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QUANTITATIVE ANALYSIS OF VEGETATION PATTERNS AND PLANT SPECIES DIVERSITY IN DIFFERENT FOREST TYPES AT YUKSAM – DZONGRI – GOCHELA SAMPLING PATH IN KHANGCHENDZONGA BIOSPHERE RESERVE, WEST SIKKIM, INDIA

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Abstract

Quantitative assessment of plant species recorded a total of 129 species belonging to 81 genera and 61 families in three forest types along Yuksam-Dzongri-Goechela sampling path. Herbaceous flora were maximum (48 species, 28 genera, 22 family) followed by trees (45 species, 29 genera, 21 family), shrub-scrub (26 species, 14 genera, 9 family), 6 epiphytes and 2 species each of bamboo, one each from mosses and lichens respectively. The highest frequency of occurrence was recorded from Plot 1; (29 species). High frequency of occurrence was recorded for tree of *Abies densa* (42.2) followed by *Rhododendron hodgsonii* (31.1) and Betula utilis, *Acer campbellii, Prunus nepalensis, Castanopsis tribuloides, Magnolia campbellii, Rhododendron falconeri* (15.6 each) respectively. The seedling frequency for *Rhododendron hodgsonii* (10.6) was highest followed by *Abies densa* (9.86), *Castanopsis tribuloides* & *Rhododendron barbatum* (5.31 each.). The saplings frequency was highest for *Abies densa* (9.10) followed by *Rhododendron hodgsonii* (8.34) and *Acer campbellii* (6.83). The highest density was recorded for *Rhododendron hodgsonii* (915.6) followed by *Rhododendron barbatum* (540.0), *Abies densa* (535.6) and *Rhododendron falconeri* (424.4), respectively. The maximum seedling density was encountered for *Rhododendron hodgsonii* (404.4) followed by sapling of *Rhododendron falconeri* (373.3) and adult of *Rhododendron hodgsonii* (295.6) were recorded. The highest Importance Value Index (IVI) of *Abies densa* effectively makes it the dominant species. Abundance –to-frequency ratio revealed woody life form had contagious distribution along the Yuksam-Dzongri-Goechela sampling path.

Keywords: Yuksam-Dzongri-Goechela, Sikkim Himalaya, Quantitative analysis, forest types, plant diversity

Introduction

PHOTO 1: *Rhododendron hodgsonii* along trekking route

The forest is a fundamental ecological resource preserving biodiversity and maintaining the ecological diversity in the region. The Khangchendzonga Biosphere Reserve (KBR) in Sikkim is an important conservation area with high ecological, biological diversity, and also contributes to natural and cultural significance in the Indian Himalayan region. The distribution of plant species in the beautiful landscape ranges from the tropical to alpine meadows. Based on topography and elevation, the habitat of KBR can be broadly categorized into wet temperate broad leaved forests, temperate conifer forest, sub-alpine forest, alpine scrubs and alpine meadows. These extreme topographic variations of the landscape provide diversity in the microclimatic conditions and habitat types, enriching the landscape as a biodiversity repository in the Himalayas (Chettri *et al*., 2008).The inventory of tree species that provides information on plant species diversity will represent an important tool to enhance our ability to maintain the biodiversity conservation and forest management purposes. Many workers have been studied in tree species diversity in northeast India by Nath *et al*., (2005), Das & Das, (2005); Kumar *et al*., (2006) and Devi and Das, (2012). In

Sikkim, several workers have been studied in tree species by Rai & Rai, 1993, Singh & Chauhan 1998, Cowan & Cowan 1929). Quantitative evaluation and analysis of the community structure are important for accurate assessment of biodiversity. The enumeration and quantification of individual species have been determined. Trees are the most important structural and functional basis of forest ecosystems and can serve as robust indicators of change and stress at the landscape scale. Tree diversity varies greatly from place to place, mainly due to variations in geography, habitat and disturbance in different forests. Human disturbance patterns also affect the structure and composition of forest ecosystem. Therefore, long-term study of tree population dynamics is crucial for our understanding of the vulnerability of the forest ecosystem.

The present work was conducted in wet temperate broad-leaved forest, temperate conifer forest, sub-alpine forest, alpine scrubs and alpine meadows. The altitude of these habitat ranges between 1800-4200 m asl. The dominant woody species along Yuksam-Dzongri-Goechela trekking route consists of *Acer campbellii, Beilschmiedia* sp, *Exbucklandia populnea, Castanopsis tribuloides, Cinnamonum impressinervium, Elaeocarpus lanceaefolius, Engelhardtia spicata, Garuga floribunda, Juglans regia, Machilus edulis, Michelia cathcartii, Michelia doltsopa, Michelia velutina, Nyssa sessiliflora, Lithocarpus fenestrata, Quercus lamellosa,* and *Rhododendron arboretum*.

PHOTO 2: *Rhododendron barbatum* along trekking route

The vegetation at tree line above Tshoka village is represented by different shrubs species viz., *Rhododendron lanatum, Rhododendron wightii* and *Rosa sericea*. Krummholz vegetation in the rocky alpine habitat is dominated by *Rhododendron anthopogon, R. lepidotum, R. setosum,* and *J. recurva,* and herbaceous flora includes

Anaphalis spp., *Bistorta affinis, Rheum acuminatum, Aconitum* spp., *Primula* spp., *Potentilla peduncularis, Juncus* sp., and many more. At around 4200 m altitude, the thickets of *R. anthopogon, R. lepidotum, R. nivale, R. setosum, J. indica, J. recurva* are common. The common associates of *Rhododendron* scrub in the alpine habitat consist of *Cassiope fastigata, Gaultheria pyroloides,* etc. The altitude beyond 4200 m remains completely snow-covered throughout the year.

Many studies have been conducted on plant species diversity in different forest types of Sikkim Himalayan Region (Pradhan & Lachungpa 1990, Rai & Rai 1993, Singh & Chauhan 1998, Dash & Singh, 2002, Cowan & Cowan 1929, Subba *et al*., 2015, Subba & Lachungpa, 2016) and in north- eastern India (Bhuyan *et al*., 2003). However, the analysis of vegetation patterns and plant species diversity in different forest types along Yuksam – Dzongri – Gochela trekking route is lacking. Therefore, the present study was carried out with the objective to quantify and analyze the vegetation pattern and plant species distribution.

STUDY AREA

Rapid biodiversity survey was conducted during April-May 2013, along Yuksam–Dzongri–Goechela trekking route, covering a distance *ca.* 40 km long transect in KBR. The elevation of the study sites ranges between 1800 – 4200 m asl, lying between latitude 27°23’ – 27°28’ N and longitude 088°°13’ - 088°10’E. Vegetation is characterized by different forest types from wet temperate mixed forest, to sub-alpine ecosystem. The KBR is endowed with rich biodiversity and is the highest biosphere reserve in the country covering 41.31%.

KBR also provides refuge to rare animals like Snow leopard, Blue sheep, Goral, Red Panda, Himalayan Thar, Serow; and avifauna such as, Blood pheasant, Himalayan Monal, Kalij Pheasant; Yellow billed-blue Magpie, etc.

METHODOLOGY

In April-May 2013, random sampling was done by laying 45 sampling plots. The plot of 20 X 20 m was laid in 45 plots at every 100 footstep distance, depending upon the site feasibility, covering a total area of 1.8 ha. Within the main plot, all the standing tree species were enumerated & measured (cbh) at 1.37 m from the ground. Within the subplots, 5 m X 5 m were laid (4 in the corner & 1 at centre) for recording the sapling & shrub. 1 m X 1m were laid for seedling species were enumerated, in the same plot was used for recording the

percent cover of herb species in the area. Plant species were identified through herbarium record and flora (Hooker JD, 1888-1890, Hooker JD 1849, Pradhan & Lachungpa, 1990, Kholia, 2010). The unidentified plants species in the field were photographed, and later identified by consulting plant taxonomy experts from GBPIHED (Sikkim Unit), & BSI and web references (www.efloras.org; www.flowersofindia.net), www.floraofchina were made and by referring to local people from the nearby villages. All the sampling plots were geotagged for reference under long-term monitoring and altitude was recorded.

The frequency, density, dominance and IVI were calculated following method given by Curtis and McIntosh (1950). The ratio of abundance to frequency for different life form was determined to get the picture of distribution patterns of the plant species in the study sites. The ratio indicates regular (<0.025), random (0.025 to 0.05) and contagious (>0.05) distributions (Curtis & Cottam 1956). All the statistical analysis were carried out with the support of Software Microsoft Office Excel 2007.

Frequency

Frequency indicates the degree of dispersion of individual species in an area and it expresses percentage of occurrence.

$$\text{Frequency (\%)} = \frac{\text{Number of quadrat in which the species occurred}}{\text{Total number of quadrat studied}} \times 100$$

Density

Density expressed as the numerical strength of a species, calculated as number of individuals per hectare

$$\text{Density} = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrat studied}}$$

Basal Cover

It is computed using girth of the tree (CBH) at 1.37 m above ground level and it determines dominance of the community.

$$\text{Relative basal Area} = \frac{\text{Total basal area of a species}}{\text{Total basal area of all species}} \times 100$$

Importance Value Index (IVI)

The importance value index (IVI) for the tree species was determined as the sum of the relative density, relative frequency and relative dominance (Curtis, 1959).

IVI= Relative dominance + Relative Density + Relative Frequency.

Distribution Pattern

The ratio of abundance to frequency for different species was determined to get the picture distribution patterns different life form. The ratio indicates regular (<0.025), random (0.025 to 0.05) and contagious (>0.05) distributions (Cottam & Curtis, 1956).

Distribution pattern (%) = Abundance of each species

Frequency of each species

Species Diversity Index

The Shannon-Weiner diversity index (Shannon and Weiner, 1963) is calculated using the species diversity in a community

$$H' = -\sum_{i=1}^{S} (ni/N) \log_2 ni/N)$$

Where, 'ni' represents total number of individuals of particular species, and 'N' represents total number of individuals of all species.

Species Richness

It is simply the number of species per unit area. Margalef's index of species richness (1958) was calculated by using formula.

$$I = (S-1)/\ln(N)$$

Where, 'S'= the number of species in the sample and 'N'= the total number of individuals in the sample.

RESULTS

Vegetation Structure

A total of 129 species belonging to 81 genera and 61 families were recorded from 45 transects in different forest types viz., wet temperate broad leaved forests, temperate conifer forest, sub-alpine forest, alpine scrubs and alpine meadows of Yuksam-Dzongri-Goechela sampling path. Herbaceous species were recorded maximum (48 species, 28 genera, 22 family) followed by tree (45 species, 29 genera, 21 family) and shrub-scrub (26 species, 14 genera, 9 family), six epiphytes, and two species from bamboo, one each from mosses and lichens respectively.

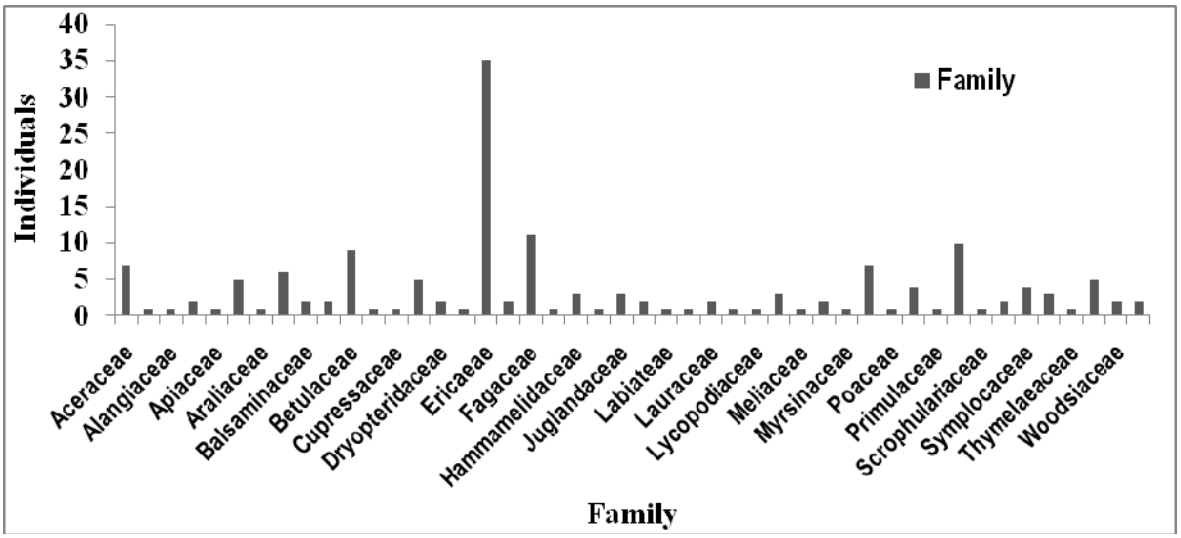

Figure 1: Family-wise species composition of Yuksam-Dzongri-Goechela sampling plot

A total of 61 families of containing 129 species represented the floral face of the study site. Maximum numbers of families were recorded from Ericaceae (35) followed by Fagaceae (11), Rosaceae (10), Betulaceae (9), Pinaceae & Aceraceae having (7 each family), Asteraceae (6), Above [**Figure 1].**

Diversity of plant species

TREE

Plant species diversity and regeneration pattern for sapling and seedlings were studied in different forest types. The percentage of high frequency from Plot 1; (29 species, 1867 m), followed by plot 3 (27 species, 1976 m) and plot 4 (24 species, 2023 m). The percentage of low frequency of occurrence was recorded from Plot 16-18, 23-25,27, 31,41 and Plot 43 – 44 with four species each respectively [**Figure 2].**

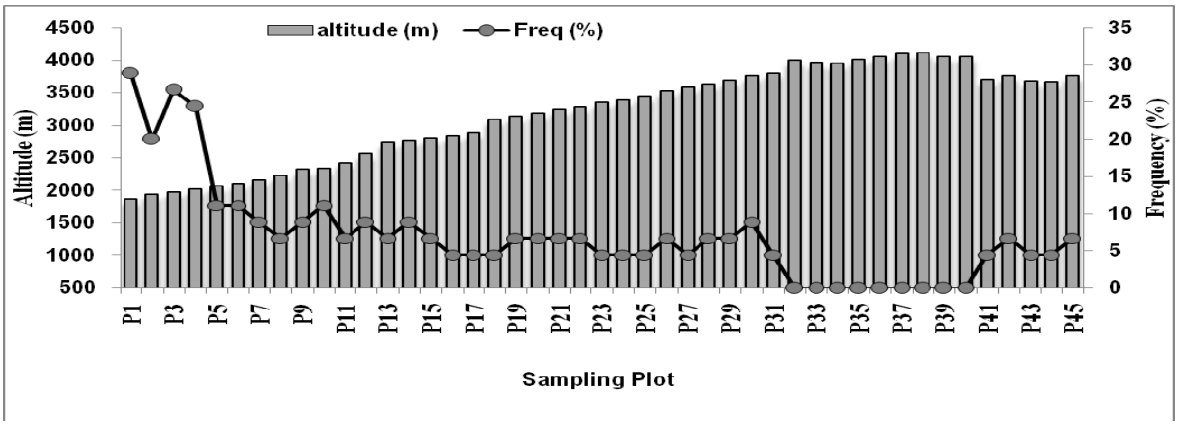

Figure 2: Altitudinal gradients and frequency (%) of tree species distribution at Yuksam-Dzongri- Goechela sampling plot in West Sikkim

High frequency of occurrence was recorded for tree of *Abies densa* (42.2) followed by *Rhododendron hodgsonii* (31.1) and *Betula utilis, Acer campbellii, Prunus nepalensis, Castanopsis tribuloides, Magnolia campbellii, Rhododendron falconeri* (15.6 each) respectively.

The seedling frequency for *Rhododendron hodgsonii* (10.6) was highest followed by *Abies densa* (9.86), *Castanopsis tribuloides* & *Rhododendron barbatum* (5.31 each.). The saplings frequency was highest for *Abies densa* (9.10) followed by *Rhododendron hodgsonii* (8.34) and *Acer campbellii* (6.83).

In general, diversity pattern for seedlings was maximum (H'=2.82) followed by sapling (H'=2.81) and adult (H'=2.79). The value of species richness was found to be 44.09 - 44.00 on the entire site. [**Table 1]**

Table 1: Structural data on the major species in the Yuksam-Dzongri – Gochela sampling path of Khangchendzonga Biosphere Reserve, West Sikkim

Sl. No	Species	Relative density	Relative frequency	Pi =ni/N	lnPi	Pi*lnPi	H
1.	*Acer campbellii* Hook. & Thom.	4.82	4.97	0.0482	-3.03	-0.1462	
2.	*Prunus nepalensis* (Ser) Stendel	4.11	4.97	0.0411	-3.19	-0.1311	
3.	*Castanopsis tribuloides* (Smith)	7.32	4.97	0.0732	-2.61	-0.1914	
4.	*Alnus nepalensis* D. Don.	0.71	1.42	0.0071	-4.94	-0.0353	
5.	*Betula alnoides* Don.	1.96	3.55	0.0196	-3.93	-0.0772	
6.	*Rhus insignis* Hook. f.	0.54	1.42	0.0054	-5.23	-0.0280	
7.	*Juglans regia* Linn.	0.54	1.42	0.0054	-5.23	-0.0280	
8.	*Cedrela febrifuga* Blume	0.54	1.42	0.0054	-5.23	-0.0280	
9.	*Macaranga pustulata* King.	0.54	1.42	0.0054	-5.23	-0.0280	
10	*Acer caudatum* Wallich.	2.68	3.55	0.0268	-3.62	-0.0970	2.79
11	*Rhododendron arboreum* var. *roseum*	6.25	4.26	0.0625	-2.77	-0.1733	
12	*Quercus glauca* Thunb	1.07	2.84	0.0107	-4.54	-0.0486	
13	*Cinnamomum impressinervium* Meisn.	0.54	1.42	0.0054	-5.23	-0.0280	
14	*Castanopsis hystrix* Hook & Thom. ex	1.61	1.42	0.0161	-4.13	-0.0664	
15	*Quercus lamellosa* Smith	2.50	2.84	0.0250	-3.69	-0.0922	
16	*Magnolia campbellii* Hook.f. & Thom.	9.46	4.97	0.0946	-2.36	-0.2231	
17	*Exbucklandia populnea* R.Br. Ex	0.36	1.42	0.0036	-5.63	-0.0201	
18	*Machilus edulis* King ex Hook. f.	0.71	2.13	0.0071	-4.94	-0.0353	

19	*Saurauia napaulensis* DC	0.36	1.42	0.0036	-5.63	-0.0201	
20	*Pieris ovalifolia* D Don.	1.07	2.13	0.0107	-4.54	-0.0486	
21	*Daphniphyllum himalayense* (Benth.)	0.54	1.42	0.0054	-5.23	-0.0280	
22	*Acer stachyophyllum* Heirn.	1.96	1.42	0.0196	-3.93	-0.0772	
23	*Elaeocarpus lanceaefolius* Roxb.	0.36	1.42	0.0036	-5.63	-0.0201	
24	*Rhododendron falconeri* Hook. f.	4.11	4.97	0.0411	-3.19	-0.1311	
25	*Tsuga dumosa* (D.Don) Eichler	1.07	2.84	0.0107	-4.54	-0.0486	
26	*Abies densa* Griffith. ex Parker	17.68	13.49	0.1768	-1.73	-0.3063	
27	*Rhododendron hodgsonii* Hook. f.	17.32	9.94	0.1732	-1.75	-0.3037	
28	*Betula utilis* D. Don	4.46	4.97	0.0446	-3.11	-0.1388	
29	*Rhododendron lanatum* Hook. f.	3.39	1.42	0.0339	-3.38	-0.1148	
30	*Rhododendron wightii* Hook. f.	0.54	1.42	0.0054	-5.23	-0.0280	

Density

The highest density was recorded for *Rhododendron hodgsonii* (915.6) followed by *Rhododendron barbatum* (540.0), *Abies densa* (535.6) and *Rhododendron falconeri* (424.4), respectively shown in **[Figure 3].** The maximum seedling density was encountered for *Rhododendron hodgsonii* (404.4) followed by sapling of *Rhododendron falconeri* (373.3) and adult of *Rhododendron hodgsonii* (295.6) were recorded.

PHOTO 3: Temperate Coniferous Forest

Some of the Rhododendron species found in Yuksam-Dzongri-Goechela trekking route in West Sikkim

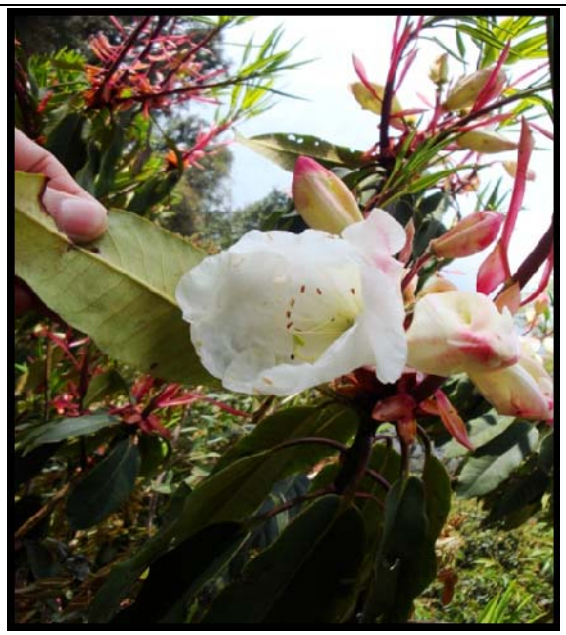

PHOTO 4: Floret of *Rhododendron hodgsonii* & *Rhododendron griffithianum*

PHOTO 5: Floret of *Rhododendron falconeri* & *Rhododendron cinnabarinum*

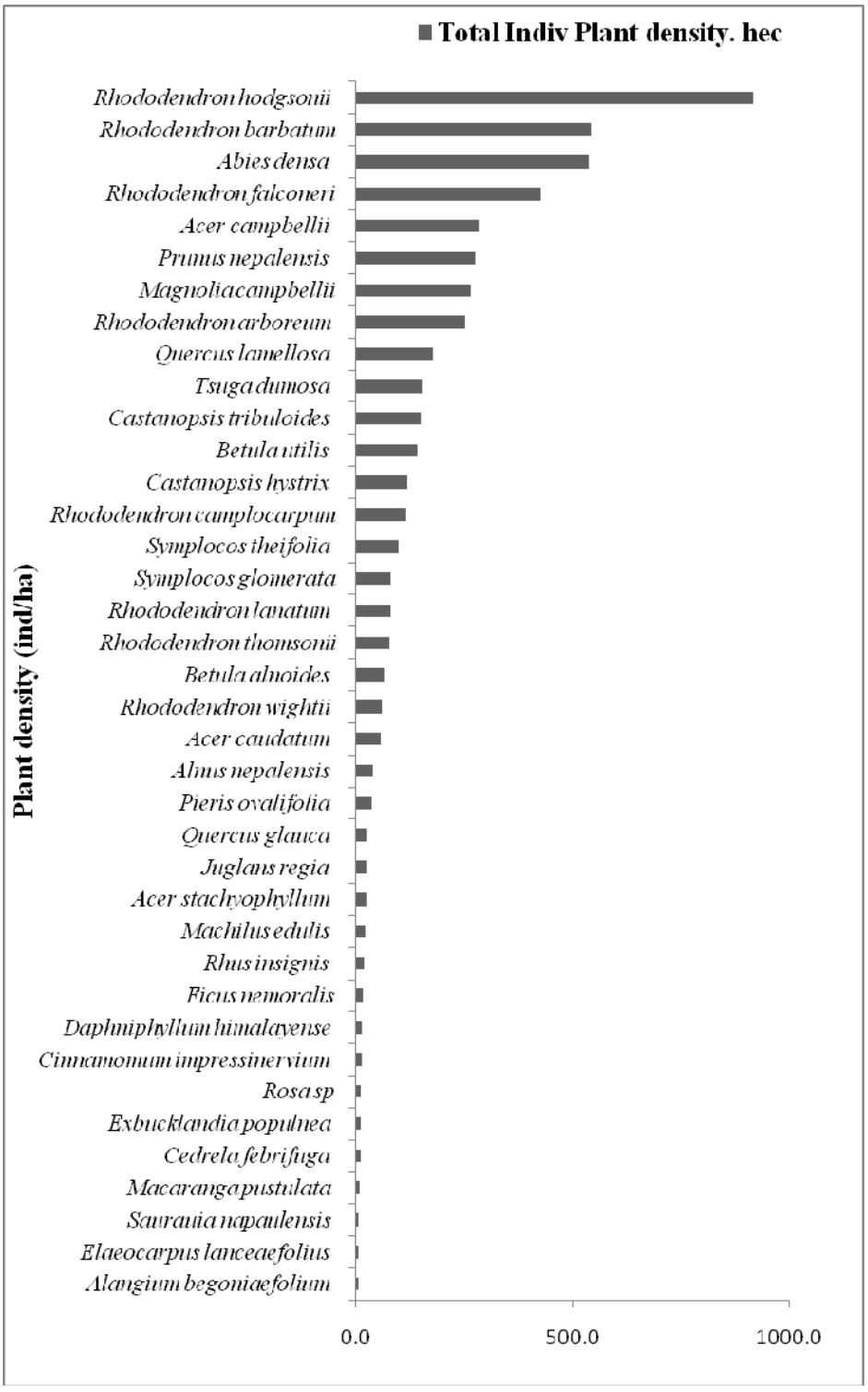

Figure 3: Plant density (ind/ha) along the sampling path

Importance Value index

The IVI values ranged 1.78 - 57.72 in different forest types in 45 sampling plots. The dominant species was recorded from *Abies densa* (57.72) followed by *Castanopsis tribuloides* (30.49), *Magnolia campbellii* (28.78) *Rhododendron arboreum* (16.39) and *Acer campbellii* (15.40) and *Quercus lamellosa* (15.03). The lowest IVI was recorded for *Saurauia napaulensis* (1.78) and *Exbucklandia populnea* (1.79) [(**Table 2)]**.

Table 2: Availability and distribution pattern of different life form in Yuksam-Dzongri Gochela sampling paths, West Sikkim

Name of the Species	Adult	Sapling		Seedling	
	IVI	Relative density	Relative frequency	Relative density	Relative frequency
Acer campbellii Hook. & Thom. Ex Hiern	15.40	7.86	6.83	2.50	2.28
Abies densa Griffith. ex Parker	57.72	5.44	9.10	9.58	9.86
Acer caudatum Wallich.	7.32	0.00	0.00	1.09	2.28
Acer stachyophyllum Heirn.	3.38	0.00	0.00	0.00	0.00
Alangium begoniaefolium (Roxb.) Baill	1.82	0.00	0.00	0.00	0.00
Alnus nepalensis D. Don.	2.25	1.01	1.52	0.33	1.52
Betula alnoides Buch. Ham. ex D. Don	5.72	1.51	2.28	0.33	1.52
Betula utilis D. Don	10.74	1.81	3.79	2.29	4.55
Castanopsis hystrix Hook & Thom.	6.89	4.13	6.83	0.33	1.52
Castanopsis tribuloides (Smith) A. DC	30.49	0.00	0.00	2.83	5.31
Cedrela febrifuga Blume	2.08	0.20	1.52	0.00	0.00
Cinnamomum impressinervium Meisn.	2.02	0.00	0.00	0.33	1.52
Daphniphyllum himalayense (Benth.) Mull.	1.98	0.30	1.52	0.00	0.00
Elaeocarpus lanceaefolius Roxb.	2.10	0.00	0.00	0.00	0.00
Exbucklandia populnea R.Br. Ex Griff	1.79	0.30	1.52	0.00	0.00
Ficus nemoralis Wall	0.00	0.20	1.52	0.54	1.52
Juglans regia Linn	2.01	0.50	1.52	0.33	1.52
Macaranga pustulata King.	2.03	0.00	0.00	0.00	0.00
Machilus edulis King ex Hook. f.	3.15	0.00	0.00	0.54	1.52
Magnolia campbellii Hook.f. & Thom.	28.78	3.23	3.79	3.70	3.79
Pentapanax leschenaultii Seem	2.00	0.00	0.00	0.00	0.00
Pieris ovalifolia D Don.	3.39	0.60	1.52	0.44	1.52
Prunus nepalensis (Ser) Stendel	13.93	4.03	3.03	6.53	4.55
Quercus glauca Thunb	5.24	0.40	1.52	0.22	1.52
Quercus lamellosa Smith	15.03	3.02	3.79	3.92	3.79

Rhododendron arboreum var. *roseum* Linn	16.39	2.42	3.79	5.88	3.79
Rhododendron barbatum Hook. f.	0.00	13.51	6.83	11.86	5.31
Rhododendron camplocarpum Hook. f.	0.00	2.42	3.79	3.05	3.79
Rhododendron falconeri Hook. f.	9.97	16.94	6.07	0.00	0.00
Rhododendron hodgsonii Hook. f.	30.03	13.41	8.34	19.80	10.62
Rhododendron lanatum Hook. f.	5.31	0.81	1.52	0.98	1.52
Rhododendron thomsonii Hook. f.	0.00	2.52	2.28	1.09	1.52
Rhododendron wightii Hook. f.	2.04	1.71	1.52	0.76	1.52
Rhus insignis Hook.f.	2.14	0.50	1.52	0.00	0.00
Rosa sp	0.00	0.50	1.52	0.00	0.00
Saurauia napaulensis DC	1.78	0.00	0.00	0.00	0.00
Symplocos glomerata King	0.00	2.62	3.03	1.09	3.03
Symplocos theifolia D. Don	0.00	4.13	3.79	0.33	1.52
Tsuga dumosa (D. Don) Eichler	5.56	2.72	3.03	3.81	1.52

Distribution patterns & Humus depth

Distribution patterns of plant species in different forest types were studied. In general, contagious distribution is common in the study sites. Correlation between the humus depths and the number of individual species were also studied to ascertain the regeneration pattern of seedlings and sapling and maximum number of species was recorded at 1.5 cm humus depth in entire sampling path.

SHRUB DIVERSITY

The common shrub/scrub encountered were *Polygonum molle, Anaphalis* sp., *Artemisia vulgaris, Berberis insignis, Daphne cannabina, Edgeworthia gardeneri, Mahonia sikkimensis, Rosa sericea, Rubus ellipticus, Rubus lineatus, Vaccinium nummularia , Viburnum cordifolium, Gaultheria* sp., and *Cassiope fastigata*. Among the shrub species maximum diversity was encountered in family Ericaceae (13) followed by Rosaceae (4) and Berberidaceae (2) **[Figure 5]**.

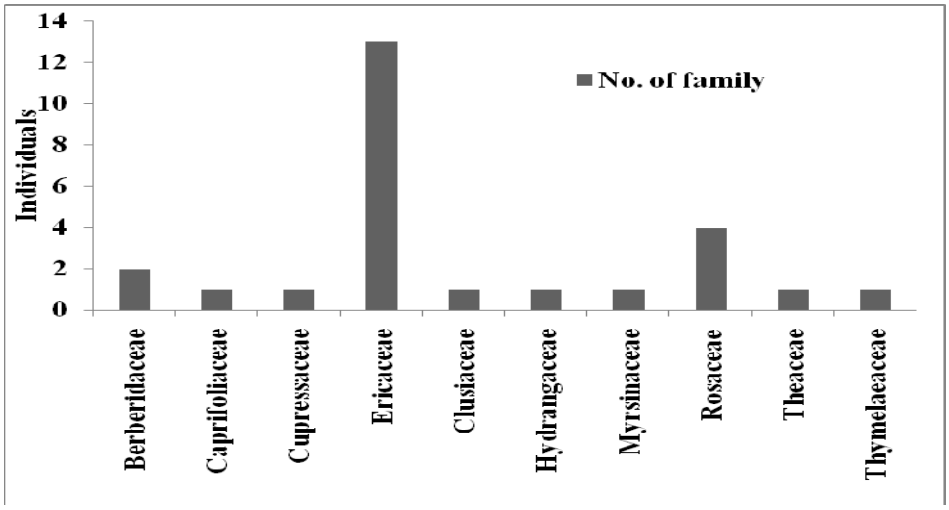

Figure 5: Family-wise species composition of shrub

HERB DIVERSITY

Herbaceous flora were dominant in family Asteraceae (6) followed by (5) Cyperaceae, Araceae, and Urticaceae [Figure 6]. The common herbs were *Arisaema* sp., *Bidens pilosa, Commelina benghalensis, Cyanodon dactylon, Elatostema* sp., *Eupatorium adenophorum, Gnaphalium* sp., *Hydrocotyle javanica, Juncus* sp., *Oxalis corniculata, Persicaria* sp, *Pilea* sp., *Pouzolzia* sp., *Swertia bimaculata, Swertia chirayita*. The ground surface is covered with the diverse fern species and rocky surfaces are fully covered by mosses (*sphagnum squarrosum*). The lichen *Usnea sikkimensis* can be seen hanging from branches of *Abies densa* and some of *Rhododendron* trees.

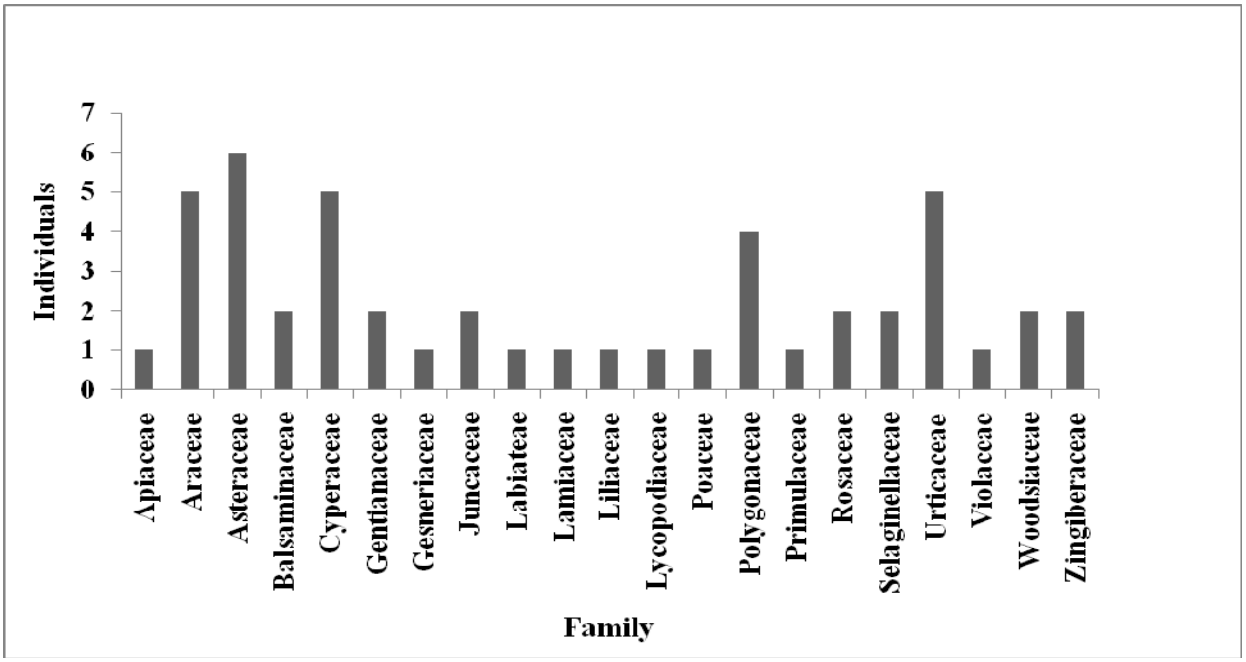

Figure 6: Family-wise species composition of herb & fern& fern-allies

DISCUSSION

The contribution of plant species richness from the study sites to the total floral diversity of KBR is considerable. The present account of 129 species belonging 61 families along the Yuksam-Dzongri-Goechela trekking routes and Khera *et al.,* (2001) reported 92 species different forest types. KBR is home to at least 140 endemic plant species spread over 41 families mention by Sharma *et al*. (2001). The species diversity and richness patterns of three different forest types were largely influenced by elevation. A downhill trend in species richness with altitude has previously been reported by several workers (Yoda 1967; Grytnes *et al*, 2002). A study area within the KBR is characterized by complex topography, which includes variation of slope, angle and aspect. The tree communities from temperate broad-leaved forest and temperate coniferous forest are characterized by high diversity of species richness as compared to alpine region. The diversity of tree species decreased with increased in elevation. It is clear that the forests in KBR are strongly influenced by elevation. Present study reported the maximum numbers of families from Ericaceae (35) followed by Fagaceae (11) and Rosaceae (10). This substantiates the similar studies made by earlier researchers in the region (Subba et al., 2015). This may be due to high diversity of *Rhododendron* species (20) in the region and contribution from associate species from family Ericaceae, viz., *Gaultheria, Cassiope, Pieris and Vaccinium.* In Sikkim, the most dominant families of flowering plants are Asteraceae (36%) as reported by (Singh & Sanjappa, 2011) & Subba *et al*., 2015). In present study, the maximum herbaceous species was recorded from Asteraceae (6) followed by (5) of Cyperaceae. The maximum shrub species diversity was reported from family Ericaceae (13) followed by Rosaceae (4) and Berberidaceae.

The higher frequency of tree was recorded within 1867 - 1976 m in temperate broad-leaved forest. There was total absent of adult tree species along 3930-4058 m in the alpine zone due to unfavorable climatic condition. Tree species viz., *Abies densa, Rhododendron hodgsonii, Acer campbellii, Prunus nepalensis, Castanopsis tribuloides, Magnolia campbellii, Rhododendron falconeri, Betula utilis* and *Rhododendron arboreum* var. *roseum* were recorded in the lower elevation zone.

Seedlings are the major structural and functional basis of temperate forest and can serve as robust indicator of regeneration practices which can balance forest (Philip *et al*., 1994). In the study sites, highest species diversity was recorded from seedlings followed by sapling and adult tree. This indicates that three forest types along trekking corridors might be under the influence of disturbance factors.

Contagious distribution pattern is common in the study sites. Tree species including seedlings and sapling showed contagious distribution pattern. This may be due to mountainous topography of the region. Contagious distribution is also influenced by local habitat, seasonality and reproductive behaviour. Odum (1971) also stated that random distribution is found in uniform environment and regular distribution occurs where competition between individuals are high.

The dominant species encountered in the study sites include *Abies densa* (57.72) followed by *Castanopsis tribuloides* (30.49), *Magnolia campbellii* (28.78), *Rhododendron arboreum* (16.39), and *Acer campbellii* (15.40) & *Quercus lamellosa* (15.03) in their descending order of IVI. The IVI potrays the phyto-siociological structure of a species in the community. The IVI also provide great help in giving the overall picture of the ecological significance of a species in the particular ecosystem. The highest IVI value of *A. densa* indicates that most of the available resources are used by this dominant species and residual resources are being trapped by the other associated competing species. The present rapid biodiversity assessment found that the temperate coniferous forest and broad-leaved forest have high plant diversity than the Alpine zone of Yuksam-Dzongri-Gochela sampling paths in West Sikkim. However, it warrants that rapid survey needs to be conducted on a seasonal basis to get the overall picture of alpha diversity of the species in the study sites.

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