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Diversity and Distribution of Medicinal Plants along Altitudinal Gradient in Temperate Himalayan Ecosystem

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was carried out to determine the floristic diversity and their distribution in Bangus valley of Langate Forest Division, District Kupwara (J&K) India. The aim of this study was to evaluate the distinction in diversity of medicinal plants at varying altitudes based on the onsite vegetation analysis. Hence, the phytosociological study was conducted to assess the floristic diversity of the region and the discussions were held with local people to ascertain the socio-economic importance of the plant diversity. The study reveals that majority of the medicinal plant

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species are mainly distributed between 2900 to 3200 meters altitude from this relatively unexplored valley. In all the sampled sites, around 51 plant species belonging to 24 families were recorded, among which 2 were tree, 3 shrub and 46 herb species. The tree vegetation was found to be dominated by *Abies pindrow* whereas *Pinus wallichiana* has very rare distribution in all the sampled sites. The shrub vegetation was dominated by *Viburnum grandiflorum* followed by *Rosa brunonii* and *Berberis lycium* respectively. In addition, around 80 plant species were reported to be used in different systems of traditional medicine. Therefore, the study provided first comprehensive baseline information on the distribution, diversity and use of plants in different traditional systems of medicine in Bangus valley of Kashmir. This baseline study can be effective for framing various conservation strategies of medicinal plants.

Keywords: Bangus; medicinal plants; diversity; use; temperate; Himalayas.

1. INTRODUCTION

India is well known for significant geographical diversity which has favored the formation of different habitats and vegetation types. Biological diversity is of fundamental importance to the functioning of all natural and human-engineered ecosystems. The survival of man is intimately related to the availability of different plant resources. Biodiversity provides enormous direct economic benefits to human kind and plays a prominent role in modulating ecosystem functions and stability. Western Himalaya has long been recognized as a distinct floristic region in India [1]. This region harbors a rich flora due to its diverse topography, wide altitudinal range and location at the intersection of several biogeography zones. The flora of western Himalaya exhibits affinities with that of Mediterranean, Siberian, Tibetan and Indo-Malayan regions. In the western Himalayan region, the prominent plant families are Asteraceae, Rosaceae, Poaceae, Ranunculaceae and Brassicaceae [2]. The vegetation is represented by lower and upper western Himalayan temperate forests, dry temperate coniferous forests, sub-alpine forests and scrubs, alpine pastures, dwarf Juniper scrub, and dry alpine scrub communities [3].

Botanically derived medicinal plants played a major role in human societies throughout history and prehistory times [4]. The traditional use of this unique group is of immense importance [5]. There has been an upsurge in the use of medicinal plants in traditional as well as allopathy systems of medicines. It is reported that, about 1289 botanicals (various parts sold) pertaining to 960 plant taxa and 575 genera spread across 169 families are traded as medicinal plants in India. Wherein about 152 families belong to angiosperm, 5 gymnosperm, 9 pteridophytes and 3 fungi and lichens group of plants with 398 herb, 251 tree, 168 shrub and climber species. The usage of these species in Indian System of Medicine (ISM) is 688 species in Ayurveda, 501 in Siddha, 328 in Unani, 197 in Tibetan and 146 in Homeopathy [6]. Medicinal properties of plants were mostly discerned through trial and error, but were also influenced by the belief systems of the people involved and often became entangled with religious and mythical practices [7].

The present study also represents the diversity, distribution and use of medicinal plants in the Bangus valley of Kashmir, J & K. This area has temperate, sub-alpine and alpine climatic conditions and is considered as very rich in biodiversity including some rare and endemic species of Medicinal Plants. The entire region is mountainous bearing very steep slopes pierced by deep valleys at few places. Some parts of the study area are devoid of any good vegetation due to the rocky tract and hill slopes. However, vegetation of the area is disappearing at an alarming pace owing to over exploitation of resources, faulty management practices and intensification of unplanned road network in the area.

The study on assessment of floristic diversity has received great attention particularly during the past few decades. The floristic diversity and vegetation structure are the significant ecological aspects of any terrestrial ecosystem. Except few studies on ethnobotany [8] and bioeconomy potential of the NTFPs [9] from the region, there is limited information available on the distribution, diversity and use of the medicinal plants along altitudinal gradient. Therefore, the present study was carried out to assess the floristic diversity of medicinal flora along altitudinal gradient, their uses and conservation status for further management practices.

2. MATERIALS AND METHODS

2.1 Study Area

The Present investigation was carried out in the Bangus Valley of Kupwara District (J&K) India (Fig. 1). Bangus is situated between 34° 22′ 2" N latitude and 74° 03′ 27" E longitude at an altitude between 2700 to 3500 meters above mean sea level. This valley is relatively an unexplored area of 300km^2 surrounded by sloppy landscapes. The area has a temperate and sub-alpine climatic condition with an average annual rainfall of 540 mm. The temperature ranges from 22°C minimum to 28°C maximum. The aspect and geo-coordinates of sampling sites is provided in Table 1.

2.2 Methodology

The results of the present study are based on an extensive field survey of the area conducted during June to October. The study sties were randomly selected on the basis of reconnaissance survey. The site was divided into three different altitudes to document the medicinal plant diversity, their uses and conservation status at these respective altitudes. The plant species collected were mostly identified on the spot with the help of local names and unidentified ones were mounted on the herbarium sheets and were identified with the help of taxonomists at university of Kashmir. Information regarding the uses were documented based on the information of the local inhabitants. The information was collected through a well-structured questionnaire containing different sections regarding uses and conservation. This exercise was conducted to know the diversity of plant resources that are being used by local people in different systems of medicine. During the field visits number of local inhabitants of different social strata viz; elderly people, women and practicing herbalists were consulted for interaction and discussions. The plant species are enlisted alphabetically and each species is provided with its botanical name, author citation, habit, family, altitudinal range, and uses in medicinal systems (Table 5).

Table 1. Geo-coordinates of Medicinal Plants Resource Assessment Sites

Site	Aspect	Elevation	Latitude	Longitude	Reference Points
I	NW	3140	34.21.04 N	74.02.01 E	Badibahek-Gujarpati- Right Bank of Nalla
II	ES	2980	34.21.13 N	74.02.02. E	Backside of abandoned army unit
III	NW	2893	34.20.49 N	74.05.03 E	Bangus Ridge upto middle
IV	NE	2971	34.20.50 N	74.05.21 E	Nildari middle & Base

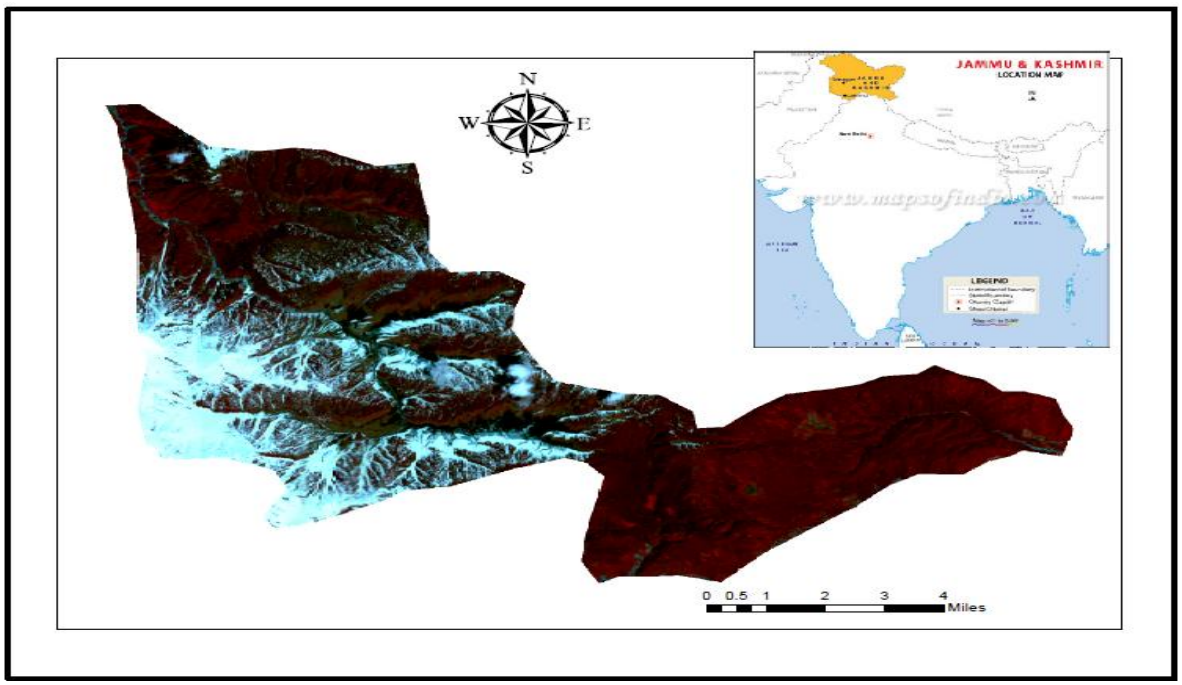

Fig. 1. Map showing location of the study area

The ecological study was carried out by laying down the quadrates. The size and number of quadrates needed were determined using the running's mean method [10]. To study the various vegetation attributes, quadrates of 10 m × 10 m size for trees, 5 m x 5 m for shrubs and 1m x 1m for herbs, were laid down [11].

2.3 Vegetation Analysis

The vegetational data was quantitatively analyzed for frequency, density and abundance [12]. The relative values of frequency, density, and dominance of all the species were summed up [13] to signify the Importance Value Index (IVI). The ratio of Abundance to Frequency (A/F) has been used to analyze the distribution of species within each site studied.

Density (D) = (Total Number of individual in All Quadrat)/ (Total Number of quadrats studied).	**Abundance (A)** = (Total Number of individuals of Species in all Quadrats) / (Total Number of quadrats in which the Species Occurred).
Frequency (%) = (Total number of quadrats in which species occurred)/ (Total number of quadrats studied) × 100	**Relative frequency** = (Number of occurrence of the species)/ Number of Occurrence of all species × 100
Relative Density = (Number of Individuals of a species)/ (Number of Individuals of all Species) × 100	**Relative Dominance** = (Total Basal Area of the Species in all Quadrats)/ (Total Basal area of all species in all the quadrats) × 100
Importance Value Index (IVI) = R. Freq. + R. Den. + R. Dom. **A/F Ratio** = (Abundance/ Frequency)	

3. RESULTS AND DISCUSSION

3.1 Floristic Diversity

In all the sampled sites, a total of 51 plant species belonging to 24 families were recorded, among which 2 were tree, 3 shrub and 46 herb species. The tree vegetation was found to be dominated by *Abies pindrow* whereas *Pinus wallichiana* had very rare distribution in all the sampled sites. The shrub vegetation was dominated by *Viburnum grandiflorum* followed by *Rosa brunonii* and *Berberis lycium* respectively. The commonly occurring species are *Abies pindrow, Berberis lycium, Geranium pratense, Podophyllum hexandrum, Myosotis arvensis, Ranunculus laetus* and *Adonis aestilavis* among others. In addition, around 80 plant species were reported to be used in different systems of traditional medicine (Table 5). The study further revealed that majority of the medicinal plant species are mostly distributed between 2900 to 3200 meters altitude in this relatively unexplored valley.

3.2 Distribution of Vegetation

The data pertaining to vegetational parameters at Site I, II, III and IV of Bangus valley are presented in Tables 2, 3, and 4 respectively. Analysis of recorded data reveals that the tree vegetation at all four surveyed sites was dominated by *Abies pindrow* with IVI of 300 at sites I, II and III, and 196.195 at site IV and whereas, *Pinus wallichiana* has very rare distribution with IVI of 103.805 at site IV only**.** The shrubby vegetation was dominated by *Viburnum grandiflorum* with IVI of 217.49 and 300 at site III and IV followed by *Rosa brunonii* with IVI of 161.72 and 82.51 at site I and II respectively. Whereas, *Berberis lycium* has less distribution with IVI of 138.28 at site I only.

Among herb species vegetation at the site I was dominated by *Plantago major* with IVI of 44.48 followed by *Ranunculus laetus*, *Nepeta linearis*, *Geranium pratense* with IVI 20.73, 19.03 and 16.09 respectively. At site II, the dominant species was found *Myosotis arvensis* followed by *Plantago major*, *Podophyllum hexandrum*, *and Geranium pratense* with IVI of 45.39, 35.53, 19.26 and 16.12. The dominant species at site III was found *Anemone biflora* followed *by Iris hookeriana*, *Myosotis arvensis*, and *Salvia nubicola* with IVI of 41.97, 29.22, 27.10, and 26.09 respectively. At site IV the dominant species was found *Nepeta linearis* followed by *Poa pratensis, Myosotis arvensis*, *Rumex hastatus* with IVI of 27.82, 19.69, 19.42, and 18.18 respectively. In all the four surveyed sites the most dominant species was found *Myosotis arvensis* followed by *Plantago major,*

Table 2. Ecological status of recorded Tree species in study area

S. No.	Species	Family	Site 1			Site 2			Site 3			Site 4		
			Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI
1	*Abies pindrow*	Pinaceae	0.019	0.023	300	0.021	0.042	300	0.012	0.1	300	0.02	0.055	196.195
2	*Pinus wallichiana*	Pinaceae	0	0	0	0	0	0	0	0		0.014	0.056	103.805

Table 3. Ecological status of Shrub species in study area

S. No.	Species	Family	Site 1			Site 2			Site 3			Site 4		
			Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI
1	*Berberis lycium*	Berberidaceae	0.01	0.03	138.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	*Rosa brunonii*	Rosaceae	0.01	0.03	161.72	0.02	0.15	82.51	0.00	0.00	0.00	0.00	0.00	0.00
3	*Viburnum grandiflorum*	Viburnaceae	0.00	0.00	0.00	0.08	0.53	217.49	0.00	0.00	0.00	0.17	0.05	300.00

Table 4. Ecological status of Herb species in study area

S. No.	Species	Family	Site 1			Site 2			Site 3			Site 4		
			Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI
1	*Aconitum heterophyllum*	Ranunculaceae	0.60	0.15	7.87	1.7	0.07	11.79	0.04	0.10	12.62	0.70	0.08	7.89
2	*Aconitum chasmanthum*	Ranunculaceae	0.50	0.13	8.33	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	*Adonis aestilavis*	Ranunculaceae	0.80	0.20	7.51	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	*Anemone biflora*	Ranunculaceae	0.00	0.00	0.00	0	0.00	0.00	0.63	0.58	41.97	1.30	1.30	6.23
5	*Arisaema costatum*	Araceae	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.20	0.05	11.98
6	*Arisaema jacquemontii*	Araceae	0.50	0.02	15.87	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	*Artemisia absinthium*	Asteraceae	0.00	0.00	0.00	2.5	0.28	11.71	0.00	0.00	0.00	0.00	0.00	0.00
8	*Bergenia ciliata*	Saxifragaceae	0.60	0.15	9.59	0.6	0.15	10.54	0.02	0.17	9.50	0.60	0.15	7.82
9	*Capsella bursa-pastoris*	Brassicaceae	0.00	0.00	0.00	0.2	0.20	6.38	0.00	0.00	0.00	0.00	0.00	0.00
10	*Carum carvi*	Apiaceae	0.20	0.05	10.25	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	*Cirsium arvense*	Asteraceae	0.30	0.08	8.53	0	0.00	0.00	0.00	0.00	0.00	1.10	0.28	9.69
12	*Cirsium wallichii*	Asteraceae	0.00	0.00	0.00	0.8	0.80	13.22	0.00	0.00	0.00	0.00	0.00	0.00
13	*Epilobium hirsutum*	Onagraceae	0.30	0.30	7.40	0.9	0.06	14.46	0.00	0.00	0.00	0.00	0.00	0.00
14	*Euphorbia wallichii*	Euphorbiaceae	0.00	0.00	0.00	1.8	1.80	9.28	0.00	0.00	0.00	0.00	0.00	0.00
15	*Fragaria vesca*	Rosaceae	0.00	0.00	0.00	0.6	0.60	7.10	0.00	0.00	0.00	4.80	0.30	17.36
16	*Fritillaria roylei*	Liliaceae	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.30	0.08	8.96

S. No.	Species	Family	Site 1			Site 2			Site 3			Site 4		
			Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI	Density (Ha^{-1})	A/F	IVI
17	*Geranium pratense*	Geraniaceae	1.30	0.02	16.09	2.8	0.08	16.12	0.11	0.11	20.98	1.00	0.11	8.21
18	*Geum elatum*	Rosaceae	0.10	0.10	3.91	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	*Impatiens glandulifera*	Balsaminaceae	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	1.60	0.10	16.32
20	*Iris hookeriana*	Iridaceae	0.20	0.20	13.55	2.2	0.55	12.38	0.20	0.33	29.22	0.60	0.60	14.06
21	*Lamium album*	Lamiaceae	0.60	0.07	6.60	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	*Malva neglecta*	Malvaceae	0.60	0.02	8.87	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	*Myosotis arvensis*	Boraginaceae.	2.80	0.18	15.48	16.6	0.20	45.39	0.36	0.51	27.10	5.80	0.36	19.42
24	*Nepeta linearis*	Lamiaceae	1.60	0.03	19.03	3.3	0.21	14.21	0.00	0.00	0.00	6.10	0.10	27.82
25	*Plantago major*	Plantaginaceae	9.10	0.09	44.48	12.9	0.26	35.53	0.23	0.63	16.67	2.20	0.55	9.39
26	*Poa pratensis*	Poaceae	1.70	0.19	10.47	0	0.00	0.00	0.24	0.67	16.28	6.20	0.39	19.69
27	*Podophyllum hexandrum*	Berberidaceae	0.70	0.18	14.41	0.6	0.04	19.26	0.02	0.10	15.04	0.00	0.00	0.00
28	*Polygonum amplexicaule*	Polygonaceae	0.20	0.20	6.14	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	*Potentilla atrosanguinea*	Rosaceae	0.20	0.20	2.92	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	*Primula denticulata*	Primulaceae	0.10	0.10	5.79	0	0.00	0.00	0.00	0.00	0.00	0.30	0.08	7.61
31	*Primula elliptica*	Primulaceae	0.00	0.00	0.00	1	0.25	6.89	0.14	0.23	16.79	0.00	0.00	0.00
32	*Prunella vulgaris*	Lamiaceae	0.30	0.30	6.49	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	*Pteris cretica*	Pteridaceae	0.40	0.04	5.89	0.6	0.04	9.31	0.06	0.18	11.36	0.70	0.18	6.00
34	*Ranunculus laetus*	Ranunculaceae	3.00	0.05	20.73	0	0.00	0.00	0.10	0.42	10.18	1.20	0.13	8.33
35	*Rumex hastatus*	Polygonaceae	0.00	0.00	0.00	0	0.00	0.00	0.06	0.25	13.31	3.10	0.09	18.18
36	*Salvia nubicola*	Lamiaceae	0.00	0.00	0.00	0	0.00	0.00	0.07	0.19	26.09	1.20	0.08	16.65
37	*Sambucus wightiana*	Viburnaceae	0.00	0.00	0.00	0.7	0.18	14.45	0.00	0.00	0.00	0.00	0.00	0.00
38	*Senecio chrysanthemoides*	Asteraceae	0.00	0.00	0.00	0.6	0.04	9.31	0.00	0.00	0.00	0.00	0.00	0.00
39	*Taraxacum officinale*	Asteraceae	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	1.30	0.14	8.54
40	*Thymus linearis*	Lamiaceae	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	3.60	0.40	13.89
41	*Trifolium pratense*	Fabaceae	0.20	0.05	4.05	1.8	0.45	8.67	0.31	0.43	25.46	1.00	0.25	6.62
42	*Trillium govanianum*	Melanthiaceae	0.60	0.15	5.46	0.7	0.08	7.15	0.03	0.12	7.42	1.70	0.07	14.83
43	*Urtica dioica*	Urticaceae	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.60	0.60	5.42
44	*Valeriana jatamansi*	Caprifoliaceae	0.00	0.00	0.00	1.2	1.20	6.18	0.00	0.00	0.00	0.00	0.00	0.00
45	*Verbascum thapsus*	Scrophulariaceae	0.90	0.00	14.29	1	0.11	10.65	0.00	0.00	0.00	0.00	0.00	0.00
46	*Viola biflora*	Violaceae	0.00	0.00	0	0	0.00	0.00	0.00	0.00	0.00	1.20	0.08	9.11

Table 5. Floristic diversity, distribution and medicinal use of recorded plants along with altitudinal gradient in study area

S. No.	Species Name	Family	Habit	Altitudinal range (m)	Medicinal system*
1.	*Abies pindrow* Royle.	Pinaceae	Tree	2100 - 3600	F
2.	*Achillea millefolium* Linn.	Asteraceae	Herb	1800 – 3600	H, U, S, M, F
3.	*Aconitum heterophyllum* Wallich ex Royle.	Ranunculaceae	Herb	2400 – 4000	A, U, T, S, F, M
4.	*Acorus calamus* Linn.	Araceae	Herb	1500 – 3000	A, U, F
5.	*Adonis aestivalis* Linn.	Ranunculaceae	Herb	1200 – 3000	F
6.	*Ajuga bracteosa*Wallich ex Benth.	Lamiaceae	Herb	1000 – 4000	A, F
7.	*Allium humile* Kunth	Amaryllidaceae	Herb	3000 – 4000	A, U, F
8.	*Angelica glauca* Edgew.	Apiaceae	Herb	2500 – 3000	A, T
9.	*Arisaema jacquemontii* Blume.	Araceae	Herb	2400 – 4000	F
10.	*Arnebia benthamii* (Wallich ex D.Don) I. M.Johnston.	Boraginaceae	Herb	3000 – 4300	A, U, F
11.	*Artemisia absinthium* Linn.	Asteraceae	Herb	1500 – 2700	A, H, M, F
12.	*Atropa accuminata* Royle ex. Lindl.	Solanaceae	Herb	1500 – 3000	A, U, F
13.	*Berberis lycium* Royle.	Berberidaceae	Shrub	1500 – 3000	A, U, F
14.	*Bergenia ciliata* (Haw.) Sternb.	Saxifragaceae	Herb	1800 – 2400	A, U, S, F
15.	*Betula utilis* D.Don.	Betulaceae	Tree	2700 – 4300	A, S, F
16.	*Cannabis sativa* Linn.	Cannabaceae	Herb	1800 – 2800	A, U, H, T, S, M, F
17.	*Capsella bursa-pastoris* (Linn.) Medikus.	Brassicaceae	Herb	1800 – 2200	H, F
18.	*Chenopodium album* Linn.	Chenopodiaceae	Herb	1500 – 3600	A, U, S, F
19.	*Cirsium falconeri* (Hook.f.) Petrak.	Asteraceae	Herb	2700 – 4300	F
20.	*Colchicum luteum* Baker.	Colchiceae	Herb	1800 – 3500	A, U, S, F
21.	*Corydalis govaniana* Wallich.	Papaveraceae	Herb	2400 – 4800	A, F
22.	*Corylus jacquemontii* Decne	Betulaceae	Tree	1800 – 3000	F
23.	*Cotoneaster nummularius* Fischer & Meyer	Rosaceae	Shrub	600 – 3000	F
24.	*Cuscuta reflexa* Roxb.	Convolvulaceae	Climber	1800 – 3300	A, S, U, F
25.	*Dactylorhiza hatagirea* (D.Don) Soo	Orchidaceae	Herb	2800 – 4000	A, U, F
26.	*Digitalis lanata* Linn.	Scrophulariaceae	Herb	2000 – 2500	U, F, M
27.	*Dioscorea deltoidea* Wall. ex Griseb	Dioscoreaceae	Climber	1800 – 2600	M, U, F
28.	*Fragaria nubicola* (Hook.f.) Lindl.	Rosaceae	Herb	1800 – 3800	F
29.	*Fritillaria roylei* Hook.	Liliaceae	Herb	2800 – 4000	A, U, F
30.	*Gentiana kurroo* Royle.	Gentianaceae	Herb	1800 – 2700	A, U, F
31.	*Geranium wallichianum* D. Don ex Sweet.	Geraniaceae	Herb	2200 – 3500	F
32.	*Geum elatum* Wallich.	Rosaceae	Herb	2700 – 4300	F
33.	*Heracleum candicans* Wallich ex DC.	Apiaceae	Herb	1800 – 3000	F
34.	*Hyoscyamus niger* Linn.	Solanaceae	Herb	2100 – 3300	A, H, U, S, M
35.	*Hypericum perforatum* Linn.	Hypericaceae	Herb	1800 – 2500	H, M, F
36.	*Impatiens glandulifera* Royle.	Balsaminaceae	Herb	1800 – 4000	F

S. No.	Species Name	Family	Habit	Altitudinal range (m)	Medicinal system*
37.	*Indigofera heterantha* Wallich ex Brandis.	Leguminosae	Shrub	1800 – 3000	F
38.	*Inula racemosa* Hook. f.	Asteraceae	Herb	2800 – 4000	F
39.	*Iris hookeriana* Foster	Iridaceae	Herb	2800 – 4000	F
40.	*Jasminum humile* Linn.	Oleaceae	Climber	1800 – 3000	A, S, T, F
41.	*Juglans regia* Linn.	Juglandaceae	Tree	1500 – 3000	A, H, T, U, S, F
42.	*Jurinea dolomiaea* Boiss.	Asteraceae	Herb	3000 – 4300	A, F
43.	*Lavatera cashemiriana* Cambess.	Malvaceae	Herb	1800 – 3600	F
44.	*Malva neglecta* Wallr.	Malvaceae	Herb	1800 – 2800	F
45.	*Meconopsis aculeata* Royle.	Papaveraceae	Herb	3000 – 4000	F
46.	*Mentha arvensis* Linn.	Lamiaceae	Herb	1800 – 2200	A, U, S, M, F
47.	*Myosotis sylvatica* Ehrh. exHoffm.	Boraginaceae	Herb	1800 – 4000	F
48.	*Nepeta linearis* Royle ex Benth.	Lamiaceae	Herb	1500 – 4000	F
49.	*Origanum vulgare* Linn.	Lamiaceae	Herb	1800 – 3000	A, U, F
50.	*Parrotiopsis jacquemontiana* (Decne.) Rehder.	Hamamelidaceae	Shrub	2000 – 2500	F
51.	*Phytolacca acinosa* Roxb.	Phytolacaceae	Herb	1500 – 3000	F
52.	*Picrorhiza kurroa* Royle ex Benth.	Scrophulariaceae	Herb	3300 – 4300	A, T, U, S, F
53.	*Pinus wallichiana* A.B. Jack.	Pinaceae	Tree	1800 – 3000	F
54.	*Plantago lanceolata* Linn.	Plantaginaceae	Herb	1800 – 2200	A, U, F
55.	*Podophyllum hexandrum* Royle.	Berberidaceae	Herb	2400 - 4500	A, U, H, M, F
56.	*Polygonatum verticillatum* (Linn.) All.	Convallariaceae	Herb	1500 - 3700	F
57.	*Primula denticulata* Smith.	Primulaceae	Herb	2800 - 3500	F
58.	*Primula elliptica* Royle	Primulaceae	Herb	3200 - 4300	F
59.	*Prunella vulgaris* Linn.	Lamiaceae	Herb	2200 - 3500	F
60.	*Rheum webbianum* Royale.	Polygonaceae	Herb	3000 - 4200	A, U, F
61.	*Rhododendron anthopogon* D. Don	Ericaceae	Shrub	3000 - 3800	A, F
62.	*Rosa webbiana* Wallich ex Royle.	Rosaceae	Shrub	1500 - 4100	S, F
63.	*Rubia cordifolia* Linn.	Rubiaceae	Climber or shrub	1200 - 2700	F
64.	*Rubus niveus* Wallich.	Rosaceae	Shrub	2200 - 3300	F
65.	*Rumex nepalensis* Sprengel.	Polygonaceae	Herb	1800 - 3000	H, F
66.	*Salvia moorcroftiana* Wall. exBenth.	Lamiaceae	Herb	2400 - 3800	F
67.	*Sambucus wightiana* Wallich ex Wight &Arn.	Viburnaceae	Shrub	1800 - 3000	U, F
68.	*Saussurea costus* (Falc.) Lipsch.	Asteraceae	Herb	2800 - 3500	A, U, M, F
69.	*Swertia petiolata* D. Don	Gentianaceae	Herb	3000 - 4500	A, U, F
70.	*Taraxacum officinale* Weber.	Asteraceae	Herb	1500 - 3800	A, H, U, S, M, F
71.	*Taxus wallichiana* (Zucc.) Pilger.	Taxaceae	Tree	2500 - 3400	A, U, M, F
72.	*Thymus linearis* Benth.	Lamiaceae	Herb	2200 - 3200	F
73.	*Trifolium pratense* Linn.	Leguminosae	Herb	1800 - 2500	U, H, M, F
74.	*Trillium govanianum* Wall. ex D.Don	Melanthiaceae	Herb	2700 - 4000	M, F

S. No.	Species Name	Family	Habit	Altitudinal range (m)	Medicinal system*
75.	*Tusilago farfara* Linn.	Asteraceae	Herb	3800 - 4500	H, U, M, F
76.	*Urtica dioica* Linn.	Urticaceae	Herb	1800 - 2500	A, H, U, F
77.	*Valeriana jatamansi* Jones.	Valerianaceae	Herb	1500 - 3600	A, U, F
78.	*Verbascum thapsus* Linn.	Scrophulariaceae	Herb	1800 - 3800	H, U, M, F
79.	*Viburnum grandiflorum* Wall. ex DC	Viburnaceae	Shrub	2500 - 3600	F
80.	*Viola biflora* W.Becker.	Violaceae	Herb	2400 - 3600	F

***Medicinal System:** A - Ayurveda, H - Homeopathy, U - Unani, S - Sidha, Tibetan, F - Folk, M - Modern system of Medicine (Allopathic)*

Iris hookeriana, and *Geranium pretense*. The higher dominance of *Myosotis arvensis*, *Plantago major*, *Iris hookeriana*, and *Geranium pratense* was attributed to their higher frequency, density and abundance as compared to the rest of the species.

The distribution and conservation of this flora can be helpful in designing the future management and conservation strategy. There are ample examples of similar documentations from plains and other regions of Himalayas [14,15,16,11,17,18]. The rural households in developing countries depend on forests for their subsistence needs. In general, these communities interact closely with forest; derive their economic livelihood and often their cultural and spiritual identity is interlinked [19]. The deterioration of plant wealth of the area needs immediate attention as most of the species may become rare due to population growth, deforestation, over-exploitation and unscientific harvesting of resources. The information on the folk uses of these plants is not well documented, there is an urgent need for more detailed research to collect the information and preserve it for future necessities.

Climate change has been predicted to affect the geographic and altitudinal distribution of global vegetation patterns. The global climate change has also affected in temperate environment of Himalayan Ecosystem as well in a way that seasonal change in climatic conditions lead to change in structure, quality and distribution of the vegetation [20].

4. CONCLUSION

The present study has elucidated the floristic diversity and distribution of medicinal plants at varying altitudes in Bangus valley of Langate Forest Division (J&K) India. The study reveals that majority of the medicinal plant species are distributed between 2900 to 3200 meters altitude. In all the sampled sites, around 51 plant species belonging to 24 families were recorded, among which 2 were tree, 3 shrub and 46 herb species. The tree vegetation was found to be dominated by *Abies pindrow,* shrubs by *Viburnum grandiflorum* and herbs by *Myosotis arvensis*. In addition, around 80 plant species were reported to be used in different systems of traditional medicine by the people of the area. Therefore, the study provided first comprehensive baseline data on the distribution, diversity and uses of plants in Bangus valley of Kashmir, which can be very useful for framing conservation and management strategies of medicinal plants.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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