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Shrub Diversity and Distribution in High Altitude Forested Zone of Indian Western Himalaya

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***Abstract*:** The high altitudes of the Himalayas are the hotspots of the biodiversity. The forests of these zones are having the unique elements of species and vast varieties of ecologically, socially and economically important vegetation. The present study was conducted in the high altitude forested zone of Kedarnath Wildlife Sanctuary Western Himalaya. The altitude range from 2000 m asl. to 3500 m asl. was covered for the extensive sampling of shrub species diversity. The present study recorded 55 species (50 dicots and 05 monocots) from the study site. The species belongs to 18 families and 31 genera in which 43 species recorded as native and 17 species as endemic to the Himalaya. Considering the good numbers of shrub species richness, nativity and endemism into this zone these high altitude forests should be conserved and manage to maintain the unique identity of this zone.

***Keywords*:** High altitude zone, Shrub diversity, Nativity, Endemism, Species richness

Western Himalaya is known for its rugged topography and steep vertical gradient and includes three states of India namely, Jammu and Kashmir, Himachal Pradesh and Uttarakhand and is known for diversity of its forests (Rawal 2021). Due to enchanting, picturesque landscapes this region has attracted ecologists, naturalists and pilgrims since time immemorial, and it has remained a centre of attraction for floristic and ecological studies from centuries. In the context of floristic diversity, Jammu and Kashmir supports about 4000 plant species, of which about 280 are trees, 573 are shrubs and > 3000 are herbs. Himachal Pradesh supports 3400 plant species, of which 323 are trees, 543 shrubs, 2534 are herbs and >500 species of medicinal plants (Samant et al., 2013), while Uttarakhand supports over 5000 species of Angiosperms, of which 538 are trees, 900 are shrubs and > 4500 are herbs (Samant 2015).

Trees at the high altitudes make a conspicuous vegetation boundary and because of heat deficiency (mainly), fail to grow beyond a certain elevation, resulting in a "physiognomic discontinnum", characterized by the separation of forests from treeless alpine meadows (Singh 2018). These transition zones have vast bio-geographic importance with a wide climatic, ecological and socio-economic relevance (Callaghan et al., 2002). These zones are the rich pockets of native and endemic species because of sharing the biomes of two distinct physiognomies i.e. forests and alpine grasslands (Dhar 2000). The high alitutde forests have their own specialized elements, as they share the elements of low temperate zones and high alpine zones (Barman et al., 2021). Along the altitudinal gradient in the Western Himalaya, various changes in vegetation compositions are apparent. The sub-tropical sal (*Shorea robusta)* and pine (*Pinus roxburghii*) forests are replaced by broadleaf (Oak–Quercus spp. and mixed broadleaf) and coniferous (*Cedrus deodara, Cupressus torulosa*, etc.) forests in temperate zone. In sub-alpine zone, birch (*Betula utilis*) and fir (*Abies pindrow, A. spectabilis*) forests along with the various combinations of broadleaf species exhibit dominance, which finally give way to the vast areas of alpine meadows (Gairola et al., 2008). The most prominent of these changes along the altitudinal range is represented by the subalpine transition between temperate forests and alpine grassland ecosystems, termed as timberline zone (Dhar 2000). Till date 1471 species of vascular plants have been reported from the high altitude zone (2000-3500 m asl.) of Uttrakhand, which includes 106 trees, 233 shrubs and 1132 herbs. This zone represents 14.0% species, 31.5% genera, and 59.6% family diversity of total reported plant diversity of Himalaya (Rawal et al., 2018). These forests are recognized for their unique conservation values and richness of economically important biodiversity (Gairola et al., 2008). The aim of current study was to assess the species richness of shrubs as provide the current status of the shrub diversity in these high altitude zones.

MATERIAL AND METHODS

Study site: The present study was conducted in the high altitude forested zone of Kedarnath Wildlife Sanctuary (30°30'03.0" to 30°29'23.8" N and 79°09'52.8" to 79°12'42.3" E) covering the altitudinal range from 2000 m asl. to 3500 m asl. in Uttarakhand, Western Himalaya. The forests of the area fall from close canopy forests (temperate) to sub-

alpine/timberline and tree line ecotone which latter give way to the alpine meadows (Rawal et al., 2023).

Methods: The extensive survey method was used covering all the seasons from 2016 to 2020 to collect the information from the study site. The plant specimens collected in field were brought to the GBP-NIHE for herbarium preparation and further examination and identification. The herbarium specimens were prepared following standard methods of herbarium preparation (Jain and Rao 1977). The specimens were identified with the help of published flora (Brandis 1906, Hooker 1906; Chowdhery and Wadhwa 1984; Osmaston 1927; Naithani 1984; Gaur 1999 and Rai et al., 2017) and Northern regional centre of Botanical Survey of India (Dehradun). The checklist of study site flora was prepared and voucher specimens were deposited at herbarium of G.B. Pant National Institute of Himalayan Environment (GBP-NIHE). Further, for the nomenclature of the species i.e. updated botanical names and other details, online websites were consulted i.e. Tropicos, The Plant List, eFlora of Pakistan, eFlora of China and Plants of the World Online [POWO]. Information on habit, altitude zones etc. were taken and list of species was updated.

The prepared list of species was further categorized in four categories: (i) endemic; (ii) near endemic (both as Himalayan endemics); (iii) native and (iv) non-native species. The species special range restriction to the Himalaya (Indian Himalayan Region, Nepal, Bhutan, Pakistan Himalaya) were considered as endemic and species having range extension beyond the Himalaya were referred as near-endemic (Samant 2015). The native and non-native species were identified based on; the species having their origin in Himalayan region and distribution in the region and neighbouring countries/states were considered as natives (Samant 2015).

RESULTS AND DISCUSSION

The present study recorded 55 shrub species (Table 1) in the high altitude forested zone, which is 23.6% of previously reported species 233 (Rawal et al., 2018) and greater than the reported number 40 (Sekar et al., 2024). Out of total recorded 55 species, 50 were dicots and 5 species were monocots. Total 18 families were recorded in which family Rosaceae was the dominant family with 7 genera and 17 species and Berberidaceae was the co-dominant family with 1 genera and 8 species (Fig. 1). In a study from western Himalaya Mehta et al. (2019) reported Rosacease as a second dominant family. Total 31 genera were recorded in which *Berberis* and *Rubus* were the dominant genera with 7 species, similar observations for genera *Berberis* was also made by Sekar et al. (2024). Considering the nativity and endemism 43 (86%) species were recorded native and 17 (34%) species as endemic. This represents the high nativity and endemism of shrub species in the representative study site, which might be governed by difficult terrain present in the region (Rawal and Tewari 2022). The present study reported a good proportion of shrub species numbers as well as native and endemic species is indication of good ecosystem and health of the forests in such high altitude regions.

CONCLUSION

The high altitude forested zones are the rich pockets of native and endemic species which have high conservation values. The transition from lower close canopy forests to timberline treeline and then the alpine meadows provide the suitable environmental condition and habitat to unique species for their growth and nourishment. The present study highlights shrub species richness, diversity and distribution in this high altitude zone and provide the baseline information for future. Having a good number of shrub species this forests zone need to be regularly monitor and maintain for conservation.

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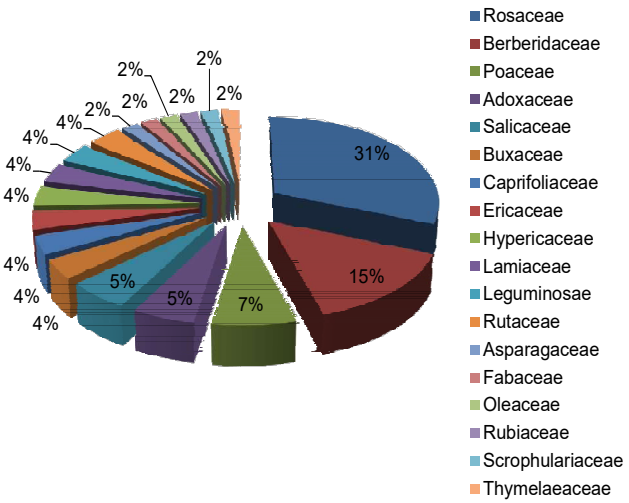

Fig. 1. Species distribution into recorded families of shrubs in the high altitude forested zone

Table 1. Checklist of shrub species recorded in the high altitude forested zone (NE-near endemic, E-endemic).

Botanical name	Family	Altitude zone (m asl.)	Endemism	Nativity	Distribution
Aruncus dioicus subsp. triternatus (Maxim.) Hara	Rosaceae	2800	-	Reg Bor Temp	North America, China, India, Japan
Asparagus filicinus Buch.-Ham ex D.Don.	Asparagaceae	2400	-	Reg Himal Burma	Bhutan, India, Myanmar, Thailand, China
Berberis lycium Royle	Berberidaceae	1600-2400	-	Reg Himal	Kashmir, Pakistan and N. W. Himalayas.
Berberis pseudumbellata R. Parker	Berberidaceae	2100	NE	Reg Himal	Pakistan, West Himalaya
Berberis aristata DC.	Berberidaceae	2600-3500	-	Reg Himal	China South-Central, East Himalaya, India, Nepal, West Himalaya
Berberis asiatica Roxb. ex DC.	Berberidaceae	1200-2400	-	Reg Himal	Afghanistan, Pakistan, Nepal, Bhutan, India
Berberis chitria Buch.-Ham. ex Lindl.	Berberidaceae	2000-3000	-	Nepal	Pakistan, India, Nepal, Bhutan
Berberis jaeschkeana C.K.Schneid.	Berberidaceae	3100	NE	Reg Himal	Pakistan, Tibet, West Himalaya
Berberis kumaonensis C.K.Schneid.	Berberidaceae	3100	NE	Reg Himal	India, Nepal
Buddleja paniculata Wall.	Scrophulariaceae	1700-2700	NE	Reg Himal Burma	Assam, China South-Central, China Southeast, East Himalaya, Myanmar, Nepal, Vietnam
Caragana versicolor Benth.	Leguminosae	2600	-	Reg Himal As Bor	Afghanistan, Pakistan, Nepal, Bhutan, China
Cotoneaster affinis Lindl.	Rosaceae	1500-3500	-	Reg Himal	Bhutan, India, Nepal, China
Cotoneaster bacillaris Wall. ex Lindl.	Rosaceae	2200	NE	Reg Himal	Afghanistan, India, Nepal, Pakistan, China, Bhutan
Cotoneaster microphyllus Wall. ex Lindl.	Rosaceae	2500-3400	-	Reg Himal	Afghanistan, Pakistan, Nepal, Bhutan, India, China
Daphne papyracea Wall. ex Steud.	Thymelaeaceae	1800-3000	NE	Reg Himal	W. Himalayas, Western Nepal, N. Uttar Pradesh, Simla, W. Pakistan
Drepanostachyum falcatum (Nees) Keng f.	Poaceae	1500-2600	-	Reg Himal	India, Nepal
Elsholtzia fruticosa (D.Don) Rehder	Lamiaceae	1500-2500	-	Reg Himal China	Bhutan, India, Nepal, China
Himalayacalamus falconeri (Hook.f. ex Munro) Keng f.	Poaceae	2000-2800	-	Reg Himal	East Himalaya, Nepal, Tibet, West Himalaya
Hypericum choisianum Wall. Ex N. Robson.	Hypericaceae	1200-2500	-	India China	Pakistan, Nepal, Bhutan, China
Hypericum oblongifolium Choisy	Hypericaceae	1500-2500	NE	Reg Himal	Western Himalayas from Kurram to Nepal, Pakistan
Indegofera heterantha Wall. ex Brandis	Fabaceae	1200-2500	-	Reg Himal	Afghanistan, China, Bhutan, India, Nepal, Pakistan, Sri lanka
Jasminum humile L.	Oleaceae	1500	-	As Trop	Afghanistan, China, Tajikistan, Pakistan, Nepal, India
Juniperus communis L.	Cupressaceae	3000-4000	-	Reg Bor Temp et Arct	Afghanistan, Alabama, Alaska, Albania, Algeria, Altay, Amur, Arizona, Austria, Baltic States, Belarus, Belgium, British Columbia, Yakutskiya, Yugoslavia, Yukon etc.
Leptodermis lanceolata Wall.	Rubiaceae	1500-2000	NE	Reg Himal	Afghanistan, Nepal, Pakistan, West Himalaya
Leycesteria Formosa Wall.	Caprifoliaceae	2000-3000	-	Reg Himal	East Himalaya, Myanmar, West Himalaya
Mahonia napaulensis DC.	Berberidaceae	1200-3000	E	Reg Himal China	Bhutan, India, Myanmar, Nepal, China

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Table 1. Checklist of shrub species recorded in the high altitude forested zone (NE-near endemic, E-endemic).

Botanical name	Family	Altitude zone (m asl.)	Endemism	Nativity	Distribution
Perilla frutescens (L.) Britton	Lamiaceae	800-2400	-	India Or	Bhutan, Cambodia, India, Indonesia (Java), Japan,
Piptanthus nepalensis (Hook.) D.Don	Leguminosae	1600-4000	NE	Reg Himal	Bhutan, India, Kashmir, Nepal, China
Potentilla rigida Wall. ex Lehm.	Rosaceae	2500-4000	-	Reg Bor Temp Ind Or	Widespread
Prinsepia utilis Royle	Rosaceae	1500	-	Reg Himal	Bhutan, N India, Nepal, Pakistan, China
Pyracantha crenulata (Roxb. ex D.Don) M.Roem.	Rosaceae	1500-2500	-	Reg Himal	Bhutan, India, Kashmir, Myanmar, Nepal, China
Rhododendron campanulatum D. Don	Ericaceae	2900-3800	NE	Reg Himal	Bhutan, N India, Kashmir, Nepal, Sikkim, China
Rhododendron lepidotum Wall. ex G. Don	Ericaceae	3000-4000	NE	Reg Himal	Nepal, Bhutan, China, Myanmar
Rosa macrophylla Lindl.	Rosaceae	1500-3500	-	Reg Himal China	Afghanistan, Bhutan, China, Nepal, Pakistan, India
Rosa moschata Herrm.	Rosaceae	2500	-	Oriens	Pakistan, Kashmir, Himalayas to Bhutan, India, Burma, China, SE Asia, Japan. Introduced-naturalized in N. America.
Rosa sericea Wall. ex Lindl.	Rosaceae	3000-4500	-	Reg Himal	Pakistan, India, Bhutan, Myanmar, China
Rubus ellipticus Sm.	Rosaceae	1500	-	India Or	Bhutan, India, Laos, Myanmar, Nepal, Pakistan, Philippines, Sikkim, Sri Lanka, Thailand, Vietnam
Rubus foliolosus D.Don	Rosaceae	1500	-	Reg Himal	India, Nepal
Rubus foliolosus var. *racemosus* (Hook.f.) B.D. Naithani/ Rubus niveus Thunb.	Rosaceae	2200	-	Reg Himal	Western Himalaya
Rubus nepalensis hort.	Rosaceae	2600	NE	Reg Himal	India, Nepal, Bhutan
Rubus niveus Thunb.	Rosaceae	1700	-	Reg Himal	China, Afghanistan, Bhutan, India, Indonesia, Kashmir, Laos, Malaysia, Myanmar, Nepal, Philippines, Sikkim, Sri Lanka, Thailand, Vietnam
Rubus paniculatus Sm.	Rosaceae	1500	-	Reg Himal	Bhutan, N India, Kashmir, Nepal, Sikkim
Rubus macilentus Jacquem. ex Cambess.	Rosaceae	2000-3500	-	Reg Himal	China South-Central, East Himalaya, Nepal, Tibet, West Himalaya
Salix denticulata Andersson	Salicaceae	2500-4000	NE	Reg Himal	Afghanistan, India, Kashmir, Nepal, Pakistan, China
Salix karelinii Turcz. ex Stschegl.	Salicaceae	3500	-	As Centr	Afghanistan, China, Kyrgyzstan, Nepal, Pakistan, Tajikistan
Salix lindleyana Wall. ex Andersson	Salicaceae	3000-4000	-	Reg Himal Amer Bor As et Amer Temp	East Himalaya
Sarcococca coriacea Müll. Arg.	Buxaceae	2100-2900	-	S E As	Assam, China South-Central, East Himalaya, India, Myanmar, Nepal, Sri Lanka, Thailand, Vietnam, West Himalaya
Sarcococca pruniformis Lindl.	Buxaceae	1600-3000	-	Ind Or Malaya	Afghanistan, India, Nepal, Pakistan, China
Skimmia anquetilia N.P. Taylor & Airy Shaw.	Rutaceae	1800-3500	-	Reg Himal	Afghanistan, Pakistan, Nepal, India

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Table 1. Checklist of shrub species recorded in the high altitude forested zone (NE-near endemic, E-endemic).

Botanical name	Family	Altitude zone (m asl.)	Endemism	Nativity	Distribution
Thamnocalamus spathiflorus (Trin.) Munro	Poaceae	2500-3500	NE	Reg Himal	East Himalaya, Nepal, Tibet, West Himalaya
Viburnum cotinifolium D.Don	Adoxaceae	2800	-	Reg Himal Amer Bor	Afghanistan, China, India, Nepal
Viburnum grandiflorum Wall. ex DC.	Adoxaceae	3050	NE	Reg Himal	Bhutan, China, India, Nepal, Pakistan
Viburnum mullaha Buch.-Ham ex D.Don	Adoxaceae	2500	-	Reg Himal	Bhutan, China, India, Nepal
Yushania anceps (Mitford)W.C. Lin.	Poaceae	2400-2800	E	Reg Himal	E. Asia - N.W. Himalayas
Zanthoxylum armatum DC.	Rutaceae	1500	-	Reg Himal China	Himalayas, from Swat to Bhutan, Khasia Hills; Japan, Korea, China, Pakistan

REFERENCES

Barman T, Samant SS and Singh A 2021. Structural diversity and regeneration pattern of forest communities in Parbati Valley, North Western Himalaya, India: Implications for conservation. *Indian Journal of Ecology* **48**(2): 332-348.

Brandis D 1906. Indian trees: being an account of trees, shrubs, woody climbers, bamboos and palms indigenous or commonly cultivated in the British Indian Empire. *Nature* **75**: 385-386.

Callaghan TV, Crawford RM, Eronen M et al 2002. The dynamics of the tundra-taiga boundary: an overview and suggested coordinated and integrated approach to research. *Ambio* **12**: 3-5.

Chowdhery HJ and Wadhwa BM 1984. *Flora of Himachal Pradesh analysis*. 3 vols. Botanical Survey of India, Calcutta.

Dhar U 2000. Prioritization of conservation sites in the timberline zone of west Himalaya, pp 193-211. In: Singh S, Sastry ARK, Mehta R and Uppal V (eds.) *Setting Biodiversity Conservation Priorities for India*. World Wide Fund for Nature-India: New Delhi, India.

Gairola S, Rawal RS and Todaria NP 2008. Forest vegetation patterns along an altitudinal gradient in sub-alpine zone of west Himalaya, India. *African Journal of Plant Science* **2**(6): 042-048.

Gaur RD 1999. *Flora of the District Garhwal, North West Himalaya*. Transmedia.

Hooker HD 1906. *A Sketch of the Flora of British India*, L. Reeve & Co., London.

Http://www.efloras.org/flora_page.aspx?Flora_id=2

Http://www.efloras.org/flora_page.aspx?Flora_id=5

Http://www.theplantlist.org/

Https://www.kew.org/

Https://www.tropicos.org/

Jain SK and Rao RR 1977. *A Hand Book of Field and Herbarium Methods*. Today and Tomorrow Printers and Publication. New Delhi.

Mehta P, Seker KC, Negi VS and Kuniyal JC 2019. S*hrub Diversity of the Western Himalaya, India*. G.B. Pant National Institute of Himalayan Environment and Sustainable Development, Almora, Uttarakhand, India.

Naithani BD 1984. *Flora of Chamoli* (Volume I and II). Botanical Survey of India, Calcutta.

Osmaston AE 1927. *A Forest flora for Kumaon*, Govt. Press. Allahabad, United–provinces.

Rai ID, Singh G and Rawat GS 2017. *Plants of Kedarnath Wildlife Sanctuary, Western Himalaya: A Field Guide*. Bishen Singh Mahendra Pal Singh.

Rawal R 2021. *Assessment of floristic diversity and rarity patterns along altitudinal gradient in the high altitude forests of Western Himalaya*. Ph.D Thesis Kumaun University Nainital.

Rawal R and Tewari LM 2022. Floristic diversity, nativity and endemism of high altitude forested landscape of Kedarnath wildlife sanctuary. *Indian Journal of Ecology* **49**(4): 1240-1246.

Rawal R, Negi VS and Tewari LM 2023. Forest dynamics along altitudinal gradient covering tree line ecotone of Indian Western Himalaya. *Biologia* **78**(12): 3339-3352.

Rawal RS, Rawal R, Rawat B, Negi VS and Pathak R 2018. Plant species diversity and rarity patterns along altitude range covering treeline ecotone in Uttarakhand: Conservation implications. *Tropical Ecology* **59**(2): 225-239.

Samant SS 2015. *Assessment, Valuation and Conservation Prioritization of Floristic Diversity in Trans, North Western and Western Himalaya*. D.Sc. thesis, Kumaun University, Nainital.

Samant SS, Joshi R and Sharma RK 2013. Biodiversity of Indian North West Himalaya pp 20-23. In: Rawal RS, Bhatt ID, Chandrasekar K and Nandi SK (eds.) *Himalayan Biodiversity Richness, Representativeness and Life Support Values*. *Hylanders Communications* (P) Ltd., Delhi.

Sekar KC, Thapliyal N, Pandey A, Joshi B, Mukherjee S et al. 2024. Plant species diversity and density patterns along altitude gradient covering high-altitude alpine regions of west Himalaya, India. *Geology, Ecology, and Landscapes* **8**(4): 559-573.

Singh SP 2018. Research on Indian Himalayan treeline ecotone: an overview. *Tropical Ecology* **59**(2): 163-176.

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