CHAPTER – II

AREA OF PRESENT STUDY

Location and physiography

The study area, the Eastern Himalayan region of India, lies between 26° 28' - 29° 30' N latitude and 87° 15' to 97° 30' E longitudes covering an area of ca 93,060 km² has been considered a distinct botanical region. The region comprises of the state of Arunachal Pradesh, Sikkim and Darjeeling district of West Bengal with an altitudinal variation ranging from ca 135 m to 8585 m. Physiographically the region consists of mountains, valleys and plateaus of various dimensions. Majority of the mountain peaks maintain an average altitude ranging from 1800 – 3000 m. Topographical variations coupled with moisture laden monsoon winds blowing across the Bay of Bengal provide heavy rainfall in most of the places and create congenial habitats for luxuriant growth of various species of the family Juncaceae. In addition to this, the region shares border with Bangladesh, Bhutan, China, Mynmar Nepal and Tibet and as a result of which there has been frequent transmigration and intermingling of floral elements from these countries and/or to those countries.

Climate

The climate in Eastern Himalaya varies greatly with the variation of altitudes. Humid subtropical climate with wet summer and mild winter having average maximum and minimum temperature of 29°C and 17.7°C prevails in most of the places. Higher reaches experience cold and humid climate with average maximum temperature of 21°C with minimum being 1.5°C. The maximum temperature is usually recorded during July and August and minimum during December and January. The average annual rainfall in the humid subtropical region is about 3000 mm whereas it is 2100 mm in the cold humid areas. The mean annual rainfall recorded at alpine region is ca 82 mm. Pre–monsoon rain occurs in April-May and monsoon (south-west) operates normally from the month of May and continues up to early October. July is the wettest month in most of the places. Humidity in rainy season exceeds 90 %. Fog is common from May to Sept. Indeed
these varied climatic conditions coupled with varied topography makes the region very important for the occurrence and growth of Juncaceae.

**Geology and soil**

Geological formation of three states of Eastern Himalayan region of India viz. Arunachal Pradesh, Sikkim and Darjeeling district of West Bengal are different. Arunachal Pradesh can be divided geographically into three zones from south to north viz. (1) the Sub-Himalayas, (2) the Lesser Himalayas, and (3) the Greater Himalayas.

The Sub-Himalayan zone consists of Neogene molassic sediments (Siwaliks) whereas the Lesser Himalayas comprises of Upper Proterozoic to Lower Palaeogene self sediments (Bomdila Group, Buxa-Miri Formations) and the Greater Himalayas has been characterised by para metamorphites and ortho metamorphites and acidic to intermediate igneous intrusions from Precambrian to Tertiary age (Sela Group, Siang Group, Lumla Formation, etc.). (Hajra et al. 1996). Sikkim Himalaya represents Tethys Sea of geological past and is much younger in age viz., “Paleozoic age”. The major portion of Sikkim is covered by Precambrian rock. The northeastern and western portions are constituted by hard massive gneiss rock which resists denudation. The southern and central region is chiefly formed of relatively soft thin slates, sedimentary, metasedimentary and half-schistose rocks which denude very easily. This area is less elevated and thickly populated although being highly landslide prone. The physical configuration of the state has been dependent on the direction of the drainage (which is southern) and also on geological structure (Kumar & Singh 2001). According to the report of Geological Survey of India (Powde & Saha 1976) the following five types of rock formations occur from south to north in the district of Darjeeling:

1. **Siwalik formation**- It comprises of the sediments deposited by the ancient Himalayan Rivers in their channels and flood plains in the last 16 – 1.5 million years where the coarse-grained sandstone, shaly sand stone, siltstone and conglomerate are the main components.

2. **Gondwana formation**- It comprises felspathic and micaceous quartzitic sandstone, carbonaceous shales, and thin lenses of crushed and sheared coal and pebble/ boulder bed.
3. Buxa formation- It comprises predominantly of dolomite, arthoquartzite, variegated phyllite inter banded with quartzites/dolomites.

4. Daling formation – It is mostly represented by slates, phyllite, quartzose phyllite inter banded with quartzites, quartz-chlorite, sericite-schist, epidiorite, carbonaceous phyllite and quartzite sulphide. Mineralisation is mostly located in the quartz-chlorite schist horizon.

5. Darjeeling formation – It comprises garnetiferous biotite gneiss, varieties of high-grade schistose rock and migmatite.

Darjeeling Himalaya has following four types of geological tracts :-

1. Hard rock region- It comprises of unaltered sedimentary rocks in the southern hills and different grades of Precambrian metamorphosed rocks over rest of the area.

2. Bhaber belt- It comprises of rock fragments, big boulders, fine-grained elastic derived from hard rock, and cones of gravels of detritus dumped by rivers and streams rushing out of mountains. The region is characterized with steep slopes bouldery surface and forest of tall trees.

3. Terai belt- It comprises of swampy area composed mostly of coarse granular materials and elastics.

4. Alluvial plain- It comprises of succession of layers of sand, silts and clay with occasional gravel beds and lenses of peaty organic matter.

Intense folding, thrusting and metamorphism resulting in a number of tectonostratigraphic units characterize the rocks of Darjeeling Himalayan region. Metamorphosis is noticed from slate to chlorite sericite schist, golden silvery mica schist, garnetiferous mica schist and coarse-grained gneisses (Rai 2002).

The soils of Eastern Himalayan region of India generally are of acidic nature and rich in humus with high percentage of nitrogen. They are sandy or sandy-loam, clay or mixed with heterogenous matrix due to erosion and depositions by the rivers. The soil in plain areas of the valleys is clay-alluvial with rich organic matter contents where as the soils in the foothills are loamy or mixed. The organic matter in the soils of Sikkim is usually 2 – 5% but at some places as low as 1% and at others as high as 10%. Available Nitrogen varies from 10 to 60%, Phosphorus 25 – 30 % and Potash 20 to 45
Plate – 2

Alpine vegetation of East Sikkim
Plate -3

Alpine vegetation of North Sikkim

Alpine vegetation of West Sikkim
The water holding capacity of soils is medium and as such the soils fall in hydrological group “B” (Kumar & Singh 2001).

Vegetation

The unique geographic, variation in climate, soil, topography and altitude has resulted in great diversity of vegetation in Eastern Himalaya, i.e. tropical to alpine. Based on the climatic conditions and altitude the vegetation of Eastern Himalaya can broadly be classified into five major types and a sixth type being the Secondary forest, which are developed in areas where the primary forest have been lost or degraded due to adverse biotic and abiotic factors. The five main forest/vegetation types are Tropical forest, Subtropical forest, Pine forest, Temperate forest and Alpine forest. (Pl. 2 - 8)

The region is having very rich and diverse floristic wealth of flowering and non-flowering plants including bryophytes, fungi, algae, lichens, etc.

The vegetation and forest types of Darjeeling district differ from its neighbouring regions of the Eastern Himalaya when considered in terms of biodiversity and distribution of floristic elements limited to this region only. It is because of the great
diversities in physiographic, climatic and edaphic conditions aided by the biotic factors (Bhujel 1996).

Attempts have been made to classify the vegetation of this region from time to time by various workers *viz.* Gamble (1875), Hooker (1849, 1906), Cowan (1929), Champion (1936), etc. Bhujel (1996) classified the vegetation based on the floristic composition and distribution of elements in the area under the following five categories: *viz.* (a) Plain and tropical Plains to 300 m (-500 m), (b) Sub-tropical (500 – 1200 m), (c) Sub-temperate (1200 – 1850 m), (d) Temperate (1850 – 3200 m (-3500 m) and (e) Sub-alpine 3200 – 3636 m (-3800 m). Thus the vegetation of entire Eastern Himalayan Region of India is classified from plain and tropical to alpine. Characteristic species available in different vegetational zones are as follows:

**Plain and tropical:** *Acrocarpus fraxinifolius, Bombax ceiba, Dillenia pentagyna, Musa, Pandanus nepalensis, Shorea robusta, Tetramelas nudiflora,* etc. Most of these trees are heavily plastered with lichens and festooned with climbers and epiphytes. The epiphytic orchids are quite numerous, of which the genera *Dendrobium* and *Cymbidium* are common.

**Sub-tropical:** *Alnus nepalensis, Bischofia javanica, Castanopsis indica, Dendrocalamus hookeri, Dichroa febrifuga, Entada pursaetha, Macaranga pustulata, Maesa spp., Mussaenda roxburghii, Pouzolzia sanguinea, Prunus cerasoides, Raphidophora eximea, Schima wallichii,* etc. The common herbaceous flora belongs to the families Asteraceae, Solanaceae, Zingiberaceae and Urticaceae. The orchid flora is also diverse in the region.

**Sub-temperate/Pine forest:** *Buddleja asiatica, B. bhutanica, Cycas pectinata, Cymbopogon flexuosus, Euphorbia royleana, Ficus oligodon, Pinus roxburghii, Rhus paniculata, Solanum erianthum, Woodfordia fruticosa,* etc.

**Temperate:** *Acer campbellii, Betula alnoides, Castanopsis hystrix, Elatostema monandrum, E. obtusum, Helwingia himalaica, Juglans regia, Lecanthes peduncularis,* etc.
Map 2. Location Map of Eastern Himalayan Region of India.

Map 3. Eastern Himalayan region of India with neighbouring countries
Plate – 4

Subtropical vegetation of West Sikkim

Temperate vegetation of Darjeeling

Alpine vegetation of Darjeeling
Tropical vegetation of South Sikkim.

Temperate vegetation of South Sikkim
Plate – 6

Tropical vegetation of Arunachal Pradesh

Subtropical vegetation of Arunachal Pradesh
Plate – 7

Temperate vegetation of Arunachal Pradesh

Pine forest of Arunachal Pradesh
Animals grazing at Juncaceae rich areas of alpine Sikkim
Lindera neesiana, L. pulcherrima, Michelia doltsopa, Pilea bracteosa, Quercus lamellosa, Rhododendron arboreum, Rosa macrophylla, R. moschata, R. sericea, Rubus lineatus, R. pentagonus, R. treutleri, Salix daltoniana, Schisandra grandiflora, Symplocos dryophila, S. lucida, Taxus baccata, etc.

Sub-alpine: Abies densa, Arundinaria griffithiana, Betula utilis, Cotoneaster spp., Daphne bholua, Gaultheria fragrantissima, Maddenia himalaica, Magnolia globosa, Panax pseudo-ginseng, Primula denticulata, Prunus rufa, Rheum acuminatum, Rhododendron cinnabarinum, R. falconeri, R. hodgsonii, Ribes spp., Rubus calophyllus, R. fragarioides, R. pentagonus, Tsuga dumosa, Viburnum nullaha, V. nervosum, etc.