AFROTHERIAN CONSERVATION

Newsletter of the IUCN/SSC Afrotheria Specialist Group

IUCN AFROTHERIA SPECIALIST GROUP

Edited by C.& M. Stuart

Number 13

September 2017

From the editors:

It seems our appeal for more input for this issue from members and interested parties has borne fruit, with a bumper issue. We thank all contributors, especially the 'golden molers' who from nothing in issue number 12 have contributed greatly to issue number 13. Thank you one and all!

One of the most important issues pointed out in several of the articles here, is how many 'new' species and subspecies are hiding in plain sight. This has very important implications for the successful conservation of many species, in particular the poorly known golden moles, many tenrecs and even the hyraxes.

We would like to have some feedback from you, the reader, as to whether you think the newsletter still has a place, or do you think articles, notes, new literature should just be placed on the Afrotheria webpage as they become available?

For issue number 14 we would greatly appreciate receiving material for publication well before the 2018 July deadline, as we will be spending lengthy periods in the field. So to another good afrotherian year ahead!

C. & M. Stuart, Loxton, South Africa
August 2017 (www.stuartonnature.com)

Lesser Hedgehog Tenrec Echinops telfairi (© *C.& M. Stuart)*

In This Issue - Number 13 - September 2017

Editorial	1
Features	
Presence of Chequered Giant Sengi (*Rhynchocyon cirnei*) at Shiwa N'gandu in northern Zambia	3
Identifying the different forms of giant sengi (*Rhynchocyon)* based on external colour pattern	7
Sengi Taxonomy - a 2017 update	10
Cape Rock Hyrax research update: Cryptic diversity in the rock hyrax from southern Africa	12
Genes reveal new golden mole cryptic lineages in the Greater-Maputaland-Pondoland-Albany region of southern Africa	15
Species distribution modelling forecasts the possible ranges and conservation status of four grassland golden mole taxa (*Amblysomus*) in South Africa	19
Planning for persistence of a Juliana's Golden Mole (*Neamblysomus julianae*) subpopulation threatened by urban development on Bronberg Ridge of Pretoria (Tshwane), South Africa	24
Small mammal monitoring: why we need more data on the Afrotheria	34
Notes from the Field	
Filling a gap in the distribution of Sengis in Ethiopia	43
Some thoughts on the distribution of Tree Hyraxes (Genus *Dendrohyrax*) in northern Tanzania	47
New bamboo named after a tenrec	50
Afrotheria News	
Message from the Chairs	51
African national park taken off World Heritage 'danger list'	51
The Tweeting Tenrec	52
Update to Sengi website	52
New Golden-rumped Sengi literature	53
Friends of Arabuko-Sokoke and other links	53
Provisional AZE Status for Arabuko-Sokoke Forest	53
2016 Red List of Mammals of South Africa, Swaziland and Lesotho	54
Notice Board - Smith Fellowship Program	55
Recent Literature	56
Guidelines for Authors / Subscription information	60

Afrotherian Conservation is published annually by the IUCN Species Survival Commission Afrotheria Specialist Group to promote the exchange of news and information on the conservation of, and applied research into, golden moles, sengis, hyraxes, tenrecs and the aardvark.

Published by IUCN, Gland, Switzerland.

ISSN: 1664-6754

Find out more about the Group on our website at http://afrotheria.net/ASG.html and follow us on Twitter **@Tweeting_Tenrec**

Features

Presence of Chequered Giant Sengi (*Rhynchocyon cirnei*) at Shiwa N'gandu in northern Zambia

Frank Willems

Mutinondo Wilderness Ltd, PO Box 450126 Mpika, Zambia, email: fwls01@gmail.com

Introduction

The Chequered Giant Sengi (*Rhynchocyon cirnei*) has long been known from the extreme northern and eastern parts of Zambia, north of a line from S9.00°E28.00° in the west to S11.00°E33.00° in the east (Ansell 1978). The presence of the species as far south as S12.45° in the Muchinga Plateau was only published recently (Willems 2016). Firm confirmation could only be presented for Mutinondo Wilderness, while oral reports suggest a more widespread distribution in the area. One of the unconfirmed localities presented in Willems (2016) was Shiwa N'gandu Estate (Fig. 1). Here I confirm this locality and include some notes on the occurrence there.

Site description

Shiwa N'gandu Estate is a 9,000 hectares private estate in Muchinga Province in northern Zambia (Fig. 1). The estate is named after its dominant feature, the 1,000 ha Lake Shiwa N'gandu, which translates into "Home of the Royal Crocodile". The Estate is best known for the old colonial manor house. Parts of the estate have been transformed into exotic tree plantations and arable land, though much of the area has retained its natural vegetation. Other dominant human activities are game farming, livestock ranching and subsistence fishing on the lake.

Elevation ranges from 1,460 m asl at the lake shores, to 1,760 m asl in the rocky hills along the north-western border of the estate. The shallow lake is bordered in part by extensive areas of sedge marshland, and in part by intensively grazed short-grass plains. The natural vegetation beyond the lake shore is dominated by broad-leaved *miombo* (*Brachystegia*) woodlands and seasonally wet *dambo* grasslands. Two major types of evergreen wooded vegetation also occur on the estate: Seepage-fed evergreen forests dominated by *Syzygium spp.* occur along drainage lines. Much drier forest, with a canopy dominated by semi-deciduous species and a dense undergrowth of evergreen thicket species, occurs on sandy soils, mainly within a kilometer-wide band along the north-western shores of the lake. Emergent trees in this forest type include *Isoberlinia angolensis*, *Brachystegia taxifolia*, *Parinari curatellifolia*, *P. excelsa* and *Faurea saligna*, among many more.

Figure 2: *A Chequered Giant Sengi at Shiwa N'gandu Estate, as it moved through a 30 m wide open area dominated by grasses located between two patches of dry forest with an understory of evergreen thicket. Photo: ©Frank Willems, 18 September 2016.*

Shiwa N'gandu and the nearby Kapishya Hot springs are listed as an Important Bird Area (number 30; Leonard 2005). The estate is also known as the Mansha River Conservation Area, reflecting the importance of wildlife conservation in the management of the estate.

Methods

I visited Shiwa N'gandu from 16 to 18 September 2016 to search for Giant Chequered Sengis (*Rhynchocyon cirnei*), focusing mainly on a patch of dry forest with an evergreen thicket understory at S11.245°/E31.720°, while shorter visits were made to other parts of the estate and Kapishya Hot springs. I searched for sengis and other fauna by slowly moving through the patch on foot, following roads and game trails.

Figure 3: *Typical vegetation at the edge of a thicket in Shiwa N'gandu Estate, where sengis were sighted. Photo: ©Frank Willems, 18 September 2016.*

Results

I spotted what I believe to be 14 different individual Chequered Giant Sengis (Fig. 1) during a total of five hours searching within a 10 ha patch of dry forest with an evergreen thicket understory on Shiwa N'gandu Estate, between coordinates S11.2443°/E31.7188° and S11.2474°/E31.7214°. I saw no sengis in other parts of the estate or at Kapishya Hot springs.

This thicket patch borders Lake Shiwa N'gandu. It is dominated by a dense, 8 m tall thicket layer of evergreen bushes and creepers. Due to the closed canopy, a herb layer was largely absent, but leaf litter was abundant (Fig. 2).

Discussion

Shiwa N'gandu lies between Mutinondo Wilderness and the extreme northern parts of Zambia, where *R. cirnei reichardi* is known to occur (Willems 2016, fig. 1). My observations now confirm a wide distribution of the Chequered Giant Sengi in the Muchinga Highlands of Zambia.

As in Mutinondo Wilderness and indeed most known localities of Chequered Giant Sengi, animals utilize evergreen closed-canopy habitats with dense leaf litter (Rathbun 2013, Willems 2016). Although the odd animal was observed in more open habitats (as in fig. 2), there is no indication that the species uses any such habitats other than to move between forest patches.

The species has been reported to be present in other dry evergreen forests within Shiwa N'gandu Estate, further northeast along the lake, as well as at Kapishya Hot springs (Willems

2016). I could not confirm these reports. The vegetation in these locations, however, seems very suitable, hence there is no reason to question these reports.

Comparing my images from Shiwa N'gandu with specimens in the Livingstone Museum from other areas of northern Zambia, suggests that the pelage patterns are essentially identical, indicating Muchinga Plateau populations belong to the subspecies *R. c. reichardi*.

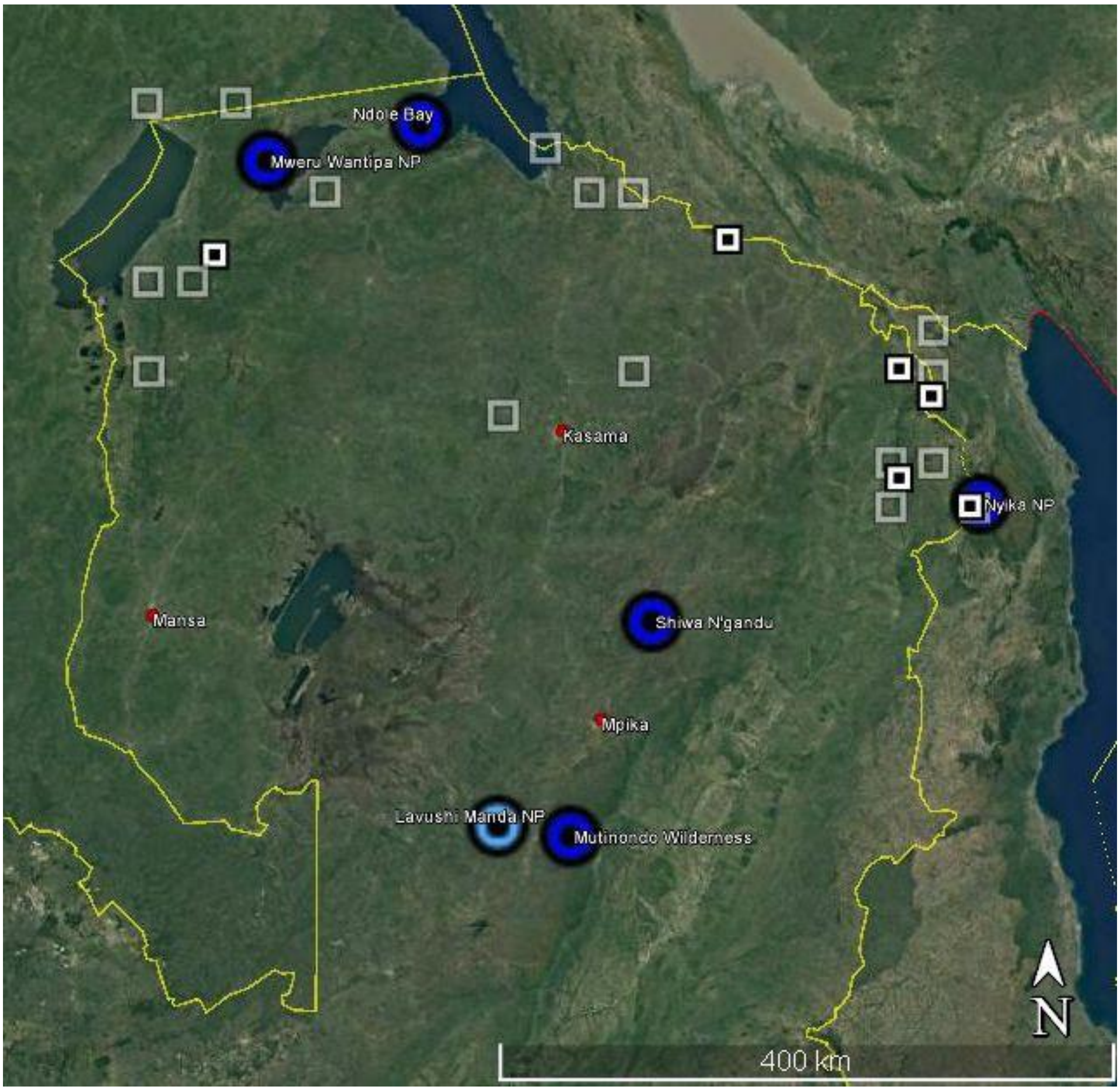

Figure 1: *Google Earth image showing the location of Shiwa N'gandu and other known localities of Chequered Giant Sengi in north-eastern Zambia. Red dots indicate major cities, black-centred squares indicate localities of museum specimens (Corbet & Hanks 1968, Ansell & Dowsett 1988, Livingstone Museum collection), open squares indicate localities given by Ansell (1978; 1/16th degree squares), circles indicate localities presented in Willems (2016) and this publication. Dark blue circles are for confirmed records, and pale blue circles for unconfirmed records, as discussed in text.*

The conservation status of Chequered Giant Sengi at Shiwa N'gandu can be considered favourable. The owners actively aim to preserve the natural habitats and wildlife on the estate. The main forms of land-use, livestock ranching and game farming, do not seem to present a short-term threat to the sengi's habitat. On the other hand, substantial areas of potentially suitable habitat have been lost in the last century as a result of conversion to arable land or exotic tree plantations. Remaining habitats have degenerated in places, being opened up for grazing by fires and manual clearing of thickets. In addition, some subsistence hunting with small wire snares was noticed in the survey patch, reportedly targeting the sengis. There is also anecdotal evidence that a domestic dog killed a sengi in the survey patch (P. Borsboom *pers. comm.*). This suggests the species is vulnerable to hunting with dogs, which is not allowed on the estate but common practice outside protected areas (own observations).

On the basis of my own observations, it can be assumed that the above detailed factors seriously threaten the long-term survival of individual populations in Zambia outside protected areas such as Shiwa N'gandu and Mutinondo Wilderness. Active conservation and further study of known populations is recommended.

Acknowledgements

The author wishes to thank Pauline Borsboom, Charlie and Jo Harvey, and Mark and Mel Harvey for their hospitality and their contributions to conservation and sustainable development on Shiwa N'gandu, Kapishya Hot springs and beyond. Galen Rathbun and Chris and Mathilde Stuart are thanked for their encouragement and comments on a draft version of this article.

References

Ansell W.F.H. 1978. The Mammals of Zambia. The National Parks and Wildlife Service, Chilanga.

Leonard P. 2005. Important Bird Areas in Zambia. Zambian Ornithological Society, Lusaka, Zambia.

Rathbun G. 2013. Rhynchocyon cirnei Chequered Giant Sengi (Chequered Elephant Shrew), pp 285-286 in Kingdon, J. *et al*. (eds) 2013. Mammals of Africa. Volume I: Introductory Chapters and Afrotheria. Bloomsbury Publishing, London.

Willems F.J. 2016. The occurrence of Chequered Giant Sengis (Rhynchocyon cirnei) in Mutinondo Wilderness and its distribution in Zambia. Afrotherian Conservation 12(23-28).

Identifying the different forms of giant sengi (*Rhynchocyon*) based on external colour patterns.

Galen B. Rathbun

Department of Ornithology and Mammalogy, California Academy of Sciences, San Francisco, CA 94118, USA

The sengi or elephant-shrew genus *Rhynchocyon* includes five species and 8 subspecies restricted to closed canopy thickets, woodlands, and forests of central and eastern Africa. All forms are diurnal and have colourful pelage patterns, thus they are relatively easy to observe, for a small (ca. 500 g) mammal (Rathbun 2009). Sightings are being reported more frequently as people move into or explore some of the more remote areas of Africa. Well-documented sightings (and especially photographs) promise to contribute to a better understanding of giant sengi distributions, and will improve conservation assessments (www.iucnredlist.org).

The main features used in identifying *Rhynchocyon* forms include the colour of the rump and face pelage, the colour of the tail and ear skin, and the pattern of parallel dark lines and associated light spots (checkering) on the pelage of the back (Corbet & Hanks 1968). However, the checkering, which is common in many forms and is likely ancestral, is variably masked by the different intensity of dark pelage on the back and rump of some forms. These dark individuals in some cases may represent geographic clines (Corbet & Hanks 1968) with lighter forms (**see key below**).

To help people identify the different forms of *Rhynchocyon*, I have constructed the following key, which follows the taxonomy of Corbet and Hanks (1968) and updates by Rovero et al. (2008), Adanje et al. (2010), and Carlen et al. (2017). With additional data and analyses, some relatively minor changes might be expected in the future. The two figures illustrating color patterns do not include all taxa, but focus on similar forms that may present identification difficulties. General distributions (http://www.sengis.org/distribution.php), also indicated in the key, often are of great help in determining identifications.

I greatly appreciate access to the collection of the Natural History Museum, London, which is the source of my images, as well as the Ditsong Museum of Natural History, Pretoria, South Africa. Useful suggestions on this paper were provided by Peter Coals and David Ribble.

References:

Andanje, S., B. R. Agwanda, G. W. Ngaruiya, R. Amin, and G. B. Rathbun. 2010. Sengi (elephant-shrew) observations from northern coastal Kenya. Journal of East African Natural History 99:1-8.

Carlen, E. J., G. B. Rathbun, L. E. Olson, C. A. Sabuni, W. T. Stanley, and J. P. Dumbacher. 2017. Reconstructing the molecular phylogeny of giant sengis (Macroscelidea: Macroscelididae: *Rhynchocyon*). Molecular Phylogenetics and Evolution 113:150-160.

Corbet, G. B., and J. Hanks. 1968. A revision of the elephant-shrews, Family Macroscelididae. Bulletin of the British Museum (Natural History) Zoology **16**:47-111.

Rathbun, G. B. 2009. Why is there discordant diversity in sengi (Mammalia: Afrotheria: Macroscelidea) taxonomy and ecology? African Journal of Ecology 47:1-13.

Rovero, F., G. B. Rathbun, A. Perkin, T. Jones, D. Ribble, C. Leonard, R. R. Mwakisoma, and N. Doggart. 2008. A new species of giant sengi or elephant-shrew (genus *Rhynchocyon*) highlights the exceptional biodiversity of the Udzungwa Mountains of Tanzania. Journal of Zoology, London 274:126-133.

Identification Key to *Rhynchocyon* taxa
based on external colour patterns and geographic distribution

1a. Rump patch distinctly yellow; Kenya, central coast--------------------------***R. chrysopygus*** (subgenus *Rhinonax*)
1b. No yellow rump patch--**2**
2a. Tail white from tip to base (sometimes with indistinct slightly darker narrow dorsum); Congo Basin and western Uganda; all are distinctly checkered, cline with western forms being darker than those to the east--***R. stuhlmanni***
2b. Tail not white, but orange or shades of brown, often with white band near tip--- **3**
3a. Tail and ear skin and face pelage bright rufous or orange; rump, back, and thigh pelage jet black (two subspecies may not be justified)------------------------------***R. petersi petersi*** (mainland eastern Africa) and---***R. p. adersi*** (Tanzania offshore islands).
3b. Tail skin various shades of brown to black, may be lighter ventrally, with variable white band near tip; ear skin shades of brown; rump colour variable-----------------**4**
4a. Face pelage gray with no yellow or brown; rump and thighs black; Tanzania, Udzungwa Mountains--***R. udzungwensis***
4b. Face pelage brownish-yellow---**5**
5a. Back and rump with distinct pattern of dark parallel lines, often checkered with light spots; lower back, rump, and thighs with no dark pelage obscuring lines and checkers---------- --**6**
5b. Back dark maroon or rufous grading to nearly black rump and thighs; dark pelage nearly obscuring darker parallel lines and checkering on back; Tanzania, south-eastern coastal lowlands (north Ruvuma River)---***R. c. macrurus*** (dark form in east-west cline, see no. 7a).
5c. Similar to no. 5b (undescribed form with incomplete understanding of colour patterns; Fig. 1); Kenya, northern coast in Boni & Dodori forests---------------------***Rhynchocyon* sp.**
6a. Pattern on rump and back composed of 3 very distinct pairs of parallel black or very dark lines with inner pair reaching ¾ of way to neck; distinct cream or white checker spots within at least the two inner pair of lines; Rift Valley highlands in Tanzania, Zambia, and Malawi (possible full species)--***R. c. reichardi*** and --***R. c. hendersoni*** (likely individuals of *reichardi* at higher elevations with darker back, rump, and sides partially masking checkering).
6b. Pattern on rump and back composed of 1 or 2 distinct pairs of dark (often chestnut) lines that reach ½ way to neck; indistinct third pair of outer lines may be present; no white checker spotting completely within each line------------------------------------**7**
7a. Background pelage on back, and especially sides and thighs, yellow-brown; central pair of lines dark brown and well-defined with closely associated brown spotting on outer edge or with outer edge broken with intruding areas the same colour as general back pelage; Tanzania, inland southeast lowlands north Ruvuma River (light inland form in west-east cline; see no. 5a)--***R. c. macrurus***
7b. Background pelage on back, and especially sides and thighs, gray-brown; central pair of lines chestnut and often ill-defined with outer edge or entire line broken with intruding lighter areas of surrounding yellow-brown colour of back (following pair may be same taxon)---**8**
8a. Mozambique (south Ruvuma River) and southern Malawi----------------- ***R. c. cirnei***
8b. Malawi, Shire Valley---***R. c. shirensis***

Figure 1. *Representatives of the various "dark" forms of* Rhynchocyon *(top 4) showing distinctive features (see key). Bottom three study skins illustrate the* R. c. macrurus *cline from the coast (top of three) to inland (bottom of three). The morphologically and taxonomically undescribed* Rhynchocyon *from northern coastal Kenya (Boni-Dodori forest area) is superficially similar to the coastal form of* R. c. macrurus *(middle skin). Catalog numbers from top to bottom from the The Natural History Museum, London, (BMNH): BMNH2007.7, BMNH55.148, BMNH62.423, BMNH62-400, BMNH62-405.*

Figure 2. *Representatives of some checkered forms of* Rhynchocyon*, illustrating the complicated dorsal pelage patterns (see key). Study skins shown and their catalog numbers (The Natural History Museum, London = BMNH; California Academy of Sciences, San Francisco = CAS), from lower left clockwise:* R. c. cirnei *from northern Mozambique (BMNH34.1.11.6, CAS 29358, and CAS29352);* R. c. macrurus *cline from inland south-eastern Tanzania (BMNH62.405, BMNH62.404, BMNH1938.10.13.5) to coastal south-eastern Tanzania (BMNH63.1852 and BMNH62.400);* R. c. shirensis *from southern Malawi (BMNH22.12.17.116, BMNH14.4.29.2, and BMNH22.12.17.115);* R. c. reichardi *from Tanzania highlands (BMNH30.2.7.1; note third outer pair of lines not visible in this view).*

Sengi Taxonomy – a 2017 update

Galen B. Rathbun

Department of Ornithology and Mammalogy, California Academy of Sciences, Golden Gate Park, San Francisco, CA, grathbun@gmail.com

During the last decade, several publications have proposed significant changes and additions to sengi taxonomy. Because taxonomy is fundamental to conservation, below I summarise the systematics of extant sengis, which includes 20 species in five genera. For subspecies taxonomy see literature cited, and for IUCN Red List status visit www.afrotheria.net. The species below ending with an * represent changes to the long-standing sengi taxonomy, as defined by Corbet and Hanks (1968). The short bibliography of peer-reviewed publications supports this updated listing.

Order: Macroscelidea Butler, 1956
- Family: Macroscelididae Bonaparte, 1838
  - Subfamily: Macroscelidinae Bonaparte, 1838
    - Tribe: Elephantulini *
      - Genus: *Elephantulus* Thomas & Schwann, 1906
        - *Elephantulus brachyrhynchus* A. Smith, 1836
        - *Elephantulus edwardii* A. Smith, 1839
        - *Elephantulus fuscipes* Thomas, 1894
        - *Elephantulus fuscus* Peters, 1852
        - *Elephantulus intufi A. Smith, 1836*
        - *Elephantulus myurus* Thomas & Schwann, 1906
        - *Elephantulus pilicaudus* Smit, 2008 *
        - *Elephantulus revoilii Huet, 1881*
        - *Elephantulus rufescens Peters, 1874*
        - *Elephantulus rupestris* A. Smith 1831
    - Tribe: Macroscelidini *
      - Genus: *Macroscelides* A. Smith, 1829
        - *Macroscelides flavicaudatus* Lundholm, 1955 *
        - *Macroscelides micus* Dumbacher & Rathbun, 2014 *
        - *Macroscelides proboscideus* Shaw, 1800
      - Genus: *Petrodromus* Peters, 1846
        - *Petrodromus tetradactylus* Peters, 1846
      - Genus: *Petrosaltator* Rathbun & Dumbacher, 2016 *
        - *Petrosaltator rozeti* Duvernoy, 1833
  - Subfamily: Rhynchocyoninae Gill 1872
    - Genus: *Rhynchocyon* Peters, 1847
      - *Rhynchocyon chrysopygus Günther, 1881*
      - *Rhynchocyon cirnei Peters, 1847*
      - *Rhynchocyon petersi* Bocage, 1880
      - *Rhynchocyon stuhlmanni* Matschie, 1893 *
      - *Rhynchocyon udzungwensis* Rathbun & Rovero, 2008 *
      - *Rhynchocyon* sp. (undescribed form, northern coastal Kenya) *

Bibliography

Corbet, G. B. 1974. Family Macroscelididae. Pages 1-6 in J. Meester and H. W. Setzer, editors. The mammals of Africa: An identification manual. Smithsonian Institution Press, Washington, DC.

Corbet, G. B., and J. Hanks. 1968. A revision of the elephant-shrews, Family Macroscelididae. Bulletin of the British Museum (Natural History) Zoology 16:47-111.

Carlen, E. J., G. B. Rathbun, L. E. Olson, C. A. Sabuni, W. T. Stanley, and J. P. Dumbacher.

2017. Reconstructing the molecular phylogeny of giant sengis (Macroscelidea; Macroscelididae: *Rhynchocyon*). Molecular Phylogenetics and Evolution 113:150-160.

Dumbacher, J. P., E. J. Carlen, and G. B. Rathbun. 2016. *Petrosaltator* gen. nov., a new genus replacement for the North African sengi *Elephantulus rozeti* (Macroscelidea; Macroscelididae). Zootaxa 4136:567-579.

Dumbacher, J. P., G. B. Rathbun, T. O. Osborne, M. Griffin, and S. J. Eiseb. 2014. A new species of round-eared sengi (genus *Macroscelides*) from Namibia. Journal of Mammalogy 95:443-454.

Dumbacher, J. P., G. B. Rathbun, H. A. Smit, and S. J. Eiseb. 2012. Phylogeny and taxonomy of the round-eared sengi or elephant-shrew, Genus Macroscelides (Mammalia, Afrotheria, Macroscelidea). PLoS (Public Library of Science) ONE 7:e32410 (32412 + 32414 suppl pages).

Rovero, F., G. B. Rathbun, A. Perkin, T. Jones, D. Ribble, C. Leonard, R. R. Mwakisoma, and N. Doggart. 2008. A new species of giant sengi or elephant-shrew (genus *Rhynchocyon*) highlights the exceptional biodiversity of the Udzungwa Mountains of Tanzania. Journal of Zoology, London 274:126-133.

Smit, H. A., T. J. Robinson, J. Watson, and B. Jansen van Vuuren. 2008. A new species of elephant-shrew (Afrotheria: Macroscelidea: *Elephantulus*) from South Africa. Journal of Mammalogy 89:1257-1269.

Cape Rock Hyrax research update: Cryptic diversity in the rock hyrax from southern Africa

K. Amanda Maswanganye

Molecular Ecology and Evolution Programme, Department of Genetics and Department of Zoology & Entomology, University of Pretoria, Pretoria, South Africa, amaswang@zoology.up.ac.za

Hyraxes are arguably the most under studied paenungulates within the Afrotheria (Springer *et al*. 1999, Murata *et al*. 2003, Shoshani 2005). The rock hyrax (*Procavia capensis*, Figure 1) occurs extensively throughout Africa, the Middle East and the Arabian Peninsula. Although *Procavia* is treated as monospecific, numerous species and subspecies have been considered in the past and there is no clear agreement among authorities (Allen 1939, Bothma 1971, Corbet 1978, Hoeck 1978, Meester *et al*. 1986, Shoshani 2005, Bloomer 2009, Bloomer and Hoeck 2013, Hoeck and Bloomer 2013).

As part of my PhD research I extended the work by Prinsloo and Robinson (1992) and Prinsloo (1993) by investigating the evolutionary relationships between the previously identified southern African rock hyrax lineages based on sequence data of mitochondrial (cytochrome *b*) and nuclear intron markers (AP5, PRKC1) and genotypes at five microsatellite loci (Gerlach *et al*. 2000, Koren and Geffen 2011). In addition, I used species distribution modelling throughout southern Africa to identify potential refugia for rock hyrax. In total I utilized 120 samples, with sub-sampling of 35 individuals for the nuclear intron amplification, based on cytochrome *b* results (Maswanganye *et al*. 2017).

***Figure 1** Rock hyraxes in their natural habitat* - Procavia capensis capensis *from southern Africa (photos P. Bloomer, Augrabies Falls National Park).*

The phylogenetic and phylogeographic analyses confirm the presence of two deep mitochondrial lineages in the north-eastern and south-western parts of South Africa (Figure 2). In addition to the 45 maternal haplotypes from South Africa, a single divergent sample from northern Namibia (courtesy of Galen Rathbun) differs by more than 10 mutational steps, but clusters closest to the south-western lineage. The nuclear data suggest some gene flow between the lineages but future analyses must distinguish between the retention of ancestral polymorphisms versus ongoing mixing between the groups. With the present sampling the multi-locus data fit a model of isolation with migration, with higher gene flow from the northern into the southern lineage. Although I did not detect any barriers to gene flow, there is a 100 km stretch from the Blyde River Canyon (Mpumalanga Province) to the Vredefort area (northern Free State Province) where the two lineages occur in close proximity (Figure 2, Maswanganye *et al.* 2017).

The distribution modelling indicated that, as expected, hyrax populations are highly dependent on rocky areas and food availability. The species distribution and population diversity is affected by habitat dependence and climatic changes. Although hyrax numbers appear to be stable over time, core areas that are resilient to climate change will ensure future persistence of hyrax diversity in southern Africa (Maswanganye *et al*. 2017).

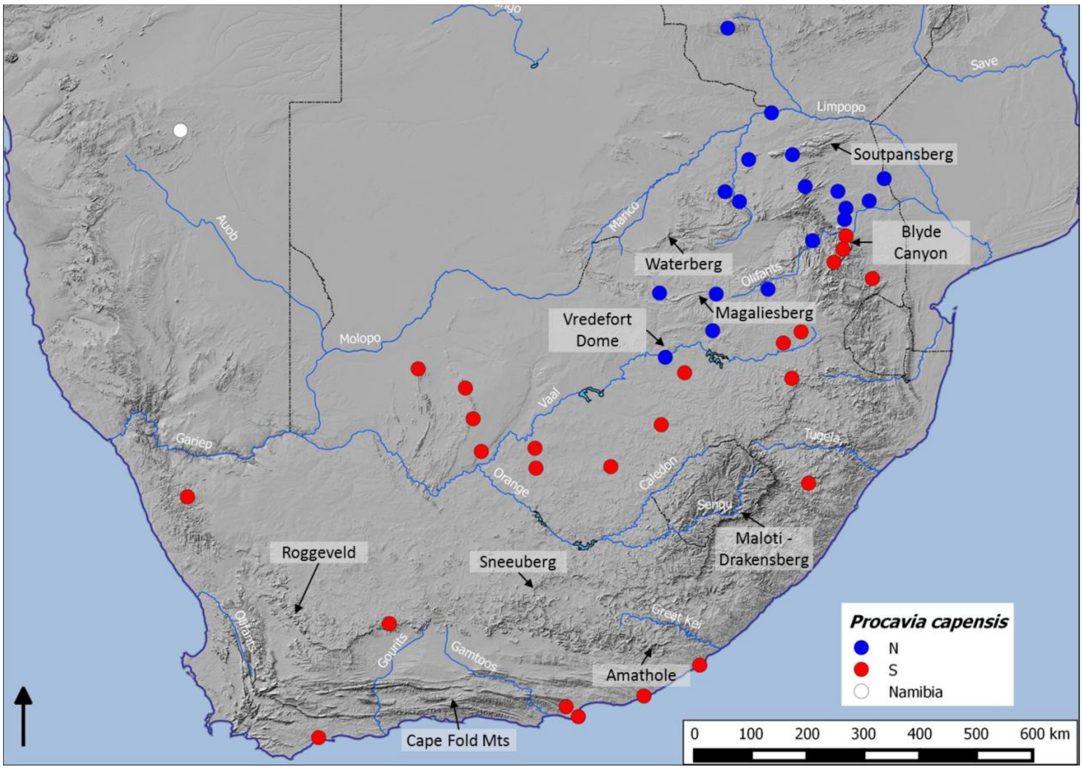

***Figure 2** Map of the sampling localities of* Procavia capensis *from southern Africa used in this study. The localities are colour coded to correspond with northern (blue), southern (red) and Namibian (white) lineages recovered in the mitochondrial DNA phylogenetic and phylogeographic analyses (modified from Maswanganye et al. 2017).*

These research findings highlight the diversity found within hyrax from South Africa and phylogenetic analysis with limited sampling indicates the distinction of these lineages from each other and from rock hyrax in Namibia, Kenya and Israel (Maswanganye *et al*. 2017). Our research group invites contribution of further hyrax material for genetic analyses. Comprehensive sampling across the distribution will enable a reassessment of species diversity in the genus and family and aid planning for their conservation. A small skin biopsy (fresh or museum specimen) is adequate for DNA extraction and interested parties can contact me for sampling instructions and storage solutions.

References

Allen, G.M. 1939. A checklist of African Mammals. *Bulletin of the Museum of Comparative Zoology at Harvard College*, 83: 1-763.

Bloomer, P. 2009. Extant hyrax diversity is vastly underestimated. *Afrotherian Conservation*, 7: 11-16.

Bloomer, P. and Hoeck, H.N. 2013. Genus *Procavia* Rock Hyrax. Pp 165 in Kingdon, J., Happold, D., Hoffman, M., Butynski, T., Happold, M. and Kalina, J. (eds.), *Mammals of Africa*. Volume I: Introductory Chapters and Afrotheria. Bloomsbury Publishing, London.

Bothma, J. du P. 1971. Order Hyracoidea. Pp 1-8 in Meester, J. and Setzer, H.W. (eds.), *The Mammals of Africa: an identification manual*. Smithsonian Institution Press, Washington D.C.

Corbet, G.B. 1978. *The Mammals of the Palaearctic region: a taxonomic review*. British Museum (N.H.) and Cornell University Press, London.

Gerlach, G., Derschum, H.S., Martin, Y. and Brinkmann, H. 2000. Characterization and isolation of DNA microsatellite primers in hyrax species (*Procavia johnstoni* and *Heterohyrax brucei*, Hyracoidea). *Molecular Ecology*, 9: 1675–1677.

Hoeck, H.N. 1978. Systematics of the Hyracoidea: towards a clarification. Pp 146-151 in Schlitter, D.A. (ed.), *Ecology and taxonomy of African Small Mammals*. Bulletin of the Carnegie Museum of Natural History, Pittsburgh.

Hoeck, H.N. and Bloomer, P. 2013. *Procavia capensis* Rock Hyrax. Pp 166-171 in Kingdon, J., Happold, D., Hoffman, M., Butynski, T., Happold, M. and Kalina, J. (eds.), *Mammals of Africa*. Volume I: Introductory Chapters and Afrotheria. Bloomsbury Publishing, London.

Koren, L. and Geffen, E. 2011. Individual identity is communicated through multiple pathways in male rock hyrax (*Procavia capensis*) songs. *Behavioural Ecology and Sociobiology, 65:* 675–684.

Maswanganye, K.A., Cunningham, M.J, Bennett, N.C., Chimimba, C.T. and Bloomer, P. 2017. Life on the rocks: Multilocus phylogeography of rock hyrax (*Procavia capensis*) from southern Africa. *Molecular Phylogenetics and Evolution,* 114: 49–62.

Meester, J.A.J., Rautenbach, I.L., Dippenaar, N.J. and Baker, C.M. 1986. *Classification of Southern African Mammals*. Transvaal Museum Monograph No. 5, Transvaal Museum, Pretoria.

Murata, Y., Nikaido, M., Sasaki, T., Cao, Y., Fukumoto, Y., Hasegawa, M. and Okada, N. 2003. Afrotherian phylogeny as inferred from complete mitochondrial genomes. *Molecular Phylogenetics and Evolution, 28*: 253–260.

Prinsloo, P. 1993. *Molecular and chromosomal phylogeny of the Hyracoidea*. Unpublished PhD thesis, University of Pretoria, Pretoria.

Prinsloo, P. and Robinson, T.J. 1992. Geographic mitochondrial DNA variation in the rock hyrax, *Procavia capensis. Molecular Biology and Evolution,* 9: 447-56.

Shoshani, J. 2005. Order Hyracoidea. Pp 87-89 in Wilson, D.E. and Reeder, D.M. (eds.), *Mammal Species of the World: A Taxonomic and Geographic Reference* (Third Edition). Johns Hopkins University Press, Baltimore, USA.

Springer, M.S., Amrine, H.M., Burk, A. and Stanhope, M.J. 1999. Additional support for Afrotheria and Paenungulata, the performance of mitochondrial versus nuclear genes, and the impact of data partitions with heterogeneous base composition. *Systematic Biology*, 48: 65-75.

Genes reveal new golden mole cryptic lineages in the Greater-Maputaland-Pondoland-Albany region of southern Africa.

Samantha Mynhardt, ASG Golden mole Section Member

Department of Genetics, University of Pretoria, smynhardt@zoology.up.ac.za

In March 2012, as part of my PhD research, I began to investigate the distribution and genetic connectivity among populations of the Hottentot Golden Mole, *Amblysomus hottentotus*, in South Africa (Fig. 1). Golden moles (Family Chrysochloridae) are small, insectivorous fossorial mammals, which are elusive and relatively under-studied, mostly due to the challenge of observing their subterranean behaviour in the wild, coupled with their failure to thrive in captivity. The family comprises 21 species, all endemic to sub-Saharan Africa, of which ten are listed as threatened on the IUCN Red Data List (2016). Most species have significantly restricted ranges and, consequently, highly fragmented and/or isolated distributions, while others, such as *A. hottentotus* and *Chrysochloris asiatica* (the Cape golden mole) appear to be relatively abundant and widespread. However, uncertainties have arisen over the taxonomic delineation of taxa within the Chrysochloridae, and the family is currently undergoing a taxonomic revision (Maree *et al.* in press).

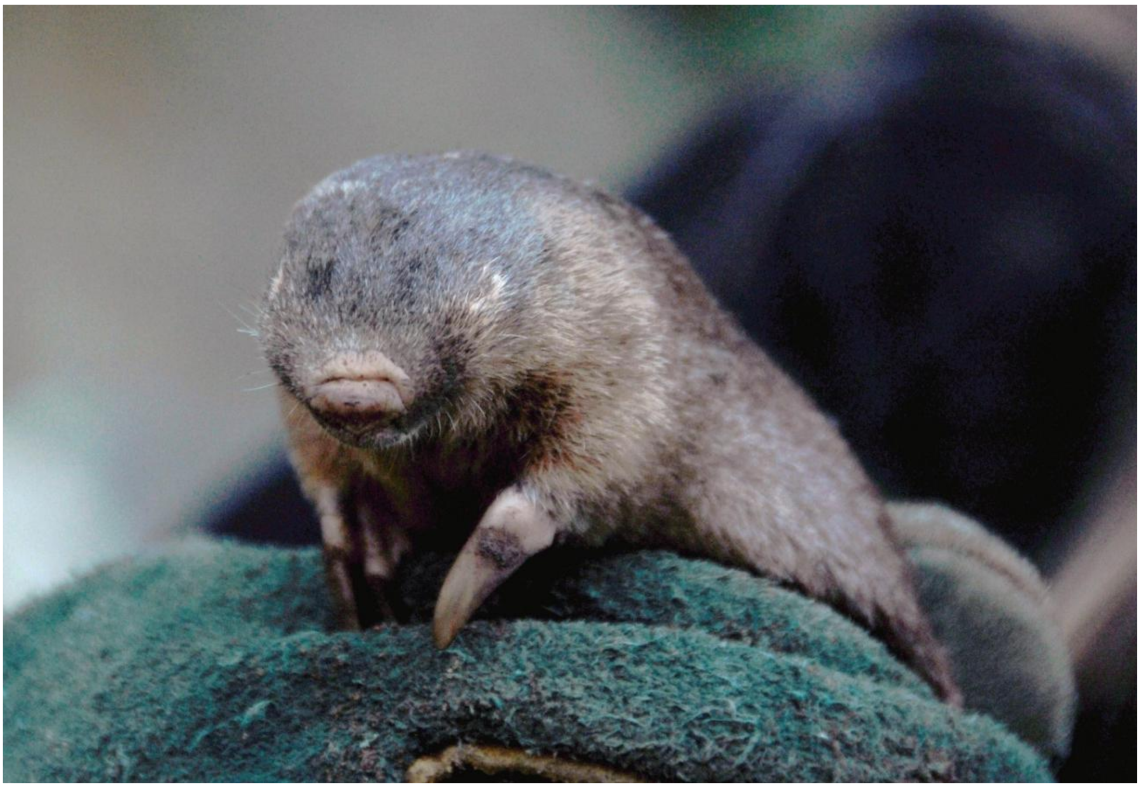

***Fig. 1** Hottentot golden mole,* Amblysomus hottentotus, *captured at Illovo, Kwa-Zulu Natal.*

Amblysomus (Pomel, 1848) is distributed across southern Africa (Bronner & Jenkins 2005) and comprises five species, primarily distinguished based on morphology and cytogenetics: *A. hottentotus* (Smith, 1829; 2n = 30), *A. marleyi* (Roberts, 1931; 2n = 30), *A. corriae* (Thomas, 1905; 2n = 30), *A. robustus* (Bronner, 2000; 2n = 36) and *A. septentrionalis* (Roberts, 1913; 2n = 34). Three of these species (*A. hottentotus, A. marleyi* and *A. robustus*) are endemic to the Greater-Maputaland-Pondoland-Albany (GMPA) region of vertebrate endemism (Perera *et al.* 2011; Fig. 2). Previous sub-specific classifications within *A. hottentotus* were based on subtle morphological distinctions, including body size, pelage colour, claw morphology, as well as cranio-dental characteristics (Fig. 2; Roberts 1951; Bronner 1996), but many of these characters appear to be ambiguous and inconclusive.

Fortunately, given the difficulties associated with trapping golden moles, when I began my studies in 2012, many *A. hottentotus* samples were already available to me, through previous combined sampling efforts of various past and present ASG members (Dr. Gary Bronner, Prof. Nigel Bennett, Dr. Sarita Maree, Dr. John Wilson and Illona Pelser). So, with one additional field trip to Kwa-Zulu Natal, which added a mere 9 specimens to my cohort of 115 (did I mention these animals are highly elusive?), I began the task of sequencing various DNA markers. Two mitochondrial gene regions (NADH dehydrogenase subunit 2, *MT-ND2*, and cytochrome *b*, cyt *b*) and one nuclear intron (Growth Hormone Receptor, GHR, intron 9) were sequenced for 124 specimens representing 50 sampling sites across the entire distribution of *Amblysomus*.

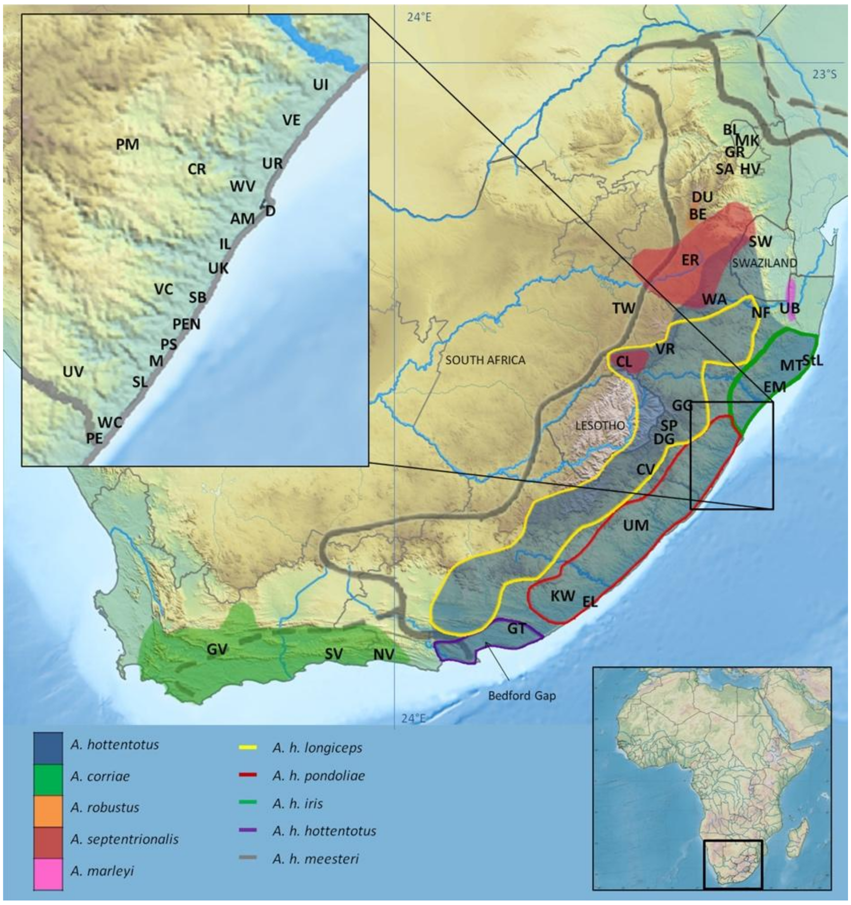

Fig. 2 *Map of southern Africa indicating the extent of the GMPA (solid grey line) and its transitional extensions (broken grey lines) (Perera et al. 2011).* Amblysomus *species distributions are indicated by coloured shading and* A. hottentotus *subspecies distributions by coloured lines.*

To gain an understanding of the extrinsic and demographic factors that have driven diversification in this "widespread species", I investigated the evolutionary history of *A. hottentotus* by means of phylogeographic analyses and divergence dating. These analyses revealed that divergence of the major *Amblysomus* lineages occurred during the early Pliocene, with later radiations during the late-Pliocene to early-Pleistocene. Congruence with well-documented palaeo-ecological and geomorphological events in southern Africa suggested that uplift of the Great Escarpment c. 5-3 Ma, followed by dissection of the eastern GMPA coastal plain by developing, deep rivers fragmented the dispersal landscape occupied by an ancestral *A. hottentotus* lineage. That, as well as habitat changes resulting from intensification of the east-west rainfall gradient across South Africa and sea level fluctuations associated with subsequent global climatic cycles, probably led to reduced gene flow between emergent coastal lineages, resulting in differentiation of the 4 coastal lineages detected by my analyses. Both geological and palaeo-climatic events were thus likely drivers of evolutionary diversification within *Amblysomus*.

Some of the taxonomic ambiguities associated with *Amblysomus* were furthermore resolved with a broad phylogeographic analysis across all *Amblysomus* species (Fig. 3). We uncovered substantial cryptic diversity within *A. hottentotus*, revealing two new lineages that qualify as evolutionarily significant units (ESUs), and demonstrating that many lineages within this assemblage may be older than some currently recognised *Amblysomus* species. Our results thus challenge the sub-specific taxonomy for *A. hottentotus*, as well as the proposed geographic limits of subspecies (Bronner 2013). We have thus proposed that *A. hottentotus* is in fact a species complex, with some major lineages possibly representing distinct species. We published our findings in 2015 (Mynhardt *et al*. 2015), providing molecular support for the recognition of various *A. hottentotus* subspecies as valid species, but have refrained from formal taxonomic revision until this hypothesis can be further corroborated by more rigorous species delimitation. However, we recommend the recognition of these ESUs for the purpose of urgent conservation management.

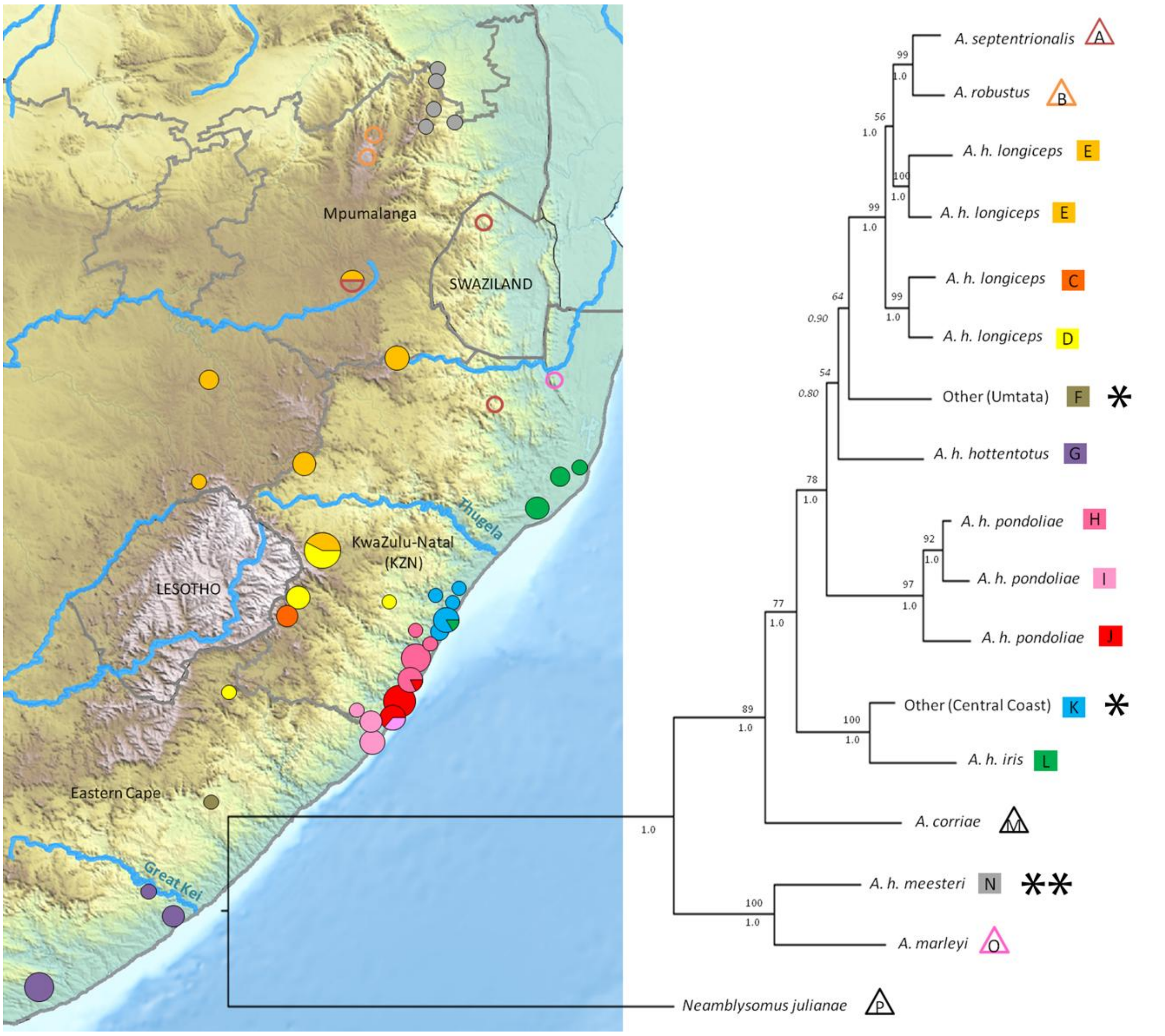

Fig. 3 *Amblysomus phylogram for the representative combined dataset (MT-ND2, cyt b and GHR intron 9), with nodal support indicated by bootstrap values above and posterior probabilities below branches; low support values are indicated in italics. Designation of* A. hottentotus *subspecies and other* Amblysomus *species (clades A-O) are denoted by coloured squares and empty triangles respectively. The colours correspond to the sampling localities depicted on the associated map. Circle sizes are representative of sample size. * Two new lineages, qualifying as evolutionarily significant units (ESUs), were identified. ** Some lineages within the* A. hottentotus *assemblage (e.g.* A. h. meesteri*) may be older than some currently recognised* Amblysomus *species (e.g.* A. robustus *and* A. septentrionalis*).*

Future studies will involve further unravelling some of the relationships among *Amblysomus* taxa that remain unclear, through further sampling, ecological niche modelling and/or more recently emerging, rigorous methods of species delimitation. Furthermore, I have conducted a pilot RAD-sequencing study in *A. hottentotus* as part of my PhD, and hope to incorporate these results, along with additional RAD-seq data in future species delimitation, as well as in finer-scale population genetics studies.

For more information see Phylogeography of a Morphologically Cryptic Golden Mole Assemblage from South-Eastern Africa. Results of this study, along with the supporting results of the pilot RAD-seq study, were also disseminated at the recent International Mammalogical Congress (IMC12) meeting in Perth, Western Australia (Mynhardt *et al*. 2017).

References:

Bronner GN (1996) Non-geographic variation in morphological characteristics of the Hottentot golden mole, *Amblysomus hottentotus* (Insectivora: Chrysochloridae). *Mammalia* **60**, 707-728.

Bronner GN (2000) New species and subspecies of golden mole (Chrysochloridae: *Amblysomus*) from Mpumalanga, South Africa. *Mammalia* **64**, 41-54.

Bronner GN, Jenkins PD (2005) Order Afrosoricida. In: *Mammal species of the World: A taxonomic and geographic reference, 3rd edition* (eds. Wilson DE, Reeder DM), pp. 71-81. Baltimore Johns Hopkins University Press.

Bronner GN (2013) Family Chrysochloridae: Golden Moles. In: *Mammals of Africa* (eds. Kingdon J, Happold D, Butynski T, *et al.*), pp. 226 - 229. Bloomsbury Publishing, London.

Mynhardt S, Maree S, Pelser I, *et al.* (2015) Phylogeography of a morphologically cryptic golden mole assemblage from South-Eastern Africa. *PLoS ONE* **10**, e0144995.

Mynhardt S, Maree S, Pelser I, *et al.* (2017) Cryptic diversity revealed in a golden mole assemblage from South-Eastern Africa. 12th International Mammalogical Congress: Advances in mammalogy in a changing world. Perth, Western Australia. 9-14 July.

Perera SJ, Ratnayake-Perera D, Proches S (2011) Vertebrate distributions indicate a greater Maputaland-Pondoland-Albany region of endemism. *South African Journal of Science* **107**, 1-15.

Roberts A (1951) *The mammals of South Africa* Trustees of 'The Mammals of South Africa' Book Fund, Johannesburg.

Species distribution modelling forecasts the possible ranges and conservation status of four grassland golden mole taxa (*Amblysomus*) in South Africa.

Gary Bronner, ASG Golden mole Section Co-ordinator

Department of Biological Sciences, University of Cape Town, P/Bag X03, Rondebosch 7701, South Africa. gary.bronner@uct.ac.za

In early 2016, Chanel Rampartab (ASG member 2014-16) was awarded an MSc degree by the University of Cape Town for a dissertation entitled "*Facilitating golden mole conservation in South African highland grasslands: A predictive modelling approach*". This study was initiated by the Threatened Grassland Species Programme of the Endangered Wildlife Trust (EWT), with seed funding from the Mohamed bin Zayed Species Conservation Fund, and additional financial support provided by National Research Foundation grants to Gary Bronner (Principal Supervisor), as well as Professors Nigel Bennett and Paulette Bloomer (University of Pretoria), who also served as project co-supervisors. Additional co-supervisors were Professor Mark Robertson (University of Pretoria) and Dr Ian Little (Endangered Wildlife Trust). Ms Lientjie Cohen (Mpumalanga Parks and Tourism Agency) kindly also provided much-needed logistical fieldwork support. The full dissertation is available on the OpenUCT portal via this link. Here we present a synopsis of the study and the main findings.

Why?

The Grassland biome of South Africa is sensitive to anthropogenic disturbances, with about 60% of the biome having been irreversibly degraded while only 2.2% is formally conserved (Little et al. 2013). Highveld (highland, altitude > 1000 m) grasslands above the Great Escarpment in Mpumalanga are among the most threatened and transformed vegetation types in the biome. The Mpumalanga Highveld grasslands span 531km^2, 44% of which has been radically transformed , in many areas irreversibly so (Ferrar and Lotter 2007), with increasing burgeoning anthropogenic demands on natural capital associated with national human population growth and vital economic growth. These grasslands are threatened by the cumulative impacts of industrial agriculture, often poor livestock ranching practices, extensive agroforestry and habitat-destroying mining, especially of coal to support the many local power stations that form the basis of South Africa's (outdated) electricity generation hub.

Four golden mole taxa (*Amblysomus hottentotus longiceps*, *A. h. meesteri*, *A. robustus*, *A. septentrionalis*) were, until the start of this study, known from only a few, scattered localities (<10 records per taxon) in the Mpumalanga grasslands. While *A. h. longiceps* and *A.h. meesteri* are currently classified as subspecies, cytogenetic and molecular evidence indicates that these taxa are evolutionarily significant units worthy of species rank (Gilbert et al. 2008; Mynhardt et al. 2015; Maree et al. in prep.; *see also insert in this newsletter by Dr Samantha Mynhardt).* Three taxa (*A. h. meesteri*, *A. robustus*, *A. septentrionalis*) are endemic to the Mpumalanga grasslands, whereas *A.h. longiceps* occurs more widely in Drakensberg grasslands on the slopes of the eastern Great Escarpment, with only two confirmed records in southern Mpumalanga (Mynhardt et al. 2015). To complicate matters even further, three of the taxa (*A. h. longiceps*, *A. robustus* and *A. septentrionalis*) are morphologically indistinguishable, necessitating the use of cytogenetic or molecular markers for species delimitation (Bronner 2000; Mynhardt et al. 2015).

Given that little is known about the biology, distributions and severity of threats faced by these elusive and cryptic chrysochlorids, this study employed species distribution modelling to predict the geographic ranges of these flagship grassland taxa, and to evaluate their conservation status, with the specific aim of better informing future protection and environmental management practices.

How?

The study involved four main activities: (i) creating initial models trained on sparse museum data records; (ii) ground-truthing of models by field surveys over 8 months during the 2013-14 austral spring/summer, during which additional specimens from previously undocumented localities were collected; (iii) genetic analyses (using the mtDNA marker *Cytochrome-b*) to determine the species identities of the newly-acquired specimens, as these taxa are morphologically indistinguishable; and (iv) refining the models and determining the conservation status of these Highveld golden moles.

Initial species distribution models were developed with maximum entropy (*MaxEnt*) software using genetically-identified historical golden mole occurrence records for 38 specimens from 32 localities (*A. h. longiceps* n=16; *A. h. meesteri* n=5; *A. robustus* n=6; *A. septentrionalis* n=5; see Figure 1), based on interpolated data for 19 bioclimatic variables, continuous altitude data, as well as categorical spatial data for land types, WWF ecoregions and vegetation types.

Results

The initial models helped to effectively focus survey efforts within the vast study area, with intensive field surveying (110 days/nights in 90 quarter degree squares covering $540km^2$) during the austral spring-summer of 2013-4 resulting in the acquisition of 25 specimens from across Mpumalanga. Genetic analysis of the mitochondrial DNA (mtDNA) cytochrome-b gene sequences from these new specimens allowed unequivocal discrimination between the four cryptic taxa with only two specimens not being diagnosed with 95% confidence.

Of the 25 newly acquired golden mole specimens, nine individuals (*A. h. meesteri* n = 2; *A. septentrionalis* n = 5; indeterminate n = 2) were captured in five quarter-degree-squares (QDSs) where no previous golden moles have been recorded. Additionally, observed activity (characteristic subsurface tunnels unique to golden moles) was also recorded in nine new QDSs, showing that the model development methods were effective for locating previously unrecorded golden mole populations.

Refined taxon distribution models (Figure 1) based on 59 genetically-identified specimens were developed through a rigorous variable selection and model evaluation process. The use of an appropriate background (land types) and spatial filtering (1 km^2 grid size given the low vagility and limited dispersal abilities of golden moles) served to minimalize sampling biases inherent in the data. *Maxent* internal and jackknife statistics showed that the final models have 95% significance, except for *A. robustus* where significance was marginal ($p = 0.06$).

Predicted golden mole distributions

The refined distribution model (Figure 1A) for *A. h. longiceps* suggests that while the range of this taxon is concentrated in the grasslands of the Wakkerstroom and Ermelo districts along the southern escarpment rim, it also potentially occurs in the northern escarpment region, with only an intermediate probability of occurrence in the eastern parts of the province and the wide intermediate Highveld expanses.

The refined model for *A. h. meesteri* (Figure 1B) predicts that this taxon has relatively narrow habitat tolerances, and occurs only in two discrete areas: the eastern parts of the northern escarpment; and southern wetlands near Wakkerstroom, with only a low probability of occurrence along the eastern rim of the Great Escarpment between those latitudinal extremes. The lack of any high probability occurrence between the northern and southern areas of high probability occurrence could be an artefact of the very small sample sizes (with all specimens originating from a small area in the NE hotspot) for this taxon, or the similarity of bioclimatic conditions in the NE and SE areas of high probability.

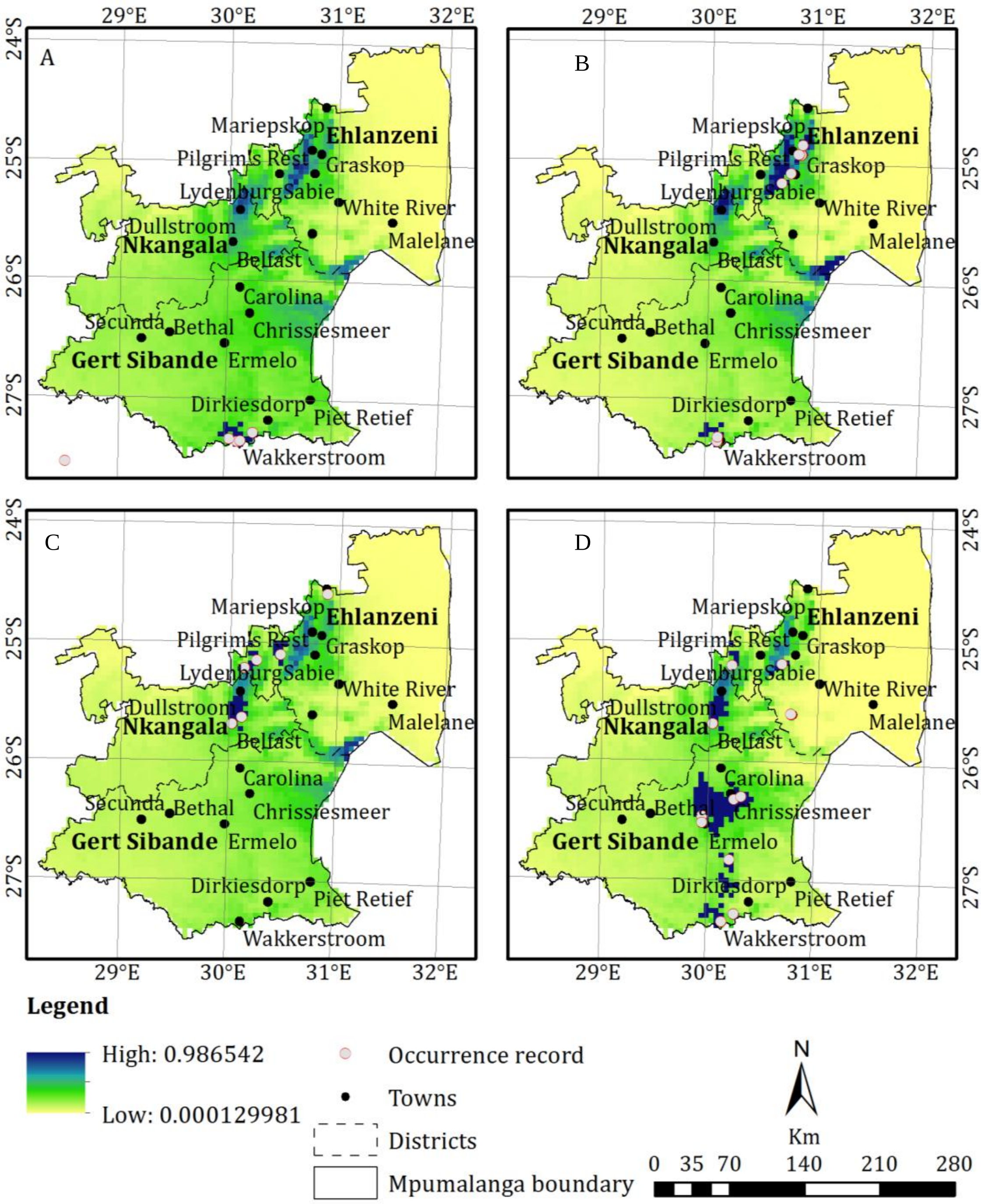

***Figure 1:** Refined species distribution models for four golden mole taxa:* A. h. longiceps *(A),* A. h. meesteri *(B),* A. robustus *(C) and* A. septentrionalis *(D). Deep blue areas indicate the highest probability of species occurrences in Mpumalanga Province, South Africa.*

The predicted distribution model for *A. robustus* (Figure 1C) suggests that this species is confined to high-altitude grasslands of north-eastern Mpumalanga, possibly extending eastwards to the Pilgrim's Rest and Mariepskop regions along the rim of the Great Escarpment where Afromontane forests adjoin grasslands. The model predictions for this species were, however, obfuscated by statistically uncertain genetic identifications of a specimen from Malelane (below the Great Escarpment) that could represent either *A. robustus* or *A. septentrionalis*, demanding that the Malelane record be excluded from analysis. Adopting a conservative approach necessitates that *A. robustus*, known and described (Bronner 2000) from only high-altitude grasslands in the Dullstroom-Lydenburg regions, is likely the most range-restricted of the four grassland golden moles in Mpumalanga grasslands, justifying its status as an IUCN Threatened (Vulnerable) species (Rampartab 2015).

Both the initial and refined model outputs of *A. septentrionalis* (Figure 1D) suggest that this species is the most widespread of the four chrysochlorid grassland taxa, with three latitudinal regions in central Mpumalanga. In addition to the high probability of occurrence in the southern wetlands and northern escarpment, the wetlands around Ermelo and Chrissiesmeer were strongly predicted to be areas where *A. septentrionalis* occurs.

Conservation implications

Based on the final model predictions, the prime habitats of all the golden mole taxa in Mpumalanga grasslands coincide with areas having high soil organic carbon content (> 3 %) and primary productivity (> 6 t/ha/an). These areas experience warm summers (mean annual temperature > 16 °C) and high precipitation (mean > 370 mm), factors that would logically equate to mild temperate subterranean grassland environments with abundant invertebrate prey. Most of these areas fall with mountain catchment areas that have long been conserved for their water-provisioning ecosystem services. That might seem to bode well from a chrysochlorid conservation perspective; but deeper analysis suggests otherwise.

Based on spatial analyses employing the refined models, the current protected areas network in Mpumalanga conserves sufficient area (> 28 %) of the *collective* distributional ranges of the four targeted chrysochlorid taxa if the "> 5 – 10% range conservation goal" is applied. However, the percentage overlap of the predicted individual taxon ranges with protected areas (*A. h. longiceps*: 2.4 %; *A. h. meesteri*: 4.4 %; *A. robustus*: 3.9 %; *A. septentrionalis*: 7.8 %) is low, suggesting that the area of prime habitats for each taxon are under-conserved by the existing protected area network. The value of currently designated ecological corridors and conservancy areas was also found to be of marginal conservation importance for the golden mole taxa, and unlikely to enhance their conservation status should such areas become formally protected.

How robust are the models?

While relatively robust, the refined distribution models are at best a first approximation of golden mole distributional ranges in Mpumalanga grasslands, given deficiencies of the data on which the models are based (e.g. small sample sizes with probable high geographic sampling biases; presence-only data; only interpolated climatic data; coarse-scale categorical data). Nonetheless, these models, which provide predictions for 19,184 cells (at a 4 km^2 grid size) are arguably better than a scant database of 59 distribution records (at a 1 km^2 locality grid size) for predicting the distributional ranges of the four targeted golden mole taxa, and thus provide a valuable conservation assessment and planning tool. Given deficiencies of the data on which the models were based, further ground-truthing is required not only to increase the number of verified occurrence records for each taxon, but also to collect presence-absence data and to develop higher-resolution spatial protected area layers (with continuous soil organic carbon content and primary productivity data) on a scale appropriate for analysing the geographic configuration and extent (including inter-connectedness) of prime habitats that these cryptic and highly-specialized subterranean afrotheres apparently prefer.

References

Bronner G.N. 2000. New species and subspecies of golden mole (Chrysochloridae: *Amblysomus*) from Mpumalanga, South Africa. *Mammalia* 64(1): 41–54.

Ferrar, T. A., and M. Lotter. 2007. *Mpumalanga Biodiversity Conservation Plan handbook*. Mpumalanga Tourism and Parks Agency. Mpumalanga Tourism and Parks Agency, Nelspruit.

Gilbert C, Maree S, Robinson TJ. Chromosomal evolution and distribution of telomeric repeats in golden moles (Chrysochloridae, Mammalia). *Cytogenet Genome Res*. 2008; 121(2): 110–119. doi: 10.1159/000125836 PMID: 18544934

Little I.T., Hockey P.A.R., Jansen B. 2013. A burning issue: Fire overrides grazing as a disturbance driver for South African grassland bird and arthropod assemblage structure and diversity. *Biological Conservation* 158:258-270.

Maree S., Bloomer P., Bennett N.C., Oosthuizen C.J., Asher R.J., Hofreiter M., Bronner G.N. (in preparation). Resolving a Rare Branch of the Afrotherian Phylogenetic Tree: a Total Evidence Phylogeny for Golden Moles (Mammalia: Chrysochloridae). To be submitted shortly to *Cladistics*.

Mynhardt S., Maree S., Pelser I., Bennett N.C., Bronner G.N., Wilson J.W., Bloomer, P. 2015. Phylogeography of a Morphologically Cryptic Golden Mole Assemblage from South-Eastern Africa. *PLoS ONE* 10(12): e0144995. doi:10.1371/journal.

Rampartab, C. 2015. *Amblysomus robustus*. The IUCN Red List of Threatened Species 2015: e.T62008A21284697. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T62008A21284697.en. Downloaded on 11 August 2017.

Planning for persistence of a Juliana's Golden Mole (*Neamblysomus julianae*) subpopulation threatened by urban development on Bronberg Ridge of Pretoria (Tshwane), South Africa

Sarita Maree

Golden mole Section Member, IUCN S.S.C. Afrotheria Specialist Group; University of Pretoria, South Africa. smaree@zoology.up.ac.za

Global environmental change can lead to shifts in ecosystem functioning and lineage diversification, altering the geographic distribution of species across landscapes. Against this backdrop of natural change, anthropogenic pressures substantially increase extinction risks. Habitat loss and fragmentation are considered serious threats to the persistence of species across diverse taxonomic groups, and particularly those with specialized habitat requirements. Golden moles (Chrysochloridae), a group of fossorial insectivores exhibiting narrow habitat tolerances, epitomize such a case, as the naturally restricted distribution ranges and very specific soil habitats required by some species are heavily impacted by human activities. The family represents one of Africa's most endangered and understudied members of the Afrotheria. Ten of the 21 currently recognized species are threatened, two species are near-threatened and three regarded as Data Deficient (IUCN Red List 2017 version 1). Yet, taxonomic uncertainties and the absence of a resolved phylogeny for the group are impeding conservation efforts and prioritization (Asher *et al.* 2010; Bronner 2013). A taxonomic revision based on combined morphological, cytogenetic and molecular data is currently under way. The results would not only contribute to effective conservation planning for the threatened species in the group (IUCN 2017-1), but also for several genetically divergent lineages discovered within recognized species such as *Amblysomus hottentotus*, of which some may well represent cryptic species in need of conservation attention (Mynhardt *et al.* 2015).

This article focuses on Juliana's golden mole (*Neamblysomus julianae*; Fig. 1), endemic to South Africa. Owing to the secretive habits of this species, several aspects of its general biology and ecology remain uncertain and not easily quantifiable (Bronner 1995a; 2013). However, our understanding of ecological variables governing habitat quality, geographic distribution, evolutionary relationships and gene flow (at regional and local scales) of Juliana's golden mole have greatly improved over the last decade. This is due to extensive field surveys, museum and laboratory-based studies and literature reviews that form part of a multi-disciplinary investigation directed towards effective conservation planning for this highly threatened and range-restricted species (Bronner 1992; 1995a, b; Jackson 2007; Jackson *et al.* 2007a, b; 2008; Jackson & Robertson 2011; Maree *et al.* 2003; Maree 2015a, b; IUCN 2017-1).

Appearance and Habits:

These animals (weighing 21g to 46g) have a slender build with cinnamon to reddish-brown dorsal pelage, fawn flanks and fawn to dull reddish-brown ventral pelage. They live underground, are weak diggers due to their delicate claws and are thus confined to soft sandy and friable loam soils through which they are able to burrow in search of prey (Bronner 2013). Burrow systems comprise deep, permanent tunnels that link up to chambers used for resting and raising young, and a number of foraging tunnels visible as broken ridges on the surface. Most foraging activity occur within the upper layer (10 – 20mm; Bronner 2013; Fig. 2). These characteristic trails are visible to the trained eye for several days after construction and are used to assess the presence of the Juliana's golden moles without actually being able to see the animals, as all known populations occur allopatrically from other chrysochlorid species. Importantly, their furrows are only evident during summer rainfall months when the soil is moist enough for burrowing activity, and they tend to be more active in the few days after rain. This should be taken into consideration when conducting specialist studies that support

Environmental Impact Assessments (EIA), as any surveys conducted during the dry winter months when subsurface activity ceases could produce misleading (false-negative) results.

Figure 1 *An adult Juliana's golden mole* (Neamblysomus julianae*); © Craig Jackson*.

Figure 2 *A characteristic subsurface foraging tunnel of a Juliana's golden mole in soft sandy-loam soil near Pretoriuskop in the Kruger National Park; © Sarita Maree.*

Distribution:

Juliana's golden mole is endemic to the northern parts of South Africa and was described from the type locality in The Willows suburb on the Bronberg Ridge in south-eastern Pretoria (Tshwane) in Gauteng Province just over 40 years ago (Meester 1972). The species is only known from three range-restricted and geographically isolated populations: the Bronberg Ridge; Nylsvley Nature Reserve and surrounding farms near Modimolle in Limpopo Province; and the vicinity of Pretoriuskop Camp in south-western Kruger National Park (KNP) in Mpumalanga Province (Fig. 3). The species' area of occupancy is estimated to be less than 2,000 km^2 and is severely fragmented; the estimated extent of occurrence of each population is as follows: Bronberg Ridge (± 33 km^2), Modimolle area (± 800 km^2) and KNP (± 400 km^2).

Figure 3 *The distributional range map of the Juliana' s golden mole (*Neamblysomus julianae*) showing the three geographically isolated populations in Tshwane, Modimolle and the Kruger National Park; Map taken from the IUCN Red List of Threatened Species 2017 version1.; www.iucn.org/map.html?id=1089).*

The Bronberg Ridge is located in a threatened terrestrial ecosystem (Bronberg Mountain Bushveld ecosystem, GP3) according to the National Environmental Management: Biodiversity Act (NEMBA 2004, section 52). The Gauteng Department of Agriculture and Rural Development's (GDARD) Conservation Plan (C-plan v3.3 edited by Compaan *et al.* 2011) also classifies the larger Bronberg Ridge System as a Critical Biodiversity Area (CBA) and identifies it a high priority area for conservation in the province, as ~19 threatened animal and plant species occur there (Biodiversity GIS for South Africa, SANBI 2011), including the Critically Endangered subpopulation of Juliana's golden mole (IUCN 2017-1). However, less than 1% of the Bronberg Ridge System is formally protected in the Faerie Glen Nature Reserve (Gauteng C-plan v3.3, Compaan *et al.* 2011).

The Bronberg is categorized as a Class 2 Ridge (5% to 35% disturbed) and the GDARD development guidelines for ridges suggest a "no-go" development policy and a 200m surrounding buffer zone to protect sensitive habitat. Only low impact development may be considered with a full EIA (Pfab 2001, 2002).

The highly restricted distribution range of the Bronberg Ridge subpopulation of Juliana's golden mole extends from Faerie Glen (eastern extreme) to Zwavelpoort (western extreme; Fig. 4). Moles are most frequently found in soft sandy soil along the northern and northeastern slopes of the Bronberg. Importantly, several records of the species' occurrence has also been confirmed on the southern side, where it was previously thought to be absent (Bronner 1995, 2008). According to our existing knowledge, the species has not been found north of Lynnwood/Graham road for many years, even though suitable habitat is present. No new populations have been found in Gauteng Province (Bronner 2008; Jackson *et al.* 2007a, b; 2008; Maree *et al*. 2003; Maree 2015a, b; IUCN 2017-1).

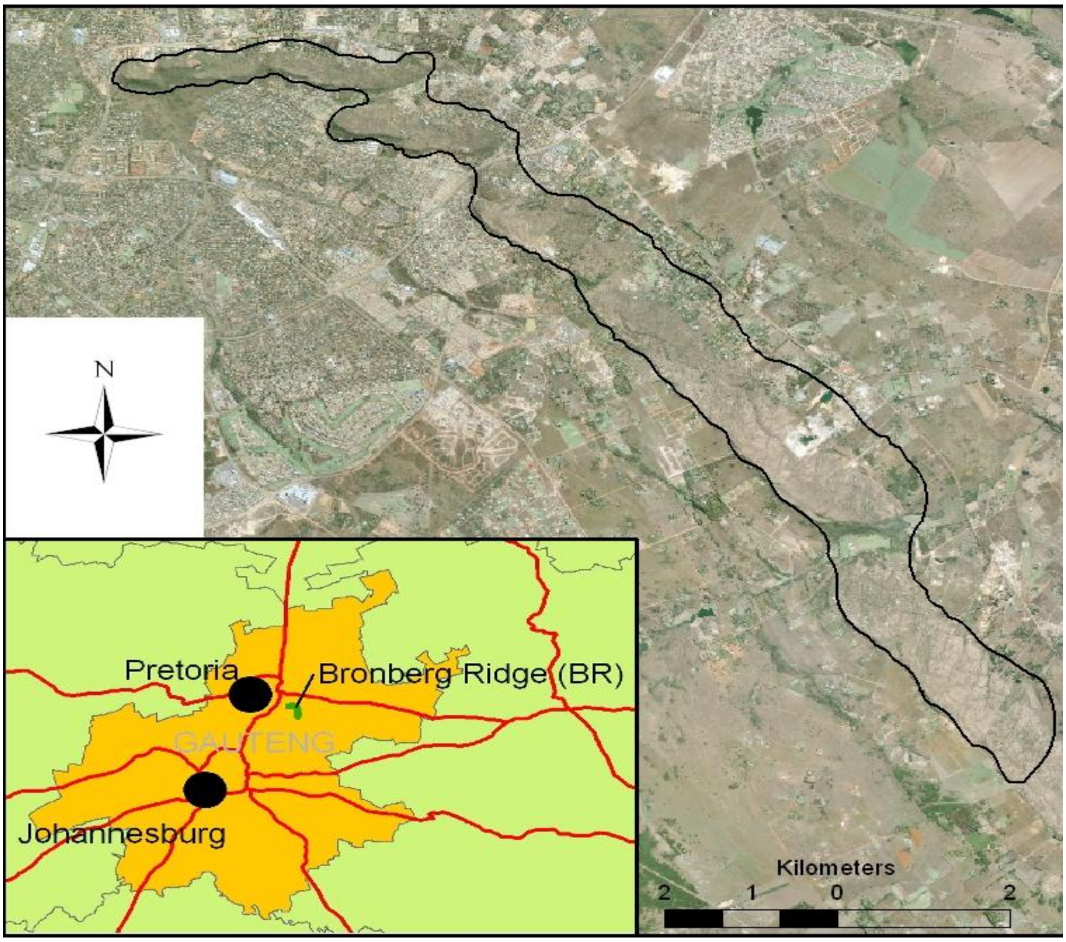

Figure 4 *Map of the Bronberg ridge area in southeastern Pretoria showing the extent of occurrence of the Critically Endangered population of the Juliana' golden mole on the Bronberg (black outline). Figure taken from Jackson (2007)* and *Jackson* et al. *(2007a).*

In the Modimolle region, the species has been recorded from soft sand and natural vegetation in Nylsvley Nature Reserve and on surrounding farms, but is also found in severely disturbed agricultural land. In the Pretoriuskop area (KNP), most specimens were recorded from pockets of friable loam soils in the Mixed Sour Bushveld vegetation type (Mucina & Rutherford 2006). The species also thrives in highly transformed areas with soils suitable for burrowing, such as irrigated suburban gardens, lawns and golf courses, which are used as alternatives to natural dispersal corridors (Bronner 2008; Jackson *et al.* 2007a, b; Jackson & Robertson 2011; Maree *et al*. 2003; Maree 2015a, b).

Habitat Characteristics:

On the northern side of the Bronberg Ridge, areas with suitable natural soils extend from the base of slopes towards the top of the ridge. Two historical primary natural dispersal corridors run in a roughly northwest-southwest direction, one at the base and the other on the mid to upper slopes. Secondary dispersal corridors often (but not necessarily) connect to the two primary routes via natural drainage lines with suitable soil characteristics (roughly north-south) and along sandy pockets with less favourable habitat on the steep slopes of the ridge. Natural dispersal corridors often connect with suburban gardens to form essential dispersal routes for the moles in areas that have been partially or severely transformed by urbanization and infrastructure development. This is particularly so on the southern side of the Bronberg Ridge where habitat fragmentation has disrupted natural dispersal corridors. Movement to and from the ridge in this area is limited with only narrow passages of suitable soil for moles to disperse through, but these often end in sandy pans that borders on formidable barriers such as roads and deep foundations surrounding large housing developments. The golden moles often use narrow passages of suitable soil to move through areas of unsuitable habitat (hard soil or rocky ridges) connecting areas with prime habitat and thus occupy much smaller areas of actual suitable habitat within the apparently larger geographic extent of their occurrence (Bronner 1995a, 2013; Jackson *et al.* 2007a, b; 2008; Maree *et al.* 2003; Maree 2015a, b).

Two major roads (Solomon Mahlangu and Swavelpoortspruit) and a residential development that bisect the Bronberg Ridge have resulted in a fragmented distribution range comprising four disjunct sections. The average lengths and widths are as follows: Section 1: 3.7 km x 0.3 km; Section 2: 2.4 km x 0.35 km; Section 3: 7.5 km x 0.9 km; Section 4: 2.5 km x 0.86 km (Fig. 5). Over the last decade, the largest of the four sections has been subjected to severe threats from intense urbanization and infrastructure development (roads, water supply infrastructure, high-density cluster housing, shopping malls and quartzite sand mining). These activities are rapidly eroding the very limited habitat remaining for the species in a densely developed urban setting (Maree *et al.* 2003; Jackson 2007; Jackson *et al.* 2007a, b; Maree 2015a, b).

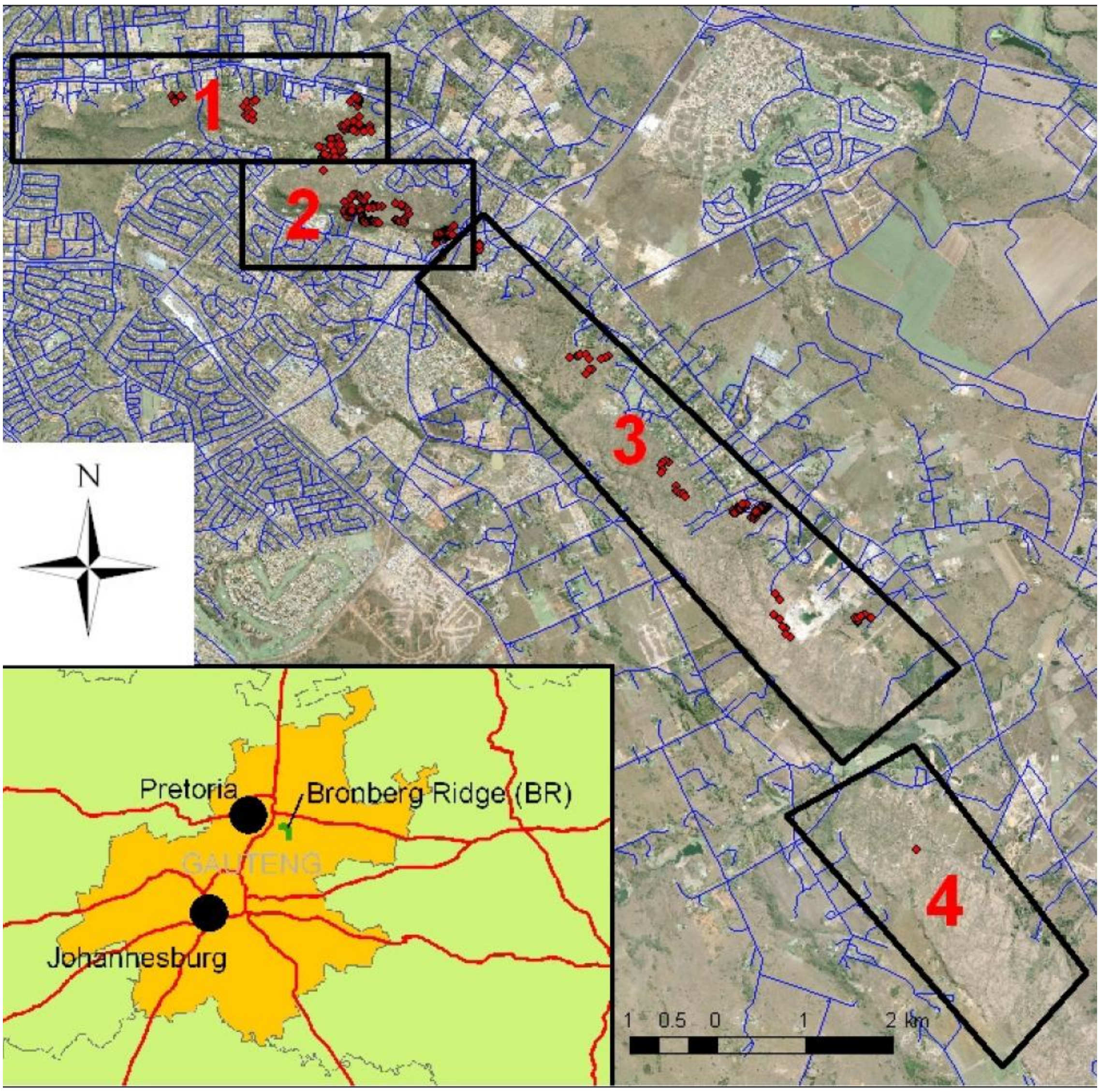

Figure 5 *Map of the Bronberg ridge area in southeastern Pretoria showing the four isolated habitat fragments (black outlines) constituting the highly restricted distribution range of the Juliana's golden mole (~21 km in length and 1.9 km width). Roads are shown in blue and red dots indicate confirmed localities of foraging tunnels in suitable soft soil. Figure taken from "A Conservation Assessment of Juliana's golden mole on the Bronberg Ridge, Gauteng, South Africa" (Jackson* et al. *2007a).*

Habitat Modelling:

Despite the fact that habitat modelling using GIS-based methods predicted several regions throughout Gauteng, Northwest, Mpumalanga and Limpopo provinces where the Juliana's golden mole could potentially occur, ground-truthing in many of these areas over the past years have rendered only two additional confirmed localities of their presence in the Modimolle region (Jackson *et al.* 2007a; Jackson & Robertson 2011; Maree 2015a, b). The presence of the species was positively correlated with soil characteristics (poorly graded size distribution of sand particles) that influence soil density, drainage, compatibility, texture and penetration resistance. These factors influence energy expenditure of golden moles during tunnelling (Jackson *et al.* 2007b). Data from this Species Distribution Model were integrated in the mammal layer of the Gauteng C-plan 3.3 (Compaan *et al.* 2011).

Evolutionary Relationships and Taxonomy:

The taxonomic status of the three known subpopulations of the Juliana's golden mole is unclear. Compelling morphological differences (colouration and dentition) exist between the KNP and the Modimolle and Bronberg populations (Bronner 1995a, 2013). Ongoing molecular research indicates pronounced genetic partitioning between the KNP and the other two subpopulations suggesting that the former represents a distinct evolutionary lineage (Maree *et al.* 2003; Jackson *et al.* 2007a; Maree *et al.* unpublished data). The small sample size from the KNP, however, precludes firm conclusions about the taxonomic status of this subpopulation. Should further genetic analyses confirm that two distinct taxa are contained within the current distribution range of the species, it would have profound implications for their conservation status, and would require strict measures to protect the reduced distribution ranges of each taxon. Given these preliminary results, it is crucial that each of the three populations should be conserved as separate Evolutionarily Significant Units (ESUs) to preserve their unique evolutionary histories (Jackson *et al.* 2007a; Maree 2015a, b; IUCN 2017-1).

Conservation Status:

The threatened status of the Juliana's golden mole has been elevated from Vulnerable (VU, B2ab (ii,iii); Bronner 2008) to Endangered (B2ab(iii); Maree 2015a, b; IUCN 2017-1). The species continues to suffer from habitat loss and fragmentation due to urban development and sand mining (Bronberg Ridge), agricultural threats (Modimolle area) and the development of the Pretoriuskop rest camp and roads infrastructure in KNP (Freitag & van Jaarsveld 1997; Jackson *et al.* 2007 a, b; 2008; Jackson & Robertson 2011; Maree *et al.* 2003; Maree 2015a, b; IUCN 2017-1). The effects of these human-induced impacts causing obstructions to animal movements (and thus gene flow) result in genetic erosion, reduced population viability and increased extinction risks, which are exacerbated by the species' narrow habitat tolerances. The ability of discontinuous patches of suitable habitat to sustain golden moles is largely dependent on their size and connectivity. When only a few individuals survive in a habitat fragment, local extinction events are more likely as a result of disease, natural or human-induced disasters and predation. Moreover, demographic parameters, reproductive success and individual fitness, which may have genetic consequences (e.g. reduced effective population size, elevated levels of inbreeding, genetic drift, reduced gene flow between neighbouring populations, genetic bottlenecks, founder effect and lower genetic diversity), can seriously compromise a population's ability to adapt to changing pressures (Bolger *et al.* 2001).

Conservation and Management Planning:

No Biodiversity Management Plan (BMP) exists for the *N. julianae* that would ensure its protection under section 43 of the NEMBA Act 10 of 2004. This, in spite of the fact that Juliana's golden mole has been assessed globally as Vulnerable, and the Bronberg Ridge population as Critically Endangered (IUCN 2017-1), and that the species was given the highest regional priority score for mammals based on regional occupancy, relative taxonomic distinctiveness, endemism and vulnerability in the former Transvaal Province of South Africa (Freitag & van Jaarsveld 1997). The species is listed as Vulnerable under the Threatened or Protected Species (ToPS, section 56 of NEMBA Act No.10 of 2004), but will no longer be protected, once the revised ToPS list is implemented, as humans do not directly utilize the species.

In light of the above, a multifaceted approach would be required to successfully conserve this enigmatic species. To this end, the development of a coordinated conservation and sustainable land-use programme for the larger Bronberg Ridge area should be considered a priority, as it would contribute substantially towards maintaining continuous dispersal corridors of the species between the upper and lower slopes, as well as east-west corridors along both the northern and southern slopes of the ridge. All efforts should be made to proclaim as much as possible of the remaining suitable habitat between Solomon Mahlangu and Swavelpoortspruit Roads as part of a formal conservation area for the species. Such an area should include areas with both natural and undisturbed habitat and transformed disturbed habitat, as every inch of suitable soil in these areas is crucial to maintain connectivity and gene flow that would improve the chances for persistence of this severely threatened subpopulation.

A synthesis of all available knowledge is essential to identify key elements required for making informed decisions for the conservation and management of the Bronberg Ridge subpopulation, and to identify avenues for future research. To this end, the author and collaborators have worked closely with the Mammal Division of GDARD, the provincial regulatory authority, concerning development of remaining natural areas in terms of the National Environmental Management Act (NEMA, Act No 107 of 1998),by organizing a workshop in 2016. Various stakeholders embarked on developing a strategic conservation and management plan for the Bronberg Ridge subpopulation, and eventually the entire species. The participants in the workshop included golden mole specialists, ecologists and environmental management specialists who gained extensive experience of the species through collaborative research with the author, as well as representatives of the Department of Environmental Affairs (DEA), Endangered Wildlife Trust (EWT) and the South African National Biodiversity Institute (SANBI). The development of a conservation management plan should build on the existing knowledge incorporated in an earlier conservation assessment of the Bronberg population for GDARD to which members of the golden mole section of the ASG contributed (Jackson *et al.* 2007b), and also consider knowledge gained from ongoing research on aspects of the biology, ecology, physiology, molecular systematics, phylogeography and population genetics of the species.

Three main working groups were established during the BMP workshop. Each group identified short and long-term goals that would assist them to address specific sections assigned to them for developing effective conservation and management strategies for the Bronberg population and the species as a whole in the future.

Group 1: Administrative and Legal Sections – Executive summary, motivation, anticipated outcomes, aims, objectives and benefits.

Group 2: Species-specific Sections – Conservation status, taxonomy, current distribution, population status, past conservation measures, research inventory and future research.

Group 3: Protected Status, EIA's, Stakeholder Engagement – Protection of available habitat, investigation of different models for legally enforceable protected areas under national, regional and provincial biodiversity legislation in various sections of the NEMBA (Act No. 10 of 2004) and the Gauteng C-plan v3-3 (Compaan *et al.* 2011), best practice guidelines for specialist assessments of the species, engagement with non-governmental conservation bodies (e.g. EWT, Center for Animal Rights, WESSA and World Wildlife Foundation), private land owners and residents associations (e.g. Shere Residents Association, Friends of Faerie Glen Nature Reserve and Friends of the Bronberg).

In the interim, GDARD is responsible for managing development actions that may lead to the destruction of patches of natural or transformed suitable habitat for the species remaining on the Bronberg Ridge (and the larger Bronberg ecosystem). To this end, GDARD makes use of existing national and provincial biodiversity legislation, policies and guidelines, such as the Gauteng Ridge Policy (Pfab 2001), the Strategic Environmental Assessment of the larger

Bronberg Ridge area (Pfab 2002) and the Gauteng Conservation Plan (C-plan v2, Pfab 2006; and v3-3, Compaan *et al.* 2011). The Species Distribution Model for Juliana's golden mole (Jackson & Robertson 2011) was also integrated in the mammal layer of the Gauteng C-plan 3.3 (Compaan *et al*. 2011). Golden mole specialists are also required to provide locality information from specialist assessments for all proposed development projects on the Bronberg Ridge to GDARD for updating the sensitivity layer. GDARD officials are also monitoring the subpopulation, yet structured surveys of its natural habitat in the area still need to be implemented.

In the absence of a formal BMP it is imperative that current attempts to integrate the available scientific data on the species with policy and legislation continue. This will require collaborative efforts including legal intervention, commenting on biodiversity policy and legislation drafts, increased pressure from non-governmental conservation organizations, residents associations and the general public to ensure that existing legislation, policies and regulations designed to provide protection for species threatened by habitat loss are enforced. Provincial and national regulatory organizations should be made aware of the severe threats facing this biologically unique and extremely rare species that occur on the Bronberg Ridge area, an irreplaceable CBA (Gauteng C-plan v3-3, Compaan *et al.* 2011).

In this context, the contributions of members of the public, concerned land-owners, environmental practitioners and organized groups such as Friends of the Faerie Glen Nature Reserve, Friends of the Bronberg and the Shere Residents Association have been invaluable for raising awareness about the existence and conservation of the Juliana's golden mole in the larger Bronberg Ridge area. In addition, articles in the printed media such as a local magazine (*The Bronberger* 2013), newspapers (*BEELD*, 8 September 2016; *Netwerk24*, and television coverage on 50/50, a well-known television series that promotes biodiversity conservation, have alerted the general public, land owners, local municipalities and national and provincial conservation authorities and developers to the Critically Endangered subpopulation of the Juliana's golden mole (50/50 video Season 9 April 2017).

Developers committed to follow recommendations of Environmental Management Plans (EMPr) and Requirements of Development (RoD) for developments granted Environmental Authorization from GDARD or DEA, are reliant on golden mole specialists for guidance in respect of minimizing impacts on the species, and for implementing potential mitigation measures as per the recommendations of the approved EMPr. If genetic clarification reveals that two taxa exist within the current extent of occurrence, adequate measures to protect the reduced distributional ranges of each taxon would be all the more important. In this context the importance of best practice guidelines for species-specific specialist assessments and adequate training cannot be over emphasized.

References

Asher R.J., Maree S., Bronner G.N., Bennett N.C., Bloomer P., Czechowski P., Meyer M., Hofreiter M. 2010. A phylogenetic estimate for golden moles (Mammalia, Afrotheria, Chrysochloridae). *BMC Evolutionary Biology* 10: 69.

Bolger D.T., Scott T.A., Rotenberry J.T. 2001. Use of corridor-like landscape structures by bird and small mammal species. *Biological Conservation* 102: 213-224.

Bronner G.N. 1992. Burrow system characteristics of seven small mammal species (Mammalia: Insectivora; Rodentia; Carnivora). *Koedoe* 35: 125-128.

Bronner G.N. 1995a. Systematic revision of the golden mole genera *Amblysomus*, *Chlorotalpa* and *Calcochloris* (Insectivora: Chrysochloromorpha: Chrysochloridae). PhD thesis, University of Natal, Durban, South Africa.

Bronner G.N. 1995b. Cytogenetic properties of nine species of golden moles. *Journal of Mammalogy* 76: 957-971.

Bronner G.N. 2008. *Neamblysomus julianae*. The IUCN Red List of Threatened Species. Version 2014-3. (www.iucnredlist.org).

Bronner G.N. 2013. Family Chrysochloridae. In: *Mammals of Africa*, *Volume 1*, Eds. J. Kingdon, D. Happold, T. Butynski et al., pp. 253-254. Bloomsbury Publishing, London, UK.

Freitag S., van Jaarsveld A.S. 1997. Relative occupancy, endemism, taxonomic distinctiveness and vulnerability: prioritising regional conservation actions. Biodiversity and Conservation, 6: 213-234.

Gauteng C-plan Version 2 analysis. Management priorities for selected protected areas in Gauteng. Unpublished Technical Report. Gauteng Department of Agriculture, Conservation and Environment, Scientific Services (GDACE), Johannesburg. Ed. M. Pfab, 2006, and subsequent updates.

Gauteng C-Plan Version 3.3 analysis. Management priorities for selected protected areas in Gauteng. Unpublished Technical Report. Gauteng Department of Agriculture and Rural Development (GDARD). Eds. Compaan *et al.* 2011.

Jackson C.R. 2007. The ecology and conservation of Juliana's golden mole (*Neamblysomus julianae*). MSc thesis, University of Pretoria, Pretoria.

International Union for the Conservation of Nature (IUCN). Red List of Threatened Species, Version 2017-1; *The family Chrysochloridae*. <http://www.iucnredlist.org>, Downloaded 10 August 2017.

Jackson C.R, Maree S., Robertson M.P., Bloomer P., Bennett N.C., Bronner G.N. 2007a. A conservation assessment of Juliana's golden mole (*Neamblysomus julianae*) on the Bronberg Ridge, Gauteng, South Africa. Unpublished Technical Report compiled for Gauteng Provincial Government Department of Agriculture, Conservation and Environment (GDACE), 93 pp.

Jackson C.R., Lubbe, N.R., Robertson M.P., Setsaas T.H., van der Waals J., Bennett N.C. 2007b. Soil properties and the distribution of the endangered Juliana's golden mole. *Journal of Zoology (London)* 274: 13-17.

Jackson C.R, Setsaas T.H., Robertson M.P., Bennett N.C. 2008. Ecological variables governing habitat quality and the distribution of the endangered Juliana's golden mole. *African Zoology* 43: 245-255.

Jackson C.R., Robertson M.P. 2011. Predicting the potential distribution of an endangered cryptic subterranean mammal from few occurrence records. *Journal for Nature Conservation* 19: 87-94.

Maree S., Bronner G.N., Jackson C.R., Bennett N.C. 2003. The conservation of golden moles (Afrosoricida; Chrysochloridae) with emphasis on the status of *Neamblysomus julianae* in South Africa. *IUCN Afrotheria Specialist Group Newsletter 2*.

Maree S. 2015a. *Neamblysomus julianae*. Bronberg subpopulation. The IUCN Red List of Threatened Species 2017 version 1, Reassessments by Afrotheria Specialist Group members. Downloaded on 10 August 2017.

Maree, S. 2015b. *Neamblysomus julianae*. The IUCN Red List of Threatened Species 2017 version 1: Downloaded on 10 August 2017.

Mynhardt S., Maree S., Pelser I., Bennett N.C., Bronner G.N., Wilson J.W., Bloomer P. 2015. Phylogeography of a Morphologically Cryptic Golden Mole Assemblage from Southeastern Africa. *PLoS ONE 10(12): e0144995. doi:10.1371/journal.pone.0144995.*

Mucina L. Rutherford M. 2006. *The vegetation of South Africa, Lesotho and Swaziland.* South African National Biodiversity Institute (SANBI), Strelitzia Press, South Africa, 807 pp.

Meester J.A.J. 1972. A new golden mole from the Transvaal (Mammalia: Chrysochloridae). *Annals of the Transvaal Museum* 28: 35-46.

Netwerk24 Nuus. 8 September 2016. *Plan bedreig mol in Pta*. *Kom net op drie plekke voor.* Extended version. <http://www.netwerk24.com/Nuus/Omgewing/plan-bedreig-mol-in-pta-20160907>.

South African National Biodiversity Institute. Threatened Species Programme. *National List of Threatened Ecosystems for South Africa.* 2011. Biodiversity GIS website, SANBI, <http://bgis.sanbi.org/ecosystems/searchecosystem.asp>.

Marais H. 2013. Molplaag teister boere en tuiniers. *The Bronberger* 13:9-11.

National Environmental Management: Biodiversity Act (NEMBA): Act No. 10 of 2004 (Gazette 26436, 7 June 2004).

National Environmental Management: Biodiversity Act (NEMBA) Threatened and Protected Species List. 2007. (Gazette 29657 No. R 152, 23 February 2007).

National Environmental Management: Biodiversity Act (NEMBA): National List of Ecosystems that are Threatened and in Need of Protection. 2011. (Gazette 34809 No. 1002, 3

December 2011).
National Environmental Management Act (NEMA): Environmental Impact Assessment (EIA) Regulations. 2014 (Regulation Gazette No. 10328, Vol. 594, 4 December 2014).
Pfab M. 2001. Development guidelines for ridges. Internal report, Gauteng Department of Agriculture, Conservation and Environment (GDACE).
Pfab M. 2002. The quartzite ridges of Gauteng. *Veld and Flora* 56-59.
Van Zyl S. 8 September 2016. *Plan bedreig mol in Pta. Kom net op drie plekke voor*. AfrikaansSentraal-B1-Beeld-B1014-17.compressed.pdf.
50/50 Season 9 April 2017, SABC2, <https://youtu.be/2RbrzCW6vJc>).

Small mammal monitoring: why we need more data on the Afrotheria

PJ Stephenson[1,2]

[1] *IUCN SSC Species Monitoring Specialist Group, c/o IUCN, Gland, Switzerland*
[2] *IUCN SSC Afrotheria Specialist Group, c/o IUCN, Gland, Switzerland*
stephensonpj@gmail.com

Introduction

The International Union for Conservation of Nature (IUCN) has been leading scientific assessments of plants, animals and fungi for more than 50 years. The flagship database for this work - the IUCN Red List of Threatened Species™ (http://www.iucnredlist.org/; IUCN 2017) - provides taxonomic, conservation status and distribution information on species that have been globally evaluated using the IUCN Red List Categories and Criteria (IUCN 2012). The data are of value to scientists, conservation agencies, project managers and donors, as well as to governments tracking the state of their biodiversity. Data compiled into a Red List Index act as an indicator for delivery of global goals, such as the Aichi Targets of the Strategic Plan for Biodiversity 2011-2020 and the Sustainable Development Goals (Brooks et al. 2015).

However, many species around the world are not properly surveyed or regularly monitored and the data on population levels, distributions and threats that are needed to complete Red List assessments are often unavailable. The mammalian super-cohort Afrotheria reflects the problems faced in accessing species data. Data on populations, threats and conservation measures are sparse for all 80 species of golden mole (Chrysolchloridae), hyrax (Hyracoidea), sengi (Macroscelidea), tenrec (Tenrecidae) and aardvark (Tubulidentata) assessed between 2015 and 2016. As a result, priority conservation actions identified for these taxa by the IUCN SSC Afrotheria Specialist Group emphasise the need to fill information gaps relating to distribution, abundance and threats (Stephenson 2016a).

This short review paper summarizes the data available for the Afrotheria, assesses the main reasons behind the data shortfall and summarizes key actions needed to fill data gaps.

The Afrotheria: a data deficient taxon

Mammals are relatively well studied, yet even among the 5,560 species of mammal assessed in the Red List, 779 (14.0 per cent) remain Data Deficient (Table 1; IUCN 2017). A taxon is considered Data Deficient "when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status" and "indicates that more information is required" (IUCN 2012). The proportion of mammals that are Data Deficient is higher in Africa than most other regions, though not as high as in South America or South/South-east Asia (Table 1).

Even for many species not considered Data Deficient, the information needed for Red List assessments are often incomplete or absent. Looking at individual taxa within the Afrotheria, no population estimates or trends exist for members of the Tenrecidae and, for each of the eight tenrec species considered threatened, the priority conservation action is to assess their range, populations and threats (see e.g. Stephenson, Soarimalala & Goodman 2016a,b,c). In the Macroscelidea, historical estimates are available for the threatened golden-rumped sengi, *Rhynchocyon chrysopygus* - but these were over limited time frames and no data are available since 2009 (Fitzgibbon & Rathbun 2015). In the Hyracoidea, some population density data were collected for tree hyraxes in Tanzania but no trends are available (Hoeck et al. 2015). There are no accurate population estimates for the Chrysochloridae and some golden mole species have been recorded only a handful of times. For example, only three individuals of the rough-haired golden mole, *Chrysospalax villosus*, have been found since 1980 (Bronner 2015d). Even for the aardvark, the largest of our specialist group species, we have no current population estimates or trends (Taylor & Lehmann 2015).

Table 1. *Native mammal species considered Data Deficient by region. Data source: IUCN (2017). Note that some species occur in more than one region.*

Region	**No. DD species**	**No. species assessed**	**% of assessed species DD**	**Rank**
Antarctic	10	29	34.5	1
FAO marine areas	43	125	34.4	2
South America	265	1,298	20.4	3
South and southeast Asia	209	1,315	15.9	4
Sub-Saharan Africa	**191**	**1,355**	**14.1**	**5**
North Africa	**28**	**200**	**14.0**	**6**
Oceania	70	632	11.1	7
West and central Asia	52	496	10.5	8
Caribbean Islands	22	214	10.3	9
Europe	22	249	8.8	10
East Asia	55	661	8.3	11
Mesoamerica	47	643	7.3	12
North America	28	466	6.0	13
North Asia	15	320	4.7	14
Total	**779**	**5,560**	**14.0**	
Afrotheria	8	80	10.0	

Habitat loss has long been known to be the greatest threat to small mammals in general and afrotheres in particular (Stephenson 1994; Entwistle & Stephenson 2000). Threat monitoring is essential for the success of mammal conservation projects (Crees et al. 2016) yet, across all families of the Afrotheria, there are no quantitative data on levels or rates of habitat loss. Hunting for the bushmeat trade may threaten several of the larger species, like aardvarks and some spiny tenrecs, yet the scale and impact of this offtake is unquantified (Taylor & Lehmann 2015; Reuter & Sewall 2016).

Table 2. *Number of search results for a selection of mammalian taxa in iSpot (www.ispotnature.org). Analysis conducted 19 July 2017. Small mammals shaded grey. Afrotheria in bold font.*

Search entry	**Number of results**	**Notes**
Tenrec	2	
Elephant-shrew	19	Sengi 6
Golden mole	29	
Aardvark	39	
Dolphin	41	Porpoise 27
Hyrax	42	
Antelope	58	
Rabbit	103	
Bear	111	
Deer	132	
Whale	142	
Hedgehog	186	
Rhino	200	
Bat	214	
Seal	254	
Horse	338	
Monkey	381	
Mouse	464	Vole 56; Rodent 78
Elephant	562	
Cat	620	
Dog	720	

Citizen science demonstrates strong potential to help collect biodiversity data (e.g. Danielsen et al 2014; Chandler et al. 2017). However, a preliminary analysis of the information being submitted to the iSpot database (www.ispotnature.org), which has a southern Africa hub, suggests there are proportionately less data on small mammals than larger ones, and less data on Afrotheria than other small mammals (Table 2).

In spite of these data deficiencies, only eight species covered by the Afrotheria Specialist Group (10 per cent) are considered Data Deficient (Table 3). This is because the Red List criteria are robust and species range (extent or area of occurrence), number of sightings and perceived trends in habitat loss allow us to calculate conservation status, even without more specific details on population trends or quantified estimates of threats from offtake or habitat loss. Many afrotheres are considered threatened, however, due primarily to the small number of recorded sightings (e.g. all threatened tenrec species are known from ten sites or less). Since small mammals are as prone to extinction as large mammals (Entwistle & Stephenson 2000) and the Chrysolchloridae has a disproportionately high incidence of threatened species compared with other mammalian taxa (Schipper et al. 2008), more data on small mammals such as the afrotheres would be of scientific and conservation value. Therefore, why are there so few data for the Afrotheria and why is more effort not made to fill the data gaps?

Why we have so few data

There are many challenges to the collection and use of data on species. Blockages to monitoring include lack of access to affordable, locally-relevant tools for data collection and analysis, as well as inadequate capacity, especially for applying modern technology (Stem et al. 2005; Stephenson et al. 2015a, 2017; Vanhove, Rochette & de Bisthoven 2017). Monitoring challenges, especially around capacity, are particularly acute in Africa (Stephenson et al. 2016). In spite of an array of methods available to survey and monitor terrestrial small mammals, many based on live trapping (see e.g. Wilson et al. 1996; Davies & Howell 2002; Figure 1), existing efforts to monitor mammals tend to focus on larger species (e.g. Swanson et al. 2015; Beaudrot et al. 2016). This reflects a broader trend where small mammals are generally subject to less research and conservation attention than larger species (Entwistle & Stephenson 2000).

Figure 1. *A Sherman trap and a pitfall trap set in a forest in Madagascar to live-trap terrestrial small mammals. Photo © PJ Stephenson*

An analysis of Data Deficient Afrotheria (Table 3), demonstrates that many poorly-known species (e.g. the Congo golden mole, Somali golden mole, dusky-footed sengi) occur where surveys are complicated by difficult access due to the remoteness of the site or the fact they occur in countries which have been subject to recent or ongoing armed conflicts (e.g. the Democratic Republic of Congo, Liberia, Somalia and South Sudan). Additional challenges with monitoring smaller Afrotheria include the fact that many species are difficult to trap or require very specialized survey methods, especially subterranean species like golden moles (e.g. Bronner 2015b) and aquatic species such as otter shrews (e.g. Stephenson 2016b) and aquatic tenrecs (Stephenson, Soarimalala & Goodman 2016a; Figure 2). Ongoing confusion over taxonomy and an abundance of cryptic species (Bronner 2015b; Everson et al. 2016) means species identification can also be difficult, further hampering accurate data gathering.

Figure 2. *The aquatic tenrec (*Limnogale mergulus*). Afrotheria that live in water or underground are difficult to monitor and are often poorly known. Photo © PJ Stephenson*

In some instances, small numbers of sightings may reflect a genuinely restricted range. This is thought to be the case with species like the giant golden mole, *Chrysospalax trevelyani* (Bronner 2015c), and Juliana's golden mole, *Neamblysomus julianae* (Maree 2015c). But for many other species we don't know if restricted ranges are genuine or simply a consequence of limited data. The risk for small mammal conservation is that assumptions and conclusions are made based on limited data. Since the polygon between isolated collection points that is used to define extent of occurrence may not always comprise suitable habitat, many species will be less widespread than data suggest, especially since some afrotheres such as tenrecs are known to have very specific habitat or microhabitat needs (e.g. Stephenson 1995) or to be found in limited altitudinal ranges (e.g. Goodman et al. 2013). Therefore, more data are required to confirm the accurate conservation status of Afrotheria species.

Conclusions and Recommendations

The development of capacity for collecting species data within biodiversity-rich countries is vital if we are to plan and monitor conservation impact (Stephenson et al. 2017). Efforts to assess accurately the Red List status of the Afrotheria, track changes over time and plan conservation interventions are dependent on more data. Key recommendations for the conservation community to make this happen include:

- Building on existing materials and guidelines, compile suitable tools for monitoring the Afrotheria (especially for those requiring specialized techniques, such as fossorial or aquatic species), make them easily available to people who need them and build capacity for their use in key sites (especially protected areas). This is likely to be most feasible through existing conservation and research projects.
- Apply the latest technologies to monitor small mammals, not just large ones, especially satellite-based and in situ remote sensing devices. For example, afrotherian species such as the aardvark, sengis, hyraxes and spiny tenrecs can be captured by camera traps (Hoeck et al. 2015; Hoffmann et al. 2016; Murphy et al. 2017) and protocols are available to use camera traps systematically (e.g. Fegraus et al 2011; Rovero & Zimmermann 2016). Satellite-based remote sensing data are increasingly accessible (Nagendra et al. 2013; Turner et al. 2015) and need to be collated across afrotherian range to assess habitat cover trends and land use changes.
- Systematic monitoring of biodiversity is required in African and Malagasy protected areas (e.g. Stephenson et al. 1994; Knights et al. 2014; Beaudrot et al. 2016), and small mammals should be integrated into new or existing monitoring programmes. Data

collection should include not only the status of species (populations, range, etc.), but also threats, especially offtake and habitat loss.

- Continue to resolve taxonomic confusion within the Afrotheria and, as research produces results, ensure new classifications are fed quickly into a) updated Red List Assessments and b) identification manuals used for survey and monitoring.
- Work with bigger NGOs and academic bodies to try to access and survey more remote sites where poorly known Afrotheria may reside. Build on and work with the Global Wildlife Conservation campaign to find lost species: https://lostspecies.org.
- Use new data to produce more scientific evidence of small mammal conservation needs, dispelling assumptions that "if the habitat is there, the species will be OK."
- Harness the potential of citizen science. We need to find ways for lessons learned elsewhere to be applied in the context of African and Malagasy small mammals to encourage local people to collect data, building on efforts like iSpot (Hutchinson 2012). A concerted awareness campaign to encourage smaller mammal work might be required and relevant IUCN SSC specialist groups (Afrotheria, Small Mammals, Bats) should collaborate.

IUCN is striving to address the challenges with species monitoring (Stephenson 2015). The recently established IUCN SSC Species Monitoring Specialist Group (www.speciesmonitoring.org) aims to enhance biodiversity conservation by improving the availability and use of data on species populations, their habitats and threats. The group's objectives revolve around developing and harmonizing monitoring tools and methods, building capacity to enhance data collection, improving data sharing and the inter-operability of databases, and increasing the monitoring of species of priority for conservation that have been neglected (such as certain taxa of smaller mammals, reptiles, amphibians, fish, invertebrates, fungi and plants).

A concerted effort by the SSC network and its partners, with taxonomic and disciplinary specialist groups working together and fund-raising together for key initiatives, could resolve some of the outstanding challenges with monitoring species. Only through such an effort can we ensure data are available to enhance the quality, accuracy and robustness of Red List assessments to measure the conservation status of small mammal species like the Afrotheria and the impact of conservation projects.

Acknowledgements

Thanks to Gary Bronner and Galen Rathbun for input into Table 3. I'd also like to acknowledge the members of the IUCN SSC Afrotheria Specialist Group for all their hard work in 2015 and 2016 to re-assess our 80 species and for drawing the best conclusions possible with the limited data available.

Table 3. *The eight species within the Afrotheria assessed in the IUCN Red List of Threatened Species as Data Deficient.*

Species	Common Name	Last Recorded Sightings	Locations	Assessment Citation & Notes
Tenrecs: 1/34 species (2.9%) DD				
Oryzorictes tetradactylus	Four-toed mole tenrec	Late 1990s; most records over 100 years old.	Madagascar: Andringitra National Park (high altitude)	Stephenson, Soarimalala & Goodman 2016d; Fossorial species; probably only trapped with pitfalls; Hard to trap; Remote, high altitude sites.
Golden moles: 3/21 species (14.3%) DD				
Huetia leucorhina	Congo golden mole	2005 in the Batéké Plateau, Gabon.	10 locations in Angola, Cameroon, Central African Republic, Democratic Republic of Congo, Republic of Congo.	Maree 2015b; Fossorial species - only trappable using tunnel or scissor traps or possibly detectable from owl pellets.
Chrysochloris visagiei (incertae sedis)	Visagie's golden mole	Only one specimen, described 1950.	Northern or Eastern Cape, South Africa (type locality may be mislabelled)	Bronner 2015a; Fossorial species - only trappable using tunnel or scissor traps or possibly detectable from owl pellets.
Calcochloris tytonis	Somali golden mole	1964. Known only from a partially complete specimen in an owl-pellet.	Giohar (Villagio Duca degli Abruzzi) in southern Somalia	Maree 2015a; Known only from 1 owl pellet from remote area. Fossorial species - only trappable using tunnel or scissor traps or possibly detectable from owl pellets.
Sengis: 4/19 species (21.1%) DD				
Elephantulus fuscipes	Dusky-footed sengi	Before 1968.	3 from South Sudan, 2 from Uganda, 4 from the Democratic Republic of Congo	Rathbun 2015a; Lack of searches in the remote areas it is known from; poor security in region.
Elephantulus fuscus	Dusky sengi	One specimen dates from about 2005, the rest pre-date 1968.	Southern Malawi, southern Mozambique and southern Zimbabwe	Rathbun 2015b; Lack of searches.
Elephantulus pilicaudus	Karoo rock sengi	2006.	5 locations in the Northern and Western Cape, South Africa	Smit-Robinson & Rathbun 2015; Highly cryptic species only identified in 2008 by genetic studies.
Elephantulus revoilii	Somali sengi	Before 1968.	6 locations in northern Somalia	Rathbun 2015c; Lack of searches in the remote areas it is known from; poor security in region.

References

Beaudrot, L., Ahumada, J.A., O'Brien, T., Alvarez-Loayza, P., Boekee, K., Campos-Arceiz, A., et al. 2016. Standardized assessment of biodiversity trends in tropical forest protected areas: The end is not in sight. *PLoS Biol*, 14(1): e1002357.

Bronner, G. 2015a. *Chrysochloris visagiei*. The IUCN Red List of Threatened Species 2015: e.T4812A21287855. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T4812A21287855.en. Downloaded on 01 May 2017.

Bronner, G. 2015b. *Cryptochloris wintoni*. The IUCN Red List of Threatened Species 2015: e.T5748A21287143. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T5748A21287143.en. Downloaded on 01 May 2017.

Bronner, G. 2015c. *Chrysospalax trevelyani*. The IUCN Red List of Threatened Species 2015: e.T4828A21289898. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T4828A21289898.en. Downloaded on 01 May 2017.

Bronner, G. 2015d. *Chrysospalax villosus*. The IUCN Red List of Threatened Species 2015: e.T4829A21290416. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T4829A21290416.en. Downloaded on 04 May 2017.

Brooks, T.M., Butchart, S.H., Cox, N.A., Heath, M., Hilton-Taylor, C., Hoffmann, M. et al. 2015. Harnessing biodiversity and conservation knowledge products to track the Aichi Targets and Sustainable Development Goals. *Biodiversity,* 16: 157-174.

Chandler, M., See, L., Buesching, C.D., Cousins, J.A., Gillies, C., Kays, R.W. et al. 2017. Involving citizen scientists in biodiversity observation. Pp. 211-237 in Walters, M. & Scoles, R.J. (eds.), *The GEO Handbook on Biodiversity Observation Networks*. Springer International Publishing, Cham, Switzerland.

Crees, J.J., Collins, A.C., Stephenson, P.J., Meredith, H.M., Young, R.P., Howe, C. et al. 2016. A comparative approach to assess drivers of success in mammalian conservation recovery programs. *Conservation Biology,* 30: 694-705.

Danielsen, F., Pirhofer-Walzl, K., Adrian, T.P., Kapijimpanga, D.R., Burgess, N.D., Jensen, P.M. et al. 2014. Linking public participation in scientific research to the indicators and needs of international environmental agreements. *Conservation Letters,* 7: 12–24.

Davies, G. & Howell, K. 2002. Small mammals: bats, rodents and insectivores. Pp 45-68 in G. Davies (ed.), *African Forest Biodiversity: A Field Survey Manual for Vertebrates.* Earthwatch, Oxford, UK.

Entwistle, A.C. & Stephenson, P.J. 2000. Small mammals and the conservation agenda. Pp. 119-139 in A.C. Entwistle & N. Dunstone (eds.), *Priorities for the Conservation of Mammalian Biodiversity: Has the Panda Had Its Day?* Cambridge University Press, Cambridge, UK.

Everson, K.M., Soarimalala, V., Goodman, S.M. & Olson, L.E., 2016. Multiple loci and complete taxonomic sampling resolve the phylogeny and biogeographic history of tenrecs (Mammalia: Tenrecidae) and reveal higher speciation rates in Madagascar's humid forests. *Systematic Biology*, 65: 890-909.

Fegraus, E.H., Lin, K., Ahumada, J.A., Baru, C., Chandra, S. & Youn, C., 2011. Data acquisition and management software for camera trap data: a case study from the TEAM Network. *Ecological Informatics,* 6: 345–53.

FitzGibbon, C. & Rathbun, G.B. 2015. *Rhynchocyon chrysopygus.* The IUCN Red List of Threatened Species 2015: e.T19705A21287265. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T19705A21287265.en. Downloaded on 01 May 2017.

Goodman, S.M., Soarimalala, V., Raheriarisena, M. & Rakotondravony, D. 2013. Small mammals: tenrecs (Tenrecidae) and rodents (Nesomyidae). Pp. 211- 269 in S.M. Goodman & M.J. Raherilalao (eds.), *Atlas d'une sélection de vertebrés terrestres de Madagascar/Atlas of selected land vertebrates of Madagascar.* Association Vahatra, Antananarivo, Madagascar.

Hoeck, H., Rovero, F., Cordeiro, N., Butynski, T., Perkin, A. & Jones, T. 2015. *Dendrohyrax validus.* The IUCN Red List of Threatened Species 2015: e.T136599A21288090. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T136599A21288090.en. Downloaded on 01 May 2017.

Hoffmann, M., Rathbun, G.B., Rovero, F., Perkin, A, Owen, N. & Burgess, N. 2016. The distribution of the genus *Rhynchocyon* in the Eastern Arc Mountains, with an emphasis on the Black-and-rufous Sengi, *Rhynchocyon petersi*. *Afrotherian Conservation,* 12: 3-8.

Hutchinson, S.-L. 2012. iSpot: a chance for South Africans to share nature *Afrotherian Conservation,* 9: 10.

IUCN 2012. *IUCN Red List Categories and Criteria: Version 3.1. Second edition.* IUCN, Gland, Switzerland and Cambridge, UK.

IUCN 2017. *The IUCN Red List of Threatened Species.* Version 2017-1. <www.iucnredlist.org>. Downloaded on 24 July 2017.

Knights, K., Cuadros, I., Zamora, C., Coad, L., Leverington, F., O'Connor, B., et al. 2014. A preliminary assessment of protected area management within the WWF 'Coastal East Africa' priority place, eastern Africa. *Parks,* 20.2: 77-88.

Maree, S. 2015a. *Calcochloris tytonis.* The IUCN Red List of Threatened Species 2015: e.T4767A21285700. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T4767A21285700.en. Downloaded on 03 May 2017.

Maree, S. 2015b. *Huetia leucorhina.* The IUCN Red List of Threatened Species 2015: e.T40597A21288887. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T40597A21288887.en. Downloaded on 03 May 2017.

Maree, S. 2015c. *Neamblysomus julianae.* The IUCN Red List of Threatened Species 2015: e.T1089A21285354. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T1089A21285354.en. Downloaded on 01 May 2017.

Murphy, A.J., Goodman, S.M., Farris, Z.J., Karpanty, S.M., Andrianjakarivelo, V. & Kelly, M.J. 2017. Landscape trends in small mammal occupancy in the Makira–Masoala protected areas, northeastern Madagascar. *Journal of Mammalogy,* 98: 272-282.

Nagendra, H., Lucas, R., Honrado, J.P., Jongman, R.H., Tarantino, C., Adamo, M. & Mairota, P. 2013. Remote sensing for conservation monitoring: Assessing protected areas, habitat extent, habitat condition, species diversity, and threats. *Ecological Indicators,* 33: 45-59.

Rathbun, G.B. 2015a. *Elephantulus fuscipes.* The IUCN Red List of Threatened Species 2015: e.T42659A21288575. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T42659A21288575.en. Downloaded on 01 May 2017.

Rathbun, G.B. 2015b. *Elephantulus fuscus*. The IUCN Red List of Threatened Species 2015: e.T42660A21288491. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T42660A21288491.en. Downloaded on 01 May 2017.

Rathbun, G.B. 2015c. *Elephantulus revoilii.* The IUCN Red List of Threatened Species 2015: e.T7137A21290721. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T7137A21290721.en. Downloaded on 01 May 2017.

Reuter, K.E. & Sewall, B.J. 2016. Taboos and sustainability of tenrec hunting in Madagascar. *Afrotherian Conservation,* 12: 11-15.

Rovero, F. & Zimmermann, F. 2016. *Camera Trapping for Wildlife Research*. Pelagic Publishing, Exeter, UK.

Schipper, J., Chanson, J.S., Chiozza, F., Cox, N.A., Hoffmann, M., Katariya, V. et al. 2008. The status of the world's land and marine mammals: diversity, threat, and knowledge. *Science,* 322: 225-230.

Smit-Robinson, H. & Rathbun, G. 2015. *Elephantulus pilicaudus.* The IUCN Red List of Threatened Species 2015: e.T165924A21291059. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T165924A21291059.en. Downloaded on 01 May 2017.

Stem, C., Margoluis, R., Salafsky, N. & Brown, M. 2005. Monitoring and evaluation in conservation: a review of trends and approaches. *Conservation Biology,* 19: 295–309.

Stephenson, P.J. 1994. Deforestation threatens the Tenrecidae of Madagascar. *Species,* 23: 66-67.

Stephenson, P.J. 1995. Small mammal microhabitat use in lowland rain forest of north-east Madagascar. *Acta Theriologica,* 40: 425-438.

Stephenson, P.J. 2015. Can IUCN Specialist Groups do more to collect species monitoring data? *Afrotherian Conservation,* 11: 12-13.

Stephenson, P.J. 2016a. Priority conservation actions for the Afrotheria. *Afrotherian Conservation,* 12: 33.

Stephenson, P.J. 2016b. *Micropotamogale lamottei.* The IUCN Red List of Threatened Species 2016: e.T13393A21287657. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T13393A21287657.en. Downloaded on 01 May 2017.

Stephenson, P.J., Bowles-Newark, N., Regan, E., Stanwell-Smith, D., Diagana, M., Hoft, R., et al. 2016. Unblocking the flow of biodiversity data for decision-making in Africa. *Biological Conservation.* DOI: 10.1016/ j.biocon.2016. 09.003.

Stephenson, P.J., Brooks, T.M., Butchart, S.H.M., Fegraus, E., Geller, G.N., Hoft, R. et al. 2017. Priorities for big biodiversity data. *Frontiers in Ecology and the Environment,* 15: 124-125.

Stephenson, P.J., Randriamahazo, H., Rakotoarison, N. & Racey, P.A. 1994. Conservation of mammalian species diversity in Ambohitantely Special Reserve, Madagascar. *Biological Conservation,* 69: 213-218.

Stephenson, P.J., Soarimalala, V. & Goodman, S.M. 2016a. *Limnogale mergulus.* The IUCN Red List of Threatened Species 2016: e.T11979A97189690. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T11979A97189690.en. Downloaded on 01 May 2017.

Stephenson, P.J., Soarimalala, V. & Goodman, S.M. 2016b. *Microgale jenkinsae.* The IUCN Red List of Threatened Species 2016: e.T62015A97192062. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T62015A97192062.en. Downloaded on 01 May 2017.

Stephenson, P.J., Soarimalala, V. & Goodman, S.M. 2016c. *Microgale nasoloi.* The IUCN Red List of Threatened Species 2016: e.T62017A97200965. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T62017A97200965.en. Downloaded on 01 May 2017.

Stephenson, P.J., Soarimalala, V. & Goodman, S. 2016d. *Oryzorictes tetradactylus.* The IUCN Red List of Threatened Species 2016: e.T40591A97203290. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T40591A97203290.en. Downloaded on 01 May 2017.

Swanson, A., Kosmala, M., Lintott, C., Simpson, R., Smith, A. & Packer, C., 2015. Snapshot Serengeti: high-frequency annotated camera trap images of 40 mammalian species in an African savannah. *Scientific Data 2:* 150026. http://dx.doi.org/10.1038/sdata.2015.26.

Taylor, A. & Lehmann, T. 2015. *Orycteropus afer.* The IUCN Red List of Threatened Species 2015: e.T41504A21286437. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T41504A21286437.en. Downloaded on 01 May 2017.

Turner, W., C. Rondinini, N. Pettorelli, B. Mora, A. K. Leidner, Z. Szantoi, G. et al. 2015. Free and open access satellite data are key to biodiversity conservation. *Biological Conservation,* 182: 173–176.

Vanhove, M.P., Rochette, A.J. & de Bisthoven, L.J. 2017. Joining science and policy in capacity development for monitoring progress towards the Aichi Biodiversity Targets in the global South. *Ecological Indicators,* 73: 694-697.

Wilson, D.E.C., Nichols, R.F., Rudran, J.D., Rasanayagam Foster, M.S., Cole, F.R., Nichols, J.D. et al. 1996. *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals.* Smithsonian Institution Press, Washington DC, USA.

Notes from the Field

Filling a gap in the distribution of Sengis in Ethiopia

Håkan Pohlstrand[1], Ludwig Siege[2]

[1]*Skottbacken 8, S-645 92 Straangnaas Sweden, Email:* hpohlstrand@gmail.com

[2]*Oberlindau 84, D-60232 Frankfurt, Germany, Email:* ludwig.siege@gmail.com

During a tour that I (HP) led to the Somali regional state of Ethiopia in March 2017, we were fortunate to observe and photograph sengis (elephant-shrews, genus *Elephantulus*) together with gundis (genus *Pectinator*; Fig. 1). They were seen between 11 and 14 March about 6 km south-east of the village of Gurdumi that is about 35 km from the town of Aware, which is some 1,100 m above sea level.

The sengis and gundis were on a heap of loose stones, apparently of volcanic origin, that was about 20 m long, 15 m wide and 2.5 m high (Fig. 2). The vast flat area surrounding the heap was otherwise acacia woodland (less than 6 m high) with compact reddish coloured soils and very few stones or rocks (Fig. 3).

During the safari, we also observed several endemic and near-endemic mammals in the acacia woodlands, including Harar Dik-dik (*Madoqua hararensis*), Guenther's Dik-dik (*Madoqua guentheri*), Silver Dik-dik *(Madoqua piacentinii)*, and Dibatag (*Ammodorcas clarkei*).

I (HP) am working on a book of wildlife photographs from this region of Ethiopia, and wanted to know which sengi we had photographed, so I contacted Galen Rathbun for his advice. I learned that there were two possibilities: the little-known Somali Sengi (*E. revoilii*) and the widespread Rufous Sengi (*E. rufescens*), but unfortunately they are difficult to distinguish because they both have the unique dark and light facial pattern around their large eyes and an obvious sternal scent gland (Figs. 1 and 4). After examining several photographs that I sent Galen, he thought the photographs were Rufous Sengis because in one image the tail has no tuft of hair at the tip and seems to be about the same length as the head and body combined (Fig. 1). Somali sengis, in contrast, have tails with a tuft that are about 20% longer than the head and body (see illustration in Rathbun, G. B., P. Agnelli, and G. Innocenti. 2014. Distribution of sengis in the Horn of Africa. Afrotherian Conservation - Newsletter of the IUCN-SCC Afrotheria Specialist Group 10:2-4).

We learned that the habitat of the Rufous Sengis is typically woodland on reddish soils, whereas Somali Sengis are thought to occupy more arid and rocky habitats, although very little is known about this species. Thus, our sightings on the rock heap surrounded by flat woodlands adds some uncertainty to the identification. The distributions of sengis can sometimes help identify similar species, but Galen pointed out that our interesting location was in a vast area with no other known records of sengis, and hundreds of kilometres from either species (Fig. 5). We hope to return to the area in the future to perhaps gather more details about the sengis, including confirming the species, and thus contribute information needed to determine the status of sengis in the region.

I am grateful to my friend and our guide Hassan Yusuf Kaariye (Magic Land Tours in Addis Ababa) for his knowledge and local contacts, without which it would not have been possible to make a trip in the Somali region. Also, thanks to Brook Kassa and the rest of the tour participants.

Figure 1*: A sengi (left) and gundi (right) among rocks in eastern Ethiopia. Photo: Tomas Carlberg.*

Figure 2: *Lower edge of the rock outcrop viewed from top, with surrounding acacia woodlands beyond. A gundi (left) and sengi (right) are basking in upper center of image on top of rocks. Photo: Håkan Pohlstrand.*

Figure 3: *Acacia woodlands and reddish soils that surrounded the isolated rocky outcrop occupied by sengis and gundis. Photo: Håkan Pohlstrand.*

Figure 4: *Large eyes, facial pattern, and sternal scent gland of a likely Rufous Sengi,* Elephantulus rufescens, *on a rocky outcrop in eastern Ethiopia. Photo: Håkan Pohlstrand.*

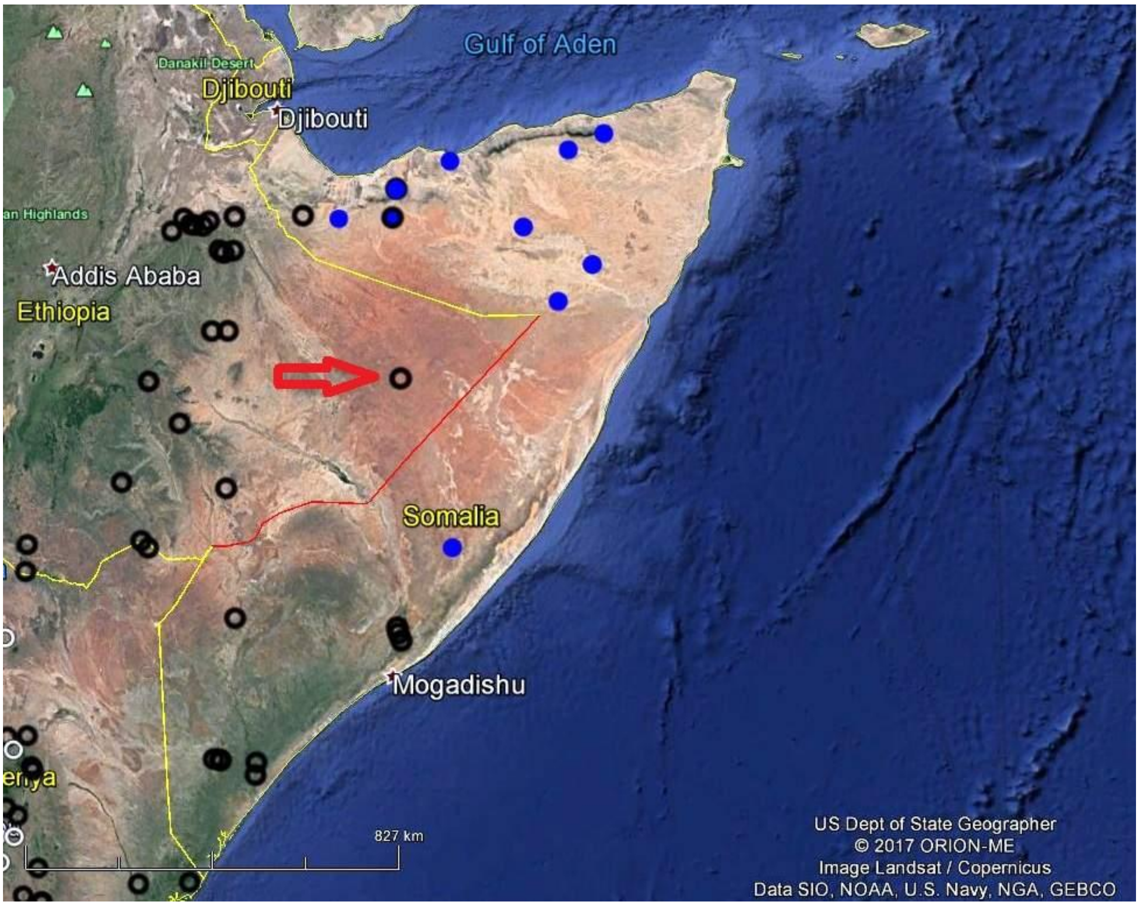

Figure 5: *Distribution (data from www.sengis.org/distribution/) of the Rufous Sengi (black) and Somali Sengi (blue) in the Horn of Africa region. Note there are only ten known sites for the latter sengi, all of which are in Somalia and predate the late 1970s. The red arrow is the location of our sightings on the rocky outcrop.*

Some thoughts on the distribution of Tree Hyraxes (Genus *Dendrohyrax*) in northern Tanzania.

Hendrik N. Hoeck (h.hoeck@gmx.ch)

While on a safari in March 2017 to the forests of Mt Meru and Ngorongoro, Tanzania, we were lucky to observe and photograph Tree Hyraxes in daytime. In past years I visited the cloud forest of Mt Meru several times but was never able to see Tree Hyraxes. Especially interesting on this trip was an encounter with a pair of Tree Hyraxes in the Mt Meru forest close to Jekukurri at an altitude of approximately of 2,200 meters (Fig. 1).

Fig.1 Tree Hyrax in a tree cavity in the Mt. Meru forest (Photo Ursula Wolf)

Currently, some of the isolated montane forests in Tanzania are thought to have different forms of hyrax (Kingdon 1971, Kingdon et al 2013, Kundaeli 1976). Those occurring on Mt. Meru are *D. validus validus* the Eastern Tree Hyrax, which are supposedly similar to the form in the Kilimanjaro and Usambara Mountain forests. However, the appearance of hyraxes from these two areas is somewhat different based on my observations in the Kilimanjaro Forest and the high altitudinal forest of the Ngorongoro, which are supposedly *D. arboreus stuhlmanni* (Hoeck 1978). Thus, it appears to me that the taxonomy of Tree Hyraxes in the montane forests of Tanzania needs to be reassessed.

Looking at the landscape, the montane forests of Kilimanjaro and Mt Meru are separated by semi-arid savanna grassland of the Sanya Plain Valley, resulting in the forest of Mt Meru being isolated and surrounded by semi-arid grassland, which probably prevents Tree Hyraxes from moving between these forest islands.

Fig 2. Tree Hyrax with young in the northern Ngorongoro Forest (close to the Sopa Lodge) at about 2,200 m (Photo Ursula Wolf)

Fig. 3. Tree Hyrax in a Vachellia xanthophloea outside Arusha Town (Photo by Daudi Peterson)

About 20 km to the south of Mt. Meru is the city of Arusha, which is partly surrounded by several *Vachellia-Senegalus* and *Ficus* tree species, including *Vachellia xanthophloea*, the Yellow Fever Tree, in which occur Tree Hyraxes (Fig. 3). To me, these isolated animals appear to be *D. arboreus*.

These casual observations raise the question about the species distribution of the isolated populations of Tree Hyraxes in northern Tanzania, where they occupy the forests on the volcanic slopes of Kilimanjaro, Mt Meru and Ngorongoro. These are forest islands surrounded by dry grasslands that Tree Hyraxes are not likely to move across. This distribution suggest that it is likely that there are different subspecies, or even species, in each isolated forest.

To assess the taxonomic status of hyraxes, Professor Dr. Lukas Keller of the Zoological Department of the University of Zürich (Switzerland) and I have started with a project to analyse the genetic distribution of the *Hyracoidea* in Africa. We have already been to Namibia and are in the process of assessing several populations there. The plan is to start soon with a field study in Tanzania, which is one of the most interesting places in the genetic distributions of the *Hyracoidea* as I have indicated above. To supplement this genetic research, morphological and behavioural research should also be undertaken, especially analysing male vocalizations that probably differ, even among closely related taxa (Hoeck 1978).

Acknowledgements

I would like to give my very special thanks to the Ranger Samweli Sakinoi for spotting the pair of Tree Hyraxes in the forest of Mt. Meru.

Thanks to Galen Rathbun for reviewing this manuscript and for his constructive edits and input. Last but not least, thanks to Ursula Wolf and Daudi Peterson for their great photographs.

Literature cited

Hoeck, H.N. 1978. Systematics of the Hyracoidea: Towards a clarification. In Ecology and Taxonomy of African Small Mammals. Schlitter, D.A., Ed. Bulletin of Carnegie Museum Nat. Hist. No. 6, Pittsburgh pp 146-151.

Kingdon, J. 1971. East African Mammals: An atlas of evolution in Africa. Academic Press. New York-London.

Kingdon, J. et al. 2013. Mammals of Africa. Volume 1. Bloomsbury. London, New Delhi, New York, Sydney.

Kundaeli, J.N. 1976. Distribution of Tree Hyrax (*Dendrohyrax validus validus* True) on Mt. Kilimanjaro, Tanzania. East African Wildl. J., **14**: 253-264.

New bamboo named after a tenrec

PJ Stephenson

A recently discovered plant genus has been named after a tenrec. *Sokinochloa* is a climbing bamboo endemic to Madagascar where it is found in montane and lowland forests, including the protected areas at Perinet and Andohahela. The new plant was described by Dr Soejatmi Dransfield of the Royal Botanic Garden, Kew. “The name *Sokinochloa* was inspired by a remark by one of the guides in Andohahela that it looked like “sokina”, the local name for the greater hedgehog tenrec” (Dransfield, S. 2016. *Kew Bulletin*, 71: 40). As you can tell from the photographs below, the likeness is uncanny. Does anyone know of any other plants named after afrotheria?

© S. Dransfield (with permission)
The inflorescence of S. australis.

© V. Soarimalala
*A greater hedgehog tenrec (*Setifer setosus*).*

Afrotheria News

Message from the Co-chairs

The membership of our specialist group was dissolved early this year, including the co-chairs, as is done by IUCN every four years. PJ Stephenson left to chair the new Monitoring Specialist Group (see page 34), and IUCN appointed Andrew Taylor as the new co-chair to serve with Galen Rathbun. Andrew and Galen have almost completed reassembling the membership, which will be found on the Membership tab at www.afrotheria.net. We welcome Voahangy Soarimalala, who has replaced PJ Stephenson as Tenrec Co-ordinator. Matthew Child, who recently coordinated the South African regional IUCN Red List, is a new member of our specialist group and will serve as our new IUCN Red List Co-ordinator, replacing Andrew Taylor who did an excellent job of guiding us through our recently completed status updates to the IUCN Red List. New members with a focus on tenrecs include Jan Decher, Raheriarisena Martin, and Toky Randriamoria. Nora Weyer has joined our group as an aardvark specialist. We would like to thank Caleb Boateng, Chabi Djagoun, Pat Holroyd, Erustus Kanga, Jonathan Kingdon, Mike Perrin, and Chanel Rampartab for their past voluntary service as members of our specialist group. Andrew and I, with the help of our section co-ordinators, will continue to fine-tune our membership based on participation and our needs for expertise.

The importance of systematics in conservation should be obvious to everyone – how do we know where to focus our conservation efforts without knowing the taxonomic status of afrotherians? Unfortunately, the extant species diversity of the aardvarks is minimal, but fortunately at present the single species seems to be stable overall. In our last newsletter we featured a summary of tenrec taxonomy. In this issue, we have a summary of hyrax and sengi taxonomy. Gary Bronner, our golden mole section co-ordinator, is working with colleagues to publish a systematic revision of the golden moles, which we hope will be completed in time for a summary in our next newsletter issue.

We would like to express our great appreciation to Chris and Mathilde Stuart for their superb editing of our newsletter. Although they have agreed to edit another issue next year, they would like us to find someone to work with them so they can hand the newsletter off to them. Please let us know if you are interested or have any suggestions.

Galen Rathbun and **Andrew Taylor**, Co-chairs, Afrotheria Specialist Group

African national park taken off World Heritage 'danger list'

Comoé National Park in Côte d'Ivoire, one of the largest protected areas in West Africa and home to several afrothere species, was added in 2003 to the list of World Heritage in danger due to farming, illegal gold mining and poaching affecting its species populations. However, following a stabilisation of the political situation in 2012, wildlife populations have recovered. As a result, on 4 July 2017, the park became the first World Heritage site to be removed from the 'danger list' in West and Central Africa in over 10 years. The decision follows a recommendation from IUCN – the official advisory body to UNESCO's World Heritage Committee.

Described as a UNESCO World Heritage site in 1983, Comoé National Park contains a remarkable variety of habitats including savannas, grasslands and forests. It is home to 620 species of plants, 500 species of birds, 35 species of amphibians and 60 species of fish. Its 135 species of mammal include at least four afrotheres, the African elephant, the aardvark and two hyrax species (see Fischer F, Gross M, Linsenmair KE. 2002. *Mammalia* 66: 83-92). For an IUCN news release on the story go to: https://goo.gl/3A3jTu.

PJ Stephenson

The Tweeting Tenrec

Do you know the answers to any of these questions?

- What is the greatest threat to Afrotheria species according to the latest IUCN Red List of Threatened Species?
- How many trap nights are needed to measure small mammal species diversity?
- What does a lowland streaked tenrec look like?
- Are opportunistic heterotherms like some afrotheres better placed to adapt to climate change?
- When is the latest *Afrotherian Conservation* newsletter due out?
- Which Afrotheria species made a cameo appearance on the latest David Attenborough TV series, *Planet Earth 2*?
- Why is it hard to access biodiversity data in Africa?
- When did the Durrell Institute of Conservation and Ecology open its MSc Scholarship scheme for 2017?
- What needs to be done for golden-rumped sengis in Arabuko-Sokoke forest, Kenya?
- How long is an aardvark tongue?
- Why was the eastern tree hyrax down-listed?

Well, you would have known all the answers to these questions if you followed the Tweeting Tenrec on Twitter. @Tweeting_tenrec is the official Twitter feed of the IUCN SSC Afrotheria Specialist Group. The social media outlet is used to share news and the latest research on the Afrotheria and their habitats, as well as useful facts and figures and relevant job offers, scholarship and funding opportunities.

Follow us today and stay informed. And if you have any relevant material you would like to see reported on the site, please contact PJ Stephenson at AfrotherianConservation@yahoo.co.uk – or send him a Tweet!

PJ Stephenson

Update to Sengi website

Recently, the sengi web site at www.sengis.org has been updated and improved. The bibliography is now accessed through Zotero rather than Mendalay, resulting in a much smoother and more powerful search function. It is also easier for the administrator to update the bibliography with additional references. The sengi distribution maps on the site are still plotted on Google Earth, but it is now easier to load and view them. Also, hundreds of new records have been added, thanks to many individuals and organizations that are too numerous to mention individually. However, an expanded feature is that the underlying metadata associated with each location now includes the source of each record (click on a location to see a balloon with metadata). Lastly, now the subspecies of *Rhynchocyon* are colour-coded. If you have an interest in the sengi literature or sengi distribution, and especially if you have conservation or research needs associated with this information, take a look.

Galen B. Rathbun

New Golden-rumped Sengi literature

Three important papers have recently been published (see recent literature section) that relate directly to the conservation of the Golden-rumped Sengi, *Rhynchocyon chrysopygus*, in coastal Kenya – an IUCN Red List Endangered species. The first paper (Carlen et al. 2017) is a phylogeny of the genus *Rhynchocyon*, and it clearly supports what has been suspected for a long time – *R. chrysopygus* is likely the more ancient of the known extant forms, which explains several morphological, behavioural, and life history traits that set it apart from other giant sengis. Indeed, with a clearer understanding of its phylogeny, perhaps the old subgenus *Rhinonax* that included *chrysopygus* should be reconsidered and redefined. This paper also returns *R. cirnei stuhlmanni* to full species. The second paper (Amin et al. 2017) is a detailed camera trap study in the Arabuko-Sokoke Forest, the main habitat of *R. chrysopygus*. The paper also includes data from a large camera trap array in the Boni and Dodori forests inland from the Kenyan coast to the north, where an undescribed giant sengi occurs. The results from the camera trapping in both areas better defines the distribution and habitat use of these two giant sengis. The third paper (Habel et al. 2017) is a detailed examination of the anthropogenic factors impacting the conservation of the Arabuko-Sokoke Forest, and possible solutions to the continuing degradation of this important center of biodiversity.

Galen B. Rathbun

Friends of Arabuko-Sokoke and other links

In the last year, Friends of Arabuko-Sokoke Forest has been revived with support for activities ranging from forest walks for visitors to policing. It also runs a website, and has an increasing presence on social media, such as Facebook. Local and non-local members of the friends are welcome, and provide a positive way of supporting conservation of the forest from near and far.

Despite many challenges, FoASF is a growing constituency that champions Arabuko-Sokoke Forest. A joint management team allows the Kenya Forest and Kenya Wildlife services (KFS and KWS), along with the Kenya Forest Research Institute (KEFRI), and National Museums of Kenya (NMK), to work together. In the community, the Arabuko-Sokoke Forest Adjacent Dwellers Association (ASFADA) provides a shared forum for three Community Forest Associations. Local and national NGOs, like Nature Kenya, and A Rocha Kenya, support the government agencies, and play an important role in working groups that focus on key areas such as research and monitoring, forest management, education and tourism, and work on local livelihoods. The innovative Kipepeo project (kipepeo.org), continues to work with butterfly and honey farmers.

A number of other initiatives, like ASSETS (Arabuko-Sokoke Forest Schools and Eco-tourism Scheme: www.assets-kenya.org) that provides bursaries to children from forest adjacent schools, and was established by A Rocha, are good ways to support the community. As is staying at Arabuko Jamii Villas, a community project that provides accommodation close to the forest (arabukojamiivillas.com). In tough times for conservation of critical sites throughout East Africa, it is good to see such a wide range of stakeholders building resilience in and around Arabuko-Sokoke since it certainly remains the single most important site for nature and people on the EA coast.

John Fanshawe and **Galen B. Rathbun**

Provisional AZE Status for Arabuko-Sokoke Forest

Following recent correspondence with IUCN and BirdLife International, Kenya's Arabuko-Sokoke Forest has been given a provisional listing as an Alliance for Zero Extinction

(AZE) site with the Golden-rumped Sengi acting as the trigger species. To qualify, single sites must contain 95% of the population of a critically endangered or endangered red list species. Working with Galen Rathbun and Clare FitzGibbon, and reviewing recent information on status and distribution, John Fanshawe of BirdLife and the Cambridge Conservation Initiative, have argued that Sokoke should qualify. It is possible that the Kenyan endemic, Clarke's Weaver *Ploceus golandi*, would be a second trigger species, but that review is still underway. AZE was launched in 2005, and engages 88 biodiversity conservation NGOs worldwide. Further background on the alliance is available here: http://www.zeroextinction.org. IUCN's page for the Golden-rumped Sengi is here: http://www.iucnredlist.org/details/19705/0.

John Fanshawe

2016 Red List of Mammals of South Africa, Swaziland and Lesotho now available

Dear Dr. Galen Rathbun

It is with great pleasure (and a large amount of relief!) that the final spreadsheet of the 2016 Red List of Mammals of South Africa, Swaziland and Lesotho is available for download here. The citations for each assessment are also included. As we complete the final editing process, the full assessments will be made available order by Order, starting in mid-January 2017. Examples of completed assessments (nine species relevant to CITES) are already available on the web page.

On behalf of the editing team, we would like to thank you for your involvement in this important project. We hope that this will be useful for a wide range of stakeholders. Plans are in motion to create an online system so that the assessments can be revised more regularly. Ongoing work includes analysis of genuine changes to produce a Red List Index, a prioritisation workshop to identify species for systematic conservation planning, and recommendations for future Red List revisions.

Should you have any queries or comments, please feel free to contact us.

Warm regards,

Matthew Child & Harriet Davies-Mostert
Matthew Child: m.child@sanbi.org.za

Dr. Harriet Davies-Mostert
Head of Conservation, Endangered Wildlife Trust
harrietd@ewt.org.za; www.ewt.org.za

Noticeboard

Smith Fellows 2018 Call for Proposals Announced

The Society for Conservation Biology is pleased to solicit applications for the **David H. Smith Conservation Research Fellowship Program**. These two year postdoctoral fellowships provide support for outstanding early-career scientists of any nationality who want to better link conservation science and theory with policy and management, improving and expanding their research skills while directing their efforts towards conservation problems of pressing concern for the United States.

Each Fellow proposes a team of at least two mentors: 1. an academic mentor who encourages the Fellow's continued development as a conservation scientist and 2. a conservation practitioner who connects the Fellow and her/his research to practical applications. Fellows may be administratively based at either an academic institution or conservation organization in the United States, typically the location of either the academic or practitioner mentor. We encourage applicants to explore both options and consider being based at the non-academic institution as that is the world less familiar to most early-career scientists and can provide valuable experience.

Fellows will spend up to three weeks per year during their fellowship attending Program-sponsored professional development retreats. These retreats provide opportunities to cultivate skills typically not covered during their academic education including: leadership, communications, professional and funder networks, and to gain better understanding of policy making and application of research.

The Smith Fellows Program and its administrative host, the Society for Conservation Biology, are committed to equity, inclusion and diversity and invites individuals who bring a diversity of culture, experience and ideas to apply. We envision that the cadre of scientists supported by the Smith Fellows Program will eventually assume leadership positions across the field of conservation science. Fellows are selected on the basis of innovation, potential for leadership and strength of proposal.

The deadline for receipt of application materials is **8 September 2017**. The Program expects to select five Fellows in January 2018 for appointments to start between March and September 2018. Fellowship awards include an annual salary of $55,000, benefits, and generous travel and research budgets.

For detailed proposal guidelines, please visit the Smith Fellow website. Questions may be directed to Shonda Foster, Program Director, by emailing sfoster@conbio.org.

Recent Literature

Compiled by T. Lehman, G.B. Rathbun, PJ Stevenson, G. Bronner, R. Asher.

Afrotheria general

Gatesy J., Meredith R.W., Janecka J.E., Simmons M.P., Murphy W.J. and Springer M.S. 2016. Resolution of a concatenation/coalescence kerfuffle: partitioned coalescence support and a robust family-level tree for Mammalia. *Cladistics* (2016) 1–38. doi: 10.1111/cla.12170

Springer M.S., Emerling C.A., Meredith R.W., Janecka J.E., Eizirik E. and MurphyW.J. 2017. Waking the undead: Implications of a soft explosive model for the timing of placental mammal diversification. *Molecular Phylogenetics and Evolution* 106: 86–102. doi: 10.1016/j.ympev.2016.09.017

Golden Moles

Bochkov A.V. 2016. A new mite species *Schizocoptes daberti* sp. n. (Acariformes: Chirodiscidae) from *Chrysochloris stuhlmanni* Matsche (Afrosoricida: Chrysochloridae) in the Democratic Republic of the Congo. *Folia Parasitologica* 63: 005 doi: 10.14411/fp.2016.005

Crumpton N., Kardjilov N. and Asher R.J. 2015. Convergence vs. Specialization in the ear region of moles (Mammalia). *Journal of Morphology* 276(8):900-914. doi: 10.1002/jmor.2039

Pollard K.A., Tran P.K. and Letowski T. 2016. Morphological differences affect speech transmission over bone conduction. *Journal of the Acoustical Society of America* 141: 936. doi: http://dx.doi.org/10.1121/1.4976001

Mason M. 2016. Structure and function of the mammalian middle ear. II: Inferring function from structure. *Journal of Anatomy* 228(2): 300–312. doi: 10.1111/joa.12316

Mason, M.J. 2016. Internally coupled ears in living mammals. *Biological Cybernetics* 110: 345. doi:10.1007/s00422-015-0675-1

Mynhardt S., Maree S., Pelser I., Bennett N.C., Bronner G.N., Wilson J.W. 2015. Phylogeography of a Morphologically Cryptic Golden Mole Assemblage from South-Eastern Africa. *PLoS ONE* 10(12): e0144995. doi:10.1371/journal.

VanBuren C. and Evans C.C. 2016. Evolution and function of anterior cervical vertebral fusion in tetrapods. *Biological Reviews* 92: 608-626. doi: 10.1111/brv.12245

Hyrax

Asher RJ, Gunnell GF, Seiffert ER, Pattinson D, Tabuce R, Hautier L, Sallam HM. 2017. Dental Eruption and Growth in Hyracoidea (Mammalia, Afrotheria). Journal of Vertebrate Paleontology e1317638. http://www.tandfonline.com/doi/full/10.1080/02724634.2017.1317638

Sengis

(for a virtually complete searchable bibliography see: www.sengis.org/bibliography.php)

Amin, R., B. R. Agwanda, B. Ogwoka, and T. Wacher. 2016. Status and behavioural ecology of sengis in the Boni-Dodori and Arabuko-Sokoke forests, Kenya, determined by camera traps. Journal East African Natural History 105:223-235.

Carlen, E. J., G. B. Rathbun, L. E. Olson, C. A. Sabuni, W. T. Stanley, and J. P. Dumbacher. 2017. Reconstructing the molecular phylogeny of giant sengis (Macroscelidea; Macroscelididae; *Rhynchocyon*). Molecular Phylogenetics and Evolution 113:150-160.

Dumbacher, J. P., E. J. Carlen, and G. B. Rathbun. 2016. *Petrosaltator* gen. nov., a new genus replacement for the North African sengi *Elephantulus rozeti* (Macroscelidea; Macroscelididae). Zootaxa 4136:567-579.

Habel, J. C., I. C. C. Casanova, C. Zamora, M. Teucher, B. Hornetz, H. Shauri, R. K. Mulwa, and L. Lens. 2017. East African coastal forest under pressure. Biodiversity and Conservation DOI: 10.1007/s10531-017-1375-z.

Hoffmann, M., G. B. Rathbun, F. Rovero, A. Perkin, N. Owen, and N. Burgess. 2016. The distribution of the genus *Rhynchocyon* in the Eastern Arc Mountains, with an emphasis on the Black-and-rufous Sengi, *Rhynchocyon petersi*. Afrotherian Conservation - Newsletter of the IUCN-SCC Afrotheria Specialist Group 12:3-8.

Hoffmann, S., I. G. Horak, N. C. Bennett, and H. Lutermann. 2016. Evidence for interspecific interactions in the ectoparasite infracommunity of a wild mammal. Parasites and Vectors 2016:9-58.

Hoffmann, S., H. J. Webster, P. R. Teske, H. Lutermann, N. C. Bennett, and B. J. Van Vuuren. 2016. Characterization of 14 polymorphic microsatellite loci develped for an Afrotherian species endemic to southern Africa, *Elephantulus myurus* (Macroscelidea: Macroscelididae). Applied Entomology and Zoology.

Kubo, T., and M. O. Kubo. 2016. Nonplantigrade foot posture: a constraint on dinosaur body size. PLoS (Public Library of Science) ONE.

Lagesse, J. V., and G. Thondhlana. 2016. The effect of land-use on small mammal diversity inside and outside the Great Fish River Nature Reserve, Eastern Cape, South Africa. Journal of Arid Environments 130:76-83.

Mason, M. J. 2016. Internally coupled ears in living mammals. Biological Cybernetics 110: 345. doi:10.1007/s00422-015-0675-1.

Mason, M. J. 2016. Structure and function of the mammalian middle ear. I: Large middle ears in small desert mammals. Journal of Anatomy 228:284-299.

Mason, M. J. 2016. Structure and function of the mammalian middle ear: II: Inferring function from strucure. Journal of Anatomy 228:300-312.

Medger, K., C. T. Chimimba, and N. C. Bennett. 2016. Is reproduction of male eastern rock sengis (*Elephantulus myurus*) from southern Africa affected by photoperiod? Canadian Journal of Zoology 94:747-752.

Puttick, M. N., and G. H. Thomas. 2016. Fossils and living taxa agree on patterns of body mass evolution: a cae study with Afrotheria. Proceeding of the Royal Society B 282:2015-2023.

Rathbun, G. 2016. Sengi biology according to postage stamps. Afrotherian Conservation - Newsletter of the IUCN-SCC Afrotheria Specialist Group 12:20-22.

Rathbun, C. 2016. Sengi meets adder. Afrotherian Conservation - Newsletter of the IUCN-SCC Afrotheria Specialist Group 12:29-30.

Rathbun, G. B., D. Ribble, T. O. Osborne, and S. J. Eiseb. 2017. Sengis (Elephant-shrews) in North-eastern Namibia. Journal of Namibia Scientific Society 65: 69-75.

Sabuni, C. A., N. Van Houtte, S. Gryseels, S. L. S. Maganga, R. H. Makundi, H. Leirs, and J. Gouy de Bellocq. 2016. Genetic structure and diversity of the black and rufous sengi in Tanzania coastal forests. Journal of Zoology 300:305-313.

Smith, H. F., W. Parker, S. H. Kotze, and M. Laurin. 2017. Morphlogical evolution of the mammalian cecum and cecal appendix. Comptes Rendus Palevol 16:39-57.

Stokes, H., B. Ogwoka, J. Bett, T. Wacher, and R. Amin. 2016. Mammal diversity survey in the northern coastal forests of Kenya: Arabuko-Sokoke forest and the Boni-Dodori forest system., Zoological Society of London, London, UK.

Willems, F. 2016. The occurrence of Chequered Giant Sengis (*Rhynchocyon cirnei*) in Mutinondo Wilderness and their distribution in Zambia. Afrotherian Conservation - Newsletter of the IUCN-SCC Afrotheria Specialist Group 12:23-28.

Tenrecs

Angsongna, A., Ato Armah, F., Boamah, S., Hambati, H., Luginaah, I., Chuenpagdee, R. and Campbell, G., 2016. A systematic review of resource habitat taboos and human health outcomes in the context of global environmental change. *Global Bioethics*, *27*(2-4): 91-111.

Borgerson, C., 2016. Optimizing conservation policy: the importance of seasonal variation in hunting and meat consumption on the Masoala Peninsula of Madagascar. *Oryx*, 50(3): 405-418.

Dave, R., Tompkins, E.L. and Schreckenberg, K., 2016. Forest ecosystem services derived by smallholder farmers in northwestern Madagascar: Storm hazard mitigation and

participation in forest management. *Forest Policy and Economics*. https://doi.org/10.1016/j.forpol.2016.09.002
Lagadec, E., Gomard, Y., Le Minter, G., Cordonin, C., Cardinale, E., Ramasindrazana, B., Dietrich, M., Goodman, S.M., Tortosa, P. and Dellagi, K., 2016. Identification of Tenrec ecaudatus, a wild mammal introduced to Mayotte Island, as a reservoir of the newly identified human pathogenic Leptospira mayottensis. *PLoS neglected tropical diseases*, *10*(8): e0004933.
Murphy, A.J., Goodman, S.M., Farris, Z.J., Karpanty, S.M., Andrianjakarivelo, V. and Kelly, M.J., 2017. Landscape trends in small mammal occupancy in the Makira–Masoala protected areas, northeastern Madagascar. *Journal of Mammalogy*, 98(1): 272-282.
Randrianarivony, T.N., Andriamihajarivo, T.H., Ramarosandratana, A.V., Rakotoarivony, F., Jeannoda, V.H., Kuhlman, A., Randrianasolo, A. and Bussmann, R., 2016. Value of useful goods and ecosystem services from Agnalavelo sacred forest and their relationships with forest conservation. *Madagascar Conservation & Development*, 11(2): 44-51.
Richard, A.F., Ratsirarson, J., Joanarisoa, E., Youssouf Jacky, I.A., Fiorentino, I. and Ranaivonasy, J., 2016. Mammalian biodiversity at Beza Mahafaly: An update. *Malagasy Nature*, 10: .25-35.
Stankowich, T. and Campbell, L.A., 2016. Living in the danger zone: exposure to predators and the evolution of spines and body armor in mammals. *Evolution*, 70(7): 1501-1511.
Tessier, C., Atiana, L.P., Lagadec, E., Le Minter, G., Denis, M. and Cardinale, E., 2016. Wild fauna as a carrier of Salmonella in Reunion Island: Impact on pig farms. *Acta tropica*, 158: 6-12.

Aardvark

Kerley, G.I.H. & Tompkins, I.D.S. 2017. Drinking by aardvark *Orycteropus afer*. *African Journal of Ecology*, Vol. 55. EARLY VIEW/ONLINE: http://dx.doi.org/10.1111/aje.12413

IUCN/SSC Global Conservation assessments

Bronner, G. & Mynhardt, S. 2015. *Amblysomus corriae*. The IUCN Red List of Threatened Species 2015: e.T62006A21284863. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T62006A21284863.en.
Bronner, G. & Mynhardt, S. 2015. *Amblysomus hottentotus*. The IUCN Red List of Threatened Species 2015: e.T41316A21286316. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T41316A21286316.en.
Bronner, G. & Mynhardt, S. 2015. *Amblysomus marleyi*. The IUCN Red List of Threatened Species 2015: e.T62007A21284544. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T62007A21284544.en.
Bronner, G. 2015. *Carpitalpa arendsi*. The IUCN Red List of Threatened Species 2015: e.T40596A21289173. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T40596A21289173.en.
Bronner, G. 2015. *Chlorotalpa duthieae*. The IUCN Red List of Threatened Species 2015: e.T4768A21285581. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T4768A21285581.en.
Bronner, G. 2015. *Chlorotalpa sclateri*. The IUCN Red List of Threatened Species 2015: e.T4766A21285759. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T4766A21285759.en.
Bronner, G. 2015. Chrysochloris asiatica. The IUCN Red List of Threatened Species 2015: e.T40600A21288387. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T40600A21288387.en.
Bronner, G. 2015. *Chrysochloris visagiei*. The IUCN Red List of Threatened Species 2015: e.T4812A21287855. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T4812A21287855.en.

Bronner, G. 2015. *Chrysospalax trevelyani*. The IUCN Red List of Threatened Species 2015: e.T4828A21289898. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T4828A21289898.en.
Bronner, G. 2015. *Chrysospalax villosus*. The IUCN Red List of Threatened Species 2015: e.T4829A21290416. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T4829A21290416.en.
Bronner, G. 2015. *Cryptochloris wintoni*. The IUCN Red List of Threatened Species 2015: e.T5748A21287143. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T5748A21287143.en.
Bronner, G. 2015. *Cryptochloris zyli*. The IUCN Red List of Threatened Species 2015: e.T5749A21286235. http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T5749A21286235.en.

South African Mammal Red List re-assessments

In collaboration with the Endangered Wildlife Trust, the following national re-assessments of 17 species were also produced by the ASG Golden mole Section, and can be viewed here.

Bronner, G. 2016. A Conservation Assessment of *Chrysochloris visagiei*.. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
Bronner, G.N. and Asher, R. 2016. A Conservation Assessment of *Chrysospalax trevelyani*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
Bronner, G.N. and Asher, R. 2016. A Conservation Assessment of *Chrysospalax villosus*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
Bronner, G.N. and Asher, R. 2016. A Conservation Assessment of *Cryptochloris wintoni*. In: M.F. Child, D. Raimondo, E. Do Linh San, L. Roxburgh and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
Bronner, G. and Asher, R. 2016. A Conservation Assessment of *Cryptochloris zyli*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
Bronner, G. and Asher, R. 2016. A Conservation Assessment of *Chrysochloris asiatica*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
Bronner, G. and Bennett, N. 2016. A Conservation Assessment of *Chlorotalpa duthieae*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
Bronner, G. and Bennett, N.C. 2016. A Conservation Assessment of *Chlorotalpa sclateri*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
Bronner, G. and Mynhardt, S. 2016. A Conservation Assessment of *Amblysomus corriae*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
Bronner, G. and Mynhardt, S. 2016. A Conservation Assessment of *Amblysomus hottentotus*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Bronner, G. and Mynhardt, S. 2016. A Conservation Assessment of *Amblysomus marleyi*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Maree, S. and Bronner, G. 2016. A Conservation Assessment of *Calcochloris obtusirostris*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Maree, S. and Bronner, G. 2016. A Conservation Assessment of *Eremitalpa granti granti*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Maree, S. and Bronner, G. 2016. A Conservation Assessment of *Neamblysomus gunningi*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Maree, S., Bennett, N. and Bronner, G. 2016. A Conservation Assessment of *Neamblysomus julianae*. In: M.F. Child, D. Raimondo, E. Do Linh San, L. Roxburgh and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Rampartab, C. and Bronner, G. 2016. A Conservation Assessment of *Amblysomus robustus*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Rampartab, C. and Bronner, G. 2016. A Conservation Assessment of *Amblysomus septentrionalis*. In: M.F. Child, L. Roxburgh, D. Raimondo, E. Do Linh San, J. Selier and H. Davies-Mostert (eds), *The Red List of Mammals of South Africa, Swaziland and Lesotho*. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Guidelines for Authors

Articles, species profiles, reviews, personal perspectives, news items and announcements for the noticeboard are invited on topics relevant to the newsletter's focus. Material for edition number 14 should be sent to Chris & Mathilde Stuart (candm@stuartonnature.com). Articles should follow the format of this edition. The editors reserve the right to edit all contributions for style and content.

Subscription Information

Afrotherian Conservation is available on the IUCN/SSC Afrotheria Specialist Group website at: http://www.afrotheria.net/. If you wish to be alerted when new editions are posted on the website, please send your name and email address to Galen Rathbun (grathbun@calacademy.org)