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PHYTOSOCIOLOGY OF *Sambucus wightiana* Wall. ex Wight and Arn. IN SONAMARG AREA OF NORTH-WESTERN HIMALAYA

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ABSTRACT

Mountainous regions are more sensitive to climate change so the plant biodiversity along elevation faces many obstacles than just competition. Thus, many plant species in these ecosystems make slight alteration in their ranges for survival. In the mountainous areas of North-Western Himalayan region, *Sambucus wightiana* is one of the major subshrub species that has begun to extend its distribution. Despite its wide distribution across the North-Western Himalaya, no comprehensive and reliable published study detailing the phytosociology of *S. wightiana* is available. Therefore, in the present study, the phytosociological relationships of *S. wightiana* in the Sonamarg area was studied. The study area was divided into 11 altitudinal bands, from lowest to highest sampling locations. The plant species associated and not associated with *S. wightiana* at each altitudinal band were collected using standard taxonomic techniques. A total of 76 plant species belonging to 35 families were found along the altitudinal gradient from 1723 to 2858 m masl. The study clearly revealed the relationship of a few plant species with *S. wightiana* and the absence of other species in *S. wightiana* plots. The findings suggest that *S. wightiana* has developed distinct phytosociological connections, which may alter because of the expected climate change as most of the species may exhibit distinctive responses to mountain warming.

Keywords: Association, elevation, Sonamarg, phytosociology, range expansion, *Sambucus wightiana*

INTRODUCTION

Since inception, ecology has placed a high priority on comprehending how living communities are formed. Extraction of many mechanisms involved in community assembly is not only fascinating, but also crucial for predicting how communities adapt to new environmental conditions. The traditional concept of assembly rules is founded on the idea that plant species do not co-occur at random but are controlled by interspecific competition (Gotzenberger *et al*., 2012). In interactive communities, biotic interactions take place between plant species at the same trophic level (Liow *et al*., 2011). The species diversity and structure of plant communities are influenced by a variety of abiotic and biotic variables (Liu *et al*., 2021). Understanding how plant communities assemble has been a central question in ecology. Disentangling the different processes involved in community assembly is not only interesting but also crucial for an understanding of how communities will behave under future environmental scenarios (Gotzenberger *et al*., 2012).

Mountains have historically served as species refugia during climatic cycles (Tang *et al*., 2018), and understanding the reasons for these transitions might help in predicting the fate of mountain biodiversity in the face of future climate change (Freeman *et al*., 2018; Rashid *et al*., 2021). However, recent decades have seen little progress toward achieving a worldwide agreement on species elevational translocation in response to climate change each on the global (Guo *et al*., 2018) and nearby scales (Crimmins *et al*., 2011). For instance, a few studies have revealed that plant species have moved upward in the mountains due to climate change during the past century (Rumpf *et al*., 2018). As climate warming is expected to shift plant species upward, the advancing species with restricted niche widths experience severe fragmentation or loss of habitats (Dirnbock *et al*., 2011). Along a mountainous part of Kashmir valley, we collected data on plant diversity associated with *Sambucus wightiana* Wall. ex Wight & Arn., a range-expanding species with significant genetic diversity (Sofi *et al*., 2021). Collecting baseline data on plant species associations that have just begun range expansion is crucial so that the response of these communities to expected climate change may be studied in long-term ecological study. The regional-scale assessment of plant species response to recent climate variability is critical for forecasting the future shifts in plant community composition, structure, and productivity. The overall goal of our cross-site analysis was to identify regional trends in plant species responses to climate. Our specific objectives were to study the floristic composition of study area and documentation of plant species which are associated and un-associated with *S. wightiana* along the elevational gradient of Sonamarg study area.

MATERIALS AND METHODS

Study area

The study was carried out in Sonamarg, which is located at 34.18°N and 75.15°E having an average elevation of 2740 m masl. It is very famous health resort in Jammu and Kashmir. The area has complex and rugged topography with high relief and moderate slopes. The climate in the region is sub-Mediterranean type, with western disturbances dominating. Western disturbances are most active throughout winter and spring seasons, with a significant drop in summer (Dar *et al*., 2017). In Sonamarg. the minimum and maximum temperature ranges from –8.1 to 19.01°C and average annual precipitation varies from 932–1,050 and 1,049–1,100 mm, while snow cover lasts for about 195 days/year.

Plant specie

Sambucus wightiana Wall. ex Wight & Arn. is a shrubby plant (Fig. 1) with a height range of 1.0-1.5 m. Its leaves are around 25 cm long and have 5-9 leaflets of length 5-18 cm. The leaflets have lanceolate shape with acute to acuminate tip. The corymbose pedunculate inflorescence is about 10 cm wide. Flowers are actinomorphic, tiny, and around 5 mm in dia. The fruit is a drupe that is globose in shape, with a diameter of 4 to 5 mm, initially orange in colour and becomes black on maturity. The seeds are oval in form and about 2.7 mm in length (Acharya and Mukherjee, 2014).

Fig. 1: *Sambucus wightiana*

Field sampling and measurements

Sonamarg mountainous terrain was separated into 11 altitudinal bands, from lowest (1723 m masl) to highest (2858 m masl) sampling location. Garmin eTrex (Garmin International, Inc., Olathe, KS) was used to record GPS coordinates of the sampling sites. Quadrats of 1 m x 1 m size were placed at each elevational gradient. Plant specimens were collected using standard taxonomic techniques (Bridson and Forman, 1998). Using standard herbarium processes, the specimens were dried and mounted on herbarium sheets. The collected specimens were accurately identified using labelled herbarium specimens maintained in the University of Kashmir Herbarium. All voucher specimens were stored at the KASH herbarium. Authentic taxonomic resources were used to cross-check the scientific names.

RESULTS AND DISCUSSION

A total of 76 plant species belonging to 35 families were recorded from the study area. Out of 76 plant species, 54 were native and 22 exotic. Among the recorded plant species, there were 66 herbs, 4 graminoids, 3 shrubs, 2 vines and 1 sub shrub. Out of the 76 documented species, 39 species were annuals, 34 perennials and 3 biennials. The total number of plant species that were found in plots with and without *S. wightiana* was 61 and 70, respectively. Among 61 species recorded in plots with *S. wightiana*, 45 plant species were native and 16 were exotic (Table 1). On the other hand, in plots without *S. wightiana*, the total number of native and exotic plant species were 51 and 19, respectively.

The number of plant species exclusively found in association in plots with and without *S. wightiana* were 6 and 15, respectively (Fig. 2). In plots with *S. wightiana*, the maximum number of species were 31 that were found at an elevation of 2521 m masl, followed by the elevation of 2424 m masl having 27 plant species, whereas 24 species were found at 2110 m masl. In plots without *S. wightiana*, the maximum number of species collected at an elevation of 2521, 2424 and 2110 m masl were 37, 33 and 28, respectively. Asteraceae was represented by the largest number (10 plant species) across the plots with *S. wightiana*, followed by Lamiaceae (5), Polygonaceae (4), Poaceae (4), and Brasicaceae (3). In plots without *S. wightiana*, the most abundant family was Asteraceae (13), followed by Lamiaceae (7), Brassicaceae (5) and Poaceae (4).

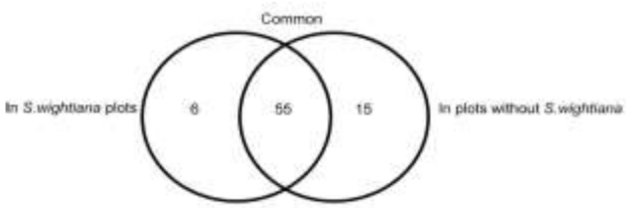

Fig. 2: The number of plant species in plots with and without *S. wightiana*

The present study revealed highest plant species richness (31 species) at elevations ranging from 2110 to 2521 m masl and species richness declined towards upper elevations which could be attributed to the phytoclimatic conditions. The declining pattern of species richness with increasing altitude has also been observed in other parts of Indian Himalaya (Acharya *et al.*, 2011; Zhang *et al*., 2015). The altitudinal gradients create variation in species richness and temperature is thought to be the most important factor controlling range limits of phytodiversity along elevation and latitudinal gradients (Halbritter *et al*., 2013). The size of the study area may also influence the relationship between altitude and species richness (Whittaker *et al*., 2001), particularly when key local factors shift considerably over small ranges. A few critical plant species, such as dominant shrub species, can nevertheless change species composition along altitudinal gradients (Walker *et al*., 2006). Geographic range alterations, expansions, and reductions are among the most common species responses to climate change. Among the most prevalent reactions of species to climate change are geographic range changes, expansions, and contractions (Molinos *et al*., 2016). The current study clearly reveals the relationship of a few species with *S. wightiana* (*Cynodon dactylon*, *Trifolium pratense*, *Trifolium repens* and *Poa annua* and the lack of other species in *S. wightiana* plots (*Trifolium repense, Stipa sibirica*, *Capsella bursa-pastoris*, *Medicago sativa*).

All the eleven study sites had a high percentage of phanerophytes (32%), which were characteristics of a humid bioclimate, and their high prevalence along the elevational gradient reflected an important role of canopy in improving the climate, influencing regeneration, herbaceous plant establishment, biodiversity preservation, and ecosystem functioning (Reddy *et al*., 2011). The co-dominance of cryptophytes like *Cirsium arvense*, *Bellis perennis*, *Bothriochloa ischaemum,* etc. at higher elevations reflected the best performance of these life forms. Cryptophytes have underground perennating organs like rhizomes and bulbs that produce energy in difficult conditions. As a result, cryptophytes become the dominant life form at higher elevations. Lower elevations (1723, 1913, and 2053 m masl) are dominated by annuals, which may be explained by soil disturbance, fast drying habitats and anthropogenic activities which provide excellent habitat for ruderals. Temperature typically drops by 0.5 to 0.6°C for every 100 m altitude gain. As a result, temperatures and growing

Table 1: Conspectus of the flora of Sonamarg, Kashmir observed during survey

S. No.	Name of the species	Family	Growth form	Life span	Status	Occurrence	
						With *S. wightiana*	Without *S. wightiana*
1.	*Achillea millefolium* L.	Asteraceae	Herb	A	Native	1	1
2.	*Amaranthus caudatus* L.	Amaranthaceae	Herb	A	Exotic	1	1
3.	*Anaphalis royleana* DC.	Asteraceae	Herb	A	Native	0	1
4.	*Anthemis cotula* L.	Asteraceae	Herb	A	Exotic	1	1
5.	*Arisaema jacquemontii* Blume	Araceae	Herb	A	Native	1	1
6.	*Artemisia absinthium* L.	Asteraceae	Herb	P	Native	1	1
7.	*Artemisia vestita* Wall. ex DC.	Asteraceae	Herb	P	Native	1	0
8.	*Barbarea intermedia* Boreau.	Brassicaceae	Herb	B	Exotic	0	1
9.	*Bellis perennis* L.	Asteraceae	Herb	A	Exotic	0	1
10.	*Bothriochloa ischaemum* Keng	Poaceae	Graminoid	P	Native	1	1
11.	*Brassica tournefortii* Gouan	Brassicaceae	Herb	A	Exotic	1	1
12.	*Cannabis sativa* L.	Cannabaceae	Herb	A	Native	0	1
13.	*Capsella bursa-pastoris* Medic.	Brassicaceae	Herb	A	Native	1	1
14.	*Cardamine hirsuta* L.	Brassicaceae	Herb	A	Exotic	0	1
15.	*Centaurea iberica* Trev. Ex Spreng	Asteraceae	Herb	A	Native	0	1
16.	*Cerastium cerastioides* (L.) Britton	Caryophyllaceae	Herb	A	Native	1	1
17.	*Chenopodium album* L.	Chenopodiaceae	Herb	P.	Exotic	1	1
18.	*Cirsium arvense* Scop.	Asteraceae	Herb	P	Native	1	1
19.	*Cirsium vulgare* (Savi) Ten.	Asteraceae	Herb	P	Native	1	1
20.	*Clinopodium vulgare* L.	Lamiaceae	Herb	P	Native	1	1
22.	*Convolvulus arvensis* L.	Convolvulaceae	Herb	A	Exotic	0	1
21.	*Conyza canadensis* (L) Cronquist	Convolvulaceae	Herb	A	Exotic	1	1
23.	*Crepis sancta* (L.) Bornm.	Asteraceae	Herb	A	Native	0	1
24.	*Cynodon dactylon* Pers.	Poaceae	Graminoid	P	Native	1	1
25.	*Digitalis lanata* Ehrh.	Scrophulariaceae	Herb	B	Exotic	1	0
26.	*Dioscorea deltoidea* Wall. Ex Griseb	Dioscoreaceae	Vine	P	Native	1	1
27.	*Dyopteris blanfordii* (Ching) Fraser-Jenkins	Dropteridaceae	Herb	P	Native	0	1
28.	*Euphorbia hispida* Boiss.	Euphorbiaceae	Herb	A	Native	1	1
29.	*Fragaria nubicola* Lindel. ex. Lacaita	Rosaceae	Herb	P	Native	1	1
30.	*Gagea elegans* Wall. ex. D.Don	Liliaceae	Herb	A	Native	1	1
31.	*Galingsoga parviflora* Cav.	Asteraceae	Herb	A	Exotic	1	1
32.	*Galium triflorum* Michx.	Rubiaceae	Herb	A	Native	1	1
33.	*Geranium pratense* L.	Geraniaceae	Herb	A	Native	1	1
34.	*Impatiens balfourii* Hook.	Balsaminaceae	Herb	A	Native	1	1
35.	*Impatiens brachycentra* Kar. & Kir.	Balsaminaceae	Herb	A	Native	0	1
36.	*Impatiens glandulifera* Royle	Balsaminaceae	Herb	A	Native	0	1
37.	*Isodon rugosus* Wall. ex. Benth	Lamiaceae	Herb	P	Native	1	1
38.	*Lamium album* L.	Lamiaceae	Herb	A	Native	1	1
39.	*Lonicera japonica* L.	Caprifoliaceae	Vine	P	Exotic	1	0
40.	*Malva neglecta* Wall.	Malvaceae	Herb	A	Native	1	1
41.	*Marrubium vulgare* L.	Lamiaceae	Herb	A	Exotic	0	1
42.	*Medicago sativa* L.	Fabaceae	Herb	P	Exotic	1	1
43.	*Mentha longifolia* L.	Lamiaceae	Herb	P	Native	1	1
44.	*Myosotis arvensis* (L.) Hill	Boraginaceae	Herb	A	Exotic	1	1
45.	*Nepeta erecta* (Boyle ex Benth.)	Lamiaceae	Herb	P	Native	1	1
46.	*Oenothera rosea* Ait.	Onagraceae	Herb	P	Exotic	1	0
47.	*Oxalis corniculata* L.	Oxalidaceae	Herb	A	Native	1	1
48.	*Phlomis spectabilis* Falc. ex Benth	Lamiaceae	Herb	P	Native	0	1
49.	*Phytolacca acinosa* Roxb.	Phytolaccaceae	Shrub	P	Native	1	1
50.	*Plantago lanceolata* L.	Plantaginaceae	Herb	A	Native	1	1
51.	*Plantago major* L.	Plantaginaceae	Herb	P	Exotic	1	1

52.	*Poa annua* L.	Poaceae	Graminoid	A	Native	1	1
53.	*Polygonum amphibium* L.	Polygonaceae	Herb	P	Native	1	1
54.	*Polygonum amplexicaule* D. Don	Polygonaceae	Herb	P	Native	1	1
55.	*Portulaca oleracea* L.	Portulacaceae	Herb	A	Exotic	1	1
56.	*Primula denticulate* Sm.	Primulaceae	Herb	P	Native	1	0
57.	*Ranunculus laetus* Wall. ex D. Don	Ranunculaceae	Herb	P	Native	1	1
58.	*Ranunculus sceleratus* L.	Ranunculaceae	Herb	A	Native	1	1
59.	*Rumex dentatus* L.	Polygonaceae	Herb	A	Native	1	1
60.	*Rumex nepalensis* Spreng.	Polygonaceae	Herb	P	Native	1	1
61.	*Sambucus wightiana* Wall. ex Wight & Arn.	Adoxaceae	Sub shrub	P	Native	1	0
62.	*Sibbaldia cuneata* Schouw ex Kunze	Rosceae	Herb	P	Native	1	1
63.	*Sisymbrium loesellii* L.	Brassicaceae	Herb	A	Exotic	1	1
64.	*Skimmia anquetilia* N.P.Ta	Rutaceae	Shrub	P	Exotic	0	1
65.	*Stellaria media* (L.) Vill.	Caryophyllaceae	Herb	A	Native	0	1
66.	*Stipa sibirica* (L.) Lam.	Poaceae	Graminoid	A	Native	1	1
67.	*Taraxacum officinale* Weber	Asteraceae	Herb	P	Native	1	1
68.	*Trifolium pratense* L.	Fabaceae	Herb	P	Native	1	1
69.	*Trifolium repens* L.	Fabaceae	Herb	P	Native	1	1
70.	*Urtica dioica* L.	Urticaceae	Herb	P	Native	1	1
71.	*Verbascum Thapsus* L.	Scrophulariaceae	Herb	B	Native	1	1
72.	*Veronica laxa* Benth.	Scrophulariaceae	Herb	A	Native	1	1
73.	*Viburnum grandiflorum* Wall. ex DC	Caprifoliaceae	Shrub	P	Native	1	1
74.	*Viola biflora* L.	Violaceae	Herb	A	Exotic	1	1
75.	*Viola odorata* L.	Violaceae	Herb	P	Native	1	1
76.	*Xanthium spinosum* L.	Asteraceae	Herb	A	Exotic	1	1

season lengths are acceptable at lower elevations of the study area, but soil moisture is not easily accessible, which may explain well- developed annual plants. Furthermore, because lower altitude locations have been subjected to anthropogenic stress, the higher proportion of chamaephytes (27%) and hemicryptophytes (20%) may be connected to the effect of anthropogenic activity. Chamaephytes and therophytes are considered signs of an adverse environment (Amjad *et al*., 2012). As a result, chamaephytes predominate in places susceptible to environmental stress. Thus, the biotic spectra at upper and lower altitudes along the transect indicates the diverse biological spectra which have emerged in response to the climatic conditions existing in the area. Positive interactions are non-trophic interactions between plant species that boost the average individual survival of at least one of the taxa involved. The proportional value of facilitation rises with environmental harshness, according to studies that examined the relative significance of positive and negative associations in plant communities across climatic factors (Bashirzadeh *et al*., 2022).

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