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EVALUATION OF ECOLOGICAL ASPECTS OF ROADSIDE VEGETATION AROUND HAVALIAN CITY USING MULTIVARIATE TECHNIQUES

SHEIKH SAEED AHMED[1*], SAIMA FAZAL[1], EHSAN ELAHI VALEEM[2*], ZAFAR IQBAL KHAN[3], GHULAM SARWAR[4] AND ZAFAR IQBAL[4]

[1]*Deptt. of Environmental Sci., Fatima Jinnah Women University, Rawalpindi, Pakistan.*
[2]*Department of Biological Sciences, University of Sargodha, Sargodha, Pakistan.*
[3]*Public Private Partnership Unit (PPPU), Planning and Development Department, Government of Sindh, Karachi-74200, Pakistan.*
[4]*Univeristy College of Agriculture, University of Sargodha, Sargodha, Pakistan*

Abstract

A survey of Abbottabad roadsides vegetation and soil was undertaken. The floristic data were analyzed by using multivariate analysis techniques *i.e.* Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA). A total of 63 plant species and 5 major communities were recognized along 5 major roadsides as demarcated by DCA and CCA. The study also investigated the vegetation structure and its relationships to selected environmental factors. This relationship was determined by CANOCO analysis. The most important factors influencing the roadside vegetation were found to be lead and copper, and zinc to some extent. This study provides the basic information to preserve and improve the roadside vegetation, for reservation of native flora.

Introduction

Roadside is designated as disturbed environment, where the physiology and growth of plants often differ as compared to non road plants. Availability of water from road surface run-off has positive effects on roadside plants, particularly in arid and semiarid region (Frenkel, 1977). Ecological species groups often are built-up in concurrence with ecosystem classification because species distributions can then be deduced among environmental gradients treated as continuums or compared among ecosystem types (Archambault *et al.,* 1989; Goebel *et al.,* 2001; Abella *et al.,* 2003).

Roadside verges and their vegetation can play an important role in tackling problems related to microclimate, soil-stabilization and control of pollution. Roadside vegetation can help significantly in reducing the adverse effects of gaseous and particulate pollutants in roadside environment. Similarly roadside plants can absorb many of the particulates which otherwise would spread widely over the agricultural land and crops. Thus they may help in protecting the food chain from accumulation of harmful pollutants. Roadside plants, particularly trees, shrubs and intense hedges can clean pollutants from the air (Ramsay, 1993).

Biosphere pollution by chemicals and heavy metals such as cadmium, nickel, zinc, lead, copper *etc.* has accelerated dramatically during the last few decades due to mining, smelting, manufacturing, use of agricultural fertilizers, pesticides, municipal wastes, traffic emissions, industrial effluents and industrial chemicals *etc.* Some of these metal ions *e.g.* Na^+, K^+, Mg^{2+}, and Ca^{2+} are most essential for life and act more like major elements such as P with respect to their cycling rates and gathering patterns (Løbersli & Steinnes, 1988).

*Corresponding authors: drsaeed@fjwu.edu.pk 00 92 321 5167726

In order to analyze variation in the floristic composition and to obtain their environmental relations, two-way indicator species analysis (TWINSPAN) and Detrended Correspondence Analysis (DCA) was used (Hill, 1979a, b). TWINSPAN analysis is a polythetic and divisive classification technique and produces indicator species for each sample plot. DECORANA was performed to explore the association between the species composition of each habitat and the environmental variables (Hill, 1979b; Hill & Guach, 1980). Detrended Correspondence Analysis DCA was used to explore the main ecological gradients of floristic discrimination (Braak & Smilauer, 1998). To help the interpretation of the ordination axes, soil properties and the relative cover values were converted into pools through multiplication by the thickness of the corresponding soil layer (Vasilopoulos *et al.*, 2007). In Canonical Correspondence Analysis (CCA) the floristic data and the environmental variables can be incorporated with in the ordination at the same time. Thus the input to CCA consists of not just the species and quadrats, but also a second data set of environmental variables (Kent & Coker, 1992). This results in an integrated ordination of species together with associated environmental factors. CCA, therefore, describes the affiliation of the group to compute environmental variables and also shows the major links between the species and environmental factors (Kashian *et al.*, 2003).

Identification of dominant vegetation communities of each group segregated by TWINSPAN (Rivas-Martı nez *et al.,* 2002), names given to each group to synthesize a great amount of information for an easier interpretation (Santos *et al.,* 2006). Canonical correspondence analysis CCA (Braak, 1986) was used as an ordination method to confirm if the classification results sufficiently reflected the floristic gradients in the data and also to reveal the relationships between illustrative variables and the composition of the vegetation. Cover percentage of each herbaceous species was used as a floristic value on both classification and ordination analyses without transformations (Santos *et al.,* 2006).

The present study was aimed as compilation of floristic and soil data from roadsides. The objectives of study were to find and estimate the average covers of each and most frequent species in the study area and to quantify the various edaphic characteristics of roadside soils in the study area.

Materials and Methods

The quadrate method of sampling was used for plant data collection. Sampling with quadrates of 1 x 2 m^2 was used. In each quadrate, percentage cover of all herbaceous vascular plant species was estimated visually as described by Kent & Coker (1992). The sampling period starts from late April and lasts till end of May. Environmental parameters, soil samples in this case, were recorded from the centre of each quadrat to determine putatively any underlying ecological controls on the vegetation. Thirty seven soil samples were collected in the whole study area. The pH of soil was determined by using glass electrode pH meter, Thermo Orion (Model 410 A) in 1:5 soil-water extract. Electric conductivity (EC) was evaluated in 1:5 soil-water extract using electric conductivity meter (cyberscan 500 cons). Concentrations of Zn, Cu, and Pb were measured by Flame Atomic Absorption Spectrometry (AAS) using Cottinee method (1982).

The District of Abbottabad is the headquarters of Hazara Division. The multivariate analysis of roadside vegetation of Havalian city and its fertility status was done; following are the results derived using multivariate techniques (DCA and CCA).

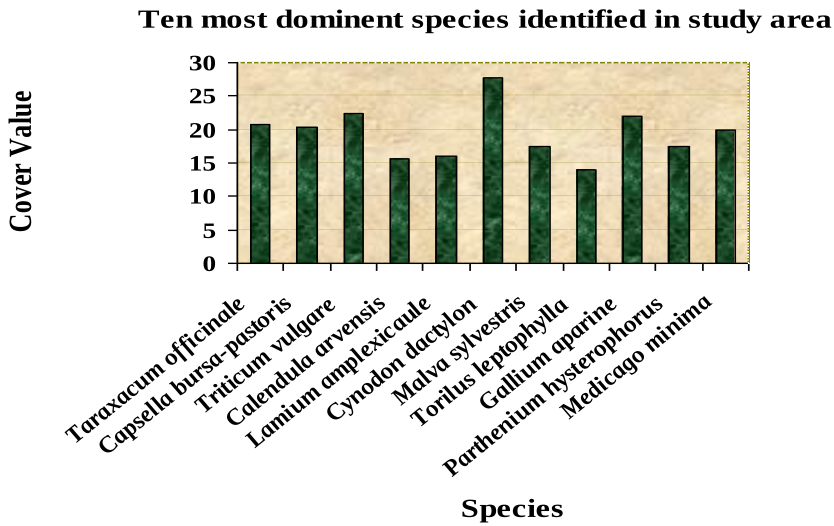

Fig. 1. Ten most dominant species identified in the study area.

Results and Discussion

Most frequent species: Vegetation analysis was carried out in Abbott Abad, which comprised of floristic data collected from 37 quadrates; 63 vascular plant species were recorded. Out of 63 species only 10 species occurred with the frequency of more then 10% and are presented (Fig. 1) which also enumerated percentage cover of each of these species calculated on the basis of whole study area.

From the DCA (Detrended correspondence analysis) result there were five communities recognised. The major groups were named after the dominant species as follows:

1. *Cynodon dactylon, Malva sylvestris, Medicago minima* community: The diagnostic species identified in this group were *Cynodon dactylon*, *Malva sylvestris,* and *Medicago minima*. They showed cover value 40%, 30% and 30% respectively. The other species *Capsella bursa-pastoris*, *Medicago minima* and *Poa aratica* also exhibited some dominance in the study area with the cover value of 30%. A total of 13 species were recorded in this group. This group can be distinguished from the other communities because of high percentage of occurrence and 40% cover value of *Cynodon dactylon*.

2. *Taraxacum officinale, Triticum vulgare, Cynodon dactylon* community: The diagnostic species identified in this group was *Triticum vulgare* recorded, having cover value 30%. Other species which occur in this community include the *Hedera nepalensis, Rumex nepalensis*, *Cynoglosum lanceolatum* and *Medicago minima.* The cover value of *Hedera nepalensis* was 20%, *Rumex nepalensis* 20%, *Cynoglosum lanceolatum* 20% and *Medicago minima* 30%. A total 14 species were recorded in this group.

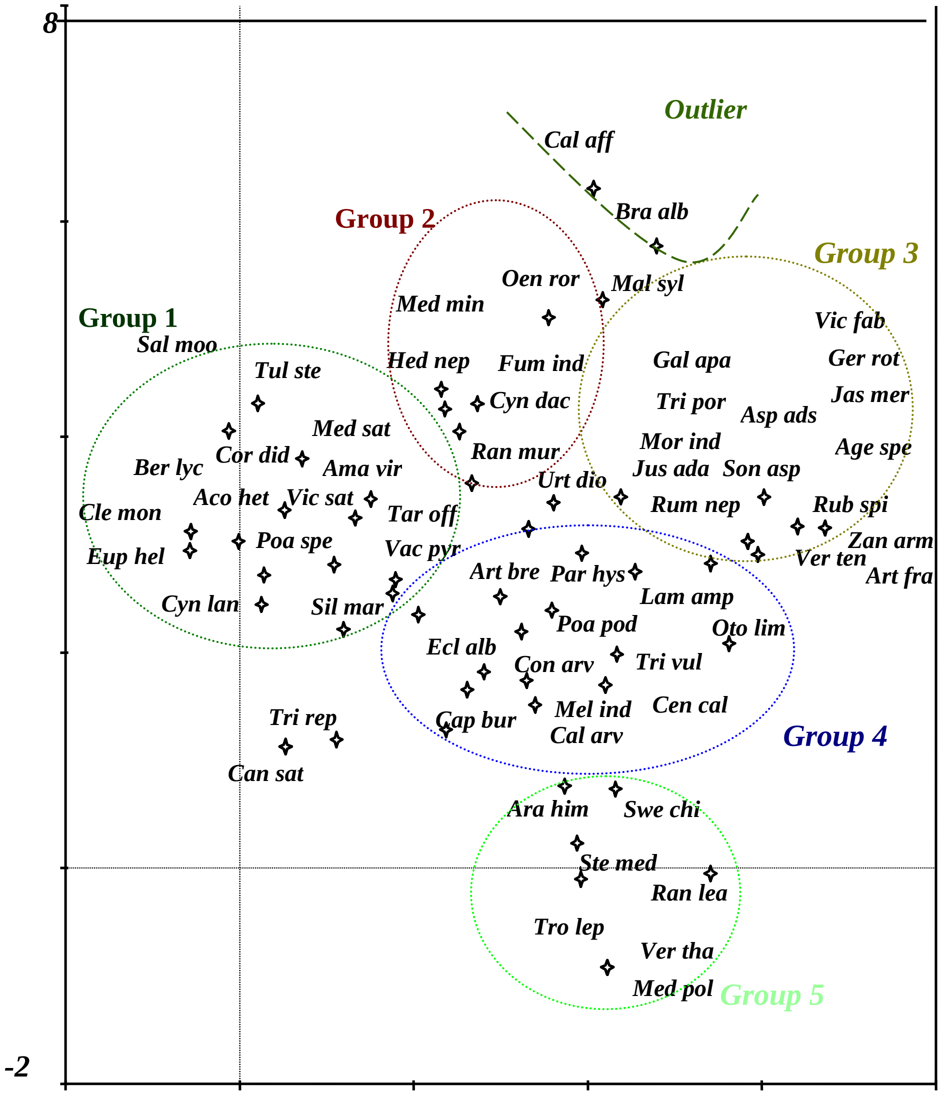

Fig. 2. Different plant groups demarcated by DCA.

3. *Triticum vulgare, Capsella bursa-pastoris, Stellaria media* community: *Capsella bursa-pastoris* was diagnostic specie identified in this group were, which exist in this community. The herbaceous stratum of *Capsella bursa-pastoris* was well developed. A total 5 species were recorded in this community.

4. *Capsella bursa-pastoris Taraxacum officinale, Cynodon dactylon* community: *Cynodon dactylon* and *Taraxacum officinale* were diagnostic species identified in this community. A total three species were recorded. The other species are the *Medicago sativa* and *Fumaria indica* with the cover value of 15% of both.

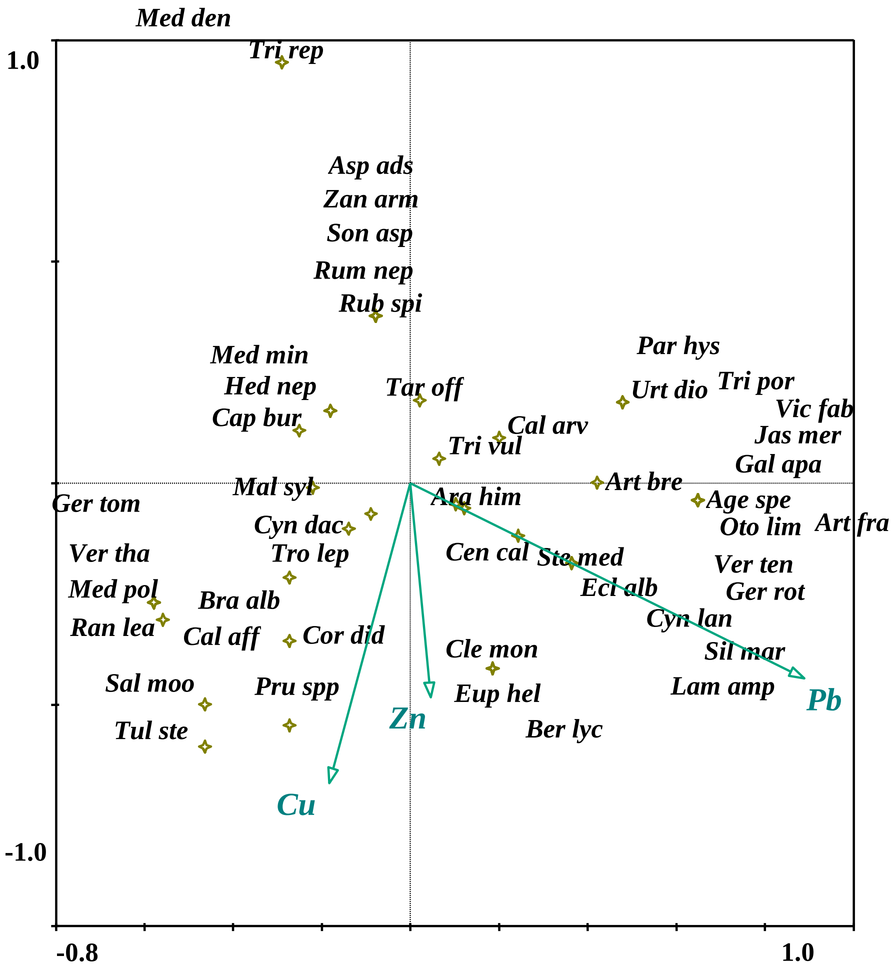

Fig. 3. Biplot diagram of species and heavy metals data along study area.

5. *Brassica alba, Calendula arvensis, Cynodon dactylon* community: *Cynodon dactylon* was diagnostic specie identified in this group and it was characterised by the presence of this indigenous grass which was also the dominant species. Other species include *Clematis Montana* and *Capsella bursa-pastoris,* having dominant cover value of *Clematis Montana* was 10% and 20% and 20%.

The biplot diagram (Fig. 2) of species and heavy metals showed that lead and copper portray more strong correlation with respect to distribution of various species role along axis 2, whereas Zn showed no significant correlation and hence played no significant role in the distribution of species along different axes. The biplot diagram (Fig. 3) of species and heavy metals showed that lead and copper portray more strong correlation with respect to distribution of various species along axis 1, whereas Zn showed no significant correlation in the distribution of species along different axes.

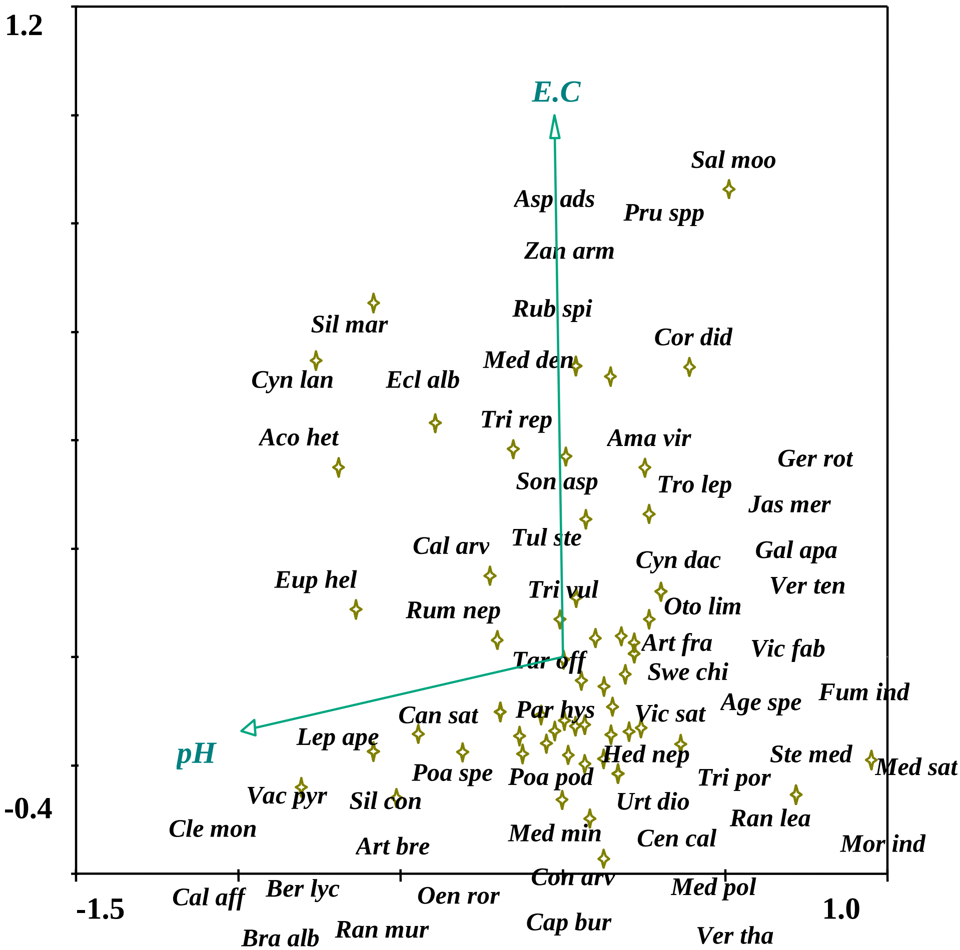

Fig. 4. Biplot diagram of species and environmental variables along study area.

Similarly biplot diagram (Fig. 4) of species and environmental variables showed more strong correlation with respect to distribution of various species along axis 1, whereas pH portrays less strong correlation, in the distribution of species. *Asparagus adscendens*, *Zanthoxylum armatum* and *Rubus spinosus* more strongly were more influenced by electric conductivity along axis1. Occurrence of species near to or beyond the tip of the arrows will be strongly positively correlated; those at the opposite end will be less strongly affected.

The present study examined the species distribution in different roads of Abbottabad. A total of 63 species were recorded from the verges of Abbott Abad district. The presence of large number of plant species on the roadside verges supports the view that it can serves as an important habitat for local flora. Similar observations had been made in previous studies of roadside vegetation in different countries (Way, 1977; Batanouny, 1979; Akbar, 1997).

Vegetation is a good indicator of quality of soil which affects it in every conceivable direction. Figure (1) enumerates the frequent and abundance species (>10 %) on the roadside in the study area. The ordination was performed by CANOCO (ter Braak and Smilauer, 1998). The DCA analysis divided the vegetation into five major communities, representing the major herbaceous flora of the study area. These communities differ from each other on the basis of difference in effects of different environmental attributes on them. The species away from major groups were discarded as outliers, as they had no distinct role in the grouping of species. The ordination diagram, in the results of such study done by He *et al.*, (2006), divided the vegetation of the area into five major groups, when analyzed; the graph showed that community 1 and 2 were transitional in their composition between the other groups.

In order to understand vegetation-soil correlation, another multivariate technique CCA was applied. pH and EC were entered as soil variables in the software. The results indicated that plant species showed strongest correlation with soil temperature and EC. However pH portrays less strong correlation, in the distribution of species. This study emphasized the importance of road verges and they can be used to preserve natural/ indigenous flora.

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