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Biodiversity of the Plant Species in Bisha, Asir Region, Southwestern Saudi Arabia

S. Z. Heneidy and L. M. Bidak
Botany Department, Faculty of Science, Alexandria University, Egypt

Abstract: The study focused on plant diversity and species richness in each landform in the southwestern region of Saudi Arabia. One hundred and forty five species were recorded, belonging to 39 families.
The most dominant families were Compositae (20 %), Graminae (14.5 %), Leguminosae and Chenopodiaceae (7 %). The contribution of the study area for ferns (25 %), gymnospermae (10 %), dicot (12 %) and monocot (11.9) of the total species in Saudi Arabia. The maximum number of plant species was attained in wadis followed by sandy plain habitats (111 and 109 respectively). The highest species richness/ habitat (111 sp./habitat) was recorded in wadis, while the lowest (56 sp./habitat) was recorded in rocky ridges . Beta diversity was estimated as the ratio between the total number of species and species richness (alpha diversity) where, there was little variation among four habitats (e.g. maximum ratio was 15.1 in sandy flat plateaus and minimum was 10.0 in both sandy rocky ridges and rocky ridges). About 10, 12, 12, and 25 % of the ferns, gymnospermae, dicotyledoneae, and monocotyledoneae were respectively the flora of Saudi Arabia. On the other hand, about 24 %, of the flowering plant occur in the southwestern region of Saudi Arabia.

Key wards: Arabian Peninsula, species richness, ferns, taxonomic diversity

Introduction

Diversity of natural ecological communities have never been more highly valued they are now, as they become increasingly threatened by the environmental crisis and human miss-uses. Biological diversity, or biodiversity, refers to the variety of distinct ecosystems or habitats, the number and variety of species within them, and the range of genetic diversity within the populations of these species. Two attributes of biodiversity have attracted particular attention from the international conservation community: species richness (the number of species in an area), and endemism (the number of species in that area that occur no where else) (Caldecott *et al*., 1996). Because these two attributes reflect the complexity, uniqueness and intactness of natural ecosystems, they are believed to indicate overall patterns of biodiversity in a useful way.

The natural conditions and geographical position of the southwestern region of Saudi Arabia make it a very distinctive region, as it occupies a key position as a bridge between south of El-Arab Peninsula (Arab Gulf and Yemen) and north of Arabian Peninsula. Its floristic composition, their economical and ecological value is varied greatly (Heneidy & Bidak, 2000). For these reasons this paper focuses on the species and floristic composition of Saudi Arabian especially the southwestern region and its role to the whole area. Consequentially, it explores the importance of the southwestern region and its contribution in the flora of Saudi Arabia.

Materials and Methods

The study area is Asir region, in the vicinity of Bisha in southwestern Saudi Arabia. It extends to or more 200 km around Bisha (18° 30', 21° 30' N and 38° 00' E) and altitude between > 354 < feet above sea level (Fig. 1). It has different wadis and physiographic provinces where, the largest one is wadi Bisha. Geologically, the study area belongs to the greater Afro-Arabia shield which is a part of Precambrian crustal plate, generally exposed and locally covered by tertiary volcanic rocks as described by Schmidt *et al*. (1972).

According to the climatic normals of southern region (average of 1966- 1986) (Table 1), Bisha area is an arid region . Recently climatic data the monthly air temperature ranges between 2 °C during January and 40 °C during August with average 24 °C. The annual mean relative humidity of the study area is about 31 % and the rainfall ranges between 100 and 123 mm y^{-1}.

Table 1: Long term averages of meteorological data of Bisha area (after Ministry of Agriculture and Water 1966 -1986).

Month	Temperature ° C			Humidity (%)			Rainfall (mm)
	Maximum	Minimum	Average	Maximum	Minimum	Average	Average (mm /month)
January	32	0.2	16.4	84	36	60	10.2
February	36.4	1.4	18.9	69	27	48	6.6
March	36.8	6.3	21.5	81	32	57	19.5
April	39.5	10.4	24.9	62	22	42	40.5
May	40.0	11.4	25.7	56	13	35	12.1
June	41.8	14.0	27.9	46	16	31	3.3
July	44.2	11.4	27.8	45	20	32	4.5
August	42.2	16.4	29.3	54	26	40	3.2
September	41.2	11.3	26.2	57	33	45	1.0
October	38.5	8.6	23.5	43	18	31	5.5
November	35.1	1.6	18.4	80	31	56	7.3
December	32.7	1.3	16.9	78	27	52	5.1
Annual average	38.4	7.85	23.1	62.9	25.1	44.1	118.8

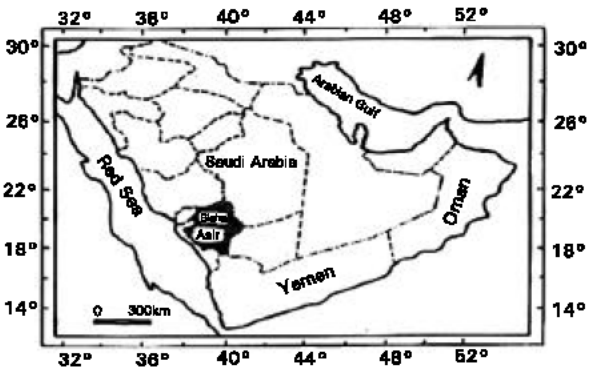

Fig. 1: Map of Saudi Arabia showing the location of the study area.

Data on the distribution of the plant in Saudi Arabia were obtained from Migahid (1996). Additional distribution data used for the analysis and diversity indices were sampled from 80 stands throughout different habitats in the southwest of Saudi Arabia.

Eighty stands (200 m^2 each) were selected according to the variation in physiognomy and physiography of the study area. In each stand list of species and their life forms were recorded. The combined estimation of cover abundance scale was used together with sociability value (Braun-Blanquet, 1964). Check on this estimate was carried out using the line intercept method (Canfield, 1941) in some stands to be sure about the accuracy of the qualitative estimation. The voucher specimens have been deposited in Botany Department (Pioneer herbarium), Faculty of Education for Girls, Bisha, Saudi Arabia. Nomenclature was according to Migahid , (1996).

Stands have been sampled qualitatively. Major habitats sampled were: sandy plains, wadis, sandy flat plateau and flat plateau (15 stands in each) while, sandy rocky ridge and rocky ridge habitats (10 stands in each). The number of stands selected in each habitat depended largely upon the variations in other environmental factors such as elevation, slope degree, the nature of soil surface and Climatic factors.

The mean number of species / stand (species richness) is presented here as average numbers per stand and species turnover as the relation between the total species recorded in each habitat and its species richness. Shannon- weaver's and Simpson's indices, respectively (Pielou, 1975) were used to express the relative evenness and relative concentration of dominance of species. All plant species were organized according to tabular comparison technique as described by Muller-Dombois and Ellenberg (1974).

Results

Species richness and taxonomy diversity: The genera and species of Ferns , Gymnospermae and Angiospermae in Saudi Arabia are listed in Table 2. These genera and species belong to 115 families. The most dominant families were Gramineae (13.0 %), Compositae (11.9 %), and Leguminosae (6.7 %). The total number of species 1196 + 50 interspecific species of which 59.5 % were perennial sand 39.5 % annuals. There were eight families of ferns and gymnospermae, ninety dicotyledoneae and 16 monocotyledonaea families.

Generally the contribution of southern region for ferns and gymnospermae are 6 and 9 species respectively (i.e. all or most of ferns and gymnospermae species are recorded in this region). Of the total perennial species 32.7% were recorded in southern region, while 20.5 % of the total annuals were in this region.

The ratios of species/genera and genera/families of the Saudi Arabia as the whole and as percentage for the south region are listed (Table 3). They indicated that higher taxonomic diversity (e.g. 1.6 for ferns, 2.0 gymnospermae and 2.3 for

Table 2: Number of perennial, annual species, families and their number in south and south Hijaz regions of Saudi Arabia according to Migahid (1996). S = South, SH = South Hijaz, and V = Variety

Family	Perennial		No. of species in S,SH	Annual		No. of species In S, SH	Total species
	Genus	Species		Genus	Species		
Equisetaceae	1	1	1	--	--	--	1
Ophioglossaceae	1	1	--	--	--	--	1
Cryptogramnataceae	1	1	1	--	--	--	1
Adiantaceae	2	1	1	--	1	--	2
Aspleniaceae	1	2	2	--	--	--	2
Sinopteridaceae	1	3	3	--	--	--	3
Cupressaceae	2	4	3	--	1	--	5
Ephedraceae	1	3	3	--	--	--	3
Ranunculaceae	3	4	2	--	3	2	7
Menispermaceae	1	1	--	--	--	--	1
Papaveraceae	4	--	--	--	6 + 1V	1 + 1V	6
Fumariaceae	1	--	--	--	2	--	2
Hypecoaceae	1	--	--	--	2	--	2
Capparceae	5	13 + 2V	4	--	--	--	13 + 2V
Cleomaceae	2	7	2	--	4	--	11
Cruciferae	30	17 + 1V	2	--	36 + 2V	4	53 + 3V
Resedaceae	4	2	--	--	5	--	7
Moringaceae	1	1	--	--	–	--	1
Guttiferae	1	3	3	--	–	--	3
Passifloraceae	1	1	1	--	–	--	1
Cistaceae	1	4	1	--	2	--	6
Tamaricaceae	2	6	--	--	--	--	6
Frankeniaceae	1	--	--	--	1	--	1
Cucurbitaceae	9	8	5	--	2	2	10
Tiliaceae	3	9	2	--	2	2	11
Malvaceae	9	15	4	--	4	1	19

Family	Perennial		No. of species in S,SH	Annual		No. of species In S, SH	Total species
	Genus	Species		Genus	Species		
Sterculiaceae	1	1	1	--	--	--	1
Oxalidaceae	1	1	--	--	--	--	1
Geraniaceae	4	7	2	--	10	1	17
Zygophyllaceae	5	15	--	--	8 + 3V	1	23 + 3V
Balanitaceae	1	1	1	--	--	--	1
Nitrariaceae	1	1	--	--	--	--	1
Euphorbiaceae	8	22 + 1V	11	--	11 + 1V	3	22 + 2 V
Rutaceae	2	2 + 1V	1 + 1V	--	--	--	2 + 1V
Burseraceae	1	3	--	--	--	--	3
Meliaceae	1	1	-	--	--	--	1
Polygaluceae	1	3	--	--	1	--	4
Anacardiaceae	1	1	--	--	--	--	1
Pistaciaceae	1	1	--	--	--	--	1
Sapindaceae	1	1	--	--	--	--	1
Cellastraceae	1	1	1	--	--	--	1
Salvadoraceae	2	2	1	--	--	--	2
Rhamnaceae	2	5	1	--	--	--	5
Vitidaceae	1	2	2	--	--	--	2
Ulmaceae	1	1	1	--	--	--	1
Moraceae	2	7	3	--	--	--	7
Urticaceae	4	4	2	--	2	1	6
Polygonaceae	5	5	1	--	6 +1V	2	
Nyctaginaceae	3	10 + 6V	4 + 3V	--	--	--	10 + 6V
Molluginaceae	3	--	--	--	3	--	3
Aizoaceae	4	2	--	--	5	--	7
Portulacaceae	1	--	--	--	2	--	2
Caryophyllaceae	20	18	7	--	27 + 2V	6	45 + 2V
Chenopodiaceae	24	34 + 1V	3	--	21	1	55
Amaranthaceae	7	6	4	--	6 + 2V	3	12 + 2V
Crassulaceae	2	2	2	--	--	--	2
Rosaceae	4	4	2	--	--	--	4
Neuradaceae	1	--	--	--	1	--	1
Leguminosae	37	80 + 2V	34	--	48 + 1V	8	128 + 3V
Aristolochiaceae	1	1	1	--	--	--	1
Lythraceae	3	2	1	--	1	--	3
Rhizophoraceae	1	1	1	--	--	--	1
Combretaceae	1	1	1	--	--	--	1
Myrtaceae	1	1	--	--	--	--	1
Onagraceae	1	1	1	--	--	--	1
Haloragidaceae	1	--	--	--	1	--	1
Cynomonaceae	1	1	--	--	--	--	1
Araliaceae	1	1	1	--	--	--	1
Umbelliferae	18	12 + 1V	--	--	11 + 1V	3	23 + 2V
Santalaceae	1	2	--	--	--	--	2
Loranthaceae	1	3	1	--	--	--	3
Salicaceae	1	2	1	--	--	--	2
Primulaceae	3	2	2	--	1	--	3
Plumbaginaceae	2	3	1	--	1	--	4
Ebenaceae	1	1	1	--	--	--	1
Oleaceae	2	3	--	--	--	--	3
Gentianaceae	1	--	--	--	1	--	1
Loyaniaceae	2	2	1	--	--	--	2
Apocynaceae	3	4	2	--	--	--	4
Asclepiadaceae	14	18	5	--	--	--	18
Rubiaceae 8	7	1	--	5 + 1V	2	12 + 1V	
Convolvulaceae	7	15	5	--	5	--	20
Cuscutaceae	1	--	--	--	2	--	2
Ehretiaceae	1	2	2	--	--	--	2
Boraginaceae	11	12 + 1V	6 + 1V	--	22 + 1V	4	44 + 2V
Verbenaceae	2	2	--	--	--	--	2
Avicenniaceae	1	1	--	--	--	--	1
Labiatae	13	32 + 2V	10	--	1	--	33 + 2V
Solanaceae	6	15	4	--	9	--	24
Scrophulariaceae	13	16	5	--	15	4	31
Acanthaceae	7	6	3	--	1	1	7
Orobanchaceae	2	6 + 1V	1	--	1	1	7 + 1V
Dipsacaceae	3	--	--	--	5 + 2V	1	5 + 2V
Plantaginaceae	1	7 + 1V	--	--	5	--	12 + 1V
Valerianaceae	1	--	--	--	1	--	1
Caprifloliaceae	1	1	1	--	--	--	1

Family	Perennial		No. of species in S,SH	Annual		No. of species In S, SH	Total species
	Genus	Species		Genus	Species		
Camanalaceae	3	2	2	--	3	3	5
Compositae	66	76 + 3V	20	--	65 + 2V	21	141 + 5V
Hydrocharitaceae	2	2	--	--	--	--	2
Potonogetonaceae	1	3	3	--	--	--	3
Zannichelliaceae	1	1	--	--	--	--	1
Liliaceae	8	11	7	--	2	--	13
Cymodoceaceae	2	4	--	--	--	--	4
Agauaceae	1	1	--	--	--	--	1
Alliaceae	1	3	--	--	--	--	3
Amaryllidaceae	1	3	3	--	--	--	3
Iridaceae	1	1	1	--	--	--	1
Juncaceae	1	6	4	--	1	--	7
Commelinaceae	1	3	3	--	--	--	3
Gramineae	72	63 + 1V	15	--	77 + 5V	18 + 3V	140 + 6V
Palmae	2	2	--	--	--	--	2
Typhaceae	1	2	--	--	--	--	2
Pandanaceae	1	1	1	--	--	--	1
Cyperaceae	5	12 + 3V	3	--	3 + 1V	--	15 + 4V
Orchidaceae	1	1	--	--	--	--	1
Total	102	119 + 4V	40	--	83 + 6V	18 + 6V	200 + 10V

Table 3: Number of genus , species (perennial and annuals) in the flora of Saudi Arabia and their percentage in southern region. Taxonmy diversity S, SH = South and south Hijaz regions, S1= species, G = Genus, F= Family.

Item	No. of Genus	Perennial species	No. of perennial. species in S, SH	No. of annual species	No. of annual. Species in S,SH	Total species		% of species in S, SH	S1/G	G/F	Present study	
						K.S.A.	S,SH				No. of species	% to total species
Ferns	5	7	7	1	0.0	8	7	88	1.6	1.25	2	25
Gymnospermae	5	9	7	1	0.0	10	7	70	2.0	1.25	1	10
Dicotyledoneae	440	595 +23V	190 + 5V	381+17V	78 + 1V	976 +40V	268 + 6V	27	2.3	4.89	118	12
Monocotyledoneae	102	119 + 1v	40	83 + 6V	18 + 3V	202 + 7V	58 + 3V	29	2.05	6.0	24	11.9
Total	552	730 + 24V	244 + 5V	466 + 23V	96 + 4V	1196 + 47V	370 + 9V	28 %	0.0	0.0	145	0.0

Table. 4: Presence percentage and life-forms of the recorded plant species * in different habitats. P : Presence percentage in relation to habitats.

Species Life-forms	Sandy plain	Wadi Wadi	Rocky ridge (Sandy)	Rocky ridge	Flat plateau (Sandy)	Flat plateau	P
Abutilon pannosum (Forst.) Schtdl. Per.	50	85	35	20	35	35	100
Acacia ehrenbergiana Hayne Per.	30	50	90	30	30	35	100
Acacia tortilis (Forssk.) Hayne Per.	30	45	95	30	35	35	100
Achillea arabica Ky. Per.	85	100	55	30	36	55	100
Adenium obescum (Forssk.) R. Per.	15	25	70	87	20	15	100
Aerva javanica (Burm. F.) Spreng Per.	95	85	80	15	20	15	100
Anabasius satifera Moq. Per.	10	30	80	70	15	10	100
Aristida adscensionis L. Ann.	15	35	100	50	15	10	100
Asparagus stipularis Forssk. Per.	25	30	75	67	50	55	100
Atractylis carduus (Forssk.) Christens Per.	30	35	75	30	10	10	100
Avena fatua L. Ann.	100	75	15	10	30	15	100
Bromus rubens Jusl. Ap. L. Ann.	85	100	35	10	25	20	100
Calotropis procera (Wild) R. Br. Per.	95	100	35	10	30	30	100
Cutandia memphitica (Spreng.) K.R. Ann.	90	100	35	10	80	75	100
Cynodon dactylon (L.) Pers. Per.	100	100	70	10	90	35	100
Echium horridum Batt. Per.	10	25	10	10	70	85	100
Euphrbia peplis L. Ann.	87	100	35	15	15	20	100
Eurypos arabicus Steud. Per.	10	10	55	80	15	20	100
Forsskalia tenacissima L. Ann.	30	35	75	85	70	90	100
Forsskalea viridis Her.ex Webb ap. Ann.	30	30	70	90	75	95	100
Ifloga spicata (Forssk.) Sch. Ann.	100	75	35	15	25	25	100
Launaea nudicaulis (L.) Hook.f. Per.	75	100	75	15	25	25	100
Launaea resedifolia (L.) Kuntz Per.	100	100	75	15	25	15	100
Lycium shawii Roem. & Schult. Per.	30	25	100	30	15	15	100
Malva parviflora L. Ann.	100	75	30	15	90	75	100
Medicago orbicularis (L.) Bartal. Ann.	75	100	35	15	25	25	100
Melilotus indicus (L.)All. Ann.	80	100	25	15	30	15	100
Panicum repens L. Per.	100	70	25	15	30	25	100
Panicum turgidum Forsk Per.	100	90	25	10	25	15	100
Papaver rhoeas L. Ann.	100	78	25	15	25	30	100
Phalaris minor Retz. Ann.	85	100	25	15	75	30	100
Plantago lanceolata L. Per.	75	70	25	15	90	78	100
Artemisia inculta Del. Per.	85	100	55	--	15	10	83
Artemisia judaica L. Per.	50	55	95	75	15	--	83
Asphodelus fistulosus L. Ann.	95	100	30	10	10	--	83
Astragalus corrugatus Bert. Ann.	55	85	--	30	10	10	83

Species Life-forms	Sandy plain	Wadi Wadi	Rocky ridge (Sandy)	Rocky ridge	Flat plateau (Sandy)	Flat plateau	P
Bassia eriophora (Schradi.) Asch. Ann.	100	95	15	--	6	10	83
Calendula micrantha Tineo et Guss. Ann.	75	85	15	--	15	10	83
Cenchrus ciliaris L. Ann.	65	75	35	--	100	80	83
Chenopodium murale L. Ann.	70	60	50	--	100	85	83
Cucamus prophetarum L. Ann.	80	70	20	--	15	15	83
Ducrosia ismaelis Asch. Per.	85	35	20	--	10	10	83
Echinops spinosissimus Turra. Per.	75	100	35	--	10	15	83
Erodium hirtum Willd Ann.	35	90	10	--	25	10	83
Eruca sativa Mill. Ann.	85	35	15	--	15	10	83
Euphorbia grandulata Frossk. Ann.	75	100	35	--	15	15	83
Fagonia cretica L. Per.	--	15	35	70	75	90	83
Filago desertorum Pomel Ann.	35	90	30	--	15	35	83
Mentha sp. Ann.	15	10	10	--	15	10	83
Ochradenus baccatus Delile Per.	15	15	10	--	90	75	83
Olea chrysophylla Lam. Per.	15	15	10	--	100	75	83
Pennisetum divisum (J. Gmel). Henr. Per.	100	90	15	--	15	15	83
Pennisetum sp Per.	25	15	25	--	90	75	83
Plantago mijor L. Per.	100	75	35	--	15	15	83
Picris radicata (Forssk.) Less. Ann.	10	10	15	--	10	5	83
Poa annua L. Ann.	80	100	30	--	25	30	83
Polypogon monspeliensis (L.) Desf. Ann.	75	100	25	--	15	15	83
Rhazya stricta Decne Per.	100	78	15	--	25	15	83
Reseda muricata Presl. Ann.	100	70	10	--	15	15	83
Ruta cholepensis L. Ann.	75	85	25	--	15	15	83
Senna italica Mill. Per.	100	78	15	--	15	20	83
Setaria vertisellata (L.) P. Beaun. Ann.	80	35	15	--	25	15	83
Sisymberium irio L. Ann.	75	90	30	--	30	15	83
Stipagrostis plumosa (L.) Munro exT Per.	100	75	15	--	15	15	83
Tribulus longipetalus Viv. Ann.	75	80	30	--	90	85	83
Trigonella foenum-graceum L. Ann.	30	30	15	--	95	75	83
Verbesina encolioides (Cav.) B & H Ann.	30	85	15	--	15	15	83
Zygophyllum album L. f. Per.	100	90	25	--	35	30	83
Zygophyllum simplex L. Ann.	100	100	25	--	30	35	83
Amaranthus graecizans L. Ann.	80	90	30	--	--	16	66
Bassia muricata (L.) Murr. Ann.	90	100	30	--	8	--	66
Blepharis ciliaris (L.) B. L. Burtt. Per.	10	10	95	35	--	--	66
Cenchrus stigerus Vahl Ann.	10	30	--	--	25	10	66
Conyza droscoridis (L) Desf. Per.	20	70	20	10	--	--	66
Euphorbia prostorata Aiton. Ann.	75	85	30	10	--	--	66
Fagonia indica Burn F. Per.	--	--	75	100	70	85	66
Hammada elegans (Bunge.) Botsch. Per.	15	15	--	--	95	35	66
Indigofera spinosa Forssk. Per.	15	10	10	--	--	15	66
Paronychia desertorum Boiss. Ann.	--	--	10	10	15	15	66
Pergularia daemia (Forssk.) Chiov. Per.	--	--	10	10	15	10	66
Plantago albicans L. Per.	10	10	--	--	15	10	66
Pulicaria orientalis Joub. & Sp. Per.	20	15	--	--	90	78	66
Rhanterium epapposum Oliv. Per.	15	15	--	--	95	70	66
Rumex vesicarius L. Ann.	10	15	--	--	10	15	66
Salsola kali L. Ann.	10	10	--	--	15	10	66
Salsola vermiculata L. Per.	--	--	15	15	75	20	66
Salvia aegyptiaca L. Per.	25	25	--	--	85	78	66
Solanum nigrum L. Ann.	100	75	15	--	15	--	66
Suaeda momoica Forssk. Per.	10	--	15	--	75	70	66
Tamarix aphylla (L.) H. Karst. Per.	15	15	--	--	85	70	66
Traganum nudatum Del. Per.	15	15	--	--	100	75	66
Withainia somnifera (L.) Dum. Per.	25	15	--	--	90	80	66
Xanthium spinosum L. Ann.	15	25	--	--	15	15	66
Anabasis oropediorum Maire. Per.	--	--	25	15	--	10	50
Astragalus sieberi DC. Per.	--	--	15	--	10	15	50
Caylusea hexagyna (Forssk.) M.L. Ann.	10	10	--	--	20	--	50
Centaurea aegyptiaca L. Ann.	--	--	10	--	30	25	50
Echinops blunchеanus Boiss. Per.	10	20	10	--	--	--	50
Echinops hussoni Boiss. Per.	10	25	15	--	--	--	50
Francoeuria crispa (Forssk.) Cass. Ann.	10	15	10	--	--	--	50
Helianthemum sessiliflorum (Desf.) P Per.	--	35	95	70	--	--	50
Heliotropium longifforum (A.DC.) St Per.	--	25	100	75	--	--	50
Latipes senegalensis Kunth. Per.	15	10	5	--	--	--	50
Otostegia fruticosa (Forssk.) Penz. Per.	--	--	10	10	10	--	50
Plantago bellardii All Per.	--	--	--	10	15	10	50
Portulaca oleracea L. Ann.	55	90	25	--	--	--	50
Psiadia arabica Jaub. Et Sp Per.	--	--	--	10	10	15	50

Species Life-forms	Sandy plain	Wadi Wadi	Rocky ridge (Sandy)	Rocky ridge	Flat plateau (Sandy)	Flat plateau	P
Savignya parviflora (Delile.) Webb. Ann.	--	--	10	--	25	30	50
Senna sp. Per.	78	80	15	--	--	--	50
Senecio flavus (Decne) Sch. Ann.	15	--	--	--	25	15	50
Senecio vulgaris L. Ann.	--	--	15	--	15	10	50
Stipagrostis ciliata (desf.) de Winter Per.	100	80	--	--	15	--	50
Ziziphus spina-christi (L.) Desf. Per.	15	50	--	--	25	--	50
Ammannia baccifera L. Ann.	--	--	--	--	25	10	33
Argemene mexicana L. Ann.	--	--	--	--	15	20	33
Arnebia hispidissima (Lehm.) DC. Ann.	10	15	--	--	--	--	33
Asparagus africana Lam. Per.	--	--	15	10	--	--	33
Capparis spinosa L. Per.	--	--	5	20	--	--	33
Citrullus colocynthis (L.) Schrad. Ann.	90	100	--	--	--	--	33
Conyza linifolia (Willd.) Viv. Ann.	75	50	--	--	--	--	33
Cyperus sp. Per.	20	10	--	--	--	--	33
Datura innoxia Mill Ann.	10	25	--	--	--	--	33
Digetaria ciliaris (Retz.) Koeler Ann.	100	75	--	--	--	--	33
Dodonaea viscosa (L.) Jacq. Per.	--	--	--	--	20	10	33
Glycyrrhiza glabra L. Per.	10	20	--	--	--	--	33
Glossonema nubicum Decne. Per.	--	--	--	--	15	10	33
Juniperus procera Hochst. Ex Endl Per.	--	--	20	35	--	--	33
Launaea sp. Ann.	10	15	--	--	--	--	33
Lavandula dentata L. Per.	--	--	--	--	10	15	33
Lavandula pubescens Decne Per.	--	--	5	5	--	--	33
Marrubium vulgare L. Per.	--	--	--	--	100	25	33
Phagnalon scalarum Schw. ExSchwa Per.	--	--	--	--	10	15	33
Reicharidia tingitana (L.) Roth. Ann.	10	15	--	--	--	--	33
Salvadora persica L. Per.	80	100	--	--	--	--	33
Silybium moriaum (L.) Goertn Ann.	-	--	15	--	--	15	33
Solanum albicaule Dunal Per.	--	--	10	15	--	--	33
Solanum icanum L. Per.	--	--	25	95	--	--	33
Sorghium bicolar (L.) Moench. Ann.	15	10	--	--	--	--	33
Thymus capitatus (L.) Link. Per.	--	--	10	30	--	--	33
Balanites aegyptiaca (L.) Del. Per.	--	--	20	--	--	--	16
Caralluma penicillata WhiteetSloane Per.	--	--	--	5	--	--	16
Datura stramonium L. Ann.	--	20	--	--	--	--	16
Jasminum floribudum R. Br. Per.	--	--	--	--	5	--	16

* The two ferns species (*Cheilanthes caanensis* (Consent.) H. P. Fuchs. And *Ceterach afficinarum* Lan. Et. DC.) are recorded only on the shadow wet places. Per. = The perennial species and Ann. = The annual species. -- Species not recorded.

Table 5: Diversity indices , species richness (number of species/ stand) of perennial and annual species in different habitats.

Diversity variable	Habitat					
	Sandy plain	Wadi	Rocky ridge (Sandy)	Rocky ridge	Flat plateau (Sandy)	Flat plateau
Perennial						
No of taxa	54.00	56.00	57.00	39.00	58.00	55.00
Simpson Diversity	0.97	0.973	0.971	0.956	0.971	0.964
Simpson Dominance	0.029	0.027	0.029	0.04	0.029	0.036
Shannon Diversity (H')	1.591	1.638	1.62	1.447	1.627	1.558
H max'	1.724	1.748	1.755	1.591	1.763	1.69
Evenness (H' / H max')	0.923	0.937	0.923	0.909	0.923	0.922
Annual						
No. of taxa	55.00	55.00	47.00	17.00	49.00	47.00
Simpson Diversity	0.976	0.977	0.969	0.893	0.964	0.961
Simpson Dominance	0.024	0.023	0.031	0.107	0.036	0.039
Shannon Diversity	1.655	1.67	1.58	1.092	1.558	1.526
H max'	1.74	1.74	1.653	1.255	1.69	1.672
Evenness (H' / H max')	0.951	0.96	0.956	0.87	0.922	0.913
Total no. of species	109.00	111.00	104.00	56.00	107.00	102.00
Species richness (no./stand)	7.3	7.4	10.4	5.6	7.1	6.8
Species turnover	14.9	15.0	10.0	10.0	15.1	15.0

dicot and 2.1 for monocot. Consequently for genera/ family were 1.25, 1.25, 4.89 and 6.0 for ferns, gymnospermae, dicot, and monocot respectively . Table 3 also shows that about 88 % of the ferns, 70 % gymnospermae, 27 % of dicot, and 29 % of monocot were recorded in south region. In general the total species recorded in the Saudi Arabia were 8, 10, 976 + 40 varieties and 202 + 7 varieties for ferns, gymnospermae, dicot, and monocot respectively.

Diversity of the study area: Thirty nine families were recorded in southwestern area (Asir region) being represented by 145 species. The most dominant families were Compositae (20 %), Graminae (14.5 %), Leguminosae and Chenopodiaceae 7 %. Table 3 shows that the contribution of the study area was for ferns (25 %), gymnospermae (10 %), dicot (12 %) and monocot (11.9%) of the total species in Saudi Arabia.

Eighty stands were distributed in 6 types of habitats and

presence percentage of each plant species for each habitat are represented in Table 4. Using tabular comparison, 145 plant species including 2 ferns are arranged in 6 habitats according to presence percentage in relation to habitats. The number of perennial species is 79 , some perennials have high presence among habitats (e.g. *Acacia tortilis, A. ehrenbergiana, Abutilon pannosum* and *Aerva javanica)* while, others are restricted between five to one habitats. The number of annuals is 64. Some annuals have high presence (e.g. *Aristida adscensionis, Avena fatua, Cutandia memphitica* and *Bromus rubens)* while, others have restricted distribution (*Bassia erioiphora, Francoeuria crispa,* and *Datura stramonium).* Generally most of species in the study area are common, and 30 % are less common, while 4.1 % are the rare species.

In general species richness and diversity indices of perennial and annual species in the study area are presented in Table 5. The highest number of perennial species is attained in sandy flat plateau and sandy rocky ridge, while for annuals is attained in sandy plains and wadis. Consequentially, the maximum number of plant species is attained in wadis followed by sandy plain habitats (111 and 109 species respectively). The highest species richness of all plant species (10.4 sp./stand) was recorded in sandy rocky ridge, and the lowest (5.6 sp./stand) was recorded in rocky ridge habitats. On the other hand, the highest species richness/ habitat (111 sp./habitat) was recorded in wadi, while the lowest (56 sp./habitat) was recorded in rocky ridge . Beta diversity was estimated as the ratio between total number of species and species richness (alpha diversity). There was little variation amongst four habitats (e.g. maximum ratio is 15.1 in sandy flat plateau and minimum ratio is 10.0 in both sandy rocky ridge and rocky ridge).

The diversity observation was born out by the indices which incorporated information on the proportional abundance of species such as Shannon index which estimates the diversity of different habitats (Table 5), where (H" = 1.638) for perennial species as example in wadis and H' = 1.447 in rocky ridge. Evenness is also a little different from 0.937 in wadis to 0.909 in rocky ridge. The lower dominance of different habitats was reflected by Simpson index (D= 0.027) in wadis while, the highest dominance was recorded in rocky ridge.

Discussion

Although the Arabian Peninsula is floristically one of richest of all phytogeographical regions of Asia because it has a large area and different climatic zones. Its biodiversity is directly threatened by climatic factors, urbanization and other pressures including overgrazing, agriculture and over-cutting Heneidy (2000). The Saudi Arabian supports 1243 species (Migahid, 1996), including the infra-specific taxa, of which about 145 species are recorded in present study, where, the southwestern region of Saudi Arabia has the highest species diversity especially trees (Abulfatih, 1991). On the other hand, Abulfatih (1984) recorded 17 shrubs, 65 herbaceous plants, 13 succulent, 2 parasites, 2 ferns and epiphytic lichens on Asir mountains. Abulfatih and Nasher (1988) recorded that 47 rare succulent species are threatened by overgrazing, road construction and lack concern of conservations. Hierarchical diversity concern taxonomic differences at other than the species level. Pielou (1975) and Magurran (1988) pointed out that in intuitive terms hierarchical (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 amongst many families as opposed to few. The present study rescals that the southern Saudi Arabia is more diverse as compared with the Arabian Peninsula as a whole.

Several ecological studies have been done in some of the phytogeographical regions of Saudi Arabia. One hundred and forty five species in the study area have economic and ecological values (e.g. medicinal, grazing, ecological,...) Heneidy & Bidak (2000). According to Al- Hubaishi and Hohenstein (1984), the southern Arabian phytogeographical region (including Yemen) contains 2000- 2500 species of flowering plants.

The vegetation composition ranges between 57 to 111 species, this difference may be due to habitat factors, moisture availability and physiographic heterogeneity. The results agree with (Ayyad & Fakhry, 1996) where the recorded species richness and diversity in the western Mediterranean region of Egypt vary along two gradients of habitat factors (moisture availability and physiographical heterogeneity). Shaltout (1985), Kutiel & Danin (1987) recorded that the high- species diversity of vegetation types in some habitat, could be related to the physiographic heterogeneity of this habitat, and also low species diversity types of other habitat may be related to the high disturbance of these habitats due to repeatable remove of the silt and weeds from this habitat.

The present study shows about 10, 12, 12, and 25 % of the ferns, gymnospermae, dicotyledoneae, and monocotyledoneae respectively of the flora of Saudi Arabia. On the other hand, about 24 %, of the flowering plants occur in southwestern region of Saudi Arabia. However, 145 species were recorded in present study comparing with 118 species recorded in the eastern region by El-Halawany and Shaltout (1993), while El-Demerdash *et al.* (1994) recorded 89 species in Tihamah coastal plains of Jazan region.

The present study also provide an overview of species richness in different land forms in southwestern areas in relation to main habitat factors, and to estimate the beta diversity (extent of biotic change) and a moisture gradient in these different land forms. It was found that sandy plain was the richest (111 species), followed by wadis, sandy flat plateaus, and sandy ridges. This is because sandy plains are characterized by wadifilling materials, sediments and a high proportion of gravel and fine grains between the boulders of soil pockets. In addition , some places work as trap of water. The wadi habitat, resulted from gullies on the top of mountains or the slopes of depressions and is characterized by deep and more organic matter, where they can receive more. The habitat of smooth forced granite outcrops and terraces of rocky surface support a sparse species- poor vegetation. This is due to a shallow soil cover inadequate to support plant growth (e.g. ridge habitat, 56 species). This agrees with that obtained by Ayyad *et al.* (2000). The high species richness and the medium species turnover of the sandy rocky ridge plant community in present study may be related to its intermediate position along the prevailing environmental gradients thus it acts as a transitional community which is usually rich in species.

These trends were recorded by Shaltout *et al.* (1994). Such habitat is characterized by medium disturbance as compared with other habitats, thus the high diversity of community consists with the medium disturbance hypothesis (see Nilsson *et al.*, 1991). On the other hand, the low species richness and species turnover of the ridge habitat (rocky ridge) may be due to the fact that most of its species are highly specific to habitat. This means that the species replacement or biotic change is low in this habitat (Wilson & Schmida, 1984). Ayyad *et al.* (2000) in Sinai Peninsula recorded that the extent

of species replacement or biotic change between different land forms reveals that the high values between habitats may reflect rapid and ecologically significant change and may also reflect the large extent of biotic change of different habitats. Environmental data may also be used in assessing the relative biodiversity of areas, not because of interest in environmental variation, but because environmental (habitat/ ecosystem) variation should indicate organismal diversity (relative number of species) (Faith & Walker, 1996). Moustafa (1990) in St. Catherine (Sinai peninsula) area, found that the organization of community types or associations is the net result of the behaviour of species in response to environmental conditions that prevail in each particular habitat. The distribution of species in the study area is governed mainly by moisture and temperature gradients that integrate the effects of many physical factors.

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