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Plant wealth of Darjiling and Sikkim Himalayas *vis-à-vis* conservation

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Abstract
The richness of the flora of Darjiling Hills along with Sikkim and Nepal parts of the Eastern Himalaya is well known and that has attracted plant lovers, explorers and hunters almost equally for the last three centuries or so. The processes of evolution worked in this part of the Himalayas almost in an undisturbed condition for millions of years assisted by much varied but extremely favourable climatic conditions and has produced innumerable new species, a good proportion of which are still endemic to the region. The vegetation structure and the flora in different parts of this region have developed as per the local climatic make-up. So, when almost tropical vegetation is found on outer low altitude areas, it is sub-alpine to alpine to arctic in high altitude areas especially above 3000 m. Terai and Duars are located at the feet of the hills are maintaining a contiguous rich vegetation.
The vegetation scenario in this region is changing very fast during last three or four decades mostly due to anthropogenic activities. Extension of civilisation along with the population explosion lead to the increase in forest extraction, rate of modification of floristic composition, pollution content, soil erosion, plant introduction, clearing of natural vegetation etc.
There is evidence that the force of evolution is still active here but the lack of proper corridor (along with other factors mentioned above) for plant migration will certainly cause the weakening of numerous local species and the rate of extinction of species will increase in a logarithmic scale.
Like any other part of this planet here also it appears to be one nearly impossible task to save the local biodiversity. Just the declaration of some Protected Areas is not enough. Activities through ecotourism are also affecting the conservation practices. Unless we succeed to conserve the natural vegetation on this planet the entire biosphere will be dead within next 100 years.

Keywords: Flora, Darjiling, Sikkim, Himalayas, conservation

Sikkim is a recently incorporated state of India and Darjiling is the northernmost district for the state of West Bengal. While Sikkim is situated completely inside the hills of Eastern Himalaya, mainly on the Singalila Range and the major part of Darjiling District is hilly. Hills of Darjiling are the outer fringes of Singalila Range. Apart from these two hilly areas vegetation in Terai and Duars, located at the feet of Darjiling hills, all together, forming a contiguous vegetation and the changes are effected mainly due to differences in altitude.

Geography

Hills of Darjiling are situated within 26° 31¢ 05" and 27° 13' 10" N latitude and between 87° 59' 30" and 88° 53' E longitude. These hills are a part of Singalila Range of Eastern Himalaya, covering an altitudinal range of c.135 m (at Sukna) to 3660 m (at Phalut). The total area of Darjiling Hills is 2417.3 sq km (another 934.6 sq km area of Darjiling district is situated in the plains of Terai). In addition, wide areas of Terai and Duars are still now covered with very rich forests, which are contiguous with the forests of Darjiling Hills. Table 1 provided some basic information on Darjeeling Hills.

The state of Sikkim is also situated on Eastern Himalaya between 27° 10' – 28° 5' N latitude and between 88° 30' – 89° E longitude. The area is entirely hilly and the altitude is varying between 244 m and 8598 m and is interlaced with jungle clad ridges and deep ravines created by and through the mountain-rivers' speed and emerald valleys alternating with their terraced hill sides and dense forests (Champion & Seth 1968). The total area of the state is 7096 sq km of which 1889.21 sq km is snow covered (Jeyaraman *et al* 1998). The forest cover is estimated as c. 42.8 % (i.e. 3124 sq km) of which 2260 sq km is protected and reserve forests (Srivastava 1993, 1996).

Climatic Variation

The climate in different parts of Darjiling hills is extremely variable. Temperature and rainfall on these hills depend on numerous factors, which include exposure to sun and wind, location, altitude, extent of forest cover, development of human habitations, etc. But, in general, while a nearly tropical climate is prevailing in foothill regions and in Terai, it is sub-

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Area:		2417.3 sq km
Location:	Latitude	26° 31' 05" to 27° 13' 10" N
	Longitude	87° 59' 30" to 88° 53' E
Altitude:		135 to 3660 m
	[Tonglu 3000 m, Sandakphu 3500 m, Phalut 3660, Upper Rechila 3060 m]	
Rainfall:	Highest (Kurseong, 1987)	469.95 cm
	Ave. in Darjiling	344.96 cm
	Ave. in Kalimpong	224.56 cm
	Ave. in Kurseong	385.23 cm
Rainy Days:	Ave. in Darjiling	154.6 days
	Ave. in Kalimpong	116.6 days
	Ave. in Kurseong	210.2 days
Humidity:		89.58 to 95.83 %
Temperature:		36°C to −10°C
Places > 3000 m: Remain Snow Covered for 1 – 4 months		

Table 1: Vital statistics of Darjiling Hills (Das 2004).

alpine in places situated above 3000 m like Tonglu (3000 m), Sandakphu (3500 m), Phalut (3660), upper Rechila (3060 m), etc. The annual rainfall is around 300 cm with the highest rainfall recorded so far is 469.95 cm at Kurseong in the year 1987. While places above 2200 m are prone to receive snowfall in winter, the places above 3000 m remain covered with snow for 1 – 4 months of the year (Table 1).

Sikkim exhibits much higher diversity in climatic conditions. While in low altitude areas, as in Darjiling, a nearly tropical climate is prevailing, it is arctic type in high-mountain areas. In between these two extremes there are all possible types of intermediate climatic conditions.

The details of climatic data are not available from major part of the state. However, the substantial amount of 58 – 76 % of annual rainfall is received during monsoon and it generally varies in between 250 – 400 cm in different areas. Almost continuous snowfall and strong wind are the additional climatic characteristics in very high altitude areas (Jeyaraman *et al* 1998).

Earliest Report of Floristic Studies on Eastern Himalaya

Earliest report of exploration in this area, so far known to us, is by D. Don in 1821, which is based on some earlier collected specimens available in A.B. Lambert's herbarium. In 1825, D. Don published the *Prodromus Florae Nepalensis*.

Important Previous Works

After the establishment of a road link with Darjiling in 1840, construction of a sanatorium, introduction of tea cultivation and the creation of Lloyd Botanic Garden (in 1878), the present history of Darjiling was initiated. Sikkim was connected to the outer world little earlier though no motorable road was available at that time. The first recognisable botanical publication for Darjiling was a note on Tonglu flora by J.D. Hooker in 1849. It is followed by two interesting publications from Gamble (1875, 1896). King & Pantling's (1898) *The Orchids of the Sikkim - Himalaya* certainly included many plants from Darjiling, particularly of Teesta Valley. Cowan & Cowan (1929) improved effectively Gamble's (1875) list of plants. Probably, Biswas & Chopra's (1956) *Common Medicinal Plants of Darjeeling and Sikkim Himalayas* initiated the present history of its floristic studies in Darjiling. Publication of (only the first volume of) the *Flora of Darjeeling and the Sikkim Himalayas* was another good attempt by Biswas (1966). Hooker's *The Flora of British India* (1872 – 1897) also included plants from Darjiling. Other publications like Hara (1966, 1971), Hara *et al* (1978, 1979, 1982), Grierson & Long (1983, 1984, 1987, 1991, 1999, 2001), Noltie (1994, 2000), Matthew (1981), Ohashi (1975), Pearce & Cribb (2002) also covered the flora of Darjiling. But, a flora exclusively for Darjiling was missing. Most of the earlier publications were not much restricted with the borders of different countries (mainly Sikkim, Nepal and Darjiling part of India). However, Hooker (1849 – 51) published an account of Rhododendrons of Sikkim and Botanical Survey of India has compiled the materials for the monocotyledonous flora of Sikkim (Hajra & Verma 1996). But, none of these works can satisfy the requirement of a Flora of Sikkim.

Major Outcome from Our Laboratory

With the District Flora Project of Botanical Survey of India the floristic exploration in the district was initiated in 1983. The result of which is the preparation of the first volume of the *Flora of Darjeeling District: I. Dicotyledons* (Bhujel *et al*, in press) Works on the second volume [*Flora of Darjeeling District: II. Monocotyledons*] is now in progress. Works on the survey of climbing angiosperms in Darjiling and Sikkim Himalayas has been completed(Samanta 1998). Survey on the floras of Neora Valley National Park (Rai 2001) and Singalila National Park also has been completed. All these works are based on freshly collected materials and not on old collections deposited in different herbaria. Lama (2004) made a detailed work on the present status and distribution of different species of *Acer* in Darjiling and Sikkim Himalaya.

Hills of Darjiling and Sikkim share almost same forests and similar type of vegetation in many parts. This has tempted us to take up some works in Sikkim and surveys are in progress in *Maenum Wild Life Sanctuary* and *Pangolakha Wild Life Sanctuary*. Surveys of *Crop Field*

Table 2: Floristic estimate for Darjiling and Sikkim regions

Areas	Bacteria & Virus	Fungi	Lichens	Algae	Bryo.	Pterido.	Gymno.	Angios.	TOTAL
Darjiling	NPR	NPR	NPR	NPR	200	250	12	2900	3362+
Sikkim	NPR	NPR	300	NPR	NPR	350	15	4500	5165+

NPR=no proper record

Weeds and *Composition of Sacred Groves in Sikkim* and *The Diversity of trees in Sikkim* are also expected to generate very interesting and useful data, which might be helpful in understanding the vegetation of this region in a much better way. Some other relevant works from this laboratory like melissopalynological studies on natural honey from Darjiling and Sikkim (Bera *et al* 1997, 2003; Mukhopadhyay 2000; Mukhopadhyay *et al* 2003 a,b) and ethnobotanical surveys in many areas of these two places (Rai *et al* 1998; Rai & Bhujel 2002; Ghosh & Das 2004; Das *et al* 2007) are also helpful in understanding the importance of the greenery of Darjiling and Sikkim areas.

Numerical strength of the flora

The flora of Darjiling district (includes Terai, Duars & Hills) appeared to be equally rich with its adjacent areas of Eastern Himalaya. *Flora of Darjeeling District: I. Dicotyledons* (Bhujel *et al*, in press) has recorded the occurrence of around 1900 species and varieties of dicotyledonous plants covering 772 genera and 159 families. But, this is not the complete picture as many difficult terrains are yet to explore. Table 2 provides an estimate for the flora of this region.

This expresses the rich phytodiversity of this region and certainly justifies its coverage by ***Himalaya Hotspot***. The moist (along with widely distributed precipitation and fog formation) environment coupled with wide range of temperature regimes is also suitable for the proliferation of non-vascular groups of plants like bacteria & viruses, fungi, lichens, algae and bryophytes. But, so far there was very little effort to complete these records.

The estimate for Sikkim is quite higher than Darjiling (Table 2). In reality, there are much more variation in habitat structure in Sikkim. Majority of the plants growing in Darjiling are also growing in Sikkim. In addition, a good amount of plants recorded from Sikkim are yet to locate in Darjiling.

This number does not include plants those are strictly under cultivation. So far the record of monocotyledonous plants are concerned, Das (1986, 1987, 1995, 2004) recorded 237 species (covering 126 genera and 34 families) of monocotyledonous plants growing in the hills between Kurseong and Lebong via Ghoom and Darjiling covering an altitudinal range of 1500 to 2400 m. However, from our ongoing survey we now expect to record around 700 species of monocots from Darjiling District alone.

The record of a very high number of species in Bhutan Flora appears to be much exceptional. But a close look in this flora will reveal that not only the recently collected specimens and the specimens deposited in different herbaria but also records from literature were also incorporated in the enumeration. This will help the explorer not only to evaluate the present flora but also to search the apparently missing taxa.

If explored properly, a very rich monocotyledonous flora will be exposed for both the regions under discussion.

Table 3: Ten dominant dicotyledonous families in the flora of Darjiling Hills (Das 1995)

Families	No. of genera	Species	
		No.	% of dicot species
Fabaceae (s.l.)	45	139	7.32
Asteraceae	59	120	6.32
Euphorbiaceae	25	82	4.32
Rubiaceae	36	80	4.21
Rosaceae	20	76	4.00
Urticaceae	16	61	3.21
Lamiaceae	33	57	3.00
Scrophulariaceae	20	48	2.53
Lauraceae	11	41	2.16
Acanthaceae	21	40	2.11

Dominating Families

Among the dicotyledons, ten dominant families can be recognised for the Darjiling flora as follows (Table 3):

Singh & Chouhan (1998) considered Orchidaceae as the most dominating family in Sikkim flora with its 448 species. From their estimate ten dominant families in Sikkim has been recorded in Table 4.

At the generic level Singh & Chouhan (1998) considered *Primula* (56 spp.) is the best represented genus in Sikkim. This is followed by *Bulbophyllum* and *Pedicularis* (43 spp. each), *Dendrobium* and *Juncus* (36 spp. each), etc.

Distributional Pattern

Along with the increase of altitude, the climatic condition also varies from a nearly tropical to sub-alpine conditions in Darjiling and arctic in Sikkim. Such change of climatic condition is having pronounced effect on the distribution of floristic elements. There is not a single species of dicotyledonous plant, which can grow throughout this altitudinal range. So, the tropical flora of foothill, Duars and Terai and that of the floras of sub-alpine and alpine regions are completely different. But, both types are equally rich. Migration of some temperate elements towards the lower subtropical tier has been noted in many areas, especially during winter when a

Table 4: Ten dominant families of flowering plants in Sikkim (Singh & Chouhan 1998).

Family	No. of sp. in India	No. of sp. in Sikkim	%age
Orchidaceae	1087	448	41
Asteraceae	1069	280	26
Poaceae	1259	271	22
Fabaceae (s.l.)	1011	201	20
Cyperaceae	533	143	27
Rosaceae	492	138	28
Scrophulariaceae	423	112	26
Rubiaceae	659	110	17
Lamiaceae	452	95	21
Euphorbiaceae	528	94	21

beautiful herbaceous flora flourishes in many places in Terai and Duars, especially in river valleys (Das 2004).

Importance of the Flora

Richness and importance of a flora is generally recognised based not only on the total number of species occurring but also on the availability of important and useful plants and, of course, the extent of endemism. The flora of Darjiling-Sikkim Hills is under exploitation since long. British rulers, to shape the huge amount of *Shorea robusta* logs into railway slippers, collected from these forests, established a sawmill at Siliguri. The fantastic amount of collected logs as recorded in the files of the sawmill is enough to express the economic importance of Darjiling vegetation. Collection and marketing (including export) of wild orchids and other potential ornamental and medicinal plants was a fascinating profession in these hills. Legally or illegally, the profession is continuing till date. There are numerous publications on the occurrence of a very large number of medicinal plants for Darjiling and Sikkim (Biswas & Chopra 1956; Yonzan *et al* 1985; Yonzone *et al* 1987; Rai & Bhujel 1999, 2002; Rai *et al* 1998; Das & Chanda 1990; Das & Mandal 2003; Das *et al* 2006; Gurung 2002; Rai & Sharma 1994). The vegetations are also rich in numerous non-timber forest produces, the social and economic values of which can no way be neglected.

Exotic Flora

Along with the migration of civilisation numerous exotic species of plants also enter a place. When the British Government established a sanatorium at Darjiling for their sick officers working in India/ Indian subcontinent, they also tried to create a more homely atmosphere with the introduction of plants, which are generally grown in their motherland. Successful introduction of tea cultivation in Darjiling also lured many people to migrate there. Along with the increase of exotic human population, the number of introduced plants also increased. Hill people in Darjiling are very much fond of gardening. For this, the process of introduction is continued even today. All the plants introduced into the Darjiling-Sikkim Hills did not liked to remain within the fence. Many of them, subsequently, got escaped from the cultivation, acclimatised and then naturalised in the vegetation of this area. That is why, today we find, naturalised exotics are growing even in remote places (Das & Chanda 1986). Biswas (1940) remarked that over 40% plants in and around Darjiling are exotics. Das (2002) recorded 114 species of naturalised/ seminaturalised/ escaped exotics from the flora Darjiling hills of which only 15 species are monocotyledonous and the rest 99 species are dicotyledonous. Of these 72 (63.16%) were probably introduced as ornaments, 3 are fruit plants and 5 are fodder plants. Two narcotic yielding plants, *Cannabis sativa* and *Nicotiana tabacum*, are also recorded in naturalised and seminaturalised condition of which the first one is a dominating weed in many localities. The recorded 26 species (i.e. 22.81%) of weedy plants migrated through different channels and are unwanted intruders though growing naturalised. Tables 5 presented different homes of exotic flora of Darjiling hills (Das 1986, 1995, 2002; Das & Chanda 1986; Das *et al* 1985; Bhujel 1996).

Like the process of introduction, the processes of escape, acclimatisation and naturalisation are also a continuous process in the vegetation. Some of the recently naturalised exotics in Darjiling-Sikkim Himalayas include *Digitalis purpurea* L., *Eomecon chionantha* Hance, *Eupatorium ligustrinum* DC., *Galinsoga quadriradiata* Ruiz & Pavon, *Lepidium sativum* L., *Lepidium virginicum* L., *Lolium perenne* L., *Monthretia crocusmiflora* Hort. ex Morren, *Nandina domestica* Thunberg, *Oenothera erythrosepala* Borbas, *Oenothera rosea* Aiton, *Oxalis tetraphylla* Cav., *Saponaria officinalis* L., *Saxifraga sarmentosa* L.f., *Solanum mauritianum* Scopoli, *Tithonia diversifolium* (Hemsl.) A. Gray and *Trifolium dubium* Sibth (Das 2002).

Endemic flora

Chatterjee (1940, 1962) has cited that 60% of the Indian flora is of Indian origin and 40% of them are endemic to the country. The concentration of endemic flora is generally high in areas with extreme climatic conditions. Warm and cold deserts, in the similar process, generally contain much higher proportion of endemic flora. In Eastern Himalaya requirements for speciation were prevalent for a very long period. There is enough indication that the process is still active in this biozone as quite a good number of new species are recorded in the recent past (Das & Chanda 1988; Das & Lama 1992; Bhujel & Yonzone 1994; Bhujel *et al* in press). Naturally, working with the flora of this region one can encounter with a good proportion of endemic flora.

In the process, it is convenient to treat endemic elements in different categories according to their extent of distribution. The floristic elements from Darjiling towards east to NE India (including N. Myanmar) draw a special attention with a larger number of endemic species. The taxa available in Darjiling can be considered under four cat-egories of distinct geographical regions (Das 1986, 1995, 2004; Bhujel & Das 2002):

1. Taxa restricted within Darjiling
2. Taxa restricted within Darjiling and Sikkim
3. Taxa restricted within E. Himalaya

Table 5: Homes of exotics recorded from Darjiling Hills.

Native place of distribution	No. of species	%age representation
Central American region	35	30.71
South American region	24	21.05
Europe and Eurasia	21	18.42
Sino-Japanese region	15	13.16
Africa	12	10.53
Central Asia	2	1.75
North America	4	3.51
Myanmar region	1	0.88
Australian region	1	0.88

4.Taxa restricted between E. Himalaya and N.E. India

Details of these categories and the plants available in Darjiling are available in Bhujel & Das (2002) and Das (2004). For Darjiling District 21.26% of dicotyledonous plants are treated as endemics. While the first two groups of plants are definitely "endemic to India", plants belonging to third and fourth groups may also grow in some neighbouring countries like Eastern Nepal and Bhutan.

Apart from these, endemics are also quite common in the monocot flora of the region. Though a monocotyledonous flora for Darjiling is not available but, Das (1986) has recorded 75 species of endemic monocots from this region. Some such plants are: *Arisaema costatum* (Wallich) Mart.; *Arisaema speciosum* var. *mirabile* (Schott) Engler; *Arundinella hookeri* Munro ex Keng; *Calanthe brevicornu* Lindley; *Calanthe trulliformis* King & Pantling; *Cautleya cathcartii* Baker; *Chiloschista usneoides* Lindley; *Commelina sikkimensis* C. B. Clarke; *Cremastra appendiculata* (D. Don) Makino; *Galeola lindleyana* (Reichenbach f.) Reichenbach f.; *Gastrochilus corymbosus* Das & Chanda; *Goodyara hemsleyana* King & Pantling; *Juncus leschenaultii* Gay; *Liparis breviscapa* Das & Dorjay; *Liparis tigerhillensis* Das & Chanda; *Nervilia nacroglossa* (Hook.f.) Schlechter; *Ophiopogon parviflorus* (Hook.f.) Hara; *Otochilus alba* Lindley; Peristylus aristatus Lindley; *Platenthera hiermaniana* (King & Pantling) Kränzl.; *Platenthera latilabris* Lindley; *Plectocomia himalayana* Griffith; *Polygonatum cathcartii* Baker; *Smilax glaucophylla* Klotzsch; *Smilax rigida* Wallich; *Tupistra clarkei* Hook.f.; *Zeuxine goodyeroides* Lindley, etc.

It is expected that much higher proportion of Sikkim flora are endemics. But, until the state is properly explored it will not be possible to assess the extent of endemism. However, Singh & Chouhan (1998) has provided a short list of endemic angiosperms from Sikkim.

Gaps in Exploration

Though Darjiling is one well-explored area and numerous plant hunters/explorers, including Sir J.D. Hooker visited the place, even then wide stretches of these hills are yet to explore. Though, there is one very old publication on the plants growing between Darjiling and Tonglu (Hooker 1849), even then most of the areas in Singalila National Park are unexplored. Neora Valley National Park is nicely explored for its upper reaches (above 2300 m; Rai 2001) but the low altitude hills of this park also appear to be very rich. Flora of Lolegaon area, eastern part of Kalimpong subdivision, hilly regions of Mahananda Wild Life Sanctuary are poorly explored or completely unexplored areas. Vegetation structure of all these remote areas are also nicely forested, comparatively less disturbed and expected to expose many novelties.

Terrains in Sikkim are much difficult for outsiders to approach. Again, a considerable area in the state is permanently snow-covered and exhibiting a tough to tackle arctic climate. So, we find wide tracts in the state remained floristically un- or under-explored. Singh & Chouhan (1998) listed some areas those need immediate attention to explore includes Kanchendzonga National Park, Pangolakha Range, Dombyong Valley, Tankara La, Sakyong Valley, Tolung, Zemu and Llonak Valleys, Karchi, Hilly reserve forest., Mainam Reserve Forest, etc. As it appears, it will take a long time to explore major parts of Sikkim vegetation systematically. So, we need to wait for a unknown length of time to get a reliable Flora of Sikkim in hand.

Botanical Survey of India has established its Sikkim Himalayan Circle at Gangtok and the scientists are now approaching slowly towards these difficult terrains systematically.

Threats to the flora

Threats to the flora of Darjiling-Sikkim Hills are multifarious, which include:

- Population explosion and consequent clearing of vegetation for the extension of settlement and cultivation
- Logging – legal or illegal
- Excessive collection of Non Timber Forest Produces (NTFP)
- Uncontrolled collection of medicinal and ornamental plants
- Collection of forest floor humus
- Plantation programs using few and mostly exotic species
- Cardamom cultivation inside the natural forests
- Selection of only one or few species for plantation
- Absence of broad corridors between the conservatories or protected areas (PA)
- Increased man made forest-fire and land slides
- Too much increase in atmospheric pollution
- Excessive increase of automobiles
- Tourism programs inside the PAs
- Absence of public awareness about the need of conservation

- Flourishing timber-based industries
- Introduction and naturalization of exotic elements, etc.

Plants missing from Darjiling Hills

The presently available check list of angiosperms for Darjiling District (Das 1986; Das & Chanda 1987; Samanta 1998; Samanta & Das 1995; Bhujel 1996) do not bear the names of numerous plants which were previously recorded for this place at least in the *Flora of British India* (Hooker 1872 - 1897) and in Cowan & Cowan's (1929) account of woody plants of North Bengal. But, the frequent changes and absence of demarcated boundaries between Sikkim, Nepal, Darjiling and Bhutan in the past made it impossible to determine the actual location of numerous previously collected specimens. Given below are the names of some angiospermic climbers those were reported earlier by Gamble (1896) and/or Cowan & Cowan (1929) from this region but could not be traced during our present (Samanta 1998) surveys: *Hibiscus scandens* Roxburgh, *Euonymus macrocarpus* Gamble, *Salacia salacioides* (Roxb.) Rao & Hemadri, *Mucuna monosperma* DC., *Dunbaria grandiflorus* (Baker) van der Maesen, *Derris monticola* (Kurz) Prain, *D. polystachya* Bentham, *Caesalpinia microphylla* Hamilton, *Bauhinia championii* Bentham, *Mussaenda mastersii* King, *Jasminum subtriplinerve* Blume, *Ecdysanthera micrantha* A. DC., *Erycibe laevigata* Choisy, *Argyreia argentea* (Roxburgh) Choisy, *Argyreia atropurpurea* (Wallich) Raizada, *A. thomsonii* (Clarke) Babu, *A. sikkimensis* (Clarke) van Ooststroom, *Merrmia kingii* (Prain) Kerr, *Piper hamiltonii* C.DC., *Smilax roxburghiana* Wallich ex Hook.f., *Calamus acanthospathus* Griffith, *C. flagellum* Griffith, *C. leptospadix* Griffith, etc.

Probably a good proportion of these plants are extinct as their known area of distribution is quite small and most of these are endemic to this region.

Threatened Plants

Das (1998) prepared a list of 183 dicotyledonous and 39 monocotyledonous (total 222) endemic and endangered plants from Darjiling Himalaya, along with their habit, general distribution (both of place and altitude), local availability i.e. the present population structure and conservation measure adopted. The list included 14 species (i.e. 6.25%) endemic to the Darjiling, 93 species (i.e. 41.52%) endemic to Eastern Himalaya, 37 species (i.e. 16.52%) extending their distribution to NE Indian states, 9 species (i.e. 4.02%) endemic to Himalayas, 69 species (i.e. 30.8%) of SE Asiatic plants and 2 species (i.e. 0.89%) of wide distribution.

The availability of most of these plants is extremely poor. There are at least 30 species in the list for which only 1 or 2 individuals have been recorded since 1980. Similarly, 15 species with 3 - 5 individuals and 132 species with only 'few plants' (6 - 40 sparsely distributed individuals) are also considered as endangered. Some other species noted here for which only 1 to few populations of different sizes have been observed so far. Though phytosociological studies have not been done, even then it is not difficult to perceive the level of threat facing by these species for their survival and all these plants may be regarded as in the *'Critically Endangered'* (CE) stage of IUCN threatened plants categories. However, the population of many other plant species appears to be very poor but could not be assessed either because of their wide distribution or due to poor knowledge about their distribution in the habitat.

Some plants, like *Aconitum bisma* (Hamilton) Rapaics, *Anemone rupicola* Cambess, *Bauhinia scandens* L., *Heracleum wallichii* DC., *Mahonia napaulensis* DC., *Michelia doltsopa* DC., *M. velutina* DC., *Nardostachys grandiflora* DC., *Rauvolfia serpentina* (L.) Kurz, *Rheum acuminatum* Hook.f. & Thomson, *Swertia chirayita* (Roxburgh) Karsten, *Hedychium coccineum* var. *squarrosum* Baker, *H. greene* W.W. Smith, etc. became rare due to over exploitation from the natural habitat.

As much as 118 species of these recorded plants have

Major Area	Biosphere Reserve	National Parks	Sanctuaries
Darjiling	Singalila Biosphere Reserve (proposed)	Neora Valley National Park	Senchal Wildlife Sanctuary
		Singalila National Park	Mahananda Wildlife Sanctuary
Sikkim	Khangchendzonga Biosphere Reserve	Khangchendzonga National Park	Shingba Rhododendron Sanctuary
			Barsey Rhododendron Sanctuary
			Kyongnosla Alpine Sanctuary
			Fambong Lho Wildlife Sanctuary
			Maenam Wildlife Sanctuary
			Pangolakha Wildlife Sanctuary

Table 6: Different types of protected areas for in situ conservation in Darjiling and Sikkim Himalayas.

not been observed to grow in any protected vegetation but the remaining plants were spotted in one or more conservatories like National Parks and Wild Life Sanctuaries. Even though growing in conservatories these plants failed to increase their population sufficiently. Most of these plants grow in very specific habitat, in some cases restricted to one small hill slope only. It is not possible to protect all those places for *in situ* conservation. So, if any special assistance is not provided to each of these species for the increase of their population, *in situ* or *ex situ*, the risk to their survival will increase every day.

Conservation Status

Realising the importance of biodiversity of Darjiling-Sikkim areas Governments of India, West Bengal and Sikkim has declared a good number of protected areas (PA). Some such important *in situ* conservatories in Darjiling and Sikkim has been presented in Table 6.

But, these PAs are not covering all types of vegetation. There are numerous species those grow in a very small restricted area like one particular hill slope. If the habitat structure of that place is disturbed then the species will be extinct.

Another problem is the absence of proper corridor connecting different PAs for the migration of species of plants and animals. A recent attempt in Darjiling has proved that it is almost impossible to establish such corridors as the places in between any two PAs is occupied or modified by people. In many places, even though the land is belonging to the Forest Department but there are well developed human settlements.

Consequences

The wide scale modification of vegetation, extension of settlements and too much urbanisation in Darjiling and Sikkim is not an isolated story. This is happening almost round the year. Just the declaration of some PAs and taking few steps to control pollution is not enough to check the increasing deleterious effects on environment and the loss of biodiversity. Most of our major projects are seriously affecting the future of the biosphere. Unless we restrict our activities and substantially decrease the extraction of natural resources, it will be impossible to save the living world on this planet. And, if we continue then after 100 years there will be no one to see what others are doing! And, we shall prove that man is the only species on this planet who is digging up his own grave in a smiling face.

Conclusion

The flora of Darjiling-Sikkim Himalayas is yet to be properly known though the process of speciation is still in force in this region. But, most of the vegetations are now highly disturbed. Though the proportion of endemic flora is quite high but the conservation measure is no sufficient. Natural vegetation is decreasing very fast and numerous species getting extinct due to change in habitat structure. It is now important to take immediate steps to complete the existing biodiversity and framing strategies for proper conservation:

- Extensive programs to complete the biodiversity exploration of the area
- Strict implementation of rules of conservation and forestry operations
- Establishment of more well-defined PAs
- Establishment of vertical and parallel broad corridors among the PAs
- Stringent control over ecotourism
- Mass education about the need of conservation
- Proper training for forest and enforcement personnel
- *Ex situ* multiplication and reintroduction of threatened species of plants
- Establishment of more *ex situ* conservatories at different altitudes and in different climatic zones
- Maximum involvement of local experts in exploration and conservation programs; etc.

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