The Sperrgebiet – a Diversity Hotspot of Desert Plants

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A small portion of the Succulent Karoo, southern Africa's hotspot of plant diversity, extends into southern Namibia. Locked up in the enigmatic Sperrgebiet or Diamond Area 1, a remarkable diversity of living diamonds rivals the riches excavated from ancient beaches beneath the sand and sea by the diamond industry. Antje Burke, a freelance plant ecologist who has worked in Namibia over 15 years, and Coleen Mannheimer, associate researcher and former curator of the National Herbarium of Namibia, take stock of the Sperrgebiet's fascinating plant riches.

Patches of yellow, pink and purple succulents, their leaves bursting with water, carpets of yellow daisies, colourful white, purple, and yellow lilies, slopes covered in delicate, violet-flowered herbs and wherever we looked there was more to be seen. We will never forget our first 'formal' plant collecting trip to the Sperrgebiet in 1996 when the entire area had received exceptionally good rains and we happened to get the timing exactly right. Many more trips followed – at least once a year – and even if we were not always as lucky as the first time, a good seven years later we feel equipped to give a report back.

We always knew this area to be rich in plant species in the Namibian context. Yet, (1) How rich? (2) How special? and (3) What are the possible reasons for this? ... are three questions we would like to explore in this article.

What and where is the Sperrgebiet?

Covering some 20 000 km^2 – if one excludes the northern strip that extends into the Namib sand sea – in the south-west of Namibia, the Sperrgebiet (German for 'forbidden territory') is a prime wilderness area at the transitional zone between winter and summer-rainfall in southern Africa (Figure 1). Extreme aridity, – annual mean rainfall increases from about to 20 mm to some 60 mm along a coast inland gradient – relentless winds, mainly from the south, and regular fog, particularly along the coast, characterise the climate of this biodiversity hotspot. Certainly not a mellow environment for plants.

Breathtaking, spectacular and contrasting landscapes abound. Dune fields, some sparsely covered in low stem succulent shrubs (*Othonna cylindrica* and *Othonna furcata*), others mobile and only supporting a few patches of robust desert grasses (e.g. *Cladoraphis spinosa* and *Stipagrostis sabulicola*) alternate with gravel plains, ancient river courses that dried up many thousands of years ago, and groups of isolated mountains (inselbergs) with variable substrates caused by the complex geology of this ancient land surface. Some patches of gravel plain are so densely packed with minute succulents (*Crassula, Dracophilus, Fenestraria, Lithops* species and many more) it is almost impossible not to step on them, while the inselbergs and mountain areas provide perfect rock gardens that any horticulturist would envy. Here tall stem succulents (e.g. *Aloe ramosissima, Tylecodon paniculatus*), a tremendous variety of dwarf succulent and deciduous shrubs, lilies, herbs, climbers and creepers congregate to form structurally diverse, aesthetically astounding and taxonomically challenging plant assemblages. Many of the leaf succulent shrubs look very much alike, but a closer look reveals that they are all very different.

Long stretches of sandy beaches with occasional rock promontories break up the regular coastline. Along here fierce winds have perpetually swept valleys that run north-south for hundreds of years, preventing all but a few, isolated hardy shrubs from taking a foothold. In the lee of rocks and outcrops, numerous dwarf succulents cling onto the often steep slopes, many, such as the appropriately named *Namibia,* endemic to these rocky coastal habitats as well as other species, such as *Eremothamnus* and several *Pelargonium* species. Salt pans adjoin the sandy beaches inland, possibly relicts of former lagoons and now maintained by underground seawater seepage. All these varied habitats provide a home for plants, predominantly succulents, which seem well adapted to this harsh desert environment. A linear oasis, the Orange River, which carries water all year round, forms the southern boundary and locally supports evergreen riparian woodlands, reedbeds and grassy lawns.

The name of the area deserves an explanation. Initially created as a buffer zone for the diamond industry, the Sperrgebiet was proclaimed by the German colonial administration in 1908. Since then it has been closed to the public, and only mining and exploration activities are allowed there. Recently, in a very restricted area, a tourism concession has been granted. Mining is restricted to a small area on the eastern boundary, the Orange River terraces, and beaches on the coast. Yet exploration activities occur throughout the area. Its status is state land with, save of the mining and exploration licences, plans to proclaim a formally protected conservation area.

How rich is the Sperrgebiet flora?
Nearly 25 % of the species comprising the entire flora of Namibia – 24.3 % to be more precise – are packed into the southwest corner of the country onto only 2.5% of Namibia's land surface. Some 1038 flowering plants have been recorded to date, and very likely more will be found in future (Burke & Mannheimer in press). In a national context this is no doubt one of the prime plant diversity hotspots. Richard Cowling, Craig Hilton-Taylor (1999) and colleagues have repeatedly drawn our attention to the Succulent Karoo's remarkable, and world-wide unrivalled arid plant diversity. Our account from the Sperrgebiet certainly supports their views.

Is the Sperrgebiet flora special?
Straight numbers aside, what else makes the Sperrgebiet flora special? Let's look at the composition of the flora. Characterised by a tremendous diversity of leaf succulents, the family Mesembryanthemaceae contributes the largest portion of species to the Sperrgebiet flora, followed closely by Asteraceae (Table 1). The two families together contribute nearly one third (31%) of the species listed. A total of 90 families are represented in the Sperrgebiet, nearly as many as the far richer Namaqualand flora to the south, which has representatives from 107 families. Amongst the vygies (as the Mesembryanthemaceae are locally known) particularly rich are the genera *Conophytum*, *Drosanthemum*, *Mesembryanthemum*, *Lithops* and *Ruschia*. A number of genera are Sperrgebiet endemics, (e.g. *Namibia*), or near-endemics (e.g. *Dracophilus*, *Hartmanthus*, *Juttadinteria*, *Psammophora*, *Synaptophyllum*). Geophytes are another important contributor to the Sperrgebiet flora, and amongst those many are restricted to this area. If we compare contribution by families to the Sperrgebiet flora, to the composition of the floras of biomes in the general area, our analysis shows that the Sperrgebiet is an integral part of the Succulent Karoo Biome. It shares many of the dominant families in the same order of importance (Table 1). However, one exception is the family Zygophyllaceae, which does not rank amongst the top ten families in neighbouring biomes. The Sperrgebiet is believed to be the centre of distribution for the genus *Zygophyllum* in southern Africa (Van Zyl 2000), explaining why some 30 species of this family occur there.

From a global perspective, Avi Shmida (1985) reported from other desert areas that Asteraceae, Poaceae and Fabaceae are the most species-rich families in drylands, neatly following the order of their contribution to the world flora in general. In the Sahara, Middle East, Asia and Australia Chenopodiaceae is also an important contributor to desert floras. While less important in southern African drylands in general, the family does feature prominently in the Sperrgebiet flora. This is a result of the profuse speciation in *Salsola* Botschantzev (1974) portrayed to have occurred in this area. However, we are not convinced that this is a true reflection of the situation in the field and more detailed taxonomic work is required to elucidate the seemingly tremendous speciation in this genus in the Sperrgebiet and Namibia in general.

Why is the Sperrgebiet flora so rich in species?
Our colleagues in South Africa have suggested that relatively predictable rains, falling in gentle showers, moderate temperature regimes, variable soil conditions – often within the space of a few tens of centimetres – and relatively recent climatic fluctuations have contributed to the Succulent Karoo's remarkable plant diversity (Cowling et al., 1998; Midgley et al. 2000). These selective forces also apply to the Sperrgebiet. Moreover, there are additional factors that may play an important role.

One is that the Sperrgebiet is positioned in a transitional area between winter and summer-rainfall in southern Africa and hence there may be two rainy seasons in a year. Temperate cyclones off the Atlantic coast bring winter rains, usually during June – September, when the south-western tip of Africa, the Cape Region, receives the bulk of its precipitation. Moist, tropical air moving in from the north and east can bring summer rains. In this part of the continent these accumulate in March-May. Often the transition between the winter- and summer rainy season is somewhat murky, and, unless one studies weather maps during rain events, rains are not always clearly attributable to one or other main pressure system. The result is that plants are blessed with a more regular supply of rain here than in other arid parts of Namibia.

Compared to the rest of the Namib desert, habitat diversity is very high. Not only in terms of the different types of habitats that are available overall, but particularly so when one looks at their spatial distribution. Instead of vast homogenous dune fields, as seen to the north, several sand sheets occur in the Sperrgebiet, interrupted by gravel plains, isolated mountains and ancient drainage systems. The complex geology, particularly in the mountainous areas, provides many different substrates, and hence more habitat diversity at the local level. Not surprising that some inselbergs (German for "isolated mountain") support endemic species, some restricted to a particular outcrop.

Richard Cowling and colleagues (1998) suggested that steep gradients of soil depth, for example, drive compositional turnover in the succulent Karoo and it could be conceived that the number and extent of habitat interfaces might well contribute to creating very diverse plant assemblages. For the Sperrgebiet these are only theories, for which hard evidence is still outstanding.

More recently, restricted access, although not the reason for the evolution of plant diversity, can nevertheless be named as a contributor to maintaining it. Elsewhere in the succulent Karoo impacts related to livestock farming have undoubtedly contributed to a decline in plant species diversity, at least locally. These impacts have largely been prevented here.

Some challenges ahead

The Sperrgebiet has undoubtedly benefited from its secluded position in a diamond mining buffer zone, having largely been inaccessible to plant collectors, livestock and off-road vehicles for nearly a century.

The flora in this area is special in that it supports a nationally unrivalled plant diversity, represents a genuine part of succulent Karoo vegetation in Namibia and – as few in-depth studies in evolution, ecology or the properties of its magnificent flora have hitherto been undertaken – may have more, as yet undiscovered, surprises in stock.

The effects of climate change, which are predicted to hit the succulent Karoo hardest on the African continent (Midgley et al. 2001), and uncertain land use status are two of the main challenges to the preservation of the Sperrgebiet flora. The former is out of our hands, but the latter can be achieved if the recommendations that emanated from the Succulent Karoo Ecosystem Plan, an internationally supported conservation planning exercise spanning the entire Succulent Karoo Biome, and the Sperrgebiet Conservation Planning Study in particular, are put in place. Mining and exploration have helped to create this special area, but these activities also contribute to losses amongst the flora. A careful balance has to be struck between the extraction of the Sperrgebiet's diamond and mineral wealth – unsustainable, yet imperative for Namibia's economic development – and the preservation of the Sperrgebiet's living diamonds.

Acknowledgments

We are indebted to Namdeb Diamond Corporation, our colleagues at the National Botanical Research Institute of Namibia, Trygve Cooper and our husbands. Without their support all this would have taken us probably another seven years to complete.

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In Pursuit of Plants

Philip Short

352 pages, 45 color illustrations, 20 b/w illustrations,

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2003 Timber Press, Portland, OR

In Surinam, plant hunter F.W. Hostmann allowed vampire bats to suck his toes; Thomas Drummond was attacked by a bear in the North American woods; George Forrest narrowly escaped rampaging llamas in western China; and in Fiji, Berthold Seemann recorded which plants cannibals used as an accompaniment to human flesh.

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Table 1. Composition of the Sperrgebiet flora with regard to the eleven largest families and their contributions in other biomes (averaged from Cowling and Hilton-Taylor 1999, Succulent Karoo: n = 3 and Nama Karoo: n = 2, except where otherwise indicated).

Family	Contribution Sperrgebiet flora	No. species in Sperrgebiet	Succulent Karoo	Nama Karoo
Mesembryanthemaceae and Aizoaceae	15.9 %	165	15.4 %	5.3 %
Asteraceae	14.9 %	155	18.6 %	18.4 %
Liliaceae (summarised)	7.8 %	80	7.9 %	5.8 %
Poaceae	5.6 %	58	6.8 %	10.2 %
Scrophulariaceae	5.3 %	55	5.9 %	4.8 %
Crassulaceae	5.1 %	53	6.3 %	2.5 % (n=1)
Fabaceae	4.6 %	48	3.6 %	3.9 %
Chenopodiaceae	3.8 %	40	2.7 % (n=1)	2.7 % (n=1)
Euphorbiaceae	3.0 %	31	2.7 % (n=2)	2.9 % (n=1)
Zygophyllaceae	2.9 %	30		
Asclepiadaceae	2.9 %	30	2.6 % (n=1)	

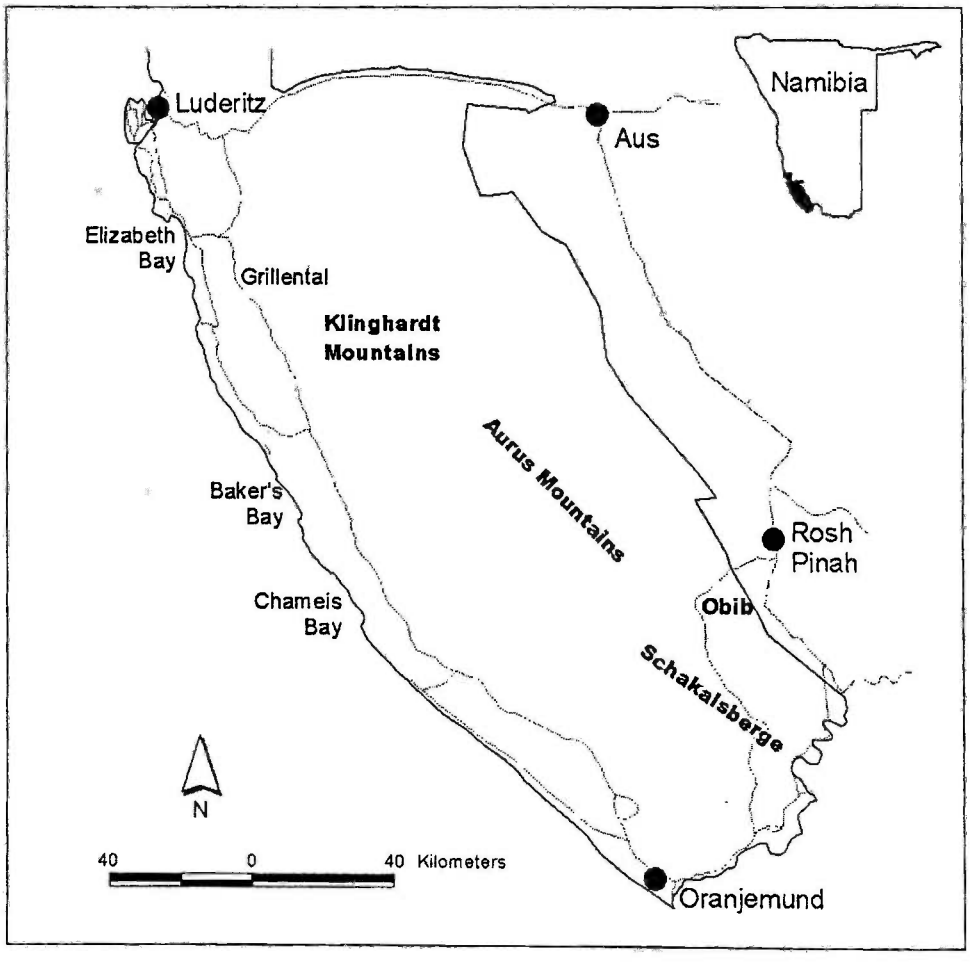

Figure 1. Landmarks in the Sperrgebiet and its position in Namibia.

Figure 2. Rocky habitats support the highest plant diversity in the Sperrgebiet (A. Burke).

Figure 3. This enormous lily, called *Whiteheadia etesionamibensis* has only recently been described. Most likely restricted to the Sperrgebiet, its leaves grow flat on the ground and can measure up to 0.5 m in length. The inflorescence stands nearly half a meter tall (A. Burke).

Figure 4. Small stem-succulents, such as *Othonna cylindrica* provide a sparse plant cover on sand sheets inland (A. Burke).

Figure 5. Inselbergs provide botanists with new discoveries at each visit (C. Mannheimer).

Figure 6. Red dune sands provide the perfect backdrop for *Gazania jurineifolia* (C. Mannheimer).

Figure 7. *Dracophilus delaetianus* is an attractive tufted mesemb, endemic to the Sperrgebiet. (C. Mannheimer).