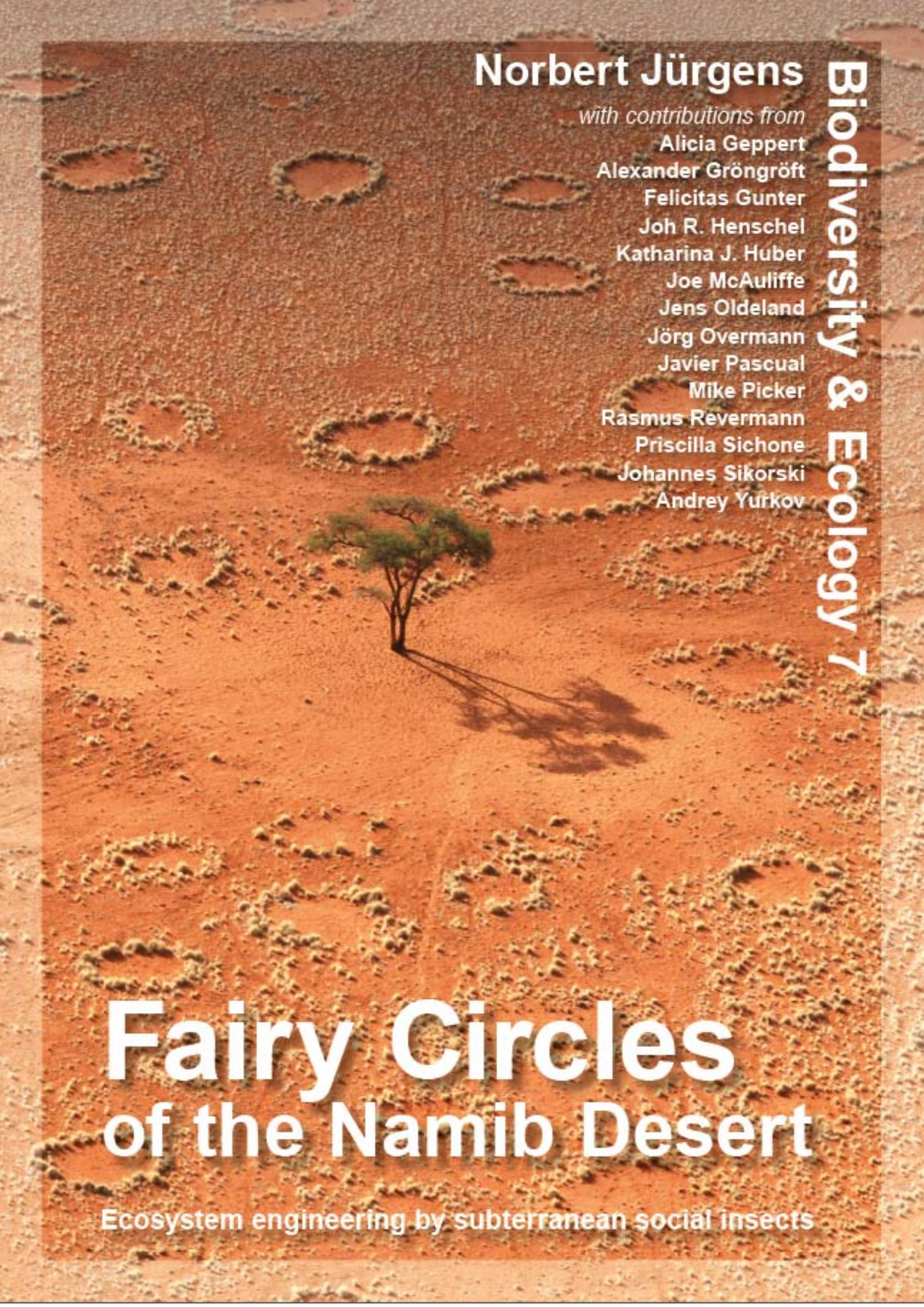

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Biodiversity & Ecology 7

Fairy Circles of the Namib Desert

Ecosystem engineering by subterranean social insects

7.3 Climatic diversity of fairy circle landscapes

Norbert Jürgens & Jens Oldeland

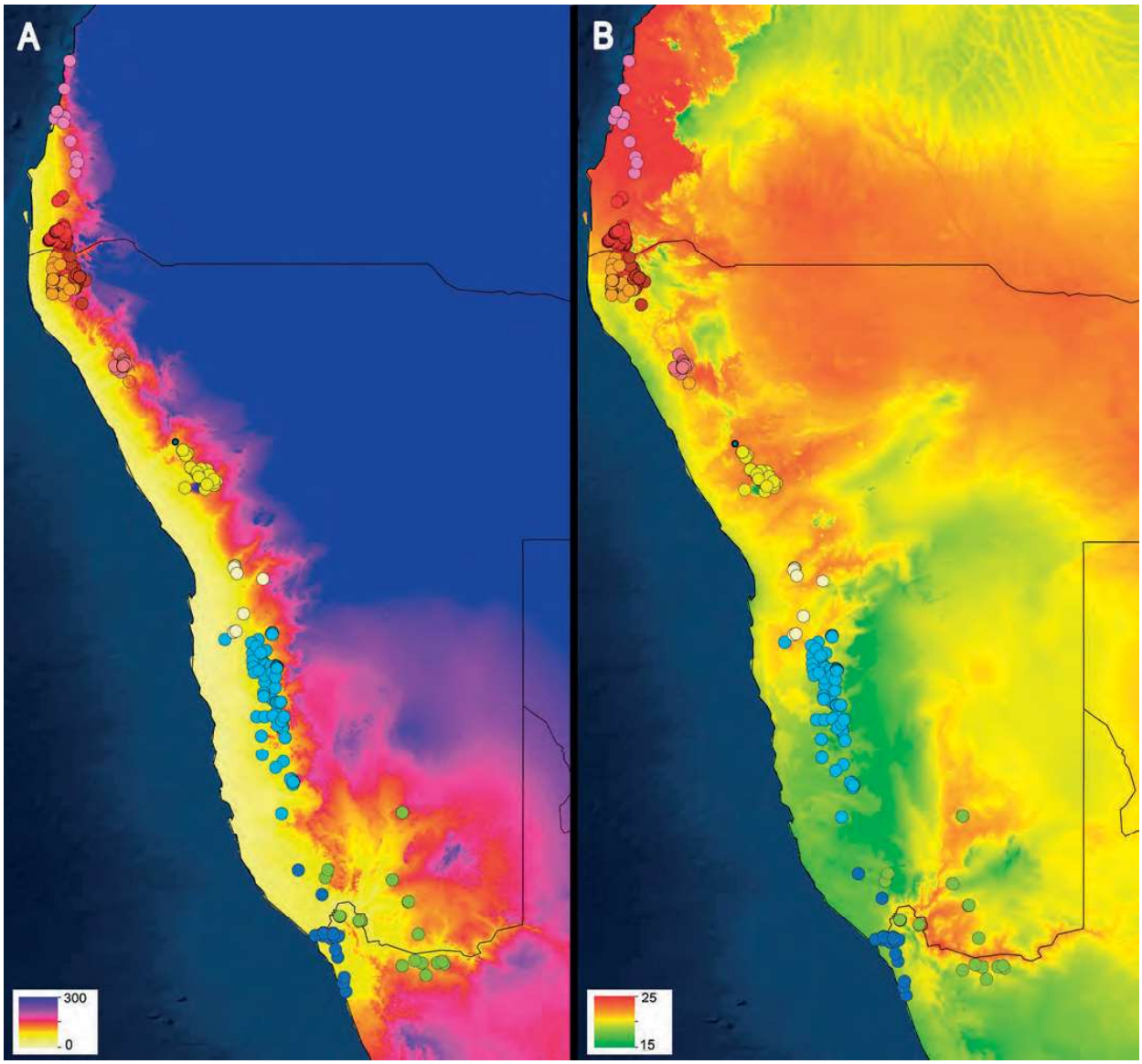

Figure 7.3.1 A and B:
A: The map on the left-hand side shows mean annual precipitation (MAP). The majority of fairy circles roughly follow the 100 mm annual precipitation (transition yellow to orange).
B: The map on the right-hand side shows mean annual temperature (MAT). Fairy circles occur from approximately 16°C (green) to more than 25°C (red).
The map was created using Imagery Basemap ArcMap 10.4. Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

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For an initial approximation of the relation between fairy circles and climate, it is worthwhile to project the fairy circle localities on maps that depict the main environmental variables in the background. In an arid region, the importance of the mean annual precipitation (MAP) is essential. Figure 7.3.1 A clearly shows that the fairy circle range mirrors the spatial pattern of a level of aridity close to a MAP of 100 mm.

Even the wide bulge to the east at the latitude of the Orange River catchment is matched by fairy circle clusters. The supply of rainwater thus appears to be an important control on the occurrence of fairy circles, with most fairy circles close to 100 mm annual precipitation (near the transition from yellow to orange on the map).

However, in the fog zone of the winter rainfall climate in the Richtersveld and Sperrgebiet, fairy circles are also found at MAPs far below 100 mm. This is a well-known combined effect of the higher air humidity, cooler temperatures and higher predictability of the winter rains.

In contrast, the mean annual temperature (MAT), shown in the background of Figure 7.3.1 B, increases strongly from the mild southern Namib in South Africa to the hot tropical climate in Angola, with no effect of these gradients on the pattern of fairy circle occurrence.

A representation of these two climatic variables in one diagram provides useful insights. In Figure 7.3.2, MAP is shown on the horizontal axis and MAT is shown on the vertical axis. On the one hand, it is clearly visible that the southern fairy circles, which occur in relatively cool temperate areas, are also found in dry areas with only 50 mm of annual precipitation. On the other hand, the fairy circles in the tropical warm zones in the north are found at 100 to 150 mm annual precipitation, and the Baba Fairy Circles even at up to 200 mm/year. This correlation could be because, in warmer zones, more water evaporates from the soil (evaporation) and transpires from the plants (transpiration) than in colder zones. It is probable that the balance of precipitation and evapotranspiration is crucial. Do fairy circles in warm northern zones only function if the higher water losses due to increased evapotranspiration are compensated by higher precipitation?

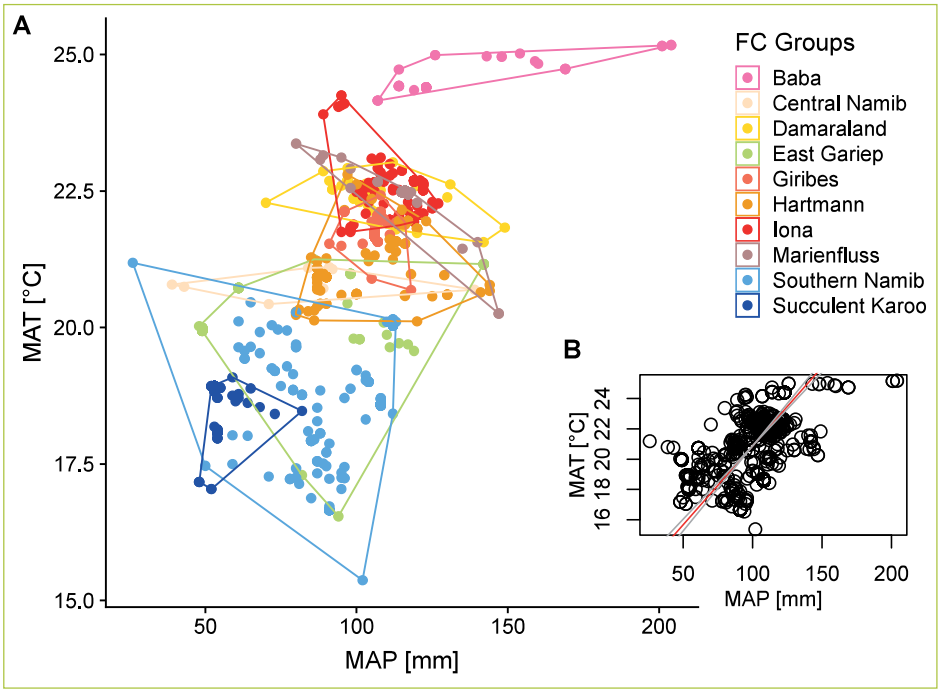

Figure 7.3.2:
The ecogram shows fairy circle occurrences of Namib in relation to the two climatic variables MAP and MAT. While fairy circles in the cooler Succulent Karoo are found at MAP 50 to 80 mm/y, sites in Northern Namibia range well above 100 mm/y, and Baba Fairy Circles in Angola are located in the range between 100 and 200 mm/y. In total, there is a clear linear relationship, which tells us that, with increasing temperature, increasing precipitation is required to allow for fairy circles.