Succulent Karoo Research Station

Symposium 30.-31st October 2025

25 Years Studying Small Mammal Socio-Ecology in a Biodiversity Hotspot

Draft Program and Abstracts Version 9. April

Day 1: Science

Time	Topic	Presenter
9:00	History of SKRS	Dr. Carsten Schradin, SKRS and CNRS
10:00	SKRS in a South African context	Prof. Neville Pillay, SKRS and Wits
10:30	**Coffee Break**	
11:00	Why to live solitarily: Lessons from the bush Karoo rat	Dr. Lindelani Makuya, SKRS and CNRS
11:30	Personality and seasonality: essential lessons from the bush Karoo rat	Dr. Heiko Rödel, University Sorbonne Paris Nord
12:00	Socio-genetics of small mammals in Goegap	PhD student, University Sorbonne Paris Nord
12:15	**Lunch break**	
13:30	The structure of bush Karoo rat lodges	Nkululeko Mbanjwa
14:00	Engineering ecosystems: How bush Karoo rats influence soil carbon sequestration	Dr. Christine Hatté, Université Paris-Saclay
14:30	Bush Karoo rats as eco-system engineers	Perfect Dlamini
15:00	**Coffee Break**	
15:30	Ecto-parasites and sociality	Nkululeko Nyawo
16:00	The acoustic network of the African striped mouse	Prof. Nicolas Mathevon, Univ. Saint-Etienne
16:30	Harshness is not stress: Lessons from the striped mouse	Dr. Carsten Schradin, SKRS and CNRS
17:00	**End of Day 1**	
17:00 – 18:00	Visit of the Succulent Karoo Research Station and the field site. Maximum of 12 people.	

Day 2: Conservation

Time	Topic	Presenter
9:00	SKRS and Goegap	Maxie Jonk, Reserve Manager Goega,
10:00	Basic science and nature conservation	Dr. Neville Pillay, SKRS and Wits
10:30	**Coffee Break**	
11:00	Succulent Karoo as a biodiversity hotspot	Phakamile Zungu, WWF and Leslie Hill Succulent Karoo Trust
11:30	Biodiversity monitoring by SKRS: plants and mammals	Dr. Lindelani Makuya
12:00	**Lunch break**	
13:30	The function of plants collected by bush Karoo rats (*Otomys unisulcatus*)	Siyabonga Sangweni SKRS and Wits
14:00	Socio-genetics and conservation	Dr. Chantal Poteaux, University Sorbonne Paris Nord
14:30	**Coffee Break**	
15:00	Biodiversity and conservation of the Succulent Karoo during the last decades	Annelise le Roux, Elmarie Heyns and Mierietjie Landman. Wilderness Foundation, Nelson Mandela University
15:30	Responding to the illegal succulent trade crisis in South Africa	Emily Kudze South African National Biodiversity Institute & WWF
16:00	**Coffee Break**	
16:30	Reptiles of Namaqualand	Johan Marais Kokerboom Biological Research Station
17:00-18:00	Visit of the Succulent Karoo Research Station and the field site. Maximum of 12 people.	
18:30	**Braai at SKRS**	

Abstracts

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History of SKRS

The Succulent Karoo Research Station SKRS was founded in 2001, when I started my field work on striped mice (*Rhabdomys pumilio*) as a postdoc at the University of the Witwatersrand. Originally, only short field studies were planned to show that paternal care occurs in striped mice under natural conditions. However, I immediately realised that this is the perfect place for long-term field studies on a mouse like rodent, which changed my career path. 40% of all mammals are rodents, most mouse like, but my study is the only one on a free-living mouse that is observed directly in its natural habitat. In 2006, I started a contract position as group-leader at the University of Zurich, Switzerland, and in 2012 as permanent researcher at the CNRS in Strasbourg, France. In 2013, SKRS was registered as a South African non-profit organisation. Long term studies on the striped mouse continued throughout the years. Studies focussed on paternal care, social flexibility, and adaptations to drought with about 100 peer-reviewed publications revolutionising our understanding of social evolution and of adaptation to drought. The closure of Goegap Nature Reserve in 2020 due to the Covid pandemic lead to change of research focus from the socially flexibly but most often group-living striped mouse to the socially flexible but most often solitary living bush Karoo rat. These studies revolutionised our understanding of the mechanisms leading to and the evolutionary consequences of solitary living. Over the 25 years of field studies at Goegap, more than 130 volunteers and research assistants from all over the world worked at SKRS, 20 master students, nine PhD students and eight postdocs collected data for their projects. Multiple collaborations were done with researchers from France, Germany, South Africa, Spain, Switzerland, UK and USA. Since 2024, three research assistants are employed by SKRS. Striped mice from Goegap were exported the first time in 2006. In the meantime, four colonies exist at research institutions worldwide, in France, the UK, and the USA, with a wide variety of studies such as vocal communication, molecular and neural basis of social behaviour, chronobiology and evolutionary developmental biology (evodevo) being conducted on them, all based on our results obtained at SKRS. In sum, the research conducted at SKRS over the last 25 years had a significant impact on multiple research fields and impacts research worldwide.

SKRS in a South African context Prof. Neville Pillay, SKRS and Wits

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Why to live solitarily: Lessons from the bush Karoo rat

Solitary living has traditionally been regarded as the ancestral as well as most common and most primitive form of social organisation in mammals. However, recent comparative studies indicate that solitary living is not ancestral for all mammalian orders, and that solitary living is an adaptation to the environment. To reach a better understating of solitary living, I studied the social system of free-living bush Karoo rats (*Otomys unisulcatus*) in the Succulent Karoo semi-desert of South Africa. I used trapping and marking, focal animal observations and mini-GPS dataloggers that I fitted simultaneously to neighbouring females. I found that 96% of female bush Karoo rats were solitary living, with social groups of two or three individuals occurring occasionally. Groups always consisted of close kin, typically females. The home ranges of kin neighbours overlapped more than those of non-kin. Neighbours were, however, attracted to the same foraging grounds, irrespective of relatedness. Females tolerated one another at shared foraging grounds, which could be interpreted as by-product mutualism, a simple form of cooperation. I recorded interactions between

neighbouring bush Karoo rats both in a neutral test arena and in the field to investigate whether solitary living was due to aggression and social intolerance. Social interactions between neighbours were rare and aggression was rare in neutral arena tests. However, female bush Karoo rats were more aggressive towards non-kin intruders in the field tests. Finally, the relationship between mother and offspring remained amicable even after the offspring had dispersed from the lodges, indicating that maternal aggression was not the mechanism that led to offspring dispersal and solitary living. In conclusion, I showed that solitary living is not always characterised by aggression and avoidance, but rather that solitary species can have non-random and individualised social interactions that are influenced by kinship.

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Personality differences in bush Karoo rats born early and late in the breeding season

In short-lived small mammals, individuals born earlier in the breeding season frequently reproduce within their season of birth. Consequently, it has been proposed that those born early benefit from a more proactive behavioral type to compete for reproductive opportunities, whereas later-borns adopt a more reactive personality to conserve energy to survive through the non-breeding season thus postponing reproduction to the following year. However, being proactive could also benefit later-borns in acquiring resources in the late breeding season essential for survival. We investigated personality differences depending on the date of birth, in relation to resource variation in a free-living population of the bush Karoo rat (*Otomys unisulcatus*). This species constructs stick lodges, a critical resource protecting the rats from the harsh semi-desert environments, whereas the availability of vacant lodges decreases with the deterministic increase in population density along the breeding season. We predicted an increased occurrence of proactive phenotypes during the later breeding season, contrasting with the commonly assumed decrease in proactive phenotypes in late season due to lack of reproductive opportunity. Behavioral testing of wild-caught individuals revealed that later-borns showed greater activity, boldness and exploration tendencies, indicating a more proactive personality. Furthermore, early-born females which reproduced within the same season showed no notable differences in personality compared to those which did not reproduce. Taken together, our results indicate that seasonal differences in personality types in the bush Karoo rat may be driven by resource constraints in the late season rather than by differences in reproduction opportunities.
This study has been published in Qui et al. (2024) Behav Ecol Sociobiol 78

Socio-genetics of small mammals in Goegap PhD student, University Sorbonne Paris Nord

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The structure of bush Karoo rat lodges

The extensive stick lodges built by bush Karoo rats are regarded as one key example of animal architecture. However, detailed studies on the lodge structure are so far missing. Here I present data on the external and internal structure of all 102 bush Karoo rat lodges on our field site next to the

Succulent karoo research Station, showing that they are on average 38 ± 12cmcm high (range: 12-68 cm) and have multiple layers with on average 2.2 1.9 entrances (range: 0-10), and 1.9 ± 1.9 platforms (range: 0-9) that can be used for basking, eating or even as latrines. Our data shows that bush Karoo rat lodges represent complex animal architecture and future studies will test how these components lead to a favourite microclimate inside the lodges.

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Engineering Ecosystems: How Bush Karoo Rats Influence Soil Carbon Sequestration

The role of Bush Karoo Rats in shaping ecosystem dynamics, particularly in soil carbon sequestration, remains poorly understood. While their lodges are expected to provide protection against predators and weather, their potential impact on soil health and carbon dynamics has received little empirical attention. Bush Karoo Rats' constructions significantly influence their surroundings including soils by concentrating organic matter, such as wood, vegetation, and feces. This addition of carbon to soil might (i) enhance biodiversity by creating favorable conditions for plant species unable to thrive in nutrient-poor soils, and (ii) contribute to a sustainable soil carbon reservoir. However, robust data to support these dynamics remain scarce. This study presents preliminary results from soil core samples collected at the Succulent Karoo Research Station in November 2024. Soil cores were sampled in paired settings: under lodges vs. outside under the same shrub species without lodge (*Zygophyllum*, *Lycium*) and unvegetated areas. Lodges had been occupied for varying durations (inc. abandoned lodges). Using isotopic geochemistry, we analyze soil organic matter through ^{14}C dating, carbon and nitrogen content, and isotopic signatures. $\delta^{13}C$ reveals the contributions of C3 and C4 plants, while $\delta^{15}N$ provides insights into the role of legumes in nitrogen cycling. The objectives are threefold: (i) quantify the carbon stock added by lodges, (ii) evaluate its sustainability, and (iii) identify factors influencing the magnitude of this additional carbon stock. These findings aim to inform conservation policies by emphasizing the overlooked role of small mammals in carbon cycling and soil health.

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Bush Karoo rats as eco-system engineers

Eco-system engineers are species believed to have a significant impact on their habitat and other species living in it. The bush Karoo rat might be such an eco-system engineer, but a detailed review about their impact on their ecosystem is so far missing. Here I summarise how bush Karoo rats influence their habitat by lodge building, i.e. the carrying away of plant material to construct lodges which influences the overall appearance of their habitat. Lodges offer shelter for many other species and impact the soil ecology, while the preferences of bush Karoo rats to forage on dominant plant species is believed to explain the higher plant biodiversity around occupied than unoccupied lodges. These results are important for both nature conservation and farming, because they show that bush Karoo rats are eco-system engineers that help to maintain a high biodiversity and healthy soils.

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Ecto-parasites and sociality

Solitary living has often been suggested to have the benefit of a lower risk to get infected with ecto-parasites. However, previous comparisons were always between small and large groups and did not include solitary individuals. It is possible that small groups are more effective in removing ecto-parasites than large groups. Thus, so far it is unknown whether solitary living had the benefit of a lower ecto-parasite load. Here I show that solitary bush Karoo rats have a less ecto-parasites than group-living striped mice and I will present a comparison between solitary and pair-living bush Karoo rats. This study shows that solitary living can have the benefit of lower ecto-parasite load.

The acoustic network of the African striped mouse Prof. Nicolas Mathevon, Univ. Saint-Etienne

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Harshness is not stress: Lessons from the striped mouse

Animals are adapted to cope with harsh environments characterised by persistent and long-lasting factors that threaten homeostasis and survival such as reduced food (energy) availability, reduced water availability, and seasonal cold or heat. Understanding these adaptations is crucial to understand species resilience to global change. Over two decades of field studies I investigated how African striped mice (*Rhabdomys pumilio*) are adapted to harshness in the Succulent Karoo semi-desert characterised by hot, dry and food restricted summers and moist benign winters. I found that striped mice are adapted to harshness via multiple behavioural and physiological mechanisms, which aim to reduce energy consumption and increase water retention. Mechanisms include social flexibility, communal huddling, sun-basking, reducing activity, broad range of blood glucose regulation, decrease of metabolic hormone levels, decrease of resting metabolic rate and by this an overall reduction of daily energy expenditure. These studies indicate that to endure harshness, animals decrease energy expenditure, which is the opposite to the physiological stress response which is characterised by a significant increase in energy expenditure. Harshness requires coping mechanisms reducing energy expenditure. Measuring the same traits in species from mild climates might help us predict species resilience to a changing world where droughts will occur more regularly. It is important to recognise that stressful environments are not synonymous with harsh environments. I thus conclude that the harshness response is different from a stress response. The stress response leads to increased energy expenditure to overcome stress, while the harshness response leads to reduced energy expenditure to endure harshness.

SKRS and Goegap Maxie Jonk, Reserve Manager Goega,

Basic science and nature conservation Dr. Neville Pillay, SKRS and Wits

Succulent Karoo as a biodiversity hotspot Phakamile Zungu, WWF and Leslie Hill Succulent Karoo Trust

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Biodiversity monitoring by SKRS: plants and mammals

The Succulent Karoo contains a biodiversity hotspot in Namaqualand, that is home to over 6000 plant species, 40% of which are endemic to the region. Although extensive studies have been conducted in the area to understand the plant diversity, little is known about the animals such as reptiles and mammals. Furthermore, only a small section of 3.5 % of the area is formally protected. At SKRS we conduct long-term monitoring of small mammals. We contributed to the South African Mammal Red Data List for five small mammal species which are the bush Karoo rat, Brants and Littledale´s whistling rat, striped mice and the round eared elephant shrew. We have 8 monitoring plots in which we measure the plant diversity every month. This allows have to also have seasonal estimates of the plan cover throughout the years. These monitoring activities contribute to the better understanding the Succulent Karoo biome and in turn can advice on authorities for its better conservation and management.

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The function of plants collected by bush Karoo rats (*Otomys unisulcatus*)

Food storing to cope with food reduction during winter has been observed in many rodents in the northern hemisphere. Food storing could also be adaptive in semi-deserts of the southern hemisphere, which experience food-restricted dry seasons. We studied the function of dried food plants found at the stick lodges of bush Karoo rats in a semi-desert in South Africa. We performed 998 focal animal observations and monitored 12 lodges to record the fate of plant pieces carried back to the lodges. Collected plant species were eaten green (68%), eaten as plantong (12%), incorporated into the structure of the lodge (11%), or their fate was unknown (9%). Especially succulents carried back to the lodge dried out, forming what we refer to as plantong. This happened mainly in the food rich moist season. However, plantong was not stored from the moist to the dry season but was consumed within 6±5 days. Bush Karoo rats readily ate plantong presented to them experimentally. We regard plantong as leftover from food freshly consumed at the lodge, but not as food collected in the moist season to be stored for later consumption during the dry season.

Socio-genetics and conservation Dr. Chantal Poteaux, University Sorbonne Paris Nord

Biodiversity and conservation of the Succulent Karoo during the last decades Annelise le Roux, Elmarie Heyns and Mierietjie Landman.
Wilderness Foundation, Nelson Mandela University

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Responding to the illegal succulent trade crisis in South Africa

The fight against the illegal trade of succulents has been ongoing and has intensified since 2019, when it was noticed that there had been an increase in demand in the ornamental trade of succulents. The succulent Karoo biome shared between South Africa and Namibia is one of the five semi-arid biodiversity hotspots in the world that is being targeted. Because of this, there has been a recent update to the IUCN Red list assessments that revealed an unprecedented decline in a number of succulent species. With most succulents having small global ranges, the possibility of losing an entire species is great. Over the past 5 years there has been numerous confiscations by law enforcements from plant traffickers. This increase in succulent poaching triggered the Department of Forestry, Fisheries and the Environment (DFFE) with the support of the South African National Biodiversity Institute (SANBI) and Worldwide Fund for Nature South Africa (WWF SA) to draft and develop a National Strategic plan to tackle this issue. In February 2022 a National Response Strategic and Action Plan (NRSAP) was finalised from a collaborative effort between government departments, conservation authorities, NGOs, and local communities to ensure the survival of succulents in Southern Africa. Since 2022, there has been progress made in the various objectives outlined in the NRSAP. This presentation will be a report on what the NRSAP is about and give an update on progress, challenges and trends.

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Reptiles of Namaqualand

The latest Conservation Status of Reptiles of South Africa, Eswatini and Lesotho (Suricata 10) lists 410 reptile species. Two reptile species, *Tetradactylus eastwoodae* and *Scelotes guentheri* are listed as extinct with three listed as Critically Endangered – *Psammobates geometricus*, *Scelotes inornatus* and *Cryptoblepharus africanus*. A further ten endemic reptiles are listed as Endangered – three chameleons, two tortoises, two skinks, one gecko and one adder. Seventeen reptiles are listed as Vulnerable with ten of them endemic to South Africa. Several species that were listed as Least Concerned have now been moved to Near Threatened as we now have better data and a better understanding of certain threats, like the increase in corvids over the past three decades that pose a threat to several reptiles but especially tortoises. Fifteen percent of reptiles globally are considered Threatened compared with 13% of reptiles in South Africa, if we include both Threatened and Near Threatened species.

Namaqualand is a true reptile paradise with 97 reptile species, consisting of 28 snake species, 13 skinks, 29 geckos, 3 agamas, 7 girdled lizards, 3 tortoises, 1 plated lizard, 1 monitor lizard, 2 flat rock lizards, 7 sand and desert lizards and 1 terrapin. The major threats to the herpetofauna of Namaqualand include habitat destruction, the explosion of corvids and the illegal pet trade while many snakes are killed on roads. Two lizards, the Large-scaled Girdled Lizard (*Cordylus macropholis)* and the Armadillo Lizard (*Ouroborus cataphractus*) are listed as near threatened while the Speckled Padloper (*Chersobius signatus*) is listed as Endangered.