Grasses on the Melville Koppies

The 160 hectares of the Melville Koppies are home to 54 documented species of indigenous grass. Despite their small size, the Koppies have a number of microclimates, and offer a range of habitats where different grass communities flourish. This short introduction is an attempt to place grasses in their evolutionary and ecological context in relation to the Koppies.

Family Poaceae

Grasses are flowering plants belonging to the family Poaceae in the division Angiospermae of the Kingdom Plantae. It is the fifth largest family of angiosperms.

The first flowering plants appear in the fossil record about 140 million years ago (Ma), but they developed abundantly in the late Cretaceous (100—65 Ma). Their sudden proliferation was regarded as a ‘abominable mystery’ by Charles Darwin (who was never reticent about potential difficulties in the application of his great theory). Today the fossil record is more complete, but the question remains controversial.

The evolution of flowering plants is significant in two ways. The gymnosperms, from which they diverged, do little to enrich the soil, or to develop humus. Flowering plants thus represent a double revolution: first their success in establishing themselves in a relatively hostile environment, and second their coming to dominate and transform it.

Previously regarded as late-comers (~55 Ma), grasses are now thought to have been present in the Cretaceous. Evidence for this comes from a 2005 analysis of dinosaur coprolites found in India. Grasses are a special case among flowering plants in that they are wind pollinated (anemophilous). This means that their flowers do not require the display mechanisms of plants which use biotic pollen vectors like bees, birds, moths and butterflies. For humans this means that they are powerful allergens, which is generally not the case with plants that use biotic pollinators.

The family Poaceae today contains over 10 000 species with nearly 1 000 found in South Africa, and grasses cover up to 30% of the earth’s surface. The ubiquity of grasses had and still has a significant influence on the formation of the earth’s surface. They bind the topsoil, and provide water sinks — trapping rainwater and releasing it slowly throughout the year. This is an important feature of the pitifully small remnants of the Mpumalanga grasslands. The binding properties of grass are most obvious where they are absent — the gully erosion (donga formation) of large areas of South Africa where grass has been lost through over-grazing.

In grasses the meristem (‘the unformed growing cellular tissue of the younger parts of plants’) lies at the base of the plant, and is, somewhat confusingly, referred to as the ‘crown’. This is crucial in enabling grass to withstand grazing and to survive, or even flourish, when burned. Dinosaur coprolites (see above) indicate that grass was grazed from a very early stage. It seems probable that even before domesticating grass humans used fire to manipulate grasslands — in South Africa there is evidence that this was done by Stone Age man to encourage not grass but geophytes, which grow in the soil at the base of grasslands. There is a great deal of research available on the effect of anthropogenic fires on grasslands and other ecosystems worldwide.

For grazers grasses present problems of their own, since they can contain inconveniently large amounts of cellulose, lignin and silica, especially in their dry form — hay for example. Grazers have evolved two methods of dealing with this: ruminants cycle material through four stomach compartments (chewing the cud is part of this process), while hindgut fermenters consume larger volumes and have specialised symbiotic bacteria to process the material. Sheep, goats, cattle and antelopes are among the ruminants;
equids, elephants and white rhino are among the hindgut fermenters. At the lower end of the scale, termites are hindgut fermenters.

**Grasses and human development**

The domestication of plants and animals from about 10,000 years ago is a significant milestone in human development. Jared Diamond’s *Guns, Germs and Steel* is a good popular source on the profound impact this had on humanity, from changing social organisation to exposure to a range of novel diseases.

Grasses were domesticated at roughly the same period in different parts of Eurasia, notably the Middle East, while the Far East produced rice. Among the requirements for a domesticable grass are that it should produce abundant seed (and thus probably be an annual) and that there should be a latent capacity for seed retention, thus enabling planned harvesting and the storage of seed for next year’s sowing. Such grasses would be candidates for artificial selection favouring these traits by humans through the millennia.

Africa is poor in domesticable grass species, with only sorghum and possibly pearl millet native to it. These are relatively poor in nutritional value when compared to maize, which has roughly ten times their value. A relatively recent import from central America, maize has become a dominant food crop in Africa and the world, though it is far less drought-resistant than sorghum or millet.

At the other extreme some grasses which would not normally be regarded as having nutritional value are classified as ‘famine food’. *Panicum maximum* (guinea grass), common on the Melville Koppies, is one such.

**Modern uses of grass**

Grass species form a large part of our day-to-day diet. These species include wheat, maize, rice, rye, barley and oats. They also lie at base of our food chain in other ways. Almost all commercial meat products are in theory based on grass, though today’s agribusiness relies on sometimes controversial methods other than simple pasturage.

Most grasses are used by humans for their seeds. An exception is sugar cane, where the stem — the culm — of the grass is crushed and processed to produce sugar. Many commercial sweeteners, particularly in the USA, are based not on sugar but on ‘corn syrup’. ‘Corn’ is a confusing word: in the USA it strictly refers to what we call maize or mielies, while in other variants of English it tends to be a generic word for various types of cereal, particularly wheat and oats.

Non-nutritional uses of grass include thatching and weaving, and the use of bamboo for innumerable purposes in Asia.

**Savannahs and Grasslands**

Grass species predominate in the Savannah (also spelled ‘Savanna’) biome which includes the South African low veld and is the dominant vegetation in Botswana, Namibia and Zimbabwe and in the Kalahari region of South Africa. Savannahs consist of a ground layer of grasses and an upper layer of woody shrubs and trees.

In the Grassland biome shrubs and trees are confined to protected slopes and watercourses.

Worldwide, Grassland biomes include the South American Savannah Biome.
Pampas, the Prairies of North America and the Steppe which extends from Hungary, through the Ukraine, to Mongolia.

Melville Koppies lies towards the north of the South African Grassland biome. This biome is found chiefly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and the Eastern Cape. The topography is mainly flat and rolling, but includes the escarpment itself. Altitude varies from near sea level to 2 850 m above sea level.\textsuperscript{12,13}

Figures available on the internet vary considerably, but there is some consensus that only about 2\% of this biome is formally protected. Estimates for the extent of its destruction depend on the bias of the source, but 60\% seems not to be an unreasonable figure. This is an amazingly high proportion, and a quick overview of the Mpumalanga grasslands shows the extent of its destruction: large areas are strip-mined for coal; large areas are ploughed for maize; the escarpment is almost entirely used for commercial forestry; and finally some areas of the former Kangwane homeland are rural slums devastated by over-grazing. The relationship between the strip-mining, the huge Eskom power stations and the grassland is complex: the power stations are dependent on the water stored in the grassland, but the ruinous strip mining supplies their fuel.\textsuperscript{14}

South African grassland (where it survives) is noted for its biodiversity. According to Braam van Wyk it is second only to fynbos in its richness, with about 82 different species per square kilometre.\textsuperscript{15} On the Melville Koppies this richness is represented on the north eastern slopes of the central section where the grassland contains numerous geophytes — perennial plants propagated by buds on underground bulbs or tubers. These plants are mostly invisible for nine or ten months of the year. In October and November they put out leaves and flowers in some profusion, especially if the moribund grass has been burned off and nutritious ash left behind.

The Nama Karoo biome\textsuperscript{16} (in contrast to the Succulent Karoo biome to its south and west) is home to many grasses — or should be: the degree of overgrazing in the Karoo has reduced much of it to a landscape of barren Karoo bush, which is slowly invading the grasslands of the Free State. It is striking that in the Karoo the difference between well managed farms and over-grazed farms can be readily seen along fence lines.

Wetlands are an important part of the grassland biome, supporting a special combination of flora and fauna, and extending the role of grasslands as a water sink — storing and filtering water as well as attenuating flood water.

Wetlands too are under threat — an example close to home is the unscrupulous destruction of wetlands in the Midrand area by housing developers.

The Melville Koppies provides two examples of slightly less recent destruction of wetlands. The UJ hockey fields lie in an area which was a testamentary bequest by Frans Geldenhuys to the city of Johannesburg. Originally this was a wetland containing seepage from the runoff from Melville. In 1975 it was appropriated (probably unlawfully, though with the connivance of the courts) by the then RAU and was filled and levelled for playing fields. Today the runoff is channelled and joins the Westdene Spruit just west of Beyers Naudé Drive, but there is still seepage from below the embankment, where a tiny wetland is dominated by the giant reed \textit{Arundo donax} (a grass, an alien invader originating, probably, in South East Asia).
At the far eastern edge of the Koppies the triangle of grass (mostly kikuyu) bounded by Rustenburg and Hill Roads was also a small wetland until the early 1950s when it was filled by the municipality with refuse, a layer of ash and then topsoil.

**Veld types, fire and grazing**

Climate largely determines the grass types found in the Grassland, Savannah and Karoo biomes. Cooler temperatures and higher rainfall lead to the development of ‘sour veld’ where nutrients are more readily leached from the soil by rain, and cold winters cause grasses to die back, leaving a fibrous and unpalatable residue. The majority of sour veld grasses are perennials. Lower altitudes produce sweet veld which retains its grazing value throughout the year. Sweet veld also recovers from natural and human damage more readily than does sour veld.

The Melville Koppies lie in a sour veld area (the average rainfall at a little over 700 mm per year is relatively high for South Africa, and the winters are cold). Thus all the grasses brown off in the winter, and the veld is susceptible to burning.

On the Melville Koppies the western (open) section is burned in its entirety almost every year, probably to its detriment. The central (closed) area has been artificially protected from fire for decades: this has resulted in bush encroachment on the northern slopes.

The grazing value of veld can be measured fairly accurately, and depends on soil types, burning, and the degree of utilisation by grazers.

Van Oudtshoorn categorises grasses into four types:

- **Decreasers** are highly palatable grasses which are the first to be utilised by grazers, and will decrease if the veld is over-grazed.
- **Increaser I** grasses tend to proliferate in areas underutilised by grazers.
- **Increaser II and III** grasses result from over-grazing.

Each of these types is well represented on the Koppies. Grazing value depends on the relative abundance of leafy material at the base of the plant, the proportion of hard-to-digest fibre, and the taste. The *Cymbopogon* (turpentine grass) species on the Koppies contain an essential oil which makes them most unpalatable. (South African *Cymbopogon* is related to ‘lemon grass’ used in eastern cuisine.)

**Distribution of grasses on Melville Koppies**

No formal study has been made recently. Ellery studied the plant communities in 1994, but since then the intensive conservation efforts of the present committee — eradication of numerous alien species as well as the felling of exotic *Acacia mearnsii* (black wattle), *Solanum mauritianum* (bugweed), conifers and eucalyptus — has made the situation very different.

Historically it is difficult to identify different periods of usage. Obviously the last five decades have been a period of underutilisation in the absence of grazers (except termites). In the early 1950s the area was an outspan for farmers taking cattle to the abattoir (then in Newtown). According to archaeologist Revil Mason this was a period of severe over-grazing. It is unknown how the area was used during the period of ownership by the Geldenhuys family. The abundance of geophytes suggests that the north-eastern area was never ploughed. The presence of kraal walls dating from the Iron Age suggests that in that period the area may have been used for small stock, probably goats — the terrain makes it unsuitable for cattle by comparison with the flatter terrain and richer soils where Greenside and Emmarentia are now.

Recent history implies that the grass communities are determined by soil type, under-utilisation, fire and weather. On the central section there are two areas of climax grassland. (Climax grassland is an area dominated by a single vigorous species.) These two areas are the north-eastern slopes bordered by Judith and Orange roads, and an area at
the summit which is in a small bowl where the soil is deeper and water accumulates. The climax grass is *Hyparrhenia hirta* (common thatching grass, an Increaser I, indicative of underutilisation). Since this flourishes in later summer, other grasses are present earlier in the season. These include *Themeda triandra* (red grass), two species of *Cymbopogon* (turpentine grass), and *Eragrostis curvula* (weeping love grass).

The crests of the ridges and the southern slopes have shallow and acidic soil (due to weathering of quartzite and quartz) and are exposed to frost. Here the grasses never reach a climax stage, and there is a very mixed population which includes *Loudetia simplex* (russet grass), various species of *Aristida* (three awn grasses), *Tristachya leucothrix* (hairy trident grass), *Monocymbium ceresiiforme* (boat grass) and *Schizachyrium sanguineum* (red autumn grass). The last two appear only in late summer.

In the forested areas *Panicum maximum* (guinea grass) is common and *Setaria megaphylla* (broad-leaved bristle grass) flourishes. These two grasses can be grown very successfully in gardens.

Common throughout the Koppies are *Eragrostis lehmanniana* (Lehmann’s love grass) and *Eragrostis racemosa* (narrow heart love grass). On the paths *Cynodon dactylon* (couch grass) is frequently found.

There are few invasive alien grasses on the Koppies. *Bromus catharticus* (rescue grass) appears, and *Pennisetum clandestinum* (kikuyu) is present where it invades from neighbouring gardens and along some parts of the spruit, but it is unable to compete with the indigenous grasses in more exposed areas and where the soil is shallow and acidic. Kikuyu, incidentally, is the only grass in South Africa which has no inflorescence, and thus reproduces vegetatively.

An area of special interest is the top of the eastern section (the ‘Louw Geldenhuys View Site’). Here a plantation of conifers was cut down in the late 1990s, and the process of succession has very quickly taken place with pioneer grasses creating grassland where there was formerly a barren wasteland below the alien trees.

In general the eastern section has been transformed in the last 15 years, with the eradication of *Lantana camera*, *Arundo donax*, *Opuntia ficus-indica* (prickly pear) and many garden escape plants. The committee has also intervened by removing hundreds of *Lophostena coriifolia* (pluisbossie) shrubs. These are indigenous, but invasive in grassland.

In conclusion, the Melville Koppies is rich in indigenous grasses, remarkable not least because it is an ecologically isolated area, hemmed in by suburban gardens, and very close to a city centre. It is an interesting example of conservation through aggressive intervention — felling of alien trees, erosion control on paths, weeding, cutting of fire-breaks and controlled burning. The western section is an example of a combination of conservation and the resilience of indigenous species in the face of high usage by many elements of the community and of frequent uncontrolled and uncontrollable burning.

The whole reserve is precious in its own way, and irreplaceable.

Notes:


All Web references valid as at 1 January 2012.


2 [http://www.sciencemag.org/content/310/5751/1177.abstract](http://www.sciencemag.org/content/310/5751/1177.abstract) Note that only the abstract of this article is available to non-subscribers. Various Creationist websites, easily found by a Google search for ‘Dinosaur Coprolites’ give interesting, often entertaining, responses to this research.
5 The effects of burning in New Zealand after Maori settlement are discussed here: http://www.pnas.org/content/107/50/21234.full?sid=b6d110b9-a7e5-40a0-88d5-1e240f05f066
and a study of the impact of burning by the first human settlers in North America is available here: http://www.fs.fed.us/fire/fmt/fmt_pdfs/fmn60-3.pdf#introductiontoaboriginalfireuseinnorthamerica
6 This explains, incidentally, why zebra (equids) and wildebeest (antelope) are often seen together: they are not in competition for the same parts of the grass.
9 http://www.hort.purdue.edu/newcrop/faminefoods/ff_families/poaceae.html
11 Map found at: http://www.plantzafrica.com/vegetation/savannah.htm
12 Map found at: http://www.plantzafrica.com/vegetation/grassland.htm
13 Map found at: http://www.sawac.co.za/articles/GrasslandFacts.htm
14 Map found at: http://www.plantzafrica.com/vegetation/namakaroo.htm
16 Van Oudtshoorn. p. 22.
17 Personal communication.