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Phytosociological description of norite koppies in the Rustenburg area, North-West Province and refinement of the distribution of the Norite Koppies Bushveld on the national vegetation classification map of South Africa

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ABSTRACT

The Norite Koppies Bushveld vegetation type boasts a distinctive and contrasting topography and species composition easily distinguished from that of surrounding areas. A phytosociological study was done on the leased mining area of the Impala Platinum Mining Company north of Rustenburg in the North-West Province. Similar norite koppies, situated west of the Norite Koppies Bushveld vegetation, and not yet mapped by Mucina & Rutherford (2006), were identified in the study area and phytosociologically described. Six plant communities and two subcommunities were identified. Multivariate statistical analyses (correspondence analyses) confirmed that the species composition of these areas corresponds with and does therefore form part of the Norite Koppies Bushveld vegetation type as described by Mucina & Rutherford (2006). Some of these communities contain *Boscia albitrunca,* a protected plant species, and should therefore be considered as areas with conservation value.

INTRODUCTION

The Norite Koppies Bushveld vegetation type (Mucina & Rutherford 2006) extends from Rustenburg in the west to Pretoria in the east and forms part of the Savanna Biome of South Africa. It consists of rocky hills that are embedded and isolated in Marikana Thornveld (Mucina & Rutherford 2006). The underlying geology is predominantly gabbro and norite with layered anorthosite of the Pyramid Gabbro-Norite, Rustenburg Layered Suite (Mucina & Rutherford 2006). Soils are mainly shallow and well drained. Percentage soil surface rockiness is high with rock size varying from small rocks to large boulders and sheet rock. The vegetation is characterized by low, semi-open to closed woodland with the woody component reaching heights of up to 5 m (Van der Meulen 1979). A dense layer of deciduous shrubs and trees is found with sparse undergrowth (Mucina & Rutherford 2006). The species composition of the norite koppies differs considerably from that of the surrounding thornveld. Norite koppies support high levels of biodiversity as well as the protected species *Boscia albitrunca* (SANBI 2009). Although this vegetation type is categorized as Least Threatened, based on remotely sensed data, ground truthing has suggested that these areas are in fact rather susceptible to disturbance (Mucina & Rutherford 2006). According to recent assessments, approximately 20 % of the koppies have been transformed mainly due to mining activities and urbanization of surrounding land (Mucina & Rutherford 2006). Thus, transformation has taken place largely around the fringes of these units. Most mining activities on these koppies are granite quarries which cause massive damage to the vegetation. The conservation of the natural biodiversity of the norite koppies is therefore a matter of concern.

Granite mining in the North-West Province contributes 46 % of the national mining of granite (North-West Department of Agriculture, Conservation and Environment 2010). This style of opencast mining poses various threats to biodiversity. These activities are responsible for the pollution and large-scale consumption of environmental resources (North-West Department of Agriculture, Conservation and Environment 2010). Significant changes in land use, population dynamics and community distribution take place as a result of the concentration and location of the mineral reserves and mines in the province (North-West Department of Agriculture, Conservation and Environment 2010). Air pollution and pollution of surface water from opencast granite mining are important threats to the environment (North-West Department of Agriculture, Conservation and Environment 2010). The pollution can also spread much further than the initial area of impact by means of streams and dams that transport pollutants and cause exchange between surface and ground water sources. Dust from opencast mines and pollutants from the transportation and processing of minerals are major sources of air pollution which also pose a threat to natural biodiversity.

The aim of this paper is to provide more detailed phytosociological information on the Norite Koppies Bushveld vegetation type than previously described by Van der Meulen (1979) and Mucina & Rutherford (2006). It also provides geo-referenced information on the existence of many smaller, isolated norite koppies west of those already described. According to the North-West Spatial Development Framework and Zoning Plan, dolomite and norite koppies are proposed protection sites, and it was further proposed that no development should occur on ridges with a slope of more than 5º in the North-West Province (Maxim Planning Solutions 2004).

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The new geo-referenced information provided by this study will enable the refining of the national vegetation classification map (Mucina & Rutherford 2006) and will consequently aid in the improved conservation of the unique vegetation found on norite koppies in the North-West Province.

STUDY AREA

The study was undertaken in the licensed operating area of the Impala Platinum Mining Company (Figure 1) with the intent of developing a conservation plan for the leased mining area. It is situated 10 km northwest of Rustenburg in the North-West Province. The area covers ± 29 334 ha.

The Rustenburg area falls in the Savanna Biome, the largest biome in South Africa. The savannas of southern Africa are found in the region of high summer rainfall and winter drought (Mucina & Rutherford 2006). Altitudes range from near sea level to 2000 m. The mean daily maximum temperature for February is rarely under 26°C and daily temperatures often exceed 32°C. The mean daily temperature remains above 10°C in most of the biome during July but on the highveld (southern edge) temperatures can drop below 0°C (Mucina & Rutherford 2006). Frost is uncommon in winter, but does occur between June and August. Outside the Kalahari areas, most of the Savanna has an annual rainfall of 500–750 mm (Mucina & Rutherford 2006). The entire study area includes four vegetation types (Mucina & Rutherford 2006). The largest part of the area is covered by the Zeerust and Marikana Thornveld. A small part in the northeastern corner of the site falls inside the Central Sandy Bushveld vegetation type. A number of norite koppies are present in the lower southeast corner constituting the Norite Koppies Bushveld vegetation type (Figure 2).

METHODS

The Braun-Blanquet vegetation sampling approach (Mueller-Dombois & Ellenberg 1974) was used. Homogenous units based on physiognomy and species composition were identified on the norite koppies through visual observations and aerial photography. Forty-three stratified random relevés of 400 m² were surveyed on both previously mapped (Mucina & Rutherford 2006) and newly mapped norite koppies. Species-area curves were constructed to determine the minimal area for a relevé (Kent & Coker 2000). Environmental characteristics (aspect, gradient, percentage soil surface rockiness) and GPS co-ordinates were taken at each relevé.

The data collected were entered into the computer database, TURBOVEG (Hennekens 1996a) and into MEGATAB, a visual editor for phytosociological tables (Hennekens 1996b). TWINSPAN was used as a first approximation to construct phytosociological tables and Braun-Blanquet procedures were followed for refinement. Subsequent multivariate analyses were performed with the computer programme CANOCO (Ter Braak 1986) to verify the communities and identify possible environmental gradients that could influence community structure and composition. The communities found on the newly mapped norite koppies were also compared to the norite koppies previously mapped by means of a Correspondence Analysis (CA) ordination in CANOCO. The relevé numbers of newly mapped koppies appear in bold in the phytosociological table to distinguish them from the previously mapped koppies by Mucina & Rutherford (2006). Mapping of the newly identified norite koppies was done in ArcView 9.2 (ESRI 2006).

The plant communities were named by combining a differential and dominant species name and then described. In the description of the first community, however, the names of two differential species were

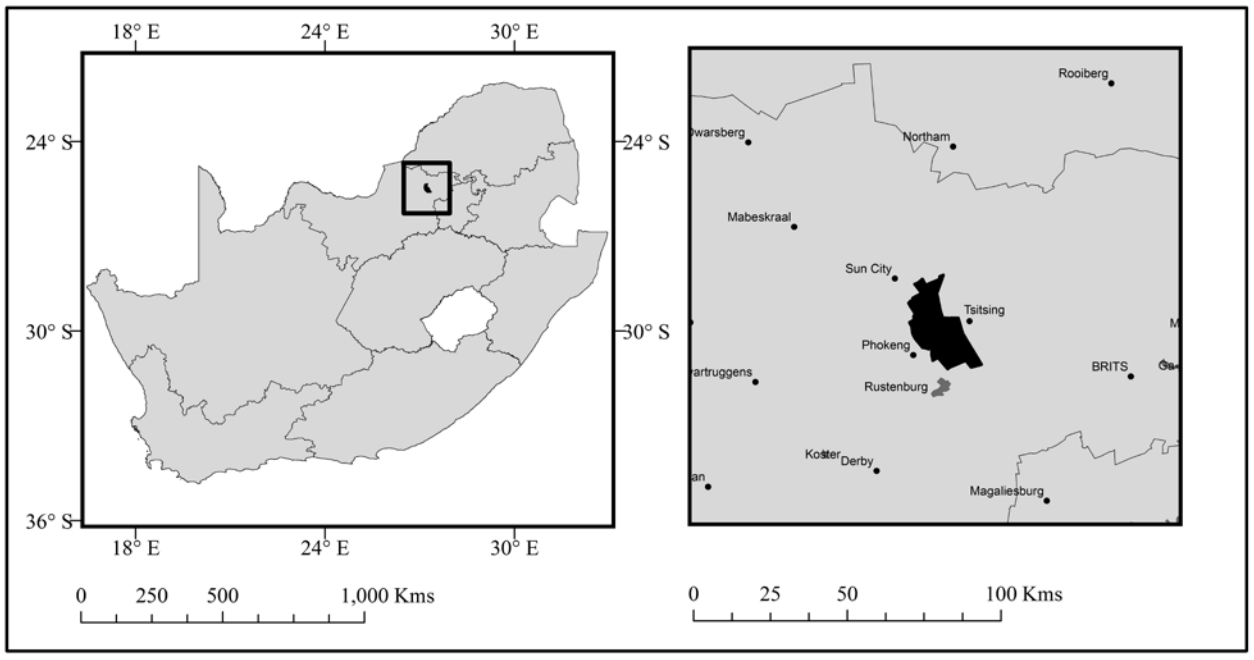

FIGURE 1.—Map of study area in South Africa.

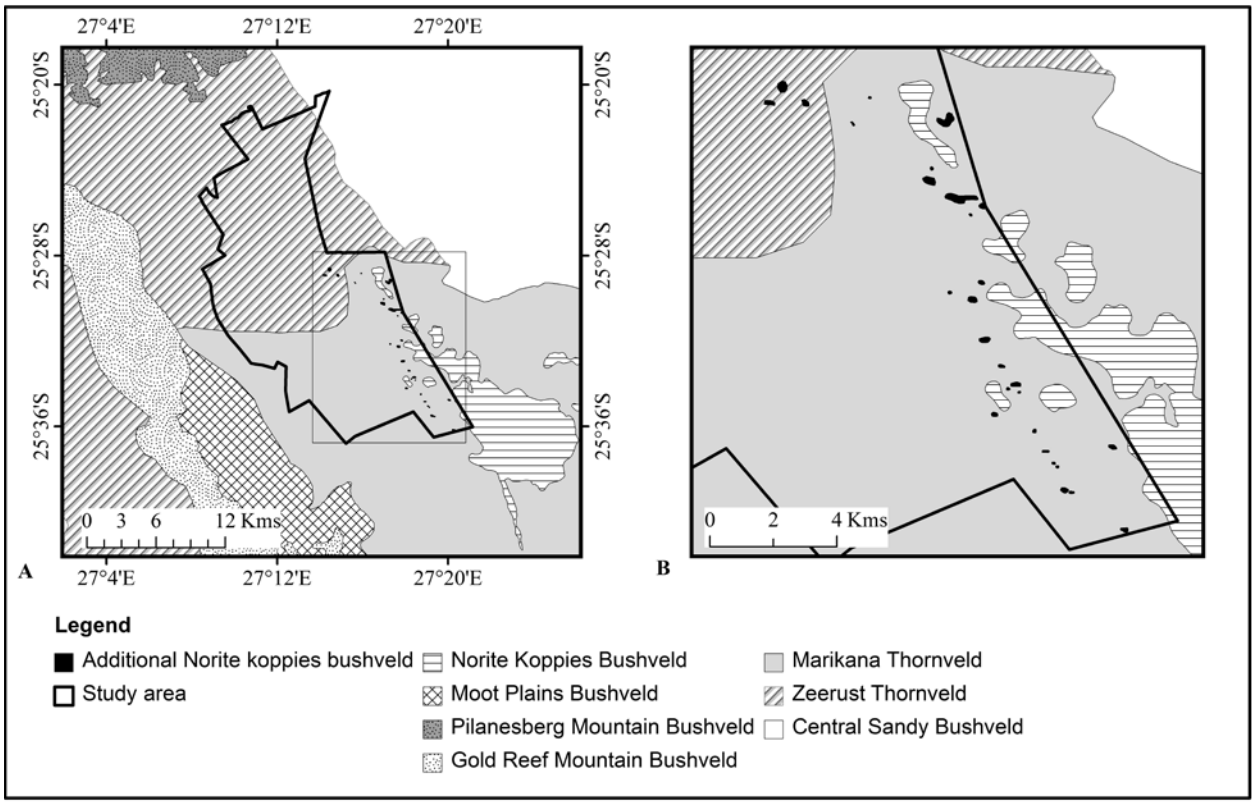

FIGURE 2.—A, map of study area and vegetation types; B, an enlarged illustration of additionally mapped norite koppies.

used instead of combining one name with the name of the dominant species.

Species names are according to Germishuizen *et al*. (2006).

Boscia albitrunca, found in certain described communities, is protected in South Africa (SANBI 2009) and was listed. Declared weeds and invaders (Henderson 2001) were also listed. These plant species are grouped into three categories according to the Conservation of Agriculture Resources Act, 1983 (Act 43 of 1983) (quoted by Henderson 2001).

RESULTS

Plant communities

Four plant communities including two subcommunities were identified, described and mapped in the norite koppies on the leased mining area of Impala Platinum. The Norite Koppies Bushveld vegetation type, as classified by Mucina & Rutherford (2006) was first described by Van der Meulen (1979) as a *Croton gratissimus–Setaria lindenbergiana* Woodland Association and also by Panagos (1996) as a *Clerodendrum glabrum–Setaria lindenbergiana* Short Closed Woodland Community. The study conducted at Impala Platinum provides data to enable the refining of the broad community described by Van der Meulen in 1979. The following communities were identified and are indicated in a phytosociological table (Appendix). *Maytenus undata* and *Maytenus albata* were not distinguished at the time of the survey but it has since come to our attention that both are present in the study area. They are therefore listed as one species. An additional list of other species which do not fall into any differential species groups was left out of the phytosociological table for logistic reasons. For any enquiries about these species the first author can be contacted.

1. *Sporobolus stapfianus–Microchloa caffra* Community

This community is present on rocky, dome-shaped outcrops appearing on koppies and also on areas of exposed sheet rock found in the thornveld between the koppies. The soil is shallow and the percentage soil surface rockiness is very high, varying between 70 % and 90 %. The degree of surface rock fragmentation can vary considerably. The species composition differs slightly between fragmented outcrops and more solid ones because fragmented surface rock areas form deeper cracks and therefore create a different habitat with deeper soil and more water penetration for certain species to exploit.

Differential species are indicated by Species Group A. They include the grasses *Sporobolus stapfianus* and *Oropetium capense* as well as the fern *Selaginella dregei*. The dominant species is the grass *Heteropogon contortus* (Species Group K) and other species include the grass *Melinis repens* (Species Group F), the tree *Sclerocarya birrea* (Species Group F) and the forb *Chascanum hederaceum* (Species Group B). The grass species *Hyperthelia dissoluta* and *Schizachyrium sanguineum* (both in Species Group A) are two species which can be associated with outcrops that have more fragmented rock surfaces. These species exclusively utilize

the micro-habitat created by the high degree of rock fragmentation and are not present on areas of solid sheet rock.

Protected species: *Boscia albitrunca* (SANBI 2009).

Declared weeds and invaders: *Opuntia ficus-indica* and *Pennisetum setaceum* (both in category 1) (Henderson 2001).

The average species richness is 55 species per relevé of which 5 % are alien species. The grass layer is the dominant stratum in this community (31 % cover). It consists mostly of low-growing species with an average height of 0.3 m but in areas of high rock fragmentation certain species can reach 2 m. Shrubs and trees are less prominent (15 % cover) and the height of the woody component varies from small shrubs (0.3 m) to taller trees of up to 5 m that grow mostly on the edges of these outcrops. The forb layer only covers 9 % of the area and consists mostly of very low growing species although some can be up to 2.2 m high.

2. *Pappea capensis–Heteropogon contortus* Community

This community is found on north-facing mid-slopes. The slopes of these areas can vary from 10° to 30° and the percentage soil surface rockiness does not exceed 60 %, which is relatively low compared to the *Ficus abutilifolia–Croton gratissimus* Community which is also found on north-facing slopes.

No differential species are found in this community. The community shares species with the *Sporobolus stapfianus–Microchloa caffra* (Species Group B) and *Setaria lindenbergiana–Acacia caffra* Communities (Species Group G). The absence of the differential species of the *Setaria lindenbergiana–Acacia caffra* Community (Species Group C), which are found on south-facing slopes, characterizes this community. This phenomenon indicates that all differential species found on northern mid-slopes also occur on south-facing slopes. There is, however, a group of differential species present on southern slopes which is not found on north-facing slopes (Species Group C). Thus, this community found on northern mid-slopes is not characterized by the presence of a certain species group but rather by the absence of the differential species group of the south-facing slopes (Species Group C). The dominant species is the grass *Heteropogon contortus* (Species Group K), and other species include the trees *Sclerocarya birrea* (Species Group F) and *Croton gratissimus* (Species Group J), as well as the shrub *Pouzolzia mixta* (Species Group K).

Protected species: *Boscia albitrunca* (SANBI 2009).

Declared weeds and invaders: *Achyranthes aspera* (category 1) (Henderson 2001).

The average species richness is 60 species per relevé of which 6 % are alien species. The woody and grass layers cover nearly 90 % and are the two dominant strata in this community. Various small shrubs are present but tall trees of up to 7 m high are more prominent while the grass layer found under the tree canopy is mostly low but can reach 2 m in height. The forb layer is not as prominent as the other strata (10 % cover) and consists mostly of small forbs but also some climbers that can grow high into trees (up to 2 m).

3. *Setaria lindenbergiana–Dombeya rotundifolia* Community

This community is found on south-facing slopes but the aspect may vary from west to southeast. Soils are mostly shallow but can be deeper in some places and the percentage soil surface rockiness varies considerably (from 40 % to 90 %).

Differential species are indicated by Species Group C which includes the grass *Setaria lindenbergiana,* the tree *Celtis africana* and the forb *Scadoxus puniceus,* while the dominant species is the tree *Dombeya rotundifolia* (Species Group J). Other species include the grass *Themeda triandra,* the shrub *Euclea crispa* and *Acacia caffra* as a tree and a shrub (all in Species Group D).

Declared weeds and invaders: *Achyranthes aspera, Cestrum laevigatum, Datura stramonium, Opuntia ficus-indica* (all in category 1), *Cynodon dactylon* (proposed category 2), *Ipomoea purpurea* (category 3) (Henderson 2001).

The average species richness is 40 species per relevé of which 8 % are alien species. The woody layer found on the south-facing slopes is very dense (64 % cover) and consists mostly of tall trees with an average height of 5 m and some that even reach up to 10 m in height. Shrubs only make up ± 15 % of the woody layer. The grass layer rarely exceeds 1.5 m in height and covers 30 % whereas the forb layer only covers 19 %. The forbs present in this community are mostly small, low-growing species and also climber species which can reach up to 4 m into trees.

This community, found on the south-facing slopes, can be divided into two subcommunities based on the difference in percentage soil surface rockiness.

3.1 *Themeda triandra–Acacia caffra* Subcommunity

This is the dominant subcommunity found on the southern slopes of koppies. It is present in areas that have a relatively low percentage soil surface rockiness (40–65 %) in comparison with the other subcommunity. This is the distinguishing environmental factor between the two subcommunities found on south-facing slopes. Soils are mostly shallow but can be deeper in some areas.

Differential species are indicated by Species Group D which includes the grass *Themeda triandra,* the shrub *Euclea crispa* and the forb *Lantana rugosa*. The dominant species is *Acacia caffra* (Species Group D) as a tree and a shrub. Other species in this subcommunity include the shrub *Asparagus suaveolens* (Species Group F), the tree *Dombeya rotundifolia* (Species Group J) and the fern *Pellaea calomelanos* (Species Group K).

Declared weeds and invaders: *Achyranthes aspera, Cestrum laevigatum, Datura stramonium, Opuntia ficus-indica* (all in category 1), *Cynodon dactylon* (proposed category 2), *Ipomoea purpurea* (category 3) (Henderson 2001).

The average species richness is 44 species per relevé of which 4 % are alien species. A dense, woody stratum is present in this subcommunity (63 %) of which 47 % is

low to taller trees (up to 7 m) and the rest is shrubs. The grass layer is well developed (48 %) but consists mostly of low-growing grasses rarely higher than 1.5 m. Forbs cover only 11 % of the area and some species can climb up to 4 m into trees. The reason for the low cover and vigorous climbing is a shortage of space and effective sunlight because of high grass and tree cover.

3.2 *Ficus burkei–Dombeya rotundifolia* Subcommunity

This subcommunity is characterized by steep, rocky cliffs with an aspect that can vary from west to south-east. It is located in areas with slopes of ± 35° and higher. The percentage soil surface rockiness is very high, varying between 65 % and 90 % and consists mostly of large, solid boulders. As mentioned in the description of the first subcommunity, this large percentage of rock cover is the distinguishing factor between the two subcommunities. Soils are very shallow.

Differential species are indicated by Species Group E and they include the tree *Ficus burkei,* the forb *Pavetta eylesii* and the grass *Digitaria sanguinalis.* The dominant species is the tree *Dombeya rotundifolia* (Species Group J), while other species include the forbs *Solanum panduriforme* (Species Group G), *Pupalia lappacea* (Species Group C) and *Abutilon austro-africanum* (Species Group I).

Declared weeds and invaders: *Achyranthes aspera* (category 1) (Henderson 2001).

The average species richness is 35 species per relevé of which 11 % are alien species. Trees which grow up to 10 m in height dominate this community (50 % cover) whereas the shrub layer only covers 15 % and does not grow higher than 1.8 m. A grass layer is nearly absent in this community (5 % cover) because of a shortage of soil and sunlight. The grass species found here do not grow over 0.8 m in height. Various small forbs and climbers are found in this community (28 % cover) which can reach heights of up to 4 m into trees.

4. *Ficus abutilifolia–Croton gratissimus* Community

This community is characterized by steep, rocky cliffs facing north or northeast. It is located in areas with very steep slopes varying from 30° to 90°. The percentage soil surface rockiness is very high, varying between 60 % and 90 %, and consists mostly of large boulders. As mentioned in the discussion of the *Pappea capensis–Heteropogon contortus* Community, the difference in percentage soil surface rockiness is what distinguishes these two communities found on the north-facing slopes of koppies. Little soil is present because of the large amount of rock and the very shallow soil found in this community.

Differential species are indicated by Species Group H which includes the trees *Ficus abutilifolia* and *Obetia tenax* and the grass *Enteropogon macrostachyus.* The dominant species is the tree *Croton gratissimus* (Species Group J). Other species include the forbs *Abutilon austro-africanum* (Species Group I), *Hibiscus subreniformis* and *Cyphostemma sulcatum* (both in Species Group J).

Declared weeds and invaders: *Datura stramonium* and *Opuntia ficus-indica* (both in category 1) (Henderson 2001).

The average species richness is relatively low with 25 species per relevé of which 4 % are alien species. This community is totally dominated by the woody component (67 %). Most of the woody stratum consists of tall trees that can reach 8 m in height. Because of the lack of sufficient soil and adequate sunlight, the grass cover is only 28 % and grasses are never higher than 1.2 m. Only small forbs that rarely grow over 1.2 m are present in this community and their cover does not exceed 9 %.

DISCUSSION

The four plant communities and two subcommunities that were identified on norite koppies inside the study area correspond with the Norite Koppies Bushveld vegetation type as described and mapped by Mucina & Rutherford (2006). A multivariate statistical comparison done between the communities of the previously mapped koppies and those newly mapped in this study shows a similar species composition. An ordination following correspondence analyses (CA) (Figure 3) was done to illustrate the correlation in species composition between the different communities.

A representative number of the newly mapped koppies were phytosociologically sampled and described to test the correlation in species composition between these koppies and the ones mapped by Mucina & Rutherford in 2006 as the Norite Koppies Bushveld vegetation type.

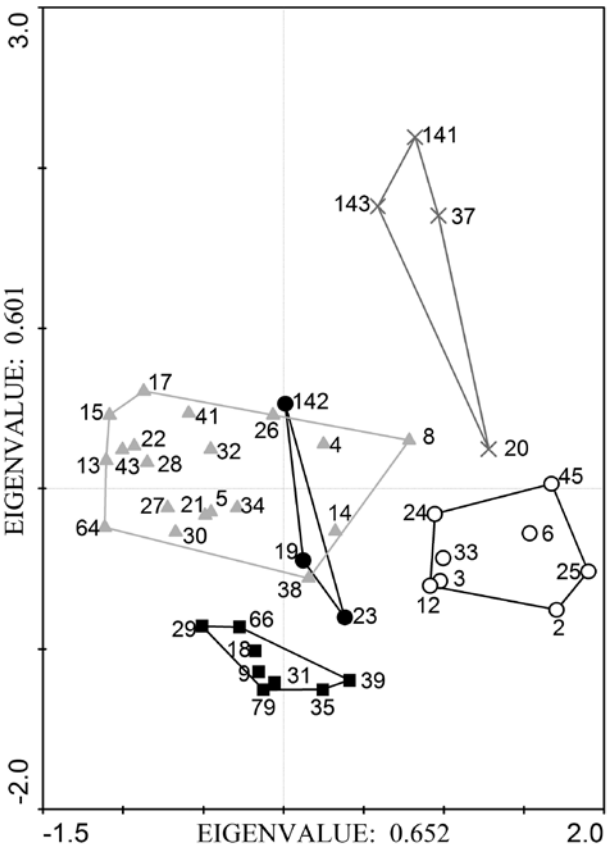

FIGURE 3.—Correspondence Analysis ordination of communities identified; Community 1, ■; Community 2, ●; Subcommunity 3.1, ▲; Subcommunity 3.2, X; Community 4, ○.

The relevés representing Community 1 formed a close grouping indicating the strong correlation in species composition between the different relevés. Community 1 is therefore similar for both the existing mapped koppies and the newly mapped koppies. This indicates that these additional koppies also form part of the Norite Koppies Bushveld vegetation type.

The relevés representing Community 2 also formed a grouping indicating the similarity in species composition between the different relevés. The overlapping of certain relevés between this community and Subcommunity 3.1 in the ordination supports our argument that this community found on the northern slopes shares various species with Subcommunity 3.1 found on south-facing slopes. The absence of certain species from Community 2 that are found in Subcommunity 3.1 is, however, what separates these two communities.

The relevés representing Subcommunity 3.1 formed a separate, larger grouping, indicating a lesser correlation in species composition compared to the correlations of the other communities. The grouping of Subcommunity 3.1 was, however, still distinct from the other communities. As with Community 1, the presence of the community on previously mapped, as well as on the newly mapped koppies indicates that these new koppies also form part of the Norite Koppies Bushveld vegetation type.

The relevés representing Subcommunity 3.2 group together. Once again this indicates a correlation in species composition between the different relevés. The presence of this community on both the mapped and unmapped koppies supports the argument that the unmapped koppies form part of the Norite Koppies Bushveld vegetation type.

The same is true for Community 4.

CONCLUSION

The plant communities identified and described on the newly mapped norite koppies on the leased mining area of the Impala Platinum Company correspond with the Norite Koppies Bushveld described by Mucina & Rutherford (2006). However, the new communities described in this paper offer a more refined description of the phytosociology of the Norite Koppies Bushveld than the broad description of Mucina & Rutherford (2006). Consequently, these new koppies can be spatially included on the vegetation map (Mucina & Rutherford 2006) to refine the map and increase the vegetation data available on the Norite Koppies Bushveld vegetation type (Mucina & Rutherford 2006). Norite koppies were also mapped in the Zeerust Thornveld, whereas Mucina & Rutherford (2006) only described norite koppies in the Marikana Thornveld. The unique species composition found in the Norite Koppies Bushveld (Mucina & Rutherford 2006) has significant conservation importance. For this reason it is proposed by the North-West Spatial Development Framework and Zoning Plan that norite koppies should be protected from development in the North-West Province (Maxim Planning Solutions 2004). The addition of this new information for the geographic extension of the Norite Koppies Bushveld (Mucina & Rutherford 2006) further to the west will aid in the conservation of norite koppies and the plant communities they represent.

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APPENDIX.—Phytosociological table of Norite koppies

Community	1								2			3																											4								
												3.1																				3.2														
Relevé numbers											1																							1	1											
	3	6	**7**		**3**	1	2	**3**	1	2	4		1	1	1	1	2	2	2	2	3	**3**	**3**	4	4		2		**3**	6	2	**3**	4	4			4	2	1	3	2	4		
	1	6	**9**	9	**5**	8	9	**9**	9	3	2	4	3	4	5	7	1	2	6	7	2	**4**	**8**	1	3	5	8	**8**	**0**	4	0	**7**	1	3	**6**	3	4	5	2	3	4	5	2
SPECIES GROUP A																																												
Sporobolus stapfianus	1	1	1	1	1	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Microchloa caffra	+	+	1	+	+	1	+	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hyperthelia dissoluta	a	1	a	.	1	1	1	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	3	.	.	.	.	.	.
Selaginella dregei	a	+	+	+	1	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus engleri	1	.	1	1	1	+	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	.	.
Ceratotheca triloba	+	.	+	1	+	+	+	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea magnusiana	+	.	+	+	+	1	+	+	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kyphocarpa angustifolia	+	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Oropetium capense	+	+	+	1	1	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Evolvulus alsinoides	+	+	+	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xerophyta retinervis	+	1	a	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vernonia poskeana	+	+	1	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oldenlandia herbacea	+	+	+	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Hermannia glanduligera	+	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bulbostylis hispidula	.	+	1	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Nidorella resedifolia	+	+	.	.	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Geigeria burkei	+	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bulbostylis humilis	.	+	+	.	+	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Loudetia simplex	.	a	.	.	.	1	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schizachyrium sanguineum	+	.	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Urochloa mosambicensis	.	.	+	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zornia milneana	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Becium angustifolium	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Portulaca hereroensis	+	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cleome monophylla	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tricholaena monachne	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sarcostemma viminale	+	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera filipes	+	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

APPENDIX.—Phytosociological table of Norite koppies. * indicates an alien species (cont.)

Community	1								2			3																											4								
												3.1																			3.2															
											1																							1	1											
Relevé numbers	**3**	6	**7**		**3**	1	2	**3**	1	2	4		1	1	1	1	2	2	2	2	3	**3**	**3**	4	4		2		**3**	6	2	**3**	4	4			4	2	1	3	2	4	
	1	6	**9**	9	**5**	8	9	**9**	9	3	2	4	3	4	5	7	1	2	6	7	2	**4**	**8**	1	3	5	8	**8**	**0**	4	0	**7**	1	3	**6**	3	4	5	2	3	4	5	2
SPECIES GROUP A (cont.)																																												
Kyllinga erecta	.	.	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.
Euphorbia schinzii	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Merremia palmata	.	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus cannabinus	+	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gladiolus permeabilis	+	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida diffusa	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trichoneura grandiglumis	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senna italica	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mollugo cerviana	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Xenostegia tridentata	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus rupestris	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Huernia transvaalensis	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia burchellii	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP B																																													
Chascanum hederaceum	1	+	+	+	+	+	+	+	+	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
* *Schkuhria pinnata*	+	+	+	+	+	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Monsonia angustifolia	+	+	+	+	+	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
* *Tagetes minuta*	.	.	+	+	+	+	.	+	1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia purpurea	+	+	+	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Setaria pumila	.	.	+	.	+	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucas martinicensis	.	.	+	.	+	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Ipomoea obscura	.	.	.	.	+	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Acalypha indica	.	+	.	+	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b	.	.	.	.	+	.	.	.	.	.	.	.	.
SPECIES GROUP C																																													
Setaria lindenbergiana	.	.	.	.	.	.	+	.	.	.	a	b	1	a	b	3	a	+	a	+	a	+	.	a	a	.	.	1	.	.	1	1	a	3	.	.	+	.	.	.	+	.	.
Celtis africana	.	.	+	.	.	.	.	.	.	.	.	+	+	.	1	1	.	1	+	+	+	.	.	+	.	1	b	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.

APPENDIX.—Phytosociological table of Norite koppies. * indicates an alien species (cont.)

Community	1								2			3																							4								
												3.1																		3.2													
Relevé numbers											1																					1	1									
	3	6	**7**		**3**	1	2	**3**	1	2	4		1	1	1	1	2	2	2	2	3	**3**	**3**	4	4		2		**3**	6	2	**3**	4	4			4	2	1	3	2	4	
	1	6	**9**	9	**5**	8	9	**9**	9	3	2	4	3	4	5	7	1	2	6	7	2	**4**	**8**	1	3	5	8	**8**	**0**	4	0	**7**	1	3	**6**	3	4	5	2	3	4	5	2
SPECIES GROUP C (cont.)																																										
Ehretia rigida	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	+	.	+	+	+	.	.	+	.	+	.	.	+	.	+	+	+	.	.	.	.	.	.	.	.	.
Pupalia lappacea	.	.	.	.	.	.	.	.	1	.	.	1	.	1	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	+	a	1	+	.	.	.	.	.	.	+	.	+
Scadoxus puniceus	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	+	.	.	.	+	.	.	+	.	.	+	.	.	.	.	1	+	+	.	.	.	.	.	.	.	+	.
* *Malvastrum coromandelianum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	+	+	.	.	.	.	.	.	.	.	+	.	.	.
* *Boerhavia cordobensis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP D																																										
Acacia caffra	.	1	.	.	+	.	.	.	.	.	.	1	b	+	3	3	b	b	1	+	1	1	+	3	3	.	a	.	a	b	.	.	.	.	.	.	+	.	.	.	.	.	.
Themeda triandra	.	.	.	.	.	+	+	.	.	+	.	1	3	.	b	a	a	1	.	b	b	a	a	3	3	.	+	.	1	a	.	.	+	.	.	.	.	.	.	.	.	.	.
Euclea crispa	+	.	+	.	.	.	.	.	.	.	.	+	1	.	+	.	+	+	+	1	+	+	+	1	+	.	3	1	1	.	.	.	.	+	.	.	+	.	.	.	1	.	.
Lantana rugosa	.	+	.	.	.	.	.	.	+	.	.	1	.	+	+	+	.	+	+	+	+	+	+	+	+	+	+	.	.	+	.	.	+	.	.	+	.	+	.	+	.	.	.
Searsia leptodictya	.	1	.	.	.	.	.	.	.	.	.	.	+	+	+	b	1	1	+	.	.	+	.	+	+	.	+	.	+	.	.	.	.	.	.	.	1	.	.	.	a	.	.
Zanthoxylum capense	.	.	.	.	.	+	.	.	.	+	.	+	+	+	.	+	+	+	+	.	.	.	.	+	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Ziziphus mucronata	.	.	+	.	.	.	+	.	.	.	.	.	1	.	1	b	+	+	.	.	.	+	.	.	+	b	a	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Thunbergia neglecta	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	+	.	1	1	.	1	+	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Clematis brachiata	.	.	.	.	.	.	.	.	.	.	+	1	1	.	.	1	.	+	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus trionum	.	.	.	+	.	+	.	.	.	+	.	.	.	.	+	+	+	+	+	+	+	+	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gymnosporia heterophylla	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	a	.	+	.	+	.	+	.	+	.	.	+	+	+	.	.	.	.	.	.	+	.	.	.	+	.	.	.
Diospyros lycioides	.	.	.	.	.	.	.	.	+	.	.	1	.	.	+	.	.	+	+	+	1	.	.	.	.	.	b	.	+	.	.	+	.	.	.	+	.	.	.	+	.	.	.
Oxalis depressa	.	.	.	.	+	+	.	.	.	.	.	+	+	.	+	+	+	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Sphedamnocarpus pruriens	.	1	.	.	.	.	.	.	1	+	.	.	1	.	b	.	1	1	.	+	+	a	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypoestes forskaolii	.	.	.	.	.	.	.	.	.	.	.	.	+	+	a	b	.	.	.	.	+	.	.	+	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Maytenus undata/albata	.	.	.	1	.	.	.	.	.	.	.	+	+	.	.	1	+	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Tarchonanthus parvicapitulatus	.	.	.	.	.	.	.	.	.	.	.	.	1	.	a	.	+	.	.	1	+	.	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vitex zeyheri	.	.	1	.	.	1	+	.	.	.	.	.	b	.	+	.	b	.	.	.	.	.	a	.	a	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Berchemia zeyheri	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	b	.	b	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Scolopia zeyheri	.	.	.	.	.	.	.	.	.	.	.	1	+	.	+	+	.	.	.	+	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cymbopogon excavatus	.	+	.	.	.	.	+	.	.	.	.	a	.	.	+	.	1	.	.	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida canescens	.	.	.	.	.	+	+	.	.	+	.	.	+	.	1	.	.	.	.	+	.	.	.	+	1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

APPENDIX.—Phytosociological table of Norite koppies. * indicates an alien species (cont.)

Community	1								2			3																								4								
												3.1																		3.2														
											1																					1	1											
Relevé numbers	**3**	6	**7**		**3**	1	2	**3**	1	2	4		1	1	1	1	2	2	2	2	3	**3**	**3**	4	4		2		**3**	6	2	**3**	4	4			4	2	1	3	2	4	
	1	6	**9**	9	**5**	8	9	**9**	9	3	2	4	3	4	5	7	1	2	6	7	2	**4**	**8**	1	3	5	8	**8**	**0**	4	0	**7**	1	3	**6**	3	4	5	2	3	4	5	2
SPECIES GROUP D (cont.)																																											
Ruellia cordata	.	.	.	.	.	.	+	.	.	+	.	.	+	.	+	.	.	+	.	1	.	.	.	.	+	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Enneapogon scoparius	.	+	.	.	.	.	.	.	+	+	.	.	.	.	.	+	+	+	.	.	+	.	.	+	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Barleria pretoriensis	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Digitaria eriantha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bridelia mollis	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	.	.	+	.	.	.	a	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Cymbopogon pospischilii	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Searsia lancea	.	.	+	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	+	.	.
Eragrostis superba	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Hermannia depressa	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Eriospermum sp.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus virgatus	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	+	.	.	.	.	a	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Clutia pulchella	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	1	a	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
* *Conyza bonariensis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Hibiscus pusillus	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Gymnosporia polyacanthus	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Searsia pyroides	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kedrostis africana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cussonia paniculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dodonaea angustifolia	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus setaceus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.
Acacia karroo	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Crabbea hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Pavonia burchellii	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Hyparrhenia filipendula	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	b	.	.	.	.	.	.	.	.	b	.	.	.	.	.	.	.	.	.	.	.	.	.
Trachypogon spicatus	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.
Flueggea virosa	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	+	.	b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Osyris lanceolata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Faurea saligna	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum setosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.

APPENDIX.—Phytosociological table of Norite koppies. * indicates an alien species (cont.)

Community	1								2			3																											4								
												3.1																			3.2															
Relevé numbers											1																						1	1											
	3	6	**7**		**3**	1	2	**3**	1	2	4		1	1	1	1	2	2	2	2	3	**3**	**3**	4	4		2		**3**	6	2	**3**	4	4			4	2	1	3	2	4	
	1	6	**9**	9	**5**	8	9	**9**	9	3	2	4	3	4	5	7	1	2	6	7	2	**4**	**8**	1	3	5	8	**8**	**0**	4	0	**7**	1	3	**6**	3	4	5	2	3	4	5	2
SPECIES GROUP E																																												
Ficus burkei	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	b	4	3	.	.	.	.	1	.	.	.	.
Pavetta eylesii	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	b	a	b	.	.	.	.	.	.	.	1	.
* *Digitaria sanguinalis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.
Kedrostis hirtella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Pavonia senegalensis	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Momordica cardiospermoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP F																																											
Vangueria infausta	+	+	+	.	.	+	1	.	.	.	.	1	.	.	+	+	1	+	.	1	+	+	+	.	1	1	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhynchosia totta	+	+	.	.	.	+	.	.	1	+	.	.	.	1	+	+	+	1	.	.	+	+	+	+	+	.	+	.	+	.	.	.	.	.	.	.	+	.	.	+	+	.	.
Melinis repens	+	+	1	+	+	+	+	+	+	+	.	.	.	+	.	.	+	.	.	a	+	.	+	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.
Grewia flava	+	+	+	.	.	+	.	.	+	.	.	.	.	.	+	+	+	+	+	+	.	+	.	1	.	.	b	.	a	+	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus suaveolens	+	.	+	.	.	+	+	.	.	+	.	+	+	+	+	+	+	+	+	+	+	+	+	.	+	+	a	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Sclerocarya birrea	+	.	1	+	+	1	.	1	a	a	.	.	.	+	.	.	.	1	.	.	+	+	+	.	.	.	.	.	+	+	.	.	.	.	.	.	1	.	+	.	1	.	.
Commelina africana	1	+	+	.	1	+	1	+	.	+	.	.	.	+	.	.	+	.	.	1	+	1	+	.	.	.	+	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.
Bothriochloa insculpta	.	.	+	+	.	+	+	.	1	+	.	.	.	b	.	.	.	.	.	+	.	a	+	+	.	b	a	.	.	1	.	.	.	.	.	.	1	.	+	1	.	.	.
Eragrostis curvula	+	.	.	.	.	+	+	.	.	+	.	.	.	+	1	.	+	.	.	+	+	+	+	+	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.
Dichrostachys cinerea	+	1	.	.	+	.	.	+	a	+	+	.	.	+	.	+	.	+	.	.	.	1	.	.	.	.	+	.	1	+	.	+	.	.	.	.	+	.	.	.	.	.	.
Phyllanthus parvulus	+	+	.	.	+	+	.	.	+	+	.	.	.	.	+	.	+	+	.	.	+	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.	+	.	.	+	.	.
Aloe marlothii	1	.	.	+	.	.	b	+	.	+	.	.	.	.	.	.	.	.	.	b	a	1	.	r	+	1	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.
Ledebouria cooperi	1	.	.	.	+	1	+	+	.	+	.	.	.	.	.	.	+	+	.	.	1	+	.	.	.	.	.	.	+	1	.	.	.	.	.	.	+	.	.	.	.	.	.
Cheilanthes viridis	.	+	.	.	+	+	.	+	+	.	.	.	.	+	+	.	.	+	+	.	.	.	.	+	.	.	.	.	+	.	.	.	.	+	.	+	.	.	+	+	.	.
Acacia tortilis	.	.	+	+	.	.	+	.	+	.	+	.	.	.	.	.	.	+	.	.	+	+	.	.	.	3	a	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
* *Bidens bipinnata*	+	+	+	+	.	.	.	.	+	+	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	1	+	+	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.
Aloe greatheadii	.	+	+	+	.	.	1	+	.	+	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.
Hyparrhenia hirta	.	+	+	.	.	+	b	.	.	1	.	+	.	.	.	.	1	.	.	.	+	.	.	.	.	.	.	.	.	a	.	.	.	.	.	.	.	.	.	.	.	.	.
* *Zinnia peruviana*	.	+	+	.	.	+	.	+	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Nidorella anomala	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Elionurus muticus	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.

APPENDIX.—Phytosociological table of Norite koppies. * indicates an alien species (cont.)

Community	1								2			3																								4								
												3.1																			3.2													
Relevé numbers											1																					1	1										
	3	6	**7**		**3**	1	2	**3**	1	2	4		1	1	1	1	2	2	2	2	3	**3**	**3**	4	4		2		**3**	6	2	**3**	4	4			4	2	1	3	2	4	
	1	6	**9**	9	**5**	8	9	**9**	9	3	2	4	3	4	5	7	1	2	6	7	2	**4**	**8**	1	3	5	8	**8**	**0**	4	0	**7**	1	3	**6**	3	4	5	2	3	4	5	2
SPECIES GROUP F (cont.)																																											
* *Gomphrena celosioides*	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Corchorus asplenifolius	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acalypha villicaulis	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP G																																											
Pappea capensis	.	1	.	.	.	.	.	.	1	1	3	.	+	1	.	1	.	+	+	1	+	+	.	1	.	.	1	.	+	+	.	.	+	+	.	.	.	.	1	.	+	.	.
Solanum panduriforme	.	.	.	.	.	.	.	.	+	+	a	+	.	+	.	.	.	+	.	+	+	+	+	1	+	+	1	a	+	.	.	+	a	1	.	.	.	.	.	.	.	.	.
Panicum maximum	.	.	.	.	.	+	.	.	a	+	+	.	.	1	.	.	.	1	.	+	+	1	.	.	.	b	1	.	.	+	.	+	1	.	.	.	.	.	.	.	.	.	.
Felicia muricata	+	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	+	.	1	+	1	.	.	1	+	.	.	+	+	.	.	+	+	.	.	.	.	.	.	.	.	.
Mundulea sericea	.	.	.	.	.	.	.	.	.	a	.	.	.	.	+	+	a	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP H																																											
Ficus abutilifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b	.	1	a	a	a	.	a	4
Enteropogon macrostachyus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	a	+	+	b	1	+
Sansevieria aethiopica	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	+	.	+	+	+
Obetia tenax	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	a	.	.	.	.	b
Hermannia floribunda	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+	+	.	a	.	+	1	.	.	1	.	.
Cyphostemma lanigerum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+	+	.	.	.	.	.	.	+
Myrsine pillansii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	+	.	.	+
Lannea discolor	.	.	.	.	.	.	.	.	a	+	.	.	.	b	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	+	.	.	+	.
Hibiscus calyphyllus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	.
Tragia rupestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	1	.	.
Combretum zeyheri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.
Tragus berteronianus	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	+	.	.	.	.
SPECIES GROUP I																																											
Abutilon austro-africanum	.	.	.	.	.	.	.	.	.	.	b	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	1	a	1	.	1	+	.	+	1	a	.	1
Cyphostemma woodii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	1	.	.	.	.	+	+	1	.	+	1	.
Triumfetta annua	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a	.	.	+	.	.	.	.	+	+	+	.

APPENDIX.—Phytosociological table of Norite koppies (cont.)

Community	1								2			3																											4								
												3.1																			3.2															
											1																							1	1											
Relevé numbers	**3**	6	**7**		**3**	1	2	**3**	1	2	4		1	1	1	1	2	2	2	2	3	**3**	**3**	4	4		2		**3**	6	2	**3**	4	4			4	2	1	3	2	4	
	1	6	**9**	9	**5**	8	9	**9**	9	3	2	4	3	4	5	7	1	2	6	7	2	**4**	**8**	1	3	5	8	**8**	**0**	4	0	**7**	1	3	**6**	3	4	5	2	3	4	5	2
SPECIES GROUP J																																												
Croton gratissimus	1	.	.	.	.	.	.	+	1	b	.	3	1	b	.	.	+	+	4	+	1	+	b	.	.	.	.	a	.	.	b	.	.	a	3	3	1	a	b	b	4	a	a
Dombeya rotundifolia	.	.	.	.	.	.	.	.	.	+	a	a	.	+	.	1	1	.	1	a	b	b	.	b	+	1	.	4	a	.	a	b	a	b	1	1	b	.	+	+	1	.	.
Hibiscus subreniformis	+	.	.	.	.	.	+	.	+	.	.	+	.	a	.	.	.	.	.	.	+	.	+	+	+	+	.	b	.	.	+	+	.	.	.	+	+	+	1	1	1	+	+
Cyphostemma sulcatum	.	.	+	.	.	.	.	.	+	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	1	+	.	.	+	+	1	a	1	1	a	+	+
Rhoicissus tridentata	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	+	.	.	+	.	.	1	1	1	.	.	.	+	.	.	+	.	.	+	+	.	+	+	.	.	+	+	+
Grewia flavescens	.	.	.	.	.	.	.	.	1	+	a	.	.	.	.	.	.	.	.	+	.	+	.	1	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	+	.	+	.
Achyranthes aspera	.	.	.	.	.	.	.	.	+	+	1	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	1	1	+	.	.	.	.	.	.	.	.	.	.
Setaria verticillata	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	.	.	+	+	.	.	.	.	.	+	.	+	.	.	.
Solanum supinum	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.
Adenia digitata	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.
SPECIES GROUP K																																												
Heteropogon contortus	a	a	1	1	a	a	b	1	b	a	b	.	1	b	.	+	+	1	.	1	1	b	a	1	a	b	a	+	1	+	.	.	1	+	.	1	1	.	+	a	1	.	.
Pellaea calomelanos	+	+	1	+	1	1	+	1	+	+	+	+	1	+	+	+	+	+	+	+	+	+	+	+	1	.	.	+	+	.	+	+	+	+	.	+	.	.	.	.	+	+	.
Chrysopogon serrulatus	a	.	a	+	a	+	1	a	.	3	.	.	.	+	.	.	b	.	.	+	1	.	b	.	.	.	.	.	1	.	+	.	.	.	.	b	b	.	3	a	a	+	+
Pouzolzia mixta	.	.	+	.	.	1	.	a	a	+	.	.	.	a	.	+	+	+	+	.	.	1	+	+	.	.	.	.	.	.	+	.	.	.	.	.	+	.	a	+	+	+	1
Combretum molle	.	.	.	.	.	+	+	.	+	+	.	.	.	1	.	+	+	1	+	1	+	.	+	1	.	.	.	.	.	.	.	+	.	.	.	a	1	.	b	1	+	+	.
Tetradenia brevispicata	.	.	+	.	+	+	.	1	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	+	.	.	b	a	.	+	1	.	.	a	.	1	.	b	.
Commelina benghalensis	+	.	.	+	.	.	+	.	+	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	a	.	+	.	.	+	+	.	.	+	.	+	+	.	.	+	+	.
Euphorbia cooperi	.	.	.	.	b	.	.	a	.	a	.	.	.	.	.	.	.	.	+	.	.	a	1	.	.	.	.	.	.	.	+	.	+	.	.	a	.	1	.	.	+	.	a
Turraea obtusifolia	+	+	.	+	.	.	.	.	.	+	.	.	.	1	.	.	.	.	.	.	.	+	.	.	.	+	+	.	+	.	.	.	a	+	.	.	.	1	.	.	.	.
* *Opuntia ficus-indica*	.	.	+	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	+	.	+	+	.	+
Acacia nilotica	.	+	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.
Euphorbia inaequilatera	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.

* indicates an alien species.