Eco-Floristic studies of native plants of the Beer Hills along the Indus River in the districts Haripur and Abbottabad, Pakistan

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Abstract

The present study was conducted to elaborate vegetation composition structure to analyze role of edaphic and topographic factors on plant species distribution and community formation during 2013–14. A mixture of quadrat and transect methods were used. The size of quadrat for trees shrubs and herbs were 10 × 5, 5 × 2, 1 × 1 meter square respectively. Different phytosociological attribute were measured at each station. Primary results reported 123 plant species belong to 46 families. Asteraceae and Lamiaceae were dominant families with 8 species each. PCORD version 5 were used for Cluster and Two Way Cluster Analyses that initiated 4 plant communities within elevation range of 529–700 m from sea level. Indicator species analyses (ISA) were used to identify indicator species of each community. CANOCO Software (version 4.5) was used to measure the influence of edaphic and topographic variables on species composition, diversity and community formation. Whereas Canonical Correspondence Analysis (CCA) was used to measure the effect of environmental variables which showed elevation and aspect were the stronger environmental variable among topographic and CaCO3 contents, electric conductivity, soil pH were the stronger edaphic factors in determination of vegetation and communities of the Bheer Hills. Grazing pressure was one of the main anthropogenic factors in this regard.

1. Introduction

The plant communities are a complex quantitative hierarchy in the vegetation science that always depends on species richness, distribution and associated ecological factors (Gaston, 2000; Maurer, 1999). These have previously been described floristically as well as physiognomically in number of ways. They have a demarcated structure in an area in relation to biotic and a biotic variation (Kent and Coker, 1992; Van Rooyen et al., 1981; Roberts and Wuest, 1999; Tainton et al., 1996; Cleaver et al., 2005; Brown and Bezuidenhout, 2005). Vegetation structure is usually influenced by environmental gradient and anthropogenic activates. In addition the edaphic and topographic factors also play a vital role in communities formation that ultimately leads to specific phytogeographic regions (Rohde, 1992). Ecological researches always tend to understand and quantify the relationship between biotic and a biotic components of an ecosystem (Tavili and Jafari, 2009). Various floristic analyses are used to identify the plant communities habitat types and important characteristic plant species (Katsuno, 1977; Fujiwara, 1987). In each sort of habitat each plant species has a microclimate and play its role in habitat formation (Duigan and Bredenkamp, 2003) and relations among populations (Scheiner, 1993). It is essential to measure and develop a suitable model to capture the natural features of

Abbreviations: ISA, Indicator Species Analysis; CCA, Canonical Correspondence Analysis; DBH, diameter at breast height; CA, Cluster Analysis; TWCA, Two Way Cluster Analysis; IVI, Importance Value Index; T, transect; S, station.

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an ecosystem for its sustainable use. Floristic analyses are the prerequisites for conservation of plant species. Therefore, current project was conducted to comprehend the role of such factor in the establishment of plant communities and its application in future conservation studies.

The Beer Hills along the Indus River have not been studied using recently developed analytical methods for vegetation characterization. The current study was therefore conducted to find out the floristic composition and vegetation structure of plant communities in the targeted region using modern tools. For this purpose plant species composition, abundance and the environmental variability, with special reference to gradient analyses were taken into consideration during 2012–2013.

2. Materials and methods

The Beer Hills are located at the bank of Indus River in two districts of Khyber Pakhtunkhwa province of Pakistan i.e., District Abbottabad and District Haripur at 34°10’ North latitude and 72°58’ East longitude with elevation 529–700 m at sea level. The temperature and precipitation equally distributed throughout the year with humid subtropical sort of climate. A total of seven transects were established at 3 km distance and within each transect five stations were recognized at 200 m interval randomly along with elevation gradient. In this a total of 34 stations with three hundred and six (306) quadrats were established using GPS (Global Positioning system) (Khan et al., 2013b). Quadrat and transect methods were used on hill slopes at all stations. Sizes of the quadrates for trees, shrubs and herbs were 10 × 5 m, 5 × 2 m and 1 × 1 m respectively (Salzer and Willoughby, 2004). Data attributes i.e., density, relative density, cover, relative cover, frequency, relative frequency and Importance Values Index (IVI) were measured at each station. The diameters of trees were measured at breast height (DBH) to find out its cover value for trees. The biological spectrum was determined using Raunkiaer Life form classification (Raunkiaer, 1934). The plant specimens were collected in each quadrat, labeled with tags, and pressed with plant presser in the field. Specimens were poisoned using 3% solution of Mercuric Chloride and Ethyl Alcohol solution and mounted on standard size herbarium sheets having a size of (17.5’ × 11.5’). All specimens were identified with the help of flora of Pakistan and other available literature (Khan et al., 2013a).

2.1. Soil analyses

The soil samples were collected up to 45 cm depth from each station through soil sampling tube. The samples were sieved to remove large particles. The soil physicochemical analyses i.e., Soil Texture, Calcium, Carbonate, Organic Matter concentration, Soil pH, Electrical Conductivity (E.C), Phosphorus and Potassium were measured in Agriculture research station Baffa Mansehra. The soil texture and pH were measured through hydrometer and pH meter respectively (Khan et al., 2012a,b; Koehler et al., 1984). While, soil organic matters were determined by standardized solution of FeSO₄ and K₂Cr₂O₇ (Nelson et al., 1996). Whereas CaCO₃ concentration were determined by acid neutralization method (Black et al., 1965). AB-DTPA extractable P and K was determined in samples through method described by Soltanpour (1991).

2.2. Data analyses

The data were statistically analyzed to find out the relationship between plant species composition and various ecological variables. For the data analysis we put the data of seven transect (34 stations and 306 quadrates) in MS EXCEL and prepared presence absence (1, 0) data sheet for CA (Cluster Analysis) and TWCA (Two Way Cluster Analysis). The plant species data were arranged horizontally and quadrates data were arranged vertically according to the software (PC-ORD version 5 software) requirement (Lepš and Šmilauer, 2003). The species and environmental data matrices were analyzed in CANOCO software version 4.5 to find the effect of environmental variables on species composition and distribution pattern.

3. Results

A research study was conducted in Beers Hills to find out plant species distribution pattern, composition and abundance in relation to environmental variables and edaphic factors.

3.1. Species composition of the Beer Hills

A total of 123 plant species were collected belong to 46 families distributed in 34 stations included 27 trees, 23 shrubs and 73 herbs species of all the vegetation. The topmost dominant families were Asteraceae and Lamiaceae having eight plant species, 13% of all species. The Amaryllidaceae, Moraceae and Poaceae have seven species each. While Malvaceae and Solanaceae with six species each respectively.

3.2. Raunkier life form

The plant species were classified through Raunkiaer (1934) classification into 5 various life form classes. The Phanerophytes was the most dominant class with 52 plant species (42%) followed by Therophytes with 37 species (30%), Hemikryptophytes with 24 species (20%), Cryptophytes with 7 species (6%) and Chamaephytes having 3 species (2%) respectively (Table 2).

3.3. Abundant and less abundant plant species of the Beer Hills

The abundant and less abundant plant species were found on the basis of Importance Values Index (IVI). The topmost abundant tree species of the study area was Mallotus philippensis, Acacia nilotica, Acacia modista, Ziziphus jujuba, Ficus benghalensis, Ficus carica, Broussonetia papyrifera, Pistacia integerrima, Dalbergia sissoo and Morus nigra with high IVI. While Punica granatum, Ailanthus altissima, Citrus aurantium, Pterospermum acerifolium, Eriobotrya japonica, Ceiba pentandra, Cassia fistula, Syzygium cumini, Juglans regia, and Ficus religiosa were recorded as less abundant trees with minimum IVI in the study area. In shrub layer the most dominant species were Dodonaea viscosa, Justicia adhatoda, Otostegia limbata, Berberis lyceum, Cotoneaster dammeri, Sageretia brendrethiana, Ziziphus nummularia, Marrubium supinum, Nerium oleander and Periplaca aphylla with IVI above than 800 in the region. The top ten rare shrub species were Lantana camara, Ipomoea carnea, Clerodendrum philippinum, Parthenocissus semicordata, Rubus fruticosus, Aerva javanica, Ricinus communis, Jasminum nudiflorum, Jasminum officinale and Calotropis procera having low Importance Values in the Beer Hills along with Indus River. In addition to, the Cynodon dactylon, Avena barbata, Medicago denticulata, Parthenium hysterophorus, Cannabis sativa, Euphorbia helioscopia, Euphorbia hirta, Nasturtium officinale, Malva neglecta, and Melica persica were the most abundant species in herbaceous layer of the region. The uppermost rare herbs recorded with minimum IVI were Datura alba, Brassica compestris, Alternanthera philoxeroides, Physalis angulata, Phragmites concreties, Achyrantes aspera, Dichipter roxburghiana, Cyphress routundes, Oxalis corniculata and Cypris niveus. Most of the rare species present in the area were palatable which faces great pressure of grazing.
Table 1
Data summary table of 123 plant species in relations with all he environmental variables.

| Axis                        | 1       | 2       | 3       | 4       | TI  |
|-----------------------------|---------|---------|---------|---------|-----|
| EV (eigen value)            | 0.363   | 0.165   | 0.105   | 0.096   | 2.216 |
| SEC (species-environment correlations) | 0.962   | 0.910   | 0.906   | 0.915   |     |
| CPVSP (cumulative percentage variance of species data) | 16.4    | 23.8    | 28.6    | 32.9    |     |
| SER (species-environment relation) | 33.0    | 47.9    | 57.5    | 66.2    |     |

SMC test

| EV (eigen value) | 0.363 | (Trace) | 1.102 |
| FR (F-ratio)     | 4.121 | FR (F-ratio) | 1.730 |
| PV (P-value)     | 0.0020 | PV (P-value) | 0.0020 |

3.4. Species area curve

Initially PC-ORD version 5 were used to draw species area curves and compositional area curves to recognize either the quadrates size was adequate or not through abundance data combined with Sorensen distance values (Ahmad et al., 2016a,b). It also comprehends the vegetation relation with environmental variables. It results that the transect number 25 show maximum number of plant species and appearing new species continuously up to station number 31 (Fig. 1).

3.5. Results of Cluster Analysis

The Cluster Analyses using PCORD version 5 clustered 34 stations (306 quadrats) into 4 plant communities or habitats (Fig. 2).

3.6. Two Way Cluster Analysis (TWCA)

The Two Way Cluster analysis showed distribution of plant species in sampling stations. It was constructed with the help of presence and absence (1, 0) data sheet by Sorensen measures. The black bubbles/dots represented the presence whereas white bubbles indicated the absence of plant species in the region. Four plant communities were recognized through grouping of various stations (Fig. 3).

3.7. Classification of plant communities

3.7.1. Ficus beghalensis-Nerium oleander-Euphorbia heterophylla community

The community name was given based on Indicator species analyses (ISA). This community was observed at elevation of 432–583 m. Ficus beghalensis, Nerium oleander and Euphorbia heterophylla were the characteristics species of tree, shrub and herb layer respectively. The other dominant species of tree layer with high IVI values included Mallotus philippensis, Broussonetia papyrifera, Ficus carica, Dalbergia sissoo and Mangifera indica. While the rare tree species were Parthenium hysterophorus, Olea ferruginea and Ficus carica. While, the rare tree species were Punica granatum, Broussonetia papyrifera, Melia azedarach, Morus nigra and Dalbergia sissoo. Regarding the shrub layer Dodonia viscosa, Justicia adhatoda, Orostegia limbata, Sageretia brennerthiana, Colebrookea opposifolia was the most dominant and Marrubium supinum, Gymnosporia royleane, Cotoneaster dammeri, Ricinus communis and Calotropis procera was the rare plant species in the region. The characteristic species of herbaceous layer was Cynodon dactylon, Solanum surattense, Parthenium hysterophorus, Medicago denticulatus, Avena barbata, Euphorbia hirta, Euphorbia helioscopia, Rumex dentatus, Delphinium bicolor, Amanthus viridis and the characteristic rare species of community was Mirabilis jalapa, Convolvulus arvensis, Solanum pseudocapsicum, Bidens pilosa, Conya canadensis, Ranunculus muricatus, Cichorium intybus, Achyranthes aspera, Phegopteris connectilis and Physalis angulata with minimum IVI.

Regarding the soil analyses of community electrical conductivity was 0.15–0.25 dsm⁻¹, Calcium carbonate was 5.2–7.2%, Potassium was 100–125 ppm and Phosphorus 5.6–8.4 ppm respectively.

3.7.2. Ficus carica - Justicia adhatoda - Parthinium hysterophorus community

This community was found between elevations of 557–640 m. The Ficus carica, Justicia adhatoda, and Parthinium hysterophorus were the dominant characteristic tree, shrub and herb. The other dominant species of the tree layer included Acacia nilotica, Acacia modesta, Ziziphus jujuba, Olea ferruginea and Ficus carica. While, the rare tree species were Punica granatum, Broussonetia papyrifera, Melia azedarach, Morus nigra and Dalbergia sissoo. Regarding the shrub layer Dodonia viscosa, Justicia adhatoda, Orostegia limbata, Sageretia brennerthiana, Colebrookea opposifolia was the most dominant and Marrubium supinum, Gymnosporia royleane, Cotoneaster dammeri, Ricinus communis and Calotropis procera was the rare plant species in the region. The characteristic species of herbaceous layer was Cynodon dactylon, Solanum surattense, Parthenium hysterophorus, Medicago denticulatus, Avena barbata, Euphorbia hirta, Euphorbia helioscopia, Rumex dentatus, Delphinium bicolor, Amanthus viridis and the characteristic rare species of community was Mirabilis jalapa, Convolvulus arvensis, Solanum pseudocapsicum, Bidens pilosa, Conya canadensis, Ranunculus muricatus, Cichorium intybus, Achyranthes aspera, Phegopteris connectilis and Physalis angulata with minimum IVI.

Regarding the soil analyses of community electrical conductivity was 0.15–0.25 dsm⁻¹, Calcium carbonate was 5.2–7.2%, Potassium was 100–125 ppm and Phosphorus 5.6–8.4 ppm respectively.

3.7.3. Melia azedarach - Dodonaea viscosa – Polygonum avicula community

This community was found at the elevation of 572–645 m. The recorded Characteristic species of tree layer was Mallotus philippensis, Pistacia integerrima, Acacia modesta, Ziziphus jujuba and Acacia nilotica. While rare trees were Olea ferruginea, Broussonetia papyrifera, Ficus racemosa, Morus alba and Melia azedarach with minimum IVI in the region. While, the dominant species of shrub vegetation in community included Dodonaea viscosa, Berberis lyceum, Orostegia limbata, Carissa opaca and Sageretia brendrethiana. In addition to,
Table 2
Plant species and Family names with Raunkiaer Life form classes.

| NO. | Botanical name of Plants | Family name | Life forms |
|-----|--------------------------|-------------|------------|
| 1   | Acacia m. (Wall.)        | Fabaceae    | Ph         |
| 2   | Acacia nilotica (L.) DeL. | Fabaceae    | Ph         |
| 3   | A. alhissimo (Mill) Swingle | Simaroubaceae | Ph         |
| 4   | Broussonetia papyrifera (L.) | Moraceae   | Ph         |
| 5   | Cassia fistula L.         | Fabaceae    | Ph         |
| 6   | C. pentandra (L.) Gaertn. | Malvaceae   | Ph         |
| 7   | Citrus aurantium L.       | Rutaceae    | Ph         |
| 8   | Dalbergia sissoo Roxb.ex.DC. | Fabaceae   | Ph         |
| 9   | Eriobotrya japonica (Thunb.) Lindl. | Rosaceae | Ph         |
| 10  | Eucalyptus camaldulensis Dehn. | Myrtaceae | Ph         |
| 11  | Ficus benghalensis L.     | Moraceae    | Ph         |
| 12  | Ficus carica L.           | Moraceae    | Ph         |
| 13  | Ficus racemosa L.         | Moraceae    | Ph         |
| 14  | Ficus religiosa L.        | Moraceae    | Ph         |
| 15  | Juglandus regia L.        | Juglandaceae | Ph         |
| 16  | Mallotus philippensis (Lam.) Muell. | Euphorbiaceae | Ph         |
| 17  | Mangifera indica L.       | Anacardiaceae | Ph         |
| 18  | M. azedarach L.           | Meliaceae   | Ph         |
| 19  | Morus alba L.             | Moraceae    | Ph         |
| 20  | Morus nigra L.            | Moraceae    | Ph         |
| 21  | Olea ferrugines Royle.    | Oleaceae    | Ph         |
| 22  | Papulus ciliata Wall.ex.Royle | Salicaceae | Ph         |
| 23  | Pistacia integerrima J.L.Stewart ex Brandis | Anacardiaceae | Ph         |
| 24  | Pterospermum acerifolium (L.) Wild. | Malvaceae | Ph         |
| 25  | Punica granatum L.        | Lythraceae  | Ph         |
| 26  | Syzygium cumini (L.) Skeels | Myrtaceae   | Ph         |
| 27  | Ziziphus jujuba Milli.  | Rhamnaceae  | Ph         |
| 28  | A. javanica (Burm.f.)shult | Amaranthaceae | Ch         |
| 29  | Berberis lyllum Royle.    | Berberidaceae | Ph         |
| 30  | Calotropis procer (L.)   | Asclepiadaceae | Ph         |
| 31  | Colebrookea oppositifola Sm | Labiatae  | Ph         |
| 32  | Clerodendrum Philippinum multiplex. | Verbenaceae | Ph         |
| 33  | Carissa opaca L.          | Apocynaceae | Ph         |
| 34  | Cotoneaster dammeri C.K.Schneid. | Rosaceae | Ph         |
| 35  | Dodonaea viscos (L.) Jacq. | Sapindaceae | Ph         |
| 36  | Gymnosporia royleana Wall. | Celastraceae | Ph         |
| 37  | Ipomoea carnea Jace.      | Convolvulaceae | Ph         |
| 38  | Jasminum nudiforum         | Myrtaceae   | Ph         |
| 39  | J. officinale L.           | Ochraceae   | Ph         |
| 40  | Justicia adhatoda L.      | Acanthaceae | Ph         |
| 41  | Lantana camara L.         | Verbenaceae | Ph         |
| 42  | Marrubium supranum L.      | Lamiaceae   | Ph         |
| 43  | Nerium oleander L.        | Apocynaceae | Ph         |
| 44  | Otostegia limbata (Benth) Boiss | Lamiaceae | Ph         |
| 45  | Parthenocissus s. Wall.   | Vitaceae    | Ph         |
| 46  | Periploca aphylla          | Euphorbiaceae | Ph         |
| 47  | Rhus fruticosus L.        | Rosaceae    | Ph         |
| 48  | Sagreeta brendrethiana J.Linn. | Rhamnaceae | Ph         |
| 49  | Woodfordia fruticosa (L.) Kurz | Lythraceae | Ph         |
| 50  | Ziziphus nummularia Burm.f. | Rhamnaceae | Ph         |
| 51  | A. asperal                      | Amaranthaceae | He         |
| 52  | A. spinosus L.             | Amaranthaceae | He         |
| 53  | A. viridis L.              | Acanthaceae | He         |
| 54  | Anthriscus sydstris L.     | Apiaceae    | Th         |
| 55  | Aragone mexicana L.        | Papaveraceae | Th         |
| 56  | Artemisia absinthium L.    | Asteraceae  | Th         |
| 57  | Arundo donax L.            | Poaceae     | Ph         |
| 58  | Avena barbata Pott ex Link | Poaceae     | Ph         |
| 59  | Barleria cristata L.       | Acanthaceae | He         |
| 60  | Bidens pilosa L.           | Asteraceae  | He         |
| 61  | Brassica campestris L.     | Brassicaceae | Th         |
| 62  | Cannabis sativa L.         | Cannabaceae | Th         |
| 63  | Celosia argentea L.        | Amaranthaceae | Th         |
| 64  | Chenopodium album L.       | Chenopodiaceae | Th         |
| 65  | Cichorium intybus L.       | Asteraceae  | Th         |
| 66  | Commelina communis L.      | Commelinaeae | Cr         |

Periploca aphylla, Gymnosporia royleana, Aerva javanica, Marrubium supranum, Polygonum aviculare and Colebrookea oppositifolia was the rare shrubs recorded with low IVI in the region. The characteristic herbaceous species are Avena barbata, Melica persica, Medecigo denculatus, Artemisia absinthium, Parthenium hysterophorus, Argemone Mexicana, Euphorbia hirta, Euphorbia helioscopia and Polygonum aviculare. The community has rare herb species with minimum IVI was Ajuga bracteosa, Malva neglecta, Arundo donax, Hybiscus caesius, Vaccaria pyramidalata, Urtica dioica, Ipomoea hederacea, Ipomoea purpurea, Physalis angulata and Solanum virginiun. The soil analyses resulted that the community has Electrical conductivity between 0.17 and 0.23 dsm⁻¹. Calcium carbonate
2.4 and 6.5%, Potassium 100 and 130 ppm and Phosphorus 7.3 and 8.2 ppm respectively.

3.7.4. Acacia nilotica - Berberis lycium - Echinochloa colona community

This community initiated at the elevation of 2485–2937 m. The dominant tree species were Acacia nilotica, Ziziphus jujuba, Mallotus philippensis with rare species Morus nigra, Ficus carica and Broussonetia papyrifera. The characteristic shrub species of the community were Indigofera heterantha and Plectranthus rugosus. While dominant species were Berberis lycium, Dodonaea viscosa, Periplaca aphylla, Justicia adhatoda, Ziziphus nummularia and rare species included Cotoneaster dammeri, Sageretia brendrethiana, Carissa opaca and Gymnosporia royleana. Among the characteristic herbaceous species Cynodon dactylon, Avena barbata, Euphorbia hirta, Medicago denculatus, Delphinium bicolor, Melica persica, Conyza bonariensis, Conyza Canadensis, Echinochloa colona and Solanum surattens. Whereas Argemone mexicana, Parthenium hysterophorous, Saliva coccinea, Chenopodium album, Leucas cephalota, Ajuga bracteosa, Barleria cristata, Sorghum vulgare, Oxalis corniculata, and Xanthium strumarium were recorded as rare herbs with minimum IVI in the region.

The soil analyses of this habitat show the electrical conductivity between 0.16 and 0.22 dsm⁻¹, Calcium carbonate 4 and 6.4%, Potassium 100 and 130 ppm and Phosphorus 6 and 9 pp, which play a significant key role in distribution of plant species of present community.

3.8. Environmental gradient

The Species and environmental data matrices were put together in CANOCO software version 4.5. All environmental variables as
Biotic factors (grazing pressure) and abiotic factors (edaphic and topographic) show significant effect on plant species composition, distribution pattern and abundance with p value \( (p < 0.002) \) (Table 1). In ordination of various plant species each cross in the figure represented a plant species and the distance between them show the similarity and differences index. All the plant species were compared with environmental gradient and soil data through CANOCO software. The treated environmental variables were altitude, aspect, grazing pressure, organic matter, phosphorous, potassium, pH, deep soil, silt and rocky soil. The CCA (bi-plot diagram) of first quadrant indicated most of the plants were assembled under the influence of CaCO\(_3\) and sandy nature of soil. While going through 3rd quadrant most of the environmental variables clustered around phosphorous, pH, organic matter concentration, potassium, high elevation range and clay nature of soil. Furthermore on the 4th quadrant most of the plants are assembled under the influence of electrical conductivity and grazing pressure (Fig. 4).

3.9. Ordination of different stations under the influence of environmental gradient

The CCA ordination bi-plot based on edaphic and topographic factors data presents the first quadrant was preliminary related with CoCO\(_3\) and sandy nature of soil (Fig. 5). The 3rd quadrants was mainly correlated with phosphorous, pH, organic matter concentration, potassium, high elevation range and clay nature of soil having T2S2, T3S2, T4S2, T5S, T5S4, T6S2 and T6S3 (T = transect, S = station). While the 4rt quadrant show aspect of electrical conductivity and grazing pressure that clustered T4S1, T5S1, T5S2, T6S1 and T7S1 respectively (Fig. 5).

3.10. Discussion

The current study revealed a total of 123 plant species of the Beer Hills along Indus River belong to 46 families. The 27 tree species (22%), 23 shrubs (19%) and 73 herbs (59%) were recorded. The study area revealed the herb species were in maximum number with greater cover, followed by trees and shrubs. Physiographic factors such as slope angle, different edaphic factors and altitudinal range effect the vegetation composition and distribution pattern. Furthermore, at higher altitude vegetation layer became decrease due to physical and biological factors that affect plant growth. The same results were reported by Haq et al. (2011) that showed...
the vegetation was rich at lower elevation as compared to higher elevation range. The flora of Beer Hills result Asteraceae, Lamiaceae, Moraceae, Amaranthaceae and Poaceae was the most dominant families of the region. Similarly Asteraceae and Lamiaceae were proved well established and largest families in flora of Pakistan by Ali and Qaiser (1995) and Stewart (1972). Plus in other adjacent locations Dar et al., 2012 reported one hundred and three families at Machaira national park Muzaffarabad. The dominant families of the investigated area were Balsaminaceae, Ranunculaceae and Asclepiadaceae. While Pant and Samant (2007) described plant biodiversity of the Western Himalaya. Similar to our results Perveen and Hussain (2007) work out on species density, cover and frequency of Gorakh hills and reported seventy-four plant species distributed in thirty-four families. Plants play a vital role in economy of a country. It was used as food, fruit, medicines, forage, timber wood, fire wood, etc. (Durrani, 2000; Malik, 2005; Shinwari et al., 1990). This research project also resulted various plant species i.e., Medicago denculatud, Malva neglecta were edible species, Mentha species, Justicia adhatoda and Acacia were medicinally use, Morus species, Melia azedarach were used as a timber and Dadonia vescosa were used as a fuel wood in the Beer Hills area. Flora of an area represents the particular species of an area which are qualitatively and quantitatively analyzed. Floristic structure of a region was very important to relate it with environmental gradient. It depends upon biotic and abiotic factors of an environment and can be affected by deforestation and over grazing particularly (Longhi et al., 1992). Similar were also reported in present work that grazing pressure effect on plant species distribution and composition. A total of 4 plant communities were identified through PCORD version 5 in study area. (Moinuddin et al., 2006; Ahmad et al., 2016a) studied the Phyto-sociological analysis of Himalayan forests of Pakistan, described twenty-four different communities and four monophonic specific forests vegetation as well as labeled the species composition and IVI values. While CANOCO Software version 4.5 was used to measure the influence of edaphic and topographic variables on species composition and diversity and community formation. Similar techniques were also applied by Khan et al. (2012b) for proper documentation of plant species. Whereas Borcard et al., 1992 performed Canonical Correspondence Analysis (CCA) by using a quantitative statistical approach to categorize among various variables. Brown and Bezuidenhout (2005) investigated National park (De mountain zebra National park, South Africa) and find out fourteen communities consuming TWINSPAN grouping. The soil pH ranges from 7.2 to 7.8; organic matter concentration from 0.52% to 0.85%, calcium carbonate amount is 2.38% to 7.2%, sand concentration was 28.6% to 58.6%, Phosphorous was 5.6 ppm to 9 ppm, potassium ranges 130 ppm to 90 ppm. Similarly (Khan et al., 2012a,b, 2014, 2016; Nazir et al., 2012; Shaheen et al., 2011; Iqbal et al., 2015; Ahmad et al., 2016a) also found out various plant communities in relation to environmental gradients. Furthermore, Noureen et al., 2008 investigated Cholistan desert, vegetation on the basis of environmental factors. Whereas, Yimer, 2007, defined that soil disturb the structure of the plant community and ground cover, amount of plant development, capability of natural regeneration and additional critical factors. In study area grazing pressure was observed higher at lower elevation range of the Beer Hills. It was also reported by Pennings and Silliman (2005) that grazing pressure was high at lower elevation. Whereas, Sakya and Bania (1998) describes, elevation play an important role in the community formation. Shank and Noorie (1950) find out that temperature and atmospheric pressure changed with increasing height other factors like soil pH, soil moisture, soil nutrients and biotic factors also take part in the formation of plant communities. Life forms of the plants were very important to describe the vegetation structure. The plant species collected in the study area were classified into five Raunkiaer classes. It was resulted that Phanerophytes was the dominant class followed by the Therophytes, Hemicryptophytes, Cryptophytes, and Chamaephytes respectively. A similar result was described by Malik and Malik (2004) in Kotli Hill Kashmir. Whereas Hadi et al. (2009) reported a phytosociological effort on weed flora in the vegetable fields of (Botanical Garden, Azakhel in summer season 2009) which consist of 30 weed species in different vegetables fields with dominant Therophytes life form class.

4. Conclusion

It was concluded that CaCO₃ contents, electrical conductivity, soil pH, organic matter concentration, phosphorous and silty nature of soil were the stronger edaphic factors. While, among topographic factor the elevation and aspect were the significant environmental variables that affect the distribution pattern, composition and diversity of plant species and communities of Beer Hills. Identification of indicator and rare plant species in the specific micro-habitat can further be used for conservation management purposes.

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Appendix A.

See Appendix A.
### Importance value index (IVI) of each plant species in the studied area.

| No. | Plant name               | T IVI 1 | T IVI 2 | T IVI 3 | T IVI 4 |
|-----|--------------------------|---------|---------|---------|---------|
| 1   | Ficus benjamina          | 279.9   | 173.8   | 286.9   | 68.8    |
| 2   | Malus sieboldii          | 263.2   | 123.3   | 151.8   | 62.2    |
| 3   | Broussonetia purpurea     | 288.2   | 96.6    | 69.5    | 61.4    |
| 4   | Ficus carica             | 181.5   | 67      | 60.2    | 62.3    |
| 5   | Dalbergia sisso          | 179.7   | 32.4    | 68.8    | 24.6    |
| 6   | Mangifera indica         | 165.3   | 32      | 57.4    | 14.3    |
| 7   | Ziziphus jujube          | 129     | 29      | 38.8    | 6.2     |
| 8   | Eucalyptus camaldulensis | 125     | 12      | 37.8    | 0       |
| 9   | Ficus carica             | 121.7   | 12      | 27.7    | 0       |
| 10  | Acacia modesta           | 121.4   | 9.9     | 6       | 0       |
| 11  | Morus nigra              | 119.9   | 9       | 4       | 0       |
| 12  | Ficus racemosa           | 115.3   | 0       | 3.8     | 0       |
| 13  | Populus ciliata          | 112.6   | 0       | 4.6     | 0       |
| 14  | Adhatoda sphaerocarpa    | 108.5   | 0       | 4.6     | 0       |
| 15  | Melia azedarach          | 95.4    | 0       | 4.6     | 0       |
| 16  | Alantlbus altissima      | 62.1    | 0       | 4.6     | 0       |
| 17  | Punica granatum          | 58.9    | 0       | 4.6     | 0       |
| 18  | Pterocarpus acerifolium  | 56.4    | 0       | 4.6     | 0       |
| 19  | Citrus aurantium         | 55      | 0       | 4.6     | 0       |
| 20  | Sageretia brendrethiana  | 34.1    | 0       | 4.6     | 0       |
| 21  | Marrubium supinum        | 30      | 0       | 4.6     | 0       |
| 22  | Ceiba pentandra          | 29.9    | 0       | 4.6     | 0       |
| 23  | Ipomoea cunoni           | 22.5    | 0       | 4.6     | 0       |
| 24  | Rumex crispus            | 17.3    | 0       | 4.6     | 0       |
| 25  | Ficus religiosa          | 15.4    | 0       | 4.6     | 0       |
| 26  | Olea europaea            | 14.8    | 0       | 4.6     | 0       |
| 27  | Justicia adhatoda        | 259.1   | 194.15  | 366.8   | 140.6   |
| 28  | Osagea digmata           | 198.7   | 190.55  | 366.8   | 133.9   |
| 29  | Nerium oleander          | 179     | 94.4    | 162.5   | 104.4   |
| 30  | Dodonaea viscosa         | 174.6   | 85.5    | 117.8   | 89.5    |
| 31  | Cotoneaster dammeri      | 167.7   | 29      | 93.3    | 48.1    |
| 32  | Morus alba               | 161     | 14.4    | 87      | 30.9    |
| 33  | Mouroumba supinum        | 112.9   | 13      | 72.2    | 26.2    |
| 34  | Ziziphus nummularia      | 86.9    | 12      | 70.5    | 25      |
| 35  | Woodfordia fruticosa     | 86.3    | 11.6    | 58.6    | 15      |
| 36  | Gymnospora royleana      | 79.3    | 1.4     | 57.1    | 13.7    |
| 37  | Lantana camara           | 76.05   | 1.03    | 28.4    | 0       |
| 38  | Ipomoea carnea           | 75.15   | 0       | 28      | 0       |
| 39  | Berberis lyrceum         | 75      | 0       | 17.3    | 0       |
| 40  | Clerodendrum Philippinum | 62.79   | 0       | 17.3    | 0       |
| 41  | Parthenocissus semicordata| 62    | 0       | 17.3    | 0       |
| 42  | Rubus fruticosus         | 53      | 0       | 17.3    | 0       |
| 43  | Carissa opaca            | 28.9    | 0       | 17.3    | 0       |
| 44  | Sageretia brendrethiana  | 23.9    | 0       | 17.3    | 0       |
| 45  | Jasminum nudiflorum      | 17      | 0       | 17.3    | 0       |
| 46  | Ricinus communis         | 16.1    | 0       | 17.3    | 0       |
| 47  | Parthenocissus semicordata| 14.1  | 0       | 17.3    | 0       |
| 48  | Calotropis procera       | 8.75    | 0       | 17.3    | 0       |
| 49  | Avena barbata            | 0       | 0       | 17.3    | 0       |
| 50  | Periplaca apheliana      | 0       | 0       | 17.3    | 0       |
| 51  | Cynodon dactylon         | 114.5   | 0       | 17.3    | 0       |
| 52  | Cannabis sativa          | 800     | 0       | 17.3    | 0       |
| 53  | Avena barbata            | 651     | 0       | 17.3    | 0       |
| 54  | Parthenium integratum    | 643     | 0       | 17.3    | 0       |
| 55  | Euphorbia helioscosa     | 640     | 0       | 17.3    | 0       |
| 56  | Medicago sativa          | 605     | 0       | 17.3    | 0       |
| 57  | Malva neglecta           | 574     | 0       | 17.3    | 0       |
| 58  | Euphorbia helioscopia    | 548     | 0       | 17.3    | 0       |
| 59  | Rumex crispus            | 434     | 0       | 17.3    | 0       |
| 60  | Mentha piperita          | 322     | 0       | 17.3    | 0       |
| 61  | Xanthium strumarium      | 316     | 0       | 17.3    | 0       |
| 62  | Sorghum vulgare          | 316     | 0       | 17.3    | 0       |
| 63  | Mentha longifolia        | 300     | 0       | 17.3    | 0       |
| 64  | Melia persica            | 263     | 0       | 17.3    | 0       |
| 65  | Celosia argentea         | 258     | 0       | 17.3    | 0       |
| 66  | Chenopodium album         | 102     | 0       | 17.3    | 0       |
| 67  | Xanthium strumarium      | 102     | 0       | 17.3    | 0       |
| 68  | Cyperus rotundus         | 43      | 0       | 17.3    | 0       |
| 69  | Cannabis sativa          | 32      | 0       | 17.3    | 0       |
| 70  | Argemone mexicana        | 30      | 0       | 17.3    | 0       |

**Notes:**
- Plant names are organized by their IVI values.
- The IVI values range from 0 to 286.9, with higher values indicating greater importance.
- Plant names are listed in alphabetical order.
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