

Inventory of species richness of Panchayat forests and adjoining Reserve forests in three districts of Garhwal Himalaya, India

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Abstract: We compared plant species richness and composition in Panchayat forests and adjoining Reserve forests, across an altitudinal range (800-2300 m asl) in three districts, Pauri, Rudraprayag and Chamoli in the Garhwal Himalaya. A total of 101 species was recorded, of which 35 were trees, 24 shrubs and 42 herbs. The tree species richness was slightly higher in Panchayat forests than Reserve forests. However, the species richness of shrubs and herbs was quite similar in the two categories of forests. The total species richness was comparatively higher in Panchayat forests than in Reserve forests at the altitudinal range 1300-1800 m asl. *Quercus leucotrichophora*, *Lyonia ovalifolia*, *Myrica esculenta*, *Pinus roxburghii*, *Pyrus pashia* and *Symplocos paniculata* were present in most of the Panchayat forests as well as in Reserve forests. Asteraceae, Ericaceae, Fagaceae, Lamiaceae, Poaceae and Rosaceae families were represented in both categories of forests. Asteraceae, Ericaceae, Poaceae and Rosaceae were more species rich than other families. The study revealed that distribution and species richness pattern in these forests was more or less similar with little correlation between total species richness and their shrub and herb species of both types of forests.

Resumen: Comparamos la riqueza y la composición de especies de plantas en los bosques de Panchayat y los bosques en reservas adyacentes, a lo largo de un intervalo altitudinal (800-2300 m snm) en tres distritos (Pauri, Rudraprayag y Chamoli) de Garhwal Himalaya. Se registró un total de 101 especies, de las cuales 35 fueron árboles, 24 arbustos y 42 hierbas. La riqueza de especies de árboles fue ligeramente mayor en los bosques de Panchayat que en los bosques de las reservas. Sin embargo, la riqueza de especies de arbustos y hierbas fue bastante similar en las dos categorías de bosque. En el intervalo de 1300 a 1800 m snm la riqueza total de especies fue comparativamente mayor en los bosques de Panchayat que en los bosques de las reservas. *Quercus leucotrichophora*, *Lyonia ovalifolia*, *Myrica esculenta*, *Pinus roxburghii*, *Pyrus pashia* y *Symplocos paniculata* estuvieron presentes en la mayoría de los bosques de Panchayat, así como en los bosques en las reservas. Las familias Asteraceae, Ericaceae, Fagaceae, Lamiaceae, Poaceae y Rosaceae estuvieron representadas en las dos categorías de bosque. Asteraceae, Ericaceae, Poaceae y Rosaceae tuvieron una riqueza de especies mayor que las otras familias. El estudio reveló que los patrones de distribución y de riqueza de especies en estos bosques fueron más o menos similares, con una correlación débil entre la riqueza total de especies y las especies de arbustos y hierbas en ambos tipos de bosque.

Resumo: Comparou-se a riqueza específica e composição das florestas de Panchayat e nas florestas da reserva vizinha, ao longo de um intervalo de altitude (800-2300 m anm) em três distritos, Pauri, Rudraprayag e Chamoli no Garhwal Himalaia. Registrou-se um total de 101 espécies das quais 35 eram árvores, 24 arbustos e 42 na categoria de ervas. A riqueza específica

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arbórea era ligeiramente superior nas florestas de Panchayat do que nas florestas da reserva. Contudo, a riqueza específica dos arbustos e ervas era quase idêntica nas duas categorias de florestas. A riqueza específica total era comparativamente mais alta nas florestas de Panchayat do que na da reserva no intervalo de altitudes de 1300-1800 m anm. As *Quercus leucotrichophora*, *Lyonia ovalifolia*, *Myrica esculenta*, *Pinus roxburghii*, *Pyrus pashia* and *Symplocos paniculata* estavam presentes na maior parte das florestas de Panchayat assim como nas da reserva florestal. As famílias Asteraceae, Ericaceae, Fagaceae, Lamiaceae, Poaceae and Rosaceae estavam representadas nas duas categorias de florestas. As Asteraceae, Ericaceae, Poaceae and Rosaceae eram as mais ricas em espécies quando comparadas com as outras famílias. O estudo revelou que o padrão de distribuição e riqueza específica nestas florestas era mais ou menos similar com uma pequena correlação entre a riqueza específica total e as suas espécies de arbustos e ervas em ambos os tipos de florestas.

Key words: Altitude, Panchayat forests, Reserve forests, species richness.

Introduction

Biodiversity is essential for human survival and economic well being and for the ecosystem function and stability (Singh 2002). Recent studies on biodiversity in relation to ecosystem functioning have revealed that species diversity enhances productivity and stability of ecosystem (Naeem *et al.* 1994; Tilman *et al.* 1996). High biodiversity favours ecological stability, whereas, accelerating species loss could lead to collapse of the ecosystem (Vitousek *et al.* 1997).

Central Himalaya has a long history of indigenous traditional forest management. The Van (Forest) Panchayat system as an institution at village level or "Village-group level" in particular has considerable potential for involving local communities in forest management and conservation (Agarwal 1996). The Van Panchayats were formed under the Panchayat Forest Rules, 1931, and have been incorporated under section 28 (2) of the Indian Forest Act, 1927. The stated objectives were to protect, develop the forests and to distribute its produce among the right holders in an equitable manner. This devolution of powers to control and manage forest for sustenance purpose is the earliest example of co - management of natural resources by the state and the local community in India. In Uttarakhand, 13% forest area is under Van Panchayat which is second large vegetational area after Reserve forest.

Van Panchayat is a type of forest owned by villagers through a VP committee and managed to

fulfill their basic needs of fuel, fodder and timber, whereas, Reserve forests owned and managed by the state forest department and protected against any type of anthropogenic pressure. There is continuous exploitation of Van Panchayat forests in terms of lopping and felling of trees for fuel wood, leaf fodder, livestock grazing and harvesting of ground vegetation for forage. The question to be answered here is whether regular use of these forests has any adverse impact on them. Therefore, it is essential to know what differences have emerged in the two types of forests in respect of species diversity and richness. Keeping this in view, a detailed inventory has been carried out to analyse species richness and floristic diversity between Panchayat and adjoining Reserve forests of Garhwal Himalaya.

Materials and methods

Study area

The study area lies between 28° 45' to 31° 27' N latitude and 77° 34' to 81° 02' E longitude, along an altitudinal gradient of 840-2300 m asl. Climatic conditions range from subtropical to temperate with an average annual rainfall ranging from 800-1400 mm. The slope, aspect and vegetation varied significantly. The monsoon rains occur from the late June to the middle of September. Three main seasons could be recognized in a year: cold and dry winter (December-February), warm and dry summer (April- June) and warm and humid rainy season (June - September).

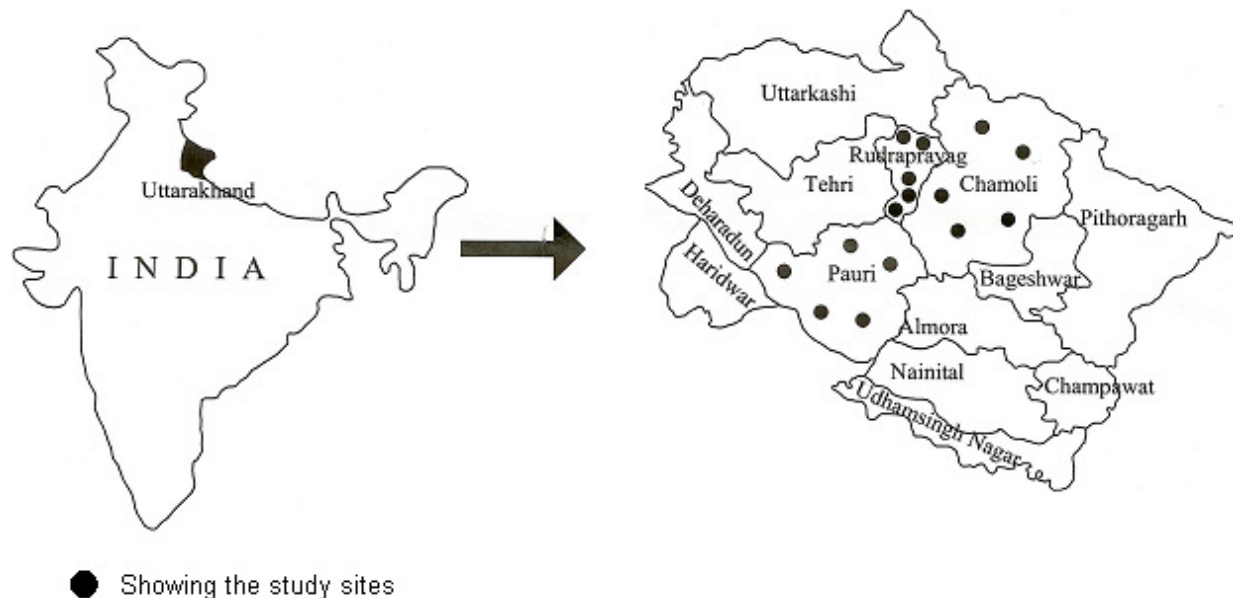


Fig. 1. Map showing the study sites.

The present study was carried out in Van Panchayats of three districts-Pauri, Rudrapur and Chamoli. Initially a total of 49 Van Panchayats were surveyed; 20 in Chamoli, 14 in Rudrapur and 15 in Pauri. Based on the altitude, area and species composition, 5 Panchayat forests and their adjoining Reserve forests were selected in each districts i.e. a total of 30 (15 Panchayat forests and 15 adjoining Reserve forests) were analyzed (Fig.1).

Methods

Each Van-Panchayat forest and their adjoining Reserve forest were studied using random sampling technique. A sample plot or quadrat of 10 x 10 m or 100 m² was used for tree species observation. Ten random sample plots for each Panchayat and adjoining Reserve forest were studied and the occurrence of different species, their number and diameter at breast height of the individuals were recorded. For shrubs, two sub plots of 5 x 5 m or 25 m² sizes were nested within 100 m² sample plot. The understorey layer (herb and grasses) was enumerated by using five 1 x 1 m or 1 m² quadrats nested within 100 m² sample plots.

Results

The number of tree species and their corresponding genera and families were generally

higher for Van Panchayat (VP) forests as compared to Reserve forests in all the three districts. For shrubs, these were equal or higher for VP forests in Pauri and Chamoli districts as compared to Reserve forests, whereas, the trend was reverse in Rudrapur district. However, for herbs the values were higher for Reserve forests as compared to VP forests in Rudrapur and Chamoli districts except Pauri district where the trend was just reverse. Overall, the number of species in all the three life forms (tree, shrub and herb) was higher in VP forests compared to Reserve forests (Table 1).

Among tree vegetation in the Van Panchayat (VP) forest of Pauri district, Ericaceae, Euphorbiaceae, Juglandaceae and Pinaceae were the dominant families (with two species each). However, in the Reserve forests Cupressaceae and Ericaceae were the dominant families (with two species each). Taxonomically, all the dominant families were equally diverse (with two genera each) in both categories of forest (Appendix Table 1). In Rudrapur district, Fagaceae and Lauraceae were the dominant families (with three species) followed by Ericaceae (with two species). In the Reserve forests, Fagaceae was the most dominant family (with three species) followed by Ericaceae and Lauraceae (with two species each) (Appendix Table 1). In the Chamoli district, Fagaceae was the most dominant family (with

Table 1. Comparison of the species under three habit groups occurring within two types of floral vegetation in three districts of Garhwal Himalaya (VP stands for Van Panchayat forest and RF stands for Reserve Forest).

Floral Vegetation		Pauri		Rudra-prayag		Chamoli		Total species		Dominant families	
		VP	RF	VP	RF	VP	RF	VP	RF	VP	RF
Tree	Species	22	17	25	20	20	20	35	31	Fagaceae, Lauraceae, Ericaceae, Juglandaceae, Pinaceae	Cupressaceae, Ericaceae, Fagaceae, Lauraceae
	Genus	22	17	21	17	18	18				
	Family	18	15	20	16	15	17				
Shrub	Species	20	20	18	21	17	15	24	23	Rosaceae, Berberidaceae, Anacardiaceae, Asteraceae, Rutaceae	Rosaceae, Berberidaceae, Anacardiaceae, Asteraceae, Fabaceae, Rutaceae
	Genus	16	16	15	17	14	11				
	Family	13	11	12	14	12	10				
Herb	Species	36	29	25	30	27	28	42	38	Asteraceae, Poaceae, Lamiaceae, Rosaceae, Rutaceae, Acantheceae, Cyperaceae & Violaceae	Asteraceae, Poaceae, Lamiaceae & Violaceae
	Genus	33	27	22	29	24	26				
	Family	19	17	13	16	14	14				
Total								101	92		

three species) followed by Cupressaceae, Ericaceae and Pinaceae (with two species). In the Reserve forest also Fagaceae was the most dominant family (with three species).

Among the shrubs in the Panchayat forests of Pauri district, Rosaceae was the most dominant family (4 species) followed by Berberidaceae (3 species) and Anacardiaceae, Asteraceae (with two species each). In the adjoining Reserve forests also Rosaceae was recorded the most dominant family (with four species) followed by Berberidaceae (with three species), Anacardiaceae, Asteraceae, Fagaceae and Rutaceae (with two species each) (Appendix Table 1). In the Panchayat forests of Rudraprayag, Rosaceae was again the most dominant family (with four species) followed by Anacardiaceae, Asteraceae, Berberidaceae (with two species each). In Panchayat forests of Chamoli district, Rosaceae was again the most dominant family (with three species) followed by Anacardiaceae, Berberidaceae and Rutaceae (with two species each). In the adjoining Reserve forests, Berberidaceae and Rosaceae were equally dominant families (with three species each) followed by Anacardiaceae (with two species).

Among herbs, in the Panchayat forests of Pauri district, Asteraceae was the most dominant family (with nine species) followed by Poaceae (4 species), Lamiaceae (with three species), Acanthaceae, Cyperaceae, Rosaceae and Violaceae (2 spp.). Similarly in the Reserve forests, Asteraceae was the most dominant family (6 spp.)

followed by Poaceae (with four species), Acanthaceae, Cyperaceae, Lamiaceae and Violaceae (with two species each). In the Panchayat forests of Rudraprayag district, Asteraceae and Poaceae were the most dominant families with six species each followed by Lamiaceae and Violaceae each with only two species. In the Reserve forests, Asteraceae was recorded the most dominant family (6 species) followed by Poaceae (with five species), Cyperaceae (with three species), Acanthaceae, Rosaceae and Lamiaceae (with two species). In the Panchayat forests of Chamoli district, Poaceae was the most dominant family (with eight species) followed by Asteraceae, Cyperaceae (with three species each), Lamiaceae, Violaceae (with two species). Similarly in the Reserve forests, Poaceae was the most dominant family (with six species) followed by Asteraceae (with five species), Lamiaceae (with three species), Acanthaceae, Cyperaceae and Violaceae (with two species each).

There were not much differences in the proportion of genera to species, genera to family and family to species between VP forests and Reserve forests for tree, shrub and herb species (Table 2).

Discussion

The overall species richness was higher in Panchayat forests as compared to Reserve forests. Total number of tree species was higher for

Table 2. Ratios of species, genus and family in Van Panchayat and Reserve Forests.

Vegetation cover	Genus: Species		Family: Species		Family: Genus	
	VP	RF	VP	RF	VP	RF
Tree	1.10	1.09	1.29	1.24	1.18	1.20
Shrub	1.22	1.48	1.53	1.61	1.25	1.26
Herb	1.10	1.06	1.89	1.86	1.71	1.75

Panchayat forests in all the three districts which showed the people’s protective attitude towards Panchayat forests (Chauhan *et al.* 2002). However, shrub and herb species were higher in the Reserve forests in Rudraprayag district. Species richness of a site experiencing disturbance is a cumulative outcome of differential responses of species to disturbance. Some species may tolerate the disturbance and the others may disappear (Sagar *et al.* 2003).

Among tree species, *Quercus leucotrichophora*, *Lyonia ovalifolia*, *Myrica esculanta*, *Pinus roxburghii*, *Pyrus pashia*, *Rhododendron arboreum* and *Symplocos paniculata* were recorded in almost every Panchayat and Reserve forests of the three districts. The Panchayat and Reserve forests were mixed in composition but dominated either by *Quercus* or Pine. Similarly, Ericaceae, Fagaceae, Myricaceae, Pinaceae, Rosaceae and Symplocaceae were the families which were present in both types of forests of the three districts.

Among the shrubs, *Berberis aristata*, *Pyracantha crenulata*, *Rubus ellipticus*, *R.*

foliolosus, *Sapium insigne* and *Woodfordia fruticosa* were found in both types of forests of all the three districts. Anacardiaceae, Asteraceae, Berberidaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Lythraceae and Rosaceae were the families which have their presence in both types of forests of three districts.

Among herbs, the species found in almost all the forests were *Anaphalis contorta*, *Apluda mutica*, *Artemisia busuca*, *Curcuma aromatica*, *Cynodon dactylon*, *Gallium asperifolium*, *Sonchus oleraceus*, *Thalictrum foliolosum* and *Viola canescens*. Asteraceae, Cyperaceae, Lamiaceae, Poaceae, Ranunculaceae, Rubiaceae, Violaceae and Zingiberaceae were the families which were present in all the Panchayat as well as adjoining Reserve forests. Rosaceae dominated both categories of forests of Pauri and Rudraprayag, however, Poaceae dominated the forests of Chamoli district.

Corelation coefficients “r” between different species in Panchayat and Reserve forests were also calculated. Positive relationships between tree species of Panchayat and Reserve forests, total species of Reserve forests and their shrub species and total species of Panchayat and their herb species occurred at 1% significance level (Table 3). At 5% significance level, there was positive relationship between total species of Panchayats and Reserve forests, total species of Reserve forests and their herb species and between herb species of Panchayats and Reserve forests (Table 3). A similar trend was followed by the total number of species and their herb species in both

Table 3. Correlation coefficients “r” between number of species in Van Panchayats (VP) and Reserve forests (RF).

Parameters	Altitude	VP tree spp.	RF tree spp.	VP shrub spp.	RF shrub spp.	VP herb spp.	RF herb spp.	VP total spp.	RF total spp.
Altitude	1								
VP tree spp.	0.26	1							
RF tree spp.	0.14	0.84*	1						
VP shrub spp.	-0.15	-0.13	0.01	1					
RF shrub spp.	0.25	0.35	0.35	0.32	1				
VP herb spp.	0.03	-0.16	-0.10	0.35	0.29	1			
RF herb spp.	-0.36	-0.32	-0.14	0.47	0.53	0.63**	1		
VP total spp.	0.12	0.35	0.36	0.51	0.51	0.83*	0.49	1	
RF total spp.	-0.05	0.39	0.58	0.39	0.84*	0.42	0.68**	0.65**	1

*Significant at 1% level, ** Significant at 5% level

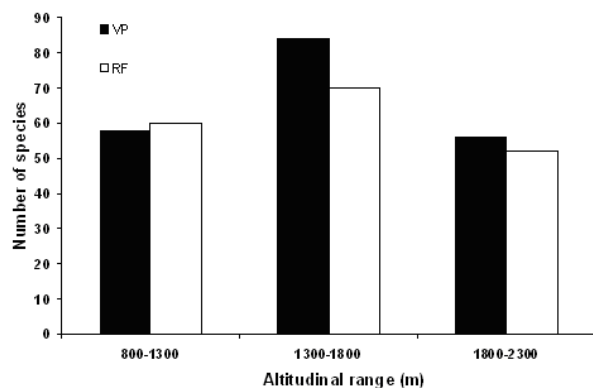


Fig 2. Comparison of species richness between Panchayat forests (VP) and Reserve forests (RF) along three different altitudinal ranges.

categories of forests (Kharkwal *et al.* 2005a). Interestingly, no correlation was found between altitude and species category in Van Panchayat as well as Reserve forests.

The species richness was also analysed in terms of altitudinal zones. In the present study, the vegetation (tree, shrub & herbs) were investigated between 800 to 2300 m asl. The total species richness ranged between 56 and 84 species in Panchayat forests and between 52 and 70 species in Reserve forests with maximum at 1300-1800 m asl in Panchayat forests as well as in Reserve forests. It declined above and below this altitudinal zone (Fig. 2). A similar pattern of species richness was reported earlier (Kharkwal *et al.* 2005b; Rawal *et al.* 1991).

The present study suggests that the similarity in species richness and composition in Panchayat and Reserve forests may be due to the same microclimate and edaphic characteristics. However, slightly higher richness in Panchayat forests indicates that traditional management of forest by local community through people's participation is a good tool for the maintenance of biodiversity and conservation. Thus it is suggested that Uttarakhand Govt. may encourage setting up more Van Panchayats.

Acknowledgements

We are thankful to the G.B.Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora, Uttarakhand and Ministry of Environment & Forests, Govt. of India, for financial support. We are also grateful to the various Van Panchayat committees for their help during the study period.

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Appendix Table 1. List of species (with family) encountered during the study and their presence or absence at different sites.

	Family	Pauri		Rudraprayag		Chamoli	
		VP	RF	VP	RF	VP	RF
TREES							
<i>Acer caesium</i> Wall.ex.Brandis.	Aceraceae	-	-	-	+	-	-
<i>Adina cordifolia</i> (Roxb.)	Rubiaceae	+	-	-	+	-	-
<i>Aesculus indica</i> Clebr.ex.cambess	Hippocastanaceae	-	-	-	+	-	-
<i>Albizia lebbek</i> (L.) Benth	Mimosaceae	+	-	+	-	+	+
<i>Alnus nepalensis</i> .D.Don.	Betulaceae	-	-	+	+	-	-
<i>Anogeissus latifolia</i> DC.	Combretaceae	+	+	-	-	-	-
<i>Bauhinia variegata</i> L. Sp.	Caesalpiniaceae	+	+	+	-	+	+
<i>Benthamidia capitata</i> Wall.ex.Roxb.	Cornaceae	-	-	-	-	+	-
<i>Bombax ceiba</i> L.	Bombacaceae	-	-	+	-	+	+
<i>Carpinus viminea</i> Lindley	Corylaceae	-	-	+	+	-	-
<i>Cassine glauca</i> (Rottboell).	Celastraceae	+	+	-	-	-	-
<i>Cedrus deodara</i> Roxb.ex.D.Don	Pinaceae	+	-	-	-	+	-
<i>Cupressus torulosa</i> D.Don.	Cupressaceae	+	+	+	-	+	-
<i>Engelhardtia spicata</i> Leschenault.ex.Blume	Juglandaceae	+	-	-	-	-	-
<i>Ficus benghalensis</i> L. Sp.	Moraceae	+	-	-	-	+	+
<i>Fraxinus micrantha</i> Lingelsheim	Oleaceae	-	-	+	-	-	+
<i>Juglans regia</i> L. Sp.	Juglandaceae	+	-	+	-	+	+
<i>Litsea monopetala</i> (Roxb.) persoon	Lauraceae	-	-	+	+	-	-
<i>L. elongata</i> (Neea) Hook.f.	Lauraceae	-	-	+	+	-	+
<i>L.glutinosa</i> (Lour.) Robinson	Lauraceae	-	-	+	-	-	-
<i>Lyonia ovalifolia</i> Wall	Ericaceae	+	+	+	+	+	+
<i>Madhuca longifolia</i> (Koenig) mac Bride.	Sapotaceae	-	+	+	+	+	+
<i>Mallotus philippensis</i> (Lam.) Muell-Arg	Euphorbiaceae	+	-	+	+	-	+
<i>Myrica esculenta</i> Buch-Ham.ex.D.Don	Myricaceae	+	+	+	+	+	+
<i>Phyllanthus emblica</i> (L.) Hook.f.in fl	Euphorbiaceae	+	-	-	-	-	-
<i>Pinus roxburghii</i> Sargent	Pinaceae	+	+	+	+	+	+
<i>Populus ciliata</i> Wall.ex Royle	Salicaceae	+	-	-	-	-	-
<i>Pyrus pashia</i> Buch-Hum. Ex D.Don	Rosaceae	+	+	+	+	+	+
<i>Quercus floribunda</i> Lindley.ex Rehder	Fagaceae	-	-	+	+	+	+
<i>Q.semecarpifolia</i> Smith.	Fagaceae	-	-	+	+	+	+
<i>Quercus leucotrichophora</i> A.Camus	Fagaceae	+	+	+	+	+	+
<i>Rhododendron arboreum</i> Smith	Ericaceae	+	+	+	+	+	+
<i>Shorea robusta</i> Roxb.ex.Gaertner.f.	Dipterocarpaceae	-	+	-	-	-	-
<i>Symplocos paniculata</i> (Thumb) Miq.	Symplocaceae	+	+	+	+	+	+
<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	+	+	+	+	-	-
<i>Tectona grandis</i> L. f., Suppl.	Verbenaceae	+	+	-	-	-	-
<i>Terminalia chebula</i> Retz	Combretaceae	-	-	+	-	-	-
<i>Thuja orientalis</i> L., Sp.	Cupressaceae	-	+	-	-	+	+
<i>Toona ciliata</i> Roemer	Meliaceae	-	+	+	+	+	+
SHRUBS							
<i>Adhatoda vasica</i> Nees.in Wall.	Acanthaceae	+	+	-	+	-	+
<i>Agave americana</i> Linn.	Agavaceae	+	-	+	+	+	+

Contd...

Appendix Table 1. Continued

	Family	Pauri		Rudraprayag		Chamoli	
		VP	RF	VP	RF	VP	RF
<i>Artemisia nilagirica</i> Cl.	Asteraceae	+	+	+	+	+	+
<i>Berberis aristata</i> DC.	Berberidaceae	+	+	+	+	+	+
<i>B.asiatica</i> DC.	Berberidaceae	+	+	-	+	+	+
<i>B.lycium</i> Royle	Berberidaceae	+	+	+	+	-	+
<i>Colebrookia oppositifolia</i> Smith	Lamiaceae	+	+	+	+	+	+
<i>Carissa congesta</i> Wight	Apocynaceae	-	-	+	+	-	-
<i>Debregeasia longifolia</i> (Burm.f.) Wedd	Urticaceae	+	+	+	+	-	-
<i>Desmodium gangeticum</i> (L.) DC.	Fabaceae	+	+	+	-	-	-
<i>Eupatorium adenophorum</i> Sprengel	Asteraceae	+	+	+	-	-	-
<i>Indigofera cassioides</i> Rottler. ex. DC	Fabaceae	-	+	-	+	+	+
<i>Lantana camara</i> Linn.	Verbenaceae	+	-	-	+	+	-
<i>Murraya koenigii</i> (L.) Spr.	Rutaceae	+	+	-	+	+	-
<i>Phoenix humilis</i> Royle	Arecaceae	-	-	-	-	+	-
<i>Prinsepia utilis</i> Royle. Illus.Bot.Himal	Rosaceae	+	+	+	+	-	-
<i>Pyracantha crenulata</i> D. Don	Rosaceae	+	+	+	+	+	+
<i>Rhus javanica</i> Smith	Anacardiaceae	+	+	+	+	+	+
<i>Rhus parviflora</i> Roxb.	Anacardiaceae	+	+	+	+	+	+
<i>Rubus ellipticus</i> D. Don	Rosaceae	+	+	+	+	+	+
<i>Rubus foliolosus</i> D. Don	Rosaceae	+	+	+	+	+	+
<i>Sapium insigne</i> (Royle) Benth. ex. Trimen	Euphorbiaceae	+	+	+	+	+	+
<i>Woodfordia fruticosa</i> (L). Kurzin.J.Asiat	Lythraceae	+	+	+	+	+	+
<i>Zanthoxylum armatum</i> DC. prodr.	Rutaceae	-	+	+	+	+	-
HERBS							
<i>Ainsliaea apetra</i> DC. Prodr.	Asteraceae	+	-	-	+	-	+
<i>Ajuga bracteosa</i> Wall ex Benth.	Lamiaceae	+	+	+	+	+	+
<i>Anaphalis contorta</i> D. Don.	Asteraceae	+	+	+	+	+	+
<i>Anaphalis triplinervis</i> (Sins) L.B clark	Asteraceae	+	-	+	-	-	-
<i>Apluda mutica</i> Linn.	Poaceae	+	+	+	+	+	+
<i>Artemisia busuca</i> Buch-Ham.Ex D.Don.	Asteraceae	+	+	+	+	+	+
<i>Artemisia gmelinii</i> Webex.	Asteraceae	+	+	+	+	-	+
<i>Arthraxon ciliaris</i> P. Beauv.	Poaceae	+	+	+	-	+	+
<i>Arundinaria falcate</i> Nees.	Poaceae	-	-	+	+	-	+
<i>Asparagus adscendens</i> Buch-Ham.ex.. Roxb.	Liliaceae	+	-	-	+	-	-
<i>Asplenium dalhausiana</i>	Aspleniaceae	+	+	+	+	+	-
<i>Bergenia ligulata</i> Wall	Saxifragaceae	+	+	-	-	-	-
<i>Carex nivalis</i> Boott in jour.	Cyperaceae	+	+	+	+	+	-
<i>Chenopodium album</i> Linn.	Chenopodiaceae	+	+	+	+	-	+
<i>Chrysopogon gryllus</i> (L.) Trinius	Poaceae	-	+	+	-	+	+
<i>Curcuma aromatica</i> Salisbury,P.	Zingiberaceae	+	+	+	+	+	+
<i>Cynodon arcuatus</i> J.S presl ex.C.B.presl.	Poaceae	-	-	-	-	+	-
<i>Cynodon dactylon</i> (L.) Persoon.	Poaceae	+	+	+	+	+	+
<i>Cyperus niveus</i> Retz	Cyperaceae	+	+	-	+	+	+
<i>Danthonia cachmyriana</i> J.&Sp	Poaceae	+	-	-	+	+	-
<i>Dryopteris odantoloma</i>	Polypodiaceae	+	+	-	+	+	-

Contd...

Appendix Table 1. Continued

	Family	Pauri		Rudraprayag		Chamoli	
		VP	RF	VP	RF	VP	RF
<i>Emperata cilindrica</i>	Poaceae	-	-	-	-	+	-
<i>Eriophorum comosum</i> Wall.ex.Nees.	Cyperaceae	-	-	-	+	+	+
<i>Fragaria nubicola</i> , Lindley	Rosaceae	+	-	-	+	-	+
<i>Gallium asperifolium</i> Wall.	Rubiaceae	+	+	+	+	+	+
<i>Geranium wallichianum</i> D.Don.ex.sweet.	Geraniaceae	+	+	-	+	+	-
<i>Gerbera gossypiana</i> Royle	Asteraceae	+	+	+	-	-	-
<i>Gnephalium luteo-album</i> (L.) Sp.	Asteraceae	+	-	-	-	-	-
<i>Goldfussia dalhousiana</i> Nees.	Acanthaceae	+	+	-	+	-	+
<i>Heteropogon contortus</i> (L.) P. Beauv.	Poaceae	-	-	+	+	+	+
<i>Micromeria biflora</i> Buch-Hum. ex. D.Don.	Lamiaceae	+	-	-	+	-	+
<i>Origanum vulgare</i> L. Sp.	Lamiaceae	+	+	+	-	+	+
<i>Oxalis corniculata</i> L. Sp.	Oxalidaceae	+	+	+	+	-	+
<i>Potentilla gerardiana</i> Lindley ex.Lehmann	Rosaceae	+	-	-	-	-	-
<i>Potentilla fulgens</i> Wall.ex.Hook.	Rosaceae	-	-	-	+	-	-
<i>Reinwartia indica</i> Dumortier	Linaceae	+	+	+	-	+	+
<i>Sonchus oleraceus</i> L. Sp.	Asteraceae	+	+	+	+	+	+
<i>Stellaria media</i> (L.) Villars.Hist.Pl.	Caryophyllaceae	+	+	+	-	+	+
<i>Strobilanthe wallichii</i> Nees.	Acanthaceae	+	+	-	+	+	+
<i>Taraxacum officinale</i> Weber in Wiggers	Asteraceae	+	+	-	+	-	-
<i>Thalictrum foliolosum</i> Dc.	Ranunculaceae	+	+	+	+	+	+
<i>Viola biflora</i> L. Sp.	Violaceae	+	+	+	-	+	+
<i>Viola canescens</i> Wall in Roxb.	Violaceae	+	+	+	+	+	+

*VP stands for Van Panchayat forest and RF stands for Reserve forest (+ and – indicate presence and absence of species).