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BIOGEOGRAPHY AND DISTRIBUTION OF GENUS *ERIA* LINDLEY (ORCHIDACEAE) IN HIMALAYAS

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Abstract

The genus *Eria* is represented by 50 species in the Himalaya. Ten species are distributed in the North Western Himalaya; 27 in Nepal Himalaya; 24 in Eastern Himalaya (including Sikkim) ; 18 in Bhutan Himalaya; and 34 in North Eastern Himalaya. Thirteen species are local endemic, five Himalayan endemic, and 28 non-Himalayan in nature. Maximum number of species is distributed within an altitudinal range of 1000-1500 m. Some species exhibit discontinuous distribution in the Himalayan region.

Introduction

THE EVOLUTIONARY interpretations are often more speculative in a family devoid of an informative fossil record as compared to that having a definite fossil history. Priority assumptions are always necessary for interpreting distribution patterns in taxa like orchids; such assumptions can be qualified if based on distribution pattern of taxa in related families or floras in which an informative fossil record exists. Studies on bio-geographical analysis of orchids have remained rather meagre.

The Himalayan ranges support an enormous floristic diversity in a wide variety of forest types. Nearly 8,000 plant species including 750 of orchids grow here. Majority of orchids (> 600 species) are East Himalayan in distribution. *Eria* Lindl. is a large genus of epiphytic orchids whose numerical strength in terms of species has been variously assessed between 350-500 (Summerhayes and Hunt, 1973). An estimate of 350 species (Pearce and Cribb, 2002), however, seems to be more realistic. Royal Botanic Gardens, Kew (2003) enlisted 404 species of *Eria*. The genus is divided into different sections based on the pseudobulb and leaf characters. In the Himalayan region, it is represented by nearly 50 species, 33 of which are recorded from the North Eastern Himalaya.

Eria is distributed from tropical Asia to Indo-Pacific; it spreads from tropical Himalaya (India,Nepal, Bhutan), China, Philippines, and Indonesia to Papua New Guinea, Pacific Islands, and Fiji (Seidenfaden ,1982). In Asia, the genus has been variously recorded from hot and humid coastal rainforests of Malaysia to the the Himalayan snow line. Present study has ventured to carry out its simple biogeographic analysis in the Himalayan region (Fig. 1).

Material and Methods

The present study is primarily based on herbarium specimens, from different herbaria, *i.e.* ASSAM, BM, BSD, CAL, DD, E, and K (acronyms in accordance with Holmgren *et al.*, 1990). In Nepal, KATH and TUCH herbaria were also used for verification of the specimens. The studies were also supplemented by field collections made during periodic visits to different Himalayan regions from 1990-2001.

The Himalaya has been variously divided into 3 and 5 regions. The former concept considers 3 wings (Western, Central, and Eastern), along its range, whereas the latter concept recognizes 3 distinct regions (Sikkim Himalaya, Bhutan Himalaya, North East Himalaya) in the Eastern wing. Presently both these concepts have been evaluated vis-a-vis distribution of *Eria* along the range.

Basic Concept and Terminology

The following terminology has been chosen as the most convenient starting point for biogeographical analysis.

1. *Endemic*: Species restricted to Himalayan region.
   - Local endemic: species restricted to a single mountain range or to a part of the Himalayan mountain range.
   - Himalaya endemic: species restricted to Himalayan mountain range and only occurring in one or two regions of the main Himalaya.
2. *Non-endemic*: Species not restricted to the Himalayan Region.
   - Himalayan species: Species confined to the Himalayan region but exhibiting wider distribution in other regions.
   - Non Himalayan Species: species confined to certain areas of Himalaya besides their distribution in certain regions beyond Himalaya.

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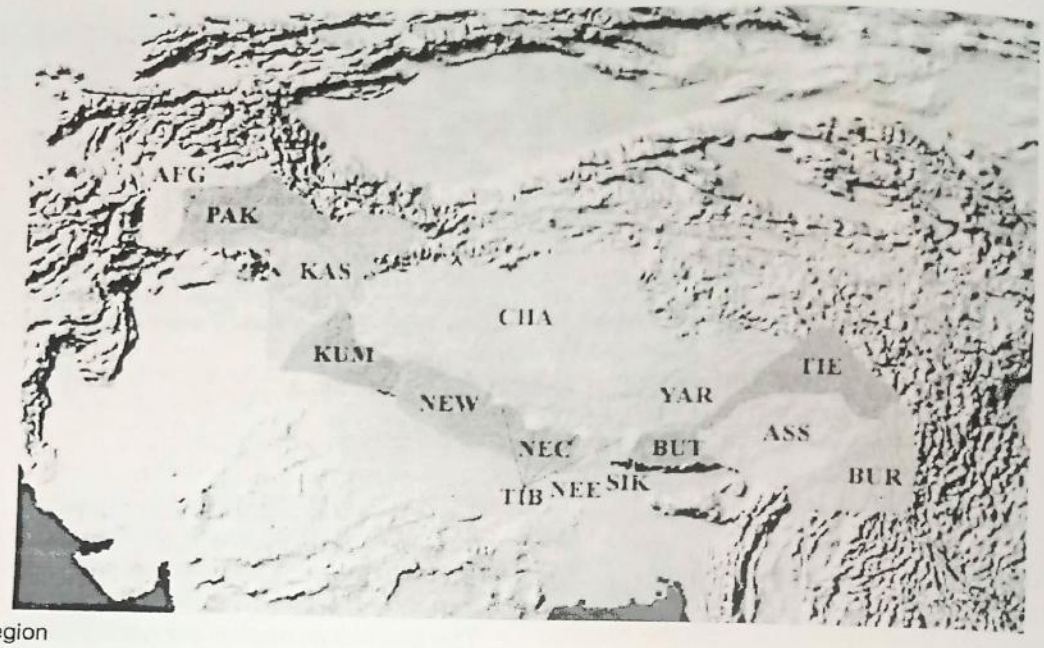

Fig. 1. Himalayan region

(Abbreviations: AFG, North Eastern Afghanistan; ASS, North Eastern India; BUT, Bhutan; BUR, Northern Union of Myanmar; CHA, High Tibetan Plateau or Chantang, China; KAS, Kashmir (India); KUM, North-Western India; NEC, Central Nepal; NEE, Eastern Nepal; NEW, Western Nepal; PAR, Northern Pakistan; SIK, Sikkim; TIB, Southern Tibet; TIE, Eastern Tibet; YAR, Yarlung Tsangpo Valley) (Source : Flore of Himalaya France, 2002).

Result and Discussion

Overall distribution of *Eria* in the Himalayan region is summarized in Table1. The distribution pattern of different species in the Himalayan regions is provided (Fig. 2). The details are as follows:

Distribution

A. Western Himalaya

- North West Himalaya: *Eria alba, E. amica, E. braccata, E. coronaria, E. excavate, E.graminifolia, E. lasiopetala, E.muscicola, E. occidentalis,* and *E. spicata.*

B. Central Himalaya

- Nepal Himalaya: *Eria acervata, E. alba, E. amica, E. annapurnanesis, E. apertiflora, E. baniae, E. biflora, E. bipunctata, E. bractescens, E. carinata E. clausa, E. concolor, E. corneri, E. coronaria, E. excavata, E. extinctoria, E. globulifera, E. graminifolia, E. laniceps, E. lasiopetala, E. muscicola, E. nepalensis, E. obesa, E. paniculata, E. pokharensis, E. pumila, E. spicata,* and *E. stricta.*

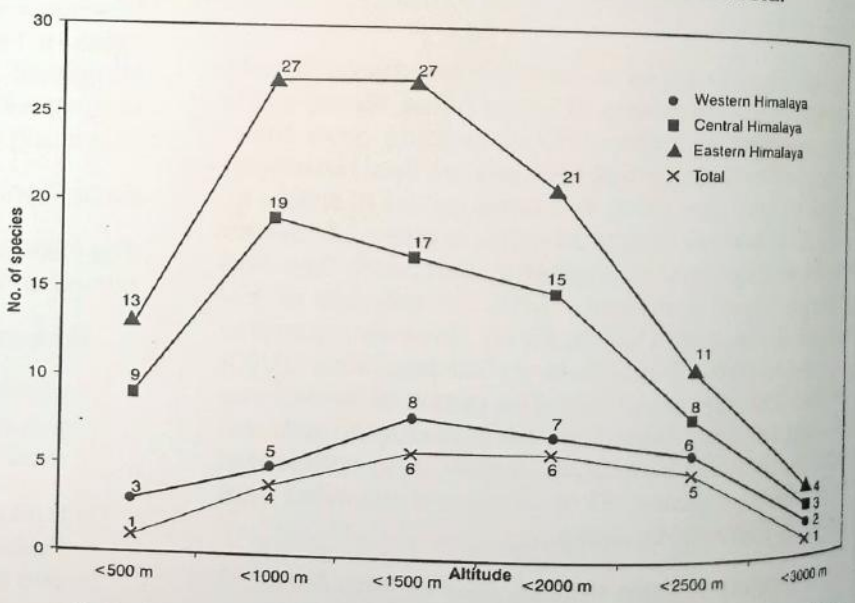

Fig.2. Genus *Eria* : Total Himalayan Species and their altitude-wise distribution in Western, Central, and Eastern Himalaya.

C. Eastern Himalaya

- Sikkim Himalaya: *Eria acervata, E. alba, E. amica, E. bambusifolia, E. biflora, E. bractescens, E. carinata E. clausa, E. coronaria, E. excavate, E. ferruginea, E. graminifolia, E. javanica, E. laniceps, E. lasiopetala, E. muscicola var. muscicola, E. muscicola var. sikkimensis, E. paniculata, E. pannea, E. pumila*

Table 1. Global distribution of *Eria*.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Himalayan Region						Other Regions															
Eria acervata Lindl.		+	+	+	+	+	+		+	+	+	+	-	+					-	-	-	-
E. alba Lindl.	+	+	+	+	+				+										-	-	-	-
E. amica Lindl.	+	+	+	+	+	+	+		+	+	+	+	+	+					-	-	-	-
E. apertiflora Summ.		+			+		+		+	+	+			+					-	-	-	-
E. arunachalensis A. N. Rao						+			+										-	-	-	-
E. bambusifolia Lindl.			+		+	+	+		+	+	+	+		+					-	-	-	-
E. baniae Bajracha. *et al.*		+																				
E. Bhutanica Bajracha. & K. K. Shrestha.				+															-	-	-	-
E. biflora Griff.		+	+			+	+		+	+	+			+			+		+	-	-	-
E. bipuncata Lindl.		+			+	+			+	+	+			+					-	-	-	-
E. braccata Lindl.	+								+										-	-	-	-
E. bractesens Lindl.		+	+			+	+	+	+	+	+			+	+	+	+		+	+	-	-
E. carinata Gib.		+	+	+	+	+		+	+	+									-	-	-	-
E. clausa King & Pantl.		+	+	+	+	+			+		+	+							-	-	-	-
E. clavicaulis Wall ex Lindl.					+	+	+		+	+				+					-	-	-	-
E. concolor Lindl.		+			+		+			+									-	-	-	-
E. connata Joseph, Hedge & Abba.				+		+	+												-	-	-	-
E.corneri Rchb.f		+				+	+				+	+	+						-	-	-	-
E. coronaria (Lindl.) Reichb.	+	+	+	+	+	+	+			+	+	+							-	-	-	-
E. crassicaulis Hk. f.					+		+												-	-	-	-
E. cristata Lindl.						+	+		+	+									-	-	-	-
E. discolor Lindl.				+	+		+		+	+				+					-	-	-	-
E. excavata Lindl. ex Hk. f.	+	+	+	+	+	+			+										-	-	-	-
E. extinctoria Oliver		+					+												-	-	-	-
E. ferruginea Lindl.			+	+	+	+			+										-	-	-	-
E. globulifera Seid.		+				+			+	+				+					-	-	-	-
E. graminifolia Lindl.	+	+	+	+	+		+		+										-	-	-	-
E. javanica (Sm.) Bl.			+		+	+	+		+	+	+		+	+	+	+	+	+	+	-	-	-
E. jengingensis Hedge *et al.*						+			+										-	-	-	-
E. lacei Summ.					+		+		+	+									-	-	-	-

Table 1. Global distribution of *Eria* species (contd.).

Species	Himalayan Region						Other Regions														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Eria laniceps Reichb.f.		?	+				+	+	+	+	+								-	-	-
E. lasiopetala (Willd.) Ormerod	+	+	+	+	+	+	+	+	+	+	+	+		+					-	-	-
E. lohitensis A. N. Rao						+			+												
E. merguensis Lindl.				+						+											
E. muscicola Lindl. var. *muscicola* Lindl.	+	+	+	+	+	+	+		+	+	+	+		+					-	-	-
E. muscicola Lindl. var. sikkimensis Bajrach. & K. K. Shrestha.			+				+		+										-	-	-
E. nepalensis Bajrach & K.K. Shrestha		+																	-	-	-
E. obesa Lindl.		+				+	+		+	+									-	-	-
E. occidentalis Seden. f.	+								+										-	-	-
E. paniculata Lindl.		+	+	+	+	+	+		+	+	+			+					-	-	-
E. pannea Lindl.			+	+	+	+	+		+	+	+	+		+		+	+	+	-	-	-
E. pokharensis Bajrach. *et al.*		+																	-	-	-
E. pudica Ridl.						+			+							+			-	-	-
E. pumila Lindl.		+	+	+	+	+	+		+	+									-	-	-
E. pusilla Lindl.			+		+	+			+	+	+	+		+					-	-	-
E. scabrillinguis Lindl.			+						+										-	-	-
E. sharmae Chaudhary *et al.*						+			+										-	-	-
E. spicata (D.Don) Hands.-Mazz.	+	+	+	+	+	+	+		+	+		+							-	-	-
E. stricta Lindl.		+	+	+	+	+			+	+	+								-	-	-
E. tomentosa Lindl.					+	+	+	+	+	+									-	-	-
E. vittata Lindl.			+		+	+			+	+	+								-	-	-

1, NW Himalaya; 2, Nepal Himalaya; 3, Sikkim Himalaya; 4, Bhutan Himalaya; 5, Assam Himalaya; 6, NE Himalaya; 7, Mayanmar; 8, Bangladesh; 9 Central Himalaya; 10, Thailand; 11, Indo-china; 12, China; 13, Taiwan; 14, Vietnam; 15, Philippine; 16, Malaysia; 17, Indonesia; 18, Borneo; 19, Java; 20 Papua New Guniea; 21, Australia; 22, Netherlands.

E. pusilla, E. spicata, E. scabrillinguis, E. stricta, and *E. vittata.*

- Bhutan Himalaya: *Eria acervata, E. alba, E. amica, E. bhutanica, E. carinata, E. clausa, E. connata, E. coronaria, E. excavata, E. ferruginea, E. graminifolia, E. lasiopetala, E. merguensis, E. muscicola, E. paniculata, E. pannea, E. pumila, E. spicata,* and *E. stricta .*

- North East Himalaya (including Assam): *Eria acervata, E. amica E. apertifolia, E. arunachalensis, E. bambusifolia, E. biflora, E. bipunctata, E. bractescens, E. carinata E. clausa, E. clavicaulis, E. connata, E. coronaria, E. cristata, E. crassicaulis, E. excavata, E. ferruginea, E. globulifera, E. graminifolia, E. javanica, E. jenginensis, E. lacei, E. kamlengensis, E. laniceps, E. lasiopetala, E. lohitensis, E. muscicola, E. obesa, E. paniculata*

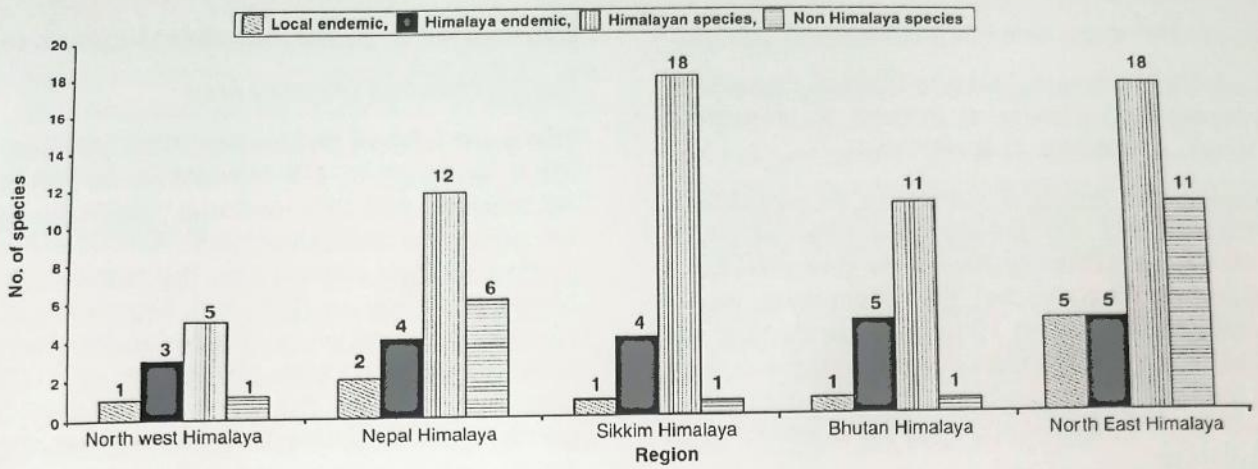

Fig. 3. Status of *Eria* in the Himalaya : Distribution of endemic, Himalayan, and Non-Himalayan species in North Western, Nepal, Sikkim, Bhutan, and North Eastern regions.

E. pannea, E. pudica, E. pumila, E. pusilla, E. sharmae, E. spicata. E. stricta, E. tomentosa, and *E. vittata.*

Endemics

Seventeen species are endemic to Himalaya. These include both the localized (local endemic) and widely distributed (Himalayan endemic) ones.

1. Local endemic species (12)

- North Western Himalaya: *Eria occidentalis.*
- Nepal Himalaya: *E. annapurnensis, E. baniae, Eria nepalensis, E. Pokharensis.*
- Sikkim Himalaya: *Eria muscicola var. sikkimensis, E. scabrillinguis.*
- Bhutan Himalaya: *Eria Bhutanica.*
- North Eastern Himalaya: *Eria arunchalensis, E. crassicaulis, E. jenginensis, E. kamlengensis, E. lohitnsis, E. sharmae .*

2. Himalayan endemic species (5)

- North Western Himalaya-North Eastern Himalaya : *Eria excavata, E. graminifolia*
- North Western Himalaya - Bhutan Himalaya: *Eria alba*
- Sikkim Himalaya- North Eastern Himalaya : *Eria ferruginea*
- Bhutan Himalaya- North Eastern Himalaya: *Eria connata*

Non -Endemics

1. Himalayan species

- North Western Himalaya-North Eastern Himalaya: *Eria amica, E. coronaria, E. muscicola, E. lasiopetala, E. spicata*
- Nepal Himalaya - North Eastern Himalaya: *Eria acervata, E. biflora, E. bractescens, E. carinata, E. clausa, E. laniceps, E. obesa. E. paniculata, E. pumila, E. stricta.*
- Sikkim Himalaya-North Eastern Himalaya: *Eria bambusifolia, E. javanica, E. pannea, E. pusilla, E. vittata*
- North Eastern Himalaya: *Eria clavicaulis.*

2. Non-Himalayan species (13)

- North-West Himalaya: *Eria braccata.*
- Nepal Himalaya: *Eria apertiflora, E. bipunctata, E. concolor, E. extinctoria, E. globulifera.*

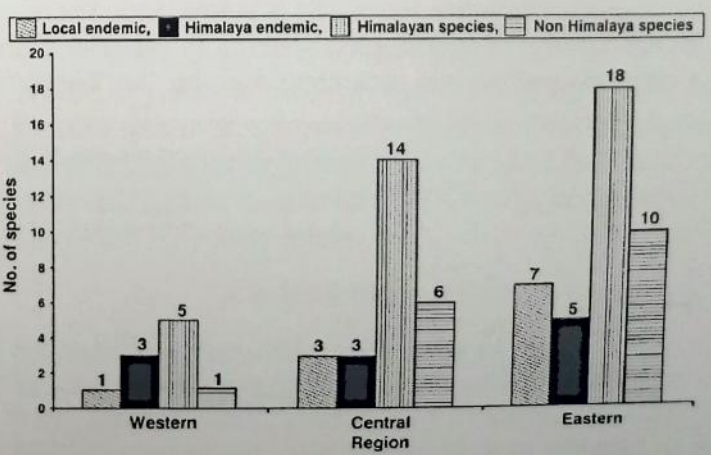

Fig. 4. : Status of *Eria* in the Himalaya : Distribution of endemic, Himalayan, and Non-Himalayan species in Western, Central, and Eastern regions.

- Bhutan Himalaya: *Eria merguensis.*
- North East Himalaya: *Eria apertiflora, E. bipunctata, E. concolor, E. cristata, E. corneri, E. globulifera, E. lacei, E. pudica, E. tomentosa,*

Significantly, *Eria amica, E. coronaria, E. pubescens, E. muscicola,* and *E. spicata* are represented at least in one of the Himalayan areas. Five of the eleven endemic species are confined to the East Himalayan region (Arunchal Predesh). The Himalayan endemics are located within the boundaries of certain regions. Such regions account for an overlapping distribution of *Eria* species in the Himalaya, and may be considered as "Diversity Areas".

Diversity Area Correlation

In general, the diversity of an area is easier to assess but it is difficult to determine an actual correlation between different species. The present study on distribution pattern of *Eria* seem to favour three segment (Western, Central, Eastern) concept of Himalaya, rather than its 5 region (Northwest Himalaya, Nepal Himalaya, Sikkim Himalaya, Bhutan Himalaya, Northeast Himalaya) concept. The number of local and endemic, Himalayan endemic, Himalayan species, and non-Himalayan species in these regions are represented in Figures 2-3.

Western Himalaya Diversity Area

The diversity in the Western Himalaya is distinct from other diversity areas of the Himalaya. The genus *Eria* is represented by 10 species in this region. These include 8.3% local endemic, 60% Himalaya endemic, 26.3% Himalaya species, and 7.1 % regional Himalaya species. Relatively lesser number of species in the region may be related to its overall dry and cool climate. Interestingly, the region also supports *Eria reticosa* which is mostly distributed in the Southern India and Sri Lanka. Its occurrence in the Himalaya is interesting. There is lesser number of overlapping species in this area than in other diversity areas, indicating, thereby, that Western

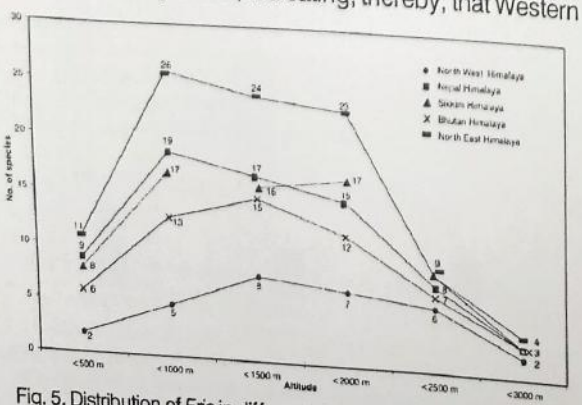

Fig. 5. Distribution of *Eria* in different Himalayan regions.

Himalaya is less diverse than other Himalayan segments.

Central Himalaya Diversity Area

The area harbours 26 species of *Eria.* As many as 25% local endemics, 8% Himalaya endemics, 68% Himalayan, and 42% regional Himalayan species of the genus are distributed here . Almost all the species overlap in their distribution. The number of species, however,differs in different segments of Central Himalayan Diversity Area. The Nepal Himalaya supports 3.24% endemic, 1.98% Himalayan, and 0.72% non-Himalayan species. *Eria* is one of the most dominant genra in Sikkim Himalaya. Higher number of species in Sikkim seems to be related to the congenial conditions (humid and moist) on the forest floor; 0.21% local endemic, 0.63% Himalayan endemic, 3.15% Himalayan, and 0.63% non-Himalayan endemic species are distributed in Sikkim Himalaya. Like wise, The Bhutan Himalaya is home to 0.33% Himalayan endemic and 0.88% Himalayan species of the genus. The number of species decreases in Nepal Himalaya; Singalila mountain acts as the major barrier to East-West migration of the flora between Nepal and Sikkim Himalaya. On the other hand, lesser number of species in Bhutan Himalaya may be attributed to its smaller geographic area, besides limited efforts to explore its orchid flora. An exact information on the distribution pattern of *Eria* in the Bhutan Himalaya, thus, may have to await publication of atleast a tentative list of its orchid flora.

Eastern Himalaya Diversity Area

Eastern Himalaya Diversity Area harbours 44 species of *Eria*. As many as 66% local endemic, 100% Himalayan endemic, 100% Himalayan, and 78.5% regional-Himalayan endemic species are distributed here. A detailed analysis of the distribution pattern of different species indicates that 0.21% and 1.86% of local endemics are respectively distributed in Sikkim and North East Himalaya, whereas 0.63%, 0.33%, and 0.96 % of Himalayan endemics are respectively distributed in Sikkim, Bhutan, and North Eastern Himalaya. 3.15%, 0.88% and 6.2% of Himalayan species and 0.63% and 0.62 % non-Himalaya species of total number of species are respectively distributed in Sikkim, Bhutan, and North Eastern Himalaya.

As per the 5 region classification of Himalaya, the genus *Eria* exhibits the following distribution pattern.

North Western Himalaya Region

The western parts of the Himalaya represents the western

Diversity are which is distinct from other diversity areas of the Himalaya. There are 10 species of *Eria* in this region and they account for 0.083% local endemic 0.60% Himalayan endemic, 0.26% Himalayan species, and 0.07 % regional Himalayan species.

Nepal Himalaya Region

It lies in the central part of the Himalaya and constitutes the Central Diversity Area. There is an overlapping of floristic components of both the Western and Eastern Himalaya. There are 27 species of genus *Eria* in this region. These include 0.25% local endemic, 0.8% Himalaya endemic, 0.68% Himalayan species, and 0.42% regional Himalayan species.

Sikkim Himalaya Region

The region lies in the Eastern part of the Himalaya and constitutes Eastern Diversity Area, which is separate from other diversity areas of Western and Central Himalaya. There are 24 species of *Eria* among them 0.16% are local endemic, 0.84% Himalayan endemic, 1% Himalayan species, and 0.07% regional-Himalaya species in this region.

Bhutan Himalaya Region

It also lies in the Eastern part of Eastern Himalaya. It is rather small as compared to other Eastern Diversity Areas, and as it is less explored, only 17 have been recorded from here; they include 0.083% local endemic, 1% Himalayan endemic, 0.63 % Himalayan species, and 0.07 % regional-Himalayan species.

North Eastern Himalaya Region (including Assam)

It also lies in the extreme East of the Eastern Himalaya, and covers several unexplored but well preserved areas. The number of species is higher than in the Western region of the Himalaya. Thirty eight species are recorded from here, among them are 0.41% local endemic, 1% Himalayan endemic, 1% Himalayan species, and 0.7% regional-Himalaya species.

Species Correlation

The Himalayan region is a suitable habitat for orchid flora. The orchid populations are highly influenced by typical monsoon climate, topographic variation, and the direction of the mountain slope. Monsoon rainfall favours luxuriant growth of the vegetation that provides shelter to orchids on the forest floor besides screening them from the canopy cover. The present studies suggest that *Eria* is mostly concentrated in the North Eastern wing due to the prevalent humid and moist warm climatic conditions.

Phytogeographically, Bhutan, Sikkim, and some parts of East Nepal, with almost identical vegetation, form an integral part of the North East Himalayan biome. The region represents the junction of migratory elements from the neighboring countries like Malaysia, Japan, Thailand, Burma, China, and Tibet.

Floristic analysis, based on literature studies, field survey, and herbarium specimens, indicates that there are 50 species of *Eria* distributed in the Himalaya from either West to East or vice versa. The region is endowed with luxuriant and varied vegetation, due to its highly conducive climatic and edaphic factors with sufficient rainfall. The genus is better represented here than in other Himalayan regions.

Interesting Distribution Pattern

Eria coronaria, *E. graminfolia* and *E. spicata* are distributed from North-west Himalaya to China, Taiwan. *Eria acervata*, *E. amica*, *E. apertiflora*, *E. bambusifolia*, *E. clavicaulis*, *E. muscicola*, *E. pubescens*, and *E. tomentosa* are distributed from Himalaya onwards to Indo-Pacific region and Java. Some species like *E. bractescens* and *E. biflora* are widely distributed from Nepal Himalaya to Australia, whereas *E. occidentalis* is mainly concentrated in the Western Himalaya as compared to *E. arunchalensis*, *E. jengingensis*, *E. lohitensis* and *E. sharmae* that are distributed only in the North Eastern Himalaya. Some species like *E. clavicaulis*, *E. globulifera*, *E. lacei*, and *E. pudica* are distributed eastwards from North East Himalaya. *E. alba*, *E. connata*, *E. excavata* and *E. ferrugenea* are only distributed in the Himalaya region. The distribution pattern of *E. reticosa* is interesting because this species is distributed in a disjuncted manner *i.e.* it is also reported from South India.

The present analysis further reveals that *Eria* species are mostly concentrated in the North-East Himalaya. Out of a total of 50 species of Himalayan *Eria*, 44 species are distributed in the Eastern Himalaya and their number gradually declines towards the Central and Western Himalayan Diversity areas.

Climatic Correlation

Climatically, the different areas offer diversity of gradients: cool and moist in Arunchal Pradesh (Eastern Himalayan region), cold desert in Ladakh (Western Himalayan region), cold dry in Tibetan Plateau, and sub-tropical in Indo-Gangetic plains. The Himalaya acts as a barrier against Monsoon wind of South and Siberian

wind of North. The rainfall varies and progressively decreases from East to West. An analysis of herbarium specimens and live collections suggests that the vertical and horizontal distribution of *Eria* is more pronounced eastwards along the Himalaya (Fig. 5).

Vertical Distribution

Species diversity in *Eria* is better seen in the tropical climates due probably to the prevalance of riverine forests which provide congenial habitats for growth and development of the genus. Even, the number of local endemic, and Himalaya species is high in this region.

In the sub-tropical and temperate regions, the number

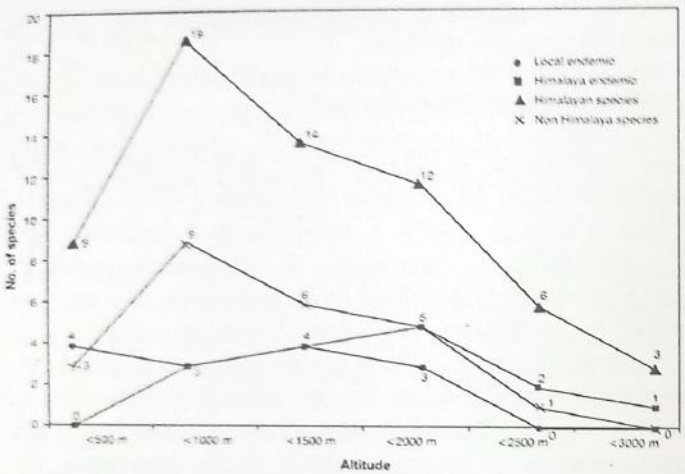

Fig. 6. Altitude wise distribution of endemic and non-endemic *Eria* species in the Himalaya.

of species is maximum in North Eastern Himalaya. It gradually decreases westwards. Such a pattern seens to be governed by climatic conditions and the aspect of slope. The climate is moist and humid and the mountain slopes are North East, East, and South East facing. In the North West Himalaya, on the other hand, the climatic is dry and cool. Incidentally, Himachal Pradesh represents the North Western limit for distribution of *Eria* along the Himalayan range. Its absence beyond the the state has been attributed to deep cuttings of Indus river that act as important barriers to westward extension of *Eria* and several other orchids in the Himalaya. (Renz, 1978, 1984; Deva and Naithani, 1986).

Eria coronaria, *E. muscicola*, *E. pubescens* and *E. spicata* are distributed from West to East and onwards to Asia- Pacific region and Java. *E. occidentalis* is mainly concentrated in the Western Himalaya, whereas *E. arunchalensis*, *E. connata*, *E. jengingensis*, *E. lohitensis*, and *E. sharmae* are North East Himalayan in distribution. Some species such as *E. alba*, *E. excavata* and *E. ferrugenea* are distributed only in the

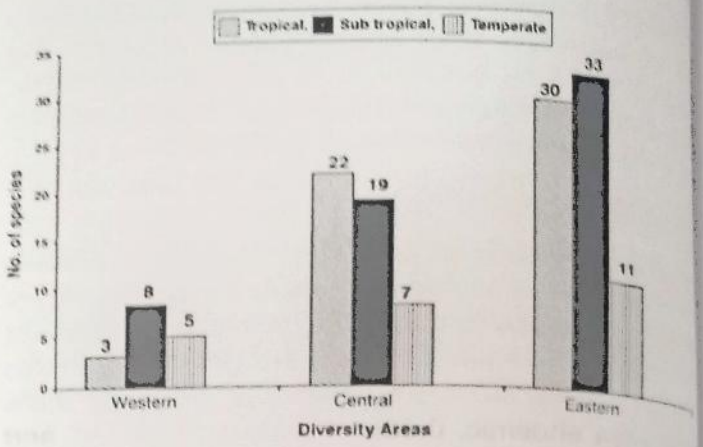

Fig. 7. Climatic zonewise distribution of *Eria* in Western, Central, and Eastern Himalayan Diversity Areas.

Himalaya region. *E. clavicaulis*, *E. globulifera*, *E. lacei*, and *E. pudica* are distributed from North East Himalaya eastwards. The distribution pattern of *E reticosa* is interesting because this species is also reported from South India. *E. biflora*, *E. bractescens*, *E. javanica*, and *E. pannea* are distributed from Himalaya up to Asia Pacific, Papua new Guinea, Pacific Island, and Java.

A perusal of the overall distbution pattern of defferent species yields the following information:

Species restricted to lower tropical region (up to 500m)	5
Species restricted to upper tropical region (up to 1000m)	10
Species restricted to lower sub-tropical region (up to 1500m)	20
Species restricted to upper sub- tropical region (up to 2000m)	13
Species restricted to lower temperate region (up to 2500m)	5
Species extending from lower tropical to upper tropical region	8
Species extending from lower tropical to lower sub-tropical region	5
Species extending from lower tropical to upper tropical region	8
Species extending from upper tropical to lower sub- tropical region	5
Species extending from upper tropical to upper sub- tropical region	2
Species extending from lower sub-tropical to upper sub-tropical region	17
Species extending from lower to sub-tropical to lower temperate Region	2

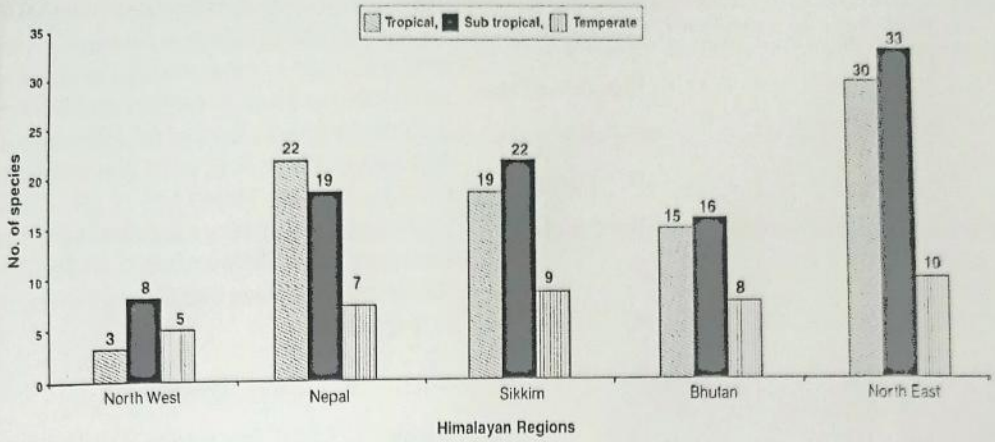

Fig. 8. The genus *Eria* in Himalaya : Number of species in different climatic zones of North West, Nepal, Sikkim, Bhutan, North East Himalayan regions.

Species extending from lower sub-tropical to lower temperate Region

The data indicate that the maximum number of species is concentrated in lower sub-tropical region. It is also interesting to note that a large number of species show an overlapping distribution in the sub-tropical rather than in the tropical and temperate regions.

The study also suggest that North Eastern Himalaya with maximum number of species, may be an active centre of species diversification. Incidentally, the Eastern Himalaya including N.E. India represents the richest habitat for plant diversity in the Himalaya.

Taxonomic Correlation

Eria has been divided in to a number of sections, 12 of which are represented in the area under study. Their region wise distribution is very significant (Tables 2, 3).

The distribution of different sections of the genus as per the three diversity areas, makes an interesting study. The section Hymeneria is better representated in Eastern Himalayan Diversity Area (EDA). It is, however, sparely represented in Central Diversity Area (CDA) and Western Diversity Area (WDA). *Eria alba*, *E. connata, E. excavata*, and *E. ferrugenea* are distributed in the Himalaya region, whereas the remaining species either extend their distribution to regions adjacent to Himalaya or vice versa. Most of the Conchidium species such *Eria lacei, E. extinctoria,* and *E. pusilla* are Indo-Malayan species and seem to have migrated from East to West.

More than 75 percent of local endemic are concentrated EDA, and most of them belong to the sections Hymeneria and Cylindrolobus. The sections Conchidium,Trichosma, lasiopetalae (subsection Densrolirium), Hymeneria, and Pinalia are represented with almost identical frequencies in all diversity areas. None of the sections exhibits a large numbers of species in WDA (Table 2).

Since EDA is more diverse than other areas, in the quality of species, it may be considered as the centre of Himalayan diversity at the sectional and intraspecies levels in *Eria*.

Conclusion

Table 2. Distribution of *Eria* sections in 3 main Himalayan wings.

Section	WDA	CDA	EDA	Total range
Eria	-	-	1	N
Conchidium	2	2	4	E, H, N
Xiphosium	-	1	1	H
Trichosma	1	2	5	H, N
Strongyleria	-	-	1	H
Dendrolirium	1	2	4	H
Mycaranthus	-	1	1	H
Cylindrolobus	-	1	5	H
Secundae	-	1	1	H
Bambusifolia	-	-	2	H
Hymeneria	4	10	15	E, H, (N)
Pinalia	2	5	5	E, H, (N)

(Abbreviations: CDA, Central Himalayan Diversity Area; E, Endemic species; EDA, Eastern Himalayan Diversity Area; H, Himalayan Species; E, Endemic species; N, Non Himalayan species; WDA, Western Himalayn Diversity Area;)

Table 3. Distribution of *Eria* sections in 5 Himalayan regions.

Section	NWH	NH	SH	BH	NEH	Total range
Eria	-	-	1	-	1	H
Conchidium	2	2	3	1	3	E, H, N
Xiphosium	-	1	1	1	1	H
Trichosma	1	2	3	2	4	H, N
Strongyleria	-	-	1	1	1	H
Secundae	-	1	1	2	1	H
Dendrolirium	1	3	3	2	4	E, H, HE, N
Mycaranthus	-	1	1	1	1	H
Cylindrolobus	-	1	1	-	5	E, H, N
Bambusifolia	-	-	1	-	2	H
Hymeneria	4	11	6	-6	9	E, H, HE, (N)
Pinalia	2	5	2	3	6	E, H, (N)

Abbreviations: NWH, North West Himalaya; NH, Nepal Himalaya; SH, Sikkim Himalaya; BH, Bhutan Himalaya; NEH, North East Himalaya; E, Endemic species; H, Himalayan Species; HE, Himalayan Endemic species; N, Non Himalayan species.

From above analysis of Diversity, Area Correlation, Species correlation, Climatic correlation and taxonomic correlation of the *Eria* in the Himalaya region shows that Himalayan species originate from the North East Himalaya region and migrate to northern and southern floristic region. Most of the Himalayan species distributed N.E. Himalaya via upper Burma to (Tibet) China, Taiwan, Japan, in direction and from N. E. Himalaya region via lower Burma, Thailand, Indo-china Malaysia, Singapore, Philippines, Papua New Guinea Australia and Netherlands in another direction. Averanov (2002) pointed out that Floristic analysis reveals clear connection of Sikang- Yunnan and North Indochinese orchids floras with flora of SE Himalaya. Other line of distribution is from N. E. Himalaya to westward through Bhutan, Sikkim, Nepal via N. W. Himalaya up to Nederland like *E. acervata*. But there are no species in Pakistan, Iran, Afghanistan. It appears again in Netherland. It shows that *E. acervata* is cosmopolitan in distribution.

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