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First floristic inventory and biological spectrum of flora of Lajbouk, Dir Lower, Khyber Pakhtunkhawa, Pakistan

Shariat Ullah*[1], Azra Rahman[1], Imran Ullah[1], Mansoor Ahmad[1] and Muhammad Idrees[1, 2]

[1]Department of Botany, University of Malakand, Chakdara, Dir Lower, Khyber Pakhtunkhwa, **Pakistan**
[2]Department of Botany, Islamia College University, Peshawar, Khyber Pakhtunkhwa, **Pakistan**

***Correspondence:** shariatullahuom@gmail.com **Received 11-06-2020, Revised: 24-07-2020, Accepted: 25-07-2020 e-Published: 30-07-2020**

The present research was designed to record the flora and other ecological characteristics of the valley. Floristic data showed that flora of the valley was diverse and consisted of 129 plants belonging to 48 families and 100 genera. The plants were categorized into various life form and leaf size classes following Raunkiaer classification. The leading families with respect to species diversity were Solanaceae and Rosaceae with (12 species, 9.23%) and (11 species, 8.46%), Poaceae 8 species, (6.15%), Asteraceae and Fabaceae (each having 7 species, (5.38%), followed by Brassicaceae, Polygonaceae (each had 5 species, 3.84% and 4 species. 3.07%). While, rest of the families consists of less than 3 (species). Due to severe climatic conditions in winter, majority of plant were found in spring, autumn and summer. The biological spectrum disclosed that, therophytes (32.30%) 42 species were the leading class followed by nanophanerophytes 22 species, (16.92%), Mesophanerophytes (17 species, 13.07%), Chamaephytes, (13 species, 10%), Hemicryptophytes (8 species, 6.15%), Geophytes (6 species, 6.6%) and Parasite (1 species, 0.76%). While, leaf size spectrum revealed that Microphyll 49 species, (37.69%) and Nanophyll (24 species, 18.46%) were prevailing classes. Seasonal variation in leaf form and life form spectra depicted that maximum species were present in spring (113 species, 86.92%) followed by summer (110 species, 84.61%). The dominancy of therophytes indicates that the research vicinity is under deep biotic and abiotic stress.

Keywords: Floristic Inventory, Biological Spectrum, Lajbouk valley, district Lower Dir, Pakistan.

INTRODUCTION

A biological spectrum of flora is a key source of the phytoclimate, depending upon on varied life forms comprising the flora. The leaf size and life form spectra are important physiognomic characters as it provide basic information about the relationship of plants among themselves as well as with physical environment. The life forms are considering the index of macro & micro climate (Shimwell, 1971). Similarly, leaf spectra have been found to be significant for plant association and other physiological processes (Oosting, 1956). Floristic compositions rely on climatic conditions, habitat and altitudinal gradient (Saima et al. 2009). Plants comprise variety of life forms in different regions and communities (Zarezade et al. 2007). In (1934) Raunkiaer, planned the life spectrum to express the various life forms dispersion in a phytoclimate under which the prevailing life forms evolved.

Various researchers have been carried out studies in different areas of Pakistan as well as

abroad such as Sher et al. (2014) reported 211 genera and 90 families comprising 260 species from Gadoon rangeland, Swabi, Pakistan. Among them Therophytes and megaphenerophytes were the principal classes followed by nanophanerophytes. (Ali et al. 2015) listed 91 plants distributed among 80 genera and 44 families from Mahaban and Malka, Buner, Pakistan. Based on Rankiarian classification hemicryptophyte and therophyte were dominant classes consisting of (24.4%). Among leaf size spectrum microphyll was dominant class with (34.4%). Badshah et al. (2016) recorded 283 species from Parachinar, Pakistan consisted of 85 families and 222 genera. Asteraceae with (29, species) was dominant family followed by lamiaceae and papilionaceae having (19, species) each. Nanophanerophytes and therophytes were highest life form classes each with 107 species (37.80%) and (47 species, 16.66%) respectively. Kuar et al. (2017) determined the floristic structure of Ambala district, Haryana, India and recorded 294 genera and 90 families with 414 species. Kharat & Mokat (2018) documented 57 families and 191 genera with 268 plants while, studying the floristic structure of Mayureshwar and Rehekuri wild life sanctuaries. Ibrahim et al. (2019) explored the diversity of plants species of Takht Bhai, Mardan, Khyber Pakhtunkhwa and listed 140 plants with 63 families. Among biological spectrum therophyte was dominating with (40.71%) and microphanerophyte with (18.57%) while, microphyll with (43.57%) was leading class of the leaf size spectra followed by nanophyll (20.71%). Anjum et al. (2020) listed 154 species with 39 families from protected and unprotected areas of Karkhasa, Balochistan, Pakistan.

A large number of plants are so far to be searched out by biologists. Therefore, plant list is a key source of botanical information of the locality and serve as a helpful preliminary point for detail study. However, no such effort has been documented yet on the floral diversity of the area. Therefore, the current project aims to investigate the checklist and other ecological characteristics of the valley.

MATERIALS AND METHODS

Introduction to area

The valley is situated between 60^0 45' 7 to 60^0 45' 5'longitude and 28^0 4'70 to 28^0 48'43" latitude in district Lower Dir, Khyber Pakhtunkhwa, Pakistan. It is located at a distance of 15km from Balambat Timergara. The altitude ranges from 1500 to 2500m above sea level. (Fig.1).

Various ecological & topographic factors affect the environment of the valley. December and January are the coldest months with minimum temperature of 10.2 C^o and 0 C^o to 2.5 C^o. June and July are the hottest months of the year; with daily maximum temperature 36.3 C^o & 34.3 C^o while, Maximum rain & snowfall occurs during December to mid-March.

Data collection and identification

From March 2018 to April 2019 regular trips were organized for preparation of floristic list along with other ecological data. The collected specimens were properly dried, preserved (1g CuSO4 & 99ml H2O) and identification was made with available literature (Ali and Nasir, 1989-1992); (Ali & Qaisar, 1995-2015). Plant specimens were accurately numbered in sequence and submitted to Herbarium, University of Malakand for future reference materials.

Data analysis

The plants were categorized into various life form and leaf size classes after Hussain (1989) and Raunkiaer (1934).

The following formulae were adopted for the calculation of biological spectrum.

$$\text{Life form} = \frac{\text{Total No. of species in a particular life form class}}{\text{Total no. of species}} \times (100)$$

$$\text{Leaf Size} = \frac{\text{Total no. of sp. in a particular leaf size class}}{\text{Total no. of species}} \times 100$$

RESULTS AND DISCUSSION

Floristics and Ecological Characteristics:

Flora represents sum total of all the plant species present in any geographic region, both wild and cultivated. Floristic configuration of any locality reflects the prevalent edaphic features, climatic conditions, anthropogenic pressure and natural stresses. Flora of the valley comprised of 130 plants with 100 genera and 48 families (Table S1). The floristic checklist revealed that 72 (55.38%) were herbs, 17 (13.07%) shrubs and 41 (31.53%) were trees (Table. 2, Fig. 2). Based on species diversity dominant families were Solanaceae and Rosaceae each with (12, species), Poaceae (8 species), Asteraceae and Fabaceae (each with 7 Species), Polygonaceae and Brassicaceae with 5, (species) each, while, rest of the families i.e Apiaceae, Ranunculaceae, Caryophyllaceae, Scrophulariaceae, Araceaea, Moraceae,

Cucurbitaceae, Euphorbiaceae, Pinaceae, Salicaceae, Liliaceae consisted less than 3 species, (Fig. 3).

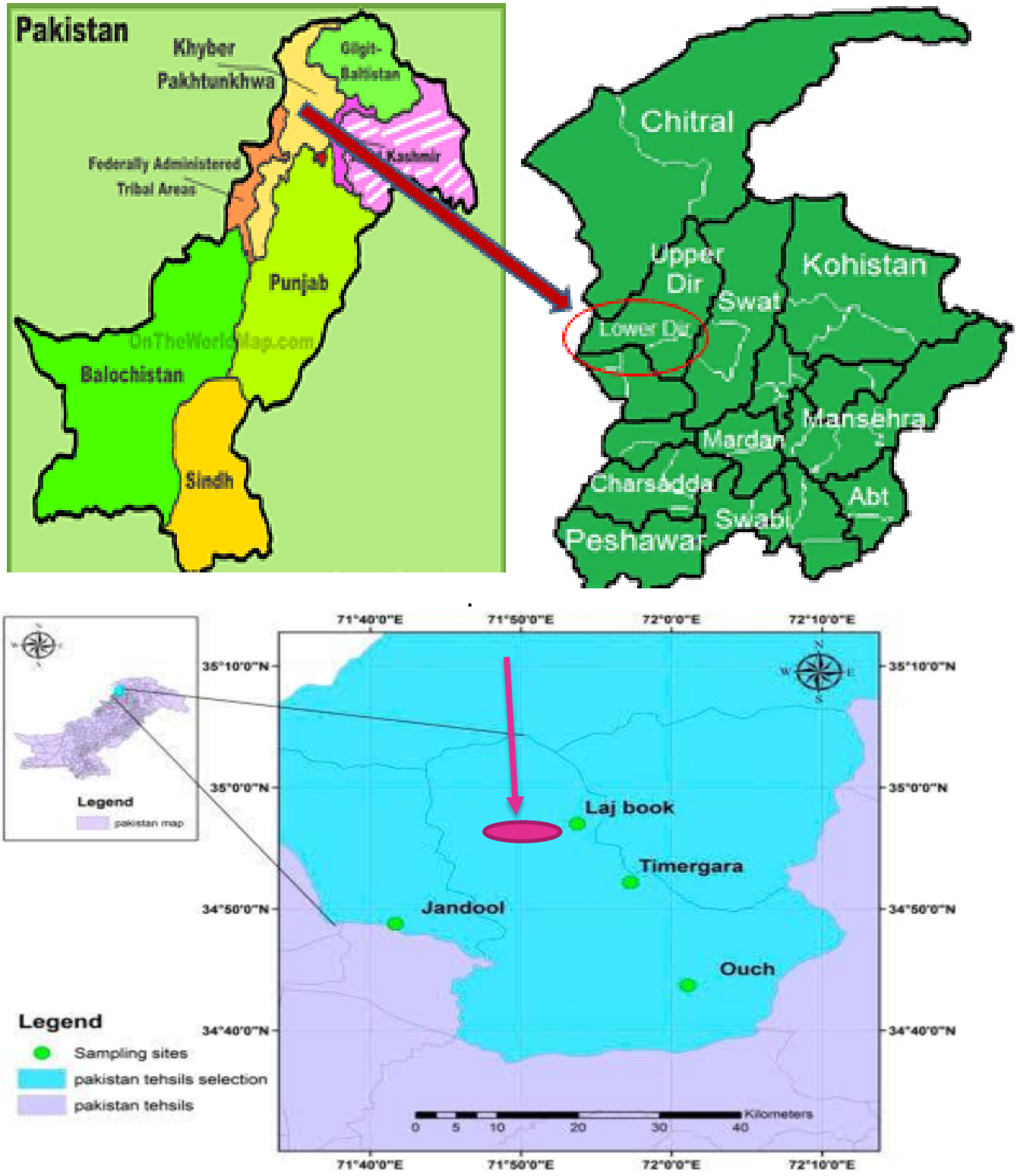

Figure 1: Map of study area.

Khan et al. (2014) and Parveen et al. (2008) also recorded these families as leading ones in their research areas. Shah et al. (2006) listed 218 plants with 63 families from Mastuj valley, Chitral. (Al-Yemeni and Sher, 2010) conducted research on Asir Mountain Suadi Arabia and reported 189 species in which Asteraceae, Lamiaceae and Poaceae were dominant families. Hussain et al. (2015) reported 104 families and 571 species from Chitral and found Papilionaceae, Asteraceae, Rosaceae, Poaceae and Lamiaceae as leading families in the area. In Lajbouk valley due to pleasant summer and harsh winter, maximum number of plants were found in spring (113 Species. 86.92%) followed by summer (110 Species. 84.61%). While, in winter, the number of species were decreased to 80 (61.53%). In autumn 82 Species (63.07%) were found (Table. 2, Fig. 4). Badshah et al. (2013) & (Durrani et al. 2010) also indicated that spring and summer flora had more plants diversity with respect to winter and autumn. Differences in floral diversity of the valley are due to the variation in habitat, altitude and climatic conditions etc.

Life form

Results of life form showed that therophytes (42 plants, 32.30%) were dominant class, Nanophanerophytes (22 species, 16.92%), Mesophanerophytes 17 species (13.07%); Microphanerophytes and Chamaephytes 13 species (10%) each while, Hemicryptopytes and Megaphanerophytes each with 8 species (6.15%), Geophytes 6 species (4.61%) and *Cuscuta reflexa* (0.65%) was found parasitic life form. (Table. 2; Fig. 5). Our results are strongly correlate with the findings of (Sharma et al. 2014); (Ali et al. 2016). The occurrence of similar biological spectra in different areas represents alike climatic conditions. The environmental conditions, of any locality are deeply affected by biotic stresses on vegetation which has promoted the quantity of short lived plants. Our results are also in line with (Ilyas et al. 2012), (Alsherif et al. 2013) and (Farag, 2014) that biotic pressure greatly affects the vegetation.

Seasonal variation in life form

Therophyte was dominant life form in spring season with (27 species, 20.76%) followed by Nanophanerophytes 20 species (15.38%), Mesophanerophytes with 17 plants, (13.07%), Magaphanerophytes had 17 species (6.09%), Microphanerophytes with 13 species, (4.66%), Hemicrpytophytes 5 species (3.84%), and Geophytes 4 species (3.07%). In summer season the species diversity was at its highest level. The most abundant were therophytes with (31 species; 23.84%), nanophanerophytes 21 species (16.15%), mesophanerophytes 17 (13.07%), microphanerophytes were represented with 13 species (10%), chamophytes and megaphanerophytes each with 8 species (6.15%) geophytes 6 species (4.61%), and hemicrpytophytes 5 species (3.84%). nanophanerophytes and mesophanerophytes dominated the autumn season with 17 Species (13.07%), followed by Therophytes 15 species (11.53%), microphanerophytes 13 species (6.74%), megaphanerophytes 8 species (6.15%), chamaephytes with 4 species (3.07%) and geophytes (2.30%) 3 species. Less numbers of plants were recorded in winter season. nanophanerophytes and mesophanerophytes was dominant life forms each with 16 species (12.30%), followed by therophytes 12 species, (9.23%), microphanerophytes (11 species. 8.46%), megaphanerophytes 8 species (6.15%), chamaephytes with 7 species (5.38%), hemicrpytophytes & Geophytes 3 species (2.30%) each. (Table. 3, Fig. 6). In the current research the life form spectrum depicted that therophytes were prevailing with respect to species abundance followed by hemicryotophytes, geophytes and nanophanerophytes. Our results have close resemblance with the results of (Cain & Castro, 1959); (Badshah et al. 2013) and (Khan et al. 2011). Therophytes have originated as life form which is able to withstand with harsh environment during the course of evolution, (Manhas et al. 2010). In Lajbouk valley severe winter favors unsuitable conditions which resulted in the quantity of these life forms. Our findings are also supported by (Sher and Khan, 2007) who recorded the therophytes and nanophanerophytes as distinguishing life forms from Bunir. Similarly, Kar et al. (2010) obtained same life form spectra from Odisha, India.

Leaf size

Outcome of leaf size spectra revealed that (37.69%), 49 species of microphyll, mesophyll and nanophylls (each with 24 species 18.46%), Leptophyll with 12 species, (9.23%), Megaphyll with 11 species, (8.46%), Macrophyll (with 7 species (5.38%) and Aphyllous with 1 species, (0.76%), (Table. 2, Fig.7). The occurrence of microphylls with high proportion might be due to arid environment.

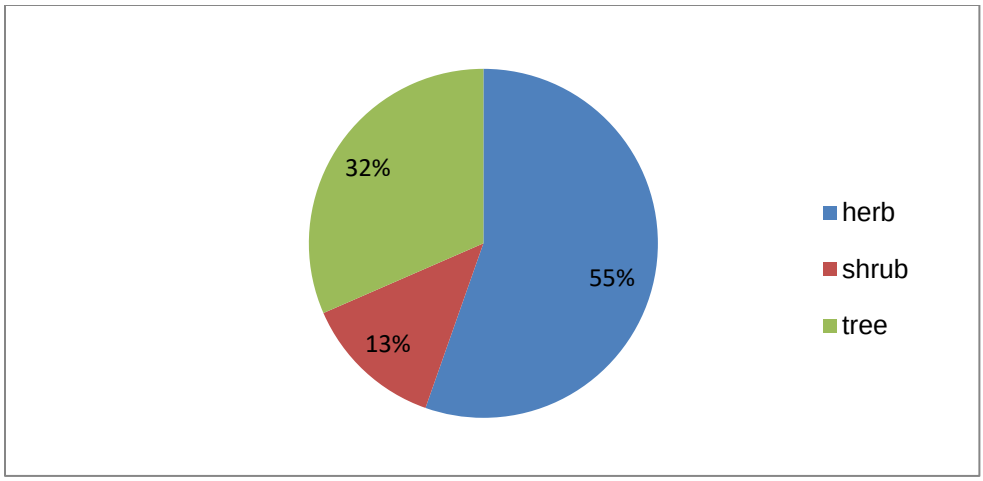

Figure 2: Classification of flora based on habit.

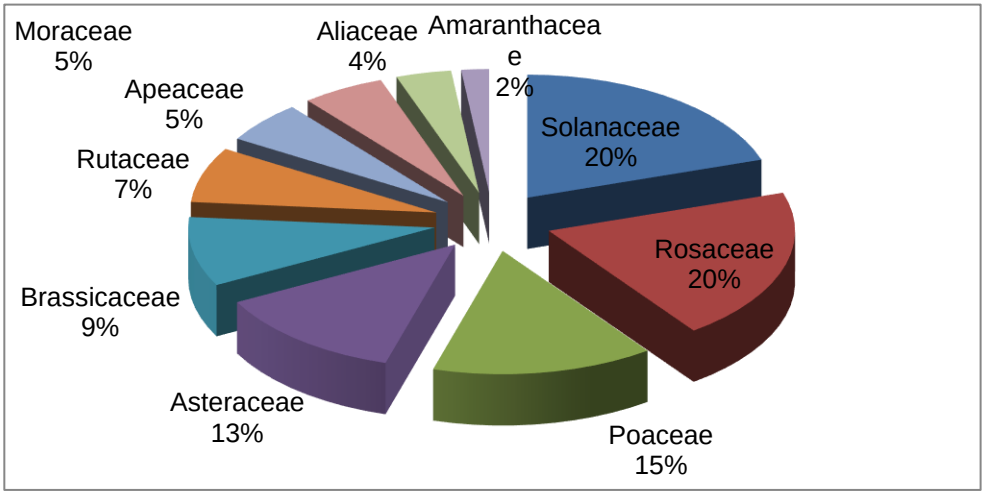

Figure 3: Classification of families based on species diversity

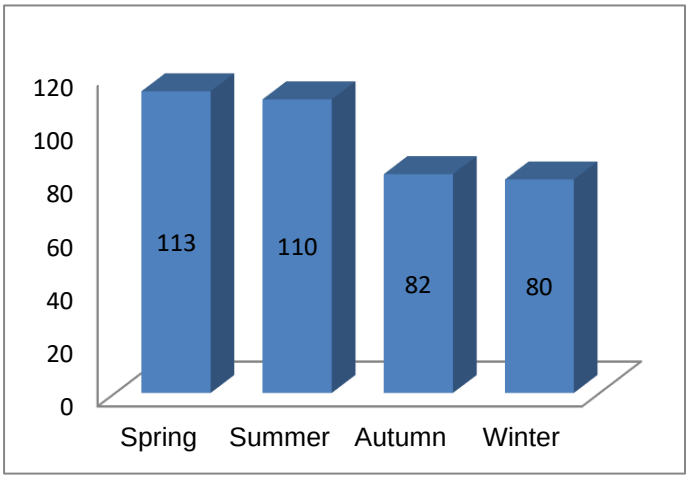

Figure 4: Seasonal variation in flora.

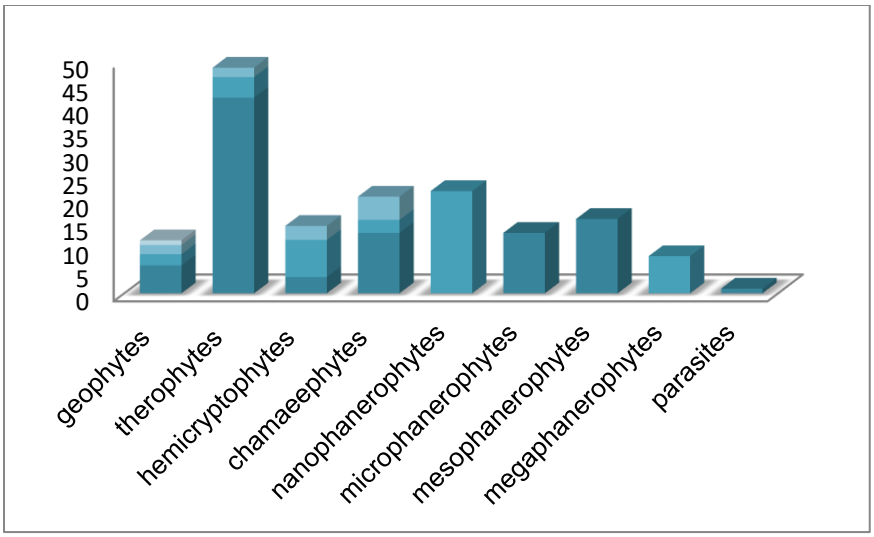

Figure 5: Various life form classes

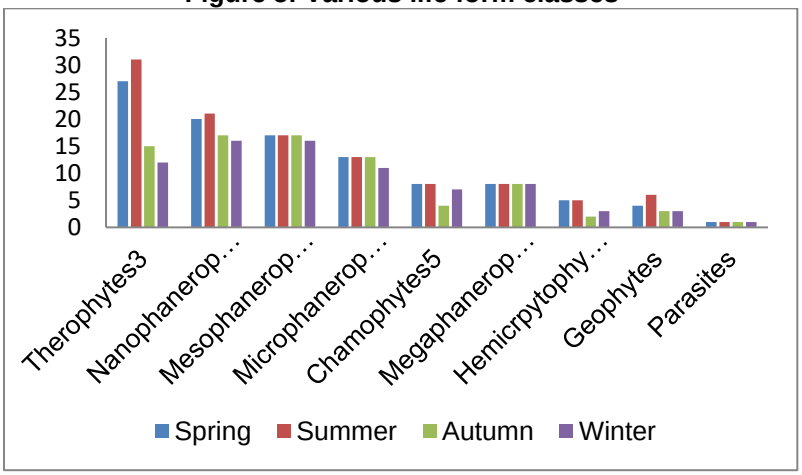

Figure 6: Seasonal variation in life form.

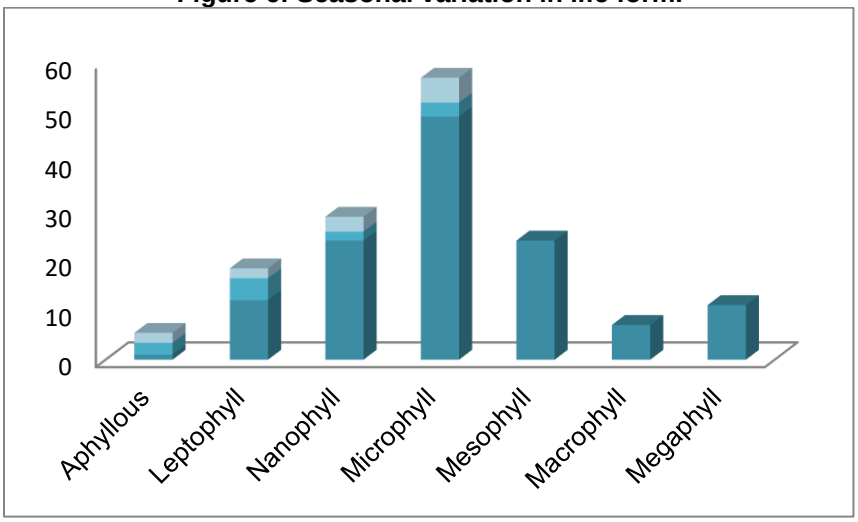

Figure 7: Various leaf size classes.

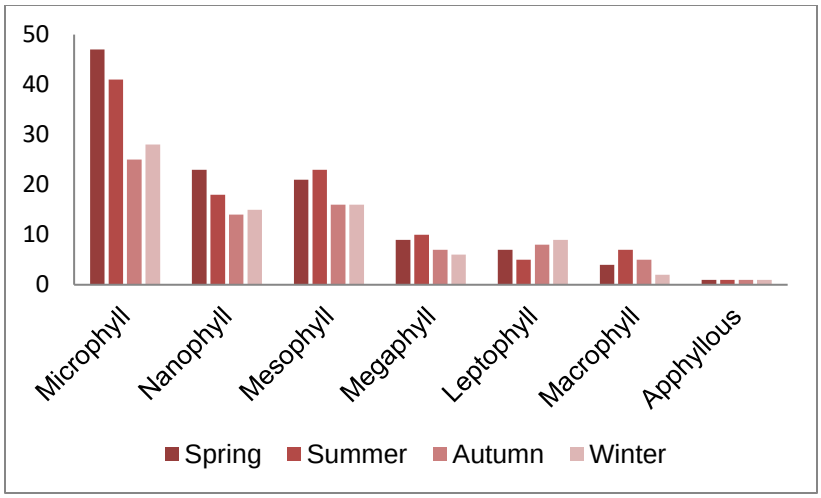

Figure 1: Seasonal variation in leaf size spectra.

Table 1: Ecological characteristics of flora.

S.no	Characteristics	No.	Percentage
1.	Species	129	_
	Families	48	_
	Genera	100	_
	_	_	_
2.	**Life Form**	Numbers of species	Percentage of species
	Geophytes	6	4.61%
	Therophytes	42	32.30%
	Hemicryptophytes	8	6.15%
	Chamaephytes	13	10%
	Nanophanerophytes	22	16.92%
	Microphanerophytes	13	10%
	Mesophanerophytes	17	13.07%
	Megaphanerophytes	8	6.15%
	Parasites	1	0.76%
3.	**Leaf Size**		
	Aphyllous	1	0.76%
	Leptophyll	12	9.23%%
	Nanophyll	24	18.46%
	Microphyll	49	37.69%
	Mesophyll	24	18.46%
	Macrophyll	7	5.38%
	Megaphyll	11	8.46%
4.	**Seasonal Variation**		
	Spring	113	86.92%
	Summer	110	84.61%
	Autumn	82	63.07%
	Winter	80	61.53%
5.	**Habit**		
	Herb	72	55.38%
	Shrub	17	13.07%
	Tree	41	31.53%

Table 2: Seasonality in life form.

S.NO	Life form	Spring	%age	Summer	%age	Autumn	%age	Winter	%age
1	Geophytes	4	3.07%	6	4.61%	3	2.30%	3	2.30%
2	Therophytes	27	20.76%	31	23.84%	15	11.53%	12	9.23%
3	Hemicrpytophytes	5	3.84%	5	3.84%	2	1.53%	3	2.30%
4	Chamophytes	8	6.15%	8	6.15%	4	8.07%	7	5.38%
5	Nanophanerophytes	20	15.38%	21	16.15%	17	13.07%	16	12.30%
6	Microphanerophytes	13	10%	13	10%	13	10%	11	8.46%
7	Mesophanerophytes	17	13.07%	17	13.07%	17	13.07%	16	12.30%
8	Megaphanerrophytes	8	6.15%	8	6.15%	8	6.15%	8	6.15%
9	Parasites	1	0.76%	1	0.76%	1	0.76%	1	0.76%

Table 3: Seasonality in leaf size.

S.NO	Leaf form	Spring	Percentage	Summer	Percentage	Autumn	Percentage	Winter	Percentage
1	Appyllous	1	0.76%	1	0.76%	1	0.76%	1	0.76%
2	Leptophyll	7	5.38%	5	3.84%	8	6.15%	9	6.92%
3	Nanophyll	23	17.69%	18	13.84%	14	10.76%	15	11.53%
4	Microphyll	47	36.15%	41	31.53%	25	19.23%	28	21.53%
5	Mesophyll	21	16.15%	23	17.69%	16	12.30%	16	12.30%
6	Macrophyll	4	3.07%	7	5.38%	5	3.84%	2	1.53%
7	Megaphyll	9	6.92%	10	7.69%	7	5.38%	6	4.61%

Among the leaf size spectrum nanophylls and microphyllous were dominant in the research area. Nanophylls & leptophylls are uusually characteristic of hot deserts while, microphylls are feature of steppes Khan et al. (2013) and Tareen & Qadir (1987). In this region's the plants suffer from drought especially in dry soil during winter. Microphyllous leaves species were abundant due to ecological adjustment for these dry situations.

The above findings closely relate with those of Khan (2013) who listed high percentage of microphylls from dry climate of Takht-e-Nasratti Karak. The result indicated that the percentage proportion of different leaf form classes varied with altitude. Dolph & Dilcher (1980) reported that broad leaved plants were dominant in tropical wet forest. This difference is mainly due to climatic variation such as temperature and wet tropical condition. Leaf size alone could not be used to identify specific leaf zone or climate. Other features of plants such as habit and root system might also play important role to establish climate.

Seasonal variation

Variation among leaf form classes depicted that microphyllous forms were dominant, 47 species (36.15%), in spring, followed by nanophyll with 23 species (17.69%) and mesophyll with 21 species (16.15%). In summer, microphyll was dominant with 41 species (31.53%). Next to them were mesophylls with 23 species (17.69%) and nanophylls with 18 species (13.84%). In autumn the most abundant leaf spectra was microphylls with 25 species (19.23%), mesophylls with 16 species (12.30%) and nanophylls with 14 species (10.76%). Microphylls were also dominant in winter 28 species, (21.53%), mesophylls with (16 species 12.30%) and nanophylls with (15 species, 11.53%), (Table. 4, Fig. 8). Leaf size is linked to climatic characters in any geographical region Batalha and Martins (2004). Differences among various leaf classes are also influenced by altitude. In the present study it was concluded that seasonal differences in leaf size classes were actually due to the existence of geophytes and therophytes. Seasonal changes occur in leaf spectra due to the herbaceous flora in the area as recorded by various scholors viz; Ali et al. (2016) and Al-Yemeni and Sher (2010). Qadir and Tareen (1987) recorded the same spectra with high proportion from Quetta (Balochistan) are also strongly backed our findings.

CONCLUSION

From the present study it was concluded that the flora of the area is diverse. The dominancy of therophytes, indicated that the investigated area was under heavy biotic pressure due to deforestation and over grazing. Most of the plants were uprooted for burning purposes and grazed by the livestock. Many plant species were decreasing in the area and special care is needed for their conservation. Because plants are the

resources that control soil erosion, land sliding, environmental pollution and provide livelihood to the local community. The floristic composition and ecological management including fortification are required, so that we can gift these resources to the next generation.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

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AUTHOR CONTRIBUTIONS

MI, IU collected the field data and wrote the manuscript, MA prepared the herbarium sheets and SU and AR designed the study, indentified the specimens and finalized the manuscript.

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