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FLORISTIC COMPOSITION, LIFE FORM AND CHOROLOGY OF PLANT LIFE AT KHULAIS REGION, WESTERN SAUDI ARABIA

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Abstract

Floristic composition of Khulais region, West Saudi Arabia, is lacking. Therefore, the present study has been undertaken to assess its Floristic composition, Life form and chorology. Results revealed that the region consider a hot-spot in the Kingdom in term of plant diversity and more diverse compared with other well studied regions in Saudi Arabia and neighboring countries. A total of 251 plant species belonging to 160 genera and 50 families were identified. The major plant families that contributed in the formation of vegetation of the area in question were Poaceae (42 species) followed by papilonaceae (20 species), Euphorbiacea and Asteraceae (18 and 15 species, respectively), while eighteen families each was represented by only one species. Therophytes exhibited the maximum number of species (41.2%), followed by Chaemophytes (31.4%), Hemicryptophytes (13.7%) and Phanerophytes (10%), while the least frequent life form class was Geophytes. Chorological characteristic of the recorded flora showed that Saharo-Arabian and Sudanian elements constitute 43.6% of the total flora. It is concluded that the area is botanically virgin and not explored extensively and intensively even though rich in vegetation, provided floristic checklist, and strongly recommend further detailed study.

Introduction

Saudi Arabia, a part of the Arabian Peninsula, covers more than 2 million sq kms and comprises several distinct physiographical regions, such as mountains, Valleys (Wadis), sandy and rocky deserts, salt pans (Sabkhahs) and lava areas (Harrats), etc. The overall climate of the country, except for Asir Province, is classified as an "arid province" within Thornthwaite's global climatic classification, and as "dry climates" in Koppen's classification (Al-Nafie, 2008). The flora of Saudi Arabia consider the richest biodiversity areas in the Arabian Peninsula and comprises important genetic resources of crop and medicinal plants and xerophytic vegetation which make up the prominent features of the plant life in the kingdom (Zahran, 1982). Species belonging to Saudi Arabia are distributed into three general categories, namely: the species of the Saharo-Sindian Zone, Sudano-Deccanian zone (in a broad sense) and the species of the Tropical African- Indian category (Alfarhan, 1999; Thomas *et al.*, 2008). A total of 2250 species (including pteridophytes and gymnosperms) in 142 families are recorded in the flora of the Kingdom of Saudi Arabia (Collenette, 1998). Besides its large number of endemic species, the components of the flora are the admixture of the elements of Asia, Africa and Mediterranean region. According to Collenette (1998), the greatest species diversity in Saudi Arabia occurs in Asir and Hijaz, the western mountainous area of the Kingdom, which borders the Red Sea which can be attributed to a greater rainfall and range of altitude from sea level up to 9,300. Many previous studies showed that topography of the area and the climatic factors are the main factors affecting the degree of speciation (Abulfatih, 1992; El-Kady *et al.,* 1995; Shaltout & Mady 1996; Shaltout *et al.,* 1997). Till now there is not a complete survey for flora of Saudi Arabia because of its wide area and the change in climate (the increase of rainfall in last three years), so it is still more floristic works is need to fulfill gaps in Saudi flora. Khulais region, the target area in the present study, is one of the most prominent hydrological areas located in the western region of Saudi Arabia, stretches between longitudes 15° 39\ and 40° to the east and latitudes 22° and 30° 22\ north, it lie within the greatest plant diversity of Saudi Arabia (Al-Nafie, 2004), containing fertile valleys with many tributaries and characterized by presence of many different habitats and agricultural activities. Its climate is characterized by high temperature in summer and warm temperature through the rest of the year, rainfall is scarce but it is increased in the last three years. Literature dealing with the flora and plant ecology of the studied area are very little (Milad, 2006). Because of floristic studies help us to assess the plant wealth and its potentiality of any given area and understanding the basic aspects of biology such as speciation, isolation, endemism and evolution, the goal of the present work is to study the floristic composition, life form and chorology of Khulais flora.

Materials and Methods

Khulais region lie between longitudes 15° 39\ and 40° to the east and latitudes 22° and 30° 22\ north north within the territory of the Arabian Shield which includes the chains in the western highlands of the Hijaz and Asir and the western part of the Nagd plateau (Fig. 1). Soils are made up of basic volcanic rocks of basaltic composition, its texture ranging between silty clay to coarse sandy and the pH ranging between 7.75 to 8.05, while soil salinity ranging from 0.4 to 7.4 mM/cm. The climate characterized by high temperature in summer and warm in the winter (Appendix 1). The area has an arid climate, the annual average rainfall is 35.1 mm. The rainfall apart from its scantiness, is irregular and variable, it ranges between 0 to 70 mm. In the last two years heavy but sporadic rainfall occurred on one or two days, e.g., 777 mm was recorded at February, 12th 2010 and at March, 15th and 16th 2011. Air temperature reach a monthly maximum of 37.4 in June and a minimum of 13.2 in

January. An extensive survey was carried out during the period of September 2010 to the September 2011. However, it was not possible to survey quantitatively the entire project area, even then every effort was made to include the entire representative, topographic and physiographic condition in the study area. The collected specimens were identified with the help of various Floras, Collenette (1985; 1998), Chaudhary (2001), Miller & Cope (1996), Migahid (1996), and Boulos (1999; 2000; 2002; 2005). The voucher specimens are deposited in the Department of Biology, Faculty of Sciences and Arts-Khulais, King Abdulaziz University. Life form classes were constructed by following Raunkiaer (1934). When several life forms were given for a taxon, the most representative taxon was chosen; variation in the life form in the field was not considered. To avoid the diverse conceptions of different authors for chorological units which have resulted in different names for the two main regions in Saudi Arabia, the general approach and terminology of Zohary (1973) for the Saharo-Arabian and Sudanian regions, which are well known, will be used.

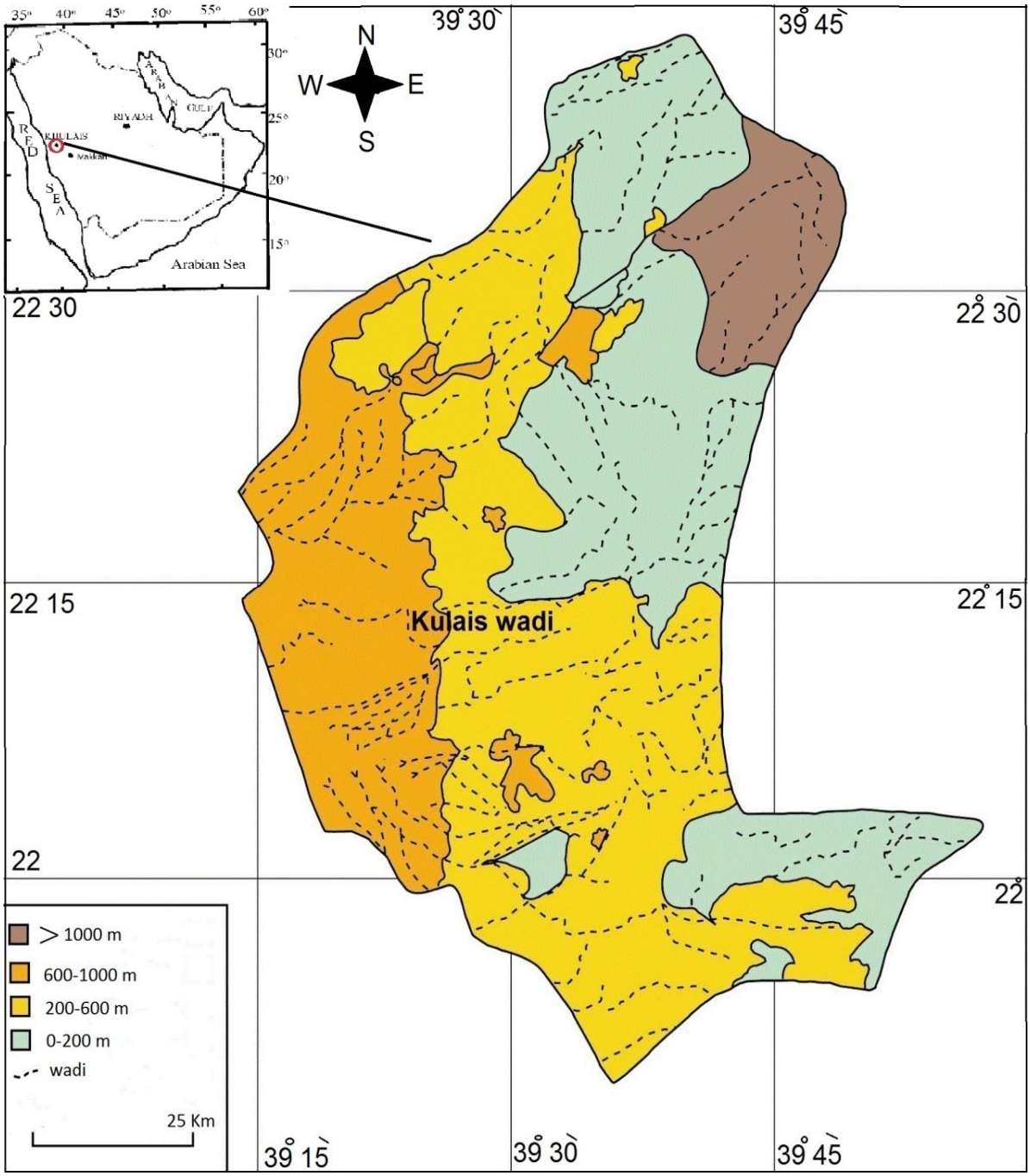

Fig. 1. Location map of the studied area showing wadi tributaries and topography, modified after El-Abdaly (2004).

Appendix 1. Some Climatic data for the studied area. Value in parentheses represent the period from 2000 to 2009 and other values for last two years.

	Rainfall (mm)	Temperature (◦C)			Relative humidity
		Max.	Min.	Mean.	
January	(10) 27.5	(28.4) 28.4	(13.2) 18.8	(20.8) 23.3	(51.1) 65
February	(0) 0	(28.1) 30.5	(15) 18.6	(21.5) 24.1	(51.4) 62.1
March	(10) 50.1	(31.4) 31.6	(16.7) 20.5	(24) 25.4	(43) 56
April	(2.2) 0	(31.1) 33.8	(18.4) 22.2	(26.2) 27.8	(37.5) 54.1
May	(1.1) 0	(35.8) 36.1	19.5) 24	(27.6) 30.1	(47.1) 52.5
June	(0) 0	(37.4) 37.2	(21.9) 25.2	(29.6) 31.26	(35) 55.7
July	(0) 0	(37.2) 40.7	(24.4) 27.9	(30.8) 33.8	(47.6) 49.1
August	(1.1) 0	(36.9) 38.6	(25.2) 28.3	(31) 33.2	(32.3) 54.7
September	(2) 0.1	(34) 37.6	(24.6) 26.6	(29.3) 31.6	(46.6) 65.5
October	(1.1) 0	(36.7) 39.2	(22.9) 24.5	(29.8) 30.9	(46.3) 61.9
November	(6.61) 0.1	(32.4) 36.3	(19.1) 22.4	(25.7) 28.7	(36.5) 53.4
December	(1.9) 2.1	(29.3) 32	(16) 19.8	(22.6) 25.7	(51) 57.5

Data obtained from Department of Hydrology, Ministry of Agriculture and Water, Riyadh

Results and Discussion

The merger of different habitats within the studied area presents a wealth of flora. A total of 250 plant species belonging to 160 genera and 50 families were identified (Appendix 2). The major plant families present in the area in question were Poaceae (42 species) followed by papilonaceae (20 species), Euphorbiacea and Asteraceae (18 and 15 species, respectively), while 18 families were represented by only one species. More than 59% of the recorded species (Appendix 2) belong to only 10 species rich families. A comparison of families in terms of the largest number of species recorded in this investigation and in similar studies in different regions of Saudi Arabia, such as: Hosni & Hegazi (1996) in the Asir Mountains, Mosallam (2007) in Taif, Alatar *et al*., (2011) in Al-Jufair Wadi and Al-Turki & Al-Olayan(2003) in Hail region. Also similar results were obtained in neighboring countries, such as Egypt (Abd EL-Ghani and Abd El-Khalik 2006; Abd El-Ghani and El-Sawaf 2004) and Jebel Marra of the Sudan (Wickens, 1976). It is well known that Poaceae, Leguminosae and Asteraceae constitute the main bulk of plant species in Saudi Arabia (collentte 1999; Al-Nafie, 2008). Poaceae (the largest family in our list) is not only the largest family in the Flora of Suadi Arabia (Collentte, 1999), but also the largest and most widespread family of flowering plants in the world (Good, 1974). This can be attributed to their wide ecological range of tolerance, and to their efficient seed dispersal capability. An outstanding feature of floristic composition of the flora of Saudi Arabia is that a few families are of floristically important as in most tropical and subtropical deserts, most plant species belong to a limited number of plant families. In the present study among 50 families, 18 families or 36% of the total number of families, are represented by one species per family. This is a common feature of desert flora and consider an indication that only a few of the large number of species that belong to these old plant families have adapted and survived in this harsh environment, while other species that could not survive have become extinct. The number of species per genus in the present study is 1.5 (250/160), a ratio less than that recorded in total area of the kingdom (Al-Nafie, 2008) which is 2.6 (840/2172). Pielou (1975) and Magurran (1988) stated that, in intuitive terms, taxonomic diversity will be higher in an area in which the species are divided amongst many genera as opposed to one in which most species belong to the same genus and still higher as these genera are divided amongest many families as opposite few families.

Appendix 2. List of plant species recorded in the studied area with their families, life forms and chorotypes.

Family	Sp. No.	Species name	Life form	Chorotype
Acanthaceae	1	*Blepharis attenuate* Napper	Ch	IT+SA
Aizoaceae	2	*Aizoon canariense* L.	Th	SU
	3	*Gisekia phranaceoides* L.	Th	TR
	4	*Sesuvium sesuviodes*(Fenzl) Verdc.	Ch	TR
	5	*Trianthema portulacastrum* L.	Th	AM
	6	*Trianthema sedifolia* Visiani	Ch	AM
	7	*Zaleya pentandra* (L.) C. Jeffrey	Th	SU
Amaranthaceae	8	*Aerva javanica* (Burm. f.) Juss. ex Schul.	Th	TR
	9	*Aerva lanata (L.) Juss.*	Th	TR
	10	*Amaranthus albus* L.	Th	AM
	11	*Amaranthus graecizan* L.	Th	Cosm
	12	*Amaranthus hybridus* L.	Th	Cosm
	13	*Amaranthus viridis* L.	Th	Cosm
	14	*Digera muricata* (L.) Mast.	Th	TR
Amaryllidaceae	15	*Pancratium sickenbergi* Asch.&Schweinf.	Ge	IT+SA
Apocynaceae	16	*Rhazya stricta* Decne.	Ch	SA+SU
Arecaceae	17	*Nannorrhops ritchieana* (Griff.) Aitch.	Ph	SA+IT
Asclepiedaceae	18	*Calotropis procera* (Aiton) W.T.Aiton	Ph	SA
	19	*Caralluma acutangula* (Decne.) N.E.Br.	Th	SA+SU
	20	*Cynanchum acutum* L.	Ch	SA
	21	*Glossonema boveanum* subsp. *nubicum* (Decne.) bullock	He	SU
	22	*Leptadenia pyrotechnica* (Forssk.) Decne.	Ph	SA+SU
	23	*Odontanthera radians* (Forssk.) D.V.Field	Ch	TR
	24	*Oxystelma esculentum* (L.F.) R.Br.	He	TR
	25	*Pergularia tomentosa* L.	Ch	SA+SU
Asphodelaceae	26	*Asphodelus tenuifolius* (Cav.) Baker	Ge	SA+SU
Asteraceae	27	*Asteriscus hierochunticus* (Michon) Wiklund	Th	SA
	28	*Conyza bonariensis* (L.) Cronquist	Ch	SA+SU
	29	*Dicoma tomentosa* Cass.	Ch	SU
	30	*Echinops hussonii* Boiss.	He	SA+ME
	31	*Echinops polyceras* Boiss.	He	IT
	32	*Echinops spinosus* L.	He	ME+SU
	33	*Flaveria trinervia* (Spreng.) Mohr	Th	SU
	34	*Iphiona scabra* DC.k	Ch	SA
	35	*Launea capitata* (Spreng.) Dandy	Th	SA
	36	*Launea mucronata* subsp. *cassiniana* (Jaub.&Spach) N.Kilian	He	SA
	37	*Launaea nudicaulis* (L.) Hook. f.	Ch	SA
	38	*Pluchea dioscoridis* (L.) DC.	Ch	SA+SU
	39	*Pulicaria orientalis* Jaub. & Spach	Ch	SA+SU
	40	*Pulicaria crispa* (Cass.) Oliv. & Hiern	Ch	SA+SU
	41	*Sonchus oleraceus* L.	Th	ME+IT
Boraginaceae	42	*Anchusa milleris* Spreng.	Th	SA
	43	*Arnebia decumbens* (Vent.) Coss.&Kralik	Th	SA+SU
	44	*Arnebia hispidissima* (Lehm.) DC.	Th	SA+SU
	45	*Heliotropium arbainense* Fresen.	Ch	SA
	46	*Heliotropium bacciferum* Forssk.	Ch	SA+SU
	47	*Heliotropium digynum*(Forssk.)	Ch	SA
	48	*Heliotropium kotschyi* (Burnge) Gurke	Ch	SA
	49	*Moltkiopsis ciliata* (Forssk.) I.M.Johnst.	Ch	SA
	50	*Trichodesma africanum* (L.)R.Br.	Th	SA

Appendix 2. (Cont'd.).

Family	Sp. No.	Species name	Life form	Chorotype
Brassicaceae	51	*Anastatica hierochuntica* L.	Th	SA
	52	*Capsella pursa pastoris (*L.) Medik.	Th	Cosm
	53	*Farsetia longisiliqua* Decne	Ch	SU
	54	*Farsetia stylosa* R. Br.	Ch	SU
	55	*Morettia canescens* Boiss.	Ch	ME
	56	*Schouwia purpurea* (F0rssk.) Schweinf.	Th	ME+SA
Burseraceae	57	*Commiphora kataf* (Forssk.)Engl.	Th	SU
Caesalpiniaceae	58	*Senna italica* Mill.	Ch	SU
	59	*Senna holosericea* (Fresen.) Greuter		
	60	*Parkinsonia aculeate* L.	Ph	AM
Capparaceae	61	*Capparis cartilaginea* Decne.	He	SU
	62	*Capparis spinosa* L.	Ch	ME
	63	*Capparis decidua* (Forssk.) Edgew.	Ph	SA+SU
	64	*Cadaba farinosa* Frossk.	Ch	SU
	65	*Cadaba glandulosa* Frossk.	Ph	TR
	66	*Diptergium glaucum* Decne.	Th	SU
	67	*Mareua crassifolia* Frossk.	Ph	SA+SU
	68	*Mareua oblongifolia* (Frossk.) A.Rich.	Ph	SU
Caryophyllaceae	69	*Cometes surattensis* L.	Th	SU
	70	*Gypsophila capillaries* (Forssk.)C.Chr.	Ch	IT
	71	*Paronychia arabica* (L.) DC.	Th	SA
	72	*Polycarpaea robbairea* (Kuntze) Greuter & Burdet	Th	SA+SU
	73	*Spergularia fallax* (Lowe) E.H.L. Krause	Th	SA
Chenopodiacea	74	*Anabasis setifera* Moq.	Ch	SA
	75	*Chenopodium murale* L.	Th	Cosm
	76	*Chenopodium album* L.	Th	Cosm
	77	*Haloxylon salicornicum* (Mo.) Bun. ex Boiss.	Ch	IT
	78	*Haloxylon scoparium* Pomel	Ch	IT
	79	*Salsola imbricata* Forssk.	Ph	SU
	80	*Salsola tetrandra* Forssk.	Ch	SA
	81	*Salsola spinescens* Moq.	Ch	Cosm
	82	*Suaeda aegyptiaca* (Hasselq.) Zohary	He	SA
	83	*Suaeda monica* Frossk.ex J.F. Gmel.	Ch	SU
	84	*Sueda vermiculata* Forssk. ex J.F. Gmel.	Ch	SA
Cleomaceae	85	*Cleome amblyocarpa* Barratte& Murb.	Ch	SA+SU
	86	*Cleome brachycarpa* DC.	Ch	SA
	87	*Cleome droserfolia* (Forssk.)Delile	Ch	SU
	88	*Cleome paradoxa* R.Br.exDC.	Ch	SU
	89	*Cleome scaposa* DC.	Th	TR
	90	*Gynandropsis gynandra* (L.)Briq.,Ann.	Ch	TR
Convolvulaceae	91	*Convolvulus arvensis* L.	Ge	Cosm
	92	*Convolvulus asyrensis* Kotchy	Ch	ME
	93	*Convolvulus cephalopodus* Alfarhan	Ch	SA
	94	*Convolvulus deserti* Hochst. & Steud.	Ch	SA
	95	*Convolvulus Fatemensis* Kunze	Ch	SA
	96	*Convolvulus glomeratus* Choisy	Ch	SU
	97	*Convolvulus spicatus* Hallier f.	Ch	SA
	98	*Cressa cretica* L.	He	ME+IT
	99	*Ipomea aquatica* Forssk.	Ch	Cosm

Appendix 2. (Cont'd.).

Family	Sp. No.	Species name	Life form	Chorotype
Cucurbitaceae	100	*Citrullus colocynthis* (L.) Schrad.	Th	SA
	101	*Momordica balsamina* L.	Th	TR
Cyperaceae	102	*Cyperus conglomerates* Rottb.	Ge	SA
	103	*Cyperus lavigatus* L.	Ge	Cosm
	104	*Cyperus rotundus* L.	Ge	Cosm
Euphorbiaceae	105	*Andrachne aspera* Spreng.	Ch	SU
	106	*Chrozophora brocchiana* Vis.	Ch	SU
	107	*Chrozophora oblongifolia* (Delile) Spreng.	Ch	SU
	108	*Chrozophora plicata* (Vahl.) Spreng.	Th	SU
	109	*Chrozophora tinctoria* (L.) Raf.	Th	SA+ME
	110	*Euphorbia arabica* T. Anderson	Th	SA
	111	*Euphorbia cuneata* Vahl	Ph	SA+SU
	112	*Euphorbia granulata* Frossk.	Th	SU
	113	*Euphorbia inaequilatera* Sond.	Th	SU
	114	*Euphorbia hirta* L.	Th	Cosm
	115	*Euphorbia peplus* L.	Th	ME +IT
	116	*Euphorbia prostrata* Ait.	Th	Cosm
	117	*Euphorbia retusa* Frossk.	Th	SA
	118	*Euphorbia scordifolia* Jacq.	Th	SU
	119	*Euphorbia serpens* Kunth	Th	AM
	120	*Erythrococca abyssinica* Pax.	Th	TR
	121	*Phyllanthus rotundifolius* Willd.	Th	Cosm
	122	*Ricinus communis* L.	Ph	TR
Frankiniaceae	123	*Frankenia revolute* Frossk.	Ch	ME
Geraniaceae	124	*Monsonia heliotropioides* (Cav.) Boiss.	Th	SU
Juncaceae	125	*Juncus rigidus* Desf.	Ge	IT+SA
Lamiaceae	126	*Lavandula coronopifolia* Poir.	Ch	SA+ SU
	127	*Salvia aegyptiaca* L.	Ch	SA+ SU
Liliaceae	128	*Dipcadi erythraeum* Webb & Berth.	Ge	SA
Lythraceae	129	*Ammannia baccifera* L.	Th	TR
Malvaceae	130	*Abutilon fruticosum* Guill. & Perr.	Ch	SU
	131	*Abutilon pannosum* (G. Forst.) Schltdl.	Ch	TR
	132	*Malva parviflora* L.	Ch	ME+IT
	133	*Sida rhambifolia* L.	Th	TR
Menispermaceae	134	*Cocculus pendulus* (J.R. & G. Forst.) Diels	Ch	SU
Mimosaceae	135	*Acacia ehrenbergiana* (Forssk.) Hayne	Ph	SU
	136	*Acacia hamulosa* Benth.	Ph	SU
	137	*Acacia raddiana* Savi	Ph	SU
	138	*Acacia tortilis* (Forssk.) Hayne	Ph	SU
	139	*Pithecellobium dulce* (Roxb.) Benth.	Ph	TR
	140	*Prosopis Juliflora* (Sw.) DC.	Ph	SA
Molluginaceae	141	*Glinus lotoides* L.	Th	ME+IT
	142	*Mollugo cerviana* (L.) Ser.	Th	TR
Moringaceae	143	*Moringa peregrine* (Forssk) F.	Ph	SU
Neuradaceae	144	*Neurada procumbens* L.	Th	Cosm
Nyctaginaceae	145	*Boerhavia diffusa* L.	Ch	SA+TR
	146	*Boerhavia repens* L.	Ch	TR
	147	*Commicarpus boissieri* (Heimerl) Cufod.	Th	SU
Palmeae	148	*Phoenix dactylifera* L.	Ph	SA
	149	*Hyphaene thebaica* (L.) Mart.	Ph	TR+SA

Appendix 2. (Cont'd.).

Family	Sp. No.	Species name	Life form	Chorotype
Papilionaceae	150	*Astragalus annularis* Forssk.	Th	SA
	151	*Astragalus corrugates* Bertol	Th	SA
	152	*Astragalus vogelii* (Webb) Bornm.	Th	SA
	153	*Astragalus tribuloides* Delile	Th	SA+IT
	154	*Crotalaria microphylla* Vahl	Th	SA+SU
	155	*Crotalaria senegalense* (Pers.) DC.	Th	SU
	156	*Indigofera argenata* L.	Ch	SU
	157	*Indigofera carulea* Roxb.	Ch	SU
	158	*Indigofera hoschstettei* Baker	Ch	SU
	159	*Indigofera oblongifolia* Forssk.	Ch	SU
	160	*Indigofera spinosa* Frossk	Th	ME
	161	*Melilotus indica* L.	Th	IT+SA
	162	*Onobrychis ptolemaica* (Delile) DC.	Ch	SU
	163	*Rhynchosia minima* (L.) DC.	Ch	SU
	164	*Sesbania sesban* (L.) Merr.	Ph	TR
	165	*Taverniera lappacea* (Forssk.) DC.	Ch	SU
	166	*Trigonella hamosa* L.	Th	SA
	167	*Trigonella stellata* Forssk.	Th	SU
	168	*Tephorosia apollineae* (Delile) DC.	Ch	SU
	169	*Tephorosia nubica* (Boiss.) Baker	Th	SA
Poaceae	170	*Aeluropus massuensia* L.	Ch	IT+SA
	171	*Avena barbata* Pott ex Link	Th	ME
	172	*Brachiaria eruciformis* (Sm.) Griseb.	Th	TR
	173	*Brachiaria leersioides* (Hochst.) stapf	Th	TR
	174	*Brachypodium distachyum* (L.) P. Beauv.	Th	ME+IT
	175	*Bromus madritensis* L.	He	ME+IT
	176	*Cenchrus ciliaris* L.	He	SA+SU
	177	*Cenchrus pennisetiformis* Hochst. & Steud.	Th	AM
	178	*Cymbopogon schoenanthus* (L.) Spreng.	Th	SA
	179	*Cynodon dactylon* (L.) Pers.	Ge	Cosm
	180	*Dactyloctenium aegyptium* (L.) P. Beauv.	Th	Cosm
	181	*Dichanthium annulatum* (Forssk.) Stapf	He	SA
	182	*Dichanthium foveolatum* (Delile) Roberty	Th	TR+SA
	183	*Digitaria ciliaris* (Retz.) Koeler	Th	TR
	184	*Echinochloa colona* (L.) Link	Th	TR
	185	*Eragrostis minor* Host.	Th	TR
	186	*Eremopyrum bonaepartis* (Spreng.) Nevski	Th	IT
	187	*Lamarckia aurea* (L.) Moench	Th	ME+IT
	188	*Lasiurus hirsutus* (Forssk.)	He	SU
	189	*Latipes sengalensis* Kunth	He	TR
	190	*Leptochloa fusca* (L.) Kunth	He	TR
	191	*Leptothrium senegalense* (Kunth) Clayton	Th	TR
	192	*Lolium rigidum* Gaudin	Th	ME+IT
	193	*Lolium perenne* L.	He	ME+IT
	194	*Ochtochloa compressa* (Forssk.) Hilu	He	TR
	195	*Panicum coloratum* L.	He	SA
	196	*Panicum turgidum* Forssk.	He	SA+SU
	197	*Pennisetum setaceum* (Forssk.) Chiov.	He	SA
	198	*Pennisetum divisum* (J.F. Gmel.) Henrard	He	SA
	199	*Phalaris minor* Retz.	Th	ME+IT
	200	*Phragmites australis* (Cav.)Trin ex Steud.	He	Cosm
	201	*Poa annua* L.	Th	Cosm

Appendix 2. (Cont'd.).

Family	Sp. No.	Species name	Life form	Chorotype
	202	*Poa bulbosa* L.	He	ME+IT
	203	*Polypogon monospliensis* (L.)	Th	SA+ME
	204	*Rostraria cristata* (L.) Tzvelev	Th	ME+IT
	205	*Setaria verticillata* (L.) P. Beauv.	Th	Cosm
	206	*Sorghum halepense* (L.) Pers.	Th	TR
	207	*Stipa capensis* Thunb.	Th	IT+SA
	208	*Stipa parviflora* Desf.	He	IT
	209	*Stipagrostis plumosa* (L.) Mun. ex T. And.	He	IT+SA
	210	*Tragus racemosus* (L.) All.	Th	SU+SA
	211	*Trisetaria macrochaeta* (Boiss.) Maire	Th	SA
Polygalaceae	212	*Polygala erioptera* DC.	Th	SA
Polygonacae	213	*Polygonum aviculare* L.	Th	Cosm
	214	*Polygonum argyrocoleum* G. Kunze	Th	IT
	215	*Polygonum equisetiforme* Sm.	He	ME+IT
	216	*Rumex vesicarius* L.	Th	SA
Portulacaeae	217	*Portulaca oleraceae* L.	Th	Cosm
	218	*Portulaca quadrifida* L.	Th	Cosm
	219	*Ochradenus arabicus* Chaudhary, Hillc. & A.G.Mill	He	SA
Resedaceae	220	*Ochradenus baccatus* Del.	He	SA
	221	*Reseda luteola* L.	Th	ME+IT
	222	*Oligomeris linifolia (Fahl ex Hornen) J.F. Macbr.*	Th	ME+IT
Rhamnaceae	223	*Ziziphus spina christi* (L)Desf	Ph	SA+SU
Rutaceae	224	*Haplophyllum tuberculatum* (Forssk.) A.Juss.	Ch	SA
Scrophulariaceae	225	*Kichxia floribunda* (Boiss.) Taeckh. & Boulos	Ch	SA
	226	*Lindenbergia indica* O. Kuntze	Ch	SU+SA
	227	*Scrophularia arguta* Soland.ex Ait.	Th	SU+SA
Solanaceae	228	*Datura innoxia* Mill.	Th	Cosm
	229	*Lycium shawii* Roem. & Schult.	Ph	SA+SU
	230	*Solanum incanum* L.	Th	SU
	231	*Solanum nigrum* L.	Th	ME+IT
	232	*Solanum sinaicum* Boiss.	Th	SA
	233	*Withania somnifera* (L). Dunal.	Ch	ME+IT
Tamaricaceae	234	*Tamarix aphylla* (L.) Karst.	Ph	SU
	235	*Tamarix nilotica* (Ehrenb.) Bunge	Ph	SA
Tiliaceae	236	*Corchorus depressus* (L.) Stocks	Ch	ME+SA
	237	*Corchorus olitorius* L.	Th	TR
	238	*Corchorus trilocularis* L.	Th	TR
Urticaceae	239	*Forsskaolea tenacissima* L.	Ch	SA+SU
Zygophyllaceae	240	*Fagonia indica* Burm. f.	Ch	SA
	241	*Fagonia mollis* Delile.	Ch	SA
	242	*Fagonia ovalifolia* Hadidi	Th	SA+SU
	243	*Zygophyllum coccienum* L.	Ch	SA
	244	*Zygophyllum album* L.F.	Ch	SA
	245	*Zygophyllum quatarense* Hadidi	Ch	SA
	246	*Zygophyllum simplex* L.	Ch	SA
	247	*Tribulus macropterus* Boiss.	Th	SU
	248	*Tribulus pentandrus* Forssk.	Ch	SA
	249	*Tribulus terrestris* L.	Th	ME+SU
	250	*Tribulus pterocarpus* Forssk.	Ch	SU
Vitaceae	251	*Cissus quadrangularis* L.	Ch	SA+SU

The life forms are: Ph, phanerophytes; Ch, chamaephytes; G, geophytes; He, hemi-cryptophytes and Th, therophytes. The chorotypes are: COSM, cosmopolitan AM, American; IT, Irano-Turanian; ME, Mediterranean; SA, Saharo-Arabian; SU, Sudano-Zambezian and TR, Tropical

Life forms of the prevailing flora exhibited a great diversity and reflect reflects a typical desert flora. The most frequent life form class was Therophytes with the maximum number of species (41.2%), followed by Chaemophytes (31.4%), Hemicryptophytes (13.7%) and Phanerophytes (10%), while the least frequent life form class was Geophytes (3.4%) (Fig. 2). Life-form spectrum in the present study is characteristic of an arid desert region with the dominance of therophyes and study support the concept of Cain (1950) and Dechenes (1969) that dry climate, overgrazing and trampling which is so prevalent on grasslands, tend to increase the percentage of therophytes through the introduction and spread of weedy grasses and forbs of this life form. Moreover, the high proportion of therophytes is also attributed to human activities according to Barbero *et al.* (1990). Therophytes (annuals and biennials) not surprisingly account for 50-60% of the total species of the region, they usually bloom and form luxurious growth in rawdhat, wadis and at the base of stable dunes, where moisture accumulates after sufficient rain. It is also necessary to point out that the increase in both Leguminosae and therophytes in a local flora can be considered a relative index of disturbance for Mediterranean ecosystems (Abdel Ghani & Abd El-Khalik, 2006). These results agree with the life form spectra in desert habitats in other parts of Saudi Arabia (e.g. El-Demerdash *et al.* 1994; Collenette, 1999; Chaudhary, 2001; Al-Turki & Al-Olayan 2003; El-Ghanem *et al.* 2010; Alatar *et al.* 2011, Daur, 2012) A similar result was obtained by Abd El-Ghani (1998) for the northern part of the Eastern Desert of Egypt. The low percent of Phanerophytes recorded in this study in agree with white and Leonard (1991) Statement that south and south-western Arabian Peninsula are very poor in tree.

Figure 2 showed that chorological characteristic of the recorded flora showed that Saharo-Arabian region elements recorded the highest number (24.5%) followed by Sudanian elements (20.1%). In addition to plant species that belong to the Saharo-Arabian and the Sudanian elements presented in the target region it has a large number of plant species which dominate in other uniregional region, such as Tropical (31 species), Irano-Turanian and American (7 species for each), while Mediterranean elements showed the least species number (6 species). The highest Bioregional elements was recorded by Saharao-Arabian- Sudanian and the Plurirgional was twenty three species. The studied area belong to The Nubo-Sindian Province which is a part of the Sudanian Region (Zohary, 1973) or Nubo-Sindian local centre of endemism belonging to the Saharo-Sindian regional zone (White & Leonard, 1991) stretches in Saudi Arabia over a narrow strip along the Red Sea coast north of Makkah as well as along Arabian Gulf coast. Saharo-Arabian elements showed the highest species number because plant species in this region show the usual ways of adaptation to aridity and very high temperature in such a harsh environment. Vegetation cover is mainly concentrated in depressions, lower ground areas such as rawdhat, wadis and ravines, where water usually accumulated. Vegetation can also be found over stable sand dunes as well as hollows between them and sand sheets that cover hamadas and stony plains (Fig. 3).

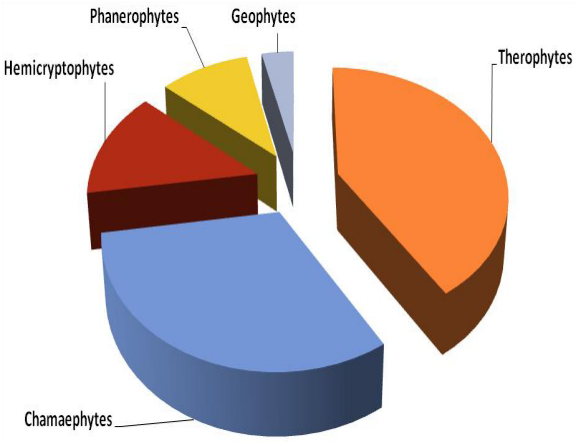

Fig. 2. Proportinal percentage of life forms for the study area.

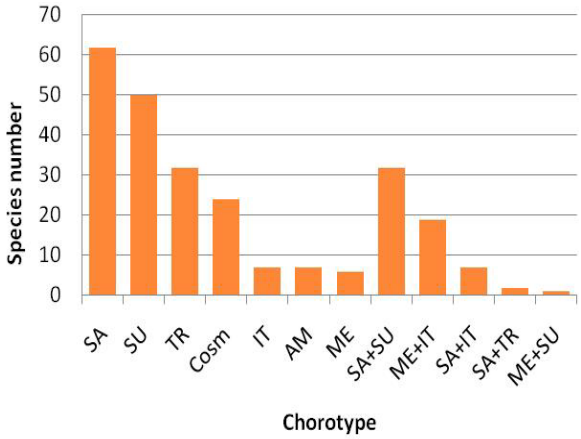

Fig. 3. Chorological types of the recorded species. bbreviations are in Appendix 2.

Conclusion

The present study is the first floristic study of Khulais wadi and showing the importance of the region in term of plant diversity (low ratios). Species numbers were very high compared to different hotspot regions in Saudi Arabia, such as: Asir Mountain, 189 speices (Al-Yemeni & Sher, 2010), Bisha, Asir, 145 spp. (Heneidy & Bidak, 2001) and Sudera, Taif, 234 spp, (Mosallam, 2007). This can be mainly due to the presence of various habitats each with particular features as regard the soil characteristics, rock type, water resources and agricultural activities. Although present study tried to record flora of different habitats yet it was a glimpse of the area. It is believed that there is ample opportunity that many plant species were left unrecorded hence need long-term comprehensive study to document.

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References

Abd El-Ghani, M.M. 1998. Environmental correlates of species distribution in arid desert ecosystems of eastern Egypt. *J Arid Environ*., 38: 297-313.

Abd El-Ghani, M.M. and K.N. Abdel-Khalik. 2006. Floristic Diversity and Phytogeography of the Gebel Elba National Park, South-East Egypt. *Turk J Bot*., 30: 121-136.

Abd El-Ghani, M.M. and N. El-Sawaf. 2004. Diversity and distribution of plant species in the agro-ecosystem of Egypt. *Syst Geogr Pl*., 74: 319-336.

Abulfatih, H.A. 1992. Vegetation zonation along an altitudinal gradient between sea level and 3000 meters in Southwestern Saudi Arabia. *J. King Saud Univ. Scien*., 1: 57-97.

Alatar, A., El-Sheikh, M.A. and J. Thomas. 2011. Vegetation analysis of Wadi Al-Jufair, a hyper-arid region in Najd, Saudi Arabia. Saudi Journal of Biological Sciences. (In press)

Alfarhan, A.H. 1999. A phytogeographical analysis of the floristic elements in Saudi Arabia. *Pak. J. Bio. Sci*., 2(3): 702-711.

Al-Nafie, A. 2004. Plant Geography of Saudi Arabia, Riyadh (In Arabic).

Al-Nafie, A. 2008. Phytogeography of Saudi Arabia. *Saud. J. Biol. Scien*., 15(1): 159-176.

Al-Turki, T.A. and H.A. Al-Qlayan. 2003. Contribution to the flora of Saudi Arabia: Hail region. Saud J Biol Scien 10: 190- 222.

Al-Yemeni, M. and H. Sher. 2010. Biological spectrum with some other ecological attributes of the flora and vegetation of the Asir Mountain of South West, Saudi Arabia. *Af. J. Biotechy*., 9(34): 5550-5559.

Barbero, M., G. Bonin, R. Loisel and P. Quzel. 1990. Changes and disturbances of forest ecosystems caused by human activities in the western part of the Mediterranean basin. *Veget*., 87: 151-173.

Boulos, L. 1999. *Flora of Egypt*, Vol. 1. Azollaceae-Oxalidaceae. Al Hadara Publishing, Cairo, 417pp.

Boulos, L. 2000. *Flora of Egypt*, Vol. 2. Geraniaceae-Boraginaceae. Al Hadara Publishing, Cairo, 352pp.

Boulos, L. 2002. *Flora of Egypt*, Vol. 3. Verbenaceae-Compositae. Al Hadara Publishing, Cairo, 373pp.

Boulos, L. 2005. *Flora of Egypt*, Vol. 4. Monocotyledons (Alismataceae-Orchidaceae). Al Hadara Publishing, Cairo, 617pp.

Cain, S.A. 1950. Life forms and phytoclimates. *Bot. Rev*., 16: 1-32.

Chaudhary, S. 2001. *Flora of the Kingdom* o/Saudi Arabia. Ministry of Agriculture and Water, Riyadh. 2(3): 1-432.

Collenette, S. 1985. An illustrated guide to the flowers of Saudi Arabia. Corpion publishing Ltd., London.

Collenette, S. 1998. Checklist of botanical species in Saudi Arabia. International Asclepiad Society, UK. pp. I-80.

Collentette, S. 1999. Wild Flowers of Saudi Arabia. National Commission for Wildlife Conservation and Development, Riyadh.

Daur, I. 2012. Plant flora in the rangeland of western Saudi Arabia. *Pak. J. Bot.,* 44: 23-26.

Deschenes, J.M. 1969. Life form spectra of contrasting slops of the grazed pastures of Northern New Jersey. *Neturalise Can*., 96: 965-978.

El-Abdaly, M.H. 2004. Rural Urbanization in Khulais Governorate. M.Sc. Thesis, Om Elqorq University (In Arabic).

El-Demerdash, M.A., A.K., Hegazy and A.M. Zilay. 1994. Distribution of plant communities in Tihamah coastal plains of Jazan region, Saudi Arabia. *Vegetat*., 112: 141-151.

El-Ghanem, W.A., L.M. Hassan, T.M. Galal and A. Badr. 2010. Floristic composition and vegetation analysis in Hail region north of central Saudi Arabia. *Saud. J. Biol. Scien*., 17: 119-128.

El-Kady, H.F., M. Ayyad and R. Born Karnum. 1995. Vegetation and recent land-use history in the desert of Maktala, Egypt. *Ad. Geo. Ecol*., 28: 109-123.

Good, R. 1974. The Geography of the Flowering Plants. Fourth Edition. London: Longman Group Limited.

Heneidy, S.Z. and L.M. Bidak. 2001. Biodiversity of plant species in Bisha, Asir region, Souwthwestern Sadi Arabia. *Pak. J. Biol. Scie*., 4(11): 1323-1330.

Hosni, H.A. and A.K. Hegazy. 1996. Contribution to the flora of Asir, Saudi Arabia. *Candollea*, 51: 169-202.

Magurran, A.E. 1988. Ecological Diversity and Its Measurements. New Jersey: Princeton University Press.

Migahid, A.M. 1996. Flora of Saudi Arabia. King Saud University Press, Riyadh, edn 4, 1 1-251 21-282 and 3:1-150.

Milad, M. 2006. Flora Study Series in Saudi Arabia: A Study of the Soil of Makkah-Madinah Road until Rabigh. Umm Al-Qura Univ. *J. Sci. Med. Eng*., 18(1): pp. 13-29.

Miller, A.G. and T.A. Cope. 1996. Flora of the Arabian Peninsula. I: 1- 586. Mosallam HAM 2007. Comparative Study on the Vegetation of Protected and Nonprotected Areas, Sudera, Taif, Saudi Arabia. *Int. J. Agric. Biol*., 9(2): 202-214.

Pielou, E.C. 1975. Ecological diversity. 1st Edn., Wiely Interscience, New York.

Raunkiaer, C. 1934. Life forms of plants and statistical geography, Oxford, 632 P.

Shaltout, K.H. and M.A. Mady. 1996. Analysis of raudhas vegetation in central Saudi Arabia. *J. Ar. Env*., 34: 441-454.

Shaltout, K.H., E.F. El-Halawany and M.M. El-Garawany. 1997. Coastal low land vegetation of eastern Saudi Arabia. *Biod Cons*., 6: 1027-1040.

Thomas, J., A.H. Alfarhan, A. Ali, A.G. Miller and L. Othman. 2008. An account on the eastern limits of Afro-Arabian plants in South Asia. *Bas App Dryd Res*., 2: 12-22.

White, F. and J. Leonard. 1991. Phytogeographical links between Africa and Southwest Asia. *Fl. Veg. Mundi*., 9: 229-246.

Wickens, G.E. 1976. The flora of Jebel Morra (Sudan Republic) and its geographical affinities. Kew Bulletin Additional Series V. London: HMSO.

Zahran, M. 1982. Vegetation Types of Saudi Arabia. King Abdel Aziz University Press, Jeddah, Saudi Arabia.

Zohary, M. 1973. Geobotanical foundations of the Middle East, 2 vols. Gustav Fischer Verlag, Stuttgart.

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