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PHYTODIVERSITY AND PLANT LIFE OF KHANPUR DAM, KHYBER PAKHTUNKHWA, PAKISTAN

RAHMATULLAH QURESHI*, HUMAIRA SHAHEEN, MUHAMMAD ILYAS, WASIM AHMED AND MUBASHRAH MUNIR

Department of Botany, Pir Mehr Ali Shah Arid Agriculture University, Murree Road, Rawalpindi, Pakistan.
**Corresponding author e-mail*: *rahmatullahq@yahoo.com*

Abstract

The present study was aimed to record the flora of Khanpur Dam, Khyber Pakhtunkhwa, Pakistan. For this purpose, the whole area was surveyed during 2009 to 2010 for the collection of plant specimens. A total of 221 plant species of 169 genera and 66 families were recorded from the study area, including two ferns, one gymnosperm, 39 monocots and 179 dicots. Poaceae was found as the most dominant family in the flora of the project area that contributed 33 species (14. 86%), followed by Asteraceae 26 spp. (11.71%), Fabaceae 13 spp. (5.86%), Amaranthaceae & Lamiaceae 9 spp. each (4.05% each), Euphorbiaceae & Solanaceae 8 spp. (3.60% each), Polygonaceae 7 spp. (3.15%) and Brassicaceae 6 spp. (2.70%), while rest of the families shared 1-5 species. It was observed that most of the taxa were perennials (49.32%) followed by annuals (47.51%) and biennial (3.17%). Herbs were dominating fraction in the floristic composition that contributed 57.47%, followed by shrubs (14.03%), grasses (10.86%) and trees (9.50%), whereas rest of 5 categories were in the range of 3.17-0.45%. Therophytes were the most abundant life form that constituted 42.53% of the total flora, followed by phanerophytes (27.15%), hemicryptophytes (18.55%), chamaephytes (7.24%) and cryptophytes (4.52%). Two species viz., *Alternanthera paronychioides* and *Boerhavia diandra* are reported for the first time from Khyber Pakhtunkhwa province.

Introduction

The study area, Khanpur Dam falls in dry deciduous forests where the most common plant species are *Acacia modesta, Cassia fistula, Ficus carica, Dodonaea viscosa* and *Zizyphus mauritiana.* The arid subtropical habitat of the region is characterized by rocky and hilly terrain of less than 1000 m elevation. The area provides a variety of habitats for mammalian species. Thick patches of thorny forest, network of nullahs, steep slopes, comparatively high rate of precipitation, unapproachable cliffs, agricultural fields having different crops, a zone between subtropical and temperate zone, thick under shrubs and a link between the plains in the south and the Himalayas in the North make it a suitable habitat for various mammalian species. From an ecological perspective, the greatest biodiversity of both plant and animal species usually occurs in the transition zone between major biomes. In Pakistan, the richest area both botanically and zoologically lies in a narrow belt along the Himalayan foothills characterized by having a subtropical climate, with annual rainfall fairly well distributed throughout the year, totaling about 40 inches (1,000 mm), and having a rich and varied plants and fauna with Indo-Malayan affinities, which provides an abundance of suitable food and shelter (Masroor, 2011).

Inventorying of floras by plant taxonomists is proverbial throughout the world to have information about the plants. A flora is a compilation of all plant species growing in any geographic area. Through these studies, valuable data is recorded which could be used as reference for future studies. Since the world is extremely variable, hence plants are not evenly distributed on the surface of the earth and each geographic zone has its own peculiar plant species quite different from plants of other such areas. Floristic surveys are helpful in proper identification of plant-wealth for their utilization on a scientific and systematic basis. The identification of local plants along with the description of an area is very important because it can show specific species of the local area and their occurrence, growing season, species hardness, distinct species, finding new species and the effect of climatic conditions like drought and over-grazing on vegetation (Ali, 2008).

Most of the floristic studies have been carried in Sindh province. Chaudhri & Chuttar (1966) have undertaken a preliminary floristic survey of Thar Desert, Sindh. They reported 122 species from the study area. Rajput *et al.* (1991) reported 40 plant species belonging to 23 families from Thar Desert, which are being used as medicinal plants for different ailments. A research project has been conducted by Bhatti *et al*., (1998-2001) for the floristic survey of the Nara desert, a Northeastern part of greater Thar Desert. They recorded 149 plant species belonging to 110 genera and 42 families. Subsequently, Qureshi (2004) brought into floristic knowledge and added much of floral element from the same area. A few papers have also been published by the author from Nara Desert (Qureshi, 2008; Qureshi & Bhatti, 2005; Qureshi, 2009). Likewise, the floristic composition of Gorakh hill (Khirthar range) has been reported by Perveen & Hussain (2007). They recorded 74 species belonging to 62 genera and 34 families. Ansari *et al*., (1993) published a Floristic list of district Khairpur. Their work serves as a checklist. Some other workers who contributed in this regard are Ahmed *et al*., (1992), Chaudhary (1960 & 1969).

From Potohar range there are few studies previously reported (Ahmed, 1964; Bhopal & Chaudhri, 1977a & b; Stewart, 1952; 1961). However, these floras have missed very important taxa and even small pockets like the project area. Besides, there is a big gap in time period; therefore there is an immediate need of the hours to revise the flora of whole country.

The aim of this study was to provide floristic checklist and plant life of the study area. The present work reports the flora and life-forms of the plants which

will serve as baseline information to taxonomists, phytosociologist, range managers and policy makers for future research in the area under study.

Materials and Methods

The study area: Khanpur Dam is located on the Haro River near the town of Khanpur (Khyber Pakhtunkhwa), about 40 km from Islamabad. It forms Khanpur Lake, a reservoir which supplies drinking water to Islamabad and Rawalpindi and irrigation water to many of the agricultural and industrial areas surrounding the cities. It is 167 feet (51 m) high and has a water storing capacity of 110,000 acre feet (Anon., 2012).

Sampling site selection: Stratified sampling technique was used for the selection of sampling sites by dividing the whole project area into two zones i.e., North and South zones based on aspect. From each zone, six sites were selected randomly from which four 50 m^2 quadrats for the collection of plant specimens.

Floristic enumeration: The whole area was thoroughly surveyed during August, 2009 to May, 2010 for the collection of plant specimens. The collected specimens were processed for pressing, drying and mounting on herbarium sheets. All specimens were identified with the help of Flora of Pakistan (Stewart, 1958; Nasir and Ali 1970-1989; Ali & Nasir 1989-1991; Ali & Qaiser, 1993-1995, 2000-2008). The determined specimens were matched in the National Herbarium, NARC Islamabad and deposited in the Herbarium of Pir Mehr Ali Shah Arid Agriculture University Rawalpindi for record. Habit of plants such as herbs, shrubs, subshrubs and trees were also determined. Life-form classes were determined following Raunkiaer (1934) and Abd el-ghani (2000).

Family importance value (FIV): All the plant species were grouped under families and calculated by dividing all the species their respective families in order to obtain FIV.

Diversity index (α, β and γ-diversity): Alpha (α), Beta (β) and Gamma (γ) diversity were measured that shows species richness irrespective to their relative abundance. Therefore α – diversity is simply the number of species in one habitat, the γ-diversity was calculated by adding the three α diversities (number of species in each habitat) but avoiding duplicate counting of species common to two or more habitats (Hawkesworth & Kalin-Arroyo, 1995; Smith & Smith, 1998; Al-Sheikh & Ghnaim, 2004; Jafari *et al*., 2004).

The similarity index (CC) between locality pairs was calculated by the formula:

$$CC = 2Ss / Sj+Sk \text{ (SØrensen, 1948)}$$

where, Ss is the number of species common to both the habitats, while Sj and Sk are the number of species in habitat 1 and habitat 2, respectively.

The β – diversity was calculated as $\beta = \gamma/\alpha$ or $BD = Sc / S$, in which Sc is the number of species in study area (combining α samples) and S is the mean number of species in α-samples (Whittaker, 1972). For comparing habitat pairs, Sc was taken as the total number of species in the two habitats excluding duplicate counting of shared or common species, while S was calculated irrespective to duplication.

Results and Discussion

The aim of the present study was to provide floristic inventory of the study area. For this purpose, the floristic survey was carried out during August, 2009 to May, 2010. The detailed enumerations are as follows:

Flora: So far, 221 plant species belonging to 169 genera and 66 families were identified from the study area. Out of them, two ferns, one gymnosperm, 39 monocots were also determined (Table 1). Two species viz., *Alternanthera paronychioides* and *Boerhavia diandra* reported for the first time from Khyber Pakhtunkhwa province.

Zonal aspect

South zone: This zone was more diversified than North zone giving 205 plant species (Table 1). Eighty nine species were shared by both the zones; while 115 species were found as narrowly distributed in this zone.

North zone: This zone possessed 106 plant species including 16 species only associated with this zone (Table 1). Besides, this zone was found having sparse vegetation as compared with south zone.

Family importance index: Poaceae was found the most dominant family in the flora of the project area that contributed 33 species (14. 86%), followed by Asteraceae (26 spp., 11.71%), Fabaceae (13 spp., 5.86%), Amaranthaceae and Lamiaceae (9 spp., 4.05% each), Euphorbiaceae and Solanaceae (8 spp., 3.60% each), Polygonaceae (7 spp., 3.15%) and Brassicaceae (6 spp., 2.70%), while rest of the families had 1-5 species.

Life-span & habit: Most of the recorded taxa were perennial natured (49.32%) followed by annuals (47.51%) and biennial (3.17%). There was dominancy of herbs that shared 57.47% in the flora, followed by shrubs (17.12%), grasses (15.32%) and subshrubs as well as trees (7.66% each), whereas rest of 4 categories of habit were in the range of 3.15-0.49%.

Life form classification: Therophytes were the most abundant life form that constituted 42.53% of the total flora, followed by phanerophytes (27.15%), hemicryptophytes (18.55%), chamaephytes (7.24%) and cryptophytes (4.52%).

Diversity index & species richness: With reference to species richness, the composite of both the zones (γ-diversity) represented 221 species distributed in169 genera and 66 families. The comparison of zonal pairs sharing with common species and Similarity Index is given in Table 2. Amongst pairs, south zone had highest value of Similarity Index (0.169) with high Beta diversity (0.56) and likewise, north zone possessed low Similarity Index and β–Diversity.

Table 1. List of plant species along with families, habit, and life form associated with north and south aspects.

S. No.	Plant species	Family	Habit	Life span	Life form	North	South
1.	*Abutilon bidentatum* Hochst. ex Rich.	Malvaceae	Shrub	Perennial	Phanerophyte	0	1
2.	*Acacia modesta* Wall.	Mimosaceae	Tree	Perennial	Phanerophyte	1	1
3.	*Achyranthes aspera* L.	Amaranthaceae	Herb	Annual	Chamaephyte	1	1
4.	*Achyranthes bidentata* Blume	Amaranthaceae	Herb	Biennial	Hemicryptophyte	1	1
5.	*Adhatoda zeylanica* Medic.	Acanthaceae	Shrub	Perennial	Phanerophyte	1	1
6.	*Adiantum capillus-veneris* L.	Adiantaceae	Herb	Perennial	Chamaephyte	1	1
7.	*Aerva javanica* (Burm. F.) Juss.	Amaranthaceae	Subshrub	Perennial	Phanerophyte	1	0
8.	*Ailanthus altissima* (Mill.) Swingle	Simarubaceae	Tree	Perennial	Phanerophyte	0	1
9.	*Ajuga bracteosa* Wall. ex Bth.	Lamiaceae	Herb	Annual	Therophyte	1	1
10.	*Ajuga parviflora* Bth.	Lamiaceae	Herb	Annual	Therophyte	0	1
11.	*Alternanthera paronychioides* St. Hil.	Amaranthaceae	Herb	Perennial	Chamaephyte	1	1
12.	*Alternanthera pungens* Kunth.	Amaranthaceae	Herb	Annual	Chamaephyte	1	1
13.	*Amaranthus graecizense* L.	Amaranthaceae	Herb	Annual	Therophyte	1	1
14.	*Amaranthus spinosus* L.	Amaranthaceae	Herb	Annual	Therophyte	0	1
15.	*Amaranthus viridis* L.	Amaranthaceae	Herb	Annual	Therophyte	1	1
16.	*Anagallis arvensis* L.	Primulaceae	Herb	Annual	Therophyte	1	1
17.	*Arabis himalaica* (Edgew.) O.E. Schulz	Brassicaceae	Herb	Annual	Therophyte	0	1
18.	*Argyrolobium roseum* (Camb.) Jaub. & Spach	Fabaceae	Herb	Perennial	Hemicryptophyte	1	1
19.	*Aristida cyanatha* Nees ex Steud.	Poaceae	Grass	Perennial	Hemicryptophyte	1	1
20.	*Artimesia scoparia* Waldst. & Kit.	Asteraceae	Herb	Annual	Therophyte	0	1
21.	*Arundo donax* L.	Poaceae	Shrub	Perennial	Hemicryptophyte	1	1
22.	*Asparagus gracilis* Royle	Asparagaceae	Shrub	Perennial	Chamaephyte	1	1
23.	*Asphodelus tenuifolius* Cavan.	Asphodelaceae	Herb	Annual	Chamaephyte	0	1
24.	*Avena fatua* L.	Poaceae	Herb	Annual	Therophyte	0	1
25.	*Bacopa monnieri* (L.) Pennell	Scrophulariaceae	Herb	Perennial	Chamaephyte	1	1
26.	*Barleria acanthoides* Vahl	Acanthaceae	Subshrub	Perennial	Chamaephyte	0	1
27.	*Barleria cristata* L.	Acanthaceae	Herbs	Perennial	Chamaephyte	0	1
28.	*Bauhinia variegata* L.	Caesalpiniaceae	Tree	Perennial	Phanerophyte	0	1
29.	*Berberis lycium* Royle.	Berberidaceae	Shrub	Perennial	Phanerophyte	0	1
30.	*Boerhavia diandra* L.	Nyctaginaceae	Herb	Perennial	Cryptophyte	1	1
31.	*Boerhavia procumbens* Banks ex Roxb.	Nyctaginaceae	Herb	Perennial	Cryptophyte	1	1
32.	*Brachiaria ramosa* (L.) Stapf	Poaceae	Grass	Annual	Therophyte	1	1
33.	*Brachiaria reptans* (L.) Gard. & C.E. Hubb.	Poaceae	Grass	Annual	Therophyte	1	1
34.	*Calendula arvensis* L.	Asteraceae	Herb	Annual	Therophyte	0	1
35.	*Calotropis procera* (Willd.) R. Br.	Asclepiadaceae	Shrub	Perennial	Phanerophyte	1	1
36.	*Cannabis sativa* L.	Cannabinaceae	Herb	Annual	Therophyte	1	1
37.	*Capsella bursa-pastoris* (L.) Medik	Brassicaceae	Herb	Annual	Therophyte	0	1
38.	*Cardiospermum halicacabum* L.	Sapindaceae	Climber	Perennial	Phanerophyte	0	1
39.	*Carissa opaca* Stapf ex. Haines	Apocynaceae	Shrub	Perennial	Phanerophyte	1	1
40.	*Carthamus oxyacantha* M. Bieb.	Asteraceae	Herb	Annual	Therophyte	1	1
41.	*Cenchrus ciliaris* L.	Poaceae	Grass	Perennial	Hemicryptophyte	0	1
42.	*Cenchrus pennisetiformis* Hochst. & Steud.	Poaceae	Grass	Perennial	Hemicryptophyte	1	1
43.	*Centaurea iberica* Trev. Ex Spreng.	Asteraceae	Herb	Biennial	Hemicryptophyte	0	1
44.	*Chenopodium album* L.	Chenopodiaceae	Herb	Annual	Therophyte	1	1
45.	*Chenopodium ambrosioides* L.	Chenopodiaceae	Subshrub	Biennial	Hemicryptophyte	1	1
46.	*Chloris barbata* Sw.	Poaceae	Grass	Annual	Hemicryptophyte	1	1
47.	*Chrozophora tinctoria* (L.) Juss.	Euphorbiaceae	Herb	Annual	Therophyte	1	0
48.	*Chrysopogon aucheri* (Boiss.) Stapf	Poaceae	Grass	Perennial	Hemicryptophyte	1	1
49.	*Cirsium arvense* (L.) Scop.	Asteraceae	Herb	Annual	Therophyte	0	1
50.	*Clematis montana* Buch.	Ranunculaceae	Climber	Perennial	Phanerophyte	0	1
51.	*Clematis nepalensis* Royle	Ranunculaceae	Climber	Perennial	Phanerophyte	0	1
52.	*Cleome viscosa* L.	Capparaceae	Herb	Annual	Therophyte	0	1
53.	*Cocculus pendulus* (J.R. & G. Forst.) Diels	Menispermaceae	Vine	Perennial	Phanerophyte	1	0
54.	*Colchicum aitchisonii* (Hook. f.) E. Nasir	Liliaceae	Herb	Annual	Therophyte	1	0
55.	*Colebrookia oppositifolia* Sm.	Lamiaceae	Shrub	Perennial	Phanerophyte	0	1
56.	*Convolvulus arvensis* L.	Convolvulaceae	Climber	Perennial	Hemicryptophyte	0	1
57.	*Conyza aegyptica* Ait.	Asteraceae	Herb	Annual	Therophyte	0	1
58.	*Conyza bonariensis* L.	Asteraceae	Herb	Annual	Therophyte	0	1
59.	*Conyza canadensis* L.	Asteraceae	Herb	Annual	Therophyte	1	1
60.	*Corchorus tridens* L.	Tiliaceae	Herb	Annual	Therophyte	0	1
61.	*Coronopus didymus* (L.) Sm.	Brassicaceae	Herb	Annual	Therophyte	1	1
62.	*Crotolaria medicaginea* Lam.	Fabaceae	Herb	Perennial	Hemicryptophyte	0	1
63.	*Cucumis melo* var. *agrestis* Naud.	Cucurbitaceae	Herb	Annual	Cryptophyte	1	1
64.	*Cuscuta reflexa* Roxb.	Cuscutaceae	Parasite	Annual	Therophyte	0	1
65.	*Cynodon dactylon* (L.) Pers.	Poaceae	Grass	Perennial	Hemicryptophyte	0	1
66.	*Cynoglossum lanceolatum* Forssk.	Boraginaceae	Herb	Annual	Therophyte	1	1
67.	*Cyperus laevigatus* L.	Cyperaceae	Sedge	Perennial	Hemicryptophyte	0	1
68.	*Cyperus rotundus* L.	Cyperaceae	Sedge	Perennial	Hemicryptophyte	1	0
69.	*D. foveolatum* (Delile) Roberty	Poaceae	Grass	Perennial	Hemicryptophyte	1	1
70.	*Dactyloctenium aegyptium* L.	Poaceae	Grass	Annual	Hemicryptophyte	1	1
71.	*Datura innoxia* Mill.	Solanaceae	Shrub	Perennial	Chamaephyte	1	1
72.	*Debregeasia salicifolia* (D. Don) Rendle	Urticaceae	Shrub	Perennial	Phanerophyte	0	1
73.	*Desmostachya bipinnata* (L.) Stapf	Poaceae	Grass	Perennial	Hemicryptophyte	0	1
74.	*Dichanthium annulatum* (Forssk.) Stapf	Poaceae	Grass	Perennial	Hemicryptophyte	1	1
75.	*Dicliptera roxburghiana* Nees	Acanthaceae	Herb	Annual	Cryptophyte	1	1

Table 1. (Cont'd.).

S. No.	Plant species	Family	Habit	Life span	Life form	North	South
76.	*Digera muricata* (L.) Mart.	Amaranthaceae	Herb	Annual	Therophyte	0	1
77.	*Digitaria sanguinalis* (L.) Scop.	Poaceae	Grass	Annual	Hemicryptophyte	1	1
78.	*Dodonaea viscosa* (L.) Jacq.	Sapindaceae	Shrub	Perennial	Phanerophyte	1	0
79.	*Echinochloa colona* (L.) Link	Poaceae	Grass	Annual	Therophyte	1	1
80.	*Echinochloa crus-galli* (L.) P. Beauv.	Poaceae	Grass	Annual	Therophyte	0	1
81.	*Echinops echinatus* Roxb.	Asteraceae	Herb	Annual	Therophyte	0	1
82.	*Eclipta prostrata* (L.) L.	Asteraceae	Herb	annual	Therophyte	1	1
83.	*Ehretia obtusifolia* Hochst ex DC.	Boraginaceae	Shrub	Perennial	Phanerophyte	1	1
84.	*Equisetum ramosissimum* (Desf.)	Equisetaceae	Herb	Perennial	Hemicryptophyte	1	1
85.	*Eragrostis aterovirens* (Desf.) Trin. ex Nees	Poaceae	Herb	Annual	Therophyte	0	1
86.	*Eragrostis cilianensis* (All.) Vig.	Poaceae	Herb	Annual	Therophyte	0	1
87.	*Eragrostis minor* Host.	Poaceae	Herb	Annual	Therophyte	1	0
88.	*Euphorbia granulata* Forssk.	Euphorbiaceae	Herb	Perennial	Therophyte	0	1
89.	*Euphorbia helioscopia* Mewski.	Euphorbiaceae	Herb	Annual	Therophyte	0	1
90.	*Euphorbia hirta* L.	Euphorbiaceae	Herb	Annual	Therophyte	0	1
91.	*Euphorbia indica* Lam.	Euphorbiaceae	Herb	Annual	Therophyte	0	1
92.	*Euphorbia prostrata* (L.) Ait	Euphorbiaceae	Herb	Perennial	Cryptophyte	0	1
93.	*Euphrasia himalayica* Wettst.	Scrophulariaceae	Herb	Annual	Therophyte	1	1
94.	*Ficus carica* L.	Moraceae	Tree	Perennial	Phanerophyte	0	1
95.	*Ficus palmata* Forssk.	Moraceae	Tree	Perennial	Phanerophyte	1	1
96.	*Ficus roxburghii* Wall. ex Brand.	Moraceae	Tree	Perennial	Phanerophyte	0	1
97.	*Flacourtia* indica (Burm. f.) Merrill	Flacourtiaceae	Tree	Perennial	Phanerophyte	0	1
98.	*Fumaria indica* (Hausskn.) H.N. Pugsley	Fumariaceae	Herb	Annual	Therophyte	0	1
99.	*Gallium aparine* L.	Rubiaceae	Herb	Annual	Therophyte	0	1
100.	*Grewia optiva* Drum. ex Burret.	Tiliaceae	Tree	Perennial	Phanerophyte	0	1
101.	*Grewia tenax* (Forssk.) Aschers & Schweinf.	Tiliaceae	Tree	Perennial	Phanerophyte	1	1
102.	*Gynandropsis gynandra* (L.) Briq.	Capparaceae	Herb	Annual	Therophyte	1	1
103.	*Hedera nepalensis* K. Koch	Araliaceae	Climber	Perennial	Hemicryptophyte	0	1
104.	*Heliotropium crispum* Stocks	Boraginaceae	Herb	Perennial	Cryptophyte	0	1
105.	*Heliotropium strigosum* Willd.	Boraginaceae	Herb	Annual	Therophyte	1	0
106.	*Heteropogon contortus* (L.) P. Beauv.	Poaceae	Grass	Perennial	Hemicryptophyte	1	0
107.	*Imperata cylindrica* (L.) Raeuschel	Poaceae	Grass	Perennial	Hemicryptophyte	1	1
108.	*Indigofera linifolia* (L. f.) Retz.	Fabaceae	Herb	Annual	Therophyte	1	1
109.	*Indigofera sessiliflora* DC.	Fabaceae	Herb	Annual	Therophyte	0	1
110.	*Ipomoea carnea* Jacq.	Convolvulaceae	Shrub	Perennial	Phanerophyte	0	1
111.	*Kickxia ramosissima* (Wall.) Janchen	Scrophulariaceae	Herb	Annual	Therophyte	1	1
112.	*Lactuca auriculata* (Wall. ex Dc.)	Asteraceae	Herb	Annual	Therophyte	1	1
113.	*Lactuca dissecta* D. Don.	Asteraceae	Herb	Annual	Therophyte	0	1
114.	*Lactuca serriola* L.	Asteraceae	Herb	Annual	Therophyte	0	1
115.	*Lantana camara* L.	Verbenaceae	Shrub	Perennial	Phanerophyte	0	1
116.	*Lantana indica* Roxb.	Verbenaceae	Shrub	Perennial	Phanerophyte	0	1
117.	*Lathyrus aphaca* L.	Fabaceae	Herb	Annual	Therophyte	0	1
118.	*Launaea procumbens* (Roxb.) Ram. & Rajgo.	Asteraceae	Herb	Annual	Chamaephyte	1	1
119.	*Lepidium sativum* L.	Brassicaceae	Herb	Annual	Therophyte	0	1
120.	*Leucas cephalotes* Spreng.	Lamiaceae	Herb	Annual	Therophyte	1	0
121.	*Lotus corniculatus* (Wald. & Kit. ex Willd.) Briq. & Rech. f.	Fabaceae	Herb	Perennial	Hemicryptophyte	0	1
122.	*Mallotus philipensis* (Lam.) Muell.	Euphorbiaceae	Tree	Perennial	Phanerophyte	0	1
123.	*Malva neglecta* Waller.	Malvaceae	Herb	Annual	Therophyte	0	1
124.	*Malvastrum coromendelianum* L.	Malvaceae	Herb	Perennial	Cryptophyte	1	1
125.	*Martynia annua* L.	Martyniaceae	Herb	Annual	Therophyte	0	1
126.	*Maytenus royleanus* (Wall. ex Lawson) Cufodontis	Celastraceae	Shrub	Perennial	Phanerophyte	1	1
127.	*Mazus pumilus* (Burm. f.) van Steenis	Scrophulariaceae	Herb	Annual	Therophyte	0	1
128.	*Medicago polymorpha* L.	Fabaceae	Herb	Annual	Therophyte	0	1
129.	*Melia azedarach* L.	Meliaceae	Tree	Perennial	Phanerophyte	0	1
130.	*Melilotus indica* (L.) All.	Fabaceae	Herb	Annual	Therophyte	0	1
131.	*Mentha longifolia* (L.) Huds.	Lamiaceae	Herb	Perennial	Hemicryptophyte	1	1
132.	*Micromeria biflora* (Ham.) Bth.	Lamiaceae	Herb	Perennial	Hemicryptophyte	0	1
133.	*Morus alba* L.	Moraceae	Tree	Perennial	Phanerophyte	0	1
134.	*Morus nigra* L.	Moraceae	Tree	Perennial	Phanerophyte	0	1
135.	*Myrsine africana* L.	Myrsinaceae	Shrub	Perennial	Phanerophyte	0	1
136.	*Nasturtium officinale* R. Br.	Brassicaceae	Herb	Biennial	Hemicryptophyte	1	1
137.	*Nerium oleander* L.	Apocynaceae	Shrub	Perennial	Phanerophyte	0	1
138.	*Olea europaea* L.	Oleaceae	Tree	Perennial	Phanerophyte	0	1
139.	*Olea ferruginea* Royle	Oleaceae	Tree	Perennial	Phanerophyte	1	1
140.	*Opuntia dillenii* Haw.	Cactaceae	Shrub	Perennial	Phanerophyte	0	1
141.	*Otostegia limbata* (Benth.) Boiss.	Lamiaceae	Shrub	Perennial	Phanerophyte	1	1
142.	*Oxalis corniculata* L.	Oxalidaceae	Herb	Perennial	Hemicryptophyte	1	1
143.	*Panicum antidotale* Retz.	Poaceae	Grass	Perennial	Hemicryptophyte	0	1
144.	*Parthenium hytserophorus* L.	Asteraceae	Herb	annual	Therophyte	1	1
145.	*Paspalidium flavidum* (Retz.) A. Camus	Poaceae	Grass	Perennial	Hemicryptophyte	1	0
146.	*Paspalum paspalodes* (Michx.) Scribner	Poaceae	Grass	Annual	Therophyte	1	0
147.	*Peganum harmala* L.	Zygophyllaceae	Herb	Annual	Therophyte	0	1
148.	*Periploca aphylla* Decne.	Asclepiadaceae	Shrub	Perennial	Phanerophyte	1	1
149.	*Persicaria barbata* (L.) Hara	Polygonaceae	Herb	Perennial	Cryptophyte	0	1
150.	*Phalaris minor* Retz.	Poaceae	Grass	Annual	Therophyte	0	1

Table 1. (Cont'd.).

S. No.	Plant species	Family	Habit	Life span	Life form	North	South
151.	*Phoenix sylvestris* Roxb.	Aricaceae	Tree	Perennial	Phanerophyte	1	
152.	*Phyla nodiflora* (L.) Greene	Verbenaceae	Herb	Biennial	Phanerophyte	1	1
153.	*Physalis minima* L.	Solanaceae	Herb	Annual	Therophyte	0	1
154.	*Pinus roxburghii* Sargent	Pinaceae	Tree	Perennial	Phanerophyte	0	1
155.	*Plantago lanceolata* L.	Plantginaceae	Herb	Annual	Therophyte	0	1
156.	*Plantago ovata* Frossk.	Plantginaceae	Herb	Annual	Therophyte	0	1
157.	*Poa annua* L.	Poaceae	Herb	Annual	Therophyte	0	1
158.	*Polygala irregularis* Boiss.	Polygalaceae	Herb	Annual	Therophyte	1	
159.	*Bistorta affine* (D. Don) Green	Polygonaceae	Herb	Annual	Hemicryptophyte	1	1
160.	*Polygonum effusum* Meirsn.	Polygonaceae	Herb	Annual	Hemicryptophyte	1	0
161.	*Polypogon fugax* Nees ex Steud.	Poaceae	Herb	Annual	Therophyte	1	1
162.	*Polypogon monspeliensis* (L.) Desf.	Poaceae	Herb	Annual	Therophyte	1	1
163.	*Populus deltoides* Bartram ex Marsh.	Salicaceae	Tree	Perennial	Phanerophyte	0	1
164.	*Portulaca oleracea* L.	Portulacaceae	Herb	Annual	Therophyte	1	1
165.	*Punica granatum* L.	Punicaceae	Shrub	Perennial	Phanerophyte	1	1
166.	*Quercus incana* Roxb.	Fagaceae	Tree	Perennial	Phanerophyte	0	1
167.	*Rananculus scleratus* L.	Rananculaceae	Herb	Annual	Therophyte	0	1
168.	*Rhynchosia minima* (L.) DC.	Fabaceae	Herb	Perennial	Hemicryptophyte	0	1
169.	*Rhynchosia pseudo-cajan* Camb.	Fabaceae	Herb	Perennial	Hemicryptophyte	1	1
170.	*Ricinis communis* L.	Euphorbiaceae	Shrub	Perennial	Phanerophyte	1	1
171.	*Rubia cordifolia* L.	Rubiaceae	Climber	Perennial	Therophyte	0	1
172.	*Rubus ellipticus* Smith	Rubiaceae	shrub	Perennial	Phanerophyte	0	1
173.	*Rumex dentatus* L.	Polygonaceae	Herb	Perennial	Chamaephyte	1	1
174.	*Rumex hastatus* D. Don	Polygonaceae	Subshrub	Perennial	Phanerophyte	0	1
175.	*Rumex nepalensis* Spreng	Polygonaceae	Herb	Perennial	Chamaephyte	1	1
176.	*Saccharum ravennae* (L.) Murray	Poaceae	Grass	Perennial	Hemicryptophyte	1	0
177.	*Saccharum spontaneum* L.	Poaceae	Grass	Perennial	Hemicryptophyte	0	1
178.	*Sageretia theezans* (L.) Brongn.	Rhamnaceae	Shrub	Perennial	Phanerophyte	0	1
179.	*Salvia moorcroftiana* Wall. ex Bth.	Lamiaceae	Herb	Annual	Cryptophyte	1	1
180.	*Salvia santolinifolia* Boiss.	Lamiaceae	Herb	Perennial	Chamaephyte	1	1
181.	*Saussurea albescens* (DC.) Schr. Bip.	Asteraceae	Herb	Annual	Therophyte	0	1
182.	*Saussurea atkinsonii* Clarke	Asteraceae	Herb	Annual	Therophyte	0	1
183.	*Saussurea heteromalla* DC.	Asteraceae	Herb	Annual	Therophyte	1	1
184.	*Setaria glauca* (L.) P. Beauv	Poaceae	Grass	Annual	Therophyte	0	1
185.	*Sida cordata* (Burm. f.) Borss.-Waalkes	Malvaceae	Herb	Biennial	Hemicryptophyte	1	1
186.	*Silene conoidea* L.	Caryophyllaceae	Herb	Annual	Therophyte	0	1
187.	*Silybum marianum* (L.) Gaerten	Asteraceae	Herb	Annual	Therophyte	0	1
188.	*Sisymbrium irio* L.	Brassicaceae	Herb	Annual	Therophyte	0	1
189.	*Solanum incanum* L.	Solanaceae	Shrub	Perennial	Phanerophyte	1	0
190.	*Solanum nigrum* L.	Solanaceae	Herb	annual	Therophyte	0	1
191.	*Solanum surattense* Burm.f.	Solanaceae	Herb	Perennial	Phanerophyte	1	1
192.	*Solanum villosum* (L.) Moench	Solanaceae	Herb	Annual	Therophyte	0	1
193.	*Sonchus arvensis* f. brachyotus (DC.) Kirp.	Asteraceae	Herb	Annual	Therophyte	1	1
194.	*Sonchus asper* (L.) Hill.	Asteraceae	Herb	Annual	Therophyte	0	1
195.	*Sonchus oleraceus* L.	Asteraceae	Herb	Annual	Therophyte	0	1
196.	*Sorghum halepense* (L.) Bern.	Poaceae	Herb	Perennial	Therophyte	1	1
197.	*Spergula arvensis* L.	Caryophyllaceae	Herb	Annual	Therophyte	1	1
198.	*Stellaria media* (L.) Cyr.	Caryophyllaceae	Herb	Annual	Therophyte	1	1
199.	*Tagetes minuta* L.	Asteraceae	Herb	Annual	Therophyte	1	1
200.	*Taraxacum officinale* Weber.	Asteraceae	Herb	Perennial	Chamaephyte	0	1
201.	*Taraxcum wallichii* DC.	Asteraceae	Herb	Perennial	Chamaephyte	0	1
202.	*Tecomella undulata* (Sm.) Seem	Bignoniaceae	Tree	Perennial	Phanerophyte	0	1
203.	*Themeda anathera* (Nees) Hack.	Poaceae	Herb	Perennial	Hemicryptophyte	1	1
204.	*Trianthema portulacastrum* L.	Aizoaceae	Herb	Annual	Therophyte	0	1
205.	*Tribulus terrestris* L.	Zygophyllaceae	Herb	Annual	Therophyte	0	1
206.	*Trichodesma indicum* (L.) R. Br.	Boraginaceae	Herb	annual	Hemicryptophyte	1	1
207.	*Trifolium repens* L.	Fabaceae	Herb	Perennial	Hemicryptophyte	0	1
208.	*Urtica pilulifera* L.	Urticaceae	Subshrub	Annual	Therophyte	0	1
209.	*Valeriana wallichii* DC.	Valerianaceae	Herb	Annual	Therophyte	1	0
210.	*Verbascum thapsus* L.	Scrophulariaceae	Herb	Biennial	Therophyte	1	1
211.	*Verbena officinalis* L.	Verbenaceae	Herb	Annual	Cryptophyte	1	1
212.	*Vicia monantha* Retz.	Fabaceae	Climber	Annual	Therophyte	1	1
213.	*Vitex negundo* L.	Verbenaceae	Shrub	Perennial	Phanerophyte	1	1
214.	*Withania coagulens* Dunal	Solanaceae	Subshrub	Perennial	Phanerophyte	0	1
215.	*Withania somnifera* (L.) Dunal	Solanaceae	Subshrub	Perennial	Phanerophyte	0	1
216.	*Woodfordia fruticosa* (L.) S. Kurz	Lathyraceae	Shrub	Perennial	Phanerophyte	0	1
217.	*Xanthium strumarium* L.	Asteraceae	Herb	Annual	Phanerophyte	1	1
218.	*Zanthoxylum alatum* Roxb.	Rutaceae	Shrub	Perennial	Phanerophyte	0	1
219.	*Zizyphus mauritiana* Mill.	Rhamnaceae	Tree	Perennial	Phanerophyte	0	1
220.	*Zizyphus nummularia* (Burm.f.) Wt.	Rhamnaceae	Shrub	Perennial	Phanerophyte	1	1
221.	*Zizyphus oxyphylla* Edgew.	Rhamnaceae	Shrub	Perennial	Phanerophyte	0	1
						106	**205**

Table 2. Similarity Index (SI) and β-diversity (BD) from two zones of Khanpur Dam.

BD		SI		
North zone	**South zone**	**North zone**	**South zone**	**Shared species**
0.15	0.56	0.10	0.74	89

Micro-habitats: Following microhabitats were determined based on physiognomic features and some indicator species were found associated with them. The detail is as follows:

Stony foothills community (SFC): This stony foothills community shares many species with the rocky slopes community such as *Dodonaea viscosa, Maytenus royleanus, Cocculus pendulus, Carissa opaca, Ehretia obtusifolia,* and *Olea ferruginea* (Fig. 1). Phytologically, this community lies between the upper slopes of mountain systems and the plains. It is the most abundant community type in the project area; however, it contains relatively small number of species. Though it occupies a range of geomorphological and geological units, most sites are relatively rocky and gravelly and are moderately steep and moderately high.

Rocky slopes sparse shrub lands (RSSS): This is low altitude community occurring relatively on gentle slopes on a range of geological substrates with typically clay and rocky soils. This microhabitat was found throughout the project area but particularly abundant in the southwest on slopping valley floor, in dry mountain regions and riverbeds. The common species of this habitat are *Dodonaea viscosa, Olea ferruginea, Maytenus royleanus, Carissa opaca, Acacia modesta* along with common grasses e.g., *Themeda anathera, Heteropogon contortus, Cenchrus ciliaris* and *Dichanthium annulatum* (Fig. 2).

Rocky reservoir bed grassland (RRBG): This is flat bed of the reservoir with rocky and gravelly soils. Most of the flora comprised of grasses viz., *Brachiaria reptans*, *Cynodon dactylon*, *Desmostachya bipinnata Dichanthium annulatum*, *Digitaria sanguinalis, Imperata cylindrica, Saccharum* spp. and a common sedge *Cyperus rotundus*, The other common herbs include *Conyza bonariensis*, *Digera muricata*, *Indigofera sessiliflora, Oxalis corniculata, Phyla nodiflora* and *Tribulus terrestris* (Fig. 3).

Significant findings: Two species viz., *Alternanthera paronychioides* (Fig. 4) and *Boerhavia diandra* (Fig. 5) reported which are rarely reported from Pakistan. The former species was recorded from the loamy ground near water bodies, whereas, the latter species was found growing on gravelly habitat (Bhamala stoopa). Furthermore, *Boerhavia diandra* is reported for the first time from KPK.

Discussion

The importance of the biodiversity of arid and semiarid lands is recently being increasingly recognized as these dry lands occupy more than 40 percent of Earth's land surface have to support more than one billion people (Hassan, 2003, Donaldson *et al.*, 2003). The natural flora and vegetation being the primary producers play the most pivotal role in every ecosystem by providing food and shelter to the natural fauna and livestock. In arid ecosystems, one of the most important ecological services of natural vegetation is the control or erosion. The process of desertification is known to be associated with decreasing species diversity and habitat degradation (Xueli & Halin 2003).

This study provides a floristic list of plant species found in and around Khanpur Dam (Table 1). Along the slopes, vegetation comprised of grasses and shrubs. Since, the area receives sufficient rains therefore much of the area was occupied by annuals and grasses (Fig. 1). This vegetation can utilize the transient water stored in the upper soil synchronic with precipitation. The upper dry layer of the surface deposits acts as a protective layer, moisture is stored in subsurface layers, and the underlying sandstone add to water storage capacity. As presented in the Results, the dominance of annual plant species is an evident of rainwater. Therophytes and phanerophytes were the most frequent, indicating a typical subtropical to tropical life-form spectrum in the study area. Therophytes constituted 43.41% of the floristic composition, followed by phanerophytes (Fig. 2). The dominance of both therophytes and phanaerophytes over other life forms reveals that it might be a response to the harsh climate and anthropogenic pressure on the flora. The other possible reason could be the availability of plentiful moisture in the form of rains. This type of study is already reported by Qureshi (2008, 2009, 2010) and in agreement with him.

The area confers a rich diversity of flora due to conservation of a large freshwater in the Dam embarked with rocky and hilly areas. Therefore, a rich floristic diversity is recorded from the whole area totaling 221 species during 2009 to 2010. This number may increase if regular monitoring be kept for next few years in different seasons. Among families, Poaceae have shown the highest diversity which is in conformity with the typical pattern of arid lands.

Both the terrestrial vegetation along the banks and macrophytes mostly formed the aquatic ecosystems. The terrestrial vegetation contributes more than 90% of organic matter input, while the aquatic floral composition affects littoral phytoplankton, zooplankton, invertebrate communities and fish communities (Smith & Smith, 1998; Nurminen, 2003).

Inventorying of flora is a starting point in conserving and sustainable use of biodiversity, while monitoring reveals in biodiversity change with the passage of time due to natural and anthropogenic causes (Stork *et al.,* 1995). Generally, monitoring of biodiversity is almost nonexistent in Pakistan (Khatoon & Ali, 2003, 2004). However, monitoring cannot be done without prior inventorying. Local inventories (α – diversity) ultimately help in understating and analyzing diversity at landscape (ß – diversity) and regional (γ– diversity) scales (Khatoon *et al.*, 2005).

Fig. 1. Stony foothills community (SFC).

Fig. 2. Rocky slopes sparse shrub lands (RSSS).

Fig. 3. Rocky reservoir bed grassland (RRBG).

Fig. 4. *Alternanthera paronychioides*.

Fig. 5. *Boerhavia diandra*.

The xeropsammophytes *Abutilon bidentum, Achyranthus aspera, Aerva javanica, Boerhavia repans, Capparis decidua, Cenchrus ciliaris, Cymbopogon jwarancusa, Fagonia indica*, *Heliotropium crispum, H. europaeum, Tamarix aphylla, Trichodesma indicum,* and *Zizyphus nummularia* were found in dry non saline sandy sites with higher fertile soils, where infiltration is higher and water accumulates in deeper layers. These species are also recorded from the Nara Desert, Pakistan (Qureshi, 2012; Qureshi & Bhatti, 2005).

Most of the flora was indigenous with few exceptions like *Parthenium hysterophorus*. This species is an exotic weed infesting a large area in the farm. This is well known weed and infested many countries (Williams & Grovers, 1980). Like other Asteraceous species, it has minute seeds armed with hairy attachment that facilitate its dispersal by wind. Therefore, it is spreading at an alarming pace in various parts of the country (Shah & Khan, 2006). Grassy weeds like *Avena fatua, Cynodon dactylon, Dactyloctenium aegyptium, Desmostachya bipinnata, Digitaria sanguinalis, Phalaris minor, Polypogon monspeliensis* along with sedge *Cyperus rotundus* were mostly infesting Rabi and Kharif crops in research farm along with annual herbs. In addition, *Anagalis arvensis, Asphodelus tenuifolius, Brachiaria reptans, Capsella bursa-pastoris, Chenopodium album, Carthamus oxyacantha, Cirsium arvense, Fumaria indica, Medicago polymorpha, Melilotus indica, Convolvulus arvensis, Alternanthera pungens, Malvestrum coromendelianum, Polygonum effusum, Stellaria media* and *Tribulus terrestris* were broad leaved weeds frequently found in the area. These are problematic weeds, which require continuous hoeing, and weeding to reduce the competition amongst the desired species.

No endemic species has been recorded from the study area; however *Alternanthera paronychioides* and *Boerhavia diandra* are recorded first time from Khyber Pakhtunkhwa Province. Besides, this area had never been explored before and this report provides baseline information about the flora of Khanpur Dam.

Conclusion

This paper reports the floral biodiversity of Khanpur Dam that will act as benchmark for the detailed study. Although present study tried to record flora of the whole area, yet it was a glimpse of the area. It is believed that there is ample opportunity that many plant species were left unrecorded hence need long-term comprehensive study to document flora and vegetation of the area in question. However, the present work will serve to students and researcher for the identification of plants of given area.

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