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Genetic resources, current ecological status and altitude wise distribution of medicinal plants diversity of Darjeeling Himalaya of West Bengal, India

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ABSTRACT

Objective: To find out the genetic resources, current ecological status and altitude wise distribution of medicinal plants diversity of Darjeeling Himalaya of West Bengal, India. **Methods:** The intensive field survey was conducted in the entire regions and necessary information were collected from the local inhabitants and literatures. **Results:** The present study revealed 218 medicinal plants species from 97 families with 195 genera distributed throughout the different altitudinal ranges of entire Darjeeling Himalaya. Of these, 6 plant species were from 3 500–45 00 m altitude, 22 from 1 800–3 500 m, 69 from 1 000–1 800 m and 121 from 130–1 000 m in the study area. There were 24 cultivated medicinal plants and the rest were wild. **Conclusions:** It is unique for rich, wide genetic diversity resources and distribution of medicinal plants in distinct climatic zones. However, the status of these some plant species are vulnerable, threatened, rare and critically endangered.

1. Introduction

Darjeeling is the northernmost district of West Bengal. The district is subdivided into four Sub-Divisions *viz*., Darjeeling sadar; Kalimpong, Kurseong and Siliguri (Figure 1). The region lies between $26^0 31'$ and $27^0 31'$ north latitude and between $87^0 59'$ and $88^0 53'$ east longitude in the Eastern Himalayan region of India[1]. It is bordered by Sikkim in the north, Terai and Dooars in the south, Bhutan in the east and Nepal in the west. The district has two topographical features. Darjeeling, Kurseong and Kalimpong form the hill areas whereas Siliguri is stationed at the foothill in a vast stretch of the plains. The shape of the district is triangular. The total area of the triangular shaped district is 3 254.7 sq. km. which is 3.68 percent of the total areas of West Bengal state. The hilly region covers 2 320 sq. km. and the remaining 934.7sq.km of the area falls in the Terai and plains. The altitudinal variations of the district range from 150 m at Siliguri to 3 636 m at Sandakphu-Phalut with a sharp physiographic contrast between the plain and the mountainous regions[2].

Darjeeling Himalaya enjoys the dignity of being blessed with ideal climatic and edaphic factors which favour and add richness to the medicinal plants wealth of the region[3]. It harvours one of the richest biodiversity in the world[4]. In the present investigation, genetic resources, current ecological status, diversity and altitude wise distribution of medicinal plant species of Darjeeling Himalaya of West Bengal, India has been studied.

2. Materials and methods

The intensive field survey was conducted in the entire Darjeeling hills including the forests. The authors visited Singhalila National Park, Darjeeling and Neora Valley National Park in Kalimpong and remote far flung areas covering all the altitudinal ranges as low as Siliguri to the as high as Sandakphu-Phalut of entire Darjeeling hills of West Bengal, India. All the medicinal plants and their necessary information were collected from the local herbal practisioners known as Jhakri or Dhami, Bonbo, Baidhya, Mangpa, Phedangma, Lama, Mata, Bhagawati, Bijuwa, Bungthing, herbal practitioners, senior men and women of different villages of study area. The necessary information from the website, scientific papers, articles, booklets and books have been utilized. The collected plant specimens were processed, described, properly identified and authenticated with the help of Flora of British India (Hooker, 1872-1897)[5]: medicinal plants (Jain SK, 1968)[6]; and from the Herbarium of Department of Botany, North

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Bengal University, Siliguri; Central National Herbarium, Indian Botanical Garden, Sibpur, Howrah and finally deposited in the Herbaria of Taxonomy and Ethnobiology Research Laboratory, Cluny Women's College, Kalimpong. In the present investigation the study of ecological status was conducted by Raunukiaer's ecological statitistics, given by Raunukiaer, (1934)[7] . It was laid out in each of the major plots, and the species habitat rich plots of 5 m×5 m were laid out diagonally for regeneration status of frequency. Quantification of studies have been carried out to find out the current status of these species from Darjeeling district[8]. All the plant specimens are arranged systematically as per their altitude wise distribution in the area with botanical names, habitat, family and ecological status.

3. Results

There were 218 medicinal plant species and 97 families with 195 genera including 54 trees, 44 shrubs, 94 herbs and 26 climbers widely distributed with four different classified altitudinal ranges of the district[9](Figure 2). The altitude wise distribution of plant species in sub-alpine zone were 6. Out of these 1 was tree and the rest 5 were herbs and in case of ecological status 4 were endangered, 1 was critically endangered and 1 was frequent (Table 1). In temperate and sub-temperate zone, there were 22 plant species. Out of these 1 was climber, 13 were herbs, 4 were shrubs and the rest 4 were trees and in case of ecological status 7 were endangered, 5 were rare, 8 were sparse, 3 were frequent, 1 was vulnerable and 1 threatened (Table 2). In sub-tropical zone, there were 69 plant species, out of these 36 were herbs, 14 were shrubs, 10 were trees and the rest 9 were climbers and in ecological status 2 were endangered, 6 were rare, 1 vulnerable, 30 were sparse, 15 were frequent, 5 were abundant and 6 were planted or cultivated in the region (Table 3) and in tropical zone there were 121 plant species. Out of these, 40 were herbs, 26 were shrubs, 39 were trees and the rest 16 were climbers and in case of ecological status, 3 were endangered, 7 were rare, 2 were threatened, 54 were sparse, 14 were frequent, 16 were common, 15 were planted and 4 were abundant (Table 4). It was found that Orchidaceae was the largest family with 10 species, followed by Zingiberaceae 8, Rubiaceae 8, Apocynaceae 6, Euphorbiaceae 6, Urticaceae 6, Asteraceae 6, Rutaceae 6, Polygonaceae 5 and Araliaceae 4 which is shown in Figure 3. Monocots are dominant over dicots in distribution and occurrence. Of these, 6 plants from 3 500 to 4 500 m altitudinal range, 22 plants from 1 800 to 3 500 m, 69 plants from 1 000 to 1800 m and 122 from 130-1000 m. Above data clearly signify that lower the altitude higher the medicinal plants distribution in study area.

Table 1.
Medicinal plants of sub-alpine zone (3 500-4 500 m).

Sl. No.	Botanical name	Habit	Family	Status
1	*Abies densa* Grief. ex Parker.	Tree	Pinaceae	Frequent
2	*Aconitum bisma* (Buch-Ham.) Rapaics.	Herb	Ranunculaceae	Endangered
3	*Aconitum spicatum* (Bruhl.) Stapf.	Herb	Ranunculaceae	Endangered
4	*Dactylorhiza hatagirea* (D. Don) Soo.	Herb	Orchidaceae	Critically Endangered
5	*Nardostachys jatamansi* DC.	Herb	Valerianaceae	Endangered
6	*Neopicrorhiza scrophulariiflora* (Pennel) D.Y. Hong.	Herb	Scrophulariaceae	Endangered

Table 2.
Medicinal plants of temperate and sub-temperate zone (1 800-3 500 m).

Sl. No.	Botanical name	Habit	Family	Status
1	*Daphne bholua* D. Don.	Shrub	Thymelaeaceae	Frequent
2	*Dicentra scandens* (D. Don) Walpers.	Climber	Fumariaceae	Rare
3	*Fragaria nubicola* (Hook. f.) Lacaita.	Herb	Rosaceae	Sparse
4	*Heracleum nepalense* D. Don.	Herb	Apiaceae	Sparse
5	*Heracleum wallichii* DC.	Herb	Apiaceae	Frequent
6	*Iris clarkei* Baker ex Hook. f.	Herb	Iridaceae	Sparse
7	*Mahonia napaulensis* DC.	Shrub	Berberidaceae	Sparse
8	*Panax pseudoginseng* Wall. var. *angustifolius* (Burkill) Li	Herb	Araliaceae	Endangered
9	*Panax pseudoginseng* Wall. var. *bipinnatifidus* (Seemab) Li	Herb	Araliaceae	Endangered
10	*Paris polyphylla* Smith.	Herb	Trilliaceae	Sparse
11	*Pentapanax fragrans* (D. Don) Ha	Tree	Araliaceae	Rare
12	*Persea fructifera* Kostermans.	Tree	Lauraceae	Sparse
13	*Podophyllum sikkimense* Chatterjee & Mukherjee.	Herb	Podophyllaceae	Endangered
14	*Rosa sericea* Lindl.	Shrub	Rosaceae	Vulnerable
15	*Rheum acuminatum* Hook. f.	Herb	Polygonaceae	Sparse
16	*Rhododendron arboretum* Smith.	Tree	Ericaceae	Frequent
17	*Satyrium nepalense* D. Don.	Herb	Orchidaceae	Sparse
18	*Swertia bimaculata* (Sieb. & Zucc.) Hook. f. & Thoms ex Clarke.	Herb	Gentianaceae	Threatened
19	*Swertia chirayita* (Roxb. ex Fleming) Karsten.	Herb	Gentianaceae	Endangered
20	*Taxus baccata* L. sub.sp. wallichiana Zucc.	Tree	Taxaceae	Endangered
21	*Valeriana hardwickii* Wall.	Herb	Valerianaceae	Rare
22	*Zanthoxylum acanthopodium* DC.	Shrub	Rutaceae	Rare

Table 3.
Medicinal plants of sub-tropical zone (1 000-1 800 m).

Sl. No.	Botanical name	Habit	Family	Status
1	*Acmella calva* (D.C.) Jansen.	Herb	Asteraceae	Frequent
2	*Acorus calamus* L.	Herb	Araceae	Sparse
3	*Ageratina adenophora* (Spreng.)King & Robinson.	Herb	Asteraceae	Abundant
4	*Ageratum conyzoides* L.	Herb	Asteraceae	Abundant
5	*Alstonia scholaris* (L.) R. Brown.	Tree	Apocynaceae	Frequent
6	*Amaranthus spinosus* L.	Herb	Amaranthaceae	Frequent
7	*Amomum subulatum* Roxb.	Herb	Zingiberaceae	Planted
8	*Anthogonium gracile* Wall ex Lindl.	Herb	Orchidaceae	Common
9	*Ardisia macrocarpa* Wall in Roxb.	Shrub	Myrsinaceae	Frequent
10	*Artemisia dubia* Wall. ex Besser.	Herb	Asteraceae	Frequent
11	*Astilbe rivularis* D. Don.	Herb	Saxifragaceae	Sparse
12	*Begonia cathcartii* Hook. f. D. Don.	Herb	Begoniaceae	Rare
13	*Belamcanda chinensis* (L.) DC.	Herb	Iridaceae	Sparse
14	*Bergenia ciliata* (Haworth) Sternberg.	Herb	Saxifragaceae	Planted
15	*Betula alnoides* D. Don.	Tree	Betulaceae	Sparse
16	*Callicarpa vestita* Wall. ex Clarke.	Tree	Verbenaceae	Sparse
17	*Cinchona succirubra* Pavon ex Klotz.	Tree	Rubiaceae	Planted
18	*Clematis buchananiana* DC.	Climber	Ranunculaceae	Vulnerable
19	*Coelogyne ovalis* Lindl.	Herb	Orchidaceae	Sparse
20	*Costus speciosus* Koen. ex Retz. Smith.	Herb	Zingiberaceae	Sparse
21	*Curcuma zedoaria* (Berg.) Rosc.	Herb	Zingiberaceae	Rare
22	*Datura suaveolens* Humb & Bonpl. ex Willd.	Shrub	Solanaceae	Sparse
23	*Dendrophthoe falcata* (L. f.) Etting.	Shrub	Loranthaceae	Sparse
24	*Didymocarpus aromaticus* Wall. ex D. Don.	Herb	Gesneriaceae	Sparse
25	*Digitalis purpurea* L.	Herb	Scrophulariaceae	Planted
26	*Dioscorea bulbifera* L.	Climber	Dioscoreaceae	Sparse
27	*Dioscorea pentaphylla* L.	Climber	Dioscoreaceae	Sparse
28	*Drymaria cordata* Willd.	Herb	Caryophyllaceae	Abundant
29	*Edgeworthia gardneri* (Wall.) Meisner.	Shrub	Thymelaeaceae	Sparse
30	*Fagopyrum dibotrys* (D. Don) Hara.	Herb	Polygonaceae	Sparse
31	*Fraxinus floribunda* Wall.	Tree	Oleaceae	Sparse
32	*Hedychium coronarium* Koen.	Herb	Zingiberaceae	Rare
33	*Holarrhena pubescens* Wall ex G. Don.	Tree	Apocynaceae	Sparse
34	*Houttyunia cordata* Thumb.	Herb	Saururaceae	Frequent
35	*Hypericum uralum* Buch.-Ham. ex D. Don.	Shrub	Hypericaceae	Sparse
36	*Juglans region* L.	Tree	Juglandaceae	Frequent
37	*Kaempferia rotunda* L.	Herb	Zingiberaceae	Rare
38	*Laportea terminalis* Wight.	Shrub	Urticaceae	Frequent
39	*Litsea cubeba* (Lour.) Persoon.	Tree	Lauraceae	Rare
40	*Pratia nummularia* (Lamk) A. Br.	Herb	Campanulaceae	Frequent
41	*Lygodium alatum* (Clarke) V.A.V.R.	Climber	Lygodioceae	Sparse
42	*Lycopodium japonicum* Thumb.	Herb	Solanaceae	Abundant
43	*Lyonia ovalifolia* (Wall.) Drude.	Tree	Ericaceae	Frequent
44	*Menthe arvensis* L.	Herb	Lamiaceae	Sparse
45	*Mussaenda treutleri* Stapf.	Shrub	Rubiaceae	Frequent
46	*Nasturtium officinale* R. Brown.	Herb	Brassicaceae	Sparse
47	*Nephrolepis cordifolia* (L.) Presl.	Herb	Nephrolepidaceae	Abundant
48	*Phytolacca acinosa* Roxb.	Herb	Polygonaceae	Sparse
49	*Piper nigrum* L.	Climber	Piperaceae	Planted
50	*Plantago erosa* Wall.	Herb	Plantaginaceae	Frequent
51	*Plumbago zeylanica* L.	Shrub	Plumbaginaceae	Rare
52	*Pouzolzia hirta (Blume)* Hassk.	Herb	Urticaceae	Frequent
53	*Pouzolzia sanguinea* (Blume) Merrill. var. *nepalensis* (Wedd.) Hara.	Shrub	Urticaceae	Frequent
54	*Rubia manjith* Roxb. ex Fleming.	Climber	Rubiaceae	Sparse
55	*Rubia sikkimensis* Kurtz.	Climber	Rubiaceae	Sparse
56	*Rubus ellipticus* Smith.	Shrub	Rosaceae	Sparse
57	*Rumex nepalensis* Sprengel.	Herb	Polygonaceae	Sparse

Table 3, continued

Sl. No.	Botanical name	Habit	Family	Status
58	*Streptolirion volubile* Edgew.	Herb	Commelinaceae	Sparse
59	*Tetradium fraxinifolium* (Hook.) T.G. Hartley.	Tree	Rutaceae	Sparse
60	*Tricosanthes lepiniana* (Naudin) Cogniaux.	Climber	Cucurbitaceae	Common
61	*Tricosanthes wallichiana* (Seringe) Wight.	Climber	Cucurbitaceae	Sparse
62	*Tupistra nutans* Wall. ex Lindl.	Herb	Liliaceae	Sparse
63	*Urtica ardens* L.	Shrub	Urticaceae	Frequent
64	*Urtica dioica* L.	Shrub	Urticaceae	Frequent
65	*Urtica parviflora* Roxb.	Herb	Urticaceae	Sparse
66	*Viscum album* L.	Shrub	Loranthaceae	Endangered
67	*Viscum liquidambaricolum* Hayata.	Shrub	Loranthaceae	Endangered
68	*Zingiber officinale* Rosc.	Herb	Zingiberaceae	Planted
69	*Zingiber rubens* Roxb.	Herb	Zingiberaceae	Planted

Table 4
Medicinal plants of tropical zone (130–1 000 m).

Sl. No.	Botanical name	Habit	Family	Status
1	*Abroma augusta* (L.) L. f.	Shrub	Sterculiaceae	Sparse
2	*Acacia catechu* (L. f.) Willd.	Tree	Mimosoideae	Sparse
3	*Acampe papillosa* (Lindl.) Lindl.	Herb	Orchidaceae	Common
4	*Achyranthes aspera* L.	Herb	Amarantaceae	Sparse
5	*Adiantum lunulatum* Burm.	Herb	Adiantaceae	Sparse
6	*Aegle marmelos* (L.) Correa.	Tree	Rutaceae	Planted
7	*Aerides odorata* Loureiro.	Herb	Orchidaceae	Sparse
8	*Aerva javanica* Juss. ex Schult.	Herb	Amaranthaceae	Frequent
9	*Aloe barbadensis* Miller.	Climber	Liliaceae	Planted
10	*Ampelocissus barbata* (Wall.) Planchon.	Climber	Vitaceae	Frequent
11	*Andrographis paniculata* (Burm. f.) Wall. ex Ness.	Herb	Acanthaceae	Sparse
12	*Anthocephalus cadamba* (Roxb.) Miquel.	Tree	Rubiaceae	Sparse
13	*Antidesma acidum* Retzium.	Shrub	Euphorbiaceae	Sparse
14	*Artocarpus heterophyllus* Lamarck.	Tree	Moraceae	Planted
15	*Artocarpus lacucha* Buch-Ham.	Tree	Moraceae	Sparse
16	*Asparagus officinalis* L.	Climber	Asperagaceae	Planted
17	*Asparagus racemosus* Wild.	Climber	Asperagaceae	Planted
18	*Azadirachta indica* Juss.	Tree	Meliaceae	Planted
19	*Bauhinia purpurea* L.	Tree	Caesalpinoideae	Sparse
20	*Bauhinia variegata* L.	Tree	Caesalpinoideae	Sparse
21	*Bischofia javanica* Blume.	Tree	Bischofiaceae	Sparse
22	*Bombax ceiba* L.	Tree	Bombaceae	Sparse
23	*Bryonopsis laciniosa* (L.) Naud.	Climber	Cucurbitaceae	Sparse
24	*Buddleja asiatica* Loureiro.	Climber	Buddlejaceae	Sparse
25	*Butea parviflora* Roxb.	Climber	Papillionoideae	Frequent
26	*Calotropis gigantea* (L.) Dryander.	Shrub	Asclepiadaceae	Sparse
27	*Cannabis sativa* L.	Shrub	Cannabiaceae	Sparse
28	*Cassia fistula* L.	Tree	Caesalpinoideae	Planted
29	*Catharanthus roseus* (L.) G. Don.	Herb	Apocynaceae	Planted
30	*Cayratia trifolia* (L.) Domin.	Climber	Vitaceae	Sparse
31	*Centella asiatica* (L) Urban.	Herb	Apiaceae	Common
32	*Cephalis ipecacuanha* (Brot.) A. Rich.	Shrub	Rubiaceae	Planted
33	*Chromolaena odorata* King & Robinson.	Shrub	Asteraceae	Common
34	*Cinnamomum tamala* (Hamilton) Nees at Ebermaier.	Tree	Lauraceae	Sparse
35	*Cissampelos pareira* L.	Climber	Menispermaceae	Sparse
36	*Clerodendrum serratum* (L.) Moon.	Shrub	Verbenaceae	Frequent
37	*Colebrookea oppositifolia* Smith.	Shrub	Lamiaceae	Sparse
38	*Curcuma aromatica* Salisbury.	Herb	Zingiberaceae	Planted
39	*Curcuma longa* L.	Herb	Zingiberaceae	Sparse
40	*Cuscuta reflexa* Roxb.	Tree	Cuscutaceae	Sparse
41	*Cymbidium aloifolium* (L.) Sw.	Herb	Orchidaceae	Sparse
42	*Cymbopogon citratus* Stapf.	Herb	Poaceae	Planted

Table 4, continued

Sl. No.	Botanical name	Habit	Family	Status
43	*Cynodon doctylon* (L.) Pers.	Herb	Poaceae	Abundant
44	*Dicliptera bupleuroides* Nees.	Herb	Acanthaceae	Sparse
45	*Dolichos biflorus* L.	Herb	Fabaceae	Planted
46	*Dalbergia sissoo* Roxb.	Tree	Kabraceae	Common
47	*Dendrobium nobile* Lindl.	Herb	Orchidaceae	Sparse
48	*Elaeocarpus sphaericus* (Gaertn.) Schumann.	Tree	Elaeocarpaceae	Rare
49	*Elsholtzia blanda* (Benth) Benth.	Herb	Lamiaceae	Sparse
50	*Entada rheedii* Sprengel. sub.spp. *Sinohimalensis* (Grierson & Long) Panigrahi L.	Climber	Mimosoideae	Sparse
51	*Equisetum debile* L.	Herb	Equisetaceae	Frequent
52	*Euphorbia hirta* L.	Herb	Euphorbiaceae	Common
53	*Fagopyrum esculentum* Moench.	Herb	Polygonaceae	Sparse
54	*Ficus semicordata* Smith.	Tree	Moraceae	Sparse
55	*Garcinia cowa* Roxb. ex DC.	Tree	Clusiaceae	Sparse
56	*Geodorum densiflorum* (Lam.) Schltr.	Herb	Orchidaceae	Rare
57	*Gloriosa superba* L.	Herb	Liliaceae	Planted
58	*Gmelina arborea* Roxb.	Tree	Verbenaceae	Frequent
59	*Gynocardia odorata* R. Brown.	Tree	Flacourtiaceae	Rare
60	*Hedyotis scandens* Roxb.	Climber	Rubiaceae	Sparse
61	*Holarrhena pubescens* (Buch-Ham.) Wall. ex G. Don.	Tree	Apocynaceae	Frequent
62	*Imperata cylindrica* (L.) Reauschel.	Herb	Poaceae	Abundant
63	*Jatropha curcas* L.	Shrub	Euphorbiaceae	Sparse
64	*Justicia adhatoda* L.	Shrub	Acanthaceae	Sparse
65	*Lagerstroemia hirsuta* (Lamarck) Willd.	Tree	Lythraceae	Sparse
66	*Mallotus philippensis* (Lamk.) Mueller.	Tree	Euphorbiaceae	Sparse
67	*Melastoma malabathricum* L.	Shrub	Melastomataceae	Frequent
68	*Mimosa himalayana* Gamble.	Shrub	Mimosoideae	Sparse
69	*Mimosa pudica* L.	Shrub	Mimosaceae	Frequent
70	*Mirabilis jalapa* L.	Herb	Nactaginaceae	Sparse
71	*Momordica dioica* Roxb.	Climber	Cucurbitaceae	Common
72	*Moringa oleifera* Lamarck.	Tree	Moringaceae	Common
73	*Morus australis* Poiret.	Tree	Moraceae	Frequent
74	*Mucuna nigricans* (Lour.) Steudel.	Climber	Papilionoideae	Sparse
75	*Murraya paniculata* (L.) Jack.	Tree	Rutaceae	Sparse
76	*Nerium odorum* L.	Shrub	Apocynaceae	Sparse
77	*Ocimum basilicum* L.	Herb	Lamiaceae	Planted
78	*Ocimum tenuiflorum* L.	Herb	Lamiaceae	Planted
79	*Osbeckia stellata* Ker-Gawler.var. stellata	Shrub	Melastomataceae	Sparse
80	*Oroxylum indicum* (L.) Kurz.	Tree	Bignoniaceae	Frequent
81	*Oxalis corniculata* L.	Herb	Geraniaceae	Frequent
82	*Paederia foetida* L.	Shrub	Rubiaceae	Sparse
83	*Phaius tankervilleae* (Bank ex I-Herit.) Blume.	Herb	Orchidaceae	Common
84	*Pholidota imbricata* Hook	Herb	Orchidaceae	Sparse
85	*Phlogacanthus thyrsiformis* (Roxb. ex Hardwick) D.J. Mabberley.	Shrub	Acanthaceae	Sparse
86	*Phyllanthus emblica* L.	Tree	Euphorbiaceae	Sparse
87	*Phyllanthus fraternus* Webster.	Herb	Euphorbiaceae	Common
88	*Physalis divaricata* L.	Shrub	Solanaceae	Sparse
89	*Piper longum* L.	Shrub	Piperaceae	Common
90	*Prunus cerasoides* D. Don.	Tree	Rosaceae	Sparse
91	*Psidium guajava* L.	Tree	Myrtaceae	Common
92	*Pupalia atropurpurea* Moq.	Herb	Amarantaceae	Sparse
93	*Rauvolfia serpentina* Bentham ex Kurz.	Shrub	Apocynaceae	Endangered
94	*Rhus chinensis* Miller.	Tree	Anacardiaceae	Rare
95	*Rhynchostylis retusa* (L.) Blume.	Herb	Orchidaceae	Sparse
96	*Schima wallichii* (DC) Kortals.	Tree	Theaceae	Abundant
97	*Scoparia dulcis* L.	Herb	Scrophulariaceae	Common
98	*Semecarpus anacardium* L.f.	Tree	Anacardiaceae	Sparse
99	*Sida acuta* Burm. f.	Shrub	Malvaceae	Common

Table 4, continued

Sl. No.	Botanical name	Habit	Family	Status
100	*Sigesbeckia oriantalis* L.	Herb	Asteraceae	Common
101	*Smilax aspericaulis* Wall.	Climber	Smilaceae	Sparse
102	*Solanum nigrum* L.	Herb	Solanaceae	Abundant
103	*Solanum torvum* Swartz.	Shrub	Solanaceae	Common
104	*Sonchus oleraceus* L.	Herb	Asteraceae	Common
105	*Sorea robusta* Gaertner f.	Tree	Dipterocarpaceae	Sparse
106	*Spermadictyon suaveolens* Roxb.	Shrub	Rubiaceae	Rare
107	*Spondias pinnata* (L. f.) Kurz.	Tree	Anacardiceae	Sparse
108	*Stephania glabra* (Roxb.) Miers.	Climber	Menispermaceae	Endangered
109	*Tamarindus indica* L.	Tree	Caesalpinoideae	Sparse
110	*Terminalia bellirica* (Gaertner) Roxb.	Tree	Combretaceae	Rare
111	*Terminalia chebula* Retzius.	Tree	Combretaceae	Rare
112	*Tetradium fraxinifolium* (Hook.) T.G. Hartley.	Tree	Rutaceae	Sparse
113	*Thysanolaena latifolia* (Roxb. ex Hornem) Honda.	Shrub	Poaceae	Planted
114	*Tinospora cordifolia* (Willd.) Hook. f. & Thoms.	Climber	Menispermaceae	Endangered
115	*Tridax procumbens* L.	Herb	Asteraceae	Sparse
116	*Urena lobata* L.	Herb	Malvaceae	Sparse
117	*Vernonia saligna* DC.	Shrub	Asteraceae	Frequent
118	*Vitex negundo* L.	Tree	Verbenaceae	Frequent
119	*Woodfordia fruticosa* (L.) Kurz.	Shrub	Lythraceae	Sparse
120	*Youngia japonica* (L.) DC.	Herb	Asteraceae	Sparse
121	*Zingiber officinale* Rocs.	Herb	Zingiberaceae	Planted

The threat status of all the plant species have been analyzed by Raunukiaer's ecological statistics of frequency and IUCN. Accordingly, 16 plants species were facing endangered, 1 critically endangered, 17 are rare, 33 are frequent, 98 are sparse, 2 vulnerable, 1 threatened, 9 are abundant, 24 were planted and 18 were common in the study areas (Table 1–4 and Figure 4).

Figure 1. Location of Darjeeling district (study area) of West Bengal, India.

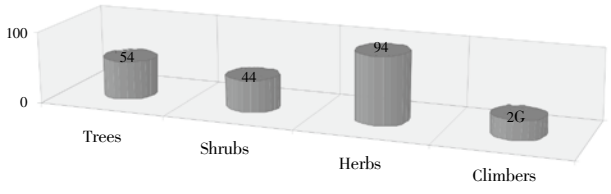

Figure 2. Distribution types of medicinal plants throughout the district.

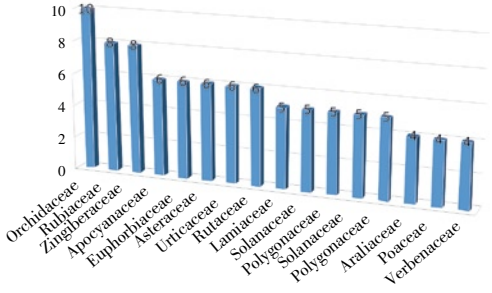

Figure 3. Genus with family wise distribution of plants.

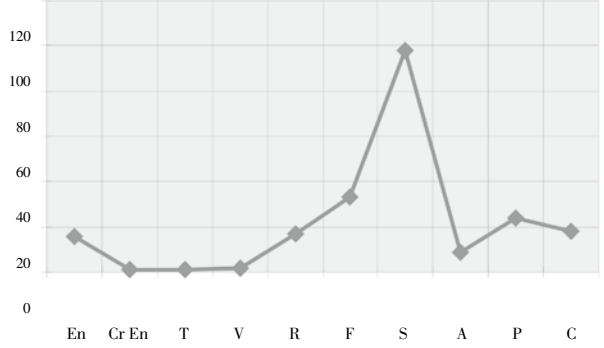

Figure 4. Ecological status of plant species.
(En=Endangered, Cr En=Critically endangered, R=Rare, =Vulnerable, F=Frequent, S=Sparse, T=Threatened, A=Abundant, P=Planted and C=Common).

4. Discussion

All these medicinal plants were still being used by various ethnic communities of Darjeeling hills of West Bengal for various ailments and diseases[10]. Distribution of these plants directly influence by the altitudinal ranges and

climatic influences. Depending upon the various changes in altitudinal ranges, from 130-3 636 m, the temperature also changes in great extremities from warmer to colder. The study area falling from plain of Siliguri 150 m to high hills of Sandakphu 3 636 m and vegetation of low altitude is quite different than the high altitude. The climate varies from one part of the district to another corresponding to the altitudes, topography and physiographic features of different areas. The district is unique in having three distinct climatic zones namely tropical, temperate and sub-alpine and it influence the richness and wide biological diversity[11]. The climatic condition of Siliguri is warmer than other hilly Sub-Divisions. Within the district the annual climatic condition remain wet summer and a dry winter. Therefore, it is concluded that there is sharp variation in the distribution of plant species at various altitudinal range. A large number of medicinal plant species are remarkably effective in treatment of several dreadful diseases of man and other animals while many more are edible, poisonous depending on the plant part and manner in which used[12]. Due to natural calamities, uncertain rainfall, raising temperature, frequent land slides, deforestation, indiscriminate collection and ignorance, the status of these plants are being vulnerable, threatened, rare and endangered.

Conflict of interest statement

We declare that we have no conflict of interest

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