

NJE Namibian Journal of Environment

Environmental Information Service, Namibia for the Ministry of Environment and Tourism, the Namibian Chamber of Environment and the Namibia University of Science and Technology.

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Editor: J IRISH



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Recommended citation format:

Burke A, Loots S (2020) Plant endemics of the TsaulKhaeb (Sperrgebiet) National Park. *Namibian Journal of Environment* 4 A: 62-70.

Cover image: LANDSAT 5 TM / Acquisition date: 09.05.2009 / False Natural Color Composite (RGB: 5,4,3) / Source: USGS Earth Explorer

Plant endemics of the TsauKhaeb (Sperrgebiet) National Park

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URL: <http://www.nje.org.na/index.php/nje/article/view/volume4-burke3>

Published online: 17th July 2020

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Date received: 7th February 2020; Date accepted: 14th May 2020.

ABSTRACT

Endemic plant species of the TsauKhaeb (Sperrgebiet) National Park in south-west Namibia were determined by reviewing spatial distribution data. These included accessible data sources at the National Botanical Research Institute in Namibia and online as well as published literature. A total of 31 strict park plant endemics, which includes 11 local endemics, was identified. Another 33 taxa are considered broader park endemics, as these can also be found just outside the borders of the park. The level of protection a taxon should receive increases with decreasing range size, making the local endemics good indicators for environmentally very sensitive habitats.

Keywords: endemic; Namib Desert; Namibia; range size; red data; Sperrgebiet; Succulent Karoo Biome; TsauKhaeb National Park

INTRODUCTION

Every country has an obligation to protect its endemic species. In practical terms this is the responsibility of conservation staff. They have a particular duty to protect and manage the endemic species which occur within their respective areas. To do this effectively conservation staff need to know which species are endemic to a particular area.

Over the past three years there has been renewed focus on the TsauKhaeb (Sperrgebiet) National Park (TKSNP) by the Ministry of Environment, Forestry and Tourism in order to better manage natural resources and develop tourism in the park. Park staff have a special responsibility to ensure that populations of species endemic to the park are not compromised by inconsiderate developments. The park is a recognised centre of plant endemism in Namibia (Van Wyk & Smith 2001, Craven 2002), but no list of plant endemics has been published to date. A list is necessary because:

- 1) The park is endowed with the richest flora anywhere in Namibia (Burke & Mannheimer 2004).
- 2) The largest component of this rich flora at a family level, the Aizoaceae (or Mesembryanthemaceae, also known as mesembs, vygies or midday flowers) is a fast and still evolving group of succulent plants (Klak *et al.* 2004). As a consequence these plants undergo constant taxonomic changes (e.g. Klak *et al.* 2007, Snijman 2013). Keeping up-to-date with these changes is a challenge.

3) Endemism requires a clear definition of area under investigation to be meaningful. For example, country boundaries are useful for administrative purposes, but often irrelevant in an ecological context. Geographic boundaries such as those defined by watersheds, mountains ranges or rivers are far more real in the natural world. However, protected area boundaries are useful for management purposes.

The aim of this paper is to present an account of the plants endemic to the TKSNP in south-west Namibia, present a management-orientated concept of endemism and describe the process, reasoning and information that led to this account.

METHODS

Study Area

The TKSNP is situated in the south-westernmost corner of Namibia. It is bordered by the Orange River in the south, the Namib Sand Sea in the north and the Atlantic coast in the west (Figure 1). The eastern boundary runs at some 75 to 100 km distance from the coast along the base of the escarpment. The climate is arid, with annual mean rainfall of 17 mm at Lüderitz and approximately 50 mm at Oranjemund and Rosh Pinah. The area lies in a transitional zone of winter- and summer rainfall in southern Africa. Fog occurs regularly and almost constant, strong, south to south-westerly winds batter plants, animal life and landforms. Landforms are varied, dictated by the underlying geology, and form an interlaced mosaic of vast sand plains, gravel and calcrete

pavements, shifting dunes, inselbergs, pans, dry rivers and mountain ranges.

The vegetation of the study area is succulent shrubland of the Succulent Karoo Biome and grassland and shrubland of the Nama Karoo and Desert Biomes. Plant diversity is high and over 1,000 vascular, indigenous plant species have been recorded in the park (Burke & Mannheimer 2004).

Data compilation

The list of endemics was compiled from distribution data obtained from the Botanical Research and Herbarium Management System (BRAHMS) of the National Botanical Research Institute (NBRI), Windhoek, Namibia, and the published species list for the Sperrgebiet (Burke & Mannheimer 2004) as a

starting point. Additional records and taxonomic changes were added from the literature, internet sources and own field observations. Table 1 lists the reviewed sources. This also includes references to species which were later excluded from the lists of endemics. Most data are held in a quarter degree grid resolution (15 minute intervals on a longitude-latitude grid), and these spatial data were used to map species' distributions.

Clear definitions of the area to which a species is endemic are required. As this is a study in a local context and needs to be useful for management purposes, we have been specific in the definitions (Table 2). Summary data are compiled for the number of taxa, which includes species, subspecies and varieties where applicable.

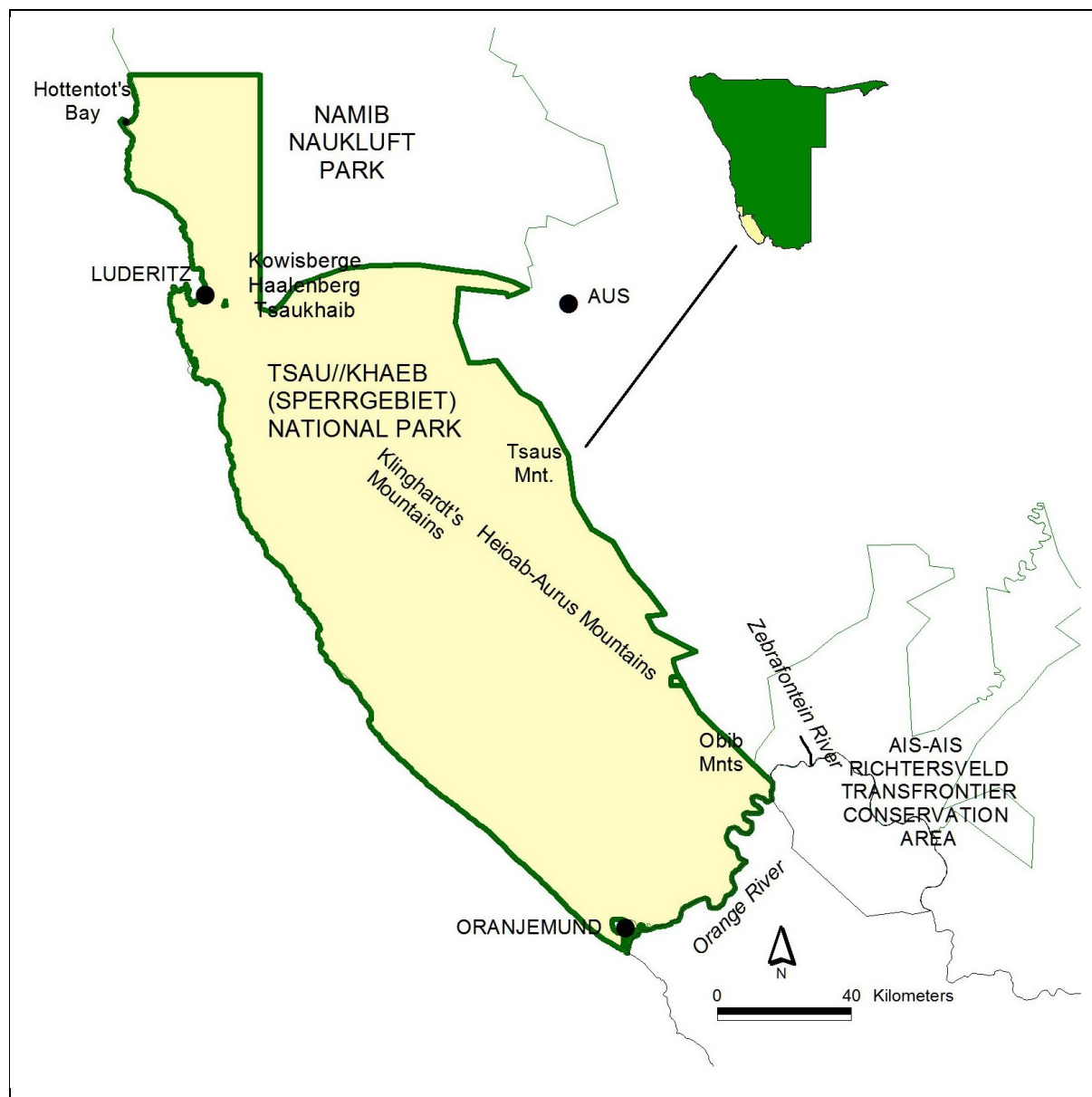


Figure 1: Location of Tsau/Khaeb (Sperrgebiet) National Park, landmarks and adjoining conservation areas.

Table 1: Sources reviewed to assess taxonomic status and geographic distribution of plant species potentially endemic to the Tsau||Khaeb (Sperrgebiet) National Park.

Source	Information	Comment
Databases		
BRAHMS database of the National Botanical Research Institute in Windhoek	List of species for all quarter degree squares covered by the park	Data not completely up-to-date
BRAHMS online	Open access distribution records of specific species	Few TKSNP endemics included
SANBI Red List	Red List assessments of South African species	If included, then not endemic to the Sperrgebiet
BIOTA	Online BIOTA southern Africa plant species list of observatories	
World Flora online	Kew Botanic Gardens' comprehensive plant list of the world	
JSTOR	Digital library of academic literature	
Literature		
Merxmuller & Schreiber (1966)	<i>Pelargonium sibthorpiiifolium</i>	
Marais (1966), Schreiber (1979)	<i>Heliophila obibensis</i>	
Schreiber (1968), Liu <i>et al.</i> (2007)	Revision of <i>Marlothiella gummifera</i>	
Herre (1971)	Genera Mesembryanthemaceae	
Botschantzev (1973, 1974, 1978)	<i>Salsola namibica</i> , <i>S. schreiberae</i> , <i>S. dolichostigma</i>	
Obermeyer (1976)	<i>Frankenia pomonensis</i>	
Van der Walt & Vorster (1981)	<i>Pelargonium cortusifolium</i>	
Barker (1983, 1987)	new <i>Lachenalia</i> species	
Duncan (1998)	<i>Lachenalia nutans</i>	
Hartmann (1998)	<i>Amphibolia</i> , <i>Antimima</i> and <i>Eberlanzia</i>	
Smith <i>et al.</i> (1998)	Mesembryanthemaceae genera	
Gibbs Russel (1991), Launert (1968-1972)	<i>Stipagrostis</i>	
Williamson (1992, 1995, 1998)	<i>Bulbine francescae</i> , <i>Crassula aurusbergensis</i> , <i>Tylecodon aurusbergensis</i> and <i>T. aridimontanus</i>	
Perry (1994)	<i>Eriospermum buchubergense</i> , <i>E. halenbergense</i>	
Snijman (1994)	<i>Strumaria phonolithica</i>	
Rundel <i>et al.</i> (1999)	Species investigated in Richtersveld include some supposed Namibian endemics	
Van Wyk & Smith (2001)	Gariiep endemics	
Cole (2000, 2005)	<i>Lithops hermetica</i> , <i>Lithops</i>	
Vollesen, (2000)	<i>Blepharis meyeri</i>	
Craven (2002), Craven & Vorster (2006)	List of endemic plant species for Namibia	
Hartmann (2002)	Handbook of succulent plants	
Hammer (2002)	<i>Conophytum</i> species	
Germishuizen & Meyer (2003)	Distribution of southern African plant species	
Nussbaum (2003)	List of species from vegetation types in the Richtersveld	
Burke & Mannheimer (2004)	Plant species list for the Sperrgebiet	
van Jaarsveld & Koutnik (2004)	<i>Cotyledon</i> and <i>Tylecodon</i>	
Loots (2005)	Distribution of prioritised plant species evaluated against IUCN Red List criteria	
Mannheimer (2006)	Revision of <i>Dracophilus</i> , <i>Juttadinteria</i> and <i>Namibia</i>	
Mucina <i>et al.</i> (2006)	Species lists for southern African vegetation types	
Klak <i>et al.</i> (2007)	Revision Mesembryanthemaceae	
Jürgens <i>et al.</i> (2010)	BIOTA data (Volume 1)	
van Wyk <i>et al.</i> (2010)	<i>Polemanniopsis namibensis</i>	
van Jaarsveld & Swanepoel (2011)	<i>Tylecodon paniculatus</i>	
Goldblatt & Manning (2013)	new <i>Moraea</i> in Aurus mountains	
Klaassen & Kwembeya (2013)	Species considered endemic to Namibia	
Snijman (2013)	Extra Cape flora (Namaqualand and southern Namib)	
Bruyns (2014)	Latest treatment of Apocynaceae in Namibia	
Kolberg & Van Slageren (2014)	<i>Pteronia</i>	
Jainta (2017)	<i>Lithops</i>	
Boatswright (2018)	<i>Calobota namibensis</i>	

Table 2: Definitions of endemism used to categorise plant species in Tsau||Khaeb (Sperrgebiet) National Park (TKSNP).

Endemism	Definition
Local endemic	TKSNP endemics which are presently only known from one or two localities or quarter degree squares within the park.
TKSNP endemic	Restricted to within the boundaries of the TKSNP.
TKSNP – NNP endemic	Main distribution is in TKSNP, but also occurring marginally in Namib-Naukluft park (NNP), such as Spencer Bay, Haalenberg, Kowis mountains and other inselbergs in the southern Namib sand sea.
TKSNP – Aus endemic	Main distribution is in TKSNP, but also recorded at Aus.
TKSNP – Orange River endemic	Main distribution is in TKSNP, but also recorded just south of the Orange River and in the Richtersveld, but not extending east of the Zebrafontein River.

RESULTS AND DISCUSSION

Overall summary

Based on our definitions and currently available data, there are presently 31 strict TKSNP endemics (Appendix 1). These comprise 11 local endemics and 20 spatially less restricted taxa. Fourteen taxa also occur nearby in the Namib-Naukluft Park, mostly just north of the public road from Lüderitz to Aus. Another three taxa are also recorded at Aus and 16 taxa also occur across the Orange River in South Africa. This amounts to a total of 64 plant taxa which can be considered endemic to the park in a broader sense. This will need to be reviewed and updated when new information becomes available.

Local endemics

Except for *Salsola hottentottica*, this group includes only taxa growing in mountain, inselberg or otherwise rocky habitats. Such local endemics are found in the Klinghardt, Tsaus, Obib and Aurus mountains. They are often habitat specialists and therefore very rare. *Lithops hermetica* for example, is found on light-coloured, calcareous substrate within darker limestone on the Tsaus mountains (Jainta 2017). This is possibly one of the harshest environments in which *Lithops* can be found (Loots 2019). One of the two miniature *Tylecodon* species, *T. aurusbergensis*, only grows under shaded overhangs or in cracks of steep, south- to west-facing slopes of inselbergs or mountains. Two *Conophytum* species, *C. taylorianum* subsp. *taylorianum* and *C. klinghardtense* subsp. *baradii* are only known from one or two localities, respectively. Whether this indicates habitat specificity or simply a lack of distribution data requires some further investigation (Young, pers. comm., May 2019).

The local endemics present a variety of growth forms. These include dwarf succulents, for example *Conophytum klinghardtense* (both subspecies), *Lithops hermetica*, *Tylecodon aridimontanum* (Figure 2) and *T. aurusbergensis*, herbs (*Heliophila obibensis*), shrubs (*Blepharis meyeri*), as well as bulbs, for example *Eriospermum buchbergense* and

Lachenalia nutans. Point or local endemics are inevitably also strict park endemics. The list of local endemics is, however, likely to change once more distribution data become available. Some of these plants are extremely cryptic and difficult to identify and may have been overlooked in field surveys. Others, such as the elusive bulb *Eriospermum buchbergense*, have only been observed once. However, for management purposes local endemics and their habitats deserve the highest protection until it is proven that they are not as limited in distribution as presently known. This follows the precautionary principle recommended in environmental management and red-listing procedures (Keith *et al.* 2000, Matsuda 2003).

TKSNP endemics

The strict park endemics largely comprise plants growing in the coastal area and therefore within the fog belt, such as *Brownanthus namibensis*, *Euphorbia verruculosa*, *Frankenia pomonensis* (Figure 2), *Marlothiella gummifera* and *Namibia cinerea*, or plants restricted to mountains and inselbergs. Examples of the latter are *Antimima aurasensis*, *Crassula aurusbergensis*, *Eriocephalus klinghardtensis* and a recently found new species of *Ornithogalum*. Only *Drimia secunda* and *Polemanniopsis namibensis* do not neatly fit into these two categories. *Drimia* grows on sand plains throughout the park and *Polemanniopsis* on plains and rocky ridges in a few scattered localities north and south of the Kaukausib valley.

TKSNP – NNP endemics

All endemics growing on the northern inselbergs of the park, such as Kowis mountains and Haalenberg, invariably also occur in the Namib-Naukluft Park as these mountains stretch across the park boundary. Some coastal endemics occur further north than the park boundary at Hottentot’s Bay such as *Ectadium virgatum* subsp. *latifolium*, *Eremothamnus marlothianus* and *Pelargonium cortusifolium*. The TKSNP-NNP endemics also represent all growth forms, except for herbs. Most are however either shrubs or compact leaf-succulents.



Figure 2: Selected plant endemics of the TsauKhaeb (Sperrgebiet) National Park (Photos: A. Burke). a) *Polemanniopsis namibensis* grows in a few isolated populations in the northern part of the park; b) The local endemic *Tylecodon aridimontanus* is presently only known from the Heioab mountain; c) *Hoodia officinalis* subsp. *delaetiana* growing from cracks in the Klinghardt Mountains; d) *Frankenia pomonensis* is restricted to the Sperrgebiet's coastal area.

TKSNP – Aus endemics

Three species with their main distribution in the TKSNP have also been recorded at Aus, just outside the park boundaries: the bulbs *Oxalis luederitzii* and *Trachyandra lanata* and the grass *Stipagrostis lanipes*.

TKSNP – Orange River endemics

Another 15 species with their main distribution in the TKSNP extend across the Orange River into South Africa. With three exceptions, the shrubs *Cynanchum meyeri*, *Rhysolobium dumosum* and *Salsola araneosa*, these are all succulents and include one succulent herb, *Synaptophyllum juttae*. *Lithops herrei*, which also occurs south of the Orange River in South Africa, is in the process of being merged with *L. optica* (Loots *et al.*, in prep). *Lithops optica* was formerly classified as a TKSNP endemic, but can now only be considered a TKSNP – Orange River

endemic. The distribution of *Rhysolobium dumosum* is not entirely clear. There is a record from Vioolsdrif in South Africa which is east of the Zebrafontein River. However, since this is the only record of *R. dumosum* so far east we have provisionally included the shrub in the list of Sperrgebiet – Orange River endemics. *Juttadinteria deserticola* is included in this group, but its range also extends north into the Namib-Naukluft Park. It could have been counted in either category.

The level of plant endemism in the TKSNP is exceptional and likely not surpassed by any other park in Namibia. Parks in South Africa in the Succulent Karoo Biome, however, likely match this level of endemism. The Richtersveld National Park for example, which is less than 10 % of the size of the TKSNP has at least 16 plant endemics (Williamson 2002).

Taxonomic uncertainties

Although we have strived to use only reliable information when compiling species distributions, errors through misidentification are not completely eliminated. Difficult groups of plants to identify are for example the *Antimima* and *Salsola* species, and South African and Namibian botanists treat certain groups differently.

The genus *Salsola*, for example has been split into innumerable species (Botschantzev 1974) and the validity of this taxonomic treatment needs to be confirmed (Kadereit, Mucina, pers. comm., October 2019). *Salsola namibica*, for example, was considered a Namibian endemic by the NBRI, but we have found records from the Richtersveld (Mucina *et al.* 2006). This is one case where possibly a different interpretation of the taxonomic treatment of *Salsola* by Botschantzev (1974) has been adopted by Namibian and South African botanists. Another example is *Antimima perforata* which is considered endemic to Namibia in the NBRI's species list (Kwembeya & Klaassen 2013), but has been recorded in Namaqualand (Nussbaum 2003). Whether this is a different interpretation of the taxonomic treatment or indeed a new distribution record requires further investigation in the field. This challenge has also been noted by Craven in her studies of the endemic flora of Namibia (2002, 2009).

The *Salsola* species received intensive review for this paper but there are conflicting records and we finally followed Botschantzev's (1974) synopsis and eliminated all species which he indicated to also occur in South Africa. This means *Salsola luederitzensis* is no longer considered endemic as indicated in the NBRI's plant species list (Kwembeya & Klaassen 2013). *Salsola schreiberiae* has in the meantime also been recorded on a farm neighbouring the Sperrgebiet and, although remaining a Namibian endemic, it is no longer considered a TKSNP endemic. Thus only *S. hottentottica* remains as a local endemic, so far only recorded from Hottentot Bay. As evident by the confusion reigning even amongst specialists, the genus *Salsola* requires some urgent attention. The Namibian species of *Salsola* have all been transferred back to *Caroxylon* (Mucina 2017), but the NBRI will retain them as *Salsola* for the time being (Chase, pers. comm., October 2019).

There are also potential identification errors in the Namibian plant database. There are records of *Pelargonium cortusifolium* from far inland on the Orange River, although it is assumed to be a coastal species. It is very difficult to differentiate *P. cortusifolium* from *P. crassicaule* and that could have resulted in a misidentification. We have therefore included *P. cortusifolium* in the current list of TKSNP endemics.

Ectadium latifolium was merged with *E. virgatum* on the plant species list for Namibia (Kwembeya & Klaassen 2013). Yet it is a valid subspecies according to World Flora online (World Flora online 2019) and is now recognised as *E. virgatum* subsp. *latifolium*.

One species was excluded because of doubtful taxonomic status: *Crassula luederitzii*. This is considered to be a synonym of *C. capitella* subsp. *thyrsiflora* (World Flora online, accessed September 2019). The species *Dracophilus proximus* and *D. montis-draconis* were merged with *D. dealbatus* and *Juttadinteria suavissima* was partly merged with *J. ausensis* and partly with *J. deserticola* after Mannheimer's (2006) revision. The status of *Juttadinteria kovisimontana* was not entirely clear and has been recommended for further studies (Mannheimer 2006). We have included *J. kovisimontana* in the current list of endemics.

Practical implications for management

By providing a detailed description and in-depth analysis of the status of endemic plants in the TKSNP, we urge natural resource and park managers to adapt their management of endemics to the conservation needs of these plants. As a general principle, the level of protection a plant species should receive increases with decreasing range. Thus the local endemics and their habitats should receive the highest protection, followed by park endemics and then the broader park endemics. Although the range size does not provide an indication of abundance, it is the closest proxy for rarity that is presently available. The next step in raising the status of TKSNP endemics will be a thorough revision of their current evaluation against red-list criteria and determining the population status of selected range-restricted species (e.g. Cousins *et al.* 2014, Phama *et al.* 2014).

CONCLUSIONS

Knowing which endemics are present is important in order to apply appropriate management strategies, such as using endemics as indicators for environmentally sensitive habitats and locations and developing suitable protection measures where necessary. Despite some taxonomic uncertainties, 31 plant species are presently considered strictly endemic to the TKSNP. Although detailed accounts have so far not been published, it is very likely that no other national park in Namibia can match this level of plant endemism.

ACKNOWLEDGEMENTS

We are indebted to Prof Ladislav Mucina and Prof Gudrun Kadereit for some insight into the difficult genus *Salsola*, and to Prof. Kaj Vollesen and Dr Iain Darbyshire for clarification on Acanthaceae distributions. Pieter van Wyk

shared his extensive knowledge of the Richtersveld flora and Andrew Young provided some difficult-to-access references. This publication is part of a project partially supported by a Namibian Chamber of Environment Grant with funding from B2Gold Namibia and Total Namibia under the title "Highlighting the importance of endemic plants of the TsauKhaeb (Sperrgebiet) National Park". Reviewers C. Mannheimer and Dr. G. Smith, both anonymous at the time, and the editor helped to improve the manuscript. We would like to thank everybody wholeheartedly for their input.

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Appendix 1. Plant endemics of the TsauKhaeb (Sperrgebiet) National Park, endemism defined as in Table 2.

1. Local endemics

Blepharis meyeri
Conophytum klinghardtense ssp. *baradii*
Conophytum klinghardtense ssp. *klinghardtense*
Conophytum taylorianum ssp. *taylorianum*
Eriospermum buchbergense
Heliophila obibensis
Lachenalia nutans
Lithops hermetica
Salsola hottentottica
Tylecodon aridimontanum
Tylecodon aurisbergensis

2. Strict TKSNP endemics

Antimima aurasensis
Antimima dolomitica
Brownanthus namibensis
Bulbine francescae
Crassula aurisbergensis
Crassula elegans ssp. *namibensis*
Drimia secunda
Eriocephalus klinghardtensis
Euphorbia verruculosa
Fenestraria rhopalophylla
Frankenia pomonensis
Hoodia officinalis ssp. *delaetiana*
Lessertia cryptantha
Marlothiella gummifera
Namibia cinerea
Ornithogalum sp.nov.
Polemanniopsis namibensis
Psammophora saxicola
Pteronia spinulosa
Strumaria phonolithica

3. TKSNP endemics and also extending into NNP

Amphiglossa thuja
Conophytum halenbergense
Ectadium virgatum ssp. *latifolium*
Eremothamnus marlothianus
Eriocephalus kingesii
Eriospermum halenbergense
Juttadinteria kovisimontana
Juttadinteria simpsonii
Calobota namibensis
Lithops francisci
Namibia ponderosa
Pelargonium cortusifolium
Salsola dolichostigma
Trachyandra peculiaris

4. TKSNP endemics and also recorded at Aus

Oxalis luederitzii
Stipagrostis lanipes
Trachyandra lanata

5. TKSNP endemics and also occurring just south of the Orange River

Antimima buchbergensis
Antimima perforata
Astridia hallii
Cynanchum meyeri
Euphorbia angrae
Juttadinteria albata
Juttadinteria deserticola
Lithops optica
Othonna clavifolia
Pelargonium sibthorpiiifolium
Psammophora longifolia
Rhyssolobium dumosum
Ruschia pollardii
Salsola araneosa
Synaptophyllum juttiae
Tridentea pachyrrhiza