FLORISTIC DIVERSITY, LIFE FORM, AND PLANT LIFE CHOROLOGY AT AL-FAWZAN RESERVE, KINGDOM OF SAUDI ARABIA

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(Received 12th Feb 2024; accepted 4th Jun 2024)

Abstract. Al-Fawzan Reserve in the middle of Saudi Arabia has poor floral diversity according to studies. A comprehensive assessment was carried out for the first time to analyze the floristic structure, phytogeographical distribution, life forms, and plant diversity of the observed taxa. A total of 145 taxa, belonging to 107 genera and 38 families within the Angiospermae, were successfully recognized. Asteraceae was the plant family that constitutes most of the study area's vegetation (25 species), followed by Brassicaceae (16 species), Fabaceae (14 species), Amaranthaceae (12 species), Poaceae (9 species), Zygophyllaceae (7 species), and Plantaginaceae (5 species, 3.4%), meanwhile, the remaining families were each characterized by the presence of one, two, three, or four species. Chamaephytes demonstrated the highest proportion of species (39.3%), followed by Therophytes (35.2%), Hemicryptophytes (11%), Geophytes and phanerophytes (6.9% each), with Parasites being the least prevalent life form group (0.7%). The floristic data of the chorological analysis revealed that the Bi-regional category is the most dominant chorotype in the study area (46.2%), followed by Mono-regional, Pluri-regional, and Worldwide (37.2%, 12.4%, 4.1%, respectively). Data from the current study exhibited that the majority of total recorded taxa (78 species) are perennials, while annuals life spans was counted for (67 species). The current study concluded that 61 species are rare. Out of them, 13 species are classified as least concern (LC) according to the IUCN dataset. The current investigation holds potential value for the effective management and conservation of the studied geographical area.
Keywords: *plant diversity, floristic composition, vegetation, phytogeographical distribution, Al-Fawzan Protectorate, Saudi Arabia*

Introduction

The floristic composition reflects the variety of plants in a given area; it is the primary source of botanical data that serves as an excellent starting point for more in-depth comprehensive research studies of a specific location (Rafay et al., 2013; Keith, 1988).

Saudi Arabia possesses one of the highly diversified floral ecosystems in the Arabian Peninsula, it is comprised of important genetic resources of medicinal and crop plants (Collenette, 1999). Saudi Arabia extends between latitude 16° 83` N – 32° 43` N and longitude 34° 36` E – 56° E, accounts for approximately 80% of the landmass of the Arabian Peninsula, covering an estimated size of 2.2 million km^2 (Almazroui et al., 2012), with roughly a total of 2220 species, 816 genera and 129 families, it is a significant source of biodiversity (Collenette, 1999; Chaudhary, 2001).

There have been several studies on the flora of the country that have been published; however, Chaudhary and Al-Jowaid (1999) and Chaudhary (1999) are the most thorough treatments of the flora. The illustrated flowers of Saudi Arabia by Collenette (1999) and several investigations have been conducted on the indigenous plant species found in specific areas of the country. For instance, Al-Eisawi and Al-Ruzayza (2015) conducted a study on the Mecca district, El-Ghanim et al. (2010) focused on the Hail

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_37093726

region, AL-Harbi (2023) examined the Al-Qassim region, Aljedaani and Fakhry (2023) explored the Jeddah region, and Hosni and Hegazy (1996) investigated the Asir region.

The cumulative count of species documented in Saudi Arabia is progressively increasing, as evidenced by recent field studies and biodiversity surveys. The first 1500 species that Migahid recorded between 1974 and 1988 provide evidence of that. According to the data presented in the Flora of Saudi Arabia, the initial figure was subsequently augmented to reach a total of 2300 over a span of almost three decades (Chaudhary, 2000, 1999; Chaudhary and Al-Jowaid, 1999; Chaudhary and Akram, 1987; Chaudhary and Zawawi, 1983; Thomas et al., 2015; Alfarhan, 2001; Masrahi et al., 2012).

Floristic studies are crucial for understanding the range of plants in a specific region and have valuable economic importance. For humans and other species living in that region, the flora supply shelter, food, and medicine (Shehata and Galal, 2015).

Due to its size and recent climate change (increased rainfall over the past three years), Saudi Arabia's flora has not yet been thoroughly surveyed, therefore, additional floristic work is still required to fill in any gaps. Consequently, the primary objective of the present study was to assess for the first time the phytogeographic distribution, floristic composition, and plant diversity of the wild plants occurring in Al-Fawzan protectorate, Saudi Arabia.

Materials and methods

The present investigation was performed in Al-Fawzan Reserve. This place is situated south of Ain Al-Suwaina, Riyadh, Saudi Arabia. It is in the middle of Saudi Arabia. It is bounded to the north by the Al-Qassim region, to the south by the Riyadh region, to the east by the Eastern region, and to the west by the Madina region. Al-Fawzan Reserve is 707 m above sea level with an area of about 1300 km^2 and lies at 25° 24' 39.489597 N, 44° 23' 39.773268 E (*Fig. 1*). The Al-Fawzan Reserve is situated in the central section of the Saharo Arabian area (Al-Nafie, 2008).

Figure 1. *Location map of Al-Fawzan Reserve, Saudi Arabia*

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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The climate of Al-Fawzan Reserve is characterized by hot dry summers and mild to cool winters. According to records from the climate change knowledge portal, the mean daily maximum and minimum temperatures vary across the study area from 25°C for April to 36°C for October and the highest temperature ever recorded was 42°C in July and August for the period from 1991- 2022. In December and January, respectively, the maximum monthly temperatures were 8°C and 6°C for the colder months. Over a 31-year period (1991–2022), March had the highest mean monthly rainfall of 39 mm, while October had the lowest mean monthly rainfall of 8 mm.

During the period from early November 2020 to the mid of April 2022, a quantitative survey of the vegetation distributed in the study area was conducted. A total of twenty-one sites were randomly investigated. A stratified random sampling method was employed (Ludwig and Reynolds, 1988). Three randomly selected quadrates 10×10 m^2 were examined at each site. At the sampling sites, all plant taxa were listed throughout the vegetation sampling process, along with the necessary field data being observed.

The life form spectra of the observed species were subjected to the classification system proposed by Raunkiaer (1934). Analysis of the chorotypes of the phytogeographical categories was determined according to (White and Léonard, 1991; Al-Nafie, 2008; Zohary, 1973). Identification of plant species was followed (Chaudhary, 2000, 1999; Collenette, 1999; Migahid and Hammouda, 1974; Migahid, 1988, 1978; Boulos, 2009). The Global Biodiversity Information Facility (GBIF, 2023), and the Plants of the World Online (POWO, 2023) were used to revise and update the nomenclature of the recognized taxa, while the Taxonomic Name Resolution Service (TNRS) was used to check for any spelling problems (Boyle et al., 2023). The rarity and the risk of extinction of species were revised based on (IUCN, 2023). The voucher specimens were deposited in Shaqra University Herbarium (SHU, proposed acronym), located in the College of Science and Arts, Sajir.

Results

The study region yielded a comprehensive record of plant species, totaling 145, which were classified into 107 genera across 38 families through our fieldwork efforts (*Table 1; Fig. 2*). The Dicotyledonous families represented about 89.7% (32 families), while the Monocotyledonous accounted for about 10.3% (six families) as shown in *Figure 3*. The families of Monocotyledonous plants include Asphodelaceae (one species), Cyperaceae (two species), Iridaceae (one species), Juncaceae (one species), Poaceae (nine species), and Typhaceae (one species) (see *Fig. 4*).

The data obtained from the present research demonstrates that the Al-Fawzan Reserve has a comparatively elevated level of plant variety, as seen in *Table 2*. The research region included a total of 38 plant families, which accounted for about 29.46% of the overall plant families documented in the flora of Saudi Arabia, consisting of 129 families. The present investigation documented a total of 108 genera, which accounted for about 13.24% of the overall genera documented in the Flora of Saudi Arabia, amounting to 816 genera. The identified plant species, consisting of 145 species, accounted for around 6.53% of the overall documented plant species throughout the whole country, which amounted to 2223 species. In the present research, the ratio of genera to species is 1.34, while the overall ratio of species per genus in the entire country is 2.72 (*Table 2*).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Table 1. *List of plant species recorded in Al-Fawzan Reserve with their families, chorotypes, life forms, life span, and economic uses*

Family	No.	Species name	Chorotype	Life spans	Life form	Economic uses
Acanthaceae	1	*Blepharis ciliaris* (L.) B.L.Burtt	IT+SA	Perennial	Ch	M, G
Aizoaceae	2	*Aizoanthemum hispanicum* (L.) H.E.K Hartmann	SA	Annual	He	G, O
	3	*Aizoon canariense* L.	IT+SA	Annual	He	G, O
	4	*Mesembryanthemum nodiflorum* L.	ES+ME+SA	Annual	Th	G
Amaranthaceae	5	*Anabasis articulata* (Forssk.) Moq.	SA	Perennial	Ch	M, G, O
	6	*Anabasis lachnantha* Aellen & Rech.f.	IT+SA	Perennial	Ch	M, G, F
	7	*Atriplex leucoclada* Boiss.	IT+SA	Perennial	Ch	M, G
	8	*Halothamnus iraqensis* Botsch.	IT+SA	Perennial	Ch	G, F, O
	9	*Haloxylon persicum* Bunge	IT+SZ	Perennial	Ch	M, G, F, O
	10	*Haloxylon salicornicum* (Moq.) Bunge ex Boiss.	IT+SZ	Perennial	Ch	M, G, E, F, O
	11	*Salsola imbricata* Forssk.	SA+SZ	Perennial	Ch	G, F, O
	12	*Salsola inermis* Forssk.	ME	Perennial	Ch	G, F, O
	13	*Salsola jordanicola* Eig.	SA	Annual	Ch	M, G, O
	14	*Salsola schweinfurthii* Solms	SA	Perennial	Ch	M, G, O
	15	*Salsola tetrandra* Forssk.	SA	Perennial	Ch	G, F, O
	16	*Salsola* volkensii Schweinf. & Asch.	IT+ME+SA	Annual	Ch	G, F
Apiaceae	17	*Anisosciadium lanatum* Boiss.	IT+SA	Annual	Ch	M, G, E
	18	*Deverra tortuosa* (Desf.) DC.	SA	Perennial	Ch	M, G, F
	19	*Ducrosia anethifolia* (DC.) Boiss.	IT+SA	Perennial	Ch	M, G, F
Apocynaceae	20	*Calotropis procera* (Aiton) W. T. Aiton	SA+SU	Perennial	Ph	G, O
	21	*Rhazya stricta* Decne.	SA+SU	Perennial	Ch	G
Asphodelaceae	22	*Asphodelus tenuifolius* Cav.	SA+SU	Annual	Ge	M, G, E, O
Asteraceae	23	*Aaronsohnia factorovskyi* Warb. & Eig	SA	Annual	Ch	M, G
	24	*Achillea fragrantissima* (Forssk.) Sch. Bip.	IT+SA	Perennial	Ch	M, G, F
	25	*Anthemis melampodina* Delile	ME+SZ	Annual	Th	O
	26	*Anthemis melampodina* subsp. deserti (Boiss.) Eig	ME+SA+SZ	Annual	Th	O
	27	*Anthemis scrobicularis* Yavin.	SA	Annual	Ch	M, G
	28	*Artemisia judaica* L.	SA	Perennial	Ch	M, G, O
	29	*Artemisia monosperma* Del.	SA	Perennial	Ch	M, G, O
	30	*Artemisia sieberi* Besser	IT+SA	Perennial	Ch	M, G, E, O
	31	*Atractylis carduus* (Forssk.) C. Chr.	SA	Perennial	Ge	M, G
	32	*Calendula tripterocarpa* Rupr.	SA	Annual	Th	M, G, E, O
	33	*Carduus pycnocephalus* subsp. *marmoratus* (Boiss. & Heldr.) P. H. Davis	ES+IT+ME+SA	Annual	Ch	O
	34	*Echinops spinosissimus* Turra	ES+IT+ME+SA	Perennial	Ch	M, G, E, F
	35	*Ifloga spicata* (Forssk.) Sch. Bip.	SA	Annual	Th	M, G
	36	*Koelpinia linearis* Pallas	IT+SA	Annual	He	M, G
	37	*Launaea capitata* (Spreng.) Dandy	IT+ME+SZ	Annual	Th	G
	38	*Launaea nudicaulis* (L.) Hook.f.	IT+SA	Annual	Ch	M, G, E, F, O
	39	*Launaea spinosa* (Forsk.) Sch.Bip. ex O.Kuntze	SA	Perennial	Ch	G
	40	*Pallenis hierochuntica* (Michon) Greuter	IT+SA	Annual	Ch	M, G, O
	41	*Picris cyanocarpa* Boiss.	SA	Annual	Th	G
	42	*Pulicaria undulata* (L.) C. A. Mey.	SA+SU	Perennial	He	M, G, E, O
	43	*Rhanterium epapposum* Oliv.	IT	Perennial	Th	G
	44	*Scorzonera papposa* DC.	IT	Perennial	He	G
	45	*Scorzonera tortuosissima* Boiss.	IT+SA	Annual	He	G
	46	*Senecio glaucus* L.	IT+SA	Annual	Th	G, E
	47	*Zoegea purpurea* Fresen	IT+SA	Annual	He	G

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Boraginaceae	48	*Arnebia decumbens* (Vent.) Coss. & Kralik	IT+SA	Annual	Th	M, G, O
	49	*Echium plantagineum* L.	COSM	Annual	Th	G
	50	*Heliotropium bacciferum* Forssk.	SA+SU	Perennial	Ch	M, F
	51	*Heliotropium crispum* Desf.	IT+SA	Perennial	Ch	M, F
Brassicaceae	52	*Anastatica hierochuntica* L.	SA	Annual	Th	M
	53	*Brassica rapa* L.	COSM	Annual	Th	F, E, O
	54	*Brassica tournefortii* Gouan	ME+SA	Annual	Th	G, E, O
	55	*Cakile arabica* Velen.	IT+SA	Annual	Th	G
	56	*Diplotaxis acris* (Forssk.) Boiss.	SA	Annual	Th	E
	57	*Diplotaxis harra* (Forssk.) Boiss.	IT+SA	Perennial	Ch	G, E, O
	58	*Eruca sativa* Mill.	ES+IT+ME+SA	Annual	Th	M, E
	59	*Erucaria hispanica* (L.) Druce	ME	Annual	Th	G
	60	*Farsetia aegyptia* Turra	SU	Perennial	Ch	M, G
	61	*Horwoodia dicksoniae* Turrill	IT	Annual	He	G
	62	*Lepidium aucheri* Boiss.	IT	Annual	He	G
	63	*Matthiola longipetala* (Vent.) DC.	IT+ME	Annual	Th	G
	64	*Moricandia sinaica* (Boiss.) Boiss.	SA	Perennial	Ch	M, G, O
	65	*Savignya parviflora* (Del.) Webb	SA	Annual	Th	G
	66	*Sisymbrium irio* L.	IT+ME	Annual	Th	M, G, E
	67	*Zilla spinosa* (L.) Prantl	SA	Perennial	Ch	M, G, F
Caprifoliaceae	68	*Lomelosia palaestina* (L.) Raf.	IT+ME	Annual	Th	G
Caryophyllaceae	69	*Gypsophila capillaris* (Forssk.) C. Chr.	IT	Annual	Th	M, O
	70	*Herniaria hirsuta* L.	ES+IT+ME	Annual	Th	G
	71	*Silene conoidea* L.	IT+ME	Annual	Th	G
	72	*Silene villosa* Forssk.	SA	Annual	Th	M, O
Cistaceae	73	*Helianthemum ledifolium* (L.) Mill.	IT+ME	Annual	Th	G
	74	*Helianthemum salicifolium* (L.) Mill.	ES+IT+ME	Annual	Th	G
	75	*Helianthemum sancti-antonii* Schweinf.	SA	Perennial	Ch	G, F
Cleomaceae	76	*Cleome amblyocarpa* Barr. & Murb.	SA+SZ	Annual	Ch	M, G, O
Convolvulaceae	77	*Convolvulus spicatus* Peter ex Hallier f.	SA	Perennial	Ch	G, F
Cucurbitaceae	78	*Citrullus colocynthis* (L.) Schrad.	SA	Perennial	He	M, G, F
	79	*Cucumis prophetarum* subsp. dissectus (Naudin) C.Jeffrey	SA+SZ	Perennial	He	G
Cyperaceae	80	*Cyperus macrorrhizus* Nees	SA	Perennial	Ge	G
	81	*Cyperus schimperianus* Steud.	SA	Perennial	Ge	G
Euophorbiaceae	82	*Chrozophora tinctoria* (L.) A.Juss.	IT+ME	Perennial	Ge	M, G, F
	83	*Euphorbia hirta* L.	IT+SA	Perennial	Th	M
	84	*Euphorbia retusa* Forssk.	ES+ME+SZ	Perennial	Th	M
Fabaceae	85	*Alhagi graecorum* Boiss.	IT+ME	Perennial	Ch	M, G, E, F, O
	86	*Astragalus arpilobus* subsp. *hauarensis* (Boiss.) Podlech	SA	Annual	He	G, F, O
	87	*Astragalus dactylocarpus* Boiss.	IT+SA	Perennial	He	G, F, O
	88	*Astragalus kahiricus* DC.	IT+SA	Perennial	He	G, F, O
	89	*Astragalus schimperi* Boiss.	SA	Annual	Th	G, F, O
	90	*Astragalus spinosus* (Forssk.) Muschl.	IT	Perennial	Ch	G
	91	*Medicago laciniata* (L.) Mill.	SA	Annual	Th	G, F, O
	92	*Melilotus indicus* (L.) All.	ME+SA+SZ	Annual	Th	G, F, O
	93	*Retama raetam* (Forssk.) Webb.	ME+SA	Perennial	Ph	M, F
	94	*Senna italica* Mill.	SU	Perennial	Ch	M, G, E, F, O
	95	*Trigonella hamosa* L.	ME+SA	Annual	Th	G
	96	*Vachellia gerrardii* var. najdensis (Chaudhary) Ragup.	SZ	Perennial	Ph	M, G, F
	97	*Vachellia oerfota* (Forssk.) Kyal. & Boatwr.	SZ	Perennial	Ph	G, O
	98	*Vachellia tortilis* (Forssk.) Galasso & Banfi	SU	Perennial	Ph	M, G, F, O

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
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Geraniaceae	99	*Erodium laciniatum* (Cav.) Willd.	ME	Annual	Th	G
Iridaceae	100	*Moraea sisyrinchium* (L.) Ker Gawl.	IT+ME	Perennial	Ge	G
Juncaceae	101	*Juncus rigidus* Desf.	IT+SA	Perennial	Ch	G, O
Lamiaceae	102	*Mentha longifolia* (L.) L.	ES+IT+ME	Perennial	Ge	M, G, E, O
	103	*Rosmarinus officinalis* L.	COSM	Perennial	Ch	M, E, O
	104	*Salvia spinosa* L.	IT	Perennial	Ch	M, G, E, F, O
	105	*Teucrium polium* L.	IT+ME	Perennial	Ch	M, G, E, F
	106	*Limeum obovatum* Vicary	SA+SZ	Perennial	Ch	G, F
Malvaceae	107	*Malva parviflora* L.	IT+ME	Annual	Th	M, G, E
Neuradaceae	108	*Neurada procumbens* L.	SA	Annual	Th	E
Orobanchaceae	109	*Cistanche phelypaea* (L.) Cout.	IT+ME+SA	Perennial	Pa	M
Papaveraceae	110	*Roemeria hybrida* (L.) DC.	ES+ME+SA	Annual	Th	G
Plantaginaceae	111	*Plantago amplexicaulis* Cav.	SA	Annual	Th	G
	112	*Plantago boissieri* Hausskn. & Bornm. Ex Bornm.	IT+ME	Annual	Th	G
	113	*Plantago ciliata* Desf.	IT+SA	Annual	Ch	G
	114	*Plantago coronopus* L.	IT+SA	Annual	He	M, G, E, O
	115	*Plantago ovata* Forssk.	IT+SA	Annual	Th	M, G
Poaceae	116	*Bromus alopecuros* Poir.	ME	Perennial	Th	G
	117	*Cenchrus ciliaris* L.	COSM	Perennial	Ge	M, G
	118	*Chloris barbata* Sw.	SZ	Perennial	He	G
	119	*Cymbopogon schoenanthus* (L.) Spreng.	SA	Perennial	Ge	G
	120	*Phragmites australis* (Cav.) Trin. ex Steud.	COSM	Perennial	Ph	M, G, E, F, O
	121	*Polypogon monspeliensis* (L.) Desf.	IT+ME+SA	Annual	Th	M, G
	122	*Schismus barbatus* (L.) Thell.	IT+SA	Annual	Th	G
	123	*Stipa capensis* Thunb.	IT+SZ	Annual	Ge	M
	124	*Stipagrostis drarii* (Tackh.) De Wint.	SA	Perennial	Ch	G
Polygonaceae	125	*Calligonum comosum* L'Hér.	IT+SA	Perennial	Ch	O
	126	*Emex spinosa* (L.) Campd.	IT+ME+SA	Annual	Th	M, G, E
	127	*Rumex vesicarius* L.	ME+SA	Annual	Th	M, G, E, O
Primulaceae	128	*AnagaIlis arvensis* L.	ES+IT+SA	Annual	Th	M, G
Resedaceae	129	*Reseda muricata* C. Presl	SA+SZ	Perennial	Th	G
Rhamnaceae	130	*Ziziphus spina-christi* (L.) Desf.	SA+SZ	Perennial	Ph	M, G, E
Rutaceae	131	*Haplophyllum tuberculatum* Juss.	SA	Perennial	Ch	M, O
Solanaceae	132	*Datura innoxia* Mill.	COSM	Annual	Ch	M, E, F
	133	*Lycium shawii* Roem. & Schult.	SA+SU	Perennial	Ch	M, G, E, F, O
	134	*Withania somnifera* (L.) Dunal	IT+ME	Perennial	Ch	M, G, E, F
Tamaricaceae	135	*Tamarix aphylla* (L.) H.Karst.	SZ	Perennial	Ph	M, G, F, O
	136	*Tamarix aucheriana* (Decne. ex Walp.) B. R. Bum	IT+SA	Perennial	Ph	F, O
	137	*Tamarix mascatensis* Bunge.	ES+IT	Perennial	Ph	F, O
Typhaceae	138	*Typha elephantina* Roxb.	IT	Perennial	Ch	M, G, E, F, O
Zygophyllaceae	139	*Fagonia bruguieri* DC.	IT+SA	Perennial	Ch	M
	140	*Fagonia glutinosa* Del.	SA	Perennial	Ch	M
	141	*Fagonia olivieri* DC.	IT+SA	Perennial	Ch	M
	142	*Tetraena hamiensis* (Schweinf.) Beier & Thulin	SA+SZ	Perennial	Ch	M, G
	143	*Tetraena simplex* (L.) Beier & Thulin	SA+SZ	Annual	Th	M
	144	*Tribulus terrestris* L.	ES+IT+ME	Annual	Th	M, G
	145	*Tetraena propinqua* (Decne.) Ghaz. & Osborne	IT+SA	Perennial	Th	M, G

COSM: Cosmopolitan, ES: Euro-Siberian, IT: Irano-Turanian, ME: Mediterranean, SA: Saharo-Arabian, SZ: Sudano-Zambesian, SU: Sudanian, Ch: chamaephytes, He: hemicryptophytes, Ge: geophytes, Ph: phanerophytes, Th: therophytes, Pa: parasites, M: medical, G: grazing, E: edible, F: fuel and O: other uses

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_37093726

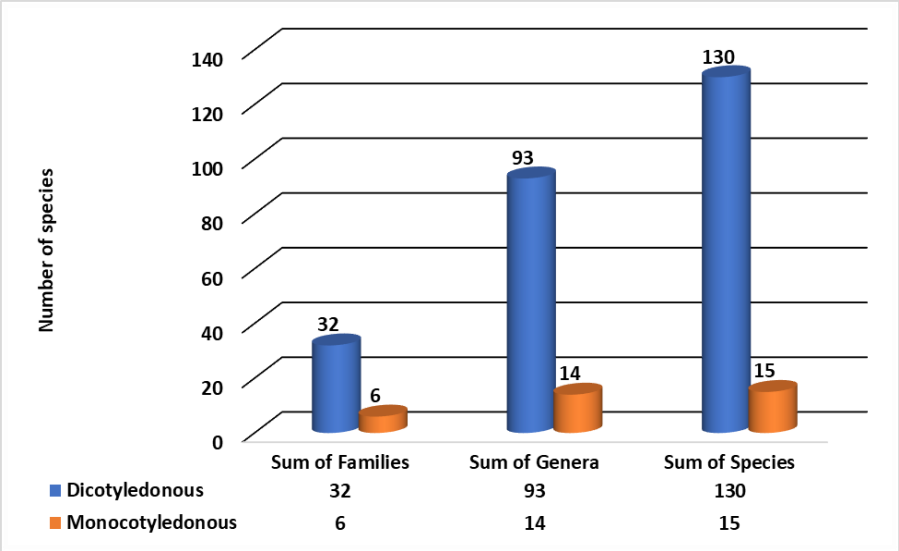

Figure 2. *Histogram of the numbers of families, genera and species based on Dicotyledonous and Monocotyledonous categories in Al-Fawzan Reserve*

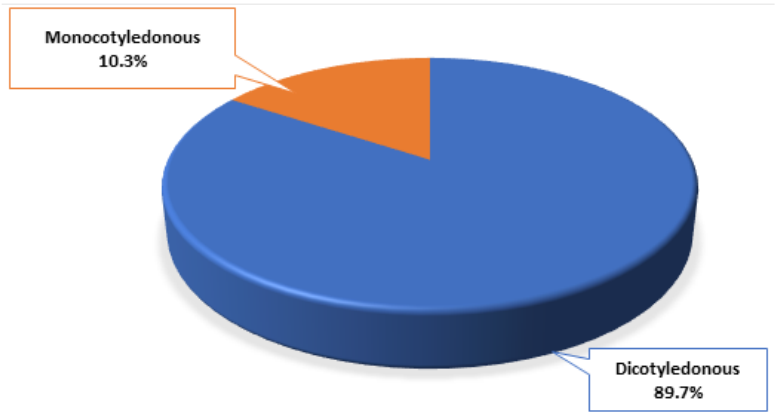

Figure 3. *Habit of the recorded species in Al-Fawzan Reserve, Saudi Arabia*

Table 2. *Comparison of floristic diversity in Al-Fawzan Reserve (the present study area) to the floristic diversity in the entire country of Saudi Arabia*

Location	Family	Genera	Species	Generic coefficient
Al-Fawzan Reserve (the present study area)	38	108	145	1.34
Saudi Arabia (Chaudhary, 2001)	129	816	2223	2.72
Percentage (%)	29.46	13.24	6.53	

The family Asteraceae had the most significant representation with a total of 25 species, accounting for 17.2% of the overall identified species. Following closely behind were Brassicaceae with 16 species (11%), Fabaceae with 14 species (9.7%), Amaranthaceae with 12 species (8.3%), Poaceae with 9 species (6.2%), Zygophyllaceae with 7 species (4.8%), and Plantaginaceae with 5 species (3.4%). Moreover, four species were represented by three families (2.8% each), three species were represented

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by seven families (2.1% each), and two species were represented by two families (1.8% each), while the rest of the families (20 families) were contributed by only one species (0.7% each) (*Fig. 4*).

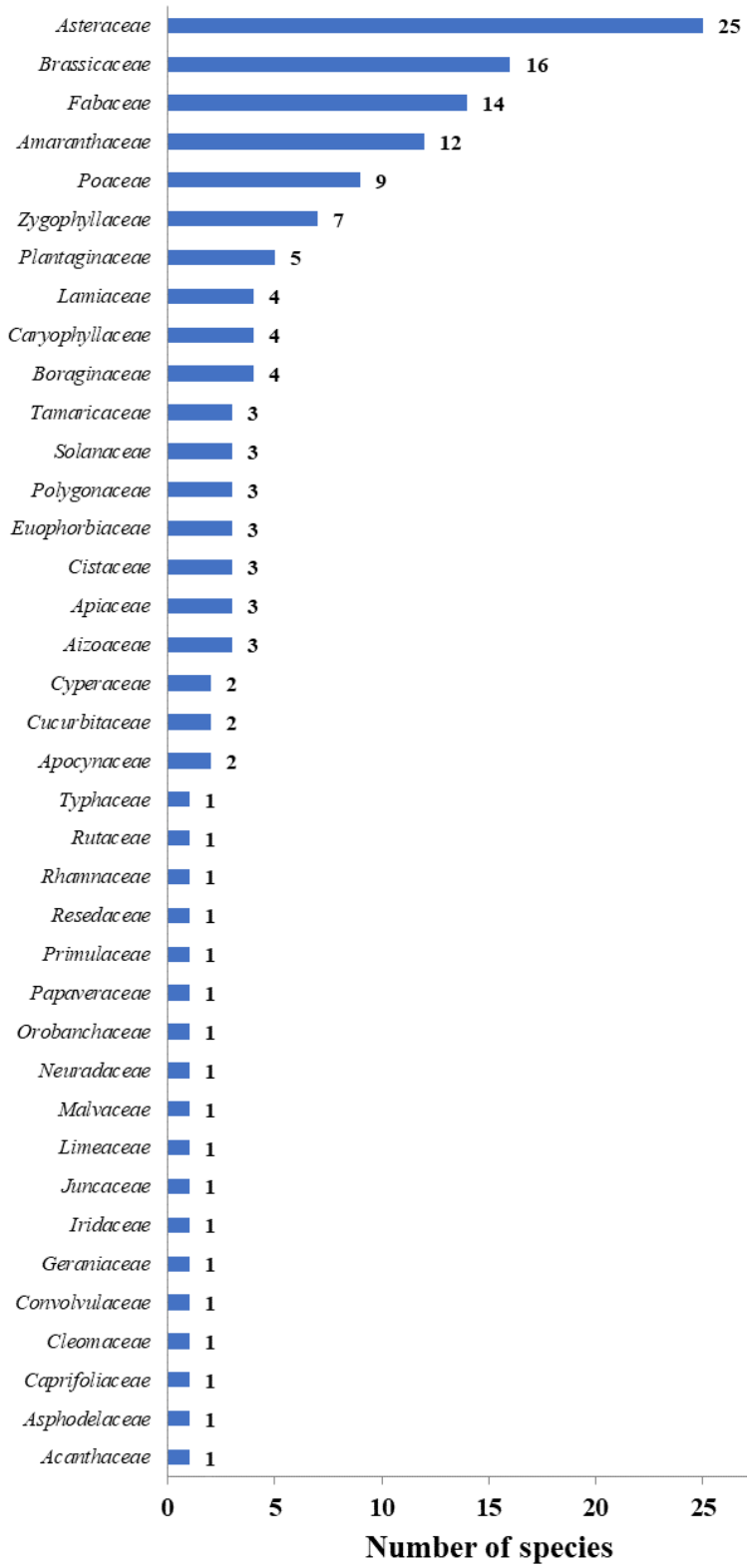

Figure 4. *Plant families of the recorded species in Al-Fawzan Reserve, Saudi Arabia*

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The research region exhibited the presence of six distinct life form spectra, which are documented in *Table 1* and visually shown in *Figure 5*. The analysis of the observed species indicated that the flora of Al-Fawzan Reserve was mostly composed of chamaephytes, accounting for 57 species or 39.3% of the total collected species.

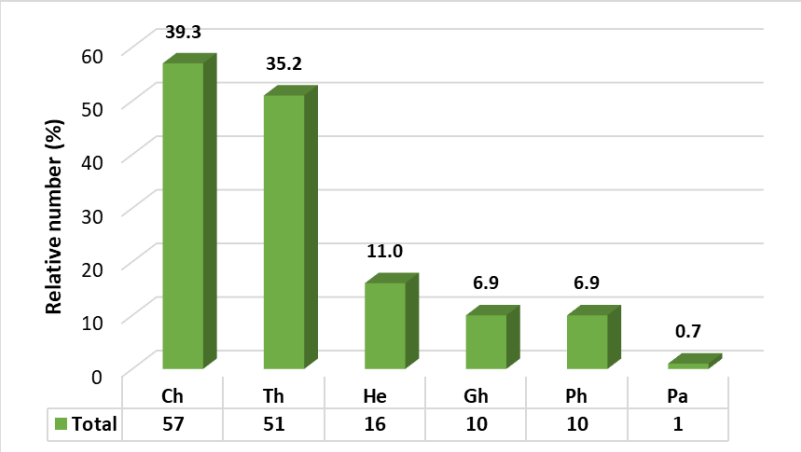

Figure 5. *Life form spectra of the recorded species in Al-Fawzan Reserve, Saudi Arabia. Ch: chamaephytes; Th: therophyte, He: hemicryptophytes; Ge: geophytes, Ph: phanerophytes, Pa: parasites*

Following chamaephytes, therophytes were the second most prevalent group, comprising 51 species or 35.2% of the total species. A total of sixteen species were identified as hemicryptophytes, accounting for about 11% of the overall species population. Both geophytes and phanerophytes are each represented by a total of 10 species, accounting for around 6.9% of the overall species collected. In contrast, the presence of parasites was limited to a single species, namely (*Cistanche phelypaea* (L.) Cout.).

The chronological spectrum exhibited significant diversity in the phytogeographical distribution of plant taxa inside the Al-Fawzan protectorate, as shown by the data presented in *Table 3* and *Figure 6*. It includes four main chorotypes: The bi-regional category exhibited the largest number of collected species with 67 taxa accounting for 46.2% of the total recorded species. The Irano-Turanian/Mediterranean (IT + ME) chorotype accounted for 8.3% of the total species, with a species count of 12. The Saharo-Arabian/Sudano-Zambesian (SA + SZ) chorotype comprised eight species, representing 5.5% of the recorded species. The Saharo-Arabian/Sudanian (SA + SU) chorotype included six species, constituting 4.1% of the recorded species. The Mediterranean/Saharo-Arabian (ME + SA) chorotype consisted of four species, contributing 2.8% to the recorded species. Lastly, the Irano-Turanian/Sudano-Zambesian (IT + SZ) chorotype comprised three species, representing 2.1% of the recorded species, and the less dominances were represented by Mediterranean/Sudano-Zambesian (ME + SZ) and Euro-Siberian/Irano-Turanian (ES + IT) with one species representing 0.7% of recognized species for each.

The second category of species coverage observed was characterized by a mono-regional chorotype, including a total of 54 species, which accounted for 37.2% of the overall distribution. The dataset consisted of five distinct chorotypes, with the Saharo-Arabian (SA) chorotype exhibiting the highest number of species, comprising 35 species or 24.1% of the total species. The Irano-Turanian (IT) chorotype had eight

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species, representing 5.5% of the total species. The Mediterranean (ME) and Saharo-Arabian (SA) chorotypes were each represented by four species, accounting for 2.8% of the total collected species. The Sudanian (SU) chorotype had the lowest representation, with only three species, representing 2.1% of the total recorded species.

Table 3. *The number of the recognized taxa belonging to the main floristic categories and their relevant percentages (%) in Al-Fawzan Reserve*

Chorotype		Number of species	Percentage (%)
Mono-regional	SA	35	24.1
	IT	8	5.5
	ME	4	2.8
	SZ	4	2.8
	SU	3	2.1
	Subtotal	**54**	**37.2**
Bi-regional	IT + SA	32	22.1
	IT + ME	12	8.3
	SA + SZ	8	5.5
	SA + SU	6	4.1
	ME + SA	4	2.8
	IT + SZ	3	2.1
	ME + SZ	1	0.7
	ES + IT	1	0.7
	Subtotal	**67**	**46.2**
Pluri-regional	ES + IT + ME	4	2.8
	IT + ME + SA	4	2.8
	ES + IT + ME + SA	3	2.1
	ES + ME + SA	2	1.4
	ME + SA + SZ	2	1.4
	ES + IT + SA	1	0.7
	ES + ME + SZ	1	0.7
	IT + ME + SZ	1	0.7
	Subtotal	**18**	**12.4**
Worldwide	COSM	6	4.1
Grand total		**145**	**100**

COSM: Cosmopolitan, ES: Euro-Siberian, IT: Irano-Turanian, ME: Mediterranean, SA: Saharo-Arabian, SZ: Sudano-Zambesian, SU: Sudanian

Meanwhile, the Pluri-regional category had eight primary chorotypes and was characterized by the presence of 18 species, accounting for 12.4% of the overall identified taxa. The Euro-Siberian/Irano-Turanian/Mediterranean (ES + IT + ME) and Irano-Turanian/Mediterranean/Saharo-Arabian (IT + ME + SA) regions exhibit the highest levels of representation. In both regions, four species each, accounting for 2.8% of the total species, are present. Additionally, the Euro-Siberian/Irano-Turanian/Mediterranean/Saharo-Arabian (ES + IT + ME + SA) region contains three species, representing 2.1% of the total species, The Euro-

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Siberian/Mediterranean/Saharo-Arabian (ES + ME + SA) and Mediterranean/Saharo-Arabian/Sudano-Zambesian (ME + SA + SZ) chorotypes exhibit the highest representation, each consisting of two species (1.4% each). Conversely, the lowest representation is observed in the Euro-Siberian/Irano-Turanian/Saharo-Arabian (ES + IT + SA), Euro-Siberian/Mediterranean/Sudano-Zambesian (ES + ME + SZ), and Irano-Turanian/Mediterranean/Sudano-Zambesian (IT + ME + SZ) chorotypes, each comprising only one species (0.7% each).

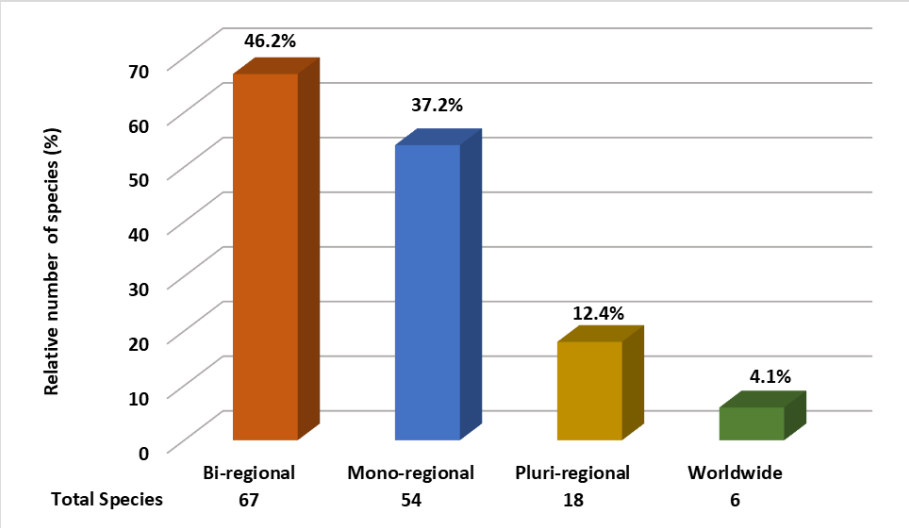

Figure 6. *Global phytogeographical distribution of Al-Fawzan Reserve, Saudi Arabia*

Finally, the cosmopolitan type occupied 4.1% of the total recorded taxa with six species (*Cenchrus ciliaris* L., *Echium plantagineum* L., *Brassica rapa* L., *Rosmarinus officinalis* L., *Phragmites australis* (Cav.) Trin. ex Steud., and *Datura innoxia* Mill.).

In relation to the life spans and durations of the taxa under investigation, it is seen that the majority of species, comprising 54% of the total recorded species, are perennials. This category is represented by 78 species. Conversely, annuals account for 46% of the recorded species, with a total of 67 species (*Fig. 7*). The bulk of taxa that have been officially recognized consist of herbaceous plants, including 102 species which account for 70% of the total number of species collected. Shrubs make up 31 species, representing 22% of the collected species, while trees are represented by 12 species, making up 8% of the total (*Fig. 8*).

Regarding the economic significance and utilizations of recognized taxa (*Fig. 9*), it is noteworthy that the predominant use of plants was for grazing purposes, accounting for 81.4% of the total taxa, followed by medicinal plants which constitute 52.4% of the identified taxa. Additionally, a proportion of 29.7% of the taxa under investigation are used as fuel sources, while 22.1% of the taxa are recognized for their edibility. In the present investigation, a total of 84 species, accounting for 58% of the recognized taxa, were identified as common, while, the remaining 61 species, comprising 42% of the taxa, were classified as rare (see *Fig. 10*).

The recognized plants were verified using the list provided by the International Union for Conservation of Nature and Natural Resources (IUCN, 2023). The Red List of IUCN and its criteria are designed to be an easy-to-understand system for classifying

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taxa that are under great threat of extinction on a worldwide scale. Nine categories are used to categorize species in IUCN Red List based on the increasing risk of extinction: (NE) not evaluated, (DD) data deficient, (LC) least concerned, (NT) near threatened, (VU) vulnerable, (EN) endangered, (CR) critically endangered, (EW) extinct in the wild, and (EX) extinct. It was remarkable that out of 145 recorded species in the current study, only 13 species were included in the Red List of IUCN (*Table 4*). All of the species mentioned are classified in the least concern category (LC). Population trends of eight species are stable (four species are assessed in Europe, two in the Mediterranean, and two globally). The worldwide population patterns for the remaining five species are globally unknown.

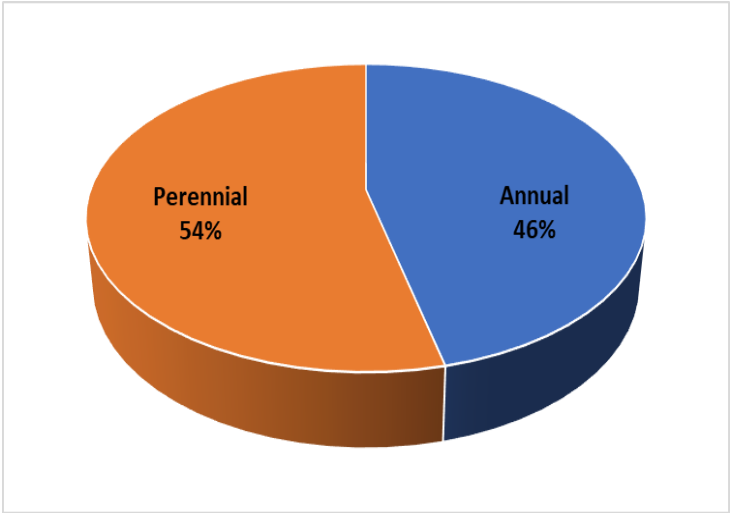

Figure 7. *Life spans of the recorded species in Al-Fawzan Reserve, Saudi Arabia*

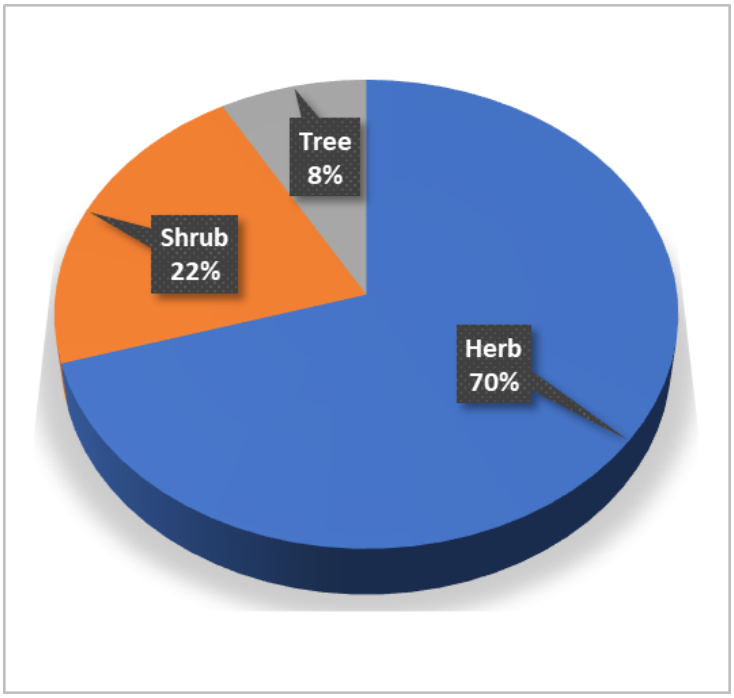

Figure 8. *Habits of the recorded species in Al-Fawzan Reserve, Saudi Arabia*

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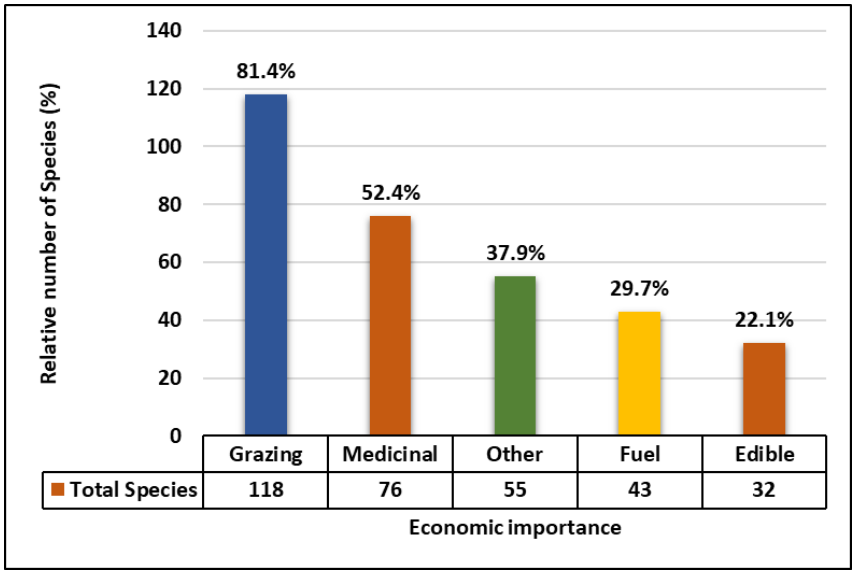

Figure 9. *Potential economic importance of the recorded species in Al-Fawzan Reserve, Saudi Arabia*

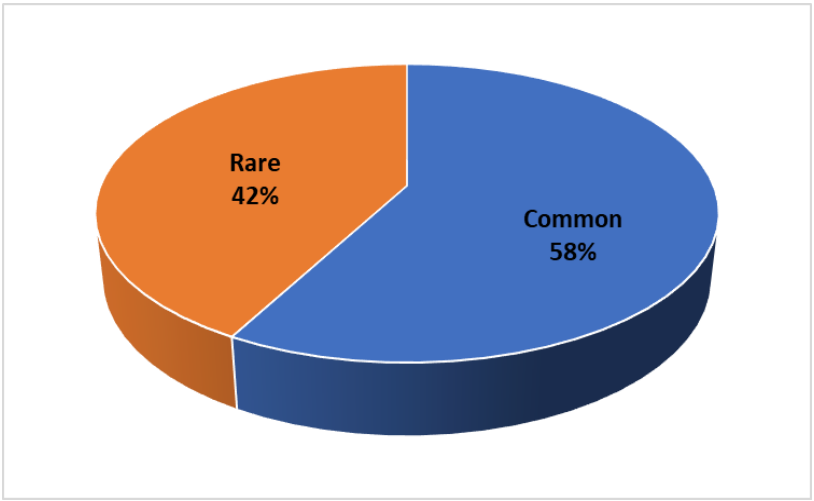

Figure 10. *Abundance of the recorded species Al-Fawzan Reserve, Saudi Arabia*

Discussion

As was previously noted, Saudi Arabia is vast nation including a variety of biogeographic zones. Consequently, it exhibits a diverse array of distinct categories at both the generic and family levels (Al-Eisawi and Al-Ruzayza, 2015).

This research is the first floristic investigation conducted on the Al-Fawzan protectorate, highlighting the region's significance in terms of plant variety, as shown by the observed low ratios. Species numbers were equal or higher compared to different hotspot regions in Saudi Arabia, such as Wadi Al Rummah, Qassim region, 59 sp. (El Ghazali et al., 2013), Wadi Tashar, Jazan, 89 sp. (El-Shabasy and Kasem, 2018), Tabuk province, 96 sp. (Al-Mutairi et al., 2016), Al-Saoda, Asir region, 103 sp. (Seraj et al., 2014), Jeddah, 107 sp. (Aljedaani and Fakhry, 2023), and Hail region, 124 sp. (El-Ghanim et al., 2010), Bisha, Asir region, 145 sp. (Heneidy and Bidak, 2001).

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Table 4. *Status of globally threatened taxa recorded in the study area as checked with the IUCN red list*

Species	Status	Population trend	Scope of assessment	Last assessed
Haloxylon persicum Bunge	LC	Unknown	Global	12 February 2020
Calotropis procera (Aiton) W. T. Aiton	LC	Unknown	Global	14 January 2022
Brassica tournefortii Gouan	LC	Stable	Europe	16 April 2010
Cyperus schimperianus Steud.	LC	Unknown	Global	07 June 2016
Chrozophora tinctoria (L.) A.Juss.	LC	Unknown	Global	02 May 2012
Medicago laciniata (L.) Mill.	LC	Stable	Europe	15 April 2010
Vachellia tortilis (Forssk.) Galasso & Banfi	LC	Stable	Global	30 January 2020
Juncus rigidus Desf.	LC	Unknown	Global	03 May 2012
Mentha longifolia (L.) L.	LC	Stable	Mediterranean	13 February 2009
Rosmarinus officinalis L.	LC	Stable	Europe	11 June 2013
Plantago ovata Forssk.	LC	Stable	Europe	26 March 2014
Typha elephantina Roxb.	LC	Stable	Mediterranean	11 February 2009
Tribulus terrestris L.	LC	Stable	Global	28 August 2019

LC: least concern

The scope of this research is limited to a particular geographic location inside Saudi Arabia, namely the Al-Fawzan Reserve. The site is situated in the central portion of the desert area of Saudi Arabia. The analysis of the present research revealed that the Al-Fawzan protectorate had a comparatively elevated level of plant variety. A total of 145 species were identified in the confines of this limited geographical region, accounting for 6.53% of the overall species documented in Saudi Arabia.

In relation to the floristic and vegetational composition within the examined region, it was observed that the families Asteraceae, Brassicaceae, Fabaceae, and Amaranthaceae had the greatest species richness, with 25, 16, 14, and 12 species respectively. The families in concern constituted almost 33% of the floral composition inside the Al-Fawzan protectorate. The high frequency of Asteraceae is in line with other floristic studies in different Saudi Arabian regions (Al-Mutairi et al., 2016; El-Ghanim et al., 2010; AL-Harbi, 2023; Elkordy et al., 2022; Seraj et al., 2014). According to Jeffrey (2007), the Asteraceae's dominance is due to its extensive phytogeographical range and effective seed dispersal. Moreover, more than 50% of all families were occupied by a single taxa: Papaveraceae, Primulaceae, Cucurbitaceae, Cleomaceae, Caprifoliaceae, Convolvulaceae, Cucurbitaceae, Limeaceae, Typhaceae, Malvaceae, Resedaceae, Rutaceae, Xanthorrhoeaceae, Neuradaceae, Orobanchaceae, Juncaceae, Acanthaceae, Rhamnaceae, Geraniaceae, and Iridaceae. The genus *Salsola* (Amaranthaceae) had the greatest species richness, consisting of six species. This was closely followed by the genera *Astragalus* (Fabaceae) and *Plantago* (Plantaginaceae), each represented by five species.

Saudi Arabia's flora exhibits a significant disparity between the number of genera and the number of species, with an average of around 2.72 species per genus. In comparison to the world average of 13.6, this figure is notably lower (Chaudhary, 2000, 1999). According to Hawksworth (1995), a phytogeographical area is exhibiting a great diverse if it has a certain number of species that belong to different genera than if it has the same number of species that only belong to a few genera. The present investigation reveals that the botanical composition of the Al-Fawzan Reserve falls below the mean level seen in the flora of Saudi Arabia, with an average species-to-genus ratio of 1.34. This observation suggests that the Al-Fawzan Reserve has a notable abundance of species variety within its flora.

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Di Biase et al. (2021) stated that the analysis of life form spectrum provides valuable data for understanding the response of plants to variations in environmental conditions. According to the findings of a floristic analysis, the dominant plant life in the research region consists of chamaephytes, which include a majority of 57 species, accounting for 39.3% of the total recognized species, followed by therophytes which are the next most prevalent group with 51 species, representing 35.2% of the total species gathered.

Furthermore, the ability of chamaephytes species to resist salinity, drought, and sediment accumulation may also contribute to their dominance (Danin, 2012; Galal and Fahmy, 2012). Nevertheless, previous studies of (Al-Sodany et al., 2016; El-Demerdash et al., 1994) came to the conclusion that the predominance of chamaephytes and therophytes in relation to other life forms signifies a hot and arid environment, topographic changes, and biotic impacts.

The research region only documented the presence of *Cistanche phelypaea* (L.) Cout., a parasitic species that primarily occurs in association with certain species of Zygophyllaceae. The findings of our investigation align with the research conducted by Farah and Al-Subaie (2006). Generally, the absence of parasitic species in a geographic area may be indicated by less water conservation (Al-Hawshabi et al., 2017).

The taxa of the study area are categorized into four main phytogeographical groups: mono-regional, bi-regional, Pluri-regional, and worldwide. At 54% and 67%, respectively, mono- and bi-regional groups account for the greatest proportion of the population. The vegetation found in Saudi Arabia is mainly belonging to the Saharo-Arabian zone, as identified by Zohary (1973). The flora belonging to the Saharo-Arabian chorotype has a notable capacity to serve as reliable indicators of the prevailing environmental conditions within desert ecosystems (Abd El-Ghani and Amer, 2003). The investigation revealed that the Saharo-Arabian (SA) region exhibited the most substantial proportion of chorotype distribution within the designated study area. Specifically, 35 species, including 24.1% of the total recognized species, were identified in this region. In comparison, the Irano-Turanian/Saharo-Arabian (IT + SA) region accounted for 32 species, representing 22.1% of the overall recognized species. The results that were obtained in this study are consistent with the findings reported by Al-Nafie (2008).

The floristic analysis of the present research reveals that perennial species exhibited dominance over annual species, with a distribution ratio of 54% to 46% correspondingly. The majority of perennial species indicated a limited amount of precipitation, which is insufficient for the development of many annual plants (Hosni and Hegazy, 1996; Aati et al., 2019).

The surveyed flora of the current study showed a predominant presence of herbaceous plant species in comparison to other forms of plant habits. About 70 percent of the recorded taxa are herbs, this dominance may be attributed to their relatively short life cycle, which facilitates their ability to withstand and adapt to extreme climatic circumstances (Gomaa, 2012).

The current investigation has concluded that a total of 61 species with a percentage of 42% are rare. Out of them, thirteen species are classified as least concern (LC) according to the IUCN dataset. These species should be given a high priority for conservation due to their rarity and potential for extinction, which implying that they may be endangered by both biotic and abiotic forces (Rabei and Elgamal, 2021).

Acknowledgment. The Deanship of Scientific Research at Shaqra University is gratefully acknowledged by the authors for supporting their work.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_37093726

REFERENCES

[1] Aati, H., El-Gamal, A., Shaheen, H., Kayser, O. (2019): Traditional use of ethnomedicinal native plants in the Kingdom of Saudi Arabia. – Journal of Ethnobiology and Ethnomedicine 15: 1-9.
[2] Abd El-Ghani, M. M., Amer, W. M. (2003): Soil–vegetation relationships in a coastal desert plain of southern Sinai, Egypt. – J. Arid. Environ. 55(4): 607-628.
[3] Al-Eisawi, D. M., Al-Ruzayza, S. (2015): The flora of holy Mecca district, Saudi Arabia. – Int. J. Bio. Cons. 7(3): 173-189.
[4] Alfarhan, A. (2001): A floristic account on Raudhat Khuraim central province Saudi Arabia. – Sau. J. Bio. Sci. 8(1): 80-103.
[5] Al-Harbi, N. A. (2023): Ecological and floristic study on the Medicinal plants in Al-Qassim region, Saudi Arabia. – Pak. J. Bot. 55(1): 185-197.
[6] Al-Hawshabi, O. S. S., Al-Meisari, M. A., El-Naggar, S. (2017): Floristic composition, life-forms and biological spectrum of Toor Al-Baha District, Lahej Governorate, Yemen. – Curr. L. Sci. 3(4): 72-91.
[7] Aljedaani, G. S., Fakhry, A. M. (2023): Floristic Diversity of Jeddah: An Arid Desert, Western Region of Saudi Arabia. – Eg. j. Bot. 63(1): 57-68.
[8] Almazroui, M., Nazrul Islam, M., Athar, H., Jones, P., Rahman, M. A. (2012): Recent climate change in the Arabian Peninsula: annual rainfall and temperature analysis of Saudi Arabia for 1978–2009. – Int. J. Clim. 32(6): 953-966.
[9] Al-Mutairi, K., Al-Shaami, S., Khorshid, Z., Moawed, M. (2016): Floristic diversity of Tabuk province, north Saudi Arabia. – J. An. Pl. Sci. 26(4): 1019-1025.
[10] Al-Nafie, A. H. (2008): Phytogeography of Saudi Arabia. – Sau. J. Bio. Sci. 15(1): 159-176.
[11] Al-Sodany, Y. M., Al-Juaid, N. S., Kahil, A. (2016): Ecology of invasive species in Saudi Arabia, Calotropis procera (Ait.) WT Ait.: floristic composition and associated plant communities. – Int. J. Ecot. Eco. 1(3): 127-140.
[12] Boulos, L. (2009): Flora of Egypt. Checklist, Egypt. – Al Hadara Publishing, Cairo.
[13] Boyle, B. L., Matasci, N., Mozzherin, D., Rees, T., Barbosa, G. C., Kumar Sajja, R., Enquist, B. J. (2023): Taxonomic Name Resolution Service. – https://tnrs.biendata.org/.
[14] Chaudhary, S. (1999): Flora of the Kingdom of Saudi Arabia, Riyadh (Saudi Arabia). – National Herbarium Ministry of Agriculture and Water, Kingdom of Saudi Arabia.
[15] Chaudhary, S. (2000): Flora of the Kingdom of Saudi Arabia, Riyadh (Saudi Arabia). – National Herbarium Ministry of Agriculture and Water, Kingdom of Saudi Arabia.
[16] Chaudhary, S. (2001): Flora of the Kingdom of Saudi Arabia, Riyadh (Saudi Arabia). – National Herbarium Ministry of Agriculture and Water, Kingdom of Saudi Arabia.
[17] Chaudhary, S. A., Akram, M. (1987): Weeds of Saudi Arabia and the Arabian Peninsula, Riyadh (Saudi Arabia). – Regional Agriculture and Water Research Center, Ministry of Agriculture and Water, Kingdom of Saudi Arabia.
[18] Chaudhary, S. A., Al-Jowaid, A. a. A. (1999): Vegetation of the Kingdom of Saudi Arabia, Riyadh (Saudi Arabia). – National Agriculture and Water Research Center, Ministry of Agriculture and Water, Kingdom of Saudi Arabia.
[19] Chaudhary, S. A., Zawawi, M. A. (1983): A Manual of Weeds of Central and Eastern Saudi Arabia, Riyadh (Saudi Arabia). – Ministry of Agriculture and Water, Regional Agriculture and Water Research Center, Kingdom of Saudi Arabia.
[20] Collenette, S. (1999): Wildflowers of Saudi Arabia, Riyadh (Saudi Arabia). – National Commission for Wildlife Conservation and Development (NCWCD), Riyadh.
[21] Danin, A. (2012): Plants of Desert Dunes. – Springer Science & Business Media, Berlin.
[22] Di Biase, L., Pace, L., Mantoni, C., Fattorini, S. (2021): Variations in plant richness, biogeographical composition, and life forms along an elevational gradient in a Mediterranean mountain. – Plants 10(10): 2090.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_37093726

[23] El Ghazali, G. E., Al-Soqeer, A. R. A., El Tayeb, G. E. (2013): Floristic and ecological studies on the plant cover of Wadi Al Rummah, Qassim Region, Saudi Arabia. – Int. Res. J. Pl. Sci. 4(10): 310-318.
[24] El-Demerdash, M., Hegazy, A., Zilay, A. (1994): Distribution of the plant communities in Tihamah coastal plains of Jazan region, Saudi Arabia. – Veg. 112(2): 141-151.
[25] El-Ghanim, W. M., Hassan, L. M., Galal, T. M., Badr, A. (2010): Floristic composition and vegetation analysis in Hail region north of central Saudi Arabia. – Sau. J. Bio. Sci. 17(2): 119-128.
[26] Elkordy, A., Nour, I. H., Ellmouni, F. Y., Al Shaye, N. A., Al-Bakre, D. A., El-Banhawy, A. (2022): Floristic diversity of Jabal Al-Ward, Southwest Tabuk Region, Kingdom of Saudi Arabia. – Agro. 12(11): 2626.
[27] El-Shabasy, A., Kasem, W. (2018): Systematic composition, species diversity and plant chorology at Wadi Tashar, Jazan, Saudi Arabia. – J. Med. Plants Stud 6(1): 83-88.
[28] Farah, A., Al-Subaie, F. (2006): Ecological studies on Thanoun (Cistanche phelypaea (L.) Cout. (Orobanchaceae) in Al-Ahsa Oasis, Saudi Arabia. – Sci. J. K. Fais. Univ. 7(1): 75-86.
[29] Galal, T. M., Fahmy, A. G. (2012): Plant diversity and community structure of Wadi Gimal protected area, Red Sea Coast of Egypt. – Afr. J. Eco. 50(3): 266-276.
[30] GBIF (2023): The Global Biodiversity Information Facility [Online]. – https://www.gbif.org/ (accessed 20 May 2023).
[31] Gomaa, N. H. (2012): Composition and diversity of weed communities in Al-Jouf province, northern Saudi Arabia. – Sau. J. Bio. Sci. 19(3): 369-376.
[32] Hawksworth, D. L. (1995): Biodiversity: Measurement and Estimation. – Springer Science & Business Media, Berlin.
[33] Heneidy, S., Bidak, L. (2001): Multipurpose plant species in Bisha, Asir region, southwestern Saudi Arabia. – Journal-King Saud University Science 13(1/2): 11-26.
[34] Hosni, H., Hegazy, A. (1996): Contribution to the flora of Asir, Saudi Arabia. – Cand. 51: 169-202.
[35] IUCN (2023): The IUCN Red List of Threatened Species [Online]. – https://www.iucnredlist.org [Accessed 25 May 2023].
[36] Jeffrey, C. (2007): Compositae: Introduction with Key to Tribes. – In: Kadereit, J. W., Jeffrey, C. (eds.) Families and Genera of Vascular Plants, Flowering Plants, Eudicots, Asterales. Springer-Verlag, Berlin.
[37] Keith, D. (1988): Floristic lists of New South Wales (III). – Cunnin. 2(1): 39-73.
[38] Ludwig, J. A., Reynolds, J. F. (1988): Statistical Ecology: A Primer in Methods and Computing. – John Wiley & Sons, Hoboken, NJ.
[39] Masrahi, Y., Al-Huqail, A., Al-Turki, T., Thomas, J. (2012): *Odyssea mucronata*, Sesbania sericea, and Sesamum alatum - new discoveries for the flora of Saudi Arabia. – Turk. J. Bot. 36(1): 39-48.
[40] Migahid, A. M. (1978): Flora of Saudi Arabia. – Riyadh University, Riyadh.
[41] Migahid, A. M. (1988): Flora of Saudi Arabia. – Riyadh University, Riyadh.
[42] Migahid, A., Hammouda, M. (1974): Flora of Saudi Arabia. – Riyadh University, Riyadh.
[43] POWO (2023): Plants of the World Online. – Facilitated by the Royal Botanic Gardens, Kew.
[44] Rabei, S., Elgamal, I. A. (2021): Floristic study of Saint Katherine protectorate, Sinai: with one new record to flora of Egypt. – Taeckh. 41(1): 32-55.
[45] Rafay, M., Khan, R. A., Yaqoob, S., Ahmad, M. (2013): Nutritional evaluation of major range grasses from Cholistan desert. – Pak. J. Nut. 12(1): 23-29.
[46] Raunkiaer, C. (1934): The Life Forms of Plants and Statistical Plant Geography; Being the Collected Papers of C. Raunkiaer. – Oxford University Press, London.
[47] Seraj, S. S., Jrais, R. N., Ayyad, S. K. (2014): Floristic composition, life form and chorology of plant life at Al-Saoda, Asir Region, South-Western Saudi Arabia. – J. Bio. Agr. Health. 4(26): 60-67.

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DOI: http://dx.doi.org/10.15666/aeer/2204_37093726

[48] Shehata, H. S., Galal, T. M. (2015): Factors affecting the distribution and associated species of *Malva parviflora* in the Nile Delta, Egypt. – Weed Biol. Manag. 15(1): 42-52.
[49] Thomas, J., Basahi, R., Al-Ansari, A., Sivadasan, M., El-Sheikh, M., Alfarhan, A., Al-Atar, A. (2015): Additions to the Flora of Saudi Arabia: two new generic records from the Southern Tihama of Saudi Arabia. – Natl. Acad. Sci. Lett. 38: 513-516.
[50] White, F., Léonard, J. (1991): Phytogeographical links between Africa and southwest Asia. – Flora et Veg. Mun. 9: 229-246.
[51] Zohary, M. (1973): Geobotanical Foundations of the Middle East. – Gustav Fischer Verlag, Stuttgart.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_37093726