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Plant Diversity and Community Structure of the Main Wadis at High Altitudes of the Western Mountains at Taif, Saudi Arabia

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THE PRESENT study aimed at surveying and identifying plant species distributed in the main valleys at high altitudes in the study area, analyzing their vegetation, depicting the prevailing plant communities and assessing the role of the environmental conditions that affect the communities. Seventy-five stands were selected to represent the the vegetation physiognomy and the accompanying environmental variations. The species abundance, life forms, chorotype, and economic uses were determined. The total number of recorded species is 165 species belonging to 128 genera and 47 families. About 69.7% of these species are perennials and 30.3% were annuals. Poaceae and Asteraceae had the highest contributions to the total flora. Chamaephytes had the highest contribution, followed by therophytes, phanerophytes, hemicryptophytes and geophytes, while hydrophytes and parasites had the lowest contribution. The economic uses of the recorded species could be arranged in descending order as follows: medicinal > grazing > fuel > human food > other uses. The mono-regional and bi-regional species were the highest, while pluri-regional and cosmopolitans were the lowest. Of the mono-regionals, 36 species were Sudano-Zambezian, 17 species were Irano-Turanean and 16 species were Saharo-Arabian. The application of TWINSPAN on the cover estimates of 165 species recorded in 75 stands, led to the recognition of 8 vegetation groups (communities) at 3rd level of classification (**I:** *Mentha longifolia* group, **II:** *Salsola imbricata* group, **III:** *Cynodon dactylon* group and **IV:** *Pluchea dioscoridis* groups on the wetland wadis, and **V:** *Aerva javanica* group, **VI:** *Acacia gerrardii* var. *gerrardii* group, **VII:** *Calotropis procera* group and **VIII:** *Acacia gerrardii* var. *gerradii-Solanum incanum* groups on multi-wadis).

Keywords: Communities, Chorotype, Economic uses, DECORANA, Taif, TWINSPAN.

Introduction

A wadi is a dried up riverbed found in the mountain valleys which come into their own after heavy rains, when the rivers start running again and the vegetation is restored. Some wadis have year-round running water, with deep, cool pools. Wadis are green, lush oases of palm trees, grasses, and flowering shrubs. Two types of wadis can be distinguished: autochthonous wadis, which start and end in the same bioclimatic belt, and allochthonous wadis which transverse several regions. In allochthonous wadis, surface runoff, water supply and plant phenology are largely independent of the precipitation regime of the area itself. The pattern of vegetation along wadi courses is determined by the nature of the drainage system, sediment grain size, groundwater level, frequency of overflow, distance from the wadi bed with respect to the water table and differences in the catchment area. A vegetation pattern referred to as a "wadi sequence" can be observed along the courses of such wadis. Wadis in the central Arabian desert have been studied by long distance transects from Taif to Riyadh (Baierle & Frey, 1986).

Biodiversity provides a wide range of useful

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biological resources. Fishing, gathering of foods and medicines from natural communities are still important to the economy of the country (Alves & Rosa, 2007). Sustainable use of such resources depends on conservation of the species used, their habitats and the maintenance of the functioning ecosystems of which they are an integral part. Apart from individual species that we use, the very existence of life on the planet depends on biological processes. In all likelihood, loss of an appreciable proportion of biological diversity will result in the demise of humankind. The balances of oxygen and carbon dioxide in the atmosphere are maintained by plant life, whereas in diverse and rich communities, microbes maintain soil formation and the balances of fertility of soils. It is likely that fewer organisms than are now present could sustain all the processes that go to make the earth a functioning system. However, we do not have any idea of just what is the limit to impoverishment of fauna and flora before function ceases. What we do know is that if the global ecosystems became dependent on only a few key species (in other words, they came to resemble crop mono-cultures), an epidemic of some kind could render the entire system non-functional. Biodiversity is therefore essential to the survival of humankind and its preservation is the responsibility of every society on earth. This is especially relevant in Saudi Arabia, where many of the ecosystems have small numbers of species and hence little in-built redundancy (Wall & Nielsen, 2012).

The Flora of Saudi Arabia and neighboring countries in the Peninsula has been neglected for a long time due to inhospitable climate and other socio-cultural issues (Alfarhan et al., 1998). Earlier publications that cover this part of the world deal with only the floras of those regions where the vegetation is rich, or regions which have had easy access for exploration. Survey of annual plants, that represent 60-70% of the total vegetation cover often results in an incomplete list of species due to the variation in the dormancy period of the seeds or the fluctuating climatic conditions. Migahid & Hammouda (1974) attempted to cover the flora of the entire region of Saudi Arabia for the first time. Migahid (1988-1990) reported that the mountainous southwestern Saudi Arabia is remarkable for its comparably dense vegetation and species diversity. Floristic explorations have resulted in the reporting of many new taxa and records (Alfarhan et al. 1998; Alfarhan, 2000; Al-Turki et al., 2001).

The tropical regions of the Saudi Arabia Kingdom, which is found in the south and southwest of the kingdom and located within Sudanian phytogeographical area, s characterized by rich plant diversity. The Sarrawat Mountains are distinguished by high altitudes for about 3700m above sea level near Abha city and decreasing gradually to north, associated with the heavy rains, high relative humidity and low temperature. Awdat et al. (1997) reported that these factors have contributed to the formation of a dense vegetation dominated by *Juniperus procera* associated with *Dodonaea viscose*, *Lavandula dentata*, *Psiadia arabica* and *Euryops arabicus*, while at lower altitudes it was dominated by *Olea europaea* ssp. forma *dulcis* and others. The present study aims at surveying and identifying plant species as well as analyzing the vegetation of the main wadis in Taif region in terms of species composition, diversity, abundance, life forms, economic uses and global distribution It aims also at depicting the prevailing plant communities and assessing the role of the environmental conditions that affect the vegetation in the study area.

Materials and Methods

Study area

Saudi Arabia extends over approximately 16° degrees of latitude, from 16° 22′ at the borders with Yemen in the south; to 32 ° 14′ at the Jordanian border in the north, and between longitudes 34° 29′ E and 55° 40′ E (Fig. 1). Taif region is located in the central foothills of the western mountains at an altitude up to 2500m above sea level. It is an important place for the people due to its scenic views and fertile valleys, which support the growth of a favorable fruits and vegetables. Agriculture had been the prime economic income in Taif. Historically the tribes of Taif grew wheat, barley and fruits such as lemon, apricot, orange, olive, peaches, pomegranate, watermelons, grapes, almonds and dates. However, the agricultural development has to pay a heavy price for the natural vegetation of Taif region. Over the years, vast areas of virgin lands have turned into agricultural lands, which resulted in the disappearance of many wild species including medicinal plants (UN-Habitat, 2016).

The climate of the study area is is typically tropical and arid. The monthly mean of climatic variables that recoded in Taif meteorological station (1997–2009) indicated that the monthly

average of minimum and maximum ambient air temperatures ranged from 7.9±1.2 to 23.4±0.8°C and 22.9±1.1 to 36.3±0.8°C, respectively with a total monthly mean of 23.2±5.1°C (Table 1). The mean maximum temperature (± SD) was 30.6 ± 4.8°C, while the average values of minimum temperature was 15.8 ± 5.5°C. The mean monthly humidity was 40.6±14.8%. The data from the last 10 years showed considerable inter-annual variation in the monthly amount (range 4.3±5.7-294.1±383.8mm mo^{-1}) and timing of rainfall. The monthly amount of rainfall ranges from 4.3±5.7 mm mo^{-1} in December to 294.1±383.8 mm mo^{-1} in September.

Sampling

Seventy five stands were selected randomly in Taif region and its adjacent area (Fig. 1) to represent the vegetation physiognomy along the environmental variations in 10 main wadis (El-Shakrah, Liyah, Al-Wahatt and Al-Waheitt, Wakdan, El-Qeim, Al-Maharam, El-Gadireen, Masarrah, El-Arg and Ghadeer El-Banat). The stand size was 20x20m (approximates the minimal area of the plant communities). In each stand, the following data were recorded: 1- list of species, 2- a visual estimate of the total cover (%) and the cover of each species according to Braun-Blanquet scale (Mueller-Dombois & Ellenberg, 1974), and 3- the human disturbance occurred in each stand (e.g., grazing, cutting and firing, etc.). Nomenclature of the recorded species was according to Migahid (1978), Chaudhary (1999, 2000), Collenette (1999) and Boulos (1999, 2000, 2002, 2005, 2009). Voucher specimens were deposited at the Herbarium of Biology Department, Faculty of Science, Taif University.

Vegetation measurements

Plant species abundance was measured using visual cover estimates and presence/absence measurements (Mueller-Dombois & Ellenberg, 1974). Life forms of the recorded species were identified according to the Raunkiaer scheme (Raunkiaer, 1937). The Chorotypes of the recorded species was gathered from Zohary (1966, 1987), Feinbrun-Dothan (1978, 1986), and Boulos (1999, 2000, 2002, 2005). The potential and actual economic uses of wild species were assessed on three bases of field observations, information collected from local inhabitants and the literature (Allred, 1968; Truax et al., 1972; Täckholm, 1974; Haslam, 1978; Feinbrun-Dothan, 1978, 1986; FAO, 1979; El-Kady, 1980; Danin, 1983; Boulos, 1983, 1989; Mossa et al., 1987; Zohary, 1987; Mandaville, 1990; Ayyad, 1992; Belal & Springuel, 1996; Shaltout, 1997).

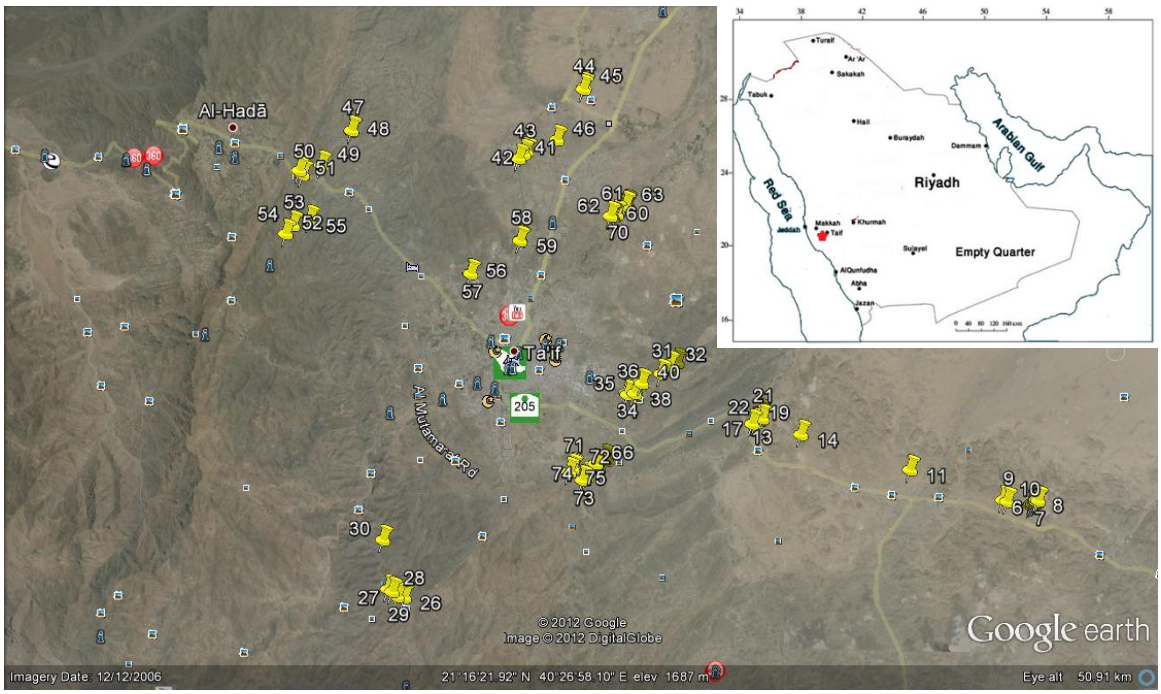

Fig. 1. Distribution of 75 stands in Taif region (red point) by using Google Earth and their coordinates (GPS).

TABLE 1. Monthly variation in air temperature (°C), relative humidity (RH), wind speed (WS) and rainfall (RF) as recorded at Taif meteorological station.

Month	Temperature (ºC)			RH (%)	WS (km hr^{-1})	RF (mm mo^{-1})
	Max.	Min.	Mean			
Jan.	22.9±1.1	7.9±1.2	15.4±1.0	58.7±5.6	5.5±0.5	12.1±12.0
Feb.	25.8±1.3	10.1±1.4	17.9±1.1	52.2±4.7	6.7±0.6	283.0±392.2
Mar.	27.5±0.9	12.0±1.2	19.8±0.7	46.5±7.1	7.2±0.9	22.5±23.7
Apr.	30.8±1.0	15.3±0.9	23.0±0.7	43.2±4.5	6.7±0.6	93.5±227.8
May	34.1±1.2	18.4±0.7	26.3±1.2	33.1±7.4	6.2±0.8	97.9±227.9
Jun.	36.3±0.8	22.2±0.9	29.4±0.6	19.6±4.2	8.3±0.6	141.8±314.4
Jul.	35.6±1.0	23.2±0.9	29.1±0.9	21.8±4.6	10.6±1.2	73.7±233.5
Aug.	36.3±0.5	23.4±0.8	29.5±0.4	27.5±4.4	9.7±0.9	92.8±229.2
Sep.	35.3±0.6	20.3±0.9	28.0±0.4	29.6±4.1	6.2±0.4	294.1±383.8
Oct.	31.2±0.7	15.3±0.6	23.5±0.6	39.7±7.9	5.0±0.4	88.0±231.8
Nov.	27.2±1.0	12.0±1.1	19.6±0.5	55.5±8.4	5.1±0.3	155.6±308.1
Dec.	24.4±1.4	9.3±1.0	16.7±1.1	60.0±6.0	5.1±0.7	4.3±5.7
Total mean	30.6±4.8	15.8±5.5	23.2±5.1	40.6±14.8	6.9±1.9	113.3±257.4

- The data are long term averages from Climatological Normals for KSA from 1997 to 2007 (Anonymous, 2008).
- The F-value for each variable are calculated (ANOVA), ***:P≤0.001.

Soil analysis

Three soil samples (composite samples) were collected and mixed from each stand as a profile at a depth of 0-50cm below the soil surface. The soil samples were brought to the laboratory in plastic bags shortly after collection, spread over paper sheets, air dried, passed through 2mm sieve to remove gravel and debris, and then packed in paper bags ready for physical and chemical analysis. Soil water extracts (1:5w/v) were prepared for the determination of soil reaction (pH) using a glass electrode pH-meter, salinity by a direct indicating conductivity bridge (mmhos cm^{-1}). Chlorides were estimated by direct titration against silver nitrate using 5% potassium chromate as indicator. Carbonates and bicarbonates were evaluated by direct titration against 1N HCl using phenolphthalein and methyl orange as indicators. All these methods are discussed by Allen et al. (1974).

Data analysis

Two-way indicator species analysis (TWINSPAN) and detrended correspondence analysis (DECORANA) were applied to the cover estimates of 165 species in 75 stands to recognize the plant communities in the study area (Hill, 1979 a,b; Hill & Gauch, 1980; Gauch & Whittaker, 1981). One-way analysis of variance (ANOVA) was calculated for the means of the soil samples in relation to vegetation groups to assess the heterogeneity of samples around their means according to SPSS software (SPSS, 2012).

Results

The recorded species in the study area, their families, vernacular names, life forms, habits, chorotypes, abundance and their uses are listed in (Table 2). The total number of recorded species in the study area was 165 species belonging to 128 genera and 47 families. About 69.7% of the recoded species (115 species)were perennials and 30.3% (50 species) were annuals. The families Poaceae and Asteraceae have the highest contribution to the total flora (each 12.7% of the total species), followed by Fabaceae (6.7%), Solanaceae and Chenopodiaceae (4.9% each), and Euphorbiaceae and Zygophyllaceae (4.2%). Twenty one families were represented only by one species; 6 families were represented by two species; and 4 families were represented by three species. On the other hand, 95 species (57.6% of the total species) were common, 61 species (37%) were rare and 9 species (5.5%) were very common. Five species were recorded in all wadis: *Acacia gerrardii* var. *gerradii, Aerva javanica, Argemone ochraleuca, Echinops spinosuss* and *Solanum incanum* and 37 species were recorded in more than 50% of the wadis (e.g. *Solanum incanum, Pulicaria undulate* subsp. *undulata, Belpharis ciliaris, Calotropis procera* and *Ricinus communis*).

TABLE 2. Floristic composition of the main wadis at Taif region.

Species	Family	Life form	Habit	Chorotype	Abundance	Vegetation groups	Wadis	Economic uses				
								M	G	E	F	O
Abutilon bidentatum A. Rich	Malvaceae	Ch	Per	IT+IN	C	III, VII,VIII	1,4,6,9	-	+	-	-	-
Acacia asak (Forssk) willd	Fabaceae	Ph	Per	SU	C	III, V, VI	2.4.9	+	+	-	+	-
Acacia etbaica Schweinf	Fabaceae	Ph	Per	SU	C	III	9	+	+	-	+	-
Acacia gerrardii Benth.var.gerrdii	Fabaceae	Ph	Per	SU	C	II, III, IV, V, VI, VII, VIII	1.2.3.4.5.6.7.8.9.10	+	+	-	+	-
Acacia seyal Delile	Fabaceae	Ph	Per	SU	C	VII	9	+	+	-	+	-
Acacia tortolis (Forssk) Hayne	Fabaceae	Ph	Per	SU	C	I, III, V, VI, VII	1.2. 4.5.6. 9.10	+	+	-	+	-
Aerva javanica (Burm.f.) juss.ex schult	Amaranthaceae	Ch	Per.	TR	C	II, III, IV, V, VI, VII, VIII	1.2.3.4.5.6.7.8.9.10	+	+	-	+	-
Aerva lanata (L.) Juss. ex Schult.	Amaranthaceae	Ch	Per	TR	C	VII	10	+	+	-	+	-
Aizoon canariense L.	Aizoaceae	Th	Ann	SU	C	IV, VI, VII, VIII	1.2.3.4.5.9.10	-	+	-	-	-
Aloe pseudorubroviolacea Laver. &Collen. Ined.	Aloaceae	Ch	Per	SU	C	VIII	6	+	-	-	-	-
Amaranthus albus L	Amaranthaceae	Th	Ann	PAL	C	VII, VIII	2.3	+	+	+	-	+
Amaranthus graecizans L .	Amaranthaceae	Th	Ann	TR	C	I, II, III, IV	9.10	+	+	-	+	-
Amaranthus hybridus L.	Amaranthaceae	Th	Ann	TR	C	II, III, VII	9.10	+	+	+	-	+
Amaranthus lividus L.	Amaranthaceae	Th	Ann	COSM	C	VI, VII	9	+	+	+	-	+
Ambrosia maritima L.	Asteraceae	Th	Ann	ME	C	I, III, IV	9.10	+	+			
Anastatica hierochuntica L.	Brassicaceae	Th	Ann	SA	C	VIII	3	+	-	-	-	-
Argemone ochraleuca Sweet	Papaveraceae	Th	Ann	TR	CC	I, II, IV, VI, VII, VIII	1.2.3.4.5.6.7.8.9.10	+	-	-	-	-
Arsetida congesta Roem	Poaceae	Th	Ann	SA	C	II, III	9	-	+	-	-	-
Asclepisa fruticosus L.	Asclepiadaceae	Ch	Ann	SU	C	IV, VI, VII, VIII	2.3. 6.7.10	-	+	-	+	-
Asclipias sinaica (Boiss.) Muschl.	Asclepiadaceae	Ch	Ann	SA	C	VIII	7	-	+	-	+	-
Asphodelus sp.aff *aestivus* Brot.	Asphodelaceae	G	Per.	ME	C	VIII	3	+	+	+	-	-
Astragallus spinosus (Forssk) Muschl	Fabaceae	Ch	Per	IT	R	VI	5	+	+		+	
Atriplex leucoclada Var. *turcomanica* (Moq) Zohory	Chenopodiaceae	Ch	Per	IT+SA	R	II,V, VI, VII, VIII	2.4.8.9	+	+	-	-	-
Bacopa monnieri (L) Pennell	Plantaginaceae	He	Per	TR	R	I, II, III, IV,V	9.10		+			

TABLE 2. Cont.

Species	Family	Life form	Habit	Chorotype	Abundance	Vegetation groups	Wadis	Economic uses				
								M	G	E	F	O
Belpharis ciliaris (L)	Acanthaceae	Ch	Per	SA +IT	C	VI, VII, VIII	1.2.3.4.5.6.7.8	+	+	-	-	-
Bidens pilosa L.	Asteraceae	Th	Ann	SA+ME+EU	R	I	9		+			
Calotropis procera (Aiton) W.T.Aiton	Asclepiadaceae	Ph	Per	SU	C	I, II, III, IV,V, VI, VII, VIII	1.2.3.4.5. 8.9.10	+	+	-	+	-
Capparis sinaica veill	Capparaceae	Ph	Per	SU	C	III	9	+	-	+	+	-
Capparis spinosa L.	Capparaceae	Ph	Per	Pluri	R	VI	5	+	-	+	+	-
Capsella bursa-pastoris (L). Medik.	Brassicaceae	Th	Ann	COSM	R	V, VII, VIII	3.4	+	+			
Centropodia forsskaolii (vahl) Cope	Poaceae	Ch	Per	SA+IT	R	VI, VII, VIII	3.4.6		+			
Chenopodium album L.	Chenopodiaceae	Th	Ann	COSM	C	VIII	3.8	+	+	+	-	-
Chenopodium ambrosioides L.	Chenopodiaceae	Th	Ann	COSM	C	V	9	+	+	+	-	-
Chenopodium murale L.	Chenopodiaceae	Th	Ann	IT+ME	C	I, IV, VII, VIII	2.3.4.9.10	-	+	+	-	-
Chenopodium opulifolium Schrad.	Chenopodiaceae	Th	Ann	ME+IT+EU	R	VII	1.4	-	+	+	-	-
Chloris barbata Sw.	Poaceae	He	Per	SU	R	II, III, IV, VI, VII	4. 9.10		+			
Chrozophora oblongifolia (Delili) Spreng	Euphorbiaceae	Ch	Per	ME+IT	C	III, VII	2. 8.9	-	+	-	-	-
Citrullus lanatus (Thunb).Mast.	Cucurbitaceae	He	Per	COSM	C	III, VII, VIII	3.4.9	+	+	-	+	-
Citrullus colocynthis (L) Schrad	Cucurbitaceae	He	Per	SA	C	VI, VII, VIII	1.2.3.4.5. 8. 10	+	+	-	+	-
Commicarpus ambiguous Meikle	Nyctaginaceae	Ph	Per	SU	R	VII	2					
Commicarpus mistus	Nyctaginaceae	Ph	Per	SU	R	VII	9	+	+			
Commicarpus plumbagineus	Nyctaginaceae	Ph	Per	SU	C	I, II, III, V, VI, VII, VIII	2.3.4.5.6.7.8.9				+	
Commicarpus sinuatus Meikle	Nyctaginaceae	Ph	Per	SU	C	V	9				+	
Convolvulus arvensis L.	Convolvulaceae	Th	Per	TR	C	VII	9	+	+	-	+	-
Conyza bonariensis(L.) Cronquist	Asteraceae	Th	Ann	PAN	R	I, III, IV	9.10	+	+		+	
Crassula shimperi Fisch	Crassulaceae	Th	Ann		R	VIII	3					
Crepis sp. aff. *ruepellii* Sch.-Bip.	Asteraceae	He	Per	ME	R	VIII	3		+			
Ctenolepis cerasiformis (Stocks) Hook.f.	Cucurbitaceae	He	Per	SA+SU	C	V, VI, VII	2. 4.5. 9	-	+	-	-	-

TABLE 2. Cont.

Species	Family	Life form	Habit	Chorotype	Abundance	Vegetation groups	Wadis	Economic uses				
								M	G	E	F	O
Cucumis prophetarum L.var *dissectus*(Naudin) C. Jeffrey.	Cucurbitaceae	He	Per	SA+SU	C	VI, VII, VIII	3.4.5. 8.10	-	+	-	-	-
Cuscuta pedicellata Ledeb.	Convolvulaceae	P	Per	SA+SU	C	I, II	9	-	+	-	-	-
Cylindrilluma solenophora (Lavr).	Asclepiadaceae	He	Per		R	, VI, VII, VIII	2.3.4. 6.7		+	+		
Cynodon dactylon (L) Pers.	Poaceae	G	Per	COSM	C	I, II, III, IV, VI, VII, VIII	2.3.4.5.8.9.10	+	+	-	-	-
Cyperus articulates L.	Cyperaceae	He	Per	TR	R	I	9	+	+	-	-	-
Cyperus laevigatus L.	Cyperaceae	He	Per	SA+ME+IT	C	I, III	9	+	+	-	-	-
Dactyloctenium aegyptium (L) Wild .	Poaceae	Th	Ann	TR	C	I, II, III, V, VII	9.10		+			
Datura innoxia Mill.	Solanaceae	Th	Per	PLuri	R	I, III,V, VI, VII, VIII	2.3.4. 6.7. 9.10	+	-	+	+	-
Digitaria nodosa Parl.	Poaceae	Th	Ann	COSM	C	I, II, IV	9.10		+			
Dodonaea angustifolia L.f.	Sapindaceae	Ch	Per	SU	C	V, VIII	6.7.9	+	+	-	+	-
Echinops spinosus L.	Asteraceae	Ch	per	ME +IT	C	I, IV, VI, VII, VIII	1.2.3.4.5.6.7.8.9.10	+	+	+	+	-
Echiochilon persicum (N.l.Burm.)	Boraginaceae	Ch	Per	SA	R	VIII	3		+		+	
Eclipta alba (L.) Hassk.	Asteraceae	Th	Ann	TR	R	I, III	9		+			
Eragrostis barrelieri Daveau.	Poaceae	Th	Ann	SA+ME	R	VII, VIII	3.4		+			
Eucalyptus globulush Labill.	Myritaceae	Ph	Per	TR+EU+PAN	C	VI	1	+	-	-	+	-
Euphorbia cactus Ehrenb.	Euphorbiaceae	Ch	Per	SU	R	VI	4.5	+	-	-	+	-
Euphorbia sp.aff. *ammak* Schweinf.	Euphorbiaceae	Th	Ann	PAN	R	VIII	3	+				
Euphorbia serpens Kunth	Euphorbiaceae	Ph	Per	endemic	R	VII	8	+				+
Euphorbia granulata Forssk.	Euphorbiaceae	Th	Ann	SA +SU	C	IV, VI, VII, VIII	1. 4.5.8.10	+	-	-	-	-
Euryops arabicus Steud.	Asteraceae	Ch	Per	SU	C	VI, VIII	3.4.6	+	-	-	+	-
Fagonia bruguieri DC.	Zygophyllaceae	Ch	Per	IT +SA	C	II, VI, VII, VIII	4. 6.7.8.9.10	+	-	-	-	-
Fagonia indica Burm.f.	Zygophyllaceae	Ch	Per	IT+SA	C	II, III, V, VI, VII, VIII	1.2.3.4.5.6. 8.9.	+	-	-	-	-
Farsetia longisilqua Decne.	Brassicaceae	Ch	Per	SU	C	VII, VIII	3.4		+			
Ficus cordata ssp.*salicifolia*(Vahl) Berg.	Moraceae	Ph	Per	TR	C	VI	2	+	+	+	+	-

TABLE 2. Cont.

Species	Family	Life form	Habit	Chorotype	Abundance	Vegetation groups	Wadis	Economic uses				
								M	G	E	F	O
Ficus palmata Forssk.	Moraceae	Ph	Per	SU	C	V, VI, VIII	2.3.6	+	+	+	+	+
Flaveria trinerva (spreng) mohr	Asteraceae	Ch	Per		CC	III, VII	4.9					
Forsskaolea tenacissima L.	Urticaceae	Ch	Per	SA +SU	C	I, III, IV, VII, VIII	1.2.3.4. 6.7. 9.10	-	-	-	-	-
Glinus lotoides L.	Molluginaceae	Th	Ann	ME+IT	R	VI	4		+			
Heliotropium arbainse Fresen.	Boraginaceae	Ch	Per	SA	C	I, II, VI, VII, VIII	2.3. 5.6.7.8.9.10	+	-	-	+	-
Heliotropium curassavicum L.	Boraginaceae	Ch	Per	PAN	C	I,V, VII, VIII	1.2.3.4. 9	+	-	-	+	-
Holosteum umbellatum L.	Caryophyllaceae	Th	Ann	ME+IT	R	VII	4					
Hyoscyamus sp	Solanaceae	Ch	Per		R	V	2	+	+			
Imperata cylindrica (L.) Raeusch.	Poaceae	G	Per	ME+SU+IT	R	II, III, IV	9.10	+	+	-	-	-
Indigofera spinosa Forssk.	Fabaceae	Ph	Per	SA	C	IV,V, VI, VII	1.2. 4.5. 9.10	+	+	-	+	+
Ipomoea aquatica L.	Convolvulaceae	Ch	Per		R	V	9		+			+
Ipomoea cairica (L.) Sweet.	Convolvulaceae	He	Per	TR	C	V	9		+			+
Juniperus procera Hochst.	Cuprassaceae	Ph	Per	COSM	C	VIII	6.7	+	+	-	+	-
Lasiurus scindicus Henarad	Poaceae	Th	Ann	SA+SU	C	I, V, VII	9		+			
Lathyrus saxatilis (Vent.) Vis.	Fabaceae	Th	Ann	ME	R	VII	1		+			
Launaea sonchoides (Cass.) N. Kilian.	Asteraceae	Th	Ann		R	III	9		+			
Lavandula dentata L.	Lamiaceae	Ch	Per	ME	C	II	9	+	+	-	-	-
Lavandula pubescens Decne	Lamiaceae	Th	Per	SA +SU	R	IV, VI, VII, VIII	1.2.3. 5.6.7.8. 10	+	+	+	-	-
Lemna gibba L.	Lemnaceae	HH	Per	COSM	R	III, IV	9.10		+			
Leptochloa obtusiflora Hoschst	Poaceae	He	Per	TR	C	I	9		+			
Lotononis platycarpa (Viv.) Pic.Serm.	Fabaceae	Th	Ann	SA+SU	C	VII	2		+			
Lycium shawii Roem.*& schult*	Solanaceae	Ch	Per	IT +SA +SU	C	II, III, V, VI, VII, VIII	1.2.3.4.5. 8.9	+	+	+	+	+
Malva parviflora L.	Malvaceae	Th	Ann	IT+ME	C	III,VI, VII, VIII	1. 3.4. 9.10	+	+	+	-	-
Maurea crassifolia Forssk.	Capparaceae	Ph	Per		C	VI, VIII	3.4.5.7	+	+	+	+	+
Melhania ovata var. *abyssinica* (Rich.) K. Schum.	Sterculiaceae	Ch	Per	SU	R	VI						
Mentha longifolia (L) Huds .	Lamiaceae	He	Per	ME+IT+EU	CC	I, II, III, IV,V	9.10	+	+	+		

TABLE 2. Cont.

Species	Family	Life form	Habit	Chorotype	Abundance	Vegetation groups	Wadis	Economic uses				
								M	G	E	F	O
Morettia parviflora Boiss.	Brassicaceae	Ch	Per	SU	C	IV, VI, VII, VIII	3.4.5.8. 10		+			
Nasturtium officinale R. BR.	Brassicaceae	He	Per	COSM	R	I, II	9		+			
Ochradenus baccatus Delile.	Resedaceae	Ch	Per	SA+SU	C	VI, VII, VIII	2.3.4.5.10	+	+	-	-	-
Ochthochloa compreesa (Forssk) Hilu.	Poaceae	He	Per	TR	C	I, II	9		+			
Olea europaea L.ssp.*cuspidata* (Wall. ex G. Don)	Oleaceae	Ch	Per	ME	C	VII, VIII	3.4	+	-	+	+	-
Onopordon heteracanthum C.A.	Asteraceae	Ch	Ann	IT	R	VIII	3.6	-	-	-	-	-
Opuntia ficus-indica.(L.) Mill.	Cactaceae	Ch	Per	PAN	C	VI, VII, VIII	3.4. 6.7	+	-	+	-	-
Oryza sativa L.	Poaceae	Ch	Per		R	II, VII	9	+	+	+	+	
Osteospermum vaillantii(Decne.) Norl.	Asteraceae	Ch	Per	SA +SU	C	I	9	+	-	-	-	-
Otostegia fruticosa (Forssk). Penz.	Lamiaceae	Ch	Per	SA	C	IV,V, VI, VII, VIII	3.4.6.9.10	+	-	-	+	-
Panicum miliaceum L.	Poaceae	Th	Ann	ME+IT+EU	R	I, III,V	9		+			
Panicum turgidum Forssk.	Poaceae	G	Per	ME+SU+IT	C	II, III, V, VI, VII, VIII	2.3.4.5.6. 8.9.10	+	+	+	+	-
Parkinsonia acueata L.	Fabaceae	Ph	Per	PAN	C	V	9	+	+		+	+
Pasidia puncutulata (DC.) Oliv. & Hiern ex Vatke.	Asteraceae	Ch	Per	TR	CC	VIII	3.6.7		+			
Paspalidium geminatum (Forssk)	Poaceae	He	Per	TR	R	I, II, III, IV	9.10		+			
Paspalum distichum L.	Poaceae	He	Per	PAN	C	I	9		+			
Peganum harmala L.	Zygophyllaceae	Ch	Per	Pluri	C	III, IV,V, VI, VII, VIII	2.3.4.5.6.8.9.10	+	+	+	+	+
Pennisetem setaceum (Forssk.) Chiov.	Poaceae	G	Per	SU	C	II, III, IV,V, VI, VII, VIII	3.4.6.9.10	-	+	+	-	-
Pergularia tomentosa L.	Euphorbiaceae	Ch	Per	SU	C	VI, VII, VIII	1.2.4.5	+	+		+	
Periploca visciformis (Vatke) K. Schum.	Apocynaceae	Ph	Per	SU	C	III,V, VI	4.5.9		+			
Phoenix dactylifera L.	Palmae	Ph	Per	SA	CC	I, II, VII	1.2.5.9	+	+	+	+	+
*Pistacia atlantica*Desf.	Asteraceae	Ph	Per	IT	R	I, III,V, VI, VIII	8.9	+	+	+	+	
Plantago ciliata Desf.	Plantaginaceae	Ch	Per	SA+SU+IT	R	VIII	5	-	+	-	-	-
Plantago major L.	Plantaginaceae	Th	Ann	PAL	R	I, IV	9.10	+	+	-	-	-

TABLE 2. Cont.

Species	Family	Life form	Habit	Chorotype	Abundance	Vegetation groups	Wadis	Economic uses				
								M	G	E	F	O
Plectranthus sp.aff. *barbatus* Andr.	Lamiaceae	Ch	Per	SU	R	I	9	+	+	+		
Plicosepalus curviflorus (Benth.)	Loranthaceae	Ph	Per	SU	R	VI, VII, VIII	1.2.4.5					
Pluchea dioscoridis L. DC .	Asteraceae	Th	Ann	SA+SU	R	I, II, III, IV,V, VII	2..4. 9.10	-	+	-	+	-
Polycarpaea repens (Forssk). Asch. & Sehweinf	Caryophyllaceae	He	Per	SU	C	VII	1		+			
Polygala Schwartziana Paiva	Polygalaceae	Ch	Per	SU	R	VI	4	-	+	-	-	-
Polygala sp.off. sp.c *steudneri*	Polygalaceae	Ch	Per	SA	R	VIII	3		+			
Polygonum aviculare L.	Polygonaceae	Th	Ann	ME+IT+EU	R	VII	10		+			
Polypogon monspliensis (L.) Desf.	Poaceae	Th	Ann	SA+ME+IT	CC	I, II, IV	9.10	+	+			
Polypogon viridis (Gouan) Breistr.	Poaceae	He	Per	ME+IT	C	I	9	+	+			
Portulaca oleracea L.	portulacaceae	Th	Ann	Pluri	C	II, III, VII	9.10	+	+	+	-	-
Pulicaria undulata (L.) C.A.Mey. subsp. *undulata*	Asteraceae	Ch	Per	PAN	C	II, III, IV,V, VI, VII, VIII	1.2.3.4.5.6. 8.9.10	+	+	+	+	-
Ricinus communis L.	Euphorbiaceae	Ph	Per	TR	CC	I, II, III, V, VI, VII, VIII	2. 4.5.6 8.9.10	+	-	+	+	-
Rosa abyssinica Lindley	Rosaceae	Ph	Per	SA	R	VIII	6.7	+			+	+
Sageretia thea (Osbeck) M.C.Johnston.	Rhamnaceae	Ph	Per	IT	R	VI, VIII	3.4.5.6		+		+	+
Salsola imbricata Forssk.	Chenopodiaceae	Ch	per	SA+SU	R	II, III,V, VI, VII, VIII	3.4.5. 8.9.10	-	+	-	+	+
Salsola kali L.	Chenopodiaceae	Th	Ann	COSM	C	II, VI, VIII	3.6.7.9	+	+	-	+	+
Salvia deserti Decne.	Lamiaceae	Ch	Per	SU	R	VII	1	+	+	-	+	-
Seetzenia lanata (Willd). Bullock.	Zygophyllaceae	Th	Ann	SU	C	V	9	+	+			
Senna italica Mill.	Fabaceae	Ch	Per	SU	C	VI	5	+	+	+	+	+
Setaria viridis L. P.Beauv.	Poaceae	Th	Ann	ME+IT+EU	CC	I	9		+			
Sisymbrium irio L.	Brassicaceae	Th	Ann	ME +IT	R	V, VI, VII, VIII	2.3.4.6.7.8.9	+	+	+	-	-
Solanum glabrata var. *sepicula* (Dunal) J.R.I. Wood	Solanaceae	Ch	Per		R	VIII	3	+	+	-	+	
Solanum incanum L.	Solanaceae	Ch	Per	SU	C	II, III, IV, VI, VII, VIII	1.2.3.4.5.6.7.8.9.10	+	+	-	+	-
Solanum lycopersicon	Solanaceae	Ch	Per		R	VI, VIII	3.4	+	+	-	+	

TABLE 2. Cont.

Species	Family	Life form	Habit	Chorotype	Abundance	Vegetation groups	Wadis	Economic uses				
								M	G	E	F	O
Solanum villosum (L) Mill.	Solanaceae	Th	Per	ES+IT+ME	C	VI, VII	4.5	-	+	-	-	-
Sonchus oleraceus L.	Asteraceae	Th	Ann	ES+IT+ME	R	I, III, IV	9.10	+	+	+	-	-
Sonchus tenerrimus L. Lam.	Asteraceae	Th	Ann	ME+IT	R	VIII	3	+	+	+		
Stipagrostis ciliata (Desf) De Winter in Kirkia.	Poaceae	He	Per	SA	C	VI, VII	1.4		+			
Suaeda vermiculata Forssk. ex. J.F. Gmel.	Chenopodiaceae	Ch	Per	SA	C	I, II	9	-	+	+	-	-
Tamarix nilotica (Ehrenb). Bumge.	Tamaricaceae	Ch	Per	SU	C	I, II, VI, VII, VIII	1.2. 4.5 9.10	+	+	-	+	-
Tribulus macropterus Boiss.	Zygophyllaceae	He	Per	SU	C	V, VI, VII, VIII	1.2.3.4. 8	+	+			
Tribulus terrestris L..var. *terrestris*	Zygophyllaceae	Th	Ann	ME+IT+EU	CC	I, II, III, IV,V, VI, VII, VIII	1.3.4.9	+	+			
Typha elephantina Roxb.	Typhaceae	Ch	Per	SA + IN	R	I, II, III, IV, VIII	5.9.10	+	+	+	+	+
Urospermum picroides (L.) F.W. Schmidt.	Asteraceae	Th	Ann	ME+IT	C	I	9	+	+	+		
Verbascum sp.aff. *deserticola* (Murb.) Hub.-Mor.	Scrophulariaceae	He	Per	SA	R	I,VI, VIII	6.7.9	+	+			
Verbesina encelioides (Cav.) Benth. & Hook.F.exA.Gray	Asteraceae	Th	Ann	PAN	C	II, IV,V, VI, VII, VIII	1.2.3.4.5.6.9.10	-	-	-	-	-
Withania somnifera (L.) Dunal.	Solanaceae	Ch	Per.	IT+ME+TR	C	I, II, VII, VIII	6. 8.9.10	+	+	+	+	-
*Xanthium pungens*Wallr.	Asteraceae	Th	Ann	COSM	C	I, II, III,VII	4.9				+	
Xanthium spinosum L.	Asteraceae	Th	Ann	COSM	C	I, IIVII, VIII	4.5.9				+	
Zaleya pentandra (Linn.) Jeffrey in Kew Bull.	Aizoaceae	He	Per	SU	R	V, VI	2.4		+			
Ziziphus spina-christi (L) Desf.	Rhamnaceae	Ph	Per	Pluri	C	V, VI, VII, VIII	2. 4.5.6.7.8.	+	+	+	-	-
Zygophyllum simplex L.	Zygophyllaceae	Th	Per	PAL	R	VII, VIII	4.8	-	+	-	-	-

Life forms: Ch, chamaephytes; G,geophytes; P, parasites; Ph, phanerophytes; Th, therophytes. Habit: Per, Perennial; Ann, Annual; Bi, Biannual. Chorotypes: SA, Saharo- Arabian ; SU, Sudano- Zambezian; IT, Irano- Turanian; ME, Mediterranean; MIT, Med- Irano- Turanian; TR, Tropical; COSM, cosmopolitan; EU, Europian; PAN, Panotropic; IN, India. The uses: M, medicinal; G, grazing; E, edible; F, fuel; O, other uses. The wadis are: 1, El-Shakrah; 2, Liyah; 3, Al-Wahatt and Al-Waheitt; 4, Wakdan; 5, El-Qeim; 6, Al-Maharam; 7, El-Gadireen; 8, Masarrah; 9, El-Arg and 10, Ghadeer El-Banat.The vegetation groups are: I, *Menthalogifolia* group; II, *Salsolaimbricata* group; III, *Cynodondactylon* group; IV, *Plucheadiosocoridis* group; V, *Aervajavanica* group; VI, *Acacia gerrardii* var. *gerrardii* group; VII, *Calotropisprocera* group and VIII, *Acacia gerrardii* var. *gerrardii-Solanumincanum* group.

The life form spectra of the recorded species in the study area indicated that chamaephytes had the highest contribution (32.7% of the total recorded species), followed by therophytes (31.5%), phanerophytes (17.6%), hemicryptophytes (13.9%) and geophytes (3.3%). While hydrophytes and parasites were the lowest with a total relative value of 0.6% (Fig. 2). Regarding the economic uses, 158 species (95.8% of the total species) have at least one aspect of the potential or actual economic uses (Table 2). Sixty three species have ≥ 3 (out of 5) economic aspects, of them 7 species have 5 economic aspects. These species are*: Ficus palmata, Senna italica, Typha elephantine, Phoenix dactylifer , Peganum harmala, Lycium shawii* and *Maurea crassifolia.* Ninety six species (58.2% of total recorded species) were medicinal, 76 species (46.1%) were grazing, 41 species (24.9%) were edible by man, 61 species (37%) were used as fuel and 19 species (11.5%) had other economic uses (Fig. 3). The economic uses of the recorded species could be arranged in a descending order as follows: medicinal > grazing > fuel > human food > other uses.

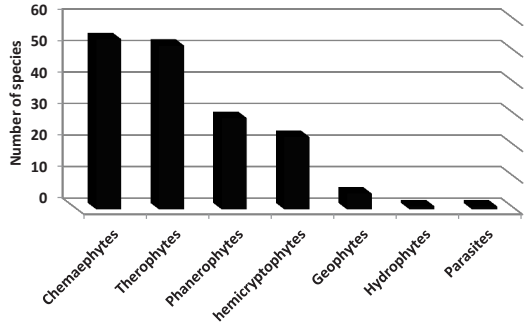

Fig. 2. Life form spectra of the recorded species in the mainwadis of Taif region.

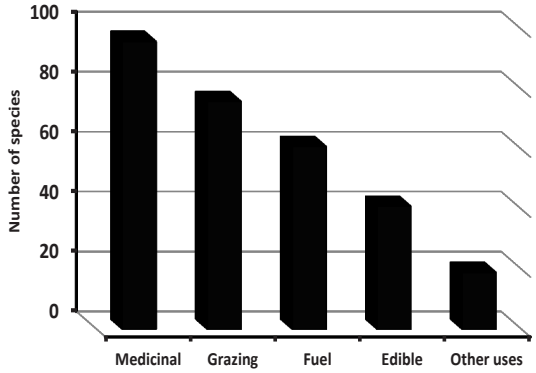

Fig. 3. Descending arrangement of the economic uses of the recorded species in the mainwadis of Taif region.

Regarding the global phytogeographical distribution, the mono-regionals elements were the highest (90 species = 54.6%), followed by bi-regionals (30 species = 18.2%), while the pluri-regional (22 species = 13.3%) and cosmopolitans (13 species = 7.9%) were the lowest (Fig. 4a). Thirty six (21.8%) of the mono-regional species were Sudano-Zambezian elements, 17 species (10.3%) were Irano-Turanean and 16 species (9.7%) were Saharo-Arabian (Fig. 4b).

The application of TWINSPAN on the cover estimates of 165 species recorded in 75 stands during the study period, led to the recognition of 20 groups at the 6th level of classification and 8 vegetation groups (communities) at the 3th level (Fig. 5). The application of DECORANA on the same set of data indicates a reasonable segregation among these groups along the ordination axes 1 and 2 (Fig. 6). The vegetation groups are named after the species that have the highest presence percentage (Table 3).

It was indicated that four vegetation groups (communities) represent the wetland wadis (**I:** *Mentha longifolia*, **II:** *Salsola imbricata*, **III:** *Cynodon dactylon*, and **IV:** *Pluchea diosocoridis*) and the other four groups represent the multi-wadis **V:** *Aerva javanica*, **VI:** *Acacia gerrardii* var. *gerrardii*, **VII:** *Calotropis procera* and **VIII:** *Acacia gerrardii* var. *gerrardii-Solanum incanum*).

I: *Mentha longifolia* group: It represents the wetland wadis (Wadi Al-Arg: 100% of its stands) and includes 52 species (31.5% of the total species). The most dominant species were: *Ricinus communis, Tamarix nilotica. Mentha longifolia, Digitaria nodosa, Cuscuta pedicillata, Nasturtium officinale* and *Ochthochloa compreesa*.

II: *Salsola imbricata* group: It represents wetland wadis (Wadi El-Arg: 100% of its stands) and includes 47 species (28.5% of the total species). The most dominant species are : *Tamarix nilotica, Polypogon monspliensis, Commicrapus plumbagineus, Cynodon dactylon, Typha elephantine, Lycium shawii, Salsola imbricata, Solanum incanum* and *Atriplex leucoclada.*

III: *Cynodon dactylon* group: It also represents wetland wadis (Wadi El-Arg: 100% of its stands) and includes 49 species (29.7% of the total species). The most dominant species are: *Tamarix nilotica, Cynodon dactylon, Mentha longifolia, Xanthium pungens* and *Acacia asak.*

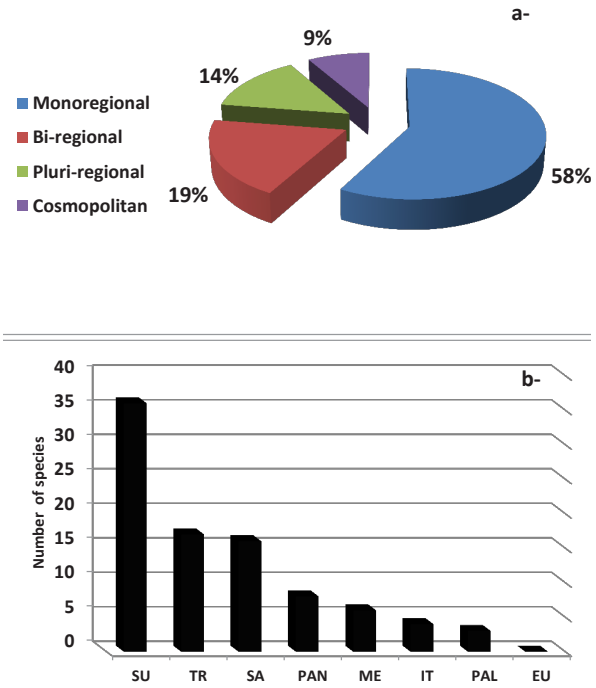

Fig. 4. Chorotype spectra the recorded species recorded species species in the mainwadis of Taif region.EU: European, IT: Irano-Turanean, ME: Mediterranean, PAL: Paleotropic, PAN: Pantropic, SA: Saharo-Arabian, SU: Sudano-Zambezian and TR: Tropicalregions

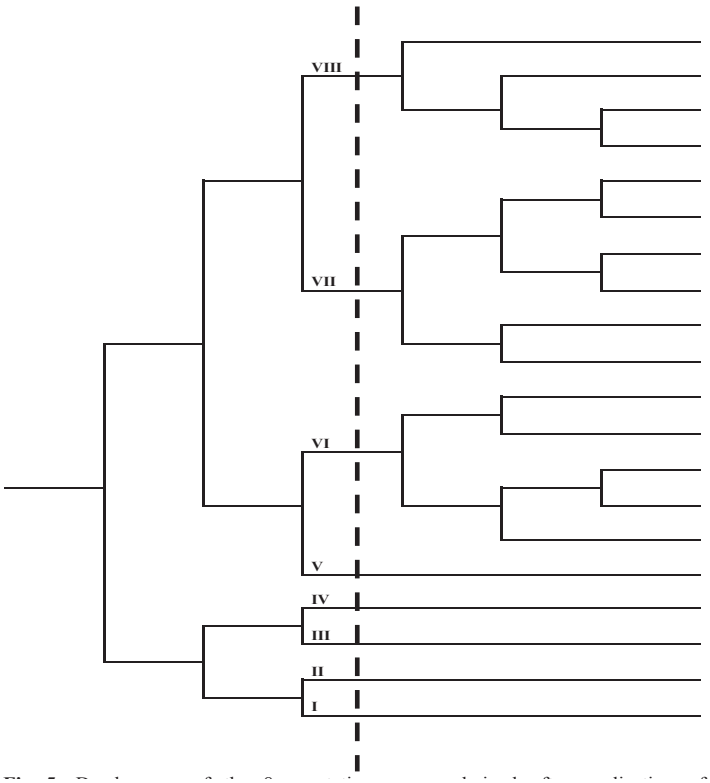

Fig. 5. Dendrogram of the 8 vegetation groups derived after application of TWINSPAN classification technique on the sampled 75 stands species in the main wadis of Taif region [The vegetation groups are: I: *Menthalogifolia* group, II: *Salsolaimbricat*a group, III: *Cynodondactylon* group, IV: *Plucheadiosocoridis* group, V: *Aerva javanica* group, VI: *Acaciagerrardii var. gerrardii* group, VII: *Calotropisprocera* group and VIII: *Acacia gerrardii var. gerrardii -Solanumincanum* group].

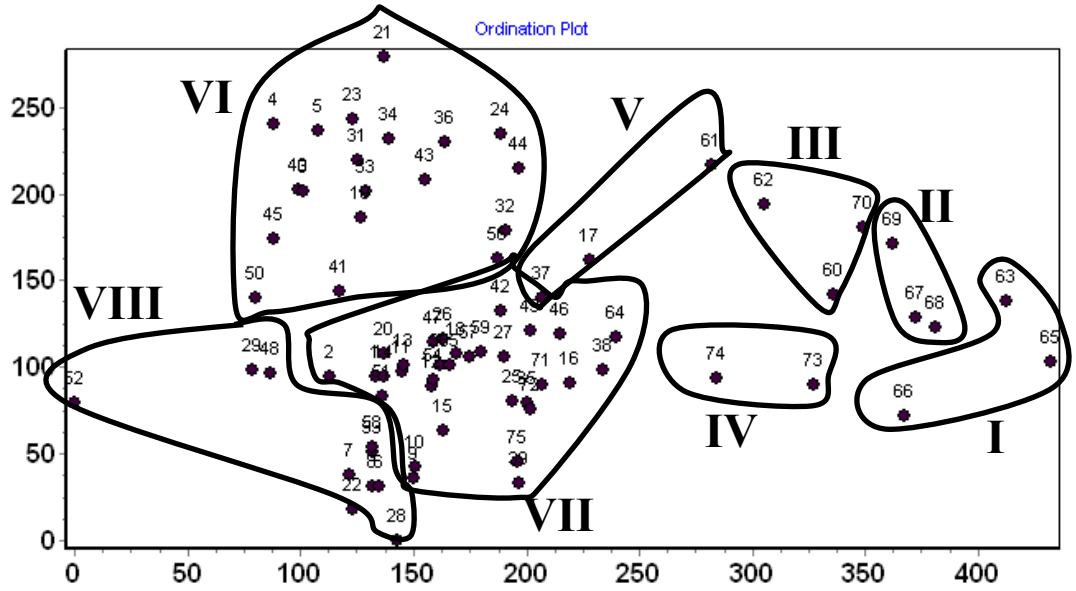

Fig. 6. Cluster centroids of the 8 vegetation groups derived after application of DECORANA ordination technique on the sampled 75 stands in the main wadis of Taif region [The vegetation groups are:. I: *Menthalogifolia* group, II: *Salsolaimbricata* group, III: *Cynodondactylon* group, IV: *Plucheadiosocoridis* group, V: *Aervajavanica* group, VI: *Acaciagerrardii var. gerrardii* group, VII: *Calotropisprocera* group and VIII: *Acacia gerrardii var. gerrardii-Solanumincanum* group].

IV: *Pluchea dioscoridis* group. It also represents wetland wadis (Wadi Ghadeer El-Banat: 100% of its stands) and includes 37 species (22.4% of the total species). The most dominant species are: *Cynodon dactylon, Mentha longifolia, Pluchea dioscoridis, Calotropis procera, Bacopa monnieri, Solanum incanum, Acacia gerrardii* var. *gerrardii, Pennisetum setaceum* and *Imperata cylindrica.*

V: *Aerva javanica* group: It represents 3 wadis (Wadi Liyah, Wadi Wakdan and Wadi El-Arg) and includes 44 species (26.7% of the total species). The most dominant species are: *Acacia gerrardii* var. *gerrardii, Aerva javanica* and *Ctenolepis cerasiformiis.*

VI: *Acacia gerrardii* var. *gerrardii* group: It represents multi-wadis and includes 67 species (40.6% of the total species). The most dominant species are: *Acacia gerrardii* var. *gerrardii, Lycium shawii, Acacia tortilis* and *Peganum harmala.*

VII: *Calotropis procera* group: It represents multi-wadis and includes 84 species (50.9% of the total species). The most dominant species are: *Acacia gerrardii* var. *gerrardii, Calotropis procera, Echinops spinosuss, Fagonia indica, Argemone ochraleuca* and *Citrullus colocynthis.*

VIII: *Acacia gerrardii v*ar. *gerrardii-Solanum incanum* group: It represents multi-wadis and includes 82 species (49.7% of the total species). The most dominant species were *Acacia gerrardii* var. *gerrardii, Solanum incanum, Echinops spinosus, Argemone ochraleuca, Lavandula pubescens, Belpharis ciliaris, Heliotropium arabainense* and *Sisymbrium irio.*

The soil analysis according to vegetation groups (communities) was indicated in Table 4. It was indicated that the soils of *Pluchea dioscoridis* group (IV) had the highest of pH (7.73±0.07), chlorides (0.19±0.00%), organic carbon (2.05±0.98%), organic matter (3.53±1.70%) and bicarbonates (0.92±0.00%). The soils of *Aerva javanica* group (V) had the highest of salinity (EC=407.90±207.70 µmhos/cm) and the lowest of organic carbon (1.16±0.54%) and organic matter (2.00±0.93%). On the other hand, the soils of *Calotropis procera* group (VII) had the lowest of pH, chlorides and bicarbonates (7.49±0.14, 0.08±0.06% and 0.37±0.29% , respectively). The soils of *Acacia gerrardii* var. *gerrardii-Solanum incanum* group (VIII) had the lowest of salinity (57.19±161.12 µmhos/cm).

TABLE 3. Characteristics of 8 vegetation groups derived after the application of TWINSPA.

VG.	Wadis										First dominant	P (%)	Second dominant	P (%)
	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10				
I									100		*Menthalogifolia*	100	*Nasturtium officinale*	100
II									100		*Salsolaimbricata*	100	*Typhaelephantina*	100
III									100		*Cynodondactylon*	100	*Menthalogifolia*	100
IV										100	*Plucheadiosocoridis*	100	*Menthalogifolia*	100
V		33		33					33		*Aervajavanica*	100	*Acacia gerrardii var. gerrardii*	100
VI	16	21		32	21	5		5			*Acacia gerrardii var. gerrardii*	95	*Acacia tortolis*	84
VII	27	35		12	4	4		4	4	12	*Calotropisprocera*	84	*Acacia gerrardii var. gerrardii*	84
VIII	6		31		6	19	25	13			*Acacia gerradii var. gerradii*	100	*Solanumincanum*	81

The groups are named as follows: I, *Menthalogifolia* group; II, *Salsolaimbricata* group, and III, *Cynodondactylon* group; IV, *Plucheadiosocoridis* group; V, *Aervajavanica* group; VI, *Acacia gerrardii* var. *gerrardii* group; VII, *Calotropisprocera* group and VIII, *Acacia gerrardii* var. *gerrardii-Solanumincanum* group. The wadis are: W1, El-Shakrah; W2, Liyah; W3, Al-Wahatt and Al-Waheitt; W4, Wakdan; W5, El-Qeim; W6, Al-Maharam; W7, El-Gadireen; W8, Masarrah; W9, El-Arg and W10: Ghadeer El-Banat.

TABLE 4. Mean ± standard deviation of the soil variables in relation to vegetation groups in the study area.

VG	pH	EC (mmhos cm^{-1})	Cl (%)	OC (%)	OM (%)	HCO3 (%)
I	7.58±0.12	155.33±85.60	0.17±0.00	1.40±1.32	2.41±2.28	0.81±0.02
II	7.58±0.13	203.90±65.31	0.18±0.00	1.24±0.56	2.13±0.97	0.86±0.01
III	7.58±0.04	199.20±148.49	0.17±0.01	1.27±0.56	2.20±0.97	0.81±0.07
IV	7.73±0.07	86.70±13.15	0.19±0.00	2.05±0.98	3.53±1.70	0.92±0.00
V	7.58±0.08	407.90±207.70	0.10±0.06	1.16±0.54	2.00±0.93	0.50±0.27
VI	7.55±0.21	225.83±312.31	0.09±0.04	1.64±1.00	2.83±1.73	0.40±0.19
VII	7.49±0.14	116.68±78.75	0.08±0.06	1.22±0.91	2.10±1.57	0.37±0.29
VIII	7.64±0.19	57.19±161.12	0.11±0.03	1.42±0.74	2.44±1.28	0.56±0.18
Mean	**7.56±0.17**	**172.16±193.81**	**0.10±0.06**	**1.40±0.87**	**2.41±1.50**	**0.49±0.27**
F-Value	**1.49**	**1.27**	**5.31*** **	**0.56**	**0.56**	**5.71*** **

- The vegetation groups are named as follows: I, *Menthalogifolia* group; II, *Salsolaimbricata* group; III, *Cynodondactylon* group; IV, *Plucheadiosocoridis* group; V, *Aervajavanica* group; VI, *Acacia gerrardii* var. *gerrardii* group; VII, *Calotropisprocera* group and VIII, *Acacia gerrardii* var. *gerrardii-Solanumincanum* group.
- *: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$

Discussion

The recorded species in the present study (165 species) represented about 7.6% of the whole flora of Saudi Arabia; their genera represent 15.2%; and their families represent 30.2%. From the floristic viewpoint, the present study can conclude that the study area seems to be one of the richest flora of the Saudi Arabia taking into account its relatively small area comparing with the area of Kingdom where it represent about 0.05% of the total area of Saudi Arabia. One of the main characteristics of the vegetation cover of Saudi Arabia is its low floristic diversity. The number of plant species that recorded in the country was 2172 species, many of which were in the wetter areas of its south-western part. Which include Sarrawat Mountains these species belong to 840 genera and 149 families (Al-Nafie, 2004). The number of species increased to 2250 by adding subspecies, extinct and species that have not been identified yet (Collenette, 1999). Numbers of families, genera, and species were very low compared to Saudi Arabia's vast land area, which is probably, the result of the harsh environmental conditions that prevail in the Saharo-Arabian region which covers vast area of the country. The mountains of the western area of Saudi Arabia which includes the study area have the greatest plant diversity, approximately 74% of the total plant species of Saudi Arabia. This may be due mainly to a greater rainfall (Al-Nafie, 2008).

Comparing the results with that of the related studies in the same study area, it was indicated that about 78% of the recoded species were recorded by the study of Al-Sodany et al. (2014). Some species were recorded in the present study and not recorded by another study such as: *Zaleya pentandra, Amaranthus albus, Amaranthus graecizans, Amaranthus hybridus, Amaranthus viridis, Periploca visciformis, Ambrosia maritima, Conyza bonariensis, Eclipta alba, Capsella bursa-pastoris , Chenopodium ambrosioides* and *Lemna gibba.* We can conclude that most of these species are related with wetlands that characterize some wadis distributed in the study area. Other species were recorded by Al-Sodany et al. (2014) and not recorded in the present study such as: *Ecbolium gymnostachyum, Aloe vacillans, Nerium oleander, Caralluma plicatiloba, Scorzonera schweinfurthia, Cupressus horizontalis, Clutia myricoides, Tarchonanthus camphorates, Terminalia cadabba* and *Azadirachta indica.* Most of these species grow in high altitudes and associated with *Juniperus* species (Al-Yasi, 2011).

It is evident that the Asteraceae) and Poaceae have the highest contribution, followed by Fabaceae. These results similar to the whole flora of Saudi Arabia where the highest families in the whole flora are Poaceae (262 species= 12.1%), Asteraceae (233 species= 10.7%), and Fabaceae (210 species= 9.7%) which represented by 705 species or 32.5% of the total plant species in the Kingdom. Also, similar trend to the flora of other similar studied region in the kingdom such as Al-Sodany et al. (2014, 2016) on the same study area; Mosallm (2007) on his comparative study on the vegetation of protected and non-protected areas, Sudera, Taif, Saudi Arabia; Abdel-Fattah & Ali (2005) on the study of vegetation-environment relations in Taif, Saudi Arabia; Al-Turki (2004) on his study of the flora of Jabal Fayfa in the south western Saudi Arabia; Al-Turki & Al-Olayan (2003) on the study of flora of Hail region; Al-Zahrani (2003) on his study on the vegetation and ecosystem of Bani Saad Mountains, south of Taif city. As in most tropical and subtropical deserts, the most plant species of Saudi Arabia belong to a limited number of plant families, for example, 1586 species belong to 23 families or 15.4% of the total families. These plant species represent 73% of the total species in the Kingdom (Al-Nafie, 2008). 46 families or 30% of the families in the country such as *Aloaceae*, *Celastraceae, Commelinacea*e, and *Burseraceae* are found only in Sarrawat Mountains (Al-Nafie, 2004).

The following is a comparison between some floristic variables in the present study and the previous studies:

An outstanding feature of floristic composition of the flora of the study area is that about half of the families are floristically important. Among 46 families, 21 families or 45.7% of the total number of families are represented by one species per family (Examples: Aizoaceae, Aloaceae, Apocynaceae, Cactaceae, Crassulaceae, and Loranthaceae). Six families, or 13.0% of the total number of families are represented by two species per family. Comparing to the whole flora of Saudi Arabia where among 149 families, 68 families or 45.6% of the total number of families are represented by single genus per family. 36 families, or 24.2% of the total number of families, are represented by one species per family. The number of genera

appears to be very high compared to the number of species. This is a common feature of desert flora. It is 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. Other species that could not survive have become extinct (Al-Nafie, 2008).

The life form spectrum indicated that chamaephytes were the most represented followed by therophytes. These results agree with that of Al-Yasi (2011) on the same study area; Heneidy & Bidak (2001) on Bisha, As irregion in southwestern of Saudi Arabia and El-Demerdash et al. (1994) in the southern region. They concluded that the dominance of chamaephytes and therophytes over other life forms in that region would seem to be the hot dry climate, topography variations and biotic influence. Also, Chamaephyte life form is able to withstand water logging, high salinity levels and a wide range of temperature variability (Beeftink, 1977; Zahran, 1982). On the other hand, the results of the present study disagree with other studies in the same region (Mosallm, 2007) which indicated that therophytes had the highest contribution. This may be due to the sampling in the present study was during season in which many annuals are dead. Moreover, he indicated that the loss of chamaephytes was due to overgrazing in that area.

From the phytogeographical viewpoint, the present study indicated that the Sudano-Zambezian elements (17 species of monoregionals) are the most represented chorotype, followed by the Irano-Turanean (17 species of monoregionals) and Saharo-Arabian elements (16 species of monoregionals), while the other elements had a minor representation. Comparing with the other related studies, Al-Nafie (2008) reported 180 species in the flora of Saudi Arabia are belongs to Saharo-Arabian Region and 88 ones to Sudanian Region. Unfortunately, the boundaries of these two regions in Saudi Arabia are still debatable, ill-defined and very difficult to delimit. The delimitation of the frontier between the two regions in the Arabian Peninsula in its southern part has always created some difficulties for a few biogeographers as well as phytogeographers who have studied the region. These difficulties arise from the fact that the southern parts of the Saharo-Arabian region are occupied by very dry, hot and bare deserts such as Al Rub Al- Khali, as well as the much more vegetated sand dunes of the Dahna and the Great Nafud. Zohary (1973) suggested that these deserts could support Sudanian species as a result of their hot climate, but are too dry to support such vegetation. In addition, many of the Saharo-Arabian elements are derived and developed from the neighboring regions, mainly the Sudanian region in the south, and the Mediterranean and Irano-Turanian regions in the north and north-west, respectively they are developed gradually but discontinuously under the increase of aridity since the Middle Miocene, which is believed to be a transitional period climatically between the humid early Tertiary and the arid Late Tertiary and Quaternary environments (Anton, 1984). The most dominant Saharo-Arabian and Sudano-Zambezian elements in the flora of study area include: *pluchea dioscoridis, Salsola imbricata, Cuscuta pedicellata, Ctenolepis cerasiformis, Cucumis prophetarum* var. *dissectus, Lotononis platycarpa, Lasiurus scindicus, Ochradenus baccatus, Blepharis ciliaris, Euphorbia granulata, Forsskaolea tenacissima, Lavandula pubescens, Lotononis platycarpa, Lycium shawii, Osteospermum vaillantii, Panicum turgidum, Pluchea dioscoridis Salsola imbricata*, and *Plantago ciliata.*

On the other hand, the present study recorded 21 species are Pluriregional, 13 of them are cosmopolitan species. According to Al-Nafie (2008), Pluriregional species that grow in many regions and widely spread all over the world such as: Himalayan Mountain, Deccan plateau, Canary Islands, Namib Desert, and South Africa are represented in the Saudi Arabian flora. The presence of these plant species from different regions is an indication on the relationship between the Arabian Peninsula and these regions. Some of these species might reached the Arabian Peninsula as a result of the climatic changes which the world witnessed a long time ago, or as a result of the distribution by human and animals specially birds which carry seeds for a long distances. Examples found in the present study include: *Aizoon canariense*, *Amaranthus graecizans, Capparis spinosa*, *Chenopodium album, Chenopodium murale, Convolvulus arvensis, Cynodon dactylon, Datura innoxia, Datura stramonium, Juniperus procera, Peganum harmala, Poa annua, Portulaca oleracea, Xanthium strumarium*, and *Ziziphus spina-christi*.

Today many medicinal plants face extinction or severe genetic loss, but detailed information is lacking. Little work has been done in Taif

region. Consequently little data is available about the medicinal plants and their status as natural resources for potential use by local inhabitants in this region (Al-Sodany et al., 2013). Ninety six percent of the total recorded species by the present study have at least one aspect of the potential or actual economic uses. Ninety six species (58.2% of total recorded species) are medicinal, 76 species (46.1% of total recorded species) are grazing, 41 species (24.9% of total recorded species) are edible by man, 61 species (37% of total recorded species) used as fuel and 19 species (11.5% of total recorded species) used as other economic uses. So, the economic uses of the recorded species could be arranged descendingly as follows: medicinal → grazing → fuel → human food → other uses. This trend similar to that recorded by Al-Sodany et al. (2014) and Heneidy & Bidak (2001) in Bisha, Asir region who recorded 75% as medicinal, 83% as grazing, 17% as edible by human and animals, 40% as fuel wood and 72% of them as other uses. However, there is a shortage of information about the multipurpose uses of natural species. Many substances that we use in our daily lives are plant products, although there are a lot of uses of plant species still unknown. Numerous medicines, many industrial products are derived of plant products. Most of all are edible plant products that form the food base of human culture (Heneidy & Bidak, 2004). On the other hand, Mossa et al. (1987) recorded 149 plant species as medicinal plants in the Saudi Arabia. Generally, the various activities have different impacts s (e.g. telecom, crop expansion, overgrazing, and overcutting). There are direct and indirect causes for ecosystem degradation and species impoverishment in the study area. The direct causes are related to mainly to the ways in which man has used and misused the natural resources since its early history. More recent, land use activities are even more devastating. Evaluation of the effects of the environmental factors threatening the wild life should be taken in consideration. So it is important to construct a representative reserve (protected natural areas) for conservation of the natural.

The application of TWINSPAN and DECORANA techniques (Hill, 1979 a, b) to the vegetation data of the present study led to the recognition of 8 vegetation groups (communities) at 3rd level of classification. These groups are completely differed than that recorded by other communities recorded by other related previous studies in the same area (Al-Sodany et al., 2014, 2016; Abdel Fattah & Ali, 2005; Mosallm, 2007). This may due to the differences in habitat types and the methods of identification of plant communities in both studies. This is the first study that identify the vegetation groups (plant communities) by using the multivariate analysis for classification (TWINSPAN) and ordination (DECORANA) in this area of the kingdom. Also, the high altitudes in the study of Al-Yasi (2011) may conclude these differences (about 2500m above sea level).

On the other hand, there are a complete differences between plant communities recognized by the present study and other related studies in the different areas of the Kingdom (Abulfatih 1991; El-Karemy & Zayed, 1992; Hegazy et al., 1998; Alyemeni, 2000; 2001; Alwadie, 2007) except *Juniperus procera* group that recognized by Hegazy et al. (1998) in altitude belt of *c.* 2500 m above sea level in Asir and Sarrawat highlands. They concluded that, on the Asir highlands (above 2500m) discontinuous plant communities exist on discrete habitat types. This appears to represent slope and exposure effects at the high elevation. In contrast, the transitional range between 500–2500m is characterized by continuity in vegetation change from one altitudinal belt to the next, with broad transitional areas and overlap between low and high altitude vegetation. Similar results and observations were described by Kassas (1955) in Sudan, Vesey-Fitzgerald (1955) in Saudi Arabia, Kassas (1957) in Egypt, Beals (1969) in Ethiopia, Brooks & Mandil (1983) in Saudi Arabia and Ghazanfar (1991) in Oman. Moreover, Moustafa (1990) in St. Catherin (Sinai Peninsula area) found that the organization of community types or associations is the net result of the behavior of species in response to environmental conditions. Ayyad et al. (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.

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التنوع النباتي وتركيب المجتمعات النباتية للوديان الرئيسية على مرتفعات الجبال الغربية بالطائف، المملكة العربية السعودية

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تهدف الدراسة الحالية إلى: مسح وتحديد الأنواع النباتية المنتشرة في الوديان الرئيسية على مرتفعات الجبال الغربية بالطائف بالمملكة العربية السعودية ، وتحليل الغطاء النباتي، وتحديد المجتمعات النباتية السائدة وبالإضافة إلى تقييم تأثير العوامل البيئية التي تؤثر على المجتمعات. تم اختيار خمسة وسبعين موقع لتمثيل التنوع النباتي والتغيرات البيئية المصاحبة. تم تحديد وفرة الأنواع، وأشكال الحياة، والتوزيع الجغرافي، والاستخدامات الاقتصادية للنباتات المسجلة. وتم تسجيل 165 نوعًا تنتمي إلى 128 جنسًا و 47 عائلة، منهم حوالي 69.7% نباتات معمرة و 30.3 % نباتات حولية. وكانت الفصيلة النجيلية والفصيلة المركبة أعلى الفصائل من حيث عدد الأنواع. وأظهرت النباتات فوق السطحية أعلى نسبة، تليها النباتات الحولية، ثم النباتات الظاهرة، بينما كانت النباتات المائية والمتطفلة هي الأقل. يمكن ترتيب الاستخدامات الاقتصادية للأنواع المسجلة بترتيب تنازلي على النحو التالي: طبية> رعوية> وقود> غذاء الإنسان> الاستخدامات الأخرى. وأظهرت النتائج أن الأنواع أحادية الإقليم وثنائية الأقاليم الإقليمية هي الأعلى ، في حين كانت الأنواع متعددة الأقاليم والكونية هي الأقل. من بين أحاديات الإقليم ، ينتمي 36 نوعًا الى المنطقة السودانية الزامبيزية، و 17 نوعًا الي المنطقة الإيرانية التورانية و16 نوعًا الى منطقة الصحراء العربية. أدى نتائج التحليل العددي (TWINSPAN) على تقديرات الغطاء لـ 165 نوعًا مسجلة في 75 موقع، إلتحديد 8 مجموعات نباتية (مجتمعات) في المستوى الثالث من التصنيف وهي مجموعات الحبق والقرضى والنجيل على الوديان ذات الأراضي الرطبة، ومجموعات الطرفة والسلم والعشار والسمر في الوديان متعددة البيئات.