Namibia Wissenschaftliche Gesellschaft
Namibia Scientific Society

JOURNAL

Volume 70 - 2023

Journal	70	Windhoek	2023	ISBN: 978-99945-76-90-6	ISSN: 1018-7677

LÜDERITZ NEST HOTEL

reservations@nesthotel.com
www.nesthotel.com

Namibia Scientific Society

JOURNAL

Volume 70 - 2023

Journal 2023 **Windhoek** **ISBN: 978-99945-76-90-6** **ISSN: 1018-7677**

Cover Photo *Albizia anthelmintica* by Antje Burke

Publisher & Advertising Namibia Scientific Society
110 Robert Mugabe Ave., Windhoek
P.O. Box 67, Windhoek / Namibia
Tel: 061-22 53 72
E-mail: info@namscience.com

Website www.namscience.com

Printing John Meinert Printing, P.O. Box 56
Windhoek / Namibia, Tel: 061-22 54 11

NAMIBIA SCIENTIFIC SOCIETY
Structure of the Society
2023

Committee of the Society

Chairman
Michael Backes
Vice Chairman
Frank Wittneben
Board Members
Zandré Duvenhage
Michael Hasheela
Helke Mocke
Guido Röschlau
Alfred Schleicher
Theo Schoeman
Roger Swart
Heike Uhrich

Affilliated Groups

Museum Grootfontein
Museum Tsumeb
Museum Lüderitzbucht

Senators of the Namibia Scientific Society

Helmut Bistri, Köln, Germany
Kuno Budack, Windhoek
Maria Fisch, Swakopmund

Honorary Members

Josef Brandmayr, Austria
Sonja Itting-Enke, Windhoek
Bertchen Kohrs, Windhoek
Dieter Ludwig, Windhoek
Gabriele Moldzio, Windhoek
Wolfgang Reith, Neuss, Germany
Sigrid Schmidt, Hildesheim, Germany
Ilme Schneider, Windhoek
Dieter Springer, Windhoek
Gunter von Schumann, Windhoek
Erika von Wietersheim, Windhoek

Secretariat

Office
P.O. Box 67
Windhoek, Namibia
Tel: 061-22 53 72
E-mail: info@namscience.com

Manager
Ruth Moldzio
Bookkeeper
Ruth Moldzio
Library
Armin Jagdhuber (Head of Library)
Gunter von Schumann
Annegret Enengl
Hanna Itula (Assistant)
Johannes Willibard (Assistant)
PA
Elfi Schneider
Publishing/Marketing
Malilo Limbo

Auditor
Christo Loubser
Beancounter

Study Groups

Astronomy
Sonja Itting-Enke, P.O. Box 5198, Whk.
Michael Backes, P.O. Box 90715, Whk.

Herpetology
Alfred Schleicher, P.O. Box 11752, Whk.

Namibian Hydrogeological Association
Ester Gustavo, P.O. Box: 21850, Whk.

Ornithology
Gudrun Middendorff, P.O. Box 81797, Whk.

Lanioturdus: Editor
Holger Kolberg, P.O. Box 3407, Whk.

The Society is a member of the following organisations

South African Archaeological Society
South African Botanical Society
Van Riebeeck Society, Cape Town

Partner Organisations

Botanical Society of Namibia
Gobabeb Research & Training Centre
Namibian Environment and Wildlife Society
National Commission on Research, Science and Technology

Corresponding Members

Imre Demhardt, Arlington, USA
Irenäus Eibl-Eibesfeldt, Max Planck Institut, Andechs, Germany

Corporate Members of the Society

African Kirikara

Amanda Miller Insurance Brokers

ATC Namibia

Atlas Engineering Solutions

Bigen Kuumba

Cynetio Cyber Security Solutions

HYPHEN Hydrogen Energy (Pty) Ltd

John Meinert Printing (Pty) Ltd

Kerry McNamara Architects Inc.

Lüderitz Nest Hotel

Matiti Safaris

Mindsinaction

Namibian Green Hydrogen Association

Namibian Uranium Association

Ohlthaver & List Group

Pay Buddy

Ondili Lodges

Pack Safari

Paratus

Pointbreak

Pupkewitz Foundation

Scientific Society Swakopmund

Sense of Africa

Solitaire Desert Farm Namibia

Ondese Safaris

Wealth Management Solutions cc

Sincere thanks for your support!

Step back in time at the home of Rock Art

Ai Aiba
THE ROCK PAINTING LODGE

Email: info@aiaiba-namibia.com
Tel.: +264 (0)61 239 199 | +264 (0)64 570 330
Web: www.aiaiba-namibia.com

Editorial

The Journal of the Namibia Scientific Society (ISSN: 1018-7677) is a cross-disciplinary journal and publishes research in all fields related to Namibia. Published since 1925, it is the longest-standing academic journal in Namibia and is distributed to libraries in various countries, e.g. Germany, South Africa, Kenya, Australia, Switzerland, and the USA. In currently 70 volumes, more than 375 articles have been published in research fields like Architecture, Climate/Weather, Conservation, (Desert) Fauna/Wildlife, Geography, Heritage management, History (colonial time and independence struggle), (Eco) Tourism, and Vegetation, mostly in English and German.

All contributions must be based on original research and are subject to peer review. Still, as indicated by the slogan of the Namibia Scientific Society "Science for Society", the strength of the Journal also lies in its multi- and inter-disciplinary orientation. Always trying to strike a balance of scientific rigour on the one hand and readability on the other, the Journal is aimed at our members as well as interested readers worldwide. In addition to the printed edition, the Journal of the Namibia Scientific Society is currently undergoing digitization and will soon appear as an Open-Access eJournal.

This 70th volume of the Journal coincides with the UN-proclaimed International Year of Basic Science for Sustainable Development (IYBSSD) 2022/2023. This year is – as they phrase it themselves – "a key moment of mobilization to convince economic and political leaders, as well as every citizen, of the importance of taking into account and mastering basic sciences to ensure a balanced, sustainable and inclusive development of the planet."[1] Basic in this context does, obviously, not mean 'simple' but 'fundamental'. It is research that is curiosity-driven and not use-inspired or even with direct industrial application. The majority of the contributions to this volume are fitting this theme, while showcasing a large variety of interesting topics. Firstly, we have a research note on a project on desert ecosystems. This is followed by research articles on Namibian rock paintings, on archaeological findings in the Zoo Park in Windhoek, and on the antimicrobial activity of three ethno-medicinal plants. This volume of the Journal closes with two book reviews, one on *Meine Kriegserlebnisse in Deutsch-Südwestafrika* and one on *Der Bart des Elefanten*. The former has recently been re-published, based on diary notes of 1907, the latter is a completely new book on the biography of the conservational hunter Volker Grellmann.

In the name of the Namibia Scientific Society, I want to thank all the authors as well as the reviewers for their tireless efforts and hope you will enjoy this 70th issue of the Journal of the Namibia Scientific Society.

Kind regards,
Michael Backes

[1] https://www.iybssd2022.org/en/home/

PUPKEWITZ FOUNDATION

Sustainability, Responsibility and Creating Shared Value

Pupkewitz Foundation is a private grantmaking foundation that works to expand opportunities in Namibia nationally through grantmaking initiatives in education, health, environment, community care, arts and culture, and sports.

Our programs address the need to promote the well-being of humanity, creating pathways for low-income people so that they can attain economic independence and create better futures for themselves and their families.

www.pupkewitzfoundation.org

Follow us:

Research Notes

Determining risk of a regime shift in a coupled arid Social-Ecological System

Theo Wassenaar[1,2], Cornelis van der Waal[2], Wilka Ndapulamo[1,2], Kakunamuua Tjiningire[1,2], Dylan Dentlinger[2], Venomukua Tjiseua[2], Francois Engelbrecht[3]
[1] Namibia University of Science and Technology, 13 Jackson Kaujeua Street, Windhoek
[2] Gobabeb Namib Research Institute, Namib-Naukluft National Park; PO Box 953, Walvis Bay
[3] University of the Witwatersrand, 1 Jan Smuts Avenue, Johannesburg, South Africa

Abstract

Southern Africa has been identified as a climate change hot-spot, warming at about twice the global rate. The projected warming and drying of this arid and semi-arid region will limit the options for adaptation to climate change, especially in marginalized communities. A particular risk is that climate change may cause an abrupt, irreversible 'regime shift' in ecological processes and functions with cascade effects on coupled social-ecological systems and profound consequences for the capacity of those systems to support livelihoods.

Together with southern African and German partners, the Gobabeb Namib Research Institute and Namibia University of Science and Technology recently launched a SASSCAL-funded project called TIPping Points Explained by Climate Change (abbreviated TIPPECC) to 1) to assess the risk of climate change induced regime shifts or tipping points in southern Africa, 2) to provide a range of climate services, and 3) to co-produce with affected communities, policymakers, and natural resource managers adaptation options to safeguard against the effects of such tipping points should they occur.

The Namibian contribution to TIPPECC (TIPPECC-Kunene) focuses on the arid zone pastoralist rangeland system of the Ovahimba of northern Kunene. Ovahimba have inhabited the region for over 200 years, surviving several intense droughts. The pastoralist lifestyle is finely attuned to its environment, adapting to seasonal and longer-term fluctuations in their resources. However, several factors, including population growth and increased sedentarisation have put pressure on the whole social-ecological system (SES), making it vulnerable to climate change and subsequent regime shifts in their resource base. TIPPECC-Kunene aims to use both traditional ecological knowledge and scientific data to determine 1) the probability of climate tipping points leading to regime shifts in the SES, and 2) those factors that will cause changes and/or shifts, with an emphasis on the role that climate tipping points will play in this. We further aim 3) to co-develop, with affected communities, feasible adaptation strategies to ongoing global change, ensuring alignment with inherent coping strategies. TIPPECC-Kunene is organised around eight thematic groups, including studies on vegetation change and degradation, livestock foraging ecology, changes in resource access rules, adaptation, and livelihoods, and the role of boreholes in driving social and environmental change.

Background

Southern Africa has been identified as a climate change hot-spot (Hoegh-Guldberg et al., 2018). Its interior regions are warming at about twice the global rate of temperature increase (Engelbrecht et al., 2015) and further drastic warming is projected under low mitigation climate change futures (Lee et al., 2021). Moreover, the region is likely to become generally drier in a warmer world (Ranasinghe et al., 2021). The projected further warming and drying of this already arid and semi-arid region will limit the options for adaptation to

climate change, especially in marginalized communities. A particular risk is that climate change may cause abrupt, irreversible shifts in ecological processes and functions (Lenton et al., 2008), with cascade effects on social systems. Such sudden, high-impact changes in natural systems (Rietkerk et al., 2004; Guttal & Jayaprakash, 2008; Zeng et al., 2012; Berdugo et al., 2020) are called 'tipping points' or 'regime shifts'. A crucial feature in dryland coupled systems is that a negative change in a driving factor – such as decreasing rainfall and more frequent heat waves – can lead to a regime shift in the associated hydrological, ecological, agricultural, and social systems, with profound consequences for the capacity of those systems to support livelihoods.

Together with southern African and German partners, we recently launched a project to study the risks that such regime shifts may significantly affect various important water, food, and biodiversity systems of southern Africa. This project, called **TIP**ping **P**oints **E**xplained by **C**limate **C**hange (abbreviated TIPPECC), is a collaboration under a SASSCAL[1]-funded Grand Challenge consortium led by the Global Change Institute (GCI) at the University of the Witwatersrand (Wits) in South Africa. The overall goals of TIPPECC are 1) to assess the risk of climate change induced tipping points in southern Africa, 2) to provide a comprehensive range of climate services, closely informed by and co-developed with various actors (e.g. policymakers, water managers, organized agriculture, rural communities, and conservation practitioners), and 3) co-produced adaptation options to safeguard against the effects of such tipping points should they occur.

TIPPECC is generating a core set of downscaled (increased local detail) climate projections and a climate services gateway offering free access to informative indicators of change in important water, food, and biodiversity systems of southern Africa. These outputs are the responsibility of the GCI, the University of Zambia (UZ), and our German partners at the Friedrich Schiller University Jena (FSU) and the Helmholtz-Zentrum Geesthacht Climate Service Center Germany in Hamburg (HZG-GERICS). In addition, five regional case studies will be investigating the potential occurrence of regime shifts or tipping points in urban and industrial water availability (South Africa: Wits), in intensively farmed beef and maize production (Botswana: University of Botswana [UB], and South Africa: GCI), in large-scale wildlife movements (Botswana: UB), in rural water supply (The Zambezi basin, Zambia: UZ) and in the arid zone pastoralist rangeland system of the northern Kunene, the home of the Ovahimba. It is the last-mentioned component of the project, led by the Gobabeb Namib Research Institute in collaboration with the Namibia University of Science and Technology (NUST), which we will refer to as **TIPPECC-Kunene**, which is the topic of this paper.

[1] Southern African Science Service Centre for Climate Change and Adaptive Land Management

A focus on the Ovahimba pastoralist[2] livelihood

The dominant form of agriculture in the arid northwest of Namibia[3] is pastoralism (Eisold et al., 2006). Pastoralism refers to a form of animal husbandry where livestock are allowed to roam freely on open rangelands. It is one of the most widespread forms of agriculture in the world, occurring on all continents except Antarctica and covering almost 25% of the world's land area (Dong, 2016). It is a complex form of adaptive natural resource management which still is practised in more than 100 countries, involving nearly a billion animals and supporting about 200 million households (FAO, 2001). Globally, pastoralists produce about 10% of the world's meat production (FAO, 2001).

It is essentially a system of management of common pool resources that developed in response to the typically high variability of resources in drylands. In its "pure" form, given no restrictions on mobility and relatively small human population density, it is an energetically conservative and sustainable form of resource consumption, with minimal long-term impacts on vegetation composition and productivity (Coughenour et al., 1985; Ward et al., 1998; Sullivan 1999).

Transhumant and nomadic pastoralism are principally practised in arid and semi-arid rangelands (Weber & Horst, 2011). Transhumance refers to a relatively stable pattern of movement between a home base and a small number of dry season pastures (e.g. mountain tops), while nomadism is characterized by continual movement of livestock in search of spatially variable quality forage. In the case of nomadism, no permanent home base is established, and movement is not planned but closely adapted to current conditions (Weber & Horst, 2011). Historically, the Ovahimba (and other Namibian pastoralist groups) practise a mixed form of these two types. Although the distinction and shifts between transhuman and nomadic forms may show an interesting and potentially important relationship with long term climate changes, this will not be further explored here, and the term pastoralism will be used to refer to both forms.

Ovahimba pastoralists, an offshoot of a larger Ovaherero group that moved into the region from the north, have inhabited much of northern Kunene for more than 200 years (Bollig & Schulte, 2014). A rich culture has developed around key features of their livelihood such as livestock ownership, free movement, family ties, livestock value, and kinship ties (Bollig & Schulte, 1999). During German colonial times and before, when human and livestock densities were lower, the management of the common pool resource

[2] For more on the pastoralist social-ecological system and its changes over the last seven decades, see Wassenaar et al. (2021), from which much of the description here has been taken.

[3] The arid northwest of Namibia is often referred to as the Kaokoveld, but that strictly refers to the World Wildlife Fund-defined Terrestrial Ecoregion encompassing the most arid western part, including the Skeleton Coast (Dinerstein et al., 2017). The term Kaokoland refers to the old Apartheid-era Native Reserve, a designation which is no longer acceptable, although it may still be encountered in the popular media, referring to northern Kunene.

of rangeland was a simple function of the availability of forage and surface water at different times of the year (Bollig & Schulte, 1999; Bollig & Gewald, 2000).

Until the 1960s most permanent and semi-permanent settlements were restricted to the higher-lying semi-arid plateau with its higher precipitation and sandy soils associated with the Kalahari system, and to larger ephemeral river courses where groundwater was readily available (Owen-Smith, 1972; Malan & Owen-Smith, 1974). Unrestricted seasonal movements occurred around these permanent settlements as livestock owners made use of ephemeral surface water to access grazing in distant pastures during the rainy season (Bollig, 2013).

Important features of this period were that 1) the group of users and managers of specific pasture resources was clearly defined and numerically small, 2) households held tenure rights in specific places that had permanent water, and 3), the absence of permanent water over most of the area meant that large tracts of land were not used at all or were used very seldom (perhaps the most crucial feature from an ecological perspective). This pattern of rangeland uses effectively meant that grazing areas were effectively rested, allowing especially perennial forage species to recover. The period between 1960 and Namibian Independence saw a marked decline in the mobility of Ovahimba pastoralists (Bollig, 2006), caused by several factors including an active political goal to control the indigenous population (Bollig, 1998; 2020). After the rise of Apartheid in South Africa in 1948, the official policy shifted towards "modernizing" agriculture in the so-called Native Reserves to enhance food production. The Odendaal Commission of 1963 aimed to grant semi-independence to Kaokoland (as the area was known at the time) and recommended borehole drilling as the key to agricultural modernization and economic development. Opening up "under-exploited pastures" in the vast arid savannas of the Kaokoveld was a core tenet of that plan (Bollig, 2013). Starting from just a few waterholes created through blasting in the 1930s, the number of boreholes and the area they covered increased rapidly and cumulatively: 136 holes were drilled in the 1960s, 128 added in the 1970s, 57 in the 1980s, and 40 in the 1990s (Bollig, 2013). This significant expansion of water infrastructure was replicated in Native Reserves across Namibia, often with minimal concern for its ecological consequences.

Perhaps the most important feature of the post-1960 drilling programme was that most of the holes were drilled in the arid zone, where the aridity index[4] ranges between 0.03 and 0.2 (Figure 1). These indices indicate a large water deficit and high plant water stress,

[4] The long-term mean of the ratio of mean annual precipitation to mean annual evapotranspiration (i.e. MAP/MAE, called the Aridity Index or AI) provides a handy index of dryness that summarises the net soil water balance (Middleton & Thomas, 1997). MAE is usually modelled as mean annual potential evapotranspiration (PET) (Zomer et al., 2008). AI values lower than 1 indicate an annual moisture deficit.
Drylands are defined as areas with AI ≤ 0.65—that is, areas in which annual mean PET is at least ~1.5 x greater than MAP. Drylands are generally considered to comprise four types—dry subhumid, semiarid, arid, and hyper-arid—reflecting an increasing moisture deficit. Conventionally, the four subtypes are divided as ranges of the AI.

pointing to an ecosystem that is highly vulnerable to the combined effect of disturbance (overgrazing) and droughts.

Coming on the back of a decade of above average rainfall in the 1950s, the increased surface water availability since the early 1960s also saw an increase in cattle numbers from ~65,000 in 1960 to ~218,000 in 2006 (Bollig, 2006). This dramatic increase happened despite a significant dip in the 1980s when a particularly intense drought led to the loss of a large part of the herd (Bollig, 2006). The higher herd size also led to a fundamental change in rangeland management rules when the traditional migration to under-utilised pastures changed from the rainy season to the dry season with apparently intensely negative effects on pasture health (Behnke, 1998a, 1998b; Bollig, 1997; Bollig & Schulte, 1999; Bollig, 2013; Werner, 2015; Bollig 2020; Coppock et al., 2022).

The apparently continuous growth in herd size coincided with an increase in human populations and, perhaps more significantly, a higher settlement density linked to boreholes. When combined with what seem to be more frequent and severe droughts, this situation becomes particularly conducive to ecological degradation. Unsurprisingly, multiple studies, along with a wealth of anecdotal evidence and oral history among pastoralist farmers, allude to a widespread loss of ecological integrity and vegetation productivity (Bollig & Schulte, 1999; Bollig, 2013; Inman et al., 2019; 2020; Coppock et al., 2022).

Despite the obvious signs of degradation, such as massive loss of topsoil in some places (Figure 2), much of the common knowledge is based on speculation or remains anecdotal, with little evidence available in the peer-reviewed literature over the last two to three decades (but see Brunotte & Sander,

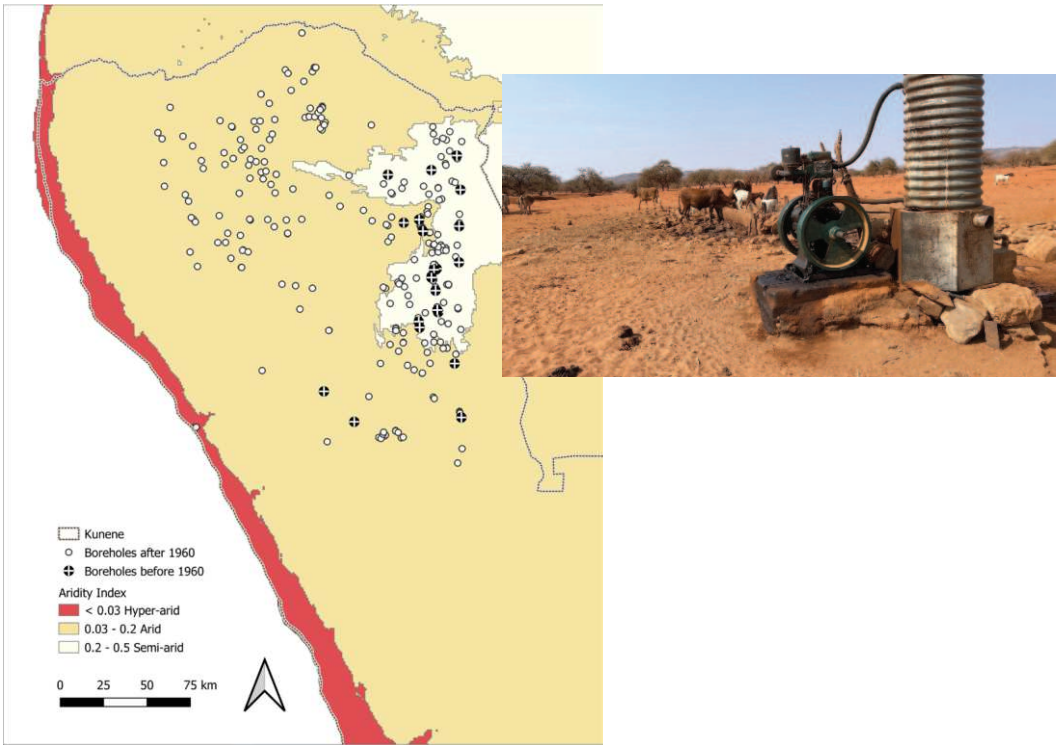


Figure 1: The location of boreholes drilled before and after 1960, on the spatial pattern of the aridity index. The aridity index is a ratio of precipitation to potential evapotranspiration. Source of point data of borehole locations and their completion dates: National Groundwater database (GROWAS) (IGRAC, 2013).

2000; Brunotte et al., 2002; Inman et al., 2019; Inman et al., 2020; Pringle, 2021; Coppock et al., 2022).

Yet the pressures on the social-ecological system (SES) have to all accounts increased dramatically as both human and livestock populations have grown, and mean precipitation has evidently declined (Ranasinghe et al., 2021). A central question facing an SES today is how to maintain system resilience and build capacity to adapt to multiple interacting forces that operate across scales and that increase at varying rates (Galvin et al., 2016). It has thus now become critical to fill several looming knowledge gaps and uncertainties to be able to provide a better assessment of the risks that the region's natural resource base – and by inference its human population – faces going into a future that is likely to be significantly warmer and drier than is current (Engelbrecht et al., 2015; Engelbrecht 2018; Ranasinghe et al., 2021). This type of information is of course crucial for developing climate change adaptation options, but more directly it is vitally important for understanding the likelihood of tipping-point kind of behaviour. A sudden and significant

change in critical climate parameters, such as drought duration and intensity and frequency of heatwaves (which may reach physiological limits for people, livestock, and plants), could catalyse a regime shift towards hyper-aridity and a death knell for pastoralism over large parts of the region.

Figure 2: Loss of topsoil in the Omungunda valley.

However, there are several uncertainties around the dynamics of the ecosystem that underpins the natural resource base, as these may be influenced not only by more frequent and intense droughts but also by different grazing rules, different herd-compositions, and potentially alternative livelihood options. In addition, there is uncertainty about the most efficient climate change adaptation strategies that build on existing social and environmental coping and risk management strategies. Interventions to date have almost all focused exclusively on improving rangeland management approaches, improving livestock quality and marketing, and rangeland restoration (Behnke, 1998a, 1998b; Coppock, 2022).

These uncertainties define the main motivation for TIPPECC-Kunene. Our project, which will be the first to integrate the critical environmental and social forcing factors into a predictive suite of models, will aim to fill in some of the more important knowledge gaps, hopefully forming the basis for the co-development of feasible adaptation strategies with communities.

Objectives and approach

The project has three main objectives. We want to use both traditional ecological and cultural knowledge and scientific data to understand 1) the probability of climate change and especially climate tipping points leading to regime shifts in the ecological and social systems (Guttal & Jayaprakash, 2008; Dakos et al., 2023) given current and likely future climate and socio-economic-political conditions, 2) the identity and nature of those factors that will cause changes or shifts, with an emphasis on the role that climate tipping points will play in this, and 3), based on results and ensuring alignment with inherent coping strategies and social mechanisms, we aim to co-develop, with affected communities, feasible adaptation strategies to ongoing global change.

Research activities will be divided into several thematic groups that will contribute to a complex of SES model(s) and related outputs (Figure 1).

Themes 1 to 5 form the core of the science activities. **Livestock foraging ecology (theme 1)** will investigate basic aspects of livestock foraging, inter alia aspects like dietary

preferences of cattle, sheep, and goats, and the impacts of foraging intensity on vegetation composition, structure and function and on keystone forage species (those species without which droughts will not be survivable). In **theme 2 (resource access rules and coping practices)** we will rely on the collective memories of the elders of the two focal communities to characterise the evolution of resource access rules, including grazing and water point access rules. Similarly, we will document inherent coping strategies and analyse their potential role in overcoming the effects of climate tipping points. The bulk of these first two themes will be made up of two Masters projects.

The **3rd theme, soil and vegetation**, focuses on the dynamics of rangeland vegetation condition across the whole northern Kunene, and will use various remote sensing products and historical photographs to analyse and map changes over the last four to five decades. As part of this theme we will additionally map the degradation trajectory, aiming to understand the possible role that climate and human population density played in this.

Anecdotal evidence that the expansion of the borehole network has had a major influence on settlement patterns, on grazing rules, and on the rise in resource access conflicts suggests that some key properties of the spatial and temporal dimensions of surface water will be strong correlates of rangeland condition, changes in resource access rules, and in sustainability of pastoralist agriculture.

For that reason, we will focus **theme 4 on surface water points**. This will entail (a) documenting and analysing the development of the borehole network, (b) the extent of the piosphere effect, and (c) the role that borehole density relative to spatial and seasonal rangeland patterns will play in determining the 'giving-up density' (the density of water points, livestock and people at which it becomes unfeasible to continue farming). Theme 4 will be addressed in a PhD study.

Climate is arguably the principal driver of resource status and condition. **Theme 5, climate**, is therefore central to the project's main thesis, namely that a shift in the climate regime – the "tipping point" – could lead to a concomitant regime shift in the ecosystem and thus in the resource base. Several climate and climate-associated variables are potentially key players in the coupling of climate change with the SES model, through various paths. Tipping points can appear in aspects such as mean and maximum temperature (Lee et al., 2021), and the frequency and intensity of heatwaves (Hoegh-Guldberg et al., 2018; Engelbrecht and Monteiro, 2021). These variables are thus likely to be important determinants for where and when livestock and humans can persist in the region.

Theme 6, the SES risk of regime shift, represents the set of outputs that will together define the likelihood of a regime shift in the resource base of the pastoralist livelihood or in other global change factors, signalling a significant threat to people's livelihoods. Depending on outcomes from the different themes, this might be in the form of a systems model that will integrate and summarise the effects of the various factors on pastoral livelihoods (see Filatova et al. [2016] for a comprehensive description of this approach), or a simpler critical analysis of the complex of results. Together, these results will describe the likelihood that climate change would lead to a drastic change in the pastoralist ecosystem

and provide opportunities to identify likely approaches to adaptation. It should also allow an assessment of the risk that these changes may be beyond the existing suite of adaptation strategies and coping range (Ash et al., 2012).

In theme 7, adaptation and livelihoods, we aim to use the results of all the studies to co-develop, with the affected communities and authorities, potential adaptation options based on inherent coping strategies. Additionally, in a parallel research effort to those in themes 1 to 5, we will investigate the extent to which the restoration of grazing resources might improve rangeland condition enough to ensure sustainability of the pastoralist livelihood and/or to become a net carbon sink. We will also investigate, through a Masters study, the potential for the restoration of a productive grass layer through thinning of encroaching mopane trees, as well as the potential for defining alternative income streams using the encroaching mopane trees for wood and other biomass products. This will be the first major effort to understand the phenomenon of encroachment in the arid zone, where the interactions between woody density and grass layer productivity are both poorly known and arguably even more sensitive to droughts than in the traditional bush encroachment zones.

Finally, all our **outreach and visibility** activities are captured in **theme 8**. Here we aim to co-develop training topics, focusing on those issues that the affected communities identify themselves, and to produce various media through which we will communicate the objectives and achievements of the project and the people that implement it, including the focal communities.

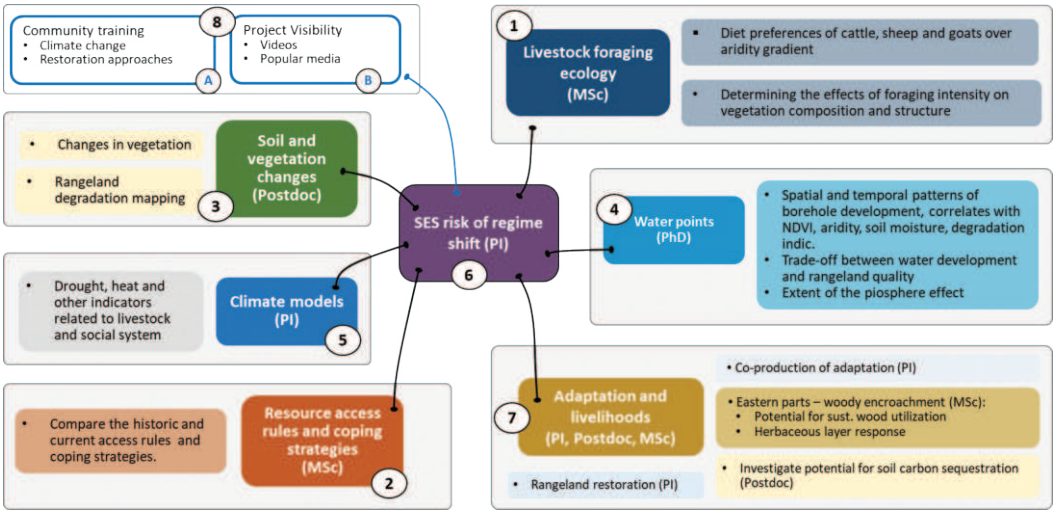


Figure 3: Diagram of the main topics and concepts addressed by TIPPECC, organised into nine thematic groups.

Study area

The study area for the TIPPECC project is in the northern part of the Kunene region in Namibia, excluding the Skeleton Coast and Etosha National Parks (Figure 4). Two sites that are embedded in this area will receive more focused research effort, namely the Okondjombo communal conservancy in the arid west and the Ombombomasitu conservancy in the semi-arid east (Figure 4).

The northern Kunene is characterized by low annual rainfall ranging from below 100 in the west to less than 350 millimetres per year in the east (Atlas of Namibia Team, 2022). The rainfall mostly falls during the summer with large variation from year to year. The variation in annual rainfall increases from east to west (Atlas of Namibia Team, 2022). Most of the study area is arid (Figure 4), where the potential evapotranspiration far exceeds the rainfall received in a year.

The topography is marked by rugged terrain, with rocky plateaus and mountainous regions covering most of the central and eastern parts. The landscape features extensive erosional features, such as canyons and inselbergs, with the prominent highlands of the escarpment transitioning into low-lying coastal plains with occasional rocky outcrops that together define several physiographic units and support several vegetation types (Viljoen, 1980; Atlas of Namibia Team, 2022).

Soils in the study area are predominantly Leptosols, interspersed with locally dominant Calcisols, Arenosols, Cambisols, and Regosols (Coetzee, 2021; Atlas of Namibia Team, 2022).

The vegetation in this region is characterized by plant species adapted to arid conditions with several species endemic to Namibia. The Kaokoveld and escarpment is one of the 19 southern African Centres of Endemism in for plants and is uniquely diverse in terms of invertebrates, mammals, birds, and reptiles (Simmons et al., 1998). Plant productivity tends to decline from east to west (Atlas of Namibia Team, 2022). The central and eastern parts are covered by the Tree-and-shrub savanna biome, transitioning to Nama Karoo and eventually Namib Desert along the coastline (Atlas of Namibia Team, 2022). Tree and shrub cover is highest in the east, with evidence of recent encroachment in places (Venter et al., 2018). Vertebrate and invertebrate diversity is relatively intact with high endemism observed in vertebrates, reptiles, birds, and mammals (Atlas of Namibia Team, 2022). Nevertheless, land degradation, linked to unsustainable agricultural practices, is currently a key risk, threatening both the biodiversity and the pastoralist system in this region (Wassenaar et al., 2021). The irreversible loss of productive vegetation in large parts of northwest Namibia seems imminent (Wassenaar et al., 2021), particularly considering the projected climate regime shifts (Engelbrecht et al., 2015; Hoegh-Guldberg et al., 2018; Engelbrecht and Monteiro, 2021; Lee et al., 2021; Ranasinghe et al., 2021).

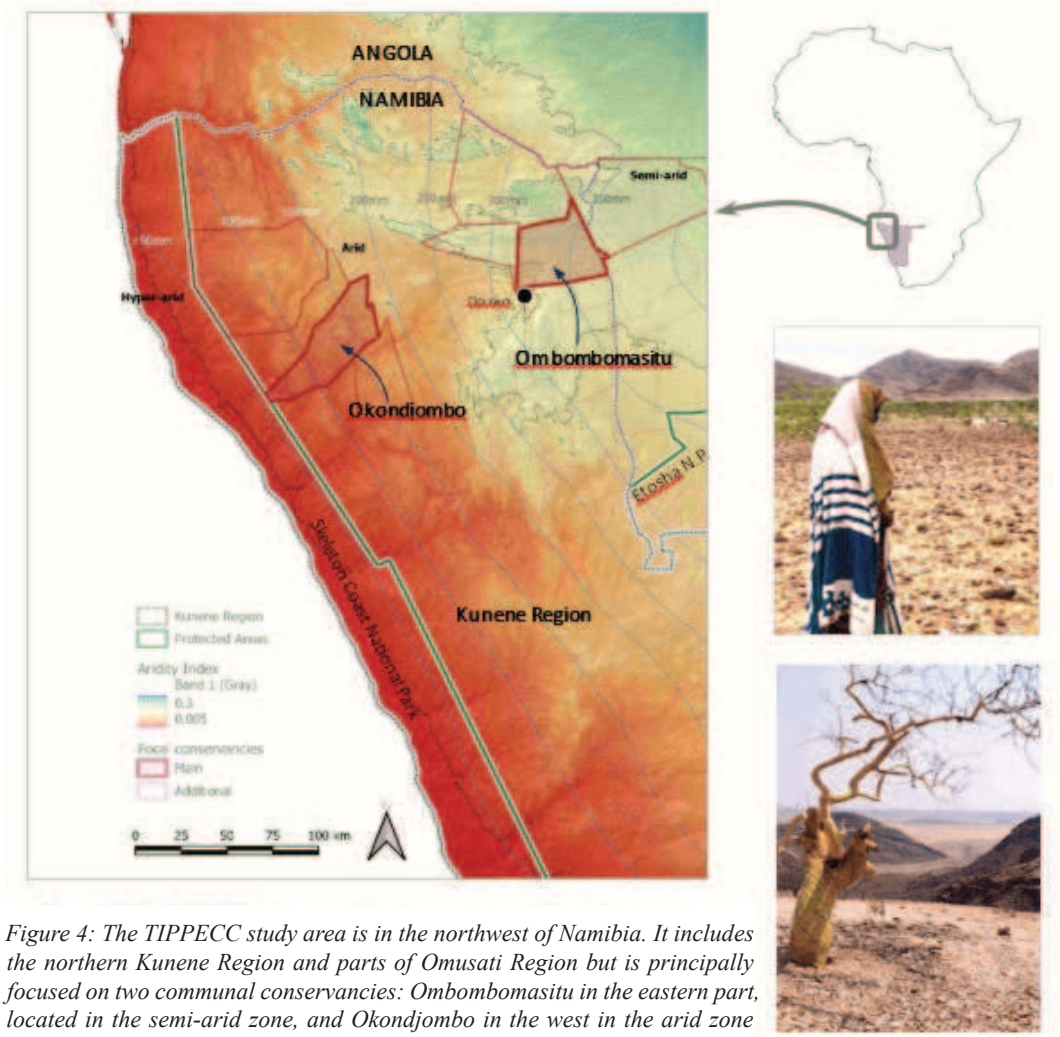


Figure 4: The TIPPECC study area is in the northwest of Namibia. It includes the northern Kunene Region and parts of Omusati Region but is principally focused on two communal conservancies: Ombombomasitu in the eastern part, located in the semi-arid zone, and Okondjombo in the west in the arid zone (thick red outlines). Some adjacent conservancies (thin red outlines) might be included in our study should the co-design process require an expanded footprint.

What do we mean by co-design

A core feature of the TIPPECC project is the focus on co-design and co-production of each aspect of the project. Co-design (also referred to as collaborative design, participatory design, co-development, or co-creation) has emerged over the last two decades as a transdisciplinary approach to collaborative problem solving across a range of disciplines, including rangeland management (Galvin et al., 2022). The core principle is that

individuals who are affected by a problem should be actively engaged in shaping solutions (Galvin et al., 2016; Turnhout et al., 2020). It recognizes that expertise is distributed among diverse stakeholders, including users, designers, policymakers, and community members (Turnhout et al., 2020). In effect, co-design attempts to leverage this collective intelligence by creating spaces for collaboration and shared decision-making.

It has the potential to address complex challenges because it is transdisciplinary, involving not only experts from various fields but also diverse stakeholders in the creative process of designing research, applications, and solutions to complex problems.

As an approach, it represents a fundamental departure from traditional, expert-driven problem-solving methods. It places an emphasis on inclusivity, active participation, and the integration of varied perspectives. In addition, it is not a one-step solution, rather emphasising an iterative approach with cycles of ideation, prototyping, testing, and refinement (Zamenopoulos & Alexiou, 2018).

In the TIPPECC project we are aiming to include the communities that we are targeting with the study, local and national authorities, and other stakeholders in the design not only of the research itself, but also of any applications that may arise from our results. Our goal is to create a working space that will foster co-creation of the investigative approach, the fieldwork and data collection, and the interpretation of results (see e.g. Bestelmeyer et al., 2019). By allowing the voices of communities (including their traditional authorities) and other stakeholders to be heard, we hope to arrive at adaptation solutions that are more sustainable and enjoy broader acceptance from the affected people.

References

AR4 Africa chapter: CHRISTENSEN, J.H. et al. (2007). Regional climate projections Climate Change 2007: The physical science basis. Contribution of Working Group I to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (eds.) Solomon, D. et al. Cambridge: Cambridge University Press.

AR5 Africa Chapter: NIANG, I. et al. (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (ed.) Barros, V.R. et al. Cambridge: Cambridge University Press pp 1199–265.

ASH, A., THORNTON, P., STOKES, C., & TOGTOHYN, C. (2012). Is proactive adaptation to climate change necessary in grazed rangelands? *Rangeland Ecology and Management*, 65: 563–568.

ATLAS OF NAMIBIA TEAM (2022). *Atlas of Namibia: its land, water and life.* Namibia Nature Foundation, Windhoek.

BANDA, K.E., MWANDIRA, W., JAKOBSEN, R., OGOLA, J., NYAMBE, I., & LARSEN, F. (2019). Mechanism of salinity change and hydrogeochemical evolution of groundwater in the Machile-Zambezi Basin, South-western Zambia. *Journal of African Earth Sciences*, 153: 72-82.

BARNES, M.L., WANG, P., CINNER, J.E., et al. (2020). Social determinants of adaptive and transformative responses to climate change. *Nature Climate Change,* 10: 823–828. https://doi.org/10.1038/s41558-020-0871-4

BEHNKE, R.H. (1998a). Grazing systems in the Northern Communal Areas of Namibia: A summary of NOLIDEP socio-economic research on range management. Unpublished Report for NOLIDEP.

BEHNKE, R.H. (1998b). Range and livestock management in the Etanga Development Area, Kunene Region. Unpublished Report for NOLIDEP.

BERDUGO, M., DELGADO-BAQUERIZO, M., SOLIVERES, S., et al. (2020). Global ecosystem thresholds driven by aridity. *Science,* 367: 787-790. DOI:10.1126/science.aay5958.

BESTELMEYER, B., BURKETT, L.M., LISTER, L., BROWN, J.R., & SCHOOLEY, R.L. (2019). Collaborative approaches to strengthen the role of science in rangeland conservation. *Rangelands,* 41: 218–226.

BOLLIG, M. (1997). Risk and risk minimisation among Himba pastoralists in northwestern Namibia. *Nomadic Peoples,* 1: 66-89. https://www.jstor.org/stable/43123511

BOLLIG, M. (1998). The colonial encapsulation of the north-western Namibian pastoral economy. *Africa: Journal of the International African Institute,* 68(4), 506-536. doi:10.2307/1161164.

BOLLIG, M. (2000). Production and exchange among the Himba of north-western Namibia. In M. Bollig & J-B. Gewald (eds.) People, cattle and land: Transformations of a pastoral society in southwestern Africa. Köppe, Cologne.

BOLLIG, M. (2006). Risk management in a hazardous environment: A comparative study of two pastoral societies. *Studies in Human Ecology and Adaptation.* Springer Science+ Business Media, Inc.

BOLLIG, M. (2013). Social-ecological change and institutional development in a pastoral community in north-western Namibia. *In* M. Bollig, et al. (2013). *Pastoralism in Africa: Past, present, and future.* Berghahn Books, Incorporated.

BOLLIG, M. (2020). Shaping the African savannah: From capitalist frontier to arid Eden in Namibia. Cambridge University Press. https://doi.org/10.1017/9781108764025.

BOLLIG, M. & GEWALD, J-B. (eds.) (2000). People, cattle and land: Transformations of a pastoral society in southwestern Africa. Köppe, Cologne.

BOLLIG, M. & SCHULTE, A. (1999). Environmental change and pastoral perceptions: Degradation and indigenous knowledge in two African pastoral communities. *Human Ecology,* 27: 493-514.

BRUNOTTE, E. & SANDER, H. (2000). Erosion of loess-like sediments in northern Namibia (basin of Opuwo) triggered by gullying and the formation of micropediments. *Zeitschrift für Geomorphologie,* 44: 249 – 267. DOI: 10.1127/zfg/44/2000/249.

BRUNOTTE, E., SANDER, H. & FRANGEN, J. (2002). Human-induced environmental changes in areas favorable and unfavorable for land-use in Kaokoland, Namibia. *Die Erde,* 133: 133–152.

CLARKE, J.J., HUNTINGFORD, C., RITCHIE, P.D. & COX, P.M. (2023). Seeking more robust early warning signals for climate tipping points: The ratio of spectra method (ROSA). *Environmental Research Letters,* 18: 035006. DOI 10.1088/1748-9326/acbc8d.

COETZEE, M.E. (2021). Soils of the Skeleton Coast National Park and Sciona project area in Namibia. Internal report for the SCIONA Project, Windhoek.

COPPOCK, D.L., CROWLEY, L., DURHAM, S.L., et al. (2022). Community-based rangeland management in Namibia improves resource governance but not environmental and economic outcomes. *Communications Earth & Environment,* 3: 32. https://doi.org/10.1038/s43247-022-00361-5

COUGHENOUR, M.B., ELLIS, J.E., SWIFT, D.M., COPPOCK, D.L., GALVIN, K., MCCABE, J.T., & HART, T.C. (1985). Energy extraction and use in a nomadic pastoral ecosystem. *Science,* 230: 619-625.

DAKOS, V., BOULTON, C. A., BUXTON, J. E., ABRAMS, J. F., et al. (2023). Tipping point detection and early-warnings in climate, ecological, and human systems, *EGUsphere* [preprint], https://doi.org/10.5194/egusphere-2023-1773.

DIEKERT, F., HEYEN, D., NESJE, F., SHAYEGH, S. (2022). Early warnings about tipping points improve management but may encourage risk taking. *Philosophical Transactions of the Royal Society,* A, 370: 1185-1204. Doi: 10.1098/rsta.2011.0304.

DINERSTEIN, E., OLSON, D., JOSHI, A., et al. (2017). An ecoregion-based approach to protecting half the terrestrial realm. *BioScience,* 67(6): 534-545. https://doi.org/10.1093/biosci/bix014.

DONG, S. (2016). Overview: Pastoralism in the World. In S. Dong, K-A.S. Kassam, J.F. Tourrand & R.B. Boone (eds.) Building resilience of human-natural systems of pastoralism in the developing world.

DU TOIT, J. (2003). Large herbivores and savanna heterogeneity. *In* J. Du Toit, K.H. Rogers, & H.C. Biggs (eds.) *The Kruger experience: Ecology and management of savanna heterogeneity.* Island Press, Washington.

EICHHORN, B. & VOGELSANG, R., 2007. A pristine landscape? Archaeological and archaeobotanical research in the Skeleton Coast Park, northwestern Namibia. Presented at the Aridity, Change and Conflict in Africa: *Colloquium Africanum,* pp. 145–164.

EISOLD, J., TÖNSJOST, S., BOLLIG, M., & LINSTÄDTER, A. (2006). Local and ecological knowledge on natural resource management – a case study from north-western Namibia. Conference on International Agricultural Research for Development, Bonn, October 11-13, 2006.

ENGELBRECHT, F., ADEGOKE, J., BOPAPE, M-J., NAIDOO, M., GARLAND, R., THATCHER, M., MCGREGOR, J., KATZFEY, J., WERNER, M., ICHOKU, C., & GATEBE, C. (2015). Projections of rapidly rising surface temperatures over Africa under low mitigation. *Environmental Research Letters*, 10, 085004.

ENGELBRECHT, F.A. & MONTEIRO, P.M.S. (2021). The IPCC Assessment Report Six Working Group 1 report and southern Africa: Reasons to take action. South African Journal of Science, 117. https://doi.org/10.17159/sajs.2021/12679.

ENGELBRECHT, F. (2018). Keynote on climate change and climate risks. Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL) Science Symposium - Science Diplomacy supporting Climate Change Action in SADC'. Lusaka, Zambia, 16 - 20 April 2018.

FAO (2001). Pastoralism in the new millennium. Animal production and health. *Paper no 150.* UN Food and Agriculture Organization, Rome

FILATOVA, T., POLHILL, J.G., & VAN EWIJK, S. (2016). Regime shifts in coupled socio-environmental systems: Review of modelling challenges and approaches. *Environmental Modelling & Software*, 75: 333-347.

FUNDER, M., MWEEMBA, C., & NYAMBE, I. (2015). Poverty, food security and local water conflicts in southern Zambia, *in* Christoplos, I. and Pain, A. (eds.): *New challenges to food security – From climate change to fragile states.* Routledge Publishers, New York. Book Chapter – 184 -199pp.

GALVIN, K., REID, R.S., FERNANDEZ-GIMENEZ, M.E., OLE KAELO, D. BAIVAL, B., & KREBS, M. (2016). Co-design of transformative research for rangeland sustainability. *Current Opinion in Environmental Sustainability,* 20: 8–14.

GAYLARD, A., OWEN-SMITH, N., & REDFERN, J. (2003). Surface water availability: Implications for heterogeneity and ecosystem processes. *In* J. du Toit, K.H. Rogers, & H.C. Biggs (eds) *The Kruger experience; ecology and management of savanna heterogeneity.* Island Press, Washington.

GUTTAL, V. & JAYAPRAKASH, C. (2008). Changing skewness: An early warning signal of regime shifts in ecosystems. *Ecology Letters,* 11(5), 450–460. doi:10.111 1/j.1461-0248.2008.0116

HOEGH-GULDBERG, O., JACOB, D., TAYLOR, M., BINDI, M., BROWN, S., CAMILLONI, I., DIEDHIOU, A., DJALANTE, R., EBI, K.L., ENGELBRECHT, F., GUIOT, J., HIJIOKA, Y., MEHROTRA, S., PAYNE, A., SENEVIRATNE, S.I., THOMAS, A., WARREN, R., & ZHOU, G. (2018). Impacts of 1.5ºC global warming on natural and human systems. *In Global warming of 1.5°C.* An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)].

IGRAC (2013). Groundwater monitoring in the SADC Region. Overview prepared for the Stockholm World Water Week 2013. International Groundwater Assessment Centre. https://www.un-igrac.org/ sites/default/files/resources/files/Report_Groundwater%20Monitoring%20in%20SADC%20region.pdf

INMAN, E.N., HOBBS, R.J., & TSVUURA, Z. (2020). No safety net in the face of climate change: The case of pastoralists in Kunene Region, Namibia. *PLoS ONE,* 15(9): e0238982. https://doi.org/ 10.1371/journal.pone.0238982

INMAN, E.N., HOBBS, R.J., TSVUURA, Z., & VALENTINE, L. (2019). Current vegetation structure and composition of woody species in community-derived categories of land degradation in a semiarid rangeland in Kunene Region, Namibia. *Land Degradation and Development,* 1–18. DOI: 10.1002/ldr.3688.

LEACH, M., SCOONES, I., & STIRLING, A. (2010). Dynamic sustainabilities: Technology, environment, social justice. London: Earthscan.

LEE J.Y., MAROTZKE, J., BALA, G., CAO, L., CORTI, S., DUNNE, J.P., ENGELBRECHT, F., FISCHER, E., FYFE, J.C., JONES, C., MAYCOCK, A., MUTEMI, J., NDIAYE, O., PANICKAL, S., & ZHOU, T. (2021). Future global climate: Scenario-based projections and near-term information. *In* Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, Yelekçi, R. Yu, & B. Zhou (eds.)]. Cambridge University Press.

LENTON, T.M., HELD, H., KRIEGLER, E., HALL, J.W., LUCHT, W., RAHMSTORF, S., & SCHELLNHUBER, H.J. (2008). Tipping elements in the earth's climate system. *Proceedings of the National Academy of Sciences,* 105: 1786 –1793.

LENTON, T.M., LIVINA, V.N., DAKOS, V., VAN NES, E.H., & SCHEFFER, M. (2012). Early warning of climate tipping points from critical slowing down: comparing methods to improve robustness. *Philosophical Transactions of the Royal Society* A, 370: 1185-204. doi: 10.1098/rsta.2011.0304.

MALAN, J.S. & OWEN-SMITH, G., 1974. The ethnobotany of Kaokoland. *Cimbebasia,* 2 (5): 131–178.

MIDDLETON, N. & THOMAS, D. (1997). *World atlas of desertification.* Arnold, London.

NÆSS, M.W. (2013). Climate change, risk management and the end of nomadic pastoralism. *International Journal of Sustainable Development & World Ecology,* 20: 123-133. DOI: 10.1080/13504509.2013.779615.

NYAMBE, I., CHABALA, A., BANDA, K., ZIMBA, H., & PHIRI, W. (2018). Determinants of spatio-temporal variability of water quality in the Barotse floodplain, western Zambia. *In:* Climate change and adaptive land management in southern Africa – assessments, changes, challenges, and solutions (eds.) Revermann, R., Krewenka, K.M., Schmiedel, U., Olwoch, J.M., Helmschrot, J., & Jürgens, N.), pp. 96-105, *Biodiversity & Ecology, 6,* Klaus Hess Publishers, Göttingen & Windhoek. doi:10.7809/b-e.00310.

O'BRIEN, K. (2018). Is the 1.5 °C target possible? Exploring the three spheres of transformation. *Current Opinions in Environmental Sustainability* 31: 153–160.

OWEN-SMITH, G. (1972). Kaokoveld: The last wilderness. *African Wildlife,* 26(2): 71-77.

OWEN-SMITH, N. (1996). Ecological guidelines for waterpoints in extensive protected areas. *South African Journal of Wildlife Research*, 26: 107-112.

PARKER, A.H & WITKOWSKI, E.T.F. (1999). Long-term impacts of abundant perennial water provision for game on herbaceous vegetation in a semi-arid African savanna woodland. *J. Arid Environ.* 41: 309–321.

PERKINS, J.S. (2019). 'Only Connect': Restoring resilience in the Kalahari ecosystem. *Journal of Environmental Management.*

PRINGLE, H. (2021). A preliminary degradation pathology of rangeland declines near Opuwo in the Kunene, Namibia: The tragedy of disrupting traditional commons management. *Sustainability in Environment,* 6-10, http://dx.doi.org/10.22158/se.v6n1p142.

RANASINGHE, R., RUANE, A.C., VAUTARD, R., et al. (2021). Climate change information for regional impact and for risk assessment. *In* Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the *Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. et al. (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1767–1926, doi:10.1017/9781009157896.014.

RIETKERK, M., DEKKER, S.C., DE RUITER, P.C., & VAN DE KOPPEL, J. (2004). Self-organized patchiness and catastrophic regime shifts in ecosystems. *Science,* 305: 1926–1929.

SCHNEGG M., & BOLLIG M. (2016). Institutions put to the test: Community-based water management in Namibia during a drought. *Journal of Arid Environments,* 124: 62-71.

SCHNEGG, M. & LINKE, T. (2015). Living institutions: Sharing and sanctioning water among pastoralists in Namibia. *World Development,* 68: 205–214.

SCHNEGG, M. & LINKE, T. (2016). Travelling models of participation: Global ideas and local translations of water management in Namibia. *International Journal of the Commons,* 10: 800-820.

SEID, M.A., KUHN, N.J., & FIKRE, T.Z. (2016). The role of pastoralism in regulating ecosystem services. *Revue Scientifique et Technique,* 35: 435-444. doi: 10.20506/rst.35.2.2534.

SEIN, D.V., MIKOLAJEWICZ, U., GRÖGER, M., FAST, I., CABOS, W., PINTO, J. G., HAGEMANN, S., SEMMLER, T., IZQUIERDO, A., & JACOB, D. (2015). Regionally coupled atmosphere-ocean- sea ice-marine biogeochemistry model ROM: 1. Description and validation. *Journal of Advances in Modeling Earth Systems* doi:10.1002/2014MS000357.

SIMMONS, R.E., GRIFFIN, M., MARAIS, E., & KOLBERG, H. (1998). Endemism in Namibia: Patterns, processes and predictions. *Biodiversity and Conservation,* 7: 513-530.

SMITH, A.B. (1992). Origins and spread of pastoralism in Africa. *Annual Review of Anthropology,* 21: 125-141.

SMITH, A.B. (2000). The origins of pastoralism in Namibia. *In:* M. Bollig & J-B. Gewald (eds.) People, cattle and land: Transformations of a pastoral society in southwestern Africa. Köppe, Cologne.

SR1.5 Chapter 3: HOEGH-GULDBERG et al. (2018). Impacts of 1.5ºC global warming on natural and human systems. *In:* Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

SULLIVAN, S. (1998). People, plants and practice in drylands: Socio-political and ecological dimensions of resource-use by Damara farmers in north-west Namibia. PhD thesis, University College London.

SULLIVAN, S. (1999). The impacts of people and livestock on topographically diverse open wood- and shrub-lands in arid north-west Namibia. *Global Ecology and Biogeography,* 8: 257–277.

SULLIVAN, S. & ROHDE, R. (2002). On non-equilibrium in arid and semi-arid grazing systems. *Journal of Biogeography,* 29: 1595-1618.

TRABUCCO, A., & ZOMER, R.J. (2010). Global Soil Water Balance Geospatial Database. CGIAR Consortium for Spatial Information. Published online, available from the CGIAR-CSI GeoPortal at https://cgiarcsi.community.

TURNHOUT, E., METZE, T., WYBORN, C., KLENK, N., & LOUDER, E. (2020). The politics of co-production: Participation, power, and transformation. *Current Opinion in Environmental Sustainability,* 42: 15-21.

VENTER, Z.S., CRAMER, M. D., & HAWKINS, H.J. (2018). Drivers of woody plant encroachment over Africa. *Nature communications,* 9(1): 2272.

VETTER, S. (2005). Rangelands at equilibrium and non-equilibrium: Recent developments in the debate. *Journal of Arid Environments,* 62: 321-341.

VILJOEN, P.I. (1980). Veldtipes, verspreiding van die groter soogdiere, en enkele aspekte van die ekologie van Kaokoland. M.Sc. thesis, University of Pretoria, Pretoria. 401 pp.

VOGELSANG, R., EICHHORN, B., & RICHTER, J. (2002). Holocene human occupation and vegetation history in northern Namibia. *Die Erde,* 133: 113-132.

WARD, D., NGAIRORUE, B.T., KATHENA, J., SAMUELS, R., & OFRAN, Y. (1998). Land degradation is not a necessary outcome of communal pastoralism in arid Namibia. *Journal of Arid Environments,* 40: 357-371.

WASSENAAR, T.D., DE CAUWER, V., BECKER, R., COETZEE, M., HAUPTFLEISCH, M., KNOX, N., LAGES, F., MBIDZO, M., MORLAND, G., NGHALIPO, E., & PORTAS, R. (2021). An integrated ecosystem management framework for the Skeleton Coast-Iona Transfrontier Park. Unpublished Report for the funders, SCIONA Project, Namibia University of Science and Technology. Available at http://sciona.nust.na/iemf.

WEBER, K.T. & HORST, S. (2011). Desertification and livestock grazing: The roles of sedentarization, mobility and rest. *Pastoralism: Research, Policy and Practice,* 1-19. http://www.pastoralismjournal.com/ content/1/1/19.

WERNER, W. (2015). Tenure reform in Namibia's communal areas. *Journal of Namibian Studies,* 18: 67–87.

ZAMENOPOULOS, T. & ALEXIOU, K. (2018). Co-design as collaborative research. *In* Facer, K & Dunleavy, K. (eds.) *Connected Communities Foundation Series.* Bristol: University of Bristol, AHRC Connected Communities Programme.

ZENG C. & WANG H. (2012). Noise and large time delay: Accelerated catastrophic regime shifts in ecosystems. *Ecological Modelling,* 233: 52-58. doi:10.1016/j.ecolmodel.2012.03.025 .

www.johnmeinert.com

Now you can also create your own Business Cards, Christmas Cards, DL Flyers and Calendars

4 Easy Steps

Step 1

DOWNLOAD AND INSTALL

Download and install the free JMP Photobook software from our site www.johnmeinert.com

Step 2

SELECT PRODUCTS

Select which product you wish to create

Step 3

CREATE YOUR DESIGN WITH YOUR IMAGES

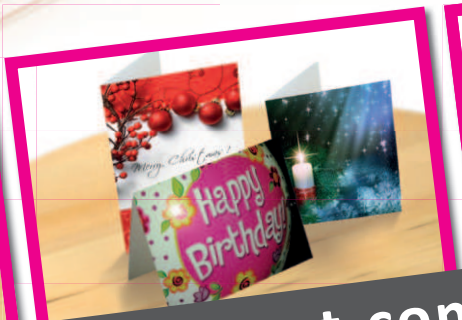
Choose from over 50 different page layout options, create your design by dragging and dropping your images onto each page and add extra text or backgrounds as you wish

Step 4

ORDER ONLINE

When finished click the shopping card button in the software menu, follow the prompts to order your product and then upload your design via your internet

The uploaded file size is optimised for easy uploading. Your beautiful product is then delivered in ±5 days.



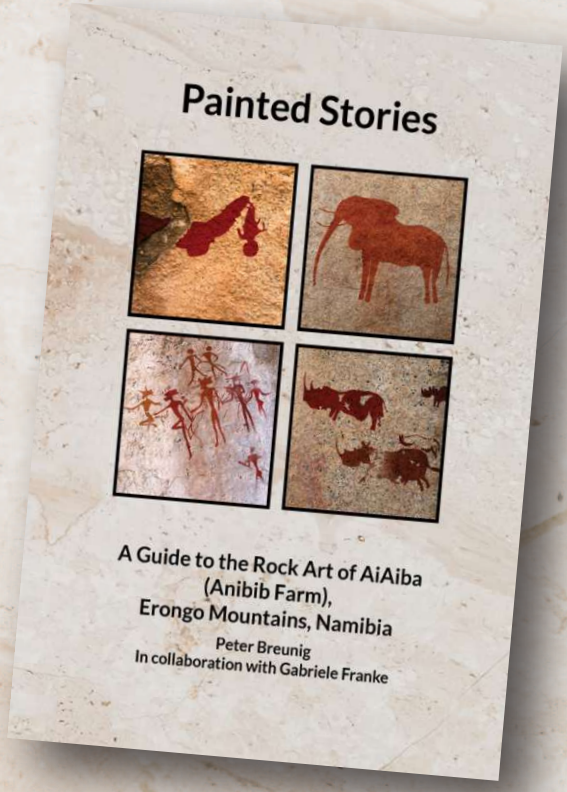
www.johnmeinert.com

Snyman Circle, 17 David Hosea Meroro Road
P.O.Box 56, Windhoek, Namibia
Phone +264 61 225411 Fax: +264 61 224843
email: jmp@mweb.com.na

JMP
JOHN MEINERT PRINTING (PTY) LTD
PHOTOBOOK

PAINTED STORIES
A GUIDE TO THE ROCK ART OF AIAIBA (ANIBIB FARM), ERONGO, NAMIBIA
by Peter Breunig
in collaboration with Gabriele Franke

While renowned archaeologist Henri Breuil counted 344 paintings in the mid-20th century, Breunig, using modern digital methods, makes the invisible visible and recorded 4,914 paintings in 208 sites.



He gives valuable insight into the representational world of Namibia's prehistoric peoples in a fascinating reader-friendly way.

Now available at
Namibia Scientific Society

Kuiseb Publishers

Art Beyond Sight

André du Pisani

Keywords: Rock art, Khomas Region, ethnography, storylines in rock art, imagistic mosaic of San (Bushman) myth, animals as symbols, art and landscape, rock art panels, artefacts, quarts-microliths.

Abstract

The rock art of the Khomas Region is not as well-known as that of the Erongo Region with its celebrated apex sites at the Dâures, Erongo Mountains, the Spitzkoppe, and !Ui-ǁaes (Twyfelfontein). Historically and intellectually, there has been less of a sustained research interest in the rock art of the Khomas Region, notwithstanding the ground-breaking work of Ernst Scherz in the 1970s and late 1980s and a sprinkling of more recent articles devoted to some of the rock art sites of the Region.

This, in and of itself, is enough reason to write about the rock art of a region yet to be comprehensively documented, surveyed and researched. Over the past eighteen years the author has visited more than 320 rock art sites located on 62 farms within the boundaries of the region. Undoubtedly, there are more sites to be documented and discovered, and through this, more insights to be gained into southern African rock art. Most of the art dates from the Later Stone Age (LSA), with some a few hundred years BP (Before Present), and typical material artefacts of that period are to be found at or in close proximity to the sites. The vast majority of the paintings are rendered in ochre and show the interaction between animals and people, and scenes from daily life, with some abstract renderings as well.

The rock art of the Khomas Region needs to be considered within a wider frame of southern African rock art research. Moreover, the researcher must be aware of and sensitive to diverse theoretical and methodological approaches to rock art, while respecting an ethnographic foundation, in an attempt to derive meaning from the paintings.

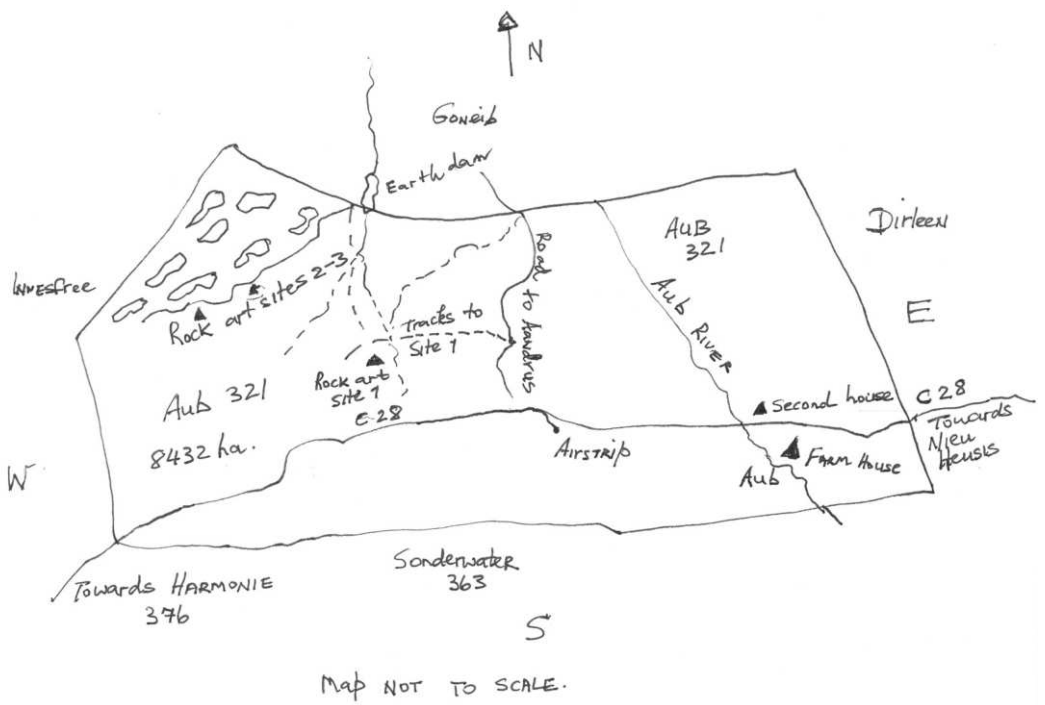
Introduction

This article is based on a field visit on 5 November 2021 to the farm Aub 321, 45°S 16°E 30' along the C-28 gravel road, some 62 kilometre west of the Capital City, Windhoek in the Khomas Region. Before it was subdivided, the farm covered an area of some 9,000 ha. It borders the farms Dirleen, Aandrus, Kariam and Sonderwater (Namibia 1:250 000 Map 2216 Windhoek, Third Edition, 1997). The article draws on earlier published work by

the author on rock art sites on several farms located within a 50km radius of Aub. As the description and analysis of the sites at Aub will show, the rock art has much in common with those on farms in the environs of the farm. Thus, a sub-regional perspective is needed to read the rock art and understand its affinity to other sites in the Region and beyond.

Aub nestles on the Khomas Hochland plateau with its undulating hills, at an altitude of 1,200 to over 2,000m above sea level. The geology comprises major rock formations collectively known as the Khomas Group, consisting mostly of schists. Soil fertility is mostly low, notwithstanding some local variation. Dominant soils are lithic leptosols, meaning the soil is thin or shallow. There are no perennial rivers in Khomas, with the Kuiseb, Swakop, and Gaub Rivers three of the most important ephemeral rivers. Median annual rainfall varies between 350 and 250mm. The biomes and vegetation are typical of highland scrubland (Mendelsohn, Jarvis, Roberts & Robertson, 2002:85, 98–9).

The author visited three rock art sites on the farm. The first looking towards the southwest comprises a mica-schist rock with an overhang that has a surface area of 200 x 50cm behind the drip line. Several rock 'markings', meaning marks made for a functional purpose, were found in places in which it would have been comfortable to sit at ease while executing some everyday tasks. One such rock 'marking' consists of a grinding hollow, oval in shape with shallow, slope-sided depressions used for ochres for paints, or for



Locality of the sites. Map: André du Pisani

grinding various foods such as bulbs and seeds; or used as a receptacle for holding eggshell roughouts so that holes could be drilled into them to produce beads. Other artefact assemblages include small pieces of potsherds (ceramics) and quartz microliths, all part of the Later Stone Age (LSA) of the past 2000 BP (Before Present) or more recent. In this case, probably a few hundred years BP.

The first site overlooks a small rivulet with a fairly dense coverage of *Acacia erioloba* (*Vachellia erioloba*; camelthorn) and *Acacia karroo* (*Vachellia karoo*; sweet thorn). The bark and leaves of the latter are a widely-used remedy for diarrhoea and dysentery. The gum, bark and leaves have also been used as an emollient and astringent for colds, conjunctivitis and haemorrhage. The gum is used as food and is also taken for oral thrush (Van Wyk, van Oudtshoorn and Gericke, 1997:24). The vegetation indicates the presence of groundwater and the leaves of the trees were green when the author visited in November 2021.

The farm has a number of climax grasses, such as *Anthephora pubescens* (wool-grass, krulblaar), *Brachiaria nigropedata* (black-footed brachiaria), *Digitaria eriantha* (woolly finger grass), and two species of *Stipagrostis* (bushman-grass), all very nutritious for grazing by game and cattle (Müller, 1983:22).

The second and third sites are located close together higher up along a mountain slope some 4km in a northerly direction from the first (we measured the distance on the odometer of our light commercial vehicle). A secondary farm road runs along the banks and, in parts, in the bed of the river that brings down a significant volume of water when in flood. Lower down the river there is an earth dam, indicating the volume of water the river transports during the wet season. Along the seam of the mountain there is a steep ravine that has to be negotiated on foot. Along the sides of the river a variety of trees grow, mostly *Acacia* species, while a number of gnarled *Boscia albitrunca* (shepherd's tree) grow along the steep slopes of the mountain. The paintings are located on the eastern side of a prominent cubistic mica-schist with a smooth surface that can be seen from afar. It is highly likely that there will be other sites in the vicinity of these two sites, as the rock formation continues further up the slope of the mountain and provides a suitable canvas for rock art.

The second and third sites, in common with the first, have similar material artefacts, replete with pottery, ostrich eggshells, grinding stones, and a variety of small microliths. The paintings are comparable to those at the first site. Some weathering and exfoliation have taken place in all three sites as these do not afford effective protection against wind and rain and against animals that rub their bodies against the rock surface. The author found fresh owl droppings on the floor of the first site, probably from the *Otus senegalensis* (African scops-owl), which prefers acacia trees that grow along the edge of rivers and are a reliable food source.

Animals as Symbols

The careful way in which the Bushmen (San)[1] painted animals, functions as an indication of respect, and at the symbolic level "operates as a device for bringing the dichotomy between animals as esteemed 'other' and as hunted prey" into sharp relief. (Eastwood, 2006:110). Animals were not only dear to the hearts of the Bushmen (San), they were also believed to be especially dear to God.

In general, animals are used by the Bushmen (San) to 'think with', and they have often been used to express complex ideas, folklore, cosmology, myth, and social values. Although the symbolism of many animals is not self-evident, Patricia Vinnicombe (1976) and David Lewis-Williams (1981, 2004) have suggested ways to explain paintings of eland in the Drakensberg of South Africa.

The first site contains various paintings of animals, among these, an elephant and several female kudu (*Tragelaphus strepsiceros*). There are numerous paintings of kudu in the Khomas Region, as indeed throughout southern Africa in eastern Botswana, South Africa, and Zimbabwe. They are painted in different ways, but mostly have certain features in common, such as large ears, humps, long necks, and males have pronounced elongated spiralling horns. In some paintings even the animal's stripes are shown. In some of the paintings of the region, kudus are often painted as the largest animal in the panel, for example on the farm *Rooisand* below the Gamsberg. (Forssman & Gutteridge, 2012:128; du Pisani, 2022:44). In this particular case, the female kudus are shown in procession with their heads held low and their chins forward as if they are browsing.

Just as in the case of other animals such as eland (*Taurotragus oryx*) and elephant, kudu has an affinity to mythology and cosmology among different San groups. According to San folklore, at creation the original *Ju|hoansi* decided to create supernatural power, which they used to give animals different designs. The kudu's stripes were made using this supernatural power, which is also known as *n|om.* The kudu is one such animal linked to *n!ao,* which associates hunting and childbirth with the weather. (Forssman & Gutteridge, 2012:128). *N!ao,* which relates to the weather and *n|om,* to the spirit world, is invested at birth and is divided into two categories: rain/cold (lucky) and dry/hot. When a woman's fluids spill on the floor or ground during childbirth, she and the baby connect and are believed to cause the weather to change. Similarly, when a hunted animal's blood drips on the ground, the animal's *n!ao* connects with the hunter, causing a change in the weather. The kudu is also linked to *n|om.* It is used to access the spirit world, where various tasks are performed such as healing, changing the weather, warding off evil spirits, and fending off attacks by large predators such as leopard and lion.

[1] The term 'Bushman' for the San people, current during the pre-colonial and colonial periods in the history of Namibia, is now regarded as derogatory. Collectively, the archaeological record of southern Africa shows that the San have occupied 50,000 or more places over the past 12,000 years (Parkington, Dlamini, 2015:77; see also Deacon & Deacon, 1999).

The Khoesan San speak a central Khoesanlanguage. The *Hai||om* of northern Namibia perform the kudu dance (Guenther, 1996). The *Khwe* groups from the Kavango regions and Botswana have a number of healing dances, one of which is the kudu medicine dance. Some Angolan *Khwe* groups have adopted the kudu dance in girls' puberty rites.

The most frequently painted animal in the central Limpopo basin of South Africa is the kudu, notably female kudu. As in the ethnography, kudu appear to be implicated in ideas about supernatural potency that shamans may harness, and also be associated by some San groups with girl's puberty rites. Thus, in San cosmology, the symbolism of kudu spans the interests of men and women and relates to at least two ritual domains. (Eastwood, 2006:111).

Notwithstanding the observations made above about kudu in the rock art of the Khomas Region, John Kinahan (2020:201, 2001:20) reminds the reader that: "Kudu are scarce in the rock art of the Namib Desert: the 815 identifiable painted motifs spread over 44 sites in the Hungorob Ravine included only fourteen kudu". Significantly, the author adds: "The scarcity of the kudu in the rock art, however, belies the ethnographically attested role of the species in women's initiation" (Kinahan, 2020:201). Estes (1991:169) identifies the female kudu as a symbol that idealized qualities of women, "in its gentle, sociable and sexually submissive nature, caring for its young until they are almost fully grown" (Quoted by Kinahan, 2020: 201).

Painted just above ground level, the procession of four female kudu is being cleansed by soft-soaking 'female rain', rain that is slow, without thunder or hurry, to emphasize the link between kudu and rain. The kudu, as with many other animals, are portrayed entering a crack or crevice in the rock wall, symbolizing their entry into or emergenc from the spirit world, slipping in or out of the spiritual space that opens in the rock face.

The other significant animal at site 1, is the elephant (*Loxodonta africana*). The 40cm long painting of an elephant is rendered in ochre and placed almost at the centre of the painted surface area of some 200 x 50cm. Features that are depicted in this image of a walking elephant include an extended trunk, curved tusks, red upper and darker underparts, a short tail and thick legs that end in round feet. The dorsal line of the elephant's back is clearly visible. The elephant has been painted as an individual. Below the painting, there is a smaller ochre image of a human person.

The elephant is one of the great meat animals, among others: eland, giraffe, rhinoceros, and hippopotamus. On account of its size and power, the elephant is regarded as containing more *n|om* (potency) than most other animals. The *Ju|hoansi* people categorise elephant meat as red, black and white. "It has all the kinds of meat in it – eland, human – it's the father of meat" (Rust & Van der Poll, 2011:22). Elephants play an important role in San mythology and cosmology. In the literature, there are references to the 'Elephant Dance' and 'Elephant Girl' that are quintessentially feminine, beautiful, intelligent and resourceful (Eastwood, 2006: 96, 101; see also: Biesele, 1993:22, 139–144). Elephants are adjudged to possess human qualities and are associated with femininity. Elephants are also linked to rain and rain-making. The Khomas Region has a few notable paintings of elephant, such

Image 1 shows the procession of female Kudu. Photo: André du Pisani

Figure 2: The Elephant painting. Photo: André du Pisani

as on the farm *Hornkranz South* and in the *Strodelhöle* on the farm *Onanis* near the border with the Erongo Region (du Pisani, 2022:48; Sandelowsky, 2013:8). Other significant paintings of elephant include the over 100mm large white elephant in the Philipps Cave on the farm Ameib in the Erongo Mountains, and the elephant painting on the farm Omburo-Ost along the Ugab Terraces west of Outjo, also in the Erongo Region.

Human figures

All three sites contain various human figures that display humans engaged in different activities such as walking, running, dancing, hunting, and standing. Some of the figures are rendered in considerable detail. The size of the largest human painting is ca. 340mm. One can clearly see the aprons that they wear, the bows and arrows and sticks that they carry, not only as tools, but also as "artefacts of the mind" to paraphrase the archaeologist, Jeanette Deacon, as quoted by Forsman and Gutteridge (2012:54–5).

This researcher did not observe dots, humans bending forward (symbolic of hunted animals that bend forward before they die), dancing sticks, or humans with tails. This may indicate normal day-to-day activities that humans engage in, rather than special rituals.

At both the first and second sites there are significant paintings of humans that may depict shamans. These paintings are elongated when compared with the other paintings of

Figure 3: A human (hunter) carrying hunting equipment. Photo: André du Pisani

humans at these sites, but do not carry any tools such as bows and arrows, dancing sticks, or bags. The figures are also not bending forwards, touching people, shooting arrows, bleeding from the nose, or having white dots coming from the neck – all features of the multiple ways shamans have been depicted in San rock art. But, they do have outstretched arms, are uncharacteristically elongated, painted with prominent torsos and well-developed leg and arm muscles, and occupy a prominent place on the panels. The paintings, while not identical, share some important similarities with paintings of shamans at other sites in the Khomas Region and may possibly depict individual shamans (du Pisani, 2021a:59–70; and du Pisani, 2021b:73–85).

Figure 4: Perhaps a painting of an individual Shaman? Photo: André du Pisani

Conclusion

Rock art offers one entry point into understanding the spiritual and social world of the San. Some paintings depict daily activities and show humans performing different activities such as standing upright, walking, sitting, running, handling tools, reflexive action, and coordinated activities (Lenssen-Erz, 2000:70). Some of these activities are very specific, such as hunting and dancing, while others are more random and less-directed.

In all cases knowledge of the ethnography of the artists seems necessary for unravelling social relations and for understanding the use of technology. Some paintings are of what David Lewis-Williams calls 'images of another world' and 'a cosmos in the brain' (Lewis-Williams, 2014:143-145). Such images are about the 'shamanistic cosmos' with its three tiers – the Spirit World (above), Daily Life, and the Spirit Realm (below) (underground, underwater). Some paintings are also about the potency of animals and their symbolic interaction with humans within one, connected universe. The features of the line and crack are consonant with the shaman's account of going underground. (Lewis-Williams, 2011:90).

In contradistinction to western bias for the near-exclusive power of the written word, San rock art transcends the narrowness of the written word, by providing alternative narratives that undermine the absolute command of the written word. The theological and philosophical concept of 'hermeneutics' comes to mind as an enquiry into human existence (du Pisani, 2022:50). The imagistic storylines in San rock art are no less compelling. The rock art of Aub provides a powerful narrative of two of the tiers of the 'shamanic cosmos': The Spirit World (above), and Daily Life. It is literally 'Art beyond Sight'!

Acknowledgements

The author wishes to express his profound gratitude and thanks to various friends and colleagues who made the visit to the farm Aub 321 possible and enjoyable. They include Mr Volker Rust who farms on a portion of the farm, Prof. Ian Liebenberg, who accompanied me on the visit, Prof. Emeritus Piet van Rooyen for his unfailing friendship and encouragement, and Prof. David Lewis-Williams, who made me look at rock art differently. Moreover, Prof. Peter Breunig has been a compelling inspiration over the past two decades; so, too, Prof. Tilman Lenssen-Erz, who has pioneered new innovative approaches to the study and understanding of rock art in Namibia and beyond.

References

BIESELE, MEGAN. 1993. *Women Like Meat The folklore and foraging ideology of the Kalahari Ju|'ʃhoan.* Witwatersrand University Press/Indiana University Press, Johannesburg/Bloomington and Indianapolis.

BREUNIG, PETER. 2014. *Archäologischer Reiseführer Namibia.* Africa Magna Verlag, Frankfurt am Main.

DEACON, H.J. & JANETTE DEACON. 1999. *Human Beginnings in South Africa Uncovering the Secrets of the Stone Age.* David Philip, Cape Town.

DU PISANI, ANDRÉ. 2020. a. 'Seeing and Remembering: Rock Art Sites at the Farm Krumneck in the Khomas Region of Namibia'. In: *Journal* Band/Volume 67 – 2020, Namibia Wissenschaftliche Gesellschaft-Namibia Scientific Society, Windhoek: pp. 13–28.

DU PISANI, ANDRÉ. 2020. b. 'The Way We Were: Rock art in the Khomas Region of Namibia'. In: *Journal* Band/Volume 67 – 2020, Namibia Wissenschaftliche Gesellschaft – Namibia Scientific Society, Windhoek: pp. 29–44.

DU PISANI, ANDRÉ. 2021. a. 'An eye for the Cycle of Life: Exploring Rock Art in the Khomas Region'. In: *Journal* Band/Volume 68 – 2021, Namibia Wissenschaftliche Gesellschaft – Namibia Scientific Society, Windhoek: pp. 59–70.

DU PISANI, ANDRÉ. 2021. b. "On the Body in Rock Art of the Khomas Region'. In: *Journal* Band/Volume 68 – 2021, Namibia Wissenschaftliche Gesellschaft – Namibia Scientific Society, Windhoek: pp. 73–85.

DU PISANI, ANDRÉ. 2021. Field Notes (Aub). Mimeo.

DU PISANI, ANDRÉ. 2022. 'Mindscapes: The Story of Namibia in Art and Stone' In: Krishnamurthy, Sarala, Nelson Mlambo, Helen Vale (eds.) *Writing Namibia: Coming of Age.* Basler Afrika Bibliographien, Basel: pp. 12–57.

EASTWOOD, EDWARD & CATHELIJISE. 2006. *Capturing the Spoor: An Exploration of Southern African Rock Art.* David Philip, Claremont/Cape Town.

FORSSMAN, TIM & LEE GUTTERIDGE. 2012. *Bushman Rock Art: An Interpretative Guide.* Southbound, Pinetown.

GUENTHER, M.G. 1996. 'Diversity and flexibility: The case of the Bushmen of southern Africa'. In: Kent, S. (ed.) *Cultural Diversity among Twentieth-Century Foragers: An African Perspective.* Cambridge University Press, Cambridge.

KINAHAN, J. 2001. *Pastoral nomads of the Namibia Desert: The people history forgot.* Namibia Archaeological Trust, Windhoek.

KINAHAN, JOHN. 2020. *Namib: The archaeology of an African desert.* UNAM Press, Windhoek.

LENSSEN-ERZ, TILMAN & RZ, MARIE-THERES. 2000. *Der Bilderberg Namibia Kunst und Geschichte einer Urlandschaft.* Thorbecke Speläothek 5, Stuttgart.

LEWIS-WILLIAMS, J.D. 1981. *Believing and Seeing: Symbolic meanings in southern San rock paintings.* Academic Press, London.

LEWIS-WILLIAMS, J.D. & PEARCE, D.G. 2004. 'Southern African rock art paintings as social intervention: a study of rain-control images'. In: *African Archaeological Review* 21: 199–228.

LEWIS-WILLIAMS, J.D. 2011. *San Rock Art – A Jacana Pocket Guide.* Jacana, Johannesburg.

LEWIS-WILLIAMS, DAVID. 2014. *The Mind in the Cave.* Thames & Hudson, London.

MENDLESOHN, JOHN, JARVIS, ALICE, ROBERTS, CAROLINE & ROBERTSON, TONY. 2002. *Atlas of Namibia – a Portrait of the Land and its People.* David Philip, Cape Town.

MÜLLER, M.A.N. 1983. *Grasse van Suidwes-Afrika/Namibië.* John Meinert (Pty) Ltde., Windhoek.

PARKINGTON, JOHN & NONHLANHLA DLAMINI. 2015. *First People ancestors of the San.* Creda Communications, Cape Town.

RUST, RENÉE & JAN VAN DER POLL. 2011. *Water, Stone and Legend Rock Art of the Klein Karoo.* Struik Travel and Heritage, Cape Town.

SANDELOWSKY, BEATRICE H. 2013. *Prehistory in the Central Namibia Desert.* Benguela Publishers, Windhoek.

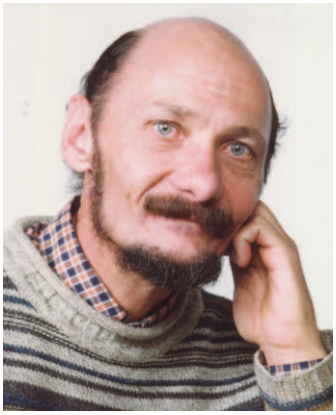
VINNICOMBE, P. 1976. *People of the eland: rock paintings of the Drakensberg Bushmen as a reflection of their life and thought.* University of Natal Press, Pietermaritzburg.

Map

Namibia 1:250,000 Windhoek 2216 Third Edition. Republic of Namibia: Department of Survey and Mapping, Windhoek.

JOURNAL 70
Namibia Scientific Society
Windhoek, Namibia 2023
ISSN: 1018-7677 ISBN: 978-99945-76-90-6

About the Author



André du Pisani is Professor Emeritus of Politics. He is an author, poet, photographer, and art collector, with research interests in history, literature, moral philosophy, politics, rock art and photography.

Author's address

P.O. Box 31589, Pioneers Park, Windhoek, 12007.
Email: andredupisani@gmail.com


Windhoek
optics
Competence for
Excellent Vision!
061 22 55 41
Follow us on social media

Preliminary results on the quantification and taphonomic analysis of the Zoo Park (Windhoek, Namibia) Proboscidean remains

Emma Haitengi (née Imalwa)
University of Namibia

Keywords: proboscideans, *Loxodont*, Holocene, taphonomic analysis, Windhoek, Zoo Park, butchering site.

Abstract

Landscaping work at Zoo Park (Windhoek, Namibia) in 1961/1962 revealed a Holocene open-air site containing proboscidean remains (*Loxodonta* spp.) associated with quartz stone artefacts. Zoo Park has been cited in various publications as a butchery site with various authors differing on the number of the elephants found at the site. To verify these claims, a taphonomic analysis and quantification of the elephant remains was carried out. The study is ongoing. The preliminary results have documented two elephants and taphonomic analysis suggests possible human exploitation of the remains. The study shows that the exploitation of elephants for subsistence at Zoo Park was likely the result of butchering related to scavenging activities.

Introduction

Proboscidean remains such as *Palaeoloxodon*, *Mammuthus*, and *Loxodonta* have been discovered at several mainly Pleistocene archaeological sites around the world and these findings reveal a once diverse and widely distributed order (MacCalman 1965, 1967; Clark and Haynes 1970; Shackley 1980, 1985; Klein 1988; Villa 1990; Rabinovich et al. 2012;

Saccà 2012; Haynes 2022). Today the order Proboscidea is represented by three species; *Loxodonta africana* (African savanna elephant), *Loxodonta cyclotis* (African forest elephant), and *Elephas maximus* (Asian elephant). Studies focusing on hominin exploitation of proboscideans draws attention to the strategies used to exploit these megafauna. Active hunting of elephants during the Pleistocene is often disputed and it is commonly accepted that elephant flesh was exploited mainly by scavenging (Saccà 2012).

In Namibia evidence pointing to probable hominin exploitation of elephants comes from two archaeological sites, namely Namib IV, and Zoo Park, which forms the focus of this paper. Namib IV is an open-air site and was discovered in 1978 by Myra Shackley (Shackley 1980, 1985). The site is located in the central Namib Desert, approximately 20 km southwest of Gobabeb (Klein 1988:18), and covers an area of over 62,500m^2 (Shackley 1985). A multidisciplinary dating approach has been used to date the site and includes uranium-thorium and biochronology dating methods (Mesfin et al. 2021; Klein 1988; Shackley 1980, 1985). These multidisciplinary dating approaches indicate a lower Pleistocene age of ~350–500ka (Haynes 2022; Mesfin et al. 2021). The artefact assemblage is composed of 75% heavy tools, the majority being cleavers and hand-axes (Shackley 1985), artefacts typically associated with the Acheulean techno-complex. Other tools making up the artefact assemblage include "choppers and cores (4.4%), flakes (16%) and a small amount of retouched formal tools" (Shackley 1985:37). In addition to artefact assemblage, faunal remains including *Palaeoloxodon* (formerly *Elephas*) *recki*, alcelaphine antelope, and black wildebeest were also discovered at the site (Shackley 1980; 1985; Klein 1988). The occurrence of migratory and water-dependent animals such as *Palaeoloxondon recki* and black wildebeest in the Namib Desert is indicative of wetter conditions during the lower Pleistocene. The water dependence of elephants and wildebeest would therefore suggest that the site and others in the vicinity were probably occupied for short periods. The faunal remains were "concentrated together with the bifacial tools, on the southern part of the pan association" (Shackley 1985:37), which supports the argument that Namib IV was a butchery site. The dominance of heavy tools however suggests opportunistic hunting at the site (Kinahan 2020).

Zoo Park is an open-air site located in Namibia's capital city Windhoek, at the corner of Independence Avenue and Fidel Castro Street. Landscaping work at Zoo Park in 1961 and 1962 revealed proboscidean remains which were ascribed to *Loxodonta zulu* (Cherkinsky and Marais 2014). However, palaeontologists Martin Pickford and Friedemann Schrenk (personal communication), have suggested that the remains are most likely *Loxodonta africana*, although confirmation rests on further analysis of the remains. The first date for the site, derived from a tusk sample, is 5200 ±140 BP (MacCalman 1965). Clark and Haynes (1970) were not convinced by the date obtained by MacCalman, suggesting either a late Pleistocene or early Holocene date based on the site's diatoms. The second date for the site is 7.2ka and was obtained from a tooth molar plate (Cherkinsky and Marais 2014).

These dates place the Zoo Park within the Holocene which is significant as the majority of archaeological sites with possible hominin exploitation of proboscideans are dated to the Pleistocene. The Holocene context of the elephant remains is important to finding out and the interaction between the elephant and Later Stone Age (LSA) hunter-gatherers.

The Zoo Park elephant remains were discovered at two separate areas which are located 10m apart (Cherkinsky and Marais 2014). The first remains were discovered in 1961, 2m below the surface (Cherkinsky and Marais 2014), comprising a tusk, lower jaw, and pelvis (MacCalman 1967). The second elephant remains were discovered in 1962, 0.35m below the surface, and include mandible, tusk, teeth, femur, pelvic bones, vertebrae, and ribs (Cherkinsky and Marais 2014). While some level of excavation was carried out at the Zoo Park as shown by the layout of the grids (Fig. 1), it is not entirely clear how systematic the excavation was. As the 1962 discovery is the only area cited where a femur was found, it is highly probably that what is shown in Fig. 1 is the 1962 discovery; additionally, the depth where the remains are exposed appears shallow, thus lending more weight to this having been the 1962 discovery. According to several publications (MacCalman 1965,

Figure 1: Photographs most probably showing the 1962 discovery. Tusk and femur are visible. (Photo: National Archives of Namibia)

1967; Clark and Haynes 1970; Stern and Lau 1989; Cherkinsky and Marais, 2014; Haynes 2022), the elephant remains from both areas were associated with quartz artefacts characterized by choppers , hammerstones and unretouched flakes, which has resulted in the site being interpreted as a butchery site. The lithic artefacts, which are curated at the National Museum of Namibia (NMN) have not been studied by me or other researchers and, as such, no additional information can be provided about them at this stage.

The interpretation of the Zoo Park as a site of probably human exploitation of proboscideans is not secure because the archaeological context in which the evidence occurs is not well documented. There is a paucity of information regarding the spatial distribution of the elephant remains and lithic artefacts. Furthermore, the number of elephants reported from the site is inconsistent: MacCalman (1965) reported three elephants, while Haynes (2022) reported two elephants from Zoo Park. The claims made by Haynes or MacCalman are not supported by any photographic or taphonomic evidence. The motivation driving this study is to shed light on the number of identified specimens (NISP), minimum number of individuals (MNI), and to look for taphonomic indicators that could support the probable exploitation of proboscideans by LSA hunter-gatherers of the Windhoek.

Material and Methods

The teeth are the most morphologically distinct element of an elephant, thus the teeth together with the tusks were used to conclude that the only animals represented at the site were elephants. When the elephants' remains were moved from the Zoo Park to the archaeology collection in the National Museum of Namibia (NMN), no consideration was given to the fact that these remains originated from two separate areas of the Zoo Park and the material was stored as if it came from a single area. The material will therefore be treated as a single assemblage. The remains were not washed or treated with chemicals, which and this would have hampered the identification of bone surface modifications.

There is clear evidence that some of the remains were conjoined/refitted in the past; conjoining/refitting of the remains, specifically the teeth, is still ongoing. Refitting or conjoining plays an important role in the accuracy of skeletal element identification and quantification. Skeletal element identification was carried out using a very limited reference collection from the Mammal Department of the NMN and several published guides (Smuts and Bezuidenhout 1994; van der Merwe 1995; Bezuidenhout and Seegers 1996; Stansfield 2015). The quantification units used to count the skeletal remains is number of identified specimens (NISP) and minimum number of individuals (MNI) based on popular textbooks (Lyman 2008; Reitz and Wing 2008; Gifford-Gonzalez 2018). The use of the two quantification units is significant because, although both are influenced by fragmentation, the degree to which fragmentation influences them differs. The NISP count is always higher

than the MNI and therefore tends to inflate the number of individuals, whereas the MNI tends to underestimate the number of individuals. Mandibles were the best-represented diagnostic skeletal elements of the assemblage and thus were used to determine the MNI.

Published criteria of the age profiles of *Loxondonta africana* (Haynes 1991; Lindeque 1991; Stansfield 2015) were used to estimate the age of Zoo Park elephants. The age of elephants was based on the correct identification of the teeth which were identified with the help of Martin Pickford (briefly looked at the teeth) and Friedeman Schrenk (via email communication). The counting of lamellae was not used as an age determination technique because different molars may have a similar number of lamellae (Lindeque 1990; Stanfield, 2016).

Taphonomic analysis was aimed at establishing whether the Later Stone Age hunter-gatherers of the Zoo Park exploited elephants. Evidence of hominin involvement with bones from archaeological sites is obtained by observing bone surfaces for cut marks, which are considered the most direct and reliable evidence of anthropogenic manipulation of archaeofaunal remains (Yravedra et al. 2010; Rabinovich et al. 2012). Only bones that were identified to skeletal level were considered for bone surface modifications. In most zooarchaeological studies, cut marks are verified through use of scanning electron microscope (SEM); however, this was not carried out in this study. Bone surface modifications were also carried out to identify carnivore and rodent gnawing marks.

Evidence of fire can also be used as direct evidence of hominin involvement with bones from archaeological sites. Natural and human activities can both create burned bone assemblages, although to varying degrees. Burned bones were assessed using Stiner et al. (1995) criteria, which consist of six categories that are identified on the basis of colour (see Table 1).

Table 1: Burn level codes from Stiner et al. (1995).

Burn Color Code	**Description**
0	Not Burned (cream/tan)
1	Slightly burned; localized and < half carbonized
2	Lightly burned; > half carbonized
3	Fully carbonized (completely black)
4	Localized; < half calcined (more black than white)
5	Half calcined (more white than black)
6	Fully calcined (completely white)

Results

Faunal assemblage preservation

The state of preservation of the faunal assemblage is not uniform, implying that the faunal remains were exposed to different conditions. The general assemblage is not well preserved and is intensely fragmented. The total assemblage consisted of 984 remains of which only 123 could be identified as skeletal elements. Fragmentation is especially evident on the tusk, which was splitting into tiny pieces (Fig. 2). Two of the tusk parts could be conjoined/refitted but this was not attempted due to the splitting. It is difficult to conclude whether the tusk parts were once the complete tusk shown in Fig. 1. The femur, whose length was 79 cm, is also very fragmented; most of the fragments were conjoined/refitted in the past (Fig. 3), with only one part being conjoined/refitted during this study. Figure 1, shows the distal end of the femur, but this part of the femur did not form part of the analysed material. The state of preservation is most probably attributed to two factors. It is highly probably the remains were damaged by the bulldozers during the landscaping work. The preservation of some of the remains *in situ* in a glass-covered showcase (Fig. 4) caused deterioration of the remains. The specimens showed variable degrees of surface abrasion, with some of the cortical surface missing or falling off. Smoothing and polishing of the bones, although present, are not very common.

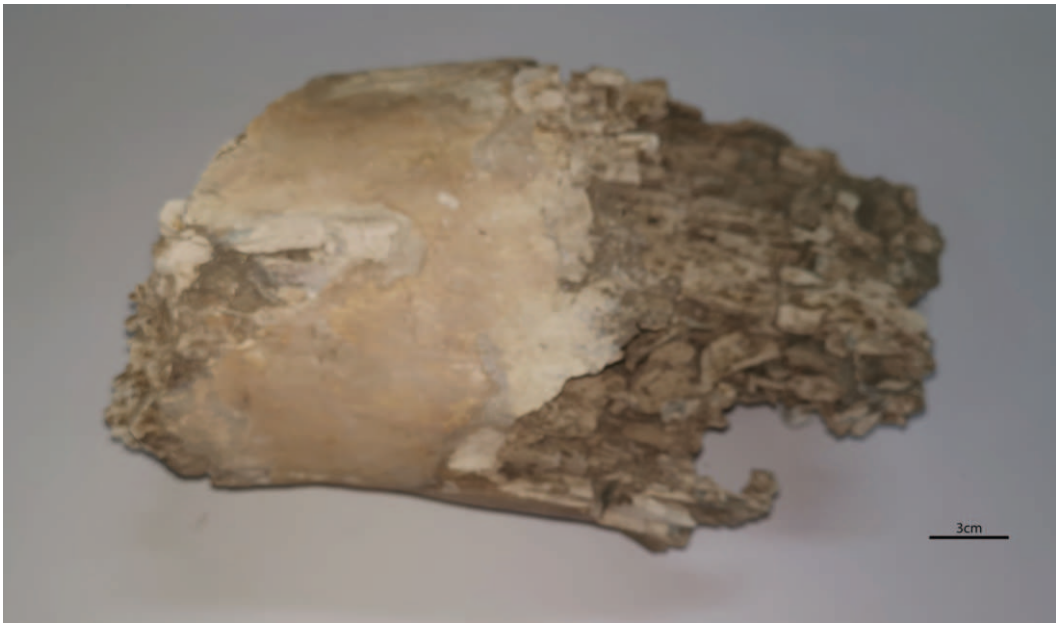


Figure 2: One of the four tusk parts from the assemblage

Figure 3: Femur showing refitting of the fragments

Figure 4: Museum staff building the showcase at one of the discovery areas, most probably the 1962 area. Photo: National Archives of Namibia

Skeletal composition

The NISP (Table 2) is low: only 123 of the remains were identified as skeletal elements. Cranial elements are represented by fragmented tusks, teeth, and skull fragments. There were many large bones that were not identified due to a limited reference collection, but also because the surfaces were eroded. Post-cranial elements are represented by ribs, pelvis, vertebrae, femur, humerus, tarsal bones, and phalanges.

The mandibular teeth (Fig. 5a and Fig. 5b) are M2 (fifth molar) and the beginning of M3 (sixth molar). Therefore, the age of this individual would be around 36-38 years in modern African elephants (personal communication with Friedemann Schrenk). The three complete M2s (Lower M2, Upper M2 and right-sided Lower M2) and the M3s that follow them are shown in Figures 6a, 6b, 7a, 7b, and 8. The M3s still require refitting with the available molar plates. The three M2s are much younger than the individual represented by the mandibular teeth; probably 22-24 years of age (personal communication with Friedemann Schrenk).

Table 2: NISP for the identified elephant skeletal elements

Skeletal element	**NISP**	**Exact identification of skeletal element**	
Skull elements	7	Occipital bone	3
		Foraminae	4
Mandible	6	Complete mandible	1
		Left-sided partial mandible with visible symphysis and posterior foramen mentale	1
		Right-sided partial mandible with visible proximal dental alveolus end and posterior foramen mentale	1
		Left-sided partial mandible with visible base of condyle and distal end of dental alveolus mandibular	1
		Left-sided partial mandible with visible condyle and shaft	1
		Mandible condyle	1
Teeth	28	Upper M2	1
		Right-sided Lower M2	1
		Lower M2	1
		Upper M3	1
		Right sided Lower M3	1
		Lower M3	1
		M3	1
		Molar plates	13
		Teeth fragments	8
Tusks	3	Indetermined	3
Vertebrae	18	Altlas	1
		Spinous processes	4
		Vertebral bodies	13
Ribs	47	Indetermined	47
Pelvis	5	sacrum	1
		Indetermined	4
Femur	1	shaft	1
Humerus	1	Condyle	1
Tarsal bones	4	Indetermined	4
Phalanges	3	Indetermined	3
Totals	123		123

Figure 5a: Mandibular teeth

Figure 5b: Interior view of left side of the complete mandible

Figure 6a: Upper M2 (fifth molar)

Figure 6b: Upper M2 (left) and upper M3 (right)

Figure 7a: Right-sided lower M2 (left) and M3 (right)

Figure 7b: Right-sided lower M2 with visible root (left) and M3 (right)

Figure 8: Lower M2 (left) and M3 (right)

The data indicate at least two elephants at Zoo Park. One individual is represented by the complete mandible (Fig. 5a), while the second individual is represented by a left-sided partial mandible (Fig. 8). The possibility of three individuals is not ruled out.

Bone surface modifications

Bone surface modification was observed only on the identified skeletal elements. Bone surface modification was hampered by the fact that the bones had not been cleaned or treated with any chemicals to remove the sediments covering some of the bone surfaces. Visible cracks can be seen on some of the bones covered in sediment, which implies that the remains were buried in a wet environment. Identification of bone surface modification was also hampered by the absence of cortical surfaces on some of the bones. Bones covered in manganese are relatively few.

Multiple parallel striations were identified on the surface of a single rib (Fig. 10); they are shallow, of various lengths and widths, without a defined orientation. Gnaw marks from rodents and carnivores were not present.

Black was the most easily identifiable colour, indicative of burning at the site. Bones showing evidence of burning are relatively few and include specimens such as occipital bone, mandibles, atlas, feet elements, vertebrae bodies, and spinal processes. The vertebrae and one foot bone are the only ones that show a complete black colouration, while the others are only partially burned. Even in cases where skeletal elements were encrusted with sediment, the evidence of fire can be still observed.

Figure 9: Left-sided partial mandible with visible symphysis and visible posterior foramen mentale

Figure 10: Rib with multiple striations

Discussion

Zoo Park is the only known Quaternary archaeological site in Namibia in which elephant remains are the only faunal remains at a site. The exploitation of proboscideans by hominins at most archaeological sites including the Zoo Park remains unclear. The interaction between the Zoo Park LSA hunter-gatherers and elephants is especially unclear as a result of the unknown spatial distribution of the lithic artefacts and elephant bones, which is not well documented.

The faunal remains from Zoo Park are highly fragmented, which limited the skeletal element identification. The elements left at the site are mostly the bulky elements such as mandibles, pelvis, and femur. These elements might have been left behind after the meat was removed or perhaps not all the elements were exploited. It is suspected that a relatively high abundance of ribs suggests that people handled the bones, but this is merely a suggestion. The tusk and the teeth were most probably left at the site because they had no nutritional value, and were not considered for other functions such as bone tools.

The preliminary data indicate the presence of two adult individuals at Zoo Park, although the possibility of a third adult individual is highly likely. While it is difficult to say with absolute certainty, the exploitation of elephants in the Zoo Park was almost certainly opportunistic, in nature similar to exploitation of elephants at Namib IV. Active hunting of elephants at Zoo Park is disputed and it is assumed here that elephants were procured mainly by scavenging. Opportunistic exploitation of the elephants mainly by scavenging is supported by various factors. Firstly, the age of the elephants: one individual is around 36–38 years and the other is probably 22–24 years. In modern African elephants animals at these ages would be very large and could be aggressive when provoked, a factor that would deter a small group of LSA hunter-gatherers from actively hunting them. Secondly, the size of a single adult elephant would have been able to sustain a band of LSA hunter-gatherers for several months and would not necessitate the killing of two adult elephants. Thirdly, the heavy tool element found at the site would not be able to pelt an elephant to death and suggests manufacture of the lithic artefacts in situ to butcher the carcasses. The most probably explanation for the number of elephants discovered at the site is the fluvial context of the site at the time, which resulted in the elephants getting stuck in the spring-fed marsh, eventually resulting in their deaths. Elephant carcasses have been documented around water points in southern African sites, because of accidents such as getting stuck in the mud or drowning (Haynes 1991). The occurrence of a migratory and water-dependent animal such as elephants in Windhoek is indicative of a permanent water source.

Cut marks are rarely documented on elephant bones because thick skin, high levels of body fat, and large muscle tendons and ligaments do not allow contact between the bones and lithic artefacts (Villa et al. 2005; Yravedra et al. 2010; Rabinovich et al. 2012; Haynes

1991; Villa 1990). The absence of cut marks on elephant bones is therefore not an argument against the exploitation of elephant carcasses by hominins. At this stage it cannot be concluded whether the multiple striations observed on the rib are cut marks or were caused by trampling. There is a need to verify these marks using scanning electron microscopy (SEM) in the future. The likelihood of detecting cut marks may have been hampered by the poor preservation state of the assemblage, which is heavily fragmented, and absence of cortical surfaces.

One of the most common marks of hominin exploitation of faunal remains found at archaeological sites is the use of fire. Burnt bones on archaeological sites may result from anthropogenic activities such as cooking, fuel for fires and waste disposal, or naturally occurring fires. Burning was not a major taphonomic factor at Zoo Park, with very few skeletal elements showing signs of burning. The burnt remains presented a black colour compatible with carbonization (Stiner et al. 1995). The low quantity of burned bones and varied burnt skeletal elements strongly indicate that the burning of the bones was not the result of naturally occurring fires. This implies that the remains were intentionally burned, thus supporting the exploitation of the elephant carcasses by LSA people.

Conclusion

A solid conclusion can still not be reached on the interaction between the Later Stone Age (LSA) hunter-gatherers and proboscideans at the Zoo Park, as the archaeological context in which the evidence occurs remains unclear. The quantification and taphonomic analysis carried out in this study has however provided more detailed information of the elephant remains found at the site. The study identified two individuals, although the possibility that three individuals were at the site is possible. The ages of the mandibular teeth and three complete M2s (fifth molars) were also revealed in this study. The exploitation of the Zoo Park elephants by people is supported by the burnt remains. The two individuals as well as their ages suggest that these elephants were most probably trapped in the marsh and people butchered already dead animals.

Acknowledgement

I would like to express my gratitude to Prof. Martin Pickford and Prof. Friedeman Schrenk for guidance in the accurate identification of the teeth. I would also like to thank the staff of the National Museum, in particular Miss Karina Efraima and Mrs Appolina Dirks, for access to material housed in the archaeology collection and for reference material housed in the mammal collection.

References

BEZUIDENHOUT, A.J., & SEEGERS, C.D. 1996. The osteology of the African elephant (Loxondonta africana): vertebral column, ribs and sternum). *Onderstepoort Journal of Veterinary Research* 63:131–147.

CHERKINSKY, A. & MARAIS, E. 2014. Rare elephant molar (Loxodonta africana zulu) from Windhoek spring deposit, Namibia. Transactions of the Royal Society of South Africa. https://doi.10.1080/0035919X.2014.936329

CLARK, J.D. & HAYNES, C.V., Jr. 1970. An elephant butchery site at Mwanganda's village, Karonga, Malawi, and its relevance for Palaeolithic archaeology. *World Archaeology* 1: 390–411.

GIFFORD-GONZALEZ, D. 2018. An introduction to zooarchaeology. Springer, Cham.

HAYNES, G. 1991. *Mammoths, mastodons , and elephants: Biology, behaviour and the fossil record.* Cambridge University Press, Cambridge.

HAYNES, G. 2022. Late Quaternary Proboscidean sites in Africa and Eurasia with possible or probable evidence for Hominin involvement. *Quaternary*, 1–45.

KINAHAN, J. 2020. Namib: *The archaeology of an African Desert.* UNAM Press, Windhoek.

KLEIN, R.G. 1988. The archaeological significance of animal bones from Acheulian sites in southern Africa. *The South African Archaeological Review* 6: 3–25.

LINDEQUE, M. (1991). Dentition and age estimation of Elephants in the Etosha National Park, Namibia. *Madoqua* 18(1): 17–25.

LYMAN, R.L. 1994. Vertebrate taphonomy. Cambridge University Press, New York.

MACCALMAN, H.R. 1965. Carbon-14 dates from South West Africa. *South African Archaeological Bulletin* 20 (80): 215.

MACCALMAN, H.R. 1967. The Zoo Park elephant site, Windhoek. *Palaeoecology of Africa* 2: 102–103.

MESFIN, I., PLEURDEAU, D., & FORESTIER, H. 2021. L'assemblage lithique du site Acheuléen de Namib IV (Namib central, Namibie)/ The lithic assemblage of the Acheulean site of Namib IV (Central Namib, Namibia). *L'Anthropologie*. https://doi.10.1016/j.anthro.2021.102848

RABINOVICH, R., ACKERMAN, O., ALADJEM, E., BARKAI, R., BITON, R., & MILEVSKY, I. 2012. Elephants at the Middle Pleistocene Acheulian open-air site of Revadim Quarry, Israel. *Quaternary International* 276–277:183–197.

REITZ, E.J., & WING, E.S. 2008. *Zooarchaeology* (Second ed.). Cambridge University Press, New York.

SACCA, D. 2012. Taphonomy of Palaeloxodon antiquus at Castel di Guido (Rome, Italy): Proboscidean carcass exploitation in the Lower Paleolithic. *Quaternary International* 276–277: 27–41.

SHACKLEY, M. 1980. An Acheulean industry with *Elephas recki* fauna from Namib IV, South West Africa (Namibia). *Nature (London)* 284: 340–341.

SHACKLEY, M. 1985. Palaeolithic archaeology of the central Namib Desert: A preliminary survey of chronology, typology and site location. *Cimbebasia Memoir* 6:1-84.

SMUTS, M.M.S., & BEZUIDENHOUT, A.J. 1994. Osteology of the pelvis limb of the African elephant (*Loxondonta africana*). *Onderstepoort Journal of Veterinary Research* 61: 51-66.

STERN, C. & LAU, B. 1989. Zoo Park: A History. Archives Service Division of the Department of National Education, SWA/Namibia, Windhoek.

STINER, M., KUHN, S., WEINER, S., & BAR-YOSEF, O. 1995. Differential burning recrystallization and fragmentation of archaeological bone. *Journal of Archaeological Science* 22: 223–237.

STANSFIELD, F.J. 2015. A novel objective method of estimating the age of mandibles from African elephants (*Loxodonta africana*). PLOS One 10 e0124980

VAN DER MERWE, N.J., BEZUIDENHOUT, A.J. & SEEGERS, C.D. 1995. The skull and mandible of the African elephant (*Loxodonta africana*). *Onderstepoort Journal of Veterinary Research* 62:245–260

VILLA, P. 1990. Torralba and Aridos: elephant exploitation in the Middle Pleistocene Spain. *Journal of Human Evolution,* 19: 299–309.

VILLA, P., SOTO, E., PEREZ-GONZALEZ, A., SANTONJA, M., MORA, R., PARCERISAS, Q., & SESE, C. 2005. New data from Ambrona (Spain): closing the hunting versus scavenging debate. *Quaternary International*, 126–128: 223–250.

YRAVEDRA, J., DOMINGUEZ-RODRIGO, M., SANTONJA, M., PEREZ-GONZALEZ, A., PANERA, J., RUBIO-JARA, S., & BAQUEDANO, E. 2010. Cut marks on the Middle Pleistocene elephant carcass of Áridos 2 (Madrid, Spain). *Journal of Archaeological Sciences,* 37: 2469-2476.

JOURNAL 70
Namibia Scientific Society
Windhoek, Namibia 2023
ISSN: 1018-7677 ISBN: 978-99945-76-90-6

About the Author

Qualifications

PhD (University of Tras-os-Montes e Alto Douro, Portugal) 2015

- Thesis title: Analysis of the management of Twyfelfontein World Heritage Site, Namibia.
- Brief synopsis: Very little has been written about the complexities of managing cultural heritage sites in Namibia, especially those of archaeological content. Consequently, my dissertation explored the management of Namibia's first world heritage site, Twyfelfontein. The aim of the dissertation was to present an overview of how the site is being managed and the challenges facing its management. Specifically, the study looked at five areas of management, namely: conservation, visitor management, interpretation, stakeholder involvement, and documentation management. The analysis reveals that the management of Twyfelfontein is mainly an institutional problem. There seem to be no clear criteria guiding the management of the site. The paper also reveals that heritage as a concept on its own is not sustainable, and the management of cultural heritage sites is to a large degree dependent on managing such sites as part of a larger cultural environmental context. The study concluded that the successful management of Twyfelfontein World Heritage Site will depend, to a great extent, on strategic planning, management structures that promote research, and stakeholder involvement.

MSc. (Muséum National d'Histoire Naturelle, France) 2009

- Thesis title: Exploitation of animals during the Holocene in Namibia: Examples of three archaeological sites from the Erongo mountains and central Namibia desert.
- Brief synopsis: The aim of the thesis was to compare the faunal remains found on three different archaeological sites, two sites in the Erongo mountains and one site in the central Namib Desert, dating to the Holocene Epoch. The purpose of comparing the faunal remains from the three sites was to ascertain the animal species found at the site and consequently provide an explanation as to how they accumulated either by natural or human agents. This information is used, not only to provide insight into the way of life in these areas during the Holocene, but also to give insight into the type of natural environment. What is significant in this research was the discovery of two caprine molars, which resulted in my first

scientific publication. Dating of the molars revealed them to be the oldest known remains of domesticated animals in Namibia and throughout southern Africa.

BSc. (Rhodes University, South Africa) 2005

Professional appointments/employment

University of Namibia

- Lecturer (archaeology, heritage, and history) 2019–present
- Research officer (Namibia History Project) 2017–2019

National Museum of Namibia (curator) 2009–2017

Ministry of Fisheries and Marine Resources (technician) 2006–2007

Other professional activities

Member of the Nominations and evaluations committee, National Heritage Council of Namibia. 2021–present.

Coordinator for the Restoration of Spitzkoppe Rock Art Project. National Heritage Council of Namibia, 2014.

Archaeology Summer School Lecturer. National Museum of Namibia, December 2009.

Publications

Haitengi, E. 2023. Einleitung. In K. Lembke (Ed.). *Die Haifischinsel: Das erste deutsche Konzentrationslager.* Nünnerich-Amus Verlag & Media, Oppenheim am Rhein.

Le Meillour, L., Zirah S., Zazzo, A., Cersoy, S., Détroit F., **Imalwa, E**., Lebon M., Nankela, A., Tombret, O., Pleurdeau, D., & Lesur, J. 2020. Palaeoproteomics gives new insight into early southern Africa pastoralism. Scientifc Reports, 10:14427. https://doi.org/10.1038/s41598-020-71374-3

Imalwa, E. 2018. The management of Twyfelfontein World Heritage Site, Namibia. In *World heritage for sustainable development in Africa.* UNESCO, 131–139. https://unesdoc.unesco.org/ark:/48223/pf0000368247

Schmidt, I., Ossendorf, G., Hensel, E., Bubenzer, O., Eichhorn, B., Gessert, L., Gwasira, G., Henselowsky, F., **Imalwa, E.,** Kehl, M., Rethemeyer,J., Ropke, A., Sealy, J., Stengel, & Tusenius, M. 2016. New investigations at the Middle Stone Age site of Pockenbank Rockshelter, Namibia. *Antiquity,* Issue 353.

Pleurdeau, D., **Imalwa, E.,** Détroit, F., Lesur, J., Veldman, A., Bahain, J. & Marais, E. 2012. Of sheep and men: Earliest direct evidence of caprine domestication in Southern Africa at Leopard Cave (Erongo Region, Namibia). PLoS One, 7(7), e40340. https://dx.doi.org/10.1371/journal.pone.0040340

Imalwa, E. (2012). Developments of Archaeological heritage management in Southern Africa: A look at heritage legislations during the colonial and post-colonial periods. *In* L. Oosterbeek, C. Martins, and Z. Domingos (eds.) *Ebo e a arte rupestre do Sudoeste de Africa.* Tomar: CEIPHAR, series "ARKEOS, Perspectives em Dialogo," Vol 33, 77–86.

Imalwa, E. Namibia: The state of Namibian rock art, Published 24 August 2011, New Era Newspaper.

Conference activity/participation

Talks:

- The management of rock art sites. COSMO Art, Omundumba Farm, September 2023.
- The Management of Twyfelfontein World Heritage Site. UNESCO International Conference on African World Heritage as a Driver for Sustainable Development, Arusha, Tanzania, June 2016.
- The Management of Twyfelfontein World Heritage Site. International Conference of Arts and Culture Policy. Windhoek, Namibia, May 2015.
- The challenges of managing museum collections. ICOM Workshop for Museum Experts, Livingstone (Zambia), May 2014.
- Underwater heritage in Namibia. Workshop on Underwater Heritage, Robben Island (South Africa), February 2010.
- Namibian rock art. Total Quality Cultural Heritage Management Conference, Polytechnic Institute of Tomar (Portugal), March 2008.

Discussant:

The role of women in the liberation struggle. Namibia History Project. University of Namibia, November 2023.

Attendee:

UNESCO Experts meeting on the Importance of Museum Collections in Paris France, 2015.

Author's address

P.O. Box 81551, Olympia, Windhoek
Email: ehaitengi@unam.na

WECKE & VOIGTS
since 1892

The Wecke & Voigts story begins in 1892, when brothers Gustav and Albert Voigts, along with their business partner, Fritz Wecke, left Germany for then South-West Africa, with big ambitions for building a business, a life, and a future in this beautiful land. Little did they know that more than 130 years and four generations later, their descendants would still call this home, and still be growing the family business to meet the changing needs of the people of Namibia.

With a store for every community in Windhoek - including five Spar outlets, a wholesaler, and the gorgeous beauty, body, bath and home store, Wecke & Voigts For You - the Wecke & Voigts group is a celebration of all that came before, and all that lies ahead.

WECKE & VOIGTS WHOLESALE

WECKE & VOIGTS for you
SOMETHING SPECIAL

SUPERSPAR
MAERUA & THE GROVE

SPAR
HOCHLAND, WESTLANE & KLEIN WINDHOEK

tops! at SPAR

One of the most versatile and interesting museums in Namibia!

Curious about cultures and ready to take a trip into the past?
To obtain a touch and feel about the country's history a visit to the Grootfontein Museum is a rewarding experience.
Contrary to expectations, the privately founded and funded museum does not only display colonial history, but also offers interesting traditional and cultural artifacts of different cultural groups.
There is a lot to discover with the large selection of the extensive range of exhibitions in the Grootfontein Museum.
Embark on an exciting journey through different rooms that exhibit interesting themes.
There is definitely something for everyone with various exhibitions such as mining, the history of Grootfontein, a wagon workshop and a blacksmith as well as an extensive exhibition of the ethnic Himba people.

The selection of exhibitions and collections is huge and guarantees exciting browsing for the whole family.

Please call or send us an email!
Please book your visit to our Grootfontein Museum at least 24 hours before visiting.

PRICES
Monday - Friday: NAD 80 per person
Saturday/Sunday/Public Holidays
PRE-BOOKING IS ESSENTIAL! : NAD 120 pp

Antje 081 477 1096
grootfonteinmuseum@gmail.com

NEW

THE WISHING-TABLE
PRE-BOOKING IS ESSENTIAL!

Are you traveling with a group? Fancy a piece of cake or a light lunch? We prepare food for groups and bake cakes for you and your guests. After the museum tour, we will be serving your pre-ordered treats amidst old machinery and tools in the beautiful inner courtyard of the museum. Groups of six or more can order a light lunch or coffee & cake from us. Pre-ordering is essential! Please book at least five days in advance. Prices and different menus are available upon request.
Would you like to reserve? Then please contact us on telephone: 081 477 1096

Antimicrobial activity of three Namibian ethno-medicinal plants:!Guxa (*Aptosimum albomarginatum* Marloth and Engl.), Aru (*Albizia anthelmintica* A. Rich Brongn.) and Gu-!aru (*Dicoma schinzii* O. Hoffm.)

Sunette Walter

Keywords: *Aptosimum albomarginatum, Albizia anthelmintica, Dicoma schinzii,* traditional ethno-medicinal plants, antimicrobial activity, Namibia.

Abstract

With antibiotic resistance being an enduring problem worldwide, alternative treatment options, such as 'natural antibiotics', should be considered. This work aimed to perform antimicrobial assays, with the purpose of scientifically evaluating the effectiveness of three Namibian ethno-medicinal plants, namely:!Guxa (*Aptosimum albomarginatum* Marloth and Engl.), Aru (*Albizia anthelmintica* A. Rich Brongn.) and Gu-!aru (*Dicoma schinzii* O. Hoffm.). It was found that !Guxa root extract exerted antimicrobial activity against five out of the eight strains tested, with strong activity against *Streptococcus sanguinis* at an extract concentration of 20mg/ml. Moderate activity was observed for the other cultures tested. *Candida albicans, Escherichia coli* and *Pseudomonas aeruginosa* were resistant

to !Guxa. These results give some scientific proof regarding the usefulness of !Guxa root extract as traditional medicine in some instances, thereby generating new knowledge to be shared with fellow researchers.

Abstrak

Met antibiotiese weerstand wat tans ’n blywende wêreldwye probleem is, moet alternatiewe opsies van behandeling, soos ‘natuurlike antibiotika’, oorweeg word. Hierdie werk het beoog om antimikrobiese toetse te doen, met die doel om die effektiwiteit van drie Namibiese etno-medisinale plante, naamlik: !Guxa (*Aptosimum albomarginatum* Marloth and Engl.), Aru (*Albizia anthelmintica* A. Rich Brongn.) en Gu-!aru (*Dicoma schinzii* O. Hoffm.), wetenskaplik te evalueer. Daar is bevind dat !Guxa wortelekstrak antimikrobiese aktiwiteit getoon het teen vyf uit agt stamme getoets, met sterk aktiwiteit teen *Streptococcus sanguinis* by ’n konsentrasie van 20mg/ml. Matige aktiwiteit het voorgekom by die ander kulture wat getoets is. *Candida albicans*, *Escherichia coli* en *Pseudomonas aeruginosa* was weerstandbiedend teen !Guxa. Hierdie resultate bewys tot ’n mate wetenskaplik dat !Guxa wortelekstrak bruikbaar kan wees as tradisionele medisyne in sommige gevalle en het gevolglik tot nuwe kennis gelei om met mede-navorsers te deel.

Introduction

Antibiotic resistance is currently a worldwide problem. Therefore, scientists should investigate alternative treatment options, such as the use of natural products. Plant-derived products may have antimicrobial properties, acting as ‘natural antibiotics’. Such natural products may in some instances also be used as adjuvants together with antibiotics.

Most cultures across the globe have developed knowledge of local plants, enabling them to use these plants for medicinal purposes (Silvério & Lopes, 2012: 110–11). Certain plants utilized in some regions are unknown to western medicine and thus studied in the field of ethnopharmacology to investigate their antimicrobial properties. The concentration of pharmacologically active compounds depends on the season during which the plants are harvested, how mature they are when harvested, and the conditions under which growth has taken place. Due to lack of regulation, the same plant product bought at different times can possess different biological properties (Silvério & Lopes, 2012: 110–11).

In the traditional setting, especially in rural areas, plants are used as natural medicine to treat various illnesses, including bacterial and viral infections. According to van Wyk & Wink (2015: 276, 284) bacteria are microorganisms consisting of a single cell surrounded by cell walls; their DNA is circular and they do not have internal membrane systems or nuclei. Viruses on the other hand, are infectious complexes of macromolecules with their genetic information as either DNA or RNA. Viruses require host cells for replication and

formation of new viral particles. *Aptosimum albomarginatum* (Marloth and Engl.) shown in Figure 1 (A) is commonly known as '!Guxa' by the Nama tribe in Namibia. The roots are pulverized, boiled as a tea, and drunk to purify the blood and cleanse the uterus. Some believe that it can cure women who experience difficulty in conceiving (S. Coetzee, personal communication, February 2015; A. Frederick, personal communication, February 2015). Staphylococcus bacteria may be associated with infection of the uterus, for example in the medical condition known as endometritis (inflammation of the endometrium). One form of this condition is known as bacteriotoxic endometritis, where it is caused by the toxins of bacteria rather than the presence of the pathogens themselves (*Dorland's illustrated medical dictionary,* 2003: 614). The prepared !Guxa tea also helps to relieve the symptoms of colds (S. Coetzee, personal communication, February 2015; A. Frederick, personal communication, February 2015). Colds are due to viruses, not bacteria. However, when one sneezes as a result of cold symptoms, lots of bacteria in the nose can quickly spread to one's surroundings and other people (Bischoff et al., 2006: 1119).

Albizia anthelmintica (A. Rich Brongn.) in Figure 1 (B) has many common names in different languages, including kersieblomboom, worm-cure albizia (Orwa et al., 2009: 1; Hoffmann, 2014), aruboom, oumahout, Wurmindenbaum, Kirschblütenbaum and omuama. According to local Nama people at Gochas, the outer part of the twigs is scraped off and the inner part is used as a chewing stick or toothbrush to clean the teeth and tongue (S. Coetzee, personal communication, February 2015; A Frederick, personal communication, February 2015). Bacteria and fungi may be associated with dental plaque and mouth infections. The bark, wood or root is boiled and milk added to treat an upset stomach or intestinal worms. Tea made from the roots and bark is drunk to treat malaria. The Samburu pastoralists in Kenya treat gonorrhoea by boiling the roots, bark and leaves, mixing it with sheep fat and giving it as an enema. Otherwise the boiled bark and roots are consumed with milk (Sullivan, 1998: 46; du Pisani, 1983; Fratkin, 1996: 75). The boiled bark, wood and roots can also be used to de-worm livestock (Fratkin, 1996: 81). The stem bark is widely used as a purgative (Orwa et al., 2009: 3).

Dicoma schinzii (O. Hoffm.) in Figure 1 (C) is also known as "Gu-!aru" in the Nama language (S. Coetzee, personal communication, February 2015; A. Frederick, personal communication, February 2015) or the 'Kalahari fever bush' (Dugmore & van Wyk, 2008). The roots and leaves are pulverized, boiled as tea and drunk or used to steam oneself in the treatment of measles, chickenpox, influenza, colds, and a blocked nose (Coetzee, 2015). These are viral infections, but bacteria such as staphylococci can be involved in congested nose or sinus infections. According to van Wyk & Gericke (2000) and Dugmore & van Wyk (2008) unspecified parts are used to treat febrile convulsions in babies in the Kalahari, hence the name 'Kalahari fever bush'.

There is an interesting folk tale ('Dicoma's shadow') behind the plant's traditional use in the Kalahari to treat febrile convulsions in babies. Van Wyk (2015) relates the story in short: It is said that if the shadow of the black shouldered kite (*Elanus caeruleus*) falls on a baby, the child will get sick, and the illness will be recognized by the spastic movements

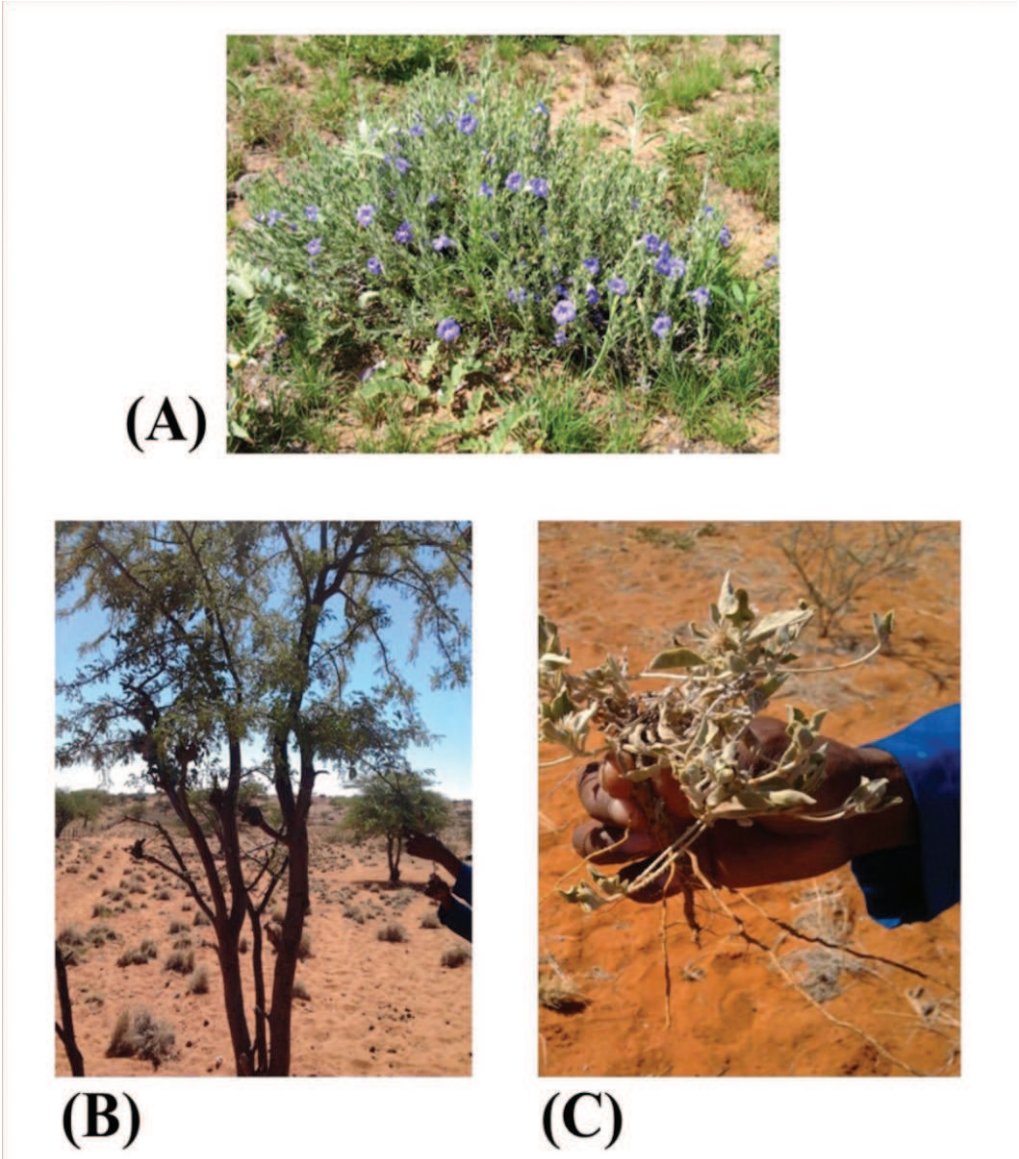


Figure 1 A. albomarginatum *(A). Image credit: southafricanplants.net;* A. anthelmintica *(B), and* D. schinzii *(C) growing in the veld at Gochas. Image credit: Sunette Walter.*

of the baby's arms, similar to the movements made by the bird's feathers when it is hovering above its prey. If the condition is not treated the infant can develop feathers on the arms. An extract of the plant can be given both topically and internally to counteract the symptoms and cure the child. In the traditional African context the symbol of the bird represents fever, since birds have a higher natural body temperature (40°C) compared to that of humans (37°C). 'The condition of the bird' refers to fever – one of the symptoms of febrile convulsions in infants.

To make sure of their effectiveness and to rule out placebo effects, this work aimed to evaluate scientifically the antimicrobial activity and medicinal value of the three Namibian ethno-medicinal plants. The objective was to test five crude methanolic extracts from the plants against seven bacterial strains and a fungus, to see if the extracts could inhibit microbial growth on agar plates. Prescott, Harley & Klein (2002) describe bacteria as single-celled organisms, made up of prokaryotic cells, whereas they describe fungi as achlorophyllous, heterotrophic, spore-bearing eucaryotes with absorptive nutrition, usually with a walled thallus.

Methodology

Cultures and plant extracts used

The following cultures were supplied by the University of Pretoria's Biochemistry Department: *Escherichia coli* ATCC 700928, *Staphylococcus aureus* ATCC 12600, *S. aureus* ATCC U3300, *Bacillus subtilis* ATCC 13933, *Streptococcus mutans* ATCC 25175, *Streptococcus sanguinis* ATCC 10556, *Pseudomonas aeruginosa*, and *Candida albicans*. Crude methanolic extracts (prepared at the University of Namibia) of !Guxa roots, Aru leaves and twigs, and Gu-!aru roots and leaves were used.

Preparation of crude extracts

To prepare crude methanolic extracts, 10g of plant material (in dried powder form) from the different plant parts was added to 100ml methanol. Flasks containing the extracts were parafilmed, placed in a cupboard and left to stand for three days (maceration), with occasional swirling. After three days, the extracts were gravitationally filtered through Whatman 110mm filter papers. The extracts were rotary evaporated in round bottom flasks at reduced pressure (91mbar) and temperature (45°C) to evaporate the methanol, and to dry and concentrate them. To avoid thermal decomposition of compounds in the plant material, the temperature set for the rotary evaporator (Heidolph, Germany) did not exceed 45°C. The flasks were labelled, sealed with parafilm, and kept at -86°C for a few hours. Thereafter, the frozen extracts were connected to a Christ Alpha 1-2 LD Plus freeze-dryer (Germany) for two to four days to further dry and concentrate them. Dried extracts were

scraped off with a spatula, weighed and stored in labelled 50ml centrifuge tubes, and kept at -86°C for further use.

Antimicrobial assays

Antimicrobial assays were performed according to the methodology described by Beukes (2015). Overnight cultures were grown in eight Eppendorf tubes each containing 1ml of brain heart infusion broth. Brain heart infusion agar was prepared, thinly poured into eight sterile 90mm petri dishes and allowed to set. Soft agar was prepared by using half the quantity of agar normally used, dispensed into eight sterile test tubes as 7ml quantities, and placed in an oven at 50°C to keep the agar molten. Plant extracts were dissolved as 20mg/ml concentrations in Eppendorf tubes containing 100% dimethyl-sulfoxide (DMSO). It was previously determined that 100% DMSO has no effect on the cultures. Tubes were vortexed to ensure that the extracts dissolved completely.

The soft agar was allowed to cool a bit, 100µl of the overnight cultures was pipetted into the soft agar, vortexed and poured as an overlay onto the brain heart infusion plates. The plates were placed in a laminar flow cabinet for half an hour to solidify. Thereafter, 10µl of each plant extract was pipetted onto the solidified agar-overlay plates (five extracts per plate). The plates were left in the laminar flow cabinet for half an hour to allow for the extracts to dry and diffuse into the agar. Finally, the plates were incubated at 37°C for 24 hours and zones of inhibition were measured to the nearest millimetre with a ruler. In cases where zones were unevenly shaped instead of circular, measurements were taken at the broadest and narrowest part and averaged.

On a second occasion, to determine the minimum inhibitory concentrations of extracts against each culture, this method was used at extract concentrations of 20, 10, 5, 2.5, 1.25 and 0.625mg/ml. Each extract was initially dissolved in 100% DMSO and subsequently diluted and vortexed in sterile triple distilled water before dripping 10µl of each concentration onto plates. The classification by Nematollahi et al. (2011) was used to interpret results: ≤ 7mm (negative), 8–10mm (weak activity), 11–14mm (moderate activity), 15–24mm (strong activity), and ≥ 25mm (very strong activity).

Results and Discussion

Antimicrobial assays

At first the five plant extracts were tested against the cultures at a single concentration of 20mg/ml. Only !Guxa roots displayed antimicrobial activity. This activity was highest in *S. sanguinis*, with an inhibition zone of 15mm (strong activity), followed by *S. aureus* ATCC 12600 (13.5mm; moderate activity), *S. mutans* (12mm; moderate activity), *S. aureus* U3300 (11.5mm; moderate activity), and *B. subtilis* (11.5mm; moderate activity).

Candida albicans, *E. coli*, and *P. aeruginosa* were resistant to !Guxa root extract, i.e., the extract was inactive or did not display antimicrobial activity against these microorganisms. Classification of activity was according to values given by Nematollahi et al. (2011).

The extracts were tested a second time at concentrations of 20, 10, 5, 2.5, 1.25, and 0.625mg/ml. Once again, only !Guxa roots displayed antimicrobial activity against the five above-mentioned strains, with no activity against the other three. With decreasing concentrations of extracts, antimicrobial activity decreased from strong (15.5mm inhibition diameter) to moderate (11mm–13mm) to weak (10.5mm) in *S. sanguinis*, moderate (11mm–12.5mm) to weak (9.5mm–10.5mm) in *S. aureus* ATCC 12600, moderate (11mm–14mm), weak (10mm) to no inhibition (0mm) in *S. mutans*, moderate (12mm) to weak (9.5mm–10.5mm) in *S. aureus* U3300, and moderate (11.5mm–14mm) to weak (10mm–10.5mm) in *B. subtilus*. *Streptococcus sanguinis*, *S. aureus* ATCC 12600, *S. aureus* U3300, and *B. subtilis* had MICs of 0.625mg/ml, while the MIC for *S. mutans* was 1.25mg/ml. Using the classification by Nematollahi et al. (2011) clinically important/usable effects of !Guxa root extracts would be at observed inhibition zones of 11mm–14mm (Moderate antimicrobial activity), 15mm–24mm (Strong activity) and ≥ 25mm (Very strong activity, not observed in this study).

Antimicrobial activity observed can to some extent be ascribed to the presence of secondary metabolites such as flavonoids, saponins and triterpenes (Walter, 2018). As mentioned in the Introduction, the concentration of pharmacologically active compounds depends on the season that the plants were harvested, how mature they were and the conditions in which growth took place (Silvério & Lopes, 2012: 110–11). These factors therefore might play a role in the biological inactivity observed with the other plant extracts.

Conclusion and Recommendations

Out of all plant extracts tested, only !Guxa root extract displayed antimicrobial activity against five out of eight strains. At a concentration of 20mg/ml this activity was highest in *S. sanguinis* (strong activity), with moderate activity against the other cultures. *Candida albicans*, *E. coli* and *P. aeruginosa* were resistant to !Guxa roots. These results give some scientific proof that !Guxa roots can be useful as traditional medicine as a natural antimicrobial agent in some instances, thereby generating new knowledge to be shared with fellow researchers. For antimicrobial activity, extract concentrations higher than 20mg/ml can be tested. Further assays should be done to determine the mode of action of the extract against the strains tested. In a doctoral study by the author (Walter, 2018) thin layer chromatography (TLC) for screening of phytochemical compounds indicated the presence of flavonoids, saponins and triterpenes in !Guxa roots. These compounds can be responsible for the roots' activity against the microorganisms. Larger, in-depth studies could look into these three compounds, as well as additional compounds. Cytotoxicity assays should also be conducted to ensure the safety of the plant and its extracts for human consumption.

As mentioned by van Wyk (2015: 10), prospective studies can look into the potential of !Guxa to be a commercial plant and a source of income for Namibians currently using it for medicinal purposes. This would however not be an easy or rapid process and its harvesting would involve permission and obtaining of permits from the relevant parties, such as the Ministry of Environment, Forestry and Tourism, as well as the farmers owning the land where these shrubs grow. With permission from the Ministry of Health, extensive clinical studies should be conducted to ensure the safety, efficacy, and potential adverse or side-effects/allergic reactions due to consumption of medicinal teas and medication or supplements manufactured from these plants or their active compounds.

Conflicts of Interests

The author declare that there is no conflict of interest.

Acknowledgements

I acknowledge and thank the University of Pretoria's Biochemistry Department, and the University of Namibia's Biomedical Research Laboratory, Biological Sciences Department where the work was carried out. Acknowledgement and thanks to the Southern African Biochemistry and Informatics for Natural Products (SABINA) and the Regional Initiative in Science and Education (RISE) for financial support. Lastly, my sincere gratitude and thanks to the people at Gochas for sharing their knowledge on traditional medicinal plants. This work forms part of an exchange visit to the Biochemistry Department, University of Pretoria, under supervision of Dr Mervyn Beukes, as part of a PhD study undertaken at the University of Namibia.

References

BEUKES, M. 2015. Personal communication. Pretoria, South Africa.

BISCHOFF, W.E., WALLIS, M.L., TUCKER, B.K., REBOUSSIN, B.A., PFALLER, M.A., HAYDEN, F.G. & SHERERTZ, R.J. 2006. "Gesundheit!" Sneezing, common colds, allergies, and *Staphylococcus aureus* dispersion, Journal of Infectious Diseases. 194 (8), 1119–1126.

COETZEE, S. 2015. Personal communication. Gochas, Namibia. *Unpublished field notes.*

Dorland's illustrated medical dictionary. 2003. 30th ed. Saunders, Philadelphia.

DU PISANI, A. 1983. Past and present plant utilization in Namaland and the lower Kuiseb River valley, South West Africa (Namibia): A preliminary report, Khoisis. 4.

DUGMORE, H. & VAN WYK, B-E. 2008. *Muthi and myths from the African bush.* Briza, Pretoria.

FRATKIN, E. 1996. Traditional medicine and concepts of healing among Samburu pastoralists of Kenya, *Journal of Ethnobiology.* 16 (1), 63–97.

FREDERICK, A. 2015. Personal communication. Gochas, Namibia. *Unpublished field notes.*

HOFFMANN, L. 2014. Meet the trees of Namibia: The worm-cure albizia (*Albizia anthelmintica*). *The Namibian* newspaper.

NEMATOLLAHI, A., AMINIMOGHADAMFAROUJ, N. & WIART, C. 2011. Antibacterial, antioxidant activity and phytochemical study of *Diospyros wallichi* – an interesting Malaysia's endemic species of *Ebenaceae, International Journal of PharmTech Research.* 3 (3), 1732–1736.

ORWA, C., MUTUA, A., KINDT, R., JAMNADASS, R. & ANTHONY, S. 2009. Agroforestree database: A tree reference and selection guide version 4.0.

PRESCOTT, L.M., HARLEY, J.P. & KLEIN, D.A. 2002. *Microbiology.* 5th ed. McGraw-Hill, New York.

SILVÉRIO, A. & LOPES, M. 2012. Antimicrobial activity of condiments, in Bobbarala, V. (ed.) *Antimicrobial agents.* Intech, Croatia: 109–128.

SULLIVAN, S. 1998. *People, plants and practice in drylands: Socio-political and ecological dimensions of resource-use by Damara farmers in north-west Namibia.* Unpublished doctoral thesis. University College, London.

VAN WYK, B-E. 2015. Die kulturele en praktiese waarde van inheemse kennis oor plantgebruike in die 21ste eeu, *Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie.* 34 (1).

VAN WYK, B-E. & GERICKE, N. 2000. *People's plants.* Briza, Pretoria.

VAN WYK, B-E. & WINK, M. 2015. *Phytomedicines, herbal drugs & plant poisons.* Briza, Pretoria.

WALTER, S. 2018. *Prevalence, antibiotic resistance trends, virulence and effect of some medicinal plants on Staphylococcus from school children in the Mariental District, Namibia.* Doctoral dissertation. University of Namibia, Windhoek.

JOURNAL 70
Namibia Scientific Society
Windhoek, Namibia 2023
ISSN: 1018-7677 ISBN: 978-99945-76-90-6

About the Author

Sunette Walter was born in Upington, South Africa. She holds a BSc degree majoring in Human Physiology and Microbiology (2006), BSc Honours in Water Sciences (2007), MSc in Environmental Sciences (2010), from the North-West University (NWU - PUKKE), Potchefstroom, South Africa, and PhD in Microbiology from the University of Namibia (UNAM). Her Honours study at NWU aimed to make use of cultivation-dependent methods for the isolation and characterization of bacteria from cooling tower biofilm- and planktonic phases. Other objectives included the investigation of the role of bacteria in fouling, corrosion and scaling, as well as determining population changes when operational conditions change. The main aim of her Master's study at NWU was to isolate, identify and characterize heterotrophic plate count (HPC) bacteria and other bacteria from biofilm and bulk water samples within the Potchefstroom drinking water distribution system. Objectives were to classify the tap water according to physico-chemical measurements and guideline values; to isolate and identify HPC bacteria from bulk water and biofilms of a reverse-osmosis (RO) filter system as well as an in-stream biofilm development device; to determine the diversity of isolates; to characterize bacteria in terms of (a) pathogenicity potential, (b) antibiotic resistance patterns and (c) their appearance in transmission electron micrographs; and to make use of scanning electron microscopy (SEM) to detect and study the structure of biofilms in RO filters and red-copper coupons. At the end of 2013, she received a prestigious fellowship from Southern African Biochemistry and Informatics for Natural Products (SABINA) in collaboration with Carnegie-SIG/RISE (Carnegie-Science Initiative Group/Regional Initiative in Science and Education) to pursue her doctoral studies at the University of Namibia, with a research visit to the Biochemistry Department, University of Pretoria in 2015. Her PhD research at UNAM aimed to investigate potentially pathogenic community-associated staphylococci in school children. Objectives for this study were to determine the prevalence of nasal *Staphylococcus aureus* and coagulase-negative staphylococci (CoNS) in school children from the Mariental District, to characterize the bacteria in terms of their antibiograms and drug-resistance patterns, to screen bacterial isolates for their ability to produce enterotoxins and produce biofilms as potential virulence factors, and to assess the antimicrobial and anti-biofilm activity of crude methanolic extracts of *Aptosimum albomarginatum* (Marloth and Engl.) roots, *Albizia anthelmintica* (A. Rich Brongn.) twigs and

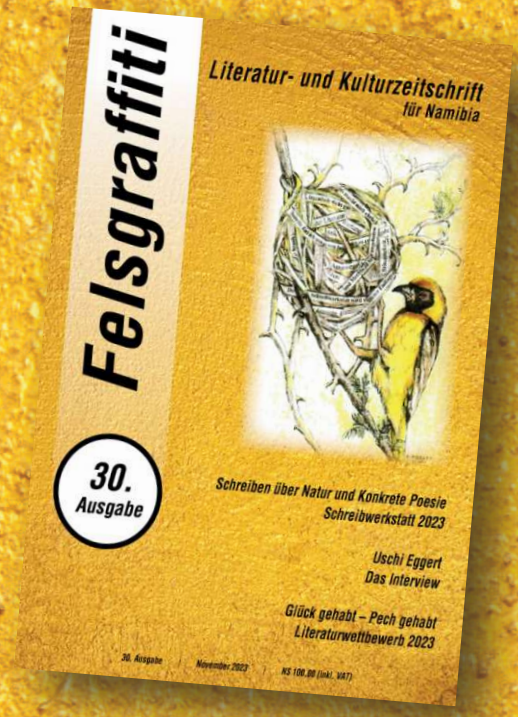
Dicoma schinzii (O. Hoffm.) against staphylococci (including multi-drug resistant strains) isolated from the learners. Her visit to the Biochemistry Department at the University of Pretoria entailed the screening of Namibian traditional medicinal plant extracts for anti-microbial- and anti-biofilm activity against bacteria and fungi. During her research at the Biomedical Research Laboratory at UNAM, she established the *Staphylococcus* section and co-supervised several undergraduate students on staphylococcal biofilms.

Author's address

PO Box 47, Mariental, 22001, Namibia; E-mail: sunette.walter8@gmail.com

Felsgraffiti

Literatur- und Kulturzeitschrift
für Namibia



30.
Ausgabe

Das Interview
Uschi Eggert

Wettbewerb 2023
Glück gehabt – Pech gehabt!

Postkarte an Goethe
Sylvia Schlettwein

Schreibwerkstatt 2023
Konkrete Poesie

Aus der Welt der Literatur
Annette von Droste-Hülshoff

Jetzt im Buchhandel erhältlich!

Rezension *Der Bart des Elefanten*

Michael Vaupel

> Dieses Buch ist genau das, was der Untertitel kommuniziert: Eine „biografische Erzählung über das Leben des Berufsjägers Volker Grellmann“. Als Leser haben wir hier stellenweise das Gefühl, mit Volker Grellmann gemütlich bei einem Kaffee oder Bier zusammenzusitzen und dem zu lauschen, was er Interessantes aus seinem Leben zu berichten hat. Leider geht das nicht mehr, da Volker Grellmann 2019 verstorben ist – er ruhe in Frieden.

Erfreulicherweise hat der Autor Wolfgang Brune genau das getan: Mit Volker Grellmann zusammengesessen und dessen Geschichten gelauscht. Da er dabei in Absprache ein Tonband mitlaufen ließ, konnte das Gesagte später verschriftlicht werden. Das ist der Grund dafür, dass diese Publikation gut lesbar ist und ein Gefühl der Nähe zum Porträtierten vermittelt. Manchen mag es allerdings stören, dass dadurch auch einiges an Umgangssprache und so mancher Kraftausdruck in dem Buch verwendet werden. Letztlich trägt dies aber zur Authentizität bei und vermittelt einen Eindruck vom Charakter Volker Grellmanns.

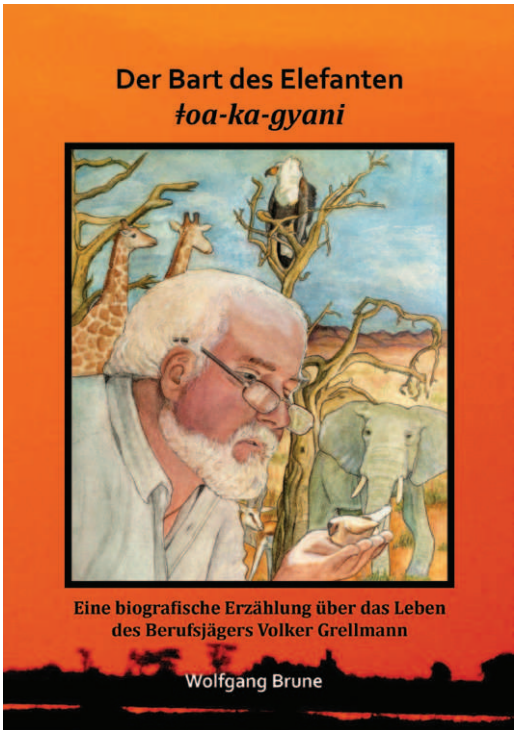
Als jemand, der Volker Grellmann nie persönlich getroffen hat, aber einiges über ihn hörte, fand ich diese biografische Erzählung höchst interessant. Denn sie verknüpft die Biografie Grellmanns gewissermaßen nebenbei mit der Landesgeschichte Namibias bzw. des früheren Südwestafrikas. Politik, Naturschutz, Jagd, Ethnologie – alle diese Themenkomplexe werden gestreift.

Und das Buch macht deutlich, dass einige Dinge, die uns heute in Namibia so vertraut sind, keineswegs schon seit Langem bestehen. Konkret: Die heute so populären Jagd- und Gästefarmen gab es zu Beginn der 1960er Jahre eben noch nicht. Grellmann schildert, wie es für gestandene Südwester Farmer unvorstellbar war, dass Jäger aus Europa um die halbe Welt fliegen, um dann für teures Geld einen Kudu zu schießen. Hier setzte Grellmann an: Mit seinem Unternehmen ANVO Hunting Safaris setzte er genau auf diese Zielgruppe der europäischen und nordamerikanischen Jäger. Er sammelte gleichgesinnte Farmer, denen das Wild auf ihren Farmen durchaus wichtig war und die für eine ethisch korrekte, nachhaltige Jagd zu gewinnen waren.

Hier spielte auch die Politik eine wichtige Rolle

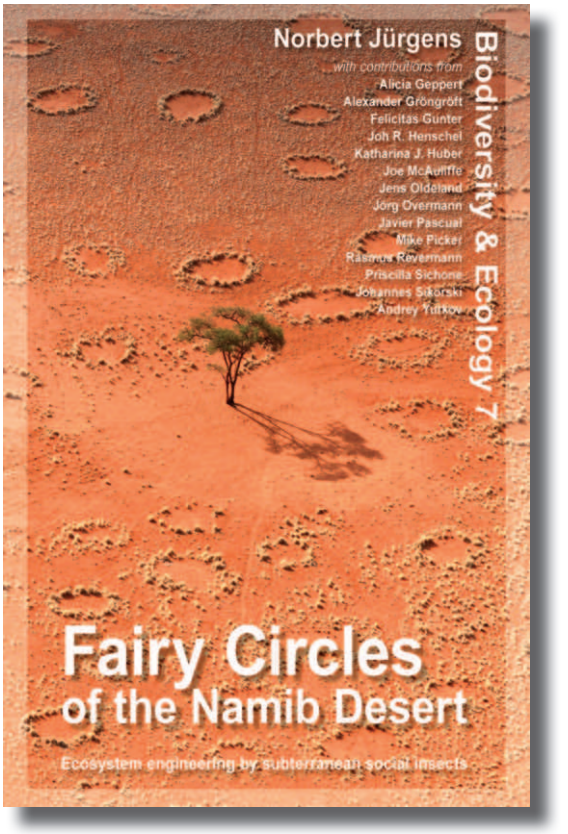
Denn in den 1960ern gehörte das Wild dem Staat.

Ein Farmer hatte deshalb kein wirtschaftliches Interesse an Wild auf seiner Farm – es konkurrierte schließlich mit den eigenen Rindern. So manch eine Farm soll beim Verkauf mit dem Attribut „wildfrei“ beworben worden sein, so Grellmann. Das wollte er ändern. Er setzte sich dafür ein, dass das Wild den Farmern zugeordnet wurde und diese einen Anteil erhielten, wenn Jagdtouristen es schossen. Gleichzeitig sollte nur so viel gejagt werden, dass die Bestände nicht gefährdet wurden.



Zum Wohle der Wildbestände und letztlich des ganzen Landes war die Tatsache, dass Volker Grellmann ein ausgesprochener „Macher“ war. Neben seinem eigenen Unternehmen war er in zahlreichen Verbänden aktiv – oft als Gründungsmitglied, wie z. B. bei der wichtigen *Namibian Professional Hunting Association* (NAPHA) im Jahr 1974. Was in der biografischen Erzählung klar wird, ist sein Bemühen um ein gutes Verhältnis zu der indigenen Bevölkerung in den Regionen seiner Jagdkonzessionen. Insbesondere sein Engagement für die San sticht dabei vorbildlich heraus. Erfreulicherweise aus Lesersicht schilderte Volker Grellmann in den Gesprächen mit dem Autoren Wolfgang Brune auch eigene Fehler und Probleme, die sich ihm stellten. Das führte zumindest beim Rezensenten zu tief empfundenem Respekt vor dem Lebenswerk Volker Grellmanns. Das gut lesbare Buch ist für an Jagd, Wildschutz und Landeskunde Interessierte ein Lektüre-Leckerbissen.

Abgerundet wird das rund 350-seitige Buch mit mehreren – teils farbigen – Abbildungen. Neben Fotos finden sich da auch Karten und z. B. ein sehr interessanter Chart zur Entwicklung der Wildbestände in Namibia/Südwestafrika. Das Buch ist 2023 beim Kuiseb Verlag der Namibia Wissenschaftlichen Gesellschaft erschienen.



Norbert Jürgens et al.

Fairy Circles
of the Namib Desert

Ecosystem engineering by subterrainean social insects

Co-authors: Alicia Geppert, Alexander Gröngröft, Felicitas Gunter, Joh R. Henschel, Katharina Huber, Joe McAuliffe, Jens Oldeland, Jörg Overmann, Javier Pascual, Mike Picker, Rasmus Revermann, Priscilla Sichone, Johannes Sikorski, Andrey Yurkov.

Biodiversity & Ecology 7
Edited by Ute Schmiedel and Manfred Finckh

Klaus Hess Publishers / Verlag
Windhoek / Göttingen

376 pages, 21 x 30 cm,
hardcover, 780 figures
Europe: ISBN 978-3-933117-96-0
Namibia/RSA: ISBN 978-99916-57-44-8

Distributed by Namibia Book Market
www.namibiabooks.com

On the eastern edge of the Namib Desert—probably the oldest continuous desert in the world—millions of ochre-coloured bare patches in the grass have created landscapes of unique beauty that are often regarded as one of the greatest mysteries in ecology: the fairy circles of the Namib Desert.

Building on more than four decades of ecological research in all parts of the Namib in Angola, Namibia, and South Africa, Norbert Jürgens and fourteen renowned authors present the natural history of the phenomenon, with all the facts understood so far, and also describe the remaining open questions.

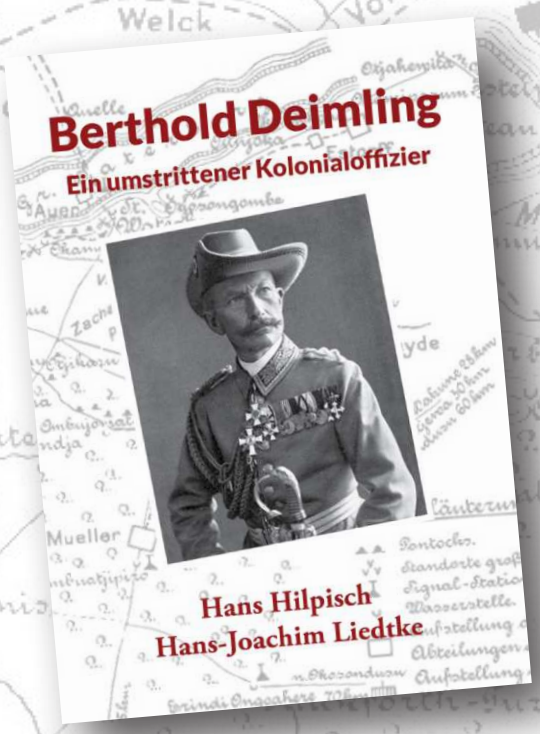
In the Namib Desert, sand termites from soil-dwelling termite families have been found to cause the fairy circles. These termites must be understood as ecosystem engineers that—comparable to the beavers in rivers of the northern hemisphere—profoundly alter the landscape and make permanent life in the desert possible.

This book offers a wealth of information based on numerous in-depth studies on the morphology, ecology and biology of fairy circles and the organisms which create, use and maintain them. Other regular vegetation patterns of the Namib Desert and neighbouring biomes are introduced and discussed, as well. Hundreds of stunning photographs invite the reader to enjoy a journey to the diversity of fairy circle landscapes in Namibia, Angola and South Africa.

www.k-hess-verlag.de

Berthold Deimling

Ein umstrittener Kolonialoffizier von Hans Hilpisch und Hans-Joachim Liedtke



Detailliert wird geschildert, wie Deimling von Ungehorsam bis zur glatten Befehlsverweigerung alles tat, um seine eigenen Vorstellungen von Kriegführung durchzusetzen.

Warum es trotz dieses Verhaltens für ihn letztlich Lorbeer anstelle von Gitterstäben gab, wird in dieser Arbeit akribisch untersucht.

Jetzt erhältlich bei der Namibia Wissenschaftlichen Gesellschaft

Kuiseb Verlag

Rezension *Meine Kriegserlebnisse …*

Michael Vaupel

Ein seit 1907 bestehendes Historiker-Rätsel ist nun gelöst. Ein deutscher Historiker fand heraus, wer wahrscheinlich die beiden anonymen Offiziere waren, auf welche das Werk *Meine Kriegserlebnisse in Deutsch-Südwestafrika* zurückgeht.

Unter lokalhistorisch Interessierten hat das Buch *Meine Kriegserlebnisse in Deutsch-Südwestafrika* eine gewisse Bekanntheit erlangt. Das Buch ist zuerst 1907 erschienen, laut Verlagsangaben in vier Auflagen mit beachtlichen 140.000 Exemplaren. Später folgte dann eine Neuauflage in Bernd Kroemers Glanz und Gloria-Verlag. Um was es geht:

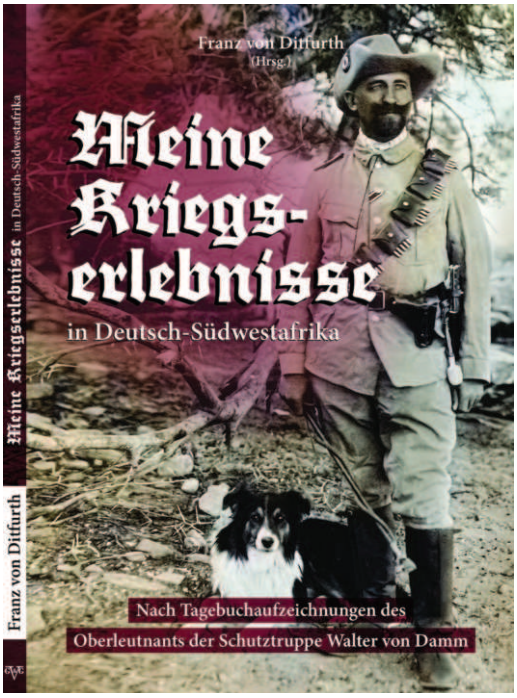
Das Buch basiert auf den Tagebuchaufzeichnungen eines anonymen Offiziers der Schutztruppe. Herausgeber ist ein ebenfalls anonymer Offizier *(Anonymus),* der wiederum die Tagebuchaufzeichnungen fleißig kommentiert. Gerade die Tatsache, dass sowohl der Tagebuchschreiber als auch der kommentierende Herausgeber unbekannt waren, umgab das Buch mit der Aura eines Geheimnisses. Ist es letztlich fiktiv, ist ein hochrangiger Militär der wahre Herausgeber, oder ein Politiker, der Konsequenzen scheute?

Akribische Recherche von Ulrich Kloos

Es sieht so aus, als ob dieses Rätsel nun gelöst ist. Denn nach der Neuauflage machte sich der Historiker Ulrich Kloos (M.A.) an die Recherche. An dieser Stelle sei seiner akribischen Vorgehensweise gedankt. Er durchforstete das Tagebuch beispielsweise nach Hinweisen wie diesem: An einem Tag fand ein Feldgottesdienst mit Pfarrer XY statt. Daraufhin schaute er, ob es Tagebuchaufzeichnungen dieses Pfarrers gab.

Die gab es – und da hielt er fest, bei welcher Kompanie er an diesem Tag war. Damit ließ sich die Suche eingrenzen. An einem Tag vermerkte der Tagebuchschreiber „Mein Geburtstag“ – so waren zumindest Tag und Monat des Geburtsdatums bekannt. Durch Hinweise wie diese gelangte Herr Kloos schließlich zum Schluss, dass der Verfasser des Tagebuchs der Oberleutnant der Schutztruppe Walter von Damm war. Als wahrscheinlichen Herausgeber recherchierte er den Bielefelder Landrat und Veteranen Franz von Ditfurth.

Wer *Anonymus* wirklich war



Der Verleger Bernd Kroemer nahm diese Erkenntnisse zum Anlass für eine komplette Neuauflage von *Meine Kriegserlebnisse in Deutsch-Südwestafrika.* Darin kommt auch der genannte Ulrich Kloos zu Wort und erläuterte seine Recherchen. Kernstück des Buches sind die lesenswerten Tagebuchaufzeichnungen des Oberleutnants Walter von Damm. Inhaltlich hat sich da natürlich nichts zu den vorigen Ausgaben geändert. Das gilt auch für die Kommentare des Herausgebers, der des Öfteren an die Herren Statler und Waldorf in der *Muppet Show* erinnert: Diese kommentieren von ihren gemütlichen Balkonplätzen aus und wissen natürlich alles besser. Das macht sie nicht unbedingt sympathisch.

Für die Neuauflage haben Bernd Kromer und sein Sohn Holger Kroemer passende Bilder zur Illustration ausgewählt. Das Inhaltsverzeichnis hätte nutzerorientierter aufgebaut sein können: Zu Beginn gibt es manchmal für jede Seite eine Überschrift – später dann entfallen auf das Kapital *Lüderitzbucht* direkt ca. 75 Seiten.

Fazit des Rezensenten

Wer bereits eine ältere Ausgabe von *Meine Kriegserlebnisse* ... besitzt, benötigt die Neuauflage nicht. Die Tagebuchaufzeichnungen inklusive Kommentar sind schließlich unverändert. Wer das Buch noch nicht besitzt und an der Kolonialgeschichte unseres Landes interessiert ist, für den kann dies ein historischer Leckerbissen sein.

JOURNAL 70
Namibia Scientific Society
Windhoek, Namibia 2023
ISSN: 1018-7677 ISBN: 978-99945-76-90-6

Guidelines for Authors

The Journal publishes scientific articles related to Namibia. All contributions must be based on original research and should constitute a definite advance in knowledge in the specific field of research. Authors bear sole responsibility for the entire content of their papers (accuracy of facts, data and language, as well as their deductions and opinions expressed). If applicable, authors must ensure the consent of third parties involved (i.e. in biographies etc.). It is the responsibility of the authors to make sure that there are no pending copyright issues regarding their articles. Referees will review the papers submitted. Based on their advice, the editor will accept or reject contributions. All refereeing is strictly confidential. Articles of 2,000 words or less may be considered for publication as a short note, in which case no separate introduction, methods, results and discussion are necessary. Short notes must, however, contain references and acknowledgements may be made if necessary. Non-reviewed articles of popular or anecdotal nature will also be considered and will be edited to conform to the style required.

Presentation

You can contribute articles in English, German or Afrikaans. Please submit the manuscript, including all drawings, graphs, and photographs. Articles in German have to conform to the "Neue deutsche Rechtschreibung". All articles must be in electronic format, preferably in a current version of MS Word, submitted on memory stick or via e-mail.

Layout

The layout must follow the following sequence:

1. Title page with title.
2. Full address of the author (P.O. Box and email).
3. Two abstracts may be submitted: one in language of paper and second abstract in language of choice.
4. Keywords: Maximum 8.
5. The Paper should consist of: Introduction, Materials and Methods, Results, Discussion, Acknowledgements and References.
6. Tables: Each on a separate page, not as part of the text.
7. Figures: Group together with captions, on a separate page, not as part of the text.
8. Graphs: Send original printout on good quality paper as well as on disk/memory stick.
9. Curriculum Vitae: Please include a short author's biography with a recent photo.

10. References: References in the text should be cited as in the following example: 'Mendelsohn and Roberts (1974) stated ...' or '... (Mendelsohn & Roberts 1997)', when giving a reference simply as authority for a statement. In the list of References, authors' names should be typed in capitals as indicated below:
    JANKOWITZ, W.J. 1983. *Die plantekologie van die Waterberg Platopark*.
    Ph.D. thesis, University of the Orange Free State, Bloemfontein.
11. Tables: Keep tables to a minimum. The same data should not be duplicated in tables and graphs. Each table must be on a separate sheet and be numbered consecutively in order of appearance, using arabic numerals. Bear in mind the limitations imposed by the size of the printed page (A5).
12. Illustrations: Photographs, figures, drawings and graphs should be submitted in a separate file (not embedded in the text file) either as JPG or as TIF with a resolution of not less than 300 dpi or as good sized paper originals (we will scan them and return them to the author).

Manuscripts must be submitted to:
The Editor:
Journal c/o Namibia Scientific Society
P O Box 67
Windhoek
Namibia
E-mail: ceo@namscience.com

Reprints

Every author is entitled to receive 5 reprints of his/her full-length paper. These are free of charge. Kindly inform the Namibia Scientific Society about such a request prior to printing.

WOLKE 9 | NAMIBIA
- OMARURU -

Ich hatte ein Grundstück in Afrika – am Fuße der Omaruru–Nase ...

Große Lebensgeschichten aus Afrika fangen so oder so ähnlich an.

Besitzen Sie ein kleines Stückchen Land in Namibia mit einem barrierefreien Haus in der Gemeinschaft mit interessanten Typen !

150 Hektar Freiheit mit 120 Grundstücken – erschlossen 14 €/m², Gemeinschafts–Wellnesscenter, Restaurant und Wasserturm–Webervogelnest–Aussichtsturm.

Wolke 9: Nicht mehr ganz Wolke 7, aber auch noch nicht ganz oben!

Mehr Informationen

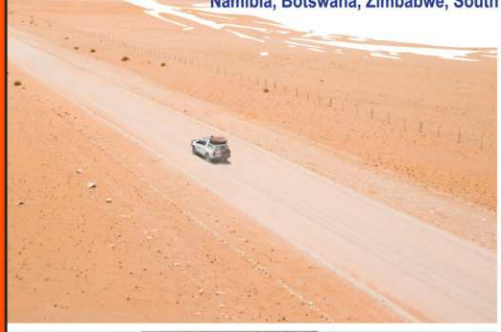
Carsten Möhle
Windhoek, Namibia

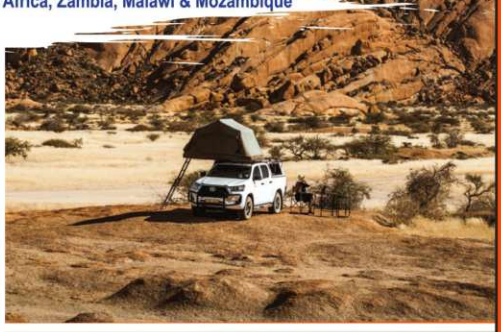
info@wolke9.com.na
www.wolke9.com.na

Asco Car Hire

WHERE YOUR ADVENTURE BEGINS

Rental of specialized 4x4 vehicles in
Namibia, Botswana, Zimbabwe, South Africa, Zambia, Malawi & Mozambique





Tel: +264 61 377200
www.ascocarhire.com
info@ascocarhire.com