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SOME PHYTOSOCIOLOGICAL STUDIES OF CHASMOPHYTES AND EDIPHYTES OF LAHORE CITY

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Abstract

A phytosociological Survey of chasmophytes and ediphytes of Lahore city was carried out during Dec. 2009 to Nov. 2010. Twenty stands of chasmophytic vegetation at different locations of the city were selected for sampling using $1 \times 1m^2$ size quadrats and a total of 52 Chasmophytes belonging to 25 families included 37 herbs, 8 shrubs and 7 trees were recorded. The chasmophytic data was analyzed by agglomerative clustering technique. Cluster analysis showed the existence of five major communities of chasmophytes with different dominants in study area. The five groups of vegetation that emerged from cluster analysis were found associated with edaphic variables such as electrical conductivity and soil organic matter, which were found particularly important in plant association constitution and distribution. On the other hand, a total of 35 species of Ediphytes belonging to 18 families were also recorded. The families Poaceae, Moraceae, Euphorbiaceae, Malvaceae, Brassicaceae, Amaranthaceae and Solanaceae were found including highest number of species, causing rigorous damage to buildings and growing along the pipe lines leakage, sewerage water and water tanks.

Introduction

Lahore is the capital of the province of Punjab and the second largest city in Pakistan after Karachi. Lahore lying between 31°15′—31°45′ N and 74°01′—74°39′ E, is bounded on the North and West by the Sheikhupura District, East by Wagah and South by Kasur District. Lahore city being 217m above sea level covers an area of 404 km² (Govt. of the Punjab, 2007).

Ediphytes or “Building plants” are vascular plants growing out from the moist wall crevices and cracks caused by leaking sewage pipes of the neglected and dilapidated, multi storeyed buildings (Hussain *et al.,* 2010). Ediphytes are an important factor within urban areas and archaeological sites, but they can also cause damage to buildings and structures through direct or indirect root processes. The most destructive weapons of building-plants are their roots, which find their way to cracks and crevices and develop tremendous mechanical and hydraulic pressure that separates bricks, plaster and lifts the concrete to create larger cracks in the buildings (Caneva *et al.,* 2008). Mishra *et al.*, (1999) discussed the role of higher plants in the deterioration of historic buildings. Almeida *et al.,* (2002) reported the weathering ability of higher plants. The historical buildings of Lahore city are in decrepit conditions showing depredation of time. All such structures provide a unique habitat for the development of a specialized flora. From botanical point of view, walls of these buildings represent a specific environment, partly similar to rocks and rock fissures (Presland, 2008).

Chasmophytes are crevices plants growing in abandoned places, cracked footpaths, and damaged foundations of buildings. The disturbance may be natural, e.g., wildfires or avalanches, or due to anthropogenic influences or constructional, e.g. road constructions, building constructions or mining, or agricultural, e.g., abandoned farming fields or abandoned irrigation ditches. These are stress tolerant vascular plants and indicators of disturbed areas. Uneven soil shrinkage under the foundation of building can lead to uneven settlement and building foundation damage (Sitaramam *et al*., 2009). Terzi & Dimco (2008) studied the Chasmophytic vegetation in South-eastern Italy. They reported a phytosociological study of chasmophytic vegetation throughout the entire distributional range of south-eastern Italy.

The present study focuses on identification of plants growing in the crevices and walls of historical buildings of Lahore city and to determine the attributes of the different types of communities of Chasmophytes prevailing in the study area.

Materials and Methods

Extensive Field Surveys were conducted during Dec. 2009 to Nov. 2010 to identify all the ediphytes (trees and shrubs) growing in the area and potentially responsible for degradations. The plant specimens were collected, mounted on herbarium sheets and identified through the available taxonomic literature, i.e. Flora of Pakistan (Nasir & Ali, 1971-2005; Ali & Qaiser, 1997-2009) and then submitted to Dr. Sultan Herbarium, Botany Department GC University, Lahore, Pakistan as voucher specimens.

The chasmophytes were quantitatively analysed using quadrats for various Phytosociological attributes such as % Density according to Ambshat & Ambshat (1969), % Frequency after Oosting (1956), Importance Value (I.V.) after Curtis (1959) were calculated for each quadrat. The relative values of frequency and density were summed to determine Importance value (IV) in a particular stand after Curtis (1959). Every species was ranked according to their importance value. The species with the highest importance value in the stand was considered as the dominant species. Information regarding Life form spectra was calculated after Raunkiaer (1934). Global positioning systems (GPS) were used to estimate the latitude and longitudes of selected sites (**Table** 1).

Table 1. Geographical coordinates of each sampling sites.

Stand No.	Location	Latitude	Longitude	Elevation
1.	Lahore Cantt	31º 30.84	74 º 21.876	205m
2.	Mall Road	31º 34.11	74 º 18.33	208m
3.	Ghalib Market	31º 34.280	74 º 18.482	208m
4.	Railway Station	31º 34.280	74 º 18.488	208m
5.	Anarkali	31º 34.286	74 º 18.482	209m
6.	Gawal Mandi	31º 33.10	74 º 18.444	209m
7.	Shahdara	31º 37	74 º 16	212m
8.	Lahore Fort	31º 17.07	74 º 18.36	211m
9.	Jahangirs Tomb	31º 37.07	74 º 17	212m
10.	Jail Road	31º 33.50	74 º 19.20	207m
11.	Davis road	31º 32.10	74 º 18.22	210m
12.	Thokar Niazbag	31º 34.248	74 º 18.46	209m
13.	Multan Road	31º 34.33	74 º 18.465	207m
14.	Scheme Morr	31º 34.0	74 º 18.44	207m
15.	Chaburji Road	31º 34.11	74 º 18.20	209m
16.	Samnabad	31º 34.33	74 º 17.99	210m
17.	Circular Road	31º 34.21	74 º 18.46	208m
18.	Canal Road	31º 34.11	74 º 18.21	209m
19.	Queens Road	31º 34.23	74 º 18.468	208m
20.	Temple Road	31º 34.28	74 º 18.45	209m

For soil analysis, the samples were collected from each stand. After removing litter from the surface, soil was dug out from 0-15cm randomly from each stand. About 500g of each soil sample was placed in polyethylene bags and sample was mixed well individually before use. The analytical work was carried out in the Environmental Research Laboratory, Botany Department GC University, Lahore, and samples were analyzed for different physiochemical characteristics such as soil texture, soil moisture contents, soil organic matter and soil EC as described by Richards (1954), Allen (1974) and Saeed (1980).

The multivariate analyses were performed using the package PC-ORD ver. 5.10 (McCune & Grace, 2002) which explains 10.74 Percent chaining. The goal of this last procedure was to test whether the groups obtained through classification correspond to communities in which there was a clear dominance and constancy of one or more species.

Results

a. Ediphytes: In all the 668 individuals of Ediphytes observed, 571 Angiospermic plants belong to woody plants (Trees) and other 97 belong to shrubs and herbaceous plants. Woody Ediphytes include 13 species belonging to 7 families, out of these 558 plants or 83.3% belonged to family Moraceae and genus *Ficus* can be considered as the most successful plant to grow in the crevices and cracks of the buildings. *Ficus religiosa* L. (409 plants or 61.2%) is the most stress tolerant and successful ediphyte.

Remaining six ediphytic trees from family Moraceae include *Ficus benghalensis* L. (86 plants or 12.8%), *Ficus elastica Roxb. ex. Hornem* (37 plants or 5.5%), *Ficus glomerata* Roxb. (18 plants or 2.7%), *Ficus virens* L. (5 plants or 0.7%), *Morus alba* L. (2 plants or 0.3%) and *Broussonetia papyrifera* (L.) Vent., (1 plant or 0.1%). Among the remaining 1.9% of the ediphytic woody plants, (2 plants or 0.3%) belong to *Bombax ceiba* L., (2 plants or 0.3%) to *Dalbergia sissoo* Roxb., (1 plants or 0.1%) to *Salvadora persica* L., (2 plants or 0.3%) to *Eucalyptus citriodora* Hook., (2 plants or 0.3%) to *Azadirachta indica* A. Juss. and (4 plants or 0.6%) belong to *Ziziphus mauritiana* Mill.

Among the 97 individuals of ediphytic shrubs and herbs observed near very moist and damp places and found under the leaking drainage pipes, gutters, roofs, bell towers, or any crack in the siding, belong to 22 species of 12 families. Among them 24 plants or 3.3% belong to family Poaceae, (10 plants or 1.5%) belong to family Amaranthaceae , 22 plants or 3.2% belong to family Euphorbiaceae and rest of the other 41 plants belong to 9 other families.

b. Chasmophytes: A detail list of the Chasmopytes with their respective families is presented in Table 2. The results indicated that a total of 52 species were recorded from railway tracks, foot paths and foundation of the buildings in the study area. These Chasmophytic species, belonging to 24 families included 36 herbs, 9 shrubs and 7 tree species show that the area is providing a diverse habitat for the growth of different plant species.

Multivariate analysis

1. **Cluster analysis (CA):** A species sample IV input data matrix was made for 20 stand and 52 species. The dendrogram resulting from cluster analysis for data using Ward's method is shown in **Fig.** 1. Hierarchical, agglomerative, Euclidean (Pythagorean) cluster analysis, joined by Ward's method has resulted in five groups including one isolated group which was excluded from calculation. The five groups derived from cluster analysis, as follows were shown in two-way cluster analysis.

Group I– *Dactyloctenium - Setaria* community: This group comprised 23 species such as *Broussonetia papyrifera, Vigna* sp., *Solanum nigrum, Setaria pumila, Conyza canadensis, Farsettia jaquemenfolium, Parthenium hysterophorous, Achyranthes aspera, Zaleya pentandra, Celosia argentia, Dactyloctenium aegyptium, Chenopodium murale, Setaria verticillata, Sporobolus coromandelianus, Dalbergia sissoo, Cassia occidentalis, Ziziphus mauritiana, Euphorbia indica, Trianthema portulacastrum , Acacia nilotica, Alternanthera pungens, Coronopus didymus* and *Euphorbia hirta.* Group I is characterized by the predominance of *Dactyloctenium aegyptium* 11.55% importance value while *Setaria pumila* was second dominant species with importance value of 9.158%.

Group II– *Tribulus - Polygonum* community: This group comprised 5 species such as *Polygonum plebejum, Commelina benghalensis, Tribulus terrestris, Verbascum thapsus* and *Digitaria* sp. *Tribulus terrestris* was dominated in group II attained 5.5% average importance value while co-dominant species *Polygonum plebejum* occupied 3.265% average importance value.

Table 2. List of common Chasmophytic species along with their respective families, life form and voucher number.

Family	Chasmophytes	Life form	Voucher no.
Aizoaceae	1. *Trianthema portulacastrum* L.	TH	GC.Herb.Bot.897
	2. *Zaleya pentandra* (Linn.) Jeffrey.	TH	GC.Herb.Bot.898
Amaranthaceae	1. *Amaranthus viridus* L.	TH	GC.Herb.Bot.865
	2. *Achyranthes aspera* L.	CH	GC.Herb.Bot.864
	3. *Alternanthera pungens* Kunth.	TH	GC.Herb.Bot.899
	4. *Alternanthera citrus* L.	TH	GC.Herb.Bot.900
	5. *Celosia argentia* L.	TH	GC.Herb.Bot.901
Asclepiadaceae	*Calotropis procera* (Ait.)	CH	GC.Herb.Bot.867
Asteraceae	1. *Xanthium strumarium* L.	TH	GC.Herb.Bot.903
	2. *Eclipta alba* L.	TH	Gc.Herb.Bot.904
	3. *Conyza Canadensis* L.	TH	Gc.Herb.Bot.905
	4. *Parthenium hysterophorous* L.	TH	Gc.Herb.Bot.906
Brassicaceae	1. *Coronopus didymus* (L.) Smith.	TH	Gc.Herb.Bot.907
	2. *Farsettia jaquemontii* Hook. F. & Thoms.	TH	Gc.Herb.Bot.869
Caesalpiniaceae	*Cassia occidentalis* L.	NP	Gc.Herb.Bot.902
Chenopodiaceae	1. *Chenopodium album* L.	TH	Gc.Herb.Bot.909
	2. *Chenopodium murale* L.	TH	Gc.Herb.Bot.910
Commelinaceae	*Commelina benghalensis* L.	TH	Gc.Herb.Bot.911
Cyperaceae	*Cyperus rotundus* L.	TH	Gc.Herb.Bot.913
Euphorbiaceae	1. *Euphorbia prostrata* Ait.	TH	Gc.Herb.Bot.871
	2. *Euphorbia indica* L.	TH	Gc.Herb.Bot.914
	3. *Euphorbia hirta* L.	TH	Gc.Herb.Bot.870
Fabaceae	1. *Dalbergia sisso* Roxb.	MP	Gc.Herb.Bot.873
	2. *Vigna radiata* L.	TH	Gc.Herb.Bot.915
Malvaceae	1. *Malvastrum coromandelianum* L.	TH	Gc.Herb.Bot.916
	2. *Abutilon indicum* (L.) Sweet.	CH	Gc.Herb.Bot.917
	3. *Malva parviflora* Wall.	H	Gc.Herb.Bot.918
Meliaceae	*Azadirachta indica* A. Juss.	MP	Gc.Herb.Bot.874
Mimosaceae	*Acacia nilotica* (Linn.) Delile	MP	Gc.Herb.Bot.897
Moraceae	1. *Ficus religiosa* L.	MP	Gc.Herb.Bot.897
	2. *Morus alba* L.	MP	Gc.Herb.Bot.920
	3. *Broussonetia papyrifera* (L.) Vent.	MP	Gc.Herb.Bot.875
Nyctaginaceae	*Boerhavia procumbens* Banks ex Rxb.	CH	Gc.Herb.Bot.882
Oxalidaceae	*Oxalis corniculata* L.	TH	Gc.Herb.Bot.883
Polygonaceae	*Polygonum plebejum* R.Br.	TH	Gc.Herb.Bot.121
Portulacaceae	*Portulaca oleracea* L.	TH	Gc.Herb.Bot.923
Rhamnaceae	*Ziziphus mauritiana* Mill.	MP	Gc.Herb.Bot.884
Solanaceae	1. *Solanum nigrum* L.	TH	Gc.Herb.Bot.924
	2. *Verbascum thapsus* L.	TH	Gc.Herb.Bot.925
	3. *Datura innoxia* Mill	CH	Gc.Herb.Bot.926
	4. *Withania somnifera* (L.) Dunal	CH	Gc.Herb.Bot.887
Poaceae	1. *Cynodon dactylon* (L.) Pers.	H	Gc.Herb.Bot.888
	2. *Dactyloctenium aegyptium* (L.) P.Beauv.	H	Gc.Herb.Bot.889
	3. *Digitaria radicosa* Presl.	H	Gc.Herb.Bot.927
	4. *Eragrostis minor* Host.	H	Gc.Herb.Bot.890
	5. *Lolium temulentum* L.	H	Gc.Herb.Bot.891
	6. *Eleusine indica* (L.) Gaerth.	H	Gc.Herb.Bot.928
	7. *Setaria pumila* (Poir.) Roem. & Schult.	H	Gc.Herb.Bot.893
	8. *Setaria verticillata* (L.) P. Beauv.	H	Gc.Herb.Bot.931
	9. *Sporobolus coromandelianus* (Retz.) Kunth	H	Gc.Herb.Bot.895
Verbenaceae	*Lantana camara* L.	NP	Gc.Herb.Bot.932
Zygophyllaceae	*Tribulus terrestris* L.	TH	Gc.Herb.Bot.896

Key: MP= Megaphenarophyte, NP= Nanophenarophyte, TH= Therophyte, H= Hemicryptophyte, CH= Chamaephyte

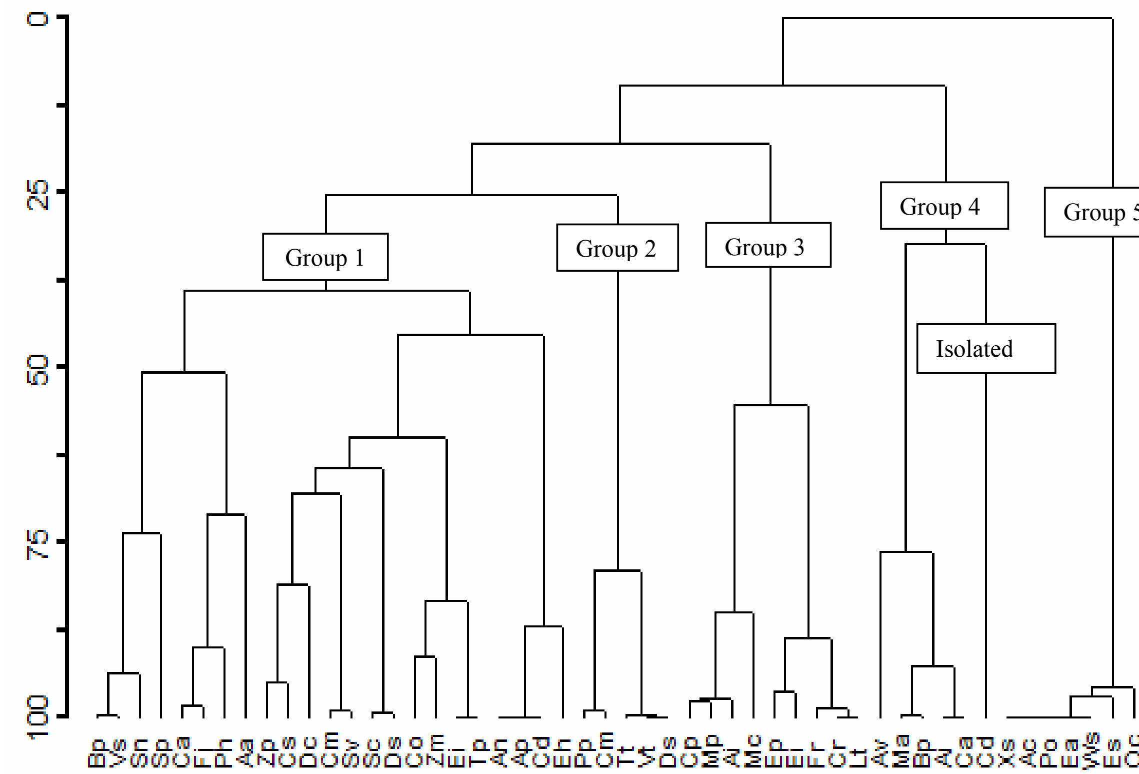

Fig. 1. Dendrogram derived from cluster analysis of chasmophytes species by Ward's method using data of 20 stands.

Group III– *Malvastrum-Calotropis-Ficus* community: This community comprised 9 species such as *Calotropis procera, Malva parviflora, Abutilon indicum, Malvastrum coromandelianum, Euphorbia prostrata, Eleusine indica, Ficus religiosa, Cyperus rotundus* and *Lolium* sp. Group III was dominated by *Malvastrum coromandelianum* (average importance value=11%) while *Calotropis procera* and *Ficus religiosa* were codominant species with importance values 3.87% and 3.65%.

Group IV– *Boerhavia- Amaranthus- Morus* community: This community comprised five species such as *Amaranthus viridus, Morus alba, Boerhavia procumbens, Azadirachta indica* and *Chenopodium album. Boerhavia procumbens* was the leading species with importance value of 4.4%, while *Amaranthus viridus* and *Morus alba* were co-dominant species with importance value of 3.65 % and 3.47%.

Group V– *Alternanthera – Xanthium- Portulaca* community: This community comprised seven species such as *Xanthium strumarium, Alternanthera citrus, Portulaca oleracea, Eclipta alba, Withania somnifera, Eragrostis minor* and *Oxalis corniculata. Alternanthera citrus* was the leading species with importance value of 11%, while *Xanthium strumarium* and *Portulaca oleracea* were co-dominant species with importance value of 7.5 % and 7%.

Discussion

Ediphytes mostly occupied the cracks and crevices of old buildings as well as the historical sites of city and *Ficus religiosa* emerged as predominant tree species, may be due to its potential to sustains wherever moisture is available causing serious damages to the buildings by its thick lignified roots, however it has the ability to tolerate long period of intermittent drought. This statement is in agreement with the findings of Sitaramam *et al*., (2010) that *Ficus religiosa* was the most abundant tree in north-west India perched on the vertical sheer of rock piles and top of ancient buildings with its 'stem–root junction expanding into thallus-like evocative structures' appearing logical and deserving serious consideration. Similar results were also reported by Hussain *et al*., (2010) in Karachi. It is also worth to mention that most of the Ediphytes were found to be growing along the pipe lines leakage, sewerage water and also abundant near water tanks. This may be due to the hydrophobic and shade loving nature of these plants. This view can be supported by Archibold & Wagner (2006).

In the present study attempt has been made to describe the Ediphytic as well as Chasmophytic vegetation of Lahore city. The results indicated that a total of 52 species were recorded from crevices of railway tracks, foot paths and foundation of buildings in the study area. The agglomerative clustering technique applied on the IV input data of 52 species and 20 stands was proved to be useful in classifying the stands into five groups of Chasmophytes occur in the study area. The results indicated that although the plant communities are though diverse and the diversity varies greatly, poor floristic similarities among the groups are seen. However, it was noticed that due to dense population of the city these plant communities are under extreme biotic or anthropogenic pressure. The seeds germination is poor due to tampering effect of cattle's and humans. These observations of the present work are in line with the findings of Dorney *et al*., (1984) and Freedman (2004).

Phytosociological and soil studies helped to understand the formation of plant communities (Ali & Kauser, 2006). The distribution of vegetation is correlated with the changes in the soil characteristics (Asplin & Fuller, 1986). It was recorded that edaphic factors played a very important role in plant community formation and vegetation composition in the study area. The results showed that there were no marked influence of topographic factors like elevation and slope gradient due to the fact that all the stands studied had no significant difference, being located on almost similar elevation and degree of slope due to flat surface. The factors contributing to vegetational gradients were EC and soil organic matter. Vegetation types dominated by *Dactyloctenium-Setaria* community and *Malvastrum-Calotropis-Ficus* communities were characterized by relatively high organic matter in comparison to other groups. Vegetation plays an important role in reducing nutrient leaching through nutrient adsorption and determines soil depth through holding of soil particles by plant roots. This is attributed to the soil OM and major nutrients like Ca, Mg and K that have a significant role in distribution of plant communities. Species richness strongly correlates with organic matter (Ali & Malik, 2010).

The vegetation types dominated by *Boerhavia-Amaranthus-Morus* community and *Alternanthera–Xanthium- Portulaca* community were characterized by relatively high electrical conductivity in comparison to other groups. It is a well known fact that different plant species have different salt tolerance level. There is not much information available concerning the plant species studied and salinity in Lahore. However, the results were in conformity with the findings of Roshier *et al*., (1996); Boer (1996) and Boer & Sargeant (1998).

However, it may be possible that the vegetation reflects the effect of rainfall water residue which break the dormancy of seeds and provide soluble nutrients to the growing seedlings in drought period. Parveen *et al*., (2008) and Kabir *et al*., (2010) pointed out that the vegetation pattern and density were greatly influenced by the rainfall especially in the urban areas.

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