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# Fairy Circles of the Namib Desert

Ecosystem engineering by subterranean social insects



# Methods

This book deals with life in a desert environment. The main motivation to compile this book is the curiosity to explore and (at least partly) understand the biology and ecology of the many organisms associated with the Namib Desert Fairy Circles and their habitats.

The main methodological approach is the careful observation and its documentation in the field. Especially the life histories of the organisms, but also their phenological changes during the seasons of a year and during the cycles of years with high moisture followed by long periods of drought were recorded at numerous localities which span the spatial extent and the environmental diversity of the entire Namib Desert.

Many properties of the organisms and ecosystems were captured by use of specific methods, which range from automated soil moisture records during more than a decade to the reconstruction of the phylogenetic tree of organisms with use of molecular gene sequences. Such specific methods are presented in the single chapters.

In the following pages we present the overarching approach which enabled us to collect and analyse data in time and space in a systematic framework which aims at fairy circle observation.

About a dozen observation sites were established in the frame of two large research projects, both funded by the Federal Ministry of Education and Research (BMBF) and both coordinated by Norbert Jürgens: BIOTA Southern Africa (Jürgens et al. 2010) and SASSCAL (Revermann et al. 2018). These projects included the establishment of numerous standardised biodiversity observatories with the size of one square kilometre in Angola, Zambia, Namibia and South Africa. The most recent information on the observation system has recently been published in Jürgens et al. (2018). All the Biodiversity Observatories can be accessed via the website: <http://www.sasscalobservationnet.org/> in combination with the data of automatic weather stations: <http://www.sasscal-weather.net.org/>. Some of these observation sites include a systematic monitoring of fairy circle and detailed records of the organisms observed and the processes taking place. Precursors of the standardized observation system date back to 1980, including the fairy circle clusters in the valley of Numees in the Richtersveld National Park.

At present ten monitoring sites generate different monitoring data. An overview of the records and equipment is given in Table M1. The location of the sites is presented in Figure M1.

**Table M1:**  
At ten monitoring sites different recording methods are applied and different technical equipment has been installed

Monitoring site	Individual fairy circle monitoring	Weather station	Soil moisture monitoring	Time lapse camera	Phenocam	Methane and carbon oxid
Baba	Y		Y			
Espinheira (Iona National Park)	Y	Y				
Halo Plains	Y		Y			
Marienfluss Featherlion Hill (weather station vandalized, not yet re-installed)	Y	(Y)	Y	(Y)	Y	Y
Giribes Leopard Rock	Y	Y	Y	Y	Y	Y
Dieprivier (Gondwana Namib Desert Lodge)	Y	Y	Y		Y	Y
Karios (Gondwana Canyon Park)	Y	Y	Y		Y	
Numees	Y	Y	Y		Y	
Springklipvlakte	Y		Y			
Yellow Dune	Y	Y	Y		Y	

### Individual fairy circle monitoring

Several dozen to several hundred fairy circles have been surveyed and permanently marked and are revisited and photographed every year. Important features like diameter are measured and all organisms and indicators of organismic activities are recorded. Several results of this type of monitoring are presented in Chapter 5.

### Soil moisture monitoring

At nine study sites soil moisture of the soil is recorded at three to five different depths, ranging from 10 to 100 cm. Time-Domain Reflectometer (TDR) (Decagon EC-5, em50 logger) sensors take hourly soil moisture measurements.

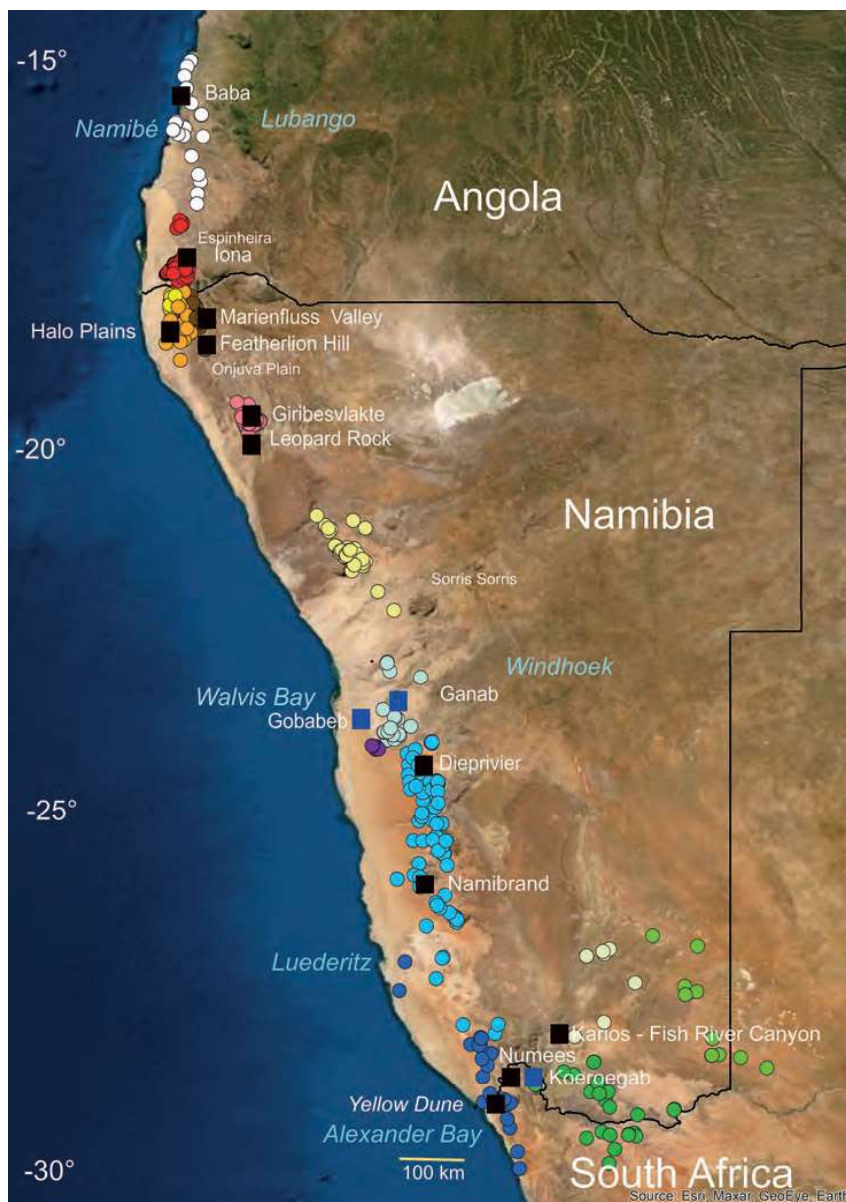
### Time lapse cameras

Cameras (Campbell Scientific CC5MPX Camera), installed at eight meters height at the mast of automatic weather stations recorded a picture each day at noon. At Giribesvlakte, 2236 days without gap have been recorded from 04.12.2015 until 26.01.2022 (access via QR code in Chapter 6.7). A shorter video shows a time series at Featherlion Hill: [http://www.sasscalobservationnet.org/obs\\_details\\_obs.php?obs\\_id=A04](http://www.sasscalobservationnet.org/obs_details_obs.php?obs_id=A04).

### Phenocams

For many fairy circles, camera traps (mostly Bushnell, Trophy Cam HD Aggressor 24MP) have been used as time lapse cameras which recorded the processes of germination, establishment and die-back of grasses following rains. These cameras are placed at only one to two meters distance to the soil surface. Therefore, they are able to record the first tip of germinating seedlings. Because of the ability to capture phenological states in detail, we use the term phenocam.

The time series of these cameras were often interrupted due to a diversity of reasons. The cameras were destroyed, stolen, the storage cards were filled due to frequent movement of tall grass plants. Furthermore, in many years of the last decade no meaningful processes could be captured because of the recent drought.



**Figure M1:**

Monitoring sites at fairy circle landscapes. Black squares: Biodiversity Observatories with fairy circles. Blue squares: Nearby monitoring sites with limited equipment. The coloured circles indicate fairy circle occurrences.