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Floristic Diversity under different habitats in Overa Wildlife Sanctuary of J&K India

*The present investigation was carried out in the Overa wildlife sanctuary in the Kashmir Valley of Jammu and Kashmir, Union Territory of India. The plant community composition and other phytosociological characteristics of the vegetation were studied in four fixed habitats of the sanctuary. The vegetation analysis was carried out by stratified random sampling. Quadrates of 10×10 m, 5×5 m and 1×1 m for trees, shrubs and herbs respectively were laid in all four habitats. The plant community composition and other phytosociological characteristics of the vegetation revealed a total of 37 plant species belonging to 25 families were recorded from the study area out of which 8 were tree species, 8 shrub species and 21 herb species. Out of the total families recorded, Asteraceae was the dominant family represented by 4 species, followed by Pinaceae, and Fabaceae with 3 species each. Malvaceae, Poaceae, Polygonaceae, Rosaceae and Sapindaceae represented by two species each. Betulaceae, Dioscoreaceae, Berberidaceae, Caprifoliaceae, Juglandaceae, Simaroubaceae, Hamamelidaceae, Cupressaceae, Ranunculaceae, Lamiaceae, Phytolacaceae, Podophyllaceae, Solanaceae, Cannabaceae, Poaceae, Urticaceae and Valerianaceae were represented by one species in each family. The phytosociology of the different habitats revealed that among trees *Abies pindrow* and *Pinus wallichiana* dominated the woodland and riverine habitat while as *Abies pindrow* and *Picea smithiana* dominated the coniferous habitat. *Betula utilis* and *Picea smithiana* dominated the sub-alpine pasture habitat. The phytosociology of shrubs envisaged that *Viburnum grandiflorum* was the most dominant shrub species in woodland, riverine and coniferous habitats whereas; *Juniperus communis* was dominant in sub-alpine pasture habitat. Similarly among herbs, *Fragaria vesca* dominated in woodland, riverine and coniferous habitats whereas *Trifolium repens* was dominant in sub-alpine pasture habitat. Among trees the value of Shannon Wiener diversity index was 1.60 in woodland, 1.37 in coniferous. In case of shrubs, the value of diversity index was 1.92 in woodland and 1.08 in sub-alpine pasture. Among herbs the value of the index in woodland was 2.68 and 3.27 in sub-alpine pasture was 2.15.*

Key words: Habitat, Diversity, Species, Phytosociology

Introduction

Phytosociological studies are essential for protecting the natural plant communities and biodiversity as well as understanding the changes experienced in the past and continuing in the future. The study of species diversity is helpful in understanding community composition, structure, change and development (Li *et al.*, 2002). Phytosociology attempts to describe the diversity in plant communities and its methods often involve the quantitative estimation of various parameters of vegetation like cover, abundance, frequency etc. Phytosociology surveys are an important tool for ecologists to assess and evaluate the vegetation types of given ecosystem. The phytosociological information about each individual tree species is essential for understanding their ecology and establishing conservation management policies for over exploited forests (Kharakwal *et al.*, 2009). Phytosociology of Himalayan forests has been subject to extensive research (Gairola *et al.*, 2008). It is true that much work has

A total of 37 plant species belonging to 25 families were recorded from the study area out of which 8 were tree species, 8 shrub species and 21 herb species.

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been conducted in Eastern and Western moist temperate Himalayan forests, the Kashmir Siwaliks have not been given proper attention due to remoteness, lack of infrastructure and danger, being at India-Pakistan border (Shaheen *et al.*, 2011).

Species diversity is one of the most crucial and important indices used for evaluating the stability and sustainability of forest communities. Information on the species composition of a forest is essential for its wise management in terms of economic value, regeneration potential and which ultimately leads to conservation of biological diversity (Verma *et al.*, 1999). The study of species diversity is helpful in understanding community composition, structure, change and development (Li *et al.*, 2002). Moreover, species diversity is affected by multi-environmental factors (Tang *et al.*, 2004) especially by the altitudinal gradient. The Forests of Overa wildlife sanctuary have not been studied for phytosociological studies. An attempt was made to identify plant communities in the area studied for understanding their ecology and for establishing management policies. Therefore present study was carried out to determine the floristic diversity under different habitats in Overa wildlife sanctuary of J&K India. This study holds significance as it will act as a base for future ecological studies in the area.

Material and Methods

Study area

The study was carried out in the Overa-Aru Wildlife Sanctuary. The Overa-Aru wildlife sanctuary (33°55'0" to 34°20'0" N and 75°5'0" to 75°32'30" E) is named after two villages of Overa and Aru located at (Himalayan biogeographical zone 2A) (Rodgers and Panwar, 1988) Southern and north-eastern boundaries of the sanctuary. The Overa-Aru wildlife sanctuary located near famous pahalgam town 76Km south of Srinagar and 40 Km from Anantnag town in Jammu and Kashmir is spread across an area of 511 Km² and ranges in altitude between 1600 m- 5400 m.

Methodology

The community composition and other phytosociological characteristics of the vegetation were studied in four habitats, through field surveys. The vegetation analysis was carried out by stratified random sampling. Quadrats of 10×10 m, 5×5 m and 1×1 m for trees, shrubs and herbs, respectively were laid along the transects in different habitats of Overa wildlife sanctuary.

Sampling procedure

Sampling was carried out at animal sighted locations. The Phyto-sociological findings of the study at animal sighted locations will be help for accessing habitats of mammals in the Overa wildlife sanctuary.

Number of habitats	:	04 (Woodland, Riverine, Coniferous, Sub-alpine pasture)
Number of blocks or sampling plots	:	39 per habitat
Plant community	Quadrant size	No. of quadrates laid per habitat
Tree	10 × 10 m	: 13
Shrub	5 × 5 m	: 13
Herb	1 × 1 m	: 13
Total number of quadrats for trees		: 52
Total number of quadrats for shrubs		: 52
Total number of quadrats for herbs		: 52
Grand Total of quadrats laid		: 156

Floristic composition

The floristic data was computed for frequency, density and abundance (Curtis and McIntosh, 1950). The relative values of frequency, density and dominance were determined as per Philips (1959). These values were summed to represent IVI (Important Value Index) of individual species in order to express the dominance and ecological success of the species (Curtis, 1959). The important quantitative analysis such as density, frequency and abundance of tree species, shrubs and herbs were determined as per Curtis and McIntosh (1950). Diversity index was calculated according to "Shannon-Wiener" diversity function prescribed by Margalef (1968).

Statistical analysis

The statistical analysis for each objective was carried out and data was subjected to analysis using standard statistical tools and procedures. The analysis of data was performed through SPSS 16.0 and MS-EXCEL statistical softwares.

Results and Discussion

During the present investigation, a total of 37 species (Table 1) distributed among 25 families were recorded in different habitats of Overa wildlife sanctuary under study. Based on number of species within the families, Asteraceae was recorded to be the largest family with 4 species in it followed by Pinaceae and Fabaceae with 3 species each. Malvaceae, Poaceae, Polygonaceae, Rosaceae and Sapindaceae represented by two species each. Betulaceae, Dioscoreaceae, Berberidaceae, Caprifoliaceae, Juglandaceae, Simaroubaceae, Hamamelidaceae, Cupressaceae, Ranunculaceae, Lamiaceae, Phytolacaceae, Podophyllaceae, Solanaceae, Cannabaceae, Poaceae, Urticaceae and Valerianaceae were represented by one species in each family.

Floristic composition under different habitats

Woodland

The data tabulated in Table 2, Table 3 and Table 4 pertaining to Woodland habitat of Overa wildlife sanctuary reveals the presence of five tree species, five shrub species and thirteen herb species. The maximum

Table 1: Available plant species present in different habitats of Overa wildlife sanctuary

S.No.	Scientific name	Common name	Local name	Family
Tress				
1	<i>Abies pindrow</i>	Fir	Budlu	Pinaceae
2	<i>Aesculus indica</i>	Horse chestnut	Han doon	Sapindaceae
3	<i>Ailanthus altissima</i>	Tree of heaven	Alamthras	Simaroubaceae
4	<i>Pinus wallichiana</i>	Kail	Kayur	Pinaceae
5	<i>Picea smithiana</i>	Spruce	Kachiul	Pinaceae
6	<i>Juglans regia</i>	Walnut	Doon	Juglandaceae
7	<i>Acer caesium</i>	Indian mapple	Trikan	Sapindaceae
8	<i>Betula utilis</i>	Himalayan birch	Bojpater	Betulaceae
Shrubs				
9	<i>Berberis lyceum</i>	Indian barberry	Kawdach	Berberidaceae
10	<i>Dioscorea deltoidea</i>	Yam	Krech	Dioscoreaceae
11	<i>Indigofera heterantha</i>	True indigo	Jand	Fabaceae
12	<i>Viburnum grandiflorum</i>	Grand viburnum	Kulmanch	Caprifoliaceae
13	<i>Sambucus wightiana</i>	Elder	Fhakee	Sambucaceae
14	<i>Parratriopsis jacquemontiana</i>	Parrotia	Poh	Hamamelidaceae
15	<i>Rubus irritans</i>	Blackberry	Jhansh	Rosaceae
16	<i>Juniperus communis</i>	Juniper	Shukcher	Cupressaceae
Herbs				
17	<i>Acontium heterophyllum</i>	Indian atees	Patis	Ranunculaceae
18	<i>Artemisia absinthium</i>	Worm wood	Tethwen	Asteraceae
19	<i>Cynodon dactylon</i>	Couch grass	Dramun	Poaceae
20	<i>Cannabis sativa</i>	Hemp	Bhang	Cannabaceae
21	<i>Datura stramonium</i>	Jim son's weed	Datur	Solanaceae
22	<i>Dactylis glomerata</i>	Orchard grass	Bagh gasseh	Poaceae
23	<i>Lavatera cashmeriana</i>	True mallow	Saz posh	Malvaceae
24	<i>Fragaria vesca</i>	Himalayan strawberry	Ringrech	Rosaceae
25	<i>Malva neglecta</i>	Common mallow	Kashir sochel	Malvaceae
26	<i>Matricaria chamomilla</i>	May scented weed	Fackh gaas	Asteraceae
27	<i>Mentha spicata</i>	Spear mint	Pudna	Lamiaceae
28	<i>Phytolacca acinosa</i>	Indian pokeweed	Hapat makai	Phytolaccaceae
9	<i>Podophyllum hexandrum</i>	Himalayan may apple	Wan wagaun	Podophyllaceae
30	<i>Rheum emodii</i>	Himalayan rhubarb	Pambechalan	Polygonaceae
31	<i>Rumex nepalensis</i>	Common Sorrel	Abej	Polygonaceae
32	<i>Saussuria costus</i>	Kuth	Kuth	Asteraceae
33	<i>Trifolium repens</i>	White clover	Safed batakh leunt	Fabaceae
34	<i>Trifolium pratens</i>	Red clover	Batakh leunt	Fabaceae
35	<i>Taraxacum officinale</i>	Common dandelion	Hand	Asteraceae
36	<i>Urtica dioica</i>	Stinging nettle	Soi	Urticaceae
37	<i>Valeriana hardwickii</i>	Indian valerian	Mushkbala	Valerianaceae

dominance was observed for *Abies pindrow* among trees with IVI value of (88.67), followed by *Pinus wallichiana* (70.01), *Picea smithiana* (60.64), *Aesculus indica* (45.63) whereas, minimum IVI was observed in case of *Alianthus altissima* (34.85). Among the shrub species present in the area *Viburnum grandiflorum* has the highest value of all the phytosociological parameters with IVI value (84.69) and was the dominant species followed by *Berberis lycium* (64.99), *Indigofera heterantha* (57.20), *Rubus irritans* (55.56), whereas the species with least IVI (37.56) was *Parrotiopsis jacquemontiana*. Among the herb species present in the area the maximum dominance was observed for *Fragaria vesca* with IVI value of (39.87), followed by *Trifolium repens* (30.95), *Malva neglecta* (27.26), *Cannabis sativa* (24.19), *Urtica dioica* (23.07) whereas, minimum IVI was observed in case of *Phytolacca acinosa* (15.18).

The total average density of trees was 823.05 m²ha⁻¹ with maximum contribution of *Abies pindrow* (200.00 m²ha⁻¹)

and minimum of *Ailanthus altissima* (130.76 m²ha⁻¹). The total average density of shrubs was 7661.51 m²ha⁻¹ with maximum contribution of *Viburnum grandiflorum* (2092.30 m²ha⁻¹) and minimum in case of *Parratriopsis jacquemontiana* (953.84 m²ha⁻¹). In case of herbs, total average density was 55.93 m²ha⁻¹ with maximum contribution of *Fragaria vesca* (6.53 m²ha⁻¹) and minimum in *Phytolacca acinosa* (2.00 m²ha⁻¹). Overall frequency was reported highest in *Abies pindrow* (76.92%), *Viburnum grandiflorum* (76.92%), and *Fragaria vesca* (84.61%) among trees, shrubs and herbs respectively.

Riverine

The data tabulated in Table 2, Table 3 and Table 4 pertaining to riverine habitat of Overa wildlife sanctuary reveals the presence of five tree species, seven shrub species and seventeen herb species. The maximum dominance was observed for *Abies pindrow* among trees with IVI value of (88.66), followed by *Pinus wallichiana* (69.43), *Aesculus indica* (49.34), *Alianthus*

Table 2: Floristic composition and phytosociological attributes of tree species in different habitat

Tree species	Family	Woodland			Riverine			Coniferous			Sub-alpine pasture		
		D	F	IVI	D	F	IVI	D	F	IVI	D	F	IVI
<i>Abies pindrow</i>	Pinaceae	200.00	76.92	88.67	176.92	84.61	88.66	184.61	76.92	99.06	138.46	69.23	63.86
<i>Aesculus indica</i>	Sapindaceae	146.15	53.84	45.63	153.84	46.15	49.34	130.76	38.46	40.86	-	-	-
<i>Allianthus altissima</i>	Simaroubaceae	130.76	38.46	34.85	138.46	61.53	47.29	-	-	-	-	-	-
<i>Pinus wallichiana</i>	Pinaceae	184.61	63.57	70.01	161.53	61.53	69.43	176.92	69.23	77.84	123.07	61.54	55.05
<i>Picea smithiana</i>	Pinaceae	161.53	61.53	60.84	-	-	-	161.53	61.53	82.24	146.15	53.84	69.58
<i>Juglans regia</i>	Juglandaceae	-	-	-	130.76	53.84	45.28	-	-	-	-	-	-
<i>Acer caesium</i>	Sapindaceae	-	-	-	-	-	-	-	-	-	84.61	38.46	29.77
<i>Betula utilis</i>	Betulaceae	-	-	-	-	-	-	-	-	-	207.69	84.61	81.74

D- Density; F- Frequency %; IVI- Importance value index

Table 3: Floristic composition and phytosociological attributes of shrub species in different habitat

Tree species	Family	Woodland			Riverine			Coniferous			Sub-alpine pasture		
		D	F	IVI	D	F	IVI	D	F	IVI	D	F	IVI
<i>Berberis lycium</i>	Berberidaceae	1753.84	61.53	64.99	2000.00	76.92	51.04	1907.69	61.53	59.03	953.84	53.84	79.01
<i>Dioscorea deltoidea</i>	Dioscoreaceae	-	-	-	1169.23	69.23	32.82	1292.30	53.84	40.16	-	-	-
<i>Indigofera heterantha</i>	Fabaceae	1476.92	53.84	57.20	1907.69	53.84	46.14	1538.46	69.23	54.49	-	-	-
<i>Viburnum grandiflorum</i>	Caprifoliaceae	2092.30	76.92	84.69	2307.69	84.61	62.65	2184.61	76.92	74.97	1076.92	69.23	99.67
<i>Sambucus wightiana</i>	Sambucaceae	-	-	-	1476.29	53.84	32.41	1230.76	69.23	40.95	-	-	-
<i>Parrotiopsis jacquemontiana</i>	Hamamelidaceae	953.84	53.84	37.56	1415.38	61.53	33.31	984.61	46.15	30.40	-	-	-
<i>Rubus irritans</i>	Rosaceae	1384.61	69.23	55.56	1661.53	69.23	41.63	-	-	-	1384.61	84.61	121.32
<i>Juniperus communis</i>	Cupressaceae	-	-	-	-	-	-	-	-	-	-	-	-

D- Density; F- Frequency %; IVI- Importance value index

altissima (47.29) whereas, minimum IVI was observed in case of *Juglans regia* (45.28). Among the shrub species present in the area *Viburnum grandiflorum* has the highest value of all the phytosociological parameters with IVI value (62.65) and was the dominant species followed by *Berberis lycium* (51.04), *Indigofera heterantha* (46.14), *Rubus irritans* (41.63), *Parrotiopsis jacquemontiana* (33.31) whereas the species with least IVI (32.41) was *Sambucus wightiana*. Among the herb species present in the area the maximum dominance was observed for *fragaria vesca* with IVI value of (30.26), followed by *Cynodon dactylon* (25.11), *Trifolium repens* (22.69), *Trifolium pretense* (21.28), *Malva neglecta* (20.17) whereas, minimum IVI was observed in case of *Urtica dioica* (11.34).

The total average density of trees was 761.51 m² ha⁻¹ with maximum contribution of *Abies pindrow* (176.05 m² ha⁻¹) and minimum of *Juglans regia* (130.76 m² ha⁻¹). The total average density of shrubs was 11937.81 m² ha⁻¹ with maximum contribution of *Viburnum grandiflorum* (2307.69 m² ha⁻¹) and minimum in case of *Dioscorea deltoidea* (1169.23 m² ha⁻¹). In case of herbs, total average density was 93.16 m² ha⁻¹ with maximum contribution of *Fragaria vesca* (9.38 m² ha⁻¹) and minimum in *Podophyllum hexandrum* (2.61 m² ha⁻¹). Overall frequency was reported highest in *Abies pindrow* (84.61%), *Viburnum grandiflorum* (84.61%), and *Fragaria vesca* (92.30%) among trees, shrubs and herbs respectively.

Coniferous

The data tabulated in Table 2, Table 3 and Table 4 pertaining to Coniferous habitat of Overa wildlife sanctuary reveals the presence of four tree species, six shrub species and fifteen herb species. The maximum dominance was observed for *Abies pindrow* among trees with IVI value of (99.06) followed by *Picea smithiana* (82.24), *Pinus wallichiana* (77.84), whereas, minimum IVI was observed in case of *Aesculus indica* (40.86) (Table 9). Among the shrub species present in the area *Viburnum grandiflorum* has the highest value of all the phytosociological parameters with IVI value (74.97) and was the dominant

Table 3: Floristic composition and phytosociological attributes of shrub species in different habitat

Tree species	Family	Woodland			Riverine			Coniferous			Sub-alpine pasture		
		D	F	IVI	D	F	IVI	D	F	IVI	D	F	IVI
<i>Aconitum heterophyllum</i>	Ranunculaceae	4.38	53.84	22.89	4.92	61.53	15.92	5.15	53.84	20.6	3.69	46.15	28.74
<i>Artemisia absinthium</i>	Asteraceae	-	-	-	4.23	69.23	16.52	3.92	46.15	16.74	-	-	-
<i>Cynodon dactylon</i>	Poaceae	-	-	-	7.00	76.92	25.11	-	-	-	-	-	-
<i>Cannabis sativa</i>	Cannabaceae	4.60	61.53	24.19	3.46	53.84	12.45	-	-	-	-	-	-
<i>Datura stramonium</i>	Solanaceae	4.30	46.15	19.53	5.92	69.23	16.27	5.23	46.15	17.30	-	-	-
<i>Dactylis glomerata</i>	Poaceae	3.46	53.84	1.12	5.76	69.23	17.13	-	-	-	4.92	61.53	34.30
<i>Lavatera cashmeriana</i>	Malvaceae	3.92	38.46	17.54	5.30	69.23	15.34	-	-	-	-	-	-
<i>Fragaria vesca</i>	Rosaceae	6.53	84.61	39.87	9.38	92.30	30.26	6.84	92.30	33.32	-	-	-
<i>Malva neglecta</i>	Malvaceae	4.76	61.53	27.26	6.46	69.23	20.17	5.84	76.92	25.35	4.76	69.23	40.32
<i>Matricaria chamomilla</i>	Asteraceae	4.15	53.84	19.35	3.69	53.84	11.98	3.61	46.15	13.84	-	-	-
<i>Mentha spicata</i>	Lamiaceae	-	-	-	-	-	-	6.15	69.23	22.11	-	-	-
<i>Phytolacca acinosa</i>	Phytolaccaceae	2.00	46.15	15.18	4.15	46.15	11.50	4.46	46.15	15.28	-	-	-
<i>Podophyllum hexandrum</i>	Podophyllaceae	-	-	-	2.61	53.84	11.37	2.38	61.53	14.58	-	-	-
<i>Rheum emodii</i>	Polygonaceae	-	-	-	4.46	-	-	3.23	61.53	18.52	2.23	46.15	24.86
<i>Rumex nepalensis</i>	Polygonaceae	3.53	53.84	20.13	4.46	69.23	15.55	3.38	53.84	18.23	3.38	61.53	33.50
<i>Saussuria costus</i>	Asteraceae	-	-	-	4.38	38.46	12.15	-	-	-	-	-	-
<i>Trifolium repens</i>	Fabaceae	6.00	76.92	30.95	7.38	84.61	22.69	7.07	84.61	28.14	5.69	69.23	42.94
<i>Trifolium pratense</i>	Fabaceae	-	-	-	7.30	76.92	21.28	6.46	76.92	25.70	5.00	69.23	39.84
<i>Taraxacum officinale</i>	Asteraceae	3.15	69.23	20.45	3.30	61.53	12.94	3.23	61.53	15.87	3.30	61.53	28.60
<i>Urtica dioica</i>	Urticaceae	5.15	61.53	23.07	3.46	46.15	11.34	-	-	-	-	-	-
<i>Valeriana hardwickii</i>	Valerianaceae	-	-	-	3.46	-	-	2.46	69.23	14.42	2.46	76.92	26.90

D- Density; F- Frequency %; IVI- Importance value index

species followed by *Berberis lycium* (59.03), *Indigofera heterantha* (54.49), *Sumbucus wightiana* (40.95), whereas the species with least IVI (30.40) was *Parrotiopsis jacquemontiana*. Among the herb species present in the area the maximum dominance was observed for *Fragaria vesca* with IVI value of (33.32), followed by *Trifolium repens* (28.14), *Trifolium pratense* (25.70), *Malva neglecta* (25.35), *Mentha spicata* (22.11) whereas, minimum IVI was observed in case of *Matricaria chamomilla* (12.84).

The total average density of trees was 653.82 m²ha⁻¹ with maximum contribution of *Abies pindrow* (184.61 m²ha⁻¹) and minimum of *Aesculus indica* (130.76 m²ha⁻¹). The total average density of shrubs was 9138.43 m²ha⁻¹ with maximum contribution of *Viburnum grandiflorum* (2184.61 m²ha⁻¹) and minimum in case of *Parratriopsis jacquemontiana* (984.61 m²ha⁻¹). In case of herbs, total average density was 69.41 m²ha⁻¹ with maximum contribution of *Trifolium repens* (7.07 m²ha⁻¹) and minimum in *Valeriana hardwickii* (2.46 m²ha⁻¹). Overall frequency was reported highest in *Abies pindrow* (76.92%), *Viburnum grandiflorum* (76.92%), and *Fragaria vesca* (92.30%) among trees, shrubs and herbs respectively.

Sub-alpine pasture

The data tabulated in Table 2, Table 3 and Table 4 pertaining to sub-alpine pasture habitat of Overa wildlife sanctuary reveals the presence of five tree species, three shrub species and nine herb species. The maximum dominance was observed for *Betula utilis* among trees with IVI value of (81.74) followed by *Picea smithiana* (69.58), *Abies pindrow* (63.86), whereas, minimum IVI was observed in case of *Acer caesium* (29.77). Among the shrub species present in the area *Juniperus communis* has the highest value of all the phytosociological parameters with IVI value (121.32) and was the dominant species followed by *Viburnum grandiflorum* (99.67) whereas the species with least IVI (79.01) was *Berberis lycium*. Among the herb species present in the area the maximum dominance was observed for *Trifolium repens* with IVI value of (42.94), followed by *Malva neglecta* (40.32), *Trifolium pratense* (39.84), *Dactylis glomerata* (34.30), *Rumex nepalensis* (33.50) whereas, minimum IVI was observed in case of *Rheum emodii* (24.86).

The total average density of trees was 699.98 m²ha⁻¹ with maximum contribution of *Betula utilis* (207.69 m²ha⁻¹) and minimum of *Acer caesium* (84.61 m²ha⁻¹). The total average density of shrubs was 3415.37 m²ha⁻¹ with maximum

contribution of *Juniperus communis* (1384.61 m²ha⁻¹) and minimum in case of *Berberis lyceum* (953.84 m²ha⁻¹). In case of herbs, total average density was 35.43 m²ha⁻¹ with maximum contribution of *Trifolium repens* (5.69 m²ha⁻¹) and minimum in *Valeriana hardwickii* (2.46 m²ha⁻¹). Overall frequency was reported highest in *Betula utilis* (84.61%), *Juniperus communis* (84.61%), and *Valeriana hardwickii* (76.92%) among trees, shrubs and herbs respectively.

Shannon Wiener diversity index of trees, shrubs and herbs

In trees, the diversity index showed a decreasing trend from habitat woodland to Coniferous with values ranging from 1.60 in Woodland to 1.37 in Coniferous and further decreased trend from habitat riverine to Sub-alpine pasture with values ranging from 1.59 in Riverine to 1.56 in Sub-alpine pasture (Table 5). In case of shrubs, the diversity index showed same trend in habitat Woodland and Coniferous and further decreasing trend from Riverine to Sub-alpine pasture. In case of herbs, the diversity index showed a decreasing trend from Habitat woodland to Sub-alpine pasture with values ranging from 2.68 in woodland, 2.65 in Coniferous, 2.52 in Riverine and 2.15 in Sub-alpine pasture habitat.

Table 5: Shannon Wiener diversity index of trees, shrubs and herbs in four Habitats of Over a Wildlife Sanctuary of Pahalgam

Habitat	Trees	Shrubs	Herbs
Woodland	1.60	1.92	2.68
Coniferous	1.37	1.57	2.65
Riverine	1.59	1.75	2.52
Sub alpine pasture	1.56	1.08	2.15
Mean	1.53	1.58	2.50
S.E±	0.05	0.18	0.12

S.E- Standard Error

There are no specific studies on floral diversity of Overa wildlife sanctuary, however, Bhat (2017) carried out the comparative study of floral diversity in Batkote Block of Pahalgam Range, and reported 59 plant species belonging to 37 families with a total of 11 tree species, 10 shrub species and 38 herb species. Out of the total families recorded, Poaceae was the dominant family with seven species. Similarly, Hussain (2009) reported 120 plant species belonging to 92 genera and 46 families. Poaceae was the dominating with 14 members in Bandipora valley, Kashmir Himalaya. Furthermore, our findings are very much parallel to the investigation carried out by Kawosa (2001) on floristic composition in Jammu and Kashmir Himalaya, who concluded that *Abies pindrow* together with *Picea smithiana* showed dominance at 2300-3300 m whereas *Cedrus deodara* and *Pinus wallichiana* showed dominance at 1600-2400 m. It was found that the IVI of *Abies pindrow* increased with the increase in elevation.

Observations recorded in terms of total shrub density were in conformation with Rana *et al.* (2015) who

reported the same range in terms of shrub density in Central Himalayan Cypress forest. The structural characteristics like density and basal area showed a marked variation among different sites. *Parrotiopsis jacquemontiana* recorded the highest average density per hectare (488.89) at A₁ (1700-2000 m) while *Rubus irritans* exhibited the lowest average (244.44) at A₃ (2300-2600 m). The density values of shrubs were within the same range value as reported by Verma (2016) on his study on Status of plant diversity along an altitudinal gradient in district Chamba, Himachal Pradesh.

Present study revealed the dominance of herbaceous species in riverine habitat followed by coniferous, woodland and sub alpine pasture habitat. This may be due to the reason that riparian zones are amongst the world's most diverse and dynamic plant habitats (Naiman and Decamps, 1997). The value of diversity index of trees was 1.37-1.60 which is in accordance with the values (1.86-2.73) reported by Ghildiyal *et al.* (1998), (0.70-3.08) Uniyal *et al.* (2010), (0.78-3.45) Raturi (2012), (0.74-2.66) Pant and Sammant (2012), (0.66-2.69) Singh *et al.* (2014), (1.1-2.05) Verma (2016). The value of diversity index of shrubs was 1.08-1.92 which is within the range of 1.05-2.57 as reported by Gairola *et al.* (2008) in sub-alpine zone of Western Himalaya, India and 1.7-2.5 as reported by Verma (2016) at District Chamba, Himachal Pradesh. The values of diversity index of herbs in our study ranged between 2.15-2.68 which is well within the range of 2.40-3.35 as reported by Gairola *et al.* (2008) in sub-alpine zone of Western Himalaya, India; 2.49-3.01 as reported by Bharali *et al.* (2011) in west Siang district of Arunachal Pradesh, India and 3.16-3.20 as reported by Verma (2016) at District Chamba, Himachal Pradesh. The diversity index of herbs in four habitats of Overa wildlife sanctuary showed a decreasing trend from lower altitude to upper altitude. This is in agreement with the trend of diversity index of shrubs and herbs as has been reported by Verma and Kapoor (2011).

Decrease in diversity and species richness at high elevation could be due to ecophysiological constraints such as reduced growing season and low temperature (Korner, 1998). Other factors such as soil fertility and topography may also affect the patterns of species richness along altitudinal gradient. Ellu and Obua (2005) have suggested that different altitudes and slopes influence the species richness. Moreover, Sharma *et al.* (2009) reported that the distribution and species richness pattern of different species are largely regulated by the altitude and climatic factors.

Several researchers have reported that the regional patterns of species richness are consequences of many interacting factors, such as plant productivity, competition, geographical area, historical or evolutionary development, regional species dynamics, regional species pool, environmental variables and human activity (Woodward, 1988; Palmer, 1991;

Eriksson, 1996; Zobel, 1997; Criddle *et al.*, 2003). The altitude, environmental factors, habitat and soil characteristics may be the main factors which eventually lead to the variations in species diversity and density in the study area.

Conclusion

The phyto sociological analysis of the study area revealed presence of 37 plant species which includes 8 trees, 8 shrubs and 21 herbs. The study area is dominated by *Abies pindrow* at lower elevations and *Betula utilis* in sub-alpine pasture. *Viburnum grandiflorum* and *Juniperus communis* were dominant shrub species whereas, *Fragaria vesca* and *Trifolium pratense* were the dominant herb species. The study area is rich source of plant diversity, effective science based management interventions and effective habitat protection and improvements are needed to ensure long term conservation of the floral diversity in the study area.

जम्मू-कश्मीर भारत के ओवेरा वन्यजीव अभयारण्य में विभिन्न

आवासों के तहत फूलों की विविधता

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सारांश

वर्तमान जांच भारत के केंद्र शासित प्रदेश जम्मू और कश्मीर की कश्मीर घाटी में ओवेरा वन्यजीव अभयारण्य में की गई थी। अभयारण्य के चार निश्चित आवासों में पादप समुदाय संरचना और वनस्पति की अन्य पादप-समाजशास्त्रीय विशेषताओं का अध्ययन किया गया। स्तरीकृत यादृच्छिक नमूनाकरण द्वारा वनस्पति विश्लेषण किया गया था। सभी चार आवासों में पेड़ों, झाड़ियों और जड़ी-बूटियों के लिए क्रमशः 10×10 मीटर, 5×मीटर और 1×1 मीटर के क्वाड्रेट रखे गए थे। पादप समुदाय संरचना और वनस्पति की अन्य पादप सामाजिकी विशेषताओं से पता चला कि अध्ययन क्षेत्र से 25 परिवारों से संबंधित कुल 37 पौधों की प्रजातियां दर्ज की गईं, जिनमें से 8 पेड़ प्रजातियां, 8 झाड़ी प्रजातियां और 21 जड़ी बूटी प्रजातियां थीं। दर्ज किए गए कुल परिवारों में से, एस्ट्रेंसेसी 4 प्रजातियों का प्रतिनिधित्व करने वाला प्रमुख परिवार था, उसके बाद पाइनेसी और फैबेसी में 3 प्रजातियां थीं। मालवेसी, पोएसी, पॉलीगोनेसी, रोसैसी और सैपिंडेसी प्रत्येक को दो प्रजातियों द्वारा दर्शाया गया है। प्रत्येक परिवार में एक प्रजाति द्वारा बेटुलासी, डायोस्कोरेसी, बेरबेरीडेसी, कैप्रिफोलियासी, जुलैंडेसी, सिमरौबैसी, हमामेलिडेई, कप्रेसेसिया, रैननकुलेसी, लैमियासी, फाइटोलेक्रेसी, पोडोफिलेसी, सोलानेसी, कैनाबैसी, पोएसी, उर्टिकासी और वेलेरियनसेई का प्रतिनिधित्व किया गया था। विभिन्न आवासों के पादप सामाजिकी से पता चला है कि पेड़ों के बीच *एबीज पिंड्रो* और *पिनस वालिचियाना* वुडलैंड और नदी के निवास स्थान पर हावी थे, जबकि *एबीज पिंड्रो* और *पिसिया स्मिथियाना* शंकुधारी निवास स्थान पर हावी थे। उप-अल्पाइन चरागाह आवास में *बेतूला यूटिलिस* और *पिसिया स्मिथियाना* हावी थे। झाड़ियों के पादप सामाजिकी ने परिकल्पना की कि *विबर्नम ग्रैंडिफ्लोरम* वुडलैंड, नदी के किनारे और शंकुधारी आवासों में सबसे प्रमुख झाड़ीदार प्रजाति थी; उप-अल्पाइन चरागाह आवास में *जुनिपरस कम्युनिस* प्रमुख था। इसी तरह जड़ी-बूटियों के

बीच, *फैगरिया वेस्का* वुडलैंड, नदी के किनारे और शंकुधारी आवासों में हावी था, जबकि *ट्राइफोलियम रेंपेंसउप-अल्पाइन* चरागाह आवास में प्रमुख था। पेड़ों में शैनन वीनर विविधता सूचकांक का मूल्य वुडलैंड में 1.60, शंकुधारी में 1.37 था। झाड़ियों के मामले में, विविधता सूचकांक का मूल्य वुडलैंड में 1.92 और उप-अल्पाइन चरागाह में 1.08 था। जड़ी-बूटियों में वुडलैंड में सूचकांक का मूल्य 2.68 और उप-अल्पाइन चरागाह में 2.15 था।

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