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Profiling soil free-living nematodes in the Namib Desert, Namibia

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Abstract: Functional structure and diversity of soil free-living nematodes in a desert environment depend on plant gender and sampling site. The objective of this study was to compare the composition, abundance and tropic group of soil free-living nematodes in the upper 0–10 cm soil layer under the male and female *Acanthosicyos horridus* Welw. ex Hook. f. plants and in the inter-shrub open areas (control) in the Namib Desert, Namibia in April 2015. Soil moisture, organic matter (OM) and pH was also analyzed. Free-living nematodes were extracted from 100 g soil using the Baermann funnel procedure, and total number of nematodes was counted under a microscope. Community composition and diversity of soil free-living nematodes were analyzed using 18S rDNA sequences. Results indicated that a total of 67 groups, including 64 species, 2 genera and 1 family were identified. Feeding behavior of 58 species were identified as follows: 15 bacteria-feeding species, 12 fungi-feeding species, 10 plant-parasite species, 5 omnivorous-predator species, 8 animal-parasite species, 5 invertebrate-parasite species and 3 non-free-living nematodes, known as marine species. Moreover, soil free-living nematodes were found to be affected by sampling locations and plant gender, and community composition and density of these nematodes were strongly influenced by soil OM content. Result confirmed that spatial location and plant cover were main factors influencing the diversity of soil free-living nematodes. Moreover, molecular tools were found to be very useful in defining the richness of soil non-free-living nematodes. In conclusion, the results elucidated the importance of biotic variables in determining the composition and abundance of soil free-living nematodes in the Namib Desert, Namibia.

Keywords: plant gender; plant cover; nematodes; trophic group; diversity; 18S rDNA

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1 Introduction

The common feature unique to all deserts is water availability that influences substrate composition and structure (Whitford, 2002). In the desert ecosystem with a high temperature, soil moisture (SM) is unpredictable in time, space and amount. SM is critical for the biotic community, and enables it to fulfill its biological functions via adaptation to such arid environment (Crawford,

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1981; Evenari et al., 1982; Wardle, 2002; Whitford, 2002).

In the Namib Desert, one of the largest sandy deserts in the world (Laity, 2008), edaphic factors result in the aridity. Despite the relatively low amount of precipitation (<200 mm), soil substrate (deep layer of sandy soil) enhances water filtration and results in the lack of water availability in the upper soil layer. As a result, moisture level in the upper soil layer combined with the extreme fluctuation in temperature drive soil biota to develop an eco-physiological adaptation due to the unpredictability of food availability (Evenari et al., 1982; Steinberger et al., 1989; Whitford, 2002). Moreover, the Namib desert is also known as one of the six coastal fog deserts whose water balance is based on the inputs of fog and dew, in addition to the precipitation (Eckardt et al., 2013). These two additional sources of water play important roles in the above-ground biotic community (Seely et al., 2005) and are of great importance to the below-ground biotic community (soil microflora, microfauna and mesofauna) (Rodriguez-Zaragoza et al., 2005; Stomeo et al., 2012; Frossard et al., 2015). However, little is known about soil free-living nematodes and the mesofauna–plant cover interactions in this desert system.

Soil free-living nematodes are known to constitute the most abundant and diverse group of multicellular animals among soil biota (Lambshead, 2004). The phylum of soil free-living nematodes is estimated to contain over one million species inhabiting aquatic and terrestrial ecosystems. These nematodes play a wide range of ecosystem function and service through interactions with the other groups of organisms in soils or sediments. Moreover, their interactions with other biota are not limited to feeding on bacteria, fungi, plant cells and omnivores. They also feed on other nematodes, heterotrophic protists and arthropod hosts (Yeates et al., 1993; Yeates and King, 1997; Levi et al., 2012). The activity, density and diversity of soil free-living nematodes in natural environments were found to be strongly influenced by soil physical-chemical characteristics and food resources (Pen-Mouratov et al., 2004; Fitoussi et al., 2016). The abundance and diversity of bacteria-feeding and fungi-feeding nematodes in a desert are the basis of distribution of plant litter (Freckman and Mankau, 1977; Steinberger et al., 1988). Therefore, it is necessary to study the density and diversity of soil free-living nematodes of common plants in a desert system.

Acanthosicyos horridus Welw. ex Hook. f. is widely distributed in the Namib Desert (Berry, 2003). The male and female plants of *A. horridus* are equally distributed (Cloudsley-Thompson, 1996). Moreover, the female plants of *A. horridus* produces succulent melon fruits that might contribute the accumulation of organic matter in its microhabitat. The objective of this study was to examine the effects of male and female *A. horridus* plants in the Namib Desert on the composition, abundance and tropic group of soil free-living nematodes. We hypothesized that abiotic components, e.g., SM, organic matter (OM), soil pH and plant gender play important roles in the composition, abundance and trophic group of soil free-living nematodes.

2 Study area and methods

2.1 Study area

The Namib Desert is hyper-arid, which is known as a detritus-driven ecosystem in Namibia, Africa. The daily mean temperature ranges from 15°C to 55°C (Seely and Louw, 1980). The mean annual precipitation is 14.1 mm. In addition, the annual input of fog equals to 69.2 mm. The average number of precipitation is 59 d, ranging from 45 to 138 d (Gobabeb Research and Training Center (GRTC) First Order Meteorological Station, Namibia). We collected soil samples in the early morning in order to avoid the heating and drying of dew. The vegetation in the Namib Desert is covered with sparsely grasses, such as *Stipagrosti sabulicola* and *Stipagrostis gonastachys*, *Arthraerua leubnitziae*, *Zygophyllum stapfii* and *A. horridus* (Louw and Seely, 1982). The perennial *A. horridus* plants that are totally leafless, attain a height of about 1.5 m, and have deep roots that are able to reach underground water. The female plants produce spiny fruits in February and April, which are eaten by animals and collected by local residents as an important food source.