Valley vegetation into presumed original *Themeda–Hyparrhenia* grasslands, but neither of the cited sources provided conclusive evidence to support this suggestion. However, in the last four decades there has been a substantial increase in woody plant cover,

mainly *A. karroo*, at altitudes roughly above 1 000 m in the Weenen/Muden area and possibly related to reduced incidence of fire (Hoffman & O'Connor 1999).

References West (1951), Edwards (1967), Camp (1999d), Breebaart et al. (2001).

SVs 3 KwaZulu-Natal Hinterland Thornveld

VT 5 Ngongoni Veld (41%), VT 23 Valley Bushveld (32%) (Acocks 1953). LR 5 Valley Thicket (46%), LR 24 Coast-Hinterland Bushveld (36%) (Low & Rebelo 1996). BRG 17 Coast Hinterland Thornveld (97%) (Camp 1999d).

Distribution KwaZulu-Natal Province: Patches, scattered immediately above SVs 6 Eastern Valley Bushveld, at altitudes 450–900 m in river valleys of mainly the Mpisi (in the Thukela River catchment), Mvoti, Umgeni (below the Howick Falls), Mlazi, and Lufafa (vicinity of Ixopo) and Mtungwane (tributaries of the Mkomazi).

Vegetation & Landscape Features Vegetation is open thornveld dominated by *Acacia* species on undulating plains found on upper margins of river valleys.

Geology & Soils Shallow sandy soils (Glenrosa and Mispah forms) developing over Ordovician Natal Group sandstones and compact, clayey soils on Dwyka diamictites (Karoo Supergroup) as well as on layered quartz-feldspar metasediments (Mapumulo Group, Mokolian) and granites of the Oribi Gorge Suite (also Mokolian). Land types mainly Fa and Fb with some Ca, Bd and Ac.

Climate Summer rainfall pattern, with some rain in winter. MAP about 650–1 000 mm. Frost infrequent. Mean monthly maximum and minimum temperatures for Pietermaritzburg 37.2°C and –1.8°C for January and June, respectively. See also climate diagram for SVs 3 KwaZulu-Natal Hinterland Thornveld.

Important Taxa Tall Tree: *Acacia robusta*. Small Trees: *Acacia natalitia* (d), *A. nilotica* (d), *Combretum molle* (d), *Ziziphus mucronata* (d), *Brachylaena elliptica*, *Cussonia spicata*, *Erythrina latissima*. Succulent Trees: *Aloe marlothii* subsp. *marlothii*, *Euphorbia ingens*. Tall Shrubs: *Calpurnia aurea*, *Coddia rudis*, *Diospyros dichrophylla*, *Ehretia rigida* subsp. *rigida*, *Grewia occidentalis*, *Gymnosporia buxifolia*, *Hibiscus calyphyllus*, *Rhus pentheri*. Low Shrubs: *Barleria obtusa*, *Chaetacanthus setiger*, *Crossandra greenstockii*, *Justicia flava*. Soft Shrub: *Hypoestes aristata* (d). Woody Climbers: *Jasminum breviflorum*, *Putterlickia verrucosa*, *Tecoma capensis*. Woody Succulent Climber: *Sarcostemma viminale*. Graminoids: *Aristida junciformis* subsp. *junciformis* (d), *Eragrostis curvula* (d), *Hyparrhenia hirta* (d), *Melinis nerviglumis* (d), *Themeda triandra* (d), *Cymbopogon nardus*, *Eragrostis capensis*, *E. chloromelas*, *E. racemosa*, *E. superba*, *Heteropogon contortus*, *Panicum maximum*, *Sporobolus fimbriatus*, *S. pyramidalis*, *Tristachya leucothrix*. Herbs: *Commelina africana*, *Ruellia patula*. Geophytic Herb: *Sansevieria hyacinthoides*.

Biogeographically Important Taxon (Southern distribution limit) Low Shrub: *Barleria elegans*.

Endemic Taxon Succulent Herb: *Aloe pruinosa*.

Conservation Vulnerable. Target 25%. None conserved in statutory conservation areas. Some 22% already transformed by cultivation and some urban or built-up areas. Erosion is low to very low, with some areas of moderate erosion.

Remark 1 Camp (1999e) suggested that his 'Coast Hinterland Thornveld' (identical with this vegetation unit) was originally *Acacia sieberiana* wooded grassland, and woodland before major disturbance occurred, but evidence is largely lacking.

Remark 2 This vegetation unit can be distinguished from SVs 2 Thukela Thornveld by higher floristic richness and a different vegetation structure (scrub and clump character). These differences are linked by Camp (1999d) to milder climatic conditions with less frequent, lighter and localised frosts in this unit.

Remark 3 One of the most prominent woody components of this unit identified in earlier literature sources as *Acacia karroo* Hayne appears to be *A. natalitia* E.Mey. (Coates Palgrave 2002, p. 291).

Reference Camp (1999d).

SVs 4 Ngongoni Veld

VT 5 Ngongoni Veld (59%) (Acocks 1953). LR 24 Coast-Hinterland Bushveld (38%), LR 42 Moist Upland Grassland (24%) (Low & Rebelo 1996). BRG 3 Moist Coast Hinterland Ngongoni Veld (44%), BRG 4 Dry Coast Hinterland Ngongoni Veld (26%) (Camp 1999a).

Distribution KwaZulu-Natal and Eastern Cape Provinces: From Melmoth in the north to near Libode in the former Transkei (including Eshowe, New Hanover, Camperdown, Eston, Richmond, Dumisa, Harding, Lusikisiki and the Libode area). Altitude 400–900 m.

Vegetation & Landscape Features Dense, tall grassland overwhelmingly dominated by unpalatable, wiry Ngongoni grass (*Aristida junciformis*), with this monodominance associated with low species diversity. Wooded areas (thornveld) are found in valleys at lower altitudes, where this vegetation unit

L. Mucina

Figure 9.67 SVs 4 Ngongoni Veld: Species-rich grasslands dominated by *Aristida junciformis* grazed by large indigenous grazers such as impala (*Aepyceros melampus*) and Burchell's zebra (*Equus burchellii*) in the Vernon Crookes Nature Reserve near Scottburgh, southern KwaZulu-Natal.

grades into SVs 3 KwaZulu-Natal Hinterland Thornveld and SVs 7 Bhisho Thornveld. Termitaria support bush clumps with *Acacia* species, *Cussonia spicata*, *Ziziphus mucronata*, *Coddia rudis*, *Ehretia rigida* etc.

Geology & Soils Acid, leached, heavy soils are derived from Karoo Supergroup sediments (including significant Dwyka tillites) and intrusive Karoo dolerites. Also Glenrosa and Mispah soils occur. Land types Fa, Ab, Ac and Aa.

Climate Summer rainfall with some rain in winter. MAP about 700–1 100 mm. Some valleys are sheltered and may show weak rainshadow effects. Frost infrequent, occurring mainly where cold air becomes trapped in valleys. Mean monthly maximum and minimum temperatures for Melmoth 37.0°C and 4.9°C for October and July, respectively. Corresponding values for New Hanover 38.2°C and –0.2°C for January and June, respectively. See also climate diagram for SVs 4 Ngongoni Veld.

Important Taxa Small Trees: *Acacia natalitia*, *A. nilotica*, *A. sieberiana* var. *woodii*. Low Shrubs: *Agathisanthemum bojeri*, *Euryops laxus*, *Gnidia anthylloides*. Graminoids: *Aristida junciformis* subsp. *junciformis* (d), *Bothriochloa insculpta*, *Eragrostis curvula*, *Hyparrhenia hirta*, *Panicum maximum*, *Paspalum scrobiculatum*, *Sporobolus africanus*, *S. pyramidalis*, *Themeda triandra*. Herbs: *Chamaecrista mimosoides*, *Conostomium natalense*, *Gerbera ambigua*, *Helichrysum allioides*, *Hermannia grandistipula*, *Pentanisia prunelloides*, *Selago tarachodes*, *Senecio exuberans*, *Vernonia galpinii*. Geophytic Herbs: *Hypoxis argentea*, *Watsonia densiflora*. Succulent Herb: *Aloe minima*.

Conservation Vulnerable. Target 25%. Only less than 1% of the unit is statutorily conserved in the Ophathe and Vernon Crookes Nature Reserves. Some 39% has been transformed for cultivation, plantations and urban development.

Remarks Within KwaZulu-Natal, this vegetation unit comprises mainly Camp's (1999a) BRG 3 and BRG 4, representing wet and dry forms of Ngongoni veld, respectively. His distinction is based on MAP of 800 mm, which is assumed to have significant agricultural importance (see Camp 2001). Major floristic differences have yet to be shown. Camp (1999a), in accordance with Acocks (1953), considers the Ngongoni Veld to be secondary.

References Killick (1958), Moll (1976), Camp (1999a, 2001).

SVs 5 KwaZulu-Natal Sandstone Sourveld

VT 5 Ngongoni Veld (55%) (Acocks 1953). LR 24 Coast-Hinterland Bushveld (50%) (Low & Rebelo 1996). BRG 3 Moist Coast Hinterland Ngongoni Veld (49%), BRG 5 Moist Midlands Mistbelt (49%) (Camp 1999a, b).

Distribution KwaZulu-Natal Province: Elevated coastal inland sandstone plateaus from Mapumulo near Kranskop in the north to St Faiths near Port Shepstone in the south (including Noodsberg, Hillcrest, Kloof, Table Mountain, Inanda, Stony Hill, Umbumbulu, Mid-Illovo, Dumisa, Highflats). Altitude 500–1 100 m.

Vegetation & Landscape Features Short, species-rich grassland with scattered low shrubs and geoxylic suffrutices. Proteaceae trees and shrubs (*Protea*, *Leucospermum*, *Faurea*) can be locally common. The dominating landscape features are flat (or rolling) plateau tops and steep slopes commonly forming table mountains.

Geology & Soils Ordovician Natal Group sandstones carry shallow, nutrient-poor, skeletal, sandy soils freely drained and including Glenrosa and Mispah forms. Land types Fa, Ac, Aa and Bb.

Climate Summer rainfall with some rain in winter. MAP about 700–1 200 mm. Mist common and important in providing additional moisture. Frost very infrequent. Mean monthly maximum and minimum temperatures for Hillcrest 35.0°C and 4.2°C and for Mid-Illovo 35.8°C and 4.7°C both for October and June/July, respectively. Corresponding values for Dalton 35.6°C and 0.9°C for October and July, respectively. See also climate diagram for SVs 5 KwaZulu-Natal Sandstone Sourveld.

Important Taxa Small Trees: *Protea caffra* (d), *P. roupelliae* subsp. *roupelliae* (d). Tall Shrubs: *Aspalathus chortophila*, *Gnidia kraussiana*, *Pachystigma macrocalyx*. Low Shrubs: *Acalypha glandulifolia*, *Agathisanthemum bojeri*, *Erica cubica* var. *cubica*, *E. natalitia*, *Protea simplex*, *P. welwitschii* subsp. *welwitschii*, *Rhus grandidens*, *Senecio medley-woodii*, *Tetraselago natalensis*, *Thunbergia atriplicifolia*, *Turraea pulchella*. Graminoids: *Aristida junciformis* subsp. *junciformis* (d), *Heteropogon contortus* (d), *Themeda triandra* (d), *Trachypogon spicatus* (d), *Tristachya leucothrix* (d), *Andropogon schirensis*, *Cymbopogon nardus*, *Digitaria diagonalis*, *D. natalensis*, *Diheteropogon amplectens*, *Elionurus muticus*, *Eragrostis plana*, *E. racemosa*, *Eulalia villosa*, *Hyparrhenia hirta*, *Monocymbium ceresiiforme*. Herbs: *Aster bakerianus*, *Cyanotis speciosa*, *Dianthus zeyheri*, *Helichrysum allioides*, *Selago tarachodes*, *Senecio dregeanus*, *Zaluzianskya pilosa*. Geophytic Herbs: *Aspidoglossum ovalifolium*, *Brachystelma perditum*, *B. pygmaeum* subsp. *flavidum*, *B. tenellum*, *Eriospermum mackenii*, *Watsonia densiflora*. Succulent Herbs: *Aloe minima*, *Senecio oxyriifolius*.

Biogeographically Important Taxa ([M]Midlands endemic, [P]Link to Pondoland, [F]Fynbos generic element, [S]Southern distribution limit) Low Shrubs: *Agathosma ovata*[F], *Erica aspalathifolia*[P], *Eriosemopsis subanisophylla*[P], *Gnidia woodii*[P],

C.R. Scott-Shaw

Figure 9.68 SVs 5 KwaZulu-Natal Sandstone Sourveld: Short grassland with the range-restricted *Gladiolus inandensis in the* Vernon Crookes Nature Reserve.

Leucospermum gerrardii[F], *Muraltia lancifolia*[P,F], *Stangeria eriopus*[P], *Syncolostemon parviflorus*[P]. Herbs: *Agathisanthemum chlorophyllum*[P], *Callilepis leptophylla*[S], *Helichrysum acutatum*[P], *H. griseum*[P], *H. pannosum*[P]. Geophytic Herbs: *Dierama pallidum*[M], *D. pumilum*[M], *Disperis woodii*[P], *Gladiolus inandensis*[P]. Succulent Herbs: *Bulbine inflata*[S], *Crassula multicava* subsp. *floribunda*[P]. Geoxylic Suffrutex: *Rhus rudatisii*[P].

Endemic Taxa Low Shrubs: *Helichrysum woodii*, *Tephrosia inandensis*. Succulent Herbaceous Climber: *Crassula inandensis*. Herbs: *Eriosema populifolium* subsp. *populifolium*, *E. rossii*, *Phymaspermum pinnatifidum*. Geophytic Herbs: *Brachystelma modestum*, *B. natalense*, *B. pulchellum*, *Cynorkis compacta*, *Gladiolus cruentus*, *Hesperantha gracilis*.

Conservation Endangered. Target 25%. Only 0.2% statutorily conserved in the Krantzkloof and Vernon Crookes Nature Reserves. Some 68% transformed for cultivation, plantations, urban development or road building. This highly transformed vegetation type is a prime agricultural area with mainly sugar cane and timber plantations. The urban sprawl of the Ethekwini (Durban) Metropolitan Area and densely populated subsistence farming areas account for most of the remainder. Apart from the critically little conserved areas (only several hundred hectares), most remaining areas are subjected to high levels of grazing and frequent fire not conducive to the recruitment of seedlings of many of the shrubs and herbs. Erosion is low to very low.

Remark 1 This vegetation unit shares a number of endemic species with CB 4 Pondoland-Ugu Sandstone Coastal Sourveld.

Remark 2 Biome affiliation of this unit is borderline and it could also be considered a candidate for the Grassland Biome.

References Killick (1958), Camp (1999a, b), Scott-Shaw (1999).

SVs 6 Eastern Valley Bushveld

VT 23 Valley Bushveld (56%) (Acocks 1953). LR 5 Valley Thicket (58%) (Low & Rebelo 1996).

Distribution KwaZulu-Natal and Eastern Cape Provinces: Deeply incised valleys of rivers including the lower reaches of the Thukela, Mvoti, Mgeni, Mlazi, Mkhomazi, Mzimkulu, Mzimkulwana, Mtamvuna, Mtentu, Msikaba, Mzimvubu (and its several tributaries), Mthatha, Mbhashe, Shixini, Qhorha and Great Kei. Very seldom extending to the coast. Altitude 100–1 000 m.

Vegetation & Landscape Features Semideciduous savanna woodlands in a mosaic with thickets, often succulent and dominated by species of *Euphorbia* and *Aloe*. Most of the river valleys run along a northwest-southeast axis which results in unequal distribution of rainfall on respective north-facing and south-facing slopes since the rain-bearing winds blow from the south. The steep north-facing slopes are sheltered from the rain and also receive greater amounts of insolation adding to xerophilous conditions on these slopes.

Geology & Soils The area is underlain by the sediments of the Karoo Supergroup with the mudstones and lesser sandstones of the Adelaide and Tarkastad Subgroups (Beaufort Group) dominant, and some Ecca Group shale. Dominant land type Fa.

Climate Summer rainfall with some rain in winter. MAP about 550–1 000 mm. Frost infrequent. Mean monthly maximum and minimum temperatures for Nagle Dam 36.9°C and 4.0°C for December and June, respectively. See also climate diagram for SVs 6 Eastern Valley Bushveld.

Important Taxa Tall Trees: *Acacia robusta*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Acacia natalitia* (d), *A. nilotica* (d), *Combretum molle* (d), *Spirostachys africana* (d), *Acacia tortilis* subsp. *heteracantha*, *Berchemia zeyheri*, *Boscia albitrunca*, *Brachylaena elliptica*, *Cussonia spicata*, *Dombeya rotundifolia*, *Encephalartos natalensis*, *E. villosus*, *Hippobromus pauciflorus*, *Schotia brachypetala*, *Ziziphus mucronata*. Succulent Trees: *Euphorbia tirucalli* (d), *Aloe marlothii* subsp. *marlothii*, *A. rupestris*, *Euphorbia ingens*, *E. triangularis*. Tall Shrubs: *Dichrostachys cinerea* (d), *Calpurnia aurea*, *Coddia rudis*, *Ehretia rigida* subsp. *rigida*, *Euclea crispa* subsp. *crispa*, *Grewia occidentalis*, *Olea europaea* subsp. *africana*. Succulent Shrubs: *Aloe arborescens*, *Euphorbia grandicornis*, *Kleinia fulgens*. Soft Shrubs: *Hypoestes aristata*, *Peristrophe cernua*. Woody Climber: *Acacia brevispica* subsp. *dregeana*. Herbaceous Climber: *Ischnolepis natalensis*. Graminoids: *Aristida congesta* (d), *Eragrostis curvula* (d), *Hyparrhenia hirta* (d), *Melinis repens* (d), *Panicum maximum* (d), *Themeda triandra* (d), *Cymbopogon pospischilii*, *Eragrostis superba*, *Heteropogon contortus*, *Panicum deustum*, *Sporobolus fimbriatus*, *S. pyramidalis*, *Tristachya leucothrix*, *Urochloa mosambicensis*. Herbs: *Achyranthes aspera*, *Hibiscus pedunculatus*. Geophytic Herb: *Sansevieria hyacinthoides*.

Endemic Taxa Tall Shrub: *Bauhinia natalensis*. Succulent Herb: *Huernia pendula.*

Conservation Least threatened. Target 25%. Only 0.8% statutorily conserved, mainly in the Luchaba Wildlife Reserve; small patches also conserved in the Oribi Gorge Nature Reserve. Some 15% transformed mainly by cultivation. Alien plant invasions are a serious threat, with *Chromolaena odorata*, *Lantana camara* and *Caesalpinia decapetala* being most problematic.

Remarks This unit (together with the SVs 1 Thukela Valley Bushveld) corresponds closely to Acocks's (1953) 'Northern Variation of the Valley Bushveld' from the Great Kei River Valley northwards. He viewed this area as transitional to

H.F. Glen

Figure 9.69 SVs 6 Eastern Valley Bushveld: Moderately dense bushveld between Mpisi River and Emabhobhane Drift on the lower Thukela River with *Ehretia rigida*, *Boscia albitrunca*, *Croton pseudopulchellus* (grey shrubs), *Euphorbia grandicornis* and *Aloe marlothii*.

the Lowveld, particularly that part from the Umkomaas River Valley northwards. Its northern variation (i.e. from the Kei northwards) is more open than his southern variation (the latter is a part of the Albany Thicket Biome) and includes 'more grass, fewer succulents and more species of definitely tropical nature'. Examples of species of this unit that extend southwards from at least the lowveld savanna of Mpumalanga, or from savanna elsewhere at this northern latitude are *Acacia nilotica*, *Euphorbia ingens*, *Spirostachys africana* and *Vitex rehmannii* (extending southwards as far as the Umkomaas River Valley), *Combretum molle* and *Dichrostachys cinerea* (extending further south to around the southern border of KwaZulu-Natal), and *A. robusta*, *Dalbergia obovata*, *Dombeya cymosa*, *E. tirucalli* and *Vangueria infausta* (extending to the vicinity of the Great Kei River Valley or enter the easternmost extremity of the Albany Thicket Biome). In contrast to the thicket vegetation found in valleys south of the Great Kei River, Vlok & Euston-Brown (2002) found that most of the Kei Valley does not have extensive stands of thicket and that thicket only occurs as small clumps, usually on north-facing slopes in a matrix of savanna. Despite considerable disturbance to the vegetation here, they stated that there was no direct evidence that thicket did occur in more extensive stands in recent times. Only over a short length along the lower Great Kei River does true Albany Thicket Biome occur (mapped as part of AT 12 Buffels Thicket; see chapter on Albany Thicket in this book).

L. Mucina

Figure 9.70 SVs 7 Bhisho Thornveld: Thornveld dominated by *Acacia natalitia* near Butterworth, Transkei, Eastern Cape.

References Edwards (1967), Morris (1967, 1969), Grunow & Morris (1969), Perkins (1997), Perkins et al. (1999).

SVs 7 Bhisho Thornveld

VT 7 Eastern Province Thornveld (37%), VT 23 Valley Bushveld (23%) (Acocks 1953). LR 16 Eastern Thorn Bushveld (50%) (Low & Rebelo 1996).

Distribution Eastern Cape Province: From near Mthatha in a band parallel to but inland of the coast to north of East London, turning to run along the southern side of the Amathole Mountains as far as Fort Beaufort. Also on dissected hills and low mountains around Grahamstown, especially to the southwest, and in a few fragments in valleys northeast of the Amathole Mountains. Altitude mostly 200–700 m.

Vegetation & Landscape Features On undulating to moderately steep slopes, sometimes in shallow, incised drainage valleys. Open savanna characterised by small trees of *Acacia natalitia* with a short to medium, dense, sour grassy understorey, usually dominated by *Themeda triandra* when in good condition. A diversity of other woody species also occur, often increasing under conditions of overgrazing.

Geology & Soils Mudstone with subordinate sandstone of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) underlies most of the area and is intruded by Karoo dolerite dykes and sills. The substrate is primarily loamy soils, but there is significant variability. The area was classified into a variety of land types, with Fa and Fb dominant.

Climate Summer rainfall with some rain in winter. MAP from about 500 mm in the west to more than 900 mm in the east. The coefficient of variation in MAP is approximately 25%, but varies from about 20% at the coast to about 30% on the inland and western parts. Frost infrequent. The mean daily maximum temperatures for January 25°C in the east and 28°C in the west and the mean daily minimum temperatures for July 3°C inland and 9°C at the coast. Mean monthly maximum and minimum temperatures for King William's Town 37.0°C and –1.6°C for February and June, respectively. See also climate diagram for SVs 7 Bhisho Thornveld.

Important Taxa Small Tree: *Acacia natalitia* (d). Tall Shrub: *Tephrosia capensis*. Low Shrubs: *Anthospermum rigidum* subsp. *pumilum*, *Chrysocoma ciliata*, *Felicia muricata*. Graminoids: *Eragrostis plana* (d), *Heteropogon contortus* (d), *Hyparrhenia hirta* (d), *Sporobolus africanus* (d), *Themeda triandra* (d), *Aristida junciformis* subsp. *junciformis*, *Bulbostylis humilis*, *Cynodon dactylon*, *Digitaria diagonalis*, *D. eriantha* subsp. *eriantha*, *Elionurus muticus*, *Eragrostis capensis*, *E. chloromelas*, *E. curvula*, *Kyllinga alata*, *Microchloa caffra*, *Paspalum dilatatum*, *Schoenoxiphium sparteum*. Herbs: *Centella asiatica*, *Commelina africana*, *Gazania linearis*, *Gerbera ambigua*, *Helichrysum miconiifolium*, *H. nudifolium* var. *pilosellum*, *H. rugulosum*, *Senecio retrorsus*, *Spermacoce natalensis*, *Wahlenbergia stellarioides*, *Zornia capensis*. Geophytic Herbs: *Hypoxis argentea*, *Moraea polystachya*, *Pellaea calomelanos*.

Conservation Least threatened. Target 25%. Only 0.2% statutorily conserved in the Doubledrift and Thomas Baines Nature Reserves. About 2% conserved in private reserves such as Shamwari Game Reserve, Rockdale Game Ranch and Fourie Safaris Game Farm. Some 20% already transformed for cultivation, urban development or plantations. Erosion is very low to moderate.

Remarks Due to the wide distribution of this unit, it incorporates a wide variety of environmental conditions. It borders on a number of other units and species from different vegetation types may co-occur along overlapping areas. Most similar to and forms a gradient to Gs 18 Bedford Dry Grassland in the west. Fire and grazing regimes appear to be key determinants of this vegetation unit, although soil characteristics are also important. *Acacia natalitia*, the main woody species of the SVs 7 Bhisho Thornveld, tends to occur in habitats with high soil moisture balance.

Reference Acocks (1988).

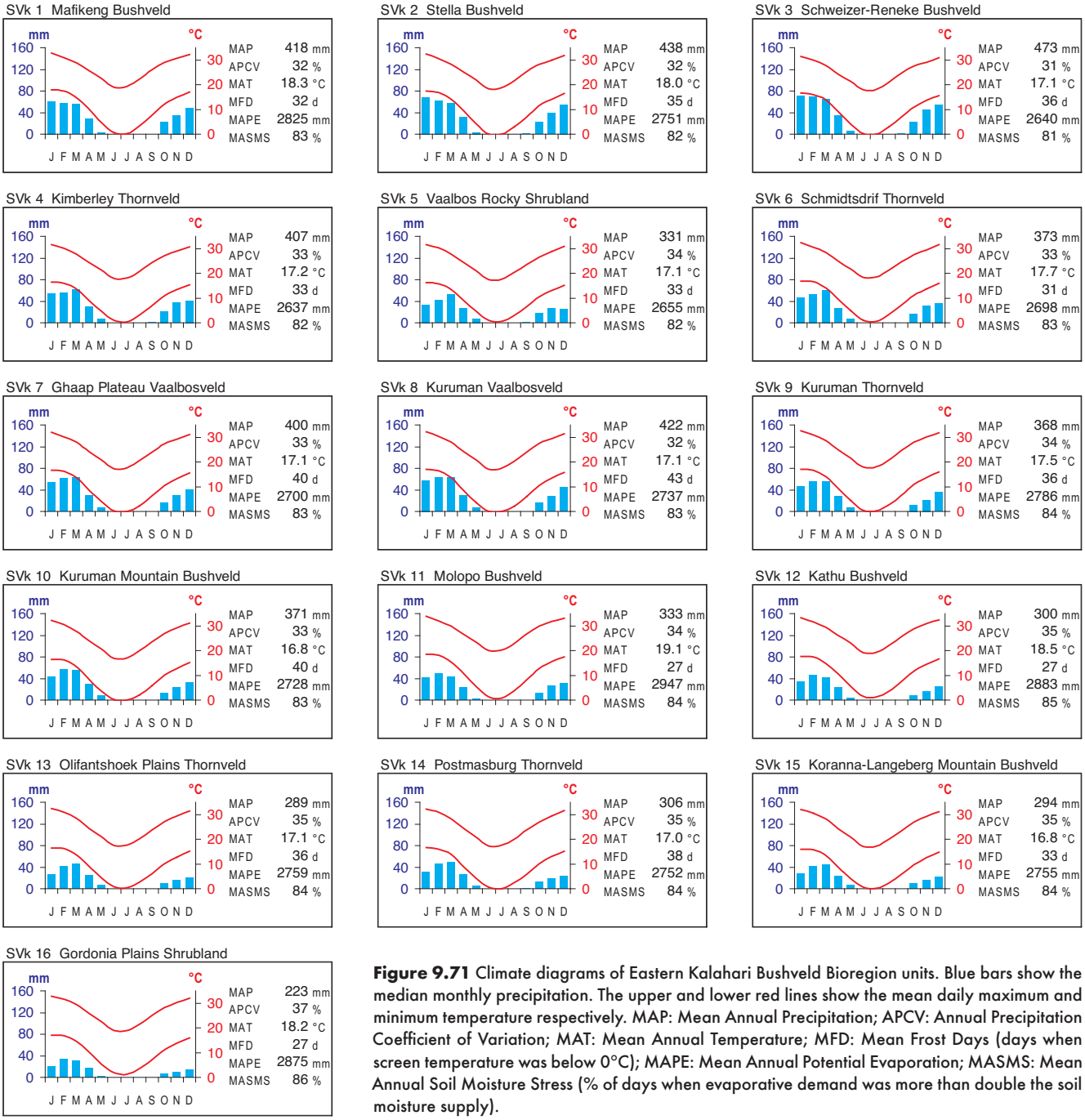


Figure 9.71 Climate diagrams of Eastern Kalahari Bushveld Bioregion units. Blue bars show the median monthly precipitation. The upper and lower red lines show the mean daily maximum and minimum temperature respectively. MAP: Mean Annual Precipitation; APCV: Annual Precipitation Coefficient of Variation; MAT: Mean Annual Temperature; MFD: Mean Frost Days (days when screen temperature was below 0°C); MAPE: Mean Annual Potential Evaporation; MASMS: Mean Annual Soil Moisture Stress (% of days when evaporative demand was more than double the soil moisture supply).

Eastern Kalahari Bushveld

SVk 1 Mafikeng Bushveld

VT 16 Kalahari Thornveld and Shrub Bushveld (76%) (Acocks 1953). LR 30 Kalahari Plains Thorn Bushveld (80%) (Low & Rebelo 1996).

Distribution North-West Province: West of Mafikeng and south of the Botswana border westwards to around Vergeleë, southwards to Piet Plessis and Setlagole. Altitude 1 100–1 400 m.

Vegetation & Landscape Features Well developed tree and shrub layers, dense stands of *Terminalia sericea*, *Acacia luederitzii* and *A. erioloba* in certain areas. Shrubs include *A. karroo*, *A. hebeclada* and *A. mellifera*, *Dichrostachys cinerea*, *Grewia flava*, *G. retinervis*, *Rhus tenuinervis* and *Ziziphus mucronata*. Grass layer is also well developed.

Geology & Soils Aeolian Kalahari sand of Tertiary to Recent age on flat sandy plains, soils deep (>1.2 m). Clovelly and Hutton soil forms. Land types Ah, Ai and Ae.

Climate Summer rainfall with very dry winters. MAP from about 350 mm in the west to about 520 mm in the east. Frost frequent in winter. Mean monthly maximum and minimum temperatures for Mmabatho 35.6°C and –1.8°C for November and June, respectively. See also climate diagram for SVk 1 Mafikeng Bushveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Acacia karroo* (d), *A. mellifera* subsp. *detinens* (d), *Terminalia sericea* (d), *Ziziphus mucronata* (d). Tall Shrubs: *Dichrostachys cinerea* (d), *Grewia flava* (d), *Rhus tenuinervis* (d), *Diospyros austro-africana*, *Ehretia rigida* subsp. *rigida*, *Rhigozum obovatum*, *Tarchonanthus camphoratus*. Low Shrubs: *Acacia hebe-*

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Figure 9.72 SVk 1 Mafikeng Bushveld: Open savanna dominated by *Ziziphus mucronata*, *Grewia flava* and *Acacia erioloba* on Wildebeesthoorn between Vergelegeë and Setlagole in the Vryburg District, North-West Province.

clada subsp. *hebeclada* (d), *Grewia retinervis* (d), *Aptosimum procumbens*, *Felicia muricata*, *Gnidia polycephala*, *Helichrysum zeyheri*, *Hoffmannseggia burchellii*, *Lantana rugosa*, *Talinum arnotii*. Geoxylic Suffrutex: *Elephantorrhiza elephantina*. Succulent Shrub: *Lycium cinereum*. Woody Climber: *Asparagus africanus*. Graminoids: *Anthephora pubescens* (d), *Cymbopogon pospischilii* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Eragrostis lehmanniana* (d), *E. pallens* (d), *Schmidtia pappophoroides* (d), *Stipagrostis uniplumis* (d), *Aristida congesta*, *A. meridionalis*, *A. mollissima* subsp. *argentea*, *A. stipitata* subsp. *stipitata*, *Brachiaria nigropedata*, *B. serrata*, *Cynodon dactylon*, *Digitaria argyrograpta*, *Eragrostis superba*, *E. trichophora*, *Melinis repens*, *Tragus racemosus*, *Urochloa panicoides*. Herbs: *Barleria macrostegia*, *Erlangea misera*, *Harpagophytum procumbens* subsp. *procumbens*, *Hermannia tomentosa*, *Hermbstaedtia odorata*, *Indigofera daleoides*, *Limeum fenestratum*, *Nidorella resedifolia*, *Oxygonum dregeanum* subsp. *canescens* var. *canescens*, *Senna italica* subsp. *arachoides*. Geophytic Herb: *Ledebouria marginata*.

Biogeographically Important Taxa (Kalahari endemics) Small Tree: *Acacia luederitzii* var. *luederitzii* (d). Graminoid: *Panicum kalaharense*.

Conservation Vulnerable. Target 16%. None conserved in statutory conservation areas but very small area conserved in the Mmabatho Recreation Area. About 25% already transformed, mainly for cultivation and urban development. Erosion is very low.

Reference Smit (2000).

SVk 2 Stella Bushveld

VT 16 Kalahari Thornveld and Shrub Bushveld (92%) (Acocks 1953). LR 33 Kalahari Plateau Bushveld (73%) (Low & Rebelo 1996).

Distribution North-West Province: North of Vryburg around Stella westwards to Louwna and eastwards to about 20 km west of Delareyville. Altitude 1 250–1 400 m.

Vegetation & Landscape Features Plains to sometimes slightly undulating plains with open tree and shrub layers and trees *Acacia erioloba* and *A. tortilis* and shrubs *A. hebeclada*, *Dichrostachys cinerea*, *Grewia flava* and *Tarchonanthus camphoratus*.

Geology & Soils Andesitic lavas of the Allanridge Formation of the Ventersdorp Supergroup, sometimes covered with silcrete or calcrete of the Kalahari Group, on flat to hilly plains. Sandy soils 0.1–0.9 m deep, various soil forms. Land types Bc and Ae, with a little Ah.

Climate Summer rainfall with very dry winters. MAP about 400–480 mm. Frost frequent in winter. See also climate diagram for SVk 2 Stella Bushveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Acacia tortilis* subsp. *heteracantha* (d), *A. caffra*, *A. karroo*, *Rhus lancea*. Tall Shrubs: *Dichrostachys cinerea* (d), *Grewia flava* (d), *Tarchonanthus camphoratus* (d), *Asparagus laricinus*, *Diospyros lycioides* subsp. *lycioides*, *D. pallens*, *Ehretia rigida* subsp. *rigida*. Low Shrubs: *Acacia hebeclada* subsp. *hebeclada* (d), *Chrysocoma ciliata* (d), *Helichrysum zeyheri*, *Pentzia viridis*, *Solanum supinum*. Succulent Shrub: *Hertia pallens*. Woody Climber: *Asparagus africanus*. Herbaceous Climber: *Rhynchosia confusa*. Graminoids: *Cenchrus ciliaris* (d), *Cymbopogon pospischilii* (d), *Eragrostis rigidior* (d), *Panicum coloratum* (d), *Themeda triandra* (d), *Aristida congesta*, *Cynodon dactylon*, *Eragrostis lehmanniana*, *E. obtusa*, *E. superba*, *Pogonarthria squarrosa*, *Sporobolus fimbriatus*, *Tragus racemosus*. Herbs: *Barleria macrostegia*, *Dicoma capensis*, *Hibiscus pusillus*, *Indigofera alternans*, *I. daleoides*, *Lippia scaberrima*, *Osteospermum muricatum*, *Tripteris aghillana*. Geophytic Herb: *Babiana hypogea*.

Conservation Vulnerable. Target 16%. None conserved in statutory conservation areas. Some 21% transformed, almost all by cultivation. Erosion is very low.

Reference Smit (2000).

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Figure 9.73 SVk 2 Stella Bushveld: Open savanna on plains with *Acacia erioloba*, *Tarchonanthus camphoratus*, *A. hebeclada* and *Eragrostis lehmanniana* var. *lehmanniana* on Klipfontein between Vryburg and Ganyesa, North-West Province.

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Figure 9.74 SVk 3 Schweizer-Reneke Bushveld: Open shrubland dominated by *Acacia hebeclada* and *Tarchonanthus camphoratus* with some *A. karroo* trees on Nieuwjaarsfontein west of Schweizer-Reneke, North-West Province.

SVk 3 Schweizer-Reneke Bushveld

VT 16 Kalahari Thornveld and Shrub Bushveld (89%) (Acocks 1953). LR 32 Kimberley Thorn Bushveld (88%) (Low & Rebelo 1996).

Distribution North-West Province: Schweizer-Reneke area in the east to Amalia in the west and from the farming areas of around Broedersput in the north to Never Mind (Christiana District) in the south. Altitude 1 250–1 400 m.

Vegetation & Landscape Features Plains, slightly undulating plains and some hills, supporting open woodland with a fairly dense shrub layer, with trees *Acacia erioloba*, *A. karroo*, *A. tortilis*, *Rhus lancea* and shrubs *A. hebeclada*, *Diospyros lycioides*, *Grewia flava*, *Tarchonanthus camphoratus*.

Geology & Soils Andesitic lavas of the Allanridge Formation of the Ventersdorp Supergroup, sometimes covered with silcrete or calcrete of the Kalahari Group. Deep (0.9–1.2 m) sandy soils, with Hutton and Clovelly the dominant soil forms. Land types Ah and Ae and some Bc.

Climate Rainfall in summer with very dry winters. MAP about 440–520 mm. Frost frequent in winter. See also climate diagram for SVk 3 Schweizer-Reneke Bushveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Acacia karroo* (d), *A. tortilis* subsp. *heteracantha* (d), *Rhus lancea* (d). Tall Shrubs: *Asparagus laricinus* (d), *Diospyros lycioides* subsp. *lycioides* (d), *Grewia flava* (d), *Tarchonanthus camphoratus* (d), *Diospyros pallens*, *Ehretia rigida* subsp. *rigida*, *Gymnosporia buxifolia*, *Rhus tridactyla*. Low Shrubs: *Acacia hebeclada* subsp. *hebeclada* (d), *Aptosimum decumbens*, *Chrysocoma ciliata*, *Gnidia polycephala*, *Pentzia viridis*. Woody Climber: *Asparagus africanus*. Graminoids: *Anthephora pubescens* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Heteropogon contortus* (d), *Stipagrostis uniplumis* (d), *Themeda triandra* (d), *Aristida congesta*, *A. stipitata* subsp. *spicata*, *Chloris virgata*, *Cynodon dactylon*, *Eragrostis biflora*, *E. rigidior*, *E. superba*, *E. trichophora*, *Sporobolus fimbriatus*. Herbs: *Barleria macrostegia*, *Hermannia tomentosa*, *Hibiscus pusillus*, *Indigofera daleoides*, *Lippia scaberrima*, *Osteospermum muricatum*, *Pollichia campestris*, *Rhynchosia adenodes*. Geophytic Herbs: *Dipcadi papillatum*, *Nerine laticoma*.

Conservation Endangered. Target 16%. None conserved in statutory conservation areas. Largely (42%) transformed, almost all by cultivation. Erosion is very low.

Reference Smit (2000).

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SVk 4 Kimberley Thornveld

VT 16 Kalahari Thornveld and Shrub Bushveld (50%) (Acocks 1953). LR 32 Kimberley Thorn Bushveld (74%) (Low & Rebelo 1996).

Distribution North-West, Free State and Northern Cape Provinces: Most of the Kimberley, Hartswater, Bloemhof and Hoopstad Districts as well as substantial parts of the Warrenton, Christiana, Taung, Boshof and to some extent the Barkly West Districts. Also includes pediment areas in the Herbert and Jacobsdal Districts. Altitude 1 050–1 400 m.

Vegetation & Landscape Features Plains often slightly irregular with well-developed tree layer with *Acacia erioloba*, *A. tortilis*, *A. karroo* and *Boscia albitrunca* and well-developed shrub layer with occasional dense stands of *Tarchonanthus camphoratus* and *A. mellifera*. Grass layer open with much uncovered soil.

Geology & Soils Andesitic lavas of the Allanridge Formation in the north and west and fine-grained sediments of the Karoo Supergroup in the south and east. Deep (0.6–1.2 m) sandy to loamy soils of the Hutton soil form (Ae and Ah land types) on slightly undulating sandy plains.

Climate Summer and autumn rainfall and very dry winters. MAP from about 300 mm in the southwest to about 500 mm in the northeast. Frost frequent in winter. Mean monthly maximum and minimum temperatures for Kimberley 37.5°C and –4.1°C for January and July, respectively. Corresponding values for

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Figure 9.75 SVk 4 Kimberley Thornveld: Open savanna dominated by *Acacia erioloba* and *A. mellifera* on Kloksfontein south-southwest of Kimberley.

Vaalharts-Agr 37.4°C and –3.9°C, respectively. See also climate diagram for SVk 4 Kimberley Thornveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Acacia karroo* (d), *A. mellifera* subsp. *detinens* (d), *A. tortilis* subsp. *heteracantha* (d), *Rhus lancea*. Tall Shrubs: *Tarchonanthus camphoratus* (d), *Diospyros pallens*, *Ehretia rigida* subsp. *rigida*, *Euclea crispa* subsp. *ovata*, *Grewia flava*, *Lycium arenicola*, *L. hirsutum*, *Rhus tridactyla*. Low Shrubs: *Acacia hebeclada* subsp. *hebeclada* (d), *Anthospermum rigidum* subsp. *pumilum*, *Helichrysum zeyheri*, *Hermannia comosa*, *Lycium pilifolium*, *Melolobium microphyllum*, *Pavonia burchellii*, *Peliostomum leucorrhizum*, *Plinthus sericeus*, *Wahlenbergia nodosa*. Succulent Shrubs: *Aloe hereroensis* var. *hereroensis*, *Lycium cinereum*. Graminoids: *Eragrostis lehmanniana* (d), *Aristida canescens*, *A. congesta*, *A. mollissima* subsp. *argentea*, *Cymbopogon pospischilii*, *Digitaria argyrograpta*, *D. eriantha* subsp. *eriantha*, *Enneapogon cenchroides*, *E. scoparius*, *Eragrostis rigidior*, *Heteropogon contortus*, *Themeda triandra*. Herbs: *Barleria macrostegia*, *Dicoma schinzii*, *Harpagophytum procumbens* subsp. *procumbens*, *Helichrysum cerastioides*, *Hermbstaedtia odorata*, *Hibiscus marlothianus*, *Jamesbrittenia aurantiaca*, *Lippia scaberrima*, *Osteospermum muricatum*, *Vahlia capensis* subsp. *vulgaris*. Succulent Herbs: *Aloe grandidentata, Piaranthus decipiens*.

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Figure 9.76 SVk 5 Vaalbos Rocky Shrubland: Open shrubland dominated here by *Tarchonanthus camphoratus*, *Acacia tortilis* and *Lycium* species on a rocky hillside on The Grange, north-east of Hopetown, Northern Cape Province.

Biogeographically Important Taxa ([GW]Griqualand West endemic, [K]Kalahari endemic) Low Shrub: *Blepharis marginata*[GW]. Succulent Shrub: *Euphorbia bergii*[GW]. Graminoid: *Panicum kalaharense*[K]. Herbs: *Helichrysum arenicola*[K], *Neuradopsis bechuanensis*[K]. Succulent Herbs: *Lithops aucampiae* subsp. *aucampiae*[GW], *Tridentea marientalensis* subsp. *marientalensis*[K].

Conservation Least threatened. Target 16%. Only 2% statutorily conserved in Vaalbos National Park as well as in Sandveld, Bloemhof Dam and S.A. Lombard Nature Reserves. Some 18% already transformed, mostly by cultivation. Erosion is very low. Area is mostly used for cattle farming or game ranching. Overgrazing leads to encroachment of *Acacia mellifera* subsp. *detinens*.

References Bezuidenhout (1994, 1995), Smit (2000).

SVk 5 Vaalbos Rocky Shrubland

VT 17 Kalahari Thornveld invaded by Karoo (31%), VT 40 False Orange River Broken Veld (21%) (Acocks 1953). LR 32 Kimberley Thorn Bushveld (44%), LR 51 Orange River Nama Karoo (36%) (Low & Rebelo 1996).

Distribution Northern Cape and Free State Provinces: Extends along solitary hills and scattered ridges east of the confluence of the Orange and Vaal Rivers, mainly in the Kimberley and Herbert Districts and west of a line bounded by the western Free State towns of Luckhoff, Petrusburg, Dealesville, Bultfontein and Hertzogville. Altitude 1 000–1 400 m.

Vegetation & Landscape Features Slopes and elevated hills and ridges within plains of mainly SVk 4 Kimberley Thornveld, also in the vicinity of NKu 3 Northern Upper Karoo. Evergreen shrub communities dominated by *Tarchonanthus camphoratus*, *Olea europaea* subsp. *africana*, *Euclea crispa*, *Diospyros lycioides*, *Rhus burchellii* and *Buddleja saligna*. Sheltered, cool sites include trees such as *R. lancea*, *Celtis africana* and *Ziziphus mucronata*. On the footslopes of the dolerite hills, where calcrete-rich soils occur, shrubs and small trees of *Acacia tortilis* and *Z. mucronata* can be dominant.

Geology & Soils A highly fragmented area on Ecca and Dwyka Group sediments and Karoo dolerites as well as on Ventersdorp Supergroup lavas (Allanridge Formation). Extensive dolerite sills which form ridges, and plateaus and slopes of koppies and small escarpments mark the erosion terraces. These dolerite sills cover alternating layers of mudstone and sandstone of sedimentary origin. The Ib land type is typical of these rock- and boulder-covered slopes. Prominent soil forms are the stony Mispah and gravel-rich Glenrosa forms derived from Jurassic dolerite, calcrete-rich soils cover the lowlands (Kimberley and Plooysburg forms).

Climate Summer and autumn rainfall with very dry winters. MAP about 250–450 mm. Frost frequent in winter, especially on bottomlands. Mean monthly maximum and minimum temperatures for Douglas 39.7°C and –4.6°C for January and July, respectively. See also climate diagram for SVk 5 Vaalbos Rocky Shrubland.

Important Taxa Small Trees: *Boscia albitrunca*, *Cussonia paniculata*, *Rhus lancea*. Tall Shrubs: *Euclea crispa* subsp. *crispa* (d), *Olea europaea* subsp. *africana* (d), *Tarchonanthus camphoratus* (d), *Ziziphus mucronata* (d), *Buddleja saligna*, *Cadaba aphylla*, *Diospyros austro-africana*, *D. lycioides* subsp. *lycioides*, *Ehretia rigida* subsp. *rigida*, *Gymnosporia polyacantha*, *Rhigozum obovatum*, *Rhus burchellii*. Low Shrubs: *Asparagus suaveolens*, *Hermannia comosa*, *Lantana rugosa*, *Lycium pilifolium*, *Pentzia globosa*, *Rhus ciliata*. Succulent Shrubs: *Cotyledon orbiculata* var. *orbiculata*, *Crassula nudicaulis*, *Kalanchoe paniculata*, *Lycium cinereum*. Graminoids: *Aristida adscensionis*, *A. congesta*, *Digitaria eriantha* subsp. *eriantha*, *Elionurus muticus*, *Enneapogon scoparius*, *Eragrostis lehmanniana*, *E. obtusa*, *Eustachys paspaloides*, *Fingerhuthia africana*, *Heteropogon contortus*, *Hyparrhenia hirta*, *Stipagrostis uniplumis*, *Themeda triandra*. Herbs: *Chascanum pinnatifidum*, *Harpagophytum procumbens* subsp. *procumbens*, *Hibiscus pusillus*. Geophytic Herbs: *Albuca setosa*, *Cheilanthes eckloniana*, *Haemanthus humilis* subsp. *humilis*, *Pellaea calomelanos*. Succulent Herbs: *Aloe grandidentata*, *Stapelia grandiflora*.

Conservation Least threatened. Target 16%. Less than 2% statutorily conserved in the Vaalbos National Park. Only about 2% already transformed.

Remarks Although similar topography and geology to that of koppies in the broad surrounds of Bloemfontein (Gh 4 Besemkaree Koppies Shrubland and Gh 7 Winburg Grassy Shrubland) in the Grassland Biome, the vegetation of this unit differs considerably in species composition through the occurrence of more arid elements.

References Malan et al. (1998, 2001), Müller (2002).

SVk 6 Schmidtsdrif Thornveld

VT 16 Kalahari Thornveld and Shrub Bushveld (56%) (Acocks 1953). LR 32 Kimberley Thorn Bushveld (89%) (Low & Rebelo 1996).

Distribution Northern Cape, Free State and North-West Provinces: Footslopes and midslopes to the southeast and below the Ghaap Plateau from around Douglas in the southwest via Schmidtsdrif towards Taung in the northeast. A small less typical section is found east of the Ghaap Plateau from Warrenton towards Hertzogville. Altitude 1 000–1 350 m.

Vegetation & Landscape Features Mostly a closed shrubby thornveld dominated by *Acacia mellifera* and *A. tortilis*. Apart from grasses, bulbous and annual herbaceous plant species are also prominent. The vegetation is sometimes very disturbed due to overgrazing by goats and other browsers.

Geology & Soils Most significant are the Dwyka diamictites and Ecca shales of the Karoo Supergroup. Shale and dolomite of the Schmidtsdrif Subgroup (Griqualand West Supergroup) are also present. Surface limestone occurs sporadically. Well-drained, shallow (<0.3 m), stony soil with large angular rocks on the soil surface. A soil-rock complex with Mispah soil form. Land types mainly Ae and Dc.

Climate Summer and autumn rainfall with very dry winters. MAP from about 250 mm in the southwest to about 450 mm in the northeast. Frost frequent in winter. See also climate diagram for SVk 6 Schmidtsdrif Thornveld.

Important Taxa Small Trees: *Acacia mellifera* subsp. *detinens* (d), *A. tortilis* subsp. *heteracantha* (d), *Ficus cordata*, *Ziziphus mucronata*. Tall Shrubs: *Tarchonanthus camphoratus* (d), *Grewia flava*. Low Shrubs: *Aptosimum albomarginatum* (d), *Barleria rigida* (d), *Monechma incanum* (d), *Pentzia incana* (d), *Hermannia affinis*, *H. comosa*, *Ptycholobium biflorum*, *Zygophyllum pubescens*. Semiparasitic Shrub: *Thesium lineatum*. Graminoids: *Aristida meridionalis* (d), *Enneapogon cenchroides* (d), *Eragrostis lehmanniana* (d), *E. obtusa* (d), *Enneapogon desvauxii*. Herbs: *Lepidium bonariense* (d), *Amaranthus praetermissus*, *Heliotropium ciliatum*, *Indigastrum parviflorum*, *Osteospermum muricatum*, *Seddera capensis*, *Stachys hyssopoides*.

Biogeographically Important Taxa (Griqualand West endemics) Low Shrub: *Blepharis marginata*. Succulent Shrub: *Prepodesma orpenii* (endemic genus).

Conservation Least threatened. Target 16%. Only 0.2% statutorily conserved in the Vaalbos National Park. Some 13% already transformed, mainly by cultivation. Erosion is very low to low. Of alien plant taxa, *Prosopis* deserves attention.

References Gubb (1980), Crowe et al. (1981), Bezuidenhout (1994), Smit (2000).

SVk 7 Ghaap Plateau Vaalbosveld

VT 16 Kalahari Thornveld and Shrub Bushveld (74%) (Acocks 1953). LR 33 Kalahari Plateau Bushveld (86%) (Low & Rebelo 1996).

Distribution Northern Cape and North-West Provinces: Flat plateau from around Campbell in the south, east of Danielskuil through Reivilo to around Vryburg in the north. Altitude 1 100–1 500 m.

Vegetation & Landscape Features Flat plateau with well-developed shrub layer with *Tarchonanthus camphoratus* and *Acacia karroo*. Open tree layer has *Olea europaea* subsp. *africana*, *A. tortilis*, *Ziziphus mucronata* and *Rhus lancea*. *Olea* is more important in the southern parts of the unit, while *A. tortilis*, *A. hebeclada* and *A. mellifera* are more important in the north and part of the west of the unit. Much of the south-central part of this unit has remarkably low cover of *Acacia* species for an arid savanna and is dominated by the nonthorny *T. camphoratus*, *R. lancea* and *O. europaea* subsp. *africana*.

Geology & Soils Surface limestone of Tertiary to Recent age, and dolomite and chert of the Campbell Group (Griqualand West Supergroup, Vaalian Erathem) support shallow soils (0.1–0.25 m) of Mispah and Hutton soil forms. Land types mainly Fc with some Ae and Ag.

Climate Summer and autumn rainfall with very dry winters. MAP from about 300 mm in the southwest to about 500 mm in the northeast. Frost frequent to very frequent in winter. Mean monthly maximum and minimum temperatures for Koopmansfontein 36.3°C and –7.5°C for January and July, respectively. Corresponding values for Armoedsvlakte (near Vryburg) 36.6°C and –5.5°C for December and July, respectively. See also climate diagram for SVk 7 Ghaap Plateau Vaalbosveld.

Important Taxa Tall Tree: *Acacia erioloba*. Small Trees: *Acacia mellifera* subsp. *detinens* (d), *Rhus lancea* (d), *Acacia karroo*, *A. tortilis* subsp. *heteracantha*, *Boscia albitrunca*. Tall Shrubs: *Olea*

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Figure 9.77 SVk 7 Ghaap Plateau Vaalbosveld: Open savanna dominated by *Tarchonanthus camphoratus* and *Olea europaea* subsp. *africana* between Papkuil and Campbell, Northern Cape Province.

europaea subsp. *africana* (d), *Rhigozum trichotomum* (d), *Tarchonanthus camphoratus* (d), *Ziziphus mucronata* (d), *Diospyros austro-africana*, *D. pallens*, *Ehretia rigida* subsp. *rigida*, *Euclea crispa* subsp. *ovata*, *Grewia flava*, *Gymnosporia buxifolia*, *Lessertia frutescens*, *Rhus tridactyla*. Low Shrubs: *Acacia hebeclada* subsp. *hebeclada* (d), *Aptosimum procumbens*, *Chrysocoma ciliata*, *Helichrysum zeyheri*, *Hermannia comosa*, *Lantana rugosa*, *Leucas capensis*, *Melolobium microphyllum*, *Peliostomum leucorrhizum*, *Pentzia globosa*, *P. viridis*, *Zygophyllum pubescens*. Succulent Shrubs: *Hertia pallens*, *Lycium cinereum*. Semiparasitic Shrub: *Thesium hystrix*. Woody Climber: *Asparagus africanus*. Graminoids: *Anthephora pubescens* (d), *Cenchrus ciliaris* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Enneapogon scoparius* (d), *Eragrostis lehmanniana* (d), *Schmidtia pappophoroides* (d), *Themeda triandra* (d), *Aristida adscensionis*, *A. congesta*, *A. diffusa*, *Cymbopogon pospischilii*, *Enneapogon cenchroides*, *E. desvauxii*, *Eragrostis echinochloidea*, *E. obtusa*, *E. rigidior*, *E. superba*, *Fingerhuthia africana*, *Heteropogon contortus*, *Sporobolus fimbriatus*, *Stipagrostis uniplumis*, *Tragus racemosus*. Herbs: *Barleria macrostegia*, *Geigeria filifolia*, *G. ornativa*, *Gisekia africana*, *Helichrysum cerastioides*, *Heliotropium ciliatum*, *Hermbstaedtia odorata*, *Hibiscus marlothianus*, *H. pusillus*, *Jamesbrittenia aurantiaca*, *Limeum fenestratum*, *Lippia scaberrima*, *Selago densiflora*, *Vahlia capensis* subsp. *vulgaris*. Succulent Herb: *Aloe grandidentata*.

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Figure 9.78 SVk 8 Kuruman Vaalbosveld: Open savanna dominated by *Tarchonanthus camphoratus* and *Rhus lancea* with a mix of grasses including *Themeda triandra* near Lykso, between Kuruman and Vryburg, North-West Province.

Biogeographically Important Taxa ([GW]Griqualand West endemic, [K]Kalahari endemic, [D]Broadly disjunct distribution) Tall Shrubs: *Lebeckia macrantha*[GW], *Nuxia gracilis*[D]. Low Shrubs: *Blepharis marginata*[GW], *Putterlickia saxatilis*[GW], *Tarchonanthus obovatus*[GW]. Succulent Shrubs: *Euphorbia wilmaniae*[GW], *Prepodesma orpenii*[GW] (endemic genus). Graminoids: *Digitaria polyphylla*[GW], *Panicum kalaharense*[K]. Herbs: *Corchorus pinnatipartitus*[GW], *Helichrysum arenicola*[K]. Succulent Herb: *Orbea knobelii*[K].

Endemic Taxon Herb: *Rennera stellata*.

Conservation Least threatened. Target 16%. None conserved in statutory conservation areas. Only about 1% already transformed. Erosion is very low.

Reference Smit (2000).

SVk 8 Kuruman Vaalbosveld

VT 16 Kalahari Thornveld and Shrub Bushveld (100%) (Acocks 1953). LR 33 Kalahari Plateau Bushveld (74%) (Low & Rebelo 1996).

Distribution North-West and Northern Cape Provinces: East of Kuruman to Lykso, south of Bendell towards Good Hope. Altitude 1 300–1 500 m.

Vegetation & Landscape Features Open tree layer characterised by *Acacia erioloba*, *A. karroo*, *Rhus lancea* and *Ziziphus mucronata*. Shrub layer poorly developed, with *Grewia flava* and *Tarchonanthus camphoratus* and grass layer open, with much bare soil in places.

Geology & Soils Carbonates and chert of the Vaalian Griqualand West Supergroup and Kalahari sediments form flat, rocky, sandy plains with shallow (0.1–0.6 m) red aeolian sands, stony and underlain by rock. Dominant land types Ae and Fc, with Hutton, Clovelly and Mispah soil forms common.

Climate Summer and autumn rainfall with very dry winters. MAP about 350–450 mm. Frost very frequent in winter. See also climate diagram for SVk 8 Kuruman Vaalbosveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Acacia karroo* (d), *Ziziphus mucronata* (d), *Rhus lancea*. Tall Shrubs: *Tarchonanthus camphoratus* (d), *Cadaba aphylla*, *Diospyros austro-africana*, *D. lycioides* subsp. *lycioides*, *Grewia flava, Gymnosporia buxifolia*. Low Shrubs: *Amphiglossa triflora*, *Anthospermum rigidum* subsp. *pumilum*, *A. rigidum* subsp. *rigidum*, *Helichrysum zeyheri*. Geoxylic Suffrutex: *Elephantorrhiza elephantina*. Succulent Shrub: *Ebracteola wilmaniae*. Herbaceous Climber: *Rhynchosia holosericea*. Graminoids: *Anthephora pubescens* (d), *Aristida meridionalis* (d), *Eragrostis lehmanniana* (d), *Stipagrostis uniplumis* (d), *Aristida stipitata* subsp. *spicata*, *Cymbopogon caesius*, *Digitaria eriantha* subsp. *eriantha*, *Fingerhuthia africana*, *Pogonarthria squarrosa*, *Schmidtia pappophoroides*, *Themeda triandra*, *Tragus koelerioides*. Herbs: *Acrotome inflata*, *Dicoma schinzii*, *Geigeria ornativa*, *Heliotropium strigosum*, *Stachys spathulata*, *Tripteris aghillana*.

Biogeographically Important Taxon (Kalahari endemic) Graminoid: *Anthephora argentea*.

Conservation Least threatened. Target 16%. None conserved in statutory conservation areas. Erosion is very low.

Remark In the dolomite area, sinkholes may be filled with wind-blown sand and occupied by conspicuous dense clumps of *Acacia erioloba*.

Reference Smit (2000).

SVk 9 Kuruman Thornveld

VT 16 Kalahari Thornveld and Shrub Bushveld (98%) (Acocks 1953). LR 30 Kalahari Plains Thorn Bushveld (67%) (Low & Rebelo 1996).

Distribution North-West and Northern Cape Provinces: On flats from the vicinity of Postmasburg and Danielskuil (here west of the Kuruman Hills) in the south extending via Kuruman to Tsineng and Dewar in the north. Altitude 1 100–1 500 m.

Vegetation & Landscape Features Flat rocky plains and some sloping hills with very well-developed, closed shrub layer and well-developed open tree stratum consisting of *Acacia erioloba*.

Geology & Soils Some Campbell Group dolomite and chert and mostly younger, superficial Kalahari Group sediments, with red wind-blown (0.3–1.2 m deep) sand. Locally, rocky pavements are formed in places. Most important land types Ae, Ai, Ag and Ah, with Hutton soil form.

Climate Summer and autumn rainfall with very dry winters. MAP about 300–450 mm. Frost frequent in winter. Mean monthly maximum and minimum temperatures for Kuruman 35.9°C and –3.3°C for January and June, respectively. See also climate diagram for SVk 9 Kuruman Thornveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Acacia mellifera* subsp. *detinens* (d), *Boscia albitrunca* (d). Tall Shrubs: *Grewia flava* (d), *Lycium hirsutum* (d), *Tarchonanthus camphoratus* (d), *Gymnosporia buxifolia*. Low Shrubs: *Acacia hebeclada* subsp. *hebeclada* (d), *Monechma divaricatum* (d), *Gnidia polycephala*, *Helichrysum zeyheri*, *Hermannia comosa*, *Pentzia calcarea*, *Plinthus sericeus*. Geoxylic Suffrutex: *Elephantorrhiza elephantina*. Graminoids: *Aristida meridionalis* (d), *A. stipitata* subsp. *stipitata* (d), *Eragrostis lehmanniana* (d), *E. echinochloidea*, *Melinis repens*. Herbs: *Dicoma schinzii*, *Gisekia africana*, *Harpagophytum procumbens* subsp. *procumbens*, *Indigofera daleoides*, *Limeum fenestratum*, *Nolletia ciliaris*, *Seddera capensis*, *Tripteris aghillana*, *Vahlia capensis* subsp. *vulgaris*.

Biogeographically Important Taxa ([GW]Griqualand West endemic, [K]Kalahari endemic, [S]Southernmost distribution in interior of southern Africa) Small Trees: *Acacia luederitzii* var. *luederitzii*[K], *Terminalia sericea*[S]. Tall Shrub: *Acacia haematoxylon*[K]. Low Shrub: *Blepharis marginata*[GW]. Graminoid: *Digitaria polyphylla*[GW]. Herb: *Corchorus pinnatipartitus*[GW].

Endemic Taxon Herb: *Gnaphalium englerianum*.

Conservation Least threatened. Target 16%. None conserved in statutory conservation areas. Only 2% already transformed. Erosion is very low.

Remark Disturbed areas north of Kuruman are characterised by *Aristida adscensionis*, *A. congesta*, *Enneapogon scoparius*, *Geigeria ornativa*, *Melhania rehmanii*, *Rhigozum trichotomum* and *Sericorema remotiflora* and the absence of *Acacia erioloba*, *A. haematoxylon* and *Grewia flava*.

Reference Smit (2000).

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Figure 9.79 SVk 9 Kuruman Thornveld: *Acacia erioloba* trees and the overwhelmingly dominant shrub *Tarchonanthus camphoratus* immediately south of Kuruman at an altitude of 1 415 m.

SVk 10 Kuruman Mountain Bushveld

VT 16 Kalahari Thornveld and Shrub Bushveld (64%) (Acocks 1953). LR 31 Kalahari Mountain Bushveld (57%) (Low & Rebelo 1996).

Distribution Northern Cape and North-West Provinces: From the Asbestos Mountains southwest and northwest of Griekwastad, along the Kuruman Hills north of Danielskuil, passing west of Kuruman town and re-emerging as isolated hills, i.e. Makhubung and the hills around Pomfret in the north. Altitude 1 100–1 800 m.

Vegetation & Landscape Features Rolling hills with generally gentle to moderate slopes and hill pediment areas with an open shrubveld with *Lebeckia macrantha* prominent in places. Grass layer is well developed.

Geology & Soils The Kuruman and Asbestos Hills consist of banded iron formation, with jaspilite, chert and riebeckite-asbestos of the Asbestos Hills Subgroup of the Griqualand West Supergroup (Vaalian). Most common land type Ib, followed by Ae, Ic and Ag. Soils are shallow sandy soils, of the Hutton form.

Climate Summer and autumn rainfall with very dry winters. MAP about 250–500 mm. Frost frequent in winter. The unit corresponds in part to cluster 17 of the 27 in the physio-climatic classification of South Africa's woodland areas with summer rainfall (Fairbanks 2000). See also climate diagram for SVk 10 Kuruman Mountain Bushveld.

Important Taxa Small Tree: *Rhus lancea*. Tall Shrubs: *Diospyros austro-africana*, *Euclea crispa* subsp. *crispa*, *E. undulata*, *Olea europaea* subsp. *africana*, *Rhus pyroides* var. *pyroides*, *R. tridactyla*, *Tarchonanthus camphoratus*, *Tephrosia longipes*. Low Shrubs: *Rhus ciliata* (d), *Amphiglossa triflora*, *Anthospermum rigidum* subsp. *pumilum*, *Gomphocarpus fruticosus* subsp. *fruticosus*, *Helichrysum zeyheri*, *Lantana rugosa*, *Wahlenbergia nodosa*. Succulent Shrubs: *Ebracteola wilmaniae*, *Hertia pallens*. Herbaceous Climber: *Rhynchosia totta*. Graminoids: *Andropogon chinensis* (d), *A. schirensis* (d), *Anthephora pubescens* (d), *Aristida congesta* (d), *Digitaria eriantha* subsp. *eriantha* (d), *Themeda triandra* (d), *Triraphis andropogonoides* (d), *Aristida diffusa*, *Brachiaria nigropedata*, *Bulbostylis burchellii*, *Cymbopogon caesius*, *Diheteropogon amplectens*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. nindensis*, *Eustachys paspaloides*, *Heteropogon contortus*, *Melinis repens*, *Schizachyrium sanguineum*, *Trichoneura grandiglumis*. Herbs: *Dicoma anomala*, *D. schinzii*, *Geigeria ornativa*, *Helichrysum cerastioides*, *Heliotropium strigosum*, *Hibiscus marlothianus*, *Kohautia cynanchica*, *Kyphocarpa angustifolia*. Geophytic Herbs: *Boophone disticha*, *Pellaea calomelanos*.

Biogeographically Important Taxa (Griqualand West endemics) Tall Shrub: *Lebeckia macrantha* (d). Low Shrubs: *Justicia puberula*, *Tarchonanthus obo-*

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Figure 9.80 SVk 10 Kuruman Mountain Bushveld: Open low bushveld with the usually leafless *Lebeckia macrantha* clearly visible at an altitude of approximately 1 680 m near Bretby between Danielskuil and Kuruman.

vatus. Succulent Shrub: *Euphorbia wilmaniae*. Graminoid: *Digitaria polyphylla*. Herb: *Sutera griquensis*.

Endemic Taxon Succulent Shrub: *Euphorbia planiceps*.

Conservation Least threatened. Target 16%. None conserved in statutory conservation areas. Very little transformed. Erosion is very low to low. Some parts in the north are heavily utilised for grazing.

Remarks Many species in this unit are widely distributed to the northeast of the subcontinent and reach their southwestern limit in this unit (e.g. *Andropogon schirensis*). There are distinct floristic differences with the relatively nearby and parallel mountains of the SVk 15 Koranna-Langeberg Mountain Bushveld. For example, *Croton gratissimus* is common in the last mentioned unit but rare in Kuruman Mountain Bushveld. *Lebeckia macrantha* shows just the reverse distributional pattern between these units. A very low form (<0.5 m) of *Acacia hebeclada* is common in the north on Makhubung hill, north of Heuningvlei.

References Smit (2000), Van Wyk & Smith (2001).

SVk 11 Molopo Bushveld

VT 16 Kalahari Thornveld and Shrub Bushveld (100%) (Acocks 1953). LR 30 Kalahari Plains Thorn Bushveld (100%) (Low & Rebelo 1996).

Distribution North-West and Northern Cape Provinces: In the Molopo area from Bray and Werda in the north on the border with Botswana, southwards through Morokweng and Tosca in the east and Vorstershoop to McCarthysrus and Eldorado in the west to Bendell in the south. Altitude 1 000–1 300 m.

Vegetation & Landscape Features Open woodland to a closed shrubland with the trees *Acacia erioloba* and *Boscia albitrunca* and shrubs *Lycium cinereum*, *L. hirsutum* and *Rhigozum trichotomum*. Grass layer is well developed in parts of the northeast, but usually fairly open.

Geology & Soils Red aeolian sand of Recent age with surface calcrete and silcrete. Soils are deep (>1.2 m) and sandy (Hutton and Clovelly soil forms). Land types mainly Ah with a little Fc.

Climate Summer and autumn rainfall with very dry winters. MAP about 250–400 mm. Frost frequent in winter. See also climate diagram for SVk 11 Molopo Bushveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Boscia albitrunca* (d), *Terminalia sericea* (d), *Acacia mellifera* subsp. *detinens*. Tall Shrubs: *Lycium hirsutum* (d), *Rhigozum trichotomum* (d), *Grewia flava*, *Lycium villosum*, *Rhus burchellii*. Low Shrubs: *Acacia hebeclada* subsp. *hebeclada*, *Aptosimum albomarginatum*, *A. marlothii*, *Eriocephalus ericoides*, *Monechma divaricatum*, *M. incanum*. Geoxylic Suffrutex: *Elephantorrhiza elephantina*. Herbaceous Climber: *Momordica balsamina*. Graminoids: *Aristida meridionalis* (d), *A. stipitata* subsp. *spicata* (d), *Cenchrus ciliaris* (d), *Eragrostis lehmanniana* (d), *Aristida congesta*, *Eragrostis biflora*, *E. pallens*, *E. rigidior*, *Pogonarthria squarrosa*, *Schmidtia kalahariensis*, *S. pappophoroides*, *Stipagrostis ciliata*, *S. uniplumis*. Herbs: *Acanthosicyos naudinianus*, *Acrotome angustifolia*, *A. inflata*, *Dicoma schinzii*, *Geigeria ornativa*, *Helichrysum cerastioides*, *Hermannia tomentosa*, *Hermbstaedtia fleckii*, *H. linearis*, *Limeum arenicolum*, *L. fenestratum*, *L. viscosum*, *Lotononis platycarpa*, *Senna italica* subsp. *arachoides*, *Sericorema remotiflora*, *Tephrosia purpurea* subsp. *leptostachya*, *Tribulus terrestris*.

Biogeographically Important Taxa (Kalahari endemics) Small Tree: *Acacia luederitzii* var. *luederitzii*. Tall Shrub: *Acacia haematoxylon*. Graminoids: *Anthephora argentea*, *Megaloprotachne albescens*, *Panicum kalaharense*.

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Figure 9.81 SVk 11 Molopo Bushveld: Plains with *Terminalia sericea*, *Boscia albitrunca*, *Acacia erioloba*, *Grewia flava*, *Stipagrostis uniplumis* and *Tribulus zeyheri* subsp. *zeyheri* on Mahakane southwest of Pomfret, Vryburg District in the North-West Province.

Conservation Least threatened. Target 16%. Only 1% statutorily conserved in the Molopo Nature Reserve. More than 1% already transformed. In the Morokweng, Konke and Ewbank regions, intense utilisation has led to encroachment of *Geigeria ornativa*, *Tribulus terrestris* and *Acacia mellifera*, while much *A. erioloba* has been destroyed by fire-wood collection. Erosion is very low.

Remark An extensive unit with increasing diversity of savanna plant species towards the north and northeast.

Reference Smit (2000).

SVk 12 Kathu Bushveld

VT 16 Kalahari Thornveld and Shrub Bushveld (100%) (Acocks 1953). LR 30 Kalahari Plains Thorn Bushveld (86%) (Low & Rebelo 1996).

Distribution Northern Cape Province: Plains from Kathu and Dibeng in the south, through Hotazel, vicinity of Frylinckspan to the Botswana border roughly between Van Zylsrus and McCarthysrus. Altitude 960–1 300 m.

Vegetation & Landscape Features Medium-tall tree layer with *Acacia erioloba* in places, but mostly open and including *Boscia albitrunca* as the prominent trees. Shrub layer generally most important with, for example, *A. mellifera*, *Diospyros lycioides* and *Lycium hirsutum*. Grass layer is variable in cover.

Geology & Soils Aeolian red sand and surface calcrete, deep (>1.2 m) sandy soils of Hutton and Clovelly soil forms. Land types mainly Ah and Ae, with some Ag.

Climate Summer and autumn rainfall with very dry winters. MAP about 220–380 mm. Frost frequent in winter. Mean monthly maximum and minimum temperatures for Sishen 37.0°C and –2.2°C for December and July, respectively. See also climate diagram for SVk 12 Kathu Bushveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Acacia mellifera* subsp. *detinens* (d), *Boscia albitrunca* (d), *Terminalia sericea*. Tall Shrubs: *Diospyros lycioides* subsp. *lycioides* (d), *Dichrostachys cinerea*, *Grewia flava*, *Gymnosporia buxifolia*, *Rhigozum brevispinosum*. Low Shrubs: *Aptosimum decumbens*, *Grewia retinervis*, *Nolletia arenosa*, *Sida cordifolia*, *Tragia dioica*. Graminoids: *Aristida meridionalis* (d), *Brachiaria nigropedata* (d), *Centropodia glauca* (d), *Eragrostis lehmanniana* (d), *Schmidtia pappophoroides* (d), *Stipagrostis ciliata* (d), *Aristida congesta*, *Eragrostis biflora*, *E. chloromelas*, *E. heteromera*, *E. pallens*, *Melinis repens*, *Schmidtia kalahariensis*, *Stipagrostis uniplumis*, *Tragus berteronianus*. Herbs: *Acrotome inflata*, *Erlangea misera*, *Gisekia africana*, *Heliotropium ciliatum*, *Hermbstaedtia fleckii*, *H. odorata*, *Limeum fenestratum*, *L. viscosum*, *Lotononis platycarpa*, *Senna italica* subsp. *arachoides*, *Tribulus terrestris*.

Biogeographically Important Taxa (Kalahari endemics) Small Tree: *Acacia luederitzii* var. *luederitzii*. Graminoids: *Anthephora argentea*, *Megaloprotachne albescens*, *Panicum kalaharense*. Herb: *Neuradopsis bechuanensis*.

Conservation Least threatened. Target 16%. None conserved in statutory conservation areas. More than 1% already transformed, including the iron ore mining locality at Sishen, one of the biggest open-cast mines in the world. Erosion is very low.

Remark One of the most strikingly dominant areas of fairly tall *Acacia erioloba* is centred on the town of Kathu, which was built around many of these trees.

Reference Smit (2000).

SVk 13 Olifantshoek Plains Thornveld

VT 17 Kalahari Thornveld invaded by Karoo (49%), VT 16 Kalahari Thornveld and Shrub Bushveld (48%) (Acocks 1953). LR 31 Kalahari Mountain Bushveld (62%) (Low & Rebelo 1996).

Distribution Northern Cape Province: Plains including most of the pediment areas of the Korannaberg, Langeberg and Asbestos Mountains as well as those of some ridges to the west of the Langeberg. From the vicinity of Sonstraal in the north, past Olifantshoek to areas north of Niekerkshoop between Volop and Griekwastad in the south. Also from Griekwastad northwards to the flats west of the Lime Acres area. Altitude 1 000–1 500 m.

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Figure 9.82 SVk 12 Kathu Bushveld: Open savanna dominated by *Acacia erioloba*, *A. mellifera* and *Grewia flava* with low cover of *Stipagrostis ciliata* against the red sand east of Oupos, in the Kuruman District north of Kathu.

Vegetation & Landscape Features A very wide and diverse unit on plains with usually open tree and shrub layers with, for example, *Acacia luederitzii*, *Boscia albitrunca* and *Rhus tenuinervis* and with a usually sparse grass layer.

Geology & Soils Red aeolian sand of Tertiary to Recent age (Kalahari Group) with silcrete and calcrete and some andesitic and basaltic lava of the Griqualand West Supergroup. Hutton soil forms, deeper than 1.2 m, on the overwhelmingly dominant Ae and to a far lesser extent Ah land types.

Climate Summer and autumn rainfall with very dry winters. MAP about 200–350 mm in the east. Frost frequent in winter. See also climate diagram for SVk 13 Olifantshoek Plains Thornveld.

Important Taxa Tall Tree: *Acacia erioloba*. Small Trees: *Boscia albitrunca* (d), *Acacia mellifera* subsp. *detinens*, *Terminalia sericea*. Tall Shrubs: *Lessertia*

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Figure 9.83 SVk 13 Olifantshoek Plains Thornveld: Very open shrubland with *Boscia albitrunca*, *Acacia luderitzii*, *Schmidtia pappophoroides* and *S. kalahariensis* in the western part of this unit.

frutescens, *Lycium hirsutum*, *Rhigozum obovatum*, *Rhus tridactyla, Tarchonanthus camphoratus.* Low Shrubs: *Aptosimum procumbens*, *Grewia retinervis*, *Hoffmannseggia burchellii*, *Lycium pilifolium*, *Solanum tomentosum*. Succulent Shrubs: *Lycium cinereum*, *Talinum caffrum*. Graminoids: *Schmidtia pappophoroides* (d), *Stipagrostis uniplumis* (d), *Aristida congesta*, *Brachiaria serrata*, *Digitaria eriantha* subsp. *eriantha*, *Melinis repens*. Herbs: *Acanthosicyos naudinianus*, *Gisekia pharnacioides*, *Hermannia tomentosa*, *Ipomoea magnusiana*, *Oxygonum delagoense*, *Pollichia campestris*, *Tephrosia purpurea* subsp. *leptostachya*. Succulent Herb: *Piaranthus decipiens.* Geoxylic Suffrutex: *Elephantorrhiza elephantina*.

Biogeographically Important Taxa ([GW]Griqualand West endemic, [K]Kalahari endemic) Small Tree: *Acacia luederitzii* var. *luederitzii*[K] (d). Tall Shrub: *Lebeckia macrantha*[GW]. Low Shrubs: *Hermannia burchellii*[K], *Justicia puberula*[GW], *Putterlickia saxatilis*[GW], *Tarchonanthus obovatus*[GW]. Graminoid: *Anthephora argentea*[K]. Herb: *Sutera griquensis*[GW].

Endemic Taxon Low Shrub: *Amphiglossa tecta*.

Conservation Least threatened. Target 16%. Only 0.3% statutorily conserved in the Witsand Nature Reserve. Only about 1% of the area has been transformed and erosion is very low.

Reference Smit (2000).

SVk 14 Postmasburg Thornveld

VT 17 Kalahari Thornveld invaded by Karoo (57%) (Acocks 1953). LR 31 Kalahari Mountain Bushveld (64%) (Low & Rebelo 1996).

Distribution Northern Cape Province: Limited area around Postmasburg along the short valley of the Groenwaterspruit to the northeast and southwest, west to Bermolli and around Heuningkrans. Altitude 1 180–1 440 m.

Vegetation & Landscape Features Flats surrounded by mountains supporting open, shrubby thornveld characterised by a dense shrub layer and often lacking a tree layer; the grass layer is very sparse. Shrubs are generally low and with a karroid affinity.

Geology & Soils Red aeolian sand of the Kalahari Group overlying the volcanics and sediments of the Griqualand West Supergroup that outcrop in places. Deep soils are of the Hutton form. Dominant land type Ag.

Climate Summer and autumn rainfall with very dry winters. MAP about 250–350 mm. Frost frequent in winter. See also climate diagram for SVk 14 Postmasburg Thornveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Acacia karroo* (d), *A. tortilis* subsp. *heteracantha* (d), *Rhus lancea* (d), *Ziziphus mucronata* (d). Tall Shrubs: *Rhus tridactyla* (d), *Diospyros lycioides* subsp. *lycioides*, *Ehretia rigida* subsp. *rigida*, *Grewia flava*, *Tarchonanthus camphoratus*. Low Shrubs: *Acacia hebeclada* subsp. *hebeclada* (d), *Felicia muricata*, *Gomphocarpus fruticosus* subsp. *fruticosus*, *Lantana rugosa*, *Melolobium microphyllum*, *Sutera halimifolia*. Succulent Shrubs: *Kalanchoe rotundifolia*, *Lycium cinereum*. Graminoids: *Digitaria eriantha* subsp. *eriantha* (d), *Enneapogon scoparius* (d), *Eragrostis lehmanniana* (d), *Aristida adscensionis*, *A. congesta*, *A. diffusa*, *Eragrostis superba*, *Heteropogon contortus*, *Melinis repens*, *Schmidtia pappophoroides*, *Stipagrostis uniplumis*. Herbs: *Dicoma anomala*, *Geigeria filifolia*, *G. ornativa*, *Hibiscus pusillus*, *Jamesbrittenia aurantiaca*, *Selago densiflora*, *Tripteris aghillana*. Geophytic Herb: *Boophone disticha*.

Biogeographically Important Taxa (Griqualand West endemics) Succulent Shrub: *Euphorbia bergii*. Graminoid: *Digitaria polyphylla*.

Conservation Least threatened. Target 16%. None of the unit is conserved in statutory conservation areas, but very little has been transformed. Erosion is very low.

Remark In contrast to eastern parts of the unit, *Tarchonanthus camphoratus* is conspicuously absent in the western parts.

Reference Smit (2000).

SVk 15 Koranna-Langeberg Mountain Bushveld

VT 16 Kalahari Thornveld and Shrub Bushveld (91%) (Acocks 1953). LR 31 Kalahari Mountain Bushveld (67%) (Low & Rebelo 1996).

Distribution Northern Cape Province: From the Tswalu Kalahari Reserve at the northern tip of the Korannaberg southwards in the form of multiple ridges to the Langeberg west of Olifantshoek and southwards along the Langeberg and some parallel ridges, to ridges in the vicinity of Volop. Also some ridges to the west of the Langeberg. Altitude 1 000–1 836 m at highest point.

Vegetation & Landscape Features Rugged mountains and steep slopes in parts of the Korannaberg but with few cliffs in the Langeberg to the south. Generally supporting open shrubland with moderately open grass cover. *Croton gratissimus* common in places, becoming particularly diminutive south of the Langeberg.

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Figure 9.84 SVk 15 Koranna-Langeberg Mountain Bushveld: Shrubland on rocky slope with *Croton gratissimus* and *Tarchonanthus camphoratus* shrubs close to Olifantshoek, Northern Cape Province.

Geology & Soils The geology of the Korannaberg and Langeberg Mountains consists of quartzite, greywacke and lenses of hematite of the Olifantshoek Supergroup (Mokolian Erathem). The soils consist of very rocky, shallow sands. Land types mainly Ic, with some Ae.

Climate Summer and autumn rainfall with very dry winters. MAP about 180–380 mm. Frost frequent in winter. See also climate diagram for SVk 15 Koranna-Langeberg Mountain Bushveld.

Important Taxa Small Trees: *Acacia mellifera* subsp. *detinens* (d), *Boscia albitrunca*, *Ficus cordata*, *Maytenus undata*. Tall Shrubs: *Ehretia rigida* subsp. *rigida*, *Euclea undulata*, *Grewia flava*, *Hibiscus micranthus*, *Rhigozum obovatum*, *Rhus burchellii*, *Tarchonanthus camphoratus*, *Tephrosia longipes*. Low Shrubs: *Croton gratissimus* (d), *Artemisia afra*, *Felicia muricata*, *Indigofera poliotes*, *Jamesbrittenia albiflora*, *Leucas capensis*, *Lophiocarpus polystachyus*, *Melhania prostrata*, *Nolletia arenosa*, *Pegolettia retrofracta*, *Psiadia punctulata*. Succulent Shrubs: *Aloe hereroensis* var. *hereroensis*, *Euphorbia avasmontana*, *E. rectirama*. Semiparasitic Shrub: *Thesium hystrix*. Woody Climber: *Putterlickia pyracantha*. Woody Succulent Climber: *Sarcostemma viminale* (d). Graminoids: *Aristida diffusa* (d), *Eragrostis curvula* (d), *Brachiaria nigropedata*, *Cenchrus ciliaris*, *Digitaria eriantha* subsp. *eriantha*, *Heteropogon contortus*, *Stipagrostis uniplumis*. Herb: *Ceratotheca triloba*. Geophytic Herbs: *Boophone disticha*, *Cheilanthes hirta*, *Pellaea calomelanos*, *Sansevieria aethiopica*.

Biogeographically Important Taxa (Griqualand West endemics) Low Shrub: *Justicia puberula*. Graminoid: *Digitaria polyphylla*.

Conservation Least threatened. Target 16%. None conserved in statutory conservation areas but partly conserved in private reserves such as the Tswalu Kalahari Reserve. Virtually none of the area is transformed. Erosion is very low.

Remark This unit forms the first, almost unbroken, mountain barrier to the east of the Kalahari on the Gordonia plains.

References Smit (2000), Van Wyk & Smith (2001).

SVk 16 Gordonia Plains Shrubland

VT 16 Kalahari Thornveld and Shrub Bushveld (100%) (Acocks 1953). LR 28 Shrubby Kalahari Dune Bushveld (81%) (Low & Rebelo 1996).

Distribution Northern Cape Province: Broad north-south band on flats west of the Korannaberg and Langeberg Mountains (and of their western pediment) and east of the main Kalahari duneveld area (for example at Pearson's Hunt). From Van Zylsrus in the north to southwest of Witsand in the south. Also as a number of isolated patches embedded in the duneveld area between the Auob and Nossob Rivers in the Kgalagadi Transfrontier Park as well as the valley containing Groot and Klein Mier south of the park. Altitude 900–1 250 m.

Vegetation & Landscape Features Plains with open grassland with occasional shrubs *Rhigozum trichotomum* and *Grewia flava*, sometimes including *Acacia haematoxylon* and scattered individuals of *A. erioloba*. The area has virtually no dunes.

Geology & Soils Aeolian sand, underlain by calcrete of the Kalahari Group, deep, loose, sandy soils of the Namib soil form on the flat plains. Land types mainly Ah and Af with a little Ae.

Climate Summer and autumn rainfall with very dry winters. MAP about 180–280 mm. Frost frequent in winter. See also climate diagram for SVk 16 Gordonia Plains Shrubland.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Tree: *Acacia mellifera* subsp. *detinens*. Tall Shrubs: *Grewia flava* (d), *Rhigozum trichotomum* (d). Low Shrubs: *Jatropha erythro-*

M.C. Rutherford

Figure 9.85 SVk 16 Gordonia Plains Shrubland: Open shrubland dominated by *Rhigozum trichotomum* and *Aristida meridionalis* with a solitary *Acacia haematoxylon* tree on Goedemoed between Olifantshoek and Upington.

poda, *Plinthus sericeus*, *Requienia sphaerosperma*. Geoxylic Suffrutex: *Elephantorrhiza elephantina*. Semiparasitic Shrub: *Thesium lineatum*. Herbaceous Climber: *Merremia tridentata*. Graminoids: *Aristida meridionalis* (d), *Centropodia glauca* (d), *Eragrostis lehmanniana* (d), *Schmidtia kalahariensis* (d), *Brachiaria glomerata*, *Bulbostylis hispidula*, *Eragrostis pallens*, *Stipagrostis uniplumis*. Herbs: *Acanthosicyos naudinianus*, *Cucumis africanus*, *Dicoma capensis*, *Harpagophytum procumbens* subsp. *procumbens*, *Heliotropium ciliatum*, *Hermannia tomentosa*, *Ipomoea hackeliana*, *Limeum argute-carinatum*, *Oxygonum dregeanum* subsp. *canescens* var. *canescens*, *Senna italica* subsp. *arachoides*, *Sericorema remotiflora*.

Biogeographically Important Taxa (Kalahari endemics) Tall Shrub: *Acacia haematoxylon*. Low Shrub: *Hermannia burchellii*. Graminoid: *Anthephora argentea*.

Conservation Least threatened. Target 16%. Some 9% statutorily conserved in the Kgalagadi Transfrontier Park. Very little of the area is transformed and erosion is very low.

References Leistner (1967), Leistner & Werger (1973), Werger & Leistner (1975), Werger (1978b), Lubbinge (1998).

Kalahari Duneveld

SVkd 1 Gordonia Duneveld

VT 16 Kalahari Thornveld and Shrub Bushveld (91%) (Acocks 1953). LR 28 Shrubby Kalahari Dune Bushveld (65%) (Low & Rebelo 1996).

Distribution Northern Cape Province: Areas with dunes comprising the largest part of the South African side of the Kgalagadi Transfrontier Park. South of the Molopo River border with Botswana (west of Van Zylsrus), interleaving with NKb 5 Kalahari Karroid Shrubland in the west (south of Rietfontein to the Orange River area) and in the south (around Upington and north of Groblershoop). Also occurs as a number of loose dune cordons south of the Orange River near Keimoes and between Upington and Putsonderwater. Eastern boundary is found at the longitude of Pearson's Hunt, but with outliers near Niekerkshoop in the southeast and Floradora in the northeast. Altitude 800–1 200 m.

D. Mucina

Figure 9.86 SVkd 1 Gordonia Duneveld: Sparse dune shrubland with *Acacia haematoxylon* (the silvery bush on the slopes) and *Stipagrostis amabilis* (the grass on the dune ridge) in the valley of the Auob River in the Kgalagadi Transfrontier Park.

Vegetation & Landscape Features Parallel dunes about 3–8 m above the plains. Open shrubland with ridges of grassland dominated by *Stipagrostis amabilis* on the dune crests and *Acacia haematoxylon* on the dune slopes, also with *A. mellifera* on lower slopes and *Rhigozum trichotomum* in the interdune straaten.

Geology & Soils Aeolian sand underlain by superficial silcretes and calcretes of the Cenozoic Kalahari Group. Fixed parallel sand dunes, with Af land type almost exclusively.

Climate Summer and autumn rainfall with very dry winters. MAP about 120–260 mm. Frost fairly frequent to frequent in winter. Mean monthly maximum and minimum temperatures for Vrouenspan 41.5°C and –4.0°C for December and July, respectively. See also climate diagram for SVkd 1 Gordonia Duneveld.

Important Taxa Small Tree: *Acacia mellifera* subsp. *detinens* (d). Tall Shrubs: *Grewia flava* (d), *Rhigozum trichotomum* (d). Low Shrubs: *Aptosimum albomarginatum*, *Monechma incanum*, *Requienia sphaerosperma*. Succulent Shrubs: *Lycium bosciifolium*, *L. pumilum*, *Talinum caffrum*. Graminoids: *Schmidtia kalahariensis* (d), *Brachiaria glomerata*, *Bulbostylis hispidula*, *Centropodia glauca*, *Eragrostis lehmanniana*, *Stipagrostis ciliata*, *S. obtusa*, *S. uniplumis*. Herbs: *Hermbstaedtia fleckii* (d), *Acanthosicyos naudinianus*, *Hermannia tomentosa*, *Limeum arenicolum*, *L. argute-carinatum*, *Oxygonum dregeanum* subsp. *canescens* var. *canescens*, *Sericorema remotiflora*, *Sesamum triphyllum*, *Tribulus zeyheri*.

Biogeographically Important Taxa (Kalahari endemics) Tall Shrub: *Acacia haematoxylon* (d). Graminoids: *Stipagrostis amabilis* (d), *Anthephora argentea*, *Megaloprotachne albescens*. Herbs: *Helichrysum arenicola*, *Kohautia ramosissima*, *Neuradopsis austro-africana*.

Conservation Least threatened. Target 16%. Some 14% statutorily conserved in the Kgalagadi Transfrontier Park. Very little transformed. Generally low erosion, but some areas with spectacular destabilisation of normally vegetated dunes (through local overstocking) favoured by photographers. Erosion is normally very low.

Remarks The unit extends into Namibia to a large extent (Leistner 1967) and very little into Botswana. Only degenerates into semimobile dunes, where heavily disturbed through intense grazing pressure.

References Leistner (1967), Bothma & De Graaff (1973), Leistner & Werger (1973), Werger & Leistner (1975), Werger (1978b), Skarpe (1986), Lubbinge (1998).

SVkd 2 Gordonia Kameeldoring Bushveld

VT 16 Kalahari Thornveld and Shrub Bushveld (100%) (Acocks 1953). LR 28 Shrubby Kalahari Dune Bushveld (82%) (Low & Rebelo 1996).

Distribution Northern Cape Province: Duneveld along the northern side of the Auob River from Mata Mata to about Gemsbokplein, and western side of the Nossob River from about Kaspersdraai to St John's Dam in the Kgalagadi Transfrontier Park. A few isolated occurrences between the Auob and Nossob

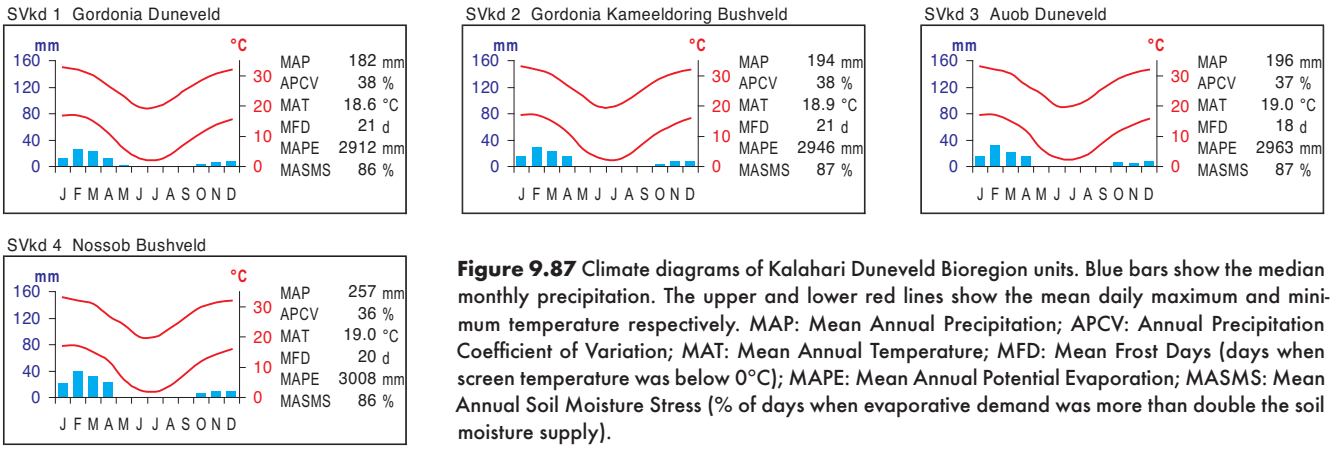

Figure 9.87 Climate diagrams of Kalahari Duneveld Bioregion units. Blue bars show the median monthly precipitation. The upper and lower red lines show the mean daily maximum and minimum temperature respectively. MAP: Mean Annual Precipitation; APCV: Annual Precipitation Coefficient of Variation; MAT: Mean Annual Temperature; MFD: Mean Frost Days (days when screen temperature was below 0°C); MAPE: Mean Annual Potential Evaporation; MASMS: Mean Annual Soil Moisture Stress (% of days when evaporative demand was more than double the soil moisture supply).

Rivers such as around Seven Pans. Also found in marginal area south of the Kuruman River near Eensaam Kasteel. Altitude 920–1 040 m.

Vegetation & Landscape Features On the dune slopes and dune straaten with well-developed tree layer, dominated by *Acacia erioloba* and *Boscia albitrunca* and shrub layer with *A. haematoxylon*, *A. mellifera* and *Rhigozum trichotomum*. Grass layer is very scanty.

Geology & Soils Aeolian undulating sand dunes underlain by calcrete, deep, loose, sandy soil of the Namib soil form. Land type Af.

Climate Summer and autumn rainfall with very dry winters. MAP about 150–250 mm. Frost fairly frequent to frequent in winter. Mean monthly maximum and minimum temperatures for Mata Mata are 40.0°C and –6.8°C for December and June, respectively. See also climate diagram for SVkd 2 Gordonia Kameeldoring Bushveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Acacia mellifera* subsp. *detinens* (d), *Boscia albitrunca* (d). Tall Shrubs: *Rhigozum trichotomum* (d), *Ehretia rigida* subsp. *rigida*, *Grewia flava*, *Lycium villosum*, *Rhus tenuinervis*. Low Shrubs: *Aptosimum albomarginatum*, *Jatropha erythropoda*, *Plinthus sericeus*, *Requienia sphaerosperma*. Graminoids: *Aristida meridionalis* (d), *Centropodia glauca* (d), *Eragrostis lehmanniana* (d), *Schmidtia kalahariensis* (d), *Stipagrostis ciliata* (d), *Brachiaria glomerata*, *Stipagrostis obtusa*, *S. uniplumis*. Herbs: *Acanthosicyos naudinianus*, *Hermannia tomentosa*, *Limeum arenicolum*, *Senna italica* subsp. *arachoides*, *Tribulus zeyheri*.

Biogeographically Important Taxa (Kalahari endemics) Tall Shrub: *Acacia haematoxylon* (d). Succulent Herbs: *Orbea knobelii*, *Tridentea marientalensis* subsp. *marientalensis*.

Conservation Least threatened. Target 16%. Some 38% statutorily conserved in the Kgalagadi Transfrontier Park. Very little transformed and showing generally little surface erosion.

References Leistner (1967), Leistner & Werger (1973), Werger & Leistner (1975), Lubbinge (1998).

SVkd 3 Auob Duneveld

VT 16 Kalahari Thornveld and Shrub Bushveld (100%) (Acocks 1953). LR 28 Shrubby Kalahari Dune Bushveld (99%) (Low & Rebelo 1996).

Distribution Northern Cape Province: Belt of duneveld south of the Auob River from Mata Mata to Twee Rivieren within the Kgalagadi Transfrontier Park as well as in the northern Mier area. Found also in the area between the Auob and Nossob Rivers near their confluence as well as small areas around the confluences of the Nossob, Molopo and Kuruman Rivers. Altitude 880–1 040 m.

M.C. Rutherford

Figure 9.88 SVkd 2 Gordonia Kameeldoring Bushveld: Interdune sandy area dominated by *Acacia erioloba* and, in the foreground, *Rhigozum trichotomum* between Nu-Quap and Craig Lockhardt about 5 km from the bed of the Auob River in the Kgalagadi Transfrontier Park, Northern Cape Province.

Vegetation & Landscape Features Open shrubland with low shrub layer dominated by *Acacia haematoxylon*, *A. mellifera* and *Rhigozum trichotomum*. Trees of *A. erioloba* and *Boscia albitrunca* are widely scattered and grass layer is scanty.

Geology & Soils Deep aeolian sand forming undulating dunes, with outcrops of calcrete, Namib soil form. Shallow soils on calcrete outcrops often with Clovelly soil form. Land type Af.

Climate Summer and autumn rainfall with very dry winters. MAP about 150–250 mm. Frost fairly frequent to frequent

M.C. Rutherford

Figure 9.89 SVkd 3 Auob Duneveld: Open shrubland with *Boscia albitrunca* and *Stipagrotis amabilis* in the foreground on the crest of a dune near Kielie Krankie, Kgalagadi Transfrontier Park, Northern Cape.

in winter. Mean monthly maximum and minimum temperatures for Twee Rivieren 40.6°C and –6.0°C for December and July, respectively. See also climate diagram for SVkd 3 Auob Duneveld.

Important Taxa Tall Tree: *Acacia erioloba*. Small Trees: *Acacia mellifera* subsp. *detinens* (d), *Boscia albitrunca*. Tall Shrubs: *Rhigozum trichotomum* (d), *Grewia flava*. Low Shrub: *Requienia sphaerosperma*. Graminoids: *Schmidtia kalahariensis* (d), *Stipagrostis ciliata* (d), *S. uniplumis* (d), *Brachiaria glomerata*, *Bulbostylis hispidula*, *Centropodia glauca*, *Eragrostis trichophora*. Herbs: *Acanthosicyos naudinianus*, *Acrotome angustifolia*, *Hermannia tomentosa*, *Limeum arenicolum*, *Sesamum triphyllum*.

Biogeographically Important Taxa (Kalahari endemics) Tall Shrub: *Acacia haematoxylon* (d). Low Shrub: *Hermannia burchellii*. Graminoid: *Stipagrostis amabilis* (d).

Conservation Least threatened. Target 16%. Some 57% statutorily conserved in the Kgalagadi Transfrontier Park. Erosion is very low.

References Leistner (1967), Leistner & Werger (1973), Werger & Leistner (1975), Lubbinge (1998).

SVkd 4 Nossob Bushveld

VT 16 Kalahari Thornveld and Shrub Bushveld (95%) (Acocks 1953). LR 27 Thorny Kalahari Dune Bushveld (83%) (Low & Rebelo 1996).

Distribution Northern Cape Province: Strip of duneveld west of the Nossob River from Nossob Camp area to Union's End as well as some patches (for example in the vicinity of the waterpoint of Dankbaar) in the far northern parts of the Kgalagadi Transfrontier Park. Altitude 980–1 120 m.

Vegetation & Landscape Features Open bushveld on plains, with relatively tall (for the southern Kalahari) tree layer with *Acacia erioloba*, *A. luederitzii* and *Boscia albitrunca* and grass layer with higher cover than towards the south.

Geology & Soils Aeolian sand of the Kalahari forming undulating dunes. Soil of the Namib soil form. Dominant land type Af.

Climate Summer and autumn rainfall with very dry winters. MAP about 200–300 mm. Frost fairly frequent to frequent in winter. Mean monthly maximum and minimum temperatures for Nossob Rest Camp 39.9°C and –6.2°C for December and July, respectively. See also climate diagram for SVkd 4 Nossob Bushveld.

Important Taxa Tall Tree: *Acacia erioloba* (d). Small Trees: *Boscia albitrunca* (d), *Acacia mellifera* subsp. *detinens*. Tall Shrubs: *Grewia flava*, *Rhus tenuinervis*. Low Shrub: *Plinthus sericeus*. Graminoids: *Schmidtia kalahariensis* (d), *Stipagrostis uniplumis* (d), *Centropodia glauca*, *Eragrostis biflora*. Herbs: *Hermbstaedtia fleckii* (d), *Acanthosicyos naudinianus*, *Pollichia campestris*.

Biogeographically Important Taxa ([K]Kalahari endemic, [D]Southwestern distribution limit in South Africa) Small Trees: *Acacia luederitzii* var. *luederitzii*[K] (d), *Albizia anthelmintica*[D]. Herb: *Neuradopsis austro-africana*[K].

Conservation Least threatened. Target 16%. All of the unit is statutorily conserved in the Kgalagadi Transfrontier Park and remains virtually untransformed. Erosion is very low.

Remark This is the southernmost part of the unit, which is more widely distributed in the neighbouring Botswana and Namibia.

References Leistner & Werger (1973), Werger & Leistner (1975), Van Rooyen et al. (1990), Lubbinge (1998).

M.C. Rutherford

Figure 9.90 SVkd 4 Nossob Bushveld: *Albizia anthelmintica* trees with *Acacia mellifera* shrubs on a large dune between Union's End and Gharagab in the Kgalagadi Transfrontier Park, Northern Cape.

8. Credits

Most of the introductory sections were written by M.C. Rutherford (sections 1, 2.1 (main part), 3.2, 3.3, 4, 5 & 6), with 2.2 by R.A. Ward, 2.3 by F. Ellis, 3.1 by L. Scott and the climate systems part of 2.1 by L. Mucina.

The mapping concepts within the Kalahari bioregions (SVk and SVkd) are based on original mapping by J.H.L. Smit, J.-W. Lubbinge and N. van Rooyen. The detailed legend of the original map was simplified by M.C. Rutherford and L. Mucina after consultation with G.J. Bredenkamp, J.H.L. Smit and H. Bezuidenhout. The southernmost parts of the units within SVk were mapped by M.C. Rutherford, L. Mucina, H. Bezuidenhout and P.J. du Preez.

The areas of the Central Bushveld, Mopane and Lowveld Bioregions were originally mapped for the project by G.J. Bredenkamp, assisted by W.H. de Frey and R.A.J. Robesson (both GIS) using concepts of G.J. Bredenkamp. Later, some of the original concepts in Mpumalanga, southern parts of Limpopo Province, Gauteng and eastern North-West Province were modified by M.C. Lötter (assisted by J.E. Burrows and S. Williamson). These changes included introduction of new units (SVcb 6 (with D.B. Hoare), 12, 14, 16, 25, 26 & SVl 7 & 13). Other new units that were introduced were SVcb 10 by D.B. Hoare, SVcb 22 by M.C. Rutherford and L. Mucina (with shape and position supplied by E. van Wyk), SVcb 24 by P.J.D. Winter and SVl 7 by M.C. Rutherford, L. Mucina and P.J.D. Winter. The sand vegetation of the northern lowveld was split into SVl 1 & 2 by L. Mucina, M.C. Lötter and M.C. Rutherford. The boundaries of most of the earlier mapped units were substantially revised (but with relatively little change to the remaining eight units, namely SVcb 5, 8, 9, 21, 23, SVmp 4, SVl 4 & SVl 15) by M.C. Lötter in many areas as well as by D.B. Hoare in Gauteng, M.C. Rutherford, especially in North-West and Limpopo Provinces, and R.J. Scholes on the Blouberg in Limpopo Province. In the Mopane Bioregion, all units, except SVmp 4, were subdivided and boundaries revised by F. Siebert & M.C. Rutherford.

The current mapping concepts covering the eastern areas of the Lowveld are rooted in Gertenbach's (1983b) 'landscapes', which have been simplified for the purpose of our map by M.C. Rutherford, L. Mucina, M.C. Lötter and F. Siebert, also in consultation with N. Zambatis and H.C. Eckhardt (both who provided the original GIS coverage of Gertenbach's landscapes and discussed the conceptual issues regarding the mapping units). The savanna mapping units of Swaziland were originally derived from an unpublished map of Swaziland by L. Dobson after reconciling the units with those across the border with South Africa. This reconciliation as well as the modification of the boundaries of these entities was done by M.C. Lötter, M.C. Rutherford and L. Mucina. The savanna units recognised for KwaZulu-Natal are the result of co-operation between K.G.T. Camp, R.G. Bennett (GIS), L. Mucina, M.C. Rutherford, C.R. Scott-Shaw, P.S. Goodman, C. Oellermann (GIS) and W.S. Matthews (in Maputaland). The boundaries were derived from the original BRGs (and lower units as defined in the map of Camp (1999a, b, c, d, e), after a series of fusions and some splitting of the original Camp's BRGs. An unpublished map by Smith (2001) was put at our disposal by Ezemvelo KZN Wildlife and was used in part for the spatial definition of some units in Maputaland. The coverage of some subescarpment (SVs) units in the Eastern Cape comes from an original contribution of D.B. Hoare, modified by M.C. Rutherford and L. Mucina, also based on information from Vlok & Euston-Brown (2002).

All Geographical Information Systems (GIS) changes on the map not specifically attributed by name above were made by L.W. Powrie. He also collated and managed all GIS changes to the map.

M.C. Rutherford contributed the descriptions of SVcb 2, 5, 9 & SVl 6 (all with G.J. Bredenkamp), SVcb 4 (with G.J. Bredenkamp and L. Mucina), of SVcb 17 & 19 (both with G.J. Bredenkamp and B.J. Henning), of SVcb 18, 20 & 23 (all with G.J. Bredenkamp and T.H. Mostert), of SVl 1 (with L. Mucina and G.J. Bredenkamp), SVl 3 (with G.J. Bredenkamp and C.E. Venter), SVl 8 & 9 (with M.C. Lötter and J.E. Burrows), SVk 7, 10, 12, 15, 16 & SVkd 1 (all with J.H.L. Smit).

M.C. Lötter contributed the descriptions of SVcb 1, 3 & 12 (all with T.H. Mostert, G.J. Bredenkamp and M.C. Rutherford), of SVcb 6, 13 & 14 (all with M.C. Rutherford), of SVcb 15 (with M.C. Rutherford, G.J. Bredenkamp and B.J. Henning), of SVcb 16 (with M.C. Rutherford, L. Mucina and G.J. Bredenkamp), of SVcb 25 & SVl 7 (both with M.C. Rutherford and J.E. Burrows), of SVcb 26 (with M.C. Rutherford, J.E. Burrows and P.J.D. Winter), of SVl 5 (with M.C. Rutherford, G.J. Bredenkamp, C.E. Venter and F. Siebert), of SVl 10, 11 & 12 (all with M.C. Rutherford, J.E. Burrows and E. Schmidt), of SVl 13 (with S. Williamson and M.C. Rutherford) and of SVl 4 & 14 (with M.C. Rutherford, G.J. Bredenkamp and C.E. Venter).

L. Mucina contributed the descriptions of SVcb 22 (with M.C. Rutherford and P.J.H. Hurter), of SVl 2 (with M.C. Lötter and M.C. Rutherford), of SVl 15 (with M.C. Rutherford), of SVl 16 (with W.S. Matthews, M.C. Lötter, J.E. Burrows, E. Schmidt, C.R. Scott-Shaw and M.C. Rutherford), of SVl 17 (with M.C. Rutherford and C.R. Scott-Shaw), of SVl 18 (with W.S. Matthews and M.C. Rutherford), of SVl 22 & 23 (both with C.R. Scott-Shaw and M.C. Rutherford), of SVl 24 (with C.R. Scott-Shaw), of SVs 1–3 (with K.G.T. Camp and M.C. Rutherford), of SVs 4 (with K.G.T. Camp, D.B. Hoare and M.C. Rutherford) and SVs 6 (with D.B. Hoare, K.G.T. Camp and M.C. Rutherford).

J.H.L. Smit contributed the descriptions of SVk 1–4 (with G.J. Bredenkamp and M.C. Rutherford), and of SVk 8, 9, 11, 13, 14 & SVkd 2 & 3 (all with M.C. Rutherford). F. Siebert contributed the descriptions of SVmp 1–8 (all with M.C. Rutherford). P.S. Goodman contributed the descriptions of SVl 19–21 (with M.C. Rutherford). D.B. Hoare contributed the descriptions of SVs 7 and SVcb 7 (with M.C. Rutherford) and SVcb 10. T.H. Mostert contributed the descriptions of SVcb 8 (with G.J. Bredenkamp and M.C. Rutherford), of SVcb 21 (with M.C. Rutherford and G.J. Bredenkamp). S.J. Siebert contributed the descriptions of SVcb 27 & 28 (both with F. Siebert, M.C. Lötter and M.C. Rutherford). G.J. Bredenkamp contributed the description of SVcb 11 (with M.C. Rutherford). P.J.D. Winter contributed the description of SVcb 24 (with M.C. Rutherford). C.R. Scott-Shaw contributed the description of SVs 5 (with L. Mucina and M.C. Rutherford). H. Bezuidenhout contributed the description of SVk 6. P.J. du Preez contributed the description of SVk 5 (with L. Mucina and M.C. Rutherford).

Assignment of growth forms of species listed was done by L. Mucina. Most references were sourced by M.C. Rutherford and L. Mucina.

M. Rouget, and others within the Directorate of Biodiversity Programmes, Policy & Planning of SANBI, provided quantitative information for each vegetation unit on conservation status and targets, areas currently conserved and areas transformed. Data for the climate diagrams of each vegetation unit were taken or derived from the work of R.E. Schulze.

The photographs were contributed mainly by M.C. Rutherford, L. Mucina, H.C. Eckhardt, M.C. Lötter and L.W. Powrie, with other contributions from W.L. McCleland, the late J.P.H. Acocks,

F. Bronkhorst, R. de la Harpe, B. Forbes, H.F. Glen, D.B. Hoare, W.S. Matthews, D. Mucina, P.C. Rutherford, C.R. Scott-Shaw, P.S. Goodman and E. van Wyk.

The concept (content and presentation) of climate diagrams was derived by M.C. Rutherford and all diagrams were prepared by L.W. Powrie based on information from Schulze (1997a).

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Other data sources used are given in the general acknowledgements in the introduction chapter of this book.

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