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 - Short communication

ANGIOSPERMIC FLORA OF WADI AL AQIQ IN AL-MADINAH AL-MUNAWARAH, SAUDI ARABIA

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Floristic investigations are not only essential to know the diversity of plants present in any area, but also are significant socio-economically. Floristic elements may provide food and medicine for human beings and other animal species of the area of occurrence (Shehata and Galal, 2015). Surveys on biodiversity, including the floras, are important for determining the phyto-distribution data required for analyses and for modeling the plants responses to global climatic changes (Llewellyn *et al*., 2010). As floristic analyses are prerequisite for plant species conservation, it is critical to examine the current status of floristic and species diversity to provide appropriate guidelines for developing effective system of conservation and management.

Kingdom of Saudi Arabia with the coordinates of 32º34`N–16º83`N, 34º36`E–56`E contains large arid desert that has an approximate area of 2, 250,000 km² and covers the main portion of the Arabian Peninsula, where the xerophytes contributes the most plant life form (Zahran, 1982). Due to its vast area, the Kingdom of Saudi Arabia contains different habitats including salt pans, valleys, mountains, rocky and sandy deserts (Alsherif *et al*., 2013). Wadis (*viz.* Wadi Al Aqiq) resemble physiographic variabilities that lead to great variation in plants distribution (Kassas and Girgis, 1964). The flora of Saudi Arabia was comprehensively studied (Chaudhary, 1999 and 2001; Collenette, 1999), but only few studies on the local or regional floras of limited portions of the country including Asir region (Hosni *et al*., 1996), Al-Qassim region (Al-Turki, 1997) and Hail region (Al-Turki and Al-Olayan, 2003; El-Ghanim *et al*., 2010) were conducted. Thus the specific floristic inventories in the local areas of Saudi Arabia are not yet sufficient. Despite the previous studies on the flora of Saudi Arabia, there are no extensive surveys on the plant diversity, life forms and chorology of plants in Al Madinah region.

Al Madinah region including Wadi Al Aqiq (upstream, midstream and downstream), located between 24°34'34" N and 39°34'58" E, has an area of 151,990 km², mostly coated by bare soil (96%). The region of the current investigation is located in the west of Saudi Arabia that lies within the Nubo-Sindian Province (Zohary, 1973) or Nubo-Sindian local centre of endemism- a subzone of the Saharo-Sindian region. This zone was typified by a xero-tropical vegetation of desert habitats requiring high temperatures and low rainfall and was considered to be of palaeotropical origin (Llewellyn *et al.*, 2010; White and Léonard, 1991). Its UTM position is EH51 and Joint Operation Graphics reference is NG37-15 (Fig. 1). Al Madinah contains little variations in elevation. The average elevation is 610.51m above sea level, while the most remarkable variations in elevation (2019.91m) are found through fifty miles. Wadi Al Aqiq is considered as one of the biggest basins in Kingdom of Saudi Arabia.

Geologically, it is an important section of the middle-western Precambrian Arabian Shield (El Maghraby, 2014). In the study area, winter is short, comfortable, dry and windy, while summer is

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long, arid and sweltering. In general, temperature is rarely above 114°F or below 47°F. The hot season lasts for 4.6 months (during May to October), while the cool season lasts for 2.9 months (during November to February). The sliding days of rainfall and the perceived humidity level in Al-Madinah stay around 0.1 inches and 1% respectively and does not vary significantly over the year.

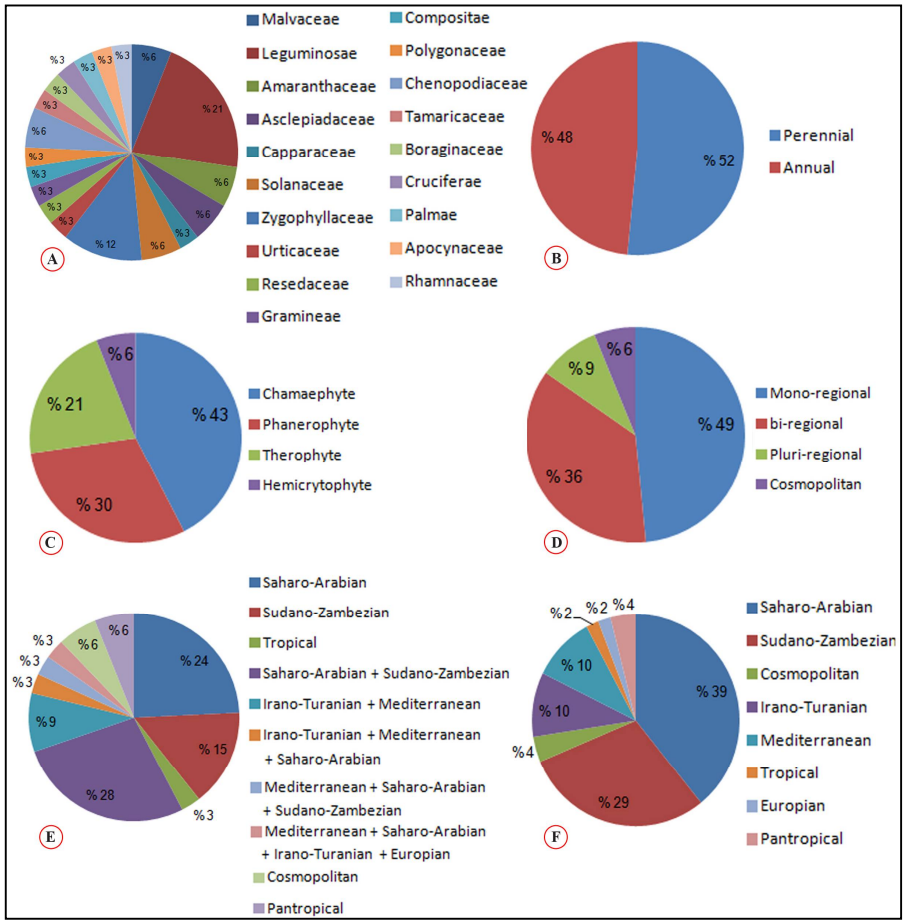

Fig. 1. A. Percentage of the represented families, B. Frequency of plant habit, C. Life form relative spectrum, D., E., and F. Floristic category spectrum of the recorded plants in Al Madinah region.

This study was performed to collect the base-line data on the angiospermic flora of Wadi Al Aqiq, Al Madinah Al Munawarah, Kingdom of Saudi Arabia. Such data would be useful in the assessment of plant diversity, plant life forms and chorology of the flora and in developing an effective system of conservation and management to help in the ecological restoration of some populated localities within the valley.

In this study, the meteorological data were gathered from weatherspark.com and https://www.yr.no/depending on two weather stations: Yanbu Airport (67%, 84 kilometers, northwest) and Prince Mohammad bin Abdul Aziz Airport (33%, 126 kilometers, northeast). The identification and authentication of the collected plant taxa (Table 1) were performed depending

on (Chaudhary, 2001; Collenette, 1999; Migahid, 1996). Voucher specimens were kept in the publicly herbarium of the Department of Biology at Taibah University. Life forms were detected according to (Raunkiaer, 1934), while the chorotypes were determined according to (Zohary, 1973).

Table 1. Plant species and family name that were collected from Wadi Al Aqiq, Saudi Arabia.

No.	Plant species	Family name
1.	*Abutilon fruticosum* Guill. & Perr., Fl. Seneg. Tent. 1: 70. 1831 (GCI)	Malvaceae
2.	*Acacia ehrenbergiana* Hayne, Getreue Darstell. Gew. x. t. 29. (IK)	Leguminosae
3.	*Acacia tortilis* Hayne, Getreue Darstell. Gew. ix. I. 31. (IK)	Leguminosae
4.	*Aerva javanica* Juss., Ann. Mus. Natl. Hist. Nat. 2: 131. 1803 (IK)	Amaranthaceae
5.	*Amaranthus viridis* L., Species Plantarum ed. 2 1763 (APNI)	Amaranthaceae
6.	*Calotropis procera* W.T.Aiton, Hort. Kew., ed. 2 [W.T. Aiton] 2: 78. 1811 (IK)	Asclepiadaceae
7.	*Capparis spinosa* L., Sp. Pl. 1: 503. 1753 [1 May 1753] (IK)	Capparaceae
8.	*Cassia italica* Lam. ex F.W.Andrews, Fl. Pl. Anglo-Egypt. Sudan ii. 117 (1952). (IK)	Leguminosae
9.	*Datura innoxia* Mill., Gard. Dict., ed. 8. Datura no. 5. 1768 [16 Apr 1768] (GCI)	Solanaceae
10.	*Fagonia schweinfurthii* (Hadidi) M.Hall, Edinburgh J. Bot. 68(2): 197. 2011	Zygophyllaceae
11.	*Forsskaolea tenacissima* L., Opobalsamum 18. 1764 [22 Dec 1764] (IK)	Urticaceae
12.	*Leucaena leucocephala* (Lam.) de Wit, Taxon x. 54 (1961). (IK)	Leguminosae
13.	*Malva parviflora* Huds., Fl. Angl. (Hudson) 268. 1762 (IK)	Malvaceae
14.	*Ochradenus baccatus* Delile, Descr. Egypte, Hist. Nat. 236, t. 31. (IK)	Resedaceae
15.	*Parkinsonia aculeata* L., Species Plantarum 2 1753 (APNI)	Leguminosae
16.	*Phoenix dactylifera* L., Species Plantarum 2 1753 (APNI)	Palmae/(Arecaceae)
17.	*Phragmites australis* (Cav.) Steud., Nomencl. Bot. ed. 2, 1: 143 (1840):. (IK)	Gramineae
18.	*Prosopis juliflora* DC., Prodr. [A. P. de Candolle] 2: 447. 1825 (IK)	Leguminosae
19.	*Pulicaria incisa* DC., Prodr. [A. P. de Candolle] 5: 479. 1836 [1-10 Oct 1836] (IK)	Compositae
20.	*Rhazya stricta* Decne., Ann. Sci. Nat., Bot. sér. 2, 4: 80. 1835 (IK)	Apocynaceae
21.	*Rumex vesicarius* L., Species Plantarum 2 1753 (APNI)	Polygonaceae
22.	*Sesbania sesban* Britton, Brooklyn Bot. Gard. Mem. i. 54 (1918). (IK)	Leguminosae
23.	*Solanum nigrum* L., Species Plantarum 2 1753 (APNI)	Solanaceae
24.	*Solenostemma oleifolium* (Nectoux) Bullock & E.A.Bruce, Kew Bull. 8(3): 359. (IK)	Asclepiadaceae
25.	*Suaeda aegyptiaca* (Hasselq.) Zohary, J. Linn. Soc., Bot. lv. 635 (1957). (IK)	Chenopodiaceae
26.	*Suaeda monoica* Forssk. ex J.F.Gmel., in Onomat. Bot. Compl. 8: 798 (1776). (IK)	Chenopodiaceae
27.	*Tamarix aphylla* (L.) H.Karst., Deut. Fl. (Karsten) 641. 1882 [May 1882] (IK)	Tamaricaceae
28.	*Tribulus macropterus* Boiss., Diagn. Pl. Orient. ser. 1, 1: 61. 1843 [Jan-Feb 1843] (IK)	Zygophyllaceae
29.	*Trichodesma africanum* (L.) Lehm., Pl. Fam. Asperif. 195. 1818 (IK)	Boraginaceae
30.	*Zilla spinosa* Prantl, Nat. Pflanzenfam. [Engler & Prantl] iii. 2 (1891) 175. (IK)	Cruciferae
31.	*Ziziphus spina-christi* (L.) Willd., Sp. Pl., ed. 4 [Willdenow] 1(2): 1105. 1798 (IK)	Rhamnaceae
32.	*Zygophyllum coccineum* L., Sp. Pl. 1: 386. 1753 [1 May 1753] (IK)	Zygophyllaceae
33.	*Zygophyllum simplex* L., Mant. Pl. 68. 1767 = *Tetraena simplex* (L.) Beier & Thulin, Pl. Syst. Evol. 240(1-4): 36 (2003).	Zygophyllaceae

This study identified total 33 plant taxa distributed in 31 genera and 19 families (Table 1). Leguminosae and Zygophyllaceae are the largest families in the study area. The major plant families were Leguminosae (Fabaceae, Mimosaceae and Caesalpiniaceae) with seven species, Zygophyllaceae with four species, Malvaceae, Amaranthaceae, Asclepiadaceae, Solanaceae and Chenopodiaceae, each with two species, and the rest of the families (12 families) with one species each. Another seven families were existed with two to seven species each (Table 1, Fig. 1A). Few

species were found to be modified and survived in tough environments and in contrast, it was inferred that few others could not survive and might have been extinct.

Table 2. Plant species that were investigated from the scanned area and their habitats, life forms and chorotypes.

No.	Plant species	Habitat	Life form	Chorotype
1.	*Abutilon fruticosum*	Perennial	Chamaephyte	Saharo-Arabian
2.	*Acacia ehrenbergiana*	Perennial	Phanerophyte	Sudano-Zambezian
3.	*Acacia tortilis*	Perennial	Phanerophyte	Sudano-Zambezian
4.	*Aerva javanica*	Perennial	Chamaephyte	Saharo-Arabian + Sudano-Zambezian
5.	*Amaranthus viridis*	Annual	Therophyte	Cosmopolitan
6.	*Calotropis procera*	Perennial	Phanerophyte	Saharo-Arabian + Sudano-Zambezian
7.	*Capparis spinosa*	Perennial	Chamaephyte	Irano-Turanian + Mediterranean;
8.	*Cassia italica*	Annual	Chamaephyte	Sudano-Zambezian
9.	*Datura innoxia*	Annual	Chamaephyte	Saharo-Arabian
10.	*Fagonia schweinfurthii*	Annual	Chamaephyte	Saharo-Arabian
11.	*Forsskaolea tenacissima*	Annual	Chamaephyte	Saharo-Arabian + Sudano-Zambezian
12.	*Leucaena leucocephala*	Perennial	Phanerophyte	Pantropical
13.	*Malva parviflora*	Annual	Therophyte	Mediterranean + Irano-Turanian
14.	*Ochradenus baccatus*	Perennial	Chamaephyte	Saharo-Arabian + Sudano-Zambezian
15.	*Parkinsonia aculeata*	Perennial	Phanerophyte	Pantropical
16.	*Phoenix dactylifera*	Perennial	Phanerophyte	Saharo-Arabian + Sudano-Zambezian
17.	*Phragmites australis*	Perennial	Hemicrytophyte	Irano-Turanian + Mediterranean + Saharo-Arabian
18.	*Prosopis juliflora*	Perennial	Phanerophyte	Saharo-Arabian
19.	*Pulicaria incisa*	Annual	Therophyte	Saharo-Arabian + Sudano-Zambezian
20.	*Rhazya stricta*	Perennial	Chamaephyte	Saharo-Arabian + Sudano-Zambezian
21.	*Rumex vesicarius*	Annual	Therophyte	Mediterranean + Saharo-Arabian + Sudano-Zambezian
22.	*Sesbania sesban*	Perennial	Phanerophyte	Tropical
23.	*Solanum nigrum*	Annual	Therophyte	Cosmopolitan
24.	*Solenostemma oleifolium*	Annual	Chamaephyte	Saharo-Arabian
25.	*Suaeda aegyptiaca*	Annual	Hemicrytophyte	Saharo-Arabian
26.	*Suaeda monoica*	Annual	Chamaephyte	Sudano-Zambezian
27.	*Tamarix aphylla*	Perennial	Phanerophyte	Sudano-Zambezian
28.	*Tribulus macropterus*	Annual	Therophyte	Irano-Turanian + Mediterranean
29.	*Trichodesma africanum*	Annual	Therophyte	Saharo-Arabian + Sudano-Zambezian
30.	*Zilla spinosa*	Perennial	Chamaephyte	Mediterranean + Saharo-Arabian+ Irano-Turanian + Europian
31.	*Ziziphus spina-christi*	Perennial	Phanerophyte	Saharo-Arabian + Sudano-Zambezian
32.	*Zygophyllum coccineum*	Annual	Chamaephyte	Saharo-Arabian
33.	*Zygophyllum simplex*	Annual	Chamaephyte	Saharo-Arabian

The plant taxa of the study area were varied between perennial (17 species, 52%) and annuals (48%), the occurrence of which might has been favoured by the relatively higher water content in the valley than that of the surrounding areas. Life form spectrum of the studied species showed a wide diversity and reflects the ideal desert vegetation (Table 2 and Fig. 1C). Data on the habit and life form revealed that chamaephytic and therophytic taxa had the largest share to the total flora of the present area. Chamaephytes were composed of 14 species (43%), followed by Phanerophytes of 10 species (30%), Therophytes of seven species (21%), and Hemicrytophytes of two species (6%). The high percentage of chamaephytes and therophytes confirmed their adaptation to the dryness and deficiency of rainfall in most of the studied area.

The taxonomic enumeration of the species per family according to this study is similar to that of the previous surveys in different regions of the Kingdom (Alatar *et al.*, 2012; Alsherif *et al.*, 2013; Mosallam, 2007). The record of the occurrence of Leguminosae with highest number of species, followed by Zygophyllaceae, in the study area, coincides with the finding of El-Ghanim *et al.* (2010) on Hail region flora. Poaceae, Leguminosae, Asteraceae represent the biggest share of plant species in Kingdom of Saudi Arabia (Al-Nafie, 2008). Similar findings were reported by different studies on the Egyptian flora (El-Ghani and El-Sawaf, 2004; El-Ghani and Abdel-Khalik, 2006). The ratio of species per genus (1.06) found in this investigation is less than that that (2.6) reported for the flora of Saudi Arabia (Al-Nafie, 2008).

According to the classification of Raunkiaer (1934), chamaephytic species had the superior position, phanerophytic, therophytic and hemicryptophytic species came in the second, third and forth positions respectively. The percentage of chamaephytes, therophytes and hemicryptophytes represent about 70% of the life form spectrum within the studied area, confirming the fact that the ascendancy of Chamaephytes and Therophytes is due to the hot and dry climatic conditions in addition to the human-animals interference. This agrees with the vegetation spectra in desert habitats in other regions of the Kingdom of Saudi Arabia as previously reported (Alatar *et al.*, 2012; Gomaa, 2012; Osman *et al.*, 2014).

The phytogeographical investigation of the studied species displayed the superiority of mono-regional taxa (49%), followed by the bi-regional taxa (36%). The pluri-regional taxa constituted only about 9% of all flora in the studied area (Table 2, Fig. 1D-F). The highest mono-regional elements were recorded in Saharo-Arabian region, which constitutes about 24%, followed by Sudano-Zambezian region comprising about 15% of the total recorded species. While the highest bi-regional elements were detected by Saharo-Arabian- and Sudano-Zambezian regions, which constitutes 28% followed by Irano-Turanian- and Mediterranean regions comprising about 9%.The results of chorological analysis of this study revealed that the Saharo-Arabian region harbours the highest percentage of the total plant taxa (about 39%), which is followed by Sudano-Zambezian region housing 29% for the total studied taxa. Moawed (2016) also found that most of the plant species in Alaqan area of Tabuk region, northwest of Saudi Arabia, belong to Saharo-Arabian or Sudano-Zambezian regions. Likewise, Alsherif *et al.* (2013) reported that Saharo-Arabian taxa had the highest contribution to the flora of Khulais region. Additionally, Seraj *et al.* (2014) recorded the ascendancy of Saharo-Arabian taxa in Al Soada region.

To the best of our knowledge the current investigation is the first floristic study in Wadi Al Aqiq and it has showed the importance of this region as important hotspot in term of plant species composition. Further studies are needed for more comprehensive analysis on the fluctuation of plant species composition, diversity and vegetation in the study area.

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