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Phytosociological studies of biodiversity park derawar fort, cholistan desert, Bahawalpur, Pakistan

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Abstract

This study was carried out to evaluate the plant communities and plant species diversity of Biodiversity Park. Vegetation survey was completed by collection data by using the line transect and Quadrate method. A quadrate measuring 1 x 1m² were laid on each transect (100m) to record the frequency, density, and coverage of plant species. Plant communities were determined on the basis of Importance Value Index (IVI). Floristic composition, Life form, and soil properties were also recorded. In general, the soils were poor in nutrients, slightly alkaline and sandy loamy in texture. A total of 68 plant species belonging to 23 families were recorded in study area. Phytosociological analysis of vegetation identified 13 plant communities based on IVI. Most of them were dominated by therophytes and were better adapted to xerophytic climatic conditions. Species such as *Cyperus rotundus, Ochthochloa compressa, Eragrostirs barrelieri, Limeum indicum, Suaeda fruticosa, Diperygium glaucum* and *Lasiurus scindicus* were dominated in all the identified communities. The life form and Habit of species were also determined and therophytes (39 species) and Phanerophyte (11 species) dominated in all the stands. Similarly herbs (34 species) grasses (16 species), shrubs (9 species), trees (7 species) and sedges (2 species) were varied number of species observed in the study area.

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Introduction

Phytosociological surveys are important tools of ecologists to assess and evaluate the vegetation types in a given ecosystem. These surveys ultimately help in the planning, management and exploitation of natural resources since important components of the food chain *viz.,* human, livestock, wildlife and soil fauna are closely associated with specific plant assemblages of the area. Phytosociology attempts to describe the diversity in plant communities and its methods often involve the quantitative estimation of various parameters of vegetation such as cover, abundance and frequency etc. (Hill, 1979).

Vegetation is the reflection of biological conditions of plant and other resources of an area. Vegetation structure depends upon existing environmental conditions. Habitat conditions depend on a number of factors including biotic interaction in the form of overgrazing, deforestation and the clearing of land for developing new settlements.

This has caused an imbalance in plant ecosystems and other associated wildlife. Therefore, vegetation studies reflect the existing state of interference caused by anthropogenic factors. In light of this aspect, many vegetation studies have been conducted previously in various parts of Pakistan (Naqvi, 1974; Chaughtai *et al.,* 1983; Chaughtai and Khattak, 1983; 1987; Hussain & Khan, 1989; Tareen & Qadir, 2000; Hameed *et al*; 2002; Malik & Hussain, 2006; Hussain *et al.,* 2006; Ahmad *et al.,* 2008; Parveen *et al.,* 2008).

The Biodiversity Park Derawar Fort stretches out on 85 acres situated near Derawar Fort Bahawalpur in Cholistan Desert of Pakistan (Wariss *et al.*, 2015; Fig. 1).

It is home to many species of butterflies and snakes which have been deprived of home places even in the desert due to climate change or anthropogenic disturbance. The Biodiversity Park places Pakistan among the countries working on safeguarding Irreplaceable. Natural resources and reducing biodiversity loss by protecting endangered species in Cholistan desert.

Although there is a great biological diversity available in Pakistan, about half of the wild life species have become extinct.

Therefore the park will serve to conserve indigenous species of flora and fauna that are on the verge of extinction in desert. The present study was conducted with the aim of assessing the plant diversity and determining the phytosociological attributes of the extant vegetation at Biodiversity Park.

Materials and methods

Filed survey

The phytosociological studies were carried out during the period 2011-2013 at the Biodiversity Park Derawar Fort, Cholistan Desert.

The line transect of 100mand Quadrate 1 x 1 m^2 were used to study and analyses the vegetation dynamics as well as to collect the primary data for quantitative analyses. Transects were laid in selected sites having the best representation of floral biodiversity and geographic extent of the area (Anon, 1962; Anon, 1968; Thalen and Junk, 1979; Cook & Stubbendieck, 1986; Rashid *et al*., 1988; Khan *et al*., 1989; Marwat *et al*., 1990; Wahid, 1990; Dasti & Agnew, 1994). A total of 8 transects, 20 m each, were laid in the study area. Vegetation attributes including frequency, density, cover and richness were recorded along with geographical parameters such as latitude, longitude and altitude using GPS (Canfield, 1940; Mueller-Dumbois and Ellenburg, 1974). To evaluate the soil structure, soil samples were also collected in each transects and analysed (Annex. 1).

Data analysis

Plant communities were determined on the basis of Importance Value Index by using Microsoft excel for numerical calculations. Frequency, density, and coverage of plant species were also determined. On the basis of Importance Value, the sampled vegetation was delineated into different plant communities.

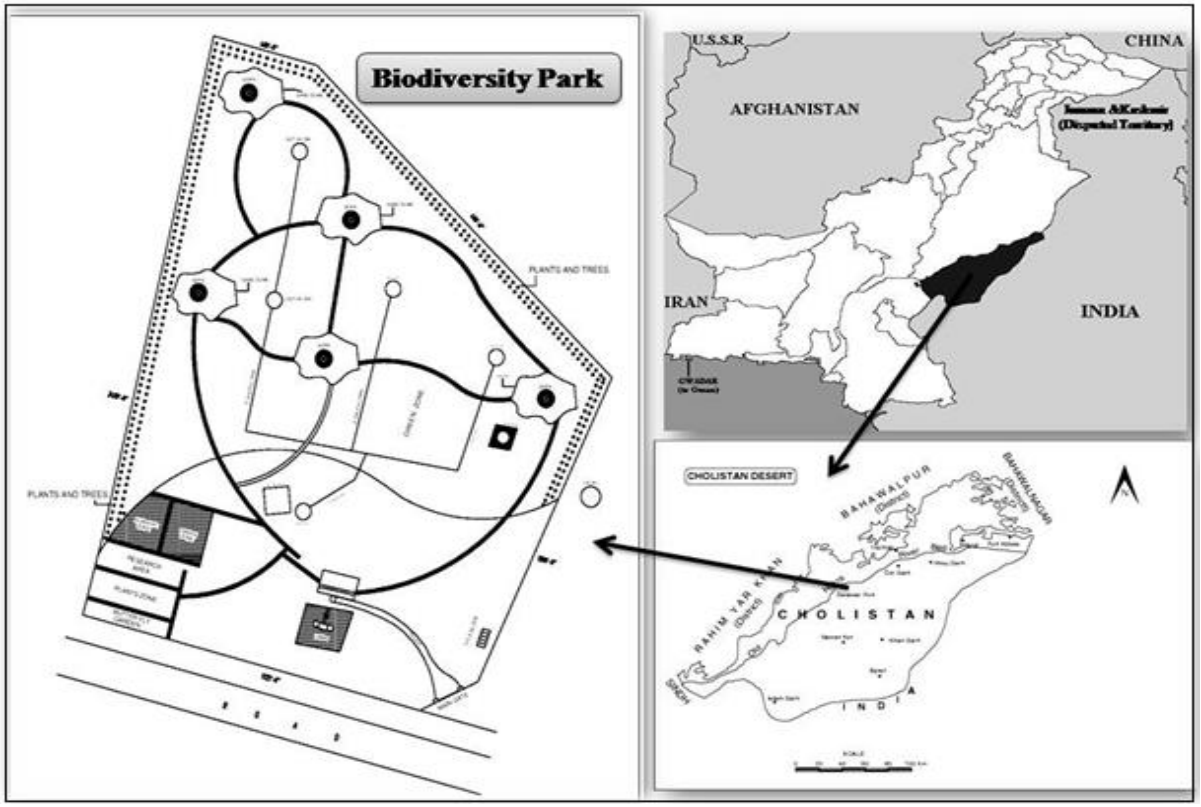

Fig. 1. Map of Biodiversity Park Derawar Fort Cholistan Desert, Bahawalpur, Pakistan. (Source; Environment Protection Agency, Bahawalpur, Pakistan).

The community within each stand was named as the species having highest Importance Value. When two or more species closely approached each other in order of Importance Value, the community shared the names of these dominants.

The name of the species with highest Importance Value appeared first followed by other dominant species. The generic names of the dominants were used for naming the community, provided they did not overlap. Species other than the dominants were classified into co-dominants, associates and rare.

Plant identification

Plants from the location of sampling points as well as isolated vegetation patches were also collected in order to maximize the number of species and their distribution patterns. Collected samples were pressed, dried and transported to herbarium of Cholistan Institute of Desert Studies, The Islamia University of Bahawalpur, Pakistan.

Plants were identified and classified following the Stewart (1972), Ali and Qaiser (1995-2005), Bhandari (1978), Cope (1982) and Chaudhary (1989).

Results and discussion

A total of 68 plant species belonging to 51 genera and 23 angiosperm families were observed at the study area and recorded (Table 1). The therophytic life form was dominant (39 species) followed by phanerophytic (11 species), chamaephytic (8 species), hemicryptophytic (8 species) and cryptophytic (2 species) (Fig. 2). On the basis of life cycle, 35 species were found to be perennial and 33 species annual. The habit of plant species varied from herbs (34 species; 25%), grasses (16 species; 12%), Shrubs (9 species; 7%), Trees (7 species; 5%) and sedges (2 species; 2%) (Fig. 3). Similar studies have been carried out in different parts of Pakistan (Arshad & Rao, 1994; Arshad & Rao, 1995; Arshad & Akbar, 2002; Wariss *et al;* 2013; Wariss *et al;* 2014; Wariss *et al;* 2015).

Table 1. List of plant species of biodiversity Park Derawar Fort, Cholistan DESERT.

Family	Species	Local name	Habit	Life cycle	Life form
Aizoaceae	*Gisekia pharnaceoides* L.		Herb	Annual	Therophyte
	Limeum indicum Stocks ex T. Anderson		Herb	Annual	Therophyte
	Sesuviumse suvioides (Fenzl) Verdc.		Herb	Annual	Therophyte
	Trianthema portulacastrum L.	Lalitsit	Herb	Annual	Therophyte
	Trianthema triquetra Rottl. & Willd.	Alvaiti	Herb	Annual	Therophyte
	Zaleya pentendra (Linn.) Jeffery	It Sit	Herb	Annual	Therophyte
	Aerva javanica (Burm. F.) Juss. Ex J.A. Schultes	Bui	Shrub	Perennial	Chamaephyte
	Digera muricata (L.) Mart.	Tandula	Herb	Annual	Therophyte
Asclepiadaceae	*Calotropis procera* (Ait.) Ait. F.	Ak	Shrub	Perennial	Phanerophyte
	Leptadenia pyrotechnica (Forssk.) Decne.	Khip	Shrub	Perennial	Phanerophyte
Asteraceae	*Echinops echinatus* Roxb.	Untkatara	Herb	Annual	Therophyte
	Launaea nudicaulis (L.) Hook.f.	Bhattal	Herb	Perennial	Hemicryptophyte
	Launaea resedifolia Druce		Herb	Perennial	Therophyte
Boraginaceae	*Heliotropium crispum* Desf.	Kali bui	Herb	Perennial	Therophyte
Capparidaceae	*Capparis decidua* (Forssk.) Edgew.	Karir, deela	Shrub	Perennial	Phanerophyte
	Cleome brachycarpa Vahl ex DC.		Herb	Annual	Therophyte
	Cleome scaposa DC.		Herb	Annual	Therophyte
	Cleome viscosa L.		Herb	Annual	Therophyte
	*Dipterygium glaucum*Decne.	Fehl	Herb	Perennial	Chamaeophyte
Chenopodiaceae	*Haloxylon stocksii* (Boiss.) Benth. & Hook.	Kahr	Herb	Annual	Chamaeophyte
	Haloxylon salicornicum (Moq.) Bunge ex Boiss.	Lana	Shrub	Perennial	Chamaeophyte
	Salsola imbricata Forssk.	Lani	Shrub	Perennial	Chamaeophyte
	Suaeda fruticosa Forssk. Ex J. F. Gmelin	Kali lani	Shrub	Perennial	Chamaeophyte
Convolvulaceae	*Convolvulus microphyllus* Linn.	Vanvari	Herb	Perennial	Therophyte
	Cressa cretica	Oin	Herb	Perennial	Chamaeophyte
Cucurbitaceae	*Citrullus colocynthis* (Linn.) Schrad.	Kortumma	Herb	Perennial	Therophyte
	*Cucumis melo*s ubsp. *Agrestis* var. *agrestis* Naudin	Chibhar	Herb	Annual	Therophyte
Cyperaceae	*Cyperus rotundus* Linnaeus	Murki	Sedge	Perennial	Cryptophyte
	Cyperus conglomerates Rottb.	Deela	Sedge	Perennial	Cryptophyte
Euphorbiaceae	*Euphorbia granulata* Forssk.	Hazardani	Herb	Annual	Therophyte
Mimosaceae	*Acacia nilotica* (Linn.) Delile	Kikar	Tree	Perennial	Phanerophyte
	Prosopis cineraria (Linn.) Druce	Jand	Tree	Perennial	Phanerophyte
	Prosopis juliflora (Swartz) DC.	Maskit	Tree	Perennial	Phanerophyte
Molluginaceae	*Mollugo cerviana* (L.) Seringe		Herb	Annual	Therophyte
Nyctaginaceae	*Boerhavia repens* Linn.	Biskhapra	Herb	Perennial	Chamaephyte
Papilionaceae	*Crotalaria burhia* Buch.-Ham. Ex Benth.	Chag	Shrub	Perennial	Therophyte
	Indigofera argentea Burm.f.		Herb	Annual	Therophyte
	Indigofera sessiliflora DC.		Herb	Annual	Therophyte
	Rhynchosia capitata (Heyne ex Roth) DC.		Herb	Annual	Therophyte
Poaceae	*Aeluropus lagopoides* (Linn.) Trin. ex Thw.		Grass	Perennial	Hemicryptophyte
	Aristida adscensionis Linn.	Lumb	Grass	Annual	Therophyte
	Aristida articulate Trin. & Rupr.	Lumb	Grass	Annual	Therophyte
	Aristida funiculate Trin, & Rupr.	Lumb	Grass	Annual	Therophyte
	Cenchrus biflorus Roxb.	Leedha	Grass	Annual	Therophyte
	Cenchrus ciliaris Linn.	Dhaman	Grass	Perennial	Hemicryptophyte
	Cenchrus setigerus Vahl	Dhaman	Grass	Perennial	Hemicryptophyte
	Cymbopogon jwarancusa (Jones) Schult.	Qatran, Khawi	Grass	Perennial	Hemicryptophyte
	Dactyloctenium aegyptium (Linn.) Willd.	Madhanaghaa	Grass	Annual	Therophyte
	Digitaria sanguinalis (Linn.) Scop.		Grass	Annual	Therophyte
	Eragrostis barrelieri Day.		Grass	Annual	Therophyte

	Eragrostis ciliaris (Linn.) P. Beauv. ex Roem. & Schult.		Grass	Annual	Therophyte
	Lasiurus scindicus Henr.	Sewan	Grass	Perennial	Hemicryptophyte
	Ochthochloacompressa (Forssk.) Hilu	Ghandhel, Chember	Grass	Perennial	Hemicryptophyte
	Sporobolus iocladas (Nees ex Trin.) Nees	Murrat	Grass	Perennial	Hemicryptophyte
	Tragus roxburghii Panigrahi		Grass	Annual	Therophyte
Polygonaceae	*Calligonum polygonoides* Linnaeus	Phog	Tree	Perennial	Phanerophyte
Polygalaceae	*Polygala erioptera* DC.		Herb	Annual	Therophyte
Portulaceae	*Portulaca oleracea* Linn.	Launak	Herb	Annual	Therophyte
	Portulaca quadrifida Linn.	Launak	Herb	Annual	Therophyte
Rhamnaceae	*Zizyphus mauritiana* Lam.	Beri	Tree	Perennial	Phanerophyte
Salvadoraceae	*Salvadora oleoides* Decne	Jal, Peelu	Tree	Perennial	Phanerophyte
Tamaricaceae	*Tamarix aphylla* (L.) Karst.	Ukhan	Tree	Perennial	Phanerophyte
	Tamarix dioica Roxb. ex Roch	Lai	Shrub	Perennial	Phanerophyte
Tiliaceae	*Corchorus depressus* (Linn.) Stocks	Boh phalli	Herb	Perennial	Therophyte
	Corchorus trilocularis Linn.		Herb	Annual	Therophyte
Zygophyllaceae	*Fagonia bruguieri* var. *laxa* Boiss.	Damahan	Herb	Perennial	Therophyte
	Tribulus longipetalus Viv.	Bhakra	Herb	Annual	Therophyte
	Tribulus terrestris Linn.	Bhakra	Herb	Annual	Therophyte

Table 2. Phytosociological attributes of *Cyperus-Ochthchloa* community.

No	Species	Density	Cover	Frequency	Relative Cover	Relative Frequency	Relative Density	IV
1	*Cymbopogon jwarancusa*	80.7	7.46	5	11.61	5.20	4.95	21.77
2	*Polygala erioptera*	129.3	21.43	5	28.10	5.20	7.94	41.25
3	*Ochtho chloacompressa*	870.7	51.87	5	13.25	5.20	53.44	71.90
4	*Lasiurus scindicus*	31.7	24.46	3.3	5.67	3.43	1.94	11.05
5	*Haloxylon salicornicum*	8.3	10.47	3.3	0.34	3.43	0.51	4.29
6	*Cleome viscosa*	5.0	0.63	5	2.12	5.20	0.31	7.63
7	*Eragrostis barrelieri*	29.3	3.92	5	0.68	5.20	1.80	7.68
8	*Fagonia bruguieri* var. *laxa*	13.0	1.25	5	0.62	5.20	0.80	6.62
9	*Trianthema triquetra*	11.7	1.15	3.3	8.89	3.43	0.72	13.04
10	*Crotalaria burhia*	74.0	16.41	5	0.75	5.20	4.54	10.49
11	*Gisekia pharnaceoides*	12.7	1.38	3.3	0.46	3.43	0.78	4.67
12	*Euphorbia granulata*	7.0	0.84	3.3	2.92	3.43	0.43	6.78
13	*Aristida adscensionis*	90.3	5.39	5	5.64	5.20	5.54	16.39
14	*Limeum indicum*	132.0	10.41	5	3.58	5.20	8.10	16.88
15	*Diptery giumglaucum*	52.0	6.60	5	0.66	5.20	3.19	9.05
16	*Sesuvium sesuvioides*	7.3	1.21	3.3	1.84	3.43	0.45	5.73
17	*Boerhavia repens*	12.0	3.40	3	0.30	3.12	0.74	4.16
18	*Cenchrus biflorus*	6.7	0.55	3.3	3.62	3.43	0.41	7.46
19	*Leptadenia pyrotechnica*	7.7	6.67	5	1.59	5.20	0.47	7.26
20	*Indigofera sessiliflora*	15.3	2.93	5	2.33	5.20	0.94	8.47
21	*Calligonum polygonoides*	7.3	4.30	5	1.00	5.20	0.45	6.65
22	*Cyperus rotundus*	25.3	1.84	5	100.00	5.20	1.55	106.76
Total		1629.33	184.55	96.1	195.96	100.00	100.00	395.96

The vegetation is thin along with few woody and shrubby species, which are mostly xeric. Based on the dominant plant species and highest importance value, the following eight plant communities were identified.

Cyperus-Ochthochloa community

According to phytosociological parameters *Cyperus rotundus* and *Ochthochloa compressa* appeared to be dominant plant species, with importance values 106.76 and 71.90 respectively and formed the community. Associated plant species were *Polygala erioptera, Cymbopogan jwarancusa, Limeum indicum, Aristida adscensionis, Trienthema triquetra, Lasiurus scindicus* and *Crotalaria burhia*. The Total numbers of plant species recorded at this transect area were 22, out of which 12 plant species were perennials and 10 were annual (Table 2).

Table 3. Phytosociological attributes of *Ochthochloa-Eragrostis* community.

No	Species	Density	Cover	Frequency	Relative Cover	Relative Frequency	Relative Density	IV
1	*Limeum indicum*	34.7	14.12	5	6.89	5.49	1.39	13.77
2	*Polygala erioptera*	156.7	25.56	5	12.48	5.49	6.28	24.25
3	*Cenchrus ciliaris*	9.7	3.30	5	1.61	5.49	0.39	7.49
4	*Lasiurus scindicus*	166.0	21.52	5	10.51	5.49	6.66	22.66
5	*Euphorbia granulata*	15.3	1.76	5	0.86	5.49	0.61	6.97
6	*Ochthochloa compressa*	1159.3	60.42	5	29.49	5.49	46.49	81.48
7	*Dipterygium glaucum*	29.3	6.80	5	3.32	5.49	1.18	9.99
8	*Haloxylon salicornicum*	17.3	14.70	5	7.17	5.49	0.69	13.36
9	*Eragrostis barrelieri*	784.3	35.75	5	17.45	5.49	31.45	54.40
10	*Citrullus colocynthis*	11.3	2.03	5	0.99	5.49	0.45	6.94
11	*Aristida adscensionis*	8.3	1.23	5	0.60	5.49	0.33	6.43
12	*Aerva jvanica*	7.3	2.13	5	1.04	5.49	0.29	6.83
13	*Tribulus longipetalus*	17.0	2.15	5	1.05	5.49	0.68	7.22
14	*Sesuvium sesuvioides*	24.7	4.01	5	1.96	5.49	0.99	8.44
15	*Trianthema triquetra*	16.3	2.71	5	1.32	5.49	0.65	7.47
16	*Mollugo cerviana*	5.3	0.57	5	0.28	5.49	0.21	5.98
17	*Cleome viscosa*	3.0	1.41	3	0.69	3.30	0.12	4.11
18	*Boerhavia repens*	14.7	2.48	4	1.21	4.40	0.59	6.20
19	*Gisekia pharnaceoides*	13.0	2.22	4	1.08	4.40	0.52	6.00
20	*Calligonum polygonoides*	34.7	14.12	5	6.89	5.49	1.39	13.77
21	*Fagonia bruguieri* var. *laxa*	156.7	25.56	5	12.48	5.49	6.28	24.25
Total		2493.57	204.87	91	100.00	100.00	100.00	300.00

Table 4. Phytosociological attributes of *Ochthchloa-Lasiurus* community.

No	Species	Density	Cover	Frequency	Relative Cover	Relative Frequency	Relative Density	IV
1	*Lasiurus scindicus*	33.3	27.72	5	20.66	4.70	7.37	32.74
2	*Haloxylon salicornicum*	21.7	17.88	5	13.33	4.70	4.79	22.82
3	*Ochthochloa compressa*	94.7	16.85	5	12.56	4.70	20.93	38.20
4	*Limeum indicum*	20.7	3.72	5	2.78	4.70	4.57	12.05
5	*Polygala erioptera*	12.3	2.79	4.3	2.08	4.05	2.73	8.85
6	*Calotropis procera*	4.7	2.60	5	1.94	4.70	1.03	7.67
7	*Eragrostis barrelieri*	10.3	1.59	4	1.18	3.76	2.28	7.23
8	*Sesuvium sesuvioides*	28.3	4.34	5	3.24	4.70	6.26	14.20
9	*Eragrostis japonica*	28.7	3.21	5	2.40	4.70	6.34	13.44
10	*Cleome viscosa*	7.7	0.65	5	0.48	4.70	1.69	6.88
11	*Aristida adscensionis*	16.0	2.25	5	1.67	4.70	3.54	9.92
12	*Dipterygium glaucum*	22.3	7.31	5	5.45	4.70	4.94	15.09
13	*Cenchrus ciliaris*	9.0	3.01	4	2.24	3.76	1.99	8.00

14	*Mollugo cerviana*	7.3	1.35	4	1.01	3.76	1.62	6.39
15	*Aerva javanica*	18.0	3.75	5	2.80	4.70	3.98	11.48
16	*Calligonum polygonoides*	4.3	7.34	3	5.47	2.82	0.96	9.25
17	*Gisekia pharnaceoides*	5.0	1.64	4	1.22	3.76	1.11	6.09
18	*Salsola imbricata*	38.0	7.03	5	5.24	4.70	8.40	18.34
19	*Tribulus terrestris*	10.3	1.62	4	1.21	3.76	2.28	7.25
20	*Suaeda fruticosa*	9.7	2.15	4	1.60	3.76	2.14	7.50
21	*Tamarix aphylla*	8.0	8.06	5	6.01	4.70	1.77	12.48
22	*Cenchrus biflorus*	24.0	1.91	5	1.43	4.70	5.31	11.44
23	*Haloxylon stocksii*	18.0	5.36	5	4.00	4.70	3.98	12.68
Total		452.26	134.13	106.3	100.00	100.00	100.00	300.00

Ochthochloa-Eragrostis community

This community consists of 21 species, out of which 11are perennials and 10 are annuals species. *Ochthochloa compressa* and *Ergrostis barrrelieri* appeared to be the dominant plant species with importance value 81.48 and 54.40 respectively, with *Polygala erioptera, Fagonia bruguieri* var. *laxa, Lasiurus scindicus, Limeum indicum, Calligonum polygonoides* and *Haloxylon salicornicum* being the codominating plant species (Table 3).

Table 5. Phytosociological attributes of *Ochthchloa-Limeum* community.

No	Species	Density	Cover	Frequency	Relative Cover	Relative Frequency	Relative Density	IV
1	*Ochthochloa compressa*	532.66	34.80	5	28.68	5.21	47.68	81.56
2	*Polygala erioptera*	48	5.54	4	4.56	4.17	4.30	13.03
3	*Cenchrus biflorus*	12.66	1.17	4	0.96	4.17	1.13	6.26
4	*Eragrostis japonica*	42.66	5.14	5	4.24	5.21	3.82	13.26
5	*Cenchrus ciliaris*	113	5.25	4	4.33	4.17	10.11	18.61
6	*Calligonum polygonoides*	6.66	2.83	4	2.33	4.17	0.60	7.09
7	*Salsola imbricata*	12.33	7.46	4	6.15	4.17	1.10	11.42
8	*Sesuvium sesuvioides*	12.66	2.00	4	1.65	4.17	1.13	6.95
9	*Euphorbia prostrata*	3.33	0.50	3	0.41	3.13	0.30	3.84
10	*Lasiurus scindicus*	4.66	3.10	3	2.55	3.13	0.42	6.10
11	*Tribulus longitelalus*	15.33	4.09	5	3.37	5.21	1.37	9.95
12	*Limeum indicum*	149.66	17.29	5	14.25	5.21	13.40	32.85
13	*Haloxylon salecornicum*	8	3.77	3	3.11	3.13	0.72	6.95
14	*Gisekia pharnaceoides*	20	2.79	5	2.30	5.21	1.79	9.30
15	*Dipterygium glaucum*	47	7.08	5	5.83	5.21	4.21	15.25
16	*Prosopis cineraria*	6	1.35	3	1.11	3.13	0.54	4.77
17	*Aristida adscensionis*	10.66	2.48	5	2.04	5.21	0.95	8.21
18	*Euphorbia hirta*	9	1.70	3	1.40	3.13	0.81	5.33
19	*Euphorbia granulata*	6.33	1.30	5	1.07	5.21	0.57	6.85
20	*Convolvulus stocksii*	5.33	0.20	4	0.16	4.17	0.48	4.81
21	*Aerva javanica*	15.66	4.14	4	3.41	4.17	1.40	8.98
22	*Corchorus depressus*	18.66	2.17	5	1.79	5.21	1.67	8.67
23	*Sporobolus ioclados*	17	5.21	4	4.29	4.17	1.52	9.98
Total		1117.25	121.36	96	100.00	100.00	100.00	300.00

Table 6. Phytosociological attributes of *Eragrostis-Dipterygium* community.

No	Species	Density	Cover	Frequency	Relative Cover	Relative Frequency	Relative Density	IV
1	*Ochthochloa compressa*	18.0	3.14	5	2.58	5.56	3.38	11.51
2	*Eragrostis barrelieri*	183.3	15.08	5	12.37	5.56	34.42	52.35
3	*Salsola imbricata*	10.0	1.69	5	1.38	5.56	1.88	8.82
4	*Sporobolus ioclados*	4.0	1.23	4	1.01	4.44	0.75	6.20
5	*Dipterygium glaucum*	34.7	30.14	5	24.73	5.56	6.51	36.79
6	*Mollugo cerviana*	5.0	0.20	4	0.16	4.44	0.94	5.55
7	*Limeum indicum*	52.3	12.02	5	9.86	5.56	9.83	25.24
8	*Trianthema triquetra*	40.0	9.35	5	7.67	5.56	7.51	20.73
9	*Aristida adscensionis*	7.0	1.24	3	1.01	3.33	1.31	5.66
10	*Crotalaria burhia*	32.7	1.13	5	0.93	5.56	6.13	12.62
11	*Haloxylon salicornicum*	22.7	12.55	5	10.30	5.56	4.25	20.11
12	*Cleome viscosa*	4.0	1.10	3	0.90	3.33	0.75	4.99
13	*Euphorbia granulata*	11.0	1.48	5	1.22	5.56	2.07	8.84
14	*Sesuvium sesuvioides*	14.0	3.89	5	3.19	5.56	2.63	11.38
15	*Fagonia bruguieri* var. *laxa*	10.0	1.48	4	1.21	4.44	1.88	7.54
16	*Suaeda fruticosa*	7.0	1.60	3	1.31	3.33	1.31	5.96
17	*Calotropis procera*	6.0	0.40	4	0.33	4.44	1.13	5.90
18	*Calligonum polygonoides*	40.0	15.54	5	12.74	5.56	7.51	25.81
19	*Lasiurus scindicus*	19.0	7.89	5	6.47	5.56	3.57	15.60
20	*Cymbopogon jwarancusa*	12.0	0.76	5	0.63	5.56	2.25	8.43
Total		532.6	121.91	90	100.00	100.00	100.01	300.01

Table 7. Phytosociological attributes of *Limeum-Ochthchloa* community.

No	Species	Density	Cover	Frequency	Relative Cover	Relative Frequency	Relative Density	IV
1	*Limeum indicum*	202.0	96.69	5	50.10	5.15	16.74	71.99
2	*Aristida adscensionis*	200.3	15.01	5	7.78	5.15	16.60	29.53
3	*Eragrostis barrelieri*	58.7	6.73	5	3.49	5.15	4.86	13.50
4	*Polygala erioptera*	26.7	3.34	5	1.73	5.15	2.21	9.09
5	*Tribulus longipetalus*	14.3	3.84	5	1.99	5.15	1.19	8.33
6	*Ochthochloa compressa*	392.7	18.87	5	9.78	5.15	32.53	47.47
7	*Aerva javanica*	9.3	2.75	5	1.43	5.15	0.77	7.35
8	*Sesuvium sesuvioides*	9.3	1.56	5	0.81	5.15	0.77	6.73
9	*Cenchrus ciliaris*	3.0	1.46	3	0.76	3.09	0.25	4.10
10	*Haloxylon salicornicum*	10.3	6.48	5	3.36	5.15	0.86	9.37
11	*Prosopis cineraria*	6.0	10.88	4	5.64	4.12	0.50	10.26
12	*Corchorus depressus*	13.3	0.74	5	0.38	5.15	1.10	6.64
13	*Cenchrus biflorus*	14.3	1.91	5	0.99	5.15	1.19	7.33
14	*Dipterygium glaucum*	96.0	10.70	5	5.55	5.15	7.95	18.65
15	*Cleome viscosa*	9.7	2.45	5	1.27	5.15	0.80	7.23
16	*Boerhavia repens*	65.7	3.55	5	1.84	5.15	5.44	12.43
17	*Aritisda funiculata*	16.3	1.68	5	0.87	5.15	1.35	7.38
18	*Euphorbia granulata*	23.0	0.97	5	0.50	5.15	1.91	7.56
19	*Trianthema triquetra*	13.0	0.83	5	0.43	5.15	1.08	6.66
20	*Crotalaria burhia*	23.0	2.55	5	1.32	5.15	1.91	8.38
Total		1206.9	192.99	97	100.00	100.00	100.00	300.00

Ochthochloa-Lasiurus community

This community consists of *Ochthochloa compressa* and *Lasiurus scindicus* plant species with importance value 38.20 and 32.74 respectively and formed the community. Associated plant species recorded in this area included *Haloxylon salicornicum, Diptrygium glaucum, Salsola imbricata, Sesuvium sesuvioides, Eragrostis japonica Tamarix aphylla, Haloxylon stocksii, Limeum indicum, Aerva javanica* and *Cenchrus biflorus*. This area had 23 plant species, 14 out of which were perennials and 9 were annuals (Table 4).

Table 8. Phytosociological attributes of *Suaeda-Ochthchloa* community.

No	Species	Density	Cover	Frequency	Relative Cover	Relative Frequency	Relative Density	IV
1	*Suaeda fruticosa*	2413.88	42.13	2	8.78	1.61	55.69	66.09
2	*Tamarix aphylla*	35.33	86.12	3	17.96	2.42	0.82	21.19
3	*Cenchrus biflorus*	4.66	1.63	3	0.34	2.42	0.11	2.87
4	*Ochthochloa compressa*	505	93.65	4	19.53	3.23	11.65	34.40
5	*Eragrostis barrelieri*	356.66	53.04	4	11.06	3.23	8.23	22.51
6	*Sesuvium sesuvioides*	18.66	11.29	5	2.35	4.03	0.43	6.82
7	*Limeum indicum*	18.33	10.61	5	2.21	4.03	0.42	6.67
8	*Capparis decidua*	4.33	15.00	5	3.13	4.03	0.10	7.26
9	*Aristida adscensionis*	37.33	12.16	5	2.54	4.03	0.86	7.43
10	*Dipterygium glaucum*	46.3	37.77	5	7.88	4.03	1.07	12.98
11	*Euphorbia granulata*	22.33	9.47	5	1.97	4.03	0.52	6.52
12	*Cloeme scaposa*	15	2.38	2	0.50	1.61	0.35	2.46
13	*Tribulus longipetalus*	104.66	34.06	4	7.10	3.23	2.41	12.74
14	*Boerhavia repens*	5.33	6.41	2	1.34	1.61	0.12	3.07
15	*Salsola imbricata*	9.33	3.18	5	0.66	4.03	0.22	4.91
16	*Trianthema triquetra*	56.33	23.01	5	4.80	4.03	1.30	10.13
17	*Gisekia pharnaceoides*	8.66	6.16	4	1.28	3.23	0.20	4.71
18	*Mollugo cerviana*	13.66	2.19	3	0.46	2.42	0.32	3.19
19	*Salvadora oleoides*	47.33	29.32	4	6.11	3.23	1.09	10.43
20	*Crotalaria burhia*	26.66	6.78	3	1.41	2.42	0.62	4.45
21	*Polygala erioptera*	19	3.92	3	0.82	2.42	0.44	3.68
22	*Dactyloctenium aegyptium*	16.33	3.10	4	0.65	3.23	0.38	4.25
23	*Haloxylon salicornicum*	71	24.08	4	5.02	3.23	1.64	9.88
24	*Aerva javanica*	27.33	3.93	5	0.82	4.03	0.63	5.48
25	*Prosopis cineraria*	70	11.40	5	2.38	4.03	1.61	8.02
26	*Calotropis procera*	63.66	7.00	5	1.46	4.03	1.47	6.96
27	*Cenchrus ciliaris*	76.66	28.53	5	5.95	4.03	1.77	11.75
28	*Lasiurus scindicus*	90	38.31	5	7.99	4.03	2.08	14.10
29	*Cymbopogon jwarancusa*	76	4.38	5	0.91	4.03	1.75	6.70
30	*Fagonia bruguieri* var. *laxa*	74.66	4.88	5	1.02	4.03	1.72	6.77
Total		4334.41	479.58	124	128.42	100.00	100.00	328.42

Ochthochloa-Limeum community

According to phytosociological attributes *Ochthochloa compressa and Limeum indicum* having the highest importance values of 81.56, 32.85 respectively and formed the community. Associated plant species recorded in this area included *Cenchrus ciliaris, Dipterygium glaucum, Eragrostis japonica, Polygala erioptera* and *Salsola imbricate* (Table 5).Total numbers of plant species recorded at this transect area were 23, out of which 14 were perennials and 9 were annuals.

Eragrostis-Dipterygium community

This community consisted of 20 plant species, out of which 13 were perennials and 7 were annuals. According to phytosociological parameters *Eragrostis barrelieri and Dipterygium glaucum* appeared to be the dominant species with importance values of 52.35 and 36.79 respectively and formed the community. Associated plant species were *Calligonum polygonoides, Limeum indicum, Trianthema triquetra, Haloxylon salicornicum, Lasiurus scindicus, Crotalaria burhia, Ochthochloa compressa* and *Sesuvium sesuvioides* (Table 6).

Limeum-Ochthochloa community

According to phytosociological attributes *Limeum indicum* and *Ochthochloa compressa* were the dominant plant species having importance values of 71.99 and 47.47 respectively and formed the community. Associated plant species recorded in this area were *Aristida adscensionis, Dipterygium glaucum, Eragrostis barrelieri, Boerhavia repens* and *Prosopis cineraria* (Table 7). The total number of plant species recorded at this transect were 20, out of which 12 were perennials and 8 were annuals.

Table 9. Phytosociological attributes of *Ochthchloa-Cyperus* community.

No	Species	Density	Cover	Frequency	Relative Cover	Relative Frequency	Relative Density	IV
1	*Cenchrus ciliaris*	297	24.05	5	6.62	4.67	5.93	17.23
2	*Haloxylon salicarnicum*	27	9.09	5	2.50	4.67	0.54	7.72
3	*Ochthochloa compressa*	1902	121.94	5	33.59	4.67	37.97	76.22
4	*Digitaria sanguinalis*	6	0.44	4	0.12	3.74	0.12	3.98
5	*Gisekia pharnaceoides*	8	0.84	3	0.23	2.80	0.16	3.19
6	*Limeum indicum*	60	8.56	5	2.36	4.67	1.20	8.23
7	*Suaeda fruticosa*	39.33	4.28	5	1.18	4.67	0.79	6.64
8	*Salsola imbricata*	6.33	3.33	4	0.92	3.74	0.13	4.78
9	*Sesuvium sesuvioides*	11.6	1.84	3	0.51	2.80	0.23	3.54
10	*Tamarix aphylla*	13	6.99	5	1.93	4.67	0.26	6.86
11	*Aristida adscensionis*	14.66	2.00	3	0.55	2.80	0.29	3.65
12	*Eragrostis barrelieri*	410	18.73	5	5.16	4.67	8.18	18.02
13	*Dipterygium glaucum*	5.3	1.24	5	0.34	4.67	0.11	5.12
14	*Heliotropium europaeum*	17	0.50	3	0.14	2.80	0.34	3.28
15	*Cymbopogon jwarancusa*	20	2.28	4	0.63	3.74	0.40	4.77
16	*Prosopis cineraria*	15	5.87	5	1.62	4.67	0.30	6.59
17	*Cressa Cretica*	909.33	23.88	5	6.58	4.67	18.15	29.40
18	*Crotalaria burhia*	30	7.83	5	2.16	4.67	0.60	7.43
19	*Cyperus rotundus*	977.66	23.26	5	6.41	4.67	19.51	30.59
20	*Lasiurus scindicus*	82.33	12.14	5	3.34	4.67	1.64	9.66
21	*Calligonum polygonoides*	4	3.52	5	0.97	4.67	0.08	5.72
22	*Prosopis juliflora*	3	2.80	3	0.77	2.80	0.06	3.63
23	*Aeluropus lagopoides*	109.66	75.31	5	20.74	4.67	2.19	27.60
24	*Sporobolus ioclados*	41.66	2.34	5	0.64	4.67	0.83	6.15
	Total	5009.86	363.08	107	181.132203	100.00	100.00	300.00

Suaeda-Ochthochloa community

This community was dominated by *Saueda fruticosa* and *Ochthochloa compressa* having importance values of 66.09 and 34.40 respectively and formed the community. Codominant plant species recorded at this area were *Eragrostis barrelieri, Tamarix aphylla, Lasiurus scindicus, Dipterygium glaucum, Tribulus longipetalus, Cenchrus ciliaris, Trianthema triquetra* and *Salvadora oleoides* (Table 8). The transect had 20 perennial and 10 annual plant species.

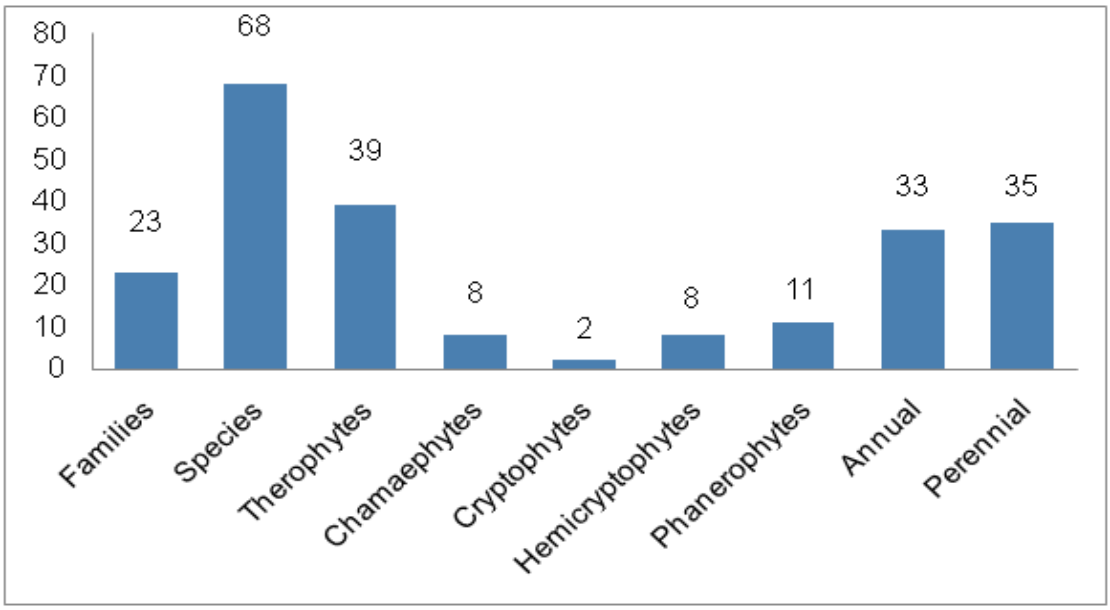

Fig. 2. Floristic composition and life form of recorded species in biodiversity Park Derawar Fort.

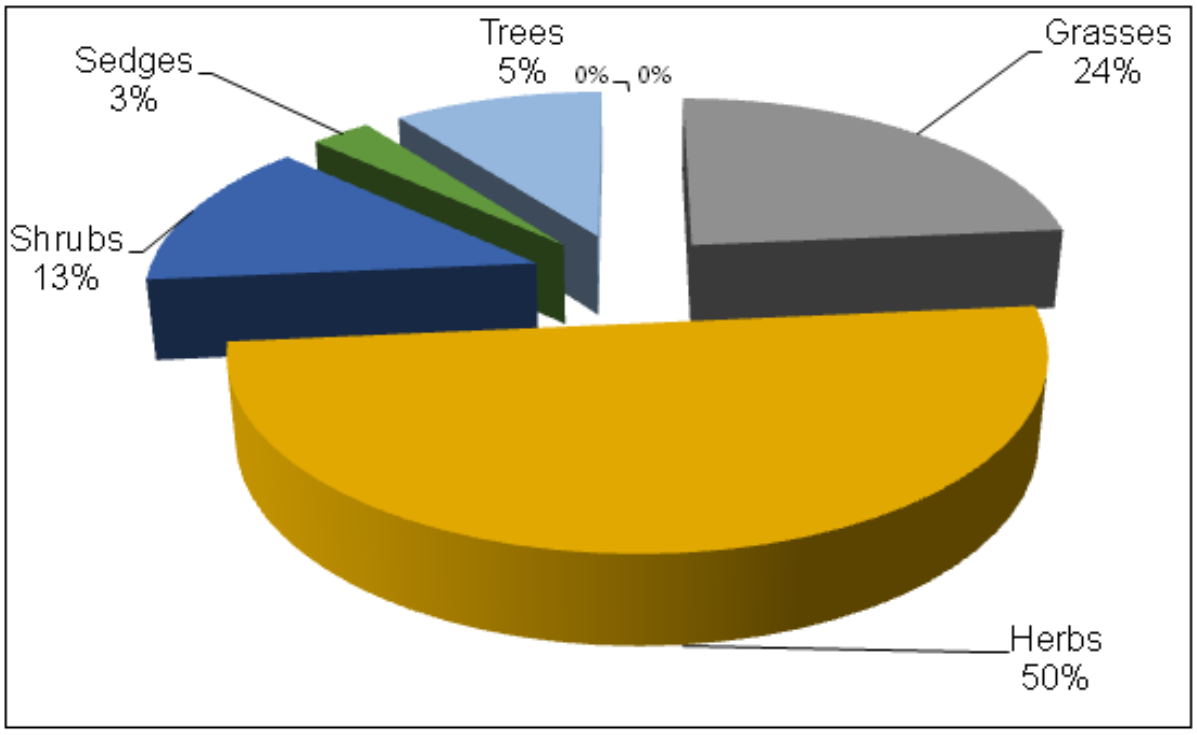

Fig. 3. Habit of recorded plant species in biodiversity Park Derawar Fort.

Ochthochloa-Cyperus community

A total of 24 plant species were recorded at this transect, out of which 13 were perennials and 7 were annuals. *Ochthochloa compressa* and *Cyperus rotundus* formed the community and appeared to be the dominant plant species with importance values of 76.22 and 30.59 respectively. Associated plant species were *Cyperus rotundus*, *Cressa cretica, Aeluropus lagopoides, Eragrostis barrelieri* and *Cenchrus ciliaris* (Table 9).

Annexure 1. Soil analysis report of biodiversity Park Derawar Fort, Cholistan Desert.

S.#	Regd. No.	pH 1:1	E.C. (ds/m) 1:10	Available -P (ppm)	Available -K (ppm)	Organic Matter %	Saturation %	Texture
T1	93095	9.1	7.5	ND*	220	ND*	29	Sandy loamy
T2	93096	9.2	18.5	ND*	50	ND*	28	Sandy loamy
T 3	93098	9.2	25.5	ND*	350	ND*	29	Sandy loamy
T4	93102	9.1	18.5	ND*	50	ND*	28	Sandy loamy
T5	93103	9.0	11.5	ND*	170	ND*	30	Sandy loamy
T 6	93105	9.2	13.2	ND*	110	ND*	30	Sandy loamy
T7	93106	9.2	7.5	ND*	220	ND*	29	Sandy loamy
T8	93107	9.1	7.5	ND*	220	ND*	29	Sandy loamy

ND=Not Determine.

Conclusion

Plant life in the study area is restricted to micro-environments where runoff water collects and provides sufficient moisture for plant growth.

The vegetation is characterized by sparseness of plant cover, a limited number of plant species and rareness of trees.

The vegetation structure is relatively simple, in which the species have to withstand the harsh environmental conditions. This is not only reflected by the hold of annuals, but also by the presence of several highly adapted, drought-resistant species.

It can be concluded that all the vegetation types under study recorded representing floristic composition related to the total area of the Cholistan desert. This baseline study can be used further to conserve, protect and manage sustainably the valuable plant diversity of the entire Cholistan desert.

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