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The extended occurrence of Maputaland Woody Grassland further south in KwaZulu-Natal, South Africa

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ABSTRACT

The distinctiveness of Maputaland Woody Grassland lies within its richness of geoxylic suffrutices and herbaceous flora. Since it is well documented in the literature and easy to distinguish from other grassland types, it was possible to confirm a locality of this unique vegetation unit west of Richards Bay, where it probably forms the southernmost outlier population of this vegetation unit in the Indian Ocean Coastal Belt Biome. Phytosociological data obtained from the study area were analysed to identify plant communities and subsequent mapping units. Floristic gradients obtained through ordination techniques revealed the relationship that exists between the Woody Grassland of the study area and the Maputaland Woody Grassland of Sileza Nature Reserve. This confirms the occurrence of Maputaland Woody Grassland at Richards Bay. Two of the plant communities identified from the Richards Bay site are distinctively different, despite previously being lumped together by different authorities as either Kwambonambi Grassland or Maputaland Woody Grassland.

INTRODUCTION

Maputaland Wooded Grassland also known as Maputaland (MWG) (Matthews et al. 1999) and the name which we prefer to use, is a vegetation unit (CB2) of the Indian Ocean Coastal Belt Biome (Mucina & Rutherford 2006), and is limited to the Maputaland Centre of Endemism that is found along the coastal plain of northern KwaZulu-Natal and southern Mozambique (Van Wyk & Smith 2001). The 'woody grasslands of Maputaland' (Myre 1964), or 'the underground forests of Africa' as described by White (1977), are characterized by the many geoxylic (often rhizomatous) suffrutices that occur there. Geoxylic suffrutices, often referred to as 'underground' or 'stunted' trees, are dwarf woody plants with annual or short-lived woody shoots sprouting from massive or extensive woody, perennial, underground axes (White 1977). Common examples of geoxylic suffrutices that occur in the woody grasslands of Maputaland are *Ancylobotrys petersiana*, *Diospyros galpinii, Elephantorrhiza elephantina*, *Eugenia albanensis, E. capensis, Maytenus nemorosa*, *Pachystigma venosum*, *Parinari capensis* subsp. *incohata* and *Salacia krausii*. MWG is also rich in plant species that are endemic to the Maputaland-Pondoland-Albany hotspot, one of the eight most important biodiversity regions in Africa (Steenkamp *et al.* 2005). A biodiversity hotspot is a region of significant biological richness and a high level of endemism which is threatened with destruction.

According to the Mucina & Rutherford (2006) map, the area west of Richards Bay, KwaZulu-Natal, is situated within the Maputaland Coastal Belt vegetation unit (CB1). The main aim of this account is to provide evidence of the occurrence of an outlying patch of MWG from this area, approximately 10 km southwest of its currently mapped southern distribution limit. MWG is not known to extend south of the Swamp Forests on the eastern side of Lake Mzingazi (Mucina & Rutherford 2006). It is necessary for this new locality to be officially recognised as of conservation importance and mapped, as it is part of the less than 10 % extent of this vegetation unit that has not been transformed in the south (Mucina & Rutherford 2006). Maddock & Benn (2000) highlighted the importance of re-assessing conservation-worthy areas of Zululand at a finer land-parcel scale, especially vegetation types not sufficiently protected by provincial authorities. Quantification is therefore required for the grassland of the study area to qualify as MWG before being considered as of conservation importance. Hence, the objectives of the study were 1, to document the floristic composition of this patch of MWG in the context of the surrounding vegetation; 2, compare its plant species composition with that of typical MWG as defined by Matthews *et al.* (1999) for Sileza Nature Reserve and other locally co-occurring grassland types of the Maputaland (CB1) and KwaZulu-Natal Coastal Belts (CB3); and 3, to map its new locality.

STUDY AREA

The study area comprises 873 hectares (8.73 km^2) of land west of Richards Bay, north of the John Ross Parkway (Highway) that connects the former with Empangeni (Figure 1). The precise locality is between latitude 28°45'36"S and 28°46'51"S, and longitude 31°58'14"E and 32°00'39"E. The terrain is slightly undulating. Geologically it consists of Cretaceous to Recent marine sediments, with shallow littoral and coastal dune deposits (Botha 1997). Mean height is 26 m a.s.l., with the highest points at ± 35 m and the lowest at 11 m. The area is drained by a network of interdune depressions that feed into numerous perennial pans just beyond the western and southern boundaries of the study area. Richards Bay lies in the subtropical zone of South Africa, with the mean annual rainfall > 1 000 mm and the mean annual temperature ± 21.5°C (Schultze 1982).

METHODS

Stratification of the study area was based on 1:50 000 stereo aerial photographs and topographical position

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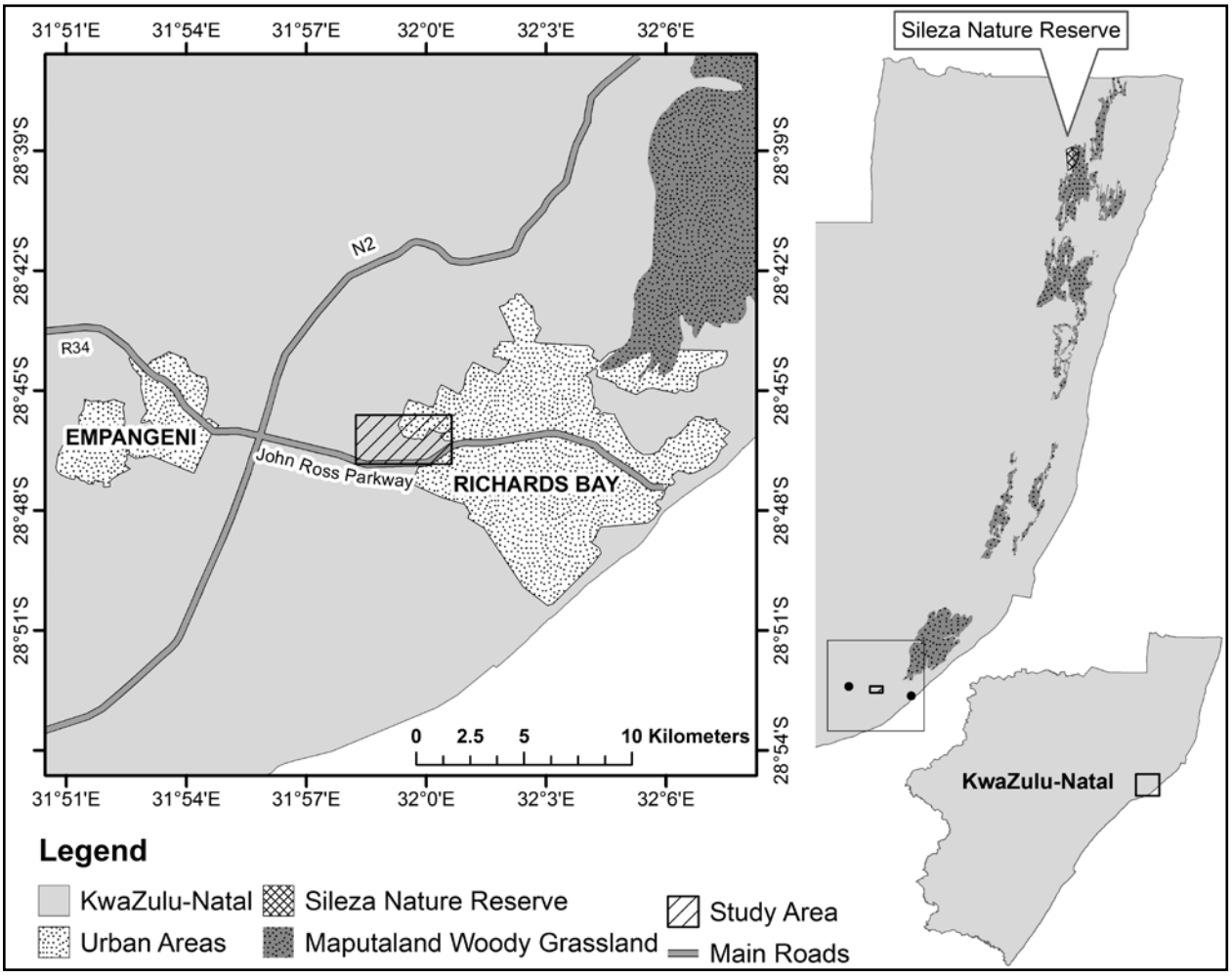

FIGURE 1.—Locality of study area at Richards Bay, KwaZulu-Natal.

using terrain types such as dune crests and interdune depressions. Relevés were compiled in 15 randomly placed sample plots within the study area. Five plots were placed in each of the three stratified homogeneous units. Cultivated and built up areas were excluded from the survey. For comparative purposes with Matthews *et al.* (1999), plot sizes were fixed at 100 m^2 (10 × 10 m). Within each sample plot, total floristic composition was recorded and a cover-abundance value assigned to each species according to the Braun-Blanquet scale (modified from Mueller-Dombois & Ellenberg 1974).

Braun-Blanquet procedures were used to refine the classification results of the TWINSPAN (Hill 1979) application using the MEGATAB computer programme (Hennekens 1996) and are presented in a phytosociological table (Table 1). The plant community names are derived from the names of the two most dominant species along with the prevailing vegetation structure or diagnostic growth form. Dominant alien species were not considered in the naming process as these taxa might in future be successfully removed from the plant community. Results from the classification and subsequent refinement were used to construct a 1:15 000 vegetation map for the study area (Figure 2). Mapping was done at plant community level in ArcMap™ of the Esri ArcGIS 9.1® computer package (ESRI 2006).

Floristic plot data from the study site and Sileza Nature Reserve, and the bordering KwaZulu-Natal Coastal Belt vegetation unit, were subjected to PRIMER (Clarke & Gorley 2001) to elucidate species turnover (spatial floristic change). This multivariate analyses technique represents a complex data matrix (samples and species) in a visual dimensional space, allowing for the assumption that plots clustered closer together resemble similar floristic composition. The derived ordination therefore represents the distance between each plot in rank order with their difference in species composition as determined by the dissimilarity coefficient (Williams 2005).

Average height (m) and canopy cover (%) of the tree, shrub and herbaceous layers were noted, and a mean value was calculated for each layer in each community. Environmental data recorded included aspect, altitude, slope, soil type, soil depth, terrain type, and rockiness of the soil surface (Table 2). Names of taxa and growth forms conform to Germishuizen *et al.* (2006). Some species, such as geophytes, especially the Orchidaceae and species of the Asclepiadoideae (Apocynaceae) could not be identified below genus level. Threatened species were identified from Scott-Shaw (1999), and updated with the latest re-assessments of the South African Red Data List (Raimondo *et al.* 2009).

TABLE 1.—Phytosociological table of 15 plots sampled from study area at Richards Bay, including 65 of 227 recorded species; 29 % of study area's flora

Species	Growth form	Woody Grassland					Woodland Mosaic					Hygrophilous Grassland				
		1	5	10	12	13	2	4	6	7	14	3	8	9	11	15
Species group A: *Parinari capensis–Digitaria natalensis* Woody Grassland																
Lobelia flaccida	Forb	+	1	+	+	+	-	-	-	-	-	-	-	-	+	-
Parinari capensis•	Suffrutex	A	1	+	1	+	+	-	-	-	-	-	-	-	-	-
Eugenia albanensis•	Suffrutex	1	1	+	+	+	1	-	-	-	-	-	-	-	-	-
Helichrysum kraussii•	Forb	-	+	1	+	+	+	-	-	-	-	-	-	-	-	+
Aristida junciformis	Grass	1	A	-	A	A	-	-	-	-	-	-	-	+	-	-
Diospyros galpinii•	Suffrutex	-	1	+	1	+	-	-	-	+	-	-	-	-	-	-
Helichrysum nudifolium	Forb	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-
Conostomium natalense	Forb	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-
Salacia kraussii•	Suffrutex	-	1	+	+	+	+	-	-	-	-	-	-	-	-	-
Hypoxis iridifolia	Forb	R	+	+	+	+	-	-	-	-	-	-	-	-	-	-
Oxygonum robustum•	Forb	R	+	+	-	+	-	-	-	-	-	-	-	-	+	-
Dactyloctenium aegyptium	Grass	1	-	+	-	+	1	-	-	-	-	-	-	-	-	-
Diospyros lycioides•	Shrub	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-
Helichrysum asperum	Forb	1	1	-	-	+	R	-	-	-	-	-	-	-	-	-
Tephrosia macropoda	Forb	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-
Tristachya leucothrix	Grass	-	A	A	1	+	-	-	-	-	-	-	-	-	-	-
Chamaecrista comosa•	Forb	-	+	+	-	-	-	-	-	-	-	+	-	-	-	-
Cissampelos hirta•	Forb	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-
Agathisanthemum bojeri•	Forb	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Species group B: *Trichilia emetica–Panicum maximum* Woodland Mosaic																
*Conyza canadensis**	Forb	-	-	-	-	-	+	+	+	+	+	-	-	-	-	-
Desmodium incanum	Forb	-	-	-	-	-	+	+	-	+	+	-	-	-	-	-
*Chromolaena odorata**	Shrub	+	-	-	-	-	-	1	+	+	-	-	-	-	-	-
Searsia nebulosa	Shrub	-	-	+	-	-	-	+	+	+	-	-	-	-	-	+
*Melia azederach**	Tree	-	-	-	-	-	+	1	+	-	+	-	-	-	-	-
Panicum maximum	Grass	-	-	-	-	-	-	A	+	A	-	-	-	1	-	-
Eugenia capensis	Shrub	-	-	-	+	-	+	-	-	+	+	-	-	-	-	-
Commelina benghalensis	Forb	-	-	-	-	-	-	+	-	+	+	-	-	-	-	-
Cyperus esculentus	Forb	-	-	-	-	-	+	-	-	+	+	-	-	-	-	-
Trichilia emetica	Tree	-	-	-	-	-	-	A	+	1	-	-	-	-	-	-
Melinis repens	Grass	+	-	-	-	-	1	-	1	+	-	-	-	-	-	-
Stenotaphrum secundatum	Grass	+	-	-	-	-	-	A	-	+	+	-	-	-	-	-
Species group C																
*Lantana camara**	Shrub	+	+	+	+	+	1	+	1	+	+	-	-	+	-	-
Hyphaene coriacea•	Tree	1	+	-	+	-	+	+	-	+	+	-	-	-	-	-
Dichrostachys cinerea•	Shrub	+	+	+	+	+	+	-	-	-	+	-	-	-	-	-
Smilax anceps	Forb	+	-	+	+	+	+	-	-	+	-	-	+	-	-	-
Vernonia centauroides	Forb	+	-	+	+	+	-	-	+	+	-	-	-	-	+	-
Chamaecrista mimosoides	Forb	-	+	+	-	+	+	-	-	+	-	-	-	+	-	-
Abrus precatorius	Forb	+	+	-	-	-	+	+	1	-	-	-	-	-	-	-
Asystasia gangetica	Forb	+	-	+	-	-	1	1	-	+	-	-	-	-	-	-
Raphionacme galpinii	Forb	R	+	-	-	-	R	-	-	+	-	-	-	-	-	-
Species group D: *Ischaemum fasciculatum–Imperata cylindrica* Hygrophilous Grassland																
Ischaemum fasciculatum	Grass	-	-	-	-	-	-	-	-	+	-	A	+	-	A	+
Pycreus polystachyos	Forb	+	-	-	-	-	-	-	-	-	-	1	+	-	+	+
Cyperus natalensis•	Forb	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+
Eragrostis inamoena	Grass	-	-	-	-	-	+	-	-	-	-	-	+	-	1	+
Juncus kraussii	Forb	-	-	-	-	-	-	-	-	-	-	+	1	+	-	+
Cyclosorus interruptus	Forb	-	-	-	-	-	-	-	-	-	-	-	A	-	-	1
Ethulia conyzoides	Forb	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+

Species	Growth form	Woody Grassland					Woodland Mosaic					Hygrophilous Grassland				
		1	5	10	12	13	2	4	6	7	14	3	8	9	11	15
Species group D: *Ischaemum fasciculatum–Imperata cylindrica* Hygrophilous Grassland (cont.)																
Abildgaardia hygrophila•	Forb	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
Dissotis canescens	Forb	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-
Species group E																
Senecio pterophorus	Forb	-	-	-	-	-	-	+	-	+	-	+	+	-	-	-
Desmodium dregeanum•	Forb	-	-	-	-	-	A	-	1	+	+	-	-	+	+	-
Cyperus solidus	Forb	+	-	-	-	-	+	-	-	+	1	+	+	-	-	+
*Eucalyptus grandis**	Tree	-	+	-	-	-	A	+	+	A	A	-	-	+	+	-
Panicum dregeanum	Grass	-	-	-	-	-	+	-	-	-	+	-	+	-	-	+
Gomphocarpus physocarpus	Forb	-	-	-	-	-	+	-	-	+	-	+	-	-	-	+
Species group F																
Cassytha filiformis	Forb	+	-	-	+	+	+	+	+	+	+	-	+	-	+	+
Chrysanthemoides monilifera	Shrub	+	-	+	+	+	1	+	+	+	+	-	+	-	-	+
Digitaria natalensis•	Grass	B	1	+	+	A	A	-	+	-	+	-	+	1	+	-
Centella asiatica	Forb	-	-	+	-	-	+	-	+	-	-	+	-	+	-	-
*Psidium guajava**	Shrub	+	+	1	-	+	-	-	1	+	+	+	1	1	-	+
Cymbopogon excavatus	Grass	+	-	1	-	-	-	-	1	-	-	-	+	-	-	-
Imperata cylindrica	Grass	1	-	-	1	-	-	-	+	-	-	1	A	1	3	A
Conyza ulmifolia	Forb	+	+	-	-	+	-	-	-	+	-	-	+	-	+	+
Cheilanthes viridis	Forb	+	-	+	-	-	+	-	-	-	+	-	-	+	-	-
Crotolaria lanceolata	Forb	+	-	+	-	-	-	-	+	-	-	-	+	-	-	-
Syzygium cordatum	Tree	-	+	-	-	-	+	-	-	+	-	-	+	-	-	-

*, introduced alien (exotic) species (Henderson 2006); •, typical, frequently occurring Maputaland Woody Grassland species (Mucina & Rutherford 2006). Braun-Blanquet scale adapted and modified from Mueller-Dombois & Ellenberg (1974): R, rare, only one individual recorded; +, > 1 individual, total cover of 1 %; 1, > 1 individual, total cover of 2–5 %; 2A, abundant, total cover of 6–12 %; 2B, abundant, total cover of 13–18 %; 3, abundant, total cover of 19–25 %.

RESULTS AND DISCUSSION

Classification

Three plant communities were identified, classified, described and mapped. Boundaries are not precise, but follow broad patterns. Especially the boundaries between Woody Grassland (plant community 1) and Hygrophilous Grassland (plant community 2) are obscure due to the mosaic nature of the vegetation.

The vegetation structure of these plant communities can be described as open, rolling grassland with scattered patches of mixed woodland and interspersed with shallow seasonal wetlands. All the plant communities are dependent on specific environmental gradients that are determined by soil type, moisture regime and past land use. Higher-lying grassland is characterized by geoxylic suffrutices. Hygrophilous grassland occurs along most interdune depressions. Indigenous and alien trees became established within remnants of old plantations and wet, disturbed sites. An ordination of the floristic data set of 15 plots (227 species) revealed three distinct assemblages of species or plant communities in the study area (Figure 3): 1, *Parinari capensis–Digitaria natalensis* Woody Grassland on crest of dunes; 2, *Trichilia emetica–Panicum maximum* Woodland Mosaic; and 3, *Ischaemum fasciculatum–Imperata cylindrica* Hygrophilous Grassland of interdune depressions.

Descriptions

The vegetation of the study area is characterized by plant communities representing two major vegetation units known as Maputaland Coastal Belt and MWG (Mucina & Rutherford 2006). These are unique systems comprising their own species complement, which have been shown to be determined by soil structure, soil depth and past land use (Matthews *et al.* 1999; Siebert *et al.* 2004). At local scales, such as the study site, variations in these environmental factors may result in many different habitat types.

1. *Parinari capensis–Digitaria natalensis* Woody Grassland on crest of dunes

This community is related to the *Themedo–Salacietum* Woody Grassland (Myre 1964) and Maputaland Wooded Grassland (Mucina & Rutherford 2006).

Environmental data: locally this grassland type occurs at an altitude of 30–34 m on the crests of dunes (level slope of 1–3°). The soil is sandy, with bare patches representing 10–25 % of sampled areas (Table 2). This Woody Grassland is prominent on the eastern side of the study area, but its prominence fades towards the western end, and when in close proximity to the other two plant communities. Woody Grassland and Hygrophilous Grassland of seasonally wet areas form an intricate mosaic, difficult to map at such a fine scale (Figure 2). Land use of this grassland is mainly grazing by roving livestock and duiker. Human activities include hunting with dogs and quad biking. The community also does not extend south of the John Ross Parkway (Highway), as in the west it is bordered by vast tracts of sugar cane plantations, in the south by an extended wetland system and in the southeast by a mine dump.

TABLE 2.—Locality data, environmental factors and vegetation structure of each sample plot/plant community

Community	Woody Grassland					Woodland Mosaic					Hygrophilous Grassland				
Plot	1	5	10	12	13	2	4	6	7	14	3	8	9	11	15
Date (d-m-2007)	08-05	08-05	09-05	09-05	09-05	08-05	08-05	08-05	08-05	09-05	08-05	09-05	09-05	09-05	09-05
Co-ordinates:															
South 28°	46'06"	46'12"	46'16"	46'06"	46'14"	45'56"	46'18"	46'01"	46'10"	46'10"	45'59"	46'20"	46'16"	46'05"	46'13"
East 31°	59'19"	58'50"	59'13"	58'58"	59'00"	59'13"	58'59"	59'03"	59'23"	59'04"	59'14"	59'16"	59'16"	58'57"	59'24"
Elevation (m)	31	32	31	34	30	32	30	31	28	28	25	23	28	24	26
Slope (°)	1	2	1	3	1	1	2	1	1	2	0	2	1	0	1
Rock (%)	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
Bare soil (%)	10	15	10	10	25	30	10	5	10	40	0	0	5	30	0
Land use	Grazed	None	None	Quads	None	Timber	None	Burn	Timber	Timber	None	None	None	None	None
Soil texture	Sand	Sand	Sand	Sand	Sand	Sand	Sand	Red clay	Sand	Sand	Sand	Humus sand	Sand	Sand	Humus sand
Mean height (m):															
Non-tree	0.5	0.5	0.7	0.4	0.5	0.4	0.6	0.5	0.6	0.3	0.5	1	0.5	0.5	0.5
Tree	2.5	5	2	2	2	6	10	11	8	8	1.5	2	4	4	2
Cover (%):															
Grasses	50	30	70	70	50	30	10	70	60	5	80	70	70	90	90
Forbs	30	30	20	15	30	10	20	20	10	10	10	30	10	5	10
Trees	10	20	5	5	0	40	70	50	50	50	0	5	5	10	5
Species/plot (100 m^2)	59	52	49	45	49	45	38	37	41	22	17	34	25	26	36

Species data: species richness was high (Table 2), ranging from 45 to 59 species/100 m^2 (mean: 50). Forbs are the most dominant growth form with 33 species, also the most recorded for any community in the study area (Figure 4). Trees are rare in this grassland, but where present they have a mean cover of 10 % per sample plot and are up to 5 m tall. The grass layer has a cover of up to 70 % and the forb layer up to 30 %. Suffrutices occur frequently, but was estimated to have a cover of less than 10 %. The non-tree layer, which includes forbs, grasses and geoxylic suffrutices has a mean height of 0.5 m.

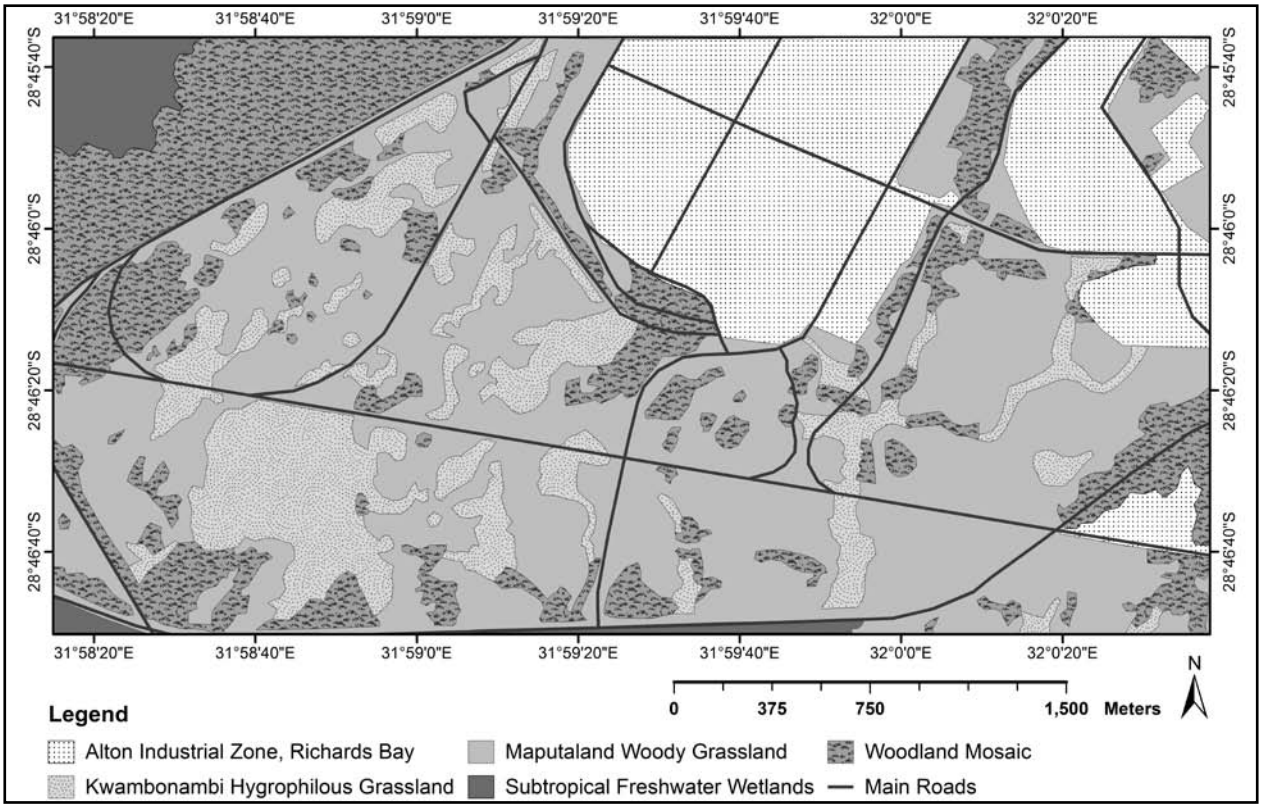

FIGURE 2.—Vegetation map of study area.

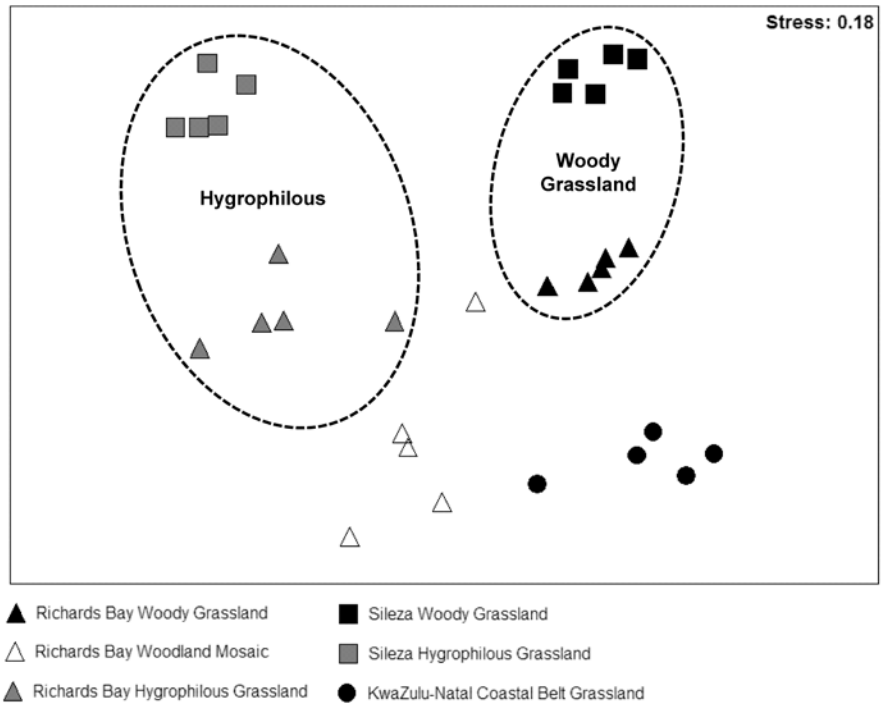

FIGURE 3.—Ordination of sample plots from study area in Richards Bay, Sileza Nature Reserve (Matthews *et al.* 1999), and Mtunzini (KwaZulu-Natal Coastal Belt Grassland).

Diagnostic species: the geoxylic suffrutices *Diospyros galpinii*, *Eugenia albanensis*, *Parinari capensis* and *Salacia kraussii*, the forbs *Conostomium natalense, Helichrysum kraussii*, *H. nudifolium*, *Hypoxis iridifolia*, *Lobelia flaccida* and *Oxygonum robustum*, and the grasses *Aristida junciformis*, *Dactyloctenium aegyptium* and *Tristachya leucothrix* (Table 1, species group A).

Species which are specifically shared with Woodland Mosaic include the trees *Hyphaene coriacea* and *Dichrostachys cinerea*, and conspicuous forbs such as *Abrus precatorius*, *Asystasia gangetica* and *Smilax anceps* (Table 1, species group C). Frequently occurring species shared with the other plant communities include the shrub *Chrysanthemoides monilifera*, and the grass *Digitaria natalensis* (Table 1, species group F), the latter which is also the most dominant species in this community. Invasive alien species that occur frequently on dune crests are stunted forms of *Lantana camara* (Table 1, species group C) and *Psidium guajava* (Table 1, species group F).

2. *Trichilia emetica–Panicum maximum* Woodland Mosaic

Environmental data: this woodland occurs at a mean altitude of 28–32 m above sea level on dunes (level slope of 1 or 2°) and is usually in close proximity to depressions where water accumulates (suggesting preference for higher water tables). The soil is sandy, except for a man-made embankment (supporting a road) of red clay that bisects the western part of the study area. Bare patches generally make up 5–40 % of sampled areas (Table 2). The embankment is the only habitat containing rocks. The Woodland Mosaic is often on the edges of the study area forming large, continuous clumps, which is interspersed by numerous smaller, scattered patches. Large clumps are probably remnants of commercial *Eucalyptus* plantations that

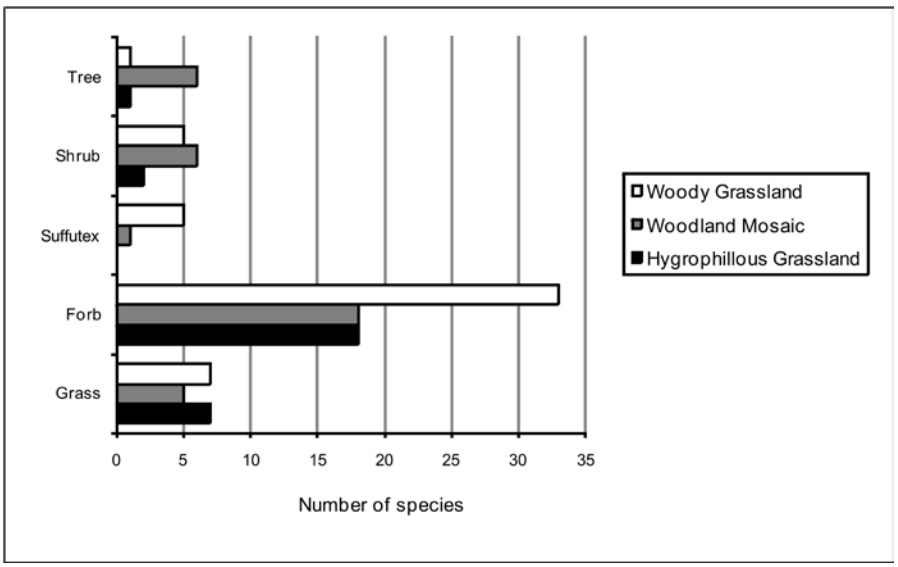

FIGURE 4.—No. species recorded for each of growth forms associated with plant communities of study area.

are no longer managed. The smaller patches were natural woodlands that have been invaded by alien trees, shrubs and forbs. Land use of this woodland is mainly associated with informal wood harvesting. The widely scattered plots of this community on the ordination suggest a high beta-diversity (Figure 3). This is probably because this community includes invaded woodlands, Woody Grassland and Hygrophilous Grassland, but the original plant communities here have been highly altered, resulting in a new community, the Woodland Mosaic.

Species data: species richness varies considerably between 22 to 45 species/100 m^2 (mean: 37) (Table 2). Although forbs are also conspicuous in this plant community, the Woodland Mosaic has the highest number of tree (6) and shrub (6) species in the study area (Figure 4). Trees predominate in this woodland, reaching up to 11 m in height and on average cover ± 50 % per sample plot (Table 2). The grass layer has a cover of up to 70 % and the forb layer up to 20 %. The non-tree layer, which includes forbs and grasses, has a mean height of 0.4 m.

Diagnostic species: the woody species *Eugenia capensis*, *Searsia nebulosa* and *Trichilia emetica*, the naturalized weed *Conyza canadensis*, the forbs *Cyperus esculentus* and *Desmodium incanum*, and the grasses *Melinis repens*, *Panicum maximum* and *Stenotaphrum secundatum* (Table 1, species group B).

Species commonly present, which are also shared with Hygrophilous Grassland, include the forbs *Cyperus solidus* and *Desmodium dregeanum*, and the grass *Panicum dregeanum* (Table 1, species group E). Species found in Woodland Mosaic which are also present in other plant communities include the tree *Syzygium cordatum*, the forb *Centella asiatica* and the fern *Cheilanthes viridis* (Table 1, species group F). Invasive alien species that occur frequently in the woodlands are *Chromolaena odorata*, *Eucalyptus grandis*, which is locally dominant, *Lantana camara* and *Melia azederach*.

3. *Ischaemum fasciculatum–Imperata cylindrica* Hygrophilous Grassland of interdune depressions

This community is related to the *Ischaemum fasciculatum–Eragrostis inamoena* Hygrophilous Grassland (Matthews *et al.* 1999), *Ischaemum fasciculatum–Centella asiatica* Hygrophilous Grassland (Lubbe 1997), Maputaland Coastal Belt in part (Mucina & Rutherford 2006) and Kwambonambi Hygrophilous Grasslands (Goodman 2007).

Environmental data: this grassland type is associated with interdune depressions at an altitude of 23 to 28 m (slope of 1° or less). It comprises the drainage lines of the study area that feed into a network of scattered, small seasonal pans outside the study site. Many of the drainage lines are invaded by alien woody species and are classified as part of Woodland Mosaic (e.g. plots 7 and 14). The soil is sandy, often humus-rich. Bare patches are rare for most sample plots of interdune depressions, but plot 11 has 30 % bare area (Table 2). The occurrence and abundance of Hygrophilous Grassland is not surprising due to the proximity of the study site to the vast Subtropical Freshwater Wetlands (Mucina & Rutherford 2006) of Richards Bay.

Species data: species richness varies between 17 and 36 species/100 m^2 (mean: 25) (Table 2). Forbs occur frequently in this community, but Hygrophilous Grassland, like the Woody Grassland, has eight grass species (Figure 4). Trees are not abundant with up to 10 % cover per sample plot and reaching a height of 4 m. The grass layer has a dense cover of up to 90 % and the forb layer up to 30 %. The non-tree layer, which includes forbs and grasses has a mean height of 0.5 m.

Diagnostic species: the sedges *Abildgaardia hygrophila*, *Cyperus natalensis*, *Juncus kraussii* and *Pycreus polystachyos*, the forbs *Dissotis canescens* and *Ethulia conyzoides*, the fern *Cyclosorus interruptus*, and the grasses *Eragrostis inamoena* and *Ischaemum fasciculatum* (Table 1, species group D).

Species which are also found in other plant communities include the forb *Conyza ulmifolia*, and the locally dominant grass *Imperata cylindrica* (Table 1, species group F). An invasive alien species that occurs frequently in wet areas is *Psidium guajava* (Table 1, species group F).

Rare, threatened and endemic plant species

The vegetation units of the Maputaland Coastal Belt and MWG are not protected extensively in many statutory conservation areas due to its high potential for commercial timber and sugar cane plantations (Steenkamp *et al.* 2005), and in the Richards Bay area specifically due to shortage of land for industrial development. Currently, only 17 % of this habitat type is conserved in South Africa and this habitat type is endangered (Mucina & Rutherford 2006).

Red Data plant species are known from the same quarter-degree grids as the study area (2831DD, 2832CC). According to Scott-Shaw (1999) there are two threatened endemic species that could occur in this type of grassland, namely *Asclepias gordon-grayae* (Endangered) and *Kniphofia leucocephala* (Critically Endangered). These species are threatened by multiple factors, including timber and sugar cane plantations, and urbanization. Neither species was recorded during the survey.

Some of the species recorded during this survey are regarded by Mucina & Rutherford (2006) to be of regional biogeographical importance and have grouped *Abildgaardia hygrophila*, *Cyperus natalensis*, *Desmodium dregeanum* and *Eugenia albanensis* as Coastal Belt Elements, *Albertisia delagoensis* and *Cissampelos hirta* as Southern Distribution Limits, and *Oxygonum robustum* as a Maputaland Endemic (which also includes Mozambique and Swaziland).

Endemic species are internationally regarded as important focal taxa to establish critical habitat for conservation priority (Leon-de la Luz & Breceda 2006). Fifteen species endemic to South Africa (Germishuizen *et al.* 2006), and specifically the coastal areas, were recorded in the study area. The endemic species complement consists of one tree, *Acacia kosiensis*, one geoxylic suffrutex, *Eugenia albanensis*, and 13 forbs (Table 3). Twelve South African endemics occur in the Woody Grassland of the study area, of which eight species are

TABLE 3.—Species considered as South African endemics or Maputaland Woody Grassland floristic elements, represented by 34 of 227 recorded species; 15 % of study area's flora

Species	Growth form	*Status	**Occurrence		
			Woody Grassland	Woodland Mosaic	Hygrophilous Grassland
Acacia kosiensis	Tree	RSA endemic	-	abundant	-
Acalypha ecklonii	Forb	RSA endemic	-	occasional	-
Agathisanthemum bojeri	Forb	MWG element	occasional	-	-
Ancylobotrys petersiana	Suffrutex	MWG element	occasional	-	-
Aristida stipitata	Grass	MWG element	very abundant	-	occasional
Chamaecrista plumosa	Forb	MWG element	frequent	-	occasional
Clutia cordata	Forb	RSA endemic	occasional	-	-
Crotalaria dura	Forb	RSA endemic	occasional	-	-
Cyperus obtusiflorus	Forb	MWG element	occasional	-	-
Dichrostachys cinerea	Shrub	MWG element	abundant	occasional	-
Digitaria natalensis	Grass	MWG element	very abundant	abundant	abundant
Diheteropogon amplectens	Grass	MWG element	occasional	-	-
Diospyros galpinii	Suffrutex	MWG element	very abundant	occasional	-
Diospyros lycioides	Shrub	MWG element	abundant	-	-
Eriosema preptum	Forb	RSA endemic	occasional	-	-
Eugenia albanensis	Suffrutex	RSA endemic	very abundant	frequent	-
Eugenia capensis	Shrub	MWG element	occasional	frequent	-
Gnidia calocephala	Forb	RSA endemic	frequent	-	-
Helichrysum allioides	Forb	RSA endemic	occasional	-	-
Helichrysum asperum	Forb	RSA endemic	abundant	rare	
Helichrysum auriceps	Forb	RSA endemic	occasional	-	-
Helichrysum kraussii	Forb	MWG element	very abundant	occasional	occasional
Hyphaene coriacea	Tree	MWG element	abundant	abundant	-
Parinari capensis	Suffrutex	MWG element	very abundant	occasional	-
Raphionacme lucens	Forb	RSA endemic	occasional	-	-
Raphionacme palustris	Forb	RSA endemic	occasional	-	-
Rhynchosia stenodon	Forb	RSA endemic	-	occasional	-
Salacia kraussii	Suffrutex	MWG element	abundant	occasional	-
Selago tarachodes	Forb	RSA endemic	occasional	occasional	occasional
Senecio erubecens	Forb	RSA endemic	frequent	-	occasional
Setaria sphacelata	Grass	MWG element	frequent	-	-
Syzygium cordatum	Tree	MWG element	occasional	frequent	occasional
Themeda triandra	Grass	MWG element	frequent	-	-
Urelytrum agropyroides	Grass	MWG element	frequent	-	-

* RSA endemic, species endemic to South Africa; MWG element, floristic element of Maputaland Woody Grassland; ** occurrence: rare, < 5; occasional, 5–10; frequent, 11–30; abundant, 31–60; very abundant, > 60.

locally restricted to it. The four species shared with the other two plant communities are *Eugenia albanensis*, *Helichrysum asperum*, *Selago tarchodes* and *Senecio erubescens*. *Acacia kosiensis*, *Acalypha ecklonii* and *Rhynchosia stenodon* are South African endemics found in the study area, but do not occur in the Woody Grassland.

Of the 133 species recorded for the Woody Grassland of the study area, 19 species, or 14 %, are regarded as floristic elements of MWG by Mucina & Rutherford (2006). This includes the trees *Hyphaene coriacea* and *Syzygium cordatum*, the shrubs *Dichrostachys cinerea* and *Diospyros lycioides*, the geoxylic suffrutices *Ancylobotrys petersiana*, *Diospyros galpinii*, *Eugenia capensis*, *Parinari capensis* and *Salacia kraussii*, the forbs *Aga-*

TABLE 4.—Three most dominant species recorded for each plant community of study area, with mean cover % per species per plant community. Data from Matthews *et al.* (1999) has been included for comparative purposes

Species	Richards Bay			Sileza Nature Reserve	
	WG	WM	HG	WG	HG
Chaetacanthus burchellii	40*	0	0	0	0
Digitaria natalensis	32•	16	14	4	0
Aristida stipitata	30+	0	4	18	0
Centella asiatica	20	40*	40*	0	16
Chrysanthemoides monilifera	16	22•	8	8	0
Desmodium incanum	0	20+	0	0	0
Imperata cylindrica	12	4	40*	0	0
Hemarthria altissima	0	4	24•	0	10
Themeda triandra	6	0	0	34*	0
Parinari capensis	28	4	0	30•	0
Diheteropogon amplectens	8	0	0	24+	0
Ischaemum fasciculatum	0	0	12	0	48*
Sorghastrum stipoides	0	0	0	0	28•
Eragrostis inamoena	0	4	14	0	24+

WG, Woody Grassland; WM, Woodland Mosaic; HG, Hygrophilous Grassland; * greatest dominance of species per vegetation type; • second greatest dominance; + third greatest dominance.

thisanthemum bojeri, *Chamaecrista plumosa*, *Cyperus obtusiflorus* and *Helichrysum kraussii*, and the grasses *Aristida stipitata*, *Digitaria natalensis*, *Diheteropogon amplectens*, *Themeda triandra*, *Setaria sphacelata* and *Urelytrum agropyroides* (Table 3).

Species composition and diversity

Siebert *et al.* (2004) showed that Woody Grassland has the highest beta-diversity of grasses of all the coastal vegetation units of Maputaland. This implies that the turnover of grass species is high between different localities of MWG. Therefore, although the Richards Bay locality is characterized by dominant species not only found in MWG (Table 4), it still fits the definition (White 1977), since it is characterized by the presence of geoxylic suffrutices. In the case of the Richards Bay locality, eight geoxylic suffrutices were recorded from the dunes, namely *Ancylobotrys petersiana* (occurring in 20 % of plots), *Diospyros galpinii* (80 %), *Elephantorrhiza elephantina* (20 %), *Eugenia albanensis* (100 %), *Maytenus nemorosa* (40 %), *Pachystigma venosum* (20 %), *Parinari capensis* subsp. *incohata* (100 %), and *Salacia kraussii* (80 %). The presence of these species in association with Maputaland Centre endemics typically found in MWG, such as *Oxygonum robustum* (Mucina & Rutherford 2006), further strengthens our appeal to recognise the Richards Bay locality as containing true MWG.

This argument is supported by an ordination (Figure 3) that relates the species composition of the different plant communities. The stress value is lower than 0.2, suggesting that the ordination is meaningful (Clarke & Gorley 2001). Although all of the plant communities are clearly grouped (Figure 3), it is evident that Woody Grassland from the Richards Bay locality is not identical to typical Woody Grassland at Sileza 300 km further north, as the ten plots are not grouped but separated in two groups of five. However, it does show that the two Woody Grassland communities are most closely related based on the shortest distance (least dissimilarity) being recorded between these two plant communities (Figure 3). The species composition of the Woody Grassland at Richards Bay showed higher dissimilarity with the Hygrophilous Grassland of interdune depressions at Richards Bay and Sileza, and the KwaZulu-Natal Coastal Belt grassland of the hills near Mtunzini. One Woodland Mosaic sample plot (plot 2) at Richards Bay is probably a Woody Grassland community invaded by alien woody species, hence its outlying position (Figure 3).

Kwambonambi Hygrophilous Grassland

The study area has recently been demarcated as priority conservation land, as it supposedly contained remnants of a highly threatened and endemic terrestrial ecosystem referred to as Kwambonambi Hygrophilous Grassland (KHG) (Goodman 2007). However, Mucina & Rutherford (2006) make no mention of such a vegetation unit, which suggests that it has been included within another vegetation unit. It is this situation that requires further clarification, as KHG is often mistakenly considered by some as MWG, because the former occurs in a mosaic with the latter as shown before (Siebert *et al.* 2004). KHG is associated with inter-dune depressions and MWG with dune crests. These two units correspond to the definitions provided for Woody Grassland and Hygrophilous Grassland respectively in the land-cover classification system for Maputaland (Smith *et al.* 2008).

MWG is well documented in the literature, and easy to distinguish from other grassland types such as Hygrophilous Grassland (Myre 1964; Matthews *et al.* 1999). KHG is poorly defined in the literature, because large tracts of land previously considered as Hygrophilous Grassland have been transformed with *Eucalyptus* plantations and, hence, its composition and boundaries are poorly documented and difficult to determine. KHG is known as the habitat of a set of threatened species considered to be endemic, defined as wet areas such as seasonal pans and interdune depressions (Scott-Shaw 1999). Such habitat types are not typical for MWG, as shown in this paper. We therefore suggest that what we mapped as *Ischaemum fasciculatum–Imperata cylindrica* Hygrophilous Grassland in this paper is what is generally referred to as KHG. It, together with other vegetation types, is included as part of what Mucina & Rutherford (2006) refer to as the Maputaland Coastal Belt vegetation unit (CB1). MWG grassland also forms part of this vegetation unit, although Mucina & Rutherford (2006) probably described it as a separate unit due to its peculiar complement of suffrutices.

CONCLUSION

This site-specific study revealed a vegetation structure and floristic diversity that corresponds to the descriptions of MWG made by Matthews *et al.* (1999). This paper confirms that MWG, a limited and threatened ecosystem, has an extent of occurrence that stretches west of Richards Bay, where it probably forms

the southernmost outlier population of the vegetation unit in the Indian Ocean Coastal Belt Biome (Van Wyk & Smith 2001). This mapped range extension of MWG will be made available to the National Vegetation Map Committee to assist in ongoing improvements to the electronic version of the national vegetation map. Another threatened ecosystem, KHG, also occurs extensively at the study site. In an urbanized and already fragmented landscape, it is important to maintain and protect such important ecosystems (Leon-de la Luz & Breceda 2006). Careful management of this patch of MWG and KHG as a green belt within a fragmented industrial zone can transform it into valuable sites in terms of biodiversity conservation (Tang *et al.* 2007).

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