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Phytoecological distribution of plant communities of two dominant tree species and their dendrochronological analysis in Jhika Gali, Murree, Pakistan

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Abstract

Naqvi, S. W., Muhammad, S., Tayyab, M., Khan, Z., Nawaz, H., Hanain, M., Khan, Z. and Mahrukh. (2023). Phytoecological distribution of plant communities of two dominant tree species and their dendrochronological analysis in Jhika Gali, Murree, Pakistan. *Bulg. J. Agric. Sci., 29*(6), 1027–1036

The research work is focused on dendroecological potential of *Pinus roxburghii* (Sarg.) and *Pinus wallichiana* (A. B. Jacks.) in Jhika gali of murree. Age, growth rate, height, diameter at breast height (dbh), and phytosociological attributes of these two pine species were determined. Increment borers were used to obtain samples from study site. 50 samples from each species were obtained. In *P. roxburghii* the growth rate varied between 0.93 cm/year to 0.58 cm/year with Dbh 193 and 189.5 cm, respectively. Height was measured in between 30.17 and 18.6 m. In first stand of *P. roxburghii* maximum growth rate was 0.93 inches/year and minimum in growth rate in second stand was 0.58 cm/year with Dbh 193 and 189.5 cm, respectively. There was an inverse correlation between growth rate and dbh, but growth rate and height it was direct. In *P. wallichiana* growth rate varied between 1.3 cm/year with dbh 64 cm and 0.41 cm/year with dbh 105.1 cm. The relationship observed between height and growth rate was directly proportional in *P. wallichiana*, while it was inverse between dbh and growth rate. In Phytosociology, 92 species were collected belonging to 44 different families. IVI values of various species varied between minimum 0.99 and maximum 2.65. TWINSPAN is indicating the diverse nature of plant communities with diverse nature of grouping. Group I (G 1), Group II (G 3) has biodiversity in some of stands while Group II (G 2) has greatest biodiversity with five subgroups and subsequent associations.

Keywords: Dendrochronology; Phytosociology; TWINSPAN; *Pinus roxburghii*; *Pinus wallichiana*

Introduction

Dendrochronology, fast growing multidisciplinary science, addresses to absolute dating of tree rings (Speer, 2010). It also explores the new horizons in the field of archeology, ecology, geomorphology, geology and environmental sciences (Divya & Kaur, 2021). The tree ring analysis technique is a powerful tool, is used to synchronize ring width time series patterns obtained from the same tree species under similar geological regions. This dating method provide historical information about landslide, insect damage, forest fire and other anthropogenic activities (Choi et al., 2020).

As the climate change and environmental degradation are among the greatest challenges facing humanity, forests are regarded as important natural resource for mitigation of climate change (Ali et al., 2021). Climate change affects forest ecosystems and species distribution of any particular habitat so, the present research work was planned to deter-

mine the dendroecological potential of conifers (Mayer et al., 2017). Age and growth rate studies of different conifers from different sites of Pakistan and around the globe were presented by different scientists. Iqbal et al. (2017) determined age and radial growth analysis of conifer tree species from Shangla, Pakistan. Khan et al. (2018) investigated the dendrochronological potential of *Abies pindrow* from KPK, Pakistan. Aryal et al. (2018) determined the growth pattern of *Pinus roxburghii* from western Nepal. Tiwari et al. (2020) observed the growth performance of planted population of *Pinus roxburghii* from central Nepal. Iqbal et al. (2020) studied tree rings of some conifers from shangla district of khyber Pakhtunkhwa, Pakistan. Gautam et al. (2020) determined the dendrochronological potential of major tree species of Nepal. Similarly, Muhammad et al. (2021) calculated age and growth rate of trees of Kashmir Point of Murree, Pakistan.

The physical and biological factors determine the nature of any forest. The interactions of these factors resulted in the species diversity with their geological regions. The loss of these resources resulting in climate variations with change in composition of plant communities. This study not only helps to prepare checklist of plant species but also it explores the distribution of plant communities which have key role in determination of climate (Muhammad & Khan, 2016). Rehman et al. (2021) observed the plant species distribution pattern and their contribution in response to ecological gradients in Himalayan region, Pakistan. Malfasi & Cannone (2021) worked on the phytosociology of the vegetation communities of the Stelvio Pass area. Ighbareyeh et al. (2021) determined the vegetation and phytosociology of plants in Palestine. Rehman et al. (2021) made an analysis on plant species composition and distribution in moist temperate forest of Himalayan, Pakistan. Ahmed & Potter (2020) determined the variation in ground flora of Tharparkar, Pakistan. Abbas et al. (2021) performed vegetation analysis and environmental relationships of Riverain plants in Egypt.

So, by considering the importance of the plant communities in the well managed forests and its role in climatic conditions, the present study was designed to determine the dendrochronological potential of *P. roxburghii* and *P. wallichiana* and phytoecological distribution of plant communities of Jhika gali tehsil Murree with following objectives. 1. To calculate the age of both species growing in this climatic sensitive site. 2. To determine the growth rate of these conifers. 3. Growth rate/diameter relationship quantification. 4. Growth rate/tree height relationship determination. 5. To determine the structure of plant communities by phytosociology survey in the field site.

Materials and Methods

Study Site

Murree, Jhika Gali is a famous hill station located in western Himalayan with pleasant summers and snowy winter (Fig. 1. a & b). Its mean annual precipitation is 1789 mm and has elevation of 2291 meters above the sea level. It is quite rich in biodiversity with more than 700 plant species. The maximum and minimum average monthly temperature range is 19.78°C – 30.61°C and 6.72°C – 15.89°C respectively. Jhika gali was selected for the present study as it signifies huge dendrochronological potential (Ahmed & Javed, 2007; Zeitler, 1985).

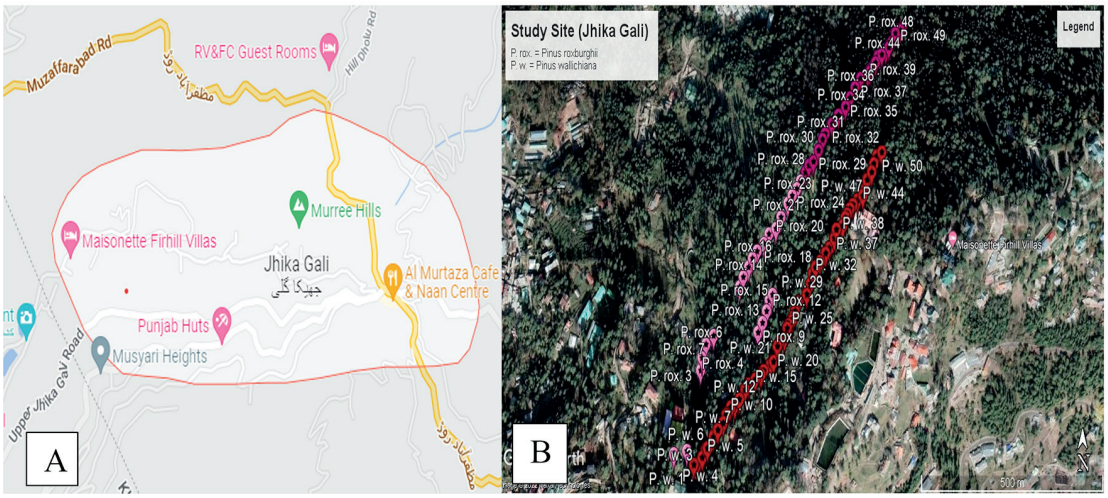

Fig. 1. *(A)*:Map of study site; *(B)*: Trees with their GPS coordinates

Dendrochronological assessment

Field survey and sample collections

After selecting the study site with tree species, samples (cores) were obtained from erect, healthy and branchless trees (Wahab et al., 2008). For this purpose, increment borers of variable sizes were used at an average height (1.3 m) above the base level of ground (Fritts, 1976). The cores were preserved and labeled with their identity i.e. diameter of tree, code of sample and GPS reading (Hart & Grissino-Mayer, 2008).

Processing and microscopic measurement

The samples were air dried very carefully in dendrochronology laboratory for a week to avoid any crack formation during further procedure after Friedrich et al. (2004). The samples were mounted on wooden frames and fixed properly and sanding was performed with electric sander machine fitted with different sizes sand papers. A varnish coat was also done on the samples to clear the rings and their boundaries after Muhammad et al. (2021), Ahmed et al. (2009). Velmex measuring system and Voortech's Measure J2X was used to measure tree rings with 0.001 mm accuracy. All the samples were crossdated successfully (Holmes et al., 1986).

Ecological assessment

The plant species were collected and identified by available literature after Nasir & Ali (1970–1989), Ali & Nasir (1990–1992), and Ali & Qaiser (1992–2007). Moreover, phytosociological study was carried out in the respective site on the basis of importance value index (density, frequency and cover) after Risser & Rice (1971), Cottam & Curtis (1956), Oosting (1956) and Daubenmire (1959).

Results and Discussion

A total of 100 tree samples were obtained from Jhika gali track. 50 cores of both species were obtained upto mid of track and rest 50 of both species were collected from mid of track to the end. All the trees of *P. roxburghii* in both strands attained the age in range of 156–333 years. While in case of *P. wallichiana*, age range was 73–208 years. The maximum age of 333 years with Dbh 198.9 cm and growth rate 0.61 cm/year was recorded in P. rox. 21. P. rox. 13 and P. rox. 22 were of 156 years as minimum age with Dbh 121.9 cm and 125.7 cm and growth rate 0.8 cm/year respectively. The maximum growth rate of 0.9 cm/year with 207 years' age and Dbh 193.04 cm was observed in P. rox. 15 while P. rox. 49 was observed with minimum growth rate 0.6 cm/year in age of 328 years with Dbh 189.5 cm. Maximum and minimum heights of 30.17 m in P. rox. 25, 18.59 m in P. rox. 10 were recorded, respectively. In P.w. 3 maximum age of 208 years with Dbh 162.6 cm and growth rate 0.4 cm/year was recorded while 73 years was recorded as minimum age in P.w. 44 and its growth rate was 1.09 cm/year with 80.01 cm Dbh. P.w. 50 having maximum growth rate of 1.3 cm/year with 108 years' age and Dbh 55.2 inches was observed while P.w. 11 was observed with minimum growth rate 0.4 cm/year in age of 169 years with Dbh 105.15 cm. Maximum and minimum heights of 24.99 m in P.w. 22, 9.44 m in P.w. 7 were recorded, respectively (Table 1).

Pure stands of *P. wallichiana* were also reported from many workers in Pakistan i.e., Hussain (2013), Siddiqui et al. (2013), Ahmed et al. (2006), Khan (2011) and Wahab (2011) that showed its ecological significance and wide amplitude with growing on timberline area. Ahmed et al. (2006), Champion et al. (1965) and Siddiqui et al. (2009) recorded these two species in some sub-tropical areas of Pakistan.

Phytosociological assessment of the vegetation of the study area was performed and importance value index of ninety-two recorded plant species was calculated. These plant species were found to be distributed among forty-four plant families which include pteridophytes, gymnosperms and angiosperms plant families. The pteridophytes were represented by family ptridaceae with six plant species include *Adiantum capillus-veneris, Adiantum incisum, Adiantum venustum, Dryopteris pallid, Pteris cretica* and *Pteris vittata* having 1.19, 1.25, 0.77, 0.81, 1.39 and 1.17 importance value index (IVI), respectively. In case of gymnosperms the only family Pinaceae was found with two plant species i.e., *P. roxburghii* and *P. wallichiana* with 1.62 and 1.36 IVI values, respectively.

Moreover, the angiosperms were found to be distributed in between two monocot plant families i.e., Cyperaceae and

Table 1. Age and growth rate studies of conifer species

No. of Parameters	Variable name	*Pinus roxburghii*		*Pinus wallichiana*	
		Max.	Min.	Max.	Min.
1	Dbh (cm)	235.2	114.8	162.6	64
2	Age (years)	333	156	208	73
3	Growth rate (cm/years)	0.93	0.58	1.3	0.41
4	Tree height (m)	30.17	18.6	25	9.45

Max. – maximum; Min. – minimum; Dbh – diameter at breast height; cm – centimeter; m – meter

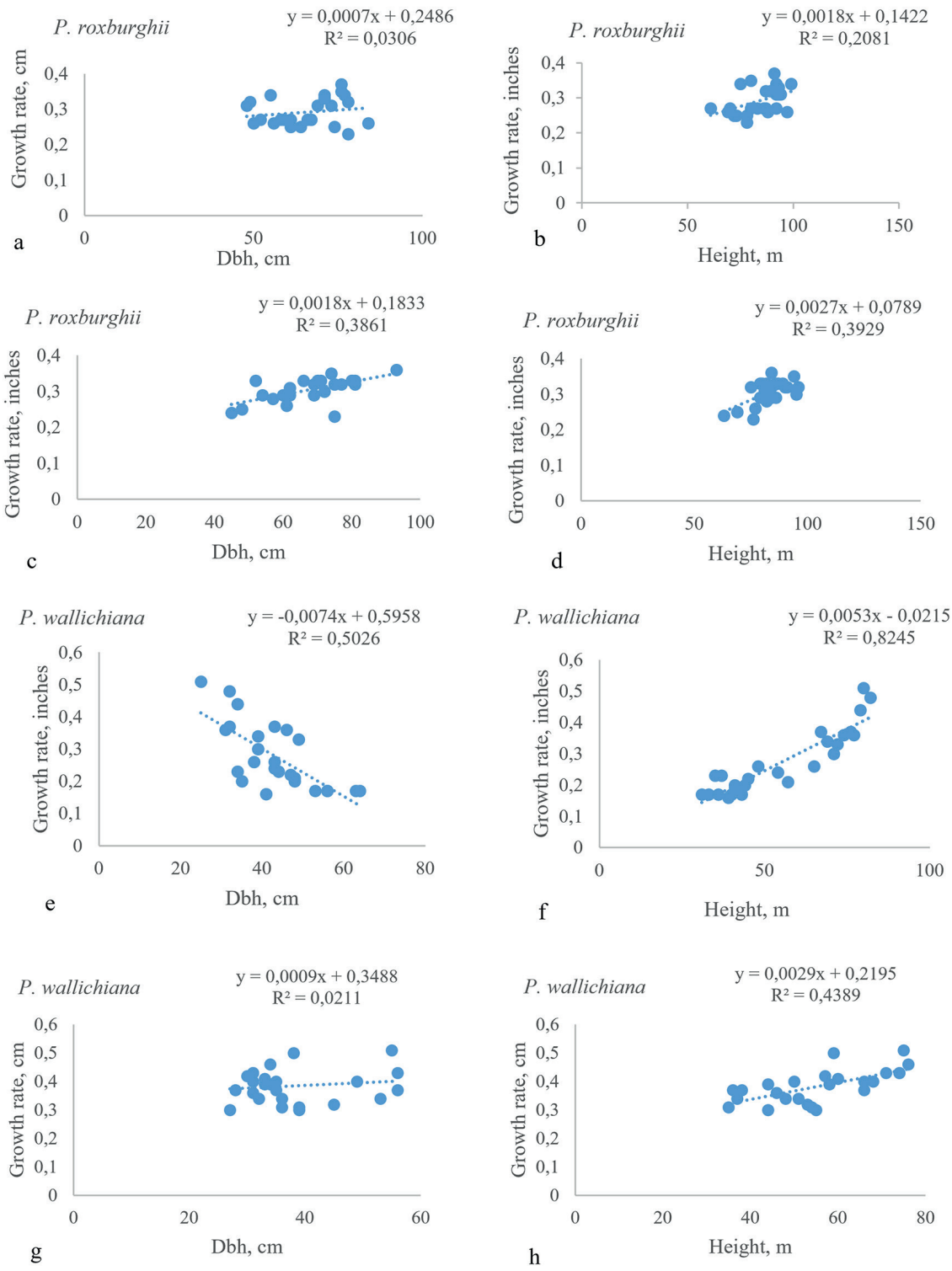

Fig. 2. Correlation between growth rate and dbh/height in *P. roxburghii* (a–d) and *P. wallichiana* (e–h)

Poaceae. The family Cyperaceae is represented by two members i.e., *Cyperus niveus* and *C. rotundus* having 1.17 and 1.15 IVI values, respectively. The family Poaceae having 11 grass species and the largest one in distribution among plant families in the area was found to have following species i.e., *Avena barbata, Cenchrus ciliaris, Cynodon dactylon, Dactyloctenium aegyptium, Desmostachya bipinnata, Dichanthium annulatum, Echinochloa colona, Eragrostis poaeoides, Poa annua, Poa pratensis, Sorghum bicolor* having 0.86, 0.78, 1.04, 1.09, 0.99, 0.97, 0.79, 1.10, 1.16 and 0.97, respectively.

Among forty dicot families the family Rosaceae and Asteraceae had eight plant species each. Family Rosaceae contain Cotoneaster sp., *Prunus armeniaca, Prunus cornu-*

Table 2. Phytosociological characters of plant species at Jhika Gali

Sr. No.	Family name	Plant Species	R.F.	R.D.	R.C.	IVI
1	Acanthaceae	1. *Dicliptera roxburghiana* Nees	0.443	2.262	0.285	0.99
2	Amaranthaceae	1. *Amaranthus viridus* L.	0.382	1.809	0.348	0.85
3	Anacardiaceae	1. *Rhus cotinus*	0.257	2.013	0.421	0.89
4	Araliaceae	1. *Arisaema jacquemontii* Blume	0.921	2.253	0.526	1.23
5	Aristolochiaceae	1. *Aristolochia punjabensis* Lace	0.349	1.714	0.469	0.84
6	Asteraceae	1. *Artemisia roxburghiana* Wall. ex. Baser	0.987	1.056	0.528	0.86
		2. *Blainvillea acmella* (L.) Philipson	0.421	1.865	0.875	1.05
		3. *Calendula arvensis* Linn.	0.765	2.093	0.659	1.17
		4. *Cirsium arvense* (L.) Urban	1.219	1.466	0.851	1.18
		5. *Conyza bonariensis* (L.) Cronquist	1.243	1.551	0.751	1.18
		6. *Eclipta alba* Hassk	1.264	0.642	0.364	0.76
		7. *Tagetes minuta* L.	0.632	0.935	0.693	0.75
		8. *Taraxicum officinale* F. H. Wigg.	1.021	1.344	0.893	1.09
7	Berberidaceae	1. *Berberis lycium* Royle	2.044	2.078	2.569	2.23
8	Boraginaceae	1. *Ehretia serrata* Roxb.	1.759	1.665	1.036	1.49
		2. *Cynoglossum lanceolatum* Forssk.	1.284	1.562	0.989	1.28
9	Buxaceae	1. *Sarcococa saligna* (Don.) Manuel	0.834	2.091	2.647	1.86
10	Cannabaceae	1. *Cannabis sativa* L.	2.126	2.291	1.874	2.09
11	Caprifoliaceae	1. *Lonicera quinquelocularis* Hardw.	0.61	2.697	0.935	1.41
		2. *Viburnum cotinifolium* D. Don	0.672	2.643	2.648	1.99
		3. *Viburnum foetens* Dcne	0.726	0.991	1.347	1.02
12	Convolvulaceae	1. *Convolvulus arvensis* L.	1.169	0.732	0.829	0.91
13	Cyperaceae	1. *Cyperus niveus* Retz.	1.112	2.016	0.385	1.17
		2. *Cyperus rotundus* L.	1.091	1.964	0.394	1.15
14	Ebenaceae	1. *Diospyros lotus* L.	1.825	2.037	2.181	2.01
15	Euphorbiaceae	1. *Euphorbia wallichii* Hk.f	0.278	0.351	0.281	0.3
16	Fagaceae	1. *Quercus dilatata* Royle	1.849	2.087	2.895	2.28
17	Gentianaceae	1. *Swertia chirata* (Roxb. ex. Fleming) Karst	1.756	0.763	0.547	1.02
18	Geraniaceae	1. *Geranium nepalense* Sweet.	1.542	0.814	0.894	1.08
		2. *G. wallichianum* D. Don ex. Sweet	1.654	0.957	0.853	1.15
19	Hippocastanaceae	1. *Aesculus indica* (Wall. ex Camb) Hook.f.	1.464	0.483	3.068	1.67
20	Labiatae	1. *Ajuga bracteosa* Wall ex. Bth.	1.422	0.657	1.075	1.05
		2. *Calamintha umbrosa* (M. Bieb.) Fisch. & Mey	1.278	0.953	0.868	1.03
		3. *Mentha longifolia* (L.) Huds.	1.682	3.769	2.494	2.65
		4. *Micromeria biflora* L.	1.164	0.953	1.148	1.09
21	Leguminosae	1. *Indigofera heterantha* Wall. ex. Brand.	1.11	0.568	1.558	1.08
		2. *Astragalus leucocephalus* Grah. Ex Benth	1.069	0.884	1.616	1.19
		3. *Trifolium repens* L.	0.636	1.191	1.183	1
22	Liliaceae	1. *Agave cantala* Roxb.	0.652	1.052	1.392	1.03
23	Lythraceae	1. *Woodfordia fruticosa* (L.) S. Kurz	0.477	0.572	1.551	0.85
24	Malvaceae	1. *Hibiscus mutabilis* L.	0.553	0.952	1.492	0.99
25	Myrsinaceae	1. *Myrsine africana* L.	2.111	1.145	1.795	1.68

Table 2. Continued

26	Oleaceae	1. *Jasminum mesnyi*	0.481	0.857	1.852	1.06
27	Onagraceae	1. *Oenothera rosea* L.	0.644	0.635	0.272	0.52
28	Pinaceae	1. *Pinus roxburghii* Sargent.	0.961	0.477	3.419	1.62
		2. *Pinus wallichiana* A. B. Jackson	1.062	0.551	2.474	1.36
29	Poaceae	1. *Avena barbata* Lin.	1.163	0.962	0.446	0.86
		2. *Cenchrus ciliaris* L.	1.229	0.539	0.568	0.78
		3. *Cynodon dactylon* (L.) Pers.	1.149	1.199	0.783	1.04
		4. *Dactyloctenium aegyptium* (L.) P. Beauv.	1.225	1.364	0.683	1.09
		5. *Desmostachya bipinnata* (L.) Stapf	1.277	0.857	0.831	0.99
		6. *Dichanthium annulatum*	1.217	1.159	0.536	0.97
		7. *Echinochloa colona* (L.) Link	1.115	0.719	0.563	0.79
		8. *Eragrostis poaeoides* P. Beauv	0.946	0.658	0.931	0.85
		9. *Poa annua* L.	1.236	0.918	1.149	1.1
		10. *Poa pratensis* L.	1.159	1.059	1.248	1.16
		11. *Sorghum bicolor* (L.) P. Beauv	1.218	0.859	0.836	0.97
30	Polygonaceae	1. *Arabidopsis amplexicaulis* Edgew.	0.915	0.354	1.258	0.84
		2. *Rumex hestatus* D. Don	1.196	0.453	1.049	0.89
		3. *Rumex nepalensis* Spreng	1.162	0.661	0.847	0.89
31	Primulaceae	1. *Androsace rotundifolia* Hardw.	0.356	0.795	1.146	0.77
32	Pteridaceae	1.*Adiantum capillus-veneris* L.	1.409	0.653	1.499	1.19
		2. *Adiantum incisum* Forsk.	1.368	0.897	1.479	1.25
		3. *Adiantum venustum* D. Don	0.588	1.198	0.535	0.77
		4. *Dryopteris pallida* Formin	1.182	0.716	0.517	0.81
		5. *Pteris cretica* L.	1.316	1.219	1.649	1.39
		6. *Pteris vitata* L.	1.421	1.059	1.023	1.39
33	Puniaceae	1. *Punica granatum* L.	1.132	1.196	0.375	0.9
34	Ranunculaceae	1. *Aconitum heterophylum* Wall. ex Royle	0.6215	1.546	0.338	0.84
		2. *Anemone vitifolia* Ham.	0.749	0.658	0.463	0.62
		3. *Aquilegia pubiflora* Wall.	0.735	0.853	0.576	0.72
		4. *Ranunculus laetus* Wall. ex. H&T	0.718	1.086	0.751	0.85
		5. *Thalictrum pedunculatum* Edgrew.	0.633	1.039	0.561	0.74
35	Rosaceae	1. *Cotoneaster* sp.	0.762	0.853	1.783	1.13
		2. *Prunus armeniaca* L.	0.992	0.658	1.683	1.11
		3. *Prunus cornuta* Wall. ex. Royle	1.048	0.849	1.849	1.25
		4. *Prunus domestica* Linn.	1.119	0.696	1.492	1.1
		5. *Rubus ellipticus* Smith	1.156	0.687	0.859	0.9
		6. *Rubus ulmifolius* Schott.	0.873	0.594	0.431	0.63
		7. *Spiraea cantoniensis* Lour.	0.816	0.524	0.374	0.57
		8. *Fragaria vesca* L.	1.813	0.472	0.918	1.07
36	Rubiaceae	1. *Galium aparine* L.	1.459	0.517	1.137	1.04
		2. *Rubia cordifolia* L.	1.264	0.573	1.694	1.18
37	Rutaceae	1. *Zanthoxylum armatum* DC.	1.396	0.814	1.184	1.13
38	Saxifragaceae	1. *Bergenia ciliate*	1.594	0.657	0.917	1.06
39	Scrophulariaceae	1. *Scrophularia decomposita* L.	1.436	0.573	0.876	0.96
40	Solanaceae	1. *Solanum nigrum* L.	1.258	0.689	0.483	0.81
41	Ulmaceae	1. *Celtis australis* Linn.	1.107	0.758	0.519	0.79
42	Urticaceae	1. *Debregesia salicifolia* (D. Don) Rendle.	0.86	0.851	1.263	0.99
		2. *Urtica dioica*	1.651	0.936	1.274	1.29
43	Valerianaceae	1. *Valeriana* sp.	0.504	0.935	0.873	0.77
44	Violaceae	1. *Violoa canescens* Wall. ex. Roxb.	1.289	0.836	0.468	0.86

R.F. – Relative frequency; R.D. – Relative density; R.C. – Relative cover; IVI – Importance Value Index

ta, Prunus domestica, Rubus ellipticus, Rubus ulmifolius, Spiraea cantoniensis and *Fragaria vesca* with 1.13, 1.11, 1.25, 1.10, 0.90, 0.63, 0.57 and 1.07 IVI values, respectively. Family Asteraceae contain *Artemisia roxburghiana, Blainvillea acmella, Calendula arvensis, Cirsium arvense, Conyza bonariensis, Elipta alba, Tagetes minuta* and *Taraxicum officinale* with 0.86, 1.05, 1.17, 1.18, 1.18, 0.76, 0.75 and 1.09 IVI, respectively. Family Rannunculaceae having five plant spercies i.e., *Aconitum heterophylum, Anemone vitifolia, Aquilegia pubiflora, Ranunculus laetus* and *Thalictrum pendunculatum* represented by 0.84, 0.62, 0.72, 0.85 and 0.74, respectively. Family Labiateae contain four plant species *Ajuga bracteosa, Calamintha umbrosa, Mentha longifolia* and *Micromeria biflora* having 1.05,

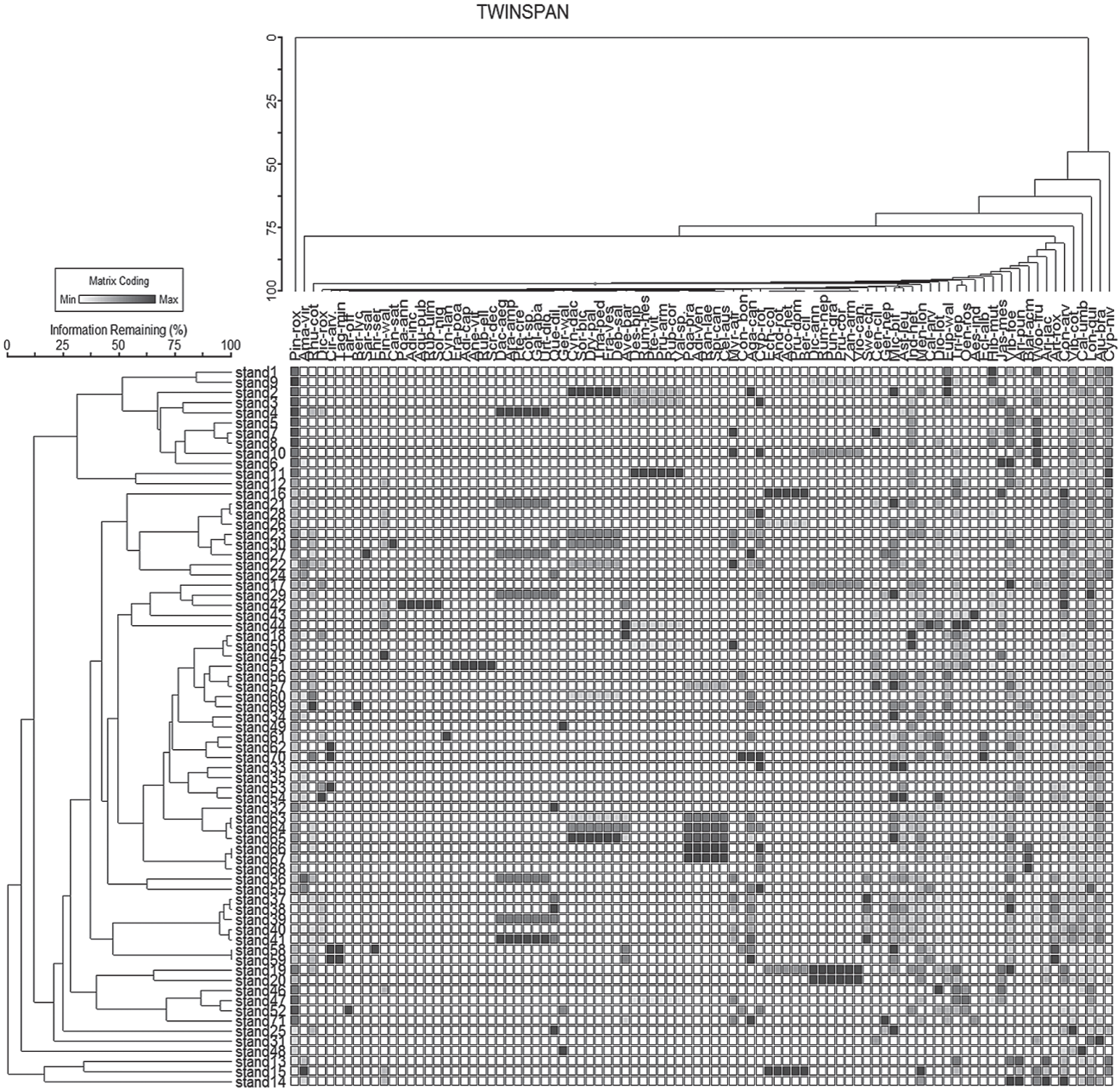

Fig. 3. Two-way indicator species analysis (TWINSPAN) analysis of plant communities of Jhika Gali, Murree

1.03, 2.65 and 1.09, respectively. Along with these three plant families i.e., Capriofoliaceae, Leguminoaceae and Polygonaceae were represented three plant species each. Capriofoliaceae had *Lonicera quinquelocularis, Viburnum cotinifolium* and *Viburnum faetens* having 1.41, 1.99 and 1.02 IVI values, respectively. Leguminoaceae contain *Indigofera heterantha, Astragalus leucocephalis* and *Trifolium repens* having 1.08, 1.19 and 1.00 IVI, respectively. Family Polygonaceae had *Arabidopsis amplexicaulis, Rumex hestatus* and *R. nepalensis* with 0.84, 0.89 and 0.89 IVI values, respectively.

The family Boraginaceae contain *Ehretia serrata* (1.49) and *Cynoglossum lanceolatum* (1.28), family Geraniaceae contain *Geranium nepalense* (1.08) and *G. wallichianum* (1.15), family Rubiaceae had *Galium aperine* (1.04) and *Rubia cordifolia* (1.18) and family Urticaceae contain *Urtica dioca* (1.29) and *Debregesia salicifolia* (0.99). Rest of the twenty-nine plant families were represented by one plant species each and their IVI values are given in Table 2. From the previous literature, it was clear that both conifer species possess thick understory vegetation as reported by Siddiqui (2011), Wahab (2011) and Khan (2011). Communities show similar phytosociological attributes with their absolute values reported by Ahmed et al. (2006). Ahmed et al. (2010) reported these phytosociological findings in moist temperate regions of Himalaya with their wide ecological amplitude. In this study site, both pine species showed dominance over other trees.

Two Way Indicator Species Analysis (TWINSPAN)

On the basis of percentage cover of ninety-two plant species occurred in sampling stands, Two Way Indicator Species analysis was performed which indicated the distribution pattern and grouping of the plant species with each other in Jhika Gali of Tehsil Murree. The results of TWINSPAN are indicated in Figure 3. Moreover, due to the diverse nature of the plant species showed diverse nature of grouping as it can be divided into three core groups i.e., Group I (G1), Group II (G2) and Group III (G3). In case of group one the plant species occurred in stand 14, 15, 13 and 48 are found to be associated in one group. On other hand in group three the plant species of stand 1, 9, 2, 3, 4, 5, 7, 8, 10, 6, 11 and 12 are found to be associated with each other as shown in Figure 3.

As for as the group two is concerned, it showed great number of diversity and has greatest diversity of plant species grouping in this main group. The group two associations of the plant species can be divided into five sub groupings, which can further be divided into subsequent associations. In this case, the 1st grouping is established among the plant species of stand 58, 59, 37, 38, 40 and 41 and second association was found in between the members of stand 36 and stand 55 plant species. The third association of plant species found to be the diverse and largest one as it showed grouping of the plant species of stand 68, 67, 66, 65, 64, 63, 32, 54, 53, 35, 33, 70, 62, 61, 49, 34, 69, 60, 57, 56, 51, 45, 50 and 18. In this main group the fourth association was found to be among the plant species of stand 44, 43, 42, 29 and 17. Moreover, the fifth association contain the plant species occurred in stand 24, 22, 27, 30, 23, 26, 28, 21 and 16 as shown in Figure 3.

Conclusion and Future Perspectives

Jhika Gali, Murree is a popular hill station, blessed with beautiful and diverse habitats and a great diversity in species composition and vegetation structure can be observed. Although *P. roxburghii* dominated completely the forest region and higher altitudes are dominated by *P. wallichiana.* With drastic climate change and anthropogenic activities, species growth lifestyle is changing with change in their habitat, due to which species have to migrate, or to retrain within their climatic tolerance boundaries. Anthropogenic activities like utilization of land for construction and agriculture, over exploitation of plant resources, grazing pressure of local livestock, deforestation for natural resources is constantly changing the vegetation structure and species composition in this area. Land sliding is playing a major role in habitat degradation. *P. roxburghii* and *P. wallichiana* are adapting to such conditions, but their over exploitation for resin tapping, timber and fuel wood is at its peak. Therefore, serious attention is needed for conservation of vegetation and biodiversity.

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