Vegetation analysis of Mahazat Al-Sayd Protected Area: The second Largest Fenced Nature Reserve in the World

Yassin M. Al-Sodany, Hosney A. Mosallam and Saleh A. Bazaid

Abstract: Mahazat Al-Sayd protected area in Saudi Arabia is of about 220,000 ha and is a gently undulating plain 180 km northeast of Taif on the Riyadh-Makkah road. It is a large protected area in central Saudi Arabia and the second largest fenced Nature Reserve in the world. The present study aims at determining the floristic composition and analyzing the vegetation of Mahazat Al-Sayd; provides a floristic list of the vascular plants, their uses, global and local phytogeographical distribution; identifies the plant communities and assesses the environmental factors that affect their distribution. This is very useful for planning with refer to protection, reclamation and management of valuable species. Ninety two species were recorded along the different sites of the protected area belong to 21 families and 70 genera. Poaceae has the highest contribution to the total flora, followed by Asteraceae, Fabaceae, Zygophyllaceae, Brassicaceae and Caryophyllaceae. Ninety four percent of the total recorded species by the present study have at least one aspect of the potential or actual economic uses: 80.4% of total recorded species are grazing, 42.4% are medicinal, 15.2% are edible by man, 21.7% used as fuel. The present study indicated that the grasses which are widespread and eaten by gazelle include Ochtochloa compressa, Panicum turgidum and Stipagrosta plumosa with Acacia tortilis trees dominating throughout, but some of plant species such as Lasiurus scindicus disappeared due to grazing. The Saharo-Arabian elements are the most represented chorotype, followed by the Sudanian, Mediterranean and Irano-Turanian elements. The life form spectrum indicated that therophytes were the most represented followed by chamaephytes. The application of TWINSPAN and DECORANA techniques led to the recognition of 4 vegetation groups (communities): I: Calligonum comosum community which comprises the two small mountains: Sha'af al-Shamali or White mountain and Sha'af al-Janubi or Black mountain, II: Acacia tortilis community which dominates the gravel habitat, III: Zygophyllum simplex community dominates the sandy flats habitat and IV: Pulicaria incisa community dominates the alluvial clays habitat. These results were discussed and compared with the other related studies.

Key words: Phytogeography • Plant communities • Life form • Economic uses • TWINSPAN • DECORANA

INTRODUCTION

The knowledge of the floristic composition of an area is a perquisite for any ecological and phytogeographical studies and conservation management activities. In studying any particular piece of vegetation from an ecological point of view, our first step must be to determine the facts as they exist on the ground: facts regarding the vegetation on the one hand; and others regarding the habitat on the other [1]. The floristic composition is the facts which more susceptible to direct study and exact characterization than any others [2]. Traditionally the designation of protected areas in Saudi Arabia especially Mahazat Al-Sayd was largely based on fauna and in particular large mammals and birds, which are more attracted for hunters. Plant biodiversity and phytogeography are other important factors, which should be considered in evaluation of conservational value of an area. Due to relative few numbers of local floristic and ecological studies in Arabian protected areas,
our knowledge about flora of Saudi Arabia and conservation management based on floristic structure and the status and list of threatened species is far from completeness.

The diversity of plant life is an essential underpinning of most of our terrestrial ecosystems. Humans and most other animals are almost totally dependent on plants, directly or indirectly. Another important role of plant life is the provision of ecosystem services, the protection of water sheds, stabilization of slopes, improvement of soils, moderation of climate and the provision of a habitat for much of our wild fauna [2]. While it is generally accepted today that the conservation of all biodiversity should be our goal, understanding the natural distribution of plants (floristic studies) is central to conserving biodiversity and managing ecosystems for long-term viability and sustainability. Saudi Arabia is a country with high diversity climate and topography, which leads to diversity in natural and biological resources. Therefore for management in order to conservation of this diversity, prevention from destruction of habitats, determining the native and resistance species and endangered species and supporting them, recognition of medicine plants for proper use of them, floristic studies is necessary.

The present study aims at determining the floristic composition and analyzing the vegetation of Mahazat Al-Sayd. It also provides a floristic list of the vascular plants, their uses, global and local phytogeographical distribution in this area. The ultimate aim of this study is to identify the plant communities and to assess the environmental factors that affect their distribution.

**Study Area:** Mahazat Al-Sayd protected area in Makkah province is of about 220,000 ha of area (2244 km²). It is a gently undulating plain 180 km northeast of Taif on the Riyadh-Makkah road. It lies between latitude of 21°57'56" and 22°21'48"N and between longitude of 41°32'56" and 42°15'17"E (Fig. 1). It is a large protected area in central Saudi Arabia and is one of the world’s largest fenced nature reserves, where it is ordered as the second largest fenced Nature Reserve in the world. The reserve is bounded to the north-west and south-west by public sealed roads outside the perimeter fence, the Taif-Riyadh highway and the Al-Khurmah roads, respectively. There is an approximately 6 km stretch of sealed road running from the main gate to the Mammal Camp inside it. An unsealed, graded perimeter track runs around the reserve inside the fence and an unsealed track runs from the Mammal Camp, through the Bird Camp,

![Fig. 1: Map showing the protected areas of Saudi Arabia including Mahazat Al-Sayd (modified after Saudi Wildlife Commission website).](image-url)
to the Al-Khurmah gate on the eastern boundary. There is a network of unsealed tracks throughout the reserve, including the overgrown remnants of large tracks that joined the towns of Al Muwayh and Al-Khurmah before the reserve was created.

The area is totally fenced and protection from livestock grazing has allowed a spectacular recovery of native vegetation. The entire 220 km perimeter is fenced with 2 m high chain-link fencing, topped with 3 strands of barbed wire, with 0.9 m of chicken mesh buried in the ground and lying behind a large earth embankment. Mahazat Al-Sayd lies on an open plain of sand and gravel on the eastern edge of the Najd Pediplain, in the Arabian Hinterland physiographic province. The area is gently undulating with elevations ranging from about 900 m above sea level in wadis and depressions, to 1100 m above sea level on the high ground to the northwest of the reserve. Two small mountains: Sha’af al-Shamali or White mountain and Sha’aaf al-Janubi or Black mountain, rise from the relatively flat eastern portion of the reserve. The substrate at Mahazat Al-Sayd may be sand, gravel, or alluvial clays and is usually loose, but not shifting, forming an even surface. Sandy soils, including gravel, cover 96.3% of the reserve's area. Basaltic relief comprises 3.65% of the surface area and is of pre-Cambrian origin, consisting of crystalline, highly metamorphosed rock. Quartz-like rock covers the remaining 0.05% of the area.

Climate of the area is tropical and arid. The monthly mean of climatic variables that reocrded in Taif meteorological station (1997-2009) indicated that the monthly average of minimum and maximum ambient temperatures ranged from 7.9±1.2 to 23.4±0.8°C and 22.9±1.1 to 36.3±0.8°C, respectively with a total monthly mean of 23.2±5.1°C. During the same period, mean monthly humidity ranged from approximately 19.6±4.2 to 60.0±6.0%. The data from last 10 years shows considerable inter-annual variation in the monthly amount (range 4.3±5.7-294.1±383.8 mm mo⁻¹) and timing of rainfall. The yearly amount of rainfall ranges from 83.3 mm yr⁻¹ in 2007 to 3312 mm yr⁻¹ in 2001. Mahazat Al-Sayd suffered from drought between 2006 and November 2008 when an average of 8 mm precipitation for this period was recorded and unusually high temperatures were recorded [3]. The mean maximum temperature between 2006 and 2008 was 36.33 ± 1.15°C, while average values for the period between 1991 and 2005 were 33.60 ± 3.03°C.

**MATERIALS AND METHODS**

Seventeen stands were selected to represent the prevailing communities along Mahazat Al-Sayd Protected Area. The stand size was about 100 x 100 m (approximates the minimal area of the plant communities). In each stand, the following data were recorded: 1-a list of the annual and perennial species, 2-first and second dominant species, 3-a visual estimate of the percentage of total cover and the cover of each species according to Braun-Blanquet scale [4] and 4-the physical changes occurred in each stand (e.g., grazing). The data were compiled into a raw table containing the recorded species (92 species) in the studied stands (17 stands). Nomenclature was according to Migahid [5], Chaudhory [6], Collenette [7] and Boulos [8-12]. The herbarium sheets of the recorded species are kept in the Herbarium of Biology Department, Faculty of Science, Taif University.

Table 1: Monthly variation in air temperature (°C), relative humidity (%), weed speed (km hr⁻¹) and rainfall (mm month⁻¹) as recorded at Taif meteorological station located in the study area. The data are long term averages (Climatological Normals for KSA, 1997 - 2007). The F-value for each variable are calculated (ANOVA). ***P<0.001

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td>Max.</td>
<td>Min.</td>
<td>Mean</td>
<td>RH (%)</td>
<td>WS (km hr⁻¹)</td>
</tr>
<tr>
<td>Jan.</td>
<td>22.9±1.1</td>
<td>7.9±1.2</td>
<td>15.4±1.0</td>
<td>58.7±5.6</td>
<td>5.5±0.5</td>
</tr>
<tr>
<td>Feb.</td>
<td>25.8±1.3</td>
<td>10.1±1.4</td>
<td>17.9±1.1</td>
<td>52.2±4.7</td>
<td>6.7±0.6</td>
</tr>
<tr>
<td>Mar.</td>
<td>27.5±0.9</td>
<td>12.0±1.2</td>
<td>19.8±0.7</td>
<td>46.5±7.1</td>
<td>7.2±0.9</td>
</tr>
<tr>
<td>Apr.</td>
<td>30.8±1.0</td>
<td>15.3±0.9</td>
<td>23.0±0.7</td>
<td>43.2±4.5</td>
<td>6.7±0.6</td>
</tr>
<tr>
<td>May</td>
<td>34.1±1.2</td>
<td>18.4±0.7</td>
<td>26.3±1.2</td>
<td>33.1±7.4</td>
<td>6.2±0.8</td>
</tr>
<tr>
<td>Jun.</td>
<td>36.3±0.8</td>
<td>22.2±0.9</td>
<td>29.4±0.6</td>
<td>19.6±4.2</td>
<td>8.3±0.6</td>
</tr>
<tr>
<td>Jul.</td>
<td>35.6±1.0</td>
<td>23.2±0.9</td>
<td>29.1±0.9</td>
<td>21.8±4.6</td>
<td>10.6±1.2</td>
</tr>
<tr>
<td>Aug.</td>
<td>36.3±0.5</td>
<td>23.4±0.8</td>
<td>29.5±0.4</td>
<td>27.5±4.4</td>
<td>9.7±0.9</td>
</tr>
<tr>
<td>Sep.</td>
<td>35.3±0.6</td>
<td>20.3±0.9</td>
<td>28.0±0.6</td>
<td>29.6±4.1</td>
<td>6.2±0.4</td>
</tr>
<tr>
<td>Oct.</td>
<td>31.2±0.7</td>
<td>15.3±0.6</td>
<td>23.5±0.6</td>
<td>39.7±7.9</td>
<td>5.0±0.4</td>
</tr>
<tr>
<td>Nov.</td>
<td>27.2±1.0</td>
<td>12.0±1.1</td>
<td>19.6±0.5</td>
<td>55.5±8.4</td>
<td>5.1±0.3</td>
</tr>
<tr>
<td>Dec.</td>
<td>24.4±1.4</td>
<td>9.3±1.0</td>
<td>16.7±1.1</td>
<td>60.0±6.0</td>
<td>5.1±0.7</td>
</tr>
<tr>
<td>Total mean</td>
<td>30.6±4.8</td>
<td>15.8±5.5</td>
<td>23.2±5.1</td>
<td>40.6±14.8</td>
<td>6.9±1.9</td>
</tr>
<tr>
<td>F-value</td>
<td>270.2***</td>
<td>348.3***</td>
<td>457.5***</td>
<td>63.8***</td>
<td>73.1***</td>
</tr>
</tbody>
</table>
Life forms of the species were identified following the Raunkiaer scheme [13]. The global geographical distribution of the recorded species in the study area was determined from Zohary [14-16], Feinbrun-Dothan [17-18] and Boulos [8-12]. This will help in assessing the rarity forms of these species. The global distribution is coded as follows: ME: Mediterranean, COSM: Cosmopolitan, SA: Saharo-Arabian, TR: Tropical, SU: Sudanian, ES: Euro-Siberian, IT: Irano-Turanian and PAN: Pantropical. The potential and actual economic uses of wild plants were assessed on three bases; field observations, information collected from local inhabitants and literature review [14-33]. Two-way indicator species analysis (TWINSPAN) and detrended correspondence analysis (DECORANA) were applied to the cover estimates of 92 species in 17 stands to recognize the plant communities in the study area [34-37].

RESULTS

Ninety one species were recorded along the different sites of Mahazat Al-Sayd Protected Area: 42 annuals (45.7%) and 49 perennials (54.3%). These species belong to 21 families and 70 genera (Table 2). Poaceae has the highest contribution to the total flora (20 species; 21.7%), followed by Asteraceae and Fabaceae (both of 14 species: 15.2%), Zygophyllaceae (6 species: 6.5%) and Brassicaceae and Caryophyllaceae (5 species: 5.4%). Twenty one species were recorded in more than 50% of the sampled stands: 8 annuals (Arnobia hispiddissima, Astragallus eremophilus, Astragalus vogelii, Eremobium aegyptiacum, Farsetia stylosa, Moretia parviflora, Octachloa compressa, Panicum turgidum, Salsola spinescens, Stipa capensis and Tribulus arabanicus).

Regarding the global floristic regions, the mono-regional have the highest contribution (39 species) followed by bi-regional (29 species) and pluri-regional (21 species including 6 cosmopolitans) (Fig. 2a). On the other hand, most of the species belong to the Saharo-Arabian (47 species) followed by Sudanian (30 species),
Table 2: Continued

<table>
<thead>
<tr>
<th>Species</th>
<th>Chorotype</th>
<th>Geographical Life form</th>
<th>Arabic name</th>
<th>Uses</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moretia parviflora Boiss.</td>
<td>SU, IT, ME</td>
<td>NL, NJ, S</td>
<td>Th</td>
<td>مورتياء الصغير esp</td>
<td>G</td>
<td>33.3</td>
<td>50.0</td>
<td>83.3</td>
</tr>
<tr>
<td>Salvia spinosae Moq. in DC</td>
<td>SA, SU</td>
<td>NL, NJ, N, NJ, E</td>
<td>Th</td>
<td>مياذة النارية</td>
<td>G, F, O</td>
<td>33.3</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total species</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24</td>
<td>44</td>
<td>68</td>
</tr>
</tbody>
</table>
Mediterranean (29 species) and Irano-Turanian elements (22 species) (Fig. 2b). The local phytogeographical distribution indicates that 59.8% of the recorded species belong to Najad region of Saudi Arabia, 53.3% to South Hijaz region, 47.8% to eastern region and 45.7% to North Hijaz region (Fig. 3). Only 9.8% belong to Al Rub’ Al-Khali region. Considering the life form spectra, therophytes have the highest contribution (46.7%), followed by chamaephytes (27.2%), geophytes-helophytes (15.2%) and hemicyryptophytes and phanerophytes (each of 5.4%) (Fig. 4).

Eighty-six species of the recorded species in this area (93.5% of the total species) have at least one aspect of the potential or actual economic uses (Table 2). Ten species have ≥ 4 (out of 5) economic aspects, these are: *Acacia tortilis*, *Acacia tortilis* ssp. *raddiana*, *Echium longifolium*, *Heliotropium arboinense*, *Indigofera spinosa*, *Launaea nudicaulis*, *Panicum turgidum*, *Pulicaria incisa*, *Pulicaria inuloides* and *Pulicaria undulata*. On the other hand, Seventy four species (80.4% of total recorded species) are grazing, 39 species (42.4% of total recorded species) are medicinal, 14 species (15.2% of total recorded species) are edible by man, 20 species (21.7% of total recorded species) used as fuel and 19 species (20.7% of total recorded species) used as other economic uses (Fig. 5). The economic uses of the recorded species could be arranged descendingly as follows grazing – medicinal – fuel – other uses – human food.

The application of the two-way indicator species analysis (TWINSPAN) to the data set of cover estimates of 92 species in 17 stands, resulted in agglomerating of 4 vegetation groups (Fig. 6A).
Fig. 6: A: Dendrogram of the 4 vegetation groups derived after the application of TWINSPAN classification technique.
B: Cluster centroids of the 4 vegetation groups along the axes 1 and 2 of DECORANA. The groups are named as follows: I: Calligonum comosum, II: Acacia tortilis, III: Zygophyllum simplex and IV: Pulicaria incisa.

Table 3: Characteristics of 4 vegetation groups derived after application of TWINSPAN of Mahazat Al-Sayd Protected Area

<table>
<thead>
<tr>
<th>Vg.</th>
<th>First dominant (%)</th>
<th>Second dominant (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Calligonum comosum</td>
<td>100 70</td>
</tr>
<tr>
<td></td>
<td>Panicum turgidum</td>
<td>100 25</td>
</tr>
<tr>
<td>II</td>
<td>Acacia tortilis</td>
<td>100 85</td>
</tr>
<tr>
<td></td>
<td>Salsola spinescens</td>
<td>100 55</td>
</tr>
<tr>
<td>III</td>
<td>Zygophyllum simplex</td>
<td>100 60</td>
</tr>
<tr>
<td></td>
<td>Arnebia hispidissima</td>
<td>100 60</td>
</tr>
<tr>
<td>IV</td>
<td>Pulicaria incisa</td>
<td>100 85</td>
</tr>
<tr>
<td></td>
<td>Zygophyllum simplex</td>
<td>100 60</td>
</tr>
</tbody>
</table>

The application of the detrended correspondence analysis (DECORANA) indicates reasonable segregation between these vegetation groups (Fig. 6B). They are named according to their dominant species as follows (Table 3): I: Calligonum comosum, II: Acacia tortilis, III: Zygophyllum simplex and IV: Pulicaria incisa.

Calligonum comosum community. It comprises the two small mountains: Sha'af al-Shamali or White mountain and Sha'af al-Janubi or Black mountain, rise from the relatively flat eastern portion of the reserve. The most dominant species are: Belpharis ciliaris, Calligonum comosum, Cyperus laevigatus, Ermobium aegyptiacum, Stipa capensis and Tribulus arabicus.

Acacia tortilis community. It comprises the gravelly habitat. The most dominant species are: Acacia tortilis, Arnebia hispidissima, Salsola spinescens, Stipa capensis and Zygophyllum simplex.

Zygophyllum simplex community. It comprises the most dominated habitat in the reserve (sandy flats habitat). The most dominant species are: Acacia tortilis, Arnebia hispidissima, Astragalus eremophilus, Astragalus vogelii, Atractylis carduus, Cleome amblyocarpa, Fagonia indica, Farsetia stylosa, Heliotropium arborescens, Indigofera spinosa, Ochthochloa compressa, Panicum turgidum, Salsola spinescens, Setosea lanata and Zygophyllum simplex.
Astragalus water stayed for relatively long time. The most dominant Fabaceae. On the other hand, similar trend to the whole clays habitat which is a depression area where the rain families; the most important families being Poaceae and grasses, including Panicum turgidum, Pennisetum setaceum, Pulicaria incisa and Zygophyllum simplex.

DISCUSSION

One of the main characteristics of the vegetation cover of Saudi Arabia is its low floristic diversity. The number of plant species that recorded in the country is 2172 species, many of which are in the wetter areas of its south-western part. These species belong to 840 genera and 149 families [38]. The number of species might be increased to 2250 by adding subspecies, extinct and species that have not been identified yet [7]. Numbers of families, genera and species are very low compared to Saudi Arabia’s vast land area, which is probably, the result of the harsh environmental conditions that prevail in the Saharo-Arabian region which covers vast area of the country [39]. The recorded species in the present study (92 species) represent about 4.2% of the whole flora of Saudi Arabia; their genera represent 8.3%; and their families represent 15%. The greatest plant diversity, approximately 74% of the total plant species of Saudi Arabia, is found in the mountainous western area which includes the study area due mainly to a greater rainfall [39]. Moreover, the reserve has recovered rapidly, with extensive though still patchy vegetation cover, which includes dwarf shrubland with emergent small trees of Acacia tortilis and other Acacia spp. Robust perennial grasses, including Panicum turgidum and Ochthochloa compressa are abundant on deeper sand and on low lying ground while Stipagrostis spp. are more abundant in rocky areas. In the spring there are also bulbs Diplcadi. Many perennial shrubs and forbs grow among the perennial grasses. Salsola spinescens dominates on alkaline soils. These results agree with the study of Gillet [40].

It is evident that the present study showed Ninety one species were recorded along the different sites of Mahazat Al-Sayd Protected Area: 42 annuals and 49 perennials. These species belong to 21 families and 70 genera; the graminoides (family Poaceae) have the highest contribution, followed by the composites (family Asteraceae) and legumes (family Fabaceae). Comparing these results with the previous studies in the same area, Gillet [40] recorded 111 species belong 91 genera and 38 families; the most important families being Poaceae and Fabaceae. On the other hand, similar trend to the whole flora of Saudi Arabia where the highest families in the whole flora are Poaceae (262 species= 12.1%), Asteraceae (233 species= 10.7%) and Fabaceae (210 species= 9.7%) which represented by 705 species or 32.5% of the total plant species in the Kingdom. Also, similar trend to the flora of other similar region in the kingdom such as Mosallam [41] on his comparative study on the vegetation of protected and non-protected areas, Sudera, Taif, Saudi Arabia, Abdel Fattah and Ali [42] on the study of the vegetation-environment relations in Taif, Saudi Arabia, Al-Turki and Al-Olayan [43] on the study of flora of Hail region, Al-Zahrani [44] on his study on the vegetation and ecosystem of Bani Saad mountains, south of Taif city and Al-Turki [45] on his study of the flora of Jabal Fayfa in the south western Saudi Arabia. As in most tropical and subtropical deserts, most plant species of Saudi Arabia belong to a limited number of plant families, for example, 1586 species belong to 23 families or 15.4% of the total families. These plant species represent 73% of the total species in the Kingdom [39].

The present study indicated that the grasses which are widespread and eaten by gazelle include Ochthochloa compressa, Panicum turgidum and Stipagrosta plumosa with Acacia tortilis trees dominating the tree layer throughout. This agree with the study of Gillet [40], but he record Lasiurus scindicus that not recorded by the present study. Arabian sand gazelle (Gazella subgutturosara marica) are predominantly grazers [46-47], but also browse dwarf shrubs and trees [48-49]. This led to the disappearance of the fodder species like Lasiurus scindicus. On the other hand, according to Barkham and Rainy [50], Acacia spp. have a dense mat of roots close to the soil surface, which rapidly utilizes any precipitation and hence rapidly "greens up" in response to even small amounts of rain. In seasons of low rainfall following those of relatively high rainfall, Acacia is able to draw on residual subsoil moisture efficiently than the grasses and produce abundant leaves, whereas grass growth may be poor [51]. On the other hand, the leaves and soft branches of these plants are eaten (browsed) mainly by Gazella. These plants provide high quality animal feed, fuel wood, charcoal, gums and other products as well as contributing to soil stabilization and improvement through nitrogen fixation. These results in contrary with Mosallam and Hassan [52] that found Acacia is eaten by other animals and Houbara at Mahazat as-sayed reserve. In this respect, Carlisle and Ghobrial [53] found that pods and leaves of...
A. tortilis were sufficiently nutritious to satisfy all the water and food requirements for the Dorcas Gazelle in the Sudan throughout the dry season and for the Dama gazelle in northern Niger [54]. Mwalyosi [55] stated that A. tortilis provides browse for many mammals. Similar suggestions were made by Mosallam [41].

From the phytogeographical viewpoint, the present study indicated that the Saharo-Arabian elements (47 species) are the most represented chorotype, followed by the Sudanian (30 species), Mediterranean (29 species) and Irano-Turanean (22 species) elements, while the other elements had a minor representation. Comparing with the other related studies, Al-Nafie [39] reported 180 species in the flora of Saudi Arabia are belongs to Saharo-Arabian Region and 88 ones to Sudanian Region. Unfortunately, the boundaries of these two regions in Saudi Arabia are still debatable, ill-defined and very difficult to delimit. The delimitation of the frontier between the two regions in the Arabian Peninsula in its southern part has always created some difficulties for a few biogeographers as well as phytogeographers who have studied the region. These difficulties arise from the fact that the southern parts of the Saharo-Arabian region are occupied by very dry, hot and vegetationless deserts such as Al Rub’ Al-Khali, as well as the much more vegetated sand dunes of the Al-Dahna and the Great Nafud. Zohary [15] suggested that these deserts could support Sudanian species as a result of their hot climate, but are too dry to support such vegetation. In addition, many of the Saharo-Arabian elements are derived and developed from the neighboring regions, mainly the Sudanian region in the south and the Mediterranean and Irano-Turanian regions in the north and north-west. They are developed gradually but discontinuously under the increase of aridity since the Middle Miocene, which is believed to be a transitional period climatically between the humid early Tertiary and the arid Late Tertiary and Quaternary environments [56]. The most dominant Saharo-Arabian and Sudanian elements in the flora of Saudi Arabia include: Arnebia hispidissima, Astragallus vogelli, Blepharis ciliaris, Euphorbia granulata, Glossonema boveanum, Heliotropium arbairensis, Lotonis platycarpa, Monsonia nivea, Panicum turgidum, Polycarpea repens, Pulicaria incise and Salsola spinescens.

On the other hand, the present study recorded 21 species are Pluriregional, six of them are cosmopolitan species. According to Al-Nafie [39], PluriregIONAL species that grow in many regions and widely spread all over the world such as: Himalayan Mountain, Deccan plateau, Canary Islands, Namib desert and South Africa are represented in the Saudi Arabian flora. The presence of these plant species from different regions is an indication on the relationship between the Arabian Peninsula and these regions. Some of these species might reached the Arabian Peninsula as a result of the climate changes which the world witnessed a long time ago, or as a result of the distribution by human and animals specially birds which carry seeds for a long distances. Examples found in the present study include: Aizoön canariense, Chenopodium murale, Cleome amblyocarpa, Cynodon dactylon, Polypogon monospeliensis, Stipagrostis plumosa and Sisymbrium orientale.

The life form spectrum indicated that therophytes were the most represented followed by chamaephytes. These results agree with that of Mosallam [41] in the National Wildlife Research Center (NWRC) at Taif, Heneidy and Bidak [32] on Bisha, Asir region in southwestern of Saudi Arabia and El-Demerdash et al. [57] in the southern region. The high percentage of therophytes indicated that there is no opportunity to flush and set phanerophytes and to a lesser extent chamaephyte due to overgrazing and also, they concluded that the dominance of therophytes and chamaephytes over other life forms in that regions would seem to be the hot dry climate, topography variations and biotic influence. These findings correspond with Floret [58], who found that seven years of protection of steppic vegetation in the Mediterranean arid zone of southern Tunisia have caused an increase in cover of perennial species. Grazing also caused changes in species composition in southwestern Arizona [59], decreased cover of perennials in the Mohave Desert and lowered productivity in the semi-arid regions of Afghanistan [60]. In addition, chamaephyte life form is able to withstand water logging, high salinity levels and a wide range of temperature variability [61-62].

Today many medicinal plants face extinction or severe genetic loss, but detailed information is lacking. No conservation action has been taken for most of the endangered medicinal plant species. For most countries, there is not even a complete inventory of medicinal plants. Much of the knowledge on their use is held by traditional societies, whose very extinct is now under threat. Little of this information has been recorded in a systematic manner and too much emphasis has been put on the potential for discovering new wonder drugs and too little on the many problems involved in the use of traditional medicines by local populations [63]. Consequently, little data is available about the medicinal plants and their status as...
natural resources for potential use by local inhabitants in this region [64]. Ninety four percent of the total recorded species by the present study have at least one aspect of the potential or actual economic uses. Seventy four species (80.4% of total recorded species) are grazing, 39 species (42.4% of total recorded species) are medicinal, 14 species (15.2% of total recorded species) are edible by man, 20 species (21.7% of total recorded species) used as fuel and 19 species (20.7% of total recorded species) used as other economic uses. The economic uses of the recorded species could be arranged descendingly as follows: grazing ~ medicinal ~ fuel ~ other uses ~ human food. This trend similar to that recorded by Heneidy and Bidak [32] in Bisha, Asir region who recorded 75% as medicinal, 83% as grazing, 17% as edible by human and animals, 40% as fuel wood and 72% of them as other uses. However, there is a shortage of information about the multipurpose uses of natural species. Many substances that we use in our daily lives are plant products, although there are a lot of uses of plant species still unknown. Numerous medicines and many industrial products are derived of plant products. Most of all are edible plant products that form the food base of human culture [33]. On the other hand, Mossa et al. [27] recorded 149 plant species as medicinal plants in the Saudi Arabia. Evaluation of the effects of the environmental factors threatening the wild life should be taken in consideration. On the other hand, the increase of fodder grazed plants in this area indicated the good selection of this area as a protected area for breeding the endangered mammals in the Saudi Arabia.

The application of TWINSPLAN and DECORANA techniques [34-35] to the vegetation data of the present study led to the recognition of 4 vegetation groups (communities): I: Calligonum comosum community which comprises the two small mountains: Sha’af al-Shamali or White mountain and Sha’af al-Janubi or Black mountain, rise from the relatively flat eastern portion of the reserve., II: Acacia tortilis community which dominates the gravel habitat, III: Zygophyllum simplex community dominates the sandy flats habitat and IV: Pulicaria incisa community dominates the alluvial clays habitat. The comparable community types were described by Mosallam [41] in the NWRC at Taif region. This may due to the similarity in habitat types but the differences in altitudes in both regions. This is the first study that identifies the vegetation groups (plant communities) in Mahazat Al-Sayd Protected Area by using the multivariate analysis for classification (TWINSPLAN) and ordination (DECORANA).

In contrast, the plant communities recognized in the present study are in contrary with other related studies in the other areas of the kingdom [65-70]. They concluded that, on the Asir highlands (above 2500 m) discontinuous plant communities exist on discrete habitat types. This appears to represent slope and exposure effects at the high elevation. In contrast, the transitional range between 500-2500 m is characterized by continuity in vegetation change from one altitudinal belt to the next, with broad transitional areas and overlap between low and high altitude vegetation. Similar results and observations were described by Kassas [71] in Sudan, Vesey-Fitzgerald [72] and Brooks and Mandil [73] in Saudi Arabia, Kassas [74] in Egypt, Beals [75] in Ethiopia and Ghazanfar [76] in Oman. Moreover, Moustafa [77] in St. Catherin (Sinai Peninsula) found that the organization of community types or associations is the net result of the behavior of species in response to environmental conditions. Ayyad et al. [78] in Sinai Peninsula recorded that the extent of species replacement or biotic change between different land forms reveals that the high values between habitats may reflect rapid and ecologically significant change and may also reflect the large extent of biotic change of different habitats.

CONCLUSION

Ninety one species were recorded along the different sites of Mahazat Al-Sayd Protected Area: 42 annuals and 49 perennials. These species represent about 4.2% of the whole flora of Saudi Arabia. The reserve has recovered rapidly, with extensive though still patchy vegetation cover, which includes dwarf shrubland with emergent small trees of Acacia tortilis and other Acacia spp. Robust perennial grasses, including Panicum turgidum and Ochthochloa compressa are abundant on deeper sand and on low lying ground while Stipagrostis spp. are more abundant in rocky areas. In the spring there are also bulbs Dichadi. Many perennial shrubs and forbs grow among the perennial grasses. Salsola spinescens dominates on alkaline soils. The present study indicated that the grasses which are widespread and eaten by gazelle include Ochthochloa compressa, Panicum turgidum and Stipagrostisa plumosa with Acacia tortilis trees dominating the tree layer throughout, but some fodder species like Lasius scindicus was disappeared. The economic uses of the recorded species could be arranged descendingly as follows: grazing ~ medicinal ~ fuel ~ other uses ~ human food. Four vegetation groups (communities) were recognized: I: Calligonum comosum...
community which comprises the two small mountains: Sha'af al-Shamali or White mountain and Sha'af al-Janubi or Black mountain, II: *Acacia tortilis* community which dominates the gravel habitat, III: *Zygophyllum simplex* community dominates the sandy flats habitat and IV: *Pulicaria incisa* community dominates the alluvial clays habitat.

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