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Ordination and classification of herbaceous vegetation in Margalla Hills National Park Islamabad Pakistan

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Abstract

The study was carried out on the growth, distribution, classification and correlation of herbaceous vegetation edaphic factors in Margalla Hills National Park, Islamabad. Sampling of vegetation and soil was performed using random sampling method. A total of 52 herbaceous plant species from 26 families were recorded in 30 quadrats. The study aimed to classify and identify plant species and to understand the soil factors playing role in community composition. TWINSPAN was used to identify distinct plant communities, which resulted in the recognition of four vegetation groups. *Malvastrum coromandelianum* and *Cicer arietinum* community was present along the agricultural crop fields, *Cynodon dactylon* and *Cerastium fontanum* community occupied the humid stands, *Micromeria biflora* and *Grewia tenax* community was present in a majority of areas. *Lepidium pinnatifidum* and *Coronopus didymus* community was grown along the road in the study area. DCA was used to determine the dominant communities in the study area. Understanding vegetation distribution in this area can help for management, reclamation, and development of Margalla Hills National park ecosystems.

Key words: *Margalla Hills, National park, TWINSPAN, DCA, Vegetation*

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Pakistan İslamabad Margalla Hills Milli Parkı'ndaki otsu vejetasyonun ordinasyonu ve sınıflandırılması

Özet

İslamabad Margalla Hills Milli Parkı otsu vejetasyonunun toprak faktörlerine göre gelişmesi, dağılışı, sınıflandırılması ve karşılaştırılması yapıldı. Vejetasyon ve toprak örneklemeleri rastgele örnekleme metoduna göre yapıldı. Alınan 30 örnek parselden toplam olarak 26 familyaya ait 52 otsu bitki türü kaydedildi. Çalışmanın amacı vejetasyondaki bitki türlerini tespit etmek ve bitki topluluklarının kompozisyonlarında toprak faktörlerinin rölünü anlamak. Açıkca görülebilen dört vejetasyon grubuna ait bitki topluluklarının belirlenmesi TWINSPAN kullanılarak yapıldı. *Malvastrum coromandelianum* ve *Cicer arietinum* topluluğu ekin tarlaları boyunca yer almakta, *Cynodon dactylon* ve *Cerastium fontanum* topluluğu nemli alanlarda bulunmakta, *Micromeria biflora* ve *Grewia tenax* topluluğu alanın büyük bir kısmını kaplamakta. *Lepidium pinnatifidum* ve Coronopus *didymus* topluluğu çalışma alanındaki yol kenarlarında gelişmekte. Çalışma alanındaki baskın topluluğu tespit edebilmek için DCA kullanıldı. Vejetasyonun alandaki dağılışının anlaşılması Margalla Hills Milli Parkı ekosistemlerinin yönetimine, gelişimine ve daha iyi değerlendirilmesine yardımcı olabilir.

Anahtar kelimeler: *: Margalla Hills, Milli park, TWINSPAN, DCA, Vejetasyon*

1. Introduction

A National park is an area set aside by a national government for the preservation of the natural environment. Most of the landscapes and their accompanying plants and animals in National parks are kept in their natural state. The World Conservation Union defines a National park as a natural area designated to protect the ecological integrity of one

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or more ecosystems for present and future generations. According to the World Database on Protected Areas (WDPA), there are approximately 2700 protected areas in the world with the designation of National Park, totaling nearly 4.4 million square kilometers in area with total number being just over 1,837 (WDPA, 2008).

The Margalla Hills National Park (MHNP) was declared National Park under the Islamabad wild life ordinance (1979) and established in 1980 wide order no. SRO 443 (1) / 80, to prohibit any consumptive use of natural resources through cultivation, grazing, mining and polluting water which flows through the Park so as to preserve and protect the flora, fauna and scenery in its natural state.

The most common kind of data set in community ecology undeniably consists of the abundance or importance of taxa indexed by sampling units (e.g. quadrats, releves, stands, traps, etc). Typically these data are ordered in a matrix with species as rows, sampling units as columns and abundance (or merely presence / absence) as the entries. Since such data matrices are multidimensional, and since the human mind is limited in its capacity to visualize more than a few dimensions, ecologists were forced to find ways to extract the most important dimensions of the data set (Palmer, 1993). Two-way Indicator Species Analysis (TWINSPAN) is a classification technique. FORTRAN computer programs are available in the public domain for performing these analyses (Hill, 1979; ter Braak, 1991). Baruch (2005) studied the vegetation–environment relationships and classification of the seasonal savannas in Venezuela. The results were classified by clustering and TWINSPAN. Xianping et al. (2006) carried out a study on quantitative classification and ordination of forest communities in Pangquangou National Nature Reserve. Forest communities were investigated using TWINSPAN, Detrended Correspondence Analysis (DCA), and Detrended Canonical Correspondence Analysis (DCCA). Using TWINSPAN, the forest communities were classified into seven types. The results of DCA and DCCA clearly reflected the relationship between the pattern of forest communities and environmental gradients. He et al. (2007) conducted a study on environmental factors affecting vegetation composition in the Alxa Plateau, China. Classification by TWINSPAN techniques resulted in the recognition of six vegetation types. Enright et al. (2005) conducted a study on desert vegetation and vegetation-environment relationships in Kirthar National Park, Sindh, Pakistan. Survey of the desert vegetation of Kirthar National Park, Pakistan, recorded 466 plant species in 372 sample quadrats. Classification was done using TWINSPAN and ordination.

The main purpose of this research was to investigate the relationship between soil characteristics with plant species to determine the most important factors affecting the separation of vegetation types. By knowing the relationships between soil and vegetation of a given area, it is possible to apply these results for other similar regions and recommend the suitable guidance for management of protected areas.

2. Materials and methods

The quadrat method of sampling was used for plant data collection. Sampling with quadrats of 1 x 2 m^2 was used. In each quadrat, percentage cover of all herbaceous vascular plant species was estimated visually as described by Kent and Coker (1992). The sampling period started from late March and lasted till end of April. A strategy of simple random sampling was used where the vegetation appeared to be homogeneous in structure and floristic composition. Simple random sampling ensures that each individual had the same probability of being chosen at any stage during the sampling process Plant species were identified using flora of West Pakistan by Stewart (1972). Vegetation data was analyzed by a series of multivariate techniques such as TWINSPAN and DCA, using PC-ORD (version 5) software.

3. Results

The results of the study are divided into two sections. Section one describes the overall vegetation pattern and grouping of different plant species. Second section described the results of plant species analysis by use of TMINSPAN and DCA.

3.1. On the basis of study conducted the floristic data collected from 30 quadrats, 52 vascular herbaceous plant species belonging to 26 families were recorded. Out of 52 species, only 11 species occurred with a cover value of more than 10 % and are presented (Figure 1). It also enumerates the percentage cover of each of these species calculated on the basis of the whole study area. It was obvious that *Rumex dentatus, Cynodon dactylon, Parthenium hysterophorus, Cicer arietinum,* and *Cerastium fontanum* were the most dominating species as far as their percentage cover values based on whole study area. Out of these dominating species, *Rumex* and *Cynodon* presented a maximum cover value of 21.2 and 19.7 % respectively. Apart from these species other species, which were enlisted on the basis of cover, were *Sida cordata, Veronica didyma, Geranium rotundifolium, Torilus leptophylla,* and *Lepidium pinnatifidum.*

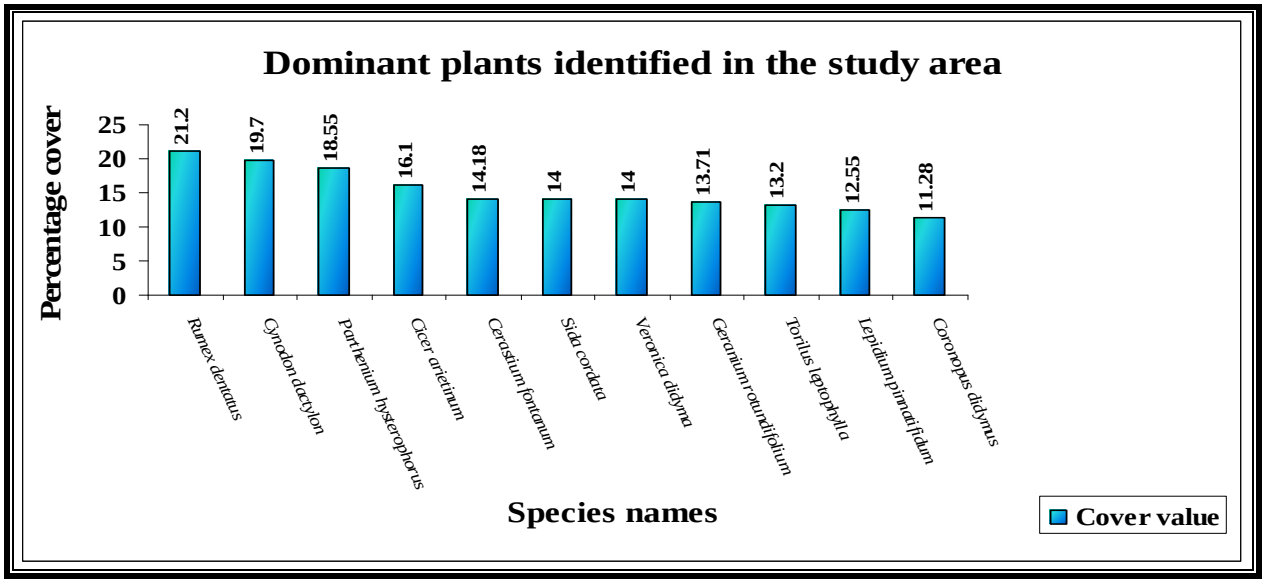

Figure 1. Ten most abundant species along with their cover values in MHNP

3.2. Vegetation of the study area was classified using TWINSPAN analysis (Figure 2). The purpose of two-way clustering (also known as biclustering) was to graphically expose the relationship between cluster analyses and one's individual data points. The resulting graph made it easy to see similarities and differences between rows in the same group, rows in different groups, columns in the same group, and columns in different groups. One can see graphically how groups of rows and columns related to each other. Two-way clustering refered to doing a cluster analysis on both the rows and columns of the matrix, followed by graphing the two dendogram simultaneously, adjacent to a representation of main matrix. Rows and columns of the main matrix are re-ordered to match the order of items in the dendogram. From TWINSPAN analysis, an ordered two-way table, which expressed briefly the relationships of the samples and species within the data set, was constructed. Sites were classified on the basis of their plant community composition in order to obtain a first approximation of the plant communities of the area. Large groups suggested by TWINSPAN were further sorted by hand, based on occurrence of important species. Based on the analysis, four major vegetation types were found. These results clearly indicated that at the first level, TWINSPAN divided the vegetation of whole study area into two major communities, which were further divided into minor communities. These minor communities were again divided into 8 sub-minor communities. But the present study was limited on the minor communities' analysis. Each community was named after the leading dominant species (Figure 2). Major community 1. *Cynodon dactylon* and *Cerastium fontanum* community; major community 2. *Lepidium pinnatifidum* and *Coronopus didymus* community and minor communities were:

3.3. Malvastrum coromandelianum and *Cicer arietinum* community

This community was widespread along the agricultural crop fields. The land was undisturbed and the community grew well over there.

3.4. Cynodon dactylon and *Cerastium fontanum* community

This community occupied the wettest stands within the study area. This habitat was characterized by a rich and continuous flow of fresh water from spring and irrigated land.

3.5. Micromeria biflora and *Grewia tenax* community

This community was present in a vast area almost devoid of trees. It was subjected to destructive cutting for fuel and other household purposes.

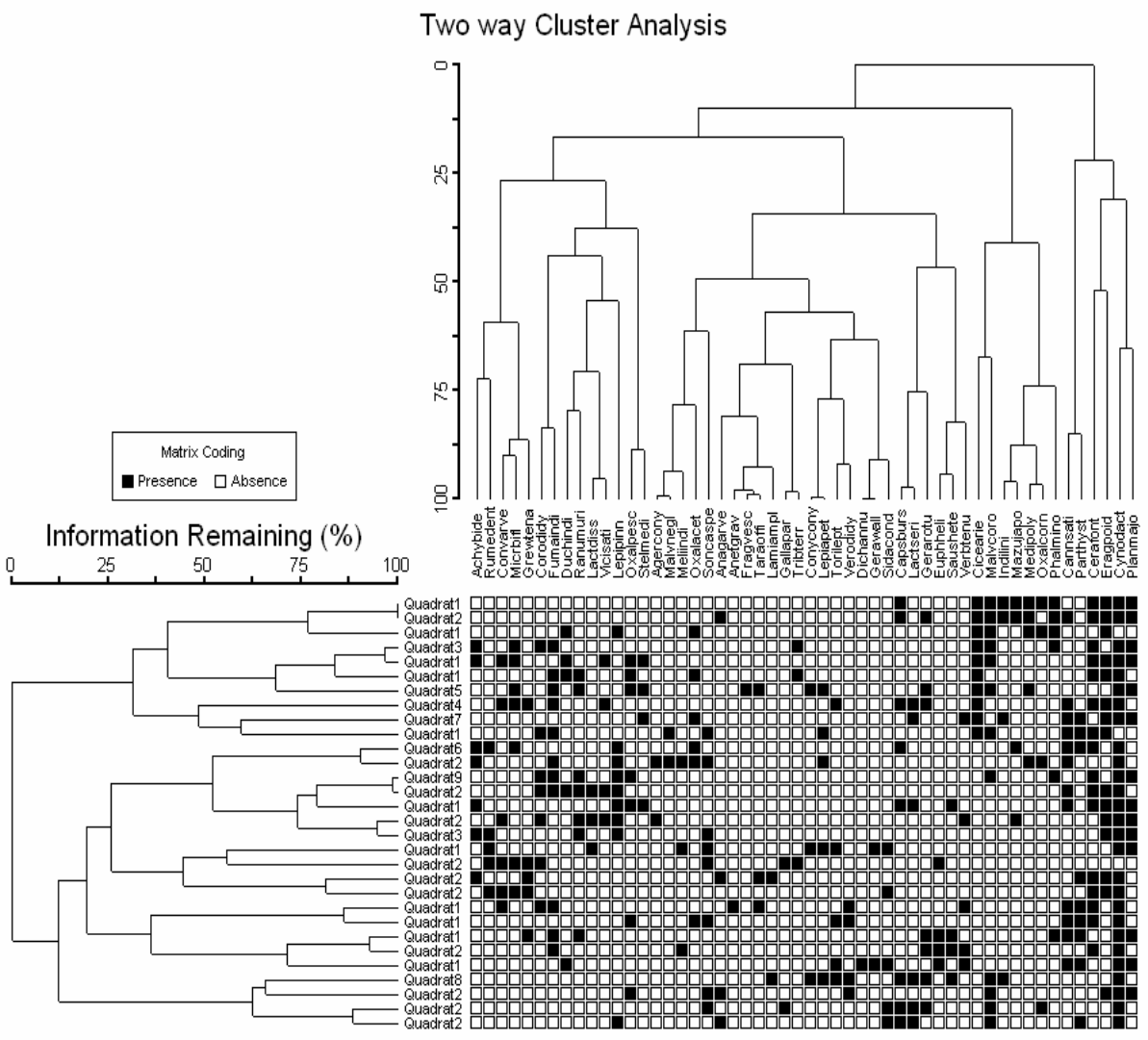

Figure 2. Two way cluster dendrograms of species and quadrats

3.6. Lepidium pinnatifidum and *Coronopus didymus* community

This community had grown along the road in the study area in urban-rural gradient. It was highly subjected to the trampling by humans and animals.

3.7. DCA analysis of overall vegetation

Three unique plant assemblages were identified within the study area. The (Figure 3) was an ordination plot of the 30 sites analyzed in this study. Three assemblage types were indicated by the groupings of group 1, group 2, and group 3. From the ordination methods, following major plant species groups were identified; *Rumex dentatus* and *Parthenium hysterophorus* group ; *Cynodon dactylon* and *Cerastium fontanum* group and *Lepidium pinnatifidum* and *Coronopus didymus* group.

3.8. Group 1.

The species present in this group include; *Anagallis arvensis, Capsella bursa-pastoris, Conyzenthus conyzoids, Dichanthium annulatum, Euphorbia helioscopia, Geranium wallichii, Grewia tenax, Lamium amplexicaule, Malvastrum coromandelianum, Micromeria biflora, Parthenium hysterophorus, Rumex dentatus, Saussurea heteromalla, Sonchus asper, Torilus leptophylla, Veronica didyma.*This group was named as *Rumex dentatus* and *Parthenium hysterophorus* group as these two species had highest cover values in the group.

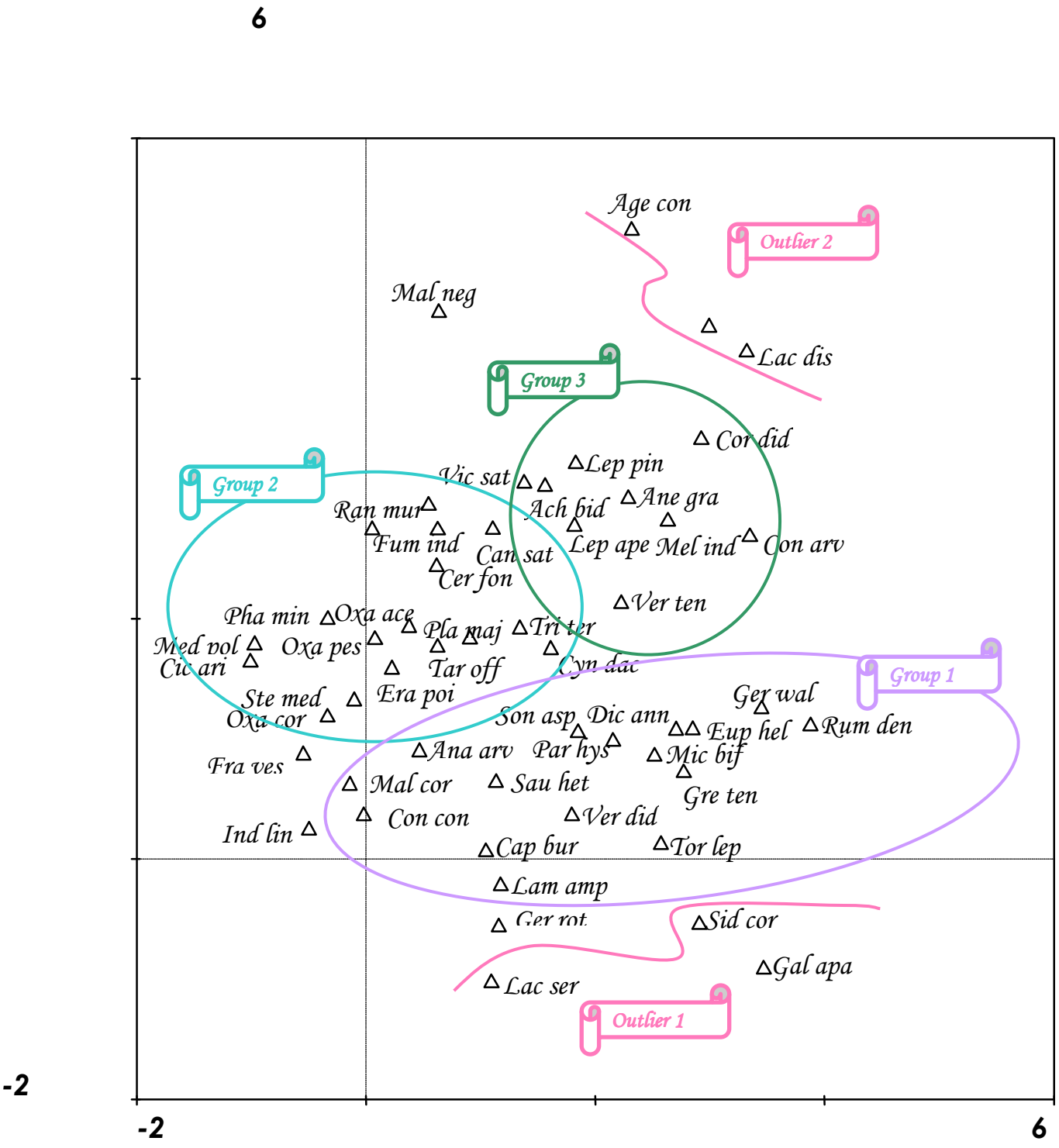

Figure 3. Description of plant communities as demarked by DCA

This group grew along the edges of main road which led to the top hills and villages. This group was situated in entire urban-rural gradient. Diagnostic species of this group was *Rumex dentatus* with the cover value of 21.2 %. It belongs to family Polygonaceae a very common perennial herb. Other most common species of this group was Parthenium *hysterophorus* of family Asteraceae. An annual herb that aggressively colonizes disturbed sites.

3.9. Group 2.

This group comprised of *Ranunculus muricatus, Duchesnea indica, Fumaria indica, Cannabis sativa, Cerastium fontanum, Phalaris minor, Oxalis acetophylla, Plantago major, Tribulus terrestris, Medicago polymorpha, Oxalis pescaprae, Taraxacum officinale, Cynodon dactylon, Eragrostis poides, Stellaria media, Oxalis corniculat* and *Cicer arietinum*. This group was named as *Cynodon dactylon* and *Cerastium fontanum* group due to the highest cover values of these two species within the group. It grew along the sloppy mountains near the crop fields so there was no trampling. The diagnostic species of this group was *Cynodon dactylon* of family Poaceae with the cover value of 19.7 %.

3.10. Group 3.

This group was designated as *Lepidium pinnatifidum* and *Coronopus didymus* group due to highest cover values of these two species in the group. It was present along hill slopes in dense vegetation with no trampling or other human / animal interaction. The diagnostic specie of this group was *Lepidium pinnatifidum* of family Brassicaceae with the cover value of 12 %. Other most dominant specie was *Coronopus didymus* of family Cruciferae. Overall in study area family Asteraceae and Brassicaceae were the most common families of the area. The species comprising this group include; *Coronopus didymus, Lepidium pinnatifidum, Vicia sativa, Achyranthes bidentata, Anagallis arvensis, Lepidium apetalum* , *Melilotus indica, Convolvulus arvensis* and *Verbena tenuisecta*.

4. Conclusions

The present study examined the species distribution in different parts of Margalla Hills National Park, Islamabad. A total number of 52 herbaceous plant species were recorded from different sites of the Park. The presence of a diverse range of herbaceous plant species in the area supports the view that the Park can serve as an important habitat for the conservation of local flora. As described in (Figure 1), the most abundant species (>10% cover value) in the study area were as follows; *Rumex dentatus, Cynodon dactylon, Parthenium hysterophorus, Cicer arietinum, Cerastium fontanum, Sida cordata, Veronica didyma, Geranium rotundifolium, Torilus leptophylla, Lepidium pinnatifidum,* and *Coronopus didymus*. The dominance of *Cynodon dactylon* was verified by the fact that it occurs on almost all soil types and was common in disturbed areas such as gardens, roadsides, overgrazed, trampled areas, uncultivated lands, localities (Martin et al., 1951). Similar study was conducted by Nansen et al. (2000). In their study, a total of 1764 trees of 32 species were identified and included in the classification of the forest vegetation.

In order to classify the vegetation into major communities identified in the study area, a technique TWINSPAN was used. Fifty two plant species were recorded from the study area, representing the common plants growing in almost all the area. Four major plant communities were obtained at the second division of the TWINSPAN classification. These communities were further subdivided into minor units based on the results. Overall dichotomy of fourteen plant groups was obtained. But the study was mainly focused on the four major communities. These included: *Malvastrum coromandelianum* and *Cicer arietinum* community; *Cynodon dactylon* and *Cerastium fontanum* community; *Micromeria biflora* and *Grewia tenax* community; *Lepidium pinnatifidum* and *Coronopus didymus* community. In a study conducted by Yeo and Blackstock (2001), TWINSPAN application revealed six biogeographical groups, each characterized by a distinctive assemblage of vegetation and habitat types. Ahmad (2004 and 2009) also conducted similar study along M-2 and District Abbotabad. The ordination study done by He et al. (2007) divided the vegetation of the area into six major groups, viz; groups 1 and 2 were transitional in their composition between the other groups. Lyon and Gross (2004) used DCA to evaluate the tree species abundance data and to determine if there were distinct assemblages. DCA ordinations summarized species abundance data by assessing the dominant patterns of variation in species composition of sample plots. The present study revealed that local community should play a vital role for protecting its bio-diversity as it has day-to-day encounter with the Park.

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