BULL. BOT. SURV. INDIA
Vol. 46., Nos. 1-4 : pp. 1-18, 2004

FLORISTIC STUDIES IN DARJEELING HILLS

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ABSTRACT

The geographical continuity of Darjeeling Hills with Nepal, Bhutan and Sikkim has resulted into the mosaic of floristic elements from these territories in the flora of the Darjeeling Hills, which is rich, both informs of luxuriance and species diversity, owing to a very congenial phyto-climatic conditions. The flora comprise 2137 species belonging to 898 genera and 193 families, of which *ca* 1900 species in 772 genera and 159 families belong to Dicots and the rest to the Monocots. While in 479 species (404 Dicots, 75 Monocots) are endemics, 114 species are exotics which have become permanent denizens in the flora of Darjeeling Hills. The flora is also rich in medicinal and other economically important species, including NTFPs. While a number of species could not be relocated in the region, *ca* 222 species have been considered endangered, of which 104 species occur within the protected areas, thus covered under *in situ* conservation. The paper epitomises the results of floristic studies carried out in the area by the author and his associates during the past 22 years and highlights both, the gaps as well as the future prospects.

INTRODUCTION

Darjeeling Hills are forming a cap on the northern boundary for the State of West Bengal (India) and is 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 *ca.*135 m (at Sukna) to 3660 m (at Phalut). The total area of Darjeeling Hills is *ca.* 2417.3 sq km (another 934.6 sq km area of Darjeeling district is situated in the plains of Terai), which is mostly forest covered. In addition, wide areas of Terai and Duars are still now covered with very rich forests, which are contiguous with the forests of Darjeeling Hills.

History of the Land

The present political demarcation of Darjeeling is quite recent. This landmass has changed hands many times within Sikkim, Nepal and India (Table 1). Again, the history of the Kalimpong part of Darjeeling hills is different, which was a part of Bhutan for a long time. The boundary of Nepal, Bhutan, Sikkim, Darjeeling, etc. were not so clearly demarcated earlier and the entire area was covered with very deep forest. So, there was every possibility that a specimen marked as Nepal might have actually been collected

from Sikkim or Darjeeling's territory. Naturally, the history of floristic studies in Darjeeling is intimately related to the same for Nepal and Sikkim, at least.

Table 1: The history of Darjeeling Hill areas.

Darjeeling part: Prior to 1789: [called *Goondri Bazar* till 1886]	In the Sovereign state of Sikkim
1789 1817 (part west to Teesta)	Gorkha army conquered it for Nepal.
10th February 1817	British restored it for Sikkim.
1827	Capt. Lloyd & Mr. Grant visited Darjeeling.
1st February 1835	Chogyal of Sikkim donated the place to British: token of friendship.
1840	First motorable road to Darjeeling.
Till 1706	Kalimpong area was annexed by Bhutan from Sikkim.
10th November 1865	Kalimpong ceded to British.
1866	Kalimpong was transferred to Darjeeling.
1850	Darjeeling was annexed to Rajsahi.
1905	Darjeeling was placed under Bhagalpur.
1912	Again transferred to Rajsahi.
1947 [at the time of India's independence]	Automatically included in West Bengal.

CLIMATIC VARIATION

The climate in different parts of Darjeeling 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-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 (Table2).

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 Darjeeling in 1840, construction of a sanatorium, introduction of tea cultivation and the creation of Lloyd Botanic Garden (in

Table 2: Some basic information on Darjeeling Hills.

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 Darjeeling	344.96 cm
	Ave. in Kalimpong	224.56 cm
	Ave. in Kurseong	385.23 cm
Rainy Days:		
	Ave. in Darjeeling	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

1878), the present history of Darjeeling was initiated. The first recognisable botanical publication for Darjeeling was a note on Tonglu flora by J.D. Hooker in 1849. It is followed by two interesting publications from Gamble (1875, 1896). King and Pantling's (1898) *The Orchids of the Sikkim Himalaya* certainly included many plants from Darjeeling, particularly of Teesta Valley. Cowan and Cowan (1929) improved effectively Gamble's (1875) list of plants. Probably, Biswas and Chopra's (1956) *Common Medicinal Plants of Darjeeling and Sikkim Himalayas* initiated the present history of its floristic studies in Darjeeling. 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 Darjeeling. Other publications like Hara (1966, 1971), Hara *et al* (1978, 1979, 1982), Grierson and Long (1983, 1984, 1987, 1991, 1999, 2001), Noltie (1994, 2000), Matthew (1981), Ohashi (1975), Pearce and Cribb (2002) also covered the flora of Darjeeling. But, a flora exclusively for Darjeeling was missing.

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.*, 2002) [now at the final stage of its printing]. Works on the second volume [*Flora of Darjeeling District: II. Monocotyledons*] is now in progress (with no financial assistance). Works

on the survey of climbing angiosperms in Darjeeling and Sikkim Himalayas (Samanta, 1998) has been completed with financial assistance from University Grants Commission. Another work, on the flora of Neora Valley National Park (Rai, 2001) also has been completed. All these four works are based on freshly collected materials and not on old collections deposited in different herbaria. A dissertation on the present status and distribution of different species of *Acer* in Darjeeling and Sikkim Himalaya is now at the concluding stage.

As we know, hills of Darjeeling and Sikkim share almost same forests and similar type of vegetation in many parts. This has tempted us take up some works in Sikkim and surveys are in progress in Maenum Wild Life Sanctuary and Pangalakha Wild Life Sanctuary. Surveys of Crop Field Weeds and Composition of Sacred Groves in Sikkim are also expected to generate very interesting and useful data, which might be helpful in understanding the Darjeeling vegetation in a much better way. On going works on Sikkim has been listed in Table 3.

Table 3: On going works within the territory of Sikkim.

Sl. No.	Districts	Title of projects
1.	South District	Flora of Maenum Wild Life Sanctuary.
2.	All Districts	Ethnobotanical studies on Lepchas in Sikkim.
3.	All Districts	Survey of crop field weeds of Sikkim.
4.	All Districts	Studies on the tree diversity in Sikkim Himalaya with special reference to the composition of sacred groves.

Some other relevant works from this laboratory like melissopalynological studies on natural honey from Darjeeling and Sikkim (Bera *et al.*, 1997; Mukhopadhyay, 2000) and ethno-botanical surveys in many areas of these two places (Rai *et al.* 1998; Rai and Bhujel 2002) are also helpful in understanding the importance of the greenery of Darjeeling hills.

Numerical strength of the flora

The flora of Darjeeling district appeared to be equally rich with its adjacent areas of Eastern Himalaya. *Flora of Darjeeling District: I. Dicotyledons* (Bhujel *et al.*, 2002) has recorded the occurrence of around 1900 species and varieties of dicotyledonous plants (Table-4).

This number does not include plants, which are strictly under cultivation. So far the record of monocotyledonous plants are concerned, Das (1986, 1995) recorded 237 species (covering 126 genera and 34 families) of monocotyledonous plants growing in the hills between Kurseong and Lebong via Ghoom and Darjeeling covering an altitudinal range of 1500 to 2400 m. Matthew (1981), on the other hand has recorded 205 species

Table 4: Numerical distribution of dicotyledonous flora of Darjeeling district.

Ranks of Taxa	Numbers
Families	159
Genera	772
Species (and varieties)	1900 (approx.)

covering 114 genera and 15 families. This has expressed the apparent richness of monocotyledonous flora for the region and the present exploration is certainly going to record a much higher number of plants. Table-5 displays the record of monocotyledonous plants in recent past from Eastern Himalaya (Hara 1966, 1971; Ohashi 1975), Nepal (Hara *et al.*, 1978, 1979, 1982), Kurseong Sub-division (Matthew, 1981) and Bhutan (including Darjeeling & Sikkim; Noltie 1994, 2000; Pearce and Cribb, 2002.).

Table 5: Records of monocotyledonous taxa in different floras covering Eastern Himalaya.

	Flora	Families*	Genera	Species & Varieties
1.	Enumeration of the Flowering Plants of Nepal	26	228	680
2.	Flora of Eastern Himalaya	33	338	950
3.	Enumeration of the Flowering Plants of Kurseong	15	114	205
4.	Flora of Bhutan	48	412	1550
5.	Das 1986, 1995	17	126	237

* There are much variations in the delimitation of different families in these works.

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 the district of Darjeeling against its wide diversity in vegetation structure and climatic conditions.

Dominating Families

Among the dicotyledons, ten dominant families can be recognised for the Darjeeling flora as follows (Table-6):

Table 6: Ten dominant dicotyledonous families in the flora of Darjeeling Hills.

Families	No. of Genera	No. of Species	% of Dicot Species
1. Leguminosae	45	139	7.32
2. Asteraceae	59	120	6.32
3. Euphorbiaceae	25	82	4.32
4. Rubiaceae	36	80	4.21
5. Rosaceae	20	76	4.00
6. Urticaceae	16	61	3.21
7. Lamiaceae	33	57	3.00
8. Scrophulariaceae	20	48	2.53
9. Lauraceae	11	41	2.16
10. Acanthaceae	21	40	2.11

Distributional Pattern

Along with the increase of altitude, the climatic condition also varies from a nearly tropical to sub-alpine conditions. 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 and Terai and that of sub-alpine region 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, specially during winter when a beautiful herbaceous flora flourishes in many places in Terai and Duars, specially in river valley (Das).

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 Darjeeling 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 amount of collected logs, as recorded in the files of the sawmill, is enough to express the economic importance of Darjeeling vegetation. Collection and marketing (including export) of wild orchids and other potential ornamental 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 in the area (Biswas and Chopra 1956; Yonzan *et al.*, 1985; Yonzone *et al.*, 1987; Rai & Bhujel 1999, 2002; Rai

et al., 1998). The vegetation is also rich in numerous non-timber forest products, the social and economic value of which can in 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 Darjeeling for the recovery of health of 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 Darjeeling 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 Darjeeling are very much fond of gardening. For this, the process of introduction is continued even today. All the plants introduced into the Darjeeling Hills did not remain within the area. Many of them, subsequently, escaped from the cultivation, acclimatised and then naturalised in the vegetation of this area. That is why, today we find, naturalised exotics growing even in remote places (Das & Chanda 1986). Biswas (1940) remarked that over 40% plants in and around Darjeeling are exotics. Das (2002) recorded 114 species of naturalised/ seminaturalised/ escaped exotics in the flora of Darjeeling hills of which, only 15 species are monocotyledonous (covering 14 genera and 7 families) the rest 99 species are dicotyledonous (covering 88 genera and 41 families). Of these, 72 (63.16%) were probably introduced as ornamental, 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 at numerous localities. The recorded 26 species (i.e. 22.81%) of weedy plants migrated through different channels and though growing in a natural way are unwanted intruders. Tables-7, 8 and 9 present different aspects of the exotic flora of Darjeeling hills (Das 1986, 1995, 2002; Das & Chanda 1986; Das *et al.*, 1985; Bhujel, 1996).

Table 7: Origin of exotics recorded from Darjeeling Hills.

Native place of distribution	No. of Species	% representation
Central American region	35	30.71
South American Countries	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

Table - 8: Habit group distribution of the exotics growing in Darjeeling Hills.

Habit Groups	No. of Species	% representation
Trees	06	5.26
Shrubs	24	21.05
Climbers	08	7.02
Perennial Herbs	26	22.81
Annual Herbs	50	43.86
TOTAL :	114	

Table - 9: Taxonomic distribution of exotic elements in Darjeeling Hills.

	No. of Families	No. of Genera	No. of Species
Dicotyledonous	41	88	99
Monocotyledonous	07	14	15
TOTAL:	48	102	114

Like the process of introduction, the processes of escape, acclimatisation and naturalisation are also a continuous process in the vegetation. Table -10 presents a list of recently naturalised plants in Darjeeling Himalaya.

Table - 10: Some recently naturalised exotics in Darjeeling Himalaya.

Name	Family
Digitalis purpurea L.	Scrophulariaceae
Eomecon chionantha Hance	Papaveraceae
Eupatorium ligustrinum DC.	Asteraceae
Galinsoga quadriradiata Ruiz & Pavon	Asteraceae
Lepidium sativum L.	Brassicaceae
L. virginicum L.	Brassicaceae
Lolium perenne L.	Poaceae
Montbretia crocosmiflora Hort. ex Morren	Iridaceae
Nandina domestica Thunberg	Nandinaceae
Oenothera erythrosepala Borbas	Onagraceae

Name	Family
Oenothera rosea Aiton	Onagraceae
Oxalis tetraphylla Cav.	Oxalidaceae
Saponaria officinalis L.	Caryophyllaceae
Saxifraga sarmentosa L.f.	Saxifragaceae
Solanum mauritianum Scopoli	Solanaceae
Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae
Trifolium dubium Sibth.	Papilionaceae

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 good 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.*, 2002). 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 stretch of distribution. The floristic elements from Darjeeling towards east to NE India (including N. Myanmar) draw a special attention with a large number of endemic species. Therefore, for the taxa available in Darjeeling, the following four categories of distinct geographical regions have been considered (Das 1986, 1995; Bhujel & Das 2002):

1. Taxa restricted within Darjeeling
2. Taxa restricted within Darjeeling and Sikkim
3. Taxa restricted within E. Himalaya
4. Taxa restricted between E. Himalaya and N.E. India

The numerical distributions of recorded endemics in these four regions are presented in Table 11.

A. Plants endemic to Darjeeling:

These plants, till date, are recorded from Darjeeling area only. Some of them are extremely rare and some are recorded from places situated very near to state or national boundaries. So, there is every possibility that they can be recorded from other states or countries in future. There is one specimen of *Acer osmastonii* at DD but with doubtful locality. Sometimes its occurrence has been claimed for Sikkim, but we have not come across any such specimen. Interestingly, *Streptocaulon sylvestre* is now endemic to North Bengal University campus only (Das, 1996; Kadir, 2001). Plants recorded for

Table 11: Dicotyledonous species of Darjeeling with restricted distribution between E. Himalaya to N.E. India.

Zones	No. of Species	% of Total Dicotyledonous Species
1. Darjeeling district	23	1.2
2. Darjeeling-Sikkim	31	1.6
3. E.Himalayan (E. Nepal Arunachal Pradesh)	143	7.53
4. E. Himalaya to N.E. India	207	10.89
TOTAL :	404	21.26

this group include: *Acer osmastonii* Gamble; *Baliospermum calycinum* var. *racemifotrum* Bhujel and Yonzone; *Beilschmiedia clarkei* Hook.f.; *Carlemannia congesta* Hook.f.; *Chrysosplenium singalilense* Hara; *Cotoneaster sandakphuensis* Klotz.; *Geum sikkimense* Prain; *Ceropegia longifolia* var. *darjeelingensis* Das and Chanda ex Bhujel and Das; *Ligularia pachycarpa* (Hook.f.) Kitamura; *Macaranga gamblei* Hook.f.; *Maytenus sikkimensis* (Prain) Raju & Babu; *Mycetia stipulata* (Hook.f.) Kuntze; *Phoebe hainesiana* Brandis; *Rhus succedanea* var. *himalaica* Hook.f.; *Rubus senchalensis* Hara; *Streptocaulon sylvestre* Wight, etc.

B. Endemic to Darjeeling and Sikkim Himalayas :

The district of Darjeeling shares a long stretch of its border, from Singalila mountain to Rachela across Teesta, with Sikkim, and the physiographic and climatic conditions also show much similarity with exceptions at some regions. Darjeeling-Sikkim Himalayas, rather, form a distinct unit of physiography and forms a contiguous habitat structure. Therefore, it is expected that the region harbour a good number of endemic species, which show their distribution both in Sikkim and Darjeeling. Following are some such endemics: *Ardisia involucrata* Kurz; *Begonia flaviflora* (Clarke) Hara; *Boehmeria macrophylla* var. *tomentosa* (Wedd.) Long; *Chirita calva* Clarke; *Clematis acuminata* var.*sikkimensis* Hook.f. & Thomson; *Elatostema sikkimense* Clarke; *Hypericum gracilipes* Fischer; *Impatiens graciliflora* Hook.f.; *Miliusa longifolia* (Hook.f. & Thomson) Sinclair; *Sonerila kurzii* Clarke; *Sorbus insignis* (Hook.f.) Hedlund; *Strobilanthes oligocephalus* T. Anderson; *Tripterospermum nigrobaccatum* Hara; *Tournefortia hookeri* Clarke, etc.

C. Plants Endemic to Eastern Himalaya (Eastern Nepal-Arunachal Pradesh):

Eastern Himalaya is extending from Eastern Nepal to Arunachal Pradesh. There are very good number (143 species i.e. 7.53%) of plants recorded from Darjeeling with their distribution extending from eastern Nepal to extreme eastern part Eastern Himalaya. Following are some such plants: *Acanthus carduaceus* Griff.; *Acer hookeri* Miq.; *Actinidia strigosa* Hook.f. & Thomson; *Agapetes hookeri* (Clarke) Sleumer; *A. sikkimensis* Airy Shaw;

Ajuga macrosperma var. *breviflora* Hook.f.; *Alstonia neriifolia* D. Don; *Aristolochia griffithii* Duchartre; *A. nakaoi* Maekawa; *Astragalus sikkimensis* Bunge; *Asystasia macrocarpa* Nees; *Beaumontia grandiflora* Wallich; *Baliospermum calycinum* var. *nepalense* (Huruswa & Tanaka) T. Chakraborti; *Begonia gemmipara* Hook.f.; *B. sikkimensis* A.DC.; *Berberis hookeri* Lemaire; *Berchemia flavescens* (Roxburgh) Brongn.; *Desmos praecox* (Hook.f. & Thomson) Safford; *Didymocarpus albicalyx* Clarke; *Codonopsis affinis* Hook.f. & Thomson; *Combretum wallichii* DC.; *Brassaiopsis mitis* Clarke; *Biswarea tonglensis* (Clarke) Cogn.; *Callicarpa vestita* Clarke; *Chirita primulacea* Clarke; *Dipsacus atratus* Clarke; *Elatostema caveanum* Grierson & Long; *E. subincisum* Wedd.; *Eriobotrya dubia* (Lindley) Decaisne; *Heracleum wallichii* DC.; *Hoya serpens* Hook.f.; *Ilex hookeri* King; *Impatiens cathcartii* Hook.f.; *I. cristata* Wallich; *I. kingii* Hook.f.; *I. stenantha* Hook.f.; *Kadsura heteroclita* (Roxburgh) Craib; *Marsdenia calesiana* Wight; *Maytenus kurzii* Bennett & Sahni; *Microsisymbrium axillare* (Hook.f. & Thomson) Schultz; *Neanotis gracilis* (Hook.f.) W.H. Lewis; *Pedicularis flexuosa* Hook.f.; *Persea clarkeana* (Hook.f.) Kostermans; *Pilea approximata* Clarke; *Populus glauca* Haines; *Potentilla peduncularis* D.Don; *Pouzolzia sanguinea* var. *nepalensis* (Wedd.) Hara; *Primula irregularis* Craib; *Pueraria sikkimensis* Prain; *Randia sikkimensis* Hook.f.; *Rheum acuminatum* Hook.f. & Thomson; *Rhododendron arboreum* ssp. *cinnamomeum* var. *roseum* Lindley; *Ribes griffithii* Hook.f. & Thomson; *Rubia charaefolia* G. Don; *Rubus splendidissimus* Hara; *Scrophularia urticaefolia* Benth.; *Smithia grandis* Baker; *Sorbus foliolosa* (Wallich) Spach. *S. sikkimensis* Edgw. & Hook.f.; *Stellaria lanata* Edgw. & Hook.f.; *Symplocos pyrifolia* G. Don; *Tetrastigma campylocarpum* (Kurz) Planch.; *Thunbergia lutea* T. Anders; *Vaccinium subdissitifolium* Stevens; *Vernonia subsessilis* DC.; *Viola hookeri* Thomson; *Vitex heterophylla* Roxburgh; *Wendlandia coriacea* (Wallich) DC., etc.

D. Endemic to Eastern Himalaya and N.E. India :

The restricted distribution of a number of taxa within the North Eastern India indicates a separate identity for this zone in the vegetation map. A large number of such plants show their range of occurrence right from Eastern Himalayan regions. In the present consideration the taxa restricted within Eastern Himalaya and N. E. India, including Northern Myanmar have been taken, and it is observed that 202 dicotyledonous species (i.e. 10.6% of dicotyledons) of this group occur in Darjeeling district. Following are some such plants: *Acer thomsonii* Miq.; *Actinodaphne angustifolia* Nees; *Aeschynanthus gracilis* Clarke; *A. sikkimensis* (Clarke) Stapf; *Alchornea mollis* (Benth.) Muell.-Arg.; *Ampelocissus sikkimensis* (Laws) Planch.; *Aralia armata* Seemann; *Argyreia hookeri* Clarke; *Aristolochia cathcartii* Hook.f.; *A. platanifolia* (Klotz.) Duch.; *Aucuba himalaica* Hook.f.; *Begonia dioica* D. Don; *B. hatacoa* D. Don; *Berberis insignis* Hook.f. & Thomson; *Brassaiopsis hispida* Seemann; *Capparis olacifolia* Hook.f. & Thomson; *Casearia kurzii* Clarke; *Castanopsis lanceifolia* (Roxburgh) Hickel & Camus; *Cinnamomum glaucescens* (Nees) Handel.-Mazz.; *Clerodendrum bracteatum* Wallich ex Walpers; *Croton himalaicus* Long; *Cyclea bicristata* (Griff.) Diels; *Daphne sureil* Smith & Cave; *Dobinea vulgaris* D. Don; *Docynia indica* (Wall.) Decaisne; *Drypetes assamica* (Hook.f.) Pax & Hoffmann;

Dunbaria circinalis (Benth.) Baker; *Dysoxylum reticulatum* King; *Ehretia wallichiana* Thomson ex Clarke; *Elaeagnus conferta* Roxburgh; *E. pyriformis* Hook.f.; *Elaeocarpus sikkimensis* Masters; *Elatostema reptans* Hook.f.; *Enkianthus deflexus* (Griff.) Schneider; *Eriobotrya petiolata* Hook.f.; *Gaultheria fragrantissima* Wallich; *G. griffithiana* Wight; *Glochidion khasiaum* (Muell.) Hook.f.; *Goldfussia capitata* Nees; *Gynocardia odorata* R. Brown; *Helicteres elongata* Masters; *Hoya globulosa* Hook.f.; *Ilex crenata* Thunb.; *Impatiens bracteata* Wallich; *I. jurpia* Hook.f. & Thomson; *Ixora acuminata* Roxburgh; *Jasminum nervosum* Lour.; *J. nepalense* Sprengel; *Lasianthus sikkimensis* Hook.f.; *Leea aequata* L.; *Lindera assamica* (Meisn.) Kurz; *Litsea albescens* (Hook.f.) Long; *L. hookeri* (Meisn.) Long; *Lithocarpus elegans* (Blume) Soepadmo; *Loranthus odoratus* Wallich; *Lycianthes biflora* (Lour.) Bitter; *Microchites elliptica* Hook.f.; *Miliusa macrocarpa* Hook.f. & Thomson *Mussaenda incana* Wallich; *Ophiorrhiza fasciculata* D. Don; *Passiflora geminiflora* D. Don; *Pedicularis furfuracea* Benth.; *Pieris formosa* (Wallich) D. Don; *Pilea cordifolia* Hook.f.; *Piper khasianum* C. DC.; *Pogostemon brachystachyus* Benth.; *Polyalthia simiarum* Hook.f. & Thomson; *Prunus rufa* var. *tricantha* (Koehne) Hara; *Pueraria lobata* var. *thomsonii* (Benth.) V. Maesen; *Quercus thomsoniana* A. DC.; *Rabdosia lophanthoides* (D. Don) Hara; *Rhododendron campylocarpum* Hook.f.; *Rhus griffithii* Hook.f.; *Rhynchosia harae* Ohashi & Tateshi; *Rubia sikkimensis* Kurz; *Salacia salacioides* (Roxburgh) Rao & Hemadri; *Sarcosperma arboreum* Hook.f.; *Spiraea micrantha* Hook.f.; *Solanum barbisetum* Nees; *Stephania elegans* Hook.f. & Thomson; *Sterculia lanceifolia* G. Don; *Stixis graveolens* (Roxburgh) Pierre; *Styrax hookeri* Clarke; etc.

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 Darjeeling is not available, Das (1986), Das and Chanda (1987) recorded 237 species (covering 17 families and 126 genera), growing between 1500 -2400 m including at least 75 species of endemics (Table-12). Following is a short list of some such plants: *Arisaema costatum* (Wallich) Mart.; *Arisaema speciosum* var. *mirabile* (Schott) Engler; *Arundinella hookeri* Munro ex Keng; *Calanthe brevicornu* Lindley; *Calanthe trulliformis* King and Pantling; *Cautleya cathcartii* Baker; *Chiloschista usneoides* Lindley; *Commelina sikkimensis* C. B. Clarke; *Cremastra appendiculata* (D. Don) Makino; *Galeola lindleyana* (Reichb. f.) Reichb. f.; *Gastrochilus corymbosus* Das & Chanda; *Goodyera hemsleyana* King & Pantling; *Juncus leschenaultii* Gay; *Liparis breviscapa* Das & Dorjay; *Liparis tigerhillensis* Das & Chanda; *Nervilia macroglossa* (Hook.f.) Schlechter; *Ophiopogon parviflorus* (Hook.f.) Hara; *Otochilus alba* Lindley; *Peristylus aristatus* Lindley; *Platenthera biermaniana* (King & Pantling) Kränzl.; *Platanthera latilabris* Lindley; *Plectocomia himalayana* Griffith; *Polygonatum cathcartii* Baker; *Smilax glaucophylla* Klotzsch; *Tupistra clarkei* Hook.f.; *Zeuxine goodyeroides* Lindley, etc.

Gaps in Exploration:

Though Darjeeling 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 be explored. Though, there is one very old publication on the plants growing between Darjeeling 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) 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. All these areas are well forested, comparatively less disturbed and expected to yield many novelties.

Table 12: Monocotyledonous species of Darjeeling Hills (1500 2400 m) with restricted distribution between E. Himalaya to N.E. India.

Zones	No. of Species	% of Total Dicotyledonous Species
Darjeeling district	05	2.11
Darjeeling-Sikkim	08	3.38
E.Himalayan (E. Nepal-Arunachal Pradesh)	21	8.86
E. Himalaya to N.E. India	41	17.30
TOTAL :	75	31.65

Threats to the flora:

Threats to the flora of Darjeeling Hills are multifarious, which include:

1. Population explosion.
2. Clear felling-legal or illegal.
3. Excessive collection of Non Timber Forest Products (NTFP).
4. Collection of medicinal and ornamental plants.
5. Collection of forest floor humus.
6. Plantation programmes using exotic species.
7. Selection of only one or few species for plantation.
8. Absence of broad corridors between the conservatories.
9. Increased man made forest-fire and land slides.
10. Increase of atmospheric pollution.

11. Excessive increase of automobiles.
12. Tourism inside the conservations areas.
13. Absence of public awareness about the need of conservation.
14. Flourishing timber-based industries.
15. Introduction and naturalization of exotic elements, etc.

Plants missing from Darjeeling Hills

The presently available check list of angiosperms of Darjeeling 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 and Cowan's (1929) account of woody plants of North Bengal. But, the frequent changes and absence of demarcated boundaries between Sikkim, Nepal, Darjeeling 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 that were reported earlier by Gamble (1896) and/or Cowan and Cowan (1929) from this region but could not be traced during our present (Samanta, 1998) surveys: *Hibiscus scandens* Roxb., *Euonymus macrocarpus* Gamble, *Salacia salacioides* (Roxb.) Rao & Hemadri, *Mucuna monosperma* DC., *Dunbaria grandiflora* (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, *Merremia 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.

Threatened Plants

Das (1998) prepared a list of 183 dicotyledonous and 39 monocotyledonous (total 222) endemic and endangered plants from Darjeeling 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 Darjeeling, 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 faced by these species for their survival and all these plants may be regarded as *'Critically Endangered'* (CR) 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 not been observed to grow in any natural conservatory but the rest of the listed plants were spotted in one or more conservation area like National Parks and Wildlife Sanctuaries. Eventhough 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 under *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.

CONCLUSION

The flora of Darjeeling Hills is yet to be properly documented. The process of speciation is still in force in this region. At the same time, most of the places are now highly disturbed. Though a good proportion of endemics are components of Darjeeling flora, but the conservation measure is not sufficient. Most of the threatened plants were not found growing inside the conservatories during last 22 years of observations in the area. Immediate steps are to be taken for complete exploration of the area and following strategies may be adopted for proper conservation:

— Complete exploration of the area
— Strict implementation of rules of conservation and forestry operations
— Establishment of few more conservatories
— Establishment of vertical and parallel broad corridors among the conservatories
— 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 Botanic Gardens for *ex situ* conservation and mass education in different climatic tiers; etc.

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