

## **CHAPTER - 8: GENERAL DISCUSSION**

The present investigation on Eco-Taxonomy of the genus *Dendrobium* Sw. (Orchidaceae) of Northeast India has been initiated since 2002 till 2005. An effort had been made in bringing out a broad idea highlighted the ecology and taxonomical aspects of the genus.

The present study had been made with all sincerity by conducting extensive surveys to the natural habitats of *Dendrobium* in the Northeastern region of India. *Dendrobium* being an epiphytic genus had been inadequately explored floristically in the northeastern region and as a result taxonomically still poorly understood. At the same time the genus was not at all studied in the region from ecological point of view. Therefore, during the present investigation an attempt had been made to observe the ecological adaptation of the *Dendrobium* species in its natural habitat in relation to environmental factors governing their growth and development and to present elaborate taxonomic reports of the genus. It was observed that the most essential factors responsible for their growth and development were rainfall, temperature, relative humidity and light while other factors like substrate (phorophyte and soil), competition from other associated plants and altitude which influence temperature, rainfall, humidity and light are equally important in determining habitat and growth of *Dendrobium* species.

The critical study on altitudinal distribution based on the field observation and available literatures have yielded the following data analysis of the species distributed in various zones (Tables-14, 15; Histogram-1). Different species differs from each other in terms of their requirement from their environment and consequently also in respect of the extent to which they can tolerate the fluctuations in their environmental conditions. This range of demands and consequent range of tolerance of a species is known as ecological amplitude (Sharma,1999). Every species has its own environmental requirements for successful growth and its own ecological amplitude. Sometimes to adapt under critical conditions the species may develop in itself several structural and physiological characteristics.

**Table-15:** Percentage (%) of occurrence of *Dendrobium* species in the different altitudinal zones of North East Region of India.

Sl. No.	Altitudinal zones	No. of <i>Dendrobium</i> species occurred	Percentage of occurrence
1	Tropical zone (100–1000 m)	51 species	60.71%
2	Subtropical zone (1000–2000 m)	69 species	82.14%
3	Temperate zone (2000–3500)	15 species	17.86%
4	Subalpine zone (3500–4500 m)	no species	-
5	Alpine zone (4500–5000 m)	no species	-
6	Extending from tropical to subtropical zone	33 species	39.29%
7	Extending from tropical to temperate zone	05 species	5.95%
8	Extending from subtropical to temperate Zone	08 species	9.52%
9	Restricted to tropical zone	13 species	15.48%
10	Restricted to subtropical zone	24 species	28.57%
11	Restricted to temperate zone	02 species	2.38%
12	Species having high ecological amplitude are 6, 7, 8	46 species	54.76%
13	Species having low ecological amplitude are 9,10,11	39 species	46.43%

From **Table-15** it is quite clear that the percentage of occurrence of *Dendrobium* species in the subtropical zone ranging from 1000–2000 m altitude is highest with 69(82.14%) because this zone with moderate rainfall, humidity, sufficient amount of temperature or light supports a large number of tree species such as *Artocarpus*, *Castanopsis*, *Terminalia*, *Schima* species etc. and the growth of mosses and lichens in the trunks and branches of trees is dense thereby facilitating *Dendrobium* species to establish successfully. The tropical zone of the study site ranging from 100-1000 m altitude supports less percentage of *Dendrobium* species 51(60.71%). in comparison to the subtropical zone

of the present investigation because the zone being devoid of heavy rainfall the quantity of moisture is also less and the temperature being high does not provide a favourable atmosphere for most of the *Dendrobium* species to flourish. The temperate zone on the other hand ranging from 2000–3500 m altitude with prolonged dry season and occasionally heavy fog and severe winter still supports the growth of *Dendrobium* species with 15(17.86%).

No *Dendrobium* species were observed in the sub-alpine zone. This zone ranging from 3500–4500 m only favours the growth of herbaceous species such as *Anemone*, *Aconitum*, *Cassiope* etc. which can hardly support the growth of epiphytic orchids except *Bulbophyllum* and *Pleione* species. The absence of *Dendrobium* in this region indicates the influence of low temperature as a limiting factor for the growth of the genus in this zone.

Lastly the alpine zone 4500–5000 m gradually merges with complete disappearance of tree growth as the zone is covered with snow for major part of the year. The vegetation in this region is a scarce where only bush and shrubs like *Arenaria*, *Ephedra*, *Saussurea* species etc. are seen. Moreover due to devoid of any woody species and extremely low temperature no epiphytic orchids occur in this region.

In the intermediate categories 46 *Dendrobium* species or 54.76 % extending from tropical to subtropical, tropical to temperate and subtropical to temperate were observed. All these have high ecological amplitude as their range of demands and tolerance are wide enough to survive in all the zones from tropical to temperate.

Similarly 39(46.43%) species of *Dendrobium* restricted to only tropical, subtropical and temperate zone were considered as species having low ecological amplitude as their range of demands and tolerance are narrow which remain confined to its own zone. The species restricted to tropical zone have thick perennating leaves that help storing food and water. The species in the subtropical zone grow under shade condition have membranous leaves.

Hence the diversity of *Dendrobium* species greatly extends up to 2000 m altitude, and above which there is a decline in their occurrence and diversity. This may be due to the increase in altitude, which causes decrease in the mean temperature and at the same time affecting other factors like air, water and the quantity of sunlight also changes.

The present investigation also includes the flowering period and flowering pattern in the *Dendrobium* species of Northeast India. It was observed that every species had a definite season of flowering once a year, which was regulated by factors like temperature, rainfall, humidity, day length and dry spells. The flowering periods were categorized into four seasons of such as spring (March-May), summer (June-August), autumn (September-November) winter period (December-February).

Total length of the daily light period to which plants are exposed has pronounced effect on the vegetative growth as well as flowering of the plants. Optimum light requirements of plants differ for different species. Each species has a definite photoperiod for flowering called critical photoperiod. Those flowering in day lengths more than the critical photoperiod (between 12-14 hours) are called **long day plants**, while others flowering at day lengths less than the critical photoperiod are known as **short-day plants**. The third types of plants are those, which reproduce irrespective of the day length, and such plants are known as intermediate or **day-neutral plants**.

The study revealed that maximum (54) species flowered during the month of spring, which indicates that the spring season is congenial for the *Dendrobium* species to bloom with a moderate range of rainfall, temperature and humidity. (Table-16, 17). Moreover during the spring season the day and night lengths are equal. So the *Dendrobium* species flowering in this season can be called as **day-neutral plants**. Due to high temperature and heavy rainfall during summer season the flowering of some *Dendrobium* species is affected and those which can withstand the high temperature and heavy rainfall can only bloom during the period the number of which is restricted to 27. In this period the days are longer than the nights and the species flowering in this season are called **long day plants**. The day and night lengths are equal in the autumns and the climate is rather warm and mild to induce flowering. 15 species have been recorded to flower in this season. Finally the minimum number of species (4) was recorded in the winter season because of less rainfall, which causes less humidity and very cold temperature. In winters days are shorter and nights longer so species blooming in this season can also be categorized as **short day plants**. The 4 species flowered during this season seem to be tolerant against low temperature and comparatively low humidity.

**Table-17: Average annual Rainfall, Temperature, Relative humidity in the four seasons of North East Region of India w.e.f. 2000-2004**

SEASONS	No. of <i>Dendrobium</i> species	RAINFALL	TEMPERATURE		RELATIVE HUMIDITY	
		In mm	Maximum (°C)	Minimum (°C)	0830 Hrs	1730 Hrs
Spring (Mar-May)	54	278.90	26.21°C	16.73°C	73.97%	69.18%
Summer (Jun-Aug)	27	668.54	27.94°C	21.67°C	87.26%	83.10%
Autumn (Sep-Nov)	15	368.14	26.22°C	17.14°C	80.98%	83.33%
Winter (Dec-Feb)	4	29.33	21.36°C	9.69°C	72.34%	70.67%

**Table-18: Photoperiod of flowering of *Dendrobium* species in North East Region of India; Abbreviations ‘ - ’ indicates absence of *Dendrobium* species.**

Seasons	PHOTOPERIOD		
	Long-day-plants	Short-day-plants	Day-neutral plants
Spring (Mar-May)	-	-	54
Summer (Jun-Aug)	27	-	-
Autumn (Sep-Nov)	-	-	15
Winter (Dec-Feb)	-	4	-

In the transitional periods during the seasons 18 species were found to bloom (Table-19). These species are considered to have high ecological amplitude as their range of tolerance to rainfall, temperature and humidity are wide enough to survive in all the seasons from spring to winter. It is interesting to note that flowering of some species of *Dendrobium* is restricted to only a particular season. *Dendrobium* species restricted to only spring, summer, autumn, winter is 41, 12, 10, 1 respectively. These 64 species restricted to its particular season may be considered as species having low ecological amplitude as their range of tolerance to the various climatic factors are narrow confining to its own season.

**Table-19: Number of *Dendrobium* species flowering in the different Seasons of North East Region of India.**

Sl.No.	Seasons	No.of <i>Dendrobium</i> species
1	Spring (March-May)	54
2	Spring-summer	13
3	Summer (June-August)	27
4	Summer-Autumn	2
5	Autumn (September-November)	15
6	Autumn-Winter	3
7	Winter (December-February)	4
8	Winter-Spring	No species
9	Restricted to Spring only	41
10	Restricted to Summer only	12
11	Restricted to Autumn only	10
12	Restricted to Winter only	1
13	Species flowered during the transitional period 2, 4, 6, 8.	18
14	Species restricted to Spring, Summer, Autumn and Winter seasons 9, 10, 11, 12	64

A comparative study was made on 25 selected *Dendrobium* species (Table-20) to understand their phenological pattern under two phases i.e. (i) Vegetative phase and (ii) Reproductive phase in both natural and artificial condition. The vegetative phase involves development of seedling and active vegetative phase. While the reproductive phase is further divided into 5 subdivisions such as development of inflorescence, flowers started to bloom, flowers in full bloom, flowers started to wither, flowers completely withered. The entire cycle from development of seedling to complete withering of flowers takes one complete year in both the natural and artificial conditions. The only difference lies in the duration of development in various phenophases. It has been observed that initially the

species under cultivation in charcoal and brick medium grows 10-15 days slower than the ones in natural habitat but as the roots get into properly intact with the medium it takes the pickup with the species growing naturally.

During the present investigation of the 25 selected species, the fruiting of 16 species or 64 % viz. *D. aphyllum*, *D. brymerianum*, *D. chrysanthum*, *D. devonianum*, *D. formosum*, *D. heterocarpum*, *D. hookerianum*, *D. infundibulum*, *D. lituiflorum*, *D. moschatum*, *D. nobile*, *D. longicornu*, *D. ochreatum*, *D. ruckeri*, *D. transparens* and *D. williamsonii* were observed, while in the remaining 9 species or 36 % viz. *D. anceps*, *D. bicameratum*, *D. densiflorum*, *D. eriaeflorum*, *D. falconeri*, *D. jenkinsii*, *D. kethii*, *D. spatella* and *D. stuposum* no fruit development were observed in the cultivated medium except in natural habitats. The fruiting periods of almost all the *Dendrobium* species in the northeast region of India has been reported by Balakrishnan, 1982; Bose & Bhattacharjee, 1980; Chowdhery, 1998; Deb et al., 2003; Hynniewta *et al.*, 2000; Rao & Deori, 1980; Shukla *et al.*, 1998; Singh *et al.*, 1990; Singh *et al.*, 2001.

This may be due to lack of macro and micronutrients or improper functioning of the root system. In the cultivated medium, since the roots of the species were not freely exposed to the air, they remain deficient of essential macro and micronutrients and hence development of fruiting hampers. Moreover, insects and pests such as aphids, caterpillars, slugs, weevils etc. attack and destroy young inflorescence and flowers, which terminates the development of fruiting.

However, in the natural habitat fruiting is hardly hampered because the species acquired sufficient macro and micronutrients from the prevailing environment and the host plants on which they grow. Moreover the roots with velamen are exposed freely in the air to capture organic nutrients from the prevailing atmospheric moisture.

The study on the diversity of *Dendrobium* have lead to many additions to its species content in each state of northeast India thereby increasing the statistics. More significantly the addition of three new species of *Dendrobium* to science and two new records for India have added to the list of *Dendrobium* of India to 84 species compared to earlier record of only 77 species (Singh *et al.* 2001). The occurrence of many *Dendrobium* species both in India and neighbouring countries like Thailand, China, Myanmar, Nepal,

Malaya indicates close affinity of vegetation patterns as the northeastern region acts as the transitional zone between India, Indo Malayan, and Indo-Chinese biogeographic regions. This has lead to frequent transmigration and intermixing of the floral elements with the help of various biotic and abiotic agencies.

Though the northeast region was endowed with an extremely rich and enormous diversity of *Dendrobium* species but at the same time this diversity richness is getting depleted due to deforestation, shifting cultivation and industrialization. The following status of the species have been categorized into endemic, rare, endangered, threatened, probably extinct, vulnerable, common and extremely rare following Lucas & Synge, 1980 and based on existing literatures such as Katakai, 1984a, 1984b; Rao, 1986; Sarkar, 1995; Shukla *et al.*, 1998; Singh *et al.*, 2001 and following Lucas & Synge, 1980)

**Table- 23: Status of *Dendrobium* Species in North East Region of India**

Status	No. of <i>Dendrobium</i> species	%(Percentage)
Rare (R)	37	44.05%
Extremely rare (eR)	15	17.86%
Endangered (E)	4	4.76%
Threatened (T)	7	8.33
Probably Extinct (Ex)	4	4.76%
Vulnerable (V)	2	2.38%
Endemic (En)	1	1.19%
Common (C)	14	16.67%

The tremendous depletion of *Dendrobium* species and other orchids species in our country must be brought into focus through seminars and symposia by Botanical Survey of India and other scientific institutions, government and non-government organizations, Orchid societies of India etc. The creation of National Parks, Sanctuaries and Biosphere Reserves in protecting natural habitats of orchids played a vital role in their conservation. The Botanical Survey of India and various state governments in northeastern region of India played a vital role in the creations of sanctuaries in the North East Region of India (Sessa orchid sanctuary and Tipi Orchid Centre in Arunachal Pradesh, Deorali and Saramsa Orchid Sanctuaries in Sikkim); Orchidariums (National Orchidarium at Botanical Survey of India,

Eastern Circle, Shillong, Meghalaya), Botanical garden, and Experimental garden (Barapani) at Botanical Survey of India, Eastern Circle, Shillong, Meghalaya, parks (Lady hyderapark locally known as Phan Nonglait park, Jawaharlal Nehru Park, Umiam, Barapani, Thangkharang Park, Cherrapunjee). Besides these, several other institutions such as Assam Agriculture University, Jorhat (AAU), Northeastern Hill University, Shillong (NEHU), Gauhati University, Guwahati, Indian Council of Agricultural research (ICAR), Barapani are also engaged in conserving orchid species in this region.

The present study revealed that the taxonomy of the genus *Dendrobium* with the largest number of species in northeast India is very vast and complicated. The 84 species and 4 varieties were grouped under 10 different sections following Seidenfaden, 1985 viz. *Aporum* (Bl.) Lindl., *Breviflores* Hook. f., *Callista* (Lour.) Schltr., *Dendrobium* Seidenf., *Formosae* (Benth & Hook. f.) Hook.f., *Grastidium* (Bl.) J. J. Sm., *Pedilum* (Bl.) Lindl., *Rhopalanthe* Schltr., *Stachyobium* Lindl., *Strongyle* Lindl. All the 10 sections were unique in its characteristics and prominently different from one another.

The present investigation revealed that the occurrence of morphological variations in size, shape, colour of the vegetative and reproductive characters of most of the *Dendrobium* species (Table-24) indicated a vast range of morphological diversities in the genus. These morphological diversities of size, shape and colour of *Dendrobium* species are environmentally induced variations and may be speculated as ecads then may later lead to ecotypes and finally new species. Careful studies have resulted in the rediscovery of *D. pycnostachyum* Lindl. which has been reported after a lapse of 61 years from Mizoram, the type locality of the species and *D. aurantiacum* which had been included in red data book by Deori, 1978 as extinct species has been rediscovered in Meghalaya the type locality of the species. Similarly two new records, *D. dantaniense* Guill. and *D. sociale* J.J. Sm. have been added to the list of Indian *Dendrobiums*. More importantly the strong morphological variation in vegetative and reproductive characters observed in *D. demudans*, *D. longicornu*, *D. wattii* has led to three interesting new species *D. numaldeorii* Deori et al., *D. arunachalense* Deori et al. and *D. meghalayense* Deori et al.

From the previous chapters it is therefore clear that the northeastern region with favourable climatic conditions is a cradle for orchid species diversity including *Dendrobium*.

As the genus being of ecologically and taxonomically important is to be saved from its depletion from various reasons through insitu, exsitu and other conservation measures.