CHAPTER-9: SUMMARY AND CONCLUSION

The present study entitled, 'Eco-taxonomy of the genus *Dendrobium* Sw. (Orchidaceae) of Northeast India' was an out come of an original research work undertaken during the period 2002 to 2005. It includes detailed study on Ecology and Taxonomy of the genus *Dendrobium* comprising of 84 species and 4 varieties in the northeastern region of India. The salient features of the present investigation have been reflected in nine different Chapters and has been summarized as follows:

Chapter-1:

The first chapter dealt with etymological study on orchidology with reference to the genus *Dendrobium*. The word '*Dendrobium*' is derived from the Greek word '*Dendron*' meaning 'trees' referring to the epiphytic habit of the genus where the species are epiphytic or living on a tree. Although a few species of *Dendrobium* may also survive as lithophytes, but all lithophytic species recorded so far are also epiphytic. The orchid species occur in all parts of the world, except in frigid and desert regions. Majority of the species are native of the tropical countries and occur in their greatest diversity in humid tropical forests. In the tropical region most orchids are epiphytic, while in the temperate regions they are mostly terrestrial. *Dendrobium* being epiphytic mostly confine from tropical to temperate region. The family represents about 20,000 species of orchid distributed all over the world by Anonymous, 1996. India represents 177 genera and 1195 species (Singh *et al.* 2001). Although till now the number of *Dendrobium* species was reported to be 103 and those from Northeast India 77 species respectively (Singh *et al.* 2001), during the present investigation a significant addition has been made to the list of *Dendrobium* species which includes 110 species from India and 84 species from Northeast India respectively. Establishment of the genus was first initiated by O. Swartz based on the type species *Dendrobium moniliforme* (L.) Swartz in 1799 in Nova Acta Societatis Scientiarum Upsaliensis and has been conserved as a generic name at the expense of earlier Ceraia Lour. (1790) and Callista Lour. (1790) Bechtel *et al.*, 1992.

The species of the genus possess various aspects of potentiality of taxonomic, economical and medicinal etc. interest. In addition to their horticultural and floricultural value many species of *Dendrobium* contained valuable 'Alkaloids' to combat different diseases that plague mankind. The original habitants of Northeast India have used many species of *Dendrobium* as 'Folk-medicine'; they also value them in their culture and belief since ages. According to Hutton, 1968, to date their various festivals are associated with the use of different species of orchids including those of *Dendrobium* species in dress and ornaments. Some species of *Dendrobium* are dye-yielding plants and some use as fodder for enhancing milk-yield in cattle. The orchids, especially the species of the genus *Dendrobium* being of great horticultural and floricultural potential serve as a good source of revenue to the various states of Northeast India and the growers can also reap profit. Many of the species and their hybrids have an important trade prospects exporting them to foreign countries, which has since long a multi-millions business.

Chapter-2:

The second chapter provides the aims and objectives of the present research on the Ecology and taxonomy of the genus *Dendrobium* Sw. (Orchidaceae) of Northeast India evolving from extensive explorations, literature surveys and herbarium studies. It has aim to study areas unreported so far pertaining to the ecological adaptation of the *Dendrobium* species in its natural habitat and cultivated medium in relation to ecological factors such as rainfall, temperature, relative humidity, sunlight, soil quality, phorophyte nature and altitude, governing their growth and development. A systematic study on the altitudinal distribution of the *Dendrobium* species in different climatic zones (Tropical, Subtropical, Temperate, Sub alpine and Alpine) is dealt in detail. The phenological study and flowering behaviour is being carried out to understand the response of the species to the climatic factors with the seasonal variations The *Dendrobium* diversity and the affinity in all the states of Northeast India, rest part of India and neighbouring countries is being carried out to find out if there is any possibility of rediscovery, new addition to the northeast region of India. The present status like (R-rare, C-common, Ex-probably extinct, eR-extremely rare, E-endangered, T-

threatened, En-endemic, V-vulnerable) along with conservation measure (in situ and ex situ). proporgation and management has been provided)

Taxonomically it has aim to analyze and identify the floral structures of all the species of *Dendrobium* found in Northeast India and to provide detailed taxonomic description on the morphological and reproductive characters of each species along with correct nomenclature, illustrations, type locality or protologues, flowering period, notes on ecology and habitat, chromosome number, notes general distribution, specimens examined for easy and clear identification of each species in the region and elsewhere in the country through extensive exploration, literature and herbarium consultation etc. and to find out whether there is any possibility of formation of ecads, ecotypes and new species. Further the present investigation is an attempt to solve any taxonomical problems like superfluity of names, synonyms, misidentified specimens that is raised while describing each species of *Dendrobium* by the aid of available literatures, type materials and herbarium specimens deposited in various herbaria of Northeast and India.

Chapter-3:

The third chapter provides an insight about the study area. The area of the present study included Northeast India comprising of the eight sister states. The physical geography and location, topography, geology and soil of each state is provided with meteorological data on rainfall, temperature and relative humidity for 5 years 2000-2004 from Meteorological department, Guwahati and Sikkim **(Tables-2-12).** The weather and climate of north east region of India is itself a type which is not comparable with any other parts of the Indian subcontinent (Barthakur, 1986). The climatic condition of northeast India is salubrious characterized by varied topography, sufficient rainfall and humidity.

Chapter-4:

The fourth chapter provides the vegetation of north east region of India. The region has been divided based on orchid habitats into (a). Tropical forests, (b). Subtropical forests, (c) Temperate forests, (d) Sub alpine forests and (e) Alpine forests. From the present investigation we can conclude that the northeastern region is very dense in vegetation with

tall tree species like *Ailanthus integrifolis*, *Atrocarpus chama*, *A. heterophyllus*, *Castanopsis echinocarpa*, *Cinnamomum glaucescens*, *Dipterocarpus retusus*, *Duabanga grandiflora*, *Mesua ferrea*, *Shorea assamica* etc, shrubs like *Acacia sinuata*, *Camellia caudata*, *Coffea khasiana*, *Maesa indica*, *Mimosa himalayana*, *Murraya paniculata*, *Solanum kurzii* etc and *herbs like Alpinia nigra*, *Costus speciosus*, *Curcuma* species, *Hedyotis auricularia* etc. The tropical and subtropical forests provide home for more orchid species including *Dendrobium* to dwell successfully in comparison to the temperate and alpine forests.

Chapter-5:

The fifth chapter deals mainly with the ecology the genus *Dendrobium*. The environmental factors such as rainfall, temperature, relative humidity, light and other factors like substrate (phorophyte and soil), competition with other associated plants and altitude (which influence temperature, sunlight, rainfall and humidity) governing the growth and development of the species are taken into account. The altitudinal distribution and the phenology of the species have been dealt in detail. The study on the altitudinal distribution of the *Dendrobium* species revealed that the maximum species flourished in the subtropical zone with 69(82.14%) species of the total 84 species followed by tropical zone with 51(60.71%) species and the minimum in the temperate zone with 15 (17.86%) species **(Table-14, 15; Histogram-1).** Of the total 84 *Dendrobium* species 46 species had high ecological amplitude as their range of tolerance were wide enough to survive in all the zones from tropical to temperate. 39 species were considered as having low ecological amplitude since their range of tolerance is narrow confining to its own zone **(Table-15).** The distribution of the *Dendrobium* species in the different altitudinal zones will provide important information to understand their adaptation to environmental factors prevailing in the respective zones. Hence altitude indicates to be an important factor in determining the habitat and growth of *Dendrobium* species.

The phenological observation revealed that the *Dendrobium* species flower in the four seasons, spring (March-May); summer (June-August); autumn (September-November) and winter (December-February). The maximum number of species (54)

flowered during the month of spring followed by 27 species in summer and 15 species in autumn and 4 species in winter **(Table-17, 19).** The variation of flowering among the species revealed the optimum requirement for rainfall, temperature, relative humidity and photoperiod. Most of the *Dendrobium* species (69) are mostly day neutral plants which flower irrespective of the day length, followed by long day plants (27 species) and few are short day plants (4 species), **Table-18.**

The study also revealed that most of the *Dendrobium* species (64) have low ecological amplitude as their range of tolerance to the climatic factors is narrow confining to its own season and 18 species were of high ecological amplitude flourishing throughout the four seasons. The phenophases observed from the development of seedling till the withering of flowers suggest that the entire cycle is one complete year in natural habitat and artificial conditions. The only difference lies in the duration of development in various phenophases **(Table-20).** Notes on fruiting were also provided for all the species as per reports of Bose & Bhattacharjee, 1980; Chowdhery, 1998; Deb *et al.*, 2003; Shukla *et al.*, 1998; Singh *et al.*, 1990; Singh *et al.*, 2001. However in the present investigation in the cultivated medium the species which could not show fruit development were *D. anceps, D. bicameratum,D. densiflorum, D. eriaeflorum, D. falconeri, D. jenkinsii, D. kethii, D. spatella* and *D. stuposum.* This may be due to lack of macro and micronutrients or improper functioning of the root system and other agents like pests that damage the growth of fruits. Hence these notes on flowering, fruiting, growth behaivour are important in taxonomy studies as well as for the conservation of the species. From these phenological studies, the hybriders can glean essential information to orchid culture. These data on phenology can be used for scientific multiplication, propagation and also for conservation of germplasm.

Chapter-6:

The sixth chapter is an attempt to study the diversity of the genus *Dendrobium* in the Northeast region of India The distribution of the species in all the states affinity with other parts of India and neighbouring countries and the status of each species have been

provided with conservation measures (**Tables-21, 22; distribution Maps-3-23**). The present investigation revealed that in comparison to earlier recorded data many species were added to each state thereby increasing the number of *Dendrobium* species in each state. While in the North East India a total of 84 species (100%) has been recorded. A maximum diversity of 52(61.90%) for Manipur, followed by Sikkim with 51(60.71%) species has been recorded which may be due to the congenial climatic condition that prevails in the states, followed by Arunachal Pradesh with 49(58.33%), species, Meghalaya with 47 (55.95%) species; Mizoram 46(54.76%) species followed by Nagaland 39(46.43%), Assam, 38(45.23%) and the minimum in Tripura 10 (11.90%) respectively. It is remarkable to note that most importantly the study revealed 3 new species new to science *viz. D. numaldeorii* Deori *et al.*, 2004a from Dibang valley, Arunachal pradesh, *D. arunachalense* Deori *et al.*, 2006b from Arunachal pradesh and *D. meghalayense* Deori *et al.*, 2006c from Meghalaya. Two new records to India *viz. D. dantaniense* Guill. Deori *et al.* 2006a from Manipur and *D. sociale* J.J. Sm. Deori *et al.*, 2004c from Nagaland has added to the list of *Dendrobium* of India. 2 rediscovery *D. pychnostachyum* Lindl. (Deori & Phukan, 2004b) from Mizoram and *D. aurantiacum* Reichb.f. Deori *et al.*, 2006d from Meghalaya has been reported. Therefore a total number of 84 species and 4 varieties have been recorded so far in Northeast region of India compared to earlier record of only 77 species (Singh *et al.*, 2001). This statistic is not stagnant and will keep varying with more new discoveries and new records. Hence the present status indicates the potential of the region to evolve more discoveries and additions. The occurrence of Northeastern *Dendrobium* species in rest part of India and neighbouring countries, suggests close affinity of Northeastern flora with Bhutan, China, Malaya, Myanmar, Nepal and Thailand.

During the present investigation *D. griffithianum, D. miserum, Dendrobium perula,* earlier reported from Assam and, *D. rhodocentrumn* from Meghalaya could not be relocated after repeated exploration and hence may be in the verge of extinction. Thus the status of the *Dendrobium* species has been categorized as Endemic (En), Rare(R), Extremely rare (eR), Endangered (E), Threatened (T), Extinct (Ex), Vulnerable (V) Common (C), **(Table-23).** Thus this tremendous depletion of *Dendrobium* can be brought

into focus through seminars and symposia by government and non-government organization, many scientific institutions and Orchid societies of India. The creation of National Park, Sanctuaries and Biosphere Reserves to protect natural habitats of orchids plays a vital role in conservation.

Chapter-7:

The seventh chapter is a detail and critical study on the vegetative and reproductive characters of all the *Dendrobium* species of Northeast India so far reported. It includes history of Orchidaceae along with literature review, genus citation and description, illustrations, photo plates, keys to the sections, species with up-to-date nomenclature and description. Information on type species, protologues, flowering and fruiting periods, ecology and habitat, chromosome numbers, notes, specimens examined and general distribution has been included. The present investigation revealed many morphological variations in size, shape, colour of the vegetative and reproductive characters for most of the *Dendrobium* species **(Table-24)** and the maximum variation was observed in the sepals, petals and lip of *D. heterocarpum* and *Dendrobium transparens*. It was observed that the size of flowers of *D. devonianum* from Arunachal Pradesh were larger than the flowers of *D. devonianum* found in Meghalaya, similarly variation in size of flower of *D. chrysanthum*, *D. chrysotoxum*, *D. crepidatum*, *D. lituiflorum*, *D. ruckeri*, *D. gibsonii*, *D. farmeri* etc. were also observed. The lip structure is a very prominent feature in *Dendrobium* to differentiate one species from another. It was observed that the lip of *D. spatella* in Arunachal Pradesh was somewhat greenish than lip of *D. spatella* found in Meghalaya. Similary variation in lip structure of *D. chrysanthum, D. chrysotoxum, D. crepidatum, D. denudans, D. gibsonii, D. heterocarpum, D.primulinum, D. ruckeri, D. transparens, D. wardianum* were also observed.

These morphological variations of size and colour of *Dendrobium* species are environmentally induced variations and may be speculated as ecads. Although the present investigation has not been able to report the formation of ecotypes in the genus but there seem to be much scope of formation of ecotypes. Taxonomically the most important character separating one species from another is the lip character, which is strong and constant and on the basis of which different species is being established.

Chapter-8:

The eight chapter includes the general discussion on altitudinal distribution of *Dendrobium* species, their phenology, flowering behaviour, diversity and taxonomy in the Northeastern region.

Thus the present research on the topic 'Eco-Taxonomy of the Genus *Dendrobium* Sw. (Orchidaceae) of North- East India that serve as a first source of information on the detailed Ecology-cum-Taxonomy studies of *Dendrobium* supplemented with important notes on economic importance would prove very useful for the researches and those interested in the study of Orchidology. The overall analysis of the genus authenticated the status of extremely rich diversity of *Dendrobium* Sw. in the North East Region of India that opened the scope for other interesting ecological, taxonomical genera of the family Orchidaceae stimulating like-wise discovery of more new additions, new species in the near future.