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Section A: Peer-reviewed papers

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Aerial census of Cape Cormorants and Cape Fur Seals at Baía dos Tigres, Angola

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ABSTRACT

A total of 250,786 Cape Cormorants, of which 16,038 were individuals on nests in 349 colonies, and 15,831 Cape Fur Seals were counted during a complete aerial photographic census of the island of Tigres and part of the adjacent coast in Angola in March 2017. Such a concentration of birds and seals and the large number of breeding Cape Cormorants highlights the need to protect Tigres and its rich surrounding waters.

Um total de 250.786 Corvo-marinhos do Cabo, dos quais 16.038 eram indivíduos em ninhos em 349 colonias, e 15.831 *Leão-marinho-do-Cabo foram contados durante uma pesquisa aérea completa da Ilha dos Tigres e parte do litoral adjacente em Angola em Março 2017. Essa concentração de Corvo-marinhos do Cabo, suas colônias de reprodução e a presença de um grande número de outras aves demonstra a necessidade de proteger Tigres e suas ricas águas circundantes.*

Keywords: aerial census; *Arctocephalus pusillus pusillus*; Baía dos Tigres; Cape cormorant; Cape fur seal; *Phalacrocorax capensis*.

INTRODUCTION

Tigres lies in the general boundary area where southern, biologically rich and cold water of the Benguela Current meets warmer, less productive water flowing from the north in the Angola Current. The interface between the two currents is known as the Angola-Benguela Front. The northern Benguela shelf around Tigres supports a considerable biomass of plankton, fish and other marine life (Hutchings et al. 2009). This includes Cape Cormorants (*Phalacrocorax capensis*) and Cape Fur Seals (*Arctocephalus pusillus pusillus*). Both predators feed on fish, are large (and thus easy to count) and are relatively abundant on and around Tigres.

Cape Cormorants are endemic to the coast of South Africa, Namibia and Angola. Their breeding range extends west and north from Algoa Bay in South Africa to southern Angola, but most birds are concentrated where nutrients and biological production is greatest in the Benguela Ecosystem. Cape Cormorants are classified as Endangered by the IUCN, their total population being estimated at about 234,000 individuals (Birdlife 2018). Cape Fur Seals are also endemic to the south-western African coast. The total southern African population of Cape Fur Seals was estimated to be about 2 million in 2004 (Kirkman et al. 2007).

Ilha dos Tigres is relatively remote and extremely flat, conditions which make it difficult to survey animal life from the ground. Five previous surveys provided counts of cormorants and seals in sample areas (Table 1). Breeding colonies of Cape Cormorants and Cape Fur Seals were documented for the first time by Dean et al. (2002) and Dyer (2007).

METHODS

Study Site

Ilha dos Tigres (strictly the island, but generally and better known as Baía dos Tigres) is the only sandy offshore island along the 200 km coast of the Namib Desert in Angola. The island was connected to the mainland prior to 1962. It supported a sizeable town and fish processing industry that disappeared after the connection to the mainland broke. An abundance of fish continues to attract artisanal fishermen from Tômbua, as well as foreign vessels that catch and process fish offshore to the west of Tigres

Table 1: *Numbers of Cape Cormorants and Cape Fur Seals counted on and around Tigres prior to 2017 and in this study.*

	Simmons et al. (2006)[1]		**Dyer (2007)[2]**	**Meÿer (2007)[3]**	**Ministério do Ambiente (2017)[4]**	**This study**
Survey month and year	January 1999	September 2001	November 2005	December 2006	2017	March 2017
Cape Cormorants	570	>4,000	2,630 pairs		15,248	250,786
Cape Fur Seals			5,167	21,440		15,831

[1] Simmons et al. (2006) is based on a survey along the coast adjacent to Tigres in 1999, and a flight over Tigres in 2001. It is not known how much of the island was surveyed from the air in 2001. The 4,000 Cape Cormorants were associated with about 2,000 nests, this being the first record of breeding in Angola (Dean et al. 2002)

[2] Dyer (2007) reported 5,167 Cape Fur Seals, of which 1,161 were pups, on Tigres Island. A Cape Cormorant fitted with a radio transmitter and tracked over four months moved (presumably to forage) within a radius of 30 km of Tigres Island. Roux (2007) reported "large numbers at Baía dos Tigres and feeding aggregations of tens of thousands of (Cape Cormorants) were observed in the bay (in August 2005) as during previous years".

[3] Meÿer (2007) reported results from an aerial census covering Tigres Island on 1 December 2006 which produced counts of 17,062 sub-adult and adult Cape Fur Seals and 4,378 pups.

[4] Ministério do Ambiente (2017) reported a total of 15,248 Cape Cormorants on Tigres Island, and another 3,305 along the coast between Tômbua and Tigres Bay. The date and spatial extent of the survey was not reported.

Data Collection and Analysis

On 1 March 2017 high resolution (4 cm per pixel) aerial photographs were taken from a Jabiru 430 Standard aircraft, with two fuselage-mounted Canon 5Dsr 50 mm focal length cameras, of the entire area of Ilha dos Tigres and part of the adjacent mainland coast (Figure 1). Each image covered about 360 by 206 metres. The survey was conducted in the morning, starting at 07h22 and ending at 10h41 (GMT+1). One of us (JMM) visited Tigres and the adjacent mainland during a low-level reconnaissance flight on 27 February 2017, and then on the ground from 28 February to 2 March 2017. Observations during those visits provided context to results obtained from the aerial photographic census.

A high-resolution monitor was used to search the images for seals and cormorants. Where possible, adjacent images with cormorants and seals were stitched together using Agisoft PhotoScan Professional or Adobe Photoshop.

Cormorants were counted manually on images where few individuals were visible. However, the majority of individuals were clustered in colonies, which we counted using the following procedure.

First, images or sections of images with colonies were imported into Adobe Photoshop. Blocks in which no birds were visible were deleted, while the remaining areas of the image were processed to enhance the contrast between the cormorants and surrounding substrate, as well as the boundary definition between each individual and the substrate and/or other individuals. This was done using combinations of Photoshop's Contrast, Brightness, Hue, Saturation, Colour Balance and Sharpen tools.

The Eyedropper tool was then used to select all pixels that represented cormorants. The selected pixels were given a distinct, simple colour (bright red or yellow, for example). This process of selection and colour replacement (using the Paint Bucket tool) was

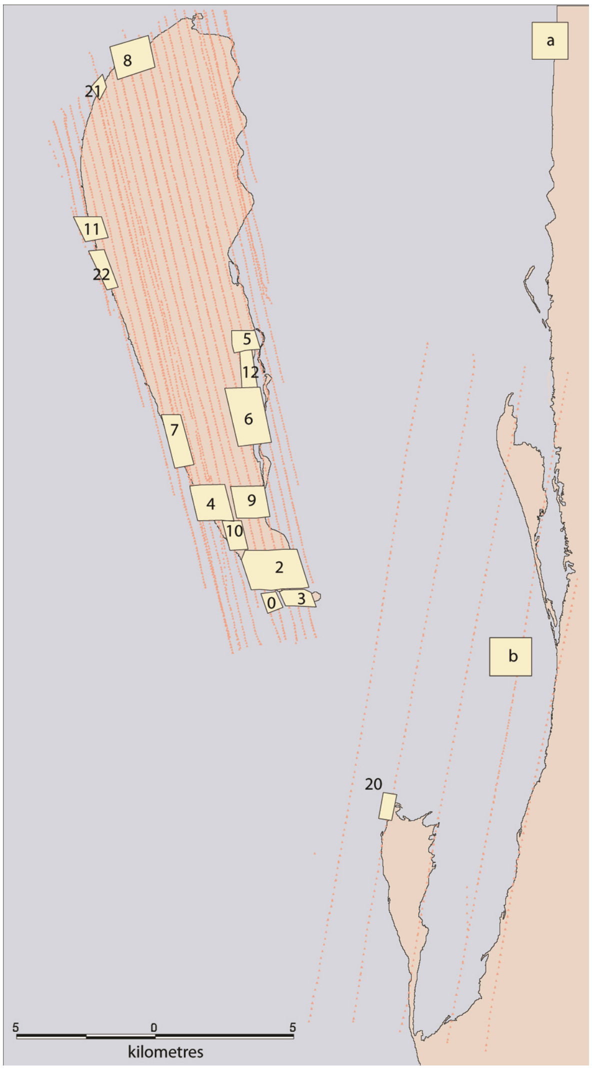

Figure 1: *The area of Ilha dos Tigres and the adjacent mainland (which is part of Iona National Park), showing lines of points (red dots) at which aerial photographs were taken. Numbered blocks cover areas where concentrations of Cape Cormorants and Cape Fur Seals were found in the aerial survey photographs, while blocks a and b are locations where the photographs shown in Figure 4 were taken.*

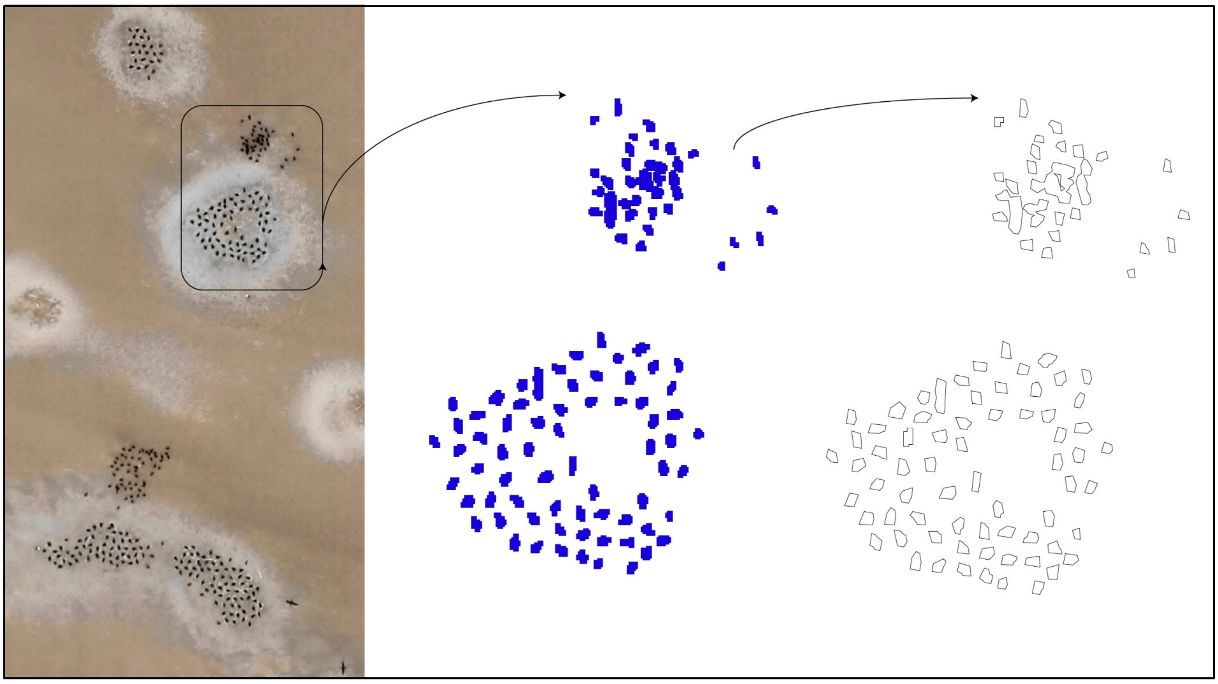

Figure 2: *Processing steps used to identify, map and count numbers of nests and individual cormorants in the original photograph (left), the selection of pixels representing cormorants (middle) and the vectorised polygons used to estimate the number of individuals (right). Note the even spacing between nesting birds, while some birds are clustered in the small flock above. Breeding colonies were regarded as separate groups or clusters of nests. For instance, four breeding colonies in areas with pale backgrounds and two non-breeding groups are visible in this image.*

repeated until we considered that all pixels representing cormorants had been found and re-coloured.

Some images were rather uniform in colour, such that the substrate was quite similar everywhere, and cormorants in different parts of the image were much the same in colour. Each of those images could be processed in one batch. Other images were more varied, requiring different parts of the images to be processed separately. This was often the case for cormorants close to the image margins which were darker and fuzzier than elsewhere. Most 'background' pixels that did not represent cormorants were deleted from these images.

Second, the images thus processed and re-coloured were imported into ArcView and converted into ArcView grids using its Spatial Analyst extension. Grid cells that had been coloured distinctive reds or yellows were selected and converted into vector polygons. The area covered by each polygon was calculated. The areas were calculated separately for each image because the units of area measurement were usually specific to each image, especially for images that could not be georeferenced (and which thus had arbitrary grid cell dimensions).

While most individual cormorants could be seen, re-coloured, mapped and then counted as separate polygons, colonies often had some clusters in which individuals could not be identified and mapped separately. The size of these groupings and all other individual polygons were summed and then divided by the average size of a polygon representing a cormorant to estimate the total number of individuals in a colony or image. Average sizes of polygons for individual cormorants were determined from samples of 100 or more polygons that clearly represented individual birds. This process is illustrated in Figure 2.

We attempted to use the same approach to count seals. However, the numbers estimated and physically counted in the images often differed substantially. This was due to the variable sizes of pups, immatures, females and bulls, as well as the great variance in the way in which seals clustered and grouped themselves. Seals were therefore counted individually.

RESULTS AND DISCUSSION

Totals of 250,786 Cape Cormorants (which included 16,038 birds on individual nests) and 15,831 Cape Fur Seals were counted on the aerial photographs. The areas in which most were recorded are shown in numbered blocks in Figure 1, while Table 2 gives the numbers recorded in each of these blocks. Most of the cormorants and seals were recorded on the island of Tigres, but a flock of 16,032 cormorants was found on a peninsula of the adjoining mainland (block 20). The largest single flock numbered about 28,058 cormorants, which formed part of those counted in block 2 (Figure 3).

Figure 3: *An estimated 28,058 individual Cape Cormorants roosting in this, the largest single flock photographed on Tigres in March 2017.*

Cape Cormorants were found nesting in 349 colonies, each having an average of 46 nests. The nests were evenly spaced across the colony areas (see examples in Figure 2) and assumed to be active because one bird was sitting on each nest. The birds visible could have been adults or well-grown nestlings if the cormorants on Tigres breed at times similar to those in Namibia (October to February – Kemper & Simmons 2015).

Substrates in and around the colonies were paler than their surrounds, presumably coloured that way by accumulations of faecal matter. Numerous other inactive colonies were visible, but we were unable to tell whether they had been used in recent months or longer ago.

Two large flocks of cormorants were recorded in areas beyond those covered by the aerial survey. The first was about 20 km north of the mainland survey zone (Figure 4a). Numbers were not estimated, but certainly thousands of cormorants and hundreds of Kelp Gulls (*Larus dominicanus*) and Great White Pelicans (*Pelecanus onocrotalus*) were present here on the 28th of February 2017 at about 10h30. The second group was encountered at sea but close to the mainland at 12h20 during the aerial reconnaissance flight on the 27th of February. This is marked as block b in Figure 1. From counts of birds in the photograph in Figure 4b and in other photographs, at least 60,000 cormorants were present in this feeding frenzy.

Many more Cape Cormorants were counted during this study than had been previously recorded in the Tigres region (Table 1). Adding the total of 250,786 (Table 2) to the current total population estimate of 234,000 Cape Cormorants (Birdlife 2018) approximately doubles the world population for this

Table 2: *Numbers of Cape Cormorants, active nests and Cape Fur Seals counted in aerial photographs taken on 1 March 2017. Block numbers refer to areas shown in Figure 1.*

Block	Cape Cormorants		Cape Fur Seals
	Birds	Nests	
0	3,508		
2	64,786	8,310	3,976
3	2,697	3,446	4,570
4	2,697	2,697	1,785
5	9,990		
6	19,430	183	
7	3,372	1,402	
8	14,414		
9	1,429		
10	10,152		
11	128		2,758
12	102,151		
20	16,032		
21			1,010
22			1,732
Total	**250,786**	**16,038**	**15,831**

Figure 4: *Flocks of Cape Cormorants, Great White Pelicans and Kelp Gulls at 16.51S, 11.82E recorded on 28 February (marked a in Figure 1) and at 16.72S, 11.81E on 27 February 2017 (marked b in Figure 1).*

species. However, the Birdlife figure is double an estimated 117,000 breeding pairs for the species, but does not account for pre-breeding birds and those not participating in breeding. How many non-breeders should be added to Birdlife's estimate of breeding birds is difficult to gauge (J Kemper pers. com. 2017), and we have no idea of the proportion of pre-breeding individuals amongst those photographed in March 2017 on Tigres. Crawford et al. (1991) had earlier estimated the total population of Cape Cormorants to be 1.355 million.

The greater number of cormorants counted in 2017 than by previous surveys at Tigres (Table 1) is likely due to this being a complete census of the island and much of the adjoining mainland coast. However, it is also possible that the distribution of Cape Cormorants has shifted north in recent years, perhaps as a further continuation of earlier shifts up the Namibian coast reported by Crawford et al. (2007). Kirkmann et al. (2012) describe a similar northward extension of range by Cape Fur Seals, and Cape Cormorants have recently extended their range south-east along the South African coast (Crawford et al. 2016).

We do not know if the groups in Figure 4 are additional to those counted in the aerial survey photographs. However, since the aerial photographs were taken in the first part of the morning on the 1st of March, it is possible that substantial numbers of cormorants could have left the island to feed elsewhere by that time of day. If the cormorants in

Figure 4a and 4b were additional to those counted on the island, it is possible that the Tigres region supports many more Cape Cormorants than the 250,786 birds counted on the aerial census images.

The number of cormorants and seals recorded during this study demonstrates the value of Baía dos Tigres in supporting large numbers of piscivores and the evident wealth of their marine food base. To these can be added substantial numbers of Kelp Gulls; Royal Terns (*Thalasseus maximus*), Greater Crested Terns (*T. bergii*), Caspian Terns (*Hydroprogne caspia*) and Damara Terns (*Sternula balaenarum*); Great White Pelicans, Greater Flamingos (*Phoenicopterus roseus*) and other species reported by Simmons et al. (2006) and Ministério do Ambiente (2017). The area is currently registered as an 'Ecologically or Biologically Significant Area' (EBSA Portal 2018). Efforts now being made by the Angolan government to proclaim Ilha dos Tigres and the surrounding coastal waters as a protected marine area (G Schroth pers. com. 2017) are therefore to be commended and supported.

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Checklist of the checkered beetles of Namibia (Coleoptera, Cleridae)

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ABSTRACT

The first checklist of Cleridae of Namibia is provided. It includes the exact label data (locations) from all specimens, distribution maps and colour plates with habitus photos of all mentioned species.

Keywords: checkered beetle; checklist; Cleridae; Coleoptera; colour habitus photos; distribution maps; museum; Namibia; specimen

INTRODUCTION

The checkered beetles (Cleridae) belong to the cucujiform superfamily Cleroidea and contain about 3,700 species. Cleridae are widely distributed (except Antarctica) and most diverse in tropical regions. With the exception of some forest-relevant species (e.g. the European *Thanasimus formicarius*), little is known about their biology. Both larvae and adults of most species are evidently predators on other insects, especially wood-infesting beetles and their larvae (Gerstmeier 2014). Opitz (2010) revised the higher classification of the Cleridae, resulting in 12 subfamilies, and a further subfamily (Epiclininae) was described by Gunter et al. (2013). The geographic distribution of Cleridae species shows a concentration in the Afrotropical region, with about 1,074 described species (29% of the world's species), including Madagascar which has a high number of endemic species (469 spp; Gerstmeier 2014). In contradiction to the species numbers, continental Africa is not well represented in the recent literature (Gerstmeier & Huesmann 2004, Gerstmeier & Weiss 2009, Gerstmeier & Eberle 2011, Gerstmeier & Salvamoser 2014, Gerstmeier 2015, Bartlett & Gerstmeier 2016). Regarding Namibia, almost no information about checkered beetles is available, so this contribution is a first step to deal with the Cleridae fauna of this country.

MATERIAL

This checklist is mainly based on material in the collection of the author (RGCM), some institutional collections and the inventory of the Brandberg Massif during 1998-1999 (NMNW). Map 1 shows the location of all collections. The institutions are abbreviated as follows:

DNMNH	Ditsong National Museum of Natural History, Pretoria, South Africa (the former Transvaal Museum of Natural History)
MFNB	Museum für Naturkunde, Berlin, Germany
NHM	The Natural History Museum, London, England
NME	Naturkunde Museum, Erfurt, Germany
NMNW	National Museum of Namibia, Windhoek, Namibia
OLML	Oberösterreichische Landesmuseum, Linz, Austria
RGCM	Roland Gerstmeier Collection, Munich, Germany
SAMC	Iziko South African Museum, Cape Town, South Africa
SANC	South African National Collection of Insects, Pretoria
SMNS	Staatliches Museum für Naturkunde, Stuttgart, Germany
WOPC	Weston Opitz Collection, Gainesville, USA

CHECKLIST

Note that the checklist reflects the original notes as they appear on the specimen labels.

Subfamily Tillinae

***Diplocladus louvelii* (Spinola, 1844)**. Plate 1, Fig. 1, Map 2

Abachaus SWA, II 1944, G. Hobohm - ditto: III 1944 (DNMNH). Namibia, Region Kunene, Buschfeld

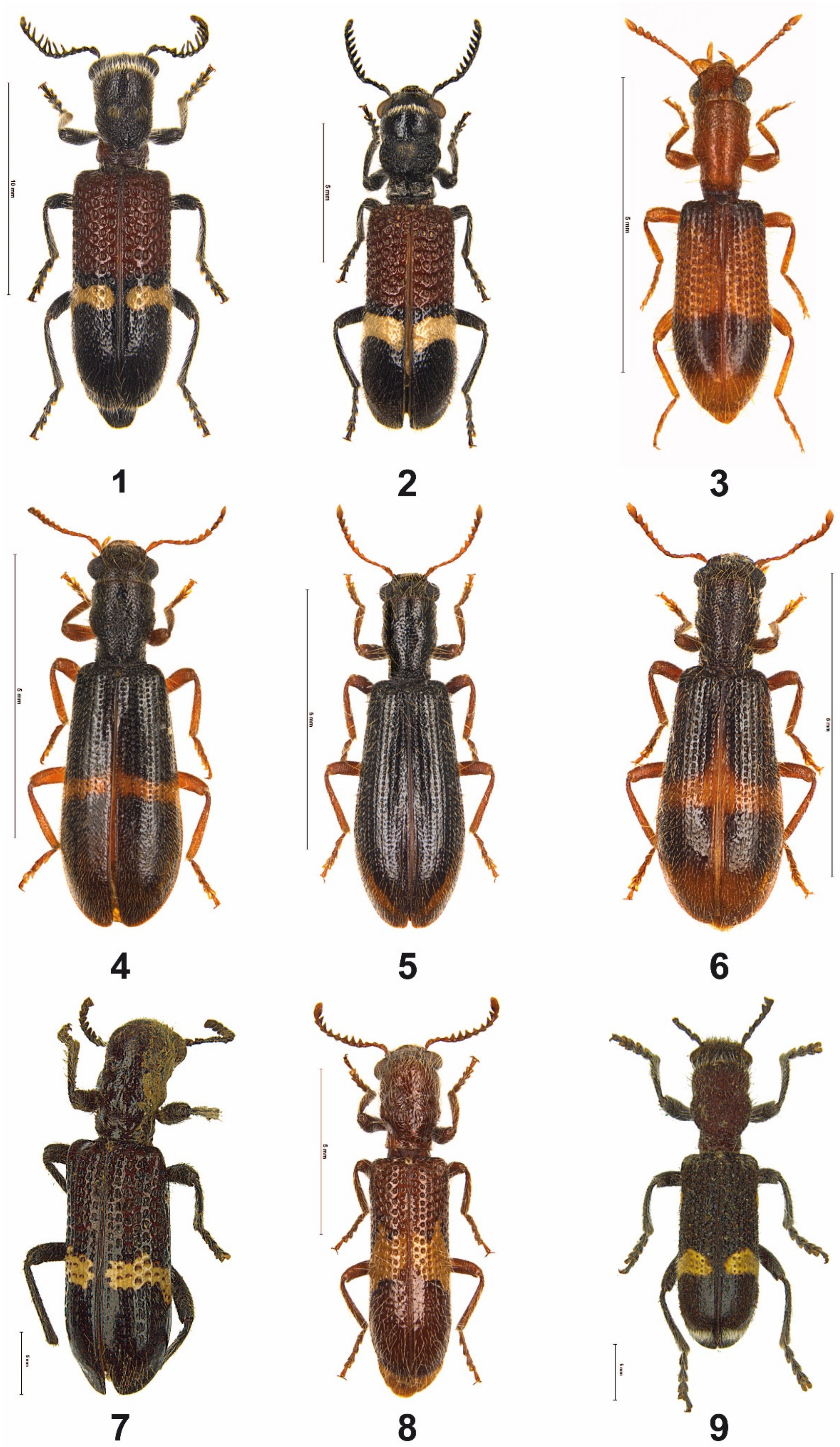


Plate 1: *Figures 1–9: 1)* Diplocladus louvelii *2)* Diplocladus oculicollis *3)* Eucymatodera parva *4)* Eucymatodera *sp. 1 5)* Eucymatodera *sp. 2 6)* Eucymatodera *sp. 3 7)* Strotocera carinata *8)* Strotocera convexa *9)* Strotocera emerita

Camp, bei Outjo, S20°05.694' E16°07.623', 1306 m, 16.03.2018, leg. R. Gerstmeier (RGCM).
Distribution: Burkina Faso, Cameroon, Congo, Ghana, Guinea, Ivory Coast, Kenya, Malawi, Mozambique, Namibia, Nigeria, Senegal, Somalia, South Africa, Sudan, Tanzania, Togo, Zimbabwe (Gerstmeier & Weiss 2009).

***Diplocladus oculicollis* (Fairmaire, 1885)**. Plate 1, Fig. 2, Map 2

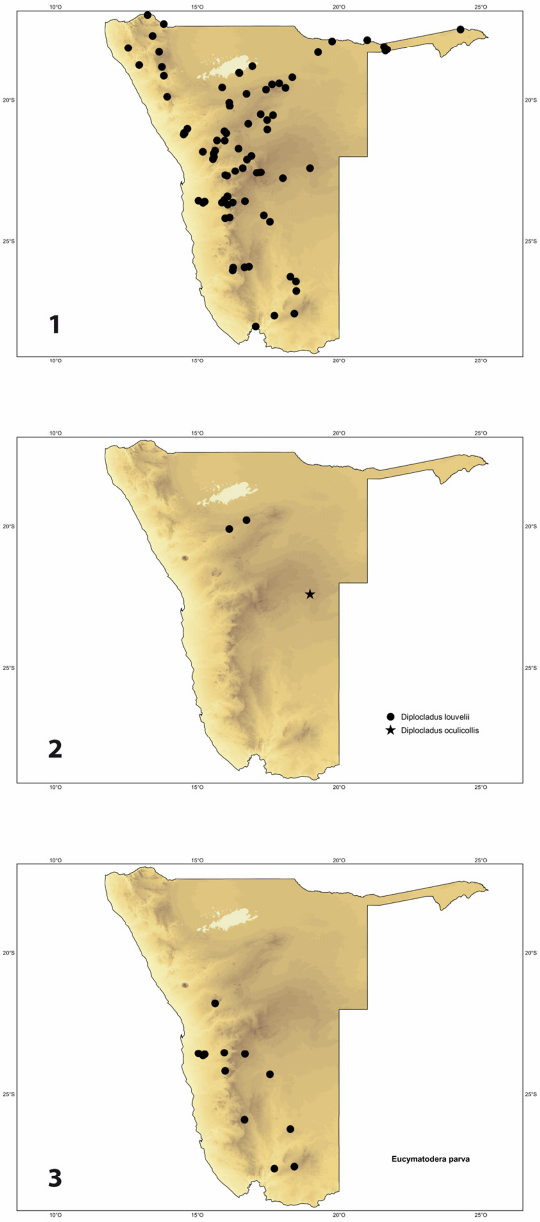
Namibia, Gobabis, 18.II.2001, leg. F. Koch (SMNS).
Distribution: Namibia (new country record), Somalia, South Africa, Transvaal, Tanzania, Togo (Gerstmeier & Weiss 2009).

***Eucymatodera parva* Schenkling, 1908**. Plate 1, Fig. 3, Map 3

Namibia, Ameib Farm, S21°47.299' E15°37.685', 1054 m, 29.02.–03.03.2016 (UV trap), leg. R. Gerstmeier (RGCM). Namibia, Ameib Ranch, ca. 27 km NO Usakos, 1070 m, Lichtfang, 19. Dez. 1992, leg. J. Wiesner & I. Worm (RGCM). Namibia, Distr. Erongo, Ameib Ranch, S21°47' E15°37', 29.9.2005, leg. R. Gerstmeier (RGCM). Namibia, Ameib Ranch (Nr. 60), ca. 20 km n Usakos, 2.1.1997, leg. R. Gerstmeier (RGCM, 5 ex.). S Namibia, NE Keetmanshoop, Mesosaurus Fossil Farm, 1100 m, 26.24S 18.28E, 18.-19.II.2010, leg. W. Schawaller (SMNS, 4 ex.). S Namibia, N Tiras Mts., Farm Lovedale, 1600 m, 25.54S 16.39E, 16.-17.II.2010, leg. W. Schawaller (SMNS). S Namibia, S Solitaire, Farm Weltevrede, 1100 m, 24.10S 15.58E, 11.-13.II.2010, leg. W. Schawaller (SMNS, 2 ex.). 7.10.90 Schüle, Namibia, Farm Kromhoek (SMNS). Namibia/Hardap, 50 km SW Rehoboth, 1525 m, 23°34.64"S 16°40.792"E, e.l. Acacia spec. 2016 leg. H. Mühle 152 (RGCM, 2 ex.). Namibia, Karas 690m, Fishriver Canyon (Hobas), 27°37.192'S 17°42.865'E, 23.2.2012, leg. H. Mühle, 176 (RGCM). Namibia, Distr. Karasburg, Fish River Canyon, Hobas Camp, S27°37' E17°42', 15.2.2005, leg. R. Gerstmeier & M. Müller (RGCM, 2 ex.). Namibia, Gibeon dist., Hardapdam (light), ca. 24.30S 17.56E, W. Lorenz, 5.2.1995 (RGCM, 2 ex.). Namibia, Lower Kuiseb River, Homeb (SANC). S.W. Afr., C. Namib, Tsondab vlei, 23.59S - 15.26E, 12.1.1974, E-Y: 538 at light, leg. Endrödy-Younga (RGCM). SWA, 24.2.1988, Karasburg, Farm Satco 88/21, Tal 12 km W der Stadt, 27.55S / 18.42E, 900 m, leg. Hubert Rausch (OLML, 2 ex.). S.W. Afr., Namib, Gobabeb Kuiseb Riv., November 1974, leg. Wharton & Grey (RGCM).
Distribution: Namibia (Schenkling 1908).

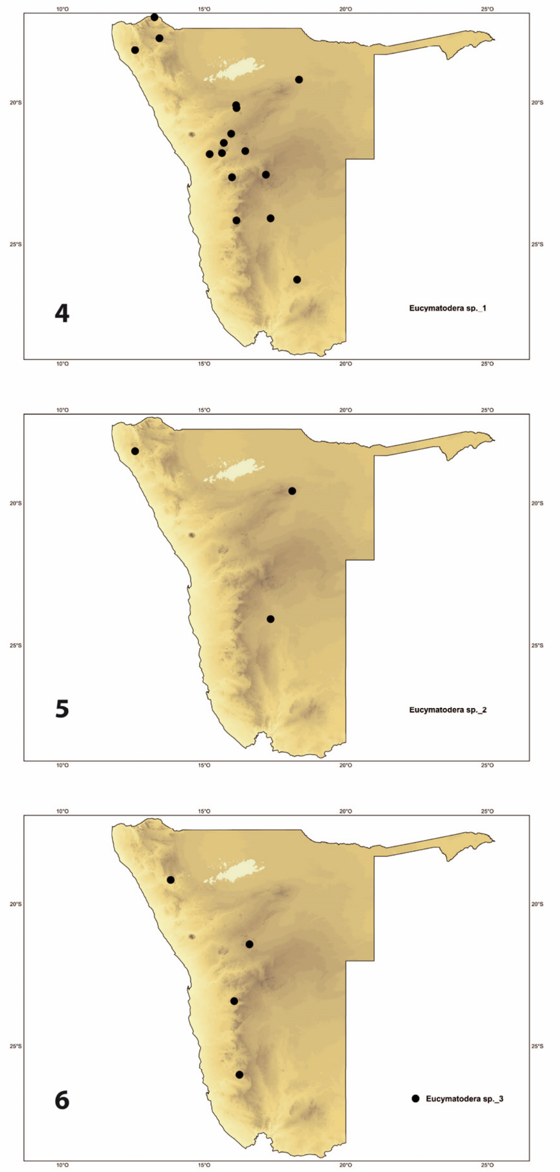
***Eucymatodera* sp. 1.** Plate 1, Fig. 4, Map 4

Namibia, 5.3.2008, Spitzkoppe, G. Werner leg. (RGCM). Namibia, Ameib Farm, S21°47.299'



***Maps 1–3**: 1) All cited locations 2)* Diplocladus louvelii*,* Diplocladus oculicollis *3)* Eucymatodera parva

E15°37.685', 1054 m, 29.02.–03.03.2016 (UV trap), leg. R. Gerstmeier (RGCM, 18 ex.). Namibia, Boscia Farm, 17 km SE Schlip, S24°04.620' E17°20.684', 1285m, 08.03.2016 (UV trap), leg. R. Gerstmeier (RGCM, 2 ex.). Namibia, W Omaruru, 25.1.1996, leg. K.+F. Adlbauer (RGCM). Namibia, Haasenhof, SE Omaruru, 21.2.1996, leg. K.+F. Adlbauer (RGCM, 3 ex.). Namibia, E Windhoek, 1900 m, 6.1.1996, leg. K. & F. Adlbauer (RGCM). Namibia, Schönfeld, N Omaruru, 1650 m, 10.1.1996, leg. K.+F. Adlbauer (RGCM, 2 ex.). Namibia, ca. 2000 m, Khomas Hochland, 22°24'82"S 16°36'00"E, Holzeintrag 1.04.1997, M. & O. Niehuis; - ditto 5.04.1997 (RGCM, 6 ex.). NW Namibia, Epupa Falls, 660 m, 11.-12.IV.2005, leg. W. Schawaller (SMNS). NW Namibia, 50 km NW Opuwo, 1300 m, 13.IV.2005, leg. W. Schawaller (SMNS). NE



Maps 4–6: *4)* Eucymatodera *sp. 1 5)* Eucymatodera *sp. 2 6)* Eucymatodera *sp. 3*

Namibia, 50 km NE Grootfontein, 1200 m, 8.-9.III.2006, leg. W. Schawaller (SMNS). N Namibia, 10 km S Outjo, 1200 m, 20.-21.IV.2005, leg. W. Schawaller (SMNS). NW Namibia, Orupembe, 700 m, 14.IV.2005, leg. W. Schawaller (SMNS, 2 ex.). S Namibia, NE Keetmanshoop, Mesosaurus Fossil Farm, 1100 m, 26.24S 18.28E, 18.-19.II.2010, leg. W. Schawaller (SMNS, 4 ex.). S Namibia, Naukluft Park East, 1500 m, 24.15S 16.14E, 7.-10.II.2010, leg. W. Schawaller (SMNS, 3 ex.). Namibia, Region Kunene, Buschfeld Camp, bei Outjo, S20°05.694' E16°07.623', 1306 m, 16.03.2018, leg. R. Gerstmeier (RGCM).

***Eucymatodera* sp. 2.** Plate 1, Fig. 5, Map 5

NW Namibia, Orupembe, 700 m, 14.IV.2005, leg. W. Schawaller (SMNS). NE Namibia, 50 km NE Grootfontein, 1200 m, 8.-9.III.2006, leg. W. Schawaller (SMNS). Namibia, Boscia Farm, 17km SE Schlip, S24°04.620' E17°20.684', 1285 m, 8.03.2016 (UV trap), leg. R. Gerstmeier (RGCM, 2 ex.).

***Eucymatodera* sp. 3.** Plate 1, Fig. 6, Map 6

Namibia, 16.03.2013, Farm Rooiklip, S 23°24'23" E 16°03'37", 1000 m a.s.l., leg. T. Wagner & C. Fischer, UV trap Plot 24 (RGCM). Namibia, 2013, Farm Rooiklip, S23°24'23" E16°03'37", 1000 m a.s.l., leg. T. Wagner & C. Fischer, Pitfall F2-DG 1 Plot 13K (RGCM). NW Namibia, Ongongo Falls, 700 m, 17.-18.IV.2005, leg. W. Schawaller (SMNS, 2 ex.). NAMIBIA, Region Karas, Tirasberge, Namtip Camp, S26°01.141' E16°14.814', 1319 m 03.-04.03.2018, leg. R. Gerstmeier (RGCM). Namibia, ca. 2000 m, Khomas Hochland, 22°24'82"S 16°36'00"E, Holzeintrag 5.04.1997, M. & O. Niehuis (RGCM).

***Strotocera carinata* Hintz, 1905**. Plate 1, Fig. 7, Map 7

Namibia, Okawango Dist., Mutompo: 60 km S Rundu, 18°18'38.7"S 19°15'29.4"E, 1180 m NN, 11.iii–16.iii.2003, singling, BIOTA 1544, leg. J. Frisch & K. Vohland (ZMB).
Distribution: Namibia, Tanzania (Gerstmeier & Weiss 2009).

***Strotocera convexa* (Hintz, 1905).** Plate 1, Fig. 8, Map 7

Namibia, 20.1.1996, Toshari Inn, NW Outjo, leg. K. & F. Adlbauer (RGCM).
Distribution: Cameroon, Kenya, Namibia (new country record), Nigeria, Rwanda, South Africa, Tanzania, Zimbabwe (Gerstmeier & Weiss 2009).

***Strotocera emerita* (Péringuey, 1899).** Plate 1, Fig. 9, Map 7

Kaoko, Otavi, S.W.A., emerita Pering. (SAMC).
Distribution: Congo, Namibia, Zambia, South Africa, Tanzania, Zimbabwe (Gerstmeier & Weiss 2009).

***Strotocera roberti* Gerstmeier & Weiss, 2009**. Plate 2, Fig. 10, Map 7

Helio, 19°03'S.,16°29'E., Etosha Nat. Park, 14 Feb.–23 Mar. 1987, Pres. pitfall traps, E. Griffin, *Gyponix* sp., det., R. Oberprieler 198 (SANC).
Distribution: Ethiopia, Ivory Coast, Mozambique, Namibia, South Africa, Tanzania, Zimbabwe (Gerstmeier & Weiss 2009).

***Strotocera versicolor* (Chevrolat, 1842).** Plate 2, Fig. 11, Map 7

DSW Afrika, Otjosondu, Casper S.G. (ZMB). S.W. Africa, Okahandja, 1320 m, 1.1934., K. Jordan, Strotocera, Ginter Ekis det. (BMNH).
Distribution: Namibia, South Africa, Zimbabwe (Gerstmeier & Weiss 2009).

***Teloclerus* sp.** Plate 2, Fig. 12, Map 8

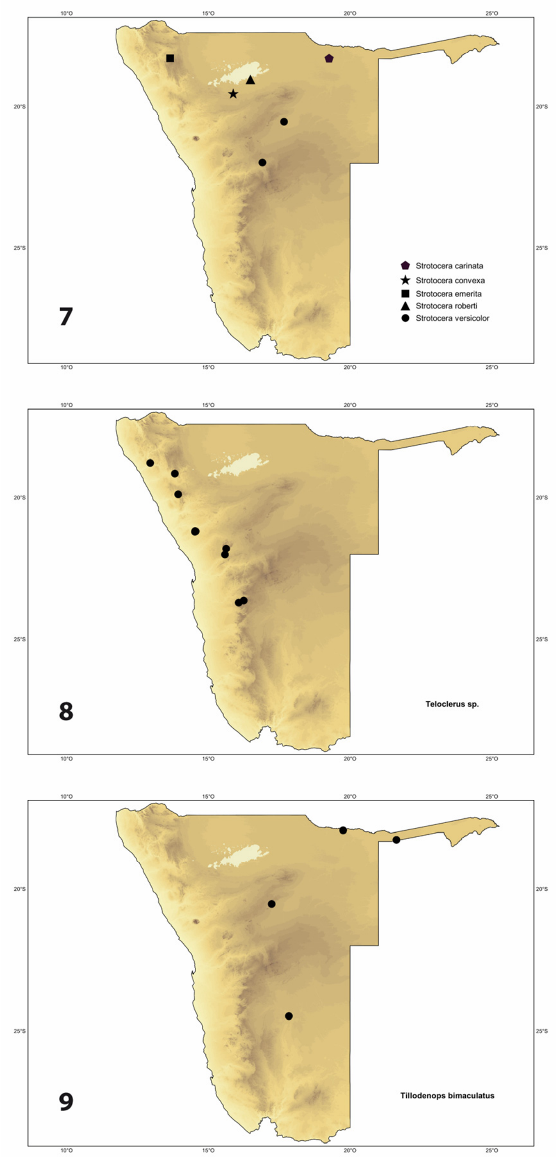
Namibia, Usakos, 21.2.88, Rausch (RGCM). Namibia, Ameib Farm, S21°47.299' E15°37.685', 1054 m, 29.02.–03.03.2016 (UV trap), leg. R. Gerstmeier (RGCM, 2 ex.). Namibia, Region Kunene, Palmwag, S19°53.237' E13°56.249', 889 m, 12.+13.03.2018, leg. R. Gerstmeier (RGCM). Namibia, Farm Probeer (Nr. 398), ca. 140 km sw Windhoek, 26.12.1996, leg. R. Gerstmeier (RGCM). S Namibia, Farm Namibgrens (Spreetshoogte), 180 m, 23.37S 16.14E, 3.-6.II.2010, leg. W. Schawaller (SMNS). NW Namibia, Purros (Hoaruzsib Valley), 300 m, 15.-16.IV.2005, leg. W. Schawaller (SMNS). NW Namibia, Ongongo Falls, 700 m, 17.-18.IV.2005, leg. W. Schawaller (SMNS). NAMIBIA, Brandberg, Wasserfallfläche at: 21°10'0.9"S, 14°32'0.9"E, 1980 m, 12.xi.1998, A.H. Kirk-Spriggs, light trap plateau edge (NMNW). NAMIBIA, Brandberg, Inside Hungorob ravine at: 21°11'30"S, 14°31'40"E, 1200 m, 26.x.1998, R. Butlin & J. Altringham, at light 1900-0700 (NMNW). NAMIBIA, Brandberg, Inside Hungorob ravine at: 21°11'30"S, 14°31'40"E, 1200 m, 25.x.1998, R. Butlin & J. Altringham, at light 1900-0700 (NMNW). NAMIBIA, Brandberg, Plateau valley at: 21°10.46'S, 14°32.52'E, 1950 m, 20.x.1998, R. Butlin & J. Altringham, at light 1900-0700 (NMNW).

***Tillodenops bimaculatus* (Schenkling, 1899).** Plate 2, Fig. 13, Map 9

Namibia, 27.12.1997, Waterberg Plateau Park, leg. J. Schindler (RGCM). Namibia, Gibeon Dist., Hardap Dam (light), ca. 24.30S 17.56E, W. Lorenz, 5.2.1995 (RGCM). NE Namibia, 20 km SE Divundu, 1000 m, 17.III.2006, leg. W. Schawaller (SMNS). NAMIBIA, Rundu (an Licht), 21.1.1993, leg. J. Gusenleitner (OLML).
Distribution: Egypt, Namibia (new country record), Niger, Sahara, Saudi Arabia, Somalia, Sudan, Chad.

***Wittmeridecus* sp.n.** Plate 2, Fig. 14, Map 10

S Namibia, NE Keetmanshoop, Mesosaurus Fossil Farm, 1100 m, 26.24S 18.28E, 18.-19.II.2010, leg. W. Schawaller (SMNS, 7 ex.). S Namibia, NE Keetmanshoop, Mesosaurus Fossil Farm, 1100 m, 26.24S 18.28E, 18.-19.II.2010, leg. W. Schawaller (RGCM, 5 ex.). NAMIBIA, Region Karas, Tirasberge, Namtip Camp, S26°01.141' E16°14.814', 1319 m 03.-04.03.2018, leg. Gerstmeier (RGCM). NAMIBIA, Region Karas, Tirasberge, Kooimasis Camp, S25°55.257' E16°15.767', 1307 m, 05.03.2018, leg. R. Gerstmeier (RGCM).



Maps 7–9: *7)* Strotocera carinata, Strotocera convexa, Strotocera emerita, Strotocera roberti, Strotocera versicolor *8)* Teloclerus *sp. 9)* Tillodenops bimaculatus

Subfamily Clerinae

***Aphelochroa sanguinea* (Thomson, 1857).** Plate 2, Fig. 15, Map 11

Namibia, 25 km SE Tsumeb, 15.1.1993, leg. J. Gusenleitner (OLML).
Distribution: Democratic Republic of the Congo, Ivory Coast, Namibia (new country record), Kenya, Malawi, South Africa, Tanzania, Uganda, Zambia, Zimbabwe.

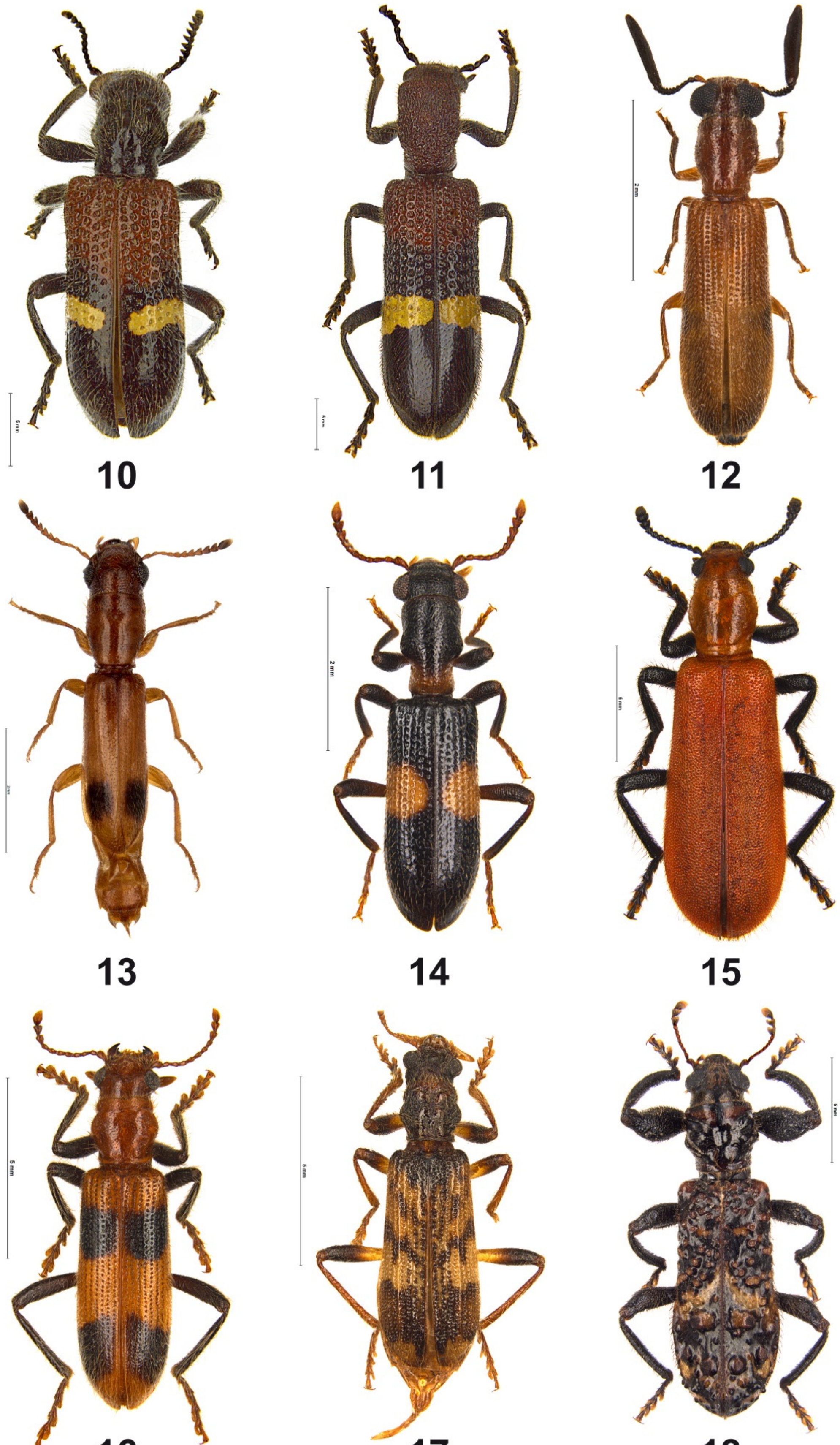


Plate 2: *Figures 10–18: 10)* Strotocera roberti *11)* Strotocera versicolor *12)* Teloclerus *sp. 13)* Tillodenops bimaculatus *14)* Wittmeridecus *sp. n. 15)* Aphelochroa sanguinea *16)* Aphelochroa *sp. 17)* Caridopus *sp. 18)* Erymanthus pustulosus

***Aphelochroa* sp.** Plate 2, Fig. 16, Map 11

Namibia, Rundu, L1992, leg. Rautenstrauch (RGCM, 4 ex.).

***Caridopus* sp.** Plate 2, Fig. 17, Map 12

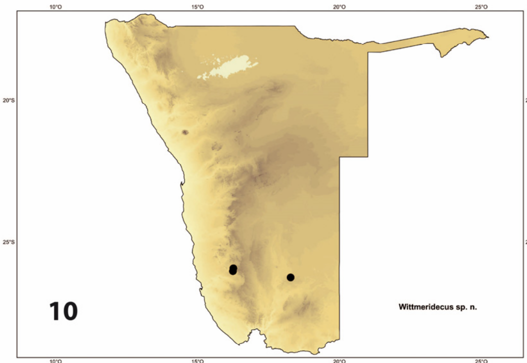
Namibia, D. Grootfontein, Tigerschlucht, NE Kombat, 19°27'18"S 17°37'53"E GPS, 1600-1700 m, 10.02.1994, leg. H.&R. Rausch, LF 94/15 (OLML).

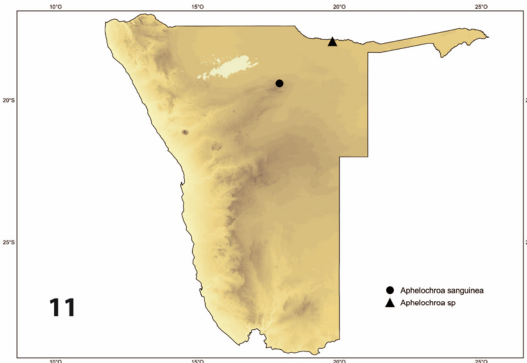
***Erymanthus pustulosus* (Quedenfeldt, 1888).** Plate 2, Fig. 18, Map 12

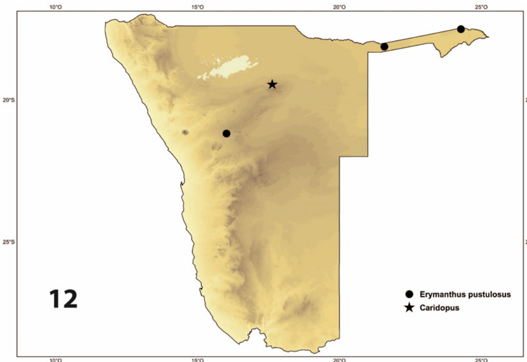
Namibia: b. Omaruru, Farm Otjua, 5.–7.X.1991, leg. U. Göllner (ZMB). Namibia, Popa Falls, Kavango, 24.xi.1993, 18°07' S/21°35' E, leg.: F. Koch (SMNS). Swa/Namibia, Caprivi, Katima Mulilo, SE17 24 Ad 10–11.I.1985, Univ. Pretoria, Dept. Entomol. Tour '85, National Coll. of Insects, Pretoria, S. Afr. (SANC).
Distribution: Benin, Cameroon, Democratic Republic of the Congo, Ethiopia, Ivory Coast, Kenya, Namibia, Mozambique, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe (Gerstmeier & Salvamoser 2014).

***Gyponyx* sp. 1.** Plate 3, Fig. 19, Map 13

Namibia, 20.1.1996, Toshari Inn, NW Outjo, leg. K. & F. Adlbauer (RGCM, 6 ex.). Namibia, 18.1.1996, Toshari Inn, NW Outjo, leg. K. & F. Adlbauer (RGCM, 2 ex.). Namibia, Region Erongo, Achab Camp (bei Usakos), S22°05.091' E15°32.940', 850 m, 10.03.2018, leg. R. Gerstmeier (RGCM, 3 ex.). Namibia, Region Karas, Mesosaurus Camp, S26°24.375' E18°28.598', 1065 m, 28.02.2018 (RGCM). Namibia, Region Kunene, Palmwag, S19°53.237' E13°56.249', 889 m, 12.+13.03.2018, leg. R. Gerstmeier (RGCM). Namibia, Halali Lodge, Etosha Pan NP, 6.1.1997, leg. R. Gerstmeier (RGCM). Namibia, Windhoek, 24./25.12.1997, leg. J. & R. Schindler (RGCM, 5 ex.). Namibia, Waterberg Plateau Park, 27.12.1997, leg. J. Schindler (RGCM, 2 ex.). Namibia: Waterberg Plateau Park, 9–11.1.1997, leg. R. Gerstmeier (RGCM, 2 ex.). Namibia, W Omaruru, 25.1.1996, leg. K.+F. Adlbauer (RGCM). Namibia, Schönfeld, N Omaruru, 1650 m, 10.1.1996, leg. K.+F. Adlbauer (RGCM, 4 ex.). NAMIBIA, Region Khomas, Farm Rooiklip, Bee trail, S23°24.738' E16°04.341', 987 m, 07.-09.03. 2018, leg. R. Gerstmeier (RGCM, 2 ex.). Namibia, Region Erongo, Brandberg Nord (vic. White Lady Lodge), S21°01.302' E14°38.844', 417 m, 11.03.2018, leg. R. Gerstmeier (RGCM, 3 ex.). SWA, 19.-20.2.88, Namib/Naukluft Park 88/16, Homeb, 18 km NW Gobabeb 23.38 S 15.12 E, 350 m, leg. Hubert Rausch (OLML, 2 ex.).







Maps 10–12: *10)* Wittmeridecus *sp. n. 11)* Aphelochroa sanguinea, Aphelochroa *sp. 12)* Caridopus *sp.*, Erymanthus pustulosus

***Gyponyx* sp. 2.** Plate 3, Fig. 20, Map 14

Namibia, E Windhoek, 1900 m, 6.1.1996, leg. K. & F. Adlbauer (RGCM, 4 ex.). Namibia, Finkenstein, 1.2.1996, leg. K.+F. Adlbauer (RGCM, 4 ex.). NAMIBIA, Brandberg, Wasserfallfläche, 1960m, 21°10.77'S, 14°32.87'E, 07.iv.1999, S. van Noorr & S.G. Compton, UV Light trap, overlooking well vegetated valley below waterfall, Bushy Karoo-Nama shrubland NA99-L03 (NMNW).

***Gyponyx* sp. 3.** Plate 3, Fig. 21, Map 14

Namibia, 27.12.1997, Waterberg Plateau Park, leg. J. Schindler (RGCM, 2 ex.). Namibia: Waterberg Plateau Park, 9–11.1.1997, leg. R. Gerstmeier

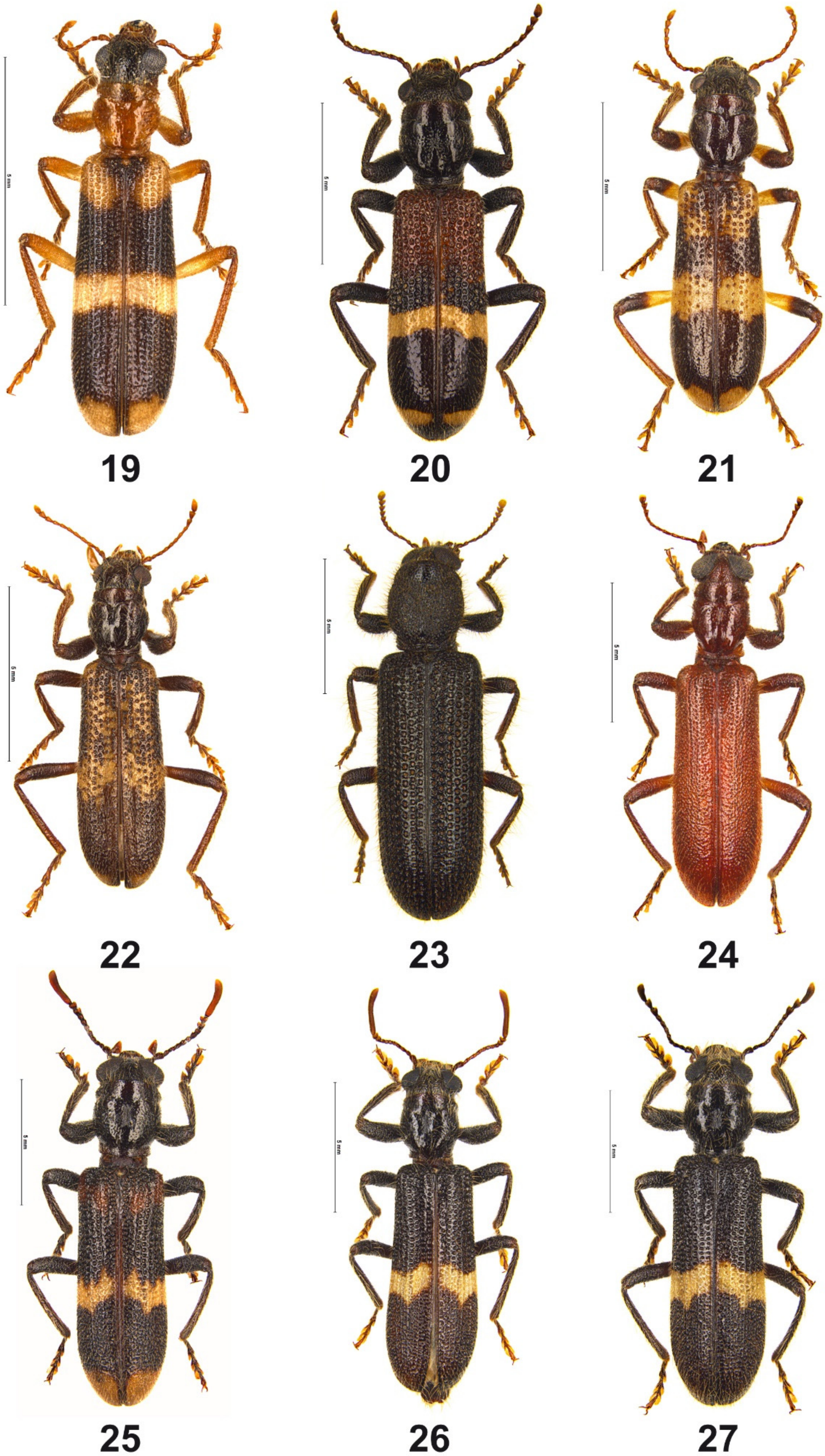
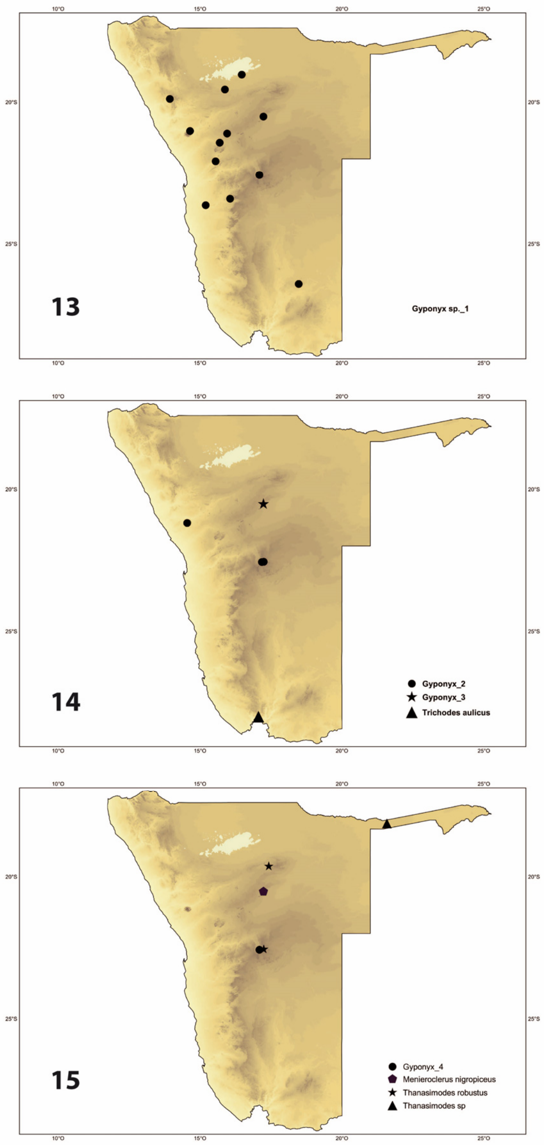


Plate 3: *Figures 19–27: 19)* Gyponyx *sp. 1 20)* Gyponyx *sp. 2 21)* Gyponyx *sp. 3 22)* Gyponyx *sp. 4 23)* Menieroclerus nigropiceus *24)* Opilo raveti *25)* Phloiocopus ferreti *26)* Phloiocopus *sp. 1, male 27)* Phloiocopus *sp. 1, female*



Maps 13–15: *13)* Gyponyx *sp. 1 14)* Gyponyx *sp. 2,* Gyponyx *sp. 3,* Trichodes aulicus *15)* Gyponyx *sp. 4,* Menieroclerus nigropiceus*,* Thanasimodes robustus*,* Thanasimodes *sp.*

(RGCM, 3 ex.). Namibia, Waterberg, 25.1.96, Richter leg. (RGCM).

***Gyponyx* sp. 4.** Plate 3, Fig. 22, Map 15

Namibia, Windhoek, III-IV.1997, leg. R. Schindler (RGCM).

***Menieroclerus nigropiceus* (Kuwert, 1893).** Plate 3, Fig. 23, Map 15

Namibia: Waterberg Plateau Park, 9–11.1.1997, leg. R. Gerstmeier (RGCM).
Distribution: Ethiopia, Kenya, Namibia, South Africa, Tanzania, Yemen, Zimbabwe (Bartlett & Gerstmeier 2016).

***Opilo raveti* Pic, 1933**. Plate 3, Fig. 24, Map 16

Namibia, 27.12.1997, Waterberg Plateau Park, leg. J. Schindler (RGCM, 2 ex.). Namibia, Waterberg Plateau Park, 9.-11.1.1997, leg. R. Gerstmeier (RGCM). NE Namibia, 120 km E Rundu, 1000 m, 15.-16.III.2006, leg. W. Schawaller (SMNS).
Distribution: Kenya, Mozambique, Namibia (new country record), Zimbabwe.

***Phloiocopus ferreti* (Reiche, 1849).** Plate 3, Fig. 25, Map 17

Namibia, Waterberg Plateau Park, 9–11.1.1997, leg. R. Gerstmeier (RGCM). Namibia, L1992, Grootfontein, leg. Rautenstrauch (RGCM). Namibia, 1.2.97, Waterberg, Richter leg. (RGCM). Namibia, 18.1.1996, Toshari Inn, NW Outjo, leg. K. & F. Adlbauer (RGCM).
Distribution: Ethiopia, Kenya, Namibia, Rwanda, Somalia, South Africa, Tanzania, Transvaal, Uganda, Zimbabwe.

***Phloiocopus* sp. 1.** Plate 3, Fig. 26, 27, Map 16

Namibia, ca. 2000 m, Khomas Hochland, 22°39'91"S 15°59'04"E, Holzeintrag 1.04.1997, M. & O. Niehuis (RGCM). Namibia, ca. 1500 m, ca. 140 km N Okahandja, 20°50.85'S 16°47.77'E, Holzeintrag 1.04.1997, M. & O. Niehuis (RGCM). Namibia, Haasenhof, SE Omaruru, 21.2.1996, leg. K.+F. Adlbauer (RGCM). Namibia, Febr. 1988, leg. M. Stelzl (RGCM). Namibia, or.-centr., Kalahari Randgebiet, Farm Pepperkorrel 294, 1640 m, 22°46'S 18°01'E, 10.-16.III.1998, H.J. Bremer leg. (RGCM). Namibia, ca. 2000 m, Khomas Hochland, 22°24'82"S 16°36'00"E, Holzeintrag 5.04.1998, M. & O. Niehuis (RGCM). Namibia, L1992, Grootfontein, leg. Rautenstrauch (RGCM). Namibia, Farm Hebron, Otjiwarongo, 11.-16.11.1996, leg. J. Schindler (RGCM). Namibia, Kaokoveld, 40-50 km N Sesfontein, 18°50'S 13°45'E, 02.III.1986, leg. F. Koch (SMNS). Namibia, Waterberg Plateau, 22.XI.1993, 30°30'S 17°14'E, F. Koch SMNS, 2 ex.). Namibia, Mahango Game Reserve, 31.X.97, leg. F. Koch (SMNS, 6 ex.). NW Namibia, Purros (Hoaruzsib Valley), 300 m, 15.-16.IV.2005, leg. W. Schawaller (SMNS, 2 ex.). Namibia, 18.1.1996, Toshari Inn, NW Outjo, leg. K. & F. Adlbauer (RGCM). SWA, 17.2.1988, Namaqualand 88/14, Helmeringhausen, 25.53S 16.49E, 1250 m, leg.: Hubert Rausch (OLML). Namibia, SW Afrika, Etoscha Nationalpark, Nähe Namutoni, 28.02.1994, leg. W.-H. Liebig (NME). Namibia, Region Kunene, Palmwag, S19°53.237' E13°56.249', 889 m, 12.+13.03.2018, leg. R. Gerstmeier (RGCM). NAMIBIA, Region Karas, Tirasberge, Namtip Camp, S26°01.141' E16°14.814', 1319 m 03.-04.03.2018, leg. Gerstmeier (RGCM).

Phloiocopus **sp. 2.** Plate 4, Fig. 28, Map 17

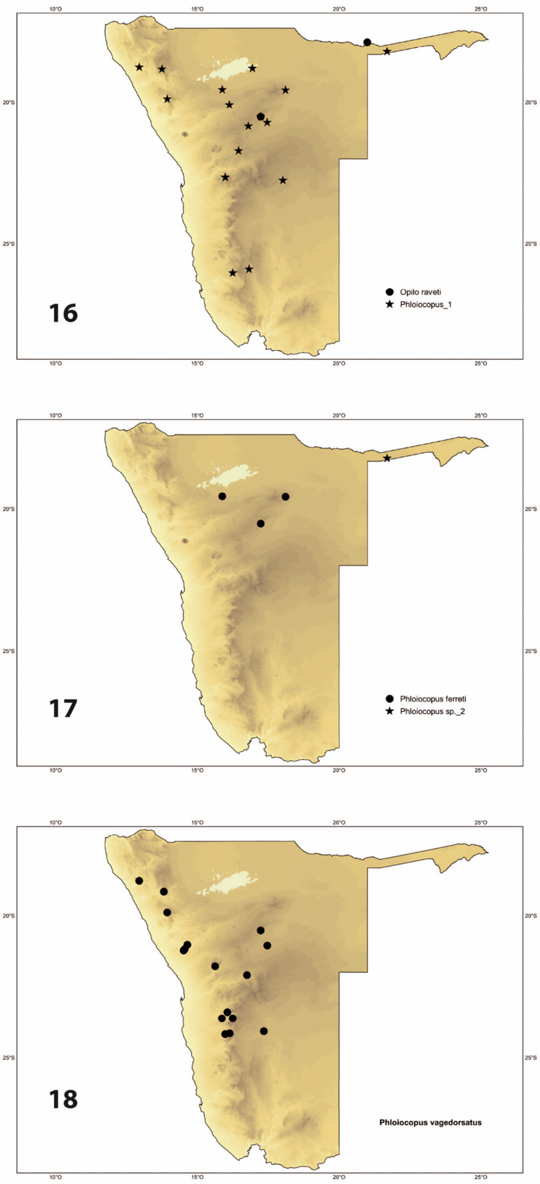
Namibia, Mahango Game Reserve, 31.X.97, leg. F. Koch (SMNS).

Phloiocopus vagedorsatus **(Fairmaire, 1888) comb. n.** Plate 4, Fig. 29, Map 18
= *Thanasimodes vagedorsatus* (Fairmaire, 1888)

N Namibia, 50 km S Okakarara, 1400 m, 4.-5.III.2006, leg. W. Schawaller (SMNS). S Namibia, Farm Namibgrens (Spreetshoogte), 180 m, 23.37S 16.14E, 3.-6.II.2010, leg. W. Schawaller (SMNS). S Namibia, Naukluft Park East, 1500 m, 24.15S 16.14E, 7.-10.II.2010, leg. W. Schawaller (SMNS). S Namibia, S Solitaire, Farm Weltevrede, 1100 m, 24.10S 15.58E, 11.-13.II.2010, leg. W. Schawaller (SMNS). NW Namibia, Purros (Hoaruzsib Valley), 300 m, 15.-16.IV.2005, leg. W. Schawaller (SMNS). Namibia, Region Khomas, Farm Boesman, S23°37.080' E15°51.645', 969 m, 06.03.2018, leg. R. Gerstmeier (RGCM). Namibia, Region Kunene, Ongongo Camp, S19°08.442' E13°49.139', 779 m, 15.03.20128, leg. R. Gerstmeier RGCM). Namibia, Waterberg, Lichtfang, Camp, 21.9.2007, Leg. A. Jarzabek-Müller (RGCM, 2 ex.). Namibia, Ameib Farm, S21°47.299' E15°37.685', 1054 m, 29.02.–03.03.2016 (UV trap), leg. R. Gerstmeier (RGCM, 4 ex.). Namibia, Boscia Farm, 17 km SE Schlip, S24°04.620' E17°20.684', 1285 m, 08.03.2016 (UV trap), leg. R. Gerstmeier (RGCM, 2 ex.). Namibia, Region Kunene, Palmwag, S19°53.237' E13°56.249', 889 m, 12.+13.03.2018, leg. R. Gerstmeier (RGCM). Namibia, 11.2.97, Groß Barmen, Richter leg. (RGCM). NAMIBIA, Region Khomas, Farm Rooiklip, Bee trail, S23°24.738' E16°04.341', 987 m, 07.-09.03. 2018, leg. R. Gerstmeier (RGCM, 2 ex.). Namibia, Region Erongo, Brandberg Nord (vic. White Lady Lodge), S21°01.302' E14°38.844', 417 m, 11.03.2018, leg. R. Gerstmeier (RGCM). NAMIBIA, Brandberg, Messum Valley, 700 m, 21°13.29'S, 14°30.98'E, 03.iv.1999, S. van Noorr & S.G. Compton, UV Light trap, sparsely vegetated river valley, Bushy Karoo-Nama shrubland NA99-L01 (NMNW, 3 ex.). NAMIBIA, Brandberg, Hungorob River at: 21°13'0.5"S, 14°31'0.1"E, 1200 m, 09.xi.1998, A.H. Kirk-Spriggs, light trap plateau edge (NMNW). NAMIBIA, Brandberg, Pools on Wasserfallfläche, 21°10'40"S, 14°33'08"E, 2000 m, 21.x.1998, R. Butlin & J. Altringham, at light 1900-0700 (NMNW).
Distribution: Namibia, South Africa.

Thanasimodes **sp.** Plate 4, Fig. 30, Map 15

Namibia-Exp. ZMB 1992, Kavango: Popa Falls, im Kavango, 18°07'S 21°35'E, 13.III.92, leg. F. Koch (SMNS).



Maps 16–18: *16)* Opilo raveti, Phloiocopus *sp. 1 17)* Phloiocopus ferreti, Phloiocopus *sp. 2 18)* Phloiocopus vagedorsatus

Thanasimodes robustus **(Boheman, 1851).** Plate 4, Fig. 31, Map 15

Namibia, 31.1.1996, Finkenstein E Windhoek, leg. K. & F. Adlbauer (RGCM). Namibia, E Otavi, 14.1.1996, leg. K.+F. Adlbauer (RGCM).
Distribution: Kenya, Namibia (new country record), Rwanda, Somalia, South Africa, Tanzania, Zimbabwe.

Trichodes aulicus **Klug, 1842**. Plate 4, Fig. 32, Map 14

Namibia: Boom River Canyon; 4 km N of Orange River; (ESE of Rosh Pinah); 28.00, 5S 17.03E 200 m; 25.–30.X.1996; M & A Wedd Expedition (SANC).
Distribution: Namibia, South Africa (Gerstmeier & Huesmann 2004).

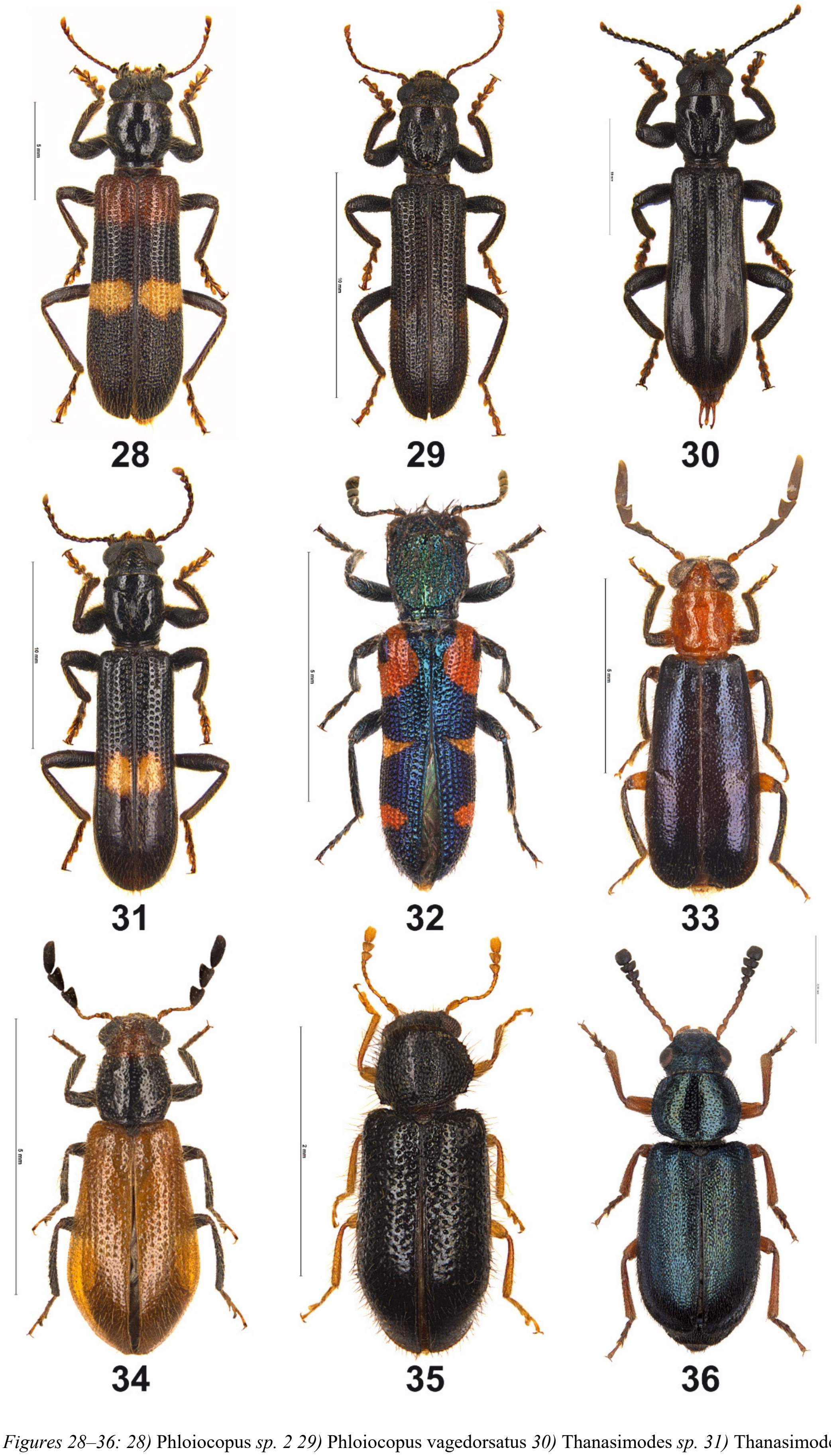


Plate 4: *Figures 28–36: 28)* Phloiocopus *sp. 2 29)* Phloiocopus vagedorsatus *30)* Thanasimodes *sp. 31)* Thanasimodes robustus *32)* Trichodes aulicus *33)* Enopliomorpha cyanipennis *34)* Enopliomorpha *sp. 35)* Korynetes semistriatus *36)* Necrobia rufipes

Subfamily Enopliinae

***Enopliomorpha cyanipennis* Pic, 1948**. Plate 4, Fig. 33, Map 19

Namibia: Waterberg Plateau Park, 9–11.1.1997, leg. R. Gerstmeier (RGCM). Namibia, 27.12.1997, Waterberg Plateau Park, leg. J. Schindler (RGCM, 3 ex.). Namibia, SE Omaruru, 26.1.1996, leg. K.+F. Adlbauer (RGCM). Namibia, N Usakos, 22.1.1996, leg. K.+F. Adlbauer (RGCM).
Distribution: Central African Republic, Namibia (new country record).

***Enopliomorpha* sp.** Plate 4, Fig. 34, Map 19

Namibia, Schönfeld, N Omaruru, 1650 m, 10.1.1996, leg. K.+F. Adlbauer (RGCM).

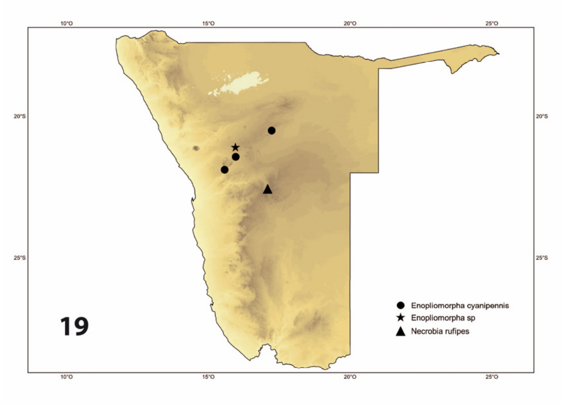
Subfamily Korynetinae

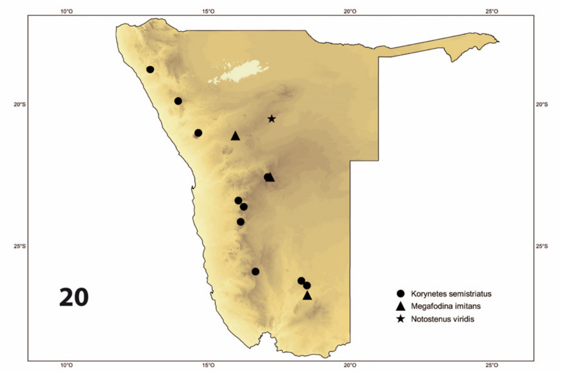
***Korynetes semistriatus* Spinola, 1844**. Plate 4, Fig. 35, Map 20

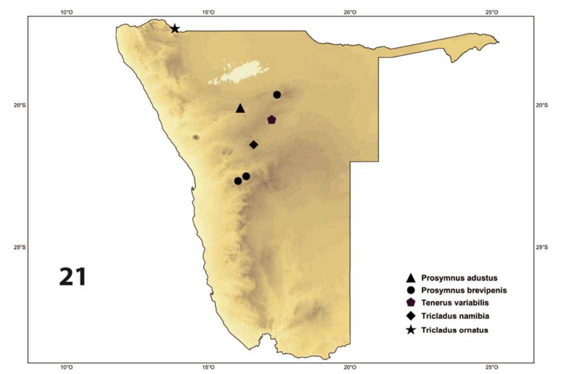
Namibia, Region Karas, Mesosaurus Camp, S26°24.375' E18°28.598', 1065 m, 28.02.2018 (RGCM). Namibia, Windhoek, 24./25.12.1997, leg. J. & R. Schindler (RGCM). Namibia, Umgebung Palmwag, 4.1.1997, leg. R. Gerstmeier (RGCM). S Namibia, Farm Namibgrens (Spreetshoogte), 180 m, 23.37S 16.14E, 3.-6.II.2010, leg. W. Schawaller (SMNS, 6 ex., RGCM, 2 ex.). NAMIBIA, Region Khomas, Farm Rooiklip, Bee trail, S23°24.738' E16°04.341', 987 m, 07.-09.03. 2018, leg. R. Gerstmeier (RGCM). Namibia, Region Erongo, Brandberg Nord (vic. White Lady Lodge), S21°01.302' E14°38.844', 417 m, 11.03.2018, leg. R. Gerstmeier (RGCM). S Namibia, N Tiras Mts., Farm Lovedale, 1600 m, 25.54S 16.39E, 16.-17.II.2010, leg. W. Schawaller (SMNS). S Namibia, Naukluft Park East, 1500 m, 24.15S 16.14E, 7.-10.II.2010, leg. W. Schawaller (SMNS). S Namibia, NE Keetmanshoop, Mesosaurus Fossil Farm, 1100 m, 26.24S 18.28E, 18.-19.II.2010, leg. W. Schawaller (SMNS, 2 ex.). NW Namibia, Purros (Hoaruzsib Valley), 300 m, 15.-16.IV.2005, leg. W. Schawaller (SMNS).
Distribution: Namibia (new country record), South Africa.

***Necrobia rufipes* (Degeer, 1775).** Plate 4, Fig. 36, Map 19

Namibia, Umg. Windhoek, 12.1996, leg. J, Schindler (RGCM).
Distribution: Cosmopolitan.







Maps 19–21: *19)* Enopliomorpha cyanipennis, Enopliomorpha *sp.*, Necrobia rufipes *20)* Korynetes semistriatus, Megafodina imitans, Notostenus viridis *21)* Prosymnus adustus, Prosymnus brevipenis, Tenerus variabilis, Tricladus namibia, Tricladus ornatus

***Notostenus viridis* (Thunberg, 1781).** Plate 5, Fig. 37, Map 20

Namibia, Distr. Otjozondjupa; Waterberg Plateau Park, 1520 m, S20°31' / E17°14', 28.02.-03.03.2011 (RGCM).
Distribution: Namibia (new country record), South Africa.

***Prosymnus adustus* Opitz, 2016**. Plate 5, Fig. 38, Map 21

Namibia, Region Kunene, Buschfeld Camp, bei Outjo, S20°05.694' E16°07.623', 1306 m, 16.03.2018, leg. R. Gerstmeier (RGCM).

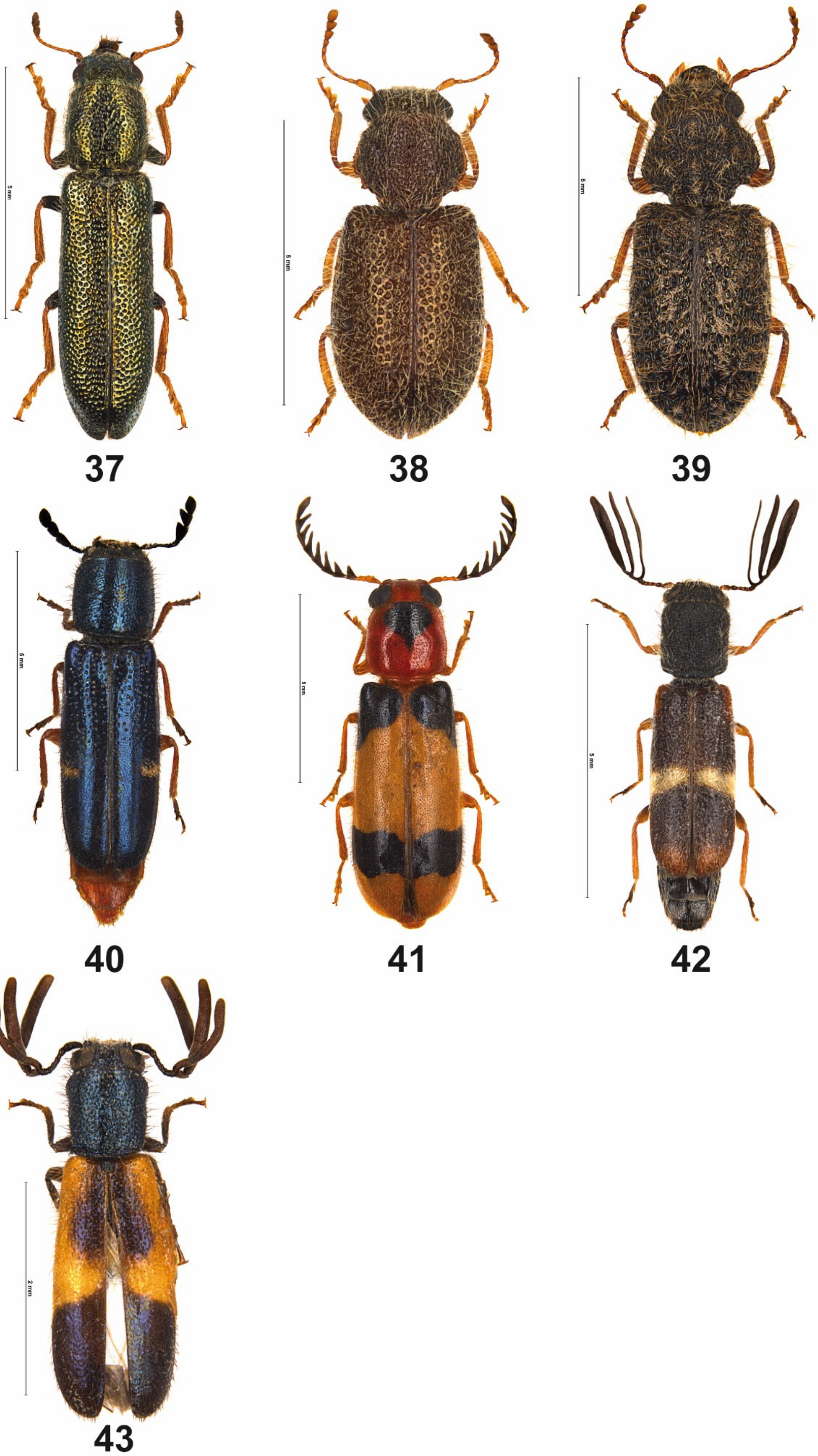


Plate 5: *Figures 37–43: 37)* Notostenus viridis *38)* Prosymnus adustus *39)* Prosymnus brevipenis *40)* Megafodina imitans *41)* Tenerus variabilis *42)* Tricladus namibia *43)* Tricladus ornatus

Distribution: Burkina Faso, Burundi, Ethiopia, Namibia (new country record), Kenya, Somalia.

***Prosymnus brevipenis* Opitz, 2016**. Plate 5, Fig. 39, Map 21

Namibia: Khomas Region, road C 28, 75 km W Windhoek, 22°45'S 14°23'E, 1780 m, 9.11.2012, leg. M. Hornburg (RGCM). Namibia, Khomas Region, road C 28, near Bosua Pass, 22°39S 16°00E, 1300 m, 10.11.2012, M. Hornburg (RGCM, 1; WOPC, 1). Namibia, E Otavi, 14.I.1996, leg. K + F. Adlbauer (RGCM).
Distribution: Ethiopia, Kenya, Namibia, South Africa, Tanzania (Opitz 2016).

Subfamily Orthopleurinae

***Megafodina (Orthopleuroides) imitans* (Schenkling, 1908).** Plate 5, Fig. 40, Map 20

Namibia, Karas Region, 42 km SE Keetmanshoop, road B1, Guruchab river, 26°44'S, 18°29'E, 845 m, 25.11.2012, leg. M. Hornburg (RGCM). Namibia, Schönfeld, N Omaruru, 1650 m, 10.1.1996, leg. K.+F. Adlbauer (RGCM). Namibia, E Windhoek, 1900 m, 6.1.1996, leg. K. & F. Adlbauer (RGCM, 2 ex.).

Distribution: Botswana, Democratic Republic of the Congo, Madagascar, Namibia (new country record), South Africa, Swaziland, Transvaal, Zambia, Zimbabwe.

***Tenerus variabilis* (Klug, 1842).** Plate 5, Fig. 41, Map 21

Namibia, Waterberg Plateau Park, 9.-11.1.1997, leg. R. Gerstmeier (RGCM, 10 ex.). Namibia, 27.12.1997, Waterberg Plateau Park, leg. J. Schindler (RGCM, 4 ex.).
Distribution: Kenya, Namibia (new country record), South Africa, Tanzania, Transvaal, Zimbabwe.

***Tricladus namibia* Opitz, 2014**. Plate 5, Fig. 42, Map 21

Namibia, ca. 2000 m, Khomas Hochland, 22°39'91"S 15°59'04"E, Holzeintrag 4.04.1998, M. & O. Niehuis (RGCM).
Distribution: Namibia (Opitz 2014).

***Tricladus ornatus* Opitz, 2014**. Plate 5, Fig. 43, Map 21

Namibia, Southwest Africa, Kaokoveld, Swartbooisdrif, 17°.19'S 13°.49'E, 10-II-1975, beaten on shore, Endrödy-Younga (WOPC).
Distribution: Namibia, South Africa, Tanzania (Opitz 2014).

Further results

Endemic species of Namibia:
Eucymatodera parva
Tricladus namibia

Southern African species:
Strotocera versicolor
Phloiocopus vagedorsatus
Trichodes aulicus
Korynetes semistriatus
Notostenus viridis

DISCUSSION

The map of all collecting locations (Map 1) shows some gaps, especially in the northern and eastern parts, but also in the south of Namibia. Further excursions are planned to fill these knowledge gaps. I tried to correlate the species distributions with biogeographic biomes, e.g. Namib Desert, Nama Karoo, Succulent Karoo and Savannah (based on Irish 1994, Mendelsohn et al. 2002), but without any success. Checkered beetles of Namibia seem to show a certain correlation with the structural diversity, indicated by the fact that most locations are situated on the Escarpment.

Cleridae are associated with dead wood (*Acacia* trees and other trees and shrubs), because most of the clerids are saproxylic and therefore they hunt larvae and other stages of wood infesting insects. Anecdotally, they appear to be generalist predators within specific niche micro-habitats. Flower visitors may feed on pollen, but mainly hunt other flower-visiting insects, e.g. *Aphelochroa sanguinalis* (Mawdsley & Sithole 2010) – *Trichodes* species are known to be nest robbers and hunt pre-adult stages of various solitary bees (Hymenoptera). In this context Cleridae may appear to transport pollen and may pollinate flowers (Mawdsley 2004).

Almost all genera of Cleridae represented in Namibia require taxonomic revision before species can be reliably identified. In response to this need, Alan Burke and I are preparing a set of revisions of genera of the subfamily Tillinae (starting with the genus *Eucymatodera*).

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Many people gave support to this publication, and helped during several trips to Namibia. My sincere thanks go to Jochen and Ralph Schindler (Windhoek) for their tireless support in collecting the beetles, with logistics and special feel-good effect during my visits. Kenneth Uiseb (MET) also facilitated the latest trip (2018) to Namibia and motivated me to do this checklist. Loide Uahengo and Edgar Mowa (NCRST) facilitated my research permit (RPIV00012018). John Irish (Namibia Biodiversity Database) helped in many ways and supported me with literature. Klaus Lendzian and Thomas Wagner (TUM) accompanied me on several trips and gave me some good lectures in botany. And, as always, my wife Marianne organised the photographic work and my friend and colleague Justin S. Bartlett (Brisbane) revised the manuscript.

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Contribution to the knowledge of southern African Lepismatidae (Thysanura, Insecta)

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ABSTRACT

A summary is given of the 78 described and several undescribed species of Lepismatidae known from southern Africa, including all previously unpublished material, keys to genera and species, distribution maps and host associations of nidicoles.

Keywords: Lepismatidae; southern Africa; Thysanura.

INTRODUCTION

Prior to this study, the Lepismatidae of southern Africa had been taxonomically treated by Escherich (1903, 1905), Silvestri (1908, 1913, 1922), Wygodzinsky (1955, 1959a, 1970), Paclt (1961, 1966, 1979), Theron (1963), Mendes (1981a, 1981b, 1982, 1988, 1993), Irish and Mendes (1988) and Irish (1986, 1987, 1988a, 1988b, 1988c, 1988d, 1989, 1994b, 1996a, 1996b).

My own work eventually led to the realisation that southern Africa in general, and the Namib Desert / Namaqualand region in particular, had the highest diversity of Lepismatidae per unit area in the world (Irish 1994a). Experience had also shown that intensive systematic sampling was needed to adequately describe and understand this diversity. To this end a project was started in 1992 that intended to collect and describe at least one sample of Lepismatidae from every quarter degree square in southern Africa, starting with South Africa. In order to meet institutional demands for publication rates, the work was split into smaller manageable parts. The first two parts, covering the Free State Province and the Central Karoo respectively (Figure 1), were published as Irish (1994b, 1996a). There will be no subsequent parts, beyond what has been included below. The 22-year gap since, and the inconclusiveness of much that follows below, all require some explanation.

Sampling for parts 3, Namaqualand, and 4, the southern Cape, was done in tandem after initial study showed it was necessary to treat this winter-rainfall area as a unit in order to adequately understand the fauna. All material from region 3 and about half of region 4 had already been processed when I was summarily dismissed by the National Museum, Bloemfontein, in January 2002. By the time my successor was appointed the computer that had held my research files was gone, as were the descriptions and illustrations for about a dozen newly described species (R. Scholtz, pers. comm., 2006). Many colour slides of live wild Lepismatidae, intended to show intact scale patterns, are also lost: no institutional memory remains of the former existence of the departmental photo collection that held them (A. Kirk-Spriggs, pers. comm., 2016). A few photographs taken since have been included in Figure 2. Study material that I had on loan from other institutions at the time of my dismissal was returned to them, but the case of the National Museum of Namibia (NMNW) needs to be mentioned. In 2017 I gained access to this collection for the first time in about 15 years. I found that the 'wet' collection, including the Lepismatidae, had been allowed to dry out. Dessication of preserved Lepismatidae is an irreversible process that effectively makes them useless for subsequent study. The collection includes/included formerly wet-preserved type material, besides many geographically unique non-type specimens, as well as unidentified or partially studied material. Almost half of the specimens reported on here, and virtually all that were included in the earlier works of Irish (1986, 1987, 1988a, 1988b, 1988c, 1988d, 1989, 1996b) and Irish & Mendes (1988), came from the NMNW collection. For some species, this represents all known material.

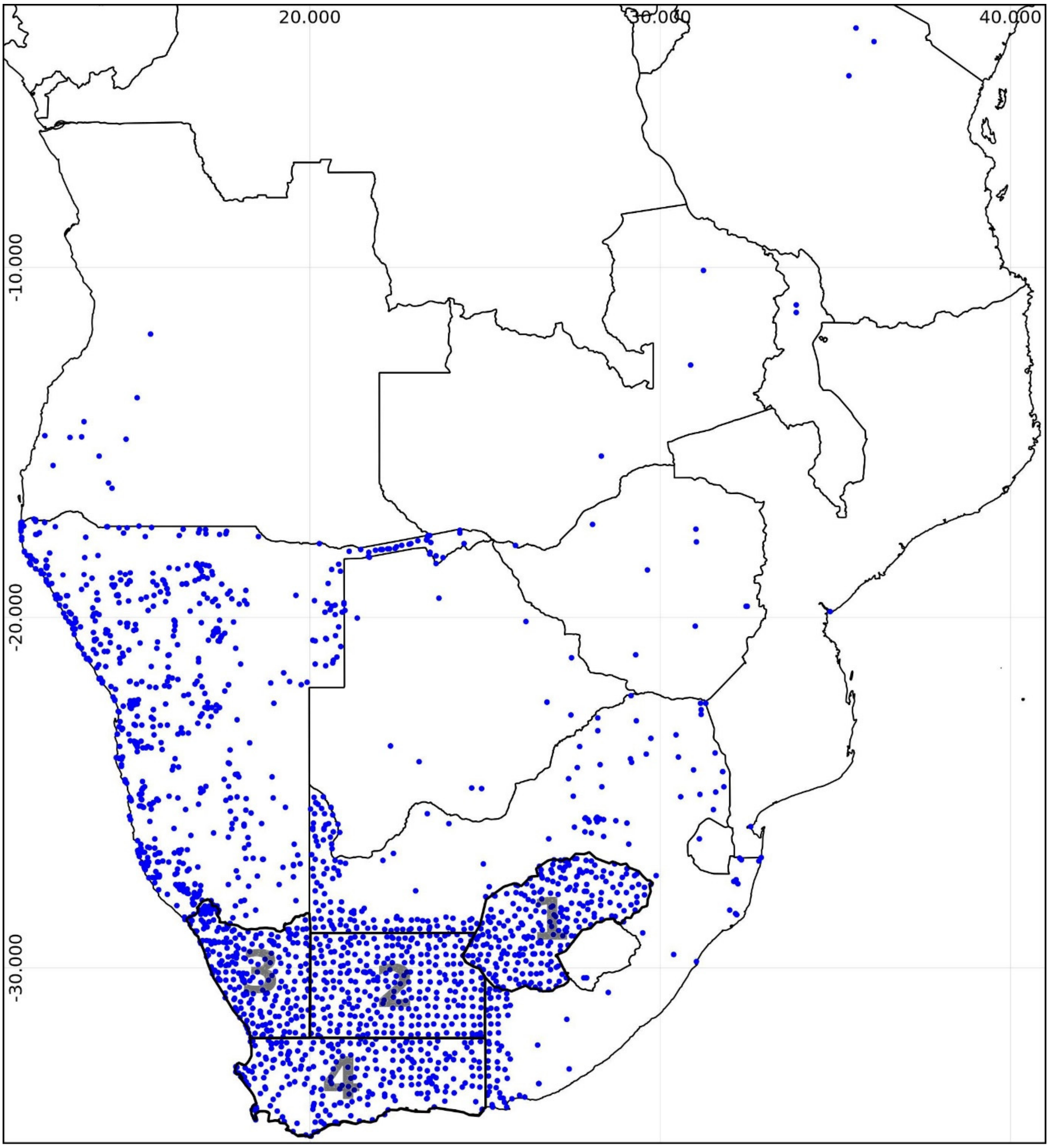

Figure 1: Southern African Lepismatidae collecting localities (blue dots) and previous sampling areas (numbers 1 to 4).

Given these and other impediments, it is impossible to continue the research. The current publication intends to summarise information that has survived. It was reconstructed from the handwritten identification note pads kept next to my microscope at the time, backed up by field books, but excluding a significant body of work that had become illegible over time. In the absence of most descriptions, all illustrations and sometimes the material as well, new species or taxonomic ambiguities have merely been mentioned.

Southern Africa is defined as it was at the time the work was done: Namibia, Botswana, Zimbabwe, South Africa, Lesotho, Swaziland and Moçambique south of the Zambezi River. All species that have been recorded from this area are included below, including all records of those same species from further north but excluding all species that have only been recorded from north of there. Discrepancies in sampling intensity as depicted in Figure 1 should be considered when interpreting distribution maps. Areas 1 to 4 were sampled equally thoroughly but for area 4 only the myrmecophiles and taxa already well known from previous work had been identified and accessioned by the time this study was terminated, explaining the sparser coverage there. The remainder of unaccessioned partially processed Lepismatidae

a. Thermobia nebulosa*, with black crossband.*

b. Thermobia vallaris.

c. Ctenolepisma longicaudata.

d. Unidentified Ctenolepisma *sp., showing colour pattern typical for* C. terebrans *and similar species.*

e. Xenolepisma globosa.

f. Monachina *sp., showing interference colours in sunlight.*

Figure 2: *Representative southern African Lepismatidae spp., showing diversity of body shapes and scale patterns.*

material from area 4 remained in the National Museum, Bloemfontein, along with a fair number of concurrently collected Ateluridae, Nicoletiidae, Meinertellidae and Diplura. These apterygotes are mentioned because they are poorly represented in other southern African collections.

Collecting locality details are summarised in Appendix 2, with locality numbers following on from parts 1 and 2 of the study. The opportunity has been taken to rectify older literature localities that were not adequately georeferenced at the time, including in my own earlier work.

In total, 6218 previously unpublished specimens of Lepismatidae and 990 associated host ant or termite specimens are treated below (Table 1).

Table 1: *Origin of study material. Institutional abbreviations follow Evenhuis (2018), with asterisks denoting collections not included in the latter.*

Coden	Institution	Curator	exx.
BMSA	National Museum, Bloemfontein, South Africa		2850
CAS	California Academy of Sciences, San Francisco, USA	Dr. W. Pulawski	82
FORC*	Private collection, Serowe, Botswana	Dr. P. Forchhammer†; currently housed at National Museum, Gaborone, Botswana	2
GRSW	Gobabeb Research and Training Centre, Gobabeb, Namibia	Dr. M.K. Seely; donated to NMNW, 1980s.	40
IICT	Centro de Zoologia do I.I.C.T., Lisboa, Portugal	Dr. L.F. Mendes	5
KNP*	Kruger National Park Research Collection, Skukuza, South Africa	Dr. L.E.O. Braack	27
MMKZ	McGregor Museum, Kimberley, South Africa	Housed at BMSA since 1990s.	1
MZLU	Lund University, Lund, Sweden	Dr. R. Danielsson	3
NHME	Natuurhistorisch Museum, Maastricht, Netherlands	Dr. F. Dingemans-Bakels	-
NMNW	National Museum of Namibia, Windhoek, Namibia		2467
SAMA	South Australian Museum, Adelaide, Australia	Dr. E.G. Matthews	8
SAMC	Iziko Museum, Cape Town, South Africa	Dr. H. Robertson	159
SANC	National Collection of Insects, Pretoria, South Africa	Mrs. V. Uys	360
TMSA	Ditsong Museum of Natural History, Pretoria, South Africa	Dr. S. Endrödy-Younga†	199
UOVS*	Entomology Department, University of the Free State, Bloemfontein, South Africa	Dr. S. Louw†	1
USNM	National Museum of Natural History, Washington D.C., USA	Dr. J. Coddington	6
ZMHB	Museum für Naturkunde der Humboldt-Universität, Berlin, Germany	Dr. J. Deckert	1
ZMUH	Zoologisches Institut und Museum, Hamburg, Germany	Dr. H. Strümpel	7

Unless specified otherwise, ant and termite identifications are by myself, using the work of Arnold (1915-1924, 1926), Bolton (1980, 1981a, 1981b, 1982, 1987), Prins (1982), Bolton and Marsh (1989), Hölldobler and Wilson (1990), Robertson and Zachariades (1997) and Fisher and Bolton (2016) for ants, and Coaton and Sheasby (1974, 1975) for termites.

Remaining otherwise unpublished records from my Ph.D. thesis (Irish 1990) have been included here under 'New material examined', without comment.

Escherichian types

A recurring problem in southern African Lepismatidae systematics is that key types of the very first South African species described by Escherich (1903, 1905) have been lost. This study had reached the stage where taxonomic decisions needed to be made despite the absence of types, hence it is necessary to document attempts made to find them. Dr. L.F. Mendes (IICT, pers. comm., 1987) had previously made extensive but unsuccessful enquiries to various European, mainly German, museums. The consensus of opinion from the latter was that the material had most probably been in Hamburg (ZMUH) but had been destroyed during World War II.

Most of Escherich's other Lepismatidae types are indeed in ZMUH but according to the type list of Weidner (1962) the missing Lepismatidae types are not included among them. Dr. H. Strümpel (pers. comm., 1985) kindly confirmed the absence of any potential unlabelled Escherich types from ZMUH. Horn and Kahle (1935-1937) mention some of Escherich's Coleoptera material that is in the Trondheim University Museum, Norway, but this includes no Thysanura (Dr. O. Solem, pers. comm., 1985). Escherich tutored at the University of Strasbourg while publishing some of his work on Lepismatidae but enquiries after possible material there were also unsuccessful.

Dr. H. Brauns was the collector of Escherich's specimens and they may have been returned to him. Horn and Kahle (1935-1937) mention material of Brauns' in ZMUH (see above), TMSA and the National Museum of Ireland, Dublin, none of which house the types in question (Drs. R.B. Toms and J.P. O'Connor, respectively, pers. comm., 1985).

Escherich (1903) mentioned receiving at least Brauns' nidicole material through Dr. E. Wasmann. Wasmann's collection is today housed at NHME. In 1992 I located what might be the types of at least three Escherichian species in the Wasmann collection, judging solely by the labels. I intended to borrow and examine them later but never could. This collection has the best potential for also housing the remaining missing types.

SYSTEMATICS

Key to southern African genera of Lepismatidae. This may not work for all species in the same genera in other geographical areas.

1. Most major macrosetae, especially those on the frons, with smooth shafts 2
- Most major macrosetae, especially those on the frons, with barbed shafts 9
2. Urotergal setation sparse, macrosetae arranged singly or in small discrete groups; if grouped, spaces between groups wider than groups 4
- Urotergal setation dense, consisting mainly of wide setal fringes; if grouped, spaces between groups narrower than groups; only found in Namib Desert dunes 3
3. Antennae short, reaching back to posterior margin of pronotum only ..... *Namibmormisma*
- Antennae long, reaching or surpassing end of abdomen ..... *Namiblepisma* gen. nov.
4. Most urotergites with 2+2 or 3+3 bristlecombs ..... *Heterolepisma*
- Most urotergites with 1+1 infralateral setal groups (that may be reduced to a single macroseta each), as well as single isolated more mediad macrosetae 5
5. Male parameres large, flat; antennal sensillae campaniform; in southern Africa, exclusively anthropophilic and rarely encountered ..... *Lepisma*
- Male parameres small, often acorn-shaped; antennal sensillae asteriform; in southern Africa, usually myrmecophilous nidicoles 6
6. All anterior thoracic notal trichobothrial areas open, all posterior areas closed..... *Afrolepisma*
- Thoracic notal trichobothrial areas not as above 7
7. All anterior thoracic notal trichobothrial areas open; posterior areas open on pronotum, closed on meso- and metanota 8
- All thoracic notal trichobothrial areas closed ..... *Xenolepisma*
8. Posterior margins of thoracic nota each with a row of evenly spaced setae ..... *Tricholepisma*
- Posterior margins of thoracic nota bare (at least in the single southern African species)..... *Neoasterolepisma*
9. Urotergite X acutely triangular; adults with two to six pairs of styli 10
- Urotergite X usually trapezoidal, at most obtusely subtriangular, never acutely triangular; at most with three pairs of styli 11
10. Prosternum with a central setal tuft; adults with two pairs of styli ..... *Acrotelsa*
- Prosternal disc not setose, no central setal tuft; adults with six pairs of styli ..... *Stylifera*
11. Urotergal setation arranged in discrete bristlecombs, or consisting mainly of sparse single setae only 12
- Urotergal setation consisting of wide undifferentiated lateral setal fringes ..... *Sabulepisma*
12. Urotergal setation consisting of at most 1+1 infralateral bristlecombs, further isolated macrosetae only 13
- Urotergal setation consisting of 2+2 or 3+3 bristlecombs on most urotergites 15
13. Urosternites with bristlecombs, consisting of at least 2 macrosetae each 14
- Urosternites each with 1+1 single macrosetae only ..... *Silvestrella*
14. Median urosternal bristlecombs completely lacking ..... *Monachina*

- Median bristlecomb present on one anterior urosternite only .... *Namunukulina*
- Median bristlecombs present on most urosternites .... *Hemilepisma*

15. At least urotergites II-V with 3+3 bristlecombs each 18
- At most 2+2 bristlecombs on any one urotergite 16

16. Median urosternal bristlecombs completely lacking .... *Ornatilepisma*
- Median urosternal bristlecombs present on most urosternites 17

17. Urotergite X subtriangular, apically rounded .... *Thermobia*
- Urotergite X distinctly trapezoidal, not rounded apically .... *Psammolepisma*

18. Urotergite I with at most 2+2 bristlecombs, usually only 1+1 19
- Urotergite I with 3+3 bristlecombs 20

19. Median urosternal bristlecombs single, or absent .... *Ctenolepisma*
- Median urosternal bristlecombs double .... *Swalepisma*

20. Each leg with two paired tarsal claws .... *Gopsilepisma*
- Each leg with a single tarsal claw only .... *Nebkhalepisma*

Note 1: the grammatical gender assigned to *Lepisma* is currently under review by the International Commission for Zoological Nomenclature (case 3704: Molero-Baltanás et al. 2016). Until resolved, this work continues to treat both *Lepisma* and all genera ending in *-lepisma* as feminine.
Note 2: for widespread taxa, lists of synonymy include only that pertinent to the study area.

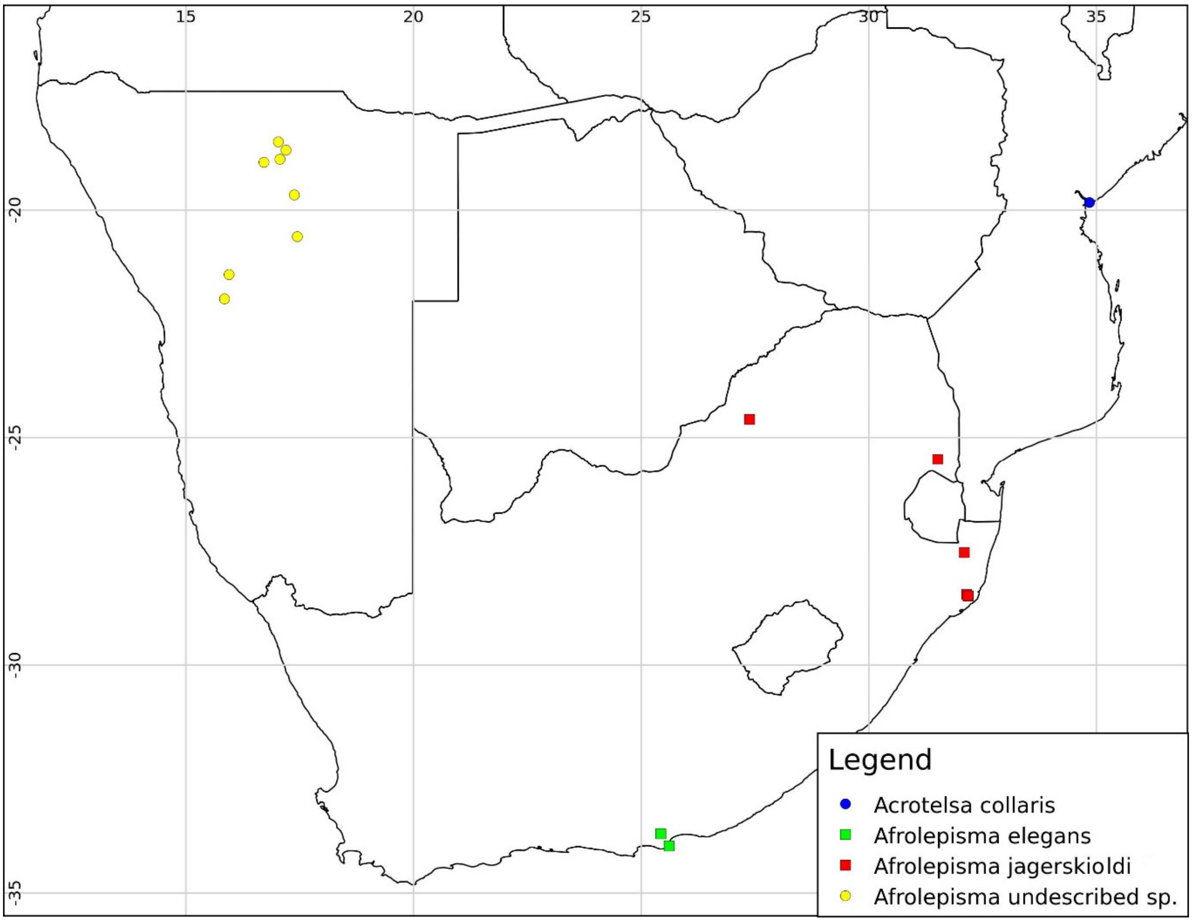

Figure 3: *Distribution of* Acrotelsa collaris *(Southern Africa only),* Afrolepisma elegans*,* Afrolepisma jagerskioldi *and an undescribed* Afrolepisma *species (see text).*

Key to southern African Afrolepisma *species; excludes the problematic* A. simulatrix*, see below, which will probably run to* A. tragardhi *in the key.*

1. Some posteriad urosternites with some spiniform setae 2
- All urosternal macrosetae normal, slender 3
2. Urotergite IX with 2+2 infralateral and 1+1 sublateral macrosetae; median urosternal bristlecombs of 13-18 macrosetae, none of which are spiniform; lateral urosternal bristlecombs of 8-12 macrosetae, of which many on urosternites IV-VIII are spiniform; distance between lateral and median urosternal combs narrow, about 1/4 to 1/5 the width of the lateral combs.. ....*A. oudemansi*
- Urotergite IX with 2+2 infralateral macrosetae only; median urosternal bristlecombs of 10-13 macrosetae, of which the external one or two on urosternites V-VIII are spiniform; lateral urosternal bristlecombs of 3-5 macrosetae, of which the inner one or two on urosternites V-VIII are spiniform; distance between median and lateral urosternal combs about twice the width of the lateral combs..*A. jagerskioldi*
3. Urotergite X apically concave, emarginate 4
- Urotergite X apically convex, rounded .... Undescribed species
4. Infralateral macrosetal group on all or most of urotergites II-VIII consisting of at least two and up to four macrosetae of generally similar length and robustness, which may or may not be accompanied by a further seta or setae; the latter, when present, generally shorter and noticeably more slender than the macrosetae; in extreme cases, when there are only two macrosetae and one is shorter, it is not more slender.. *A. tragardhi*
- Infralateral macrosetal group on all or most of urotergites II-VIII consisting of a single macroseta only, which is usually accompanied by a second seta on most urotergites; the latter seta generally shorter and noticeably more slender than the macroseta; in extreme cases, when both setae are of similar length, one is still more slender than the other....................... 5
5. Urotergite X long, narrow, about 1.5 times as long as width at base; larger, adult body length usually > 6 mm; light coloured species; median urosternal bristlecombs of 12-19, laterals of 5-8 macrosetae each 7
- Urotergite X short, about as long as width at base; large or small; dark coloured species; median urosternal bristlecombs of 8-10, laterals of 3-5 macrosetae each.. 6
6. Small-bodied, adult body length usually 6 mm or less; hosts with variety of ants, seldom with *Messor* spp. .... *A. szeptyckii*
- Large-bodied, adult body length usually 6 mm or more; hosts exclusively with *Messor* spp.................. Unresolved taxon
7. Urotergite IX lacking submedian macrosetae...*A. sesotho*
- Urotergite IX with 1+1 submedian macrosetae ....*A. elegans*

Genus *Acrotelsa* Escherich

Acrotelsa Escherich 1905: 105.

Acrotelsa collaris (F.)

Lepisma collaris Fabricius 1793: 64.
Acrotelsa collaris (F.) Escherich 1905: 107; Stach 1935: 88; Paclt 1966: 157.

A tropicopolitan anthropophile that has been recorded from the study area (Figure 3) and is also known from further north but was not encountered during this study.

Literature records: ANGOLA. 000. Farm Bavaria, Nord-Angola (locality untraced) (Paclt 1966). MOÇAMBIQUE. 558. Beira (Stach 1935).

Genus *Afrolepisma* Mendes

Asterolepisma (Afrolepisma) Mendes 1981a: 201.
Afrolepisma Mendes 1988: 12.

Afrolepisma elegans (Escherich) comb. nov.

Lepisma elegans Escherich 1903: 362, 1905: 58; Mendes 1988: 10.

Mendes (1988), in his revision of *Lepisma s.l.*, listed *Lepisma elegans* as *species inquirenda* because there were neither types nor alternative study material available to him. Material that I had collected in 1987, some 35 km northwest of the type locality, with the same ant as one of the type hosts, later turned out to be the same species. In 1992 I found bottles in the Maastricht Museum that were labelled as being the types of *L. elegans*. Unfortunately, this study was terminated before I could compare my specimens to the types or redescribe the species. Nevertheless, I am confident in my identification, firstly because of the correspondence in locality and host and secondly because of the presence of 1+1 submedian macrosetae on urotergite IX in my specimens. The species was originally described as having such setae and illustrated with them in Figure 11a of Escherich (1903). However, in Figure 14a of Escherich (1905) the same setae are not shown and dorsal setation is described only as being 'the same as in previous species'. I was led by the fact that submedian urotergite IX setae are uncommon in the genus and finding specimens with such setae corresponding in host and locality with Escherich's original (1903) description and illustration was a strong indication that they are the same. The new combination with *Afrolepisma* is based on the arrangement of the trichobothrial areas on the thoracic nota in the new material. The following description was based on the slide-mounted dissection of the 'Die Bron' female but the accompanying figures have been lost.

A. elegans resembles both *A. sesotho* and *A. tragardhi* in general appearance. It differs from both in the setation of urotergite IX. *A. tragardhi* frequents similar hosts (Ponerinae ants) but *A. sesotho* is usually found with *Messor* spp.

Body shape elongate lachrymiform. Base colour yellowish white. Pigment mostly absent, faint on legs only. Dorsal scales light brownish in alcohol, ventral scales transparent. Live colouration not noted. Macrosetae golden yellow, shafts smooth, often apically bifid, especially on frons. Antennal length 0.6-0.7 times body length. Antennal sensillae asteriform, 2-6 pronged. Maxillary palp short and plump, with at least one two-pronged apical sensilla. Distal segment of labial palp only mildly widened, asymmetrical, with five sensillae in two rows.

Thoracic notal setation not recorded. All anterior thoracic notal trichobothrial areas open, all posterior areas closed. Prosternum with 1+1 apicolateral bristlecombs of 7-9 macrosetae each, as well as 1-2 + 1-2 subapical macrosetae. Mesosternum with 1+1 bristlecombs of 7-9 macrosetae each. Metasternum with 1+1 bristlecombs of 10 macrosetae each. Tarsi with two claws and an empodium each. Tibia III about 1.3 times longer than tibia I.

Urotergites I and IX each with 1+1 infralateral, 1+1 sublateral and 1+1 submedian macrosetae. Urotergites II – VIII each with 1+1 infralateral, 1+1 sublateral, 1+1 lateral and 1+1 submedian macrosetae. Urotergite X about as long as its basal width, posteriorly shallowly but distinctly emarginate, with 1+1 macrosetae on the posterolateral angles.

Urosternite I medially salient with 1 median bristlecomb of 5 macrosetae. Urosternite II with 1 median bristlecomb of 12 macrosetae. Urosternites III – VII with 1+1+1 bristlecombs, of which the lateral ones are composed of 4-7 macrosetae each and the median ones of 12-19 macrosetae each. Setation of urosternite VIII and coxites IX for male not recorded. Female coxites VIII without bristlecombs but with a marginal setal fringe; coxites IX with outer processes about twice length of inner processes, with a marginal setal fringe.
Both sexes with two pairs of styli. Ovipositor fairly short, extending beyond the tips of coxites IX by about the length of styli IX, without special characters. Penis without special characters. Male parameres small, acorn-shaped, with a few small setae only. Cerci each about 0.3 times, median filament about 0.4 times body length. Body length of female 7.6 mm, of male 6.1 mm (Escherich (1905) gave the body length of the types as 9mm).

Literature record: SOUTH AFRICA. 1963. Port Elizabeth (type locality; *Technomyrmex albipes foreli*, *Bothroponera granosa*, *Plectroctena mandibularis*) (Escherich 1903, 1905).

Cotypes in NHME, located but not examined: three vials, along with other material in a larger container labelled 'W XLVIII Myrmecophilen XI', as follows:
a) 'Lepisma elegans Escherich bei Plectroctena mandibularis, Capkolonie, Port Elizabeth' (1 large specimen broken in two parts).
b) 'Lepisma elegans Escherich bei Technomyrmex albipes Forel: Emery (teste Emery!), Capkolonie' (1 medium-sized specimen, intact, apparently in good condition).
c) 'Lepisma elegans Escherich (jung) bei Bothroponera granosa?, Cap kolonie, Port Elizabeth, Brauns!' (about three specimens, broken, small).

Material examined: 2 (1 female – dissected, slide mounted, 1 male); both NMNW.
Locality: SOUTH AFRICA. 1935. Die Bron, Uitenhage (*Plectroctena mandibularis,* as *P. conjugata*, det. H. Robertson 1988, #C1125).

A. elegans is myrmecophilous. The types were collected with the ants *Technomyrmex pallipes* (Smith) (recorded as *Technomyrmex albipes foreli* Emery), *Bothroponera granosa* (Roger) and *Plectroctena mandibularis* Smith. The present material was found under a stone in a nest of the latter. Of the four recorded host records, three belong to the subfamily Ponerinae and two are *Plectroctena mandibularis*, suggesting the latter might be the primary hosts. Despite searching, no other specimens or indeed any myrmecophiles could be found closer to the type locality and this is ascribed to the habitat disruption wrought by urbanisation and the encroachment of alien vegetation in the century since the types were collected.

The species is probably more widespread but is currently known from a limited area in the Eastern Cape Province in South Africa only (Figure 3). The '*L. elegans*' material previously listed from Botswana and northern Namibia by Silvestri (1908, 1922) was examined and found to belong to *A. tragardhi* instead.

Afrolepisma jagerskioldi (Silvestri)

Lepisma Jägerskiöldi Silvestri 1913: 10; Paclt 1961: 77.
Asterolepisma (Afrolepisma) jaegerskioldi (Silvestri). Mendes 1981a: 271.
Afrolepisma jaegerskioldi (Silvestri). Mendes 1988: 56.

A poorly known species recorded from a few localities in northeastern South Africa only (Figure 3). The area has not been adequately sampled and the species is expected to be more widespread in the eastern Savanna Biome.

A. jagerskioldi had also been recorded from northern Namibia by Silvestri (1922) but those specimens represent another, undescribed species, see below.

Although one of the original records was from an unspecified termite's nest, ants are the usual hosts for *Afrolepisma* species and most subsequent samples were found with unspecified ants. Host specificity is undetermined; the only identified ants are *Camponotus rufoglaucus* and a *Tetramorium* species.

The species was named for Swedish (Finnish born) zoologist Leonard Jägerskiöld (1867-1945). Article 32.5.2.1 of the International Code of Zoological Nomenclature states that diacritics should always be removed from taxonomical names, except when they are umlauts in a German name published before 1985, which is not the case here. Neither the emendation *jaegerskioldi* by Mendes (1981a) nor *jaegerskioeldi* by Irish (1990) were therefore correct.

Literature records: SOUTH AFRICA. 1385. Umfolozi drift (unspecified termites). 1389. Umfolozi (type localities) (Silvestri 1913, examined by Mendes 1981b).
SOUTH AFRICA. 1269. Malelane Camp (*Camponotus rufoglaucus*) (Paclt 1961).

Material examined: 3 (2 females, 1 male); 3 NMNW. Localities. SOUTH AFRICA. 1254. Thabazimbi (unspecified ants). 1337. 3 km NW Ubombo (*Tetramorium* sp.).

Afrolepisma undescribed species

Lepisma jägerskiöldi (*nec* Silvestri 1913) Silvestri 1922: 85.

On purely distributional grounds, both Paclt (1966) and Mendes (1988) had previously doubted the accuracy of Silvestri's (1922) records of *A. jagerskioldi* from northern Namibia. I have examined Silvestri's specimens (two males, in ZMUH, respectively from Omaruru and Karibib, according to the labels, although the published localities were Omaruru and Otavifontein) and found that they belong to yet another, undescribed, species. It lacks spiniform urosternal setation and is otherwise recognisable by a characteristically apically rounded tenth urotergite. The normal urosternal setation excludes it from both *A. jagerskioldi* and *A. oudemansi*, the latter identity suggested by Mendes (1988). The shape of urotergite X excludes it from *A. tragardhi*, the identity suggested by Paclt (1966). Females have longer than usual inner processes of coxites IX, resembling *A. simulatrix* in this respect, but the two species have differently shaped urotergites X, as well as different distribution areas.

The current study was interrupted before the species could be described. It has been found at a number of places in northern Namibia (Figure 3). Most were collected with ants but no hosts were ever identified; some came from pit traps.

Literature records: NAMIBIA. 760. Otavifontein, 5 km Otavi. 887. Omaruru (as ‘Omarum’). [914. Karibib]. (Silvestri 1922).

Details of Silvestri (1922) material examined:
One ?male, labelled: a) Hamb. dtsch.-s.w.afr. Studienr. 1911. Omaruru. W. Michaelsen. leg. 21.-22.VI.1911. ded. b) Lepisma jägerskiöldi Silv., F. Silvestri determ. (ZMUH).
1 male, labelled: a) Hamb. dtsch.-s.w.afr. Studienr. 1911. Karibib. W. Michaelsen. leg. 23.-26.VI.1911. ded. b) Lepisma jägerskiöldi Silv., F. Silvestri determ. (ZMUH).

Specimens referable to this taxon were seen from the following localities. The record of the number of specimens involved has been lost.
NAMIBIA. 654. Beisebvlakte. 670. Operet 312. 687. Leeudrink. 694. Batia. 836. Okakarara area. 911. Otjihangweberg (all NMNW).

Afrolepisma oudemansi (Escherich)

Lepisma oudemansi Escherich 1905: 53.
Afrolepisma oudemansi (Escherich). Mendes 1988: 65; Irish 1994b: 464, 1996a: 170, 1996b: 15

Widely but sparsely distributed throughout southern Africa (Figure 4); it is absent from the better-sampled winter rainfall areas of the southern Cape and Namaqualand but other apparent gaps in distribution have to be attributed to insufficient sampling. The species is here recorded from Zimbabwe for the first time.

It is myrmecophilous and is usually found in ants' nests under stones. The overwhelmingly preferred hosts are *Pheidole* spp. but there are a few single records from other ants or termites. They have also been found without ants under stones, in pit traps or under dry elephant dung.

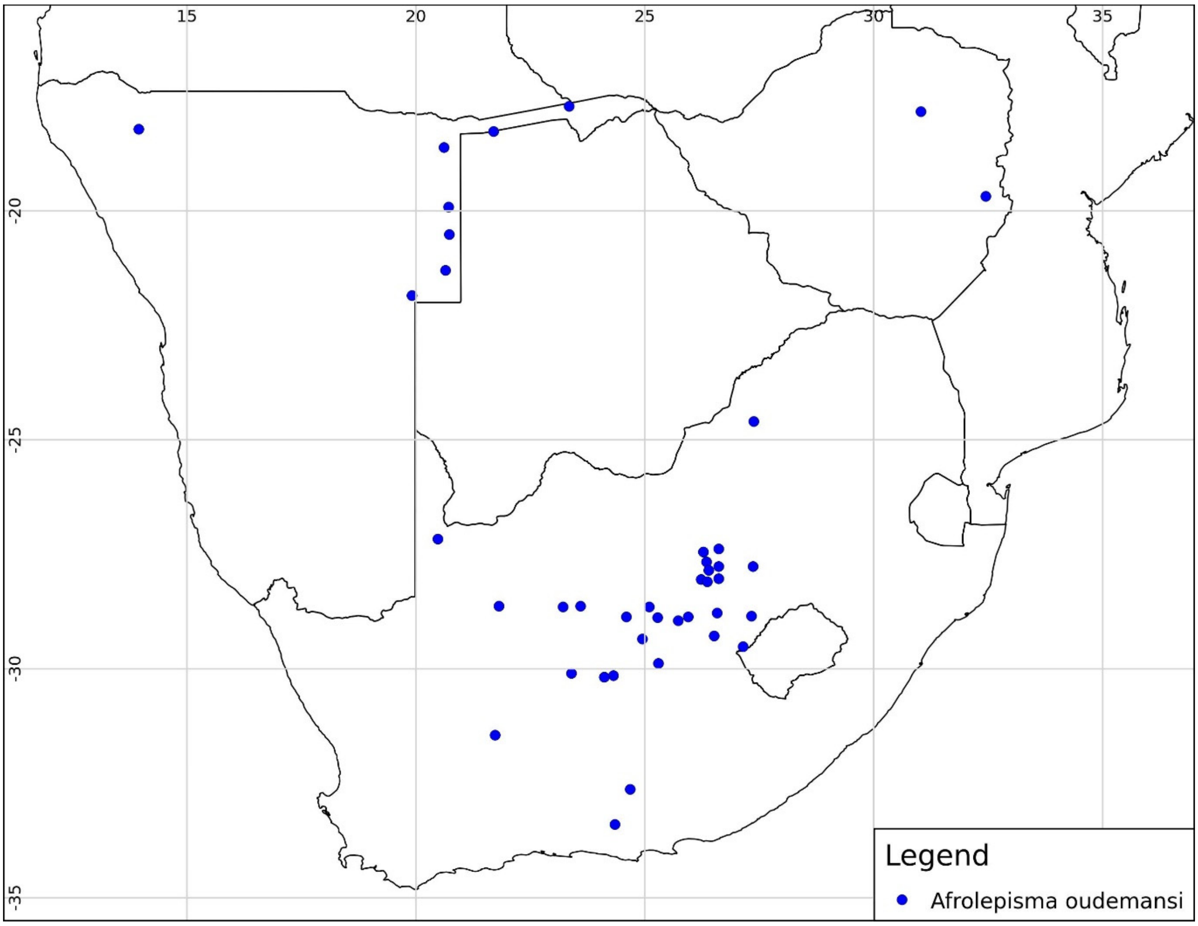

Figure 4: *Distribution of* Afrolepisma oudemansi.

Literature records: SOUTH AFRICA. 24. Bothaville (type locality) (Escherich 1905, examined by Mendes 1988).
NAMIBIA. 607. Kwando River. 666. Kaudom Game Reserve. 782. Nama Pan. (Irish 1996b).
Also 18 localities in Irish (1994b) and 4 in Irish (1996a).

New material examined: 18 (8 females, 7 males, 3 unsexed); 9 BMSA, 7 NMNW, 1 CAS, 1 SAMA. Also 58 hosts.
New localities. NAMIBIA. 634. 4 km NE Orumana. 638. Mahango Game Reserve. 832. Northern Vet. Fence (*Pheidole* sp.). 880. Epukiro River. 906. Alkmar 512 (*Tetramorium peringueyi*). SOUTH AFRICA. 1254. Thabazimbi (*Pheidole* sp.). 1328. Loch Nagar (*Pheidole* sp.). 1343. Fairfield (*Pheidole* sp.). 1407. Gariep (*Pheidole* sp.). 1410. Kleinbegin (*Pheidole* sp.). 1415. Merino (*Pheidole* sp.). 1446. Driekoppies (*Pheidole* sp.). 1796. Quimby Holme (*Pheidole* sp.). 1904. Skietkraal (*Pheidole* sp.). ZIMBABWE. 2007. Salisbury (*Pheidole* sp.). 2009. 3 km S of Hot Springs.

Afrolepisma sesotho (Wygodzinsky)

Lepisma sesotho Wygodzinsky 1955: 135.

Afrolepisma sesotho (Wygodzinsky) Mendes 1988: 71; Irish 1994b: 465; Irish 1996a: 170.

The species is widespread in mainly western southern Africa (Figure 5). Records are very sparse outside the primary sampled area and the range extent towards the north and east is unknown. Its absence from the southwestern Cape is real. The species is newly recorded from Namibia here.

It is expected that its distribution will ultimately be shown to coincide with that of its primary host, ants of the genus *Messor*. Very few active *Messor* nests that were examined during this study did not harbour at least some of these animals and they are found with whatever *Messor* species occurs in a given area. Nevertheless, they are occasionally found with other hosts as well and host associations with both the ant *Platythyrea lamellosa* and the termite *Odontotermes transvaalensis* are newly recorded here. Occasional specimens were collected in pit traps or at light.

Literature records: LESOTHO. 553. Dikolobeng River (type locality; unspecified ants) (Wygodzinsky 1955).
Also 29 localities in Irish (1994b) and 21 in Irish (1996a).

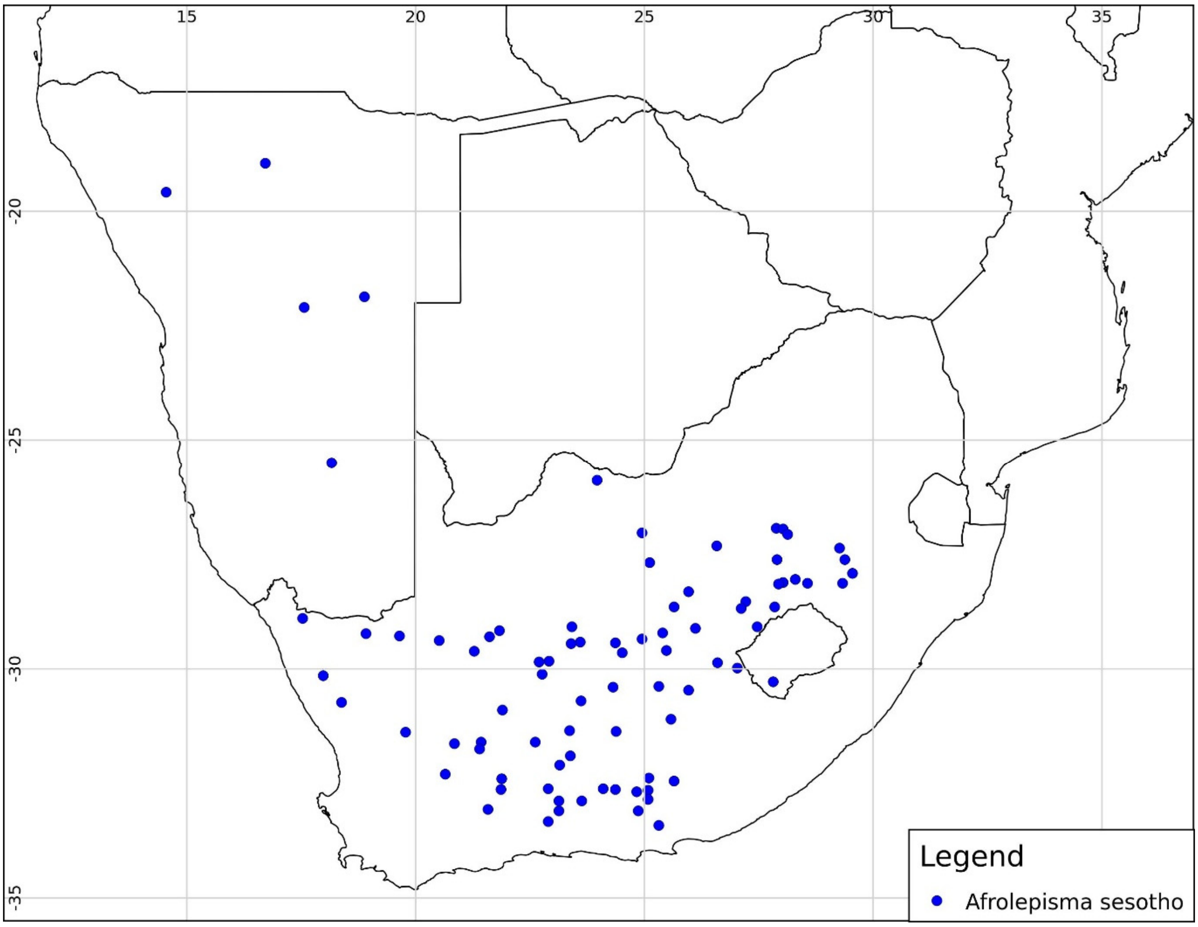

***Figure 5:** Distribution of* Afrolepisma sesotho.

New material examined: 92 (40 females, 35 males, 17 unsexed); 73 BMSA, 1 SAMC, 7 SANC, 11 NMNW. Also 103 hosts.

New localities: NAMIBIA. 694. Batia (*Messor tropicorum*, det. H. Robertson, 1988, #C1127). 751. Bruno 614. 908. Owingi 246 (*Messor denticornis*, det. H. Robertson 1988, #C1128). 922. Onganja East 190 (*Messor tropicorum*, det. H. Robertson, 1988, #C1129). 1077. Mukorob (pit trap). SOUTH AFRICA. 1291. Tosca (*Platythyrea lamellosa,* ID ex label, determiner unknown). 1325. 14 mi. ex Vryburg – Schweizer-Reneke (*Odontotermes transvaalensis*, det. W.G.H. Coaton, T-787). 1342. 39 mi. ex Schweizer-Reneke – Christiana (*Trinervitermes trinervoides,* det. W.G.H. Coaton, T-811). 1453. Kristalberge (*Messor denticornis*). 1496. Gamsberg, Site D. 1507. Gannapoort (*Messor capensis*). 1571. Dassiefontein (*Messor denticornis*). 1615. Stofkraal (unidentified ants). 1641. Driefontein (*Messor denticornis*). 1665. Hantamsberg-plato (under stone, no ants recorded). 1715. Bruinrug (*Messor capensis*). 1748. 10 km N Sutherland (*Messor capensis*, det. H. Robertson 1988, #C1107). 1760. Sondagsrivier (*Messor denticornis*). 1762. Benoni (*Messor denticornis*). 1770. Tarkapas, summit (*Messor denticornis*). 1787. Vrede-en-Lus (*Messor denticornis*). 1789. Vlakfontein (*Messor capensis*). 1792. Matjiesgoedkop (*Messor denticornis*). 1795. Bosrant (*Messor capensis*). 1799. Kafferskop (*Messor* sp.). 1803. 8 km NW Ebenezer (*Messor denticornis*). 1821. Westondale (*Messor denticornis*). 1831. 3 km NW Rietbron (*Messor denticornis*). 1832. Blomplaas (*Messor capensis*). 1846. Blaauwkrantz (*Messor denticornis*). 1854. Kareedam (*Messor capensis*). 1855. Kalkfontein (*Messor capensis*). 1891. Spitskop (*Messor capensis*). 1908. Vaalhoedskraal (*Messor denticornis*).

Afrolepisma simulatrix (Wygodzinsky)

Lepisma simulatrix Wygodzinsky 1955: 130.
Asterolepisma (Afrolepisma) simulatrix (Wygodzinsky). Mendes 1981a: 208.
Afrolepisma simulatrix (Wygodzinsky). Mendes 1988: 72.

A. simulatrix is known only from the types, from a single locality in the southern Cape (Figure 6). In most respects, including recorded hosts, they resemble *A. sesotho* but two differences are apparent from the description. Firstly, *A. simulatrix* has infralateral urotergal setal groups composed of two macrosetae, sometimes accompanied by a third, smaller seta. Wygodzinsky (1955) did not describe these macrosetae but his Figures 287 and 288, and his

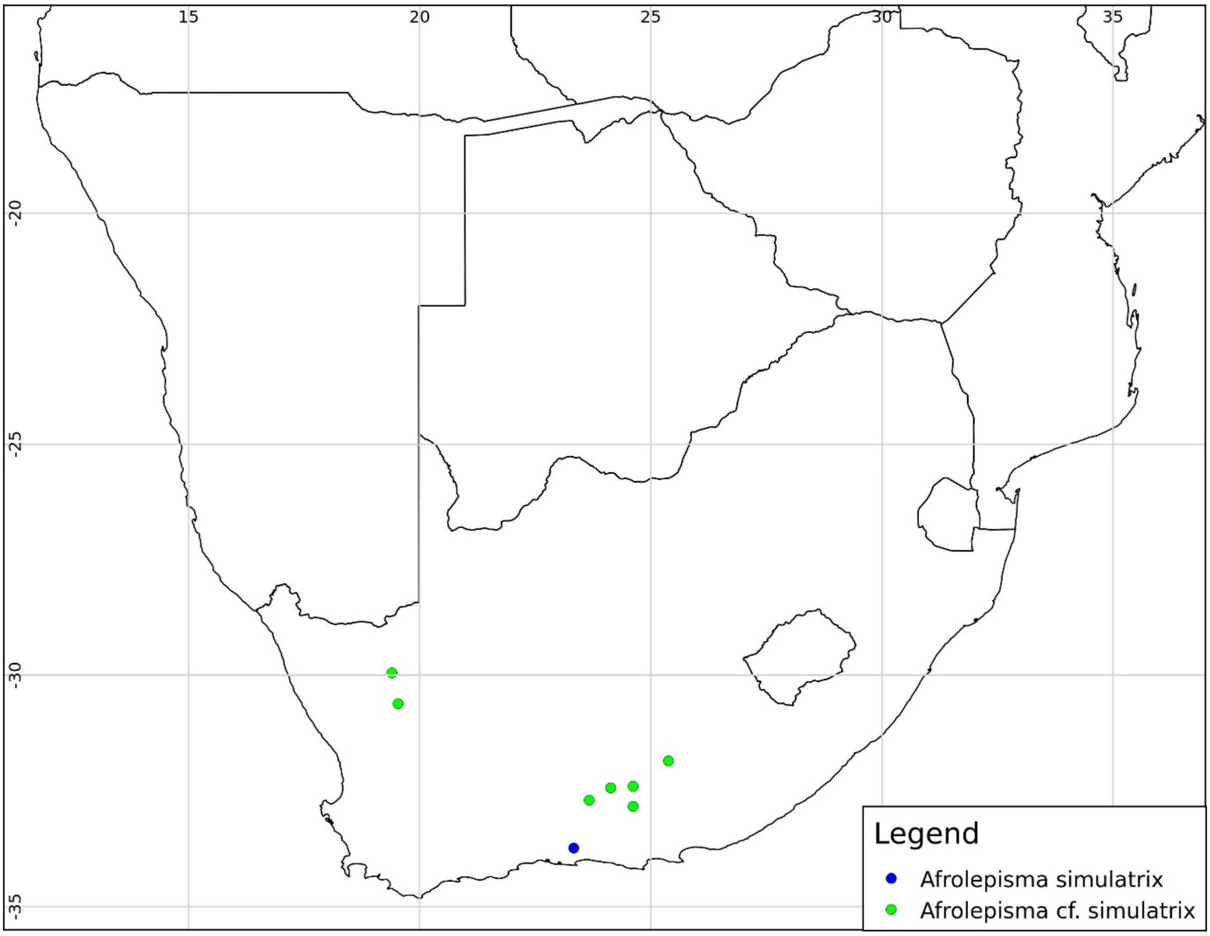

***Figure 6**: Distribution of* Afrolepisma simulatrix *and specimens possibly referable to it.*

use of them in his key, suggest that the two main setae in *A. simulatrix* are of similar length and each as thick as the other. The infralateral macrosetae in *A. sesotho* are similarly arranged but one of the pair is usually half or more thinner than the other. I did find rare individuals of *A. sesotho* that had both setae of a particular macrosetal pair robust and similar to each other but this could be recognised as an aberration by its asymmetry: only the setal groups on one side of one or two urotergites would be so, not all. The second difference between the two species is in the length of the inner processes of the female coxites IX, which are as long as styli IX in *A. simulatrix* but usually only about two thirds their length in *A. sesotho*. Wygodzinsky described *A. simulatrix* and *A. sesotho* in the same paper but did not discuss the differences between them.

Mendes (1988) examined a female paratype of *A. simulatrix*, confirming the length of the inner processes of coxites IX. However, this specimen had lost most urotergal setae due to damage and he could not add any information on them, nor did Mendes then see any material of *A. sesotho*.

The holotype and most paratypes were collected with ants of the genus *Messor* Forel and this is assumed to be the main host. One type specimen was additionally stated to have been collected at the same locality and date but associated with the genus *Aphaenogaster* Mayr instead. The latter ants must have been misidentified because *Aphaenogaster* does not occur in South Africa.

Literature records: SOUTH AFRICA. 1939. Haarlem (type locality; *Messor* sp.) (Wygodzinsky 1955, Mendes 1988).

While processing material collected from *Messor* hosts during this study, a small number of specimens with stout infralateral urotergal macrosetae, or long female coxites IX, or both, were set aside for later study but the work was terminated before they could be investigated in any detail. A listing of the material follows but it is not necessarily the case that this sample is either homogeneous or representative of *A. simulatrix*. Also see the note on aberrant *A. szeptyckii* material below. The specimens have been mapped as *A.* cf. *simulatrix* in Figure 6. The geographical distance and climatological difference between the two northwestern localities and the main cluster in the southeast might be indicative of taxonomic differences between the two groups of samples as well.

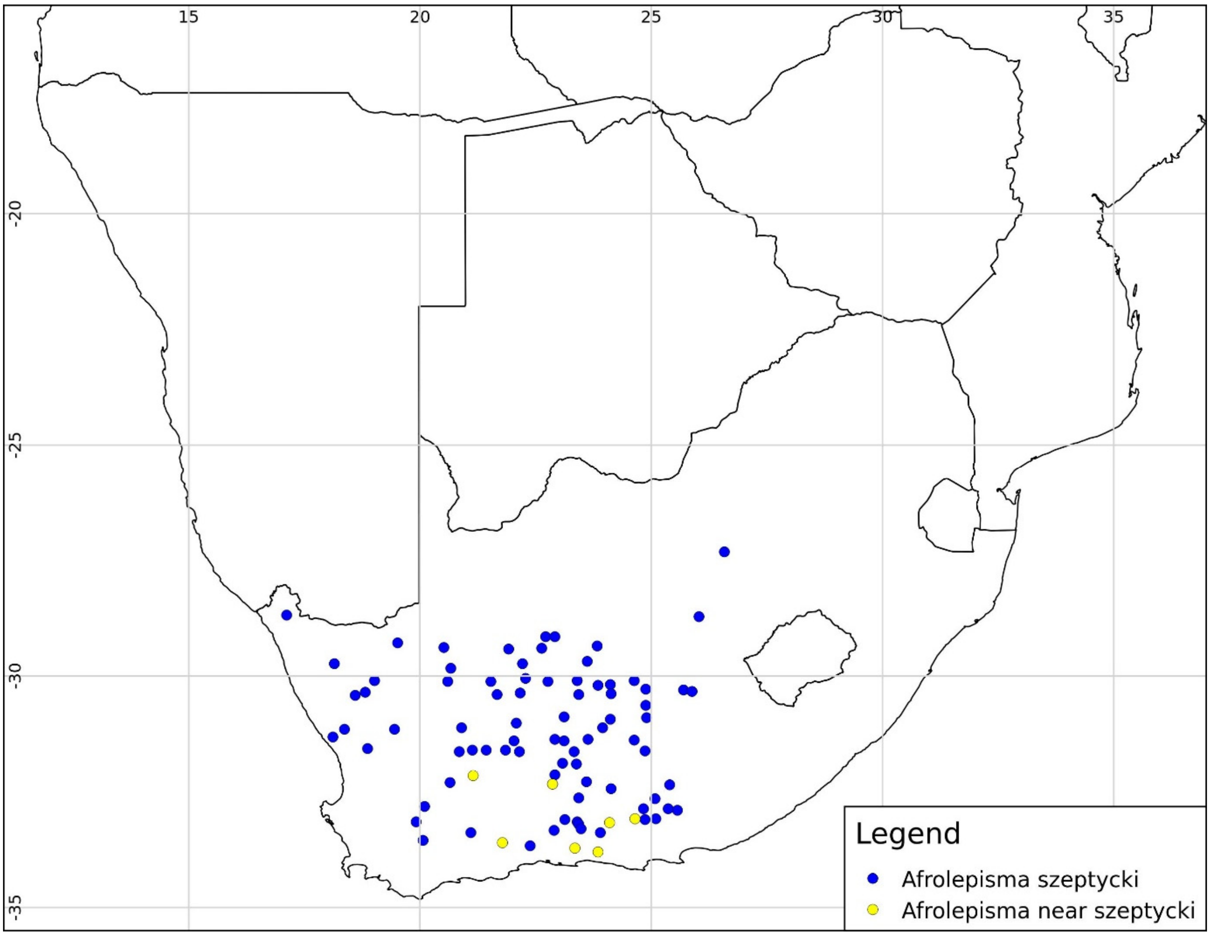

Figure 7: Distribution of Afrolepisma szeptyckii *and taxon similar to it.*

Material examined: 14 (9 females, 3 males, 2 unsexed); 14 BMSA. Also 38 hosts.
Localities: SOUTH AFRICA. 1557. Gifkop 166 (*Messor denticornis*). 1603. Gt. Rooiberg (*Messor capensis*). 1694. Kleindoornberg (*Messor denticornis*). 1763. Belmont (*Messor capensis*). 1765. Arcadia (*Messor capensis*). 1807. Whisky Nek (*Messor capensis*). 1817. Buffelsfontein (*Messor capensis*).

Afrolepisma szeptyckii (Mendes)

Asterolepisma (Afrolepisma) szeptyckii Mendes 1981: 274.
Afrolepisma szeptyckii (Mendes). Mendes 1988: 75; Irish 1994b: 467; Irish 1996a: 172

Besides the types, the species is only known from material collected during the current study. It is sparsely but widely distributed throughout the primary sampling area (Figure 7) and almost certainly occurs elsewhere in southern Africa as well but the study was interrupted before this could be established. In life they are dull black with a characteristic reddish tinge.

They are primarily myrmecophilous, having only once been found in a termite nest. They utilise a wide variety of ants (at least 17 species) but the main hosts are *Tetramorium* spp. (45% of records), *Camponotus* spp. (25%) and *Ocymyrmex* spp. (20%).
Literature records: 448. Streydom by Filipstown (type locality). (Mendes 1981a).
Also 4 localities in Irish (1994b) and 42 in Irish (1996a).

New material examined: 76 (16 females, 46 males, 14 unsexed); 59 BMSA, 1 SAMC, 2 SANC, 14 NMNW. Also 131 hosts.
Localities: SOUTH AFRICA. 1419. Black Hills (*Camponotus maculatus*). 1506. Witkoppies (*Ocymyrmex barbiger).* 1541. 20 mi. ex Springbok – Gamoep (*Baucaliotermes hainesi det.* W.G.H. Coaton, TM-11665). 1564. Nabaab (*Camponotus fulvopilosus*). 1588. Kassie se Pomp (*Camponotus maculatus*). 1595. Tweelingdam (*Camponotus fulvopilosus*). 1644. 2 km SE Nuwerus (*Ocymyrmex barbiger*). 1646. Perdeberg (deserted ant nest). 1657. Rooivlei (*Camponotus maculatus*). 1672. De Kamp (*Camponotus storeatus*). 1725. Riem (*Tetramorium* sp.). 1746. Sarelsrivier (*Tetramorium* sp.). 1748. 10 km N Sutherland (*Ocymyrmex* sp., det. H. Robertson, #C1108). 1752. Sunnyside (*Ocymyrmex barbiger*). 1754. Jakhalsfontein (*Ocymyrmex barbiger*). 1765. Arcadia (*Camponotus maculatus*). 1794. Doornhoek (*Tetramorium* sp.). 1799. Kafferskop (*Dolioponera*

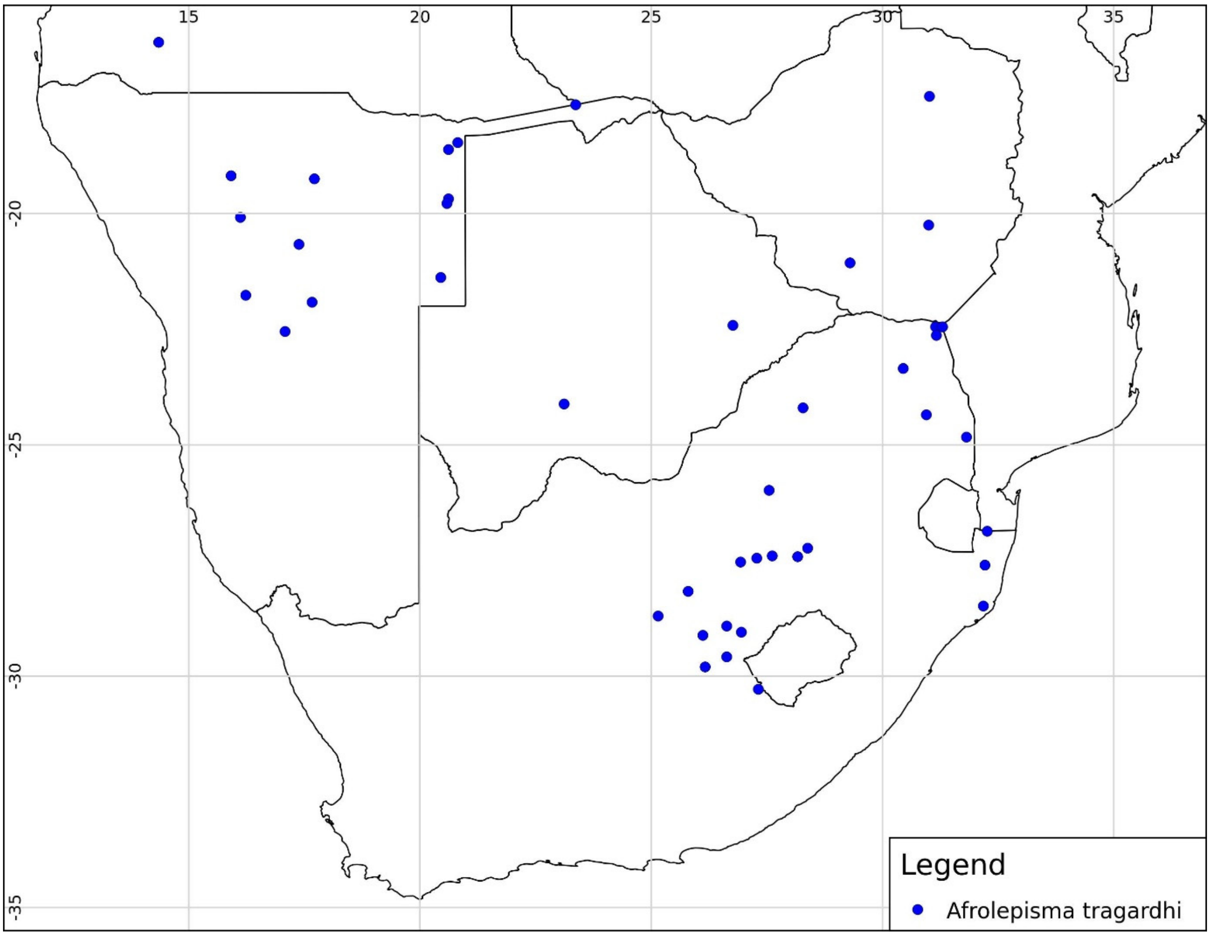

Figure 8: *Distribution of* Afrolepisma tragardhi.

sp.). 1814. Jukfontein (*Camponotus* sp.). 1825. Shamrock (*Tetramorium* sp.). 1826. The Ridges (*Camponotus maculatus*). 1836. Niekerksberg (*Camponotus maculatus*). 1851. Toekomst (*Messor denticornis*). 1854. Kareedam (*Tetramorium* sp.). 1855. Kalkfontein (*Tetramorium s*p.). 1864. Kolkiesrivier (*Camponotus* sp.). 1867. Brakfontein Farm (*Tetramorium signatum det.* H. Robertson, #C1311). 1871. Perdepoort (*Tetramorium* sp.). 1883. Willowmore (*Messor capensis, Pheidole* sp., det. H. Robertson, #C1120,1110). 1891. Spitskop (*Tetramorium* sp.). 1899. Beeskraal (*Tetramorium* sp.). 1900. Verekraal (*Tetramorium* sp.). 1917. Nougas (*Meranoplus peringueyi*). 1917. Nougas (*Rhoptomyrmex* sp.). 1932. Kromhoogte (*Tetramorium* sp.).

The above list excludes a number of anomalous specimens that will run to *A. szeptyckii* in the key above but differ in being relatively large, shiny pure black in colour and consistently found with *Messor* spp. only. In at least one case (locality 1752) both *A. szeptyckii* and anomalous specimens were found at the same locality, albeit with different hosts. The anomalous material is mapped in Figure 7 as '*Afrolepisma* near *szeptyckii'* and comes from a limited area in the southern Cape. They were also found near Haarlem, the type locality of *A. simulatrix*, and with the same host, but their relatively shorter urotergites X (as typical for *A. szeptyckii*) precludes them from being confused with the latter. Irish (1996a) had previously listed an unusually large individual of *A. szeptyckii* but that was not found with *Messor* spp. The study was terminated before these enigmatic specimens could be subjected to detailed study.

All material is in BMSA but numbers of specimens, or specific *Messor* species involved, were not recorded. SOUTH AFRICA. 1730. Seleryfontein. 1752. Sunnyside. 1850. Groenvlei. 1870. Aandrus. 1925. Badshoogte. 1936. Haarlem, 2 km NE. 1943. Joubertina, N.

Afrolepisma tragardhi (Silvestri)

Lepisma Trägårdhi Silvestri 1913: 8; Wygodzinsky 1955: 134.

Lepisma elegans, nec Escherich 1903. Silvestri 1908: 291, 1922: 85. Misidentified, see below.

Lepisma traegardhi Silvestri. Paclt 1966: 150.

Asterolepisma (Afrolepisma) trägardhi (Silvestri). Mendes 1981a: 208.

Afrolepisma traegardhi (Silvestri). Mendes 1988: 75; Irish 1994b: 468; Irish 1996b: 15.

A. tragardhi occurs throughout the Savanna Biome areas of southern Africa (Figure 8). It had previously been recorded from South Africa, Namibia, Botswana and Zimbabwe, and is here first recorded for Angola as well. It is relatively common where it occurs, and systematic sampling will probably show it to be more evenly distributed than current records suggest.

It is normally myrmecophilous and is most commonly found with ants of the subfamily Ponerinae (about 60% of host records) but has also been recorded with a small number of other ants, most of which are *Camponotus* spp. The current records continue the trend for consistent host preference within a given geographical area, previously noted by Irish (1994b), notably the cluster of *Megaponera analis* associated samples listed below. Geographically correlated host differences may imply that *A. tragardhi* is taxonomically more complex than currently understood but the study was interrupted before sufficient material to test this hypothesis was collected.

At dusk on 19 July 1995 I observed a colony of *Megaponera analis* ants near Ombazu in northwestern Namibia (-17.7828° S, 13.7772° E), moving to a new temporary nest site. For some time after the column had passed, individuals of what were probably *Afrolepisma tragardhi* (identification retrospectively based on host preference and general appearance; material no longer available) were seen following them. The ants could no longer be seen nor could the clicking sound they make be heard but the lepismatids followed their trail exactly, presumably by olfactory means. This observation agrees with that of a collector quoted by Wygodzinsky (1957) for *Afrolepisma leleupi* in Zambia, also with *Megaponera analis*, where 'The *Lepisma* were moving amongst the column apparently without fear and continued to follow the 50 feet route for some 10-12 minutes after the column of ants ended.'

The Lanner Gorge Cave (locality 1234) examples were not nidicolous but were collected associated with dry bat guano inside a cave as described by Braack (1989).

The species was named for Swedish entomologist Ivar Trägårdh (1878-1951). Similar to the case for *A. jagerskioldi* above, the emendation of *traegardhi*, as previously also used by myself, is therefore incorrect.

Literature records: SOUTH AFRICA. 1389. Umfolozi (type locality) (Silvestri 1913).
BOTSWANA. 549. Kang (as *Lepisma elegans*. Published as Kang but specimen labelled 'Kang-Kakir' [= 550. Kang-Khakhea]) (Silvestri 1908). [Specimens examined by Irish (1990) and identity confirmed as current species.]
NAMIBIA. 720. Tsumeb. 961. Paulinenhof. (Silvestri 1922, both as *Lepisma elegans*; re-examined as above);
SOUTH AFRICA. 1256. Leeu Pan. ZIMBABWE. 2012. Jessie, 5 mi. WNW West Nicholson. (Wygodzinsky 1955) (Mendes 1988).
NAMIBIA. 897. Farm Okosongomingo, Bez. Omaruru; 950. Windhoek (Paclt 1966) (Mendes 1988).
NAMIBIA. 601. Sifuma. 650. Kaudom-Cwiba junction. 666. Kaudom Game Reserve. 764. Tsumkwe, 10 km SE. 767. Gautscha Pan, 4 km N. (Irish 1996b).
Also 13 localities in Irish (1994b).

New material examined: 81 (34 females, 36 males, 11 unsexed); 27 KNP, 38 SAMC, 7 NMNW, 2 CAS, 2 ZMUH, 3 SANC, 1 FORC, 1 ZMHB.
Localities: ANGOLA. 540. 4 mi. SE of Cahama. BOTSWANA. 546. Swaneng Hill School. NAMIBIA. 716. Okaukuejo. 786. 2 mi. NW of Outjo. 844. Hamakari Süd 373. 884. Gemsboklaagte. 911. Otjihangweberg. SOUTH AFRICA. 1234. Lanner Gorge Cave. 1235. Pafuri (*Megaponera analis,* as *M. foetens,* det. L.E.O. Braack). 1236. Klopperfontein (*Megaponera analis,* as *M. foetens,* det. L.E.O. Braack). 1241. 10 km W Giyani (*Megaponera analis,* as *M. foetens,* det. H. Robertson, #C628). 1249. Boschdraai farm (*Camponotus* sp., det. H. Robertson, #C436). 1251. Hoedspruit (*Megaponera* sp. ex label). 1294. Magaliesburg (unspecified ponerines). 1316. Ndumu Game Reserve nr. Mvutsheni Pan (*Bothroponera kruegeri,* as *Pachycondyla krugeri,* det. H. Robertson, C890). 1339. Mkuze Game Reserve, below Mantuma (*Platythyrea arnoldi,* det. H. Robertson, C559). ZIMBABWE. 2006. Mazoe Estates (*Platythyrea ?cribrinodis*, det. H.G. Robertson, C785, C1105). 2006. Mazoe Estates (*Polyrhachis gagates*, det. H.G. Robertson, C861). 2011. Kyle View Chalets (*Platythyrea lamellosa,* det. H.G. Robertson, C 769).

Genus *Ctenolepisma* Escherich

Ctenolepisma Escherich 1905: 75.

Ctenolepisma activa Silvestri

Ctenolepisma activa Silvestri 1922: 82.
Ctenolepisma (Sceletolepisma) activa Silvestri. Irish 1987: 190, 1996b: 16.

The species is currently known only from central and northern Namibia (Figure 9), although it is likely to occur in adjacent territories as well.

Literature records: NAMIBIA. 887. Omaruru (type locality) (Silvestri 1922).
NAMIBIA. 730. Zebrapomp, Kaross. 748. 10 km N Kamandjab. 908. Owingi 246. 912. 1 km E Otjihangweberg. (Irish 1987).

Key to southern African Ctenolepisma *species.*

1. Median urosternal bristlecombs absent from all urosternites 2
- Median urosternal bristlecombs present on at least some urosternites 3
2. Urotergites II – VI with 3+3 bristlecombs; always anthrophophilic .... *C. longicaudata*
- Urotergites II – V, VI or VII with 3+3 bristlecombs; never anthropophilic .... three undescribed *Ctenolepisma* species, see below
3. Median bristlecombs present on four urosternites (II-V) 4
- Median bristlecombs present on five urosternites (II-VI) 5
- Median bristlecombs present on six urosternites (II-VII) 14
- Median bristlecombs present on seven urosternites (I-VII) 7
4. Adults with three pairs of styli; antennae and caudal filaments not annulated; currently known from Gauteng only .... *C. pretoriana*
- Adults with two pairs of styli; antennae and caudal filaments annulated; currently known from the Western Cape only .... *C. weberi*
5. Distal segment of labial palp with three sensory papillae only .... *C. africanella*
- Distal segment of labial palp with five sensory papillae 6
6. Urotergites II – VII with 3+3 bristlecombs .... *C. solitaria* sp. nov.
- Urotergites II – VI with 3+3 bristlecombs .... *Ctenolepisma* undescribed species near *pretoriana*
7. Urosternite II with one median bristlecomb 10
- Urosternite II with 1+1+1 bristlecombs 8
8. Urotergites II-V with 3+3 bristlecombs .... *C. pauliani*
- Urotergites II-VI with 3+3 bristlecombs 9
- Urotergites II-VII with 3+3 bristlecombs .... *C. ovsensis*
- Urotergites II-VIII with 3+3 bristlecombs .... *C. arenicola*
9. Inner processes of coxites IX short; adults of both sexes with one pair of styli only; thoracic sternal bristlecombs of 3-8 macrosetae each; northern Namibia .... *C. activa*
- Inner processes of coxites IX longer; adults with one or two pairs of styli; thoracic sternal bristlecombs of 3-16 macrosetae each; south western South Africa to southern Namibia .... *C. capensis*
10. Urotergites II-V with 3+3 bristlecombs .... *C. corvina*
- Urotergites II-VI with 3+3 bristlecombs 11
11. Urotergite I with 1+1 bristlecombs .... *C. desperata*
- Urotergite I with 2+2 bristlecombs 12
12. Females 13
- Males .... *C. namaquensis / karooensis* indet.
13. Female posterior gonapophyses sclerotised .... *C. karooensis*
- Female posterior gonapophyses unsclerotised .... *C. namaquensis*
14. Urosternite III with 1+1+1 bristlecombs 15
- Urosternite III with one median bristlecomb only .... *C. spinipes*
15. Urotergites II-V with 3+3 bristlecombs 16
- Urotergites II-VI with 3+3 bristlecombs 23
- Urotergites II-VII with 3+3 bristlecombs 35
- Urotergites II-VIII with 3+3 bristlecombs 21
16. Urotergite I with 1+1 bristlecombs only 17
- Urotergite I with 2+2 bristlecombs; coxites IX each with 2+2 transverse bristlecombs, in addition to fringe .... *C. namibensis*
17. Coxites IX with 1+1 transverse bristlecombs, in addition to fringe .... *C. lociplana*
- Coxites IX with marginal setal fringe only 18
18. Urotergite X posteriorly straight, rounded or only slightly emarginate; one or two pairs of styli 19
- Urotergite X very short and posteriorly deeply emarginate; adults with one pair of styli only .... *C. ossilitoralis*
19. Adults with two pairs of styli; female posterior gonapophyses apically sclerotised or unsclerotised. 20
- Adults with one pair of styli only; female posterior gonapophyses unsclerotised .... *C. subterebrans*
20. Tibia III robustly setated, with many (7+) ventral spines exceeding diameter of tibia in length; female posterior gonapophyses sclerotised .... *C. terebrans*
- Tibia III moderately to weakly setated, with at most 4-6 ventral spines, if any, attaining but not surpassing tibial diameter in length; female posterior gonapophyses unsclerotised .... *C. penrithae*

21. Urotergite I with 1+1 bristlecombs 22
- Urotergite I with 2+2 bristlecombs .... *Ctenolepisma* undescribed sp. near *parcespinata*
22. Female posterior gonapophyses sclerotised; Succulent Karoo habitats ....*C. parcespinata*
- Female posterior gonapophyses unsclerotised; Nama-Karoo and Savanna habitats.................................... *C. plusiochaeta*
23. Urotergite I with 1+1 bristlecombs 27
- Urotergite I with 2+2 bristlecombs... 24
24. 1+1 posterolateral thoracic notal bristlecombs present 25
- Posterolateral thoracic notal bristlecombs absent...*C. huabensis*
25. Females.. 26
- Males...*C. intercursa / prompta* indet.
26. Female posterior gonapophyses apically sclerotised .... *C. intercursa*
- Female posterior gonapophyses apically unsclerotised .... *C. prompta*
27. Coxites IX with transverse bristlecombs, in addition to marginal setal fringe...*C. placida*
- Coxites IX with marginal setal fringe only.. 28
28. Urotergite X short, width to length ratio less than 0.50 29
- Urotergite X of normal length, width to length ratio more than 0.50 30
29. Prosternum with 5-6 + 5-6 bristlecombs...*C. ugabensis*
- Prosternum with 2-3 + 2-3 bristlecombs .... *C. detritus*
30. Prosternum with 2-4 + 2-4 bristlecombs; mesosternum with at most 3+3 bristlecombs... 31
- Prosternum with 4-6 + 4-6 bristlecombs; mesosternum with at least 3+3 bristlecombs .... *C. occidentalis*
31. Female posterior gonapophyses sclerotised; tibia III with spines as long as or longer than tibial diameter in length.......
....*C. latera*
- Female posterior gonapophyses unsclerotised, at most narrowly hyaline; tibia III with spines shorter than tibial diameter in length.. 32
32. Median urosternal bristlecombs tending to be larger than lateral ones; posterolateral thoracic notal bristlecombs of 4-7 macrosetae each.. *C. saxeta*
- Lateral urosternal bristlecombs tending to be larger than median ones; posterolateral thoracic notal bristlecombs of 2-4 macrosetae each.. 33
33. Occurs in northern Namibia and southern Angola; metasternum with 1-2 + 1-2 bristlecombs 34
- Occurs in Northern Cape, South Africa; metasternum with 2-3 + 2-3 bristlecombs .... *C. boschimana*
34. Prosternal bristlecombs apical, proximal to each other..*C. inornata*
- Prosternal bristlecombs situated further apart .... *C. kaokoensis*
35. Coxites IX with marginal setal fringes only 37
- Coxites IX with 1-5 transverse bristlecombs each, in addition to a marginal fringe 36
36. Thoracic sterna with normal bristlecombs, in addition to marginal setal fringes... *C. luederitzi*
- Thoracic sterna with marginal setal fringes only..*C. psammophila*
37. Female posterior gonapophyses apically sclerotised; tibia III more robustly setated, with most ventral spines attaining or surpassing tibial diameter in length 38
- Female posterior gonapophyses apically unsclerotised; tibia III less robustly setated, with few, if any, ventral spines attaining but not surpassing tibial diameter in length 39
38. Female posterior gonapophyses apical sclerotised portion slender and parallel to shaft of ovipositor, moderately sclerotised, often hyaline; median urosternal bristlecombs of 3-5 macrosetae each .... *C. pluriseta*
- Female posterior gonapophyses apical sclerotised portion robust, heavily sclerotised and bent dorsad at an angle of about 45° to shaft of ovipositor; median urosternal bristlecombs of 5-12 macrosetae each .... *C. suliptera*
39. Urotergite I with 1+1 bristlecombs 40
- Urotergite I with 2+2 bristlecombs .... *C. orangica*
40. Most larger dorsal scales paucistriate; lifestyle myrmecophilous .... *C. messor*
- All larger dorsal scales multistriate; not myrmecophilous 41
41. Body elongate and parallel-sided, thorax not much wider than abdomen; relatively small (up to 10 mm body length); usually lightly pigmented; macrosetae yellowish brown or light brownish, never black; scales unicoloured, shades of brown or grey, never black; adults with two pairs of styli .... *C. grandipalpis*
- Not with the same combination of characters; thorax always distinctly wider than abdomen (i.e. the 'normal' shape for southern African *Ctenolepisma* spp.), outline of body not parallel-sided; large or small; lightly or heavily pigmented; macrosetae brownish or black; scale colour brownish or black, unicoloured or bicoloured; adults with one or two pairs of styli 42

42. Heavily pigmented; macrosetae black or very dark brown; scale cover mostly black or very dark brown 43
- Lightly ('normally') pigmented; macrosetae yellowish brown or light brownish; scale cover shades of brown, never dark brown; very large species, up to 19 mm body length, occurrence mainly around the Lower Orange River.......................... .... *Ctenolepisma* undescribed species near *grandipalpis* 1
43. Scale cover bicoloured, black and white (in fresh material at least); urotergite X about as wide as long; adults with one pair of styli; northeastern southern Africa .... *C. picturata*
- Scale cover unicoloured, shades of black or brown... 44
44. Small-bodied; urotergite X very short, about half as long as wide; number of styli not noted; southwestern southern Africa .... *Ctenolepisma* undescribed species near *grandipalpis 2*
- 'Normal'-sized; urotergite X of 'normal' proportions, about as wide as long; adults with two pairs of styli; northern southern Africa.. *Ctenolepisma* undescribed species near *grandipalpis 3*

Different subgeneric classifications have been proposed for *Ctenolepisma* by Wygodzinsky (1955), Irish (1987) and Kaplin (1993). In the light of the underlying data deficiency (see Irish 1994b), none have been used here.

NAMIBIA. 632. Nakatwa. 669. Leeupan (Irish 1996b).

New material examined: 10 (4 females, 5 males, 1 unsexed). 10 NMNW
Localities: NAMIBIA. 593. Onesi. 649. 19 km ESE Omupanda. 844. Hamakari Süd 373. 866. Weissenfels 35.

Ctenolepisma africanella Wygodzinsky

Ctenolepisma africanella Wygodzinsky 1955: 146.
Ctenolepisma (Sceletolepisma) africanella Wygodzinsky. Irish 1987: 154.

A species of the Fynbos Biome (Figure 9). The apparent disjunction between populations in the Western and Eastern Cape is probably an artefact related to the incomplete processing of material collected for this study.

It is a small-bodied species, with a characteristically flat body, usually heavily pigmented. The macrosetae are dark brown to black. The short urotergite X and the 3 sensillae on the distal labial palp are distinctive. Most specimens were from detritus-rich microhabitats, typically among dead leaves, or under stones among dead leaves.
Literature records: SOUTH AFRICA. 1927. Bainskloof. 1973. Viljoenspas (type locality) (Wygodzinsky 1955).
SOUTH AFRICA. 1885. Grahamstad. 1997. Bushy Park (Irish 1987).

New material examined: 23 (11 females, 11 males, 1 unsexed); 17 BMSA, 5 TMSA, 1 SAMC.
Localities: SOUTH AFRICA. 1848. Langebaan. 1875. 8 km N Yzerfontein. 1929. Congoskraal. 1934. Cornville. 1940. The Downs. 1952. Van Stadens Nat. Res. 1962. Vanstadensmond. 1980. Botrivier, 6 km S. 1986. Mosselberg, Fernkloof Nat. Res. 1999. Struisbaai.

Ctenolepisma arenicola Wygodzinsky

Ctenolepisma (Sceletolepisma) arenicola Wygodzinsky 1955: 154; Irish 1987: 193.

A marine littoral species that has only been found under driftwood on beaches along the northern Namibian coast (Figure 9). It has not yet been recorded from Angola but may occur. Towards the south the known records stop abruptly at the Ugab River, a fact possibly attributable to the change in beach utilisation at the Ugab River: none in the wilderness conservation area to the north but progressively heavier recreational beach use further south. The single isolated record from further south is again located in a wilderness conservation area.

Literature records: NAMIBIA. 696. Rocky Point (type locality) (Wygodzinsky 1955).
NAMIBIA. 565. Kunene River Mouth (South bank). 570. 7 km N Bosluisbaai. 571. Bosluisbaai. 585. Bosluisbaai, 12 km S. 633. 10 km NNW Angra Fria. 645. Cape Fria. 789. 18 km SSE Terrace Bay. 808. Torra Bay. 853. Toscanini. 865. Ambrose Bay. 875. Ugab River Mouth. 1018. Edvard Bohlen wreck (Irish 1987).

New material examined: 307 (130 females, 135 males, 42 unsexed). 307 (NMNW).
Localities: NAMIBIA. 567. Skeleton Coast Park. 569. Skeleton Coast Park. 583. Skeleton Coast Park. 589. Skeleton Coast Park. 605. Skeleton Coast Park. 609. Skeleton Coast Park. 626. Wreck of Kya Maru. 628. Wreck of Kya Maru. 646. Cape Fria. 651. Skeleton Coast Park. 662. Skeleton Coast Park. 675. Skeleton Coast Park. 689. Skeleton Coast Park. 697. Rocky Point. 708. Hoarusib River Mouth. 739. Hoanib River Mouth. 758. Skeleton Coast Park. 775. Skeleton Coast Park. 784. Terrace Bay. 809. Torra Bay. 827. Koigab River Mouth. 850. Toscanini Bay. 874. Ugab River Mouth.

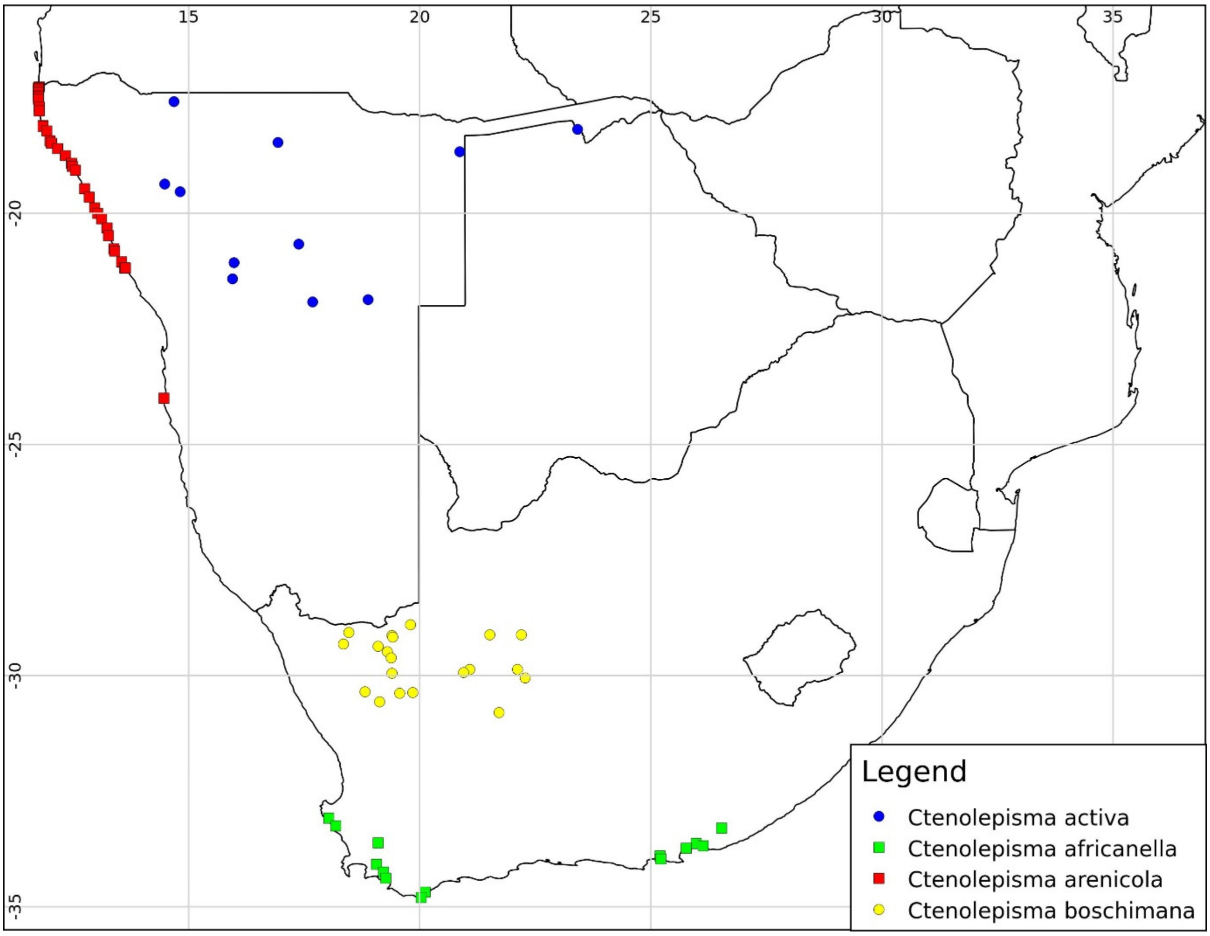

Figure 9: *Distribution of* Ctenolepisma activa*,* C. africanella*,* C. arenicola *and* C. boschimana.

Ctenolepisma boschimana Irish

Ctenolepisma (Sceletolepisma) boschimana Irish 1996a: 186.
Ctenolepisma prompta Wygodzinsky 1955: 142. Misidentified.

The species is only known from the Bushmanland region of northwestern South Africa (Figure 9). It has not yet been recorded from adjacent Namibia but might occur there as well.

Literature records (as *C. prompta*): SOUTH AFRICA. 1456. 30 mi. NE Pofadder. 1483. Pofadder. (Wygodzinsky 1955). Irish (1987) had already established that the above material did not belong to *C. prompta* but possibly to an undescribed species; the latter has since been described as *C. boschimana*. Also 7 localities in Irish (1996a).

New material examined: 43 (18 females, 23 males, 2 unsexed); 40 BMSA, 3 NMNW.
Localities: SOUTH AFRICA. 1480. Apoolskop. 1489. 4 km S Pofadder. 1511. Dikkop. 1515. N Wolfkop. 1522. Luttigshoop. 1529. Heuningvlei. 1557. Gifkop 166. 1588. Kassie se Pomp. 1591. Uilklip. 1593. 69 km N Loeriesfontein. 1599. Springbokkeel.

Ctenolepisma capensis Irish

Ctenolepisma (Sceletolepisma) capensis Irish 1987: 192, 1996a: 173.

As currently known, the species is mainly confined to the Succulent Karoo Biome but patchily distributed there, with isolated occurrences further east (Figure 10). It might also occur in the Southern Cape (sampling area 4) but that material was not processed to the point that would have revealed this. It is here first recorded for far southern Namibia.

Literature records: SOUTH AFRICA. 1492. Kleinduin. 1500. 10 km W Anenouspas. 1840. Jacobsbaai (type locality) (Irish 1987).
Also 3 localities in Irish (1996a).

New material examined: 100 (55 females, 39 males, 6 unsexed); 72 BMSA, 25 NMNW, 3 SAMC.
Localities: NAMIBIA. 1227. Luginsland 124. SOUTH AFRICA. 1365. 2 km S Wallekraal Mine. 1499. Windpoort. 1527. Wolfberg. 1531. 2 km NE Grootmis. 1593. 69 km N Loeriesfontein. 1613.

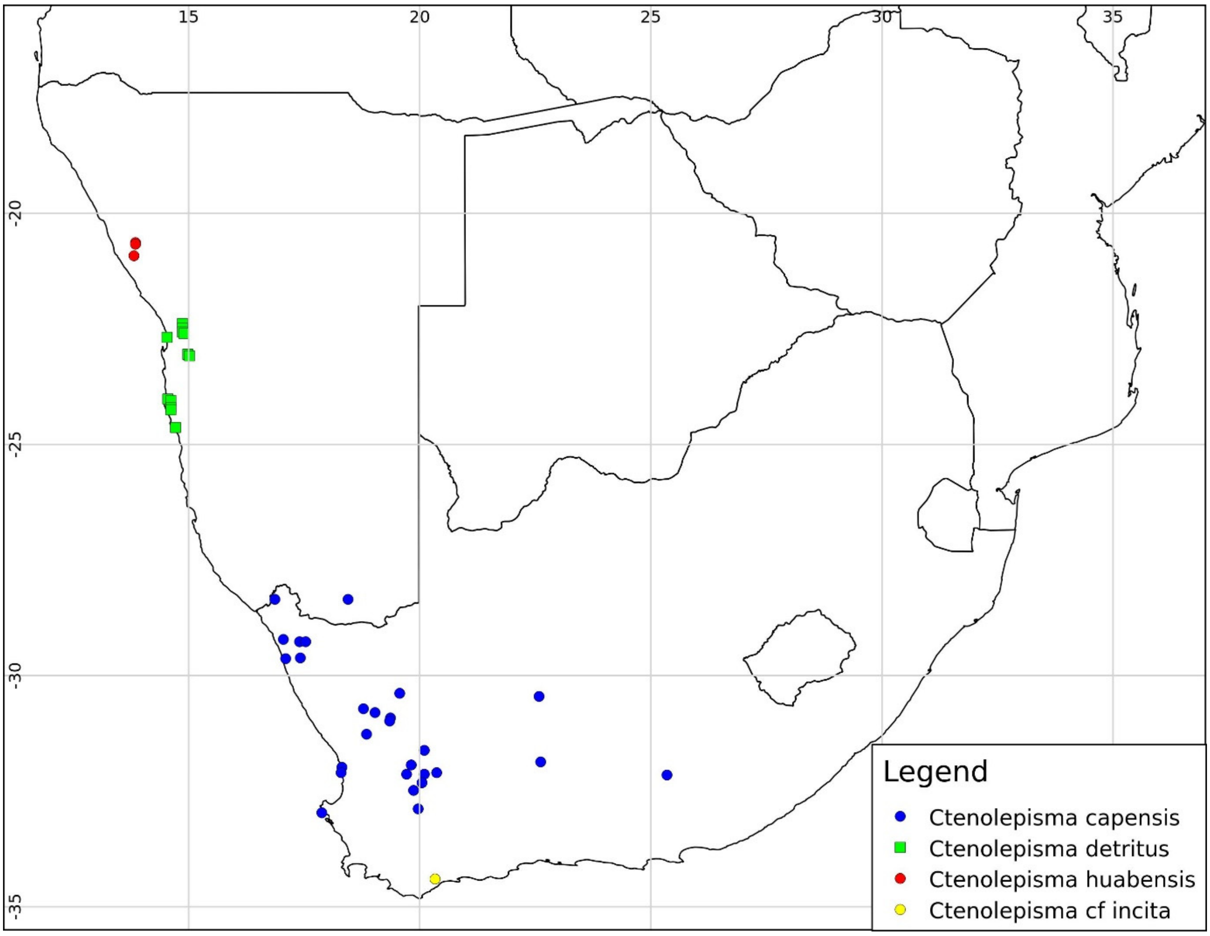

Figure 10: *Distribution of* Ctenolepisma capensis*,* C. detritus*,* C. huabensis *and* C. *cf.* incita.

Kokerboomkraal. 1621. Roelf se Berg. 1633. 10 km NW Loeriesfontein. 1636. Kamdanie. 1654. NE Saggiesberg. 1699. Sandkop. 1702. Seweputs. 1713. Lamberts Bay. 1714. Kompromis. 1722. Van Wyksvlei. 1723. Ganagapas. 1732. Kaalplaats. 1750. Langrug. 1773. Jakkalskop. 1828. Klein Hangklip.

Ctenolepisma corvina Silvestri

Ctenolepisma corvina Silvestri 1908: 293.
Ctenolepisma (Sceletolepisma) corvina Silvestri. Irish 1987: 195.

A seldom encountered species that is confined to a limited northern part of the Succulent Karoo Biome (Figure 11). In life they have a characteristic black scale covering; the species name, based on Latin *corvus*, raven, probably alludes to this.

C. corvina is myrmecophilous. One sample listed below was found with *Tetramorium* ants. One of the samples from Irish (1987) was also found with ants but at that time the association was regarded as incidental and the ants were not identified. All other known material is either from pit traps or carried no collecting information.

The species had also been recorded from far northwestern Namibia (631. Orupembe) by Wygodzinsky (1955): 139. The specimen was examined by Irish (1987) and found not to belong to *C. corvina* and to be indeterminate otherwise. Nothing similar has since been found in the same area.

Literature records: SOUTH AFRICA. 1501. Steinkopf (type locality) (Silvestri 1908). NAMIBIA. 1147. Agub Mt. SW. SOUTH AFRICA. 1505. Anenous Pass, S side (Irish 1987).

New material examined: 16 (7 females, 9 males); 14 BMSA, 1 SAMC, 1 GRSW (also 12 hosts).
Localities: SOUTH AFRICA. 1367. Hottentotsparadys (*Tetramorium* sp.). 1491. Muisvlak. 1498. Port Nolloth.

Ctenolepisma desperata Irish

Ctenolepisma (Sceletolepisma) desperata Irish 1987: 197.

A species of the Succulent Karoo Biome, currently known from a limited part of northwestern South Africa only (Figure 12).

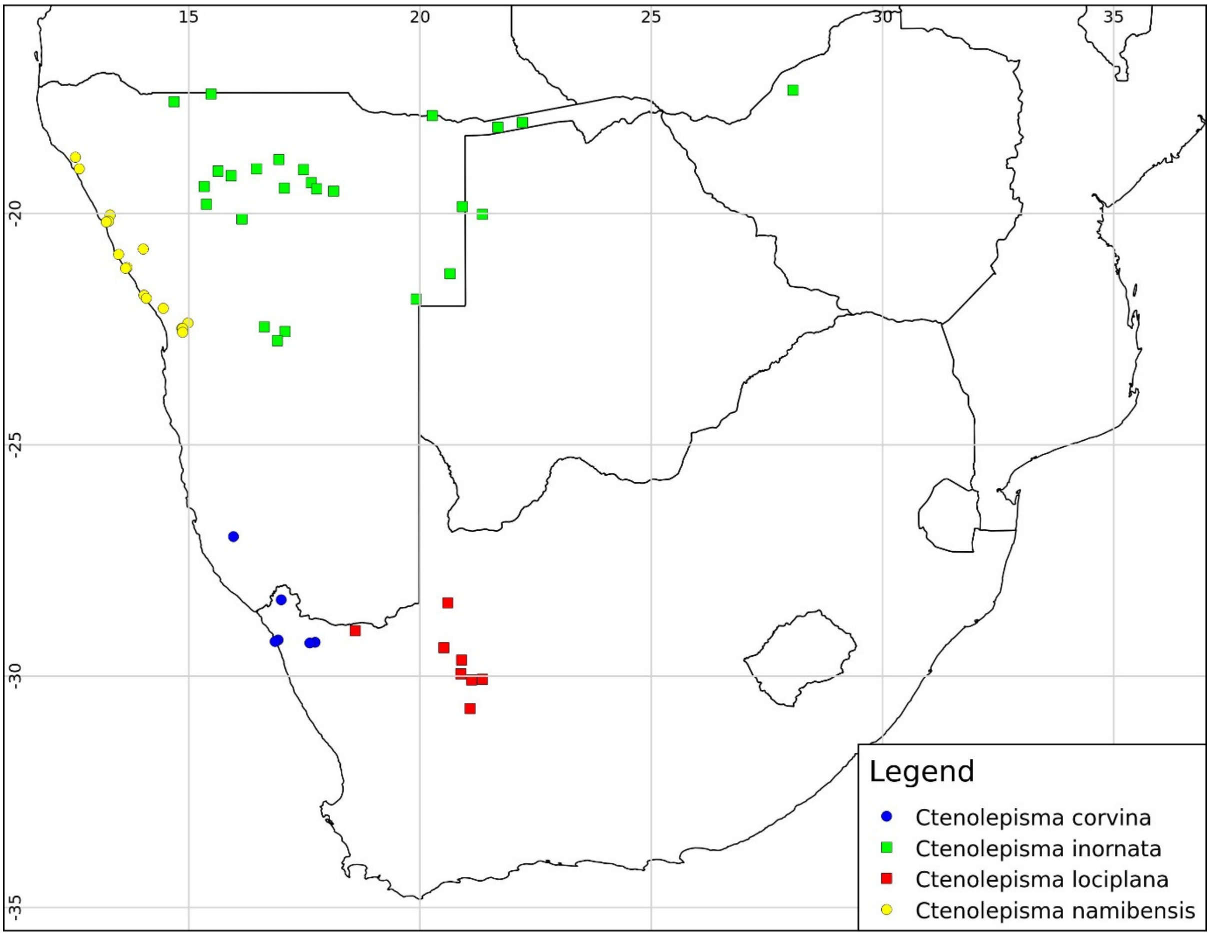

Figure 11: *Distribution of* Ctenolepisma corvina*,* C. inornata*,* C. lociplana *and* C. namibensis*.*

Literature records: SOUTH AFRICA. 1492. Kleinduin. 1495. Farquarson. 1505. Anenous Pass, S side (Irish 1987).
New material examined: 19 (6 females, 12 males, 1 unsexed); 18 BMSA, 1 NMNW.
Localities: SOUTH AFRICA. 1455. Swartduinkop. 1478. SW Henkries. 1487. Geselskapbank. 1489. 4 km S Pofadder. 1496. Gamsberg Site D. 1544. Dabeep. 1553. 10 km E Gamoep. 1595. Tweelingdam.

Ctenolepisma detritus Irish

Ctenolepisma (Sceletolepisma) detritus Irish 1987: 167.

The species is known from a limited part of the Central Namib Desert only, with an isolated subpopulation further south in the Meob-Conception area (Figure 10). In both areas it lives in the leaf detritus that accumulates under perennial shrubs on gravel plains but is absent from the intervening vegetationless dune habitat.

Literature records: NAMIBIA. 933. Swakopmund District. 944. Swakopmund District. 952. Swakopmund District. 957. Swakopmund District. 974. Vogelfederberg. 1022. Diamond Area II. 1026. Diamond Area II. 1035. Fischersbrunn. (Irish 1987).

New material examined: 10 (4 females, 6 males); 8 NMNW, 2 GRSW.
Localities: NAMIBIA. 935. Arandis area. 945. Upper Ostrich Gorge. 947. Lower Ostrich Gorge. 963. Swakopmund, riverbed. 977. Gobabeb, 52.4 km N. 1020. Conception Water. 1025. Charlottenfelder.

Ctenolepisma grandipalpis and cf. *grandipalpis* Escherich

Ctenolepisma grandipalpis Escherich 1905: 85; Silvestri 1913: 11; Wygodzinsky 1955: 148.
Ctenolepisma laticauda Silvestri 1922: 79; Mendes 1982:645. Re-assessment needed.
Ctenolepisma (Sceletolepisma) grandipalpis Escherich. Irish 1987: 188, 1994b: 469, 1996a: 174, 1996b: 16.

Ctenolepisma grandipalpis s.l. is one of the most widespread Lepismatidae species in southern Africa and has also been recorded from East Africa (Figure 13). It is recorded here for the first time from both Angola and Botswana. Its ubiquitousness has masked the sympatric existence of a few similar but subtly different species in some parts of its range. The latter only became apparent once abundant

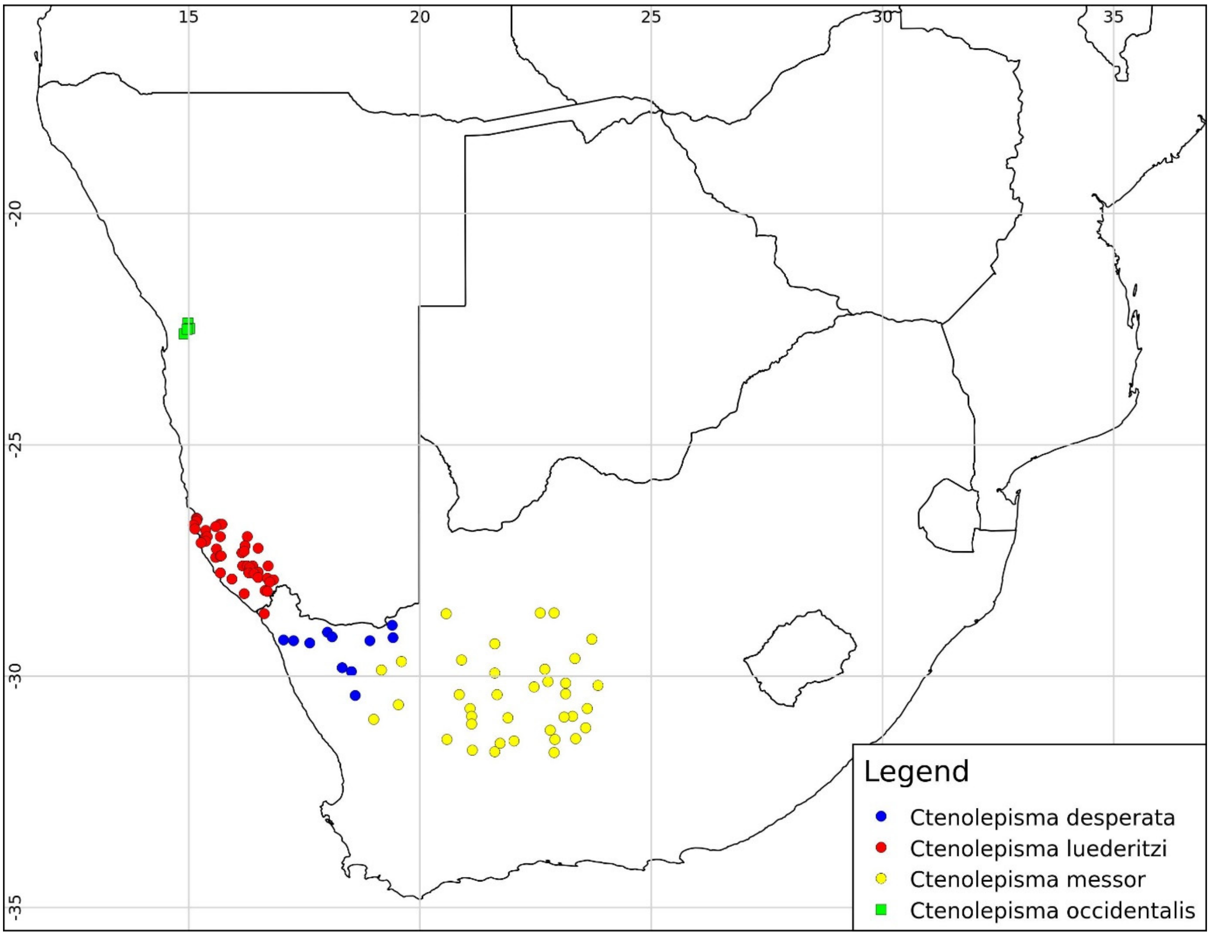

Figure 12: *Distribution of* Ctenolepisma desperata*,* C. luederitzi*,* C. messor *and* C. occidentalis*.*

systematically sampled material (Irish 1994b, 1996a) became available. *C. messor* was the first such species to be described. At least two and possibly three more potential species had been identified when this study was terminated.

Typical *C. grandipalpis* is relatively small (maximum about 10 mm body length), very slender ('parallel-sided', as originally described), with yellowish brown to brown macrosetae and brownish scales, with no or only light pigment. The slender shape is reminiscent of most juvenile *Ctenolepisma* spp. and their concurrent small size led me to believe (Irish 1987) that the types of *C. grandipalpis* were subadult. The subsequent systematically sampled material from Irish (1994b, 1996a), as well as the material listed below from the southern and eastern Cape, whence *C. grandipalpis* was originally described, showed that *C. grandipalpis* is indeed consistently a small and parallel-sided species. The larger, wider-bodied specimens on which the redescription of *C. grandipalpis* in Irish (1987) was based were only encountered in the far northwest of the systematically sampled area and are evidently a different species. It and two other potential undescribed species are further discussed below.

I list here everything that had been identified as *C. grandipalpis* over the course of this study but besides the Escherichian types, I can only be certain that the material treated in Irish (1994b, 1996a) is indeed *C. grandipalpis s.s.* There is a reasonable expectation that most material listed below from the southern Cape will also be so. Everything else is best called 'cf. *grandipalpis'* at this time and needs to be re-assessed. The status of *C. laticauda*, previously synonymised with *C. grandipalpis*, also needs to be re-examined in this context.

C. grandipalpis is not nidicolous. Both Silvestri (1913) and Wygodzinsky (1970) recorded them with termites, the latter in an abandoned *Trinervitermes* mound. I myself found two in a nest of *Trinervitermes trinervoides* at Alkmar (locality 906) in 1982. At the time *Ctenolepisma* species were not considered to ever be nidicolous and I treated their presence in the nest as incidental. With the wisdom of hindsight, it seems possible that there is an undescribed termitophilous species resembling *C. grandipalpis,* living in *Trinervitermes* mounds.

Literature records: SOUTH AFRICA. 1874. Matjesfontein. 1881. Willowmore. 1912. Ladismith. 1963. Port Elizabeth. 0000. 'Klipfontein' (ambiguous

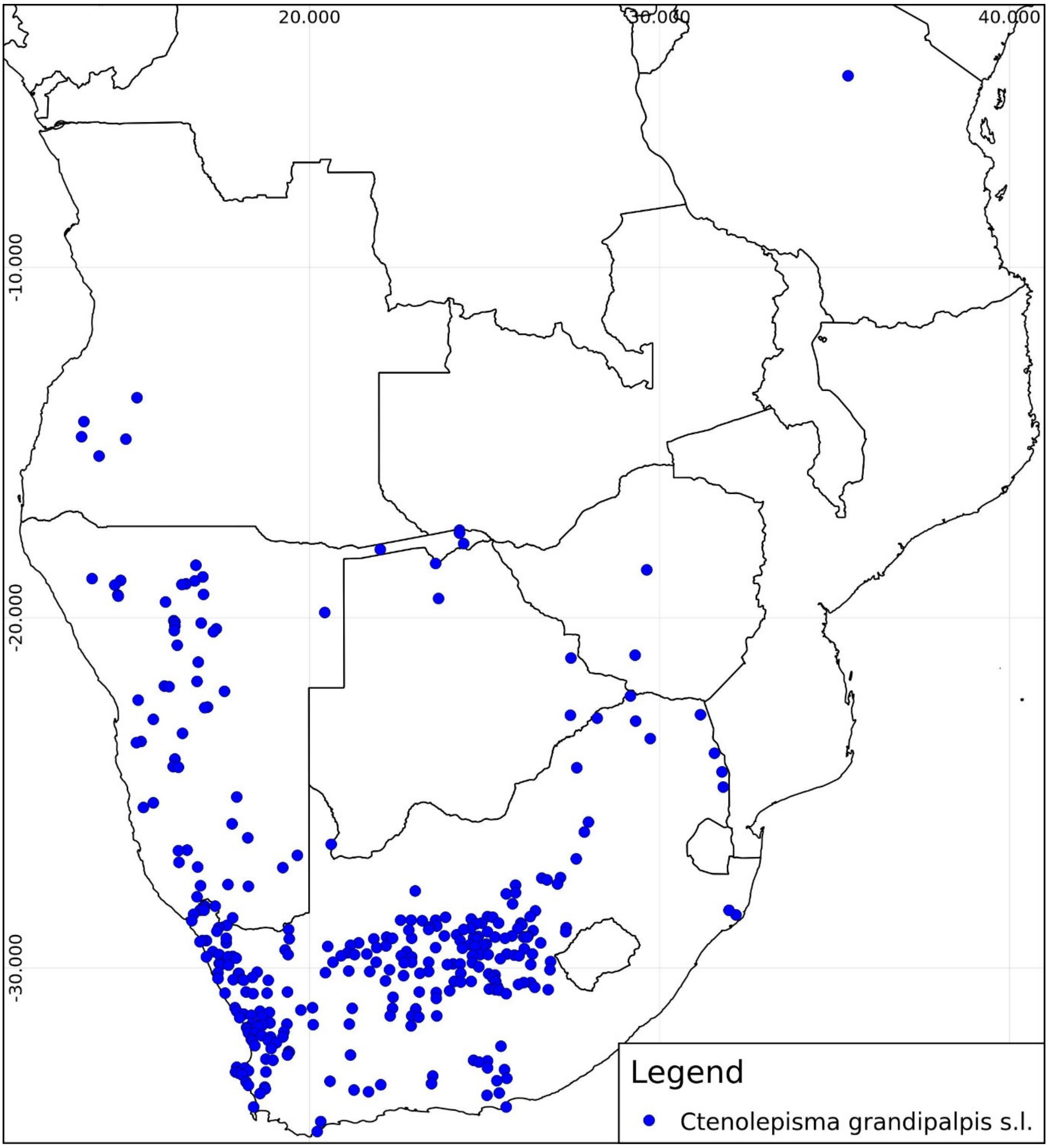

Figure 13: *Distribution of* Ctenolepisma grandipalpis *and cf.* grandipalpis*.*

locality, untraced but probably in Western Cape) (Escherich 1905).

SOUTH AFRICA. 1370. Junction White & Black Umfolozi Rivers (unspecified termites). 1389. Umfolozi. (Silvestri 1913).
NAMIBIA. 914. Karibib. 950. Windhuk (both as *C. laticauda*) (Silvestri 1922).
SOUTH AFRICA. 442. De Aar. 1244. Letaba Camp. 1252. Satara Camp. 1256. Leeu Pan. 1310. Tweede Rivieren. 1720. Pakhuis Pass, eastern part. 1791. Grey's Pass. 1890. Platberg, Swartbergpas. 1902. Malmesbury, 5 mi. N. 1909. Malmesbury. 1958. Echo Valley, Table Mountain. 1987. Bredasdorp, 20 mi. ENE. 1995. Arniston. ZIMBABWE. 2008. Drechin, near Cricket. 2012. Jessie, 5 mi. WNW West Nicholson. (Wygodzinsky 1955).
TANZANIA. 2014. Katesh. (Wygodzinsky 1965).
SOUTH AFRICA. 1463. 47 mi. ex Groblershoop to Griekwastad (with *Promirotermes*, in derelict *Trinervitermes* mound) (Wygodzinsky 1970).
NAMIBIA. 996. 6 km NW Gobabeb (as *C. laticauda*) (Mendes 1982).
NAMIBIA. 700. Halali-koppie. 749. Afguns 447. 795. Omarassa 4. 804. Teufelsburg 153. 817. Ombindi Karambi 155. 852. Lehmpütz 76. 916. Fr iedrichsfelde. 922. Onganja East 190. 928. 4 km S Trekkopje. 951. Windhoek. 1002. Kuiseb River.

1084. Brukkaros. 1117. Plateau 38. 1132. Aroab. 1161. Warmfontein 280. 1188. Hobas 374. SOUTH AFRICA. 1237. Dzundwini. 1355. Maerpoort (referred to undescribed sp. 1 below). 1356. Numeesmyn. 1386. Brandkaross. 1412. 13 km SSW Grootderm. 1429. Vioolsdrif. 1492. Kleinduin. 1505. Anenous Pass, S side. 1533. Springbok Modderfontein. 1535. Schaaprivier. 1536. Spektakelberg. 1579. Graskom. 1587. 8 km SE Leliefontein. 1653. Flaminksvlakte. 1685. Wiedou. 1781. Het Kruis. 1837. Brackfontein Farm. 1840. Jacobsbaai. 1845. 4 km NE Langebaan. 1892. Cape Town, 65 km N. 1914. Calitzdorp. 1921. Melkbos to Malmesbury. 1996. Arniston. (Irish 1987).
NAMIBIA. 588. Katima Mulilo. 594. 10 km S Katima Mulilo. 615. Lake Liambezi. 623. 21 km W Omega. 648. Nkasa Island. 773. Tse-Baraka. (Irish 1996b).
Also 58 localities in Irish (1994b) and 57 in Irish (1996a).

New material examined: 493 (206 females, 229 males, 58 unsexed); 288 BMSA, 137 NMNW, 45 TMSA, 18 CAS, 4 GRSW, 1 MMKZ.
Localities: ANGOLA. 531. 2 mi. N Caconda. 532. 32 mi. NE of Vila Arriaga. 534. 5 mi. N Sa da Bandeira. 536. 23 mi. W Vila Folgares. 537. 24 mi. SE of Chibia. BOTSWANA. 542. 5 km SE Moremi S Gate. 545. 5 km NW Francistown. 548. 50 km SE Palapye. NAMIBIA. 653. Andoni. 683. Bloubokdraai. 686. Otjomatemba. 690. Onauatinda. 704. Rietfontein, Etosha N.P. 711. Klippan. 724. Aikab, Etosha Nat. Park. 727. Kaross. 728. Kaross. 786. 2 mi. NW of Outjo. 790. Outjo. 811. Waterberg Plateau Park. 821. Waterberg Plateau Park. 878. Otjiku 192. 900. 15 mi. NW Okahandja. 906. Alkmar 512. 954. Windhoek, Eros Mt. 970. Namib Park Border. 991. Farm Hohenheim. 1021. Zais 6. 1027. Tsams Ost 2. 1028. Naukluft. 1052. Tafelkop. 1067. Guinasibberg. 1074. Hauchab Mt. 1102. Khabus 146. 1122. 1 km NW Aus. 1148. Nieu-Tsaus 1160. 1160. Rooiberg 70. 1191. Kolke 84. 1209. Grabwasser 261. 1211. 2 km ESE Rosh Pinah. 1223. 2 km W Grootpenseiland. 1230. 18 mi. N of Vools Drift. SOUTH AFRICA. 57. Theronsdrif. 1233. Pontdrif. 1238. Swartwater. 1239. Blinkpan Saltworks. 1242. Dwarsrivier. 1250. Tweeloopfontein. 1286. Hennopsrivier. 1300. Roodepoort. 1345. Sishen Mine Area. 1354. Kodaspiek. 1363. Tatasberg, W foot. 1365. 2 km S Wallekraal Mine. 1366. 2 km S Helskloof (West). 1367. Hottentotsparadys. 1379. Haakiesdoorn. 1383. Rosyntjieberg. 1393. Avondson. 1400. Nooitgedacht 66. 1403. Jakkalsputs. 1408. Poufontein. 1409. Eureka. 1410. Kleinbegin. 1415. Merino. 1424. Kimberley. 1433. 7 km W Campbell. 1438. 14 km E Griekwastad. 1439. N Klipbok. 1446. Driekoppies. 1455. Swartduinkop. 1460. Koekais. 1461. Duikersput. 1462. Baviaanskop. 1468. Ratelfontein. 1471. S of Goodhouse. 1485. Vlieholteberg. 1489. 4 km S Pofadder. 1491. Muisvlak. 1494. Augrabies. 1497. Port Nolloth. 1499. Windpoort. 1522. Luttigshoop. 1523. Tnong-Gys. 1527. Wolfberg. 1529. Heuningvlei. 1539. S of Springbok. 1548. Witduin. 1554. Kourkamma. 1555. Buffels R. 1567. Stofkraal. 1569. Noos. 1570. Sneeukop. 1571. Dassiefontein. 1578. Kap-Kap. 1583. Tierkop. 1584. 1 km S Leliefontein. 1588. Kassie se Pomp. 1601. Rietfontein Poort. 1604. Vogelfontein 71. 1606. Rooikop. 1608. Agteroorberg. 1609. Vaalkop. 1612. Rietkop. 1614. Kokerboomkraal. 1615. Stofkraal. 1617. Groenfontein. 1642. S Katdoringvlei. 1649. 5 km NE Windkraal. 1652. Brakfontein. 1654. NE Saggiesberg. 1657. Rooivlei. 1658. Potklei. 1666. Rooiberg. 1667. SE Baievlei. 1672. De Kamp. 1673. 3 km SE Lutzville. 1674. Augustfontein. 1679. Gipsmyn. 1681. 20 km W Vredendal. 1683. Papendorp. 1689. Botterkloofpas. 1692. S Doringbaai. 1695. Vaalvlei. 1698. Skurfkop. 1700. Kraaibosberg. 1701. Doorn Bosch 19. 1704. Nortier farm. 1707. 8 mi. NW Clanwilliam. 1709. Kookfontein. 1740. Middelpos. 1743. Mountain Zebra National Park. 1747. 11 mi. S of Clanwilliam. 1758. Cederberg, E track. 1761. Cederberg, E track. 1767. Cederberg, E track. 1772. Cederberg, E track. 1774. Karelskraalpas. 1796. Quimby Holme. 1799. Kafferskop. 1803. 8 km NW Ebenezer. 1815. Besters Kraal 38. 1818. Oliphants Kraal 61. 1821. Westondale. 1836. Niekerksberg. 1842. Berg Rivier 4 mi. S of Picketberg. 1844. Blouwaterbaai. 1849. Wind Heuvel 77. 1868. Wapadskloof. 1872. Crown Hill. 1873. Abrahamskraal farm. 1875. 8 km N Yzerfontein. 1883. Willowmore. 1920. 20 km N Uitenhage. 1928. Sutton Vale.

Ctenolepisma undescribed species near *grandipalpis* 1

Ctenolepisma (Sceletolepisma) grandipalpis Irish 1987: 188 *nec* Escherich 1905.

Very large, possibly the largest *Ctenolepisma* species known. A female from Kristalberge (locality 1453) at 19 mm and a male from Maerpoort (locality 1355) at 17 mm body length are the two largest southern African *Ctenolepisma* specimens I have seen. The Maerpoort male was one of the specimens on which the *C. grandipalpis* redescription in Irish (1987) was based. They have been mainly found under stones and dive into the sand under the stone when the stone is lifted (*C. grandipalpis* does not sanddive). The scale pattern resembles that of *C. terebrans:* with bold yellowish cross lines, where typical *C. grandipalpis* is unicolorous and drab. The median urosternal bristlecombs, especially anteriorly, are unusually wide.

Specimens from the following localities were set aside for later study as possibly belonging to this taxon and they are mapped in Figure 14. Most are in the north west of the systematically sampled area, in the region of the Lower Orange River valley.

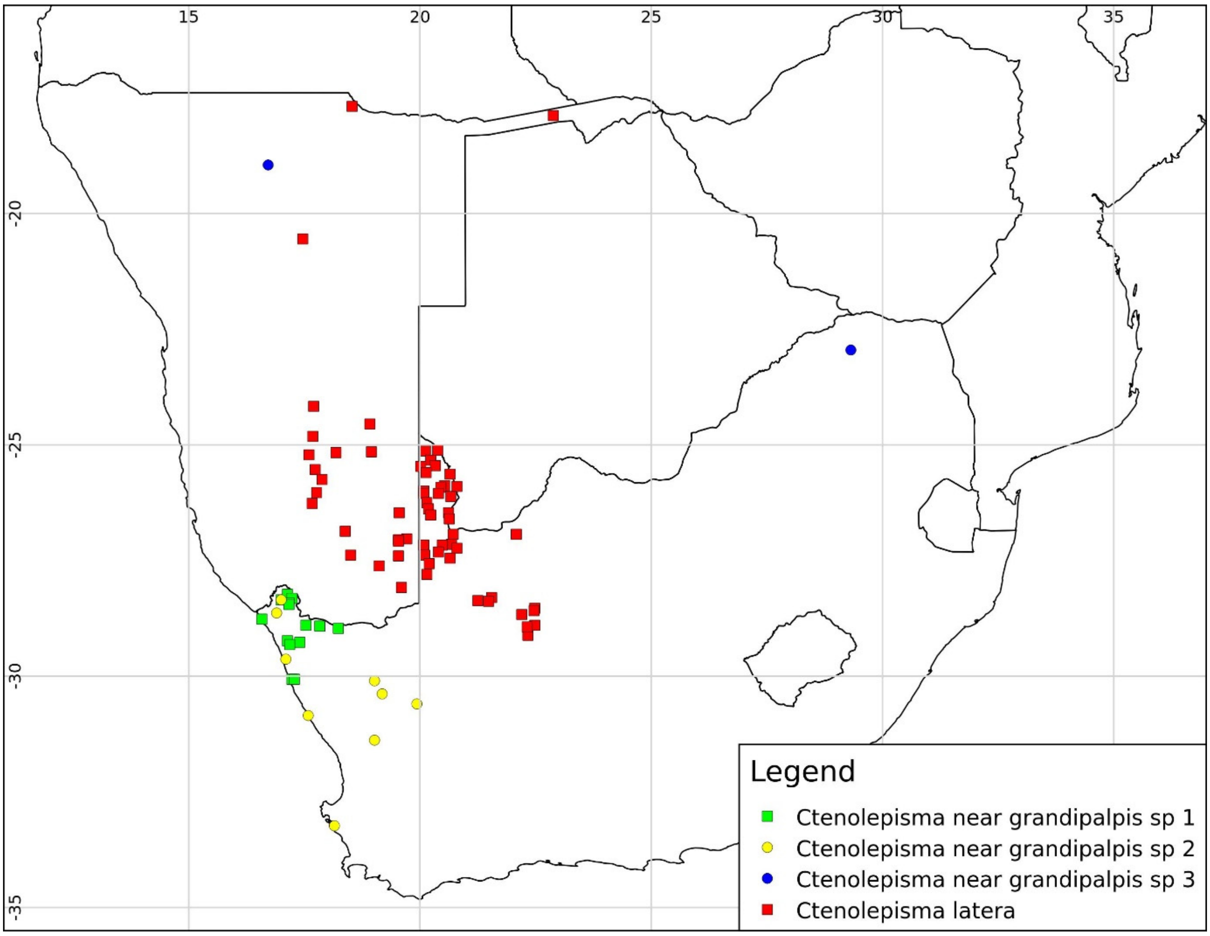

Figure 14: *Distribution of three undescribed species near* Ctenolepisma grandipalpis*, as well as* C. latera*.*

Localities: SOUTH AFRICA. 1355. Maerpoort. 1363. Tatasberg, W foot. 1367. Hottentotsparadys. 1379. Haakiesdoorn. 1383. Rosyntjieberg. 1425. Boegoeberg-Suid. 1453. Kristalberge. 1462. Baviaanskop. 1471. S of Goodhouse. 1499. Windpoort. 1510. SW Abbevlak. 1560. Geelduine. 1561. Heidons.

Ctenolepisma undescribed species near *grandipalpis* 2

Small-bodied specimens with urotergites X that are distinctly shorter than usual for *C. grandipalpis*, heavier than usual pigmentation and black macrosetae. They were collected in detritus-rich microhabitats, usually on deep sand or dunes, and they probably represent an undescribed species as well.

Specimens from the following localities were set aside for later study as possibly belonging to this taxon and they are mapped in Figure 14. Localities are also towards the northwest of the systematically sampled area but extend further south than the previous species.

Localities: SOUTH AFRICA. 1367. Hottentotsparadys. 1403. Jakkalsputs. 1494. Augrabies. 1531. 2 km NE Grootmis. 1534. Kleinsee, beach. 1564. Nabaab. 1592. Nabiseep. 1600. Witputs. 1624. Groenriviermond. 1662. Vanrhynspas. 1873. Abrahamskraal farm.

Ctenolepisma undescribed species near *grandipalpis* 3

Samples from two widely separated localities (Figure 14) have an overall abdominal setation that places them near *C. grandipalpis* but also have heavy pigmentation, black scales and black setae. In the latter respects they resemble *C. picturata* but differ in the absence of a bicoloured scale pattern and in having two pairs of styli. They differ from the preceding undescribed species by the longer urotergite X.

Localities: NAMIBIA. 694. Batia. SOUTH AFRICA. 1239. Blinkpan Saltworks.

Ctenolepisma huabensis Irish

Ctenolepisma (Sceletolepisma) huabensis Irish 1988a: 44.

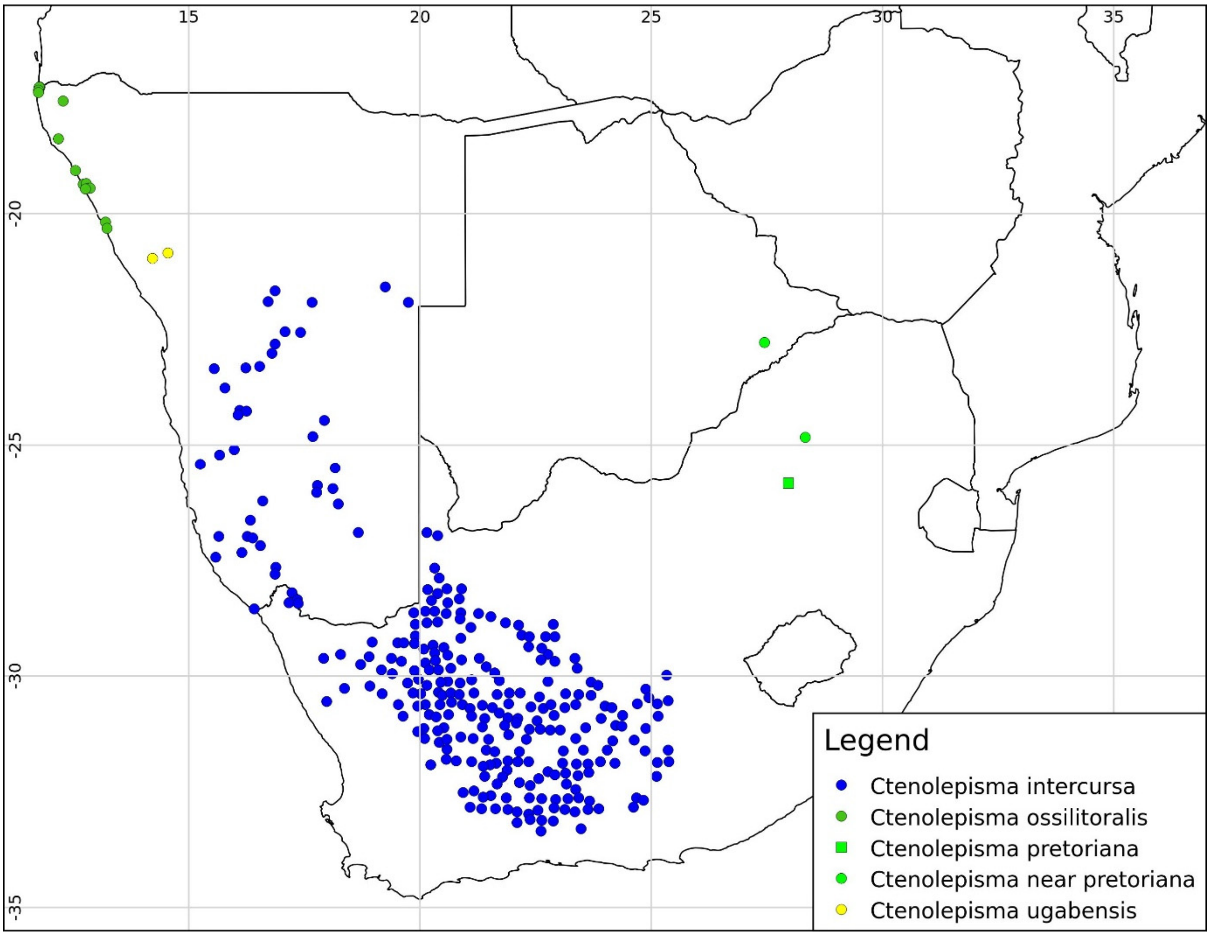

Figure 15: *Distribution of* Ctenolepisma intercursa*,* C. ossilitoralis*,* C. pretoriana*,* C. *near* pretoriana *and* C. ugabensis*.*

A highly habitat- and range-restricted species known only from isolated patches of windblown sand in the Lower Huab River valley, Namibia (Figure 10).

Literature records: NAMIBIA. 840. Terrace Spring. 843. Huab River Valley (Irish 1988a).

New material examined: 1 female, NMNW.
Locality: NAMIBIA. 859. Gemsbok Altar.

Ctenolepisma cf. *incita* Silvestri

Ctenolepisma incita Silvestri 1918: 17.
Ctenolepisma sp. near *incita* Silvestri. Wygodzinsky 1955: 140.

Wygodzinsky (1955) listed a single male from De Hoop Vlei at Windhoek Farm (locality 1989; Figure 10) as belonging to the group near *incita* Silvestri 1918 but considered the specimen (in MZLU, not seen) too imperfect for description. Assuming that by 'near *incita*' he meant small-bodied, with 3+3 bristlecombs on urotergites II-V, a short urotergite X and at least some paucistriate scales, nothing obviously similar was found among fully processed material from the current study. The cosmopolitan tramp species, *C. rothschildi* Silvestri 1907 of which *C. incita* is a potential synonym (Irish 1995), is the most likely suspect, although *C. rothschildi* has not yet been recorded from southern Africa otherwise.

Ctenolepisma inornata Irish

Ctenolepisma (Sceletolepisma) inornata Irish 1987: 182, 1996b: 16.

Widespread in northern Namibia, here also first recorded from Botswana and Zimbabwe (Figure 11).

Literature records: NAMIBIA. 700. Halali-koppie. 712. Sprokieswoud. 715. Okaukuejo. 725. Uithoek 770. 735. Olifantshoek 297. 768. Hohenstein 39. 906. Alkmar 512. 951. Windhoek (Irish 1987).
NAMIBIA. 613. 8 km E Mashari. 620. Omega Base. 629. Buffalo Base. 774. Kremetartkop (Irish 1996b).

New material examined: 53 (20 females, 30 males, 3 unsexed); 31 NMNW, 21 BMSA, 1 CAS.
Localities: BOTSWANA. 543. Gchwihaba Hills. NAMIBIA. 580. Onhelelwa. 593. Onesi. 683. Bloubokdraai. 706. Dinaib 852. 717. Okaukuejo Rest Camp. 738. Success 438. 741. Ghaub 47. 746. Grootfontein, 4 km NE. 790. Outjo. 880. Epukiro River. 937. Khomaskop 414. 965. 15 mi. SW

Windhoek. ZIMBABWE. 2005. Siabuwa Comm. Lands.

Ctenolepisma intercursa Silvestri

Ctenolepisma intercursa Silvestri 1922: 80; Wygodzinsky 1955: 142, 1970: 253; Coaton and Sheasby 1974: 54.
Ctenolepisma (Sceletolepisma) intercursa Silvestri. Irish 1987: 179, 1994b: 471, 1996a: 175.

Common under stones mainly in the Nama-Karoo Biome (Figure 15). Many specimens had parasitic mites attached to them – mite samples were deposited in both NMNW and BMSA. The species is not nidicolous and the termite associations recorded by Wygodzinsky (1970) and Coaton and Sheasby (1974) are incidental.

When intact the overall dorsal scale cover is shiny brownish-grey. The posterior edge of the head capsule is marked by a narrow transverse line of black scales. The dorsal abdomen is speckled with single black or gold scales, clustered around the submedian and sublateral urotergal bristlecombs, thereby creating four faint longitudinal lines on the abdomen. Description based on live freshly moulted specimen at Garingberg (locality 1436).

Literature records: NAMIBIA. 910. Waldau. 950. Windhuk (type locality). 956. Bismarckberge, Voigtsland (Silvestri 1922).
SOUTH AFRICA. 442. De Aar. 1351. Steenkamp Puts. (Wygodzinsky 1955).
SOUTH AFRICA. 361. 3 mi. ex Brandvlei towards Kenhardt. 278. 55 mi. ex Kenhardt – Pofadder. 1509. 85 mi. ex Kenhardt towards Pofadder. (Wygodzinsky 1970). Preceding three repeated in Coaton and Sheasby (1974), with additionally: 1800. 48 km ex Beaufort West towards Willowmore.
NAMIBIA. 889. Ombirisu 684. 890. Okaruheke Wes 45. 911. Otjihangweberg. 913. Volstruiswerf 513. 951. Windhoek. 967. Haris 367. 973. Gurumanas Wes 241. 987. Göllschau 20. 992. Gamsberg. 993. Namib Desert Park. 1014. Far East dunes. 1041. Dickdorn 98. 1063. 10 km NW Chowagasberg. 1074. Hauchab Mt. 1084. Brukkaros. 1089. 3 km S Berseba. 1100. Tiras 39. 1116. Aus Townlands 36. 1137. Donkermodder 60. 1145. Kaukausib fountain. 1151. Arutal 25. 1170. Diamond Area I. 1181. Klinghardts Mountains W. 1199. Namuskluftberg. 1229. Oranjemund. SOUTH AFRICA. 1382. Klipneus. 1800. 30 mi. ex Beaufort West towards Willowmore [the same as Coaton and Sheasby (1974) but inadvertently listed as a new record] (Irish 1987). Also 2 localities in Irish (1994b) and 127 in Irish (1996a).

New material examined: 657 (259 females, 298 males, 100 unsexed); 492 BMSA, 104 TMSA, 60 NMNW, 1 CAS.

Localities: NAMIBIA. 1027. Tsams Ost 2. 1028. Naukluft. 1029. Felseneck. 1030. 17 km N Mariental. 1051. Wolwedans 144. 1087. 70 km N Keetmanshoop. 1102. Khabus 146. 1148. Nieu-Tsaus 142. 1164. Pockenbank 68. 1191. Kolke 84. 1221. 3 km NNE Stormberg. SOUTH AFRICA: 1317. Eierdopkoppies. 1322. Bloukrans. 1341. Abeam. 1347. Setlaarsrus. 1350. Koegoeroep Wes. 1352. Tolkoppies. 1353. Langklip. 1364. Nooitgedacht. 1369. Springbokvlakte. 1371. Riemvasmaak, NW. 1379. Haakiesdoorn. 1380. Lutzputs. 1397. Nelsputs. 1398. Augrabies Nat. Park. 1405. Bo-Narries. 1406. 7 km NW Keimoes. 1413. 10 km N Kakamas. 1414. Swartkop. 1422. Red Wing. 1427. Koekoeb. 1436. Garingberg. 1440. Nabies. 1441. Wegdraai. 1449. Bladgrond. 1451. Bakenkop. 1457. Tsebe. 1470. Piet Rooisberg. 1484. Valsvlei. 1503. Gamsberg Site P. 1506. Witkoppies. 1507. Gannapoort. 1524. Brooke se Punt. 1526. Klawermuis. 1528. Kabas. 1529. Heuningvlei. 1537. Shaw se Vlei. 1542. Hoendernesvlei. 1549. Koffiemeul. 1551. Soutdwaggas. 1557. Gifkop 166. 1562. T'Boop Noord. 1573. Dwaggas. 1576. Wolfkop. 1578. Kap-Kap. 1591. Uilklip. 1592. Nabiseep. 1598. Garies. 1601. Rietfontein Poort. 1603. Gt. Rooiberg. 1607. 10 km S Witputs. 1627. Redman. 1628. Groenfontein. 1650. Driekuil. 1676. Doornberg Hoek. 1694. Kleindoornberg. 1696. Wolwevlei. 1706. Blomfontein. 1708. Dejagerspas. 1712. Jonkersnek. 1715. Bruinrug. 1725. Riem. 1731. Tafelkop. 1733. Eselfontein. 1734. Cradock. 1738. Oukloofpas. 1742. Moltenopas. 1749. Grantham. 1751. Danskraal. 1753. Hopewell. 1756. Paardefontein. 1768. Vaalvlei. 1774. Karelskraalpas. 1775. Portugalsrivier. 1780. Hartbeeskop. 1786. Platkop. 1792. Matjiesgoedkop. 1793. Plaatjiesrivier. 1794. Doornhoek. 1796. Quimby Holme. 1797. Driekop. 1798. Jossieville. 1803. 8 km NW Ebenezer. 1807. Whisky Nek. 1816. Rietfontein. 1817. Buffelsfontein. 1820. Rusgevonden. 1822. Stel se Nek. 1823. Bakenskop. 1824. Vrede Rust. 1830. Rietfontein. 1831. 3 km NW Rietbron. 1832. Blomplaas. 1835. Amospoortjie. 1838. Varsfontein. 1839. Makoukuil. 1843. Kleinwaterval. 1853. Botterkraal. 1859. Kalkgat. 1861. Rietkuil. 1869. Hoek se Kop. 1883. Willowmore. 1897. Vrolikheid.

Ctenolepisma intercursa/prompta indet.

Ctenolepisma promptum Silvestri. Paclt 1966: 154.
Ctenolepisma (Sceletolepisma) intercursa/prompta indet. Irish 1987: 180.
Ctenolepisma intercursa/prompta indet. Irish 1994b: 471, 1996a: 176.

Males of *C. intercursa* and *C. prompta* are indistinguishable, unless accompanied by females. In previous work I listed them as *Ctenolepisma intercursa/prompta* indet. During this study it became clear that *C. intercursa* is commoner in the Nama-Karoo Biome (Figure 15) while *C. prompta* is

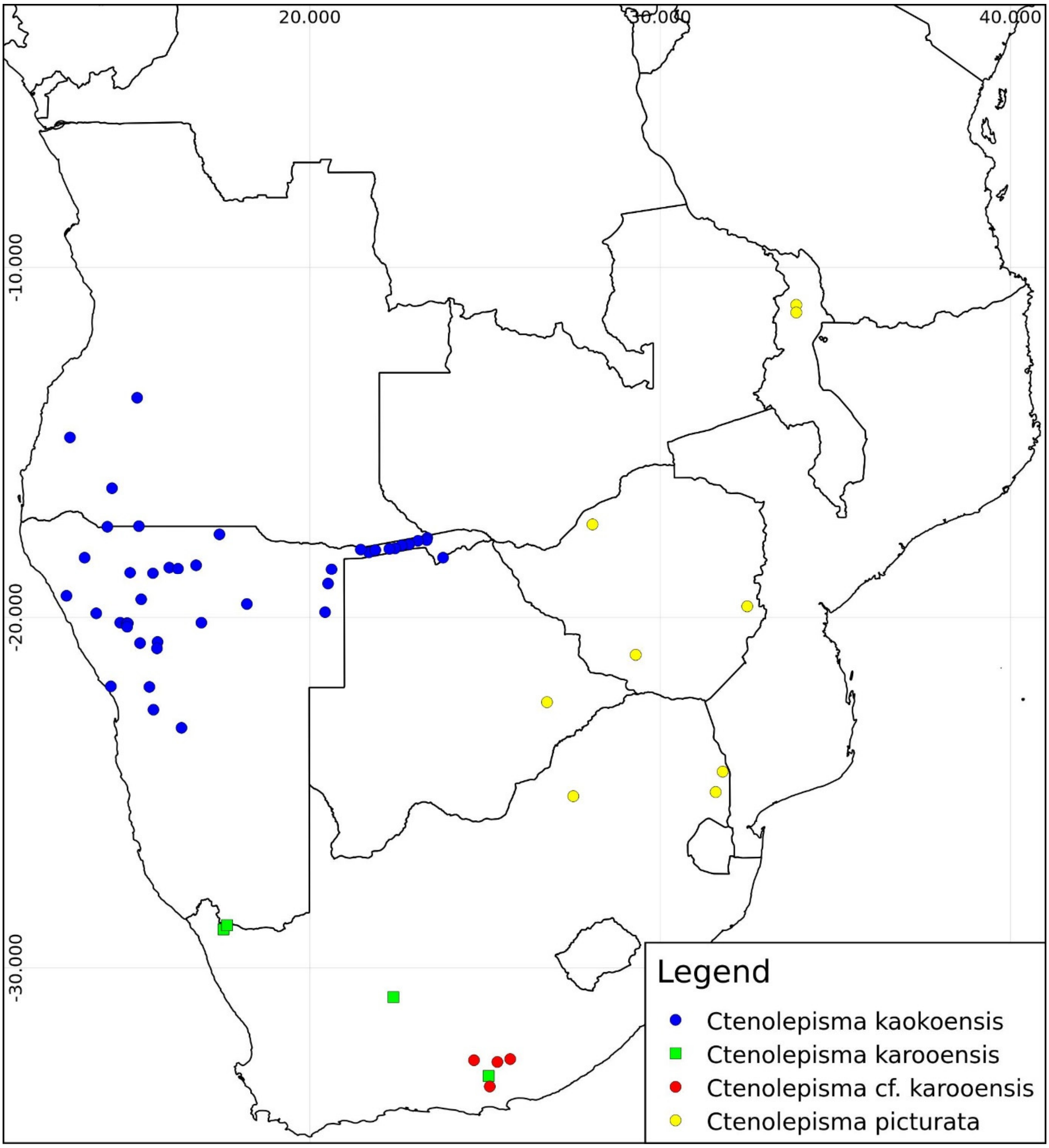

Figure 16: *Distribution of* Ctenolepisma kaokoensis*,* C. karooensis*,* C. *cf.* karooensis *and* C. picturata*.*

commoner in the Savanna Biome (Figure 18). Their distribution ranges narrowly overlap. All-male samples of both species fall within their combined distribution ranges and were here determined as one or the other mainly by considering the habitat at the collecting locality and then referring them to the habitat-appropriate species. There is also a difference in scale colour patterns between the two species but this is only useful when freshly moulted material is available. The pattern for *C. intercursa* was described above but no details have survived for *C. prompta,* besides it being different.

Ctenolepisma kaokoensis Irish

Ctenolepisma (Sceletolepisma) kaokoensis Irish 1987: 184, 1996b: 16.

A species known mainly from northern Namibia (Figure 16), here recorded from Angola for the first time and expected to be more widespread in the Savanna Biome than current records indicate. Both records from the Namib Desert (Uhima, locality 733, and Omdel Reservoir, 915) are representative of major seasonal riverbeds where the species was found under driftwood, presumably washed there from savanna areas further upstream.

Literature records: NAMIBIA. 578. Ruacana. 639. Oruvandjei. 733. Uhima. 742. Urumube 287 (type locality). 776. Palmwag 702. 795. Omarassa 4. 917. 18 km W Usakos. (Irish 1987).
NAMIBIA. 607.Kwando River. 610. Kongola. 611.Manywa River. 616. 2 km SE Qeya River. 617. 1 km SW Qonisha River. 619. 19 km E Omega. 621. 8 km E Omega. 622. Gelukkie. 625. 30 km E Bagani. 629. Buffalo Base. 640. Malengalenga. 666. Kaudom Game Reserve. 701. Kaudom Game Reserve. 772. Te-barku (Irish 1996b).

New material examined: 56 (18 females, 19 males, 19 unsexed); 47 NMNW, 5 BMSA, 4 CAS.
Localities: ANGOLA. 531. 2 mi. N Caconda. 535. 17 mi. W Vila Arriaga. 540. 4 mi. SE of Cahama. NAMIBIA. 575. Onangombe. 599. Enyana. 653. Andoni. 660. Ekuma River. 663. Etosha Pan. 673. Dorsland. 674. Narawandu. 756. Lichtenau, SE Grootfontein. 794. Welkom 680. 797. Nantis 679. 798. Rockeys 682. 806. Bergville 490. 847. Okoronjona 6. 849. Sebraskop 410. 857. Otjongoro 20. 915. Omdel Reservoir. 960. Namib Desert Park. 982. Verloren 32.

Ctenolepisma karooensis Irish

Ctenolepisma (Sceletolepisma) karooensis Irish 1996a: 192.

The female specimens listed here differ in minor details from the holotype, previously the only known specimen. Some are slightly larger, with body lengths up to 9.5 mm (holotype: 8.25 mm). In one the ovipositor is longer, extending past the apices of styli IX by about 1.25 times the latter's length (holotype: ovipositor not extending past the apices of styli IX). All have only one pair of styli. In other respects, they conform to the holotype and I am confident in referring them to the same taxon. As expected the males identified as belonging to *C. karooensis* by association with *C. karooensis* females in the same samples are indistinguishable from male *C. namaquensis*. The species is not common and the currently known distribution is very disjunct, clustered in two areas both far removed from the type locality (Figure 16).

Literature records: 1 in Irish (1996a).

New material examined: 11 (3 females, 8 males); 10 BMSA, 1 TMSA.
Localities: SOUTH AFRICA. 1428. Vioolsdrif. 1453. Kristalberge. 1851. Toekomst.

Additional material was provisionally referred to *C. karooensis* on the grounds of similar overall abdominal setation, but being four male specimens only, their identity could not be confirmed. They are listed here instead of under *C. namaquensis* on geographical probability and were mapped in Figure 16 as *Ctenolepisma cf. karooensis*. The localities are clustered around a confirmed female locality. Localities: SOUTH AFRICA. 1782. Voslonia. 1796. Quimby Holme. 1804. Bruintjieshoogte. 1901. Glen Grove.

Ctenolepisma latera Irish

Ctenolepisma (Sceletolepisma) latera Irish 1987: 159, 1996a: 177, 1996b: 16.

A psammophilous species that occurs mainly in the southwestern Kalahari (Figure 14), where it can be found under dead grass clumps or shed camelthorn (*Acacia erioloba*) bark on dunes. It has not yet been recorded from southwestern Botswana but can be expected to occur there as well. The isolated three northernmost localities (604, 614, 834) are also from areas of Kalahari sand but are climatologically incongruous. All three records were based on more or less damaged preservative pitfall trap material and might have benefited from re-assessment; being NMNW material, this is no longer possible.

Literature records: NAMIBIA. 1024. Chulon, Narib Oos 602. 1033. Sandfeld 314 (type locality). 1041. Dickdorn 98. 1078. Fish/Lewer Rivers confluence. 1081. Karakanos. 1089. 3 km S Berseba. 1101. Gavaams 6. 1153. Swartbaas Ost 285. 1156. Vredeshoop 283. 1177. Hohedun 277. 1189. Blinkoog 30. 1361. SOUTH AFRICA. Koras 412. 1376. 25 km ENE Upington. 1390. Witsand. (Irish 1987).
NAMIBIA. 604. 5 km NE Dikweya. 614. 49 km W Kongola. (Irish 1996b).
Also 1 locality in Irish (1996a).

New material examined: 231 (82 females, 118 males, 31 unsexed); 207 BMSA, 23 NMNW; 1 TMSA.
Localities: NAMIBIA. 834. Hereroland West. 1041. Dickdorn 98. 1057. Tranendal 184. 1059. Goamus 70. 1064. Kaitzub. 1106. Wildheim Ost 384. 1135. Verschluss 54. 1154. Vredeshoop 283. 1173. Noachabeb 97. 1217. Heiragabis River. SOUTH AFRICA. 1260. 4 km SW Grootbrak. 1262. 5 km N Karup. 1264. 9 km SE Bayip. 1267. Sewepanne. 1268. Driefendas. 1270. 1 km S Lammermoor. 1273. 4 km NW Cheleka. 1290. 3 km S Dochfour. 1292. Jan se Draai. 1293. Vaalpan. 1295. 5 km N Kafferspan. 1297. Kafferspan. 1298. 3 km SW Rooibrak. 1299. Kij Gamies. 1303. Sebobogas. 1308. Witstraat. 1309. Tweerivieren. 1312. Dwangas. 1313. Struisdam. 1319. Witdraai. 1320. Surprise 33. 1326. Loch Leven. 1327. Spieëlkop. 1328. Loch Nagar. 1329. Gordonia District. 1331. Rondepan. 1334. Kakolk. 1335. Merriespan. 1338. 5 km SE Noenieput. 1344. Rouxvlei. 1373. Karakoelproefplaas. 1395. Brulsand. 1416. Witkoppies. 1458. Bingap 184. 1465. 39 km E Groblershoop.

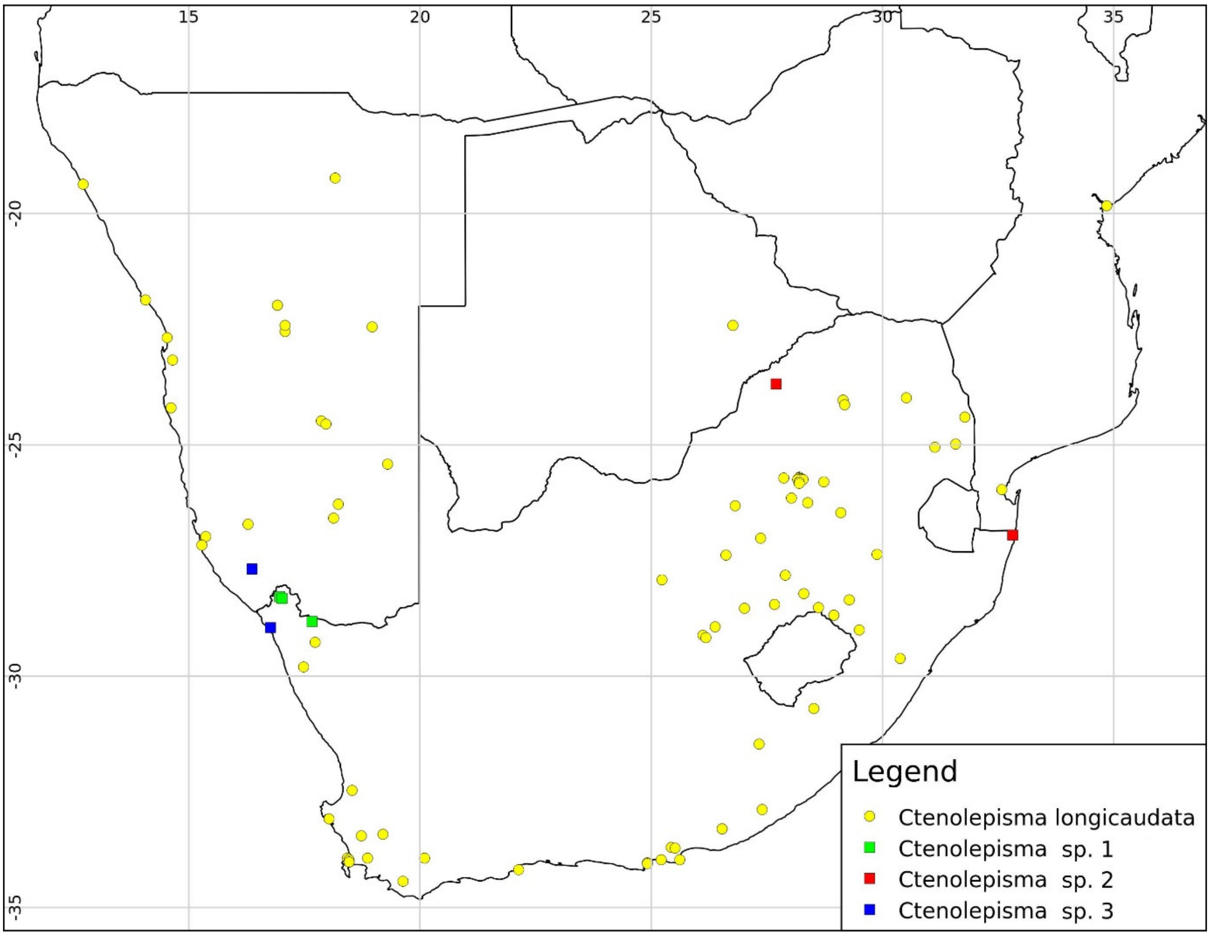

Figure 17: *Distribution of* Ctenolepisma longicaudata *(southern Africa only) and three undescribed* Ctenolepisma *species.*

Ctenolepisma lociplana Irish

Ctenolepisma (Sceletolepisma) lociplana Irish 1996a: 189.

Currently known from a limited area in northwestern South Africa only (Figure 11). All material was from under stones but one label noted that the specimen sanddived under the stone. Another label noted that the scale colour in life was black.

Literature records: 6 in Irish (1996a).

New material examined: 3 (1 female, 2 males); 2 BMSA, 1 NMNW
Localities: SOUTH AFRICA. 1380. Lutzputs. 1469. 28 km S Vioolsdrif. 1475. Dabenoris.

Ctenolepisma longicaudata Escherich

Ctenolepisma longicaudata Escherich 1905: 83; Silvestri 1908: 291; Silvestri 1922: 85; Wygodzinsky 1955: 140; Theron 1963: 126; Heeg 1967a: 43, 1967b: 21, 1969: 135; Mendes 1982: 645; Mendes 1993: 101.
Ctenolepisma urbana Slabaugh. Theron 1963: 126.
Ctenolepisma longicaudatum Escherich. Paclt 1966:152.
Ctenolepisma lingicaudatum Escherich. Paclt 1969: 223 (*lapsus*).
Ctenolepisma (Ctenolepisma) longicaudata Escherich. Irish 1987: 151, 1994b: 469.

This cosmopolitan anthropophile happened to have been described from South Africa but it is unlikely to have originated here; similar species occur in the Mediterranean region and it may have come from there. Though widespread in southern Africa (Figure 17), it has not been found away from human habitation. Most records are from towns but it can be found wherever humans live, including in nature reserves. They can persist after habitation is abandoned, for as long as a structure remains; the locations Charlottenfelder (1025) and Jammerbucht (1162) below are historical mining sites on the Namibian coast that were abandoned at the outbreak of the First World War in 1914; the species was collected there in 1984 and 1986 respectively. Early in this study, all southern African *Ctenolepisma* species that lack median urosternal bristlecombs were treated as *C. longicaudata* but after the gradual realisation that there were such indigenous species as well (see below), I verified the identity of all material previously identified by myself as *C. longicaudata*, wherever possible.

Literature localities (southern Africa only):

SOUTH AFRICA. 24. Bothaville (type locality) (Escherich 1905).
BOTSWANA. 550. Kang-Khakhea. 552. Severelela. NAMIBIA. 983. Rooibank. 1128. Kubub. SOUTH AFRICA. 1501. Steinkopf. 1543. Kamaggas. (Silvestri 1908).
NAMIBIA. 719. Neitsas. 918. Okahandja (as Okahanda). 936. Brakwater (as Brackwater). 962. Swakopmund (Silvestri 1922).
SOUTH AFRICA. 1420. Royal Natal National Park. 1530. Pietermaritzburg. 1611. Mount Fletcher. 1937. Amanzi Estate. 1976. Mosselbaai. (Wygodzinsky 1955).
NAMI
BIA. 938. Gobabis. 1032. Mariental. SOUTH AFRICA. 1306. Ventersdorp. 1333. Volksrust. 1669. Indwe. 1771. Redelinghuys. 1833. King William's Town. 1906. Wolseley. 1909. Malmesbury. 1954. Cape Town. 1955. Stellenbosch. 1956. Bonnievale (Theron 1963, as both *C. longicaudata* and *C. urbana*).

MOÇAMBIQUE. 558. Beira. NAMIBIA. 919. Orungauu bei Okahandja. ((Paclt 1966)
SOUTH AFRICA. 1884. Grahamstown. (Heeg 1967a, b, 1969).
NAMIBIA. 1112. Keetmanshoop (Paclt 1969).
SOUTH AFRICA. 1279. Pretoria. (Mendes 1982).
BOTSWANA. 546. Swaneng Hill School. NAMIBIA. 729. Möwebaai. 907. Mile 72. 918. Okahandja. 951. Windhoek. 1025. Charlottenfelder. 1031. Hardap Rest Camp. 1142. Grillenthal. SOUTH AFRICA. 1248. Makapansgat. 1258. Hazyview. 1276. Pretoria. 1278. Colbyn, Pretoria. 1302. Parktown North. 1348. Christiana. 1421. Royal Natal National Park. 1885. Grahamstad. (Irish 1987).
MOÇAMBIQUE. 559. Maputo. (Mendes 1993a)
Also 13 localities in Irish (1994b).

New material examined: 53 (28 females, 19 males, 6 unsexed); 39 BMSA, 1 CAS, 7 SAMC, 4 SANC, 2 NMNW.
Localities: NAMIBIA. 1102. Khabus 146. 1162. Jammerbucht. SOUTH AFRICA. 1246. Leydsdorp. 1247. Percy Fyfe N.R. 1252. Satara. 1257. Skukuza. 1265. Loskop Dam N.R. 1274. Arcadia, Pretoria. 1275. Hartebeespoort. 1276. Pretoria. 1280. Val de Grace. 1283. Kloofsig. 1284. Bronkhorstspruit. 1287. Lyttelton. 1304. Brakpan. 1311. Evander. 1346. Grootkraal. 1474. Champagne Valley Resort. 1490. Fauna, Bloemfontein. 1847. Langebaan. 1886. Grahamstown. 1935. Die Bron, Uitenhage. 1959. Claremont. 1961. Vanstadensmond. 1963. Port Elizabeth. 1964. Plumstead. 1965. Plumstead. 1966. Plumstead. 1968. Wavecrest, Jeffreys Bay. 1971. Jeffreys Bay. 1992. Salmonsdam.

Unidentified *Ctenolepisma* material lacking median urosternal bristlecombs

At the time of Irish (1987), *C. longicaudata* was the only *Ctenolepisma* species lacking median urosternal bristlecombs that was known from southern Africa. Over time, small numbers of naturally occurring indigenous species with the same character state were found. Unfortunately, this study was terminated before they could be properly studied. A variety were collected or received, the majority from the more humid parts of South Africa (southern Cape, eastern Cape, Kwazulu-Natal, Mpumulanga escarpment) but details for only three potential species have survived.

Ctenolepisma species 1

Urotergites II – VI with 3+3 bristlecombs. One pair of styli.

Encountered in a limited area along the Lower Orange River only (Figure 17). Specimens were found under peeling bark of trees (*Acacia karroo* and *Parkinsonia africana* recorded) and were collected by beating. The habitat is arid Succulent Karoo, which is characterised by a lack of trees, and in one case the single tree they were collected from was the only one as far as could be seen.

Localities: SOUTH AFRICA. 1357. Numeesmyn. 1362. Paradyskloof. 1434. SE Vioolsdrif.

Ctenolepisma species 2

Urotergites II – VII with 3+3 bristlecombs. Urotergite X very short. Three pairs of styli.

Found in northeastern South Africa (Figure 17), under bark of trees (only alien *Eucalyptus* specified).

Localities: SOUTH AFRICA. 1243. Onverwacht. 1321. Kosi Bay Nat. Res.

Ctenolepisma species 3

Urotergites II – V with 3+3 bristlecombs. Two pairs of styli.

Found in plant detritus under shrubs in northwestern South Africa and adjacent Namibia (Figure 17).

Localities: NAMIBIA. 1193. Aurusberg. SOUTH AFRICA. 1467. Holgat Riv. 5 km from mouth.

Ctenolepisma luederitzi Irish

Ctenolepisma (Sceletolepisma) luederitzi Irish 1987: 164.
Ctenolepisma terebrans var. *pluriseta* Silvestri 1908: 292, 1922:79 (*p.p.).*

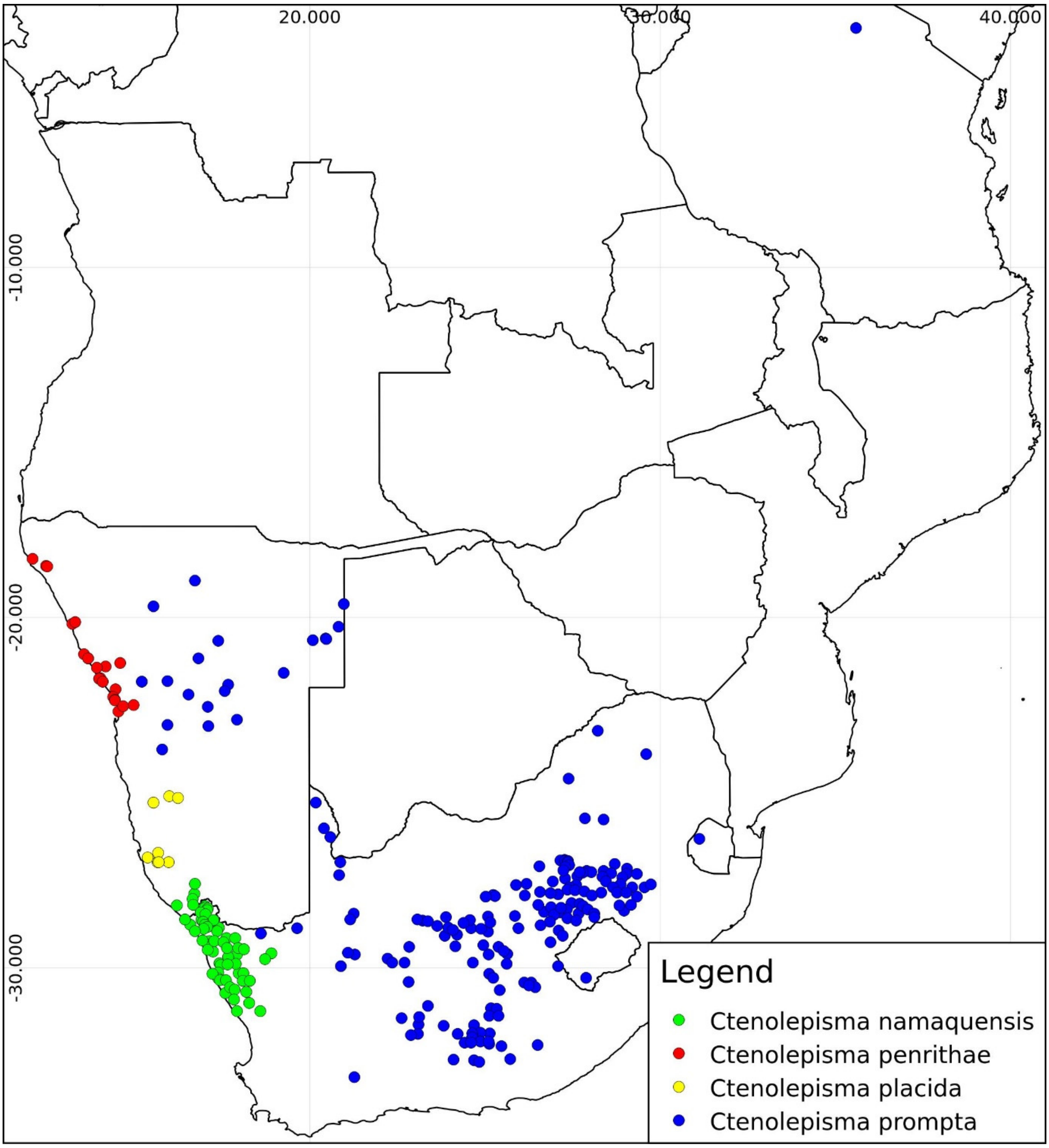

Figure 18: *Distribution of* Ctenolepisma namaquensis*,* C. penrithae*,* C. placida *and* C. prompta*.*

A species of the arid northern Succulent Karoo Biome, near-endemic to Namibia (Figure 12). Note that the latitude for the holotype locality, 10 km NW Rosh Pinah (locality 1204), was misprinted in Irish (1987) as 27°42'S. It should be 27°53' S.

Literature records: NAMIBIA. 1120. Lüderitzbucht (Silvestri 1908, 1922) (as *C. pluriseta*).
NAMIBIA. 1113. Agate Beach. 1119. Lüderitz. 1125. Tsaukhaib Mts. 1126. Tsaukhaib Mts E. 1130. Grosse Bucht. 1131. Diamond Area I. 1134. 7 km N Grillenthal. 1142. Grillenthal. 1143. 2 km N Dreizackberg. 1146. 2 km E Kaukausib. 1155. 10 km S Grillenthal. 1163. Tsaus dunes. 1166. Pockenbank 68. 1170. Diamond Area I. 1176. Klinghardts Mountains. 1181. Klinghardts Mountains W. 1184. Uguchab River. 1185. Aurus. 1187. Süd Witpütz 31. 1198. Boesmanberg. 1202. Diamond Area I. 1204. 10 km NW Rosh Pinah. 1208. Namuskluft 88. 1218. Obib dunes. 1219. Daberas dunes. 1222. Wolwekop. SOUTH AFRICA. 1412. 13 km SSW Grootderm. (Irish 1987).

New material examined: 57 (16 females, 15 males, 26 unsexed); 57 NMNW.
Localities: NAMIBIA. 1110. E of Agate Beach. 1115. Angra Bay. 1133. Atlas Bay. 1148. Nieu-Tsaus 142. 1159. Prinzenbucht. 1168. Klinghardt

Mountains. 1169. Anib Pan Borehole. 1175. Sargdeckel. 1186. Kegelberg. 1190. E Aurus Mts. 1193. Aurusberg. 1195. Diamond Area I. 1196. 5 km N Chameis Gate. 1197. Roter Kamm. 1206. Boegoeberg. 1210. Rosh Pinah.

Ctenolepisma messor Irish

Ctenolepisma (Sceletolepisma) messor Irish 1996a: 182.

One of the few confirmed myrmecophilous *Ctenolepisma* species, currently known only from the Central Nama-Karoo Biome in South Africa (Figure 12) but potentially more widespread. Unidentified myrmecophilous *Ctenolepisma* material was also seen from at least the Namibian localities 709 and 951.

Literature records: 30 in Irish (1996a).

New material examined: 9 (3 females, 5 males, 1 unsexed); 9 BMSA. Also 28 hosts.
Localities: SOUTH AFRICA. 1408. Poufontein (*Messor denticornis).* 1409. Eureka (*Messor denticornis*). 1413. 10 km N Kakamas (*Tetramorium* sp.). 1537. Shaw se Vlei (*Messor denticornis*). 1549. Koffiemeul (*Messor denticornis*). 1603. Gt. Rooiberg (*Messor capensis*). 1634. Klein Graafwater (unaccompanied by ants).

Ctenolepisma namaquensis Irish

Ctenolepisma (Sceletolepisma) namaquensis Irish 1987: 198.

A common species in part of the Succulent Karoo Biome (Figure 18). This is one of the few species for which the distribution range as currently known likely closely approximates the actual entire distribution range. Note that the latitude for one of the paratype localities, 10 km S Jakkalsputs (locality 1426), was misprinted in Irish (1987) as 28°31'S. It should be 28°46'S.

Literature records: NAMIBIA. 1204. 10 km NW Rosh Pinah. 1220. Rooilepel. 1222. Wolwekop. 1231. Pink Pan. SOUTH AFRICA. 1356. Numeesmyn. 1358. Die Koei. 1368. Rosyntjiewater. 1388. 2 km E Khubus. 1403. Jakkalsputs. 1404. 22 km N Eksteenfontein. 1426. 10 km S Jakkalsputs. 1495. Farquarson. 1500. 10 km W Anenouspas. 1535. Schaaprivier. 1579. Graskom. 1653. Flaminksvlakte. (Irish 1987).

New material examined: 85 (42 females, 40 males, 3 unsexed); 64 BMSA, 18 NMNW, 3 GRSW.
New localities: NAMIBIA. 1183. Süd Witpüts. 1212. Obib Mountain. SOUTH AFRICA. 1354. Kodaspiek. 1357. Numeesmyn. 1360. Blackie's Prospect. 1366. 2 km S Helskloof (West). 1377. Cornellskop. 1418. Jakkalsputs dunes. 1425. Boegoeberg-Suid. 1435. W Wildeperderant. 1439. N Klipbok. 1447. Katkop. 1466. 2 km N Holgatmond. 1468. Ratelfontein. 1485. Vlieholteberg. 1486. Doringwater. 1491. Muisvlak. 1494. Augrabies. 1510. SW Abbevlak. 1518. Varswater. 1519. 12 km NNE Concordia. 1520. Kaitob. 1521. Skilpadnou. 1523. Tnong-Gys. 1526. Klawermuis. 1528. Kabas. 1542. Hoendernesvlei. 1548. Witduin. 1550. Eenriet. 1552. Messelpad. 1554. Kourkamma. 1569. Noos. 1570. Sneeukop. 1572. Meyershoek. 1574. Somnaasbaai. 1585. 5 km W Wallekraal. 1586. Rooiberg. 1589. Eselkop. 1590. Paulshoek. 1597. Bruinkop. 1602. De Hoog. 1608. Agteroorberg. 1612. Rietkop. 1631. 4 km S Oudam. 1637. 5 km NE Bitterfontein. 1652. Brakfontein.

Ctenolepisma namibensis Irish

Ctenolepisma (Sceletolepisma) namibensis Irish 1987: 172.

A species of the northern Namib Desert, that does not occur south of the Swakop River (Figure 11).

Literature records: NAMIBIA. 679. Khumib River ca. 15 km from mouth. 699. Hoarusib Riv., 9 km from mouth. 740. Hoanib River Mouth. 785. Samanab River. 796. Unjab River. 856. Huab River, 5 km from mouth. 870. Ugab River gate. 875. Ugab River Mouth. 921. 25 km ENE Hentiesbaai. 931. 6 km N Arandis. 942. Rössing Mts E. 943. Rössing Mts E. 953. Rössing Mts SE. (Irish 1987).

New material examined: 12 (2 females, 9 males, 1 unsexed); 12 NMNW.
Localities: NAMIBIA. 801. Uniab Delta. 851. Gaias. 896. 6 km E Kaapkruis. 902. Lagunenberg.

Ctenolepisma occidentalis Irish

Ctenolepisma (Sceletolepisma) occidentalis Irish 1987: 169.

A highly range-restricted species confined to a limited part of the Central Namib Desert only (Figure 12). Unpublished work for a mining company in 2011 showed that the distribution range does not extend significantly beyond that initially described.

Literature records: NAMIBIA. 931. 6 km N Arandis. 946. Upper Panner Gorge. 947. Lower Ostrich Gorge. 957. Swakopmund District. (Irish 1987).

Ctenolepisma orangica Irish

Ctenolepisma (Sceletolepisma) orangica Irish 1994b: 471, 1996a: 177.

A South African species, the distribution range of which as currently known is clustered and disjunct (Figure 19). It is difficult to explain other than as an artefact of insufficient sampling, or incomplete

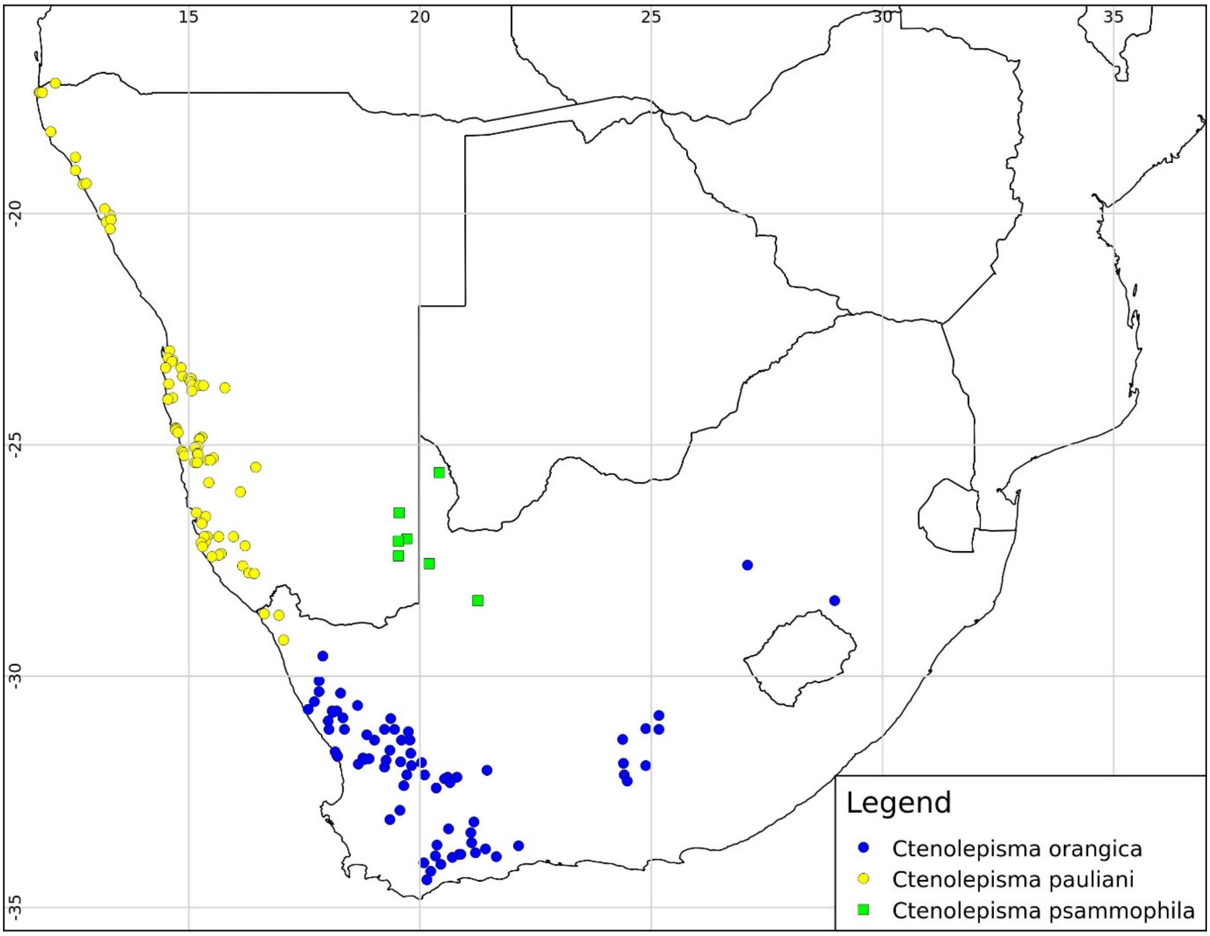

Figure 19: *Distribution of* Ctenolepisma orangica*,* C. pauliani *and* C. psammophila*.*

processing of sampled material. The intact live scale cover is shiny black.

Literature records: 2 in Irish (1994b) and 5 in Irish (1996a).

New material examined: 303 (125 females, 165 males, 13 unsexed); 262 BMSA, 32 NMNW, 6 CAS, 3 TMSA.
Localities: SOUTH AFRICA. 1525. 6 km SW Concordia. 1563. Tweerivier. 1583. Tierkop. 1590. Paulshoek. 1597. Bruinkop. 1605. Rietmond. 1612. Rietkop. 1618. Mostertsvlei. 1619. Vonkelfontein. 1620. 33 km N Bitterfontein. 1625. Driefontein 137. 1632. Groenpunt. 1633. 10 km NW Loeriesfontein. 1635. 2 km W Rietpoort. 1643. Geelkop. 1644. 2 km SE Nuwerus. 1645. Bakenskop. 1646. Perdeberg. 1647. Jakkalsfontein. 1649. 5 km NE Windkraal. 1654. NE Saggiesberg. 1662. Vanrhynspas. 1664. Merweshoek. 1665. Hantamsberg-plato. 1674. Augustfontein. 1678. Olifantskliphoogte. 1680. Nuwefontein. 1682. Noordhoek. 1683. Papendorp. 1684. 2 mi. S Papendorp. 1685. Wiedou. 1686. Gifbergpas. 1687. Waterval. 1688. Vondeling. 1689. Botterkloofpas. 1693. Vlakkraal. 1697. Olyfen. 1699. Sandkop. 1701. Doorn Bosch 19. 1705. Klipheuwelkoppe 1722. Van Wyksvlei. 1723. Ganagapas. 1726. Oudebergpas. 1736. Brandkop. 1737. Oubank. 1741. 27 km NW Sutherland. 1745. Vallei van Verlatenheid. 1748. 10 km N Sutherland. 1755. Tweefontein. 1764. Oubergpas, summit. 1834. Katbakkiespas. 1852. Groenfontein. 1866. Spitskopvlakte. 1880. Fisantekraal. 1899. Beeskraal. 1924. Vensterkrans. 1930. Bylshoek. 1931. Highgate. 1938. Vanwyksdorp, W. 1944. Miertjieskraal, E. 1947. Lemoenhoek. 1948. Sandhoek. 1950. Rietrivier. 1951. Waaikraal. 1953. Modderasfontein. 1967. Ribbokkop. 1972. Bontebok National Park. 1978. Uitkyk. 1988. Rooivlei.

Ctenolepisma ossilitoralis Irish

Ctenolepisma (Sceletolepisma) ossilitoralis Irish 1987: 173.

A species of the northern Namib Desert (Figure 15). All localities are on or near the coast, except 'Kunene River, 44 km S' (locality 591) which is 60 km inland, a significant distance considering the steep east-west climatic gradient of the Namib. The inland specimens have posterolateral thoracic notal bristlecombs composed of 3-4 macrosetae each, instead of the usual two only. Unfortunately, their poor condition (preservative pit trap material) prevented positive

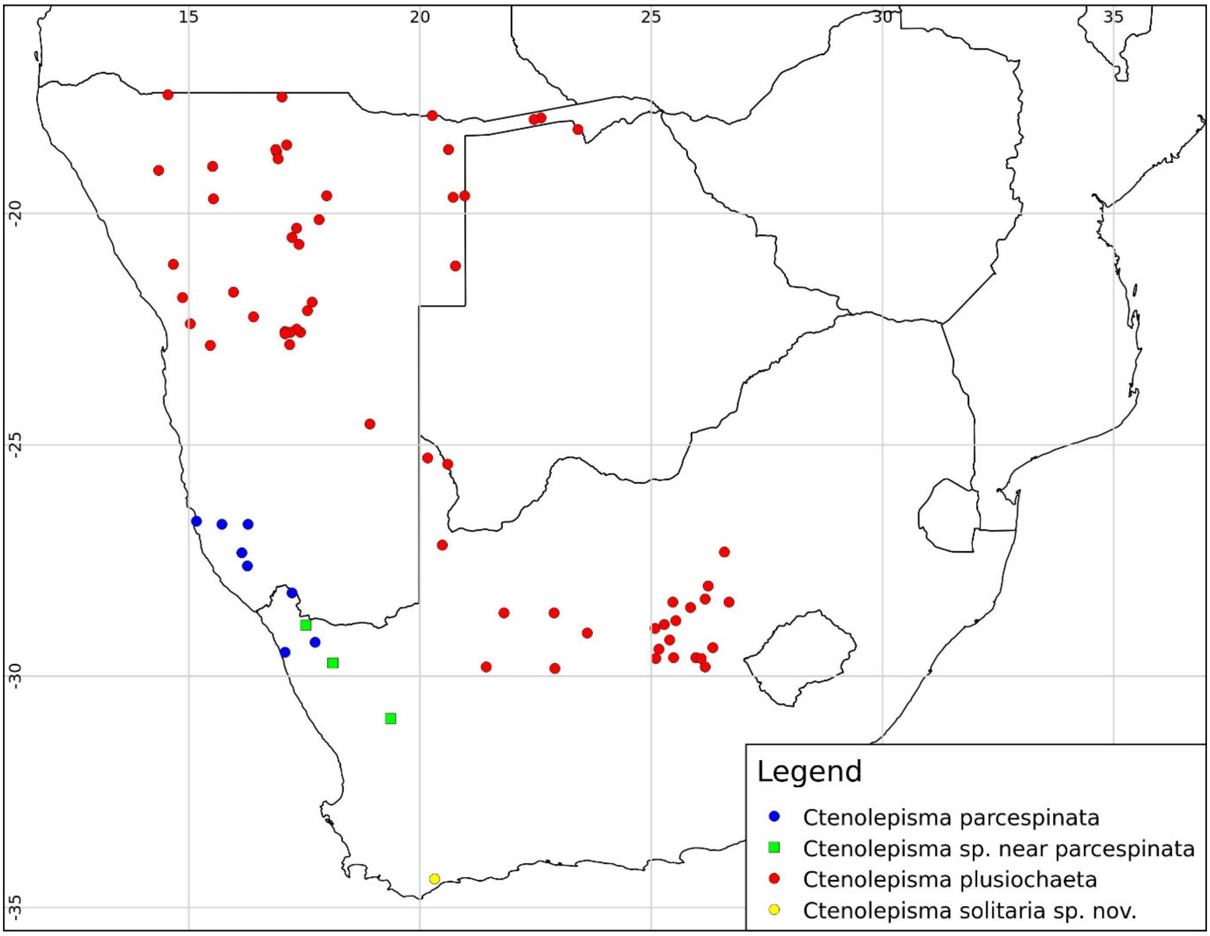

Figure 20: *Distribution of* Ctenolepisma parcespinata*,* C. *sp. near* parcespinata*,* C. plusiochaeta *and* C. solitaria *sp. nov.*

determination as to whether they represented a new taxon or not.

Literature records: ANGOLA. 541. Kunene River, 3 km from mouth, N Bank. NAMIBIA. 565. Kunene River Mouth (S bank). 570. 7 km N Bosluisbaai. 571. Bosluisbaai. 707. Hoarusib River [Mouth]. 726. 8 km E Möwebaai. 729. Möwebaai. 736. Hoanib Oase. 740. Hoanib River Mouth. 799. Uniab River delta. (Irish 1987).

New material examined: 18 (10 females, 6 males, 2 unsexed); 16 NMNW, 2 TMSA
Localities: NAMIBIA. 564. Kunene R.M. 591. Kunene River, 44 km S. 643. Nadas River area. 737. Lower Hoanib Riv. 809. Torra Bay.

Ctenolepisma ovsensis Irish

Ctenolepisma (Sceletolepisma) ovsensis Irish 1994b: 473.

Incorrect literature records: 2 in Irish (1994b).

C. ovsensis is still known only from the types but the published type localities are incorrect. The types were purportedly collected on the same day at two proximate localities in the central Free State province. At the time, it was incongruous that my own and much more intensive collecting throughout the same area and the surrounding rest of the province had not turned up any additional material but after confirming with the collector, a technician in the department, I described the species on good faith as actually being from there. It subsequently became known that the claimed collecting never took place. Material from an unknown source was mislabelled to create the illusion that collecting had been done, while spending the day otherwise. Apparently, this was not an isolated incident. I have therefore disregarded all other material collected by both involved individuals as being geographically unreliable. The type locality of *C. ovsensis* cannot be specified other than just 'South Africa' but is unlikely to have come from the intensively sampled areas 1 to 4 (Figure 1).

Ctenolepisma parcespinata Silvestri

Ctenolepisma parcespinata Silvestri 1908:292.
Ctenolepisma plusiochaeta Silvestri 1922: 83 (*p.p.*).
Ctenolepisma (Sceletolepisma) parcespinata Silvestri. Irish 1987: 186.

A very poorly known species from the arid northern Succulent Karoo Biome (Figure 20). Males can not be reliably distinguished from those of *C. plusiochaeta* and three of the four new localities listed below are unfortunately represented by males only. They were referred to *C. parcespinata* on habitat and distributional grounds, in that all are from winter rainfall Succulent Karoo areas, whereas *C. plusiochaeta* is known only from summer rainfall Nama-Karoo and Savanna areas.

Literature records: SOUTH AFRICA. 1501. Steinkopf (type locality) (Silvestri 1908).
NAMIBIA. 1120. Lüderitzbucht (as *C. plusiochaeta*) (Silvestri 1922).
NAMIBIA. 1126. Tsaukhaib Mts E. 1170. Diamond Area I. (Irish 1987).

New material examined: 5 (2 females, 3 males); 1 BMSA, 3 NMNW, 1 CAS.
Localities: NAMIBIA. 1129. Kubub, Aus. 1185. Aurus [females]. 1221. 3 km NNE Stormberg. SOUTH AFRICA. 1521. Skilpadnou.

Ctenolepisma undescribed species near *parcespinata*

Specimens that resemble *C. parcespinata* in having 3+3 bristlecombs on urotergites II-VIII but differ in having 2+2 bristlecombs on urotergite I. They were found in northwestern South Africa (Figure 20) and in one case myrmecophily with *Messor* ants was confirmed.

Localities: SOUTH AFRICA. 1453. Kristalberge (*Messor denticornis*). 1540. Pramkop. 1633. 10 km NW Loeriesfontein.

Ctenolepisma pauliani Wygodzinsky

Ctenolepisma pauliani Wygodzinsky 1959a: 442; Watson and Irish 1988:286.
Ctenolepisma (Sceletolepisma) pauliani Wygodzinsky. Irish 1987: 194.

Found on dunes in the Namib Desert (Figure 19). The mapped disjunction in distribution between the northern and southern Namib is real and corresponds to the duneless area separating the northern and southern Namib dune fields. Towards the south they occur on more or less isolated dune patches but still within the coastal desert climate zone. The locality Kronenhof (1076) is interesting in this regard, being the furthest inland the species has been recorded at 160 km from the coast, and separated by about 50 km from the two nearest dune tongues to the northwest and southwest, that are still connected to the main Namib dune sea. As such, it is located outside the Desert Biome and in the Nama-Karoo Biome instead. The identification from there was based on imperfect preservative pitfall trap material and re-examination of fresh material may be useful to confirm the status of this population.

A small number of specimens of a different species, broadly conforming to *C. pauliani* including in overall urotergal and urosternal setation but living in rocky and gravel plains habitats rather than on dunes, was recorded from the Arandis / Rössing area of the Central Namib Desert in 1984. The material, from preservative pitfall traps, was not suitable for description of a new species at the time and it has not been seen again since.

Literature records: NAMIBIA. 988. Sandwich Bay. 999. Gobabeb. (Wygodzinsky 1959a);
NAMIBIA. 572. 1 km E Bosluisbaai. 573. 3 km E Bosluisbaai. 574. Northern Namib. 635. Cape Fria Radio Station. 679. Khumib River ca. 15 km from mouth. 707. Hoarusib River Mouth. 726. 8 km E Möwebaai. 729. Möwebaai. 778. Kharu-Gaiseb River. 785. Samanab River. 796. Unjab River. 813. Torra Bay dunes. 972. Duin 7. 980. Rooibank, 10 km W. 984. Rooibank. 989. Sandwich Harbour. 990. Swartbank. 994. Jumbo dune. 997. Kahani dune. 1000. Gobabeb. 1007. Visitor's dune. 1010. Gobabeb, 15 km S. 1011. Noctivaga dune. 1012. Mniszechi's Vlei. 1014. Far East dunes. 1016. Tsondab Flats. 1017. Diamond Area II. 1019. Conception. 1035. Fischersbrunn. 1037. Coast S of Fischersbrunn. 1039. 11 km SSE Fischersbrunn. 1042. Witberg. 1043. 4 km W Witberg. 1044. Diamond Area II. 1049. Diamond Area II. 1050. Diamond Area II. 1053. 2 km N Sylvia Hill. 1058. 5 km SE Sylvia Hill. 1060. SE 2515Aa4. 1062. Diamond Area II. 1065. Diamond Area II. 1067. Guinasibberg. 1068. Diamond Area II. 1069. 5 km SW Guinasibberg. 1071. SE 2515Ac4. 1072. Uri-Hauchab Mt. 1083. SE 2515Cd2. 1108. Haris. 1124. 2 km N Grasplatz. 1141. 2 km W Grillenthal. 1142. Grillenthal. 1143. 2 km N Dreizackberg. 1145. Kaukausib fountain. 1147. Agub Mt. SW. 1155. 10 km S Grillenthal. 1163. Tsaus dunes. 1171. Klinghardts Mountains. 1172. Klinghardts Mountains. 1184. Uguchab River. 1198. Boesmanberg. SOUTH AFRICA. 1412. 13 km SSW Grootderm. 1492. Kleinduin. (Irish 1987).

New material examined: 50 (18 females, 19 males, 13 unsexed); 48 NMNW, 1 TMSA, 1 CAS.
Localities: NAMIBIA. 561. Northern Namib dunes. 792. Eastern edge of Unjab River dunes. 801. Uniab Delta. 984. Rooibank. 985. Rooibank, SW of. 1001. Gobabeb, Namib Res. Station. 1004. Namib Park, SE Corner. 1008. Half Shaft Camp. 1020. Conception Water. 1036. Dunes E of Meob fishing camp. 1076. Kronenhof 117. 1088. Tirasduine. 1105. East of Boot Bay. 1144. Kaukausib. 1157. Diamond Area I. 1165. Pomona. 1178. Klinghardt Mountains. 1197. Roter Kamm. SOUTH AFRICA. 1418. Jakkalsputs dunes.

Ctenolepisma penrithae Irish

Ctenolepisma (Sceletolepisma) penrithae Irish 1987: 175.

A species of the Central and Northern Namib Desert (Figure 18).

Literature records: NAMIBIA. 641. Okau. 657. Ogams. 865. Ambrose Bay. 870. Ugab River gate. 879. Nabab. 888. Messum River. 892. 10 km NE Cape Cross. 904. Grootspitskop. 921. 25 km ENE Hentiesbaai. 949. 20 km NE Swakopmund. (Irish 1987).

New material examined: 61 (27 females, 24 males, 10 unsexed); 58 NMNW, 2 CAS, 1 GRSW.
Localities: NAMIBIA. 655. near Ogams. 791. Uniab O v. duine. 801. Uniab Delta. 871. Ugab River nr. Mouth. 885. Messum Crater. 894. 1 km N Kaapkruis. 895. Kaapkruis, Robfabriek. 896. 6 km E Kaapkruis. 901. Lagunenberg. 902. Lagunenberg. 926. 12 mi. S Hentiesbaai. 927. 23 mi. N Swakopmund. 930. 6 km N Wlotzkasbaken. 947. Lower Ostrich Gorge. 963. Swakopmund, riverbed.

Ctenolepisma picturata Wygodzinsky

Ctenolepisma picturata Wygodzinsky 1955: 149.
Ctenolepisma (Sceletolepisma) picturata Wygodzinsky. Irish 1987: 190.

A poorly known species from the eastern half of southern Africa (Figure 16), here recorded for the first time from Botswana and Malawi.

In the case of relatively intact specimens, the bold black and white pattern is distinctive and the white frons can be particularly striking. Indifferently preserved material may resemble other non-slender-bodied taxa near *C. grandipalpis,* but *C. picturata* is always very heavily pigmented, a state less commonly present in superficially similar species. In the adult female, the narrow distal segment of the labial palp and the very short and slender ovipositor (often barely surpassing the tips of coxites IX), as well as the single pair of styli, are distinctive. In most female *C. grandipalpis* and similar species the latter combination would be found only in clearly immature specimens.

Literature records: SOUTH AFRICA. 1257. Skukuza (type locality). ZIMBABWE. 2012. Jessie, 5 mi. WNW West Nicholson. (Wygodzinsky 1955).
SOUTH AFRICA. 1253. Satara Region. (Irish 1987).

New material examined: 13 (10 females, 3 males); 9 BMSA, 3 CAS, 1 FORC.
Localities: BOTSWANA. 547. Farmers Brigade. MALAWI. 556. 6 mi. S of Njakwa. 557. 6 mi. N of Ekwendeni. SOUTH AFRICA. 1259. Boschkop Farm. ZIMBABWE. 2005. Siabuwa Comm. Lands. 2010. 54 mi. S of Umtali.

Ctenolepisma placida Irish

Ctenolepisma (Sceletolepisma) placida Irish 1987: 162.

Known only from a limited area of the southern Namib Desert, in sandy habitats adjacent to but outside the main dune sea (Figure 18).

Literature records: NAMIBIA. 1055. Vrede 80. 1067. Guinasibberg. 1125. Tsaukhaib Mts. 1134. 7 km N Grillenthal (type locality). 1145. Kaukausib fountain. 1146. 2 km E Kaukausib. 1147. Agub Mt. SW (Irish 1987).

New material examined: 4 (2 females, 1 male, 1 unsexed); 4 NMNW.
Locality: NAMIBIA. 1051. Wolwedans 144.

Ctenolepisma pluriseta Silvestri

Ctenolepisma terebrans var. *pluriseta* Silvestri 1908: 292, 1922:79 (*p.p.*).
Ctenolepisma terebrans pluriseta Silvestri. Wygodzinsky 1955: 139, 1965: 86.
Ctenolepisma pluriseta Silvestri. Paclt 1966:154.
Ctenolepisma (Sceletolepisma) pluriseta Silvestri. Irish 1987: 158, 1996a: 178, 1996b: 17.

Widespread in southern Africa on Kalahari sand (Figure 21).

Following the description of the very similar *C. suliptera*, it became necessary to verify the identity of all previous material identified as *C. pluriseta*. Those cases where this was not possible are marked with asterisks in the lists below and they are mapped separately in Figure 21. All unverified *C. pluriseta* records are from northern Namibia but they are interspersed among many verified Namibian *C. pluriseta* records, while there are no verified Namibian *C. suliptera* records, therefore it is likely that *C. suliptera* does not occur in Namibia and previous Namibian *C. pluriseta* records are indeed of this species.

Literature records (asterisks indicate unverified samples as above): BOTSWANA. 550. Kang-Khakhea (Silvestri 1908).
NAMIBIA. 914. Karibib*. 918. Okahandja (as Okahandia)*. 920. Usakos*. 923. Teufelsbach*. 950. Windhuk (as Winduck)* (Silvestri 1922).
TANZANIA. 2013. Makuyuni. 2014. Katesh (Wygodzinsky 1965).
NAMIBIA. 897. Farm Okosongomingo, Bez. Omaruru. 920. Usakos* (Paclt 1966).
BOTSWANA. 544. Nata. NAMIBIA. 833. Otjitoroa Süd 55*. 905. Labora 436. 906. Alkmar 512. 913. Volstruiswerf 513. 971. The Dunes 234. 1005. Blumfelde 95. 1023. 11 km SE Kalkrand. 1024. Chulon, Narib Oos 602. 1033. Sandfeld 314. 1041. Dickdorn 98. 1047. Daweb 43. 1056. 4 km WSW

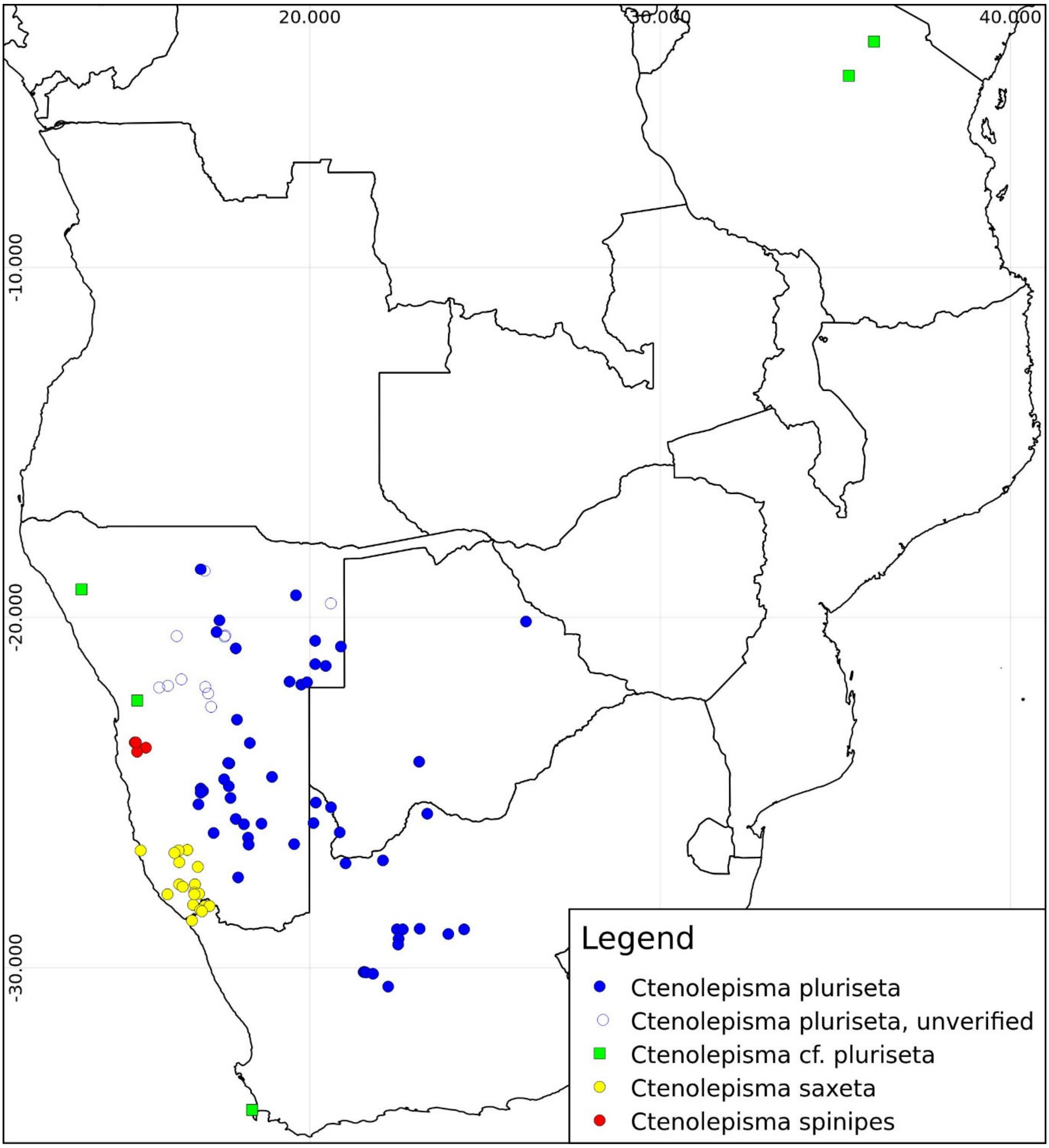

Figure 21: *Distribution of* Ctenolepisma pluriseta *and similar taxa,* C. saxeta *and* C. spinipes.

Gibeon. 1081. Karakanos. 1086. Tses (Irish 1987, except one sample referred to *C. suliptera*).
NAMIBIA. 732. Bushmanland. 754. Tsumkwe* (Irish 1996b).
Also 7 localities in Irish (1996a).

New material examined (asterisks indicate unverified samples for which identification pre-dates the description of *C. suliptera*): 211 (60 females, 67 males, 84 unsexed); 199 NMNW, 7 BMSA, 5 CAS.
Localities: NAMIBIA. 664. Mushare. 668. 12 mi. NW Namutoni*. 787. Gutweide 135. 823. Waterberg Plateau Park. 831. Hereroland West. 834. Hereroland West*. 845. Confluence Eiseb - Otjinoko Rivers. 854. Rooiboklaagte. 858. Hereroland East. 882. Hereroland East. 884. Gemsboklaagte. 1034. Haribes NW 18. 1045. 12 km SW Maltahöhe. 1048. Burgsdorf Noord 188. 1070. Amhub 78. 1085. Habis 181. 1099. Untersee 26. 1102. Khabus 146. 1106. Wildheim Ost 384. 1107. Gariganus 157. 1179. 37 mi. NW of Grünau*. SOUTH AFRICA. 1263. Bayip. 1266. Nossobkamp. 1272. Ottowa 1/30. 1288. Craig Lockhart. 1301. Melkdraai. 1320. Surprise 33. 1324. King's Rest 205. 1452. Middelplaas. 1458. Bingap 184. 1459. Holkrans. 1461. Duikersput.

The identity of the following material is uncertain and they have been mapped as *Ctenolepisma cf. pluriseta* in Figure 21:

A single immature male of *C. pluriseta* recorded from Hout Bay, Cape Peninsula (locality 1969) by Wygodzinsky (1955) can not be placed at present. Examination of the specimen proved inconclusive (Irish 1994b). Neither *C. pluriseta* nor *C. suliptera* have been recorded anywhere near the Cape Peninsula and on habitat grounds it is unlikely that either will occur there. Nothing similar was found in processed southern Cape material.

On grounds of habitat incompatibility, the records from Tanzania by Wygodzinsky (1965) are unlikely to be true *C. pluriseta* either but they could plausibly be *C. suliptera*.

Two further samples were identified as *C. pluriseta* at an early stage of this study but have not been rechecked since. Given what we now know of the species, its habitat preference and verified distribution range, both are highly unlikely to be true *C. pluriseta* but it is not immediately apparent what else they might be. The material is: NAMIBIA. 718. Okambondevlakte (NMNW). 932. 40 mi. E Swakopmund (CAS).

Ctenolepisma plusiochaeta Silvestri

Ctenolepisma plusiochaeta Silvestri 1922: 83 (*p.p.*); Wygodzinsky 1955: 154.
Ctenolepisma (Sceletolepisma) plusiochaeta Silvestri. Irish 1987: 185,1994b: 481, 1996a: 179, 1996b: 17.

Widespread in central South Africa and northern Namibia (Figure 20); the distribution does not make much biogeographical sense at present and this is ascribed to incomplete sampling. *C. plusiochaeta* is not normally myrmecophilous but small numbers have been recorded in ant nests, mostly with *Pheidole* spp. Myrmecophilous specimens should be carefully re-evaluated in case they represent a different species but this study was terminated before that could be done.

Literature records: NAMIBIA. 948. Neudamm. 950. Windhuk. 956. Bismarckberge, Voigtsland (type locality) (Silvestri 1922).
NAMIBIA. 710. Kowares (Wygodzinsky 1955).
NAMIBIA. 682. Namutoni. 698. Ozonjuitji Mbari. 759. Makuri Pan. 762. Chaudamas 33. 911. Otjihangweberg. 922. Onganja East 190. 934. 2 km NE Arandisberg. 951. Windhoek. 955. Hoffnung 66. 958. Pionierspark, Windhoek. 968. Gocheganas 26. 969. Groot Tinkas. 1033. Sandfeld 314. (Irish 1987).
NAMIBIA. 613. 8 km E Mashari. 617. 1 km SW Qonisha River. 618. 3 km NE Chwaha River. 632. Nakatwa. 666. Kaudom Game Reserve. 757. Aha Hills. (Irish 1996b).
Also 17 localities in Irish (1994b) and 3 in Irish (1996a).

New material examined: 34 (13 females, 15 males, 6 unsexed); 12 NMNW, 21 BMSA, 1 CAS. Also 8 hosts.
Localities: NAMIBIA. 581. 10 km SE Etunda. 587. Ovamboland. 656. Acacia. 665. S of Mushara. 668. 12 mi. NW Namutoni. 755. Otjihaenenavallei. 793. Omega 978. 811. Waterberg Plateau Park. 830. Waterberg Rest Camp. 844. Hamakari Süd 373. 868. Tsisabvallei. 869. Epukiro River. 891. Erongo Ost 82. 898. Marenica 114. 925. Westfalenhof 23. SOUTH AFRICA. 1263. Bayip (*Tetramorium rufescens* Stitz). 1266. Nossobkamp (*Pheidole* sp.). 1328. Loch Nagar. 1407. Gariep (*Pheidole* sp.). 1409. Eureka (*Pheidole* sp.).

Ctenolepisma pretoriana Wygodzinsky and undescribed species near

Ctenolepisma pretoriana Wygodzinsky 1955: 140.
Ctenolepisma (Sceletolepisma) pretoriana Wygodzinsky. Irish 1987: 153.

C. pretoriana is only known from the type locality west of Pretoria (Figure 15).

Literature records: SOUTH AFRICA. 1285. Hennop's rivier (type locality) (Wygodzinsky 1955). 1286. Hennopsrivier. (Irish 1987).

The original description stated that urosternite VI had 1+1+1 bristlecombs but Irish (1987) found that the holotype had only 1+1 bristlecombs on urosternite VI, as had newly collected topotypical material. Since then, additional material conforming to *C. pretoriana* in most respects, but with 1+1+1 bristlecombs on urosternite VI, has come to light from the same general area: SOUTH AFRICA. 1255. Klein Kariba. (BMSA). Further material with three pairs of styli, but with details of urosternal setation no longer available, may also belong here: BOTSWANA. 548. 50 km SE Palapye (NMNW). The study was terminated before the case could be investigated further but it is clear that two different species are involved, of which one is undescribed. The latter material was mapped as *C.* near *pretoriana* in Figure 15.

Ctenolepisma prompta Silvestri

Ctenolepisma prompta Silvestri 1922:77.
Ctenolepisma petronia Wygodzinsky 1955: 143.
Ctenolepisma cf. *petronia* Wygodzinsky 1965: 86.
Ctenolepisma cf. *prompta* Silvestri. Mendes 1982*:* 638.
Ctenolepisma (Sceletolepisma) prompta Silvestri. Irish 1987: 177, 1994b: 482, 1996a: 180, 1996b: 17.

Widespread in Central South Africa and Northern Namibia (Figure 18), with distribution biased towards the Savanna Biome. Gaps in distribution as currently known can be attributed to unequal sampling effort. It has also been recorded from Tanzania, which is entirely plausible on habitat grounds but needs confirmation because of the wide separation from its verified range. It is here recorded for the first time from Swaziland, in fact the first of any Lepismatidae from that country.

Literature records: NAMIBIA. 950. Windhuk (type locality) (Silvestri 1922).
LESOTHO. 554. Mt. Morosi, 7500 ft. SOUTH AFRICA. 516. Lootsberg. 1340. Botha's Pass. 1384. Upington. 1430. Kakamas. (All as *C. petronia)*. (Wygodzinsky 1955).
TANZANIA. 2015. Ngorongoro Crater. (as *C.* cf. *petronia*) (Wygodzinsky 1965).
SOUTH AFRICA. 1277. Hartbeestpoort Dam. 1739. Barrow's Hope. (as *C.* cf. *prompta*) (Mendes 1982).
NAMIBIA. 762. Chaudamas 33. 807. Karakapi - Daneib confluence. 873. Wewelsburg 191 (misspelled as Welwesburg). 889. Ombirisu 684. 904. Grootspitskop. 911. Otjihangweberg. 922. Onganja East 190. 951. Windhoek. 971. The Dunes 234. 1014. Far East dunes. SOUTH AFRICA. 469. Victoria West. 1240. Moonlight. 1348. Christiana. 1703. Wellwood. (Irish 1987).
NAMIBIA. 757. Aha Hills. (Irish 1996b).
Also 87 localities in Irish (1994b) and 21 in Irish (1996a).

New material examined: 206 (95 females, 90 males, 21 unsexed); 159 BMSA, 39 NMNW, 3 CAS, 2 TMSA, 2 USNM, 1 UOVS.
Localities: NAMIBIA. 694. Batia. 837. Eiseb River. 839. Theronsvlei. 842. Eiseb River. 844. Hamakari Süd 373. 899. Spes Bona 105. 924. Swakoppoortdam. 976. Us Pass road. 979. 14 mi. N of Rehoboth. SOUTH AFRICA. 1245. 10 mi. E of Pietersburg. 1254. Thabazimbi. 1263. Bayip. 1282. Swartkoppies. 1296. Kamkwa. 1305. 2 km N Munro. 1323. Murray. 1330. Koppiesdam Nat. Res. 1332. Vrysoutpan. 1349. Hartebeestpan 330. 1359. Allemanskraaldam. 1393. Avondson. 1401. Kaboes. 1402. Mamapula. 1411. Witplaas. 1415. Merino. 1417. Brakfontein. 1423. Quintus. 1433. 7 km W Campbell. 1442. Badsfontein. 1443. Ysterberg. 1446. Driekoppies. 1464. Roodepan. 1475. Dabenoris. 1606. Rooikop. 1647. Jakkalsfontein. 1648. Wynton. 1660. Schoombeesklip. 1661. Hartebeestfontein. 1696. Wolwevlei. 1716. Modderfontein. 1717. Beletskloof. 1726. Oudebergpas. 1727. Goliatskraalkop. 1734. Cradock. 1743. Mountain Zebra National Park. 1782. Voslonia. 1789. Vlakfontein. 1796. Quimby Holme. 1803. 8 km NW Ebenezer. 1858. 1 km N Koup. SWAZILAND. 2000. Mbabane.

Ctenolepisma psammophila Irish

Ctenolepisma (Sceletolepisma) psammophila Irish 1988a: 42.

Only found on dunes in the southwestern Kalahari (Figure 19). Here recorded from South Africa for the first time.

Literature records: NAMIBIA. 1153. Swartbaas Ost 285. 1156. Vredeshoop 283. 1177. Hohedun 277 (type locality). (Irish 1988a).

New material examined: 8 (6 females, 2 males); 8 BMSA.
Localities: NAMIBIA. 1106. Wildheim Ost 384. SOUTH AFRICA. 1271. Klein-Stofpan. 1338. 5 km SE Noenieput. 1373. Karakoelproefplaas.

Ctenolepisma saxeta Irish

Ctenolepisma (Sceletolepisma) saxeta Irish 1987: 180.

A species of the arid northern Succulent Karoo Biome, mainly in Namibia (Figure 21). The distribution as currently known is likely the entire range.

Literature records: NAMIBIA. 1117. Plateau 38. 1119. Lüderitz. 1187. Süd Witpütz 31. 1204. 10 km NW Rosh Pinah. 1220. Rooilepel. SOUTH AFRICA. 1355. Maerpoort. 1375. 5 km NE Cornellskop (type locality). 1412. 13 km SSW Grootderm. (Irish 1987).

New material examined: 29 (13 females, 15 males, 1 unsexed); 25 NMNW, 3 TMSA, 1 BMSA.
Localities: NAMIBIA. 1122. 1 km NW Aus. 1127. Heinrichsfelde 10. 1148. Nieu-Tsaus 142. 1160. Rooiberg 70. 1185. Aurus. 1193. Aurusberg. 1201. Spitskop 111. 1205. Rosh Pinah at. 1206. Boegoeberg. 1207. 10 km NW Rosh Pinah. SOUTH AFRICA. 1354. Kodaspiek. 1365. 2 km S Wallekraal Mine.

Ctenolepisma solitaria sp. nov.

http://zoobank.org/10B3CAD7-9AEB-4206-9178-FA5E5A5DD577

Ctenolepisma weberi Wygodzinsky 1955: 152, *nec* Escherich 1905.

Wygodzinsky (1955) redescribed *C. weberi* but examination of topotypical material of the latter (see below) has shown that they are not the same. A new name is here proposed for *C. weberi sensu* Wygodzinsky. Wygodzinsky's description, of an adult male, is sufficient to recognise the species. The female remains unknown.

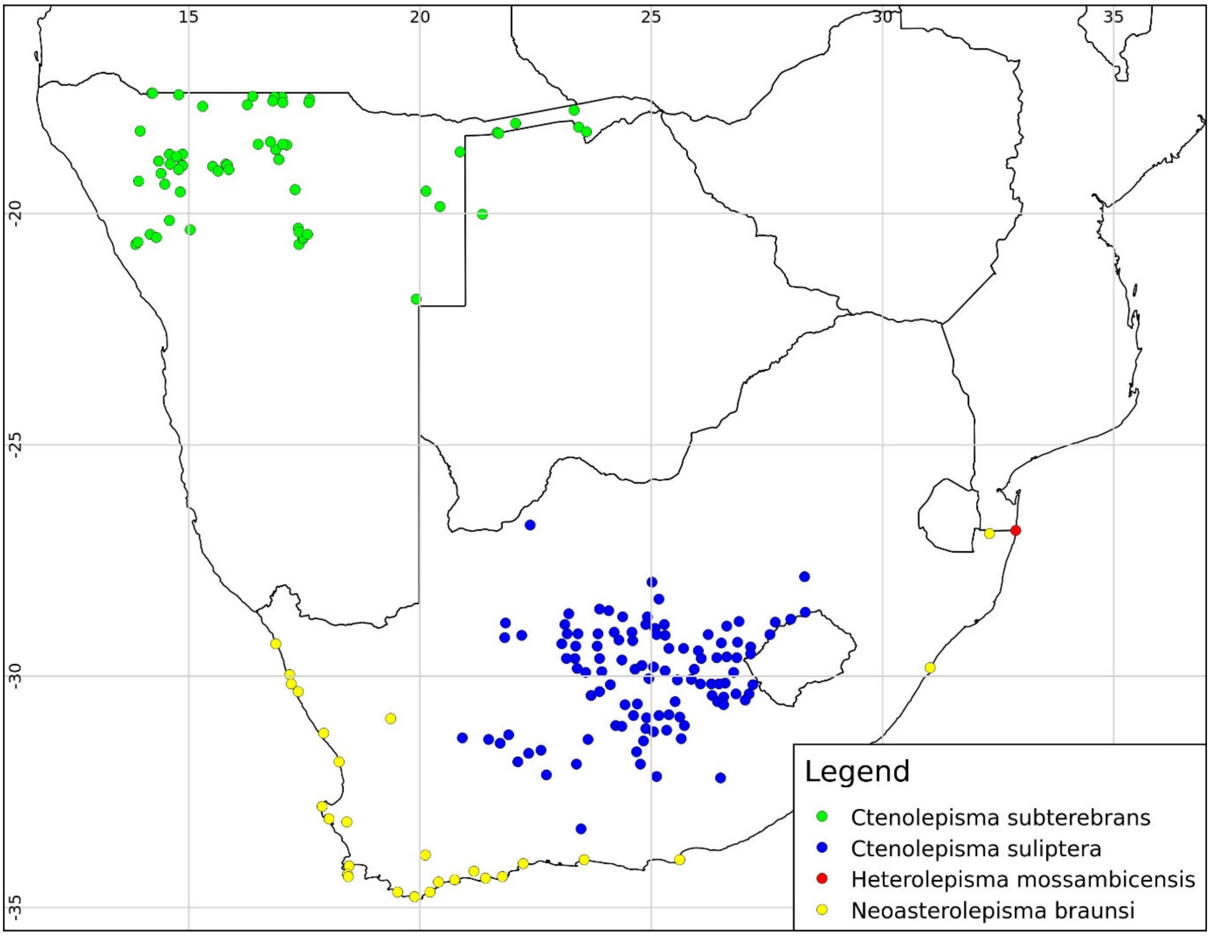

Figure 22: *Distribution of* Ctenolepisma subterebrans*,* C. suliptera*,* Heterolepisma mossambicensis *and* Neoasterolepisma braunsi.

C. solitaria differs from *C. weberi* in the setation of urosternite VI, which has 1+1+1 bristlecombs in the present species but only 1+1 in *C. weberi*. The only other southern African species with a similar urosternal setation to *C. solitaria* are *C. africanella* and the undescribed species near *C. pretoriana* listed above. *C. solitaria* differs from *C. africanella* in having only 1+1 bristlecombs on the metasternum, and 5 sensory papillae on the labial palp. It differs from the undescribed species in urotergal setation.

Material examined: Holotype, male, body length 10.7 mm, labelled: "S. Afr. Cape, 1/1 1951. Windhoek Farm. På och under torra Aloëstammer. Ca. 20 miles ONO Bredasdorp. Swedish South Africa Expedition 1950-51. Dr. Brinck - Dr. Rudebeck. Zoological Institute, University, Lund. / 912. / Ctenolepisma weberi Escherich, Wygodzinsky det. INST. MED. REG. / Holotypus, Ctenolepisma solitaria sp. nov., det. J. Irish, 1986." In alcohol. (MZLU).
Wygodzinsky listed 3 males. Mere fragments remain of the other two and they are not regarded as functional types. The type locality corresponds to locality 1987. Bredasdorp, 20 mi. ENE (Figure 20).

Etymology: from the Latin *solitarius, -a* (alone), referring to the fact that the species is reliably known from a single specimen only. Although the current project did collect near the type locality, it was terminated before that material had been studied.

Ctenolepisma spinipes Irish

Ctenolepisma (Sceletolepisma) spinipes Irish 1987: 200.

The species remains known only from a limited area along the northern edge of the main Namib sand sea, where it lives on gravelly interdune valleys (Figure 21). It has not been found on the dunes themselves, nor on the gravel plains outside the sand sea.

Literature records: NAMIBIA. 997. Kahani dune (type locality). 1012. Mniszechi's Vlei. 1016. Tsondab Flats. (Irish 1987).

New material examined: 1 female (GRSW).
Locality: NAMIBIA. 998. Gobabeb IDV.

Ctenolepisma subterebrans Irish

Ctenolepisma (Sceletolepisma) subterebrans Irish 1987: 166, 1996b: 17.

Known mainly from northern Namibia (Figure 22) but probably also occurs in adjacent Angola and Zambia. Here recorded from Botswana for the first time.

Literature records: NAMIBIA. 634. 4 km NE Orumana. 647. SE Ovamboland. 658. Andonivlakte S. 685. Okumutati. 695. Olifantsrus. 698. Ozonjuitji Mbari. 702. Leeukamp. 714. Luiperdskop. 722. Khowarib Schlucht. 730. Zebrapomp, Kaross. 747. Tsumkwe, 40 km NW. 748. 10 km N Kamandjab. 794. Welkom 680. 838. Huab River (type locality). 843. Huab River Valley. 906. Alkmar 512 (Irish 1987).

NAMIBIA. 608. Kwando River. 624. 13 km W Omega. 630. Mudumu Nat. Park. 636. Sangwali. 637.Thinderevu Omuramba. 669. Leeupan. 773. Tse-Baraka. (Irish 1996b).

New material examined: 393 (119 females, 141 males, 133 unsexed); 389 NMNW, 4 BMSA.
Localities: BOTSWANA. 543. Gchwihaba Hills. NAMIBIA. 577. Hippo Pool. 579. Ruacana Falls area. 582. Mahenene Agric. Research Station. 584. Edimba. 586. Odila River. 587. Ovamboland. 590. Onduri. 592. Onghwiya. 595. Onamihongwa. 596. Etudilondjaba. 600. 21 km S Eenhana. 603. Ogongo Agric. Col. 638. Mahango Game Reserve. 652. Poacher's Point. 654. Beisebvlakte. 656. Acacia. 664. Mushare. 665. S of Mushara. 671. NW Etosha Nat. Park. 673. Dorsland. 678. Dorstland. 683. Bloubokdraai. 684. Etosha Park. 690. Onauatinda. 691. 10 km NNW Okondeka. 692. Olifantsrus. 693. 3.5 km N Okondeka. 703. W of Wolfsnes. 713. Sprokieswoud. 743. Aigamas 471. 812. Elandsdrink. 815. Navarre 383. 822. Waterberg Plateau Park. 825. De Riet 720. 826. Hereroland West. 829. Rendezvous 533. 831. Hereroland West. 834. Hereroland West. 844. Hamakari Süd 373.

Ctenolepisma suliptera Irish

Ctenolepisma (Sceletolepisma) suliptera Irish 1994b: 476, 1996a: 180.
Ctenolepisma pluriseta Silvestri. Mendes 1982: 646, *nec* Silvestri 1908.
Ctenolepisma (Sceletolepisma) pluriseta Irish 1987: 158 (*p.p.*), *nec* Silvestri 1908.

Currently known from Central South Africa only (Figure 22) but probably more widespread.

Literature records: SOUTH AFRICA. 1739. Barrow's Hope (as *C. pluriseta*). (Mendes 1982). Specimen not examined but illustration of ovipositor tip leaves no doubt that this is indeed *C. suliptera*.
SOUTH AFRICA. 1724. De Hoop (as *C. pluriseta*). (Irish 1987). Re-examined and verified to be *C. suliptera*.
Also 49 localities in Irish (1994b) and 39 in Irish (1996a).

New material examined: 43 (28 females, 13 males, 2 unsexed); 36 BMSA, 7 NMNW.
Localities: SOUTH AFRICA: 1314. Kalkrandjies 703. 1349. Hartebeestpan 330. 1393. Avondson. 1396. Schmidtsdrif, 15 km N. 1415. Merino. 1423. Quintus. 1441. Wegdraai. 1452. Middelplaas. 1623. Springfontein. 1625. Driefontein 137. 1630. Bobbejaankop. 1638. Sunnyside. 1648. Wynton. 1651. Glen Alan. 1659. Teebus, 2 km NW. 1734. Cradock. 1882. Willowmore.

Ctenolepisma terebrans Silvestri

Ctenolepisma terebrans Silvestri 1908: 291; Wygodzinsky 1955: 138, 1970; 253; Watson and Irish 1988: 286.
Ctenolepisma (Sceletolepisma) terebrans Silvestri. Irish 1987: 155, 1996a: 181, 1996b: 17.

A species of sandy habitats, widespread in western southern Africa, with distribution centred on the wider Kalahari sand system and outliers (Figure 23). Specimens from the Namib Desert sand sea tend to be smaller with longer appendages, parallel-sided, and lack the characteristic colour pattern compared to those from the rest of the range. Some surviving notes suggest a difference in thoracic sternal setation as well. As a young taxonomist I noticed this (Irish 1987) but eventually decided I must be mistaken and that Namib specimens were not a distinct species, mainly because the initial identification had been done by no less than the acknowledged world expert at the time, Dr. P. Wygodzinsky. Today I believe them to be probably distinct but for lack of sufficient surviving information both are still lumped as *C. terebrans* below.

The intact scale pattern of typical (Kalahari) specimens is very distinctive and resembles that in Figure 2d. The overall ground colour is dark grey with a golden sheen. There are narrow yellow lines on the lateral and posterior edges of the thoracic nota, as well as the posterior edges of all urotergites, creating a transverse striped effect. Description based on a live, freshly moulted individual from Garingberg (locality 1463).

Literature records: BOTSWANA. 550. Kang-Khakhea. 551. Severelela-Kooa (type locality) (Silvestri 1908).
SOUTH AFRICA. 1493. Aggeneys. (Wygodzinsky 1955).
SOUTH AFRICA. 451. 18 mi. De Aar to Philipstown. 1610. Colesberg District. (Wygodzinsky 1970).

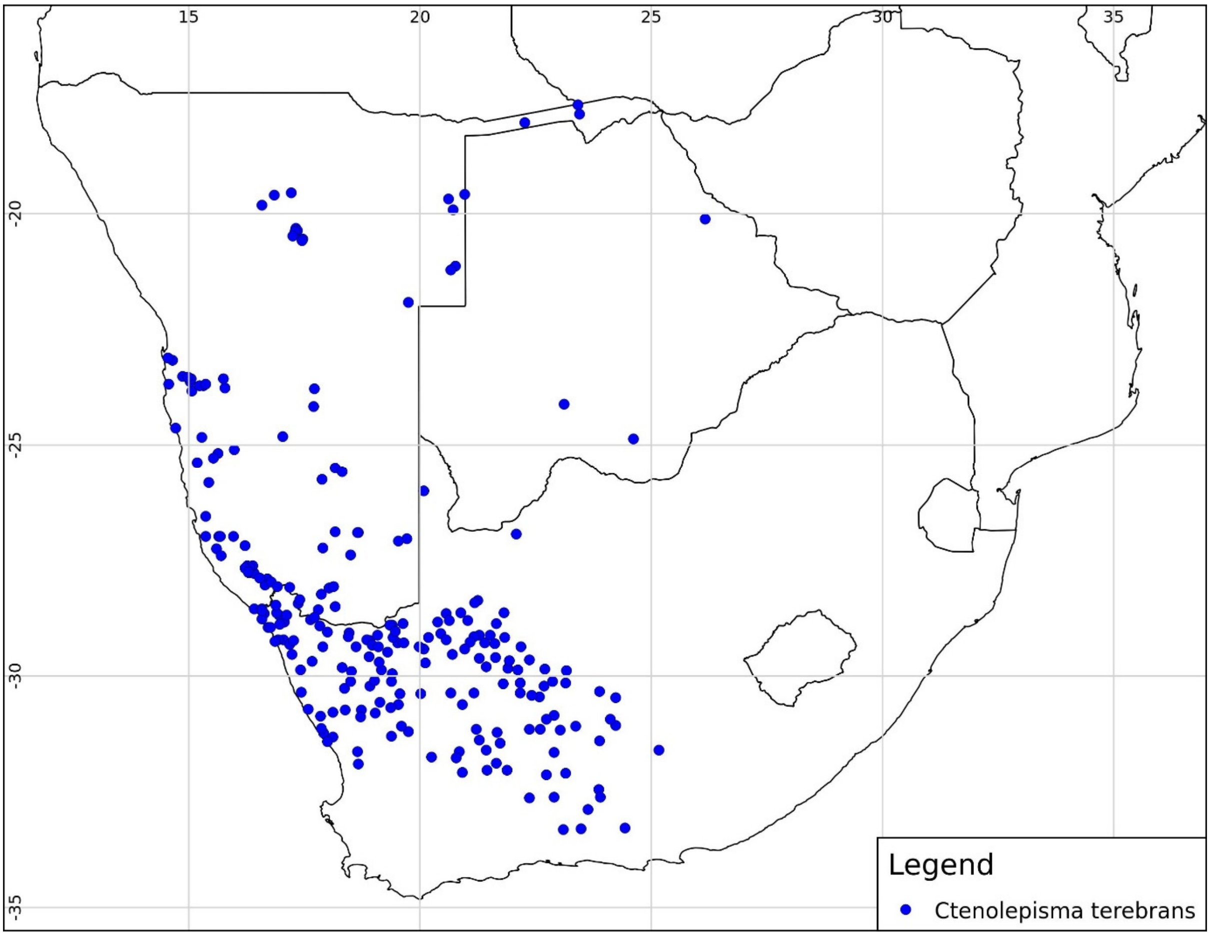

Figure 23: *Distribution of* Ctenolepisma terebrans.

NAMIBIA. 999. Gobabeb. (Edney 1971a, b). Identification in doubt, see Irish (1987: 157).

BOTSWANA. 544. Nata. NAMIBIA. 752. Tsumkwe, 50 km E. 782. Nama Pan. 913. Volstruiswerf 513. 980. Rooibank, 10 km W. 984. Rooibank. 994. Jumbo dune. 997. Kahani dune. 1007. Visitor's dune. 1009. Elephant Valley. 1011. Noctivaga dune. 1012. Mniszechi's Vlei. 1014. Far East dunes. 1016. Tsondab Flats. 1024. Chulon, Narib Oos 602. 1035. Fischersbrunn. 1042. Witberg. 1061. 15 km NW Chowagasberg. 1066. 1 km SE Guinasibberg. 1072. Uri-Hauchab Mt. 1081. Karakanos. 1083. SE 2515Cd2. 1108. Haris. 1137. Donkermodder 60. 1142. Grillenthal. 1145. Kaukausib fountain. 1146. 2 km E Kaukausib. 1147. Agub Mt. SW. 1153. Swartbaas Ost 285. 1156. Vredeshoop 283. 1163. Tsaus dunes. 1176. Klinghardts Mountains. 1185. Aurus. 1198. Boesmanberg. 1212. Obib Mountain. 1229. Oranjemund. 1232. Vioolsdrif, 11 km ENE. SOUTH AFRICA. 1382. Klipneus. 1387. 10 km WSW Khubus. 1392. 4 km WSW Grootderm. 1394. Kortdoringberg. 1403. Jakkalsputs. 1412. 13 km SSW Grootderm. 1429. Vioolsdrif. 1476. Hierlê, op Nongcaib. 1492. Kleinduin. 1495. Farquarson. 1535. Schaaprivier. 1724. De Hoop (Irish 1987).

NAMIBIA. 602. Singalamwe. 612. Menziasubila Mulopo. 621. 8 km E Omega. 763.Tjokwe. (Irish 1996b).
Also 56 localities in Irish (1996a).

New material examined: 537 (189 females, 250 males, 98 unsexed); 292 NMNW, 199 BMSA, 23 CAS, 10 TMSA, 9 SAMC, 4 GRSW.
Localities: NAMIBIA. 750. Uisib 427. 753. Merwe 412. 770. Nimitz 353. 810. Waterberg Plateau Park. 818. Waterberg Plateau Park. 820. Waterberg Plateau Park. 828. Waterberg Plateau Park. 834. Hereroland West. 835. Okakarara. 869. Epukiro River. 876. Epukiro River. 984. Rooibank. 995. Khomabes. 1002. Kuiseb River. 1004. Namib Park SE Corner. 1008. Half Shaft Camp. 1015. Itaga 198. 1040. 3 mi. E of Maltahöhe. 1051. Wolwedans 144, Chateau dune. 1077. Mukorob. 1079. Dorn-Daberas 16. 1136. Aikanes 128. 1138. Donkermodder 60. 1167. Oase 195. 1168. Klinghardt Mountains. 1173. Noachabeb 97. 1186. Kegelberg. 1190. E Aurus Mts. 1192. S of Aurus Vlei. 1193. Aurusberg. 1194. Roter Kamm. 1197. Roter Kamm. 1203. Obib dunes. 1207. 10 km NW Rosh Pinah. 1211. 2 km ESE Rosh Pinah. 1213. Norachas 14. 1214. Lorelei Mine, 2 km SE. 1215. Norachas 14. 1216. Fish River Mouth. 1225. Middelpos. 1226. Aussenkehr se Berg, S slope. 1228.

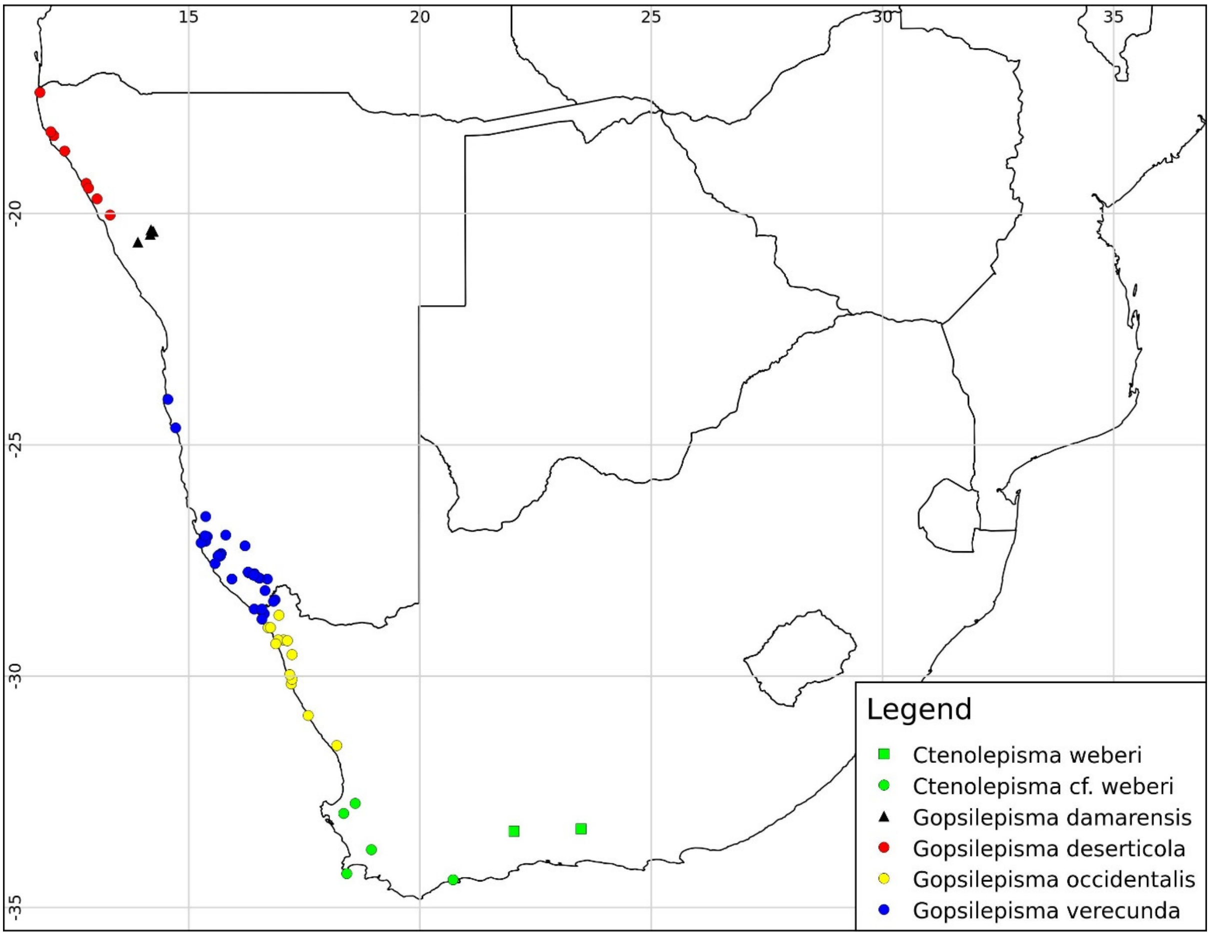

Figure 24: *Distribution of* Ctenolepisma weberi *and cf.* weberi*,* Gopsilepisma damarensis*,* G. deserticola*,* G. occidentalis *and* G. verecunda

Bruinheuwel 257. 1230. 18 mi. N of Viools Drift. SOUTH AFRICA. 1295. 5 km N Kafferspan. 1320. Surprise 33. 1373. Karakoelproefplaas. 1381. 8 km WNW Upington. 1406. 7 km NW Keimoes. 1407. Gariep. 1413. 10 km N Kakamas. 1418. Jakkalsputs dunes. 1419. Black Hills. 1425. Boegoeberg-Suid. 1431. Kakamas. 1432. Brakfontein. 1435. W Wildeperderant. 1436. Garingberg. 1443. Ysterberg. 1445. Vaalkop. 1447. Katkop. 1454. Coboopduine. 1455. Swartduinkop. 1462. Baviaanskop. 1466. 2 km N Holgatmond. 1467. Holgat Riv. 5 km from mouth. 1478. SW Henkries. 1480. Apoolskop. 1482. Swartkoppies. 1488. Amam. 1489. 4 km S Pofadder. 1491. Muisvlak. 1496. Gamsberg Site D. 1497. Port Nolloth. 1498. Port Nolloth. 1506. Witkoppies. 1507. Gannapoort. 1510. SW Abbevlak. 1512. Blomhoek, duine S. 1513. Dwarsberg. 1514. 100 km W Pofadder. 1515. N Wolfkop. 1516. Vaalkop. 1522. Luttigshoop. 1523. Tnong-Gys. 1526. Klawermuis. 1538. Beesskeurvlei. 1544. Dabeep. 1548. Witduin. 1549. Koffiemeul. 1553. 10 km E Gamoep. 1557. Gifkop 166. 1564. Nabaab. 1567. Stofkraal. 1568. Calvinia District. 1576. Wolfkop. 1578. Kap-Kap. 1585. 5 km W Wallekraal. 1593. 69 km N Loeriesfontein. 1599. Springbokkeel. 1603. Gt. Rooiberg. 1609. Vaalkop. 1612. Rietkop. 1615. Stofkraal. 1616. Lepelvlakte. 1620. 33 km N Bitterfontein. 1621. Roelf se Berg. 1626. Oudam. 1629. Leeukuil. 1640. Kareeboomwater. 1642. S Katdoringvlei. 1649. 5 km NE Windkraal. 1652. Brakfontein. 1656. Ouberg. 1657. Rooivlei. 1667. SE Baievlei. 1675. Rooikop. 1679. Gipsmyn. 1697. Olyfen. 1705. Klipheuwelkoppe. 1706. Blomfontein. 1710. Vaalkop. 1715. Bruinrug. 1769. Wolwekop. 1787. Vrede-en-Lus. 1788. Vanderbergskuil. 1793. Plaatjiesrivier. 1832. Blomplaas. 1879. 6 mi. NE Steytlerville. 1883. Willowmore. 1889. Volmoed.

Ctenolepisma ugabensis Irish

Ctenolepisma (Sceletolepisma) ugabensis Irish 1987: 170.

A range-restricted Namib Desert species (Figure 15), not seen again since the original description.

Literature records: NAMIBIA. 855. Vegkop 528. 862. Ugab River (type locality). (Irish 1987).

Ctenolepisma weberi Escherich

Ctenolepisma weberi Escherich 1905: 86.
Ctenolepisma (Sceletolepisma) weberi Escherich. Irish 1987: 155.

Irish (1987) noted that the original description of *C. weberi* was inadequate by modern standards and that the redescription by Wygodzinsky (1955) did not necessarily refer to the same species. The types of *C. weberi* have not been traced but newly collected topotypical material allowed the redescription below. This confirmed that *C. weberi sensu* Wygodzinsky is a different species and it has been renamed as *C. solitaria* above. The illustrations that should have accompanied this redescription have unfortunately also been lost.

Body shape and general appearance reminiscent of *Thermobia* spp. Body length of adult female 9 mm. Ground colour of body yellowish white. Violaceous pigment present, especially distinct on the palpi, legs and posterior abdomen, forming annulations on the legs and caudal filaments. Scales dorsally fairly dark brownish, ventrally transparent. Macrosetae golden yellow. Maxillary palp moderately slender. Distal segment of labial palp unilaterally dilated, about 1 to 1.25 times wider than long; sensillae not seen.

Thoracic nota each with 1+1 posterolateral bristlecombs of 3-4 macrosetae each. Pronotum with 8+8, meso- and metanota each with 6-7+6-7 lateral bristlecombs of 2-4 macrosetae each.

Urotergal setation: 1+1 / 3+3 / 3+3 / 3+3 / 3+3 / 3+3 / 3+3 / 2+2 / 0 / 1+1 bristlecombs. Sublateral bristlecombs of 5-7, median and submedian bristlecombs of 4-6 macrosetae each. Urotergite X trapezoidal, short, posteriorly straight to slightly emarginate, with a marginal setal fringe and 1+1 bristlecombs of 5 macrosetae each.

Prosternum with 2-3+2-3 bristlecombs of 5-7 macrosetae each. Mesosternum with 1-2+1-2 bristlecombs of 4-11 macrosetae each. Metasternum with 1+1 bristlecombs of 9-11 macrosetae each. Successive posteriad pairs of legs lengthening moderately, tibia III about 1.75 times length of tibia I. Tibiae each with 3-4 strong ventral spines.

Urosternal setation: 0 / 1 / 1+1+1 / 1+1+1 / 1+1+1 / 1+1 / 1+1 / 1+1 / - bristlecombs. Lateral bristlecombs of 7-12, median bristlecombs of 5-7 macrosetae each. Coxites IX subtriangular, fairly slender in female, with a robust marginal setal fringe. Adult female with two pairs of styli, immature male with one pair only. Ovipositor slender, fairly short, reaching beyond the apices of styli IX by about 0.3 times the latter's length; apices of gonapophyses unsclerotised.

The only other southern African species with similar urosternal setation to *C. weberi* is *C. pretoriana*, which differs by having three pairs of styli in adults and by not having annulations on the antennae and caudal filaments.

Redescribed from two specimens: 1 adult female, 1 immature male, with locality: 1896. Swartbergpas, summit. (NMNW). They were collected by beating dry Restionaceae.

Literature records: SOUTH AFRICA. 1881. Willowmore. 1895. Zwartberg-Pass (type locality). (Escherich 1905). (Note: Despite repeated collections over many years at and around Willowmore, no material potentially referable to this species was ever found there. The habitat difference between Willowmore and the top of Swartberg Pass make it less likely that the same species would occur at both.)

A species of the Fynbos Biome (Figure 24). Material from at least the following localities were provisionally sorted to *C. weberi* but the study was terminated before their identity could be confirmed. They may or may not be *C. weberi, C. solitaria*, or neither, and were included in Figure 24 as *C.* cf. *weberi*: SOUTH AFRICA. 1810. Keurbos. 1841. 5 km S Jantjiesfontein. 1941. Paarlrots. 1981. Sirkelsvlei. 1990. Potteberg Estates. Though no other definite locality records survive, I recall a large *Ctenolepisma* species, presumably *C. weberi*, with a distinctive scale pattern consisting of a dark median dorsal line along the whole length of the body, that could reliably be found by beating dry Restionaceae remains in especially the high-altitude Fynbos Biome throughout the southern Cape.

Genus *Gopsilepisma* Irish

Gopsilepisma Irish 1989: 135.

The genus is only known from shrub-coppice dune habitats in near-coastal southwestern Africa.

Key to Gopsilepisma *species:*

1. Urosternite III with 1+1+1 bristlecombs 2
- Urosternite III with a single median bristlecomb only .... *G. damarensis*
2. Adults with one pair of styli 3
- Adults completely lacking styli .... *G. deserticola*
3. Median urosternal bristlecombs of 9-16 macrosetae each .... *G. occidentalis*
- Median urosternal bristlecombs of 2-5 macrosetae each .... *G. verecunda*

Gopsilepisma damarensis Irish

Gopsilepisma damarensis Irish 1989: 142.

A range-restricted species only found on windblown sand in the lower Huab River valley (Figure 24); it has not been recorded again since the original description. *Ctenolepisma huabensis* and *Psammolepisma huabensis*, similarly range-restricted, occur in the same habitat.

Literature records: NAMIBIA. 814. Bethanis. 819. Vrede 719. 825. De Riet 720. 838. Huab River. (Irish 1989).

Gopsilepisma deserticola Irish

Gopsilepisma deserticola Irish 1989: 141.

Found on the northern Namib Desert coast (Figure 24); it has not been recorded again since the original description.

Literature records: NAMIBIA. 573. 3 km E Bosluisbaai. 635. Cape Fria Radio Station. 641. Okau. 667. Skeleton Coast Park. 726. 8 km E Möwebaai. 736. Hoanib Oase. 761. Skeleton Coast Park. 785. Samanab River. (Irish 1989).

Gopsilepisma occidentalis Irish

Gopsilepisma occidentalis Irish 1989: 139.
Gopsilepisma occidentoralis (lapsus) Irish 1989: 144.

Found on the Namaqualand coast (Figure 24). A single specimen of what is believed to have been this species (identified by overall habit and linear pattern) was also seen at locality 1624, Groenriviermond, but evaded capture. Systematic sampling has confirmed the striking parapatric distribution between this species and *G. verecunda*.

Literature records: SOUTH AFRICA. 1492. Kleinduin (type locality). 1671. Kommandokraal. (Irish 1989).

New material examined: 27 (13 females, 10 males, 4 unsexed); 4 BMSA, 17 NMNW, 6 GRSW.
Localities: SOUTH AFRICA. 1418. Jakkalsputs dunes. 1466. 2 km N Holgatmond. 1467. Holgat Riv. 5 km from mouth. 1491. Muisvlak. 1494. Augrabies. 1508. S McDougall's Bay. 1523. Tnong-Gys. 1559. Elandsklip. 1560. Geelduine. 1574. Somnaasbaai.

Gopsilepisma verecunda Irish

Gopsilepisma verecunda Irish 1989: 135.

Common in the arid Northern Succulent Karoo Biome (Figure 24) with an isolated population in the Meob-Conception area further north.

Literature records: NAMIBIA. 1019. Conception. 1035. Fischersbrunn. 1108. Haris. 1139. Diamond Area I. 1140. 2 km N Grillenthal. 1142. Grillenthal. 1143. 2 km N Dreizackberg. 1155. 10 km S Grillenthal. 1159. Prinzenbucht. 1163. Tsaus dunes. 1171. Klinghardts Mountains. 1172. Klinghardts Mountains. 1174. Klinghardts Mountains. 1175. Sargdeckel. 1182. Buntfeldschuh. 1198. Boesmanberg. 1202. Diamond Area I. 1206. Boegoeberg. 1218. Obib dunes. 1229. Oranjemund. 1392. SOUTH AFRICA. 4 km WSW Grootderm. 1412. 13 km SSW Grootderm. (Irish 1989).

New material examined: 69 (35 females, 28 males, 6 unsexed); 1 BMSA, 68 NMNW.
Localities: NAMIBIA. 1194. Roter Kamm. 1197. Roter Kamm. 1200. Boesmanberg. 1203. Obib dunes. 1207. 10 km NW Rosh Pinah. SOUTH AFRICA. 1365. 2 km S Wallekraal Mine. 1374. Bloeddrif, 3 km on Annisfontein Road. 1425. Boegoeberg-Suid.

Genus *Hemilepisma* Paclt

Braunsiella Escherich 1905: 67 (*nec Braunsiella* Raffray 1901).
Braunsina Escherich 1905: 145 (*nec Braunsina* Buckman 1902).
Hemilepisma Paclt 1967: 34.

The genus is monospecific.

Hemilepisma heymonsi (Escherich)

Braunsiella heymonsi Escherich 1905: 68.
Braunsina heymonsi (Escherich). Silvestri 1922: 85; Wygodzinsky 1955: 163.
Hemilepisma heymonsi (Escherich). Paclt 1967: 34.
Braunsiella grassii Escherich 1905: 69. **syn. nov.**
Braunsina grassii (Escherich). Wygodzinsky 1955: 163.
Hemilepisma grassii (Escherich). Paclt 1967: 34.
Braunsina nudata Wygodzinsky 1955: 163. **syn. nov.**
Hemilepisma nudatum (Wygodzinsky). Paclt 1967: 34.

All described *Hemilepisma* species are synonymised here. Escherich (1905) described the genus and original two species *H. heymonsi* and *H. grassii*, both from Willowmore in South Africa. He distinguished them on details of body shape, pigmentation and appendage length, with *H. grassii* having a more slender body, shorter appendages and no pigmentation. I found immature *Hemilepisma* specimens to differ in the same ways from adults in the same samples. *H. grassii* was described with a body length about 20% shorter than *H. heymonsi*, supporting the notion that it was immature. Even to the naked eye, the small, slender, light-reddish *grassii* morphotype is easily distinguished from the larger, more globose, dark brown *heymonsi* morphotype, but careful examination of all available material revealed no taxonomically significant

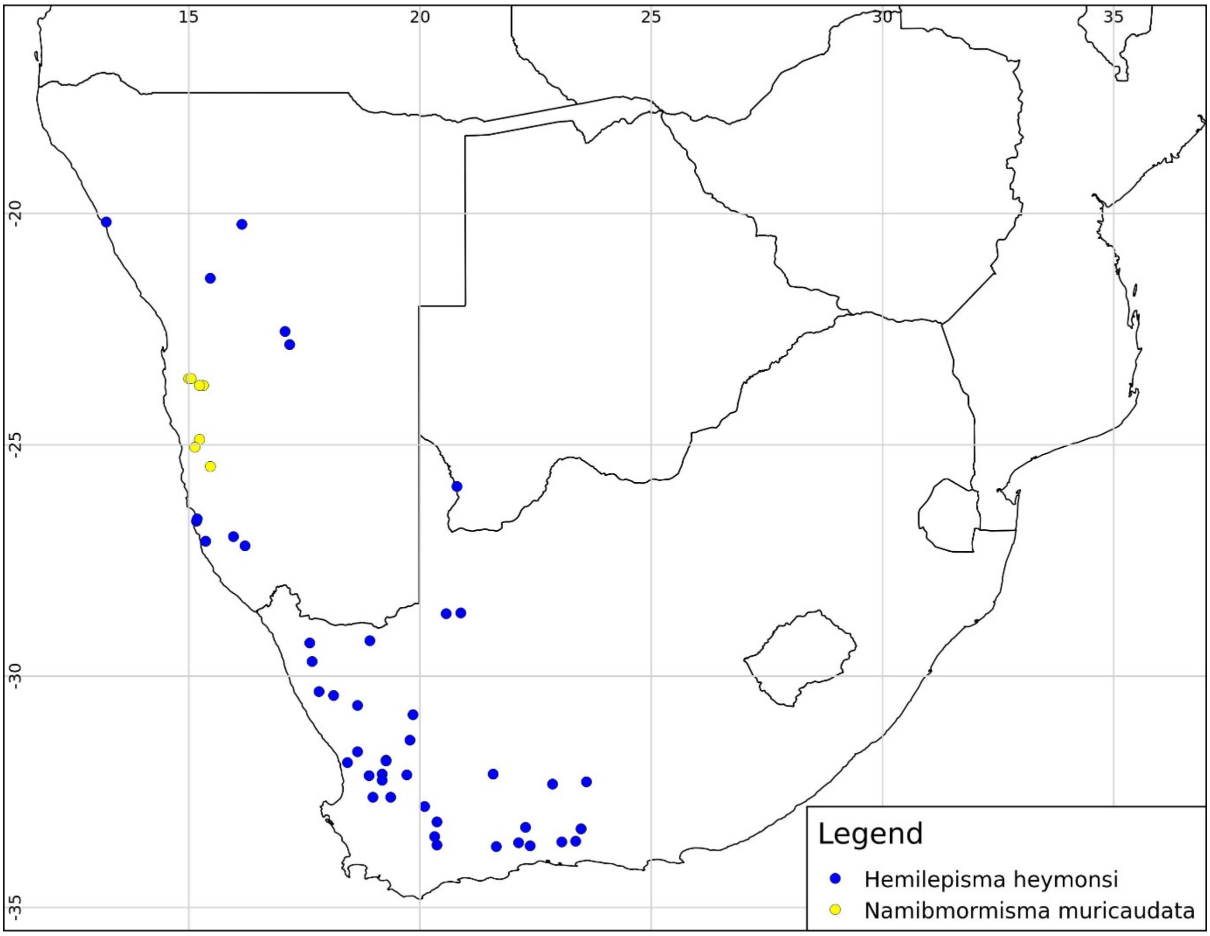

Figure 25: *Distribution of* Hemilepisma heymonsi *and* Namibmormisma muricaudata.

differences between them. Both were encountered throughout the taxon's range, often in the same sample.

Wygodzinsky (1955) added the third species, *H. nudata* from Botterkloofpas in South Africa. It was distinguished from the two prior species primarily in its perceived lack of dorsal setation. Escherich (1905) in his generic description had noted the presence of 1+1 exceedingly tiny (‘*winzige rudimentäre*’) dorsal bristles on each thoracic notum and on urotergites II-VIII of *Hemilepisma* but his illustration of *H. heymonsi* (Tafel I, Fig. 9) depicts much more substantial bristles. All *Hemilepisma* specimens examined here had bristles but they are tiny and inconspicuous. They are similar in size and appearance to those in the `bare spots' on the pronota of *Ctenolepisma* spp., as described in Irish (1996a), and best recognised by the tiny bare indentations in the scale cover surrounding their bases, too. In anything less than pristine material, they are exceedingly difficult to see but careful examination of the types of *H. nudata* confirmed that they are indeed present in that taxon as well. Wygodzinsky evidently based the distinction of his new species on the inaccurate illustration of *H. heymonsi*, rather than the description.

The types of Escherich's original two species have not been traced but I have examined fresh topotypical material from Willowmore, collected with the same ant genus as the type hosts. I have also examined both the types of *H. nudata* and fresh topotypical material from Botterkloofpas. Considering them in the context of the relatively large number of specimens from intervening and surrounding localities as listed below, I conclude that the three described species are identical, in so far as it is possible to be certain in the absence of Escherich's types. The name of the first described species (*H. heymonsi*) becomes the valid one for the taxon. Wygodzinsky's (1950) very detailed description of *H. nudata* is sufficient to recognise the species, with the addition of details of dorsal setation as given above.

In life, *H. heymonsi* is easily recognisable by the pattern, as illustrated by Wygodzinsky (1955). The background colour is a rich honey brown with a coppery sheen, and the markings on this are yellowish. The cross bar on the anterior abdomen is the most prominent and persistent, the other minor markings tend to become inconspicuous in even moderately abraded material. The antennae, legs, palpi and caudal appendages are pure white. *H. heymonsi* is normally myrmecophilous and is most frequently found with *Tetramorium* species (49%), less frequently with *Ocymyrmex* species (23%), *Pheidole* species (17%), and *Anoplolepis custodiens* (11%). It was twice found in the same nest with *A. szeptyckii*. It has also been found with more than one different host at the same locality, e.g. number 1877 below. Occasional specimens were also collected in pit traps, or under stones unaccompanied by ants.

The species is widely but sparsely distributed in western southern Africa (Figure 25).

Examined types of *Braunsina nudata,* in MZLU:
Material: Male (holotype), female (allotype). Paratypes: 1 female, 6 males, 1 broken unsexed (Wygodzinsky 1955 lists two more paratypes than I saw).
Labels: a) Braunsina nudata Wygodzinsky, Wygodzinsky det. INST. MED. REG. b) 896 c) S. Afr. C.P. Clanwilliam Botter's Kloof 30.11.50. under sten. Swedish South Africa Expedition 1950-51 Dr. Brinck - Dr. Rudebeck. Zoological Institute, University, Lund. d) HOLOTYPE ALLOTYPE or PARATYPES.

Literature records: SOUTH AFRICA. 1881. Willowmore (type locality of both *B. heymonsi* and *B. grassii*; respectively no host recorded and *Pheidole capensis*) (Escherich 1905).
NAMIBIA. 950. Windhuk 1120. Lüderitzbucht. (both as *Braunsina heymonsi,* all specimens examined) (Silvestri 1922).
SOUTH AFRICA. 1690. Botter Kloof Pass (type locality of *B. nudata*, no host recorded) (Wygodzinsky 1955).

Material examined: 108 (36 females, 52 males, 20 unsexed); 60 BMSA, 39 NMNW, 5 ZMUH, 4 CAS. Also 134 hosts.
Localities: NAMIBIA. 801. Uniab Delta (*Tetramorium rufescens*). 803. 8 mi. S of Outjo. 886. 2 km NE Omaruru (unspecified ants). 968. Gocheganas 26. 1113. Agate Beach. 1147. Agub Mt. SW (*Ocymyrmex* sp.). 1155. 10 km S Grillenthal. 1163. Tsaus Mt. (*Tetramorium* sp.). SOUTH AFRICA. 1292. Jan se Draai (*Ocymyrmex hirsutus*). 1406. 7 km NW Keimoes (*Tetramorium* sp.). 1413. 10 km N Kakamas (*Tetramorium* sp.). 1496. Gamsberg Site D. 1505. Anenous Pass, S side. 1535. Schaaprivier. 1583. Tierkop (*Anoplolepis custodiens*). 1594. Blouberg (*Anoplolepis custodiens*). 1605. Rietmond (*Tetramorium solidum*). 1622. Kalkgat (*Tetramorium clunum*). 1665. Hantamsberg-plato (*Tetramorium* sp.). 1679. Gipsmyn (*Tetramorium solidum*). 1689. Botterkloofpas (*Pheidole* sp.). 1695. Vaalvlei (*Tetramorium solidum*). 1718. Uitkykpas, summit (*Pheidole* sp.). 1719. Steenkampsvlakte (*Tetramorium* sp.). 1722. Van Wyksvlei (*Ocymyrmex barbiger*). 1728. Karooberg (*Tetramorium* sp.). 1744. 4 km NW Wuppertal (*Ocymyrmex barbiger*). 1746. Sarelsrivier (*Tetramorium* sp.). 1752. Sunnyside (*Ocymyrmex barbiger*). 1783. Citrusdal, 2 mi. SW. 1784. Grootrivierhoogte, summit (*Anoplolepis custodiens*). 1814. Jukfontein (*Ocymyrmex barbiger*). 1865. Driekoppe (*Tetramorium* sp.). 1877. Kareedouwpas (*Ocymyrmex barbiger*). 1877. Kareedouwpas (*Tetramorium* sp.). 1882. Willowmore (*Pheidole* sp. det H Robertson 1988). 1911. Bloutoring (*Tetramorium* sp.). 1918. Hartbeesrivier (*Tetramorium* sp.). 1922. Grasrug (*Ocymyrmex barbiger*). 1926. Kansavlakte (*Pheidole* sp.). 1930. Bylshoek (*Anoplolepis custodiens*). 1932. Kromhoogte (*Tetramorium* sp.). 1933. Rooibergpas (*Pheidole* sp.).

Genus *Heterolepisma* Escherich

Heterolepisma Escherich 1905: 63.

Only one species has been recorded from southern Africa.

Heterolepisma mossambicensis Mendes

Heterolepisma mossambicensis Mendes 1993: 92.

The species is only known from one collection on the Moçambique / South African border (Figure 22). No material of any *Heterolepisma* sp. was encountered during this study, probably because eastern southern Africa where they are more likely to occur was poorly sampled.

Literature records: MOÇAMBIQUE. 560. Ponta do Ouro. (Mendes 1993a).

Genus *Lepisma* L.

Lepisma Linnaeus 1758: 608.

Not indigenous to southern Africa; only one anthropophilic species has been found here.

Lepisma saccharina L.

Lepisma saccharina Linnaeus 1758: 608; Theron 1963: 125.

A cosmopolitan anthropophile, originally probably from the Mediterranean region, where two of the three other non-anthropophilic species in the genus are found. It is newly recorded here for Namibia.

The species name was indiscriminately used to refer to anthropophilic Lepismatidae in general in the older southern African entomological literature but Theron (1963) showed that most such references referred to *Ctenolepisma longicaudata* instead. He found that *L. saccharina* was actually quite uncommon in southern

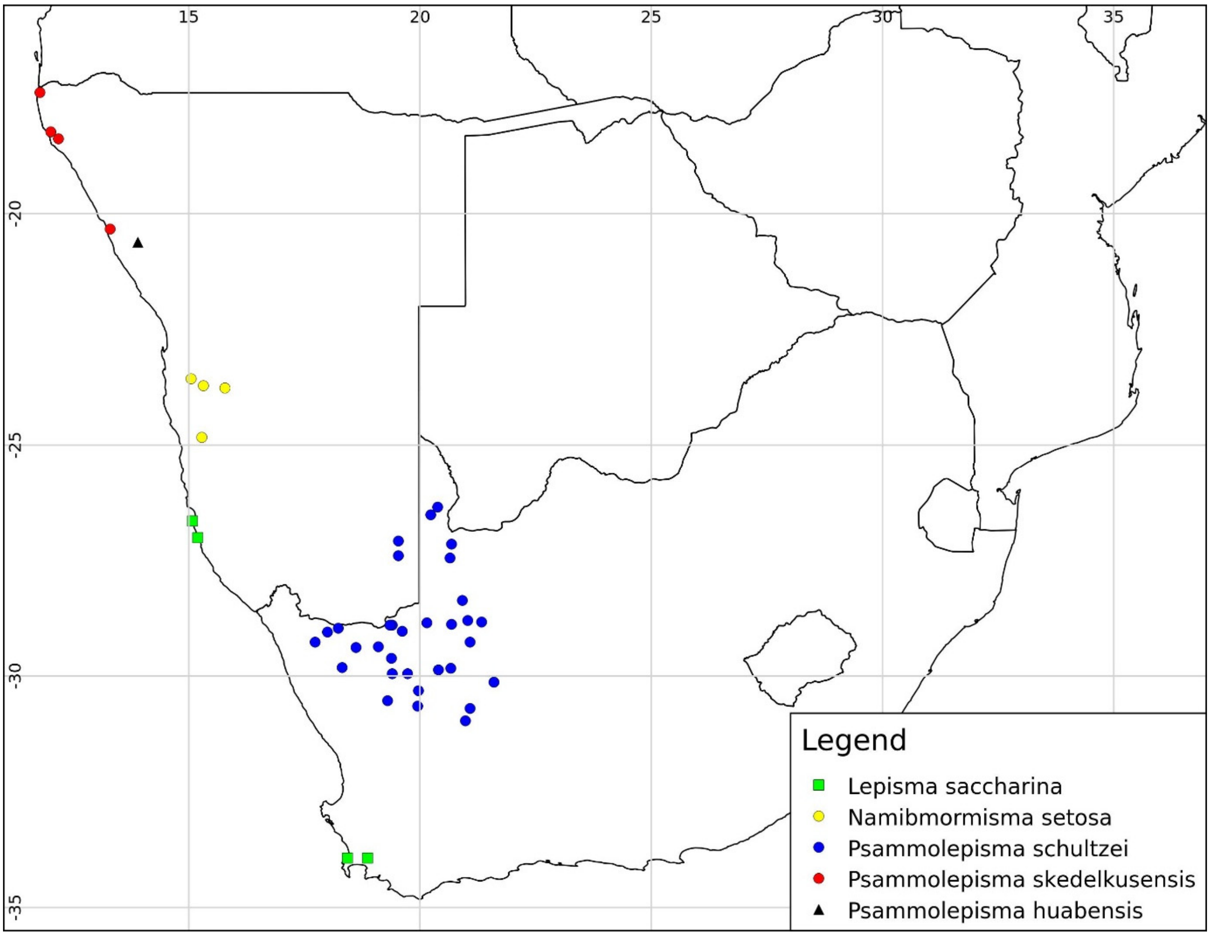

Figure 26: *Distribution of* Lepisma saccharina *(southern Africa only),* Namibmormisma setosa *and three* Psammolepisma *species.*

Africa and recorded it from only two locations in the southwestern Cape. The specimens were not preserved (pers. comm., the late J.G. Theron, 1987), so their identity could not be confirmed.

In an attempt to procure fresh material from the same area, I contacted pest control businesses in Cape Town with requests for material of any anthropophilic Lepismatidae they encountered but this turned up only *C. longicaudata*. Although this study concentrated on indigenous Lepismatidae, and anthropophiles were collected only incidentally, I did not find *L. saccharina* anywhere in mainland southern Africa. The only confirmed records are from guano islands off the Namibian coast, where they were found in abandoned outbuildings (Figure 26). The bioclimatic conditions at these new locations confirm the climatic basis for its absence from most of southern Africa (Theron 1963).

Literature records: SOUTH AFRICA. 1954. Cape Town. 1955. Stellenbosch (Theron 1963).

Material examined: 36 (11 females, 9 males, 16 unsexed); 36 NMNW.
Localities: NAMIBIA. 1118. Halifax Island. 1150. Possession Island.

Genus *Monachina* Silvestri

Monachina Silvestri 1908: 295; Irish 1988b: 9.

Monachina stilifera Silvestri

Monachina stilifera Silvestri 1908: 295; Mendes 1983 :7; Irish 1988b: 9.

Occurs in the arid parts of western southern Africa (Figure 27), in three subspecies. The subspecies overlap in distribution, and specimens from the zones of overlap may have a mix of character states; they were listed below with the subspecies they most resemble. It has also been recorded from the Cape Verde Islands (Mendes 1983), probably as an alien introduction.

Key to southern African species and subspecies of Monachina:

1. Adults with one pair of styli 2
- Adults lacking styli 3
2. Inner process of coxites IX at most half stylus length; dorsal scales as usual for family, longer in longitudinal direction, with many parallel striae; widespread in western southern Africa .... *M. stilifera stilifera*
- Inner process of coxites IX almost as long as stylus; at least some dorsal scales modified, wider in the transverse direction, with only 3-5 divergent striae; only known from the Victoria Falls area, Zambia .... *M. zambesi*
3. Coxite IX relatively narrower, with an indentation in the outer margin at the usual position of the stylus .... *M. stilifera schultzei*
- Coxite IX relatively wider, outer margin straight, lacking indentations .... *M. stilifera recta*

Always associated with habitats that contain an abundance of dry organic material, typically dry vegetable detritus under plants but also dry dung. They can be fairly reliably found in the droppings that accumulate below the nests of Sociable Weavers (*Philetairus socius*, Ploceidae), or in dung middens of Dassie (*Procavia capensis*, Procaviidae) or Klipspringer (*Oreotragus oreotragus*, Bovidae). They have also been found on dry bat guano in caves (localities 744, 959 and 1378 below). The species is not nidicolous; recorded termite associations (Wygodzinsky 1970) are incidental. Both *Monachina* and termites can be knocked out of the same dry grass clump but this represents shared resource utilisation rather than mutualism.

Rare individuals with pristine scale cover appear blue or purple in sunlight (Figure 2f), whereas normal, abraded specimens are silvery. The striae on the scales provide the structure that creates blue wave interference colours under certain sunlight conditions.

Monachina stilifera stilifera Silvestri

Monachina stilifera Silvestri 1908: 295.
Monachina stilifera stilifera Silvestri. Irish 1988b: 9, 1996a: 194.

In Irish (1988b) I said that this subspecies lacks sensory papillae on the distal segment of the labial palp. A better microscope has shown that four papillae are present but they are very small and exceedingly difficult to see.

Found from the southern Cape northwards as far as southwestern Namibia (Figure 27), overlapping with *M.s. schultzei* in the northern half of its range.

Literature records: NAMIBIA. 1120. Lüderitzbucht. 1158. Prince of Wales Bay (as *M. stilifera)*. (Silvestri 1908).
NAMIBIA. 1072. Uri-Hauchab Mt. 1074. Hauchab Mt. 1119. Lüderitz. 1140. 2 km N Grillenthal. 1143. 2 km N Dreizackberg. 1145. Kaukausib fountain. 1147. Agub Mt. SW. 1155. 10 km S Grillenthal. SOUTH AFRICA. 1355. Maerpoort. 1382. Klipneus. 1412. 13 km SSW Grootderm. (Irish 1988b).
Also 3 localities in Irish (1996a).

New material examined: 199 (102 females, 72 males, 25 unsexed); 113 BMSA, 68 NMNW, 18 GRSW.
Localities: NAMIBIA. 1003. Station Dune. 1111. Diamond Area I. 1122. 1 km NW Aus. 1194. Roter Kamm. 1216. Fish River Mouth. 1221. 3 km NNE Stormberg. SOUTH AFRICA. 1362. Paradyskloof. 1363. Tatasberg, W foot. 1379. Haakiesdoorn. 1399. Maanrots. 1418. Jakkalsputs dunes. 1440. Nabies. 1448. Kristalrivier. 1455. Swartduinkop. 1473. Paul se Puts 143. 1478. SW Henkries. 1479. Grootberg. 1511. Dikkop. 1515. N Wolfkop. 1523. Tnong-Gys. 1532. Kaffervloer. 1547. Swartbakenknop. 1549. Koffiemeul. 1557. Gifkop 166. 1558. Klerk se Vloer. 1559. Elandsklip. 1568. Calvinia District. 1578. Kap-Kap. 1581. Blouboskom. 1612. Rietkop. 1614. Kokerboomkraal. 1633. 10 km NW Loeriesfontein. 1662. Vanrhynspas. 1680. Nuwefontein. 1721. Middelplaas. 1733. Eselfontein. 1757. Vaalkoppies. 1766. Mied se Berg. 1801. Gifkop. 1811. Grootdam. 1819. Agterland. 1827. Swartruggens, foot. 1835. Amospoortjie. 1841. 5 km S Jantjiesfontein. 1849. Wind Heuvel 77. 1856. Massenberg. 1872. Crown Hill. 1883. Willowmore. 1974. Aalwynkop, Bontebokpark. 1977. Landplaas.

Monachina stilifera schultzei Silvestri

Monachina schultzei Silvestri 1908: 296; Wygodzinsky 1970: 253.
Monachina stilifera schultzei Silvestri. Irish 1988b: 12; Irish 1996a: 195.

Found from the northern Cape in South Africa, through southern to west-central Namibia (Figure 27). In the south it overlaps with *M.s. stilifera* but also occurs well eastwards beyond the latter's range. In the north it overlaps with *M.s. recta*, with the few localities again concentrated towards the east of the latter's range.

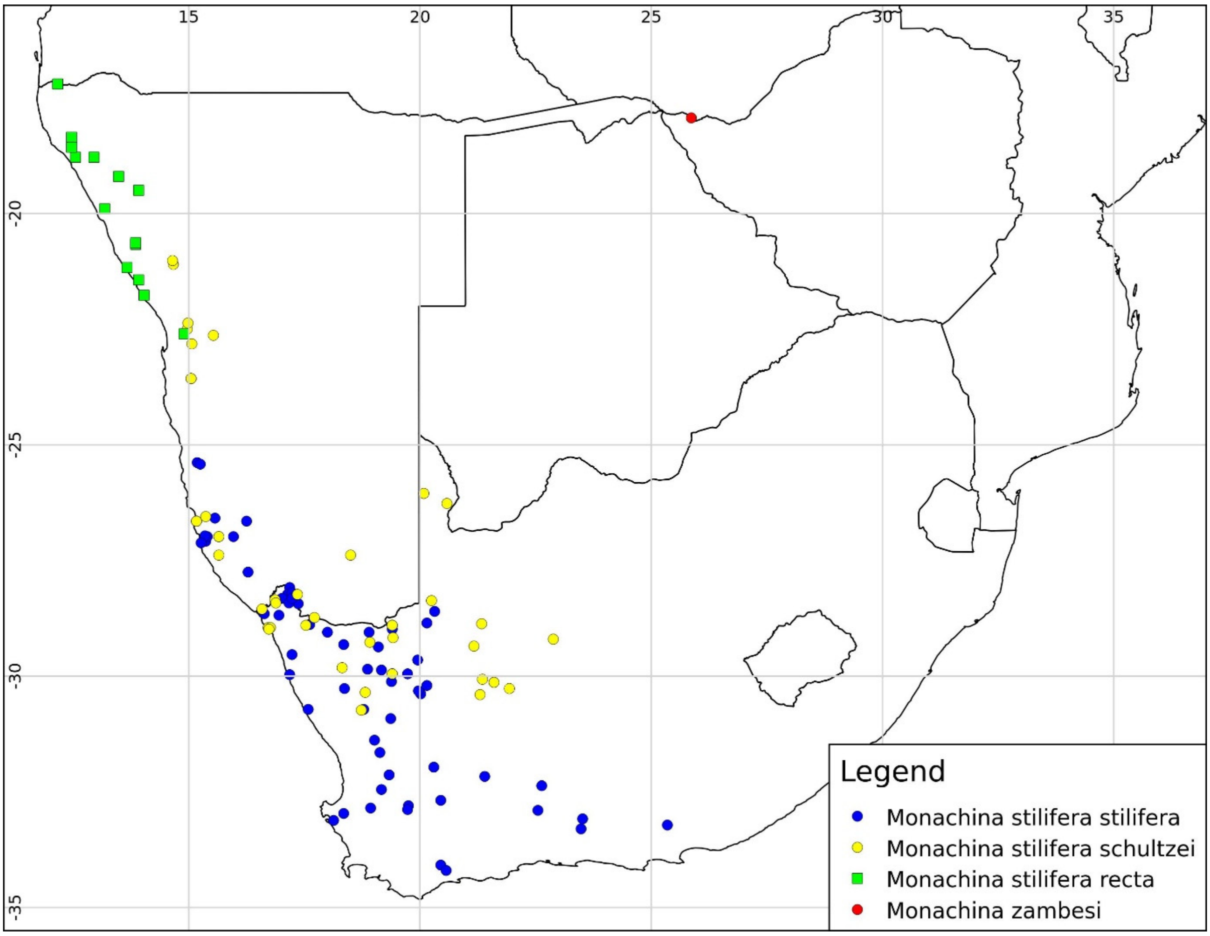

Figure 27: *Distribution of* Monachina stilifera *subspecies (southern Africa only) and* M. zambesi.

Literature records: NAMIBIA. 1120. Lüderitzbucht (as *M. schultzei*). (Silvestri 1908).
SOUTH AFRICA. 330. 36 mi. ex Griekwastad towards Prieska. 1444. 32 mi. ex Upington towards Kenhardt. 1502. 35 mi. ex Pofadder toward Springbok (as *M. schultzei*). (Wygodzinsky 1970).
NAMIBIA. 863. Gomatsarab. 868. Tsisabvallei. 931. 6 km N Arandis. 947. Lower Ostrich Gorge. 1000. Gobabeb. 1002. Kuiseb River. 1108. Haris. 1145. Kaukausib fountain. 1172. Klinghardts Mountains. 1224. Grootpens. 1232. Vioolsdrif, 11 km ENE. SOUTH AFRICA. 1392. 4 km WSW Grootderm. (Irish 1988b).
Also 5 localities in Irish (1996a).

New material examined: 53 (19 females, 26 males, 8 unsexed); 31 BMSA, 22 NMNW.
New localities: NAMIBIA. 959. Gifgat 2. 966. Husab area. 1173. Noachabeb 97.
SOUTH AFRICA. 1297. Kafferspan. 1305. 2 km N Munro. 1365. 2 km S Wallekraal Mine. 1371. Riemvasmaak, NW. 1378. Wondergat. 1453. Kristalberge. 1455. Swartduinkop. 1466. 2 km N Holgatmond. 1467. Holgat Riv. 5 km from mouth. 1472. 1 km S Holgatmond. 1489. 4 km S Pofadder. 1544. Dabeep. 1557. Gifkop 166. 1588. Kassie se Pomp. 1616. Lepelvlakte.

Monachina stilifera recta Irish

Monachina stilifera recta Irish 1988b: 13.
Monachina schultzei (*nec* Silvestri 1908). Wygodzinsky 1955: 162.

Found in the Central and northern Namib (Figure 27).

Literature records: NAMIBIA. 642. 15 mi. S Orupembe. 659. 30 mi. S Orupembe. (as *M. schultzei*) (Wygodzinsky 1955).
679. Khumib River ca. 15 km from mouth. 680. Purros. 718. Okambondevlakte. 778. Kharu-Gaiseb River. 840. Terrace Spring. 843. Huab River Valley. 870. Ugab River gate. 888. Messum River. 957. Swakopmund District. (Irish 1988b).

New material examined: 26 (13 females, 12 males, 1 unsexed); 16 NMNW, 9 BMSA, 1 TMSA.
Localities: NAMIBIA. 562. [near] Kunene R. 744. T.o.D. 885. Messum Crater. 896. 6 km E Kaapkruis.

Monachina zambesi Wygodzinsky

Monachina zambesi Wygodzinsky 1955: 159.

Known only from the types from southern Zambia (Figure 27).

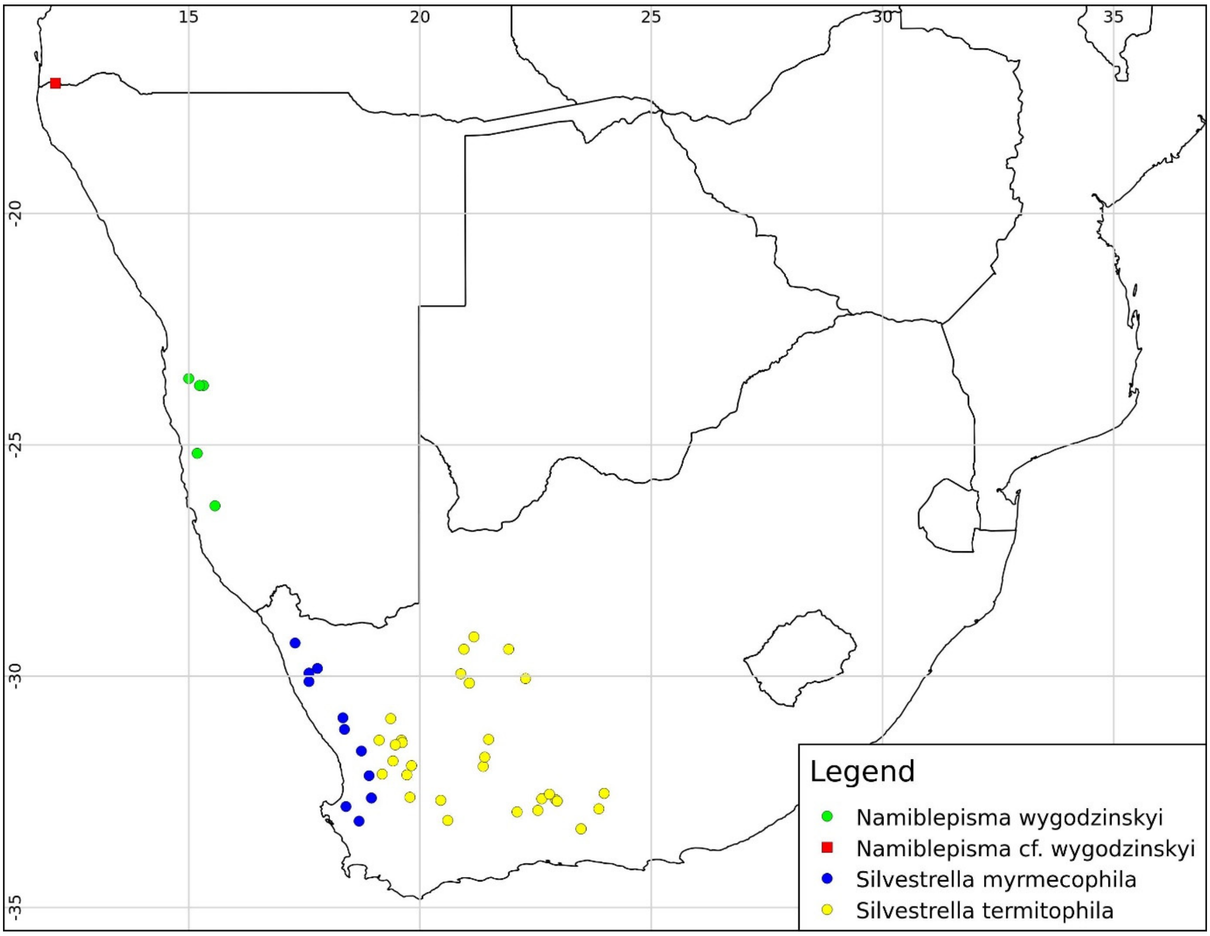

Figure 28: *Distribution of* Namiblepisma wygodzinskyi *and* N. *cf.* wygodzinskyi, Silvestrella myrmecophila *and* S. termitophila.

Literature records: ZAMBIA. 2004. Livingstone, Zambesi River below Victoria Falls. (Wygodzinsky 1955).

Genus *Namiblepisma* gen. nov.

http://zoobank.org/AB19D462-820D-428F-A343-48A9E2AF8595

Genus indescr. Irish 1990: 134.

Type species: *Mormisma wygodzinskyi* Irish 1986.

Body length up to 7 mm. Body shape squat and thickset. Pigment absent. Macrosetae smooth (probably secondarily so), often apically bifid. Antennal sensillae poculiform. Antennae as long as body length. Setation of head as in *Namibmormisma* but oblique setal fields on vertex wider. Distal segment of labial palp with three small sensory papillae arranged in one row. Thoracic nota with wide marginal setal fringes; trichobothrial areas absent / obscured. Urotergites I – IX each with 1+1 lateral setal fringes, that are simple and undifferentiated. Urotergite X short, trapezoidal, with 1+1 setal fields. Tarsi with two elongate, highly asymmetrical claws, lacking an empodium. Urosternites I – VII (female) or VIII (male) with a median setal group that is split in two on anterior urosternites but merged on posteriad urosternites. Urosternites III – VII (female) or VIII (male) also with 1+1 lateral setal groups. Styli absent. Ovipositor conical, very short, apices of gonapophyses unsclerotised. Parameres lacking. Cerci swollen, sexual dimorphism in lengths of cerci and terminal filament.

The type species is one of three ultrapsammophilous Namib Desert Lepismatidae that were originally described in the Saharan genus *Mormisma* Silvestri by Irish (1986). When it became clear that they do not belong in *Mormisma*, two of them were re-assigned to the new genus *Namibmormisma* by Irish and Mendes (1988); "*Mormisma" wygodzinskyi* was also excluded from *Mormisma* at the time but it was not transferred to *Namibmormisma,* where it clearly did not fit either. It temporarily became generically indeterminate, pending further study to clarify its relationship with the simultaneously described genera *Sabulepisma* and *Swalepisma*. Subsequent study (Irish 1990) showed that it has characters in common with both *Swalepisma* and *Sabulepisma* but differs significantly from both in respectively urotergal and urosternal setation. It differs from

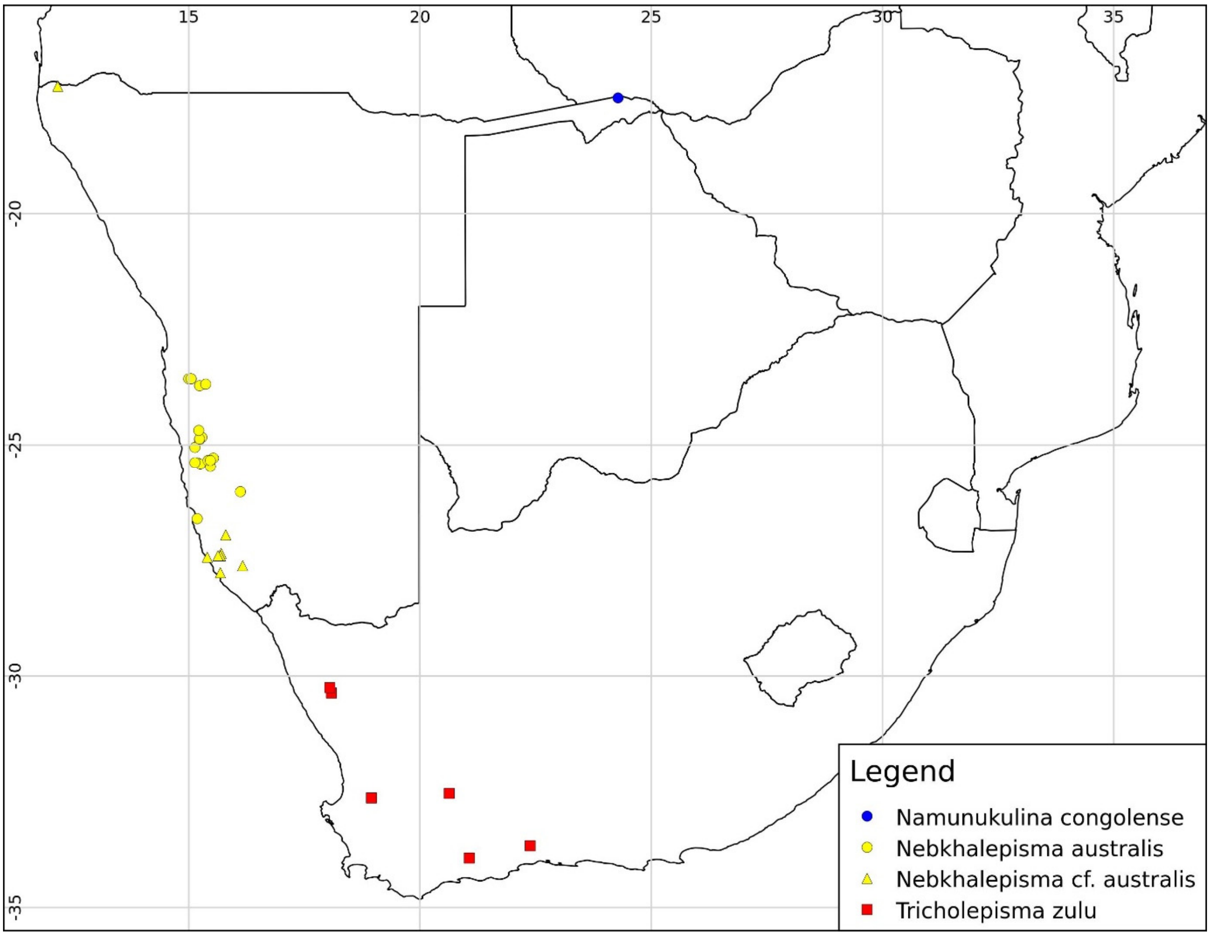

Figure 29: *Distribution of* Namunukulina congolense *(southern Africa only),* Nebkhalepisma australis*,* N. *cf.* australis *and* Tricholepisma zulu.

Namibmormisma in both urotergal and urosternal setation, in antennal length and in tarsal claw morphology. Another new genus was needed to accommodate the single included species.

Namiblepisma wygodzinskyi (Irish) comb. nov.

Mormisma wygodzinskyi Irish 1986: 359; Watson and Irish 1988: 286.
"Mormisma" wygodzinskyi Irish 1990: 135.

As currently known, confined in distribution to the main Namib dune sea (Figure 28).
Literature records: NAMIBIA. 997. Kahani dune. 1011. Noctivaga dune. 1012. Mniszechi's Vlei. (Irish 1986).
New material examined: 7 (2 females, 1 male, 4 unsexed); 7 TMSA.
Localities: NAMIBIA. 1060. SE 2515Aa4. 1103. Koichab Pan Area.

Material from the far northern Namib (locality 561) was referred to this genus but being damaged preservative pit trap specimens, could not be positively identified to species level. Given the separation in distance from the confirmed distribution range, it might not be *N. wygodzinskyi* and was therefore included in Figure 28 as *Namiblepisma* cf. *wygodzinskyi*.

Genus *Namibmormisma* Irish

Namibmormisma Irish, in Irish & Mendes 1988: 275.

Namibmormisma muricaudata (Irish)

Mormisma muricaudata Irish 1986: 355.
Hyperlepisma australis Wygodzinsky 1959a: 444, pro parte (nymph).
Namibmormisma muricaudata (Irish) in Irish & Mendes 1988: 276; Watson and Irish 1988: 286.

Confined to the main Namib dune sea (Figure 25).

Literature records: NAMIBIA. 997. Kahani dune. 1000. Gobabeb. 1011. Noctivaga dune. 1044. Diamond Area II. 1050. Diamond Area II. 1075. Diamond Area II. (Irish 1986).

New material examined: 1 unsexed; 1 NMNW.
Localities: NAMIBIA. 1012. Mniszechi's Vlei.

Key to species of Namibmormisma*:*

1. Urotergite IX with 1+1 lateral setal fringes .... *N. setosa*

- Urotergite IX asetose .... *N. muricaudata*

Namibmormisma setosa **(Irish)**

Mormisma setosa Irish 1986: 358.
Namibmormisma setosa (Irish) in Irish & Mendes 1988: 276; Watson and Irish 1988: 286.

Confined to the main Namib dune sea (Figure 26).

Literature records: NAMIBIA. 1012. Mniszechi's Vlei. 1042. Witberg. (Irish 1986).

New material examined: 2 (1 male, 2 unsexed); 3 NMNW.
Localities: NAMIBIA. 1000. Gobabeb. 1014. Far East dunes. 1074. Hauchab Mt.

Genus *Namunukulina* Wygodzinsky

Namunukulina Wygodzinsky 1957: 94.

A single species has been found in southern Africa.

Namunukulina congolense **Mendes**

Namunukulina congolense Mendes 1982: 652; Irish 1996b: 17.

The species has been recorded only once in southern Africa (Figure 29). Otherwise it is only known from the Virunga National Park in the eastern Democratic Republic of the Congo.

Literature records: NAMIBIA. 588. Katima Mulilo. (Irish 1996b).

Genus *Nebkhalepisma* Irish

Nebkhalepisma Irish 1988a: 39.

The genus is monospecific.

Nebkhalepisma australis **(Wygodzinsky)**

Hyperlepisma australis Wygodzinsky 1959a: 444; Watson and Irish 1988*:* 286.
Nebkhalepisma australis (Wygodzinsky). Irish 1988a: 40.

The verified distribution is confined to the main Namib dune sea only (Figure 29) but see below.

Literature records: NAMIBIA. 999. Gobabeb (type locality). (Wygodzinsky 1959a).
NAMIBIA. 997. Kahani dune. 1000. Gobabeb. 1009. Elephant Valley. 1011. Noctivaga dune. 1042. Witberg. 1043. 4 km W Witberg. 1044. Diamond Area II. 1050. Diamond Area II. 1067. Guinasibberg. 1068. Diamond Area II. 1069. 5 km SW Guinasibberg. 1071. SE 2515Ac4. 1072. Uri-Hauchab Mt. 1074. Hauchab Mt. 1075. Diamond Area II. 1088. Tirasduine. (Irish 1988a).

New localities: 2 males (NMNW).
NAMIBIA. 1038. Sossusvlei, ca. 10 km NW. 1114. Agate Beach, Lüderitz.

Specimens belonging to *Nebkhalepisma* were also collected outside the main Namib dune sea towards the south, in Succulent Karoo instead of Desert Biome habitats. The SEM micrographs of *N. australis* in Irish (1988a) were based on specimens from this area (localities 1180 and 1196). As more southern specimens became available I noticed subtle differences (the details of which have not survived) between them and *N. australis s.s.*, and began treating them as potentially different species. The study was terminated before their status could be clarified. A single sample from the far northern Namib was referred to *Nebkhalepisma* on the basis of tarsal claw morphology at the time but never identified further. Because of the distance separating it from the verified distribution range of *N. australis*, it might also be something different. These unverified specimens were mapped in Figure 29 as *N. cf. australis.* Their localities are:
NAMIBIA. 563. Northern Namib. 1139. Diamond Area I. 1171. Klinghardts Mountains. 1174. Klinghardts Mountains. 1175. Sargdeckel. 1180. Bogenfels. 1184. Uguchab River. 1196. 5 km N Chameis Gate.

Genus *Neoasterolepisma* Mendes

Asterolepisma Mendes 1978: 93 (*p.p.*).
Asterolepisma (Asterolepisma) Mendes 1981a: 201 (*p.p.*).
Neoasterolepisma Mendes 1988: 13.

There is only one species in southern Africa.

Neoasterolepisma braunsi **(Escherich)**

Lepisma braunsi Escherich 1903: 364, 1905: 50; Silvestri 1908: 291, 1913: 11; Wygodzinsky 1955: 125, 1970: 253.
Neoasterolepisma braunsi (Escherich). Mendes 1988: 104.

Occurs near the South African coast, seldom found further inland (Figure 22). Their preferred hosts are ants of the genus *Crematogaster.* The bulk of material came from above-ground cardboard nests of *Crematogaster* spp. in subcoastal dune vegetation. Such nests may include very large numbers of Lepismatidae, in two cases 94 and 61 specimens

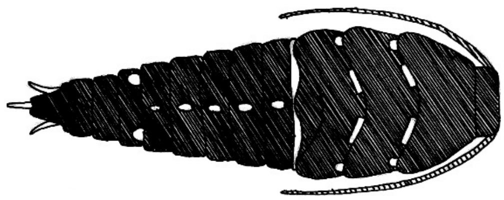

Figure 30: *Typical scale pattern of* Neoasterolepisma braunsi.

respectively. Most examined nests included at least one lepismatid. The few inland samples for *N. braunsi* were also found with *Crematogaster* species but then mostly those that nest under stones, only one was knocked from a *Crematogaster* nest in a dry grass clump. The specimen from Muizenberg (locality 1975) was active in full sunlight on a bare beach far from any vegetation or obvious ant nests.

A species by this name has also been recorded in a non-taxonomical paper (Hocking 1970) from Tanzania, where it inhabits nests of *Crematogaster mimosae* and C*rematogaster sjostedti* in the swollen bases of *Acacia* thorns. The identical host genus renders the identification plausible but the pattern described as 'chevroned' does not fit southern African material (see below). It is here considered to likely be a related but different species, and its identity needs to be confirmed.

In life, *N. braunsi* has a black scale covering with white markings where the black scales are absent or transparent. The basic scheme is illustrated in Figure 30: there are anterolateral white marks on the mesonotum, metanotum and urotergite VII, and a transverse white band posteriad on urotergite I. There is much individual variation in the appearance of the small white dots on urotergites II-VI. There may be either a single median row as illustrated, or 1+1 lateral rows, or a median and 1+1 lateral rows, or no dots at all. When lacking dots they greatly resemble *Xenolepisma globosa*. Specimens with different patterns are otherwise similar and different patterns may be seen in the same sample, therefore no special taxonomical significance is attached to it.

Judging solely by the labels, what are probably the types of *L. braunsi* were located in the Maastricht Natural History Museum (NHME); the specimens themselves were not examined. They are:
Probable cotypes, numerous specimens labelled: Bei Cremastogaster peringueyi, Port Elizabeth, 4/V/1897, Dr. H. Brauns!, Dünen, Kartonnest an der Erde. In larger container labelled: W LXIII, Myrmecophilen XVI.
Associated with the cotypes, although the host was not mentioned in the original description; 2 specimens labelled: Lepisma braunsi, det. Escherich, bei Termes unidentatus, Port Elizabeth, 9/VI/1896, Brauns. In larger container labelled: 'W XLV, Termitophilen I'.

Literature records: SOUTH AFRICA. 1963. Port Elizabeth (type locality; *Crematogaster peringueyi* and *Monomorium delagoense*) (Escherich 1903, 1905).
The specimen (in ZMHB) listed from an unspecified locality by Silvestri (1908) was examined and its identity confirmed but its label is a number only. The same publication treats material from Namaqualand, where the species is known to occur, as well as southern Namibia and southern Botswana, where it has not been found.
SOUTH AFRICA. 1545. Stanford Hill. (Silvestri 1913).
SOUTH AFRICA. 1983. Cape Point. (Wygodzinsky 1955, Mendes 1988)
SOUTH AFRICA. 1970. Groot Brakrivier (*Bifiditermes durbanensis*; this material from SANC has been re-examined; 1 female, 6 males) (Wygodzinsky 1970).

Material examined: 223 (72 females, 116 males, 35 unsexed); 94 SAMC, 64 NMNW, 64 BMSA, 1 SANC. Plus 91 hosts.
Localities: SOUTH AFRICA. 1318. Ndumu Game Res. below rest camp (*Crematogaster* nest C 881). 1508. S McDougall's Bay (*Crematogaster* sp.). 1559. Elandsklip (*Crematogaster* sp.). 1574. Somnaasbaai (*Crematogaster* sp.). 1582. 9 km E Hondeklipbaai (*Crematogaster* sp.). 1633. 10 km NW Loeriesfontein. (*Crematogaster* sp.). 1652. Brakfontein (*Camponotus* sp.). 1692. S Doringbaai (*Crematogaster* sp.). 1812. Paternoster (*Crematogaster* sp.). 1847. Langebaan (*Crematogaster* sp.). 1863. Ganskraal (*Crematogaster* sp.). 1949. Skilpadhoogte (*Crematogaster* sp.). 1960. Nature's Valley (*Crematogaster* sp.). 1975. Muizenberg. 1979. Swartheuwel (*Crematogaster* sp.). 1982. Smitswinkelvlakte (*Crematogaster* sp.). 1984. Droëvlei (*Crematogaster* sp.). 1985. Stilbaai-Oos (*Crematogaster* sp.). 1991. Infanta, W (*Crematogaster* sp.). 1993. De Hoop (*Crematogaster* sp.). 1994. Afsaal (*Crematogaster* sp.). 1996. Arniston (*Crematogaster* sp.). 1998. Brandfontein Nature Res. (*Crematogaster* nest, SAM-HYM-COO7228).

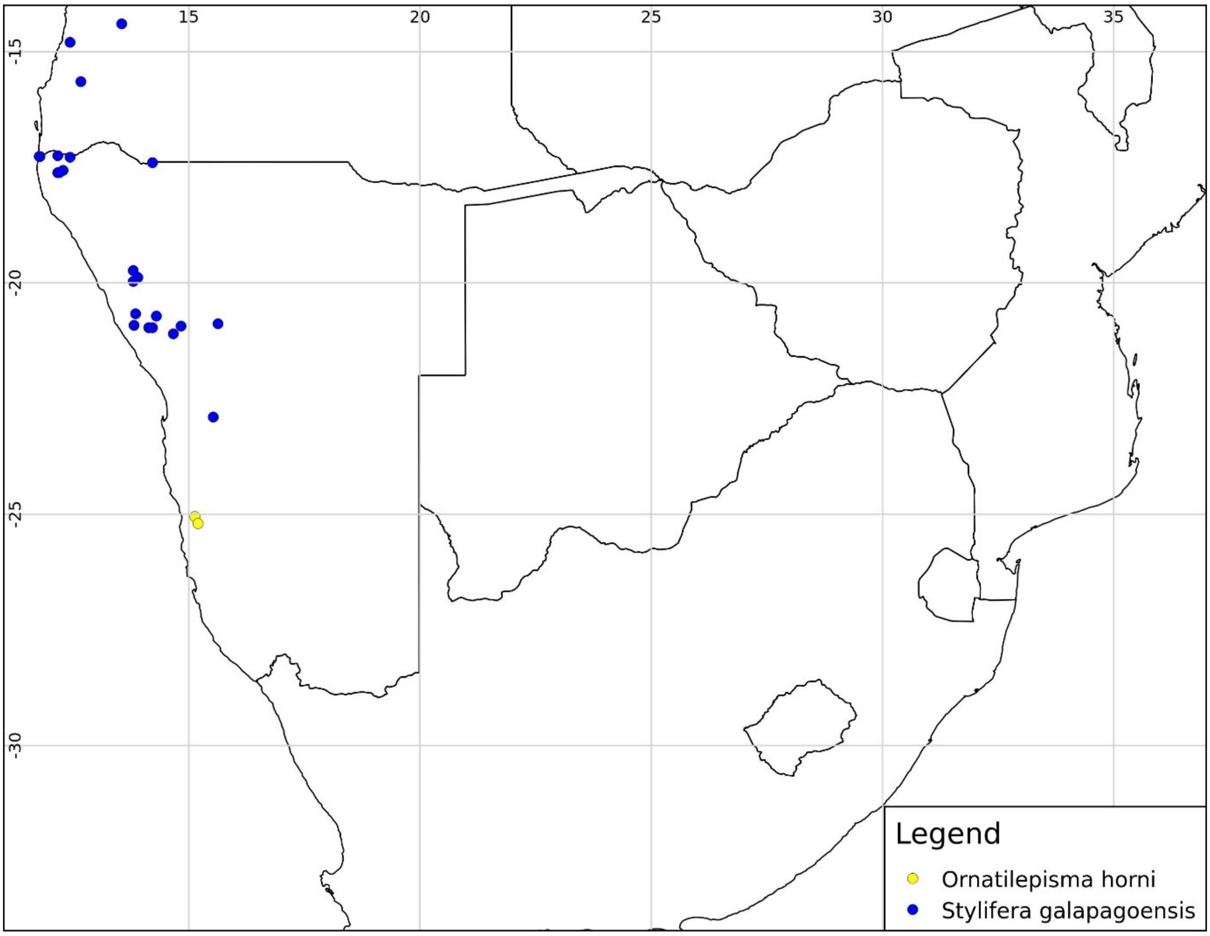

Figure 31: *Distribution of* Ornatilepisma horni *and* Stylifera galapagoensis *(the latter southern Africa only).*

Genus *Ornatilepisma* Irish

Ornatilepisma Irish 1988a: 31.

The genus is monospecific.

Ornatilepisma horni Irish

Ornatilepisma horni Irish 1988a: 32.

Only known from a limited part of the main Namib dune sea (Figure 31). Not recorded again since the original description.

Literature records: NAMIBIA. 1050. Diamond Area II. 1062. Diamond Area II. (Irish 1988a).

Genus *Psammolepisma* Irish

Psammolepisma Irish 1988a: 32.

Psammolepisma huabensis Irish

Psammolepisma huabensis Irish 1988a: 36.

Known only from the type locality in the Lower Huab River valley (Figure 26).

Literature records: 838. Huab River. (Irish 1988a).

Psammolepisma schultzei (Silvestri)

Ctenolepisma schultzei Silvestri 1908: 294.

Key to Psammolepisma *species:*

1. Urosternite VII with 1+1 bristlecombs only .... *P. schultzei*

- Urosternite VII with 1+1+1 bristlecombs 2

2. Meso- and metasterna with 1+1 bristlecombs each; ovipositor apically sclerotised; adult females with one pair of styli only .... *P. huabensis*

- Meso- and metasterna with 2+2 bristlecombs each; ovipositor *per se* apically sclerotised, but with stout spiniform setae; adult females with two pairs of styli .... *P. skedelkusensis*

Psammolepisma schultzei (Silvestri): Irish 1988a: 34, 1996a: 195.

Found in northwestern South Africa and southern Namibia (Figure 26). Probably more widespread in Namibia than current records suggest.

Literature records: SOUTH AFRICA. 1501. Steinkopf (type locality) (Silvestri 1908).
NAMIBIA. 1156. Vredeshoop 283. 1177. Hohedun 277. SOUTH AFRICA. 1477. Gemsbokvlakte. 1517. 60 mi. ex Pofadder towards Springbok. (Irish 1988a). Also 6 localities in Irish (1996a).

New material examined: 81 (42 females, 37 males, 2 unsexed); 80 BMSA, 1 NMNW.
Localities: SOUTH AFRICA. 1307. Tonsip. 1312. Dwangas. 1326. Loch Leven. 1335. Merriespan. 1372. Droëhout. 1432. Brakfontein. 1437. Klipbakke. 1440. Nabies. 1450. Swartpad. 1454. Coboopduine. 1455. Swartduinkop. 1471. S of Goodhouse. 1478. SW Henkries. 1515. N Wolfkop. 1529. Heuningvlei. 1544. Dabeep. 1547. Swartbakenknop. 1557. Gifkop 166. 1558. Klerk se Vloer. 1581. Blouboskom. 1596. Sandkraal. 1607. 10 km S Witputs.

Psammolepisma skedelkusensis **Irish**

Psammolepisma skedelkusensis Irish 1988a: 38.

Found along the northern Namibian coast (Figure 26). Not seen again since the original description.

Literature records: NAMIBIA. 573. 3 km E Bosluisbaai. 635. Cape Fria Radio Station. 644. Skeleton Coast Park. 813. Torra Bay dunes. (Irish 1988a).

Genus *Sabulepisma* Irish

Sabulepisma Irish, in Irish & Mendes 1988: 276.
Monospecific.

Sabulepisma multiformis **Irish**

Sabulepisma multiformis Irish, in Irish & Mendes 1988: 276; Watson and Irish 1988: 286.

Found in Namib Desert sand dunes (Figure 32), showing extensive intraspecific morphological variation, of which at least some is geographically based. The original description listed Central, Southern and Northern morphotypes but refrained from giving them taxonomic status because of character overlap. This was the best interpretation possible with the available material, however, the southern morphotype was represented by relatively few specimens and localities from a biogeographically complex and poorly understood area, while the northern morphotype was recorded from a single locality only. The single additional specimen listed below represents a large northward extension of the known range but is unfortunately immature and does not contribute to the understanding of variation. Geographical variation in this taxon should be re-examined once more material from a wider range of localities is available.

Literature records: NAMIBIA. 785. Samanab River. 964. Dunes S Swakopmund. 994. Jumbo dune. 997. Kahani dune. 1000. Gobabeb. 1010. Gobabeb, 15 km S. 1011. Noctivaga dune. 1012. Mniszechi's Vlei. 1013. Hudaob dunes. 1014. Far East dunes. 1016. Tsondab Flats. 1046. 10 km SW Witberg. 1060. SE 2515Aa4. 1073. 2 mi. W Harus Mt. 1103. Koichab Pan Area. 1155. 10 km S Grillenthal. 1184. Uguchab River. (Irish & Mendes 1988).

New material examined: 1 unsexed, NMNW.
Locality: NAMIBIA. 561. Northern Namib dunes.

Genus *Silvestrella* Escherich

Silvestrella Escherich 1905: 65.

Escherich (1905) described the two species *Silvestrella termitophila* and *S. myrmecophila*. The types of neither species have been located.

S. termitophila was found with the termite *Microhodotermes viator* (Latreille) at Willowmore (locality 1881) in the southern Cape and its status is quite clear. My concept of it is based on the examination of topotypical material collected with the type host, as well as a large number of samples from the same host in a restricted geographical area (see below).

The case of *S. myrmecophila* was initially less clearcut. It was described with no type locality and the host was an unspecified ant. It was not illustrated and was distinguished from *S. termitophila* by a number of unsatisfactory characters: body size, colouring, antennal length and thickness of cerci only. Wygodzinsky (1955, 1970) examined specimens that had also been found with *M. viator,* that he referred to *S. myrmecophila*. They differed from 'typical' *S. termitophila* by the possession of discal setae on urotergite X. Wygodzinsky's material came from the far west of the genus' range and during the present survey specimens with discal setae were also found only in the west. Escherich did not mention discal setae and in the absence of types it is not possible to say definitively whether *S. myrmecophila sensu* Wygodzinsky is really the same taxon as *S. myrmecophila sensu* Escherich. However, the fact that the present study did not turn up any additional species does suggest that Wygodzinsky was correct, so in the interest of stability, I have

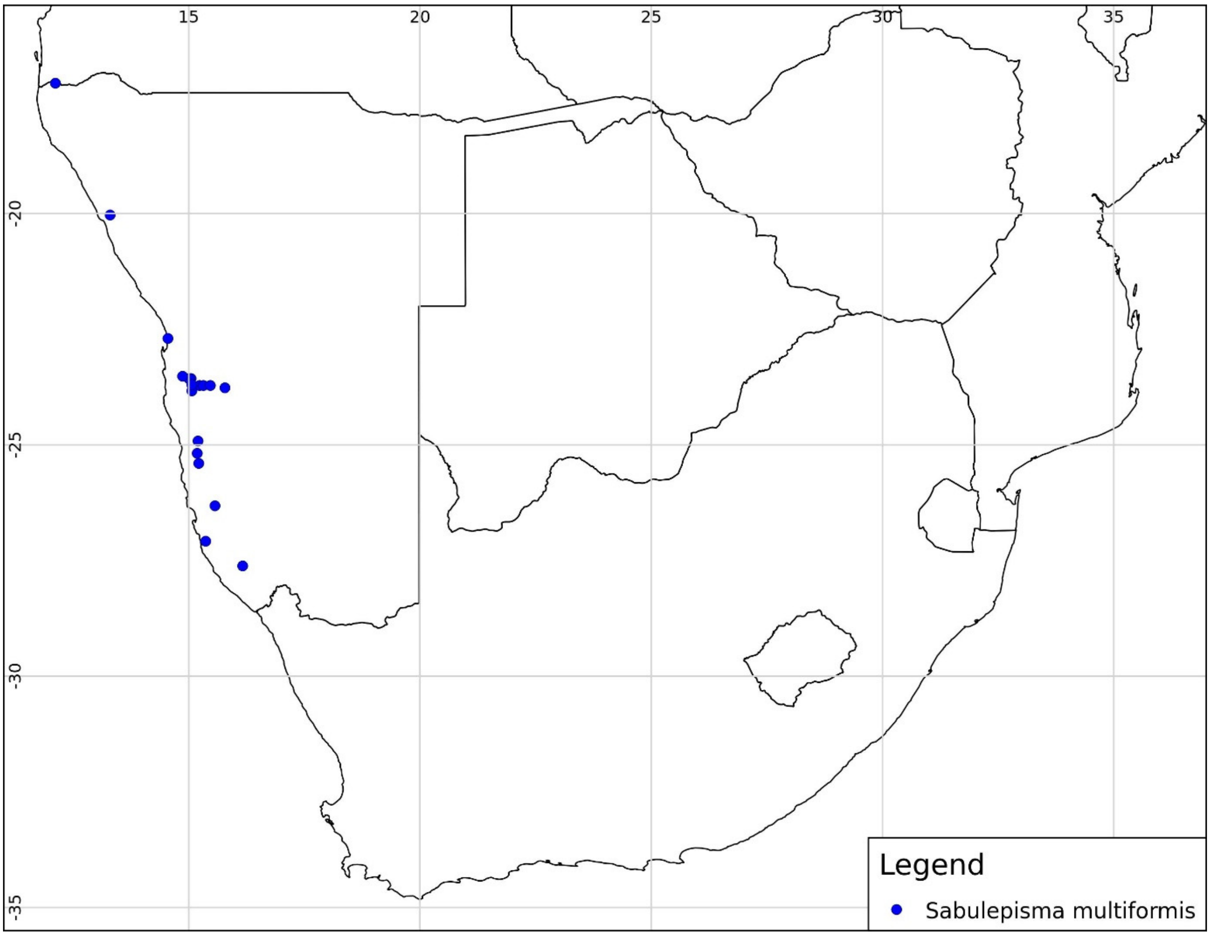

***Figure 32:** Distribution of* Sabulepisma multiformis.

decided to accept Wygodzinsky's definition of *S. myrmecophila*. The presence or absence of discal setae on urotergite X separated available material into two parapatric populations that were interpreted as Escherich's original two species.

The single sample of *Silvestrella* found with ants during this survey was typical *S. termitophila* and I believe that ants are incidental hosts only. In life *Silvestrella* are pale yellowish or yellowish-white in colour.

Silvestrella myrmecophila Escherich

Silvestrella myrmecophila Escherich 1905: 67; Wygodzinsky 1955: 168, 1970: 253; Coaton and Sheasby 1974: 54.

Found in far western South Africa (Figure 28), typically in Succulent Karoo Biome areas and exclusively with *Microhodotermes viator.* My concept of this species was based on material that included some from the same geographical locality and host as those in Wygodzinsky (1955), as well all material listed by Wygodzinsky (1970) and Coaton and Sheasby (1974).

Literature records: SOUTH AFRICA. 1881. Willowmore (type locality; unspecified ants) (Escherich 1905). [not mapped, see discussion of genus above]
SOUTH AFRICA. 1791. Grey's Pass (*Microhodotermes viator,* as *Hodotermes viator*) (Wygodzinsky 1955).
SOUTH AFRICA. 1677. Vanrhynsdorp (*Microhodotermes viator*) (Wygodzinsky 1970).

Key to species of Silvestrella*:*

1. Urotergite X with marginal setal fringe only, disc of tergum asetose; more common in summer rainfall areas, typically Nama-Karoo Biome .... *S. termitophila*

- Urotergite X with 1+1 macrosetae submedially on the tergal disc, in addition to marginal setal fringe; more common in winter rainfall areas, typically Succulent Karoo Biome .... *S. myrmecophila*

SOUTH AFRICA: 1677. Vanrhynsdorp (*Microhodotermes viator*). 1504. Steinkopf, 48 km ex towards Port Nolloth (*Microhodotermes viator*). 1546. Springbok, 24 km ex towards Hondeklipbaai (*Microhodotermes viator*). 1556. Springbok, 56 km ex towards Hondeklipbaai (*Microhodotermes viator*). (Coaton and Sheasby 1974).

Material examined: 24 (3 females, 18 males, 3 unsexed); 21 BMSA, 3 SANC. Also 23 hosts.
Localities: SOUTH AFRICA. 1565. 2 km S Soebatsfontein (*Microhodotermes viator).* 1632. Groenpunt (*Microhodotermes viator*). 1644. 2 km SE Nuwerus (*Microhodotermes viator*). 1728. Karooberg (*Microhodotermes viator*). 1790. Piekenierskloofpas, summit (*Microhodotermes viator*) [this locality is geographically identical to 1791. Grey's Pass in Wygodzinsky 1955]. 1813. Tzaarskuil (*Microhodotermes viator*). 1860. Goudmyn se Berg (*Microhodotermes viator*).

Silvestrella termitophila Escherich

Silvestrella termitophila Escherich 1905: 66, Wygodzinsky 1970: 253; Coaton and Sheasby 1974: 54; Irish 1996a: 196

Found in the interior of western South Africa (Figure 28), typically in Nama-Karoo Biome areas. Many large samples from a restricted geographical area were examined. The SANC material was collected by W.G.H. Coaton and J.L. Sheasby, and consisted of 142 specimens from 22 different nests (including 46 specimens from the same one nest) collected at locality 1805; another 88 specimens from 15 nests collected at the same locality under a different name (locality 1806) six months later, as well as 110 specimens from 12 different nests collected at locality 1779, 22 km away but in the same habitat.

They live almost exclusively with *Microhodotermes viator* but have occasionally been found with ants as well, of which only *Ophthalmopone hottentota* had been identified.
Literature records: SOUTH AFRICA. 1881. Willowmore (type locality; *Microhodotermes viator*, as *Hodotermes viator*) (Escherich 1905).
SOUTH AFRICA. 276. 15 mi. ex Kenhardt – Pofadder (*Microhodotermes viator*). 298. 60 mi. ex Kenhardt – Williston. 502. 42 mi. ex Williston – Fraserburg (*Microhodotermes viator*). 1663. Nieuwoudtville (*Microhodotermes viator*). 1668. 10 mi. ex Calvinia toward Loeriesfontein (*Microhodotermes viator*). 1670. 68 mi. ex Clanwilliam toward Calvinia (*Microhodotermes viator*). 1800. 30 mi. ex Beaufort West toward Willowmore (*Microhodotermes viator*). (Wygodzinsky 1970; Coaton & Sheasby 1974) [all of the latter, in SANC, were examined, see above]

Also 6 localities in Irish (1996a).

New material examined: 367 (23 females, 28 males, 316 unsexed); 340 SANC, 24 BMSA, 2 SAMC, 1 NMNW. Also 19 hosts.
Localities: SOUTH AFRICA. 1633. 10 km NW Loeriesfontein (abandoned nest under stone, no host recorded). 1664. Merweshoek (*Microhodotermes viator*). 1691. Soutpan (*Microhodotermes viator*). 1699. Sandkop (*Microhodotermes viator*). 1718. Uitkykpas, summit (*Microhodotermes viator*). 1722. Van Wyksvlei (*Microhodotermes viator*). 1777. 10 km SW of Aberdeen (*Ophthalmopone hottentota* (Emery) nest C1310, det. H.G. Robertson). 1779. Saucyskuil (*Microhodotermes viator*). 1785. Groot Kapelsfontein (*Microhodotermes viator*). 1797. Driekop (*Microhodotermes viator*). 1801. Gifkop (*Microhodotermes viator*). 1805. 56 km ex Beaufort West towards Willowmore (*Microhodotermes viator*). 1806. Eerstewater, 56 km ex Beaufort West towards Willowmore (*Microhodotermes viator*). 1824. Vrede Rust (*Microhodotermes viator*). 1835. Amospoortjie (*Microhodotermes viator*). 1838. Varsfontein (*Microhodotermes viator*). 1857. 13 km N Matjiesfontein (*Microhodotermes viator*). 1883. Willowmore (*Microhodotermes viator*).

Genus *Stylifera* Stach

Acrotelsa (Stylifera) Stach 1932: 345.
Stylifera Stach. Wygodzinsky 1959b: 38; Irish 1988: 59.

Only one species occurs in southern Africa.

Stylifera galapagoensis (Banks)

Lepisma galapagoensis Banks 1901: 541.

Stylifera galapagoensis (Banks). Paclt 1959: 172; Irish 1988c: 60.

Found in northwestern Namibia and southwestern Angola (Figure 31); also Peru and the Galapagos Islands.

Literature records: ANGOLA. 532. Vila Arriaga, 32 mi. NE. 533. Moçamedes, 36 mi. NE. 538. Moçamedes, 48 mi. SE. 541. Kunene River, 3 km from mouth, N Bank. NAMIBIA. 566. Kunene River, 3 km from mouth (S bank). 568. Otjinungwa, 2-3 km S. 591. Kunene River, 44 km S. 765. The Canyons. 777. Uniabwater. 783. Goabis. 843. Huab River Valley. 860. Ugab River. 861. Ugab River. 862. Ugab River. 868. Tsisabvallei. 970. Namib Park Border. (Irish 1988c)

New material examined: 30 (10 females, 6 males, 14 unsexed); 18 NMNW, 12 TMSA.
Localities: NAMIBIA. 563. Northern Namib. 579. Ruacana Falls area. 597. (No name). 598. (No name). 848. NW of Doros Crater. 857. Otjongoro 20. 859. Gemsbok Altar.

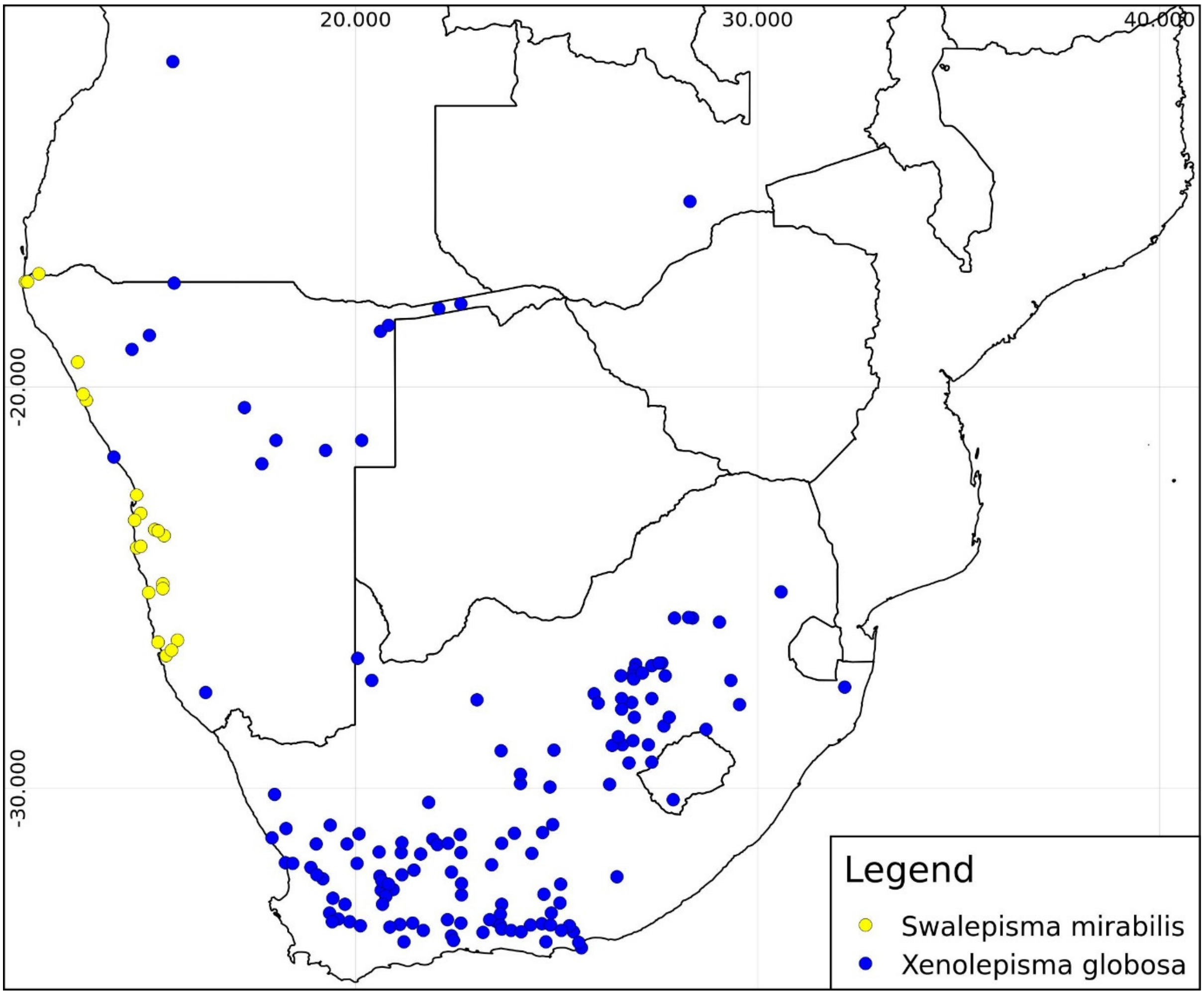

Figure 33: *Distribution of* Swalepisma mirabilis *and* Xenolepisma globose.

Genus *Swalepisma* Irish

Swalepisma Irish, in Irish & Mendes 1988: 279.

Monospecific.

Swalepisma mirabilis Irish

Swalepisma mirabilis Irish, in Irish & Mendes 1988: 280; Watson and Irish 1988: 286.

Found in vegetationless dunes in the Namib Desert (Figure 33).

Literature records: NAMIBIA. 573. 3 km E Bosluisbaai. 574. Northern Namib. 734. Hoanib River. 800. Dunes in Uniab River. 813. Torra Bay dunes. 964. Dunes S Swakopmund. 984. Rooibank. 989. Sandwich Harbour. 997. Kahani dune. 1006. Natab. 1011. Noctivaga dune. 1017. Diamond Area II. 1019. Conception. 1046. 10 km SW Witberg. 1049. Diamond Area II. 1053. 2 km N Sylvia Hill. 1103. Koichab Pan Area. 1104. 30 km N of Lüderitz. 1109. 3 km E Haris. 1124. 2 km N Grasplatz. (Irish & Mendes 1988).

New material examined: 3 males (NMNW).

Locality: NAMIBIA. 561. Northern Namib dunes.

Genus *Thermobia* Bergroth

Thermobia Bergroth 1890: 233.

Thermobia aegyptiaca (Lucas)

Lepisma aegyptiaca Lucas 1842: 559.
Thermobia aegypthiaca (lapsus). Silvestri 1922: 85 *(p.p.)*.
Lepismodes aegyptiacus (Lucas). Wygodzinsky 1955: 157 *(p.p.)*.
Thermobia aegyptiaca (Lucas). Paclt 1966: 155 *(p.p.)*; Irish 1988d: 19; Irish 1996b: 18.

The nominal species is widespread throughout North Africa and into Asia. It had also previously been recorded from East and southern Africa (Figure 34) but there is now some uncertainty as to whether the southern African taxon is indeed conspecific with the North African one and in any case the southern African taxon also appears to be heterogeneous.

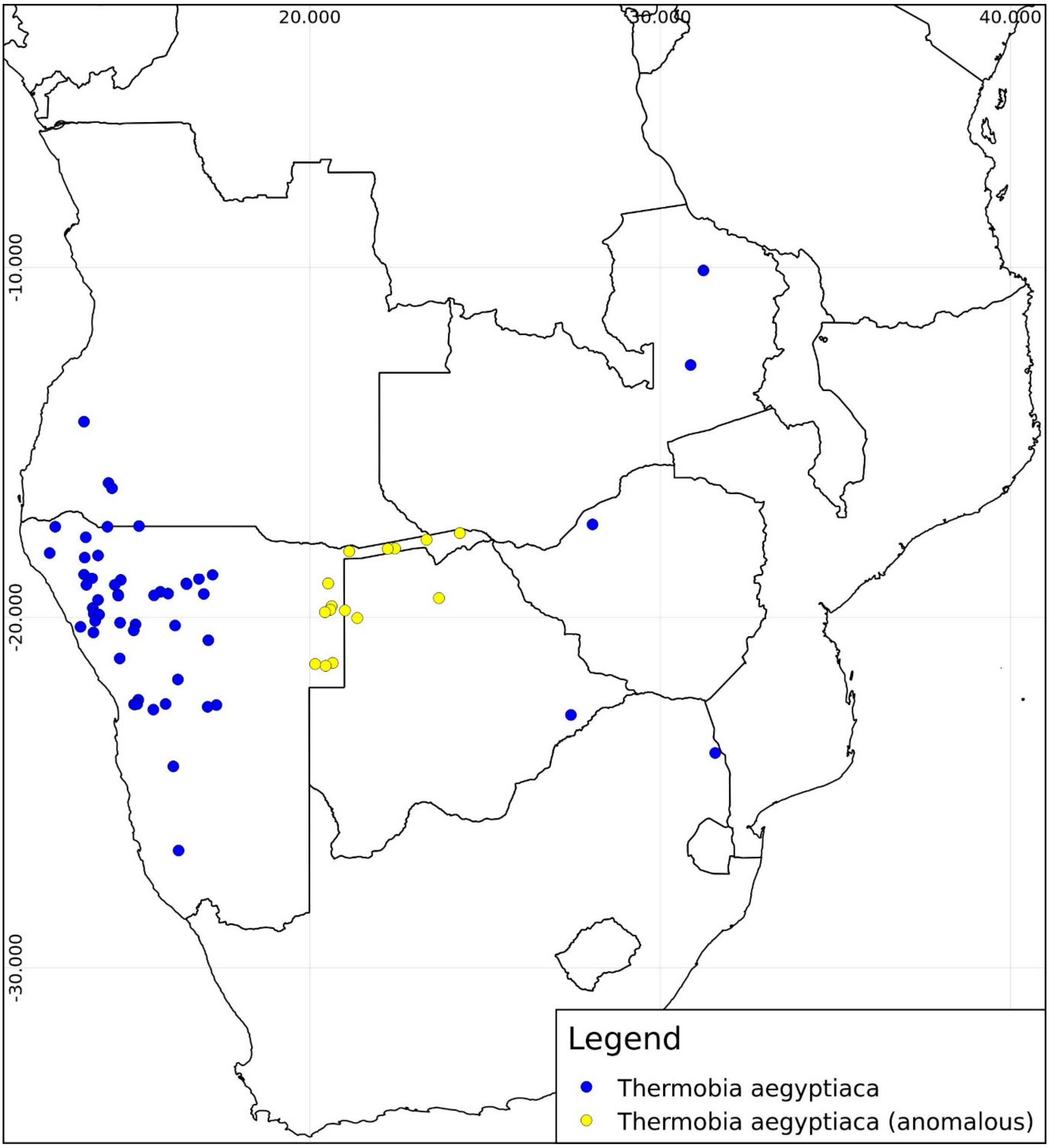

Figure 34: *Distribution of* Thermobia aegyptiaca *(southern Africa only) and anomalous small non-petrophilous specimens hitherto included in* T. aegyptiaca.

The North African type was not available when I revised the genus (Irish 1988d) and I based my diagnosis of *T. aegyptiaca* on comparison of relatively abundant southern African material with less and less well preserved North African specimens, against the background of previous southern African records of *T. aegyptiaca* by knowledgeable taxonomists like Silvestri and Wygodzinsky. I observed reduced submedian bristlecombs on urotergite VIII in all southern African material seen then and since and believed I saw the same in the available North African material. However, Mendes (1993a) subsequently recorded specimens from North Africa that had all urotergal VIII bristlecombs of normal size. The implication is that two different species are involved, the only question is what name to use for which. Molero Baltanás *et al*. (2012) recently designated a neotype for *T. aegyptiaca*; they did not explicitly specify the character state of urotergite VIII but did state that the species was distinguished by the characters used in Irish (1988). This may mean that a new name is required for *T. aegyptiaca* sensu Mendes (1993a). Re-assessment of all North African material is needed to clarify the matter. Workers may note that the character state is very prone to misinterpretation: when counting from urotergites IX/X anteriad, it is easy to overlook the reduced submedian VIII

Key to southern African Thermobia *species and subspecies.*

1. Urotergite VIII with 2+2 bristlecombs, both of regular and approximately equal size 2
- Urotergite VIII with 2+2 bristlecombs, lateral pair regular sized but submedian pair reduced to 1 or 2 macrosetae only .. .. *T. aegyptiaca* (southern Africa)
2. Posterolateral thoracic notal bristlecombs are multiseriate setal clusters .... *T. nebulosa racemifera*
- Posterolateral thoracic notal bristlecombs are 'normal', uniseriate bristlecombs 3
3. Males .... *T. nebulosa / vallaris* indet.
- Females 4
3. Apices of female posterior gonapophyses sclerotised .... *T. nebulosa nebulosa*
- Apices of female posterior gonapophyses unsclerotised .... *T. vallaris*

bristlecombs, especially in cases where the sublateral VIII bristlecombs are not visible from above and the posterior urotergites are concatenated. In such cases the urotergite VII bristlecombs appear where the urotergite VIII bristlecombs are expected in all other *Thermobia* spp. The remedy is to count the submedian bristlecombs from urotergite II posteriad, especially when indifferently preserved material is involved.

Thermobia spp. are the most petrophilous Lepismatidae known to me. They will continue to cling to a stone that has been picked up and keep on running to the other side of the stone as it is turned around in the hand, unlike petrophilous *Ctenolepisma* spp. that tend to drop to the ground quickly. They are typically found in rock on rock situations, as under flakes of exfoliating granite. It therefore came as a surprise to find apparent *Thermobia* specimens under tree bark or leaf litter on sand in completely rockless environments (literally zero rocks for tens of thousands of square kilometres) in northeastern Namibia and northern Botswana. Besides the atypical habitat, they were also very small compared to typical *Thermobia* spp., often with apparent adults at about 5 mm body length. Otherwise they conformed to *T. aegyptiaca* to the extent that they were initially identified as such, but as more samples of consistently small-bodied specimens from rockless habitats in the same area became available, it seemed more likely that they represented another taxon. Unfortunately, the study was terminated before the material could be re-examined in detail. Their localities have been marked with asterisks in the list below and mapped as ‘anomalous’ in Figure 34.

Literature records: NAMIBIA. 841. Farm Okosongomingo, Kleiner Waterberg. 948. Neudamm [specimen untraced, identity unverified: Irish 1988d]. 950. Windhuk. (Silvestri 1922).
NAMIBIA. 631. Orupembe (as Anabib). SOUTH AFRICA. 1244. Letaba Camp. (Wygodzinsky 1955).
NAMIBIA. 897. Okosongomingo, Bez. Omaruru. 950. Windhoek (Paclt 1966).
ANGOLA. 532. Vila Arriaga, 32 mi. NE. 539. 10 mi. NW Cahama. 540. 4 mi. SE Cahama. BOTSWANA. 542. 5 km SE Moremi S Gate*. NAMIBIA. 627. Popa Falls*. 634. 4 km NE Orumana. 639. Oruvandjei. 677. Otjikondavirongo. 681. Ruimte 935. 690. Onauatinda. 700. Halali-koppie. 711. Klippan. 721. Ondundozonananandana Mts. 723. Okaukuejo, 10 mi. S. 728. Kaross. 731. Bakenkop 431. 765. The Canyons. 766. Gautscha Pan. 780. Diamantgat. 773. Tse-Baraka*. 781. Palm 708. 788. Rooiplaat 710. 794. Welkom 680. 802. 1 km N Fransfontein. 803. 8 mi. S of Outjo. 805. Skeleton Coast Park. 824. 1 km N Ugibputs. 872. Upper Brandberg. 929. Swakopmund District. 939. Rössing Mine. 940. Lower Dome Gorge. 945. Upper Ostrich Gorge. 946. Upper Panner Gorge. 970. Namib Park Border. ZAMBIA. 2001. Kasama, 11 mi. N. 2002. Kanona, 32 mi. NE. (Irish 1988d).

Also 7 localities in Irish (1996b), all anomalous material*.

New material examined: 76 (42 females, 27 males, 7 unsexed); 53 NMNW, 23 BMSA.
Localities: BOTSWANA. 543. Gchwihaba Hills*. 548. 50 km SE Palapye. NAMIBIA. 575. Onangombe. 576. Orokatuwo. 579. Ruacana Falls area. 606. Orohona. 686. Otjomatemba. 688. Kalkheuwel. 705. Helio. 709. 6 km N Sesfontein. 724. Aikab, Etosha Nat. Park. 727. Kaross. 745. Sesfontein area. 816. Khorixas town. 880. Epukiro River*. 882. Hereroland East*. 884. Gemsboklaagte*. 941. Otjimbingwe 104. 960. Namib Desert Park. 1027. Tsams Ost 2. 1122. 1 km NW Aus. ZIMBABWE. 2005. Siabuwa Comm. Lands.

Thermobia nebulosa Irish

Thermobia nebulosa Irish 1988d: 24.

The species occurs in the Namib Desert, usually proximate to the coast, with a southern and a northern subspecies that overlap in distribution in the Central Namib (Figure 35). It has also been recorded from

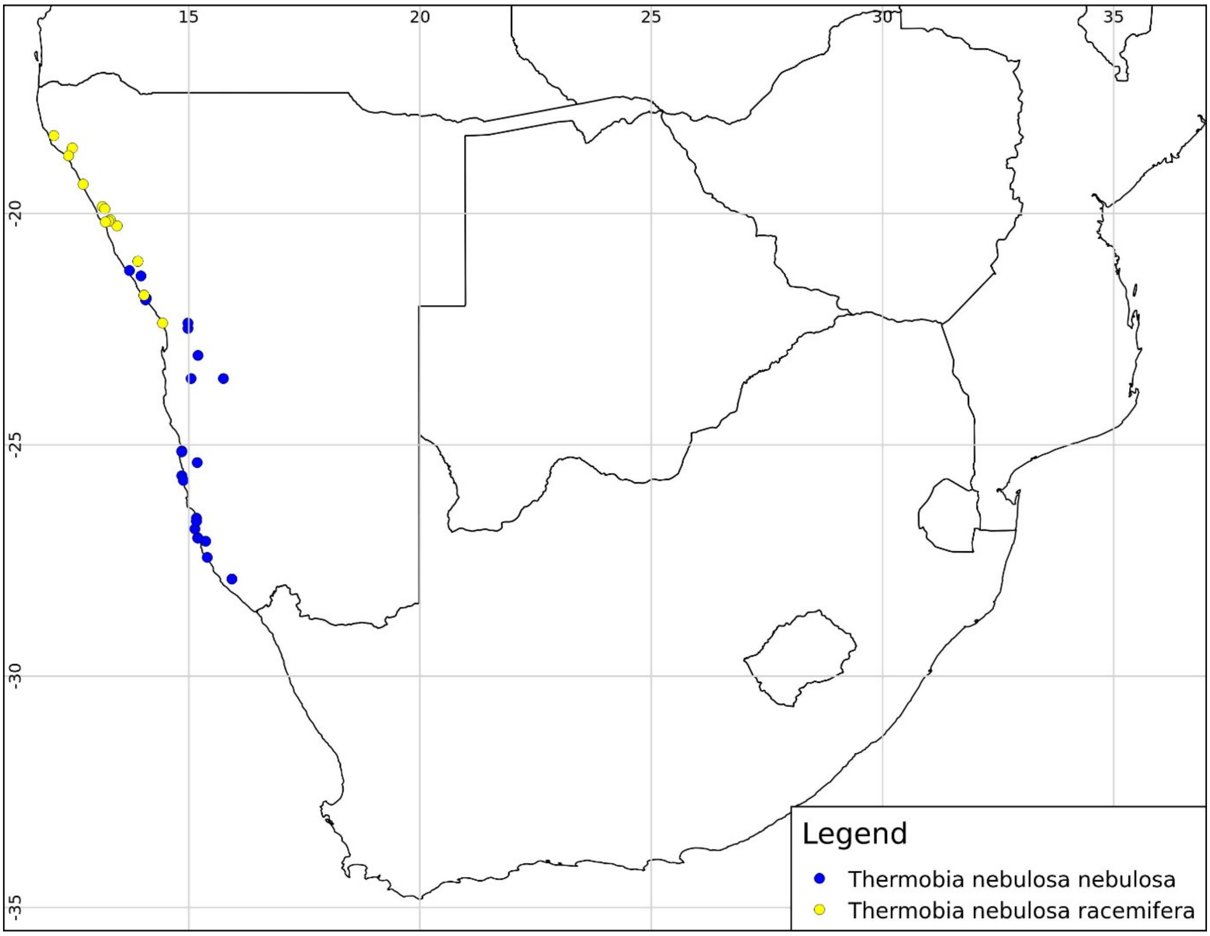

Figure 35: *Distribution of two subspecies of Thermobia nebulosi.*

the offshore Penguin and Possession Islands. The scale pattern is distinctive with a black crossbar on the anterior abdomen (Figure 2a).

Thermobia nebulosa nebulosa Irish

Thermobia nebulosa nebulosa Irish 1988d: 26.
Thermobia aegypthiaca (*lapsus*) Silvestri 1922: 85 (*p.p.*).

Literature records: NAMIBIA. 1120. Lüderitzbucht. 1121. Pinguin Isl. (as *T. aegypthiaca*) (Silvestri 1922).
NAMIBIA. 877. Tantalite Mine. 883. Swakopmund District. 896. 6 km E Kaapkruis. 901. Lagunenberg. 907. Mile 72. 931. 6 km N Arandis. 945. Upper Ostrich Gorge. 975. Ubib. 1000. Gobabeb. 1004. Namib Park, SE Corner. 1053. 2 km N Sylvia Hill. 1054. Sylvia Hill. 1072. Uri-Hauchab Mt. 1080. Spencer Bay / Noordhoek. 1119. Lüderitz. 1155. 10 km S Grillenthal. 1180. Bogenfels. 1206. Boegoeberg. (Irish 1988d).

New material examined: 19 (11 females, 8 males); 19 NMNW.
Localities: NAMIBIA. 1082. Between Saddle Hill North and Spencer Bay. 1110. E of Agate Beach. 1133. Atlas Bay. 1149. Possession Island. 1150. Possession Island. 1152. Possession Island.

Thermobia nebulosa racemifera Irish

Thermobia nebulosa racemifera Irish 1988d: 27.

Literature records: NAMIBIA. 641. Okau. 661. 9 km S Ogams. 676. Sarusas Mine. 729. Möwebaai. 771. Northern Namib. 779. Northern Namib. 796. Uniab River. 801. Uniab Delta. 805. Skeleton Coast Park. 896. 6 km E Kaapkruis. 930. 6 km N Wlotzkasbaken. (Irish 1988d).

New material examined: 2 (1 male, 1 unsexed); 2 NMNW.
Localities: NAMIBIA. 791. Uniab O v. duine. 864. Saltputz.

Thermobia nebulosa / vallaris indet.

Thermobia aegypthiaca (*lapsus*) Silvestri 1922: 85 (*p.p.*).
Thermobia aegyptiaca (Lucas) Paclt 1966: 156 (*p.p.*).

Males of *T. vallaris* and *T. nebulosa nebulosa* can not be reliably distinguished in isolation and need to be identified with reference to associated females. If there are none, material from south of the Orange

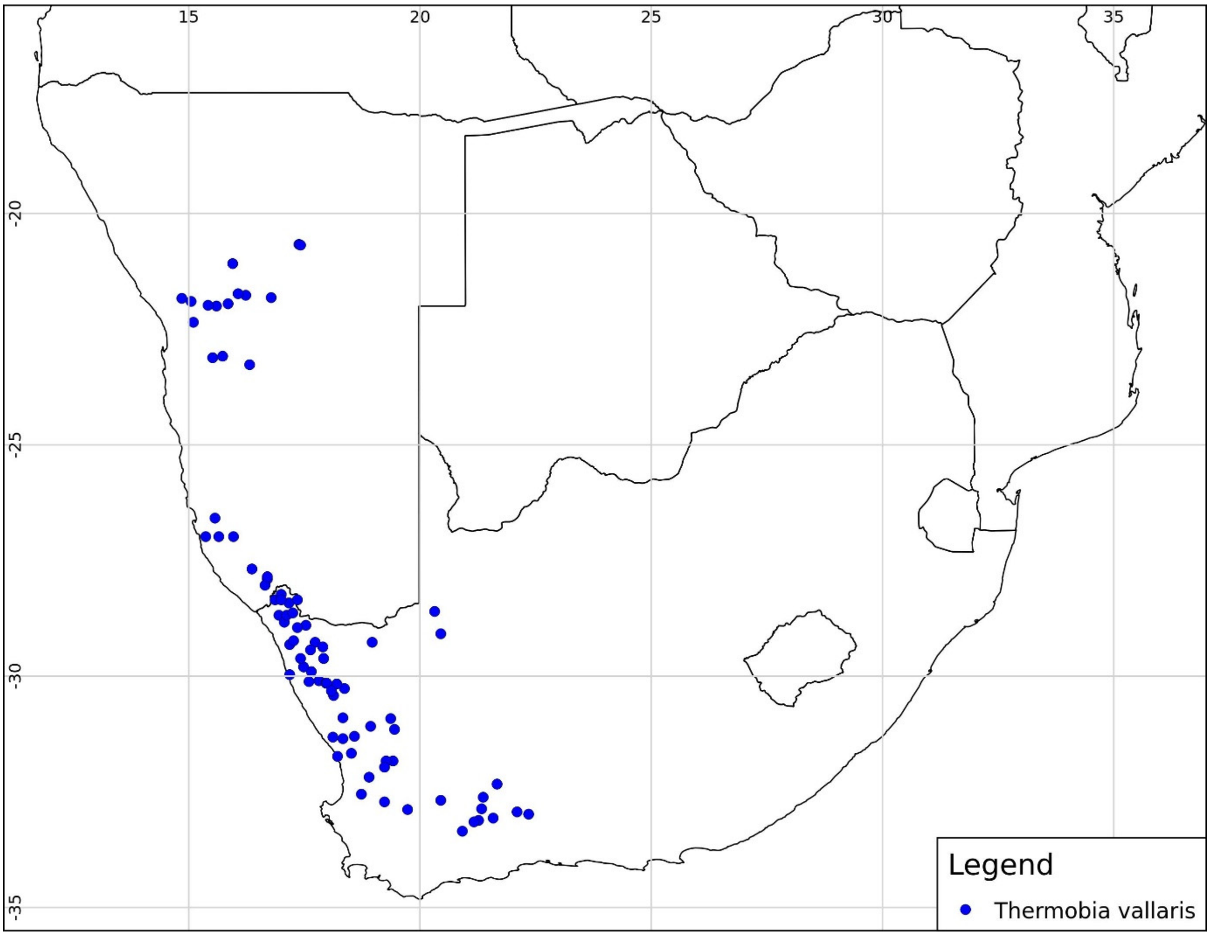

***Figure 36:** Distribution of* Thermobia vallaris.

River, where *T. nebulosa* has not been found, can safely be assumed to be *T. vallaris*. North of the Orange River, coastal material tends to be *T. nebulosa* while more inland material is usually *T. vallaris*, but there is overlap in distribution. All such material seen falls within the combined ranges of both species and has not been listed separately.

Literature records: NAMIBIA. 1123. Kolmannskuppe (as *T. aegypthiaca*) (Silvestri 1922). NAMIBIA. 1120. (as *T. aegyptiaca*) Lüderitz (Paclt 1966). All males, examined by Irish (1988d).

Thermobia vallaris Irish

Thermobia vallaris Irish 1988d: 22, 1996a: 197
Thermobia aegyptiaca (*nec* Lucas) Silvestri 1908: 295.
Thermobia aegypthiaca (lapsus) Silvestri 1922: 85 *(p.p.).*
Lepismodes aegyptiacus (Lucas) Wygodzinsky 1955: 157 *(p.p.).*
Thermobia aegyptiaca (Lucas) Paclt 1966: 155 *(p.p.).*

A species of the escarpment in western southern Africa, with some isolated records further inland (Figure 36). The distribution gap in southern Namibia is attributed to insufficient sampling. The scale cover is grey with black cross-markings (Figure 2b). One specimen was eating a fresh exuvium, presumably its own, when collected and continued consuming it after being captured.

Literature records: SOUTH AFRICA. 1501. Steinkopf. 1543. Kamaggas (originally as *T. aegyptiaca,* (Silvestri 1908). Listed as *T. nebulosa / vallaris* indet. by Irish (1988d) but systematic collection has shown that only *T. vallaris* occurs near either place.
NAMIBIA. 914. Karibib. 920. Usakos. (Silvestri 1922)
SOUTH AFRICA. 1690. Botter Kloof Pass (as *L. aegyptiaca*). (Wygodzinsky 1955).
897. Farm Okosongomingo, Bez. Omaruru. 920. Usakos. (both as *T. aegyptiaca*) (Paclt 1966);
NAMIBIA. 867. Omaue 29. 900. 15 mi. NW Okahandja. 903. 16 km WSW Klein Spitskop. 909. 6 km SSW Klein Spitskop. 917. 18 km W Usakos. 929. Swakopmund District. 970. Namib Park Border. 981. Ganab. 1142. Grillenthal. 1145. Kaukausib fountain. 1147. Agub Mt. SW. 1212. Obib Mountain. 1404. 22 km N Eksteenfontein. 1495. Farquarson (type locality). 1655. 18 mi. SE Nuwerus. 1681. 20 km W Vredendal. 1685. Wiedou. (Irish 1988d).
Also 1 locality in Irish (1996a).

New material examined: 205 (87 females, 111 males, 7 unsexed); 145 BMSA, 47 NMNW, 7 SAMA, 4 USNM, 2 TMSA.

Localities: NAMIBIA. 844. Hamakari Süd 373. 846. Hamakari Süd 373. 893. Nooitgedag 49. 978. Us Pass road. 986. Gamsberg Pass, top. 1111. Diamond Area I. 1193. Aurusberg. 1201. Spitskop 111. 1207. 10 km NW Rosh Pinah. SOUTH AFRICA. 1354. Kodaspiek. 1365. 2 km S Wallekraal Mine. 1367. Hottentotsparadys. 1369. Springbokvlakte. 1379. Haakiesdoorn. 1399. Maanrots. 1418. Jakkalsputs dunes. 1419. Black Hills. 1435. W Wildeperderant. 1453. Kristalberge. 1468. Ratelfontein. 1503. Gamsberg Site P. 1510. SW Abbevlak. 1513. Dwarsberg. 1518. Varswater. 1527. Wolfberg. 1528. Kabas. 1552. Messelpad. 1559. Elandsklip. 1563. Tweerivier. 1565. 2 km S Soebatsfontein. 1570. Sneeukop. 1571. Dassiefontein. 1575. Bailey's Pass. 1578. Kap-Kap. 1580. Lilyfontein, Kamiesbergen. 1594. Blouberg. 1632. Groenpunt. 1633. 10 km NW Loeriesfontein. 1639. Driekuil. 1646. Perdeberg. 1657. Rooivlei. 1658. Potklei. 1691. Soutpan. 1701. Doorn Bosch 19. 1735. Clanwilliam. 1751. Danskraal. 1778. Valentinusfontein. 1786. Platkop. 1801. Gifkop. 1808. Tandfontein. 1822. Stel se Nek. 1827. Swartruggens, foot. 1838. Varsfontein. 1843. Kleinwaterval. 1846. Blaauwkrantz. 1858. 1 km N Koup. 1866. Spitskopvlakte. 1893. Witnekke.

Genus *Tricholepisma* Paclt

Lepisma (Tricholepisma) Paclt 1967: 16.
Tricholepisma Paclt. Mendes 1988: 11.

Only one species in southern Africa.

Tricholepisma zulu (Wygodzinsky)

Lepisma zulu Wygodzinsky 1955: 122.
Tricholepisma zulu (Wygodzinsky). Mendes 1988: 46.

T. zulu was previously known from the types only. It occurs uncommonly in the Fynbos Biome, including the isolated northern outlier of fynbos on the Kamiesberg in Namaqualand (Figure 29). The admittedly limited material available shows some geographical variation. Specimens from the southern Cape were associated with *Anoplolepis* sp. ants and were generally of a light reddish-grey colour with no scale pattern. The Namaqualand material was associated with *Camponotus* spp. ants and was dark brown or black in colour, with a *Xenolepisma globosa* - like scale pattern being recorded for at least the Eselkop (locality 1589) specimen. The type locality lies between these two distribution areas. The type description agrees with the Kamiesberg material in both general colour and host but fresh material from the type locality conforms to southern specimens. There are no other obvious differences between the two groups.

Literature records: SOUTH AFRICA. 1791. Grey's Pass (type locality; with *Camponotus* sp.; in MZLU, not examined) (Wygodzinsky 1955) (Mendes 1988).

Material examined: 15 (9 females, 5 males, 1 unsexed); 10 NMNW, 5 BMSA. Also 26 hosts.
SOUTH AFRICA. 1577. Horinggat (*Camponotus* cf. *maculatus*). 1589. Eselkop (*Camponotus* sp.). 1776. Verlatekloof (*Anoplolepis* sp., det H. Robertson 1988). 1790. Piekenierskloofpas, summit (*Anoplolepis steingroeveri*). 1932. Kromhoogte (*Anoplolepis steingroeveri*). 1957. Gysmanshoekpas (*Anoplolepis steingroeveri*).

A single specimen referred to *Tricholepisma* was collected at a light trap at Skerpioenbult, northern Namibia (locality 672, NMNW). It was set aside for later detailed study that never happened. On geographical and habitat grounds it is unlikely to be *T. zulu* and is likely an undescribed species.

Genus *Xenolepisma* Mendes

Asterolepisma (Xenolepisma) Mendes 1981a: 201.
Xenolepisma Mendes 1988: 12.

Only one species in southern Africa.

Xenolepisma globosa (Escherich)

Lepisma braunsi (p.p.) Escherich 1903: 365.
Lepisma globosa Escherich 1905: 50; Wygodzinsky 1955:128, 1970:253.
Asterolepisma (Xenolepisma) globosa (Escherich) Mendes 1981: 307.
Xenolepisma globosa (Escherich). Mendes 1988: 88; Irish 1994b: 483; Irish 1996a: 198; Irish 1996b: 19.

The commonest and most widespread myrmecophilous lepismatid in southern Africa (Figure 33), occurring in a wide range of habitats but scarce in or absent from the Fynbos Biome. It is here recorded for the first time from both Angola and Zambia. They have been found with at least 14 different ant hosts, most commonly with *Anoplolepis* spp. (49% of samples). They have twice been incidentally recorded from termite nests but are not normally termitophilous.

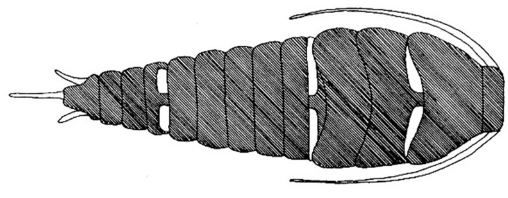

Figure 37: *Typical scale pattern of* Xenolepisma globosa *(after Irish 1994a).*

In life the scale cover is black or very dark brown, with transverse white markings where scales are transparent (Figures 2e, 37).

Observations on live animals in opened nests indicate that they move about freely among the ants, who do not react when fishmoths move between or under them. Individual body size of adult *X. globosa* is proportional to the size of the host ant. Those found with small ants like *Monomorium* or *Lepisiota* spp. are tiny, while the largest individuals I encountered were found with large ants like *Camponotus fulvopilosus*.

Literature records: SOUTH AFRICA. 1963. Port Elizabeth (type locality; *Camponotus maculatus cognatus*) (Escherich 1903, 1905).
SOUTH AFRICA. 1261. 10 mi. SE Lydenburg.
LESOTHO. 555. Mt. Morosi, 5700 ft. (Wygodzinsky 1955; Mendes 1988)
NAMIBIA. 881. Farm Etemba, 100 mi. E Okahandja (*Macrotermes natalensis*). (Wygodzinsky 1970b).
SOUTH AFRICA. 1739. Barrow's Hope. (Mendes 1981a).
Also 30 localities in Irish (1994b), 20 in Irish (1996a) and 3 in Irish (1996b).

New material examined: 178 (81 females, 77 males, 20 unsexed); 110 BMSA, 57 NMNW, 5 IICT, 4 CAS, 2 SAMC. Also 319 hosts.
New localities: (specimens without hosts either from pit traps, or no host recorded).
ANGOLA. 530. 5 mi. NW of Namba. NAMIBIA. 580. Onhelelwa. (unspecified ants). 624. 13 km W Omega. 673. Dorsland. 711. Klippan. 830. Waterberg Rest Camp (*Lepisiota* sp.). 882. Hereroland East. 889. Ombirisu 684 (*Pheidole* sp. det. H. Robertson 1988). 895. Robfabriek, Kaapkruis (*Lepisiota* sp., as *Acantholepis* sp., det. H. Robertson 1988). 911. Otjihangweberg. 1185. Aurus (*Lepisiota* sp., as *Acantholepis* sp., det. H. Robertson 1988). SOUTH AFRICA. 1280. Val de Grace. (*Anoplolepis custodiens*, det. H. Robertson 1988). 1281. Saartjiesnek. (*Anoplolepis custodiens*). 1282. Swartkoppies. 1289. 12 mi. W Witbank. 1315. 2 km SE Rietfontein (*Anoplolepis steingroeveri*). 1331. Rondepan (*Lepisiota* sp.). 1336. 11 km NW Ubombo (*Anoplolepis custodiens*). 1343. Fairfield (*Tetramorium dichroum*). 1345. Sishen Mine Area (*Anoplolepis custodiens*). 1391. Honingkloof (*Anoplolepis* sp.). 1571. Dassiefontein (*Anoplolepis custodiens*). 1633. 10 km NW Loeriesfontein (*Anoplolepis steingroeveri*). 1637. 5 km NE Bitterfontein (unspecified ants). 1652. Brakfontein (*Lepisiota* sp.). 1662. Vanrhynspas (*Anoplolepis steingroeveri*). 1665. Hantamsberg-plato (*Anoplolepis custodiens*). 1692. S Doringbaai (*Lepisiota* sp.). 1695. Vaalvlei (*Lepisiota* sp.). 1700. Kraaibosberg (unspecified ants). 1705. Klipheuwelkoppe (*Anoplolepis steingroeveri*). 1711. Bastardspoort (*Anoplolepis steingroeveri*). 1729. Pakhuispas, summit (*Lepisiota* sp.). 1730. Seleryfontein. (*Lepisiota* sp.). 1736. Brandkop (*Anoplolepis custodiens*). 1744. 4 km NW Wuppertal (*Anoplolepis custodiens*). 1748. 10 km N Sutherland. (*Ocymyrmex* sp., det. H. Robertson 1988). 1757. Vaalkoppies (*Camponotus fulvopilosus*). 1759. Sutherland Sterrewag (*Anoplolepis custodiens*). 1760. Sondagsrivier (*Tetramorium* sp.). 1775. Portugalsrivier (*Crematogaster* sp.). 1776. Verlatekloof (*Anoplolepis custodiens* det H. Robertson 1988). 1796. Quimby Holme (*Crematogaster* sp.). 1797. Driekop (*Crematogaster* sp.). 1802. Komsbergpas (*Camponotus* sp.). 1802. Komsbergpas (*Anoplolepis custodiens*). 1809. Blinkbergpas, summit (*Anoplolepis custodiens*). 1821. Westondale (*Crematogaster* sp.). 1827. Swartruggens, foot (*Anoplolepis custodiens*). 1829. Bakenshoogte (*Anoplolepis custodiens*). 1832. Blomplaas (*Anoplolepis* sp.). 1852. Groenfontein (*Anoplolepis custodiens*). 1855. Kalkfontein (*Tetramorium* sp.). 1862. Kilbourne (*Anoplolepis custodiens*). 1876. Amperbo (*Camponotus* sp.). 1877. Kareedouwpas (unspecified ants). 1878. Doringhoek (*Anoplolepis custodiens*). 1882. Willowmore (*Anoplolepis custodiens* det H. Robertson 1988). 1883. Willowmore (*Anoplolepis custodiens* det H. Robertson 1988). 1883. Willowmore (*Camponotus ?maculatus* det H. Robertson 1988). 1883. Willowmore. (*Anoplolepis steingroeveri* det H. Robertson 1988). 1887. De Rust (*Anoplolepis custodiens*). 1888. Kwartelfontein (*Lepisiota* sp.). 1894. Seweweekspoort, N (*Anoplolepis steingroeveri*). 1897. Vrolikheid (*Anoplolepis custodiens*). 1898. Erekroonspoort (*Camponotus fulvopilosus*). 1899. Beeskraal (*Anoplolepis steingroeveri*). 1903. Wildealslaagte (*Anoplolepis custodiens*). 1904. Skietkraal (*Pheidole* sp.). 1905. Gorrielaagte (*Camponotus* cf. *maculatus*). 1905. Gorrielaagte (*Tetramorium* sp.). 1907. Touwsrivier, SE (*Lepisiota* sp.). 1908. Vaalhoedskraal (*Camponotus maculatus*). 1910. Die Outol (*Lepisiota* sp.). 1913. Nuwekloofpas, summit (*Lepisiota* sp.). 1914. Calitzdorp. 1915. Verlorenrivier (*Tetramorium* sp.). 1916. Mannetjie (*Camponotus maculatus*). 1919. Skuinspadkloof (*Anoplolepis* sp.). 1920. 20 km N Uitenhage (*Anoplolepis custodiens*, det H. Robertson 1988, C1126). 1923. Uniondale, 9 km NNE (*Anoplolepis custodiens*, det H. Robertson 1988). 1932. Kromhoogte (*Anoplolepis steingroeveri*). 1942. 3 mi. N of Herold. 1944. Miertjieskraal, E (*Anoplolepis steingroeveri*). 1945. Rooivlei, N (unspecified ants). 1946. Perseverance (*Anoplolepis steingroeveri*). ZAMBIA. 2003. Xanadu farm, Lusaka (*Lepisiota* sp., as *Acantholepis* nest C 291).

DISCUSSION

A summary of recorded hosts for southern African nidicolous Lepismatidae is given in Appendix 1. Eight species have sufficient numbers of host records to determine host specificity (Table 2).

Both *Silvestrella* spp. are highly host specific with the same one termite species, *Microhodotermes viator,* in geographically separated areas. They are also the only known obligate termitophilous Lepismatidae. The myrmecophilous Lepismatidae tend to be host specific at the ant genus level, thus *N. braunsi* is very host specific with *Crematogaster* spp. and both *A. sesotho* and *C. messor* are specific to *Messor* spp. *A. tragardhi* occurs with a variety of ants but most of them belong to the subfamily Ponerinae; given that Ponerinae are less common ants in the habitats that were most intensively sampled here, this is probably a real association. The three species *H. heymonsi, X. globosa* and *A. szeptyckii* each occur with a wide variety of ants and their apparent association with *Tetramorium* or *Anoplolepis* spp. is more likely because those are very common ants that get sampled more frequently, rather than any preference for those genera.

The exact nature of the relationship between nidicole and host is not known in any of these cases but one trend may be noted. *Microhodotermes viator* is a harvester termite and *Messor* spp. are harvester ants. Their nests contain large amounts of dry plant material, which is food for Lepismatidae. Each harbours two specialist Lepismatidae nidicoles. *Pheidole* ants are also harvesters and although the sample was small, evidence suggested that *Afrolepisma oudemansi* might be *Pheidole* specialist, while some material currently treated as *C. plusiochaeta* was also collected with *Pheidole* spp.

The only other known large sample of myrmecophilous Lepismatidae host records that has been analysed came from Spain (Molero-Baltanás et al. 2017). While the two datasets are not comparable and the faunas are very different, it is of interest that they also found most host specificity at the ant genus level, they encountered both generalist (many hosts) and specialist nidicoles, and the majority of their specialist myrmecophiles were associated with *Messor* spp.

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Table 2: *Host specific southern African Lepismatidae.*

Nidicole	Preferred host	% preferred	Other hosts
Silvestrella spp.	*Microhodotermes viator*	95%	1
Neoasterolepisma braunsi	*Crematogaster* spp.	92%	3
Afrolepisma sesotho	*Messor* spp.	88%	5
Ctenolepisma messor	*Messor* spp.	76%	3
Afrolepisma tragardhi	Ponerinae spp.	60%	5
Hemilepisma heymonsi	*Tetramorium* spp.	49%	7
Xenolepisma globosa	*Anoplolepis* spp.	49%	17
Afrolepisma szeptyckii	*Tetramorium* spp.	45%	15

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APPENDIX 1

Host list for obligate nidicolous southern African Lepismatidae species. Where host preference is clear, this is indicated by a bold, capitalised 'X'. Sources: current material, Irish (1994b, 1996a) and all cited literature sources.
Abbreviations for Lepismatidae: A = *Afrolepisma*, C = *Ctenolepisma*, H = *Hemilepisma*, N = *Neoasterolepisma*, S = *Silvestrella*, T = *Tricholepisma*, X = *Xenolepisma*, followed by the first three letters of the species name.
*The ant genus *Dolioponera* does not occur in southern Africa (Fisher & Bolton 2016). My misidentification of the material was based on the generic key in Hölldobler & Wilson (1990) at the time and although it is definitely a ponerine, its correct identity is otherwise not known.

Host	A. ele	A. jae	A. und	A. oud	A. ses	A. sim	A. sze	A. tra	C. cor	C. mes	H. hey	N. bra	S. myr	S. ter	T. zul	X. glo	Total spp.
FORMICIDAE **Subfamily Dolichoderinae**																	
Technomyrmex pallipes (Smith)	x																1
Subfamily Dorylinae																	
Dorylus braunsi Emery				x													1
Subfamily Formicidae																	
Anoplolepis custodiens (Smith)											x					**X**	2
Anoplolepis steingroeveri (Forel)										x					**X**	**X**	3
Anoplolepis sp.															x	**X**	2
Camponotus angusticeps Emery								x									1
Camponotus fulvopilosus (De Geer)							x									x	2
Camponotus maculatus (F.)					x		x	x							x	x	5
Camponotus storeatus Forel							x										1
Camponotus rufoglaucus (Jerdon)		x															1
Camponotus vestitus (Smith)							x										1
Camponotus sp.							x	x				x			**X**	x	5
Lepisiota sp.																x	1
Polyrhachis gagates Smith								x									1
Subfamily Myrmicinae																	
Crematogaster peringueyi Emery												x					1
Crematogaster sp.												**X**				x	2

Host	A. ele	A. jae	A. und	A. oud	A. ses	A. sim	A. sze	A. tra	C. cor	C. mes	H. hey	N. bra	S. myr	S. ter	T. zul	X. glo	Total spp.
Messor capensis Mayr					**X**		x			**X**							3
Messor decipiens Santschi					**X**					**X**							2
Messor denticornis Forel					**X**		x			**X**							3
Messor tropicorum Wheeler					**X**												1
Messor sp.					**X**	x				**X**							3
Meranoplus peringueyi Emery							x									x	2
Monomorium albopilosum Emery																x	1
Monomorium delagoense Forel												x					1
Monomorium cf. fridae Forel																x	1
Myrmicaria nigra (Mayr)																x	1
Ocymyrmex barbiger Emery							x				x						2
Ocymyrmex hirsutus Forel											x						1
Ocymyrmex sp.							x				x					x	3
Pheidole capensis Mayr											x						1
Pheidole sp.				**X**			x	x			x					x	5
Rhoptomyrmex sp.							x										1
Tetramorium clunum Forel							**X**			x	**X**						3
Tetramorium dichroum Santschi							**X**									x	2
Tetramorium peringueyi Arnold				x													*1*
Tetramorium rufescens Stitz							**X**			x	**X**						*3*
Tetramorium sericeiventre Emery							**X**									x	2
Tetramorium signatum Emery							**X**										1
Tetramorium solidum Emery							**X**				**X**						2
Tetramorium sp.		x					**X**		x		**X**					x	5
Subfamily Ponerinae																	
*Bothroponera granosa (*Roger)	x																1
Bothroponera kruegeri (Forel)								**X**									1
**Dolioponera* sp.							x										1

Host	A. ele	A. jae	A. und	A. oud	A. ses	A. sim	A. sze	A. tra	C. cor	C. mes	H. hey	N. bra	S. myr	S. ter	T. zul	X. glo	Total spp.
Megaponera analis (Latreille)								**X**									1
Megaponera sp.								**X**									1
Ophthalmopone hottentota (Emery)														x			1
Platythyrea arnoldi Forel								**X**									1
Platythyrea cf. *cribrinodis* (Gerstaecker)								**X**									1
Platythyrea lamellosa (Roger)					x			**X**									2
Platythyrea schultzei Forel								**X**									1
Plectroctena mandibularis F. Smith	**X**							**X**									2
Ponerinae unspecified								**X**									1
Subfamily indet.																	
Unspecified ants		x	x	x	x		x				x			x		x	
ISOPTERA **Family Hodotermitidae**																	
Hodotermes mossambicus (Hagen)				x													1
Microhodotermes viator (Latreille)													**X**	**X**			2
Family Kalotermitidae																	
Bifiditermes durbanensis (Haviland)												x					1
Family Termitidae																	
Amitermes hastatus (Haviland)					x												1
Astalotermes brevior (Holmgren)																x	1
Baucaliotermes hainesi (Fuller)							x										1
Macrotermes natalensis (Haviland)																x	1
Odontotermes transvaalensis (Sjöstedt)					x												1
Trinervitermes trinervoides (Sjöstedt)					x												1
Family indet.																	
Unspecified termites		x															

APPENDIX 2

Locality details for southern African Lepismatidae. Details for localities 1 – 529 are in Irish (1994b, 1996a). In some cases more information was available at the time when the material was examined but has been lost since.

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
ANGOLA						
5 mi. NW of Namba	530	-11.900	15.450	29-V-1958	E.S. Ross, R.E. Leech	CAS
2 mi. N Caconda	531	-13.717	15.067	7-XII-1966	E.S. Ross, K. Lorenzen	CAS
32 mi. NE of Vila Arriaga [now Bibala]	532	-14.400	13.550	23-V-1958	E.S. Ross, R.E. Leech	CAS
Moçamedes, 36 mi. NE [now Namibe]	533	-14.800	12.433		Irish (1988c)	
5 mi N Sa da Bandeira [now Lubango]	534	-14.833	13.483	10-XII-1966	E.S. Ross, K. Lorenzen	CAS
17 mi. W Vila Arriaga	535	-14.850	13.150	10-XII-1966	E.S. Ross, K. Lorenzen	CAS
23 mi W Vila Folgares	536	-14.900	14.750	8-XII-1966	E.S. Ross, K. Lorenzen	CAS
24 mi. SE of Chibia	537	-15.383	13.983	19-V-1958	E.S. Ross, R.E. Leech	CAS
Moçamedes, 48 mi. SE	538	-15.650	12.667		Irish (1988c)	
10 mi. NW Cahama	539	-16.150	14.250		Irish (1988d)	
4 mi. SE of Cahama	540	-16.300	14.350	18-V-1958	E.S. Ross, R.E. Leech	CAS
Kunene River, 3 km from mouth, N Bank	541	-17.267	11.783	II-1982	J. Irish	NMNW
BOTSWANA						
5 km SE Moremi S Gate	542	-19.450	23.683	9-I-1981	J. Irish	NMNW
Gchwihaba Hills	543	-20.017	21.350	14-VII-1993	J. Irish	BMSA
Nata [actually 10 km N]	544	-20.117	26.167	8-I-1981	J. Irish	NMNW
5 km NW Francistown	545	-21.150	27.467	7-I-1981	J. Irish	NMNW
Swaneng Hill School	546	-22.417	26.767	15-X-1983	P. Forchhammer	FORC
Farmers Brigade 5 km SE of Serowe	547	-22.417	26.767	1988	P. Forchhammer	FORC
50 km SE Palapye	548	-22.783	27.450	7-I-1981	J. Irish	NMNW
Kang	549	-23.667	22.300		Silvestri (1908)	
Kang-Khakhea / Khakhea-Kang / Kang-Kakir [= between Khekhu and Kang]	550	-24.117	23.117		Silvestri (1908)	
Severelela-Kooa [= between Seherelela and Kue Pans]	551	-24.867	24.617		Silvestri (1908)	
Severelela [= Seherelela Pan]	552	-24.883	24.900		Silvestri (1908)	
LESOTHO						
Dikolobeng River	553	-30.283	27.817		Wygodzinsky (1955)	
Mt. Morosi, 7500 ft.	554	-30.283	27.883		Wygodzinsky (1955)	
Mt. Morosi, 5700 ft.	555	-30.283	27.900		Wygodzinsky (1955)	
MALAWI						
6 mi S of Njakwa	556	-11.067	33.883	21-II-1958	E.S. Ross, R.E. Leech	CAS
6 mi. N of Ekwendeni	557	-11.283	33.883	21-II-1958	E.S. Ross, R.E. Leech	CAS
MOÇAMBIQUE						
Beira	558	-19.833	34.850		Stach (1935)	
Maputo	559	-25.967	32.583		Mendes (1993b)	
Ponta do Ouro	560	-26.850	32.883		Mendes (1993b)	
NAMIBIA						
Northern Namib dunes at:	561	-17.183	12.117	24-IV-1991	E. Marais	NMNW
[near] Kunene River at:	562	-17.200	12.167	13-II-1984	S. Endrödy-Younga (EY2067)	TMSA

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Northern Namib at:	563	-17.250	12.167	19-X-1988	E. Griffin, L. Malan	NMNW
Kunene R[iver].M[outh].	564	-17.267	11.767	3-X-1968	P.G. Olivier	NMNW
Kunene River Mouth (S bank)	565	-17.267	11.767	1-II-1982	J. Irish	NMNW
Kunene River, 3 km from mouth (S bank)	566	-17.267	11.767	29-I-1982	J. Irish	NMNW
Skeleton Coast Park at:	567	-17.283	11.750	19-III-1998	MLS 01	NMNW
Otjinungwa, 2-3 km S	568	-17.283	12.433		Irish (1988c)	
Skeleton Coast Park at:	569	-17.300	11.750	19-III-1998	MLS 02	NMNW
7 km N Bosluisbaai	570	-17.333	11.750	2-II-1982	J. Irish	NMNW
Bosluisbaai	571	-17.383	11.750	30-I-1982	J. Irish	NMNW
1 km E Bosluisbaai	572	-17.383	11.767	2-II-1982	J. Irish	NMNW
3 km E Bosluisbaai	573	-17.383	11.783	26-I-1982	J. Irish	NMNW
Northern Namib at:	574	-17.383	11.833	27-I-1982	J. Irish	NMNW
Onangombe	575	-17.383	15.117	19-I-1993	E. Marais	NMNW
Orokatuwo	576	-17.400	12.733	14-V-1991	E. Griffin	NMNW
Hippo Pool	577	-17.400	14.200	15-I-1993	E. Marais	NMNW
Ruacana	578	-17.400	14.217		Irish (1987)	
Ruacana Falls area	579	-17.400	14.217	12-VIII-1989	E. Marais	NMNW
Onhelelwa	580	-17.417	15.483	20-I-1993	E. Marais	NMNW
10 km SE Etunda	581	-17.433	14.550	9-VIII-1989	E. Marais	NMNW
Mahenene Agric. Research Station	582	-17.433	14.783	5-X-1993	B. Wohlleber	NMNW
Skeleton Coast Park at:	583	-17.450	11.750	20-III-1998	MLS 04	NMNW
Edimba	584	-17.467	16.383	26-I-1993	E. Marais	NMNW
12 km S Bosluisbaai	585	-17.483	11.750	II-1982	J. Irish	NMNW
Odila River at:	586	-17.483	16.850	23-I-1993	E. Marais	NMNW
Ovamboland at:	587	-17.483	17.017	24-I-1993	E. Marais	NMNW
Katima Mulilo	588	-17.500	24.283	25-II-1982	E. Irish	NMNW
Skeleton Coast Park at:	589	-17.533	11.750	20-III-1998	MLS 05	NMNW
Onduri [correct: Ondwi]	590	-17.533	17.617	26-I-1993	E. Marais	NMNW
Kunene River, 44 km S at:	591	-17.567	12.283	17-II-1983	S. Endrödy-Younga (EY2074)	TMSA
Onghwiya	592	-17.567	16.817	26-II-1993	E. Marais	NMNW
Onesi	593	-17.583	14.683	31-VII-1989	E. Marais	NMNW
10 km S Katima Mulilo	594	-17.583	24.283		Irish (1996b)	
Onamihongwa	595	-17.600	17.033	26-I-1993	E. Marais	NMNW
Etudilondjaba	596	-17.600	17.600	27-I-1993	E. Marais	NMNW
(No name)	597	-17.617	12.167	14-X-1988	E. Griffin	NMNW
(No name)	598	-17.617	12.200	15-X-1988	E. Griffin	NMNW
Enyana	599	-17.617	17.417	27-I-1993	E. Marais	NMNW
21 km S Eenhana	600	-17.650	16.267	25-I-1993	E. Marais	NMNW
Sifuma	601	-17.650	23.367		Irish (1996b)	
Singalamwe	602	-17.650	23.417		Irish (1996b)	
Ogongo Agric. Col.	603	-17.683	15.300	XII-1993		NMNW
5 km NE Dikweya	604	-17.683	18.533		Irish (1996b)	
Skeleton Coast Park at:	605	-17.700	11.767	20-III-1998	MLS 06	NMNW
Orohona	606	-17.700	13.600	11-XI-1989	C.S. Roberts	NMNW
Kwando River at:	607	-17.717	23.350		Irish (1996b)	

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Kwando River at:	608	-17.767	23.333		Irish (1996b)	
Skeleton Coast Park at:	609	-17.783	11.767	20-III-1998	MLS 07	NMNW
Kongola	610	-17.783	23.333		Irish (1996b)	
Manywa River at:	611	-17.800	23.083		Irish (1996b)	
Menziasubila Mulopo	612	-17.850	23.450		Irish (1996b)	
8 km E Mashari	613	-17.883	20.267		Irish (1996b)	
49 km W Kongola	614	-17.883	22.883		Irish (1996b)	
Lake Liambezi	615	-17.883	24.400	II-1983	E. Irish	NMNW
2 km SE Qeya River at:	616	-17.900	22.833		Irish (1996b)	
1 km SW Qonisha River at:	617	-17.933	22.617		Irish (1996b)	
3 km NE Chwaha River at:	618	-17.967	22.467		Irish (1996b)	
19 km E Omega	619	-18.017	22.433		Irish (1996b)	
Omega Base	620	-18.033	22.217		Irish (1996b)	
8 km E Omega	621	-18.033	22.267		Irish (1996b)	
Gelukkie	622	-18.050	21.450		Irish (1996b)	
21 km W Omega	623	-18.050	22.017		Irish (1996b)	
13 km W Omega at:	624	-18.050	22.067		Irish (1996b)	
30 km E Bagani at:	625	-18.067	21.867		Irish (1996b)	
Wreck of Kya Maru	626	-18.100	11.850	20-III-1998	MLS 10	NMNW
Popa Falls	627	-18.100	21.117		Irish (1988d)	
Wreck of Kya Maru	628	-18.117	11.850	20-III-1998	MLS 09	NMNW
Buffalo Base	629	-18.133	21.683		Irish (1996b)	
Mudumu Nat. Park at:	630	-18.133	23.433		Irish (1996b)	
Orupembe [= Anabib]	631	-18.150	12.567		Wygodzinsky (1955)	
Nakatwa	632	-18.183	23.417		Irish (1996b)	
10 km NNW Angra Fria	633	-18.217	11.933	II-1982	P. Bridgeford	NMNW
4 km NE Orumana	634	-18.217	13.950	21-II-1985	J. Irish	NMNW
Cape Fria Radio Station	635	-18.233	12.017	21-I-1982	J. Irish	NMNW
Sangwali	636	-18.233	23.600		Irish (1996b)	
Thinderevu Omuramba at:	637	-18.250	21.667		Irish (1996b)	
Mahango Game Reserve at:	638	-18.267	21.700	2-III-1992	M. Pusch	NMNW
Oruvandjei	639	-18.283	13.567	22-II-1985	J. Irish, H. Rust	NMNW
Malengalenga	640	-18.283	23.800		Irish (1996b)	
Okau	641	-18.317	12.083	5-II-1982	J. Irish	NMNW
15 mi. S Orupembe	642	-18.350	12.467		Wygodzinsky (1955)	
Nadas River area at:	643	-18.383	12.183	5-II-1982	J. Irish	NMNW
Skeleton Coast Park at:	644	-18.383	12.183	5-II-1982	J. Irish	NMNW
Cape Fria	645	-18.433	12.000	II-1982	J. Irish	NMNW
Cape Fria	646	-18.433	12.000	21-III-1998	MLS 13	NMNW
SE Ovamboland at:	647	-18.450	16.767	10-VI-1985	J. Irish	NMNW
Nkasa Island	648	-18.450	23.600		Irish (1996b)	
19 km ESE Omupanda	649	-18.467	16.933	14-XI-1989	E. Marais	NMNW
Kaudom-Cwiba Junction	650	-18.467	20.817		Irish (1996b)	
Skeleton Coast Park at:	651	-18.483	12.033	21-III-1998	MLS 14	NMNW
Poacher's Point	652	-18.500	16.500	1986	E. Griffin	NMNW

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Andoni	653	-18.500	16.750	4-IX-1987	E. Griffin	NMNW
Beisebvlakte	654	-18.500	17.033	14-XI-1989	E. Marais	NMNW
near Ogams at:	655	-18.517	12.467	II-1984	M.-L. Penrith	NMNW
Acacia	656	-18.517	17.117	14-XI-1989	E. Marais	NMNW
Ogams	657	-18.533	12.500	30-I-1982	P. Bridgeford	NMNW
Andonivlakte S at:	658	-18.550	16.817	8-VI-1985	J. Irish	NMNW
30 mi. S Orupembe	659	-18.567	12.467		Wygodzinsky (1955)	
Ekuma River at	660	-18.567	15.983	30-IV-1987	J. Irish	NMNW
9 km S Ogams	661	-18.583	12.483	30-I-1982	P. Bridgeford	NMNW
Skeleton Coast Park at:	662	-18.600	12.167	21-III-1998	MLS 15	NMNW
Etosha Pan at:	663	-18.600	16.233	1-V-1987	J. Irish	NMNW
Mushare	664	-18.617	16.883	X-1986	E. Griffin	NMNW
S of Mushara	665	-18.617	16.883	IV-1988	E. Griffin	NMNW
Kaudom Game Reserve at:	666	-18.617	20.617		Irish (1996b)	
Skeleton Coast Park at:	667	-18.650	12.317	5-II-1982	J. Irish	NMNW
12 mi. NW Namutoni	668	-18.667	16.900	18-XII-1966	E.S. Ross, K. Lorenzen	CAS
Leeupan	669	-18.667	20.867		Irish (1996b)	
Operet 312 at:	670	-18.683	17.200	10-VI-1985	J. Irish	NMNW
NW Etosha Nat. Park at:	671	-18.717	14.583	5-V-1987	J. Irish	NMNW
Skerpioenbult	672	-18.717	14.867	4-V-1987	J. Irish	NMNW
Dorsland	673	-18.717	14.867	4-V-1987	J. Irish	NMNW
Narawandu	674	-18.733	15.517			NMNW
Skeleton Coast Park at:	675	-18.750	12.333	21-III-1998	MLS 16	NMNW
Sarusas Mine	676	-18.750	12.400	31-I-1982	P. Bridgeford	NMNW
Otjikondavirongo	677	-18.767	13.550	24-II-1985	J. Irish	NMNW
Dorstland	678	-18.767	14.733	II-1987	E. Griffin	NMNW
Khumib River ca. 15 km from mouth	679	-18.783	12.550	21-I-1981	J. Irish	NMNW
Purros	680	-18.783	12.950	22-I-1981	J. Irish	NMNW
Ruimte 935	681	-18.783	17.217	7-VI-1985	J. Irish	NMNW
Namutoni	682	-18.817	16.933	9-VI-1985	J. Irish	NMNW
Bloubokdraai	683	-18.833	16.950	15-XI-1987	E. Griffin	NMNW
Etosha Park at:	684	-18.833	16.950	9-VI-1985	J. Irish	NMNW
Okumutati	685	-18.867	14.350	19-II-1985	J. Irish	NMNW
Otjomatemba	686	-18.883	13.783	15-VII-1995	J. Irish	BMSA
Leeudrink	687	-18.883	17.067	22-I-1987	J. Irish	NMNW
Kalkheuwel	688	-18.900	16.833	13-I-1987	J. Irish	NMNW
Skeleton Coast Park at:	689	-18.917	12.467	21-III-1998	MLS 18	NMNW
Onauatinda	690	-18.933	14.600	6-V-1987	J. Irish	NMNW
10 km NNW Okondeka	691	-18.933	15.800	29-IV-1987	J. Irish	NMNW
Olifantsrus	692	-18.950	14.850	7-VIII-1987	E. Griffin	NMNW
3.5 km N Okondeka	693	-18.950	15.833	15-IX-1987	E. Griffin	NMNW
Batia	694	-18.950	16.717	21-I-1987	J. Irish	NMNW
Olifantsrus	695	-18.967	14.867	22-X-1982	J. Irish	NMNW
Rocky Point	696	-18.983	12.483		Wygodzinsky (1955)	
Rocky Point	697	-18.983	12.483	22-III-1998	MLS 19	NMNW

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Ozonjuitji Mbari	698	-18.983	15.517	22-X-1982	J. Irish	NMNW
Hoarusib Riv., 9 km from mouth	699	-19.033	12.633	20-I-1981	J. Irish	NMNW
Halali-koppie	700	-19.033	16.467	11-VI-1985	J. Irish	NMNW
Kaudom Game Reserve at:	701	-19.033	20.517		Irish (1996b)	
Leeukamp	702	-19.050	14.783	22-X-1982	J. Irish	NMNW
W of Wolfsnes	703	-19.050	15.867	1987	E. Griffin	NMNW
Rietfontein, Etosha N.P.	704	-19.050	16.350	18-V-1986	E. Griffin	NMNW
Helio	705	-19.050	16.483	27-III-1988	E. Griffin	NMNW
Dinaib 852	706	-19.050	17.483	7-VI-1985	J. Irish	NMNW
Hoarusib River [Mouth]	707	-19.067	12.550	31-I-1982	P. Bridgeford	NMNW
Hoarusib River Mouth	708	-19.067	12.550	22-III-1998	MLS 20	NMNW
6 km N Sesfontein	709	-19.067	13.617	15-VII-1995	J. Irish	BMSA
Kowares	710	-19.067	14.350		Wygodzinsky (1955)	
Klippan	711	-19.067	14.433	8-V-1987	J. Irish	NMNW
Sprokieswoud	712	-19.083	15.633	14-VI-1985	J. Irish	NMNW
Sprokieswoud	713	-19.083	15.633	10-V-1988	E. Griffin	NMNW
Luiperdskop	714	-19.133	14.400	23-X-1982	J. Irish	NMNW
Okaukuejo	715	-19.183	15.917	21-X-1982	J. Irish	NMNW
Okaukuejo	716	-19.183	15.917	12-VI-1985	J. Irish	NMNW
Okaukuejo Rest Camp	717	-19.183	15.917	11-VIII-1988	W. Versfeld	NMNW
Okambondevlakte	718	-19.200	13.483	17-I-1981	J. Irish	NMNW
Neitsas	719	-19.233	18.167		Silvestri (1922)	
Tsumeb	720	-19.250	17.717		Silvestri (1922)	
Ondundozonananandana Mts.	721	-19.267	15.733	1987	E. Griffin	NMNW
Khowarib Schlucht at:	722	-19.300	13.917	25-II-1985	J. Irish	NMNW
Okaukuejo, 10 mi. S	723	-19.317	15.950		Irish (1988d)	
Aikab, Etosha Nat. Park	724	-19.333	16.967	5-VII-1993	J. Irish	NMNW
Uithoek 770	725	-19.333	17.650	7-VI-1985	J. Irish	NMNW
8 km E Möwebaai	726	-19.350	12.783	20-I-1981	J. Irish	NMNW
Kaross	727	-19.350	14.517	14-XI-1986	E. Griffin	NMNW
Kaross	728	-19.383	14.533	10-V-1987	J. Irish	NMNW
Möwebaai	729	-19.367	12.717	28-III-1982	J. Irish	NMNW
Zebrapomp, Kaross	730	-19.367	14.483	10-V-1987	J. Irish	NMNW
Bakenkop 431	731	-19.367	15.550	15-VI-1985	J. Irish	NMNW
Bushmanland at:	732	-19.367	19.600		Irish (1996b)	
Uhima	733	-19.383	13.050	I-1981	J. Irish	NMNW
Hoanib River at:	734	-19.383	13.083	8-XII-1971	M.J. Penrith	NMNW
Olifantshoek 297	735	-19.417	15.333	15-VI-1985	J. Irish	NMNW
Hoanib Oase	736	-19.450	12.833	6-II-1982	J. Irish	NMNW
Lower Hoanib Riv. at:	737	-19.450	12.867	24-V-1982	P. Bridgeford	NMNW
Success 438	738	-19.450	17.067	5-VII-1993	J. Irish	BMSA
Hoanib River Mouth	739	-19.467	12.750	22-III-1998	MLS 23	NMNW
Hoanib River Mouth	740	-19.467	12.767	23-I-1982	J. Irish	NMNW
Ghaub 47	741	-19.467	17.767	VII-1986	J. Irish	NMNW
Urumube 287	742	-19.483	15.183	15-VI-1985	J. Irish	NMNW

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Aigamas 471	743	-19.483	17.300	22-IX-1985	J. Irish	NMNW
T.o.D.	744	-19.500	13.917	14-VII-1995	J. Irish	BMSA
Sesfontein area at:	745	-19.500	13.950	14-VII-1995	J. Irish	BMSA
Grootfontein, 4 km NE	746	-19.517	18.133	5-XI-1985	J. Irish	NMNW
Tsumkwe, 40 km NW	747	-19.517	20.133	14-VI-1984	E. Griffin	NMNW
10 km N Kamandjab	748	-19.533	14.817		J. Irish	NMNW
Afguns 447	749	-19.550	15.883	15-VI-1985	J. Irish	NMNW
Uisib 427	750	-19.550	17.217	12-I-1987	J. Irish	NMNW
Bruno 614	751	-19.583	14.550	20-II-1995	E. Marais	NMNW
Tsumkwe, 50 km E	752	-19.583	20.967	I-1984	J. Irish	NMNW
Merwe 412	753	-19.600	16.850	1-XI-1985	J. Irish	NMNW
Tsumkwe	754	-19.600	20.500	21-1-1984	J. Irish	NMNW
Otjihaenenavallei at:	755	-19.617	17.983	5-XI-1985	J. Irish	NMNW
Lichtenau, SE Grootfontein	756	-19.617	18.200	6-XI-1985	J. Irish	NMNW
Aha Hills at:	757	-19.617	20.967		Irish (1996b)	
Skeleton Coast Park at:	758	-19.650	12.850	23-III-1998	MLS 24	NMNW
Makuri Pan	759	-19.650	20.717		H. Berger-dell'Moore	NMNW
Otavifontein	760	-19.667	17.383		Silvestri (1922)	
Skeleton Coast Park at:	761	-19.683	13.017	19-I-1981	J. Irish	NMNW
Chaudamas 33	762	-19.683	15.533	15-VI-1985	J. Irish	NMNW
Tjokwe	763	-19.683	20.617		H. Berger-dell'Moore	NMNW
Tsumkwe, 10 km SE	764	-19.683	20.617		Irish (1996b)	
The Canyons	765	-19.733	13.800	23-I-1981	J. Irish	NMNW
Gautscha Pan	766	-19.783	20.583	23-I-1984	J. Irish	NMNW
Gautscha Pan, 4 km N	767	-19.783	20.583	22-I-1984	J. Irish	NMNW
Hohenstein 39	768	-19.800	15.383	15-VI-1985	J. Irish	NMNW
Aha Hills at:	769	-19.800	21.000	17-I-1984	J. Irish	NMNW
Nimitz 353	770	-19.817	16.583	1-XI-1985	J. Irish	NMNW
Northern Namib at:	771	-19.850	13.133	I-1981	J. Irish	NMNW
Te-barku	772	-19.850	20.433		Irish (1996b)	
Tse-Baraka	773	-19.850	20.433		H. Berger-dell'Moore	NMNW
Kremetartkop	774	-19.850	20.917	18-I-1984	J. Irish	NMNW
Skeleton Coast Park at:	775	-19.883	12.967	23-III-1998	MLS 25	NMNW
Palmwag 702	776	-19.883	13.900	X-1982	J. Irish	NMNW
Uniabwater	777	-19.883	13.900	X-1982	J. Irish	NMNW
Kharu-Gaiseb River at:	778	-19.900	13.183	4-VIII-1982	M.-L. Penrith	NMNW
Northern Namib at:	779	-19.900	13.183	26-I-1983	M.K. Seely	TMSA
Diamantgat	780	-19.900	13.833	X-1982	J. Irish	NMNW
Palm 708	781	-19.917	13.983	X-1982	J. Irish	NMNW
Nama Pan	782	-19.917	20.717	22-I-1984	J. Irish	NMNW
Goabis	783	-19.967	13.800	X-1982	J. Irish	NMNW
Terrace Bay at:	784	-20.000	13.033	23-III-1998	MLS 26	NMNW
Samanab River at:	785	-20.033	13.300	3-VIII-1982	M.-L. Penrith	NMNW
2 mi. NW of Outjo	786	-20.083	16.117	14-V-1958	E.S. Ross, R.E. Leech	CAS
Gutweide 135	787	-20.083	17.417	6-XI-1985	J. Irish	NMNW

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Rooiplaat 710 at:	788	-20.100	13.867	X-1982	J. Irish	NMNW
18km SSE Terrace Bay	789	-20.117	13.117	28-III-1982	J. Irish	NMNW
Outjo	790	-20.117	16.150	5-VII-1993	J. Irish	BMSA
Uniab O v. duine	791	-20.133	13.300	12-IV-1987	J. Irish	NMNW
Eastern edge of Unjab River dunes	792	-20.133	13.317	26-VII-1990	C.S. Roberts	NMNW
Omega 978	793	-20.133	17.817	24-I-1987	J. Irish	NMNW
Welkom 680	794	-20.150	14.583	30-X-1985	J. Irish	NMNW
Omarassa 4 at:	795	-20.150	16.900	7-VI-1985	J. Irish	NMNW
Unjab River at:	796	-20.167	13.267	5-VIII-1982	M.-L. Penrith	NMNW
Nantis 679	797	-20.167	14.767	31-X-1985	J. Irish	NMNW
Rockeys 682	798	-20.167	14.800	31-X-1985	J. Irish	NMNW
Uniab River delta at:	799	-20.183	13.200	6-VIII-1982	M.-L. Penrith	NMNW
Dunes in Uniab River	800	-20.183	13.217		Irish & Mendes (1988)	
Uniab Delta	801	-20.183	13.217	9-IV-1987	J. Irish	NMNW
1 km N Fransfontein	802	-20.200	15.017	1-XI-1985	J. Irish	NMNW
8 mi. S of Outjo	803	-20.233	16.150	13-V-1958	E.S. Ross, R.E. Leech	CAS
Teufelsburg 153	804	-20.233	16.150	16-VI-1985	J. Irish	NMNW
Skeleton Coast Park at:	805	-20.267	13.450		Irish (1988d)	
Bergville 490	806	-20.267	14.783	29-X-1985	J. Irish	NMNW
Karakapi - Daneib confluence	807	-20.267	20.817	I-1984	J. Irish	NMNW
Torra Bay	808	-20.317	13.233	5-XI-1968	P.G. Olivier	NMNW
Torra Bay	809	-20.317	13.233	23-III-1998	MLS 28	NMNW
Waterberg Plateau Park at:	810	-20.317	17.317	26-IX-1991	M. Pusch	NMNW
Waterberg Plateau Park at:	811	-20.317	17.333	1991	M. Pusch	NMNW
Elandsdrink	812	-20.317	17.367	19-IV-1993	M. Pusch	NMNW
Torra Bay dunes	813	-20.333	13.300	20-XI-1980	B.A. Curtis	NMNW
Bethanis, 57.1 mi W Welwitschia	814	-20.350	14.183	23-I-1968		NMNW
Navarre 383	815	-20.350	15.033	1-XI-1985	J. Irish	NMNW
Khorixas town	816	-20.367	14.967	31-III-1992	J. Irish	BMSA
Ombindi Karambi 155	817	-20.367	16.133	16-VI-1985	J. Irish	NMNW
Waterberg Plateau Park at:	818	-20.367	17.350	1991	M. Pusch	NMNW
Vrede 719 at:	819	-20.383	14.233	30-X-1982	J. Irish	NMNW
Waterberg Plateau Park at:	820	-20.383	17.300	II-1992	M. Pusch	NMNW
Waterberg Plateau Park at:	821	-20.400	17.250	VII-1991	M. Pusch	NMNW
Waterberg Plateau Park at:	822	-20.400	17.383	VII-1991	M. Pusch	NMNW
Waterberg Plateau Park at:	823	-20.417	17.333	XI-1992	M. Pusch	NMNW
1 km N Ugibputs	824	-20.433	13.817	X-1982	J. Irish	NMNW
De Riet 720 at:	825	-20.450	14.167	20-X-1982	J. Irish	NMNW
Hereroland West at:	826	-20.450	17.567	VII-1991	M. Pusch	NMNW
Koigab River Mouth	827	-20.483	13.267	23-III-1998	MLS 29	NMNW
Waterberg Plateau Park at:	828	-20.483	17.250	I-1992	M. Pusch	NMNW
Rendezvous 533	829	-20.517	14.300	8-III-1989	J. Irish	NMNW
Waterberg Rest Camp	830	-20.517	17.233	11-IV-1990	E. Marais	NMNW
Hereroland West at:	831	-20.517	17.483	1992	M. Pusch	NMNW
Northern Vet. Fence, 5 km E of Gam Road	832	-20.517	20.733	19-XI-1988	E. Marais	NMNW

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Otjitoroa Süd 55	833	-20.533	16.100		Irish (1987)	
Hereroland West at:	834	-20.550	17.467	1992	M. Pusch	NMNW
Okakarara	835	-20.583	17.450	XII-1988	I. Kavendjii	NMNW
Okakarara area	836	-20.583	17.450	1989	M. Paxton	NMNW
Eiseb River at:	837	-20.600	20.450	19-XI-1988	E. Marais	NMNW
Huab River at:	838	-20.617	13.900	27-X-1982	J. Irish	NMNW
Theronsvlei	839	-20.617	20.467	20-I-1984	J. Irish	NMNW
Terrace Spring	840	-20.633	13.850	26-X-1982	J. Irish	NMNW
Farm Okosongomingo, Kleiner Waterberg	841	-20.650	17.100		Silvestri (1922)	
Eiseb River at Veterinary Fence	842	-20.650	20.083	17-XI-1988	E. Marais	NMNW
Huab River Valley at:	843	-20.667	13.850	26-X-1982	J. Irish	NMNW
Hamakari Süd 373	844	-20.667	17.383	1992	M. Pusch	NMNW
Confluence Eiseb - Otjinoko Rivers	845	-20.667	20.150	15-XII-1988	M. Paxton	NMNW
Hamakari Süd 373	846	-20.683	17.417	VII-1991	M. Pusch	NMNW
Okoronjona 6	847	-20.700	15.650	28-X-1985	J. Irish	NMNW
NW of Doros Crater	848	-20.717	14.300	10-VIII-1985	E. Griffin	NMNW
Sebraskop 410	849	-20.733	15.150	13-IV-1987	J. Irish	NMNW
Toscanini Bay	850	-20.767	13.383	24-III-1998	MLS 30	NMNW
Gaias	851	-20.767	14.017	5-VIII-1985	E. Griffin	NMNW
Lehmpütz 76	852	-20.783	16.217	16-VI-1985	J. Irish	NMNW
Toscanini	853	-20.817	13.400	14-XII-1981	J. Irish	NMNW
Rooiboklaagte	854	-20.833	20.883	23-XI-1988	E. Marais	NMNW
Vegkop 528 at:	855	-20.850	14.550	30-X-1982	J. Irish	NMNW
Huab River, 5 km from mouth	856	-20.883	13.483	22-I-1982	J. Irish	NMNW
Otjongoro 20	857	-20.883	15.633	V-1988	J. Komen	NMNW
Hereroland East at:	858	-20.883	17.883	XII-1988	M. Paxton	NMNW
Gemsbok Altar	859	-20.917	13.817	13-XI-1989	C.S. Roberts	NMNW
Ugab River at:	860	-20.933	14.833		Irish (1988c)	
Ugab River nr. Brandberg West Mine	861	-20.967	14.133		Irish (1988c)	
Ugab River at:	862	-20.967	14.217	29-X-1982	J. Irish	NMNW
Gomatsarab	863	-21.017	14.650	10-VI-1987	J. Irish	NMNW
Saltputz	864	-21.033	13.900	1-XII-1988	E. Griffin	NMNW
Ambrose Bay	865	-21.050	13.550	27-III-1982	J. Irish	NMNW
Weissenfels 35 at:	866	-21.067	15.983	12-II-1986	J. Irish	NMNW
Omaue 29	867	-21.083	15.950	31-VIII-1985	J. Irish	NMNW
Tsisabvallei, Brandberg	868	-21.100	14.667	24-I-1981	J. Irish	NMNW
Epukiro River, 6 km S Elandslaagte	869	-21.133	20.767	22-XI-1988	E. Marais	NMNW
Ugab River gate	870	-21.167	13.667	7-II-1982	J. Irish	NMNW
Ugab River nr. mouth	871	-21.167	13.667	11-VI-1987	J. Irish	NMNW
Upper Brandberg	872	-21.167	14.567	15-III-1985	H. Rust	NMNW
Wewelsburg 191	873	-21.167	16.817		J. Irish	NMNW
Ugab River Mouth	874	-21.183	13.617	24-III-1998	MLS 32	NMNW
Ugab River Mouth	875	-21.183	13.633	28-III-1982	J. Irish	NMNW
Epukiro Riv. at:	876	-21.217	20.667	23-XI-1988	E. Marais	NMNW
Tantalite Mine	877	-21.233	13.717	14-III-1982	M.-L. Penrith	NMNW

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Otjiku 192	878	-21.267	16.817	29-XI-1988	E. Marais	NMNW
Nabab	879	-21.300	14.583	XI-1982	J. Irish	NMNW
Epukiro Riv. at:	880	-21.300	20.650	24-XI-1988	E. Marais	NMNW
Farm Etemba, 100 mi. E Okahandja	881	-21.333	18.017		Wygodzinsky (1970)	
Hereroland E at:	882	-21.333	20.150	26-XI-1988	E. Marais	NMNW
Swakopmund District at:	883	-21.350	13.967	XII-1981	J. Irish	NMNW
Gemsboklaagte at:	884	-21.383	20.450	25-XI-1988	E. Marais	NMNW
Messum Crater at:	885	-21.400	14.167	8-IV-1987	J. Irish	NMNW
2 km NE Omaruru	886	-21.400	15.467	31-VIII-1985	J. Irish	NMNW
Omaruru	887	-21.417	15.950		Silvestri (1922)	
Messum River 10 km from coast	888	-21.433	13.917	12-XII-1981	J. Irish	NMNW
Ombirisu 684	889	-21.583	19.250	4-III-1982	J. Irish	NMNW
Okaruheke Wes 45	890	-21.667	16.867		J. Irish	NMNW
Erongo Ost 82 at:	891	-21.700	15.967	28-X-1985	J. Irish	NMNW
10 km NE Cape Cross	892	-21.733	14.017	12-XII-1981	J. Irish	NMNW
Nooitgedag 49	893	-21.733	16.067	2-VI-1993	J. Irish	BMSA
1 km N Kaapkruis	894	-21.750	13.983	7-IV-1987	J. Irish	NMNW
Kaapkruis, Robfabriek	895	-21.750	13.983	7-IV-1987	J. Irish	NMNW
6 km E Kaapkruis	896	-21.767	14.033	7-IV-1987	J. Irish	NMNW
Farm Okosongomingo, Bez. Omaruru	897	-21.767	16.233		Paclt (1966)	
Marenica 114 at:	898	-21.817	14.867	3-II-1986	J. Irish	NMNW
Spes Bona 105 at:	899	-21.817	15.933	28-X-1985	J. Irish	NMNW
15 mi. NW Okahandja	900	-21.817	16.783	9-V-1958	E.S. Ross, R.E. Leech	CAS
Lagunenberg	901	-21.833	14.083	11-II-1982	M.-L. Penrith	NMNW
Lagunenberg	902	-21.833	14.083	7-IV-1987	J. Irish	NMNW
16 km WSW Klein Spitskop	903	-21.833	14.850	27-III-1982	J. Irish	NMNW
Grootspitskop at:	904	-21.833	15.200	VIII-1982	J. Irish	NMNW
Labora 436	905	-21.833	19.417	4-III-1982	J. Irish	NMNW
Alkmar 512	906	-21.850	19.917	2-III-1982	J. Irish	NMNW
Mile 72	907	-21.867	14.067	10-III-1982	M.-L. Penrith	NMNW
Owingi 246	908	-21.867	18.883	27-II-1982	J. Irish	NMNW
6 km SSW Klein Spitskop	909	-21.900	15.050	27-III-1982	J. Irish	NMNW
Waldau	910	-21.900	16.717		Silvestri (1922)	
Otjihangweberg	911	-21.917	17.667	24-II-1982	J. Irish	NMNW
1 km E Otjihangweberg	912	-21.917	17.683	25-II-1982	J. Irish	NMNW
Volstruiswerf 513	913	-21.917	19.750	3-III-1982	J. Irish	NMNW
Karibib	914	-21.950	15.850		Silvestri (1922)	
Omdel Reservoir	915	-21.967	14.317	8-IV-1987	J. Irish	NMNW
Friedrichsfelde	916	-21.967	15.983	27-III-1982	J. Irish	NMNW
18 km W Usakos	917	-21.983	15.417	27-III-1982	J. Irish	NMNW
Okahandja	918	-21.983	16.917		Silvestri (1922)	
Orungauu bei Okahandja	919	-21.983	16.917		Paclt (1966)	
Usakos	920	-22.000	15.600		Silvestri (1922), Paclt (1966)	
25 km ENE Hentiesbaai	921	-22.050	14.450	15-XII-1981	J. Irish	NMNW
Onganja East 190	922	-22.100	17.567	24-II-1982	J. Irish	NMNW

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Teufelsbach	923	-22.167	17.000		Silvestri (1922)	
Swakoppoortdam	924	-22.200	16.533		J. Irish	NMNW
Westfalenhof 23	925	-22.233	16.400	28-X-1985	J. Irish	NMNW
12 mi. S Hentiesbaai	926	-22.267	14.383	24-XII-1966	E.S. Ross, K. Lorenzen	CAS
23 mi. N Swakopmund	927	-22.350	14.433	1-I-1967	E.S. Ross, K. Lorenzen	CAS
4 km S Trekkopje	928	-22.350	15.100		J. Irish	NMNW
Swakopmund District at:	929	-22.350	15.100	12-IV-1984	J. Irish	NMNW
6 km N Wlotzkasbaken	930	-22.367	14.433	21-VII-1987	B. Schieferstein	GRSW
6 km N Arandis	931	-22.367	14.983	1984	J. Irish, H. Liessner	NMNW
40 mi E Swakopmund	932	-22.367	15.067	24-XII-1966	E.S. Ross, K. Lorenzen	CAS
Swakopmund District at:	933	-22.383	14.867	1984	J. Irish	NMNW
2 km NE Arandisberg	934	-22.383	15.033		J. Irish	NMNW
Arandis area	935	-22.417	14.983	14-II-1984	J. Irish	NMNW
Brakwater	936	-22.417	17.083		Silvestri (1922)	
Khomaskop 414	937	-22.450	16.633	28-X-1985	J. Irish	NMNW
Gobabis	938	-22.450	18.967		Theron (1963)	
Rössing Mine	939	-22.467	15.033		J. Irish	NMNW
Lower Dome Gorge	940	-22.467	15.067	1984	J. Irish, H. Liessner	NMNW
Otjimbingwe 104 at:	941	-22.467	15.883	1-IV-1992	J. Irish	BMSA
Rössing Mts. E at:	942	-22.483	14.850	1-VIII-1984	J. Irish, H. Liessner	NMNW
Rössing Mts. E at:	943	-22.483	14.867	1-VIII-1984	J. Irish, H. Liessner	NMNW
Swakopmund District at:	944	-22.483	14.867	1-VIII-1984	J. Irish, H. Liessner	NMNW
Upper Ostrich Gorge	945	-22.483	14.983	1984	J. Irish, H. Liessner	NMNW
Upper Panner Gorge	946	-22.483	15.017	1984	J. Irish, H. Liessner	NMNW
Lower Ostrich Gorge	947	-22.500	14.967	1984	J. Irish, H. Liessner	NMNW
Neudamm	948	-22.500	17.333		Silvestri (1922)	
20 km NE Swakopmund	949	-22.533	14.667	11-XII-1981	J. Irish	NMNW
Windhuk/hoek	950	-22.550	17.083		Silvestri (1922), Paclt (1966)	
Windhoek	951	-22.550	17.083	various	J. Irish	NMNW
Swakopmund District at:	952	-22.567	14.867	1-VIII-1984	J. Irish, H. Liessner	NMNW
Rössing Mts SE at:	953	-22.567	14.867	1-VIII-1984	J. Irish, H. Liessner	NMNW
Windhoek, Eros Mt.	954	-22.567	17.000	20-X-1974	S. Endrödy-Younga (EY390)	TMSA
Hoffnung 66	955	-22.567	17.200	3-II-1971	M.-L. Penrith	NMNW
Bismarckberge, Voigtsland	956	-22.567	17.417		Silvestri (1922)	
Swakopmund District at:	957	-22.600	14.900	29-VIII-1984	J. Irish, H. Liessner	NMNW
Pionierspark, Windhoek	958	-22.600	17.083	1983	J. Irish	NMNW
Gifgat 2	959	-22.633	15.533	19-V-1990	J. Irish	NMNW
Namib Desert Park at:	960	-22.633	15.533	11-VII-1995	J. Irish	BMSA
Paulinenhof	961	-22.667	17.317		Silvestri (1922)	
Swakopmund	962	-22.683	14.533		Silvestri (1922)	
Swakopmund, riverbed	963	-22.683	14.533	24-VII-1983	J. Irish	NMNW
Dunes S Swakopmund	964	-22.700	14.550	12-XII-1981	J. Irish	NMNW
15 mi. SW Windhoek	965	-22.750	16.917	25-XII-1966	E.S. Ross, K. Lorenzen	CAS
Husab area at:	966	-22.817	15.067	11-VII-1995	J. Irish	BMSA
Haris 367	967	-22.817	16.867	14-III-1983	J. Irish	NMNW

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Gocheganas 26	968	-22.833	17.183	various	M.-L. Penrith	NMNW
Groot Tinkas	969	-22.850	15.467	IV-1983	J. Irish	NMNW
Namib Park Border at:	970	-22.900	15.533	6-VI-1986	B.D. Colahan	NMNW
The Dunes 234	971	-22.917	17.917	VII-1982	J. Irish	NMNW
Duin 7	972	-22.967	14.583		Irish (1987)	
Gurumanas Wes 241	973	-23.017	16.800	14-III-1983	J. Irish	NMNW
Vogelfederberg	974	-23.050	14.983	3-IV-1983	J. Irish	NMNW
Ubib	975	-23.067	15.200	4-IV-1983	J. Irish	NMNW
Us Pass road at:	976	-23.067	15.933	15-XI-1974	S. Endrödy-Younga (EY473)	TMSA
Gobabeb, 52.4 km N	977	-23.083	15.017	22-IX-1987		GRSW
Us Pass road at:	978	-23.083	15.733	15-XI-1974	S. Endrödy-Younga (EY470)	TMSA
14 mi N of Rehoboth	979	-23.100	17.100	8-V-1958	E.S. Ross, R.E. Leech	CAS
Rooibank, 10 km W	980	-23.117	14.550			GRSW
Ganab	981	-23.117	15.517	16-XII-1971	R. Taylor	TMSA
Verloren 32	982	-23.150	16.333	28-VI-1993	J. Irish	BMSA
Rooibank	983	-23.167	14.650		Silvestri (1908)	
Rooibank	984	-23.167	14.650	various	GRSW staff	GRSW
Rooibank, SW of	985	-23.200	14.633			GRSW
Gamsberg Pass, top	986	-23.267	16.317	27-VI-1993	J. Irish	BMSA
Göllschau 20	987	-23.300	16.533	14-III-1983	J. Irish	NMNW
Sandwich Bay	988	-23.333	14.500		Wygodzinsky (1959a)	
Sandwich Harbour	989	-23.333	14.500			GRSW
Swartbank	990	-23.333	14.833			GRSW
Farm Hohenheim	991	-23.300	16.367	21-X-1974	S. Endrödy-Younga (EY406)	TMSA
Gamsberg [= foot & E slopes]	992	-23.333	16.233	8-X-1984	J. Irish	NMNW
Namib Desert Park at:	993	-23.350	15.550	III-1983	J. Irish	NMNW
Jumbo Dune	994	-23.517	14.867			GRSW
Khomabes	995	-23.533	14.983	9-IX-1987	H.G. Robertson	SAMC
Gobabeb, 6 km NW	996	-23.533	15.183		Mendes (1982)	
Kahani Dune	997	-23.567	15.000	various	GRSW staff	GRSW
Gobabeb IDV [= interdune valley]	998	-23.567	15.033	27-II-1987	R. Watson	GRSW
Gobabeb	999	-23.567	15.050		Wygodzinsky (1959a), Edney (1971)	
Gobabeb	1000	-23.567	15.050	various	various	GRSW
Gobabeb, Namib Res. Station	1001	-23.567	15.050	29-XII-1966	E.S. Ross, K. Lorenzen	CAS
Kuiseb River nr. Gobabeb	1002	-23.567	15.050	1983-1984	SANC staff	SANC
Station Dune, Gobabeb	1003	-23.567	15.050	XII-1987	C.R.B. Watson	GRSW
Namib Park, SE Corner	1004	-23.567	15.750	26-XI-1974	S. Endrödy-Younga (EY496)	TMSA
Blumfelde 95	1005	-23.583	18.283	VII-1982	J. Irish	NMNW
Natab	1006	-23.600	15.083	29-XI-1975	M.K. Seely	GRSW
Visitor's Dune	1007	-23.633	15.033			GRSW
Half Shaft Camp	1008	-23.683	14.567		M. Griffin	NMNW
Elephant Valley	1009	-23.683	15.367	4-I-1981	L. Praetorius	GRSW
Gobabeb, 15 km S	1010	-23.700	15.067	14-V-1984	J. Irish, H. Liessner	NMNW
Noctivaga Dune	1011	-23.717	15.233	various	GRSW staff	GRSW
Mniszechi's Vlei [often as 'Miss Checkie's Vley']	1012	-23.717	15.317	various	GRSW staff	GRSW

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Hudaob dunes	1013	-23.717	15.467	15-X-1976	M.K. Seely	GRSW
Far East dunes	1014	-23.767	15.783	various	GRSW staff	GRSW
Itaga 198	1015	-23.783	17.717	IV-2003	R. Poller, F. van Deventer	NMNW
Tsondab Flats at:	1016	-23.833	15.067	15-V-1984	J. Irish, H. Liessner	NMNW
Diamond Area II at:	1017	-23.983	14.650	16-V-1984	J. Irish, H. Liessner	NMNW
Edvard Bohlen wreck	1018	-24.000	14.467		J. Irish	NMNW
Conception	1019	-24.017	14.550	17-V-1984	J. Irish, H. Liessner	NMNW
Conception Water	1020	-24.017	14.550	7-IV-1986	E. Griffin	NMNW
Zais 6	1021	-24.033	16.150	4-IV-1986	J. Irish	NMNW
Diamond Area II at:	1022	-24.050	14.617	18-V-1984	J. Irish	NMNW
11 km SE Kalkrand	1023	-24.150	17.667	IV-1982	J. Irish	NMNW
Chulon, on Narib Oos 602	1024	-24.167	17.700	various	M.-L. Penrith	NMNW
Charlottenfelder	1025	-24.200	14.617	19-V-1984	J. Irish, H. Liessner	NMNW
Diamond Area II at:	1026	-24.250	14.617	20-V-1984	J. Irish	NMNW
Tsams Ost 2 at:	1027	-24.250	16.100	27-VIII-1989	J. Irish	NMNW
Naukluft	1028	-24.267	16.240	26-X-1974	S. Endrödy-Younga (EY423, 428)	TMSA
Felseneck	1029	-24.350	16.067	25-X-1974	S. Endrödy-Younga (EY417,19, 20)	TMSA
17 km N Mariental	1030	-24.467	17.933	14-III-1988	J. Irish	NMNW
Hardap Rest Camp	1031	-24.483	17.867		Irish (1987)	
Mariental	1032	-24.550	17.967		Theron (1963)	
Sandfeld 314	1033	-24.550	18.917	13-VII-1982	J. Irish	NMNW
Haribes NW 18	1034	-24.617	17.550	IV-2003	R. Poller, F. van Deventer	NMNW
Fischersbrunn	1035	-24.633	14.717	21-5-1984	J. Irish; H. Liessner	NMNW
Dunes E of Meob fishing camp	1036	-24.650	14.733	19-XI-1992	E. Griffin	NMNW
Coast S of Fischersbrunn	1037	-24.683	14.717	VI-1982	J. Irish	NMNW
Sossusvlei, ca. 10 km NW	1038	-24.683	15.217	1985	P. Horn	NMNW
11 km SSE Fischersbrunn	1039	-24.733	14.767	VI-1982	J. Irish	NMNW
3 mi. E Maltahöhe	1040	-24.817	17.033	7-V-1958	E.S. Ross, R.E. Leech	CAS
Dickdorn 98	1041	-24.817	17.683	6-VI-1982	J. Irish, M.-L. Penrith	NMNW
Witberg [foot, NW]	1042	-24.833	15.283	26-VI-1982	J. Irish	NMNW
4 km W Witberg	1043	-24.867	15.233	VI-1982	J. Irish	NMNW
Diamond Area II at:	1044	-24.883	15.233	26-VI-1982	J. Irish	NMNW
12 km SW Maltahöhe	1045	-24.883	16.883	10-I-1990	J. Irish	NMNW
10 km SW Witberg	1046	-24.917	15.200	14-IX-1971	M.-L. Penrith	NMNW
Daweb 43	1047	-24.950	16.950	X-1982	J. Irish	NMNW
Burgsdorf Noord 188	1048	-25.000	16.883	IV-2003	R. Poller, F. van Deventer	NMNW
Diamond Area II at:	1049	-25.033	15.200	25-VI-1982	J. Irish	NMNW
Diamond Area II at:	1050	-25.050	15.133	25-VI-1982	J. Irish	NMNW
Wolwedans 144 / Chateau dune	1051	-25.100	15.983	12-III-1992	E. Griffin	NMNW
Tafelkop	1052	-25.117	17.917	9-VIII-1995	J. Irish	BMSA
2 km N Sylvia Hill	1053	-25.133	14.850	23-VI-1982	J. Irish	NMNW
Sylvia Hill	1054	-25.150	14.850	23-VI-1982	J. Irish	NMNW
Vrede 80 at:	1055	-25.150	16.233	21-VI-1982	J. Irish	NMNW
4 km WSW Gibeon	1056	-25.150	17.733	VIII-1982	J. Irish	NMNW
Tranendal 184 at:	1057	-25.150	18.950	4-IV-1992	J. Irish	BMSA

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5 km SE Sylvia Hill	1058	-25.167	14.883	VI-1982	J. Irish	NMNW
Goamus 70	1059	-25.167	18.183	IV-2003	R. Poller, F. van Deventer	NMNW
SE 2515Aa4	1060	-25.183	15.183	5-I-1977	E. Holm	TMSA
15 km NW Chowagasberg	1061	-25.183	15.633	VI-1982	J. Irish	NMNW
Diamond Area II at:	1062	-25.200	15.200	16-IV-1983	P. Horn	NMNW
10 km NW Chowagasberg	1063	-25.217	15.667	VI-1982	J. Irish	NMNW
Kaitzub	1064	-25.217	17.600	IV-2003	R. Poller, F. van Deventer	NMNW
Diamond Area II at:	1065	-25.233	14.900		Irish (1987)	
1 km SE Guinasibberg	1066	-25.283	15.533	VI-1982	J. Irish	NMNW
Guinasibberg	1067	-25.283	15.533	16-IV-1983	P. Horn	NMNW
Diamond Area II at:	1068	-25.333	15.417	VI-1982	J. Irish	NMNW
5 km SW Guinasibberg	1069	-25.333	15.467	IV-1983	P. Horn	NMNW
Amhub 78	1070	-25.333	16.817	IV-2003	R. Poller, F. van Deventer	NMNW
SE 2515Ac4	1071	-25.383	15.133	6-VI-1977	E. Holm	TMSA
Uri-Hauchab Mt.	1072	-25.383	15.183	24-V-1983	J. Irish	NMNW
2 m[iles] W Harus Mt	1073	-25.400	15.217	8-V-1969	O.P.M. Prozesky	NMNW
Hauchab Mt.	1074	-25.417	15.250	25-V-1983	J. Irish	NMNW
Diamond Area II at:	1075	-25.467	15.467	22-VI-1982	J. Irish	NMNW
Kronenhof 117	1076	-25.483	16.450	IV-2003	R. Poller, F. van Deventer	NMNW
Mukorob	1077	-25.500	18.167	27-III-1988	J. Irish	NMNW
Fish/Lewer Rivers confluence	1078	-25.533	17.733	7-VII-1982	J. Irish	NMNW
Dorn-Daberas 16	1079	-25.583	18.317	IV-2003	R. Poller, F. van Deventer	NMNW
Spencer Bay / Noordhoek	1080	-25.667	14.850	11-I-1974	M.K. Seely	TMSA
Karakanos	1081	-25.750	17.883	8-VIII-1983	J. Irish	NMNW
Between Saddle Hill North and Spencer Bay	1082	-25.767	14.883	7-XII-1989	E. Griffin	NMNW
SE 2515Cd2	1083	-25.817	15.433			TMSA
Brukkaros	1084	-25.883	17.783	8-VIII-1983	J. Irish	NMNW
Habis 181	1085	-25.883	18.617	IV-2003	R. Poller, F. van Deventer	NMNW
Tses [actually dune S of]	1086	-25.900	18.117		J. Irish	NMNW
70 km N Keetmanshoop	1087	-25.950	18.117	18-VII-1993	J. Irish	BMSA
Tirasduine	1088	-26.017	16.117	8-IV-1986	J. Irish	NMNW
3 km S Berseba	1089	-26.033	17.767	9-VIII-1983	J. Irish, E. Griffin	NMNW
Untersee 26	1099	-26.150	17.250	IV-2003	R. Poller, F. van Deventer	NMNW
Tiras 39	1100	-26.217	16.600	IX-1982	J. Irish	NMNW
Gavaams 6	1101	-26.267	17.667	9-VIII-1983	J. Irish	NMNW
Khabus 146	1102	-26.283	18.233	1988	N. & G. Olivier	NMNW
Koichab Pan area at 2615Bc1	1103	-26.317	15.567	4-VI-1982	Univ. Pretoria	TMSA
30 km N of Lüderitz	1104	-26.367	15.083	5-X-1979	E. Holm, C.H. Scholtz	TMSA
East of Boot Bay	1105	-26.467	15.167	5-XII-1989	E. Griffin	NMNW
Wildheim Ost 384	1106	-26.467	19.550	6-VI-1986	Ent. Dept.	BMSA
Gariganus 157	1107	-26.483	18.250	26-III-1988	J. Irish	NMNW
Haris	1108	-26.550	15.367	6-X-1982	J. Irish	NMNW
3 km E Haris	1109	-26.567	15.417	6-X-1982	J. Irish	NMNW
E of Agate Beach	1110	-26.583	15.167	9-XII-1989	E. Griffin	NMNW
Diamond Area I at:	1111	-26.583	15.567	26-XI-1993	E. Marais	NMNW

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Keetmanshoop	1112	-26.583	18.133		Paclt (1969)	
Agate Beach	1113	-26.600	15.183	6-XII-1980	J. Irish	NMNW
Agate Beach, Lüderitz	1114	-26.600	15.183	22-X-1970	C.G. Coetzee, M.-L. Penrith	NMNW
Angra Bay	1115	-26.600	15.183	27-III-1998	MLS 42	NMNW
Aus Townlands 36 at:	1116	-26.633	16.333	IX-1982	J. Irish	NMNW
Plateau 38	1117	-26.633	16.500			NMNW
Halifax Island	1118	-26.650	15.081	20-I-2003	A.H. Kirk-Spriggs	NMNW
Lüderitz	1119	-26.650	15.167	22-VIII-1983	E. Griffin	NMNW
Lüderitzbucht / Angra Pequena	1120	-26.650	15.167		Silvestri (1908), Silvestri (1922), Paclt (1966)	
Pinguin Isl.	1121	-26.650	15.167		Silvestri (1922)	
1 km NW Aus	1122	-26.650	16.250	15-VIII-1990	C.S. Roberts, E. Marais	NMNW
Kolmannskuppe [in error as: Kolmanuskuppe]	1123	-26.700	15.233		Silvestri (1922)	
2 km N Grasplatz	1124	-26.700	15.283	6-X-1982	J. Irish	NMNW
Tsaukhaib Mts at:	1125	-26.717	15.667	11-VIII-1983	E. Griffin	NMNW
Tsaukhaib Mts E at:	1126	-26.717	15.717	11-VIII-1983	J. Irish	NMNW
Heinrichsfelde 10	1127	-26.717	16.133	11-XI-1993	E. Marais	NMNW
Kubub	1128	-26.717	16.283		Silvestri (1908)	
Kubub, Aus	1129	-26.717	16.283	5-V-1958	E.S. Ross, R.E. Leech	CAS
Grosse Bucht	1130	-26.733	15.100	27-XII-1982	J. Irish	NMNW
Diamond Area I at 2615Dc	1131	-26.767	15.583	11-VIII-1983	J. Irish	NMNW
Aroab	1132	-26.783	19.650	VIII-1982	J. Irish	NMNW
Atlas Bay	1133	-26.817	15.133	26-XI-1993	E. Marais	NMNW
7 km N Grillenthal	1134	-26.850	15.367	29-IX-1982	J. Irish	NMNW
Verschluss 54	1135	-26.867	18.383	IV-2003	R. Poller, F. van Deventer	NMNW
Aikanes 128	1136	-26.883	18.167	IV-2003	R. Poller, F. van Deventer	NMNW
Donkermodder 60	1137	-26.900	18.667	6-VII-1982	J. Irish, M.-L. Penrith	NMNW
Donkermodder 60	1138	-26.900	18.650	IV-2003	R. Poller, F. van Deventer	NMNW
Diamond Area I at:	1139	-26.950	15.800	IX-1982	J. Irish	NMNW
2 km N Grillenthal	1140	-26.967	15.350	IX-1982	J. Irish	NMNW
2 km W Grillenthal	1141	-26.983	15.333	IX-1982	J. Irish	NMNW
Grillenthal	1142	-26.983	15.367	9-IV-1986	J. Irish	NMNW
2 km N Dreizackberg	1143	-26.983	15.400	IX-1982	J. Irish	NMNW
Kaukausib	1144	-26.983	15.650	2-XI-1986	E. Griffin	NMNW
Kaukausib fountain	1145	-26.983	15.650	10-VIII-1983	J. Irish	NMNW
2 km E Kaukausib	1146	-26.983	15.683	12-VIII-1983	J. Irish	NMNW
Agub Mt. SW at:	1147	-26.983	15.967	13-VIII-1983	J. Irish	NMNW
Nieu-Tsaus 142	1148	-26.983	16.267	16-VIII-1990	C.S. Roberts, E. Marais	NMNW
Possession Island	1149	-27.009	15.193	28-I-2003	A.H. Kirk-Spriggs	NMNW
Possession Island, Possession (House) Bay area	1150	-27.011	15.194	30-V-2005	A.H. Kirk-Spriggs, G. Shihepo	NMNW
Arutal 25	1151	-27.017	16.383	6-XII-1980	J. Irish	NMNW
Possession Island, Springdrift Bay area	1152	-27.017	15.198	29-V-2005	A.H. Kirk-Spriggs, G. Shihepo	NMNW
Swartbaas Ost 285	1153	-27.033	19.717	11-VII-1982	J. Irish, M.-L. Penrith	NMNW
Vredeshoop 283	1154	-27.050	19.533	IV-2003	R. Poller, F. van Deventer	NMNW
10 km S Grillenthal	1155	-27.083	15.367	4-X-1982	J. Irish	NMNW
Vredeshoop 283	1156	-27.083	19.533	10-VII-1982	J. Irish	NMNW

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Diamond Area I at:	1157	-27.117	15.267	25-XI-1993	E. Marais	NMNW
Prince of Wales Bay	1158	-27.117	15.267		Silvestri (1908)	
Prinzenbucht	1159	-27.117	15.267	9-IV-1986	J. Irish	NMNW
Rooiberg 70	1160	-27.117	16.800	8-VIII-1990	C.S. Roberts, E. Marais	NMNW
Warmfontein 280	1161	-27.133	19.233	VIII-1982	J. Irish	NMNW
Jammerbucht	1162	-27.167	15.283	10-IV-1986	J. Irish	NMNW
Tsaus Mt. & dunes at:	1163	-27.183	16.217	13-VIII-1983	J. Irish	NMNW
Pockenbank 68	1164	-27.183	16.550	17-VIII-1990	C.S. Roberts, E. Marais	NMNW
Pomona	1165	-27.200	15.300	11-IV-1986	J. Irish	NMNW
Pockenbank 68 at:	1166	-27.233	16.500	1-I-1983	J. Irish	NMNW
Oase 195	1167	-27.233	17.900	IV-2003	R. Poller, F. van Deventer	NMNW
Klinghardt Mountains foothills at:	1168	-27.250	15.600	18-VI-1993	E. Griffin	NMNW
Anib Pan Borehole	1169	-27.300	16.200	14-I-1989	B.A. Curtis, G. Alexander	NMNW
Diamond Area I at 2716Ac	1170	-27.333	16.150	14-VIII-1983	J. Irish, E. Griffin	NMNW
Klinghardts Mountains at:	1171	-27.350	15.700	3-X-1982	J. Irish	NMNW
Klinghardts Mountains at:	1172	-27.383	15.650	4-X-1982	J. Irish	NMNW
Noachabeb 97	1173	-27.383	18.500	11-VII-1986	Ent. Dept.	BMSA
Klinghardts Mountains at:	1174	-27.400	15.633	X-1982	J. Irish	NMNW
Sargdeckel, Klinghardts Mts.	1175	-27.400	15.683	10-X-1982	M.-L. Penrith	NMNW
Klinghardts Mountains at:	1176	-27.400	15.700	4-X-1982	J. Irish	NMNW
Hohedun 277	1177	-27.400	19.533	10-VII-1982	J. Irish	NMNW
Klinghardt Mountains foothills at:	1178	-27.417	15.500	24-VI-1993	E. Griffin	NMNW
37 mi. NW of Grünau	1179	-27.417	17.950	4-V-1958	E.S. Ross, R.E. Leech	CAS
Bogenfels	1180	-27.433	15.400	11-IV-1986	J. Irish	NMNW
Klinghardts Mountains W at:	1181	-27.433	15.583	4-X-1982	J. Irish	NMNW
Buntfeldschuh	1182	-27.567	15.567	12-IV-1986	J. Irish	NMNW
Süd Witpüts	1183	-27.600	16.717	VIII-1990	C.S. Roberts, E. Marais	NMNW
Uguchab River at:	1184	-27.617	16.167	15-VIII-1983	J. Irish, E. Griffin	NMNW
Aurus	1185	-27.617	16.267	15-VIII-1983	J. Irish, E. Griffin	NMNW
Kegelberg	1186	-27.617	16.383	27-IX-1994	E. Marais	NMNW
Süd Witpütz 31	1187	-27.617	16.717	7-XII-1980	J. Irish	NMNW
Hobas 374	1188	-27.617	17.667		Irish (1987)	
Blinkoog 30	1189	-27.617	19.117	17-X-1971	M.-L. Penrith, C.G. Coetzee, P.G. Olivier	NMNW
E Aurus Mts at:	1190	-27.650	16.317	5-XI-1986	J.U.M. Jarvis	NMNW
Kolke 84	1191	-27.650	16.883	14-VIII-1990	C.S. Roberts, E. Marais	NMNW
S of Aurus Vlei at:	1192	-27.667	16.217	20-I-1989	B.A. Curtis	NMNW
Aurusberg	1193	-27.683	16.367	17-XI-1992	Huns Exp. '92	NMNW
Roter Kamm	1194	-27.750	16.283	18-XI-1992	Huns Exp. '92	NMNW
Diamond Area I at:	1195	-27.750	16.500	7-XI-1980	E. Griffin	NMNW
5 km N Chameis Gate	1196	-27.767	15.683	13-IV-1986	J. Irish	NMNW
Roter Kamm	1197	-27.767	16.300	30-VI-1989	C.S. Roberts	NMNW
Boesmanberg	1198	-27.783	16.417	15-VIII-1983	J. Irish	NMNW
Namuskluftberg	1199	-27.800	16.867	4-XII-1980	J. Irish	NMNW
Boesmanberg	1200	-27.817	16.400	16-XI-1992	Huns Exp. '92	NMNW
Spitskop 111	1201	-27.850	16.700	19-VIII-1990	C.S. Roberts, E. Marais	NMNW

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Diamond Area I at:	1202	-27.867	16.500	17-VIII-1983	J. Irish	NMNW
Obib dunes at:	1203	-27.883	16.533	19-XI-1992	Huns Exp. '92	NMNW
10 km NW Rosh Pinah	1204	-27.883	16.700	3-XII-1980	J. Irish	NMNW
Rosh Pinah at:	1205	-27.883	16.833	14-IX-1973	S. Endrödy-Younga (EY106)	TMSA
Boegoeberg	1206	-27.900	15.933	20-VIII-1983	J. Irish, E. Griffin	NMNW
10 km NW Rosh Pinah	1207	-27.900	16.700	13-VIII-1990	C.S. Roberts, E. Marais	NMNW
Namuskluft 88	1208	-27.917	16.833	6-X-1970	Ent. Dept.	NMNW
Grabwasser 261	1209	-27.667	18.250	9-VII-1986	Ent. Dept.	BMSA
Rosh Pinah	1210	-27.967	16.750			NMNW
2 km ESE Rosh Pinah	1211	-27.967	16.783	13-VIII-1990	C.S. Roberts, E. Marais	NMNW
Obib Mountain	1212	-28.033	16.650	23-XI-1980	J. Irish	NMNW
Norachas 14	1213	-28.100	18.033	16-IV-1986	J. Irish	NMNW
Lorelei Mine, 2 km SE	1214	-28.067	16.917	23-VIII-2000	J. Irish	NMNW
Norachas 14	1215	-28.067	18.133	IV-2003	R. Poller, F. van Deventer	NMNW
Fish River Mouth, sandy patch on hillslope E of	1216	-28.083	17.183	23-VIII-2000	J. Irish	NMNW
Heiragabis River	1217	-28.083	19.600		S. Endrödy-Younga	TMSA
Obib dunes at:	1218	-28.150	16.650	17-VIII-1983	J. Irish	NMNW
Daberas dunes at:	1219	-28.167	16.700	VIII-1983	J. Irish	NMNW
Rooilepel	1220	-28.200	16.667	19-VIII-1983	E. Griffin	NMNW
3 km NNE Stormberg	1221	-28.200	17.233	11-VIII-1990	C.S. Roberts, E. Marais	NMNW
Wolwekop	1222	-28.217	16.200	20-VIII-1983	J. Irish	NMNW
2 km W Grootpenseiland	1223	-28.233	17.300	10-VIII-1990	C.S. Roberts, E. Marais	NMNW
Grootpens	1224	-28.233	17.350	2-XII-1980	J. Irish	NMNW
Middelpos	1225	-28.233	17.867	IV-2003	R. Poller, F. van Deventer	NMNW
Aussenkehr se Berg, S slope	1226	-28.350	17.400	VIII-2000	J. Irish	NMNW
Luginsland 124	1227	-28.350	18.450		J. Irish	NMNW
Bruinheuwel 257	1228	-28.500	18.167	IV-2003	R. Poller, F. van Deventer	NMNW
Oranjemund	1229	-28.550	16.417	1980	J. Irish	NMNW
Viools Drift, 18 mi. N	1230	-28.567	17.800	3-V-1958	E.S. Ross, R.E. Leech	CAS
Pink Pan, Oranjemund	1231	-28.617	16.433	23-XII-1980	J. Irish	NMNW
Vioolsdrif, 11km ENE	1232	-28.733	17.717	2-XII-1980	J. Irish	NMNW
SOUTH AFRICA - additional to localities in Irish (1994b, 1996a)						
Pontdrif	1233	-22.233	29.167	19-V-1996	M. de Wet	BMSA
Lanner Gorge Cave	1234	-22.450	31.150	IX-1983	L.E.O. Braack	KNP
Pafuri	1235	-22.450	31.300	26-VI-1984	L.E.O. Braack	KNP
Klopperfontein	1236	-22.633	31.167	27-III-1984	L.E.O. Braack	KNP
Dzundwini	1237	-22.767	31.167		Irish (1987)	
Swartwater	1238	-22.867	28.217	13-X-1991	J. Irish, D. Dreyer	BMSA
Blinkpan Saltworks	1239	-22.950	29.317	14-I-1988	E. Holm, E. Marais	NMNW
Moonlight	1240	-23.233	28.217		J. Irish	NMNW
10 km W Giyani	1241	-23.350	30.450	18-X-1987	H.G. Robertson	SAMC
Dwarsrivier, 35 mi. S Louis Trichardt	1242	-23.450	29.733	26-III-1958	E.S. Ross, R.E. Leech	CAS
Onverwacht	1243	-23.683	27.700	12-X-1991	J. Irish	BMSA
Letaba Camp	1244	-23.867	31.567		Wygodzinsky (1955)	
10 mi. E Pietersburg	1245	-23.900	29.600	26-III-1958	E.S. Ross, R.E. Leech	CAS

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Leydsdorp	1246	-23.983	30.517	27-III-1958	E.S. Ross, R.E. Leech	CAS
Percy Fyfe N.R.	1247	-24.033	29.150		Irish (1990)	
Makapansgat	1248	-24.133	29.183		Irish (1987)	
Boschdraai farm	1249	-24.200	28.283	13-VI-1987	H.G. Robertson	SAMC
Tweeloopfontein	1250	-24.283	27.633	26-III-1989	E. Marais	NMNW
Hoedspruit	1251	-24.350	30.950	11-II-1986	R.M. Crewe	SANC
Satara Camp	1252	-24.400	31.783		Wygodzinsky (1955)	
Satara Region	1253	-24.400	31.783			TMSA
Thabazimbi	1254	-24.600	27.383	24-III-1989	E. Marais	NMNW
Klein Kariba	1255	-24.833	28.333	28-XI-1996	L.N. Lotz	BMSA
Leeu Pan	1256	-24.833	31.817		Wygodzinsky (1955)	
Skukuza	1257	-24.983	31.583		Wygodzinsky (1955)	
Hazyview	1258	-25.050	31.133		Irish (1987)	
Boschkop Farm	1259	-25.100	27.517	23-IV-1995	J. Harrison	BMSA
4 km SW Grootbrak	1260	-25.117	20.383	13-II-1996	J. Irish	BMSA
10 mi. SE Lydenburg	1261	-25.117	30.583		Wygodzinsky (1955)	
5 km N Karup	1262	-25.133	20.117	14-II-1996	J. Irish	BMSA
Bayip	1263	-25.283	20.167	14-II-1996	J. Irish	BMSA
9 km SE Bayip	1264	-25.333	20.233	14-II-1996	J. Irish	BMSA
Loskop Dam N.R.	1265	-25.417	19.300		Irish (1990)	
Nossobkamp	1266	-25.417	20.600	13-II-1996	J. Irish	BMSA
Sewepanne	1267	-25.450	20.333	14-II-1996	J. Irish	BMSA
Driefendas	1268	-25.467	20.017	14-II-1996	J. Irish	BMSA
Malelane Camp	1269	-25.483	31.517		Paclt (1961)	
1 km S Lammermoor	1270	-25.600	20.133	14-II-1996	J. Irish	BMSA
Klein-Stofpan	1271	-25.600	20.417	14-II-1996	J. Irish	BMSA
Ottowa 1/30	1272	-25.600	23.350	30-VI-1986	Ent. Dept.	BMSA
4 km NW Cheleka	1273	-25.633	20.650	13-II-1996	J. Irish	BMSA
Arcadia, Pretoria	1274	-25.700	28.200	16-III-1996	L. Nieuwoudt	BMSA
Hartebeespoort	1275	-25.717	27.867	24-II-1996	D. Wellmann	BMSA
Pretoria	1276	-25.717	28.183	3-VI-1980	C.G.E. Moolman	SANC
Hartbeestpoort Dam	1277	-25.733	27.850		Mendes (1982)	
Colbyn, Pretoria	1278	-25.733	28.233		Irish (1987)	
Pretoria	1279	-25.750	28.167		Mendes (1982)	
Val de Grace, Pretoria	1280	-25.750	28.283	25-XI-1983	J. Irish	NMNW
Saartjiesnek	1281	-25.767	27.933	III-1981	E. Holm	NMNW
Swartkoppies	1282	-25.767	28.383	7-XI-1992	J. Irish	BMSA
Kloofsig	1283	-25.800	28.200	22-III-1996	S.P. Schoeman	BMSA
Bronkhorstspruit	1284	-25.800	28.733		Irish (1990)	
Hennop's rivier	1285	-25.833	27.967		Wygodzinsky (1955)	
Hennopsrivier	1286	-25.833	27.967		J. Irish	NMNW
Lyttelton	1287	-25.833	28.200		Irish (1990)	
Craig Lockhart	1288	-25.867	20.100	15-II-1996	J. Irish	BMSA
12 mi. W of Witbank	1289	-25.867	29.050	30-III-1958	E.S. Ross, R.E. Leech	CAS
3 km S Dochfour	1290	-25.883	20.533	12-II-1996	J. Irish, C. de Waal	BMSA

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Tosca	1291	-25.883	23.967	28-V-1988	M. Villet	SAMC
Jan se Draai	1292	-25.900	20.800	12-II-1996	J. Irish, C. de Waal	BMSA
Vaalpan	1293	-25.917	20.450	15-II-1996	J. Irish	BMSA
Magaliesburg	1294	-25.983	27.550	3-III-2000	C. Griffiths	BMSA
5 km N Kafferspan	1295	-26.000	20.083	15-II-1996	J. Irish, R. Erasmus	BMSA
Kamkwa	1296	-26.017	20.400	15-II-1996	J. Irish	BMSA
Kafferspan	1297	-26.050	20.083	15-II-1996	J. Irish, R. Erasmus	BMSA
3 km SW Rooibrak	1298	-26.050	20.400	12-II-1996	J. Irish, C. de Waal	BMSA
Kij Gamies	1299	-26.117	20.667	12-II-1996	J. Irish, C. de Waal	BMSA
Roodepoort	1300	-26.117	27.850	18-V-1996	L. Lombard	BMSA
Melkdraai	1301	-26.133	20.850	12-II-1996	J. Irish, C. de Waal	BMSA
Parktown North	1302	-26.150	28.033		Irish (1987)	
Sebobogas	1303	-26.250	20.150	11-II-1996	J. Irish	BMSA
Brakpan	1304	-26.250	28.383	16-II-1996	G. Durandt	BMSA
2 km N Munro	1305	-26.267	20.583	15-II-1996	J. Irish	BMSA
Ventersdorp	1306	-26.317	26.817		Theron (1963)	
Tonsip	1307	-26.350	20.383	11-II-1996	J. Irish	BMSA
Witstraat	1308	-26.383	20.183	11-II-1996	J. Irish	BMSA
Tweerivieren	1309	-26.467	20.617	16-II-1996	J. Irish	BMSA
Tweede Rivieren [= Tweerivieren]	1310	-26.467	20.617		Wygodzinsky (1955)	
Evander	1311	-26.467	29.100	27-III-1996	Q. Kritzinger	BMSA
Dwangas	1312	-26.517	20.233	11-II-1996	J. Irish	BMSA
Struisdam	1313	-26.600	20.633	11-II-1996	J. Irish	BMSA
Kalkrandjies 703	1314	-26.733	22.383	1-VII-1986	Ent. Dept.	BMSA
2 km SE Rietfontein	1315	-26.767	20.050	10-II-1996	J. Irish	BMSA
Ndumu Game Reserve nr. Mvutsheni Pan	1316	-26.867	32.267	27-I-1988	H.G. Robertson	SAMC
Eierdopkoppies	1317	-26.900	20.150	10-II-1996	J. Irish	BMSA
Ndumu Game Reserve below Rest Camp	1318	-26.917	32.317	26-I-1986	H.G. Robertson	SAMC
Witdraai Police Reserve	1319	-26.933	20.717	5-VII-1986	Ent. Dept.	BMSA
Surprise 33	1320	-26.933	22.083	1-VII-1986	Ent. Dept.	BMSA
Kosi Bay Nat. Res.	1321	-26.950	32.817	5-XII-1994	L.N. Lotz	BMSA
Bloukrans	1322	-26.967	20.383	10-II-1996	J. Irish	BMSA
Murray	1323	-26.983	20.867	11-II-1996	J. Irish	BMSA
King's Rest 205	1324	-27.017	21.017	3-VII-1986	Ent. Dept.	BMSA
14 mi. ex Vryburg - Schweizer-Reneke	1325	-27.033	24.950	5-IV-1970	J.L. Sheasby	SANC
Loch Leven	1326	-27.150	20.683	10-II-1996	J. Irish	BMSA
Spieëlkop	1327	-27.167	20.083	10-II-1996	J. Irish	BMSA
Loch Nagar	1328	-27.167	20.483	10-II-1996	J. Irish	BMSA
Gordonia District at:	1329	-27.233	20.800	16-I-1996	J. Irish	BMSA
Koppiesdam Nat. Res.	1330	-27.267	27.700	28-IX-1993	L.N. Lotz	BMSA
Rondepan	1331	-27.317	20.400	10-II-1996	J. Irish	BMSA
Vrysoutpan	1332	-27.350	20.833	16-II-1996	J. Irish	BMSA
Volksrust	1333	-27.367	29.883		Theron (1963)	
Kakolk	1334	-27.383	20.100	10-II-1996	J. Irish	BMSA
Merriespan	1335	-27.450	20.650	10-II-1996	J. Irish	BMSA

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11 km NW Ubombo	1336	-27.483	32.167	15-VII-1989	J. Irish	NMNW
3 km NW Ubombo	1337	-27.533	32.100	15-VII-1989	J. Irish	NMNW
5 km SE Noenieput	1338	-27.567	20.200	9-II-1996	J. Irish	BMSA
Mkuze Game Reserve, below Mantuma	1339	-27.600	32.217	30-IX-1987	H.G. Robertson	SAMC
Botha's Pass	1340	-27.617	29.733		Wygodzinsky (1955)	
Abeam	1341	-27.667	20.317	9-II-1996	J. Irish	BMSA
39 mi. ex Schweizer-Reneke - Christiana	1342	-27.683	25.117	8-IV-1970	J.L. Sheasby	SANC
Fairfield	1343	-27.767	27.367	30-IX-1993	J. Irish, L.N. Lotz	BMSA
Rouxvlei	1344	-27.800	20.150	9-II-1996	J. Irish	BMSA
Sishen Mine Area at:	1345	-27.800	23.017	7-IX-1994	J. Irish	BMSA
Grootkraal	1346	-27.817	27.900	1-IV-1995	M. Lamprecht	BMSA
Setlaarsrus	1347	-27.883	20.417	9-II-1996	J. Irish	BMSA
Christiana	1348	-27.917	25.233		Irish (1987)	
Hartebeestpan 330	1349	-27.967	25.017	15-IV-1987	Ent. Dept.	BMSA
Koegoeroep Wes	1350	-28.117	20.583	9-II-1996	J. Irish	BMSA
Steenkamp Puts [=Steenkampsputs]	1351	-28.117	20.900		Wygodzinsky (1955)	
Tolkoppies	1352	-28.133	20.167	9-II-1996	J. Irish	BMSA
Langklip	1353	-28.217	20.383	8-VII-1995	J. Irish	BMSA
Kodaspiek	1354	-28.233	17.000	1-IX-2000	J. Irish	BMSA
Maerpoort	1355	-28.233	17.133	29-XI-1980	J. Irish	NMNW
Numeesmyn	1356	-28.283	16.967	22-XII-1980	J. Irish	NMNW
Numeesmyn	1357	-28.283	16.967	1-X-1988	J. Irish	NMNW
Die Koei	1358	-28.283	17.000	22-XII-1980	J. Irish	NMNW
Allemanskraaldam	1359	-28.283	27.167	21-VI-1994	L.N. Lotz	BMSA
Blackie's Prospect	1360	-28.300	17.083	3-X-1991	S. Louw	BMSA
Koras 412	1361	-28.300	21.550		Irish (1987)	
Paradyskloof	1362	-28.317	17.017	2-X-1988	J. Irish	NMNW
Tatasberg, W foot	1363	-28.317	17.233	2-IX-2000	J. Irish	BMSA
Nooitgedacht	1364	-28.333	20.850	8-II-1996	J. Irish	BMSA
2 km S Wallekraal Mine	1365	-28.350	16.867	30-IX-1988	J. Irish	NMNW
2 km S Helskloof (West)	1366	-28.350	16.983	26-XI-1980	J. Irish	NMNW
Hottentotsparadys	1367	-28.350	17.000	31-VIII-2000	J. Irish	BMSA
Rosyntjiewater	1368	-28.350	17.067	22-XII-1980	J. Irish	NMNW
Springbokvlakte at:	1369	-28.350	17.350	2-IX-2000	J. Irish	BMSA
Junction White & Black Umfolozi Rivers	1370	-28.350	31.983		Silvestri (1913)	
Riemvasmaak, NW at:	1371	-28.367	20.250	8-II-1996	J. Irish	BMSA
Droëhout	1372	-28.367	20.917	8-II-1996	J. Irish	BMSA
Karakoelproefplaas, Upington	1373	-28.367	21.250	X-1990	T. v.d. Linde	BMSA
Bloeddrif, 3 km on Annisfontein Road	1374	-28.383	16.833	5-X-1991	S. Louw	BMSA
5 km NE Cornellskop	1375	-28.383	16.917	22-XII-1980	J. Irish	NMNW
25 km ENE Upington	1376	-28.383	21.483	24-XI-1983	J. Irish	NMNW
Cornellskop	1377	-28.417	16.883	29-IX-1988	J. Irish	NMNW
Wondergat	1378	-28.417	16.883	24-IX-1994	J. Irish	BMSA
Haakiesdoorn	1379	-28.417	17.167	3-IX-2000	J. Irish	BMSA
Lutzputs	1380	-28.417	20.600	8-II-1996	J. Irish	BMSA

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8 km WNW Upington	1381	-28.417	21.183	15-I-1994	R. Douglas	BMSA
Klipneus	1382	-28.433	17.367	27-XI-1980	J. Irish	NMNW
Rosyntjieberg at:	1383	-28.450	17.167	3-X-1991	S. Louw	BMSA
Upington	1384	-28.450	21.250		Wygodzinsky (1955)	
Umfolozi drift	1385	-28.450	32.150		Silvestri (1913)	
Brandkaross	1386	-28.467	16.683		Irish (1987)	
10 km WSW Khubus	1387	-28.467	16.883		Irish (1987)	
2 km E Khubus	1388	-28.467	17.017	25-XI-1980	J. Irish	
Umfolozi	1389	-28.483	32.183		Silvestri (1913)	
Witsand	1390	-28.533	22.483	14-XII-1983	J. Irish	NMNW
Honingkloof	1391	-28.533	28.717	7-VII-1994	J. Irish	BMSA
4 km WSW Grootderm	1392	-28.550	16.583	25-XI-1981	J. Irish	NMNW
Avondson	1393	-28.550	23.883	5-II-1996	J. Irish	BMSA
Kortdoringberg	1394	-28.583	16.583	6-IX-1982	J. Irish	NMNW
Brulsand	1395	-28.583	22.467	6-II-1996	J. Irish	BMSA
Schmidtsdrif, 15 km N	1396	-28.583	24.083	5-II-1996	J. Irish	BMSA
Nelsputs	1397	-28.600	20.117	6-XII-1994	J. Irish	BMSA
Augrabies Nat. Park	1398	-28.600	20.317	12-IX-1985	Ent. Dept.	BMSA
Maanrots	1399	-28.600	20.317	7-II-1996	J. Irish	BMSA
Nooitgedacht 66	1400	-28.600	24.617	21-V-1986	Ent. Dept.	BMSA
Kaboes	1401	-28.617	21.150	7-II-1996	J. Irish	BMSA
Mamapula	1402	-28.617	23.067	6-IX-1994	J. Irish	BMSA
Jakkalsputs	1403	-28.633	16.900	9-IX-1982	M.-L. Penrith	NMNW
22 km N Eksteenfontein	1404	-28.633	17.250	11-IX-1982	M.-L. Penrith	NMNW
Bo-Narries	1405	-28.633	19.867	6-XII-1994	J. Irish	BMSA
7 km NW Keimoes	1406	-28.633	20.883	9-II-1996	J. Irish	BMSA
Gariep	1407	-28.633	21.817	6-II-1996	J. Irish	BMSA
Poufontein	1408	-28.633	22.600	6-II-1996	J. Irish	BMSA
Eureka	1409	-28.633	22.900	6-II-1996	J. Irish	BMSA
Kleinbegin	1410	-28.633	23.600	5-II-1996	J. Irish	BMSA
Witplaas	1411	-28.633	24.567	5-II-1996	J. Irish	BMSA
13 km SSW Grootderm	1412	-28.650	16.633	6-IX-1982	J. Irish	NMNW
10 km N Kakamas	1413	-28.650	20.567	8-II-1996	J. Irish	BMSA
Swartkop	1414	-28.650	21.267	7-II-1996	J. Irish	BMSA
Merino	1415	-28.650	23.217	6-II-1996	J. Irish	BMSA
Witkoppies	1416	-28.667	22.200	6-II-1996	J. Irish	BMSA
Brakfontein	1417	-28.667	23.367	10-IX-1991	J. Irish	BMSA
Jakkalsputs dunes	1418	-28.683	16.950	3-X-1988	J. Irish	NMNW
Black Hills	1419	-28.683	17.117	18-IX-1994	J. Irish	BMSA
Royal Natal National Park	1420	-28.683	28.950		Wygodzinsky (1955)	
Royal Natal National Park	1421	-28.683	28.950		J. Irish	NMNW
Red Wing	1422	-28.717	21.533	5-XII-1994	J. Irish	BMSA
Quintus	1423	-28.717	24.383	5-II-1996	J. Irish	BMSA
Kimberley	1424	-28.733	24.767	30-I-1948	R.J. Power	MMKZ
Boegoeberg-Suid	1425	-28.767	16.583	28-IX-1988	J. Irish	NMNW

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10 km S Jakkalsputs	1426	-28.767	17.000	11-IX-1982	M.-L. Penrith	NMNW
Koekoeb	1427	-28.767	20.867	7-II-1996	J. Irish	BMSA
Vioolsdrif, Namaqualand	1428	-28.783	17.633	6-VIII-1961	G. van Son, L. Vári	TMSA
Vioolsdrif	1429	-28.783	17.633		Irish (1987)	
Kakamas	1430	-28.767	20.617		Wygodzinsky (1955)	
Kakamas [= just S of]	1431	-28.800	20.633			
Brakfontein	1432	-28.800	21.033	7-II-1996	J. Irish	BMSA
7 km W Campbell	1433	-28.800	23.633	5-XII-1994	J. Irish	BMSA
SE Vioolsdrif at:	1434	-28.817	17.667	17-IX-1994	J. Irish	BMSA
W Wildeperderant at:	1435	-28.833	17.067	18-IX-1994	J. Irish	BMSA
Garingberg	1436	-28.833	20.383	8-II-1996	J. Irish	BMSA
Klipbakke	1437	-28.833	21.333	7-II-1996	J. Irish	BMSA
14 km E Griekwastad	1438	-28.833	23.417	16-X-1990	J. Irish	BMSA
N Klipbok at:	1439	-28.850	17.400	18-IX-1994	J. Irish	BMSA
Nabies	1440	-28.850	20.150	8-II-1996	J. Irish	BMSA
Wegdraai	1441	-28.850	21.850	6-II-1996	J. Irish	BMSA
Badsfontein	1442	-28.850	23.950	5-II-1996	J. Irish	BMSA
Ysterberg	1443	-28.867	19.633	6-XII-1994	J. Irish	BMSA
32 mi. ex Upington towards Kenhardt	1444	-28.867	21.333		Wygodzinsky (1970)	
Vaalkop	1445	-28.867	21.650	5-XII-1994	J. Irish	BMSA
Driekoppies	1446	-28.867	24.600	6-IX-1994	J. Irish	BMSA
Katkop	1447	-28.883	16.967	18-IX-1994	J. Irish	BMSA
Kristalrivier at:	1448	-28.883	17.617	18-IX-1994	J. Irish	BMSA
Bladgrond	1449	-28.883	19.900	6-XII-1994	J. Irish	BMSA
Swartpad	1450	-28.883	20.683	7-II-1996	J. Irish	BMSA
Bakenkop	1451	-28.883	22.883	5-XII-1994	J. Irish	BMSA
Middelplaas	1452	-28.883	23.133	5-XII-1994	J. Irish	BMSA
Kristalberge at:	1453	-28.900	17.533	7-IX-2000	J. Irish	BMSA
Coboopduine	1454	-28.900	19.350	16-III-1988	J. Irish	NMNW
Swartduinkop	1455	-28.900	19.400	17-X-1990	J. Irish, L.N. Lotz, S. Louw	BMSA
30 mi. NE Pofadder	1456	-28.900	19.800		Wygodzinsky (1955)	
Tsebe	1457	-28.900	22.133	5-XII-1994	J. Irish	BMSA
Bingap 184	1458	-28.900	22.483	12-IX-1985	S. Louw	BMSA
Holkrans	1459	-28.900	22.650	5-XII-1994	J. Irish	BMSA
Koekais	1460	-28.900	23.400	6-IX-1994	J. Irish	BMSA
Duikersput	1461	-28.900	24.400	5-XII-1994	J. Irish	BMSA
Baviaanskop	1462	-28.917	17.833	17-IX-1994	J. Irish	BMSA
47 mi. ex Groblershoop towards Griekwastad	1463	-28.917	22.833		Wygodzinsky (1970)	
Roodepan	1464	-28.917	24.083	5-XII-1994	J. Irish	BMSA
39 km E Groblershoop	1465	-28.933	22.317	16-X-1990	J. Irish	BMSA
2 km N Holgatmond	1466	-28.950	16.717	26-IX-1988	J. Irish	NMNW
Holgat Riv. 5 km from mouth	1467	-28.950	16.767	27-IX-1988	J. Irish	NMNW
Ratelfontein	1468	-28.950	17.350	18-IX-1994	J. Irish	BMSA
28 km S Vioolsdrif	1469	-28.950	17.783	10-VII-1987	J. Irish	NMNW
Piet Rooisberg	1470	-28.950	21.100	7-II-1996	J. Irish	BMSA

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
S of Goodhouse at:	1471	-28.967	18.233	26-IX-1994	J. Irish	BMSA
1 km S Holgatmond	1472	-28.983	16.733	27-IX-1988	J. Irish	NMNW
Paul se Puts 143	1473	-28.983	19.400	18-X-1990	J. Irish	BMSA
Champagne Valley Resort	1474	-29.000	29.500	26-IX-2000	L.N. Lotz	BMSA
Dabenoris	1475	-29.017	18.600	29-IX-1994	J. Irish	BMSA
Hierlê, op Nongcaib	1476	-29.033	19.467	IX-1982	M.-L. Penrith	NMNW
Gemsbokvlakte	1477	-29.033	19.617			NMNW
SW Henkries at:	1478	-29.050	18.000	26-IX-1994	J. Irish	BMSA
Grootberg	1479	-29.050	18.900	6-XI-1994	J. Irish	BMSA
Apoolskop	1480	-29.067	18.467	26-IX-1994	J. Irish	BMSA
Pofadder, 20 km on Kakamas Rd.	1481	-29.067	19.583	13-IX-1985	Ent. Dept.	BMSA
Swartkoppies	1482	-29.117	19.083	6-XII-1994	J. Irish	BMSA
Pofadder	1483	-29.133	19.400		Wygodzinsky (1955)	
Valsvlei	1484	-29.133	19.900	7-XII-1994	J. Irish	BMSA
Vlieholteberg	1485	-29.150	17.617	25-IX-1994	J. Irish	BMSA
Doringwater	1486	-29.150	17.867	17-IX-1994	J. Irish	BMSA
Geselskapbank	1487	-29.150	18.100	26-IX-1994	J. Irish	BMSA
Amam	1488	-29.150	18.450	26-IX-1994	J. Irish	BMSA
4 km S Pofadder	1489	-29.167	19.417	17-III-1988	J. Irish	NMNW
Fauna, Bloemfontein	1490	-29.167	26.183	13-XI-1994	L.N. Lotz	BMSA
Muisvlak	1491	-29.217	16.933	23-I-1989	DERU staff	GRSW
Kleinduin	1492	-29.217	17.050	30-XI-1980	J. Irish	NMNW
Aggeneys	1493	-29.217	18.850		Wygodzinsky (1955)	
Augrabies, Port Nolloth	1494	-29.233	17.133	23-I-1989	DERU staff	GRSW
Farquarson	1495	-29.233	17.267	13-IX-1982	M.-L. Penrith	NMNW
Gamsberg, Site D	1496	-29.233	18.917	23-III-1999	J. Irish	BMSA
Port Nolloth	1497	-29.250	16.867	23-I-1989	G. Alexander	NMNW
Port Nolloth	1498	-29.250	16.867			SAMC
Windpoort	1499	-29.267	17.400	16-IX-1994	J. Irish	BMSA
10 km W Anenouspas	1500	-29.267	17.533	9-XII-1980	J. Irish	NMNW
Steinkopf	1501	-29.267	17.733		Silvestri (1908)	
35 mi. ex Pofadder toward Springbok	1502	-29.267	18.917		Wygodzinsky (1970)	
Gamsberg, Site P	1503	-29.267	18.967	23-III-1999	J. Irish	BMSA
Steinkopf, 48 km ex towards Port Nolloth	1504	-29.283	17.300		W.G.H. Coaton, J.L. Sheasby	SANC
Anenous Pass, S side	1505	-29.283	17.617	7-IX-1982	M.-L. Penrith	NMNW
Witkoppies	1506	-29.283	19.517	17-III-1988	J. Irish	NMNW
Gannapoort	1507	-29.283	19.650	17-III-1988	J. Irish	NMNW
S McDougall's Bay	1508	-29.300	16.883	16-IX-1994	J. Irish	BMSA
85 mi. ex Kenhardt to Pofadder	1509	-29.300	19.883		Wygodzinsky (1970)	
SW Abbevlak at:	1510	-29.317	17.183	16-IX-1994	J. Irish	BMSA
Dikkop	1511	-29.317	18.350	26-IX-1994	J. Irish	BMSA
Blomhoek, duine S	1512	-29.333	18.967	25-III-1988	J. Irish	NMNW
Dwarsberg	1513	-29.367	17.900	17-IX-1994	J. Irish	BMSA
100 km W Pofadder	1514	-29.367	18.617	VIII-1977	S. Endrödy-Younga	TMSA
N Wolfkop at:	1515	-29.367	19.100	27-IX-1994	J. Irish	BMSA

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Vaalkop	1516	-29.367	19.983	17-III-1988	J. Irish	NMNW
60 mi. ex Pofadder towards Springbok	1517	-29.383	18.617		W.G.H. Coaton, J.L. Sheasby	SANC
Varswater	1518	-29.433	17.633	16-IX-1994	J. Irish	BMSA
12 km NNE Concordia [= Leeupoort]	1519	-29.433	17.950	19-X-1990	J. Irish	BMSA
Kaitob	1520	-29.467	18.117	7-XII-1994	J. Irish	BMSA
Skilpadnou	1521	-29.483	17.083	16-IX-1994	J. Irish	BMSA
Luttigshoop	1522	-29.483	19.300	27-IX-1994	J. Irish	BMSA
Tnong-Gys	1523	-29.533	17.233	24-IX-1988	J. Irish	NMNW
Brooke se Punt	1524	-29.533	18.283	17-XII-1994	J. Irish	BMSA
6 km SW Concordia	1525	-29.567	17.900	19-X-1990	L.N. Lotz	BMSA
Klawermuis	1526	-29.583	18.900	25-III-1988	J. Irish	NMNW
Wolfberg	1527	-29.617	17.417	16-IX-1994	J. Irish	BMSA
Kabas	1528	-29.617	17.917	17-IX-1994	J. Irish	BMSA
Heuningvlei	1529	-29.617	19.383	27-IX-1994	J. Irish	BMSA
Pietermaritzburg	1530	-29.617	30.383		Wygodzinsky (1955)	
2 km NE Grootmis	1531	-29.633	17.100	16-IX-1994	J. Irish	BMSA
Kaffervloer	1532	-29.650	19.950	8-XII-1994	J. Irish	BMSA
Springbok Modderfontein	1533	-29.667	17.800		Irish (1987)	
Kleinsee, beach	1534	-29.683	17.050	4-IX-2000	J. Irish	BMSA
Schaaprivier	1535	-29.683	17.667	15-IX-1982	M.-L. Penrith	NMNW
Spektakelberg	1536	-29.683	17.667	IX-1982	M.-L. Penrith	NMNW
Shaw se Vlei	1537	-29.683	19.600	8-XII-1994	J. Irish	BMSA
Beesskeurvlei	1538	-29.700	19.117	7-XII-1994	J. Irish	BMSA
S of Springbok, at:	1539	-29.717	17.900	19-VIII-1992	E. Irish	BMSA
Pramkop	1540	-29.717	18.117	7-XII-1994	J. Irish	BMSA
20 mi. ex Springbok - Gamoep	1541	-29.733	18.150	7-IV-1963	J.L. Sheasby	SANC
Hoendernesvlei	1542	-29.750	18.717	7-XII-1994	J. Irish	BMSA
Kamaggas	1543	-29.800	17.483		Silvestri (1908)	
Dabeep	1544	-29.817	18.317	19-X-1990	Irish, Lotz, Louw	BMSA
Stamford Hill [as Stanford Hill]	1545	-29.817	31.033		Silvestri (1913)	
Springbok, 24 km ex towards Hondeklipbaai	1546	-29.833	17.783		W.G.H. Coaton, J.L. Sheasby	SANC
Swartbakenknop	1547	-29.850	18.867	7-XII-1994	J. Irish	BMSA
Witduin	1548	-29.867	17.417	23-IX-1988	J. Irish	NMNW
Koffiemeul	1549	-29.867	19.167	27-IX-1994	J. Irish	BMSA
Eenriet	1550	-29.883	17.883	15-IX-1994	J. Irish	BMSA
Soutdwaggas	1551	-29.883	19.883	8-XII-1994	J. Irish	BMSA
Messelpad	1552	-29.900	17.650	15-IX-1994	J. Irish	BMSA
10 km E Gamoep	1553	-29.900	18.517	25-III-1988	J. Irish	NMNW
Kourkamma	1554	-29.917	17.450	23-IX-1988	J. Irish	NMNW
Buffels R. between Springbok and Hondeklip Bay	1555	-29.917	17.683	IX-1931	K.H.B[arnard].	SAMA
Springbok, 56 km ex towards Hondeklipbaai	1556	-29.933	17.600		W.G.H. Coaton, J.L. Sheasby	SANC
Gifkop 166 at:	1557	-29.950	19.400	24-X-1990	J. Irish, L.N. Lotz, S. Louw	BMSA
Klerk se Vloer	1558	-29.950	19.733	8-XII-1994	J. Irish	BMSA
Elandsklip	1559	-29.967	17.183	4-IX-2000	J. Irish	BMSA
Geelduine	1560	-30.067	17.233	18-VI-1987	J. Irish	NMNW

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Heidons	1561	-30.067	17.283	17-VI-1987	J. Irish	NMNW
T'Boop Noord	1562	-30.067	19.967	25-X-1990	J. Irish	BMSA
Tweerivier	1563	-30.100	17.817	15-IX-1994	J. Irish	BMSA
Nabaab	1564	-30.100	19.017	12-IX-1995	J. Irish	BMSA
2 km S Soebatsfontein	1565	-30.117	17.600	15-IX-1994	J. Irish	BMSA
Stofkraal	1567	-30.117	18.500	13-IX-1995	J. Irish	BMSA
Calvinia District at:	1568	-30.117	19.383	8-XII-1994	J. Irish	BMSA
Noos	1569	-30.133	17.383	15-IX-1994	J. Irish	BMSA
Sneeukop	1570	-30.150	17.967	21-IX-1988	J. Irish	NMNW
Dassiefontein	1571	-30.150	17.983	20-IX-1988	J. Irish	NMNW
Meyershoek	1572	-30.150	18.100	13-IX-1995	J. Irish	BMSA
Dwaggas	1573	-30.150	19.733	8-XII-1994	J. Irish	BMSA
Somnaasbaai	1574	-30.167	17.217	4-IX-2000	J. Irish	BMSA
Bailey's Pass	1575	-30.167	18.200	13-IX-1995	J. Irish	BMSA
Wolfkop	1576	-30.217	18.917	12-IX-1995	J. Irish	BMSA
Horinggat	1577	-30.250	18.050	22-IX-1988	J. Irish	NMNW
Kap-Kap	1578	-30.267	18.367	19-X-1990	J. Irish, L.N. Lotz, S. Louw	BMSA
Graskom	1579	-30.300	17.383	18-IX-1982	M.-L. Penrith	NMNW
Lilyfontein, Kamiesbergen	1580	-30.317	18.083	IX-1931	K.H.B[arnard].	SAMA
Blouboskom	1581	-30.317	19.967	9-XII-1994	J. Irish	BMSA
9 km E Hondeklipbaai	1582	-30.333	17.367	15-IX-1994	J. Irish	BMSA
Tierkop	1583	-30.333	17.817	14-IX-1994	J. Irish	BMSA
1 km S Leliefontein	1584	-30.333	18.083		J. Irish	NMNW
5 km W Wallekraal	1585	-30.350	17.433	15-IX-1994	J. Irish	BMSA
Rooiberg	1586	-30.350	17.600	14-IX-1994	J. Irish	BMSA
8 km SE Leliefontein	1587	-30.350	18.117		Irish (1987)	
Kassie se Pomp	1588	-30.350	18.817	27-IX-1994	J. Irish	BMSA
Eselkop	1589	-30.367	18.083	22-IX-1988	J. Irish	NMNW
Paulshoek	1590	-30.367	18.283	13-IX-1995	J. Irish	BMSA
Uilklip	1591	-30.367	19.850	9-XII-1994	J. Irish	BMSA
Nabiseep	1592	-30.383	19.183	12-IX-1995	J. Irish	BMSA
69 km N Loeriesfontein	1593	-30.383	19.567	23-X-1990	J. Irish, L.N. Lotz, S. Louw	BMSA
Blouberg	1594	-30.417	18.133	13-IX-1995	J. Irish	BMSA
Tweelingdam	1595	-30.417	18.600	27-IX-1994	J. Irish	BMSA
Sandkraal	1596	-30.533	19.300	12-IX-1995	J. Irish	BMSA
Bruinkop	1597	-30.550	17.717	14-IX-1994	J. Irish	BMSA
Garies	1598	-30.550	17.983	15-XI-1949	B. Malkin	CAS
Springbokkeel	1599	-30.567	19.133	12-IX-1995	J. Irish	BMSA
Witputs	1600	-30.600	19.933	20-I-1994	J. Irish	BMSA
Rietfontein Poort	1601	-30.600	25.133	22-II-1995	J. Irish	BMSA
De Hoog	1602	-30.617	17.850	14-IX-1994	J. Irish	BMSA
Gt. Rooiberg	1603	-30.617	19.533	8-XII-1994	J. Irish	BMSA
Vogelfontein 71 at:	1604	-30.617	25.300	23-III-1995	L.N. Lotz	BMSA
Rietmond	1605	-30.633	18.650	27-IX-1994	J. Irish	BMSA
Rooikop	1606	-30.633	25.417	15-V-1995	J. Irish	BMSA

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10 km S Witputs	1607	-30.650	19.950	20-I-1994	J. Irish	BMSA
Agteroorberg	1608	-30.683	18.183	27-IX-1994	J. Irish	BMSA
Vaalkop	1609	-30.683	19.367	12-IX-1995	J. Irish	BMSA
Colesberg District, unspecified locality [taken at town]	1610	-30.717	25.100		Wygodzinsky (1955)	
Mount Fletcher	1611	-30.700	28.517		Wygodzinsky (1955)	
Rietkop	1612	-30.717	17.583	14-IX-1994	J. Irish	BMSA
Kokerboomkraal	1613	-30.717	18.783	24-III-1988	J. Irish	NMNW
Kokerboomkraal	1614	-30.717	18.783	21-X-1990	J. Irish	BMSA
Stofkraal	1615	-30.733	18.383	27-IX-1994	J. Irish	BMSA
Lepelvlakte	1616	-30.733	18.733	14-IX-1995	J. Irish	BMSA
Groenfontein	1617	-30.733	25.617	8-IX-1997	J. Irish	BMSA
Mostertsvlei	1618	-30.750	18.100	16-III-1993	L.N. Lotz	BMSA
Vonkelfontein	1619	-30.750	18.200	16-III-1993	L.N. Lotz	BMSA
33 km N Bitterfontein	1620	-30.783	18.117	19-VI-1987	J. Irish	NMNW
Roelf se Berg	1621	-30.800	19.033	24-III-1988	J. Irish	NMNW
Kalkgat	1622	-30.833	19.850	9-XII-1994	J. Irish	BMSA
Springfontein	1623	-30.833	25.383	15-V-1995	J. Irish	BMSA
Groenriviermond	1624	-30.850	17.583	14-IX-1994	J. Irish	BMSA
Driefontein 137	1625	-30.850	25.167	23-III-1995	L.N. Lotz	BMSA
Oudam	1626	-30.867	17.850	13-IX-1994	J. Irish	BMSA
Redman	1627	-30.867	19.633	9-XII-1994	J. Irish	BMSA
Groenfontein	1628	-30.867	25.150	22-II-1995	J. Irish	BMSA
Leeukuil	1629	-30.883	18.717	14-IX-1995	J. Irish	BMSA
Bobbejaankop	1630	-30.883	25.617	8-IX-1997	J. Irish	BMSA
4 km S Oudam	1631	-30.900	17.833	13-IX-1994	J. Irish	BMSA
Groenpunt	1632	-30.900	18.333	14-IX-1995	J. Irish	BMSA
10 km NW Loeriesfontein	1633	-30.917	19.367	21-X-1990	J. Irish, L.N. Lotz, S. Louw	BMSA
Klein Graafwater	1634	-30.933	19.000	14-IX-1995	J. Irish	BMSA
2 km W Rietpoort	1635	-30.967	18.017	13-IX-1994	J. Irish	BMSA
Kamdanie	1636	-30.983	19.350	24-III-1988	J. Irish	NMNW
5 km NE Bitterfontein	1637	-31.000	18.267	15-V-1986	J. Irish	NMNW
Sunnyside	1638	-31.067	25.717	XI-1985	Ent. Dept.	BMSA
Driekuil	1639	-31.083	18.933	14-IX-1995	J. Irish	BMSA
Kareeboomwater	1640	-31.083	19.600	24-III-1988	J. Irish	NMNW
Driefontein	1641	-31.100	25.583	8-IX-1997	J. Irish	BMSA
S Katdoringvlei at:	1642	-31.133	17.867	13-IX-1994	J. Irish	BMSA
Geelkop	1643	-31.150	18.033	13-IX-1994	J. Irish	BMSA
2 km SE Nuwerus	1644	-31.150	18.367	13-IX-1994	J. Irish	BMSA
Bakenskop	1645	-31.150	19.233	15-IX-1995	J. Irish	BMSA
Perdeberg	1646	-31.150	19.450	12-IX-1995	J. Irish	BMSA
Jakkalsfontein	1647	-31.150	25.167	22-II-1995	J. Irish	BMSA
Wynton	1648	-31.167	25.333	15-V-1995	J. Irish	BMSA
5 km NE Windkraal	1649	-31.200	19.750	24-III-1988	J. Irish	NMNW
Driekuil	1650	-31.200	19.950	24-III-1988	J. Irish	NMNW
Glen Alan	1651	-31.200	25.050	22-II-1995	J. Irish	BMSA

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Brakfontein	1652	-31.233	17.917	13-IX-1994	J. Irish	BMSA
Flaminksvlakte	1653	-31.233	18.583	20-IX-1982	M.-L. Penrith	NMNW
NE Saggiesberg at:	1654	-31.267	18.850	14-IX-1995	J. Irish	BMSA
18 mi. SE Nuwerus	1655	-31.300	18.583		Irish (1988c)	
Ouberg	1656	-31.300	19.383	15-IX-1995	J. Irish	BMSA
Rooivlei	1657	-31.317	18.117	12-IX-1994	J. Irish	BMSA
Potklei	1658	-31.350	18.333	12-IX-1994	J. Irish	BMSA
Teebus, 2 km NW	1659	-31.350	25.650	8-IX-1997	J. Irish	BMSA
Schoombeesklip	1660	-31.367	25.117	22-II-1995	J. Irish	BMSA
Hartebeestfontein	1661	-31.367	25.383	15-V-1995	J. Irish	BMSA
Vanrhynspas, summit	1662	-31.383	19.017	15-IX-1995	J. Irish	BMSA
Nieuwoudtville	1663	-31.383	19.117		Wygodzinsky (1970)	
Merweshoek	1664	-31.383	19.600	12-IX-1995	J. Irish	BMSA
Hantamsberg-plato	1665	-31.383	19.783	23-III-1988	J. Irish	NMNW
Rooiberg	1666	-31.400	18.633	13-IX-1994	J. Irish	BMSA
SE Baievlei	1667	-31.417	18.000	12-IX-1994	J. Irish	BMSA
10 mi. / 16 km ex Calvinia towards Loeriesfontein	1668	-31.433	19.617		Wygodzinsky (1970)	
Indwe	1669	-31.467	27.333		Theron (1963)	
68 mi. / 109 km ex Clanwilliam towards Calvinia	1670	-31.483	19.467		Wygodzinsky (1970)	
Kommandokraal	1671	-31.500	18.200	19-IX-1982	M.-L. Penrith	NMNW
De Kamp	1672	-31.567	18.867	11-IX-1994	J. Irish	BMSA
3 km SE Lutzville	1673	-31.583	18.367	12-IX-1994	J. Irish	BMSA
Augustfontein	1674	-31.600	19.350	15-IX-1995	J. Irish	BMSA
Rooikop	1675	-31.600	25.167	22-II-1995	J. Irish	BMSA
Doornberg Hoek	1676	-31.600	25.367	4-III-1995	J. Irish	BMSA
Vanrhynsdorp	1677	-31.617	18.733		Wygodzinsky (1970)	
Olifantskliphoogte	1678	-31.633	18.167	12-IX-1994	J. Irish	BMSA
Gipsmyn	1679	-31.633	18.650	12-IX-1994	J. Irish	BMSA
Nuwefontein	1680	-31.650	19.133	15-IX-1995	J. Irish	BMSA
20 km W Vredendal	1681	-31.667	18.517	19-VIII-1983	S. Endrödy-Younga (EY1948)	TMSA
Noordhoek	1682	-31.667	19.800	9-XII-1994	J. Irish	BMSA
Papendorp	1683	-31.700	18.200	22-IX-1967	E.S. Ross, A.R.Stephen	CAS
2 mi. S Papendorp	1684	-31.733	18.217	6-I-1967	E.S. Ross, K. Lorenzen	CAS
Wiedou	1685	-31.733	18.217	IX-1982	M.-L. Penrith	NMNW
Gifbergpas	1686	-31.767	18.767	11-IX-1994	J. Irish	BMSA
Waterval	1687	-31.783	18.900	11-IX-1994	J. Irish	BMSA
Vondeling	1688	-31.800	18.800	11-IX-1994	J. Irish	BMSA
Botterkloofpas, summit	1689	-31.817	19.267	16-IX-1995	J. Irish	BMSA
Botter Kloof Pass	1690	-31.833	19.267		Wygodzinsky (1955)	
Soutpan	1691	-31.833	19.417	15-IX-1995	J. Irish	BMSA
S Doringbaai at:	1692	-31.850	18.250	28-IX-1994	J. Irish	BMSA
Vlakkraal	1693	-31.850	19.583	15-IX-1995	J. Irish	BMSA
Kleindoornberg	1694	-31.850	25.383	4-III-1995	J. Irish	BMSA
Vaalvlei	1695	-31.867	18.433	28-IX-1994	J. Irish	BMSA
Wolwevlei	1696	-31.867	25.133	22-II-1995	J. Irish	BMSA

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Olyfen	1697	-31.900	18.667	16-IX-1995	J. Irish	BMSA
Skurfkop	1698	-31.933	18.633	16-IX-1995	J. Irish	BMSA
Sandkop	1699	-31.933	19.817	15-IX-1995	J. Irish	BMSA
Kraaibosberg	1700	-31.967	18.883	16-IX-1995	J. Irish	BMSA
Doorn Bosch 19	1701	-31.967	19.233	19-X-1987	Ent. Dept.	BMSA
Seweputs	1702	-31.983	18.317	16-V-1986	J. Irish	NMNW
Wellwood	1703	-31.983	24.633	14-IX-1983	S. Endrödy-Younga (EY2007)	TMSA
Nortier Farm	1704	-32.033	18.333		S. Endrödy-Younga	TMSA
Klipheuwelkoppe	1705	-32.033	21.450	21-III-1988	J. Irish	NMNW
Blomfontein	1706	-32.033	21.883	25-II-1995	J. Irish	BMSA
8 mi. NW Clanwilliam	1707	-32.067	18.817	1-V-1958	E.S. Ross, R.E. Leech	CAS
Dejagerspas, top	1708	-32.067	22.767	25-II-1995	J. Irish	BMSA
Kookfontein	1709	-32.083	18.367	28-IX-1994	J. Irish	BMSA
Vaalkop	1710	-32.083	20.917	25-X-1995	J. Irish	BMSA
Bastardspoort	1711	-32.083	22.383	25-II-1995	J. Irish	BMSA
Jonkersnek	1712	-32.083	23.650	24-II-1995	J. Irish	BMSA
Lamberts Bay	1713	-32.100	18.300	16-II-1979	R.K. Brooke	SAMC
Kompromis	1714	-32.100	20.367	22-III-1988	J. Irish	NMNW
Bruinrug	1715	-32.100	23.150	24-II-1995	J. Irish	BMSA
Modderfontein	1716	-32.100	24.867	23-II-1995	J. Irish	BMSA
Beletskloof	1717	-32.100	25.100	16-V-1995	J. Irish	BMSA
Uitkykpas, summit	1718	-32.117	19.183	16-IX-1995	J. Irish	BMSA
Steenkampsvlakte	1719	-32.117	21.583	10-XII-1994	J. Irish	BMSA
Pakhuis Pass, eastern part	1720	-32.133	19.050		Wygodzinsky (1955)	
Middelplaas	1721	-32.133	19.333	16-IX-1995	J. Irish	BMSA
Van Wyksvlei	1722	-32.133	19.717	26-X-1995	J. Irish	BMSA
Ganagapas	1723	-32.133	20.100	10-XII-1996	J. Irish	BMSA
De Hoop	1724	-32.133	22.733	15-9-1983	M.-L. Penrith	NMNW
Riem	1725	-32.133	22.917	25-II-1995	J. Irish	BMSA
Oudebergpas	1726	-32.133	24.417	24-II-1995	J. Irish	BMSA
Goliatskraalkop	1727	-32.133	24.600	23-II-1995	J. Irish	BMSA
Karooberg	1728	-32.150	18.900	17-IX-1995	J. Irish	BMSA
Pakhuispas, summit	1729	-32.150	19.033	17-IX-1995	J. Irish	BMSA
Seleryfontein	1730	-32.150	21.150	25-X-1995	J. Irish	BMSA
Tafelkop	1731	-32.150	23.417	24-II-1995	J. Irish	BMSA
Kaalplaats	1732	-32.150	25.350	16-V-1995	J. Irish	BMSA
Eselfontein	1733	-32.167	21.400	21-III-1988	J. Irish	NMNW
Cradock	1734	-32.167	25.117	1986	Ent. Dept.	BMSA
Clanwilliam	1735	-32.183	18.900	IX-1931	K.H.B[arnard].	SAMA
Brandkop	1736	-32.183	20.600	25-X-1995	J. Irish	BMSA
Oubank	1737	-32.183	20.800	10-XII-1994	J. Irish	BMSA
Oukloofpas at:	1738	-32.183	21.783	25-II-1995	J. Irish	BMSA
'Barrow's Hope, by Tarkastadt, distr. Queenstown', possibly = Bowerhope	1739	-32.200	26.500		Mendes (1981b, 1982)	
Middelpos	1740	-32.217	18.433	28-IX-1994	J. Irish	BMSA
27 km NW Sutherland	1741	-32.217	20.533	22-III-1988	J. Irish	NMNW

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Moltenopas, at:	1742	-32.217	22.567	25-II-1995	J. Irish	BMSA
Mountain Zebra National Park	1743	-32.233	25.467	29-X-1985	Ent. Dept.	BMSA
4 km NW Wuppertal	1744	-32.250	19.183	16-IX-1995	J. Irish	BMSA
Vallei van Verlatenheid	1745	-32.267	24.483	24-II-1995	J. Irish	BMSA
Sarelsrivier	1746	-32.283	23.600	24-II-1995	J. Irish	BMSA
11 mi. S Clanwilliam	1747	-32.300	18.900	1-V-1958	E.S. Ross, R.E. Leech	CAS
10 km N Sutherland	1748	-32.300	20.650	20-VI-1987	J. Irish	NMNW
Grantham	1749	-32.300	22.150	26-II-1995	J. Irish	BMSA
Langrug	1750	-32.317	20.050	26-X-1995	J. Irish	BMSA
Danskraal	1751	-32.333	21.667	26-II-1995	J. Irish	BMSA
Sunnyside	1752	-32.333	22.867	11-XII-1994	J. Irish	BMSA
Hopewell	1753	-32.333	23.167	11-XII-1994	J. Irish	BMSA
Jakhalsfontein	1754	-32.350	25.400	9-IX-1997	J. Irish	BMSA
Tweefontein	1755	-32.367	19.650	26-X-1995	J. Irish	BMSA
Paardefontein	1756	-32.367	22.383	26-II-1995	J. Irish	BMSA
Vaalkoppies	1757	-32.367	22.633	1-XI-1994	J. Irish	BMSA
Cederberg, E track, at:	1758	-32.383	19.400	21-VIII-1983	S. Endrödy-Younga (EY1958, 1959)	TMSA
Sutherland Sterrewag	1759	-32.383	20.817	22-III-1988	J. Irish	NMNW
Sondagsrivier	1760	-32.383	25.100	9-IX-1997	J. Irish	BMSA
Cederberg, E track, at:	1761	-32.400	19.417	21-VIII-1983	S. Endrödy-Younga (EY1957)	TMSA
Benoni	1762	-32.400	21.883	10-XII-1994	J. Irish	BMSA
Belmont	1763	-32.400	24.617	23-II-1995	J. Irish	BMSA
Oubergpas, summit	1764	-32.417	20.350	25-X-1995	J. Irish	BMSA
Arcadia	1765	-32.433	24.133	3-III-1995	J. Irish	BMSA
Mied se Berg	1766	-32.450	19.167	17-X-1995	J. Irish	BMSA
Cederberg, E track, at:	1767	-32.450	19.383	21-VIII-1983	S. Endrödy-Younga (EY1955)	TMSA
Vaalvlei	1768	-32.450	23.367	2-III-1995	J. Irish	BMSA
Wolwekop	1769	-32.450	23.867	11-XII-1994	J. Irish	BMSA
Tarkapas, summit	1770	-32.450	25.650	10-IX-1997	J. Irish	BMSA
Redelinghuys	1771	-32.467	18.533		Theron (1963)	
Cederberg, E track, at:	1772	-32.483	19.367	21-VIII-1983	S. Endrödy-Younga (EY1954)	TMSA
Jakkalskop	1773	-32.483	19.867	26-X-1995	J. Irish	BMSA
Karelskraalpas	1774	-32.483	21.167	21-III-1988	J. Irish	NMNW
Portugalsrivier	1775	-32.517	20.933	25-X-1995	J. Irish	BMSA
Verlatekloof	1776	-32.533	20.633	20-VI-1987	J. Irish	NMNW
10 km SW Aberdeen	1777	-32.533	23.983	5-IX-1988	H.G. Robertson	SAMC
Valentinusfontein	1778	-32.550	18.733	17-IX-1995	J. Irish	BMSA
Saucyskuil, 30 km ex Beaufort West towards Willowmore	1779	-32.550	22.800	11-X-1979	J.L. Sheasby	SANC
Hartbeeskop	1780	-32.583	21.533	26-II-1995	J. Irish	BMSA
Het Kruis	1781	-32.600	18.750		Theron (1963)	
Voslonia	1782	-32.600	25.717	10-IX-1997	J. Irish	BMSA
Citrusdal, 2 mi. SW	1783	-32.617	18.983	30-IV-1958	E.S. Ross, R.E. Leech	CAS
Grootrivierhoogte, summit	1784	-32.617	19.367	27-X-1995	J. Irish	BMSA
Groot Kapelsfontein	1785	-32.617	19.783	27-X-1995	J. Irish	BMSA
Platkop	1786	-32.617	21.367	26-II-1995	J. Irish	BMSA

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Vrede-en-Lus	1787	-32.617	22.900	28-II-1995	J. Irish	BMSA
Vanderbergskuil	1788	-32.617	23.900	2-III-1995	J. Irish	BMSA
Vlakfontein	1789	-32.617	24.100	3-III-1995	J. Irish	BMSA
Piekenierskloofpas, summit	1790	-32.633	18.950	28-X-1995	J. Irish	BMSA
Grey's Pass	1791	-32.633	18.950		Wygodzinsky (1955)	
Matjiesgoedkop	1792	-32.633	21.867	26-II-1995	J. Irish	BMSA
Plaatjiesrivier	1793	-32.633	22.367	27-II-1995	J. Irish	BMSA
Doornhoek	1794	-32.633	23.433	1-III-1995	J. Irish	BMSA
Bosrant	1795	-32.633	24.367	3-III-1995	J. Irish	BMSA
Quimby Holme	1796	-32.633	24.683	3-III-1995	J. Irish	BMSA
Driekop	1797	-32.650	22.633	28-II-1995	J. Irish	BMSA
Jossieville	1798	-32.650	23.200	1-III-1995	J. Irish	BMSA
Kafferskop	1799	-32.650	25.083	11-IX-1997	J. Irish	BMSA
30 mi. / 48 km ex Beaufort West towards Willowmore	1800	-32.667	22.933	19-IX-1961	W.G.H. Coaton	SANC
Gifkop	1801	-32.683	20.450	30-X-1995	J. Irish	BMSA
Komsbergpas	1802	-32.683	20.750	22-IX-1995	J. Irish	BMSA
8 km NW Ebenezer	1803	-32.683	24.833	16-V-1995	J. Irish	BMSA
Bruintjieshoogte	1804	-32.683	25.350	9-IX-1997	J. Irish	BMSA
56 km ex Beaufort West towards Willowmore	1805	-32.700	22.967	8-IV-1979	J.L. Sheasby	SANC
Eerstewater, 56 km ex Beaufort West towards Willowmore	1806	-32.700	22.967	14-X-1979	J.L. Sheasby	SANC
Whisky Nek	1807	-32.700	23.667	2-III-1995	J. Irish	BMSA
Tandfontein	1808	-32.717	19.233	29-X-1995	J. Irish	BMSA
Blinkbergpas, summit	1809	-32.733	19.433	27-X-1995	J. Irish	BMSA
Keurbos	1810	-32.750	18.600	21-IX-1995	J. Irish	BMSA
Grootdam	1811	-32.800	19.750	27-X-1995	J. Irish	BMSA
Paternoster	1812	-32.817	17.883	18-IX-1995	J. Irish	BMSA
Tzaarskuil	1813	-32.817	18.400	21-IX-1995	J. Irish	BMSA
Jukfontein	1814	-32.817	20.100	30-X-1995	J. Irish	BMSA
Besters Kraal 38	1815	-32.833	17.917	24-X-1987	Ent. Dept.	BMSA
Rietfontein	1816	-32.833	21.083	22-IX-1995	J. Irish	BMSA
Buffelsfontein	1817	-32.833	24.617	3-III-1995	J. Irish	BMSA
Oliphants Kraal 61 at:	1818	-32.850	18.150	23-X-1987	Ent. Dept.	BMSA
Agterland	1819	-32.850	18.933	28-X-1995	J. Irish	BMSA
Rusgevonden	1820	-32.850	22.900	28-II-1995	J. Irish	BMSA
Westondale	1821	-32.850	25.083	11-IX-1997	J. Irish	BMSA
Stel se Nek	1822	-32.867	21.333	26-II-1995	J. Irish	BMSA
Bakenskop	1823	-32.867	21.633	27-II-1995	J. Irish	BMSA
Vrede Rust	1824	-32.867	23.867	2-III-1995	J. Irish	BMSA
Shamrock	1825	-32.867	24.833	16-V-1995	J. Irish	BMSA
The Ridges	1826	-32.867	25.367	12-IX-1997	J. Irish	BMSA
Swartruggens, foot at:	1827	-32.883	19.733	27-X-1995	J. Irish	BMSA
Klein Hangklip	1828	-32.883	19.967	30-X-1995	J. Irish	BMSA
Bakenshoogte	1829	-32.883	20.667	30-X-1995	J. Irish	BMSA
Rietfontein	1830	-32.883	21.900	27-II-1995	J. Irish	BMSA
3 km NW Rietbron	1831	-32.883	23.133	1-III-1995	J. Irish	BMSA

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Blomplaas	1832	-32.883	23.633	2-III-1995	J. Irish	BMSA
King William's Town	1833	-32.883	27.400		Theron (1963)	
Katbakkiespas	1834	-32.900	19.567	27-X-1995	J. Irish	BMSA
Amospoortjie	1835	-32.900	22.550	28-II-1995	J. Irish	BMSA
Niekerksberg	1836	-32.900	25.567	12-IX-1997	J. Irish	BMSA
Brackfontein Farm	1837	-32.933	18.250	23-VIII-1983	S. Endrödy-Younga (EY1967)	TMSA
Varsfontein	1838	-32.933	22.100	28-II-1995	J. Irish	BMSA
Makoukuil	1839	-32.933	23.350	1-III-1995	J. Irish	BMSA
Jacobsbaai	1840	-32.967	17.883	1978	A.J. Prins	SAMC
5 km S Jantjiesfontein	1841	-32.967	18.350	21-IX-1995	J. Irish	BMSA
Berg Rivier, 4 mi. S of Picketberg	1842	-32.967	18.750	30-IV-1958	E.S. Ross, R.E. Leech	CAS
Kleinwaterval	1843	-32.983	22.350	28-II-1995	J. Irish	BMSA
Blouwaterbaai	1844	-33.000	17.967	30-XI-1993	J. Irish	BMSA
4 km NE Langebaan	1845	-33.050	18.067	24-VIII-1983	S. Endrödy-Younga (EY1971)	TMSA
Blaauwkrantz	1846	-33.067	21.583	27-II-1995	J. Irish	BMSA
Langebaan	1847	-33.083	18.033	1-XII-1993	J. Irish	BMSA
Langebaan	1848	-33.083	18.033	IX-1997	C. Griffiths	BMSA
Wind Heuvel 77	1849	-33.083	23.517	16-XII-1986	S. Louw	BMSA
Groenvlei	1850	-33.083	24.650	17-V-1995	J. Irish	BMSA
Toekomst	1851	-33.083	25.100	11-IX-1997	J. Irish	BMSA
Groenfontein	1852	-33.100	19.350	29-X-1995	J. Irish	BMSA
Botterkraal	1853	-33.100	22.383	1-III-1995	J. Irish	BMSA
Kareedam	1854	-33.100	23.133	1-III-1995	J. Irish	BMSA
Kalkfontein	1855	-33.100	24.867	17-V-1995	J. Irish	BMSA
Massenberg	1856	-33.117	18.133	18-IX-1995	J. Irish	BMSA
13 km N Matjiesfontein	1857	-33.117	20.600	30-X-1995	J. Irish	BMSA
1 km N Koup	1858	-33.117	21.267	26-III-1978	D. & M. Davis, B. Akerbergs	USNM
Kalkgat	1859	-33.117	22.633	1-III-1995	J. Irish	BMSA
Goudmyn se Berg	1860	-33.133	18.683	22-IX-1995	J. Irish	BMSA
Rietkuil	1861	-33.133	22.883	1-III-1995	J. Irish	BMSA
Kilbourne	1862	-33.133	23.600	18-V-1995	J. Irish	BMSA
Ganskraal	1863	-33.150	18.417	21-IX-1995	J. Irish	BMSA
Kolkiesrivier	1864	-33.150	19.917	7-V-1996	J. Irish	BMSA
Driekoppe	1865	-33.150	20.367	7-V-1996	J. Irish	BMSA
Spitskopvlakte	1866	-33.150	21.167	21-V-1995	J. Irish	BMSA
Brakfontein Farm	1867	-33.150	23.400	5-IX-1988	H.G. Robertson	SAMC
Wapadskloof	1868	-33.150	25.633	12-IX-1997	J. Irish	BMSA
Hoek se Kop	1869	-33.167	22.100	28-II-1995	J. Irish	BMSA
Aandrus	1870	-33.167	24.100	18-V-1995	J. Irish	BMSA
Perdepoort	1871	-33.200	23.433	2-III-1995	J. Irish	BMSA
Crown Hill	1872	-33.217	25.350	11-IX-1997	J. Irish	BMSA
Abrahamskraal farm	1873	-33.233	18.150	25-VIII-1983	S. Endrödy-Younga (EY1976)	TMSA
Matjiesfontein [as 'Matjesfontein']	1874	-33.233	20.583		Escherich (1905)	
8 km N Yzerfontein	1875	-33.250	18.183	25-VIII-1983	S. Endrödy-Younga (EY1978)	TMSA
Amperbo	1876	-33.250	19.567	29-X-1995	J. Irish	BMSA

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Kareedouwpas	1877	-33.267	22.283	19-V-1995	J. Irish	BMSA
Doringhoek	1878	-33.267	23.333	19-V-1995	J. Irish	BMSA
6 mi. NE Steytlerville	1879	-33.283	24.433	19-IV-1958	E.S. Ross, R.E. Leech	CAS
Fisantekraal	1880	-33.300	20.617	15-V-1996	J. Irish	BMSA
Willowmore	1881	-33.300	23.483		Escherich (1905)	
Willowmore	1882	-33.300	23.483	27-V-1986	J. Irish	NMNW
Willowmore	1883	-33.300	23.483	23-VI-1987	J. Irish	NMNW
Grahamstown	1884	-33.300	26.533		Heeg (1967, 1969)	
Grahamstad	1885	-33.300	26.533		J. Irish	NMNW
Grahamstown	1886	-33.300	26.533	24-VIII-1986	S. van Noort	SAMC
De Rust	1887	-33.317	19.417	7-V-1996	J. Irish	BMSA
Kwartelfontein	1888	-33.317	19.850	14-V-1996	J. Irish	BMSA
Volmoed	1889	-33.317	23.100	19-V-1995	J. Irish	BMSA
Platberg, Swartbergpas	1890	-33.333	22.033		Wygodzinsky (1955)	
Spitskop	1891	-33.333	22.900	19-V-1995	J. Irish	BMSA
Cape Town, 65 km N	1892	-33.350	18.250	30-VIII-1983	S. Endrödy-Younga (EY1998, 1999)	TMSA
Witnekke	1893	-33.350	20.917	21-V-1995	J. Irish	BMSA
Seweweekspoort, N at:	1894	-33.350	21.417	21-V-1995	J. Irish	BMSA
Zwartberg-Pass; taken at:	1895	-33.350	22.033		Escherich (1905)	
Swartbergpas, summit	1896	-33.350	22.033	31-V-1986	J. Irish	NMNW
Vrolikheid	1897	-33.350	22.617	19-V-1995	J. Irish	BMSA
Erekroonspoort	1898	-33.367	24.633	17-V-1995	J. Irish	BMSA
Beeskraal	1899	-33.383	21.100	21-V-1995	J. Irish	BMSA
Verekraal	1900	-33.383	23.900	18-V-1995	J. Irish	BMSA
Glen Grove	1901	-33.383	25.133	13-IX-1997	J. Irish	BMSA
Malmesbury, 5 mi. N	1902	-33.400	18.717		Wygodzinsky (1955)	
Wildealslaagte	1903	-33.400	23.600	18-V-1995	J. Irish	BMSA
Skietkraal	1904	-33.400	24.350	18-V-1995	J. Irish	BMSA
Gorrielaagte	1905	-33.400	24.850	17-V-1995	J. Irish	BMSA
Wolseley	1906	-33.417	19.200		Theron (1963)	
Touwsrivier, SE at:	1907	-33.417	20.117	15-V-1996	J. Irish	BMSA
Vaalhoedskraal	1908	-33.417	25.317	13-IX-1997	J. Irish	BMSA
Malmesbury	1909	-33.450	18.733		Wygodzinsky (1955), Theron (1963)	
Die Outol	1910	-33.450	20.850	31-X-1995	J. Irish	BMSA
Bloutoring	1911	-33.467	20.317	15-V-1996	J. Irish	BMSA
Ladismith [as Ladysmith]	1912	-33.483	21.267		Escherich (1905)	
Nuwekloofpas, summit	1913	-33.500	23.633	25-V-1995	J. Irish	BMSA
Calitzdorp	1914	-33.533	21.683	22-III-1979	A.J. Prins	SAMC
Verlorenrivier	1915	-33.533	23.867	25-V-1995	J. Irish	BMSA
Mannetjie	1916	-33.533	25.117	13-IX-1997	J. Irish	BMSA
Nougas	1917	-33.550	20.067	14-V-1996	J. Irish	BMSA
Hartbeesrivier	1918	-33.567	23.367	25-V-1995	J. Irish	BMSA
Skuinspadkloof	1919	-33.567	24.117	25-V-1995	J. Irish	BMSA
20 km N Uitenhage	1920	-33.567	25.417	26-VI-1987	J. Irish	NMNW
Melkbos to Malmesbury	1921	-33.583	18.583		Irish (1987)	

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Grasrug	1922	-33.583	23.067	24-V-1995	J. Irish	BMSA
Uniondale, 9 km NNE	1923	-33.583	23.167	27-V-1986	J. Irish	NMNW
Vensterkrans	1924	-33.600	21.117	31-X-1995	J. Irish	BMSA
Badshoogte	1925	-33.600	21.783	22-V-1995	J. Irish	BMSA
Kansavlakte	1926	-33.600	22.133	22-V-1995	J. Irish	BMSA
Bainskloof	1927	-33.617	19.100		Wygodzinsky (1955)	
Sutton Vale	1928	-33.633	25.067	14-IX-1997	J. Irish	BMSA
Congoskraal	1929	-33.633	25.983	14-IX-1997	J. Irish	BMSA
Bylshoek	1930	-33.650	20.367	15-V-1996	J. Irish	BMSA
Highgate	1931	-33.667	22.133	25-XI-1993	J. Irish	BMSA
Kromhoogte	1932	-33.667	22.383	23-V-1995	J. Irish	BMSA
Rooibergpas, at:	1933	-33.683	21.650	22-V-1995	J. Irish	BMSA
Cornville	1934	-33.683	26.133	14-IX-1997	J. Irish	BMSA
Die Bron, Uitenhage	1935	-33.700	25.433	24-VI-1987	J. Irish	NMNW
Haarlem, 2 km NE	1936	-33.717	23.350	2-XI-1995	J. Irish	BMSA
Amanzi Estate	1937	-33.717	25.517		Wygodzinsky (1955)	
Vanwyksdorp, W at:	1938	-33.733	21.417	11-X-1996	J. Irish	BMSA
Haarlem	1939	-33.733	23.333		Wygodzinsky (1955)	
The Downs	1940	-33.733	25.767	15-IX-1997	J. Irish	BMSA
Paarlrots	1941	-33.750	18.950	20-IX-1995	J. Irish	BMSA
3 mi N of Herold	1942	-33.783	22.433	24-IV-1958	E.S. Ross, R.E. Leech	CAS
Joubertina, N at:	1943	-33.800	23.850	15-X-1996	J. Irish	BMSA
Miertjieskraal, E at:	1944	-33.817	21.200	10-X-1996	J. Irish	BMSA
Rooivlei, N at:	1945	-33.817	24.733	16-X-1996	J. Irish	BMSA
Perseverance	1946	-33.833	25.550			BMSA
Lemoenhoek	1947	-33.850	20.850	28-X-1987	Ent. Dept.	BMSA
Sandhoek	1948	-33.850	20.883	16-V-1996	J. Irish	BMSA
Skilpadhoogte	1949	-33.867	20.117	13-V-1996	J. Irish	BMSA
Rietrivier	1950	-33.883	20.333	16-V-1996	J. Irish	BMSA
Waaikraal	1951	-33.900	21.650	11-X-1996	J. Irish	BMSA
Van Stadens Nat. Res.	1952	-33.900	25.200	14-I-1995	J. Irish	BMSA
Modderasfontein	1953	-33.917	20.700	16-V-1996	J. Irish	BMSA
Cape Town	1954	-33.933	18.433		Theron (1963)	
Stellenbosch	1955	-33.933	18.867		Theron (1963)	
Bonnievale	1956	-33.933	20.100		Theron (1963)	
Gysmanshoekpas	1957	-33.933	21.067	10-X-1996	J. Irish	BMSA
Echo Valley, Table Mountain	1958	-33.967	18.400		Wygodzinsky (1955)	
Claremont	1959	-33.967	18.467	VIII-1992	Rentokill staff	BMSA
Nature's Valley	1960	-33.967	23.550	28-V-1986	J. Irish	BMSA
Vanstadensmond	1961	-33.967	25.217	8-I-1995	E. Irish	BMSA
Vanstadensmond	1962	-33.967	25.217	12-I-1995	J. Irish	BMSA
Port Elizabeth	1963	-33.967	25.617		Escherich (1903, 1905)	
Plumstead	1964	-34.017	18.467	III-1996	J.J. Irish	BMSA
Plumstead	1965	-34.017	18.467	VII-1996	J.J. Irish	SAMC
Plumstead	1966	-34.017	18.467	28-XI-1993	E. Irish	BMSA

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
Ribbokkop	1967	-34.033	20.083	13-V-1996	J. Irish	BMSA
Wavecrest, Jeffreys Bay	1968	-34.033	24.917	24-I-1993	J. Irish	BMSA
Hout Bay	1969	-34.050	18.350		Wygodzinsky (1955)	
Groot Brakrivier	1970	-34.050	22.233		Wygodzinsky (1970)	
Jeffreys Bay	1971	-34.050	24.917	4-XII-1993	L.N. Lotz	BMSA
Bontebok National Park	1972	-34.067	20.450	30-X-1987	Ent. Dept.	BMSA
Viljoenspas	1973	-34.083	19.067		Wygodzinsky (1955)	
Aalwynkop, Bontebokpark	1974	-34.083	20.450	8-X-1996	J. Irish	BMSA
Muizenberg	1975	-34.100	18.467	7-XII-1993	J. Irish	BMSA
Mosselbaai	1976	-34.183	22.133		Wygodzinsky (1955)	
Landplaas	1977	-34.200	20.567	8-X-1996	J. Irish	BMSA
Uitkyk	1978	-34.217	20.233	13-V-1996	J. Irish	BMSA
Swartheuwel	1979	-34.217	21.167	10-X-1996	J. Irish	BMSA
Botrivier, 6 km S	1980	-34.250	19.217	27-VIII-1983	S. Endrödy-Younga (EY1980)	TMSA
Sirkelsvlei	1981	-34.267	18.417	30-III-1995	H.G. Robertson	SAMC
Smitswinkelvlakte	1982	-34.283	18.433	19-IX-1995	J. Irish	BMSA
Cape Point	1983	-34.333	18.450		Wygodzinsky (1955)	
Droëvlei	1984	-34.333	21.783	1-XI-1995	J. Irish	BMSA
Stilbaai-Oos	1985	-34.367	21.417	9-XII-1991	J. Irish	BMSA
Mosselberg, Fernkloof Nat. Res	1986	-34.383	19.267	12-III-1995	S. van Noort	SAMC
Bredasdorp, 20 mi. ENE	1987	-34.383	20.317		Wygodzinsky (1955)	
Rooivlei	1988	-34.400	20.150	12-V-1996	J. Irish	BMSA
De Hoop Vlei at Windhoek Farm	1989	-34.400	20.333		Wygodzinsky (1955)	
The Potteberg Estates at:	1990	-34.400	20.717	29-X-1987	Ent. Dept.	BMSA
Infanta, W at:	1991	-34.400	20.750	9-X-1996	J. Irish	BMSA
Salmonsdam	1992	-34.433	19.633	11-V-1996	J. Irish	BMSA
De Hoop	1993	-34.450	20.400	9-X-1996	J. Irish	BMSA
Afsaal	1994	-34.667	19.517	21-V-1986	J. Irish	NMNW, IICT
Arniston	1995	-34.667	20.217		Wygodzinsky (1955)	
Arniston	1996	-34.667	20.217	22-V-1986	J. Irish	NMNW
Bushy Park	1997	-34.683	20.117	28-VIII-1983	S. Endrödy-Younga (EY1992)	TMSA
Brandfontein Nature Res.	1998	-34.767	19.883	15-VIII-1992	H.G. Robertson	SAMC
Struisbaai	1999	-34.800	20.033	27-VIII-1983	S. Endrödy-Younga (EY1990)	TMSA
SWAZILAND						
Mbabane	2000	-26.317	31.117	27-XII-1980	A.J. van Schalkwyk	UOVS
TANZANIA						
Makuyuni	2013	-3.550	36.102		Wygodzinsky (1965)	
Katesh	2014	-4.526	35.385		Wygodzinsky (1965)	
Ngorongoro Crater	2015	-3.162	35.588		Wygodzinsky (1965)	
ZAMBIA						
Kasama, 11 mi N	2001	-10.083	31.233		Irish (1988c)	
Kanona, 32 mi NE	2002	-12.783	30.867		Irish (1988c)	
Xanadu Farm, Lusaka	2003	-15.383	28.317	I-1987	R.J. Nefdt	SAMC
Livingstone, Zambesi River below Victoria Falls	2004	-17.933	25.867		Wygodzinsky (1955)	

Locality	No.	Latitude S	Longitude E	Date	Collector(s) or publication	Collection
ZIMBABWE						
Siabuwa Comm. Lands at:	2005	-17.333	28.067	24-VI-1988	C.C.D. Tingle	BMSA
Mazoe Estates	2006	-17.467	31.017	12-XII-1987	H.G. Robertson	SAMC
Salisbury [now Harare]	2007	-17.833	31.033	1937	C. Cuthbertson	SAMA
Drechin, near Cricket	2008	-18.633	29.633		Wygodzinsky (1955)	
3 km S of Hot Springs	2009	-19.683	32.450	2-VII-1972	E.S. Ross	CAS
54 mi. S of Umtali [now Mutare]	2010	-19.683	32.483	18-III-1958	E.S. Ross, R.E. Leech	CAS
Kyle View Chalets	2011	-20.250	31.000	30-XI-1987	H.G. Robertson	SAMC
Jessie, 5 mi. WNW West Nicholson	2012	-21.067	29.300		Wygodzinsky (1955)	

A spatial and temporal assessment of human-snake conflicts in Windhoek, Namibia

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ABSTRACT

Conflict between snakes and people in urban areas is a problem Windhoek shares with many cities around the world. Surrounded by farm and natural land, the capital city of Namibia experiences regular snake occurrence in and around houses, gardens and industrial sites. We analysed snake removal data from the city's designated snake removal institution, Snakes of Namibia, in order to determine abundance and diversity of snakes occurring in the city during the summer of 2015-2016, and identify possible reasons for conflicts. Over the period August 2015 to April 2016, 182 snakes of 12 species were removed from homes, gardens and industrial sites in the city. Puff adder (*Bitis arietans arietans*) and zebra snake (*Naja nigricincta*) which represented 35% and 29% respectively of all removal incidents. Of the other species, only brown house snake (*Boaedon capensis*) and boomslang (*Dispholidus typus viridis*) accounted for more than 6% of removals. Monthly snake removals correlated highly with monthly total rainfall, with highest number of incidents reported in January 2016 (23%, n=41). Incidents were concentrated in the eastern and southern suburbs, as a result of garden irrigation although the study could not measure whether reporting diligence was consistent across all suburbs. Although 81% (n=147) of snake incidents involved venomous species no snakebite incidents were reported during the period.

Keywords: human-snake conflict; Namibia; Serpentes; snakes; spatial; Windhoek

INTRODUCTION

Human-wildlife conflict is rising globally as wildlife populations increase in urban environments, mainly as a result of the expansion of urban areas which encroach on wildlife habitat (Madden 2004). This results in increased competition for resources such as food and space (Kaplan et al. 2011). Mostly seen as a rural problem in Namibia, research and management of human-wildlife conflict focuses on predator-livestock conflict (Dickman et al. 2013, Weise et al. 2015) and mega-herbivore-cultivation agriculture conflict (Hoare 2015). No studies have been published on urban snake occurrences in Namibia, which are perceived as a safety concern to humans, as 16% (n=14) of Namibia's snake species are known to be highly venomous and life threatening. Historically, the most commonly observed response to snake occurrences in and around Windhoek has been people killing snakes in homes, gardens and workspaces. This, together with habitat destruction and fragmentation in the fast-growing city and surrounding areas (Namplace 2016), could be a conservation concern for populations of endemic snake species known to occur in the area. In addition, attempting to kill snakes increases the risk of humans being bitten, by threatening snakes into defensive envenomation.

There are 1,654 described species of reptiles in Africa (Reptile Database 2016) with the highest diversity being in southern Africa (Branch 1999). Of these, 261 species occur in Namibia (Simmons et al. 1998), and 78 in the greater Windhoek area (Envirodynamics 2009). Snakes account for 86 species (Herrmann & Branch 2013) of which 36 are expected to occur in the larger Windhoek area (this includes blind, thread, python, burrowing and typical snakes) (Envirodynamics 2009). Of these, eight are regarded as endemic to Namibia, but none are known to be under threat (Simmons et al. 1998).

Snakes and humans cohabitate in many parts of the world, from rural to urban environments (Butler et al. 2005). In some cases snakes may even prefer areas with human activity over truly natural habitats (Shine & Fitzgerald 1996, Clemann et al. 2004). In order to reduce persecution of snakes, and reduce human envenomation risk, a voluntary group (Snakes of Namibia) removes and relocates snakes from potential conflict sites in and around Windhoek.

This study analysed ecological and morphological data from human-snake conflict events over a nine-month period (August 2015 to April 2016) to provide insight into the possibility of deriving scientifically sound ecological and biometric information about this understudied taxon. This helps to improve the knowledge of reptiles in Namibia, a subject largely neglected in ecology of the continent (Tolley et al. 2016). The study further explored the value of the information in reducing human-snake conflict in and around Windhoek.

METHODS

Study Area

Windhoek has a rapidly growing population of over 350,000, with a growth rate of 40% between 2001 and 2011 (Namibia Statistics Agency 2011). It is situated in the Highland Shrubland vegetation type of the Tree and Shrub Savanna Biome, which is characterised by low, unpredictable rainfall (350-400 mm) (Mendelsohn at al 2002). Dominant woody species include a number of *Acacia* (*sensu lato*) species (e.g. *Acacia mellifera*, *A. hebeclada*, *A. hereroensis*) while climax grass species are dominated by *Anthephora pubescens*, *Brachiaria nigropedata*, and *Heteropogon contortus* (Joubert et al. 2008). It is surrounded by the Auas and Eros mountains, areas identified as hosting a high number of endemic vertebrates (Griffin 2000).

Methodology

The non-profit organisation, Snakes of Namibia, has been removing reptiles from urban areas in greater Windhoek since late 2013. With the service well known by 2015 and officially reported as such in local media and by Windhoek emergency services as well as the Ministry of Environment and Tourism (Windhoek Observer 30 April 2015, Travel News 22 January 2015), snake reports from Snakes of Namibia as of the spring of 2015 were considered to be relatively representative of overall human-snake conflicts during this period. Relying on reporting to accurately reflect incident frequency and density should, however, be considered with caution as not all incidents are reported. Another human-wildlife conflict activity (bird strikes) in greater Windhoek, found only 25% of all incidents were reported even though reporting was a statutory requirement (Hauptfleisch et al. 2013). The true number of human-snake conflict incidents are likely to therefore be much higher than those reported.

Biometric data captured were snout-vent length, maximum girth and mass, while the air and ground temperature at the point of capture were also recorded.

RESULTS

Species Captured

Between August 2015 and April 2016, 182 snakes of 12 species were removed from residential and industrial sites in and around Windhoek. Species most encountered were *Bitis arietans arietans*, which represented 36% (n=65) of incidents and *Naja nigricincta*, 29% (n=53) (Table 1). Of the other species, only *Boaedon capensis*, 12% (n=21) and *Dispholidus typus viridis*, 9% (n=17) accounted for more than 9% of incidents. Of the above, 177 individuals were sexed, of which 57% (n=101) were females and 43% (n=76) were males. Of particular interest was the preponderance of males in *B. a. arietans* (63%) and females in *N. nigricincta* (83%).

Temporal Patterns

The highest numbers of snakes were removed in January 2016 (23%, n=41), with a clear increase from August 2015, which had the lowest number removed (2%, n=4), and a decreasing trend after January 2016, generally following the monthly rainfall pattern (Figure 1). For the five most reported species, the numbers correlated significantly with monthly

Table 1: *Snakes relocated from residential and industrial sites in the greater Windhoek area between August 2015 and April 2016*

Common name	Scientific name	n	%	Un-sexed	Female n	Male n	Female %	Male %
Anchieta's Cobra	*Naja anchietae*	9	5.0	0	8	1	88.9	11.1
Anchieta's Dwarf Python	*Python anchietae*	1	0.6	0	1	0	100.0	0.0
Black Mamba	*Dendroaspis polylepis*	3	1.7	0	1	2	66.7	33.3
Boomslang	*Dispholidus typus viridis*	17	9.3	0	10	7	58.8	41.2
Brown House Snake	*Boaedon capensis*	21	11.5	1	9	11	45.0	55.0
Leopard Whip Snake	*Psammophis leopardinus*	1	0.6	0	1	0	100.0	0.0
Mole Snake	*Pseudaspis cana*	3	1.7	0	0	3	0.0	100.0
Puff Adder	*Bitis arietans arietans*	65	35.7	2	22	41	34.9	65.1
Southern African Python	*Python natalensis*	2	1.1	0	1	1	50.0	50.0
Spotted Bush Snake	*Philothamnus semivariegatus*	3	1.7	0	2	1	66.7	33.3
Western Stripe-bellied Sand Snake	*Psammophis subtaeniatus*	4	2.2	0	2	2	50.0	50.0
Zebra Snake	*Naja nigricincta*	53	29.1	2	44	7	86.3	13.7
	Total number relocated	**182**		**5**	**101**	**76**		

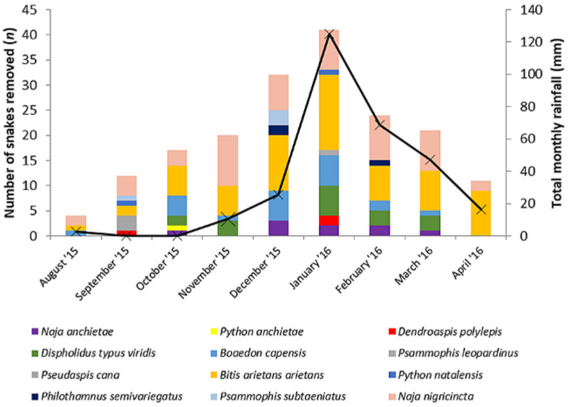

Figure 1: *Monthly variations in species and numbers of snakes removed from residential and industrial sites in the greater Windhoek area and monthly rainfall for the same period.*

rainfall for *B. a. arietans* (r=0.76, df=7, p<0.05) and *D. t. viridis* (r=0.82, df=7, p<0.01). For *N. anchietae* (r=0.58, df=7, p>0.05), *N. nigricincta* (r=0.55, df=7, p>0.05) and *B. capensis* (r=0.51, df=7, p>0.05) the correlation was positive but not significant.

Bitis a. arietans was the most commonly removed species in four months of the nine-month period (October, December, January and March), and jointly highest number with *N. nigricincta* in February (n=8). *Naja nigricincta* was the second most abundant species, dominating removals in August, September, November and February. There was no temporal trend to the dominance of either species.

Spatial Patterns

Figure 2 displays the location and Figure 3 the density of human-snake incidents over the study period. Only 18% (n=33) of snakes were found in buildings, with the remaining being found in gardens, on pavements or roads, as well as unspecified locations. Of 163 recorded locations, the suburb of Eros had the highest occurrence (n=26, 16%), followed by Ludwigsdorf (n=16, 10%) and all other suburbs between one and ten incidents each.

Morphological and Environmental Findings

Table 2 summarises the environmental temperature and biometric data of the five most commonly removed species. The high standard deviation in mass and measurements indicates that juveniles and adults were removed. Of the five most commonly removed species *B. a. arietans* favoured the coolest ground temperatures, significantly cooler ($Z_{4,128}$=3.05, p=0.005) than *N. nigricincta*. A similar trend was noted with air temperature, although this was marginally not statistically significant ($Z_{4,128}$=1.64, p=0.058). *Naja anchietae*, *D. typus viridis* and *B. capensis* were captured in a wide variety of air (24.3˚C to 39.1˚C) and ground (22.1˚C to 44.1˚C) temperatures.

DISCUSSION

The 12 species involved in human-snake conflict incidents during the nine-month reporting period represent 33% of the 36 species of snakes expected to occur in the greater Windhoek area (Envirodynamics 2009). The only previously published data on reptile observations in the area (Envirodynamics 2009) confirmed 12 out of the 36 expected species. Five species observed by Envirodynamics (2009) which were not reported during this study were *Lycophidion capense* (Cape wolf snake), *Psammophylax tritaeniatus* (striped grass snake), *Psammophis namibensis* (Namib sand snake), *Telescopus semiannulatus polystictus* (Damara tiger snake) and *Naja nivea* (Cape cobra). We were, however, able to add *Psammophis leopardinus*, *Philothamnus semivariegatus* and *D. typus viridis* to confirmed observations from the area. *Psammophis subtaeniatus*, *N. anchietae* and *Dendroaspis polylepis* had not been observed or reported previously in Windhoek or surrounding areas (Envirodynamics 2009). The dissimilarity between this study and the previously published records may be indicative of the low intensity of sampling and research of Namibian reptiles (Bauer 1992). It may also be due to changes in the snake community of the area, a factor that will only be confirmed after a few years of similar analysis, as this study presents the baseline.

Of the 182 snake conflict incidents reported, 81% (n=147) were with venomous species, indicating the potential impact of the conflict on human safety. Despite this, none of the incidents led to bites (Dr. C. Buys pers. comm.). An estimated 1.8 million snakebites occur annually throughout the world, and sub-Saharan Africa is, together with South and South-east Asia, responsible for most incidents (Kasturiratne et al. 2008). Envenomation risk is often highest for humans deliberately exposing themselves to the snakes in order to catch or kill them without the necessary equipment and training (Morandi & Williams 1997). By reporting snake observations to Snakes of Namibia, it likely prevented homeowners from this deliberate exposure and risk of envenomation. Envenomation risk to snake handlers was reduced through regular snakebite handling refresher training and mandatory use of approved snake handling tools (hooks, tongs, tubes).

Overall, 101 female snakes of all species were removed compared to 76 males. This may be attributed to differences found in the movement patterns of sexes in some species in relation to

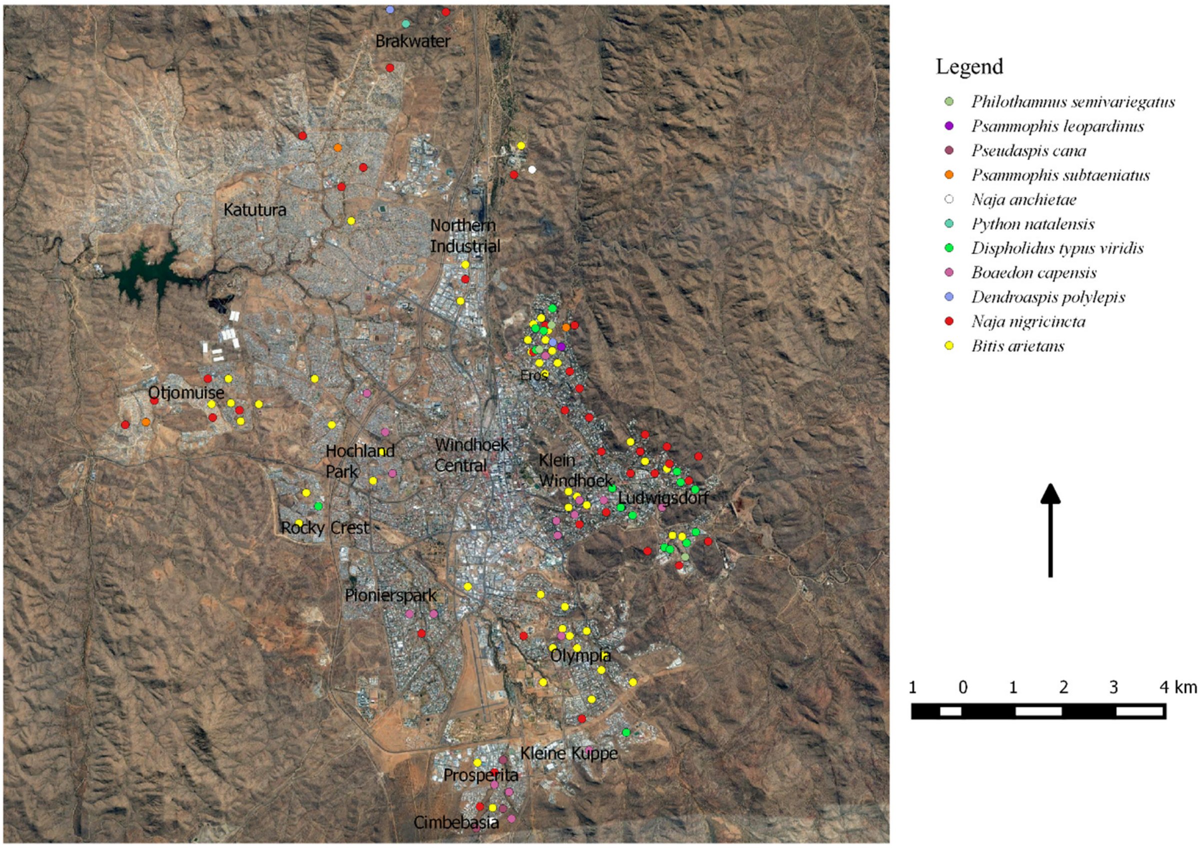

Figure 2: *Location of snake removals in Windhoek (August 2015 to April 2016)*

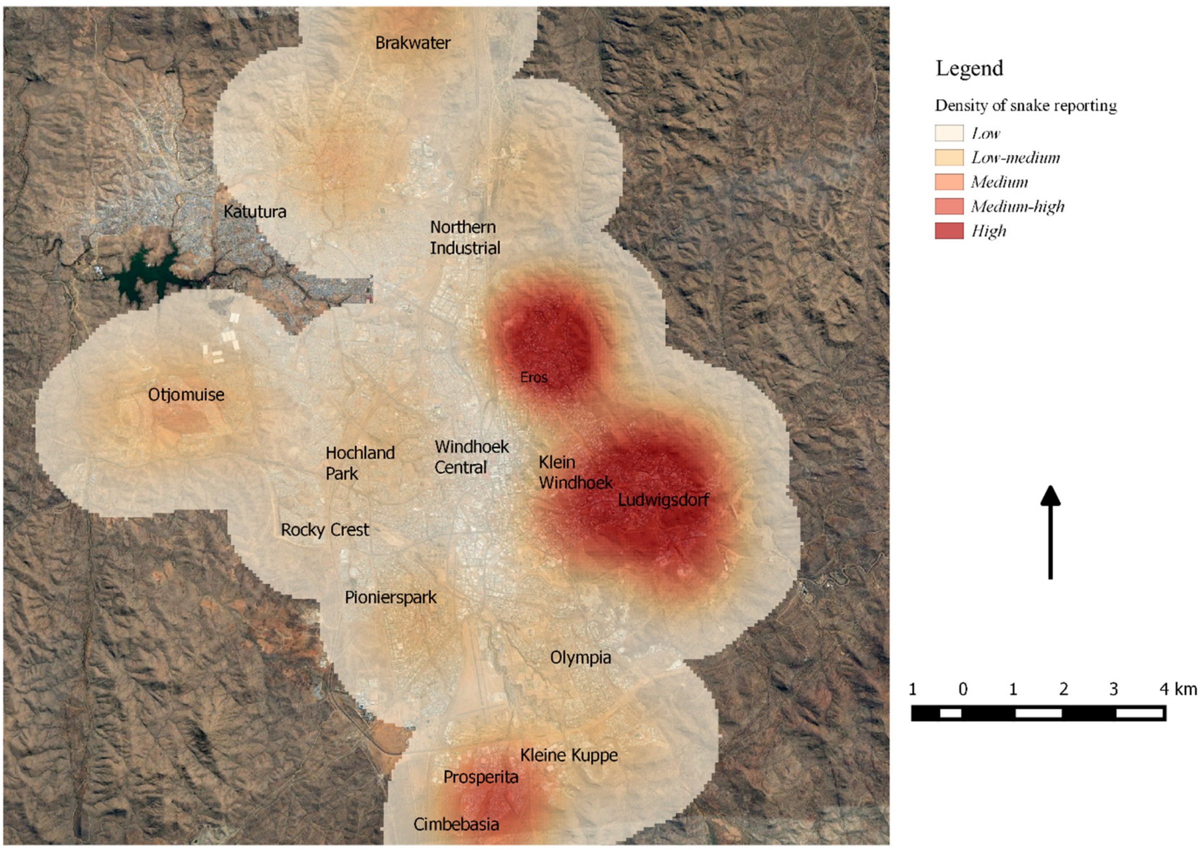

Figure 3: *Density of snake removals in Windhoek (August 2015 to April 2016)*

climate and food availability (Shine 1987, Shine & Lambeck 1990). For the most commonly removed snake, male *B. a. arietans* were removed twice as often as females. This may be a result of their higher activity in search of mates or in defence of territory (Shine & Lambeck 1990). For the next most common species found in this study, *N. nigricincta*, female removals were six times more common than males. This disparity may be attributed to females seeking sheltered nesting sites.

The strong correlation between snake conflict incidents and rainfall could be attributed to reptiles' inactivity in times of drought (Shine & Lambeck 1990, Whitaker & Shine 2002, Luiselli 2008) when food is scarce. This is particularly appropriate in Windhoek's xeric climate.

A concentration of incidents in the eastern suburbs corresponds with high income housing areas (New Era Newspaper 2015) such as Eros and Ludwigsdorf, characterised by large irrigated gardens on the outskirts of town. The third area of concentrated reportings in the south is varied land use (light industrial in Prosperita, and middle income residential in Cimbebasia). Artificial habitat diversity as a result of the mixed land use could explain the high concentration of snake occurrence, with species richness being high (n=5) in relation to the number of incidents (n=11). Prosperita also borders the Windhoek golf course, where the irrigation and vegetation cultivation has been found to result in an increased abundance of rodents (Hauptfleisch & Avenant 2015). The spatial distribution of snake incidents in Windhoek may, however, be heavily influenced by the diligence of residents to report such incidents. Although the city raises awareness regarding the snake removal service (Nhongu 2015), people are still likely to kill snakes (Envirodynamics 2009) and not alert the authorities.

A high variance in the mass, snout-vent length and girth of the five most commonly reported species indicates that both young and adults of a particular species frequented the urban habitats. *Naja anchietae* endured the highest variance in air and ground temperature, indicating that they were not particularly seeking the urban habitats for thermoregulation. *Bitis a. arietans* showed a significant preference for cool air and ground temperatures in or around the shelter of garden and building structures.

The analysis of snake removal data may be useful in reducing human-snake conflict or its consequences in the Windhoek area. Understanding snake activity patterns in relation to environmental factors can inform changed human behaviour and activity to minimise snakebite risk (Akani et al. 2013). Similarly, co-occurrence data can be used to predict areas where venomous species are likely to be encountered. Annual snake community occurrence (spatial and temporal) can also inform antivenom development, production and storage for most commonly encountered venomous species. Antivenom production is costly (Morais & Massaldi 2006) and has not yet been developed for *N. nigricincta* (Muller et al. 2012), the second most commonly reported snake in Windhoek. The city is severely water stressed (van Rensburg 2016) and hydrophilic lawns and gardens are discouraged. The indicated preference of snakes for the irrigated gardens of wealthier suburbs provides an added incentive to residents and landscapers to promote xerophytic garden development

We did not consider the fate of the relocated snakes, however Butler et al. (2005) found that relocated snakes would still often occupy areas with human habitation, although their home ranges were found to be considerably larger post-relocation. This aspect will need to be addressed to determine the conservation benefit snake relocation holds. The rapid expansion of Windhoek (Namibia Statistics Agency 2011) will likely have a negative impact on its biodiversity (Envirodynamics 2009). Comparing future "snake season" removal data for the city with this study will supplement biodiversity monitoring for the city, as snakes are known to be useful indicators of community structure (Luiselli 2008) and as ectotherms, climate change (Herrmann & Branch 2013). Furthermore, analysing the genomics of removed snakes would provide a valuable baseline of population genetic structure, as no such information is available at population level in Namibia (Herrmann & Branch 2013).

CONCLUSION

With 182 human-snake conflict incidents reported over the summer of 2015-2016, and over 80% of incidents involving venomous snake species, it is clearly a serious type of human-wildlife conflict, generally ignored by the conservation and wildlife community in Namibia. Puff adder (*B. a. arietans*) and zebra snake (*N. nigricincta*) were by far (64%) the most common snakes removed, with a further 10 species being responsible for the remaining 36% of urban snake removals. Most removals were from the eastern and southern high-income and multiple-use suburbs of Windhoek, and were most frequent in high-rainfall months.

ACKNOWLEDGEMENTS

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Snakes of Namibia about snake occurrences. We also thank Dr. Christo Buys, Windhoek health-care practitioner, for information on snake-bite incidents in Namibia.

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Determining rehabilitation effectiveness at the Otjikoto Gold Mine, Otjozondjupa Region, Namibia, using high-resolution NIR aerial imagery

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ABSTRACT

Mine rehabilitation is compulsory under the Namibian Environmental Management Act. B2Gold's Otjikoto gold mine complies by committing to rehabilitation of their waste-rock dumps and other disturbance features within their mining licence area in the Otjozondjupa Region. As the mine is in the early stages of operation and has committed to run-of-mine rehabilitation, there have been some rehabilitation attempts. Initial rehabilitation of an abandoned section of a district gravel road (D2808) and the western face of a waste rock dump (known as SP11) has been undertaken. Rehabilitation measures included ripping of the soil surface of the gravel road as well as covering the ripped soil surface and the waste rock dump slopes with stored topsoil removed from the first mining cut before it was excavated. We investigated the extent of vegetation establishment of these rehabilitation measures with the aid of high-resolution near infra-red aerial imagery coupled with ground-based observations on established plant biomass. It was evident that simple ripping of the road surface allowed limited establishment of grasses, which was greatly improved if the ripped surface was covered by stockpiled topsoil. Likewise, covering the waste rock dump with topsoil resulted in the natural establishment of various grasses, but also the leguminous shrubs *Dichrostachys cinerea* and *Mundulea sericea*. Erosion of the applied topsoil on the waste rock slope was, however, found to limit vegetation establishment. The natural establishment of both *Dichrostachys cinerea* and *Mundulea sericea* indicates a high potential for these species to be used for basic stabilisation of the slopes, possibly enabling colonisation by a variety of other species which we have listed. Several techniques published to aid the stabilisation of the slopes and establishment of vegetation cover were also reviewed and contextualised for Namibian conditions.

Keywords: *Dichrostachys cinerea;* gravel road rehabilitation; *Mundulea sericea;* natural revegetation; NDVI; waste rock dump rehabilitation

INTRODUCTION

Open-cast mining is known to have a destructive effect on the environment. Next to the physical destruction of habitats for mining and associated infrastructure, add-on effects like wind and rain erosion, dust generation, seepage of toxic wastes (including heavy metal pollution) and ground water contamination are common problems (Hahn et al. 2004, Navarro et al. 2008, Sheoran et al. 2010, Mapaure et al. 2011, Kossoff et al. 2014). Under the Mine Closure Framework, members of the Namibia Chamber of Mines subscribe to timely establishment and implementation of a closure plan for any particular mine. From an environmental perspective, this Mine Closure Framework prescribes to "protect public health and safety and the environment by using safe and responsible closure practices; reduce or eliminate adverse environmental effects once the mine ceases operations; establish conditions that are consistent with the predetermined end-use objectives and reduce the need for long-term monitoring and maintenance by establishing effective physical, chemical and ecological stability of disturbed areas" (Chamber of Mines of Namibia 2010). Legally, the reduction of mining impacts on the environment in Namibia is required for a licence to operate under the Environmental Management Act 7 of 2007 (Government of the Republic of Namibia 2007) and the Minerals (Mining and Prospecting) Act 33 of 1992 (Government of the Republic of Namibia 1992). Implicitly, this includes effective mine restoration or rehabilitation.

Effective mine-site restoration requires an understanding of the purpose of land use after mine closure, functioning of the landscape, and consequently an agreed set of targets between different stakeholders of what needs to be achieved post-mining (Chamber of Mines of Namibia 2010, Tongway & Ludwig 2012). Restoration is defined as "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability" (Society for Ecological Restoration Science & Policy Working Group 2002). Depending on the severity of degradation, the resilience of the ecosystem and the set restoration targets, different categories of restoration are recognised: (i) near-natural restoration; (ii) ecological restoration; (iii) ecological rehabilitation and (iv) reclamation. Whereas restoration aims at returning the ecosystem to a pre-disturbance state, rehabilitation aims at improving ecosystem functionality without necessarily returning to the pre-disturbance state (van Andel & Aronson 2012). Reclamation is often achieved by merely doing basic physical shaping to reduce visual concerns. Given the nature and severity of open-cast mining operations, a mine closure plan would mostly not be able to achieve much more than basic reclamation, although at a more local scale some parts of a mining footprint should achieve rehabilitation or ecological restoration if effectively managed.

To fulfil their statutory obligation and implement best practice rehabilitation the Otjikoto Gold Mine initiated experimental rehabilitation efforts on its SP11 waste rock dump, as well as an abandoned section of the district gravel road (number D2808) in the mining area within two years of commencing mining operations. Best practice dictates that reclamation and restoration activities do not only commence post-mining but integrate into run-of-mine activities (Cooke & Johnson 2002). The targets of this reclamation were to prevent dust generation from the surface, as well as preventing water erosion of the waste rock dump slopes.

The aim of this study was to assess the effectiveness of vegetation establishment (considering spatial homogeneity) on the SP11 waste rock dump and the abandoned D2808 road section using high resolution Unmanned Aerial Vehicle (UAV) visual and near infra-red (NIR) imagery, ground-truthed with on-site physical surveys.

METHODS

Study Site

The Otjikoto Gold Mine is situated in the Otjozondjupa Region of Namibia along the B6 road north of Otjiwarongo towards Otavi (Figure 1). The natural vegetation belongs to the Thornbush Savanna *sensu* Giess (1998). The vegetation can best be described as densely encroached, closed tall bushland *sensu* Edwards (1983) (own observation). The tree and shrub layers are dominated by various *Acacia* (*sensu lato*) species, specifically *A. mellifera* subsp. *detinens* and *A. luederitzii*. *Dichrostachys cinerea*

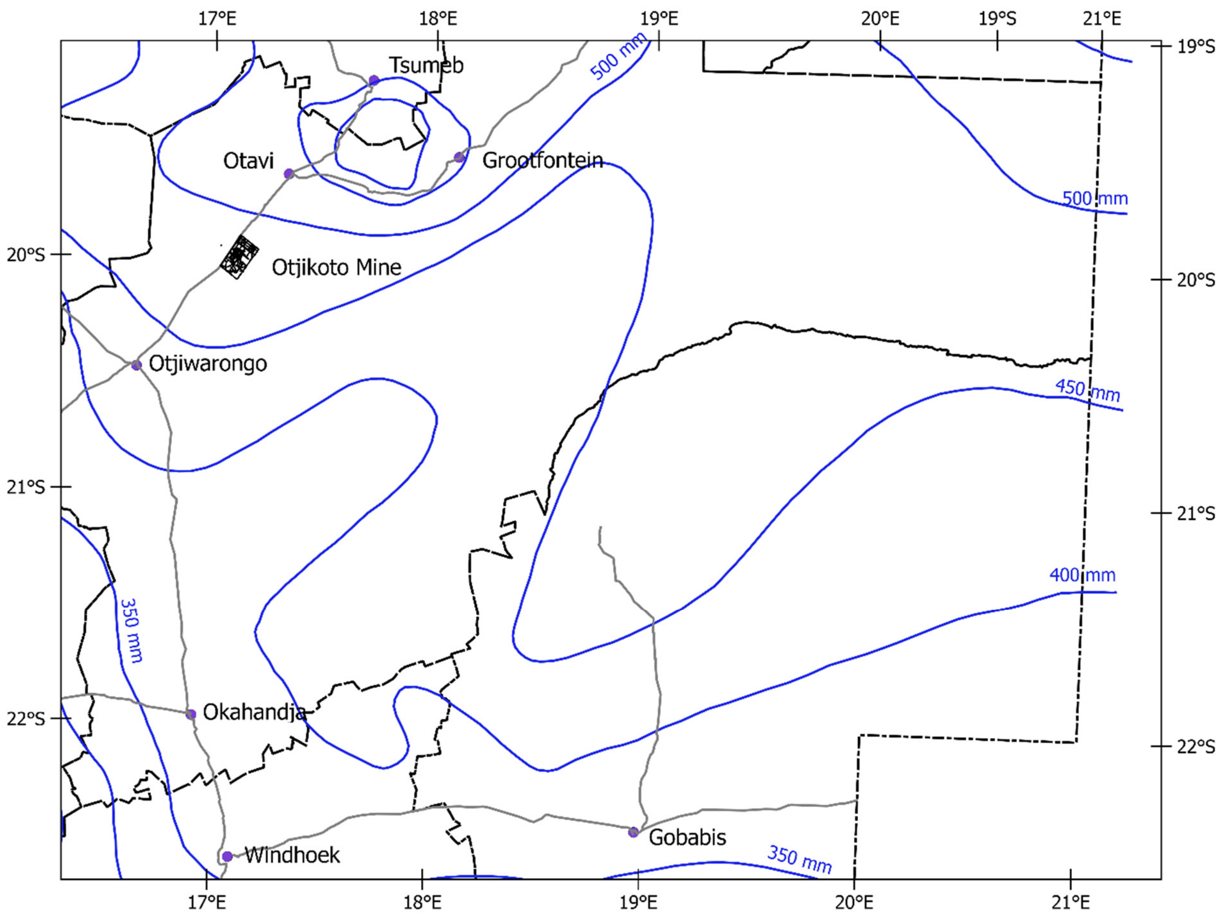

Figure 1: *General position of the Otjikoto Mine in the Otjozondjupa region, central Namibia. The average annual rainfall is indicated in blue. Data source: NARIS (2001).*

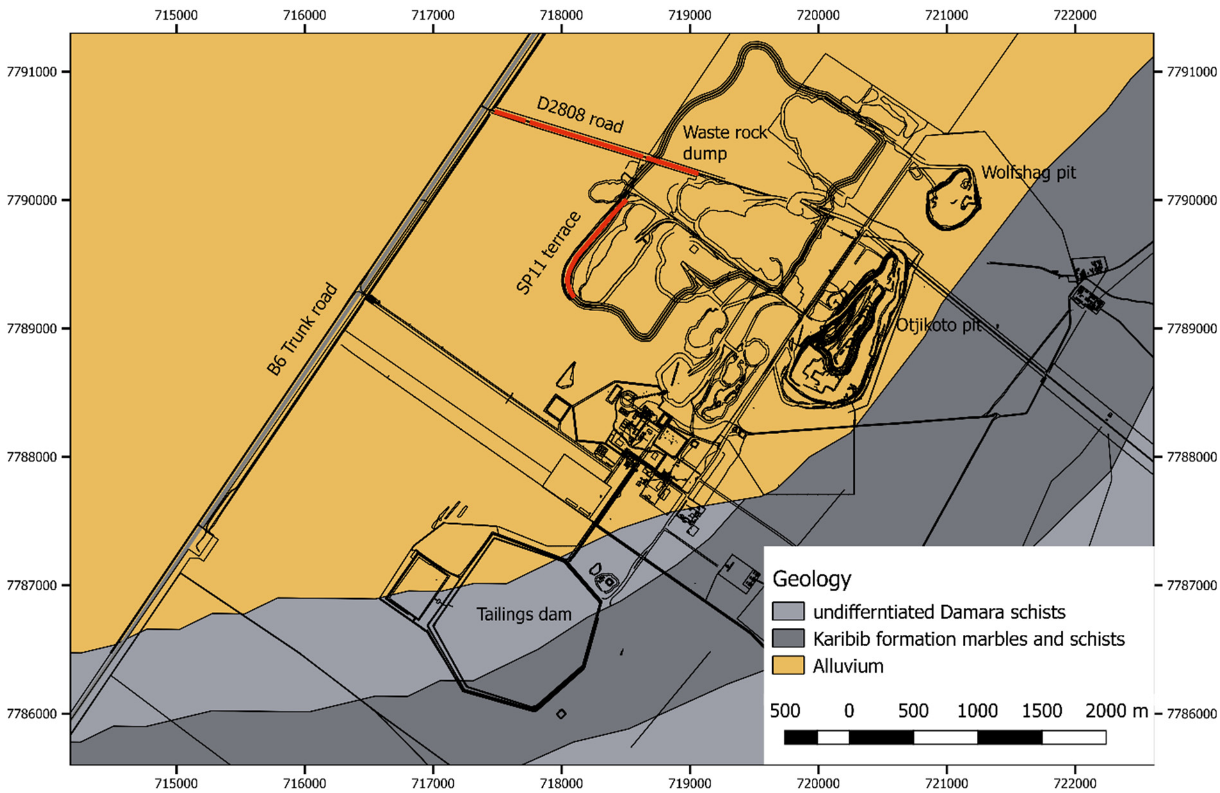

Figure 2: *Overview of the Otjikoto Mine, indicating the basic surface geology. The study areas for this paper are indicated in red. Geological data source: Geological Survey (1980).*

and *Catophractes alexandri* are also common. With occasional *Terminalia prunioides* trees, this vegetation forms a transition to the Karstveld *sensu* Giess (1998) further north.

The open-cast mine pit (Otjikoto Pit) is situated on rocks of the Karibib formation, with mostly marbles, schist and ortho-amphibolite (Geological Survey 1980). The study site (SP11 waste rock dump and abandoned section of the D2808 gravel road) is on an alluvial plain to the west of the pit, dominated by mollic leptosols (i.e. shallow, stony, dark, fine-grained soils over a petro-calcic horizon) as dominant soil type (ICC et al. 2000) (Figure 2). The climate is semi-arid with summer rainfall, with a mean annual precipitation of between 450 and 500 mm. Rainfall is generally between December and April each year (Mendelsohn et al. 2002).

Abandoned road and waste rock rehabilitation sites

A section of the original district road (number D2808) was relocated northwards in 2013 as its route crossed the mining area (Figure 2). The road was originally constructed with readily available calcrete gravel, which was compacted. The unaffected section of the road within the mining area, not impacted by excavation, was partially reclaimed in December 2016 under the mine environmental management programme (Figure 3). The entire road surface was ripped with a bulldozer, and stored topsoil was used to cover the ripped road surface (ca 8 to 9 m wide), but not the adjacent road reserve. Topsoil covering varied amongst the different sections as detailed in Table 1.

The SP11 waste rock dump (Figures 2 and 6) was formed from the ore-bearing marble crush and overburden material extracted from the initial Otjikoto pit. The dump was terraced, with 20 m high terraces sloped at 18°, interspersed with 5 m horizontal benches. The lower terraced slope, once completed, was horizontally ripped and covered with a 15 cm layer of soil removed from the Otjikoto pit before mining in 2013. Section WRD2015 was covered in December 2015 and Section WRD2016 in December 2016 and January 2017 (Figure 6).

The Wolfshag and Otjikoto topsoils differ in that Wolfshag topsoil is a deeper soil (up to 70 cm deep) with less calcrete than the soils from Otjikoto. Both the Wolfshag and Otjikoto topsoils are sandy loams (19% clay content, 62% and 69% sand content for Otjikoto and Wolfshag respectively). The soils both have a fairly high pH of 8.4 to 8.5 and an electric conductivity of 166 µS/m and 142 µS/m for Otjikoto and Wolfshag respectively (Diener 2018).

Table 1: *Segments identified along the abandoned part of the D2808 gravel road, with their treatment. Positions are given as UTM Zone 33S co-ordinates.*

	Western extent	Eastern extent	Length (m)	Treatment
Section 1	717488.3, 7790687.7	717739.0, 7790611.1	262.1	Ripped road surface, covered unevenly to 15 cm depth with topsoil from Wolfshag Pit area using a bulldozer to spread
Control	717739.0, 7790611.1	717944.8, 7790548.1	215.2	Ripped road surface, no topsoil cover
Section 2	717944.6, 7790548.1	718345.8, 7790425.4	419.5	Ripped road surface, covered with topsoil from Wolfshag Pit area to more than 30 cm depth, graded
Section 3	718345.8, 7790425.4	718660.8, 7790329.5	329.3	Ripped road surface, covered with topsoil from Wolfshag Pit area to approximately 15 cm depth, graded
Section 4	718670.8, 7790326.2	719137.2, 7790183.4	487.8	Ripped road surface, covered with topsoil from Wolfshag Pit area to approximately 15 cm depth, graded

Drone survey

An aerial survey of the D2808 and the waste rock dump was undertaken on 22 March 2017. For the purpose, four flights with an eBee (Sensefly) were undertaken. Each site was flown twice, once with a Canon G9X Red-Green-Blue (RGB) camera, the second flight with a Canon S110 camera modified for Near Infra-Red (NIR) photography. The G9X camera records regular colour photos (RGB) at 450 nm (blue), 520 nm (green) and 660 nm (red). The S110 camera has been modified to record at 550 nm (green), 625 nm (red) and 850 nm (NIR) (senseFly 2014, 2016). The weather was partially cloudy, with an easterly wind between 3 and 6 m/s. The aerial photos were stitched into an orthophotograph with Pix4D software (*Pix4Dmapper Pro* 2016), without using any ground control points. Georeferencing thus relied solely on GPS locations tagged to the individual images by the drone autopilot. Flight and image characteristics are detailed in Table 2.

Aerial image analysis and data extraction

During stitching the individual images to an orthophoto with Pix4D, a digital surface model (DSM) is created. The RGB orthophoto was only used for visual interpretation and not processed further. From the NIR image colour indices for the three bands (red, green and NIR) were calculated, and from these the two vegetation indices NDVI (Tucker 1979, Bannari et al. 1995) and Modified SAVI (Qi et al. 1994a) were created. The original Soil Adjusted Vegetation Index (SAVI) (Huete 1988) was developed to compensate for differing background soil brightness, especially in situations with low vegetation cover. However, this index depends on a (known) soil brightness factor *L*, and on the degree of vegetation cover. With this dependability in mind, Qi *et al.* (1994) developed a way in which the *L* factor could be calculated from the NIR and red reflectance, thus negating the need to independently determine the value of *L*. This Modified SAVI (or MSAVI2) is relatively insensitive to soil brightness, and thus more effective than the NDVI in situations of low vegetation cover, i.e. with a Leaf Area Index (LAI) of below 1.2 (Qi et al. 1994b). For comparison, an LAI of 1.2 corresponds to between 48% canopy cover in maize fields and 58% canopy cover in wheat fields (Nielsen et al. 2012).

The RGB images were used as a baseline map in QGIS (*QGIS 2.14.5-Essen* 2016). As the Pix4D

Table 2: *Flight and photograph characteristics during the aerial survey of an abandoned section of the D2808 road as well as the waste rock dump at Otjikoto Mine.*

	Flight 1	Flight 2	Flight 3	Flight 4
Target	D2808	D2808	Waste Rock Dump	Waste Rock Dump
Camera	S110 (NIR)	G9X (RGB)	G9X (RGB)	S110 (NIR)
Start of flight	15h22	16h05	16h32	16h59
Flight duration	19 min 20 sec	18 min 34 sec	19 min 50 sec	22 min 44 sec
Planned ground sampling distance	5 cm	5 cm	5 cm	5 cm
Average altitude	143 m	211 m	211 m	143 m
Planned individual image footprint	200.0 x 150.0 m	273.6 x 182.4 m	273.6 x 182.4 m	200.0 x 150.0 m
Planned lateral / longitudinal overlap of images	60% / 75%	60% / 75%	60% / 75%	60% / 75%
No of photos taken	222	191	167	221
Sun azimuth (A_Z) (Hoffmann 2015)	296.4°	288.9°	285.2°	282.0°
Sun elevation (β) (Hoffmann 2015)	49.2°	39.8°	33.8°	27.6°
Shadow length per 1 m height (Hoffmann 2015)	0.86 m	1.20 m	1.50 m	1.91 m
Area covered	128.137 ha	178.731 ha	128.172 ha	105.587 ha
Resulting image quality: Average ground resolution	5.08 cm	4.7 cm	4.61 cm	4.82 cm
Resulting image quality: RSM error	X: 0.6223 m Y: 0.4636 m Z: 1.5477 m	X: 0.6063 m Y: 0.2747 m Z: 1.0491 m	X: 0.3637 m Y: 0.3456 m Z: 0.4828 m	X: 0.4510 m Y: 0.5628 m Z: 0.3798 m

software georeferenced these images in the UTM Zone 33S projection (based on WGS84), this was taken as the projection for the entire project. From this, the centre of the D2808 road was marked with a line on the RGB image. For each of the five visually identified road sections (Table 1), a digital transect line was constructed, just shorter (ca 1 m) than the full extent of the road section length, to avoid edge effects. This section centre-line was used with the QGIS plugin "swath profile" to extract a series of swath profiles parallel to the centre-line, following the method described by Hergarten et al. (2014). Each swath was 0.2 m from the previous. The NDVI values and MSAVI2 values were sampled every 0.2 m along the entire swath. These values were averaged along the swath. In this way, a profile of the average NDVI values as well as average MSAVI2 values (both with standard deviation) up to 27 m either side of the centre line was established for each road section. This profile can roughly be subdivided into the following zones from the centre: 0 - 4.5 m: road surface, 4.5 - 13.5 m: road verge (road reserve), and 13.5 - 27 m: natural vegetation. This applies to both sides of the centre-line.

For the terraced SP11 waste rock dump, a similar method was followed. For ease of interpretation, a set of contour lines, with 1 m altitudinal difference, was generated from the DSM of the RGB image. The 1525 m contour line was taken as the top edge of the slope which was reclaimed by covering it with topsoil. Again, two sections could be identified (Table 3), being reclaimed in two different years. Two lines were constructed following the 1525 m contour, representing the top edge of these two sections. Again, using the plugin "swath profile", the average NDVI and average MSAVI2 values were extracted along a series of swath lines 0.2 m apart, sampling each 0.2 m along the swath. Swaths were extracted up to 35 m from the base line. For orientation purposes, an altitudinal profile was also extracted from the RGB DSM. As the "swath profile" plugin extracts data on either side of the base line, the profile extends to the top of the dump. The northern part, next to the WRD2016 section, has been freshly deposited / levelled and thus has no vegetation establishment. This part thus serves as control. The southern part of the top of the dump, adjacent to the WRD2015 section, has been fairly undisturbed for at least two seasons and shows some natural vegetation establishment. This section can therefore be regarded as a further treatment of rehabilitation without intervention.

Biomass

As ground-truth to the aerial images, biomass clippings were conducted on the rehabilitated section of the D2808 district road. Biomass clippings were done on 12 replicates for the control section (untreated section) of the road, as well as 12 replicates on all road sections covered with topsoil, irrespective of topsoil or application type (Diener 2018). Biomass was clipped within a 1 m^2 quadrat (following Bester 1988) in May 2017. The clippings were collected in paper bags and allowed to air-dry in the sun for 48 hours before weighing. Similar biomass clippings were collected on SP11, differentiating between the two sections treated at different times (2015 and 2016 respectively). A one-way ANOVA was applied between the two treatments on the road as well as on SP11 separately, using Statistica 10 (*STATISTICA* 2013).

RESULTS

D2808

The five identified sections of the abandoned D2808 road (as described in Table 1) are depicted in Figure 3 (top), whilst the NDVI profiles of the same sections are depicted in Figure 3 (bottom).

The RGB image (Figure 3 top) clearly indicates the unvegetated control section. The same road section shows partially white in the NDVI (Figure 3 bottom), which indicates that the glare from the unvegetated, white road surface, combined with a high sun elevation, was too intense for the camera sensor to provide reliable values.

The MSAVI2 results were very similar to the NDVI, except that differences were more difficult to detect. This confirms the problem described by Huete (1988) and Qi et al. (1994) that the SAVI and MSAVI lose

Table 3: *Segments identified along the reclaimed slope of the waste rock dump, with their treatment. Positions are given as UTM Zone 33S co-ordinates.*

	North-western extent	**South-eastern extent**	**Length (m)**	**Treatment**
WRD2015	718497.9, 7789992.6	718115.4, 7789553.7	316.6	Topsoil from Otjikoto pit, covered December 2015
Southern upper dump	Adjacent (north-east of) WRD2015			Natural vegetation establishment, no intervention
WRD2016	718115.4, 7789553.7	718088.9, 7789255.7	579.0	Topsoil from Wolfshag pit, covered December 2016 to January 2017
Northern upper dump	Adjacent (north-east of) WRD2016			Control, freshly levelled and unvegetated, no intervention

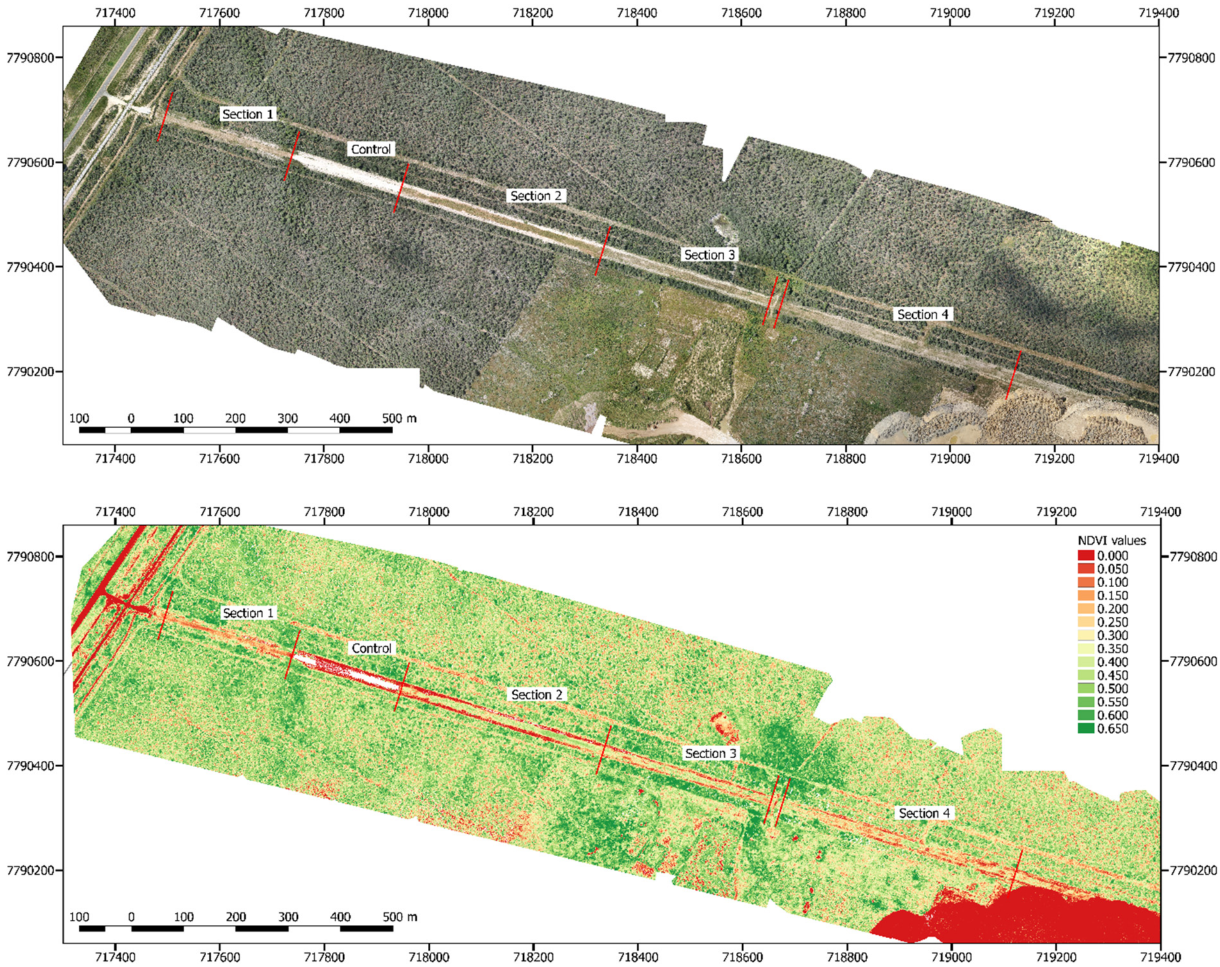

Figure 3: *Aerial view of the abandoned section of the D2808 road. Various sections identified and described are indicated. Top: RGB image, bottom: NDVI image.*

some information compared to NDVI. For this reason, the MSAVI2 was not further regarded.

The NDVI cross section values for the unreclaimed control contrast the elevated values represented by the undisturbed vegetated areas starting ca 13 m from the centre of the road in either direction, followed by a reduction in vegetation on the road verges (ca 5 to 13 m from the road centre) to the calcrete gravel compacted road surface (ca 4.5 to 5 m to either side from the road centre) (Figure 4). Relative success of revegetation of the road surface in sections 1 to 4 is illustrated by the difference in the average NDVI value between the unreclaimed road surface (control) and the average value of each section within 5 m of the road centre. It shows section 2 to have most successfully revegetated (NVDI mean 0.373, SD 0.032). Sections 3 and 4 produced lower average NDVI values (section 3 NDVI mean 0.323, SD 0.021; section 4 NDVI mean 0.273, SD 0.032) than section 2, but higher than section 1 (NDVI mean 0.189, SD 0.058), which was ripped, with an uneven, thin spread of topsoil. This is also partially confirmed by the standing dry biomass measurements (Figure 5) which were significantly higher in sections 2, 3, and 4 than in road section 1 which was ripped but not topsoiled $F(1.94)=29.99$, $p<0.001$.

Figure 3 clearly indicates that the road verge (ca 4.5 to 13 m from the road centre) was not reclaimed – resulting in consistently lower NDVI values than the ripped and soil-covered road surface, and even the section of road which was ripped but not soil-covered. This supports the findings of various studies and guidance documents on reclamation and rehabilitation (Sheoran et al. 2010, Zhang et al. 2015).

Waste Rock Dump

The waste rock dump terrace slope rehabilitated in 2016 (WRD2016) (Table 3) shows a fairly dense vegetation cover along the upper 10 m of the terrace (NDVI mean 0.514, SD 0.134) (Figures 6 right and 7).

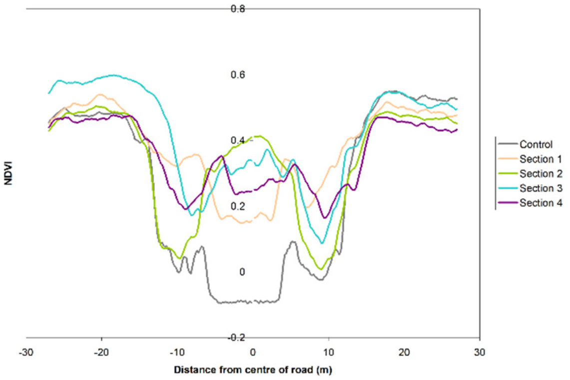

Figure 4: *NDVI profile (cross sectional) for the five sections of the abandoned D2808 road.*

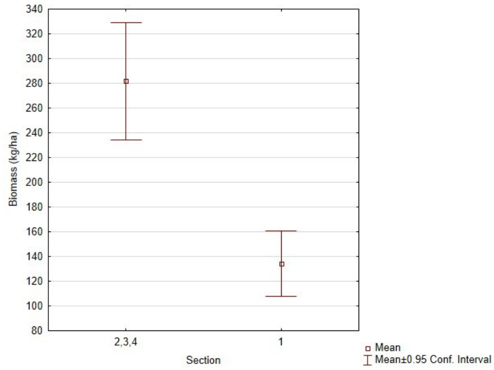

Figure 5: *Field measured standing dry plant biomass (n=12) for road sections (within 2 m if the road centre)*

These NDVI values are comparable to those of nearby natural vegetation surrounding the rehabilitated road (compare Figure 4 to Figure 7), indicating a similar density in vegetative ground cover. This vegetation cover is dominated by naturally established dense stands of *Stipagrostis hirtigluma* interspersed by other grass species (own observations). There is however an evident decline in vegetation cover from the top of the slope to the bottom. This is indicative of either an uneven spread of the topsoil from top to bottom, or erosion of the lower slopes, both phenomena common in waste rock rehabilitation sites (Sheoran et al. 2010). Section WRD2015 (Table 3) shows a highly uneven vegetative cover with sections of bare ground clearly visible (Figure 6 left). The upper slope area seems to be less vegetated than similar parts of the 2016 treatment, but the bottom slope shows more dense vegetation cover. This is indicative of erosion of the topsoil which has accumulated at the lower slope following three rainfall seasons. Signs of erosion are widespread along this section.

Two leguminose shrub species, *Dichrostachys cinerea* and *Mundulea sericea*, were observed on the SP11 waste rock dump, both in the WRD2015 and WRD2016 sections. Visual inspection of the aerial images revealed a greyish shrub on the lower slopes of SP11, which could be *Dichrostachys cinerea.*

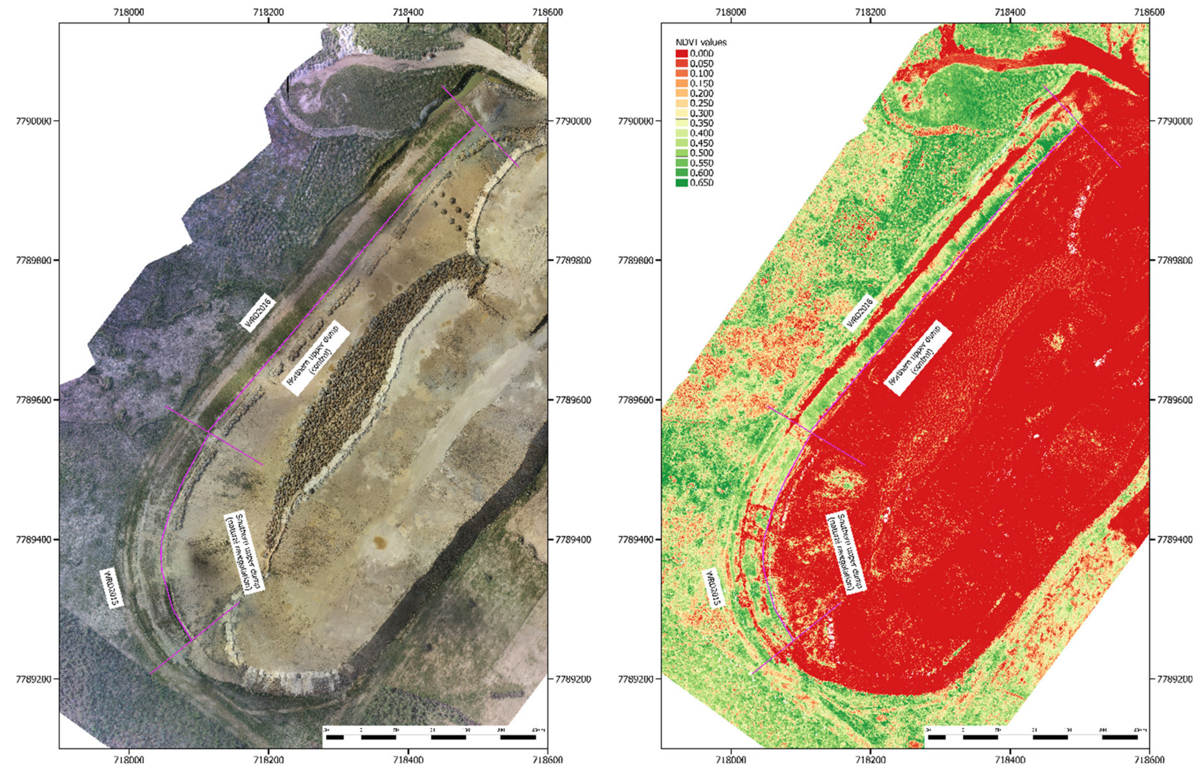

Figure 6: *Aerial view of the reclaimed SP11 waste rock dump. Various sections identified and described, as well as the upper edge of the reclaimed slope, are indicated. Left: RGB image, right: NDVI image.*

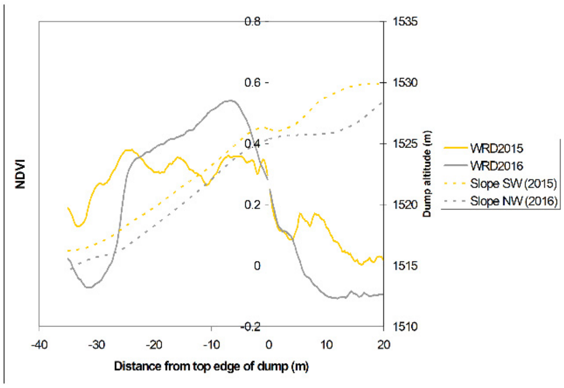

Figure 7: NDVI profile for the reclaimed waste rock dump slope. The respective dump slope altitude is indicated as thin dashed lines for reference purposes (not to scale).

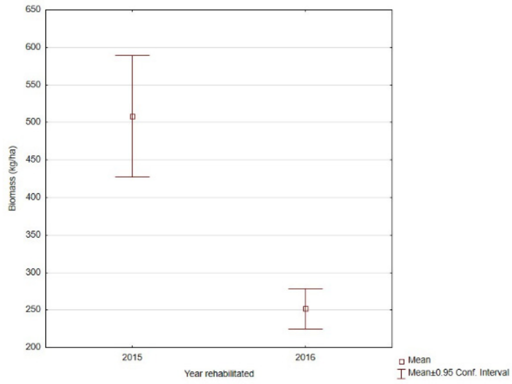

Figure 8: Field measured standing dry plant biomass for the portion of the SP11 terrace rehabilitated in 2015 compared to the portion rehabilitated in 2016. (n=12)

Overall standing plant biomass was significantly higher $F(1.94)=36.69$, $p<0.001$ for the two-year-old rehabilitated area (WRD2015) than the one-year-old rehabilitated area (WRD2016) (Figure 8). This was in part attributed to the relatively young establishment of grasses (one season) within the WRD2016 section, as well as the uneven distribution from top to bottom as evident in Figure 8. Monitoring data also indicate a weak early-season establishment on WRD2016 compared to the already established grass sward of WRD2015. This was however was reversed, with better and more stable ground cover on WRD2016 than on WRD2015 later during the season (July and November 2017 surveys).

DISCUSSION

UAVs have become a useful tool in vegetation monitoring (Rasmussen et al. 2013, Getzin et al. 2014, Cruzan et al. 2016, Cunliffe et al. 2016, Müllerová et al. 2017, Oldeland et al. 2017), although scientists often turn to it for its popularity rather than its applicability (Freeman & Freeland 2015). In this study it was found particularly useful in detecting micro-level differences (at a spatial resolution of less than 5 cm) in a seemingly homogenous area. Within an active mining area, it was possible for the observer to remain at a safe distance from machinery and potential health (dust and noise) impacts. For this reason UAV monitoring has also been selected for e.g. forest fires (Casbeer et al. 2005), gas pipelines and highway traffic monitoring (Ro et al. 2007).

The study was able to comparatively determine vegetation establishment success among ad-hoc rehabilitation treatments applied on the mine. It is, however, impossible to comment on whether the rehabilitation in general, or certain treatments are effective in terms of Otjikoto Mine's environmental management commitments because of the lack of a detailed rehabilitation plan. The mine has chosen instead to develop a broader rehabilitation framework (SLR 2014), which does not specify rehabilitation methods or provide rehabilitation indicators or targets. Best practice suggests that a mine rehabilitation plan with clear definition of rehabilitation methods and monitoring targets is key to guiding and tracking rehabilitation progress (Cook 1976, Ludwig et al. 2003, Thompson & Thompson 2004).

Natural revegetation is evident on the top of the southern part of the dump (Figure 5), but is slow in establishment. This is consistent with findings by Martínez-Ruiz et al. (2007) and Valente et al. (2012), requiring interventions to improve establishment and further natural development. A basic intervention is the spreading of topsoil over the actual waste rock, as applied at the Otjikoto mine (Gilman et al. 1985, Maiti & Maiti 2015). Soil amelioration can be achieved by applying fertilizer (Tordoff et al. 2000, Cooke & Johnson 2002, Mendez & Maier 2008, Sheoran et al. 2010), mixing the poor-quality topsoil with biochar (i.e. 'fines' from the charcoal industry) (Beesley et al. 2011, Artiola et al. 2012, Paz-Ferreiro et al. 2014), or alternatively spreading biosolids on top of the applied topsoil. Such biosolids could be sewerage sludge, manure or even wood chips (produced from cleared shrubs in the bush-encroached surroundings) (Cooke & Johnson 2002, Sheoran et al. 2010). Especially sewerage sludge, but also wood chips, will have a fertilizing effect on the topsoil, whilst biochar improves the organic carbon content, the overall soils structure and also serves as a filter for unwanted phytotoxins from the soils. Many of these methods require adequate soil moisture and should be tested at a small scale within the semi-arid savanna rainfall regime.

Topsoil is prone to denitrification during storage, whilst other soil nutrients (especially phosphorous) are also rather limited (Sheoran et al. 2010). Because of this, inoculations with arbuscular mycorrhizal fungi as well as rhizobia are recommended (Bell et al. 2003, Lucy et al. 2004, Sheoran et al. 2010). Rhizobia will assist the newly established vegetative cover to take up mineral nutrients, and also to manage any heavy metal residues in the dumps (Calvaruso et al. 2006, Mendez & Maier 2008). This is expected to be especially important in the rehabilitation of tailings dumps, but should be trialled first to assess its effectiveness.

The study indicated that slope erosion is a challenge which rehabilitation encounters on the SP11 waste rock dump. Slope rehabilitation commonly encounters erosion as a challenge. Research into slope design to reduce erosion is plentiful (Evans et al. 2000, Hancock et al. 2003, Martín-Duque et al. 2010). Terrace length and slope angle are two factors that are commonly considered. This has resulted in the mining company selecting the 18° slope and 20 m slope length sections between benches (SLR 2012). Our observations in Figures 5 and 6, however, indicate that erosion is a major factor over the short two-year period already. Classic slope design has been found to favour slope instability and water erosion (Martín-Duque et al. 2010), and geomorphic natural reclamation models are progressively more favoured (Hancock et al. 2003, Martín-Duque et al. 2010). Means of reducing rainfall runoff along the 20 m slope are recommended. Techniques such as active revegetation with a nursing crop (Tanner et al. 1986), provision of mulch (Bradshaw 2000) and ungulate hoof action (Savory 1988) should be investigated.

Establishment of a permanent vegetation cover is essential in order to stabilise the waste rock dump, preventing wind- and water erosion and potential contamination of the surrounding area by undesired, potentially toxic minerals washed down from the dump (Tordoff et al. 2000, Wong 2003, Mendez & Maier 2008). Perennial vegetation cover will be preferred, as it protects the covering soil best from wind- and water erosion. Deep-rooted trees have a special role to play in stabilisation (Gilman et al. 1985, Nilaweera & Nutalaya 1999, Mendez & Maier 2008, Stokes et al. 2009). As the topsoil available is limited (due to the very shallow A-horizon of the mollic leptosols), only a relatively thin layer is spread onto the dumps at Otjikoto Mine. The topsoil is also of fairly poor quality, with a high pH similar to the rock substrate within the waste rock dump. The natural establishment of *Dichrostachys cinerea* and *Mundulea sericea* on the waste rock dump indicates a high potential for these species to colonise these habitats and provide the first stabilisation of the spread topsoil and serve as an initial nursing plant for other species (Tanner et al. 1986). *Dichrostachys cinerea* is a known invader, favouring disturbed soils (Bell & Van Staden 1993, Moleele et al. 2002, De Klerk 2004, Mannheimer & Curtis 2009), and it's seeds survive well in stored soils. As a matter of fact, burial of the seeds in soils for prolonged times favour their germination rate (Van Staden et al. 1994). These factors, however, make this species a potentially double-edged sword, depending on the (yet to be determined) long-term rehabilitation goals for the waste rock dumps. It has the potential to outcompete all other vegetation (De Klerk 2004), reducing biodiversity on the rehabilitated area, but can also result in a stable slope with sustainable plant growth (Wakeling & Bond 2007, Stokes et al. 2009). *Mundulea sericea* could be an important keystone species, as it is leguminose and will enable nitrogen enrichment of these soils (Piha et al. 1995b).

This study did not consider specific species establishment, an important aspect to determine the effectiveness of rehabilitation more holistically (Ludwig et al. 2003, Thompson & Thompson 2004). It is also not an aspect currently considered by mine rehabilitation practices. The natural establishment of a dense sward of *Stipagrostis hirtigluma*, with some shrubs of *Dichrostachys cinerea* and *Mundulea sericea,* would fulfil basic reclamation requirements of establishing vegetative cover on the dump slopes. This would, however, not be a long-term sustainable goal, as *Stipagrostis hirtigluma* is short-lived, often even annual (Müller 2007) and *Dichrostachys cinerea* an aggressive invader (see above). The initial successful dense vegetative cover could be thus of short duration should *Dichrostachys cinerea* take over and replace the ground cover afforded by the present grass sward.

Establishment of an adequate perennial vegetation cover to restore ecological functionality will require targeted interventions to establish specific key species. An ideal situation will be the establishment of a mixture of native grasses and woody plants, avoiding exotic species and/or possible invaders (Sheoran et al. 2010). This can be achieved by targeted seeding and/or planting of saplings of indigenous species tolerant to high pH soils. In order to achieve long-term ecological rehabilitation, we recommend establishing the following species, based on their known habitat preferences in Namibia (see e.g. Mannheimer & Curtis 2009, Müller 2007, Strohbach & Kutuahuripa 2014): the dwarf shrub species *Eriocephalus luederitzianus, Leucosphaera bainesii* and *Ptycholobium biflorum* and the grass species *Enneapogon desvauxii, E. scoparius* and *Fingerhuthia africana. Catophractes alexandri* (a shrub, ca 2 m high), as well as common plains species of the surrounding area, including the leguminose species *Acacia mellifera* subsp. *detinens* and *A. luederitzii,* could potentially be established by direct reseeding, or by planting of saplings. The above combination of species would create an artificial ecosystem comparable to the surrounding plains and rocky outcrops.

Given the coarse, rather blocky nature of the substrate of the waste rock dump, the following Karstveld mountain tree species *Kirkia acuminata, Euphorbia* *guerichiana, Moringa ovalifolia, Lannea discolor, Commiphora glaucescens* and/or *Berchemia discolor* can also be experimentally established. The grass species *Danthoniopsis dinteri* (annual) and *Triraphis ramosissima* (perennial) are also typical of these rocky habitats and are prolific seeders. If successful, all these species would create a woodland habitat not unlike the nearby Karstveld, allowing for an advanced state of ecological restoration. Near-natural restoration is unlikely to be achieved.

Further evaluation of the suitability of these species can be done using criteria discussed by Gilman et al. (1985), Mukhopadhyay et al. (2013), Nilaweera & Nutalaya (1999) and Schroth (1995), but also by experimental planting.

Soil moisture is critical for the successful establishment of tree and shrub species especially. Due to the steep, smooth nature of the dumps, and the thin topsoil layer, little rain water is held in the topsoil. Most will either run off, or percolate into the very porous waste rock dump. Improved water holding capacity can be achieved by the use of 'hydrogel' as part of the planting medium of saplings (Sarvaš et al. 2007). Watering saplings with drip irrigation is recommended by Cooke & Johnson (2002), Mendez & Maier (2008) and Tordoff et al. (2000). Such irrigation should, however, be limited by cost and water availability, and limited to only the establishment phase of the saplings (i.e. one or two seasons only) to avoid dependency. In the long-term, rainwater harvesting techniques, either through benching (Piha et al. 1995a, Wong 2003), or through construction of contoured weirs along the slope (Vohland & Barry 2009, Oweis 2016) will be more successful. Moreover, such measures will limit erosion of the applied topsoil. Erosion can also be reduced by shaping the dumps according to geomorphic principles, i.e. a convex upper slope and a concave bottom slope (Hancock et al. 2003). Excessive water damming on the top of the dump should be drained on specially constructed run-off channels (Wong 2003).

Overall, there are a large variety of techniques available for successful reclamation of the mine dumps at Otjikoto Mine. These range from reshaping the dumps to reduce erosion and improve water infiltration, to soil amelioration and targeted selection of species to be used for reclamation. What is urgently needed is a plan for rehabilitation (Cooke & Johnson 2002), as well as targeted experimentation with various interventions to promote establishment of a perennial vegetation cover. Evaluation of successful establishment should be done using multiple indicators, including annual NIR aerial photography, species composition as well as soil condition. As previously stated, these require an initial development of a detailed rehabilitation plan (Ludwig et al. 2003, Thompson & Thompson 2004).

This study did not consider the chemical composition of the soils, or the interactions between the chemistry of the soil and underlying materials, but relied on the comparative physical rehabilitation treatments as applied by the mining company over the past two years.

IMPLICATIONS FOR PRACTICE

Most importantly, any measure of effectiveness of rehabilitation needs to be compared to a clear goal, targets and indicators.

Retrospective inspection of ad-hoc rehabilitation treatments can provide insights into determining the most effective methods for rehabilitation areas and predicting challenges which will face mine rehabilitation later in the lifecycle.

UAVs can be time and labour efficient tools for regular vegetation establishment monitoring at a high spatial resolution on rehabilitated sites. Their results do not, however, consider species composition, which is an important dimension to determine ecological functioning of rehabilitated areas.

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A contribution to the reptiles of the Kunene River Mouth area

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Abstract

Knowledge of the herpetofauna associated with the Kunene River mouth area is incomplete with few published records. During a field visit in January 2018, eight species previously not known to occur in the area were identified, increasing the known reptile species richness to 18 species. Of these at least three species (possibly four if FitzSimon's burrowing skink is included) are endemic with the Cunene racer listed as indeterminate (rare?) and vulnerable, underscoring the importance of the general Kunene River mouth area for reptiles. The area remains unique and all developments, especially if located in the sensitive areas, should be approached with caution.

Keywords: Kunene River mouth; Namibia; reptiles; Skeleton Coast

Introduction

There is a general paucity of information regarding the herpetofauna associated with the Kunene River mouth as this area has, until recently, been notoriously remote, and located within the inhospitable Skeleton Coast National Park. Few reptiles are associated with the Namibian coastal saline areas (Cunningham & Jankowitz 2010) while relatively few reptiles (only eight species – water monitor, crocodile, four species of freshwater terrapins and two species of snakes [*Colubridae*]) are associated and/or dependent on wetlands in Namibia (Griffin & Channing 1991).The overall reptile diversity and endemism in the general Kunene River mouth area is estimated at between 31-40 species and 13-16 species respectively (Mendelsohn et al. 2002). Griffin (1998) presents figures of between 11-20 and 1-2 for endemic lizards and snakes from the area. The Skeleton Coast Park, including the Kunene River mouth area, has an estimated 77 species in total (Griffin 1998). However, published records of reptiles from the actual Kunene River mouth area are limited to Griffin and Channing (1991), Simmons et al. (1993), Anderson et al. (2001) and Paterson (2007) who confirm at least four, six, seven and two species respectively – with a total species richness of 10 species. While the focus in the past has mainly been on the importance of the Kunene River estuary for avifauna, this paper contributes to the knowledge of the reptiles of this immensely important habitat in an otherwise marginal environment.

Methods

Study Site

The general Kunene River mouth area falls within the Northern Namib (Giess 1971) or Northern Desert and the vegetation structure is classified as sparse grasslands (Mendelsohn et al. 2002). The area is extremely barren with the perennial Kunene River and associated vegetated delta area, on the border between Angola and Namibia, the only true lifeline in the general area. The area is dominated by sand dunes with the average annual rainfall of between 50 and 100mm and a high coefficient of variation (80-90%), although the coastal areas typically receive much less. Average annual temperatures are mild, between 20 and 22°C, with fog an important source of moisture, especially during the winter months. Average plant production is extremely low with variation in green vegetation biomass viewed as very low (0-5%) (Mendelsohn et al. 2002). The area is dominated by southerly winds and offshore the cold Benguela Current has an upwelling cell – Kunene Cell – which results in nutrient-rich waters rich in fish and other marine resources (Mendelsohn et al. 2002).

The Kunene River has a flow of about 5.5 km² of water each year and a mouth of about 3 km in width, although often with an extensive sand bar across its mouth depending on the river flow and rainfall in the highlands of Angola, while the wetland area is approximately 500 ha in size and shared by Angola and Namibia (Robertson et al. 2012).

The Kunene River is viewed as a site of special ecological importance in Namibia due to the presence of sea turtles and migrant shorebirds while the entire coastline is also important due to its biotic richness – e.g. arachnids, birds and lichens (Curtis & Barnard 1998).The general area is regarded as "low" in overall (all terrestrial species) diversity while the overall terrestrial endemism on the other hand is "average to high" (Mendelsohn et al. 2002).

Human activities are limited in the area and currently include the Northern Namibia Development Company (Pty) Ltd (NNDC) camp site (staff accommodation), main plant, engineering and logistics facilities and landing strip (See Figure 1).The footprint of these facilities is small and all temporary in nature with minimal impact on the Kunene River as most of the facilities, except for the camp site, are located away from the river.

Data Collection

A comprehensive literature review (i.e. desktop study) regarding the reptiles that could potentially occur in the general Kunene River mouth area was conducted (Penrith 1971, Broadley 1983, Buys & Buys 1983, Griffin & Channing 1991, Marais

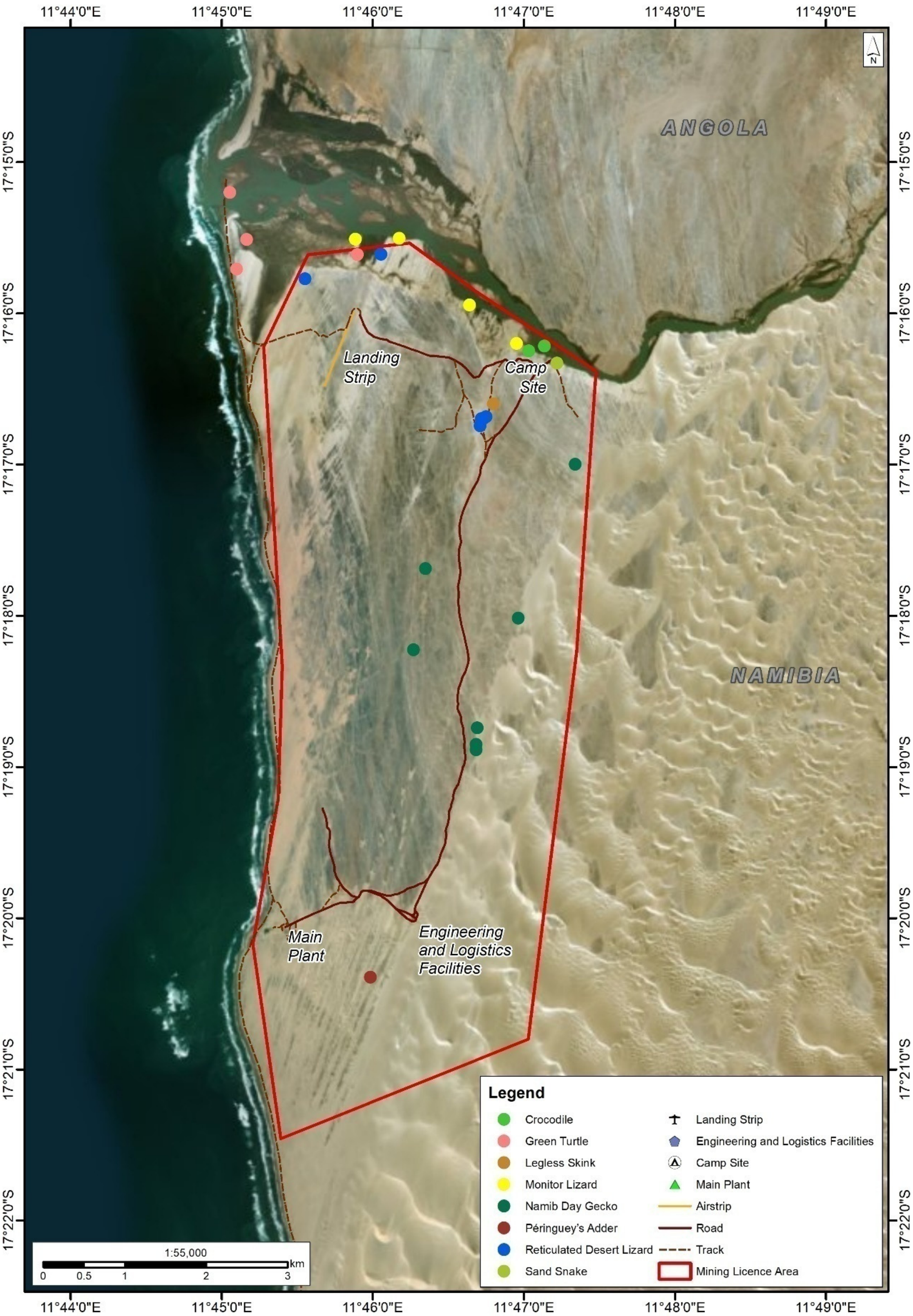

Figure 1: Location of confirmed reptile sightings within the proposed Northern Namibia Development Company (Pty) Ltd mining licence area

1992, Simmons et al. 1993, Branch 1998, Boycott & Bourquin 2000, Anderson et al. 2001, Bauer et al. 2001, Griffin 2003, 2004, Cunningham 2006, Alexander & Marais 2007, Paterson 2007, Tolley & Burger 2007, Branch 2008, Alderton 2009, Bates et al. 2014, Cunningham & Jankowitz 2010, Ceríacoet al. 2016, Lyet et al. 2016, IUCN 2018, Hebbard n.d.).

This was followed by a rapid site visit (fieldwork) between 15 and 18 January 2018.The fieldwork was not limited to reptiles only, so no structured approach was followed, but rather an opportunistic search for reptiles in likely hiding places in a variety of habitats. This was conducted on foot over approximately 5-6 hours per day, which included diurnal and nocturnal searches. Nocturnal searches were conducted using a Sun King portable solar light. Reptiles observed were either caught by hand or by using an active capture technique called 'reptile noosing' where an extendable fishing rod was fitted with a soft thread noose, positioned over the head of an unsuspecting individual and pulled tight. This technique does not result in the death or injury of the caught specimen. Species caught were identified *in situ*, photographed and released unharmed at the point of capture.

Furthermore, we include personal communications with knowledgeable NNDC staff who have spent much time in the area. Their sightings were included where supported by photographs and/or video footage. Video footage of the Cunene racer was also independently verified by Aaron Bauer.

Results and Discussion

Literature Review

Approximately 261 species of reptiles are known or expected to occur in Namibia, thus supporting approximately 30% of the continent's species diversity, of which at least 22% or 55 species are classified as endemic. Furthermore, the occurrence of reptiles of "conservation concern" includes about 67% of Namibian reptiles (Griffin 1998).

According to the literature review at least 45 species of reptiles are expected to occur in the general area with 17 species being endemic – i.e. 37.8% endemic (Table 1). The 45 species expected to occur in the general Kunene River mouth area consist of at least three turtles and one terrapin; nine snakes; 16 lizards; one monitor lizard; one agama; one chameleon; 12 gecko and one crocodile. Geckos (12 species with eight species being endemic [66.7%] and two species classified as rare) and lizards (16 species with five species being endemic [31.3%] and one species classified as rare) are the most important groups of reptiles expected to occur in the general area. Griffin (1998) confirms the importance of the gecko fauna in Namibia, while Namibia with approximately 129 species of lizards (Lacertilia) has one of the continent's richest lizard fauna. A survey conducted in the neighbouring Namibe Province in Angola during 2013 resulted in 37 reptile taxa, including three undescribed species and two new country records (Ceríaco et al. 2016), although this survey did not include the Kunene River mouth area.

According to the Namibian conservation status, five species expected to occur in the area (Nile soft-shelled terrapin, chimba skink, Cunene racer, long-headed tropical house gecko and San Steyn's thick-toed gecko) are classified as rare; three species as protected game; four species as indeterminate; one species as insufficiently known and seven species as peripheral. The IUCN (2018) classifies eight species with some form of conservation status (including least concern – LC) from the general area of which one species is classified as endangered (green turtle) (Figure 2), four species as vulnerable (leatherback turtle, olive ridley turtle, Nile soft-shelled terrapin and Cunene racer) and three species as least concern. However, most reptiles have not yet been assessed for the IUCN Red List. Furthermore, Bates et al. (2014) classifies one species each as critically endangered (web-footed gecko), endangered (leatherback turtle), vulnerable (Nile crocodile), near threatened (green turtle) and data deficient (olive ridley turtle), while eight species are listed by CITES as either Appendix One or Appendix Two species (See Table 1).

Figure 2: *Green turtle carapace found amongst reeds in the Kunene River mouth estuary.*

Table 1: *Reptile diversity expected (Branch 1998) and confirmed during the fieldwork (√); personal communications with Northern Namibia Development Company (Pty) Ltd staff (√*) and published records from other studies conducted in the area.*

Species: Scientific name	**Species: Common name**	**This study**	**Griffin & Channing (1991)**	**Simmons *et al.* (1993)**	**Anderson *et al.* (2001)**	**Paterson (2007)**	**Namibian conservation and legal status**	**International status**		
								Bates et al. (2014)	**IUCN (2018)**	**CITES**
TURTLES AND TERRAPINS										
Dermochelys coriacea	Leatherback Turtle	√*					Peripheral	E	V	C1
Chelonia mydas	Green Turtle	√	√	√	√	√	Peripheral	NT	E	C1
Lepidochelys olivacea	Olive Ridley Turtle						Indeterminate; Peripheral	DD	V	C1
Trionyx triunguis	Nile Soft-shelled Terrapin	√*	√	√	√	√	Indeterminate (rare?); Peripheral		V	
SNAKES										
Pythons										
Python natalensis	Southern African Python	√*		√			Vulnerable; Peripheral; Protected Game			C2
Typical Snakes										
Boaedon capensis (Lamprophis fuliginosus)	Brown House Snake						Secure			
Psammophis trigrammus	Western Sand Snake						Endemic; Secure			
Psammophis notostictus	Karoo Sand Snake			√			Secure			
Psammophis leightoni namibensis	Namib Sand Snake	√					Secure			
Coluber zebrina	Cunene Racer	√*					Endemic; Indeterminate (rare?)		V	
Bitis arietans	Puff Adder	√*					Secure			
Bitis caudalis	Horned Adder				√		Secure			
Bitis peringueyi	Péringuey's Adder	√					Endemic; Secure		LC	
LIZARDS										
Skinks										
Typhlacontias johnsonii	Johnson's Burrowing Skink	?					Secure			
Typhlacontias puntatissimus	Speckled Burrowing Skink						Secure			
Typhlacontias brevipes	FitzSimon's Burrowing Skink	?					Endemic; Secure			
Trachylepis chimbana	Chimba Skink						Rare?			
Trachylepis hoeschi	Hoesch's Skink						Endemic; Secure			
Trachylepis laevis	Angolan Blue-tailed Skink						Secure			
Trachylepis sulcata ansorgii	Western Rock Skink				√		Secure			
Trachylepis variegata variegata	Variegated Skink						Secure			
Old World Lizards										
Meroles anchietae	Shovel-snouted Lizard	√*					Secure			
Meroles reticulatus	Reticulated Desert Lizard	√			√		Endemic; Secure			
Nucras intertexta	Spotted Sandveld Lizard						Secure			

Pedioplanis breviceps	Short-headed Sand Lizard					Endemic; Secure			
Pedioplanis benguellensis	Angolan Sand Lizard					Secure			
Desert Plated Lizards									
Gerrhosaurus (Angolosaurus) skoogi	Desert Plated Lizard					Endemic; Secure		LC	
Plated Lizards									
Gerrhosaurus nigrolineatus	Black-lined Plated Lizard					Secure			
Girdled Lizards									
Cordylus machadoi	Machodoe's Girdled Lizard					Insufficiently known			C2
Monitors									
Varanus niloticus	Nile or Water Monitor	√	√	√		Vulnerable; Peripheral; Protected Game			C2
Agama									
Agama planiceps	Namibian Rock Agama					Endemic; Secure			
Chameleons									
Chamaeleo namaquensis	Namaqua Chameleon					Secure			C2
Geckos									
Hemidactylus longicephalus	Long Headed Tropical House Gecko					Rare			
Pachydactylus caraculicus	Angolan Banded Thick-toed Gecko					Secure			
Pachydactylus fitzsimonsi	FitzSimon's Thick-toed Gecko					Endemic; Secure			
Pachydactylus oreophilus	Kaokoveld Thick-toed Gecko					Secure			
Pachydactylus turneri	Turner's Thick-toed Gecko					Secure			
Pachydactylus scherzi	Schertz's Thick-toed Gecko					Endemic; Secure			
Pachydactylus scutatus	Large-scaled Thick-toed Gecko					Endemic; Secure			
Pachydactylus sansteyni	San Steyn's Thick-toed Gecko					Endemic; Indeterminate (rare?)			
Pachydactylus (Palmato gecko) rangei	Web-footed Gecko					Endemic; Secure	CE		
Pachydactylus vanzyli	Kaoko Web-footed Gecko					Endemic; Secure			
Rhoptropus afer	Common Namib Day Gecko	√				Endemic; Secure			
Rhoptropus biporosus	Kaokoveld Namib Day Gecko				√	Endemic; Secure			
Crocodiles									
Crocodylus niloticus	Nile Crocodile	√	√	√	√	Peripheral; Protected Game	V	LC	C2

Namibian conservation and legal status according to the Nature Conservation Ordinance No 4 of 1975 (Griffin 2003)
Endemic – includes Southern African Status (Branch 1998)
Bates et al. (2014): CE – Critically Endangered; E – Endangered; V – Vulnerable; NT – Near Threatened; DD – Data Deficient
IUCN (2018): E – Endangered; V – Vulnerable; LC – Least Concern [All other species not yet assessed]
CITES: CITES Appendix 1 or 2 species
? – tracks observed but could not be linked to species

Although the three turtles (leatherback, green and olive ridley) are not classified under the Nature Conservation Ordinance of 1975 they are protected under the Sea Fisheries Regulations of 2001 (Griffin 2003). Leatherback turtle occurs along the entire coast while only two carapaces have been located for olive ridley turtle along the northern Skeleton Coast. It is not known if green turtle breeds along the Namibia coast, but it is known to occur in the Kunene River mouth estuary (Griffin 2003). Nile soft-shelled terrapin was first discovered during a survey between September and October 1969 at Foz do Cunene (Penrith 1971) with the Kunene River mouth viewed as the southernmost range of the species in Africa (Penrith 1971, Griffin & Channing 1991, Branch 1998). Other aquatic species that may occur in the area, although not yet confirmed, include the helmeted terrapin (Griffin & Channing 1991), yellow-bellied sea snake (Branch 1998), loggerhead turtle and hawksbill turtle (Griffin 2003).

Crocodiles are viewed as peripherally endangered due to diminishing habitat and human encroachment and estimated to be in the vicinity of 806 individuals (all size classes – direct count abundance = 562 individuals) along the 352km of the Namibian Kunene River (i.e. a bountiful 2.29 crocodiles/km).The Kunene River mouth area has an estimated nine individuals (range: 4-22 individuals) within the 1-3 m size class and three individuals (range: 2-5 individuals) within the 3 m+ size class (this within an 8km river segment surveyed from the mouth inland) (Lyet et al. 2016).

The little known and endemic Cunene racer (only three records from the Opuwo and Khorixas Districts in northern Namibia – Bauer et al. 2001, Griffin 2003), Southern African python and the endemic Péringuey's Adder (Figure 3) are viewed as the most important snakes potentially occurring in the general area. Southern African Python is known from the Kunene River mouth area while Péringuey's adder occurs in the sandy coastal/inland vegetated dune hummock areas. Furthermore, Anderson et al. (2001) include desert plated lizard from Möwe Bay and web-footed gecko from Rocky Point, albeit further to the south. Although Anderson et al. (2001) indicate that several Kaokoveld Namib day gecko individuals were observed near the Kunene River mouth, Griffin (2003) indicates that they only occur in the Pro-Namib between the Brandberg and southern Opuwo, indicating a possible confusion with the ubiquitous rupicolous common Namib day gecko (pers. obs.).

Figure 3: Bitis peringueyi *(Péringuey's adder) located between Salsola spp. inland dune hummocks.*

Fieldwork

During the fieldwork seven species were observed while another seven species were confirmed using Northern Namibia Development Company (Pty) Ltd staff personal records – i.e. 14 species in total – from the general Kunene River mouth area. Of these at least three species (possibly four if FitzSimon's burrowing skink is included – See Table 1) are endemic with the Cunene racer furthermore listed as indeterminate (rare?) and vulnerable by Griffin (2003) and the IUCN (2018), respectively. The most important species from a conservation status perspective are the turtles (leatherback and green), Nile soft-shelled terrapin, Southern African python, Péringuey's adder and the little-known Cunene racer. While Nile soft-shelled terrapin is known to breed in the area, breeding has not been confirmed for green turtle although expected. Southern African Python and Péringuey's adder have a widespread distribution throughout Namibia while Cunene racer, previously only known from a few sites further to the east, was identified from very shaky video footage. (Although the footage was scanty, the overall appearance and behaviour was not that of a zebra snake; the observer, J. van Rooyen, being familiar with the latter species, was also convinced it was something other than a zebra snake, a species not yet documented as occurring in the area although no barriers exist to exclude it from the area).The holotype for Cunene racer is from the Ruacana area with another two specimens confirmed from the Kamanjab and Warmquelle areas further south (Bauer et al. 2001). Although currently viewed as a Namibian endemic (Griffin 2003), this species is also expected, although not yet confirmed, to occur in Angola (Bauer et al. 2001) since the Kunene River is not viewed as a geographic barrier. Our sighting is thus approximately 260 km to the west of the type locality, consequently increasing the known range of this species further westwards. Tracks of either Johnson's burrowing skink or FitzSimon's burrowing skink (Figure 4) were observed, but could not be linked (i.e. confirmed) to the species (See Figures 5&6 as examples of reticulated desert lizard and Nile monitor from the area and Figure 1 for the species location map).

Figure 4: *Tell-tale burrowing skink (Johnson's or FitzSimon's) tracks within inland Salsola spp. dune hummocks.*

Figure 5: *Reticulated desert lizard was found on sandy substrate in the area.*

Figure 6: *Nile monitor tracks were common in wet areas along the Kunene River.*

Figure 7: *Namib day gecko was found in rocky gravel plain areas.*

Of the 14 species confirmed, eight species had not previously been documented from the general area and include the leatherback turtle, Namib sand snake, Cunene racer, puff adder, Péringuey's adder, unidentified burrowing skink, shovel-snouted lizard and common Namib day gecko (Figure 7) - i.e. increasing the known reptile species richness to 18 species.

More species potentially occur in the area as perennial rivers are not viewed as zoogeographic barriers to reptiles or known to occur further east along the Kunene River and potentially could be in the vicinity – e.g. Angolan banded thick-toed gecko (known from Swartboois Drift) – although not yet confirmed from the area (Haacke 1970).

Conclusion

The very high percentage of unique and/or endemic species underscores the importance of the general Kunene River mouth area for reptiles. Very little is known regarding the three turtles (leatherback, green and olive ridley) and the Nile soft-shelled terrapin. All except olive ridley turtle have been recorded here and are expected to breed in the area. Although these species are not exclusively associated with this area, the importance of the Kunene River mouth area for these species is not well understood and requires further research.

According to the literature review, the most important reptiles, excluding the three turtles and Nile soft-shelled terrapin, are the Southern African python, Cunene racer and Péringuey's adder, the dune-dwelling endemic, herbivorous desert plated lizard, the rare long-headed tropical house gecko, various endemic and range restricted thick-toed geckos and the endemic and range restricted Kaoko web-footed gecko. Except for the Nile soft-shelled terrapin, which has its southernmost distribution at the Kunene River mouth, none of the other important reptiles is exclusively associated with the area.

However, the area remains unique and all developments, especially in the sensitive areas, should be approached with caution. According to Griffin (1998) emergency grazing and large-scale mineral extraction in critical habitats are some of the biggest problems facing reptiles in Namibia. Simmons et al. (1993) sums it up best: "its small size; extreme isolation; high avian species richness and unusual herpetofauna make it a unique and important coastal wetland".

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Status of the Rock Pratincole in the Kapako area of the Okavango River, Kavango East, Namibia

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Abstract

A boat survey conducted on 30 December 2017 along an 8.6 km stretch of the Okavango River revealed 45 adult Rock Pratincoles and 20 young birds. This brings the estimated number of Rock Pratincoles in the Okavango system in Namibia to about 361 birds, and for all river systems in Namibia to about 410 birds.

Keywords: *Glareola nuchalis;* Namibia; Okavango river; Rock Pratincole; status.

Introduction

The distribution of the Rock Pratincole (*Glareola nuchalis*) is confined to sub-Saharan Africa. In southern Africa it is an intra-African migrant, arriving mainly in August when the water levels of the large river systems are low and in-stream rocks are exposed, and departing by January when the rivers rise. In Namibia Rock Pratincoles are confined mainly to areas of rocky outcrops in the Okavango, Chobe and Zambezi rivers. The birds roost and nest on these exposed rocks (Figure 1), and hawk for insects over the water and adjacent riparian belt, mainly at dawn and dusk. For most of the day, they perch unobtrusively on the rocks (Hockey et al. 2005, Simmons et al. 2015). Fourteen previous breeding records for Rock Pratincoles in Namibia give laying months in October (two), November (seven) and December (five) (Brown et al. 2015).

Figure 1: *Adult Rock Pratincole (left) with chick about 12 days old, perched on an exposed rock in the Okavango River. Photographed 30 December 2017.*

Namibia's Rock Pratincole population is estimated to be fewer than 950 birds (Simmons et al. 2015). However, they have never been systematically surveyed across their range in Namibia, and the numbers actually recorded from isolated counts are much smaller – about 365 birds. I report here on a Rock Pratincole survey in the Kapako area of the Okavango River in December 2017.

Study area and methods

The Kapako area is situated in the Kavango East region, about 170 km due east of Rundu. The survey was conducted from a boat on 30 December 2017, from 09h15 to 12h20, starting near Rudhiva at 17.98530S; 21.35220E and ending about 1.5 km downstream of Diyana at 18.01420S; 21.40970E, a distance on the river of 8.6 km (Figure 2). All rocky outcrops in-stream and along the river banks were carefully examined using 8 x 40 binoculars, and all Rock Pratincoles seen were photographed using a Sony DSC – HX200V camera with built in GPS. Young birds were subsequently aged from the digital images on a high-resolution screen. The age of young birds plus the incubation period of about 20 days (Tarboton 2011) were used to calculate the approximate date when eggs were laid.

Results and discussion

In total 45 adult and 20 young birds were recorded on this survey (Table 1), bringing the estimated number of Rock Pratincoles in the Okavango system in Namibia to about 361 birds, and for all river systems in Namibia to about 410 birds. The density of adults over the 8.6 km stretch of river was on average 5.2 birds per km. This compares to 6.3 birds per km on a 230 km stretch of the Zambezi River between Kazungula and Lake Kariba (Williams et al. 1989), and 2.2 and 7.0 birds per km in the Kariba and Mupata Gorges respectively on the Zambezi River (Wood & Tree 1992). The density of Rock Pratincoles on the Okavango River in Namibia varies widely, from no rocky outcrops and no birds along much of the river, to about

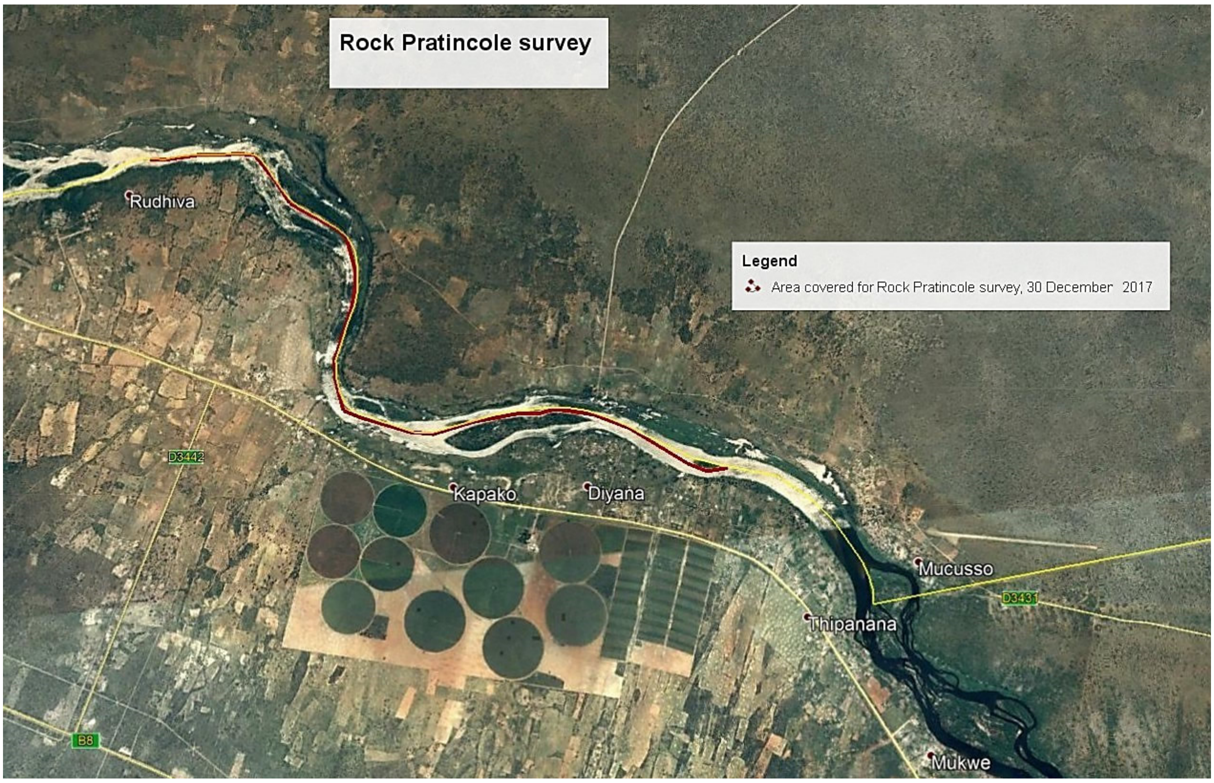

Figure 2: Section of the Okavango River in the Kapako area that was surveyed (red line), 30 December 2017.

19 birds per km along the 15 km stretch between just north of Mukwe to Divundu, where the river divides into numerous channels and islands, strewn with rocky outcrops.

Rock Pratincoles lay 1-2 (mean 1.7) eggs per clutch, between August and December, with a peak in September in Zambia, October in Zimbabwe (Hockey et al. 2005) and November in Namibia (n=34), combining past records (Brown et al. 2015) and those from this survey (Figure 3). The ratio of young to adult birds was 1:2.25, or about 0.4 young per adult. A colony of about 150 birds in Gabon monitored over nine years fledged on average just under 0.2 young per adult per year (Brosset 1974).

There are rocky sections of the Okavango, Chobe and Zambezi rivers in Namibia that have not yet been surveyed for Rock Pratincoles. I would encourage birders and conservation officials to target these unsurveyed stretches to help complete the assessment of the Rock Pratincole population in Namibia.

***Table 1:** Known numbers of Rock Pratincoles in Namibia.*

River system	Section of river	Number of Rock Pratincoles		Reference
		Recorded	Estimated	
Okavango	Namushasha, west of Rundu	4 birds	4 birds	CB 2016 pers. obs.
	Shankara area	6 pairs	12 birds	MP in Simmons et al. 2015
	Kapako area	45 ad bird 20 juv birds	45 birds	This survey
	Just N of Mukwe to Divundu	57 birds	285 birds	CB in Simmons et al. 2015
	Popa Falls	4-6 pairs	8-12 birds	MP in Simmons et al. 2015
	Mahango, Bwabwata NP	3 birds	3 birds	MP in Simmons et al. 2015
	Total Okavango		**361 birds**	
Chobe	Impalila – Kasane rapids	12 pairs	24 birds	Randal 2001
		11 pairs	22 birds	CB in Simmons et al. 2015
	Total Chobe		**24 birds**	
Zambezi	Near Wenela-Sesheke bridge	7 birds	7 birds	CB in Simmons et al. 2015
	Adjacent to Impalila Island	9 pairs	18 birds	CB in Simmons et al. 2015
	Total Zambezi		**25 birds**	
Total recorded birds for Namibia			**410**	

Abbreviations: CB – Chris Brown, MP – Mark Paxton

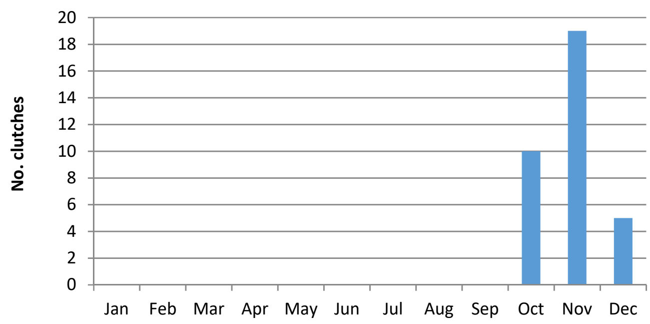

Figure 3: *Laying months for Rock Pratincoles in Namibia.*

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