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Vegetation ecology of phytogenic hillocks (nabkhas) in coastal habitats of Jal Az-Zor National Park, Kuwait: Role of patches and edaphic factors

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ABSTRACT

Phytogenic sandy hillocks (Arab. 'nabkha') are very frequently occurring aeolian deposits along the coastal plain of Kuwait. We investigated the vegetation of 42 nabkhas in a coastal habitat of Jal Az-Zor National Park, Kuwait. Sixty-two species were recorded (47 annuals and 15 perennials) in the studied nabkhas. Four vegetation types were recognized after classifying the vegetation of the nabkhas by TWINSPAN. They were named after their dominating host species which are *Nitraria retusa*, *Zygophyllum qatarense*, *Haloxylon salicornicum* and *Panicum turgidum*. Using Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA), we assessed the relationships between environmental gradients, floristic composition, species diversity, and geomorphology aspects of the studied habitats. Notable environmental variables affecting the distribution of the vegetation types in the study area were: geomorphological aspect, size of plants forming the core of the nabkha, moisture and nutrients contents, salinity, sand and silt components, and pH.

Introduction

Kuwait is located in the north-eastern corner of the Arabian Desert where it constitutes a part of the north-western coastal flat of the Arabian Gulf (Fig. 1). Due to its dry, hot and windy climate, the detrital nature of its bed rock and its location downwind of the high deflational area of the Mesopotamian flood plains, Kuwait witnesses remarkable amounts of aeolian-based landscape structures. Almost-all types of erosional and depositional aeolian landforms are present within the desert of Kuwait (Khalaf et al., 1995).

The vegetation cover in such habitats is often spatially discontinuous due to the formation of phytogenic mounds 'nabkhas' that create patches where microclimate and soil properties are different from inter-nabkha patches (Schlesinger et al., 1990). The 'Nabkha' is a mound-like accumulation of wind-driven sediments around vegetation. The patchy vegetation leads, in turn, to spatial heterogeneity of soil properties because the infiltration of rainfall to the soil profile is confined to the area beneath plant canopies, while barren interplant spaces generate overland flow and soil erosion by wind and water, and nutrient losses from landscape (Batanouny and Batanouny, 1968; Danin, 1996; El-Bana et al., 2002; Shachak and Lovett, 1998). The patchiness is caused by the growth of some plant species that act as key-stone species or 'ecosystem engineers', which can create, modify and maintain habitats by improving and conserving soil water availability, accumulating and conserving soil nutrients, and thus increasing the biodiversity (El-Bana et al., 2002; Lawton, 1994).

Nabkhas represent 'fertility islands' for many species, which in turn influence long-term vegetation dynamics and ecosystem processes, especially as they can survive for millennia (Danin, 1996). Moreover, nabkhas have a role in combating land degradation through stabilizing soil surfaces by preventing soil erosion and in facilitating plant recruitment and survivorship (Shachak and Lovett, 1998). Brown and Porembski (1997, 2000) considered the *Haloxylon salicornicum* shrub as a major 'ecosystem engineer' accumulating soil mounds around the shoots, so that favorable patches are created for growth of other plants in the degraded Kuwait desert. Therefore, such phytogenic mounds have generally been regarded as 'safe sites' for plants in sand-depleted and oil polluted areas, and constitute in general sites of relatively high plant productivity and diversity in arid and semi-arid lands (Brown and Porembski, 1997, 2000; El-Bana et al., 2002).

Kuwait has suffered severely from the effects of desertification in recent years, mainly due to soil erosion and overgrazing (Brown and Porembski, 1997; Khalaf, 1989). Previous studies have documented and described the presence of nabkhas associated with certain chamaephytes in Arabia (e.g. Batanouny and Batanouny, 1968, 1969; El-Sheikh et al., 2006; El-Sheikh and Abbadi, 2004;

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