Chapter VII

Summary

Darjeeling Himalaya is the northernmost part of West Bengal and globally known as one of the Biodiversity Hotspot Zones. It has the most complicated boundaries. It shares its boundaries with Nepal in the west and Bhutan towards the East; the river Teesta forms its Northern border with the Sikkim with its Southern border being with the district of Jalpaiguri of West Bengal. The borders of Nepal, Sikkim and Darjeeling meet at the Phalut forming a tri-junction with a similar tri-junction at Rachela. The total area of the region is 3149 sq. km. and is situated in between 26º 27' 05" and 27º 13' 10" North latitude and between 88º 53' 00" and 87º 59' 30" East longitude. The altitudinal range of region varies between ±120 m amsl to 3660 m amsl. The district has two topographical features. Darjeeling, Kurseong and Kalimpong form the hill areas whereas Siliguri is stationed at the foothill in a vast stretch of the plains. The Darjeeling Himalaya covers three administrative Sub-Divisions *viz*. Darjeeling sadar, Kalimpong and Kurseong.

Darjeeling Himalaya is a part of the Singhalila range of Eastern Himalaya which is well known for its rich biodiversity. Darjeeling Himalayan region is basically mountainous with highly variable topography and very complicated terrains with large portion of the hills being inaccessible. Deep valleys, undulating irregular ridges, sloppy landmass, different soil types, diverse drainage pattern with variation in climatic condition resulted in varied ecological diversity. The great significance of its natural richness the IUCN has included it within the *Himalayan Biodiversity Hotspot.*

The climatic condition of Darjeeling Himalaya is very peculiar by its complex topographic condition and greater altitudinal variation. This variation widely effects the vegetation of the region, and that also determines the range of distribution of different plant species. It exhibits a distinctive monsoon climate, with wet summer, cold and dry winter. Maximum precipitation is brought about by South-West monsoon flowing from

the Bay of Bengal during June to September. The average annual rainfall varies from 2,004 mm to 4,400 mm. Because of different land facing and altitudinal variation in the hills has fluctuation in temperature regime; with warm plains, cool weather in the higher altitudes and extreme cold in the upper reaches. Normally January is the coldest month and the daily temperature at Rachela, Lava, Sonada, Darjeeling often going down below 0^0C. The relative humidity is higher towards the higher altitude (above 2000 m) ranging from 85-99% during monsoons, and generally decreases towards the lower elevations.

The parent material of Darjeeling soil is Darjeeling gneiss. The soil of Darjeeling Himalaya is represented with five orders *viz. ultisols, alfisols, mollisols, entisols* and *inceptols.* The soils are derived from weathering of underlying rocks. The depth of the soil varies in different regions, with texture varying from fine sand, loam to coarse sand. The greater portion of the area is covered by stiff reddish loam and stiff red clay and pure sand, a condition favourable for the cultivation of Tea. The soils are covered under thick forest litters rich in humus and the pH of the soil is generally acidic.

The region has its own identity and recognition from the biodiversity point of view and it has four protected areas (Singalila National Park and Neora Valley National Park, Senchal Wild Life Sanctuary and Mahananda Wild Life Sanctuary) and a large number of reserve and non-reserved forests, and plantation forests in different ecological zones provide an ideal home for diverse flora, fauna and microbes. Some of the forests are still vergin and under explored. Deeper inside of the National Parks of the region are sporadic explored owing to its inaccessibility and other difficulties. The great significance of the region lies in its wide range of habitats representing all type of vegetation resources thereby producing a favorable environmental for ecological diversity. The region appreciably displays a wide range of economically important plant species. The diverse habitats and immense bioresources are of tremendous environmental values to the scientists, botanists, foresters and environmentalists around the world and the region exhibits an excellent example of *in situ* conservation of both flora and fauna.

Most importantly, the region holds it wide range of habitats representing all forms of habit pertaining to plant resources. The Darjeeling Himalaya is also a unique natural conservatory for the state and also for the country. National Parks and some forest areas of Darjeeling Himalaya situated in the most difficult Himalayan terrain and are still unexplored. Being undisturbed for many centuries, the region holds incredible richness in floristic diversity. Significantly, it also holds greater values, in respect of scientific, environmental and cultural aspects.

Darjeeling Himalayan region is repository of Orchid species. The rich diversity of Orchids of the region are of great value to the orchidologists, researchers, botanists, environmentalists, nurserymen, foresters and floriculturists across the world. The region is unique from its counterparts because of its distinct geographical orientation, sharp altitudinal variations with diverse climatic conditions resulting in the tremendous rich diversity vegetation. The Orchid flora keeps a large meaning, particularly in terms of aesthetic, environmental, educational and utilization aspects. The present study has clearly indicated that the region represents a comparatively higher percentage of species diversity and the region is known as epicenter of Orchid species.

Sir J. D. Hooker was the pioneer for the floristic exploration of Darjeeling. Later many botanists have given their labour following him till date. In comparison with the other prominent fractional works of (Hooker, 1888-1890); (Pearce & Cribb, 2002); (Hara, 1966); (Hara, 1971); flora of Eastern Himalaya, third report (Ohashi, 1975); (Bruhl, 1926); (Pradhan, 1976 and 1979); (Pradhan & Pradhan, 1997) in the region and the present survey on Orchid flora of Darjeeling Himalaya is great significant and represents 321 species under 86 genera which is the remarkable record of Orchid diversity resources of the region. The above findings are significant and very vital which represent and determine the richness of Orchid diversity of the region.

The Orchid flora of the region also reveals the occurrence of epiphytic species is greater than the terrestrial and saprophytic species. The region being remained less distressed and of constant presence of the pioneer habitats consequently exhibits

significant number of endemic taxa. Apart from that out of 321 species, over 29.58% are endemic and the species of surrounding regions like Sikkim and Bhutan are also largely available in the region. There are 3 monotypic Orchid genera in the region. The genera *Bulbophyllum* and *Dendrobium* possess maximum number of species in the region. The findings are very vital which depict and determine the floristic richness of the region.

During the recent past a great deal of damage has been done to the richness of the Orchid diversity of Darjeeling Himalaya. Many threatened species have been recorded from the region and many other species are now becoming rarer in natural habitat. Random felling of old host trees in the region and new plantation by forest departments, extension of tea cultivation cause greater harm to the natural population of epiphytic species and other developmental works along with multifarious anthropological activities create serious threats to the terrestrial species. Plantation of exotic trees like *Cryptomeria japonica, Pinus patula* etc. cause greater impact on soil and many herbaceous flora including terrestrial Orchid species are getting lost in the region. The rapidly increasing human population in the region exerting tremendous pressure on the vegetation of this area resulting in the loss of many Orchid species and leading to many becoming threatened. Therefore, effective and strong habitat conservation is highly emphasized throughout the region by proper planning.

Because of congenial varied agroclimatic climatic condition, the region is rich in vegetation resources and also supports a significant number of species of foreign origin. The species of foreign origin those were recorded from the region are from, Afghanistan, Africa, America, Australia, China, Nepal, Pakistan, China, Malaysia, Thailand, Vietnam etc. some earlier worker discover new species like *Coelogyne pempahesyana, Dendrobium darjeelingense, Gastrochilus pseudocorymbus, Liparis tigerhelensis* etc. and present survey discover one var. nov. *Geodorum densiflorum* var. *kalimpongense,* and species level, sharp and remarkable intraspecies floral morphology and colour variation of *Chilochista parishii, Crepidium acuminatum, Cymbidium lowianum, Dendrobium anceps, Eria lasiopetala, Geodorum densiflorum, Phalaenopsis lobbii, Pinalia amica, Vanda cristata* etc. have been observed and reported 41 new distributional records from the region and enough for the delimitations of taxa, and are the future scope of fascinating research.

The intact inner landmass of Neora Valley National Park of Darjeeling district has been remained unexplored and undisturbed for hundreds of years, which ultimately could be an excellent model of *cradle for evolution* of species for floristic diversity in the Eastern Himalayan region (Rai & Das, 2002). Similarly, deeper inside of Singhalila National Park is also still remained unexplored and undisturbed. Hence, due to biological isolation, habitat conservation, continues natural evolutionary process in the regional biota, the Orchid flora of the region uphold an invaluable resource for the various fields of scientific study in coming days.

Although sporadic collection have been made by different botanists after the visits of Sir J. D. Hooker, P. Bruhl, in the region in last two hundred years. Therefore, the task of recording the available information of native Orchid species is to be immensely important. As a result, the Orchid flora holds tremendous potential for those desires to further multifaceted scientific utilities on diseases and insect-pests occurrence, pollination and seed dispersal mechanism, germination and host specific and altitude wise distribution of Orchid species in the region.

The biotic disturbing elements including cattle grazing, indiscriminate collection, illegal harvesting of forest produce, massive invasion of noxious weeds etc. are the major causes for the ultimate loss of vegetation including Orchid species from the region. Ultimately the abiotic factors that ultimately disturbed the ecology of the region are top layer soil erosion, frequent landslide, heavy monsoon rainfall, strong winds and other ecological degradation.

Many Orchid species of North Eastern states frequently available in local floral nurseries, research institutions, botanical garden and domestic gardens of many local people of the region by Orchid enthusiests, floriculturists, nurserymen, botanists etc. Regular long term introduction of such species in the region since independence cause many of the species successfully acclimatize in the region. Now such introduced and acclimatize species also become additional floral wealth of the region.

In comparison with other district of West Bengal, Darjeeling Himalayan region of Darjeeling district holds significant position in case of Orchid diversity resources and is declared as hot spots zone and it deserves to be taken up in the top priority for conservation aspect. Therefore, efficient and extensive conservation program considering the total genetic resources needs to be laid down to facilitate the process of natural system of regeneration. Detailed ecological investigations are urgently suggested to properly understand the habitat preferences of these taxa.

Many Orchid species having immense economic prospects; some are medicinally important, ethnobotanically useful and some possess great ornamental values. Besides them, some species possess strong aroma. If such species extensively cultivate and supplied to pharmaceutical industries, it will certainly create lot of employment opportunity throughout the region. Considering this facts, Orchid species resources of the Darjeeling Himalaya shall be immense potential for the growing needs of scientific population and needs to be exploited in a sustainable and scientific manner.