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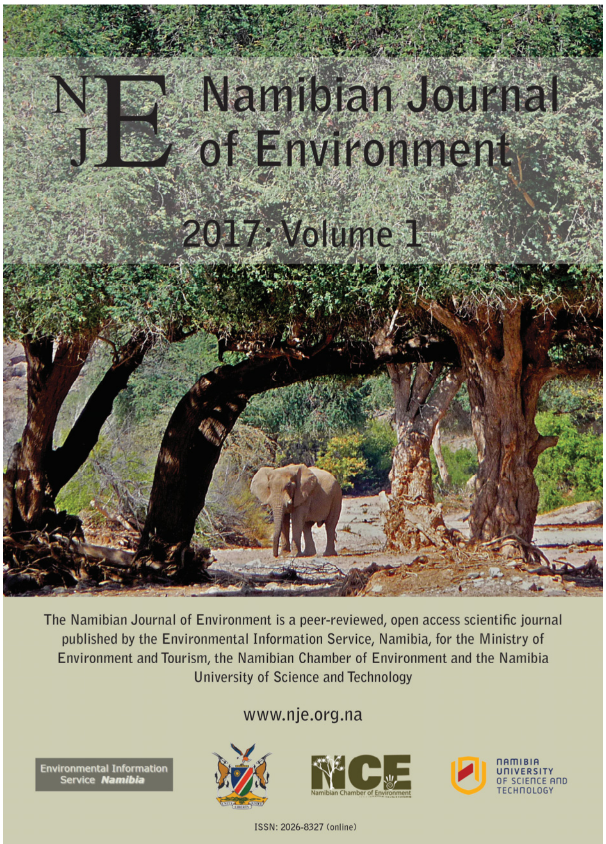

SECTION A: PEER-REVIEWED PAPERS

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Vegetation of the Auas-Oanob Conservancy in the Khomas Hochland of Namibia

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ABSTRACT

The Auas-Oanob Conservancy is situated in the very rugged, botanically highly diverse Khomas Hochland in central Namibia. A number of vegetation-related studies have been undertaken in this highland before, but none covering the full extent of the conservancy, and with different interpretations of the syntaxonomy of the vegetation. The current study aimed to describe and map the vegetation of the conservancy for practical management purposes. A total of 229 relevés was compiled within the conservancy, and 72 relevés from other studies (falling either within the conservancy, or the nearby Auas Mountain range) were added. The data were classified with a Modified TWINSPAN. Three large groups were identified: (a) the high-altitude veld of the Auas Mountain range, with three associations being recognised on the basis of altitude and aspect; (b) the lowlands and valley veld with five associations, and (c) the Khomas Hochland veld with five associations. These 13 associations are described, mapped and compared to descriptions of the vegetation in the vicinity of the conservancy. A higher-order syntaxonomy, with three orders, one subdivided into two alliances, is suggested. This higher-order syntaxonomy needs to be further investigated, taking into account vegetation descriptions of the greater Khomas Hochland. The high-altitude veld of the Auas Mountain range has a unique composition with a high degree of endemisim and a sub-alpine character. Due to its restricted range, there is an urgent need for formal protection. Two associations within the lowland and valley veld are under threat, being the *Platycarphella carlinoides—Chloris virgata* association of the *omiramba* (erosion) and the *Schmidtia kalahariensis—Acacia erioloba* association in the bottom lands at Omeya (development). Bush encroachment is a general threat to various upland associations.

Keywords: Auas Mountains; freehold conservancies; Highland Savanna; Khomas Hochland; phytosociology; vegetation classification; Namibia

INTRODUCTION

The Auas-Oanob Conservancy consists of a cluster of freehold (commercial) farms south and south-west of Windhoek (Figure 1a), with a total area of 105,644 ha (Shaw & Marker 2010). The farms are used mainly for cattle farming, but horse breeding, game farming, hunting and ecotourism are also practised. In forming a freehold conservancy, the owners subscribe to the principle of "...a legally protected area of a group of land-occupiers practicing co-operative management based on a sustainable utilisation strategy, promotion of the conservation of natural resources and wildlife, and the desire to reinstate the original biodiversity with the basic goal of sharing resources amongst all members" (Shaw & Marker 2010). With more than 88% of all wildlife in Namibia occurring outside national parks, it was deemed necessary to form such conservancies to aid in the protection and sustainable utilisation of this renewable natural resource (NACSO 2010, Shaw & Marker 2010).

The Auas-Oanob Conservancy is situated in the *Khomas Hochland* ('Khomas Highland', often referred to as the 'Central Highlands') in central Namibia. This very rugged, high altitude (reaching 2,000 m asl) landscape was formed through extensive faulting and erosion of the soft schists of the Damara Sequence, and forms a broad south-west to north-east oriented band through central Namibia (Swart & Marais 2009). The ruggedness of the landscape gives rise to a plethora of habitats, which, in turn, result in a high diversity of plant and animal species (Craven 2001, Mendelsohn et al. 2002). Giess (1998) referred to the vegetation of this landscape as the 'Highland savanna'.

To date, three studies have been undertaken to describe portions of this Highland savanna vegetation type: (a) Volk and Leippert (1971) studied the farms Binsenheim and Voigtland to the south-east and east of Windhoek; (b) Kellner (1986) reported on the Daan Viljoen Game Reserve, as well as portions of the farms Claratal and Bergvlug (west, south-west and east of Windhoek) and (c) Burke and Wittneben

(2007) investigated the Auas Mountain range south of Windhoek. Burke and Wittneben (2007) give an overview of composition and structure of the high-altitude Auas Mountain range vegetation, but provide no formal classification. Both Volk and Leippert (1971) and Kellner (1986) provide phytosociological descriptions of the vegetation at lower elevations in similar habitats, however, they differ in interpretation and syntaxonomy of the vegetation. Kellner (1986) describes the vegetation of the northern part of the farm Claratal as dominated by the *Acacia hereroensis—Brachiaria nigropedata*[1] savanna. This is the only part of the Auas-Oanob Conservancy that has an existing description of the vegetation.

This study aims at describing and mapping the vegetation of the entire Auas-Oanob Conservancy in order to serve as baseline information for the management of this important resource.

STUDY AREA

Topography and geology

The Lichtenstein Mountains, which form a southern extension of the Auas Mountain range, dominate the landscape of the central-eastern part of the conservancy. The highest peaks of the Lichtenstein mountains rise to 2,400 m, whereas the Molkteblick, as highest peak in the Auas Mountains, rises to 2,450 m (Jarvis et al. 2008). To the east, these taper out into the Omeya valley, which is closed in the far south-east of the study area by the Oamites Mountain.

To the west of the Lichtenstein Mountains, an undulating plateau forms the upper catchment of the Oanob River. This catchment is characterised by a number of *omiramba* (flat watercourses without discernable gradients - King 1963, Strohbach 2008), which feed into the endoreic Oanob river. The Oanob plateau ends in the north-west along the watershed to the Kuiseb valley, which forms the typical moderately steep to steep mountainous highland of the Khomas Hochland. To the south and south-west of the Oanob plateau, the mountainous highland of the Khomas Hochland sets in again, less steeply, forming a rolling landscape.

The geology is dominated by various formations of the Damara Sequence. The Oanob plateau and adjacent Kuiseb catchment are formed by highly erodible quartz-biotite (‘mica’) schists of the Kuiseb Formation (Geological Survey 1980, South African Committee for Stratgraphy 1980). The Auas Mountains and Lichtenstein Mountains form a band of the Auas Formation, which consists of interbedded layers of quartzite. To the south of the Auas Formation is an extensive band of the Chuos Formation, bounded by a narrow band of the Kudis Subgroup. Both these formations are also characterised by schists, whilst the Chuos Formation contains a variety of other lithological layers (South African Committee for Stratigraphy 1980). The Aris / Omeya valley is underlain by gneisses and schists of the Hohewarte Complex, which is to the south, overlain by quaternary alluvial deposits (South African Committee for Stratigraphy 1980). In the far south, the Oamites mountain forms part of the Billstein Formation, characterised by grey quartzites and acidic igneous rocks (South African Committee for Stratigraphy 1980).

Climate

The climate of the Auas-Oanob Conservancy can best be described as a subtropical steppe climate (BS), following Köppen (1936). The mean annual rainfall ranges from below 300 mm in the far south-west to about 350 mm in the north-east (Figure 1a). No information is available on the orographic effect of the high mountain ranges on the precipitation, but it is expected to be considerable. Temperatures can rise to about 36°C in summer, whilst frost can be expected during the winter months from May till as late as October (Figure 2).

METHODS

Field survey

Surveying followed the general method employed for the Vegetation Survey of Namibia project (Strohbach 2001, 2014). Sampling of 229 plots throughout the study area took place during April 2000 and again in April 2002. At each survey plot of 20 x 50 m, a Braun-Blanquet type relevé was compiled. All vascular plant species occurring were noted down, as well as their typical growth forms and estimated crown cover. Habitat descriptors included: the position, by way of a GPS-reading (referenced to Schwarzeck), the landscape, local topography, slope and aspect, lithology, degradation indicators, as well as a photograph. Unknown species and reference specimens were collected, identified and deposited at the National Herbarium of Namibia (WIND). The relevé data were captured on TurboVeg (Hennekens & Schaminée 2001). The data form part of GIVD AF-NA-001 (Dengler et al. 2011, Strohbach & Kangombe 2012). Two further sets of data were available for the northern part of the conservancy: 19 relevés compiled by Kellner (1986) on the farm Claratal (also part of GIVD AF-NA-001), as well as

[1] Recent name changes to the genus *Acacia* (Kyalangalilwa et al. 2013) have not been recognised by prevailing taxonomic literature in Namibia (Klaassen & Kwembeya 2013). To avoid confusion, also in the reference to older vegetation descriptions, the name *Acacia* is thus used throughout this paper. Alternative names are provided in the appendices.

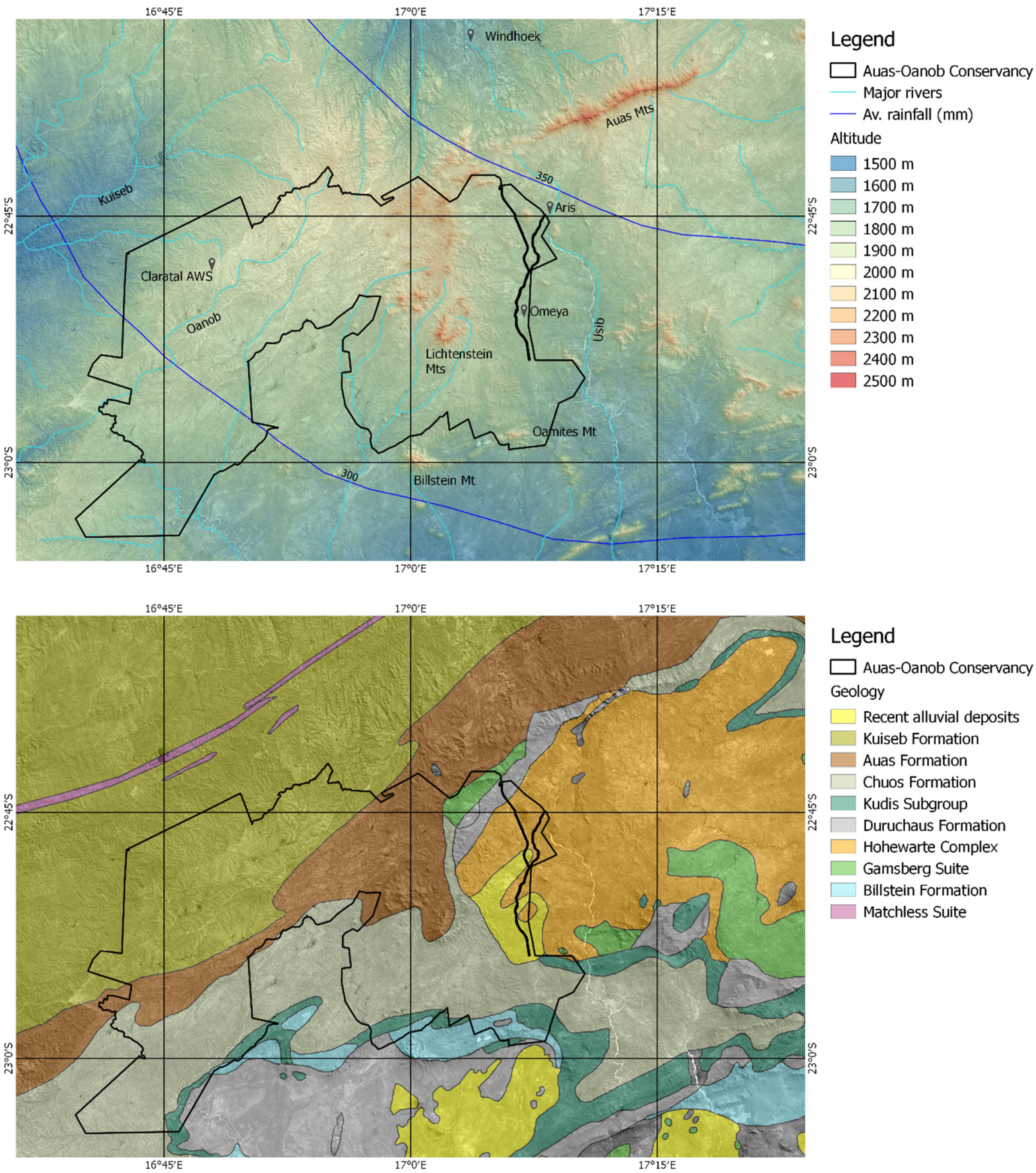


Figure 1a *(above): Altitude and topography of the study area.* ***1b*** *(below): Geological formations of the study area. Data sources: background image: LandSat TM scene path 178 row 076 band 7, dated 4 May 2001; Auas-Oanob Conservancy boundaries: "Environmental Information Service Namibia" (2014); DEM for altitude map: Jarvis et al. (2008); rainfall isohyets and rivers: (NARIS 2001); geological information: Geological Survey (1980).*

19 relevés from the Claratal BIOTA observatory (Jürgens et al. 2010, forming part of AF-00-003 - Muche et al. 2012), collected in 2005 by the author of this paper. As the high Lichtenstein mountains form a southern extension of the Auas mountain range, 34 relevés available as part of GIVD AF-NA-001 from Burke and Wittneben (2007), collected in 2004 in the Auas mountains, were also included in the extended data set.

Essential differences in data collecting were as follows: Kellner (1986) collected his relevés on a 625 m^2 plot (25 x 25 m). His original field notes were not available: the data were captured from phytosociological tables. No GPSs were available at the time of collecting, meaning that the exact location of his sample plots is unknown. Burke and Wittneben (2007) collected their relevés on undefined plots, essentially a short transect, along an altitudinal gradient (A Burke pers. com). This was necessary

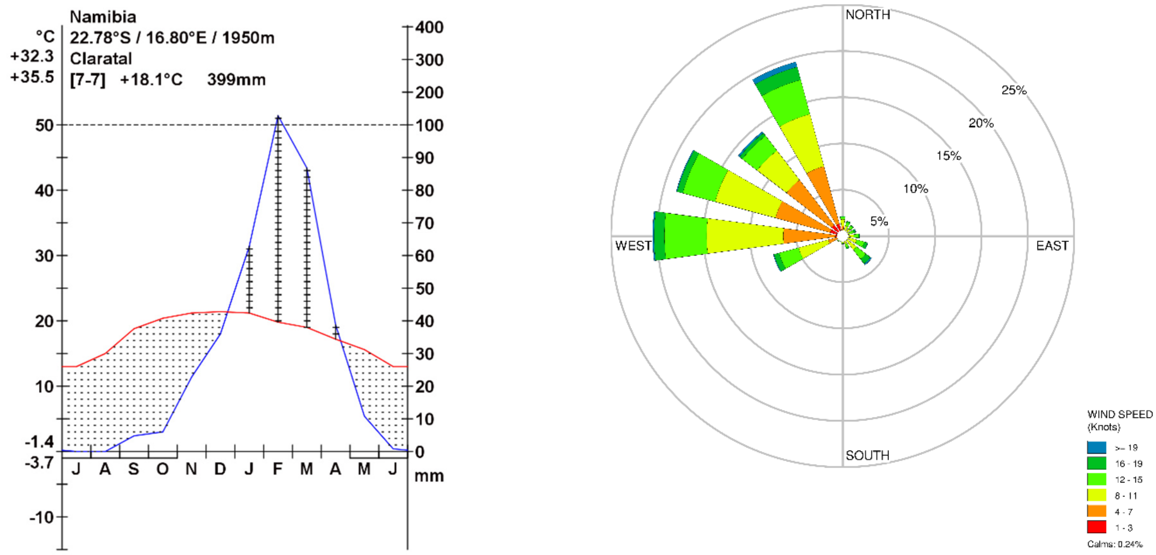


Figure 2: *Climate diagram following the convention of Walter et al. (1975) and wind rose of Claratal within the Auas-Oanob Conservancy. Data source: SASSCAL (2014).*

due to the extremely steep and rough terrain. GPS positions for the start of each transect are known, and the habitat descriptions followed largely the standards of the Vegetation Survey. Missing habitat data (e.g. geology) could be extracted from GPS sources based on the GPS position. The Claratal BIOTA observatory relevés were collected on 20 x 50 m plots, following the standards of the Vegetation Survey of Namibia project. The only difference is that their position was predetermined, and the plots strictly oriented in an east-west direction. This results in an occasional mixture of habitats. In this way one of the original 20 relevés from the observatory had to be excluded. To avoid observer bias, data were cleaned before processing following methods described by Strohbach (2014).

The final, extended data set consists of 301 relevés, with 514 species.

Data analysis

Modified TWINSPAN (Roleček et al. 2009), using average Sørensen dissimilarity as diversity measure, was used for classification. For the first classification, pseudospecies cut levels were set at 0 and 10% since many species occurred widely spread, but abundance was low outside their typical niche habitats. Crispness values (Botta-Dukát et al. 2005) for this first classification indicated a highly reliable subdivision into three clusters. Due to highly varying internal diversity within each cluster, it was necessary to split the data set into three subsets, and classify each subset separately. These three subsets represent (a) the high-altitude mountain veld of the Auas range, (b) the lowlands and valley habitats and (c) the upland Khomas Hochland veld.

The three subsets were further classified as follows: For the first cluster (high mountain veld of the Auas range), best results were achieved without the use of pseudospecies. Classification procedures were stopped with four subdivisions based on crispness values (Botta-Dukát et al. 2005). Pseudospecies (set at 0 and 10%) were utilised in the classification of the subsequent two data sets. Classification of the second subset was stopped, again based on crispness values, after five subdivisions. However, especially the riparian vegetation proved to be ill-defined. For this reason, Cocktail (Bruelheide & Flintrop 1994) was utilised to select relevés with a combination of *Ziziphus mucronata, Searsia lancea, Cynodon dactylon* and a high abundance of *Acacia karroo*, based on a description by Kellner (1986).

Classification of the third subset was stopped after three subdivisions, as these represented the best ecologically interpretable results. However, rocky outcrops, highlighted by both Volk and Leippert (1972) and Kellner (1986) as distinctly different from the vegetation of the rolling hills of the Khomas Hochland, were not defined at all. Cocktail (Bruelheide & Flintrop 1994) was thus employed to select 11 relevés from cluster 2 to define a new group based on the occurrence of *Manuleopsis dinteri, Triraphis rammosissioma, Pennisetum foermeranum* and *Ozoroa crassinervia*. Furthermore, during field work it was observed that the vegetation of the far south-western uplands subtly changed to a more xeric form, with *Panicum arbusculum* replacing *Brachiaria nigropedata*. This trend was subsequently confirmed with further field work to the west and south of the present study area, but did not reflect in the present classification of the third data subset (uplands of the Khomas Hochland). Therefore, Cocktail (Bruelheide & Flintrop 1994) was again employed to define a new group based on the presence of *Aizoon schellenbergii, Aptosimum albomarginatum, Panicum arbusculum* and *Hibiscus discophorus*. Seven relevés were selected this way from group four and made into an additional group five.

Diagnostic species were determined using the phi coefficient of association (Chytrý et al. 2002). For this calculation the numbers of relevés were standardised following Tichý and Chytrý (2006). Species with phi≥40 were considered as diagnostic and with phi≥60 as highly diagnostic; however, species with a non-significant fidelity at α=0.05 using Fisher's exact test were omitted. Species occurring with at least a 60% frequency were regarded as constant and with at least an 80% frequency as highly constant.

The average structure for each grouping (i.e. average tree, shrub, dwarf shrub, perennial grass, annual grass and herb cover) was calculated using the available growth form data. The Shannon Index (as an index of evenness) ($H'=-\Sigma p_i \ln p_i$) and Simpson's Index (as an index of dominance) ($D=\Sigma(n/N)^2$) (Peet 1974) were calculated for each relevé using Juice (Tichý et al. 2011). For the species density (number of species per 1,000 m^2), the relevé data from Kellner (1986) were excluded, as these were sampled on 625 m^2 plots (25 x 25 m), not 1,000 m^2 plots as all other relevés.

A Nonmetric Multidimensional Scaling ordination (NMS) (Kruskal 1964) was calculated with PC-ORD version 6.08 (McCune et al. 2002). The data set was reduced by removing the data from Kellner (1986), as these had the most incomplete habitat data, and no lat/long localities to derive data from GIS sources (e.g. altitude, annual precipitation, slope, etc.) The resulting database had 282 relevés with 14 environmental factors, in addition to the classification results. Average Sørensen dissimilarity was used as distance measure, and the ordination was calculated in three dimensions (i.e. three resulting axes), based on an initial scree plot of stress versus dimensions (McCune et al. 2002, Peck 2010). The solutions were calculated with 250 iterations using real data. To aid the interpretation of the resulting scatter plots of the ordination results, the environmental parameters were overlain in a joint plot.

Mapping

Mapping was performed using a Landsat 7 ETM satellite scene path 178 row 076, dated 4 May 2001. The satellite image was clipped to an area slightly larger than the study area before further processing. This clip was imported into the Definiens software package (Definiens 2006) and segmented into relatively homogenous areas. The segments were classified using the classified sample sites as ground truth data. In a final step, the resulting shape file was clipped according to the farm boundaries and areas for each landscape calculated using the QGIS 2.4.0 Chugiak software package (QGIS 2014).

RESULTS

Classification results

The classification results are depicted in Figure 3 as a dendrogram.

Observer bias could not be detected, with relevés from various data sources being classified in eight of 13 associations (Table 1). No outlying groups (which is a tell-tale indication of observer bias) could be detected (Figure 6a) (Edwards 2000, Strohbach 2014). It needs to be remembered that Burke and Wittneben (2007) focused specifically on the High Mountain Veld, and their relevés thus dominate the classification results of those associations. Conversely, two of their relevés classified into the Khomas Hochland Veld, representing the foothills to the High Mountain Veld. Also, Kellner's focus (1986) was specifically on the Khomas Hochland part of Claratal, and his relevés were accordingly classified into the associations of the Khomas Hochland Veld.

The full phytosociological table is presented as downloadable online Appendix 1, the synoptic table as downloadable Appendix 2. The classification yielded 13 associations in three higher-order syntaxa, one with two subassociations. The associations are not described formally according to the International Code for Phytosociological Nomenclature (ICPN) (Weber et al. 2000), pending further descriptions of the vegetation of the greater Khomas Hochland as well as a review of the syntaxonomy of these. Within the description, highly diagnostic species (with phi coefficient >60) and highly constant species (occurring in more than 80% or relevés) are indicated in **bold**.

1 *Digitaria eriantha—Osyris lanceolata* high mountain veld

Provisionally recognised at the level of an alliance, the high mountain veld (above 2,000 m asl) represents a unique cluster of associations related to high altitudes. Three associations, one with two subassociations related to aspect, were recognised.

1.1 *Eriocephalus dinteri—Danthoniopsis ramosa* high altitude mountain veld of the south-facing slopes

A total of eight relevés has been classified into this association. It is characterised by the diagnostic species ***Eriocephalus dinteri, Jamesbrittenia pallida, Cheilanthes hirta, Selago alopecuroides,***

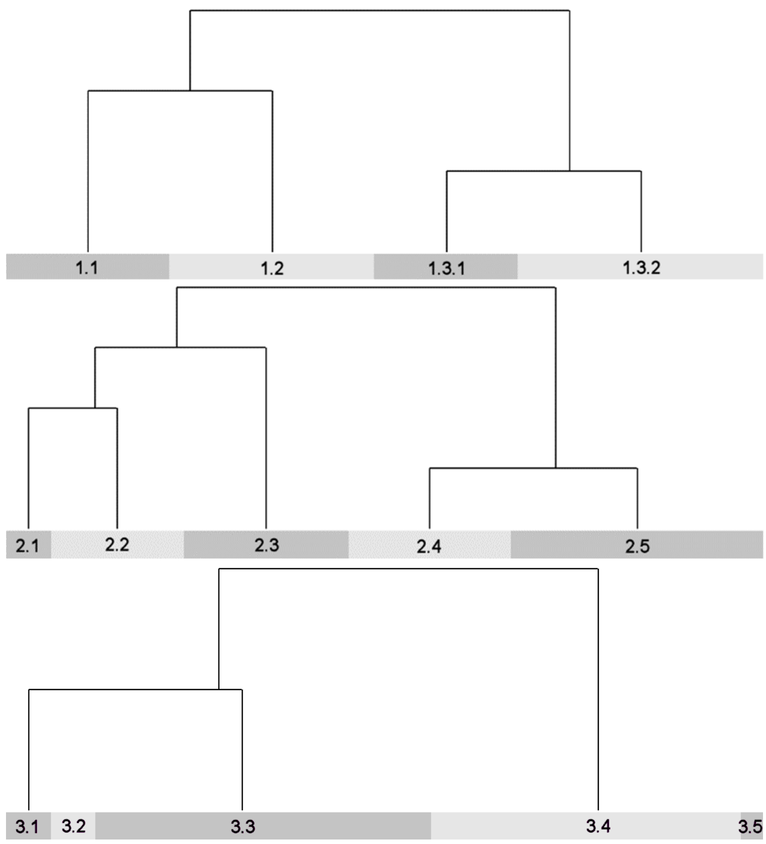


Figure 3: *Dendrograms depicting the classification results. (a) subset 1, representing the high Auas mountain vegetation; (b) subset 2, representing the vegetation of the lowlands and valleys, and (c) subset 3, representing vegetation of the uplands of the Khomas Hochland.*

Table 1: *Overview of classification results, indicating the source of relevé data on which the description of associations is based.*

Veld type	Association (no of relevés)	Data source			
		Strohbach	Kellner (1986)	Burke & Wittneben (2007)	BIOTA (Jürgens et al. 2010)
High Mountain Veld	1.1 (8)			8	
	1.2 (10)			10	
	1.3 (19)	5		14	
Lowlands and valley habitats	2.1 (12)	11			1
	2.2 (6)	6			
	2.3 (9)	9			
	2.4 (8)	7			1
	2.5 (16)	16			
Khomas Hochland Veld	3.1 (12)	12			
	3.2 (13)	10	3		
	3.3 (99)	65	16	2	16
	3.4 (80)	79			1
	3.5 (9)	9			

Frankenia pomonensis, Leucas glabrata, Senecio inaequidens, Namacodon schinzianum, Eragrostis rigidior and *Tagetes minuta*. These are constantly associated with ***Hypoestes forskaolii, Digitaria eriantha, Danthoniopsis ramosa,*** *Oxalis purpurascens, Tarchonanthus camphoratus, Eragrostis scopelophila* and *Eragrostis nindensis*. A total of 47 species has been observed in this association, with, on average, 27 species per 1,000 m^2. This association occurs on the upper southern slopes of the Auas mountain range, from about 2,150 m upwards. The southern slopes are extremely steep (>50°), often with steep cliff faces. The relatively high shrub cover, mostly confined to rock crevices, and the virtual lack of annual grass species are conspicuous (Figure 4a).

1.2 *Danthoniopsis ramosa—Olea europaea* high altitude mountain veld of the north-facing slopes

Ten relevés have been classified into this association. It is characterised by the diagnostic species ***Selago angustibractea, Lopholaena cneorifolia, Cheilanthes multifida, Adromischus* species, *Jamesbrittenia lyperioides, Eriocephalus scariosus, Babiana hypogea, Anthospermum* species,** *Cineraria canescens, Calostephane marlothiana, Hypoxis iridifolia, Felicia muricata, Wahlenbergia denticulata, Tristachya superba, Silene burchellii* var. *burchellii, Helichrysum obtusum, Gladiolus saccatus, Crassula capitella* subsp. *nodulosa, Monsonia burkeana, Euphorbia spartaria, Thesium lacinulatum, Brachiaria serrata, Ebracteola montis-moltkei* and *Cotyledon orbiculata*. These are constantly associated with ***Tarchonanthus camphoratus, Acacia hereroensis,*** *Hypoestes forskaolii, Digitaria eriantha, Danthoniopsis ramosa* and *Chascanum pinnatifidum***.** A total of 88 species has been observed in this association, with an average of 48 species per 1,000 m^2.

This association occurs on the upper northern slopes of the Auas mountain range, again from 2,200 m upwards. The slopes are very steep, flattening off near the mountain peak (but never forming a 'flat' plateau). The soil surface is rock-strewn, with a 50-80% cover of blocky rock boulders. With increasing altitude, the shrub layer (up to 3 m high) recedes and the vegetation becomes dominated by grasses (Burke & Wittneben 2007) (Figures 4b and 5a).

1.3 *Acacia hereroensis—Tarchonanthus camphoratus* mid-altitude mountain veld

A total of 19 relevés has been classified into this association. It is characterised by the diagnostic species ***Anthephora pubescens, Kyphocarpa angustifolia, Heteropogon contortus, Combretum apiculatum* subsp. *apiculatum* subsp. *apiculatum, Ziziphus mucronata, Andropogon chinensis, Brachiaria nigropedata,*** *Schmidtia pappophoroides, Microchloa caffra, Phyllanthus pentandrus, Hibiscus sulfuranthus*, *Dombeya rotundifolia, Talinum caffrum, Cenchrus ciliaris, Geigeria ornativa, Hibiscus pusillus, Fingerhuthia africana, Dyschoriste pseuderecta, Oxygonum* species and *Eragrostis echinochloidea.* These are constantly associated with ***Tarchonanthus camphoratus, Acacia hereroensis, Pellaea calomelanos, Hypoestes forskaolii, Eragrostis scopelophila, Eragrostis nindensis,*** *Searsia marlothii, Digitaria eriantha* and *Commelina africana***.** A total of 125 species has been observed in this association, with, on average, 47 species per 1,000 m^2.

This association occurs on the mid-slopes of the Auas mountain range, at a mean altitude from 2,000 - 2,250 m asl. The slopes are steep to very steep (up to 50°), but less rock-strewn than at higher altitudes (rock and large stone cover each up to 40%). Gravel cover on these slopes becomes more prominent, also up to 40%. The association can be subdivided into two subassociations based on aspect.

1.3.1 *Acacia hereroensis—Tarchonanthus camphoratus—elephanthorrhiza suffruticosa* mountain veld of the northern slopes

A total of seven relevés has been classified into this subassociation. It is characterised by the diagnostic species ***Elephantorrhiza suffruticosa, Vigna frutescens, Eragrostis porosa, Elephantorrhiza elephantina, Trochomeria macrocarpa, Solanum delagoense, Albuca* species, *Cyperus margaritaceus, Tephrosia rhodesica, Sida chrysantha, Evolvulus alsinoides, Ipomoea holubii, Lantana dinteri,*** *Montinia caryophyllacea, Lycium eenii, Dicoma macrocephala, Stipagrostis uniplumis* var. *uniplumis, Dipcadi glaucum* and *Ipomoea obscura* var. *obscura*. These are constantly associated by ***Tarchonanthus camphoratus, Searsia marlothii, Pellaea calomelanos, Melinis repens* subsp. *repens, Hypoestes forskaolii, Heteropogon contortus, Eragrostis scopelophila, Eragrostis nindensis, Commelina africana, Brachiaria nigropedata, Acacia hereroensis,*** *Digitaria eriantha* and *Chascanum pinnatifidum*. A total of 105 species has been observed in this subassociation, with, on average, 58 species per 1,000 m^2.

This subassociation occurs on the northern slopes of the Auas Mountain range. Shrub cover is relatively low, forming an open shrubland between 2-3 m high. The perennial grass cover is variable, but can reach more than 50% (Burke & Wittneben 2007) (Figure 4c).

1.3.2 *Acacia hereroensis—Tarchonanthus camphoratus—monelytrum luederitzianum* mountain veld of the southern slopes

A total of 12 relevés has been classified into this subassociation. It is characterised by the diagnostic species ***Monelytrum luederitzianum, Thesium xerophyticum, Bidens biternata,*** *Raphionacme velutina, Phyllanthus* species, *Melinis repens* subsp. *grandiflora, Eragrostis lehmanniana, Solanum capense, Pogonarthria squarrosa, Hermannia affinis, Drimia sanguinea* and *Aristida effusa*. These are constantly associated by ***Tarchonanthus camphoratus, Acacia hereroensis, Pellaea calomelanos, Melinis repens* subsp. *repens, Hypoestes forskaolii, Eragrostis scopelophila, Eragrostis nindensis, Digitaria eriantha,*** *Searsia marlothii, Solanum lichtensteinii* and *Anthephora pubescens*. A total of 104 species has been observed in this subassociation, with, on average, 40 species per 1,000 m^2.

This subassociation occurs on the southern and western mid-slopes of the Auas Mountain range including the Lichtenstein mountains. Shrub cover is denser than on the upper reaches, forming a moderately closed, tall shrubland. Grass cover is less variable, from 50 to 60% cover, but occasionally even reaching 70% cover (Figures 4d and 5b).

2. Lowlands and valley habitats

The vegetation of the lowlands, particularly the riverine vegetation, alluvial plains of the Omeya valley as well as the foot slopes of the Khomas Hochland form a mixture of vegetation types, which cannot all logically be associated with a clear, single syntaxon. Five associations have been identified here as follows:

2.1 *Acacia karroo—Cynodon dactylon* riparian vegetation

Twelve relevés have been classified into this association. It is characterised by the diagnostic species ***Gomphocarpus fruticosus,*** *Cynodon dactylon, Ziziphus mucronata, Achyranthes aspera* var. *sicula, Searsia lancea, Felicia muricata* and *Acacia karroo*. These are constantly associated with ***Bidens biternata,*** *Tagetes minuta, Chloris virgata, Cenchrus ciliaris* and *Schkuhria pinnata***.** A total of 127 species has been observed in this association, with an average of 39 species per 1,000 m^2.

This association typically occurs as a moderately closed bushland to sub-continuous thicket *sensu* Edwards (1983), dominated by *Acacia karroo, Ziziphus mucronata* and *Searsia lancea* trees between 8 to 15 m high along the banks of ephemeral rivers both within the steeper Khomas Hochland landscapes as well as the flatter plains landscapes (Figure 4e and 5c). The herbaceous layer is often dominated by weedy (often annual) and/or shade-loving species. As this association occurs along riverbeds, seeds and other propagules from other, nearby associations are often washed in, resulting in a highly diverse species composition. In this way, even typical sand bank species like *Stipagrostis namaquensis* and *Schmidtia kalahariensis* (which are not known shade species) occur here occasionally.

2.2 *Stipagrostis namaquensis* sand banks

Six relevés have been classified into this association. It is characterised by the diagnostic species ***Stipagrostis namaquensis, Felicia clavipilosa, Indigofera alternans,*** *Hermbstaedtia odorata* and *Melianthus comosus*. These are constantly associated with ***Acacia karroo,*** *Pogonarthria fleckii, Bulbostylis hispidula, Bidens biternata* and *Acrotome* species. A total of 38 species has been observed in this association, with, on average, 21 species per 1,000 m^2.

This association occurs within the river bed on sand banks that are stable enough to support a fairly dense grass layer, but frequently threatened by flash floods, so that only a few trees become established. *Acacia karroo* is thus a typical pioneer species in this community, occurring mostly only as juvenile plants or small shrubs. The structure is typically a tall, moderately-closed grassland *sensu* Edwards (1983) (Figure 4f and 5d).

2.3 *Platycarphella carlinoides—Chloris virgata* floodplains and omiramba

A total of nine relevés was classified into this association. It is characterised by the diagnostic species ***Hypertelis salsoloides, Tragus berteronianus, Talinum caffrum, Oxalis depressa,*** *Tragus racemosus, Monsonia angustifolia, Eragrostis pilgeriana, Aptosimum glandulosum, Platycarphella carlinoides, Talinum arnotii, Digitaria eriantha, Pentzia incana,* and *Eragrostis nindensis*. These are constantly associated by ***Kyllinga alata*****,** ***Ursinia nana, Pogonarthria fleckii,*** *Eragrostis echinochloidea, Chloris virgata, Mollugo cerviana, Melinis repens* subsp. *grandiflora, Geigeria pectidea, Eragrostis porosa, Commelina benghalensis* and *Acacia karroo***.** A total of 109 species has been observed in this association, with, on average, 43 species per 1,000 m^2.

This association is found in the shallow drainage systems (*omiramba*) within the Oanob plateau. These end in rivers and tributary streams of the Oanob River. Typically, they are dominated by a dense, tall grass sward consisting of a combination of annual and perennial species (Figure 4g and 5e). Occasional tree clumps (*Acacia karroo* and/or *Acacia erioloba*) indicate the close relationship to the riverine system, in particular the *Cynodon dactylon—Acacia karroo* riverine woodlands. The soils are fine-grained with virtually no stone cover.

2.4 *Pupalia lappacea—Acacia mellifera* bush-encroached lowlands

A total of eight relevés has been classified into this association. It is characterised by the diagnostic species ***Boscia albitrunca, Gisekia africana, Phyllanthus pentandrus, Pupalia lappacea,*** *Senecio consanguineus, Citrullus lanatus, Acacia mellifera* subsp. *detinens, Otoptera burchellii, Melolobium macrocalyx, Catophractes alexandri, Albizia anthelmintica* and *Phaeoptilum spinosum.* These are constantly associated with *Pogonarthria fleckii, Mollugo cerviana, Lycium bosciifolium, Schmidtia kalahariensis, Oxygonum* species, *Ocimum americanum* var. *americanum, Nidorella resedifolia, Lycium eenii, Eragrostis porosa, Commelina benghalensis, Acrotome* species and *Acacia erioloba***.** A total of 109 species has been observed in this association, with, on average, 41 species per 1,000 m^2.

This association occurs in various habitats, often on footslopes of the mountainous highland of the Khomas Hochland, in patches on the Oanob plateau as well as in the undulating landscape of the southern Khomas Hochland. Several large expanses of this vegetation type are visible along the main road (B1) between Windhoek and Rehoboth near the Oamites Mountain, as well as along the C26. These tall, moderately closed shrublands are dominated by *Acacia mellifera* subsp. *detinens* and *Catophractes alexandri,* with *Leucosphaera bainesii* conspicuous in the understorey. The grass layer is generally very weakly developed, with a variety of herbaceous, often weedy, species (Figure 4h and 5f).

2.5 *Schmidtia kalahariensis—Acacia erioloba* woodlands of the Omeya valley

A total of 16 relevés has been classified into this association. It is characterised by the diagnostic species ***Hypertelis bowkeriana, Nidorella resedifolia,*** *Helichrysum candolleanum, Ifloga glomerata, Geigeria ornativa, Eragrostis cylindriflora, Acacia erioloba, Geigeria pectidea, Kyphocarpa angustifolia* and *Aptosimum albomarginatum*. These are constantly associated with ***Pogonarthria fleckii, Mollugo cerviana, Lycium bosciifolium, Kyllinga* species,** *Ursinia nana, Eragrostis lehmanniana, Commelina benghalensis, Chloris virgata* and *Melinis repens* subsp. *grandiflora***.** A total of 111 species has been observed in this association, with, on average, 40 species per 1,000 m^2.

These tall, semi-open woodlands are dominated by *Acacia erioloba* (Figure 4i and 5g). The grass layer is dominated by the annual *Schmidtia kalahariensis* in association with *Aristida congesta* subsp. *congesta* and *Anthephora schinzii*. The poisonous species *Geigeria pectidea* and *Elephantorrhiza elephantina* are conspicuous in the herbaceous layer. The association has a park-like appearance (resulting in the development of a golf-estate within this association), but because of the highly unpalatable, annual grass sward and high abundance of poisonous species (*Geigeria pectidea* and *Elephantorrhiza elephantina*) it has low potential for livestock farming.

3. *Acacia hereroensis* veld of the Khomas Hochland

Acacia hereroensis is the characteristic species of the Highland savanna *sensu* Giess (1998). This third group of associations all contain this characteristic species. The other unifying feature is the undulating to steep hilly and mountainous landscape, generally with shallow, stony soils.

3.1 *Ornithoglossum calcicola—Fingerhuthia africana* mountain veld of the Oamites mountain

A total of 12 relevés has been classified into this association. It is characterised by the diagnostic species ***Ornithoglossum calcicola, Melhania damarana, Crotalaria kurtii, Thesium xerophyticum,*** *Monechma genistifolium* subsp. *genistifolium, Enneapogon scoparius, Cleome suffruticosa, Stipagrostis hirtigluma, Zygophyllum pubescens, Sarcostemma viminale, Euphorbia lignosa, Polygala pallida, Pelargonium otaviense, Stipagrostis ciliata, Peliostomum leucorrhizum* and *Euclea undulata*. These are constantly associated with ***Searsia marlothii, Fingerhuthia africana, Eragrostis nindensis, Acacia hereroensis,*** *Enneapogon cenchroides, Talinum caffrum, Otoptera burchellii, Cenchrus ciliaris* and *Acacia mellifera* subsp. *detinens.* A total of 101 species has been observed in this association, with, on average, 37 species per 1,000 m^2.

This tall, semi-open shrubland is typically dominated by *Acacia mellifera* subsp. *detinens, Combretum apiculatum* subsp. *apiculatum* and *Acacia hereroensis* in the shrub layer, and *Fingerhuthia africana, Stipagrostis hirtigluma, Monelytrum luederitzianum* and *Enneapogon desvauxii* in the grass layer (Figures 4j and 5h). The association occupies very steep slopes (>60%) with stony soils. Up to 40% of the soil surface is covered with rocks, with smaller fragments also covering up to 40% in total.

3.2 *Triraphis ramosissima—Manuleopsis dinteri* veld of the rocky outcrops

A total of 13 relevés has been classified into this association. It is characterised by the diagnostic species ***Pennisetum foermeranum, Cheilanthes marlothii,*** *Bidens biternata, Manuleopsis dinteri, Pellaea calomelanos, Combretum apiculatum* subsp. *apiculatum* subsp. *apiculatum, Ozoroa crassinervia, Triraphis ramosissima, Eragrostis scopelophila, Kalanchoe lanceolata* and *Phyllanthus pentandrus.* These are constantly associated by ***Searsia marlothii, Cenchrus ciliaris, Melinis repens* subsp. *grandiflora, Anthephora pubescens, Acacia hereroensis,*** *Eragrostis nindensis, Stipagrostis uniplumis* var. *uniplumis, Enneapogon cenchroides, Tarchonanthus camphoratus, Talinum caffrum* and *Digitaria eriantha.* A total of 110 species has been observed in this association, with, on average, 45 species per 1,000 m^2.

This association is found on the rocky outcrops scattered throughout the Khomas Hochland. Although by definition a short, moderately closed bushland, the small sizes of these outcrops (on average less than 0.25 ha) and patchy distribution in the landscape do not warrant this description (Figures

4k and 5i). These rocky outcrops, due to the layered nature of the schists, are well-fissured and provide habitats for smaller, shade-loving plants like ferns (*Pellaea calomelanos, Cheilanthes* species). Although not exclusively, most of these rocky outcrops are south facing.

3.3 *Brachiaria nigropedata—Acacia hereroensis* veld of the central Khomas Hochland

A total of 99 relevés has been classified into this association. It is characterised by *Ziziphus mucronata* and *Brachiaria nigropedata,* which are constantly associated by ***Searsia marlothii, Anthephora pubescens, Acacia hereroensis, Eragrostis nindensis,*** *Melinis repens* subsp. *grandiflora, Stipagrostis uniplumis* var. *uniplumis, Monelytrum luederitzianum, Aristida meridionalis, Schmidtia pappophoroides, Kyphocarpa angustifolia* and *Cenchrus ciliaris*. A total of 152 species has been observed in this association, with, on average, 39 species per 1,000 m^2.

These semi-open to moderately closed tall shrublands, or occasionally, low bushlands are dominated by *Acacia hereroensis* in the tree and shrub layer, and *Eragrostis nindensis, Aristida adscensionis, Brachiaria nigropedata, Monelytrum luederitzianum, Aristida meridionalis* and *Stipagrostis uniplumis* in the grass layer (Figure 4l). The altitude ranges from 1,760 to 2,100 m asl, whilst slopes are moderately steep to steep (Figure 5j). No affinity to a particular aspect could be detected. Stone and rock cover is variable, but a high cover of quartz pebbles (40-80%) (referred to as pebble mulch) is conspicuous.

3.4 *Panicum lanipes—Pentzia incana* veld of the Oanob Plateau

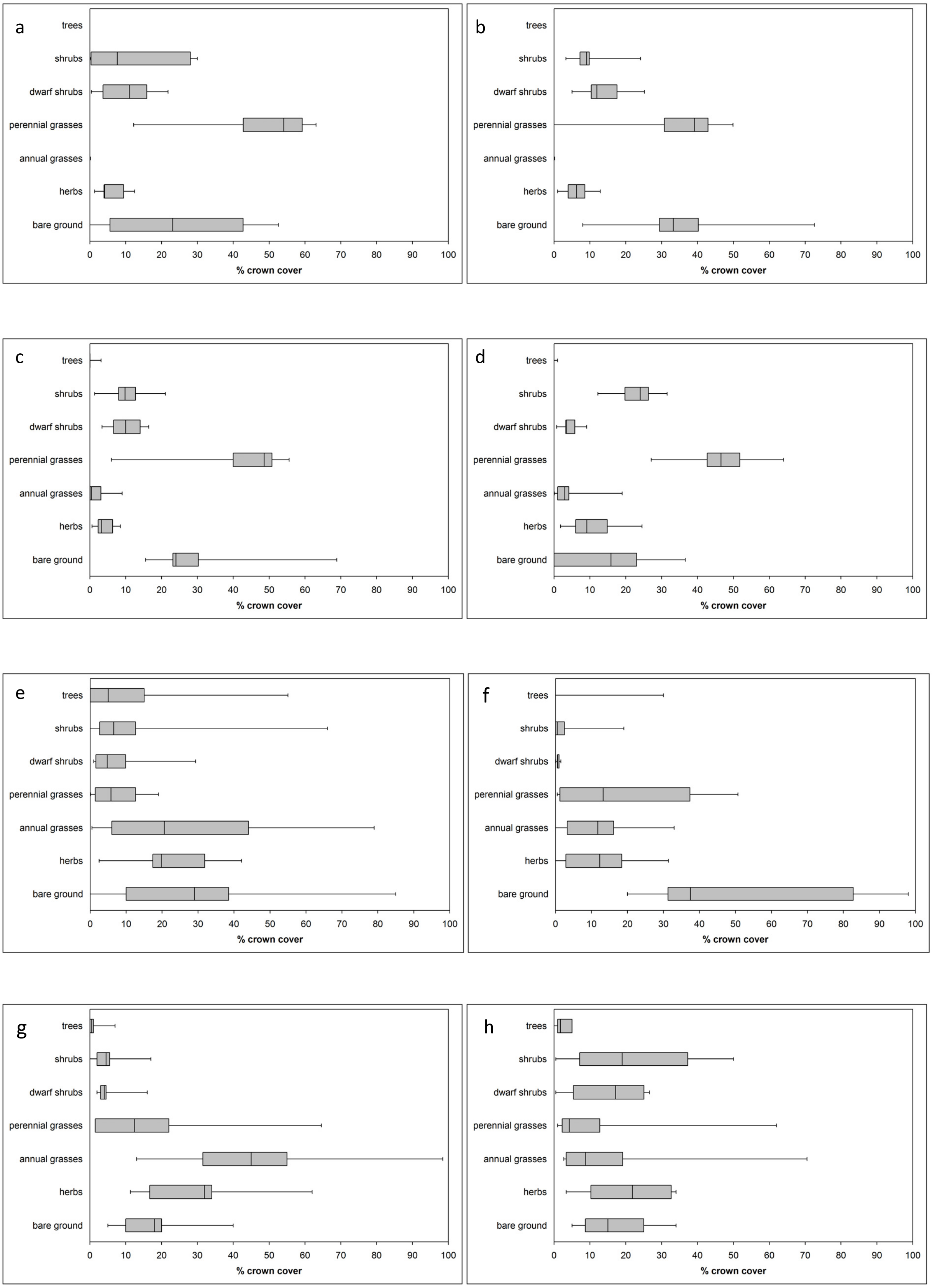
A total of 80 relevés has been classified into this association. It is characterised by *Panicum lanipes, Plinthus sericeus, Pentzia incana, Tragus berteronianus, Blepharis integrifolia, Barleria rigida* and *Ipomoea bolusiana.* These are constantly associated with ***Acacia mellifera* subsp. *detinens, Eragrostis nindensis, Kyphocarpa angustifolia, Aristida adscensionis,*** *Microchloa caffra, Talinum caffrum, Schmidtia pappophoroides, Melinis repens* subsp. *grandiflora, Hirpicium gazanioides, Hermannia modesta, Eriocephalus luederitzianus, Chascanum pinnatifidum, Leucosphaera bainesii, Pogonarthria fleckii, Phaeoptilum spinosum, Stipagrostis uniplumis* var. *uniplumis, Monelytrum luederitzianum, Searsia marlothii* and *Fingerhuthia africana.* A total of 206 species has been observed in this association, with, on average, 53 species per 1,000 m^2.

The Oanob plateau has a very distinct karroid structure (Figure 4 m), with the dwarf shrub species *Leucosphaera bainesii, Eriocephalus luederitzianus* and *Pentzia incana* dominating. Larger shrubs are generally fairly sparse, with a tendency for species from the adjacent *Brachiaria nigropedata—Acacia hereroensis* association to encroach. In patches, *Acacia mellifera* subsp. *detinens* forms dense bushlands within this landscape. The altitude of the Oanob plateau ranges from 1,680-2,040 m asl., with an undulating to rolling relief (<10° slopes) (Figure 5k). The lithology is similar to the adjacent association, dominated by schists of the Kuiseb, Auas and Chuos Formations. Rock outcrops are generally absent, with relatively few large stones. The pebble mulch typical of the Khomas Hochland is, however, present (40-80% cover). The plateau is interspersed with numerous *omiramba*, as described for association 2.3 (Figure 8).

3.5 *Panicum arbusculum—Acacia mellifera* veld of the southern Khomas Hochland

A total of nine relevés has been classified into this association. It is characterised by the diagnostic species ***Kohautia cynanchica, Aizoon schellenbergii, Aptosimum albomarginatum, Panicum arbusculum, Justicia guerkeana, Catophractes alexandri, Ipomoea obscura* var. *obscura,*** *Heliotropium ciliatum, Aptosimum lineare, Pentzia monocephala, Hibiscus discophorus, Phyllanthus maderaspatensis, Phaeoptilum spinosum, Ptycholobium biflorum* subsp. *angolensis, Ocimum americanum* var. *americanum, Aptosimum spinescens, Eriospermum flagelliforme, Asparagus exuvialis, Melhania virescens, Leucosphaera bainesii, Eriocephalus luederitzianus* and *Pogonarthria fleckii.* These are constantly associated by ***Stipagrostis uniplumis* var. *uniplumis, Kyphocarpa angustifolia, Fingerhuthia africana, Eragrostis nindensis, Acacia mellifera* subsp. *detinens, Pogonarthria fleckii, Microchloa caffra, Melinis repens* subsp. *grandiflora,* and *Hermannia modesta*.** A total of 118 species has been observed in this association, with, on average, 60 species per 1,000 m^2.

These moderately closed, high shrublands are dominated by *Acacia mellifera* subsp. *detinens, Catophractes alexandri* and *Phaeoptilum spinosum*, with the occasional *Rhigozum trichotomum*. The absence of *Brachiaria nigropedata* and the presence of *Panicum arbusculum*, a grass species known as a climax grass in the rocky slopes of the Nama-Karoo in southern Namibia, is conspicuous (Figure 4n and 5l). The landscape is generally rolling (<10°) and not as steep as the central Khomas Hochland. Stone cover, with the exception of pebble mulch, is also lower than in similar landscapes within this cluster of vegetation associations. The altitude ranges from 1,670-1,810 m asl.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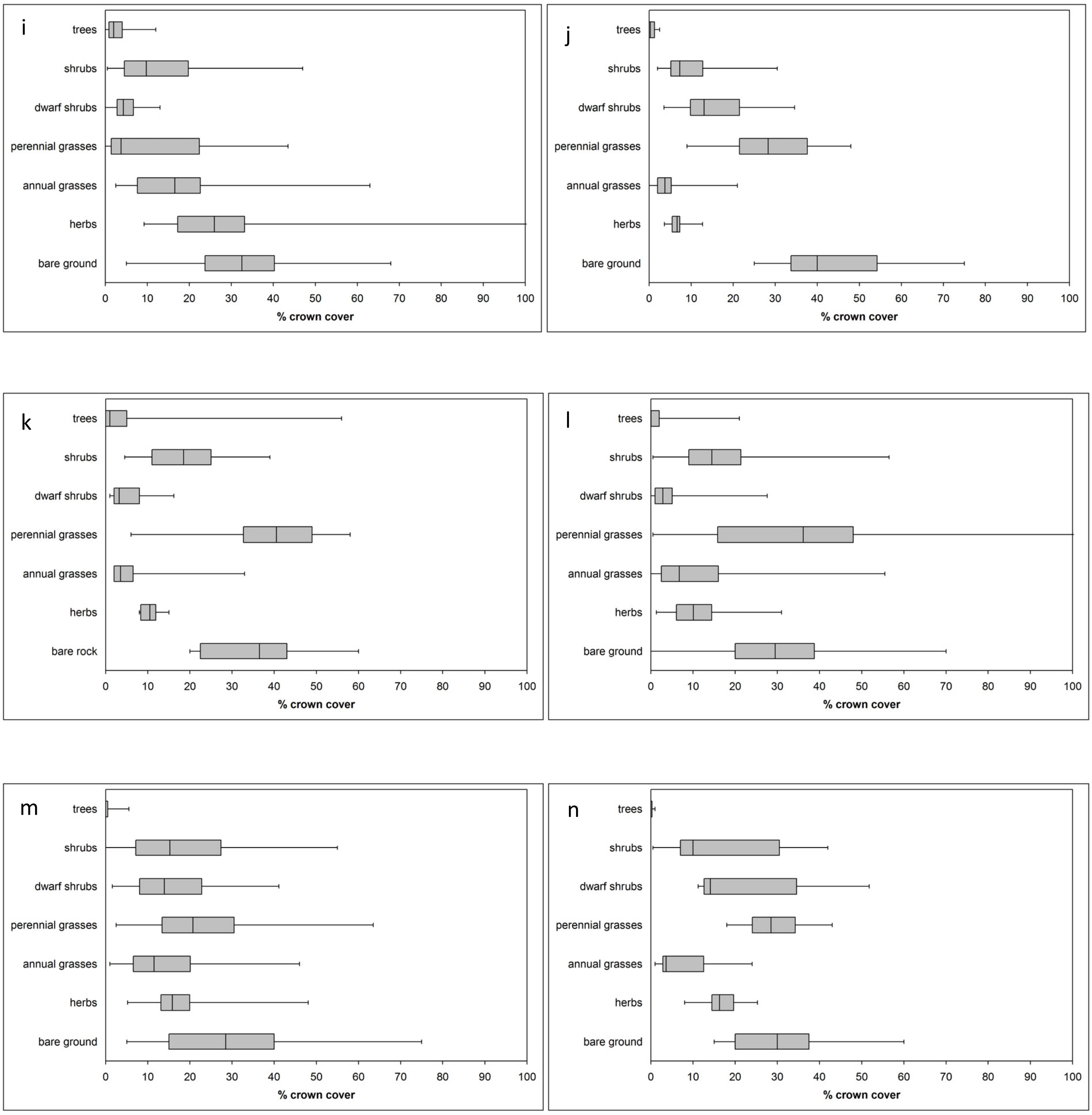

***Figure 4:** Box-and-whisker plots of the typical structure of the various associations and subassociations. a)* Eriocephalus dinteri—Danthoniopsis ramosa *association; b)* Danthoniopsis ramosa—Olea europaea *association; c)* Acacia hereroensis—Tarchonanthus camphoratus—elephanthorrhiza suffruticosa *subassociation; d)* Acacia hereroensis—Tarchonanthus camphoratus—monelytrum luederitzianum *subassociation; e)* Acacia karroo—Cynodon dactylon *association; f)* Stipagrostis namaquensis *association; g)* Platycarphella carlinoides—Chloris virgata *association; h)* Pupalia lappacea—Acacia mellifera *association; i)* Schmidtia kalahariensis—Acacia erioloba *association; j)* Ornithoglossum calcicola—Fingerhuthia africana *association; k)* Triraphis ramosissima—Manuleopsis dinteri *association; l)* Brachiaria nigropedata—Acacia hereroensis *association; m)* Panicum lanipes—Pentzia incana *association; n)* Panicum arbusculum—Acacia mellifera *association.*

Environmental Gradients

The NMS produced an ordination in three dimensions, with the final stress for the best solution being 17.248, and an instability of 0.000, after 76 iterations. The high mountain veld is distinctly separated from the remaining clusters along Axis 1, whilst the lowlands and valley habitats are clearly separated from the Khomas Hochland veld along Axis 3 (Figure 6a). The overlap between association 2.3 (*Pupalia lappacea—Acacia mellifera* bush-encroached lowlands) and the Khomas Hochland veld indicates the close relationship between these two groupings, with association 2.3 most likely being an encroached / degraded form of the Khomas Hochland veld.

Axis 1 presents an altitudinal and precipitation gradient (Figure 6b and c). Altitude is correlated to Axis 1 with r=0.802, whilst precipitation is correlated


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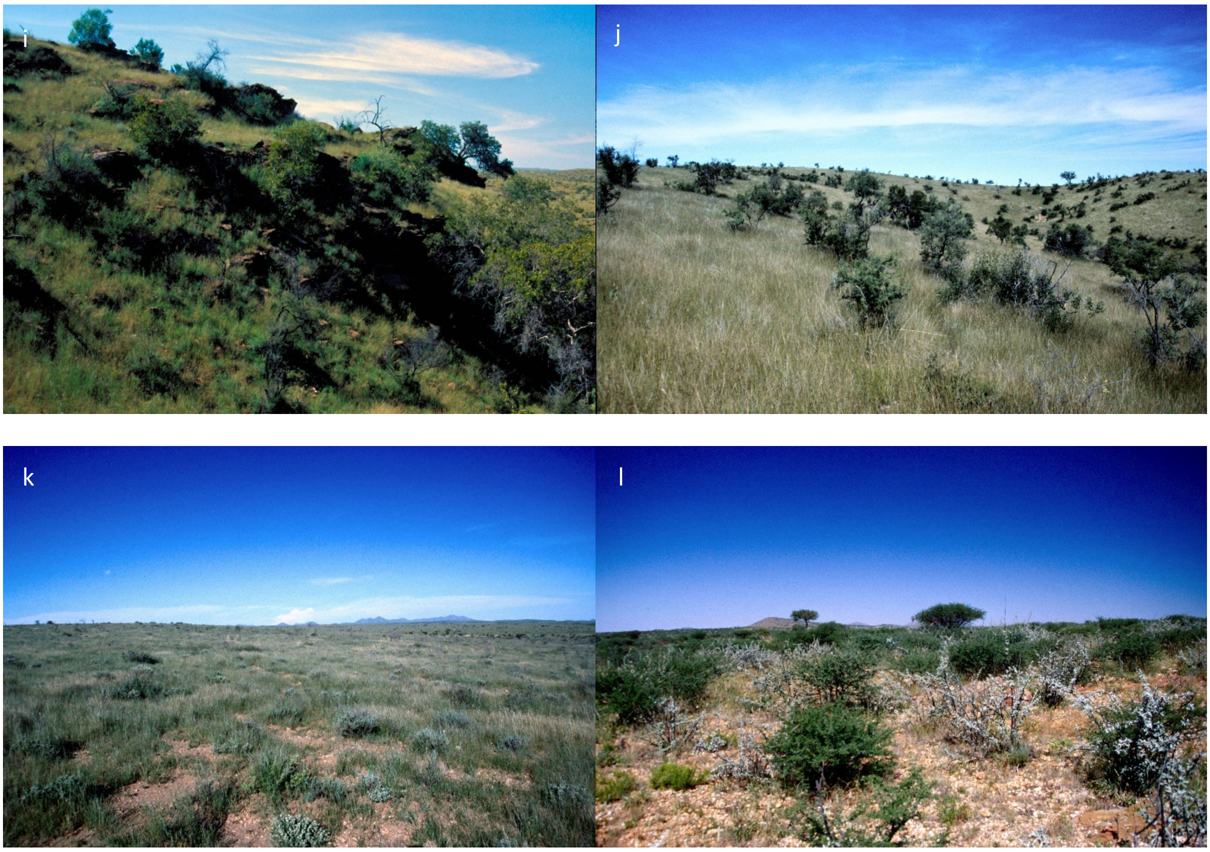

Figure 5: *Typical views of the various associations and subassociations. a)* Danthoniopsis ramosa—Olea europaea *association; b)* Acacia hereroensis—Tarchonanthus camphoratus—monelytrum luederitzianum subassociation*; c)* Acacia karroo—Cynodon dactylon *association; d)* Stipagrostis namaquensis *association; e)* Platycarphella carlinoides—Chloris virgata *association; f)* Pupalia lappacea—Acacia mellifera *association; g)* Schmidtia kalahariensis—Acacia erioloba *association; h)* Ornithoglossum calcicola—Fingerhuthia africana *association; i)* Triraphis ramosissima—Manuleopsis dinteri *association; j)* Brachiaria nigropedata—Acacia hereroensis *association; k)* Panicum lanipes—Pentzia incana *association; l)* Panicum arbusculum—Acacia mellifera *association. Source: Photo 5a: Dr A. Burke, all others by the author.*

to this axis with r=0.632. Axis 2 and 3 represent gradients related to primarily geology, which also manifest themselves in slope and stoniness gradients (Figure 6b and 6c). In Axis 2 a clear split between relevés compiled on the Kuiseb - and the Chuos Formations is evident (Figure 6b), whilst relevés compiled on the Auas Formation form a link between these two groupings. Axis 3 depicts a gradient between metamorphic rock types (mostly schists and quarzites, but also marbles) and more recent fluvial sedimentary deposits (Figure 6c). This could also be interpreted as a gradient from more skeletal soils with a high stone or rock content to deeper soils with a high gravel content, typical of alluvial deposits.

Biodiversity indicators

The species richness per 1,000 m^2, Shannon Index and Simpson's Index are depicted in Figure 7.

Vegetation map

It was not possible to map all individual vegetation associations separately, especially as a number of these occur as small patches, embedded within larger associations (Figure 8). The roughness of the terrain, coupled with numerous shade areas complicated mapping further. For this reason, larger landscape units were mapped, incorporating the major (dominating) vegetation associations, with included smaller associations (Table 2). This follows the SOTER approach of landscape mapping (FAO 1995). A similar approach has been followed by, amongst others, van Rooyen et al. (2008) and Hüttich et al. (2009).

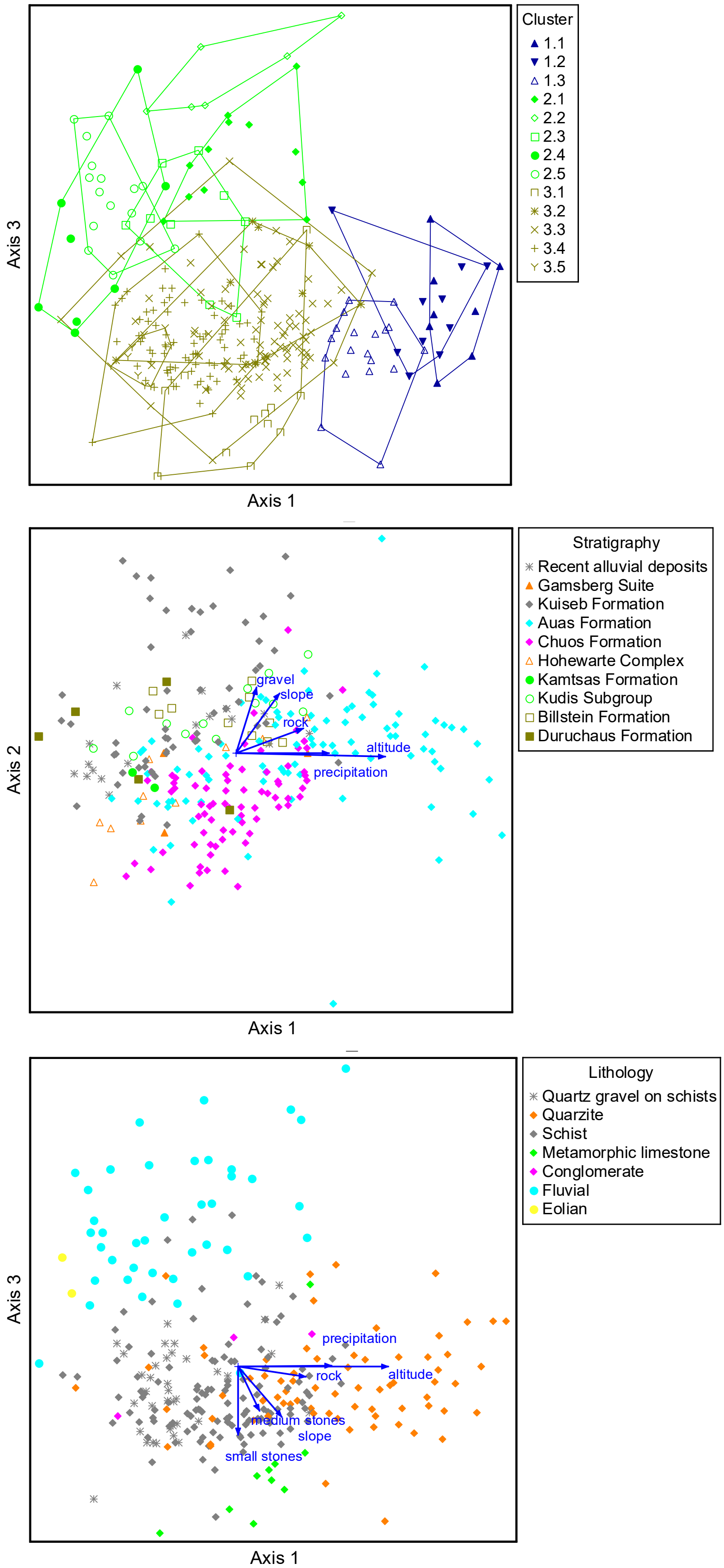

Figure 6: *Scatter plots of the NMS ordination: (a) with the classification results indicated as convex hulls; (b) indicating the geological stratification as well as environmental factors as biplots; and (c) indicating the lithology of the substrate as well as environmental factors as biplots.*

Table 2: *Vegetation associations included in the various mapping units depicted in Figure 8, as well as their measured area*

Mapping unit	**Major vegetation association**	**Included vegetation association**	**Area within conservancy (ha)**
High Auas mountains	*Eriocephalus dinteri—Danthoniopsis ramosa* (1.1); *Danthoniopsis ramosa—Olea europaea* (1.2); *Acacia hereroensis—Tarchonanthus camphoratus* (1.3)		10,840.8
Rivers	*Cynodon dactylon—Acacia karroo* (2.1)	*Stipagrostis namaquensis* (2.2)	1,724.3
Omiramba	*Platycarphella carlinoides—Chloris virgata* (2.3)		4,298.8
Bush-encroached lowlands*	*Pupalia lappacea—Acacia mellifera* (2.4)	*Panicum arbusculum—Acacia mellifera* (3.5)	12,831.2
Omeya Camelthorn savanna	*Schmidtia kalahariensis—Acacia erioloba* (2.5)	*Pupalia lappacea—Acacia mellifera* (2.4)	7,818.0
Oamites mountain	*Ornithoglossum calcicola—Fingerhuthia africana* (3.1)		261.9
Central Khomas Hochland	*Brachiaria nigropedata—Acacia hereroensis* (3.3)	*Triraphis ramosissima—Manuleopsis dinteri* (3.2); *Pupalia lappacea—Acacia mellifera* (2.4)	41,907.9
Oanob plateau	*Panicum lanipes—Pentzia incana* (3.4)	*Pupalia lappacea—Acacia mellifera* (2.4)	26,745.8
Southern Khomas Hochland	*Panicum arbusculum—Acacia mellifera* (3.5)	*Pupalia lappacea—Acacia mellifera* (2.4)	18,038.8

* The full extent of this unit is unclear.

DISCUSSION

Species Diversity

The low species richness of association 2.2 (*Stipagrostis namaquensis* sandbank vegetation), coupled with low Shannon and Simpson's indices, is conspicuous (Figure 7). These are indicative of the absolute dominance of the vegetation by this hard, reed-like grass (Figure 5d). The often- observed dominance by *Acacia karroo* in association 2.1 (riparian vegetation), and *Acacia erioloba* and *Schmidtia kalahariensis* for the Omeya valley veld (association 2.5), is also reflected in these Simpson's index ranges.

More diverse, but equally dominated by a single species, is association 2.4, the *Pupalia lappacea—Acacia mellifera* lowlands, according to the Simpson's Index (Figure 7c). The generally wide ranges in low Simpson index values for many associations are also conspicuous, specifically the Khomas Hochland mountain veld (associations 3.1 to 3.5). This is indicative of a tendency of these vegetation types to become bush-encroached (mostly by *Acacia mellifera*), in this way showing a high degree of dominance and less diversity. This is contrary to findings of De Klerk (2004), which indicate that the Khomas Hochland is largely unaffected by bush encroachment.

Degradation trends

Bush encroachment is the biggest threat to the vegetation (and thus grazing resources) in central and northern Namibia (Bester 1998, De Klerk 2004). This problem was observed in the *Brachiaria nigropedata—Acacia hereroensis,* the *Panicum lanipes—Pentzia incana* and the *Panicum arbusculum—Acacia mellifera* associations. A large number of plots from these three associations are encroached by dense stands of *Acacia mellifera* and would fit, from a structural point of view, into the *Pupalia lappacea—Acacia mellifera* association. For this reason, the definition of this association is to be regarded as incomplete, and the mapping of it questionable.

The *omiramba*, in their original state, formed extensive seasonal wetlands with extremely high soil moisture, supporting dense perennial grassland. However, already in the early 1970s, Volk and Leippert (1971) commented that the vegetation of the *omiramba* (their *Themeda triandra* association) was badly degraded, with the only example of the original vegetation remaining in an exclosure on the farm Voigtland. Within the study area, the *Platycarphella carlinoides—Chloris virgata* association is also dominated by grasses, albeit a mixture of perennial and annual grasses, with a strong component of pioneer grasses (e.g. *Aristida*

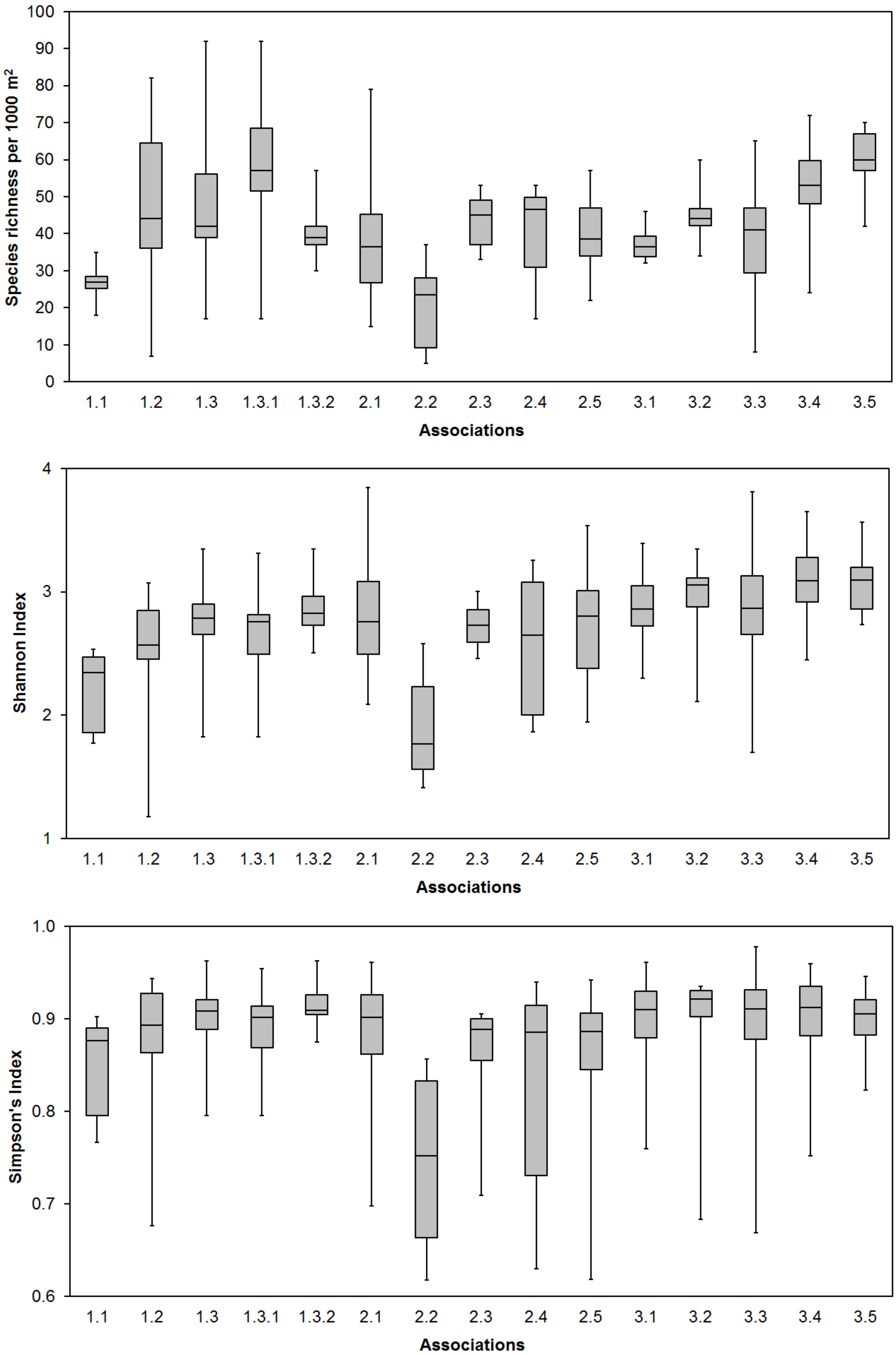

Figure 7: *Diversity indicators for the various associations described. a) Species richness; b) Shannon index and c) Simpson's Index.*

congesta, Tragus racemosus, Eragrostis pilgeriana, Pogonarthria fleckii, Anthephora schinzii, Chloris virgata, *Melinis repens* subsp. *grandiflora* and *Eragrostis porosa*) (Müller 2007). Climax grasses like *Eragrostis superba*, *Digitaria eriantha*, *Cymbopogon pospischilii* and *Themeda triandra* only occur occasionally in protected niches. The soils are highly erodible, forming extensive gullies (Volk & Leippert 1971, Shamathe et al. 2008). In this way, the rivers are extending steadily uphill into this association. A similar situation has been described for western Australian, where erosion is leading to extensive landscape desiccation (Pringle & Tinley 2003). This means that erosion of the omiramba will not only lead to further degradation of this ecosystem, but will be likely to also have a detrimental effect on the adjacent upstream landscapes by drying these up.

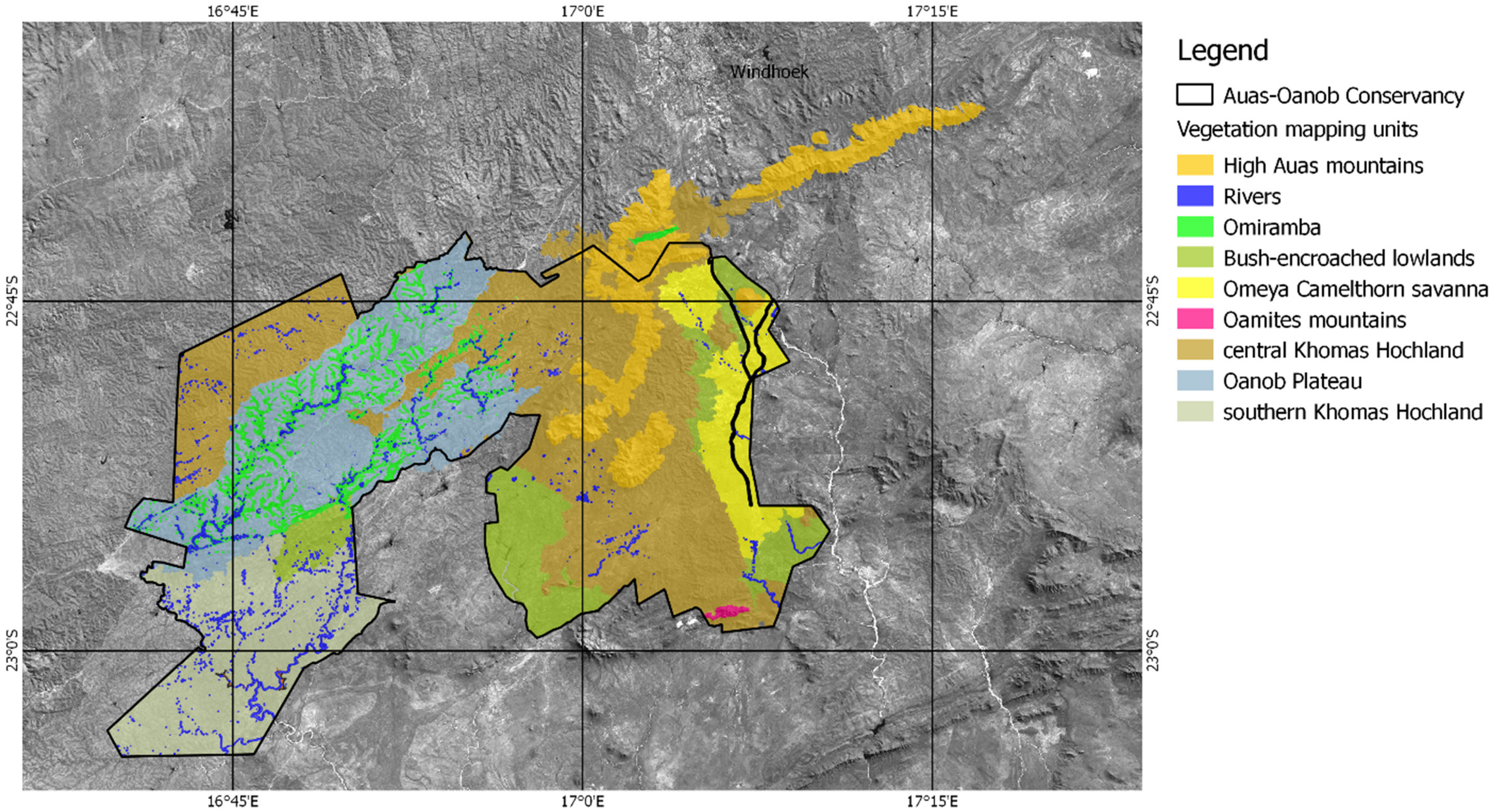

Figure 8: *Map of the landscapes associated with dominant vegetation types listed in Table 1 within the Auas-Oanob Conservancy and Auas Mountain range. For an A0 size version of this map see downloadable Appendix 3.*

Species conservation

The Auas Mountain range has been identified as a botanically important area in need of protection, because it supports rare, endemic plant species as well as relicts of Grassland and Succulent Karoo vegetation within high altitude habitats (Hofmeyr 2004). Within the three vegetation associations on this mountain range 217 species occur, of which 15 (or 6.9%) are endemic to Namibia. The Khomas Hochland vegetation contains 23 species endemic to Namibia, which is proportionally less (5.8% of 399 species), but also nine exotic species (or 2.3%). Two of these, *Opuntia stricta* and *Prosopis glandulosa*, have been classified as the most aggressive invaders in Namibia (Brown et al. 1985, Bethune et al. 2004,). Neither has reached problematic proportions within the conservancy yet, but the danger of spreading is real.

In conclusion, the Auas-Oanob Conservancy contains several unique landscapes, which can be characterised by high species diversity, a high number of endemic species, high-altitude mountainous habitats, but also arid wetland habitats in the form of the *omiramba*. Current land use is no direct threat to the species richness, but, through various forms of land degradation like erosion, bush encroachment and/or the threat of alien invasive species, will be likely to cause a change of habitat, which in turn, will threaten the plant species diversity and consequently also the habitat of wild and domesticated animal species. The presented description, as well as the original relevé data with associated photographs, will serve as a valuable resource in monitoring changes in the vegetation within this conservancy.

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