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Livestock paths on Namaqualand quartz fields: Will the endemic flora disappear?

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ABSTRACT

Quartz fields are rare features that contribute significantly to vegetation diversity and endemism of South Africa's Succulent Karoo Biome. The Riethuis-Wallekraal quartz fields in the north-western Namaqualand area of South Africa contain 17 quartz field specialist species of which seven are endemic to this specific area. Hoof-action by livestock has formed paths of approximately 0.30 m on these quartz fields. It would be important to conservationists to understand whether direct (e.g. trampling) and indirect effects (e.g. burial of flora by sediment movement) associated with the livestock paths holds any threat to the dwarf succulent (<0.05 m) and micro-chamaephytes (0.06–0.15 m) endemic to the quartz fields. We tested the hypotheses that the unique quartz field vegetation and biological soil crusts would be affected by loose soil particles transported downslope from the paths. The soil stability index, total vegetation cover, cover of specialized quartz field species and species diversity were lower on livestock paths but did not differ between upslope and downslope locations. Livestock paths also had lower cover and fewer quartz field specialist species. It is concluded that under conditions of intense and continuous grazing, livestock are likely to have an even stronger negative impact on the specialist quartz field flora.

1. Introduction

The Succulent Karoo is a biodiversity hotspot in the semi-arid winter rainfall region of southern Africa, which contains a high proportion of endemic plant species (Myers et al., 2000). Quartz fields are rare features of South Africa's Succulent Karoo Biome as they are represented in only five of the biome's 63 vegetation units and cover less than 8% of the biome's 111,000 km^2 surface area (Mucina et al., 2006). Despite their small area, quartz fields contribute significantly to plant diversity and endemism in the Succulent Karoo as 155 (10%) of its 1600 endemic species are restricted to quartz fields (Schmiedel, 2004). The dwarf vegetation of quartz fields contains growth forms and species very different from surrounding non-quartz field habitats (Schmiedel, 2002). Microclimate conditions also differ from the surroundings in that the surface covering of angular white stones gives rise to lower air temperatures at the soil surface (Schmiedel and Jürgens, 2004).

Geographic separation of quartz fields has resulted in high levels of plant compositional turnover resulting in six quartz field regions being recognized namely, Little Karoo, Knersvlakte, Riethuis-Wallekraal, Northern Richtersveld, Southern Richtersveld and Bushmanland-Warmbad (Schmiedel, 2004). The Riethuis-Wallekraal quartz fields occur on the lowlands of the Namaqualand region in north-western South Africa. This quartz field area contains 17 quartz field specialist species belonging to the Asteraceae and Crassulaceae as well as to the Mesembryanthema group within the Aizoaceae. Seven species are restricted to these quartz fields (Schmiedel, 2004).

Livestock farming is the dominant land use in the Succulent Karoo (Hoffman et al., 1999). It is likely that prolonged livestock hoof action would have impacted the biological soil crusts of the Riethuis-Wallekraal quartz fields and that this should be noticeable when indexing soil aggregate stability. A study by Kaltenecker et al. (1999) found significant biological soil crust recovery after livestock exclusion in Sagewood plant communities in the arid winter rainfall region of the United States of America. Concostrina-Zubiri et al. (2013) also suggest that heavy grazing by livestock may alter biological soil crust patterns in rangeland landscapes. Biological soil crusts, especially those types at the late succession stage, are indicators of healthy and stable soils as they contribute to soil organic matter, the binding of soil particles (Belnap et al., 2001a), as well as resistance to water and wind erosion (McKenna-Neuman et al., 1996; Eldridge and Leys, 2003).

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Biological soil crusts have been observed on the quartz fields of the study area (pers. obs.). It can be expected that changes in biological soil crust composition and functioning, as a result of livestock disturbance on the Riethuis-Wallekraal quartz fields, will be reflected in its vegetation composition. Biological soil crusts are beneficial for plants as they fix atmospheric nitrogen (Aranibar et al., 2003) making this limiting nutrient available to shallow-rooted plants such as quartz field specialists. The destruction of biological soil crusts may also facilitate the establishment of invasive plant species (Hernandez and Sandquist, 2011).

Beside possible damage to biological soil crusts, other likely consequences of trampling are physical damage to plants, soil compaction and accelerated soil erosion. Soil compaction alters soil structure and hydrology which can affect water absorption by plants (Kozlowski, 1999). Depending on the intensity and period of livestock stocking rates these factors can cause vegetation change, as has been observed along a piosphere in the Tanqua Karoo part of the Succulent Karoo biome (Beukes and Ellis, 2003). Haarmeyer et al. (2010) found that intense stocking of livestock reduced species richness and the abundance of endemic species on quartz field vegetation.

Livestock paths approximately 0.30 m wide are present on the Riethuis-Wallekraal quartz fields (Fig. 1). These paths are seemingly denuded of vegetation and appear to have more exposed soil than areas away from livestock paths. Smooth surfaces will offer less resistance to wind and water erosion, and loose soil particles are more likely to be displaced by such erosion forces. More than half of the Riethuis-Wallekraal endemic quartz field flora are dwarf succulents <0.05 m in height (Schmiedel, 2002) (refer to Appendix 1 that lists the flora endemic to the Riethuis-Wallkekraal quartz fields and their growth forms). Because of the undulating terrain on which the Riethuis-Wallekraal quartz fields are located, we sampled quartz field vegetation and soil aggregate stability upslope and downslope of the paths. Loose soil particles dislodged by livestock hoof action are expected to move downslope during rain and such soil deposition could be to the detriment to the unique quartz field vegetation. Burial of dwarf succulent plants is likely to have negative impacts on their growth and survival. Fig. 2 shows a typical example of a dwarf succulent species of the Riethuis-Wallkeraal quartz fields that is vulnerable to trampling and soil burial. Of concern to conservationists is whether plant species unique to quartz field vegetation will be able to persist in the face of livestock pressures.

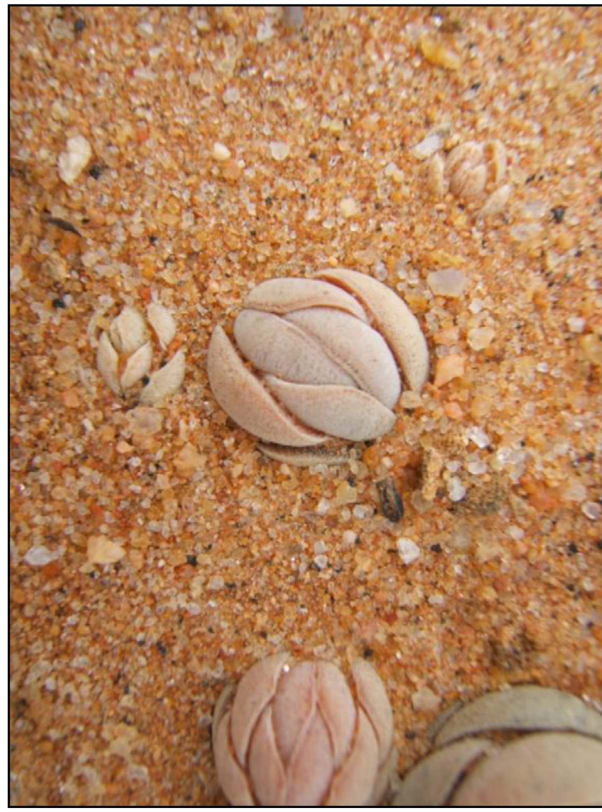

Fig. 2. *Crassula alstonii* a dwarf succulent vulnerable to livestock trampling and soil burial. Photo: Carlo Van Tonder.

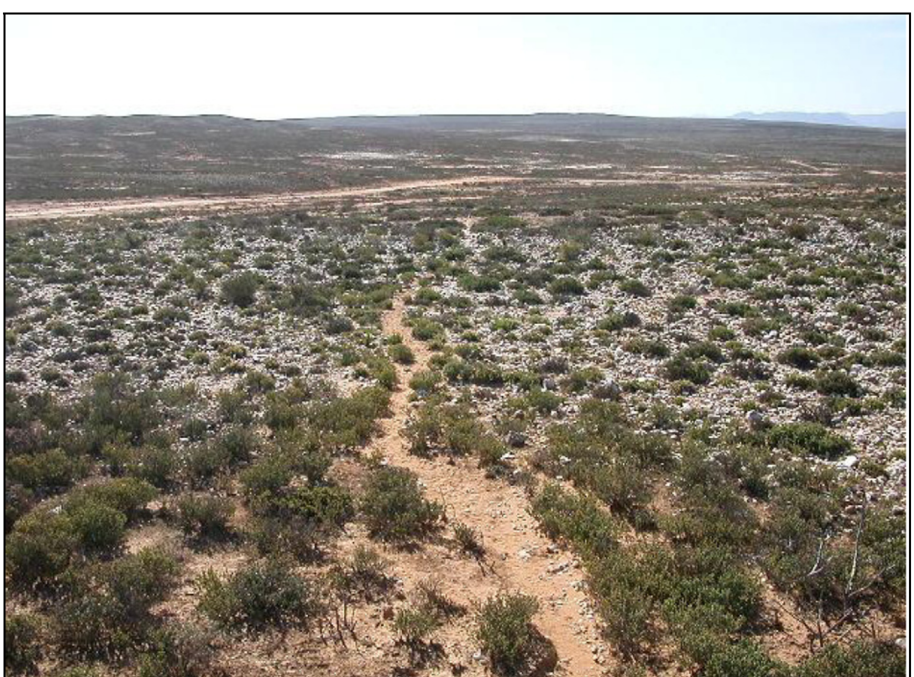

Fig. 1. A livestock path formed on a quartz patch in the Riethuis-Wallekraal region. Photo: Carlo Van Tonder.