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Seasonal variability in fungal endophytes from Aizoaceae plants in the Succulent Karoo biodiversity hotspot, South Africa

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ABSTRACT

All ten species of Aizoaceae screened in this study were populated with endophytes. Fifty nine fungal species from 25 genera, including fourteen rare species, were identified. Seasonal specificity was observed; with 32 and 21 fungal endophytes isolated only during the flowering and dry seasons, respectively. The genus *Fusarium* was the most abundant in samples from the flowering season, whilst *Alternaria* and *Cladosporium* were equally abundant in the dry season. Rarely isolated genera included *Neophaeosphaeria, Periconia, Preussia, Schizothecium* and *Truncatella*. *Fusarium oxysporum*, *Paecilomyces victoriae* and *Talaromyces pinophilus* were the largest contributors to the differences in community structure observed for fungal endophytes from the different seasons. Endophytic fungal richness was very high in comparison to other global arid regions. This is the first record of all these fungal species isolated from Aizoaceae plants in their endemic environment in the most biodiverse arid region in the world, the Succulent Karoo in South Africa.

1. Introduction

Since the official establishment of Biodiversity Hotspots in 1989, the International Union for Conservation (IUCN) has recognised the Succulent Karoo in South Africa as the most biodiverse arid region in the world due to its incomparable alpha (local) diversity, astonishing beta diversity along habitat gradients and gamma diversity along geographical gradients (Myers et al., 2000; Desmet and Cowling, 2004; Sloan et al., 2014). In spite of its ecological and socioeconomic importance the natural habitat of the Succulent Karoo has been subjected to intense destruction and little has been done to protect its natural resources (SANParks , 2014). Within this ecoregion a family of leaf succulents, the Aizoaceae (Caryophyllales, Plantae) represent the most remarkable radiation in the entire plant kingdom, with a single ancestor diverging into numerous species (Klak et al., 2004). Commonly known as mesembs or “ice plants”, or by their Afrikaans vernacular name of “vygies” in South Africa, these endemic plants thrive despite nutrient poor soils, limited water availability and large diurnal temperature fluctuations (Smith et al., 1998).

Recent studies have highlighted the importance of the contribution of microbial life to plant thermotolerance, drought resistance and other important survival strategies by showing that diverse secondary metabolites are produced by the endophytic fungi harboured inside the plants rather than by the plants themselves (Moncrieff et al., 2015; Mishra et al., 2016). Fungal endophytes are phylogenetically diverse microscopic, eukaryotic organisms that colonise, either inter- or intracellularly, the healthy living, internal tissues of their host without causing any disease symptoms (Rodriguez et al., 2009; Massimo et al., 2015). Most studies exploring endophytes have been done in humid regions, with surprisingly few studies done in arid and semi-arid regions, where the focus has only been on cacti or grass species (Suryanarayanan et al., 2005; Loro et al., 2012; Bezerra et al., 2012, 2013).

Seasonality has been shown to influence fungal endophytic communities associated with olive trees in the Mediterranean (Martins et al., 2016) as well as black plum in India (Yadav et al., 2016) while in other regions such as the Atlantic rain forest seasonality has been shown to be of minor importance (Bonfim et al., 2016). In the Namaqua National Park, sited in the South African Succulent Karoo biodiversity hotspot, the dynamics of plant communities change dramatically after the rainfall period, from May to September, when more than 60% of the annual precipitation occurs (South African Weather Service, www.weathersa.co.za).

This study is founded on the hypothesis that the fungal endophyte diversity associated with mesembs in the Succulent Karoo will be high and influenced by seasonality. The objectives of this study were: 1) to

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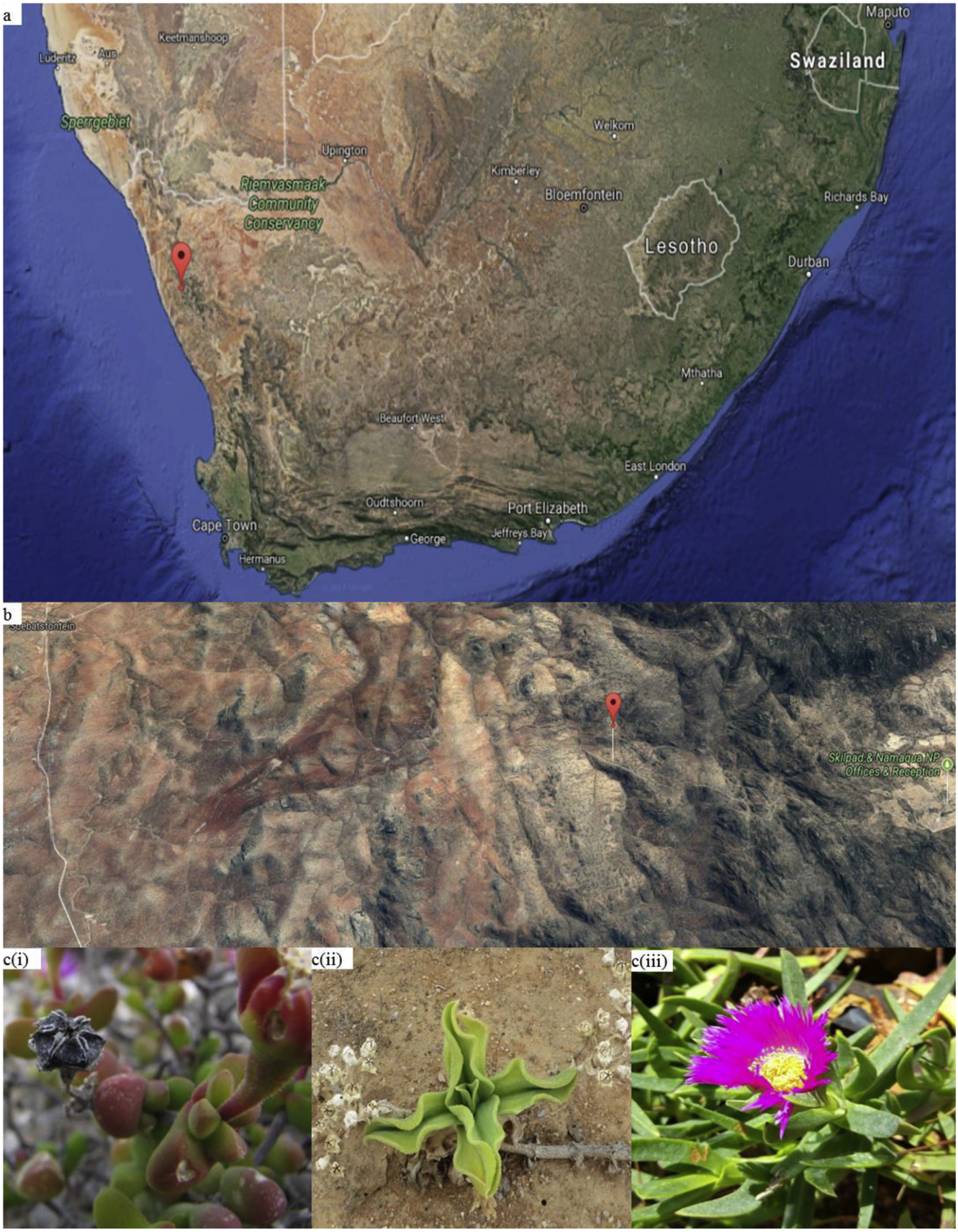

Fig. 1. a) Map of South Africa indicating the sampling site; b Map of the sampling site, close to Skilpad camp in the Namaqua National Park, in the Succulent Karoo biome in South Africa (Google maps, 2017); c) three species of mesemb plants, (i) *Drosanthemum diversifolium*, (ii) *Mesembryanthemum barklyi*, (iii) *Carpobrotus edulis*.