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FLORISTIC INVENTORY, ECOLOGICAL CHARACTERISTICS AND BIOLOGICAL SPECTRUM OF RANGELAND, DISTRICT TANK, PAKISTAN

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Abstract

This study was conducted to assess the floristic composition and its ecological characteristics of District Tank during 2007- 2011 in different seasons. The floristic diversity consisted of 205 species within 56 families. Based on number of species, Poaceae (34 Spp), Papilionaceae (19 Spp), Asteraceae (14 Spp), Chenopodiaceae (10 Spp) and Brassicaceae (9 Spp), Euphorbiaceae (8 Spp), Boraginaceae and Polygonaceae, (each with 7 species) were the leading families. The other families had less than 7 species. Based on the habitat 140 (68.3%) species were growing wild as mesophytes and xerophytes. While 46 species (22.4%) were classified as hydrophytes, 10 species (4.8%) were found both in wet and dry conditions; and 9 species (4.6%) were cultivated for various purposes. There were 24 species (11.7%) with spiny nature. Spinescence is also an indicator of dry soil and environment. Among the perennial species, 19 were deciduous and 83 evergreen. The leaf lamina was simple in 152 species (74.1%), 5 species (2.4%) were leafless, while in the remaining 48 species (23.4%) had compound leaves. Biological spectrum of flora indicated that therophytes followed by hemicryptophytes were dominant. Leaf spectra revealed that nanophylls, leptophylls, microphylls and mesophylls were the most prevalent leaf sizes. *Cuscuta reflexa, Capparis decidua, Periploca aphylla, P. calophlla* and *Equisetum arvense* were aphyllous species.

Introduction

Tank is the southernmost district of Khyber Pakhtunkhwa province. Tank lies on the boundary with South Waziristan agency. The Town of Tank was ruled by late Nawab Shah Nawaz Khan. It was made tehsil of District Dera Ismail Khan in 1878 and upgraded to the level of District in 1992. District Tank lies from 31°-15' to 30°-31' N latitudes and 70°- 22' E longitudes. It has an area of 1679 km^2.

Flora, all plant species in any specific geographic region, which are characteristic of a geological period or that inhabit a particular ecosystem. The flora includes the number of species, while vegetation refers to their distribution and number of individuals and size of each of the relative importance (Ali, 2008). Inventory of floras by plant taxonomists is a common practice throughout the world to have information about plants. A flora is a compiled checklist of plant species growing in any geographic area. Through this practice, valuable data is recorded which could be used as reference for future studies. Since the world is extremely variable, hence a vast range of floras are available ranging from concise or Field Floras to Research Floras (Qureshi *et al*., 2011). The climate of the study area is semiarid type with almost level topography. The biological spectrum obtained in the present study reflects aridity. This area has scrub vegetation with scattered trees. Species richness, life forms and dispersal modes of plants are related to altitudinal and rainfall gradients. The low percentage of tree species indicates intensive deforestation. The investigated area has the potential to support the growth of trees and shrubs yet human and cattle have degraded the overall floristic and vegetation.

Due to aridity, its large population depends upon livestock rearing as source of their livelihoods in Tank. Due to heavy grazing most of the rangelands in the province have degraded that need rehabilitation and improvement in their productive potential. Internally displaced families and their cattle enhanced decreased and adversely affected the productivity and carrying capacity of rangelands. It is important to mention that in Tank in addition also over exploited by local communities for the collection of fuel wood. No literature is available except that of Badshah & Hussain (2010) and Badshah & Hussain (2011a,b) who worked on different aspect of plant resources. The present work was therefore important to report floristic diversity and its ecological characteristics as a first step towards finding possibility of its improvement and exploration for the betterment of the local inhabitants.

Materials and Methods

Frequent visits were made in different seasons. Plants were collected, dried and preserved. They were identified with the help of available literature (Nasir & Ali, 1971-1999, Ali & Qaisar, 1995-2009). A complete floristic list along with families was compiled. Plants were classified into life form and leaf size classes according to Hussain (1989) and Hussain *et al.,* (2006). The listed voucher specimens were deposited in the herbarium, Department of Botany, University of Peshawar. Biological spectrum and leaf sizes classes were determined following Raunkiaer (1934) and Hussain (1989).

Result and Discussion

Floristic composition and its ecological characteristics: Floristic diversity of a region is the total of the species within its boundaries, weather wild or cultivated, which is a reflection of vegetation and plant resources. Plant resources are affected by agriculture, over grazing, anthropogenic interaction and natural disasters. The flora of District Tank consisted of 205 species of 56 families (Table 1). Of them, 159 species belonged to Dicot and 45 species to Monocot. *Equisetum* was the only Pteridophyte. Poaceae (34 Spp), Papilionaceae (19 Spp), Asteraceae (14 Spp), Chenopodiaceae (10 Spp) and Brassicaceae (9 Spp) were the leading families. They were followed by Euphorbiaceae

(8 Spp), Boraginaceae, and Polygonaceae (each with 7 spp.). Amaranthaceae and Solanaceae had 6 species each. Mimosaceae and Malvaceae had 5 and 4 species, respectively. Asclepiadaceae and Zygophyllaceae each had 4 species. Each of the Apiaceae, Lamiaceae, Caryophyllaceae, Convolvulaceae, Moraceae and Plantaginaceae had 3 species. Rest of the 37 families either had two or less than 2 species. Poaceae, Papilionaceae, Asteraceae, Chenopodiaceae and Brassicaceae were the leading families. Malik & Malik (2004) also reported these families to be well represented in Kotli Hill during monsoon. Marwat & Qureshi (2000) and Durrani *et al*., (2005) also observed that these families were dominant in their respective study areas. Some other studies also indicated similar results in Flora of Pakistan (Ali & Qaisar, 1995-2009) and abroad (Antije *et al*., 2003; Eilu *et al*., 2004). Our results are consistently supported by them as Poaceea, Asteraceae and Chenopodiaceae have emerged as the common families in the investigated area. Mendez (2005) and Muthuramkumar *et al*., (2006) also stated the abundance of same families in Laguna and Western Ghats. The members of Poaceae and Asteraceae due to their wide ecological amplitude are diverse in their habitat occurrence.

The floristic list of Nara desert Bhatti *et al*., (2001), Qureshi & Bhatti (2005), Parveen *et al*., (2008), Qureshi & Bhatti (2008) also reported high number of species in these families which also supports our finding. Both these families have also been reported to have more species than other families in flora of Chakwal (Hussain *et al*., 2009). *Euphorbia* with 5 species was the largest genus followed by *Aristida* and *Chenopodium* each with 4 species. *Saccharum*, *Amaranthus*, *Heliotropium*, *Convolvulus*, *Prosopis*, *Medicago* and *Plantago* each had 3 species. The remaining genera possessed one or 2 species (Table 1). These genera along with others are well represented in Pakistan (Nasir & Ali, 1971- 2007; Ali & Qaisar, 1995-2009; Stewart, 1972). Some other studies also reported these genera having more species in other areas (Ferraz *et al*., 2004; Durrani *et al*., 2005; Pinheiro *et al*., 2006). Seasonal variation and climatic conditions are very much obvious in Pakistan. There are distinct spring, summer, autumn and winter seasons, all categorized by a definite range of temperature, rainfall and humidity. In Tank the summer is hot while winter is cold. Generally spring and summer have higher number of species than other season. Same was observed in the present study. Seasonal variations showed that spring had 138 species (67.3 %), followed by summer with 100 species (48.7%), winter 78 species (38.0%) and autumn 76 species (37.1%) (Table 2). Seasonality of climate has definitely shaped four aspect of the flora. Woody, shrubby, and some perennial herbs were common to all the seasons. The differences in different aspect were primarily due to the annuals, bulb bearing plants and some sporadic occasional ephemerals. Studies by Durrani *et al*., (2010) and Ahmad *et al*., (2009) have also shown that spring and summer flora/ aspect have higher number of species than other aspects. This is what the present findings also reported.

Based on the habitat 140 (68.3%) species growing wild, were mesophytes including xerophytes. The flora was mostly composed of wild xerophytic plants. Similar results were obtained by Musila *et al*., (2003) and Gimenez *et al*., (2004). While 46 species (22.4%) were classified as hydrophytes, 10 species (4.8%) were found both in wet and dry conditions; and 9 species (4.6%) were cultivated for various purposes. There were 24 species (11.7%) with spiny nature. Spinescence is also an indicator of dry soil and environment. Among the perennial species, 19 were deciduous and 83 evergreen. The leaf lamina was simple in 152 species (74.1%), 5 species (2.4%) were leafless, while in the remaining 48 species (23.4%), it was compound or divided. Aphyllous species are also indicator of harsh environment. These species although five in our case, do tell the aridity of the area. Same species have been reported from other parts of Pakistan (Durrani *et al*., 2005; Badshah *et al*., 2006; Durrani *et al*., 2010) indicating some common features of the habitat. The ratio of herbaceous to woody/shrubby species was 4: 1. Sher *et al*., (2003) also recorded similarly from Udigram Swat, Hussain *et al*., (2005) from Ghalegay Swat, Sher & Khan (2007) from Buner and Fazal *et al*., (2010) from District Haripur.

Although floristically many species were listed from the semiarid District Tank, however, quantitatively they had limited distribution with restricted life cycle. A rich flora is the sign of high species diversity and species richness. Floristic composition is a qualitative feature that alone cannot reflect the true depiction of this semiarid zone, thus there is a need of quantitative consideration of the vegetation resources. Floristic composition is a better parameter of plant life, gene pool and diversity of plants in any area. The ecological behavior of plant like life form, leaf size spectra, phenology, habit and its ethnoecological potential is to be worked out.

Life form and its seasonal variation: The life form reflects physiognomy of the flora and vegetation, which is the result of all life processes in combination with environment. It helps in the recognition of ecological elucidation of vegetation. Life form of Raunkiaer (1934) classification is more reliable, which is based upon the principal of position and degree of protection to perennating bud during the unfavorable or adverse condition.

When Raunkiaerean classification was used, it was seen that overall therophytes (98 Spp., 47.8%) followed by hemicryptophytes (30 Spp., 14.6%) dominated the flora. Geophytes (24 Spp., 11.7%), chamaephytes (23 Spp., 11.2%), nanophanerophytes (17 Spp., 8.3%) and microphanerophytes (12 spp., 5.9%) were next in term of species. *Cuscuta reflexa* was the only parasitic plant (Table 3). Raunkiaer (1934) distinguished three major phytoclimates on the basis of life form on the earth. It includes phanerophytic climate in the tropics, therophytic in deserts and hemicryptophytic in the greater part of cold temperate zone. The present overall spectrum shows the dominance of therophytic flora. Biological spectra are important in comparing geographically and habitually widely separated plant communities and also considered as an indicator of prevailing environmental condition. Biological spectra changes due to biotic influences like agricultural practices, grazing, deforestation, trampling and climatic change.

Table 1. Floristic list, seasonal composition, biological and leaf size spectrum of plants of District Tank.

S. No.	Division / family / species	Habitat	Seasonality				L. form	L. size	Lamina	Spinescence
			A	W	S	Sm				
	A. Pteridophyta									
	1. Equisetaceae									
1.	*Equisetum arvense* L.	W	-	-	+	-	G	Ap	Abs	-
	B. Monocotyledons									
	2. Alliaceae									
2.	*Allium sativum* L.	C	-	+	+	-	G	N	S	-
3.	*Allium cepa* L.	C	-	+	+	-	G	N	S	-
	3. Arecaceae									
4.	*Phoenix dactylifera* L.	W & D	+	+	+	+	Mp	Mes	Com	-
	4. Asphodelaceae									
5.	*Asphodelus tenuifolius* Cav.	D	-	+	-	-	G	L	S	-
	5. Cypraceae									
6.	*Cyprus difformis* L.	W	-	+	+	-	G	N	S	-
7.	*Cyprus rotundus* L.	W	+	+	-	+	G	N	S	-
	6. Juncaceae									
8.	*Juncus bufonius* L.	W	-	-	+	+	G	L	S	-
9.	*Juncus inflexus* L.	W	-	-	+	+	G	L	S	-
	7. Poaceae									
10.	*Aristida adscensionis* L.	D	+	-	-	-	H	Mic	S	-
11.	*Aristida cyanantha* Nees ex Steud.	D	-	-	-	+	H	Mic	S	-
12.	*Aristida mutabilis* Trin. & Rupr.	D	+	+	+	-	Th	N	S	-
13.	*Aristida triticoides* Henr.	D	+	-	-	-	H	N	S	-
14.	*Avena sativa* L.	D	-	+	-	-	Th	N	S	-
15.	*Cenchrus biflorus* Roxb.	D	+	+	-	-	H	L	S	-
16.	*Cenchrus ciliaris* L.	D	-	+	-	+	H	L	S	-
17.	*Cymbopogon jwarancusa* (Jones) Schult.	D	-	-	+	-	H	N	S	-
18.	*Cynodon dactylon* (L.) Pers.	W & D	+	+	+	+	H	L	S	-
19.	*Dactyloctenium aegyptium* (L.) Willd.	D	-	+	-	-	Th	Mic	S	-
20.	*Desmostachya bipinnata* (L.) Stapf.	D & W	+	-	+	-	H	N	S	-
21.	*Dichanthium annulatum* (Forssk.) Stapf.	D & W	-	+	-	-	H	N	S	-
22.	*Echinochloa colona* (L.) Link.	D	-	+	+	-	Th	N	S	-
23.	*Echinochloa crus-galli* (L.) Beauv.	D	-	-	-	+	Th	N	S	-
24.	*Eragrostis cilianensis* (All.) Lut. ex F.T.	D	-	-	+	+	H	N	S	-
25.	*Eragrostis minor* Host.	D & W	-	-	+	-	Th	N	S	-
26.	*Imperata cylindrica* L.	W	+	-	+	-	G	L	S	-
27.	*Ochthochloa compressa* (Forssk.) Hilu	D	-	-	+	-	H	N	S	-
28.	*Oryza sativa* L.	C	-	-	-	+	Th	Mic	S	-
29.	*Panicum antidotale* Retz.	D	+	-	-	-	H	N	S	-
30.	*Panicum capillare* L.	D	-	-	+	-	Th	N	S	-
31.	*Phalaris aquatica* L.	W	-	-	-	+	G	N	S	-
32.	*Phragmites karka* (Retz.) Trin. ex Steud.	W	+	-	+	+	Ch	Mes	S	-
33.	*Poa annua* L.	W	-	+	+	-	Th	L	S	-
34.	*Poa infirma* H. B. K.	W	-	-	-	+	Th	L	S	-
35.	*Polypogon monspeliensis* (L.) Desf.	W	-	-	+	-	Th	Mic	S	-
36.	*Saccharum bengalense* Retz.	D & W	+	-	+	+	Ch	N	S	-
37.	*Saccharum munja* Roxb.	D	+	-	-	-	Ch	N	S	-
38.	*Saccharum spontaneum* L.	D	+	+	-	-	Ch	L	S	-
39.	*Schismus barbatus* (L.) Thell.	W	-	+	-	-	H	N	S	-
40.	*Sclerochloa dura* (L.) P. Beauv.	D	-	-	+	+	Th	N	S	-
41.	*Setaria verticillata* (L.) P. Beauv.	D	-	+	-	-	Th	L	S	-
42.	*Triticum aestivum* L.	C	-	+	+	+	Th	Mic	S	-
43.	*Zea mays* L.	C	-	-	-	+	Th	Mes	S	-

Table 1. (Cont'd.).

S. No.	Division / family / species	Habitat	Seasonality				L. form	L. size	Lamina	Spinescence
			A	W	S	Sm				
	8. Typhaceae									
44.	*Typha latifolia* L.	W	+	+	+	+	G	Mes	S	-
45.	*Typha minima* Funck ex Hoppe	W	+	-	-	+	G	Mes	S	-
	C. Dicotyledon									
	1. Aizoaceae									
46.	*Trianthema portulacastrum* L.	D	-	-	-	+	Th	N	S	-
	2. Amaranthaceae									
47.	*Achyranthes aspera* L.	D	+	-	-	-	Th	N	S	Sp
48.	*Aerva javanica* (Burm. f.) Juss.	D	+	+	+	+	Ch	L	S	-
49.	*Aerva lanata* (L.) Juss. ex Schult.	D	+	+	+	+	Ch	L	S	-
50.	*Amaranthus graecizans* L.	D	-	-	-	+	Th	L	S	-
51.	*Amaranthus spinosus* L.	D	-	-	+	-	Th	N	S	Sp
52.	*Amaranthus viridis* L.	D	+	-	-	-	Th	N	S	-
	3. Apiaceae									
53.	*Anethum graveolens* L.	D	-	-	+	-	Th	L	Dis	-
54.	*Psammogeton biternatum* Edgew.	D	-	-	+	+	Th	L	Dis	-
55.	*Torilis japonica* (Houtt.) DC.	D	-	-	+	-	Th	N	Dis	-
	4. Apocyanaceae									
56.	*Nerium indicum* Mill.	W	+	+	+	+	Np	Mic	S	-
57.	*Rhazya stricta* Decne.	D	-	-	+	+	Ch	N	S	-
	5. Asclepiadaceae									
58.	*Calotropis procera ssp. hamiltonii* (Wight) Ali.	D	+	+	+	+	Ch	Mes	S	-
59.	*Oxystelma esculentum* (L. f.) R. Brown.	D	-	-	-	+	Ch	L	S	-
60.	*Periploca aphylla* Decne.	D	+	+	+	+	Np	Ap	Abs	-
61.	*Periploca calophylla* (Wight) Falc.	D	+	+	+	+	Np	Ap	Abs	-
	6. Asteraceae									
62.	*Centaurea iberica* Trevir. ex Spreng.	D	-	-	+	-	Th	N	Dis	Sp
63.	*Centaurea moschata* L.	D	-	-	+	-	Th	N	Dis	Sp
64.	*Conyza canadensis* (L.) Cronquist	D	-	-	+	+	Th	Mic	S	-
65.	*Cousinia minuta* Boiss.	D	-	-	-	+	Th	N	S	-
66.	*Eclipta alba* (L.) Hassk.	W	+	+	+	-	G	N	S	-
67.	*Filago arenaria* (Smoljan.) Chrtek & Holub	D	-	-	+	-	Th	L	S	-
68.	*Ifloga spicata* (Forssk.) Sch. Bip.	D	-	-	+	-	Th	L	S	-
69.	*Launaea nudicaulis* (L.) Hook.f.	D	+	-	+	-	Th	Mes	S	-
70.	*Pulicaria crispa* (Forssk.) B.H.	D	-	-	-	+	H	L	S	-
71.	*Sonchus asper* (L.) Hill	W	-	+	-	-	Th	Mic	Dis	-
72.	*Sonchus oleraceus* L.	W	-	-	-	+	Th	Mic	Dis	-
73.	*Taraxacum officinale* F. H. Wigg.	W	-	-	-	+	Th	Mic	S	-
74.	*Tricholepis chaetolepis* (Boiss.) Rech. f.	D	-	-	+	-	Th	L	S	-
75.	*Xanthium strumarium* L.	D	-	-	+	-	Th	N	S	Sp
	7. Boraginaceae									
76.	*Arnebia hispidissima* (Lehm.) A. DC.	D	-	-	+	-	Th	L	S	-
77.	*Arnebia guttata* Bunge	D	-	-	+	-	Th	L	S	-
78.	*Cynoglossum lanceolatum* Forssk.	D	+	-	-	-	H	N	S	-
79.	*Gastrocotyle hispida* (Forssk.) Bunge	D	-	+	-	-	H	Mic	S	-
80.	*Heliotropium elipticum* Ledeb.	D	-	-	+	+	Th	N	S	-
81.	*Heliotropium europaeum* L.	D	-	-	+	-	Th	Mic	S	-
82.	*Heliotropium ovalifolium* Forssk.	D	-	-	+	+	Th	Mic	S	-
	8. Brassicaceae									
83.	*Brassica rapa subsp. campestris* (L.) Clapham.	C	-	+	+	-	Th	N	Dis	-
84.	*Coronopus didymus* (L.) Smith	W	+	+	-	-	Th	Mic	Dis	-
85.	*Crambe cordifolia* Steven	W	-	-	-	+	Th	Mic	S	-
86.	*Farsetia hamiltonii* Royle.	D	-	-	+	+	Np	L	S	-
87.	*Farsetia ramosissima* Hochst. ex Boiss.	D	-	-	+	+	Th	N	S	-

Table 1. (Cont'd.).

S. No.	Division / family / species	Habitat	Seasonality				L. form	L. size	Lamina	Spinescence
			A	W	S	Sm				
88.	*Malcolmia africana* (L.) R. Br.	D	-	-	+	-	Th	N	S	-
89.	*Malcolmia scorpioides* (Bunge) Boiss.	D	-	-	-	+	Th	Mic	S	-
90.	*Matthiola incana* (L.) R. Br.	D	-	+	+	-	Th	Mic	S	-
91.	*Sisymbrium irio* L.	D	-	-	+	+	Th	N	Dis	-
	9. Campanulaceae									
92.	*Campanula benthamii* Wall. ex Kitamura	W	-	-	-	+	Ch	N	S	-
93.	*Campanula sulaimanii* E. Nasir.	W	-	-	+	-	Ch	N	S	-
	10. Capparidaceae									
94.	*Capparis decidua* (Forssk.) Edgew.	D	+	+	+	+	Np	Ap	Abs	Sp
95.	*Cleome brachycarpa* Vahl ex DC.	D	-	+	-	-	Th	N	Com	-
	11. Caryophyllaceae									
96.	*Silene conoidea* L.	D	-	-	+	-	Th	N	S	-
97.	*Spergula arvensis* L.	W	-	-	+	-	Th	N	S	-
98.	*Spergularia marina* (L.) Griseb.	W	-	-	+	-	Th	L	S	-
	12. Ceasalpinaceae									
99.	*Cassia senna* L.	D	-	-	-	+	Ch	L	Com	-
	13. Chenopodiaceae									
100.	*Atriplex griffithii* Moq.	D	-	+	+	+	Np	N	S	-
101.	*Chenopodium album* L.	D	-	+	+	-	Th	N	S	-
102.	*Chenopodium ambrosioides* L.	W	-	-	+	-	Th	L	S	-
103.	*Chenopodium murale* L.	D	+	-	-	-	Th	L	S	-
104.	*Chenopodium nepalense* Colla	D	-	-	-	+	Th	N	S	-
105.	*Halostachys belangerana* (Moq.) Botsch.	D	+	-	-	-	Np	L	S	-
106.	*Haloxylon multiflorum* (Moq.) Bunge ex Boiss.	D	+	+	+	+	Ch	L	S	-
107.	*Kochia indica* Wight	D	-	+	+	+	Th	L	S	-
108.	*Salsola foetida* Del.ex Spreng.	D	+	+	+	+	Ch	L	S	-
109.	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	D	+	+	+	+	Ch	L	S	-
	14. Convolvulaceae									
110.	*Convolvulus arvesis* L.	D	-	+	-	-	Th	N	S	-
111.	*Convolvulus microphyllus* Sieb.ex Spreng.	D	+	-	-	+	Th	N	S	-
112.	*Convolvulus prostrata* Forssk.	D	+	-	-	+	Th	L	S	-
	15. Cucurbitaceae									
113.	*Citrullus colocynthis* (L.) Schrad.	D	+	-	-	-	Th	Mic	Dis	-
	16. Cuscutaceae									
114.	*Cuscuta reflexa* Roxb.	D	+	+	+	+	P	Ap	Abs	-
	17. Euphorbiaceae									
115.	*Chrozophora oblongifolia* (Del.) Adr. Juss. ex Spreng.	D	-	-	-	+	H	N	S	-
116.	*Chrozophora tinctoria* (L.) Raf.	D	-	-	-	+	Th	Mic	S	-
117.	*Euphorbia dracunculoides* Lam.	D	-	-	+	-	H	L	S	-
118.	*Euphorbia granulata* Forssk.	D	+	-	-	-	H	L	S	-
119.	*Euphorbia helioscopia* L.	D	-	-	+	-	Th	N	S	-
120.	*Euphorbia prostrata* Ait.	D	+	-	+	-	Th	L	S	-
121.	*Euphorbia thymifolia* L.	D	+	-	-	-	Th	L	S	-
122.	*Ricinus communis* L.	D	-	-	+	+	Ch	Mes	S	-
	18. Fumariaceae									
123.	*Fumaria indica* (Hausskn.) Pugsley	D	-	+	-	-	Th	N	Dis	-
	19. Gentianaceae									
124.	*Centaurium spicatum* (L.) Fritsch	D	-	-	+	-	Th	N	Dis	-
125.	*Centaurium pulchellum* (Sw.) Druce	D	-	-	+	-	Th	L	Dis	-
	20. Hypericaceae									
126.	*Hypericum perforatum* L.	D	-	+	-	-	Ch	N	S	-
	21. Lamiaceae									
127.	*Ocimum basilicum* L.	D	+	+	+	+	Ch	N	S	-
128.	*Mentha longifolia* (L.) L.	W	-	+	+	-	G	N	S	-
129.	*Mentha spicata* L.	W	-	+	+	-	G	N	S	-

Table 1. (Cont'd.).

S. No.	Division / family / species	Habitat	Seasonality				L. form	L. size	Lamina	Spinescence
			A	W	S	Sm				
	22. Malvaceae									
130.	*Abutilon bidentatum* Hochst.ex A. Rich.	D	+	+	+	+	Ch	N	S	-
131.	*Malva neglecta* Wallr.	D	-	+	+	+	Th	Mic	S	-
132.	*Malva parviflora* L.	D	-	-	+	+	Th	Mic	S	-
133.	*Malvastrum coromandelianum* (L.) Garcke	D	-	-	+	-	H	N	S	-
	23. Meliaceae									
134.	*Melia azedarach* L.	D	+	+	+	+	Mp	N	Com	-
	24. Mimosaceae									
135.	*Acacia modesta* Wall.	D	+	+	+	+	Mp	L	Com	Sp
136.	*Acacia nilotica ssp. nilotica* (L.) Wild. ex Delile	D	+	+	+	+	MP	L	Com	Sp
137.	*Prosopis cineraria* (L.) Druce	D	+	+	+	+	Np	L	Com	Sp
138.	*Prosopis farcta* (Banks & Sol.) Macbride.	D	+	+	+	+	Mp	L	Com	Sp
139.	*Prosopis juliflora* Swartz.	D	+	+	+	+	Np	L	Com	Sp
	25. Moraceae									
140.	*Ficus carica* L.	D	+	+	+	+	Np	Mes	S	-
141.	*Morus alba* L.	D	+	+	+	+	Mp	Mes	S	-
142.	*Morus nigra* L.	D	+	+	+	+	Mp	Mes	S	-
	26. Myrtaceae									
143.	*Eucalyptus globulus* Labill.	D	+	+	+	+	Mp	N	S	-
	27. Nyctiginaceae									
144.	*Boerhavia diffusa* L.	D	-	+	-	-	H	N	S	-
145.	*Boerhavia procumbens* Banks ex Roxb.	D	+	-	-	-	H	N	S	-
	28. Oxalidaceae									
146.	*Oxalis corniculata* L.	W	-	-	+	+	Th	N	Com	-
	29. Papavaraceae									
147.	*Hypecoum pendulum* L.	D	-	-	+	+	Th	L	Dis	-
	30. Papilionaceae									
148.	*Alhagi maurorum* Medic.	D	-	-	-	+	H	L	S	Sp
149.	*Astragalus tribuloides* Delile	D	+	-	-	-	Ch	L	Com	Sp
150.	*Astragalus amherstianus* Royle ex Benth.	D	-	-	+	-	Ch	L	Com	Sp
151.	*Cicer arietinum* L.	C	-	-	+	-	Th	L	Com	-
152.	*Crotolaria burhia* Buch.-Ham. ex Benth.	D	-	-	-	+	Np	L	S	-
153.	*Cyamopsis tetragonoloba* (L.) Taubert	D	-	-	-	+	Th	N	Com	-
154.	*Dalbergia sissoo* Roxb.	W & D	+	+	+	+	Mp	N	Com	-
155.	*Lathyrus aphaca* L.	W	+	-	-	-	Th	N	Com	-
156.	*Lathyrus sativus* L.	W	-	-	+	+	Th	N	Com	-
157.	*Medicago minima* (L.) Grufb	W	-	-	+	+	Th	N	Com	-
158.	*Medicago polymorpha* L.	W	-	-	+	-	Th	N	Com	-
159.	*Medicago laciniata* (L.) Mill.	D	-	+	+	-	Th	N	Com	-
160.	*Melilotus indica* (L.) All.	D	-	+	+	-	Th	N	S	-
161.	*Melilotus alba* Desr.	D	-	-	+	+	Th	L	S	-
162.	*Parkinsonia aculeata* L.	D	+	+	+	+	Np	N	Com	-
163.	*Trifolium alexandrianum* L.	C	-	+	+	-	Th	N	Com	-
164.	*Trifolium repens* L.	C	-	+	+	-	Th	N	Com	-
165.	*Vicia faba* L.	D	-	-	+	-	Th	N	Com	-
166.	*Vicia tetrasperma* (L.) Schreber.	D	-	-	+	+	Th	N	Com	-
	31. Portulacaceae									
167.	*Portulaca quadrifida* L.	D & W	-	-	+	-	Th	N	S	-
	32. Plantaginaceae									
168.	*Plantago ciliata subsp. lanata* (Boiss.) Rech.	D	+	-	-	+	Th	N	S	-
169.	*Plantago lanceolata* L.	W	-	-	+	+	Th	N	S	-
170.	*Plantago major* L.	W	-	-	+	+	Th	Mic	S	-
	33. Polygonaceae									
171.	*Calligonum polygonoides* L.	D	+	+	+	+	Np	L	S	-

Table 1. (Cont'd.).

S. No.	Division / family / species	Habitat	Seasonality				L. form	L. size	Lamina	Spinescence
			A	W	S	Sm				
172.	*Emex australis* Steinh.	D	-	+	-	-	Th	Mic	S	Sp
173.	*Emex spinosus* (L.) Campd.	D	-	-	+	-	Th	Mic	S	Sp
174.	*Polygonum patulum* M. Bieb.	D	+	-	-	-	G	N	S	-
175.	*Polygonum plebejum* R. Br.	D	-	+	+	-	H	N	S	-
176.	*Rumex dentatus* L.	W	-	-	+	-	G	Mes	S	-
177.	*Rumex obtusifolius* L.	W	+	-	+	-	G	Mic	S	-
	34. Primulaceae									
178.	*Anagallis arvensis* L.	W	-	-	-	+	Th	N	S	-
	35. Ranunculaceae									
179.	*Ranunculus muricatus* L.	W	-	-	+	-	G	Mic	Dis	-
180.	*Ranunculus sceleratus* L.	W	-	-	+	+	G	Mic	Dis	-
	36. Resedaceae									
181.	*Oligomeris linifolia* (Vahl.) Macbride	D	-	-	+	-	Th	N	S	-
182.	*Reseda odorata* L.	D	-	+	-	-	Th	N	S	-
	37. Rhamnaceae									
183.	*Zizyphus mauritiana* Lam.	D	+	+	+	+	Mp	N	S	Sp
184.	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	D	+	+	+	+	Np	N	S	Sp
	38. Salvadoraceae									
185.	*Salvadora oleoides* Decne.	D	+	+	+	+	Np	N	S	-
	39. Sapindaceae									
186.	*Dodonaea viscosa* (L.) Jacq.	D	+	+	+	+	Np	N	S	-
	40. Scrophulariaceae									
187.	*Veronica aqutica* Bern.	W	-	-	+	-	G	N	Dis	-
188.	*Veronica biloba* L.	W	-	-	+	-	Th	N	Dis	-
	41. Solanaceae									
189.	*Datura alba* Nees.	D	-	-	+	-	Th	Mic	S	Sp
190.	*Hyoscyamus squarrosus* Griffith	D	-	-	+	+	Ch	Mic	S	Sp
191.	*Solanum nigrum* L.	W & D	-	-	+	+	Th	Mic	S	-
192.	*Solanum surattense* Burm. f.	D	+	-	-	-	H	N	S	Sp
193.	*Withania coagulans* (Stocks) Dunal	D	+	+	+	+	Ch	Mic	S	-
194.	*Withania somnifera* (L.) Dunal	D	-	-	+	+	Ch	Mic	S	-
	42. Tamaricaceae									
195.	*Tamarix aphylla* (L.) Karst	D	+	+	+	+	Mp	L	S	-
196.	*Tamarix dioica* Roxb. ex Roth.	W	+	+	+	+	Np	L	S	-
	43. Tiliaceae									
197.	*Corchorus aestuans* L.	W	+	-	-	-	Th	L	S	-
	44. Ulmaceae									
198.	*Celtis eriocarpa* Decne.	D	+	+	+	+	Mp	N	S	-
	45. Urticaceae									
199.	*Urtica pilulifera* L.	W & D	-	-	+	-	G	Mic	S	-
	46. Verbinaceae									
200.	*Vitex negundo* L.	W	+	+	+	+	Np	N	Com	-
	47. Violaceae									
201.	*Viola stocksii* Boiss.	W	+	-	-	-	G	Mic	S	-
	48. Zygophyllaceae									
202.	*Fagonia indica* var. *schweinfurthii* Hadidi	D	+	+	-	-	Th	L	S	Sp
203.	*Peganum harmala* L.	D	-	-	+	-	H	L	Dis	-
204.	*Tribulus terrestris* L.	D	+	-	-	-	H	L	Com	Sp
205.	*Tribulus pentandrus* Forssk.	D	-	-	+	-	H	L	Com	Sp

Key: D = Dry; W = Wet; C = Cultivated; A = Autumn; S = spring; W = Winter; Sm = Summer; Th = Therophyte; H = Hemicryptophyte; Ch = Chamaephyte; G = Geophyte; Np = Nanophanerophyte; Mp = Microphanerophyte;.P = Parasite L = Leptophyll; N = Nanophyll; Mic = Microphyll; Mes = Mesophyll; Ap = Aphyllous; S = Simple; Dis = Disected; Com = Compound; Abs = Absent; Sp = Spiny

Table 2. Summary of characteristics of flora of District Tank.

S. No.	Ecological characteristics	No.	Percentage
1.	**Flora**		
i.	Total species	205	-
ii.	Family	56	-
iii.	Genera	142	-
2.	**Seasonality/Aspect**		
i.	Autumn	76	19.4
ii.	Winter	78	19.9
iii.	Spring	138	35.2
iv.	Summer	100	25.5
3.	**Habitat types**		
i.	Wet	46	22.4
ii.	Dry	140	68.3
iii.	Both	10	4.8
iv.	Cultivated	9	4.6
4.	**Habit**		
i.	Ever green	83	40.5
ii.	Deciduous	19	9.3
iii.	Spiny	24	11.7
5.	**Lamina shape**		
i.	Simple	152	74.1
ii.	Compound/ divided	48	23.4
iii.	Aphyllous	5	2.4
6.	**Life form spectra**		
i.	Therophyte	98	47.8
ii.	Hemicryptophyte	30	14.6
iii.	Chamaephyte	23	11.2
iv.	Geophyte	24	11.7
v.	Nanophanerophyte	17	8.3
vi.	Microphanerophyte	12	5.8
vii.	Parasite	1	0.5
7.	**Leaf size spectra**		
i.	Leptophyll	57	27.8
ii.	Nanophyll	96	46.8
iii.	Microphyll	35	17.1
iv.	Mesophyll	12	5.8
v.	Aphyllous	5	2.4

Seasonal variation in life form indicated that in autumn the dominant life form was therophytic and nanophanerophytic each with 15 (19.7%) species. It was followed by hemicryptophytes and microphanerophytes, respectively with 13 (17.1%) species and 12 (15.7%) species. Chamaephytes with 11 (14.4%) species and geophytes with 9 (11.8%) species were next life form classes in autumn. *Cucuta reflexa* was the only parasitic species (Tables 2, 3).

In winter season therophytes with 25 (32.0%) species dominated. Nanophanerophytes with 13 (16.6 %) species, microphanerophytes 12 (15.3%) species, hemicryptophytes 10 (12.8%) species, chamaephytes 9 (11.5%) species and geophytes with 8 (10.2%) species were next in order (Table 3).

During spring therophytes with 61 (44.2%) species emerged as dominant due to favorable growing season. Nanophanerophytes 16 (11.5%) species, hemicryptophytes 14 (10.1%) species, microphanerophytes 12 (8.6%) species, chamaephytes 15 (10.8%) species and geophytes 19 (13.7%) species were next important life form classes.

During summer there were 37 species (37%) therophyte, 17 (17%) nanophanerophyte, 11 (11%) hemicryptophytes, 12 (12%) microphanerophytes, 14 (14 %) chamaephytes and 8 (8%) were geophytes (Table 3).

From the distribution of flora into various life form classes, it can be visualized that the flora and ultimately the vegetation might be stratified into tree layers composed of microphanerophytes, tall shrub layers composed of nanophanerophytes, a second low shrub layer consisting of chamaephytes and herbaceous layer formed by all herbaceous species including therophytes, geophytes, hemicryptophytes etc. Due to aridity, heavy deforestation and overgrazing a meaningful stratification cannot be seen except at certain localized protected places.

Table 3. Seasonal variation in life form and leaf size spectra of plants of District Tank.

Parameters		Season							
		Autumn		Winter		Spring		Summer	
		No	% age	No	% age	No	% age	No	% age
	a. Life form								
1.	Therophyte	15	19.7	25	32	61	44.2	37	37
2.	Hemicryptophyte	13	17.1	10	12.8	14	10.1	11	11
3.	Chamaephyte	11	14.5	9	11.5	15	10.9	14	14
4.	Nanophanerophyte	15	19.7	13	16.7	16	11.6	17	17
5.	Microphanerophyte	12	15.8	12	15.4	12	8.7	12	12
6.	Geophyte	9	11.8	8	10.2	19	13.8	8	8
7.	Parasites	1	1.3	1	1.3	1	0.7	1	1
	Total	**76**	**100**	**78**	**100**	**138**	**100**	**100**	**100**
	b. Leaf size								
1.	Leptophyll	26	34.2	21	26.9	32	23.2	29	29
2.	Nanophyll	30	39.5	38	48.7	62	44.9	38	38
3.	Microphyll	7	9.2	9	11.5	19	13.8	19	19
4.	Mesophyll	9	11.8	6	7.7	10	7.2	10	10
5.	Aphyllous	4	2.6	4	5.3	4	2.8	4	4
	Total	**76**	**100**	**78**	**100**	**138**	**100**	**100**	**100**

The life form spectra of flora and communities in the current study indicated that therophytes followed by hemicryptophytes dominated the flora. Geophytes, chamaephytes, nanophanerophytes and microphanerophytes were next in term of species. *Cuscuta reflexa* was the only parasitic plant. Cain & Castro (1959) and Shimwell (1971) reported that therophytes are characteristics of desert climate. Batalha & Martins (2002) reported that in Brazil the dominant life form was hemicryptophyte and phanerophytes which also in accordance with the present study. Gutkowski *et al*., (2002) also reported as in the present study.

Costa *et al*., (2007) reported that therophytes and phanerophytes are generally the most common life forms in south eastern Brazil a situation similar to the present findings. Hussain *et al*., (2009), Sher & Khan (2007) and Fazal *et al*., (2010) observed similar trends regarding prevalence of therophytes and hemicryptophytes in degraded and arid environment.

Generally in all the seasons and spring in particular therophytes and nanophanerophytes were dominant due to favorable growing season. During spring and early summer, there is always flush of annual plants. The dominance of therophytes occur due to unfavorable habitat conditions as suggested by others (Musila *et al*., 2003; Guo *et al*., 2009; Manhas *et al*., 2010) and our findings agree with them. Nazir & Malik (2006) reported that the biological spectrum of Sarsawa hill Kotli consisted of nanophanerophyte, therophytes and hemicryptophytes. The predominance of therophytes is reflected similar to the present study. In semi desert habitat of District Tank Chamaephytes were prominent partly because of saline soil and adverse climatic conditions.

Batalha & Martins (2002) also considered chamaephytes and therophytes as the major life form in unfavorable condition in desert and open physiognomies. In the investigated area hot and dry and waterlogged and saline condition coupled with over grazing lead to harsh condition. The results also agree with those of Sher & Khan (2007) who also stated that therophytes and nanophanerophytes were characteristics of subtropical habitats of Chagharzai Bunir. The findings of Kar *et al*., (2010) are also in line with our findings as they reported the dominance of therophyte and nanophanerophytes in grasslands of Odisha, India.

Leaf size spectra and its seasonal variation: The overall leaf size spectra showed that there were 46.8% (96 Spp) nanophylls, 27.8% (57 Spp) leptophylls, 17.1% (35 Spp) microphylls and 5.9% (12 Spp) mesophylls. While *Cuscuta reflexa*, *Capparis decidua*, *Periploca aphylla, P. calophlla* and *Equisetum arvense* (5 Spp., 2.4%) were aphyllous species (Table 3).

Seasonal variation in the leaf size spectra indicated that during spring nanophylls with 62 species (44.9%) was the dominant leaf size class. Leptophylls with 32 species (23.2%), microphylls 19 species (13.7%), mesophylls 10 species (7.2%) and aphyllous with 4 species (2.8%) were next in order. Nanophylls with 38 species (38%), leptophylls with 29 species (29%), microphylls with 19 species (19%) and aphyllous with 4 species (4%) were respectively present in summer. While in autumn nanophylls with 30 species (39.4%) and leptophylls with 26 species (34.2%) were major leaf size classes. Mesophyll 9 (11.8%), microphyll 7 (9.2%) and aphyllous with 4 species (2.6%) were next in order. During winter there were with 38 species (48.7%) nanophylls and 21 species leptophylls. Microphyllous 9 (11.5%) and mesophyllous 6 species (7.7%) were others leaf size classes. *Capparis decidua, Periploca aphylla, P. calophylla* and *Cuscuta reflexa* were aphyllous species in all the seasons (Table 3). Microphylls are usually characteristics of steppes, while nanophylls and leptophylls are characteristics of hot desert and saline habitats (Cain & Castro, 1959; Tareen & Qader, 1993; Husain *et al*., 2005). The present study recorded high % age of leptophylls during spring followed by nanophylls and microphylls. Dry and hot season had high percentage of nanonphylls.

Similarly, Sher & Khan (2007) reported high percentage of leptophylls and nanophylls from Chagarzai area. Species with small leaves are generally characteristics of dry and adverse habitats adapted to arid region (Nasir & Sultan, 2002).

Hussain & Chudhary (2009) reported higher percentage of microphyllous in contrast to our findings owing to moist environmental condition in Azad Kashmir. In dry habitats soil generally have poor nutrient contents due to which roots feel difficulty in absorbing soil moisture as in the present study, encouraging leptophyllous and nanophyllous vegetation.

In the present study it was observed that proportion of various leaf size classes change seasonally owing to presence of annuals and bulbous geophytes. However, the perennials and evergreens almost retained the same status in all the seasons. Batalha & Martins (2004) also observed that leaf size is positively related to drought and soil condition. Malik *et al*., (2007) and Badshah *et al*., (2010) reported microphyllous and nanophyllous as the dominant leaf size from Kotli Azad Kashmir and Waziristan. This disagreement is mainly due to altitudinal variation in climate and habitat condition. The situation in our case is generally xeric with saline patches. The size of leaves alone could not be used to identify specific leaf zone or climates. Other feature of plants such as habit and root system might also play important role.

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