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Biogeography of Platberg, Eastern Free State, South Africa: Links with Afromontane Regions and South African Biomes

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1. Introduction

This chapter comprises a vegetation analysis of Platberg, eastern Free State, South Africa (Figure 1). Platberg is an inselberg which has high botanical diversity, with associated species richness, and high numbers of endemic taxa only found at high altitudes over 2 000 m.a.s.l. indicative of montain flora.

Inselbergs are one of the most striking and persistent landform types in Africa (Goudie 1996) and are defined as an isolated hill, knob, koppie or small mountain, which stands alone and rises abruptly, island-like, from the surrounding terrain (Sarthou & Villiers 1998). In the eastern Free State, South Africa, rising abruptly from the flat terrain of the Karoo sediments, are a series of more than 20 prominent inselbergs all over 2000 m high. These flat-topped, steep-sided inselbergs stretch north from the Qwa-Qwa scarp, which constitutes the northern endpoint of the Maluti-Drakensberg. Geologically, these inselbergs are an extension of the Maluti Drakensberg, and occur along a line prescribed by the Great Escarpment (King 1963) at 1800 m. They form a discrete island-like archipelago stretching over 200 km, connecting the main Lesotho-Maluti-Drakensberg with the Mpumalanga-Drakensberg, and the Highveld Mountains to the north.

Inselbergs are formed from igneous or sedimentary rocks, capped by more resistant strata. The remnants of the resistant igneous capping form the distinct flat-topped mesas, buttes or table mountains. Platberg (Figure 2) and all the other inselbergs are the structurally controlled remnants of such weathering processes (King 1963; Moon & Dardis 1992). As prominent landscape features, geomorhologically they are formed by extensive subsurface decay along joints. The subsequently loosened material is removed by water, wind and gravity, with thawing and freezing assisting the process (Moon & Dardis 1992). The accompanying erosional detritus, rocks, boulders and gravel, form the steep slopes to the inselbergs, which are slowly buried in the rock debris (Figure 3). It is the packing of this weathered material, which provides the numerous ecological niches for the development of biodiverse plant communities characterised by inselbergs (Sarthou & Villiers 1998).

The unique, high altitude conditions found above 2 000 m, lead to high levels of endemism in organisms; bryophytes, plants and animals (Hillard & Burtt 1987; Van Wyk & Smith 2001; Carbutt & Edwards 2006; Mucina & Rutherford 2006). This is due to the compression of climatic life zones over a short distance that makes mountains hot spots for biological diversity (Körner 2003). Inselbergs may be regarded as analogous with an archipelago of islands in an 'ocean' of low-level vegetation types which act as an isolation factor (Taylor 1996; MacArthur & Wilson 2001).

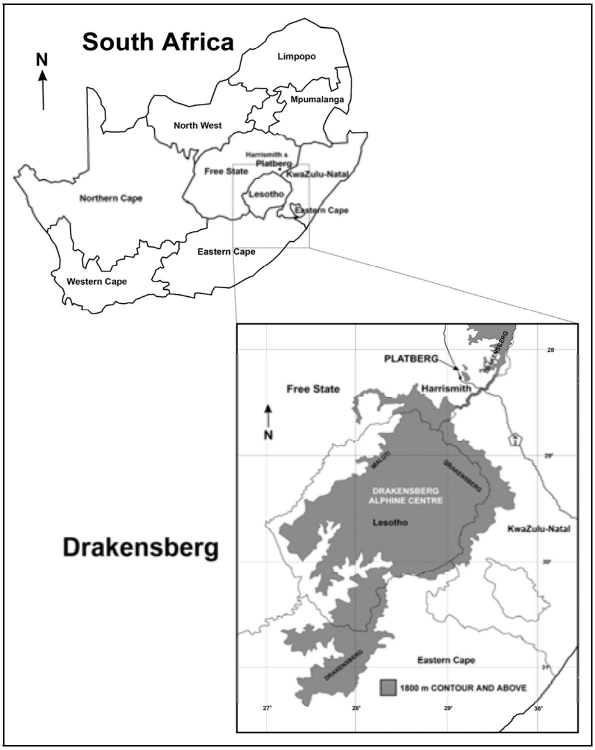

Fig. 1. Platberg, Eastern Free State, South Africa (Brand 2008).

This in turn precludes plant species with less mobile seed dispersal mechanisms from propagating over wide ranges, and allows for high levels of endemism to develop (Taylor 1996). High levels of endemism mean that a large proportion of the available gene pool is unique to that site, and inselbergs and mountains therefore have an important role to play in the maintenance of genetic diversity (Taylor 1996; Mucina & Rutherford 2006).
Inselbergs are differentiated from their surroundings by harsher edaphic and microclimatic conditions (Porembski & Barthlott 1995), consequently they host distinctive species, forming unique phytosociological associations, which differ from the lowland vegetation matrix in which they are embedded (Porembski & Brown 1995; Porembski et al., 1996, 1997, 1998; Sarthou & Villiers 1998; Parmentier et al., 2006). The vegetation map of Mucina & Rutherford (2006) shows Platberg as an inselberg embedded in the lowland grassland but also as a high altitude vegetation unit designated as the Gd 8 Lesotho Highland Basalt Grassland, part of the Drakensberg Grasslands predominantly associated with the broader Drakensberg Alpine Centre (DAC). Prior to this study no field data was available to prove this hypothesis. These studies provides empirical data on a detailed vegetation level that

shows strong floristic and plant community similarities with Gd 8 Lesotho Highland Basalt Grassland, and demonstrates Platberg is an extension of the same phytochoria as the DAC.

Fig. 2. The contact between the dark dolerite cap and the lighter sandstone is a distinct feature of Platberg.

Fig. 3. Mobile boulder beds on Platberg provide habitat for species and vegetation unique to inselbergs and the Afromontane region.

1.1 African phytochoria and species richness

The phytochoria of Africa have been formally classified by White (1983), who defined eighteen major phytochoria for Africa. The two phytochoria of interest for this work as are the *Afromontane* archipelago-like regional centre of endemism (VIII), and embedded within the *Afromontane* phytochoria is the *Afroalpine* archipelago-like centre of extreme floristic impoverishment (IX). The basis of White's work was to produce a vegetation map for Africa, using two criteria: the physiognomy of the most extensive vegetation type, and floristic composition. This produced a useful, broad scale map of regional biodiversity, but did not have the resolution to show species richness on the local or community level.

A map showing continental wide African sites of high biodiversity using both the taxon-based approach and the geographical or inventory-based approach are presented by Mutke et al., (2001). This Global Information System (GIS) approach to map African phytodiversity shows good correlation with climatic, edaphic and biotic parameters for African phytodiversity for the Drakensburg/Natal Area – analogous to White's *Afromontane* archipelago-like regional centre of endemism. This study has improved on White's broad scale map, but being a desktop study still does not provide detailed information of species richness on the local community scale.

Regional mapping of the biodiversity by Van Wyk and Smith (2001) and Mucina & Rutherford (2006) provides a more detailed pattern of plant diversity, which correlates well with the geological map of the African land surface (White 1983; Hillard & Burtt 1987). The South African Drakensberg is shown within this archipelago-like regional endemic centre, which Hillard & Burtt (1987) called the *Eastern Mountain Region* (EMR), first used by Phillips in 1917 (Carbutt & Edwards 2004).

The use of the EMR has not been followed as it shows a broader, topographically less well-differentiated area and is a loose correlation with the more precise geographical/ topographical designation of the Drakensberg Alpine Centre (DAC) (Van Wyk & Smith 2001). However, what Hillard & Burtt (1987) where alluding to, in using the term 'EMR', was to differentiate the Drakensberg and surrounding high altitude areas from the rest of the continental wide *Afromontane* region due to its unique and rich floristic composition. Biogeographically, the DAC and Platberg also show relatively strong floristic affinities with the Cape Floristic Region (Linder 2003; Carbutt & Edwards 2004, 2006) or the Fynbos Biome as defined by Mucina & Rutherford (2006). Other biogeographical links are shared with Nama-Karoo Biome found in the drier interior of the sub-continent and further north the sub tropical African and Eurasian flora (Mutke et al., 2001). It is within this broader Afromontane biogeographical context, including being one of an 'island-like' archipelago of inselbergs that Platberg's biological diversity is considered.

2. Methods

The field-derived data was analysed using phytosociological principles. The statistical analysis of vegetation and environmental data, which underpins phytosociology, provides a measure for biodiversity that is incorporated in the concepts of species richness and evenness or relative abundance. A total of 393 relevés where analysed for the entire Platberg. The scope of the study was to sample vegetation plots above the 1 800 m contour in order to work within the limits set by Killick (1978a) who regarded the region in the Drakensberg above the 1 800 m as a distinct floristic region - the Afroalpine Region. The topography of the plain in which Platberg is situated, is relatively flat, rising abruptly at the 1 900 m contour, this being the start of the footslopes, which was used as the lower limit set for sampling.

Additionally, the PRECIS (National Herbarium Pretoria **[PRE]** **C**omputer **I**nformation **S**ystem) data from the South African National Biodiversity Institute (SANBI), Pretoria, was used to compare species with the Platberg data. The PRECIS list is compiled from field collections and plotted on a grid square frame with each grid covering 30 x 30 km². Even though the PRECIS data covers the same grid square as Platberg, it is mostly flatland under 1 800 m lower than the footslopes of Platberg which start at 1 900 m. The comparison was done to reveal correlations and connections, which exist with Platberg and the vegetation of the lower lying regions, in which the vegetation of Platberg is embedded. The disadvantage of the PRECIS list is that very few of the common species are normally recorded which will result in there being a lower number of species per hectare.

3. Results

The vegetation on Platberg is dominated by grasses and shows an intergrade of floristic associations and habitat features in common with several other major vegetation types of the Grassland, Fynbos, Afrotemperate Forest and Nana-Karoo Biomes. Fynbos as well as succulents, particularly Mesembryanthemaceae from the Nama-Karoo Biome grow on Platberg. These floristic elements also extend to the DAC. Woody shrubs and forest remnants grow in the specalised ecological niches in sheltered gullies, boulder beds and rocky terrain. Numerous wetlands occur, forming distinct hygrophilous communities. Geophytes and forbs add significantly to the biodiversity of all vegetation types and grow in all habitats. Only two Gymnosperms occur, the indigenous, forest emergent tree *Podocarpus latifolius*, and the exotic *Pinus patula*, established in timber plantations at lower altitudes, which have now invaded and are replacing the indigenous vegetation on the cool southern slopes. Pterdophyte diversity is relatively low, comprising a total of 16 species, 10 genera and 8 families. Ferns are widespread and occur throughout all habitats, on all aspects – hot northern, cool southern and at all altitudes. Three of the ferns, *Dryopteris dracomontana, Mohria rigida* and *Polystichum dracomontanum* are endemic to the DAC. All but one species (*Pellaea calomelanos*) occur at altitude throughout the Afromontane region. The exotic bracken, *Pteridium aquilinum* occurs on the lower footslopes with *Searsia pyroides* subsp *gracilis*. The prostrate fern, *Selaginella caffrorum* is a mat forming species, which forms unique communities that contribute to inselberg vegetation structure. *Selaginella* communities are found on open, sheet rock on Platberg, Korannaberg, Thaba Nchu and other inselbergs as well in the DAC. *Afrotrilepis pilosa* mats occurring on granite inselbergs of west Africa are physiognomic equivalents.

Of the 974 species, in the PRECIS database, collected in the 2828AC Harrismith grid, about 670 (68.8%) species occur on Platberg above 1 900m. The rest (31.2%) occur on the surrounding lowlands. The 670 species found on Platberg were correlated with DAC species lists of Van Zinderen Bakker (1973), Killick (1963, 1978a, 1979b), Hill (1996), Low & Rebelo (1996), Carbutt & Edwards (2004, 2006), Hoare & Bredenkamp (2001), (Moffett 2001), Smith & Van Wyk (2001) and Mucina & Rutherford (2006). A strong genus level correlation of over 80% was found between Platberg and the DAC, which includes exotic angiosperm taxa such as *Pinus, Acacia,* Bidens, Tagetes, etc. (Carbutt & Edwards 2004).

Of the 670 species recorded on Platberg, several species are new records for the Free State and represent range extensions, or have only been collected once before (Brand et al., 2010). One of these species *Struthiola angustiloba*, a rare KwaZulu-Natal species was collected on Platberg. Two Asteraceae species also collected on Platberg, *Helichrysum harveyanum* and *H. truncatum* are Northwest/Gauteng and Mpumalanga endemics, giving new range extensions of 400-500 km south to Platberg. These new range extensions are not totally unexpected, given that mountain chains act as routes of migration (Körner 2003) and with similar altitude and ecological conditions, distance is not a critical factor (400-500 km), but similarity in live zones determines speciation, rarity and endemism (Körner 2003).

Of the 670 vascular plants recorded on Platberg, there are 305 genera in 96 families (Table 1). Of these 27 are endemic or near-endemic species also found in the Drakensberg Alpine Centre

(DAC). Only 22 alien plants occur of which most are annual Dicotyledons (Brand et al., 2010), which is a good indicator of limited human influence on the vegetation of the Platberg plateau.

	Families	Genera	Species
Pteridophytes	8	10	16
Gymnosperms	2	2	2
Angiosperms	86	293	652
(Monocotyledons)	(23)	(104)	(214)
(Dicotyledons)	(63)	(189)	(438)
Totals	**96**	**305**	**670**

Table 1. Floristic composition for Platberg (Brand et al., 2010)

4. Affinities with other regions

Platberg shares many climatic, edaphic and biotic similarities with the Drakensburg Alpine Centre (DAC). Biogeographically and chorologically it falls within the DAC and shares many of the same plant species and endemic taxa (Brand et al., 2010). Biogeographical and botanically the DAC is seen as a transition zone, a migratory pathway and repository for taxa of diverse regions and biomes (Killick 1963, 1978a, 1978b, Hillard & Burtt 1987, Carbutt & Edwards 2004, Mucina & Rutherford 2006). The DAC has some 2800 species of vascular plants of which 929 are endemic or near-endemic angiosperms in an area of 40 000 km² (Carbutt & Edwards 2004, 2006). The Global Information System (GIS) approach of Mutke et al. (2001) correlates well with these figures, showing a plant species richness > 3000 species per 10 000 km².

The two largest plant families on Platberg are Asteraceae (40 genera, 126 species, comprising 18.8% of the flora), and Poaceae (39 genera, 73 species, 10.9% of the flora). This pattern of high diversity of Asteraceae is common to the DAC where it is represented by 65 genera and 430 species and 17% of the total flora (Carbutt & Edwards 2004). The pattern is the same for Poaceae where, in the DAC it is represented by 86 genera and 267 species and contributes 11% to the total species flora (Carbutt & Edwards 2004). The Grassland Biome with the DAC, Platberg in its centre, has provided idea habitat for the rapid spread of Asteraceae, as well as the development and radiation of grasses (Carbutt & Edwards 2004).

Floristic composition for Platberg and the DAC shows Asteraceae as the largest family (Brand et al., 2010). This trend is the same for the Cape flora, with significant correlation within the top 12–20 families (Goldblatt & Manning 2000). The second most specious family on Platberg is Poaceae (39 genera, 73 species, 10.9% of the flora) followed by Cyperaceae (18 genera, 39 species, 5.8% of total flora), which reflects a similar floral composition to the DAC (Carbutt & Edwards 2004, 2006; Mucina & Rutherford 2006). This trend with the same ranking for the top 3-10 families plus rations of floristic compositions is also found with the more grassy regions to the arid western interior and higher altitude, wetter northern areas of South Africa (Kooij et al., 1990; Du Preez & Bredenkamp 1991; Fuls 1993; Eckhardt et al. 1993, 1995; Malan 1998).

The ranking of Poaceae and Cyperaceae as the second and third richest families on Platberg and the DAC, which is in contrast to the Cape flora, where Poaceae and Cyperaceae are poorly represented with Restionaceae filling the environmental and floristic position of the Poaceae (Goldblatt & Manning 2000; Brand et al., 2010). For the Cape fynbos Fabaceae is the second largest family followed by Iridaceae, Aizoaceae, Ericaceae and Scrophulariaceae

(Goldblatt & Manning 2000). With the exception of Ericaceae, these families for significant floral structure and species composition represented in the top 7 families for Platberg and the DAC (Brand et al., 2010).

The fynbos vegetation elements found on Platberg and the DAC show close affinities with similar fynbos of the Cape Floral Region (CFR). These fynbos elements are characterised by *Passerina*, *Cliffortia, Metalasia* and *Muraltia* species which all exhibit narrow, but extensive ranges, located on depaupered soils of the Clarens Sandstone Formation. There are two distinct fynbos vegetation types found on Platberg and the DAC. They are described as the Gd 9 Drakensberg–Amathole Afromontane Fynbos, and the Gm 24 Northern Escarpment Afromontane Fynbos (Mucina & Rutherford 2006).

4.1 Vegetation composition and structure: Grasses and forbs using C_3, C_4 and CAM pathways

To understand how rising CO_2 levels with increased temperatures may affect plant species composition and vegetation structure, an analysis of plant communities using CAM, C_4 and C_3 metabolic pathways was done. At high temperatures C_4 outcompete C_3 plants (Retallack 2001), it would be predicted that high altitude vegetation using the C_3 pathway would show a reduction of range, an upward shift in distribution and a loss of species. Most of the grasses comprising the Grassland Biome occur at altitudes below 1 200 m and consequently use the C_4 pathway, while most montane grasses, trees and shrubs use the C_3 pathway. Asteraceae, also use the C_3 pathway while Wetland plants, ferns, Gymnosperms and succulents use Crassulacean Acid Metabolism (CAM). The analysis of the plant families on Platberg using C_3, C_4 and Crassulacean Acid Metabolism (CAM) are from Brand et al., (2010).

The phytosociological analysis for Platberg found 39 distinct plant communities (Brand et al., 2008, 2009, 2010) all of which contain a combination of Asteraceae Poaceae, and Cyperaceae. Only 7 plant communities are dominated by woody/shrubs and exclusively use the C_3 pathway. The remaining 32 that plant communities are structure by species using C_4 pathways, CAM or high altitude grasses which use the C_3 pathway. Excluding the woody/shrub communities 82% of the formally classified plant communities use C_3, C_4 or CAM pathways (Table 2).

Plant Family	Pathway	Gen. No.	Gen %	Spp. No	Species (%)
Asteraceae	most C_4/ C_3	40	13.1	126	18.8
Poaceae	mixed C_4 C_3	39	12.8	73	10.9
Cyperaceae	C_4	18	5.9	39	5.8
Crassulaceae	CAM	3	1.0	13	1.9
Caryophyllaceae	C_4	9	1.2	4	1.3
Euphorbiaceae	C_4	3	1.0	8	1.2
Brassicaceae	C_4	4	1.3	4	0.6
Amaranthaceae	C_4	2	0,7	5	0.7
Mesembryanthe-maceae	CAM	2	0.7	4	0.6
Chenopodiaceae	C_4	1	0.3	1	0.1
Restionaceae	C_4	1	0.3	1	0.1
Totals		**122**	**44.6%**	**278**	**42%**

Table 2. Platberg vegetation using C_3, C_4 or CAM pathways

On a species level, succulent families using CAM pathways total 278 species and 122 genera **(Table 1).** This accounts for 44.6% of the total genera and 42% of the total species found on Platberg.

4.2 Grass diversity

A total of 73 grass species where collected on Platberg with 29 species using C_3 metabolism, and 30 species using C_4 metabolism, the remaining 14 species use mixed C_3/C_4 metabolism (Figure 4). The C_3/C_4 split is almost equal however, an examination of grass community structure on Platberg shows grasses using C_4 metabolism dominate.

Only one grass *Helictotrichon longifolium* and the mountain bamboo *Thamnocalamus tessellatus*, uses C_3 metabolism, with *Digitaria monodactyla* and *Pennisetum sphacelatum* showing mixed C_3/C_4 metabolism, the majority of the communities and species show the use of C_4 metabolism, which represents 83% of the grass community structure on Platberg.

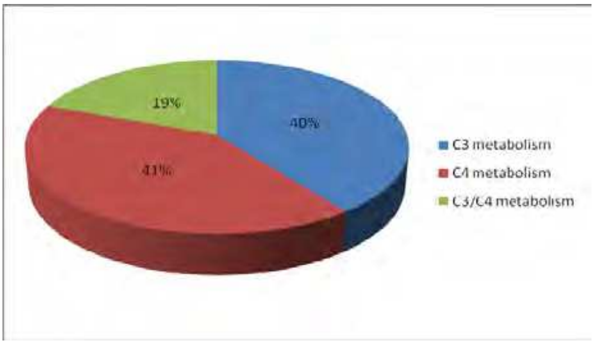

Fig. 4. Ratio of grass metabolic pathways on Platberg.

5. Discussion

5.1 Forest Biome affinities

The entire forest biome in South Africa is composed of a number of fragmented forest patches, either continuous as in the Southern Afrotemperate Forests of the Tsitsikamma region of the western Cape, fragmented Southern Mistbelt Forest for the Eastern Cape and Northern Afrotemperate Forests in the Drakensberg, or contiguous Northern Mistbelt mountain patches in Mpumalanga and Limpopo Provinces, or disjunct, scattered Northern Afrotemperate Forests growing in the Magaliesberg in the North Western Province (Von Maltitz 2003, Mucina & Rutherford 2006).

These relictual elements of the Afrotemperate Forests (von Maltitz 2003) are all regarded as depaupered or 'biogeographically' eroded as well as previously linked as recently as the Pleistocene > 2 My BP (Scott et al., 2003). Today they are fragmented and are found as refugia in inselbergs (Brand et al., 2009) or relictual scarp situations on elevated ranges (Von Maltitz 2003; Mucina & Rutherford 2006). Afrotemperate forests have also retreated into kloofs (narrow, incised canyons) or have lost numerous Afrotemperate species through episodes of climate change, encroachment by Grassland and Savanna Biomes, or reduction by fire and grazing. Fire in particular is important in shaping the modern appearance and distribution of the forest (Mucina & Rutherford 2006), patches of which are found below

Van Reenen's Pass 60km east of Platberg, Royal Natal National Park to the west and the main Drakensberg at Qwa-Qwa to the south (Figure 5).
The highest altitude Afrotemperate *Podocarpus* forest in South Africa grows on Nelsons Kop at 2 230 m (Von Maltitz 2003), an inselberg about 20 km northeast of Platberg, and as with the forest patch on Platberg, it is located on the cool south-eastern side, below the basalt on the Clarens Formation sandstones. Other Northern Afrotemperate Forest affinities are found to the south, in the Fynbos Biome, and the Savanna Biome mountains to the north (von Maltitz 2003; Mucina & Rutherford 2006).

Fig. 5. *Podocarpus* forest patches below the Clarens Formation sandstone confined to fire protected gullies of the Drakensberg and Great Escarpment.

5.2 Fynbos Biome affinities

Fynbos on Platberg occurs in 13 different communities, which can be grouped into two communities (Brand 2008). The sclerophyllous vegetation is characterised by *Passerina montana*, a fynbos taxa endemic to the Cape (Figure 6). These fynbos communities have a species richness varying between 14 – 54 species per 30 m², with an average of 28.34 species per 30 m². This is lower compared with the grassland vegetation, which has 11 – 54 per 30 m² with an average of 32 per 30 m², which gives a moderate species diversity index. A minimum 16 fynbos genera comprising 22 species occur on Platberg. The fynbos is located in two distinct habitats: the lower altitude zone at 2000 m growing on the mineral poor soils of the Cave Sandstone of the Clarens Formation, and the higher altitude zone at 2200 m on the rocky, basaltic, mineral rich rim of the plateau just below the exposed summit grassland (Brand et al., 2008).
Fynbos and the Gm 24 Northern Escarpment Afromontane Fynbos (Mucina & Rutherford 2006). This afromontane fynbos community is found on most of inselbergs including the Floristically, and structurally, the *Passerina montana* fynbos-like shrubland elements found on Platberg conform with the Gd 6 Drakensberg-Amathole Afromontane Korannaberg 200km west, and a similar altitude of 2000-2200 m in the Drakensberg. For Mucina & Rutherford (2006) it is structurally and floristically different from the other Afromontane fynbos species rich community found at higher altitudes and embedded in the Gd 8 Lesotho Highveld Basalt Grassland.

The Afromontane fynbos genera found on Platberg are Passerina, Cliffortia, Erica, Euryops, Helichrysum, Macowania, Metalasia, Muraltia, Pentaschistis, Ischyrolepis, Schoenoxiphium and Watsonia, all of which are endemic taxa typically found in the Cape Floristic Region (Goldblatt & Manning 2000).

The grass-like genus *Restio* is a major component of the Cape flora not found on Platberg or the broader Drakensberg, however, *Ischyrolepis schoenoides,* is found on Platberg and other inselbergs in the Free State (Du Preez & Bredenkamp 1991; Malan 1998) and could be regarded as an ecological equivalent for *Restio*, as its growth form and habitat is similar. Phylogenetically, these two genera are closely related (Haaksma & Linder 2000) and Germishuizen et al., (2006) lists *Restio schoenoides*, *Kunth* (1) as a synonym for *Ischyrolepis schoenoides* (Kunth) H.P. Linder (Brand et al. 2010). The remnants of fynbos vegetation on Platberg may be relicts from cooler periods when more extensive fynbos migrated over lower altitudes starting during the Late Pleistocene and evident up to the last Glacial Maximum (Scott et al., 1997).

Fig. 6. Fynbos *Passerina montana* shrub community on Clarens Sandstone on Platberg.

Pollen taken from sites at Clarens, a town in the semi-arid interior of the Free State, 200km west of Platberg, and the Rose Cave site, near Ladybrand, 500km to the west of Platberg, located at the extreme western footslopes of the DAC, show a similar pattern for fynbos genera *Protea* and *Cliffortia* which were more abundant and are typical of upland vegetation.

5.3 Nama-Karoo Biome affinities

Limited affinities are found with the Nana-Karoo flora on Platberg. These are mostly succulents from the Mesembryanthemaceae (2 genera, 4 species) and low shrubs, *Chrysocoms ciliata, Felicia filifolia, F. muricata* the most representative, found on the warm north and west sides of Platberg (Brand et al., 2010), and may represent previous climatic conditions of hotter, drier periods with less seasonal fluctuation (Scott 1988). Succulent evolution and distribution is not favoured by high rainfall and freezing temperatures extended over days (Smith et al., 1998; van Wyk & Smith 2001), which would be the environmental limiting factors responsible for the low numbers of succulents found at altitude (Körner 2003) on Platberg and DAC.

5.4 Grassland Biome affinities

Grasses, the family Poaceae, is the single most important plant family for humanity (Gibbs-Russell 1991). It is distributed over all seven continents and is the fifth largest plant family on earth and the second largest family for the DAC. Globally, Poaceae comprise some 770 genera and 9 700 species (Gibbs-Russell 1991). Southern Africa there are approximately 194 genera and 967 species of which 329 are endemic (Carbutt & Edwards 2004, 2006). For the Drakensberg Alpine Centre there are 86 genera and 267 species, of which 22 endemic or near-endemic genera comprising 39 endemic or near-endemic species (Carbutt & Edwards 2004, 2006). Grasses, particularly C_4 pathway users, are better than plant families in stripping and utilising CO_2 from the atmosphere. Grasses store the Carbon below ground in roots and soils (Retallack 2001), and with the Savanna Biome are enormous sinks for Carbon (Table 3).

Country/Region	Vegetation	Mean C (kg m $^{-2}$)
Tanzania:		
Serengeti	Tall grassland	51.4
Serengeti	Dry woodland	12.8
India:		
Uttar Pradesh	Terai grassland	23.5
Uttar Pradesh	Monsoon forest	3.9
U.S.A.:		
Iowa	Tall prairie	14.9
Illinois	Oak forest	8.2

Table 3. Mean Carbon (C) content in soils under Modern Grasslands and adjacent Woodlands (modified from Retallack 2001)

Platberg and the DAC are within the Grassland Biome, and as such are dominated by grasses. Grassland is a complex mix of graminoids, forbs and geophytes (Mucina & Rutherford 2006). Geophytes are abundant on Platberg, with Amaryllidaceae, Asphodelaceae, Hyacinthaceae, Hypoxidaceae and Iridaceae growing throughout the grassland, fynbos, woody/shrub and wetland communities. These geophyte families are also important fynbos components (Goldblatt & Manning 2000) and are prominent members in the Succulent and Nama Karoo Biomes (Van Wyk & Smith 2001; Pond et al., 2002; Mucina & Rutherford 2006).

On a regional scale, strong floristic affinities exist between Platberg and the Drakensberg grasslands to the south (Bester 1998), which includes Qwa-Qwa (Moffett 2001), the Golden Gate Highlands National Park (Roberts 1969; Kay et al., 1993), the central Cathedral Peak area, and southern Drakensberg (Killick 1963, 1978a, 1978b; Van Zinderen Bakker 1973; Hillard & Burtt 1987), the Stormberg and Eastern Cape Drakensberg (Hill 1996; Carbutt & Edwards 2004), as well as Korannaberg to the western interior of the Free State (Du Preez & Bredenkamp 1991; Du Preez et al., 1991).

The development of high biodiversity and species richness of Poaceae across the Grassland Biome has a number of explanations; these include a combination of weather (Mean Frost Days, and minimum daily temperature) and moisture availability (Mutke et al., 2001), soils, and the effects of fire and grazing (Seabloom & Richards 2003). Moisture availability is an important factor in determining species richness (Mutke et al., 2001) particularly for grasses, maximum growth occurs for up to four days after rain (Cavagnora 1988), which allows grasses to outcompete geophytes and forbs with similar morphology (Mucina & Rutherford 2006). The Drakensberg and Platberg have much higher precipitation than the surrounding areas 700-2400 mm (Mucina & Rutherford 2006), this provides for more moisture availability at higher, cooler altitudes. The lower regions of the Grassland Biome have lower rainfall 454 mm average (Mucina & Rutherford 2006), and are more humid. This moisture availability divides the grassland into high altitude Moist grassland dominated by species using C_3 metabolism and low, altitude Dry grassland dominated by species using C_4 metabolism.

Platberg on the cool southern and eastern sides in particular, provide in current times, a similar habitat and climatic conditions reminiscent of both Holocene and Pleistocene with the grassland on the plateau a mix of upland C_3 grasses form cooler times, mixed with C_4 grasses from corresponding warmer times (Scott & Vogel 2000). On Platberg, the predominance of C_4 grasses indicates that it falls within the core of the Grassland Biome, with a species composition similar to that dominated by C_4 grasses from the supertribe Andropogonodae which includes *Andropogon, Trachypogon, Heteropogon, Cymbopogon, Diheteropogon, Monocymbium, Tristachya, Schizachyrium, Themeda* and *Hyparrhenia* (Gibbs-Russell et al., 1991; Mucina & Rutherford 2006). The abundant C_3 grass *Helictotrichon longifolium*, found on the open plateau area of Platberg, would suggest a link with the predominant high altitude Drakensberg grasses dominated by C_3 grasses. The other abundant C_3 grass on Platberg is from the smallest of the five Grass subfamilies, Bambusoideae, the mountain bamboo *Thamnocalamus tessellatus*. On Platberg *Thamnocalamus tessellatus* forms dense stands, which grow on the cool, moist, sheltered south slopes of Platberg. These stands occur below the vertical cliffs at about 2000 m, and in some of the gullies which drain the seasonal streams as low as 1980 m (Brand et al., 2009). The *Thamnocalamus tessellatus* vegetation community is dominated by this monotypic, endemic genus, which is a species-poor community with limited presence of the low trees *Buddleja loricata, Searsia divaricata* and *Leucosidea sericea* (Brand et al., 2009). Shading out of competition and the dense rhizomatous, root system inhibits growth of other species.

In Africa, Bambusoideae are mainly tropical species confined to the humid forest shade where *Arundinaria alpina* grows in dense stands on mountains between 2 130 m and 3 200 m (White 1983). In South Africa *Thamnocalamus tessellatus* (previously named *Arundinaria tessellatus*) is confined predominantly at high altitudes of 2 700 m in the Stormberg and Drakensberg, but may be found as low as 1450 m (Pooley 2003) on the Ngeli inselberg in KwaZulu/Natal. Where it does occur in South Africa, *Thamnocalamus tessellatus* has a limited range, composed of disjunct populations – it only occurs again in the Himalayas (Pooley 2003).

The almost total dominance of C_4 grasses on Platberg is somewhat anomalous as it would have been predicted that for Platberg, with its relatively high altitude of 2 350 m with snow, frost and freezing temperatures, high rainfall between 700 – 1 200 mm per annum and close proximity to the Drakensberg, would be dominated or at least have a higher cover/abundance of C_3 grasses. However, despite the cold conditions on Platberg, its altitude may be below the limit for continuous cold for extended periods, and thus below the altitude at which C_3 grasses metabolic pathway predominates (Pitterman & Sage 2000; Sage 2001) as with the higher elevations at 3000 m for the Drakensberg (Hillard & Burtt 1987; Mucina & Rutherford 2006). The grassland structure and composition on Platberg may also be a reflection of palaeocological conditions, which started in the Miocene some 20 million years ago (Scott et al., 1997).

5.5 Wetland affinities

Wetlands form distinct and unique vegetation communities embedded in all eight Biomes in South Africa as well as through out the mountains and associated phytochoria of the Afromontane Region. Consequently, in South Africa, wetlands have been assigned the formal vegetation designation of Azonal units (Mucina & Rutherford 2006). Wetlands on Platberg are embedded in the grassland as playas or pans with semi-permanent, or permanent open water (Figure 7), which is the key factor that determines the common species shared by wetlands (Stock et al., 2004). A total of 13 naturally occupying, different wetland types where identified with 188 species including five alien (weeds) plants. The wetlands are not particularly species rich, with an average of 13.56 species per 30 m² (the lowest for all vegetation types), ranging from 7–29 species per sample plot. This is lower than found for other high altitude wetlands by Fuls (1993) and Malan (1998) who recorded 21 species per plot. Wetland vegetation is dominated by a single species or two to three species mostly hydrophilic grasses, sedges or juncales, which contributes to a low diversity index (Burgoyne et al., 2000). Sedge dominated wetlands occur on inselbergs in West Africa (Porembski & Brown 1995) and are a feature of most, if not all inselbergs (Parmentier et al., 2006). Very few species are endemic to high altitude wetlands, the majority also occurring in low altitude fresh water wetlands (Collins 2005). This inflates the total species richness in wetlands as numerous species will also occur in association with, but not exclusively to wetlands, the status of these species associated with wetlands (wetland indicator status), are classified into 5 categories. Due to the geology on Platberg; it is capped with lava, no vernal pools occur. Vernal pools are abundant on the lower altitude inselbergs (Korannaberg, Thaba Nchu and Thaba Patswa), in the arid interior and north of Platberg where the more resistant igneous capping has been lost and the softer sandstone exposed weathering to form vernal pools. Vernal pools are species poor with a low biodiversity, but contain Obligate Wetland, and Facultative wetland species with a high proportion of endemics (Du Preez & Bredenkamp 1991; Mucina & Rutherford 2006).

6. Phytogeographic comparison and biodiversity of Platberg

The concept of islands having high numbers of endemics (MacArthur & Wilson 2001) associated; generally with low species richness (Linden 2003) is typical of island fauna and flora as well as African mountain regions (Kingdom 1989). Platberg, as an inselberg 'island' does not fully reflect this association; it has high numbers of endemics, 27 (Brand et al., 2010), but has high species richness with a total of 670 taxa.
On a global scale the United Kingdom (Whales, Scotland, Northern Ireland and England), covers 312 000 km² (a surface area four-orders-of-magnitude larger than Platberg which is 30 km²) with a total vascular plant species count of approximately 1400 of which none are endemic (Preston et al., 2002). In comparison Platberg has 670 species with the 27 endemic. It is problematic trying to compare species richness (alpha-diversity), with turnover between habitats (beta-diversity) and turnover between floras from one landscape to another (gamma-diversity), (Cowling et al., 1992). Similarities in edaphic conditions must take into account and environmental differences minimised to be able to match the differences in habitat gradients (Cowling et al., 1992). For Platberg it is relatively easy to match alpha-diversity with sites elsewhere. However, this becomes more problematic with beta and gamma diversity as different researcher use different plot sizes for similar biomes. For grassland Perkins et al., (1999a) uses 25² m, for Platberg plot size is 30 m² while Eckhardt et al. (1993, 1995), Fuls (1993) and Kay (1993) use 100 m² plot sizes.

Fig. 7. High altitude freshwater wetlands embedded in grassland on Platberg summit plateau.

Phytogeographic comparison for the vegetation of Platberg and Korannaberg is shown in Table 5 (Brand et al., 2010). There is a high degree of similarity for the Angiosperm flora for Platberg and Korannaberg with the larger numbers for Korannaberg possibly the result of the much larger area, (MacArthur & Wilson 2001, Cowling et al., 2002), which, as surface area increases, more species can be supported (Linder 2003, Gröger & Barthlott 1996). The higher species numbers for Korannaberg could be due to its position, which has strong Afromontane, Nana Karoo and Savanna Biome floristic influences (Du Preez & Bredenkamp 1991, Du Preez et al. 1991).

Site	Families	Genera	Species	Area (km²)
Platberg this survey 2007	96	305	670	30.0
Korannaberg (Du Preez 1991)	115	385	767	129.52
Golden Gate National Park (Kay 1983)	N/A	N/A	566	47.9
Kammanasie Nature Reserve (Clever et al. 2005)	> 76	> 229	481	494.30
Bourke's Luck, Mpumalanga (Brown et al. 2005)	73	176	263	5.244

Table 5. A summary of Platberg and Korannaberg floras other sites, (modified from Brand et al., 2010)

However, climate and topography are only part of the explanation for high biodiversity and it is rather actual diversity of plant communities, which provides a measure of habitat diversity, (Cowling & Lombard 2002) and is a reflection of response to climate change (Scott et al., 1997; Mucina & Rutherford 2006).

For the Ivory Coast inselbergs, species composition was highest for Poaceae, then Cyperaceae, Scrophulariaceae and Lentibulariaceae. Species number and diversity were closely related to rainfall patterns for inselberg habitats (Porembski & Barthlott 1995). An examination of *Afrotrilepis pilosa* vegetation mats, shows the most species rich families are

Cyperaceae (3 species), Poaceae (2), Orchidaceae (2) and Rubiaceae (2) with a total of only 15 species found on 100 relevés. For the *Selaginella caffrorum* mats on Platberg Poaceae was the most species rich family (9), second was Asteraceae (8), Cyperaceae with 4 and Crassulaceae with 3 species with a total of 100 species in 4 relevés giving an average of 25 species. Geophytes are abundant (6) with none occurring on the *Afrotrilepis pilosa* mats and few occurring on the Ivory Coast inselbergs. The high geophytes numbers is a trend seen in the DAC and an influence from the geophyte rich Cape flora (Goldblatt & Manning 2001).

Porembski et al., (1996) found that on the vegetation of small size inselbergs in West African rain forests, 66 species of vascular plants occurred in 29 families, with the numbers showing good correlation with inselberg size. The largest Families are Poaceae, Cyperaceae, with Acanthaeceae, Commelinaceae and Malvaceae. Biogeographic affinities show species distribution widespread for Sudano-Zambezian elements, which are widespread for vegetation on inselbergs in the Comoé National Park in the Ivory Coast with Poaceae, Cyperaceae and Fabaceae comprising the most species rich families out of a total of 216 species found on 18 inselbergs (Porembski & Brown 1995); with most species found not being restricted to the inselbergs but in other habitats, savanna, marshes or waste ground.

Inselbergs host a comparatively high amount of endemic species, 86 on Venezuelan inselbergs (Gröger & Barthlot 1996). Endemic angiosperms in the Drakensberg number 410, on Platberg, endemics number 27, three of which are Pterdophytes (Brand et al., 2010). Additionally, Table 6 shows a comparison of the most abundant inselberg family level vegetation.

Platberg South Africa (Brand et al., 2010)	**Zimbabwe Inselbergs (Seine et al., 1998)**	**Ivory Coast Inselbergs Porembski et al., 1996)**	**Venezuela Inselbergs (Gröger & Barthlot 1996)**
1. Asteraceae 126	Poaceae 53	Poaceae 72	Cyperaceae 40
2. Poaceae 73	Cyperaceae 40	Cyperaceae 68	Rubiaceae 40
3. Cyperaceae 39	Fabaceae 40	Fabaceae 62	Melastomataceae 36
4. Fabaceae 33	Asteraceae 33	Scrophulariaceae 23	Orchidaceae 33
5. Scrophulariaceae 28	Scrophulariaceae 22	Rubiaceae 22	Poaceae 31
6. Hyacinthaceae 21	Euphorbiaceae 18	Orchidaceae 15	Bromeliaceae 20
7. Orchidaceae 16	Rubiaceae 18	Commelinaceae 14	Apocynaceae 18
8. Iridaceae 16	Lamiaceae 14	Lentibulaceae 14	Caesalpiniaceae 18
9. Geraniaceae 15	Adiantaceae 12	Caesalpiniaceae 13	Fabaceae 17
10. Crassulaceae 13	Acanthaceae 10	Euphorbiaceae 13	Euphorbiaceae 15

Table 6. A comparison of the 10 largest plant families for African and South American inselbergs (numbers represent species per family).

It is obvious that some families have better representation on inselbergs than others. An immediate difference is Poaceae, which is fifth largest for Venezuela while it is first for the Ivory Coast and Zimbabwe, and second for Platberg and the DAC (Brand et al., 2010), with other species rich families of Cyperaceae, Asteraceae, Fabaceae, Scrophulariaceae and Orchidaceae. The trend for Platberg species rich flora is comparable to the DAC (Brand et al., 2010). The floristic trends shown on these disparate sites, all show high abundance for

Asteraceae, Poaceae and Fabaceae which may represent the pattern of evolutionary radiation seen for these groups during the Eocene as well as associated ungulate grazers and predatory fauna (Retallack 2001). Cyperaceae is another important group, and its exploitation of environmental niches and evolution, may be parallel with Grasses, but may show a some-what different route. Cyperaceae are a widespread family, but generally have a lesser cover abundance throughout their range compared with grasses (Du Preez & Bredenkamp 1991; Kooij 1990; Perkins et al., 1999a; Bester 1998). Cyperaceae (like Poaceae) seems to have evolved C_4 photosynthetic pathways several times (Clayton 1975; Ferrier 2002; Stock et al., 2004) and even though they form components of grasslands and are commonly associated with wetlands and other seasonally moist areas, they also occur in arid regions (Gordon-Grey 1995; Jürgens 1997; Stock et al., 2004). Unlike Grasses (Gibbs-Russell et al., 1991) for Cyperaceae in southern Africa, no strong relationship is found such as altitude and rainfall (Stock et al., 2004). Their development may be less dependent on the mechanisms responsible for grass radiation, it may be that co-evolution of grasses and ungulates, climate change and CO_2 level changes, is a reflection of composition found in the DAC, Platberg and the inselbergs compared in Table 3, which show a general pattern for the top most specious families to include Asteraceae, Poaceae, Cyperaceae and Fabaceae.

For Venezuela inselberg flora, Asteraceae is significantly under represented which is a reflection of the South American regional flora, which occurs in high rainfall areas (Gröger & Barthlot 1996). This is the same trend shown for Ivory Coast inselbergs, moisture availability is the common environmental factor (Gröger & Barthlot 1996). Asteraceae is not well represented in west Africa, unlike East Africa where in Zimbabwe, the DAC and Platberg significant high levels of Asteraceae are found. This trend is representative of the Asteraceae for arid and semi-arid regions, including the CFR (Jürgens 1997; Linder 2003, Mucina & Rutherford 2006) where high levels of endemic species (63.2%) are found.

7. Factors influencing inselberg flora

7.1 Hybridisation

For the DAC, Hillard and Burtt (1987) list 21 hybrid taxa of which three (two *Senecio* crossed species and one *Cephalaria*) are exclusive to high altitude DAC records, and do not occur on Platberg, while the *Protea roupelliae* x *P. subvestita* cross has both species growing in the vicinity of Platberg. Of the remaining 17 hybrids it could be that some or all of them may occur on Platberg. This level of taxonomic expertise must wait for future detailed analysis. Hillard & Burtt (1987) do not offer an explanation for the occurrence of these 21-recorded hybrids (it is possible there are more). However, hybridisation breaks down species boundaries. Linden (2003) reports for the Cape flora, where species co-occur, such as *Moraea* hybrids, these are frequently found. This is the case also for *Romulea* with artificial hybrids cultivated for *Sparaxis, Watsonia* and *Ixia* of which *Watsonia* and *Morea* occur on Platberg (Linden 2003). Most of these Cape hybrids are sterile, however, hybridisation, sterile or not, is an environmental response to selection forces, which, in the case of Cape flora, limit gene flow (Linden 2003).

For the higher areas of the DAC, and Platberg as an inselberg, a degree of geographical isolation occurs which allows for edaphic and microclimatic, as well as larger, longer climatic and geological processes, to provide for geographical isolation of species (MacArthur & Wilson 2001; Porembski & Brown 1995; Gröger & Barthlott 1996; Linden 2003). This isolation has allowed for speciation and to quote from Linden (2003, page 623):

" … factors that allow (and drive?) speciation may be very similar to those that allow species to co-exist. These factors could be expected to include those that limit gene flow between sister species, as well as those that result in differential selection. Reproductive isolation is needed to prevent the ecological specialisation from being lost…."
This may offer a partial explanation for the high numbers of hybrids recorded, as well as the speciation and high numbers of endemics or near-endemics observed within the DAC and by extension, Platberg. Hybrids and rare species do not contribute to community patterns (beta-diversity), but are important for maintenance of biological diversity (Mutke et al. 2001; Cowling & Lombard 2002).

7.2 Pollination: Birds, insects and wind

7.2.1 Birds

For the central and southern Drakensberg, Hillard & Burtt (1987) have recorded bird pollination for *Protea, Kniphofia, Watsonia, Pelargonium schlecterii, Sutherlandea montana, Halleria lucida* and *Leonotis.* Most *Protea* species have a specalised feeding connection with Sugar birds *(Promerops* spp.) and Sunbirds (*Nectariania* species) detailed by Kingdom (1989) as well as the Cape Canary (*Serinus leucopterus*) and a beetle specialists which also feeds on Protea nectar. Except for *Protea*, all the other plant species occur on Platberg. This form of pollination, where a single pollinator will visit different, but close-by species with similar flower morphology and physiology, may also be responsible for the phytosociological associations of some plants. On Platberg, such community assemblage corresponds to the *Leonotis ocymifolia–Watsonia lepida* and *Halleria lucida* plant associations (Brand et al., 2009). Limited empirical research has been done to establish the connection between bird/plant community associations and is a subject for future investigation.

7.2.2 Insects

Hillard and Burtt (1987) have also described pollination by bees of highly specalised plants; Orchidaceae, and Scrophulariaceae. In the Fynbos Biome closely related plant species could have very different pollinators, with pollinator selection playing a central role in speciation and species richness (Linden 2003). Hillard & Burtt (1987) and Linden (2003) discuss the possible link between insect pollinators and floral guilds (phytosociological communities), with the possibility that such guilds are the results of insect/plant interaction and association.
Orchidaceae is a species rich family in the Cape flora and comprise 3.3% of the entire flora (Goldblatt & Manning 2000), 5.2% of the angiosperm DAC flora (Carbutt & Edwards 2004) and 2.7% of Platberg flora. Many orchid species are unique to select habitats. It may be that the process of pollination as well as pollinator selection (Hillard & Burtt 1987, Linden 2003) may play a significant part in accounting for the high numbers of Orchidaceae found in the Cape flora, on the Drakensberg and at Platberg.

7.2.3 Wind

On Platberg, Asteraceae has the greatest numbers of genera and species, however grasses are the most dominant plant group with Cyperaceae the third most abundant. Wind dispersal is an important mechanism of pollination for grasses (Gibbs-Russell 1991) and for sedges (Gordon-Grey 1995). Wind pollination is also important for *Cliffortia* and *Anthospermum* fynbos species (Hillard & Burtt 1987), both of which are abundant on

Platberg as well as the DAC. This long-distance dispersal by wind allows for crossing mountain valleys, from one isolated peak or inselberg to another.

Pollination by wind allows for gene flow between disparate areas (Cowling & Lombard 2002), which have different geology, soils, moisture availability and climate (Burke 2001, 2002; Linder 2003). The effects of wind to influences floristic composition and species richness over long distances and connect different regions is seen on the granite inselbergs in West African (Porembski et al., 1996), Namibian (Burke 2001), and Mulanje (Burrows & Willis 2005), basalt lavas of Platberg (Brand et al., 2010), the Drakensberg (Mucina & Rutherford 2006), and quartzite of the Cape Fold Mountains (Linden 2002).

8. Conclusion

Platberg is a centre of significant biological diversity, with high species richness, vegetation and ecosystem complexity and a centre of genetic diversity and variation. It occurs as an island in the Grassland 'sea' and shares inselberg floral richness and endemism which can be tracked via the Afromontane archipelago-like string of inselbergs and mountains which stretch north through the Chimanimani Mountains, into Malawi, the East African Arc of Mountains via Tanzania and north through Ethiopia into Eurasia. It also shows a western tract via the Congo, Ivory Coast and Cameroon inselbergs and mountains.

The current vegetation patterns on Platberg reflect changes in palaeo-environmental cycles of cooling and warming which, since Miocene times have had the greatest influence on the texture and composition of plants and speciation on Platberg. Floristically and choriologically, Platberg has a grass composition showing transition between C_3 high altitude grasses and C_4 grasses, the latter favouring hotter temperatures, lower altitude and lower rainfall. It also has a significant composition of plant families using CAM, C_3, C_4 and metabolism. This floristic composition is shared by the DAC. Current trends towards climate change will alter the composition and species numbers of grasses as well as other plant families, which use these metabolic pathways.

Floristic and compositional connections extend up the Great Escarpment via a series of inselbergs as well along sheltered gullies into the Lebombo Mountains, and west via the Magaliesberg (Figure 8). Affinities are also shown in the Chimanimani Mountains, with attenuation in the Mulanje Massif and Nyika Plateau. Floristic connections are also shared with other inselbergs in west and central Africa and show extension along the Afro montane mountain region.

Climate changes have directly influenced the evolution, structure and composition of the vegetation of southern Africa, the main driving force possibly being orbital (Croll/Milankovitch) cycles (Kutzbach 1976; Bennett 1999; Muller & MacDonald 1999; Linder 2003). The most significant, relatively recent changes started in the Palaeocene (65 million years BP) with the Gondwana break-up. This started a cycle of erosion and uplift of the interior of southern Africa. Cycles of glaciations and interglaciation, cool wet, hot dry periods, influenced the environment and forced high speciation (Bennett 1999), still evident in the high species richness exhibited today in the flora of the DAC, Platberg and the Cape flora. At the start of the Quaternary (2.4 million years BP) the DAC and Cape Flora were much as they are today, but showed range extensions and contractions due to the longer, cooler, wetter 100 000 year glaciations, and the shorter, hotter, drier 10 000 year interglaciation periods.

Fire and the grazing by herbivores also helped shape the vegetation, with the greatest influence on the Grassland Biome. These cumulative effects, geological processes, climate

change, CO_2 level fluctuations, fire and grazing are all responsible for the present day species richness and diversity recorded on Platberg and its parent vegetation of the Drakensberg. The Grassland Biome in South Africa is second largest of all eight Biomes (354 593.501 km²) after the Savanna Biome (412 544.091 km², Mucina & Rutherford 2006), with both Biomes providing an enormous sink for Carbon as well as climate amelioration.
Between 30–55% of the Grassland biome has already been transformed with only 5.5% protection. Grassland is under significant threat of continual transformation, the most severe is ploughing, which disrupts the soil and releases not only moisture, but also nutrients and Carbon (Mucina & Rutherford 2006).

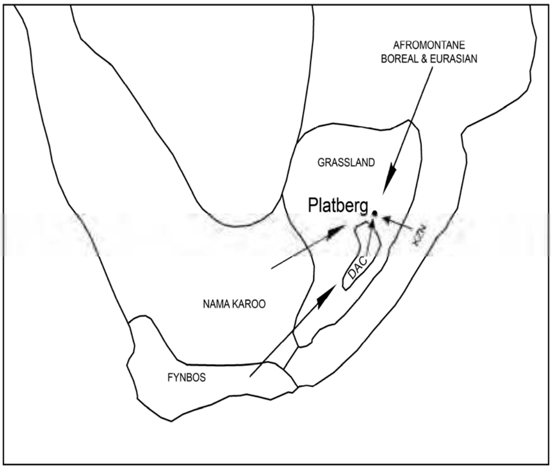

Fig. 8. Platberg showing tracks of the major floristic influences (modified from Rutherford & Westfall 1994).

Undisturbed grassland provides a significant Carbon sink, and should thus be given priority status for conservation, which should include both the above ground and belowground grass and soil ecosystems (Retallack 2001).
Historically in South Africa, areas for conservation were not selected primarily for ecological reasons until the mid 1970's (and then only in the Cape), but were rather based on other criteria, such as national strategically protection of the watershed around dams; fragmented forest areas to protect the water sources higher up in the mountains, or politically determined boundaries such as the Kruger National Park. It was only between 1971 and 1982 in the Cape, that a few wilderness areas were established for scientific research in natural ecosystems, aesthetic values they engendered and physical and spiritual opportunities they afforded (Rebelo 1992). Biogeographical considerations such as fynbos being 'islands' surrounded by forest were used as well as critical plant population size and habitat. These parameters plus total land surface were selected in determining conservation areas. It was found that for mountain areas, the minimum statuary size for reserves should be at least 10 000 ha (Rebelo 1992). Human population growth and increased urbanisation are seen as two major threats to natural ecosystems, with the implications for conservation of the effects of unrestricted human population growth being considered (Rebelo 1992; Ferrier 2002).

The scale of human impact on the biogeographical distribution of plants and animals will only continue to grow globally, but specifically in Africa, with the continued existence of many plant and animal species more dependant on human social, rather than on physical environmental factors (Meadows 1996; Anderson et al., 2001; Mutke et al., 2001). The African landscape, in particular East Africa, has had a long history of influence by humans, i.e. the Savanna and Grassland Biomes (Meadows 1996). Globally, and in the context of the use of resources and climate change in Africa, the human species now exerts an influence on all other species of organism, which in its scale and intensity is critical in the future evolution of the African flora and fauna (Kingdom 1989; Meadows 1996; Anderson 2001; Mucina & Rutherford 2006).
The conservation value of Platberg is significant: is a link between high altitude C_3 grasses and lowland C_4 grasses. It is also the best-preserved continuous high altitude grassland within the Grassland Biome and has escaped agricultural activity which giving the site a unique status, and leaves enormous scope for future research (Smith & Young 1987). Platberg is an excellent natural history laboratory, which connects the present day environment with geological, palaeo-environmental and evolutionary processes from modern Holocene to Jurassic times (Scott et al.1997; Anderson 2001; Linder 2003; Mucina & Rutherford 2006).

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Snow on Platberg, Figure 4. Kind permission of Theunis Bekker.
Figure 8, Wetlands on Platberg is courtesy of Nacelle Collins.

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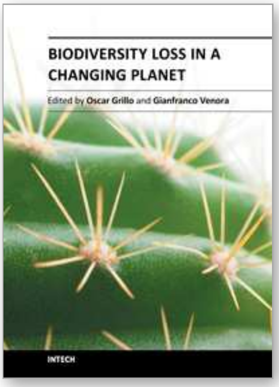

Biodiversity Loss in a Changing Planet

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Every ecosystem is a complex organization of carefully mixed life forms; a dynamic and particularly sensible system. Consequently, their progressive decline may accelerate climate change and vice versa, influencing flora and fauna composition and distribution, resulting in the loss of biodiversity. Climate changes effects are the principal topics of this volume. Written by internationally renowned contributors, Biodiversity loss in a changing planet offers attractive study cases focused on biodiversity evaluations and provisions in several different ecosystems, analysing the current life condition of many life forms, and covering very different biogeographic zones of the planet.