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*Full Length Research Paper*

# Biological spectrum with some other ecological attributes of the flora and vegetation of the Asir Mountain of South West, Saudi Arabia

**Mohammad Al-Yemeni and Hassan Sher***

Department of Botany and Microbiology, College of Science, King Saud University, Riyadh, Kingdom of Saudi Arabia.

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**Based on the current available information on the flora and vegetation of the Asir mountain of SW Saudi Arabia, spectra on life form and some other ecological attributes were analyzed and reviewed in different sub-ecosystem of the investigated area. The floristic list of Asir Mountain of the Kingdom of Saudi Arabia consists of 189 species belonging to 74 families, 65 dicotyledons (dicots), 4 monocotyledons (monocots), while gymnosperms and pteridophytes were represented by one family each. Asteraceae was the dominating family in the study area. According to the Raunkiaerian life form therophytes (36.5%) followed by hemicryptophytes (15%) and geophytes (12.5%) were dominant in the area. Chaemophytes 6.5%, mesophanerophytes 3%, megaphanerophytes 2%, nanophaneorophytes 13% and climbers 1.5% contribution in the establishment of vegetation structure in the study area. In leaf size spectra, the analysis revealed that microphylls (38.5%) followed by nanophylls (24%), leptophylls (13.5%), mesophylls (12%), macrophylls (3%) and megaphylls (1%) construct the vegetation belt of the area. The biological spectrum of the high altitude was characterized by phanerophytes mainly representing nanophanerophytic followed by hemicryptophytic and geophytic species. These were increasing with the rise in elevation while the megaphanerophytic species were decreasing. The vegetation cover in general and the tree layer in particular were observed very rare and sparse. The grassland vegetation is characterized by the largest percentage of hemicryptophytes. In this region, the vegetation expression was predominantly evergreen, although the tree flora has considerable elements of deciduous species. The dominance of phanerophytes appears to be due to high rainfall, temperature and low biotic pressure. However, the population of therophytic species was increasing in highly grazed and eroded areas.**

**Key words:** Biological spectrum, Asir mountain, leaf size, life form, biotic and abiotic factors.

## INTRODUCTION

The Kingdom of Saudi Arabia is known to have different natural sites with great biological diversity and productivity and such sites are fundamental in the synergistic frame-work of associated ecosystems (Abuzinada et al., 2005). The vegetational structure showed some variations in its distributional behaviour in different sites of the country, which may be attributed to changes in water resources, climatic factors, edaphic variables and anthropogenic pressures along the elevation gradient (Hegazy et al., 2007).

The vegetation composition of Saudi Arabia reflects the geographical position of the Arabian Peninsula between Africa, Asia and Europe. Consequently, the flora has many elements of two of the eight global terrestrial realms; namely the Palaearctic (Europe and Asia) and the Afro-tropical (Africa south of the Sahara) as well as a smaller complement of elements from the Indo-Malayan terrestrial realm. It is thus an area of ecological and academic significance (Ghazanfar, 2007). The climate of Saudi Arabia can be characterized as arid (Hegazy et al., 2007; FAO, 1996; Abulfatih, 1992). Ecologically, such zones are fragile and difficult to develop and use. Except in limited areas, the vegetation of arid areas is sparse and usually highly specialized both morphologically as well as

*Corresponding author. E-mail: hassan.botany@gmail.com.

physiologically. However, conversion of natural habitats into agricultural land and development of residential areas have greatly decreased the vegetation structure in many parts of the Kingdom (Sher and Hussain, 2009 and Ghazanfar, 2007).

Climate determines the type of plants that can exist in each ecosystem and the general appearance of vegetation is referred to as physiognomy. It constitutes general structure, shape and life forms of the species comprising the vegetation and actually the classification of vegetation type has been done on the basis of physiognomy. The individual species in a community can be grouped into various life forms on the basis of their physiognomy appearance and growth performance. The life form of the vegetation is the product of their genetic pool and tolerance towards the climatic variation. Moreover, biological spectra are important physiognomic attributes that have been widely used in vegetation analysis. The life form spectra are said to be the indicators of micro and macroclimate (Asmus, 1990). Similarly, leaf size classes have been found to be very useful for associations. The leaf size knowledge may help in the understanding of physiological processes of plants and plant communities (Deeva, 1976). Literature dealing with the plant ecology of Saudi Arabia shows that very little work has been done on the vegetation analysis, life form and leaf size spectra. The only reference for the whole Kingdom is that of Al-Yemeni and Zayed (1999) and Al-Yemeni (2000) who gave detail of the community structure around Riyadh, Saudi Arabia. He also elaborated the effect of ecological factor in shaping the vegetation of the area. In view of the above applications for Raunkiaerian concepts, the presentation endeavour was initiated with an aim to (1) ascertain variation of life form and leaf size spectra in different plant communities of different climatic zones; (2) evaluate the Raunkiaerian spectra based on species list with the quantitative data (importance value) of species, and (3) elucidate the relationship between vegetation and an elevational gradient in the study area. We also discuss the potential role of anthropogenic activities and environmental factors on the observed trends.

## MATERIALS AND METHODS

### Study area

Asir Mountain is located in the South West of the Kingdom of Saudi Arabia and lies between 19°52′ N latitudes and 42°30′ E longitudes. The elevation of the area varies from 600 m at Jedda-Gizan coastal road to 2000 m at the Al Abna village. The forest of the area is a fundamental and potentially sustainable source of many services including economically and ecologically important edible, medicinal and aromatic plants. The diversity of climate, altitude, edaphic and geographic attributes for plant growth signify three sectors of the phytogeographic regions viz: Tehama (less than 600 m), Gentle-Slope (600-900 m) and Steep-slope (900-2000 m).

The present evaluation on the biological spectra of the flora and vegetation was carried out during spring and summer 2010. Life form reflects the adaptation of plants to climate. The relative proportion of different life form for a given region or area is called its biospectrum. The plants were classified into different life form classes according to Raunkiaer (1934) and were accordingly assigned to various RaunKiaerin life form and leaf size classes.

Raunkiaerin approach explains and helps in understanding the flora and structure of vegetation in relation to prevailing eco-biological conditions. For example an undisturbed forest would look somewhat different from its degraded counterpart. In this context, it also reflects the impact of current biotic factors, like overgrazing, over harvesting, deforestation on the overall vegetation structure and composition. It also influences the economic value of plants in various ways. The approach is useful in developing management plan for the sustainable harvest of plant resources.

Biological spectrum of the flora based on the life form was prepared by following Raunkiar (1934) life form classes as follows:

### Therophytes

Annual seed bearing plants which complete their life cycle in one year and over winter; the unfavourable season by means of seeds or spores.

### Geophytes

Perennating buds located below the surface of soil including plants with deep rhizomes, bulbs, tubers and corms, etc.

### Hydrophytes

Submerged hydrophytes are those rooted in the muddy substratum. The above ground or upper parts die at the end of growing season.

### Hemicrytophytes

Herbaceous perennial in which aerial portion of plant dies at the end of growing season, leaving a perennating bud at or just beneath the ground surface.

### Chamaeophytes

Perennating buds located close to the ground surface (below the height of 25 cm). They include herbaceous, low woody trailing, low stem succulents and cushion plants.

### Phanerophytes

They are shrubby and tree species whose perennating buds are borne on aerial shoot reaching a height of at least 25 cm or more above the ground surface (Table 1). After having assigned a life form to all the plants Raunkiarian spectra was calculated as follows:

$$\text{Biological spectra} = \frac{\text{Number of species falling in a particular life form classes}}{\text{Total number of all the species for that community/stand}} \times 100$$

### Leaf size classes

The leaf size knowledge helps in understanding physiological process of plants and plant communities and is useful in classifying

**Table 1.** Leaf size and phanerophytes classes.

| Leaf Size Classes | | Phanerophytes | |
|---|---|---|---|
| **Type** | **Leaf area (Sq.mm)** | **Type** | **Length (m)** |
| Leptophyll | Up to 25 | Megaphanerophytes | 30 or above |
| Nanophyll | 25 – 225 | Mesophanerophytes | 7.5 to 30 |
| Microphyll | 225 to 2025 | Nanophanerophytes | 0.25 to 7.5 |
| Mesophyll | 2025 to 18225 | | |
| Macrophyll | 18225 to 164025 | | |
| Megaphyll | Larger than 164025 | | |

the associations. Plants were classified into Raunkiarian leaf sizes (Raunkiaer, 1934) (Table 1). Raunkiaer spectrum was calculated as follows:

$$\text{Leaf size spectra} = \frac{\text{Number of species falling in a particular leaf size classes}}{\text{Total number of all the species for that community/stand}} \times 100$$

## RESULTS AND DISCUSSION

The floristic list of the study area comprised 189 species belonging to 74 families. It included 65 dicots, 4 monocots, while gymnosperms, and pteridophytes were represented each by one family. Asteraceae (19 spp.), Lamiaceae (13 spp.) and Poaceae (11 spp.) were the most represented families. These were followed by Papilionaceae (10 spp.), Rosaceae (9 spp.), Ranunculaceae (7 spp.) and Apiaceae (3 spp.). The remaining families had one or two species.

According to the Raunkiaerian life form, therophytes (36.5%) were dominant in the area (Tables 2 and 3). Hemicryptophytes and geophytes were the next dominant with an overall representation of 15 and 12.5%, respectively. Chaemophytes 6.5%, mesophanerophytes 3%, megaphanerophytes 2%, nanophaneorophytes 13% and climbers 1.5% contribution in the establishment of vegetation in the study area (Tables 2 and 3). In leaf size spectra, RaunKiaerian approach also revealed that microphylls (41.5%) dominanted the study area. They were followed by nanophylls (24%), leptophylls (13.5%), mesophylls (12%), macrophylls (3%) and megaphylls (1%), respectively (Tables 2 and 3).

## DISCUSSION

The floristic list of Asir Mountain of the Kingdom of Saudi Arabia consists of 189 species belonging to 74 families. Asteraceae was the dominating family in the study area. The present study observed that many species were found in the forest habitat and grassland of the study area, having distribution, restricted life cycle with xeromorphic characters. This was reflected by small leaf size, stunted growth, sparse distribution, isolated individuals and dwarf height, that is, all characteristics of xerophytic flora. A rich flora would definitely mean high species diversity and species richness in the study area. However, floristic composition is a qualitative character and it alone cannot be a good indicator of forest productivity and health. This feature must be supplemented with some quantitative measurements to assess properly the health of forest ecosystem. Yet the floristic composition is a good source of plant life, gene pool and diversity of plants of any area and the present list serves this purpose. It will help the forest and wildlife managers in their efforts for improving the wealth of an area.

Biological spectra are useful in comparing geographically widely separated plant communities and these physiognomic features of the ecosystem are regarded as indicators of biotic interaction, climate and habitat deterioration. Occurrence of similar biological spectrum in different regions indicates similar climatic conditions. According to Raunkiaer (1934), the climate of a region is characterized by life form, while the biological spectrum of the region exceeds the percentage of the same life form. However, due to biological disturbance, the proportion of life forms may be altered. Biological spectrum may be materially changed due to introduction of therophytes like annual weeds, biotic influences like agricultural practices and grazing, deforestation and trampling, etc. They have been widely used in understanding the flora and community/ vegetation structure in relation to prevailing environmental conditions. The overall vegetation of the study area is dominated by therophytes followed by hemicryptophytes and geophytes. The predominance of therophytes indicates a disturbed environmental condition where phanerophytes cannot establish themselves. Anthropogenic activities including overgrazing, overharvesting and developmental form reduces the macro element of the vegetation. The same is true in this study as macro elements such as trees have been removed for earning livelihood, terrace cultivation and as a fuel wood source. This facilitates the dominance of other life form classes. The findings of Sher et al. (2004a,b) support our results as he also observed that extensive biotic influences increased short lived annuals. Shah et al. (1991) and Sikarwar (1996) reported that hemicryptophytes are indicator of high altitude, while therophytes are characteristic of desert climate and geophytes are indicator of mediterranean climate. The

**Table 2.** Floristic list, life form, and leaf size spectra of the flora and vegetation of Asir Mountain, Saudi Arabia.

| S/N | Name of Species | Life form | Leaf size spectra | Autumn | Summer |
|---|---|---|---|---|---|
| 1 | **Adiantaceae** | | | | |
| 1 | Adiantum capillus-veneris L. | H | Na | + | + |
| 2 | *A. incisum* Forssk. | H | L | + | + |
| 3 | *Cheilanthes coriaceae* Decene. | H | Na | – | + |
| 4 | *C. pteridioides* (Reichard)C.Chr | H | Na | – | + |
| **2** | **Amaranthaceae** | | | | |
| 5 | *A chyranthes aspera* L. | Ch | Mi | – | + |
| 6 | *Amaranthus spinosus* L. | Ch | Mi | – | + |
| 7 | *A. viridis* L. | Ch | Mi | – | + |
| **3** | **Apiaceae** | | | | |
| 8 | *Ammi vasnaga* L. Lamk. | Th | L | – | + |
| 9 | *Oenanthe javanica* L. Lamk. | Th | L | – | + |
| 10 | *Pimpinella anisum* Boiss. | Th | L | – | + |
| **4** | **Aizoaceae** | | | | |
| 11 | *Aizoon canariense* L | G | Mi | + | + |
| **5** | **Acanthaceae** | | | | |
| 12 | *Justicia odora* (Forssk).Lam | Np | Me | + | + |
| **6** | **Anacardiaceae** | | | | |
| 13 | *Pistacia integerrima* J.L.Stewart ex Brandis. | Ch | Me | + | + |
| **7** | **Asclepiadaceae** | | | | |
| 14 | *Calotropis procera* (Willd) R.Br. | Th | Me | – | + |
| **8** | **Asteraeae** | | | | |
| 15 | *Achillea biebersteinii* Afan. | H | L | – | + |
| 16 | *Artemisia sieberi* Besser. | Ch | Na | – | + |
| 17 | *A.scoparia* Waldst. and Kit. | Ch | Na | + | + |
| 18 | *Calendula arvensis* L. | Th | Mi | – | + |
| 19 | *C. triptercarpa* Rupr. | Th | Mi | – | + |
| 20 | *Cichorium intybus* L. | Th | Mi | – | + |
| 21 | *Conyza stricta* Willd. | Th | Na | – | + |
| 22 | *Echinops viscous* DC. | Th | Mi | – | + |
| 22 | *Echinops viscous* DC. | Th | Mi | – | + |
| 23 | *Dianthus strictus* Bank and Sol. | Th | Na | – | + |
| 24 | *Fagonia indica* Burm. f. | Th | Na | – | + |
| 25 | *Launaea procumbens* (Roxb.) | Th | Na | – | + |
| 26 | *Senecio flavus* (Decne)Sch.Bip | Th | Na | – | + |
| 27 | *Sonchus asper* (L.) Hill. | Th | Mi | – | + |
| 28 | *Tagetes minuta* L. | Th | Mi | – | + |
| 29 | *Taraxacum cyprium* Lindb | G | Mi | – | + |
| 30 | *Pulicaria crispa* (Forssk)BandHf. | G | Mi | – | + |
| 31 | *Tolpis virgata* Scop. | Th | Mi | – | + |
| 32 | *Tragopogon dubius* Scop. | G | Mi | – | + |
| 33 | *Xanthium spinosum* L. | Th | Na | – | – |
| **9** | **Berbeyaceae** | | | | |
| 34 | *Berbeya oleoides* schweinf. | Np | Mi | + | + |
| **10** | **Boraginaceae** | | | | |
| 35 | *Cynoglossum bottae* Defl | H | Mi | – | + |
| 36 | *Cordia sinensis* Lam. | Th | Mi | – | + |
| 37 | *Trichodesma* calatiforme Hochst. | Th | Na | – | + |

**Table 2.** Continued.

| | | | | | |
|---|---|---|---|---|---|
| **11** | **Brassicaceae** | | | | |
| 38 | *Brassica campestris* L. | Th | Na | – | + |
| 39 | *Capsella bursapastoris* (L.) Medic. | Th | Na | – | + |
| 40 | *Cardamine macrophylla* Willd. | Th | Na | – | + |
| 41 | *Lepidium cerugul* L. | Th | Mi | – | + |
| 42 | *Nasturtium officinale* R.Br. | Th | Mi | + | + |
| 43 | *Neslia apiculata* Fich. May and Ave. | Th | Mi | – | + |
| **12** | **Burseraceae** | | | | |
| 44 | *Commiphora erythraea* L. | Np | Mi | + | + |
| 45 | *C.myrraha* (Nees) Engl. | Np | Mi | + | + |
| **13** | **Campulanaceae** | | | | |
| 46 | *Campanula erinus* L. | Th | Mi | – | + |
| **14** | **Caprifoliaceae** | | | | |
| 47 | *Lonicera etrusca* Santi. | Np | Me | + | + |
| **15** | **Capparaceae** | | | | |
| 48 | *capparis spinosa* L. | Np | Me | + | + |
| **16** | **Caryophyllaceae** | | | | |
| 49 | *Cerastium dichotomum* L. | Th | Na | | |
| 50 | *Silene conoidea* L. | Th | Na | – | + |
| 51 | *S. gallica* L | Th | Na | – | + |
| 52 | *Stellaria media* (L.) Vill. Cyr. | Th | L | – | + |
| **17** | **Cactaceae** | | | | |
| 53 | *Opuntia dillenii* Haw. | Np | L | | |
| **18** | **Chenopodiaceae** | | | | |
| 54 | *Chenopodium album* L. | Th | Mi | – | + |
| 55 | *C. botrys* L. | Th | Na | – | + |
| 56 | *C. ambrosioides* L. | Th | Mi | – | + |
| **19** | **Celastraceae** | | | | |
| 57 | *Maytenus undata* L. | Np | Mi | -- | + |
| **20** | **Commelinaceae** | | | | |
| 58 | *Commeina benghalensis* L. | Th | Na | – | + |
| **21** | **Convolvulaceae** | | | | |
| 59 | *Convolvulus arvensis* L. | Th | Mi | – | + |
| 60 | *Ipomea eriocarpa* R.Br. | Th | Mi | – | + |
| 61 | *I. triflroa* Forssk. | Th | Mi | – | + |
| **22** | **Cucurbitaceae** | | | | |
| 62 | *Citrullus colocynthis* (L) Schard. | Th | Mi | – | + |
| **23** | **Crassulaceae** | | | | |
| 63 | *Sedum hispanicum* L. | H | Mi | – | + |
| **24** | **Cistaceae** | | | | |
| 64 | *Fumanas arabica* L. | Th | Mi | – | + |
| **25** | **Dipsacaceae** | | | | |
| 65 | *Scabiosa olivieri* Coult. | G | Mi | – | + |
| **26** | **Ebenaceae** | | | | |
| 66 | *Diospyros mespiliformis* Hochst. | Mp | Mg | + | + |
| **27** | **Elatinaceae** | | | | |
| 67 | *Bergia polyantha* Sond. | Mp | Mi | + | + |

**Table 2.** Continued.

| | | | | | |
|---|---|---|---|---|---|
| **28** | **Euphorbiaceae** | | | | |
| 68 | *Andrachne aspera* Spreng. | Th | L | | |
| 69 | *Euphorbia arabica* (Hochst) Boiss | Th | Na | – | + |
| 70 | *E. densa* Schrenk. | Th | Na | – | + |
| 71 | *E. granulata* Forssk. | Th | Na | – | + |
| 72 | *Ricinus communis* L. | Th | L | | |
| **29** | **Flacoutiaceae** | | | | |
| 73 | *Oncoba spinosa* L. | Th | Na | + | + |
| **30** | **Furankeniaceae** | | | | |
| 74 | *Frankenia hirsuta* L. | Th | Na | – | + |
| **32** | **Gentianaceae** | | | | |
| 75 | *Sebaea* Sp. | Th | Mi | – | + |
| 76 | *Swertiawoodii* J.Shah. | Th | Mi | – | + |
| **33** | **Geraniaceae** | | | | |
| 77 | *Geranium molle* L. | Th | Mi | – | + |
| 78 | G. *ocellatum* Camb. | Th | Mi | – | + |
| **34** | **Haloragaceae** | | | | |
| 79 | *Myriophyllum spicatum* L. | Ch | Mi | + | + |
| **35** | **Iridaceae** | | | | |
| 80 | *Iris postii* Mouterde. | G | Me | – | + |
| 81 | *I. albicanus* Pax. | G | Me | – | + |
| **36** | **Lamiaceae** | | | | |
| 82 | *Ajuga bracteosa* Wall. ex. Bth. | H | Mi | – | + |
| 83 | *A.arabica* P.Davis. | H | Mi | – | + |
| 84 | *M. longifolia* (L.) Huds. | Hydro | L | – | + |
| 85 | *Marrubium vulgare* L. | H | Mi | – | + |
| 86 | Nepeta *sheilae* I.C.Hedge andKing. | Th | Mi | – | + |
| 87 | *Micromeria biflora* (Ham.) Bth. | Ch | Mi | – | + |
| 88 | *Origanum syriacum* L. | Ch | Mi | – | + |
| 89 | *Otostegia fruitcosa* (Bth.) Sebald. | Ch | Mi | + | + |
| 90 | *Teucrium polium* L. | H | Na | – | + |
| 91 | *Salvia merjemie* Forssk. | Ch | Mg | – | + |
| 92 | *Plectranthus asirensis* J.R.I.Wood.. | S | Me | – | + |
| 93 | *Stachys aegyptiaca* Pers. | H | Na | – | + |
| **37** | **Liliaceae** | | | | |
| 94 | *Asparagus falcatus* L | Np | Na | + | + |
| 95 | *A. africanus* Lam. | Np | Na | + | + |
| 96 | *Asphodelus tenuifolius* Cavan. | G | Mi | – | + |
| 97 | *Allium stamineum* Boiss. | G | Mi | – | + |
| 98 | *Polygonatum verticillatum* All. | G | Me | – | + |
| 99 | *Tulipa stellata* Hk.f. | G | Mi | – | + |
| **38** | **Malvaceae** | | | | |
| 100 | *Malva neglecta* Wall. | H | Mi | – | + |
| **39** | **Meliaceae** | | | | |
| 101 | *Trichilia emetica* Vahl. | Np | Na | + | + |
| **40** | **Moringaceae** | | | | |
| 102 | *Moringa* peregrine (Forssk)F | H | Mi | – | + |
| **41** | **Moraceae** | | | | |
| 103 | *Ficus salicifolia* Vahl. | Mp | Ma | + | + |
| 104 | *F.surr* Forrssk. | Mp | Ma | + | + |

**Table 2.** Continued.

| | | | | | |
|---|---|---|---|---|---|
| **42** | **Myrsinaceae** | | | | |
| 105 | *Myrsine africana* L. | Np | Na | + | + |
| **43** | **Hyperiaceae** | | | | |
| 106 | *Hypericum perforatum* L. | Th | Mi | – | + |
| 107 | *H. oblongifolium* Choisy | H | Na | + | + |
| **44** | **Oleaceae** | | | | |
| 108 | *Jasminum humile* L. | Np | Mi | + | + |
| 109 | *J. officinale* L. | Np | Mi | + | + |
| 110 | *Olea europaea* L. | Mp | Na | + | + |
| **45** | **Oxalidaceae** | | | | |
| 111 | *Oxalis corniculata* L. | Th | Na | – | + |
| **46** | **Onagraceae** | | | | |
| 112 | *Epilobium hirsutum* L. | H | Mi | – | + |
| **47** | **Paeonaceae** | | | | |
| 113 | *Paeonia emodi* Wall. ex. Hk.f. | G | Me | – | + |
| **48** | **Papaveraceae** | | | | |
| 114 | *Papaver rhoeas* L. | Th | Mi | + | + |
| **49** | **Plantaginaceae** | | | | |
| 115 | *Plantago lanceolata* L. | H | Mi | – | + |
| 116 | *P. major* Aitch. | H | Mi | – | + |
| **50** | **Polygonoceae** | | | | |
| 117 | *Persicaria amplexicaule* D.Don. | Th | Na | – | + |
| 118 | *Polygonum barbatum* L. | Th | Na | – | + |
| 119 | *P. himalaiense* H.Gross. | Th | Na | – | + |
| 120 | *Rumex hastatus* D.Don. | Th | Na | – | + |
| 121 | *R. nepelensis* Spray. | H | Me | – | + |
| **51** | **Portulaceae** | | | | |
| 122 | *Portulaca oleracea* L. | Th | Na | – | + |
| **52** | **Primulaceae** | | | | |
| 123 | *Anagalis arvensis* L. | Th | Na | – | + |
| 124 | *Androsacce rotundifolia* Hardw. | Th | Na | – | + |
| 125 | *Primula denticulata* Smith. | Th | Na | – | + |
| **53** | **Papilionaceae** | | | | |
| 126 | *Astragalus graveolens* Buch.Ham. ex. Bth. | Ch | Mi | + | + |
| 127 | *Indigofera spinosa* Forssk. | Np | L | + | + |
| 128 | *Lathyrus aphaca* L. | Th | L | – | + |
| 129 | *L. odoratus* L. | Th | L | – | + |
| 130 | *Medicago polymorpha* L. | Th | L | – | + |
| 131 | *M. lupulina* L. | Th | Na | – | + |
| 132 | *Melilotus indicus* (L.) All. | Th | Na | – | + |
| 133 | *Trifolium repens* L. | Th | Na | – | + |
| **54** | **Mimosaceae** | | | | |
| 134 | *Acacia modesta* Wall. | Mep | L | + | + |
| 135 | *A. negrri* Pichi-Serm | Mep | L | + | + |
| **55** | **Ranunculaceae** | | | | |
| 136 | Aconitum violaceum Stapf. | G | Na | – | + |
| 137 | *Aquilegia fragrans* Bth. | G | Na | – | + |
| 138 | *Caltha palustris* L. | G | Na | – | + |
| 139 | *Clematis grata* Roxb. ex. D.C. | G | Mi | – | + |
| 140 | *Delphinum anagalis* L. | G | Na | – | + |
| 141 | *Ranunculus arvensis* L. | G | Me | – | + |
| 142 | *R. muricatus* L. | G | Na | – | + |
| 143 | *Thalictrum foliosum* D.C. | Th | Mi | – | + |

**Table 2.** Continued.

| | | | | | |
|---|---|---|---|---|---|
| **56** | **Rubiaceae** | | | | |
| 144 | *Galium aparina* L. | Th | Na | – | + |
| **57** | **Rutaceae** | | | | |
| 145 | *Zanthoxylum armatum* DC. | Mp | Na | + | + |
| **58** | **Rhamnaceae** | | | | |
| 146 | *Zizyphus spina-christi* (L.).Willd. | Np | Na | + | + |
| 147 | *Z. oxyphylla* Edgew. | Np | Na | + | + |
| **59** | **Rosaceae** | | | | |
| 148 | *Cotoneaster nummularia* Fisch. and Mey. | Np | Mi | + | + |
| 149 | *C. microphylla* Wall. ex Lindl. | Np | Mi | + | + |
| 150 | *Fragaria indica* Andr. | H | Mi | – | + |
| 151 | *F. nubicola* Lindl. Ex lacaita | H | Mi | – | + |
| 152 | *Pyrus pashia* Ham. ex D.Don. | Np | Mi | + | + |
| 153 | *Rubus fruticosus* Hk.f. | Np | Mi | + | + |
| 154 | *Rosa moschata* non J.Herrm | Np | Mi | + | + |
| 155 | *R. indica* L. | Np | Mi | + | + |
| 156 | *R. webbiana* Wall. ex Royle | Np | Mi | + | + |
| 157 | *Sibbaldia cuneata* Kunze. | H | Mi | – | + |
| 158 | *Spiraea lindleyana* Wall. | Np | Mi | + | + |
| **60** | **Salicaceae** | | | | |
| 159 | *Salix babylonica* L. | Np | Me | + | + |
| **61** | **Saxifragaceae** | | | | |
| 160 | *Bergenia ciliata* (Haw.) Sternb | G | Me | – | + |
| **62** | **Simarubaceae** | | | | |
| 161 | *Ailanthus altissima* (Mill.) Swingle. | Mp | Mi | + | + |
| **63** | **Sapindaceae** | | | | |
| 162 | *Dodonaea viscosa* (L.) Jacq. | Np | Na | + | + |
| **64** | **Scrophulariaceae** | | | | |
| 163 | *Verbascum thapsus* L. | H | Mg | – | + |
| 164 | *Veronica biloba* L. | Th | L | – | + |
| **65** | **Solonaceae** | | | | |
| 165 | *Datura stramonium* L. | Ch | Me | – | + |
| 166 | *Solanum nigrum* L. | Th | Na | – | + |
| 167 | *S. surrattense* Brum. F. | Th | Na | – | + |
| 168 | *Hyoscymus niger* L. | Th | Na | – | + |
| 169 | *Withania somnifera* (L). Dunal. | Ch | Me | – | + |
| **66** | **Thymeleaceae** | | | | |
| 170 | *Daphne mucronata* Royle. | Np | Mi | + | + |
| **67** | **Ulmaceae** | | | | |
| 171 | *Celtis africana* L. | Mp | Mi | + | + |
| **68** | **Urticaceae** | | | | |
| 172 | *Debregasia salicifolia* (D.Don.) R. Mp | Mi | + | + | |
| 173 | *Urtica urens* L. | Th | Mi | – | + |
| **69** | **Verbenaceae** | | | | |
| 174 | *Verbascum yemense* D. | H | L | + | + |
| **70** | **Violaceae** | | | | |
| 175 | *Viola cinerea* Boiss. | Th | Mi | – | + |
| **71** | **Valerianaceae** | | | | |
| 176 | *Valeriaella discoidea* (L) Loisel. | Th | Na | – | + |

**Table 2.** Continued.

| | | | | | |
|---|---|---|---|---|---|
| **72** | **Poaceae** | | | | |
| 177 | *Avena fatua* L. | Th | L | – | + |
| 178 | *Cynodon dactylon* (L.) Pers. | H | L | – | + |
| 179 | *Aristida cyanantha* Nees ex Steud. | H | L | – | + |
| 180 | *Bromus japonicus* Thunb. | H | L | – | + |
| 181 | *Chrysopogon montanus* Trin. ex Spreng. | H | L | – | + |
| 182 | *Cenchrus ciliaris* L. | H | Mi | – | + |
| 183 | *Themeda anathera* (Nees) Haw. | H | Mi | – | + |
| 184 | *Hordeum vulgare* L. | H | Mi | – | + |
| 185 | *Dichanthium annulatum* (Forrsk.) Stapf. | H | L | – | + |
| 186 | *Saccharum spontaneum* L. | H | L | – | + |
| 187 | *Lolium multiflorum* Lamk. | H | Mi | – | + |
| **73** | **Pinaceae** | | | | |
| 188 | *Juniperus excelsa*.M.Bieb. | Mp | Na | + | + |
| **74** | **Palmae** | | | | |
| 189 | *Phoenix dactylifera* L. | T | Me | – | + |

+ Grows, – Dormant.
Th, Therophytes; L, leptophylls; H, hemicrytophytes; Mi, microphylls; Ch, chamaeophytes Na, nanophylls; Mg, megaphanerophytes; Me, mesophylls; Np, nanophanerophytes; Mg, Megaphylls; G, Geophytes; Ma, Macrophylls; Mp, Mesophanerophytes; Hyd, Hydrophytes; Para, Parasites.

climate of study area varies from arid, semiarid to alpine types at different altitudes. The biological spectrum obtained in the present study reflects the existing environmental conditions. The present findings regarding the dominance of hemicryptophytes and therophytes agree with Al-Yemeni and Zayed (1999). Although the area has potential to support the growth of trees and shrubs, megaphanerophytes and nanophanerophytes decreased due to human activity. Deforestation is one of the major factors that has dwindled the regeneration of woody species. However, deforestation and overgrazing have reduced the tree vegetation to scrub and open grassland. This is consistent with the findings of Gupta and Kachroo (1983), who reported similar trends for the flora of Yasmarg valley, in Indian occupied Kashmir.

Similar trends regarding prevalence of therophytes was observed by Malik and Hussain (1987) in Girbanr and Dabargai hills. In alpine habitat cushion and chamaephytes became more prominent, because of adverse soil and climatic conditions. Sher et al. (2004) reported 36% short forbs, 27% cushion and spreading forbs 17% each in the alpine vegetation at Swat Pakistan. In our case, too chamaephytes were more dominant than other life forms in the alpine part of the study area. The predominance of therophytes in variable conditions such as dry, hot or cold, met for low to higher elevation might be the reason for their higher percentage in the present study. Raunkiaerian life form spectra failed to explain the numerical status of plants in the field, whereas quantitative characters such as density, frequency and canopy cover are more useful parameters in depicting the existing quantitative vegetation structure and related climatic conditions.

Leaf size spectra indicated that micro-nanophyllous species were dominating the area. In the study area, it was observed that plants suffer from adverse conditions such as poor soil development and strong winds. Therefore, plants adapt themselves to the prevailing conditions to reduce their requirements by reducing their size, height, foliage and duration of growth. Therophytic and hemicrytophytic life form coupled with small leaf size is a good strategy of plants to cope with adverse environmental and deteriorated habitat conditions. Overgrazing and deforestation in such a climate further intensifies the adverse effects of environment. Microphylls are usually characteristic of steppes, while nanophylls and leptophylls are characteristic of hot deserts (Hussain and Malook, 1984; Sikwarwar, 1996). The present study shows that leptophylls were high at the foot hills, while microphylls and nanophylls were present in high altitudes. Species with large leaves occur in warmer climates while smaller leaves are characteristic of dry climates and degraded habitats. The observed relationship between small leaves and cold or hot desert climates are adaptive features in retaining moisture. The soil is generally poor in the mountainous area where roots feel difficulty in absorbing soil moisture. Ali et al. (1987) also observed that the percentage of microphylls was positively related with the increasing altitude and this also support our findings. The situation in our case is far more xeric than in the wet tropics. The size of leaves alone could not be used to identify specific leaf zone or climates. Other features of plants such as

**Table 3.** Life form and leaf size spectra of plants of the flora and vegetation of Asir Mountain of Saudi Arabia. Number in percentage (in parenthesis).

| S/N | Life form | | Leaf size spectra | |
|---|---|---|---|---|
| 1 | Therophytes | 77 (36.5%) | Leptophylls | 27 (13.5%) |
| 2 | Hemicryptophytes | 33 (15%) | Microphylls | 80 (38.5%) |
| 3 | Chamaeophytes | 13 (6.5%) | Nanophylls | 60 (24%) |
| 4 | Nanophanerophytes | 28 (13%) | Mesophylls | 24 (12%) |
| 5 | Megaphanerophytes | 6 (4%) | Macrophylls | 10 (3%) |
| 6 | Geophytes | 24 (12%) | Megaphylls | 1 (1%) |
| 7 | Hydrophytes | 2 (1%) | | |
| 8 | Climbers | 3 (1.5%) | | |
| 9 | Mesophanerophytes | 8 (3%) | | |

habit and root system might also play important role.

## Conclusion

The study concluded that the vegetation is predominantly evergreen types, intermixed with deciduous species particularly at lower altitude representing semi-phanerophytic to therophytic climate. The study also concludes that hemicrtophytes, nano-phanerophytes, geophytes and therophytes constitutes the higher percentage than the normal spectrum. It clearly indicates that some anthropogenic (overgrazing and developmental activities) and natural factors (drought) are operating together and reducing the chances of formation of new and original life from vegetation structure.

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