# Chapter - 8

# ANALYSIS OF THE FLORA

The flora of the partially Himalayan district Darjeeling was not known properly. The area was surveyed by many stalwart floristic experts incliding Sir J.D. Hooker, Cambell, Griffith, Fr. Buchanan Hamilton, H. Hara, H. Ohashi, K.P. Biswas, D.G. Long, H.J. Noltie and many others. In recent years K.M. Matthew, A.P. Das and R.B. Bhujel and significantly contributing knowledge to the flora of Darjeeling district. Even then a complete flora for the district was not available. Hills of Darjeeling and the places in Terai and Duars are well known and preferred spots for on field traing for the students of botany and forestry.

R.B. Bhujel has presented the Dicotyledonous flora of Darjeeling district in 1996 which is now in press for publication. The present work, the Monocotyledonous flora of Darjeeling will complete the angiospermic flora of this floristically extremely important district.

The District of Darjeeling is a hugely populated place, though it has some quite well conserved, least interfered and even virgin places still rich in plant diversity. The most of the efficient reasons for development of such a rich floristic diversity of the region is its diversity in habitat structure, wide altitudinal ranges, unique and much variable climatic conditions, variation in adaphic and topographic conditions, high and widely distributed precipitation and the natural inter-relationship within the species. The Darjeeling region of the Eastern Himalaya has attracted a large number of tourists, botanists and naturalists from throughout the world at least for the last three centuries as it is floristically rich vegetation against the background of tallest Himalayan snow-covered peaks. The region forms a part of the IUCN recognized *Himalaya Biodiversity Hotspot.*

## 8.1. TAXONOMIC DISTRIBUTION DICOTYLEDONOUS FLORA

A recent survey on dicotyledonous flora of the district has recorded the presence of as much as 1877 species and varieties of dicotyledonous angiosperms covering 159 families and 772 genera (Bhujel 1996). The present floristic survey of the district revealed a very rich flora, and a total of 768 species and varieties of 299 genera belonging to 36 families of monocotyledonous angiosperms

As it is observed in any part of the world, the vegetation of Darjeeling district is also dominated by the dicotyledonous angiosperms. A comparison of the previous floristic studies covering this area (Hooker, J. D. 1872–1896; Hara *et al* 1966, 1971; Ohashi 1975; Bhujel 1996, Noltie 1994, 2000; Pearce & Cribb 2002 etc) with the present work revealed that the monocot-dicot ratio of the flora of the district is approximately 1: 3.33.

Due to the widely varied but much favourable environmental and topographical conditions ranging from plains of Terai and deep and hot tropical river valleys (Tista, Mahananda, Rangeet, etc.) to simmering cold snow line as well as the contagious topography with other floristically rich areas of Eastern Himalaya towards the northern part and with the tropical regions of Gangetic plains of northern Bengal through the numerous river valleys towards its southern part, the district equally represents all the habit groups of plants such as herbs, shrubs, trees, climbers, epiphytes, parasites, saprophytes, symbionts etc. The dense forests of the valley housed a large number of economically important species of plants including numerous NTFP species. The local people use large number of wild floristic wealth which has been found to be of

great economic significance for them including food, fodder, ornamental, medicine, religious and socially valuables etc. Poaceae, Araceae, Arecaceae, Orchidaceae, Dioscoreaceae, Zingiberaceae, Amryllidaceae etc. are the most important monocotyledonous families which contributed maximum number of potentially important species of plants for the human welfare (Das & Chanda 1990; Rai 2002; Pandit *et al* 2004; Ghosh & Das 2007; Rai *et al* 2008; Das *et al* 2010).

## 8.2. ANALYSIS

### 8.2.1. NUMERICAL DISTRIBUTION OF TAXA

The present floristic survey of the Darjeeling district dealing with the monocotyledonous angiosperms revealed the presence of a total of 768 species and varieties of 299 genera belonging to 36 families (Table 8.1).

**Table 8.1.** Numerical representation of monocotyledonous flora of Darjeeling district

| Taxon | Number |
|---|---|
| Families | 36 |
| Genera | 299 |
| Species ( and varieties) | 768 |

Numerical distribution of the recorded 36 families of Monocotyledonous angiosperms is shown in the following table. (Table 8.2)

**Table 8.2.** Family-wise [*sensu* APG-III] numerical distribution of Monocotyledonous flora of Darjeeling District

| Sl. No. | Familiy | No. of Genera | No. of Species |
|---|---|---|---|
| 1 | Acoraceae | 1 | 1 |
| 2 | Alismataceae | 4 | 5 |
| 3 | Amaryllidaceae | 4 | 10 |
| 4 | Aponogetonaceae | 1 | 4 |
| 5 | Araceae | 19 | 53 |
| 6 | Arecaceae | 12 | 19 |
| 7 | Asparagaceae | 14 | 29 |
| 8 | Bromeliaceae | 1 | 1 |
| 9 | Burmanniaceae | 1 | 1 |
| 10 | Cannaceae | 1 | 2 |
| 11 | Colchicaceae | 2 | 3 |
| 12 | Commelinaceae | 9 | 24 |
| 13 | Costaceae | 1 | 1 |
| 14 | Cyperaceae | 20 | 106 |
| 15 | Dioscoreaceae | 1 | 10 |
| 16 | Eriocaulaceae | 1 | 7 |
| 17 | Hydrocharitaceae | 6 | 7 |
| 18 | Hypoxidaceae | 3 | 5 |
| 19 | Iridaceae | 6 | 7 |
| 20 | Juncaceae | 2 | 8 |
| 21 | Liliaceae | 2 | 2 |

| Sl. No. | Familiy | No. of Genera | No. of Species |
|---|---|---|---|
| 22 | Marantaceae | 3 | 3 |
| 23 | Melanthiaceae | 1 | 1 |
| 24 | Musaceae | 1 | 3 |
| 25 | Orchidaceae | 66 | 187 |
| 26 | Pandanaceae | 1 | 2 |
| 27 | Poaceae | 94 | 207 |
| 28 | Pontederiaceae | 2 | 3 |
| 29 | Potamogetonaceae | 1 | 2 |
| 30 | Smilacaceae | 2 | 13 |
| 31 | Stemonaceae | 1 | 1 |
| 32 | Tofieldiaceae | 1 | 1 |
| 33 | Typhaceae | 1 | 1 |
| 34 | Xanthorrhoeaceae | 2 | 2 |
| 35 | Xyridaceae | 1 | 1 |
| 36 | Zingiberaceae | 11 | 36 |
| | **TOTAL** | **299** | **768** |

Numerical dominance of the monocot families was observed and the result revealed that Poaceae with 207 species and varieties from 94 genera is the largest and most dominating family of angiosperms as a whole (including the dicots) as far as the flora of the Darjeeling district is concerned. It is followed by Orchidaceae (187 species from 66 genera). Nine of the 36 recorded monocot families are represented in the flora by one species only and five families by two species. Numerical dominance of the monocot families of the district are shown in Table 8.3.

**Table 8.3.** Ten dominant Monocotyledonous families [*sensu* APG-III] of Darjeeling District

| Sl. No. | Families | No. of Genera | No. of Species |
|---|---|---|---|
| 1 | Poaceae | 94 | 207 |
| 2 | Orchidaceae | 66 | 187 |
| 3 | Cyperaceae | 20 | 106 |
| 4 | Araceae | 19 | 53 |
| 5 | Zingiberaceae | 11 | 36 |
| 6 | Asparagaceae | 14 | 29 |
| 7 | Commelinaceae | 9 | 24 |
| 8 | Arecaceae | 12 | 19 |
| 9 | Smilacaceae | 2 | 13 |
| 10 | Dioscoreaceae & Amaryllidaceae | 1 4 | 10 each |

The picture of Angiospermic Flora of Darjeeling district is now complete along with the earlier account of R.B. Bhujel's (1996) *Studies on the Dicotyledonous Flora of Darjeeling District* combined with the present work on the monocotyledonous flora. The result reveals the presence of a total of 3332 species and varieties of Angiosperms from 1300 genera belonging to 240 families (Table 8.4). Presence of 3332 species angiospermic plants within a small district of 3351.9 km$^2$ area is really striking and it clearly denotes the richness of biosphere of the district beyond any contradiction.

**Table 8.4.** Angiospermic flora of Darjeeling district.

| Taxa | Numbers | | |
|---|---|---|---|
| | Dicots | Monocots | TOTAL |
| Families | 204 | 36 | 240 |
| Genera | 1001 | 299 | 1300 |
| Species & varieties | 2564 | 768 | 3332 |

As per Bhujel's (1996) flora of the dicotyledonous plants of Darjeeling the top ten families are Liguminosae with 131 species, Compositae (110 species), Euphorbiaceae (77 species), Rubiaceae (76 species), Rosaceae (74 species), Urticaceae (58 species), Labiatae (56 species), Scrophulariaceae (*s.l.*, 44 species), Lauraceae (41 species) and Acanthaceae (39 species). Now, after combining both the works the relative position of dominating families in both the classes are now changed and such a combined list is presented in Table 8.5.

**Table 8.5.** Ten dominant Angiosperm families of Darjeeling district (After Das 1986; Bhujel 1996 & Present work).

| Sl. No. | Dicotyledons | | Monocotyledons | | Combined sequence | |
|---|---|---|---|---|---|---|
| | Family | Species | Family | Species | Family | Species |
| 1 | Fabaceae (s.l.) | 131 | Poaceae | 207 | Poaceae | 207 |
| 2 | Asteraceae | 110 | Orchidaceae | 187 | Orchidaceae | 187 |
| 3 | Euphorbiaceae | 77 | Cyperaceae | 106 | Fabaceae (s.l.) | 131 |
| 4 | Rubiaceae | 76 | Araceae | 53 | Asteraceae | 110 |
| 5 | Rosaceae | 74 | Zingiberaceae | 36 | Cyperaceae | 106 |
| 6 | Urticaceae | 58 | Asparagaceae | 29 | Euphorbiaceae | 77 |
| 7 | Lamiaceae | 56 | Commelinaceae | 24 | Rubiaceae | 76 |
| 8 | Scrophulariaceae | 44 | Arecaceae | 19 | Rosaceae | 74 |
| 9 | Lauraceae | 41 | Smilacaceae | 13 | Urticaceae | 58 |
| 10 | Acanthaceae | 39 | Dioscoreaceae | 10 | Lamiaceae | 56 |

A comparative analysis of the flora regarding 10 dominant angiospermic families was made with previously recorded floristic works on and along the adjoining areas of Darjeeling district within the Eastern Himalaya such as *Flora of British India* (Hooker 1872–'97), *Flora of Eastern Himalaya* (Hara 1966, 1971; Ohashi 1975), *An Enumeration of Flowering Plants of Nepal* (Hara *et al* 1978, 1979 & 1982), *An overview of plant diversity of Sikkim* (Singh & Chauhan 1998) and *Flora of Bhutan* (Vols. 1 & 2, Grierson & Long 1983, 1984, 1987, 1991, 1999, 2001 and vol. 3 Noltie 1994, 2000; Pearce & Cribb 2002) with that of the present work in Table 8.6. It shows the families like Poaceae, Orchidaceae, Leguminosae (sub-families treated together) Composite, Cyperaceae, Rosaceae, Euphorbiaceae etc. are the most dominant ones in generalised term, with a little variations on dominance over the flora of the Eastern Himalayan region. Slight changes and ups and downs in the ranking is due to size of coverage area, location, ethnic interferences of area, topography etc.

From the analysis of Table 8.6, it can be concluded that the scenario of the flora of Darjeeling district is almost similar with that of the rest of the Eastern Himalaya. Slight variations have occurred in the ranking of the families that may naturally happen due to various factors. Only the Nepal flora (Hara *et al* 1978, 1979 & 1982) shows more deviation than any other.

**Table 8.6.** List of 10 dominant Angiospermic families in *Flora of British India* [FBI], *Flora of Eastern Himalaya* [FEH], *An Enumeration of Flowering Plants of Nepal* [EFPN], *An overview of plant diversity of Sikkim* (PDS), *Flora of Bhutan* [FB] and the Darjeeling District [FDD].

| *Sl. No* | **FBI** | **FEH** | **EFPN** | **PDS** | **FB** | **FDD** |
|---|---|---|---|---|---|---|
| 1 | Orchidaceae | Orchidaceae | Compositae | Orchidaceae | Orchidaceae | Poaceae |
| 2 | Compositae | Leguminosae | Poaceae | Compositae | Poaceae | Orchidaceae |
| 3 | Poaceae | Poaceae | Leguminosae | Poaceae | Compositae | Leguminosae |
| 4 | Rosaceae | Compositae | Cyperaceae | Leguminosae | Leguminosae | Compositae |
| 5 | Cyperaceae | Cyperaceae | Scrophulariaceae | Cyperaceae | Cyperaceae | Cyperaceae |
| 6 | Geraniaceae | Rosaceae | Labiatae | Rosaceae | Scrophulariaceae | Euphorbiaceae |
| 7 | Ericaceae | Scrophulariaceae | Ranunculaceae | Scrophulariaceae | Rosaceae | Rubiaceae |
| 8 | Liliaceae | Labiatae | Orchidaceae | Rubiaceae | Rubiaceae | Rosaceae |
| 9 | Labiatae | Ranunculaceae | Gentinaceae | Labiatae | Labiatae | Urticaceae |
| 10 | Umbelliferae | Urticaceae | Rubiaceae | Euphorbiaceae | Ranunculaceae | Lamiaceae |

Comparing the analysis of the dominance of the families in the recent previous records it is clear that Orchidaceae is the most dominant family of plants not only among the Liliopsida (monocots) but of the entire Magnoliophyta (Angiosperms) (Table 8.7). But, in the present work this family ranked down in 2nd position due to inadequate and improper collection, physical difficulties in collection due to their mostly epiphytic habit and difficulties in proper identification of the orchidaceous plants particularly in vegetative condition. Many orchids take long time to flower and have very short duration floral-life. Also, for orchids most of the important key characters of identification are taken from their flowers. So, many orchids remained unidentified. On the other hand, grasses are always easily available with adequate flowering materials. However, from the experience of the field observation, it can be concluded that the 2nd ranking of Orchidaceae in Darjeeling flora can also occupy the top position with time to explore in left over patches of vegetation and collection and study of more flowering materials. It is always suggested that further comprehensive work on smaller taxa, particularly at family level is required for acquiring better knowledge on the flora of this region.

**Table 8.7.** List of 10 dominant monocotyledonous families in the *Flora of British India* [FBI], *Flora of Eastern Himalaya* [FEH], *An Enumeration of Flowering Plants of Nepal* [EFPN], *An overview of plant diversity of Sikkim* (PDS), *Flora of Bhutan* [FB] and the Darjeeling District [FDD].

| Sl.No | **FBI** | **FEH** | **EFPN** | **PDS** | **FB** | **FDD** |
|---|---|---|---|---|---|---|
| 1 | Orchidaceae | Orchidaceae | Orchidaceae | Orchidaceae | Orchidaceae | Poaceae |
| 2 | Poaceae | Poaceae | Poaceae | Poaceae | Poaceae | Orchidaceae |
| 3 | Cyperaceae | Cyperaceae | Cyperaceae | Liliaceae | Cyperaceae | Cyperaceae |
| 4 | Liliaceae | Liliaceae | Liliaceae | Zingiberaceae | Zingiberaceae | Araceae |
| 5 | Araceae | Araceae | Araceae | Cyperaceae | Araceae | Zingiberaceae |
| 6 | Zingiberaceae | Juncaceae | Zingiberaceae | Araceae | Juncaceae | Asparagaceae |
| 7 | Juncaceae | Zingiberaceae | Juncaceae | Juncaceae | Commelinaceae | Commelinaceae |
| 8 | Commelinaceae | Commelinaceae | Commelinaceae | Commelinaceae | Convallariaceae | Arecaceae |
| 9 | Smilacaceae | Smilacaceae | Smilacaceae | Arecaceae | Arecaceae | Smilacaceae |
| 10 | Arecaceae | Dioscoreaceae | Arecaceae | Smilacaceae | Liliaceae | Dioscoreaceae |

**Table 8.8.** List of some Dominant Monocotyledonous Genera in the flora of Darjeeling District

| Genus | Family | Number of lower taxa |
|---|---|---|
| *Carex* | Cyperaceae | 26 |
| *Dendrobium* | Orchidaceae | 25 |
| *Cyperus* | Cyperaceae | 24 |
| *Fimbristylis* | Cyperaceae | 14 each |
| *Bulbophyllum* | Orchidaceae | |
| *Arisaema* | Araceae | 12 each |
| *Smilax* | Smilacaceae | |
| *Dioscorea* | Discoreacee | 10 each |
| *Coelogyne* | Orchidaceae | |
| *Hedychium* | Zingiberaceae | |
| *Eragrostis* | Poaceae | 9 each |
| *Digitaria* | Poaceae | |

The Table 8.8 presents the highest representing genera in the Darjeeling flora and further analysis expose the dominance of orchids and sedges in this list. There are three sedge-genera and four orchid-genera in this table.

## 8.2.2. COMPARISON OF FLORA OF DARJEELING DISTRICT WITH OTHER ADJOINING FLORAS

Four previously published comprehensive floristic works on the adjoining areas of the district of Darjeeling within the Eastern Himalaya (Eastern Nepal to Bhutan) were taken in account and a comparative analysis of the monocotyledonous flora was prepared with that of the present work. The selected previous comprehensive works include (1) *Flora of Eastern Himalaya* (Hara 1966, 1971; Ohashi 1975) which has engrossed the plant collections from some hilly places of East Nepal, Darjeeling-Sikkim Himalaya and Bhutan, (2) *An Enumeration of the Flowering Plants of Nepal* (Hara *et al* 1978) covering the Nepal portion, (3) *Flora of Sikkim* (Hajra & Verma 1996) covering the Sikkim Himalaya portion (for monocots) and (4) *Flora of Bhutan* (Noltie 1994, 2000; Pearce & Cribb 2002) covering not only the Bhutan portion of the East Himalaya but included Darjeeling-Sikkim parts of the Himalayas, Terai-Duars of North Bengal and the Chumbi Valley of Tibet Autonomous Region (TAR).

A numerical comparison of the different angiospermic taxa as enumerated in the four above mentioned floras on Eastern Himalayas published in the recent past, and that of the present work has been highlighted in Table 8.9.

**Table 8.9.** Comparative numerical representation of different monocotyledonous taxa in the four recently published floras on different portions of Eastern Himalaya and in the present work [*Abbreviations*: FEH – Flora of Eastern Himalaya; EFPN – *Enumeration of the Flowering Plants of Nepal*; FS – *Flora of Sikkim*; FB – *Flora of Bhutan*]

| | Representation in recent floras | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FEH | | EFPN | | FS | | FB | | Present Work | |
| FAMILIES | *Gen.* | *Sp.* | *Gen.* | *Sp.* | *Gen.* | *Sp.* | *Gen.* | *Sp.* | *Gen.* | *Sp.* |
| 1. Acoraceae | – | – | – | – | 1 | 2 | 1 | 1 | 1 | 1 |
| 2. Agavaceae | – | – | 1 | 4 | 4 | 5 | 2 | 3 | – | – |
| 3. Alismataceae | 1 | 1 | 3 | 5 | – | – | 1 | 2 | 4 | 5 |
| 4. Alliaceae | – | – | – | – | – | – | 3 | 12 | – | – |
| 5. Amaryllidaceae | – | – | 5 | 12 | 4 | 5 | 4 | 5 | 4 | 10 |
| 6. Anthericaceae | – | – | – | – | – | – | 1 | 2 | – | – |

| FAMILIES | Representation in recent floras | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FEH | | EFPN | | F S | | FB | | Present Work | |
| | *Gen.* | *Sp.* | *Gen.* | *Sp.* | *Gen.* | *Sp.* | *Gen.* | *Sp.* | *Gen.* | *Sp.* |
| 7. Aonogetonaceae | – | – | – | – | – | – | 1 | 1 | 1 | 4 |
| 8. Araceae | 14 | 37 | 15 | 40 | 12 | 40 | 17 | 48 | 19 | 53 |
| 9. Arecaceae | – | – | 6 | 11 | 10 | 18 | 13 | 24 | 12 | 19 |
| 10. Asparagaceae | – | – | – | – | – | – | 1 | 3 | 14 | 29 |
| 11. Asphodelaceae | – | – | – | – | – | – | 1 | 1 | – | – |
| 12. Bromeliaceae | – | – | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 |
| 13. Burmanniaceae | 1 | 1 | 1 | 3 | – | – | 1 | 2 | 1 | 1 |
| 14. Butomaceae | – | – | 1 | 2 | – | – | – | – | – | – |
| 15. Cannaceae | 1 | 1 | 1 | 4 | 1 | 2 | 1 | 4 | 1 | 2 |
| 16. Colchicaceae | – | – | – | – | – | – | 1 | 1 | 2 | 3 |
| 17. Commelinaceae | 9 | 16 | 9 | 21 | 8 | 22 | 11 | 31 | 9 | 24 |
| 18. Convallariaceae | – | – | – | – | – | – | 6 | 28 | – | – |
| 19. Costaceae | – | – | – | – | 1 | 2 | 1 | 2 | 1 | 1 |
| 20. Cyperaceae | 10 | 114 | 19 | 171 | 18 | 45 | 19 | 180 | 20 | 106 |
| 21. Dioscoreaceae | 1 | 8 | 1 | 13 | 1 | 7 | 1 | 13 | 1 | 10 |
| 22. Dracaenaceae | – | – | – | – | – | – | 2 | 2 | – | – |
| 23. Eriocaulaceae | 1 | 6 | 1 | 13 | 1 | 6 | 1 | 6 | 1 | 7 |
| 24 Hemerocallidaceae | – | – | – | – | – | – | 1 | 1 | – | – |
| 25. Hydrocharitaceae | 1 | 1 | 5 | 7 | – | – | 3 | 3 | 6 | 7 |
| 26. Hypoxidaceae | 2 | 3 | 2 | 5 | 1 | 4 | 3 | 6 | 3 | 5 |
| 27. Iridaceae | 2 | 4 | 2 | 7 | 4 | 7 | 5 | 13 | 6 | 7 |
| 28. Juncaceae | 2 | 26 | 2 | 36 | 2 | 35 | 2 | 41 | 2 | 8 |
| 29. Juncaginaceae | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | – | – |
| 30. Lemnaceae | 2 | 2 | 3 | 4 | | | 1 | 2 | – | – |
| 31. Liliaceae | 24 | 50 | 33 | 77 | 35 | 85 | 6 | 16 | 2 | 2 |
| 32. Limnocharitaceae | – | – | – | – | – | – | 1 | 1 | – | – |
| 33. Marantaceae | 1 | 1 | 1 | 1 | – | – | 2 | 3 | 3 | 3 |
| 34. Melanthiaceae | – | – | – | – | – | – | 3 | 5 | 1 | 1 |
| 35. Musaceae | – | – | 1 | 2 | 1 | 4 | 1 | 5 | 1 | 3 |
| 36. Najadaceae | 1 | 1 | 1 | 2 | – | – | | | – | – |
| 37. Orchidaceae | 61 | 188 | 83 | 312 | 115 | 443 | 132 | 579 | 66 | 187 |
| 38. Pandanaceae | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 |
| 39. Phormiaceae | – | – | – | – | – | – | 1 | 1 | – | – |
| 40. Poaceae | 78 | 183 | 106 | 346 | 104 | 281 | 125 | 381 | 94 | 207 |
| 41. Pogostemonaceae | – | – | 1 | 8 | – | – | – | – | – | – |
| 42. Pontederiaceae | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 3 |
| 43. Potamogetonaceae | – | – | – | – | 1 | 4 | 1 | 6 | 1 | 2 |
| 44. Stemonaceae | – | – | – | – | – | – | – | – | 1 | 1 |
| 45. Smilacaceae | 1 | 15 | 1 | 15 | 1 | 13 | 2 | 14 | 2 | 13 |
| 46. Sparganiaceae | – | – | – | – | 1 | 1 | 1 | 1 | – | – |
| 47. Trilliaceae | – | – | – | – | – | – | 3 | 4 | – | – |
| 48. Typhaceae | 1 | 1 | 1 | 2 | – | – | 1 | 1 | 1 | 1 |
| 49. Uvulariaceae | – | – | – | – | – | – | 4 | 7 | – | – |
| 50. Xanthorrhoeaceae | – | – | – | – | – | – | – | – | 2 | 2 |
| 51. Xyridaceae | – | – | 1 | 2 | 1 | 3 | 1 | 3 | 1 | 1 |
| 52. Zingiberaceae | 8 | 17 | 10 | 37 | 12 | 49 | 14 | 47 | 11 | 36 |
| **TOTAL** | **226** | **681** | **321** | **1169** | **344** | **1092** | **407** | **1519** | **299** | **768** |
| **Number of Family** | **24** | | **32** | | **27** | | **47** | | **36** | |

[*Note:* The family Liliaceae has been further divided into many new families according to more recent classification of Kubitzki (1998), FB and the recent work have followed this. Therefore in earlier floras (FEH, EFPN and FS) representation of this family is larger. The newly created families and their respected genera earlierly included within Liliaceae are as follows (this classification was followed in FB): Alliaceae: *Allium;* Anthericaceae: *Chlorophytum;* Amaryllidaceae: *Crinum, Pancratium, Zephyranthes;* Asparagaceae: *Asparagus*; Asphodelaceae: *Aloe, Kniphofia;* Colchicaceae: *Gloriosa;* Uvulariaceae: *Disporum;* Convallariaceae: *Campylandra, Convallaria; Liriope, Maianthemum, Ophiopogon, Peliosanthes, Polygonatum, Theropogon, Tupistra*; Dracaenaceae: *Dracaena*; Hemerocallidaceae: *Dianella, Hemerocallis*; Liliaceae: *Cardiocrinum, Clintonia, Fritillaria, Gagea, Lilium, Lloydia, Notholirion, Tulipa*; Melanthiaceae: *Aletris, Tofieldia, Ypsilandra*; Smilacaceae: *Heterosmilax, Smilax*; Trilliaceae: *Paris, Trillium*; Lomandraceae: *Cordyline* etc.]

The most recent classification, based upon DNA phylogenetics, 'An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III-2009' published in the Botanical Journal of the Linnean Society, 161. 105–121. 2009 (Chase & Reveal 2009), has been followed in the present work. Many families have been merged together according to this classification therefore the number of families in the present work has been contracted within 36. The contraction of families (within the study area) according to the APG–III are as follows: the pro-families Agavaceae, Convallariaceae, Dracaenaceae, Anthericaceae etc. are merged within a single family Asparagaceae; Alliacea and Lemnaceae have been included in Amaryllidaceae and Araceae respectively.

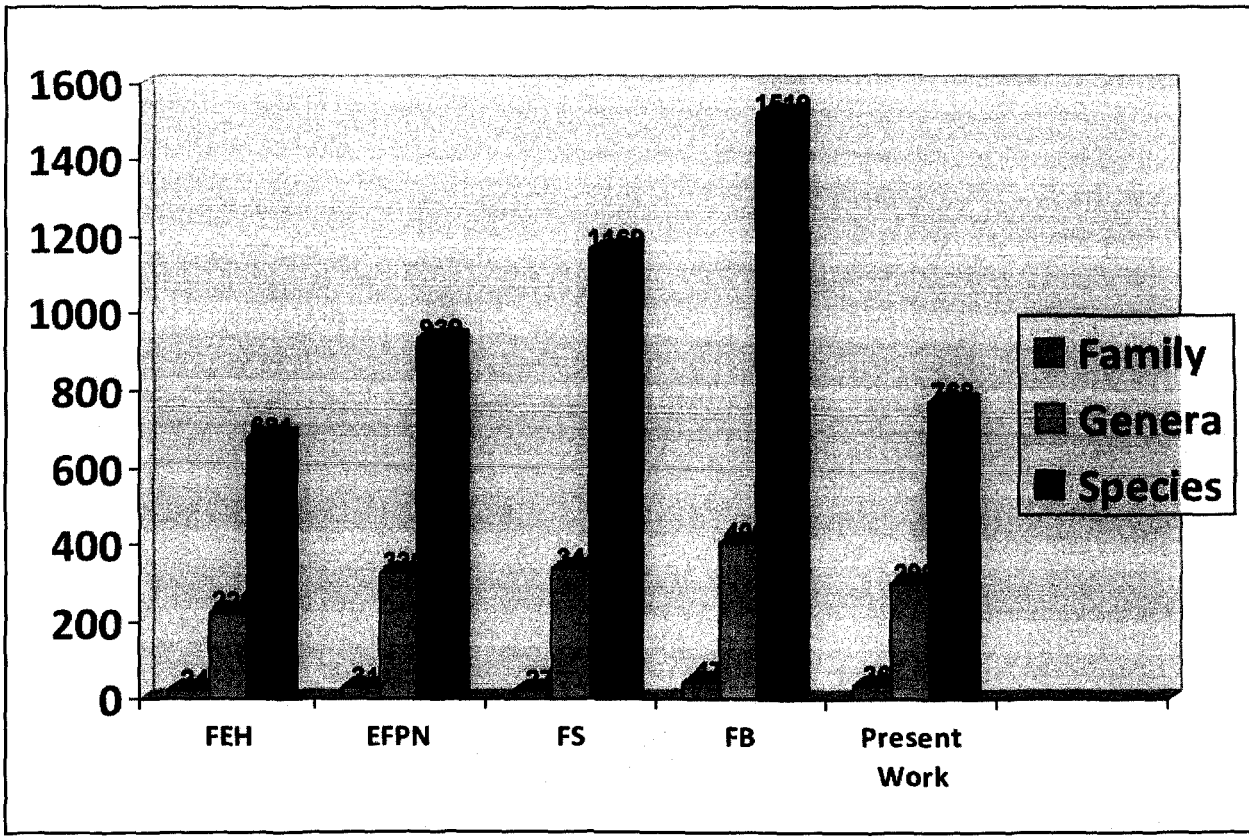


**Fig. 8.1.** Diagrammatic Comparison of numerical representation of different monocotyledonous taxa in the present work with that of four recently published flora on the Eastern Himalaya

**Table 8.10.** Comparison of different monocotyledonous taxa in % representation in the four recently published flora on Eastern Himalayas with the present work

| Treatises | | Present Work | FEH | EFPN | FS | FB |
|---|---|---|---|---|---|---|
| Family | Number | 36 | 24 | 32 | 27 | 47 |
| | Comparative (%) | | 150 | 133.33 | 112.5 | 76.6 |
| Genera | Number | 299 | 226 | 321 | 344 | 407 |
| | Comparative (%) | | 132.30 | 93.15 | 86.92 | 73.46 |
| Species | Number | 768 | 681 | 1169 | 1092 | 1519 |
| | Comparative (%) | | 112.77 | 65.69 | 70.33 | 50.56 |

The Fig. 8.1 and Table 8.10 in combination indicate the comparative figures of numerical representation of different ranks of monocotyledonous taxa (families, genera and species) as recorded in four previous treatises and in the present survey. The figures revealed one interesting fact that the elements of the monocot flora of Darjeeling district represent more than those recorded in the *Flora of Eastern Himalaya*, where only 681 monocotyledonous species under 226 genera of 24 families has been recorded for the whole of the Eastern Himalaya, where as the present work on Darjeeling District that represent only a small part of Eastern Himalaya has exposed the occurrence of as much as 768 species representing 299 genera of 36 monocot families. The data indicates that a small area of the Darjeeling district is richer with 112.77 %, 132.30 % and 150 % in monocotyledonous species, genera and the families respectively than that of the FEH; 93.15 % genera with 65.69 % species and varieties of *Enumeration of Flowering Plants of Nepal* and likewise 86.92 % genera with 70.33 % species and varieties (Monocot) of *Flora of Sikkim* have been recorded in the present work. The comparative study reflects the richness of the district in respect of monocotyledonous wealth. The third volume [in three parts] of *Flora of Bhutan* (Noltie 1994, 2000; Pearce & Cribb 2002) on monocotyledonous flora has enumerated 1519 species and varieties from 407 genera, which is a very much comprehensive work covering a vast area including Terai, Duars and hills of Darjeeling in North Bengal to the Chumbi Valley of TAR along north-south and from Darjeeling to Kameng District of Arunachal Pradesh along west – east dimensions. The present work have recorded nearly all (45 of 47 except Juncaginaceae and Sparganiaceae if counted as per that classification) monocot families and 73.46 % and 50.56 % genera and species those were recorded in the third volume of the *Flora of Bhutan*.

The above fact shows that the elements of East Himalayan flora have nicely concentrated in the virgin habitats of Darjeeling district. It is therefore, interesting to note that a small landmass of 3,149 km$^2$ area is supporting the major chunk of the floristic elements of the vast Eastern Himalaya reflecting its extremely rich biodiversity.

### 8.2.3. HABIT GROUPS

The huge area of the district of Darjeeling is occupied by tea gardens, farms for other cultivated crops, villages, towns and cities where the gradual colonisation and encroachment by human has degraded and modified the natural habitat and badly affected the biodiversity (Das 2004), even though there are still many pockets within the district which are more or less remained undisturbed and unexplored for centuries, where the richness of floristic composition is naturally preserved and the habitat of these different forms of life nearly intact. The occurrence of wide range variation in habitat structure helped to colonise species of diverse habit groups in the flora of the district (Das 2004). Even the momocot flora of Darjeeling

represents a great diversity almost in all forms of habit groups of plants, except parasites. There is comparatively a higher representation of annual and perennial terrestrial herbs and epiphytes in monocot flora while the Shrubs, Climbers and Trees exhibit lower representation. On the other hand, saprophytes are represented by at least 4 very interesting orchids. No parasitic monocotyledonous plant was recorded. The Table 8.11 exhibits the distribution of habit groups in the monocotyledonous flora of Darjeeling district.

**Table 8.11:** Different Habit Groups of Monocotyledonous Plants in the flora of Darjeeling district

| Habit Group | No. of species | % of total species |
|---|---|---|
| Herbs Annual | 102 | 13.30 |
| Herbs Perennial | 399 | 51.95 |
| Herbs Epiphytic | 127 | 16.53 |
| Hydrophytes (Herbs) | 46 | 06.00 |
| Saprophytes (Herbs) | 4 | 00.52 |
| Total Herbs | 678 | 88.30 |
| Shrubs | 43 | 05.60 |
| Climbers | 34 | 04.41 |
| Trees | 13 | 01.69 |
| **TOTAL** | **768** | **100** |

### 8.2.3.1. Herbs

The floristic analysis of Darjeeling district revealed that among the monocotyledonous flora the proportion of herbaceous species are in much higher in comparison to any other habit groups (Table 8.11). The herbaceous monocotyledonous plants may be annual, perennial, epiphytes, hydrophytes, saprophytes etc. which altogether comprise 678 out of 768 species occupying 88.3 % of the total recorded monocot flora from the district. Representation of 4.41 % climbers is also mostly dominated by herbaceous climbers. The herbaceous flora are dominant mostly in all around, the wide crop fields in Terai, open hill slops, open forest patches and the ground cover vegetation in the dense forests as well.

The members of most of the monocotyledonous families are herbaceous. 30 out of 36 recorded families including the most dominating ones like Poaceae, Orchidaceae, Cyperaceae, Commelinaceae, Juncaceae, Zingiberaceae etc. represent the main floristic feature of a land mass and are dominated by herbs.

#### (a) Dry Land Herbs:

The most predominating herbs on the dry open lands of the district includes different species of grasses as *Eragrostis* spp, *Arthraxon* spp, *Capillipedium* spp, *Imperata cylindrica, Chrysopogon* spp, *Digitaria* spp, *Oplismenus* spp, *Panicum* spp, *Setaria* spp, *Elusine indica, Sporobolus* spp, *Microstegium* spp, *Pogonetherum* spp, *Saccharum* spp, *Arundinella* spp, *Ischaemum* spp, *Agrostis* spp, *Isachne* spp, *Brachiaria* spp. etc; the sedges like *Cyperus* spp, *Fimbristylis* spp, *Kyllinga* spp, *Pycreus* spp; aroid species like *Arisaema, Alocasia* and *Colocasia* spp; members of Commelinaceae eg. *Commelina* spp, *Cyanotis* spp, *Murdannia* spp etc towards the lower altitude, where as different species of *Poa, Caerx* and *Juncus, Pennisetum clandestinum, Auxonopus compresssus* are occurring in high altitude areas.

#### (b) Sedges and Marsh Land Herbs:

The most of the wet and marshy lands are inhabited by numerous species of sedges (Cyperaceae) of which the most dominants are the species of *Schoenoplectus, Eleocharis, Scirpus, Cyperus, Fimbristylys, Eriocaulon* etc. Other important marshland herbs include *Juncus* spp, *Acorus calamus,*

*Colocasia antiquorum, Lasia spinosa, Floscopa scandens, Eriocaulon* spp, *Butomopsis latifolia, Echinochloa crus-galli, Isachne globosa, Hymenachne acutigluma, Sacciolepis interrupta, Oryza sativa, O. perennis, Leptochloa* spp, *Ottochloa nodosa* etc.

**(c) Epiphytic herbs:**

As much as 127 species of Liliopsida are growing as epiphytes in Darjeeling Hills, which represent 16.53 % of the total recorded monocot flora. Different species of Orchidaceae are dominating in this habit group. Starting from Terai, climbing through the forests of foot-hills and extending to the sub-alpine conifer and *Rhododendron* forests, the orchids occupy their top position amongst the epiphytes. Different species of *Bulbophyllum, Coelogyne, Dendrobium, Cymbidium, Eria, Acampe, Aerides, Luisia, Otochillus, Papilionanthe* etc. are the predominant epiphytic orchids. Other monocotyledonous epiphytes includes some aroides like *Remusatia vivipara,* species of *Pothos, Rhaphidophora* etc. and other plants like *Polygonatum punctatum, P. oppositifolium, Cautleya gracilis, C. spicata* and some species of *Hedychium, Cautleya,* etc. are quite common. There are many epiphytes which are successfully growing also as lithophytes taking assistance of local moist environment.

**(d) Hydrophytic herbs:**

Different species of Liliopsida also exhibit their predominance in the aquatic habitats within the district. 46 species of different genera comprise about 6 % of total monocot flora of the district. Different species of *Spirodela, Wolffia, Cryptocoryne, Blyxa, Najas, Nechamandra, Potamogeton, Ottochloa, Paspalidium,* including *Eichhornia crassipes, Pistia stratoites, Aponogeton undulatum, Vallisneria spiralis, Hydrilla verticillata, Ottelia alismoides, Leersia hexandra, Hygrorhyza aristata, Lemna perpusilla, Monochoria hastata, M. vaginalis* etc. are the important hydrophytes especially in the stagnant water bodies in the Teari. *Eichhornia, Pistia, Lemna* are free floating; and *Aponogeton, Vallisneria, Hydrilla, Ottelia, Leersia, Hygrorhyza, Monochoria, Potamogeton, Paspalidium geminatum, Ottochloa nodosa,* etc are submerged species rooting at the bottom-soil in the water-bodies specially when the water-level in the habitat reduced much and these plants then collect water from the clay for their survival like marshland plants.

**(e) Saprophytic or mycotrophic Herbes:**

At least 4 species of terrestrial orchids *Galeola falconeri, G. lindleyana, Didymoplexis pallens* and *Lecanorchis sikkimensis* grow on forest floor with decaying tree bases, thick layer of deckying leaves or under the shades of bamboos and get nutrition mycotrophically, with hairy absorbent roots and glandular tubers without leaves. They lac chlorophyll and colour of plants may be white, brown, yellow etc., i.e. other than green. Few other orchids, like species of *Anoectochilus, Odontochils, Goodyara* etc. also grow on decaying leaves, but as they also possess green photosynthetic leaves so cannot be grouped under saprophytic or mycotrophic, rather they may be treated as hetero- mycotrophs (Pridgeon *et al,* 1999).

### 8.2.3.2. Shrubs

The present analysis revealed that the shrubs among the monocots are comparatively quite less in number, however, they play an important role with about 6 % contribution towards the monocot vegetation of the district. The most common shrubby species of the district include some species of *Smilax* like *S. elegans, S. ferox, S. minuta*; grasses like *Thysanolana latifolia, Neyraudia arundinacea, Arundo donax, Phragmites karka, Saccharum longesetosum* etc; some agaves as *Agave sisalana, A. Americana, A. lurida, Furcraea selloa*; bananas like *Musa balbisiana, M. sikkimensis*; canes and palm shrubs as *Calamus erectus, C. latifolius, Licuala peltata, Phoenix acaulis, Wallichia oblongifolia, Stachyphrynium placentarium* and *Pandanus unguifer* etc. Amischotolype hookeri is one very interesting shruby member of Commelinaceae.

### 8.2.3.3. Climbers

The diversity of climbers, with their wide habit structures, is also forming one important constituent of the vegetation of Darjeeling, having at least 4.5 % contribution with 34 species, towards the monocot flora of the district. The monocotyledonous climbers of the district can be classified as herbaceous and shrubby depending upon their habit forms and mode of climbing. They can further be categorised as twinner, root climber, tendril climber, scandent and epiphytic climbers etc. The climbers are well distributed in all types of vegetation.

**(a) Herbaceous climbers:**

Herbaceous monocotyledonous climbers of the district flora are mainly represented by different species of Yams which are tuberous perennial twinners and have a good contribution in ethnobotany and ethnic economy. The most common herbaceous monocot twinners include *Streptolirion volubile*; different species of *Dioscorea* like *D. bulbifera, D. deltoidea, D. belophylla, D. hamiltonii, D. hispida, D. pentaphylla, D. prazeri* and *D. pubera* etc. The representatives of root climbers who attach themselves to the host with the help of their arial roots are mostly the species of Araceae like *Pothos cathcartii, P. scandens* etc.

**(b) Shrubby climbers:**

The patches of forests of different elevations of the district are densely covered with different shrubby climbers. The most common shrubby monocot climbers are the different species of Smilacaceae like *Smilax aspericaulis, S. lancifolia, S. menispermoidea, S. orthroptera, S. ovalifolia, S. perfoliata* etc along with a single species of *Heterosmilax, H. japonica,* they all exhibit tendril climbing characters. In addition, some climbing palms are also found growing as woody, thorny climbers include *Daemonorops jenkinsiana* and *Calamus guruba, C. latifolius* etc. within the tropical forests of Terai and foot-hills, whereas *Plectocomia himalayana* grows in the upper hill forests. Large root climbers of Araceae like *Scindapsus officinalis* and different species of *Rhaphidophora* like *R. calophylla, R. decursiva, R. glauca, R, grandis* and *R. hookeri* etc. may be treated in this group.

### 8.2.3.4. Trees

The tree habit in the monocotyledonous flora can be traced with very little number of species. Altogether 13 species of monocot trees share almost 2 % contribution in the monocot flora of the district. Few palm trees represent this category especially in the fields of Terai and lower hills in addition with other trees like *Pandanus furcatus* which is a major tree species dominating even other dicot trees in few patches in lower hill forests and along Tista-Rangit and other hot river belts. In these regions palm trees like *Caryota urens, Phoenix rupicola* and *Wallichia disticha* etc. also occupy a good position. The canopy of wide Terai and foot hills fields has readily altered with the cultivated palms like *Cocos nucifera, Areca catechu* and *Phoenix sylvestris*; *Trachycarpus fortunei* is seems to be commonly planted along gardens above 1500 m. In this context, large bamboos may be included as 'grass-tree' because of their size and woody stem. The diameter of culm of the largest bamboo of area *Dendrocalamus giganteus* measures upto 30 cm. Different species of *Dendrocalamus* such as *D. hamiltonii, D. hookeri, D. sikkimensis* and of *Bambusa* like *B. balcooa, B. nutans, B. tulda* may be listed under this category.

### 8.2.4. PATTERN OF DISTRIBUTION

The distribution of the elements of monocotyledonous flora in the district of Darjeeling between the elevation of 98 m to 3636 m amsl is distinctly marked by enormous variation of habit groups i.e. herbs, shrubs, epiphytes and climbers etc. Obviously the plains and the lower altitude warmer areas concentrate the maximum number of floristic elements than the stressed habitat conditions of high altitude sub-alpine regions. Considering the altitude based distribution, following tiers/ categories can be recognized:

**A. *The Tropical Zone*** (98 –500 m amsl): This zone of the district comprises the plains of Terai from 120 m, the foot-hills, and the lower hills up to 500 m amsl which are extended deep into the area through the valleys of larger rivers like Tista, Great and Little Rangit, Rammam, Balasan, Mahananda, Ryang, Relli, Chel, Lesh, Ghish, Jaldhaka etc. Southern belt of the Terai plains is mostly occupied by tea gardens and cultivated fields for numerous other crop-plants. Such type of vegetation is dominated by different weedy species including numerous grasses i.e. different species of *Arundinella, Axonopus, Chrysopogon, Cynodon, Digitaria, Echinochloa, Elusine, Eragrostis, Hemarthria, Imperata, Isachne, Oplismenus, Panicum, Paspalum, Pennisetum, Pogonetherum, Saccharum, Setaria, Sporobolus, Brachiaria* etc. Different species of bamboos are found both in the wild and also in cultivation. Most of the sedges are also concentrated in this region. Different open grasslands and marshes are the preferred habitats for the species of *Actinoscirpus, Bulbostylis, Cyperus, Eleocharis, Fimbristylis, Fuirena, Kyllinga, Pycreus, Schoenoplectus, Scirpus* and *Scleria* etc. The ditches and streams are dominated by different species of *Sagittaria, Alocasia, Colocasia, Eriocaulon, Monochoria, Potamogeton, Hydrilla verticillata, Ottelia alismoides, Vallisneria spiralis, Butomopsis latifolia, Lasia spinosa, Eichhornia crassipes, Leersia haxandra, Hygrorhyza aristata, Hymenachne acutigluma, Sacciolepis interrupta* etc. Among the important elements of other monocot families of this region includes different cultivated palms like *Phoenix sylvestris, Cocos nucifera, Areca catechu* also.

Along with the above mentioned species the forests of Terai, foot-hills and the hot tropical valleys enjoy the rich floristic elements like species of *Commelina, Cynotis* and *Murdannia*; and *Chlorophytum arundinaceum, Molineria capitulate, Curculigo orchidoides, Phrynium* species, *Musa balbisiana, Pandanus furcatus, P. unguifer, Apluda mutica, Cymbopogon* spp, *Saccharum* spp, *Pogonetherum* spp, *Globba racemosa, Calamus erectus, Wallichia disticha, Hemiorchis pantlingii, Zingiber crysantheum* etc. as the floor flora. Climbers such as *Daemonorops jenkinsiana, Pothos scandens, Scindapsus officinalis, Rhaphidophora* spp, different species of *Dioscorea,* mainly *D. bulbifera, D. prazeri, D. hispida, D. pentaphylla* etc, species of *Smilax* compose the peculiar structure of these forests.

One of the important peculiarities of this belt is the rich concentration of epiphytic orchids and they are concentrated mainly in the hot valleys of Tista, Rangit and other rivers, The Mahananda Wildlife Sanctury and the other forests of the Terai. The most important orchids of this region include *Acampe papillosa, A. rigida, Aerides multiflorum, A. odoratum, Bulbophyllum careyanum, Cymbidium aloifolium, Dendrobium* spp. mainly *D. crepidatum, D. fimbriatum, D. moschatum, Eria lasiopetala, Dendrobium fugax, Papilionanthe teres, Rhynchostylis retusa, Pholidota imbricata, Smitinandia micrantha, Thunia alba, Tropidia angulosa, Vanda* spp etc.

**B. *Sub-Tropical Zone*** (500 – 1200 m amsl): This zone of the district includes the tropical lower-middle hills ranging altitude from 500 to 1200 m amsl comprising dense broad-leaved semi-evergreen to evergreen forest forming dense canopy. Some of the important monocot angiosperms of this zone include grasses like *Apluda mutica, Arthraxon lancifolius, Capillipedium assimile, C. parviflorum, Cymbopogon* spp, *Imperata cylindrica, Microstegium* spp, *Spodiopogon lacei, Themeda* spp, *Arundinella* spp, *Elusine indica, Eragrostis* spp, *Neyraudia arundinacea, Sporobolus* spp, *Digitaria* spp, *Echinochloa* spp, *Panicum* spp, *Pennisetum* spp, *Sacciolepis* spp, *Setaria* spp, *Brachiaria* spp, *Thysanolana latifolia.* Different bamboos including *Bambusa* spp, *Dendrocalamus hamiltonii, Dendrocalamus giganteus. The most important herbaceous monocots of this zones are Amorphophallus bulbifer, Arisaema tortuosum, Colocasia affinis, C. fallax, Remusatia pumila, Calamus erectus, Phoenix rupicola, Wallichia oblongifolia, Commelina* spp, *Cyanotis* spp, *Murdannia* spp, *Cyperus* spp, *Fimbristylis* spp, *Kyllinga* spp, *Pycreus* spp, *Scleria* spp, *Dioscorea* spp, *Pandanus furcatus, Smilax* spp, *Globba* spp, *Hedychium* spp etc. Epiphytic and terrestrial orchids prefer the region such as *Pholidota articulata, Goodyera procera, Arundina graminifolia,, Bulbophyllum* spp, *Coelogyne corymbosa, C. cristata, Dendrobium crepidatum, D. densiflorum, D. fimbriatum, Eria bractescens, Goodyera procera,*

*Liparis resupinata, L. odorata, Crepidium acuminatum, Dienia ophrydis, Nervilia gammieana, Oberonia* spp, *Pholidota articulata, Thunia alba* etc.

**C. *Sub-Temperate/ Warm Temperate Zone*** (1200 – 1850 m amsl): The sub-temperate zone includes the forest of upper-middle hills from 1200 to 1850 m amsl is extremely thick and is covered with mostly medium-sized evergreen tree species. A large number of mosses, lichens and other epiphytes are often seems to be hanging over the barks and branches of the trees, and the herb, shrub and fern species are abundant on forest floor. The prevalently seen monocotyledonous taxa in this zone are the grasses like *Arthraxon quartinianus, Capillipedium* spp, *Arundo donax, Arundinella* spp, *Cynodon dactylon, Elusine indica, Eragrostis nigra, E. japonica, Neyraudia arundinacea, Sporobolus fertilis, Digitaria* spp, *Oplismenus burmannii, O. compositus, Panicum* spp, *Setaria palmifolia, S. pumila* etc. The bamboos like *Ampelocalamus patellaris, Bambusa nutans, Dendrocalamus hamiltonii, D. Hookeri, D. Sikkimensis* and *Himalcalamus hookerianus* etc. prefer to grow in this zone. Other important monocotyledonous ground covering herbs of the zone include *Arisaema tortosum, Colocasia esculenta, Remusatia pumila, R. vivipara, Sauromatum venosum, Commelina benghalensis, C. diffusa, Cyanotis vaga, Murdannia spirata, Disporum cantoniense, Rhopalephora scaberrima, Molineria capitulata, Globba multiflora Juncus prismatocarpus,* etc. Climbers like *Rhaphidophora calophylla, R. glauca, Dioscorea bulbifera, D. hamiltonii* and bushy shrubs like *Smilax* spp decorate the forests of this zone. It is seems that quite shaddy slopes are often fully covered by *Amomum subulatum* cultivation. The important sedges commonly encountered in the belt include *Caerx filicina, C. cruciata, C. longipes, C. myosurus, C. remota, Cyperus cyperoides, C. sikkimensis, Fimbristylis* spp, *Kyllinga* spp. etc. The dominant orchids of this zone may be listed as *Agrostophyllum callosum, Anthogonium gracile, Bulbophyllum cariniflorum, B. leopardinum, Coelogyne corymbosa, C. ovalis, Cymbidium lowianum, Dendrobium amoenum, D. aphyllum, D. densiflorum, D. nobile, D. transparens, Eria coronaria, E. spicata, E. stricta, Luisia zeylanica, Oberonia emerginata, Otochillus lancilabius, Phalaenopsis taenialis, Rhynchostylis retusa, Vandopsis undulata* and so on. It is seems habitat of orchids tends more towards terrestrial than epiphytic with the increase of altitude. Many ground orchids like *Crepidium khasianum, C. acuminatum, C. purpureum, Otochillus lancilabius, Calanthe trulliformis, Conchidium muscicola, Malaxis muscifera, Peristylis aristatus* etc. decorate the open and shaddy slops of this zone.

**D. *Temperate Zone*** (1850 – 3200 m amsl): Temperate forests, cold and rocky open mountain slopes of upper hills constitute this zone. The two National Parks of the district namely Singalila National Park and Neora Valley National Park (major part) and, The Senchel-Jorepokhari Wildlife Sanctuary is located within this zone. Main salient features of the region are the lower non-coniferous temperate deciduous forests constituting with *Lindera, Michelia, Quercus, Betula, Acer* and *Magnolia* complex and the upper coniferous and *Rhododendron* belt. Important monocotyledonous population of this zone include *Chlorophytum nepalense, Cyanotis fasciculata, Streptolirion volubile, Maianthemum fuscum, M. oleraceum, Ophiopogon* spp, *Polygonatum* spp, *Tupistra nutans, Rohdea nepalensis, Molineria crassifolia, Iris clarkei, Cardiocrinum giganteum, Smilax elegans, S. aspericaulis, S. munita, Globba clarkei, Plectocomia himalyana, Paris polyphylla,* species of *Hedychium* and *Cautleya* etc. Different aroid species have domination over this zone such as *Arisaema concinum, A. consanguineum, A. costatum, A. griffithii, A. intermedium, A. jacquemontii, A. nepenthoides, A. propinquum, A. speciosum, A. utile* and *Remusatia hookeriana* etc. Almost over ¾ th of the total species of *Caerx, Kobresia* and *Juncus* are predominantly distributed over here. Terrestrial ground orchids show dominance over the epiphytic ones on the higher altitude. Some important terrestrial orchids of this zone are *Herminium lanceum, Platanthera biermanniana, Satyrium nepalense, Spiranthes sinensis, Habenaria arietina, Calanthe plantaginea, C. brevicornu, C. tricarinata, C. trulliformis, Odontochilus lanceolatus, Cephalenthera longifolia, Eulalia* spp, *Liparis* spp, and the epiphytic orchids may be listed as *Bulbophyllum affine, B. gamblei, Coelogyne barbata, C. nitida, Cymbidium longifolium, Dendrobium candidum, D. longicornu,*

*Dendrobium rotundatum, Eria musicola, E. stricta, Gastrochilus distichus, Oberonia obcordata, Otochillus fuscus, Pleione praecox, P. humilis, P. hookeriana* etc. Perennial and annual grasses obviously cover the open slops they are *Miscanthes nepalensis, Saccharum rufipilum, Tenaxia cumminsii,* species of *Agrostis, Anthoxanthum, Alopecurus, Calamagrostis, Holcus, Trisetum, Thamnocalamus, Tripogon, Festuca, Poa* and *Lolium.* The bamboo brakes are the common feature of this zone which is mainly composed of *Yushania maling, Arundinaria racemosa* and often *Cephalostachyum captatitum.*

**E. *Sub-alpine Zone*** (3200 – 3700 m amsl): The uppermost belt of the district ranging from and above 3200 m is categorized as sub-alpine region. The upper ridges of the temperate zone of Singalila mountain is the only representative zone in the district of this type. This uppermost tier of the district is dominated by *Abis-Rhododendron-Rosa* Association. Few monocotyledonous taxa are observed in this region like *Arisaema utile, Arisaema jacquemontii, Polygonatum cirrhifolium, Polygonatum verticillatum,* some species of *Caerx, Kobresia* [*K. fragilis, K. pygmaea, K. uncinoides*], few species of *Juncus, Luzula plumosa, Fritillaria cirrhosa, Tofieldia himalaica, Oreorchis micrantha,* some tufted xerophytic grasses like *Danthonia cuminsii,* species of *Garnotia, Agrostis, Tripogon, Festuca* and *Poa* and some small sized bamboos in brakes *Arundinaria* and *Yushania* spp.

## 8.2.5. ALTITUDINAL VARIATION AND THE FLORA

Variations in altitude (98 m to 3636 m amsl), temperature (–5° C to 40° C), relative humidity (20 % to 95 %); rainfall (225 to 500 ml), clouds, fog and mists, exposure of different hill slops, soil condition etc greatly affect and favour the local flora. Among these factors, altitude is the most important that determines the kind of climate and the flora of the region. The altitude has exposed the geographical surfaces of the district to different surfaces and precipitation zones, as a result at least 15 tree associations has been developed within the district with effect in variation and diversity of vaegetation types. Some species like *Lasia spinosa, Cyperus compactus, Potamogeton* spp., *Scleria caricina, Ottelia alismoides, Vallisneria spiralis* etc. never ascend above an altitude of 300 m on the other hand *Juncus grisebachii, Fritillaria cirrhosa, Danthonia cuminsii* etc. do not descend below an altitude of 3000 m. These types of flora show sharply contrasting ecological habitat fall within parameters of the district and indicate the two diverse ends of the boundary of the district and its flora as well.

A comparative study on the distribution of the recorded monocotyledonous flora of the district has been made along the five altitude based climatic zones. The results are displayed in Table 8.12 and Figure 8.2.

**Table 8.12.** Zone wise representation in percentage of monocotyledonous flora of Darjeeling district

| | **Tropical Zone, 98 –500 m** | **Sub-tropical Zone, 500 – 1200 m** | **Sub-temperate Zone, 1200 – 1850 m** | **Temperate Zone, 1850 – 3200 m** | **Sub-alpine Zone, 3200 – 3700 m** |
|---|---|---|---|---|---|
| **Number of species** | 426 | 407 | 340 | 307 | 85 |
| **Percent of Distribution** | 55.47 % | 53 % | 44.27 % | 39.97 % | 11.06 % |

The Table 8.12 and the Figure 8.2 (on the next page) revealed the distribution pattern of the monocotyledonous angiosperms in the district, which is inversely proportional to the altitude. Number of species is decreasing along with the increase in altitude. The foot hills and the lower hot river valleys are covered with dense tropical forests those host as high as 55.47 % of total monocotyledonous species recorded. Vast area of land from lower to middle hills are used for cultivation and development of Tea gardens so it engraves 2 % lesser density of diversity is observed in the sub-tropical region. The upper most sub-alpine zone shows poor richness in vegetation and houses only 11.1 % of recorded monocot species which is due to the chilling cold and unfavourable climatic conditions.

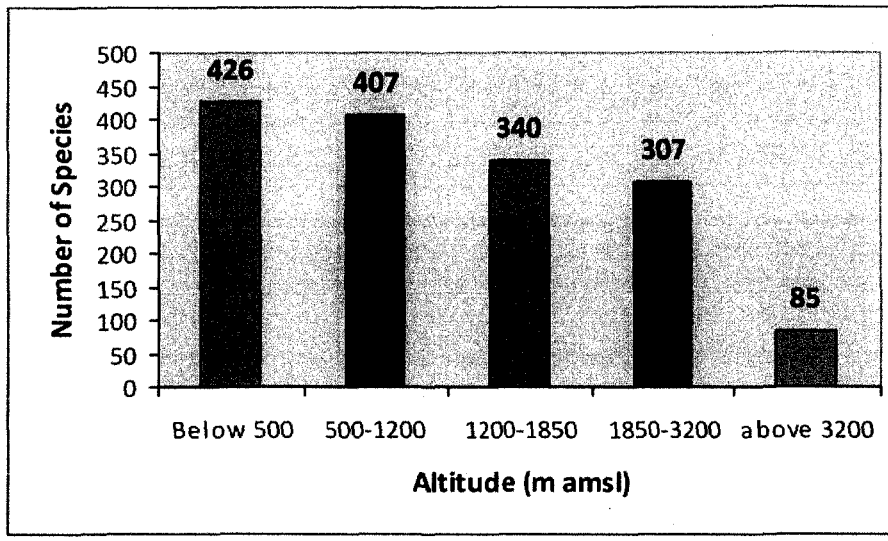


**Figure 8.2.** Numerical presentation of zone-wise representation of monocotyledonous flora of Darjeeling

### 8.2.5.1. Flora with Wide Vertical Distribution Range

The distribution of the floral elements is on one hand, greatly affected by the climatic and altitudinal factors, however on the other hand there are numerous species of monocotyledonous angiosperms which shows a wide vertical range of distribution. Such species of monocots can be categories in two distinct altitudinal zones viz (a) Tropical to Temperate Zone i.e. Terai to upper hills (120 to ± 2500 m) and (b) Temperate to Sub-alpine Zone (1850 to 3700 m). Such category of plants shows their own kind of climatic adaptability. Mostly the cosmopolitan and pan-tropical or other widely occurring elements of Himalayan, Sino-Himalayan, and SE Asian to Malaysian distribution show such diversity in the district flora. Few representatives of such elements are listed below (Table 8.13).

**Table 8.13:** List of some species with wide vertical distributional range

**(a)** Tropical to Temperate Zone

| Name | Family | Distribution range |
|---|---|---|
| *Acorus calamus* | Acoraceae | upto 2500 m |
| *Crinum amoenum* | Amaryllidaceae | upto 2000 m |
| *Arisaema tortuosum* | Araceae | 250 – 2500 m |
| *Colocasia esculenta* | –do– | upto 2000 m |
| *Rhaphidophora calophylla* | –do– | 300 – 2000 m |
| *Remusatia pumila* | –do– | 500 – 2200 m |
| *Remusatia vivipara* | –do– | 600 – 2000 m |
| *Ophiopogon wallichianus* | Asparagaceae | 200 – 2500 m |
| *Canna indica* | Cannaceae | upto 2000 m |
| *Commelina paludosa* | Commelinaceae | upto 2100 m |
| *Cyanotis fasciculata* | –do– | upto 2100 m |
| *Murdannia edulis* | –do– | upto 2000 m |
| *M. nudiflora* | –do– | upto 2400 m |
| *M. spirata* | –do– | upto 2400 m |
| *Bulbostylis densa* | Cyperaceae | upto 2300 m |
| *Carex cruciata* | –do– | 500 – 2500 m |
| *Carex myosurus* | –do– | 300 – 2400 m |
| *Carex stramentitia* | –do– | 600 – 2600 m |

| Name | Family | Distribution range |
|---|---|---|
| *Cyperus compressus* | Cyperaceae | upto 2200 m |
| *C. cuspidatus* | –do– | upto 2000 m |
| *C. cyperoides* | –do– | 250 – 2400 m |
| *C. iria* | –do– | upto 2000 m |
| *C. rotundus* | –do– | upto 2300 m |
| *C. sikkimensis* | –do– | 500 – 2000 m |
| *Eriophorum comosum* | –do– | 300 – 2300 m |
| *Fimbristylis complanata* | –do– | upto 3200 m |
| *F. dichotoma* | –do– | upto 3100 m |
| *Kyllinga brevifolia* | –do– | upto 2400 m |
| *Lipocarpha chinensis* | –do– | upto 2100 m |
| *Pycreus flavidus* | –do– | upto 2400 m |
| *P. polystachyos* | –do– | upto 2100 m |
| *P. sanguinolentus* | –do– | upto 2000 m |
| *Schoenoplectiella articulata* | –do– | upto 2000 m |
| *S. mucronata* | –do– | upto 2500 m |
| *Dioscorea alata* | Dioscoreaceae | upto 2000 m |
| *Molineria capitulata* | Hypoxidaceae | 200 – 2100 m |
| *Capillipedium assimile* | Poaceae | 250 – 2400 m |
| *Imperata cylindrica* | –do– | upto 2500 m |
| *Cephalostachyum capitatum* | –do– | 700 – 2400 m |
| *Pogonatherum crinitum* | –do– | upto 2200 m |
| *P. paniceum* | –do– | 500 – 2200 m |
| *Themeda arundinacea* | –do– | upto 2200 m |
| *Arundinella hookeri* | –do– | upto 2200 m |
| *Cynodon dactylon* | –do– | upto 2500 m |
| *Eleusine indica* | –do– | upto 2500 m |
| *Eragrostis nigra* | –do– | 500 – 2300 m |
| *Neyraudia arundinacea* | –do– | 200 – 2000 m |
| *Sporobolus diandrus* | –do– | upto 2000 m |
| *Sporobolus fertilis* | –do– | 400 – 2000 m |
| *Zea mays* | –do– | upto 2200 m |
| *Axonopus compressus* | –do– | upto 2200 m |
| *Brachiaria villosa* | –do– | upto 2500 m |
| *Digitaria ciliaris* | –do– | upto 2250 m |
| *Oplismenus compositus* | –do– | upto 2400 m |
| *Panicum notatum* | –do– | upto 2300 m |
| *Paspalum distichum* | –do– | upto 2300 m |
| *P. scrobiculatum* | –do– | upto 2000 m |
| *Setaria palmifolia* | –do– | 200 – 2850 m |
| *Setaria plicata* | –do– | 400 – 2000 m |
| *Setaria pumila* | –do– | upto 2700 m |
| *Poa annua* | –do– | upto 2600 m |
| *Triticum aestivum* | –do– | upto 2000 m |
| *Dendrobium fimbriatum* | Orchidaceae | upto 2300 m |
| *Agrostophyllum myrianthum* | –do– | 400 – 2100 m |
| *Agrostophyllum planicaule* | –do– | 300 – 2100 m |
| *Arundina graminifolia* | –do– | 300 – 2000 m |
| *Cymbidium lowianum* | –do– | 600 – 2300 m |
| *Cymbidium tracyanum* | –do– | 600 – 2300 m |

(b) Temperate to Sub-alpine Zone

| Name | Family | Distribution range |
|---|---|---|
| *Arisaema costatum* | Araceae | 2200 – 3500 m |
| *A. griffithii* | –do– | 2000 – 3500 m |
| *A. intermedium* | –do– | 2000 – 3500 m |
| *A. nepenthoides* | –do– | 1900 – 3400 m |
| *A. jacquemontii* | –do– | 2200 – 3500 m |
| *A. propinquum* | –do– | 2500 – 3500 m |
| *A. utile* | –do– | 2500 – 3500 m |
| *Maianthemum oleraceum* | Asparagaceae | 2000 – 3300 m |
| *Ophiopogon intermedius* | –do– | 1500 – 3000 m |
| *Polygonatum cathcartii* | –do– | 1500 – 3300 m |
| *Carex setigera* | Cyperaceae | 1500 – 3000 m |
| *C. alopecuroides* | –do– | 1700 – 3000 m |
| *C. decora* | –do– | 2000 – 3300 m |
| *C. filicina* | –do– | 2100 – 3050 m |
| *C. remota* | –do– | 2000 – 3500 m |
| *C. teres* | –do– | 2300 – 3500 m |
| *Juncus bufonius* | Juncaceae | 1600 – 3100 m |
| *Juncus effusus* | –do– | 2000 – 3000 m |
| *Juncus wallichianus* | –do– | 1100 – 3100 m |
| *Calanthe puberula* | Orchidaceae | 1200 – 3000 m |
| *Agrostis micrantha* | Poaceae | 1000 – 3660 m |
| *Agrostis pilosula* | –do– | 2000 – 3200 m |
| *Helictotrichon virescens* | –do– | 1800 – 3000 m |
| *Tripogon filiformis* | –do– | 1200 – 3500 m |
| *Festuca leptopogon* | –do– | 1400 – 3000 m |
| *Agrostis micrantha* | –do– | 1000 – 3660 m |
| *Helictotrichon virescens* | –do– | 1800 – 3000 m |
| *Tripogon filiformis* | –do– | 1200 – 3500 m |
| *Festuca leptopogon* | –do– | 1400 – 3000 m |

Above tables reveal that species of Sedges and Grasses have much higher tendency along with Aroides and Orchids to spread along wide vertical ranges between tropical to temperate zones and also from temperate to sub-alpine zones, where as the members of Asparagaceae and Juncaceae also spread widely along the higher elevations.

### 8.2.6. FLOWERING AND FRUITING PERIODS

Flowering and fruiting season of a species is one of the important features of any flora, and these have tremendous value in many other fields of science including proper identification of a plant. Das & Chanda (1987) first published the flowering calendar for the temperate (1500 – 2400 m) flora of Darjeeling hills. However, detailed records of flowering and fruiting seasons of different species of recorded monocotyledonous plants for the entire Darjeeling district has been presented in Chapter 4. However, during grouping of species according to their flowering and fruiting seasons, it has been observed that it cannot give a distinct account as there will be several cases of overlapping. Altitude of a place can directly affect the flowering and fruiting season of a plant, therefore, same individual may not have a same flowering and fruiting season for localities in different altitude. For example *Dendrobium fimbriatum* starts flowering in late February – March in the Terai and foot hill forests but the same species flower in

late May at Darjeeling. Some species like *Eragrostis coarctata, Musa balbisiana, Crinum asiaticum* etc. flower almost round the year.

However, season wise grouping of the taxa will show the maximum and minimum concentration of flowering and fruiting of monocotyledonous plants for a particular season in the District of Darjeeling. This type of analysis is much helpful for the peoples related with plant taxonomy or any other field of science related to plants, forest managements, tourism, plant exploration, breeding, cytogenetics, etc.

It has been observed that most of the monocotyledonous species have almost simultaneous flowering and fruiting periods except few those delayed to mature fruits after flowering. Therefore, both the flowering and fruiting seasons for a species has been taken together.

For the convenience, a whole year can be divided into four flowering and fruiting seasons for the monocotyledonous flora of Darjeeling district:

**A. Dry & Cold Winter** (December – February)

**B. Dry & Hot Summer** (March – May)

**C. Monsoon/ Rainy Season** (June – August)

**D. Autumn and beginning of Winter** (September – November)

Following this pattern of grouping, it has been observed that majority of the monocot taxa have concentrated their flowering and fruiting around monsoon or rainy season. Almost 81 % monocotyledonous angiosperms flowers and fruits from pre-monsoon season i.e. starting during *Dry and Hot Season* in March–May to Monsoon during June – August. The number of flowering species achieve its peak during Monsoon when almost half of the species (46.62 %) of monocots remain in their reproductive phase. The reason for such positive response to flowering by most of the monocot flora during Monsoon is probably that the annuals starting their active life after the winter is over takes some time to produce flower and, for the geophytes and other rhizomatous/ bulbous perennial herbs also possess rhizomes or the under ground ground portion only as perennial, rest of the vegetative portion usually annually dry up. Therefore, these plants need to complete their flowering within September as the temperature starts reducing quickly from October forcing majority of the species either to complete their life cycle or to go for hibernation. During the Post-Monsoon seasons i. e. *autumn* and *Dry & Cold Winter*, least number of species remain in flower. Hardly 19 % of flowering monocots remain in flower during this cold season (October to

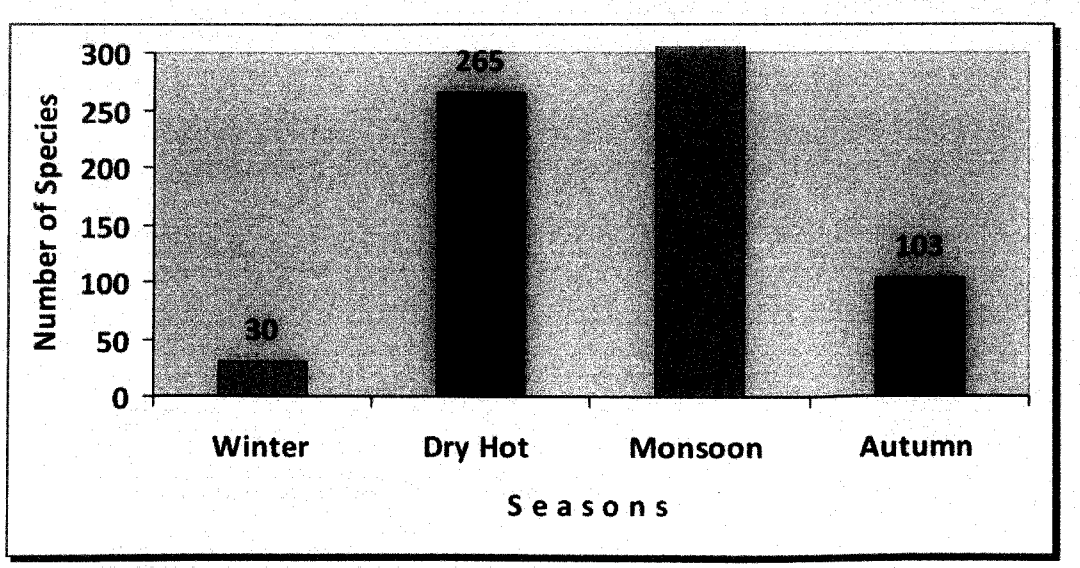


**Figure 8.3.** Season wise flowering of monocotyledonous flora of Darjeeling.

February). Actually many species remains in reproductive fase for continuous two to three seasons overlapping, like April to September or July to October, these species have been counted for both the seasons. A season wise data flowering monocots recorded for are as follows:

| | | |
|---|---|---|
| December – February | : 30 species | : 3.9 % |
| March – May | : 265 species | : 34.5 % |
| June – August | : 335 species | : 46.62 % |
| September – November | : 103 species | : 13.41 % |

The season wise flowering of monocotyledonous flora of Darjeeling district is diagrammatically represented Figure 8.3 on previous page.

## 8.2.7. PHYTOGEOGRAPHY OF MONOCOTYLEDONOUS FLORA

As the mountains of the Himalayas are extremely complex in respect to their geographical structure for which any biological survey in the region becomes extremely difficult. Therefore, a vast section of its flora might have still been under explored or even unexplored. Though it has to be explored more, but even with the present incomplete knowledge on the vast biodiversity of the East Himalayan region, it is sufficient to indicate that the area is one of the biologically richest regions in the world (Nayar 1996).

With due course of human civilization and their migration, migration of birds and animals, different floral elements also migrate in different parts of the world. Floristic picture of any place of the world, now, will provide evidences in its favour. It is the truth also for the flora of Darjeeling. Darjeeling flora is also a mixture of numerous plants of common distribution of the world (Das 1995, 2002, 2004). It is quite interesting to note that people have migrated to Darjeeling area only a few centuries back. Later on Britishers entered there in the early part of nineteenth century and established their colonial characters in their establishments. This has led to the introduction of numerous foreign plants into the flora of this region, many of which have escaped and naturalised in due course of time (Das 2002).

### 8.2.7.1. Elements of the Flora

An analysis of the recorded monocotyledonous flora of Darjeeling district shows the following Phyto-geographical relationships that have been presented in Table 8.14 below:

**Table 8.14.** Elements of Monocotyledonous flora of Darjeeling district

| **Elements of the flora** | | **No. of species** | | **Percentage** | |
|---|---|---|---|---|---|
| Himalayan | East Himalaya | 198 | 106 | 25.78 | 13.80 |
| | Himalaya West to East | | 92 | | 11.98 |
| S.E. Asian and Malaysian | | 185 | | 24.11 | |
| Sino-Himalayan | | 153 | | 19.94 | |
| Pantropical | | 75 | | 9.75 | |
| Afro-Asiatic | | 26 | | 3.38 | |
| Central Asiatic | | 22 | | 2.86 | |
| Indian and Indian Subcontinental | | 25 | | 3.25 | |
| American | | 22 | | 2.86 | |
| Cosmopolitan | | 24 | | 3.12 | |
| Eurasian | | 18 | | 2.34 | |
| Australian | | 3 | | 0.4 | |
| Others | | 17 | | 2.21 | |
| **Total:** | | **768** | | | |

Origin or the nativity and their distribution of the individual species of the flora was studied during the work. The results revealed that majority of the monocotyledonous species are of Himalayan, Sino-Himalayan and SE Asian origin and distribution. Almost 13 % of them are of Cosmopolitan or the Pantropical in nature, very few elements represent other different origin like African, Eurasian, Australian etc. A detailed Analysis has been given below:

**I. Himalayan and East-Himalayan elements:**

More than ¼th of the monocotyledonous flora of the district indicates the indigence with Himalayan elements. A number of 198 species comprising 25.78 % of total monocot flora is the largest with comparison of any other floral elements of the district are belonging to this category. Out of this, 106 species are restricted within Eastern Himalaya, i.e. between Eastern Nepal to Arunachal Pradesh, and rest, 92 are confined within the boundary of the Great Himalayas from Kashmir to Arunachal Pradesh. Few examples of such elements are some species of *Arisaema* like *A. costatum, A. griffithii, A. intermedium* var. *biflagellatum, A. propinquum, A. utile* and *Amorphophallus napalensis* etc.; some endemic species of *Carex* and *Kobresia* as *C. daltonii, C. inanis, C. inclinis, C. pulchra, C. speciosa, K. fragilis, K. uncinoides;* important orchids like *Bulbophyllum cariniflorum, Esmeralda cathcartii, Gastrochilus inconspicuous, Luisia zeylanica, Malaxis muscifera, Platanthera biermanniana, Satyrium nepalense* var. *ciliatum* and so on. The other important Himalayan monocots include *Fimbristylis stolonifera, Peliosanthes griffithii, Dioscorea prazeri, Eriocaulon edwardii, Juncus grisebachii, Tofieldia himalaica, Musa sikkimensis, Cymbopogon bhutanicus, Eulalia mollis, Danthonia cuminsii, Drepanostachyum intermedium, Yushania maling, Bromus himalaicus, Smilax wallichii, Hedychium densiflorum, Zingiber crysantheum* etc.

**II. SE Asian and Malaysian Elements:**

The South-eastern Asian countries from Myanmar to Papua New Guinea includes in between the countries like Thailand, Laos, Vietnam, Cambodia, Malaysia, Indonesia, Philippines etc. The common floristic elements of this region are treated as S.E. Asian and Malaysian elements. The boundary of the distribution often jumps beyond to N. Australia, Indian Ocean islands and even upto Pacific islands. From the results of the present study the fact lightened is that a large proportion of the monocot plants of Eastern Himalaya are distributed in this region. Viewing over the distribution pattern of the flora of the *Himalayan Biodiversity Hotspot* it will be clearly observed that most of the elements are distributed through tropical Himalaya or Eastern Himalaya to SE Asian tropical countries. The study recorded a huge number of 185 species comprising 24.11 % of total monocot flora of Darjeeling district are distributed throughout this distribution belt. It has also been cleared that those are very common and abundant species in the flora of Eastern Himalayan. Most of the common terrestrial and epiphytic orchids like *Aerides odoratum, Bulbophyllum crassipes, Cleisostoma subulatum, Cymbidium aloifolium, Gastrochilus calceolaris, Geodorum densiflorum, Herminium lanceum, Malaxis calophylla, Oberonia mucronata, Rhynchostylis retusa, Smitinandia mirantha, Thunia alba, Tropidia angulosa* and grasses like *Arthraxon quartinianus, Capillipedium assimile, C. Parviflorum, Hemarthria compressa, Microstegium ciliatum, Saccharum aurandinaceum, S. rufipilum, Themeda* species, *Garnotia tenella, Dendrocalamus giganteus, Hygrorhyza aristata, Hymenachne acutigluma, Panicum psilopodium, Setaria plicata* are included in the list of such elements. The list may further be extended with some very common other monocot plants like *Monochoria hastata, Monochoria vaginalis, Pothos scandens, Commelina paludosa, Cyanotis axillaries, Floscopa scandens, Murdannia japonica, Rhopalephora scaberrima, Cheilocostus speciosus, Fimbristylis acuminata, Pycreus pumilus, Pycreus stramineus, Dioscorea belophylla, Juncus prismatocarpus, Kaempferia rotunda* and *Zingiber zerumbet* etc.

**III. Sino-Himalayan Eelements:**

The monocot plants of Chinese origin have very little position in the district flora, but the elements occurring in the cross boundary of Indo-China show quite a large representation. Basically, it is the result of extension of the distribution of Himalayan elements to the Chinese land or vice-versa. These floras are distributed from

Himalayas to Himalayan Tibet, Northern Myanmar and South-Eastern China and some times extending towards north-east up to Japan and Korea. A significant number of 153 species of such type contribute 19.94 % to the total monocot flora. Some such representative elements include *Wallichia oblongifolia, Commelina maculata, Murdannia divergens, Pollia subumbellata, Maianthemum fuscum, M. oleraceum, Peliosanthes macrophylla, Polygonatum cirrhifolium, P. oppositifolium, Tupistra aurantiaca, Caerx longipes, C. nubigena, C. obscura, C. setosa, Kobresia pygmaea, Iris clarkei, Juncus ochraceus, Luzula plumosa, Smilax elegans, Smilax munita, Alpinia calcarata, Amomum dealbatum* etc. Most of the orchid species of the district are also falling within this category. some orchids of Sino-Himalayan distribution are *Bulbophyllum monanthum, Calanthe brevicornu, C. planteginea, C. truliformis, Coelogyne barbata, C. corymbosa, C. cristata, C. punctulata, Dendrobium hookerianum, Diplomeris hirsuta, Pinalia graminifolia, Gastrochilus distichus, Nervilia gammieana, Oreorchis micrantha, Papilionanthe teres, Phalaenopsis taenialis, Platanthera clavigera, Pleione humilis, P. precox, Vandopsis undulata,* etc. Many grasses like *Arthraxon quartinianus, Capillipedium assimile, Coleorachis khasiana, Cymbopogon khasianus, Miscanthes nepalensis, Saccharum longesetosum,* species of *Arundinella* and *Agrostis, Helictrotrichon virescens, Tripogon filiformis, Panicum khasianum* and bamboos such as *Ampelocalamus patellaris, Arundinaria racemosa, Dendrocalamus sikkimensis* are some significant representative elements.

**IV. Cosmopolitan and Pantropical Elements:**

A recognizable number of 75 monocot plants representing 9.75 % were found to be of Pantropical distribution, and 24 species i.e. 3.12 % are of cosmopolitan in distribution. Altogether 12.87 % elements of the total monocot flora of the district were found to be of such category. The plants of this nature have a good distribution and population structure within the area. Also, they can grow and survive in various climatic conditions due to their wide ecological amplitude. Some of these include aroides like *Alocasia macrorrhizos, Colocasia esculenta* etc; most of the species of Cyperaceae as *Bulbostylis barbata, Cyperus compressus, C. cuspidatus, C. difformis, C. digitatus, Fimbristylis complanata, Isolepis setacea, Kyllinga bervifolia, Lipocarpha chinensis, Pycreus polystachyos* etc. Numerous species of grasses also show cosmopolitan distribution like *Hackelochloa granularis, Heteropogon contortus, Saccharum officinarum, Arundo donax, Cynodon dactylon, Dactyloctenium aegypticum, Elusine indica, Eragrostis pilosa, Axonopus compressus, Digitaria ciliaris, Echinochloa crus-galli, Oplismenus compositus, Paspalum conjugatum* etc. which are known to have world wide in their distribution.

**V. Afro-Asiatic Elements:**

Some common plants originating and distributing from Africa and Arabian region are constituting 3.38 % (i.e. 26 species) the Darjeeling district monocot flora. Some such plants are *Eragrostis unioloides, Acroceras zizanioides, Pennisetum clandestinum, P. orientale, Setaria palmifolia, Lolium multiflorum* etc.

**VI. Central Asiatic Elements:**

Some elements of the flora which has been simultaneously spreading through the Himalayas upto this area from Western and Central Asian regions like Turkey, Iran, Iraq, Afghanistan, Pakistan; countries liberated from the former USSR like Russia, Tajikistan, Uzbekistan and western China etc. are coming under this category. 22 species of this category has been recognized, which comprise at least 2.86 % of the district's monocot flora. Most common examples of these plants include *Arisaema jacquemontii, Schoenoplectus triqueter, Dioscorea deltoidea, Eriocaulon cinereum, Chrysopogon gryllus, Pogonetherum paniceum, Trisetum clarkei, Hemarthria, compressa Phalaris, minor, Arthraxon lancifolius, Festuca gigantica* etc.

**VII. Elements of Indian mainland and Indian Subcontinent:**

The mainland of India shows difference with the Himalayan highlands in many aspects, the vegetation structure is one of these. Being a contiguous landmass the district also indicates the significant presence of common Indo-Gangetic and Deccan plant species. But, the elements that actually originated and

dispersed from India and Indian Subcontinent are very few. Only 25 species constituting 3.25 % species of the total monocotyledonous flora of Darjeeling falls in this category. Some of these are *Agrostis triaristata, Amorphophallus bulbifer, Curcuma aromatica, Ischaemum indicum, Phrynium pubinerve, Stachyphrynium placentarium, Cymbopogon nardus, Cymbopogon flexuosus, Aponogeton undulatum, Alpinia calcarata, Zingiber purpureum,* etc.

**VIII. American Elements:**

Many plants of North to South American origin especially of Mexican and Brazilian region also have a good representation in the Darjeeling district monocot flora. Most of these plants were introduced to decorate the gardens and parks in the area. 22 species constituting 2.86 % of the monocot flora were listed, few of them are *Eichornia crassipes,* different species of *Agave* like *A. americana, A. lurida, A. sisalana; Furcraea selloa, Zephyranthes carinata, Z. candida, Paspalum dilatatum* etc

**IX. Eurasian Elements:**

A small proportion, i.e. 2.34 % of the total monocot flora of the district is represented by 18 species of Eurasian elements. *Dactylis glomerata, Smilax aspara, Polygonatum verticillatum, Schoenoplectus triqueter* etc. are examples of some of the plants common with Europe and Russia.

**X. Australian Elements:**

Only two species of grasses, *Phragmites karka* and *Perotis indica* and *Cordyline australis* were recognised as Australian representatives in the district's monocot flora. The former and the later, probably are introduced and middle one be migrated element.

Presence of large proportion of the Himalayan elements in the flora indicates towards the duniqueness of vegitational structure of the district. Almost half of the total monocot flora of the district (including the Sino-Himalayan elements, 351 species i.e. 45.7 %) speaks for the originality of the monocot flora as Himalayan. Further, 185 species acquiring 24.11 % of monocots showed alliance with S.E. Asian-Malaysian elements rather than Indian or Indian subcontinental elements. This character is very much interesting and unique, which is not common to other regions of the country except Himalayas. Among these Himalayan elements especially the East Himalayan flora possess more tendency to be endemic to the region.

### 8.2.7.2. Emdemism with Respect to Monocot Flora

Before the compilation of his *Flora of British India,* in 1849 Sir J. D. Hooker commented that *Indian flora is the representation of migratory species*. But, with the end of his own work in 1906 and onwards with effort of various explorers it has been proved that India is a suitable home for the endemic flora. It hosts about 6850 endemic plant species and of which almost half i.e. 3165 species occupying 46.2 % grow in the Himalayan regions (D. Chatterjee 1939). The latter studies undertaken by many workers it is being estimated that about 60 % of the Indian flora are of Indian origin, and out of which 14 % being exclusively endemic to India ) (D. Chatterjee 1939, 1962).

The district of Darjeeling, being a part of *Himalayan Biodiversity Hotspot,* is not contradictory with other regions of its parallel. Records prevail that 30 % species of dicotyledonous plants from the region are endemic to Eastern Himalaya from the district (Das 1986, 1995, 2004; Bhujel 1996, Bhujel & Das 2000, 2002). Latest studies on dicotyledonous flora of the district Bhujel (1996) listed about 405 endemic dicot species (15.79 %) in Darjeeling district occuring along Eastern Himalaya and North-East India of which 29 species were restricted within the district. From a narrow tract of Senchal mountains from Kurseong to Lebong, Das (1986) reported more than 10 % endemic angiosperms. While exploring the vergine vegetation of Neora Valley National Park, Rai (2001) recorded over 14 % of plant taxa as endemic to Himalaya from a small geographic area of 88 sq km of the park.

Phytogeographically the Great Himalayas has been divided into 3 main divisions, namely Western Himalaya (Kashmir and Himachal Pradesh), Central Himalaya (Uttaranchal to Western Nepal) and Eastern Himalaya (East Nepal to Arunachal Pradesh) (D. Chatterjee 1962). The Eastern Himalaya comprises the Geographycal boundaries of eastern Nepal, the Darjeeling-Sikkim Himalaya, Bhutan and Arunachal Pradesh. To assess the endemism particularly of the Darjeeling district and to find out their status, the whole region of East Himalaya can be divided into four phytogeographical divisions as (a) Nepal portion (Western quarter of E Himalaya), (b) Darjeeling-Sikkim Himalaya (West-Central quarter of E Himalaya) anc (c) Bhutan (East-Central quarter of E. Himalaya) and (d) Arunachal Pradesh (Eastern quarter of E Himalaya). With accordance to above phytogeographical divisions the endemism of the floristic elements of Darjeeling district can also be studied as follows (Das 1986, 2004):

1. Taxa Endemic to Darjeeling and Sikkim
2. Taxa Endemic to Nepal to Bhutan
3. Taxa Endemic to Eastern Himalaya
4. Taxa Endemic to Eastern Himalaya and NE India
5. Taxa Endemic to Himalaya (Kashmir to Arunachal Pradesh)

Following this framework of various zones of Himalaya as well as of Eastern Himalaya and little extending to the North East India, the recorded monocotyledonous flora showed endemism as follows:

## I. Endemic to Darjeeling and Sikkim

Twelve monocot species are identified to be exclusively endemic to the hills of Darjeeling and Sikkim Himalayas and the foothills and adjoining Dooars region. 50 % of these species are orchids. Three of these are the newly introduced taxa. List of these species shown in Table 8.15.

**Table 8.15.** Flora Endemic to Darjeeling and Sikkim Himalayas

| Name of species | Family |
|---|---|
| 1. *Acampe praemorsa* var. *flava* | Orchidaceae |
| 2. *Cyperus sikkimensis* | Cyperaceae |
| 3. *Crepidium josephianum* | –do– |
| 4. *Gastrochilus corymbosus* | –do– |
| 5. *Globba leucopetala* | Zingiberaceae |
| 6. *Globba andersonii* | –do– |
| 7. *Goodyera hemsleyana* | Orchidaceae |
| 8. *Liparis nervosa* var. *khasiana* | –do– |
| 9. *Liparis tigerhillensis* | –do– |
| 10. *Musa sikkimensis* | Musaceae |
| 11. *Nervilia gammieana* | –do– |
| 12. *Typhonium roxburghii* var. *longispathum* | Araceae |

## II. Endemic to Eastern Nepal to Bhutan

There are also some elements those have quite restricted distribution from Eastern Nepal to Darjeeling-Sikkim Himalayas or Darjeeling-Sikkim Himalayas and Bhutan etc, their distribution have been assumpted from Eastern Nepal to Bhutan. As much as 21 such species are reported from Darjeeling district are listed below in Table 8.16.

## III. Endemic to Eastern Himalaya

The taxa having restricted distribution within the East Himalayan region as a whole from Eastern Nepal to Arunachal Pradesh are taken under this category. Maximum numbers of endemic species fall under this category. A record of 30 monocot plant species are recognized as endemic to Eastern Himalaya as presented in Table 8.17.

**Table 8.16.** Flora Endemic to Eastern Nepal to Bhutan

| Name of species | Family |
|---|---|
| 1. *Arisaema costatum* | Araceae |
| 2. *Bromus himalaicus* | Poaceae |
| 3. *Caerx crassipes* | Cyperaceae |
| 4. *C. daltonii* | –do– |
| 5. *C. decora* | –do– |
| 6. *C. pulchra* | –do– |
| 7. *C. vesiculosa* | –do– |
| 8. *Cautleya spicata* | Zingiberaceae |
| 9. *Cymbopogon bhutanicus* | Poaceae |
| 10. *Fimbristylis stolonifera* | Cyperaceae |
| 11. *Himalcalamus falconeri* | Poaceae |
| 12. *Kobresia fragilis* | Cyperaceae |
| 13. *K. uncinoides* | –do– |
| 14. *Isachne sikkimensis* | Poaceae |
| 15. *Juncus grisebachii* | Juncaceae |
| 16. *Lecanorchis sikkimensis* | Poaceae |
| 17. *Platanthera biermanniana* | Orchidaceae |
| 18. *Poa gammieana* | Poaceae |
| 19. *Poa himalayana* | –do– |
| 20. *Satyrium nepalense var. ciliatum* | Orchidaceae |
| 21. *Tofieldia himalaica* | Tofieldiaceae |

**Table 8.17.** Taxa Endemic to Eastern Himalaya

| Name of species | Family |
|---|---|
| 1. *Agrostophyllum myrianthum* | Orchidaceae |
| 2. *Arisaema griffithii* | Araceae |
| 3. *A. speciosum* var. *mirabile* | –do– |
| 4. *A. utile* | –do– |
| 5. *Bulbophyllum yoksunense* | Orchidaceae |
| 6. *Curcuma zedoaria* | Zingiberaceae |
| 7. *Cymbopogon microthecus* | Poaceae |
| 8. *Dioscorea prazeri* | Dioscoreaceae |
| 9. *Drepanostachyum intermedium* | Poaceae |
| 10. *Globba andersonii* | Zingiberaceae |
| 11. *G. clarkei* | –do– |
| 12. *G. multiflora* | –do– |
| 13. *Gastrochilus dasypogon* | Orchidaceae |
| 14. *Hedychium densiflorum* | Zingiberaceae |
| 15. *H. thyrsiforme* | –do– |
| 16. *Hemiorchis pantlingii* | –do– |
| 17. *Luisia tristis* | Orchidaceae |
| 18. *Malaxis muscifera* | –do– |
| 19. *Pandanus furcatus* | Pandanaceae |
| 20. *Papilionanthe uniflora* | Orchidaceae |
| 21. *Peliosanthes griffithii* | Asparagaceae |
| 22. *Phoenix rupicola* | Arecaceae |
| 23. *Pleione humilis* | Orchidaceae |
| 24. *Poa sikkimensis* | Poaceae |
| 25. *Pollia subumbellata* | Commelinaceae |

| Name of species | Family |
|---|---|
| 26. *Roscoea purpurea* | Zingiberaceae |
| 27. *Smilax wallichii* | Smilacaceae |
| 28. *Trisetum spicatum* ssp. *himalaicum* | Poaceae |
| 29. *Yushania microphylla* | –do– |
| 30. *Y. maling* | –do– |

## IV. Endemic to Eastern Himalaya and North-East India

Considering a fact to be respected that due to much similarities in climatic, physical and geographical conditions, the similarities are also being reflected by the vegetation of many places of North Eastern sister states of India. The floristic elements of Garo, Jayanti and Khasia hills of Meghalaya, hills of Manipur, Nagaland, Mizoram, Tripura and even the plains of Assam exhibit co-relationship with that of the Eastern Himalaya in many aspects. In this regard a large number of endemic monocot plants of E Himalaya showed a little leap towards these places. Therefore a category of monocot species of Darjeeling district endemic to Eastern Himalaya including the North-East India has been taken in consider. A considerable number of 31 such elements are listed below in table 8.18.

**Table 8.18.** Taxa Endemic to Eastern Himalayas Extending to North-East India

| Name of species | Family |
|---|---|
| 1. *Amischotolype mollissima* | Commelinaceae |
| 2. *Bulbophyllum gamblei* | Orchidaceae |
| 3. *B. sarcophylloides* | –do– |
| 4. *Calamus latifolius* | Arecaceae |
| 5. *C. leptospadix* | –do– |
| 6. *Cephalostachyum captatitum* | Poaceae |
| 7. *Dendrobium porphyrochillum* | Orchidaceae |
| 8. *D. transparens* | –do– |
| 9. *Drepanostachyum khasianum* | Poaceae |
| 10. *D. polystachyum* | –do– |
| 11. *Esmeralda cathcartii* | Orchidaceae |
| 12. *Garnotia polypogonoides* | Poaceae |
| 13. *Globba clarkei* | Zingiberaceae |
| 14. *G. racemosa* | –do– |
| 15. *Hedychium ellipticum* | –do– |
| 16. *H. gardnerianum* | –do– |
| 17. *H. glaucum* | –do– |
| 18. *H. greenii* | –do– |
| 19. *Habenaria arietina* | Orchidaceae |
| 20. *Hemiorchis pantlingii* | Zingiberaceae |
| 21. *Heterosmilax japonica* | Smilacaceae |
| 22. *Himalcalamus hookerianus* | Poaceae |
| 23. *Molineria crassifolia* | Hypoxidaceae |
| 24. *Oberonia angustifolia* | Orchidaceae |
| 25. *Ophiopogon wallichianus* | Asparagacae |
| 26. *Phoenix acaulis* | Arecaceae |
| 27. *Poa khasiana* | Poaceae |
| 28. *Smilax minutiflora* | Smilacaceae |
| 29. *S. orthroptera* | –do– |
| 30. *Tupistra nutans* | Asparagacae |
| 31. *Zingiber rubens* | Zingiberaceae |

## IV. Endemic to Himalaya

The floristic diversity of the district shows a great alliance with the Himalayan elements as discussed earlier. A remarkable amount of flora endemic to the Himalaya as a whole from Kashmir to Arunachal Pradesh are also been detected. A list of 16 such endemic monocots are shown below in Table 8.19.

**Table 8.19.** Taxa Endemic to Himalayas

| Name of species | Family |
|---|---|
| 1. *Allium stracheyi* | Amaryllidaceae |
| 2. *A. wallichii* | –do– |
| 3. *Amorphophallus napalensis* | Araceae |
| 4. *Arisaema intermedium* | –do– |
| 5. *A. jacquemontii* | –do– |
| 6. *A. propinquum* | –do– |
| 7. *A. speciosum* var. *mirabile* | –do– |
| 8. *Carex inclinis* | Cyperaceae |
| 9. *C. pulchra* | –do– |
| 10. *Chiloschista usneoides* | Orchidaceae |
| 11. *Dendrobium amoenum* | –do– |
| 12. *Dioscorea deltoidea* | Dioscoreaceae |
| 13. *Eriocaulon edwardii* | Eriocaulaceae |
| 14. *Gastrochilus inconspicuus* | –do– |
| 15. *Tenaxia cuminsii* | Poaceae |
| 16. *Trisetum clarkei* | –do– |

While analysing the endemism of the monocotyledonous flora of Darjeeling district 110 endemic elements were detected those comprises 14.32 % of total monocot flora. The figure is note worthy as it expresses the virginity of the area in respect of vegetation. It has been observed that in the earlier literatures we found a maximum percentage of endemism in one particular area due to poor exploration of the adjoining areas. On the other hand, it is also be noticed that with the comprehensive exploration of different poorly or un-explored areas, the existence of the floristic elements revealed so the percentage of endemism in respect to flora of the same area will decrease in due course of time. The elements also spread by there own naturally or by cause during the time spend. Endemism of the district monocot species in respect of different vegetational zones within the Himalayan territory are shown in the Table 8.20 below.

**Table 8.20.** Endemism of monocotyledonous flora of Darjeeling district

| Category of Endemism | Total Monocot species | No. of Endemic Species | Percentage of Endemism |
|---|---|---|---|
| Darjeeling and Sikkim | 768 | 12 | 1.56 |
| Nepal to Bhutan | | 21 | 2.73 |
| Eastern Himalaya | | 30 | 3.9 |
| Eastern Himalaya and NE India | | 31 | 4.03 |
| Himalaya | | 16 | 2.08 |
| **Total** | **768** | **110** | **14.32** |

While studying the great Himalaya, it is noteworthy to study it only by the front face but also to glance over to its back face, that is Tibet, because the mountains are made up of the two opposite slopes. In this regards, the floristic elements of this slope of the Himalayas may infiltrate to the other slope too. In the present study as many as 53 monocotyledonous species have been recorded which have been migrated little beyond the boundary of Indian Himalayas upwards to Tibet and east-wards from Arunachal or NE India to Southern most portion of China and Northern Myanmar. A list of such elements are shown in the Table 8.21.

**Table 8.21.** Flora endemic to Himalaya little expanding to Tibet (S China), N Myanmar or Bangladesh

| Name of species | Family | Expanded upto |
|---|---|---|
| *Calamus erectus* | Arecaceae | Bangladesh |
| *Phoenix sylvestris* | –do– | –do– |
| *Vanda tessellata* | Orchidaceae | –do– |
| *Amorphophallus margaritifer* | Araceae | –do– |
| *Bambusa balcooa* | Poaceae | –do– |
| *B. jaintiana* | –do– | –do– |
| *Arisaema speciosum* | Araceae | Tibet (S China) |
| *Arisaema tortuosum* | –do– | –do– |
| *Polygonatum cathcartii* | Asparagaceae | –do– |
| *Polygonatum cirrhifolium* | –do– | –do– |
| *Polygonatum oppositifolium* | –do– | –do– |
| *Rohdea nepalensis* | –do– | –do– |
| *Carex longipes* | Cyperaceae | –do– |
| *Carex inanis* | –do– | –do– |
| *Carex setosa* | –do– | –do– |
| *Carex teres* | –do– | –do– |
| *Fimbristylis stolonifera* | –do– | –do– |
| *Kobresia fragilis* | –do– | –do– |
| *Juncus ochraceus* | Juncaceae | –do– |
| *Juncus grisebachii* | –do– | –do– |
| *Fritillaria cirrhosa* | Liliaceae | –do– |
| *Eulalia mollis* | Poaceae | –do– |
| *Arundinaria racemosa* | –do– | –do– |
| *Cymbopogon pendulus* | –do– | –do– |
| *Dendrocalamus sikkimensis* | –do– | –do– |
| *Himalayacalamus falconeri* | –do– | –do– |
| *Thamnocalamus spathiflorus* | –do– | –do– |
| *Isachne sikkimensis* | –do– | –do– |
| *Festuca polycolea* | –do– | –do– |
| *Roscoea purpurea* | Zingiberaceae | –do– |
| *Calanthe plantaginea* | Orchidaceae | –do– |
| *Coelogyne barbata* | –do– | –do– |
| *Coelogyne cristata* | –do– | –do– |
| *Diplomeris hirsuta* | –do– | –do– |
| *Liparis resupinata* | –do– | –do– |
| *Pinalia graminifolia* | –do– | –do– |
| *Platanthera clavigera* | –do– | –do– |
| *Platanthera latilabris* | –do– | –do– |
| *Vandopsis undulata* | –do– | –do– |
| *Calamagrostis emodensis* | Poaceae | W China |

| Name of species | Family | Expanded upto |
|---|---|---|
| *Dendrobium amoenum* | Orchidaceae | Bangladesh, N Myanmar |
| *Dendrobium hookerianum* | –do– | S China, N Myanmar |
| *Dendrobium rotundatum* | –do– | –do– |
| *Eriophorum comosum* | –do– | –do– |
| *Phalaenopsis taenialis* | –do– | –do– |
| *Oreorchis micrantha* | –do– | –do– |
| *Papilionanthe vandarum* | –do– | –do– |
| *Murdannia divergens* | –do– | –do– |
| *Liparis deflexa* | –do– | N Myanmar |
| *Zeuxine affinis* | –do– | –do– |
| *Nervilia macroglossa* | –do– | –do– |
| *Dendrocalamus hookeri* | Poaceae | –do– |
| *Crinum amoenum* | Amaryllidaceae | –do– |

### 8.2.7.3. Exotic Monocotyledons

As human being always dependent upon the natural resources to fulfill his day by day needs. Plant resources are obviously one of them. Wild birds and animals also expose the same nature to some extent. For this reason huge number of plant species migrate from one place to other. Most of the exotic elements of a place are seems to be desirably introduced for food, fiber, fruits, flowers, drug and other values of human benefit. Migration of plants species to distant parts is a continuous natural phenomenon and is facilitated by various geological and climatic factors. Various connecting links like land, bridge and the vast marine carriages may be attributed a best medium for the purpose. Such kind of migratory root is observed within the southern portion of Himalaya, Indian sub-continent, South India, Sri Lanka, Andaman and the South East Asia to the Malaysian territory extending to Australia through Papua New Guinea. Migration is a long and continuous biological process. The migrated exotic elements need to acclimatise and establish themselves in the new climatic condition, then propagate and finally naturalise there. Exotic species are one of the important components of East Himalayan floristic elements, many of them have already been naturalised and some are in the process of naturalisation. Regarding the introduction of exotic elements to the Himalayan region, it is believed that the natural migration is affected through three routes, (1) Migration of South East Asiatic floristic elements through the low altitude hill ranges of North East India, (2) Migration of the European floristic elements through different parallel mountain systems, and (3) Migration of tropical and subtropical elements of Deccan and Peninsular India through the vast plains of mainland of India.

Introduction of British colonies, establishments of tea garden in early nineteenth century is an important factor for the migration of many plant species of this region. Many exotic edible and ornamental species were intentionally introduced to meet the human need and desire. The exotic flora can be categorized into two categories viz migratory and introduced, which formed one of the integral components of the vegetation of Eastern Himalayas. Recently, many botanists like Biswas (1940), Hara (1966-71), Ohashi (1975), Mathew (1981), Hajra & Das (1982) have worked on exotic plant species of Eastern Himalayas, like wise Das (1984, 1986, 2002), Bhujel (1984), Rai P C (2001), Rai S K (2002) etc. have worked on same specially of Darjeeling Himalaya and have further added some exotic plant species to the list of Eastern Himalayan.

Das & Chanda (1986) and Das (2002) recorded the naturalization of 114 species of exotic plants in the flora of Darjeeling. Of these only 14 species were from the monocotyledons covering 13 genera from seven families. The Darjeeling district with its varied topography and contiguous geographical situation and the varied other factors mentioned above, is rich in exotic floristic elements. It has been observed that

most of the exotic species of the region are of South and Central American, Mexican, Chinese and European origin and rest of Australian, African, Siberian and Indian plant elements. Examples of such monocots are listed in the following Table 8.22 along with their status of naturalization and their respective country of origin.

**Table 8.22.** List of some Exotic Monocotyledonous species of Darjeeling district

| Name of species | Family | Status | Country of Origin |
|---|---|---|---|
| *Acroceras zizanioides* | Poaceae | Naturalized | Tropical Africa |
| *Agave americana* | Asparagaceae | Planted | America |
| *A. sisalana* | –do– | Escaped | Mexico |
| *A. vera-cruz* | –do– | Planted | Mexico |
| *Alocasia macrorrhizos* | Araceae | Naturalized | Tropical SE Asia |
| *Ananas comosus* | Bromeliaceae | Planted | America |
| *Axonopus compressus* | Poaceae | Naturalized | S America |
| *Canna indica* var. *edulis* | Cannaceae | –do– | America |
| *Chrysapogon zizanioides* | Poaceae | –do– | Indian mainland |
| *Crocosmia* × *crocosmiiflora* | Iridaceae | –do– | Africa |
| *Cymbopogon nardus* | Poaceae | –do– | S India & Sri Lanka |
| *Eichhornia crassipes* | Pontederiaceae | –do– | Brazil |
| *Eleutherine bulbosa* | Iridaceae | Planted | South Africa. |
| *Freesia refracta* | –do– | –do– | South Africa |
| *Furcraea selloa* | Asparagaceae | Escaped | America |
| *Gladiolus dalenii* | Iridaceae | Planted | Africa & Madagascar |
| *Hemerocallis fulva* | Hemerocallidaceae | Naturalized | China |
| *Holcus lanatus* | Poaceae | –do– | Europe |
| *Hydrilla verticillata* | Hemerocallidaceae | –do– | SE Europe, Africa, Asia and Australia |
| *Hymenocallis littoralis* | Amaryllidaceae | –do– | Mexico & C America |
| *Iris domestica* | Iridaceae | Planted | China and Japan |
| *Limnocharis flava* | Alismataceae | Naturalized | Caribbean, C S America |
| *Monochoria vaginalis* | Pontederiaceae | –do– | SE Asia |
| *Paspalum dilatatum* | Poaceae | –do– | S America |
| *Pennisetum clandestinum* | –do– | –do– | E Africa |
| *P.orientale* | –do– | –do– | N Africa, Arabia, C & SE Asia |
| *P. purpureum* | –do– | –do– | Africa |
| *Phalaris minor* | –do– | –do– | Mediterranian Asia |
| *Phrynium pubinerve* | Marantaceae | –do– | Indian mainland |
| *Potamogeton crispus* | Potamogetonaceae | –do– | Europe |
| *Sansevieria cylindrica* | Asparagaceae | Planted | America |
| *S. trifasciata* | –do– | Semi-naturalized | America |
| *Setaria pumila* | Poaceae | Naturalized | Asia and Europe |
| *Tigridia pavonia* | Iridaceae | Planted | Mexico and Guatemala |
| *Tradescantia fluminensis* | Commelinaceae | Semi-naturalized | Tropical South America |
| *T. pallida* | –do– | Escaped | Mexico and C America |
| *T. virginiana* | –do– | –do– | Mexico and C America |
| *Tripsacum laxum* | Poaceae | Planted/ Escaped | Guatemala |
| *Typha elephantina* | Typhaceae | Naturalized | Exotic; introduced and naturalised |
| *Xanthosoma sagittifolium* | Araceae | Escaped | S America, and Carribean islands |
| *Yucca aliofolia* | Asparagaceae | Planted | Mexico |
| *Zantedeschia aethiopica* | Araceae | Semi-naturalized | Africa |
| *Zea mays* | Poaceae | Planted/Naturalized | America and Mexico |
| *Zephyranthes candida* | Amaryllidaceae | Semi-naturalized | S America |
| *Zephyranthes carinata* | Amaryllidaceae | Naturalized | Maxico |
| *Zingiber officinale* | Zingiberaceae | Planted | China |
| *Z. purpureum* | –do– | –do– | Indian mainland |
| *Z. zerumbet* | –do– | Semi-naturalized | S India & Sri Lanka |

It is noteworthy that the naturalisation process of exotic species in these patches of East Himalayan region has gradual ecological implications. The rapid propagation and growth of exotic weeds like *Eichornia crassipes, Monochoria vaginalis* etc. have invade most of the ditches, marshes and wetlands in the Terai and low hills, similarly a most important exotic weed introduced as a lawn grass in the upper hills *Pennisetum clandestinum* has played a great disturbance upsetting the local ecological balance as well as creating environmentally unhygienic microclimate in those places. Thus, the proliferation of exotics in the Himalayan regions is an alarming threat to the local floristic elements.

### 8.2.7.4. Rare and Threatened Monocots

With the passage of time the overall habitat conditions changes due to innumerable reasons. In the present situation man initiated changes or modifications are playing dangerous role for the survival of different species of organisms in the habitat. Along with this the natural forces of evolution are also forcing species to change and to adopt with the changed habitat conditions. During all these natural and/or man-induced processes many established existing species fails to cope-up with the changed conditions and that affects their physiology and in turn to their survival. So, we find, numerous species round the world becoming endangered at an accelerated rate. As a result, many flora and fauna have already been extinct or running fast towards the death at every moment. Conservation of these living natural 'resources' which are facing the threat for extinction is one of the very few most important tasks for the man today. And, that is for their own survival. Besides the natural causes, anthropogenic factors like habitat destruction through grazing, urbanisation and innumerable other developmental activities and over exploitation are the major factors for drastic habitat changes. During last few decades, exploration, assessment and inventory in respect to the phytodiversity of India by the scientists of Botanical Survey of India and other active botanical explorers, about 1500 rare and threatened species of both flowering and non-flowering plants have been identified and, compiled into Red Data Sheets and published in five volumes of the Red Data Books of Indian Plants (Nayar & Sastry 1987, 1988, 1990). Many plant species found in this district have also occupied their place in that list as shown in Table 8. 23.

**Table 8. 23.** List of some RET Plants of India from Darjeeling district recognized by BSI/ IUCN [Abb. CR: Critically Endangered; EN: Endangered; VU: Vulnerable]

| Name of species | Family | Status | Place of occurrencre |
|---|---|---|---|
| *Allium stracheyi* | Amaryllidaceae | VU | Rimbick |
| *Aponogeton appendiculatus* | Aponogetonaceae | Rare | Terai |
| *Arisaema speciosum* | Araceae | CR | Darjeeling, Sonada, Labha, Neora Valley |
| *Amorphophallus margaritiferum* | Araceae | Rare | Mahananda Wildlife Sanctuary |
| *Phoenix rupicola* | Arecaceae | CR | Tista Rangit and Balasan river valleys, Rohini |
| *Dioscorea deltoidea* | Dioscoreaceae | EN | Kainjalay, Gairibas and Rongo |
| *Acampe rigida* | Orchidaceae | EN | Mahananda Wildlife Sanctuary |
| *Corymborkis veratrifolia* | –do– | Rare | Tista river valley, Najoke, Sevok forest |
| *Cymbidium cochleare* | –do– | Rare | Senchal Wildlife Sanctuary, Lepchajagat, Rammam to Gorkhey |
| *Cymbidium hookerianum* | –do– | Rare | Darjeeling |
| *Dendrobium nobile* | –do– | VU | Kurseong, Sirisey, Jhepi, Lodhoma |
| *Diplomeris hirsuta* | –do– | CR | Baghpool area of Sevok, Rungdung valley |
| *Dendrobium fugax* | –do– | EN | Sukna, Mahananda Wildlife Sanctuary, Tista river valley |
| *Malaxis muscifera* | –do– | CR | Kolbong, Tiger Hill |
| *Platanthera biermanniana* | –do– | CR | Birch Hill & Tiger Hill |
| *Tropidia curculigoides* | –do– | EN | Tista river valley |
| *Fritillaria cirrhosa* | Liliaceae | EN | Around Sandakphu |
| *Pandanus unguifer* | Pandanaceae | EN | Dulkajhar, Mahananda Wildlife Sanctuary Samsing Fari |
| *Polygonatum verticillatum* | Asparagaceae | VU | Tumling, Gairibas |

During the present floristic exploration, many such taxa were recognized which are found extremely rare within the study area. These Rare, Endangered and Threatened plant species have also been listed in table 8.24, which may help the further assessment of their availability status and framing appropriate strategies for their conservation conservation, including multiplication and scientific evaluation towards their usefulness for the selfish human society.

**Table 8. 24.** List of some rare monocot plants from Darjeeling district (suggestive)

| Name of species | Family | Place of occurrence |
|---|---|---|
| *Allium wallichii* | Amaryllidaceae | Alubari, NeoraValley |
| *Arisaema costatum* | Araceae | Tumling to below Sandakphu, Jalapahar |
| *Arisaema intermedium* | –do– | Sandakphu, Phalut, Neora Valley |
| *Arisaema speciosum* var. *mirabile* | –do– | Tiger Hill – Senchal area |
| *Sauromatum venosum* | –do– | Goke to Kolbong, Lingten |
| *Typhonium roxburghii* var. *longispathum* | –do– | Below Rongtong |
| *Calamus guruba* | Arecaceae | Mahananda Wildlife Sanctuary |
| *Calamus latifolius* | –do– | Mahananda Wildlife Sanctuary |
| *Calamus leptospadix* | –do– | Samsing, Kumai, |
| *Pinanga gracilis* | –do– | Terai, hot river valleys, Rungdung |
| *Asparagus filicinus* | Asparagaceae | around Darjeeling |
| *Asparagus griffithii* | –do– | around Darjeeling |
| *Asparagus officinalis* | –do– | Rarely cultivated |
| *Polygonatum cirrhifolium* | –do– | Singalila and Neora Valley National Park, Senchal area |
| *Burmannia coelestis* | Burmanniaceae | NBU campus, Rungdung |
| *Gloriosa superba* | Colchicaceae | Sukna, Pankhabari |
| *Scleria rugosa* | Cyperaceae | Around Darjeeling |
| *Eriocaulon edwardii* | Eriocaulaceae | Dulkajhar forest |
| *Juncus effusus* | Juncaceae | Tigerhill, few places in Neora Valley |
| *Juncus grisebachii* | –do– | Sandakphu area |
| *Juncus inflexus* | –do– | Llyod Botanical Garden, Senchal |
| *Himalayacalamus falconeri* | Poaceae | Rachila |
| *Thamnocalamus spathiflorus* | –do– | Ruka Hill, Neora Valley |
| *Tripogon trifidus* | –do– | Tiger Hill and Senchal area |
| *Oryza meyeriana* | –do– | Panighatta, Labarbotey |
| *Stemona tuberosa* | Stemonaceae | Found in only places like Kalijhora and below Deorali, above 27 mile |
| *Heterosmilax japonica* | Smilacaceae | only two plants found in Jalapahar area |
| *Smilax wallichii* | –do– | Neora Valley, Marybong to Rishihat |
| *Etlingera linguiformis* | Zingiberaceae | Kalijhora |
| *Globba leucopetala* | –do– | Around Baghpool |
| *Hedychium densiflorum* | –do– | Lepchajagat, lower boarder of Singalila National Park, Sukia pokhari to Maney Bhanjyang |

## 8.2.8. ECONOMIC ASSESSMENT

From the economic point of view, the floristic resources of Darjeeling district are regarded as high value green assets. A large number of monocotyledonous angiosperms of the district have been found to be highly economically valuable for their suitable useful qualities like medicinal, ornamental, aromatic, edible, fodder, house-building, religious, etc. Many being used in various domestic purposes and as human cultural heritage. A large number of edible herbs and shrubs are reported to be helpful to solve the food problem especially natural calamities and famines and food scarcities during long political disturbances. District is also found to be the storehouse of resources for traditional system of medicines (TSM) practiced by the local practitioners, village doctors, faith-healers etc.

The district possess two National Parks, two Wildlife Sanctuaries and many Reserved and other unreserved forests within its territory, therefore it also harvests a large number of diverse, precious and high-valued timber producing species. *Shoresa robusta, Tectona grandis, Terminalia* spp., *Dalbergia sissoo, Schima wallichii, Taxus baccata, Tsuga dumosa, Alnus nepalensis, Alcimandra cthcartii, Mangnolia campbellii* and *Magnolia champaca* are only few examples of timber species having high demand, growing abundantly within the district.

The virgin places of the district like Singalila mountain, Neora Valley, Senchal and Lepchajagat forests, the valleys of Tista and Rangit etc. serves as storehouse of germplasm of several wild plant species having immense horticultural significance. There are numerous species of orchids, trees, shrubs, herbs and climbers of monocotyledonous families having ornamental importance. For their beautiful and attractive flowers, fruits, foliage or the characteristic shape, many monocots of the district have been introduced into the gardens and parks even in many other countries.

The economic importance of the floral resources of the district can be studied separately as follows:

### 8.2.8.1. Medicinal Resources

Being a part of The Great Himalayas which is recognized as the store house of medicine since the Pre-Vedic era and the Vedic Ayurved, the hills of Darjeeling also possesses a huge store of a large variety of plants of therapeutic values. Beside the well known medicinal plants of the Himalayas like *Aconitum ferox, Astilbe rivularis, Swertia chirayita, Bergenia ciliata, Artemisia vulgaris, Eupatorium adenophorum, Ageratum conyzoides, Panax pseudo-ginseng, Taxus baccata* etc., there are many monocotyledonous species growing within the territory of the district, which are established as important medicinal plants and includes: *Acorus calamus, Aloe vera, Alpinia calcarata, Alpinia nigra, Amomum subulatum, Asparagus recemosus, Cheilocostus speciosus, Curcuma aromatica, Curcuma caesia, Curcuma longa, Curcuma zedoaria, Cymbopogon flexuosus, Dioscorea deltoidea, Dioscorea prazeri, Hedychium coronarium, Kaempferia galanga, Kaempferia rotunda, Zingiber officinale, Zingiber purpureum, Zingiber zerumbet* etc.

The vast storage of plant biodiversity of the district harvest many plants of medicinal values. These plants can be grouped into three categories, viz, (1) Cultivated plants of known active principles and pharmaceutical properties [e.g. species of *Cinchona, Dioscorea, Rouwolfia, Digitalis* etc.] which are cultivated in Mungpoo, Munsong, Gairibas-Rongo etc. with government initiatives. (2) Wild plants with known pharmaceutical value [e.g. species of *Aconitum, Panax, Rubia, Terminalia* etc.] are such kind of medicinal plants whose value is known but are not cultivated and facing threats from the plant hunters and collected illegally for pharmaceutical industries. (3) Wild plants of unknown or less known ethnomedicinal uses.

### 8.2.8.2. Potential Ornamentals

Darjeeling district also deserve numerous floras of great horticultural significance. Some of them have already found places into the gardens and parks. Das & Chanda (1990) analysed the ornamental potentiality

of the temperate flora of Darjeeling Hills. The wild orchids, *Primulas, Rhododendrons, Acers* etc. are the plants of the district which has a very a bright prospect with a great potentiality in the market world wide in future. A few species with potentiality as ornamental plants may be listed as *Paris polyphylla, Pleione praecox, Asparagus racemosus, Bulbophyllum* spp., *Satyrium nepalense, Herpysma longicaulis, Calanthe* spp., *Cymbidium* spp., *Polygonatum* spp., *Gonatanthus pumilus, Alocasia odora, Rhaphidophora* spp., *Licuala peltata, Trachycarpus* spp., *Ophiopogon* spp., *Aerides* spp., *Arundina graminifolia, Ascocentrum ampullaceum, Coelogyne* spp., *Cymbidium* spp., *Dendrobium* spp., *Papilionanthe* spp., *Phaius tankervilleae, Rhynchostylis retusa, Vanda* spp., *Bambusa vulgaris, Hedychium coronarium* etc.

### 8.2.8.3. Edible Species

Monocotyledonous plant species has dominance over any other taxa as far as the production of food material is concerned. Grasses or the members of Poaceae are called as '*Green Gold*' as the most of the foods for human consumption is obtained from grasses. Rice (*Oryza sativa),* Wheat (*Triticum aestivum),* Corn (*Zea mays),* Finger millet *(Eleusine coracana)* are the traditional cultivation practices of the District in large scale, with occasional and low scale cultivation of Barley (*Hordeum vulgare),* Oat *(Avena sativa),* Sorghum *(Sorghum bicolor)* and Sugaercane (*Saccharum officinarum*). However, many non-grass monocotyledonous food plants are widely cultivated in the area which include Onion *(Allium cepa),* Garlic *(Allium sativum),* Coconut *(Cocos nucifera),* banana *(Musa x paradisiaca),* Yams *(Dioscorea* spp.), *Alocasia* spp, *Amorphophallus* spp., *Colocasia esculenta, Xanthosoma* spp. and *Canna indica* var. *edulis.* The species mentioned above are the cultivated crops which fulfills the daily food needs of local people. In addition to these many other edible monocot species found in the wild at varied places of the district and serve as the purpose of emergency food-need and may form the most important food source for the people living in remote localities. These edible resources can also be scientifically processed and developed and can be brought to market for revenue generation.

### 8.2.8.4. Spice Plants

Some of the cultivated and semi-cultivated monocot species or their wild relatives are often used as spices. It includes species of *Allium* and the members of Zingiberaceae (*Amomum, Curcuma, Zingiber*). cultivated sipce plants of Darjeeling include *Allium sativum, A. cepa,* and *A. hookeri* and their wild variety *A. wallichii* (later two occasionally used instead of *A. cepa*). The zingiberacian species like *Amomum subulatum* (cultivated), *A. dealbatum* (wild), *Curcuma longa, C. zedoaria, Zingiber officinale, Z. rubens* etc.

### 8.2.8.5. Fodder Plants

Darjeeling being mostly a hilly district there is no good scope in agriculture except in the Terai. This is why most of the villagers here tend to maintain good number livestock including cows, goats, pigs, sheeps, buffelows, yaks, etc. To fulfill the demand of milk and meat, there is a remarkable development in this alternative occupation in the villages. Cow and buffalo for milk and goat and pig for meat are the most important livestock resources of the district.

Many monocotyledonous plants are referred to be good fodder for these lovestocks. Cow, buffalo and goat require leafy green fodder while the pig needs cooked or boiled. Almost all the grasses (Poaceae) act as good fodder for cattle and aroids for the pigs. Some examples of fodder plants for cattle include different grasses like species of *Arundinella, Axonopus, Capillipedium, Digitaria, Oplismenus, Panicum, Pogonetherum, Saccharum* other grasses like *Apluda mutica, Arundo donax, Centotheca lappacea, Imperata cylindrica, Pennisetum clandestinum, Pennisetum orientale, Pennisetum purpureum, Phragmites karka, Pseudechinolaena polystachya, Setaria intermedia, Setaria palmifolia, Thysanolana latifolia* etc. Almost all specie of Bamboos, leaves of *Musa* spp., *Canna* etc

often given to cattle. *Neyraudia arundinacea* var. *zollingeri* is not suggested to give for goats as it is often poisonous for them. Similarly some members of Araceae and other plants are used to fed pigs. Leaves, petioles, rhizomes, stolones etc. are cut into pieces, cooked and fed to them. Some important monocotyledonous fodder for pigs may be listed as *Alocasia indica, Alocasia macrorrhizos, Amorphophallus bulbifer, Arisaema speciosum, Arisaema utile, Colocasia esculenta, Colocasia antiquorum, Canna edulis* etc.

### 8.2.8.6. Non-Timber Forest Produces (NTFPs)

Vast forest coverage of the district is also very rich in enormous plants those produce some usable and/or marketable products and are generally referred as Non-Timber Forest Produces. Most of the villagers and people living in the remote forest villages are mostly dependent upon the NTFPs for to maintain their day to day life. Majority of the NTFPs are obtained from the dicotyledonous plants, although there are sufficient number of monocotyledonous species in the district which may also be catagorised as NTFPs. Use of different species of *Dioscorea, Colocasia esculenta, C. antiquorum, Amorphophallus bulbifer, Arisaema speciosum* etc. by those people as found in wild as an alternative source of foods and vegetables; *Acorus calamus, Cheilocustus speciosus, Zingiber* spp. etc as medicine; different bamboos like *Bambusa* and *Dendrocalamus* in various purposes; *Arundo donax* and *Thysanolana latifolia* culms as fuel anflorescence as broom, etc. indicate their usefulness as NTFP. Table 8.25 shows a small list of monocotyledonous NTFPs and their uses of the district.

**Table 8.25.** Most valuable 100 NTFP species of Monocots from Darjeeling District

| Name of Plants | Family | Local/common Name | Parts in use and used as |
|---|---|---|---|
| *Acorus calamus* | Acoraceae | *Bojo* (N) | Rhizomes medicinally used |
| *Allium hookeri* | Amaryllidaceae | *Dungdunge* (N) | Whole plant eaten as vegetable |
| *Allium stracheyi* | –do– | *Chhepi* (N) | Bulbs as vegetable |
| *Allium wallichii* | –do– | *Jangali pyaj, Gope* (N) | Bulbs as pickle & medicinally |
| *Alocasia cucullata* | | *Darsane* (N) | Planted as ornamental for good luck |
| *Alpinia calcarata* | Zingiberaceae | | Fruits and rhizomes used medicinally |
| *Alpinia malaccensis* | –do– | | –do– |
| *Alpinia nigra* | –do– | | –do– |
| *Amomum dealbatum* | –do– | *Churumpha* (N) | Fruits medicinal |
| *Amomum subulatum* | –do– | *Aleiñchi* (N) | Seeds used medicinally, spice |
| *Amorphophallus bulbifer* | Araceae | *Gurbo* (N) | Tender petioles as vegetable |
| *Amorphophallus margaritifer* | –do– | | Used in Indian Ayurved, paste of tuber is applied in snake bite |
| *Ampelocalamus patellaris* | Poaceae | *Niba* (N) | Culm for weaving of roofing mats; leaves as fodder |
| *Apluda mutica* | –do– | *Kharuki* (N) | Good fodder for cattle |
| *Arisaema griffithii* | Araceae | | Tubers crushed into powders and bread prepared, eaten by Sherpas |
| *Arisaema speciosum* | –do– | *Gurbo* (N) | Shoot as fodder for pigs |
| *Arisaema utile* | –do– | | Tubers Fermented for liquor. |
| *Arundinaria racemosa* | Poaceae | *Sānu mālingo* (N) | Culm for weaving of roofing mats; leaves as fodder |
| *Arundinella bengalensis* | –do– | *Furkay* (N) | Broom made of infl. axis |
| *Arundinella decempedialis* | –do– | *Furkay* (N) | Roofing material |
| *Arundo donax* | –do– | *Narkat* (N) | Support for climbing crops, good fodder; soil binder |
| *Asparagus filicinus* | Asparagaceae | *Ban Kurilo* (N) | Tender shoots used as vegetables, roots as medicines |
| *Asparagus officinalis* | –do– | *Kurilo* (N) | Tender shoot used as vegetable |
| *Asparagus racemosus* | –do– | *Satamuli* (B) | Important in Ayuredic medicine |

| Name of Plants | Family | Local/common Name | Parts in use and used as |
|---|---|---|---|
| *Bambusa balcooa* | Poaceae | *Baro Bāns* (B) | heavy duty constructions; leaves as animal fodder |
| *Bambusa jaintiana* | –do– | *Mugi Bāns* (N) | Common uses of Bamboo |
| *Bambusa nutans* | –do– | *Māl Bāns* (N) | Weaving baskets heavy duty constructions; leaves as animal fodder |
| *Bambusa tulda* | –do– | *Singare Bāns* (N); *Mitenga Bāns* (B). | –do– |
| *Calamus erectus* | Arecaceae | *Phyakre Bet, Bet Geda* (N) | Fruits chewed as *Supari,* young shoots as vegetable |
| *Calamus guruba* | –do– | *Gauri Bet* (N) | Culms used in furniture making in low scale |
| *Calamus latifolius* | –do– | *Putli Bet* (N) | –do– |
| *Calamus leptospadix* | –do– | *Kukhre Bet, Lutey Bet* (N) | –do– |
| *Canna indica* var. *edulis* | Cannaceae | *Phul tarul, Kera tarul, Pustakari* (N | sweet boiled rhizomes eaten as food, fermented to get alcohol |
| *Capillipedium* spp. | Poaceae | *Kharuki* (N) | Good fodder for cattle |
| *Centotheca lappacea* | –do– | | –do– |
| *Cephalostachyum captatitum* | –do– | *Gopay Bāns, Dullo Bāns* (N) | Make bows and arrows |
| *Cheilocostus speciosus* | Costaceae | *Bet Louri* (N) | Stem used in urinary tract infections |
| *Chrysopogon gryllus* | Poaceae | *Babiyo* (N) | Dried leaves rolled to make rope |
| *Colocasia antiquorum* | Araceae | *Kalo mane* (N), *katchu* (B) | Stoloniferous runners and petioles as vegetable. Whole plant as fodder for pigs. |
| *Colocasia esculenta* | –do– | *Singane pindalu Mane*(N) | Rhizomes and petioles as vegetable |
| *Curcuma aromatica* | Zingiberaceae | *Ban Besar* (N) | Rhizomes used medicinally |
| *Curcuma caesia* | –do– | *Kalo Halud* (B) | Rhizomes medicinally important |
| *Curcuma zedoaria* | –do– | *Haledo* (N) | –do– |
| *Cymbopogon bhutanicus* | Poaceae | *Kush* (N) | Planted for Citronella oil; religious uses by Hindus |
| *Cymbopogon nardus* | –do– | *Kush* (N) | Citronella oil is obtained |
| *Cynodon dactylon* | –do– | *Dubo(N), Durba(B)* | Religious uses by Hindus; used for treatment of Jaundice by Ojhas |
| *Cyperus pangorei* | Cyperaceae | | Mats are made using the stem |
| *Cyperus rotundus* | –do– | *Mothey* (N) | Used as stringent |
| *Daemonorops jenkinsiana* | Arecaceae | *Dhyangre, Bet* (N) | Culms used as '*Bet*' in low scale |
| *Dendrocalamus giganteus* | Poaceae | *Bhāloo Bāns* (N) | Culms in various purposes, leaves as fodder |
| *Dendrocalamus hamiltonii* | –do– | *Choya/ Tama Bāns* (N) | Culms for rope making & tying & weaving purposes; tender shoots as vegetable |
| *Dendrocalamus hookeri* | –do– | *Kalo Bhāloo Bāns* (N) | Culms used in multi-purpose, leaves as fodder |
| *Dendrocalamus sikkimensis* | –do– | *Bhāloo Bāns* (N) | –do– |
| *Dioscorea alata* | Dioscoreaceae | *Ghar Tarul* (N) *Chupri alu* (B) | Tuber and bulbils eaten boiled/ cooked |
| *Dioscorea deltoidea* | –do– | | Tubers medicinal |
| *Dioscorea hamiltonii* | –do– | *Ban Tarul* (N) | Sweet tubers eaten boiled |
| *Dioscorea pentaphylla* | –do– | *Bhyagur* (N) | tubers edible |

| Name of Plants | Family | Local/common Name | Parts in use and used as |
|---|---|---|---|
| *Drepanostachyum intermedium* | Poaceae | *Titay Nigalo* (N) | Weaving, support for climbing crops, fodder |
| *Drepanostachyum khasianum* | –do– | *Ban nigalo* (N) | –do– |
| *Drepanostachyum polystachyum* | –do– | *Nigalo* (N) | –do– |
| *Eleusine coracana* | –do– | *Kodo* (N) | Alcoholic liquor like *jaaṁr, raksi* and *tongba* fermented |
| *Fritillaria cirrhosa* | Liliaceae | *Kakoli* (N) | Bulbs are used medicinally |
| *Gladiolus dalenii* | Iridaceae | | Cultivated in horticulture |
| *Gloriosa superba* | Colchicaceae | *Ulat Chandal* (B) | Medicinally important |
| *Himalcalamus falconeri* | Poaceae | *Singane* (N) | Weaving and fodder |
| *Himalcalamus hookerianus* | –do– | *Pareng* (N) | –do– |
| *Imperata cylindrica* | –do– | *Siru, Khar* (N) | Roofing material |
| *Kaempferia rotunda* | Zingiberaceae | *Bhuin Champa* (N) | Tubers medicinally used variously |
| *Livistona chinensis* | Arecaceae | *Chinese fan palm* | Leaves used for making fans |
| *Melocanna baccifera* | Poaceae | *Filim Bāns* (N)/ *Muli Bāns* (B) | Culms in various pur-poses, leaves as fodder |
| *Musa balbisiana* | Musaceae | *Ban Kera* (N) | Male flowers & young shoots used for salads & curries. Seed used medicinally |
| *Musa sikkimensis* | –do– | *Ban Kera* (N) | –do– |
| *Neyraudia reynaudiana* | –do– | *Ghungring* (N) | Stem used by the ethnic medicinal practitioners, and in ritual rites by tribals |
| *Pandanus furcatus* | Pandanaceae | *Tarika* (N), | Fuel, Fruits edible, |
| *Pennisetum orientale* | Poaceae | | Good fodder for cattle |
| *Pennisetum purpureum* | –do– | *Sarkari ghaňs* (N) *napier grass* | –do– |
| *Phoenix sylvestris* | Arecaceae | *Tadi* (N); *Khejoor* (B) | Trunk juice boiled to make molass called *Khejur Gur* Leaves used for making numerous useful items, |
| *Phragmites karka* | Poaceae | | Good fodder for cattle |
| *Phrynium pubinerve* | Marantaceae | *Kabai* (N) | stem sticks used to make sitting stool |
| *Plectocomia Himalyana* | Arecaceae | *Gauri bet* (N) | Ropes are made from fibers of stem |
| *Pogonetherum crinitum* | Poaceae | *Sano Musure Kharuki* (N) | Good fodder for cattle |
| *Pogonetherum paniceum* | –do– | *Musure Kharuki* (N) | –do– |
| *Polygonatum oppositifolium* | Asparagaceae | *Rukh Khirauňlo* (N) | Young shoot often eaten as vegetable |
| *Remusatia hookeriana* | Araceae | | Blades of very young spathe as vegetable |
| *Rhaphidophora spp* | –do– | *Kanchirnu* (N) | Good fodder for cattle; often planted as ornamental |
| *Saccharum spontaneum* | Poaceae | *Kaash* (N, B) | Stem used in death rites by Bengali people |
| *Setaria palmifolia* | –do– | *Dhoti saro* (N) | Excellent fodder for cattle |
| *Smilax aspericaulis* | Smilacaceae | *Kukurdainay* (N) | Stem as toothbrush, fruits edible |
| *Stachyphrynium placentarium* | Marantaceae | *Kabai* (N) | Leaves used to make waterproof *Ghoom* (N) used as umbrella |
| *Thamnocalamus spathiflorus* | Poaceae | *Rato nigalo* (N) | Weaving, support for climbing crops, fodder |
| *Thysanolana latifolia* | –do– | *Amliso;Kũchcho* (N) | Inflorescences for brooms, leaves as fodder, roots medicinally in toothache |
| *Tupistra nutans* | Asparagaceae | Naakimmo (N) | inflorescece is eaten as vegetable |
| *Typhonium trilobatum* | Araceae | *Kharkon Pata* (B,R) | Leaves as vegetable. |

| Name of Plants | Family | Local/common Name | Parts in use and used as |
|---|---|---|---|
| *Wallichia disticha* | Arecaceae | *Thakro* (N) | Whole plant as fuel |
| *Xanthosoma spp.* | –do– | *Pindalu* (N) | Rhizomes and petioles as vegetable |
| *Yushania maling* | Poaceae | *Malingo* (N) | Culms in various purposes, leaves as fodder; tender shoots eaten as vegetable |
| *Zingiber crysanthum* | Zingiberaceae | | Rhizomes & seeds yield aromatic oil |
| *Zingiber montanum* | –do– | *Phachyang* (N) | Aromatic rhizomes are used medicinally |
| *Zingiber rubens* | –do– | *Bengal ginger* | Seeds often used as spice |
| *Zingiber zerumbet* | –do– | *Shampoo ginger* | Rhizomes used medicinally |

### 8.2.9. NEW DESCOVERIES

The present work has contributed some new discoveries of plants and/ or their new distribution area to the flora of Darjeeling district, which were not recorded earlier. For the last few years some records of new taxa and new distribution are being made time to time by some botanists including Das *et al* 1985; Das & Chanda 1986, 1988; Das & Lama 1992; Bhujel & Yonzone 1994; Bhujel & Das 1996; Rai & Das 2001; Rai & Das 2007; Das *et al* 2008; Kumar *et al* 2009; Das *et al* 2010; Paul & Kumar 2012; Moktan *et al* 2012; Yonzone *et al* 2012; Rai & Das 2013; Thapa *et al* 2013, 2014; Chowdhury *et al* 2013; Rai *et al* 2014; Nirola & Das 2014 and so on. In this work also, few new records of taxa and new records of distribution have been documented from the district of Darjeeling. In future, there is further scope and expectations for more such records of new taxa are to be documented as well.

#### 8.2.9.1. New Taxa

In the present work 3 new monocotyledonous taxa have been discovered from different places within the boundary of Darjeeling district and its adjoining places. Among these taxa one is new species (*species novo*) and two others are new varieties (*var. nov.*). Their detailed descriptions, distinguishing characters, distribution, Latin translations, illustrations and photographs have been given in the chapter of Systematic analysis (Chapter 6). All the holotypes have been deposited in NBU Herbariu. The new Taxa are:

**A. *New Species***

1. ***Globba leucopetala*** S. Nirola & AP Das, [Zingiberraceae], *sp. nov.*

**Flowering & Fruiting** : July – September

**Exsiccate** : Around Baghpool (Coronation Bridge), Sevoke, 200 – 300 m, *S Nirola & A P Das 1334*, dtd. 06.07.2011 [Holotype; NBU]

**Status** : Rare.

**Local Distribution** : Tista river valley, around Baghpool, 200 – 500 m; Endemic for Darjeeling hills

**Etymology** : With reference to white colour of sepals and petals.

(Plate 5, 50 c).

***B. New variety***

1. ***Acampe praemorsa*** var. ***flava*** (AP. Das, T.K. Katham *et* S. Nirola) AP. Das *et* S. Nirola, [Orchidaceae] *comb. nov. Acampe papillosa* var. *flava* AP. Das, T.K. Katham *et* S. Nirola, *Pleione* 4(1): 155 – 157. 2010.

**Flowering & Fruiting** : November – December

**Exsiccate** : *AP Das, TK Katham & S Nirola 4193*, dtd. 17.11.2009 [Holotype; NBU]

**Status** : Rare.

**Local Distribution** : Bagrakote, Duars, Jalpaiguri, 150–300 m; Endemic for the Duars region of West Bengal.

**Etymology** : With reference to yellow colour of lip.

2. ***Typhonium roxburghii*** var. ***longispathum*** S. Nirola & AP Das, [Araceae], *var. nov. Pleione* 8(2): 498 – 500. 2014.

**Flowering & Fruiting** : April – June

**Exsiccates** : HOLOTYPE: Below Rongtong, 400 m, *S Nirola & AP Das 1237 A*, dtd. 26.04. 2010 (CAL); ISOTYPE: *S Nirola & AP Das 1237 B, C, D*, dtd. 26.04. 2010.

**Status** : Rare.

**Local Distribution** : Rongtong foothills of Darjeeling district, W. Bengal; ± 400 m; Endemic to Darjiling Hills.

**Etymology** : With reference to long and filiform spathe blade.

(Plate 6, 20 h)

### 8.2.9.2. New Distribution Records

The present work, at least 16 species of monocotyledonous plants collected within the district have been reported to be the new in terms of distribution as they were not reported from this region or from the state of West Bengal earlier. A list of such plants, their distribution in the District and their general distribution from where they are reported, are given below in table 8.26.

**Table 8.26.** List of monocotyledonous species reported from Darjeeling district as new distribution record.

| Name of species & Family | Location/ Distribution area | New distribution record for | Earlier reported from |
|---|---|---|---|
| *Acroceras zizanioides* (Poaceae) | Terai; upto 200m | North Bengal | Native of tropical Africa; Mexico, S America, Bhutan, India (Assam) |
| *Anthoxanthum hookeri* (Poaceae) | Kurseong – Darjeeling, Ghoom – Maneybhanjyang 1500–2500 m | W. Bengal | Nepal, Bhutan & NE India, S China, N Myanmar |
| *Ariopsis protenthera* (Araceae) | Tista river valley, Pankhabari toMakaibari forest, bellow Tindharey; 200 – 1200 m | W. Bengal | NE India |
| *Cymbopogon bhutanicus* (Poaceae) | Terai and foot-hills; upto 500 m | India | Bhutan |
| *Cymbopogon khasianus* (Poaceae) | Terai, Dudhey, Panighatta; Terai to mid hills; upto 1500 m | W. Bengal | Bhutan, Myanmar, N Thailand & S China |
| *Eriocaulon edwardii* (Eriocaulaceae) | Dulkajhar forest 120 – 150 m | W. Bengal | Endemic to N. India to E. Himalaya |
| *Eriodes barbata* (Orchidaceae) | Birik, Lohapul, Tista river valley; upto 700 m. | W. Bengal | Sikkim, E Himalaya, NE India, Bhutan; Myanmar, China, Thailand, Vietnam |

| Name of species & Family | Location/ Distribution area | New distribution record for | Earlier reported from |
|---|---|---|---|
| *Murdannia divergens* (Commelinaceae) | Terai to Pankhabari area; upto 700 m | North Bengal | India (Main land), Bhutan, N Myanmar, S China |
| *Oplismenus undulatifolius* (Poaceae) | Foot hills, Pankhabari, upto 500 m | W. Bengal | Bhutan |
| *Polytrias indica* (Poaceae) | Terai and foothills (Bengdubi, Matigara, Pankhabari); upto 700m | North Bengal | India (Main land), Southeast Asia |
| *Scleria biflora* (Cyperaceae) | Panighatta, Terai to foot-hills; upto 600 m | North Bengal | Tropics & Subtropics of Asia |
| *Scleria rugosa* (Cyperaceae) | Around Darjeeling, (2000 – 2300 m) | North Bengal | India(Main land), Myanmar, Sri Lanka, China, Thailand, Vietnam, Indonesia, Malaysia, Japan, S Korea, Philippines; N Australia, Indian Ocean islands, Pacific islands. |
| *Staurochilus ramosus* (Orchidaceae) | Dulkajhar, NBU and NBMCH Campuses; Terai; upto 500 m | W. Bengal | Eastern Himalaya, NE India, Myanmar, Thailand |
| *Tradescantia fluminensis* (Commelinaceae) | Lower part of Llyod Botanic Garden, Chatakpur to Tung; 1600–2300 m | A new record of naturaliza-tion in India | Tropical South America, naturalized elsewhere |
| *Typhonium roxburghii* (Araceae) | Mahananda Wildlife Sanctuary, Salugara to Sevoke, upto 250 m | North Bengal | India, Bangladesh, China, Sri Lanka, Japan, Thailand, Indonesia, Malaysia, Philippines, New Guinea; E Africa, W Australia, S America |
| *Vanda alpina* (Orchidaceae) | Rammam, Kolbong; 1000 – 2700 m | W. Bengal | Eastern Himalayas (Sikkim – Bhutan); S China, N Vietnam |

## 8.3. Final Assessment

Das (1986, 1995, 2004), Bhujel (1996), Bhujel & Das (2002) analyzed mostly the dicotyledonous flora of Darjeeling District of West Bengal. The wide climatic and physiographic variations, altitudinal gradients, connection with the very long migratory routs of different climatic tiers, aspects, exposure to warm planes in one side and permanently snow-covered peaks in the back ground, introduction and naturalization, etc. has rendered the Darjeeling vegetation to become enriched with diverse floritic elements. Their observations, assessments and comments is almost equally reflected in the present record of the monocotyledonous flora of this district.

Unfortunately, the vegetation of the entire Darjeeling District, from warm rolling plains of Terai to the semi-alpine high mountains, almost in every steps there are extremely high anthropogenic interferences. Natural vegetation stretches are disappearing vast against the very fast inroad of concrete based urbalization, high pollution level, implementation of major projects etc. all are degrading the Darjeeling vegetation endangering the survival of innumerable species of plants.