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RESEARCH ARTICLE

Floristic survey of Darjeeling Himalaya with emphasis on endemism and conservation status

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Abstract

The Darjeeling district of West Bengal, India, is an ideal home to many taxa, like any other part of the Great Himalayas. The floristic survey of the Darjeeling district provides an overview of the region's biodiversity within the Eastern Himalayan hotspot. The present study documented diverse plant taxa from the Darjeeling Himalaya by preparing herbarium specimens using standard methods, identifying them taxonomically and assessing their threat status using the IUCN Red List database. Using floristic inventories analysed through diversity indices (Shannon, Simpson, Margalef), similarity measures (Jaccard, Sørensen), non-metric multidimensional scaling (NMDS) ordination and permutational multivariate analysis of variance (PERMANOVA), quantified the spatial patterns of plant diversity across the study area. This study showed that Orchidaceae, Rosaceae, Lamiaceae, Fabaceae and Acanthaceae are the dominant plant families in the area and recorded 11 plant species that are either endemic or regionally restricted. The study revealed high alpha diversity (species richness 40–109; H′ = 3.69–4.69) and strong beta diversity driven mainly by species turnover (Jaccard dissimilarity 0.28–0.94), with altitude and associated temperature gradients significantly structuring community composition (PERMANOVA R^2 = 0.316, p = 0.001), whereas precipitation had no significant effect. The conservation status shows that almost 76 % of the plant species are in the "Not Evaluated" (NE) category, followed by "Least Concern" (LC; 19 %), "Endangered" (EN; 1.2 %) and "Critically Endangered" (CR; 1%). The floristic exploration data on species richness and diversity of the flora provide valuable baseline data for future studies.

Keywords: Darjeeling; Eastern Himalaya; endemic; floristic Study; IUCN status

Introduction

Darjeeling, the northernmost district of West Bengal, is located between 26°31'–27°31' N latitude and 87°59'–88°53' E longitude. It is part of India's Eastern Himalayan region, bordered by Bhutan to the east, Nepal to the west, Sikkim to the north and the Terai and Dooars regions of West Bengal to the south. The name "Darjeeling" is believed to have originated from the Tibetan term *Dorje-ling*, meaning "Land of the Thunderbolt," where *dorje* refers to the celestial sceptre symbolising a thunderbolt and *ling* means land. Collectively, the term signifies "the land of the thunderbolt", reflecting the region's cultural and spiritual heritage and its renown as the "Queen of Hills". Darjeeling is well-known for its mystical enchantment and stunning landscapes. The district, divided into four subdivisions, showcases two distinct topographical features. Darjeeling Sadar, Kurseong and Mirik constitute the hilly terrain, whereas Siliguri lies in the plains at the foothills. The district covers an area of 3149 km^2 and has an average annual rainfall of 3092 mm. As a significant hotspot for biodiversity, the Eastern Himalayas have drawn much attention from researchers for their exceptional biogeographical significance and high species richness. Along the elevational gradient, the region's varied climate conditions provide an optimal environment for sustaining rich phyto-diversity. The extensive variation in vegetation structure supports nearly all major taxonomic groups of plants (1–3).

The Darjeeling Himalaya encompasses a wide elevational range, extending from approximately 132 m at Sukuna to 3636 m at Phalut above sea level. This gradient gives rise to a remarkable diversity of ecological conditions and vegetation types, which are broadly classified into five zones: tropical (up to 500 m), subtropical (500–1200 m), sub-temperate (1200–1850 m), temperate (1850–3200 m) and subalpine (above 3200 m). Within the temperate zone (1850–3200 m), vegetation is further stratified into three distinct forest subtypes: temperate broad-leaved forest (1850–2400 m), evergreen oak forest (2400–2800 m) and hemlock–rhododendron forest (2800–3200 m) (1, 4). Botanical exploration in the Darjeeling Himalaya dates back over 150 years, beginning with Sir J. D. Hooker's pioneering documentation of the flora of Tonglu in 1849 (5). Subsequent efforts led to comprehensive inventories of trees, shrubs and climbers found in the forests of the region (6). The three-volume series Flora of Eastern Himalaya offers an extensive account of the area's plant diversity (7), complemented by significant contributions from The Flora of Bhutan, including many species native to this

region (8). Further botanical studies have enriched our understanding of the region's flora, including research on dicotyledons (9), angiospermic climbers (10), monocotyledons (11), orchids (12, 13) and pteridophytes (14). In addition, phytosociological analyses and checklists of dicots have contributed valuable insights into the composition and structure of these unique plant communities (4).

Although several floristic studies and checklists exist for the Darjeeling Himalaya, many are outdated, focus on limited plant groups, or lack systematic sampling across elevation gradients. Ongoing land-use changes, human pressure and climate-related shifts in vegetation further emphasise the need for updated baseline information. In this context, the present study explored the rich plant diversity of the Darjeeling district by surveying its varied vegetation across different elevations and habitats. Along with documenting the floristic composition, the conservation status of the species and the identified endemic plants in this region are also examined. This study aimed to better understand the unique plant life of this Himalayan landscape and to highlight the importance of protecting its rare and region-specific flora. The study presents an updated, field-verified checklist, reports several species not recorded in earlier local inventories and adds new distributional records for the Darjeeling Himalaya.

Materials and Methods

Study area

The floristic study of the Darjeeling district was conducted up to an altitude of 3500 m above sea level. The area of Darjeeling is geographically located at latitude 27°01′59″ N and longitude 88°16′00″ E. Floristic collections were made from the tropical and subtropical lowlands represented by Bijanbari, Mungpoo, Relling, Upper Relling and Teesta Valley; the temperate mid-hills represented by Kurseong, Takdah, Sonada, Rimbick, Mirik, Upper Langurdang, Chota Hatta, Bara Hatta, Bichgaon and Lamahatta; and the subalpine ridge represented by Maneybhanjang, Tonglu and Dhotrey (Fig. 1).

Field survey and data collection

The study conducted a comprehensive floristic survey across selected locations in the study area from 2022 to 2024. To adequately capture seasonal and phenological variability, each study site was visited twice in each of the four major seasons, namely spring, summer, monsoon and winter. The species diversity was assessed using a reconnaissance survey combined with opportunistic/random walk sampling. The study area was systematically surveyed along existing forest trails and ridgelines to cover all major microhabitats and elevational zones. During this survey, GPS coordinates, habitat photographs, herbarium specimens and other relevant plant parts were systematically collected. Each species was recorded in a field notebook along with a brief taxonomic description. Post-collection, the specimens were processed following standard herbarium protocols (15), including preservation, poisoning and mounting on herbarium sheets and deposited at the Herbarium of CCRAS–Regional Ayurveda Research Institute, Gangtok, a registered Herbarium with the acronym RARI. Plant specimens were identified using standard taxonomic literature, herbarium comparisons, floras and manuals of Sikkim and Darjeeling and by verifying updated botanical names and author citations through online databases International Plant Names Index (www.ipni.org), The World Flora Online (www.worldfloraonline.org) and Plants of the World Online (powo.science.kew.org).

Statistical analysis

Alpha diversity

Species occurrence data were compiled into a species × site matrix using presence–absence coding (1 = presence, 0 = absence). Species richness was calculated for each site as the total number of plant species recorded. In addition to species richness, the Shannon diversity index (H′), Simpson's diversity index (1 − D) and Margalef's richness index (DM) were calculated using the *vegan* package in R to capture different aspects of species diversity.

Beta diversity

Beta diversity among sites was assessed using presence–absence data. Pairwise compositional dissimilarity was calculated using the Jaccard index with the vegdist() function in the *vegan* package in R. Total beta diversity was further partitioned into species turnover (β_{jtu}) and nestedness (β_{jne}) components using the beta.pair() function of the betapart package in R, following Baselga's method. The contribution of individual sites to overall beta diversity was assessed using Site Contribution to Beta Diversity (SCBD) values, which partitions total beta diversity into site-wise contributions. The presence–absence matrix was first Hellinger-transformed and SCBD were then calculated using the beta.div() function in the vegan package in R. The pairwise floristic similarity among sites was quantified using Sørensen's similarity coefficient. The Sørensen's similarity coefficient was calculated from presence–absence data using the binary Bray–Curtis (Sørensen) index implemented in the *vegan* package in R.

Non-metric multidimensional scaling (NMDS) ordination, Permutational multivariate analysis of variance (PERMANOVA) and Regression analyses

Species composition was analysed using NMDS based on Jaccard dissimilarity to visualize patterns of community similarity among sites. Environmental drivers of community structure were assessed using environmental vector fitting (envfit) with altitude (m), mean annual temperature (°C) and annual precipitation (mm), with significance tested using 999 permutations (Supplementary Table 1). Differences in community composition among predefined altitude zones were evaluated using PERMANOVA (adonis2) and multivariate dispersion among groups was examined using betadisper, followed by analysis of variance (ANOVA) to assess homogeneity of dispersion. Relationships between species richness and environmental variables were examined using Pearson's and Spearman's correlation analyses, followed by simple and multiple linear regression models. Variance inflation factors (VIF) were calculated to assess multicollinearity among predictors and model selection was based on statistical significance, explanatory power and collinearity diagnostics.

Results and Discussion

Floristic composition

The floristic exploration of Darjeeling has a long and distinguished history, beginning with the earliest known report by D. Don in 1821, based on specimens from A. B. Lambert's herbarium. Don later published Prodromus Florae Nepalensis in 1825 (16), laying the foundation for future botanical studies in the Eastern Himalayas. J. D. Hooker's note on the flora of Tonglu in 1849 is considered the first recognisable botanical publication specifically for Darjeeling (5), followed by notable contributions from James Sykes Gamble,

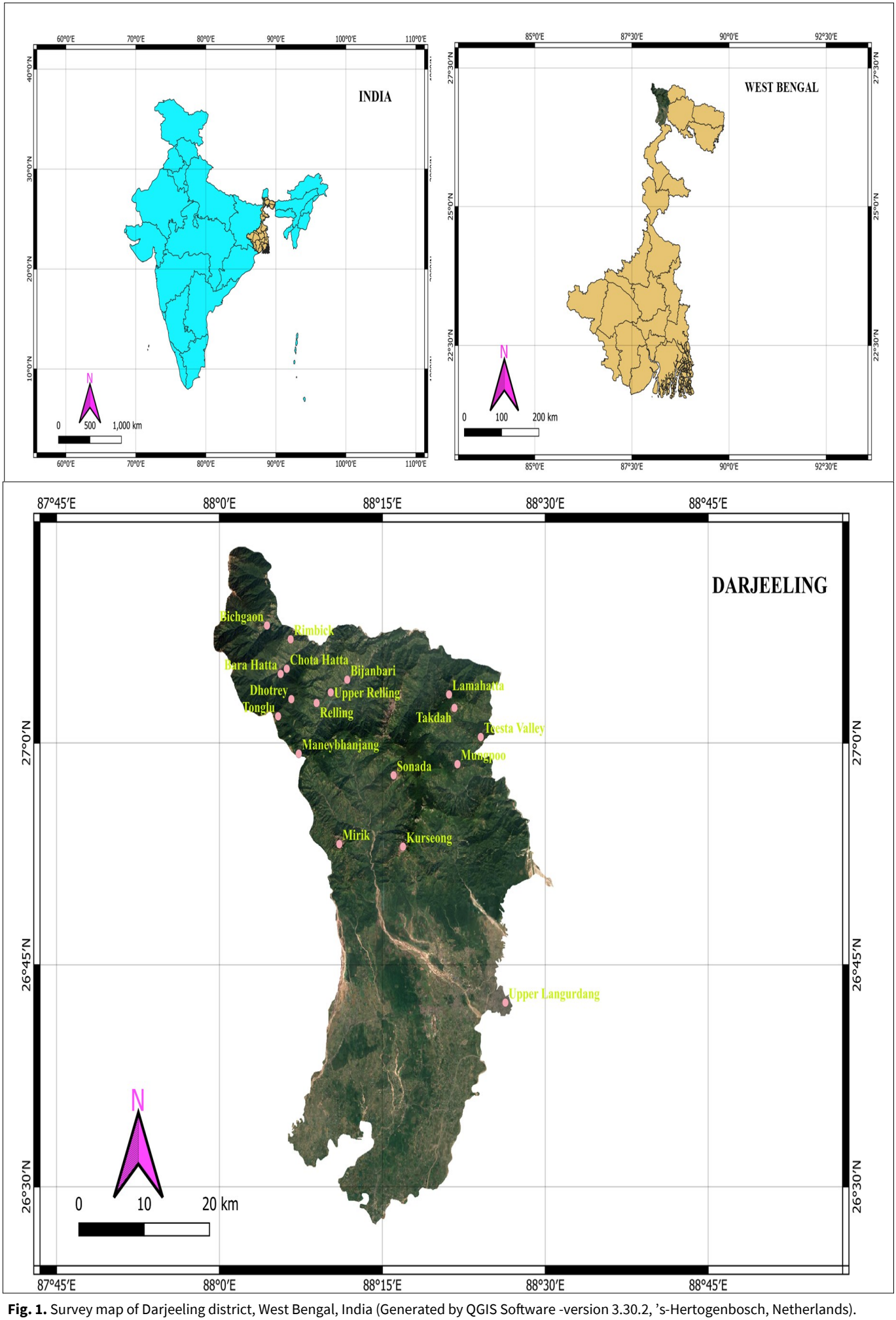


Fig. 1. Survey map of Darjeeling district, West Bengal, India (Generated by QGIS Software -version 3.30.2, 's-Hertogenbosch, Netherlands).

Alexander Martin Cowan and John Marshall Cowan (6, 17). The publication of Common Medicinal Plants of Darjeeling and Sikkim Himalayas marked the beginning of a new phase of modern floristic studies in the region (18), followed by Flora of Darjeeling and the Sikkim Himalayas (Vol. I) (19). Hooker's comprehensive "The Flora of British India" also included Darjeeling flora (20). Subsequent works by Matthew and Hara further contributed to the botanical literature (21, 22). Further, few studies have explored the endemic monocot flora of the Darjeeling Himalaya (11). In some studies, researchers have highlighted the rich medicinal plant diversity of the Darjeeling Himalaya, illustrating how these plant resources vary across different altitudes and ecological settings. These works also draw attention to the shared plant wealth of the Darjeeling and Sikkim Himalayas, emphasizing the increasing need to conserve and protect these valuable natural resources (23, 24).

The present study assessed the wild floristic diversity of the Darjeeling district, focusing on species distribution, diversity, endemism and conservation status according to the International Union for Conservation of Nature (IUCN). Photographs of selected important plant species are presented in Fig. 2 and Fig. 3. The study identified 258 plant species belonging to 195 genera of 81 families (Table 1). From the collected specimens 67 % are found to be herbs, followed by 18 % shrubs, 7 % trees and 8 % climbers (Fig. 4). Orchidaceae was the most represented family (17 specimens), followed by Rosaceae (15), Lamiaceae (14), Rubiaceae (12) and Fabaceae (11). Other frequently encountered families included Urticaceae (10); Zingiberaceae, Asteraceae and Acanthaceae (9 each); Polygonaceae, Malvaceae and Begoniaceae (7 each), Asparagaceae, Solanaceae and Ranunculaceae (6 each); Gesneriaceae, Gentianaceae, Campanulaceae and Apocynaceae (5 each); with Poaceae, Commelinaceae, Berberidaceae, Apiaceae and Amaranthaceae (4 specimens each). Families such as Melastomataceae, Hypericaceae, Convolvulaceae, Araliaceae and others indicate localised or less abundant taxa. The other 50 families, including Lauraceae, Ericaceae, Myrtaceae, Fagaceae and Euphorbiaceae, were represented by a single specimen (Fig. 5), suggesting rare or habitat-specific occurrences. The dominance of families such as Orchidaceae and Asteraceae aligns with typical patterns of Eastern Himalayan flora, reflecting both widespread adaptability and niche specialisation.

Alpha diversity

Alpha diversity summarizes the variety of species within a site and provides a foundation for comparing community structure across habitats, elevations and disturbance gradients. To capture complementary aspects of community structure, three commonly used indices were used in this study. Shannon's diversity index (H') combines species richness and evenness into a single information-theoretic measure; Simpson's index (1–D), which is sensitive to dominance by abundant species and therefore highlights changes in community evenness; and Margalef's richness index (d), provides a simple, abundance-adjusted measure of species richness (S) (25–27).

A marked variation in plant species diversity was observed across the studied sites (Table 2). Species richness ranged from 40 to 109 species (Fig. 6A), with the highest richness recorded at Kurseong and Relling (both with 109 species), followed by Teesta Valley (99 species) and Bijanbari and Takdah (both 94 species). The lowest species richness was observed at Tonglu (40 species) and Maneybhanjang (43 species). The Shannon diversity index (H') values varied from 3.69 (Tonglu) to 4.69 (Kurseong and Relling), which indicates overall high species diversity across most sites (Fig. 6B). Sites such as Teesta Valley (H' = 4.60), Bijanbari and Takdah (H' = 4.54) and Mirik (H' = 4.48) also exhibited high community heterogeneity. The Simpson's diversity index (1−D) values were consistently high (0.97–0.99), suggesting low dominance and high evenness in species distribution across sites. The highest Simpson values were recorded for Kurseong and Relling (0.9908), whereas relatively lower values were observed at Tonglu (0.975) and Maneybhanjang (0.9767). Margalef's richness index (d) ranged from 10.57 (Tonglu) to 23.02 (Kurseong and Relling), which also supports the observed gradient in species richness along the landscape. Based on frequency and relative frequency data, the vegetation exhibits a highly uneven distribution, with a small group of widespread species showing the highest frequencies (18 occurrences; ~1.38 % relative frequency each), whereas a large proportion of species occur very rarely (1–2 occurrences; ~0.08–0.15 %), indicating high species richness, with clear dominance by a few common taxa and a long tail of rare species (Supplementary Table 2). The observed higher richness and diversity at lower to mid-elevation orvalley sites (Kurseong, Mirik, Teesta Valley) and reduced richness at high-elevation sites (Tonglu, Maneybhanjang) aligns with multiple regional surveys that report a hump-shaped or declining richness pattern with elevation in the Eastern Himalaya (28–30).

Beta diversity

Beta diversity refers to the degree of change in species composition among sites and is a crucial metric for understanding spatial heterogeneity, species turnover and the landscape-level organisation of biodiversity. In complex mountain systems, beta diversity is particularly important because steep elevational gradients, variable microclimates and differential anthropogenic pressures often result in high compositional turnover over relatively short geographic distances. Among the commonly used presence–absence-based measures of beta diversity, Jaccard's similarity coefficient and Sørensen's similarity coefficient are widely applied in floristic and ecological studies. Jaccard's index emphasizes shared species relative to the total species pool and is sensitive to species turnover among sites, whereas Sørensen's index gives greater weight to shared species and is therefore considered more robust for ecological comparisons where sampling intensity varies (31, 32).

In this study, pairwise Jaccard dissimilarity values (β_{jac}) indicated high species turnover among most sites, with values ranging from 0.28 to 0.94, which shows strong compositional heterogeneity across the region (Supplementary Table 3). The lowest dissimilarity was observed between the Teesta Valley and Mirik (0.28), indicating a high degree of similarity in species composition. In contrast, Tonglu consistently showed very high dissimilarity with most sites (β_{jac}> 0.88), suggesting a distinct floristic assemblage. Moderate dissimilarity values were recorded among mid-elevation sites such as Kurseong, Relling, Bijanbari, Takdah and Sonada, indicating partial species sharing with notable turnover. The spatial patterns of pairwise Jaccard dissimilarity were further visualised using a heatmap and Unweighted Pair Group Method with Arithmetic Mean (UPGMA) clustering (Fig. 7A). The heatmap revealed clear blocks of low and high dissimilarity, with mid-elevation sites forming a cohesive cluster, while Tonglu was consistently isolated, reflecting its distinct species composition (Fig. 7B). The UPGMA dendrogram further supported this pattern by grouping ecologically similar sites together, indicating strong

Table 1. Details of plant species recorded during the floristic survey of Darjeeling district

Botanical name	Family	Habit	Locality	Field notebook number	Accession number	IUCN status	GPS
Abroma augustum (L.) L.f.	Malvaceae	Tree	Mirik	2706	RARI 5526	NE	26°53'00" N, 88°06'40'' E
Abutilon indicum (L.) Sweet	Malvaceae	Shrub	Teesta Valley	3019	RARI 5725	NE	26°03'06'' N, 88°25'18'' E
Achyranthes aspera L.	Amaranthaceae	Herb	Relling	2532	RARI 5318	NE	27°02'27'' N, 88°09'10'' E
Achyranthes bidentata Blume	Amaranthaceae	Herb	Takdah	2879	RARI 5727	NE	27°02'12'' N, 88°20'39'' E
Acmella oleracea (L.) R.K. Jansen	Asteraceae	Herb	Kurseong	2990	RARI 5729	LC	26°54'29'' N, 88°18'23'' E
Aconitum arunii P.Agnihotri, D.Husain &	Ranunculaceae	Herb	Tonglu	2956	RARI 5500	LC	27°02'00'' N, 88°05'00'' E
Aconitum heterophylloides (Brühl) Stapf	Ranunculaceae	Herb	Tonglu	2957	RARI 5680	LC	27°02'00'' N, 88°05'00'' E
Aeginetia indica L.	Orobanchaceae	Herb	Dhotrey	2653	RARI 5731	LC	27°03'02'' N,
Aeschynanthus bracteatus Wall. ex A. DC.	Gesneriaceae	Herb	Sonada	2910	RARI 5835	NE	26°58'23'' N, 88°16'39'' E
Ageratina adenophora (Spreng.)	Asteraceae	Herb	Takdah	2870	RARI 5732	NE	27°02'13'' N, 88°20'46'' E
Agrimonia eupatoria L.	Rosaceae	Herb	Dhotrey	2698	RARI 5608	NE	27°03'00 ''N, 88°06'47'' E
Ainsliaea latifolia (D.Don) Sch.Bip.	Asteraceae	Herb	Takdah	2872	RARI5503	NE	27°02'13'' N, 88°20'46'' E
Ajuga integrifolia Buch.-Ham. ex. D. Don	Lamiaceae	Herb	Relling	2510	RARI 5734	NE	27°03'28'' N, 88°08'13'' E
Alstonia scholaris (L.) R.Br.	Apocynaceae	Tree	Takdah	2882	RARI 5735	LC	27°01'52'' N, 88°20'7.9'' E
Amaranthus tricolor L.	Amaranthaceae	Herb	Relling	2758	RARI 5853	NE	27°02'35'' N, 88°09'07'' E
Amaranthus viridis L.	Amaranthaceae	Herb	Relling	2508	RARI 5300	NE	27°03'28'' N, 88°08'13'' E
Andrographis paniculata Burn.f.	Acanthaceae	Herb	Bijanbari	2692	RARI 5858	NE	26°04'05'' N, 88°11'427'' E
Anthogonium gracile Wall. ex Lindl.	Orchidaceae	Herb	Takdah	2884	RARI 5737	NE	27°01'52'' N, 88°20'7.9'' E
Apium graveolens L.	Apiaceae	Herb	Upper Relling	2690	RARI 5846	LC	27°03'26'' N, 88°10'15'' E
Argostemma sarmentosum Wall.	Rubiaceae	Herb	Takdah	2876	RARI 5738	NE	27°02'12'' N, 88°20'39'' E
Arisaema concinnum Schott	Araceae	Herb	Takdah	2867	RARI 5739	NE	27°02'13'' N, 88°20'46'' E
Arisaema jacquemontii Blume	Araceae	Herb	Tonglu	2959	RARI 5589	LC	27°02'00'' N, 88°05'07'' E
Artemisia vulgaris L.	Asteraceae	Herb	Kurseong	3014	RARI 5507	NE	26°53'43'' N, 88°18'11'' E
Arundina graminifolia (D.Don) Hochr.	Orchidaceae	Herb	Teesta Valley	3017	RARI5509	NE	27°00'43'' N, 88°25'30'' E
Asparagus racemosus Willd.	Asparagaceae	Herb	Sonada	2892	RARI 5590	NE	26°58'28'' N, 88°16'44'' E
Astilbe rivularis Buch. -Ham. ex D. Don	Saxifragaceae	Herb	Rimbick	2658	RARI 5571	NE	27°07'11'' N, 88°06'56'' E
Artocarpus lacucha Buch Ham.	Moraceae	Tree	Sonada	2904	RARI 5864	NE	26°57'25'' N, 88°16'38'' E
Azadirachta indica A.Juss.	Meliaceae	Tree	Chota Hatta	2660	RARI 5841	LC	27°04'41'' N, 88°07'34'' E
Barleria cristata L.	Acanthaceae	Herb	Relling	2530	RARI 5457	NE	27°03'15'' N, 88°09'46'' E

Bambusa bambos Willd	Poaceae	Herb	Upper Langurdang	2766	RARI 5861	NE	26°43'49'' N, 88°28'01'' E
Barleria prionitis L.	Acanthaceae	Herb	Relling	2513	RARI 5305	NE	27°03'28'' N, 88°08'13'' E
Begonia cathcartii Hook.f. & Thomson	Begoniaceae	Herb	Sonada	2889	RARI 5740	NE	26°58'28'' N, 88°16'44'' E
Begonia flaviflora H.Hara	Begoniaceae	Herb	Sonada	2906	RARI 5591	NE	26°58'23'' N, 88°16'39'' E
Begonia hatacoa Buch. -Ham. ex D.Don	Begoniaceae	Herb	Maneybhanjang	2923	RARI 5662	NE	27°03'02'' N, 88°07'05'' E
Begonia josephi A. DC.	Begoniaceae	Herb	Sonada	2905	RARI 5663	NE	26°58'23'' N, 88°16'39'' E
Begonia palmata D.Don	Begoniaceae	Herb	Kurseong	3013	RARI 5694	NE	26°54'16'' N, 88°17'33'' E
Begonia picta Sm.	Begoniaceae	Herb	Maneybhanjang	2916	RARI 5742	NE	27°03'03'' N, 88°07'12'' E
Begonia sikkimensis A. DC.	Begoniaceae	Herb	Takdah	2871	RARI 5745	NE	27°02'13'' N, 88°20'46'' E
Berberis angulosa Wall. exHook.f. & Thomson	Berberidaceae	Shrub	Tonglu	2950	RARI 5644	NE	27°02'04'' N, 88°05'14'' E
Berberis aristata DC.	Berberidaceae	Shrub	Tonglu	2963	RARI 5512	LC	27°02'04'' N, 88°05'14'' E
Berberis hookeri Lem.	Berberidaceae	Shrub	Tonglu	2965	RARI 5691	NE	27°01'54'' N, 88°05'03'' E
Berberis napaulensis (DC.) Spreng.	Berberidaceae	Shrub	Kurseong	3016	RARI 5747	NE	26°53'43'' N, 88°18'11'' E
Bergenia ciliata (Haw.) Sternb	Saxifragaceae	Herb	Dhotrey	2677	RARI 5481	LC	27°02'55'' N, 88°06'25'' E
Bidens pilosa L.	Asteraceae	Herb	Teesta Valley	2772	RARI 5746	NE	27°01'49'' N, 88°24'03'' E
Bistorta amplexicaulis (D.Don) Greene	Polygonaceae	Herb	Dhotrey	2933	RARI 5515	NE	27°03'00'' N, 88°06'33'' E
*Boehmeria virgata (*G.Forst.) Guill.	Urticaceae	Herb	Kurseong	3007	RARI 5748	LC	26°53'41'' N, 88°19'01'' E
Brugmansia suaveolens (Humb. & Bonpl. ex Willd.) Sweet	Solanaceae	Shrub	Sonada	2911	RARI 5749	EW	26°58'23'' N, 88°16'39'' E
Buddleja asiatica Lour.	Scrophulariaceae	Shrub	Mirik	2701	RARI 5606	LC	26°53'53'' N, 88°11'38'' E
Bulbophyllum leopardinum (Wall.) Lindl. ex Wall.	Orchidaceae	Herb	Takdah	2878	RARI 5518	LC	27°02'12'' N, 88°20'39'' E
Calanthe puberula Lindl.	Orchidaceae	Herb	Takdah	2864	RARI 5567	NE	27°02'15'' N, 88°27'45'' E
Callicarpa macrophylla Vahl	Lamiaceae	Shrub	Upper Langurdang	3002	RARI 5860	LC	26°52'40'' N, 88°18'43'' E
Calotropis gigantea (L.) W.T.Aiton	Apocynaceae	Shrub	Sonada	2909	RARI 5855	NE	26°57'27'' N, 88°16'45'' E
Campanula latifolia L.	Campanulaceae	Herb	Relling	2511	RARI 5751	NE	27°03'38 ''N, 88°08'19'' E
Cannabis sativa L.	Cannabaceae	Herb	Relling	2491	RARI 5615	NE	27°01'47'' N, 88°07'43'' E
Carica papaya L.	Caricaceae	Herb	Relling	2515	RARI 5841	DD	27°02'31'' N, 88°08'55'' E
Catharanthus roseus (L.) G.Don	Apocynaceae	Herb	Bijanbari	2981	RARI 5752	NE	27°03'46'' N, 88°25'12'' E
Cautleya spicata (Sm.) Baker	Zingiberaceae	Herb	Dhotrey	2929	RARI 5579	LC	27°03'00'' N, 88°06'33'' E
Centella asiatica (L.) Urb.	Apiaceae	Herb	Teesta Valley	2727	RARI 5754	LC	27°00'05'' N, 88°24'10'' E
Ceropegia pubescens Wall.	Apocynaceae	Climber	Kurseong	2987	RARI 5697	NE	26°54'20'' N, 88°17'30'' E
Chlorophytum nepalense (Lindl.) Baker	Asparagaceae	Herb	Dhotrey	2699.	RARI 5755	NE	27°03'05'' N, 88°06'31'' E

Cinchona pubescens Vahl	Rubiaceae	Tree	Mungpoo	2664	RARI 5699	LC	26°57'33'' N, 88°22'28'' E
Cirsium eriophoroides (Hook.f.) Petr.	Asteraceae	Herb	Tonglu	2962	RARI 5541	NE	27°02'04'' N, 88°05'14'' E
Cissampelos pareira L. var. hirsute (Buch.-Ham. ex DC.) Forman	Menispermaceae	Climber	Rimbick	2726	RARI 5756	NE	27°07'00'' N, 88°06'31'' E
Cissus quadrangularis L.	Vitaceae	Climber	Upper Langurdang	2712	RARI 5838	NE	26°44'22'' N, 88°27'37'' E
Citrus maxima (Burm.) Merr.	Rutaceae	Tree	Kurseong	2994	RARI 5698	LC	26°53'25'' N, 88°17'32'' E
Clematis buchananiana DC.	Ranunculaceae	Climber	Kurseong	3009	RARI 5596	NE	26°52'33'' N, 88°17'02'' E
Clematis tongluensis (Brühl) Tamura	Ranunculaceae	Climber	Tonglu	2947	RARI 5578	NE	27°02'16'' N, 88°05'40'' E
Clerodendrum japonicum (Thunb.) *Sweet*	Lamiaceae	Shrub	Bijanbari	2980	RARI 5757	LC	27°03'30'' N, 88°25'46'' E
Clinopodium umbrosum K.Koch	Lamiaceae	Herb	Relling	2540	RARI 5670	NE	27°02'11'' N, 88°08'46'' E
Codonopsis viridis Wall.	Campanulaceae	Climber	Bijanbari	2535	RARI 5701	NE	27°04'07'' N, 88°11'25'' E
Coffea arabica L.	Rubiaceae	Shrub	Teesta Valley	2723	RARI 5636	EN	27°06'01'' N, 88°24'12'' E
Commelina caroliniana Walter	Commelinaceae	Herb	Takdah	2874	RARI 5669	LC	27°02'13'' N, 88°20'46'' E
Commelina diffusa Burm.f.	Commelinaceae	Herb	Mungpoo	2662	RARI 5673	LC	26°59'37'' N, 88°20'43'' E
Commelina paludosa Blume	Commelinaceae	Herb	Takdah	2865	RARI 5668	NE	27°02'15'' N, 88°27'45'' E
Cotoneaster microphyllus Wall. ex Lindl.	Rosaceae	Shrub	Tonglu	2955	RARI 5524	NE	27°02'00'' N, 88°05'00'' E
Crepidium acuminatum (D.Don) Szlach.	Orchidaceae	Herb	Takdah	2869	RARI 5569	NE	27°02'1'' N, 88°20'32'' E
Crepidium khasianum (Hook.f.) Szlach.	Orchidaceae	Herb	Kurseong	2997	RARI 5543	NE	26°52'41'' N, 88°18'52'' E
Crepidium purpureum (Lindl.) Szlach.	Orchidaceae	Herb	Kurseong	2999	RARI 5545	NE	26°52'40'' N, 88°18'43'' E
Crotalaria alata Buch.-Ham. ex D.Don	Fabaceae	Herb	Kurseong	2991	RARI 5711	NE	26°54'29'' N, 88°18'23'' E
Crotalaria prostrata Roxb.	Fabaceae	Herb	Bijanbari	2503	RARI5288,	NE	27°04'21'' N, 88°11'08'' E
Curcuma caesia Roxb.	Zingiberaceae	Herb	Bichgaon	2765	RARI 5849	NE	27°00'29'' N, 88°15'34'' E
Curcuma longa L.	Zingiberaceae	Herb	Bijanbari	2984	RARI 5573	DD	27°04'26'' N, 88°24'10'' E
Curcuma zedoaria (Christm.) Roscoe	Zingiberaceae	Herb	Mungpoo	2661	RARI 5839	DD	26°58'21'' N, 88°22'48'' E
Cuscuta reflexa Roxb.	Convolvulaceae	Climber	Bijanbari	2977	RARI 5573	LC	27°03'46'' N, 88°25'12'' E
Cymbopogon flexuosus (Nees ex Steud.) Will.Watson	Poaceae	Herb	Mirik	2707	RARI 5628	NE	26°53'59'' N, 88°10'43'' E
Cynodon dactylon (L.) Pers.	Poaceae	Herb	Teesta Valley	2720	RARI 5760	NE	27°07'44'' N, 88°30'08'' E
Cyrtosia lindleyana Hook.f. & Thomson	Orchidaceae	Herb	Maneybhanjang	2922	RARI 5679	NE	27°03'02'' N, 88°07'05'' E
Daphne bholua Buch.-Ham. ex D. Don	Thymelaeaceae	Shrub	Dhotrey	2762	RARI 5582	NE	27°02'28'' N, 88°06'26'' E
Datura metel L.	Solanaceae	Shrub	Kurseong	3001	RARI 5761	NE	26°52'40'' N, 88°18'43'' E

Debregeasia longifolia (Burm.f.) Wedd.	Urticaceae	Shrub	Dhotrey	2769	RARI 5763	LC	27°02'28'' N, 88°05'27'' E
Desmodium confertum DC.	Fabaceae	Shrub	Relling	2499	RARI 5630	NE	27°02'38'' N, 88°08'33'' E
Desmodium gangeticum (L.) DC	Fabaceae	Herb	Bijanbari	2498	RARI 5282	NE	27°03'56'' N, 88°11'24'' E
Dicliptera chinensis (L.) Juss.	Acanthaceae	Herb	Rimbick	2756	RARI 5764	NE	27°07'13'' N, 88°7'22'' E
Didymocarpus albicalyx C.B.Clarke	Gesneriaceae	Herb	Sonada	2907	RARI 5616	NE	26°58'23'' N, 88°16'39'' E
Didymocarpus aurantiacus C.B.Clarke	Gesneriaceae	Herb	Kurseong	2993	RARI 5618	NE	26°53'25'' N, 88°17'32'' E
Didymocarpus mortonii C.B. Clarke	Gesneriaceae	Herb	Kurseong	2988	RARI 5620	NE	26°54'20'' N, 88°17'30'' E
Didymocarpus pedicellatus R.Br.	Gesneriaceae	Herb	Takdah	2885	RARI 5623	NE	27°02'08'' N, 88°19'30'' E
Dimetia scandens (Roxb.) R.J. Wang	Rubiaceae	Climber	Bara Hatta	2715	RARI 5765	NE	27°04'48'' N, 88°06'24'' E
Dobinea vulgaris Buch.-Ham ex D.Don	Polygonaceae	Shrub	Teesta Valley	2543	RARI 5766	NE	27°01'22'' N, 88°23'34'' E
Drymaria cordata (L.) Willd. ex Schult.	Caryophyllaceae	Herb	Bijanbari	2987	RARI 5712	NE	27°00'43'' N, 88°25'30'' E
Elatostema sessile J.R.Forst. & G.Forst.	Urticaceae	Herb	Tonglu	2943	RARI 5677	LC	27°02'23'' N, 88°05'51'' E
Elsholtzia blanda (Benth.) Benth.	Lamiaceae	Herb	Dhotrey	2696	RARI 5686	NE	27°02'23" N, 88°05'59" E
Engelhardia spicata Lechen. ex Blume	Juglandaceae	Tree	Maneybhanjang	2764	RARI 5640	LC	26°58'11'' N, 88°07'34'' E
Equisetum debile L.	Equisetaceae	Herb	Kurseong	2704	RARI 5842	LC	26°49'32'' N, 88°17'11'' E
Equisetum diffusum D.Don	Equisetaceae	Herb	Kurseong	3006	RARI 5767	NE	26°53'41'' N, 88°19'01'' E
Erythranthe nepalensis (Benth.) G.L.Nesom	Phrymaceae	Herb	Maneybhanjang	2914	RARI 5702	NE	27°01'07'' N, 88°05'47'' E
Evodia fraxinafolia Hook.f. & Benth.	Rutaceae	Tree	Rimbick	2682	RARI 5843	NE	27°07'05'' N, 88°06'38'' E
Exbucklandia populnea (R.Br. ex Griff.)	Hamamelidaceae	Tree	Kurseong	3005	RARI 5770	LC	26°53'41'' N, 88°19'01'' E
Fraxinus floribunda Wall.	Oleaceae	Tree	Chota Hatta	2670	RARI 5840	EN	27°04'59'' N, 88°06'46'' E
Galium hirtiflorum Req. ex DC.	Rubiaceae	Herb	Takdah	2877	RARI 5772	NE	27°02'12'' N, 88°20'39'' E
Geranium nepalense Sweet	Geraniaceae	Herb	Kurseong	3012	RARI 5774	NE	26°54'16'' N, 88°17'33'' E
Girardina diversifolia (Link) Friis	Urticaceae	Herb	Chota Hatta	2667	RARI 5844	NE	27°03'53'' N, 88°11'17'' E
Globba clarkei Baker	Zingiberaceae	Herb	Sonada	2901	RARI 5659	NE	26°58'33'' N, 88°16'45'' E
Gonostegia hirta (Blume) Miq.	Urticaceae	Herb	Bijanbari	2973	RARI 5775	NE	27°03'59 ''N, 88°10'50'' E
Goodyera hemsleyana King & Pantl.	Orchidaceae	Herb	Tonglu	2945	RARI 5539	NE	27°02'16'' N, 88°05'40'' E
Habenaria arietina Hook.f.	Orchidaceae	Herb	Maneybhanjang	2915	RARI 5558	NE	27°01'07'' N, 88°05'47'' E
Halenia elliptica D.Don	Gentianaceae	Herb	Tonglu	2961	RARI 5534	LC	27°01'59'' N, 88°05'07'' E
Hedychium coccineum Buch.-Ham. ex Sm.	Zingiberaceae	Herb	Kurseong	3000	RARI 5776	NE	26°52'40'' N, 88°18'43'' E

Hedychium gracile Roxb.	Zingiberaceae	Herb	Kurseong	2998	RARI 5777	NE	26°54'13'' N, 88°17'24'' E
Hellenia speciosa (J.Koenig) S.R.Dutta	Costaceae	Herb	Bijanbari	2976	RARI 5778	LC	26°54'20'' N, 88°17'30'' E
Helwingia himalaica Hook.f. & Thomson ex C.B.Clarke	Helwingiaceae	Shrub	Dhotrey	2937	RARI 5536	NE	27°02'23'' N, 88°05'51'' E
Hemiphragma heterophyllum Wall.	Plantaginaceae	Herb	Tonglu	2767	RARI 5703	NE	27°03'19" N, 88°14'01"E
Herminium clavigerum (Lindl.) X.H.Jin, Schuit., Raskoti & Lu Q.Huang	Orchidaceae	Herb	Rimbick	2925	RARI 5780	NE	27°03'02'' N, 88°07'05'' E
Herminium edgeworthii (Hook.f. ex-Collett) X.H.Jin, Schuit., Raskoti & Lu Q.Huang	Orchidaceae	Herb	Tonglu	2946	RARI 5531	NE	27°02'16'' N, 88°05'40'' E
Herminium lanceum (Thunb. ex Sw.) Vuijk	Orchidaceae	Herb	Maneybhanjang	2918	RARI 5600	NE	27°03'03'' N, 88°07'12'' E
Herminium latilabris (Lindl.) X.H.Jin, Schuit., Raskoti & Lu Q.Huang	Orchidaceae	Herb	Maneybhanjang	2924	RARI 5601	NE	27°03'02'' N, 88°07'05'' E
Herminium mackinnonii Duthie	Orchidaceae	Herb	Kurseong	3004	RARI 5602	NE	26°53'46'' N, 88°20'12'' E
Hibiscus × rosa-sinensis L.	Malvaceae	Shrub	Kurseong	3011	RARI 5781	NE	26°53'53'' N, 88°17'08'' E
Houttuynia cordata Thunb.	Saururaceae	Herb	Bijanbari	2969	RARI 5574	NE	27°03'59'' N, 88°10'50'' E
Hydrangea febrifuga (Lour.) Y.De Smet & Granados	Hydrangeaceae	Shrub	Sonada	2898	RARI 5593	NE	26°58'33'' N, 88°16'45'' E
Hydrangea robusta Hook. f. & Thomson	Hydrangeaceae	Shrub	Dhotrey	2672	RARI 5705	NE	27°02'50'' N, 88°06'35'' E
Hydrocotyle himalaica P.K.Mukh.	Araliaceae	Herb	Dhotrey	2930	RARI 5547	NE	27°03'00'' N, 88°06'33'' E
Hypericum himalaicum N.Robson	Hypericaceae	Herb	Maneybhanjang	2912	RARI 5713	NE	27°01'07'' N, 88°05'47'' E
Hypericum hookerianum Wight & Arn	Hypericaceae	Herb	Dhotrey	2932	RARI 5784	NE	27°03'00'' N, 88°06'33'' E
Hypericum uralum Buch.-Ham. ex D.Don	Hypericaceae	Herb	Dhotrey	2936	RARI 5587	NE	27°03'00'' N, 88°06'33'' E
Hypoestes phyllostachya Baker.	Acanthaceae	Herb	Bijanbari	2505	RARI 5293	NE	27°03'59'' N, 88°11'14'' E
Ipomoea purpurea (L.) Roth	Convolvulaceae	Climber	Sonada	2888	RARI 5785	NE	26°58'28'' N, 88°16'44.4'' E
Ipomoea triloba L.	Convolvulaceae	Climber	Relling	2527	RARI5313	LC	27°01'56'' N, 88°09'05'' E
Iris clarkei Baker ex Hook.f.	Iridaceae	Herb	Tonglu	2958	RARI 5847	NE	27°02'00'' N, 88°05'07'' E
Isodon repens (Wall. ex Benth.) Murata	Lamiaceae	Herb	Teesta Valley	2541	RARI 5786	NE	27°05'19'' N, 88°23'25'' E
Isodon scrophularioides (Wall. ex Benth.) Murata	Lamiaceae	Herb	Bijanbari	2537	RARI 5775	NE	27°03'54'' N, 88°11'27'' E
Jacobaea raphanifolia (Wall. ex DC.) B.Nord.	Asteraceae	Herb	Tonglu	2951	RARI 5787	NE	27°02'04'' N, 88°05'14'' E
Kaempferia rotunda L.	Zingiberaceae	Herb	Mirik	2686	RARI 5554	NE	26°53'58'' N, 88°10'33'' E

Kalanchoe ceratophylla Haw.	Crassulaceae	Herb	Relling	2760	RARI 5788	NE	27°02'22 ''N, 88°09'31'' E
Leucus lavandulifolia Sm.	Lamiaceae	Herb	Chota Hatta	2666	RARI5460	NE	27°05'04'' N, 88°06'43'' E
Lithospermum officinale L.	Boraginaceae	Herb	Tonglu	2942	RARI 5788	NE	27°02'23'' N, 88°05'51'' E
Litsea cubeba (Lour.) Pers.	Lauraceae	Tree	Bara Hatta	2671	RARI 5486	LC	27°04'26'' N, 88°05'34'' E
Lobelia montana Reinw. ex Blume	Campanulaceae	Herb	Relling	2534	RARI 5476	NE	27°02'33'' N, 88°08'51'' E
Lobelia numularia Reinw. ex Blume	Campanulaceae	Herb	Rimbick	2683	RARI 5640	NE	27°07'13'' N, 88°06'43'' E
Lobelia pyramidalis Wall.	Campanulaceae	Herb	Kurseong	3015	RARI 5792	NE	26°53'43'' N, 88°18'11'' E
Luculia pinceana Hook.	Rubiaceae	Tree	Relling	2494	RARI 5278	LC	27°01'55'' N, 88°08'35'' E
Lycopodium clavatum L.	Lycopodiaceae	Herb	Dhotrey	2674	RARI 5472	NE	27°03'01'' N, 88°06'37'' E
Lycopodium japonicum Thunb.	Lycopodiaceae	Herb	Bijanbari	2971	RARI 5793	NE	27°03'59'' N, 88°10'50'' E
Lysimachia laxa Baudo	Primulaceae	Herb	Sonada	2893	RARI 5794	NE	26°58'33'' N, 88°16'45'' E
Maianthemum oleraceum (Baker) LaFrankie	Asparagaceae	Herb	Tonglu	2941	RARI 5527	NE	27°02'23'' N, 88°05'51'' E
Melastoma malabathricum L.	Melastomataceae	Shrub	Bijanbari	2975	RARI 5655	NE	27°03'59'' N, 88°10'50'' E
Mentha spicata L.	Lamiaceae	Herb	Mungpoo	2663	RARI 5843	LC	26°59'22'' N, 88°21'00'' E
Mimosa diplotricha C. Wright. ex Sauvalle	Fabaceae	Herb	Relling	2528	RARI 5316	NE	27°02'06'' N, 88°09'03'' E
Mimosa pudica L.	Fabaceae	Herb	Teesta valley	3018	RARI 5594	LC	27°03'03'' N, 88°25'30'' E
Mimosa rubicaulis subsp. himalayana (Gamble) H.Ohashi	Fabaceae	Shrub	Kurseong	2995	RARI 5529	NE	26°53'25'' N, 88°17'32'' E
Monotropa uniflora L.	Ericaceae	Herb	Tonglu	2948	RARI 5576	NE	26 02'36'' N, 88°05'58'' E
Moringa oleifera Lam.	Moringaceae	Tree	Relling	2506	RARI 5850	LC	27°02'24'' N, 88°08'29'' E
Mussaenda frondosa L.	Rubiaceae	Shrub	Teesta Valley	2722	RARI 5651	LC	27°00'56'' N, 88°23'48'' E
Neillia thyrsiflora D.Don	Rosaceae	Shrub	Mirik	2705	RARI 5673	LC	26°53'54'' N, 88°10'40'' E
Neohymenopogon parasiticus (Wall.) Bennet	Rubiaceae	Shrub	Dhotrey	2935	RARI 5795	NE	27°03'00'' N, 88°06'33'' E
Nephrolepis cordifolia (L.) C.Presl	Polypodiaceae	Herb	Bijanbari	2974	RARI 5575	NE	27°03'59'' N, 88°10'50'' E
Nicandra physalodes (L.) Garten.	Solanaceae	Herb	Bijanbari	2501	RARI 5287	NE	27°04'00'' N, 88°09'40'' E
Nyctanthes arbor-tristis L.	Oleaceae	Shrub	Chota Hatta	2711	RARI 5854	LC	27°04'29'' N, 88°05'40'' E
Ocimum gratissimum L.	Lamiaceae	Herb	Maneybhanjang	2771	RARI 5648	NE	26°59'17'' N, 88°07'44'' E
Ocimum tenuiflorum L.	Lamiaceae	Herb	Mirik	2687	RARI 5854	NE	26°53'18'' N, 88°11'53'' E
Oenanthe thomsonii C.B.Clarke	Apiaceae	Herb	Sonada	2894	RARI 5671	NE	26°58'33'' N, 88°16'21'' E
Ophiopogon clarkei Hook.f.	Asparagaceae	Herb	Takdah	2875	RARI 5563	NE	27°02'12'' N, 88°20'39'' E

Ophiopogon intermedius D.Don	Asparagaceae	Herb	Takdah	2866	RARI 5565	NE	27°02'15'' N, 88°27'45'' E
Ophiorrhiza fasciculata D.Don	Rubiaceae	Herb	Sonada	2890	RARI 5599	NE	26°58'28'' N, 88°16'44'' E
Ophiorrhiza thomsonii Hook.f.	Rubiaceae	Herb	Takdah	2868	RARI 5649	NE	27°02'13'' N, 88°20'46'' E
Oroxylum indicum (L.) Benth. ex Kurz	Bignoniaceae	Tree	Takdah	2881	RARI 5848	LC	27°02'13'' N, 88°20'47'' E
Ototropis conferta (DC.) H.Ohashi & K.Ohashi	Fabaceae	Shrub	Teesta Valley	2542	RARI 5474	NE	27°06'04'' N, 88°23'01'' E
Oxalis latifolia Kunth	Oxalidaceae	Herb	Mirik	2703	RARI 5854	NE	26°53'04'' N, 88°11'04'' E
Oxyspora paniculata (D.Don) DC.	Melastomaceae	Shrub	Dhotrey	2763	RARI 5676	NE	27°02'23'' N, 88°05'55'' E
Panax pseudoginseng Wall.	Araliaceae	Herb	Tonglu	2960	RARI 5577	CR	27°01'59'' N, 88°05'07'' E
Paris polyphylla Sm.	Melanthiaceae	Herb	Tonglu	2944	RARI 5520	VU	27°02'16'' N, 88°05'40'' E
Pedicularis diffusa Prain	Orobanchaceae	Herb	Tonglu	2954	RARI 5549	NE	27°02'04'' N, 88°05'14'' E
Persicaria capitata (Buch.-Ham. ex D.Don) H.Gross	Polygonaceae	Herb	Dhotrey	2940	RARI 5796	NE	27°02'23'' N, 88°05'51'' E
Persicaria posumbu (Buch.-Ham. ex D.Don) H.Gross	Polygonaceae	Herb	Tonglu	2968	RARI 5798	NE	27°01'58'' N, 88°05'06'' E
Phanera vahlii (Wight & Arn.) Benth.	Caesalpiniaceae	Climber	Teesta valley	2665	RARI 5862	NE	27°01'46'' N, 88°25'06'' E
Phlomoides hamosa (Benth.) Mathiesen	Lamiaceae	Herb	Rimbick	2681	RARI 5779	NE	27°07'08'' N, 88°06'41''E
Physalis peruviana L.	Solanaceae	Herb	Bara Hatta	2724	RARI 5603	LC	27°06'17'' N, 88°05'51'' E
Phytolacca acinosa Roxb.	Phytolaccaceae	Herb	Dhotrey	2928	RARI 5799	NE	27°03'02'' N, 88°07'05'' E
Pilea anisophylla Wedd.	Urticaceae	Herb	Sonada	2903	RARI 5801	NE	26°58'33'' N, 88°16'45'' E
Pilea umbrosa Wedd. ex Blume	Urticaceae	Herb	Sonada	2908	RARI 5802	NE	26°58'23'' N, 88°16'39'' E
*Piptanthus nepalensis (*Hook.) Sweet	Fabaceae	Shrub	Bijanbari	2979	RARI 5803	NE	27°03'46'' N, 88°25'12'' E
Plantago asiatica L.	Plantaginaceae	Herb	Bijanbari	2970	RARI 5578	NE	27°03'59'' N, 88°10'50'' E
Pleione hookeriana (Lindl.) Rollisson	Orchidaceae	Herb	Tonglu	2964	RARI 5722	NE	27°01'54'' N, 88°05'03'' E
Plumbago zeylanica L.	Plumbaginaceae	Herb	Relling	2529	RARI 5804	NE	27°02'47'' N, 88°05'09'' E
Potentilla anseria (L.) Rydb.	Rosaceae	Herb	Relling	2512	RARI 5634	NE	27°03'08'' N, 88°07'40'' E
Pouzolzia sanguinea (Blume) Merr.	Urticaceae	Herb	Teesta Valley	2725	RARI 5857	NE	27°05'11'' N, 88°24'10'' E
Prunella vulgaris L.	Lamiaceae	Herb	Dhotrey	2931	RARI 5654	LC	27°03'00'' N, 88°06'33'' E
Prunus cerasoides D.Don	Rosaceae	Tree	Relling	2533	RARI 5320	NE	27°02'43'' N, 88°09'37'' E
Psidium guajava L.	Myrtaceae	Tree	Teesta valley	3020	RARI 5852	LC	27°00'43'' N, 88°25'30'' E
Pteris biaurita L.	Pteridaceae	Herb	Bijanbari	2538	RARI 5837	NE	27°02'41'' N, 88°09'42'' E
Quercus lamellosa Sm.	Fagaceae	Tree	Dhotrey	2679	RARI 5856	NT	27°02'33'' N, 88°06'41'' E
Reinwardtia indica Dumort.	Linaceae	Shrub	Relling	2531	RARI 5806	NE	27°02'39'' N, 88°09'34'' E

Rheum acuminatum Hook.f. & Thomson	Polygonaceae	Herb	Dhotrey	2934	RARI 5521	NE	27°03'00'' N, 88°06'33'' E
Rheum australe D.Don	Polygonaceae	Herb	Tonglu	2761	RARI 5807	DD	27°01'46'' N, 88°05'20'' E
Richardia scabra L.	Rubiaceae	Herb	Bijanbari	2972	RARI 5808	NE	27°03'59'' N, 88°10'50'' E
Ricinus communis L.	Euphorbiaceae	Shrub	Teesta Valley	2546	RARI 5479	LC	27°05'33'' N, 88°22'22'' E
Rosa macrophylla Lindl	Rosaceae	Shrub	Bara Hatta	2668	RARI 5468	NE	27°04'50'' N, 88°06'26'' E
Rosa sericea Lindl.	Rosaceae	Shrub	Upper Relling	2536	RARI 5480	NE	27°04'03" N, 88°12'20"E
Rubia cordifolia L.	Rubiaceae	Climber	Rimbick	2926	RARI 5638	NE	27°03'02'' N, 88°07'05'' E
Rubia sikkimensis Kurz	Rubiaceae	Climber	Lamahatta	2770	RARI 5490	NE	27°03'41'' N, 88°21'25'' E
Rubus calycinoides Kuntze	Rosaceae	Shrub	Sonada	2899	RARI 5610	NE	26°58'33'' N, 88°16'45'' E
Rubus ellipticus Sm	Rosaceae	Shrub	Bijanbari	2691	RARI5522	LC	27°04'26'' N, 88°24'10'' E
Rubus gothicus Frid. & Gelert	Rosaceae	Shrub	Rimbick	2689	RARI 5809	NE	27°07'27'' N, 88°06'19'' E
Rubus kumaonensis N.P.Balakr.	Rosaceae	Shrub	Dhotrey	2673	RARI 5487	NE	27°02'45'' N, 88°06'04'' E
Rubus paniculatus Sm.	Rosaceae	Shrub	Sonada	2896	RARI 5609	NE	26°58'33'' N, 88°16'45'' E
Rubus splendidissimus H.Hara	Rosaceae	Shrub	Dhotrey	2695	RARI 5612	NE	27°02'39'' N, 88°06'15'' E
Rubus treutleri Hook.f.	Rosaceae	Shrub	Rimbick	2927	RARI 5810	NE	27°03'02'' N, 88°07'05'' E
Rumex nepalensis Spreng.	Polygonaceae	Herb	Bijanbari	2986	RARI 5682	NE	27°04'26'' N, 88°24'10'' E
Rungia pectinata (L.) Nees.	Acanthaceae	Herb	Relling	2507	RARI 5297	NE	27°02'46'' N, 88°07'58'' E
Sarcopyramis napalensis Wall.	Melastomataceae	Herb	Takdah	2886	RARI 5811	NE	27°02'8,5'' N, 88°19'30.9'' E
Satyrium nepalense var. nepalense	Orchidaceae	Herb	Dhotrey	2693	RARI 5604	NE	27°02'41" N 88° 06'12"E
Schima wallichii (DC.) Korth.	Theaceae	Tree	Kurseong	3010	RARI 5812	LC	26°53'53'' N, 88°17'08'' E
Schisandra grandiflora (Wall.) Hook.f. & Thomson	Schisandraceae	Climber	Tonglu	2953	RARI 5813	NE	27°02'04'' N, 88°05'14'' E
Scutellaria discolor Wall. ex Benth.	Lamiaceae	Herb	Takdah	2887	RARI 5592	NE	27°02'8,5'' N, 88°19'30.9'' E
Scutellaria repens Buch.Ham.ex D.Don	Lamiaceae	Herb	Bijanbari	2504	RARI 5290	NE	27°04'08" N 88° 11'42"E
Sida cordifolia L.	Malvaceae	Herb	Dhotrey	2676	RARI 5720	NE	27°02'56'' N, 88°06'51'' E
Sohmaea laxiflora (DC.) H.Ohashi & K.Ohashi	Fabaceae	Shrub	Teesta Valley	2719	RARI 5709	NE	27°07'44'' N, 88°30'08'' E
Solanum laxum Spreng.	Solanaceae	Climber	Kurseong	2989	RARI 5814	NE	26°54'29'' N, 88°18'23'' E
Solanum nigrum L.	Solanaceae	Herb	Bijanbari	2982	RARI 5816	NE	27°04'26'' N, 88°24'10'' E

Sonchus oleraceus L.	Asteraceae	Herb	Relling	2495	RARI 5818	NE	27°02'34'' N, 88°09'30'' E
Streptolirion volubile Edgew.	Commelinaceae	Climber	Maneybhanjang	2657	RARI 5820	NE	27°02'41'' N, 88°09'42'' E
Swertia angustifolia Buch. -Ham. ex D.Don	Gentianaceae	Herb	Upper Relling	2509	RARI 5303	NE	27°02'15'' N, 88°07'56'' E
Swertia bimaculata (Siebold & Zucc.) Hook.f. & Thomson ex C.B.Clarke	Gentianaceae	Herb	Maneybhanjang	2921	RARI 5595	NE	27°03'03'' N, 88°08'17'' E
Swertia chirayita (Roxb.) H. Karst.	Gentianaceae	Herb	Bara Hatta	2710	RARI 5822	CR	27°04'34'' N, 88°06'11'' E
Synotis cappa Buch.-Ham. ex D.Don	Asteraceae	Shrub	Teesta Valley	2545	RARI 5674	NE	27°01'13'' N, 88°24'43'' E
Tabernaemontana divaricata (L.) R.Br. ex Roem. & Schult	Apocynaceae	Shrub	Relling	2757	RARI 5855	NE	27°02'33'' N, 88°08'37'' E
Taxus wallichiana Zucc.	Taxaceae	Tree	Dhotrey	2773	RARI 5491	EN	27°02'53'' N, 88°06'18'' E
Tetrataenium nepalense (D.Don) Manden.	Apiaceae	Herb	Dhotrey	2678	RARI 5683	NE	27°02'22'' N, 88°07'31'' E
Thalictrum chelidonii DC.	Ranunculaceae	Herb	Tonglu	2952	RARI 5642	NE	27°02'04'' N, 88°05'14'' E
Thalictrum foliolosum DC.	Ranunculaceae	Herb	Dhotrey	2938	RARI 5723	NE	27°02'23'' N, 88°05'51'' E
Thunbergia coccinea Wall. ex D.Don	Acanthaceae	Climber	Maneybhanjang	2919	RARI 5823	NE	27°03'03'' N, 88°07'12'' E
Thunbergia fragrans Roxb.	Acanthaceae	Climber	Bijanbari	2978	RARI 5717	NE	27°03'46'' N, 88°25'12'' E
Thunbergia lutea T.Anderson	Acanthaceae	Climber	Relling	2684	RARI 5825	NE	27°03'41'' N, 88°11'03'' E
Thysanolaena latifolia (Roxb. ex Hornem.) Honda	Poaceae	Herb	Bichgaon	2700	RARI 5859	NE	27°00'50'' N, 88°15'30'' E
Torenia bicolor Dalzell	Linderniaceae	Herb	Sonada	2900	RARI 5716	LC	26°58'33'' N, 88°16'45'' E
Tripterospermum volubile (D.Don) H.Hara	Gentianaceae	Climber	Relling	2759	RARI 3720	NE	27°03'17'' N, 88°10'23'' E
Triumfetta rhomboidea Jacq.	Malvaceae	Shrub	Rimbick	2655	RARI 5667	NE	27°06'38'' N, 88°07'06'' E
Tropaeolum majus L.	Tropaeolaceae	Herb	Kurseong	2992	RARI 5827	NE	26°54'29'' N, 88°18'23'' E
Tupistra nutans Wall. ex Lindl	Asparagaceae	Herb	Bara Hatta	2713	RARI 5827	NE	27°05'20'' N, 88°05'41'' E
Urena lobata L.	Malvaceae	Herb	Relling	2516	RARI 5310	LC	27°02'21'' N, 88°08'55'' E
Urtica ardens Link	Urticaceae	Herb	Upper Langurdang	2717	RARI 5828	NE	26°44'12'' N, 88°28'33'' E

Urtica parviflora Roxb.	Urticaceae	Herb	Rimbick	2755	RARI 5863	NE	27°07'14'' N, 88°06'20'' E
Utricularia striatula Sm.	Lentibulariaceae	Herb	Kurseong	2996	RARI 5830	LC	26°52'41'' N, 88°18'52'' E
Viburnum nervosum D.Don	Viburnaceae	Shrub	Takdah	2883	RARI 5832	LC	27°01'52'' N, 88°20'7.9'' E
Vigna umbellata (Thunb.) Ohwi & H.Ohashi	Fabaceae	Climber	Upper Langurdang	2718	RARI 5833	NE	26°42'32'' N, 88°25'41'' E
Viola pilosa Blume	Violaceae	Herb	Sonada	2891	RARI 5721	NE	26°58'28.5'' N, 88°16'44.4''E
Viscum articulatum Burm.f.	Santalaceae	Shrub (hemiparasitic)	Dhotrey	2768	RARI 5834	NE	27°03'00'' N, 88°06'40'' E
Zingiber officinale Roscoe	Zingiberaceae	Herb	Relling	2685	RARI 5855	DD	27°03'36'' N, 88°08'29'' E

NE: Not Evaluated; LC: Least Concern; EN: Endangered; CR: Critically Endangered; DD: Data Deficient.

Table 2. Floristic diversity indices by site

Location	Shannon index (H')	Simpson index (D)	Margalef (d)	Species richness
Dhotrey	4.189655	0.984848	15.514405	66
Kurseong	4.691348	0.990826	23.021102	109
Relling	4.691348	0.990826	23.021102	109
Bijanbari	4.543295	0.989362	20.469726	94
Tonglu	3.688879	0.975	10.572316	40
Takdah	4.543295	0.989362	20.469726	94
Sonada	4.418841	0.987952	18.556904	83
Maneybhanjang	3.7612	0.976744	11.166649	43
Rimbick	4.143135	0.984127	14.964515	63
Teesta Valley	4.59512	0.989899	21.326974	99
Mirik	4.477337	0.988636	19.431194	88
Upper Langurdang	4.007333	0.981818	13.475296	55
Chota Hatta	3.828641	0.978261	11.753517	46
Mungpoo	4.356709	0.987179	17.673892	78
Bara Hatta	4.248495	0.985714	16.241044	70
Upper Relling	4.127134	0.983871	14.780231	62
Bichgaon	3.806662	0.977778	11.558682	45
Lamahatta	4.025352	0.982143	13.663402	56

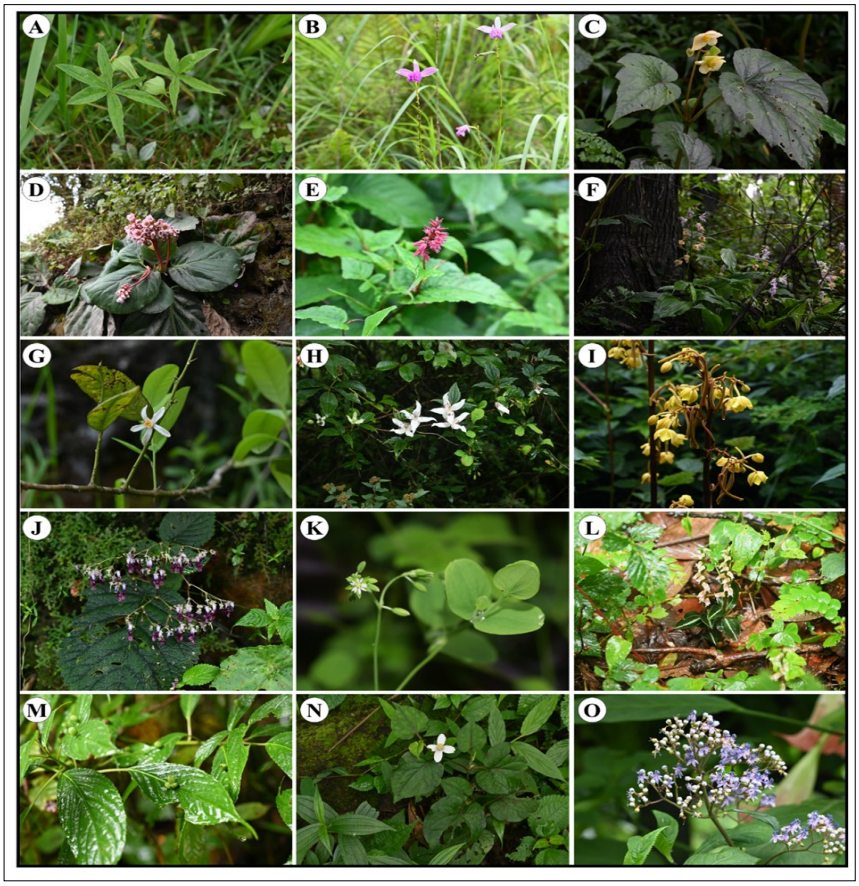


Fig. 2. Selected plant species documented across various ecological zones of the Darjeeling Himalaya. (A) *Arisaema jacquemontii* Blume; (B) *Arundina graminifolia* (D. Don) Hochr.; (C) *Begonia flaviflora* H.Hara; (D) *Bergenia ciliata* (Haw.) Sternb.; (E) *Bistorta amplexicaulis* (D.Don) Greene; (F) *Calanthe puberula* Lindl.; (G) *Citrus maxima* (Burm.) Merr.; (H) *Clematis tongluensis* (Brühl) Tamura; (I) *Cyrtosia lindleyana* Hook.f. & Thomson; (J) *Didymocarpus albicalyx* C.B. Clarke; (K) *Drymaria cordata* (L.) Willd. ex Schult.; (L) *Goodyera hemsleyana* King & Pantl.; (M) *Helwingia himalaica* Hook.f. & Thomson ex C.B.Clarke; (N) *Houttuynia cordata* Thunb.; (O) *Hydrangea febrifuga* (Lour.)Y. De Smet & Granados.

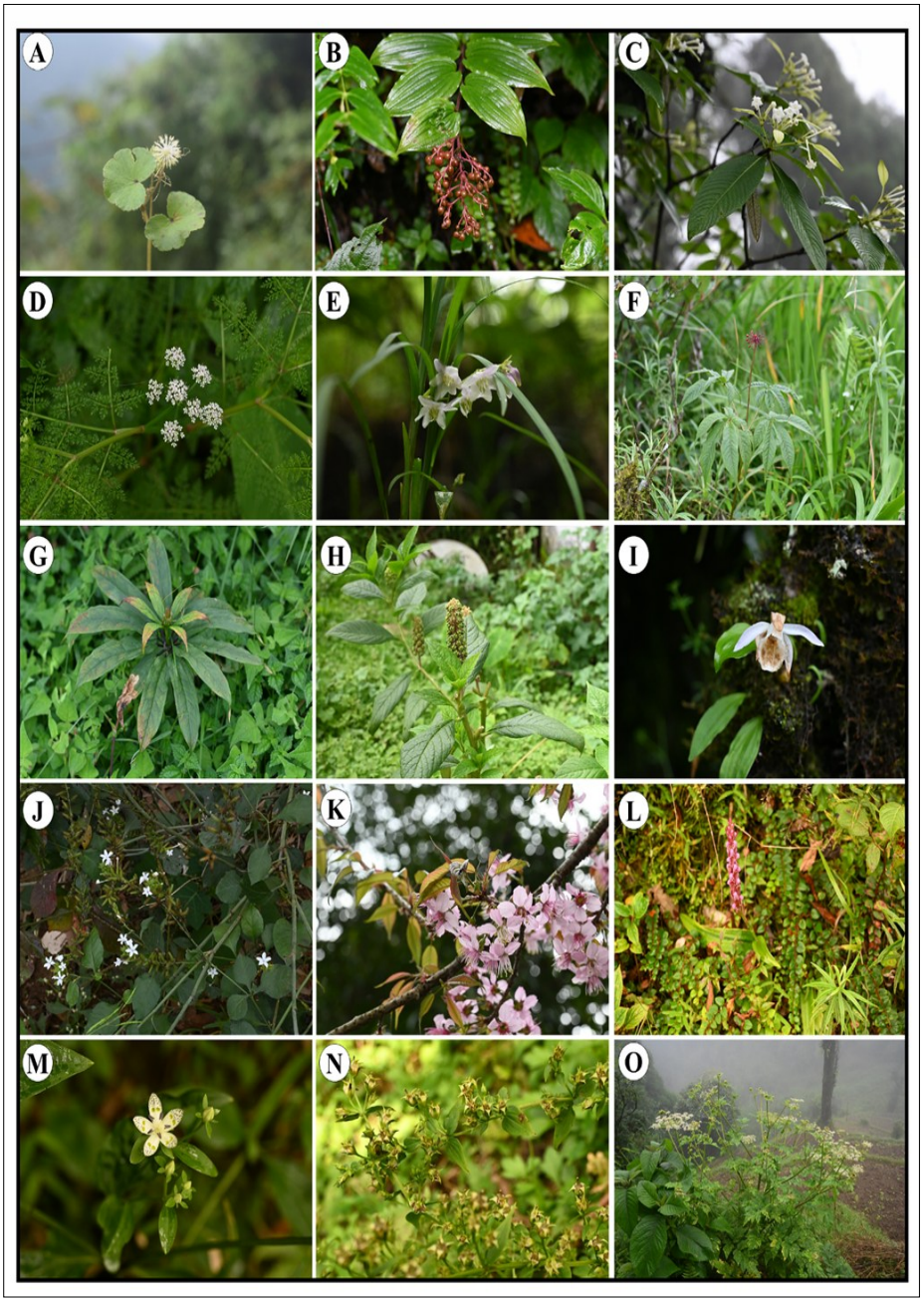


Fig. 3. Additional selected plant species documented from distinct ecological zones of the Darjeeling Himalaya. (A) *Hydrocotyle himalaica* P.K. Mukh; (B) *Maianthemum oleraceum* (Baker) LaFrankie; (C) *Neohymenopogon parasiticus* (Wall.) Bennet; (D) *Oenanthe thomsonii* C.B. Clarke; (E) *Ophiopogon intermedius* D.Don; (F) *Panax pseudoginseng* Wall.; (G) *Paris polyphylla* Sm.; (H) *Phytolacca acinosa* Roxb.; (I) *Pleione hookeriana* (Lindl.) Rollisson; (J) *Plumbago zeylanica* L.; (K) *Prunus cerasoides* D.Don; (L) *Satyrium nepalense* var. *nepalense*; (M) *Swertia bimaculata* (Siebold & Zucc.) Hook.f. & Thomson ex C.B. Clarke; (N) *Swertia chirayita* (Roxb.) H.Karst.; (O) *Tetrataenium nepalense* (D.Don) Manden.

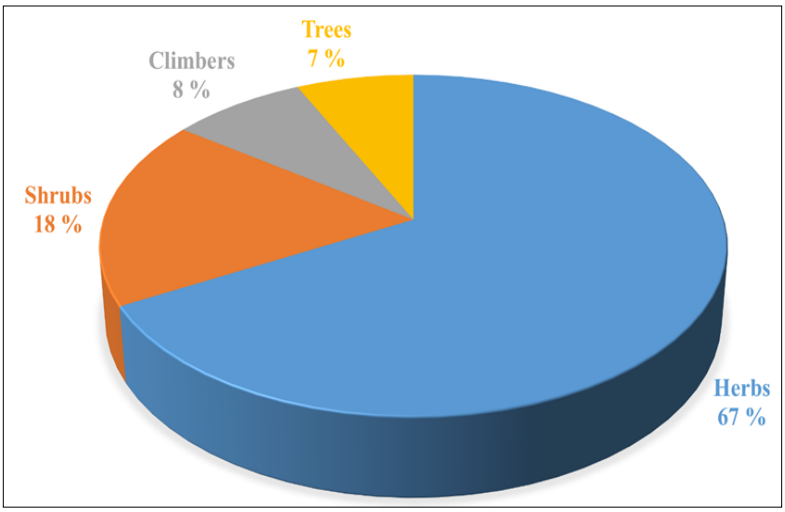


Fig. 4. Graphical representation of the growth habits of the documented plant species.

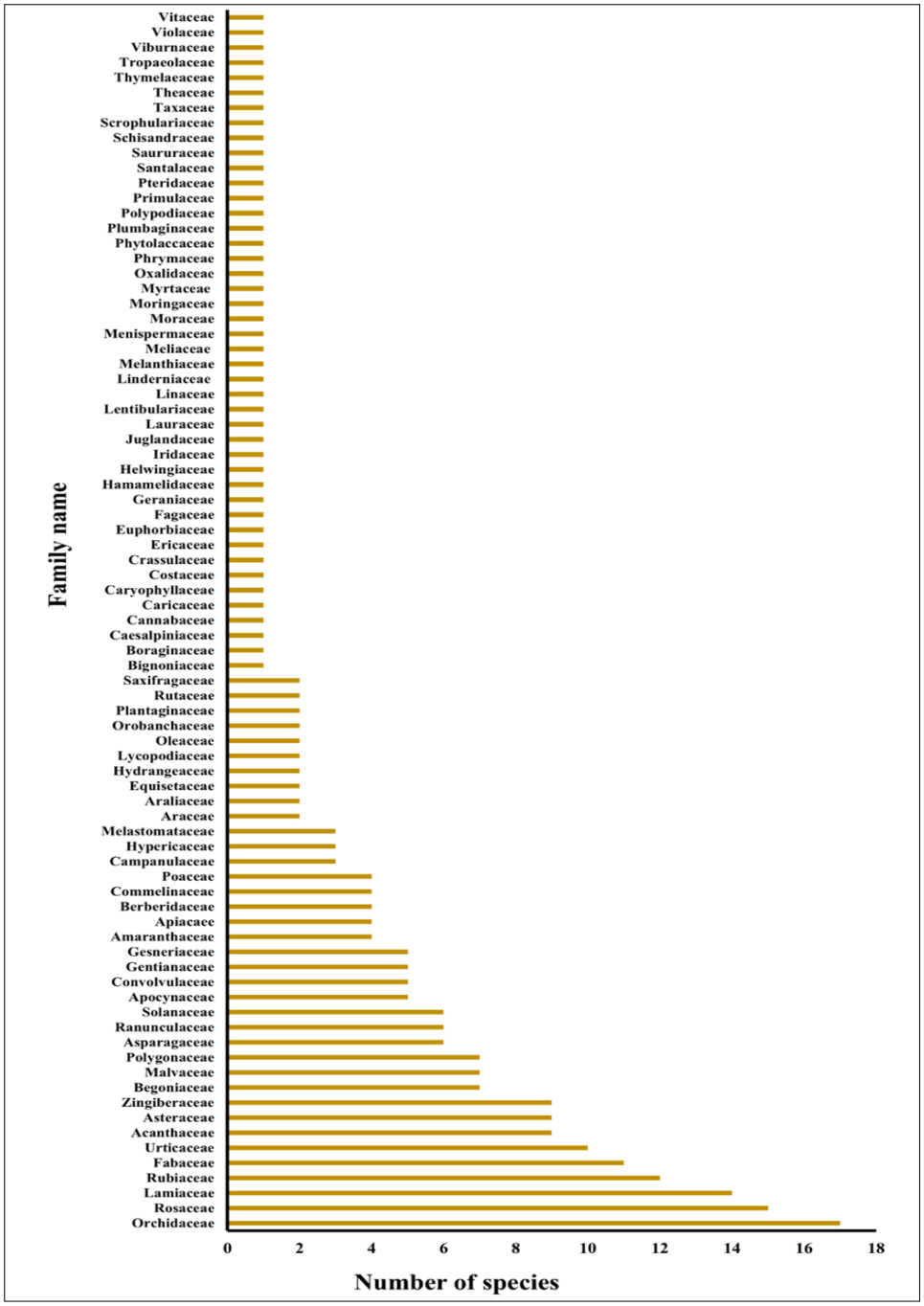
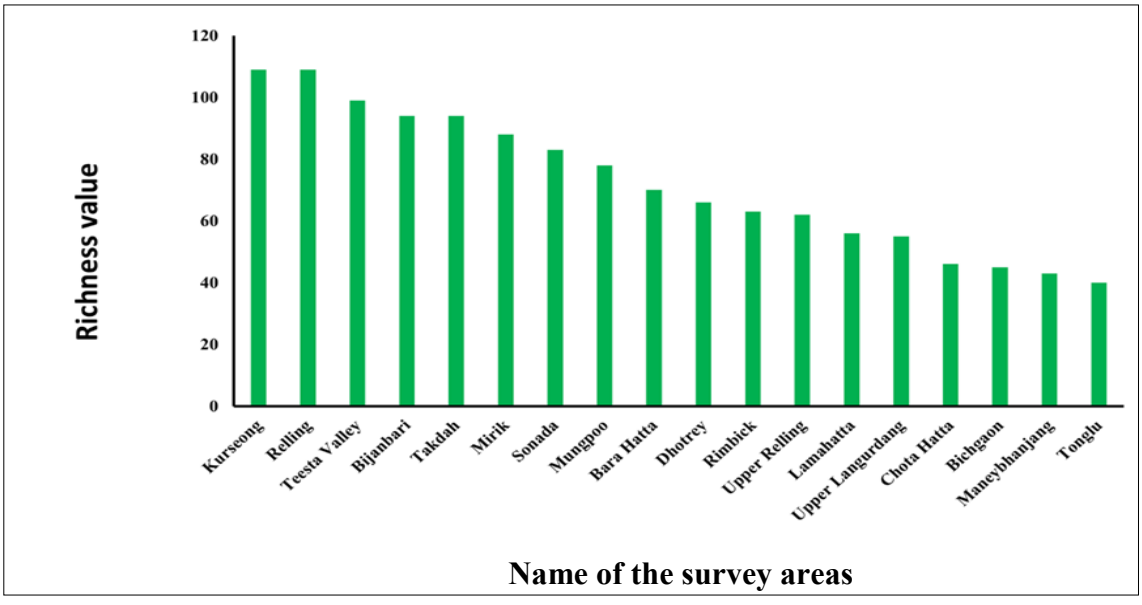


Fig. 5. Graphical representation of plant families and the corresponding number of documented species.



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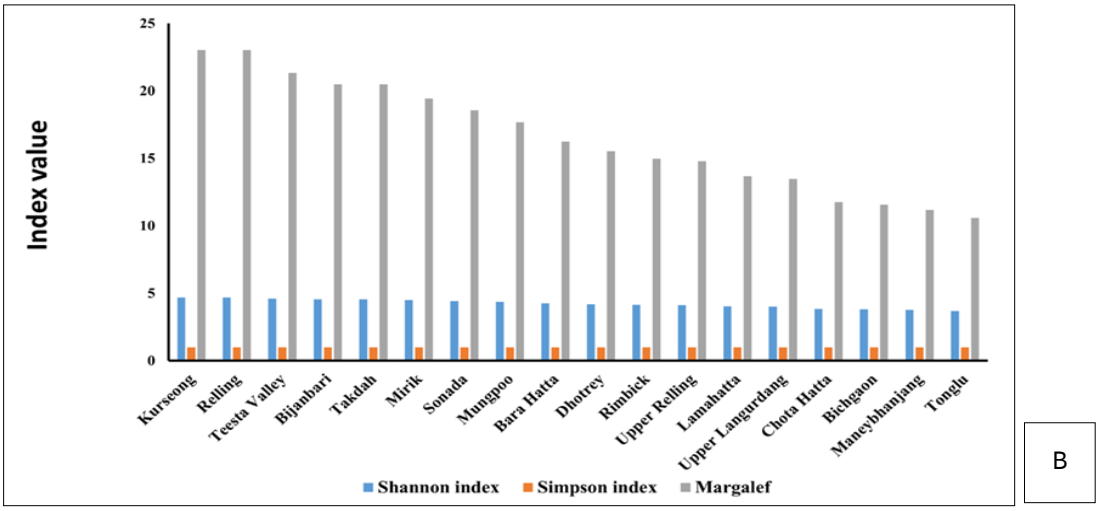

Fig. 6. Bar graphs showing (A) species richness and (B) diversity indices (Shannon, Simpson and Margalef) across the study area.

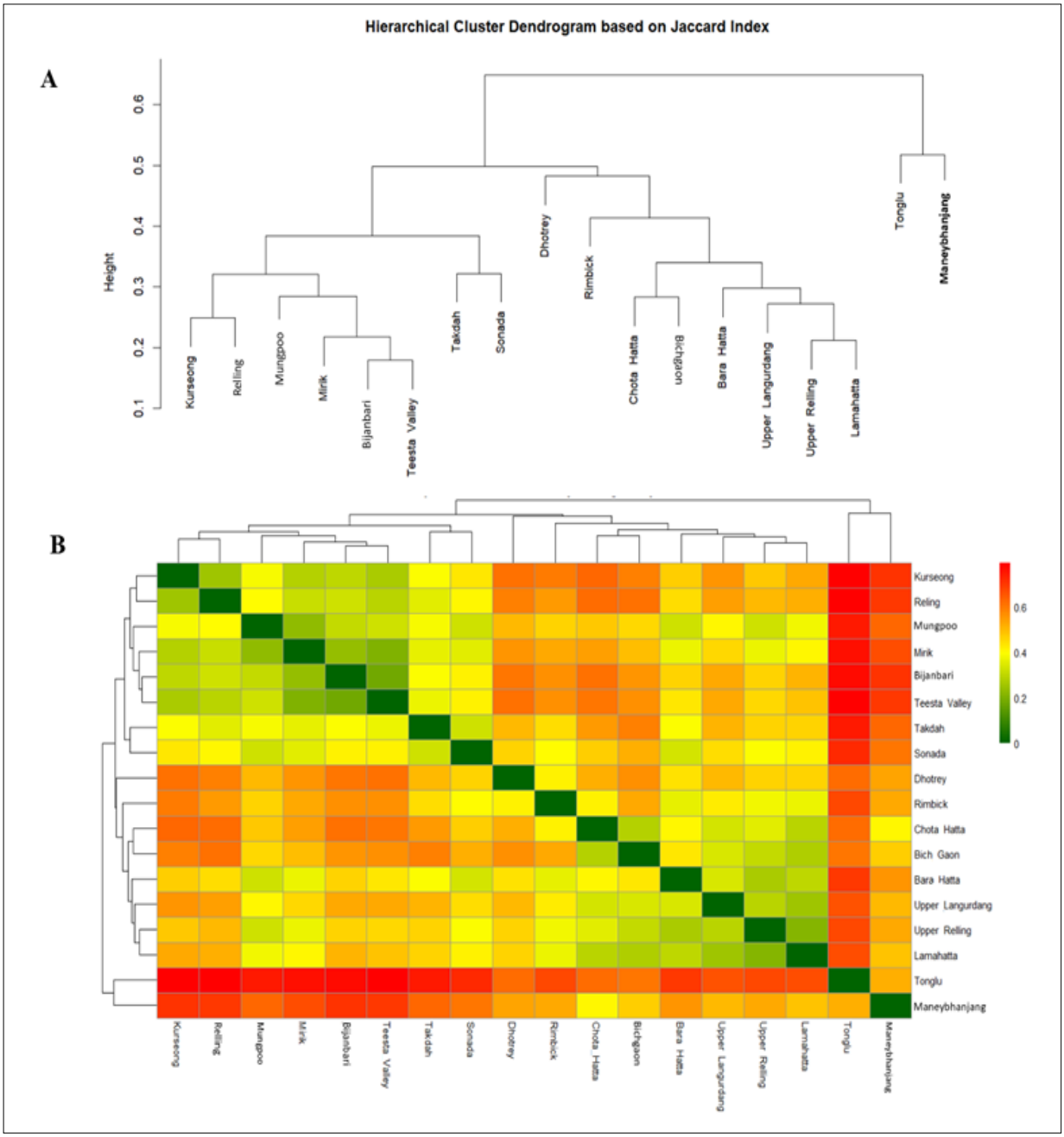

Fig. 7. Floristic relationships among study sites based on Jaccard dissimilarity derived from presence–absence data. (A) UPGMA dendrogram illustrating clustering of ecologically similar sites and the clear separation of high-elevation locations; (B) heatmap of pairwise Jaccard dissimilarity (βjac), where warmer colors indicate higher compositional dissimilarity, reflecting spatial variation in floristic composition along the elevational gradient.

Table 3. List of endemic species in the Darjeeling Himalaya

Sl. No.	Name	Altitudinal range (m)	Habitat	IUCN status
1.	*Aconitum arunii* P.Agnihotri, D.Husain & T.Husain	2000–3500	Montane slopes	LC
2.	*Aconitum heterophyllum* Wall. ex Royle	2300–3500	Subalpine grassy slopes, meadows, open humus-rich slopes and forest edges	LC
3.	*Didymocarpus albicalyx* C.B.Clarke	1000–2000	Humid montane biomes; subshrub on moist habitats	NE
4.	*Didymocarpus aurantiacus* C.B.Clarke	1000–2000	Humid forest margins, moist shady sites	NE
5.	*Didymocarpus mortonii* C.B.Clarke	~1550	Wet evergreen to moist montane banks, shaded rocky and loamy banks	NE
6.	*Didymocarpus pedicellatus* R.Br.	500–2000	Moist shaded banks, rocky humus-rich banks	NE
7.	*Galium hirtiflorum* Req. ex DC.	1200–2200	Montane woodland margins, grassy slopes	NE
8.	*Herminium clavigerum* (Lindl.) X.H.Jin, Schuit., Raskoti & Lu Q.Huang	2000–3000	Terrestrial orchid in subalpine montane grasslands and shady slopes	NE
9.	*Herminium mackinonii* Duthie	1100–3500	Terrestrial orchid in montane meadows, grassy slopes and forest edges	NE
10.	*Swertia chirayita* (Roxb.) H.Karst.	1200–2800	Temperate shady slopes	CR
11.	*Thalictrum chelidonii* DC.	~2300–3600	Forests and shrubberies in alpine margins	NE

NE: Not Evaluated; LC: Least Concern; CR: Critically Endangered.

compositional structuring along elevation gradients.

The species turnover component (β_{jtu}) exhibited consistently high values across most site pairs, indicating that species replacement is the primary driver of beta diversity in the study region (Supplementary Table 4). Very high turnover was observed between Tonglu and most other sites ($\beta_{jtu} \approx 0.80–0.90$), reflecting a highly distinct species assemblage. In contrast, low turnover values were recorded between Kurseong–Bichgaon (0.04) and Mirik–Bichgaon (0.04), suggesting strong floristic similarity among these sites. The dominance of β_{jtu} over nestedness confirms that spatial variation in plant communities is mainly governed by species substitution rather than simple species loss or gain.

The nestedness component of beta diversity (β_{jne}) showed generally low to moderate values across most site pairs, indicating that species replacement rather than nested species loss was the dominant process structuring community dissimilarity. Very low β_{jne} values were observed between several closely related sites (e.g., Kurseong–Relling, Bijanbari–Takdah), suggesting minimal nestedness effects. In contrast, relatively higher nestedness values were recorded for site pairs involving Bichgaon, Chota Hatta and Upper Langurdang, reflecting localised subsets of species within the regional flora (Supplementary Table 5). This pattern suggests that variation in species composition across sites was primarily driven by species replacement rather than the nested loss or gain of species.

Site contribution to beta diversity values varied across the study area, which indicates unequal contributions of individual sites to overall compositional heterogeneity. The highest SCBD values were recorded for Dhotrey (0.104) and Tonglu (0.101), followed by Kurseong (0.094), suggesting these sites harbour more distinct species assemblages. In contrast, Bichgaon (0.015) and Lamahatta (0.020) showed the lowest contributions, indicating relatively higher floristic similarity with other sites (Supplementary Table 6).

Pairwise floristic similarity among the study sites, assessed using Sørensen's similarity coefficient, revealed moderate to high overlap in species composition (Supplementary Table 7). Similarity values ranged from 0.12 to 0.83, indicating pronounced spatial heterogeneity across the Darjeeling Himalaya. The highest floristic similarity was observed between Teesta Valley and Mirik (S = 0.834), followed by Upper Relling and Lamahatta (S = 0.814) and Upper Relling and Bichgaon (S = 0.804), suggesting strong compositional resemblance among geographically or ecologically proximate sites. In contrast, Tonglu consistently exhibited low similarity with most locations (S = 0.119–0.34), reflecting distinct species composition likely associated with higher elevation and unique environmental conditions.

Non-metric multidimensional scaling, permutational multivariate analysis of variance and environmental determinants of community structure

NMDS ordination based on Jaccard dissimilarity showed clear site grouping along environmental gradients (Supplementary Fig. 1). The plot illustrates distinct clustering of sites across low-, mid- and high-altitude zones (NMDS1 = −0.753, NMDS2 = −0.658, $r^2 = 0.784$, $p = 0.001$), indicating that altitude plays an important role in shaping species composition. Mean temperature also influenced community patterns (NMDS1 = 0.614, NMDS2 = 0.789, $r^2 = 0.896$, $p = 0.001$), whereas precipitation had little effect ($r^2 = 0.033$, $p = 0.779$) on site distribution in the ordination space (Supplementary Table 8).

Permutational multivariate analysis of variance analysis confirmed that species composition differed significantly among altitude zones (adonis2: $F = 3.47$, $R^2 = 0.316$, $p = 0.001$), indicating that approximately 31.6 % of the variation in beta diversity was explained by altitudinal stratification. When continuous environmental variables were considered together, the combined model including altitude, mean temperature and precipitation was also significant ($F = 2.94$, $R^2 = 0.387$, $p = 0.002$). However, analysis of multivariate dispersion revealed significant heterogeneity among altitude zones (betadisper ANOVA: $F = 10.95$, $p = 0.001$), suggesting that observed differences in community composition reflected both shifts in group centroids and variation in within-zone compositional heterogeneity (Supplementary Table 9–11).

Species richness showed a significant negative correlation with altitude (Pearson $r = -0.697$; Spearman $p = -0.733$) and a significant positive correlation with mean temperature (Pearson $r = 0.619$; Spearman $p = 0.659$), while precipitation exhibited no meaningful correlation with richness (Pearson $r = 0.047$) (Supplementary Table 12, 13). Simple linear regression indicated that species richness declined significantly with increasing altitude ($\beta = -0.0268$, $t = -3.89$, $p = 0.001$; $R^2 = 0.486$) and increased with temperature ($\beta = 4.38$, $t = 3.15$, $p = 0.006$; $R^2 = 0.383$), whereas precipitation had no significant effect ($p = 0.853$) (Supplementary Table 14). In the multiple regression model including

altitude and precipitation, altitude remained a significant predictor of species richness (β = -0.0276, t = −3.92, p = 0.001), while precipitation remained non-significant (p = 0.428), with the model explaining 50.7 % of the variance in species richness (Adjusted R^2 = 0.403) (Supplementary Table 15, 16). Species richness declines with increasing altitude and increases with mean annual temperature, whereas precipitation exerts a negligible effect (Fig. 8A and B). The VIF analysis indicated low to moderate multicollinearity among the environmental predictors (Supplementary Table 17). Altitude (VIF = 5.05) and mean temperature (VIF = 4.95) showed moderate collinearity but remained within acceptable limits, whereas precipitation exhibited a very low VIF value (1.09), indicating minimal multicollinearity and a largely independent contribution to the model.

Endemic plants

In the Darjeeling Hills, part of the Eastern Himalaya and a global biodiversity hotspot, plant diversity is supported by the region's varied landscape, wide altitudinal range and diverse climate. Previous studies have documented 237 plant species belonging to 126 genera across 17 families, growing at elevations ranging from 1500 to 2400 m in the Darjeeling Himalayas, highlighting the presence of 75 endemic species within this group (2). Later, a comprehensive list of 222 endemic and endangered plant species from the region was compiled, comprising 183 dicotyledonous and 39 monocotyledonous taxa. Among these, 14 species (6.25 %) were found to be strictly endemic to the Darjeeling region (2). In another study, 16 plant species were recorded as narrowly endemic or rare species from Darjeeling (2), followed by 9 monocotyledonous plant species from the Darjeeling and Sikkim Himalayas, which were documented as endemic (11). This study in the Darjeeling Hills revealed the presence of 11 endemic or regionally restricted plant species. *Aconitum arunii* P.Agnihotri, D.Husain & T.Husain, strictly endemic to the Eastern Himalaya, was among the most noteworthy. *Aconitum heterophylloides* (Brühl) Stapf, with a limited range across Jammu & Kashmir, Himachal Pradesh, Nepal, Bhutan and Sikkim, was identified within the surveyed habitats, reinforcing its regional endemism. Several species of *Didymocarpus* contributed to the diversity, including *Didymocarpus albicalyx* C.B. Clarke and

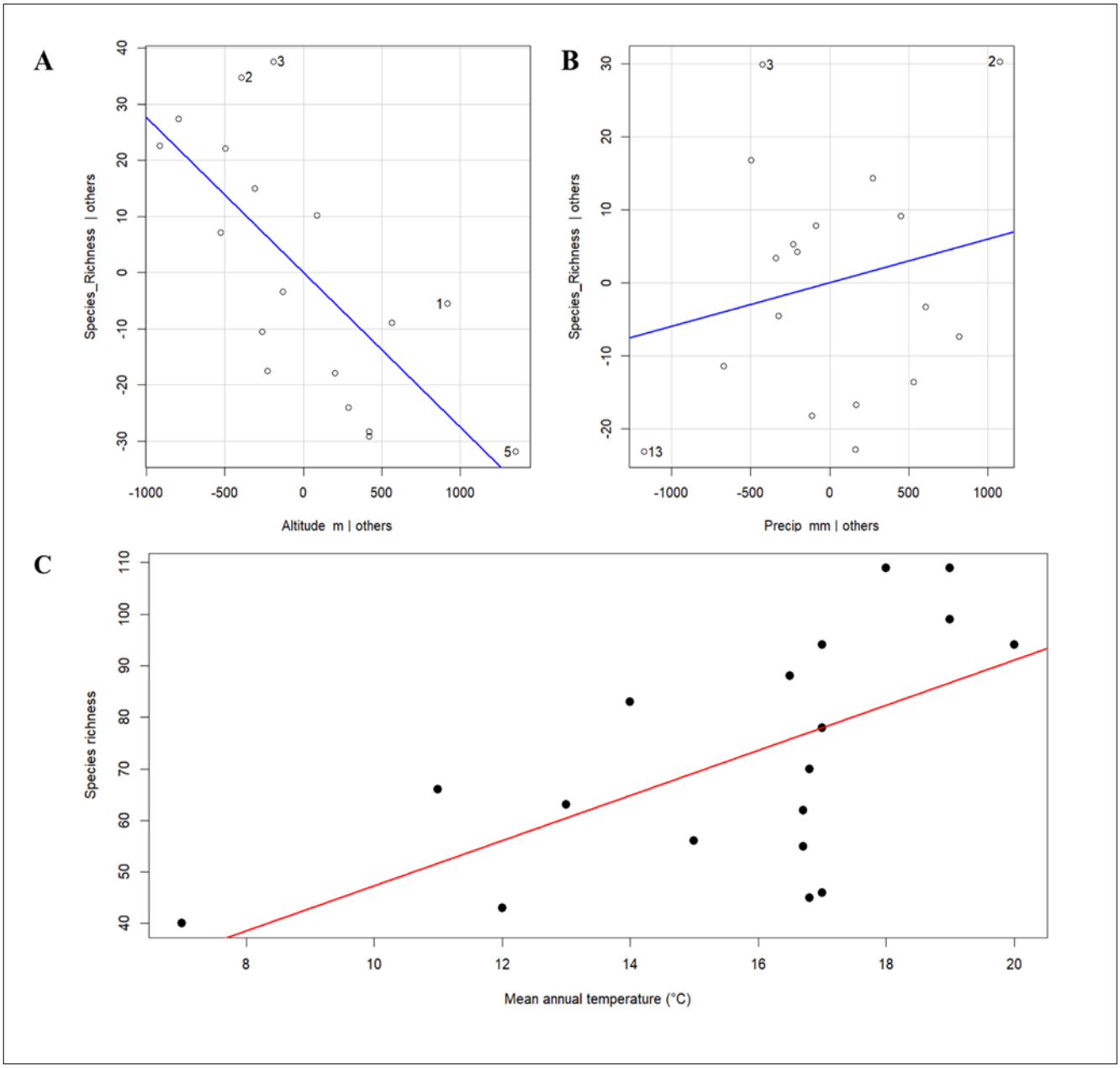

Fig. 8. Added-variable (partial regression) plots illustrating the independent effects of altitude (A) and precipitation (B) on species richness after accounting for the influence of other predictors in the multiple linear regression model (C) Relationship between species richness and mean annual temperature across the study sites. Points represent individual sampling locations and fitted lines indicate partial regression slopes.

Didymocarpus aurantiacus C.B. Clarke, which were previously known mainly from Nepal and the Eastern Indian Himalayas. *Didymocarpus mortonii* C.B. Clarke, characteristic of the Eastern Himalayan belt and *Didymocarpus pedicellatus* R. Br., confined to the Indian Himalayan region and Nepal, were also observed. The herb *Galium hirtiflorum* Req. ex DC., native to the central Himalayan zone, has been added to the list of species with a narrow distribution. Among terrestrial orchids, *Herminium clavigerum* (Lindl.) X.H.Jin, Schuit., Raskoti & Lu Q.Huang and *Herminium mackinnonii* Duthie, both associated with high-altitude Himalayan and Tibetan zones, were present in suitable alpine niches. The medicinally important *Swertia chirayita* (Roxb.) H.Karst., though widely distributed across the Indian Himalayan region, appeared in scattered populations, consistent with its conservation-sensitive status. *Thalictrum chelidonii* DC., typically documented in the Indian Himalayas and Tibet, was also found in the present study area (Table 3). These species highlight the unique ecological character of the region and underscore the importance of conserving its distinctive plant diversity. Our observations clearly demonstrate the value of detailed floristic documentation and habitat protection, as many of these plants, not strictly endemic at a global scale, occur within narrow geographic ranges and effectively function as regional endemics. Owing to their restricted distributions and habitat specificity, such species need high conservation priority.

Conservation status

The Darjeeling Himalayas host a wide variety of plants, from tropical to alpine, because of their unique climate and elevation. While early efforts, such as botanical gardens and forest laws, helped protect this biodiversity, threats like deforestation and climate change still pose serious challenges. This study highlights the need for continued conservation and sustainable ecotourism to preserve the region's unique plant life. A ten-year survey across seven protected areas in the Indian Himalayas recorded 60 threatened medicinal plant species, including 22 % classified as critically endangered, 16 % as endangered and 27 % as vulnerable, with 32 species endemic to the Himalayan region. Population densities varied widely across habitats and protected areas and many were extensively used by indigenous healers, highlighting the urgent need to establish dedicated medicinal plant conservation areas to ensure their long-term survival (33). In the IUCN status evaluation of the specimens collected during the current study, the majority (196 taxa) were categorised as Not Evaluated (NE), highlighting a substantial gap in conservation assessment. Forty-nine taxa were assessed as Least Concern (LC), while the threatened categories included Critically Endangered (CR; 2), Endangered (EN; 3), Vulnerable (VU; 1) and Extinct in the Wild (EW; 1) (Fig. 9). During the survey, *Brugmansia suaveolens* (Humb. & Bonpl. ex Willd.) Sweet was the only species found to be EW, due to long-term habitat modification and the disappearance of natural populations, with the species now largely surviving in cultivated or ornamental settings. Two highly valued medicinal plants, *Panax pseudoginseng* Wall. and *Swertia chirayita* (Roxb.) H. Karst. were recorded as CR. Their decline is mainly linked to heavy and often unregulated harvesting, slow natural regeneration and the loss of suitable forest habitats (34). Similarly, *Coffea arabica* L., *Fraxinus floribunda* Wall. and *Taxus wallichiana* Zucc., categorized as EN, are increasingly threatened by forest fragmentation, land-use change and extraction pressures. In particular, *T. wallichiana* has suffered severe population reductions due to extensive exploitation for taxane-based pharmaceutical compounds (35). The *Quercus lamellosa* Sm. was found to be Near Threatened (NT) and five species represented by *Carica papaya* L., *Curcuma longa* L., *Curcuma zedoaria* (Christm.) Roscoe, *Rheum australe* D.Don, *Zingiber officinale* Roscoe were Data Deficient (DD). The high number of NE taxa reflects gaps in taxonomic work, limited field surveys and the lack of recent conservation assessments for many species in the region.

Effective recovery of these species will require a combination of habitat protection and sustainable management. Regulating wild collection, promoting cultivation to reduce pressure on natural populations and adopting *ex situ* conservation measures such as seed banking, nursery development and tissue culture propagation are especially important for slow-growing and high-demand medicinal plants. Involving local communities through awareness and stewardship programs can further support long-term conservation and recovery of threatened plant species in the Darjeeling region (34, 36–38).

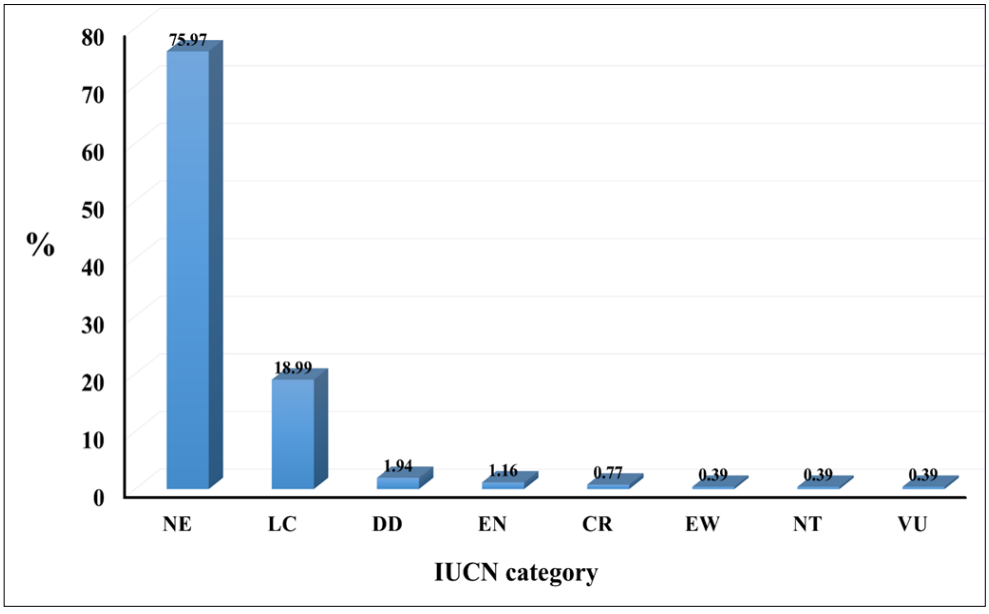

Fig. 9. Conservation status of documented plants in the Darjeeling Himalaya.

Conclusion

The present study documents the rich and heterogeneous plant diversity of Darjeeling district, shaped by its complex topography and diverse habitat types and underscores its ecological importance within the Eastern Himalayas. The occurrence of rare, threatened and medicinally significant plant species highlights emerging conservation challenges linked to habitat degradation, unsustainable extraction and changing land-use practices. To ensure the long-term conservation of this botanical wealth, strengthened habitat protection and targeted species recovery measures, including *ex situ* conservation through seed banks and propagation of threatened taxa, are essential. The development of a Darjeeling-specific floristic database, coupled with community participation through citizen science–based biodiversity monitoring, would facilitate continuous assessment of floristic changes and support informed conservation planning. Collectively, these efforts can contribute to sustainable management and preservation of plant diversity in the Darjeeling Himalaya.

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Authors' contributions

Conceptualisation, methodology, visualisation and writing were carried out by AS, KS and SAHA. Conceptualisation and methodology were also contributed by S and SKS. Editing and reviewing of the manuscript were performed by AS, KS, SAHA, S, SKS, SN, AM, AKS, JCA, NS and RA. Supervision of the study was provided by SN, AM, NS and RA. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

References

1. Hussain S, Hore DK. Collection and conservation of major medicinal plants of Arunachal Pradesh. Indian For. 2008;134(12):1663–79.
2. Das AP. Floristic studies in Darjeeling Hills. Nelumbo. 2004;46(1–4):1–18. https://doi.org/10.20324/nelumbo/v46/2004/74109
3. Das AP. Diversity of angiospermic flora of Darjeeling Hills. Taxon Biodivers. 1995;118–27.
4. Mallick JK. An annotated checklist of dicotyledonous angiosperms in Darjeeling Himalayas and foothills, West Bengal, India. J New Biol Rep. 2020;9(2):94–208.
5. Hooker JD. Notes chiefly botanical, made during an excursion from Darjiling to Tonglo, a lofty mountain on the confines of Sikkim and Nepal. J Asiat Soc Bengal. 1849;18(1):419–46.
6. Gamble JS. List of the trees, shrubs and large climbers found in the Darjeeling District, Bengal. Calcutta: Presidency Jail Press; 1896.
7. Hara H. The flora of eastern Himalaya: results of the botanical expedition to eastern Himalaya organized by the University of Tokyo 1960 and 1963. Tokyo: Univ Tokyo Press; 1966.
8. Goyder DJ, Grierson AJC, Long DG, Bates M. Flora of Bhutan including a record of plants from Sikkim and Darjeeling. Kew Bull. 2000;55(3):758–9. https://doi.org/10.2307/4118795
9. Bhujel R. Studies on the dicotyledonous flora of Darjeeling district. [Doctoral thesis]. Siliguri: Univ North Bengal; 1996. https://ir.nbu.ac.in/handle/123456789/875
10. Samanta A. Taxonomical and phytosociological studies on the angiospermic climbers of Darjeeling and Sikkim Himalayas [Doctoral thesis]. SiliguriUniv North Bengal; 1998.
11. Nirola S, Das AP. Endemic monocot flora of Darjeeling Himalaya, West Bengal, India. Pleione. 2017;11(1):116–24.
12. Yonzone R, Lama D, Bhujel RB, Gogoi K, Rai S. Taxonomic assessment on the reported orchid species of Darjeeling district from flora of Bhutan, the orchids of Bhutan: a review. Int J Pharm Life Sci. 2012;3(4):1590–606.
13. Yonzone R, Lama D, Bhujel RB, Rai S. Orchid species diversity of Darjeeling Himalaya of India. Int J Pharm Life Sci. 2012;3(3):1533–50.
14. Thapa N. Studies on the pteridophytic flora of Darjeeling Hills. [Doctoral thesis]. Siliguri: Univ North Bengal; 2016. https://ir.nbu.ac.in/handle/123456789/2579
15. Jain SK, Rao RR. A handbook of field and herbarium methods. New Delhi: Today & Tomorrow's Printers Publ; 1977.
16. Don D. Prodromus florae Nepalensis. Dehra Dun: Bishen Singh Mahendra Pal Singh; 1976. Repr. of 1825 ed.
17. Cowan AM, Cowan JM. The trees of northern Bengal: including shrubs, woody climbers, bamboos, palms and tree ferns. Calcutta: Bengal Secretariat Book Depot; 1929.
18. Biswas K, Chopra R. Common medicinal plants of Darjeeling and Sikkim Himalayas. Alipore (West Bengal): Superintendent, Government Printing, West Bengal Government Press; 1956.
19. Biswas K. Plants of Darjeeling and Sikkim Himalayas. Calcutta (West Bengal): Superintendent, Government Printing, West Bengal Govt. Press; 1966.
20. Hooker JD. The flora of British India. Vol. 6. London: L Reeve & Co.; 1894.
21. Matthew K. An enumeration of the flowering plants of Kurseong, Darjeeling District, West Bengal, India. Dehra Dun: Bishen Singh Mahendra Pal Singh; 1981.
22. Hara H. Flora of eastern Himalaya, second report. Taxon. 1972;21(1):186. https://doi.org/10.2307/1219257
23. Das A, Ghosh C. Plant wealth of Darjiling and Sikkim Himalayas vis-à-vis conservation. NBU J Plant Sci. 2022;5(1):25–33. https://doi.org/10.55734/NBUJPS.2011.v05i01.004
24. Yonzone R, Bhujel RB, Rai S. Genetic resources, current ecological status and altitude-wise distribution of medicinal plants diversity of Darjeeling Himalaya of West Bengal, India. Asian Pac J Trop Biomed. 2012;2(1):S439–45. https://doi.org/10.1016/S2221-1691(12)60203-2
25. Margalef R. Information theory in ecology. Mem Real Acad Cienc Artes Barcelona. 1957;32:373–449.
26. Simpson EH. Measurement of diversity. Nature. 1949;163(4148):688. https://doi.org/10.1038/163688a0
27. Shannon CE. A mathematical theory of communication. Bell Syst Tech J. 1948;27(3):379–423. https://doi.org/10.1002/j.1538-7305.1948.tb01338.x

28. Negi VS, Pandey A, Singh A, Bahukhandi A, Pharswan DS, Gaira KS, et al. Elevation gradients alter vegetation attributes in mountain ecosystems of eastern Himalaya, India. Front For Glob Change. 2024;7. https://doi.org/10.3389/ffgc.2024.1381488

29. Saikia P, Deka J, Bharali S, Kumar A, Tripathi OP, Singha LB, et al. Plant diversity patterns and conservation status of eastern Himalayan forests in Arunachal Pradesh, Northeast India. For Ecosyst. 2017;4:28. https://doi.org/10.1186/s40663-017-0117-8

30. Yadav BK, Bhatta KP, Ayer S, Basnet P, Dhakal N, Sharma S, et al. Elevation shapes tree composition, structure and diversity more than soil properties in the Annapurna Conservation Area, Nepal. Trees For People. 2025;20:100902. https://doi.org/10.1016/j.tfp.2025.100902

31. Koleff P, Gaston KJ, Lennon JJ. Measuring beta diversity for presence–absence data. J Anim Ecol. 2003;72(3):367–82. https://doi.org/10.1046/j.1365-2656.2003.00710.x

32. Magurran AE. Measuring biological diversity. Curr Biol. 2021;31 (19):R1174–7. https://doi.org/10.1016/j.cub.2021.07.049

33. Kala CP. Indigenous uses, population density and conservation of threatened medicinal plants in protected areas of the Indian Himalayas. Conserv Biol. 2005;19(2):368–78. https://doi.org/10.1111/j.1523-1739.2005.00602.x

34. Hussain S, Hore DK. Collection and conservation of major medicinal plants of Darjeeling and Sikkim Himalayas. Indian J Tradit Knowl. 2007;6(2):352–7.

35. Paul A, Bharali S, Khan ML, Tripathi OP. Anthropogenic disturbances led to risk of extinction of *Taxus wallichiana* Zuccarini, an endangered medicinal tree in Arunachal Himalaya. Nat Areas J. 2013;33(4):447–54. https://doi.org/10.3375/043.033.0408

36. Sharma S, Thokchom R. A review on endangered medicinal plants of India and their conservation. J Crop Weed. 2014;10(2):205–18.

37. Marcus M. Sustainability and conservation strategies for endangered medicinal plant species. Int J Herbal Sci. 2024;5(2):1–7.

38. Chen SL, Yu H, Luo HM, Wu Q, Li CF, Steinmetz A. Conservation and sustainable use of medicinal plants: problems, progress and prospects. Chin Med. 2016;11:37. https://doi.org/10.1186/s13020-016-0108-7

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