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Life form spectrum of vegetation in *Betula* dominant tree stands along the available altitudinal gradient in north western Himalayas of Kashmir

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Abstract
The study on Life form spectrum of vegetation was carried out in *Betula utilis* forests in the high altitude forests of Central and North Kashmir of Western Himalayas, during the year 2014-2015, concentrated along the three altitudinal gradients viz. 3,000 – 3,200, 3,200 – 3,400 and 3,400 – 3,600m amsl in two *Betula* dominant stands at Sonamarg (Sind Forest Division) and Gulmarg (Special Forest Division Tangmarg).The study sites host a remarkable floristic richness with majority of taxa belonging to family Asteraceae followed by Poaceae, Lamiaceae and Rosaceae at both the study sites. The taxonomic compendium of plant community at Sonamarg included a total of 48 plant species (5 trees, 4 shrubs and 39 grasses and herbs) belonging to 26 families on South Eastern aspect and 53 plant species (4 trees, 7 shrubs and 42 grasses and herbs) belonging to 28 families on South Western slopes. The taxonomic compendium of plant community at Gulmarg included a total of 54 plant species (3 trees, 7 shrubs and 44 grasses and herbs) belonging to 28 families. But *Betula* stands studied exhibited a high vulnerability to disturbances in terms of anthropogenic activities viz. lopping/cutting trees for fodder and fuelwood. These latent productive areas rendered non-productive by biotic pressures till today, should be given protection from such interferences. The *Betula* forest should therefore be declared as reboisement areas where nature needs to be aided to restock them by artificial planting collection at least till sufficient regeneration establishment is attained.

Keywords: *Betula utilis***,** anthropogenic, Himalayas, asteraceae, community

1. Introduction
The floral diversity of Himalayan zone is documented to have distinct biological communities with high level of endemism due to their topography (Gairola *et al.*, 2008) [7]. These ecosystems are climatically most vulnerable geographic regions of the world (Cavaliere, 2009; Glatzel, 2009) [2] [9].The timberline ecotones in these Himalayas are marked by the culmination of the forested zone, describes the most prominent ecological boundary in the high mountain forests. The microclimate, topography and altitude are the most significant attributes in determining the structure and function of plant communities along these timberlines (Xu *et al.*, 2009; Rawat, 1984) [29] [19]. In addition, several anthropogenic/biotic interferences influence the overall physiognomy and community structure of this specific ecological niche. Often the interfaces resulting from various factors lead to a complex spatial heterogeneity in forest structure and mosaics of forest succession (Timilsina *et al.*, 2007) [26]. All these ecotones are known to be sensitive to species adaptability because of their own specific microclimatic conditions. The distribution of vegetation in this zone is strongly influenced by various parameters such as temperature, precipitation, wind, isolation, topography, soils, and seral development which rapidly change along the elevational gradient (Krauchi *et al.*, 2000) [14]. The microclimate, topography and altitude are the most significant attributes in determining the structure and function of plant communities along these timberlines. *Betula utilis* D. Don (Himalayan birch, Bhurja) a tree line species normally grows between an elevation of 2500 to 3600 m (Stainton, 1972) [24]. The massive deforestation and over-exploitation of *Betula utilis* trees for various purposes has caused loss/reduction of habitat in many of its native groves in the entire Himalayan range (Cuirong and Mark, 1998) [4, 5]. Himalayan birch in Kashmir has been assigned the status of critically endangered trees by ENVIS Centre on Conservation of Medicinal Plants, FRLHT, Bangalore (Anonymous, 2010) [1].

Betula utilis is a versatile plant with multifarious uses. It produces a compound, betulin, which has anticancer activity by suppressing growth of malignant melanoma and cancer of liver and lungs. Betulin is isolated from the bark of *B. utilis* that contains betulin up to 12% of its weight (Thurnher *et al.*, 2003) [25]. Betulin possess anti-inflammatory, antiviral, anti-HIV, hepato-protective properties. Some of derivatives of betulinic acid also show high anti-HIV and antiviral activities. *B. utilis* bark is antiseptic and carminative and is also reported to contain karachic acid which is aromatic with antiseptic properties (Singh *et al.,* 2012; Sharma *et al.,* 2010; Mayaux *et al.,* 1994;) [23] [15]. Traditionally the bark *B. utilis* is used to cure rheumatism, gout, malaria by human being. Water boiled with bark is taken in cases of jaundice and used as drops to relieve earache. People in the Kumaon region of Uttrakhan, and Nepal, use the resinous paste for contraceptive purposes. The specific fungal growth (bhurja-granthi) on some parts of the plant has long been used by locals in traditional medicine. Birch leaves are used to make a diuretic tea for colds, dysentery and stomach ailments its leavess have also been used on the scalp to reduce hair loss and dandruff.

The spatial patterns of vegetation composition and seedling recruitment of Himalayan birch (*Betula utilis*) in Kashmir is yet to invite the attention of researchers. The lack of information on community attributes of this treeline species and its ecology are the two major concerns to devise a management plan for restocking these high mountain forests (Stainton, 1972; Krauchi *et al.,* 2000) [24] [14]. With these shortcomings the present study was undertaken to document the life form spectrum of vegetation in *Betula utilis* dominant tree stands along the available altitudinal gradient comprising treeline in two high altitude Forests Divisions of Western Himalayas of Kashmir

Materials and Methods

Study sites

The study was carried out along the three elevations 3,000–3,200 m, 3,200–3,400 and 3,400–3,600 m amsl in *Betula utilis* forests in Sind Forest Division (Sonamarg) and Tangmarg Forest Division (Gulmarg). The Sindh Forest Division with the total area of 37,901 ha lies between 34° 72.04′ and 34° 28.25′ north 74° 42.32′ to 75°26.57′ east. The altitude of this forest division ranges from 1,587 m to 5,248 m with dominant *Betula* stands forming their habitat between 3,000–3,750 m amsl. The Tangmarg Forest Division is spread over an area of 76,585 ha and located between 34°11.23′ north latitude and 74°22.03′ east (Fig. 1).

The study sites exhibits temperate climate experiencing four distinct seasons: a severe winter, a cold spring, a mild summer and an autumn. The mean annual minimum and maximum temperature ranges from –8.1 to 19.01°C and –4.4 to 17.6°C at Sonamarg and Gulmarg respectively. The mean temperature of the warmest month is July with 22.0°C. The average annual precipitation at Sonamarg and Gulmarg varies from 932–1,050 and 1,049–1,100 mm, while snow cover at the selected sites lasts for about 195 and 180 days/year respectively. A stratified random sampling method (Greig-smith, 1983; Krebs, 1989) [10] was employed and vegetation analysis on each altitude and aspect was replicated by laying quadrates on almost constant slope through transect walk method. This type of analysis minimizes environmental influence other than those related to the altitude and aspect (Pielou, 1977). The study areas were divided into three altitudinal gradients of 3,000 - 3,200 m, 3,200 - 3,400 m and 3400 - 3,600 m amsl. The trees were recorded in 10 × 10 m quadrant across the selected sites. The 10 × 10 m quadrates were further divided into two sub-quadrates of 5 × 5 m size for recording shrubs. Further, the sub-quadrates were again divided in 1 × 1 m quadrates for recording ground flora (Shrestha *et al.,* 2007). A Global Positioning System (GPS) was trailed to aid in location of quadrates along the altitudinal gradient at each site. Significant taxonomic reservoirs (Willis, 1970) [28] were used for identification of plant herbaria collected from the study sites.

Significant taxonomic reservoirs (Willis, 1970) [28] were used for identification of plant herbaria collected from the study sites. Specimens of some of the species which could not be recognized at the species level were got identified by expert taxonomists in Division of Environmental Sciences, Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar, Srinagar. For this purpose herbarium specimens with some distinguishing characteristics of general appearance of vegetative or reproductive material were prepared and these served as a crude basis for their identification and classification.

Result and Discussion

The prominent forest vegetation is mostly confined to the moist north-facing slope and the valley floor in both the study sites. However, isolated trees and small stands of *Juniperus spp*. at lower elevations and *Betula utilis* at higher elevations are found on the sunny slope. On the north-facing slope the lower belt (3000-3500 m) has blue pine and juniper forests, while the upper belt (up to 3300 m) has fir (*Abies pindrow*) and birch (*Betula utilis*) forests up to the treeline (3600 m). *Betula utilis* has descended to the valley floor (3000 m) along the moist water course. It is also found in isolated stands on the southwest-facing slope of the valley, where soil moisture is relatively high. The moist alpine scrub above the treeline on the north-facing slope is dominated by Rhododendrons and *Juniperus spp*. On the dry southern slope, alpine scrub has dwarf and prostrate junipers, Rosa spp. and *Berberis spp*.

The structure and composition of the vegetation not only reflects the nature of basic trophic structure but also forms habitat for numerous organisms. Therefore, information on the various parameters of the vegetation with concurrent recording of abiotic factors become quite valuable in a variety of ecological problems such as an input to environmental impact program monitoring management practices or as a basis for predicting possible climatic and edaphic changes (Rawat and Bhainsora, 1999) [18]. Changes in vegetation overtime may also need to be described using concept of succession and climax (Kent and Coker, 1992) [12]. The phyto-sociological study incorporates mainly the description of the vegetation of the terrain because it not only provides detailed information about the composition of trees, shrubs, herbs and climber communities but also their functional aspects. It is assumed that the dominating plant species actually determine the structure of a community and not another characteristic, an aggregation of organisms in space and time which forms a distinct ecological unit. The species which exert major controlling influence within these ecological units by virtue of their numbers, size, production or other activities are described as ecological dominants (Odum, 1971) [16].

The *Betula utilis* stands surveyed in the two Forests Divisions were segregated into three vertical gradients-the lower altitudinal gradient (3000-3200 m), the middle layer (3200-3400m) and the upper belt (3400-3600m). The observations revealed that *Betula utilis* was generally found on southern slopes where it formed a continuous tree line particularly along the ridges where the soil receives snowmelt water from higher elevations. The vertical and horizontal distribution of *Betula utilis* in the study areas appears to be governed by soil moisture that drips down along the slope. The distribution of *Betula utilis* along the altitudinal gradient at the selected sites should thus be seen as its adaptation to higher elevation which experience cold climate and receives most of its precipitation as snow. Colwell and Hurt (1994) [3] have suggested that mid-elevation peaks in species richness arise because of the increasing overlap of species ranges towards the centre of the domain, as the extent of the elevation ranges of species is bounded by the highest and lowest elevations.

The holistic view of the vegetation data revealed that total 65 species (5 trees species, 7 shrub species and 53 herb species) were present at both the study sites (Fig. 2). The data further envisages that total 59 plant species recorded from the three altitudinal gradients in *Betula* dominated stands of Sonamarg (Sindh Forest Division) belonged to 54 genera represented by 30 families. Similarly, *Betula* dominant stands in Gulmarg Forest Division comprised 28 number of families which represented 48 genera and 54 species. While Poaceae was a dominant family with 7 number of species in Sonamarg (Sindh Forest Division), Asteraceae was the principal family at Gulmarg with representation of 7 species. The co-dominant families in Sonamarg (Sindh Forest Division) included Asteraceae, Rosaceae and Lamiaceae with representation of 6, 5 and 3 number of species. Similarly the co-dominant families in Gulmarg Forest Division included Poaceae, Lamiaceae and Violaceae with representation of 5, 4 and 3 number of species. Further out of the total 59 species recorded in Sonamarg (Sindh Forest Division), 5 were trees, 7 were shrubs and 47 were herbs. Similarly *Betula* stands at Gulmarg comprised 3 trees, 7 shrubs and 44 herb species (Table 1).

At Sonamarg *Betula utilis* was found growing in association with species like *Abies pindrow*, *Pinus wallichiana*, *Acer caesium* and *Picea smithiana* at lower altitudinal gradient (3000-3200 m), *Abies pindrow*, *Pinus wallichiana* and *Acer caesium* at middle altitude (3200-3400m) and *Abies pindrow* and *Pinus wallichiana* at upper altitudinal range (3400-3600m) on South Eastern aspect. Sharma and Raina (2013) [21] have also reported *Betula utilis* growing between 3000-3500m in North-Western Himalayas of Jammu and Kashmir. The prominent species associated with *Betula* on South Western aspect included *Abies pindrow*, *Pinus wallichiana* and *Acer caesium* at lower altitude, *Abies pindrow*, *Pinus wallichiana* and *Acer caesium* at middle altitude and *Pinus wallichiana* at upper altitudinal range. At Gulmerg while *Betula* formed a dominant association with *Abies pindrow* and *Pinus wallichiana* at upper elevation, *Abies pindrow* and *Pinus wallichiana* formed main community with *Betula* on middle altitude. The prominent association of *Betula* on lower altitude included *Abies pindrow* and *Pinus wallichiana*. Sub-alpine and temperate forests in the Himalayan region are often dominated by conifers or broad leaved deciduous species (Gairola *et al.*, 2008) [7] with former representing a transition zone (ecotone) between the latter and the alpine ecosystems. Further, with increasing altitude the dominant plant cover changes from a deciduous broad-leaved forest to coniferous forest (forming climax tree line) and to a woody shrub community and ultimately alpine meadows. Ground surface of the subalpine forests received low intensity light under the canopy since the forest had high density and crown closure which tended to decrease in the higher elevations. The poor ground vegetation in alpine and subalpine forests is associated with decline in temperature in these zones (Jiangming *et al.*, 2008) [11]. Documentation of plant community composition and structure is thus essential for understanding the factors influencing plant community development in high elevation ecosystems. Paul (2008) [17] reported the identical trend from temperate broadleaved Rhododendron forest of Western Arunachal Pradesh, but with higher representation of trees (26), shrubs (40) and grasses and herbs (56). The species composition of the plant community on both the study sites followed a similar trend of herbs > shrubs > trees as reported by Dar (2011) [6] in Branwar temperate coniferous forests of Kashmir. The results of the present study are in conformity with those reported by Shrestha *et al.* (2007) from *Betula* stands of Trans-Himalayan Dry Valley in Central Nepal. The overall pattern of species composition exhibited inverse relationship and decreased with increasing altitude. The species composition at lower, middle and upper altitudes in *Betula* forests was 43, 36 and 35 in Sonamarg and 37, 40, and 39 in Gulmarg forest divisions respectively. Kharkwal *et al.* (2005) [13] and Gairola *et al.* (2008) [7] have also recorded a similar pattern of decreasing species composition along an altitudinal gradient in temperate and alpine zones of Central and Western Himalayas respectively. Several other workers have also reported decreasing trend in species composition and its regulation by altitude and aspect (Sharma *et al.,* 2009; Ghimire *et al.,* 2008; Wang *et al.,* 2007) [20] [8] [27].

Table 4: Floristic diversity and life form spectrum of vegetation in *Betula* dominant tree stands at Sonamarg and Gulmarg forest ranges along the available altitudinal gradient

Species	Family	Life form	Sonamarg						Gulmarg		
			South East			South West			South West		
			3000-3200 m	3200-3400 m	3400-3600 m	3000-3200 m	3200-3400 m	3400-3600 m	3000-3200 m	3200-3400 m	3400-3600 m
Acer caesium Wall. Ex Brandis	Aceraceae	T	+	+	-	+	+	-	-	-	-
Daucus carota L.	Apiaceae	H	+	-	-	+	+	-	+	-	-
Artimesa absinthum L.	Asteraceae	H	+	+	+	+	+	+	+	+	+
Aster spp.		H	-	-	-	-	-	-	+	-	-
Taraxacum officinale Weber.		H	+	+	+	+	+	+	+	+	+
Anaphalis busu Buch. Ham. DC.		H	-	-	+	-	-	+	-	+	+
Anaphalis triplinervis Sims ex		H	+	+	+	+	+	+	+	+	+
Cirsium falconeri Hook. f.		H	-	+	+	+	+	+	-	+	+
Tanacetum dolichophallus		H	-	+	-	-	+	-	+	-	-
Impatiens brachycentrus L.	Balsaminaceae	H	-	+	+	-	-	-	-	-	-
Impatiens thomsonii Hook. f.		H	+	-	-	+	+	-	+	+	+
Berberis pachyacantha	Berberidaceae	S	-	-	-	+	-	+	+	+	+

Ahrendt.											
Myosotis sylvatica Ehrh. ex Hoffm.	Boraginaceae	H	+	+	-	-	+	-	-	-	-
Betula utilis D.Don	*Betulaceae*	T	+	+	+	+	+	+	+	+	+
Viburnum grandiflorum Wall. ex DC	Caprifoliaceae	S	-	-	-	+	-	-	+	-	-
Rhodiola imbricata Edgew.	Crassulaceae	H	-	-	+	-	+	+	+	+	+
Rosularia alpestris (Kar. & Kir.) Boriss.		H	-	+	+	-	+	+	-	+	+
Sedum oreades (Decne.) Raym		H	+	+	+	-	+	-	-	+	+
Juniperus Communis L.	Cupressaceae	S	+	+	+	+	+	+	+	+	+
Gaultheria trichophylla Royle	*Ericaceae*	H	-	-	+	-	+	+	-	+	+
Rhododendron anthopogon Sm.		S	-	+	+	-	+	+	-	+	+
Rhododendron campanulatum D.Don		S	-	+	-	-	+	+	-	+	+
Euphorbia wallachii Wall.	Euphorbiaceae	H	+	-	-	-	-	+	+	+	+
Trifolium repens L.	Fabaceae	H	-	-	-	+	+	-	+	-	-
Swertia petiolata D. Don	Gentianaceae	H	-	-	+	-	+	+	+	+	+
Geranium pretense L.	Geraniaceae	H	-	-	-	-	-	-	-	+	+
Clinopodium vulgare L.	Lamiaceae	H	+	+	+	+	+	+	+	+	+
Nepeta laevigata D.Don		H	+	+	-	-	+	+	+	-	-
Phlomis bracteosa Royle ex Benth.		H	-	-	+	-	+	+	-	+	+
Salvia spps.		H	-	-	-	-	-	-	+	-	-
Epilobium laxum Royle.	Onagraceae	H	-	-	+	+	+	+	-	+	+
Corydalis cashmeriana Wall.	Papaveraceae	H	+	-	-	-	-	-	-	-	-
Abies pindrow Royle.	Pinaceae	T	+	+	+	+	+	-	+	+	+
Picea smithiana (Wall.) Boiss.		T	+	-	-	-	-	-	-	-	-
Pinus wallichiana A.B. Jackson		T	+	+	+	+	+	-	+	+	+
Agropyron lanceolatum Scribn. & J.G. Sm.	Poaceae	H	-	-	-	+	-	+	-	+	+
Bromus spps		H	+	-	-	-	-	-	+		
Poa alpine L.		H	-	+	-	-	-	-	-	+	+
Poa annua Linn.		H	+	+	+	-	-	-	+	-	-
Poa aungostifolia Linn.		H	+	+	+	-	+	+	+	+	+
Poa persica Trin.		H	-	-	-	+	+	-	-	-	-
Stipa spps.		H	-	+	-	-	-	-	+	-	-
Podophyllum hexandrum Royle	Podophyllaceae	H	+	-	-	+	-	+	-	+	+
Polemonium caeruleum L.	Polemoniaceae	H	+	+	+	-	-	+	-	+	+
Bistorta vaccinifolia (Wall.) Greene	Polygonaceae	H	-	-	+	-	+	+	-	+	+
Bistorta vivipara L.		H	-	-	-	-	-	-	-	-	-
Oxyria digyna L.		H	-	-	-	+	+	+	-	-	-
Rumex dentatus L.		H	-	-	+	+	+	-	-	-	-
Aquilegia nivalis Falc ex Jackson	Ranunculaceae	H	+	-	-	+	-	-	+	-	+
Anemone obtusiloba L.		H	-	+	-	+	+	+	+	+	+
Aconitum heterophyllum Wall.		H	+	-	-	-	+	-	+	-	-
Fragaria nubicola Lindl. ex Lacaita	Rosaceae	H	+	+	+	+	+	+	+	+	+
Geum elatum L.		H	-	-	-	+	-	-	-	+	+
Rubus anteiafera L.		H	-	-	-	+	-	-	-	-	-
Geum roylei Wall. ex. F.Bolle		H	-	+	-	+	-	-	-	-	-
Sibbaldia cuneata Kunze.		H	-	-	+	+	+	+	+	+	+
Galium aparine Bess.	Rubiaceae	H	-	-	-	+	-	-	+	-	-
Salix denticulata N.J. Andress.	*Salicaceae*	S	+	+	-	+	-	-	+	+	-
Salix flabellaris N.J. Andress.		S	-	-	-	-	+	-	-	+	+
Bergenia ciliata (Haw.) Sternb.	Saxifragaceae	H	-	+	+	-	+	+	-	+	+

Bupleurum longifolium L.	Umbelliferae	H	+	-	-	-	-	-	+	-	-
Urtica dioica L.	Urticaceae	H	-	-	-	+	-	+	-	-	-
Viola biflora L.	Violaceae	H	+	-	+	+	-	-	+	+	+
Viola pilosa Bl.		H	-	-	-	-	+	-	+	+	+
Viola sylvestris Lam.		H	-	-	-	-	-	-	+	+	+

T= Tree; S= Shrub, H= Herb, + = Present,-= Absent, Families 31 and species 65

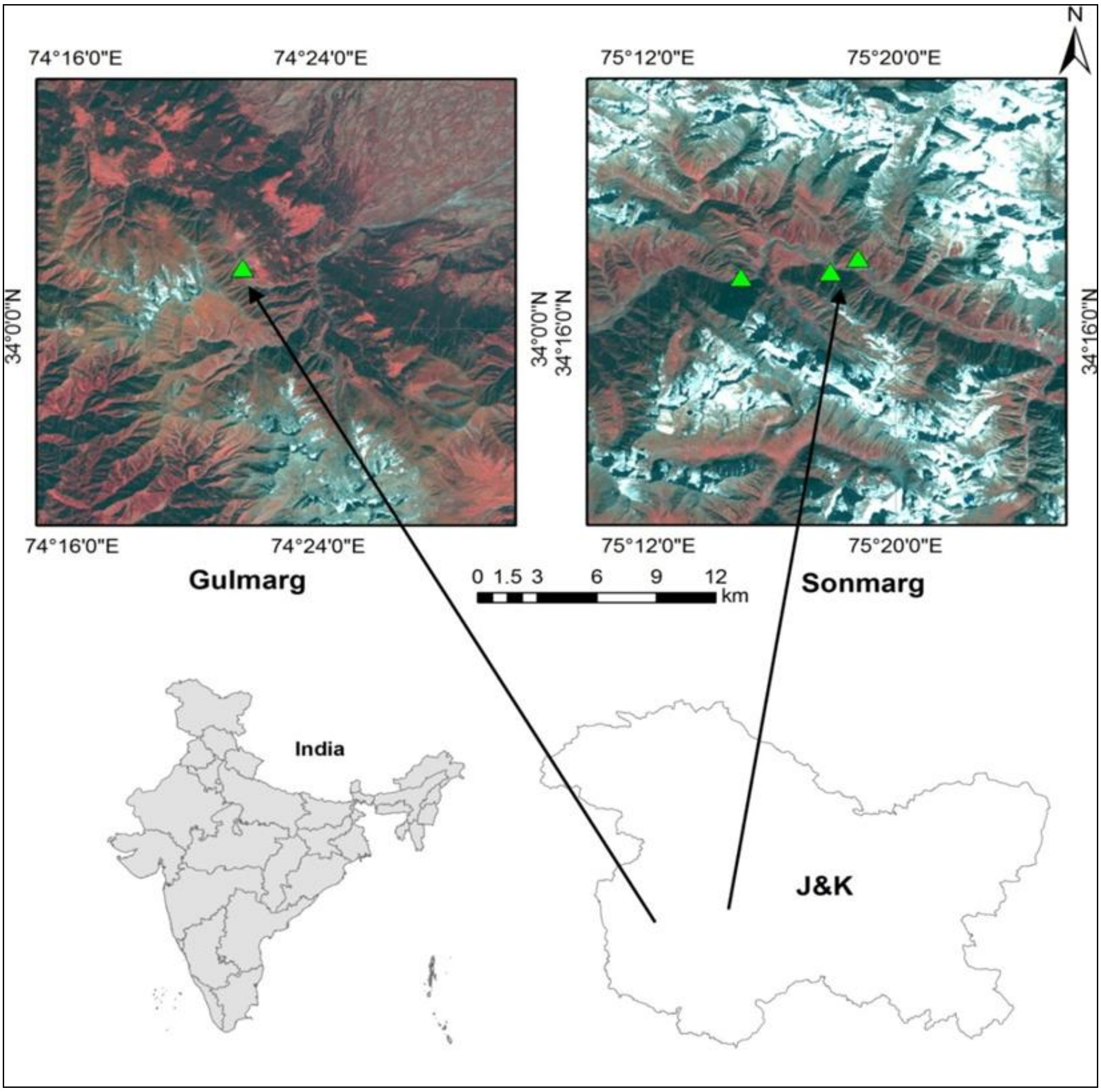

Fig 1: Map of study sites

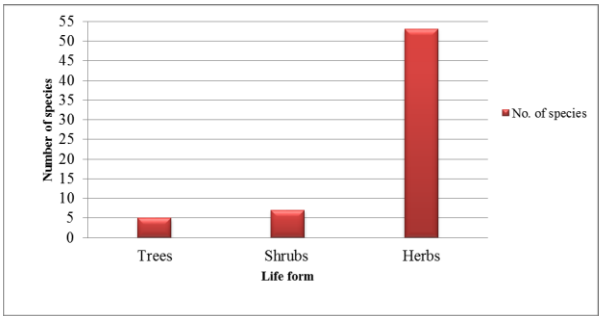

Fig 2: Number of species under different life form spectra at study sites.

Conclusion

The study sites host a remarkable floristic richness with majority of taxa belonging to family Asteraceae followed by Poaceae, Lamiaceae and Rosaceae at both the study sites. The taxonomic compendium of plant community at Sonamarg included a total of 48 plant species (5 trees, 4 shrubs and 39 grasses and herbs) belonging to 26 families on South Eastern aspect and 53 plant species (4 trees, 7 shrubs and 42 grasses and herbs) belonging to 28 families on South Western slopes. The taxonomic compendium of plant community at Gulmarg included a total of 54 plant species (3 trees, 7 shrubs and 44 grasses and herbs) belonging to 28 families. But *Betula* stands studied exhibited a high vulnerability to disturbances in terms of anthropogenic activities viz. lopping/cutting trees for fodder and fuelwood.

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