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Exploring the vegetation dynamics and community assemblage in Ayubia National Park, Rawalpindi, Pakistan, using CCA

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ABSTRACT The relationship between species diversity and overall community assemblage was identified in two different zones in Ayubia National Park (Rawalpindi, NE-Pakistan) which is recognized as protected area. Canonical Correspondence Analysis (CCA) was used to find correlation of environmental variables with species abundance/richness. Results showed that in Zone 1 species were rather scattered due to the less availability of organic matter and soil moisture as they occupy the less dense forest cover. Whereas Zone 2 showed the opposite trends. Finally the overall zones showed that maximum number of quadrats included Zone 2 species due to a great forest cover with excess amount of organic matter and soil moisture. The study highlighted the importance of dynamic nature and composition of vegetation and stressed the need of conservation of native flora for future generations.

KEY WORDS Canonical Correspondence Analysis, Species richness, Soil moisture, Ayubia National Park, Pakistan.

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INTRODUCTION

A National park is an area set aside by a national government for the preservation of the natural environment. The World Conservation Union defines a National park as a natural area designated to protect the ecological integrity of one or more ecosystems for present and future generations. In Pakistan, the earlier ecological studies were generally observational. The earlier studies, generally appeared in 1950's, were confined to visual description of the vegetation, and no attempts were made to recognize community types and to correlate them with the relevant environmental factors. On the contrary, advanced multivariate techniques of ordination and cluster analysis had been routinely used in Europe and other parts of the world. There are numerous ordination methods accessible in plant bionetwork, some of which have been extensively used, e.g. Principal Component Analysis (PCA) and Detrended Correspondence Analysis (DCA) (Hill & Gauch, 1980), whereas some others only sporadically used (Zhang, 2004). A series of studies using different ordination techniques were carried out in Pakistan by Ahmad et al., 2009; Ahmad, 2009; Jabeen & Ahmad, 2009; Pirzada et al., 2009; Ahmad et al., 2010a, b; Ahmad, 2011. In Canonical Correspondence Analysis (CCA) the floristic statistics and the environmental variables can be assimilated within the ordination (Kashian et al., 2003). Within the Ayubia National Park, the study area was the moist temperate forest in Rawalpindi, NE-Pakistan (Fig. 1), showing a high diversity of susceptible plant and animal species. The geographical location of the park is 330° 52' N and 730° 90' E (Farooque, 2002).

The aim of this research was to quantify the vegetation in Ayubia National Park using ordination techniques and to determine the soil-vegetation relationship to provide basic awareness for preservation of nationally significant native flora.

A list of plant species present in the study area is provided in Table 1. Apart from their importance from ecological point of view few species are used as medicinal herbs by local inhabitants. Observed biodiversity of occuring species indicate that this area can be used for conservation of native flora.

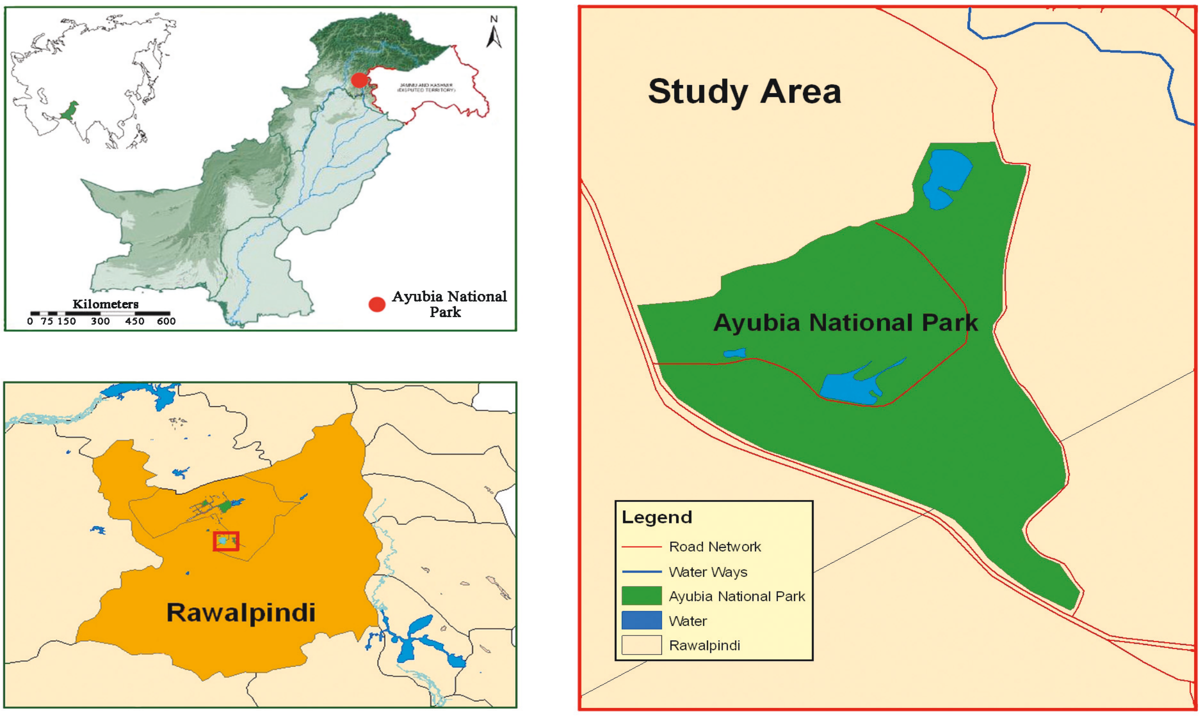

Figure 1. The geographical location of the Ayubia National Park, Rawalpindi, NE-Pakistan.

MATERIALS AND METHODS

For the clear communities demarcation study area was divided into two zones. Zone 1 was located about 1 m from the walking track. 60 quadrats were laid down along both sides (30 quadrats on each side). Quadrat method was used for the collection of vegetation data. Quadrat size of 1×1 m was selected because a high number of herbs and shrubs were present in the area. Within each quadrat, cover values of plants were recorded by visual estimation according to Domin Cover Scale (Kent & Coker, 1995). Nomenclature was as in Nasir & Rafiq (1995). Soil variables include pH, organic matter (Nikolskii, 1963) and soil moisture (Allen, 1974). Principal Component Analysis (PCA) and Canonical Correspondence Analysis (CCA) ordination methods were applied for data quantification and analysis.

RESULTS

The most important way of exploring the multivariate data sets is based on the ordination results. In fact, the first ordination axis is frequently correlated with one environmental variable, thus helping in identifying the abundance and occurrence of individual species related to environmental factors. Different or multiple approaches can depict such a relation including the response curve of species along the moisture gradient. In Zone 1 classification of species was based upon soil moisture content within 30 Quadrats. Biplot of species and environmental variables against soil moisture divided it into four classes i.e. Class Moisture 1 included 13 Quadrats, Class Moisture 2 included 4 Quadrats, Class Moisture 3 included 10 Quadrats and Class Moisture 4 included 3 Quadrats.The results showed that Zone 1 species mostly fall into class moisture 1 due to availability of thick forest cover and high contents of organic matter. The distance between the symbols in the diagram approximates the different distribution of relative abundance of the species across the area.

Points resulting very close to each other correspond to species often occurring together. Segmentation of these symbols into slices was based on currently active classification of samples. Relative size of particular pie-slice corresponds to relative importance (measured either by number of presences or sum of

Species name	Families
Vinca major Linnaeus (1789)	Apocynaceae
Hedera nepalensis K.Koch (1753)	Araliaceae
Polygonatum verticillatum All. (1754)	Aspargaceae
Cichorium intybus Linnaeus (1753)	Asteraceae
Taraxacum officinale Wigg. (1881)	Asteraceae
Asparagus gracilis Royle (1753)	Asteraceae
Thlaspi griffithianum (Boiss.) Boiss (1753)	Brassicaceae
Cardamine impatiens Linnaeus (1753)	Brassicaceae
Sisymbrium decomposita Linnaeus (1753)	Brassicaceae
Cannabis sativa (Linnaeus) (1753)	Canabinaceae
Viburnum foetens Decaisne (1753)	Caprifoliaceae
Cerastrium fontanum Baumg. (1753)	Caryophullaceae
Dipsacus strictus D. Don (1754)	Dipasaceae
Euphorbia wallichii Hook.f. (1753)	Euphorbiaceae
Indigofera heterantha Wall ex. Brand. (1753)	Fabaceae
Erodium cicutarium (Linnaeus) L, Herit ex Ait. (1789)	Geraniaceae
Mentha longifolia (Linnaeus) All. (1753)	Lamiaceae
Calamintha vulgaris Linnaeus (1754)	Lamiaceae
Nepeta connata Linnaeus (1753)	Lamiaceae
Lonicera quinquelocularis Hardw. (1753)	Linaceae
Oxalis corniculata Linnaeus (1753)	Oxalidaceae
Plantago major Linnaeus (1753)	Plantaginaceae
Poa pratensis Linnaeus (1753)	Poaceae
Cynodon dactylon (Linnaeus) Pers. (1753)	Poaceae
Polyphyllum hexandrum I. (1753)	Podophyllaceae
Rumex nepalensis Spreng. (1753)	Polygonaceae
Adiantum caudatum Forsk (1753)	Pteridaceae
Dryopteris ramose (Hope) C.Chr. (1753)	Pteridaceae
Adiantum capillus-veneris Linnaeus (1753)	Pteridaceae
Clematis grata Wall. (1754)	Ranunculaceae
Aquilegia pubiflora Wall ex Royle (1754)	Ranunculaceae
Fragaria vesca Lindley ex Lacaita (1753)	Rosaceae
Fragaria nubicola Lindley ex Lacaita (1753)	Rosaceae
Duchesnea indica (Andr.) Focke (1811)	Rosaceae
Potentilla gerardiana Lindley ex Lehm. (1753)	Rosaceae
Galium aparine Linnaeus (1753)	Rubiaceae
Bergenia himalaica Boriss. (1974)	Saxifragaceae
Bergenia ciliate (Haw.) (1831)	Saxifragaceae
Scrophularia decomposita Royle ex Benth (1753)	Scrophulariaceae
Urtica dioica Linnaeus (1753)	Urticaceae
Valeriana jatamansi Jane (1805)	Valerianaceae
Valerianella dentatam (L.) Poll. (1754)	Valerianaceae
Viola canescens Wall.ex Roxb. (1753)	Violaceae

Table 1: List of plant species in Ayubia National Park, Rawalpindi, Pakistan.

abundances) of the current species in the particular class of samples (Fig. 2).

Similarly, figure 3 explains the classification of species of Zone 2 in relation to soil moisture content. Soil moisture was separated into four classes i.e. Class moisture 1 included 8 Quadrats, Class moisture 2 included 7 Quadrats, Class moisture 3 included 9 Quadrats and Class moisture 4 included 6 Quadrats, the maximum number of samples occurring in Class moisture 3. This analysis depicts that Zone 2 species fall in class moisture 3 because of more availability of organic matter and maximum forest cover in that area. Overall species of both zones classification respect to soil moisture was analyzed. It showed that Class moisture 1 included 18 Quadrats, Class moisture 2 included 24 Quadrats, Class moisture 3 included 5 Quadrats and Class moisture 4 included 13 Quadrats. The analysis of these results showed that a high number of Quadrats comprised Zone 2-species due to dense forest canopy resulting in more availability of raw material for the formation of organic matter (Fig. 4).

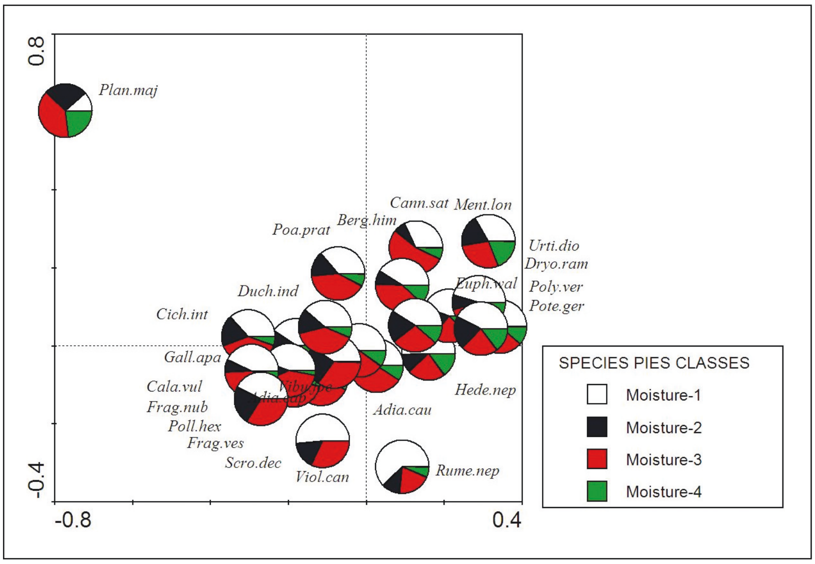

Figure 2: Pie symbols plot of (Zone 1) species over classes of samples with different soil moisture.

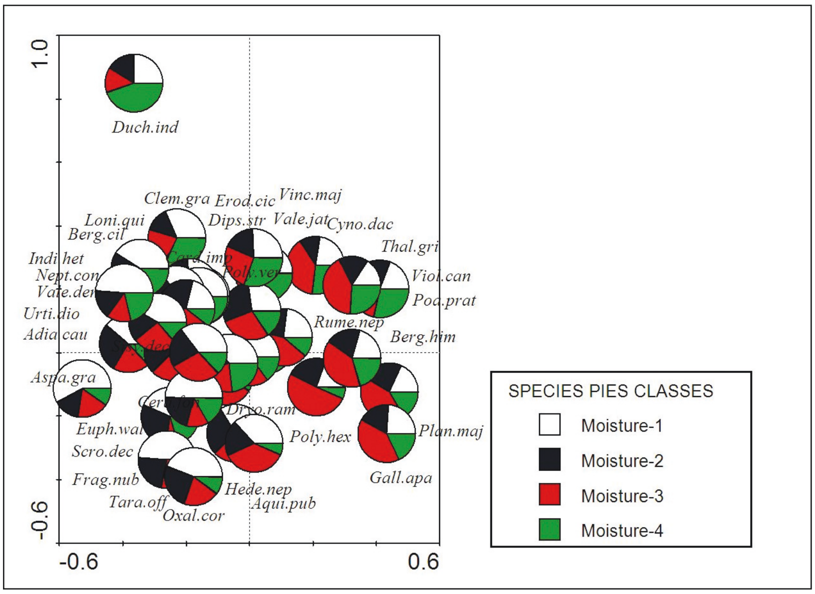

Figure 3: Pie symbols plot (Zone 2) of species over classes of samples with different soil moisture.

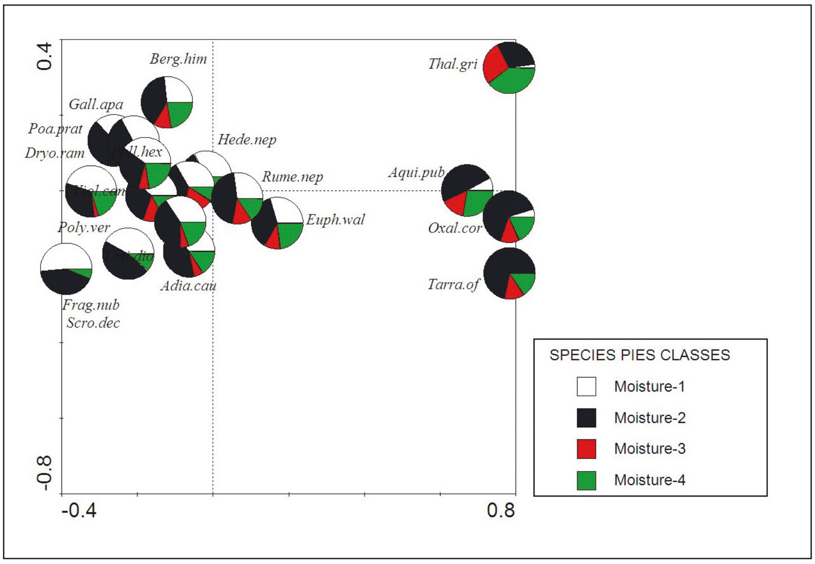

Figure 4: Pie symbols plot (Both Zones) of species over classes of samples with different soil moisture.

DISCUSSIONS

Multivariate analysis technique called Canonical Correspondence Analysis (CCA) was used in this study in Ayubia National Park to identify the correlation between species occurrence/abundance and environmental variables. This ordination technique assumed that species abundance was unimodally distributed along environmental gradients. Species richness is mostly correlated with soil moisture and pH. Organic matter was the factor strongly correlated with species richness in dense vegetation (Welle et al., 2003). Soil pH can also be correlated with species richness, high species richness results in declining as pH declines (Gough et al., 2000; Roem & Berendse, 2000). The study area was divided in different zones i.e. Zone 1 and Zone 2, CCA was applied to classify the species richness. Results of Zone 1 were completely different from Zone 2 as the soil moisture and organic matter were highest in Zone 2 due to dense vegetation. Same results were revealed when overall species data were employed for CCA analysis. The most of the researches revealed that high temperature as well as irrigation manipulations exhibit unusual level of impact on diverse taxa moreover, they may influence species abundance and species richness in a complementary way. Soil is the most species rich component in many terrestrial ecosystems (Adams & Wall, 2000; André et al., 2002) and also plays significant function within ecosystem, affecting processes including plant growth as well as decomposition (Coleman & Hendrix, 2000). Results of present study stress the need of conservation and preservation of native flora.

REFERENCES

Adams G.A. & Wall D.H., 2000. Biodiversity above and below the surface of soils and sediments: linkages and implications for global change. Bioscience, 50: 1043–1048.

Ahmad S.S., 2009. Ordination and classification of herbaceous vegetation in Margalla Hills National Park Islamabad Pakistan. Biolological Diversity and Conservation, 2: 38-44.

Ahmad S.S., 2011. Canonical Correspondence Analysis of the relationships of roadside vegetation to its edaphic factors: a case study of Lahore-Islamabad motorway (M-2). Pakistan Journal of Botany, 43: 1673-1677.

Ahmad S.S., Fazal S., Valeem E.E., Khan Z.I., Sarwar G. & Iqbal Z., 2009. Evaluation of ecological aspects of roadside vegetation around Havalian city using Multivariate techniques. Pakistan Journal of Botany, 41: 53-60.

Ahmad S.S., Wahid A. & Akbar K. F., 2010a. Multivariate classification and data analysis of vegetation along Motorway (M-2), Pakistan. Pakistan Journal of Botany, 42: 1173-1185.

Ahmad I., Ahmad M.S.A., Hussain M., Ashraf M. & Hameed M.Y. & Hameed M., 2010b. Spatiotemporal Aspects of plant community structure in Open Scrub Rangelands of Sub-Mountainous Himalayan Plateaus. Pakistan Journal of Botany, 42: 3431-3440.

Allen S.E., 1974. Chemical analysis of ecological materials. Blackwell scientific publications, Oxford. London, 565 pp.

André H.M., Ducarme X. & Lebrun P., 2002. Soil biodiversity: Myth, reality or conning? Oikos, 96: 3-24.

Coleman D.C. & Hendrix P.F., 2000. Invertebrates as Webmasters in Ecosystems. Institute of Ecology, CABI Publishing, New York, 352 pp.

Farooque M., 2002. Management Plan of Ayubia National Park 2002-2007. Natural resource conservation project, Galiat, Abbotabad, 11-12.

Gough L., Shaver G.R., Carrol J., Royer D.L. & Laundre J.A., 2000.Vascular plant species richness in Alaskan arctic tundra: The importance of soil pH. Journal of Ecology, 88: 54-66.

Hill M.O. & Gauch H.G., 1980. Detrended correspondence analysis, an improved ordination technique. Vegetatio, 42: 47-58.

Jabeen T. & Ahmad S.S., 2009. Multivariate analysis of environmental and vegetation data of Ayub National Park, Rawalpindi. Soil and Environment, 28: 106-112.

Kashian D.M., Barnes B.V. & Walker W.S., 2003. Ecological species groups of landform-level ecosystems dominated by jack pine in northern Lower Michigan, USA. Plant Ecology, 166: 75-91.

Kent M. & Coker P., 1995. Vegetation Description and Analysis: a practical approach. Belhaven Press, London, 363 pp.

Nasir Y J. & Rafiq R A., 1995. Wild Flowers of Pakistan. Oxford University Press., Karachi, 298 pp.

Nikolskii N.N., 1963. Practical soil sciences. Tech Services, U.S., Department of Commerce, Washington, 240 pp.

Pirzada H. Ahmad S.S. & Audil R., 2009. Monitoring of soil lead pollution using roadside plants (*Dalbergia sissoo* and *Cannabis sativa*) utilizing multivariate analysis. Pakistan Journal of Botany, 41: 1729-1736.

Roem W.J. & Berendse F., 2000. Soil acidity and nutrient supply ratio as possible factors determining changes in plant species diversity in grassland and healthland communities. Biological conservation, 92: 151-161.

Welle V., Marlies E.W., Peter V., Gaius R. & Frank B., 2003. Factors determining the species richness in Alaska arctic tundra. Journal of Vegetation Science, 14: 711-720.

Zhang J.T., 2004. Quantitative Ecology. Science Press, Beijing, China: 516-522.