Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 9, No. 1, p. 194-203, 2016
http://www.innspub.net

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RESEARCH PAPER

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Multivariate analysis of plant communities of Jhika Gali jogging track of Tehsil Murree, Pakistan through two way indicator species analysis (TWINSPAN)

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Article published on July 21, 2016

Key words: Multivariate Analysis, Plant Communities, Tehsil Murree, TWINSPAN.

Abstract

In order to study the plant community structure of the Jhika Gali of Tehsil Murree, Pakistan, a multivariate approach i.e. Two Way Indicator Species Analysis was used along with this Importance Value Index (IVI) of plant species present in these communities were calculated. Total 71 quadrats were taken, in which 119 plant species belonging to 43 plant families were recorded. Among which one family Adiantaceae represents Pteridophytes, family Coniferae belongs to Gymnosperms, family Poaceae to monocots and rest of the families belong to dicot families. Among which family Asteraceae was found dominant with 20 plant species followed by family Labiatae with 9 plant species, followed by family Polygonaceae having 7 plant species. Six plant species were found in family Rosaceae and two families i.e. Acanthaceae and Papilionaceae contain 5 plant species each. Family Convolvulaceae, Geraniaceae and Ranunculaceae contain 4 plant species each and family Balsaminaceae, Gentianaceae and Umbelliferae contain 3 plant species each followed by family Apocynaceae, Caprifoliaceae, Cupuliferaceae, Oleaceae and Rubiacea contain 2 plant species each. Moreover, rest of the 23 plant families having one plant species each. Moreover, two main groups of plant communities were formed through TWINSPAN, in which group-I represent 19 plant species and group-II is comparatively a larger group having two major plant communities which are having two sub associations each. Plant community-I contain 16 and 45 plant species by both of the subassociations respectively and two sub associations of plant community-II contain 6 and 33 plant species respectively.

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Introduction

Murree hills once known as "Thanda Jungle" is under immense pressure of over population and unplanned tourism. In order to fulfill the living needs of the local community and the tourists, rapid civil work is going on in and around these hills. For catering the needs of developing Murree, government has planned the "New Murree" project which will cover about 4,111 acres of the thick forest. In this very case the reserve forests of the Murree will lose 8% of the total forest. Moreover, the issue of urbanization is coupled with unmanaged tourism and solid waste management is creating problems of water and air pollution in the area. Above all, the construction of 43 Km long Murree Express Highway contributed a lot in heavy landslides which ultimately contributed in the loss of biodiversity particularly the forest diversity (Ali, 2012; IUCN-Pak, 2005).

Importance of these forests is recognized, as its rapid loss in the area resulting in change of climatic conditions which are also changing the composition of the plant communities in the area. For enhancing the landscape beauty and conservation status of the plants such studies has its own importance. Study like this not only helps to prepare the checklist of the plants of the area but also it narrates the distribution pattern of the plant communities of the area which are considered as the key factors in determination of environmental conditions (Woodward, 1992). Several studies have been performed by various ecologists in various parts of Pakistan and World which are listed below which enhances the importance of the methods used to evaluate the plant communities of the study area.

Abbas *et al.* (2009) highlighted the phytosociological analysis in the range of Grey Goral in Pakistan and in Azad and Jammu Kashmir by using TWINSPAN. Total ninety nine including twenty two trees, twenty four shrubs, thirty one herbs and fifty two grasses.

Kharkwal *et al.* (2009) carried out phytosociological analysis, composition and diversity among the herbs in the sub-tropical forests of Central Himalayan. A total of 111 herbaceous species, representing 87 genera and 36 families were recorded.

Ahmad (2009) carried out a study on the growth, distribution, classification of herbaceous flora in Margalla Hills National Park, Islamabad. In 30 quadrats, total of 52 species of herbs belonging to 26 families were recorded. TWINSPAN was used for recognition of plant communities resulting in the identification of four plant communities.

Ali and Malik (2010a) conducted the community analysis in the open urban spaces viz., green belts, parks and gardens of Islamabad City. Total 162 plant species representing 137 genera and 58 families were estimated. Two Way Indicator Species Analysis (TWINSPAN) was used to classify the composition of floristic species into four major community types which showed overlapping in an ordination space.

Shaheen *et al.* (2011) surveyed natural vegetation of the Hanna Lake, Baluchistan by conducting TWINSPAN and DCA analysis. The area was divided into two zones in which Zone I had sixteen plant families and thirty eight plant species as recorded from two quadrats. Moreover, in Zone II thirty six plant species belonging to sixteen plant families were identified.

Hameed *et al.* (2012) explored the floral diversity of the Himalayan foothill region of Murree (Punjab) in order to find out the structure of vegetation and conservation status of economically important plants. Total 248 plant species were recorded which were found distributed in fifty six plant families. Family Poaceae was found dominant with forty eight grass species.

Khan *et al.* (2012) studied the phytosociological attributes of the moist temperate vegetation of Thandiani Forest, district Abbottabad, Pakistan. Fifteen plant communities were recorded having ninety plant species in the form of twenty three shrubs, forty four herbs and twenty three trees.

Hussain *et al.* (2013) conducted the phytosociological survey to evaluate trends of thirty two stands of shrubs and herbs in the forests of Central Karakoram National Park (CKNP), Gilgit-Baltistan, Pakistan. First three dominant species were selected in the non-forested area depending upon phytosociological analysis and Important Value Index (IVI). Ahmad *et al.* (2013) studied the vegetation pattern along the motorway (M-1) from Rawalpindi to Attock district covering about 90 Kms. Total 145 plant species were identified belonging to 23 different plant families. These plant species were found to be distributed in between two main groups and fourteen sub groups (plant communities) by TWINSPAN analysis.

Ahmad *et al.* (2014) performed phytosociological studies by using the Two Way Indicator Species Analysis (TWINSPAN) in Changa Manga Forest, Lahore, Pakistan. During the study 45 plant species were identified from the area which was distributed among 24 plant families, representing through the hierarchical dendrogram.

Bokhari *et al.* (2016) studied the composition of plant communities in coniferous forests of Azad Kashmir, Pakistan through multivariate analysis. Results were interpreted by Cluster analysis in which six groups were found dominated by various pine species. In group I and V *Pinus wallichiana* was dominated and found co-dominant in group III and other species like *Abies pindrow, Cedrus deodara, Pinus roxburghii* and *Picea smithiana* were found in other groups. From the results, it was concluded that disturbance in the area was due to the natural anthropogenic activities and over grazing.

By considering the importance of the plant communities in well managed forests and its role in climatic conditions from above mentioned literature, present research work was planned to investigate the research area which comprises of Kuldana Reserve Forest and Kashmir Point Reserve Forest for its plant diversity and distribution pattern of plant communities in it. This study could serve as step forward towards the conservation efforts/status of the local flora.

Materials and methods

In order to study the attributes of plant communities (Phytosociology) of JhikaGali jogging track following methodology was adopted.

Sampling of plant communities

For this purpose random sampling technique was used by laying down quadrats of 10 m^2size for trees, shrubs and herbs (Clements, 1905).

Floristic composition

Floristic composition of the plant communities were determined by collecting and identifying the plant species with the help of available literature (Nasir and Ali, 1982; Ali and Nasir, 1990-92; Ali and Qaiser, 1992-2007).

Attributes of plant communities

Attributes of plant communities were studied by tabulating % Frequency (%F), Density (D) and % Cover after McIntosh (1962), Curtis & McIntosh (1950) and Daubenmire (1959) respectively. From these basic values, relative frequency (RF), relative density (RD) and relative cover (RC) was determined after Muller-Dombois & Ellenberg (1974). From these values, Importance Value Index (IVI) was calculated by following Risser and Rice (1971).

Two Way Indicator Species Analysis (TWINSPAN)

Moreover, for classification of plant communities, Two Way Indicator Species Analysis (TWINSPAN) was applied by using PC Ord-6.19 (Hill, 1979b; McCune and Mefford, 2010).

Results and discussion

Total 71 quadrats were taken to analyze the vegetation structure of the study area. 119 plant species belonging to 43 plant families, among which family Adiantaceae represents Pteridophytes having two plant species, family Coniferae belongs to Gymnosperms with four trees, family Poaceae to monocots with seven grasses and rest of the families belong to dicot families. Among which family Asteraceae was found dominant with 20 plant species followed by family Labiatae with 9 plant species,

followed by family Polygonaceae having 7 plant species. Six plant species were found in family Rosaceaeand two families i.e. Acanthaceae and Papilionaceae contain 5 plant species each. Family Convolvulaceae, Geraniaceae and Ranunculaceae contain 4 plant species each and family Balsaminaceae, Gentianaceae and Umbelliferae contain 3 plant species each followed by family Apocynaceae, Caprifoliaceae, Cupuliferaceae, Oleaceae and Rubiaceae contain 2 plant species each. Moreover, rest of the 23 plant families having one plant species each with variable Importance Value Index as shown in table 1.

Table 1. Importance Value Index (IVI) of Plant Species of JhikaGali Jogging Track along with their Abbreviations.

S. No.	Family	Plant Species	Abbrevia-tions	Relative Frequency	Relative Density	Relative Cover	IVI*
01	Acanthaceae	*1.Diclipterabupleuroides* Nees in Wall.	Dic-bup	13.50	25.45	7.75	15.56
		2.Strobilanthesurticifolia Wall. ex Kuntze	Str-urt	10.50	13.45	11.75	11.9
		3.S. wallichii Nees in Wall.	Str-wal	7.85	12.31	18.75	12.97
		*4.S. glutinosus*Nees.	Str-alu	9.78	11.35	13.46	11.53
		5.S. attenuates Nees.	Str-att	14.76	11.78	14.45	13.66
02	Adiantaceae	1.*Adiantum capillu-veneris* L.	Adi-cap	16.63	13.75	6.65	12.34
		2.*A. caudatum* L.	Adi-cau	6.65	11.78	4.45	7.62
03	Amaranthaceae	*1.Amaranthus viridis* L.	Ama-vir	13.11	15.67	18.98	15.92
04	Anacardaceae	*1.Rhus cotinus* L.	Rhu-cot	6.77	23.32	67.55	32.54
05	Apiaceae	*1.Trachyspermum ammi* Sprague	Tra-amm	11.43	6.59	8.72	8.91
06	Apocynaceae	1.*Nerium indicum* Mill	Ner-ind	13.72	14.83	21.66	16.73
		2.*Vinca major* L.	Vin-maj	21.41	7.75	13.6	14.25
07	Araliaceae	1.*Hedera nepalensis* K. Koch	Hed-nep	8.43	7.11	6.11	7.21
08	Asteraceae	1.*Achillea millefolium* L.	Ach-mil	6.07	7.13	11.13	8.11
		2.*Ageratum conyzoides* L.	Age-con	7.88	3.34	9.33	6.85
		3.*Ainsliaea aptera* Dc.	Ain-apt	13.11	12.46	11.78	12.45
		4.*Anaphalis contorta* Dc.	Ana-con	7.76	6.65	3.32	5.91
		5.*Anthemis cotula* L.	Ant-cot	5.88	22.33	38.66	22.29
		6.*Artemisia vulgare*L.	Art-vul	16.76	15.43	11.89	14.89
		7.*Astermolliusculus* (DC.) C.B. Clarke	Ast-mol	58.72	65.32	31.76	51.93
		8.*Bellis perennis* L.	Bel-per	51.43	17.88	21.56	30.29
		9.*Bidensbiternata* (Lour.) Merr. &Sherff	Bid-bit	16.65	13.32	11.76	13.91
		10.*Conyza bonariensis* L.	Con-bon	11.32	9.33	3.11	7.92
		11.*Launaea nudicaulus* L.	Lau-nud	13.78	6.11	2.11	7.33
		12.*Parthenium hysterophorus*L.	Par-hys	31.32	21.63	27.89	26.94
		13.*Senecio chrysanthemoides* Dc.	Sen-chr	6.33	5.11	8.99	6.81
		14.*Serratula pallida* L.	Ser-pal	3.11	2.15	3.44	2.9
		15.*Silybummarianum*(L.) Gaertn.	Sil-mar	4.16	2.68	5.73	4.19
		16.*Sonchusasper*(L.) Hill	Son-asp	7.86	8.11	6.33	7.43
		17.*Tagetesminuta*L.	Tag-min	3.78	6.75	9.65	6.72
		18.*Traxacumofficinale* (L.) Weber ex F.H. Wigg	Tra-off	3.78	5.44	7.48	5.56

S. No.	Family	Plant Species	Abbrevia-tions	Relative Frequency	Relative Density	Relative Cover	IVI*
		19.*Tricholepisfurcata* DC.	Tri-fur	1.78	2.43	4.11	2.77
		20.*Xanthium strumarium* L.	Xan-str	7.78	9.11	8.32	8.4
		1.Impatiens brachycentra K. and K.	Imp-bra	19.78	11.73	32.33	21.28
09	Balsaminaceae	*2.I. edgeworthii*Hk.f.	Imp-edg	17.88	13.43	11.32	14.21
		3.I. glandulifera Royle	Imp-gla	6.33	11.45	10.78	9.52
10	Boraginaceae	*1.Cynoglossumlanceolatum* Forssk.	Cyn-lan	1.11	1.32	1.78	1.40
11	Buxaceae	1.*Sarcococcasaligna* (D.Don) Muell.	Sar-sal	6.23	4.32	11.75	7.43
12	Cannabaceae	*1.Cannabis sativa* L.	Can-sat	23.32	32.13	35.68	30.43
13	Caprifoliaceae	*1.Viburnum cotinifolium* D. Don	Vib-cot	4.11	3.11	15.65	7.62
		*2.V. nervosum*D. Don	Vib-ner	3.12	2.63	13.42	6.39
14	Caryophllaceae	1.*Vaccaria hispanica*(Miller)	Vac-his	1.32	0.77	0.13	0.74
		1.Pinus roxburghii Sargent	Pin-rox	32.33	23.78	68.72	41.61
15	Coniferae	*2.P. wallichiana* A.B. Jacks.	Pin-wal	21.56	29.76	75.43	42.25
		3.Cedrusdeodara Loudon.	Ced-deo	13.22	6.33	56.63	25.39
		4.Taxus baccata L.	Tax-bac	7.78	7.11	42.58	19.15
		1.Convolvulus arvensis L.	Con-arv	1.45	2.45	3.11	2.33
16	Convolvulaceae	*2.Ipomoea alba* L.	Ipo-alb	1.76	1.43	0.11	1.1
		3.I. purpurea (L.) Roth	Ipo-pur	1.13	2.13	1.18	1.48
		*4.Porana paniculata*Roxb., Bridal Wreath	Por-pan	1.76	2.95	0.66	1.79
17	Coriariaceae	*1.Coriarianepalensis* Wall.	Cor-nep	1.76	2.13	0.13	1.34
18	Cornaceae	*1.Cornusmacrophylla* Wall. exRoxb.	Cor-mac	3.11	2.33	15.43	6.95
19	Cucurbitaceae	1.*Coccinia grandis* L.	Coc-gra	1.43	1.55	0.76	1.24
20	Cupuliferae	*1.Quercusincana*Roxb.	Que-inc	11.32	9.32	22.26	14.3
		*2.Q. dilatata*Lindi.	Que-dil	7.32	8.11	13.23	9.55
21	Cuscutaceae	1.*Cuscutareflexa*Roxb.	Cus-ref	2.32	1.32	4.32	2.64
		*1.Ciminalis kurroo*Adans	Cim-kur	3.11	7.88	2.76	4.58
22	Gentianaceae	*2.Swertiacordata*Wall.	Swe-cor	6.72	11.76	7.28	8.57
		*3.S. paniculata*Wall.	Swe-pan	4.42	3.78	4.33	4.17
		*1.Geraniumlucidium*L.	Ger-luc	7.88	11.23	12.33	10.48
23	Geraniaceae	*2.G. nepalense* Sw.	Ger-nep	11.32	6.38	4.33	7.34
		3.G. rotundifolium L.	Ger-rot	7.11	3.465	6.48	5.68
		4.G. wallichianum D. Don.	Ger-wal	5.45	3.23	2.11	3.9
24	Hippocastanaceae	*1.Aesculusindica* Colebr.	Aes-ind	6.56	8.72	63.42	26.23
		1.*Ajugabracteosa* Wall.	Aju-bra	3.43	2.56	3.73	3.24
		2.*Anisomeles* sp. R. Br.	Ani-sp.	5.11	3.76	2.11	3.66
		3.*Anisomelesindica* (L.) Kuntze.	Ani-ind	3.76	4.45	3.21	3.8
		4.*Clinopodium umbrosum* L.	Cli-umb	11.24	9.43	18.76	13.14
25	Labiatae	5.*Mentha sativa* L.	Men-sat	13.72	9.75	21.85	15.1
		6.*Nepeta* sp.	Nep-sp.	6.78	5.11	3.31	5.06
		7.*Phlomisspectabilis*Falc.	Phl-spe	3.78	4.23	3.11	3.7
		8.Prunella vulgaris L.	Pru-vul	16.38	32.33	11.43	20.04
		9.*Scutellaria linearis* Benth	Scu-lin	13.43	9.88	7.85	10.38

S. No.	Family	Plant Species	Abbrevia-tions	Relative Frequency	Relative Density	Relative Cover	IVI*
26	Oleaceae	*1.Jasminumgrandiflorum* Linn.	Jas-gra	6.72	5.11	21.75	11.19
		*2.J. mesyni*Hance	Jas-mey	9.87	6.75	16.78	11.13
27	Onagraceae	*1.Oenotherarosea* L. ex Ait., Hort.	Oen-ros	5.43	6.67	11.43	7.84
28	Oxalidaceae	*1.Oxalis corniculata* L.	Oxa-cor	6.67	5.13	2.13	4.64
		1.Desmodiumgangeticum (L.) DC.	Des-gag	13.12	22.45	45.43	27
		2.Indigofera heterantha L.	Ind-het	16.77	11.77	23.43	17.32
29	Papilionaceae	*3.Medicago polymorpha* L.	Med-pol	3.45	5.65	5.78	4.96
		4.Melilotus indica L.	Mel-ind	2.33	3.11	0.77	2.07
		5.Trifolium repens L.	Tri-rep	4.45	5.65	0.98	3.69
30	Plantaginaceae	1.*Veronica agrestris*L.	Ver-agr	3.11	4.11	0.67	2.63
		*1.Cenchrus cilliaris*L.	Cen-cil	5.67	6.65	3.11	5.14
		2.Cynodondactylon (L.) Pers.	Cyn-dac	11.32	7.11	4.65	7.69
		*3.Digitaria*sp. (L.) Scop	Dig-sp.	6.76	5.88	0.73	4.45
31	Poaceae	*4.Imperatacylindrica*(L.) P.Beauv.	Imp-cyl	0.33	0.45	1.76	0.84
		5.Poa annua L.	Poa-ann	1.33	1.56	0.45	1.11
		6.Setariapumila(Poir.) Roem. & Schult.	Ste-pum	1.33	1.74	0.68	1.25
		7.S. gluaca(L.) Beauv.	Ste-glu	1.09	0.89	0.56	0.84
		1.Persicariabarbata(L.) H.Hara	Per-bar	17.81	11.45	13.45	14.23
		2.P. nepalensis (Meissn.) H. Gross	Per-nep	13.11	12.32	13.11	12.84
		3.*Polygonumamplexicaule*D. Don	Pol-amp	21.65	7.78	19.78	16.4
32	Polygonaceae	*4.P.aviculare* L.	Pol-avi	3.14	2.45	4.32	3.3
		5.P. plebeium R.Br.	Pol-ple	1.32	1.78	0.56	1.22
		6.Rumexdentatus (L.) Mantissa	Rum-den	7.34	6.11	9.32	7.59
		7.R. hastatus D. Don.	Rum-has	3.11	2.68	3.45	3.08
33	Primulariaceae	*1.Anagalis arvensis* L.	Ana-arv	1.22	1.11	0.11	0.81
34	Ranunculaceae	*1.Clematis grata* Wall.	Cle-gra	13.11	6.78	9.25	9.71
		*2.C. montana*Buch.Ham. ex DC.	Cle-mon	7.86	4.78	8.87	7.17
		3.Ranunculus muricatus L.	Ran-mur	11.78	15.67	7.21	11.55
		4.R. sceleratus L.	Ran-sec	10.11	12.33	6.11	9.51
		*1.Berberis lyceum*Royle	Ber-lyc	5.65	7.90	15.65	9.73
		2.Duchesnea indica (Andrews) Focke in Engl. &Prantl	Duc-ind	13.23	8.99	7.85	10.02
35	Rosaceae	*3.Fragariavesca* Hook. f.	Fra-ves	6.66	4.45	6.11	5.74
		*4.Potentilla*sp.L.	Pot-sp.	1.33	2.11	0.45	1.29
		5. Pyruspashia L.	Pyr-pas	5.67	7.11	33.11	15.29
		6.Rosabrunonii Lindl.	Ros-bru	9.11	6.33	11.32	8.91
36	Rubiaceae	*1.Galium aparine* L.	Gal-apa	3.11	6.88	23.45	11.14
		2.G. asperifolium wall.	Gal-asp	2.68	3.11	16.78	7.52
37	Rutaceae	*1.Skimmialaureola*Sieb. &Zucc.	Ski-lau	4.13	5.53	43.11	17.59
38	Sapindaceae	*1.Acer pictum*Thunberg	Ace-pic	7.11	5.55	43.18	18.61
39	Saxifragaceae	*1.Saxifrage ciliata* (Maximowicz) H. Ohashi	Sax-cil	11.22	6.76	11.75	9.91

S. No.	Family	Plant Species	Abbrevia-tions	Relative Frequency	Relative Density	Relative Cover	IVI*
40	Solanaceae	*1.Solanum nigrum* L.	Sol-nig	3.43	2.11	3.78	3.1
		*1.Bupleurumlanceolatum*Wall.	Bup-lan	3.11	2.76	4.89	3.58
41	Umbelliferae	*2.Eryngiumcoeruleum* M-Bieb.	Ery-coe	1.78	2.11	8.99	4.29
		3.Heracleumcandicans Wall. ex DC.	Her-can	3.76	3.11	3.89	3.58
42	Urticaceae	*1.Urtica dioca* L.	Urt-dio	5.67	8.96	11.13	8.58
43	Verbenaceae	1.*Verbena officinalis* L.	Ver-off	5.61	6.32	8.76	6.89

*IVI= Importance Value Index.

TWINSPAN Analysis of the Plant Species

Based upon the data collected from the study area, Two Way Indicator Species Analysis (TWINSPAN) was performed and from the results it was observed that plant species of the study area were divided into two main groups i.e. Group-I and Group-II as indicated in fig. 1.

Plant Communities of Group-I

Plant community of group-I represents some major indicator species of the moist temperate forest with IVI values in which *Pinus roxburghii* (41.61), *P. wallichiana* (42.25) and *Dicliptera bupleuroides* (15.56) with 16 other plant species with different Importance Value Index (IVI) values, which include *Urticadioca* (8.58), *Skimmia laureola* (17.59), *Berberis lyceum* (9.73), *Polygonum plebeium* (1.22), *Poaannua* (1.11), *Medicago polymorpha* (4.96), *Prunella vulgaris* (20.04), *Cuscuta reflexa* (2.64), *Ajuga bracteosa* (3.24), *Acer pictum* (18.61), *Duchesnea indica* (10.02), *Rumex dentatus* (7.59), *Setaria pumila* (1.25), *Melilotus indica* (2.07), *Scutellaria linearis* (10.38) and *Ipomea purpurea* (1.48) as shown in table 1 and fig. 1.

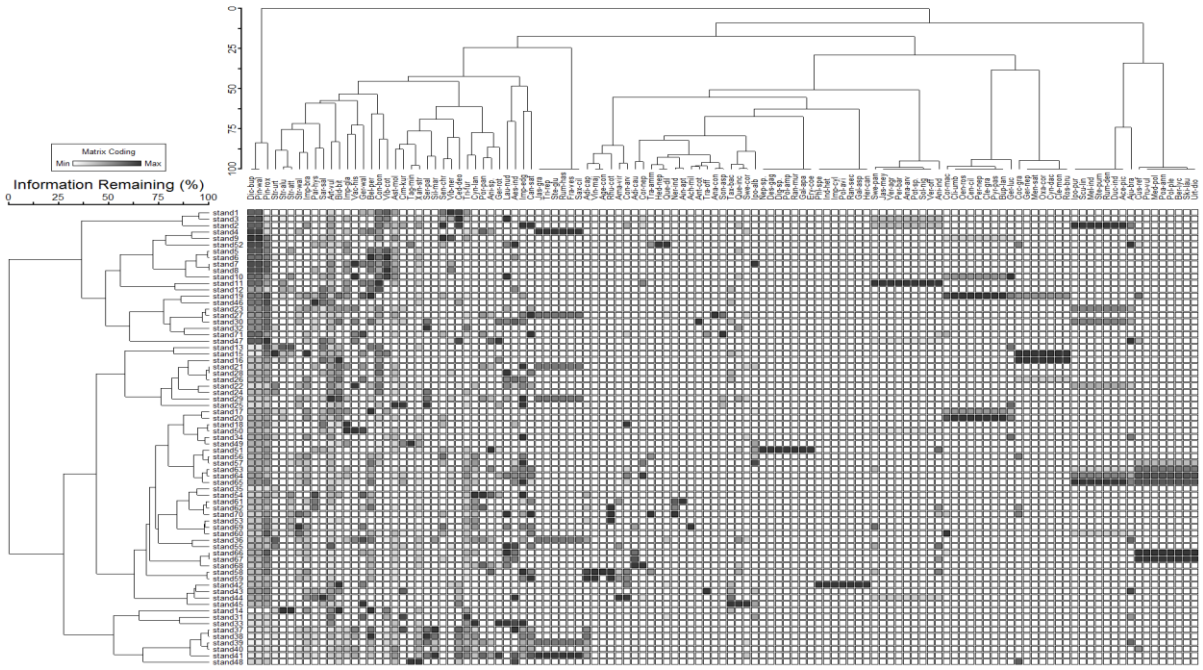

Fig. 1. Two Way Indicator Species Analysis of JhikaGali jogging track of Tehsil Murree, Pakistan.

Plant Communities of Group-II

It is comparatively a larger group of plant species making associations and sub associations. Two major plant communities with complex plant distribution pattern were found which are divided into sub associations.

Moreover, plant community-II have two sub association in which sub association-I represents the small community of plants with 6 plants and the sub association-II with second large community of the area with 33 plants as shown in fig. 1, the details of each these sub associations with their plant groups having different IVI values are as follows:

Phytosociological distribution of plant community-I

The plant community-I contain two sub associations among which the sub association-I is represented by 16 plant species and sub association-II by 45 plant species having different Importance Value Index (IVI). Sub association-I is represented by 16 plant species i.e. *Rosa brunonii* having 8.91 Importance Value Index (IVI), *Clematis Montana* (7.17), *Cynodon dactylon* (7.69), *Oxalis corniculata* (4.64), *Mentha sativa* (15.10), *Geranium nepalense* (7.34), *Coccinia grandis* (1.24), *G. lucidium* (10.48), *Bupleurum lanceolatum* (3.58), *Pyrus pashia* (15.29), *Clematis grata* (9.71), *Persicaria nepalensis* (12.84), *Cenchrus cilliaris* (5.14), *Oenothera rosea* (7.84), *Clinopodium umbrosum* (13.14) and *Cornus macrophylla* (6.95) as shown in table 1.

Forty five plant species were collected in sub association-II along with their IVI values which not only narrates the community structure of plants but also the distribution pattern of the plants within these communities. These plants are *Anisomeles indica* with 3.80 IVI, *Verbena officinalis* (6.89), *Solanum nigrum* (3.10), *Potentilla* sp. (1.29), *Anagalis arvensis* (0.81), *Persicaria barbata* (14.23), *Veronica agrestris* (2.63), *Jasminum mesyni* (11.13), *Swertiapan iculata* (4.17), *Heracleum candicans* (3.58), *Galiumas perifolium* (7.52), *Ranunculus sceleratus* (9.51), *Polygonum aviculare* (3.30), *Imperata cylinderica* (0.84), *Indigofera heterantha* (17.32), *Phlomis spectabilis* (3.70), *Eryngium coeruleum* (4.29), *Galium aparine* (11.14), *Ranunculus muricatus* (11.55), *Polygonum amplexicaule* (16.40), *Digitaria* sp.(4.45), *Desmodium gangeticum* (27.00), *Nepeta* sp.(5.06), *Ipomoea alba* (1.10), *Swertia cordata* (8.57), *Quercus incana* (14.30), *Taxus baccata* (19.15), *Sonchus asper* (7.43), *Traxacum officinale* (5.56), *Anaphalis contorta* (5.91), *Anthemis cotula* (22.29), *Achillea millefolium* (8.11), *Ainsliaea aptera* (12.45), *Nerium indicum* (16.73), *Quercus dilatata* (9.55), *Hedera nepalensis* (7.21), *Trachyspermum ammi* (8.91), *Coriaria nepalensis* (1.34), *Adiantum caudatum* (7.62), *Convolvulus arvensis* (2.33), *Amaranthus viridis* (15.29), *Rhus cotinus* (32.54), *Ageratum conyzoides* (6.85), *Vinca major* (14.25) and *Adiantum capillus-veneris* (12.34) as shown in table 1.

Phytosociological distribution of plant community-II

The plant community-II having two sub associations among which the sub association-I is represented by 6 plant species and sub association-II with 33 plant species along with variable IVI values. Sub association-I contain small plant community with 6 plant species i.e. *Saxifrage ciliata*, *Fragariavesca*, *Rumex hastatus*, *Setariagluaca*, *Trifolium repens* and *Jasminum grandiflorum* having 9.91, 5.74, 3.08, 0.84, 3.69 and 11.19 respectively.

Sub association-II contain 33 plant species represents the second largest plant community of the area. The plant species are *Cannabis sativus* (3.43), *Impatiens edgeworthii* (14.21), *Aesculus indica* (26.23), *Launaeanudicaulus* (7.33), *Geranium rotundifolium* (5.68), *Anisomeles* sp. (3.66), *Porana paniculata* (1.79), *Cynoglossum lanceolatum* (1.40), *Tricholepis furcata* (2.77), *Cedrus deodara* (25.39), *Viburnum nervosum* (6.39), *Senecio chrysanthemoides* (6.81), *Silybum marianum* (4.19), *Serratula pallida* (2.90), *Xanthium strumarium* (8.40), *Tagetes minuta* (6.72), *Ciminalis kurroo* (4.58), *Aster molliasculus* (51.93), *Viburnum cotinifolium* (7.62), *Conyza bonariensis* (7.92), *Bellis perennis* (30.29), *G. wallichianum* (3.90), *Vaccaria hispanica* (0.74), *I. glandulifera* (9.52), *Bidens biternata* (13.91), *Artemisia vulgare* (14.89), *Sarcococca saligna* (7.43), *Parthenium hysterophorus* (2.94), *I. brachycentra* (21.28), *Strobilanthes wallichii* (12.97), *S. attenuates* (13.68), *S. glutinosus* (11.53) and *S. urticifolia* (11.90) as shown in table 1.

Hilly areas like Murree are the richest zones of biodiversity but by ever increasing pressure of unchecked development in the area and the unmanaged tourism contributed towards the loss of the biodiversity. Along with these the dependence of the local community over these forests for food, medicine and fodder is also damaging the area. One of the biggest issue of the area is the encroachment which is day by day vanishing the forests from the "Queens of Hills", and associated problems are increasing day by day in the area like presence of garbage heaps along the slopes, due to improper solid waste management thus creating problems for the residents of Tehsil Murree in the form of increased crow, dog and mice density around the city (Ali, 2012; IUCN-Pak, 2005). Moreover, the issues of construction of new housing colonies, water pollution due to the untreated waste water polluting the nearby streams and the increasing number of the vehicles during the peak seasons of the tourism are some of the reasons which are ultimately contributing in the air pollution at present, unlike the past days. Such factors occurring in the area are resulting in the changed patterns of precipitation, land sliding, increased temperature and change in the composition of the plant communities (Malik, 2016; Ali, 2012).

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