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Floristic study of the Al-Shafa Highlands in Taif, Western Saudi Arabia

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ABSTRACT

The Al-Shafa Highlands, a formerly undersuerveyed region, lie on the edges of the Sarawat mountain series, 25 km southwest of Taif City, Saudi Arabia. In this study, the floristic composition, life forms, and chorological categories of species distribution were analysed within belts of different elevations in the Al-Shafa area. A total of 222 species in 167 genera representing 54 families of vascular plants were listed. Most species were therophytes (54%), followed by phanerophytes (15%). The highest percentage of species was Saharo-Sindian, with monoregional, biregional and multiregional species occurring. Three endemic species were also recorded: *Aloe armatissima, Centaurothamnus maximus,* and *Picris scabra*. The family Compositae contributed most species at high elevations. A hierarchical classification showed that high elevation belts were floristically more homogenous than low elevation belts. With increasing elevation, the proportions of therophytes and hemicryptophytes increased, while the Sudano-Zambesian and tropical elements decreased and Mediterranean elements increased with increasing elevation. Primarily, this study highlighted the importance of the flora of the Al-Shafa Highlands and likely improved the understanding of the distribution and ecology of plant taxa within the region. Moreover, this study provides baseline information to help the authorities plan proper strategies for the management and conservation of the Al-Shafa Highlands, which were recently identified as a region for internal tourism.

1. Introduction

The diversity of native flora is an important component of our terrestrial ecosystems that has a primary role in protecting the environmental stability of a region (Cunningham et al., 2015). A diverse flora also helps to stabilize slopes, to improve soils, to buffer weather extremes and to provide habitat for wild fauna (Pearse and Hipp, 2009). The Kingdom of Saudi Arabia is a huge area of arid land that covers more than two and a quarter million square kilometres. The country covers the major part of the Arabian Peninsula and is distinguished by several ecosystems varying in levels of plant species diversity (Abdel Khalik et al., 2013). Saudi Arabia is an ancient massif with a geologic structure that developed at the identical time as the Alps (Powers et al., 1966). The vast landscape is composed of different habitats that include valleys (Wadis), mountains, sandy and rocky deserts, meadows (Raudhahs) and saltpans (Sabkhahs). From a broader geographical perspective, Saudi Arabia can be divided into two distinct zones, the rainy highlands of the western and southwestern regions and the arid and more arid lands of the interior (Al-Nafie, 2008). The flora of Saudi Arabia is the most species rich on the Arabian Peninsula and contains very important genetic resources for crops and medicinal plants (Mossa et al., 1987). The components of this flora come from Asia, Africa, and the Mediterranean (Al-Nafie, 2008).

According to Körner (2000), mountains greatly influence patterns of global species richness. Because of the richness of habitats and the unique microclimatic conditions that are in contrast to those of their surroundings, mountains support many endemic species and shelter specialised plant and animal communities (Cano-Ortiz et al., 2016; Hedberg, 1986). The Asir Mountains of Saudi Arabia form a continued series of escarpments, which extend from Taif to the Yemen border, running parallel to the Red Sea for approximately 1800 km. The peaks reach elevations over 2000 m near Taif and over 3000 m in the Abha area. According to the report of Osman et al. (2014), northwestern and southwestern Saudi Arabia are densely vegetated and contain the highest number of species, with approximately 70% of the country's plant species reported from these areas.

The study was conducted in the Al-Shafa area on the edge of the Sarawat mountain series, south of Taif City, Saudi Arabia (Fig. 1), which is an important part of southwestern Saudi Arabia because the elevation range extends to 2300 m above sea level (a.s.l.; Al-Nafie, 2008). The area is ecologically unique and is on one of the

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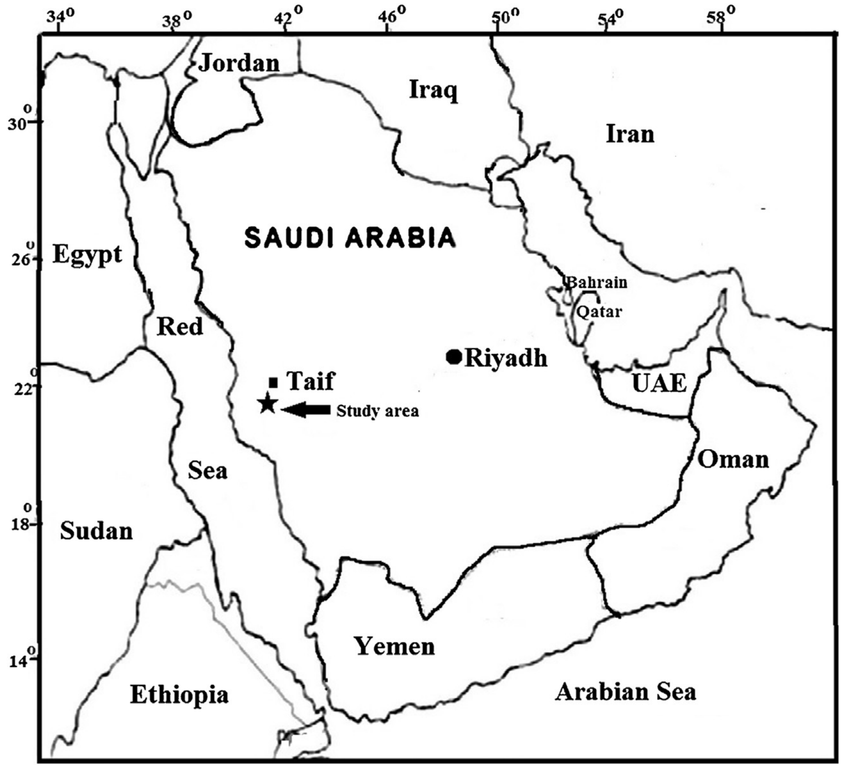

Fig. 1. Location map of the studied area.

primary migratory flyways between Eurasia and Africa (Ady, 1995). The Al-Shafa Highlands attract domestic tourism, particularly in the summer because of the outstanding views and temperate climate. The Al-Shafa Highlands have long experienced human activity being a significant source of wood for uses such as house construction and fuel for cooking and heating. Unfortunately, these lands have been misused, primarily through intensive cutting and overgrazing. The aims of the current study were to identify the wild plants growing in the Al-Shafa Highlands and to study the effects of the elevation gradient on the floristic composition and the main life forms of the plant species.

2. Materials and methods

2.1. Study area

The Al-Shafa Highlands (Fig. 1) lie in the Sarawat mountain chains, 25 km southwest of Taif City, Saudi Arabia (21°4.8′32″N, 40°18.9′28″E). The highland slopes and foothills are formed primarily of resistant, coarse pink granite, mixed with grey diorite and granodiorite (Ady, 1995). The rocks are largely exposed, steep-faced, with almost no soil cover and sparsely covered with vegetation that is primarily limited to crevices or small depressions in which fine sediments have accumulated in pockets. Large boulders, small stones and gravel are found in the steep runnels. The climate is arid with 181 mm as the 30-year average annual rainfall (Hasanean and Almazroui, 2015). The rainy season is between April and November, and the mean annual temperature is 22.8 °C, with the coldest mean temperatures (15 °C) in January and the warmest (29 °C) in July (Fig. 2).

2.2. Sample collection

To detect a relationship between plant species richness and altitude, the main elevation gradient (from 1700 to 2300 m a.s.l.) was divided into 7 bands of 100-m elevation each, and the numbers of species, genera and families were counted per band. Plant samples were collected from 34 stands (five stands for each belt of elevation, except at 1800 m a.s.l. with four stands), which represented the different habitats of the study area and were usually placed perpendicular to the slope. In each stand, we marked five 10 m × 20 m plots, each separated by 30 m. We decided to intentionally locate the plots in areas selected with similar vegetation because of the different habitats in some elevation belts. For each elevation band, five soil samples were collected from a profile of 0–25 cm in depth. These five soil samples were pooled to form one composite sample, which was air-dried and thoroughly mixed. Soil texture was determined by the hydrometer method, which provided quantitative data on the percentage of sand, silt, and clay. Soil pH and conductivity were determined in a saturated soil paste extract with pH and conductivity meters, respectively. Organic matter (Walkley-Black; Broadbent, 1965) and total nitrogen (Kjeldahl; Bremmer, 1965) were determined. The collected plant specimens were identified and named according to Collentette (1999), Migahid (1996), and Chaudhary (2001); they were deposited in the Herbarium of the Biology Department at Taif University. Life forms of the identified species were determined depending upon the location of the regenerative buds and the parts that were shed during the unfavourable season (Raunkiaer, 1934). The biogeographic affinities of the investigated species were determined at each elevation belt according to Wickens (1976) and Zohary (1973).

2.3. Statistical analyses

We assessed floristic similarities among elevation belts by performing a hierarchical classification analysis based on presence/absence data with Wards' (minimum variance) method and Euclidean distances as a dissimilarity measure (Ward, 1963). The analysis was performed with the Statistica statistical software package ver. 8 (StatSoft, Inc., Tulsa, OK, USA). JACCARD'S similarity