

THE GENUS *ERIA* Lindley (ORCHIDACEAE) IN THE
HIMALAYAS - A TAXONOMIC REVISION

A Dissertation submitted to the Central Department of Botany
Institute of Science and Technology, Tribhuvan University
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Devendra Mananda Bajracharya

Lecturer

Department of Botany, Amrit Campus
Tribhuvan University
Kathmandu, Nepal

Academic Supervisor

Prof. Krishna Kumar Shrestha, Ph. D.

Central Department of Botany
Tribhuvan University, Kritipur
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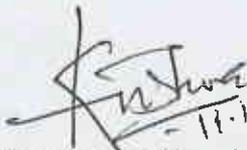
In memory of my parents
Late Riddhimananda Bajracharya
&
Late Laxmi Shova Bajracharya



TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF BOTANY
Kritipur, Kathmandu. NEPAL

CERTIFICATE

This is to certify that the dissertation entitled "The Genus Eria Lindley (Orchidaceae) in the Himalayas- A Taxonomic Revision" was carried out by Mr. Devendra Mananda Bajracharya under my supervision. This work has been accomplished on the basis of candidate's original research work and submitted here for his Doctor of Philosophy (Ph. D.) Degree in Botany, from Tribhuvan University, Kathmandu, Nepal. To the best of my knowledge, the results of this work have not been submitted for any other degree either in whole or in part for a degree at this or any other University. Therefore, I'm pleased to forward this thesis for the final approval and acceptance.


- 11.10.2003

Krishna Kumar Shrestha, Ph. D.

Professor

*Central Department of Botany
Tribhuvan University, Kirtipur
Kathmandu, NEPAL*

Decalaration of Originality

It is declared that the work presented in this thesis, to the best of candidate's knowledge and belief, is original and candidate's own work, except as acknowledged in the text. The material has not been submitted, either in whole or in part, for a degree at this or any other University.

11th Dec. 2003



Devendra Mananda Bajracharya

Preface

It has been my aim to study *Eria* and revise the genus *Eria* of the Himalaya region and analyse available information on the Himalayan, with updated classification and treatment of all taxa of the genus. Emphasis has been given to compile historical as well as modern concept on gross morphology, micro-morphological, bio-geographical, phylogenetical relationship at interspecific and infraspecific level of the genus. I have felt it my task to supply information on the diversity of orchid species, with special emphasis on one of the complicated genera of Orchidaceae, by providing the correct nomenclatures, identification keys, and comprehensive description including the line drawings of all *Eria* species reported from the Himalaya.

For the present study, all herbarium specimens housed in Nepal (KATH, TUCH), India (CAL, DD, ASSAM) and the U.K. (BM, K, and E), as well as living specimens collected from different parts of the country (east, central and west Nepal) were thoroughly examined wherever possible. Although this work is strictly a regional analysis, it also includes the specimens from neighboring countries (India and Bhutan) as well to give the best possible picture of general distribution.

One of the main objectives of the present study was to prepare the monograph of the Himalayan *Eria*. Lindley's concept of *Eria* was broad; it would hardly be justified to say this work as a comprehensive study of the genus since the Himalayan *Eria* comprises only 12% of the whole genus. Clearly, there is such diversity in the genus that it seems tempting to return to some of the older generic taxa. Some of those proposed by Blume, but rejected by Lindley and others, or to elevate some of the earlier proposed subgenus or section to the generic level needs serious consideration. The only step I have ventured to take here is to accept some earlier concept that *Trichotosia* Bl. could be separated. From the present study it is clear that there are other groups that could equally well be considered as separate genera such as *Tylostylis* Bl. and *Mycarathes* Rcbh. f.

The result of present work is submitted here for the fulfillment for Doctor of Philosophy (Ph. D.) degree in Botany under Tribhuvan University, Kathmandu, Nepal. Quite extensive studies have been made on the Orchid flora of surrounding areas such as Sikkim, Bhutan, Arunchal Pradesh, and North-West Himalaya as the regional flora. Revisionary work of this genus has not been conducted in the Himalayan region so far. Thus, it is hoped that this work would be able to fill the gap of regional flora on the particular genus *Eria*, even if not to one's entire satisfaction, and may serve as an impetus.

11th December, 2003
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Acronyms and Abbreviations

A	Arnold Arboretum, Harvard University, Massachusetts, USA.
ACFPN	Annotated Checklist of the Flowering Plants of Nepal
APNI	Australian Plant Name Index, Queensland Herbarium, Australia.
ASSAM	Botanical Survey of India, Eastern Circle, Shillong, India.
B	Botanisches Museum, Berlin-Dahlem, Germany.
BM	The Natural History Museum, London, UK.
BO	Bogor herbarium, Java, Indonesia.
BRI	Queensland Herbarium, Australia.
BSD	Botanical Survey of India, Northern Circle, Dehra Dun, India.
BSI	Botanical Survey of India, Kolkata, India.
C	Museum, Botanicum, Hauniense, Copenhagen Denmark.
CAL	Central National Herbarium, Botanical survey of India, Kolkata, India.
DD	Forest Research Institute, Dehra Dun, India.
E	Royal Botanic Garden, Edinburgh, Scotland, UK.
EFPN	The Enumeration of Flowering Plants of Nepal.
GH	Harvard University, Massachusetts, USA.
GRC	Gray Cards Index, Harvard University, Massachusetts, USA.
INSA	Indian Science Academy, New Delhi, India.
IK	Indexes Kewensis, Kew, UK.
IOST	Institute of Science and Technology, Kirtipur, Nepal.
IUCN	The World Conservation Union Geneva, Switzerland.
LRMP	Land Resource Mapping Project, Kathmandu.
K	Royal Botanic Gardens, Kew, UK.
K-W	Kew – Wallich herbarium, Kew, UK.
K-Lindl.	Kew- Lindley herbarium, Kew, UK.
KATH	National Herbarium and Plant Laboratories, Kathmandu, Nepal.
L	Leiden Herbarium, the Netherlands.
LINN	The Linnaean Society of London, London, UK.
LIV	Liverpool Museum, London, UK
MO	Missouri Botanical Garden, Missouri, USA.
NLFPGN	Name lists of Flowering Plants and Gymnosperms of Nepal.
NY	New York Botanical Garden, New York, USA.
RONAST	Royal Nepal Academy of Science and Technology, Nepal.
TI	University Museum, University of Tokyo, Japan.

TU	Tribhuvan University, Kathmandu, Nepal.
TUCH	Tribhuvan University Central Herbarium, Kirtipur Nepal
UGC	University Grants Commission, Kathmandu, Nepal.
<i>c., ca.</i>	<i>circa</i> : about (approximate)
<i>cf.</i>	<i>confer</i> : compare
<i>ed.</i>	edition
<i>eds.</i>	editors
<i>e.g.</i>	<i>example gratia</i> : for example
<i>& al.</i>	and other
<i>f,</i>	<i>filius</i> : son; <i>fide</i> : according to (after a personal name)
<i>fig.</i>	<i>figura</i> : figs figures(s)
<i>i.e.</i>	<i>id est</i> : that is
<i>illus.</i>	illustrated
MS., MSS	<i>manuscriptum, manuscripta</i> : manuscript
N.B	notebene, note well
n.d	no date of publication
nov.	<i>novus</i> , new
p.	pp. pages
<i>s.l.</i>	<i>sensu lato</i> : in a broad sense
<i>s.n</i>	<i>sine numero</i> : without a number, unnumbered
<i>s.str, s.s.</i>	<i>sensu stricto</i> : in a marrow sense
sp.	<i>species</i>
ssp.	<i>subspecies</i>
<i>typ.</i>	<i>Typus</i> :type
var.	<i>varietas</i> : variety
<i>viz.</i>	<i>videlicet</i> : namely
vol.	volume (s)

Executive Summary

- The genus *Eria*, belonging to the family Orchidaceae, comprises 404 species in the world and is distributed from Tropical Asia to Indo-pacific. They are obligate epiphytes, growing in small or large tufts on the branches of trees with usually erect and rarely pendulous habit. Due to diverse morphological variations, the genus is regarded as one of the most complicated genera for systematic study. Moreover, no study has been done so far on the systematics of *Eria* in the Himalayan region. So the overall aim of the research is to revise the genus *Eria* with the following objectives: to undertake systematic study of the genus *Eria* in the Himalayas, to study the micro-morphological features of the Himalayan *Eria* (stomatal complex, seed morphology and pollen morphology), to analyze the biogeography of the Himalayan *Eria*, and to establish the phylogenetic interrelationship among different species of *Eria* using cladistic analysis.
- The morpho-geographical study was based on thorough examination of herbarium materials as well as fresh collection of plants. More than 600 specimens were studied deposited in different Herbaria such as BM, K, and E (UK), CAL, BSD, DD, and SIKKIM (India), KATH and TUCH (Nepal). Several personal collections from different parts of Nepal were also critically examined. Additional materials (colour plates, type photograph) sent from C, L, GH, MO, and NY have been examined. Living plants were collected from various parts of Nepal Himalaya and Bhutan during 1992-2002. Cladistic analysis was performed by Nona 2000 version (Nixon 1999-2000) to trace out the relationship between species. Biogeography analysis was carried out by the detailed study of the herbarium specimens.
- The principles of specific delimitation followed in the present revision are founded upon a traditional morphological species concept. That is, the species are distinguished by discontinuous variation in several morphological characters preferably representing vegetative as well as floral characters.
- The genus *Eria* comprises 49 species, in the Himalayan region, from Kashmir to the boarder of Burma. Out of 49 species *E. spicata*, *E. coronaria*, *E. muscicola*, *E. acervata*, *E. amica*, and *E. lasiopetala*, are most common species in the Himalayan region.
- The Himalayan *Eria* has been categorized into 12 sections, viz. *Eria*, *Conchidium* Griff., *Xiphosium* Griff., *Trichosma* Lindl., *Bambusifolia* Hook.f., *Cylindrolous* (Bl.) Lindl., *Hymeneria* Lindl., *Pinalia* Seindf., *Mycaranthes* Rchb.f., *Dendrolirium* (Bl.) Lindl., *Stecundae* Leavitt, and *Strongyleria* Pftz.,
- Section *Trichosma* is further divided into two new series viz. *Coronariae* and *Clausae* and the section *Dendrolirium* comprises two new series *Ferruginae* and *Pubescentae*.

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- Present investigation recognized five new species, viz. *E. nepalensis* D. M. Bajracharya & K. K. Shrestha from C. Nepal, *E. bhutanica* D. M. Bajracharya & K. K. Shrestha from Bhutan, *E. baniaii* D. M. Bajracharya, L. R. Shakya & M. K. Chettri from C. Nepal, *E. pokharensis* D. M. Bajracharya, A. Subedi & K. K. Shrestha from C. Nepal, and *E. sikkimensis* D. M. Bajracharya & K. K. Shrestha, from Sikkim. They have been reported the new species here, and already published in international peer reviewed journals.
 - Five species of *Eria*, viz. *E. apertiflora*, *E. bipunctata*, *E. clausa*, *E. concolor* and *E. obesa*, have been recorded as new addition to the Flora of Nepal.
 - *E. lohitensis* was reduced as synonym of *E. glandulifera*.
 - Some doubtful as well as less known species like *Eria acutifolia*, *E. oranta*, *E. sutepensis*, and *E. scrabriliguis* have excluded from the Himalayan taxa of *Eria*, and suggested further detailed study of these species. *E. kamlangensis* was not included in the present study here due to the lack of opportunity to authentic specimens.
 - Leaf surface of 28 species of *Eria* were examined with the help of Light Microscope (LM). Micro-morphological characters of the leaf surface of *Eria* show variation in the size, shape and the density of stomata, as well as arrangement of subsidiary cells. Elliptical and circular shapes of stomata have been recorded, and seven different types of stomatal complex have been recognized on the basis of shape of stoma and arrangement of subsidiary cells.
 - Examination with the help of (LM), 28 species of *Eria* revealed silica bodies (stegmata) in 22 species. Stegmata are absent in *E. muscicola*, and *E. pannea*, and not distinct in *E. coronaria* and *E. merguensis*. Remaining species have spherical stegmata in the leaves of *Eria* except *E. javanica* having conical type of stegmata. The stegmata of *Eria* reflect taxonomically useful information at the groups.
 - Seed morphology of 19 species of Himalayan *Eria* has been studied through Light Microscope (LM). "A" "B" and "D" type of seeds shape are confirmed in *Eria*. According to Dressler's classification (1993), three types of seeds are confirmed such as *Vanda* type (12 species), *Epidendrum* type (4 Species) and *Eulophia* type (1 species). The seeds of *Eria* reflect taxonomically useful information at the sectional level. Six groups were classified on the basis of seed type.
 - Morphological study of pollinia of 20 species of *Eria* revealed that the pollen grains are tetrads and rhomboidal in shape, and adhere as "calymmate type" by observing under SEM and LM. Sculpture of pollen grains shows smooth exine on the outer wall, and the tectum surfaces of pollens are observed smooth and inaperturate through LM in *Eria*. While examined under SEM, tectum of *E. spicata*, *E. amica* and *E. alba* was psilate type, where as in *E. bipunctata* the tectum was scabrate and perforate in *E. lasiopetala*. Thus, the pollen morphology data are significant in the delimitation of generic and subtribal level.

-
- Based on the results of morphological, anatomical, palynological study and secondary data from karyo-morphology and cytology, the cladistic analysis reveals that the Himalayan *Eria* could be separated into two distinct groups and suggested that the Himalayan *Eria* is monophyletic. The present study indicates that vegetative characters are also useful in the phylogenetic analysis.
 - All the Himalayan species of *Eria* are distributed from tropical to temperate region (500-3500 m). Its distribution is poor in the Western Himalaya and does not extend beyond Uttaranchal Pradesh, India. The diversity of species, on the basis of climate correlation, species correlation and taxonomic correlation of the species, shows that number of *Eria* species is high in Eastern Himalayan region (39 species) low in Western Himalayan region (10 species). Maximum numbers of species is concentrated at an attitude between 1000-1500 m, and abruptly decrease above 2000 m.
 - Biogeographically analysis reveals that Himalayan *Eria* might be originated from the North-East Himalayan region and distributed in two directions in the Northern and Southern floristic regions. They are mainly concentrated in the eastern part of both hemisphere and less in western part.
 - A formal revised classification of *Eria* must be awaited, once the complete revision of the genus is accomplished or revisions of the genus in other continents of the world are being published.

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1. Introduction

1. Introduction

1.1 Background

Phytogeographically, Orchidaceae is a cosmopolitan family widely distributed in the tropical and subtropical regions of the World. The Orchid family is regarded as one of the largest, most diverse and distinctive families of flowering plants (Garay 1960; Dressler & Dorson 1960; Melchior 1964; Burns-Balogh & Funk 1986; and Dressler 1981, 1993). Estimates of the size of the orchid family vary widely. It is often difficult to determine the families' composition, because considerably few orchids groups have been studied in detail. According to rough estimates, there are about 25,000 species of orchids present in the world, which means Orchidaceae comprises about 7-10% of flowering plant species (Atwood 1986). It was estimated that more than 850 species of orchids occur in the Himalayan region (Royal Botanic Gardens Kew, 2003).

The origin and evolution of the Orchidaceae requires clarification. The discontinuous distribution of the family between continents and the fossil evidence of the genus *Protorchis* is presence in Eocene, and suggest that Orchidaceae appeared as early as the Cretaceous period (Stebbins 1957). After than the occasional presence of primitive forms, however, there are few clues available to provide insight into orchid evolution (Schmid & Schmid 1977; Takhtajan 1997).

The first center of orchid distribution appears to be in Asia, where four subfamilies and five tribes, followed by South America, which is home to the three subfamilies and four tribes, and finally Africa where there are two subfamilies and three tribes, represent the family (Chen 1982). Among these areas, orchid diversity is focused in the Eastern Asiatic region, which contains 12 genera belonging to five tribes; the Indo-Chinese Region contain nine genera and four tribes; and in the Malaysian, Caribbean, Venezuela and Surinam, and Amazon region contain six genera and two-three tribes (Takhtajan 1969). The number of genera present in the remaining regions is rather low. Chen (1982) considers the Eastern Asian Region may be the centre of origin of Orchidaceae, because many primitive genera are found in this region.

Dahlgren and Rasmussen (1983) claimed that the Orchidaceae is derived from Liliales s. str.. Orchidaceae is closely related to Burmanniaceae, as both are being included in the order *Microspermae* (Bentham & Hooker 1883). Orchidaceae is quite similar to Hypoxidaceae (Rolfe 1910; Hallier 1912; Gobi 1916; Hutchinsion 1934; Garay 1960; Rao 1969; Takhtajan 1987) especially the genera *Hypoxis* and *Curculigo*.

Molecular evidence from ribulose-bisphosphate carboxylase gene (*rbcL*) sequences, cladistic analysis, morphological analysis and phylogenetic analysis also supports the proposed relationship between Orchidaceae and Hypoxidaceae (Dressler 1981, 1993; Dahlgren & al. 1985; Burns-Balogh & Funk 1986; Judd & al. 1993; Dressler & Chase 1995; Cameron & al. 1999; Freudenstein & Rasmussen 1999).

Orchids are distributed from northern Sweden and Alaska to Tierra del Fuego and Macquarie Island in the south, and are most abundant and diverse in the rain forests of these regions (Dressler 1981). In terms of species diversity, South America is the richest with 8,266 species, followed by Tropical Asia with 6800 species and Tropical Africa with 3131 species (Dressler 1981). Within Asia, Thailand has 1200 species (Nanakorn & al. 1995); India has 1141 species (Kumar & Manilal 1994) and Malaysia has about 1000 species (Seidenfaden & Wood 1992). In the Himalaya region, Arunachal Pradesh comprises 545 species (Chowdhery 1998), Sikkim has 448 species (Sukla & al. 1998); Bhutan, including Sikkim and Darjeeling, is represented by 579 species (Pearce & Cribb 2002). Nepal has about 386 species (Bajracharya & Shakya 2002), and the Western Himalaya (from Border of Pakistan to Kumaon Garhwal) had represented by 239 species (Deva & Naithani 1986).

Some of the largest genera of Orchidaceae are *Pleurothallis*, which comprises about 1120 species followed by *Bulbophyllum* about 1000 species, and *Dendrobium* about 900 species (Judd et al. 1999). Several genera such as *Chamaegastrodia*, *Herpysma*, *Epiblema*, and *Coeloglossum*, etc. are monotypic

Orchidaceae is prized for its unique and beautiful flowers, of which many species are grown as ornamentals. The family includes species hybrids and cultivars of *Cattleya*, *Cymbidium*, *Dendrobium*, *Epidendrum* and *Vanda*. Some genera like *Dendrobium*, *Coelogyne*, *Cymbidium*, *Pleione*, etc. have spectacular flowers and could be regarded as precious wealth of genetic resources.

1.2 Classification of Orchidaceae

Lindley (1826) divided entire orchids into two families Apostasiaceae and Orchidaceae, with seven tribes. Schlechter (1926) divided the family into two subfamilies *Diandrae* and *Monandrae*, two subdivisions *Bastoniae* and *Acrotonae*, and two tribes *Polychondreae* and *Kerophareae*. Orchids are recognized as member of three distinct families Apostasiaceae, Cyrtipediaceae and Orchidaceae (Vermeulen 1966, Dahlgren & Rasmussen 1983, Szlachetko 1995). Szlachetko (1995) recognized eight subfamilies (*Thelymitroideae*, *Orchidoideae*, *Tropidiodeae*, *Spiranthoideae*, *Neottioideae*, *Vanilloideae*, *Epidendroideae* and *Vandoideae*) in Orchidaceae, with 47 tribes and 140 subtribes (including 2 new tribes and 28 new subtribes), with

about 750 genera. Garay (1972), however, divided Orchidaceae into 5 subfamilies with eight tribes *Apostasioideae*, *Cypripedioideae*, *Orchidoideae*, *Neottoideae* and *Epipendroideae*. Takhtajan (1997) has also accepted this classification.

Dressler (1993) recognized Orchidaceae as a distinct family and divided into five subfamilies (*Apostasioideae*, *Cypripedioideae*, *Spiranθοideae*, *Orchidoideae* and *Epipendroideae*) 22 tribes and 62 subtribes.

Based on the classification proposed by various taxonomists Orchidaceae *s. lat.* can be divided into three to eight subfamilies. Modern evidences of phylogenetic classification suggested that the families like Apostasiaceae and Cypripediaceae had be regarded as the separate families (Stern & *al.* 1993b, Judd & *al.* 1993) and Orchidaceae (*s. lat.*) can be classified into three subfamilies namely *Orchidoideae*, *Neottoideae* and *Epipendroideae*.

1.3 General Morphology of Orchidaceae

Perennial Herbs. Terrestrial or epiphytic, sometimes saprophytic and lacking chlorophyll, mostly symbiotic with fungi. Leaves alternate or basal (rarely opposite or whorled), sometimes reduced to scales, simple, entire; frequently fleshy and attached to an enlarged or swollen stem, commonly sheathing at the base. Flowers strongly irregular, perfect (rarely unisexual), epigynous. Inflorescence of a solitary flower or flowers borne in panicle, raceme or spikes. Sepals 3, distinct or connate, green or petaloid. Petals 3, distinct or connate, 2 similar with median one very different called labellum or lip; commonly with a nectar appendage, sac, or spur attached; often attractively coloured. Stamens 1 or 2, adnate completely to the style, forming a massive structure called column; anthers opening by longitudinal slits; pollen united into 1-8 waxy masses called as pollinia, the pollinia often hidden behind a cap-like sterile -lobed of the stigma, called a rostellum. Pistil compound, of 3 united carpels; locules 1 or 3; ovules numerous and borne on axile or parietal placenta; ovary inferior and half-twisted, so the flowers turns upside down during development; style 1, stigma various. Fruit capsule. Seed tiny and numerous, embryo minute, endosperm lacking.

1.4 Statement of the problem

The orchid genus *Eria* Lindl. (*Epipendroideae*; *Podochileae*, *Eriinae*,) is distributed from the tropical & subtropical regions of Asia to the Pacific and represented from India to the Polynesia, Polunesian Islands. There are 404 species of *Eria* in the world and 48 species in the Himalayan region (Royal Botanic Gardens, Kew 2003).

First generic protologue was published in 1825 (in Edward's *Botanical Register*, t. 904 on 1st August 1825) by Lindley, based on the material of W. J. Hooker's *Dendrobium ? pubescens* Hook. *E. stellata* was recognized as the type species of the genus *Eria*. Later on, Lindley (1830)

described 25 species of *Eria* in his "Genera and species of Orchidaceous Plants". The first monograph of the genus was published by Kranzlin (1911) recognizing 241 species. Seidenfaden (1982) wrote the general account of *Eria* and *Trichotosia* of Thailand. So far, there is not a complete revisionary work on the genus *Eria* of the regional or the worldwide kind. King and Pantling (1898), Rindley (1924), Holttum (1957), Seidenfaden & Smitinad (1965), Banerjee & Pradhan (1984), Seidenfaden (1984, 1992), Deva and Naithani (1986), Seidenfaden & Wood (1992), Averanov (1994, 2000) Chowdhery (1998) and Pearce & Cribb (2002) concentrated mainly on the taxonomy of the regional orchid Flora, including *Eria*.

Many orchid taxonomists have defined the systematic position of the genus *Eria*. This genus is closely related to *Dendrobium*: the vegetative parts and the flowers are similar in structure. *Eria* is however distinguished by the following feature: nearly always pubescent, and this feature extends not only to the leaves and stem, but usually also to the sepals, ovary and flowered stalk, base of lip not joint to column foot; pollinia 8 in two groups of 4, with caudicles. So it is very difficult to distinguish from its nearest genus *Dendrobium*, resembling that of small *Dendrobium* flowers (Rasmussen 1985). Many workers emphasised the need for detailed taxonomic revision of the genus *Eria*. The genus *Eria* shows great vegetative morphological variation and two type of seeds (Dressler 1986), so there are no clear derived features to delimit the group, and some of the species now place in *Eria* may need to be reclassified in this group. The classification of this group became quite tentative (Dressler 1993). In recent studies, the spherical silica bodies have been considered an important feature in the subtribe *Eriinae*. Dressler & Cook (1988) reported that *Eria javanica* has conical silica bodies, where as in other species silica bodies are spherical in the subtribe *Eriinae* (Mollor & Rasmussen 1984), and also differed from other members of *Eriinae* in having plicate leaves. Plicate leaves are considered ancestral in the orchidaeeae and, in addition to the conical stegmata, imply that the genus *Eria* is polyphyletic in origin. This presents a considerable problem for the correct delimitation of *Eria*. Anderson & al. (1988) also studied the vegetative characters within *Eria* and found that *Eria s. l.* could not be supported as a monophyletic group. Hashimoto & Tanaka (1983) studied the karyomorphology of some *Eria* species, and found that the sectional delimitation of *Hymeneria*, *Pinalia* and *Strongyleria*, are probably untenable. Each of these example shows that *Eria* is one of the difficult genera within the Orchidaceae. Dressler (1993) also emphasized that considering the factors it is quite possible that *Eria* itself could be resolved into two or more groups.

The main aim of this study is to score additional diagnostic characters from the morphology, anatomy, palynology and biogeography of *Eria* species from the Himalayan region, and to conduct phylogenetic analysis based on the available data to solve taxonomic problem

arising within the genus. This work is primarily based on the study of herbarium specimens deposited at different Herbaria and living collection from the Himalayan region.

1.5. Study Area (An account of the Himalaya and the vegetation types)

The Himalayas constitute a vast stretch of mountain, which runs almost in parallel ranges. This is the world's highest mountain system, which extends nearly 3000 km long, from 73° - 97° East longitudes and from 27° - 37° North latitudes. The Himalayas include borders of Afghanistan in the west to northern Myanmar in the east, and covering an area of approximately 236, 000 sq. km. The width of the Himalayan system varies between 80-300 Km (Manandhar 1985). The Himalayan range as a whole virtually encloses the Indos-Gangetic Plains. As a result of alluvium from the mountains, the river systems drain the Himalayan catchments in the sea. In terms of physiography and vegetation, the Himalaya can be divided into three zones extending their whole length. These zones are: (1) The outer Himalaya or Siwalik range, extending from the Gangetic plain to 1500 m; (2) The Middle Himalaya, ranging from 1600-4000 m. and (3) The Great Himalayas occurring at an average altitude of 6100 m (Manandhar 1985).

The important geographical divisions of the Himalayas are: (1) **Western Himalaya**, comprising the northern part of Afghanistan and Pakistan, Jammu and Kashmir, Himachal Pradesh, and Uttaranchal Pradesh upto the western border of Nepal, (2) **Central Himalaya** or the **Nepal Himalaya**, comprising from south to north, with three ranges (a) Lowland Terai and Churiya or Siwalik, (b) Mid hill or Middle Himalaya, and (c) inner or Great Himalaya (Khoshoo 1993), and (3) **Eastern Himalaya**, extending from North Bengal Hills to Sikkim, Bhutan Arunachal Pradesh and Northern Myanmar (Mani 1985).

The present study includes the area of Great Himalayan range, from the Northern part of Pakistan in the West to Arunachal Pradesh (India) in the East (including Assam, Meghalaya), excluding China (Southern China, Tibet), Bangladesh and Myanmar (Fig. 1).

Vegetation

The vegetation of the Himalayas has been described by Schweinfurth (1957) Swan and Leviton (1962), Banerji (1963, 1964, and 1973), Hara (1966), Champion & Seth (1968), Stainton (1972), Dobremez (1972), Wadia (1975), Shrestha (1982), Mani (1984-1985), Rodgers (1985), Singh & Singh (1987), and Ohba (1988).

(a) **Western Himalaya:** The Siwalik of Western Himalaya is characterized by *Shorea robusta*, which ascends up to an elevation of about 1000 m. This is mainly a deciduous forest belt associated with *Lagerstroemia parviflora*, *Dalbergia sissoo*, *Anogeissus latifolius* and *Terminalia tomentosa*. Between 1000 and 2000 m, the forest is dominated by *Pinus roxburghii*. Above 1500

m, *Pinus roxburghii* is associated with *Quercus incana* and *Rhododendron arboretum*. Between 2000-2800 m, *Quercus incana* is replaced by *Quercus dilatata*. At an altitude above 2800 m, the zone is characterized by Oak - conifer forest. The prominent species in this region are *Quercus semecarpifolia*, *Abies pindrow*, *Rhododendron arboreum*, *Taxus wallichiana*, and *Cedrus deodara*. At an altitude between 3000 and 4000 m is timberline vegetation including *Betula utilis*, *Abies spectabilis* and *Rhododendron campanulatum*.

(b) **Central Himalaya or Nepal Himalaya:** The central Himalaya is classified into five physiographic zones (LRMP 1986). These horizontal bands stretching west to east across Nepal's 800km length are spread over varying elevations and divided into Eastern, Central and Western sectors. The Terai zone falls below 1000 m and represented by the warm and humid region. It consists of many kinds of deciduous trees pre-dominant the "Sal" tree, *Shorea robusta*. s associated with Sal forest are *Adina cordifolia*, *Dillenia pentagyna*, *Terminalia bellirica*, *T. chebula*, *Lagerstroemia parviflora*, *Syzygium cumini*, *Bombax ceiba* etc. Above this, lies the Siwaliks and the Southern slope of Mahabharat range between 500- 1000 m. The dominant species in the Central and Eastern Nepal is *Schima wallichii*, and *Castanopsis indica* in the lower belt, and *C. tribuloides* replace *C. indica* in the upper belts. In the Western Nepal this zone is characterized by the occurrence of *Pinus roxburghii* forest. Other trees species associated with this zone are *Alnus nepalensis*, *Engelhardia spicata*, *Lithocarpus elegans*, *Michelia champaca*, *Rhododendron arborium*, *Michelia champaca*, *M. velutina*, and *Talauma hodgsonii*, *Prunus carmesina*, in this area.

This zone includes principally the Mahabharat range, which lies almost parallel and north to south hills from east to west between 1000 – 3000 m. The lower part of the zone is largely under cultivation, but higher up there are extensive forest of evergreen oak, rhododendrons, and Laurels in the Eastern and Central Nepal, whereas Western Nepal is dominated by evergreen coniferous and deciduous mixed forests. Laurels and evergreen oak forests are found in the lower parts of this zone, which is associated with *Acer oblongum*, *Alnus nepalensis*, etc. Mixed broad-leaved deciduous forest in the upper temperate zone including species such as *Acer campbellii*, *Corylus ferox*, *Magnolia campbellii*, *Euonymus tingens*, *Lidiera pulcherrima*, *Litsea doshia*, *Populus ciliata*, *Prunus cornuta*, *Tsuga dumosa* and *Quercus lamellosa*. The broad-leaved forest region are also pre-dominated by of *Rhododendron falconeri*, *R. fulgens*, *R. grande*, *R. hodgsonii* are in the Eastern Nepal. Similarly, Western Himalayan elements like *Cedrus deodara*, *Pinus wallichiana*, in addition to *Cupressus torulosa*, *Picea smithiana*, *Juglans regia*, and *Aesculus indica* are common in the western side of the country. The other associated trees are *Abies pindrow*, *Acer cappadocicum*, *Corylus jacquemontii*, *Morus serrata*, and *Quercus floribunda*, *Ulmus wallichiana*.

This zone represented by High mountains lies on the slopes of the Himalayan region from 3000 m. to the tree-line which occur at about 4000 m. This zone is characterized by coniferous forest

of *Abies spectabilis* however, the tree-line vegetation includes *Betula utilis* and *Rhododendron cowanianum*, *R. grande*, and *R. falconeri*. Midland of Western Nepal is associated with *Acer acuminatum*, *Prunus cornuta*, *P. rufa*, *Picea smithiana*, *Sorbus cuspidata*, and *Taxus wallichiana*. The Central and Western mid-land *Betula* forest lies at the upper level of this zone where *Rhododendron campanulatum* is commonly found and associated species are *Acer pectinatum*, *Juniperus recurva*, *Lyonia villosa*, *Potentilla fructicosa*, *Rhododendron lepidotum*, *Sorbus foliosa* etc. In Western Nepal, *Quercus semecarpifolia* is predominant on dry south facing slopes, which is contrast to its paucity in Eastern Nepal. Above the High mountain zone, it represented by High Himalaya lies between the tree-line (4000 m.) and snow-line (5000 m.). This zone is represented by moist alpine scrub and dry alpine scrub. Timber is lacking and vegetation covers, consists mainly of grasses, herbs and dwarf shrubs. Most of the plants are hairy and colored. In the region of moist alpine scrub, *Rhododendron compylocarpum*, *R. fulgens*, and *R. wightii*, common shrubs, while are characteristic features of the Eastern midland. Additionally, *R. anthopogon*, *R. lepidotum*, *R. pumilum*, *R. setosum*, *Juniperus recurva*, *Lonicera obovata*, and *Salix sikkimensis* form dense carpet in some places. In the Central and Western midlands of this zone the main component is *Betula utilis*, and less frequently found *Juniperus indica*, *Lonicera obovata*, *Potentilla fructosa* and shrubby rhododendrons.

Dry alpine scrub vegetation are found in the inner valleys, such as *Juniperus recurva* in the lower belt and *J. indica*, and *J. squamata* in the upper belt of the Eastern and Central region of this zone. The increasingly dry conditions at the upper level are marked by the occurrence of *Ephedra gerardiana*, *Hippophae tibetiana*, and *Myricaria germanica*, on riverside terraces.

(c) **Eastern Himalaya:** In this region, from lowland to an elevation of 800 m, a humid tropical, largely evergreen rain forests occur, which is dominated by *Shorea robusta*, *Adina stipulata*, *Dalbergia sissoo*, *Dillenia speciosa*, *Bauhinia vahlii*, *Lagerstroemia parviflora*, and *Terminalia tomentosa*. This is succeeded, at elevations of 1500-1700 m by a broad-leaved zone dominated by *Castanopsis indica*, *Schima wallichii*, *Ficus semicordata*, *Engelhartia spicata*, *Enonymus tingens*, *Michelia kisopa* and *Quercus lamellosa*. Above this zone *Quercus incana* is predominant at an elevation of about 2800 m. There is a marked dominance of laurel species associated with *Rhododendron arboreum*, *Acer campbelli*, *Lyonia ovalifolia*, and *Symplocos theifolia* at 2500-2800 m. From 2500 m upto the timberline, *Betula utilis*, *Abies spectabilis*, *Tsuga dumosa* are the common species. At elevation between 4000 and 5000 m there are bushes of *Rhododendron* (*R. anthopogon*, *R. lepidotum*, *R. nivale*, *Juniperus spp*, and *Saussurea* species.

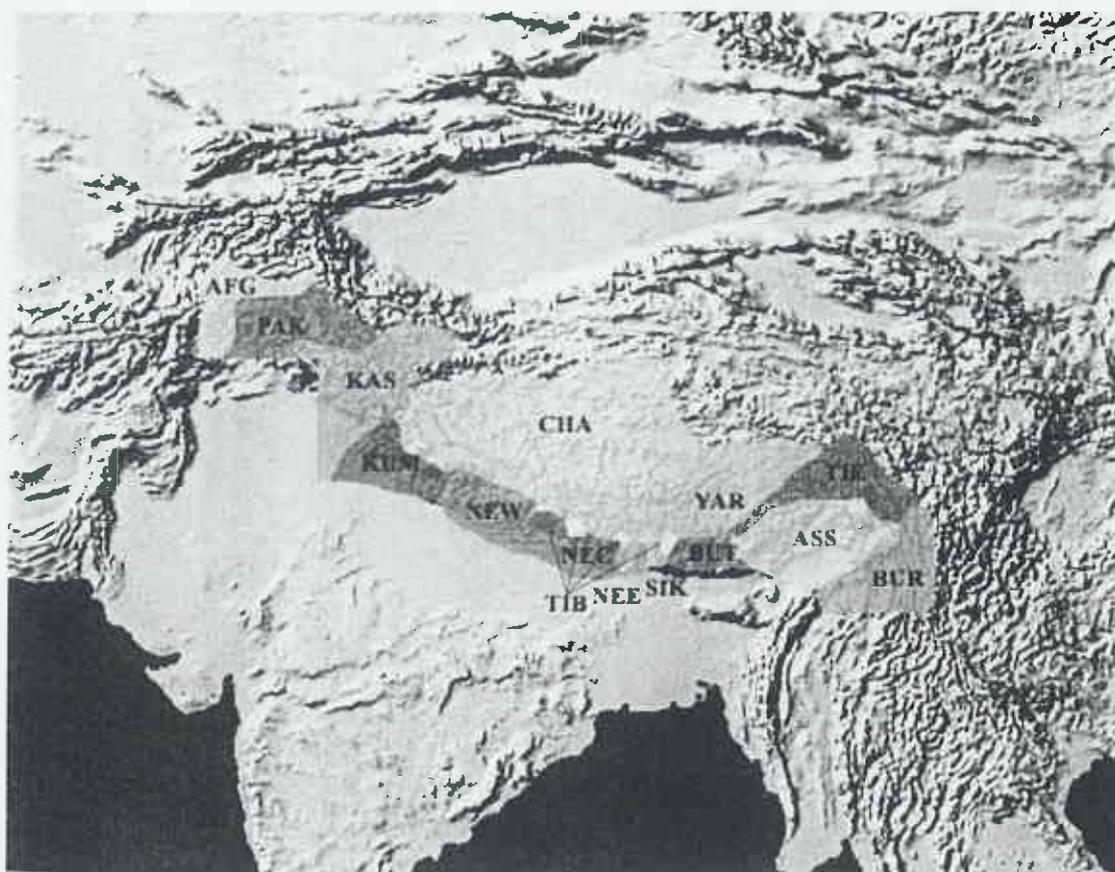


Fig. 1 Study Area of the Himalayan Region (excluding CHA, TIB, TIE and YAR)

(Abbreviation: AFG: North- Eastern Afghanistan; ASS: North Eastern India; BUT: Bhutan; BUR: Northern Union of Myanmar; CHA: High Tibetan plateau or Chantang, China; KAS: Kashmir; KUM: North-Western India; NEC: Central Nepal; NEE: Eastern Nepal; NEW: Western Nepal; PAK: Northern Pakistan; SIK: Sikkim; TIB: Southern Tibet; TIE: Eastern Tibet; YAR: Yarlung Tsanpo valley) (Source Flora of Himalaya, France, 2002)

1.6. Objectives

The detailed treatment of the genus *Eria* in the world is much awaited as the first monograph of *Eria* published by Kranzlin dates back to 1911. Besides this, Seidenfaden (1982) published a detailed account as the revision of the *Eria* of Thailand. Many experts have emphasized the need of detailed taxonomic revision of the genus *Eria*, because it is a neglected genus as well as taxonomically complicated genus among the Orchidaceae.

Realizing limited taxonomic work on the genus, a taxonomic revision of *Eria* in the Himalayas has been undertaken. Emphasis is given on gross morphological characters, as well as evidences from anatomy, palynology, seed morphology, biogeography and cladistic analysis are also incorporated to prepare a new account of the Himalayan *Eria*. Major objectives of the present research are as follows:

1. To undertake systematic study of the genus *Eria* in the Himalayas:
 - i. to update and revise the classification system by studying gross morphology,
 - ii. delimitation of taxa within the genus,
 - iii. enumeration of the entire taxa of *Eria*,
 - iv. to update nomenclatural changes of the genus,
 - v. to prepare identification keys (section, species and infraspecific level),
 - vi. to prepare taxonomic treatment of individual species with illustrations, author and bibliographic citations, full synonyms, precise designation of types, the flowering season; horizontal and vertical distribution, and citation of exsiccatae specimens, and
 - vii. to prepare the distribution maps for each species within section level, on the basis of localities given in herbarium as well as from field survey.
2. To study the micromorphological features of the Himalayan *Eria*: to study the stomatal complex, seed morphology and pollen morphology.
3. To study the biogeography of the Himalayan *Eria*
4. To establish the phylogenetic interrelationship among different species of *Eria*, using cladistic analysis based on morphological, micromorphology, and karyo-morphological characters.
5. To document secondary data of karyo-morphology of *Eria*, for delimitation of the species.

2. Review of Literature

2. Review of Literature

The chapter provides available literatures (systematic works) that deals with the genus *Eria* from the Himalaya as well as other parts of the world.

Konig (1791) described *Epidendrum Fl. aëris?* (= *Eria lasiopetala*) and *Epidendrum tomentosum* (= *E. tomentosum*) in *Observationes Botanicae*.

Buchanan-Hamilton (1802) reported *Pinalia alba* (= *Eria spicata*), in his unpublished manuscript, from Nepal.

Willdenow (1805) described *Aerides lasiopetalum* (= *Eria lasiopetala*) from India.

Hooker (1824) described *Dendrobium ? pubescens* (= *E. lasiopetala*) from Nepal.

D. Don (1825) reported *Octomeria spicata* (= *Eria spicata*) from Nepal.

Blume (1825) reported 10 species of *Dendrolirium*, three species of *Mycaranthes*, one species of *Callostylis* and four species of *Trichotosia*. Several species of these genera have been transferred to the genus *Eria* later on.

Lindley (1825) first described the genus *Eria*, based on the description of *Dendrobium ? pubescens* described by Hooker. He mentioned *Eria stellata* (= *E. javanica*) as the type species of the genus *Eria*, based on the *Dendrobium javanicum* Swartz from Java.

Lindley (1826) described a new species, *Eria stricta*, from Nepal.

Lindley (1830a) described a new species, *Eria paniculata*, from Nepal.

Lindley (1830b) described 25 species of *Eria* in "Genera and species of Orchidaceous Plants", including nine species of *Eria* (*Eria paniculata*, *E. flava*, *E. ornata*, *E. stellata*, *E. alba*, *E. excavata*, *E. pumila*, *E. obesa*, and *E. convallarioides*) from the Himalaya.

Blume (1836) changed the status of *Dendrobium javanicum* Swartz to *Eria javanica*.

Lindley (1839) reported *Eria ferruginea* as a new species from India.

Lindley (1840) reported two species of *Eria* from India (*Eria clavicaulis*, *E. planicaulis*), and one each from Singapore and Malaya.

Lindley (1841) reported *Eria polyura* from Manila, *E. bractesensis* Malaya, Singapore and *E. pulchella* from India; and *E. armeniaca*, *E. longilabris*, and *E. polyura* from Philippines; and two (*Eria bipunctata* and *Coelogyne coronaria* = *E. coronaria*) from East India.

Lindley (1842) reported *Trichosoma suavis* (= *Eria coronaria* or *E. suavis*) from East India, *E. mucronata*, *E. pannea* from Singapore, *E. acutifolia* from India and *E. rosea* from China.

Griffith (1845) reported *Xiphosium acuminatum* (= *Eria carinata*) from India.

Lindley (1851) reported *Eria acervata* from East India.

Griffith (1851) reported eight species of *Eria* (*E. cytidripoda* = *E. coronaria*) *E. biflora*, *E. flava* and *Conchidium pusillum* (= *E. pusilla*) from East India.

Wight (1852) illustrated and described four species of *Eria* (*E. reticosa*) from India.

Reichenbach (1857) gave the sectional key of *Eria* and described 24 species of *Eria* in different sections, He included *E. stellata* in *Stellatae* Rchb. f.; *E. micrantha*, in *Multiflorae* Rchb. f.; and *E. ferox* in section *Trichotosia* Rchb. f.

Lindley (1859) described 67 species of *Eria* from India in different sections viz. *Eria braccata*, *E. muscicola*, and *E. pusilla*, in the section *Conchidium* Griff., *E. flava*, and *E. pannea*, in *Dendrolirium* Bl.; *E. carinata*, *E. scabriliguis*, and *E. vittata* in *Xiphosium* Giff.; *E. discolor* in *Tylostylis* Bl.; *E. stricta*, and *E. merguensis* in *Mycaranthes* Bl.; *E. suavis* in *Trichosma* Lindl.; *E. convallarioides*, *E. excavata*, *E. alba*, *E. obesa*, and *E. graminifolia*, in *Hymenaria* Lindl.; *E. paniculata*, in *Eriura* Lindl.; *E. biflora*, and *E. ferruginea*, in *Trichotosia* Bl.; *E. khasiana*, and *E. clavicaulis*, *E* in *Cylindrolobus* Bl.; *E. bambusifolia* in the section *Urostachya* Lindl

Reichenbach (1861) described and mentioned 55 species of *Eria* in different sections *Eria braccata*, *E. pusilla*, in *Conchidium* Griff.; *E. acervata* in *Acervatae* Rchb. f.; *E. stellata* in *Xiphosium* Lindl. *E. ornata*, in *Dendrolirium* (Bl.) Lindl.; *E. stricta* in *Mycaranthes* Rchb. f.; *E. coronaria*, *Trichosma suavis* in *Trichosma* Lindl.; *E. pannea*, in *Cylindrolobus* (Bl.) Lindl., *E. ferruginea*, in *Trichotosia* Bl.; *E. paniculata*, in *Eriura* Lindl.; *E. pubescens* (= *E. lasiopetala*), *E. convallarioides*, *E. multiflora*, *E. bractescens*, *E. obesa*, *E. clavicaulis*, *E. pumila*, *E. bipunctata*, in *Hymenaria* Lindl.

Reichenbach (1863) described two new species *Eria rufinula* (= *Trichotosia pulvinata*) and *E. laniceps* from Himalaya.

Reichenbach (1864) recorded *Eria fragrens* from Sikkim; and *Eria dasypus* from Burma.

Thwaites (1864a) enumerated six species of *Eria* (*E. braccata*, *E. muscicola*) from Ceylon.

Reichenbach (1870) described *E. amica* from Assam.

Oliver (1871) described *Eria extinctoria* from Burma.

Reichenbach (1878) described *Eria corneri* from Formosa.

Parish (1883) reported three species *E. obsea*, *E. extinctoria*, and *E. vestita* and enlisted 32 species of *Eria* (*E. discolor*, *E. pannea*, *E. fragrans*, *E. acervata*, *E. concolor*, *E. convallarioides*, *E. merguensis*, *E. muscicola*.) from Burma,

Hooker (1889) reported and provided illustration of 21 species of *Eria* including *E. andersonii* (= *E. amica*), *E. crassicaulis*, *E. alba*, *E. excavata*, *E. graminifolia*, *E. acervata* and *E. confuse* (= *E. amica*) from British India.

Veitch (1889) also accepted *Trichosoma suavis* (= *Eria coronaria* or *E. suavis*) as separate genus.

Hooker (1890) reported further 94 species of *Eria* including *E. reticosa*, *E. braccata*, *E. pusilla*, and *E. extinctoria* in *Conchidium* Lindl.; *E. muscicola* in *Bryobium* Benth.; *E. paniculata*, in *Eriura* Lindl.; *E. stricta*, *E. merguensis* in *Mycaranthes* Lindl.; *E. convallarioides*, *E. pumila*, *E. bipunctata*, *E. scabrilinguis*, *E. obesa*, *E. fragrans* (= *E. javanica*), *E. vittata*, *E. graminifolia*, *E. excavata*, *E. alba*, *E. confusa*, *E. acervata*, *E. bractescens*, *E. concolor*, *E. clavicaulis*, *E. amica*, *E. biflora* in *Hymeneria* Lindl.; *E. flava* (= *E. lasiopetala*), *E. pulchella*, *E. tomentosa*, *E. ferruginea*, *E. pannea*, in *Dendrolirium* Lindl.; *E. bambusifolia*, *E. crassicaulis*, in *Bambusifolia* Hook.f.; *E. carinata* in *Xiphosium* Lindl. in Flora of British India.

Kuntze (1891) accepted the name *Pinalia* for *Eria* and changed all species of *Eria* into *Pinalia* and named as *P. acervata* (= *Eria acervata*), *P. amica* (= *E. amica*), *P. bambusifolia* (= *E. bambusifolia*), *P. barbata* (= *E. barbata*), *P. biflora* (= *E. biflora*), *P. bipunctata* (= *E. bipunctata*), *P. braccata* (= *E. braccata*), *P. bractescens* (= *E. bractescens*), *P. calamifolia* (= *E. calamifolia*), *P. carinata* (= *E. carinata*), *P. clavicaulis* (= *E. clavicaulis*), *P. concolor* (= *E. concolor*), *P. confusa* (= *E. confusa*), *P. crassicaulis* (= *E. crassicaulis*), *P. excavata* (= *E. excavata*), *P. extinctoria* (= *E. extinctoria*), *P. ferruginea* (= *E. ferruginea*), *P. fragrans* (= *E. fragrans*), *P. graminifolia* (= *E. graminifolia*), *P. merguensis* (= *E. merguensis*), *P. muscicola* (= *E. muscicola*), *P. obesa* (= *E. obesa*), *P. paniculata* (= *E. paniculata*), *P. pannea* (= *E. pannea*), *P. pumila* (= *E. pumila*), *P. pusilla* (= *E. pusilla*), *P. reticosa* (= *E. reticosa*), *P. scabrilinguis* (= *E. scabrilinguis*), *P. stellata* (= *E. stellata*), *P. stricta* (= *E. stricta*), *P. tomentosa* (= *E. tomentosa*), and *P. vittata* (= *E. vittata*) for Himalayan species.

Rolfe (1892) reported new species *Eria cristata*, from Burma.

Grant (1895) reported 36 species of *Eria* including (*E. acervata*, *E. biflora*, *E. bractescens*, *E. concolor*, *E. convallarioides*, *E. extinctoria*, *E. flava* var. *lanata*, *E. fragrans* (= *E. javanica*), *E. merguensis*, *E. muscicola*, *E. obesa*, *E. pannea*, *E. pumila*, and *E. tomentosa*.) from Burma.

Hooker (1895) mentioned three species, *Eria obesa* and *E. clavicaulis* in section *Hymeneria* and *E. discolor* in *Dendrolirion*, from India.

Ridley (1896) enumerated 49 species and described the genus *Eria* from Malay Peninsula and mentioned *E. bractescens*, *E. pudica*, in *Hymeneria* Lindl.; *E. pannea*, *E. stellata* (= *E. javanica*), in *Dendrolirion* Lindl.

King and Pantling (1896) described the new species *Eria clausa* and *Eria fibuliformis* from Sikkim Himalaya.

King and Pantling (1898) described and illustration of 21 species of *Eria* from Sikkim Himalaya viz *E. muscicola* in section *Bryobium* Benth.; *E. biflora*, *E. convallarioides*, *E. pumila*, *E. bambusifolia*, *E. graminifolia*, *E. vittata*, *E. bractescens*, *E. clausa*, *E. fragrans* (= *E. javanica*), *E. excavata*, *E. confusa*, *E. acervata* in *Hymeneria* Lindl.; *E. coronaria* in *Trichosma* Lindl.; *E. stricta* in *Mycaranthes* Lindl.; *E. paniculata* in *Eriura* Lindl.; *E. flava* (= *E. lasiopetala*), and *E. pannea* in *Dendrolirion* Lindl., *E. dayphylla*, and *E. rufinula* in *Trichotomia* Rchb. f.; and *E. carinata* in section *Xiphosium* Lindl.

Smith (1905) mentioned 35 species of the genus *Eria* including (*E. biflora*) in *Cylindrolobus* Bl.; from Java for Himalayn region.

Duthie (1906) reported *Eria alba*, *E. flava*, and *E. convallarioides* from North-West Himalaya.

Ridley (1907-1908) reported the 49 species of *Eria*, including (*Eria cristata*, in *Trichotomia* Rchb. f.; *E. stellata* (= *E. javanica*), in *Stellatae* Rchb. f.; *E. bractescens*, in *Bractescentes* Ridl., *E. pudica*, in the section *Nutantes* Ridl.) from Malayan Peninsula.

Leavitt (1909) described 46 species of the *Eria* including viz. (*E. bractescens*, in *Hymeneria* Lindl.) from Philippines, and proposed the new section *Secundae* for *E. stricta*.

Kranzlin (1911) revised whole genus *Eria* and described more than 240 species of *Eria* from the World. He included the Himalayan species *E. braccata*, *E. extinctoria*, *E. muscicola*, *E. pusilla*, in sub section *Euconchidium* of the section *Conchidium* Lindl.; *E. carinata*, *E. clausa* in sub section *Euxiphosium*; *E. fragrans* (= *E. javanica*), *E. javanica* in sub section *Convolutae* of the section *Xiphosium* Lindl.; *E. merguensis*, *E. stricta*, in *Mycaranthes* Rchb. f.; *E. calamifolia*, *E. pannea*, *E. albido-tomentosa*, *E. ferruginea*, *E. coronaria*, *E. flava* (= *E. lasiopetala*), *E. tomentosa*, in *Dendrolirion* Lindl.; *E. alba*, *E. acervata*, *E. excavata*, *E. graminifolia*, in sub section *Hyacinthoideae*, *E. vittata*, *E. obesa*, *E. corneri*, *E. scabrilinguis*, *E. amica*, *E. bractescens*, *E. pudica*, *E. confusa* (= *E. amica*), in sub section *Bractescentes* Ridl.; *E. biflora*, *E. cristata*, *E. pumila*, *E. concolor*, *E. clavicaulis*, in sub section *Clavatae*, *E. convallarioides* in sub

section *Floribundae* of section *Hymeneria* Lindl.; and *E. crassicaulis*, *E. bambusifolia*, *E. paniculata*, in section *Eriurae* Lindl.;

Ridley (1924) reported the 51 species of *Eria* including *E. pudica*, in the section *Eriura* Lindl.; *E. bractescens*, in *Bractescentes* Ridl.; *E. stellata* (= *E. javanica*), in *Stellatae* Rchb. f.; and *E. pannea* in the section *Dendrolirion* Lindl.) from Malay Peninsula

Bruhl (1926) enlisted 21 species of *Eria* from Sikkim Himalaya viz. *E. pumila*, *E. rufinula*, *E. paniculata*, *E. muscicola*, *E. dasyphylla*, *E. pannea*, *E. confusa* (= *E. amica*), *E. biflora*, *E. coronaria*, *E. stricta*, *E. bambusifolia*, *E. graminifolia*, *E. convallarioides* (= *E. spicata*), *E. carinata*, *E. bractescens*, *E. acervata*, *E. excavata*, *E. vittata*, *E. fragrans* (= *E. javanica*), *E. flava* (= *E. lasiopetala*), *E. clausa* and *Eria discolor* is separated as *Tylostylis discolor*.

Handel -Mazzetti. (1929) reported two species of *Eria graminifolia*, *E. salwinensis*, and new combination of *E. spicata* from South-West China.

Summerhayes (1929a) reported new species *Eria apertiflora* from Assam.

Summerhayes (1929b) reported new species *Eria lacei*, and *E. conica*, from Burma.

Summerhayes (1932) reported *Eria hindei* (= *E. pudica*) as new species to Assam.

Kihara (1952) reported *Eria alba* from Manasalu from Nepal Himalaya.

Holtum (1957) described and illustrated the 60 species of *Eria* (including *E. cristata* in the section *Trichotosia* Rchb. f.; *E. biflora* in *Cylindrolobus* Bl.; *E. javanica* in *Goniorhabdos* J.J. Sm.; *E. pannea* in *Strongyleria* Pfitz.; *E. bractescens*, *E. pudica*, in section *Hymeneria* Lindl.) from Malaya.

Mitra (1958) reported 29 species of *Eria* from Eastern India viz. *E. pusilla*, *E. muscicola*, *E. paniculata*, *E. stricta*, *E. convallarioides* (= *E. spicata*), *E. pumila*, *E. bipunctata*, *E. scabrilinguis*, *E. vittata*, *E. graminifolia*, *E. excavata*, *E. alba*, *E. coronaria*, *E. confusa* (= *E. amica*), *E. acervata*, *E. bractescens*, *E. clavicaulis*, *E. amica*, *E. biflora*, *E. tomentosa*, *E. ferruginea*, *E. pannea*, *E. bambusifolia*, *E. crassicaulis*, and *E. carinata* were included in the Himalayan region.

Seidenfaden and Smitinand (1958-1965) listed 43 species of *Eria* and included *E. muscicola*, in *Conchidium* Lindl.; *E. javanica* in *Goniorhabdos* Schltr.; *E. tomentosa*, in *Dendrolirium* Lindl.; *E. pannea*, and *E. globifera* in *Strongyleria* Pfitz.; *E. paniculata*, in *Mycaranthes* Lindl.; *E. stricta* in *Cymboglossum* J. J. Sm.; *E. coronaria*, *E. biflora*, *E. cristata*, in *Cylindrolobus* Bl.; *E. bambusifolia* in *Bambusifolia* Hk. f.; *E. bractescens*, *E. bipunctata*, *E. spicata*, *E. pumila*, *E. acervata*, *E. amica*, in section *Hymeneria* Lindl from Thailand.

Deb (1961) enlisted three species of *Eria* viz. *E. coronaria*, *E. excavata* and *E. muscicola* from Manipur territory.

Hara & al. (1966) reported six species *Eria coronaria*, *E. discolor*, *E. excavata*, *E. flava* var. *lanta*, *E. graminifolia*, *E. muscicola*, *E. pannea* from Eastern Himalaya.

Arora (1969) reported from *Eria excavata* from Western Himalaya.

Banerji and Thapa (1970) recorded nine species of *Eria* from Nepal *E. alba*, *E. bractescens*, *E. confusa* (= *E. amica*), *E. convallarioides* (= *E. spicata*), *E. coronaria*, *E. excavata*, *E. flava* (= *E. lasiopetala*), *E. graminifolia*, and *E. paniculata*.

Hara & al. (1971) reported four species *Eria clausa*, *E. coronaria*, *E. paniculata* and *E. stricta* from Eastern Himalaya.

Rao and BalaKrishnan (1973) enumerate seven species of *Eria* from Bhutan viz. *Eria alba*, *E. clausa*, *E. confusa*, *E. graminifolia*, *E. coronaria*, *E. stricta*, *E. muscicola*, *E. carinata*, and *E. merguensis*.

Herklots (1974) reported *Eria coronaria*, *E. puchella*, *E. flava* (= *E. lasiopetala*) *E. ferruginea* and *E. confusa* (= *E. amica*) from Nepal and India

Hara & al. (1975) reported two species *Eria dasyphylla*, *E. muscicola* from Eastern Himalaya.

Malla, Shrestha, Rajbhandari, Shrestha, Adikari, and Adhikari, (1976) described *Eria muscicola* from Langtang Valley of Nepal Himalaya.

Deori and Malhotra (1977) recorded a new species *Eria pudica* from Khasi and Jaintia Hills.

Banerji and Thapa (1978) reported ten species of *Eria* from Nepal viz. *E. alba*, *E. bractescens*, *E. confusa* (= *E. amica*), *E. convallarioides*, *E. coronaria*, *E. excavata*, *E. flava*, *E. graminifolia*, *E. muscicola*, and *E. paniculata*.

Hara, Stearn and Williams (1978) enumerated 12 species of *Eria* viz. *E. alba*, *E. bractescens*, *E. confuse* (= *E. amica*), *E. coronaria* (= *Trichosma suavis*), *E. dasyphylla* (= *Trichotisia dasyphylla*), *E. excavata*, *E. graminifolia*, *E. muscicola*, *E. paniculata*, *E. pubescens* (= *E. lasiopetala*), *E. spicata*, and *E. stricta* from Nepal Himalaya. Besides that *Trichosma suavis* (= *E. coronaria*)

Pradhan (1979) reported 29 species of *Eria* from India among them *E. reticosa*, *E. muscicola*, in *Conchidium* Lindl.; *E. javanica* in *Goniorhabdos* J. J. Sm. *E. hindei* (= *E. pudica*), and *E. carinata* in *Xiphosium* Lindl.; *E. flava* (= *E. lasiopetala*) in *Dendrolinum* Lindl.; *E. pannea*

in *Strongyleria* Pftiz.; *E. paniculata* in *Mycaranthes* Lindl.; *E. coronaria*, and *E. biflora* in *Cylindrolobus* Bl.; *E. acervata*, *E. excavata*, *E. clausa*, *E. mysorensis*, *E. pumila*, *E. graminifolia*, *E. bractescens*, *E. amica*, *E. spicata*, *E. vittata*, and *E. fragrans* (= *E. javanica*) in *Hymeneria* Lindl.; *E. stricta* in *Cymboglossum* J. J. Sm; and *E. bambusifolia* in section *Bambusifolia* Hk.f.; in India.

Paudyal and Shakya (1981) enlisted *Eria clausa*, *E. confusa* (= *E. amica*), *E. coronaria*, *E. excavata*, *E. pumila* and *E. spicata* from Southern hill forest of Kathmandu valley.

Seidenfaden (1982) reported and illustration of 47 species of *Eria* (including *Eria javanica* in section *Eria*; *E. pusilla*, *E. muscicola*, *E. lacei*, *E. extinctoria*, in *Conchidium* Lindl.; *E. carinata* in *Xiphidium* Lindl.; *E. coronaria*, and *E. vittata* in *Trichosma* Lindl.; *E. pannea* in *Strongyleria* Pftiz.; *E. discolor* in *Tylostylis* Lindl.; *E. tomentosa*, *E. laniceps*, *E. pubescens* (= *E. lasiopetala*) in *Dendrolirium* Lindl. *E. paniculata*, in *Mycaranthes* Rchb. f.; *E. merguensis*, and *E. porteri* in *Secundae* Leavitt; *E. biflora*, *E. clavicaulis*, *E. cristata*, in *Cylindrolobus* Bl.; *E. bambusifolia* in *Bambusifolia* Hk. f.; *E. concolor*, *E. obesa*, *E. amica*, *E. acervata*, *E. sutenpensis*, *E. bractescens*, and *E. xanthocheila* in *Hymeneria* Lindl.; *E. bipunctata*, *E. apertiflora*, *E. pumila*, *E. globulifera*, and *E. spicata* in *Pinalia* Lindl.) from Thailand.

Seidenfaden and Arora (1982) described the *Eria alba*, *E. amica*, *E. coronaria*, *E. excavata*, *E. graminifolia*, *E. muscicola*, *E. occidentalis*, *E. pubescens* (= *E. lasiopetala*), *E. spicata* and *E. reticosa* from North West Himalaya. *E. occidentalis* reported as new species to North West Himalaya

Joseph, Hegde, and Abbareddy (1982) reported the new species *Eria connata* from lower Kameng district, Arunachal Pradesh of North-East Himalaya.

Amatya (1982) reported seven species of *Eria* namely *Eria clausa*, *E. coronaria*, *E. excavata*, *E. pubescens* (= *E. lasiopetala*), *E. pumila*, *E. spicata*, and *E. confusa* from Northern Hill forest of Kathmandu Valley.

Banerji and Pradhan (1984) reported and illustrated 14 species *Eria* from Nepal Himalaya. He included the following species *Eria acervata*, *E. alba*, *E. amica*, *E. bractescens*, *E. carinata*, *E. coronaria*, *E. discolor*, *E. excavata*, *E. graminifolia*, *E. muscicola*, *E. paniculata*, *E. pubescens* (= *E. lasiopetala*), *E. spicata* and *E. stricta*.

Chen and Tsi (1984) re-established of *Callostylis rigida* to *Eria discolor* from China.

Hegde (1984) listed ten species of *Eria* namely *Eria acervata*, *E. connata*, *E. coronaria*, *E. ferruginea*, *E. flava*, *E. fragrans*, *E. paniculara*, *E. pannea*, *E. spicata*, and *E. stricta*, from Arunachal Pradesh.

Seidenfaden (1984) discussed the establishment of a new genus *Ascidieria* typified from *Eria longifolia* Hook. fil. and the maintenance of *Eria stricta* Lindl. is as the type for sect. *Secundae* Leavitt on *Eria* is proposed.

Deva and Naithani (1986) reported nine species *Eria alba*, *E. amica*, *E. coronaria*, *E. graminifolia*, *E. muscicola*, *E. occidentalis*, *E. pubescens*, *E. reticosa*, and *E. spicata* from North West Himalaya.

Ghatak and Devi (1986) reported *Eria pannea* from Manipur.

Rao (1986) enumerated of 26 species of *Eria* from Arunchal Pradesh viz. *E. acervata*, *E. amica*, *E. bambusifolia*, *E. biflora*, *E. bipunctata*, *E. bractescens*, *E. carinata*, *E. clausa*, *E. clavicaulis*, *E. connata*, *E. coronaria*, *E. excavata*, *E. ferruginea*, *E. graminifolia*, *E. javanica*, *E. muscicola*, *E. paniculata*, *E. pannea*, *E. pubescens* (= *E. lasiopetala*), *E. pudica*, *E. pumila*, *E. pusilla*, *E. spicata*, *E. stricta*, *E. tomentosa* and *E. vittata*.

Malla, Rajbhandari, Shrestha, Adikari, Adhikari, and Shakya (1986) described *Eria paniculata*, *E. convallaroides*, *E. graminifolia*, *E. excavata*, *E. bractescens*, *E. confusa* (= *E. amica*) and *E. coronaria* from Kathmandu valley.

Deorji and Phukan (1988) described a new species *Eria glandulifera* from Meghalaya, India.

Rao, Haridasan and Hegde (1989) reported *Eria lohitensis* as new species from Arunchal Pradesh.

Wood (1989) reported *Eria extinctoria*, new to Nepal Himalaya.

Averyanov (1989) enumerated 18 species of *Eria* from Vietnam including *E. bambusifolia* in section *Bambusifolia* Hk.f.; *E. ridleyi*, and *E. paniculata* in *Mycaranthes* Rchb.f.; *E. coronaria*, and *E. corneri* in *Trichosma* Lindl.; *E. tomentosa*, *E. pubescens* (*E. lasiopetala*), and *E. albido-tomentosa* (= *E. pubescens*) in *Dendrolirium* Lindl.; *E. pannea*, in *Strongyleria* Pfitz.; *E. globulifera*, *E. bipunctata*, and *E. apertiflora* in *Pinalia* Lindl..

Comber (1990) reported 39 species of *Eria* from Java including *E. biflora*, in section *Cylindrolobus* Bl., *E. javanica* section *Eria*; *E. discolor* in section *Tylostylis* Lindl.; *E. albido-tomentosa* (= *E. pubescens*) in section *Dendrolirium* Lindl.;

Naithani (1991) enlisted 15 additional species of *Eria* occurring in India, Nepal and Bhutan such as *Eria albiflora*, *E. apertiflora*, *E. clausa*, *E. connata*, *E. globulifera*, *E. lacei*, *E. minima*, *E. muscicola* var. *brevilinguis*, *E. muscicola* var. *ponmudiana*, *E. obesa*, *E. occidentalis*, *E. pseudo-clavicaulis*, *E. pudica*, *E. roscans*, *E. rupestris*, and *E. tiagii*.

Pangty, Samant and Rawat (1991) reported nine species of *Eria* from Kumaun Himalaya viz. *E. alba*, *E. amica*, *E. coronaria*, *E. graminifolia*, *E. muscicola*, *E. occidentalis*, *E. pubescens* (= *E. lasiopetala*), *E. reticosa* and *E. spicata*.

Seidenfaden (1992) reported with illustrations 46 species of *Eria* from Indo-China including *Eria javanica* in section *Eria*; *E. pusilla*, *E. muscicola*, in *Conchidium* Lindl.; *E. coronaria*, *E. corneri*, *E. clausa* in *Trichosma* Lindl.; *E. pannea* in *Strongylaria* Pfitz.; *E. discolor* in *Tylostylis* Lindl.; *E. tomentosa*, *E. laniceps*, *E. pubescens*, in *Dendrolirium* Lindl.; *E. paniculata*, in *Mycaranthes* Rchb.f. *E. biflora*, in *Cylindrolobus* Bl.; *E. bambusifolia* in *Bambusifolia* Hk.f.; *E. acervata*, *E. sutepensis*, *E. bractescens*, and *E. amica* in *Hymeneria* Lindl.; *E. bipunctata*, *E. globulifera*, and *E. apertiflora* in *Pinalia* Lindl.

Seidenfaden and Wood (1992) reported with illustrations 47 species of *Eria* from Malaysia Peninsular and Singapore including *Eria javanica* in section *Eria*, *E. pannea*, in *Strongylaria* Pfitz.; *E. puchella* in *Tylostylis* Lindl.; *E. pubescens*, *E. ornate* in *Dendrobium* Lindl.; *E. biflora*, in *Cylindrolobus* Bl. and *E. bractescens*, *E. pudica* in *Hymeneria* Lindl.

Chowdhery, Giri, and Pal (1993) reported the new species *Eria sharmae* from lower Subabsisr, Arunchal Pradesh of North –East Himalaya.

Hegde (1993a) reported *Eria jengingensis* as new species from Arunchal Pradesh.

Hegde (1993b) reported *Eria cristata* from Arunchal Pradesh, India.

Koba & al. (1994) listed 12 species of *Eria* from Nepal Himalaya viz. *E. alba*, *E. bractescens*, *E. confusa*, *E. coronaria*, *E. dasyphylla* (= *Trichotsia dasyphylla*), *E. excavata*, *E. graminifolia*, *E. muscicola*, *E. paniculata*, *E. pubescens* (= *E. lasiopetala*), *E. spicata*, *E. stricta*.

Kumar and Manilal (1994) enumerated 54 species of *Eria* from India sub continental region. It included *Eria* namely *E. acervata*, *E. acutifolia*, *E. alba*, *E. albiflora*, *E. amica*, *E. andramanica*, *E. apertiflora*, *E. bambusifolia*, *E. biflora*, *E. bipunctata*, *E. bractescens*, *E. bractescens* var. *kurzii*, *E. calamifolia*, *E. carinata*, *E. clausa*, *E. clavicaulis*, *E. connata*, *E. coronaria*, *E. dalzellii*, *E. discolor*, *E. excavata*, *E. exilis*, *E. ferruginea*, *E. glandulifera*, *E. graminifolia*, *E. javanica*, *E. lacei*, *E. laniceps*, *E. meghasaniensis*, *E. microchilos*, *E. muscicola*, *E. muscicola* var. *brevilinguis*, *E. mysorensis*, *E. nana*, *E. obesa*, *E. occidentalis*, *E. paniculata*, *E. pannea*, *E. pauciflora*, *E. polystachya*, *E. pseudoclavicaulis*, *E. pubescens* (= *E. lasiopetala*), *E. pudica*, *E. pumila*, *E. pusilla*, *E. reticosa*, *E. scabrilliguis*, *E. sharmae*, *E. spicata*, *E. stricta*, *E. sutepensis*, *E. tiagii*, *E. tomentosa*, and *E. vittata*.

Shakya, Chhetri and Bajracharya (1994) enumerated *Eria alba*, *E. amica*, *E. bractescens*, *E. coronaria*, *E. excavata*, *E. graminifolia*, and *E. spicata* from Kathmandu valley.

Karthikeyan, Jain, Nayar, and Sanjappa (1995) enumerated the 56 species of *Eria* from India. such as *Eria acervata*, *E. acutifolia*, *E. alba*, *E. albiflora*, *E. amica*, *E. andamanica*, *E. apertiflora*, *E. bambusifolia*, *E. bicolor*, *E. biflora*, *E. bipunctata*, *E. braccata*, *E. bractescens* var. *bractescens*, *E. bractescens* var. *affinis*, *E. bractescens* var. *kurzii*, *E. carinata*, *E. clausa*, *E. clavicaulis*, *E. connata*, *E. coronaria*, *E. crassicaulis*, *E. dalzellii*, *E. dalzellii* var. *fimbriata*, *E. excavata*, *E. exilis*, *E. ferruginea*, *E. graminifolia*, *E. javanica*, *E. lacei*, *E. laniceps*, *E. microchilos*, *E. muscicola* var. *muscicola*, *E. muscicola* var. *brevilinguis*, *E. muscicola* var. *pomudiana*, *E. mysorensis*, *E. nana*, *E. obesa*, *E. occidentalis*, *E. paniculata*, *E. pannea*, *E. pauciflora*, *E. polystachya*, *E. pseudo-clavicaulis*, *E. pubescens*, *E. pubescens* (= *E. lasiopetala*) var. *lanata*, *E. pudica*, *E. pumila*, *E. pusilla*, *E. reticosa*, *E. roseanus*, *E. scabrilinguis*, *E. spicata*, *E. stricta*, *E. tiagii*, *E. tomentosa*, and *E. vittata*.

Ormerod (1995) give the new combination of *E. pubescens* to *E. lasiopetala*.

Seidenfaden (1995) described two species of *Eria* from Thailand as well as give the new combination of *E. lasiopetala* for *E. pubescens* from Thailand

Chauhan, Singh and Singh (1996) reported 10 species *Eria* from Namdapha of Arunachal Pradesh of North-East Himalaya viz. *E. acervata*, *E. amica*, *E. clausa*, *E. clavicaulis*, *E. discolor*, *E. ferruginea*, *E. paniculata*, *E. pannea*, *E. pubescens* (= *E. lasiopetala*), and *E. stricta*

Hajra and Verma (1996) recorded 22 species of *Eria* from Sikkim viz. *E. acervata*, *E. alba*, *E. amica*, *E. bambusifolia*, *E. biflora*, *E. bractescens*, *E. carinata*, *E. clausa*, *E. coronaria*, *E. excavata*, *E. ferruginea*, *E. graminifolia*, *E. javanica*, *E. laniceps*, *E. muscicola*, *E. paniculata*, *E. pubescens* (= *E. lasiopetala*), *E. pumila*, *E. pusilla*, *E. stricta*, *E. spicata* and *E. vittata*.

Rao (1996) reported *Eria apertiflora*, *Eria corneri* and new combination of *Eria coreneri* var *clausa* from Arunachal Pradesh, India.

Chowdhery and Pal (1997) enumerated the checklist of Orchidaceae from Arunachal Pradesh, it 30 species of *Eria* namely *Eria acervata*, *E. amica*, *E. bambusifolia*, *E. biflora*, *E. bipunctata*, *E. bractescens*, *E. carinata*, *E. clausa*, *E. clavicaulis*, *E. connata*, *E. coronaria*, *E. cristata*, *E. excavata*, *E. ferruginea*, *E. globulifera*, *E. graminifolia*, *E. javanica*, *E. jengingensis*, *E. lohitensis*, *E. muscicola*, *E. paniculata*, *E. pannea*, *E. pubescens* (= *E. lasiopetala*), *E. pudica*, *E. pumila*, *E. pusilla*, *E. sharmae*, *E. spicata*, *E. stricta*, *E. tomentosa*, and *E. vittata* are recorded from Arunachal Pradesh.

Shukla, Singh and Chauhan (1998) enumerated the 21 species of *Eria* from Sikkim Himalaya viz. *E. alba*, *E. acervata*, *E. amica*, *E. bambusifolia*, *E. biflora*, *E. bractescens*, *E. carinata*, *E. clausa*, *E. coronaria*, *E. crassicaulis*, *E. excavata*, *E. geminifolia*, *E. javanica*, *E.*

musciicola, *E. paniculata*, *E. pannea*, *E. pubescens* (= *E. lasiopetala*), *E. pumila*, *E. scabrilinguis*, *E. spicata* and *E. vittata*.

Rao (1998) described the *Eria arunchelensis* as new species to Arunachal Pradesh of North-East Himalaya.

Chowdhery (1998) recorded 33 species of *Eria* from Arunachal Pradesh viz. *E. acervata*, *E. amica*, *E. apertiflora*, *E. bambusifolia*, *E. biflora*, *E. bipunctata*, *E. bractescens*, *E. carinata*, *E. clausa*, *E. clavicaulis*, *E. connata*, *E. coronaria*, *E. cristata*, *E. corneri*, *E. excavata*, *E. ferruginea*, *E. globulifera*, *E. graminifolia*, *E. javanica*, *E. jengingensis*, *E. lohitisensis*, *E. musciicola*, *E. paniculata*, *E. pannea*, *E. pubescens* (= *E. lasiopetala*), *E. pudica*, *E. pumila*, *E. pusilla*, *E. sharmae*, *E. spicata*, *E. stricta*, *E. tomentosa*, and *E. vittata*.

Bajracharya (1999) enumerated three species of *Eria amica*, *E. coronaria*, and *E. spicata* from Gorkha District of Nepal Himalaya

Bose, Bhattacharjee, and Basak (1999) listed 45 species of *Eria* from India among them *Eria acervata*, *E. alba*, *E. amica*, *E. andamanica*, *E. bambusifolia*, *E. biflora*, *E. bipunctata*, *E. braccata*, *E. bractescens*, *E. carinata*, *E. clausa*, *E. clavicaulis*, *E. convallaroides* (= *E. spicata*), *E. coronaria*, *E. crassicaulis*, *E. excavata*, *E. ferruginea*, *E. graminifolia*, *E. javanica*, *E. lacei*, *E. laniceps*, *E. musciicola*, *E. obesa*, *E. paniculata*, *E. pannea*, *E. pubescens* (= *E. lasiopetala*), *E. pumila*, *E. pusilla*, *E. reticosa*, *E. scabrilinguis*, *E. spicata*, *E. tomentosa*, and *E. vittata*, are recorded from Himalayan region.

Hynniewta, Katak and Wadhwa (2000) recorded 13 species of *Eria* viz. *E. acervata*, *E. alba*, *E. amica*, *E. bambusifolia*, *E. bractescens*, *E. coronaria*, *E. excavata*, *E. graminifolia*, *E. paniculata*, *E. pannea*, *E. spicata*, *E. stricta*, and *E. vittata* from Nagaland.

Press and Shrestha (2000) enlisted *Octomeria spicata* D. Don as Hamilton's flowering plant collections from Central Nepal.

Press, Shrestha and Suttan (2000) enumerate 14 species of *Eria* viz. *Eria alba*, *E. amica*, *E. bractescens*, *E. confusa*, *E. coronaria*, *E. dasyphylla*, *E. excavata*, *E. graminifolia*, *E. musciicola*, *E. paniculata*, *E. pubescens* (= *E. lasiopetala*), *E. spicata*, *E. stricta* and *Trichosma suavis* from Nepal.

Shrestha and Press (2000) prepared the Catalogue of Type Specimens from Nepal including *Eria alba*, *E. confusa* (= *E. amica*), *E. excavata*, *E. flava* (= *E. lasiopetala*), and *Octomeria spicata* (= *E. spicata*) as type specimens for Nepalese flora.

White and Sharma (2000) mentioned ten species of *Eria* from tropical region of Tribhuvan Rajpath and Hetauda of Nepal Himalaya viz. *Eria amica*, *E. biflora*, *E. bractescens*, *E.*

coronaria, *E. excavata*, *E. extinctoria*, *E. graminifolia*, *E. muscicola*, *E. pubescens* (= *E. lasiopetala*), and *E. spicata*.

Bajracharya (2001) reported two new species *Eria apertiflora* and *E. bipunctata* from Nepal Himalaya.

Bajracharya, Shakya and Subedi (2001) enumerated the *Eria* viz. *E. amica*, *E. apertiflora*, *E. bipunctata*, *E. bractescens*, *E. discolor*, *E. pubescens* (= *E. lasiopetala*) and *E. spicata* from Morang of East Nepal.

Barua (2001) enlisted the four species of *Eria* from Kamrup district of Assam, *Eria* viz. *E. bractescens*, *E. paniculata*, *E. pubescens* (= *E. lasiopetala*) and *E. tomentosa*.

Rajbhandari and Bhattaria (2001) described and illustrated the seven species of *Eria* in Beautiful Orchids of Nepal, included *Eria amica*, *E. biflora*, *E. carinata*, *E. coronaria*, *E. graminifolia*, *E. paniculata*, and *E. spicata*

Subedi (2002) enlisted ten species of *Eria* from Pokhara valley viz. *Eria amica*, *E. apertiflora*, *E. bipunctata*, *E. bractescens*, *E. clausa*, *E. excavata*, *E. graminifolia*, *E. muscicola*, *E. paniculata*, and *E. spicata*.

Ghimeri (2002) recorded two species of *Eria* viz. *E. bipunctata* and *E. paniculata* from Bajrabarahi area of Kathmandu.

Clements and Jones (2002) separate the section *Hymeneria* into new genus *Hymeneria* and it includes three species of Newzealand and Austrelian species of *Eria* into *Hymeneria fitzalanii*, *Hymeneria kingii*, *Hymeneria obesa*.

Pearce and Cribb (2002) illustrated and described 23 species of *Eria* from Bhutan and adjoining area of Sikkim and Darjeeling Himalaya viz. *Eria javanica* in section *Eria*; *E. muscicola* in *Conchidium* Lindl.; *E. carinata* in *Xiphosium* Lindl.; *E. vittata*, *E. coronaria*, and *E. clausa* in *Trichosma* Lindl.; *E. pannea* in *Strogylaria* Pflitz.; *E. discolor* in *Tylostylis* Lindl.; *E. ferruginea*, *E. lasiopetala* in *Dendrolirium* Lindl.; *E. paniculata* in *Mycaranthes* Rchb. f.; *E. stricta* in *Secundae* Leavitt; *E. biflora* in *Cylindrolobus* Bl.; *E. bambusifolia* in *Bambusifolia* Hk. f.; *E. acervata*, *E. alba*, *E. amica*, *E. bractescens*, *E. excavata*, and *E. graminifolia*, in *Hymeneria* Lindl.; *E. connata*, *E. pumila*, and *E. spicata* in *Pinalia* Lindl.. Besides that they also enumerated 12 species of *Eria* as the doubtful and imperfectly known species from area also viz. *E. albiflora*, *E. apertiflora*, *E. bractea*, *E. clavicaulis*, *E. coroneri*, *E. crassicaulis*, *E. laniceps*, *E. muscicola* var. *oblonga*, *E. ornata*, *E. pudica*, *E. pusilla*, and *E. scabrilinguis*.

Bajracharya, Shakya and Chettri (2002 publ. 2003 June) described a new species *Eria baniaii* from Nepal Himalaya.

Rao, A. N. (2002 publ. 2003 June,) *E. kamlangensis* a new species was described from Arunachal Pradesh, India.

Bajracharya and Shrestha (2003) described a new species *Eria bhutanica* from Bhutan Himalaya.

Bajracharya and Shrestha (2003, June) described a new species *Eria nepalensis* from Nepal Himalaya.

Rajbhandari (2003) enlisted new records of Orchids from Nepal which are not included in "An enumeration of the flowering plants of Nepal Vol I (Hara & al, 1978) and "Annotated checklist of the flowering plants of Nepal" (Press & al, 2000) *Eria* viz. *E. acervata*, *E. apertiflora*, *E. bipunctata*, *E. biflora*, *E. carinata*, *E. discolor*, *E. extinctoria*.

Amatya (2003) enlisted *Eria alba*, *E. amica*, *E. bipunctata*, *E. coronaria*, *E. graminifolia*, *E. lasiopetala*, *E. muscicola*, and *E. spicata* from the far Western region of Nepal.

3. Systematic study

3. Systematic study of the genus *Eria* Lindl.

3.1 Introduction

3.1.1 Systematic position of the genus *Eria* Lindl.

The genus *Eria* is one of the polymorphic genera within Orchidaceae. It is very difficult to distinguish from its related genus *Trichostia*. These two genera are very close, however, *Trichostia* species possesses only hairy flower bracts and leaf sheath alone in compared to *Eria* species. It is also closely related to *Dendrobium*: the vegetative parts and the flowers are similar in structure. *Eria* is however distinguished by the following feature: nearly always pubescent, and this feature extends not only to the leaves and stem, but usually also to the sepals, ovary and flowered stalk, base of lip not joint to column foot; pollinia 8 in two groups of 4, with caudicles.

Eria is distributed from India to the Polynesian Island and contains 400-500 species (Sumerhayes and Hunt 1973; Bechtel, Cribb and Launert 1981), Royal Botanic Gardens, Kew (2003). However, the genus has not been revised over its entire area of distribution, and the generic delimitation towards *Trichostia* with *Eria* and other epidendroid genera having eight pollinia species are unclear.

Many orchid taxonomists have worked out systematic position of the genus *Eria* in the family Orchidaceae. Lindley (1825) placed the genus within and division *Epidendreae*, Gynandria monoandria, whereas Schlechter (1926) placed in the tribe *Kerosphaerae* (sub-family *Monandreae*), this was followed by Banerjee & Pradhan (1984).

Genus *Eria* is placed in the subtribe *Erineae* of the tribe *Epidendreae* under the series *Microspermae* by Bentham & Hooker (1862-83). This was followed by Hooker 1890; King & Pantling 1898; Duthie 1903). The genus *Eria* is placed in the sub family *Monondreae*, division *Acrotonae*, sub division *Pleuranthae*, tribe *Sympodiales* and sub tribe *Dendrobinae* (Engler & Prantl 1889; Kranzlin, 1911). Diels (1936) mentioned it on the tribe *Kerosphaerae*, series *Epidendreae*, and sub series *Dendrobinae*.

The genus *Eria* is placed under the sub-family *Epidendroideae*, tribe *Epidendreae* (Garay 1972; Takhtajan 1997). Dressler (1981) placed *Eria* into the sub-family *Epidendroideae*, the tribe *Epidendreae* and the sub-tribe *Eriinae*.

Dressler (1993) revised his work and gave the phylogenetic classification of Orchids, which is accepted by most of the later workers.

Dressler (1993), Szlachetko (1995) and Pearce & Cribb (2002) included *Eria* in the sub-family *Epidendroideae*, tribe *Podochileae*, sub tribe *Eriinae*.

3.1.2 Morphology of the genus *Eria* Lindl.

Epiphytic plants, usually rhizomatose. Stem often dilated into various pseudobulbs, rarely not dilated, with 1 to many nodes, base with sheaths. Leaves 1 to several, usually at apex of pseudobulb or at nodes apically, rarely distichous on not dilated stems or scattered on stems. Inflorescences lateral or terminal, often racemose, rarely 1-flowered, cottony or glabrous. Floral bracts small or slightly large. Flowers often small, rarely large and brightly colored. Sepals free, abaxially pilose or glabrous. Lateral sepals adnate to column foot and forming a conspicuous mentum. Petals similar to dorsal sepals or smaller. Labellum with or without nodes, often 3-lobed, adaxially often with longitudinal ridges and calli. Column and column foot short or long; anthers incompletely 4-loculed; pollinia base contracted into a stalk, attached to viscidium. Ovary pilose or glabrous. Capsule \pm cylindrical.

3.1.3 Generic and sectional delimitation of *Eria*

The generic name *Eria* was established by Lindley (1825), based on the material of W. J. Hooker's *Dendrobium ? pubescens* Hook. with the characteristic feature of woolly inflorescence and perianth, tri-lobed labellum and 8 pollinia. Earlier, Buchanan-Hamilton (1802) described a species *Pinalia alba* referred to as *Octomeria spicata* by D. Don (1824), that was later designated as *Eria spicata* (D. Don) Hand.-Mazz. Blume (1825) described a number of *Eria* species but assigned them different names such as *Trichotosia*, *Mycaranthes*, *Dendrolirium*, *Ceratium*, and *Cylindrolobus*. *Eria* as a genus was established with the publication of Generic protologue in Bot Reg in 1825. However, *Eria* was not thoroughly described until Lindley's "Genera and Species Orchidaceous Plants" (1830), where 24 species and one sub-genus *Pinalia* were outlined. Since then, the number of *Eria* species gradually increased. In the Himalayas and its adjoining areas also the numbers of *Eria* species increased with extensive exploration by many botanists.

Reichenbach (1857) was the first person to propose an infrageneric key of *Eria*. He included seven sections for fifteen species in the sections *Phreatia*, *Stellata*, *Flavae*, *Anciptes*, *Mycaranthes*, *Multiflorae*, and *Trichotosia*.

- **Lindley** (1859) proposed a sectional key to the genus *Eria*, and emphasised newly supposed genera created by different workers as the sections for the genus. He included genera like *Conchidium* and *Xiphosium* of Griffith, *Tylostylis*, *Dendrolirium*, *Cylindrolobus* and *Trichotosia* of Blume; and his own genus *Trichosma* as section of the genus *Eria*. Lindley (1859) introduced three more sections *Hymenaria*, *Eriura* as well *Urostachya*, and classified 67 species of *Eria* under this section. He also merged his genus *Bryobium* to the section *Conchidium*.

Miquel (1855-1859) while working on the orchids of the Netherlands, described eight sections for *Eria* proposed by Lindley (1859), and included *Eria stellata* in the section *Dendrolirium*.

Reichenbach (1861), while reviewing Lindley's (1859) sections, revised his section and added a new section *Acervata* (*E. acervata*). He retained Lindley's section *Xiphosium* in place of the section *Stellata* (*E. stellata*).

Bentham and Hooker (1883) described ten sections for the genus *Eria*, adding sections *Porpax* and *Bryobium* to Lindley's system, and splitting the Lindley's section *Conchidium* into *Conchidium* and *Bryobium*.

Engler (1888) mentioned 12 sections introducing two more new sections *Strongyleria* (*E. pannea*) and *Myristicaria* (*E. myristiciformis*). He also accepted Reichenbach's section *Acervatae* (*E. acervata*). Engler, however, excluded the section *Porpax* and described it as a separate genus.

Hooker (1890) placed *Eria* under the tribe *Epidendreae* and sub-tribe *Erieae* of the family Orchidaceae. He recognized 94 species of *Eria* from British India and proposed 13 sectional keys to the genus. Hooker introduced four new sections *Bambusifolia* (*E. bambusifolia*), *Acridostachya* (*E. aeridostachya*), *Dilochiopsis* (*E. scartechinii*) *Pellaianthus* (*E. leciophylla*) and *Porpax* (*E. articulate*). He excluded the sections *Cylindrolobus* and *Urostachya* merging them into *Hymeneria* and *Bambusifolia*. He excluded the section *Trichosma* and described it a separate genus.

King and Pantling (1898) placed *Eria* under tribe *Epidendreae*. They mentioned 21 species of *Eria* under eight sections. They excluded the sections *Conchidium*, *Porpax* and *Tylostylis*. *Porpax* and *Tylostylis* were described as a separate genus, and *Conchidium* was merged into the section *Bryobium*. Additionally, they accepted the section *Trichosma* (*E. coronaria*) which was placed under the separate genus *Trichosma* by Hooker.

Smith (1905) classified 35 species of *Eria* into eight sections for the Flora of Java. He proposed a new section *Convolutae* (*E. rugosa*), and also accepted the section *Callostylis* instead of *Tylostylis* (*E. rigida*).

* **Duthie** (1906) described three species of *Eria* from North-Western Himalaya under the tribe *Epidendreae*.

Ridley (1907-1908) described 49 species of *Eria* from Malaya under ten sections. He proposed two new sections *Bractescentae* and *Natanae*, and accepted the section *Stellatae* (*E. javanica* and related species) proposed by Reichenbach (1857), and the section *Dilochiopsis* (*E.*

scartechinii) proposed by Hooker (1890). He also separated the two sections *Porpax* and *Tylostylis* and described them as distinct genera. He reclassified most of the species of the section *Hymenaria* into *Bractescentae* and *Nutanae*.

Leavitt (1909) described 14 species of *Eria* from the Philippines under eight sections including *Trichotosia*. He replaced the section *Mycaranthes* of Lindley (*E. stricta*) with the new section *Secundae*.

Kranzlin (1911) prepared the world monograph of the genus *Eria*. He described 241 species of *Eria* arranged into eight sections. He introduced new section *Ornithidiformes*, and most of the sections were divided into sub-sections such as *Conchidium* (into *Alvisia* and *Euconchidium*), *Xiphosium* (into *Euxiphosium* and *Convolutae*) *Hymenaria* (into *Hyacinthoideae*, *Bractescentes*, *Clavata*, and *Floribundae*) based on the morphological characters of pseudobulbs and leaves.

Koorders (1911) described 34 species of *Eria* from Java, under eight sections. He also accepted the section *Convolutae* (*E. rugosa*) of Smith (1905).

Schlechter (1912) defined three subgenera of the genus *Eria*. He described 32 species of *Eria* from New Guinea, under 8 sections. He introduced new sections *Aporodes*, *Goniorhabdos* and *Polyurea*. He also separated the section *Trichotosia* and described as a distinct genus.

Ridley (1924) revised his previous sectional classification (1907-1908) and described 50 species of *Eria* from the Malaya Peninsula. He changed the section *Bambusifolia* into *Cylindrolobus* and shifted all the species of section *Bambusifolia* into it. He also separated the section *Trichotosia* and described it as a separate genus.

Holtum (1957) described 61 species of *Eria* from the Malaya, with 11 sections. He included the section *Cymboglossum* proposed by Smith (1933) and accepted the section *Callostylis* of Blume in place of *Tylostylis* proposed by J. J. Smith (1905).

Seidenfaden and Smitinand (1965) described 13 sections for 44 species of *Eria* from Thailand. They also accepted the section *Trichotosia* as a separate genus, and included *E. stellata* in the section *Goniorhabdos* Schltr.

Pradhan (1979) described 28 species of Indian *Eria* under eleven sections. He also placed *E. stellata* into the section *Goniorhabdos* Schltr.

Brieger & al. (1981) prepared a monographic study of *Dendrobium* and *Eria*. They included *Eria* in the sub-tribe *Dendrobinae* and divided into six "Gattungseihen", the fifth one being *Eriae*. Gattungsreihe *Apoda* included *Cymboglossum* and *Gunnarorchis* as 'Gattungen'. A new monotypic genus *Gunnarorchis* included *Eria perpushilla*. They assigned *Eria stricta* as the

type for the genus *Cymboglossum* (J.J.Smith) Breig. *Trichosma*, *Mycarantes* and *Cylindrolobus* were treated as in addition to separate genera in a Gattungsreihe *Caulescentes*, which included inter alia genus *Trichotomia*. They placed *Eria* in the fifth one being named Gattungsreihe *Eriae* and included the four genera such as *Aeidostachya*, *Urostachya*, *Dendolirium* and *Eria*, which was re-established as a separate genus. They had proposed six Gattung for *Eria*, *Stallatae*, *Strongyleria*, *Pellaenthus*, *Clavatae* *Polyura*, and *Hymeneria*. Gattungsreihe *Dimophophyllae* included *Conchidium*, *Xiphosium* and *Callostylis* as separate genus.

Seidenfaden (1982) described 63 species of *Eria* from Thailand under 17 sections. He proposed two new sections *Eria* (for the type species *E. Javanica*) and *Pinalia* (for unrelated species of the section of *Hymeneria*), which was proposed by Lindley in 1830 as a subgenus of the *Eria*. He also accepted the section *Secundae* proposed by Leavitt (1909) for the small and woolly plant with secunde inflorescences.

Banerjee and Pradhan (1984) described 14 species of *Eria* from Nepal (Central Himalaya). Their study was based mainly on the herbarium specimens deposited at KATH. They placed *Eria* under the tribe *Kerosphaeroideae*, but did not mention any section of the genus *Eria*.

Seidenfaden (1984) clarified confusion concerning the understanding of the section *Cymboglossum* Schltr. of the genus *Eria*. He established the new genus *Ascidieria* typified by *Eria longifolia* Hook.f. He also assigned *Eria stricta* Lindl as the type for the section *Secundae* Leavitt.

Anderson & al. (1988) provided a new sectional key of the genus *Eria*, based on the vegetative characters and habitat. It included ten habitats types for different *Eria* species.

Comber (1989) divided 27 species of *Eria* from Java into 10 sections. He accepted the recent section key of Seidenfaden (1982) and pointed out the two *Eria* sections *Tylostylis* and *Mycarantes* into two separate genera of the family Orchidaceae.

Dressler (1990) included *Eria* in the tribe Epidendroideae under the subtribe *Eriinae*.

Seidenfaden (1992) listed 46 species of *Eria* from Indo-China under 14 sections. He followed the same pattern used in the Thai species of *Eria*. He also pointed that the traditional system of sections requires significant revision.

* **Seidenfaden and Wood** (1992) described 48 species of *Eria* from the Malaya Peninsula and Singapore, and placed them into 11 sections. Their classification is based on the Holttum collection.

Dressler (1993) included the genus *Eria* in the sub-tribe *Eriinae*, tribe *Podochileae*, and Dendrobioid subclade in Epidendroid phylad of subfamily Epidendroideae.

Averyanov (1994) described 30 species of *Eria* from Vietnam, which he placed into 14 sections. He also accepted Seidenfaden's system of classification; however, he separated the section *Tylostylis* into a separate genus *Callostylis*.

Szlachetko (1995) included the genus *Eria* into the subtribe *Eriinae* of the tribe *Podochileae*.

Pearce and Cribb (2002) enumerated 33 species of *Eria* from Bhutan, and adjoining area of Sikkim and the Darjeeling area of the Himalaya, and described them under ten sections.

Clements and Jones (2002) changed the section *Hymeneria* into the new genus *Hymeneria* (Lindl.). M. A. Clem. & D. L. Jones.

A comprehensive revision of the genus *Eria* of Himalayan region has not been undertaken so far. The present study divided the genus into 12 sections namely, *Eria*, *Conchidium*, *Xiphosium*, *Trichosma*, *Dendrolirium*, *Stongyria*, *Secudae*, *Bambusifolia*, *Mycaranthes*, *Hymeneria*, *Pinalia* and *Cylindrolobus*. The section *Trichosma* includes two series *Clausae* and *Coronariae*, and section *Dendrolirium* includes two series *Ferruginea* and *pubesentae*. The section *Tylostylis* was accepted as a separate genus *Callostylis* for *Eria discolor* based on the treatment of Flora of China (2003). In present study, have ventured to take here is to accept some earlier concept that *Trichotosia* Bl. could be separated. The treatment of the genus *Eria* has been followed the treatment of Seidenfaden (1982).

This present revision revealed 49 species of *Eria* in the Himalayas, including newly described taxa such as *Eria nepalensis*, *E. pokharensis*, *E. bhutanica*, *E. baniaii* and *E. sikkimensis* (Bajracharya 2002, Bajracharya & Shrestha 2003; Bajracharya & al. 2002).

Five species of *Eria* namely, *Eria acutifolia*, *Eria scabrilinguis*, *Eria sutepensis*, *Eria kamlengensis* and *Eria ornata* and one variety *E. pubescens* (= *E. lasiopetala*) var. *lanata* are not included in the present study due to the lack of specimens in the herbaria of ASSAM, BM, CAL, E, DD, K and SIKKIM. *E. ornata* Lindl., *Eria scabrilinguis* Lindl., which are reported from the Sikkim Himalaya (Bose & Bhattacharjee 1980; Lindley 1859) as well as *E. acutifolia* and *E. sutepensis* could not trace out in the above herbaria. A. N. Rao (2002) had described a new species of *Eria kamlengensis* from Arunachal in *Jour. India Orchid Soc.* 16(1-2) 2002 publ. 2003, is not included in the present study due to the lack of opportunity to study authentic specimens.

Table 1: Overview of most important infrageneric classification of the genus *Eria* Lindl. (Contd.)

Botanical name	Rech.f. (1857)	Lindl. (1859)	Rech.f. (1851)	Hook.f. (1890)	King & Pantl. (1898)	Reid. (1907)	Leavt. (1909)	Kranz. (1911)	Ridg. (1924)	Holt. (1934)	Sedden. (1935)	Pradhan (1976)	Briegleb & al. (1981) (Genit./Sec)	Sedden. (1982)	Chenier. (1981)	Sedden. (1982)	Sedden & Wood. (1992)	Ayer. (1994)	Pearce & Cobb. (2002)	Present Work (2003)
<i>E. graminifolia</i>	Hym	Hym	Xiph	Hym	Hym	Stell	Xiph	Hym	Stell	Goni	Goni	Goni/H		Eria	Eria				Hym	Eria
<i>E. javanica</i>																				
<i>E. juggerianum</i>																				
<i>E. facel</i>																				
<i>E. toncops</i>																				
<i>E. lasiopetalab</i>		Dend						Dend												
<i>E. merquensis</i>		Dend																		
<i>E. muscicola</i>		Conc						Conc												
<i>E. obesa</i>		Hym	Hym					Hym												
<i>E. occidentalis</i>																				
<i>E. paniculata</i>		Eriu	Eriu					Eriu												
<i>E. parnea</i>		Dend	Cylin					Dend												
<i>E. polkaensis</i>																				
<i>E. pudica</i>																				
<i>E. purpila</i>																				
<i>E. pusilla</i>		Conc	Conc					Conc												
<i>E. scaberrimipilis</i>		Xiph						Hym												
<i>E. sharnae</i>																				
<i>E. sikimensis</i>																				
<i>E. spicata</i>		Hym	Hym					Hym												
<i>E. stricta</i>		Myca						Myca												
<i>E. linnarivaya</i>																				
<i>E. villosa</i>		Xiph						Hym												

Abb: Acer=Acerata; Bamb=Bambusifolia; Brac=Bractescentes; Bryo=Bryobium; (C) =Clavatae; clav=Clavatae; (Co)= Coronariae; Conc=Conchidium; Cymb=Cymboglossum; Cylin=Cylindrolobus; Dend=Dendrolinon, Dendrolobus; Eria=Eria, Eriu=Etiara Eriuae; (F)= Ferruginae; Goni=Goniorhabdos; Hym=Hymneria; Myca=Mycaralibus; Nut=Nutantes, Pina =Pinalia; (P)= Pubescentae; Secundae= Secun; Stell=Stellatae; Siron=Strongyleria; Trich=Trichostoma; Trichm= Trichostoma; Tylo=Tylostylis (Genus), Tylo=Tylostylis section is separate as distinct genus *Callostylis*

3.2. Materials and Methods

3.2 Materials and Methods

The present research is primarily based on study of herbarium specimens deposited in different Herbaria of the world. The herbarium materials were examined from the following herbaria (acronyms in accordance with Holmgren & *al*, 1990): ASSAM, BSD, CAL, and DD (India), BM, E and K (U.K.), KATH and TUCH (Nepal). In course of research period, numerous collections were also made in different parts of Nepal (1990-2002) and Bhutan (1997, 2002).

3.2.1 Collection of the specimens

Living specimens were collected from various parts of Nepal Himalaya and Bhutan, from 1990-2002. The flowers were preserved in 70% alcohol and brought to the laboratory for further study. The areas that were visited in the Western Nepal include: Kanchanpur, including Royal Sukla Phanta Wildlife Reserve (100-500m); Banke and Bardiya (100-500m), including Royal Bardiya National Park. In Central Nepal, collections were done from Gulmi (500-2500); Arghakhanchi (200-2500); Mustang (1000-3000m); Baglung (200-2000m); Myagdi district (500-3100m); Bharihawa (200-500m); Palpa (200-2000); Syangja (1000-2000m); Kaski (100-3000m), including Annapurna conservation Area; Lamjung and Manang (200-3000m); Makawanpur (400-2478 m), Chitwan, including Royal Chitwan National Park (200-500m); Gorkha (500-2000m); Kathmandu Valley and adjoining areas (1340-2800m); Rasuwa (1000-3500m), including Lantang National Park; Sindupalanchok (500-2500m); and Dolakha (1300-2800m). More specimens were collected from Eastern Nepal namely, Arun Valley and Makalu Barun National Parks and Conservation Area in Sankhuwa Sabha district (450-2800m); Itahari (200-500m); Dhankuta (500-2000m), Ilam (400-1500m), and Jhapa districts (80-500m) of East Nepal.

The Bhutanese specimens were collected from different regions of Western and Central Bhutan (1200-3000 m), including Tongsa (Mangde chu and its surrounding area), Bumthang, Phunaka (Wanngdu Phodrang area and Rimchu area), and Thimphu.

Two to three sets of herbarium specimens were prepared for each specimen, whenever possible. The first set of herbarium specimens were deposited in the National Herbarium and Plant Laboratories (KATH), and second set has been deposited in Tribhuvan University Herbarium (TUCH). Other duplicate specimens will be sent to other international herbaria such as CAL (India), E (UK) and TI (Japan).

3.2.2 Study of Herbarium and living specimens

All vegetative structures, except the floral bracts, were measured in a dry state. Dried floral parts were prepared for microscopic study by putting the materials in 5 ml culture tube

with 99 % alcohol, and the tube was deeped in a hot water bath (Seidenfaden 1968). The materials were quickly transferred to normal water, maintained in room temperature, in order to preserve in its natural shape. Few droplets of liquid detergent were added later on for the detail study and measurement of the floral bracts and floral parts. Measurement of floral bracts, sepals, petals and labellum were made by spreading out to their full extent. Measurements of the pseudobulbs were taken only from the matured pseudobulbs. Measurements of the leaves were also made from the matured leaves.

3.2.3 Identification and description

The identification of collected specimens were verified and identified with the help of the available taxonomic literatures on *Eria* such as protologue text, monographs, revisions, and flora, etc. (Lindley 1830, 1859; Blume 1836; Reichenbach 1857; Kranzlin 1911; J.D. Hooker 1890; King & Pantling 1898; Brieger & al. 1981; Seidenfaden 1982, 1992; Pearce & Cribb 2002). Collected specimens of *Eria* were compared with the exsiccatæ specimens deposited at KATH and TUCH (Nepal) ASSAM, CAL, DD, DBD, and SIKKIM (India); BM, E, K, K- LINDL. and K-W (UK).

All Himalayan specimens of *Eria* were also verified with the help of type specimens deposited at BM, CAL, K, K-LINDL. K-W and E. The photographs of type specimens received from various herbaria of the World such as C (Denmark), L (The Netherlands), GH, MO and NY (USA) were also used for authentication of identified specimens.

Correspondence with some orchid specialists of A, AMES (USA), B (Germany), BO (Indonesia), BRI (Australia), LINN and LIV (UK) were made for the verification of doubtful specimens.

The original literature were collected from the libraries of different institutes, mainly from The Natural History Museum, London and Royal Botanic Gardens, Kew (UK), and National Herbarium, Kolkata (India). Other relevant literatures were received from Washington University library (USA), University of Florida, Gainesville (USA), Botanisk Laboratorium, University of Copenhagen, Gothersgade (Denmark), Botanischer Garten, Ruprecht-Karl- Universitat, Heidelberg (Germany) and Institute of Botany, Academia sinica, Beijing (China).

An elaborate description, illustrated by line drawing, is provided for each species. Terms relating to the appearance of inflorescence follow de Vogel (1988), Pederson (1997), and Gravendeel & De Vogel (2000), while terms relating to structure of the column follow Rasmussen (1986). The remaining morphological terms are generally used in accordance with the vocabulary of Stearn (1989).

Original author citations and synonyms of each taxon were validated following standard taxonomic literatures and indexes such as International Plant Nomenclature Index (IPNI), including Index Kewensis (IK), Gray Card Index (GRC), and Monocot Checklist of Orchidaceae prepared by Royal Botanic Gardens Kew, UK (2003). Description of the taxa followed the pattern of Flora of Bhutan (Pearce & Cribb 2002).

A full synonym is given for each accepted taxon. Bibliographical information, on the other hand, has been limited to include the publication in which each name was first published. Author citations followed the abbreviations in the International Plant Names Index (IPNI) database available at <http://www.ipni.org>, which includes Brummitt and Powell's Authors of plant names (Brummitt and Powell, 1992). Titles of the books have been abbreviated according to Stafleu & Cowan (1976-1988), TL-2 (Taxonomic Literature, ed. 2) (Stafleu and Mennega, 1992-2000); while periodical titles follow Bridson (1991), B-P-H/S (Botanico-Periodicum-Huntianum/Supplementum). This can be found at the Harvard University homepage at http://www.huh.harvard.edu/databases/cms/publication_index.html, whenever possible.

Typifications of all recognized taxa (accepted as well as synonyms) are adopted from Seidenfaden (1982), Shrestha & Press (2000), and Pearce & Cribb (2002).

Information concerning altitudinal range, habitat, vernacular name, local uses, and flower colour of the plants were noted from secondary information given in the herbarium sheet as well as from the living specimens. Conservation status for each species is provided, as far as possible, following IUCN threat categories (Lucas and Synge 1978).

Distribution map of all species were plotted at the sectional level. Exact localities of plant collections have been incorporated for each species. A list of collectors, in chronological order, is also presented. The acronyms of herbaria, where the specimens are deposited, are also mentioned. An exclamation mark following herbarium acronym indicates that the specimens were examined personally.

3.3. RESULTS AND DISCUSSION

3.3. Results and Discussion

3.3.1 Morphology

3.3.1.1 Habit and Habitat

The habit of *Eria* is relatively uniform i.e. all the 49 species of *Eria* recorded from the Himalayan region are perennial epiphytic herbs. They range from small to medium, erect or pendulous sympodial habits, except *Eria paniculata* where the habit looks like monopodial type. The size of the plant is highly variable among species. The smallest Himalayan species *Eria muscicola*, for instance, has discoid pseudobulb measuring ca. 0.5 cm, leaves membranous, 4-5 cm long, inflorescence 4-5 flowered, while *E. bambusifolia* the largest species may have 90 cm long pseudobulb, leaves thick, 15-17 cm long, and inflorescence 10-20 cm long with many flowers.

Most *Eria* species are obligate epiphytic on the tree trunks, sometimes they are lithophytic, and sheltered under filtered sunlight of tree canopy. Generally, the humid forests are suitable habitat for the growth of epiphytic orchids. They are found in small or large tufts on the branches of trees, with erect rarely pendulous habit (*E. paniculata*). Most species of section *Conchidium* like *Eria muscicola*, *E. extinctoria*, *E. lacei*, *E. pusilla* and *E. braccata* are covered to the host tree as mosses. They are mainly distributed in the subtropical region to temperate region, ranging from 500 – 3000 m. (Table 2).

3.3.1.2 Root and Rhizome

The roots of *Eria* are typical epiphytic root covered with velamen. The velamen is considered as *Calanthe* type, i.e. velamen usually 3 to 4 layered without helical thickening. Cell walls often show relatively small pores, stabkorper lacking. Endodermis cells frequently large and slightly thickened. Root cortex always parenchymatous (Prorembski & Barthlott 1988). Root hairs may be found on the root, but only at their point of contact with a substrate surface. The root appears from the rhizome or from the base of pseudobulb, and they are much thickened.

Most of the species of *Eria* have sympodial rhizomes. Two distinct types of rhizomes are found in *Eria*. (a) Creeping rhizome with long elongated internodes and widely separated pseudobulbs, and (b) closely congested nodes, plant with short rhizome and more or less clustered pseudobulb. The first type of rhizomes is found throughout the sections *Eria*, *Dendrolirium* and *Stongyleria*, as well as in the section *Conchidium* (*Eria pusilla*). In the rhizome, the rhizomatous segment consists of 3-8 (-11) internodes with scaly leaves. The rhizome segments normally produce two functional buds, which generate new plants. Where as the second types of rhizomes are found in the rest of the species.

Table 2: Distribution range and comparison of morphological characters in *Eria* Lindl. (Orchidaceae)

S. N.	Botanical Names	Distribution	Altitude (m)	Length of pseudobulb/stem (cm)	Leaf size L x B (cm)	Length of inflorescence (cm)	Flower size (cm)	Colour of Flower	Flowering Period
1	<i>E. acervata</i>	Nepal-Sikkim Himalaya	500-700	2-8	6-14 x 2-2.5	3-4.5	1.5-1.6	Yellow, creamy white	June-July
2	<i>E. alba</i>	Kumaon-Sikkim Himalaya	1400-2300	3-7	9-15 x 0.5-2.5	3-4	0.7-1.5 cm	White, lip yellow and red	July-Aug
3	<i>E. amica</i>	Nepal-North East Himalaya	1400-1600	4-15	7-21 x 0.9	5-7.5	0.6-0.9	Pale straw colour with red nerves, lip dark purple, mid lobe yellow	July-Aug
4	<i>E. apertiflora</i>	Nepal-North East Himalaya	1600	9-16.0	13-21 x 2.5-5.5	8-10.0	0.3-0.5	White with yellow at the tip of the lip	July-Aug
5	<i>E. arnachalensis</i>	North East Himalaya	150	15-24	10-14 x 1.5	1.0-1.5	1.2	White, abaxial terminal lobe;	Feb-Mar
6	<i>E. bambusbula</i>	Sikkim-North East Himalaya	1100-2000	40-50	13-22.0 x 2.5-4.0	14-20	1.2	Grey-white striped with red	Oct-Dec
7	<i>E. benasi</i>	Nepal Himalaya	1600	3.0	No seen	ca. 2	1.12-1.25	White, with many pink veins.	Jan.
8	<i>E. biftara</i>	Nepal-North East Himalaya	1000-1300	6-12	4-6 x 0.5-0.9	0.6-0.8	0.2-0.3	Pale yellow	Sept
9	<i>E. bhutanica</i>	Bhutan Himalaya	Ca. 2100	3-4	6-15 x 1.3	3-4	1.3-0.5	Creamy white, pale yellow inside	June
10	<i>E. bhuncala</i>	Nepal-North East Himalaya	1000-1700	4-6.5	8-15 x 2.5-3	4-8	0.3	White, lined with pink	July-Aug
11	<i>E. brachysepals</i>	Nepal-North East Himalaya	300-1000	5-10	10-17 x 0.8-3.5	6-10	0.7-2	White, family pinkish	April
12	<i>E. braccala</i>	North West Himalaya	1500-2300	1.5-2 diameter	7.0 x 2.0	4.0	3 cm	White	June
13	<i>E. carinata</i>	Nepal-North East Himalaya	1000	5-5.8	12-25 x 0.5-7	15-30	2-2.5 x 1	Greenish purple, lip deep dull yellow veined crimson	Nov-Jan
14	<i>E. clausa</i>	Nepal-North East Himalaya	1000-1600	2-4	4-15.0 x 2-2.5	1.5-4	0.8	Pale green with some brown stripes on the lip	Feb-Mar
15	<i>E. cliviculata</i>	North East Himalaya	1700	15-20	5-6 x 0.5-0.9	1.5	1-1.5	White, lip white with purple margins	July-Aug
16	<i>E. consobor</i>	Nepal Himalaya	500	3-5	14 x 1.3	4-5	1.5-0.2 cm	Greenish yellow	June
17	<i>E. connata</i>	Bhutan-North East Himalaya	1200-1500	5-15.0	6-8.0 x 1.0-1.7	0-2	0.5	White with yellow, fragrant	July-Aug
18	<i>E. comeri</i>	North East - Himalaya	1500	4-6	15-35 x 2-6	12-15	1-1.5	White to pale greenish-pale yellow	July
19	<i>E. coronaria</i>	North West Himalaya-North East Himalaya	1500-2000	7-15	9-21 x 2-4	5-15.0	2.0-3.0	Creamy white or pale straw coloured, lip tinged yellow	July-Aug
20	<i>E. crassicaulis</i>	Sikkim-North East Himalaya	1300-1700	30	10-15 x 2-4	10-12	1.2	Pale, banded with purple	Oct-Dec
21	<i>E. cristata</i>	North East Himalaya	1000-1500	5-20	6-11 x 2-2.5	3-5	1-1.5	Creamy white	April
23	<i>E. excavata</i>	Nepal-Sikkim Himalaya	1300-2000	1-3.6	7-17 x 1-3	4-5	0.5-1.5	Yellow with pink side lobe	June-July
24	<i>E. eviflora</i>	Nepal Himalaya	500-600	0.5-1 diameter	3 x 1	5-5	0.3 cm	White	April-May
25	<i>E. ferruginea</i>	Sikkim-North East Himalaya	1300	6-9	12-18 x 3-4	6-12	3.0	Yellowish green to washed with purple pink	April-May
26	<i>E. glandulifera</i>	North East - Himalaya	1500-1600	20	12-15 x 2.0	3.0-3.5	2-3.5	White	July-Aug
27	<i>E. globulifera</i>	Nepal-North East Himalaya	1000-1200	12-13	6-8.0 x 1.5	1.5-2.0	3-6	Creamy white mid lobe of lip st. yellow	July-Aug

Table 2: Distribution range and comparison of morphological characters in *Eria* Lindl. (Orchidaceae), cont...

S. N.	Botanical Names	Distribution	Altitude (m)	Length of pseudobulb/stem (cm)	Leaf size L x B (cm)	Length of inflorescence (cm)	Flower size (cm)	Colour of Flower	Flowering Period
28	<i>E. grammifolia</i>	Nepal- North East Himalaya	1600-2300	12-15	9-15.0 x 0.7-2.2	1.5-2	1.2	White, ridges of lip and its mid lobe yellowish, side lobe red	July-Aug
29	<i>E. javanica</i>	Sikkim- North East Himalaya	500-700	12.0	50.0 x 6.0	60.0	4.0	White to pale yellowish	April-June
30	<i>E. longipetala</i>	North East Himalaya	650-850	18-26	5-6 x 1.5	ca. 1.3	±1.3	yellowish-brown, lined pink, partly opening.	March-June
31	<i>E. jacei</i>	North East Himalaya	1100	1.0	Not seen	2-2.5	1.0	Yellow	March
32	<i>E. lanceipes</i>	Sikkim- North East Himalaya	1000	5.0	13.0 x 3.0	25.0	3.5	Yellow.	Jan
33	<i>E. lasiocarpata</i>	North West - North East Himalaya	100-1000	10.0	25.0 x 4.0	30.0	1.5	Greenish yellow with purplish marking	May-June
34	<i>E. merguensis</i>	Bhutan Himalaya	1000-1500	7-10	6-7	0.40-0.5	0.7	White, coarsely tomentose	Feb-March
35	<i>E. musciicola</i>	North West - North East Himalaya	1000-1500	0.2-0.6 diameter.	3.0 x 0.5	2.5	0.5	Yellowish green, secundae	July-august
36	<i>E. nepalensis</i>	Nepal Himalaya	500	4-5	11-13 x 3.5-4.5	20	1.5-2.0	Yellowish, tomentose	August
37	<i>E. obesa</i>	Nepal Himalaya	2000-2300	4-7	leaf less	2-3	2.0 across	White	Aug
38	<i>E. occidentalis</i>	North West Himalaya	1200-1500	4.0	6.0 x 1.2	3.5	0.5	Dull whitish, glabrous	Jan-Aug
39	<i>E. paniculata</i>	Nepal- North East Himalaya	1000-1300	30.0	6-25 x 0.3-1.2	5-20.0	0.3-0.5	Pale yellowish green, lip lavender coloured, with brown blotches	Jan-April
40	<i>E. pamea</i>	Sikkim- North East Himalaya	1500-1700	3-5	3-18 x 0.2-0.5	2-3	1-1.5	White with golden inner surface, lip dark purplish	May-June
41	<i>E. pokharenensis</i>	Nepal Himalaya	900-1000	3-4	4-6 x 9-10	6-7	1-1.2	Yellowish white, curved, rust pubescent at the base	May-June
42	<i>E. pudica</i>	North East Himalaya	500-1200	2-4-3.9	7-20 x 1.5-3.5	4-6	0.5	White, lip down turned, lip triangular	June
43	<i>E. pumila</i>	Nepal- North East Himalaya	200-500	5-7.5	5-8 x 0.5-2	0.2-0.3	0.6	White flushed with pink, lateral lobes of lip red	Aug-Sept
44	<i>E. pusilla</i>	Sikkim- North East Himalaya	1300-1700	6.0	2.5 x 0.5	2.5	0.8	Creamy white, pale white	July-Aug
45	<i>E. shamae</i>	North East Himalaya	450-500	6-9	10-15 x 1.6-2.0	4-5.7	1.0	pink yellow	June-July
46	<i>E. Sikkimensis</i>	Sikkim Himalaya	1000	0.2 diameter	3-4 x 0.3-0.4	1.5-3	0.3-0.4	Small, pale green to yellowish, compact	August
47	<i>E. spicata</i>	North West - North East Himalaya	1000-1800	20.0	16.0 x 5.0	15.0	1.0	White or pale straw coloured, lip tinged yellow	July-Aug
48	<i>E. stricta</i>	Nepal- North East Himalaya	300-1500	12.0	10.0 x 2.5	12	0.3	White flushed with pink, side of the lip streaked yellow	Feb-Mar
49	<i>E. tomentosa</i>	North East Himalaya	1000-1300	5-10	7-15 x 2.5-6.5	30.0	1.0	Brown tomentose	July-Aug
50	<i>E. villosa</i>	Sikkim- North East Himalaya	1600-2000	7-12	15-20.0 x 3.5-5.5	15-20	2.0	Green striped with red	Mar-April

3.3.1.3 Pseudobulbs (Stem or Erect shoot)

Long-lived, well-developed pseudobulbs are found in all species of *Eria*. They are variable in size, and the internodes are uni-nodal to multi-nodal. Though a few species have compact, congested and discoid pseudobulbs such as *Eria muscicola*, *E. pusilla*, *E. braccata*, *E. extinctoria* *E. lacei*, whereas, in other species they are generally slender and more or less fusiform or cylindrical, conical or ovate or oval, rarely terete (*E. pannea*).

The erect part of the shoot in the rhizome is congested in *Eria muscicola*, *E. pusilla* and less in *E. pannea*. Whereas, other species have at least one (*E. javanica*, *E. carinata*, *E. clausa*) and most species have elongated internodes in the erect part of the shoots. Some species have erect, slender, cylindrical stems (*E. paniculata*, *E. clavicaulis*, *E. arunachalensis*), but majority have more or less distinctly developed pseudobulbs with varying numbers of internodes. The number of internodes may vary from one, two to three internodes exceeding in the length and breadth of the pseudobulbs as in the section *Pinalia* and *Hymeneria*. In some species, the erect part of the shoot consistently contains only one internode which may be sub globose to ovoid pseudobulbs such as in the section *Eria*, *Xiphosium*, *Trichosma* (*Eria vittata*, *E. clausa*) and *Conchidium* (*E. lacei*) and narrowly slender, elliptic to oblong in *E. coronaria* (*Trichosma*), and *E. stricta* (*Secundae*), (Table 2).

3.3.1.4 Leaves and Leaf sheaths

In the fully developed and matured *Eria*, the foliage leaf and the tubular leaf sheath is separated by an abscission zone from the lamina. The scaly leaves are tubular and terminated by short, free apex, without an abscission layer. The transition between the foliage leaves and scaly leaves is gradual in some species, but most often, there is abrupt shift from leaves with short, erect tip to others with distinct lamina. The foliage leaves towards the tip of a pseudobulbs stem often have a short leaf sheath, which has well developed lamina. In some species such as in *Eria carinata*, the apex of the pseudobulbs may be completely non-sheathing foliage leaf or one or several bracts with reduced lamina and little or no sheathing base.

The leaf sheath may be thick, three to four cell layered and soft or thin and membranous. In several species, the leaf sheath on the erect part of the shoot remains green when the lamina is shed. The sheath may even expand to form a persistent cover on the swollen pseudobulbs. In *Eria paniculata* the leaf sheath is free and tubular as in most of the other orchids. However, in many species of *Eria*, it is very difficult to see the actual base of the leaf, because the sheath tends to be tightly appressed or more or less adnate to around the pseudobulbs or underlying leaf sheaths. When the partly or loosely adnate leaf sheath splits along the veins, or if the leaf sheaths pulled away from the stem, only the veins come loose in *Hymeneria*, *Cylindrolobus*. In the section *Eria*, *Secundae*, *Trichosma*, the leaf sheaths are tightly, completely adnate, connected with the stem surface.

In those species, where leaf sheath is persistent and covers the pseudobulb, may develop conspicuous pattern of longitudinal stripes and/or special texture around the pseudobulb. *Eria stricta* has a long, adnate, membranous leaf sheath, covering the slender pseudobulb stem. In *E. lacei*, the leaf sheath is thin and membranous and is almost invisible, whereas, the sheath of the lower foliage leaf of *E. javanica* is green, fleshy and adnate surrounding the pseudobulb. It persists, even after the shedding of the lamina, and becomes grey and coriaceous, but remain green and fleshy in *E. coronaria* and *E. vittata*.

In some species such as *Eria javanica*, *E. coronaria* and *E. vittata*, there are one conspicuous, succulent internode in the erect part of the shoot having two foliage leaves which shows marked differences in the shape of the two leaves. The lowermost leaf has a long sheath enclosing the pseudobulbous internodes, whereas the leaves on the top of the pseudobulbs have a short inconspicuous leaf sheath. Such leaves also differ in the competence of their buds; only these above the pseudobulbs will sprout into inflorescence, (Table 2).

3.3.1.5 Buds

Anderson & al. (1988) reported that in the rhizomatous parts of the shoots, there are two types of buds, which will function as either renewal bud or reserved buds. The subtending leaf of the renewal buds is usually a scaly leaf or rarely the lowermost foliage leaves. The flower buds are situated immediately above the renewal bud, which functions as reserve bud in few cases. Other lateral buds of the erect part of shoot may develop lateral inflorescence. These buds are subtended either by scale leaves, foliage leaves or bracts. Especially in the pseudobulbous species, the inflorescence buds are clustered densely at the apex or developed singly at the uppermost node of pseudobulbs, which closely resembles a terminal inflorescence. Apart from the production of lateral inflorescence, the bud of the erect part of the shoot in general is not developed, except few species *Eria carnicolor*, *E. copelandii*, *E. microchila* and *E. philippinensis* from Thailand (Anderson & al. 1988). In stem with many pseudobulbous internodes groups in sections *Cylindrolobus* and *Hymeneria*, the bud of the lateral inflorescence breaks through the very short leaf sheath. The leaf sheath extends further down the stem on the side of the axillary bud, which is basal extension and is shed as oval scale from the bud sprout called as "Trap door" (Kerr 1977). The surface of subtending leaf sheath remains tight during maturation of the inflorescence buds, besides that; in many species, the bud leaves a deep impression in the stem surface.

3.3.1.6 Inflorescence

All the *Eria* species having caulescent habit, and are characterized by inflorescence, which are distinctly differentiated into peduncle and rachis, although the peduncle is sometime very short. Frequently, the peduncle is very slender and curved due to the weight of the flower bearing rachis as in *Eria javanica*, and *E. vittata*. The inflorescence develops either from apical, lateral or basal portion of the pseudobulbs with peduncle and rachis. On the basis of the position and origin

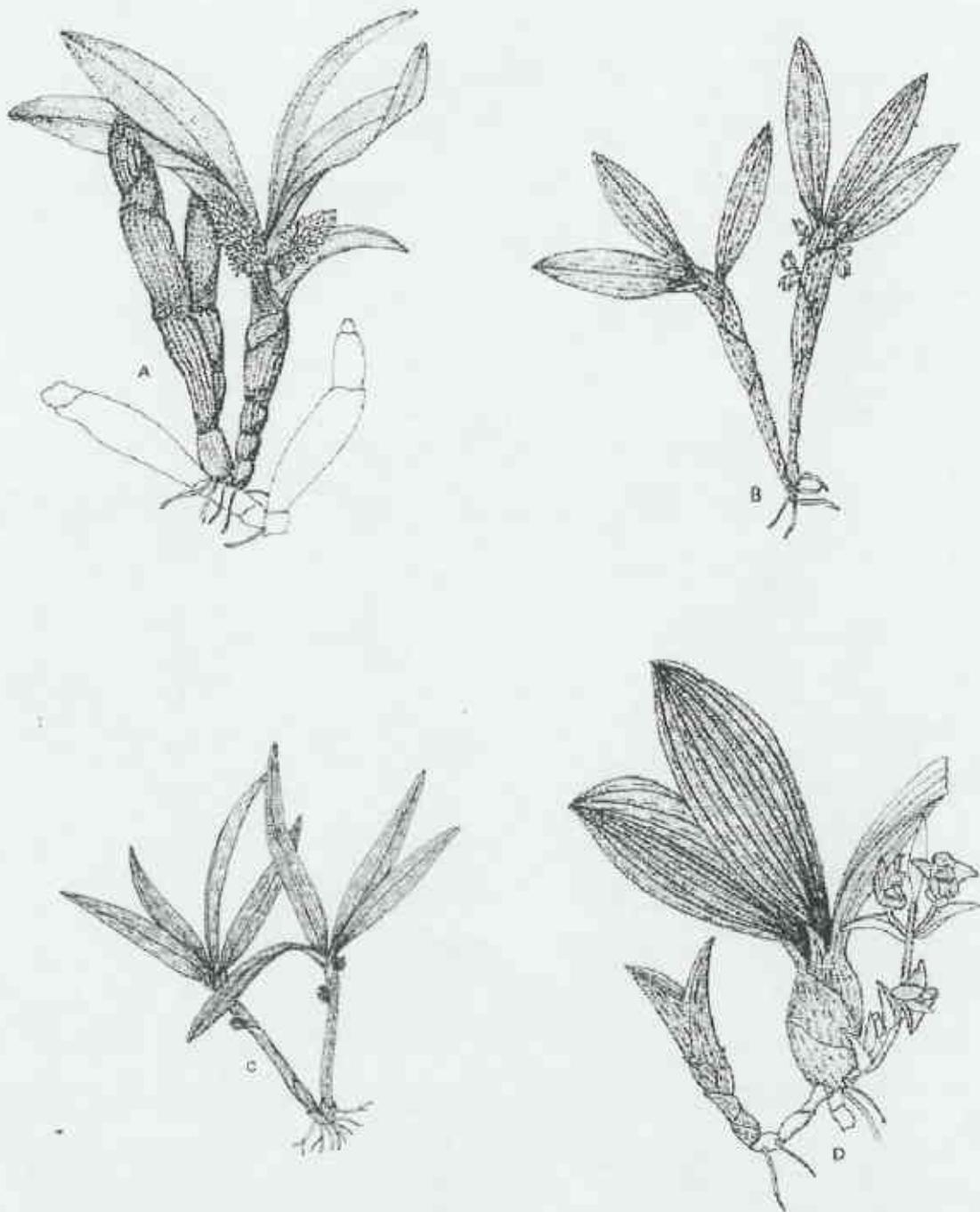


Fig. 2 Types of Inflorescence, A Hysteranthous (*E. globulifera*); B. Synanthous (*E. biflora*); C. Protoanthous (*E. pumila*); and D. Heteranthous (*E. nepalensis*)

of the inflorescence, four different types of inflorescence are differentiated (De Vogel 1988, Pederson 1997, Gravenedeel 2000).

❖ **Hysteranthous inflorescence:** The inflorescence develops on the top of a full-grown pseudobulb, with fully developed leaves. Such type of inflorescence is seen in *Eria muscicola*, *E. sikkimensis*, *E. lacei*, *E. pusilla*, *E. braccata*, *E. extinctoria*, *E. spicata*, *E. apertiflora*, *E. bipunctata*, *E. occidentalis*, *E. stricta*, *E. merguensis*, *E. bambusifolia*, *E. crassicaulis*, *E. paniculata*, *E. globulifera*, *E. bhutanica*, *E. pokharensis*, and *E. pannea* (Fig. 2 A).

❖ **Synanthous inflorescence:** When the inflorescence sprouts simultaneously with the leaf, subtending it from a shoot and still not fully developed terminal pseudobulbs, such inflorescence is referred here as Synanthous type. For example, *Eria biflora*, *E. arunachalensis*, *E. glandulifera*, *E. clavicaulis*, *E. jungingensis*, *E. cristata*, *E. banialii*, *E. obesa*, *E. bractecensens*, *E. aervata*, *E. excavata*, *E. amica*, *E. sharmae*, *E. concolor*, *E. alba*, *E. graminifolia*, *E. sticta*, *E. coronaria*, *E. vittata*, *E. clausa*, and *E. corneri*, *E. carinata*, *E. javanica*, and *E. pudica* (Fig. 2 B).

❖ **Protoanthous Inflorescence:** Inflorescence developing on the top of vegetative shoot, of which the terminal internode is not yet developed, but the leaf or leaves are developed simultaneously, as in *Eria connata* and *E. pumila* (Fig. 2 C).

❖ **Heteranthous inflorescence:** The vegetative shoot from which the inflorescence sprouts, never develop leaves and terminal internodes, never enlarged into pseudobulbs. The older inflorescence is seemed lateral on the rhizome. Such type of inflorescence is seen in *Eria lasiopetala*, *E. lancieps*, *E. nepalensis*, *E. tometosa*, and *E. ferruginea* (Fig. 2 D).

In *Eria stricta*, the inflorescence is distinctly terminal and also having distichous flowers and bracts. In case of *E. carinata*, the position of inflorescence is terminal, which is covered by two sterile bracts and consecutive flower- subtending bracts, which continue to the distichous phyllotaxy of the erect shoot.

In many species, the erect shoot is congested, so it is difficult to determine the exact position of an inflorescence arising from middle of a dense rosette leaves. In *Eria pannea* the inflorescence is subtended by the uppermost leaf, which is a small bract concealed by foliage leaves. Besides that presence of a minute shoot tip on the erect shoot is the only indication of lateral insertion of the inflorescence. No such indication of a lateral inflorescence is observed in *E. muscicola* and *E. pusilla*, so that their inflorescence is interpreted as terminal.

Moreover, lateral inflorescence occurs in all other species. In *Eria paniculata*, several inflorescences are produced on each module, subtended by the uppermost foliage leaf or bracts above it. The bract and the bases of the inflorescences are concealed by foliage leaf sheaths on the intact shoot. The lateral inflorescence of *E. lacei* and *E. pannea* are likewise subtended by a short bract above the foliage leaves, but due to its solitary nature these inflorescence is closely resemble to the terminal one. Obviously, lateral inflorescence of other species is either subtended

by foliage leaves or by foliage leaves as well as the upper scale leaves. They are usually gathered towards the upper end of the stem.

Inflorescences originating from the lower part of the erect shoot have been found in the section *Cylindrolobus*. The inflorescences are lateral and have spiral phyllotaxy except the section *Cylindrolobus*. In *Cylindrolobus*, the flowers are two to few flowered and distichous, and conspicuous bracts present in the inflorescence.

In *Eria lasiopetala* the inflorescence is originated in different mode from isomodular to heteromodular architecture (Anderson & al. 1988).

Generally, the inflorescence in *Eria* is differentiated into peduncle and a rachis, the peduncle is short. Frequently the scape is slender and curved due to number of flower-bearing rachis as in *Eria javanica* and *E. vittata*. In *E. javanica* the inflorescence is synanthous, with convolute leaves subtending the inflorescence, and the young leaves are loose funnel-shaped around the base of the peduncle, during the early development stage.

In the remaining species of synanthous inflorescence and conduplicate leaves, the peduncle is usually free from the subtending leaf at the time of flowering. In *Eria clausa* and *E. corneri*, the subtending leaf is funnel shaped around the base of peduncle of the inflorescence, which shows affinity with *E. javanica* too. However, in most of the species the peduncle of the flowering inflorescence is in a shorter or longer distance, tightly enclosed by unexpanded leaf sheaths.

The rachis is few to many flowered, lax to dense and always slender in transverse section. The flowers are always distichously alternating. The rachis is frequently pendent due to the weight of the flowers, but erect rachis occurs as well. In most of the *Eria* species, the flowering starts from the proximal part of the rachis, but in some species the flowering starts from the distal part of the rachis such as in *Eria javanica* and *E. paniculata*.

3.3.1.7 Floral bracts

The floral bracts are persistent and scarious to membranous. They are usually provided with many conspicuous nerves; more rarely with a few, sometimes inconspicuous one. The outline of the bract is variable, usually broad with entire margin, but in *Eria glandulifera* the margin is hairy. The morphology of the floral bract is variable in most of the species and even in a single inflorescence. *E. lasiopetala* and *E. nepalensis* is delimited by the size of floral bracts.

Table 3: Comparative structure of bracts in *Eria* Lindl.

S.N.	Botanical name	Length (m)	Breadth (c)	Shape	Apex	Surface	Veins	Other distinguished characters
1	<i>Eria acerosa</i>	6-8	3-6	Lanceolate	Acute	Glabrous	3	Rolled in pedicel and ovary
2	<i>Eria alba</i>	4-6	1.5-2.5	Elliptic-lanceolate	Acuminate	Glabrous	3	Green, broad, reflexed
3	<i>Eria amica</i>	7-15	3	Ovate-oblong	Acute	Glabrous	3 to 4	Hairy at the base and apex
4	<i>Eria apertiflora</i>	5-10	3	Oblong-lanceolate	Acute	Glabrous	3	Pale brown spotted
5	<i>Eria arunachalensis</i>	8-10	6-8	Ovate-oblong	Acute	Hairy	many	Greenish yellow to tumeric yellow, covered with brown base externally
6	<i>Eria bambusaefolia</i>	3-6	2.5-4	Suborbicular	Apiculate	Pubescent	3	Rust pubescence, coriaceous, broad
7	<i>Eria banata</i>	3	1.1	Ovate-lanceolate	Acuminate	Glabrous	1	Margin slightly crose
8	<i>Eria bhutanica</i>	7	2	Ovate-lanceolate	Acute	Pubescent	3	Yellowish-white
9	<i>Eria biflora</i>	4-6	2-4	Elliptic	Acute	Glabrous	1	Large, petaloid, pale yellow and fleshy
10	<i>Eria bipunctata</i>	4-6	2-3	Lanceolate	Acute	Glabrous	3	Scattered hairs on the edge
11	<i>Eria braccata</i>	9	3.5	Cordate	Mucronate	Glabrous	3	Wavy and pale brown
12	<i>Eria bracteocens</i>	6-15	2.3-5	Elliptic	Apiculate	Glabrous	3	Margins sometime involute
13	<i>Eria carinata</i>	20-40	2-3	Lanceolate	Acuminate	Glabrous	1	Three winged stalked ovary
14	<i>Eria cinnia</i>	4	1.5	Obscurely obsolete	Acute	-	1	Obscurely reduced to ring like at the base of stalked ovary
15	<i>Eria cloviantha</i>	10-20	5	Ovate-oblong lanceo	Acute	Glabrous	Many	Membranous spreading, concave
16	<i>Eria concolor</i>	2	1	Ovate-lanceolate	Acute	Glabrous	3	Small and narrow
17	<i>Eria comuta</i>	6.0-7.5	5.0-6.5	Ovate	Acute	Glabrous	5	Gland dotted
18	<i>Eria corueta</i>	ca. 3	-	-	-	-	-	Minute or absent
19	<i>Eria coronaria</i>	25-50	20-30	Linear-lanceolate	Acute	Glabrous	3	Greenish brown
20	<i>Eria crassicaulis</i>	5-6	2	Orbicular or ovate	Acute	Hairy	many	Brown tomentose
21	<i>Eria cristata</i>	8	1.5	Ovate	Acute	Hairy	1	Copper brown in colour
22	<i>Eria excavata</i>	6	1	Ovate-oblancoolate	Acute	Glabrous	6	Yellowish-white or pale green colour
23	<i>Eria extinctaria</i>	ca. 1	ca. 0.5	Oblong	-	-	-	Boat shaped
24	<i>Eria ferruginea</i>	10-20	5	Lanceolate-ovate	Acute	Tomentose	3	Large, reflexed
25	<i>Eria glandulifera</i>	8	4	Ovate-lanceolate	Acute	pubescent	3	Gland dotted
26	<i>Eria globulifera</i>	4-5	2-2.5	Oblong	Acute	Glabrous	3	Few hairs on the edge
27	<i>Eria graminifolia</i>	6-7	1.5-2.5	Ovate-lanceolate	Acuminate	Glabrous	5	Apical margin fimbriate
28	<i>Eria javanica</i>	7-12	3	Lanceolate	Acuminate	Glabrous	3	-
29	<i>Eria jengjengensis</i>	1.5	0.5	Ovate	acute	Glabrous	1	-
30	<i>Eria laevis</i>	2-3	2-3	Ovate	Acute	Glabrous	1	-
31	<i>Eria lanceus</i>	10-14	2-4	Oblong-lanceolate	Acute	Pubescent	6	Blunt at the base
32	<i>Eria laxiopetala</i>	7-12	3-4	Oblong-lanceolate	Acute	Tomentose	5	White tomentose
33	<i>Eria marginata</i>	1.5	-	-	-	Tomentose	-	Minute
34	<i>Eria muscicula</i>	3	1.5	Oblanceolate	Acuminate	Glabrous	1	Thin veins
35	<i>Eria nepalensis</i>	40	15	Oblong-lanceolate	Acute	Glabrous	1	Boat shaped, longer than pedicel and ovary
36	<i>Eria obesa</i>	2.5-3	1.5	Ovate	Acute	Glabrous	5	Reflexed
37	<i>Eria occidentalis</i>	5	2	Ovate	Acute	Glabrous	3	Much recurved
38	<i>Eria paniculata</i>	4-8	2-2.5	Oblanceolate	Acuminate	Glabrous	3	Greenish dull purple,
39	<i>Eria paucica</i>	5-9	3-4	Ovate-lanceolate	Acute	Pubescent	3	Densely woolly
40	<i>Eria pokharensis</i>	8-9	2	Triangular	Acuminate	Pubescent	1	Scattered hairs on the edge and finely pubescent in dorsal
41	<i>Eria pudica</i>	2-2.5	1	Ovate	Acuminate	Pubescent	-	Almost equal to pedicel and ovary
42	<i>Eria pusilla</i>	2-2.5	1.5	Oblong	Acuminate	-	2	Serrate margin
43	<i>Eria pusilla</i>	0.8-1	0.5	Ovate	Acuminate	Glabrous	3	Thin veins
44	<i>Eria sharmae</i>	10-12	6-7	Oblong	Acute	Glabrous	8	Erect but recurved at mature
45	<i>Eria Sikkimensis</i>	3-5	1.5	Ovate-lanceolate	Acuminate	Glabrous	1	Thin veins
46	<i>Eria spicata</i>	5-7	3	Ovate	Acute	Glabrous	1	-
47	<i>Eria stricta</i>	15	2	Ovate	Acute	Glabrous	3	Distichus mucronate
48	<i>Eria tomentosa</i>	14-17	5-8	Broadly oblong	Acute	Pubescent	3	Yellow to orange yellow
49	<i>Eria vittata</i>	1	-	Ovate	-	-	-	Reduced to thickened ring, minute

In some species, the natural position of the floral bract exhibits a characteristic glumaceous confirmation (in section *Conchidium*). The bracts are fully developed earlier than flowers they subtend, and consequently protect the young flower buds effectively. In *Eria braccata*, the glumaceous floral bract is large and also protects the expanded flower (Table 3).

3.3.1.8 Indumentum

Small brown, black or whitish hairs are present on the pedicel and ovary at dorsal and lateral sepal of the taxa studied. The size and abundance of the hairs may vary considerably. In low magnification, the indumentum is considered homologous. This might be justified, because their microscopic structure was not studied in higher magnification.

3.3.1.9 General characters of the flowers

Generally, the flowers of *Eria* are long lasting, and all flowers in an inflorescence develop almost simultaneously. There are some specific difference regarding the sequence of flowering, but in all cases flowers of inflorescence expands before the first flower developed one after another.

The colour of flowers varies greatly within *Eria*. In many species, the flowers are white or relatively yellowish white and red colours are relatively rare (*Eria carinata*). Considerable variations in the flower colour are found at infra specific as well as inter-specific level (Table 2).

3.3.1.10 Perianth

The perianth of *Eria* is trimerous. Present study has accepted the traditional terms of the orchidologist and applied the terms "sepals" and "petals", although the outermost whorl of the tepal are not truly sepaloid. The ventral petal is slightly too strongly modified into variously shaped lip or labellum. The term 'petal' refers exclusively to the lateral one. The lateral sepals are mostly connate at the base of the foot in all species of *Eria*, except *Eria paniculata*, whereas, the dorsal sepals are free in all Himalayan *Eria*. The petals are always free. In the outline, the sepal and petals vary from linear to oblong ovate and more or less concave with mentum. The sepals and petals are usually 3-5 veined from the base. The main veins are often branched in few species. Sometimes the sepals and petals are gradually recurved or incurved, but they are never bent in a right angle as often seen in *Pholidota* Lindl. ex Hook.f. Both the sepals and petals are rounded to acute or acuminate at the apex. The sepals and petals are always entire, but the surface of the sepals is pubescent or tomentose, whereas, the petals are glabrous or less pubescent. The characters listed above often contribute to important diagnostic features, especially at specific level (Table 4, 5 and 6).

3.3.1.11 Labellum

The morphology of the labellum is very diverse within *Eria* on shape, size, margins, presence or absence of lobules, variation of the terminal or lateral lobe. The terminal lobe is emarginate or two lobulate, or not lobulate; veins and callus or keels are present or absent.

Table 4 : Comparative structure of Dorsal sepal in *Eria* Lindl.

S.N	Botanical name	Length (mm)	Breadth (mm)	Shape	Apex	Veins	Surface	Other distinguished characters
1	<i>Eria acervata</i>	7-8	2-4	Oblong-lanceolate	Acuminate	3	Glabrous	Yellow-white, apex tinged with green
2	<i>Eria alba</i>	7-9	2-4	Oblong-lanceolate	Acute	3	Glabrous	-
3	<i>Eria umica</i>	7-8	2-2.5	Elliptic lanceolate	Acute	3-5	Pubescent	Blunt, incurved, anemate
4	<i>Eria upuriflora</i>	3-6.5	2-3	Lanceolate-ovate	Obtuse	3	Glabrous	-
5	<i>Eria arunachalensis</i>	8-9	4-4.5	Ovate-oblong	Sub acute	5	Tomentose	Covered by brown tomentose
6	<i>Eria hamnisiifolia</i>	10-13	3-4.5	Oblong-lanceolate	Obtuse	5	Tomentose	Broad at base, reddish pubescent
7	<i>Eria haniata</i>	ca. 5	1.5-2	Oblong-lanceolate	Acute	3	Glabrous	Lightly 3 nerved (pink)
8	<i>Eria bhutanica</i>	6-6.5	3-3.8	Oblong-elliptic	Acute	3	Pubescent	Thin, entire
9	<i>Eria biflora</i>	3-6	4	Ovate	Acute	3	Glabrous	-
10	<i>Eria bipunctata</i>	4-5	2-2.5	Ovate	Obtuse	3	Glabrous	Thick, white with purplish tint.
11	<i>Eria braccata</i>	20-37	4-7	Oblong-lanceolate	Acute	9	Glabrous	White or diffused pale pink
12	<i>Eria bractescens</i>	5-12	2	Oblong-lanceolate	Acute	5	Glabrous	Short pedicellate, curved backwards
13	<i>Eria curiosa</i>	15-22	3-5	Oblong-lanceolate	Acute	5	Glabrous	Short pedicellate, yellow or green
14	<i>Eria clausa</i>	6-10	3 to 4	Oblong-lanceolate	Obtuse	5	Glabrous	Closed flowered
15	<i>Eria clavicornis</i>	10-15	4-5	Ovate-lanceolate	Acute	3	Glabrous	Sub-connate, subundulate, white
16	<i>Eria concolor</i>	5-6.5	2-2.5	Oblong	Acute	3	Glabrous	-
17	<i>Eria connata</i>	5-6.5	2.5-3	Ovate	Obtuse	3	Glabrous	Hooded over the column
18	<i>Eria cornet</i>	10-13	4-6	Linear-lanceolate	Obtuse	3-5	Glabrous	-
19	<i>Eria coronaria</i>	15-20	7-8	Elliptic-oblong	Obtuse	3	Glabrous	White
20	<i>Eria crassicaulis</i>	9-10	4-5	Oblong-ovate	Obtuse	3	Tomentose	Sessile, thick
21	<i>Eria cristata</i>	7-8	1.5	Oblong-ovate	Acute	3	Hairy	-
22	<i>Eria excavata</i>	6-7	2-2.5	Elliptic-lanceolate	Acute	3	Pubescent	Yellowish white, rust pubescent
23	<i>Eria extinctoria</i>	4-5	3-3.5	Ovate	Acute	5	Glabrous	White, smaller than lateral sepals
24	<i>Eria ferrogenea</i>	15-20	5	Oblong-lanceolate	Obtuse	6	Tomentose	Olive brown with darker stripe.
25	<i>Eria glandulifera</i>	8-10	2	Narrow lanceolate	Acuminate	3	Pubescent	Gland dotted
26	<i>Eria globulifera</i>	4-5	1-1.5	Ovate	Acute	3	Glabrous	-
27	<i>Eria graminifolia</i>	6-10	2.5-4	Elliptic-lanceolate	Acute	5	Glabrous	Broad and thin
28	<i>Eria javanica</i>	17-28	4-5	Lanceolate	acute	3	Pubescent	Relaxed at apex, entire, pubescent
29	<i>Eria leucoginea</i>	7-8	3-3.5	Ovate-lanceolate	Acute	3	Glabrous	-
30	<i>Eria laevi</i>	8-9	2-5	Lanceolate	Sub acute	5	Glabrous	Concave, broad, sub-glabrous
31	<i>Eria laniceps</i>	15	4	Lanceolate	Acute	3	Tomentose	Densely woolly
32	<i>Eria latipetala</i>	10-15	5	Lanceolate	Obtuse	3-5	Tomentose	Densely woolly
33	<i>Eria merquensis</i>	1-1.5	0.8-1	Oblong	Obtuse	Many	Tomentose	Densely woolly
34	<i>Eria muscicola</i>	2-4	0.8-2	Lanceolate	Acuminate	3	Glabrous	-
35	<i>Eria nepalensis</i>	17-19	5	Lanceolate	Obtuse	3	Tomentose	Densely woolly
36	<i>Eria obesa</i>	10-12	2	Lanceolate	Acuminate	5	Glabrous	-
37	<i>Eria occidentalis</i>	4-5	3.5	Ovate	Acute	3	Glabrous	Dull white, small flower
38	<i>Eria paniculata</i>	3-5	2-2.5	Ovate	Obtuse	3	Tomentose	Oil drop at base, glabrous in young
39	<i>Eria pannei</i>	5-8	2-5	Elliptic-lanceolate	Obtuse	3	Tomentose	Sessile, narrowly pointed
40	<i>Eria phokharensis</i>	4-6	2-3	Ovate	Obtuse	3	Pubescent	Yellowish white
41	<i>Eria pulica</i>	3.5-4	2-2.5	Elliptic	Obtuse	5	Glabrous	Shorter than lateral sepals
42	<i>Eria pumila</i>	2-2.5	1-1.5	Oblong	Obtuse	3	Glabrous	Sessile
43	<i>Eria pusilla</i>	5-6.5	2-2.5	Ovate	Acuminate	3	Glabrous	Pale white
44	<i>Eria sharmae</i>	11-12	4-5	Oblong	acute	3	Glabrous	Nerved extend up to apex
45	<i>Eria sikkimensis</i>	2-4	0.8-2	Lanceolate	Acuminate	3	Greenish	-
46	<i>Eria spicata</i>	3-5	1.5-2	Ovate	Obtuse	3	Glabrous	Entire, yellowish white
47	<i>Eria stricta</i>	0.8-2	1.5-2	Ovate	Obtuse	3	Tomentose	Densely woolly
48	<i>Eria tomentosa</i>	10	3-5	Ovate-lanceolate	acute	3	Tomentose	Covered by brown hairs
49	<i>Eria vittata</i>	8-30	1.3-2	Ovate-oblong	acute	5-5	Glabrous	White, tinged with purple-red striped

In *Eria*, character of the labellum has been given top priority in the delimiting the species. The labellum is sessile to short clawed. Among the Himalayan species, the following type of labellum can be distinguished with regard to the outline of the terminal lobe of labellum. Besides that, the character of lateral lobe as well as other supporting characters is used as important taxonomic character to distinguish the genus at infraspecific level. Following types of labellum have been observed in Himalayan *Eria*:

Type A. Labellum entire, simple, obscurely tri-lobed or without distinct side lobe. This type is represented in *Eria muscicola*, *E. sikkeminsis*, *E. pusilla*, *E. pannea*, *E. stricta*, *E. baniaii*, *E. concolor*, *E. obesa*, *E. bambusifolia*, *E. vittata*, and *E. biflora*, (Fig 3 A).

Type B. Tri-lobed labellum with bilobulate or emarginated terminal lobe. This type is found in *Eria extincoria*, *E. occidentalis*, *E. pumila*, *E. acervata*, *E. bractesens*, *E. sharmae*, and *E. amica* (Fig 3 B).

Type C. Labellum tri-lobed, with broad terminal lobe and truncate. This type is represented by *Eria paniculata*, *E. merguensis*, *E. crassicaulis*, *E. lasiopetala*, *E. tomentosa*, *E. lanceips*, *E. nepalensis*, *E. arunachalensis*, *E. pokharensis*, *E. cristata*, *E. graminifolia*, *E. excavata*, *E. bhutanica* and *E. bipunctata*, (Fig 3C).

Type D. Tri-lobed with orbicular or triangular terminal lobe. This type is represented by *Eria lacei*, *E. coronaria*, *E. cornerie*, *E. cluasa*, *E. connata*, *E. alba*, *E. pudica*, *E. clavicaulis*, *E. spicata*, *E. apertiflora* and *E. globulifera*. (Fig 3 D).

Type E. Tri-lobes with long to oblong terminal lobes, comparatively broad lateral lobe: as in *Eria javanica*, *E. braccata*, *E. carinata*, *E. jengingensis* and *E. glandulifera* (Fig 3 E).

Type F. Tri-lobed with small and narrow lateral lobe, inconspicuous and large prominent terminal lobe. *Eria ferruginea*. (Fig 3 F).

It should be emphasized that the categories listed above are established in order to illustrate the general patterns of variation in the labellum outline. From an evolutionary point of view, some of the categories are probably highly artificial and intermediate forms are frequently encountered.

In majority of the species, margin of the labellum is usually entire. In few species the margin are clothed with minute smooth hairs (*Eria glandulifera*, *E. arunachalensis*), whereas in *E. braccata*, *E. lacei*, *E. ferruginea*, *E. crassicaulis*, and *E. clavicaulis*, terminal lobe are erose or serrate.

Usually the labellums are veinless. In few species of the section *Pinalia* and *Bambusifolia*, they have distinct three to five or more veins. The prominent three veined labellum are found in *E. spicata*, *E. apertiflora*, *E. bipunctata*, *E. globulifera*, and *E. occidentalis*. In *E. bambusifolia* and *E. crassicaulis* the labellum has five to more veins

Mostly the labellum is flat in the genus *Eria*. In *E. connata*, *E. ferruginea*, *E. pudica*, saccate like structure is present at the base. Channel like labellum is also seen in *E. jungenginsis*.

Table 5: Comparative structure of Lateral sepals in *Eria* Lindl.

S.N	Botanical name	Length (mm)	Breadth (mm)	Shape	Apex	Veins	Surface	Other distinguished characters
1	<i>Eria acervata</i>	10	4	Oblong-lanceolate	Acuminate	5	Glabrous	Falcate, glabrous, yellowish-white
2	<i>Eria alba</i>	10	3.5	Ovate-lanceolate	Acute	3	Glabrous	Falcate, unequal
3	<i>Eria amica</i>	7.5	5	Ovate	Acute	5	Glabrous	Falcate, mentum present
4	<i>Eria apertiflora</i>	4-6	2	Ovate	Acute	3	Glabrous	Sub falcate, mentum present
5	<i>Eria arnchelensis</i>	10-11.5	7	Ovate	Acute	7	Glabrous	Connate with U shape columnfoot
6	<i>Eria bambusifolia</i>	16	4	Elliptic	Obtuse	5	Tomentose	Falcate, mentum present
7	<i>Eria banaii</i>	5.5	0.2	Oblong-lanceolate	Acute	2	Glabrous	Falcate, broad at base
8	<i>Eria bhutanica</i>	11	5	Oblong	Acute	3	Pubescent	Falcate, mentum absent
9	<i>Eria biflora</i>	5-6.5	4	Ovate	Obtuse	1	Glabrous	Mentum present.
10	<i>Eria bipuncata</i>	6	3	Ovate	Acute	3	Glabrous	Mentum present.
11	<i>Eria braccata</i>	12-35	5-7	Oblong	Acute	4	Glabrous	Conical, falcate, emarginated
12	<i>Eria bracteosa</i>	7-12	2-4	Lanceolate	Acute	5	Glabrous	Falcate, deflexed at the base
13	<i>Eria curvata</i>	24-25	6	Ovate	Acute	3	Glabrous	Denticulate near apex, gibbous mentum
14	<i>Eria clausa</i>	6-8	2-3	Oblong	Obtuse	5	Glabrous	Slightly falcate, mentum globose
15	<i>Eria clavicaulis</i>	10-15	7	Triangular	Acute	5	Glabrous	Lateral sepal with keels mentum present
16	<i>Eria concolor</i>	5-5.5	2	Ovate-triangular	Acuminate	3	Glabrous	Mentum present
17	<i>Eria connata</i>	7-8	2-2.5	Oblong-lanceolate	Obtuse	3	Glabrous	Tubular mentum
18	<i>Eria corneri</i>	9-10	6	Triangular-oblong	Sub-obtuse	5	Glabrous	Mentum present
19	<i>Eria coronaria</i>	16-20	7-8	Elliptic-lanceolate	Acute	3	Glabrous	Mentum conical obtuse
20	<i>Eria crassicaulis</i>	10-12	5-6	Oblong	Obtuse	3	Pubescent	Mentum present
21	<i>Eria cristata</i>	8	1.2	Oblong	Acute	3	Pubescent	Falcate
22	<i>Eria excuvata</i>	5-6	3	Elliptic-lanceolate	Acute	5	Pubescent	Falcate,
23	<i>Eria extinctoria</i>	10	3	Triangular	Acute	5	Glabrous	Mentum present, conical
24	<i>Eria ferruginea</i>	20-25	10	Oblong/ovate	Obtuse/subacute	9	Tomentose	Longer than D sepal, mentum round
25	<i>Eria glandulifera</i>	7-10	5	Lanceolate	Acuminate	3	Pubescent	Mentum present
26	<i>Eria glabulifera</i>	4-5	2-2.5	Triangular	Obtuse	3	Glabrous	Falcate
27	<i>Eria graminifolia</i>	6-8	3-5	Lanceolate	Acute	4	Glabrous	Sub-falcate
28	<i>Eria javanica</i>	15	4	Lanceolate	Acute	4	Pubescent	Falcate, round at base
29	<i>Eria jengoyettala</i>	7-9	3-4	Ovate	Acute	3	Glabrous	Falcate, gland dotted
30	<i>Eria lacei</i>	9-10	4-5	Obliquely triangular	Acute	3	Glabrous	Falcate, mentum round
31	<i>Eria laniceps</i>	18	4	Oblanceolate	Acute	6	Tomentose	Falcate, Mentum curved.
32	<i>Eria lasiopetala</i>	14-15	8	Triangular lanceolate	Acute	5	Tomentose	Falcate, mentum round, coriaceous
33	<i>Eria merguensis</i>	1-1.5	Ca 1	Oblong	Obtuse	3	Tomentose	Mentum conical curved
34	<i>Eria muscicola</i>	4	2	Ovate-lanceolate	Acuminate	3	Glabrous	Falcate
35	<i>Eria nepalensis</i>	10-12	9	Lanceolate	Obtuse	3	Tomentose	Falcate, mentum sub globose
36	<i>Eria obesa</i>	11-12	3	Lanceolate	Acute	5	Glabrous	Falcate
37	<i>Eria occidentalis</i>	6	4.5	Triangular	Acute	3	Glabrous	Mentum present
38	<i>Eria paniculata</i>	5-6	3-4	Triangular	Sub-acute	5	Pubescent	Sub falcate, mentum short
39	<i>Eria pumila</i>	5-10	2-5	Ovate-triangular	Acute	3	Tomentose	Weakly falcate, mentum conical, obtuse
40	<i>Eria pokharensis</i>	6-7	3	Oblong	Obtuse	4	Pubescent	Mentum present
41	<i>Eria pulchra</i>	4-5	3	Ovate	Apiculate	5	Tomentose	Mentum present
42	<i>Eria pumila</i>	2-	1.5	Oblong	Obtuse	3	Glabrous	Mentum present, round
43	<i>Eria pusilla</i>	5-5.5	2.5	Lanceolate	Acuminate	3	Glabrous	Triangular, mentum long and distinct
44	<i>Eria sharmae</i>	10-12	5-6	Oblong-lanceolate	Acute	3	Glabrous	Mentum present
45	<i>Eria yakkimontis</i>	3-4	0.8-1	Lanceolate	Acuminate	3	Glabrous	Falcate
46	<i>Eria spicata</i>	3	2	Ovate	Acute	3	Glabrous	Mentum present, short
47	<i>Eria stricta</i>	15-20	2	Ovate	Obtuse	3	Tomentose	Mentum absent
48	<i>Eria tomentosa</i>	10-12	8	Lanceolate	Acute	3	Tomentose	Falcate, mentum large, incurved
49	<i>Eria vittata</i>	5-12	5-1	Triangular-oblong	Acute	3	Glabrous	Falcate, mentum round, conical

Table 6: Comparative structure of Petal in *Eria* Lindl.

S.N.	Botanical name	Length (mm)	Breadth (mm)	Shape	Apex	Veins	Colour	Other distinguished characters
1	<i>Eria acervata</i>	7-9	2-3	Lanceolate-oblong	Acute	2	Yellow	Membraneous, glabrous
2	<i>Eria alba</i>	7	1-3	Lanceolate-oblong	Acute	3	White	Glabrous, margin thin
3	<i>Eria amica</i>	7-10	2-3	Lanceolate	Acute	3-5	Brown	Truncate, glabrous, membranous
4	<i>Eria operiflora</i>	3	1	Elliptic-lanceolate	Obtuse	1	White	Glabrous
5	<i>Eria uranochelonea</i>	8-8.5	3.5	Oblong	Obtuse	3	Yellow	Serrulate margin
6	<i>Eria hamulifolia</i>	7-9	2-3	Elliptic-oblong	Obtuse	3	Brown	Blunt, glabrous, falcate
7	<i>Eria hamata</i>	5	1.5	Lanceolate	Obtuse	3	White	Connate with column
8	<i>Eria bhutanica</i>	6	2	Ovate	Acute	3	White	Glabrous
9	<i>Eria biflora</i>	2-3	1.5	Oblong	Obtuse	3	Yellow	Narrow than sepals
10	<i>Eria bipunctata</i>	2.5-3	2	Ovate	Obtuse	3	White	Edge thin, glabrous
11	<i>Eria bracteata</i>	19-32	5-7	Obtuse-lanceolate	Acute	7	White	Glabrous
12	<i>Eria bracteocent</i>	9-10	2-2.5	Oblong-lanceolate	Obtuse	3	White	Shorter than dorsal sepal, glabrous
13	<i>Eria carinata</i>	18-20	6	Obtuse-lanceolate	Acute	5-9	Yellow	Glabrous
14	<i>Eria clavata</i>	5-8	2-3	Oblong	Obtuse	3	Yellowish	Subfalcate, glabrous
15	<i>Eria clavicaulis</i>	10-12	5	Oblong	Acute	3	White	Glabrous
16	<i>Eria cancolor</i>	5-5.5	2	Linear	Acute	2-5	Yellowish green	Glabrous
17	<i>Eria cannata</i>	3-4	1.5-2	Ovate-lanceolate	Blunt	3	White	Shorter than sepals
18	<i>Eria caribae</i>	11-13	2-3	Linear-lanceolate	Acute	3	Pale yellow	More or less recurved
19	<i>Eria coronaria</i>	16-19	6-9	Obtuse-lanceolate	Acute	3	White	Glabrous
20	<i>Eria crassicaulis</i>	10-11	3-4	Oblong	Obtuse	5-7	Yellow	Pubescent
21	<i>Eria cristata</i>	5	1.2	Lanceolate	Acute	3	White	Glabrous
22	<i>Eria eccurva</i>	5	1	Elliptic-lanceolate	Acute	5	White	Membranous
23	<i>Eria extinctaria</i>	9	4	Oblong-lanceolate	Obtuse	3	White	Membranous
24	<i>Eria ferruginea</i>	12-14	5-6	Obovate	Obtuse	5	Yellow	Many branch veins
25	<i>Eria glandulifera</i>	8	1.5	Oblong-lanceolate	Acute	3	White	Falcate, glabrous, gland dotted
26	<i>Eria globulifera</i>	2.5-3	2	Oblong-lanceolate	Obtuse	3	White	Membranous
27	<i>Eria graminifolia</i>	6-9	1.5-2	Elliptic-lanceolate	Obtuse	3	White	Glabrous
28	<i>Eria javanica</i>	15	2	Lanceolate-oblong	Acute	3	White	Glabrous
29	<i>Eria jengjengensis</i>	5-6	1.5	Ovate-lanceolate	Acute	3	Yellow	Margin at apex incurved
30	<i>Eria lacei</i>	5	2	Oblong	Obtuse	5	Yellowish white	Glabrous
31	<i>Eria lanceps</i>	10	1	Lanceolate	Acute	3	Yellow	Falcate or spatulate
32	<i>Eria lasiopedala</i>	9-10	4	Oblong	Obtuse	5	Yellow	White pubescens
33	<i>Eria margensis</i>	2	0.8	Elliptic	Acute	1	Yellowish	Glabrous
34	<i>Eria mucicola</i>	2-3.4	0.6-0.9	Lanceolate-oblong	Auminate	3	White	Edge thin, glabrous
35	<i>Eria napidenya</i>	10	4	Lanceolate	Obtuse	3	Yellow	Falcate
36	<i>Eria obesa</i>	10-12	2	Oblong-lanceolate	Obtuse	5	White	Glabrous
37	<i>Eria occidentalis</i>	5-6	2.5-3	Oblong	Acute	3	Green	Glabrous, pinkish tint
38	<i>Eria paniculata</i>	3-4	1.5-2	Lanceolate-oblong	Obtuse	3	White	Slightly crose
39	<i>Eria pumila</i>	6	2	Elliptic-lanceolate	Acute	3	Yellow	Sparely hairy
40	<i>Eria puhkarenata</i>	6-6.5	1.5-2	Lanceolate	Obtuse	3	Yellow	Thin
41	<i>Eria pudica</i>	4-4.5	2	Elliptic-oblong	Obtuse	3	White	Falcate, shallowly bi-lobed apex
42	<i>Eria pumila</i>	2.5	1	Oblong	Acute	1	White	Membranous
43	<i>Eria pusilla</i>	4	2	Lanceolate	Acute	1	Pale yellow	Narrow and unequal
44	<i>Eria shornuae</i>	8-9	3.5-4	Elliptic-lanceolate	Obtuse	3	Yellow	Deep purplish
45	<i>Eria sikkimensis</i>	2-2.4	0.6-0.9	Narrowly lanceolate	Acute	3	Greenish	Membranous thin edge, glabrous
46	<i>Eria spicata</i>	2.5-3	2	Ovate or oblong	Obtuse	1	White	Glabrous
46	<i>Eria stricta</i>	2-3	1.5-2	Ovate-rotund	Obtuse	1	White	Membranous, thin edge
48	<i>Eria tomentosa</i>	10	2.7	Obtuse-lanceolate	Acute	3	Yellow	Slightly falcate
49	<i>Eria vitata</i>	10	2	Ligulate	Obtuse	3	Whitish	Thick, and falcate

The ornamentation on the labellum surface of *Eria* is variable within the species. Most of the Himalayan species have with or without callus, keels, and ridges on the disc of labellum. Following ornamentation type has been observed in the labellum of Himalayan *Eria* (Fig. 3).

Type A. Without orientation on the disc of labellum: *E. sikkimensis*, *E. apertiflora*, *E. bipunctata*, *E. spicata*, *E. globulifera*, and *E. occidentalis*.

Type B. Callii at the base of labellum: *E. muscicola*, *E. pusilla*, *E. biflora*, *E. jengingensis* and *E. pumila*.

Type C. Callii on the disc of labellum: *E. lasiopetala*, *E. tomentosa*, *E. nepalensis*, *E. laniceps*, *E. arunachalensis*, *E. excavata*, and *E. pokharensis*.

Type D. Papillose keel on disc: *E. merguensis*, *E. bambusifolia*, *E. crassicaulis*, *E. cristata*, *E. pudica*, *E. clavicaulis*, and *E. glandulifera*.

Type E. Lamellate keels on the disc: *E. acervata*, *E. alba*, *E. amica*, *E. bractescens*, *E. connata*, *E. graminifolia*, *E. concolor*, *E. baniaii*, and *E. obusa*.

Type F. Ridge on the disc: *E. sharmae* and *E. carinata*.

Type G. Cruneate keels from base to apex: *E. javanica*, *E. braccata*, *E. clausa*, *E. coronaria*, *E. corneri*, and *E. vittata*.

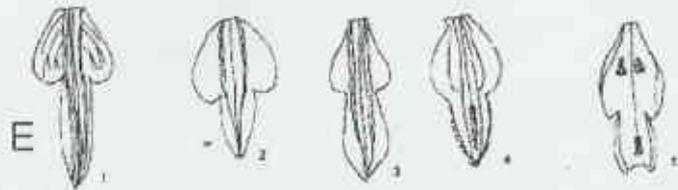
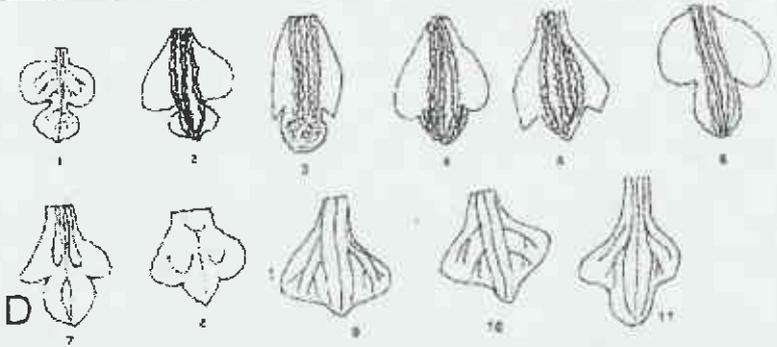
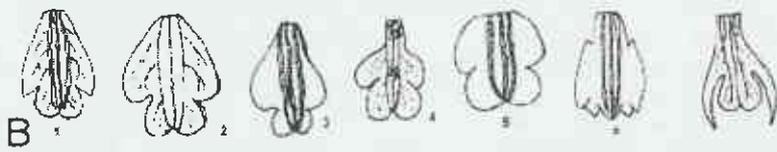
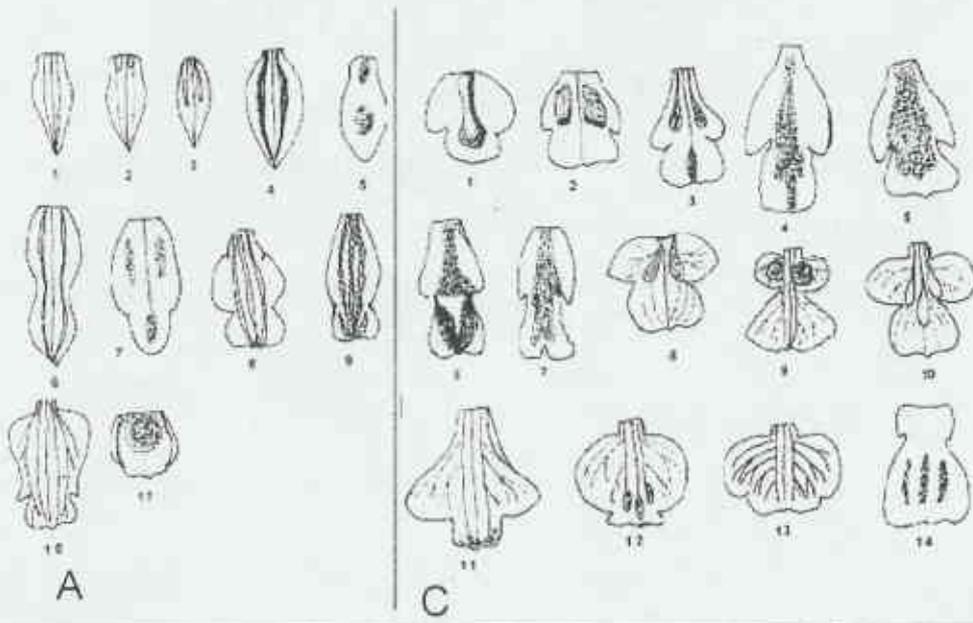
► Others types (keels and callii on the disc of labellum):

1. Undistinct keels: *E. exteintoria*, *E. lacei*
2. Glandular callii: *E. pannea*
3. Irregular callii: *E. ferruginea*
4. Clavated callii: *E. paniculata*
5. Depressed callii: *E. stricta*
6. Circular callii on the lateral lobe: *E. bhutanica*

Two varieties of *Eria muscicola* are recognized, based on the presence or absence of the callii on the base of labellum. The *E. muscicola* has two small callii at the base, where as in *E. sikkimensis* callii are absent at the base of the labellum.

In *Eria*, the labellum is attached at the base of column and usually spreading in flower. In comparison to sepal and lateral petals, the labellum is initiated late in the ontogeny. It is comparatively larger than sepal and petals.

Thus the characters of labellum are usually diagnostic one with regard to delimitation of species and the variety of *Eria*. A few sections are also delimited by the character of labellum. (Table 7).



3.3.1.12 Column

The column of *Eria* is generally, 0.2 - 0.5 mm long, sub-erect or semi terete to some what clavate, and may stout or slender, straight or incurved. The general shape of the column is more or less constant in *Eria*. The filaments are fused along the whole length of the style to form column. There is presence of a single outer fertile anther. The anther is inserted near the stigma base, which does not extend above the rostellum. The anther is inserted on the filament at or near, rarely below the base of the stigma with broad or narrow base of the operculum. It does not extend above the rostellum. The anther is terminal and incumbent and flexibly attached by short connective on distinct collar like clinandrium. The anther is usually provided with wart on its tip. It is bilobulate or incompletely quadrate and dehisces ventrally by slits. Its outline is variable depending on the straight ontogenetic development, but the shape of the apex is usually constant over time and is sometimes of taxonomic importance. The apex of the anther is mostly acute or obtuse.

The anther contains eight relatively hard pollinia, which are laterally flattened to fusiform or clavate, obovoid in shape. They are always quite entire and connected to the viscidium by short caudicle. It is difficult to observe the exact limit between pollinium and caudicle. The viscidium is minute, more or less orbicular or quadrate or ellipsoid and extremely fragile, and the stipe is absent.

The pistil is short and stigma directed forward to incumbent anther. The stigma consists of three lobes. The lateral lobes are somewhat orbicular or laterally oblong with distinct depresses, and median lobe modified to rostellum. The rostellum is flat, entire, triangular and ligulate. It is bent towards the stigmatic cavity in some species.

A long terete foot is found in *Eria muscicola*, *E. vittata*, *E. laniceps*, *E. obesa*, *E. acervata*, *E. connata*, *E. clavicaulis*, *E. lohitensis*, and *E. crassicaulis*, while remaining species have short column foot. In *E. graminifolia*, *E. amica*, and *E. alba* the foot is prominent and agglutinate with ovary. In *E. bractescens* white minutely hairy spot is present at the centre of the foot. Moreover, thin membranous wings are present in the foot of *E. crassicaulis*.

The stigmatic cavity is mostly entire, but some of the species are the bi-lobed inside the cavity. The bi-lobed species are *Eria ferruginea*, *E. laniceps*, *E. lasiopetala*, *E. obesa*, *E. bractescens*, *E. acervata*, *E. excavata*, *E. pokharensis*, *E. sharmae*, *E. graminifolia*, *E. apertiflora*, *E. pumila*, *E. globulifera*, *E. spicata*, *E. biflora*, and *E. clavicaulis*. Furthermore, *E. braccata* has stellate marking in the stigmatic cavity, triangular in *E. lacei*, sub-globular in *E. clausa*. "U" shaped in *E. stricta*, "V" shaped thickening at the base in *E. tomentosa*, and kidney shaped in *E. pudica*, which shows taxonomic importance for the delimitation of the genus *Eria*.

3.3.1.13 Fruit and seeds

The fruit of *Eria* is uniloculate, ellipsoid, with 6 - 8 longitudinal keels; with extent, shriveled column constituting a small beak. In species with characteristic column morphology, the shriveled

column on a capsule is in combination with vegetative characters. In most of the species, the labellum may also persist for longer period on the ripening capsule and may likewise facilitate the identification of fruiting specimens. The shape of the capsule is almost uniform throughout the genus. The seeds are numerous, transparent in colour, and consists of ellipsoid to fusiform embryo, enclosed in a papery testa in all the species. The details of seed morphology are discussed in Chapter V.

Table 7: Comparative study of Labellum morphology of the genus *Eria* Lindl.

Scientific name	Labellum										Lateral lobe			Terminal lobe		Distinguished character on disc
	Outline	L (mm)	B (mm)	Shape	Apex	Margin	Veins	shape	Apex	margin	shape	Apex	Margin	Apex	Margin	
<i>E. acervata</i>	Tri lobed	6-8	5	Obovate	Apiculate	Entire	3	Oblong	Obtuse	Entire	Entire	Obtuse	Entire	Apiculate	Entire	Three lamellae keels, erect lamellae at base and central, oblong at apex
<i>E. alba</i>	Tri lobed	8	4	oblong	Obtuse	Entire	3	Triangular oblong	Obtuse	Entire	Entire	Obtuse	Entire	Acute or apiculate	Entire	Three lamellae ridge between the lateral lobe, slender, and macular one at the terminal lobe
<i>E. amica</i>	Tri lobed	10	5	Spatulate	Acute	Entire	3	Triangular	Obtuse	Entire	Entire	Obtuse	Entire	Emerginate	Wavy	Three lamellae keels from base to apex,
<i>E. apertiflora</i>	Tri lobed	2.5-3	2	rhomboid	Obtuse	Wavy	3	Semi-circular	Obtuse	Entire	Entire	Obtuse	Entire	Obtuse	Wavy	Relatively narrow at the base, thick at the tip, white with yellow at the tip, rarely purplish, no callus.
<i>E. arunchelensis</i>	Tri lobed	5.5-6	7	Obovate	Refuse	Entire	3	Auricular	Round	Entire	Entire	Round	Entire	Refuse	Hairy	Three calli in the upper half of labellum, middle callus placed above two lateral calli towards the apex of terminal lobe.
<i>E. bambusifolia</i>	Obscurely tri lobed	6-9	4-7	Ovale oblong	Obtuse, truncate	Entire	5	Oblong	Obtuse	Entire	Entire	Oblong	Entire	Oblong	Entire	Three mealy papillose keels
<i>E. banail</i>	Simple	ca. 4.5	3	Ovale	Acute	Entire	3			Entire	Entire		Entire		Entire	
<i>E. bhutanica</i>	Tri lobed	5	3	Obrullate	Obtuse	Entire	3	Oval	Obtuse	Entire	Entire	Obtuse	Entire	Tridentate	Entire	Disc with three pink calli
<i>E. biflora</i>	Simple or obscurely tri-lobed	40	3	Ovale oblong	Incurved	Entire	no	Incurved	Acute	Entire	Entire	Acute	Entire	Obtuse	Entire	Two circular ridge on the disc between lateral lobe, base
<i>E. bipunctata</i>	Tri lobed	3	2.5	Rhomboid	Obtuse	Entire	3	Triangular	Obtuse	Entire	Entire	Obtuse	Entire	Obtuse	Entire	2 smooth oblong lamellae keels from base to apex
<i>E. braccata</i>	Tri-lobed	17-22	2	Oblong obovate	Acute/obtuse	Entire	3	Oblong	Acute	Entire	Entire	Acute	Entire	Obtuse	Entire	No callus
<i>E. bradesiens</i>	Tri lobed	7 to 10	6	Oblong	Emerginate	Entire	3	Rounded falcate	Obtuse	Entire	Entire	Obtuse	Entire	Obtuse	Entire	Two narrow yellow crest running from base of lip beyond lateral lobe
<i>E. carinata</i>	Tri-lobed	14-20	5-6	Oblong	Apiculate	Wavy	many	Ob-lanceolate	Round	Entire	Entire	Round	Entire	Wrinkled	Entire	Three papillose lamellae keels running from base to apex
<i>E. clausa</i>	Tri-lobed	9 to 10	6	Oblong	Obtuse	Entire	3	Rounded	Obtuse	Entire	Entire	Dellexed	Entire	Obtuse	Entire	3 to 5 ridge from base to apex apex, crimson
<i>E. clarivalis</i>	Tri-lobed	10 to 20	10	Oblcordate	Emerginate	Entire	3	Rounded	Obtuse	Entire	Entire	Obtuse	Entire	Emerginate	Wavy	5 to 7 amellata keels from base to lip of labellum
<i>E. concolor</i>	Obscurely tri-lobed	6-7	2	Oblong	Acute/obtuse	Entire	3	Narrow		Entire	Entire		Entire		Entire	The papillose callus strong yellow edge: hypochile obovate, epichile orbicular
<i>E. cornata</i>	Tri lobed	6-6.5	2-2.5	Ob-lanceolate	Warty	Entire	3	Narrow	Triangular	Entire	Entire	Triangular	Entire	Emerginate	Wavy	Three thick keels on the disc, merging at apex of epichile between two half moon shape cushion, median keels with distinct swelling base
<i>E. cornuti</i>	Tri-lobed	9-10	6-8	Ovate-rhomboid	Obtuse	Entire	3	Semi oblong	Round	Entire	Entire	Round	Entire	Obtuse	Wavy	3 ridges, lateral ridge broader thick

Table 7: Comparative study of Labellum morphology of the genus *Eria* Lindl. Contd...

Scientific name	Labellum				Lateral lobe			Terminal lobe		Distinguished character on disc		
	Outline	L (mm)	B (mm)	Shape	Apex	Margin	Veins	shape	margin		Apex	Margin
<i>E. coronaria</i>	Tri lobed	16-17	9-10	Oblong orbicular	Obtuse	Wavy	3	Triangular	Wavy	Obtuse	Undulate	5-7 crenate ridge on the surface of lip
<i>E. crassicaulis</i>	Tri lobed	7-9	8-9	Ovale	Obtuse	Entire	3	Arctular	Wavy	Emarginated	Warty	Three furturaceous keels at the claw axis and terminal lobe
<i>E. cristata</i>	Tri lobed	8	8	Rectangular	Obtuse	Entire	Indistinct	Sub orbicular	Wavy	Truncate	Wavy	Three papillose keels on the disc, one papillose keels on the middle of terminal lobe, base of keels erect and glossy
<i>E. excavata</i>	Tri lobed	8	4	Obovate	Occasionally emarginate	Entire	3	Rounded	Entire	Acute bilobulate	Entire	Two elongated calli from base to middle of the lateral lobes
<i>E. extirpata</i>	Tri lobed	9	8	Ob cordate orbicular	Bilobulate	Wavy	3	Rounded	Wavy	Bilobulate	Wavy	No distinct keels, three obscure minute papillose hairy like warty distally at the centre of labellum
<i>E. ferruginea</i>	Tri lobed	10-12	13-14	Horse shoe	Bilobulate	Serrate	3	Lanceolate small	Entire	Bi-lobed	Serrate	Irregular keels, crested dentate lamellae converging from the lateral lobe; saccate like on hypochile, epichile irregular large, crisped
<i>E. grandiflora</i>	Tri lobed	5-7	3	Oblong	Acute	Hairy	3	Round	Entire	Acute	Hairy	Vertical hairy ridge on the disc
<i>E. globulifera</i>	Tri lobed	1.8-3	1	Oblong	Obtuse	Entire	3	Semicircular	Entire	Obtuse	Entire	No callus
<i>E. graminifolia</i>	Tri lobed	5-8	4-5	Broadly oblong	Emarginate	Entire	3	Oblong	Entire	Obtuse or Emarginate	Entire	Three unequal fleshy lamellae ridge at base, central ridge large, oblong callus, terminating above the base of terminal lobe
<i>E. javanica</i>	Tri lobed	10	2	Narrowly oblong	Obtuse	Entire	3 to 5	Oblong, rounded	Entire	Obtuse	Entire	3-5 longitudinal keels from base to apex
<i>E. junciformis</i>	Tri lobed	5	1.8	Decurved	Micro	Entire	3	Oblong	Entire	Acute	Entire	Three calli on the middle infolded at margin calli at the centre
<i>E. laevis</i>	Tri lobed	10-13	4	Orbicular	Obtuse	Wavy	3	Circular, broad	Deflexed	Obtuse	Crenulate	Undistinct orientation on the disc, without claw, gradually swelling upward, Yellow dotted on tip.
<i>E. laniceps</i>	Tri lobed	7-10	4	Oblanceolate	Apiculate	Entire or wavy	Not distinct	Oblong	Entire	Rounded	Wavy	Three apiculate near the apex more or less, truncate, notched, small recurved
<i>E. lasiopetala</i>	Tri lobed	14	10	Oblong	Emarginate	Entire	Not distinct	Semicircular	Entire	Obtuse	Entire	Three callus on the disc
<i>E. meruensis</i>	Tri lobed	1.8-2	1.8	Rectangular	Truncate	Entire	Not distinct	Auricular like	Entire	Obtuse	Entire	Two fat longitudinal calli at disc

Table 7: Comparative study of Labellum morphology of the genus *Eria* Lindl.

Scientific name	Labellum											Terminal lobe			Distinguished character on disc
	Outline	L (mm)	B (mm)	Shape	Apex	Margin	Veins	shape	Lateral lobe		Apex	shape	Margin		
									Apex	margin					
<i>E. muscivora</i>	Simple	2	0.9-1	Oblong lanceolate	Erosete	Entire	3	.	Acute	-	-	Serrate	Trioblong	Two calli at base	
<i>E. nepalensis</i>	Tri lobed	1.3	0.6-0.7	Rectangular linear oblong	Acuminate, obtuse	Crenate	No distinct	Small	-	-	-	Crenate	Emerginate obtuse	Triangular calli at apex and kidney shaped on both side of epichile	
<i>E. obesa</i>	Simple	7	2	Linear oblong	Obtuse	Wavy	3	.	-	-	-	Wavy	Obtuse	3 thickened keels from base to apex	
<i>E. occidentalis</i>	Tri lobed	4.5	2	Fan shaped Sub orbicular	Bicupulate	Entire	3	Orbicular	Obtuse	Entire	Entire	Entire	Blotulate	No keels or callus	
<i>E. paniculata</i>	Tri lobed	3-4	2-4	Sub orbicular	Acute	Entire	No	Sub oblong	Sub acute	Entire	Entire	Erosete	Obtuse	a large elevated, concave, disciform calli on the base to the apex.	
<i>E. pauciflora</i>	Simple	8	3	Ovate	Obtuse	Weakly undulate	No distinct	.	-	-	-	Undulate	Obtuse	Granular calli in the base and near apex. A patch of white fleshy hairiness near apex	
<i>E. podivarsata</i>	Tri lobed	5	4	Rectangular	Obtuse	Hairy	3	Circular	Obtuse	Hairy	Hairy	Entire	Trioblong	Two calli near the lateral lobes.	
<i>E. poeppigii</i>	Tri lobed	3-4.5	2 to 3	Oblong	Acute	Entire	3	Oblong	Sub acute	Entire	Wavy	Entire	Triangular	2 keels on the disc	
<i>E. purpurea</i>	Tri lobed	2	1.5	Broadly oblong	Blotulate	Entire	3	Lanceolate	Acuminate	Entire	Entire	Wavy	Bilobulate with sinus	Two calli lateral lobe tooth like, two fat calli at the base of the labellum	
<i>E. poellii</i>	Simple	5	2	Lanceolate	Acute	Repose	3	.	-	-	-	Erosete	Acute	2 longitudinal keels on the proximal end of labellum	
<i>E. sharmasii</i>	Tri lobed	9 to 10	4 to 5	Obovate oblong	Emerginate	Entire	3	Ovals / broadly triangular	Acute	Entire	Entire	Entire	3-lobulate, emerginate	Three thickened ridged from the base extending parallel to apical lobe	
<i>E. ankamensis</i>	Simple	2	0.5-1.2	Ovate oblong	Erosete	Entire	3	.	-	-	-	Serrate	Acute	Without calli at base	
<i>E. apicata</i>	Tri lobed	3-3.5	4	Fan shaped	Obtuse	Entire	3	Triangular / round	Obtuse	Entire	Entire	Entire	Obtuse	No callus on the disc	
<i>E. stricta</i>	Obsoletely Tri lobed	1-3	1.5-2	Suborbicular	Acute	Entire	no	Sub-orbicular	Rounded	Entire	Entire	Entire	Truncate	Depressed calli present between the lateral lobe on disc	
<i>E. tomentosa</i>	Tri lobed	10-12	8-9	Oblong	Obtuse	Wavy	3	Narrow	Obtuse	Wavy	Wavy	Wavy	Emerginate	y figure narrow keel near the apex	
<i>E. villosa</i>	Simple	5	2 to 3	Oblong	Obtuse	Crenulate	3	.	-	-	-	Crenulate	Decurved	5 crenulate ridge from base to apex	

3.3.2 Taxonomy

3.3.2.1 Description of the genus *Eria* Lindl.

Eria Lindley, in Edwards's Bot. Reg. 11 (1825), t. 904. (*nom. cons.*)

Callostylis Blume, *Bijdr.*: 340 (1825).

Ceratium Blume, *Bijdr.*: 341 (1825).

Dendrolirium Blume, *Bijdr.*: 343 (1825).

Mycaranthes Blume, *Bijdr.*: 352 (1825).

Octomeria D.Don, *Prodr. Fl. Nepal.*: 31 (1825), *nom. illeg.*

Pinalia Buch.-Ham. ex Lindl., *Orchid. Scelet.*: 21 (1826).

Tylostylis Blume, *Fl. Javae*: 6 (1828).

Erioxantha Raf., *Gard. Mag.* (London) **8**: 247 (1832).

Bryobium Lindl., *Intr. Nat. Syst. Bot.*, ed. **2**: 446 (1836).

Exeria Raf., *Fl. Tellur.* **4**: 49 (1838).

Pierardia Raf., *Fl. Tellur.* **4**: 41 (1838), *nom. illeg.*

Trichosma Lindl., Edwards's Bot. Reg. **28**: t. 21 (1842).

Xiphosium Griff., *Calcutta J. Nat. Hist.* **5**: 364 (1845).

Conchidium Griff., *Not. Pl. Asiat.* **3**: 321 (1851).

Alvisia Lindl., *Fol. Orchid.* **8**: 1 (1859).

Forbesina Ridl., *J. Bot.* **63**(Suppl.): 120 (1926).

Aeridostachya (Hook.f.) Brieger, *Schlechter Orchideen* **1**(11-12): 714 (1981).

Campanulorchis Brieger in R.Schlechter, *Orchideen*, ed. **3**, **1**(11-12): 750 (1981).

Cylindrolobus (Blume) Brieger in R.Schlechter, *Orchideen*, ed. **3**, **1**(11-12): 664 (1981).

Cymboglossum (J.J.Sm.) Brieger in R.Schlechter, *Orchideen*, ed. **3**, **1**(11-12): 649 (1981), *no basionym ref.*

Dilochiopsis (Hook.f.) Brieger, *Schlechter Orchideen* **1**: 662 (1981).

Dolichopsis (Hook.f.) Brieger, *Schlechter Orchideen* **1**: 622 (1981), *nom. illeg.*

Gunnarorchis Brieger, *Schlechter Orchideen* **1**(11-12): 650 (1981).

Urøstachya (Lindl.) Brieger, *Schlechter Orchideen* **1**(11-12): 716 (1981).

Ascidieria Seidenf., *Nordic J. Bot.* **4**: 44 (1984).

Hymeneria (Lindl.) M.A.Clem. & D.L.Jones, *Orchadian* **13**: 501 (2002).

The habit of *Eria* species is highly variable, ranging from epiphytic to rarely terrestrial polymorphic herbs. The size of the **pseudobulbs** varies from ca. 0.2 cm (*E. lacei*) to 90 cm high (*E. bambusifolia*). They have one to several internodes, which are slender or thick and fleshy with a long or short creeping basal portion. Some species totally lack pseudobulbs (*E. paniculata*), instead fleshy leafy stems are observed. Some species bear two - many **leaves**, and are rarely 1-leaved (*E. carinata* and *E.*

pudica). The **stem** is leafy throughout or near the apex only, which is flat or terete, duplicate or rarely convolute (*E. javanica*), thin-textured to coriaceous and entire. The basal part is covered with sheaths. There is a great diversity in leaf size and its persistence. **Inflorescence** are terminal racemes or axillary, rarely 1-flowered on the tip of the pseudobulbs (*E. braccata*), or usually lateral from upper part of the pseudobulb, erect or pendulous, the rachis often hirsute or woolly. **Flowers** are few or numerous, resupinate, mostly small to medium sized, 0.2 cm (*E. exilis*) to 4.0 cm (*E. javanica*), glabrous or sometimes pubescent outside, rarely showy and may have brightly coloured, large and narrow conspicuous bracts. The **sepals** are subequal, free; the lateral sepals larger, the dorsal one free, the lateral one often oblique at the base and sometimes adnate or connate to the foot of the column, forming a short or comparatively long chain forming a short to long and spur-like or saccate mentum. **Petals** are similar to the dorsal sepal. The **labellum** is attached to column foot and is inseted on it; the labellum are usually tri lobed or some are obscurely tri-lobed or simple (*E. muscicola*, *E. sikkimensis*, *E. pusilla*, and *E. vittata*), entire or erose, sessile, with or without keels; the base of the labellum not form any spur by uniting with edges of column foot. **Column** concave, short, broad, more or less 2-winged, the base elongate with prominent foot, clinandrium collar like. **Anther** is terminal, incumbent, operculate, hard and mobile, mainly 2-celled or imperfectly 4- or 8- celled in each lobe. **Pollinia** 8, in two groups of 4, waxy, laterally flattened, ovoid or pyriform, each groups with single caudicle, which is sticky and attached in 2 pairs of four by narrow bases to the viscidium, which is single and bent towards the stigmatic cavity, the rostellum ligulate. **Stigma** is curved, entire or lobed inside the cavity. The **pedicel and ovary** is long or short, woolly or glabrous in nature.

Note: According ICBN rules, *E. stellata* Lindl. (= *E. javanica*) is the conserved as type species of the genus *Eria*. It cannot be removed from the genus *Eria* without a major nomenclatural overhaul. Aactually, Lindley (1825) described the genus *Eria*, based on the material *Dendrobium pubescens* Hook., in Edward's *Bot. Reg.* t. 904. In this publication, he mentioned that "this genus has been founded in the work above cited upon a remarkable plant from Nipal, the *Dendrobium pubescens* of Professor Hooker, and the subject of this article. It differs from all the other genera, having the flower of *Dendrobium* in the number of its pollen masses with exception of *Octomeria*". Lindley (1825) did not gave the binominal name of *Dendrobium pubescens* as *Eria pubescens* in the first published description of the genus. But Lindley (1830) mentioned *E. pubescens* (= *E. lasiopetala*) Lindl. *Bot. Reg.* t. 904 as synonym of *E. flava*. But there is no any reference about it in *Bot. Reg.* t. 904. So it became the problem for the typifiction of genus *Eria* based on *Dendrobium pubescens* as type of the genus. He also cited at the end as 'Collectanea Botanica 42B in edita' in his first published description. When turning the plate in the question there is the figure of *E. stricta* Lindl. *sp. nov.*, but there is no reference to the *D. pubescens* nor *E. stellata*, which was published in 1826. There is some confusion about the date of publication of *Collectanea Botanica*. Most of the reference refer that date of *Coll. Bot.* is published in 1826. The genus name *Eria* was first publshed by Lindley in his "Gen. Spec. Orch. Pl. 63 (May 1830). When the question about the typification was raised, ICBN considered naturally that *E. stellata* being the first epithet with binominal nomaclature appear in print in Edwards's *Bot. Reg.* t.904 (1825), and the type of the

genus *E. stellata* was conserved in 1905. However, there is no doubt that *Dendrobium pubescens* should be indeed the holotype of the genus *Eria*, under the present Code of Botanical Nomenclature and Bot. Reg. 1825; sub t. 904. However, Lindley (1825) forgot to draw the consequences by transferring that taxon to *Eria*, so for the time being, we have to accept the general opinion as *E. stellata* is the type of the genus *Eria*.

Seidenfaden (1982) also discussed the question of the type species of the genus and deal more detailed about it. He also emphasized that it is of more than academic interest because when the genus is split up, the epithet *Eria* will follow the type species and for all the taxa removed from the group containing this and new combination will be needed. He also suggested that a species of the section *Hymeneria* would be much more appropriate as nomenclatural type, as this would permit retention of the name *Eria* for most of the species now known under this name.

In the present study, it is also tried for the re-typification of the genus *Eria*, based on the Himalayan species, which is not justified for the other species of *Eria*. But on the basis of cladistic analysis it shows that the genus *Eria* might be *Eria* s.s and can be divided into two groups. Dressler (1993) also mentioned that we need to resolve the nomenclatural problem and to know about the feature of the *Eria* in the broad sense before new combination. The present study concluded that much broader knowledge is necessary and re-typification of the genus will only possible after the detail regional revision on the genus *Eria*.



Fig. : 4 *Eria javanica* (Swartz) Blume, (Type material copied from Bot. Reg. t. 904, 1825)

3.3.2.2 .Synopsis of the classification of the genus *Eria* Lindl.

Family: Orchidaceae

Subfamily Epidendroideae

Tribe Podochileae

Subtribe Eriinae

Genus *Eria* Lindl.

Section I **Conchidium** (Griff.) Lindl.: *Eria braccata* Lindl., *E. pusilla* (Griff.) Lindl., *E. muscicola* (Lindl.) Lindl. *E. sikkimensis* D. M. Bajracharya & K. K. Shrestha, *E. lacei* Summerhayes, *E. extinctoria* Oliver

Section II **Eria** : *E. javanica* (Sw.) Blume

Section III **Xiphosium** (Griff.) Lindl.: *E. carinata* Gibson ex Lindl.

Section IV **Trichosma** Lindl.

Series I Coronariae D. M. Bajracharya & K. K. Shrestha : *E. coronaria* (Lindl.) Rchb.f.

Series II Clausae D. M. Bajracharya & K. K. Shrestha : *E. clausa* King & Pantl. *E. vittata* Lindl., *E. corneri* Rchb.f.

Section V **Strongyeria** Pfitz: *E. pannea* Lindl..

Section VI **Dendrolirium** (Blume) Lindl.

Series I Pubesentae D. M. Bajracharya & K. K. Shrestha : *E. lasiopetala* (Willd.) Ormerod, *E. laniceps* Rchb.f, *E. nepalensis* D. M. Bajracharya & K. K. Shrestha, *E. tomentosa* Hook.f.,

Series II Ferruginae: D. M. Bajracharya & K. K. Shrestha : *E ferruginea* Lindl.

Section VII **Mycarathes** Rchb.f: *E. paniculata* Lindl.

Section VIII **Secundae** Leavitt: *E. stricta* Lindl., *E. merguensis* Lindl.

Section IX **Cylindrolobus** Blume: *E. biflora* Griff., *E. cristata* Rolfe., *E. glandulifera* Deori & Phukan, *E. arunachalensis* A.. N. Rao, *E. jungingensis* Hedge, *E. clavicaulis* Lindl.,

Section X **Bambusifoliae** Hook. f. : *E. bambusifolia* Lindl., *E. crassicaulis* Hook.f.

Section XI **Hymeneria** Lindl.: *E. pudica* Ridley, *E. concolor* Par. & Rchb.f, *E. obesa* Lindl., *E. amica* Rchb.f, *E. sharama* Chowdhery & al., *E. bhutanica* D. M. Bajracharya & K.K. Shrestha, *E. pokharensis* D. M. Bajracharya & K.K. Shrestha, *E. acervata* Lindl., *E. excavate* Lindl., *E. graminifolia* Lindl., *E. baniaii* D. M. Bajracharya, & al., *E. bractescens* Lindl., *E. alba* Lindl..

Section XII **Pinalia** (Lindl.) Seiden.: *E. connata* Joseph & al., *E. pumila* Lindl., *E. spicata* (D.Don) Hand.-Mazz, *E. bipunctata* Lindl., *E. apertiflora* Summerhayes, *E. glabulifera* Seiden., *E. occidentalis* Seiden.

3.3.2.3 key to the sections of the genus *Eria* Lindl

- 1.a Pseudobulb or stem consisting of 1- distinct internodes 2
- 1.b Pseudobulbs or stems consisting of many internodes 5
- 2.a Pseudobulbs depressed, **I Conchidium**
- 2.b Pseudobulbs ovoid to oblong –ovoid or cylindrical 3
- 3.a Leaves convolute in bud; flower 3-3.5 cm across, strongly fragrant **II Eria**
- 3.b Leaves conduplicate in bud; flower ca. 2 – 20 mm across, not fragrant 4
- 4.a Plant with only one leaf; floral bracts conspicuously large longer than pedicel and ovary---
..... **III Xiphosium**
- 4.b Plant with 2 or more leave; floral bracts inconspicuously shorter than pedicel and ovary ---
..... **IV Trichosma**
- 5.a Leaves terete, < 4 mm wide **V Stongyeria**
- 5.b Leaves flat and resupinate > 4 mm wide 6
- 6.a Pseudobulb loosely arranged on creeping rhizome; Inflorescence arises from the base of
pseudobulb; flowers large, > 3 cm **VI Dendrolirium**
- 6.b Pseudobulb or stems dense; Inflorescence arise from the apex of pseudobulb; flower
small, 7
- 7.a Labellum with a central linear white mealy band from base to apex; callus present;
..... **VII Mycaranthes**
- 7.b Labellum without band and callus 8
- 8.a Flowers small < 1 cm, congested on inflorescence; ditichous on rachis; stem sheaths
inconspicuous..... **VIII Secundae**
- 8.b Flower large > 1 cm; if flowers small, then loosely arranged 9
- 9.a Inflorescence lateral with two flowers, rarely 1 flowered; glabrous outside; floral bract
large; labellum with 2 variously shaped thickened appendages **IX Cyliandrolobus**
- 9.b Inflorescence terminal or lateral many flowered; pubescent or glabrous outside; floral bract
small; labellum disc without above appendage 10
- 10.a Stem clavate; leaves numerous borne throughout stem; distichous, densely tomentose
flowers; obscurely tri-lobed labellum **X Bambusifoliae**
- 10.b Stem mostly dilated into pseudobulb; leaves five or more borne at apex, not distichous,
glabrous or pubescent flowers, distinctly tri-lobed or obscurely tri-lobed or simple 11
- 11.a Flowers large, median size flowers loosely arranged on rachis; the labellum adnate to
column foot with distinct joint; attached with a point to the column foot at acute angle
..... **XI Hymeneria**
- 11.b Flowers small, small size flowers congested on rachis, small size flowers; the labellum
with short claws, firmly connected to column foot without conspicuous joints; not above
..... **XII Panafia**

3.3.2.4 Discussion on Sections and Series of *Eria*

Reviewing different system of sectional key characters proposed by Reichenbach (1857, 1861), Lindley (1859), Bentham and Hooker (1883), Pfitzer (1888), J. D. Hooker (1890), J. J. Smith (1905), Ridley (1907), Leavitt (1909), Kranzlin (1911), Holttum (1957) Seidenfaden (1982), Averyanov (1994) and Pearce and Cribb (2002), the genus *Eria* is divided into number of sections, on the basis of nature of leaves, floweres; pseudobulbs, labellum and column characters. The sections described so far are: *Acervata*, *Aeridostachya*, *Ancipites*, *Bambusifoliae*, *Bryobium*, *Callostylis*, *Conchidium*, *Convolutae*, *Cylindrolobus*, *Dendrolirium*, *Eriura*, *Flavae*, *Hymenaria*, *Micranthes*, *Nutantes*, *Pinalia*, *Secundae*, *Stellata*, *Stongyleria*, *Trichosma*, *Tylostylis*, and *Xiphosium*.

Among the above sections, 12 sections have been accepted here for the Himalayan species of *Eria*, viz. *Conchidium*, *Xiphosium*, *Trichosma*, *Dendrolirium*, *Hymeneria*, *Micranthes*, and *Cylindrolobus* (Lindley 1859), *Bambusifoliae* (J. D. Hooker, 1890), *Eria* and *Pinalia* (Seidenfaden 1982), *Stongyleria* (Pftizer 1888), and *Sceundae* (Leavitt 1909).

Present study proposed the new series *Coronariae* and *clausae* in the section *Trichosma* and *Ferruginae* and *Pubescentae* in the section *Dendrolirum*. The former series are divided on the basis of ovoid vs. irregular shaped pollinia; and latter series are divided on the basis of nature of pseudobulbs and ornamentation labellum.

3.3.2.5 key to the species of the genus *Eria* Lindl.

- | | | |
|-----|---|---------------------------------|
| 1.a | Pseudobulb or stem consisting of 1- distinct internode | 2 |
| 1.b | Pseudobulbs or stems consisting of many internodes | 13 |
| 2.a | Pseudobulbs depressed | 3 |
| 2.b | Pseudobulbs ovoid to oblong –ovoid or cylindrical | 8 |
| 3.a | Pseudobulbs small, < 1 cm; flowers small to medium, 1-2 cm long | 4 |
| 3.b | Pseudobulbs large, > 1 cm; flowers large, ca. 3 cm long | 1. <i>E. braccata</i> |
| 4.a | Leaves with long seta, inflorescence with 1 or 2 flowered | 2. <i>E. pusilla</i> |
| 4.b | Leaves without seta, inflorescence with 2-3 (-6) flowered | 5 |
| 5.a | Pseudobulbs discoid, covered by fine reticulate network, inflorescence more than 4 flowered | 6 |
| 5.b | Pseudobulbs globular, without reticulate network inflorescence less than 4 flowered | 7 |
| 6.a | Labellum with callii at base | 3. <i>E. muscicola</i> |
| 6.b | Labellum without callii | 4. <i>E. sikkimensis</i> |

-
- 7.a Dorsal sepal 8-9 mm long, terminal lobe of labellum orbicular, apex wavy-crenulate -----
-----5. **E. lacei**
- 7.b Dorsal sepal ca. 4 mm long, terminal lobe of labellum rounded, apex bilobulate, -----
-----6. **E. extinctoria**
- 8.a Leaves convolute in bud; flowers 3-3.5 cm across, strongly fragrant -----7. **E. javanica**
- 8.b Leaves conduplicate in bud; flower less than 3 cm across, not strongly fragrant as above --
----- 9
- 9.a Pseudobulbs with only one leaf; floral bract 2-4cm, conspicuously longer than pedicel and
ovary -----8. **E. carinata**
- 9.b Pseudobulbs with 2 or more leaves; floral bract inconspicuously shorter than pesicel and
ovary -----10
- 10.a Pseudobulbs slender, cylindrical, open flowered, pollinia irregular, two larger and two
smaller Labellum without median keels on hypochile -----9. **E. coronaria**
- 10.b Pseudobulbs pseudobulbous, closed flowered, pollinia regular, all are identical in shape
and size Labellum with three keels from base to apex -----11
- 11.a Pseudobulbs loosely arranged; leaves less than 20 cm ----- 12
- 11.b Pseudobulb densely arranged; leaves 15-45 cm long -----10. **E. corneri**
- 12.a Inflorescence many flowered; sepal and petal with purplish brown stripes, labellum simple,
entire, lateral lobe indistinct -----11. **E. vittata**
- 12.b Inflorescence 1-or 3-6 flowered; sepal and petal without stripes; labellum tri-lobed, lateral
lobed distinct -----12. **E. clausa**
- 13.a Leaves terete, cylindrical < 4 mm wide, syanthous inflorescence, -----13. **E. pannea**
- 13.b Leaves flat, resupinate > 4 mm wide, other type of inflorescences ----- 14
- 14.a Pseudobulb loosely arranged on creeping rhizome; inflorescence arises from the base of
pseudobulb; flowers large, > 3 cm across ----- 15
- 14.b Pseudobulb or stems dense; Inflorescence arise from the apex of pseudobulb; flower
small, < 3 cm across, -----19
- 15.a Pseudobulb absent, inflorescence rust to olive tomentose; flowers > 2 cm across -----
-----14. **E. ferruginea**
- 15.b Pseudobulb present, inflorescence white or olive to yellow tomentose; flowers < 2 cm
across----- 16
- 16.a Pedicel plus ovary and sepals light brown tomentose, stigmatic cavity with 'V' shaped
thickened at base -----15. **E. tomentosa**
- 16.b Pedicel plus ovary and sepals white tomentose, stigmatic cavity with linear appendages
like lobed inside the cavity ----- 17
- 17.a Floral bract, ca. 10 (-15) mm long, labellum irregularly rectangular with broad -----
-----16. **E. laniceps**
- 17.b Floral bract ca. 20-40 mm or shorter, labellum oblong ----- 18

-
- 18.a Floral bract \pm 20 mm long, terminal lobe oblong, acute -----17. **E. lasiopetala**
- 18.b Floral bract 40 mm long, terminal lobe rectangular, emarginate -----18. **E. nepalensis**
- 19.a Labellum with a central linear white mealy band from base to apex; callus present -----
-----19. **E. paniculata**
- 19.b Labellum without band and callus -----20
- 20.a Flowers small < 1 cm, congested on inflorescence; -----21
- 20.b Flower large > 1 cm; if flowers small, then loosely arranged on rachis -----22
- 21.a Flowers secundae, Labellum with depressed callii -----20. **E. stricta**
- 21.b Flowers facing all ways labellum with two fat parallel longitudinal callii -----
-----21. **E. merguensis**
- 22.a Inflorescence lateral with two flowers, rarely 1 flowered; glabrous outside; floral bract large; labellum with 2 variously shaped thickened appendages -----23
- 22.b Inflorescence terminal or lateral many flowered; pubescent or glabrous outside; floral bract small; labellum disc without above appendage -----28
- 23.a Labellum entire or obscurely tri-lobed -----22. **E. biflora**
- 23.b Labellum distinctly tri-lobed -----24
- 24.a Pedicellate-ovary laterally curved, and glabrous -----23. **E. jengingensis**
- 24.b Pedicellate ovary erect, glabrous or pubescent -----25
- 25.a Floral bracts > \pm 1 mm, inflorescence 2 in numbers -----26
- 25.b Floral bracts < \pm 1 mm, inflorescence more than 2 in numbers -----27
- 26.a Flowers < \pm 2 cm, mentum round -----24. **E. clavicaulis**
- 26.b Flowers > \pm 2 cm, mentum "U" shaped -----25. **E. arunchalensis**
- 27.a Sepal acute, 5-nerved; terminal lobe of labellum broadly ovate; margin entire -----
-----26. **E. cristata**
- 27.b Sepal acuminate; 3-nerved; terminal lobe of labellum oblong; margin ciliate -----
-----27. **E. glandulifera**
- 28.a Stem clavate; leaves numerous borne throughout stem; distichous, densely tomentose flowers; labellum obscurely or distinctly lobed -----29
- 28.b Stem mostly dilated into pseudobulb; leaves five or more borne at apex, not distichous, glabrous or pubescent flowers, labellum distinctly or obscurely tri-lobed or simple -----30
- 29.a Labellum obscurely tri-lobed, rhomboid shaped; three mealy papillous keels on disc -----
-----28. **E. bambusifolia**
- 29.b Labellum tri-lobed, orbicular shaped; furfuraceous at claw axis and terminal lobe -----
-----29. **E. crassicaulis**
- 30.a Flowers large, median size flowers loosely arranged on rachis; the labellum adnate to column foot with distinct joint; attached with a point to the column foot at acute angle ----31

-
- 30.b Flowers small, small size flowers congested on rachis, small size flowers; the labellum with short claws, firmly connected to column foot without conspicuous joints; not above ----- 43
- 31.a Pseudobulb apically with 1 terminal leaf, inflorescence nearly as long as petiole -----
----- **30. E. pudica**
- 31.b Pseudobulbs apically with 2 or more leaves, inflorescence longer than petiole -----32
- 32.a Labellum entire or obscurely tri-lobed ----- 33
- 32.b Labellum distinctly tri-lobed ----- 35
- 33.a Flower greenish yellow, labellum obscurely tri-lobed with an indentation separating hypochile and epichile -----**31. E. concolor**
- 33.b Flower white or pink, labellum entire without indentation between hypochile and epichile ---
----- 34
- 34.a Sepals, petals and labellum white, bract entire, pedicel and ovary pubescent -----
----- **32. E. obesa**
- 34.b Sepals, petals and labellum pink, bract slightly erose, pedicel and ovary glabrous -----
----- **33. E. baniaii**
- 35.a Pseudobulb cylindric -----36
- 35.b Pseudobulb ovoid-ellipsoid ----- 37
- 36.a Pseudobulbs narrowly cylindric, ca. 4-9 cm tall, sepals and petals pale yellow -----
-----**34. E. bractescens**
- 36.b Pseudobulbs long-cylindric, more than 10 cm tall, sepals and petals pure white -----
----- **35 E. graminifolia**
- 37.a Pedicel plus ovary glabrous or slightly hairy ----- 38
- 37.b Pedicel plus ovary hairy or densely pubescent ----- 40
- 38.a Leaf apex obtuse, emarginate or bi-lobed; sepals and petals white tinged with green -----
-----**36 E. acervata**
- 38.b Leaf apex acute; sepals and petals buff-yellow to greenish ----- 39
- 39.a Floral bract ovate, terminal lobe reniform, yellow, flushed with brown -----**37. E. amica**
- 39.b Floral bract oblong, terminal lobe rectangular, bright yellow -----**38. E. sharmae**
- 40.a Floral bracts < 5 mm long; rachis pubescent; ovary < 6 mm long; labellum with 2 ridges base -----
----- **39. E. alba**
- 40.b Floral bract > 5 mm long; rachis pubescent; ovary > 6 mm long; labellum with 2 variable callus ----- 41
- 41.a Floral bracts 6 mm, labellum suborbicular shaped shorter than pedicellate ovary -----
----- **40 E. excavata**
- 41.b Floral bracts more than 6 mm, other shaped, shorter or longer than pedicellate ovary -----
----- 42
- 42.a Terminal lobe of labellum obovate, without sinus, trilobulate -----**41. E. pokharensis**

-
- 42.b Terminal lobe of labellum obtrullate, rhomboid, sinus present, bilobulate -----
----- **42. E. bhutanica**
- 43.a Inflorescence a lax raceme ----- 44
- 43.b Inflorescence densely sub-cylindrical or globose dense ----- 46
- 44.a Pseudobulb narrow-conical, terminal lobe of labellum bilobulate ----- **43. E. occidentalis**
- 44.b Pseudobulb stem or fusiform, terminal lobe of labellum obtuse ----- 45
- 45.a Pseudobulb fusiform, flowers small (< 3 mm), dorsal sepal 3-4 mm, labellum distinctly
yellow ----- **44. E. bipunctata**
- 45.b Pseudobulb stem like, flowers large (> 5 mm), dorsal sepal 5-8 mm, labellum yellow, rarely
purplish. ----- **45. E. apertiflora**
- 46.a Inflorescence dense globose head with many flowered, terminal lobe of labellum bilobulate
or not ----- 47
- 46.b Inflorescence small ovoid, dense, short sub-cylindrical with many flowered, terminal lobe of
labellum acute or obtuse ----- 48
- 47.a Lateral sepals narrow, terminal lobe not bilobulate; mentum tubular ----- **46. E. connata**
- 47.b Lateral sepals lanceolate and triangular; terminal lobe bilobulate; mentum round -----
----- **47. E. pumila**
- 48.a Terminal lobe of labellum orbicular as long as broad at base, flower bright yellow, lateral
lobe labellum semicircular or ovate ----- **48. E. globulifera**
- 48.b Terminal lobe of labellum deltoid, and widening from base; flower white, with purplish tint,
lateral lobe of labellum triangular ----- **49. E. spicata**

3.3.2.6 Description of Taxa

Section I. *Conchidium* (Griffith) Lindley, *Jour. Proc. Linn. Soc.* 3:46, 1859.

Stemless habit, slender with or without a rhizome, small uninodal depressed, globose or slightly flattened pseudobulbs without conspicuous nodes; abaxially sometimes with white reticulately membranous sheaths; membranous leaves; tiny one to few solitary flowered inflorescences borne at apex of pseudobulbs.

Type: *Conchidium pusillum* Griffith. *Not. Pl. Asist.* 3: 321, lc. 3: t. 310 (1851).

Note: This section was proposed by Lindley (1859) based on the genus *Conchidium*, it includes all the minute entities with small uninodal pseudobulbs and tiny one-to few-flowered inflorescence. Bentham & hooker (1883) split the section into two establishing besides section *Conchidium* a new section *Bryobium*. King & Pantling (1898) accepted the section *Bryobium* instead of *Conchidium*. Kranzlin (1911) excluded the section *Bryobium* and accepted the sub section *Alvisia* and *euconchidium* for the section *Conchidium*. Later on, all species belongs to the section *Bryobium* and sub section *Alvisia* were merged in the section *Conchidium*. The section *Bryobium* and sub section *Alvisia* were not accepted by later workers. Recently Brieger (1981) accepted the section *Conchidium* was as the separate genus *Conchidium* along with new genus *Gunnarorchis* for *E. perpusilla*, which also agreed by Sedienfaden (1992) but not followed Brieger system for Orchids of Indo china. Clements & Jones (2002) again proposed the new genus *Bryobium* for some *Eria* species. In the present study, the section *conchidium* proposed by Lindly (1859) has been accepted for Himalayan species.

About ten species: Himalaya (NW Himalaya, Nepal, Sikkim, Bhutan, NE Himalaya), tropical Asia to S China; six species in Himalaya. *E. pusilla* (Griff.) Lindl., *E. sikkimensis* D.M. Bajracharya & K. K. Shrestha, *E. muscicola* Lindl., *E. extinctoria* Lindl., *E. lacei* Summ., and *E. braccata* Lindl.

- | | | |
|-----|---|--------------------------|
| 1.a | Pseudobulbs small, < 1 cm; flowers small to medium, 1-2 cm long | 2 |
| 1.b | Pseudobulbs large, > 1 cm; flowers large, ca. 3 cm long | 1. <i>E. braccata</i> |
| 2.a | Leaves with long seta, inflorescence with 1 or 2 flowered | 2. <i>E. pusilla</i> |
| 2.b | Leaves without seta, inflorescence with 2-3 (-6) flowered | 3 |
| 3.a | Pseudobulbs discoid, covered by fine reticulate network, inflorescence more than 4 flowered | 4 |
| 3.b | Pseudobulbs globular, without reticulate network, inflorescence less than 4 flowered | 5 |
| 4.a | Labellum with callii at base | 3. <i>E. muscicola</i> |
| 4.b | Labellum without callii | 4. <i>E. sikkimensis</i> |
| 5.a | Dorsal sepal 8-9 mm long, terminal lobe of labellum orbicular, apex wavy-crenulate | 5. <i>E. lacei</i> |

5.b Dorsal sepal ca. 4 mm long terminal lobe of labellum rounded, apex bilobulate -----

----- 6. *E. extinctoria*

1. ***Eria braccata*** (Lindley) Lindley, *J. Proc. Linn. Soc.* **3**: 46 (1859); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50**: 18 (1911); Trimen & J. D. Hooker, *Handb. Fl. Ceyl.* **4**:165 (1890); J.D.Hooker, *Fl. Brit. Ind.* **5**: 787 (1890); Pearce & Cribb, *Fl. Bhutan* **3** (3): 384 (2002).

Dendrobium braccatum Lindl., *Gen. Sp. Orchid. Pl.* :75 (1830).

Pinalia braccata (Lindl.) Kuntze, *Revis. Gen.* **2**: 679 (1891).

Eria uniflora Datzell, in Hooker's *J. Bot. Kew Gard. Misc* **4**: 111 (1852).

Conchidium braccatum (Lindl.) Brieger, *Schlechter's Orchideen* **1** (11-12): 752 (1981).

Eria braccata Dalz. & Gibs, *Fl. Bombay* : 262 (1861); (non Lindl. 1959.).

Eria reticosa Wight, *Icon. Pl. Ind. Orient.* **V**: 5 (1851); J.D.Hooker, *Fl. Brit. Ind.* **5**: 787 (1890); Pradhan, *Indian Orchids II*, :349 (1979); Seidenfaden & Arora, *Nord. J. Bot.* **2**: 15(1982); Deva & Naithani, *Orch. Fl. N. W. Himal.* **287**. t. 162 (1986); Pangtey & al., *Orch. Kumaun Himal.* :116 (1991).

Pinalia reticosa (Wight) Kuntze, *Revis. Gen.* **2**: 679 (1891).

Epiphytic herbs. *Pseudobulbs* discoid caespitose, about 1.5 cm diameter, enclosed with reticulate sheath, which becomes loose on drying. *Leaf sheath* 1-2, arisen from the base of pseudobulb, sheathed at the base, 0.7-1.3 mm long, cylindric, oblique at the mouth; denticulate, mucronate, greenish below. *Leaves* 2, appears together with the flowers, broadly oblong or oblong-lanceolate, 2-7 x 0.8-2 cm, tapered at the base, acute, entire, dark green, thin. *Inflorescence* solitary; rachis 3-4 cm long, generally arising on one side, thick, long, curved by the weight of the flower. *Floral bracts* 9 x 3.5 mm, membranous, pale brownish, almost orbicular in outline, cordate, boat shaped, mucronate, sheathing, mid veins and 2 lateral veins are distinct. *Pedicele and ovary* 4-5 mm long slightly curved, light brown. *Flowers* white, solitary, and resupinate, expanding, sweetly and strongly scented, 2-3 cm in diameter, when flattened 4.5-5 cm across. *Sepals* 2-3 cm long, white flushed pink; *Dorsal sepal* broadly oblong-lanceolate, acute, mucronate, 20-37 x 4.7 mm, white or diffused with pale pink, entire, glabrous, 9-nerved; *Lateral sepals* falcate, oblong, acute, white, 20-35 x 5-7 mm; *mentum* 8-11 mm long, curved, oblong-conical, white, emarginate and straight. *Petals* oblong-lanceolate, acute or sub mucronate, 1.8-3.2 x 5-7 mm, about equal to sepals, glabrous, white, 7-veined. *Labellum* tri-lobed, oblong-obovate in outline, 17-23 mm long, sessile; lateral lobe 5-7 x 1-2 mm, narrow, acute or rounded, entire, margin red, with two orange-yellow crest running from the base of tip to beyond lateral lobe; terminal lobe 8-

10 x 4 mm, oblong, often slightly dilated in apical half, rounded or tapering at apex, crenulate; disc with two yellow ridges, pubescent. *Column* short, white, tinged with green, foot 10 x 3 mm, curved, narrowly oblong, yellow with reddish purple margin and parallel purple veins on inner face; clinandrium 3 x 3 mm, white, reddish inside, obovate-oblong, to form conical operculum; operculum conical, sub-concave at back, rostellum ligulate. *Pollinia* 8, yellow, the upper 4 ovoid-oblong, lower 4 minute, all attach to short granular membranous caudicle; viscidium simple and ellipsoid. *Stigmatic cavity* pale green with stellate marking in center (Fig. 5).

Type: Sri Lanka, *Macrae 53* (Holotype: K-LINDL)

Distribution: 1500-2300 m. Himalaya (Kumaon, Gahrwal), Sri Lanka, South India.

Status: Rare

Flowering: June- September

Chromosome Number: $2n=42$ (Jorapur & Kulkarni 1979, 1980; Singh 1981).

SPECIMENS EXAMINED: **North West Himalaya:** Kumaun: Pithoragarh-Askot, Jauljibi-Bridal Path, 1700m, 11.8.1980, *Arora 70848* (DD!); *Sin. loc.*, *D. Ritchie 707* (*Eria uniflora*, K!); **Sri Lanka:** Nuivara Eliya Dist. Hakgala 2300m, C.M. Gery-Malbar Concon, *Hooker. & T. Thomson s.n.* (BM!); Nuivara Eliya Dist. Hakgala 2300 m, 7.12.78, *Wilson & S. Silva 3060*, (K!); *Sin. loc.*, *Gardener 859, 1847* (K!); *Sin. loc.*, *C. B. Clarke 2356* (BM!); **Adamin Peak Ceylon, 2.7.1978, L. H. Cramer 61284** (K!). **India:** Pycarrah, *Wight s.n.* (Type of *E. reticosa*, Holotype:: K!); *Dalzell s.n.* (type of *Eria uniflora*, Holotype:: K!); Madras (Niligiri), Pakaya 1820m, *J. S. Gamble 17457*, June 1886 (K!), Niligiri, 21.6.1908, *Boewne 5/23*, (K!).

Note: This species is previously known as *Dendrobium braccatum* Lindl. and *E. reticosa* Wight. According to ICBN rules of priority, *E. reticosa* Wight has been changed into *E. braccata* Lindl. (1859). This species is reported from Western Himalaya by Arora & Seidenfaden. (1982). Bose & Bhattacharjee (1980) reported the species from Sikkim as well. The specimens could not be traced in the herbaria of CAL and SIKKIM. According to Deva & Naithani (1986) this species is very distinct, which will require a phytogeographical explanation that the species spread widely in South India, and recorded in an isolated spot of the Western Himalaya. They also emphasized that this is the only example in the genus *Eria*, which has such a peculiar distribution. However, there are several species of Himalayan plants which are also discontinuously distributed in South India from Himalaya or *vice versa*.

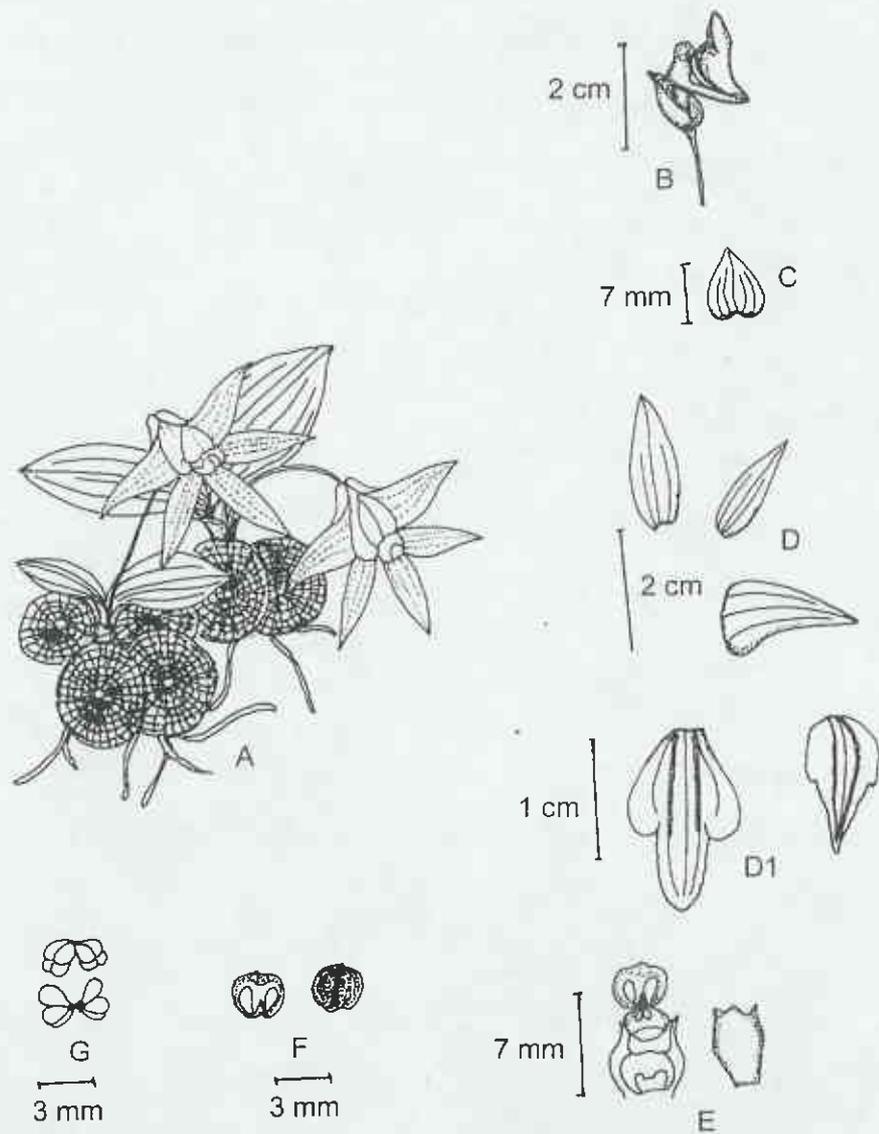


Fig. 5: *Eria braccata* (Lindley) Lindley (*Hooker. f. & T. Thomson s.n. BM*) A. Habit; B. Lateral view of Column with labellum and bract; C. Bract; D. Spreading of Sepal, Petal; D₁, Labellum; E. Column; F. Operculum; G. Pollinia.

2. **Eria pusilla** (Griffith) Lindley, *J. Prod. Linn. Soc.* **3**: 48 (1859); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50**: 21 (1911); Seidenfaden, *Opera Bot.* **62**: 31 (1982); Hajra & Verma, *Fl. Sikkim* **2**: 69 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :377 f. 277 (1998); Pearce & Cribb, *Fl. Bhutan* **3** (3): 386 (2002).

Conchidium pusillum Griff., *Not. Pl. Asist.* **3**: 321, lc. 3: t. 310 (1851).

Pinalia pusilla (Griff.) Kuntze, *Revis. Gen. Pl.* **2**: 679 (1891).

Epiphytic herbs, 2-5 cm high. *Rhizome* creeping, slender, wiry and tubular, with white membranous sheathed. *Pseudobulbs* 4-5 mm in diameter, semiglobose, well spreading on creeping rhizome with a pair of small depressed, globose pseudobulbs without reticulate network. *Leaves* 2-3, ovate-lanceolate or spatulately ovate, ca. 1.6 x 0.4 cm, arising from between opposite pseudobulb, obovate-lanceolate, obovate or sub elliptic, with long seta at the apex, 4-veined. *Inflorescence* terminal, axillary, solitary, arising from inner side of leaves, rarely bi-flowered, proteranthous, rachis 2-2.5 cm, long. *Floral bract* ovate, acuminate, ca. 0.8-1 x 0.5 mm, thin veins, concave, longer than pedicel and ovary, ca. 1 mm long. *Pedicel and ovary* short, ca. 1.5 mm. *Flowers* small, ca. 6 mm, pale-white. *Sepals* white, 5-5.5 mm long; *Dorsal sepal* ovate, 5-6.5 x 2-2.5 mm, acuminate, glabrous; *Lateral sepals* lanceolate, triangular, acuminate, glabrous, 5-5.5 x 2.5 mm, adnate to column foot and forming mentum, mentum long, incurved and distinct. *Petals* similar to dorsal sepal, lanceolate, acute, ca. 4 x 2 mm, pale white, narrow, unequal, *Labellum* simple, lanceolate, ca. 5 mm, slightly recurved, apex finely rugose, erose to fine dentate margin, disc with 2 strips, at proximal part, elongated to near middle with two longitudinal keels. *Column* short, glabrous, foot ca. 0.2 mm long, distinct, and curved; operculum small, rostellum minute and ligulate. *Pollinia* 8, elliptic; viscidium simple. *Stigmatic cavity* entire. (Fig. 6)

Type : Assam (India), 'Churra Punjee' (Cherapunji), *Griff. Herb* 143, 13.10.1835 (Holotype: K!).

Distribution: 1300-1700 m. Himalaya (Assam, Arunachal Pradesh, N. of Burma), Thailand, Vietnam, China and Indo-China.

Status: Intermediate

Etymology: From the Latin word '*pusillus*' (= very small).

SPECIMENS EXAMINED: **Assam**: Khasia Cherra punjee and Chunay, *Griff Kew distr* 2127 (K!); *Herb Wight* 666 (K!) type of *C. pusilla* and *C. uniflora*; *Pomrang*, *Hooker & Thomson s.n* (K!); Mamloo, *Clarke* 45711 (K!) Nongbreden *Clark* 42667 (K!); Mount Khasia *Hooker & Thomson* 28 (CAL!); **North East Himalaya**: Kameng, Subansiri, between 1000-1200 m.; *H. J. Chowdhery*; **Burma** : Nam Tawau valley 5-6000m, *Kingdon-Ward* 13458 (BM!).

Note: All materials of *E. pusilla* deposited in the herbaria of K, BM and CAL were examined. The specimen collected by Kingdon-Ward *s.n.* from Burma (BM) was unidentified. It is almost similar to *E. pusilla*, but the flower is larger than *E. pusilla*, otherwise morphologically it is conspecific of *E. pusilla*. Pearce & Cribb (2002) mentioned that it is doubtfully recorded, and imperfectly known species from Bhutan and adjoining area of Sikkim and Darjeeling Area.

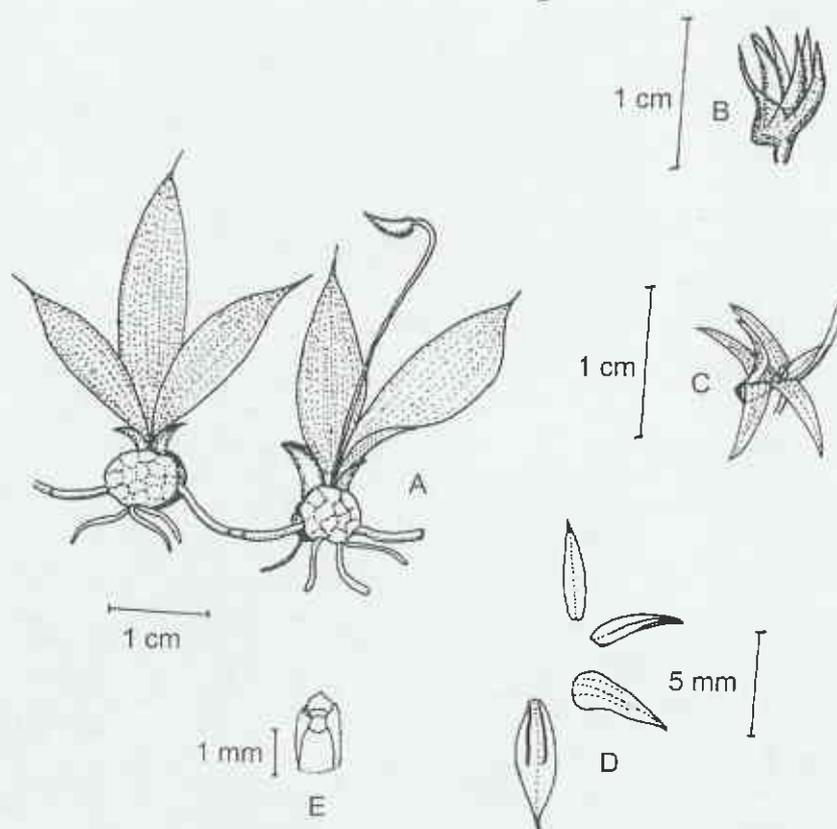


Fig. 6. *Eria pusilla* (Griffith) Lindley, (*Hooker 54 K!*) A. Habit; B. Flower; C. Lateral view of flower; D. Spreading of Sepal, Petal and Labellum; F. Column.

Eria muscicola (Lindley) Lindley, *J. Proc. Linn. Soc.* **3**: 47 (1859); J.D.Hooker, *Fl. Brit. Ind.* **5**: 789 (1890), op. cit. **6**: 190 (1890); King and Pantling, *Ann. Bot. Gard. Calc.* **8**: 119. t. 159 (1898); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50**: 20 (1911); Tuyama, in Hara (eds.) *Fl. East. Himal.* :434 (1966); Banerji & Thapa, *J. Bombay Nat. Hist. Soc.* :153 (1970); Tuyama, in Ohashi (eds.) *Fl. East. Himal.* :143 (1975); Hara & al., *EFPN* **1**: 42 (1978); Pradhan, *Indian Orchids* **2**: :350 (1979); Seidenfaden, *Opera Bot.* **62**: 32 (1982); Banerji & Pradhan, *Orch. Nepal Himalaya* :264, pl. 265 (1984); Koba & al., *NLFPGN* :196 (1994); Hajra & Verma, *Fl. Sikkim* **2**: 68 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :371 f. 222 (1998); Press & al., *ACFPN* :215 (2000). Pearce & Cribb, *Fl. Bhutan* **3** (3): 370 (2002).

Dendrobium muscicola Lindl., *Wall. Cat.* 2017 nom.nud.; *Gen & Sp. Orch.* :75 (1830).

Pinalia muscicola (Lindl.) Kuntze, *Revis. Gen* **2**: 679 (1891).

Dendrobium parviflorum D.Don, *Prodr. Fl. Nepal.* :34 (1825).

Conchidium muscicola (Lindl.) Rauschert, *Feddes Reper* **94**: 444 (1983).

Epiphytic herbs, 3-4 cm high. Without rhizome; *Pseudobulbs* caespitose, clustered on a rather slender creeping rhizome, depressed, globose to discoid, 4-6 x 4-6 mm in diameter, covered by white thread like reticulating veins. *Leaves* 3-4, petiolate or sessile, ovate to obovate-oblongate or spatulate, 3-4 x 0.3-0.4 cm, acute or apiculate, entire, glabrous, leaves arisen from the apex of pseudobulbs, 5-7 veined, green, thick. *Leaf sheath* membranous, greyish in colour, dry present below the leaves. *Inflorescence* terminal, erect, arises from the inner side of two leaves, racemose type. secund, rachis 1.5-3 cm long, angular, glabrous, green, spike, 4-6 flowered as long as the leaves. *Floral bracts* ovate-lanceolate, 3-5 x 1.5 mm, acuminate, longer than the sessile ovary; the minute base of the apex thick veined. *Pedicel and ovary* ca.2 mm long, glabrous. *Flowers* sessile, small, pale-green to yellowish, 3-4 x 1.5 mm, 9 mm across, when flattened, faces straight. *Sepals* unequal, lanceolate, acuminate, spreading, 2.5-4.5 x 0.8-1 mm; *dorsal sepal* lanceolate, 2-4 x 0.8-2 mm, finely acuminate, 1-3 veined; *Lateral sepals* ovate-lanceolate, falcate, 3-4 x 0.8-1 mm, entire, acuminate, glabrous, 3 veined; *mentum* ca. 2 mm long, small, round or subglobose. *Petals* as long as sepals, narrowly lanceolate, 2-2.4 x 0.6-0.9 mm, thin, membranous, acuminate, entire, thin edged, 1-3 nerved. *Labellum* simple, narrowly lanceolate or ovate or oblong-lanceolate or sub elliptic, ca. 2 x 0.9-1.2 mm or half as long as sepal and petals, acute, concave, slightly dilated and deflexed at the middle, without lateral lobes; erose, apically with the minutely trilobulate or irregular teeth, apex acuminate, 3-veined, two calli at the very base of the disc. *Column* ca.1.5-2 mm, glabrous, short, broad, with long curved foot, ca.1.2 mm long; *operculum* semiglobose, ca. 0.7 x 0.5 mm smooth, 4 chambers in each lobe; *rostellum* ligulate, bent towards the stigma. *Pollinia* 8, yellow, four in each locules, obovoid, membranous and glandular caudicle; *viscidium* is simple and ellipsoid. *Stigmatic cavity* entire, 0.2 mm long (Fig. 7).

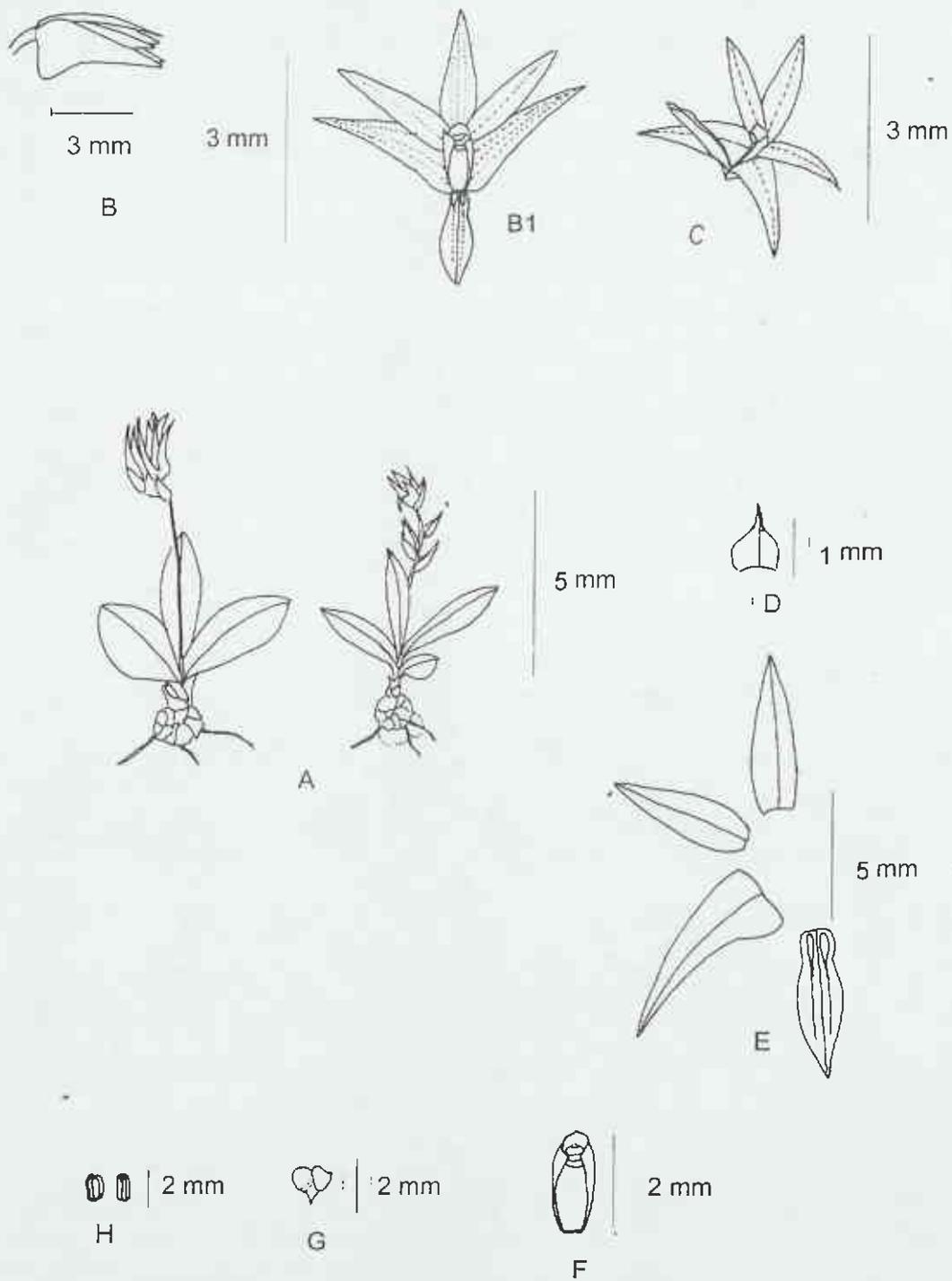


Fig. 7. *Eria muscicola* (Lindley) Lindley, (*D. M. Bajracharya* 251, TUCH!), A. Habit; B. Flower B1: Front view of flower C. Lateral view of flower; D. Bract; E. Spreading of Sepal, Petal; E₁, Labellum; F. Column; G. Operculum; H. Pollinia.

Type: Nepal, Gossainthan, Napalia, Wallich 2017, 17 June 1820 (Holotype: K-LINDL; isotype: K-W! K!).

Distribution: 1000-1500 m, Himalaya (NW Himalaya, Nepal, Sikkim, Assam, Bhutan, Arunchal Pradesh, N. of Burma), Laos, Vietnam, China, Sri Lanka.

Status : Common

Flowering: July-August

Etymology: From the Latin word '*musus*' (moss) and '*cola*' (dwelling), referring to the plant's habitat.

Chromosome Number: n= 18 (Mehra & Sehgal 1976)

SPECIMENS EXAMINED: **North West Himalaya:** Kumaun: Pithoragarh: Askot, Jauljibi Bridal Path, 11.8.1980, Arora 70847 (DD!) Nainital Sat -tal Kalakoti 1361 (DD!). **Nepal:** *W. Nepal:* Doti, Bank of Rangeni Tal on Bhanj Tree Chhatiwon, 1250 m, June 2002, G. Amatya 24. *C. Nepal :* Hituda Lamidanda 1500m, August 1994, Sharma & White 068, (K!); Sindhupalanchok, Malamchi 1200m, 8.1.200, D. M. Bajracharya 251, (KATH!, TUCH!); Lumle 1500m, Feb. 1997, A. Subedi s.n. (TUCH!); *E. Nepal :* Bir-gaon 1820m, P. R. Shakya 1872, (K! KATH!); Above Mangalbare 2760 m. 8.6.1972, P.R. Shakya 1412, (KATH); Near Phidim, Panchther dist.1460m, 18.11.1978, P. Pradhan, N. P. Manandhar & N. Amatya 888, (KATH!) **Sikkim:** Singtom , Pantling 163, (K!, BM! E! & CAL !); Phedong 900m, 12.10.1887, Clarke 9587, (K!); Are Sikkim, 23.8.1910 Smith 4521 (CAL!). **Bhutan:** Nyoth 2000m, Oct. 1965, Balakrishna 44223, (CAL!); **Assam:** Cherrapunjee, Khasia 1000m, W.N. Koelz 30445, (K!); Nawryngkneng , Khasia Hill 1500m, 31. 10. 1951, W. N. Koelz 28955, (K!). Khasia 1000m, 14 10.1886, C. B. Clarke 45059, (K!); Khasia 1000, 12. 10. 1836 C. B. Clarke 45832, (K!); Mumloo Khasia, 1200m, Rebh 45711 (K!); Durrang , Haintea Hill, Prain 145, July 1895 (BM!); Khasia, July 1883, Mann 31/1884, (CAL!); Renging, 23.2.12 Burkill 36691, (CAL!); **North East Himalaya :** Kameng, Lohit, Siang, Subansisri, Tirap; Between 1200-1800 m.; H. J. Chowdhery **Burma:** Kaclui Hill, Aug. 1898, Mokeem s.n., (K! CAL!).

Note: Several specimens of *E. muscicola* were examined deposited in BM, CAL, E, K, KATH and TUCH. Pantling (1891, 1897) had collected two specimens of *E. muscicola* from two different localities of Sikkim (Nanchi and Singtum). King & Pantling (1898) described *E. muscicola* in "Orchids of Sikkim Himalaya" based on the specimens collected by Pantling (Pantling 163 from Nanchi in 1891) deposited at K and CAL. They did not mention up to variety level for this taxa. Rolfe has written in the specimen of Nanchi as "*non muscicola*" for the same specimen deposited at CAL, whereas another specimen collected from Singtum had considered by him as true *E. muscicola*.

Seidenfaden (1982) discussed the taxonomy and varieties of *E. muscicola*, and had studied the specimen of Pantling 163 from Nanchi, but he was unable to identify this specimen at variety level, due to unavailability of the fresh Nepalese specimen. Pearce and Cribb (2002) also studied Pantling 163 at K, they were also doubtful about this specimen, whether it represents var.

musciicola or var. *oblonga*. They felt this uncertain and resolved to treat them as conspecific. They placed *E. musciicola* var. *oblonga* as doubtfully recorded and imperfectly known species. On one hand they mentioned that Pantling 163 Nanchi specimen corresponds with drawing of var. *oblonga* (CP 2355) at Kew, on the other hand they are not certain about its occurrence in their study area.

From the critical examination of this tiny species (Pantling 163, Nanchi K, CAL) it is found that this is not the var. *oblonga*. Presence of reticulate network in pseudobulb, absence of two distinct calli at the base of labellum, and absence of hairs on abaxial surface of labellum strongly suggest this species as new species of *Eria* (i.e. *Eria sikkimensis*).

4. ***Eria sikkimensis*** D. M. Bajracharya & K. K. Shrestha *sp. nov.*, Rheedea (in communication)

Pseudobulbis descoideus cum retinervis, bracteis grandis, oblongus-lanceolatus, acutis, labello oblanceolatus, serrate anterior margine, sine calli ad basii.

Epiphytic herbs, 3-4 cm high. *Rhizome* slender creeping. *Pseudobulbs* caespitose, clustered on a rather slender creeping rhizome, depressed, globose to discoid, 4-6 x 4-6 mm in diameter, covered by white thread like reticulating veins. *Leaves* 3-4, petiolate or sessile, ovate to obovate-oblanceolate, 3-4 x 0.3-0.4 cm, acute or apiculate, entire, glabrous, leaves arisen from the apex of pseudobulbs, 5-7 veined, green, thick. *Inflorescence* terminal, erect, arises from the middle of two leaves, racemose with compact flowers. *Leaf sheath* membranous, greyish in colour, dry present below the leaves, secund, rachis 1.5-3 cm long, angular, glabrous, green, spike, 4-6 flowered as long as the leaves. *Floral bracts* ovate-lanceolate, 3-5 x 1.5 mm, acuminate, longer than the sessile ovary; the minute base of the apex thick veined. *Pedicel and ovary* ca. 2 mm long, glabrous. *Flowers* sessile, small, pale-green to yellowish, 3-4 x 1.5 mm, 9 mm when flattened, faces straight. *Sepals* unequal, lanceolate, spreading, 2.5-4.5 x 0.8-1 mm, acuminate; *dorsal sepal* lanceolate, 2-4 x 0.8-2 mm, finely acuminate, 1-3 veined; *Lateral sepals* falcate, ovate-lanceolate, 3-4 x 0.8-1 mm, entire, acuminate, glabrous, 3 veined; *mentum* ca. 2 mm long, round or subglobose. *Petals* as long as sepals, narrowly lanceolate, 2-2.4 x 0.6-0.9 mm, thin, membranous, acuminate, entire, thin edged, 1-3 nerved. *Labellum* narrow, ovate-oblong, concave, ca. 2 x 0.9-1.2 mm or half as long as sepal and petals, slightly dilated and deflexed at the middle, without lateral lobes, apex erose, minutely tri-lobulate, serrate margin, without calli at the base, 3-veined. *Column* ca. 1.5-2 mm, glabrous, short, broad, with long curved foot, ca. 1.2 mm long; *operculum* ca. 0.7 x 0.5 mm smooth, 4 chambers in each lobe; *rostellum* ligulate, bent towards the stigma *Pollinia* 8, four in each locules, obovoid, membranous and glandular caudicle; *viscidium* is simple and ellipsoid. *Stigmatic cavity* entire, 0.2 mm long (Fig. 8).

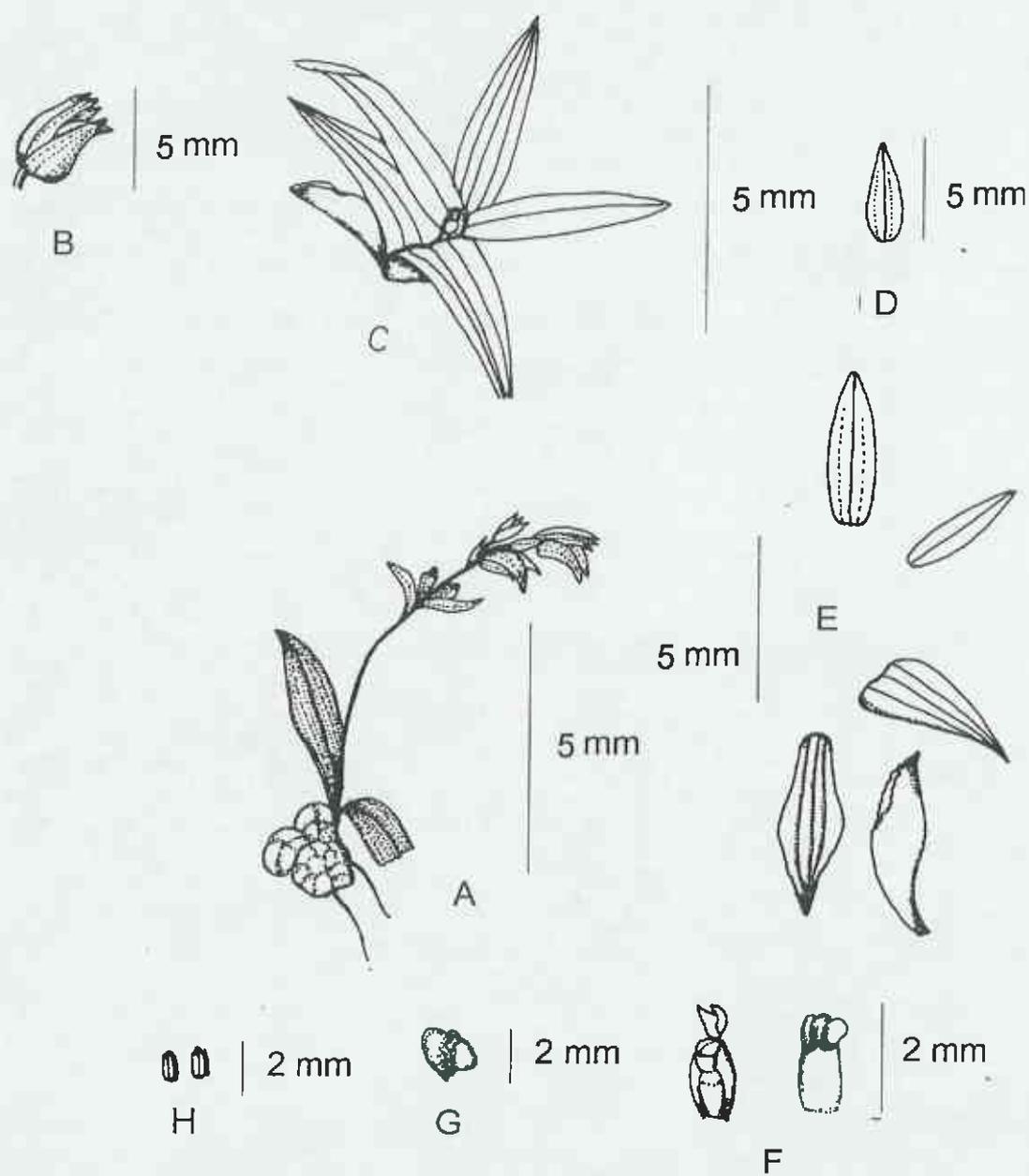


Fig. 8. *Eria sikkimensis* D. M. Bajracharya & K. K. Shrestha, *sp. nov.* (Pantling 163, CAL!) A. Habit; B. Front view of flower; C. Lateral view of column with labellum; D. Bract; E. Spreading of Sepal, and Petal and Labellum; F. Column; G. Operculum; and H. Pollinia.

Type: Sikkim (India), Nachi (Nanchi), *Pantling* 163, Aug 1891 (Holotype: CAL!, isotype: K!).

Distribution: 1000 m., Himalaya (Sikkim).

Status: Rare and Endemic

Flowering: July

Note: Known only from the type material.

5. **Eria lacei** Summerhayes, Bull. Misc. Inform. 1929: *Kew Bull.* :308 (1929); Seidenfaden, *Opera. Bot.* 62: 35 (1982).

Epiphytic herbs, 4-5 cm high. *Pseudobulbs* aggregated without a fine reticulate network, globular or sub-globose, ca. 1 cm in diameter, apex depressed, apex more or less truncately cut off. *Leaves* not seen. *Inflorescence* terminal from the centre of pseudobulbs, hysteroanthous, erect, 1-2 (-4) flowered, provided with single, acute cataphyll; rachis ca. 2-2.5 cm long, often two flowered. *Floral bract* ovate, membranous, 2-3 mm. *Pedicel and ovary* ca. 9-1.3 mm, glabrous, ridged. *Flowers* 10 x 6 mm, yellow. *Sepals* unequal, lanceolate, acute, 8-10 x 2-5 mm; *dorsal sepal* lanceolate, 8-9 x 2-5 mm, sub-glabrous, broad, and concave, with 5 veins; *lateral sepals* obliquely triangular, 9-10 x 4-5 mm, acute, thin, glabrous, with 5 veins; *mentum* 4.5mm, straight and round. *Petals* oblong, 6-7 x 2.5-3 mm, obtuse, thin, 1-veined. *Labellum* 10-13 mm long, without claw, gradually swelling upwards, trilobed; terminal lobe orbicular, 5 x 4 mm, somewhat wavy at apex with yellow dotted, thick; lateral lobe almost circular broad, deflexed. *Column* 2 x 1 mm, short, glabrous, foot 5 x 0.5 mm; *clandrium* usually collar like; *operculum* 2 x 1 mm, outer surface glabrous, inner 8 chambered, pouches like structure; *rostellum* ligulate, bent towards the stigmatic cavity. *Pollinia* 8, ca. 0.75 mm, laterally compressed, ovoid, with membranous caudicle; *viscidium* simple and single. *Stigmatic cavity* 1 x 0.75 mm, entire, triangular at base (Fig. 9).

Type: Burma, Lampe chaung, 1000m, *J. H. Lace* 4751, 23.3.1909. (Holotype: K!).

Distribution: 1000 m., Himalaya (Assam, Burma).

Status : Rare

Flowering: March

Etymology: Named after J.H. Lace, who first recorded the plant.

SPECIMENS EXAMINED: Assam: Phongpani 1100m, March 1918, *Parry* 632, (K!);

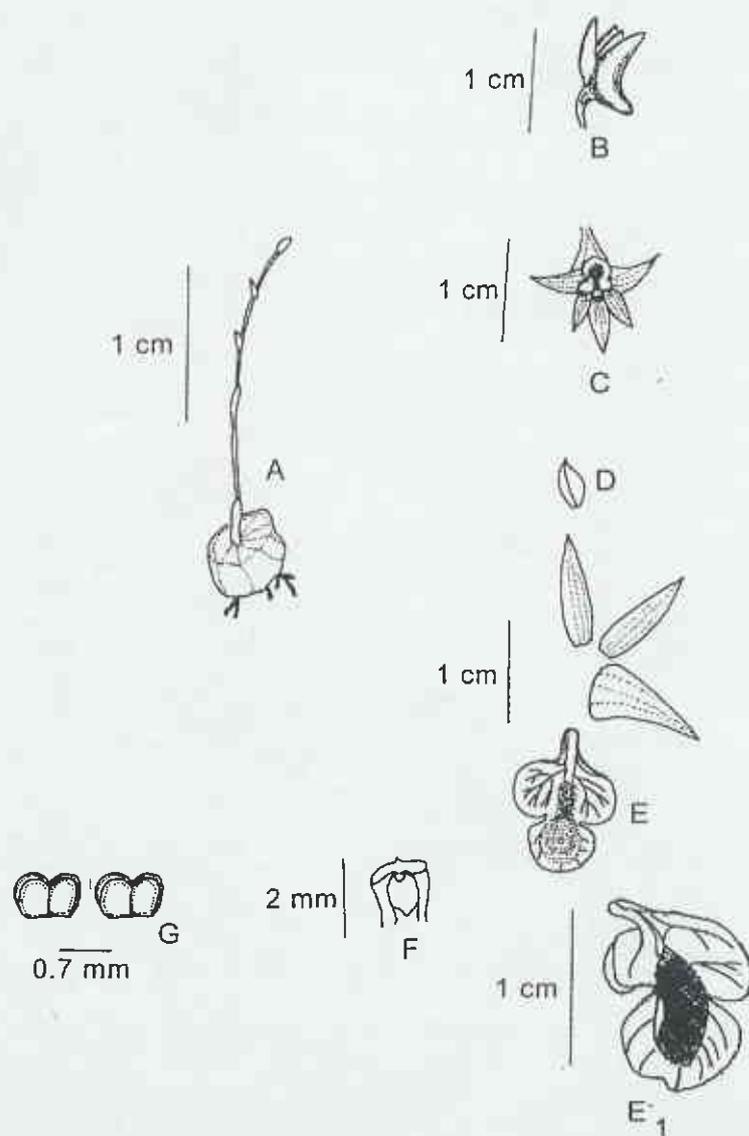


Fig. 9. *Eria lacei*. Summerhayes, (Lace 4751, Type K!) A. Habit; B. Flower; C. Front view of flower; D. Bract; E. Spreading of Sepal, Petal and labellum ; E₁: Labellum (drawing from type); F. Column; G. Pollinia.

6. **Eria extintoria** (Lindley) Oliver, *Bot. Mag.* t. 5910 (1871); J. D. Hooker, *Fl. Brit. Ind.* **7**: 88 (1890). Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50**: 17 (1911); Wood, *Die Orchidee* **40** (6): 201 (1989).

Dendrobium extentorium Lindl., *Edwards's Bot. Reg.* **21**: sub. t. 1756 (1835).

Pinalia extintoria (Lindl.) Kuntz, *Revis. Gen. Pl.* **2**: 679(1891)

Epiphytic herbs. *Pseudobulbs* uninodal, globose, depressed at the tip, growing in small patches, 0.8-1 cm in diameter, without reticulate network. *Leaf* one, small, ca. 5 x 1 cm, lanceolate, blunt-pointed at the apex, and taper to the base of the pseudobulbs. *Inflorescence* solitary flower, hysteroanthous, with scape terminal, on the apical part of pseudobulb; rachis 5-6 cm long, thin, reddish in colour. *Floral bracts* boat shaped, minute. *Pesicel* and ovary ca. 4.5 cm dull red brown. *Flower* white, 0.8 cm, with pink flush on the tip. *Sepals* ovate, triangular, acute, 4-10 x 3-5 mm; *dorsal sepal* ovate, ca. 4 x 3 mm, acute, much smaller than lateral sepals, with 5 veins; *lateral sepals* triangular, 10 x 5 mm, acute, 5-veined; *mentum* ca. 8 mm long, longer than the lateral sepals, conical, incurved, 2-lobed. *Petals* oblong-lanceolate, obtuse, 9 x 4 mm, with 3-veined. *Labellum* tri-lobed, 9 x 8 mm, 3-veined, lip base and inner throat yellow, lobes brushed with pink flush; terminal lobes large and broader than long, orbicular to obovate, bilobulate, short and overlapping the lateral lobes, which are relatively large; lateral lobes small, rounded and crenate, base of lip is tapering narrow, and attached to the foot of the column, disc of the lip has three obscure minute papillose hairy line, which become warty distally at the centre of lip. *Column* very short, ca. 1 mm, column foot 8 mm long; *operculum* blotched, with deep purple red on each side; *rotellum* ligulate. *Pollinia* 8, rounded, united by suddenly tapering caudicles, viscidium simple. *Stigmatic cavity* entire, ca. 2 mm, oblong (Fig. 10).

Type: Burma, Moulmen, Griffith 358 (Holotype: K-LINDL!).

Distribution: 500-600 m., Himalaya (Nepal, Burma).

Status: Endangered

Flowering: April- May

Etymology: Candle-snuffer shaped flowers

SPECIMENS EXAMINED: **Nepal:** C. Nepal: Churia, Samari Khola, C. Nepal. White & Sharma s.n., 14 April 1997 (K!); Churia Khola 500m, 10 Km of Hetuda Makwanpur, K. J. White 1, 12 March 1989 (KATH!); D. M. Bajracharya 421, 6 Nov. 2001 (KATH! TUCH!); R.C. J. Susuhue 13/17, 21 Sept. 1927 (K!); **Burma:** Moulmain, Prain s.n., April 1898 (CAL!), A. Meebold 15502 (CAL!), Burma, G. Giles s.n. (CAL!).

Note: Wood (1989) discussed the position of *Eria extintoria* in *Die Orchidee*. *Eria extintoria* is the new taxa for the flora of Nepal, which was reported by White & Sharma (1989), collected from Churia Hill of Hetauda, Makawanpur, Nepal. This taxon is not included in the EFPN (Hara & al. 1978); NLFPNG (Koba & al. 1990) and ACFPN (Press & al. 2000).

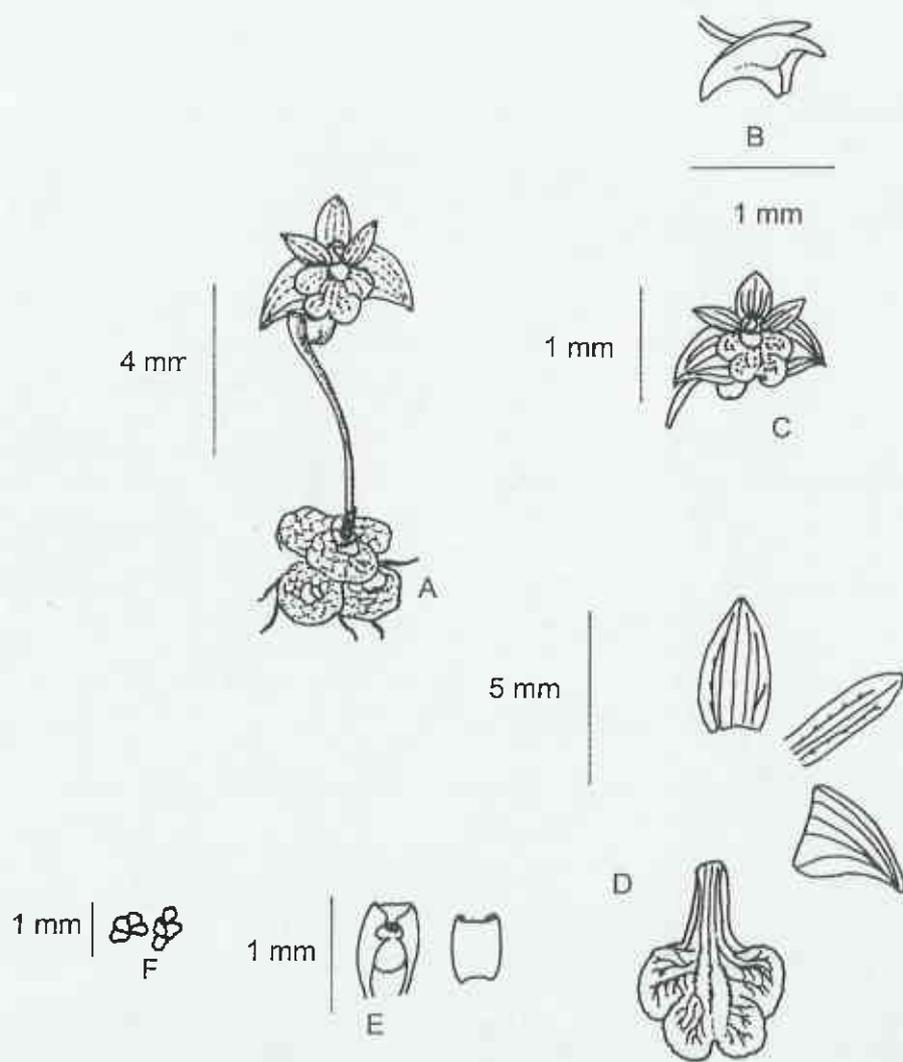


Fig 10. *Eria extinctoria* (Lindley) Oliver (*D. M. Bajracharya* 421, TUCH) A. Habit; B. Flower
C. Front view of flower; D. Spreading of Sepal, Petal and Labellum; E. Column; F. Pollinia.

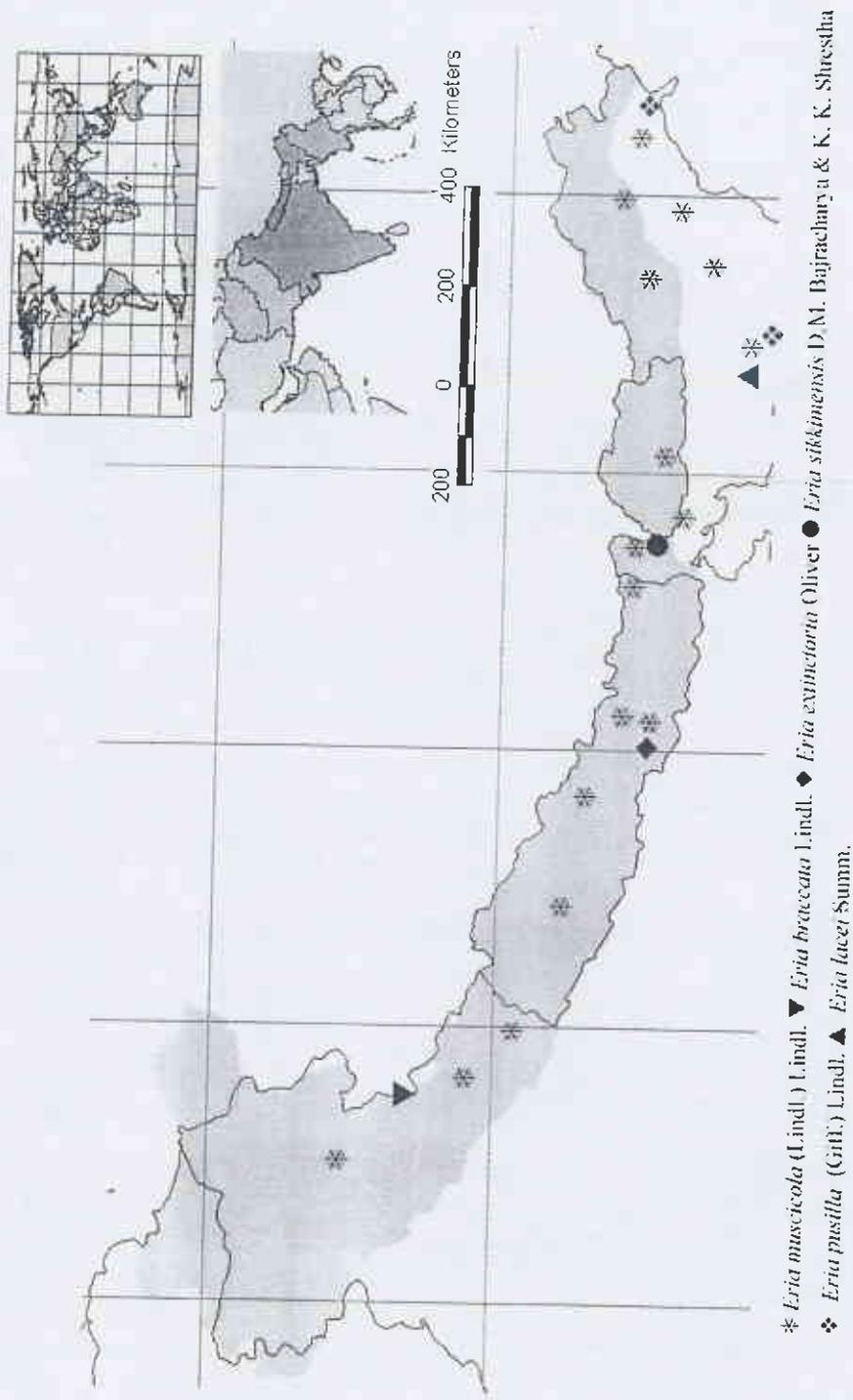


Fig. 11 : Distribution Map of the section Conchidium

Section II. *Eria*

Rhizomatous; pseudobulbs covered by large wide sheaths, which are fused; two large leaves at apex, convolute leaves in bud; unusual leaves among the genus *Eria*, conspicuously jointed just above the base, petiole articulate; long inflorescence emerges from near the top of pseudobulbs with large and many stellate flowers; perianth sublanceolate.

Type: *Eria stellata* Lindley, Edward's *Bot. Reg.* t. 904, 1825.

Note: *Eria javanica* (= *E. stellata*) is generally accepted as the type species of the genus *Eria*. According to the ICBN rule, section *Eria* is to be applied as the type section of the genus (Seidanfaden 1982). Before that Blume (1825) placed *E. javanica* (*Dendrolirium rugosum*) into the section *Cosminum* of the genus *Dendrolirium*, which was accepted by Bentham & Hooker (1883). Reichenbach (1857) was the first person who proposed the sectional name *Eria* for the genus *Eria*, and included *E. stellata* (*E. javanica*) in the section *Stellata*. Recently, Brieger (1981) also included *E. javanica* in the section *Stellata* of the genus *Eria*.

Lindley (1859) did not mention sectional name and *E. stellata* in his proposed section. Reichenbach (1861) after reviewing Lindley's section, he placed *E. stellata* in Lindley's (1859) section *Xiphosium*. J. D. Hooker (1890) and King & Pantling (1898) placed *E. fragrans* (one of the synonyms of *E. stellata*) into the section *Hymenaria*. J. J. Smith (1905) placed *E. rugosa* (one of the synonyms of *E. javanica*) into the section *Convolvulatae*, due to special character of convolute leaves. Schlechter (1910) and Kranzlin (1911) accepted Smith's section *Convolvulatae*. Later Schlechter (1912) proposed new section *Goiorhabdos* for *E. javanica*. It was followed by subsequent workers like J. J. Smith (1905), Holttum (1957), Seidanfaden and Smitinand (1965) and Pradhan (1979).

Considering the above facts it has been accepted here that *E. Javanica* is the type species of the genus *Eria*, belongs to the section *Eria*, which was proposed and accepted by Seidenfaden (1982, 1992) and other researchers like Comber (1989), Seidenfaden & Wood (1992), Averyanov (1994) and Pearce & Cribb (2002). This section differs from all other sections of *Eria*, because it has convolute leaves, the edges of a leaf overlap each other in bud condition, with conical silica bodies (Dressler & Cook 1988).

One species: ?? Himalaya (Sikkim, NE Himalaya), Indonesia to SE Asia and New Guinea only
Eria javanica (Sw.) Bl.

7. ***Eria Javanica*** (Swartz) Blume, Rumphia 2: 23 (1836); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 26 (1911); Seidenfaden & Smitinand, Orch. Thailand: 64 (1960); Pradhan, Indian Orch. 2: 352 (1979); Seidenfaden, *Opera Bot.* 62: 26 (1982); Hajra & Verma, Fl. Sikkim 2: 68 (1996); Chowdhery, Orch. Fl. Arunachal Prad.: 367, pl. 220 (1998); Bose *et. al.*, Orch. India

:236 (1999); Pearce & Cribb, *Fl. Bhutan* 3 (3): 369 (2002).

Dendrobium javanicum Sw., *Kongl. Vetensk. Acad. Nya. Handl.* 21: 247 (1800).

Dendrobium javanicum Sw., *Neues J. Bot.* 1(1): 96 (1805).

Eria stellata Lindl., in *Bot. Reg.* t. 904 (Aug. 1825); Lindley, *Gen. & Sp. Orchids. Pl.*: 67 (1830); Rchb. f., *Bonpl.* :54 (1857); Miquel, *Fl. Nederlan. Indie* 3: 661 (1859); Rchb. f., *Walp. Ann.* 6: 269 (1861); Rindley, *Tr. Linn. Soc. Ser. 2 (Bot.)* 3: 366 (1893).

Dendrobium perakense Hook. f., *Fl. Brit. Ind.* 5: 712 (1890).

Eria rugosa (Blume) Lindl., *Gen. & Sp. Orch. Pl.* :67 (1830).

Eria cochleata Lindl., *Bot. Reg.* 30: misc. 14 (1844).

Eria fragrans Rchb. f., *Bot. Zeit XXII*: 415 (1864); (1883); J. D. Hooker, *Fl. Brit. Ind.* 5: 784 (1890); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* 8: 122, pl 168 (1898); Kränzlin in Engler, A. (ed.) *Das Pflanzenreich Hfl.* 50: 24 (1911); Joseph, *Bull. Bot. Surv. Ind.* 12 (1-4): 75 (1970); Pradhan Hedge, *Arunachal Forest News* 3 (3): 6 (1980).

Pinalia fragrans (Rchb. f.) Kuntze, *Revis. Gar.* 2: 679 (1891).

Pinalia rugosa (Blume) Kuntze, *Revis. Gar.* 2: 679 (1891).

Epiphytic or semiterrestrial or epiphytic herbs, 16-20 cm high. *Rhizomes* distinct, stout, covered with fibrous sheaths; single internodes 3-6 cm. *Pseudobulbs* erect, compressed, fusiform or conical or cylindrical with leaves at the apex, covered by 3 leaf sheath, 5-7 x 1-1.5 cm long. *Leaf sheaths* ovoid-ellipsoid or lanceolate, acuminate, 5-6 cm, membranous and covering young pseudobulbs. *Leaves* convolute/plicate, 2 at the apex of a pseudobulb, with short petiole, elliptic-lanceolate to obovate-lanceolate, 11-27 x 2-4.5 cm, acuminate, entire, coriaceous, glabrous, 10-veined. *Inflorescence* arising from apex of pseudobulbs, subterminal, erect or suberect, sheathing at base, raceme lax, 10-16 flowered, pubescent and decurved, peduncle 2-8 cm long, rachis 20-32 cm long, longer than leaves, pubescent. *Floral bracts* oblong-lanceolate or ovate, caduceous, acuminate or acute, 0.9-12 x 3-4 mm, pubescent, thick, 1-veined, and longer than pedicel and ovary. *Pedicel and ovary* 6-10 x 2 mm, as long as floral bract, pubescent. *Flowers* white, fragrant, 13 x 10 mm across, facing in all directions, star shaped, white to pale yellowish, 30-35 mm across when flattened. *Sepals* unequal, abaxially rust pubescent; *dorsal sepal* lanceolate, acuminate or acute, 17-28 x 4-5 mm, reflexed at apex, thin, entire, pubescent outside, 3-veined; *lateral sepals* falcate-lanceolate, slightly shorter than dorsal sepal, 15 x 4 mm, acute or acuminate, falcate, thin, pubescent outside, round at the base, 4-veined, lateral sepals adnate to column foot and forming a short rounded, incurved mentum, 5 mm long from the columnfoot to its tip and round. *Petals* lanceolate, sub-falcate, acute to acuminate, 13-15 x 2-5 mm, thin, glabrous, entire, 3-veined. *Labellum* 10-15 x 2 mm, tri-lobed, narrowly oblong or ovate-lanceolate, obtuse, glabrous, base

rounded, entire, hang to the column foot, with 3-veins; lateral lobes erect, short, 6 x 2 mm, auriculate, weakly falcate, oblong, rounded and obtuse, sub erect; terminal lobe narrowly oblong-lanceolate, acute, deflexed, 10 x 3 mm, disc with 3-5 longitudinal keels on the labellum, arising from the base to apex. *Column* short, 4-6 x 2 mm, glabrous, thick, curved and broad, clinandrium usually collar like, rostellum ligulate, erect, broad, bent upward to stigmatic cavity, operculum ovoid, 1 x 2 mm, lobed, glabrous, dotted. *Pollinia* 8, brown, laterally flattened, reinforced or obovoid-ellipsoid, attached in four, caudicle glandular, and sticky; viscidium simple. *Stigmatic cavity* 4 x 2 mm, entire (Fig. 12).

Type: Java, *Thunburg s.n.* (Holotype, not located).

Distribution: 500-700 m. Himalaya: (Sikkim, Bhutan, Assam, Arunchal Pradesh, N. of Burma), China, Thailand, Philippines, Malaysia and, Indonesia to Papua New Guinea.

Flowering: July –September.

Status : Rare

Etymology: From Java, where the species was first reported.

Chromosome Number: $2n=36$ (Hasimoto & Tanaka 1983)

SPECIMENS EXAMINED: **Sikkim:** Tropical valley of Sikkim, July & Aug. 1891 *R. Pantling* 91, (K!),

Tropical valley of Sikkim, Aug. 1898 *R. Pantling* 91, (CAL!) Sikkim Himalaya, *G. King* 2306 (CAL!);

Bhutan: Bootan, *Moken s.n.* (CAL!); **North East Himalaya:** Kameng, Siang, Subansiri, Tirap; between 500-1000 m.; *H. J. Chowdhery*; **Burma:** Unknown Coll. Dec 1897(CAL!).

Note: The type specimen of *E. javanica* could not be traced in K, BM, E, and CAL herbaria. While preparing orchids of Bhutan, Pearce and Cribb (2002) searched the type material of this species, with the help of Roland Moberg (UPS), Bertil Nordenstam (S) and U-M Hiltgard (SBT), but they were unable to trace out the specimen in these herbaria. Researcher also agreed with their suggestion that if further searches have been failed, a neotype will have to be selected.

Eria javanica is a peculiar species in the genus *Eria* in several ways. Each pseudobulbs form a single internode, each pseudobulb bears two large leaves, the leaves are convolute, when folded in the bud, where the edges of a leaf overlap each other, which is unusual in *Eria*. All other species of *Eria* and all *Dendrobium* have conduplicate leaves, where the edge of leaf may meet when folded in the bud, but do not overlap in immature stage. Convolute and conduplicate leaves in the same genus or groups of genus are rare. Another striking feature of *E. javanica* shows very tall inflorescence, with rather large flowers, also distinctive from near the top of pseudobulbs with one-jointed pseudobulbs to which the leaf-sheaths are fused. This combination of characters is not found in any other species of *Eria*.

Eria javanica is considered as type of the genus. This will involve a very large number of new series of species due to its morphological characters of leaf arrangement and nature of pseudobulbs.

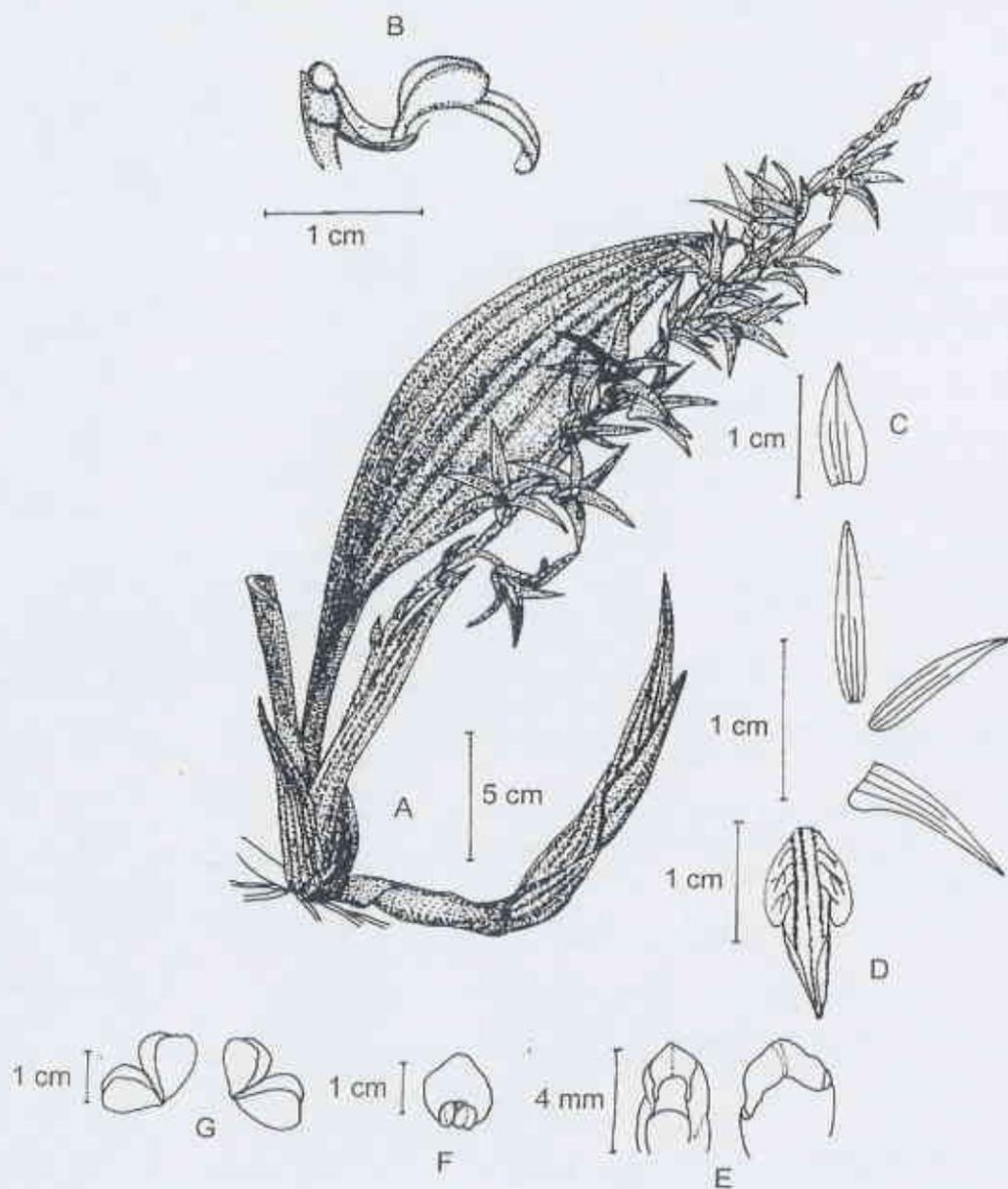


Fig. 12. *Eria javanica* (Swartz) Blume. (Copied from Bot. Reg. 1825) A. Habit; B. Lateral view of column with labellum; C. Bract; D. Spreading of Sepal, Petal; D₁ Labellum; E. Column; F. Operculum; G. Pollinia.

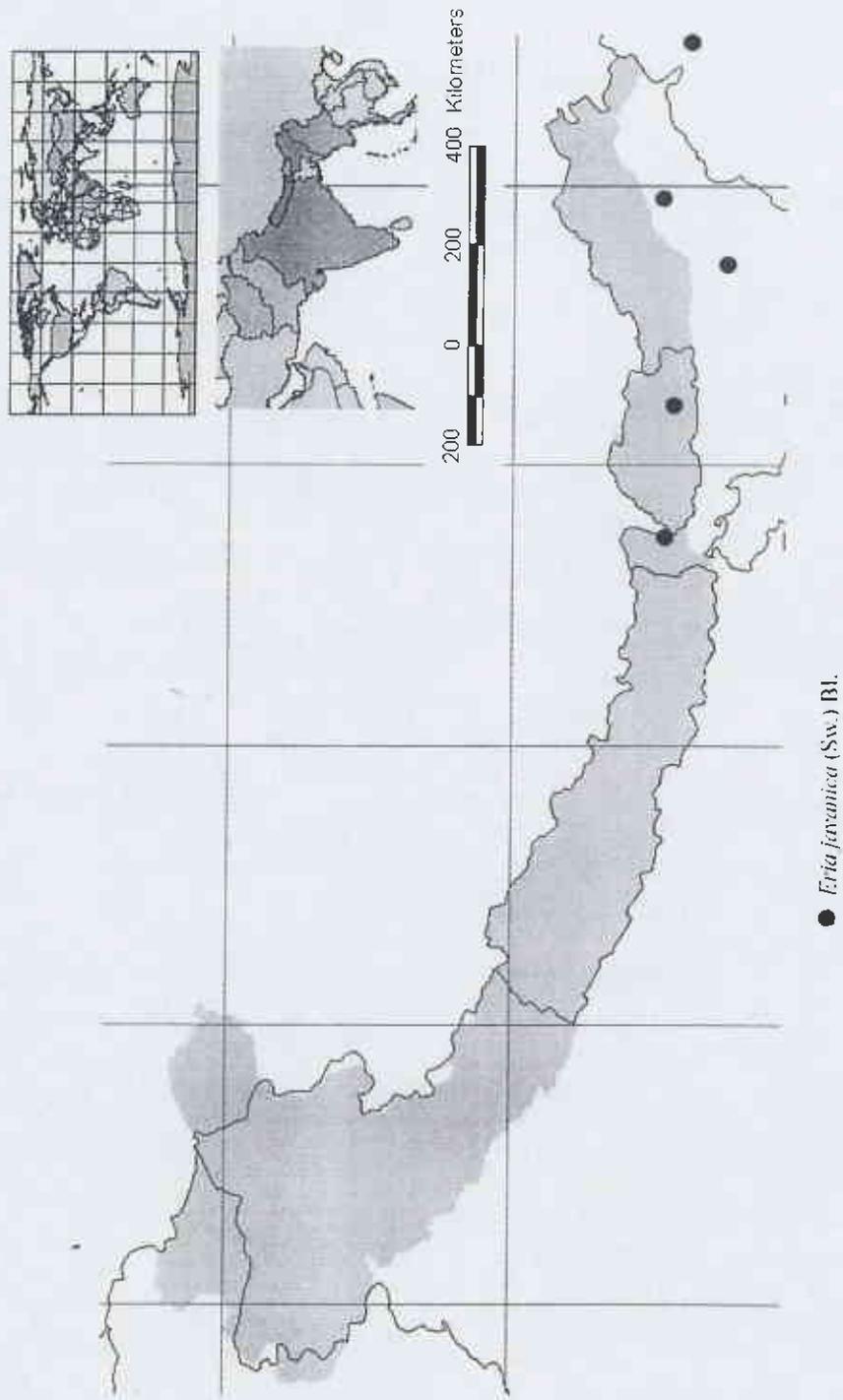


Fig. 13: Distribution Map of the section *Eria*

Section III. *Xiphosium* (Griffith) Lindley, *Jour. Linn. Soc.* 3: 50, 1859

Rhizomes stout; pseudobulbs without distinct nodes; leaves solitary, large, long petiole; Inflorescence borne at the apex of young pseudobulb, lower half surrounded by stiff sheath; floral bract large, 2-5 cm; flowered naked, large, smooth; keeled on pedicel and ovary.

Type: *Xiphosium acuminatum* Griff., *Calcutta J. Nat. Hist.* 5: 365, pl.25 (1845).

Note: Griffith (1845) established a new genus *Xiphosium*, based on *Xiphosium acuminatum*. Lindley (1859) included *Xiphosium acuminatum* in the section *Xiphosium* of the genus *Eria*, with two more species *Eria Scabrilinguis* and *E. vittata* on the basis of Cathcart drawing. However, existence of *Eria Scabrilinguis* being doubtful, because no specimen of this species are deposited in any of the herbaria. *Eria vittata* was transferred to the section *Trichosma* later on, having two leaves with closed flowers. Reichenbach (1861) included Griffith's Khasia plant under *Eria rosea* and added a considerable number of other species including *E. stellata*, *E. cochleata*, *E. speciosa*, *E. bicornis*, *E. ania*, *E. wightii*, *E. barbata*, and *E. paucifolia* to the section *Xiphosium*. Excluding *E. rosea* and *E. stellata* all other allied species mentioned by Reichenbach (1861) were transferred to the genus *Tainia*. Kränzlin (1911) also accepted the section *Xiphosium* and divided into two sub-sections *Euxiphosium* and *Convolutae*. The species like *E. carinata* and *E. rosea* with *E. clausa* were referred in the sub-section *Euxiphosium*, whereas *E. fragrans* and *E. javanica* in the sub-section *Convolutae*. *Eria carinata* is the only species of Himalayan region that belong to the section *Xiphosium*. The section *Xiphosium* was raised to the status of genus *Xiphosium* Griff. by Brieger (1981), but it has not been accepted.

Two species, Himalaya (Bhutan, Sikkim, Nepal) India, Thailand; only one species in Himalaya *Eria carinata* Giff.

8. ***Eria carinata*** Gibson ex Lindley, *J. Linn. Soc.* 3: 50. (1859); J.D.Hooker., *Fl. Brit. Ind.* 5: 808 (1890); King & Pantling, *Ann. Bot. Gard. Calc.* 8: 129, pl.179 (1898); Kränzlin in Engler, A. (eds) *Das Pflanzenreich Hfl.* 50: 22 (1911); Pradhan, *Indian Orchids* 2, :352 (1979); Seidenfaden, *Opera Bot.* 62: 34 (1982); Banerji & Pradhan, *Orch. Nepal Himalaya* :254 (1984); Hajra & Verma, *Fl. Sikkim* 2: 67 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :357, f. 212 (1998); Rajbhandari & Bhattarai, *Beautiful Orch. Nepal* :123 pl. 122 (2001); Pearce & Cribb, *Fl. Bhutan* 3 (3): 371 (2002).

Xiphosium acuminatum Griff., *Calcutta J. Nat. Hist.* 5: 365, pl.25 (1845).

Pinalia carinata (Lindl.) Kuntze, *Revis. Gen. Pl.* 2: 679 (1891).

Eria rosea Wall. *Numer. List*: 7409 (1832), nom. Inval.

Eria fordii Rolfe, *Gard. Chron., n.s.* 25: 584 (1886).

Epiphytic herbs, 15-28 cm high. *Rhizome* very short, creeping and overlapping, woody, covered with dark scarios sheath. *Pseudobulbs* conical or cylindrical-ovoid, compressed, furrowed when matured, obscurely -sided; 5.5-8 x 0.6-3 cm. *Leaf* single, elliptic-oblong or lanceolate, 12-22 x 3.7-7.5 cm, acute, coriaceous, petiolate, jointed and tapering at the base; petiole grooved, 2-7 cm long, channelled upto 9 cm long, distinctly 1-veined. *Inflorescence* borne from basal undeveloped pseudobulb, erect, pendulous, 15-30 cm long; raceme with 3 to 5 drooping, polished flowers; peduncle 8-15 cm long, concealed by undeveloped, conduplicate, young leaf, overlapping, sword shaped upper sheath, sheathed by numerous large equitant bracts, 2.5-7.5 cm long; rachis 4-7 cm long. *Leaf sheaths* lanceolate, 4-5, acute, 2-8 cm x 1-1.8 cm; *floral bract* narrowly linear, or lanceolate, 2-4 x 0.2-0.3 cm, acuminate, spreading, longer than the three-winged stalked ovary. *Pedicel and ovary* three-winged on stalked ovary, triangular, 10 x 3 mm. *Flowers* greenish-purple, crimson red with red veins, 2 x 1 cm in size, and 4-5 cm across, when flattened, facing downward. *Sepals* equal, oblong-lanceolate, slightly spreading, 1.5-2.2 x 0.3-0.5 cm, acuminate, shortly keeled; *dorsal sepal* short pedicellate, ovate to oblong-lanceolate, 15-20 x 3-6 mm, acuminate, light yellow or green, glabrous, with 7 veins; *lateral sepals* ovate, 24 x 6 mm, acute, glabrous at the base, yellowish, and denticulate keels near the apex; straight, adnate with columnfoot to form a gibbous mentum mentum 4 mm long, short, round. *Petals* ovate-lanceolate or oblong-rhomboid 18-20 x 4-6 mm, acute or acuminate, membranous, entire, glabrous, yellowish-green, 5-9 veined. *Labellum* obscurely tri-lobed, oblong, deflexed, 14-20 x 5-6 mm, decurved from the middle; lateral lobe narrowly oblanceolate, small, 10 x 2 mm, round, erect, wavy, thick, red-brown crimson, jointed with column foot, with many veins; terminal lobe broadly oblong to sublanceolate, 20 x 5 mm, apiculate, much recurved, reflexed in the centre; disc with a ridge along the middle from base to apex, and two shorter lines between the lateral lobes, pale purple. *Column* glabrous, 8-15 x 2 mm, white, much curved, 3-toothed at apex; foot shorter than its length, broader, pale yellow and white; clinandrium thickened, crested, lip bilobed; rostellum small, ligulate, bent towards the stigma; operculum 3 x 2 mm, thickened, orbicular. *Pollinia* 8, elliptic, attached to broad granular membranous caudicle; viscidium single and ellipsoid. *Stigmatic cavity* ca. 2 x 1 mm, entire, lobed at the base (Fig. 15).

Type: Assam (India), Churra Punjee (Cherapunji), Khasia, Griffith 5121, ct. 1837 (Holotype K-Lindl!, isotype K!).

Distribution: 1000m., Himalaya (Nepal, Sikkim, Assam, Bhutan, Burma) and Thailand.

Status: Intermediate

Flowering: November-January.

Etymology : Derived from the Latin word '*carinatus*' (keeled), referring to the shape of the sepals.

SPECIMENS EXAMINED: Nepal: *E. Nepal:* Mewa Khola, 7.9.1975, L.W. Beer 25725, (BM!); Jagat, Dharapani, 1430-2000, 9.7.1973, D.P. Joshi & M.M. Amatya 370 (KATH!); Cultivated in Bot.

Gard. Cal. 23 Nov. 1954 (CAL!). **Sikkim:** Sikkim Himalaya 1200m, *R. Pantling* 1, June 1982 (BM!); Tropical valley, *R. Pantling* 1, 1898(CAL!); Sikkim, *King s.n.*, March 1877 (CAL!). **Bhutan:** Mongerdzeng, *Balakrishna* 44651, Nov. 1956 (CAL!). Phunaka, Rimchu area, 6 4. 2002, *D. M. Bajracharya* 408 (TUCH); **Assam**; Khasia, *Griffith* 97, 5121 (type K!); Sylhet, *Griffith*, Wall Cat. 7409 Herb. Lindl. (K!); Dharni, Jaintea Hills, *Prain* 154, March 1899 (CAL!); Jawai, 13.12..1895, *S.E. Rita s.n.* (CAL!); Shillong, *Mann s.n.*, 1885 (CAL!); Iharan, March 1899, *Prain* 154, (CAL!); **North East Himalaya:** Kameng, Lohit, Siang Subansisri, Tirap; between 1200-1800 m.; *H. J. Chowdhery s.n.*

Note: Griffith collected a specimen from Cherra Punjee in Oct. 1837, and described it as the genus *Xiphosium*, which is distinguished from *Eria* by remarkable inflorescence, smooth perianthium, carinate sepals and triquetrous ovary, and named as *Xiphosium acuminatum*. Gibson named *Eria carinata* for the same entity of plants, however this name was not published by Gibson. Later on, Lindley (1859) published and validated Gibson's name when Lindley transferred Griffith's species into *Eria* under the section *Xiphosium* and called as *Eria carinata* Gibson ex Lindl. This view was also supported by Pearce and Cribb (2002). According to ICBN Article 11.4 the proposed name of *E. carinata* is justified, because when Lindley (1859) had proposed new name for *Xiphosium acuminatum* to *E. carinata* instead of *E. acuminata*. It was previously and validly published as *E. acuminata* by Lindley in 1830. Nomenclature of Griffith's epithet the *Eria acuminata* for *Xiphosium acuminatum* is not available; therefore, the name *E. carinata* for *Xiphosium acuminatum* is rightly justified.

Seidenfaden (1982) did not prefer to consider Gibson as the authority of *E. carinata*, because he has not published his proposed name for the taxon in *Cal. J. Nat. Hist.* 5: 365 (1845), only communicated it by Griffith in his description. But Lindley has followed Kew rules while transferring Griffith's entity to *Eria*. So, Seidenfaden assumed that Lindley to be the author for the taxon. On the above characters mentioned by Griffith (1837), Brieger (1981) re-established it as a separate genus *Xiphosium*, and changed its nomenclature of *Eria carinata* to *Xiphosium acuminata* Griff.

This taxon is mentioned by Banerjee & Pradhan (1984) but not included in EFPN (Hara & al. 1978), NLFPGN (Koba & al. 1990) and ACFPN (Press & al. 2000).

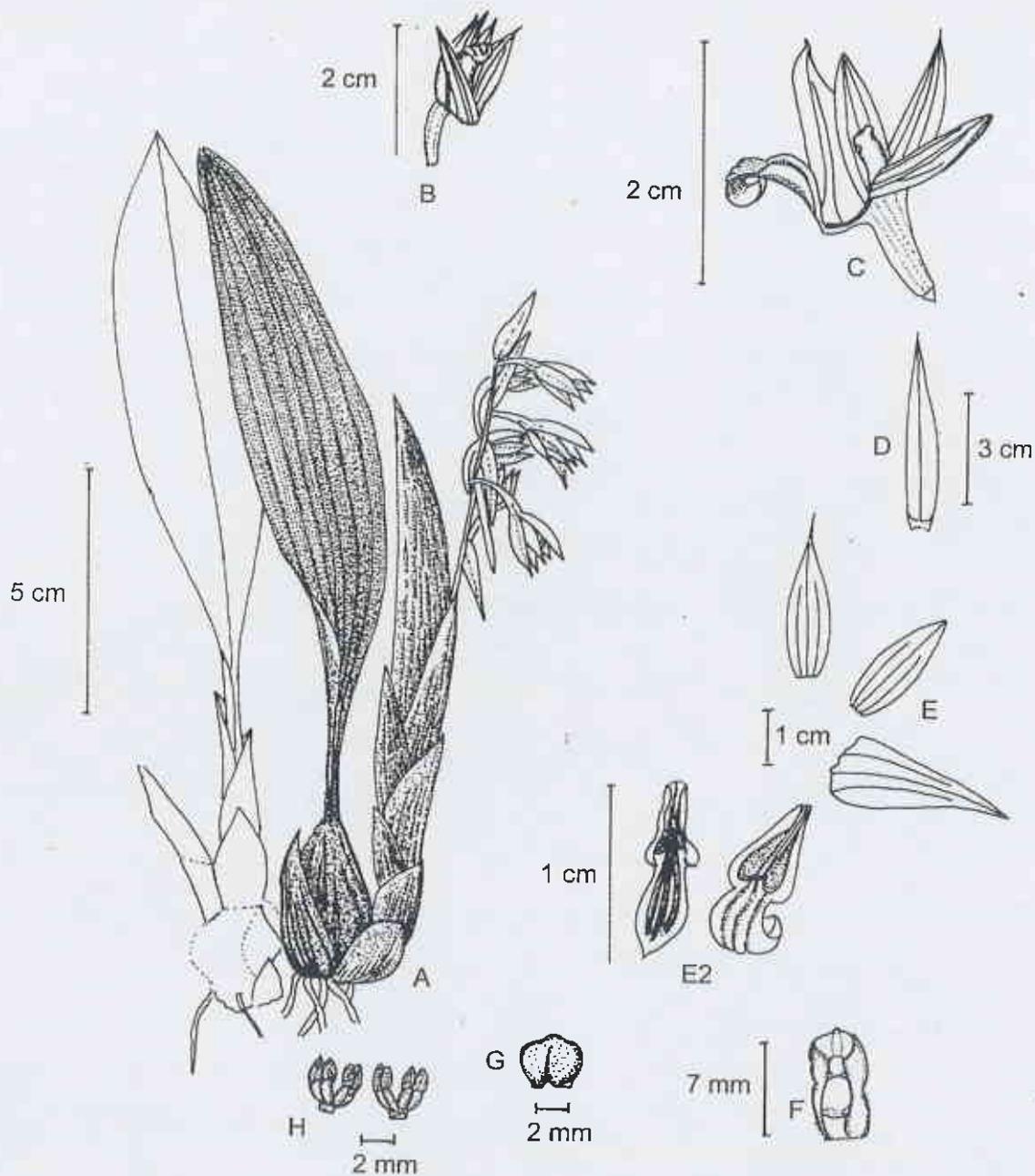
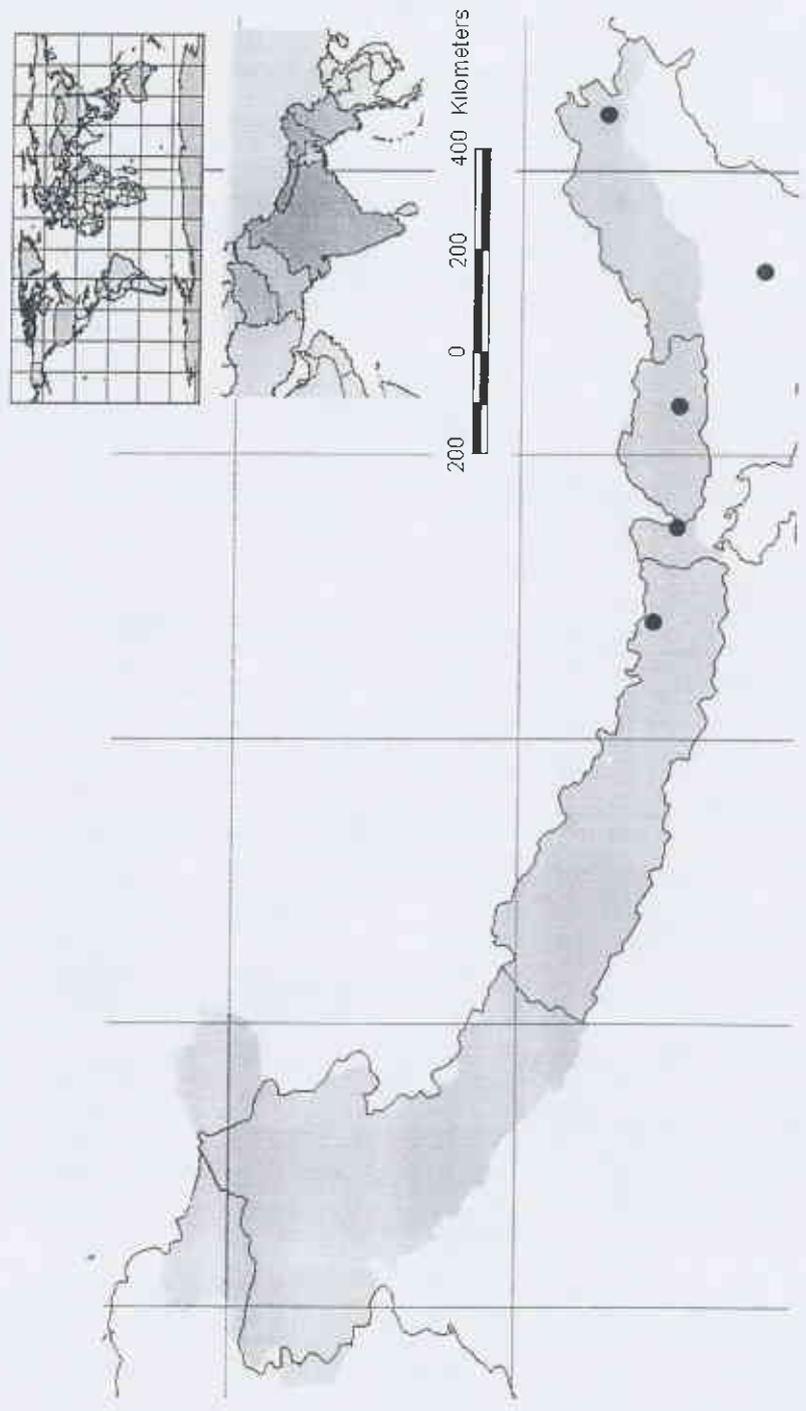


Fig 14. *Eria carinata* Gibson ex Lindley (Griffith 5121, type K) A. Habit; B. Flower; C. Lateral view of flower; D. Bract; E. Spreading of Sepal, Petal; E₂ Labellum; F. Column; G. Operculum; H. Pollinia.



● *Eria carinata* Gib. ex Lindl.

Fig. 15: Distribution Map of the section Xiphosium

Section IV. *Trichosma* Lindley, *Jour. Proc. Linn. Soc.* 3: 52, 1859

Rhizomes slender; plants with uninodal, pseudobulb oblong, ovoid-ellipsoid or cylindrical without nodes; 2-leaved at apex of pseudobulb, conduplicate; terminal inflorescence arising from between 2 leaves or near leaves, few to many flowered; minute or distinct floral bracts; labellum with 2 or more, usually wavy lamellatae keels on the middle lobe of the labellum.

Type: *Trichosma suavis* Lindley, *Jour. Linn. Soc.* 3: 52, 1859 (*Coelogyne coronaria* Lindley, *Bot. Reg.* 27; 178. misc. 83, 1841).

Note: This section was proposed by Lindley (1859) based on the genus *Trichosma* and placed *E. coronaria* (= *Coelogyne coronaria*) on it. Reichenbach (1861) also accepted the section *Trichosma*. However, Hooker (1890) considered *Trichosma* as the separate genus, despite Lindley's transfer. King & Pantling (1898) followed Lindley system and this has been accepted by later workers. Brieger (1981) also accepted *Trichosma* as separate genus under the section *Caulescentes* of the sub tribe *Dendrobiinae*. Pradhan (1979) referred *E. coronaria*, previously placed in section *Trichosma*, kept into the section *Cylindrolobus* with which the taxa shares the general appearance. The present study accepts the section *Trichosma*, which was proposed and followed by Lindley (1859) and Reichenbach (1961).

Open flower, large bracts cylindrical pseudobulbs and irregular pollinia are the distinct morphological character of *E. coronaria* (= *Coelogyne coronaria*) that can be distinguished from other members such as *E. clausa*, *E. vittata* and *E. corneri* of the section *Trichosma*. In the present study, based on well distinct characters of pseudobulbs, floral bracts, labellum, closed or opened flowered with 5-7 wavy, regular or irregular pollinia, the section *Trichosma* has been divided into two series.

About 11 species: Himalaya (NW. Himalaya, Nepal, Sikkim, Bhutan, NE. Himalaya), Tropical Asia, four species in Himalaya. *E. coronaria* Rech.f., *E. clausa*, King & Pantl. *E. corneri* Rech.f., *E. vittata* Lindl.

Key to the series *Trichosma*

- 1.a Pseudobulbs slender, cylindrical; flowers open; Floral bract more than 3 mm long; pollinia irregular, two large and two small in size ————— **series I *Coronariae***
- 1.b Pseudobulbs pseudobulbous; flowers closed, Floral bract less than 3 mm long; pollinia regular, ovoid, all are of same size ————— **series II *Clausae***

Series I. *Coronariae* D. M. Bajracharya et K. K. Shrestha ser. nov.

Caulibus cylindricibus, teretibus angustissimis, diphyllis, bracteis longum q.v.3 mm; flores apertusbus; pollinium irregularis di grandi et di parvullii; clinandrio trilobo anterce roundata fornicate

[*E. coronaria* (Lindl.) Rchb.f.]. **Type:** *Eria coronaria* (Lindley) H. G. Reichenbach., in *Walp. Ann.* 6: 272, 1861. (*Coelogyne coronaria* Lindley, *Bot. Reg.* 27: 178, misc. 83, 1841); [Holotype: K-LINDL.!].

Note: The morphological and micro-morphological characters reveal that the series could be separate into new genus in the near future or it may retain as the genus *Trichosma*.

Series II. Clausae D. M. Bajracharya & K. K. Shrestha *ser. nov.*

Caulibus oblong or ovato, di vel tri phyllis, bracteis parvuli q.v.3 mm vel carens; flores clausibus vel inapertus; pollinium regularis ovoidii eadem amplitudine (*E. vittata* Lindl., *E. clausa* King & Pantl., and *E. corneri* Rchb. f.). **Type** *E. clausa* King & Pantl., *Jour. As. Soc. Beng.* 65(2): 121, 1896 (Holotype: CAL!).

Series I. Coronariae D.M. Bajracharya & K.K. Shrestha *ser. nov.*

9. ***Eria coronaria*** (Lindley) H. G. Reichenbach., in W. G. Walpers, *Ann. Bot. Syst.* 6: 272 (1861); Rchb. f., *Gard. Chron.* 1: 234 (1876); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* 8: 124, pl. 172 (1898); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 53 (1911); Tuyama in Hara (eds.), *Fl. East. Himal.* :433 (1966); Banerji & Thapa, *J. Bombay Nat. Hist. Soc.* :150 (1970); Tuyama in Hara (eds.), *Fl. East. Himal.* :186 (1971); Cribb, *Orch. Reviews* :130 f. 76 (1976); Hara & al., *EFPN* 1: 42 (1978); Pradhan, *Indian Orch.* 2: 357, pl.119 (1979); Seidenfaden, *Opera Bot.* 62: 40 (1982); Banerji & Pradhan, *Orch. Nepal Himalaya*: 256, pl. 257 (1984); Deva & Naithani, *Orch. Fl. N. W. Himal.* :281, f 279 (1986); Koba & al., *NLFPGN* :196 (1994); Hajra & Verma, *Fl. Sikkim* 2: 67 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* 361, f. 215 (1998); Hynniewta & al., *Orch. Nagaland* 174, f. 56 (2000); Press & al., *ACFPN*: 215 (2000); Rajbhandari & Bhattarai, *Beautiful Orch. Nepal*: 125 pl. 124 (2001); Pearce & Cribb, *Fl. Bhutan* 3 (3): 372 (2002).

Coelogyne coronaria Lindl., *Edwards's Bot. Reg.* 27 (misc.): 83, no 178 (1841).

Trichosma coronaria (Lindl.) Kuntze, *Revis. Gen. Pl.* 2: 681 (1891).

Trichosma suavis Lindl., *Edwards's Bot. Reg.* 28: t.21 (1842); Hara & al., *EFPN* 1: 57, (1978). Koba & al., *NLFPGN* :526 (1994); Press & al., *ACFPN* :225 (2000).

Eria suavis (Lindl.) Lindl., *J. proc. Linn. Soc.* 3: 52 (1859); Koba & al *NLFPGN* :196 (1994).

Eria cylindropoda Griff., *Not. Pl. Asiat.* 3: 299 (1851).

Trichosma cylindropoda Griff., *Not. Pl. Asiat.* 3: 299 (1851).

Epiphytic herbs, 8.0-19.5 or upto 38 cm high. Rhizomes often with funnel shaped leathery sheaths. *leaf sheath* adnate to cylindrical pseudobulbs, tubular at the base, fibrous, 3-6 cm long. *Pseudobulb* tufted, congested, thin, not dilated, stem like, cylindric, slender, with a single node, 7-16 x 0.2-0.4 cm;. *Leaves* 2, terminal, sub-opposite, narrowly elliptic to obovate-elliptic, rarely ovate-lanceolate, 9-21 x 2-4 cm, acute or acuminate, jointed, coriaceous, sub-sessile, grooved, sub-opposite, 9 veined (3 veins in the protologue). *Inflorescence* terminal, arising from the between 2 leaves, racemose, erect, 5-15 cm long, laxly 4- to 6-flowered; apically often curved, with 1 sheathlike structure at base, peduncle short and sheathed at base, glabrous, 1.5-2.5 cm long; rachis 2-3 cm long, zigzag, glabrous. *Floral bract* linear-lanceolate, rarely ovate-lanceolate, 2-5 x 2-3 mm, acute, shorter than pedicel and ovary, greenish brown with 3-veined. *Pedicel and ovary* glabrous, pinkish, 1.5-2 cm long. *Flowers* white or greenish yellow and fragrant, 4-6 in numbers, 2-3 cm long, 3.7-4.5 cm across, creamy, lateral lobes of labellum purplish. *Sepals* sub-equal in length, spreading, glabrous 15-20 x 7-8 mm; *dorsal sepal* elliptic-oblong, white, 15-20 x 5-6 mm, obtuse or sub-acute, glabrous, with 3 veins; *lateral sepals* unequal, slightly oblique, falcate, elliptic-lanceolate, 16-20 x 7-8 mm, acute; broad base attached to the side of the column, creamy white, with 3 veins; adnate to column foot and forming a conspicuous mentum, 5 mm long, short, conical obtuse. *Petals* creamy white, oblanceolate-oblong or elliptic-oblong, 16-19 x 6-9 mm, acute or obtuse, thin, glabrous, 3-veined. *Labellum* tri-lobed, oblong, orbicular, obtuse, 16-17 x 9-10 mm, white flushed with purple externally and having some dark streaks of purple on the lateral lobes, motile; lateral lobes large, rounded or sub oblong, perpendicularly or acutely angle with terminal lobe, with 2 dilated crenate ridges, striped with purple; terminal lobe small, sub-orbicular or triangular, acute, revolute, disc with 5-7 undulate lamellae, unequal, crenate ridges, yellow with purple dots; disc between the lateral lobes with two broad, dilated ridges extending from base to apex of the terminal lobe; *Column* 5-7 mm long, stout, reddish coloured; foot tapering short, ca. 5 mm; clinandrium trilobed, collar shaped, semicircular, glabrous; rostellum ligulate, triangular, small; operculum 3 x 2 mm. *Pollinia* 8, yellow, ovate, irregular, laterally flattened, 2 x 1 mm across; pollinia two large and two small, and attached to sticky caudicle; viscidium simple, ellipsoid. *Stigmatic cavity* 3 x 1 mm, entire. Fruit ellipsoid, slightly dilated towards apex, 20-25 x 7-9 mm (Fig. 16).

Type: Assam (India), 'Churra Punjee' (Cherapunji), Khasia; *J. Gibson s.n.* (Holotype: K-LINDL!).

Distribution: 1600-2000 m., Himalaya (NW Himalaya, Nepal, Sikkim, Bhutan, Arunchal Pradesh), China, Thailand and Vietnam.

Flowering: October- January

Etymology: From the Latin word '*coronaries*' (forming a crown)

Chromosome Number: n= 18 (Mehra & Vij 1970, 1976); n=17-19; 22-26 (Mehra & Sehgal 1980, 2n= 36 (Chatterji 1965b, Shekhar 1984).

SPECIMENS EXAMINED: **North west Himalaya:** Kumaun: Pithoragarh: Maitli- Dafia Dhoora, 23-5-1979, Arora 66208, (DD!). **Nepal:** W. Nepal: Chhatiwon, Doti, Oct. 2002, G. Amatya 22.; A. Ghanteswor, Doti 1550 m, G. Amatya 27; C. Nepal: Daman, Makawanpur 2300m, 10.10.1997, D. M. Bajracharya 0128 (TUCH); Pantari 2100m, 31.10.1954, Station, Sykes & Williams 9331, (K!, BM!); Phulchoki 1500, 7.11.1997, P. Pradhan 378, (KATH); Devi Than Danda 2000, Oct. 1965, (14-7-023 (Nepali Date), B.K. Basukala 5902; Shivapuri 2000 m., 8.9.1977, P. Pradhan & N. Shrestha 388, (KATH); E. Nepal: Num- Kanbari 2100m, 4.12.71, C.R. Lancaster, D. Morris, L.W. Beer 12361, (BM!); Near Raksa Ilam 2050m, 19.11.1978, P. Pradhan, & al 668, (KATH); Tehathum 1650m, 16-11-1978, P Pradhan et. al. 663, (KATH); Sine loc. M. L. Banerjee 54 (CAL!); Pathivara 1600m., 7 .6. 2003, D. M. Bajracharya & L. R. Shakya 514; Mikhalajung 2000 m. 12 .6. 2003 . D. M. Bajracharya & L. R. Shakya 570. **Sikkim:** Sino loc. 1800m, J. D. Hooker 144 (K!); Sept-Oct 1892, R. Pantling 27, (K!), J. D. Hooker (K!); Darjeling 1500m, C. B. Clarke 9724 (K!); Sainep: N.E. Sikkim 1525 m, June 1828, Parry 481 (K!); Darjeeling, Gamble 28062 (BM!); Duruli, 13 .11.1908, Craib, W.G. 44, (CAL!); Sikkim Ulumeng, 25 .11. 1908, Craib 312, (CAL!); Tropical Valley, Feb. 1892, Panting 127, (CAL!). **Bhutan:** Dumsong 1800, 15.1.75, Gamble 216A (K!); Yenpu La 1500m., Ludlew & Shefriff 2873 (K!, E!); Dumsong 1800m, 17.11.1875, C.B. Clarke 26413 (BM!); Chassilikha, 21.12. 963, G. V. Subha Rao 293 (CAL!); Shambang, 18.11. 1964, D. B. Deb 419, (CAL!); Nyoth 2000 m, March 1965, Balkrishna 43023, (CAL!); Nyoth 2000 m, Oct.1965, Balakrishna 44219, (CAL!); Shemgang 1950m, D.B. Deb 419 (CAL!). **Assam:** Shillong Peak 1800m, N. L. Bor 20889 (K!); W. corner of Api, Tani valley subannan division of NEFA 1500, 27.4.1965, Lose & Hutchinsion 522; Shillong Peak 2100m, 14.12.1952, Thakur Rup Chand 6698, (K!); Khasia 1200 m, 2. 12. 1871, C. B. Clarke 14504, (BM!); Sirhai, Manipur 3400m, 26. 10. 1948, Kingdon-Wards 18272, (BM!); Jarain 1200m Jaintea, 21.11 1872, C. B. Clarke 17877, (BM!); Griffith Lindl. Herb. (K!); J. D. Hooker s.n. (K!); Griff. 5117 (K! type); sino loc. 2.12.1871, C. B. Clarke 14505, (K!); Griffith 1013, 1258, (type of *E. cylindropoda* K!); Khasia, Oct 1896, S. E. Rita s.n. , (CAL!); Cherra, 26.3.1960, D.C.S. Raju 21381, (CAL!); Khasia, Nov. 1887, Manns s.n. (CAL!). **North East Himalaya:** Begil, 6 6.1961 G.V. Subha Rao 24767, (CAL!); **North East Himalaya :** Kameng, Lohit, Siang Subansisri, Tirap; between 500-1000 m.; H. J. Chowdhery s.n.

Note: Lindley described a new species *Coelogyne coronaria* in Bot. Reg. 27: 83 (1841), and later on, he again described another species as *Trichosma suavis* in 1842 for *Eria coronaria*. Lindley (1859) transferred *Trichosma suavis* to *Eria suavis*, and placed in the section *Trichosma*. He changed the status of the genus *Trichosma* into sectional level of the genus *Eria*, and admitted that "Prof. Reichenbach is right". Actually, Reichenbach did not publish his opinion for *Eria suavis* and *Eria coronaria* until 1861. Lindley did not mention *Coelogyne coronaria* in his enumeration (1859), but *Trichosma suavis* has been regarded as the synonym of *Eria coronaria* according to Kew rules.

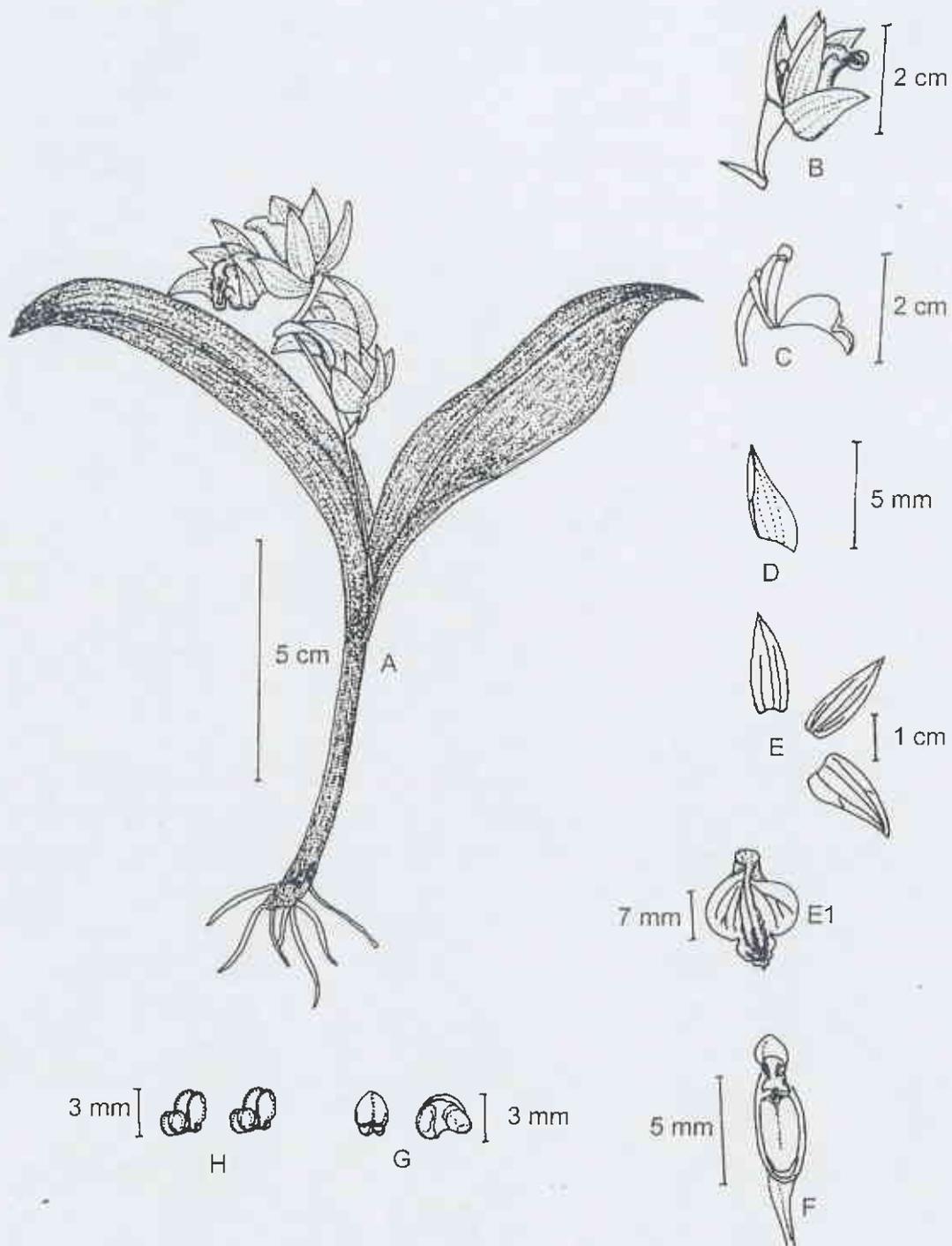


Fig 16. *Eria coronaria* (Lindley) H. G. Reichenbach (*D. M. Bajracharya* 128, TUCH!) A: Habit; B: Flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

Reichenbach (1861) treated *Trichosma suavis* as a separate taxon along with *E. coronaria* in the section *Trichosma*. King & Pantling (1898) followed Lindley system and this has been accepted by later workers.

Hara & al (1978) and Press & al (2000) enumerate *Eria coronaria* and *Trichosma suavis* as the separate taxa without verifying the specimens. The present study verified *Eria coronaria* and *Trichosma suavis* are conspecific. Moreover, this species is much related to *Eria clausa*, *E. vittata*, and *E. corneri* in its labellum character i.e. mostly laminate keels on the terminal lobe of the lip, however, *Eria coronaria* is not related with above species, because the pseudobulb is slender in *E. coronaria* whereas other has oblong, ovoid to ellipsoid type. The structure of pollinia also differs from others. Therefore, the present study has proposed the separate sub section *Coronariae* for *Eria coronaria* within the section *Trichosma*. Chen & Tsi (1987) also described *E. medongensis* a peloric species closely related to *E. coronaria* from the Meddong region of SE Xijang. This specimen could not be examined during the present work.

Series II. Clausae D.M. Bajracharya & K.K. Shrestha *Ser. nov.*

Pseudobulbs pseudobulbous, closed flowered, pollinia regular, all are identical in shape and size Labellum with three keels from base to apex

- | | | |
|-----|--|-----------------------|
| 1.a | Pseudobulbs loosely arranged; leaves less than 20 cm | 2 |
| 1.b | Pseudobulb densely arranged; leaves 15-45 cm long | 10. E. corneri |
| 2.a | Inflorescence many flowered; sepal and petal with purplish brown stripes, labellum simple, entire, lateral lobe indistinct | 11. E. vittata |
| 2.b | Inflorescence 1-or 3-6 flowered; sepal and petal without stripes; labellum tri-lobed, lateral lobed distinct | 12. E. clausa |

10. *Eria corneri* H. G. Reichenbach, *Gard. Chron.* new ser. **10**: 106 (1878); Liu & Su, *Fl. Taiwan* **5**: 983 (1978); Pearce & Cribb, *Fl. Bhutan* **3** (3): 385 (2002).

E. goldschmidtian Schltr., *Orchis*. **4**: 107 (1910).

E. septemlamella Hay., *Icon. Pl. Formos.* **4**: 56, f. 24 (1914).

E. yakushimensis Nakai, *Bot. Mag.* (Tokyo) **36**: 20 (1922).

Dendrobium bonianum Ganep., *Bull. Mus. Natl. Hist. Nat.* **II**, **2**: 233 (1930).

E. boniana (Gagnep.) T. Tang & F. T. Wang, *Acta Phytotax. Sin.* **1**: 84 (1951).

E. petelotii Gagnep., *Bull. Mus. Natl. Hist. Nat.* **II**, **2**: 309.

Epiphytic herbs. *Pseudobulbs* closely tufted, congested, ovoid-oblong to ellipsoid, often 4-ridged, usually 4-6 cm long; ca. 2 cm in diameter, with 2 or 3 membranous sheaths, base covered by 2-3 scales sheaths, before maturity. *Leaves* 2 or 3, conduplicate, elliptic-oblongate or oblong, 15-35 x 2-6 cm, acute or acuminate, attenuate, canaliculated at base, gradually tapering into a sub-petiolate base; leaf blade arcuate. *Inflorescence* lateral, arising from outside of leaves near pseudobulb apex, 12-15 cm long; base embraced by 1 membranous sheath, rachis ca 1.5 cm long, somewhat arcuate, densely flowered. *Floral bracts* minute or absent ca. 3 mm long. *Pedicel and ovary* glabrous, 6-10 mm long. *Flowers* more or less secund, white or slightly tinged yellow, dense, white to pale greenish-pale yellow, ca. 1-1.5 cm. *Sepals* unequal, oblong-lanceolate, triangular, 10-13 x 3-6 mm; *dorsal sepal* linear-lanceolate or triangular, 10-13 x 4-6 mm, acute or acuminate, 3-5 veined; *lateral sepals* obliquely triangular-oblong, 9-10 x 6 mm long, sub-obtuse or bluntly rounded and apiculate, 5-veined; base of lateral lobe adnate to column foot and forming distinct mentum; mentum obtuse. *Petals* linear-lanceolate, more or less recurved, 11-13 x 2-3 mm acute. *Labellum* tri-lobed, ovate-rhomboid, 9-10 x 6-8 mm, labellum articulated with foot of column at base, the labellum white with a purplish terminal lobe and purplish streaks over the lateral lobes; lateral lobe suberect, semi-oblong and the apex of lateral lobe rounded, slightly embracing column, 2.5 mm long; terminal lobe deltoid or ovate-triangular, obtuse, 3.5-4 x 3 mm wide, reflexed; disc 3-keeled, usually 2 short keels near the apex; the keels undulate-cristlike or ciliate like lamellae adaxially, yellow with purple towards apex, the lateral keels giving off a branch at the base of terminal lobe into 5 parallel papillose keels. *Column* 3-4 x 2.2 mm, semicylindrical, column foot 4 mm; operculum 2 celled, 2 x 1.6 mm, brown when dry; cliandrium collar like; rostellum not bent towards the stigmatic cavity. *Pollinia* 8, triangular-ovate, flat, in 2 pairs; visidium simple. *Stigmatic cavity* lightly convex and entire. *Fruit* capsule, ellipsoid, 1.3-1.5 cm long (Fig. 17).

Type: Taiwan, *Sin. loc.* (Holotype: GH)

Distribution: 1500 m., Himalaya (Nepal, North-East Himalaya), China, Hongkong, Hainan, Taiwan, Laos, Cambodia.

Flowering : July

Etymology: The epithet of the species is named in honour of Arther Corner, who collected the specimen from Formosa.

Chromosome Number: 2n= 36 (Hasimoto & Tanaka 1983).

SPECIMENS EXAMINED: India: Northeast Himalaya, Sessa, Arunchal Pradesh, A. N. Rao 26050 (Orchid Herbarium Tipi). **Formosa:** *Sin. Loc.* (Photograph Herb. Reichenbach GH!).

Note: *Eria corneri* is characterized by its 4- to 5-angled pseudobulb, with one enlarged internode. Lin (1977) considered *E. corneri* as close to *E. javanica* having convolute leaves, but differs in having angled pseudobulbs and without creeping rhizome. Rao (1996) considered it as synonym of

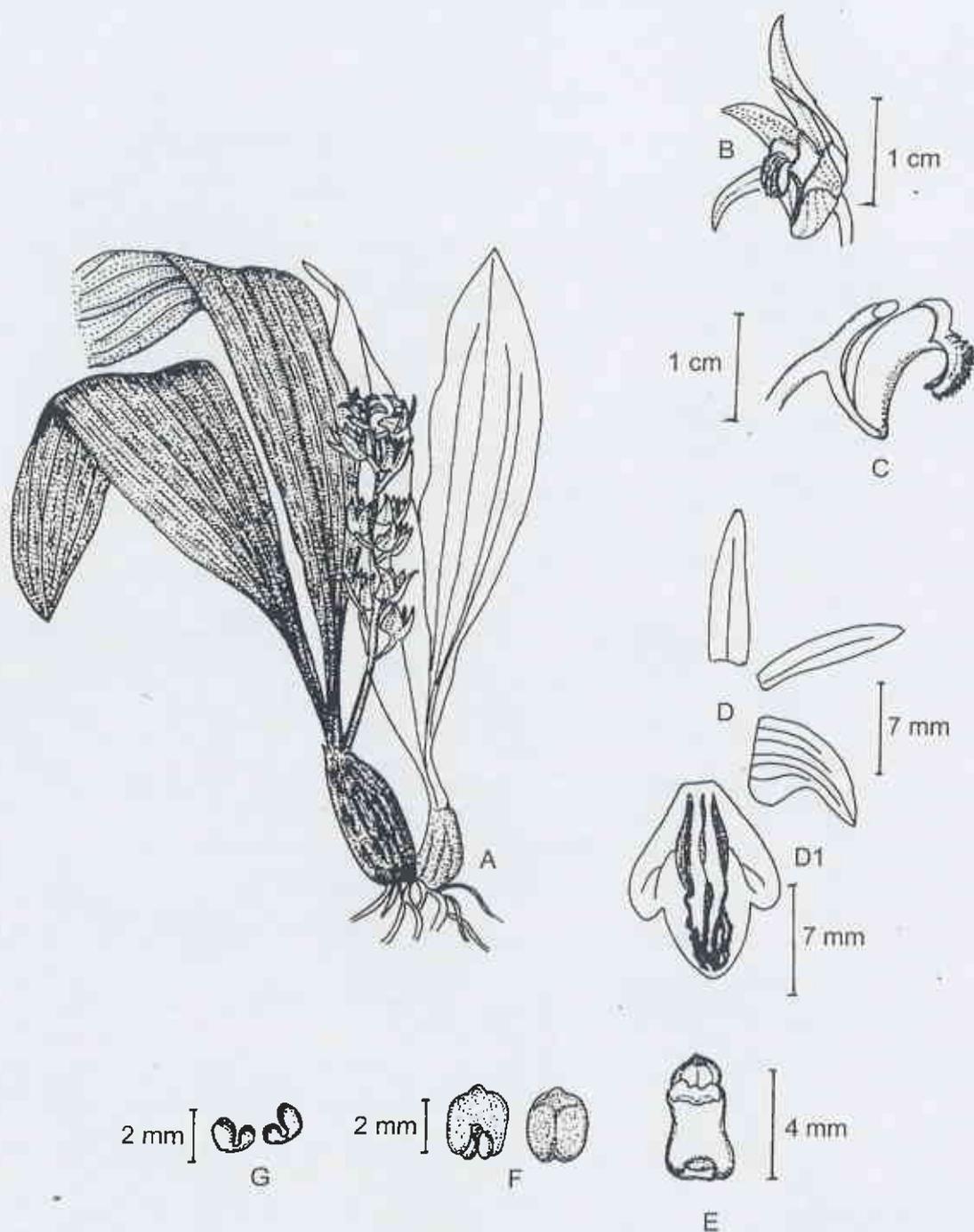


Fig. 17. *Eria cornari* H. G. Reichenbach, A: Habit; B: Flower; C: Lateral view of column with labellum; D: Spreading of Sepal, Petal; D₁: Labellum; E: Column; F: Operculum; G: Pollinia.

E. clausa var *corneri*. Averyanov (1994) treated it as distinct species; Present study accepted it as a separate species.

11. ***Eria vittata*** Lindley, *J. Proc. Linn. Soc.* **3**: 51 (1859); Rchb. f., *Gard. Chron.* **1**: 330 (1882); J. D. Hooker, *Fl. Brit. Ind.* **5**: 794 (1890); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* **8**: 120, pl. 165 (1898); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50**: 75 (1911); Pradhan, *Indian Orch.* :365 (1979); Seidenfaden, *Opera Bot.* **62**: 42 (1982); Hajra & Verma, *Fl. Sikkim* **2**: 70 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :385, f. 231 (1998); Hynniewta & al, *Orch. Nagaland* :183 (2000); Pearce & Cribb, *Fl. Bhutan* **3** (3): 374 (2002).

Pinalia vittata (Lindl.) Kuntze, *Revis. Gen. Pl.* **2**: 679 (1891).

Epiphytic herbs, 20-30 cm high. *Rhizomes* with numerous long roots, slender, glabrous, creeping, stout, nodes with a funnel shaped leathery sheathed and thick with pseudobulbs. *Pseudobulbs* 2-3 cm apart at distant or clustered, 7-12 x 0.6-1 cm, long, ovoid-conical or oblong, slender, thick, below narrowing upward to 1 cm; 2-4 large unequal membranous sheaths, longer sheath enclosing entire pseudobulb, base of leaves, and base of inflorescence, brown, 2-3 x 1-1.5 cm. *Leaves* 2, membranous, elliptic or lanceolate, 15-20 x 4-5 cm, acute rarely acuminate, membranous, tapering to petiole base, gradually concave, 5-7 veined; petiole 0.8-3 cm long. *Inflorescence* a terminal raceme, 15-20 cm long, elongated, arising from apex of pseudobulbs, decurved, dense flowers drooping, so that rachis is directed downwards; peduncle glabrous, rachis 6-8 cm long, glabrous, base of the peduncle with 2-3 sheathed at the base; *sheaths* lanceolate, acute, 1-2 cm long. *Floral bracts* reduced to thickened ring, minute, ovate or triangular, persistent, short, ca. 0.8 mm long. *Pedicel and ovary* 10 x 2 mm, green, glabrous. *Flowers* pale green, 1-2 cm across, glabrous, green, striped with red, sweet smelled. *Sepals* sub-equal, 1.2-1.3 cm long; *dorsal sepal* broad, ovate-oblong, 0.8-3 x 0.13-0.2 cm, acute or sub-acute, thick, white, tinged with purple-red striped, 3-5-veined, concave; *lateral sepals* triangular-oblong, falcate, 0.5-1.2 x 0.5 x 1 cm, acute, glabrous, spreading, white, tinged with purple-red striped 3-veined, adnate to column foot and forming mentum; mentum round, ca. 0.6 mm long, broad, conical, obtuse. *Petals* white, thick, slightly falcate, narrowly linear-oblong or ligulate, ca. 6-10 x 1.5-2 mm, obtuse to sub-truncate, 3-veined. *Labellum* simple, broadly elliptic-oblong, without lobe, decurved, 0.5-1 x 0.2-0.3 cm, apex subtruncate, slightly mucronulate, margins crenulate, obtuse, attached to base of column foot; disc with 5 crenulate lamellae, from base to apex, undulate, greenish purple, purplish brown or fine linear marking or longitudinal stripes. *Column* with anther laterally compressed, short, 5-9 x 1-2 mm, slender, glabrous, curved, and acute, columnfoot ca. 0.9 x 1.2 mm long, purple; clinandrium usually collar like, 1 mm across; rostellum elongate, cylindrical, red, erect toward the stigma; operculum ovate, 2 x 1.2 mm; connective elongated, deltoid, exceeding operculum,

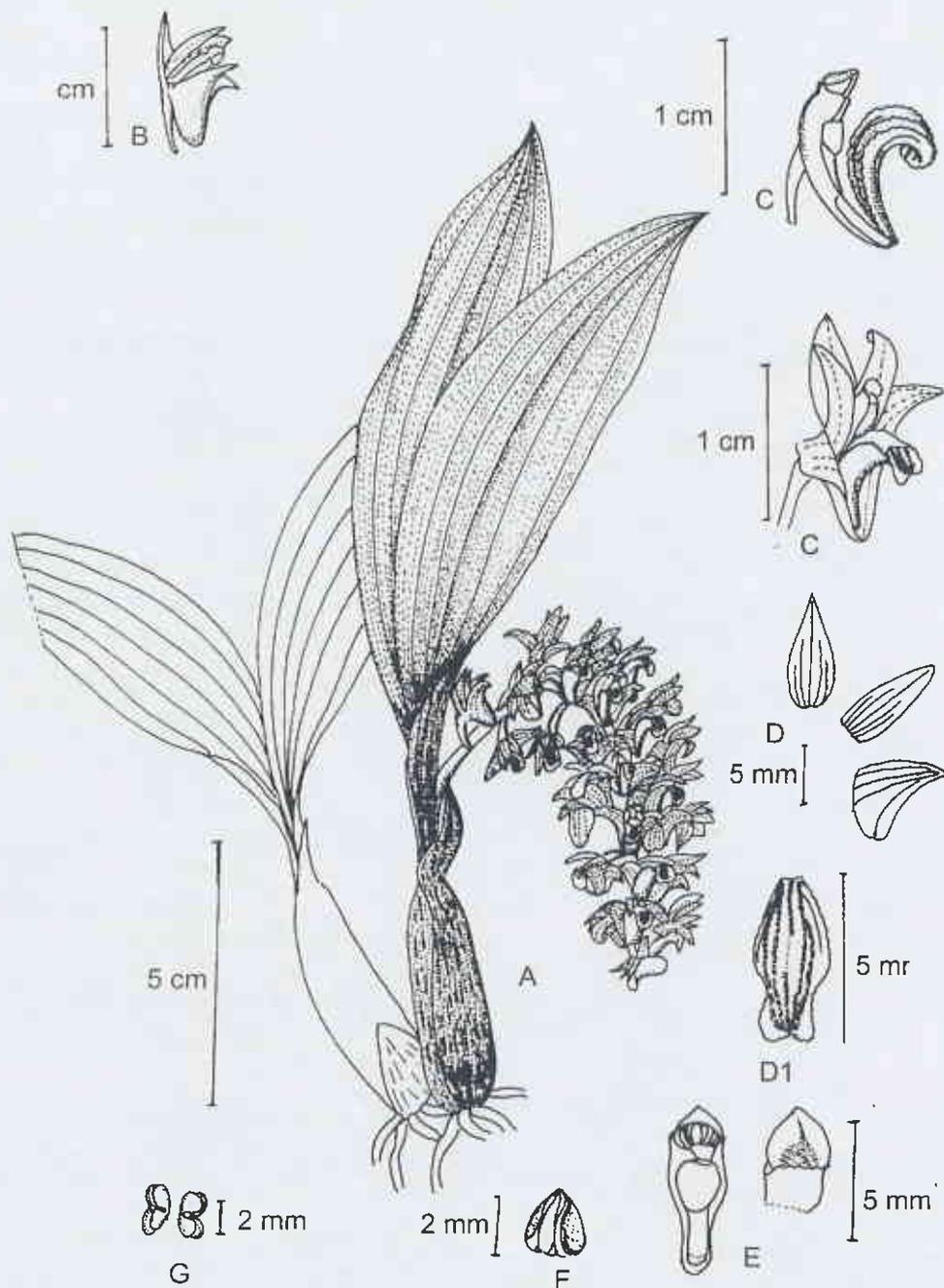


Fig. 18. *Eria vittata* Lindley (*Pantling* 62. K) A: Habit; B: Flower; C: Lateral view of column with labellum; C: Lateral view of flower; D: Spreading of Sepal, Petal; D₁: Labellum; E: Column; F: Operculum; G: Pollinia.

smooth, 8 chambered. *Pollinia* 8, ovoid, ca. 0.5 mm wide, clustered in a group of four at the back, by granular membranous candicle; viscidium is simple and ellipsoid. *Stigmatic cavity* entire, 2 x 1.5 mm (Fig. 18).

Type: Sikkim (India), *sino loc.*, Cathcart's s.n. drawing (Holotype: K!)

Distribution: 1600-2000 m., Himalaya (Sikkim, Assam, Burma) Thailand.

Flowering: January- March

Etymology: From the Latin word '*Vittatus*' (Striped), with reference to characters of sepals and petals.

SPECIMENS EXAMINED: Sikkim: Sikkim, (K- LINDL.!); Sikkim, March 1893, 1R. Pantling 61. (K!, CAL!); Sikkim Himalaya, March 1893, R. Pantling s.n., (BM!, CAL!); Sikkim, 23. 1876, King s.n. (CAL!). **Bhutan:** Bhutan, 1897, Mokin s.n. (CAL!); **Manipur:** Poishing, May 1882, Wallich 7451. (CAL!); **North East Himalaya :** Kameng, between 1200-2500 m.; H. J. Chowdhery, s.n.

Note: Lindley (1859) described *E. vittata* in the section *Xiphosium* along with *E. carinata*, due to the presence of large flowers and distinct smooth pseudo-bulbs. Kränzlin (1911) included this species in the section *Hymeneria* and sub-section *Bractescentes*, with regard to ovate to fusiform or cylindrical pseudobulbs, conspicuous bracts, many flower with simple sessile labellum characters. But later workers placed it in the section *Trichosma*, due to common character of two leaved stem with (sub) terminal inflorescence of up to 12 flowers on a rachis, with minute bracts, labellum with 2 or more usually wavy keels. Besides that *E. clausa* and *E. corneri* have been proposed as synonyms of *E. vittata*, due to the cleistogamous flowers (King and Pantling 1898; Averyanov 1994; and Rao 1996).

12. Eria clausa King & Pantling, *Jour. Asiatic. Soc. Beng. Pl.* 2, Nat. Hist. **65**: 121 (1896); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50**: 20 (1911); King & Pantling, *Ann. Bot. Gard. Calc.* **8**: 121, pl.167 (1898); Seidenfaden, *Opera Bot.* **114**: 169 (1992); Hajra & Verma, *Fl. Sikkim* **2**: 67 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :357 (1998); Pearce & Cribb, *Fl. Bhutan* **3** (3): 371 (2002).

Eria corneri var. *clausa* (King & Pantling) A. N. Rao, *J. Econ. Taxon. Bot.* **20** (3): 708 (1996).

Eria clausa J. J. Smith, *Bull. Dep. Agric. Indes Neerl.* **39**: 13 (1919).

- Epiphytic herbs, 4-15 cm high. *Rhizome* ca. 2.5 x 0.5 cm, slender, thick, jointed, smooth with few short membranous sheaths; 2-3 nodes are present in the rhizomatous segments. *Scaly leaves* 2 in rhizome. *Pseudobulbs* 3-5 cm apart, ovoid or ellipsoid, blunt at apex, single node, bases clothed with fibrous sheaths, rugose when dry, 1.5-4 x 1.5-2 cm. *Leaves* 1-3, apical to pseudobulbs, elliptic-lanceolate, 4-15 x 2-2.5 cm, acute to acuminate, tapering both ends, membranous, petiolate or sessile, with 5-veins; petiole grooved, 0.8-2 cm long. *Inflorescence* 1-2,

terminal raceme, arising from the innerside of leaves, lax, erect, 5-10 flowered, shorter than leaves; flowers in peduncles, peduncle with 2 membranous sheathed at base, glabrous, 1.5-2.5 cm long; rachis 1.5-2.5 cm long, glabrous, zigzag, one or two from the top of pseudobulbs, each enveloped for more than half its length by a narrow convolute sheath; sheaths lanceolate, acute membranous. *Floral bracts* nearly obscurely obsolete, 0.4 x 2 mm, and represented by slightly thickened ring at the base of stalked ovary. *Pedicel and ovary* longer than floral bracts, glabrous, 7-10 x 2 mm. *Flower* 0.8-1 cm across, pale greenish with brown streaks, do not open, slightly shorter than the ovary. *Sepals* oblong-lanceolate, obtuse to sub acute, 6-7 mm; *dorsal sepal* oblong-lanceolate, 6-10 x 3-4 mm, thin, obtuse to sub-acute, glabrous 5-veined; *lateral sepals* oblong-lanceolate, falcate, 6-8 x 2-3 mm, obtuse, 5-veins adnate to column foot and forming mentum; mentum globose, 5 mm long from the foot of column to the tip, lateral margin of column adjacent to the tip. *Petals* slightly falcate, oblong, ca. 8 x 2-3 mm, obtuse, thin, 3-veined. *Labellum* tri-lobed, oblong or obovate, 9-10 x 6 mm, lateral lobes obliquely rounded near the apex, 7 x 2 mm, deflexed, the edge entire, with 3 longitudinal high lamellae; terminal lobe broadly ovate, obtuse, 9-10 x 6 mm, short, caruncled, globose; disc with 5-7 sinuous parallel lamellae raised from base to apex, lateral lamellae with an undulately arcuate lamellae at terminal lobe base. *Column* 3 x 1 mm, long, straight, glabrous; column foot 4 x 2 mm, curved; clinandrium collar like, 2 mm across; rostellum flattened, against the back of the cliandrium, ligulate; operculum 1.8 x 1 mm, ovoid, outer surface glabrous, inner surface of operculum with four locules. *Pollinia* 8, broadly obovoid with glandular caudicle; viscidium is simple and ellipsoid. *Stigmatic cavity* small with two sub-globular convexities inside its lower margin, ca. 0.5-1 mm long (Fig. 19).

Type: Sikkim (India), Sittong point, 2000m, *R. Pantling* 559, Feb. 1891 (Holotype: CAL!; isotype, K!).

Distribution: 1600-2700 m., Himalaya (Nepal, Sikkim, Bhutan, Arunchal Pradesh, Burma), China, Yunnan, Kwangsi, Vietnam.

Flowering: February- May.

Etymology: From the Latin word 'clauses' (Closed)

SPECIMENS EXAMINED: **Nepal:** *C. Nepal:* *Napalia* Wall. s.n. 7 (BM!); Kaskikot, Pokhra valley ca.1300 m, 14 9.1997 *D. M. Bajracharya* 47, (TUCH!); 2.1.2001 *A. Subidi* 447, (TUCH!); **Sikkim :** Sittong 2000m, Feb. 1891, *R. Pantling* 559, (Type K!). **Bhutan:** Without precise locality, *Balakrajshna* 43039 (CAL!). **North East Himalaya:** Kameng, Siang Subansisri, Tirap; between 1000-1500 m. *H. J. Chowdhery*; **Burma:** Gamlan Myitkyina 2000m *C. W. D. Kermode* 17044 (K!).

Note: King & Pantling (1898) suggested that *E. clausa* might be cleistogamous form of *E. vittata* and considered as conspecific with *E. vittata*. *E. clausa* is also closely related to *E. boniana* (Gagnepain) T. Tang & F.T.Wang and to *E. corneri* Reihb.f. Tang and Wang (1951), Lang & Tsi (1976) and Seidenfaden (1992) treated them as distinct species.

Averyanov (1994) treated *E. clausa* as a synonym of *E. corneri*. Rao (1996) suggested that it was a cleistogamous form of *E. corneri*. From the thorough examination of the materials of *E. corneri* it is now clear that *E. corneri* has clustered pseudobulb, whereas *E. clausa* has well spaced pseudobulbs. Thus, *E. corneri* has been proposed here as the distinct species, not the synonym of *E. clausa*.

This species is new records to the Flora of Nepal. Paudyal and Sakya (1981) reported *Eria clausa* as new report from Pharping, C. Nepal, but specimen citation as well as description and Herbarium number was not mentioned. Similarly, Gupta (1985) also claimed *E. clausa* as new record for Flora of Nepal. But as Paudyal and Sakya (1981) no information was included except the name. In the present study, specimen of *E. clausa* deposited BM, CAL, and K were thoroughly examined, described with illustration and citation of specimen. Therefore, the occurrence of *E. clausa* in Nepal has been validated here.

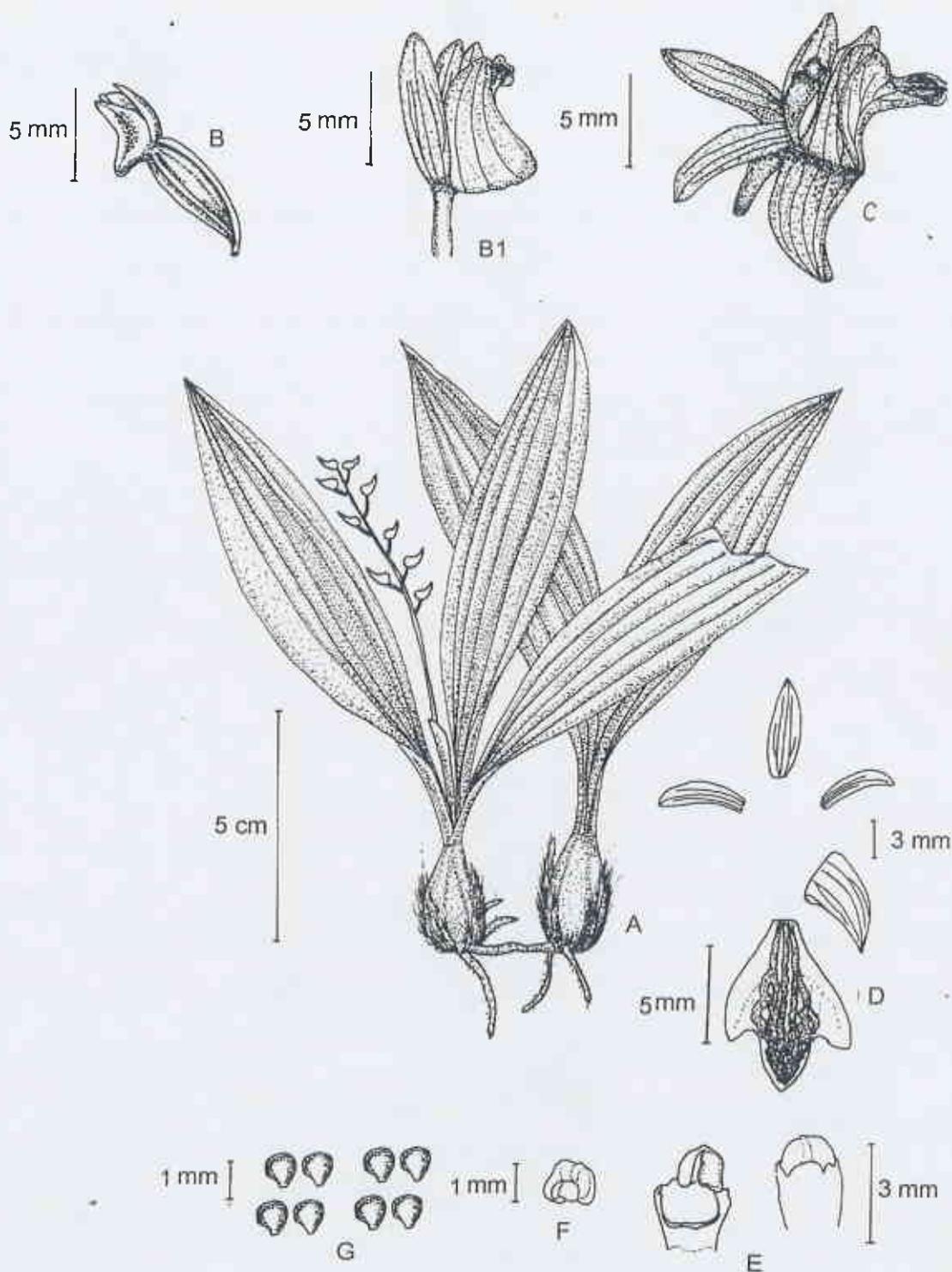


Fig.19. *Eria clausa* King & Pantling. (Pantling 559, type K!) A: Habit; B and B1: Lateral view of flower; D: Spreading of Sepal, Petal and D1: Labellum; E: Column; F: Operculum; G: Pollinia.

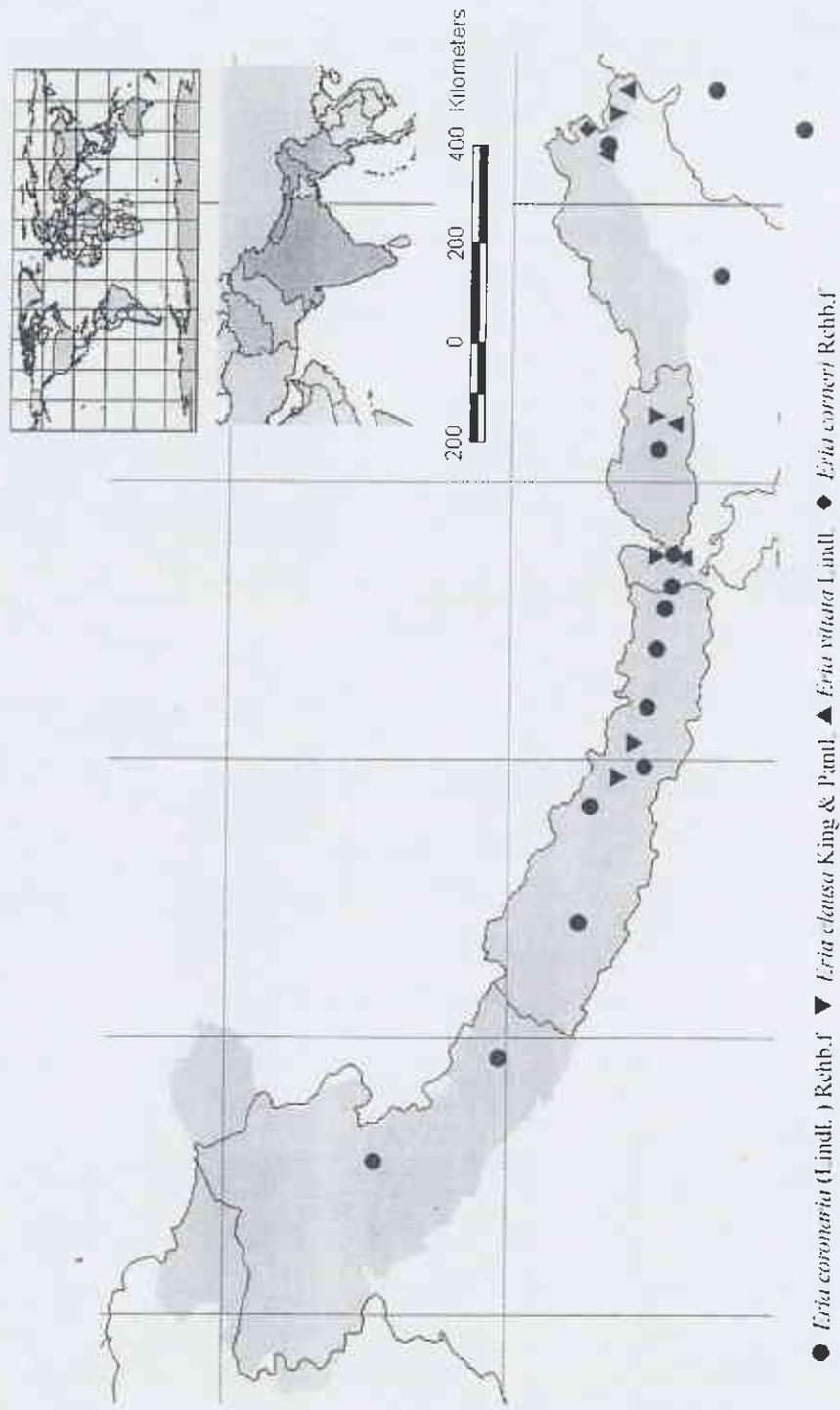


Fig. 20: Distribution Map of the section *Trichosma*

Section V. *Strongyleria* Pfitzer, *Nat. Pflanzenf.* : 175, 1888.

Rhizomes slender, creeping; pseudobulbs inconspicuous, congested or scattered with single joint with sheathing at base; leaves 1-4, terete, fleshy, borne apically on pseudobulb; inflorescence terminal, at apex of pseudobulb, short; floral bract hairy; 1-5 flowered, woolly externally, flowers fairly large with a mentum more than half as long as the dorsal sepal; labellum simple, fleshy with or without lateral lobes. Mealy papillous cushions at the base and near apex.

Type: *E. pannea* Lindley, *Jour. Proc. Linn. Soc.* **3**: 50, 1859

Note: When Lindley (1859) proposed the section *Dendrolirium* for the genus *Eria*, he included *E. pannea* in it. Later, Bentham and Hooker (1883), J.D. Hooker (1890), and Kranzlin (1911) accepted the section *Dendrolirium* for this taxa. Pfitzer (1888) proposed the section name *Stongyleria* based on this character " Stamm schlank, Labb. Drehrund", and only included *E. pannea* in it. J. J. Smith accepted the Pfitzer's section when established a new taxon *E. jacobsonii*. The section *Stongyleria* has been accepted and included *E. pannea* Lindl. in the present study.

About seven species. Himalaya (Sikkim, Bhutan, NE Himalaya), tropical Asia to S China one species in Himalaya. *E. pannea* Lindl..

13. *Eria pannea* Lindley, *Edwards's Bot. Reg.* 28 (misc.): 64, 79 (1842); Lindl., *J. Proc. Linn. Soc.* **3**: 50 (1859); J.D.Hooker, *Fl. Brit. Ind.* **5**: 804 (1890); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* **8**: 127, pl. 176 (1898); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50**: 44, 75 Fig. a and b (1911); Tuyama in Hara (eds.), *Fl. East. Himal.* : 434 (1966); Pradhan, *Indian Orch.*, **2** :356 (1979); Seidenfaden, *Opera Bot.* **62**: 45 (1982); Hajra & Verma, *Fl. Sikkim* **2**: 68 (1996); Chowdhery, *Orch. Fl. of Arunachal Prad.* :371, f. 222, 273 (1998); Hynniewta & al, *Orch. Nagaland* :181 (2000); Pearce & Cribb, *Fl. Bhutan* **3** (3): 374 (2002).

Pinalia pannea (Lindl.) Kuntze, *Revis. Gen. Pl.* **2**: 679 (1891).

Eria teretifolia Griff., *Itin. Pl. Khasyah Mts.* :202, pl. 1185 (1842); *Not.* **3**: 298, t. 300, Fig. 2 (non. Griff., 1851).

Eria odoratissima Teijsm. & Binn., *Tijdsch. Ned. Indië* **27**: 17 (1864).

- *Eria calamifolia* Hook. f., *Fl. Brit. Ind.* **9**: 191(1890) *syn. nov.*; Kränzlin, in Engler (ed.), *Das Pflanzenreich Hfl.* **50**: 47 (1911).

Pinalia calaifolia (Hook. f.) Kuntze, *Revis. Gen. Pl.* **2**: 679 (1891).

Epiphytic or lithophytic herbs, 10-25 cm high, small, densely covered with white pilose hairs when young, early glabrescent except for inflorescence. *Rhizomes* conspicuous, long

creeping, slender, covered with white woolly sheath, when young as thick as crow-quill, internode 3-5 cm long. *Pseudobulb* absent. *Stem* very short, cylindrical, terete, not swollen, 2-5 cm long, 3-4 rhizomatous segments, basally with 2 or 3 tubular sheaths, apically with 2-3 scaly leaves in the rhizome, 4-5 nodes in the erect stems, woolly. *Leaves* 2-6, linear, fleshy, cylindrical, terete, laterally flattened, fleshy, curved, acuminate, 3-18 x 0.2-0.5 cm, vein inconspicuous. *Inflorescence* in terminal raceme, arising from inner sides of the leaves, spicate, 2-5 flowered, peduncle woolly, 1-3 cm long; rachis 2-6 cm long, weakly zigzag, arise from the axil of the upper leaves, densely woolly, base with 1 or 2 membranous bracts. *Floral bracts* ovate-lanceolate, 5-9 x 4 mm, acute or obtuse, outer surface woolly white. *Pedicel and ovary* woolly white, 4-6 x 1.5 mm. *Flowers* yellowish-green, 10 x 6 mm, 2 cm when flattened, sessile, vanilla fragrant, densely white woolly outside. *Sepals* identical, elliptic-lanceolate to ovate-triangular, acute, woolly white; *dorsal sepal* broadly elliptic-lanceolate, 5-9 x 2-5 mm, obtuse or bluntly rounded, thick, sessile, 3-veined; *lateral sepals* ovate-triangular, weakly-falcate, 5-10 x 2-5 mm, obtuse or acute, thickened, 3-veined, adnate to column foot and forming mentum; mentum short, blunt, curved, conical, obtuse, 6 mm long. *Petals* elliptic-lanceolate to ovate-oblong, 3-4 x 2-3 mm, rarely linear, acute, thin, golden brown-yellowish in colour, sparsely hairy. *Labellum* simple, fleshy, subobovate-elliptic or ovate-oblong, 5-8 x 3 mm, obtuse, concave, spatulate, margin weakly undulate, entire, with a patch of white mealy hairs near the apex on abaxial surface, white pubescent in adaxial surface, base narrowed with yellow oblong-glandular calli at the base. *Column* short, 1-3 mm, straight, pubescent externally, glabrous internally, green, foot curved; clinandrium collar like; rostellum ligulate, bent towards the stigma.; operculum ovate, 2-3 mm wide, glabrous outside. *Pollinia* 8, yellow, pearl shaped, flat, clavate, grouping into two, caudicle with glandular appendages, viscidium simple and ellipsoid. *Stigmatic cavity* 1.5 x 1 mm, entire, not lobed (Fig. .22).

Type specimen: Singapore, cult. *Loddiges* 252 (Holotype:?, K-LINDL!); Eastern Himalaya, *Griffith* 5108 (type of *E. teretifolia*, Kl!); *Mann* 72, (type of *E. calamifolia* Kl!).

Distribution: 500- 900 m., Himalaya (Sikkim, Assam, Bhutan, Burma), Thailand, Laos, Vietnam, Malaya, Sumatra, Riau, Banks, Borneo.

Flowering: May-July

Status: Common

Etymology: From the Latin word '*pannosus*' (with the appearance of felt or cloth), with reference to the indumentum of peduncle.

Chromosome Number: $n = 18$ (Mehra & Vij 1970; 1976); $2n = 38$ (Hasimoto & Tanaka 1983; Li/x & Chen 1989)

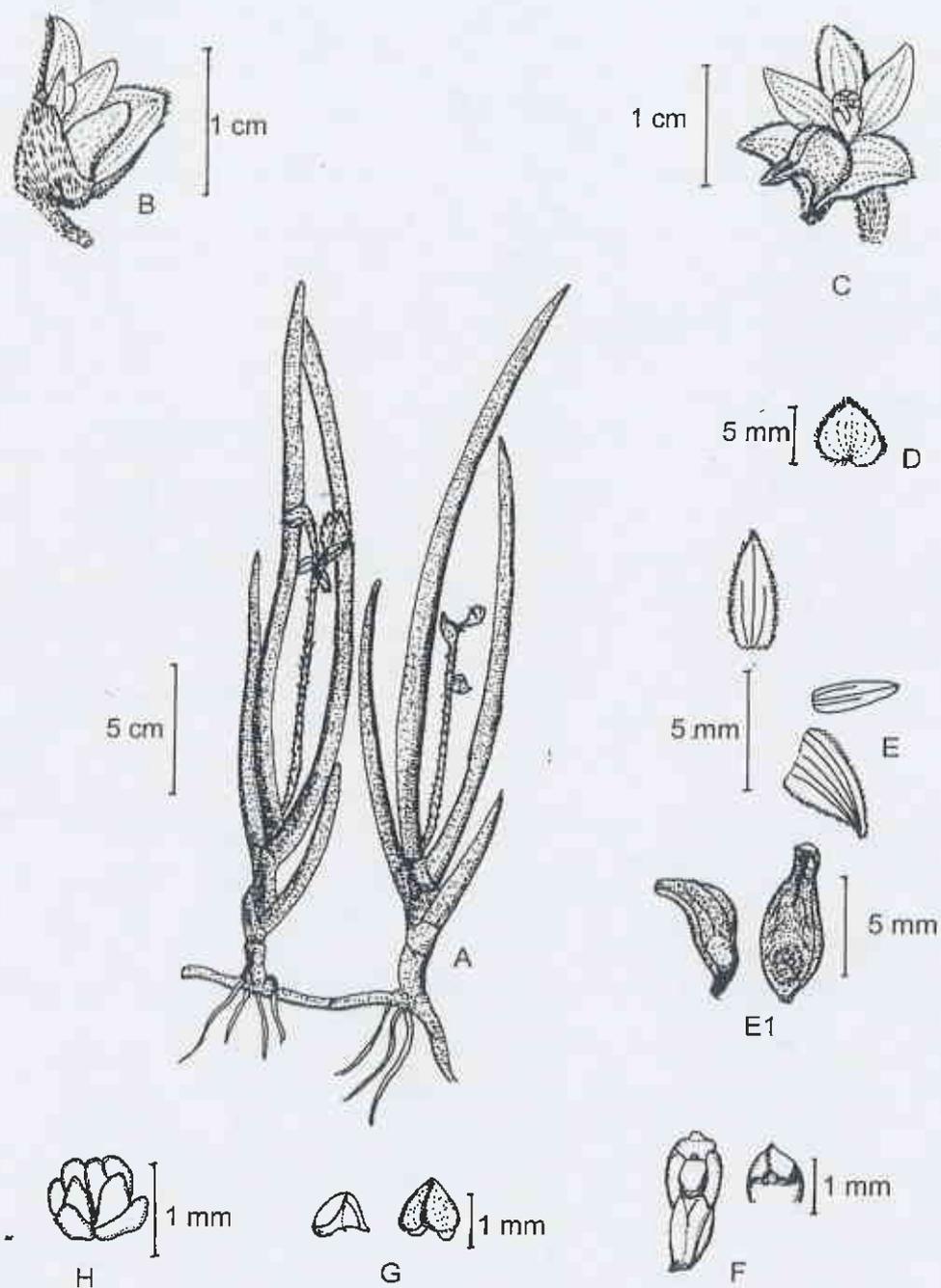


Fig 21. *Eria pannea* Lindley, (D. M. Bajracharya 463, TUCH) A: Habit; B: Flower; C: Front view of flower; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

SPECIMENS EXAMINED: **Sikkim:** Eastern Himalaya, *E. latifolia*. Griffith 5108 (Type K!); Sikkim J.D.Hooker, 137. May (K!); Tropical valley of Sikkim Himalaya, May 1891, R. Pantling 144, (BM!); Above the Rahni below Gangtok, April-May 1912, K.P. Tab 76 (14/136), (BM!); Sikkim, Hooker & Thmoson s.n. (CAL!); Sikkim, V. Narayanswami & party 517 (CAL!); **Bhutan:** Anitish, Bhutan, June 1902, D. Praus, (CAL!); Ghukha Timpu 1200m, 19.11.14, R.K. Cooper & A.K. Bulleycheshire 3631 (E!); Bhutan, Griffith s.n. (K-LINDL.); Phunaka district, Rimchu area 1600 m. 6 .4. 2002 D. M. Bajracharya 463, (TUCH); **Assam:** Khasia 900m, J. D. Hooker, 62 (K-LINDL.); J.D. Hooker s.n. (K!); Haflong, N. Cachar Hills Assam 1000m, 19.8 1908, G. Craib 323, (K! CAL!); Tharani, Jantea Hills, April 1899, Prain 155, (K! CAL!); Themokidima, 20.5.1895, BSI 11673, (CAL!); Naga Hill, Dec. 1907, Meebold 7209, (CAL!); Iadaca river, April 1899, Prain s.n. (CAL!); Namchi, 7.7.1909, Smith & Cave 838, (CAL!); Sikkim, B.D.Sharma 370 (CAL!); Tropical Valley, Khasia, Labb s.n. (K-LINDL.); Jahosring Peak, Janitea Hill Assam 1100 m, Mann s.n., March 1890 (K!); Khasia, May 1891, Pantling 144, (CAL!); Loong to Gingtok, Unknown 220, 17 .5. 1927 (CAL!); **North East Himalaya :** Kameng, Lohit, Siang, Subansisri, Tirap; between 100-1000 m.; H. J. Chowdhery; s.n. **Burma:** N.E. Upper Burma 2000-2500 m, Sept 1824, George Forrest 25121, (K!); Upper Burma N.E. 2500-2700m, July 1925, G. Forrest 27028, (K!); Mindat, W. Central Burma 1500m, Kingdonwards 211818 (BM!); Mindat 1500-1700m, 2.5.56, Kingdonwards 22218, (K!); L. N. Markha-Salvin divide upper Burma, 1924-25, G. Forrest 27028, (K!); Mount Victoria, 1924, R.K. Cooper 6087, (K!); Heize, 18. 4.1921, Russell 2043, (CAL!); Bantal, Kengtung, April 1938, Dickason 9271, (CAL!); Kachin Hill 1500m, 16 6.1897, Pottinger s.n. (CAL!); Kachin Hill, Mokin s.n.(CAL!) Tetagin-Shimbasu, 9.10. 1923, L. Daun 67, (K!).

Note: Lindley based his original description of *Eria pannea* on a plant imported from Singapore by Loddiges (252). There is an unlabelled sheet in the Lindley herbarium at Kew which bears a single flowered plant and drawing by Lindley. There is no Loddiges specimen in the collection, and Pearce & Cribb (2002) suspect that this sheet is the type material of *E. pannea*.

In the BM, K and CAL herbaria, there are some specimens of *Eria calamifolia* which was established as a new taxon by J.D. Hooker, on the basis of collected material of Gustav Mann from Makum Forest, upper Assam in 1884. This is also conspecific of *E. pannea*. J.D. Hooker (1890) and King & Pantling (1898) indicated that *E. pannea* occur in Sikkim, Khasia, Tenasserim, Malaya and Borneo. Griffith collected *Eria terrifolia* from Malacca, and he suggested that it may be different from Sikkim and Khasia species of *E. pannea*. Detail examination of *Eria terrifolia* and exhibit identical gross morphological characters, excluding the floral bracts. Therefore, it is concluded here that *E. terrifolia* is also conspecific, and treated here as synonym of *E. pannea*. Kranzlin (1910) described *E. calamifolia* and *E. pannea* as two different species, however, as *E. terrifolia*, *E. calamifolia* is also identical with *E. pannea*, therefore, it has been merged here under *E. pannea*.

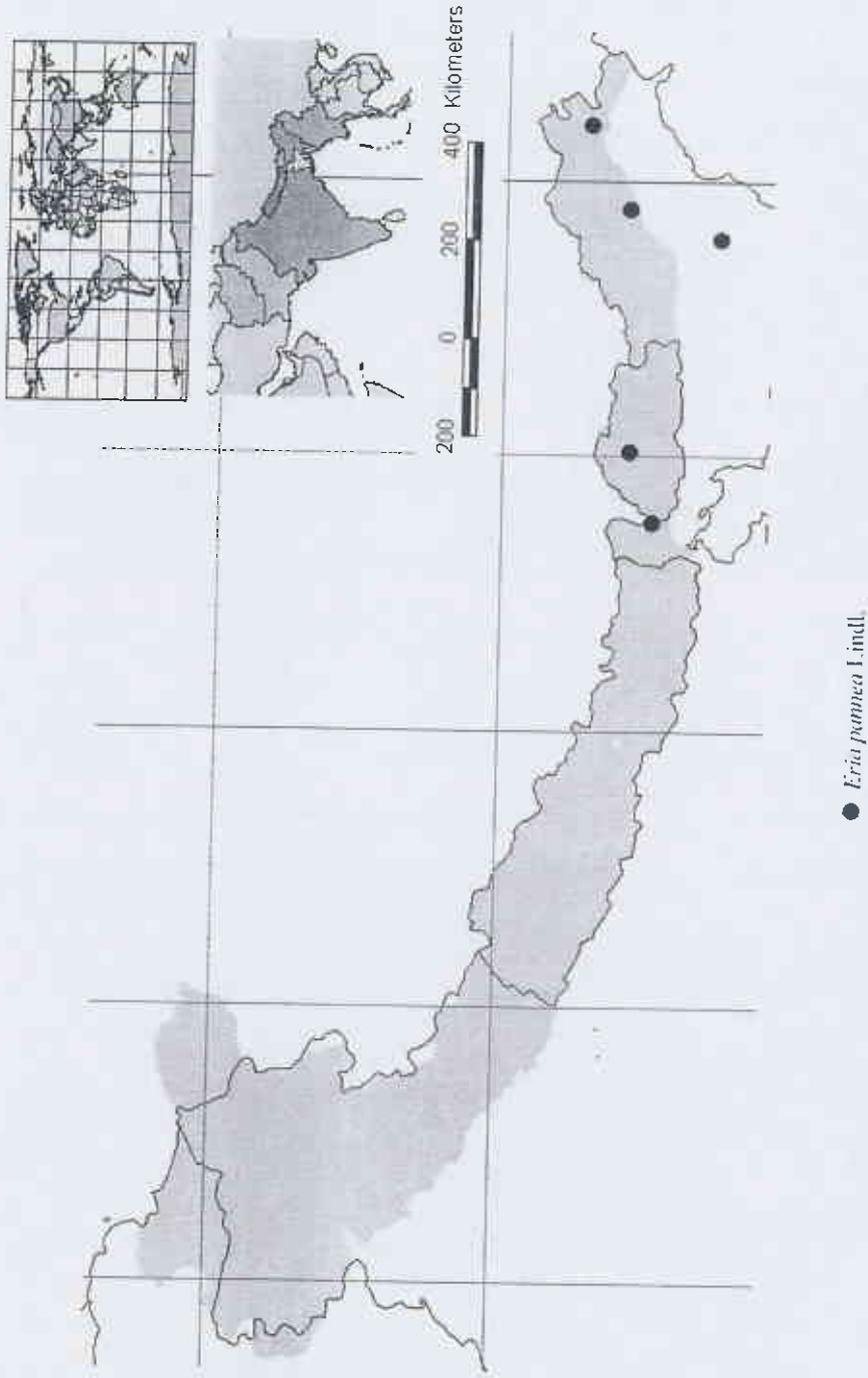


Fig. 22: Distribution Map of the section *Strongyleia*

Section VI. Dendrolirium (Blume) Lindley, *Jour. Proc. Linn. Soc.* 3: 46, 1859.

Rhizome slender, with short, and thick pseudobulbs loosely arranged on creeping rhizome; leaves 2-4 near the apex; inflorescences arising from pseudobulb base; scape and rachis more or less hairy with rather large bracts; 5-15, large flowered, cottony or pubescent. Labellum with callus on the disc.

Type: *Dendrolirium ornata* Blume, *Bijdr. Fl. Ned. Ind.* :345, 1825.

Note: Lindley (1859) proposed the new section *Dendrolirium*, which was named after Blume's generic name includes all large flowered woolly *Eria* species with pseudobulbs. Lindley mentioned 7 taxa, under section *Dendrolirium*. Other workers placed these taxa under three different sections *Dendrolirium* (*E. ornata*, *E. flava*, *E. elongata*, *E. lanata*, and *E. sicaria*), *Aeridostachya* (*E. aeridostachya*) and *Strongylaria* (*E. pannea*) of the genus *Eria*. Blume (1825) described twenty one species in his genus *Dendrolirium* and most of these have been placed in other sections of *Eria* by later workers. Now only two species *D. ornata* (= *E. ornata*) and *D. albidotomentosa* (= *E. lasiopetala*) are included in the section *Dendrolirium*.

Reichenbach (1857) named the section *Flavae* and included *E. ornata*. Later Reichenbach (1861) gave up his section *Flavae* and accepted Lindley's section *Dendrolirium*, but he did not mention *E. flava* in the section *Dendrolirium*. Therefore, the section name *Dendrolirium* has given priority by later workers. Bentham and Hooker (1883) also accepted the section *Dendrolirium* and included *E. flava*, *E. armeniaca* and other several species of *Eria*, which are now removed to other sections. J.D. Hooker (1890) included large number of species in this section, some of which have been moved to other genera like *Tainiopsis* and *Ceratostylis*. But Brieger (1981) raised the section *Dendrolirium* to the rank of separate genus *Dendrolirium* on the basis of Blume's plant *D. ornatum*.

About 12 species: Himalya (NW Himalya, Nepal, Sikkim, Bhutan, NE.Himalaya) India, Myanmar, Sikkim, Thailand ?? to SE Asia and S China; five species in Himalaya *E. lasiopetala* (Willd.) Ormerod, *E. laniceps* Reich.f., *E. tomentosa* (Koeng) Hook. f, *E. ferruginea* Lindl. and *E. nepalensis* D. M. Bajracharya & K. K. Shrestha.

Key to series of Section *Dendrolirium*

- 1.a Pseudobulb absent, labellum horse-shoe shaped with saccate excavate at base, irregular keels on the disc ----- Series I ***Ferrugineae***
- 1.b Pseudobulb present, labellum broad, oblong, rectangular, smooth at the base of labellum, thickened callii on the disc ----- Series II ***Pubescentae***

Series I. Ferrugineae D. M. Bajracharya & K. K. Shrestha *ser. nov.*

Caulibus teretibus, labelli hippocrepicus cum saccatus excavatae ad basim, irregularis carina cristis in disci. *E. ferruginea* Lindl. **Type:** *Eria ferruginea* Lindley., Bot. Reg. :135, 1839 (Holotype: K-LINDL!).

Species included : *Eria ferruginea* Lindl.

Series II. Pubescentae D. M. Bajracharya & K. K. Shrestha *ser. nov.*

Caulibus pseudobulbous, labelli oblong rectangularis, sino saccatus excavatae ad basim, crassus callii un disci. **Type:** *Eria pubescens* (Hooker) Steudel. *Nom. Bot.* 2, ed 1 566, 1844 [*Dendrobium pubescens* Hooker, *Ex. Fl.* 2: t. 124, 1825], (Holotype: BM!).

Species included : (*E. lasiopetala* (Willd.) Ormerod, *E. laniceps* Rcbh.f., *E. tomentose* Hook.f., *E. nepalensis* D. M. Bajracharya et K.K. Shrestha).

Series I Ferruginae D. M. Bajracharya & K. K. Shrestha *ser. nov.*

14. ***Eria ferruginea*** Lindley, *Edwards's Bot. Reg.* :135 (1839); J. D. Hooker f., *Fl. Brit. Ind* 5: 804 (1890); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 52 (1911); Hajra & Verma, *Fl. Sikkim* 2: 67 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :371, f. 222 (1998); Pearce & Cribb, *Fl. Bhutan* 3 (3): 375 (2002).

Pinalia ferruginea (Lindl.) Kuntze, *Revis. Gen. Pl.* 2: 679 (1891).

Epiphytic herbs, about 20 cm high. *Rhizomes* thick, creeping rhizome 5-10 cm long, jointed and annual growth covered with leaf sheath; terminal shoot with three apical leaves, 5-6 nodes on the rhizomatous segments, 4-5 scaly leaves. *Pseudobulb* not distinct. *Stem* 8-9 x 0.5-0.6 cm, 4-5 nodes on the erect parts, cylindrical, slender, terete, jointed, branched and sheathed; young sheath brown tomentose. *Leaf Sheath* ovate-lanceolate, membranous, dry. *Leaves* 1-2 arising from pseudobulb apex, 15-17 x 1.2-3 cm, narrowly lanceolate or elliptic-oblong, blunt, acute to sub-acuminate, coriaceous, petiolate, jointed, narrow at the base; petiole grooved 1.6-2 cm long. *Inflorescence* arising from base of pseudobulb, 8-15 flowers in lax racemes, raceme 8-15 cm long, peduncle brown-tomentose in young; rachis arising or emerged, ca. 2-3 cm long from the base of annual growth, stout, tomentose; sheathed at the base, 1.5-1.8 x 0.4-0.6 cm, lanceolate, acuminate, tomentose. *Floral bracts* lanceolate or ovate, large, 1-2 x 0.5 cm, acute, tomentose, reflexed. *Pedicel and ovary* brown-tomentose, 2-2.6 cm long. *Flowers* yellowish-green to whitish or dark, pinkish browns or dull crimson, tomentose outside, 2-3 cm, with purple-pink labellum. *Sepals*

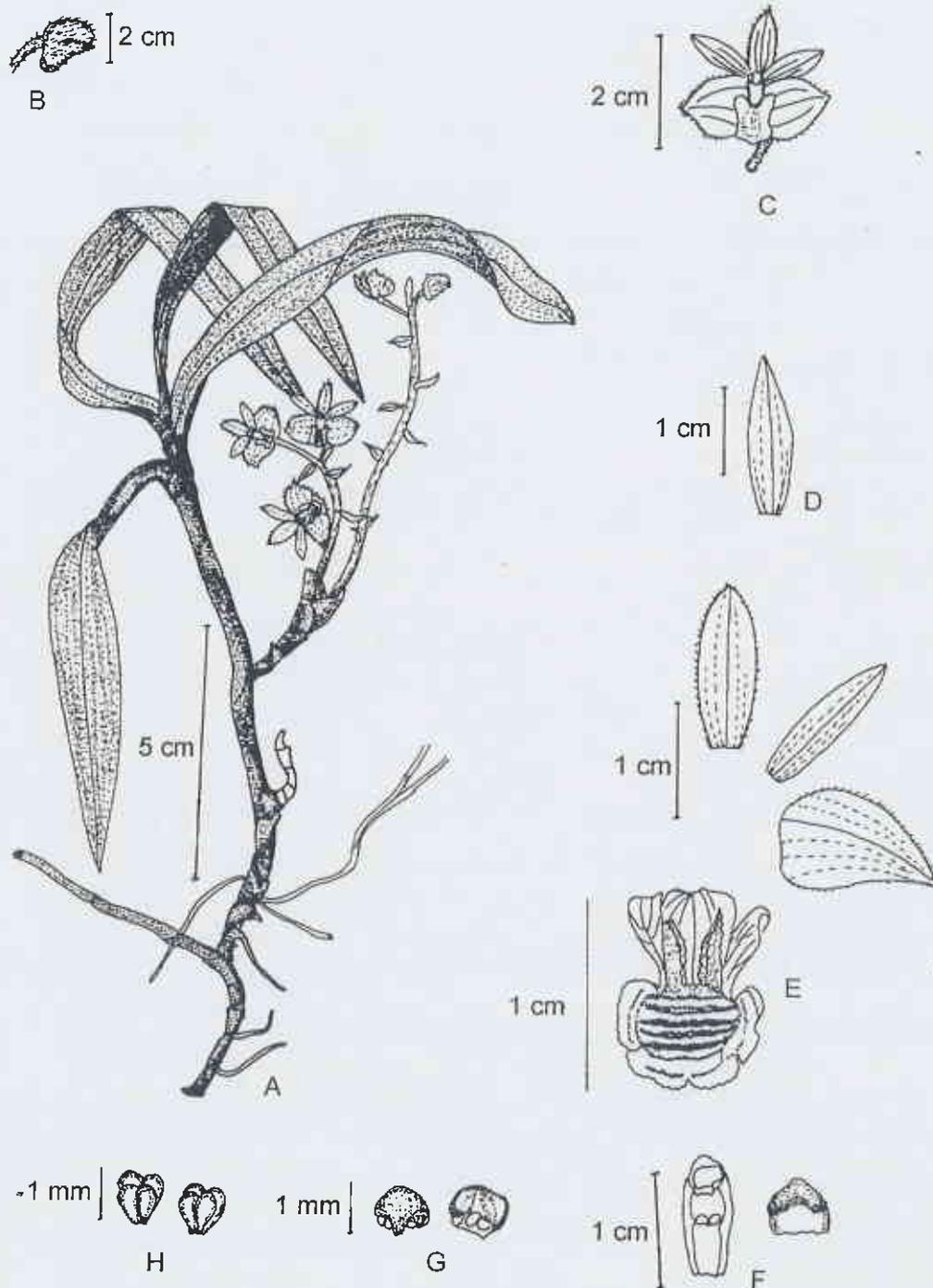


Fig 23. *Eria ferruginea* Lindley. (D. M. Bajracharya 460, TUCH) A: Habit; B: Flower; C: Front view of flower; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

oblong, obtuse, 1.1-1.7 x 0.6-0.7 cm, tomentose outside; *dorsal sepal* oblong-lanceolate, obtuse, coriaceous, 15-20 x 5 mm, olive brown with darker stripe, 6-veined; *lateral sepals* larger than dorsal sepal, very broad, ovate or oblong, obtuse or subacute, 2-2.5 x 1 cm, with 9- veins, adnate to column foot, dark pinkish brown tomentose outside, keel absent, straight; *mentum* round, 3 mm long. *Petals* obovate-lanceolate, obtuse-subacute, 1.2-1.4 x 0.5-0.6 cm. *Labellum* trilobed, 1-1.2 x 1.3-1.4 cm, incurved with deep folds and horse shoe shaped, hypochile shortly clawed, saccate at base; epichile short, crisped, lateral lobe small, erect, retuse, round to subquadrate; terminal lobe transversely ovate oblong, serrate, broadly 2-lobed; sub plicate and fleshy; disc large, with 2 thick toothed crests lamellae or irregular keels, crisped, converging from the lateral lobes. *Column* 0.8-2 cm long, broad, short, moderate, stout, incurved, column foot long; clinandrium collar like; rostellum ligulate, truncate; operculum 1 mm, glabrous and brown, 8-chambered in side. *Pollinia* 8, waxy, obovoid, caudicle waxy, attached to the tip of the pollinia; viscidium is simple and ellipsoid. *Stigmatic cavity* 4 x 2 mm, lobed in the lower margin in the cavity. *Fruit capsule*, 5-6 x 0.8-1 cm. (Fig. 23)

Type: Khasia, India; *Loddiges* s.n. (Holotype: K-LINDL!).

Distribution: 800-1800 m., Himalaya, (Sikkim, Assam, Bhutan, Arunachal Pradesh).

Status: Endangered

Flowering: May-June

Etymology: From the Latin word 'ferrugineus' (rusty), with reference to the tomentose inflorescence.

Chromosome Number: 2n= 38 (Biswas 1980)

SPECIMENS EXAMINED: **Sikkim:** Sin locality, *H. Thomes*, (CAL!); Sikkim, *Pantling* 314, 1894 (CAL!); Buxa- Bhutan Road, Japoorguri, 17-1900m, 16 5. 1949 *V. Nayrayanswami & party* 2529, (CAL!); **Assam:** Khasia, 18.5.1886, *C. B. Clarke* 42923, (K!); *Griffith* 5125 (Type K!); *J. D. Hooker* s.n., (K!); May 1899, *Prain* 102, (K!); Cherrapunjee, 26.4.1952, *W. N. Koelz* 29478, (K!); 5.8.1952, *W. N. Koelz* 29742, (K!); 13.5.1954, *Rup chand* 7658, (K!). Assam, June 1893, *King* s.n., (CAL!), Tharnu, Jaintea Hills, May 1899, *Prain* 102, (CAL!) Jaintea Hill, *Pantling* s.n 1897 (CAL!), Jawai, 15.5.1896, *S.C. Rita* s.n., (CAL!); **Bhutan:** Kamechu (Wangdue) 800 m. Feb. 1998; *D. B. Gurung* 106; 5 .4. 2002, *D. M. Bajracharya* 460, (TUCH); **North East Himalaya:** Lohit Dist. Hayalling, 13 1 1970, *J. Joseph* 48924, (CAL!); Kameng, Lohit, Siang Subansisri, Tirap; Between 1200-1600 m., *H. J. Chowdhery* s.n..

Note: *E. ferruginea* Lindl. was placed in the section *Trichotosia* by Lindley (1859). *J. D. Hooker* (1890) and later workers considered it in the section *Dendrolirium* (Bl.) Lindl., based on large densely tomentose flowers. *E. ferruginea* is closely related to *E. tomentosa* (Konig) Hook. f., but the former species has inconspicuous pseudobulbs, densely tomentose, and a different shape of labellum than other species. In the present study, this taxon is separated and placed in the series

Ferrugineae, based on the labellum morphology and absence of pseudobulbs. This species is recently recorded from Bhutan by Pearce and Cribb (2002).

Series II Pubescentae D. M. Bajracharya & K. K. Shrestha *ser. nov.*

- 1.a Pedicel plus ovary and sepals light brown tomentose, stigmatic cavity thickened as 'V' shaped thickened at base 15. **E. tomentosa**
- 1.b Pedicel plus ovary and sepals white tomentose, stigmatic cavity with linear appendages like lobed inside the cavity 2
- 2.a Floral bract, ca. 10 (-15) mm long, labellum irregular rectangular with broad 16. **E. laniceps**
- 2.b Floral bract ca. 20-40 mm or shorter, labellum oblong 3
- 3.a Floral bract \pm 20 mm long, terminal lobe oblong, acute 17. **E. lasiopetala**
- 3.b Floral bract 40 mm long, terminal lobe rectangular, emarginate 18. **E. nepalensis**

15. **Eria tomentosa** (J. König.) J. D. Hooker, *Fl. Brit. Ind.* **5**: 803 (1890); Grant, *Orch. of Burma* :149 (1895); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50**: 56 (1911); Seidenfaden, *Opera Bot.* **62**: 57 (1982); Chowdhery, *Orch. Fl. Arunachal Prad.* :371 f. 222 (1998).

Epidendrum tomentosum J. König, in A. J. Retzius' *Observ. Bot.* **6**: 53 (1791).

Pinalia tomentosa (J. König) Kuntz, *Revis. Gen. Pl.* **2**: 679 (1891).

Eria fuerstenbergiana Schltr. *Orchis* **8**:132 (1914).

Epiphytic herbs, upto 13-15 cm high, include leaves. *Rhizomes* woody, and well developed internodes short, clothed with imbricating coriaceous sheaths, between each two pseudobulbs, internodes smooth, glossy, partly covered with scarioys scales or leaf sheaths. *Pseudobulbs* 3-4 (-5) cm apart, ellipsoidal or ovate-oblong, laterally compressed, 5-8 x 1.5-4.5 cm, often with 2 or 3 nodes, with 2 or 3 membranous sheaths at base. *Leaves* 3-4, shortly petiolate, 1-3 cm long, ovate-elliptic or oblanceolate, 7-15 x 2.5-6.5 cm, acute or obtuse, coriaceous, narrowed at the base. *Inflorescence* 10-15 flowered, racemes, densely brown tomentose; rachis arising from the rhizome near the base of pseudobulbs, covered by imbricated sheaths at base, upto 30 cm long. Sheaths at the base with fleshy or thick-coriaceous short bract. *Floral bracts* broadly ovate or oblong, 1.4-1.7 x 0.5-0.8 cm, yellow to orange-yellow, acute or acuminate, densely yellowish brown tomentose, coarsely veined, with roughened and thickened inter-vein areas. *Pedicel and ovary* 1.3 cm long, light brown-tomentose. *Flowers* greenish or yellow, ca. 3 cm long, 1.5 cm across, brown tomentose. *Sepals* thickly coriaceous, obtuse, densely yellowish brown tomentose, slightly thick; *dorsal sepal* ovate-lanceolate, ca. 10 x 4.3 mm, acute, brown-tomentose, 5-veined; *lateral sepals*

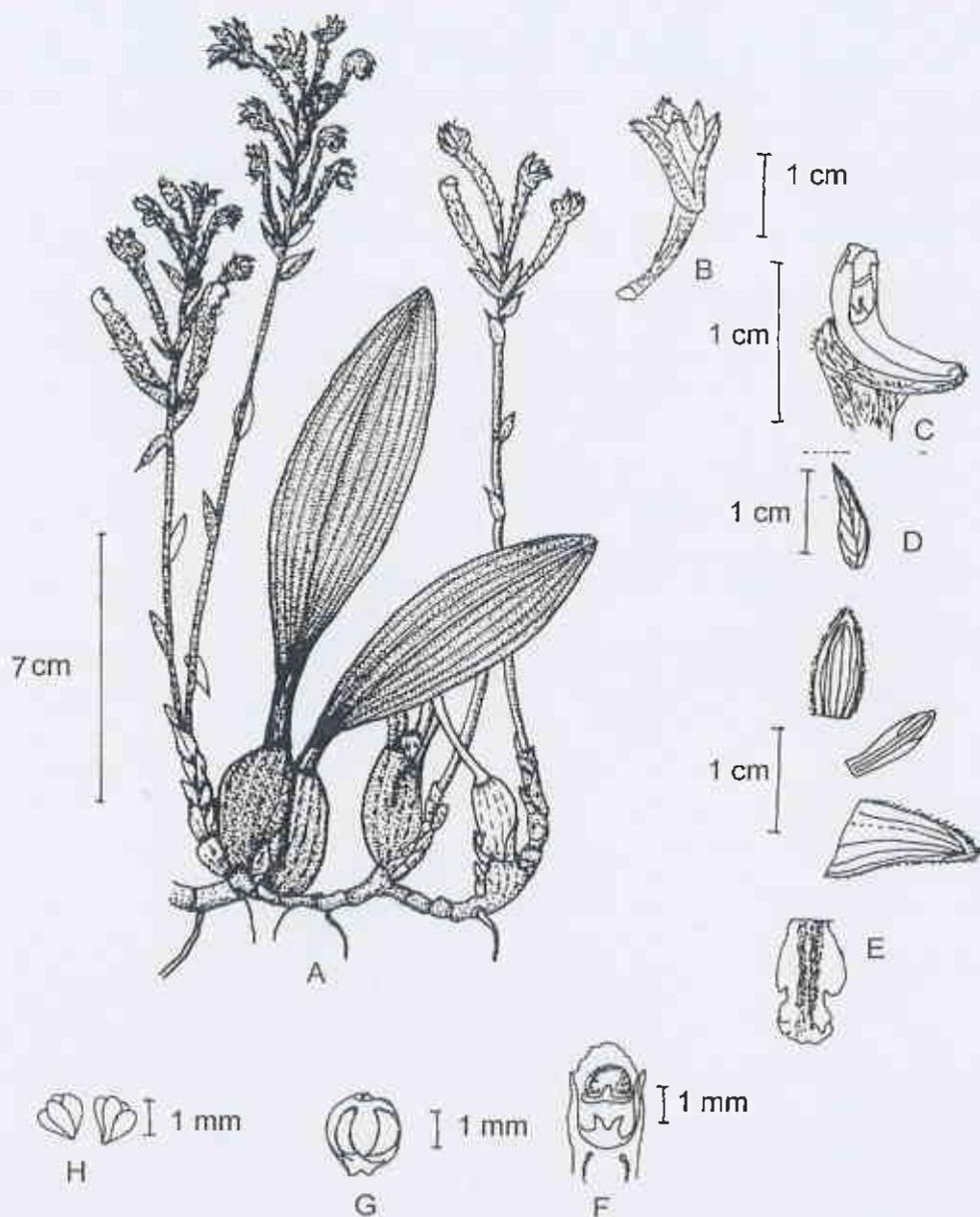


Fig. 24. *Eria tomentosa* (J. König) J. D. Hooker, (*J. D. Hooker*, 66 Kl) A: Habit; B: Flower; C: Lateral view of column; D: Bract; E: Spreading of Sepal, Petal and Labellum; F: Column; G: Operculum; H: Pollinia.

ovate-lanceolate, falcate, ca. 12 x 8 mm, near as long as dorsal sepal, acuminate, coriaceous, adnate to column foot and forming mentum; mentum large, incurved, brown tomentose, 5-veined. *Petals* ovate-lanceolate, acute, ca. 10 x 2.7 mm, slightly shorter than sepal, 3-veined, glabrous. *Labellum* tri-lobed, oblong, curved outward, 10-12 x 8-9 mm, broadly clawed, glabrous, much recurved, yellowish; terminal lobe subobovate-oblong, when spreading 6-7 mm, suberect, undulate apex rounded and apiculate; later lobe small, dentate, sub erect, obtuse or truncate; disc thick with 1 strongly nerved, with very prominent mid nerve from base to the entire length of the disc, calli on the disc varying, usually broad, flat band from base and splitting on the terminal lobe in "Y-shaped," continues nearly to apex, a pair of lateral narrow keels splitting off from the median band; margin of labellum and keels red; *Column* stout, ca. 4 mm long, semicylindrical, foot at the right angles, ca 3-4 mm long, curved; rostellum reflexed, clinandrium collar like, with wavy margin; operculum subglobose, ca 2.2 mm across. *Pollinia* obovoid, 8, yellow, in a group of four. *Stigmatic cavity* with prominent V-shaped thickening at the base. *Fruit* capsules 2.5-5.5 x 0.5-0.7 cm, with 2 to 3 cm long stalk at the base, and persistent column at top. (Fig. 24)

Type: Thailand, Lalang Island E. of Phuket. *Konig s.n.*, 20 June 1779, (Holotype: K!; isotype, LIV)

Distribution: 1000-1300 m., Himalaya, (Assam, Arunchal Pradesh, Burma), Thailand, Indo-China, Vietnam.

Status: Endangered.

Etymology: From the Latin word '*tomentosus*' (curled or curved hairs) referring to the hairs on the flowers.

Flowering: September-November.

SPECIMENS EXAMINED: Assam: Khasia, *J. D. Hooker*, . 66, (K- LINDL!); Seetakood, Chittagong, *J. D. Hooker*, & *Thomson* 557 (K!); Sylhet, *Wall.* 1773/2 p.p.; Khasia, *J. D. Hooker* & *Thomson* 1772 (K!); Cherrapunjee, 5.5 1952, *Koelz* 29679, (K!); Lushi Hills, Nantiyl, 26. 5.1953, *Rup Chand* 7048, (K!); Pufame, Jaintea Hills, April 1899, *Prain* 91, (CAL!); North East Himalaya :Kameng, Lohit, Subansiri, between 100-1000 m.; *H. J. Chowdhery*; Burma: Sino loc, Mymyo, *Gard. s.n.* (K!); *Rule* 5274 (K!); *Toungoo B.G.* 5 (K!); Maymyo, *Samud* 13566 (K!); Moulmein (Griffith: *Parish* 109, drawing in K!); Upper Burma, July 1892, *Huk s.n.* (BM!).

16. ***Eria laniceps*** H. G. Reichenbach, *Hamburger Garten-Blumenzeitung*. 19: 10 (1863); *Rchb. f., Xen. Orch.* 2: 162, pl. 168 (1863); *Seidenfaden, Opera Bot.* 62: 49 (1882); Hajra & Verma, *Fl. Sikkim* 2: 68 (1996); Pearce and Cribb, *Fl. Bhutan* 3 (3): 385 (2002).

Eria flava Griff. *Not.* 3: 301 (1851), non Lindl.

Epiphytic herbs, 25-30 cm high. *Rhizomes* creeping, slender, 2-3 nodes between two pseudobulbs. *Pseudobulbs* conical or fusiform, with 2-3 nodes, 5 cm long, with vertical furrow, covered by leaf sheath as well as scaly leaves. *Leaf sheath* at the base of pseudobulbs, ca. 3 x 2

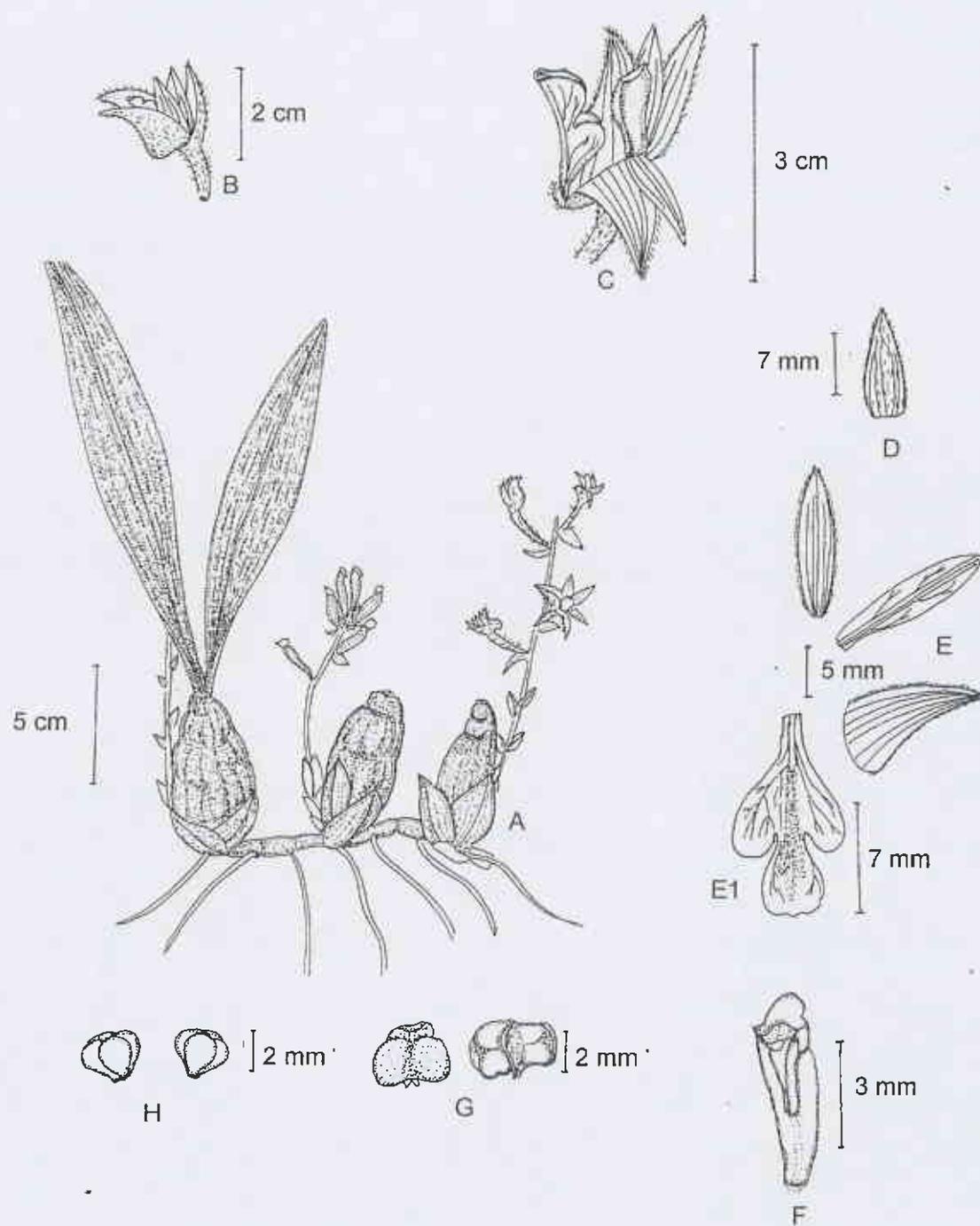


Fig. 25. *Eria laniceps*. H. G. Reichenbach, (*Parish 57 K!*) A: Habit; B: Flower; C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

cm, oblong, acute. *Leaves* 3-5 in numbers, narrowly oblong or lanceolate, 13.6 -14 x 2-3 cm, acute, glabrous, thin, 6-veined. *Inflorescence* lateral, lax raceme, densely pubescent in the rachis; rachis 25 cm long, longer than leaves, arise from the lateral side of the pseudobulbs, with 2-3 empty bracts. *Floral bracts* oblong-lanceolate, 10-15 x 2-4 mm, acute, pubescent, blunt at the base, 6-veined, shorter than pedicel and ovary. *Pedicel and ovary* 18 x 3 mm, woolly white. *Flowers* greenish yellow, 3 cm across, densely woolly outside. *Sepals* unequal, densely woolly outside; *dorsal sepal* lanceolate, 15 x 4 mm, yellow, acute; *lateral sepals* oblanceolate, falcate, 18 x 4 mm, acute, entire, thick; *mentum* curved, 5 mm long from the columnfoot to its tip. *Petals* lanceolate or falcate to spatulate, 10 x 2 mm, thin, acute, 3-veined. *Labellum* trilobed, purple in lower half, 7-10 x 4 mm, irregularly rectangular with broad, oblanceolate, truncate, thick, entire or wavy margin, three apiculate callii near the apex, 3-veined; lateral lobe oblong, 8 x 3 mm, round; terminal lobe obovate, truncate, 10 x 5 mm, apiculate, thick, more or less notched or wavy, disc thickened, broad, two three callii on the disc with brownish marking on the lip. *Column* 4 x 1 mm long, curved, shorter than foot, foot 5 mm long; operculum 2.5 x 1.5 mm, glabrous, bifid, notched at the tip of the operculum; *clandrium* collar like; *rostellum* ligulate, bent towards the stigma. *Pollinia* 8; obovoid; *viscidium* simple; *caudicle* gelatinous, sticky. *Stigmatic cavity* 2 x 1 mm, double folded in the outer wall, 2 lobed inside the stigma. (Fig. 25)

Type:? Nepal, Falconer 1024 (Holotype: GH; isotype, CAL; K!)

Distribution: 1000 m., Himalaya (? Nepal, Sikkim, Assam, Burma), Thailand, Laos.

Status: Rare

Flowering: January

SPECIMENS EXAMINED: Nepal. unknown locality: Falconer 1024 (Holo K!; Iso type CAL!); Griffith 346 Herb. Lindl. (K!); **Sikkim** : Sikkim *Sin. Loc.*, J. D. Hooker 63 pp, (K-LINDL.!); J. D. Hooker s.n. (W!); Parish 51 (K!); **Assam** : Sin loc. E. Bangal, Griffith 5124 (K!); Sylhet, March 1885, Mann s.n. (CAL!); South of Pileng, 10.3.1912, Barkill 38215 (CAL!); Saduja, Feb. 1902, Chatterjee s.n. (CAL!); **Burma**: Maumein, Lobb s.n. (K-LINDL.!) type of *E. elongata*.; Zimjaik, Griffith 347 (K-LINDL.!) Amherst, 21.1 1912, Lace 5594, (K!); Martaban, 1859, Bradis s.n. (CAL!), Rangoan, March 1911 Meebold 13071, (CAL!); Laroj Indroja Hill, Jan 1901, Mokim 256, (CAL!); Sin Loc. Falconer s.n. (CAL!); Pulje, Lace 5594 (CAL!); Valley of side chamg, 300 m, 31. 3. 1919, Russell 165, (CAL!).

Note: Several specimens of *E. laniceps* including specimens of Hooker, Griffith and Falconer, deposited at Kew, CAL. and photograph of Ames herbarium (A) were examined. There are only two specimens of *E. laniceps* collected by Falconer (1024 and 1025) at CAL, Kew and a photograph of Herb Falconer 1024 (A). All these specimens were identified by Reichenbach as "*E. laniceps*". Falconer did not mention the locality of collection in his specimen No. 1024, but Falconer 1025 (CAL) was collected from Kumoan. Reichenbach. (1863) in "Die achte *E. laniceps*" mentioned

that Falconer's specimen should be "wohl aus Nepal" (of type specimen of *E. laniceps*, from Nepal). Recently, Pearce & Cribb (2002) also pointed that the type locality of *E. laniceps* is in Nepal. On the basis of the evidence, it could not exclude the possibility that a specimen of Wallich's collection from Nepal in 1820 turned up in Falconer's herbarium, and concluded here that *E. laniceps* is additional taxon for the flora of Nepal based on Falconer 1024 specimen.

Reichenbach had indicated that Falconer' 1025 is the true *Dendrobium pubescens*. But the present study revealed that Falconer 1024 and 1025 (deposited at CAL) are identical, and both specimens are *E. laniceps*. This opinion seems to be shared by Rolfe, who determined Falconer 1025 as "*E. laniceps*. In the present study, all materials of unnumbered J. D. Hooker collection from Sikkim in April, Pantling 130, were examined and considered as *E. laniceps* and verified it *E. lasiopetala*. Hajra & Verma (1986) also mention the *E. laniceps* in Sikkim *s. l.* but it could not be trace out in CAL and SIKKIM. Sikkim material of *E. laniceps* is consider doubtful.

17. ***Eria lasiopetala*** (Willdenow) Ormerod, *Opera Bot.* **124**: 22 (1995); Pearce & Cribb, *Fl. Bhutan* **3** (3): 376 (2002).

Epidendrum flos aeris J: Konig, in A. J. Retzius', *Observ. Bot.* **6**: 64 (1791).

Aerides lasiopetala Willdenow, *Sp. Pl.* **4** (1): 130 (1805).

Epidendrum lasiopetala (Willd.) Poir, in J. B. A. M. de Lamarck *Encycl. Suppl.* **1**: 384 (1810).

Dendrobium pubescens Hook., *Exot. Fl.* **2**: t.124 (1825).

Eria pubescens (Hook.) Lindl. ex Loudon, *Hort. Brit.* :372 (1830)

Octomeria pubescens (Hook.) Spreng., *Syst. Veg.* **4** (2): 30, 310 (1827).

Octomeria flava Wall ex Lindl. *Gen. Sp. Orch. Pl.* :65 (1830), *nom. nud.*

Eria flava Lindl., Wall. *Cat. no 1983 p.p.*, *nom. nud.*; *Gen. & Sp. Orch.* :65 (1830); J. D. Hooker *Fl. Brit. Ind.* **5**: 801, 1890; Koba & al *NLFPGN* :196 (1994).

Eria pubescens (Hook.) Steud., *Nomen. Bot.* **2** ed. 1, 566 (1840); Hara & al., *EFPN.* **1**: 42 (1978); Seidenfaden, *Opera Bot.* **62**: 49 (1982); Banerji & Pradhan, *Orch. Nepal Himalaya* :266, pl. 267 (1984); Koba & al., *NLFPGN* :196 (1994); Hajra & Burma, *Fl. Sikkim* **2**: 69 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :373, f. 225 (1998); Press & al., *ACFPN* :216 (2000).

Pinalia albidotomentosa (Blume) Kuntze, *Revis. Gen. Pl.* **2**: 678 (1891).

Pinalia pubescens (Hook.) Kuntze., *loc. cit.* (1891).

Epiphytic herbs, ca. 15-20 cm high; well spaced pseudobulbs, scattered roots arise from the rhizome. *Rhizome* stout, transverse, covered by tubular leathery sheaths, 1-1.5 cm long. *Pseudobulbs* compressed, large, ovoid, fusiform-ellipsoid, 8-10 x 3-4 cm, furrowed, covered by membranous sheaths at the base; sheaths membranous, thin, 2-3 x 1.5 cm long, brown in colour. *Leaves* 3-5, short petiolate, elliptic to oblong-lanceolate, 7-16.5 x 2-5 cm, base and apex acute or acuminate, narrow at the base, coriaceous, 8-14 veined; petiole grooved, 1-3.5 cm long. *Inflorescence* lateral, arising from near the base of pseudobulb, erect, 10-20 cm, not exceeding leaves, with white cottony hairs, racemose, 5-(7)-12 flowered; peduncle pale-white tomentose, enclosed by 6-8 membranous imbricate sheaths at base, 2-5 cm long; sheaths overlapping, ovate, 0.5-1 cm long, acute; rachis ca. 15 cm long, white tomentose, glabrate except for rachis when fruit mature. *Floral bract* ovate-lanceolate or oblong-lanceolate, acute, thin, persistent, inner brown, externally white tomentose, 18-19 x 3-4 mm, with 5-veined. *Pedicel and ovary* white, ca. 1.5-3 cm long, white tomentose. *Flowers* 1-1.5 cm long, 3-4 cm across, when spreading 3 cm across, green to yellow, large, showy, white tomentose outside. *Sepals* unequal, densely woolly outside; *dorsal sepal* small, lanceolate, 10-15 x 5 mm, yellowish inside, woolly outside, obtuse, coriaceous, 3-5 veined; *lateral sepals* spreading, triangular, lanceolate, slightly oblique, 14-15 x 8 mm, coriaceous, acute; lateral sepal keeled, 9-veined adnate to column foot and forming mentum; mentum bluntly round, 2 mm long. *Petals* elongate-oblong, 9-10 x 4 mm, obtuse, thin, yellowish, parallel to column, 5 veined. *Lobellum* tri-lobed and apically undulate, ovate, truncate, base contracted into claw, 1-1.4 x 0.6-1.0 cm, crimson-purple to pinkish-yellow, coriaceous; terminal lobe 6 mm wide when flattened, suboblong, acute, recurved, thick, disc with an obovate-lanceolate thickened area from base to terminal apex, middle one is oval shaped; lateral lobes semiobovate, 7 x 4 mm, short, erect, truncate at apex with dotted claw jointed column, *Column* 4-10 x 2 mm, thick and short, cylindrical, curved, glabrous, whitish yellow; foot short, ca 5 mm; clinandrium usually collar like; rostellum ligulate, bent towards the stigmatic cavity; operculum yellow semispherical 2 x 1 mm, glabrous, four locules in each chamber. *Pollinia* 8, obovoid, laterally flattened, broadly obovoid, caudicle is granular; viscidium simple and ellipsoid. *Stigmatic cavity* ca. 3 x 2 mm, entire, two lobed at the base of the cavity. (Fig. 26)

Type: Thailand, Phuket, König s.n. (Holotype: not located). *Dendrobium? pubescens* Hook. f., India, cult. Shepherd, 1820 (Wallich s.n., K!), (Holotype: K?).

E. flava Lindl., Nepal, Nawakot, Wallich 1973.1 (Holotype: BMI, isotype K-W, sheet 1, CAL)

Distribution: 500-1600 m., Himalaya (NW Himalaya, Nepal, Sikkim, Bhutan, Assam, Arunchal Pradesh, Burma) C. India, Laos, Cambodia, Vietnam, Thailand, and China.

Flowering: February – April (- August).

Status: Common

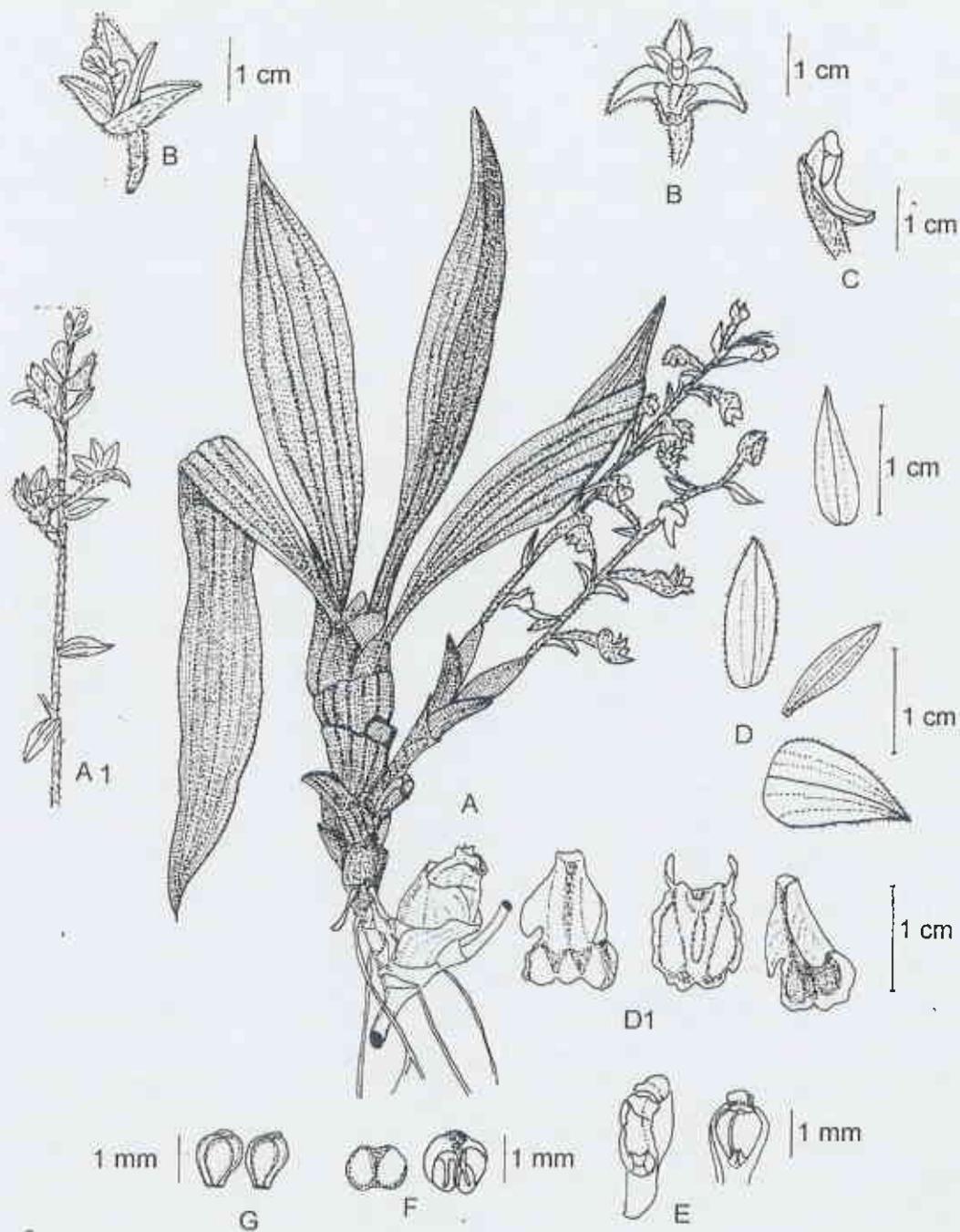


Fig 26. *E. lasiopetala* (Willdenow) Ormerod (*D. M. Bajracharya* 265, TUCH!) A: Habit; A₁ Inflorescence (Type KI) ; B: Flower; C: Lateral view of column; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

Etymology: From the Greek word '*lasio*' (woolly), and '*petalon*' (petal/sepal).

Chromosome Number: $2n = 38$ (Biawas 1980); $2n = 40$ (Vij & al. 1976b)

SPECIMENS EXAMINED: **NorthWest Himalaya:** Garhwal: Dehra Dun *Mackinnon* 24158 (DD!); Jameson s.n. (DD!); Pauri- Outer Garhwal hills, *Inayat* 25804 (DD!); Kumaun: Pithoragarh- Didihat, 2.9.1968, *Arora* 38851, (DD!); Askot, *Arora* 66129 (DD!); Dafiadhura, 2000 m. 16.5.1975, *Arora* 37200, (DD!); Maitli 15.3.1976, *Arora* 55819, (DD!); Quiti, 1400 m, 9.5.1965, *Nair* 35705, (DD!); Gori Valley Gargia, 24.4.1962, *Baram Bhattacharyya* 21199, (DD!); Samadhura-Tejam, . 9.6.1958, *T. A. Rao* 6589 (DD!); Milam, 10.6.1958, *T. A. Rao* 6601, (DD!); Baram-lumti (pithoragarh), 5.5.1994 *D. K. Singh & S. K. Murti* 86904, (DD!); Baram, 18.4.1984, *Balodi* 55819, (DD!); **unknown origin** (Wall anno. 1820 KI). **Nepal:** *W. Nepal* : Doti, Way to Gabar, Niruli, 1250 m, May 2002, *G. Amatya* 25; Bajhang Rupal, 1000 m., 14.4.1984, *P. Pradhan & R.K. Uprety, N. Pradhan & N. Dabadi* 1300, (KATH!); Surkhet, Huke, 780m, 22.2.1991, *N. P. Manandhar & N. Amatya* 139-91, (KATH!); *C. Nepal* : Noakote, Napalia, (Probably Wall. 1983/1p.p W-K! Isotype CAL! Holotype:); Hetuda 500 m., 26.2.2000 *D. M. Bajracharya* CN 265, (TUCH!); Hetuda, *Sharma & White*. s.n. (KI!); Wall Cat 1973/a (E!), *Wall* 1973/b (BM!); Parbat, Kushma, 16. 3. 1978, *P. M. Amatya, B. Roy* 403, (KATH); Kaski, Lumle 500m, 15.3.999, *D. Bajracharya* 210, (TUCH!); Heteuda 450 m. 23. 4.2000, *D.M. Bajracharya* 310, (TUCH!); *E. Nepal* : Morang, Raja Rani, 14.1.2001, *D. Bajracharya, L. R. Shakya & A. Subedi* 380, (TUCH!); Ilam, Godak, *Pradhan, P. & al.*, 736 (KATH!); Ilam, Near Rakse, 1900 m, 18.11.1978, *P. Pradhan, N. P. Manandhar, & N. Amatya* 789, (KATH!); **Sikkim:** Sino. loc. (Ganmie s.n KI); *Pantling* 130 March 1893 (KI, BM!); *J. D. Hooker* s.n. (KI); Feb. 1896, *Haines* 611, (KI); *G. King* s.n.); **N. E. India:** Lu shin Hills, *Parry* 215 (KI); Tidding valley, *Kingdon-Ward* 7945 (KI); Dalka Ghats, *Gamble* 897a (KI); **Bhutan:** Sarbhang dist. Singikhola, *Grierson & Long* 3618 (E!); Gayleyphng dist. between Lodri and Aie Bridge, 280m, 22.4.1982, *Grierson & Long* 3617, (E!); Rongsong 700 m, 13. 8.1913. *G. H. Cave* (E!); **North East Himalaya:** Siang Subansisri, Tirap; Between 100-1000 m. *H. J. Chowdhery*. s.n.

Note: This species is related to *E. tomentosa* and *E. nepalensis*, but differ from *E. tomentosa* with grayish-yellowish tomentose pedicel and ovary, and light brown tomentose sepals. Where as it differs from *E. nepalensis* having large bract and two shoots develop simultaneously from the base of pseudobulb, one sterile which will form next years pseudobulb, the other forming the 20 cm long stiffly erect inflorescence. Pearce & Cribb (2002) also pointed out that there is confusion in the identifies of *E. lasiopetala* and closely related species, *E. laniceps*, *E. abidotomentosa* and *E. lanata* to *E. laniceps*. They have mentioned that *Eria elongata* and *E. flava* var. *elongata* are referred as *E. lasiopetala* or *E. laniceps*. Seidenfaden (1982) considered that *E. laniceps* and *E. elongata* are conspecific. *E. elongata*, *E. abidotomentosa* and *E. lanata* are not included in the present study, because these materials are not traced out from Himalayan region.

Seidanfaden (1982) discussed the problem in depth and treated *E. laniceps* as a distinct species. In his key, he stated that the inflorescence is often two in *E. laniceps*, however, when examined the type specimens of *E. laniceps* there is single inflorescence in the Falconer's specimen deposited at K, A, and CAL. Pearce & Cribb (2002) also observed the same. Seidanfaden also noted that *E. laniceps* flowers in February and *E. lasiopetala* flowers in (September-) November. But J. D. Hooker's specimens of *E. lasiopetala* from Sikkim flowered in February. In the present study, most of the collected specimens of *E. lasiopetala* are flowered in August to November. Pearce & Cribb (2002) concluded that due to minor differences in floral size and the characters that do not help to separate these plants and considered that all these specimens can be referred as *E. lasiopetala*. J. D. Hooker (1890), King & Pantling (1898) have also treated *E. laniceps* as the synonym of *E. lasiopetala*. In the present study, when examined the specimens of Falconer 1024 and 1025 (K, CAL) and the protologue of Reichenbach, it can be concluded that *E. laniceps* is the distinct species in the Himalayan region.

18. ***Eria nepalensis*** D. M. Bajracharya & K. K. Shrestha, *Jour. Jpn. Bot.* **78** (3): 158 (2003).

E. kamlangensis A. N. Rao, *Jour. Ind. Orchid. Soc.* **16** (1-2): 61 (2002 Publ. 2003).

Epiphytic herbs, 15-17 cm high with distinct spreading rhizomes; *pseudobulb* ovate, laterally compressed, 4-5 cm long, 5-6 cm diameter, half of the pseudobulb covered by leaf sheaths; *leaf sheaths* membranous, reddish brown. *Leaves* 3, coriaceous, short petiolate, overlapping to the pseudobulbs, ovate-oblong, acute, narrow at base, 11-13 cm x 3.5-4.5 cm, (7-9) veins. From the base of the old pseudobulbs two shoots develop simultaneously, one sterile which will form next years pseudobulb, the other forming the 20 cm long stiffly erect inflorescence, scape covered by leaf sheaths at base, ca. 10 cm long, rachis cylindrical. *Bract* oblong-lanceolate, acute, glabrous, boat-shaped, 4 x 1.5 cm, green, coriaceous, longer than pedicel and ovary. *Pedicel and ovary* 2-2.5(-3) cm long, covered by white tomentose hairs. *Flowers* yellow, 3-5 in number, 1.5-2.0 cm across, opposite, decussate, lax in an inflorescence and tomentose. *Sepals* unequal, oblong-lanceolate, densely tomentose outside; *dorsal sepal* ca. 1.7-1.9 x 0.5 cm, lanceolate, obtuse; *lateral sepals* 1.0-1.2 x 0.9 cm, falcate, oblong, acute. *Petals* ca. 1 x 0.4 cm, parallel to column, obliquely lanceolate, obtuse, glabrous. *Labellum* distinctly tri-lobed, broadest ca. 1.3 cm long, 0.6-0.7 cm broad at middle; lateral lobes small, acute, erect, puberulous; terminal lobe rectangular, emarginated or bifid, recurved, crenate, apiculate, epichile thickened at apex with a triangular callus and two kidney-shaped callus on both sides of epichile extending from base to junction of lateral lobe to terminal lobe, no other ornamentation on the disc. *Column* ca. 0.4 cm, erect, glabrous, foot ca. 1 cm long; clinandrium collar-like; operculum two loculate, globose; rostellum simple, ligulate, bent towards stigmatic cavity; viscidium ellipsoid. *Pollinia* 8, laterally flattened,

obovoid, attached with glandular caudicle. *Stigmatic cavity* ca. 2 mm broad, two appendages present inside cavity. (Fig. 27)

Type: Nepal, Royal Chitwan national Park, Shawara, Narayani, 200 m, *Devendra M. Bajraçharya* CN 260, 26-Feb-2000, (Holotype: KATH!; isotype, TUCH!).

Distribution: 500 m., Himalaya (Nepal).

Flowering :Aug

Status : Endemic

Etymology: From Nepal, where the species was first found.

Note: *Eria nepalensis* is related to *E. latilabellis* Seid., and *E. lasiopetala* (Willd.) Ormerod, but it can be easily distinguished by the characters of floral bracts, inflorescence, and labellum. This species is endemic to Nepal Himalaya.

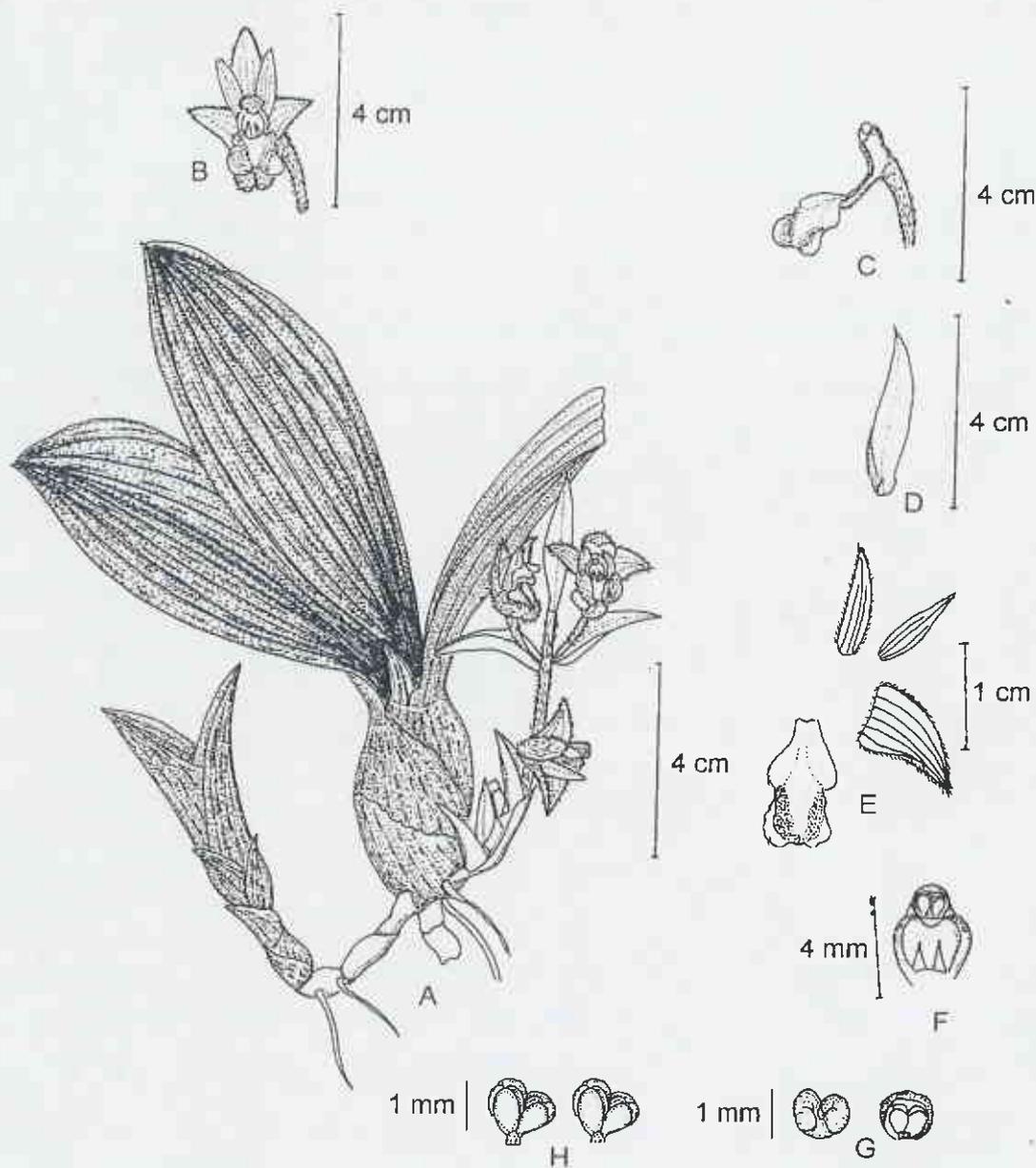


Fig. 27. *Eria nepalensis* D. M. Bajracharya & K. K. Shrestha (*D. M. Bajracharya 260 KATHI*)
 A: Habit; B: Flower C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal,
 Petal; and Labellum; F: Column; G: Operculum; H: Pollinia.

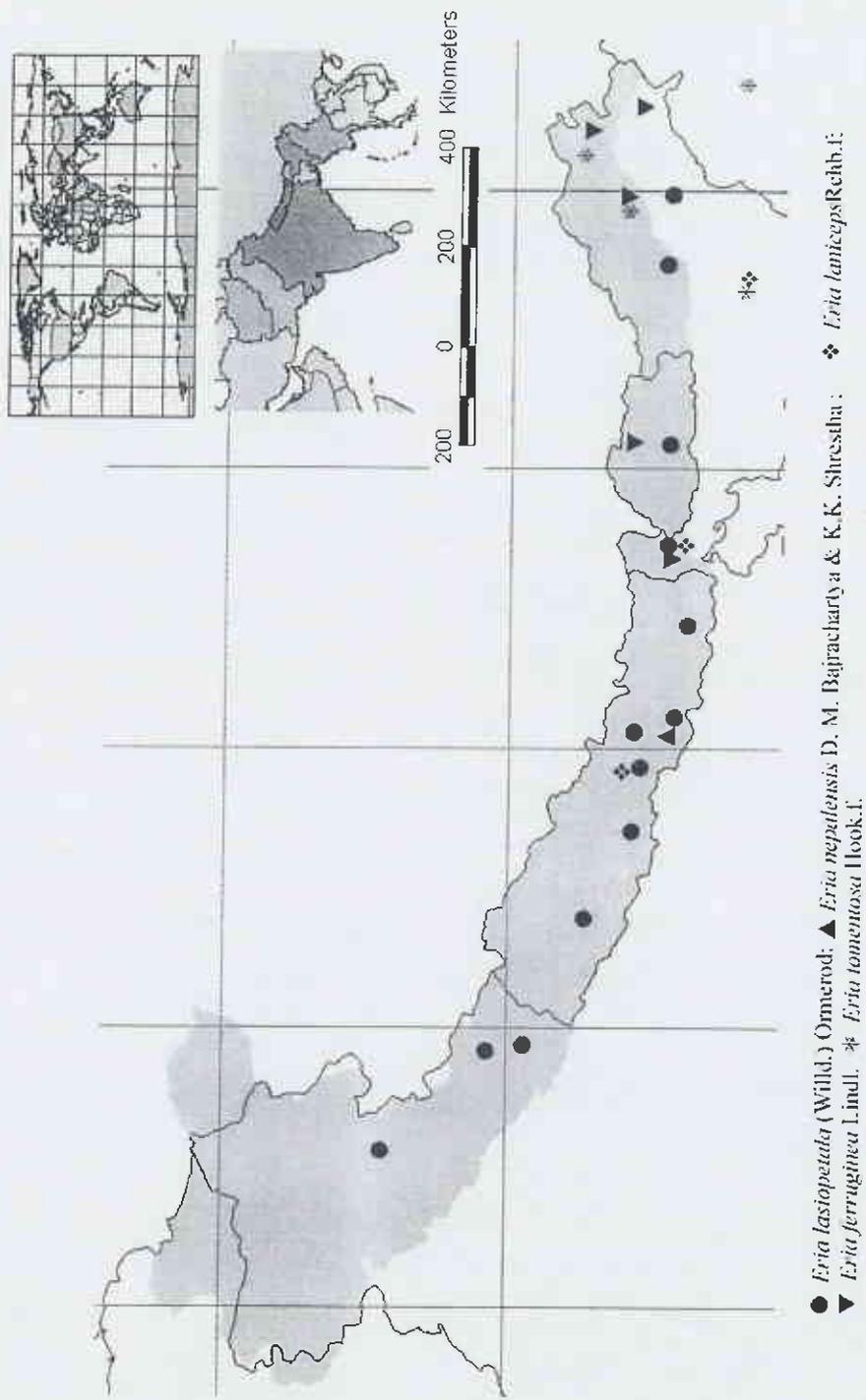


Fig. 28. Distribution Map of the section *Dendrolirium*

Section VII. Mycaranthes H. G. Reichenbach, *Bonplendia* 5: 55, 1857.

Rhizomes short, creeping; stems not dilated into pseudobulbs fairly long, placed very close together on them, but sometimes thick, leafy borne throughout the stem; leaves relatively long and narrow; and superficially resemble a monopodial orchids; inflorescence terminal, usually 3- 4, erect, covered with short woolly hairs; small and many flowers; labellum with well-developed side lobed; usually large, powdery callus on the midlobe; column foot long.

Type: *Eria latifolia* (Blume) H. G. Reichenbach, *Bonplendia*. 5: 55 1857 (*Mycaranthes latifolia* Blume *Bijdr.* 352, 1825).

Note: Blume (1825) proposed *Mycaranthes* as a separate genus for three taxa *M. oblitterata*, *M. latifolia* and *M. lobata*. Lindley (1830) accepted the genus *Mycaranthes* and added *E. stricta* to the genus as *M. stricta*, along with *M. oblitterata*, *M. latifolia* and *M. lobata*, instead of placing *Eria stricta* in the genus *Eria*. Reichenbach (1857) proposed the section *Mycaranthes* belonging to the genus *Eria*, and transferred all three taxa of Blume' in this section, but not included *Mycaranthes stricta* in this section.

Lindley (1859) also proposed the sectional name *Mycaranthes* (Lindl.) Lindl., with *Mycaranthes stricta* as the type species of the section. Unfortunately Lindley overlooked Reichenbach's section *Mycaranthes*. Although none of Blume' taxa were included in it, Lindley incorporated Blume's *Mycaranthes latifolia* in to the section *Eriura*. Later on, Leavitt (1909) proposed the new section *Secundae* for *E. stricta* and accepted *Mycaranthes* as the section for the *Eria paniculata* and allies by later workers. In the present work *Eria paniculata* is included under the section *Mycaranthes*. Though the section *Mycaranthes* consist of distinct characters which is different from other sections of *Eria*, many workers including Lindley (1830), Seidanfaden (1982), and Comber (1989), believed that *Mycaranthes* may belong to a distinct genus. On this basis, Breiger (1981) proposed a separate genus *Mycaranthes*, and included all species of *Eria* belonging to the section *Mycaranthes*.

About 20 species: SE Asia to ?? tropical Himalayas (Nepal, Sikkim, Bhutan, NE Himalaya) and S China; one species in Himalaya.

19. * ***Eria paniculata*** Lindley, in N. Wallich, *Pl. Asiatic. Rar.* 1: 32, t.36 (1830); Lindl., *Gen. Sp. Orch. Pl.* :65 (1830); Lindl., *Bot. Reg.* :28 (1842); Lindl., *J. Linn. Soc.* 3: 55 (1859); J.D.Hooker, *Fl. Brit. Ind.* 5: 789 (1890); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* 8: 126, pl. 174 (1898); Kränzlin, in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 125 (1911); Banerji & Thapa, *J. Bombay Nat. Hist. Soc.* :152 (1970); Tuyama in Hara (eds.), *Fl. East. Himal.* :186 (1971); Hara & al., *EFPN* 1: 42

(1978); Pradhan, Indian Orch. :356 (1979); Seidenfaden, *Opera Bot.* **62**: 49 (1982); Banerji & Pradhan, Orch. Nepal Himalaya :248 (1984); Seidenfaden, *Opera Bot.* **114**: 179 (1992); Koba & al., NLFPGN :196 (1994); Hajra & Verma, Fl. Sikkim **2**: 68 (1996); Chowdhery, Orch. Fl. Arunachal Prad. :373, f. 223 (1998); Hynniewta & al., Orch. Nagaland :179, f.59 (2000); Press et. al., ACFPN :216 (2000); Pearce & Cribb, Fl. Bhutan **3** (3): 377 (2002).

Dendrobium floribundum D. Don., Prod. Fl. Nepal. :34 (1825).

Pinilia paniculata (Lindl.) Kuntze, Revis. Gen. **2**: 679 (1891).

Epiphytic or terrestrial herbs, upto 30-50 cm high; tufted, caespitose and sub pendulous on the tree. *Root* fibrous, much branched, long and dark. *Pseudobulbs* absent. *Stem* 30 cm long, pendent, woody, cylindrical or terete, reed like, with many nodes, elongate and obsolete compressed, Leaf sheath embracing entire internode, fibrously lacerate, persistent,; *sheaths* tubular, 2-4 cm long, subcoriaceous. *Leaves* many, alternately arranged along the stem, fleshy, thickly leathery, narrowly linear-lanceolate, 6-25 x 0.3-1.2 cm, coriaceous, acuminate, rigid, upper surface shining, sub glabrous, vein inconspicuous. sub-sessile to shortly petiolate, leaf blade transversely jointed on the stem, with distinct midrib. *Inflorescence*, terminal fasciculate to paniculate, 2-4, arising from inner side of leaves, 10-15 cm, densely flowered; peduncle sheaths, simple or branched, 3.5-8 cm long, densely grayish white woolly pubescent; sheathes long-lanceolate; rachis 5-20 cm, terete, fleshy, and densely grayish tomentose. *Floral bracts* ovate-lanceolate, 4-8 x 2.5-5 mm, acuminate, falcate, slightly curved and often spreading reflexed, membranous, persistent, abaxillary with grayish white hairs or hairy only basally, nearly as long as stalked of the ovary,. *Pedicel and ovary* 3-6 mm long, shortly curved, densely grayish white cottony, with three linear lines. *Flowers* many, small, ca. 3-5 mm across, pale yellowish green with reddish dotted on the upper surface, acrid-scented, tomentose outside. *Sepals* triangular, ovate, 3-5 x 2-2.5 mm, acute or obtuse, densely grayish white cottony; *dorsal sepal* ovate-elliptic, 3-5 x 2-2.5 mm, obtuse, pale-yellow green, with red dotted and oil droplets, villosus at the base outside, glabrous in young; *lateral sepals* obliquely triangular with broad base, sub-falcate, 5-6 x 3-4 mm, sub-acute or obtuse, spreading, covered by softly and sparsely pubescent externally (puberulent externally), 5-veined, adnate to column foot forming ca.2 mm mentum; mentum, short, curved. *Petals* elliptic-lanceolate to obovate, thin, ca. 3-4 x 1.5-2 mm, sub-acute or obtuse, glabrous, margin slightly erose, base slightly contracted, apex bluntly rounded, 3-veined. *Labellum* tri-lobed, subflabellate or sub orbicular in outline, 3-4 x 2-4 mm across, sessile, base with a short stalk, without nodes, apex bluntly rounded; lateral lobe sub falcate, subovate- triangular, and sub-acute, minute red dotted; terminal lobe broadly sub-orbicular or subtrapezoid, decurved, bilobed, crenulated, margin erose, with pale lavender with brownish blotches; disc 2 largely callose, thickened, with disciform callus,

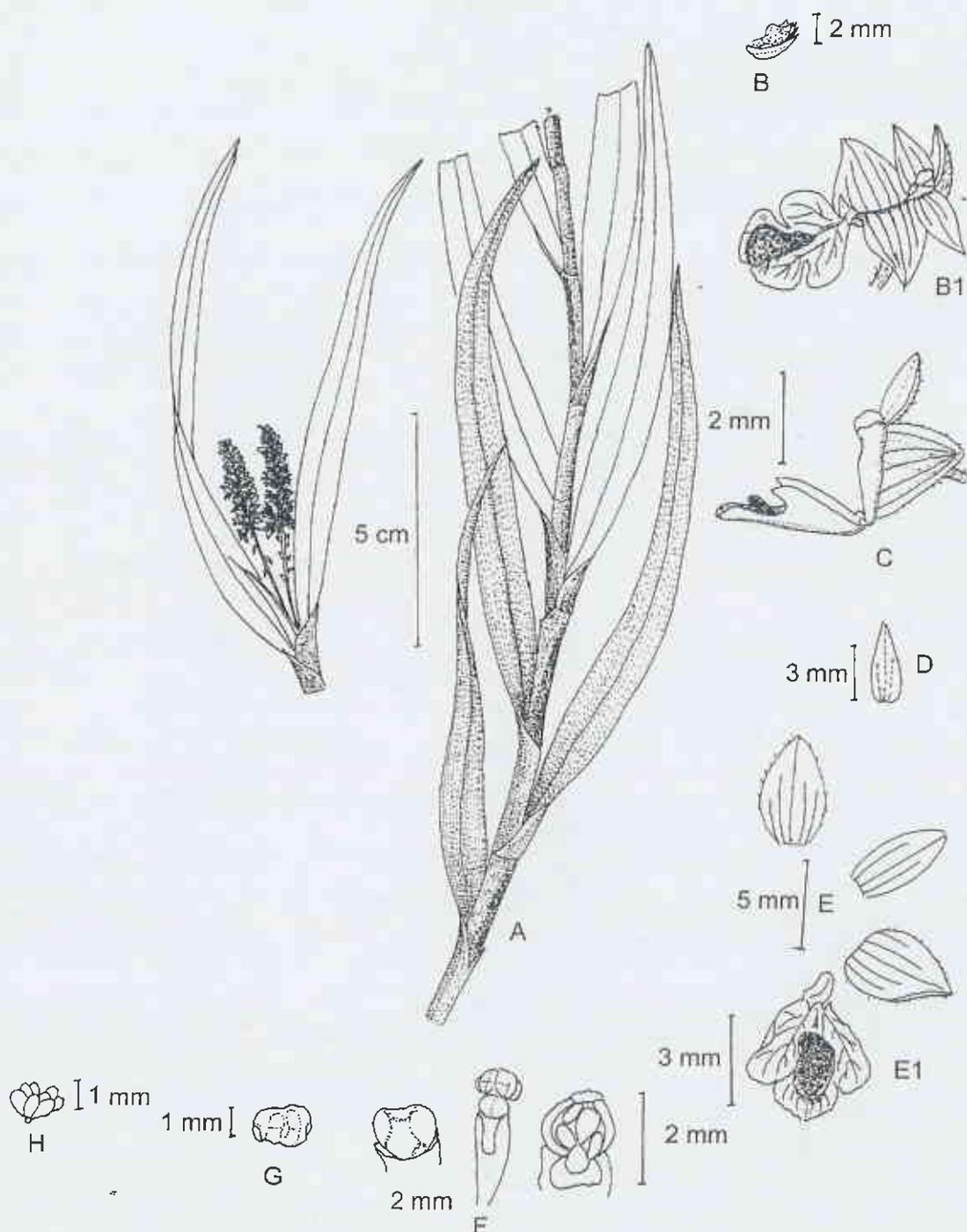


Fig. 29. *Eria paniculata* Lindley, (*D. M. Bajracharya* 230, TUCHI!) A: Habit; B: Flower C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

basal callus round and with large, cylindric callus from base to apex, white, both mealy, two oblong conical calli are present on each side of column. *Column* ca. 2 mm long, short, stout; foot straight, narrow, ca. 2 mm long, curved; clinandrium collar like; rostellum ligulate; operculum ovoid, ca. 1.5 x 1 mm, connective thickened, glabrous outside, 8 chambered, much shrunken when the flowers expands, and imperfectly 8-celled into two groups. *Pollinia* 8, brown, pearl shaped, clavate, glandular caudicle; viscidium simple and ellipsoid. *Stigmatic cavity* ca. 1.5 x 1 mm, and entire. (Fig. 29)

Type: Bangladesh, Pandua, *E. De. Silva Wall.cat. 1971* (Holotype: K-LINDLI, isotype BMI, KI, K-WI); *Dendrobium floribundum* type Nepal, *Wallich. s.n.* (Holotype: BM!); *Wall Cal. 1971*, (isotype, K-Lindl., CAL).

Distribution: 1300-1900 m., Himalaya (Nepal, Sikkim, Bhutan, Assam, Arunchal pradeh, Burma), Thailand, Laos, Cambodia, Vietnam.

Flowering: May- August.

Status: Endangered

Etymology: From the Latin word '*paniculatus*' (paniculate) with reference to the paniculate inflorescence.

Chromosome Number: $n = 19$ (Mehra & Sehgal 1976); $n = 19+0-2B$ (Vij & Sood 1986)

SPECIMENS EXAMINED: **Nepal:** *Wall Cal. 1971*, (Type, K-Lindl.); *C. Nepal*: Kathmandu, Bajrabarahi forest 1500 m, 15.6.1966, *A.P. Schilling* 841, (KI); Kathmandu, Bajrabarahi 1500 m., 20.4.1999, *D. M. Bajracharya* 230, (KATH); Kaski, Mardi Khola, Annapurna 2100 m, 24.5.83, *J. D. A. Stainton* 8617, (KI); Kaski, Panchase, Pokhara 2500m, 22. 4.2003, *D. M. Bajracharya* 470, **Sikkim:** Darjeeling, 2000m, 1.3.1896, *C. B. Clarke s.n.* (KI); Darjeeling, 1000m Oct. 1882, *Gamble* 10337, (KI); *Pantling* 103, sino loc. (KI) Tropical Valley, *Pantling* 103, Jan. – April 1892 (CAL!); Lachoong, July 1886, *King s.n.*, (CAL!); Jumlong, 29.4.1876, *C. B. Clarke* 27704, (CAL!); Sine loc., *Kelz* 344, (CAL!); **Assam:** Khasia, *J. D. Hooker s.n.* (KI); Cherrapunge, Khasia 1200m; 5.8.1952, *Rup Chand s.n.*, (KI); Cherrapunje, Khasia, 30.7.1952, *W. N. Koelz* 30926, (KI); Khasia 300m, 19.4.1955, *Rup Chand* 8375, (KI); Jamlu, 1895, *BSI* 11835, (CAL!); Sine loc. June 1896, *Jw Sulei s.n.*, (CAL!); Khasia Hills, May 177, *Sine Coll.* 357 (CAL!); Khasia, Ncon 354 Herb Kurz (CAL!); Padeng, Jaintea Hills, March 1899, *Prain* 171 (CAL!); Shugtom-Jowal Road, March 1890, *King s.n.*, (CAL!); Jawai- Jantea Hill, June 1899, *Prain* 250, (CAL!); Jaentia & Khasia Hill, Feb 1897, *Pantling s.n.*, (CAL!); Omtapok, Jaintea Hill, March 1899, *Prain* 266, (CAL!); Tesangki, Assam 1500m, 16.5.1935, *Bore* 2648, (KI); Assam, Jan 1915, *Parry* 554, (KI); **North East Himalaya:** Arunchal Pradesh: Deomali east of Khasia, 21. 6.1961, *D. B. Deb* 25907 (CAL); Kameng, Iohit, Siang, Subansisri, Tirap; between 500-1000 m.; *H. J. Chowdhery s.n.*; **Burma:** *Griffith* 5111, (KI); *Sumlwe* 12112, 21.9.1927, (KI); Kachin Hill, 1897, *Mokim s.n.* (CAL!).

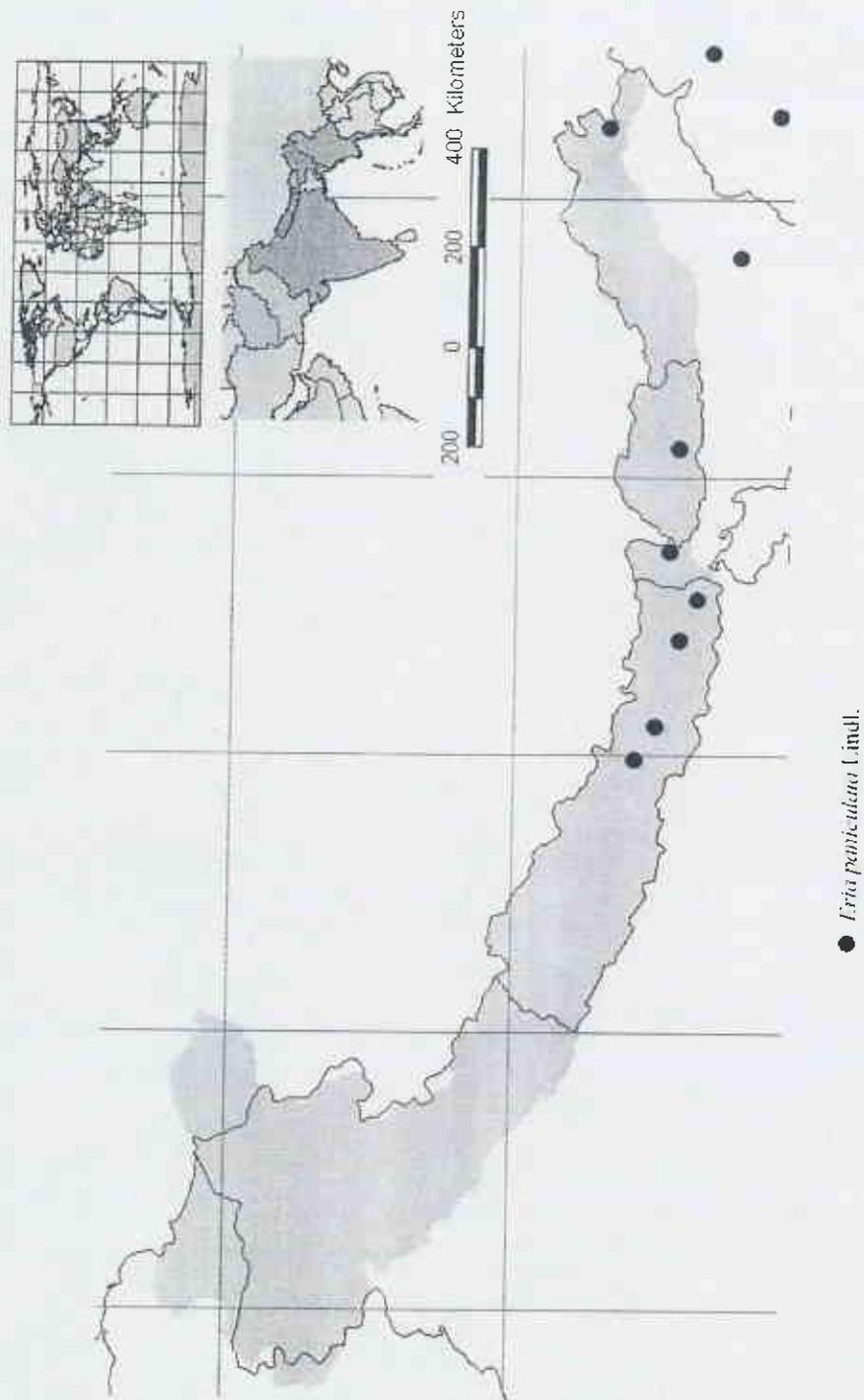


Fig. 30: Distribution Map of the section *Mycaranthes*

Section VIII. Secundae Leavitt, *Phil. J. Sci. Bot.* **4** (3): 217, 1909.

Small plants with fleshy pseudobulbs or stems tubular like with one internodes, base surrounded with sheath; apex with 1-3 leaves; Inflorescence flanked by 2 leaves, congested, 1-2, sub-terminal inflorescence with densely white tomentose; rachis carrying many minute dense to sub-dense flowers and secund; floral bract hairy; sepals tomentose outside; the labellum shallowly tri-lobed, without lamellae.

Type : *E. stricta* Lindl., *Coll. Bot.* :41b, 1826.

Note: Lindley (1859), Reichenbach (1861), Hooker f. (1890), King and Pantling (1898), and Kranzlin (1911) wrongly placed *Eria stricta*, *E. retusa* and *E. merguensis* in the section *Mycaranthes*. Smith (1905) moved *E. retusa* and *E. merguensis* in the section *Hymenaria*. Seidanfaden & al. (1969) and Pradhan (1979) placed *E. stricta* in the section *Cymboglossum*. Seidenfaden (1982) accepted the sectional name *Secundae* for *E. stricta* and *E. merguensis*. However, Brieger (1981) disregarded the section *Secundae* and placed *E. stricta* into a separate genus *Cymboglossum*, as the type species of his genus *Cymboglossum*. In the present study, *E. stricta* and *E. merguensis* are included here in the section *Secundae*, a name proposed by Leavitt (1909). Leavitt had included only *E. stricta* in this section.

About five species: SW China, India, Myanmar, Himalaya (Nepal, Sikkim, Bhutan, NE Himalaya) Thailand, Vietnam; two species in Himalaya *Eria stricta*, and *E. merguensis*.

- 1.a Flowers secundae, labellum with depressed callii ----- **20. E. stricta**
 1.b Flowers facing all planes, labellum with two fat parallel longitudinal callii -----
 ----- **21. E. merguensis**

20. Eria stricta Lindley, *Coll. Bot.* :1, 41b (1825); J. D. Hooker, *Fl. Brit. Ind.* **5**: 791 (1890); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* **8**: 125, t.173 (1898); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50**: 41 (1911); Tuyama in Hara (eds.), *Fl. East, Himal.* **2**: 186 (1971); Hara & al., *EFPN* **1**: 42 (1978); Banerji & Pradhan, *Orch. Nepal Himalaya* :248 (1984); Koba & al., *NLFPGN* :196 (1994); Hajra & Burma, *Fl. Sikkim* **2**: 69 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :381, f. 230 (1998); Hynniewta & al., *Orch. Nagaland* :183, f. 61 (2000); Press & al., *ACFPN* :216 (2000); Pearce & Cribb, *Fl. Bhutan* **3** (3): 378 (2002).

Mycaranthes stricta (Lindl.) Lindl. in N. Wallich, *Numb. List* 1970 (1829); Lindl. *Gen. Sp. Orchid. Pl.* : 63 (1830).

Pinalia stricta (Lindl.) Kuntze, *Revis. Gen.* **2**: 679 (1891).

Octomeria secunda Wall. ex Lindl. *Gen. Sp. Orchid. Pl.* 63 (1830)

Eria secundiflora Griff., *Not.* **3**: 302 (1851).

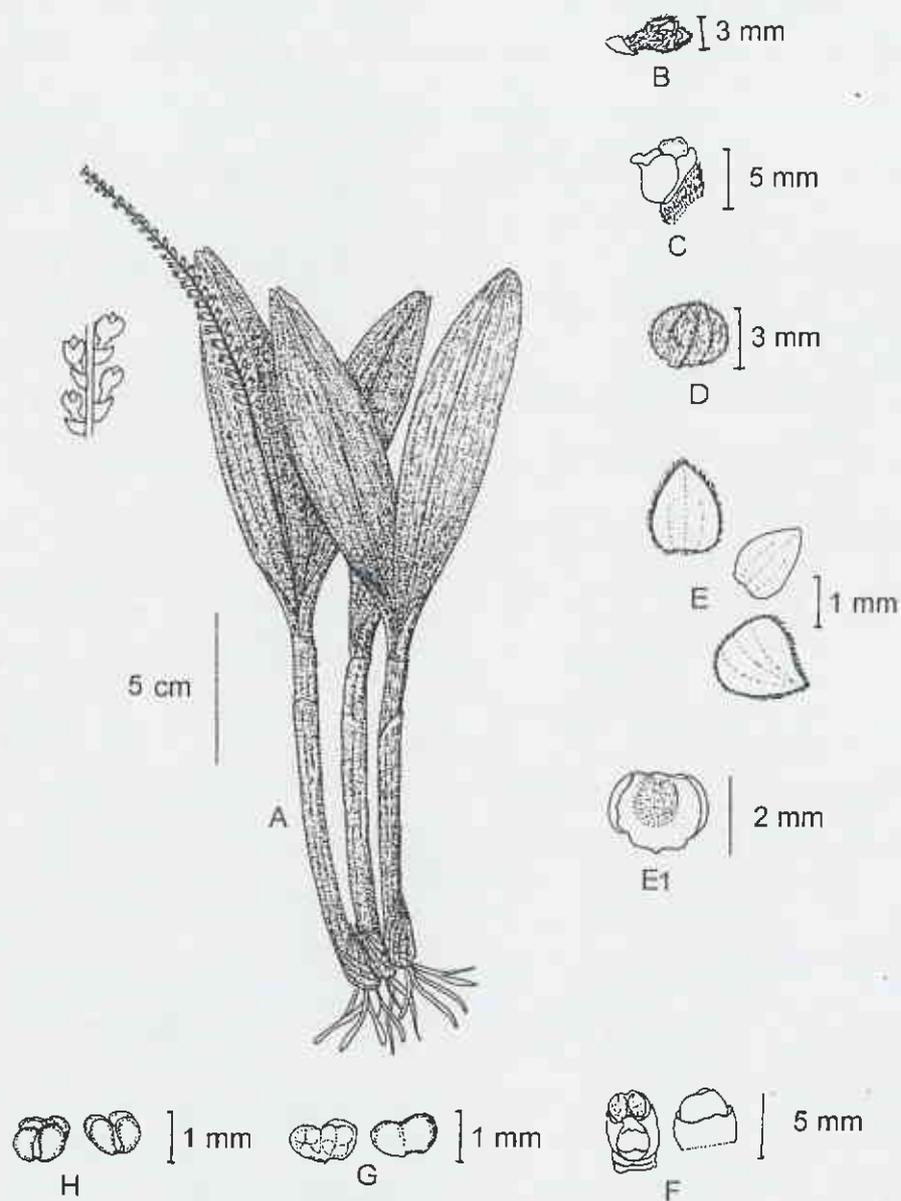


Fig . 31. *Eria stricta* Lindley. (D. M. Bajracharya 200 TUCHI), A: Habit; B: Flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

Epiphytic herbs, upto 15-30 cm high including inflorescence; bearing only one node in the erect part. *Root* fibrous, branched. *Rhizomes* inconspicuous. *Pseudobulbs* congested, crowded, short, often cohering, cylindric, erect, tufted, 9-14 cm x 1 cm, crowded stem, covered with fibrously lacerated sheaths remains, apex slight dilated with one internode, and double folded leaves; sheaths membranous, 2-3 cm long, acute, presence of abscission layer. *Leaves* 2, arising from the apex of pseudobulb, 6-10 x 1.5-2 cm, cauline, sub-coriaceous, oblong-lanceolate, acute, emarginate, entire, with 8 veined, shortly petiolate; petiole grooved, ca. 4-5 mm long. *Inflorescence* 1 or 2, arising from inside of leaves near pseudobulb apex, terminal spike, erect, racemose, densely many flowered with scundae and 1 triangular bracts at base; the peduncle is naked and white cottony, 2-8 cm long; rachis 5-10 cm long, white cottony. *Floral bracts* ovate or rhombic, acute, 1.5 x 2 mm, distichous, mucronate, broad, glabrous, white, 3-veined. *Pedicel and ovary* 4 x 1.5 mm, densely woolly. *Flowers* white, 3-4 x 2 mm, densely pilose with white hairs externally, facing straight and secund, flushed with pink, lip white streaked with yellow. *Sepals* identical, densely woolly in abaxially; ovate, 2-3 x 1-1.5 mm; *dorsal sepal* ovate, obtuse, 0.8-2 x 1.5-2 mm, dense woolly outside, 3-veined; *lateral sepals* ovate, ovate-triangular, subequal, obtuse, 1.5-2.0 x 2 mm, densely woolly outside, 3-veined, adnate to column foot forming mentum; mentum small. *Petals* ovate-orbicular (rotund), membranous, blunt, as long as sepals, transparent, obtuse, 2-3 x 1.5-2 mm, entire, thin edged, 1-veined. *Labellum* obscurely tri-lobed, 2-3 x 1.5 mm, sub-orbicular or rotund, concave, terminal lobe apically with a gibbous callus, sometime entire terminal lobe apically thickened, 2-3 mm long; lateral lobe 1.5 x 0.8 mm, sub-triangular, parallel to terminal lobe with flattened calli, shallow, rounded; terminal lobe 1 x 0.9 mm, compress, rounded, very short, broad, truncate apex bluntly rounded; disc centrally present between the lateral lobe, ca. 0.5 mm wide, thickening from base of terminal lobe apex, with depressed callus, nectar secreting, dividing into two chambers by short rib continued upward on the foot of the column. *Column* ca. 0.5-1 mm long, obtriangular wing, broad, smooth, foot short, ca. 2 mm; clinandrium collar like; rostellum ligulate, bent towards the stigma; operculum ovate, 1 mm, yellow pink, at outer surface. *Pollinia* 8, sub-globose, mass in four each, each mass attached separately to the quadrate gland by glandular elastic thread; viscidium simple and ellipsoid and broadly obovoid. *Stigmatic cavity* entire, at the tip of the stigmatic cavity two lobed "u" shape (Fig. 31).

Type: Nepal, Toka, Napalia 1821, Wallich 1970, Feb. 1821 (Holotype: K- LINDL. Iso CAL, K, K-W.)

Disrtibution: 300-1500 m., Himalaya (Nepal, Sikkim, Bhutan, Assam, Arunchal Pradesh, Burma), Thailand.

Flowering: Feb- March.

Status: Endangered.

Etymology: From the Latin strictus (upright/straight)

Chromosome Number: $2n=40$ (Hasimoto & Tanaka 1983)

SPECIMENS EXAMINED: **Nepal** : *C. Nepal*: Kathmandu, Toka, Napalia, Feb. 1821, Wall 1970, (K Lindl., K-W!), = *Octomeria secunda* Wall.); *E. Nepal*: Shankushbha distract, Arun valley 1500m, 30.3.1999, D. M. Bajracharya 200, (TUCHI; KATH!); **Sikkim** : Tropical valley of Sikkim Himalaya, 1.2.1891, R. Pantling 65, (K!); Sikkim Himalaya 1500, J. D. Hooker, s.n. (K!); Tropical Valley, R. Pantling 65, (BM!); Haflong, 5 2. 1901, N. Gil 172, (CAL!); Nov to Feb 1893, Pantling 65, (CAL!); July 1895, Pantling 65, (CAL!); Gammie s.n. (CAL!); 17 2.1896 King s.n. (CAL!) Griffith 5118 (CAL!); J. D. Hooker s.n. (CAL!); **Assam**: Khasia, Griffith s.n. (Herb. Lindl. K!); Khasia 1200m, July 24/50. J. D. Hooker 59, (K-Lindl.); Khasia, Griffith 5118/5119 (K!); Jawai, July 1897, Pantling s.n. (CAL!), Jankmukh, 16 12.1911, Burkill 37188, (CAL!); Serpo Vallry, 29 1.1912 Burkill 36387, (CAL!); **Bhutan** : Gaylegphug Dist. Karai Khola above AIR Bridge, Gaylegphug 510m, 22.3.1982, Grierson & Long 3943, (E!); Gaylegphug 3000m, 15 12.1963, G. Sen Gupta 901, (CAL!); Gaylegphug 270m, , Dec 1963, Sen Gupta 901 (CAL!); **North East Himalaya** : Kameng, Lohit, Siang Subansiri, Tirap; Between 100-1000 m.; H. J. Chowdhery; **Burma** : Sincum Reo, Bhawan Loei sion 2000m, Mawing 4923 15.2.1927(K!); Sin.loc., F. Kingdom-Wards 9068, 1930.31 (BM!); Upper Burma 1800-2500m, F. Kingdom-Wards 13523, 3.12.1937(BM!); Man Tesang 1500 m, Toppin S. M. 6360, Feb 1912 (CAL!); Kachin Hill, Pottinger s. n. 18 March 1897 (CAL!); Kachin Hill, Mokim s.n., July 1898 (CAL!).

Note: Seidenfaden and Smitinand (1959-65) treated *E. siamensis* Schltr. as a synonym of *E. stricta*, but Seidenfaden (1982) reviewed the position of *E. stricta* and concluded that they are two distinct taxa. The *E. siamensis* has triangular, acuminate to acute floral bracts, while those of *E. stricta* has ovate and acute floral bracts. Similarly, the petal of *E. siamensis* are twice larger than *E. stricta*, and the lip is also different from *E. stricta*.

21. **Eria merguensis** Lindley, *J. Linn. Soc.* **3**: 52, (1859); *Rchb. f., Tr. Linn. Soc.* **30**: 137 (1874); *Gard. Chron.* : 616 (1880); J.D.Hooker, *Fl. Brit. Ind.* **5**: 791 (1890); Grant, *Orch. Burma.* :142 (1895); Seidenfaden, *Opera Bot.* **62**: 82 (1982)

Pinalia merguensis (Lindl.) Kze. *Revis. Gen.* **2**: 679 (1891).

Mycaranthes merguensis (Lindl.) Rauscher, *Feddes Repert.* **94**: 456 (1983).

Epiphytic herbs, *Pseudobulbs* cylindrical-clavate, ca. 7-10 cm long, covered by leaf sheaths: Leaf sheaths membranous, *Leaves* usually 3-leaved, 5- 6 x 2-3 cm, linear-lanceolate, obtuse or acute, coriaceous. *Inflorescence* sub-terminal, ca.7 cm, often two together, long-tomentose, rachis hairy with many flowered irregularly placed, facing all sides, not second. *Floral bracts* minute, obsolete, covered by long tomentose. *Pedicel and ovary* coarsely tomentose. *Flowers* minute, irregular placing on the rachis. *Sepals* oblong, unequal coarsely tomentose; *dorsal*

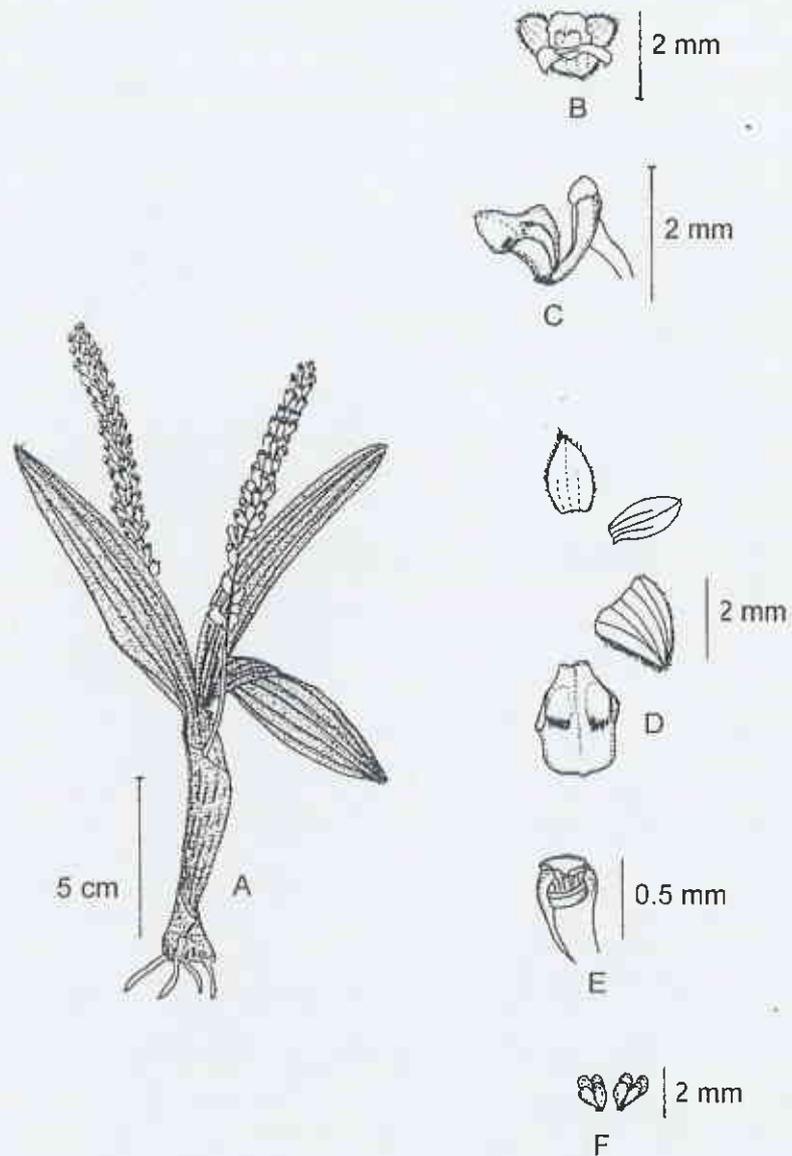


Fig 32. *Eria merguensis* Lindley, (*D. M. Bajracharya* 110, TUCH!) **A:** Habit; **B:** Flower; **C:** Lateral view of column with labellum; **D:** Spreading of Sepal, Petal; and Labellum; **E:** Column; **F:** Pollinia.

sepal oblong, obtuse ca. 1-1.5 mm long; *Lateral sepals* 2 x 1.5-1.8 mm, oblong, obtuse, densely tomentose, 4 veins, mentum present, round, base of lateral lobe fused; *petals* elliptic, acute, ca. 2 x 0.8 mm, 1 vein; *labellum* trilobed, ca. 1.8-2 x 2-1.8 mm, truncate apex, lateral lobe oblong, obtuse, ca. 1 mm long, short, erect; terminal lobe broad, ca. 1 x 1 mm, thick, entire, truncate with acute apex, ca. 1.5 mm, disc with two fat, parallel, longitudinal calli on both side of lateral lobe. *Column* short, ca. 0.5-0.8 mm, erect, recurved, small, entire, columnfoot short; clinadrium collar like; operculum ca. 1 mm broad, *Pollinia* 8, pyriform, mass of four attached to glandular disc, *Stigmatic cavity* entire, ca. 0.4 mm. (Fig. 32).

Type: Burma Mergui, Griffith 1034 (K!); Kew distribution 5120

Distribution: 1000 m., Himalaya, Burma

Flowering: april

Status: Rare

Etymology: From Mergue, from where the plant was recorded first time.

SPECIMENS EXAMINED: Bhutan: Shemgang, 20 4.1964, G. Sen Gupta 1265, (CAL!); Mangde chu, 1000m, 15 8. 1997, D. M. Bajrachaya 110, (TUCH!); Burma : Moulmein, Jan 1897, Peche s.n. (CAL!); Mergui, , March 1911, Meebold 14150 (CAL!).

Note: *Eria merguensis* is reported here as a new record for the flora of Bhutan. This species was collected from Shemgang, by G. Sen Gupta 1265, 20 April 1964.(CAL!); and Mangde chu, 1000 m. D. M. Bajrachaya 201, 15 Aug 1997 (TUCH). *Eria merguensis* is closely related to *E. stricta*, but differs mainly from the latter in the type of inflorescence, pseudobulbs and calli. Interestingly, Pearce and Cribb (2002) also did not mention this species in the Flora of Bhutan. Cladistic analysis shows its close affinity with the Section *Dendrolirium*, based on shape of pseudobulbs, labellum apex, and nature of orientation on the disc, but it differs in the size of flowers and inflorescence type. Therefore, it can not be merged in the recent section *Dendrolirium*, but suggested to place in a separate section.

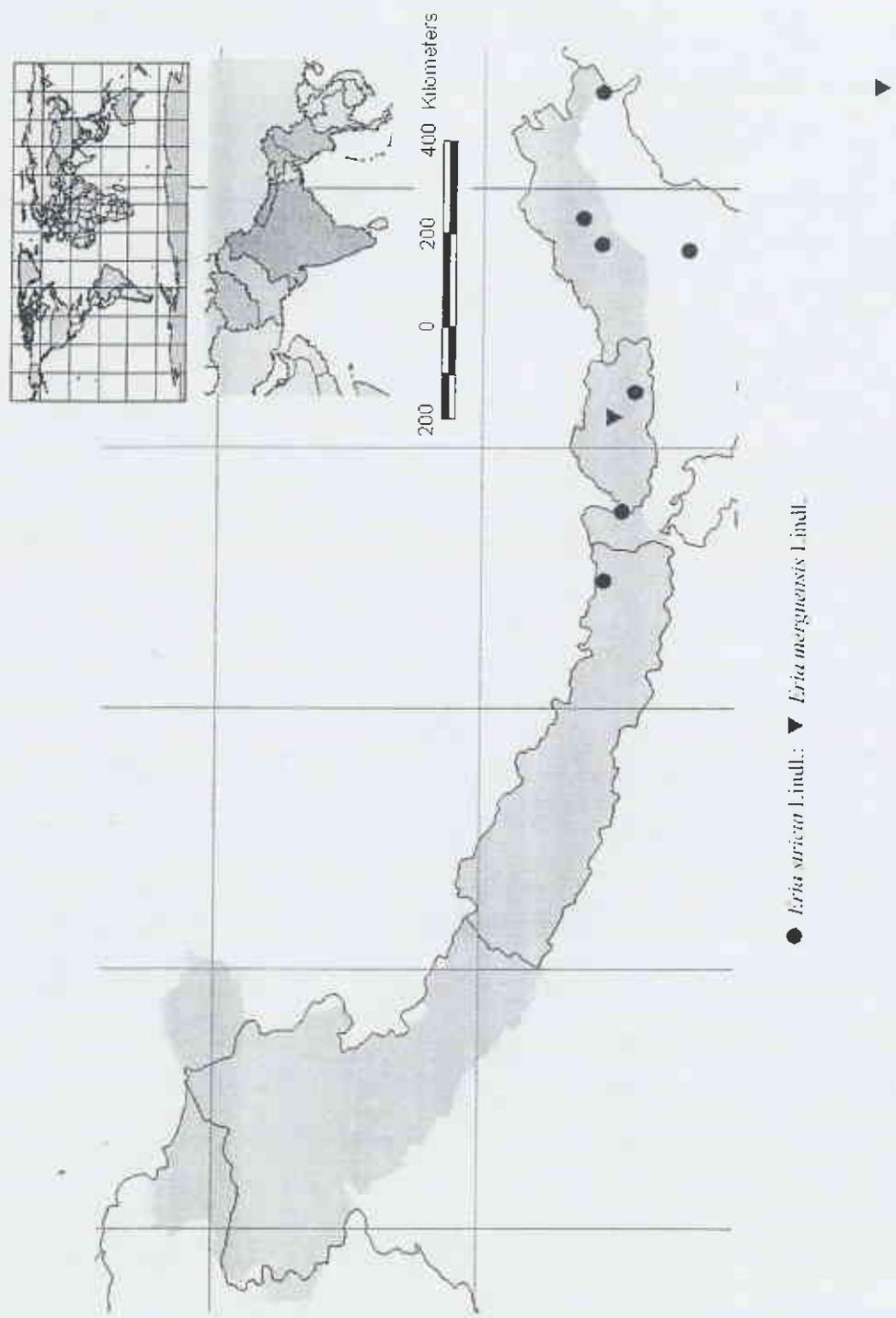


Fig. 33. Distribution Map of the section *Secundae*

Section IX. *Cylindrolobus* Blume, *Mus. Bot. Lugd.* 2: 182, 1856.

Stem short or more often long, hard and woody, cylindrical or slightly clavate, leafy throughout or only on the apical part; Inflorescence short, lateral or often apparently terminal; leaves glabrous; usually with conspicuous fleshy reddish or yellowish spreading bracts, with long pedicelled flowers, mentum relatively short or broad; labellum three-lobed, usually with glabrous, smooth longitudinal keels.

Type: *Eria compressa* (Blume) Blume, *Mus. Bot. Lugd.* 2: 182, 1856 (*Ceratium compressum* Bl., *Bijdr.* :341, 1825).

Note: Blume (1828) proposed the new taxa *Cylindrolobus* for his genus *Ceratium*. Later, Blume (1856) made it as the sub genus *Eria*. Lindley (1859) proposed new section and accepted it as the section *Cylindrolobus* for the genus *Eria*. Later workers Bentham and Hooker (1883), Pfitzer (1888), J. J. Smith (1905), Leavitt (1909), Holttum (1957) and Seidenfaden (1982) also accepted it. Kranzlin (1911) considered section *Cylindrolobus* as sub section of *Trichotisia*. Brieger (1981) separated it into the genus *Cylindrolobus*, but *E. biflora* is shifted into the section *Clavatae* of the genus *Eria* (Brieger 1981).

About 22 species: from Himalaya (Nepal, Sikkim, Bhutan, NE Himalaya) to Indonesia; six species in Himalaya *Eria biflora*, *E. clavicaulis*, *E. arunchalensis*, *E. glandulifera*, *E. cristata*, and *E. jengengensis*.

- | | | |
|-----|---|-----------------------------|
| 1.a | Labellum entire or obscurely tri-lobed | 22. <i>E. biflora</i> |
| 1.b | Labellum distinctly tri-lobed | 2 |
| 2.a | Pedicellate-ovary laterally curved, and glabrous | 23. <i>E. jengengensis</i> |
| 2.b | Pedicellate ovary erect, glabrous or pubescent | 3 |
| 3.a | Floral bracts > ±1 mm, inflorescence always 2 | 4 |
| 3.b | Floral bracts < ±1 mm, inflorescence more than 2 | 5 |
| 4.a | Flowers < ±2 cm, mentum round | 24. <i>E. clavicaulis</i> |
| 4.b | Flowers > ±2 cm, mentum "U" shaped | 25. <i>E. arunchalensis</i> |
| 5.a | Sepal acute, 5-nerved; terminal lobe of labellum broadly ovate; margin entire | 26. <i>E. cristata</i> |
| 5.b | Sepal acuminate, 3- nerved; terminal lobe of labellum oblong, margin ciliate | 27. <i>E. glandulifera</i> |

24. **Eria biflora** Griffith, Not. 3: 302 (1851); J.D.Hooker, Fl. Brit. Ind. 5: 800 (1890); King & Pantling, Ann. Roy. Bot. Gard. Calc. 8: 117, pl. 160 (1898); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 98 (1911); Pradhan, Indian Orch. :357 (1979); Seidanfaden, *Opera Bot.* 62: 90 (1982); Seidanfaden, *Opera Bot.* 114: 183 (1992); Hajra & Verma, Fl. Sikkim 2: 66 (1996); Chowdhery, Orch. Fl. of Arunachal Prad. 354, f. 210 (1998); White & Sharma, Wild Orchids in Nepal. :234 (2000) Rajbhandari & Bhattarai, Beautiful Orchid of Nepal. 121 (2001); Pearce & Cribb, Fl. Bhutan 3 (3): 378 (2002).

Pinalia biflora (Griff.) Kuntze, Revis. Gen. 2: 679 (1891).

Epiphytic herbs, 15-20 cm high including leaves. *Root* clustered. *Pseudobulbs* clustered, club shaped, stem-like, tufted, placed 1 cm apart on rhizome, contiguous, clavate, distinctly swollen and fleshy, compressed, ca. 1 cm thick, 6- 12 x 0.3-0.5 cm long, widened and flattened at the apex and linear at base, covered by several scattered sheaths. *Sheath* scars, membranous, lanceolate, 1.5-2.4 cm long. *Leaves* 3-5, arising from pseudobulb apex, narrowly elliptic-lanceolate, \pm 4-6 x 0.5-0.9 cm, sub-acute to acute, fleshy, and prominently 1-veined, tapering at base with short petiole, jointed; petiole grooved 2-4 cm long. *Inflorescence* short, axillary racemose, usually 2 flowered, sometime 3 flowered along the $\frac{1}{2}$ part of the pseudobulb, 6-8 mm long; peduncles short, compressed, glabrous, rachis ca. 2 mm long, compressed, slightly pubescent. *Floral bract* as long as the flower, large, elliptic, 4-6 x 2-4 mm, acute, recurved, petaloid, pale yellow and fleshy. *Pedicel and ovary* 2-4 mm long, ovary shortly stalked, pubescent. *Flowers* hardly opened, 2-3 mm long, ca. 5-6 mm broad, pale yellow or yellowish white, glabrous. *Sepals* connivent, unequal, narrowly elliptic, acute, 3-8 mm long; *dorsal sepal* ovate or narrowly elliptic, 3-6 x 4 mm, acute; *lateral sepals* ovate, triangular, falcate, ca. 5-6.5 x 4 mm, obtuse and broad bases; mentum triangular, 1- 1.5 mm long. *Petals* nearly as long as sepals, oblong, ca. 2-3 x 1.5 mm, obtuse, white, narrow than sepals. *Labellum* simple, entire to obscurely tri-lobed, ovate-oblong to subpandurate in outline, 2-4 x 0.3 cm, with incurved lateral lobes, hinged on the column foot; lateral lobes short to obscure, incurve; terminal lobe oblong, obtuse, blunt, emerginate, with papillose margin; disc with a central smooth oblong callus at apex of the labellum, 2 erect parallel lamellae at the base. *Column* straight, broad, column foot short, broad at base, white with a light yellow tip, clnandrium usually collar like, rostellum ligulate, operculum ca. 2 mm with a orbicular fleshy top and membranous edge. *Pollinia* 8, obovoid, viscidium simple, membranous. *Stigmatic cavity* ca.2 mm, broad, two horns inside the cavity (Fig. 34).

Type: Burma, Mergui, Griffith 830 type (Holotype: K- LINDL!).

Distribution: 350-500 m, Himalaya (Nepal, Sikkim, Bhutan, Assam, Arunchal Pradesh, Burma), Thailand, Laos, Vietnam, Malaya, Sumatra, Java.

Flowering: September- November.

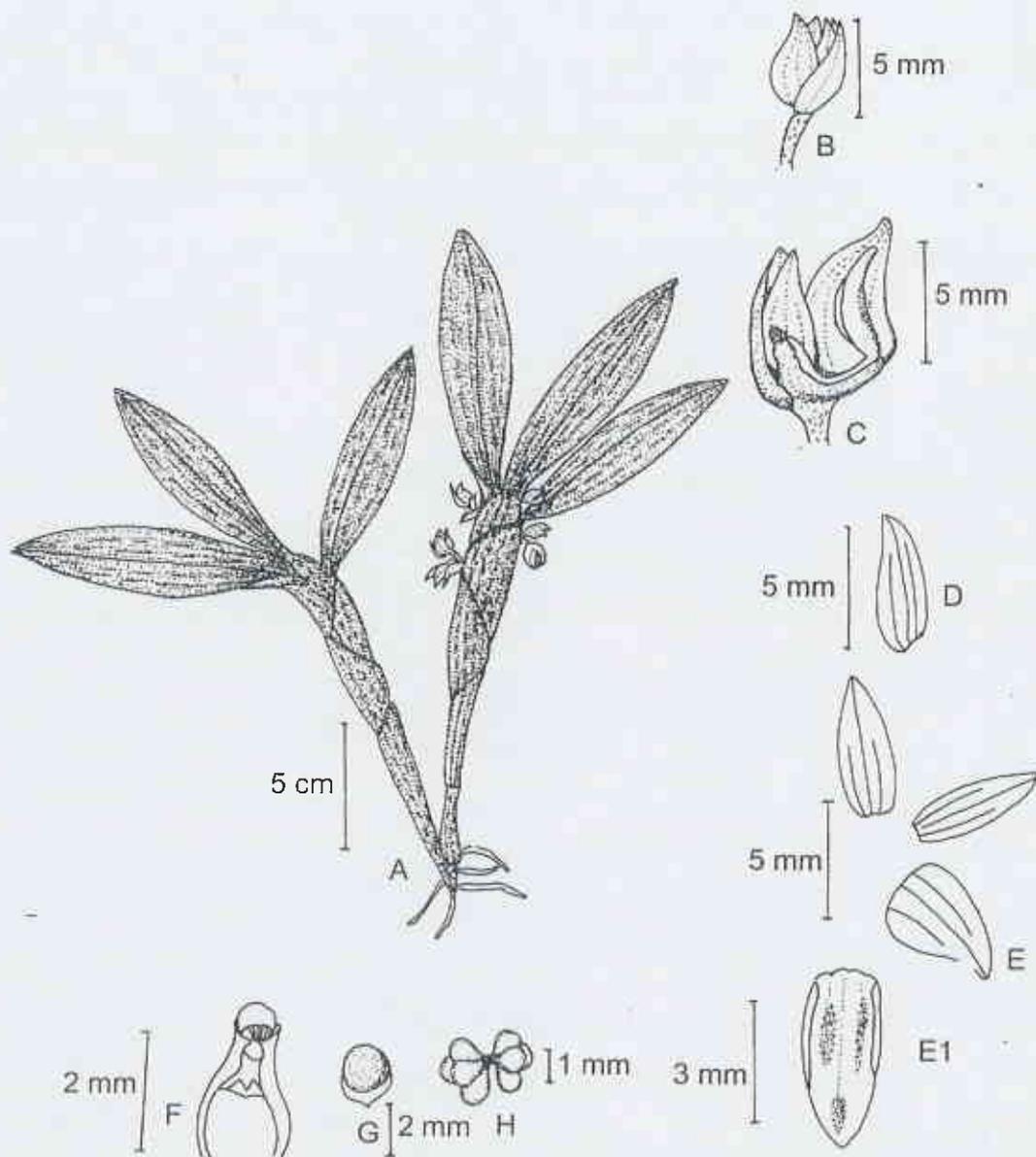


Fig 34. *Eria biflora* Griffith, (Sharma & White 182, Kl) A: Habit; B: Flower; C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

Status: Rare

Etymology: From the Latin word 'bi'(two) and 'flos'(flowers).

Chromosome Number: $n = 19, 21$ (Mehra & Sehgal 1976); $2n = 42$ (Biswas 1980); $2n = 46$ (Hasimoto & Tanaka 1983).

SPECIMENS EXAMINED: **Nepal:** **C. Nepal:** North of Hetuda, 500-700 m, *Sharma & White* 182, 16 Oct 1991, (K!); **Sikkim:** Tropical Valley Sept 1893 *R. Pantling* 244 (K!); Sino loc (lc. Cathcart fide J.D.Hooker, (K!); **North East Himalaya:** Kameng, Subansiri, Tirap; between 100-1000 m.; *H. J. Chowdhery*; **Burma:** Mergui, *Griffith* 808/820, (K-Lindl.), *Griffith* 830 type (K!); **Malaya:** Gua Musang Kelantan, *Carr* 167 (K!).

Note: This species is not enlisted in EFPN (Hara & al. 1978), NLFPGN (Koba & al. 1994) and ACFPN (Press & al. 2000), but recently listed by White & Sharma (2000) and Rajbhandari & Bhattarai (2001).

25. Eria jengingensis Hedge, *Jour. Orch. Soc. Ind.* 7(1-2): 13-15 (1993); Chowdhery, *Orch. Fl. of Arunachal Pradesh* :371 (1998).

Epiphytic herb, 18-26 cm high, erect, clusters. Root thin wiry roots produced gives rise from the basal nodes of old pseudobulbs. *Pseudobulbs* stem like, cylindrical, some what thickened at the apex, brached with distinct node and internodes covered by depressed sheathes. *Leaves* 3-5, elliptic-lanceolate, 5-6 x 1.5-1.8 cm acute, coriaceous. *Inflorescence* lateral, racemes, short with 2-3 flowered arising from the nodes opposite to leaf axils or from the internodal region, all along the stem, more towards the apical region; rachis short enclosed in bracteate sheathes, ca. 1.3 cm long. *Floral bracts* broadly ovate, acute, 1.5 x 0.5 mm, $2/3^{\text{rd}}$ as long as pedicel and ovary. *Pedicel and ovary* curved laterally. *Flowers* yellowish-brown, tinged pink, bracteate, partly opening, ± 1.3 cm long. *Sepals* ovate, 7-8 x 3-3.5 mm, acute, unequal; *dorsal sepal* ovate-lanceolate, 7-8 x 3-3.5 mm, with 3-veined; *lateral sepals* ovate, ca. 7-9 x 3-4 mm, acute, falcate and gland dotted, broad at base attached a long the mentum, curved, 3-veined. *Petals* shorter than sepals ovate-lanceolate, ca. 5-6 x 1.5 mm long, acute, margin at apex incurved, wavy, 3-nerved. *Labellum* tri-lobed, ca. 5 x 1.8 mm, curved along column foot, yellowish at the base and in between callus, pale pinkish, deep pink at the callii and margins of terminal lobe that are infolded; lateral lobe erect, thick, forming a channel and partly covered the column; terminal lobe oblong, channelled, decurved, fleshy, thick, forming a mucro at the end with pink raised callus, disc with two callii near at the centre. *Column* ca. 2 mm, with short column-foot, *Pollina* 8; four numbers in each group, obovoid, placed within grooved operculum. Stigmatic surface grooved. (Fig 35)

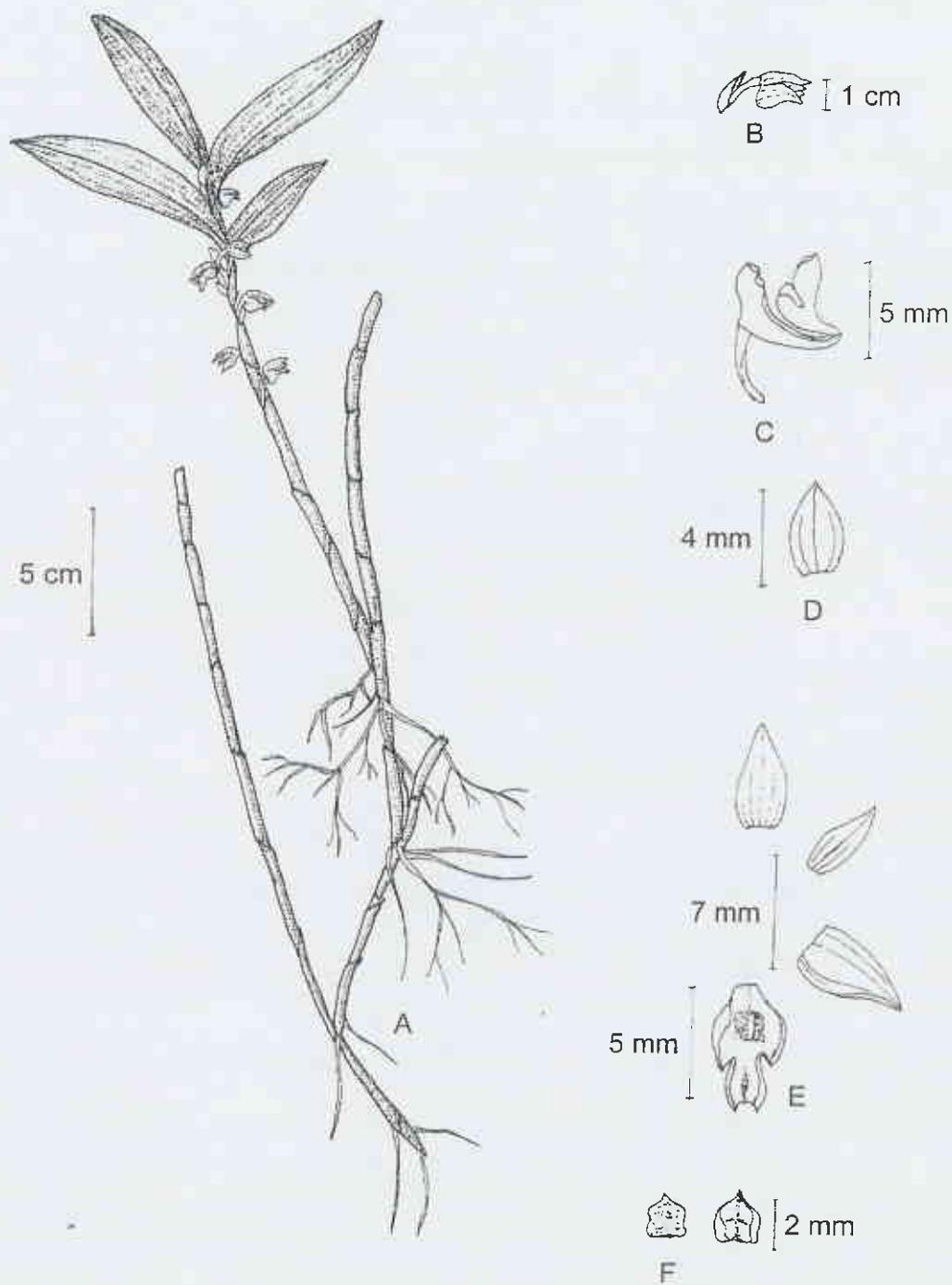


Fig 35. *Eria jengingensis* Hedge (*H.J. Chowdhery s.n. CAL!*). A: Habit; B: Flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Operculum.

Type: India, Arunachal Pradesh, East Siang District, Jenging alt. ca. 700m, 22 March 1993 Hegde 27608 –A. (Holotype, Orchid herbarium, Tipi and Naharlagun)

Distribution: 700 m, Himalaya (North East Himalaya).

Flowering: March- April

Status : Endemic

Etymology: From Jenging of Arunachal, where the plant first recorded.

SPECIMENS EXAMINED: **North East Himalaya:** India, Arunachal Pradesh, East Siang district, Jenngging 700m, 22 March 1993, *Hegde S.N. 27608-A* (Holo : Orchid herbarium Tipi and Naharlagun); Sing 650-80 m, H. J. Chowdhery s. n. (*personal collection*)

Note: This species resemble the habit of *E. tomentosifolia* Hay from Taiwan, but differs considerably in floral characters. On the basis of typical character of lateral inflorescence, it is preferred to place in the section *cylindrolobus*.

26. *Eria clavicaulis* Wallich ex Lindley, *Edward's Bot. Reg.* **26** (misc): 90 (1840); J.D.Hooker, *Fl. Brit. Ind.* **5**: 799 (1890); J. D. Hooker, *The century of Indian Orch.* :**21** pl. 31(1895); Kränzlin in Engler A. (eds.) *Das Pflanzenreich Hfl.* **50**: 102 (1911); Seidenfaden, *Opera Bot.* **62**: 93 (1982); Chowdhery, *Orch. Fl. of Arunachal Prad.* :357, f. 213 (1998); Pearce & Cribb, *Fl. Bhutan.* **3** (3): 384 (2002).

Pinalia clavicaulis (Wall. ex Lindl.) Kuntze, *Revis.. Gen. Pl.* **2**: 679 (1891).

Cylindrolobus clavicaulis (Wall. Ex Lindl.) Rauchert, *Feddes Repert.* **94**: 445 (1983).

Eria khasiana Lindl., *Jour. Proc. Linn. Soc* **3**: 59, (1859).

Epiphytic herbs, upto 35 cm high. *Pseudobulbs* stem like, cylindrical crowded, clavate, 15-20 cm long, very narrow at the base and gradually thickened upwards with many grooved, sheathed; sheaths scars brown and ovate, 1-2.5 cm long, when mature it became pale green and speckled with darker. *Leaves* 3-4, elliptic-lanceolate, 5-10 x 1-2 cm long, acute to acuminate, spreading and reflexed, cuneate at the base. *Inflorescence* terminal or sub terminal shorter than leaves 2-3 flowers, 1.5-2-5 cm long; rachis 3-4 cm, short with broad basal sheath, glabrous. *Floral bracts* ovate-oblong or lanceolate, 1-2 cm long, acute, membranous, spreading, concave, recurved, and many nerved. *Pedicel and ovary* 2-3 cm long, glabrous. *Flowers* white, 1- 1.5 cm across, glabrous. *Sepals* ovate-lanceolate, unequal, 10 cm, glabrous, white; *dorsal sepal* ovate, lanceolate, 10-15 x 4-5 mm, acute, with 3-veins; *lateral sepals* triangular, falcate, thin, 10-15 x 7 mm, acute, glabrous, lateral sepal with keels, straight; *mentum* ca. 2 mm long, rounded, incurved. *Petals* broadly oblong, 10-12 x 3 mm, acute, with 3-veins. *Labellum* tri-lobed, 1-2 x 1 cm, obcordate, obovate at hypochile,

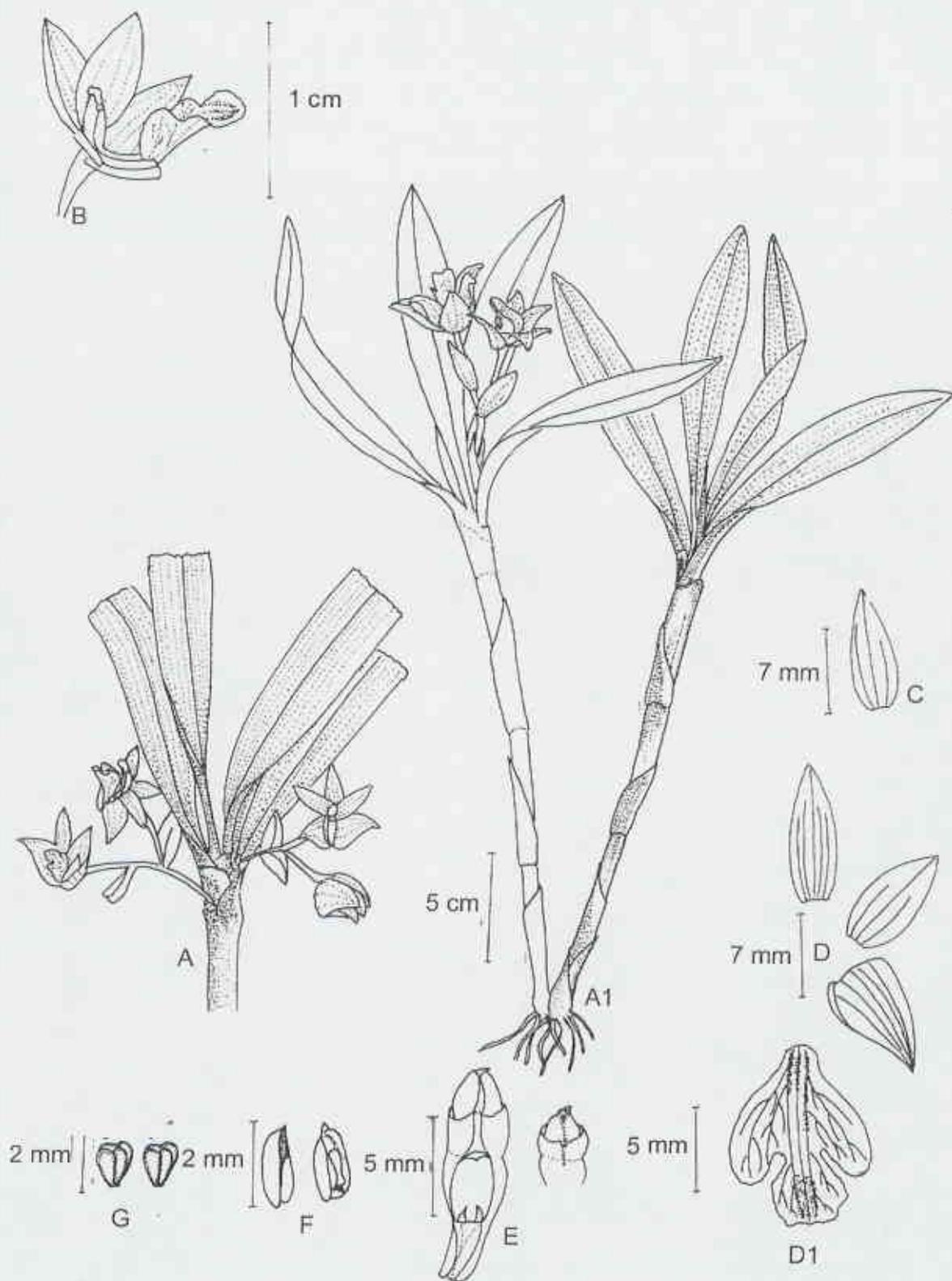


Fig. 36. *Eria clavicaulis* Wallich ex Lindley, A: Habit, A₁ Habit (*Wall* s.n., type, K!); B: Lateral view of flower; C: Bract; D: Spreading of Sepal, Petal; D₁: Labellum; E: Column; F: Operculum; G: Pollinia.

small, orbicular at epichile, emarginate, terminal lobe strongly yellow, edges of the lateral lobes and terminal lobe strongly red purple; lateral lobe large and rounded, with 3-veins; terminal lobe shorter, rounded and crenate, disc with papillae callus at the centre which is thick, fat and short; besides that disc with two lateral papillous callii on the labellum with purple margin and yellow disc. *Column* 5 mm long, slender, glabrous with purple line, in front side yellow purplish, fleshy, foot 6 mm long, curved thin membranous wings are present in the foot; clinandrium collar like; operculum 2-2.5 x 1 mm, glabrous; rostellum ligulate. *Pollinia* 8, obovoid, caudicle glandular, membranous, viscidium simple and ellipsoid. *Stigmatic cavity* 2 x 1 mm, lobed at the base (Fig. 36).

Type: India: unlocalised, *Loddigis s.n.* (Type K-LINDL.);

Distribution: Himalaya (Sikkim, Assam, Arunachal Pradesh, Burma), Thailand, Indo-China.

Elevation : 1700 m.

Flowering: September- October.

Etymology: From the Latin Clavi (club shaped) and caulis (Stem).

SPECIMENS EXAMINED: Assam : "India" Wall s.n. (Type, K- LINDL.); Khasia Griffith s.n. (ann 1844) (K- LINDL. type of E. Khasiana); Padenchi-Rap, Jantea Hill, *Prair* 30, Oct. 1899 (CAL!) Khasia, *Mann s.n.* (CAL!) Jawai, 13 12.1895, *S. E. Rita* 8/12, (CAL!), South slope of Bapu 4900m, 8 3.1912, *Burkill* 36970, (CAL!); **North East Himalaya:** Kameng, Lohit, Siang Subansiri, Tirap; between 200-1000 m. *H. J. Chowdherys.n.*; **Burma :** Aracan Swin 78 (K!); Kachin Hill, Jan 1898, *Mokim s.n.*, (CAL!); Hsamsip 2500m, *H. Wood s.n.*, 1903 (CAL!); Kao Nagar stream, Dawna range 2100m, 29 1.1912 *Lace* 5644, (CAL!).

Note: Pearce & Cribb (2002) mentioned that they were unable to locate any material of Rao & Deori (1980) from Arunachal Pradesh as well as specimen collected by Das & Deori (1983) from Sikkim. However, in the present study, the existence of *E. clavicaulis* has been confirmed by examining specimen from Arunachal Pradesh, collected by H.J. Chowdhery (CAL!).

27. *Eria arunachalensis* A. N. Rao, *J. Econ. Tax. Bot.* **21:** 3 (1997, publ.1998).

Epiphytic herbs; 15-24 cm high. *Pseudobulbs* stem like, cylindrical, caespitose, clavate, with distinct nodes and internodes, 2/3 lower parts covered with scarious leaf sheaths and 1/3 upper part with leafy. *Leaves* 4-5, sessile, elliptic-lanceolate, 10-14 x 1.5-2.5 cm, acute – acuminate, sessile. *Inflorescence* racemes, 2-flowered, 3 to 4 leaf opposed; peduncle 1.0-1.5 cm long, green, covered with brown tomentose. *Floral bracts* ovate-oblong, 8-10 x 6-8 mm, acute, many nerved, greenish yellow to turmeric yellow, covered with brown hairs at base externally. *Pedicel and ovary* ca. 1 mm long, green covered with brown tomentose. *Flowers* small, 2 cm in diameter. *Sepals* unequal, ovate, acute to sub-acute covered by brown tomentose; *dorsal sepals* ovate-oblong, subacute, ca 9-10 x 4 mm, fleshy at apex, 5-veined; *Lateral sepals* obliquely ovate,

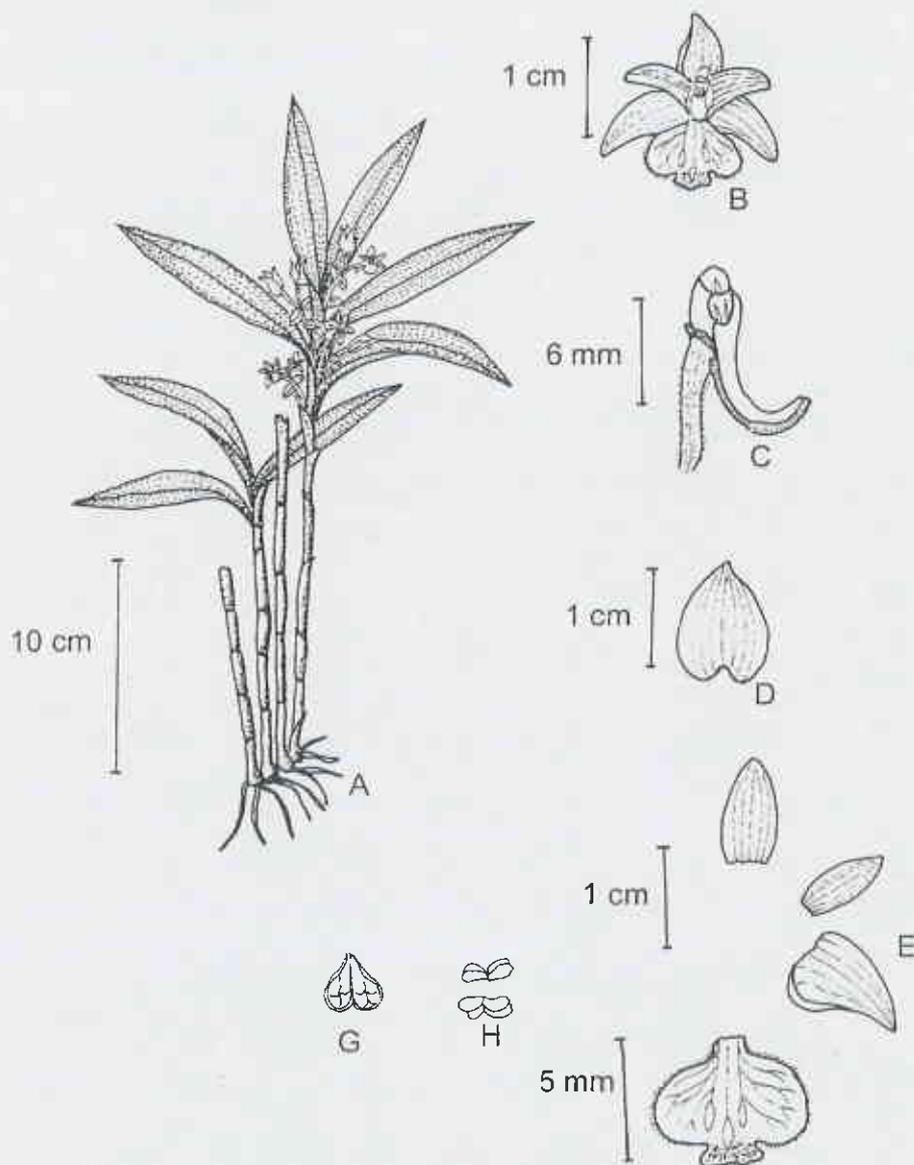


Fig. 37. *Eria arunchelensis* A. N. Rao. (Rao 30108-B, CALI) A: Habit; B: Flower; C: Lateral view of column; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

acute, ca. 10-11.5 x 7 mm, connate with U-shaped bent column foot along the outer margins and forming a globular mentum, 7-veined. *Petals* oblong, ca. 8-8.5 x 3.5 mm, obtuse, rarely lobed at the apex, serrulate at margin. *Labellum* tri-lobed, obovate, ca. 5.5-6 x 7 mm, retuse, hinged on the tip of the column foot; lateral lobed ca. 4 x 2 mm, auricular, white; terminal lobed ca. 1 x 3 mm, shorter, transversely oblong, retuse; disc with 3-callii in the upper half of labellum, middle callus placed above the two laterals towards apex of terminal lobe and pubescent. *Column* ca. 4 mm, long, white, column foot "U-shaped" ca. 7 mm long; clinandrium ca. 1.5 mm diameter, sparsely pubescent at anterior ends. *Pollinia* 8 in two groups, obovoid, caudicle waxy, *Stigmatic cavity* with two acuminate processes (Fig. 37).

Type: India, Arunachal Pradesh, West Siang district, Kaying 150 m, A. N. Rao 30108-A, 15-2-1997, (holo. Orchid Herbarium Tipi); A. N. Rao 30108-b (para. CALI)

Distribution : Himalaya (North East Himalaya).

Flowering: Feb.- March.

Etymology: From Arunachal Pradesh, where the plant first recorded.

Status: Endemic

Note: *Eria arunachalensis* is more allied to *E. foetida* Aver'yanov, in having tomentose flowers with globose mentum but differs in the characters of labellum. *E. arunachalensis* has a shorter terminal lobe with 3 calli, a distinct longer callii near the terminal lobe and 2 calli on lateral side. It is preferred here to place it in the section *Cylindrolobus*, because of its typical lateral inflorescence emerged below from the lateral side of the leaves with two flowers.

- 28. *Eria cristata*** Rolfe, *Kew Bull.* 139 (1892); Krañzlin, in Engler A. (eds.) *Das Pflanzenreich Hfl.* 50: 98 (1911); Seidenfaden, *Opera Bot* 62: 96 (1982); Hegde, *Arunachal For. News* 11 (2): 4-6 (1993); Chowdhery, *Orch. Fl. Arunachal Prad.* :361. f. 216 (1998).

Epiphytic tufted herbs upto 30 cm including leaves. *Pseudobulbs* stem-like, cylindrical to subclavate, 5-20 x 1-1.5 cm, younger shoots taller than old, node sheathes at the base, furrowed; older pseudobulbs are bearing the scar of inflorescence. *Leaves* 3-5 at the apical region of pseudobulbs, elliptic-oblong, 6-11 x 2-2.5 cm, slightly narrowed at base and tapering at apex and base and pointed, sessile, base broad sheathing at the node. *Inflorescence* sub terminal-axillary, bearing two terminal flowers; rachis ca. 3-5 cm long, with white brownish hairy. *Floral bracts* ovate, ca. 8 x 15 mm, acute, copper brown, hairy. *Pedicel and ovary* 2-3 cm long, pubescent. *Flower* creamy white, ca. 1-1.5 cm across. *Sepals* subequal, 6-10 mm long, hairy; *dorsal sepal* oblong-ovate, 7-8 x 1.5 mm acute, with 3-veins; *lateral sepals* oblong, acute, falcate ca. 8 x 1.2 mm, broad at the base 3-veins. *Petals* shorter or as long as dorsal sepal, lanceolate, ca. 5 x 1.2 mm, acute 3-veins. *Labellum* tri-lobed, white to cream, ca. 8 x 8 mm, as long as broad almost rectangular; lateral

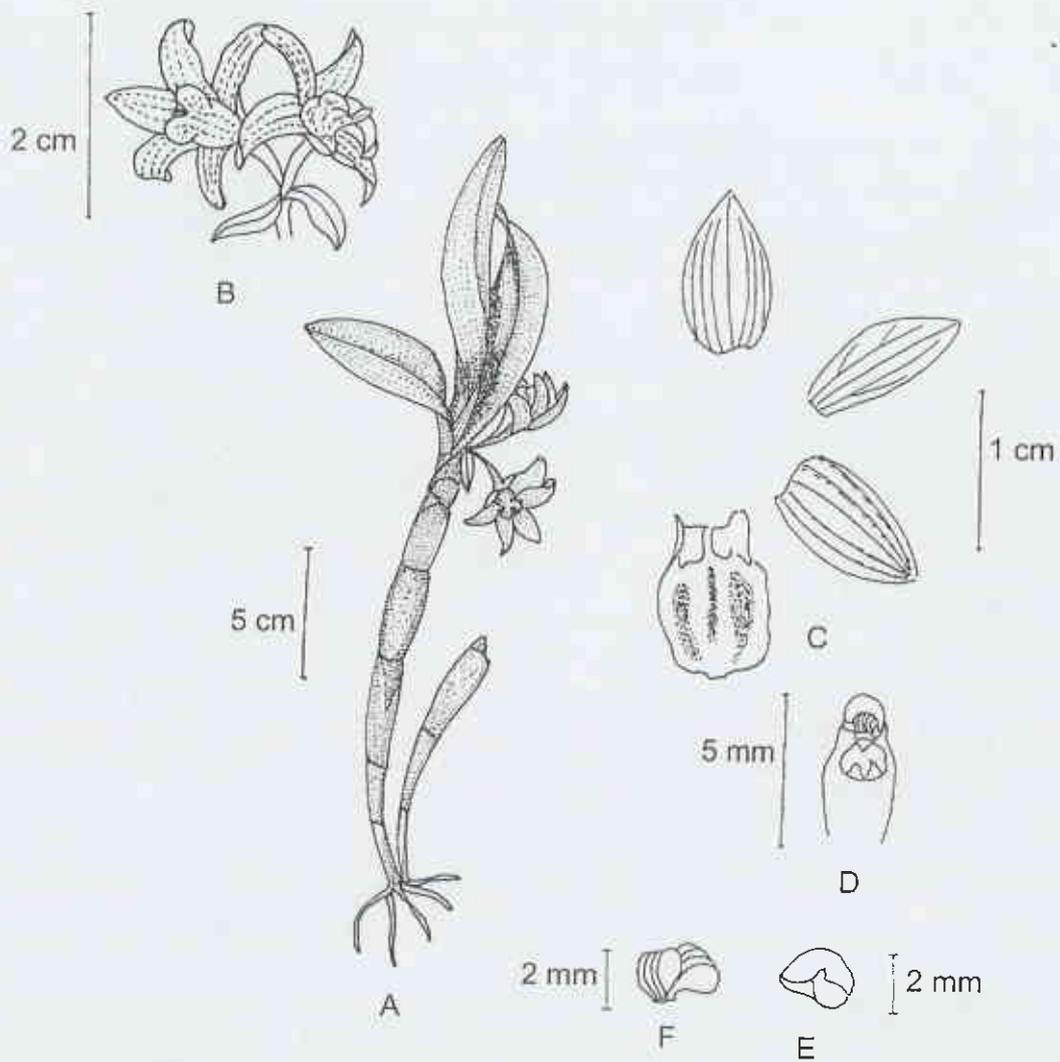


Fig. 38. *Eria cristata* Rolfe (*Peche s.n* Kl) A: Habit; B: Flower; C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal; and Labellum; F: Column; G: Operculum; H: Pollinia.

lobe sub-orbicular, erect, pinkish towards margin, touching the both side of the column, forming a concavity at base, terminal lobe orbicular, truncate, upcurved, deep yellow, hairy slightly deflexed; disc with 3 keels, basal keels are erect and glossy, the third median and terminal keels towards apical lobe is hairy. *Column* stout, concave, white, ca. 5 mm, long with a long drawn curved foot, lateral margin of column incurved, clinandrium collar like, rostellum bent toward the the stigmatic cavity, operculum orbicular, ca. 1mm, creamy with groove inside or pollinia. *Pollina* 8, obovoids, attached with small caudicle. Stigmatic surface glossy grooved, stigmatic cavity with lobed (Fig. 38).

Type: Burma, Moulmein (Peche s.n. K! Type).

Distribution: 1000-1500 m, Himalaya, (North East Himalaya, Burma), Thailand, Indo-China.

Flowering: February- April.

Status: Rare

Etymology: From the Latin *Crista* (terminal tuft) to reference to the inflorescence.

SPECIMENS EXAMINED: North East Himalaya: Arunchal Pradesh, Jenggim, 6.3.1993, S. N. Hegde 27601, (CAL!);

29. *Eria glandulifera* Deori & Phukan, *J. Orch. Soc. India* 2 (1, 2): 55-57, (1988).

Eria lohitisensis A. N. Rao & Harid, S. N. Hegde, *Jour Bombay Nat. Hist. Soc.* 86 (2) :229 (1989); Chowdhery, *Orch. Fl. Arunachal Prad.* :371, f. 222 (1998).

Epiphytic herbs, erect herbs upto 36 cm high including leaves. *Rhizome* creeping, hairy like. *Pseudobulbs* stem like, cylindrc-clavate, slender, about ca. 16-20 cm long, and 0.8 cm thick, with sheath scars. *Leaves* upto 6, shortly terminal, narrowly, shortly petiolate, oblong-lanceolate, 9-15 x 2-2.5 cm, acuminate, obliquely bifid, 5 veined. *Inflorescence* many, 2-flowered, arising laterally from the stem at various interval from middle on the stem to sub-terminus; rachis ca. 3.5 cm, white pubescent, with two sterile bracts at short interval. *Floral bract* ovate-oblong ca. 7-8 x 4 mm, acute or obtuse, shorter than the pedicel and ovary. *Pedicels and ovary* 1-1.5 cm long, hairy. *Flowers* white, small, ca. 2 - 3.5 cm long, pedicelled, upright in pairs on short bracteate peduncle from leaf opposed upper stem nodes. *Sepals* unequal, 0.7-10 mm long, outside pubescent gland dotted within; *dorsal sepal* narrowly lanceolate, ca. 8-10 x 2 mm, acuminate, 3-nerved; *lateral sepals* obliquely lanceolate or ovate-triangular, ca. 7-10 x 5 mm, acuminate, white pubescent outside (lateral margin finely serrulate), forming a mentum with the foot of column, 3-veined, mentum obtuse. *Petals* ligulate, falcate, oblong-obtuse, ca. 8 x 1.5 mm, acute to acuminate, glabrous, 3-veined more or less densely glandotted within (Petal oblong-lanceolate, acute to acuminate, 3-veins). *Labellum* tri-lobed, sessile, oblong, ca. 5 x 3 mm, attached to the base of incurved tip of the column foot; mainly 3-veined (lip about 7 x 3 mm broad across the lateral lobe, shorter than sepal

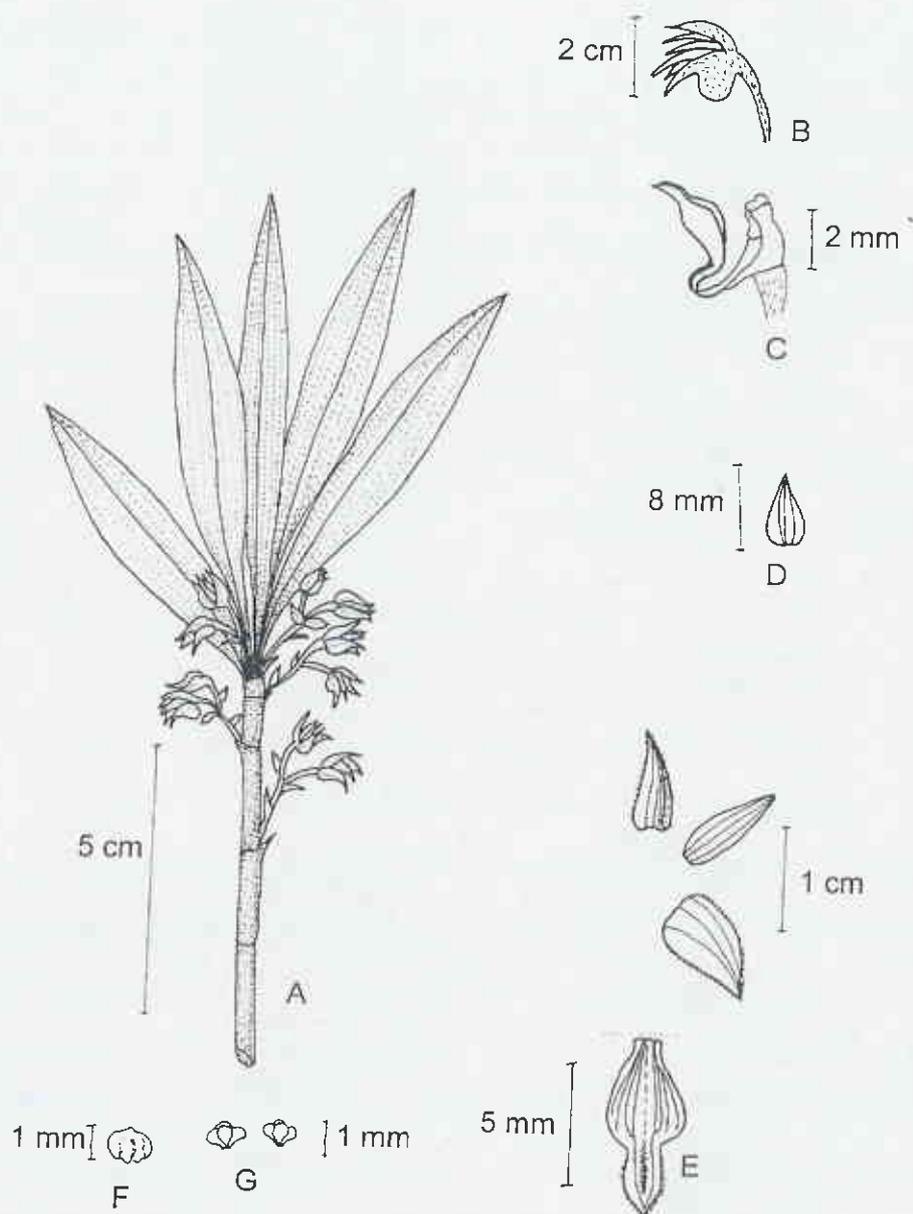


Fig 39. *Eria glandulifera* Deori & Phukan (C. Deori 71816 A CALI) A: Habit; B: Flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Operculum; G: Pollinia.

and Petals, 3-lobed), lateral lobe rounded, ca. 4 mm, and erect (side lobe erect, rounded); terminal lobe ovate, obtuse, reflexed, (3 mm, oblong, acute, ciliated at margin) 3 mm long, acute-obtuse, ciliated at margin, reflexed, long clavate hairs at the base of terminal lobe; disc with yellow ciliate at margin with a median vertical lamellae; and 2 prominent parallel vertical lamellae, lateral lamellae on the disc glabrous, narrowly clavate, thin, erect extended upto the base of terminal lobe. A medium longitudinal glandular hair along the periphery of the terminal lobe on the dorsal side. *Column* ca. 2 mm long, column foot flat, much larger than column, which is incurved at apex; operculum cap semi-globular, 4-celled, claudrium collar like. *Pollina* 8; obovoid (Fig. 39).

Type: India, Meghalaya, Khasia hills, Mawsmai forest, Assam 18.4.1978N. C. Deori 71816 A (Holotype: CAL!); Arunachal Pradesh, Lohit district, Mailang-Mithumna 1600m; 11 May 1985 Haridasan 2185 (Holotype of *E. lohitisensis* Arunachal Forest Herbarium).

Distribution: 1500-1600 m., Himalaya (Assam, North-Eastern Himalaya).

Status: Indian Endemic

Flowering: April-May

Etymology: From Latin Glandule (gland) and fera (all plant parts)

SPECIMENS EXAMINED: North East Himalaya: Arunachal Pradesh, Lohit district, Mailang-Mithumna 1600m; 11 5.1985 Haridasan 2185 (holo. of *E. lohitisensis* Arunachal Forest Herbarium).

Note: *E. glandulifera* is conspecific to *E. lohitisensis*. They differ only in the presence and absence of gland dotted characters. The present study prefers to place *E. glandulifera* in the section *Cylindrolobus*, on the basis of its typical lateral inflorescence emerged below from the lateral side of the leaves with two flowers.

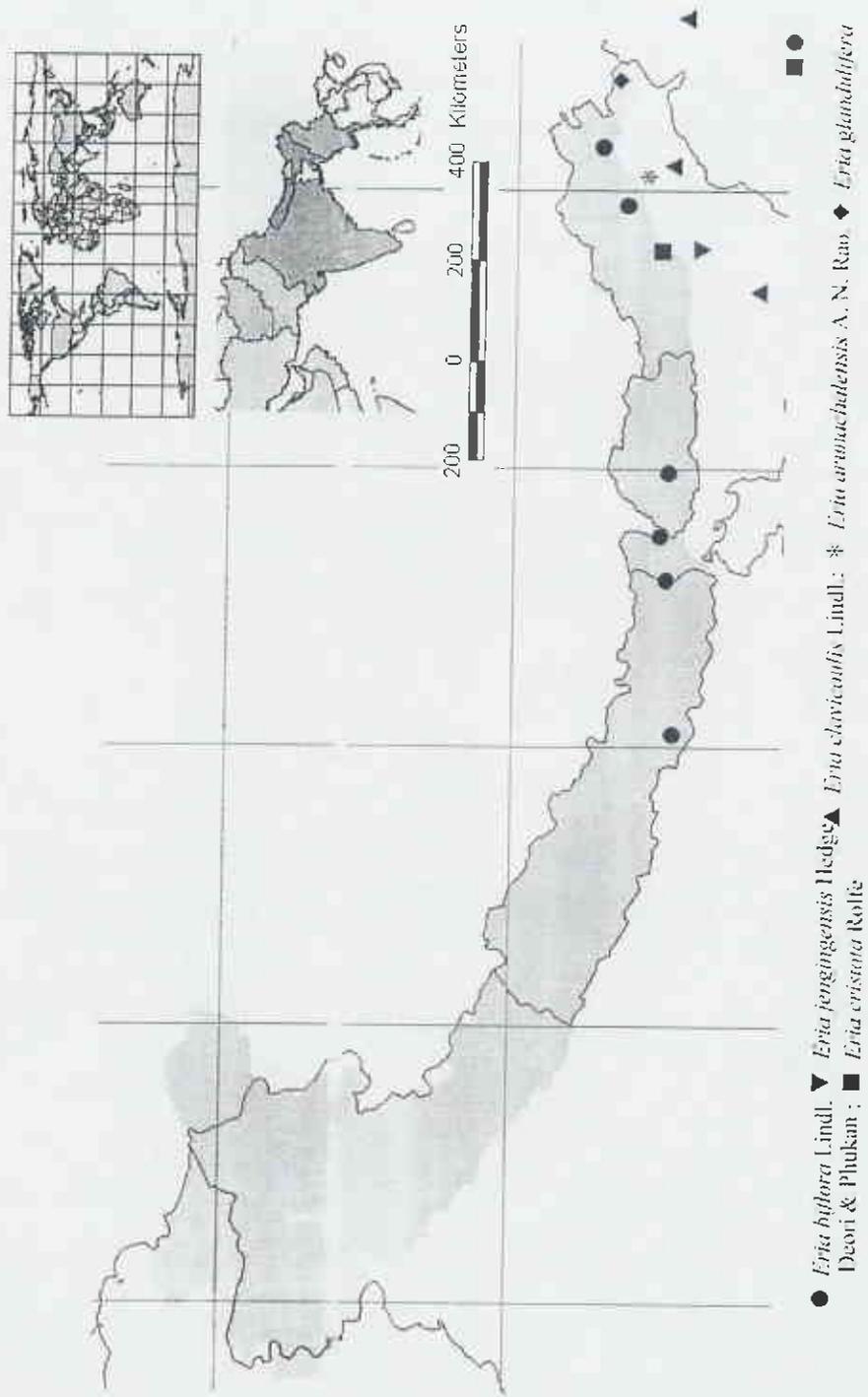


Fig. 40: Distribution Map of the section *Cylindrolobus*

Section X. Bambusifoliae J. D. Hooker, *Fl. Brit. India* 5: 786, 1890.

Stem (pseudobulbs) cylindrical, tall, terete, erect, leafy throughout; leaves distichous, elliptic or lanceolate, glabrous; inflorescence long, in raceme opposite to leaves, with several flowers, glabrous or tomentose, floral bract small; labellum narrowly attached to column foot at an acute angle, a joint is clearly visible.

Type: *E. bambusifolia* Lindley, *Jour. Proc. Linn. Soc.* 3: 61, 1859.

Note: The section *Bambusifoliae* was proposed by J. D. Hooker (1890) and comprise two Himalayan species *Eria bambusifolia* and *E. crassicaulis*, and another species *E. leptocarpa*. Lindley (1859) placed *E. bambusifolia* in the section *Urostachya*, where as Kranzlin (1911) placed it in section *Erurae*. Later workers King and Pantling (1898), Seidenfaden & al. (1965), Pradhan (1979), Seidenfaden (1982) had accepted it as the section *Bambusifoliae*. Brieger (1981) placed *E. bambusifolia* and *E. crassicaulis* into his new genus *Cylindrolobus* in the section *Bambusifoliae*.

Three species: ?? from Himalaya (Sikkim, NE Himalaya) Indonesia to Malaysia; two species in Himalaya. *Eria bambusifolia* and *E. crassicaulis*.

- 1.a Labellum obscurely tri lobed, rhomboid shaped; three mealy papillous keels on disc -----
 -----29. **E. bambusifolia**
- 1.b. Labellum tri-lobed, orbicular shaped; furfuraceous at claw axis and terminal lobe -----
 -----30. **E. crassicaulis**

29. *Eria bambusifolia* Lindley, *J. Proc. Linn. Soc.* 3: 61 (1859); J. D. Hooker, *Fl. Brit. Ind.* 5: 805 (1890); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* 8: 119, pl. 163 (1898); Kränzlin in Engler (eds.), *Das Pflanzenreich* *Wfl.* 50: 118. (1911); Pradhan, *Indian Orch.* :366 (1979); Seidenfaden, *Opera Bot.* 62: 98 (1982); Seidenfaden, *Opera Bot.* 114: 186 (1992); Hajra & Burma, *Fl. Sikkim* 2: 66 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :350, f. 209 (1998); Hynniewta & al., *Orch. Nagaland* :172 (2000); Pearce & Cribb, *Fl. Bhutan* 3 (3): 379 (2002).

Cylindrolobus bambusifolia (Lindl.) Brieger, *Schlechter Orchideen* 1 (11-12):664 (1981).

Pinalaia bambusifolia (Lindl.) Kuntze, *Revis. Gen.* 2: 679 (1891).

Epiphytic herbs, at out 30-50 cm high including leaves. *Pseudobulbs* absent or reduced. *Stem* cylindric, terete, elongated, thick, enveloped with large blunt tubular sheaths, 40 x 0.5-1 cm, with distinct nodes and internodes on the elongated stem like *Pseudobulbs*; *sheaths* broadly ovate, obtuse, 2-4 cm long. *Leaves* borne apically on the stem, many, 6-10, alternate at the tip, distichous, narrowly elliptic-oblong, 13-22 x 2.5-5 cm, acuminate, narrow at the base with long and clasping sheaths, glabrous, coriaceous, 7-9 veined, tapering to a sheathing base. *Inflorescence* apical, 2-7, on stem, opposite leaves axillary racemose to sub-paniculate, lax; peduncle sheaths,

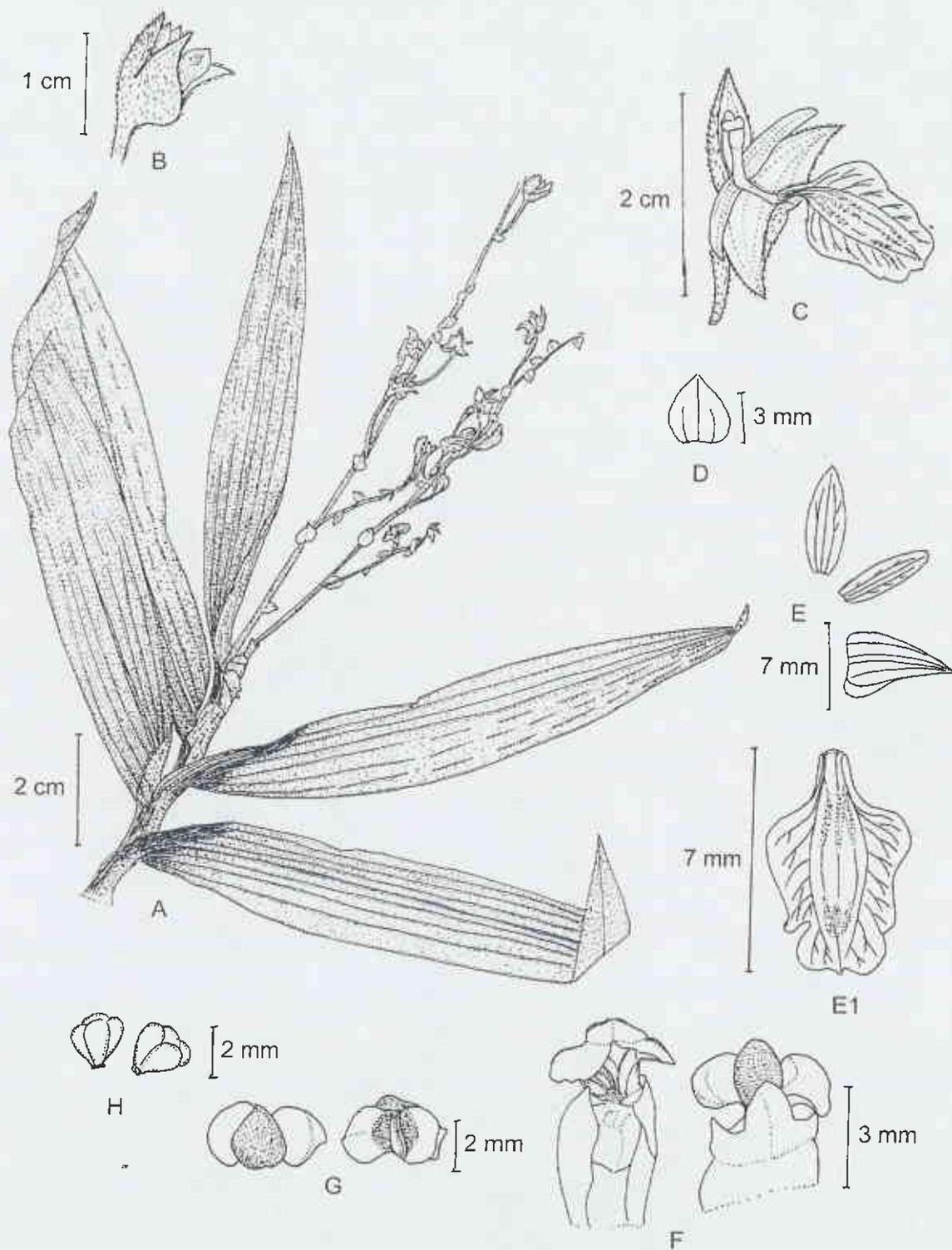


Fig 41. *Eria bambusifolia* Lindley (*Griffith s.n.*, K!). A: Habit; B: Flower; C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

upto 3-5 cm long, reddish-pubescent, *sheaths* broadly ovate, 6-7 mm long, obtuse; rachis upto 14-20 cm long, zigzagged, sometime curved and scorpioidal, reddish-pubescent, base often with 2 or 3 bracts. *Floral bracts* broad, sub-rhombic, 3-6 x 3.5-4 mm, apiculate, coriaceous, covered with reddish-brown hairs. *Pedicel and ovary* 1.5-2 mm, reddish-pubescent. *Flowers* white, distant, ca. 10 x 7 mm broad, ca. 2 cm across when flattened, densely covered with reddish-brown hairs, pale brownish red veins. *Sepals* 0.9-1.2 x 0.3-0.4 cm, unequal, reddish externally, 5-veined, spreading; *dorsal sepal* elliptic or oblong-lanceolate, 10-13 x 3-4.5 mm, obtuse, coriaceous, broad at the base, reddish-pubescent; *lateral sepals* falcate, oblong-lanceolate, 8 x 2 mm, obtuse, adnate to column foot and forming a short mentum, mentum 3-5 mm long. *Petals* elliptic-oblong, obtuse, 7-9 x 2-3 mm, slightly falcate, spreading, 3-veined. *Lebllum* obscurely tri-lobed, 6-9 x 4-6 mm, ovate-oblong, or ovate-triangular, (trullatus vel angulato-obovate), 10 x 6 mm, deflected below the middle, apex mucronate and thickened, broad at the base, base truncate with an upcurved ca. 2 mm claw and thickened, entire, 5-veined, three veins from the base to apex and two short additional veins near the apex, many side veins; lateral lobe small, ca. 7 x 1 mm long.; terminal lobe small, ovate-oblong, ca. 1 x 0.05 mm, obtuse; disc with brownish red from base to apex with 3-mealy white papillous lamellate of equal length; basal lamella thick, thinner upward, apically absent. *Column* including anthers 5-9 x 1.5 mm long, curved, yellow to pink, glabrous, winged on both sides and wing ca. 1 mm wide; operculum hooded, ca. 1.5 mm, column foot ca. 3 x 1 mm straight; clinandrium collar like, toothed; rostellum ligulate and bent towards the stigmatic cavity; operculum ca. 2 mm wide, 4 chambered inside. *Pollinia* 8, laterally compressed, brown, obovoid-elliptic attached with glandular caudicle, connective long, obtuse, coriaceous; viscidium single. *Stigmatic cavity* laterally broad, 2 mm. *Fruit* cylindrical, slender, 3-4 x 0.2-0.4 cm. (Fig. 41)

Type: Assam (India), Khasia Hills, *Simond* 64 (syntype, K-Lindl!) *Griffith* s. n. (syntype, K-Lindl!).

Distribution: 1000-1300 m, Himalaya (Sikkim, Bhutan, Assam, Arunchal Pradesh, Burma), Thailand, and China.

Flowering: October.- Dec

Status: Endangered

Etymology: From the Latin word '*bambusa*' (bamboo) and '*folius*' (leaved).

Chromosome Number: $n=20$ (Mehra & Sehgal 1974); $2n=38$ (Hegde & Ingaihalli 1988).

SPECIMENS EXAMINED: **Sikkim** : Rissioom 600m, Oct. 1895, *R. Pantling* 355, Oct. 1895 (K! CAL!); Sino loc. *J. D. Hooker* 360 (K!); Tropical Valley 355, Oct 1895 (CAL!); **NE India** : Khasia 600m, *Griffith* s.n., (K-Lindl.); *Simon* 64 (K-Lindl.); *Rup Chand* 5198 (K!); *Mann* s.n fide King & Pantling, Jeypore Hills (K!) *R.H. Beddome* 8178 (K); **North East Himalaya:** Kameng, Lohit, Siang Subansiri, Tirap; between 500-1000 m.; *H. J. Chowdhery* **Burma** : Topot to Pinkin 1300, *Robertson* 84(K!); Hpugnkhku Kachin *Keena & al.* 3828 (K!); Kachin Hill, *Mokim*, 1898 (CAL!).

30. ***Eria crassicaulis*** J. D. Hooker, Fl. Brit. Ind. 5: 805 (1890); Icon pl. 21: t. 2076 (1892); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 116 (1911); Pearce & Cribb, Fl. Bhutan. 3 (3): 385 (2002).

Eria clavicaulis Wall ex Lindl., J. Proc. Linn. Soc. 3: 59 (1859); non Bot. Reg.

Pinalia crassicaulis (Hook. f.) Kuntze, Revis. Gen. :679 (1891).

Cylindrolobus crassicaulis (Hook.f.) Brieger Schlecter *Orchideeen* 1 (11-12) :664 (1981).

Epiphytic herbs, 60 cm in high. *Rhizome* reduced. *Pseudobulbs* 0. *Stem* thick, elongate, about 30 cm long, with distinct nodes and internodes, internodes covered by sheaths. *Leaves* opposite, sub-terminal, oval-elliptic or elliptic-lanceolate, 10-15 x 2-4 cm, unequally acute or acuminate, 2-fid, coriaceous, many nerved. *Inflorescence* laterally raceme, laxly, many flowers; rachis 10-12 cm long, covered by brown tomentose. *Floral bracts* small, orbicular or ovate, 5-6 cm long, acute, *Pedicel and ovary* 2.5 cm long, covered by brown tomentose. *Flowers* 1 cm across, when flattened 2-3 cm across, pale banded with purple facing straight. *Sepals* unequal, 9-10 mm long, tomentose; *dorsal sepal* oblong-ovate, 9-10 x 4.5-5 mm, obtuse, sessile, thick, 5-veined; *lateral sepals* broadly oblong, triangular or slightly incurved, 10-12 x 5-6 mm, obtuse, thick, no keels 5-veined; *mentum* short, curved, 2-2.5 mm. *Petals* oblong, thin, 10-11.5 x 4-4.5 mm, obtuse, 3-veined. *Labellum* tri-lobed emarginated, base not contracted, claw axis and terminal lobe furfuraceous; lateral lobe narrow and round; terminal lobe furfuraceous, broadly emerginate, entire, covered by brown hairs on base, base of the labellum is not contacted with claw axis; disc simple, thick, 2 nerves, furfuraceous at claw and terminal lobe, which is laterally arise from the base of the lip to a apex. *Column*: 6 mm long, glabrous, and decurved; foot 4 mm long; *clandrium* collar like; *operculum*: 2 x 1 mm, glabrous outside; *rostellum* ligulate, bent towards the stigmatic cavity. *Pollinia* 8, pyriform or obovoid, caudicle granular viscid, viscidium simple and ellipsoid. Lateral lobe of stigma is continuous upto the end of the foot. *Stigmatic cavity* 3 x 1 mm, entire (Fig. 42).

Type: Assam (India), Khasia Mountains, Pomrang, J. D. Hooker & Thomson 9 (Holotype: K-LINDL)

Distribution: Himalaya (Sikkim, Assam)..

Elevation : 1300-1700 m

Flowering : Oct-Dec.

Status: Rare

Etymology: From Latin word 'Crass' (thickly) 'caulis' (stem)

Chromosome Number: n= 18 (Mehra & Sehgal 1976); 2n= 42 (Singh 1981)

SPECIMENS EXAMINED: Assam : Khasia Mountains, Pomrang, J. D. Hooker & Thomson 9 (Holo K-Lindl.); Griffith s.n. (K!); J. D. Hooker s.n., (K!); Paurang Heran , Lindley 9, 13.11.1850. (K!); India : Wall s.n. (K!)

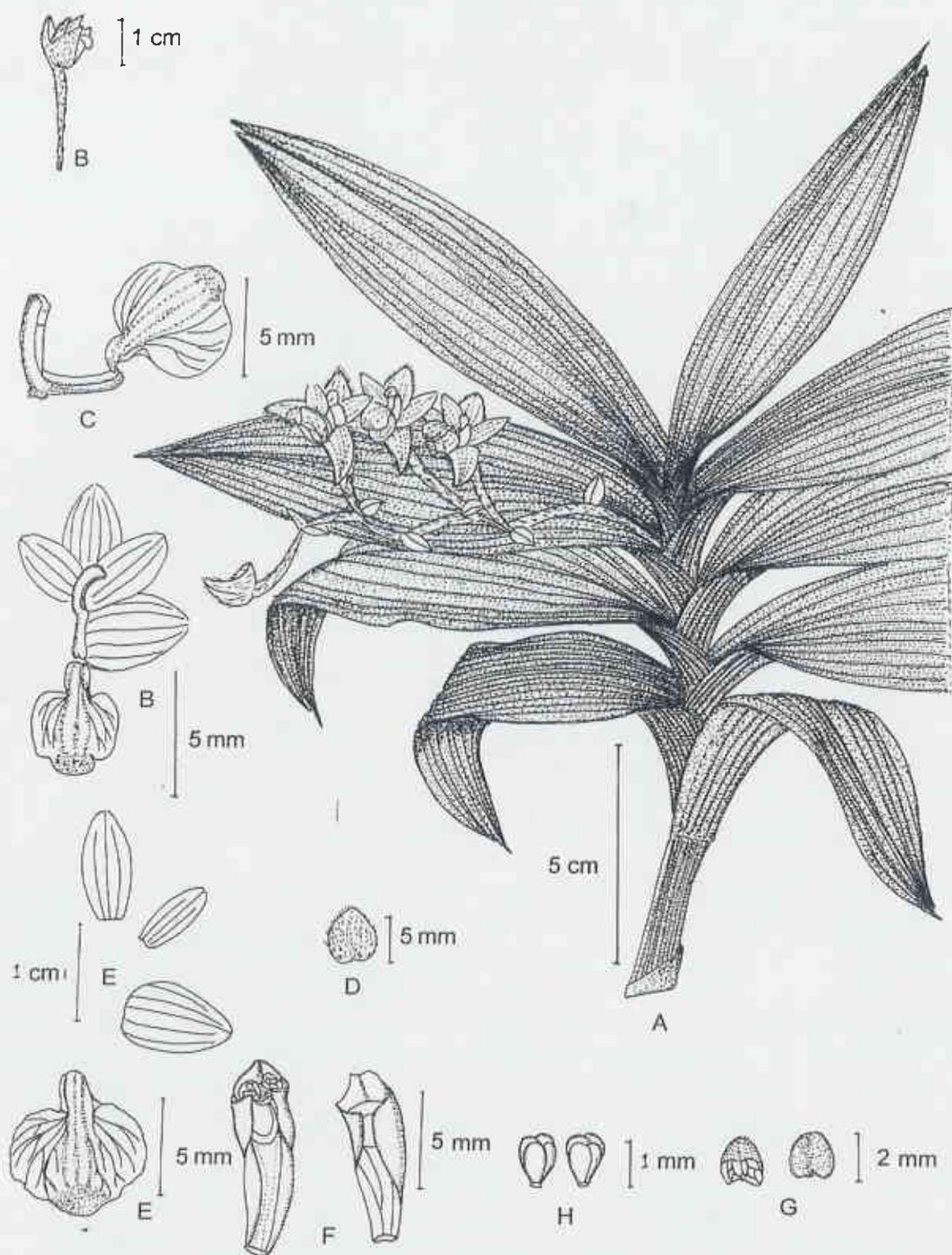


Fig. 42 *Eria crassicaulis* J. D. Hooker A: Habit (*Hooker & Thomson* 9, type K.I) ; B: Flower; B1: Front view of flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal; E: Labellum; F: Column; G: Operculum; H: Pollinia.

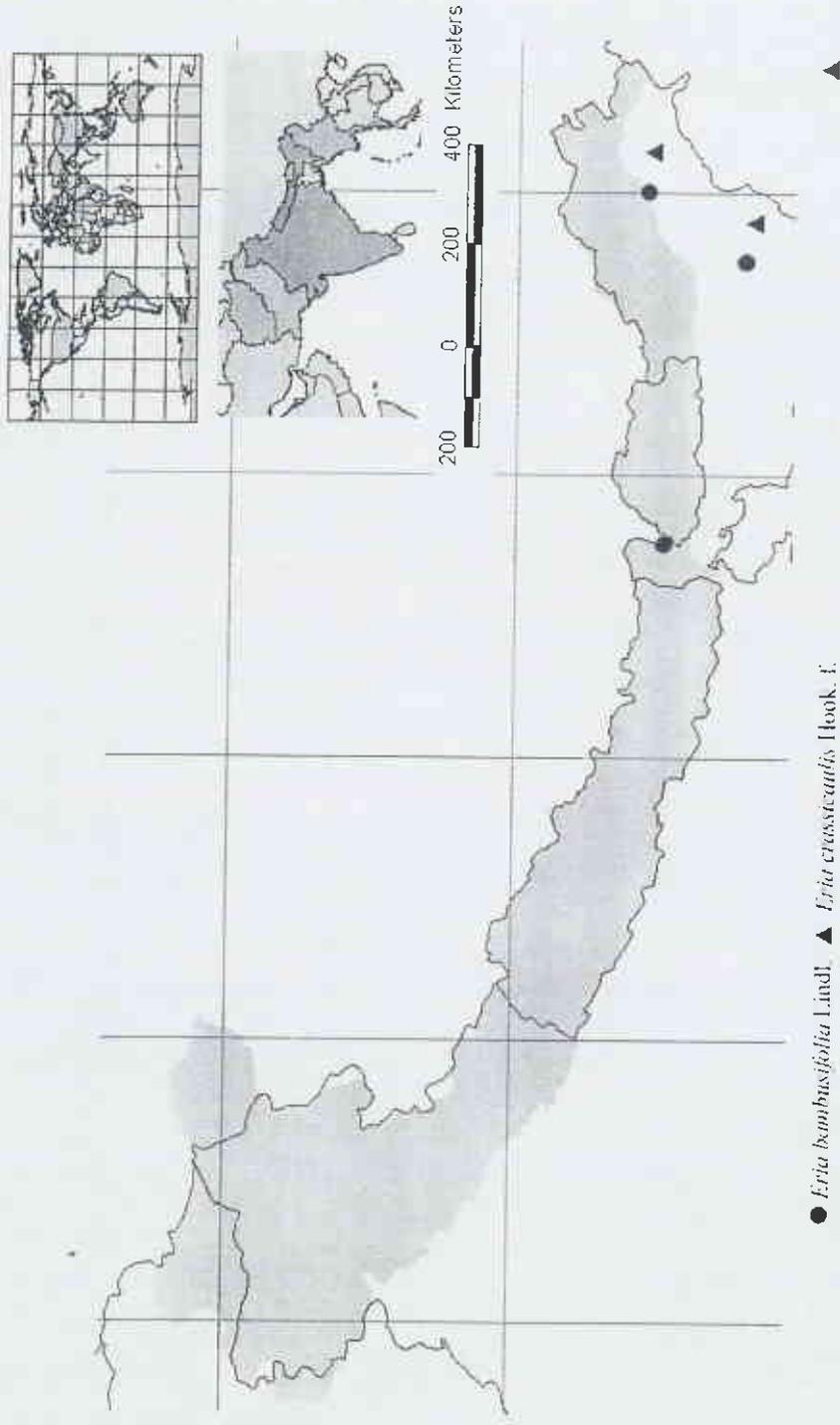


Fig. 43: Distribution Map of the section *Bambusifolia*

Section XI. Hymeneria Lindley, *Jour. Linn. Soc.* 3: 52, 1859.

Pseudobulbs (Stem) more or less fleshy; pseudobulbs with nodes sheathing at base; leaves appear near the apex of pseudobulbs, 1-6 leaves, Inflorescences arising from apex of pseudobulb or sometime from leaf axil, erect, more or less hairy; flowers large, laxly 5-20 flowered, pubescent or glabrous; floral bracts conspicuous; labellum often tri-lobed, various shaped; labellum is attached with a point to the distinct column foot.

Type: *Eria bractescens* Lindley, *Jour. Proc. Linn. Soc.* 3: 52, 1859.

Note: This section was not well characterized by Lindley (1859), and others who followed him in attributing species to it. Lindley (1859) proposed the section *Hymeneria*, included "all those species having fleshy somewhat shapeless stem with a few thin leaves". He did not propose a type species for it. Lindley indicated that "this section might be divided into subdivision, containing plants like *E. convallarioides* (*E. spicata*) and *E. pumila* and another plants allied to *E. bractescens*". On the basis of this indication Seidenfaden (1982) proposed the section *Hymeneria* s. l., which is separated into two sections *Hymeneria* and *Pinalia*, and proposed the type species for the section *Hymeneria* as *Eria bractescens*.

Reichenbach (1861) proposed the section *Acervatae* for *E. acervata*, which was not accepted by later workers. In the mean time Ridley (1907, 1924) proposed the separate section *Bractescentae* for the section *Hymeneria*. Brieger (1981) placed it on the genus *Eria* as section. Clements & Jones (2002) proposed the section *Hymeneria* as new genus *Hymeneria*.

About 110 species: Himalaya (NW Himalaya, Nepal, Sikkim, Bhutan, NE Himalaya) tropical Asia and Pacific. 13 species in Himalaya *E. acervata*, *E. amica*, *E. alba*, *E. baniaii*, *E. bhutnica*, *E. bractescens*, *E. concolor*, *E. excavata*, *E. graminifolia*, *E. obesa*, *E. pudica*, *E. pokharensis*, and *E. sharmae*.

- | | | |
|-----|--|------------------------|
| 1.a | Pseudobulb apically with 1 terminal leaf, inflorescence nearly as long as petiole ----- | |
| | ----- | 30. E. pudica |
| 1.b | Pseudobulbs apically with 2 or more leaves, inflorescence longer than petiole ----- | 2 |
| 2.a | Labellum entire or obscurely tri-lobed ----- | 3 |
| 2.b | Labellum distinctly tri-lobed ----- | 5 |
| 3.a | Flower greenish yellow, floral bract small or narrow, labellum obscurely tri-lobed with an indentation separating hypochile and epichile ----- | 31. E. concolor |
| 3.b | Flower white or pink, floral bracts large, labellum entire without indentation between hypochile and epichile ----- | 4 |
| 4.a | Sepals, petals and labellum white, bract entire, pedicel and ovary pubescent ----- | |
| | ----- | 32. E. obesa |
| 4.b | Sepals, petals and labellum pink, bract slightly erose, pedicel and ovary glabrous ----- | |

-
- 33. **E. baniaii**
- 5.a Pseudobulb cylindric 6
- 5.b Pseudobulb ovoid-ellipsoid 7
- 6.a Pseudobulbs narrowly cylindric, ca. 4-9 cm tall, sepals and petals pale yellow
..... 34. **E. bractescens**
- 6.b Pseudobulbs long-cylindric, more than 10 cm tall, sepals and petals pure white
..... 35. **E. graminifolia**
- 7.a Pedicel plus ovary glabrous or slightly hairy 8
- 7.b Pedicel plus ovary hairy or densely pubescent 10
- 8.a Leaf apex obtuse, emarginate or bi-lobed; sepals and petals white tinged with green
..... 36. **E. acervata**
- 8.b Leaf apex acute; sepals and petals buff-yellow to greenish 9
- 9.a Floral bract ovate, terminal lobe reniform, yellow, flushed with brown 37 **E. amica**
- 9.b Floral bract oblong, terminal lobe rectangular, bright yellow 38 **E. sharmae**
- 10.a Floral bracts < 5 mm long; rachis pubescent; ovary < 6 mm long; labellum with 2 ridges
base 39 **E. alba**
- 10.b Floral bract > 5 mm long; rachis pubescent; ovary > 6 mm long; labellum with 2 variable
callus 11
- 11.a Floral bracts 6 mm, labellum sub orbicular shape, shorter than pedicellate ovary
..... 40. **E. excavata**
- 11.b Floral bracts more than 6 mm, labellum other shaped, shorter or longer than pedicellate
ovary 12
- 12.a Terminal lobe of labellum obovate, without sinus, trilobulate 41. **E. pokharensis**
- 12.b Terminal lobe of labellum obtrullate, rhomboid, sinus present, bilobulate
..... 42. **E. bhutanica**

30. Eria pudica Ridley, *Jour. Linn. Soc.* **32**: 294 (1896); Fl. Malay. Penin. **4**: 85 (1924); Holtum, Fl. Malaya **1**: 391 (1957); Rao & Hedge, *Kew Bull.* **39**: 635 (1984); Deori & Malhotra, *J. Bombay Nat. Hist. Soc.* **74** (1): 205 (1987). Chowdhery, *Orch. Fl. Arunachal Pradesh* :377 (1998); Pearce & Cribb, *Fl. Bhutan* **3** (3): 386 (2002).

Eria hindei Summerh. *Kew Bull.* :321 (1932).

Epiphytic herbs, 15-20 cm high, including leaves. *Rhizome* thick, 3-4 cm when dry, with membranous sheath; *Pseudobulbs* erect, congested, 0.5-1 cm apart, attenuate toward both ends, ovate, crowded, 2.4-3.9 x 2 cm, widely separated; creeping stem thick, cylindrical, with 2 or 3

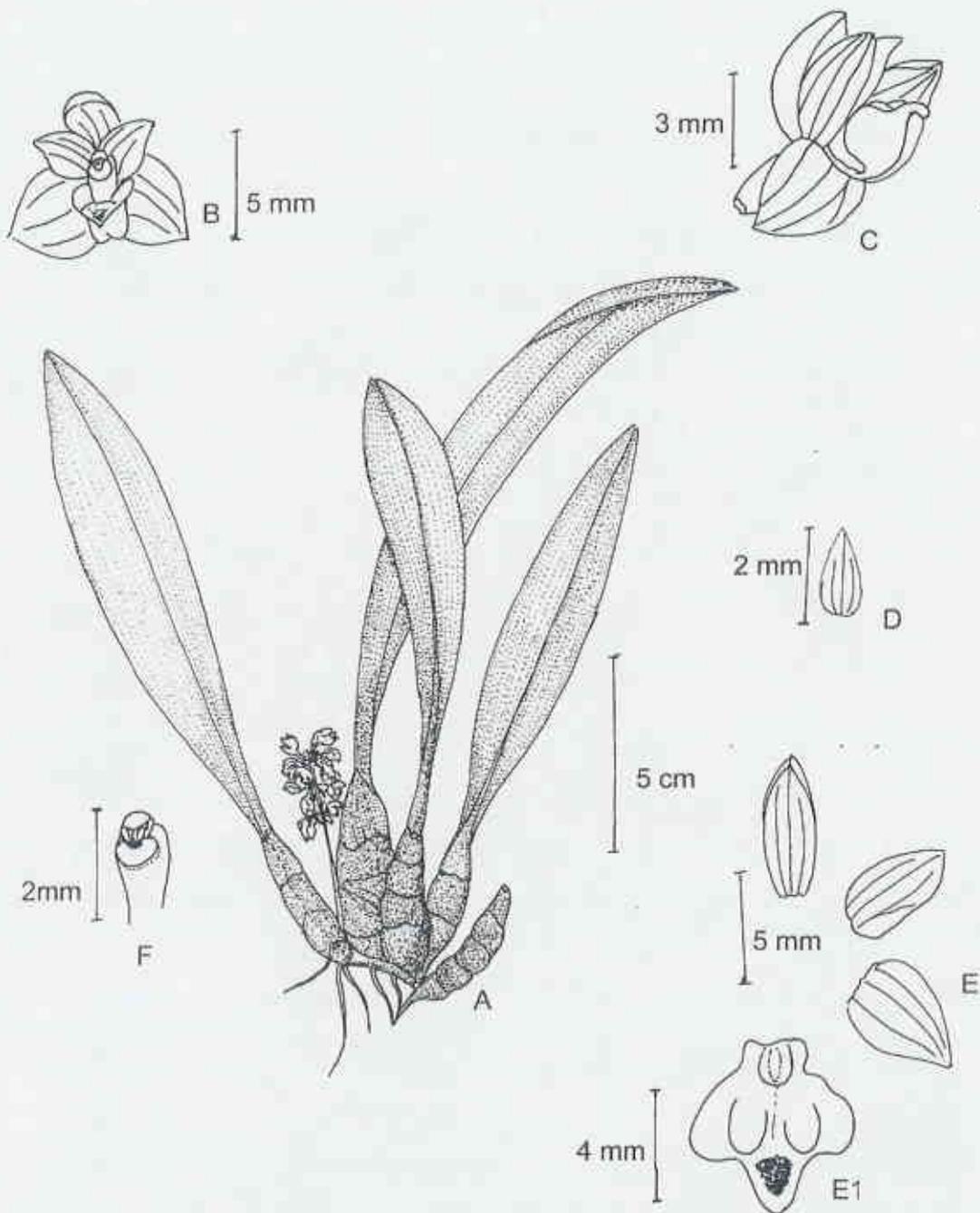


Fig 44. *Eria pudica* Ridley, (*Chaudhary s.n. CAL !*) A: Habit; B: Flower; C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column.

nodes covered by sheathes when young. *Leaves* solitary, rarely two; petiolate, petiole 4 cm long, elliptic-oblong or oblanceolate, 7-20 x 1.5-3.5 cm, subacute or obtuse, bifid, coriaceous. 9-11 veins. *Inflorescence* raceme, arising laterally from the node of pseudobulb, erect, 3-4 cm long, 6-10 or more flowered on the upper half; rachis 6 cm long; peduncle ca. 1.2 cm long, densely covered with grayish white pubescent. *Floral bract* ovate, ca. 2-2.5 mm long, almost equal to pedicel and ovary, acute or acuminate, sparsely grayish white pubescent. *Pedicel and ovary* ca. 2-3 mm long, and covered by grayish white woolly tomentose. *Flowers* many, small, greenish white with red veins, tomentose, about 3-5 mm long, 6 mm across when open, the sepals and petals spreading. *Sepals* similar, ca. 4-5 x 2-3 mm long, spreading, white tomentose outside, glabrous inside; *dorsal sepal* smaller and shorter than lateral sepal, elliptic, 3.5-4 x 2-2.5 mm, obtuse or apiculate, blunt, abaxillary white pubescent, gland dotted, obscurely 5-veined; *lateral sepals* obliquely ovate, 4-5 x 3 mm, broadly ovate, obtuse or apiculate, curved, 5-veined, adnate to column foot, forming a mentum; mentum saccate like, gland dotted. *Petals* as long as sepals, elliptic-oblong, 4-4.5 x 2 mm, obtuse, falcate, shallowly bilobed at apex, glabrous, 3-veined. *Labellum* short and broad, trilobed, rhombic to broadly elliptic, 3-4.5 x 3 mm, white, flushed with purple, oblong, saccate at the base, adnate to the base of column by a short claw, 3-veined; lateral lobe obscurely small, oblong, falcate, sub-acute, edge violets, hardly separated from terminal lobe; terminal lobe longer, broadly ovate-oblong, triangular, truncate, obtuse, white, ca. 2 mm long, reflexed, down-turned, flushed with purple, disc with two short, rounded reddish brown callus on the base of lateral lobe, apically with 1 central reddish brown anchorlike appendage. *Column* ca. 2 mm long, white, erect, column foot short, reddish brown ca. 1.5 mm; operculum yellow, depressed, rotundate, margin emarginate, rostellum ovate. *Pollinia* 8, unequal, pearly shaped ca. 0.5 mm, rarely cohering by sticky masses at their base, viscidium simple. *Stigmatic cavity* kidney shaped (Fig. 44).

Type: Singapore, Changi, Rindley s.n. (Holotype: K!).

Distribution: 500-1200 m., Himalaya (Assam, NE Himalaya), Malaya Peninsula, Singapore.

Elevation: Flowering: April-July

SPECIMENS EXAMINED: Assam. Omtey, Jaintea Hill, Prain 318, June 1899 (CAL!); North East Himalaya: Arunachal Kameng, Subansiri, 500-1200, H.G. Chaudhary s.n.

Note: Summerhayes (1932) added a new taxon *Eria hindei* in this section Xiphosium having the one-leaved pseudobulbs, but it differs *inter alia* in having the sepal tomentosa outside. Therefore later workers Holttum (1957), *Eria hindei* is to be changed into section *Hymeneria* and as maintained as synonyms of *Eria pudica*.

31. ***Eria concolor*** C.S.P. Parish & H. G. Reichenbach, *Trans. Linn. Soc.* **30**: 148 (1874); Parish in Mason, F. (eds.) *Burmah*, ed. **4**: 194 (1883); J. D. Hooker, *Fl. Brit. Ind.* **5**: 798 (1890). Krañzlin, in Engler A. (eds.) *Das Pflanzenreich Hfl.* **50**: 102 (1911). Seidenfaden, *Opera Bot.* **62**: 103 (1982).

Pinalia concolor (C. S. P. Parish & Rchb.f.) Kuntze, in *Revis. Gen.* **2**: 679, (1891).

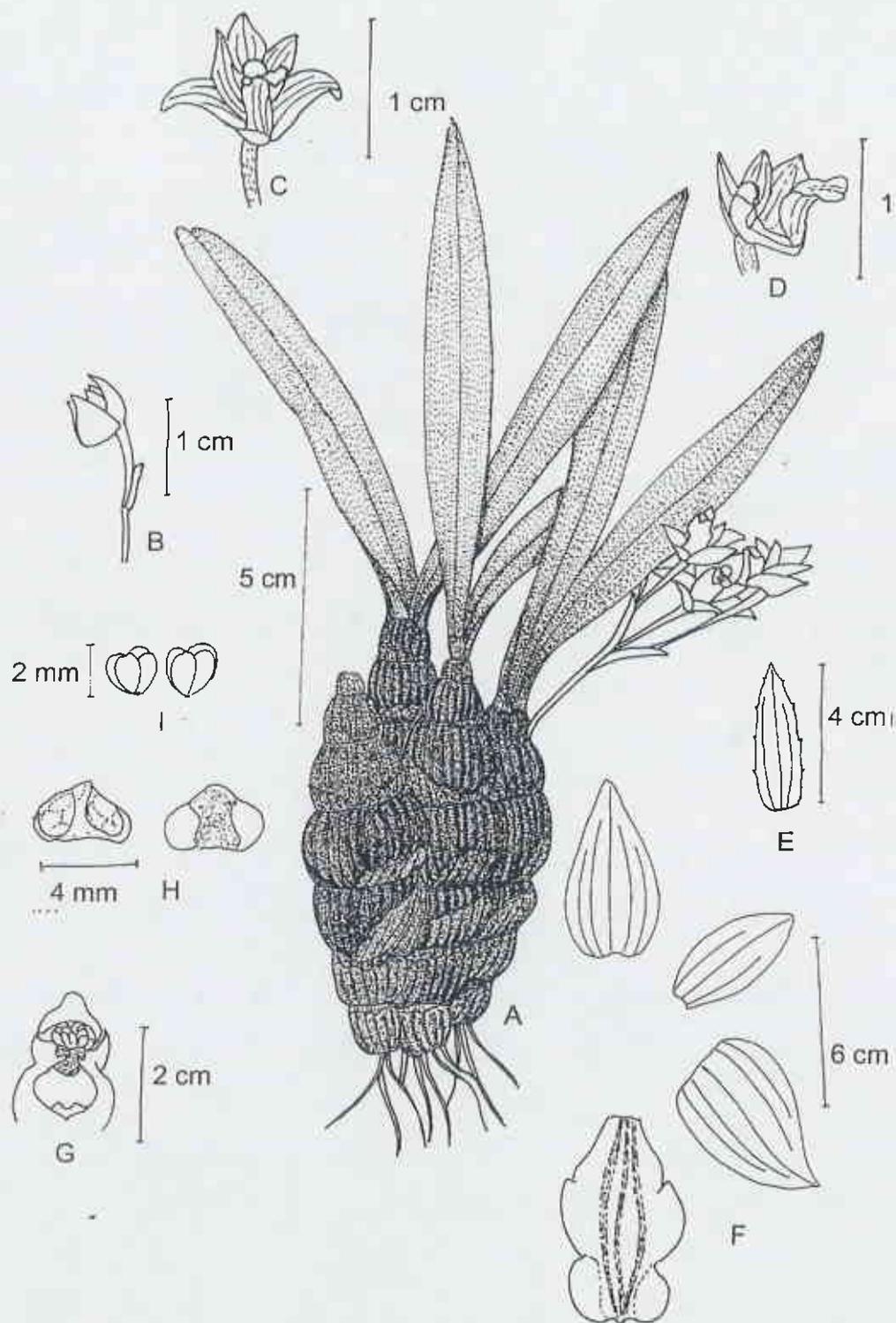


Fig. 45. *Eria concolor* Parish. & H. G. Reichenbach, (*D. M. Bajracharya & al.* 600 TUCHI) A: Habit; B: Flower C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal and Labellum; F: Column; G: Operculum; H: Pollinia.

Epiphytic orchids, 15-20 cm high. *Pseudobulbs* cylindrical, fusiform usually 3- 5 cm high, with 4-5 internodes, often swelling between nodes, when fresh bright green in color, *Pseudobulbs* covered with small leaf blades on sheath, older pseudobulbs grayish green with white line from veins of old sheaths. *Leaves* linear-lanceolate, acute, 14 x 1.3-2 cm, 2-3 (-4) at top, very narrow membranous *Inflorescence* receme sub erect, few flowered (2-6), sparsely pubescent. *Floral bract* small, ovate-lanceolate, acute, ca. 2 x 1 mm, glabrous. *Pedicel and ovary* longer than saccate mentum, more or less hairy. *Flowers* greenish yellow, ca. 1.5-2 mm in across, glabrous within, shade of dull pink claret and yellow. *Sepals* ovate-lanceolate, acute, 5-7.5 x 2-3 mm, glabrous; *dorsal sepal* oblong, acute, 5- 6.5 x 2- 2.5 mm, glabrous, 3-veined, *lateral sepals* ovate-lanceolate, 5-5.5 x 2 mm, acuminate, falcate, 3-veined; mentum obtusely triangular. *Petals* linear, acute, ca. 5.5 x 2 mm, glabrous, 3-5 veined. *Labellum* obscurely tri-lobed, small indentation in an obtuse angle between hypochile and epichile, which broader than long, 6-7 x 2 mm long broadest nearly 4 mm when flattened at hypochile oblong, obtuse, base narrow cuneate, lateral lobed very narrow; terminal lobe orbicular, retuse, apiculate; disc with a thick keels merging at apex of epichile between two half-moon shaped cushion, median keel with distinct swelling at base. *Column* ca. 2-3 mm, glabrous, curved, foot 5-6 mm long, curved, distinct joint between labellum and foot, operculum ca. 1 mm, pea shaped with two dotted; clinandrium collar like, rostellum minute and ligulate. *Pollinia* 8, obovoid, attached to caudicle, simple viscidium. *Stigma cavity* laterally broad, ca. 1-1.5 mm long and two small lobed inside the cavity (Fig. 45).

Type: Burma: Moulmein Parish 128 (K!).

Distribution: 500 m Burma, Himalaya (Nepal)

Flowering : June

Etymology : From Latin Word "Concolor" (Same colour)

SPECIMENS EXAMINED: Nepal: *E. Nepal:* Bhogatini, Raja Rani V. D. C, Letang, Morang, 500 m. 6 11. 2001, *D. M. Bajracharya, L. R. Shakya & A. Subedi* 424; (TUCH). Morang, Letang,. 9. 6. 2003, *D. M. Bajracharya, L. R. Shakya & A. Subedi* 600,.

Note: This species is new record for Flora of Nepal.

32. ***Eria obesa*** Lindley, Gen & Sp. Orch. :68 (1830); Lindl., *Bot. Reg.* 30: sub t. 29 (1844); Lindl., *Jour. Proc. Linn. Soc.* 3: 53 (1859); J. D. Hooker, Fl. Brit. Ind. 5: 793 (1890); Kränzlin, in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 82 (1911); Seidenfaden, *Opera Bot.* 62: 105 (1982).

Pinalia obesa (Lindl.) Kuntze, in *Revis. Gen.* 2: 679, (1891).

Eria lindleyana Griff., *Not.* 3: 300 (1851).

Hymeneria Obesa (Lindl.) M.A. Clem. & D.L. Jones *Orchideen* 13: 501 (2002).

Eria prainii Briquet, *Annuaire Conserv., Jard. Bot. Geneve* 4: 210 (1900).

Epiphytic herbs, 15-17 cm high. *Pseudobulbs* stout, clavate-ovate, 4-7 cm long, green, with scarious sheath. *Sheaths* brown, 1-1.5 cm long, scarious. *Leaves* shed before flowering. Leaves develop in autumn, 5-6 in number, lanceolate or ovate-lanceolate, ca. 12 x 1 cm, leaves appears before the *Pseudobulbs* started swelling, glabrous (Griff. 18:300). *Inflorescence* raceme, sub-corymbose arranged laterally on a year old pseudobulbs, 2-4 flowered, puberulous, rachis 1 cm long. *Floral bracts* large, ovate, greenish dull purple, ca. 2.5-3 x 2.5 mm, acute, thin, entire, reflexed, bract at the junction of the stalks, 5 veins. *Pedicel and ovary* 1.4-2 mm long, pubescent. *Flowers* white with tinge of pink, ca. 2 cm across, glabrous. *Sepals* unequal, 1.0-12 cm long; *dorsal sepal* lanceolate, 10-12 x 2 mm, acuminate, entire, glabrous, 5 veined; *lateral sepals* lanceolate, acute, 10-12 x 1.5-3 mm, slightly oblique, falcate, acuminate, entire, white, glabrous, thin, 5-veins; *mentum* ca.1 mm, round, curved, subconic. *Petals* oblong-lanceolate, 10-12 x 2 mm, obtuse, thin, glabrous, and 3 veined. *Labellum* without indentation between hypochile and epichile, yellow, nearly as long as sepals and petals, linear-oblong, 0.8-12 x 3 mm, entire, obscurely uniform, thin; disc with 3 pink, uniformed thickened keels, with lateral lobe veins, edges of lobe somewhat thin. *Column* 3-4 x 2 mm long, white, glabrous, curved; *foot* 4-5 mm long, concave; *operculum* ca. 1 mm, sub-orbicular, thick, *pappus* at the upper surface, two lobed, within 8 chambered; *clinandrium* collar like, erect, posterior acute, *rostellum* minute and ligulate. *Pollinia* 8, obovoid, laterally compressed, attached to glandular caudicle, *viscidium* simple. *Stigmatic cavity* 1.5-3 mm long, curved, low stigma obscured furrowed or grooved, two long lobes inside the cavity (Fig. 46).

Type specimen: Burma, Altran, Martaban, Wallich 1976, (type K-Lindl.?)

Distribution: 500m., Himalaya (Assam, Burma), Thailand.

Flowering: August

Status: Rare.

Etymology: From the Latin word 'Obesus' (fat/stout), with reference to stout pseudobulb..

SPECIMENS EXAMINED: **Nepal:** E. Nepal : Bhogatini, Raja Rani V. D. C, Letang, Morang, 500 m. 14 1. 2001, D. M. Bajracharya. L. R. Shakya & A. Subedi 394, (TUCH); **NE. India:** Palak, Lushi Hills, Parry (K!); Lorraine s.n. (K 9461!); **Burma:** Moulmein, Griffith drawing (K!); Mergui, Griffith 374 (Herb. Lindl. K!); Mergui 554 type of the *E. lindleyana*, Parish 24(K!); Amherest, Lace 4495 (K!); Parkinson 5288(K!); Moulmein, ., 29 12.1896, Peche s.n (CAL!); Kadanigh, 1912, Meebold 17045, (CAL!); Puge to Thagahta, 21 1. 1912 Lace 5595, (CAL!); Jaraj, Dec. 1900, Mokim 219, (CAL!); Paphi, 1912, Meebold 17044 (CAL!); Nabule velley, Dec. 1900, Mokim 160, (CAL!).

Note: Lindley (1844) described *E. obesa* from Martaban specimen in Wallich's herbarium (K-W). But there is no specimen of Wallich 1976 in Lindley herbarium (K- LINDL.). There is a collection of Griffith from Burma (drawing only). The leaves could not be trace out in the collected materials of *E. obesa* deposited in CAL, K and E herbaria, including fresh specimen collected in my field visit. Seidenfaden (1982) mentioned the size and number of the leaves about 4-6 and size of ca.12 x 1

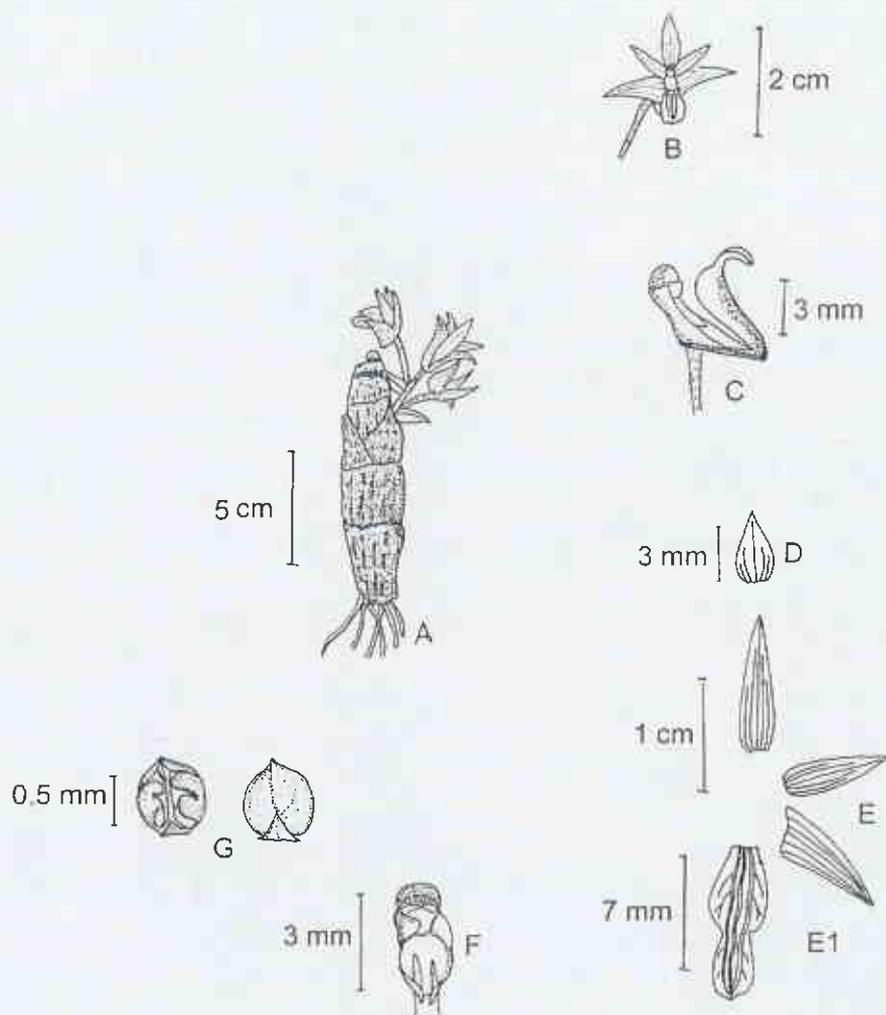


Fig 46. *Eria obesa* Lindley, (*D. M. Bajracharya* 394 TUCH!) A: Habit; B: Flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum.

cm, which was found before the Pseudobulbs starting to swelling. Clement & Jones (2002) transferred *E. obesa* to *Hymeneria obesa* on the basis of molecular study and proposed the type species for the new genus *Hymeneria*. This species is also new record for Flora of Nepal.

32. Eria baniaii D.M.Bajracharya, L.R. Shakya et M. K. Chettri, *J. Orchids Soc. Ind.* **16** (1-2) : 91-93 (2002, publ. 2003).

Very small epiphytic herb, 3 cm high; *pseudobulbs* ca. 3 x 0.5 cm, with of lower distinct node and upper node indistinct gradually tapering towards the apex, many nerves, membranous scales at nodes scales with. *Leaves* (absent during flowering period). *Inflorescence* a raceme, arising from the base of leafless pseudobulbs; 10 flowered, raceme as long as or slightly exceeds length of pseudobulbs. *Bracts* ovate-lanceolate, ca. 3 x 1.1 mm, acuminate, margin slightly erose. *Pediceal and ovary* ca. 2-2.5 mm, glabrous, as long as bract. *Flowers* ca. 1. 12-1.25 cm across, not well spreading, white, with many pink veins. *Sepals* unequal; *dorsal sepal* oblong-lanceolate, ca. 6 x 1.5-2 mm long, lightly 3 nerved (pink) connate with column; *lateral sepals* oblong-lanceolate, ca. 5.5 x 2 mm long, falcate, acute, broad below, 2-nerved (pink), basally connate with other lateral sepals and column; mentum rounded. *Petals* oblong-lanceolate, ca. 5 x 1.5 mm long, obtuse, 3-nerved (pink), connate with column. *Labellum* entire, simple, ovate, ca. 4.5 x 3 mm, acute, more or less deltoid, disc with three pink calli, small nerve spreading from the calli, lower portion of labellum tapering and connate with column. *Column* short, ca. 2 mm long, flat with pink coloured margin, lateral margin folded forward; clinandrium terminal. *Pollinia* 8, laterally flattened, in two pairs, glandular dotted, presence of very short caudicle, yellow. *Stigmatic cavity* entire (Fig. 47).

Type: Nepal, C. Nepal, Kathmandu Valley, E. North facing slope Khani Gaon, Godavari, 1600 m., 26.1.1993, D. M. Bajracharya, L. R. Shakya & M. K. Chettri CBS 150, (Holotype: TUCH!; isotype, KATH!).

Distribution: 1600 m., Himalaya (Nepal), the species is so far known only from the type locality.

Flowering: April.

Status: Endemic

Etymology: The specific epithet of this orchid species is coined in honor of senior taxonomist and Associate Professor Mr. Amrit Man Singh Bania, former Head of Botany Department, Amrit Campus for his valuable contribution in the field of Botany in Nepal.

Note: This species is allied to *E. obesa* Lindl. due to the presence of dry persistent sheaths on pseudobulbs, and three light pink uniform keels on the light labellum and it differs from latter in having small pseudobulbs; eroded bract, and pink coloured sepals, petal and labellum. This species is also allied with *Dendrobium porphyrochilum* Lindl. in its vegetative characters like pseudobulbs, sepals, petal and labellum, and it is distinguished from it by the presence of 8 pollinia.

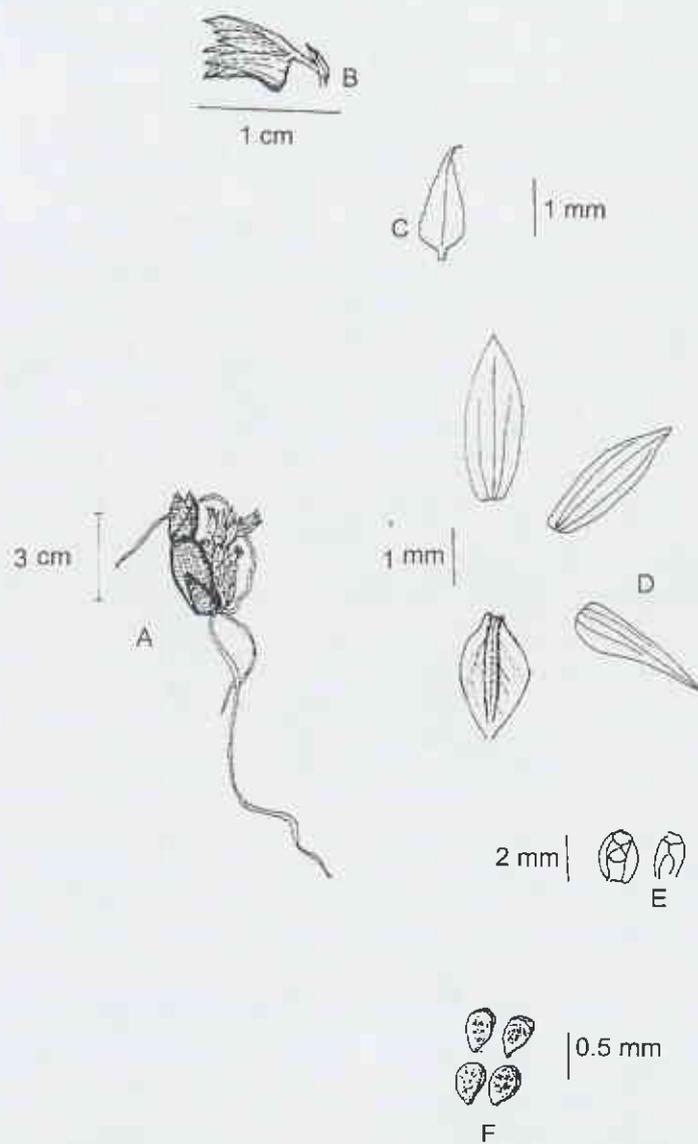


Fig 47. *Eria baniaii* D. M. Bajracharya & al (*D. M. Bajracharya & al.* 160, KATH!) A: Habit; B: Flower; C: Bract; D: Spreading of Sepal, Petal and Labellum; E: Column; F: Pollinia.

33. ***Eria bractescens*** Lindley, Edward's *Bot Reg.*: 18, (misc.) 27 (1841); Lindl., Edward's *Bot Reg.* 30: t. 29 (1844); J. D. Hooker, *Fl. Brit. Ind.* 5: 796 (1890); Rindl. *Tr. Linn. Soc.* 2 (3): 366 (1893); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* 8: 120, t. 166 (1898); Prain, *Bengal Pl.* :761 (1903); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 88 (1911); Ridley, *J. Str. Br. Roy. As. Soc.* 59: 195 (1911); Seidenfaden. & Smitinand, *Orch. Thailand*: 305, f. 228 (1960); Banerjee & Thapa, *Orch. Nepal.* :149 (1970); Thothathri & al., *Bull. Bot. Sur. Ind.* 15(3-4): 258 (1973); Hara & al., *EFPN* 1: 42 (1978); Pradhan, *Indian Orch.* :363 (1979); Seidenfaden, *Opera Bot.* 62:111 (1982); Banerji & Pradhan, *Orch. Nepal Himalaya* :252, f.253 (1984); Koba & al., *NLFPGN* :196 (1994); Hajra & Verma, *Fl. Sikkim* 2:66 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :354, f. 211 (1998); Hynniewta & al., *Orch. Nagaland* :174, f. 55, (2000); Press & al., *ACFPN* :215 (2000); Pearce & Cribb, *Fl. Bhutan* , 3 (3): 381 (2002).

Pinalia bractescens (Lindl.) Kuntze, *Revis.. Gen.* 2: 679 (1891).

Eria dillwynii Hook f. *Bot. Mag.* 71: t. 4163 (1845); Lindl., Edward's *Bot Reg.* 31: misc. 63 (1845); Lindl., *Jour. proc. Linn. Soc.* 3: 55 (1859); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 87(1911).

Eria pulchella Griff., *Not.* 3: 297 (1851), (non Lindl.); Lindl., *Jour. Proc. Linn. Soc.* 3: 54 (1859).

Eria littoralis Teijsm & Binnend., *Nat. Tijds. Ned. Ind.* 24: 312 (1862).

Eria griffithii Rchb.f., *Xen. Orch.* 2: 163 (1870); Parish, in Mason (ed.) *Burmah*, 4: 194 (1883); J.D.Hooker f., *Fl. Brit. Ind.* 5: 797 (1890); Grant, *Fl. Burma* :140 (1895).

Pinalia puchella (Griff.) Kuntze, *Revis. Gen.* 2: 679 (1891).

Dendrobium subterrestre Gagnep. *Bull. Nat. Hist. (Paris)* 2.s. 2 (1): 239.(1930); *syn. nov.- Eria affinis auct. non Griff.*, Parish, in Mason F (ed.), *Burmah*, ed. 4 :194 (1883).

Epiphytic herbs, upto 12-25 cm high, *Pseudobulbs* 5-8 x 1.7-2 cm thick, size variable, narrowly cylindrical-conical, some what wrinkled, slender and stem like, slightly curved, some are compressed, internode single, mostly covered by the persistent leaf sheaths. *Leaf sheath* ca.1-2 cm, membranous, covering pseudobulbs. *Leaves* 2-6, sessile or short petiolate, elliptic-oblong, 10-17 x 0.8-3.5 cm, acute or sub-acute, sub-coriaceous, 9-veined, with a strong central vein; petiole grooved, ca. 1 cm long. *Inflorescence* 2, in axillary raceme, 6-10 cm long, laxly 6-7 flowered, peduncle sheathed at base, glabrous, 2-2.5 cm long; sheaths ovate, acute, membranous; rachis 3-5 cm long, glabrous. *Empty bracts* oblong-lanceolate, 2.0 cm x sheaths ovate, acute, membranous; rachis 3-5 cm long, glabrous. *Empty bracts* oblong-lanceolate, 2.0 cm x 5 mm, acute, triangular, upper one smaller, membranous, yellowish. *Floral bracts* elliptic-ovate, 6-1.5 x 2-3.5 mm long, apiculate, reflexed, shorter than the long stalked ovary, pale yellow, and margin sometime involute. *Pedicel and ovary* 7-14 mm long, greenish yellow, cylindrical, and glabrous. *Flowers* are not widely opening, ca. 0.7-2 x 1 cm across, delicate, creamy white or pale yellow and greenish, glabrous

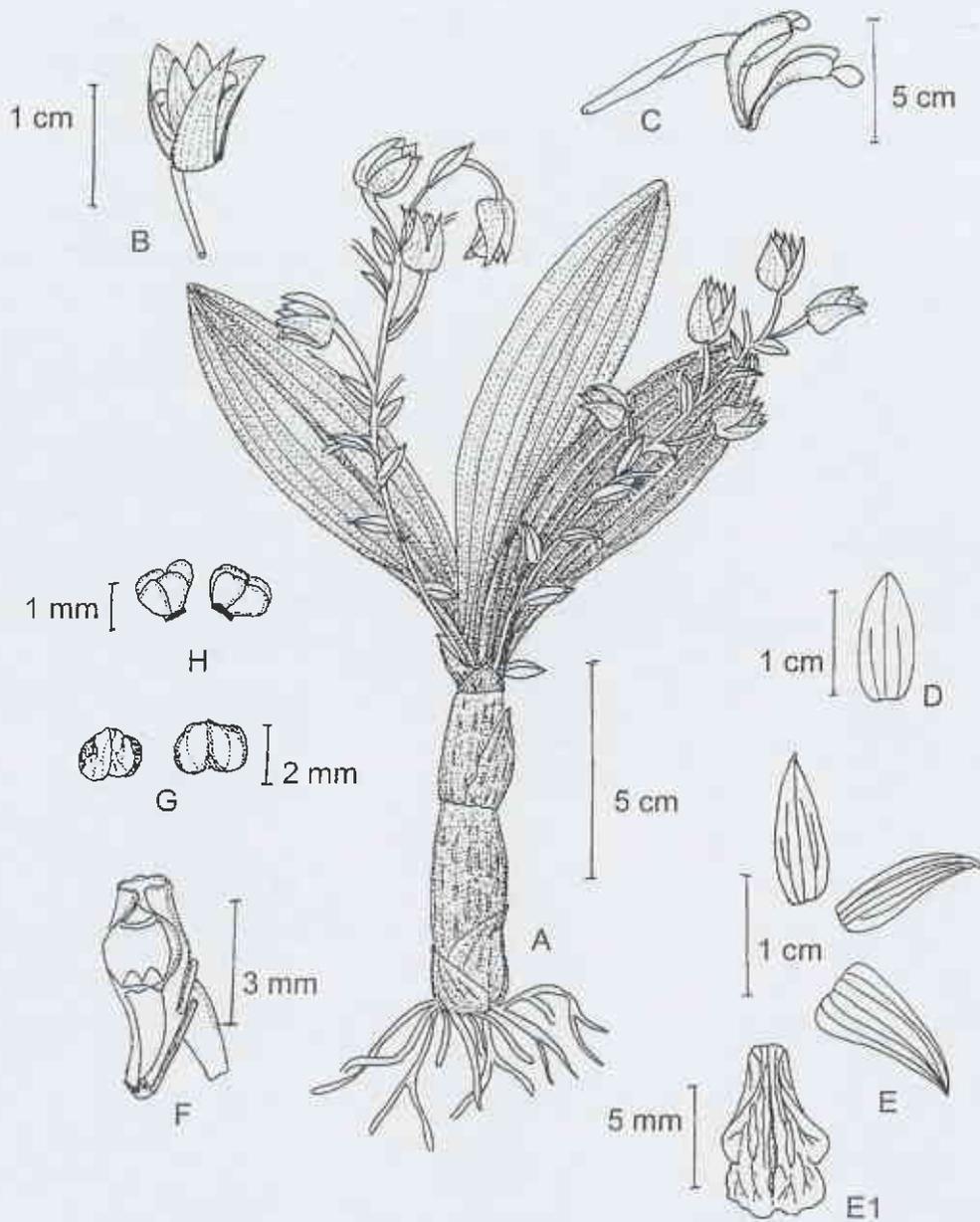


Fig 48. *Eria bractescens* Lindley, (*D. M. Bajracharya* 032, TUCH) A: Habit; B: Flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

Sepals 0.5-1.1 x 0.4-0.5 cm, similar, elliptic, sub acute, spreading, glabrous, sub-equal; *dorsal sepal* oblong to elliptic-lanceolate, 5-12 x 2 mm, acute or subacute, entire, curved backwards, glabrous, short pedicellate, 5 veined; *lateral sepals* ovate or elliptic-lanceolate, 7-12 x 2-4 mm at the base, falcate, acute or sub-acute, delicate, entire, blunt, deflexed at the apex, 5 veined; *mentum* ca. 4 mm long, sub erect, conical, obtuse. *Petals* narrowly oblong-lanceolate, 9-10 x 2-2.5 mm, obtuse, revolute, broad across the base, membranous, entire, shorter than the dorsal sepal with recurved tip. *Labellum* tri-lobed, oblong, 5-10 x 4-6 mm, as long as sepals and petals, expanded towards the apex; lateral lobes deep pink, erect, large, rounded, falcate, deleted in the basal half and having glandular margin, pink or red; terminal lobe creamy, quadrate, decurved, obovate or oblong, fleshy and wrinkled, bilobulate or nearly 3-lobed, entire, blunt, deflexed at the apex; disc with 3 lamellae, unequal, creamy and papillose, running along nearly its entire length, rarely the central lamellae discontinuous, the two lateral lamellae dilated towards base, the middle one terminating at the apex of terminal lobe, glandular at margin. *Column* cylindrical, stout, ca. 3-5 mm long, foot short, white, minutely hairy, spotted at the central of the foot; slightly winged at apex; column foot short, ca. 4 mm, white; *operculum* 2 mm across, bilobed, 4 locules in each lobe; clinandrium collar like, apical; *restellum* minute, obtuse and ligulate. *Pollinia* 8, obovoid, compressed, in two groups, attached with glandular caudicle; *viscidium* simple and ellipsoid. *Stigmatic cavity* broad, 2 lobed at the base of the cavity. *Fruit* ellipsoid to fusiform, 2-3 x 0.3-0.4 cm (Fig. 48).

Type: Singapore, Loddiges 214 (syntype, K: not found); Myanmar, Griffith 1055 (syntype, K-LINDL!).

Distribution: 2000 m. Himalaya (Nepal, Sikkim, Bhutan, Assam, Burma), Laos, Cambodia, Vietnam, Malaya, Indonesia, Philippines, and New Guinea.

Flowering: April-June.

Status: Rare

Etymology: From the Latin word '*Bracteatus*' (with bract).

Chromosome Number: $n=20$ (Vij & Mehra 1976); $2n=40$ (Sharma & Chatterji 1966); $2n=38$ (Hasimoto & Tanaka 1983).

SPECIMENS EXAMINED: **Nepal:** C. Nepal: Makwanpur, Kaleshower, Makwanpur Gadhi 610m, D.M. Bajracharya 032 (TUCH). Makwanpur, Makwanpur Gadi 1600m, 24.2.1992, K. J. White 13, (KATH!); E. Nepal: Morang, Letang 500, Morang, 16.2.2001, D.M. Bajracharya, L.R. Shakyas & A. Subedi (TUCH!); Sine loc M. L. Banerjee 304 (CAL!); Sine loc. M. L. Banerjee 222 (CAL!); Ilam, Raja Rani 570m, 19.4.1979, P. Pradhan, R. Nirula & M. Gorkhali 785, (KATH!); **Sikkim:** Sikkim Himalaya 200m April 1892 K!, R. Pantling 137, (CAL!); Darjeeling, Subrangan s.n. (K!). **Assam:** Khasia, Apr.1897 Pantling s.n. (CAL!); Poloitea State, H., 20.2.1923, Emblen s.n., (CAL!) Sin. loc. R.S. Rao 1444 (CAL!); **North East Himalaya :** Subansiri, between 200-1000 m.; H. J. Chowdhery; **Burma:** Griffith 183, Griff 1055 (KLINDL!) type *Eria pulchella* Griff. (K!); Parish 107 (K!); Parish 196 *Eria affinis* (K!); **India** April 1892, Pantling 137, 400m (K!); Jouke ghat, Kunz 340

(CAL!); Mergui, March 1911, *Meebold* 14509, (CAL!); Rangaon, March 1911, *Meebold* 14701, (CAL!); Tena District, *Biswas* 1273, 497, & 915 (CAL!); Burma, April 1897, *Peche s.n.* (CAL!); Moulmain, July 1897, *Pache s.n.*, (CAL!); Moulmain, April 1897, *Peche s.n.* (CAL!).

34. *Eria graminifolia* Lindley, *Jour. proc. Linn. Soc.* **3**: 54, (1959); J. D. Hooker, *lc. pl.* **19**: t.1847 (1889); J. D. Hooker, *Fl. Brit. Ind.* **5**: 794 (1890); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* **8**: 119, t. 164 (1898); Kränzlin, in Engler, A. (eds.), *Das Pflanzenreich Hfl.* **50**: 67 (1911); Tuyama (1966) in Hara (eds.), *Fl. E. Himal* :434 (1966); Banerji & Thapa, *J. Bombay Nat. Hist. Soc.* **67**: 152 (1970); Hara & al., *EFPN* **1**: 42 (1978). Banerji & Pradhan, *Orch. Nepal Himalaya* :262, pl. 263 (1984); Chowdhery, *Orch. Fl. Arunachal Prad.* :367, f. 219 (1998); Hynniewta & al., *Orch. Nagaland* 176, f. 58 (2000); Koba & al., *NLFPGN* :196 (1994); Hajra & Verma, *Fl. Sikkim* **2**: 67 (1996); Press & al., *ACFPN* :215 (2000); Pearce & Cribb, *Fl. Bhutan* **3**(3): 382 (2002).

Pinalia graminifolia (Lindl.) Kuntze, *Revis. Gen.* **2**: 679 (1891).

Epiphytic herbs, upto 18-30 cm high. *Root* clustered along the stem. *Pseudobulbs* 12-25 x 0.8-1.2 cm, congested, narrowly cylindrical, stem like, elongated, sheathed with nodes when young, coherent at base; 5 or 6 membranous sheaths, sheaths tubular, variable, 2-8 x 0.6-1 cm. *Leaves* 2-6, clustered at apex of pseudobulb, linear-lanceolate to narrowly oblong-elliptic, 7-15 x 0.9-2.2 cm, acuminate, narrowed towards base, shortly petiolate, grooved, ca. 0.8-1 cm long, thickly membranous, 7-9 veined. *Inflorescence* 2-3 in number, terminal or sub-terminal, arising from near apex of pseudobulb, shorter than leaves, erect, laxly racemose, 15-20 flowers; peduncle short, glandular, yellowish brown pubescence, ca. 2 cm long; rachis 4-10 cm long, loosely glandular, yellowish brown pubescent. *Floral bracts* broad, ovate-lanceolate, 6-7 x 1.5- 2.5 mm, acuminate, brownish green, apical margin fimbriate, shorter than pedicel and ovary. *Pedicel and ovary* 4 -8 x 1 mm long, covered with yellowish brown pubescence. *Flowers* white, labellum spotted with yellow, 1.5-2 cm across, mildly scented. *Sepals* unequal, elliptic, lanceolate, acute or obtuse, 0.8-1.1 x 0.3-0.6 cm, 3 to 5-veined, white; *dorsal sepal* oblong-lanceolate, 6-10 x 2.5-4 mm, thin, acute, broad, glabrous, white, 5-veined; *lateral sepals* slightly lanceolate or oblong, 6-8 x 3-5 mm, sub-falcate, acute or acuminate, straight; *mentum* rounded, short, ca. 6 mm. *Petals* narrow oblong, elliptic-lanceolate, 6-9 x 1.5- 2 mm equal to sepals, sub-acute or obtuse, thin, weakly falcate, white, and 3-veined. *Labellum* tri-lobed, obovate, 5-8 x 4-5 mm across when lateral lobes spreading, Lateral lobe fleshy, broadly oblong perpendicular to terminal lobe, erect, truncate, incurved, and red; terminal lobe transversely oblong or more or less orbicular, emarginate; disc with three yellowish unequal fleshy lamellae ridges at the base, middle central ridge large, oblong callus, terminating above the base of terminal lobe, disc ridges yellow-white. *Column* subcylindrical, ca. 3.5-4 mm, long, and massive, white, purple flushed in front, erect with prominent foot agglutinate with ovary, stout, puberulous; *clinandrium* narrowly winged on both sides; *operculum* subovoid erect, ca. 1 x 0.75 mm, movable, partition well divide into 4 chambers, connective thick, wide,

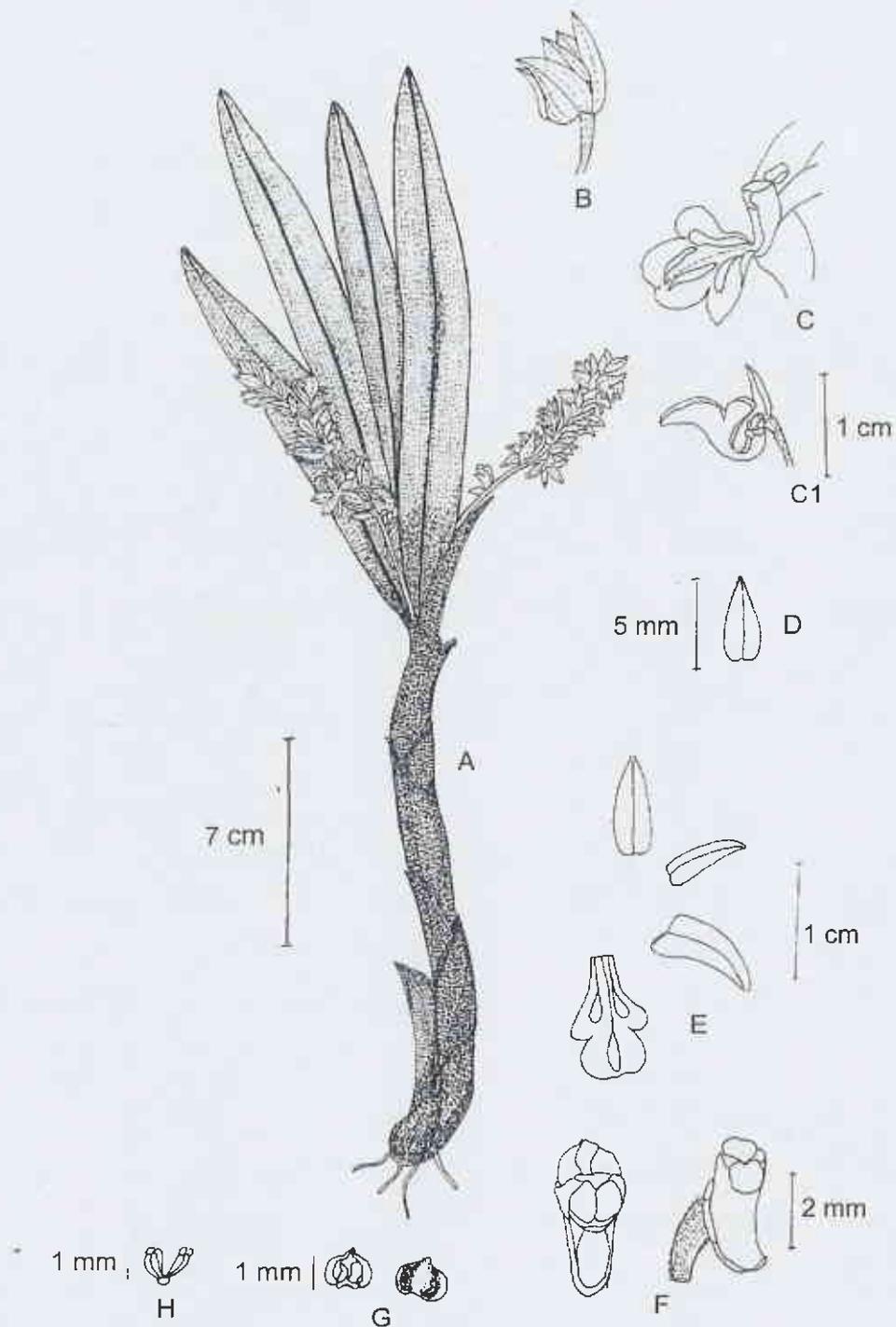


Fig 49. *Eria graminifolia* Lindley, (*D. M. Bajracharya* 350, TUCH!) A: Habit; B: flower; C and C1: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal and Labellum; F: Column; G: Operculum; H: Pollinia.

covering both locule; outer surface reddish dotted, inner smooth; rostellum simple, truncate, bent towards the stigmatic cavity, shelf like. *Pollinia* 8, brown, compact, linear-clavate, laterally flattened, caudicle, compact of the apical grains, sticky; viscidium simple and ellipsoid. *Stigma* filled with waxy material; *stigmatic cavity* double lobed, split into two parts. *Fruit* fusiform, 0.8-1.5 x 0.2-0.25 cm, (Fig. 49).

Type: India, Darjeeling, Griffith *s.n.* (Holotype: K-Lindl!)

Distribution: 1600-2200 m., Himalaya (NW Himalaya, Nepal, Sikkim, Bhutan) China.

Elevation: Flowering: June - August

Etymology: Derived from the Latin word '*graminifolius*' (grass-leaved)

Chromosome Number: n=19 (Mehra & Vij 1970; 1976); 2n= 38 (Biswas 1980); 2n= 42 (Hasimoto & Tanaka 1983).

SPECIMENS EXAMINED: **North west Himalaya:** Kumaun: Pithoragarh- Didihat 1800 m., May-June 1960, T. A. Rao 11808, (DD!); Govan manda, 2900m, 28.6.1981, Goel 73002, (DD!); Dudakoti, 2200 m., 26. 6.1979, Naithani 68112, (DD!). **Nepal: W. Nepal:** Doti, Chhathiwon 1350 m, Sept 2002, G. Amataya 23, **C. Nepal:** Kathmandu, Bagdowar, 11. 9.1977, P. Pradhan & N. Shrestha 564, (KATH!); *E. Nepal:* Sankhuwa sobha Sindhuwa, 14. 11. 1978, P. Pradhan, N.P. Manandhar & N. Shrestha 794, (KATH!); Makawanpur, Daman, Sharma & White 127 (K!) Makawanpur, Daman, Oct. 1996, White & Sharma 170, (K!); Kathmandu, Chisapani danda N. of Kathmandu, 24.5.1973, Crey-Wilson & Philip 119, (K!); Kathmandu, Godawari 1600m, 15 8.2000, D. M. Bajracharya 350, (TUCH!); Kathmandu, Chitray 1700 m., 4 8.1979, S. Dahal & N. Dawadi 865, (KATH!); Ghodepani 2400 m., 21 7.1976, D. P. Joshi & S. K. Dhungana 7613890, (KATH!). **Sikkim:** Darjeeling, Griffith 1844 (K-LINDL!); Darjeeling, June 1882, Gamble 10575, (K!); Darjeeling, 8.8.1876, Gamble 904, (K!); Griffith 5115, (K!); Sikkim 1500m, J. D. Hooker, *s.n.* (K!); Sikkim Himalaya 3000m, July/ Aug. 1892, R. Pantling 371, (K!); Chongthong 2000m, , July 1897, R. Pantling 371 (K!); Sikkim, N. of District, Lemas of Lachung 2400m, D. G. Long & H. J. Nollie *s.n.* (E!); Sikkim Himalaya 2000m July -Aug. 1892, R. Pantling 311 (BM!); Schohul, June 1895, Pantling 371, (CAL!); Doobdi, 1.8.1892 Gammie 231, (CAL!) Cheemytong, Smith & Cave 913, (CAL!); **Bhutan:** Valley of the Senghke, 6.8.28, Wood 7251, (K!); between Tashiyangtse and Tobrang 1850m, Balakrishna 41991 (CAL!); between Nyothand Tashiyangtse 2000m, Oct. 1965, Balakrishna 44256, (CAL!); **North East Himalaya :** Kameng, Lohit, Siang, Subansiri, Tirap; between 1500-2000 m.; H. J. Chowdhery; **Burma:** Upper Burma, , June 1925, C. Forrest, 26955 (K!); C. Forrest 27242 Sept 1925 (K!). May 1925, C. Forrest 26606 (K!).

35. **Eria acervata** Lindley., *Jour. Hort. Soc.* 6: 57 (1851); J. D. Hooker, *Fl. Brit. Ind.* 5: 797 (1890); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 61 (1911); Seidenfaden, *Opera Bot.* 62: 123 (1982); Banerji & Pradhan, *Orch. Nepal Himalaya* :248, pl. 249 (1984); Hajra & Verma, *Fl. Sikkim* 2: 65 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :350, f. 207 (1998); Hynniewta & al., *Orch. Nagaland* :168, f.53 (2000). Pearce & Cribb, *Fl. Bhutan* 3 (3): 379 (2002).

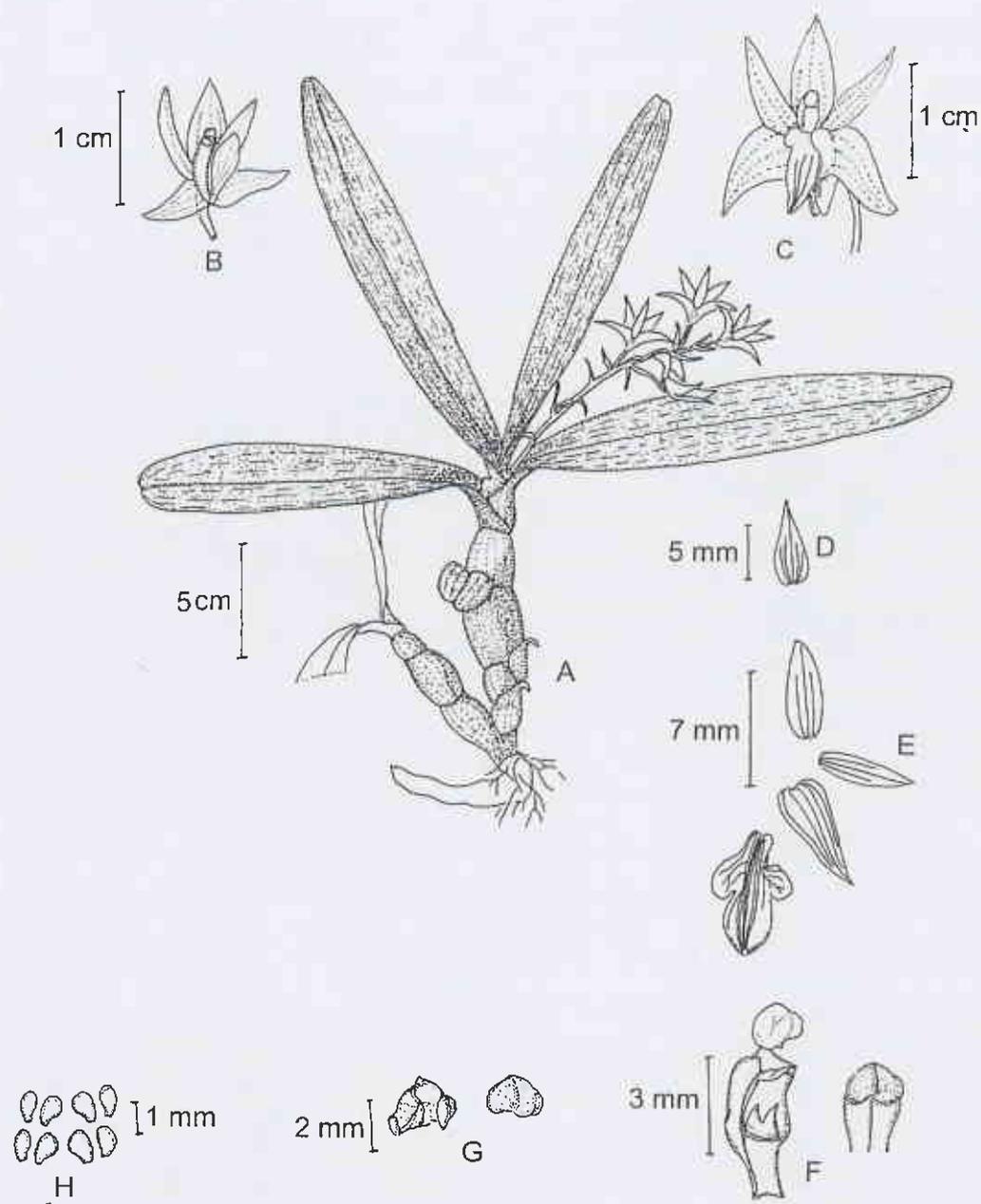


Fig 50. *Eria acervata* Lindley. (*P.Pradhan, & al* 895, KATH!), A: Habit; B flower; C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal and Labellum; F: Column; G: Operculum; H: Pollinia.

Pinalia acervata (Lindl.) Kuntze, Revis. Gen. 2: 679 (1891).

Denrobium seriatum Wall. ex Hook. f. Fl. Brit. India 5: 796 (1890).

Eria Poilanei Gagnep. Bull. Mus. Natl. Hist. Nat. II, 2,: 310 (1930).

Epiphytic herbs, up to 12-25 cm high, including leaves. *Rhizome* stout, clothed within fibrous sheaths, scattered roots along the rhizome. *Pseudobulbs* more or less compressed, flask-like to oblong-ellipsoid, shaped, densely crowded, furrowed, sheathed when young, 2-6 x 1.5-1.7 mm, thick, grooved; 2-5 sheaths membranous-fibrous, lanceolate, 2-5 cm long, scars marked on pseudobulb when old. *Leaves* 2-6, oblong-ob lanceolate, 6-14 cm x 12-25 mm, acute or obtuse-emarginate, pale green, sub-coriaceous, tapered towards base, glabrous, with 8 or 9 veins, unequal, notched and blunt at tip; petiolate, petiole grooved, ca. 0.5-4 cm long. *Inflorescence* laterally raceme, laxly few flowered, 1-3 arising from the axils of the leaves; about the half of the leaves, glabrous; peduncle puberulous, sheathed, 1-2 cm long; *leaf sheaths* lanceolate, 4-5, reflexed, 1-1.5 cm long; rachis 3-4.5 cm long, glabrous. *Floral bracts* brownish green, half as long as pedicel and ovary, ovate or lanceolate, 6-1.7 x 3-6 mm, acute or acuminate, margin sparsely denticulate, reflexed, 3-veined. *Pedicel and ovary* slender, pale green, 9-1.2 x 1 mm, glabrous. *Flowers* ca. 1.5-1.6 cm long, 2.0-2.2 mm across, creamy white or yellow, membranous, glabrous, *Sepals* unequal, lanceolate, 0.7-1.1 x 0.5 cm, acuminate, tinged with green at apex; *dorsal sepal* ovate or oblong-lanceolate, 7-8 x 3-4 mm, thin, acuminate, glabrous, broad at the base, yellowish white, tinged with green at apex, 5 veined; *lateral sepals* obliquely ovate-lanceolate, falcate, 10 x 4 mm, thin, acute or acuminate, and broad at the base, glabrous, yellowish white with green at apex, 5-veined, adnate to column foot and forming a mentum; mentum conical, short, ca. 2 mm long, obtuse, deep, glabrous, incurved. *Petals* narrowly lanceolate, 7-9 x 2-3 mm, acute or obtuse, ovate at the base, thin, yellowish. *Labellum* tri-lobed, oblong or obovate, broadly cuneate, 6-8 x 5 mm, base knee- curved, white with tinged yellow apex; lateral lobe falcate oblong, obtuse, ca. 2 mm wide, entire, thick, tinged with yellow; terminal lobe sub-orbicular to ovate, apiculate, margin entire, acute; disc with three erect narrow, parallel lamellae ridges from the base to near apex, 2 erect lamellae from base to middle of terminal lobe, oblong callus at apex. *Column* very short, ca. 3-4 x 2 mm, glabrous, white, slightly curved; foot massive, long, erect, broad, curved, 4 mm long; clinandrium collar-shaped; operculum 2 mm, terminal, yellow, elliptic, glabrous; rostellum ligulate, erect bent towards the stigma. *Pollinia* 8, deep brown when dry, compactly obovoid-clavate or subobtriangular, slightly flattened, viscidium simple and ellipsoid. *Stigmatic cavity* wet, entire, bilobed inside the cavity (Fig. 50).

Type: Holotype: not present, Lectotype (selected from IC on. In *J. Hort. Soc. London* 6: 57, 1851 by Pearce & Cribb 2002).

Distribution: 500-700 m., Himalaya (Nepal, Sikkim, Assam, Arunchal Pradesh), Burma, Laos, Cambodia, Thailand, Vietnam and China.

Flowering: May- August.

Etymology: From the Latin word 'acervatus' (heaped) with reference to the stacked pseudobulbs.

Chromosome Number: $n = 20$ (Mehra & Sehgal 1975); $2n = 38$ (Hasimoto & Tanaka 1983, Li/X & R-Y Chen 1989, Li/X & Tanaka 1992)

SPECIMENS EXAMINED: **Nepal:** C. Nepal: Mustang, Ghasa 2000m, 23.3.1978, P.M. Amatya & B. Roy 456176, (KATH!); **E. Nepal:** Ilam, Ranga Pani, 550m, 23.11.1978, P.Pradhan, N. P. Mandhar & Amatya 895, (KATH!); **Sikkim :** Sikkim, June 1892, Pantling 170, (BM! CAL!); R. Pantling 137 (K!); Sikkim, June 1890, Parish 12176, (K!); Sikkim 800-1200m, R. Pantling 137 (K!) *Eria glabra* King & Pantling-MSS= *E. coronarea*; Valley of Testa, July 1984, Pantling 170, (CAL!); Tropical Valley of Sikkim, June-July 1898, Pantling 170, (CAL!); Sine loc. June 1982, Pantling 170, (CAL!); Jemi Sikkim, June-July 1891, Pantling 170, (CAL!); **Assam :** Bhoilas 1200m Khasia, , 6.8.1886, C.B. Clarke 44446 (K!); Khasia, July, J. D. Hooker . 50 (K!); Antu, Jaintea Hill, May 1899, Dr. Prain 129, (BM!); Khasia: J. D. Hooker & T. Thomson 68 (K-Lindl.); (K!); Bntie, Jantea Hills, May 1899, Prain 129, (CAL!); Gomachii, Jantea Hills, May 1899, Prain 228, (CAL!); Shillong , G. K. Deke 14028 (CAL!); **Bhutan** Bowes Lyon 15119 (BM!); Tongsa 1500m, F. Ludlow, G. Sherriff and J. H. Hicks 17026, (BM!); Valley of the Nanaung Kha 1200-1700m, 17.7.1917, J.K. Wood 3326, (E!); Wakka to Nagminu, , 5.8.1961, D. B. Deb 26551 (CAL!); Near Trongsa 2000 m, 5.8.1949, Ludlow, Sherriff & Hicks 17029, (CAL!); Tongsa 2500m, **North East Himalaya:** Kameng, Siang Subansiri, Tirap; between 500-1000 m.; H. J. Chowdhery s.n ; **Burma :** Southern Shan States, 1200 m, 1.2.1957, Lois & Soren Ederod B-44,.(K!); Kachim Hill., July 1898, Mokkem s.n. (K!); sin. Loc. J. D. Hooker s.n. (K!); Mayamya, G. Swin nac 53 (K!); Burma, June 1800, Parish 276 (K!); Kachin Hill, July 1898, Mokim s.n. (CAL!).

Note: This species was reported by Banerjee and Pradhan (1984) as new record for Flora of Nepal. It is not mentioned in EFPN (Hara & al. 1978), NLFPNG (Koba & al. 1990) and ACFPN (Press & al. 2000).

36. Eria amica H. G. Reichenbach, *Xen. Orch.* **2:** 162, t. 168 III, 6-9 (1870); J. D. Hooker, *Fl. Brit. Ind.* **5:** 800 (1890); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50:** 86 (1911); Pradhan, *Indian Orch.* **2:** 364 (1979); Seidenfaden, *Opera Bot.* **62:** 116 (1982); Banerji & Pradhan, *Orch. Nepal Himal* :250 pl. 251 (1984); Hajra & Verma, *Fl. Sikkim* **2:** 65 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :350, f. 208 a,b, (1998); Hynniewta & al., *Orch. Nagaland* :170 (2000); Rajbhāndari & Bhattarai, *Beautiful Orch. Nep.* :119, pl.118 (2001); Press & al., *ACFPN* : 333 (2000); Pearce & Cribb, *Fl. Bhutan* **3** (3): 380 (2002).

Pinalia amica (Rchb.f.) Kuntze, *Revis. Gen. Pl.* **2:** 679 (1891).

Eria excavata Lindl., *Gen. & Spec. Orch.* : 67 (1830), *pro parte*.

Eria confusa J.D.Hooker f., *lc. Pl.*, t. 1850 (1889); J. D.Hooker , *Fl. Brit. Ind.* **5:** 796 (1890); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* **8:** 122, pl 169 (1898); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50:** 91 (1911); Banerji & Thapa, *J. Bombay Nat. Hist.*

Soc. :150 (1970); Herklots, *Orch. Reviews* :288 (1974); Hara & al., *EFPN* 1: 42 (1978); Koba & al., *NLFPGN* :196 (1994); Press & al., *ACFPN* :215 (2000).
Pinalia confusa (Hooker, f.) Kuntze, *loc. cit.* (1891).
Eria andersonii Hooker, f., *Fl. Brit. Ind.* 5: 795 (1890); J.D.Hooker, *lc. Pl.* 2069 (1892).
Pinalia andersonii (Hooker, f.) Kuntze, *loc. cit.* (1891).

Epiphytic herbs, upto 12-30 cm high. *Rhizome* clustered along the pseudobulb. *Pseudobulbs* elongate-clavate, erect, fusiform to cylindrical, deeply furrowed, 4-15 x 0.7-0.15 cm, glabrous, thick, the basal part enclosed by the sheathing base and two or three large sheaths scattered along their surface. *Sheaths* 1-2 cm long. *Leaves* 3-5 rarely 2 arising from pseudobulb apex, linear-lanceolate to oblong-lanceolate, 7-21 x 0.6-2 cm, acute, thick, glabrous, tapered to petiolate base and 8-12 veins; petiole grooved, 0.6-2 cm long. *Inflorescence* arising from the axils of leaf-sheaths below the leaves, lateral raceme 1 or 2 (-4) arising from each pseudobulb, erect to sub-erect, lax 6-10 flowered, nearly sessile; peduncle slender, 2-3 cm long; rachis slender, puberulous, 5-6 cm long. *Floral bracts* large, longer than the pedicel and ovary, elliptic or elliptic-lanceolate, 7-1.5 x 3 mm, sub-acute, reflexed or deflexed, brownish yellow, hairy at the base and the apex, 6-7 veined and 4 sub-veined, glabrous. *Pedicel and ovary* 1.2-2.5 cm long, slender, reddish brown, pubescent. *Flowers* 7-9 x 2 mm, ca. 1-2.4 cm across when flattened, buff yellow to greenish yellow, with reddish brown to brownish nerved. *Sepals* unequal, ca. 0.8-1.2 x 0.5 cm, rusty curved pubescent outside, sepals yellowish to greenish-yellow with red veins and yellow apices; *dorsal sepal* broadly oblong-lanceolate, 7-8 x 2-2.5 mm, acute, blunt, incurved, attenuate, 3-5 veined; *lateral sepals* broadly ovate-triangular, 7.5 x 5 mm, blunt, oblique, acute, membranous, truncate, white with purple lines, 5-veined, adnate to column foot and forming a mentum; mentum conical, ca. 4-6 mm long, obtuse, pubescent at the outer surface. *Petals* narrower than the dorsal sepal, linear-lanceolate to elliptic-lanceolate, 7-10 x 2-3 mm, acuminate or acute, and membranous, truncate, thin, brown with parallel striation, 3-5 veined. *Labellum* tri-lobed, subobovate-elliptic 0.8-10 x 0.5-0.8 mm, spathulate, shortly clawed, truncate at the base; labellum pink with bright yellow apex and red lateral lobes and keels.; lateral lobes triangular, ovate-elliptic, incurved, ca. 3 x 1.5 mm, obtuse to sub-acute, erect, yellow with red-brown edges; terminal lobe reniform or spathulate, ca. 3-4 x ca. 4.5 mm, transversely oblong to elliptic, emarginated, broad, bright greenish yellow, fleshy, deflexed, with brown margin, retuse, to 2-lobed, lobes broad, rounded; disc with 3-lamellae keels, brownish yellow, unequal, middle one longer and thickened on terminal lobe, lateral lamellae thickened from labellum disc base and ridged, extended to the terminal lobe base. *Column* 3-8 x 1 mm, terete, pubescent, massive, short, brownish yellow and incurved; column foot 2-3 mm long; clinandrium collar like, erect, with short prominent foot at the tip; oprculum imperfectly quadrilocular or semispherical, ca. 1.5 mm, fertile, bent forward, movable, partition wall well developed, divided into 4 chambers; connective thin, fleshy; rostellum ligulate,

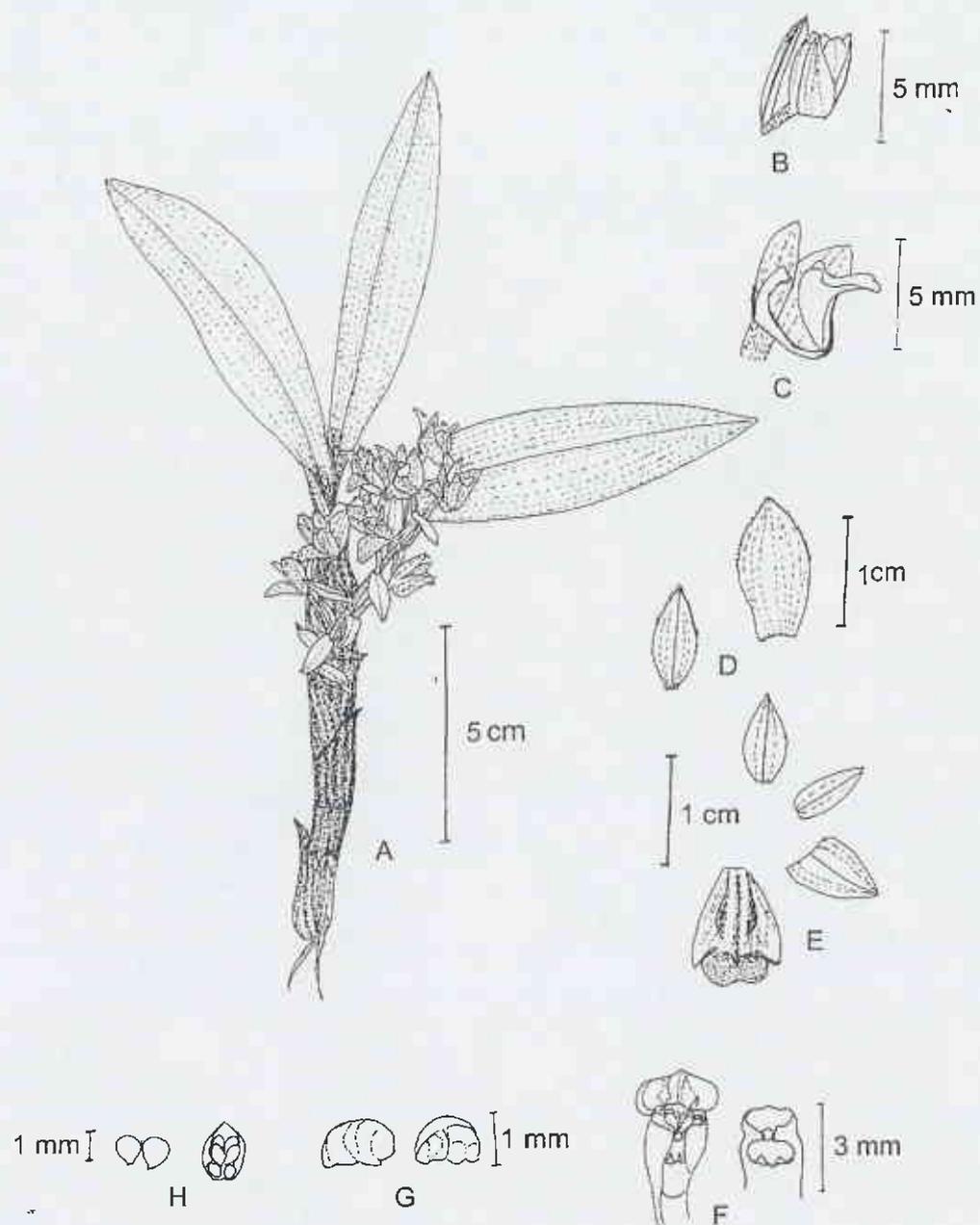


Fig 51. *Eria amica* H. G. Reichenbach, (*D. M. Bajracharya* 651.) A: Habit; B: flower; C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal and Labellum; F: Column; G: Operculum; H: Pollinia.

simple, bent towards the stigma. *Pollinia* 8, waxy, pale yellow, compact, obtriangular, ca. 0.5 mm, laterally flattened, caudicle composed of sticky materials; viscidium simple and ellipsoid, single, composed of partially macerated cells with sticky material. *Stigmatic cavity* 1.5 x 1 mm, entire, stigma single lobed, entire, wet (Fig. 51).

Type: Assam (India), *sino loc.*, Commercially imported by Day *s.n.* (Holotype: W: not found); *Lectotype*: (selected by Pearce & Cribb from [icon in] J. Day, Drawing of Orch. 11: t.63 (1866).

Distribution: Himalaya (NW. Himalaya, Nepal, Sikkim, Bhutan, Assam, NE Himalaya, Burma), Thailand, Laos, Vietnam, Taiwan, China.

Elevation: 1400- 1600 m.

Flowering: March-May.

Etymology: From the Latin word '*amica*' (a female friend), but the reference is obscure.

Chromosome Number: n= 18 (Mehra & Kashyap 1984b; 1989).

SPECIMENS EXAMINED: **North west Himalaya:** Kumaun: Pithoragarh: Maitli, 2000 m. 15.3.1976, Arora 55815, (DD!); **Nepal:** W. Nepal Doti, Ghanteswor, 1200-1500, June 2002, G. Amatya 21.; C. Nepal : Makawanpur, Makawanpur Gadi, March 1992, K. White *s.n.* (K!); Kathmandu, Godawari 2000m, 11.4.1978, P. Pradhan 400, (KATH!); Gorkha, Dharundi, Rundung, 600 m. D. M. Bajracharya 65, 14.5.1997; Kaski, Mardi Khola, , 25.4. 83, J. D. A. Stainton 8622; Mustang, Ghasa, 25.3.1978, P. M. Amatay and B. Roy 456/78; E. Nepal : Morang Letang., 500 m., 9.6.2003, D. M. Bajracharya & L. R. Shakya 602.; **Sikkim:** Sikkim, J. D. Hooker, *s.n.* (K!); Ruigeum, Valley of Testa, May 1897, R. Pantling 257, (K!); **Assam:** Nungpo Khasia 1000 m, 5.4.1886, C. B. Clarke 43365, (K!); Delei Valley 1000m, 20.3.28, F.K. Wards 7980, (K!); Valley of the Ham Tamai, F. Kingdon-wards 297/110 (K!); Aijal, Assam, Parry 640 (K!); Takubama Naga Hills 2000 m, 27.8.1950, Walter. N. Koelz 26846, (K!); Cherrapunjr, Khasia Hill 1500m, Walter N. Koelz 30647 (K!); Sangao Lushiai Hills 1500m, Rup Chand 6896 (K!); Blue Mountain 2300 m, 21.4.1953, Rup Chand *s.n.*, (K!); **Bhutan:** Tama 1500-1600 m, 15.4.1964, G Sen Gupta 1171, (CAL!) Nahi-Gaselem Nrti- Labeyssa 1500m D. B. Gurung *s.n.*; **North East Himalaya :** Kameng, Siang Subansisri, Tirap; between 500-1000 m.; H. J. Chowdhery, **Burma:** Ami Saku 1000 m, 25.5.1913, J.H. Lace *s.n.* (K!).

Note: The confusion arose about *E. amica* and *E. confusa*, when Lindley (1830) described his *Eria excavata* based on the material collected by Wallich from Nepal (Wallich cat. no. 1974). Lindley described two quite distinct species *E. excavata* and *E. amica* described as *E. excavata*. Several specimens of *E. excavata*, *E. confusa* and *E. amica* deposited in BM, E, CAL, K and KATH were examined to confirm that *E. excavata* is a distinct species, whereas *E. confusa* is considered as synonym of *E. amica*.

In EFPN (Hara & *al.* 1978) and NLFPGN (Koba & *al.* 1990) did not mentioned *E. amica*, and treated a separate species *E. confusa*. Whereas in ACFPN (Press & *al.* 2000) mentioned *E. confusa* and *E. amica* as two distinct species. It has been confirmed here as *E. confusa* is conspecific to *E. amica*.

37. **Eria sharmae** H.J Chowdhery, G.S. Giri & G.D. Pal, *Indian Jour. Forestry* **16** (1): 91 (1993). Chowdhery, Orch. Arunachal Prad. :381, f. 228 (1998).

Epiphytic herbs, 15-22 cm high. *Roots* fibrous, brown, densely hairy. *Pseudobulbs* 4-7 together, elongate-clavate, terete, 6-9 cm long, longitudinally and shallowly furrowed, glaucous, dull green to light brown in colour, with 2-3 nodal scars at maturity, imbricately sheathed at the base. *Sheaths* ovate, 15-20 x 10-13 mm, acute, 8-10 veined, membranous, glabrous, brownish, scattered with white dotted. *Leaves* always in pairs, two, oblong-lanceolate, 10-15 x 1.5- 2 cm, acute, narrowed at the base, 6-8 veins coriaceous; petioles \pm 5 mm long, channelled, glabrous. *Inflorescence* solitary raceme, arising laterally from distal ends of pseudobulbs, 10-15 mm long, below the leaves; peduncle 4.5-7 cm long, 6-10 flowered; rachis densely puberulous, pinkish-green, partially enclosed at the base by membranous, brownish scales, glabrous, brownish scales. *Floral bracts* oblong, 1-1.2 x 0.6-0.7 cm, acute, glabrous, yellowish green, erect, recurved at maturity, shorter than the pedicel and ovary, 8-veined. *Pedicel and ovary* 3 cm long, terete, slightly bent, densely puberulous, pinkish. *Flowers* erect, ca. 1 cm across, pinkish-yellow, showy. *Sepals* unequal, oblong, acute, 1.0-1.2 cm long; *dorsal sepal* oblong, 11-12 x 4-5 mm, acute, reflexed, entire, glabrous, 3-veined, deep pale yellow, nerves extend upto the apices.; *lateral sepals* oblong, falcate, 10-12 x 5-6 mm, acute, reflexed, glabrous, yellowish-green; nerves continuous, deep purple, 3-veined. *Petals* elliptic-lanceolate, 8-9 x 3.5-4 mm, obtuse, erect, glabrous, yellowish, deep purple, 3-veined. *Labellum* tri-lobed, obovate-oblong, 9-10 x 4-5 mm, glabrous; lateral lobe ovate-acute or broadly triangular 3 x 2 mm, scarlet; terminal lobe decurved, more or less rectangular in outline, 3 mm long, 6 mm broad, emarginate or unequally 3 lobulate at the apex; margin fleshy, bright yellow; disc with three thickened ridges from the base extending parallel to the apical terminal lobe. *Column* ca. 4.5-5 mm long, slightly curved, yellow; operculum ovoid \pm 2mm diam., bilobed, pale-yellow. *Pollinia* 8, obovoid. *Stigmatic cavity* without horn like projection inside (Fig. 52).

Type: N.E. Himalaya, Arunachal Pradesh (India), Lower Subsir District, Itanagar, 450-500 m, 20 Feb. 1992, Chowdhery, H. J., s.n. (Holotype: CALI).

Distribution: 450-500 m., Himalaya (North East Himalaya).

Flowering: February-March

Etymology: The species is named after Dr. B.D. Sharma, Director Botanical Survey of India, for his valuable contribution in the field of botany in India.

SPECIMENS EXAMINED: North Eastern Himalaya: Arunachal Pradesh, Lower Subsir District, Itanagar, 450-500 m, 20.2.1992, H.J. Chowdhery 1726, (Holo CALI).

Note: *Eria sharmae* is reported by Chowdhery from Arunachal Pradesh based on a single specimen. This species is closely related to *Eria amica* Rchb. f., but *E. sharmae* can be distinguished by shallowly furrowed pseudobulb, paired leaves; flowers 6-10 flowered, terminal

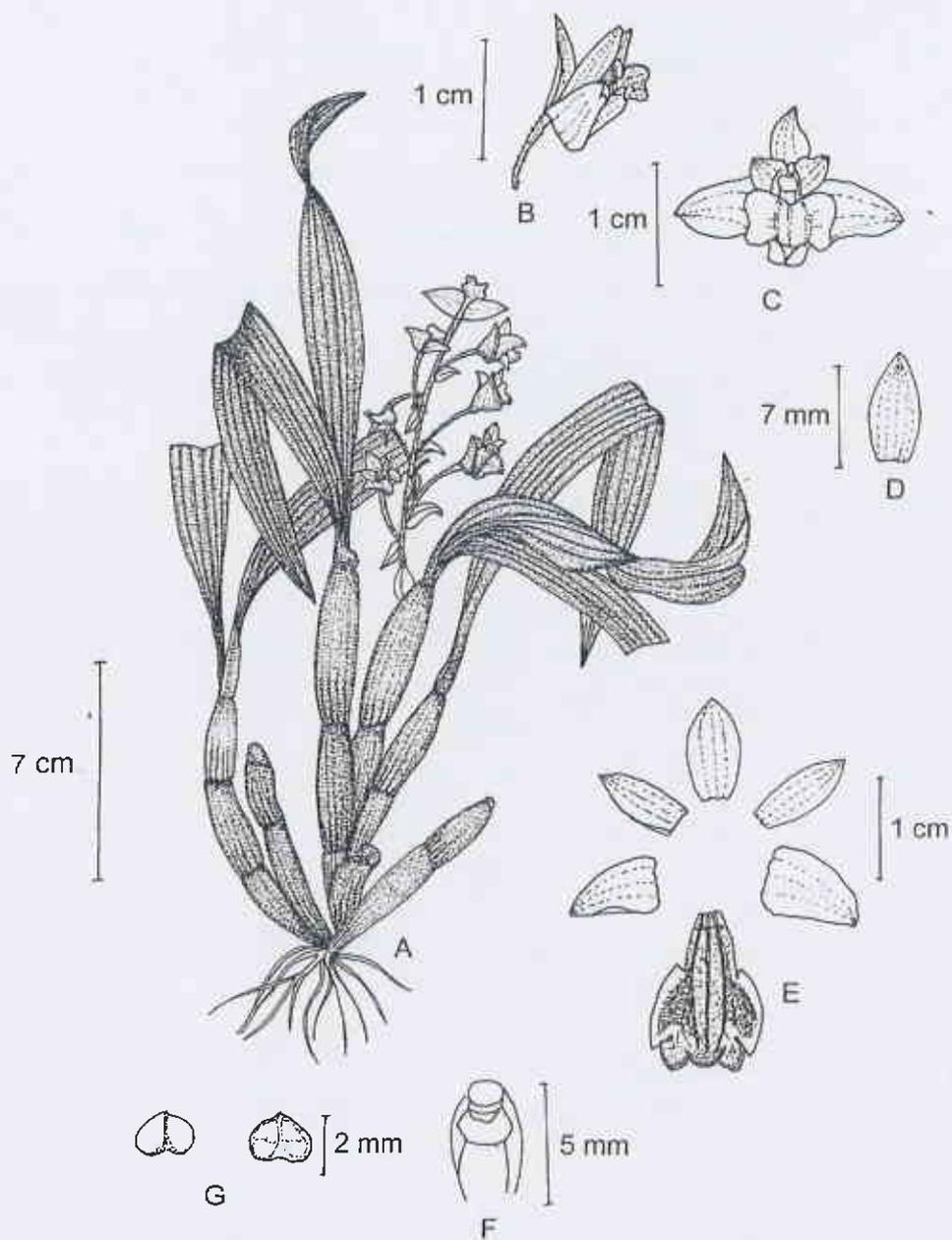


Fig 52. *Eria sharmae* H.J Chowdhery, G.S. Giri & G.D. Pal (*Chawdhary 1726, CAL!*). A: Habit; B: flower; C: Front view of flower; D: Bract; E: Spreading of Sepal, Petal and Labellum; F: Column; G: Operculum

lobe of labellum rectangular and stigmatic cavity without horn like projection inside the cavity. This species belongs in the section *Hymeneria*.

38. *Eria alba* Lindley, Gen & Sp. Orchid. :67 (1830); J.D.Hooker, Ic. pl. t. 1845 (1889); J. D. Hooker, Fl. Brit. Ind. **5**: 795 (1890); Duthie, Ann. Roy. Bot. Gard. Calc. **9**: 111 t. 102 (1902); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50**: 60 (1911); Banerji & Thapa, *J. Bombay. Nat. Hist. Soc.* **67**: 149 (1970); Hara & al., EFPN **1**: 42 (1978); Banerji & Pradhan, Orch. Nepal Himalaya :248 (1984); Koba & al. NLFPGN :196 (1994); Hajra & Verma, Fl. Sikkim **2**: 66. (1996); Hynniewta & al., Orch. Nagaland :170 f. 54, (2000); Press & al., ACFPN :215 (2000); Pearce & Cribb, Fl. Bhutan **3** (3): 380 (2002).

Octomeria alba Wall. ex. Lindl., Gen. Sp. Orch. Pl. :67 (1830); *nom. nud.* (1830).

Pinalia leucantha Kuntze, Revis. Gen. **2**: 679 (1891), *nom. alt.*

Epiphytic herbs, 10-25 cm high. Root clustered at the rhizome. *Pseudobulbs* crowded, ovoid to flasked-shaped, densely arranged, 1-3 x 0.5-2 cm long, tapering at each ends, not elongated, marked with distinct many vertical lines and few concentric scars. *Leaves* 3-5, arranged in opposite row, and sheathed at the base, linear-lanceolate or oblong-lanceolate, 9-15 x 0.5-2.5 cm, acute or acuminate, bifid, narrowed and petiolate at base; petiole grooved 1-2 cm long, and many strong veined. *Inflorescence* terminal, erect, raceme lax 4-8 flowered; flowers arising in between the leaves; rachis 3-4 cm long, peduncle short, sparsely pubescent. *Floral bracts* equal or shorter than the pedicel and ovary, elliptic-ovate, thin, 4-6 x 1.5-2.5 mm, acute to acuminate, reflexed, green, broad, glabrous and 3-veined. *Pedicel and ovary* 5-6 x 1 mm, slender, sparsely pubescent, white. *Flowers* white, sweet scented, 7-15 mm long, ca. 2.0 cm across, white. *Sepals* unequal, spreading, oblong, or elliptic-lanceolate, ca. 0.7-1.0 x 0.2-0.4 cm, white, pubescent externally; *dorsal sepal* oblong lanceolate, thin, 7-9 x 2-4 mm, acute, and 3-veined; *lateral sepals* unequal, elliptic-lanceolate, falcate, 10 x 3.5 mm, acute, broad at the base, 3-veined. *Petals* shorter than sepals, linear-oblong, 7-9 x 1-3 mm, membranous, sub-acute, broad, glabrous, margin thin, white, 3-veined. *Labellum* tri-lobed, fleshy, clawed at base, oblong, 8-11 x 4 mm, broadly clawed, thick, obtuse, glabrous, margin thick; labellum yellow with purple on edges of lateral lobes; lateral lobes triangular-oblong, 5 x 2 mm, obtuse, erect-incurved, tinged with reddish purple.; terminal lobe oblong- orbicular, entire, acute or apiculate, yellow and red deflexed; disc with 3 lamellae ridges, two thick ridges between the lateral lobe and slender macular at the median lobe, slender, base of the lip broad and clawed. *Column* agglutinate with ovary, 4-9 cm long, lacking column foot; mentum broad, obtuse; clinandrium collar like, operculum 2 x 2 mm, bean shaped, short and massive, erect, broad, with thick connective, wide and covering both locules; rostellum truncate, erect or bend towards the stigma. *Pollinia* 8, compact, granular, ovate-oblong, laterally flattened; caudicle compact of apical grains and sticky; viscidium ligulate and ellipsoid, cellular. *Stigmatic cavity* entire, 1.5 x 2 mm. *Fruit* ellipsoidal, 1.5-1.8 x 0.3-0.4 cm (Fig. 53).

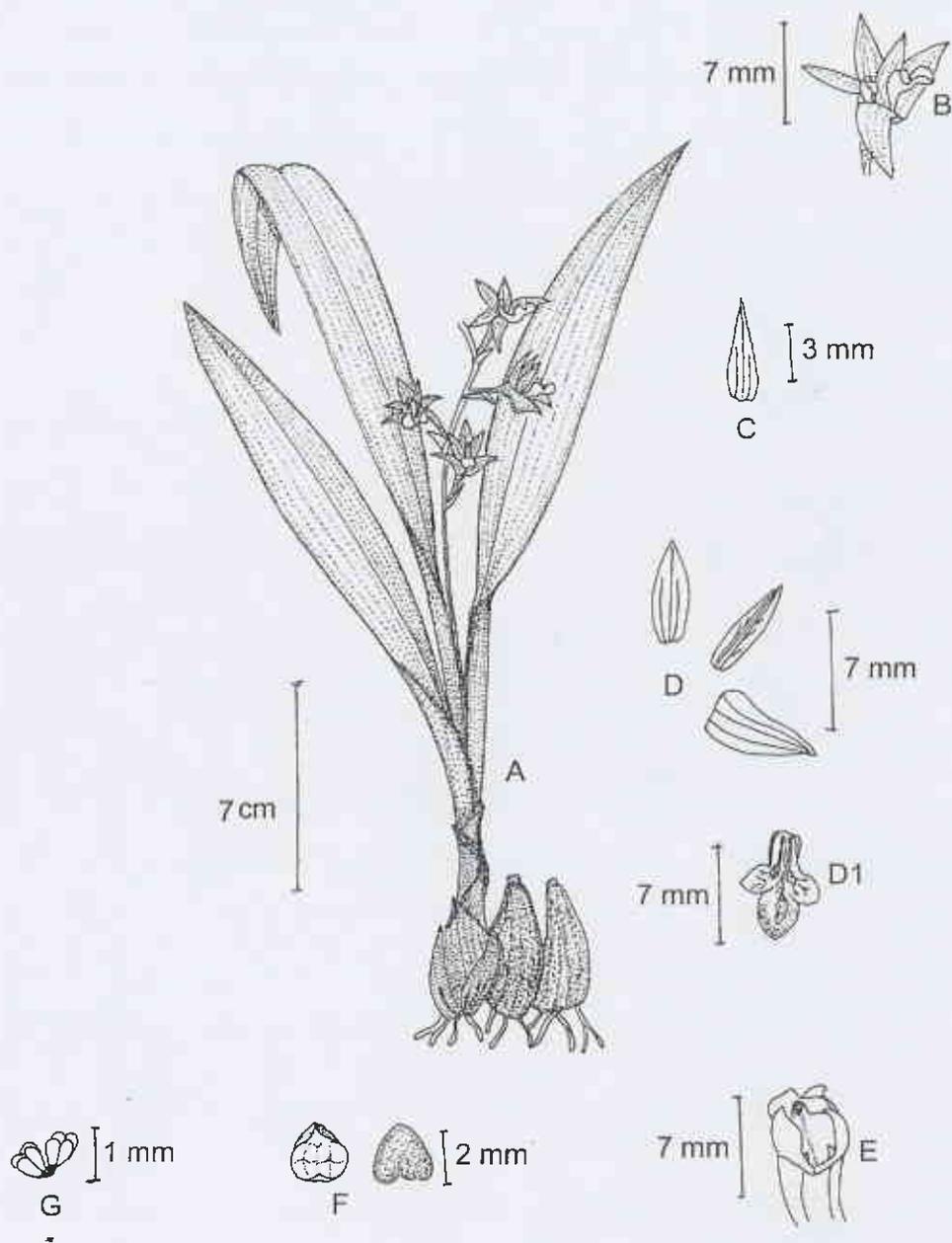


Fig 53. *Eria alba* Lindley (L.R. Shaky, s.n.) A: Habit; B: Lateral view of flower; C: Bract; D: Spreading of Sepal, Petal; D₁: Labellum; E: Column; F: Operculum; G: Pollinia.

Type: Nepaliae, Sheopure, *Wallich. s.n.*, May 1820? (Holotype: K-LINDL!)

Distribution: 1400-2300 m Himalaya (NW Himalaya, Nepal, Sikkim, Bhutan, NE Himalaya).

Flowering: April- June.

Status: Himalayan endemic

Etymology: From the Latin word '*albus*' (white), with reference to the flower colour.

Chromosome Number: $2n=36$ (Mehra & Seghal 1974), $2n=40$ (Vij & al. 1976a).

SPECIMENS EXAMINED: **N.W. Himalaya:** **Garhwal,** *T. Thomson s.n.*, (K!); Mussooria 1800-2500m, July 1898, *P. Mackinnon* 21747, (BM!); Chairi Road 3500 m, *J. H. Lace* 1899(E!); Himalchal Pradesh, *Falconer* 1023 (CAL!); Ramni- Sutol, 2000 m. 14.5.1959, *Rau* (BSI) 10161, (CAL! DD!); **Dehra Dun** Mussoorie, *Mackinnon* 22982 (DD!); Near Mussoorie, July 1898, *Mackinnon* 21747, (DD! CAL!); **Utter pradesh :** **Pangi** Utter pradesh, 24.5.1899, *Harsakh* 23345, (CAL!); **Tehri:** Ghuarua & Chamba Road, *Harsukh* 23345 (DD!); Agralhal above Narendra nager, *Deva* 9730 (DD!). **Pauri:** Pauri, April 1978 *A.S. Rao* 62817 (DD!); **Chamoli:** Satal 2500 m, 16.5.1959, *M. A. Rau* 10161, (DD!); Kumaon, 6.6.1974, *C. M. Arora* 52459 (CAL!); **Mussouri,** 24.5.1898, *Mackimmon* s.n. (CAL!); Khankot, *Colett* 159 (CAL!). **Pithoragarh:** Maitli 2200 m, 30.5.1974, *Arora* 53440, (DD!); Dafiadhura, 2600 m, 6.6.1974, *Arora* 52459, (DD!); **Almora:** Loharkhet 2000-3200 m, 20.9.1957, *T. A. Rao* 4229, (DD!) Juni, **Pangtey** s.n. (DD!); Gorana 2000m, 24.9.1979, *A. K. Goel* 67817, (DD!); **Nepal:** *W. Nepal:* Doti, Ghhatiwon, 1200-1700 m, June 2002, *G. Amatya* 20; *C. Nepal:* Argakhachi, 1600-2000m, 5.11.1998, *L.R. Shakya*, s.n. (TUCH!); *Nepalia Wall.s.n.* (BM!); Mustang, Lete North of Dana, 3500m, 26.5.54, *Stainton, Sakyas & Williams* 689, (BM!); West of Metlajam 2000m, 24.5.1969, *L.H. J. Williams* 162, (BM!); *E. Nepal:* Khimti Khola 3000m, 21.5.1964, *D. Mc. Cosh* 83, (BM!); Salpa Dara 3200 m, 7.8.1981, *Stainton* 8328, (E!); **Sikkim :** Darjeeling 3000 m, *S.K.* 186 (K!); *Falconer* Herb 1023 (K!); Senchuil 2500 m, May 1894, *R. Pantling*, (BM!); Sikkim, *J. D. Hooker* s.n (BM!); **Assam:** Mount Khasia, 1200 m, *J. D. Hooker*, f. & *T. Thomson* s.n. (E!); **Bhutan :** Trashi Yangsi Dzong, E. Bhutan, 24.4.1949, *F. Ludlow, G. Sherrif & J. H. Hicks* 20569 (BM!); Tashigang Dist. Chartenkora Bhutan 1900m, 13.5.1994, *S. Bowes Lyon* 10084, (E!); Tashiyangtsi from Nyoth, March 1965, *Balakrishna* 41967, (CAL!).

39. *Eria excavata* Lindley, Gen. Sp. Orch. . Pl. :67 (1830); *J. D. Hooker* Fl. Brit. Ind. **5:** 795 (1890); *J.D.Hooker*, Icon pl. **19:** 1890 (1895); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* **50:** 66 (1911); Seidenfaden, *Opera Bot.* **62:** 123 (1982); Hara & a. EFNP. **1:** 42 (1978); Banerji & Pradhan, Orch. Nepal Himalaya :260, pl. 261(1984); Koba & al NLFPGN :196 (1994); Hajra & Verma, Fl. Sikkim **2:** 67 (1996); Chowdhery, Orch. Arunachal Prad. :363, f. 217 (1998); Hynniewta & al., Orch. Nagaland :176, f. 57 (2000); Press & al., ACFPN :215 (2000); Pearce & Cribb, Fl. Bhutan **3** (3): 381 (2002).

Pinalia excavata (Lindl.) Kuntze, Revis.. Gen. Pl. **2:** 679 (1891).

Eria flava var. *rubida* Lindl., *Jour. Linn. Soc.* **3:** 49 (1859).

Eria sphaerochila Lindl. *Jour. Proc. Linn. Soc. Bot.* 3: 54 (1959)

Octomeria excavata Wall., *Numer. List* :1974 (1829), *nom.nud.*

Octomeria excavata Wall., in Lindl. *Gen. Sp. Orch. Pl.* :67 (1830) *pro. syn.*

Epiphytic herbs, upto 13-20 cm high. *Rhizome* scattered stout covered with fibrously lacerated sheath remains, along the base of pseudobulbs. *Pseudobulbs* arranged in a row, sub cylindrical, tapering at each end, compressed, rugose, wrinkled, 1-3.5 x 0.2-0.5 cm, narrow at the apex, sheathing at base. *Leaves* 4-6, elliptic-lanceolate to oblong-lanceolate, 7-17 x 1-3 cm, acute, membranous, overlapping at base; petiolate, petiole grooved, 1-2 cm long, 7 or 8 veined. *Inflorescence* arising from leaf axil, terminal raceme, solitary, as long as leaf, erect to slightly decurved, laxly 6-12 flowered; rachis ca. 14-18 cm long, more or less reddish, brown pubescent; peduncle sheathless, 2.5-5 cm long, pubescent. *Floral bracts* ovate-lanceolate, 6-9 x 1 mm, slightly shorter than pedicel and ovary, acute or acuminate, glabrous, yellowish-white or pale green, brown pubescent, 6-veined. *Pedicel and ovary* 10 x 2 mm, reddish or pale green, brown pubescent. *Flowers* facing straight, pale cream, white 0.5-1.5 x 0.8 cm, ca. 14 mm across when flattened. *Sepals* unequal, brown pubescent outside, connivent, 5-7 mm long and 3-veined; *dorsal sepal* broadly subelliptic-lanceolate, ca.6-7 x 2 mm, acute, yellowish white, and rusty-pubescent, 3-veined; *lateral sepals* falcate, broadly oblique, elliptic-oblong or ovate-lanceolate, ca.5-6 x 3 mm, acute or sub-acute, as long as dorsal sepal, slightly wider, connivent, membranous, white, rusty pubescent on the outer surface, 3-veined, adnate to column foot and forming a mentum. *Petals* elliptic-lanceolate, ca. 4-5 x 1 mm, acute or obtuse, membranous, thin, 3-veined. *Labellum* trilobed, suborbicular, base concave, sessile, obovate, 4-8 x 3-4 mm, pale green, yellowish-red marking, lateral lobe small, erect, rounded, obtuse 4 x 2 mm; terminal lobe subreniform, ca. 4 x 5 mm, emarginated, veins 5 from base, decurved, transversely oblong-cordate or sub-orbicular; acute, occasionally emarginate, deflexed, yellow with red marking about its base; disc rugulose, disc with variable calluses, flabellate, lamellate, or thickened, central one to apex and forming apicula, and 2-callose basally, thickened, warty-rugulose in terminal lobe, base of the lip broad and drooping. *Column* agglutinate with ovary, ca. 1.5-3 x 1 mm, glabrous, greenish yellow, excavate in dried specimen; column foot very short, incurved; clinandrium collar like, reflexed, bent forward, movable, partition well developed and divided into 8 chambers, ca. 2 x 1.5 mm; restellum triangular, ligulate, bent towards the stigmatic cavity. *Pollinia* 8, compact, sub-clavate or obovoid, laterally flattened, caudicle composed of apical grain of pollinia, sticky; viscidium simple and ellipsoid. *Stigmatic cavity* ca. 2 x 1 mm, entire, double lobed and wet. *Fruit* capsule ellipsoid, ribbed, 1.3-1.9 x 0.3-0.6 cm (Fig. 54).

Type: Nepaliae, Sheopore Wallich *Cat.* 1974 p.p. (Holotype: K-LINDLI; isotype, K-WI, KI, CALI).

Distribution: 1300-2200 m., Himalaya, (Garhwal, Kumaon, Nepal, Sikkim, Assam, Bhutan, North East Himalaya).

Flowering: May- June.

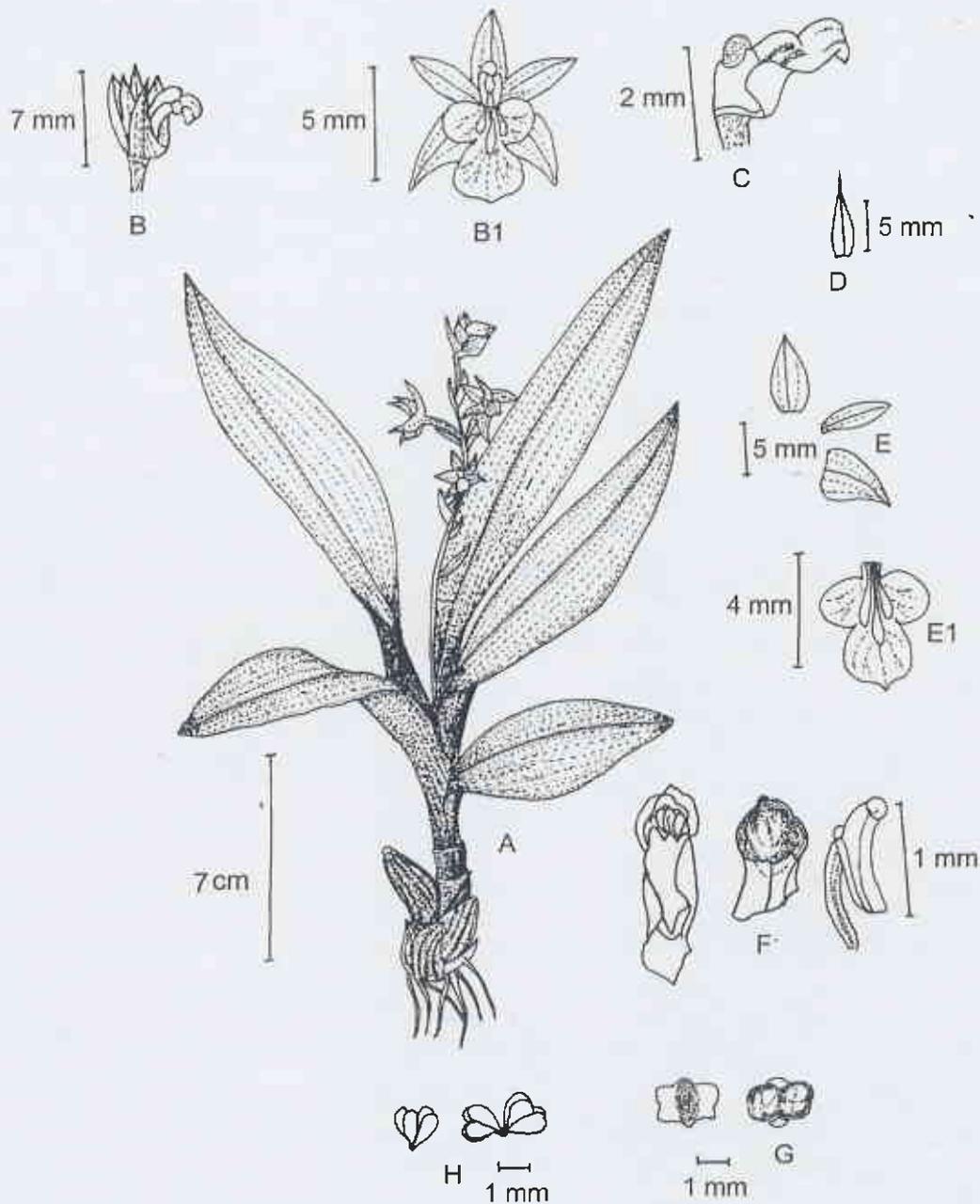


Fig 54. *Eria excavata* Lindley. (*D. M. Bajracharya 489 KATHI*) A: Habit; B, Lateral view; B₁: Front view of flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal and E₁ Labellum; F, F₁, F₂: Column; G, G₁, G₂: Operculum; H: Pollinia.

Status: Himalayan endemic.

Etymology: From the Latin word 'excavatus' (hollowed out), with reference to the hollow stigma of dried material.

Chromosome Number: $n=20$ (Mehra & Vij 1970); $2n=38$ (Biswas 1980).

SPECIMENS EXAMINED: **North West Himalaya:** Maitli- Dafia Dhoora, 2800 m. 8.9.1979, *Arora* 45590, (DD!). **Nepal:** *C. Nepal:* Kathmandu, Toka, Napalia, *Wall* s.n. May 1821, (K-Lindl.), 1974 *Eria excavata*= *Octomeria excavata* K-W!; Nepal, *Wall*.s.n. (K!); Gorkha, Near Ngyek, 7.6.1983, *P.R. Shakya* 7779, (KATH!); *P.R. Shakya* 808 (KATH!); *P. Pradhan* 792 (KATH!), Makawanpur, Daman *D. M. Bajracharya* 489, 15 May 2003 (TUCH!); *NP Manandhar* 98-92 (KATH!), Makawanpur, Lami Danda, Dec 1996, *White & Sharma* 171, (K!); **E. Nepal :** Taplejung, Mikhalajung 2000m., 6.6 2003, *D. M. Bajracharya & L. R. Shakya* 563 (TUCH!). **Sikkim Himalaya:** Sikkim superior, May 1885, *C. B. Clarke* 46457, (K!); Darjeeling 2000 m, *Gamble* 9997 (K!); Sikkim Himalaya, June 1893, *R. Pantling* 273, (K!); Joogloo, 3.8.1862, *T. Anderson* 1238, (CAL!) Jooloo, *S. Kunz* s.n (CAL!); Great Rangist, 16.8.1862, *T. Anderson* 1239, (CAL!); **Assam:** Khasia, *Griffith* 1012, (K!); Sryong 2200 m, 22.5.1886 *C. B. Clarke* 43937, (BM!); Shillong Peak, June 1886, *Mann* s.n., (CAL!); Khasia Hill, June 1889, *Mann* s.n. (CAL!); Khasia Hill Unknown 80/1884, (CAL!); Shillong, 5 6. 1958, *R. S. Rao* 11191, (CAL!); Peak forest Shillong, 28.10.1959, *G. K. Deke* 19138, (CAL!); Khasia, April 1897, *Pantling* s.n. (CAL!); **Manipur:** Sirohu 2600 m, *S. K. Mukerjee* 3237 (CAL!). **Bhutan Himalaya:** Chukku dist. between Tunudag and Tola 2000, 22.2.1982, *Grierson & Long* 3122, (E!); Patibhir 1500-1600m, 15.4.1964 *G. Sen Gupt* 1171, (CAL!); Bhutan, *J. C. White* s.n. (13), May (CAL!); **West Bengal** Darjeeling, Oct 1886, *Gamble* 9997, (CAL!); Bungalow, 14.6.1877, *King* 4753, (CAL!) Lovha 2000-2500 m, 8. 11.1961, *G. Sen Gupta* 317, (CAL!); **North East Himalaya :** Kameng, Siang Subansisri, Tirap; between 1500-2000 m., *H. J. Chowdhery* s.n.

Note: King and Pantling (1898) noted that the specimens gathered in Sikkim were self-pollinating and considered that the species might be a cleistogamous form of the related *E. alba*. They also commented that the column was not excavated in the living material in *E. excavata*. From the present study it confirmed that *E. excavata* has not cleistogamous form of the flowers.

41. *Eria pokharensis*. *D. M. Bajracharya, A. Subedi & K. K. Shrestha, sp. nov. J. Orchids Soc. Ind.* (in communication)

Eria pokharensis *Bajracharya, Subedi et Shrestha sp. nov. quamis E. excavata sit simillima labelli quadrangularis, oblonga trilobii quum complanatus ca. 6mm, labellum sine junctus super columie esursum minor, concavus, mid lobii crassus et planus quadrangularis, circa longiores quam latus basi, trilobulii acutis erecto curvus lobo lateralii orbiculii, erecto ciliatus flavidus cum roseus apexi, bicallii inter lateral lobii et convolutus*

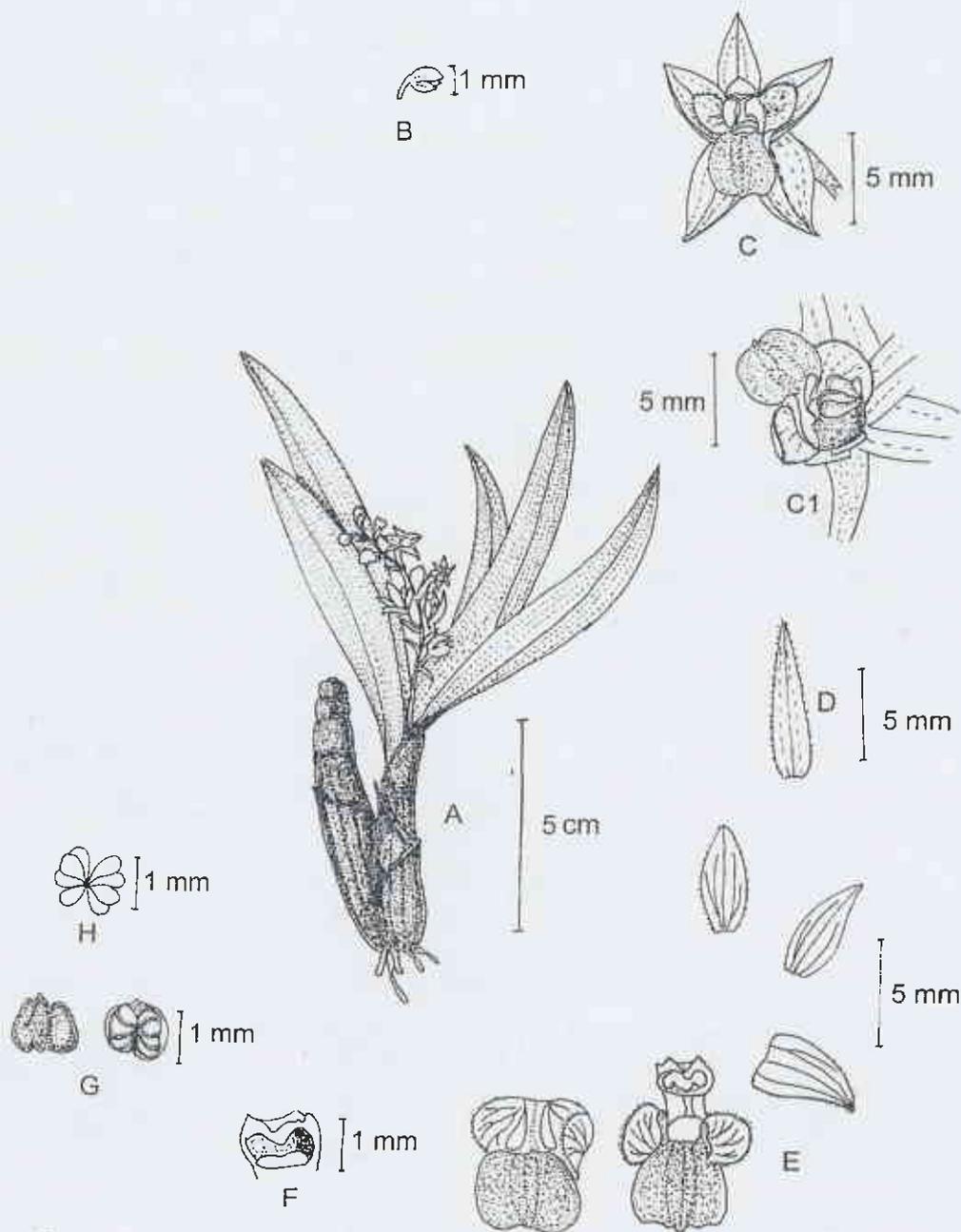


Fig 55. *Eria pokharensis* D. M. Bajracharya & al (*D. M. Bajracharya & A. Subedi 220, KATHI*) A: Habit; B: flower; C & C₁: Lateral and front views of flower; D: Bract; E: Spreading of Sepal, Petal and Labellum; F: Column; G: Operculum; H: Pollinia.

Epiphytic orchid about high 7-12 cm high. *Root* arises at the base of the pseudobulbs. *Pseudobulbs* clavate and club shaped, 3-4 cm x 2 cm long, covered by the leaf sheath in chain, wrinkle in the old pseudobulbs. *Leaf sheath* 4-5 in number, ca. 1-1.5 cm long, totally covered the pseudobulbs during young, membranous, green in young, and brown at old, deltoid, acute, thin, edge membranous, 8-veined. *Leaves* 4-5 in number, at the tip of the pseudobulbs, 4-6 x 0.9-1.0 cm, and oblong-lanceolate, acute, entire, thin, glabrous, folded leaves 7-veined. *Inflorescence* 2-3 cm, raceme, lax, terminal, arise from the middle of the leaf, 5-6 flowered, *peduncle* ca. 1-1.5 (-2) cm long, rachis 5-7 cm long, slightly pubescent. *Floral bracts* ca. 8-9 x 2 mm, triangular, acuminate, scattered hairs on the edge, 3-veined, shorter than pedicel and ovary, dorsal surface finely pubescent. *Pedicel and ovary* ca. 10-15 x 2 mm, erect, pubescent. *Flowers* ca. 1-1.2 cm across, yellowish white, curved, rust pubescent at the base. *Sepals* obliquely oblong-ovate, pubescent; *dorsal sepal* ca. 4-6 x 2-3 mm, yellowish white, ovate, obtuse, 3-veined; *lateral sepals* ca. 6-7 x 3 mm, obliquely oblong, falcate, obtuse, 4-veined; *mentum* absent. *Petals* ca. 6-6.5 x 1.5-2 mm, lanceolate, thin, obtuse, and yellowish white, with 3-veined. *Labellum* tri-lobed, ca. 5 x 4 mm, when flattened ca. 6 mm, rectangular, oblong, labellum without a joint, arising above the column from the upward, curved, which is short, concave; lateral-lobe circular, ca. 1-1.5 x 1 mm, erect, hairy yellowish white; terminal lobe rectangular, ca. 3.5 x 3.2 mm, thick about as long as broad at the base, thick and flat, tri-lobed, acute, up curved, sinus longer, acute; disc with pink at the tip, two callii in between and rolled. *Column* ca. 1.5 mm long, stout, glabrous curved, not excavate; foot short and reduced, lip arise directly from the column; clinandrium collar like; operculum pea shaped ca. 1.5 x 1.25 mm, viscidium simple and ellipsoid, glandular in outside. *Pollinia* 8, pyriform; caudicle glandular; rostellum ligulate, bent towards the stigmata. *Stigmatic cavity* ca. 1-1.5 x 0.5 mm, entire, pointed lobed inside the cavity. (Fig. 55)

Type: Nepal, Lumle, Pokhara, Gadaki zone, 900-1000 m., 10.4. 2000, D. M. Bajracharya, and A. Subedi. CN 220, (Holotype: KATH,).

Distribution: 900-1000 m. Nepal, Pokhara valley.

Flowering: April-June

Status: Endemic to Himalaya

Etymology: The specific epithet of the new taxon *pokheransis* is based on the famous place "Pokhara", Nepal Himalaya from where specimens were collected.

SPECIMENS EXAMINED: Nepal: C. Nepal : Lumle, Pokhara, Gadaki zone, D. M. Bajracharya, A. Subedi. CN 220, 350, 14 April 2000. (Holotype: TUCH! Isotype: KATH!,).

Note: *Eria pokharensis* shows close affinity with *E. excavata* Lindl., but it can be easily distinguished from the latter by tri-lobed labellum, terminal lobe rectangular, tri-lobulate, disc with two callii; operculum pea shaped and pyriform pollinia.

42. **Eria bhutanica** D. M. Bajracharya & K.K. Shrestha, *Harvard Paper of Botany* 7 (2): 403-405 (2003).

Epiphytic herbs, 15-20 cm tall. *Roots* from base of pseudobulb. *Pseudobulbs* 3-4 cm long, crowded on creeping root stock, ovoid, tapering apically, marked with vertical lines, clavate, sub-cylindrical, nodes of pseudobulbs 2, one node on erect portion; leaf sheath per pseudobulb 2 or 3, ca. 20 x 5 mm, auriculate, thin, acute. *Leaves* 4-5 in number, lanceolate, acute, folded, 8-15 x 1.3-1.5 cm, thin, glabrous, entire, 9-veined. *Inflorescences* racemes, terminal, 5-7 flowered, only one inflorescence emerging from pseudobulb, as long as leaf; *Rachis* 3-4 cm long, pubescent. *Floral bracts*, ovate-lanceolate, acute, ca. 7 x 2 mm yellowish-white, pubescent. *Pedicel and ovary* ca. 9-10 mm long, gray pubescent. *Flowers* ca. 13 x 5 mm, creamy white, pale yellow inside. *Sepals* unequal oblong-elliptic, 5-8 x 3mm; *Dorsal sepal* oblong-elliptic, acute, ca. 6-6.5 x 3-3.8 mm, thin, entire, pubescent, 3-veined; *Lateral sepals* obliquely oblong, acute, ca. 8 x 3 mm, pubescent, 3-veined, mentum absent. *Petals* ovate, acute, thin, ca. 6 x 2 mm, glabrous, white, 3-veined. *Labellum* ca. 5 x 3 mm, obtrullate, 3-lobed, terminal lobe rhomboid, broad, crenate, tridentate, ca. 5.5 mm long, sinus shorter, obtuse; lateral lobes oval, ca. 2-2.5 x 2 mm, deflexed, tinged reddish purple, disc with two circular ridges between lateral lobes, base of lip round. *Column* ca. 3 x 1.5 mm, glabrous, curved, columnfoot ca. 1.5 mm; clinandrium collar like; operculum ca. 2 x 1 mm, purple red, bilobed, each lobe 4-chambered; *Rostellum* ligulate, bent towards the stigmatic cavity. *Pollinia* 8; broadly obovoid, caudicle waxy; viscidium simple, ellipsoid. *Stigmatic cavity* ca. 1.5 x 1 mm, entire. (Fig. 56)

Type: Bhutan, Retang-Tangchu 7000 ft, S. Bomes Lyon 15000, 9.6.1969 (Holotype: BM!).

Distribution: 3340 m., Himalaya (Bhutan).

Flowering: June.

Status: Endemic to Himalaya

Etymology: Named after the country of origin, Bhutan, where the type specimen was collected.

SPECIMENS EXAMINED: Bhutan, Retang-Tangchu 2000 m, S. Bomes Lyon 15000, 9.6.1969 (Holotype: BM!).

Note: *Eria bhutanica* is close to *E. excavata* Lindl., however, it can be easily distinguished by characters like obtrullatus, tri-lobed labellum; terminal lobe rhomboid, tridentate; lateral lobe deflexed, tinged with reddish purple, disc with two circular ridge between the lateral lobes

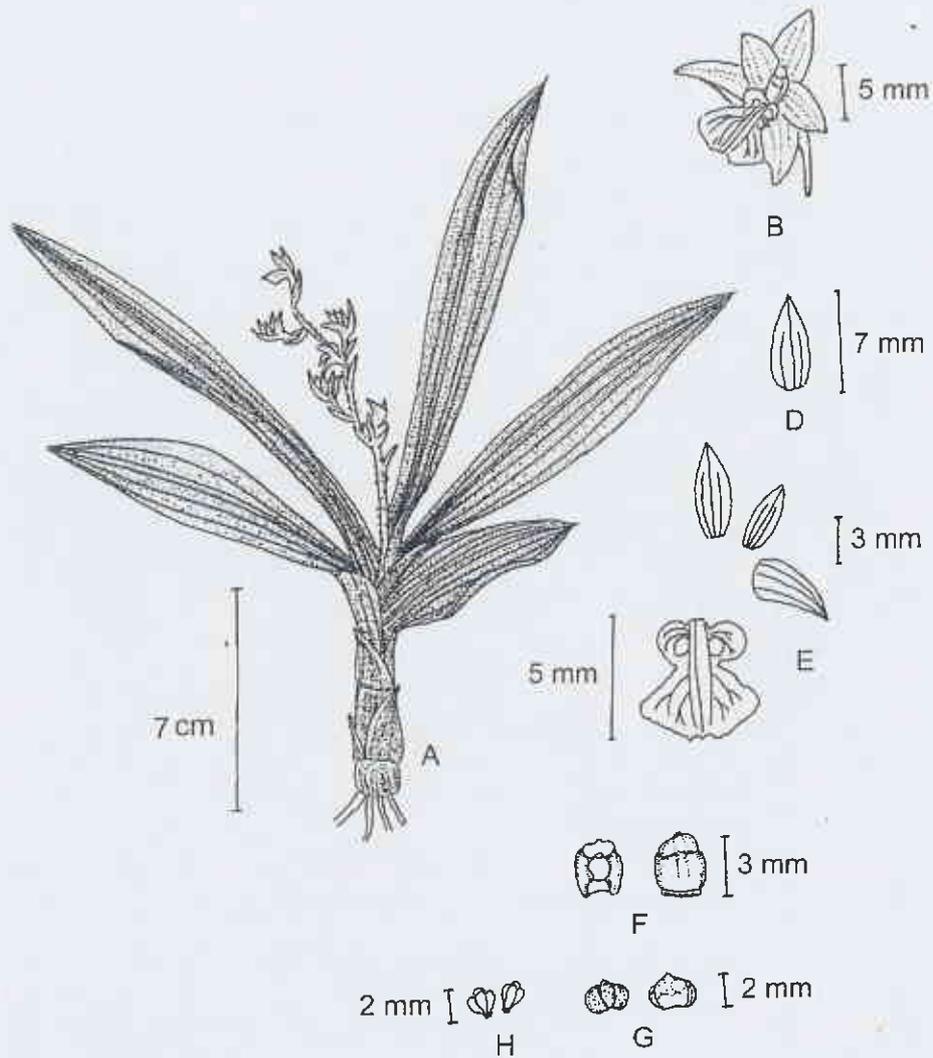


Fig 56. *Eria bhutanica* D. M. Bajracharya & K. K. Shrestha. (*Bowes Lyon* 15000, BM !) A: Habit; B: flower; C: Bract; D: Spreading of Sepal, Petal and D₁ Labellum; E: Column; F: Operculum; G: Pollinia.

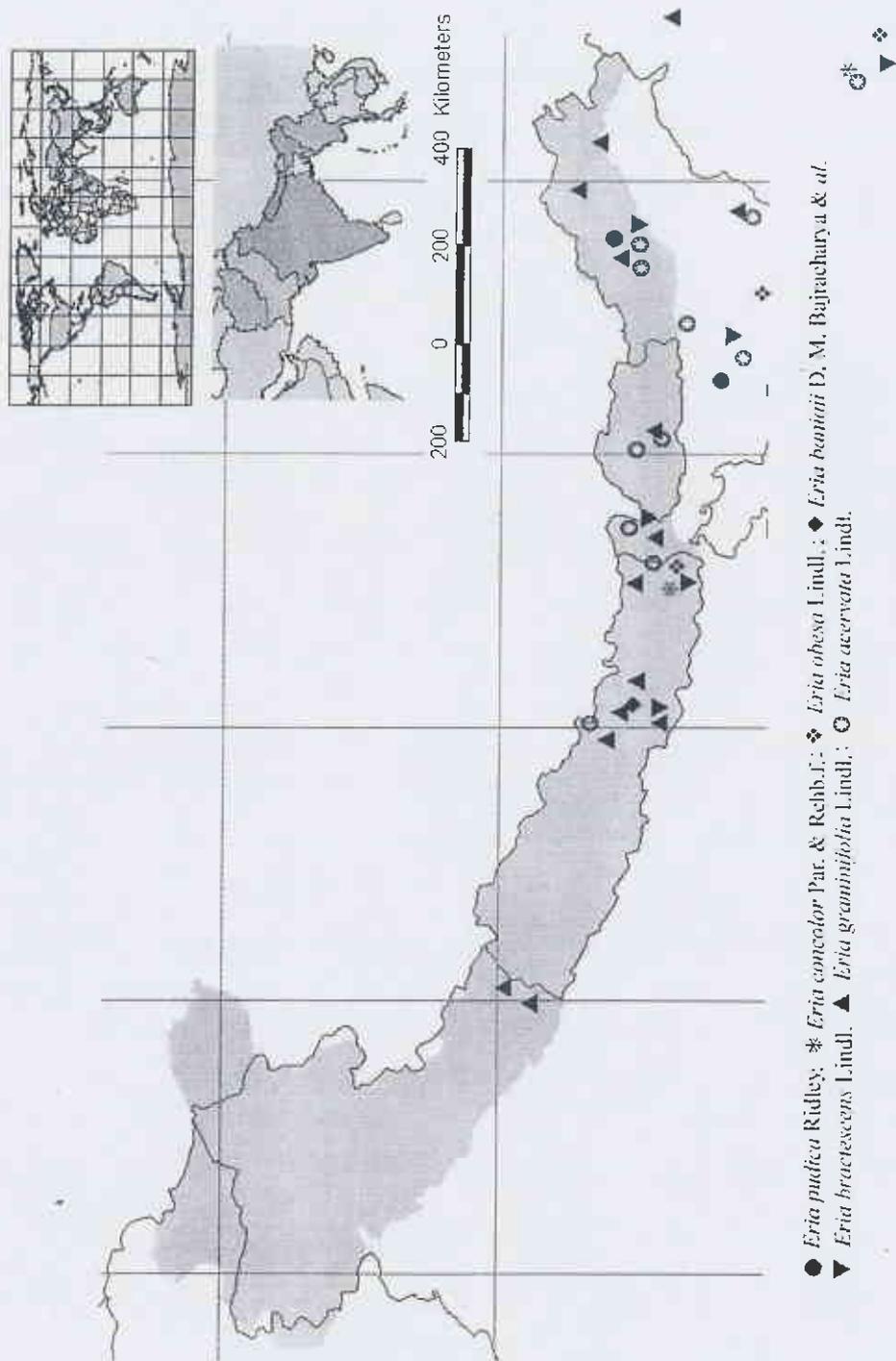


Fig. 57 Distribution Map of the section Hymeneria

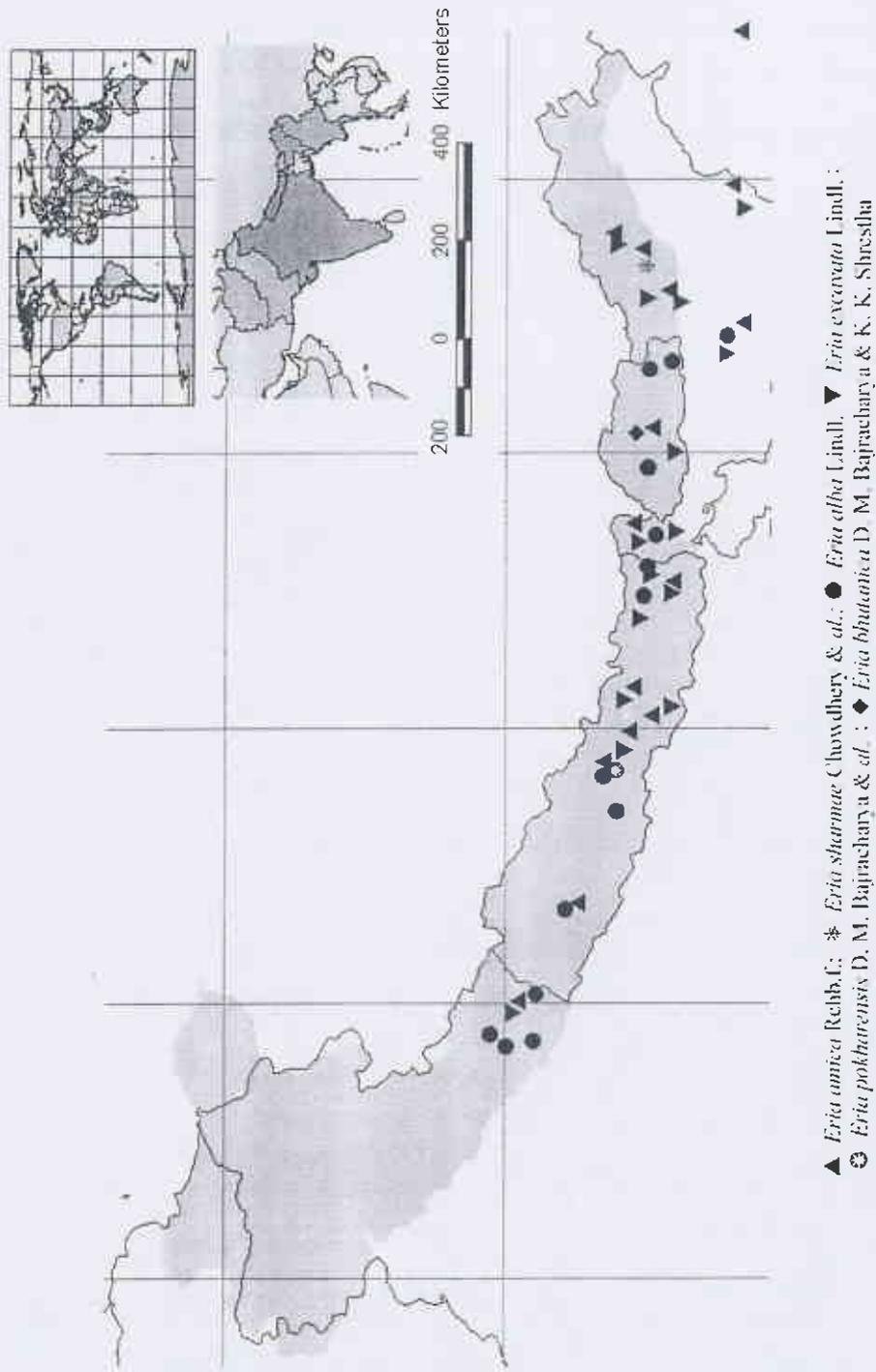


Fig. 57 Distribution Map of the section Hymeneria

Section XII. Pinalia (Lindley) Seidanfaden, *Opera Bot.* 62: 121, 1982.

Pseudobulb (stem) more or less fleshy; pseudobulb with nodes, sheathing at base; leaves apical with 1-6 leaves; inflorescence lateral arising from apex of pseudobulb, globose or spicate, laxly 5-20 or more flowered, pubescent or glabrous; floral bract conspicuous; labellum tri-lobed, column terete, clavate, column continuing directly into the base of the labellum.

Type: *E. convallariodes* Lindley. Gen & Sp. Orchid. Pl. 70: 1830 (as sub genus *Pinalia*), [*Octomeria spicata* Buch-Ham ex D. Don, *Prod. Fl. Nepal.* 31, 1825].

Note: The section *Pinalia* was proposed by Seidenfaden (1982). The generic name *Pinalia* was given by Lindley (1826), later he treated it as the subgenus *Pinalia* under the genus *Eria* in 1830, and included *Eria convallariodes* in it. Lindley (1859) proposed several new sections, but he did not mention his old subgenus *Pinalia*, but placed *Eria convallariodes* in the section *Hymenaria*. He noted that the section *Hymenaria* might be subdivided, one subdivision containing "those with a dense inflorescence like *E. convallariodes* and *E. pumila*". In this section (*Pinalia*), *Eria spicata* and its allies can be included, which is quite different from the section *Hymenaria*, by up curved column foot with concave upper surface and fat rounded edges continuing from base of labellum and not acute angle and without joint are included; whereas in *Hymenaria* the lip is attached with the column foot at an acute angle, more or less movable with distinct joint.

About 12 species: from Himalaya (NW Himalaya, Nepal, Sikkim, Bhutan, NE Himalaya) through SW China to Myanmar and Thailand; seven species in Himalaya *E. apertiflora*, *E. bipunctata*, *E. connata*, *E. glabulifera*, *E. spicata*, *E. occidentalis*, and *E. pumila*.

- 1.a Inflorescence a lax raceme 2
- 1.b Inflorescence densely sub-cylindrical or globose dense 4
- 2.a Pseudobulb narrow-conical, terminal lobe of labellum bilobulate ----- **E. occidentalis**
- 2.b Pseudobulb stem or fusiform, terminal lobe of labellum obtuse 3
- 3.a Pseudobulb fusiform, flowers small (< 3 mm), dorsal sepal 3-4 mm, labellum distinctly yellow **E. bipunctata**
- 3.b Pseudobulb stem like, flowers large (> 5 mm), dorsal sepal 5-8 mm, labellum yellow, rarely purplish. **E. apertiflora**
- 4.a Inflorescence dense globose head with many flowered, terminal lobe of labellum bilobulate or not 5
- 4.b Inflorescence small ovoid, dense, short sub-cylindrical with many flowered, terminal lobe of labellum acute or obtuse 6
- 5.a Lateral sepals narrow, terminal lobe not bilobulate; mentum tubular ----- **E. connata**

- 5.b Lateral sepals lanceolate and triangular; terminal lobe bilobulate; mentum round -----
----- **E. pumila**
- 6.a Terminal lobe of labellum orbicular as long as broad at base, flower bright yellow, lateral
lobe of labellum semicircular or ovate ----- **E. globulifera**
- 6.b Terminal lobe of labelum deltoid, and widening from base; flower white, with purplish tint,
lateral lobe of labellum triangular ----- **E. spicata.**

43. Eria occidentalis Seidenfaden, *Nord. J. Bot.* **2**: 15, f. 1, (1982); Deva & Naithani *Orch. Western Himal.* :285 (1986); Pangtey & al., *Orch. Kumaun Himal.* :115 (1991).

Epiphytic herbs, *Pseudobulbs* clustered, narrow-conical 3-4 x 1-1.5 cm, covered with large sheathes when young. *Leaves* 2-6, lanceolate, 8-10 x 1-1.2 cm, acute-acuminate, tapering towards both ends, short petiolate, ca. 1-2 cm long. *Inflorescence* erect, lax, 7-10 flowered, sub terminal from young developed pseudobulbs, often two together; rachis ca. 2.5-3 cm long, thinly pubescent (stellate hairy). *Floral bracts* ovate, ca. 5 x 2 mm long, acute, much recurved. *Pedicel and ovary* ca. 5 mm long, with thin stellate hairs. Flowers 5-6 mm across, dull whitish, glabrous. *Sepals* unequal, 5-6 x 3-5 mm, white; *dorsal sepal* ovate, 4-5 x 3.5 mm long, acute 3 veined; *lateral sepals* broad, triangular, ca. 6 x 4.5 mm broad at base, not much oblique; mentum present. *Petals* as long as sepals, oblong or lanceolate, 5-6 x 2.5-3 mm, acute-acuminate, sepals and petals with light green or pinkish tint. *Labellum* tri-lobed, ca. 4.5 mm long, fan shaped, bilobulate, ca. 5 mm broad across when flattened; lateral lobes broad, orbicular, light pink; terminal lobe ca. 1 mm long, short bilobulate, recurved, yellow; possibly three indistinct narrow keels on blade; hypochile of labellum dark purple. *Column* short, column foot concave at upper side, long, distally turned upwards, merging without joint into fan shaped labellum; operculum pea shaped; clinandrium collar like; rostellum ligulate. *Pollinia* 8, obovoid; viscidium, simple. *Stigmatic cavity* entire. *Fruit* fusiform, 8-9 mm long. (Fig. 58)

Type: North-West Himalaya, **Kumaun (India):** Between Chowpta and Maitli, Pithoragarh 1550m, Arora 70806 (Holotype: C; isotype DD!)

Distribution: between 1200-1300m, North West Himalaya (Garhwal to Kumaun)

Flowering : July- August

Status: Endemic to Himalaya

Etymology: From the Latin word '*Occidentalis*' (western), with reference to the western locality.

SPECIMENS EXAMINED: **North west Himalaya:** Garhwal Chamoli, Ukhimath, M. A. Rau 38785 (DD!); Kumaun: Pithoragarh between Chowpta and Maitli 1700 m, 7.8.1980, Arora 70806, (C Holotype: DD Isotype!); Dafiadhura, 2000 m. Arora 55824, 15.3.1976, (DD!).

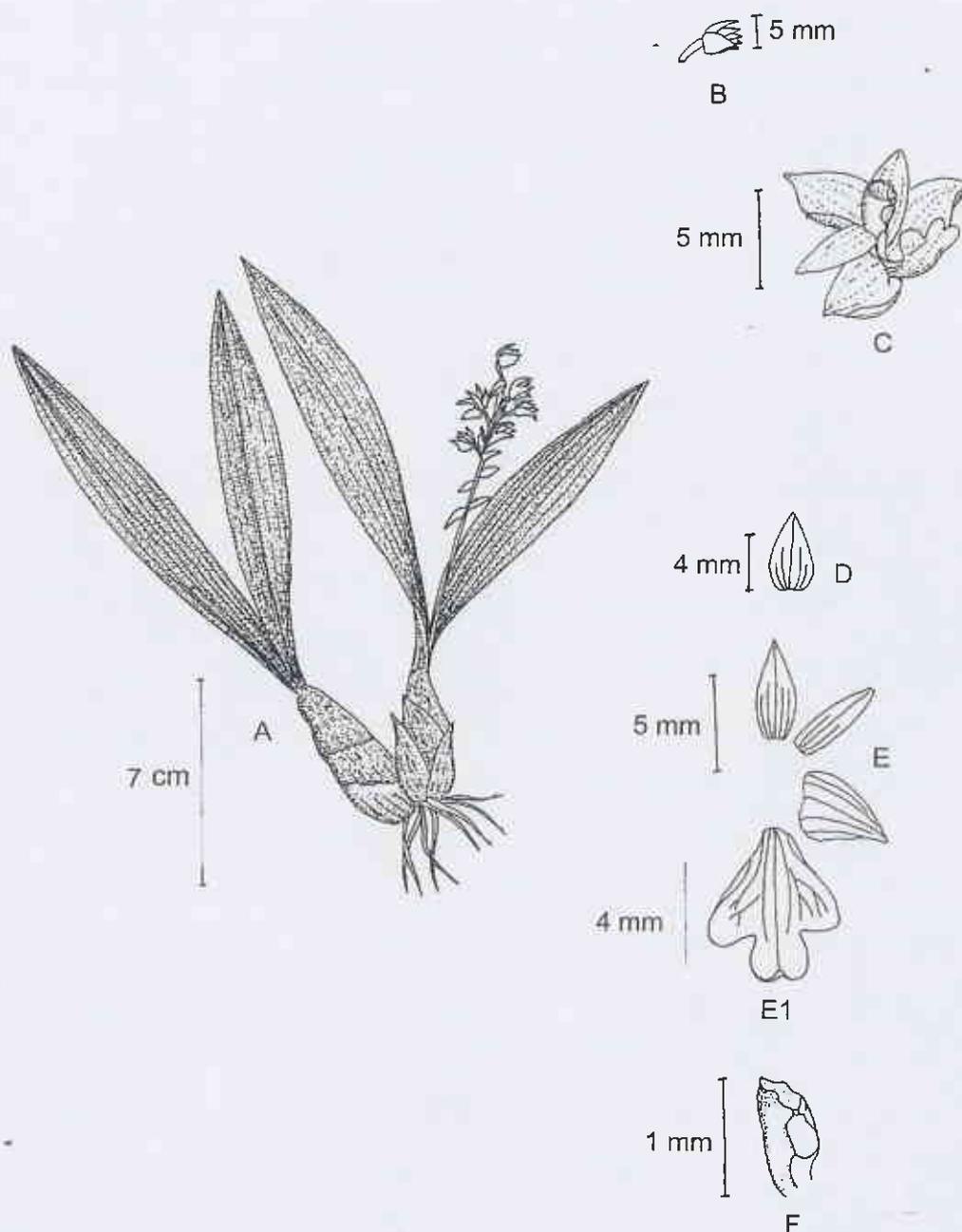


Fig 58. *Eria occidentalis* Seidenfaden (Arora 70806, DD!) A: Habit; B: Flower; C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column.

44. **Eria bipunctata** Lindley, Edward's *Bot. Reg.* (Misc.) 83 (1841); J. D. Hooker, f., *Fl. Brit. Ind.* 5: 792 (1890); Kränzlin in Engler, A. (ed.) *Das Pflanzenreich Hfl.* 50: 109 (1911); Seidenfaden, *Opera Bot.* 62: 123. f 73, pl IXb (1982). Chowdhery, *Orch. Arunachal Prad.* :354 (1998); Bajracharya, *Jour. Jpn. Bot.* 76: 297 (2001).

Pinalia bipunctata (Lindl.) Kuntze *Revis. Gen. Pl.* 2: 679 (1891).

Eria eberhardtii Gagnep. *Bull. Mus. Natl. Hist. Nat.* II, 2: 306 (1930).

Epiphytic herbs, 20-22 cm high. *Pseudobulbs* fusiform, compressed, obovoid to clavate, sympodial, 4-6.5 cm x 1.5-2 cm, with four or five nodes in pseudobulbs, covered by 2 or 3 membranous leaf sheath; *leaf sheaths* 3 or 4 in number, deltoid, entire, acute, abscission layer presence. *Leaves* rolled around the pseudobulbs, 5-6, cauline, obovate-elliptic to elliptic, 8-15 x 2.5-3 cm, acute, subcoriaceous, attenuate, glabrous, entire, 9-veined. *Inflorescence* lateral, in lax raceme, 4-8 cm long, bent, peduncle 1.5-2 cm long; rachis 4-72 cm long with many flowered, pubescent. *Floral bracts* lanceolate, 4-6 mm x 2.5 mm, acute, glabrous, translucent, indumentum scattered along the edge, lower bracts longer than pedicel and ovary, 3-veined. *Pedicel and ovary* ca. 4-5 mm x 0.5 mm, sparsely pubescent. *Flowers* creamy white, ca. 3 x 2.5 mm, 6 mm across when flattened. *Sepals* unequal, 5-6 x 2-5 mm, white, glabrous; *dorsal sepal* broadly elliptic, obtuse, glabrous, entire, thick, white with a purplish tint, ca. 4-5 x 2.5 mm; *lateral sepals* oblong-elliptic, slightly oblique, ca. 6 x 5 mm, acute, thick, 3-5 veined; adnate to column foot and forming mentum; mentum 5 mm long from the foot of the column to its tip, round, incurved. *Petals* oblong, obtuse, membranous, thin, glabrous, 2.5-3 x 2 mm, entire, 3-veins, white, petal edge thin. *Labellum* tri lobed, rhomboid shaped with broad claw, ca. 3-4 x 2.5 mm, thick, short; lateral-lobes round or subtriangular, base spreading narrow, hypochile with large and nearly broad at labellum, deflexed; terminal lobe thick, 2.5 x 2.5 mm, ca. 3-3.5 mm across when flattened down, subtriangular, smaller than lateral lobe, conspicuously thickened, obtuse, sinus with outgrowth with yellow patch at its tip, entire, convex, 3-veined. *Column* ca. 2 x 1 mm, reflexed, light brown; foot 3 mm long; operculum light purple, ca. 1.5 mm across; clinandrium collar like; rostellum ligulate. *Pollinia* 8, pyriform, pollinia attached with gelatinous membranous caudicle; viscidium simple and ellipsoid. *Stigmatic cavity* oval shaped outside, entire, and ca. 1.5 x 1 mm. (Fig. 59)

Type: Assam (India), Khasia Gibson s. n. (Holotype: K!)

Distribution: 1000-1700 m, Himalaya (Nepal, Assam, NE Himalaya, Burma), Thailand, Indo-China, Vietnam.

Flowering: July -Sept.

Status: Common

Origin: Himalayan species

Etymology: From the Latin word 'Bī' (two) 'punctatus' (dotted).

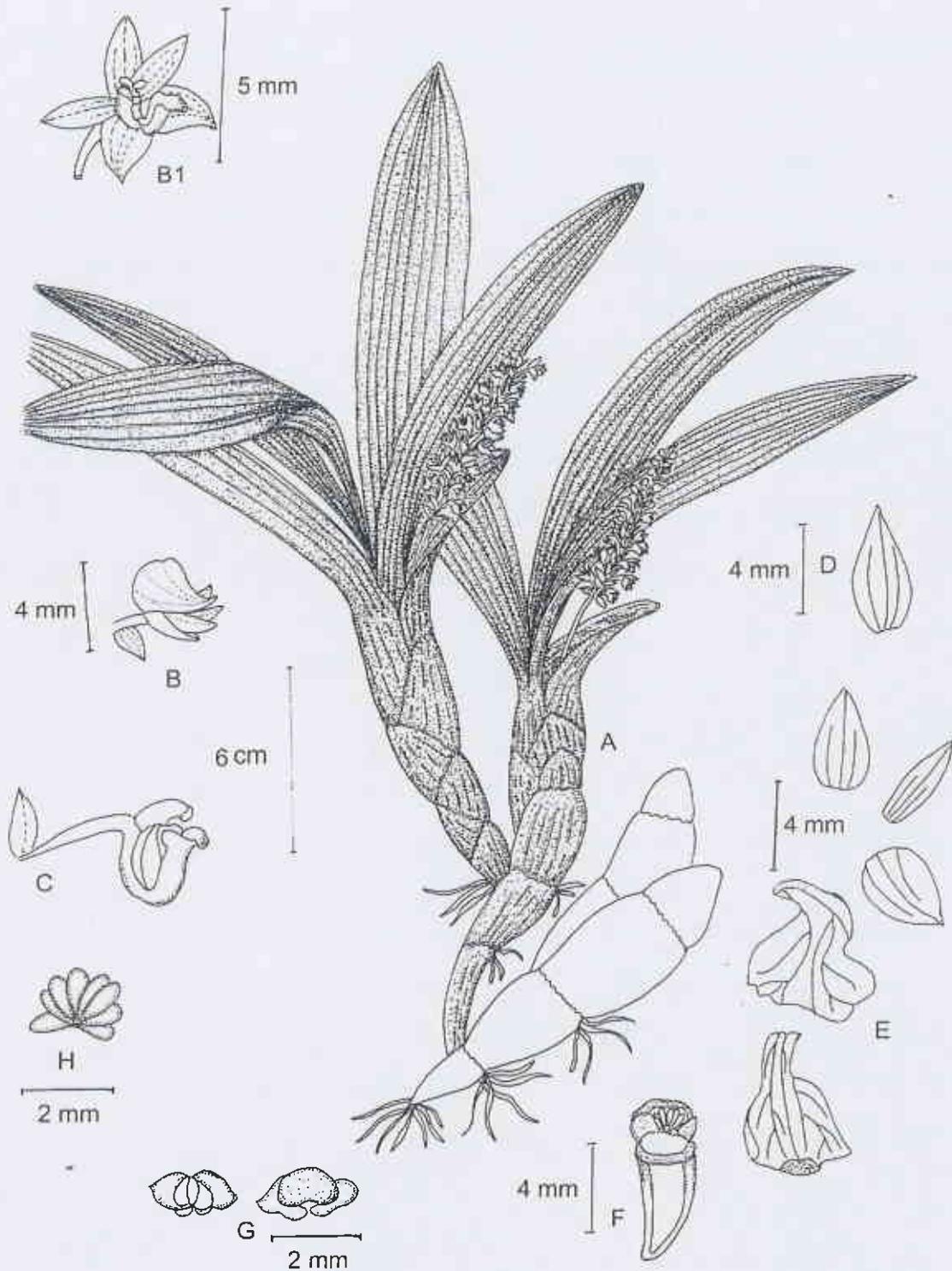


Fig 59. *Eria bipunctata* Lindley, (*D. M. Bajracharya* CN 121 TUCH!) A: Habit; B: Flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal and Labellum; F: Column; G: Operculum; H: Pollinia.

SPECIMENS EXAMINED: **Nepal: W. Nepal** : Doti, Chhatiwon, 1350-1450 m. Aug. 2002, G. Amatya 23.; **C. Nepal**: Kaski, Ghodepani, 1600 m, 18.8.1997, D. M. Bajracharya CN0121, (TUCH!, KATH!); Kaski, Bakkri Kharka, Modi Khola 1700 m, 17.7.1954, Stainton, Sykes & Williams 6397 (BM!); Kaski, Puranchaur, Seti Khola 1100 m, 24.7.1954, Stainton, Sykes & Williams 474, (BM!); **Assam**: Khasia Gibsons.n. (K! type); Walter N. Koelz 30544, 14 July 1952 (K!); **North East Himalaya** : Subansiri; between 1000-1500 m, H. J. Chowdhery; **Burma**: Upper Burma, 1893, Abdul Khalil s.n. (CAL!).

Note: Most of the *E bipunctata* specimens deposited in BM, K, CAL, KATH and TUCH are identified as *E. spicata* by previous workers. *E. bipunctata* differs from *E. spicata* with laxly inflorescence, and rhomboid shaped labellum with broad claw where as *E. spicata* having dense inflorescence with deltoid shaped labellum, and widening from base. This species is new record for the Flora of Nepal.

45. **Eria apertiflora** Summerhayes, *Kew Bull.* 9: (1929); Seidenfaden, *Opera Bot.* 62: 123, Fig. 74, pl. IX d (1982); Seidenfaden, *Opera Bot.* 114: 191 (1992); Bajracharya, *Jour. Jpn. Bot* 76: 297 (2001); Pearce & Cribb, *Fl. Bhutan* 3 (3): 384 (2002).

Epiphytic herbs, 20-22 cm high. *Pseudobulbs* stem-like, slender, sympodial, 9.5-16 cm long, with 4-6 nodes in pseudobulbs, covered by leaf sheath; *leaf sheath* 3, ovate, entire, acute, grayish-green with white veins, and presence of abscission layer. *Leaves* oblong-lanceolate, 4-5 leaves rolled around pseudobulbs, 13-21 x 2.8-5.5 cm, acute, sub-coracious, 9-veined. *Inflorescence* 8-10 cm long, lateral raceme, cylindrical, many flowered and lax; rachis 3-4 cm long, pubescent. *Floral bracts* ovate, ca. 5-10 x 3 mm, acute, shiny white, with yellow stripe. *Pedicel and ovary* ca. 2.5 mm long, pubescent. *Flowers* 3-5 mm long, ca. 7 mm across when flattened the flower, yellowish white with yellow at the tip of the lip. *Sepals* unequal, 3-7 x 2 mm, yellowish white, glabrous; *dorsal sepal* lanceolate-ovate, obtuse, thick, 3.5-6.5(-8) x 2-3 mm, 3-veined; *lateral sepals* oblique-ovate, sub-falcate, ca. 4-6 x 2 mm, acute, glabrous, entire; *mentum* reflexed, concave, ca. 3 mm long from the foot of column to its tip. *Petals* elliptic-lanceolate, ca. 3 x 1 mm, obtuse, glabrous, thin, entire, white, edge thin, with 1-vein. *Labellum* tri-lobed, ca. 2.5-3 x 2 mm, when flattened, 3.5-4 mm across between tips of the lateral lobes lobes, rhomboid, obtuse, thick, yellowish white at the apex, rarely purplish, wavy margin, relatively narrow at the base with 3-veins; lateral lobe semicircular, ca. 2.5-3 mm, obtuse; terminal lobe triangular, 2.5-3 x 2 mm, obtuse, thick, short pointed, deflexed; *Column* ca. 1 x 0.75 mm, glabrous, reflexed, concave, dark brown dotted; foot ca.1 mm long, short; operculum ca.1 x 0.05 mm white, bilobed; *Pollinia* 8, waxy, obovoid; clinandrium collar like; viscidium simple, and ellipsoid; rostellum ligulate, bent toward the stigmatic cavity. *Stigmatic cavity* ca. 1 x 0.5 mm, cordate shaped with two pointed appendages inside the cavity. (Fig. 60)

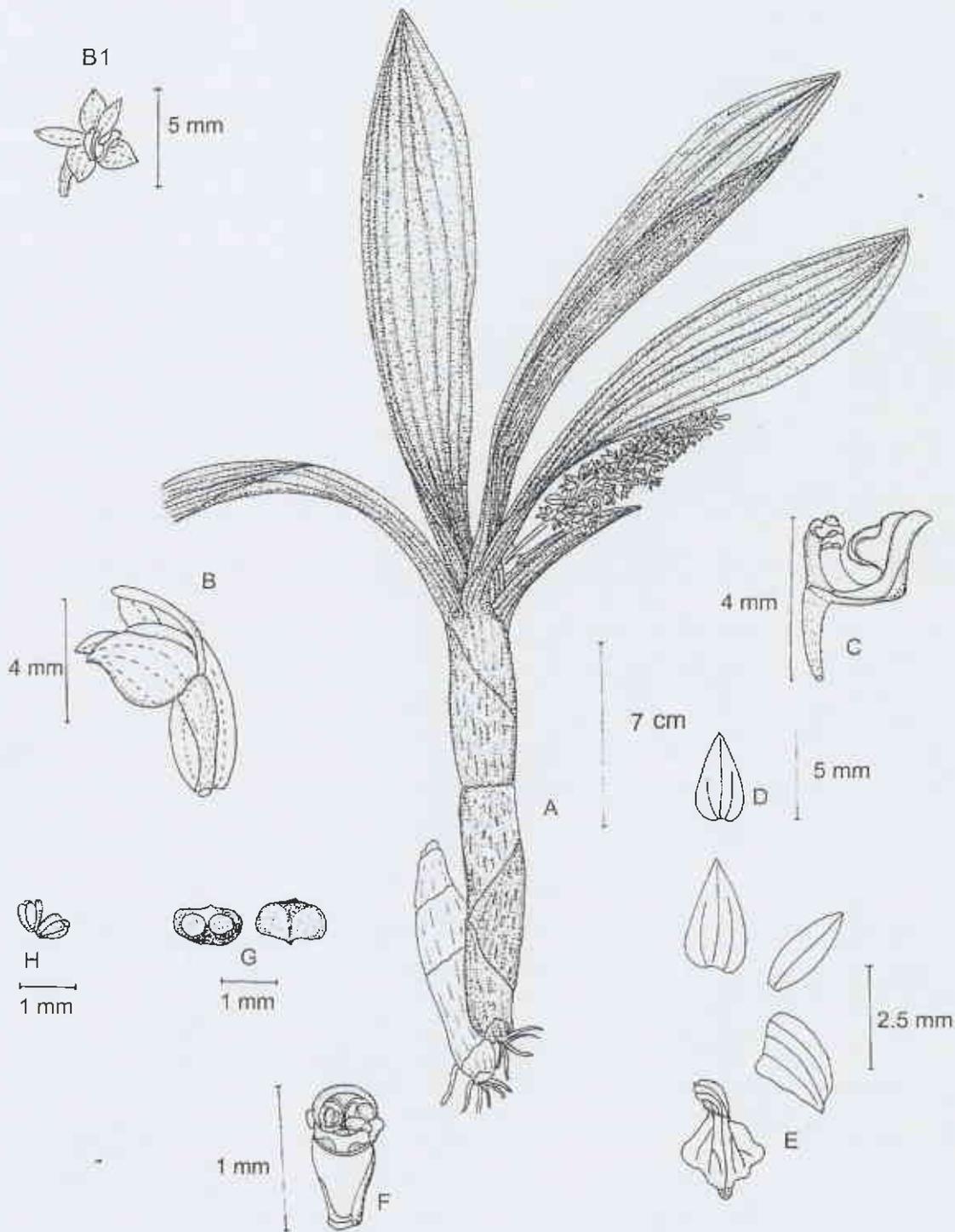


Fig 60. *Eria apertiflora* Summerhayes, (D. M. Bajracharya CN 109 TUCH!) A: Habit; B: Flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal and Labellum; F: Column; G: Operculum; H: Pollinia.

Type: Assam (India), *Hinde s. n.* (Holotype: K!),

Distribution: 1600 m, Himalaya (Nepal, Bhutan and Assam) Thailand, Indo-china, Burma, and Vietnam.

Flowering: November- January.

Status : Common

Etymology: From the Latin word 'apertus' (opened) and 'flora' (flowers).

SPECIMENS EXAMINED: **Nepal:** C. Nepal: Kaski, Central Nepal, Landruk, 1600 m, 24 11 1997, *D. M. Bajracharya* CN 0109, (TUCH!); **Assam:** *Hinde s. n.* (Type K!); Khasia: *Griffith s.n.*, Kew dist.# 5113 (K!), Khasia: *J.D. Hooker & Thomson* 211, (K!). Burma: Moulmein, *Parish* 140 (K!).

North East Himalaya : Khellong, Arunachal Pradesh, *A. N. Rao* 26073 (Orchid Herbarium Tipi).

Bhutan : Rimchu- Tashilhang 1400 m., *D. B. Gurung* 8.8.95; Rimchu, 1200 m., 6. 4. 2002 *D. M. Bajracharya* 465 (TUCH).

Note: Preace and Cribb (2002) mentioned *Eria apertiflora* as a doubtful species in Flora of Bhutan. The specimens examined from Bhutan as well as Assam and Nepal confirms the presence of this species in Eastern Himalaya including Bhutan and Nepal. This species is new record for Nepal and Bhutan.

46. ***Eria connata*** J. Joseph, S.N. Hedge & Abbar, *Bull. Bot. Sur India* 24: 114, f.1-7, (1982 publ 1983); Chowdhery, *Orch. Fl. Arunachal Prad.* :361, f. 214, (1998); Pearce & Cribb, *Fl. Bhutan* 3 (3): 382 (2002)..

Epiphytic herbs, upto 25 cm long including leaves. *Root* slender, wiry. *Pseudobulbs* sub-cylindric, 5-15 x 0.8-1 cm, slightly compressed, obliquely noded, leafless when old shoot arise from the base of old pseudobulb, 4-6 sheathing at the base of nodes. *Leaves* 4-5, terminal, sessile, narrowly elliptic, weakly falcate, 6-8 x 1.0-1.7 cm, acuminate, distichous, coriaceous, 5-7 veined. *Inflorescence* racemes heads, pendent, densely many flowered, one or two axillary or leaf opposed, subsessile, and globose or sub globose, proteranthous. *Floral bract* unequal, broadly ovate to suborbicular, 6.0-7.5 x 5.0-6.5 mm, acute to acuminate, gland dotted, much longer than the ovary, erect, concave, concealing the ovary, 5 veined. *Pediceal and ovary* curved, 5-6 x 1 mm, densely pubescent. *Flowers* many arunate, crowded, numerous, ca. 0.5 cm across, bracteate, shortly pedicellate and slightly fragrant, not widely opening, white with yellow labellum. *Sepals* white, unequal, gland dotted, 3-7 x 2-3 mm; *dorsal sepal* ovate, 3.5-4 x 2.5-3 mm, obtuse, hooded over column glabrous with 3 veins; *lateral sepals* obliquely oblong-lanceolate, 7-8 x 2-2.5 mm, obtuse, and thickened at the apex, adnate to lateral sides of the column foot forms a long tubular mentum, scrotiform, and closely enveloping in the labellum. *Petals* narrow, shorter than sepals, ovate-lanceolate, 3-4 x 1.5-2 mm, obtuse, membranous, blunt at the tip. *Labellum* tri-lobed, narrowly oblanceolate, longer than the dorsal sepal and petals, 6-6.5 x 2-2.5 mm, but shorter than

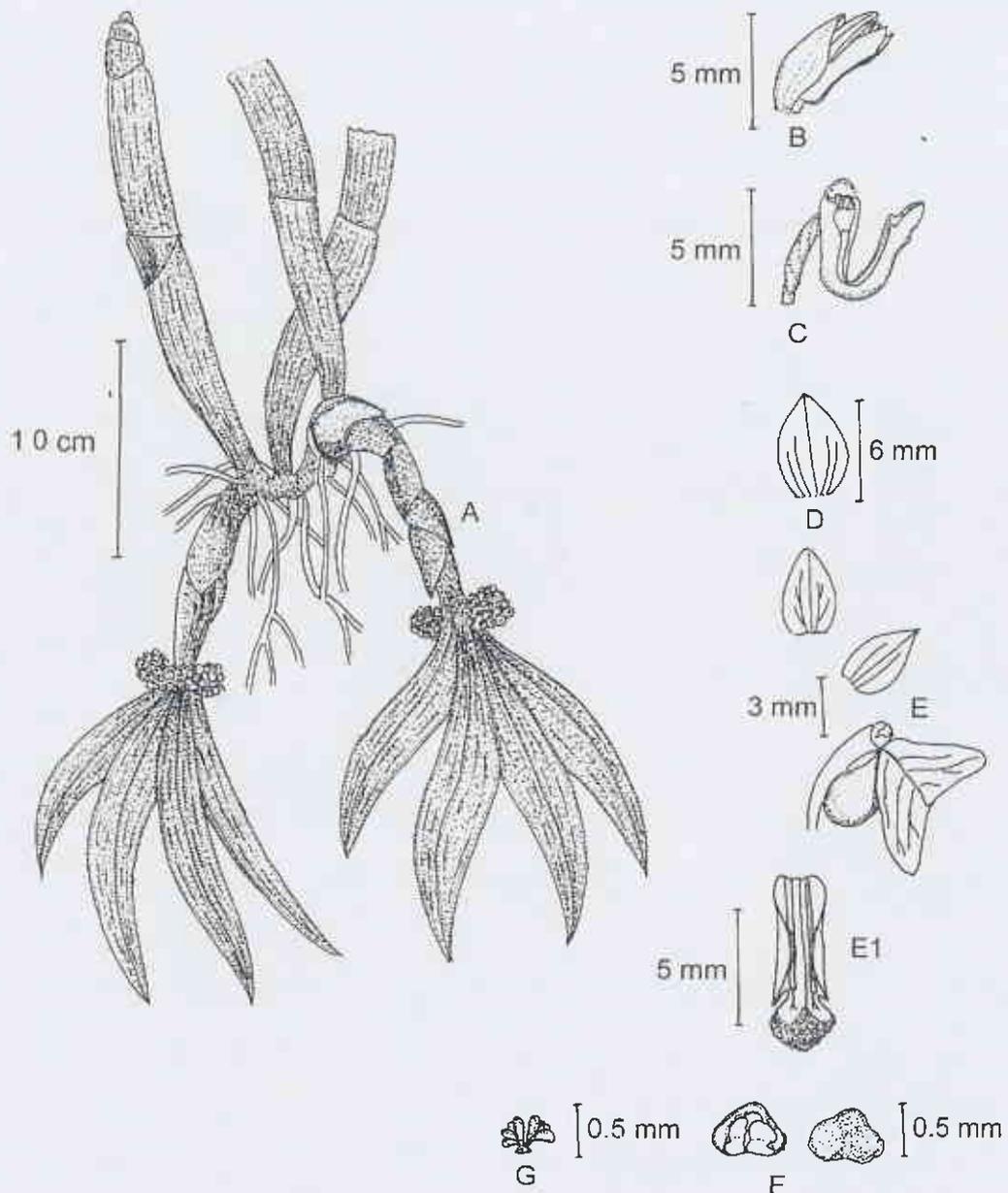


Fig 61. *Eria connata* Joseph, Hedge & Abbareddy (*Abbareddy* 62391, CAL!) A: Habit; B: Flower; C: Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Operculum; G: Pollinia.

the lateral sepals, straight, shallowly saccate at the base, sparsely gland dotted, attached to the tip of the foot; lateral lobe erect, narrow, 4.5-5 mm, long, acute or obtuse, triangular, involute; terminal lobe orbicular, small, 1.5-2 x 2 mm, fleshy, flat, convex, warted adaxially, golden yellow; disc with 3-longitudinally lamellate, lateral lamellae much broader and thicker, not continuous with the terminal lobe, median lamellae very narrow, dilated at the apex and joined with the thickened terminal lobe. *Column* ca. 1.5-2 mm, short, stout, erect with long foot; foot 3.5-4.5 mm, broader, parallel to and subequal with the ovary, dilated and slightly incurved at the tip, prominently 3-ridged within; operculum ca 1.0 x 1.5 mm. *Pollinia* yellow, 8 in two groups of four each, pyriform, long stalked with a common obscure disc. *Fruit* shortly pedicelated, 11 x 3 mm, densely pubescent, 6-ridged, green. (Fig. 61)

Type: North East Himalaya (India), Lecti Sessa District, Arunchal Pradesh, Joseph, Hedge & Abareddy 62391A, 7 Aug. 1980 (Type, CAL!).

Origin : Himalaya Endemic

Distribution: 1200-1500 m , Himalaya (North-East Himalaya)

Status: Endangered

Flowering: July-August.

Etymology: From the Latin word '*conatus*' (fused) in reference to the lateral sepals.

SPECIMENS EXAMINED: Bhutan: Unlocalised, Grierson & Long 4100 (E!). North East Himalaya: (CAL); Kameng, between 1100-1500 m.; H. J. Chowdhery.

47. **Eria pumila** Lindley, Gen & Sp. Orchid. Pl. :68 (1830); Lindl., Edward's Bot. Reg. 24: 79 misc.147 (1838); J. D. Hooker . f., Fl. Brit. Ind. 5: 791 (1890); King & Pantling, Ann. Roy. Bot. Gard. Calc. 8: 118, pl. 162, (1898); Sedinfedan, Opera Bot. 62: 123 (1982); Hajra & Verma, Fl. Sikkim 2: 69 (1996); Chowdhery, Orch. Fl. Arunachal Prad. : 377, f. 226 (1998); Pearce & Cribb, Fl. Bhutan 3 (3): 383 (2002).

Panalia pumila (Lindl.) Kuntze, Revis. Gen. 2: 679 (1891).

Epiphytic herbs, 15-17 cm high, 6-7 nodes in erect parts. *Rhizomes* narrowly stout, cylindrical, 8-11 x 1. 1.5 cm, covered with fibrous sheathes. *Pseudobulbs* thick crowded, elongate, sub cylindrical or clavate, compressed, weakly falcate, club shaped, 5-7.5 x 1.2-1.3 cm. *Sheaths* membranous, lanceolate, acute, 1-1.6 cm long. *Leaves* 4-5, linear-lanceolate, acute, coriaceous, glabrous, 5-8 x 0.5- 2 mm, tapered to a short, sheathing petiole, jointed. *Inflorescence* short, 0.4-1 cm across, in axillary, globose-capitate head, densely many flowered; peduncles ca. 1 mm long axillary, pubescent; rachis 2-5 mm long, pubescent. *Floral bract* oblong, broad, sub-acute or acuminate, glabrous, membranous ca. 2-2.5 x 1.5 mm, serrate margin. *Pedicel and ovary* ca. 2 mm long, tomentose. *Flowers* 2-3 mm across, white, fleshed with red or pink, minute, and fragrant. *Sepals* identical, broadly oblong, obtuse 2-3 x 1-1.5 mm; *dorsal sepal* broad, oblong, obtuse, 2-2.5 x 1-1.5 mm, entire, glabrous, sessile, 3 veined; *lateral sepals* triangular, oblong, obtuse, entire,

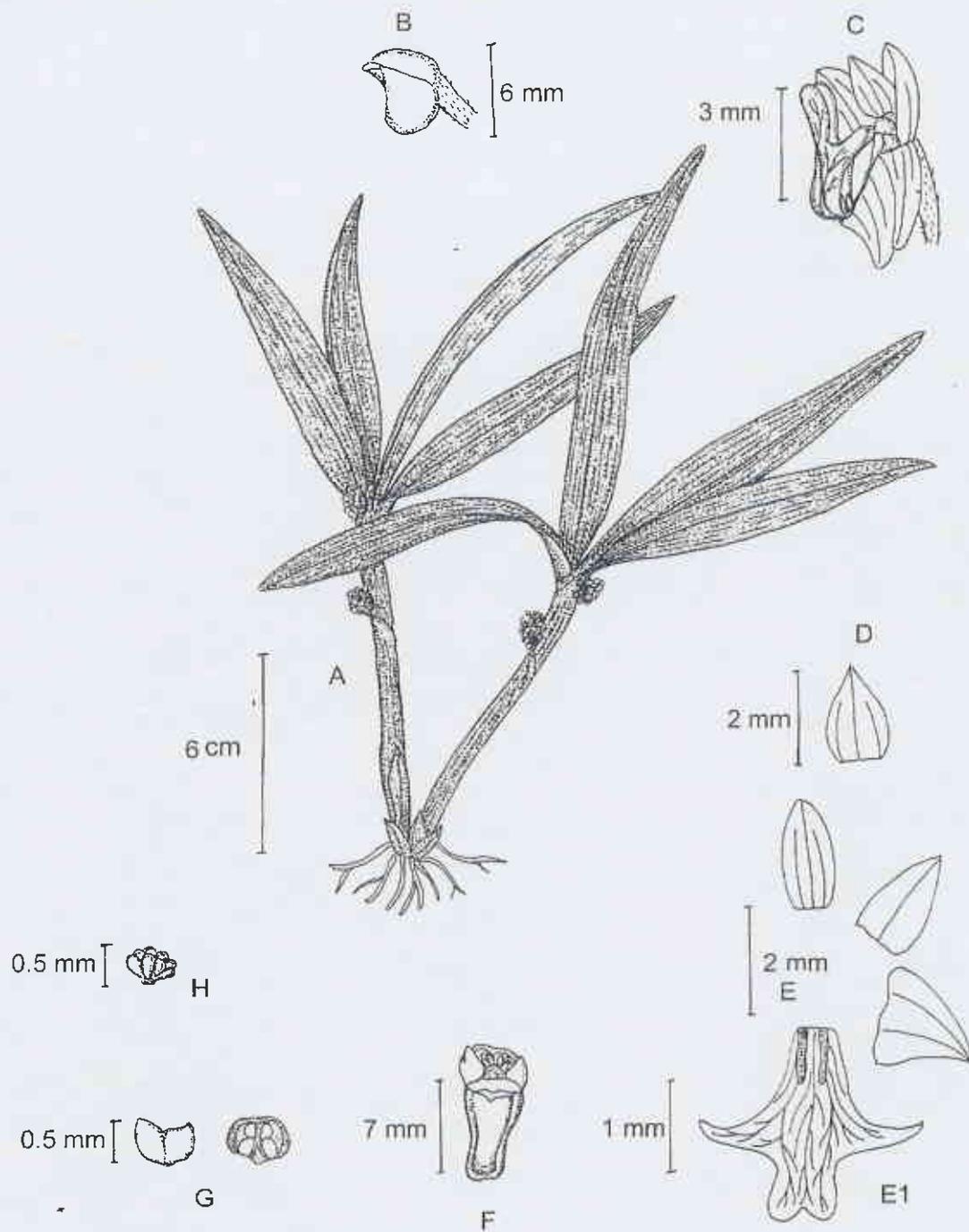


Fig 62. *Eria pumila* Lindley, (Wall 1732, K!) A: Habit; B: Flower; C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

glabrous, white, ca. 2 x 1.5 mm broad; mentum rounded, ca. 0.5 mm. *Petals* narrowly oblong, acute or obtuse, 2-5 x 1 mm, blunt, spreading, thin. *Labellum* tri-lobed, broadly oblong, 2-3 x 1 mm long; lateral lobe short, spreading, lanceolate, narrowly triangular, much longer than the broad of the base, acute to acuminate, erect, red-purple; terminal lobe broad, orbicular, bilobulate at apex, hispid-pubescent; disc with two flat calli at the base of the labellum, greenish. *Column* ca. 2 mm long, yellow, pubescent, column foot distinct, short and flat, ca. 2 mm long; clinandrium collar like; operculum ca. 0.75 mm, broad, glabrous, thin; rostellum ligulate, erect. *Pollinia* 8, obovoid or strictly clavate, attached to a small depressed globular caudicle; viscidium simple and ellipsoid. *Stigmatic cavity* ca. 1 mm broad, entire, with 2-minute appendage on the lower margin. (Fig. 62)

Type: Bangladesh, Pandua *F. De. Silva*, Wall. Cat. 1972, (Holotype: K-LINDL! Isotype, CAL!, K-W!, K!).

Distribution: 200-500 m, Himalaya (Sikkim, Assam, Bhutan, Burma) Bangladesh, Thailand.

Flowering: March-August.

Origin: Himalayan species.

Status: Endangered

Etymology: From the Latin word '*pumilio*' (a dwarf), with reference to the nature of flower.

SPECIMENS EXAMINED: **Sikkim:** Valley of the Testa 300 m *R. Pantling*, s.n. (BM!); Sikkim, Aug 1899 *Pantling* 291, (K!); Valley of Testa Aug. 1899, *Pantling* 291, (CAL!); **Assam:** Tundua *Wall* 1732, (K Type!; Iso type CAL!); Cheriapunjee, 17.7.1951, *Walter N. Koelz* 30627, (K!) *Walter N. Koelz* 30712 (K!); Tundua Sylhets, *Wall* 1972 (K-W!); Jaintea Hills, July 1899, *Prain* 316 (CAL!); **Bhutan:** Sarbhay dist. Longa Khola near Phipsoo, 17.3.1992, *Grierson & Long* 7388 (E!); **North East Himalaya :** Kameng, Lohit, Siang Subansiri, Tirap; between 500-1000 m., *H. J. Chowdhery* s.n.; **Burma:** Mergui, 12 11.1900, *Mokim* s.n. (CAL!).

Note: This species was reported from Bajrabarahi South of Kathmandu Valley as new record to Nepal (Paudyal & Sakya 1981, Amatya 1982, Gupta 1984), Paudyal & Sakya as well as Gupta did not cite the voucher specimen and description in their papers. Although Amatya (1982) was described voucher specimen with its description in his thesis, but there is no specimen in TUCH and KATH herbaria. In the present studied, it could not trace out in both Herbaria but the occurrence of *E. pumila* in Nepal has been validated here.

48. ***Eria globulifera*** Seidenfaden, *Opera Bot.* 63: 125, f 77, (1982). Chowdhery, *Orch. Fl. Arunachal Prad.* :363 f. 218 (1998).

Epiphytic orchid, upto 40 cm high including leaves. *Pseudobulbs* (stems) highly variable, usually fat, clavate, ca. 5 cm long, but sometime 12-13 cm x 1-1.5 cm, sheathed at the base, furrowed. *Leaves* sessile, 3-5, elliptic-oblong, 6-8 x 1.5-2.5 cm. acute, 5-veined. *Inflorescence* 2-3 in numbers; axillary, densely clustered, 15-20 mm long; rachis ca. 5 mm long; *Floral bract* ovate, 4-

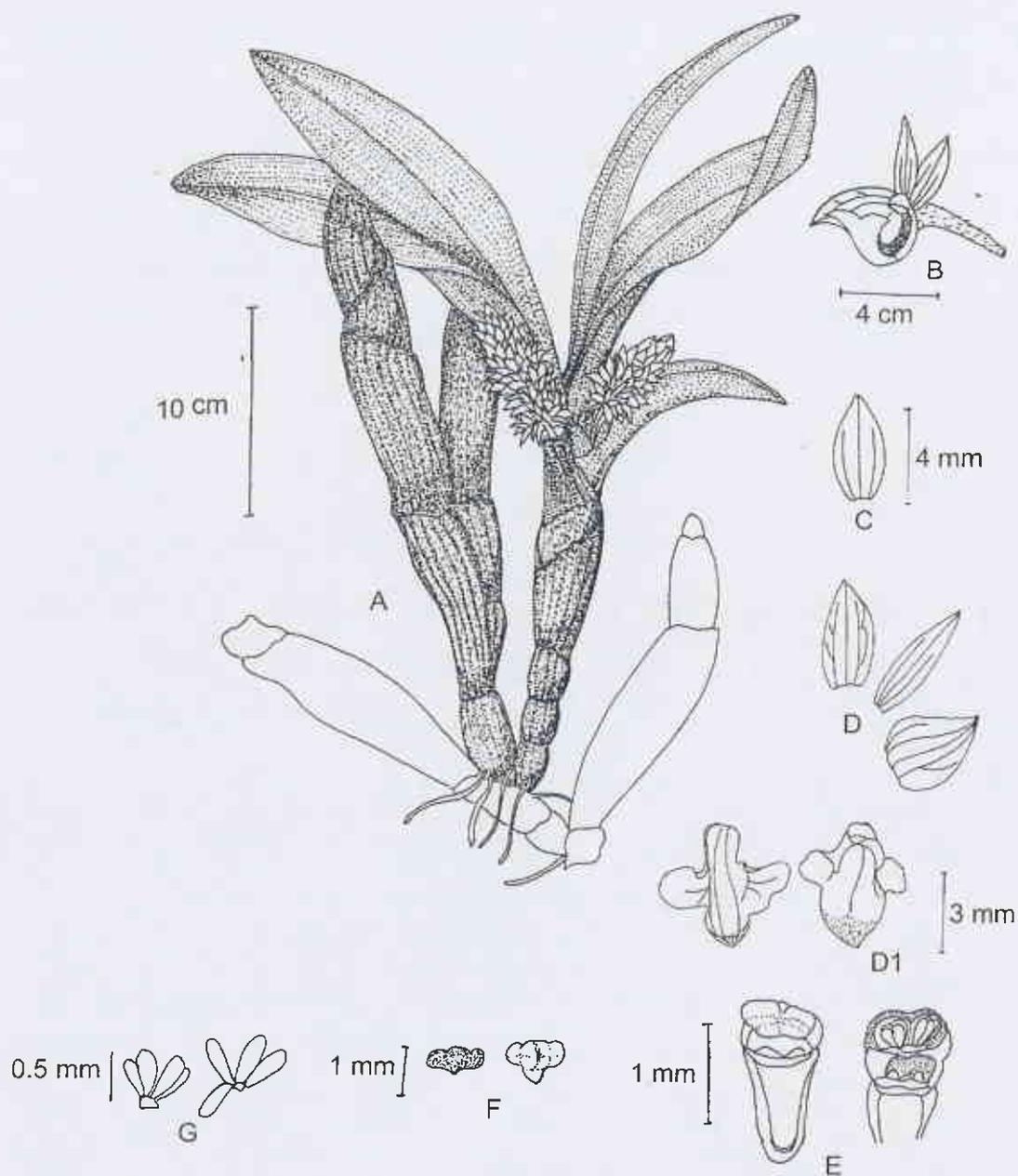


Fig 63. *Eria globulifera* Seidenfaden, (*D. M. Bajracharya* 221 TUCH!) A: Habit; B: Lateral view of flower; C: Bract; D: Spreading of Sepal, Petal; D₁: Labellum; E: Column; F: Operculum; G: Pollinia.

Sepals unequal, 4-5 x 2-3 mm; *dorsal sepal*, ovate, ca. 4-5 x 1-1.5 mm long, acute, glabrous, 3-veined; *lateral sepals* triangular, falcate, 4-5 x 2-2.5 mm broad, obtuse, 3-veined. *Petals* lanceolate-oblong, shorter than sepals, ca. 2.5-3 x 2 mm, membranous, obtuse, and 3-veined. *Labellum* trilobed, 1.8-3 mm across when flattened; labellum without a joint, raising above the column from the upwards, curved, fat; terminal lobe orbicular, as long as broad at the base, thick, upcurved, lateral lobe smaller, semicircular, placed on the lower half of the blade. *Column* stout, ca. 1.5 mm long, columnfoot, concave, bright yellow, rostellum ligulate, bent upwards, clinandrium collar like. *Pollinia* 8 in number, obovoid; attached; viscidium simple. *Stigmatic cavity* broad, ca. 1.5 mm, with two lobes inside. (Fig. 63)

Type: Thailand, Doi Pae Poe 1050-1200m, GT 7317 (type, C).

Distribution: 1000-1200 m, Himalaya (Nepal, NE Himalaya), Thailand, Indo-China, Vietnam.

Origin: South East Asiatic Malaysian

Flowering: Not known.

Status: Endangered

Etymology: From the Latin word '*globifer*' (globule bearing), with reference to the structure of flower.

SPECIMENS EXAMINED: Nepal: Kaski, Landruk, 1600 m, 24.11.1997, D. M. Bajracharya 221, (TUCH!). North East Himalaya : Subansiri, Tirap; Between 1000-1500 m.; H. J. Chowdhery, s.n.

Note: This species is recorded as new to the Flora of Nepal.

49. **Eria spicata** (D. Don) Handel-Mazzetti, *Symb. Sin.* 7: 1353 (1936); Hara & al., *EFPN* 1: 42, (1978); Seidenfaden, *Opera Bot.* 62: 126 (1982); Banerji & Pradhan, *Jour. Bamboy Nat. Hist. Soc.* 268, pl. 269 (1986); Koba & al *NLFPGN* :196 (1994); Hajra & Verma, *Fl. Sikkim* 2: 69 (1996); Chowdhery, *Orch. Fl. Arunachal Prad.* :381, f. 229 (1998); Hynniewta & al, *Orch. Nagaland* :181 (2000); Press & al, *ACFPN* :216 (2000); Pearce & Cribb, *Fl. Bhutan* 3 (3): 383 (2002).

Octomeria spicata D. Don, *Prodr. Fl. Nepal* 31: (1825).

Pinalia alba Buch.-Ham ex Lindl. *Orchid. Scelet.*: 21 (1826).

Eria convallarioides Lindl. *Wall. Cat.* 1975, (1829) *nom. Nud*; Lindl., *Gen & Sp. Orch.* :70 (1830); Lindl., *Bot. Reg.* 27: t. 62 mis. 58 (1841); 33: (1853); J.D. Hooker f., *Fl. Brit. Ind.* 5: 791 (1890); King & Pantling, *Ann. Roy. Bot. Gard. Calc.* 8: 118, pl. 161 (1898); Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 110, (1911); Banerji & Thapa, *Orch. of Nepal* 150, (1970); Koba & al *NLFPGN* :196 (1994)..

Octomeria convallarioides Wall. Ex Lindl., *Gen. Sp. Orchid. Pl.* :70 (1830).

Eria salwinensis Handel-Mazzetti, *Symb. Sin* 7: 1352 (1936).

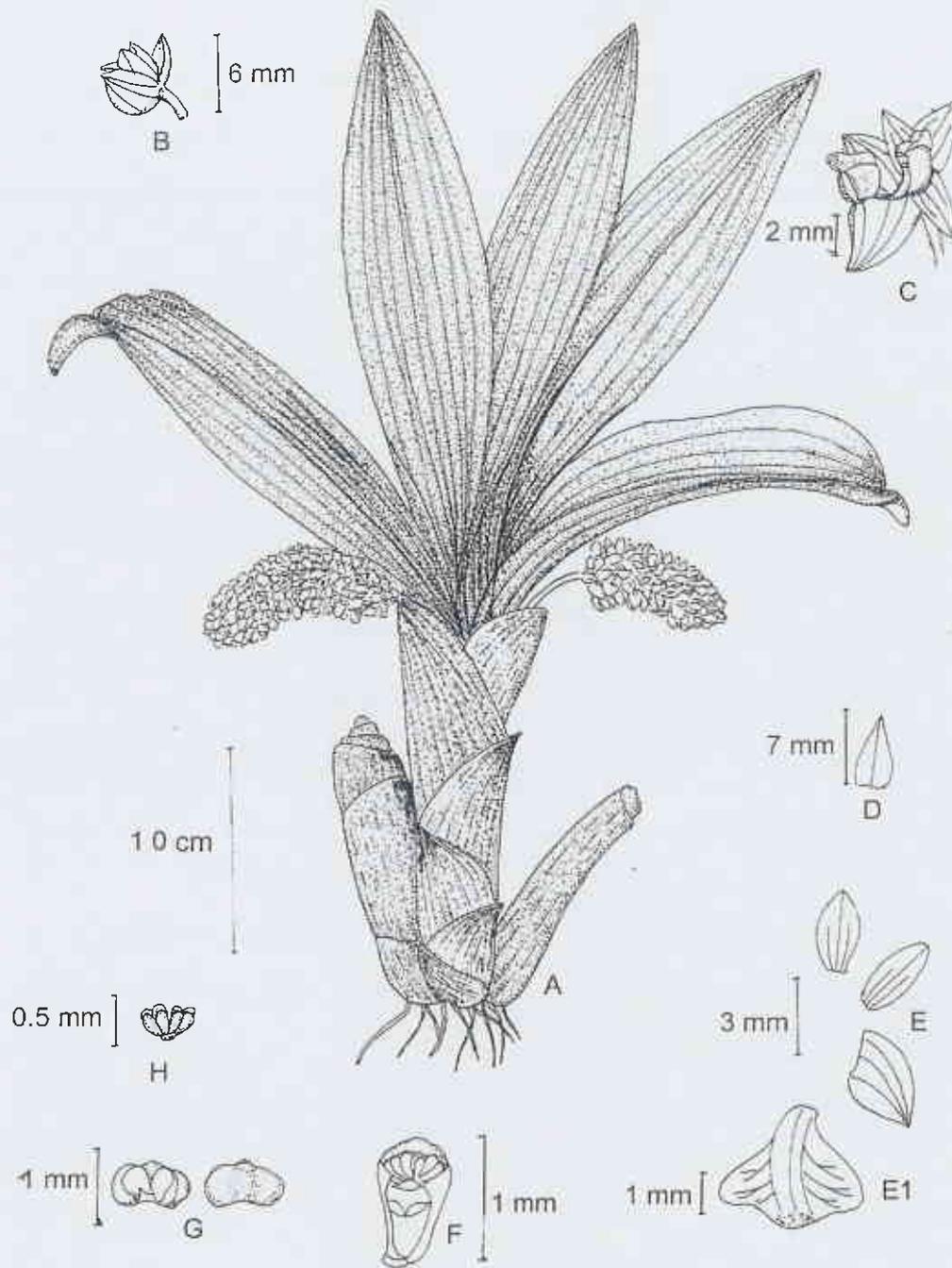


Fig 64. *Eria spicata* (D. Don) Handel-Mazzetti, (*D. M. Bajracharya* 234 TUCH!) A: Habit; B: Flower; C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum; H: Pollinia.

Epiphytic herbs, 30-35 cm high including leaves, *Pseudobulbs* 3.5-10 x 0.5-2 cm, tufted, 2-3 numbers of nodes covered by the 5 or 6 membranous leaf sheath when young, cylindrical to fusiform, compressed, oblong or thick spindle shaped; *sheaths* elliptic-lanceolate, 5-7 x 1.5-2 cm, acute, membranous, overlapping. *Leaves* 4-6, elliptic-lanceolate, or oblong-lanceolate to oblanceolate, 15-19 x 3.5-4.5 cm, acute or obtuse, glabrous, sub-coriaceous, green, petiolate, petiole grooved, 1.5-5 cm long and with 7-11 veins. *Inflorescence* 2-3 in numbers emerged from the axillary of the pseudobulbs, 5-6 cm, decurved, broadly cylindrical, raceme, spicate, densely packed in a usually globular or ovoid, peduncle glabrous, 4-8 cm long, rachis 3-10 cm long, glabrous. *Floral bracts* ovate-lanceolate, 5-7 x 1-3 mm, acute, concave, wavy, thick, glabrous, yellowish, with 1-veins. *Pedicel and ovary* 2-3 x 1 mm, puberulent. *Flowers*, 3-5 mm across, 6 mm when flattened, white with yellowish-white with purplish tint apex, sub-globose, glabrous, pubescent near the ovary. *Sepals* subequal, broadly ovate, obtuse 3-5 x 1.5-3.5 mm, yellowish white; *dorsal sepal* ovate or elliptic, 3-5 x 1.5-2 mm, obtuse, thick, glabrous, entire, 3-veined; *lateral sepals* ovate-triangular, 3-6 x 2.5 mm, acute, slightly falcate, sub-coriaceous, concave, broad at the base, glabrous, entire, sometime with light purple dot on the tip on the sepals 3-veined; adnate to column foot and forming mentum, mentum short, round, ca. 2 mm long. *Petals* oblanceolate-oblong, ovate, 2.5-4 x 1.5-3 mm, obtuse, membranous, white, glabrous, thin edge, 1-veined. *Labellum* obscurely tri-lobed, rhomboid shape or wedge shaped, or fan shaped, labellum tinged with yellow, concave, ca. 3 x 4 mm, sub-acute, non-coriaceous, uniformly widening from the base, base narrowed into claw, entire, 3-veins; lateral lobe large, shallow, triangular or round and perpendicular to terminal lobe, ca. 3 x 1.5 mm, obtuse, more or less straight frontedge, light purple; terminal lobe triangular or sub-orbicular, deltoid, acuminate, ca 3 x 2 mm, obtuse, ca. 4 mm across when flattened, dark yellow; disc without lamellae; *Column* ca. 3 x 2 mm, short, smooth, white, tined with red, slender, curved; column foot ca. 2 x 1 mm, incurved, cylindrical, clavate; clinandrium ca. 2 mm across, collar like; operculum ca. 1 x 0.5 mm, sub-circular, dotted in the outer surface; rostellum ligulate, shelf like. *Pollinia* 8; broadly obovoid or linear-clavate, caudicle gelatinous membranous, sticky at the apex of the pollinia; viscidium simple and ellipsoid. *Stigmatic cavity* 1.5 x 1 mm, heart shaped, prominent appendage inside the cavity and movable. *Fruit* cylindrical-ovoid, 5-9 x 5-6 mm. (Fig. 65)

Type: Kathmandu, Narayanhity, Nepal, *Dr. Buchananum* s.n. 15 8.1802 (holotype BM! Iso syn LINN! Herb no. 1396.16.1); Nepal Wallich s.n. (syntype BM!); Wall. 1975 (type of *E. convallarioides* Holotype: K-Lindl!, iso K!).

Distribution: 1000-1200 m Himalaya (NW Himalaya, Nepal, Sikkim, Assam, Bhutan NE Himalaya, Burma), Thailand, Indo-China, Yunnan.

Status: Common

Etymology: From the Latin spicatus (bearing a spike).

Flowering: February- August.

Chromosome Number: n=18 (Chatterji 1965b.); n= 20 (Mehra & Vij 1970, 1976; Mehra & Sehgal 1974, Shekhar 1984); n= 20+ 2B (Vij & Shekhar 1985); 2n= 38 (Chatterji 1965b, Vij & Shekhar 1985, Hasimoto & Tanaka 1983, Mehra & Kashap 1978, 1984b, 1989, Vijaykumar & Subramanian 1994)

SPECIMENS EXAMINED:North west Himalaya: Garhwal: Dehra Dun, *Falconer* 167/61 (DD!); *Jameson s.n.* (DD!); Sahashtradhara, *Deva* 2183 (DD!); Nemboowala, *Inayat* 25813 (DD!); Pauri-Lansdown, *Robert* 25406 (DD!); Chamoli-Batwalchari, *T. A. Rao* 6448 (DD!); Phata, *Nair* 35918 (DD!); *Mehrotra* 3910 (DD!); Vishnuprayag-Joshimath, *M. A. Rau* 10637 (DD!); Kumoan: Gori valley, 13.8.1886, *Duthie* 5990, (K! DD!); Dehardun, *Gamble* 27575, March 1898 (K!); Kumaon, *Strachey & winter bottom* 13 (K!); Pithoragarh- Dafiadhura, *Arora* 49508, 55821, 70835, & 70827 (DD!); Thal, *Arora* 36406 (DD!); Askot, *Inayat* 24087(a) (DD!); *Bhattacharya* 21157 (DD!); *Arora* 36471 (DD!); Didihat, *M. A. Rau* 35316 (DD!); *Arora* 38406, 41334 & 41378 (DD!); Maitli-Chowpata, *Arora* 70835 (DD!); Madhkote, *Bhattacharyya* 21343 (DD!); Kali valley at Balwkot, *Inayat* 24087(b) (DD!); Bojpatu, Gori Valley *Inayat* 24086 (DD!). **Nepal:** **W. Nepal:** Doti, Chhatiwon, 1350 m., Aug. 2002, *G. Amatya* 26, **C. Nepal:** Napalia, *Wall* 1975, (K- LINDL.); Toka, *Wall s.n.* Aug 1821 (K-WI); Kathmandu, Godawari 1500 m., 18.8. 1967, *Williams & Stainton* 8134, (K!); Kaski, Setikhola 1200 m, 29.8.83, *Stainton* 8783, (K!); Kaski, Mardi khola, Annapurna, 3.9.83, *Stainton* 877, (K!), Kaski, Khare, E. of Lumle 1700 m., *Grey-wilson & Philip* 267 (K!); Narayanhity, Nepal, *Dr. Buchananum s.n.* 15 8.1802 (Type BM!). Ghandruk 1650, 12.9.1997, *D. M. Bajracharya* 121,, Landruk 1600 m., 24.11.1997, *M. Bajracharya* 234, (TUCH!); Godawari 1600 m., 12.1. 2000, *D. M. Bajracharya* 250, (TUCH!); **Sikkim:** Darjeeling 2000 m, July 1882, *Gamble* 10505B, (K!); *Griffith* 5113 (K!); 19.7.1876, *C.B. Clarke* 12207, (BM!); Sikkim, *J. D. Hooker s.n.* (K-LINDL.); **Assam:** Cherapunjee, Khasia 1500m, 28.7.1952, *W.N. Koelz* 30860, (K!); 21.7.1952, *W.N. Koelz* 30709, (K!); Naga Hills, August 1886, *D. Prain* 45 (K!); Khasia, *J. D. Hooker, f. s.n.*, (K!); **Bhutan:** Richa, Punakha 1500 m., 30.8.14, *R.E. Cooper* 2459, (E!); Phuntsholing dist. Above Richending, 27.8.14 *Grierson & Long* 2960, (E!); Tembja, Punakha 2000m, 27.8.14, *R.E. Cooper* 2861, (E!); **North East Himalaya :** Kameng, Lohit, Siang Subansisri, Tirap; between 1000-1500 m., *H. J. Chowdhery*; **Burma:** Kachin Hill, *Mokim s.n.*, Aug 1898 (CAL!).

Note: Buchanan-Hamilton (1802-03) collected a species of *Eria* from Narayanhity, Nepal and reported as *Pinalia alba* in his unpublished manuscript. D. Don (1825) proposed the name *Octomeria spicata* for *Pinalia alba*. Later, Handel-Mazzetti (1929) described a new species *Eria salweenensis* from Northwest Yunnan, and at the same time he proposed the name *Eria spicata* for *Pinalia alba* (*Octomeria spicata*). Lindley (1830) gave the new name for this species as *Eria convallarioides*. Hooker (1890), King & Pantling (1898) followed this name as proposed by Lindley. However, in the present study, *E. spicata* is considered as a valid name and *E. convallarioides* as one of the synonyms of *E. spicata*.

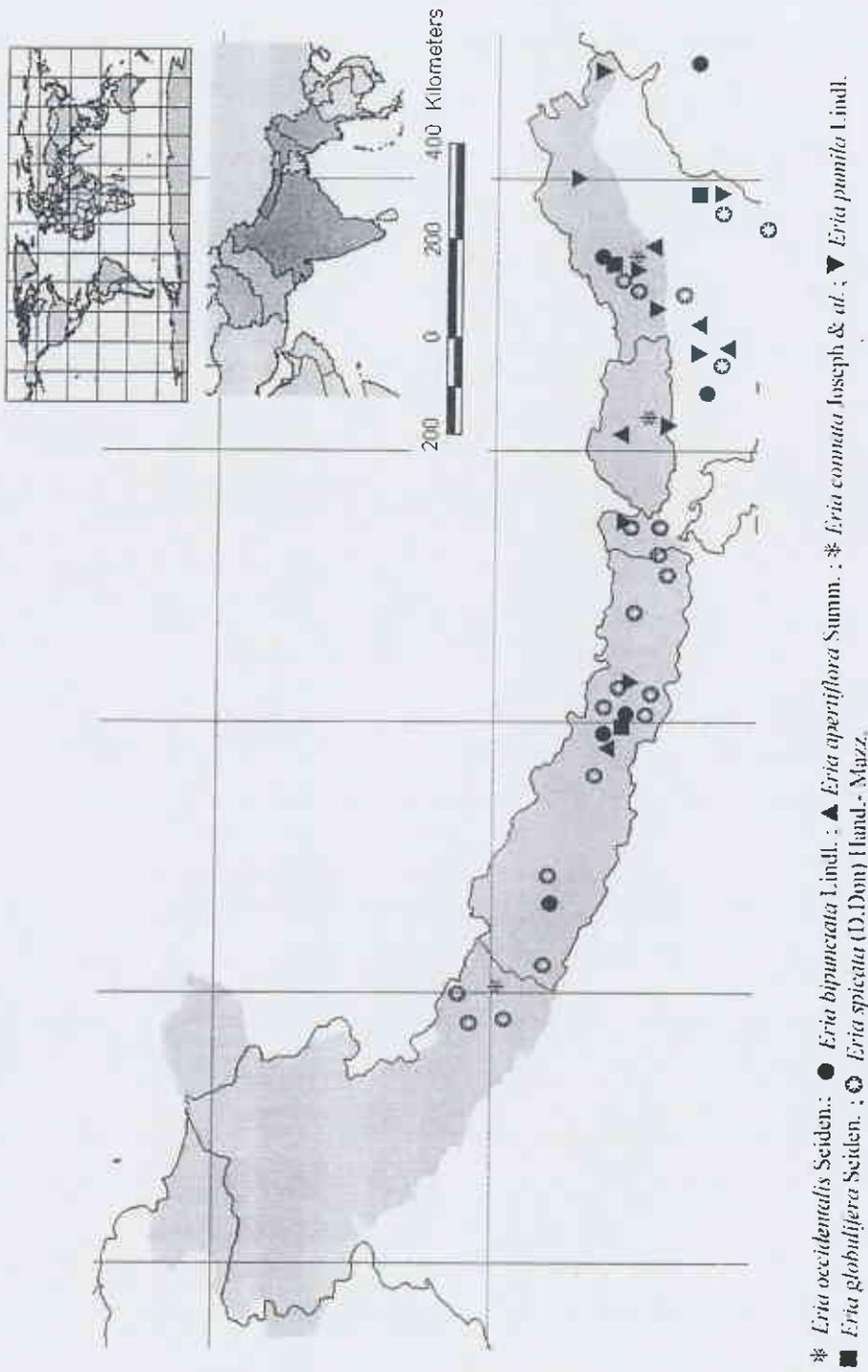


Fig. 65: Distribution Map of the section *Pinafia*

Excluded Species

E. albiflora Rolfe in *Bull. Misc. inform., Kew* 1983: 1893.

This species was reported by Bose & Bhattacharjee (1980) from Sikkim. While examining all specimens of *Eria* in the herbaria of India, U.K. and Nepal, the specimen of *E. albiflora* could not be traced out. Therefore, this species has been excluded in the present work.

E. discolor (Blume) Lindley, *Jour. Proc. Linn. Soc.* 3: 51, (1859); Pearce & Cribb, *Fl. of Bhutan*. 3(3): 384, 2002.

Blume (1825) described a genus *Callostylis*, later he changed its name to *Tylostylis* in 1828 considering on the ground of a hybrid language. Seidenfaden (1982) and Pearce and Cribb (2002) kept it into the genus *Eria*. Seidenfaden (1982) indicated the generic name *Tylostylis* as the superfluous name. If the section elevated to the rank of the generic name for *Eria discolor* should be *Callostylis* and specific epithet is *Callostylis rigida* Bl for *Eria discolor* Lindl would have priority. However, the present study revealed that *Eria discolor* belongs to a distinct genus rather than the *Eria*. It has long and curved column with large fat cushion on the upper side of its column foot; sepals and petal are more or less hairy on the both sides and mentum is formed. All these characteristics are not found in its allied species of *Eria*. Therefore this species has been excluded from the genus *Eria*, and emphasized that it should belong to the genus *Tylostylis*, as the name *T. discolor* (Lindley) Hook. Hooker (1890) King & Pantling (1898) Chowdhery (1998) also included this species in the genus *Tylostylis*. Brieger (1981), and Chen (1984) given newly combined name of *Tylostylis* into *Callostylis* on above ground.

This species is not included in EFPN (Hara & al 1978); NLFPGN (Koba & al 1994) and ACFPN (Press & al 2002) but Banerjee & Pradhan (1984) reported from Nepal Himalaya.

E. kamlengensis A. N. Rao *Jour. Orchid. Soc. Ind.* 16 (1-2): 61-64, 2002.

Recently, this species has been reported by A. N. Rao from Arunachal Pradesh. This specimen could not be examined during the present work. On the basis of protologue text and illustration, this species seems to be conspecific to *E. nepalensis*.

E. ornata (Blume) Lindley, *Gen. Sp. Orchid. Pl.* :66 (1830); Pearce & Cribb, *Fl. of Bhutan*. 3(3): 384, 2002.

This species was reported by Bose & Bhattacharjee (1980) from Sikkim. Seidenfaden (1982) mentioned that the specimen reported from the NE India seems to be misidentification with

the closely related species *E. tomentosa* (Konig) Hook. f.. Due to unavailability of the specimens of *E. ornata* collected from Sikkim and adjoining areas, it is not possible to discuss further on this species.

E. scabrilinguis Lindley, *Jour. Linn Soc.* 3:51 (1859); Pearce & Cribb, *Fl. Bhutan.* 3(3) :384, (2002).

This species was described by Lindley (1859) from Sikkim Himalaya, based on the drawing of Cathcart. Bose & Bhattacharjee (1980) mentioned that the species exist in Sikkim. Das & Deori (1983) also described *E. scabrilinguis* from Sikkim. However, herbarium material of this species could not be traced in any of the herbaria studied. Therefore, this species is excluded in the present context.

Eria sutepensis Rolfe ex Downie, *Bull. Misc. Inform. Kew* 1925: 376 (1925).

The specimens of this species could not be trace out during the present study, either in K, BM, CAL or KATH collected from Himalayan region. Therefore, it is considered as excluded species from the Himalayan region.

The following specimens are not reported from Himalayan region, so it is not included in the present study as synonyms:

Eria albdotomentosa (Blume) Lindley., *Gen. Sp. Orch. Pl.* :66 (1830).

Eria elongata Lindley, *J. Proc. Linn. Soc.* 3: 49 (1859).

Eria flava var. ***elongata*** (Lindley.) Kränzlin in Engler (eds.), *Das Pflanzenreich Hfl.* 50: 55 (1911).

4. MICRO-MORPHOLOGY STUDY

4.1 Morphology of Stomata and Stegmata on the leaf surface of the genus *Eria* Lindl.

4.1.1 Introduction

4.1.1.1 Stomata complex

Micro-morphological characters on leaf epidermal features had used widely in taxonomic and phylogenetic studies, because they can provide valuable information (Patal 1979, Stace 1980, Davis 1997). Some of the notable work in this direction are: Stebbins and Khush (1961), Inamder (1968), Withner & al. (1974), Kaushik (1983) and Rao and Khasim (1987), Croxdale (2000), who have studied the stomatal patterning in some angiosperms. Within Orchidaceae there have been several morphological studies on stomatal types based on their structure (Ross 1966, Williams 1975, Singh 1981, Kaushik 1983, Khasim and Rao 1990). Additionally Rasmussen (1987) studied the stomata ontogeny in the orchids.

The ecological significance of dermal characters has also been suggested (Kaushik 1983, Rasmussen 1987). Du puy and Cribb (1988) have found variation of stomatal shape in the genus *Cymbidium* and Isaiah & al. (1990) studied the vegetative anatomy of two species of *Eria*. Vij & al. (1991) also examined epidermal feature of Indian orchids for taxonomic and ecological implications.

Existence of two types of stomatal shapes in the genus *Dendrobium* and its systematic significance has been discussed (Yukawa & al. 1992). Khasim & Rao (1990) studied anatomy in relation to taxonomy in some members of *Epidendroideae* as well. The shape of subsidiary cells had been used to distinguish the stomatal complex of Orchidaceae into several types (Arditti 1992).

Rosinski (1992) proposed that two types of stomata within *Dendrochilum* should be recognized. Stern (1997) had studied the vegetative anatomy of different species of orchids including leaf anatomy in the subtribe Orchidinae, and Habenariinae. Stern and Judd (1999, 2000) studied leaf anatomy, comparative vegetative anatomy and systematics of *Vanilla* and the tribe *Vanilleae*. Where Himalayan species are concerned, among the twelve species of the genus *Oberonia*, eight types of stomata had classified according to the arrangement of subsidiary cells (Shakya 1999).

4.1.1.2 Stegmata or Silica bodies

The stegmata or silica cell found in Orchidales accumulates silicon in a central body of distinctive shape. Link (1849) was the first to observe silica cells in orchids but described them as projections from the sclerenchyma. In orchids, silica bodies are only found lining sclerenchyma. Mettenius (1864) recognized the cellular nature of stegmata and called them "deckzellen". Kohl (1889) reported that the stegmata are restricted to the monocotyledons families, such as Orchidaceae, Palmae, Maranthaceae, Musaceae and with some doubt in Juncaceae. Stegmata or silica bodies are present in vascular bundle sheaths, fibres bundles of leaves and pseudobulbs in longitudinal rows. These silica bodies are found in all major orchid groups except the soft leaved Orchidaceae, but not found in delicate or soft herbaceous plants. In Orchidaceae, the silica bodies had not found in the sub-tribe *Bulbophyllinae*. Kohl (1889) distinguished two main kinds of stegmata in orchids, whereas Dressler (1993) indicated that most of the orchids the silica bodies are roughly conical in shape, but are spherical and rather lumpy in the *Vanndeeae*, *Eriinae*, *Podochillinae* and *Dendrobiinae*. Solrender and Meyer (1930) surveyed fourteen papers and reported occurrence and absence of stegmata in various orchid genera.

Although the distribution of stegmata and stegmata type in orchids seems to be of systematic value and phylogenetic interest, little attention had paid to them. Pridgeon & Williams (1979) briefly mentioned silica cells in connection with vascular bundle in the stem of *Dresslerella* (*Pleurothallidinae*) without stating the shape of the silica bodies. However, Pridgeon & Stern (1982) found stegmata with conical silica bodies in *Myoxanthus* (*Pleurothallidinae*). Moller & Rasmussen (1984) studied the distribution of stegmata or silica bodies in 130 species representing 105 genera. They pointed out that stegmata occur in leaves and stems as longitudinal files of silica cells lining fibre bundle or vascular bundle sheaths. Dressler and Cook (1988) reported the presence of conical silica bodies in *E. javanica*.

4.1.2 Materials and Methods

This study had based on 29 species of living plants collected from different parts of the country, and dry materials from herbarium specimens. Observations had made on both the abaxial and adaxial epidermis and had based on at least ten random replications. The main characters analyzed were size, shape, margin of epidermal cells and distribution frequency and density of stomata.

Approximately 1 cm² of leaf tissue was removed from the middle section of the leaf and placed in a test tube. Equal parts of glacial acetic acid and 20 ml. of hydrogen peroxide had added in water, in sufficient quantity to cover the material, and the tube had then heated to 70°C for a while. After approximately 2 hours, the epidermal layer were teased apart, washed in water

and stained by 10% alcoholic Safranin and 90% alcoholic light green. The permanent microscope slides were made by dehydrating the materials through an alcohol series (70%, 95%, and 100% ethanol), and mounted on DPX. Slides were photographed using a photomicroscope (XS200/201) or drawn using a camera lucida attached to the microscope. Patel's description (1979) had used to identify stomatal type. The relevant figures were drawn in uniform magnification (10 X and 40 X), which has been referred in Table 8.

4.1.3. Results and Discussion

4.1.3.1. Stomata Complex (Fig. 68, Plate I –IV)

Among the taxa studied, the stomatal complex of 28 species of *Eria* had examined with Light microscope (LM), to assess the leaf surface characters, which had be used to revise systematics of the genus (Table 8). The leaf surface and stomatal characters of *Eria* show variation in length, breadth, density and arrangement of subsidiary cells. In addition, surface sculpturing of epidermal cells varied with the habit of plant. The stomata of *Eria* have several advantages for use as taxonomic markers, for example, there is no shortage of data, because each and every species examined has distinct stomata, and their size and shape are stable both within the same individuals and among individual of one species when compared with the size and shape of other epidermal cells.

The epidermis of *Eria* had more or less uniform in shape. They are usually irregular or regular in form, oval and rectangular to polygonal in shape as seen under the Light Microscope (LM). However, there is considerable variation in the micro-morphological characters of epidermal cells, subsidiary cells and stomatal types. The epidermal cells are relatively larger on the adaxial surface, and epidermal cells are polygonal to rectangular shaped with thick or thin wall in nature, and the cells are parenchymatous or sclerenchymatous type. In general, the stomata are restricted to the abaxial leaf surface and posses four to six subsidiary cells.

The leaves are hypostomatic condition in most of the orchids (Mobius 1887, Singh 1981, Williams 1979, Avadhani & *al.* 1982), and longitudinally orientated. In general, the *Eria* leaf is hypostomatic, having thin walls polygonal to rectangular epidermal cells. Stomata are on the abaxial surface and posses four to six subsidiary cells. Epidermal cells vary from species to species. Isaiah & *al* (1990) also described stomata in *E. discolor* and *E. stricta* present on abaxial surface and posses four or five subsidiary cells.

In the present study, two types of stomatal complexes had compared for the verification of stomatal complexes in *Eria*. Most species of *Eria* have the tetracytic type of stomata. Patel's classification (1979) distinguished tetracytic (a-tetracytic, b-tetracytic, and c-tetracytic), perihaplocytic, anisocytic and hexacytic stomata complexes, and each type having four to six subsidiary cells. According to Rasmussen's classification (1987), four distinct stomata types such

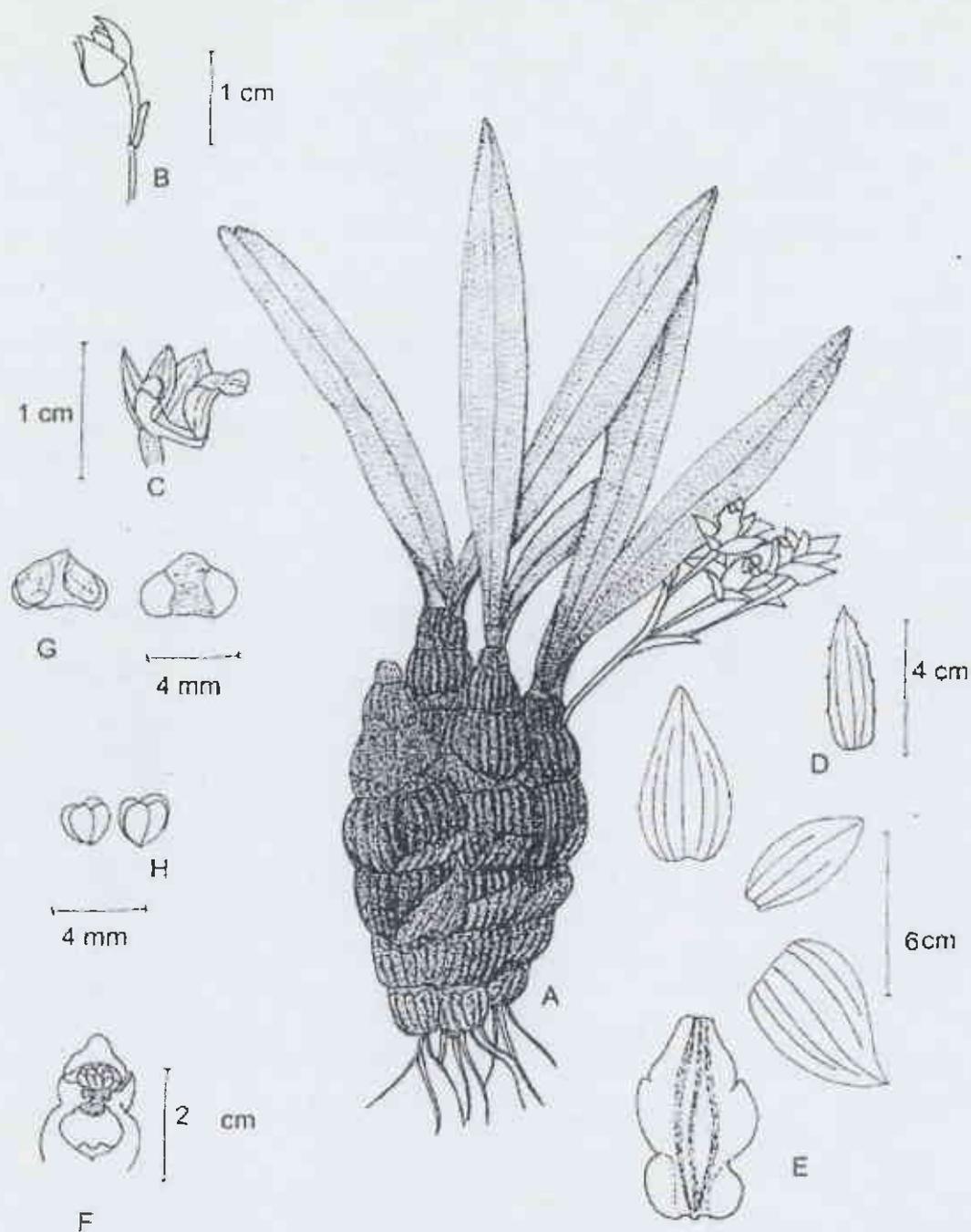


Fig. 45. *Eria concolor* Parish. & H. G. Reichenbach, (*D. M. Bajracharya & al*, 600 TUCH) A: Habit; B: Flower C: Lateral view of flower; D: Bract; E: Spreading of Sepal, Petal; and Labellum; F: Column; G: Operculum; H: Pollinia.

with small leaf blades on sheath, older pseudobulbs grayish green with white line from veins of old sheaths. *Leaves* at top, 14 x 1.3-2 cm, linear-lanceolate, acute, very narrow membranous. *Inflorescence* raceme sub erect, pubescent, few flowered (2-6), sparsely pubescent., *Floral bract* ovate-lanceolate, acute 5mm, small.; *Pedicel plus ovary* longer than saccate mentum, more or less hairy. *Flowers* 1.5-2 mm in diam, greenish yellow, membranous glabrous within, shade of dull pink claret and yellow. *Sepals* ovate-lanceolate, acute, 5-7.5 x 2-3 mm, glabrous; *dorsal sepal* oblong, acute, 5- 6.5 mm glabrous, 3-veined *lateral sepals* ovate-lanceolate, acuminate, falcate, 3-veined; mentum obtusely triangular. *Petals* linear, acute, ca. 5.5 mm, glabrous, 3-5 veined. *Labellum* obscurely tri-lobed, small indentation in an obtuse angle between hypochile and epichile, 6-7 mm long broadest nearly 4 mm when flattened at hypochile oblong, base narrow cuneate, side lobed very narrow, disk with a thick keels merging at apex of epichile between two half-moon shaped cushion, median keel with distinct swelling at base, terminal lobe retuse, apiculate. *Column* ca. 2-3 mm, glabrous, curved, foot 5-6 mm long, curved, distinct joint between labellum and foot, operculum ca. 1 mm, pea shaped, clinandrium collar like, rostellum minute and ligulate. *Pollinia* 8, obovoid, attached to caudicle, simple viscidium. *Stigma cavity* ca. 1-1.5 mm long laterally, and two small lobed inside the cavity.

Type specimens: Burma: Moulmein Parish 128 (K!).

Distribution: Nepal, Burma.

Specimen examined: Nepal, Bhogatini, Raja Rani V. D. C, Letang, Morang, E. Nepal, 500 m., D. M. Bajracharya. L. R. Shakya & A. Subedi 424; 6 Nov 2001 (TUCH). **Burma:** Moulmein Parish 128 (K!).

Etymology: From the Latin concolor to reference the uniform in colour:

Eria obesa Lindl. Wall Cat. N. 1976, 1829: in Gen & Sp. Orch., 68. (1830): Lindl. Bot. Reg. **30**: sub T. 29:1844: **53** (1859). Hooker, f., Fl. Brit. Ind. 5: 793. (1890); Grant, Orchids of Burma. 143, (1895). Kranzlin in Engler A. (eds.), *Das Pflanzenreich Hfl*, **50**: 82, (1911). Seidinfedan, *Opera Botanica*. **62**: 105, (1982).

Eria lindleyana Griff. Not. **3**: 300 (1851).

Eria prainii Briquet (1900). *Ann. Cons. Et. Jard. Bot. Geneve*. **4**: 210.

Epiphytic herbs, 15-17 cm high. *Pseudobulbs* stoutly, clavate-ovate, 4-7 cm long, green with scarious sheath. Leaf sheath 1-1.5 cm long, brown, scarious. *Leaves* the leaves shad before the flowering. The leaves are developed in autumn, about 5-6 leaves and 12 x 1 cm appear before the Pseudobulbs started swelling, lanceolate or ovate-lanceolate or glabrous (Griff. 18:300); rachis 1 cm long, Inflorescence raceme, lateral sub-corymbose, 2-4 in numbers, puberulous. *Floral Bract* large, ovate, thin, 3 mm, entire, reflexed bract at the junction of the stalks, acute. *Pedicel plus ovary* 1.4-2 mm long, pubescent. *Flowers* white, 2 cm across in diameter, glabrous. *Sepals* unequal, 1.0-1.2 cm long; *Dorsal sepal* lanceolate, acuminate, entire, 1-1.2 cm x 2 mm,

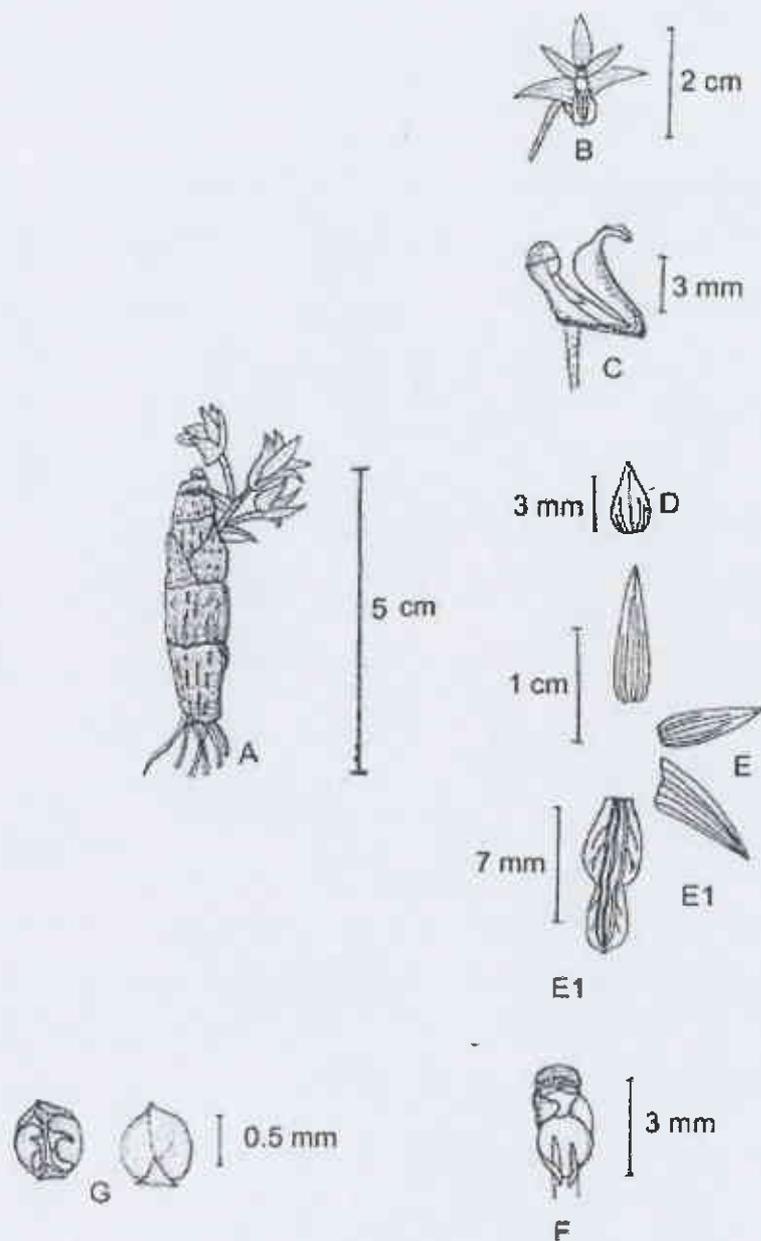


Fig 46. *Eria obesa* Lindley, (*D. M. Bajracharya* 394 TUCH) A: Habit; B: Flower; Lateral view of column with labellum; D: Bract; E: Spreading of Sepal, Petal; E₁: Labellum; F: Column; G: Operculum.

glabrous with 5 veined. *Lateral sepals* lanceolate, slightly oblique, falcate acuminate 12 x 1.5-3 mm, entire, white, glabrous, thin, 5-veins; mentum : 1mm, round, curved, subcoric. *Petals* oblong-lanceolate, obtuse, 10-12 x 2 mm, thin, glabrous, and 3 veins. *Labellum* nearly as long as sepals and petals, linear-oblong, 0.8-12 mm long, 3 mm broad, entire, obscurely uniformed, thin, 3 thickened keels with lateral lobe veins, edges of lobed somewhat thin. *Column* 3-4 mm long, 2 mm in diameter, white, glabrous, curved; foot 4-5 mm long, concave; operculum 1 mm, sub-orbicular, thick, pappus at the upper surface, two lobed within 8 chambered; clinandrium callor like, erect posterior acute, 1 dentate; rostellum minute and ligulate. *Pollina* 8, obovoid, laterally compressed in appendiculate, attached to glandular caudicle; visidium simple. *Stigmatic cavity* 1.5-3 mm long, curved, low stigma obscured furrow or groove, two long lobes inside the cavity.

Type specimen: Burma Altran, Martabon, Wall 1976, type. (K!).

Distribution: Nepal, N.E. India, Burma, Thailand.

Specimen examined: Nepal Bhogatini, Raja Rani V. D. C, Letang, Morang, E. Nepal, 500 m. *D. M. Bajracharya, L. R. Shakya & A. Subedi* 394, 14 Jan 2001 (TUCH); **NE. India:** Palak, Lushi Hills, Parry (K!); Lorraine s.n. (K 9461!); **Burma:** Altran, Martabon, Wall 1976, type. (holotype K!); Moulmein, Griffith drawing (K!); Mergui, Griffith 374 (Herb. Lindl. K!); Mergui 554 type of the *E. lindleyana*, Parish 24(K!); Amherest, Lace 4495 (K!); Parkinson 5288(K!); Moulmein, Peche s.n 29 Dec. 1896 (CAL!); Kadanigh Meebold 17045, 1912 (CAL!); Puge to Thagahta, Lace 5595, 21 Jan. 1912 (CAL!); Jaraj, Mokim 219, Dec. 1900 (CAL!); Paphi, Meebold 17044, 1912 (CAL!); Nabule velley, Mokim 160, Dec. 1900(CAL!).

Etymology: From the Latin Obesus (fat/stout) to reference to pseudobulb.

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Eria corneri var. *clausa* (King & Pantling) A. N. Rao, *J. Econ. Taxon. Bot.* **20** (3): 708 (1996).

Eria clausa J. J. Smith, *Bull. Dep. Agric. Indes Neerl.* **39**: 13 (1919).

Epiphytic herbs, 4-15 cm high. *Rhizome* ca. 2.5 x 0.5 cm, thick, jointed, smooth with few short membranous sheaths; 2-3 nodes are present in the rhizomatous segments. *Scaly leaves* 2 in rhizome. *Pseudobulbs* 3-5 cm apart, ovoid or ellipsoid, blunt at apex, single node, bases clothed with fibrous sheaths, rugose when dry, 1.5-4 x 1.5-2 cm. *Leaves* 2, apical to pseudobulbs, elliptic-lanceolate, 4-15 x 2-2.5 cm, acute to acuminate, tapering both ends, membranous, petiolate or sessile, with 5-veins; petiole grooved, 0.8-2 cm long. *Inflorescence* 1-2, terminal raceme, arising from the pseudobulb apex, lax, erect, 5-10 flowered, shorter than leaves; flowers in penducles, penducle sheathed, glabrous, 1.5-2.5 cm long; rachis 1.5-2.5 cm long, glabrous, zigzag, one or two from the top of pseudobulbs, each enveloped for more than half its length by a narrow convolute sheath; sheaths lanceolate, acute membranous. *Floral bracts* nearly obscurely obsolete, 0.4 x 2 mm, and represented by slightly thickened ring at the base of stalked ovary. *Pedicel plus ovary* longer than floral bracts, glabrous, 7-10 x 2 mm. *Flower* 0.8-1 cm across, pale greenish with brown streaks, do not open, slightly shorter than the ovary. *Sepals* identical; *dorsal sepal* oblong-lanceolate, 6-10 x 3-4 mm, thin, obtuse to sub-acute, glabrous 5-veined; *lateral sepals* oblong, 6-8 x 2-3 mm, obtuse, 5-veins; *mentum* globose, 5 mm long from the foot of column to the tip, lateral margin of column adjacent to the tip. *Petals* slightly falcate, oblong, ca. 8 x 2-3 mm, obtuse, thin, 3-veined. *Labellum* tri-lobed, oblong, 9-10 x 6 mm, two lateral lobes obliquely rounded near the apex, 7 x 2 mm, deflexed, the edge entire; terminal lobe 9-10 x 6 mm, short, caruncled, globose; disc with 5-7 sinuous vertical parallel lamellae raised from base to apex, the outer ones reduced. *Column* 3 x 1 mm, long, straight, glabrous; column foot 4 x 2 mm, curved; clinandrium collar like, 2 mm across; rostellum flattened, against the back of the cliandrium, ligulate; operculum 1.8 x 1 mm, outer surface glabrous, inner surface of operculum with four locules. *Pollinia* 8, broadly obovoid with glandular caudicle; visidium is simple and ellipsoid. *Stigmatic cavity* small with two sub-globular convexities inside its lower margin, ca. 0.5-1 mm long.

Type specimen: Sikkim (India), Sittong point, 2000m, *R. Pantling* 559, Feb. 1891 (Holotype, CALI; Isotype, KI).

Distribution: Himalaya (Nepal, Sikkim, Bhutan, Arunchal Pradesh, Burma), China, Yunnan, Kwangsi, Vietnam.

Specimens examined: Nepal, Napalia Wall. *s.n.* 7 (BM!); Lumle, Pokhara valley, 1500 m. D.M. Bajracharya & A. Subedi 230, 10 March 1999 (TUCH); Sikkim : Sittong 2000m, *R. Pantling* 559, Feb. 1891 (Type KI). Bhutan: Without precise locality, Balakrishna 43039 (CALI). Burma: Gamlan Myitkyina 2000m *C. W. D. Kermode* 17044 (KI);

Elevation ranges: 1600-2800 m.

Etymology: From the Latin word '*clauses*' (Closed)

Flowering: February- May.

Note: King & Pantling (1898) suggested that *E. clausa* might be cleistogamous form of *E. vittata* and considered as conspecific with *E. vittata*. *E. clausa* is also closely related to *E. boniana* (Gagnepain) T. Tang & F.T.Wang and to *E. corneri* Reihb.f. Tang & Wang (1951), Lang & Tsi (1976) and Seidenfaden (1992) treated them as distinct species. Averyanov (1994) treated *E. clausa* as a synonym of *E. corneri*. Rao (1996) suggested that *E. clausa* is a cleistogamous form of *E. corneri*. By thorough examination of the materials of *E. corneri* it is clear that *E. corneri* has clustered pseudobulbs, where as *E. clausa* has well spaced pseudobulbs. Thus, *E. corneri* has been proposed here as the distinct species, not the synonym of *E. clausa* and the later species is new to Flora of Nepal.

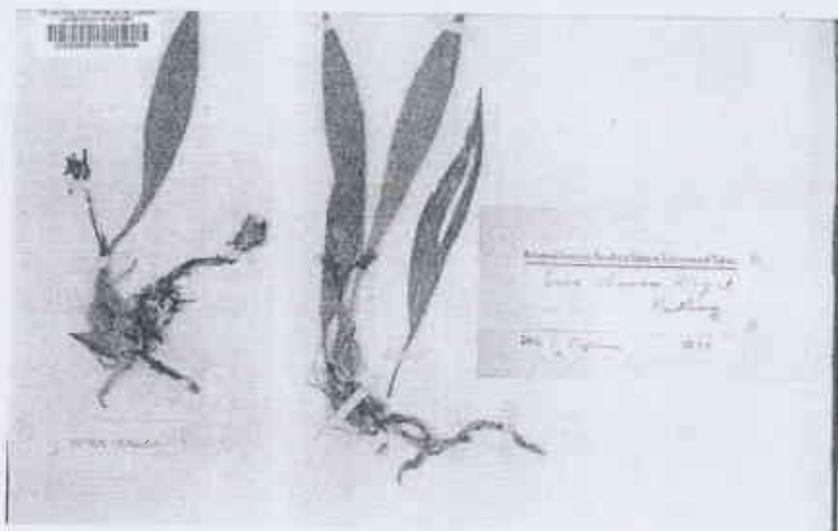
Acknowledgments

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Eria clausa King & Pantling collected by Wallich

NOTES ON *ERIA MUSCICOLA* (LINDL.) LINDL. (ORCHIDACEAE) AND ITS ALLIED NOVELTIES

DEVENDRA M. BAJRACHARYA & KRISHNA K. SHRESTHA*

Amrit Campus, Tribhuvan University, Lainchaur, Kathmandu,

*Central Department of Botany, Tribhuvan University, Kirtipur, Kathmandu, Nepal

ABSTRACT

Taxonomy of *Eria muscicola* (Lindl.) Lindl. is clarified with the recognition of one new species, *E. sikkimensis* D. M. Bajracharya & K. K. Shrestha, and elevation of two varieties to species status – *E. brevilinguis* (Joseph & Chandrasekaran) D. M. Bajracharya & K. K. Shrestha, *stat. nov.* and *E. oblonga* (Trimen) D. M. Bajracharya & K. K. Shrestha, *stat. nov.* based on *E. muscicola* (Lindl.) var. *brevilinguis* Joseph & Chandrasekaran and *E. muscicola* (Lindl.) Lindl. var. *oblonga* Trimen respectively. All are illustrated based on types as well as new collections.

INTRODUCTION

In the second part of his *Contributions to the Orchidology of India*, Lindley (1859) accepted Conchidium as a Section of *Eria* and characterized it as "small stemless species, with rounded or depressed pseudobulbs, membraneous leaves, and flowers solitary or in few-flowered racemes, for the most part very minute". He listed 9 species- *Eria braccata* Lindl., *E. lichenora* (Wight) Lindl. (now belongs to the genus *Porpax* Lindl.), *E. nana* A. Rich., *E. muscicola* (Lindl.) Lindl., *E. microchilos* (Dalz.) Lindl., *E. dalzellii* (Hook.) Lindl. *E. articulata* Lindl., *E. pusilla* (Griff.) Lindl. and *E. sinica* (Lindl.) Lindl. Many experts believe that this section has quite unrelated species that are better placed in other sections. Seidenfaden (1982) in his revision of Thai orchids included 8 species in this section with the comment that they may not be closely related.

The history of *Eria muscicola* is much complicated and the lack of good authentic materials only festers the problem. Lindley (1830) described his *Dendrobium muscicola* based on a Wallich collection (Wallich 2017, received from Lambert) from Nepal. This is now at Kew and in a miserable condition. Later, when transferred to *Eria* Lindley (1859) provided a new description based on some Ceylonese collections. This has created some confusion as it was later proved that Ceylonese plant is not identical with the Nepalese type. Convinced of the uniqueness of the Ceylon plant, Trimen (1885) described a new variety *oblonga* under *E. muscicola*. This variety was long forgotten until Joseph & Chandrasekaran (1973) added another new variety, closely

related to the former and this time from South India. King & Pantling (1898), and Seidenfaden (1982) who studied materials involved in this mess confirm that Gardner's collection is very different from the Nepalese plant. Pantling had access to a lot of specimens including CP 2355 and his own collections from Sikkim available at CAL during his studies. Of the many Sikkim collections, the one from Namtse collected at 5000 ft. in August 1891 is very different from others in having serrate anterior margin for the lip. Rolfe already commented on this sheet at Kew 'non *E. muscicola*'. Pantling's Pl. 191 made after this specimen is also not *E. muscicola*.

During the first author's studies on the genus *Eria* of the Himalayan regions supported by the Darwin Initiative (UK) all the major European collections could be studied critically and the results are presented below. Let us first examine *E. muscicola* (Lindl.) Lindl. and then compare the allied species to see how they are different.

Key to species

- 1. Pseudobulbs discoid or ovoid, covered by fine reticulate network ----- 2
 Pseudobulbs elongate or oblong, without reticulate network ----- 3
- 2. Labellum entire, trilobulate apex, with basal callii, puberulous below -----
 ----- **E. muscicola**
 Labellum serrate, acute apex, without basal callii, glabrous below -----
 ----- **E. sikkimensis**
- 3. Labellum entire, oblong basal callii present, 1-2 flowered ----- **E. brevilinguis**
 Labellum wavy basal callii absent, 3-6 flowered----- **E. oblonga**

1. *Eria muscicola* (Lindl.) Lindl., *J. Linn. Soc.* **3**: 47. (1859); Hooker f. 1890:789; King & Pantling 1898:117; Seidenfaden 1982:32.

Dendrobium muscicola Lindl., Wall. Cat. 2017, **nom. nud.**; *Gen. Sp. Orch.* 75. 1830 (Type: Nepal, Wallich 2017 K!).

Labellum of this species has a median thickened line, tip more fleshy than the body and puberulous below. See comparison of lip of the four species (Fig. 1).

Flowers: July

Distribution: India, Nepal, Bhutan, Burma, Thailand, Laos, Vietnam and China.

Notes: We studied the type specimen of *E. muscicola* and other authentic collections of *E. muscicola* at BM, CAL, E, K-W, K- LINDL., KATH and TUCH and compared with our own collections made from Nepal.

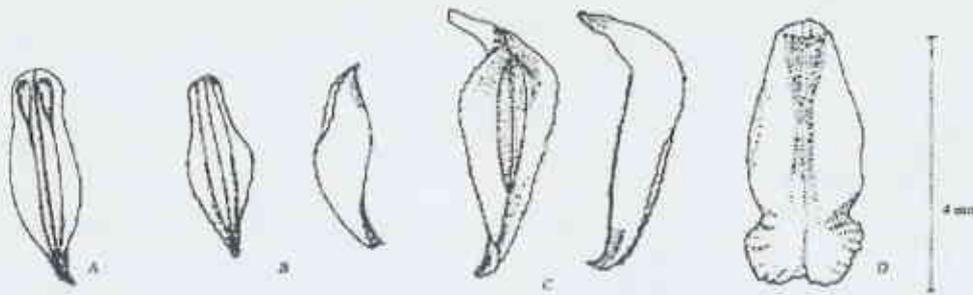


Fig: 1 A comparative structures of labellum of different species A: *E. muscicola* Lindl.; B: *E. sikkimensis* D. M. Bajracharya & K. K. Shrestha; C: *E. oblonga* (Trimen) D. M. Bajracharya & K. K. Shrestha; and D: *E. brevilinguis* (Joseph. & Chandrasekaran) D. M. Bajracharya & K. K. Shrestha.

2. *Eria sikkimensis* D. M. Bajracharya & K. K. Shrestha, *sp. nov.* – Fig. 2.

Pseudobulbis descoideus cum retinervis, bracteis grandis, oblongus-lanceolatus, acutis, labello oblanceolatus, serrate anterior margine, sine calli ad basii.

Type: India, Sikkim: Namtse 5000 ft. August 1891, R. Pantling 163 (holotype CAL!, Isotype K-Lindl. !)

Epiphytic herbs, 3-4 cm high. *Rhizome* slender, creeping. *Pseudobulbs* caespitose, clustered on a rather slender creeping rhizome, depressed, globose to discoid, 4-6 x 4-6 mm in diameter, covered by white thread like reticulating veins. *Leaves* 3-4, arising from the apex of the pseudobulb, petiolate or sessile, ovate to obovate-oblanceolate, 3-4 x 0.3-0.4 cm, acute or apiculate, entire, glabrous, 5-7-veined, green, thick. *Inflorescence* terminal, erect, arising between middle of two leaves, racemose with compact flowers. *Leaf sheath* membranous, grayish in colour. *Rachis* 1.5-3 cm long, angular, glabrous, green; spike 4-6 flowered, as long as the leaves. *Floral bracts* ovate-lanceolate, 3-5 x 1.5 mm, acute, longer than the sessile ovary, the minute base of the apex thick-veined, acuminate. *Pedicel and ovary* ca. 2 mm long, glabrous. *Flowers* sessile, small, pale green to yellowish, 3-4 x 1.5 mm, 9 mm when flattened. *Sepals* unequal, lanceolate, spreading, 2.5-4.5 x 0.8-1 mm, acuminate; *dorsal sepal* lanceolate, 2-4 x 0.8-2 mm, 1-3 veined, finely acuminate; *lateral sepals* falcate, ovate-lanceolate, 3-4 x 0.8-1 mm, entire, acuminate; glabrous, 3-veined; *mentum* ca 2 mm long, round or subglobose. *Petals* as long as sepals, narrowly lanceolate, 2-2.4 x 0.6-0.9 mm, thin, membranous, acuminate, entire, thin edged, 1-3-veined. *Labellum* simple, narrow, oblanceolate, concave, ca. 2 x 0.9-1.2 mm or half as long as sepal and petals and deflexed at middle, acute apex, margin serrate, without any calli at base, 3-veined. *Column* ca. 1.5-2 mm, glabrous, short, broad, with long curved foot, ca. 1.2 mm long; *operculum* ca. 0.7 x 0.5 mm, smooth, 2-lobed inside, each lobe with four chambers; *rostellum* ligulate, bent towards the stigma. *Pollinia* 8, four in each lobe, obovoid, membranous

and with glandulate caudicle; *viscidium* simple and ellipsoid. *Stigmatic cavity* entire, ca. 0.2 mm long. *Fruits* not observed.

This species is obviously related to *E. muscicola* (Lindl.) Lindl., but different in having a ovoid pseudobulb with reticulate veins, large oblong-lanceolate, acute bract and oblanceolate, glabrous lip with serrate anterior margin without basal calli.

Flowering: During August

Distribution: Sikkim (Endemic).

Notes: Pearce & Cribb (2002), who studied the specimen at Kew, expressed doubt about its status.

3. *Eria oblonga* (Trimen) D. M. Bajracharya & K. K. Shrestha, *stat. nov.*

Eria muscicola (Lindl.) Lindl. var. *oblonga* Trimen, *J. Ceylon Br. Roy. As. Soc.* 9: 88. (1885).

(Type: Sri Lanka, C. P. 2355, BM!, CAL!).

We are convinced that the Ceylonese element thus far treated as a variety under *E. muscicola* is entirely different from it on account of larger flowers, labellum without calli at base and only about half as long as the dorsal sepal and elongated pseudobulbs. Already Thwaites (1864) expressed his doubt in accepting this as *E. muscicola*. Trimen's treatment of this as a variety under *E. muscicola* was accepted by Hooker f. But Pantling who studied C P 2355 at CAL didn't consider it matching with the Sikkim plant. Jayaweera (1981) in his treatment of Ceylon orchids didn't mention the variety and treated it as *E. muscicola* only with the comment that 'the flowers of the Ceylon specimens are larger and the species differs from the Burmese representative in the ovate-lanceolate labellum which is subacute at the apex and wavy at the margin.'

Flowers: During July-October.

Distribution: Sri Lanka (Endemic).

Notes: The CAL specimen of C P 2355 has a beautiful pencil sketch by Pantling showing the labellum without any raised lines and with no calli at base and quite entire margin, floral bract which is longer than the sessile ovary and very short column.

4. *Eria brevilinguis* (Joseph & Chandrasekaran) D. M. Bajracharya & K. K. Shrestha, *stat. nov.*

Eria muscicola (Lindl.) Lindl. var. *brevilinguis* Joseph & Chandrasekaran, *Bull. Bot. Surv. India* 15(3-4): 267. (1976). (Type: India, Kerala, Western Slopes of Agastyamalai at 1800 m. 6th September 1973 Joseph 44630A (CAL!), B-K (MH!).

When first described as a variety under *E. muscicola* (Lindl.) Lindl. near var. *oblonga* Trimen, this was stated to differ in having a ligulate and sessile labellum with a median oblong callus at base. In this respect it is obviously more related to *E. nana* A. Rich. than to *E. muscicola* (Lindl.) Lindl.

Flowers: During September.

Distribution: India, Kerala (Endemic).

Notes: Known only from one locality in Kerala.

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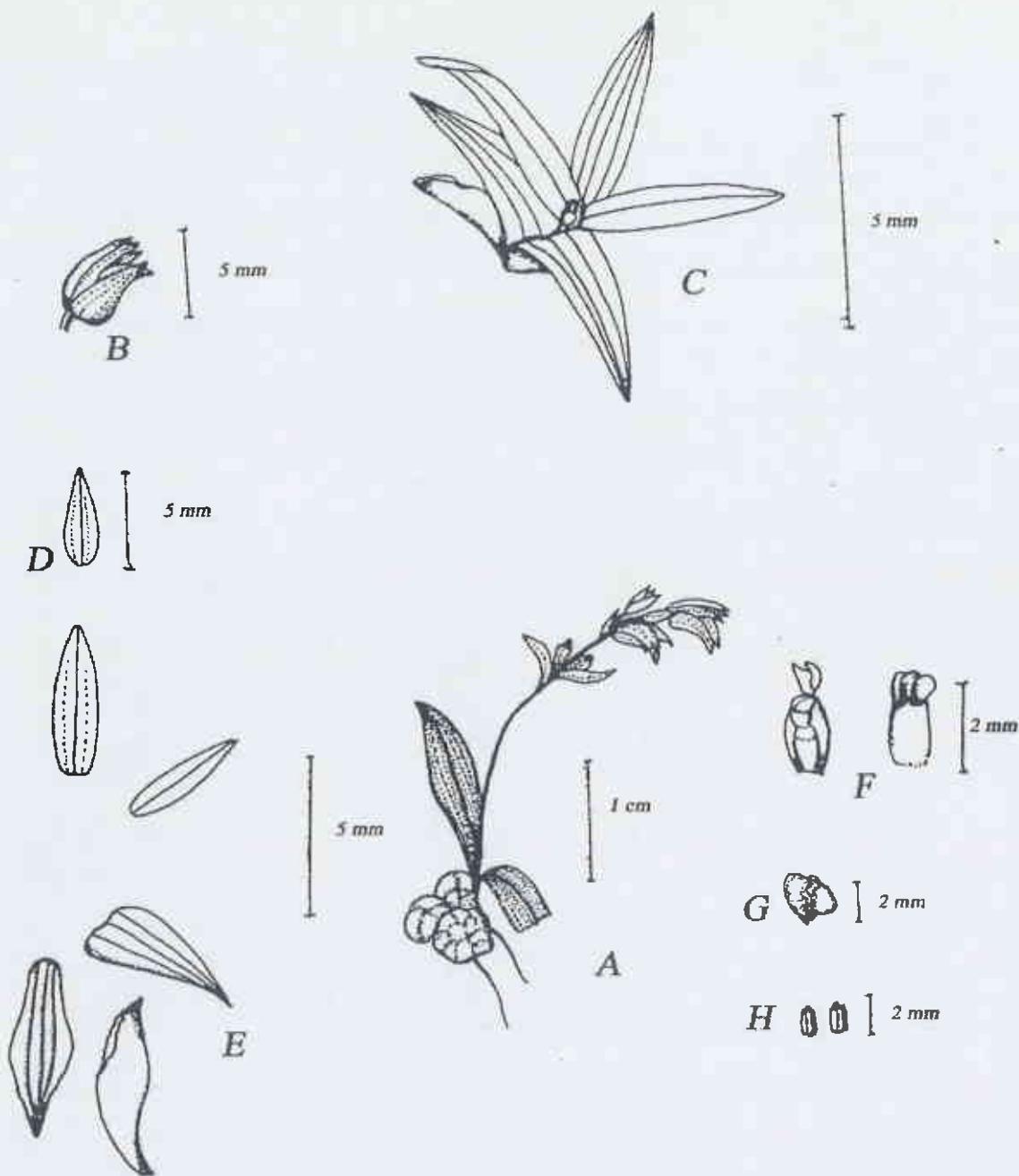
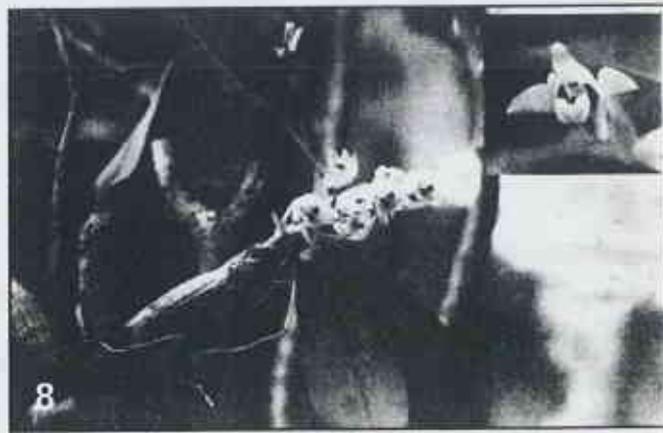
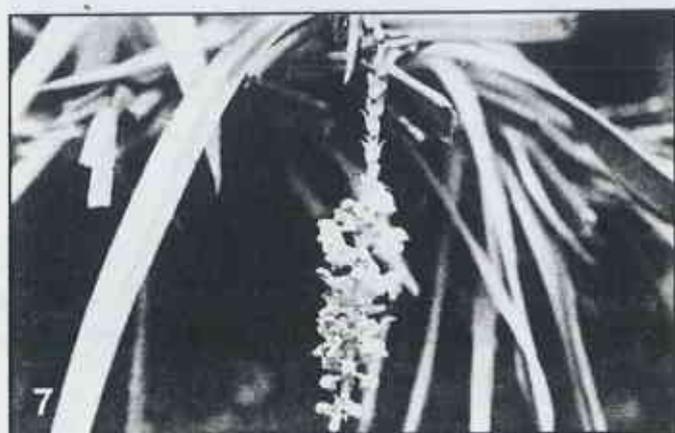
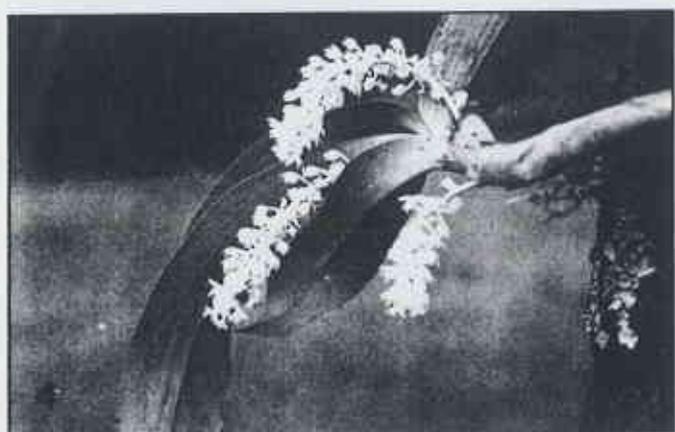
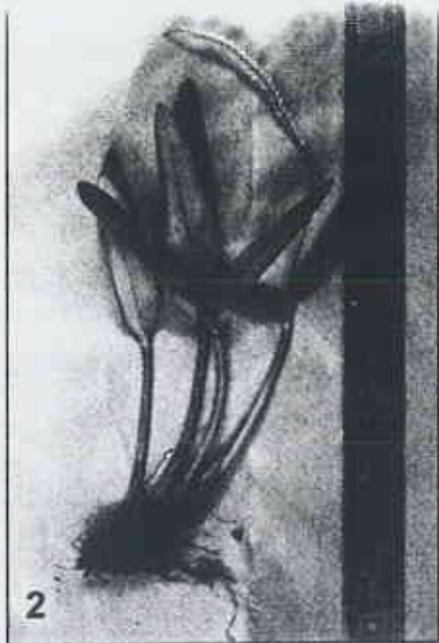
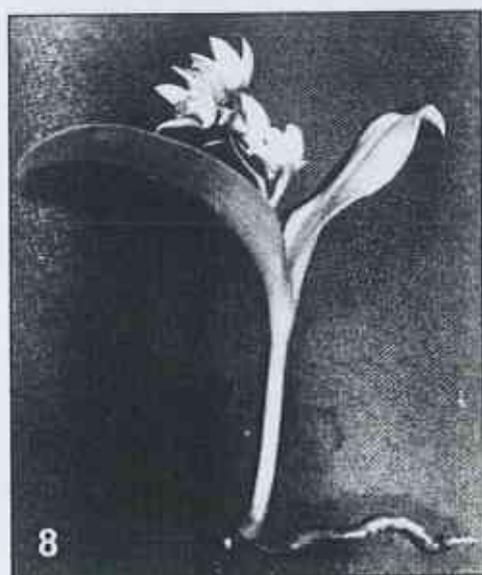
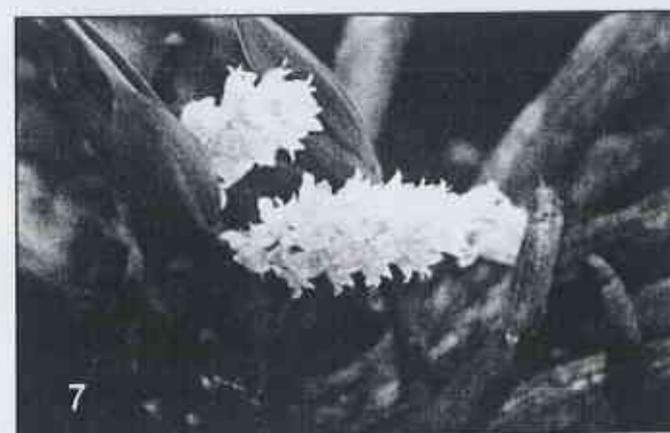
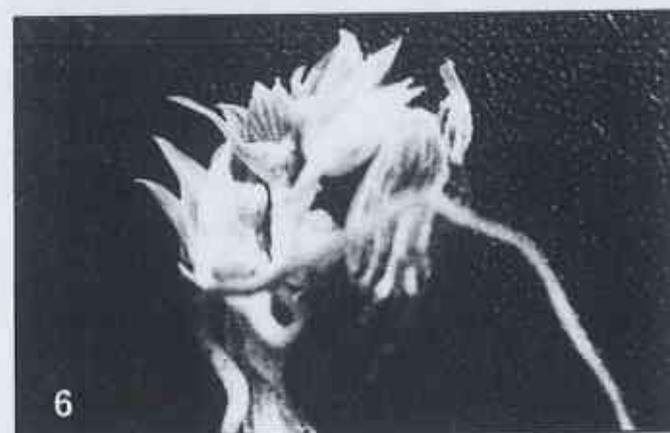
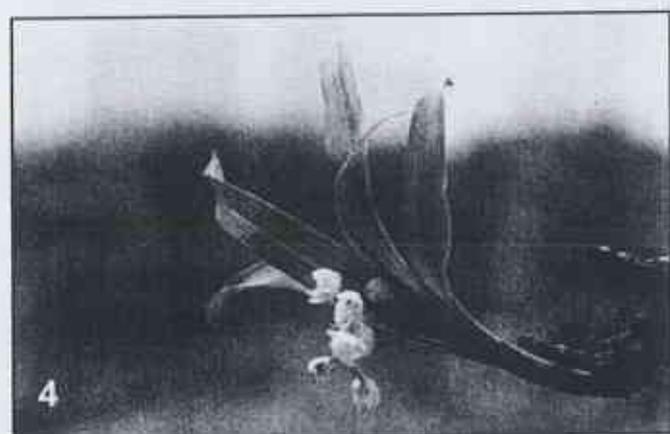
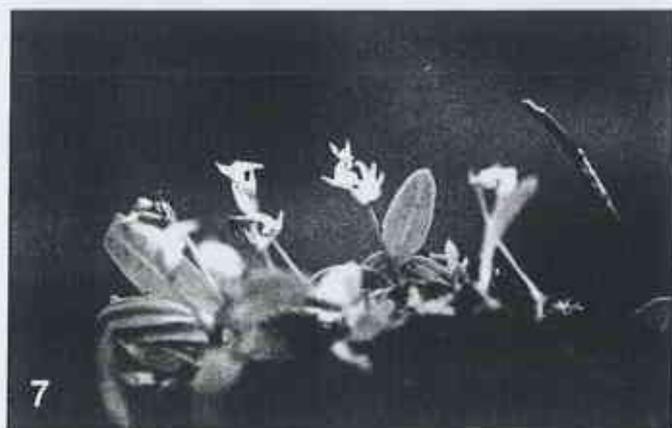
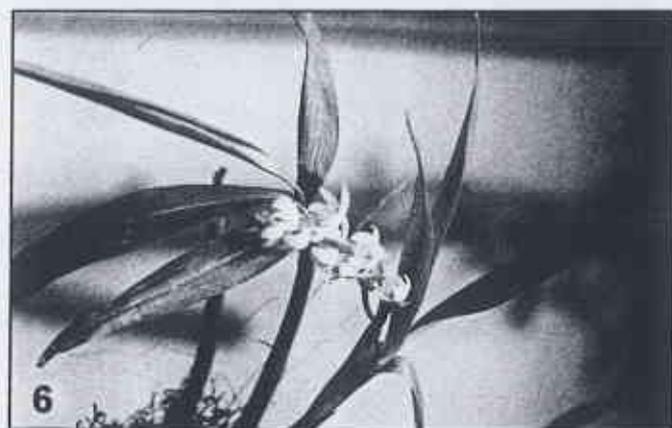
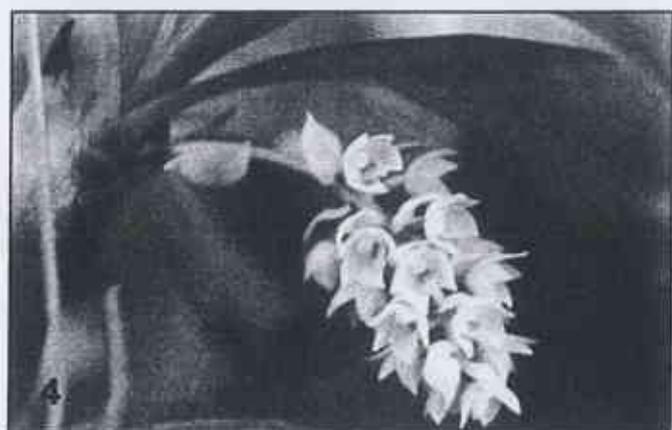


Fig: 2 A: *Eria sikkimensis* D. M. Bajracharya & K. K. Shrestha Habit (Namtse specimen, Pantling 163, CAL); B: Single flower; C: Opening of flower; D: Bract; E: Spreading of dorsal sepal, lateral sepal, petal and labellum; F: Column; G: Operculum H: Pollinia.

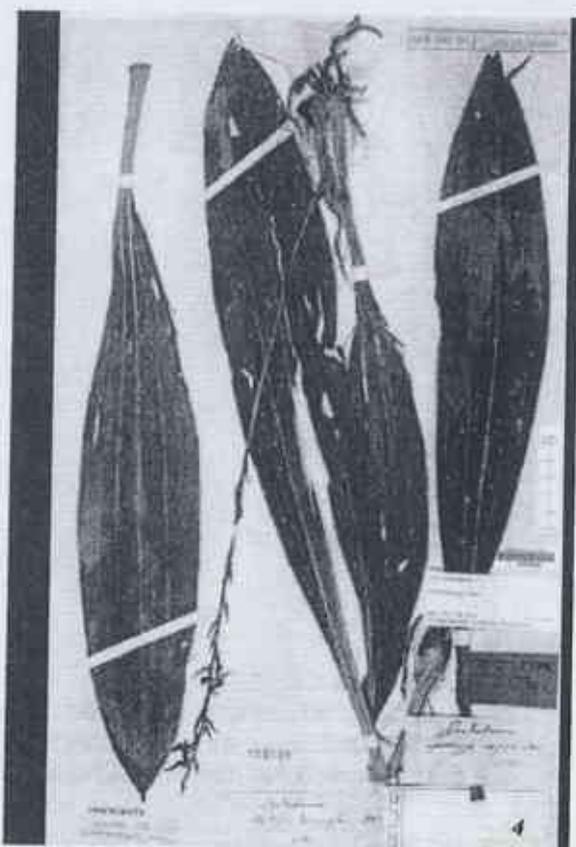
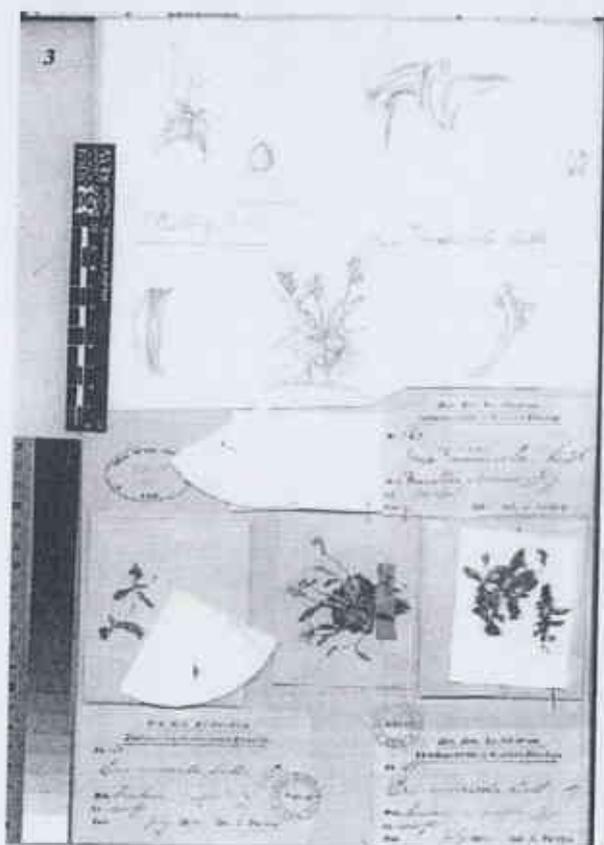
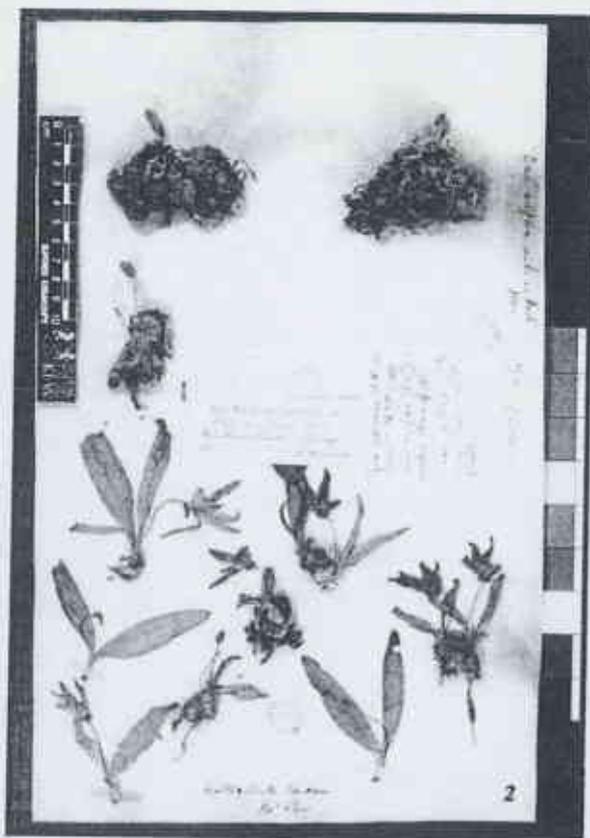
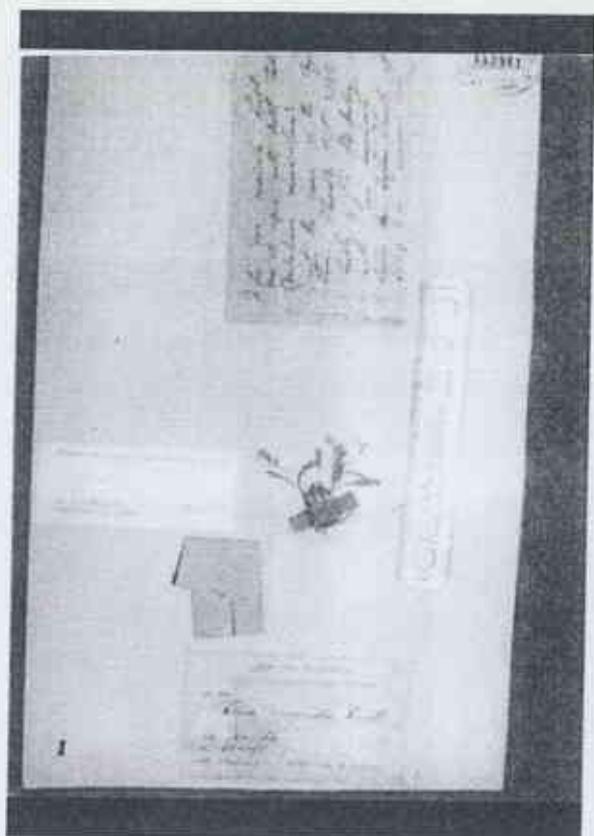
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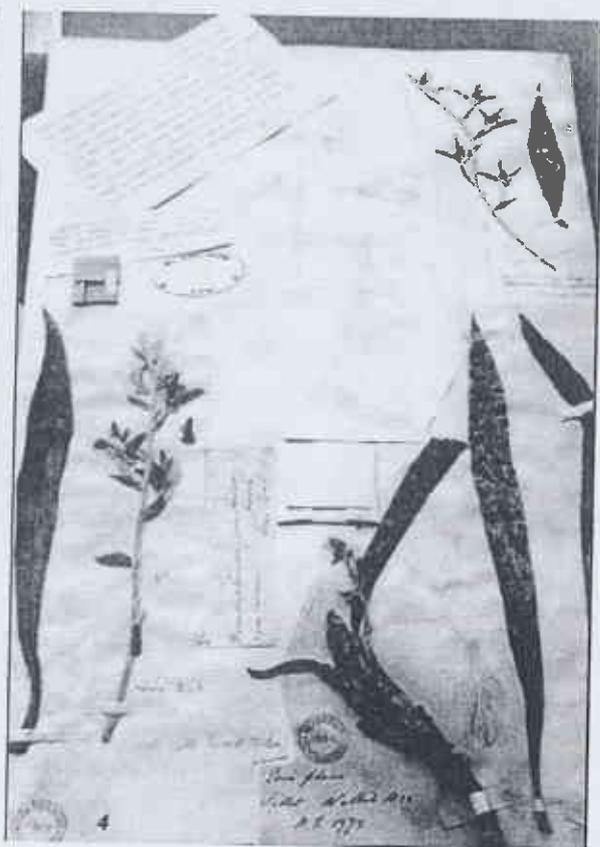
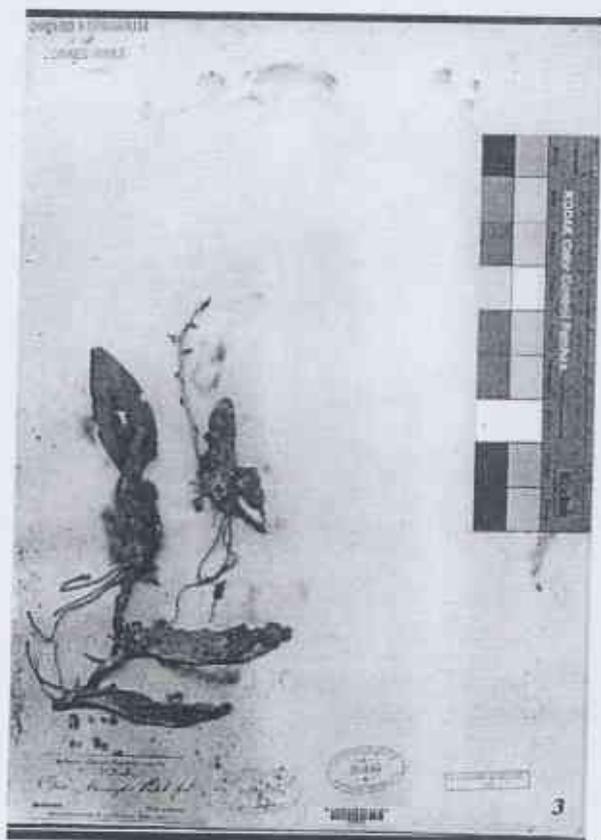
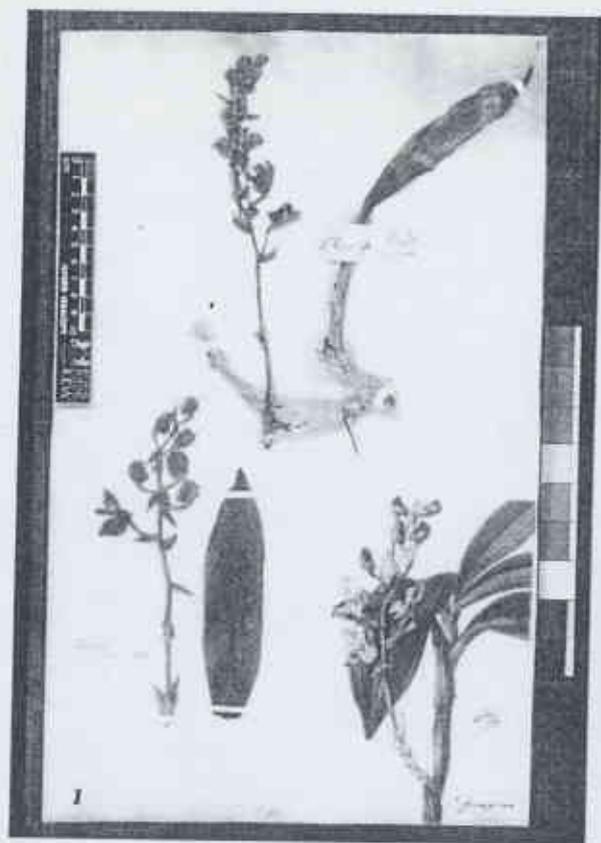


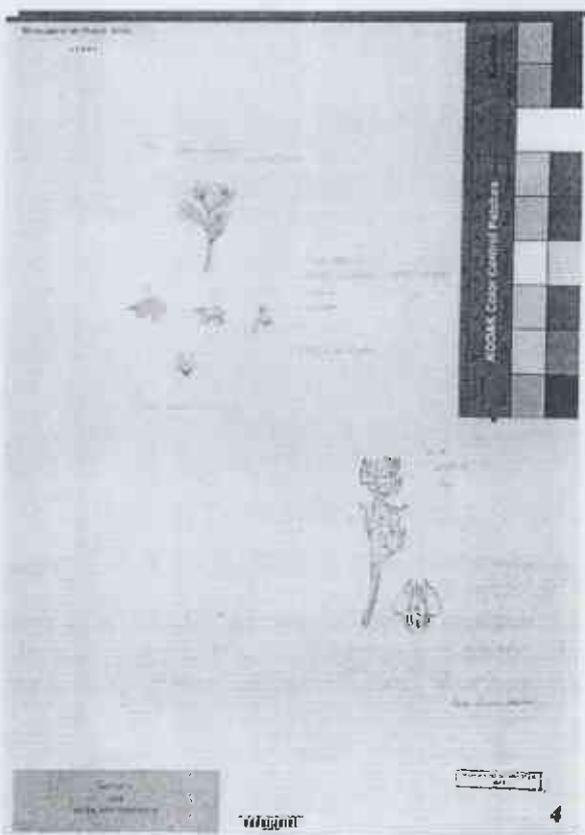
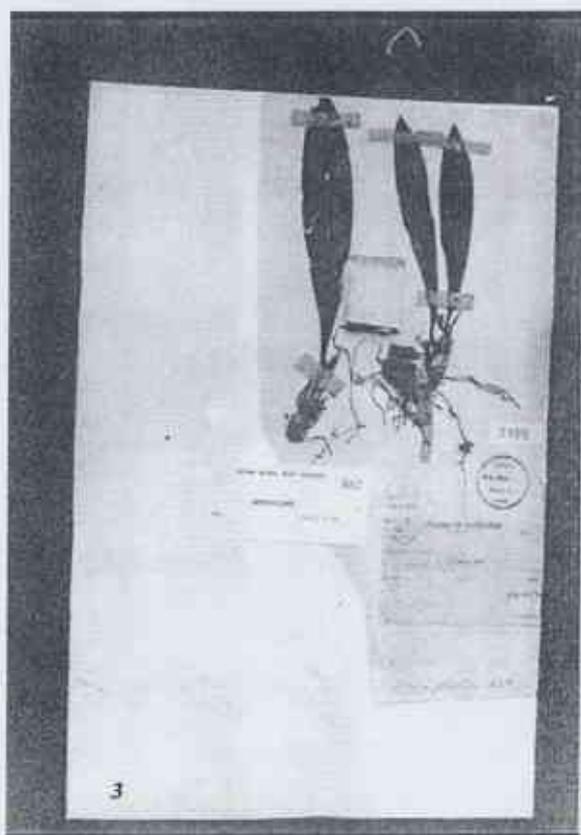
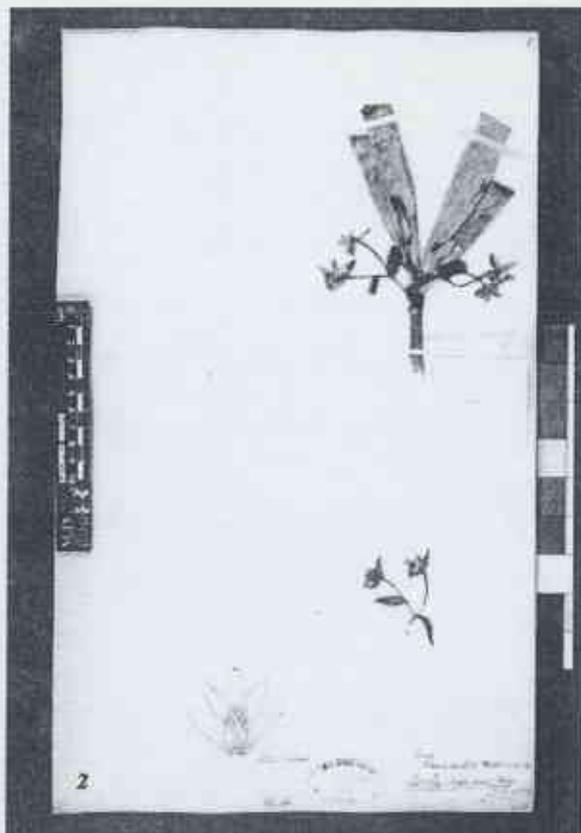


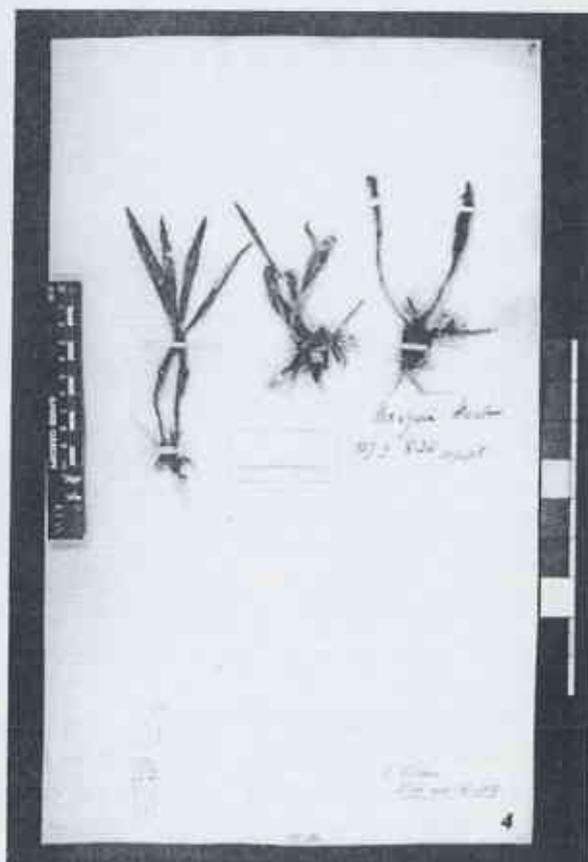
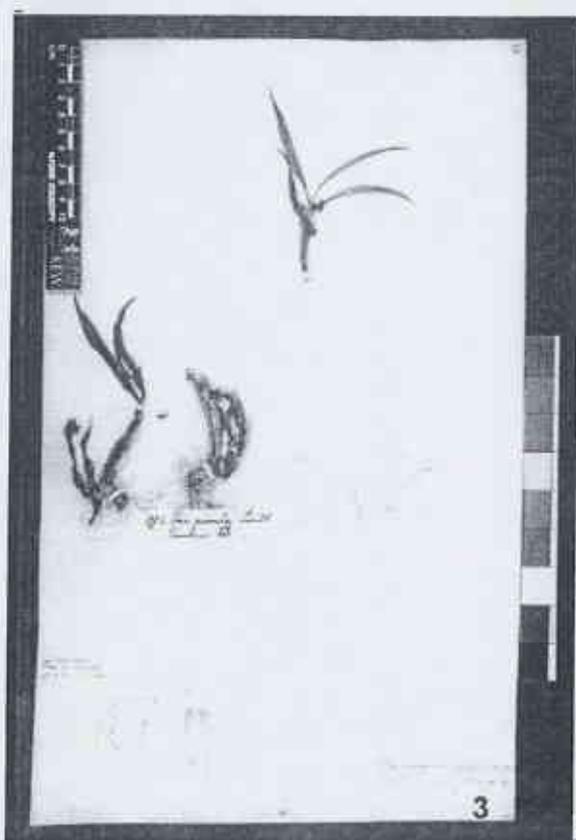
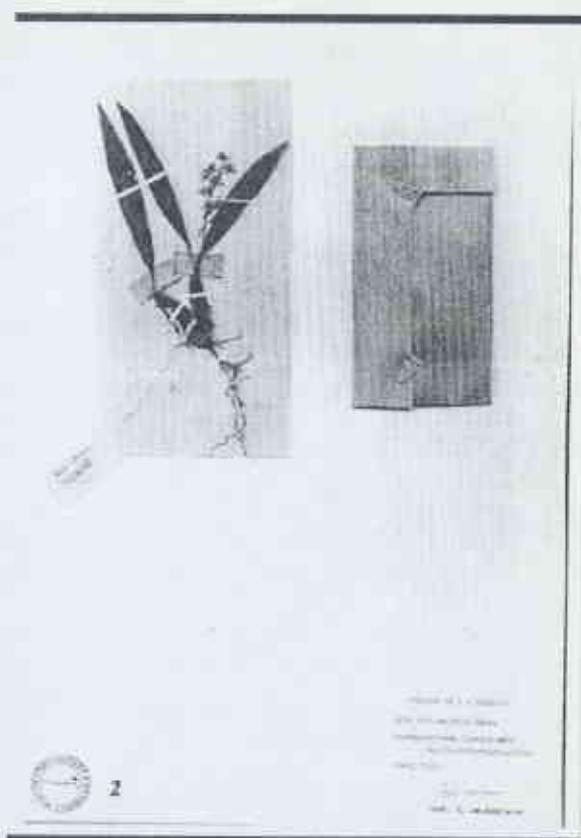
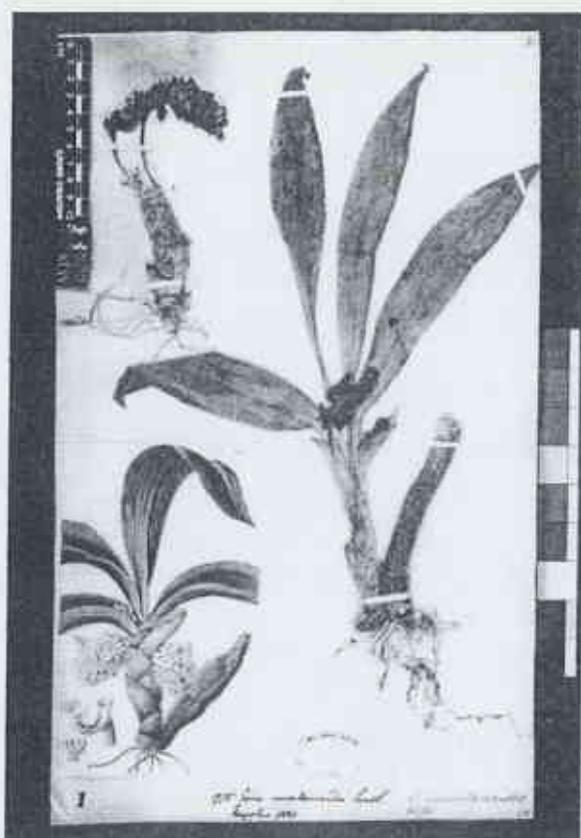


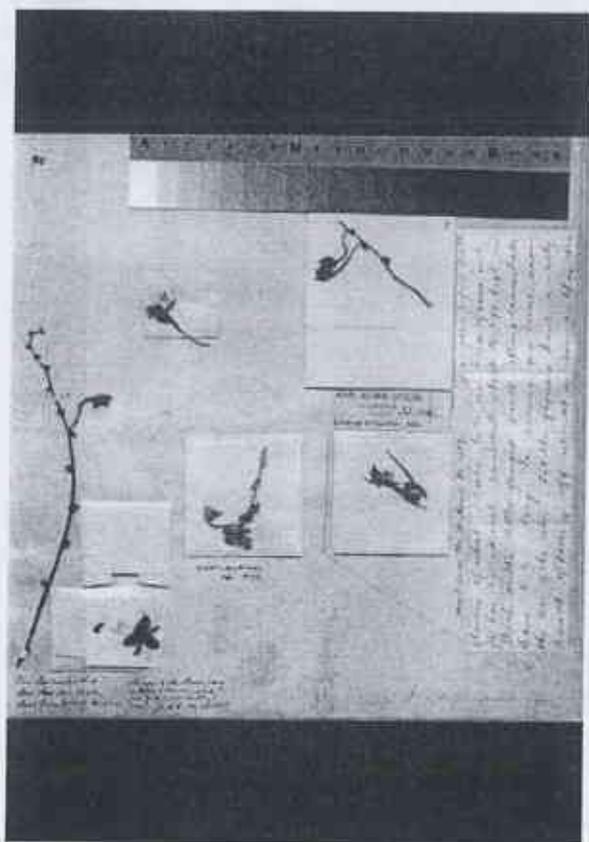
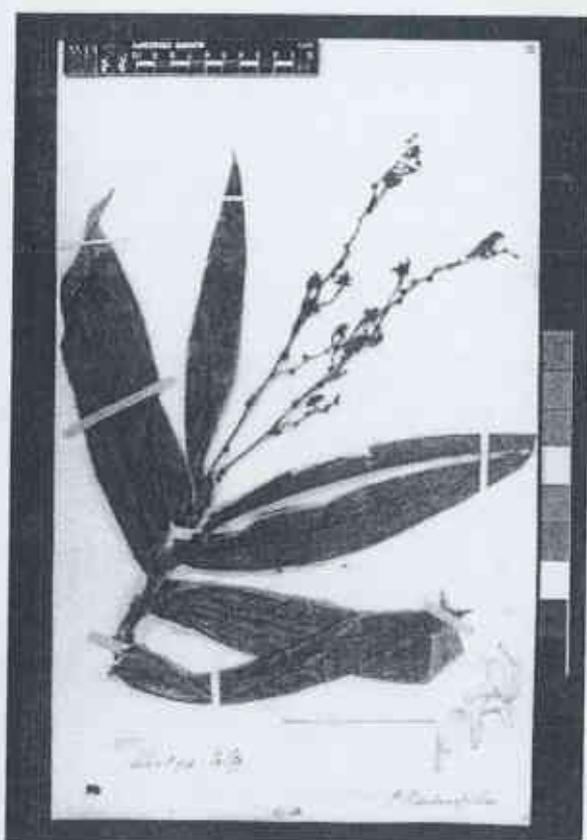
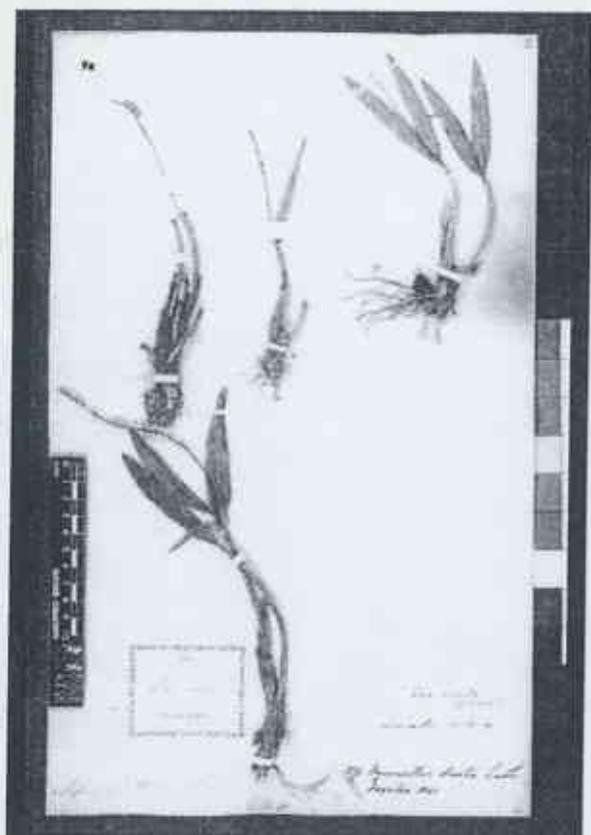
Type photographs











as tetracytic, anisocytic, cyclocytic and floating stomatal complexes are differentiated. In the present study, it has been revealed that tetracytic type of stomata is most common type in *Eria*, whereas, cyclocytic stomatal complexes rarely present in some species (*E. apertifolia*, *E. graminifolia*, and *E. stricta*), (Table 8). Rao and Khasim (1987) observed cyclocytic stomata in *E. acervata*, and *E. braccata*. Vij & al (1991) recorded tetracytic type stomata in *E. spicata* (= *E. convollarioides*).

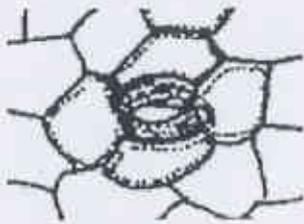


Plate I. Elliptic type of stoma

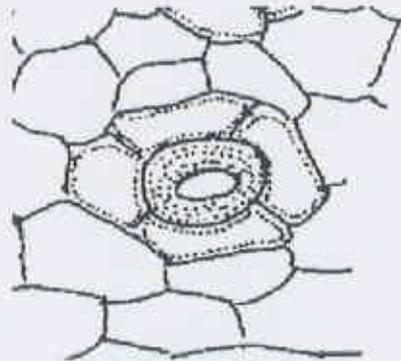
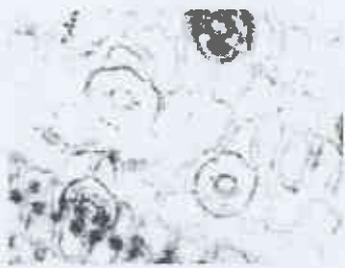
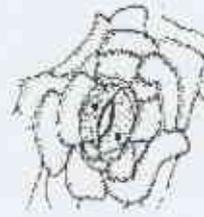


Plate II. Round type of Stoma

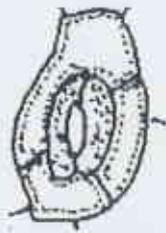
Fig. 66: Type of stomata present in the genus *Eria*



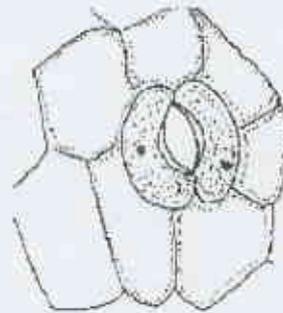
A



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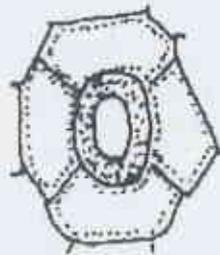
C



D



E



F



G

Fig 66 A: Type of Stomata: Type A Epidermal cell sclerenchymatous with circular stoma; **Type B:** Epidermal cell oval shaped; **Type C:** Anisocytic stomata; **Type D:** Cyclocytic Stomata; **Type E:** A-tetracytic stomata; **Type F** B-tetracytic stomata; **Type G:** C-tetracytic stomata.

Various modified stomatal shapes had known to exist within Orchidaceae, including elliptical, circular, transversely elliptical and angular stomata (Rasmussen 1987). Two types of stomata shape had found in the present study, the elliptic stoma type and circular to sub orbicular stoma type. These types define stomata in a broad sense, which includes the pore, two guard cells, and their outer ledge. Type I is elliptic with a slit like opening and gradually sloping towards polar region. In contrast, Type II is rather circular with round to spindle-shaped openings and steep sides. Interestingly, except for the species *E. clausa*, all members of *Eria* have just one stomatal type i.e type I stomata. Thus, present study tentatively subdivided the genus into two groups according to stomatal shape. Group I with elliptic type of stomata and Group II with circular or sub-circular type stomata in *E. clausa* (Sections *Trichosma.*), (Fig 65, Plate I).

The relative ratio between ledge width and length (W/L) shows that it is low in *E. nepalensis* (0.4-1.0 μm), and high in *E. spicata* (0.9-14.5 μm). The area of stoma (L x W) is higher in *E. carinata* (875.00-1312.5 μm) and less in *E. bipunctata* (112.5-187.5 μm). Stomatal ledge length is variable in Orchidaceae. Cribb (1975) cited value from 9 μm to 110 μm , while in the present study, stomatal length show a wide variation from 12.5 μm in *E. clausa* to 37.5 μm in *E. carinata* and *E. ferruginea*. The shape of stomatal opening also varies among orchid species, which ranges from a narrow slits, circular holes to bluntly cornered rectangular (Rasmussen 1987).

In the present study, the stomatal density (D) varies from 11.28-12 to 90.2-101.58 $/\mu\text{m}^2$. *E. clausa* exhibited range between 90.2-101.58 $/\mu\text{m}^2$, and in *E. ferruginea* it is 11.28-12.00 $/\mu\text{m}^2$. De bary (1877) claimed that the normal range of stomatal density in higher plant is about 40 to 300 $/\mu\text{m}^2$. Ziegenspeck (1936) described a range of 17-121 $/\mu\text{m}^2$; 40-110 $/\mu\text{m}^2$ (Singh and Singh 1974), 8- 110 $/\mu\text{m}^2$ (Avadhani & al 1982) in orchids, which compares fairly well with the data for reports in this groups of plants. Ziegenspeck (1936) recorded a higher stomatal density in species from marshy habitats. Goh & al. (1977) also observed stomatal densities and pointed out that reduced stomatal density had correlated with the extent of leaf succulence; more the succulence, lesser the density of stomata in leaves. Similarly, higher stomatal density had observed in *E. clausa*, which occurs in open and sunny habitat.

The opening length relative to ledge length (OL/L) is smaller in *E. ferruginea* ranging from 0.04 μm and much bigger up to 0.83 μm in *E. bipunctata*. Probably, it may be due to the tropical habitat and wide opening of stoma in sunny days in the orchids. A smaller stomatal chamber had been likewise correlated with xeric habitat in orchids (Ziegenspeck 1936).

Stoma is the fundamental boundary between the exterior tissue of the living organism and its environment. Consequently, one may assume that stomatal shape and size can be influenced by various environmental factors. Solrender and Meyer (1930) reported that epiphytic species generally have smaller stomata than terrestrial.

On the basis of epidermal character of leaves and nature of stomata type, *Eria* can be classified as followed (Modified from Patal 1979).(Fig. 67, Plate I –IV)

- | | | |
|-----|--|---|
| 1.a | Epidermal cells irregular, sclernchymatous with circular stoma ----- | Type A: <i>E. clausa</i> |
| 1.b | Epidermal cells regular, parenchymatous with elliptic stoma ----- | 2 |
| 2.a | Epidermal cells oval shaped ----- | Type B: <i>E. pannea</i> |
| 2.b | Epidermal cells polygonal shaped ----- | 3 |
| 3.a | Subsidiary cell tetracytic and anisocytic ----- | Type C: <i>E. muscicola</i> , |
| 3.b | Subsidiary cell tetracytic, or cyclocytic ----- | 4 |
| 4.a | Stomata cyclocytic ----- | Type D: <i>E. apertifolia</i> , <i>E. coronaria</i> <i>E. graminifolia</i> , <i>E. stricta</i> . |
| 4.b | Stomata tetracytic ----- | 5 |
| 5.a | Stomata a-tetracytic ----- | Type E: <i>E. lasiopetala</i> , <i>E. nepalensis</i> , <i>E. tomentosa</i> , <i>E. ferruginea</i> , <i>E. laniceps</i> , <i>E. merguensis</i> , <i>E. paniculata</i> , <i>E. concolor</i> , <i>E. pudica</i> , <i>E. amica</i> , <i>E. bractescens</i> , <i>E. bambusifolia</i> , <i>E. carinata</i> . <i>E. clavicaulis</i> , <i>E. bipunctata</i> , <i>E. acervata</i> . |
| 5.b | Stomata not a-tetracytic ----- | 6 |
| 6.a | Stomata b-tetracytic ----- | Type F: <i>E. excavata</i> , |
| 6.b | Stomata c-tetracytic ----- | Type G : <i>E. spicata</i> , <i>E. vittata</i> |

4.1.3.2. Stegmata

The stegmata or silica bodies on the leaf surface of 28 species of *Eria* had studied. Stegmata are short cells forming longitudinal files along fibres, which may be either fibre strands or bundle sheaths around vascular bundles. The presence of spherical bodies of stegmata with spiny surface had recorded in all species. The shape of the cell is approximately isodiametric in most species, but conical in *E. javanica*.

Of the 28 species studied in the present investigation, 22 species of *Eria* have the spherical bodies of stegmata. Stegmata are absent in *E. muscicola*, *E. pannea*, and *E. carinata* and not distinct in *E. coronaria* and *E. merguensis*. Remaining species of *Eria* (*E. clausa*, *E. apertifolia*, *E. graminifolia*, *E. stricta*, *E. clavicaulis*, *E. bipunctata*, *E. lasiopetala*, *E. nepalensis*, *E. tomentosa*, *E. ferruginea*, *E. laniceps*, *E. paniculata*, *E. concolor*, *E. pudica*, *E. bipunctata*, *E. clavicaulis*, *E. amica*, *E. bractescens*, *E. Excavata*, *E. spicata*, and *E. vittata*) have spherical stegmata in the leaves. Moller & Rasmussen (1984) reported the presence of spherical stegmata

in *E. muscicola* (Sect. *Conchidium*), but it is not observed in the present study. Dressler & Cook (1988) reported the presence of conical silica bodies in *E. Javanica* (Sect. *Eria*), this data has been used as a secondary information for classification in the present study (Fig 68, Plate I & II)

Moller & Rasmussen (1984) pointed out that the most common condition in the tribe Epidendroideae is that of conical silica bodies, but spherical ones are found in the subtribes *Eriinae*, and *Dendrobiinae*. It is justified by the present study too.

The lack of stigmata may either be an autpomorphy for this sequence compared with the presence of spherical bodies, or represent an intermediate state between the conical and spherical bodies. These two conditions differ not only in the shape of silica bodies but also in the pattern of wall thickenings of stigmatal cells.

On the basis of nature of silica bodies, *Eria* can be classified as follows:

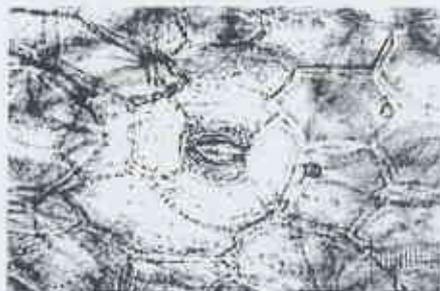
- 1.a Silica bodies absent or not distinct 2
- 1.b Silica bodies present 3
- 2.a Silica bodies absent **Type A:** *E. muscicola*, *E. pannea*,
- 2.b Silica bodies not distinct **Type B:** *E. coronaria*, *E. bambusifolia*, *E. merguensis*
- 3.a Silica bodies conical shaped **Type C:** *E. javanica*
- 3.b Silica bodies spherical shaped **Type D:** *E. clausa*, *E. carinata*, *E. apertifolia*,
E. graminifolia, *E. stricta*, *E. clavicaulis*, *E. bipunctata*, *E. lasiopetala*, *E. nepalensis*, *E. tomentosa*, *E. ferruginea*, *E. laniceps*, *E. paniculata*, *E. concolor*, *E. pudica*, *E. bipunctata*, *E. clavicaulis*, *E. amica*, *E. bractescens*, *E. Excavata*, *E. spicata*, *E. vittata*

In conclusion, the study of stomatal complexes, stigmata bodies, and epidermal layers of leaves of *Eria* reveal valuable characters that had be used in the delimitation of the taxa of *Eria* at the species level.

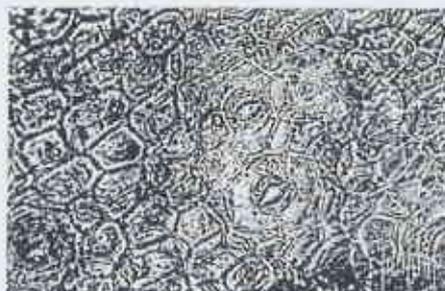
Table 8. Micro-morphological characters of Leaf surface of *Eria* Lindl. (Mean value of stomata)

Section	Sub section	Botanical name	Measurement of Stomata (µm)										Epidermal cells		Stomata type	Stigmata
			D	L	W	W/L	L x W	LO	LO/L	Type	Shape					
Conchidium	Coronaria	<i>E. muscivora</i>	67.90	22.5-32.5	17.5-20	0.69-0.88	437-650	17.5-20	0.50-0.57	Elliptic	Paranchymatous	Polygonal	Tetra- anisocytic	Absent		
	Clausea	<i>E. coronaria</i>	44.5-45.15	17.5-22.5	17.5-20	0.7-1.14	306.25-393.75	7.5-12.5	0.44-0.57	Elliptic	Paenchymatous	Irregular	Tetra and anisocytic	Not distinct		
Trichosma		<i>E. clausa</i>	90.2-101.59	12.5-17.5	10-12.5	0.6-1	158.25-306.25	7.5-10	0.57-0.6	Round	Sclerenchymatous	Polygonal	a-Tetra	Spherical		
		<i>E. villata</i>	22.57-33.86	20.5-22.5	15-20	0.2-0.8	112.5-450	12.5-17.5	0.55-0.77	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
Xiphosium		<i>E. canariata</i>	22.57-33.86	35-37.5	25-30	0.71-0.93	87.5-1312.5	1.5-17.5	0.35-0.50	Elliptic	Paenchymatous	Polygonal	a-Tetra	Absent		
		<i>E. lausipetala</i>	22.57-56.3	25-30	22.5-25	0.83-0.90	562.5-750	20-22.5	0.75-0.9	Elliptic	Paenchymatous	Polygonal	a-Tetra	spherical		
Dendrorhizum		<i>E. nepalensis</i>	21.57-22.60	25-30	12.5-25	0.4-1	343.75-687.5	12.5-20	0.41-0.72	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
		<i>E. tomentososa</i>	22.57-33.86	25-32.5	20-30	0.64-0.92	500-975	20-25	0.71-0.8	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
Stonyaria		<i>E. ferruginea</i>	11.26-12	30-37.5	15-25	0.8-1	450-973.5	15-25	0.04-0.06	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
		<i>E. laniceps</i>	22.55-33.86	22.5-25	15-17.5	0.7-0.8	375-437	15-17.5	0.53-0.66	Elliptic	Paenchymatous	Polygonal	a-Tetra	spherical		
Stonyaria		<i>E. penaria</i>	21.59-22.57	22.5-25	17.5-25	0.77-1	393.75-625	17.5-20	0.5-0.8	Elliptic	Paenchymatous	oval	a-Tetra	Absent		
		<i>E. stricta</i>	22.57-67.72	20.0-22.5	15.0-17.5	0.75-0.87	300-393.75	12.5-17.5	0.55-0.875	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
Stuedee		<i>E. meguensis</i>	33.7-67.7	22.5-25	17.5-20	0.77-0.87	393.75-450	17.5-20	0.50-0.57	Elliptic	Paenchymatous	Polygonal	a-Tetra	Not distinct		
		<i>E. paniculata</i>	45.14-56.43	25.5-27.5	17.5-22.5	0.63-0.83	481.25-846.76	20-22.5	0.72-0.81	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
Bambusifolia		<i>E. bambusifolia</i>	56.6-79	17.5-20	10-15	0.85-0.87	175-300	10-15	0.09-0.1	Elliptic	Paenchymatous	Polygonal	a-Tetra	Not distinct		
		<i>E. clavicularis</i>	45.14-79.00	20-25	12.5-17.5	0.5-0.87	300-350	10.0-15	0.5-0.75	Elliptic	Paenchymatous	Polygonal	a-Tetra	Not distinct		
Cylindrolobus		<i>E. brachlencens</i>	56.4-90.29	20.0-22.5	17.5-20	0.75-0.88	300-450	12.5-15	0.55-0.75	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
		<i>E. amica</i>	33.8-58.43	17.5-22.5	16.5-17.5	0.71-1	306.25-393.75	12.5-15	0.5-0.75	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
Hymenaria		<i>E. acervalata</i>	67.72-90.29	17.5-20	15-17.5	0.75-1	262.25-306.25	8.0-10	0.50-0.57	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
		<i>E. albia</i>	67.72-79.0	15-17.5	10.0-12.5	0.57-0.83	175-218.75	12.0-12.5	0.71-0.83	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
Hymenaria		<i>E. concolor</i>	45.14-79.00	20-25	17.0-17.5	0.7-0.87	350-437.5	10.0-20.0	0.40-8	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
		<i>E. oxavalata</i>	56.43-67.72	15-22.5	12.5-15	0.55-1	225-337.5	15-20	0.6-1	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
Hymenaria		<i>E. graniticola</i>	67.72-90.29	17.5-20.0	10.0-12.5	0.5-1	175-218.75	10.0-15	0.5-0.83	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
		<i>E. parvica</i>	56.43-67.72	15.0-20.0	12.5-15	0.71-1	218.75-300	12.0-12.5	0.62-0.83	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
Panilia		<i>E. aperitiflora</i>	56.43-79.00	17.5-20	12.5-17.5	0.42-0.8	250-350	7.5-10	0.375-0.5	Elliptic	Paenchymatous	Polygonal	a-Tetra	Spherical		
		<i>E. bipunctata</i>	67.72-79.00	14.0-15	7.5-12.5	0.5-0.83	112.5-187.5	12.5-15	0.63-1.0	Elliptic	Paenchymatous	Polygonal	Tetra	Spherical		
Steliatia		<i>E. spicata</i>	33.86-67.72	20.0-25	20.0-22.5	0.9-1	400-562.5	15-20	0.6-0.8	Elliptic	Paenchymatous	Polygonal	c-tetra	Spherical		
		<i>E. javanica</i>	N.O	N.O	N.O	N.O	N.O	N.O	N.O	Elliptic	Paenchymatous	N.O	N.O	Conical		

N: B: N: O: Not observed; D=: Density; W=: Width of ledge; L=: Length of ledge; W/L: ledge width relative to length; W x L=: Product of width and length; OL/L=: opening length; OL/L=: opening length relative to ledge length.



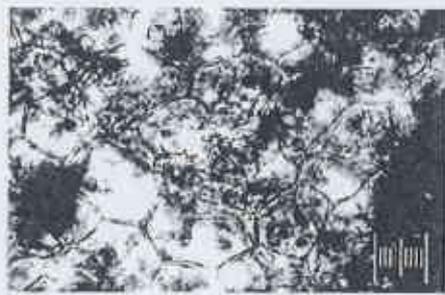
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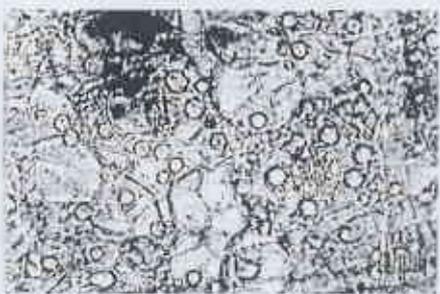
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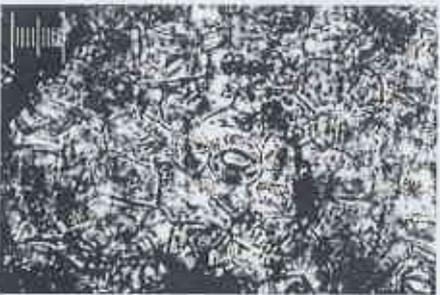
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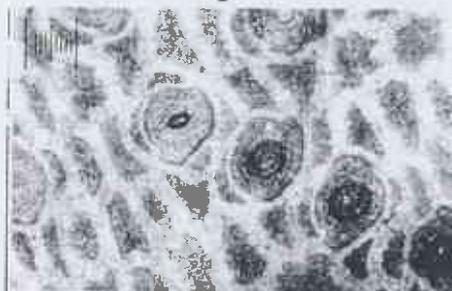
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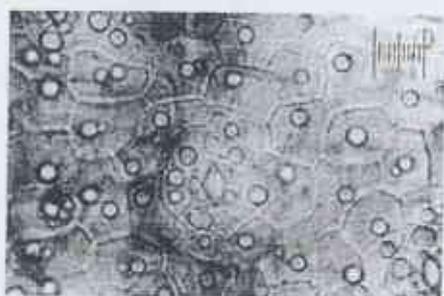
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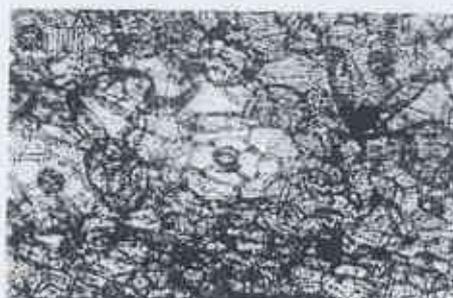
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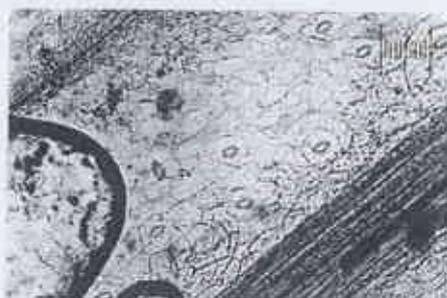
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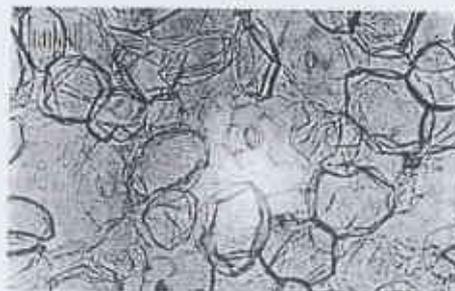
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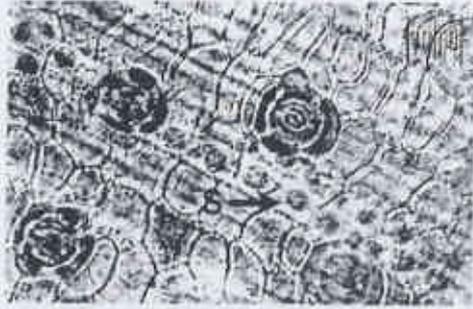
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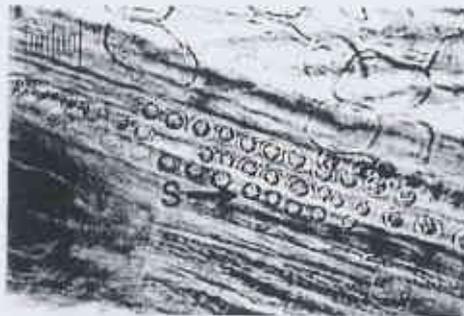
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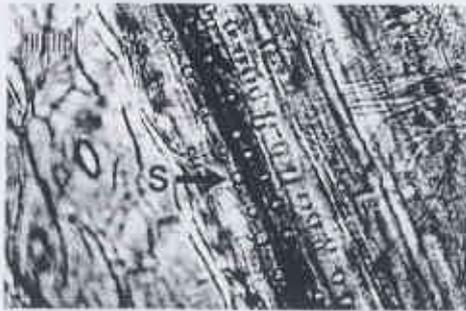
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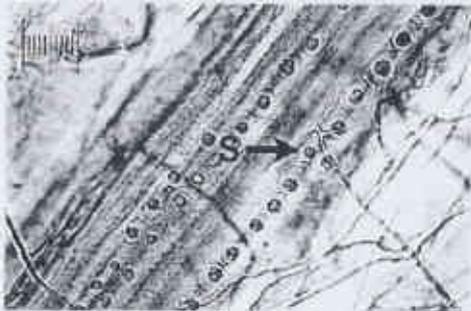
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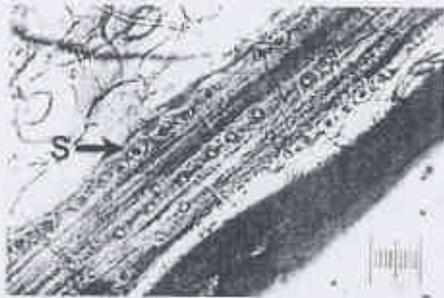
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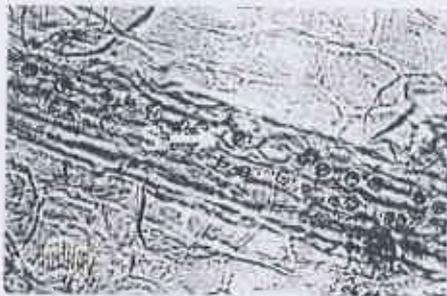
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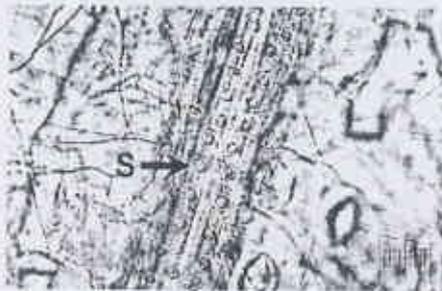
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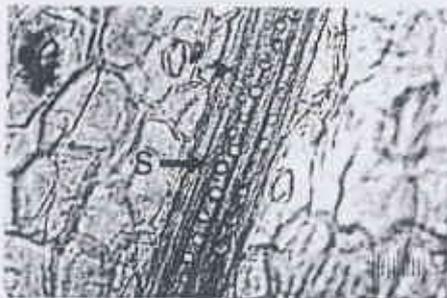
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4.2 Seed Morphology of the genus *Eria* Lindl.

4.2.1 Introduction

Studies of seed structure, like fruit structure, had much neglected. Orchid seeds are very small, minute and dust like in appearance, and produced in large numbers (1,300-4,000,000 seeds per capsule). Seed morphology had regarded as one of the potentially useful new sources of data in plant systematics. Their taxonomic value had first hinted at by Clifford and Smith (1969), though these characters have been rarely little (Beer 1863; Rauh & *al.* 1975; Barthlott 1976; Hass 1977 a, b; Barthlott and Ziegler 1980, 1981; Healey & *al.* 1980; Dressler 1986b, 1990, 1993; Molvray and Kores 1995; Tohda 1983, 1985, 1986). Zielger (1981) carried out extensive work on the seed morphology of family Orchidaceae using the scanning electron microscope (SEM), but his results have yet to be published. Barthlott (1976) concluded that the seed morphology will be a useful feature at higher taxonomic levels, generally at or above the sub-tribe, but no intensive effort has been directed in examining its usefulness at lower levels. Shakya (1999) studied the seed morphology of 18 species of *Oberonia*. He point out that the seeds of *Oberonia* do not reflect taxonomically useful information at the section and series levels.

4.2.2 Materials and methods

The seeds of 19 species (out of fifty species) of *Eria* from Himalayan regions were obtained from living collection as well as herbarium specimens (K, BM, CAL, KATH and TUCH), and examined with the help of a Light microscope (LM). Slides had been photographed using a photomicroscope (XS 200/201).

The shape, size (length, breadth) and other gross morphology of the seed structure had thoroughly studied by Light Microscope (LM). Characters of fused anticlinal and periclinal walls, arrangement of testa cells, and seed type in selected species of *Eria* had used in the classification at species level.

4.2.3 Results

4.2.3.1 Seed shape

Orchid seeds are simple, minute, dust like and consist only of undifferentiated embryo and seed coat. Clifford and Smith (1969) identified five basic categories of seed shapes in orchids (Fig 69). The five seed shapes (cumcumber, filametous, pear, sac, and spindle) were disringuished by Bartholtt (1976). Most of these types and its variation were observed by Vij & *al.*

(1992). According to them most of the *Epidendreae* has "C" and "D" type of seed shape. The seed shapes of *Eria* are fusiform as in most other orchids (Linder and Kurzeil 1994). They belong to "A" "B" and "D" shape class following Clifford and Smith (1969). None of the seeds of the Himalayan *Eria* fall under shape class "C" and "E". The shape of seed class "A" is characterized by both ends narrow and linear (*E. carinata*), class "B" is characterized by one end of the seed broad, more or less the same size or slightly narrow than the middle portion of the seed, showing its point of attachment (*E. alba*). In the shape "D" both ends of the seed are tapering. Majority of the species falls under the shape class "D" (*E. spicata*, *E. lasiopetala*, etc.), (Fig. 70, Plate I, -IV).

In the present study, the drying process of fresh seeds demonstrated 25-40% decrease in seed width but little or no decrease in length. Chase and Pippen (1988) also observed same rate of decrease in size of seeds in Oncidiinae. According to Dressler (1993) there are two types of seeds in the tribe Eriinae. In the present observation, there were three distinct types are recorded namely, Vanda type, Epidendrium type and Eulophia type. Vanda type (*E. muscicola*, *E. coronaria*, *E. lasiopetala*) and Epidendrium type (*E. extinctoria*, *E. alba*) are common, whereas Eulophia type was recorded only in *E. clausa*.

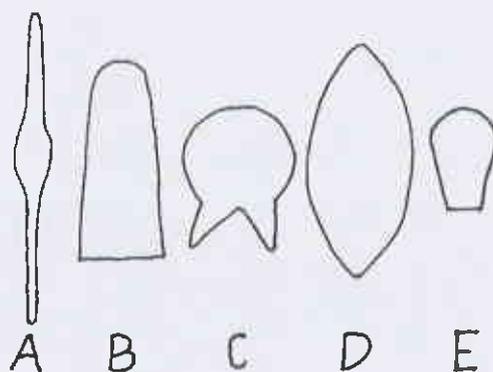


Fig. 69: Clifford and Smith's type of Seed shape

4.2.3.2 Seed size

The seed size is one of the most striking features of the Orchidaceae; the seeds though are microscopic, exhibit a great deal of size diversity. In general, the size of seeds in orchids varies from 0.25-0.75 mm wide and 0.3- 5 mm long. In case of *Eria*, it ranges from 0.75-2.2 mm in length.

Based on their L/W ratio of the seed, two types of cells are distinguished as truncated type ($l/w < 6.0$) and elongated type ($L/W > 6.0$). In *Eria*, ratio of seeds is highly truncate as in *E. paniculata*, *E. clausa*, *E. alba*, *E. excavata*, *E. lasiopetala*, and *E. tomentosa*. Arditti & al. (1979) considered the relative degree of truncation of the seed as a taxonomic parameter and similar utility of this parameter in identifying some of the species. In the present study, the relative degree of truncation of the seeds is directly correlated with an increase in their length rather than their width. Similar finding was also observed by Arditti & al. (1979).

4.2.3.3 Testa cell shape

Generally, the seed coats of orchids had generally represented by a single layer of elongated and transparent testa cells, usually derived from the epidermis of outer integument. The testa cells are transparent with variously lignified walls at maturity (Abraham & Vatsala 1981, Vij & al. 1992). The embryo had enclosed in a thin, papery testa cells. The testa cells are one layer thick, elongate, rectangular or oval, with uneven and thickened anticlinal walls. The testa is extension or regular sculpturing of anticlinal and periclinal walls. The testa consists of dead cells with their outer periclinal wall concave, forming elongated groove and depresses to the inner one. The anticlinal walls of the testa cells had raised and fused with the anticlinal walls of adjacent cells. The fusions of two anticlinal walls had indicated by presence of groove or rarely with raised ridge. The anticlinal wall of testa cells of most orchid seeds had raised but do not form elongate processes and this is also true for *Eria*. Their size, shape and wall thickening pattern had employed as useful taxonomic parameter in species delimitation (Clifford & Smith 1969; Barthlott 1978, Arditti & al. 1979, 1980; Healey & al. 1980; Barthlott and Zeigler 1980, 1981).

The shapes of testa cells are uniformly quadrilateral and fusiform in the tribe *Epidendreae* (Clifford & Smith 1969). The longitudinal and the transverse cell walls are thicker than the surface and subsurface walls, giving a characteristic net like appearance. In the present study, some variation in testa cell shape had observed within the seeds of different species. Thus, basically two kinds of testa cells, viz. quadrilateral and fusiform type are observed in *Eria*.

In the majority of *Eria* species, the anticlinal walls show presence of groove. In some species, both the groove and raised ridge between anticlinal walls were found (*E. alba*). In *E. clausa*, the anticlinal and periclinal walls are distinct. The common average thickness of the fused

anticlinal walls is 4 μm in most of the species, but in *E. alba* and *E. bambusifolia*, the anticlinal wall is 8 μm thickened.

All cells are similar and distinctly narrow, elongated, fusiform or quadrilateral shape with smooth periclinal cells, cell corners are not rounded, but prominently acute angled; anticlinal wall is high, narrow and sharp angled (*E. muscicola*). The testa cells are distinctly elongated; intercellular space is absent, the broader cell had never covered by folded "cuticle", and definite thickenings are present on both anticlinal and periclinal walls (*E. clausa*). The testa cells had so strongly elongated that the longitudinal anticlinal wall is in contact. The seed surface has also made up of marginal ridges. Periclinal thickenings had not seen in *E. muscicola* and *E. pannea*. The diameter of the chalazal pole of most *Eria* is roughly the same as or slightly narrower than the middle portion of seed. The micropylar pole gradually became narrow.

An attempt have been made to arrange the species of *Eria* into five types, according to Clifford & Smith (1969) and Dressler (1993), based on the study of seed morphology of limited number of species. The seeds of *Eria* reflect taxonomically useful information at the section levels (Fig. 70, Plate I-IV).

- 1.a Seed shaped fusiform ----- 2
- 1.b Seed shaped elliptic ----- **Type A:** *E. coronaria*, *E. stricta*, *E. bambusifolia*, *E. spicata*
- 2.a "A" or "D" shaped seed with vanda type ----- 3
- 2.b "D" shaped seed with Eulophia type -----: **Type B:** *E. clausa*
- 3.a "A" shaped seed with vanda type ----- **Type C:** *E. carinata*
- 3.b "D" shaped seed with vanda type or epidendrum type ----- 4
- 4.a "D" shaped seed with vanda type ----- **Type C:** *E. merguensis*, *E. lasiopetala*, *E. tomentosa*, *E. ferruginea*, *E. pannea*, and *E. aperiflora*
- 4.b "D" shape seed with epidendrum type ----- **Type D:** *E. extinctoria*, *E. paniculata*, *E. excavata*

4.2.4 Discussion

The seeds of *Eria* are more or less uniform in shape. However, there are considerable variation in micromorphological characters of anticlinal walls, periclinal walls and orientation of testa cells. The seeds are fusiform with narrow elongated testa cells and prominent raised fused anticlinal walls that run more or less straight or diagonal. They provide rigidity to the seed coats and protect the embryo. Clifford and Smith (1969) studied seed attributes of orchid species. They classified five basic categories of seed shapes and arranged them into the tribes and the sub tribes based on the classification of Dressler and Dodson (1960). They mentioned the tribe *Epidendreae* with different seed shapes, cell shape, and thickening of the testa cells except *Eria*. Vij & al. (1992) enlisted *E. spicata* has elliptical shaped seed, fusiform testa cell with thick

longitudinal/ transverse walls having cross band thickening pattern on surface walls. In the present study, seed morphology of 19 species of *Eria* had examined, which shows great variation in size, shape and testa walls within the genus (Table 10).

According to Dressler (1993), 19 species of *Eria* belongs to three types of seeds namely, Vanda type, Epidendrum type and Eulophia type. Vanda type and Epidendrum types are common types in majority of the species, where as Eulophia type was observed only in *E. clausa*. The size of seeds varies from 75 μ m (*E. coronaria*) to 220 μ m in length (*E. bambusifolia*). Similarly, width of the seed varies from 25 μ m (*E. coronaria*) to 120 μ m (*E. alba*). "A" shaped seed was observed in *E. carianta*, "B" shaped in *E. coronaria* and "BD" shaped type in *E. alba*. Testa thickening patterns with fused anticlinal walls, grooved and ridged were observed in *E. clausa* and *E. excavate*, whereas the remaining species possess only grooved testa.

Dressler (1986) pointed out that the genus *Eria* shows two different seeds type with great vegetative morphological variation. Dressler (1993) also pointed out that seed structure of *Eriinae* has needed to know more about it. In conclusion, the study of seed attributes in *Eria* show valuable character that can be used in delimitation of the taxa of *Eria* at species level.

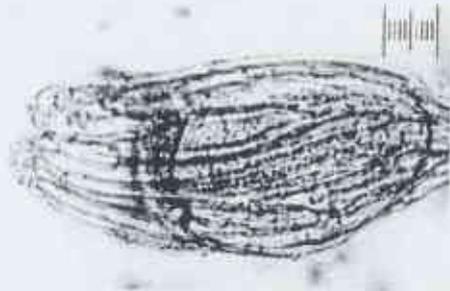
Table 9: Comparative Seed Morphology of the Himalayan *Eria*

Character Taxa	Seed			Testa			Seed type (Dessler 1993)	
	Shape (Clifford & Smith 1969)	Length	Breadth (µm)	LAW	Shape	Thickening pattern		
						Two anticlinal walls (µm)		Fused anticlinal walls
Section Conchidium								
<i>Eria muscivola</i>	D	200	48	4.16	A	4.00	Grooved	
<i>E. extinctoria</i>	D	150	62.5	2.4	A	10.00	Grooved	
Section Trichosma								
<i>E. clausa</i>	D	180	80.	2.25	A	4.00	Grooved and ridge	
<i>E. cornaria</i>	B	75	25	2.5	A	3.00	Grooved	
Section Xiphosium								
<i>E. curvata</i>	A	200	62.5	2.5	A	3.2	Grooved	
Section Secunda								
<i>E. stricta</i>	B	180	80	2.25	A	4.00	Grooved	
<i>E. merguensis</i>	D	480	120	4	A	4.00	Grooved	
Section Dentrolium								
<i>E. lasiopetala</i>	D	160	64	2.5	A	4.00	Grooved	
<i>E. tomentosa</i>	D	148	64	2.31	A	4.00	Grooved	
<i>E. ferruginea</i>	D	220	72	3.05	A	4.00	Grooved	
Section Strongylaria								
<i>E. pannea</i>	D	148	40	3.7	A	4.00	Grooved	
Section Bambusifolia								
<i>E. bambusifolia</i>	B	220	60	3.66	A	8.00	Grooved	
Section Mycaranthus								
<i>E. paniculata</i>	D	152	68	2.23	A	4.00	Grooved	
Section Hymeneria								
<i>E. alba</i>	BD	180	120	1.5	A	8.00	Grooved and ridge	
<i>E. excavata</i>	D	160	88	1.81	A	4.00	Grooved	
Section Pitila								
<i>E. aperiflora</i>	D	100	37.5	2.61	A	5.00	Grooved	
<i>E. bipunctata</i>	D	160	80	2	A	4.00	Grooved	
<i>E. spicata</i>	B	180	120	1.5	A	4.00	grooved	

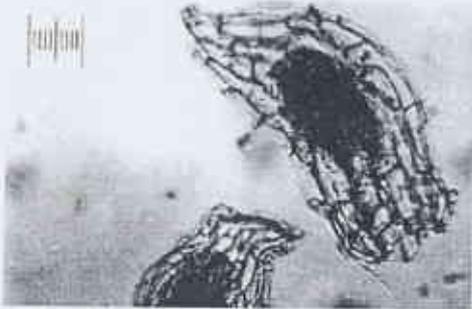
N.B: Testa shape: A: fusiform, B: Quadrilateral shapes, Thickening of testa surface: below 4 µm = Thin.; above 4 µm = Thick



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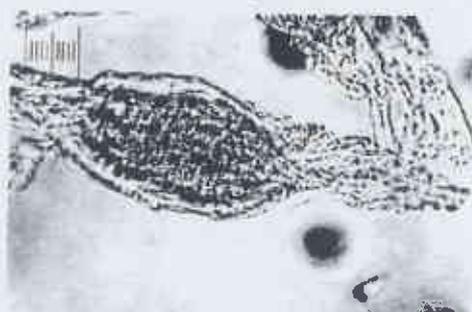
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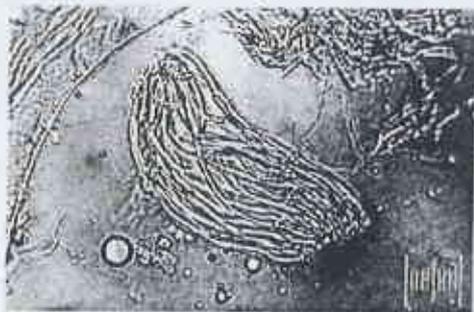
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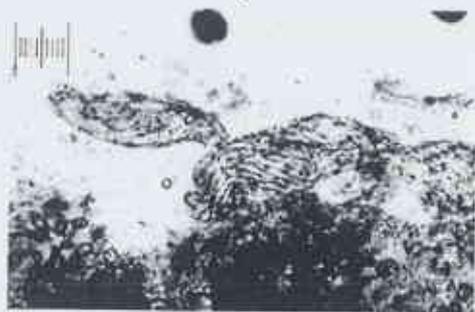
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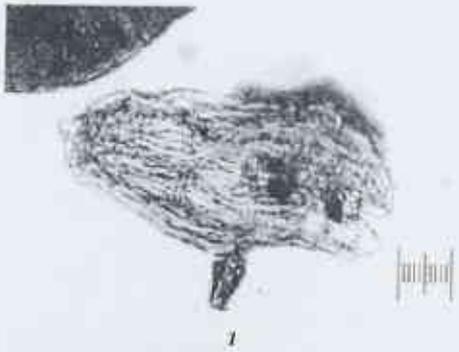
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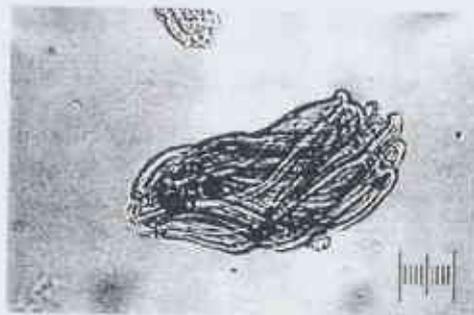
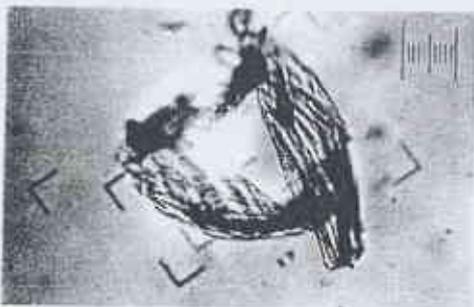
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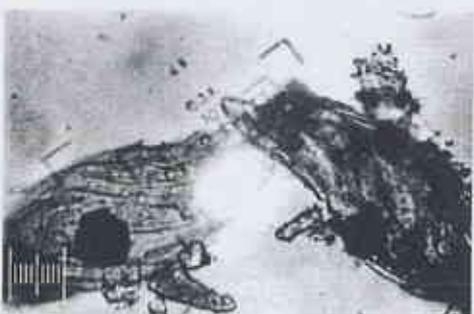
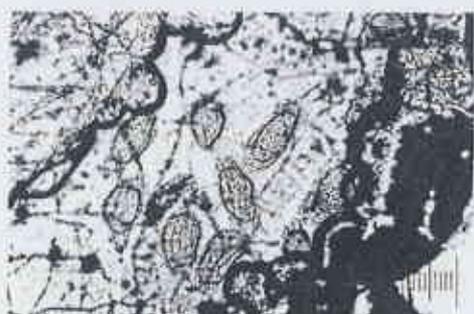
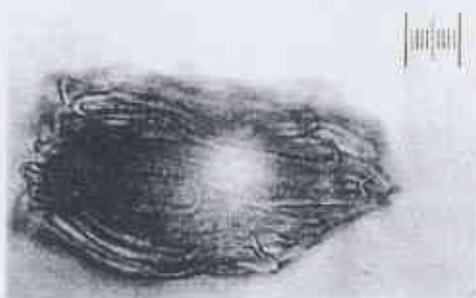
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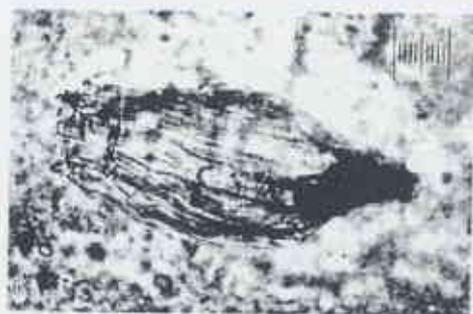


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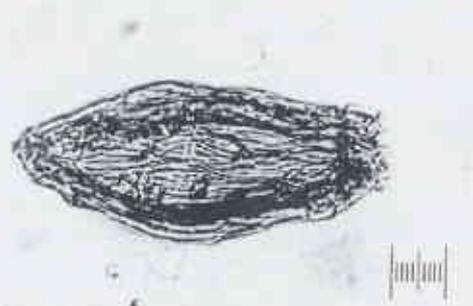
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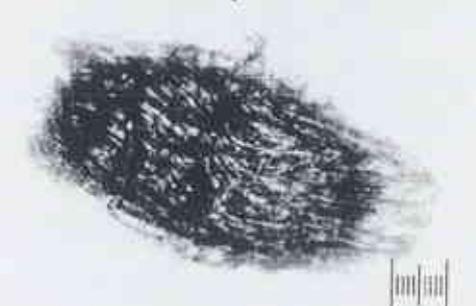
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4.3. Pollen morphology of the genus *Eria* Lindl.

4.3.1 Introduction

Pollen grains and spores are of special significance in plant science, having a unique entity in plants. Although being gametophyte in nature, pollen grain plays an important role in the systematic work. Palynology is one of the strong parameter which shows characteristic features among plant taxa in small group, and considered as an important part in taxonomic treatment. This type of work can be useful to delimit the taxa within groups. There is great variation even in the smaller groups of the plants within each genus or each species (Eide 1987).

Wodehouse (1935) described pollen grains of fossils as well as living taxa of Gymnosperms and Angiosperms in "pollen grains". Erdtman (1952, 1962) contributed a treatise on pollen analysis. He presented a summary of pollen morphological characters of most of the families of angiosperms. He had great contribution on Acetolysis techniques for the preparation of pollen slides for light microscope study. Similarly, elaborated pollen terminology has been developed for the position, number, shape of aperture and exine sculptures (Nair 1965, Punt & *al.* 1994).

Regarding the orchid species, the palynological study plays a major role in its identification and classification. In Orchidaceae, the pollen grains remain in tetrad or aggregated into larger masses. An individual massula is composed of tetrad, which form the basic pollen unit. Only the tetrad walls on the outer surface of massula have a well developed exine (Chesslet & Linder 1993). However, single grains occur in *Apostsiodeae*, *Cyperipediodeae*, *Vanillinae*, some *Diurideae*, *Neottieae*, and *Pogoniinae* (Dressler 1981). Individual pollen is composed of tetrad which forms the basic unit for most of Orchidaceae. Only the tetrad walls on the outer surface have a well developed exine. The main characters of the taxonomic value in pollen grains are the numbers, position of furrows, apertures, morphoforms, exine stratification pattern, and other associated characters of pollen grain (Sivarajan 1985). The major systems of classification of orchids are based on the variation in pollinia, pollen and the associated features (Dressler 1960). So, being special feature, this study support systematic work to evaluate identification of plant taxa and elucidate evolution.

In early 19th century, pollinium character is considered as one of the most important characters and being used in the Orchidaceae as tools for systematic study. Brown (1810) recognized five sections in the family based upon pollen packaging and texture. Lindley (1926) classified the Orchidaceae into the sections and the tribes mainly based upon pollinium characters. He used three main characters in his classifications: (1) number of pollinia per anther, (2) orientation of individual pollinia in the anther (whether pollinia are superposed or not), and (3) nature of pole subpackaging within the pollinium (solid or sectile pollinia). Reichenbach (1852) first examined the development of pollen and associate structures in Orchidaceae. In recent studies, palynological characters have employed some or all of them in phylogenetic analysis within the family (Burns-Balogh and Funk 1986; Dressler 1990a, b, c, 1993).

In early period, the study of pollen grain structure had been neglected. In recent years, this character has been used for the delimitation of species with the help of Scanning microscope (SEM) and Transmission Electron Microscope (TEM), which provide the excellent results of structure of pollen, pattern of exine, and pollen walls etc of individual species (Williams and Broome 1976; Schill and Pfeiffer 1977; Newton and Williams 1978; Schill 1978; Ackerman and Williams 1981; Burns-Balogh and Hesse 1988; Hesse & al 1989; Zavada 1990).

In the family Orchidaceae, there is an extreme cohesion of pollens forming pollinia. Vij & Kasyap (1978) pointed out the taxonomic usefulness of pollen association in the multipalynous family Orchidaceae. They had studied fifty species of orchids species and among them, they investigated that single pollen grains were found in relatively primitive groups such as *Paphiopedilum villosum*, *Cyperipedium cordigerum*, and *Cephalanthera ensifolia*. Pollen tetrads were common in the tribe *Neottieae* and *Epidendrieae*, and perfect massulae occur in the *Orchidoideae* and some *Neottieae*, where the shape of the massulae can be of taxonomic value for lower-level classification.

4.3.2 Material and methods

Pollen grains of selected twenty species of *Eria* were examined in the present work. The living materials were collected from different part of the Himalayan region, and the herbarium specimens were also used for pollen analysis (Table 12).

Pollen slides were prepared by 'Acetolysis Method' as proposed by Erdtman (1966). The polliniferous materials or pollinia were taken out from the flowers (using fine forceps or dissecting needle). For the dry materials, the flowers were rehydrated in distilled water, with a drop of detergent, before taken out the pollinia. A small sieve was taken and kept on the mouth of funnel and its neck was inserted into the test tube. Then the pollinia were transferred into sieve and macerated with the help of blunted clean glass rod. The macerating materials in the sieve were washed through with distilled water. Before centrifuge, few drop of lactic acid was added to the

materials, and centrifuged for 5 min. at 3000 rpm/min. The supernatant solution was decanted, leaving pellet of pollen in base of the tube. The pellets of pollen were treated with glacial acetic acids, and centrifuged for 5 min. at 3000 rpm/min again and decanted. Then 13.5 % acetic anhydride + 3.5 ml conc. sulphuric acid was added to the materials in the tube drop by drop. After that the materials were stirred with the help of the sacker and then materials were heated in metal block to 110^o C for 2-5 minute, till material turned brown in colour. Then the mixture was allowed to cool for few minutes. The mixture was again centrifuged and waste acid was decanted. The mixture was washed and decanted at least twice with distilled water. For preparation of glass slides and SEM stubs the sample was divided into 2 parts.

For mounting on the glass slides, small piece of gelatin jelly was taken with help of tip of clean sterilized needle and made adhere the pollen grains. The jelly with the materials was put on the clean slide at the middle and warmed on the sprit lamp to melt. As soon as the jelly was melted, the cover glass was used to cover the material. At last, the cover glass was sealed with wax for observation on high power microscope. The observations were carried out with the help of Light microscope (LM). Slides were photographed using a photomicroscope (XS200/201) at 40 X 100X magnification. About 20 pollen tetrads were observed and examined for each specimen.

For SEM observation, Scanning Electron Microscope (JEOL JSM –T200) had used in BM. The materials were fixed in stub with the help of double side adhesive tape. Gold- palladium coating of the material was done for three minutes in Polaron Equipment Limited, SEM Coating unit E5100. SEM microphotographs were taken with the help of Mamiya SLR camera. The terminology used to describe size, shape and aperture of pollen tetrads were taken from Punt & al. (1994).

4.3.3 Results & Discussions

The present study shows that all species of *Eria* have compound pollen in tetrad, inaperturate and smooth in nature. The shape and size of pollen tetrad varies from species to species. The tetrads are irregularly shaped as a result of their compact organization within pollinium.. Most of them are isodiametric and rhomboid in shape. Exine morphology and sculpture of *Eria* are similar among the species examined. A brief description of pollen morphology and ornamentation of each species examined under SEM and LM had given below (Table 10 and Fig. 71, 72 and 73).

Among 50 species of *Eria*, which have been treated and studied on morphological variation in detail, only 20 species belonging to ten sections have been studied palynologically in the present work. This study showed that the taxa of *Eria* tended to be rather constant with respect to pollen morphology. Most species possess similar shape of pollen tetrads but slightly variable in the size, aperture, nature of exine, etc. Some *Epidendroideae* with soft pollinia also have more or less heavily sculptured pollen grains, but more or advanced member of the

Epidendroideae have thick but relative smooth exine on the outer walls of the pollinia (Dressler 1993). The result shows that shape of pollen tetrad shows remarkable variation among the species. Most of the species are rhomboidal shaped pollen tetrad and inaperturate. The size varies from 84-200µm length, smooth exine on the outer wall of pollinia. The tectum surfaces of pollens had smooth in *Eria* as observed by LM. In *E. spicata*, *E. amica* and *E. alba*, tectum is psilate, where as in *E. bipunctata* it is scabrate, and in *E. lasiopetala*, the tectum is perforate (SEM), which is the main feature for the phylogeny of the orchids and the evolution of their pollen (Burns-Balogh 1983).

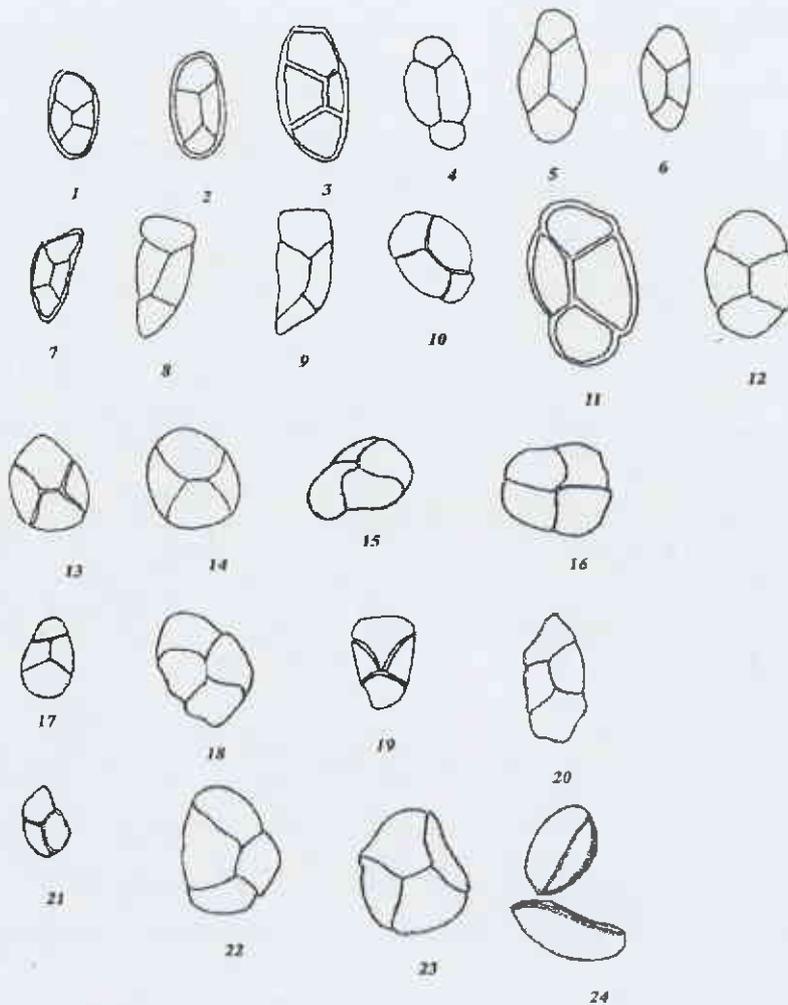
The arrangement of microspores in the tetrads may be isobilateral or linear. Isobilateral tetrads are common in *Eria*. Chesselet & Linder (1993) reported that pollen tetrad had isobilateral in *Orchideae*, *Satyliinae*, *Disperis* and *Disinae*, and noted that externally pollen tetrads are more or less spherical shaped. Linear tetrads had reported by Hesse & al. (1989) in *Orchidaceae*.

Pollen occurs irregularly tetrads that have a strong tendency to adhere (Ackerman & Williams 1980). Pollen cohesion into polyads had been achieved either by a continuous exine or by wall bridges. Knox & McConchie (1986) support a classification of cohesion in compound pollen that distinguishes simple cohesion of tectum from crosswall cohesion, in which connecting bridges occur between adjacent units (Skvarla & al 1976, Takahashi & Sohma 1980, 1984). Van Campo & Guinet (1961) classified polyads into calymmate and acalymmate type. In calymmate type, the grains had fused by tectum, which surrounds the pollen unit, whereas in acalymmate type, the tectum is interrupted between grains. In the present study pollen tetrads had adhered as "calymmate type" by observing with SEM and LM in *Eria*. Chardard (1969) reported calymmate pollinium in *Phajus tanervillae*. Zavada (1983) recorded calymmate pollinia in *Clesostoma recemiferum*. Chesselet & Linder (1993) reported pollen tetrads in tribe *Disinae* as calymmate type, but the mussulae and pollinia are acalymmate type. It had also supported by Schill & Pfeiffer (1977) that accept some representatives groups of the *Vandoideae*, the pollinia and mussulae as acalymmate type and pollen tetrads are as calymmate type except in *Neottia*.

Therefore, present study concluded that the pollen morphology data do not distinguish characteristic features for species delimitation. Pollen in *Eria* is too uniform for taxonomic resolution. However, pollen data do contain good information at the generic and subtribal levels.

Table 10: Comparative study of pollen morphology of Himalayan *Eria* Lindl.

Botanical Name	Nature	Size (μm)	Exine struture		Shape
			LM	SEM	
Section <i>Eria</i> <i>E. Javanica</i>	Tetrad	120	smooth	-	Rectangular
Section <i>Conchidium</i> <i>E. muscicola</i>	Tetrad	84	smooth	-	Ellipsoid
Section <i>Trichosma</i> <i>E. clausa</i>	Tetrad	110	smooth	-	Ellipsoid
<i>E. coronaria</i>	Tetrad	100	smooth	-	Ellipsoid
<i>E. vittata</i>	Tetrad	100	smooth	-	Ellipsoid
Section <i>Dendrorium</i> <i>E. lasiopetala</i>			smooth	Punctu	
<i>E. Pannea</i>	Tetrad	120	smooth	m	Ellipsoid
<i>E. ferruginea</i>	Tetrad	110	smooth	-	Ellipsoid
<i>E. tomentosa</i>	Tetrad	140	smooth	-	Ovoid
	Tetrad	100		-	Ovoid
Section <i>Mycaranthus</i> <i>E. paniculata</i>	Tetrad	104	smooth	-	Ellipsoid
Section <i>Bambusifoliae</i> <i>E. bambusifolia</i>	Tetrad	160	smooth	-	Rhomboidal
<i>E. crassicaulis</i>	Tetrad	132	smooth	-	Ovoid
Section <i>Hymenria</i> <i>E. alba</i>	Tetrad	-	smooth	Psilate	Elliptic
<i>E. amica</i>	Tetrad	200	smooth	-	Isodiametric
<i>E. acervata</i>	Tetrad	200	smooth	-	Ellipsoid
<i>E. bracteascens</i>	Tetrad	120	smooth	-	Rhomboidal
<i>E. excavata</i>	Tetrad	80	smooth	-	Rhomboidal
Section <i>Pinalia</i> <i>E. apertiflora</i>	Tetrad	100	smooth	-	ovoid
<i>E. bipunctata</i>	Tetrad	60	smooth	scabrate	Rhomboidal
<i>E. spicata</i>	Tetrad	104	smooth	psilate	ellipsoid



1. *E. ferruginea*; 2 @. *E. amica*; 3. *E. spicata*; 4. *E. muscicola*; 5. *E. javanica*; 6. *E. stricta*; 7. *E. bipunctata*;
 8. *E. bambusifolia*; 9. *E. coronaria*; 10. *E. ucervata*; 11. *E. crassicaulis*; 12. *E. alba*; 13. *E. granulifolia*
 14. *E. vittata*; 15. *E. lusiopetala*; 16. *E. spicata*; 17. *E. pannes*; 18. *E. tomentosa*; 19. *E. excavata*; 20. *E. apertiflora*
 21. *E. bractescens*; 22. *E. crassicaulis*; 23. *E. clausa*; 24. *E. paniculata*.

Fig. 71: Pollen morphology of *Eria* (Camera lucida drawing)

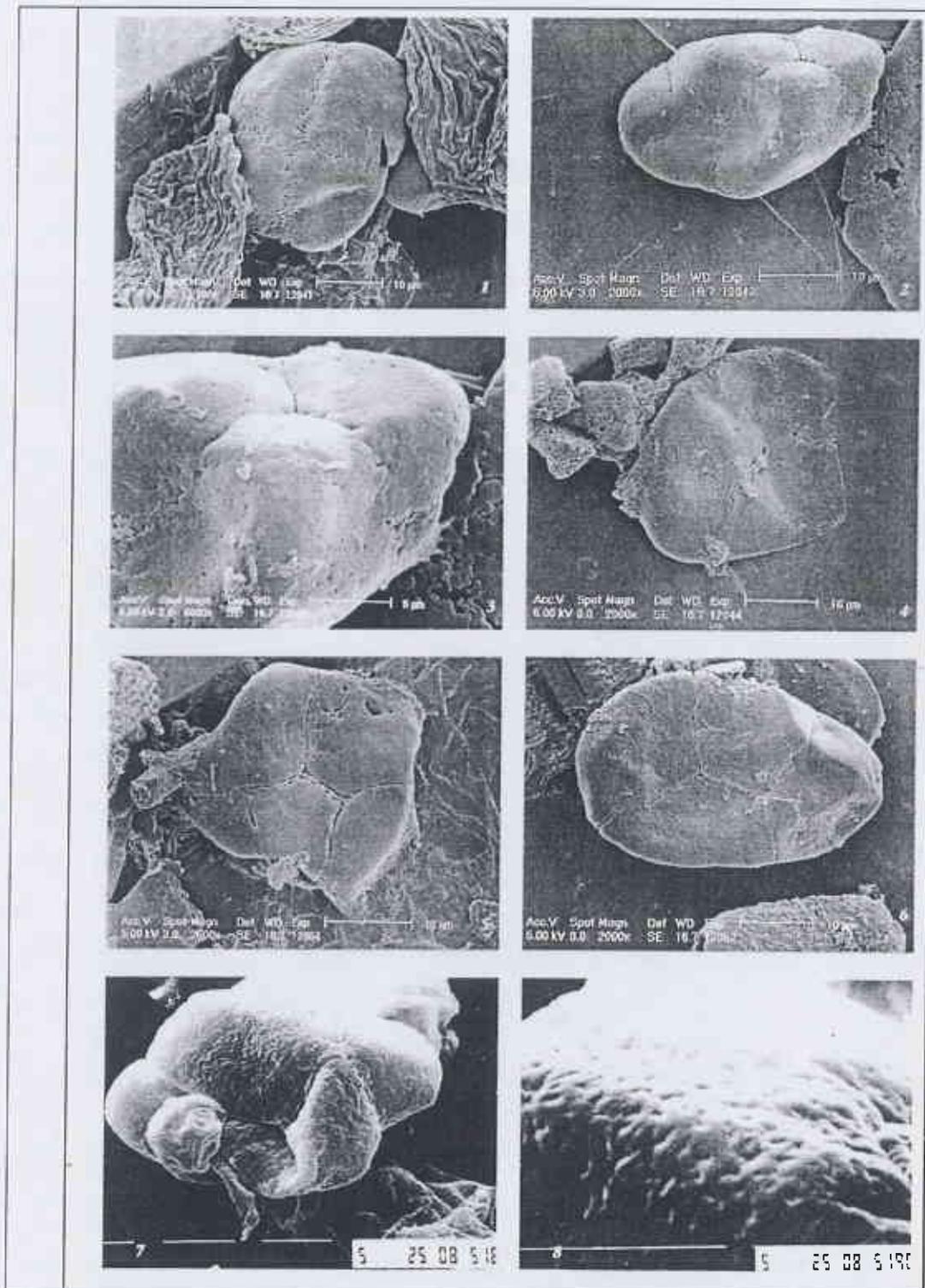


Fig. 72: Pollen morphology of *Eria* (SEM)

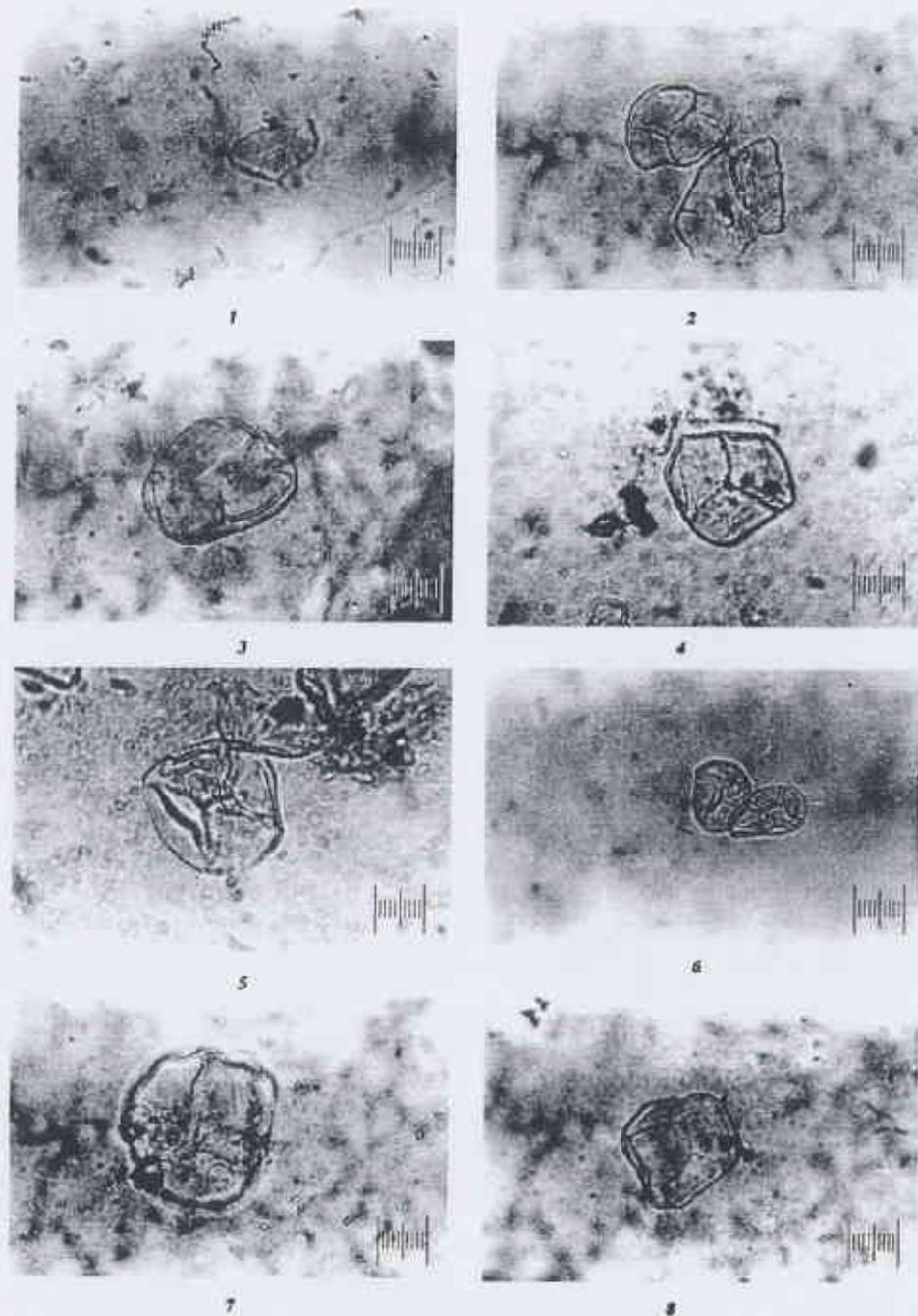


Fig. 73: Pollen morphology of *Eria* (LM)

5. CLADISTIC ANALYSIS

5 Morphological Cladistic analysis of the genus *Eria* Lindl.

5.1 Introduction

The genus *Eria* Lindl. (subfamily *Epidendroideae*, tribe *Podochiiae* subtribe *Eriinae*) is one of the polymorphic genera within the family *Orchidaceae*. It comprises about 404 species in the world and 49 species in the Himalayan region, (RBG Kew, 2003). It is distributed in the Himalaya, Malaysia, Indo-China, Java and Asia-pacific region of the world. All the species are characterized by sympodial growths, uni-nodal to multi-nodal pseudobulbs, with terminal and lateral inflorescence. This genus is closely related to *Trichotosia* in every aspect, except the hairy flower bracts and leaf sheath along rhizome. Taxonomically, this group has received relatively little attention from taxonomists, and considered as a difficult group within the family. The main characters used for species delimitation are shape of pseudobulbs, number of leaves, and ornamentation on the labellum.

The cladistic or phylogenetic approach is most widely accepted approach for system of classification in the plant systematics. Cladistics can be defined as the concepts and methods for the determination of branching of evolution (Stuessy 1990). Sokal and Sneath (1963) described it as "cladistic relationship refers to the paths of the ancestral lineages and there described the sequence of branching of the ancestral lines". Hening (1966) preferred the term 'Phylogenetic systematics' instead of cladistics. Hennig (1979) argued that classification should reflect the branching pattern of evolution rather than the degree of advancement and divergence. He also stated that only such groups are strictly monophyletic, composing of an ancestral taxon and all of its descendants should be recognized.

In the phylogenetic systematics, various characteristics of plants are referred to as "characters", and new characters are called "derived characters" (apomorphies). A group composed of an ancestor and all of its descendants are known as monophyletic groups, which are recognized on the basis of shared derived character (or synapomorphies). Synapomorphies arise in ancestral groups and are present in all of its members. The evolutionary relationship is generally shown by constructing a phylogenetic tree, also called a cladogram. The tree must be rooted in order to polarize all character changes i.e. more recent characters and ancestral characters. Cladograms are rooted on an out-group or groups (Swofford & al. 1996; Judd & al. 1999).

Hedberg (1995) mentioned that cladistics, now a-days often computerized methodology for taxonomic research is claimed by its proponents to more advanced and less subjective than traditional evolutionary systems.

Neyland & *al* (1995) analyzed the cladistic analysis of subtribe *Pleurothallidinae* based on 45 anatomical/morphological characters. The result shows eight most parsimonious trees (length=230; CI=0.27) and the cladistic analysis suggests that *Pleurothallus* is not a natural genus and, perhaps may be divided into several discrete genera.

Repetur & *al*. (1997) analyzed phylogeny of the genus *Bromheadia* using 27 characters. It shows that *Bromheadia* is monophyletic genus with one very distinctive apomorphic character, i.e. shape of the stipe of the pollinia.

Cozzoline & *al*. (1998) analyzed phylogenetic relationship in *Orchis* and some related genera by using chloroplast DNA. The cladistic analysis showed *Orchis* as a paraphyletic group, and the genus is divided into two clades. These results, which agree to a great extent with literature evidence on chromosome and isozymes, have been compared with various traditional systematic hypotheses for the genus.

Cameron & *al*. (1999) performed a cladistic parsimony analysis of *rbcL* nucleotide sequence data from 171 taxa representing nearly all tribes and subtribes of Orchidaceae are presented here. These analyses divide the family into five primary monophyletic clades: *apostasioid*, *cyripedioid*, *vanilloid*, *orchidoid*, and *epidendroid* orchids, arranged in that order. These clades, with the exception of the vanilloids, essentially correspond to currently recognized subfamilies. A distinct subfamily, based upon tribe *Vanilleae*, is supported for *Vanilla* and its allies. The general tree topology is, for the most part, congruent with previously published hypotheses of intrafamilial relationships; however, there is no evidence supporting the previously recognized subfamilies *Spiranθοideae*, *Neottioideae*, or *Vandoideae*. Subfamily *Spiranθοideae* is embedded within a single clade containing members of *Orchidoideae* and sister to tribe *Diurideae*. Genera representing tribe *Tropideae* are placed within the epidendroid clade. Most traditional subtribal units are supported within each clade, but few tribes, as currently circumscribed, are monophyletic. Although powerful in assessing monophyly of clades within the family, in this case *rbcL* fails to provide strong support for the interrelationships of the subfamilies (i.e., along the spine of the tree). The cladograms presented here should serve as a standard to which future morphological and molecular studies can be compared.

Freudenstein & Rasmussen (1999) performed the cladistic analysis of Orchidaceae undertaking 98 genera and using 71 morphological apomorphic characters based on a reconsideration of previous character analyses and newly discovered variation. The equally weighted analysis found 60,000 most parsimonious trees with low consistency (CI=0.29), but high retention (RI=0.83). The strict consensus reveals a significant amount of structure, and most

traditionally recognized subfamilies are supported as monophyletic, including *Apostasioideae*, *Cypripelloideae*, *Spiranthoideae* and *Epidendroideae*. Sub family *Orchidoideae*, in the broad sense, are paraphyletic, giving rise to the Spiranthoids. They also mentioned that the importance of vegetative characters as evidence putatively independent from floral features had demonstrated in the placement of *Tropidia*.

Gravendeel & Vogel (2000) performed a phylogenetic analysis of subtribe *Coelogynae* based on 41 morphological and four anatomical characters. The results show that the tribe *Coelogyninae* is monophyly and the subtribe *Coelogynae* appears as polyphyletic.

Until now, there is no explicit vegetative and reproductive morphological study in cladistic analysis of *Eria*. Present study expects that such an analysis would be useful for evaluating previous system of classification. It provides a concrete, explicit set of characters data and coding, in contrast with previous classification based on informal phenetic comparisons and allows the evaluation of traditionally emphasized characters.

5.2 Materials and Methods

5.2.1. Sampling

Recent revision attempts to analyze 40 taxa of *Eria*. The sampling includes 12 sections, out of 17 sections, currently recognized within *Eria*. The endemic species such as *E. arunchalensis*, *E. baniaii*, *E. bhutanica*, *E. glandulifera*, *E. jengengensis*, *E. sharmae*, *E. occidentalis*, *E. pokharensis*, and *E. sikkemensis*, which have less than two specimens, are not included in the analysis. Besides that other species of *Eria* belongs to other sections were excluded here as unknown species of the Himalayan region. Members of the genus *Eria* showed considerable variation in the reproductive and vegetative morphology. The analysis presents the interrelationship among the closely related taxa. Out groups were sampled from the tribe *Arundinae* as a basal member of Old World *Epidendreae* (Dressler 1993) for using morphological data.

The characters used for the cladistic analysis are discussed and outlined below:

Character and character states used in the phylogenetic analysis of *Eria*

0. Rhizome: (0) present; (1) very short.
1. shape of pseudobulb: (0) discoid; (1) conical; (2) obovate; (3) cylindrical.
2. Pseudobulb, number of internode: (0) several (1) only one
3. Leaf position at pseudobulbs: (0) throughout pseudobulbs/stem; (1) at apex.
4. Leaf texture: (0) soft; (1) coriaceous.

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5. Number of leaves: (0) two or more than two; (1) one.
 6. Leaves phylotaxy: (0) opposite; (1) distichous.
 7. Inflorescence surface: (0) glabrous; (1) hairy.
 8. Inflorescence position: (0) erect or sub erect; (1) pendulous.
 9. Inflorescence type: (0) heteranthous, (1) protoanthous; (2) synanthous; (3) hysteroanthous.
 10. Inflorescence number of flower: (0) <10;(1) >10.
 11. Floral bract: (0) caduceus; (1) persistent.
 12. Floral bract surface: (0) glabrous; (1) hairy.
 13. Floral bract shape: (0) linear/lanceolate; (1) ovate-oblong/ elliptic.
 14. Pedicellate ovary: (0) glabrous; (1) hairy.
 15. Labellum length:(0) smaller than 10mm; (1) between 10 and 30mm; (2) larger than 30mm.
 16. Sepal indumentum: (0) glabrous; (1) hairy.
 17. Lateral sepal: (0)adnate; (1) free.
 18. Petal shape: (0) oblong-ovate; (1) linear/lanceolate.
 19. Joint between column and labellum: (0) absent; (1) present.
 20. Labellum shape: (0)simple or obscurely tri-lobed; (1) tri-lobed.
 21. Ornamentation on the disc: (0) absent; (1) present.
 22. Labellum apex :(0) acute/obtuse; (1) lobed.
 23. Nature of ornamentation on disc:(0)absent/in distinct(1)lamellate/Ridges/ Keels(2)callii.
 24. Number of ornamentation on disc: (0) < 3; (1) > 3 ;(2) absent.
 25. Base of labellum with callii: (0) absent; (1)present.
 26. Callus at terminal lobe: (0) absent;(1) present.
 27. Terminal lobe, number of keels: (0) absent; (1) present.
 28. Angle between column and labellum: (0) acute; (1) obtuse.
 29. Pollinia shape: (0) laterally flattened; (1) other shape.
 30. Stegmata: (0) conical; (1) spherical; (2) absent.
 31. Stomata class: (0) type A; (1) type B; (2) type C; (3) type D; (4) type E; (5) type F; (6) - type G.
 32. Subsidiary cells: (0) elongated; (1) circular.
 33. Chromosome number: (0) $2n=24$; (1) $2n=34-38$; (2) $2n=40,42$ or more.
 34. Karyo-type: (0) type a; (1) type b; (2) type e; (3) type f; (4) type g; (5) type h; (6) type i.
 35. Seed classification: (0) vanda type; (1) Epidendrum type; (2) Eulophia type.
 36. Habit classification:(0) habit a; (1) habit b; (2) habit c; (3) habit d; (4) habit e; (5) habit f; (6) habit g ;(7) habit h; (8) habit i; (9) habit j.
 37. Number of pollinia:(0) 8; (1)4.
 38. Leaf type: (0) convolute; (1) plicate; (2) terate.

5.2.2. Morphological analysis

The characteristics of the genus were taken largely from the recent findings, based on living and preserved specimens housed in various herbaria of Nepal, India and the U.K. In total, 37 multi-state and binary characters were scored. Variation in characters for the taxa examined was scored from at least 5 different collections. All multistate characters were coded as unordered unless specified. The following characters and character state were used. The data matrix had shown in Table 11.

5.2.2.1. Macro-morphology:

Habit classification: Anderson & *al.* (1980) classified the habit types of *Eria* and *Trichotosia*. That type has been adopted for the present study. They have proposed **Habit a:** the erect part of the shoot with elongated internodes of approximately equal length, reed like, foliage leaves from base, inflorescence lateral, subtended by leaves all along the erect part of the shoot. **Habit b:** the erect part of the shoot with elongated internodes of approximately equal length, reed like, foliage leaves from base, inflorescence are only subtended by uppermost foliage leaves or bracts, subtended by leaves all along the erect part of the shoot. **Habit c:** the erect part of the shoot rather congested with crowded leaves, inflorescence lateral. **Habit d:** the erect part of the shoot with internodes of approximately equal length, foliage leaves gathered at the top, inflorescence subtend by scale leaves and foliage leaves. **Habit e:** the foliage leaves often from enlarging from the basal part of the shoot, gradually enlarging towards the top, succulent internodes of unequal length, inflorescence subtended by foliage leaves only. **Habit f:** the erect part of the shoot with only dominating internodes, foliage leaves from the base, but some time sheathing up the stem, the upper foliage leaves or bracts subtending the lateral inflorescences. **Habit g:** The modules (the rhizomatous, rooting part with scale leaves only) of two different kinds, some carrying foliage leaves, other specialized towards flowering, the inflorescences produced laterally on the stem of floriferous modules. **Habit h:** the erect part of the shoot with one dominating internode, the foliage leaves at the top, inflorescence terminal. **Habit i:** the erect part of the shoot very congested, the rhizomatous part of the shoot pseudobulbous, inflorescence terminal. **Habit j:** the erect part of the shoot carrying branches, which are again branched, forming erect non-rooting sympodia.

Pseudobulbs- one or more than two leaves are present in the pseudobulbs, consisting of one internode or more than one internodes throughout the stem, or at the apex of pseudobulbs, and living more than one growth season are present in all taxa of *Eria* examined. In several taxa, a considerable amount of intraspecific variation is present in the shape and spacing between the pseudobulbs, which is also included as the prominent character.

Leaves- The texture of dried leaves varies considerably within *Eria*, from thin membranous papery to leathery. This is also the case for shape of the leaves and number of main veins (varying from one up to nine or more). All these characters could not be divided unambiguously into discrete, non-overlapping state recommended by Pimental & Riggins (1987), and were therefore omitted.

Inflorescence- Four types of inflorescences are recognized. In heteranthous inflorescences, the terminal internodes of vegetative shoot, from which the inflorescence sprouts, neither a pseudobulbs nor a leaf at any stage. The old inflorescences seem lateral on the rhizome. In hysteranthous inflorescence, the inflorescence develops on top of full grown pseudobulbs with fully developed leaves. In proteranthous inflorescence, the leaf from the immature pseudobulbs at the base is still hidden in the scales of the inflorescence-bearing young shoot during anthesis. In syanthous inflorescence, the inflorescence sprouts simultaneously with leaf subtending it from a shoot with still undeveloped terminal pseudobulbs (De Vogal 1988, Pederson & al. 1997, Gravendeel & De Vogal 2000, Pearce & Cribb 2002).

The position of inflorescence is coded as erect when the rachis is almost vertical. This was the case for most of the species examined. When the rachis is distinctly curved, this is coded as pendulous. The gap present in the number of flowers is considered to be distinct enough to recognize the following states in the characters: flowers <10 in number and flowers > 10 in number. Some of the species has imbricate or isolated bracts present on the base of the rachis. These bracts are identical with the floral bracts in shape and size, but do not accompany with flowers. They are not considered to be homologous with the sterile bracts at the base of the rachis. Floral bracts are coded as caducous when they fall off after anthesis and persistent when they are still attached to the rachis after the flowers or fruit has fallen off.

Flower colour: Considerable variation in flower colour is found in *Eria*, therefore, this character is not used in the analysis, although it is used as key character for sectional delimitation within *Eria*.

Flower indumentum: Small brown, black or whitish hairs are present on inflorescence, pedicel and ovary, dorsal sepal and lateral sepals of several taxa studied. This is the main character for the delimitation of species within the sections. The size, shape and density of hairs varies considerably. All types of indumentum are considered homologous, which might not be justified, because their microscopic structure was not studied.

Petals and sepals: Petals are coded as linear when they are more than ten times longer than wide, otherwise they are coded as ovate-oblong or orbicular.

Labellum: Morphology of labellum is very diverse within the species of *Eria*. The base of the labellum having saccate or mentum present in the species which might be homologous character of *Eria*, thus did not used this character in the present analysis. However, the shape and size of

labellum had considered for this analysis. The variation in labellum size appears to be more or less continuous. However, flower size is an important key character for the section delimitation within *Eria*. Therefore, the following states in this character had used: flower small (labellum length < 10 mm), flower medium (labellum length 10-30 mm) and flowers large (labellum length > 30 mm). The lateral lobes of hypochile and epichile had considered to be absent when no clear distinction can be made with blade, and small, when they are present on less than quarter of the total labellum length.

Column: The column had coded as short when it does not cover more than half of the total labellum length. Angle between column foot and labellum, and joint between column foot with labellum are the key characters for delimitation of section within *Eria*. Therefore, the following characters are coded as present (labellum narrowly attached to column foot in an acute angle with clearly visible jointed), absent (labellum thickly attached to column foot without an acute angle and firmly connected without distinct joint). The structure of column foot is thickened at the base of the column where the labellum is attached. Whether it is actually column or labellum tissue that is thickened is often not clear, so this character is excluded. All anther of *Eria* studied contains eight pollinia, which are obovoid to fusiform and clavate with laterally flattened in shape and have caudicles, consisting of sterile pollen. Small differences in pollinium shape were found between the taxa studied due to the often vague limit between pollinium and caudicle, so this character is also excluded in the present analysis.

Capsule and Seeds: Variation in capsule shape appears to be rather uniform for the taxa examined, and these characters are not used. However, morphology of the seed is included according the classification of Dressler's type.

5.2.2.2. Vegetative anatomy

Leaves (epidermal surface): The size and shape of stomata are tetracytic, accompanied by rarely four or six subsidiary cells. Classification of stomata was made according to the shape and size of stomata. Within *Eria*, the shape of stigmata is rather uniform, both conical and spherical silica bodies are present, with extended base on the vascular strand and side veins of the leaves of the cell adjacent to the sclerenchyma are present (Moller & Rasmussen 1984). Dressler & Cook (1988) found conical stigmata in *E. javanica*, which is only coded presence/absence of the characters. Types of the stigmata studied in few taxa were also included.

5.2.2.3. Karyo-morphological characters

Karyo-morphological characters were included from different literature sources such as Vij (1986), Jorapur & Kulkarni (1979) and Hashimoto & Tanaka (1987). The genus could be delimited into sections, therefore, present study included the karyo-morphological types of the genus *Eria* (Appendix No.1)

5.2.3. Phylogenetic analysis

The phylogenetic analysis bootstrap and Jackknife consensus were performed on the morphological data with NONA 2000 version (Nixon 1999-2000). All characters were analyzed by using Wagner parsimony as implemented in NONA (Goloboff 1993b). The heuristic search strategy was performed by random addition with ten replicates and TBR (tree bisection reconnection) swapping. The heuristic methods generally performed when the number of samples in an analysis is very large. Heuristic methods generally use 'hill climbing technique' to find optimum cladogram. Two such technique are stepwise addition and branch swapping. Stepwise addition process adds taxa to the developing cladogram in the initial building phase of an analysis. Initially, a cladogram of three taxa is chosen, then the fourth one is added to one of the three branches. A fifth taxon is then selected and added to the network followed by the rest of the taxa under study. Random addition is one of the criteria of addition sequence of the remaining taxa, which can adopted a non-rigorous mean to evaluate the effectiveness of heuristic procedures. If a heuristic search performed with 100 replicate random additions and the same set of most parsimonious tree is obtained each time, then one can be certain that these trees topology represent global optima for the given data set.

Branch swapping on the other hand is another algorithm that can be used to optimize a cladogram, because manipulation of additional sequence alone generally yields only optimum. This can be done by performing a series of predefined arrangements of the cladograms in a way to find shorter tree topology (Kitching & *al.* 1998).

Branch swapping algorithms used in the analysis were Tree Bisection. As a measure of character fit, ensemble consistency (CI) and ensemble retention (RI) indices were calculated for the maximally parsimonious tree by NONA Bootstrapping (Felsenstein 1985) was performed as a measure of confidence interval in the phylogenetic trees. Bootstrapping values were obtained from 1000 pseudo-replicates in a parsimony analysis using a heuristic search method of NONA. Bootstrapping is a statistical method, which involved resampling point with replacement, to generate a number of bootstrap sample of the same size as that of the original data set. Each of these replicates is analyzed and variation among the result estimates considered for the indication of the size of the error in making phylogenetic estimates from the original data. The confidence of the particular clade [a group that includes a most recent common ancestor plus all and only all of its descendants (Kitching & *al.* 1998)] increases with increasing bootstrap value.

Majority rules consensus tree can be used to construct phylogeny indicating all of the inferred monophyletic groups, which were present in a majority of the bootstrap sample (Felsenstein 1985).

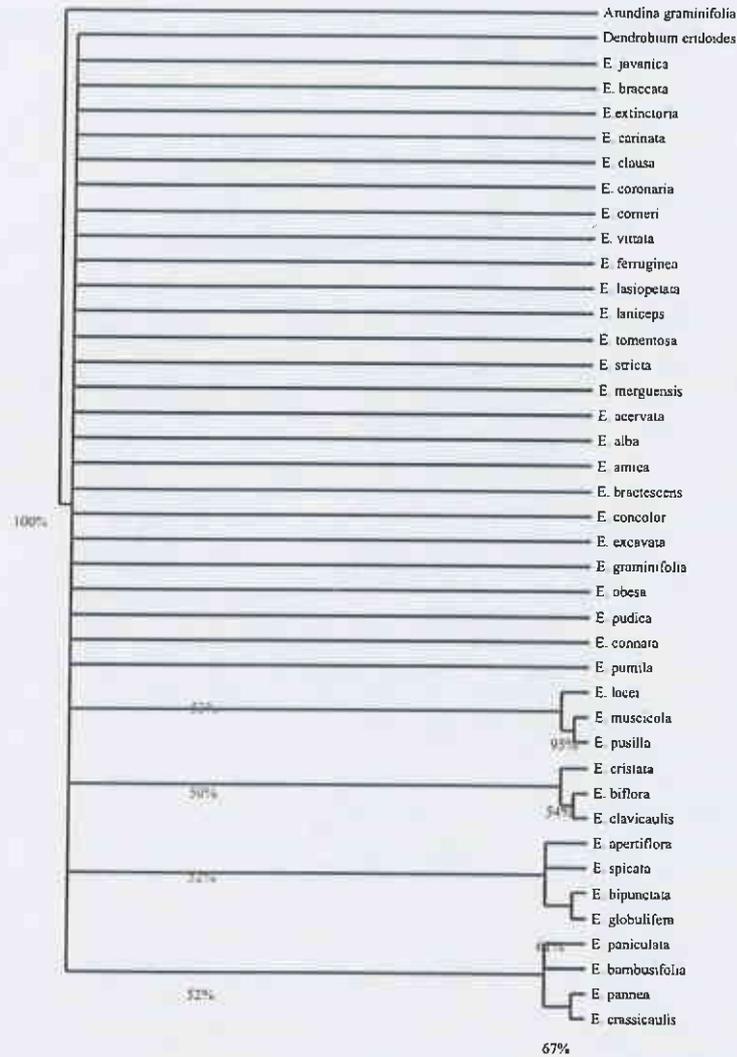


Fig. 75: Bootstrap consensus of 213 trees from parsimony analysis of micromorphological and anatomical data with bootstrap only percentage > 50 % are given).

Branch swapping algorithms used in the analysis were Tree Bisection. As a measure of character fit, ensemble consistency (CI) and ensemble retention (RI) indices were calculated for the maximally parsimonious tree by NONA. Bootstrapping (Felsenstein 1985) was performed as a measure of confidence interval in the phylogenetic trees. Bootstrapping values were obtained from 1000 pseudo-replicates in a parsimony analysis using a heuristic search method of NONA. Bootstrapping is a statistical method, which involved resampling points with replacement, to generate a number of bootstrap samples of the same size as that of the original data set. Each of these replicates is analyzed and variation among the result estimates considered for the indication of the size of the error in making phylogenetic estimates from the original data. The confidence of the particular clade [a group that includes a most recent common ancestor plus all and only all of its descendants (Kitching & al. 1998)] increases with increasing bootstrap value. Majority rules consensus tree can be used to construct phylogeny indicating all of the inferred monophyletic groups, which were present in a majority of the bootstrap sample (Felsenstein 1985).

5.3 Results

5.3.2. Morphological results

In total, 40 characters were used, of which 35 are morphological and 3 anatomical and 2 cytological characters. The data matrix includes 38 phylogenetically informative characters. The maximum parsimony analysis yielded 100 most parsimonious trees (length=272, CI=25; RI=54). A strict consensus tree, the bootstrap consensus topology and corresponding branch support trees had presented (fig. 73 74 and 75).

Maximum parsimony (MP) yielded one parsimonious tree (length=272 CI=25; RI=54). The total evidence tree strongly supports the Himalayan *Eria* as monophyletic (100%).

5.3.2. Phylogenetic results

The characters and character states used are shown in Table 12 and Table 13 contains the data matrix. The characters are unordered and all have equal weight. The analysis results in one cladogram (Fig. 74) with a length of 272 steps, a consistency index 0.25 and retention index of 0.54. Most of the groups had high bootstrap percentages between 80-99 % within some group (Fig 75).

Maximum parsimony yielded two most parsimonious trees. The total evidence trees strongly supported the paraphyly of the *Eria* (100%). Other strong supported clades are *E. lacei* (53 %), *E. muscicola* plus *E. pusilla* (95%), *E. cristata* (50 %), *E. biflora* plus *E. clavicaulis* (54%), *E. paniculata* and *E. bambusifolia* (51 %), *E. panea* plus *E. crassicaulis* (62%), *E. apertiflora*, *E. spicata* (52 %), *E. bipunctata* plus *E. globulifera* (61%) and other remaining species are (< 50%) (Fig 76).

5.4 Discussion

The genus *Eria* is one of difficult groups within Orchidaceae for classification. It had many species related with its morphological characters, but it distinct from other groups by having 8 pollinia.

The consistency index of morphological analysis of 0.25 represents a high level of homoplasy and retention index (0.54%) suggested high level of homoplasy in the data set. It may be caused by the use with synapomorphies characters (2, 11, 35- 40 except 36). Moreover, the resolution and nodal support as defined by number of synapomorphic is low (Fig. 74 and 76), which may be due to equal ratio of terminal taxa (41) to character (40). Many recent studies have indicated that phylogenetic resolution and bootstrap percentage are improved by directly combining different data sets (De Queiroz & *al.* 1995; Chase & Cox 1998; Wiens 1998).

The consistency index of 0.26 represents a high level of homoplasmy and may be a function of rapid rate of evolution believed to have occurred in Orchidaceae (Dressler 1993). The high level of congruence among the morphological data sets and low number of Maximum parsimony tree (MPT) and higher resolution in combined analysis strengthen the confidence in the combined tree as a good hypothesis of phylogenetic relationships of *Eria* and the *Arundiae*.

Present study supports Himalayan *Eria* as monophyletic, because bootstrap support for the taxa is high (100%), and synapomorphies includes leaf position and leaf type. Morphological characters are identified, which support each monophyletic groups in the total evidence tree. Transformation series of certain characters are reconstructed. All morphological autopomorphies and synomorphies are depicted in Fig 74 and 76.

The cladistic analysis revealed two distinct trees evolved from morphology, anatomy, pollen and seed morphology and karyo-type as well as habit type characters of the species. The out-group clade had separated from *Eria* clade based on the leaf position on the pseudobulbs and nature of leaves from out-group. The rhizome arose early in phylogeny of the genus *Eria*. It is absent in clade I as plesiomorphic condition, and present which is derived condition in clade II. In the clade I discoid shape pseudobulbs is reconstructed as derived from conical shape. The habit classification of Habit 'e' is the plesiomorphic character state and habit 'f' as derived in clade I. Ovate-oblong shaped floral bracts are reconstructed as derived from linear/ lanceolate shape. The size of flowers shows a general tendency to change from large (plesiomorphic state) to intermediate to small (derived state).

Characters that support clade I in the *Eria* are uninodal pseudobulb, and 'e' type habit classification. Discoid and conical shape is derived from pseudobulubous shape of pseudobulbs. Characters, which are present in the majority of the taxa in clade I are shape of

pollinia, nature of stigmata, number of orientation on disc, floral bract shape, petal shape, and joint between column and labellum.

The second major clade of *Eria* is supported by presence of rhizome (with *E. lasiopetala*, *E. feruginea*, *E. laniceps* and *E. tomentosa*), linear/ lanceolate floral bracts (except *E. acervata*, *E. spicata*, *E. bipunctata*, *E. paniculata*, *E. excavata*, *E. amica* and *E. graminifolia*), labellum length between 10-30 mm (except *E. globulifera*, *E. crassicaulis*, *E. clavicaulis* and *E. amica*), and b-type of karyotype of chromosomes (except sub clade *E. bambusifolia*- *E. tomentosa* and *E. graminifolia* sub clade). Characters which are present in the majority of taxa in clade II are hairy inflorescence, more than ten flowers, lateral sepal adnate, phyllotaxy of leaves and synathous inflorescences (Fig. 74 and 76).

In the cladistic analysis of *Eria*, large groups had based on morphological data. Many characters did not support them, because the ratio of characters to the taxa is small. Examination of one of the most parsimonious tree from the equally weighted analysis reveals nodes with one to six characters supporting them, with many of these being homoplastic changes. Since there are few enough characters changes per branch that they can show support indices such as bootstraps (Felsensteins 1985), Bremer support (Bremer 1988) and Jackknifing (Farris & al 1996) are less important for the morphological analysis than for molecular analysis. However, present study implement Felsenstein' (1985) bootstrapping, and Farris' (1996) Jackknifing procedures on the data set for more quantitative assessment of relative branch support. The results are not surprising, since those clades that appear in the strict consensus tree are supported by several characters (Fig. 75 and 76).

Although the consistency index in the equally weighted analysis is relatively low, it is not unusually low for the size of the data matrix (Sanderson & Donoghue 1989). In spite of high level of homoplasmy, there are considerable structures in the consensus tree. This indicates that the effect of homoplasmy had confined to specific areas of the trees. Besides, that retention index is not high (0.54%) showing that the characters are functioning as plesiomorphic to a high degree.

The resolution in the equally weighted tree has distinct pattern, major taxa equivalent to the sectional groups are clearly delimited. The composition of these groups is remarkably similar to that many previous classifications. This suggests that intuitive classification of the past often have placed weight of the good character at these levels.

Conclusion

The result of cladistic analysis suggests that the genus *Eria* is monophyletic. Restriction of *Eria* to the *Eria* clade, therefore, may be divided into two groups *Eria* Clade I and *Eria* Clade II (Fig. 74 and 76).

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1. First restriction of *Eria* to the clade I includes all the uninodal pseudobulbous plants such as sections *Conchidium*, *Trichosma*, *Xiphosium* and *Stellatae* including type species (*E. stellata*), with the erect part of the shoot with only one dominating internodes, lateral inflorescence(s) at the top of the shoots.
 2. The second restriction *Eria* to the clade II includes all the remaining taxa. The main morphological characters that distinguishes the species from *Eria sensu stricto* are the presence or absence of rhizome, ovate or oblong floral bracts, and length of labellum between 10 mm to 30 mm.

Vegetative characters had excluded from the phylogenetic analysis of Orchidaceae (Burns-Balogh and Funk 1986). But Freudenstein and Rasmussen (1999) used morphological characters in the analysis. They found that it is also very important characters in the analysis. Gravendeel & Vogel (2000) also employed the morphological characters in the analysis, and they had found the good results in the *Ceologyne* for the reconstruction of the groups within species. Besides these, Neyland & Urbatsch (1995) also employed the morphological as well as anatomical characters in the sub tribe *Pleurothallidinae*, and the distinct groups within the sub tribe *Pleurothallidinae*.

This study represents the first attempt to bring cladistic resolution to the Himalayan genus *Eria*. Because the characters used in the present study exhibit a high level of homoplasy and branch nodes on the cladogram. Detailed data of taxon should be evaluated in order to clarify further the phylogeny of this vast genus *Eria*.

It is clear the study that, the genus *Eria* is monophyletic in origin. The proposed hypothetical classification based on the cladistic analysis is more or less identical with traditional scheme of classification as Lindley (1859).

6. BIOGEOGRAPHY STUDY

6. Bio-geography of the genus *Eria* Lindl.

6.1. Introduction

Bio-geographical analyses dealing with members of Orchidaceae are comparatively rare, probably because evolutionary interpretation must always be more speculative in the family and devoid of an informative fossil record than in other families. As it appears, priority assumptions are always necessary when interpreting orchid distribution patterns. Fortunately, a prior assumptions can be qualified, *i.e.* if they are based on the observations on the distribution related families or floras in which an informative fossil record exists. Present study has ventured to carry out a simple biogeography analysis of *Eria* in the Himalayan region.

The varied forest types of Himalaya ranges had endowed with enormous floristic diversity. Out of 8,000 species of Himalaya plants, 750 taxa of Orchidaceae had represented in the Himalaya. Of which 600 taxa of Orchidaceae had found in the Eastern Himalaya. The genus *Eria* Lindl. was one of the larger aggregations of orchids into one genus in Orchidaceae. It has estimate of about 400-500 species in the world (Summerhayes & Hunt 1973; Bechtel, Cribb & Launert 1981), but 350 species seems to be a more reasonable figure (Pearce & Cribb 2002). Recently, Royal Botanic Gardens Kew (2003) enlisted 404 species of *Eria*. It is divided into thirteen to seventeen groups according to the nature of pseudobulbs and leaf characters. The Himalayan region hosts about 50 species of *Eria*, of which 33 species of *Eria* are recorded from the North East frontier Area and Arunachal Pradesh of North-Eastern Himalaya.

Seidenfaden (1982) mentioned the general distribution pattern of *Eria*, and characterized the total range of the genus from Tropical Asia to Indo-pacific. It is spread across tropical Asia, from Himalaya, China, The Philippines, Indonesia, Papua New Guinea, and Pacific Island to Fiji. Due to wide range of distribution, the genus has been recorded from the hot humid coastal rainforest of Malaysian to the snow line of the Himalaya.

6.1.1. Biogeographical region of the Himalaya

The Himalayas constitute one of the three major geomorphological divisions of Indian subcontinent and extends 2,500 km in length and 250 km breadth, covering a great latitudinal and longitudinal expanse between about 27°-38°N and 76°-104°E. respectively. In contrast to the geologically stable and ancient Indian Peninsula, the Himalayan ranges are geodynamically unstable with young topography (Singh & Singh 1992). The Himalaya is the youngest mountain system in the world. The Himalaya lies on the bordering region of Boreal and Paleotropical floristic region of the World (Good 1974). The mountain chains lie across the path of monsoon wind. The Himalaya enforces powerful isolation in the band-like migration and covered about 8000-Km from west to east length wise or vice versa.

Recognizing the heterogeneous dispersion of the bio-diversity elements in the Himalaya, based on geology, altitude, vegetation and spatial pattern of distribution, the Himalaya is classified variously. Wadia (1975) categorized it in three broad regions: Northern or Tibetan region, Central or Himalaya region and outer or sub-Himalaya region. He classified the Himalaya based on the altitude into Great Himalaya (average 6,100 m); Lesser Himalaya (3,600-4000m); and outer Himalaya between (800-1,000m). Bordit (1961) and Mani (1990) also proposed a similar transition along horizontal gradient but with slightly differences in the length of various chains.

Troll (1972) proposed a three dimensional framework reflecting a transition from south to north; south east to North-East, and from lowland to high land in his vegetation analysis of the Himalaya. Schweinfurth (1957) has given a very detailed regional analysis and description of the vegetation type in the Himalayas. Later, Schweinfurth (1968 and 1984) had categorized the Himalayan region into twenty-one types of vegetation and identified into three levels of differentiation. He included (a) sequence of transition from evergreen rain forest in east to semi-desert type in the North West, (b) a distinct vertical gradation discernible in a series of profiles, and (c) contrast between the "outer Himalaya" with luxuriant monsoon forest; "inner Himalaya" with moderately moist boreal coniferous forest and, the arid "Tibetan Himalaya" characterized by high altitude steppe vegetation.

Meusel (1971) and Meusel & Schubert (1971) suggested that forest and shrub communities of West Himalaya exhibits considerable Mediterranean influence. Dhar & Kochroo (1982, 1983) suggested the Kashmir flora leans heavily towards Central Asia, and South China axis.

Biogeographically, the Himalaya is a complex region of the world. A sharp and distinct contrast characterized the eastern and western limit with blend of their elements in the centre of the region. The region was influenced by different floristic elements such as Irano-Turanian, Euro-Siberian, Sahoo-Sindhian, Mediterranean, Sino-Japanese, and Indo-Malayan (Dhar 1996).

Rodgers (1985) divided the Himalaya into five biotic provinces (Ladakh, NW Himalaya, W. Himalaya, C. Himalaya and NE. Himalaya) under two bio-geographical regions, boreal and Indo-Malayan. He also proposed that Himalaya fall in the boreal region. Himalayas is divided into two bio-geographical regions, Sino-Siberian and Sino-Himalayan. The Western and Eastern flanks of the Himalaya are different.

Table-12: Biotic province of the Himalayas

Bio-geographical region	Biotic province	Biomes	Phytogeographic division
Boreal Region			
1. Sino-Siberian	Ladakh	Tundra	Western and central Asiatic
2. Sino-Himalayan	NWHimalaya	Alpine	Western and central Asiatic
		Temperate	Western and central Asiatic
		Sub-tropical	Sino-Japanese/ Eastern Asiatic
	W. Himalaya	Alpine	Western and central Asiatic
		Temperate	Western and central Asiatic
		Sub-tropical	Sino-Japanese/ Eastern Asiatic
	C. Himalaya	Alpine	Sino-Japanese/ Eastern Asiatic
		Temperate	Sino-Japanese/ Eastern Asiatic
		Sub-tropical	Sino-Japanese/ Eastern Asiatic
	NE. Himalaya	Alpine	Sino-Japanese/ Eastern Asiatic
		Temperate	Sino-Japanese/ Eastern Asiatic
		Sub-tropical	Sino-Japanese/ Eastern Asiatic

Source: Rodger (1985)

The Himalayan region is the combination of eastern and western Himalayan province of Holarctic Kingdom of floristic regions of the world (Takhtajan 1986). It lies from Tsango river basin to 92° east longitude by warm and humid climate in the East Himalaya and Nuristan Valley of river Kabul, Kurram, Kunar, Swat, Gilgit, Waziritan and southern slope and offspurs of Western Himalayan westwards approximately from 80° east longitude, which is at the average length of 1000m above sea level. It is contrast to the other province, which is characterized by monsoon climate that impact a definite character to its plants.

The difference between the two flanks is due to several factors. The western range lies at 36° North latitude and the area with low rainfall. These ranges descend as low as 2,135m in Kashmir. This affects the tree line vegetation, which is at an altitude of 3600m. On the other hand, eastern range lies at 27° north and is among the wettest region in the world. This area receives the full thrust of monsoon winds from Bay of Bengal, which are trapped in the Arunachal pradesh, in the corner where the Himalayan ranges bend southwards. The monsoon is intense here leading to erosion of much of Siwaliks in the east from Koshi to Manas in Bhutan. Eastern range descends to 3,960 m, the Kanchanjunga area. The tree line is higher (4,579 m.) in the eastern Himalaya (Rao 1993).

The western Himalayan range is much wider and cooler with drier climate. In contrast the eastern range is among the wettest regions of the world with great bio-diversity. The Western range has a vegetation of cool loving and drought resistant climate dominated by conifers, legumes, grasses and Composite, where as the Eastern range harbours a wet

humid sub-tropical vegetation rich in Magnolias, Oaks, Laurels, Rhododendrons, and large number of epiphytic orchids and ferns.

A compendium of Himalayan biotic endemism is not available. However, Naya (1980) recorded 68 Himalayan genera as monotypic and endemic to the Himalayan region. Chatterjee (1939) reported 28.8% of plants endemic to the Himalaya. Whereas, Mani (1978) suggests four thousand species as endemic to the Himalayan region. Compared to the west, species endemism is quite high (39 %) in eastern Himalaya (Myers 1988).

6.1.2. Vegetation

There have been many attempts of classification of the vegetation types of the Himalayan region. Schweinfurth (1957) made an excellent analysis of the flora of the Himalaya particularly regarding the horizontal and vertical distribution of the vegetation in the mountain system. However, Champion & Seth (1968); Singh & Singh (1987) have also described the forest vegetation of the Himalaya, and made comprehensive and more popular attempt. Stainton (1972), Dobremez (1972) also described the vegetation type of Nepal Himalaya in detail.

Western Himalaya

The western parts of the Himalaya extends from Kumaun to Chitral (J.D. Hooker 1904) and lies between 28°45' to 36° N latitude and between 71° 30' to 80°-40° E longitude. It spreads over two countries Pakistan and India, viz. Chitral, Dir, Hazara, and North Rawalpindi in Pakistan, and Jammu, Kashmir, Himachal Pradesh, and North commissionaires of Garhwal and Kumaun in India. Broadly speaking, the western Himalayan region has six type of forests: tropical deciduous, tropical pine, Himalaya moist temperate, Himalaya dry temperate, sub-alpine and alpine pasture/scrub. This type of vegetation is characterized by less precipitation, cold loving, drought tolerance, and temperate coniferous forest with large population, more often a single coniferous species.

Central Himalaya

Central part of the Himalaya, often called Nepal Himalaya, lies between 26°22' to 30° N latitude and between 80° 4' to 88°-12° E longitude. Vegetation of Central Himalaya is composite expression of the interaction between plants and their environmental condition prevailing there on climate, which differs according to the differences in altitude ranges or geographical location. Hence, the distribution of plants and vegetation can be best studied in relation to the altitude. The Central Himalaya is divided into six major climatic regions: tropical, sub-tropical, temperate, sub-alpine, alpine and nival region. The vegetation type of Central Himalaya is now fairly well recognized. Banerji (1963, 1964, 1973) has briefly discussed on the phytogeography of Nepal. Stainton (1972) has elucidated detail forest types of Nepal. Dobremez and his co-workers (1972-1975) prepared series of vegetation maps of

Nepal. It includes more comprehensive work concerning the vegetation study of the entire country.

The distribution pattern of vegetation type along the length is not the same. All the three regions western, central and eastern have their own vegetation and floristic identities. *Pinus roxburghii* forest, so extensive in sub-tropical region of western Nepal is rare and limited in small patches in the central and eastern Nepal. *Aesculus-Juglans-Acer* forest of temperate belt in western Nepal is rather absent in the central and eastern Nepal. Similarly *Lithocarpus pachphylla* forest and preponderance of *Rhododendron* species are special features of Eastern Nepal. It seems that vegetation type of Central Himalaya is the mixed vegetation of western and eastern Himalaya. It shows that it is the cross-road of Asiatic vegetation and meeting place of eastern and western Himalaya vegetation (Stearn 1960).

Eastern Himalaya

This Eastern Himalaya extends from North Bengal Hills, Sikkim, Bhutan to Arunachal Pradesh, Nagaland, Manipur and Mizoram, Mikir Hills in Assam and Khasi and Jantia Hills in Meghalaya, lies between 22°-30° N latitude and 89°-97° E longitude. The Eastern Himalayan region is bound on the west by Nepal, on the North by Tibet and East by Burma. Eastern Himalayan region has five types of forests: tropical, tropical evergreen, sub-tropical, eastern temperate, alpine and stormy desert. The area is characterized by high rainfall, moist, and cool climate, sub-tropical and tropical vegetation, while rhododendrons are abundant and form mixed forest. It is also regarded as the remnants of *Podocarpus* flora of Gondwanaland. In fact, it is here that the Deccan plate struck the northern continent.

The following classification has been chosen as the most convenient starting point for biogeographical analysis of *Eria* in Himalaya region, on the basis of political boundaries (Bajracharya 2001).

- > **North-west Himalaya:** It starts from the border between Afghanistan to Garhwal - Kumaon.
- > **Nepal Himalaya:** It covers the western border Mahakali River in the west board to Mechi River in the east of Nepal Himalaya.
- > **Sikkim Himalaya:** It extended from the Eastern border of Nepal and West Bengal to Western border between Sikkim and Bhutan Himalaya.
- > **Bhutan Himalaya:** It lies between the western border of Sikkim Himalaya and Eastern border of North Eastern Himalaya.
- > **North-East Himalaya:** It covers the Eastern parts of India including Meghalaya, Arunachal Pradesh and up to the border of Burma.

6.2. Materials and methods

The distribution pattern of the *Eria* species in the Himalaya is analyzed on the basis of extensive field observation, intensive literature survey and the examination of the herbarium specimens deposited in different herbaria such as K, BM, E, CAL, ASSAM, BSHC, BSD, DD, KATH, TUCH. Database information of the genus *Eria* from GH, C, MO, NYBG and L, as well as living collections had studied to understand the status and distribution of the genus based on the morph-geographical characters.

Large number of Himalayan *Eria* species is concentrated in the Eastern Himalaya, *i.e.* Sikkim Himalaya, Arunchal Pradesh and Assam (Maghalaya, Khasia hills) is the main centre for Himalayan *Eria*. The Himalayan *Eria* decreases slowly towards west, Nepal, Bhutan, and North-West Himalayan region. Beyond west from North-West Himalayan region, there are no records of *Eria* from the Himalayan region (Fig. 1).

6.3 Basic Concept and terminology

The following classification has been chosen as the most convenient starting point for biogeographical analysis of the genus *Eria*.

1. **Endemic:** Species restricted to Himalayan region.
 - *Local endemic:* species restricted to a single mountain range or to part of the Himalaya mountain range.
 - *Himalaya endemic:* species restricted to Himalaya mountain range and only occurring in one or two localities of the main Himalaya.
2. **Non-endemic:** Species not restricted to the Himalayan region.
 - *Himalayan species:* Species confined to the Himalaya region but exhibiting more wide distribution to other region.
 - *Non Himalayan Species:* species confined to the certain area of Himalaya only, but also exhibiting in certain region beyond Himalaya.

Admittedly, the name of the above categories does present a few shortcomings; for instance, some "local endemic" have wider range than some "Himalaya endemic" but, after all these exceptions are few and the chronological concepts covered by the names are more important than the names themselves.

Vermeulen (1993) dealt bio-geography of 110 species of *Bulbophyllum* from New Guinea. Pederson (1997) analysed distribution of 89 species of *Dendrochilum* in Philippines, which differs from the Vermeulen (1993) concept, because Pederson did not use unit range, but apply the means to illustrate the heterogeneity of distribution among the regional as well as among the national endemic.

6.4 Results and Discussions

6.4.1 Overall Distribution pattern

A comprehensive list of Himalayan *Eria* species distribution in the Himalayan region is summarized below (Table 13)

1. **North-West Himalaya:** *Eria alba*, *E. amica*, *E. braccata*, *E. coronaria*, *E. excavata*, *E. graminifolia*, *E. muscicola*, *E. lasiopetala*, *E. occidentalis*, and *E. spicata*.
2. **Nepal Himalaya:** *Eria acervata*, *E. alba*, *E. amica*, *E. apertiflora*, *E. baniaii*, *E. biflora*, *E. bipunctata*, *E. bractescens*, *E. carinata*, *E. clausa*, *E. concolor*, *E. coronaria*, *E. excavata*, *E. extincoria*, *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*.
3. **Sikkim Himalaya:** *Eria acervata*, *E. alba*, *E. amica*, *E. bambusifolia*, *E. biflora*, *E. bractescens*, *E. carinata*, *E. clausa*, *E. coronaria*, *E. excavata*, *E. ferruginea*, *E. graminifolia*, *E. javanica*, *E. laniceps*, *E. lasiopetala*, *E. muscicola*, *E. sikkimensis*, *E. paniculata*, *E. pannea*, *E. pumila*, *E. pusilla*, *E. spicata*, *E. Scabrilinguis*, *E. stricta* and *E. vittata*.
4. **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*.
5. **North East Himalaya (including Assam area):** *Eria acervata*, *E. amica*, *E. apertiflora*, *E. arunachalensis*, *E. bambusifolia*, *E. biflora*, *E. bipunctata*, *E. bractescens*, *E. carinata*, *E. clausa*, *E. clavicaulis*, *E. corneri*, *E. connata*, *E. coronaria*, *E. cristata*, *E. crassicaulis*, *E. excavata*, *E. ferruginea*, *E. glandulifera*, *E. globulifera*, *E. graminifolia*, *E. javanica*, *E. jenginensis*, *E. lacei*, *E. laniceps*, *E. lasiopetala*, *E. muscicola*, *E. obesa*, *E. paniculata*, *E. pannea*, *E. pudica*, *E. pumila*, *E. pusilla*, *E. sharmae*, *E. spicata*, *E. stricta*, *E. tomentosa* and *E. vittata*.

† Endemic Species

1. **Local endemic species (12)**
 - ❖ **NW-Himalaya:** *E. occidentalis*
 - ❖ **Nepal Himalaya:** *E. nepalensis*, *E. pokharensis*, *E. baniaii*.
 - ❖ **Sikkim Himalaya:** *E. sikkimensis*, *E. scabrilinguis* (Extinct)
 - ❖ **Bhutan Himalaya:** *E. bhutanica*
 - ❖ **NE-Himalaya:** *E. arunachalensis*, *E. crassicaulis*, *E. jenginensis*, *E. sharmae*, *E. glandulifera*.

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2. **Himalayan endemic species (5)**
- ❖ NW Himalaya-NE Himalaya: *E. excavata*, *E. graminifolia*
 - ❖ NW Himalaya-Bhutan Himalaya: *E. alba*
 - ❖ Sikkim Himalaya-NE Himalaya: *E. ferruginea*
 - ❖ Bhutan Himalaya-NE Himalaya: *E. connata*
- ↓
- Non –Endemic Species (28)**
1. **Himalayan species**
- ❖ NW Himalaya to NE Himalaya: *E. amica*, *E. coronaria*, *E. muscicola*, *E. lasiopetala*, and *E. spicata*
 - ❖ Nepal Himalaya to NE Himalaya: *Eria acervata*, *E. biflora*, *E. bractescens*, *E. carinata*, *E. clausa*, *E. laniceps*, *E. obesa*, *E. paniculata*, *E. pumila*, and *E. stricta*
 - ❖ Sikkim Himalaya to NE Himalaya: *E. bambusifolia*, *E. javanica*, *E. pannea*, *E. pusilla*, and *E. vittata*
 - ❖ NE Himalaya: *Eria clavicaulis*
2. **Non-Himalayan species**
- ❖ North-West Himalaya: *Eria braccata*
 - ❖ Nepal Himalaya: *Eria apertiflora*, *E. bipunctata*, *E. concolor*, *E. extinctoria*, *E. globulifera*.
 - ❖ Bhutan Himalaya: *Eria merguensis*.
 - ❖ North East Himalaya: *Eria apertiflora*, *E. bipunctata*, *E. concolor*, *E. cristata*, *E. corneri*, *E. globulifera*, *E. lacei*, *E. pudica*, and *E. tomentosa*.

Based on the above observation, it has been revealed that *E. amica*, *E. coronaria*, *E. pubescens* (= *E. lasiopetala*), *E. muscicola* and *E. spicata* have broader distribution range and found to occur throughout on the Himalaya. It had also noticed that five out of the twelve endemic species occur in the Eastern Himalayan region, particularly in Arunachal Pradesh (Table 13 & 14). The Himalayan endemic is located within the boundaries of certain Himalayan region, which had defined by overlapping distribution of the species in the small unit of Himalaya. It is also turn out that these areas of Himalayan species can be considered more generally as "Diversity area", and this directly lead to the overlapping distribution pattern of *Eria* in the Himalaya region.

6.4.2 Diversity Area Correlation

In general, diversity of the area, can be calculated, but it is very difficult to determine the actual correlation between or among species by analyzing the distribution pattern of *Eria* in the Himalayan region. Following pattern of distribution is found, which shows that Himalayan region as a whole can be divided into three or more segments which is previously discussed above (77 A).

Table-13: Distribution pattern and Phenology of the Genus *Eria* Lindl. in Himalaya

Botanical name	Distribution	Altitude (m)	Flowering Period
<i>Eria acervata</i> Lindl.	Nepal Himalaya to Sikkim Himalaya	500-700	June-July
<i>E. alba</i> Lindl.	NW Himalaya to Bhutan Himalaya	1400-2300	July-Aug
<i>E. amica</i> Lindl.	Nepal Himalaya to NE Himalaya	1400-1600	July-Aug
<i>E. apertiflora</i> Summ.	Nepal Himalaya and NE Himalaya	1600	Jul-Aug
<i>E. arunachalensis</i> A. N. Rao	NE Himalaya	600-700	July
<i>E. bambusifolia</i> Lindl.	Sikkim Himalaya to NE Himalaya	1100-2000	Oct.-Dec
<i>E. baniaii</i> D. M. Bajracharya et al	Nepal Himalaya	1600	May
<i>E. bhutanica</i> D.M.Bajracharya et al	Bhutan Himalaya	1500	June
<i>E. biflora</i> Griff.	Nepal Himalaya to NE Himalaya	1000-1300	Sept
<i>E. bipunctata</i> Lindl.	Nepal Himalaya and NE Himalaya	1900-1700	July-Aug
<i>E. Braccata</i> Lindl.	Western Himalaya	1500-2300	Aug
<i>E. bractescens</i> Lindl.	Nepal Himalaya to NE Himalaya	300-1000	April
<i>E. carinata</i> Gib.	Nepal Himalaya to NE Himalaya	1000	Nov-Jan
<i>E. clausa</i> King & Pantl.	Nepal Himalaya to NE Himalaya	1000-1600	Feb.-Mar
<i>E. clavicaulis</i> Wall ex Lindl.	Bhutan Himalaya and NE Himalaya	1700	July-Aug
<i>E. concolor</i> Reich.f	Nepal Himalaya	500	Jan-Feb
<i>E. connata</i> Joseph, Hedge & Abba	Bhutan Himalaya and NE Himalaya	1200-1500	Jul-Aug
<i>E. corneria</i> Rechb.f.	NE Himalaya	1500	-
<i>E. coronaria</i> (Lindl.) Reichb.	NW Himalaya to NE Himalaya	1500-2000	July-Aug
<i>E. crassicaulis</i> Hk.f.	Sikkim Himalaya and NE Himalaya	1300-1700	Oct.-Dec
<i>E. cristata</i> Rolfe	NE Himalaya	1000-1500	Nov-Feb
<i>E. excavata</i> Lindl. Ex Hk.f.	NW Himalaya to Sikkim Himalaya	1300-2000	June-July
<i>E. extinctoria</i> Oliver	Nepal Himalaya	500-600	June-Aug
<i>E. ferruginea</i> Lindl.	Bhutan Himalaya and NE Himalaya	1300	April-May
<i>E. glandulifera</i>	NE Himalaya	500	-
<i>E. globulifera</i> Seid.	Nepal Himalaya and NE Himalaya	1000-1200	Jul-Aug
<i>E. graminifolia</i> Lindl.	Nepal Himalaya to NE Himalaya	1600-2000	July-Aug
<i>E. javanica</i> (Sm.) Bl.	Sikkim Himalaya to NE Himalaya	500-700	April-June
<i>E. jengingensis</i> Hedge et al	NE Himalaya	650-850	March-June
<i>E. lacei</i> Summ.	NE Himalaya	1100	March
<i>E. laniceps</i> Reichb.f.	Nepal Himalaya to NE Himalaya	1000	Jan
<i>E. lasiopetala</i> (Willd.) Ormenrod	NW Himalaya to NE Himalaya	100-1000	May-June
<i>E. lohitensis</i> A. N. Rao	NE Himalaya	1500-1600	May-July
<i>E. merguensis</i> Lindl	Bhutan Himalaya	500	Feb- March
<i>E. muscicola</i> Lindl.	NW Himalaya to NE Himalaya	1000-1500	August
<i>E. nepalensis</i> DM.Bajracharya et al	Nepal Himalaya	500	August
<i>E. obesa</i> Lindl.	NE Himalaya	2000-2300	June-July
<i>E. occidentalis</i> Seden.f.	Western Himalaya	1200-1500	Jul-Aug
<i>E. paniculata</i> Lindl.	Nepal Himalaya to NE Himalaya	1000-1300	Jan-April
<i>E. panna</i> Lindl.	Sikkim Himalaya to NE Himalaya	1500-1700	May
<i>E. pokharensis</i> DM.Bajracharya et al	Nepal Himalaya	100-1000	May-June
<i>E. pudica</i> Ridl.	NE Himalaya	500-1200	June
<i>E. pumila</i> Lindl.	Nepal Himalaya to NE Himalaya	200-500	August
<i>E. pusilla</i> Lindl.	Sikkim Himalaya to NE Himalaya	1300-1700	July-Aug
<i>E. scabrilinguis</i> Lindl.	Sikkim Himalaya to E Himalaya	N.A. ca. 500	April-June
<i>E. sharmae</i> -Chaudhary et al.	NE Himalaya	450-500	June- July
<i>E. sikkimensis</i> Bajracharya & Shrestha	Sikkim Himalaya	1600	July - August
<i>E. spicata</i> (D. Don) Hants. -Mazz.	NW to NE Himalaya	1000-1800	July-Aug
<i>E. stricta</i> Lindl.	Nepal to NE Himalaya	300-1300	Feb.-Mar
<i>E. tomentosa</i> Hk.f.	NE Himalaya	1000-1300	July-Aug
<i>E. vittata</i> Lindl.	Sikkim to NE Himalaya	1600-2000	Mar-April

Western Himalayan Diversity Area (WDA)

Western Diversity area differs from other diversity area of the Himalayan region, these areas are mostly dry, cool and arid zone of the Himalaya, with decreased the number of *Eria* species. Besides, that there was no record of *Eria* species from Pakistan. It accumulates 10 species of *Eria* in WDA region. The same value of distribution, such as this area accumulate 0.24% local endemic species, 0.3% Himalaya endemic species; 0.2% Himalaya species and 0.28% non Himalaya species. Besides that *Eria braccata* is distributed in disjunction manner i.e., this plant is mostly distributed in the Southern India and Ceylon only, but also appear in the Himalaya region which is one of the interesting feature of the genus. There is less number of species overlapping in this area, than other diversity area, which indicates western Himalaya is less diverse than other Himalaya.

Central Himalayan Diversity Area (CDA)

Central Himalayan diversity area accumulates 28 species of *Eria*. The central Himalayan diversity area had mixed climatic properties. There are 0.72% local endemic species; 0.4% Himalaya endemic species; 5.2% Himalayan species and 1.68% non Himalayan species. Almost all the species are overlapping in this area so that number of species increases in the area than other.

Eastern Himalayan Diversity Area (EDA)

Eastern Himalaya diversity area accumulates 44 species of *Eria*, including 1.92% local endemic species, 0.5% Himalaya endemic species, 7.6% Himalayan species; and 2.8% non-Himalaya endemic species. The higher number of orchid species is due to high degree of precipitation and high humidity. Therefore, the humid forests of the eastern Himalaya provide a very suitable habitat for growth of both terrestrial and epiphytic orchids.

Sikkim Himalaya comprises 0.24% local endemic species; 0.4% Himalaya endemic species; 7.6% Himalaya species and 0.28% non-Himalaya endemic species. Pearce and Cribb (2002) mentioned 23 species of *Eria* from Bhutan and adjoining area of Sikkim and Darjeeling. Similarly, the Bhutan Himalaya consists of 0.24% local endemic species; 0.5% Himalaya endemic species; 4.8% Himalaya species and 0.28% non-Himalaya species.

The above-mentioned broad classification of diversity area can be restricted into a simple and convenient system of diversity areas as given below (Fig. 77 B).

Table 14. Distribution of *Eria* Lindl. (Orchidaceae) in the Himalayas and other region of the World

Botanical name	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														
<i>Eria aservata</i>	+	+	+	+	+	+	+	-	+	+	+	+	-	+	-	-	-	-	-	-	-	-
<i>Eria alba</i>	+	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria amica</i>	+	+	+	+	+	+	+	-	+	+	+	+	+	+	-	-	-	-	-	-	-	-
<i>Eria asertiflora</i>	+	+	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria arunachalensis</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria bambusifolia</i>	+	-	+	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria banaii</i>	+	+	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Eria bhutanica</i>	+	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Eria biflora</i>	+	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria bipunctata</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria braccata</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria bracteosus</i>	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria carinata</i>	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria clausa</i>	+	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria clavicaulis</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria concolor</i>	+	+	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria connata</i>	+	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Eria comeni</i>	+	-	-	-	+	+	+	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria coronata</i>	+	+	+	+	+	+	+	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria crassicaulis</i>	+	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Eria cristata</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria excavata</i>	+	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria extinctionis</i>	+	+	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Eria ferruginea</i>	+	-	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria glandulifera</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria globulifera</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria graminifolia</i>	+	+	+	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria javanica</i>	+	-	+	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria jehingensis</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria lacei</i> Summ.	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria lanceps</i>	+	+	+	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria lasiopetala</i>	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria merquensis</i>	+	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Eria muscicola</i>	+	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria nepalensis</i>	+	+	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Eria obesa</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria occidentalis</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria paniculata</i>	+	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria pannaia</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria pokharensis</i>	+	+	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria pudica</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria pumila</i>	+	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria pusilla</i>	+	-	+	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria scabrilinguis</i>	+	-	+	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria shamae</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria sikkimensis</i>	+	-	+	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria spicata</i>	+	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria stricta</i>	+	+	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria tomentosa</i>	+	-	-	-	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<i>Eria vittata</i>	+	-	+	+	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-

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

North-West Himalaya Diversity Region

The extreme part of western Himalaya region constitute as North-west Himalaya diversity region, lies between 28°45' to 36° N and 71° 30' to 80°-40° E, which includes Pakistan (including Chitral, other mountains of Pakistan, and India (Includes Punjab, Jammu & Kashmir, Himachal Pradesh, Kumaon area) of Western Himalaya. So the western Himalayan parts of the Himalaya constitute as North-West Himalayan Diversity region, which is separate from other diversity area of the Himalaya due to less rainfall, and humidity with arid atmosphere. It comprises of 10 species of *Eria* in this region, besides this, there are no records of *Eria* species from Pakistan and Afghanistan. This area accumulates 0.24% of local endemic species; 0.3% Himalaya endemic species; 2% Himalaya species and 0.28 % regional Himalayan species.

Nepal Himalaya Diversity Region

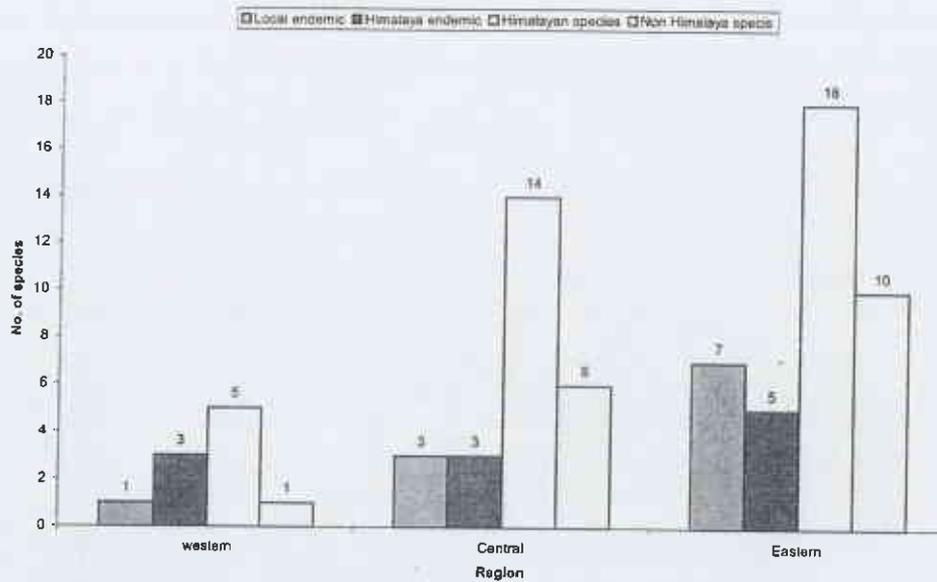
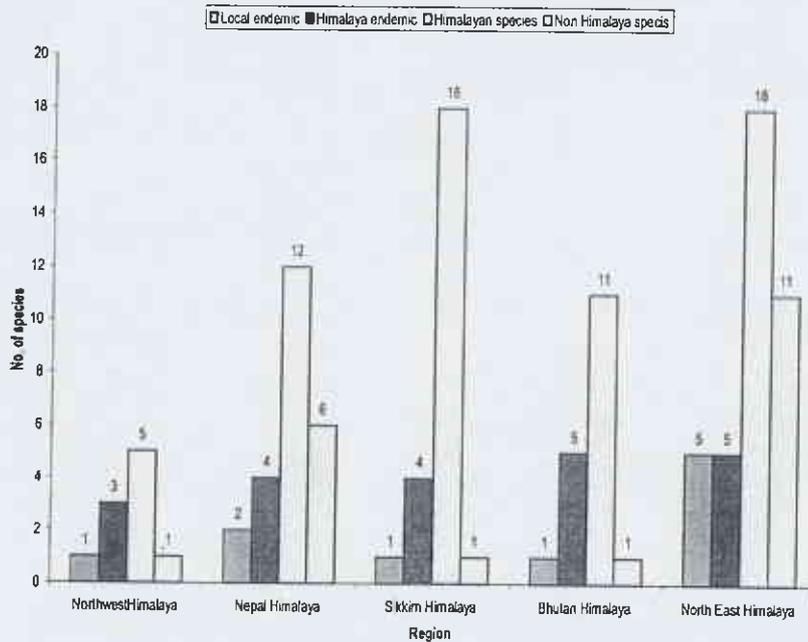
It lies in the central part of the Himalaya, between 26°22' to 30° N and between 80° 4' to 88°-12° E. Both floristic components of Western and Eastern Himalaya mix in this diversity region. There are 26 species of *Eria* in this region, among them there are 0.72% local endemic species; 0.4% of Himalaya endemic species; 5.2% of Himalaya species and 1.68% of non Himalaya species. It also shows that the number of species decreases in Nepal Himalaya due to Singalila Mountain, which acts as the main barrier between Nepal and Sikkim Himalaya, for migration of the flora from east to west.

Sikkim Himalayan Diversity Region

It includes the Eastern Himalayan region, lies between 27°10'-28° 5' N and 88° 30' to 89° E. There are 24 species of *Eria*, among them 0.24% local endemic species, 0.4% of Himalaya endemic species, 7.6% of Himalaya species and 0.28% regional-Himalaya species. Das & *al.* (2002) mentioned that *Eria* is one of the dominant species of orchids in Sikkim Himalaya. Present study shows that a detail study on Orchid flora of Sikkim is needed.

Bhutan Himalaya Diversity Region

It includes the Eastern parts of the Himalaya, lies at 26°40'-28°21'N and 88°45'-92°10'E, which is the smallest area among the other diversity area and is the least explored area in the Eastern Himalaya. Pearce & Cribb (2002) also mentioned that much more survey work is needed before the preparation of full inventory. There are only 18 species of *Eria* recorded among which 0.24% local endemic species; 0.5% Himalaya endemic species; 4.8 % Himalaya species and 0.28 % non-Himalaya species. In Bhutan Himalaya, the number reported less due to small area as well as less exploration of the orchid flora from Bhutan Himalaya.

A. Status of the genus *Eria* Lindl. in the Himalayas (Broader concept)Fig. 77 A: Status of the genus *Eria* Lindl. in the Himalayas (Broader concept)Status of the genus *Eria* Lindl. in the Himalayas (Revised concept)Fig. 77 B: Status of the genus *Eria* Lindl. in the Himalayas (Revised concept)

North-East Himalaya Diversity Region (including Assam Area)

It lies at the extremely east of the Eastern Himalaya at 26°28'- 29°30'N and 91°30'-97°30'E. It covers an unexplored area and well preserved area. The number of species is higher than western region of the Himalaya, due to higher rainfall from both South-West and Northeast monsoon and relative humidity reaches as high as 80%, which is one of the important factors for the growth of orchids. There are 38 species of *Eria* recorded from this region; among them 8.33 % are local endemic species; 0.5% Himalaya endemic, 7.9% Himalaya species and 3.08% non-Himalaya species.

Maximum number of local endemic (8.33%) is present in North-East Himalaya region. About 0.5% Himalayan endemic species are present in Bhutan and North East Himalayan region. Higher percent of Himalayan species, 7.9% and 7.6 % respectively in North East Himalaya and Sikkim Himalaya. Maximum number of Non-Himalaya species (3.08%) distributed in North-East Himalaya, 1.68% in Nepal Himalaya, whereas 0.28% in Sikkim, and Bhutan respectively

6.4.3 Species Distribution

It is evident that the distribution of *Eria* in the Himalaya is mostly concentrated in the North-East Himalaya region, due to humid and moist warm climatic condition than North-west Himalaya. Orchid population is highly influenced by typical monsoon climate, topographic variation and the direction of the mountain slope facing. Monsoon greatly influences the luxuriant growth of the vegetation that provides shelter for all the orchids in the forest floor.

In the floristic analysis, there are 49 species of *Eria* distributed in the Himalayan range. The present data is based on literature, field survey and herbarium specimens deposited from this regions. The data suggested that the genus *Eria* is mostly distributed in the North-East Himalaya than other part of the Himalayan region. It is endowed with luxuriant and different type of vegetation, due to its conducive climatic and adaphic factors with sufficient rainfall.

Phytogeographically, the forest vegetation of Bhutan, Sikkim and some parts of East Nepal also form an integral part of the biome of Northeast Himalayan elements. This region forms the junction of migratory elements from the neighboring countries like Malaya, Japan, Thailand, Burma, China and Tibet.

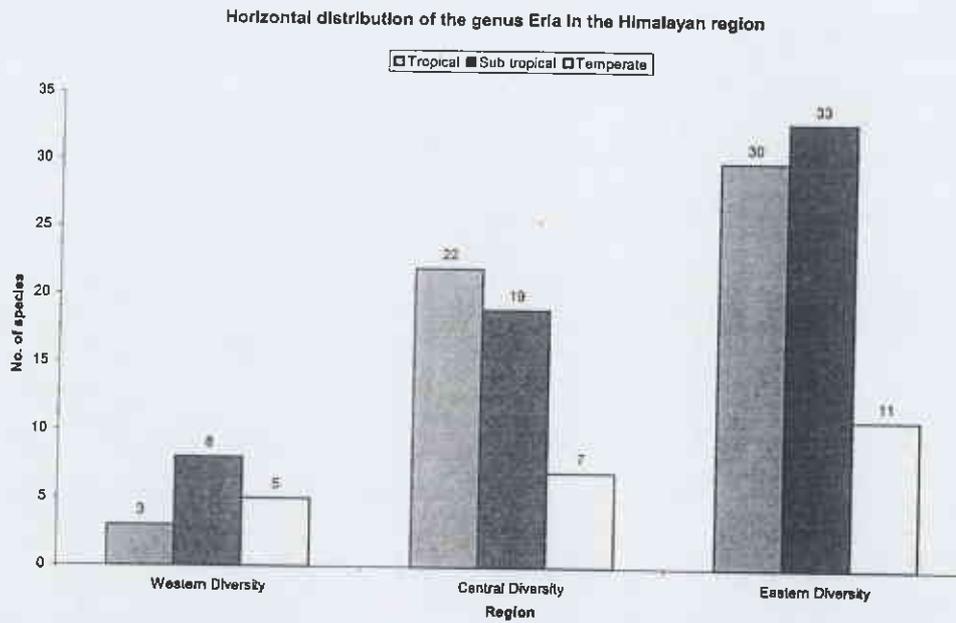


Fig. 78 A: Horizontal distribution of the genus *Eria* in the Himalayan region (Broader concept)

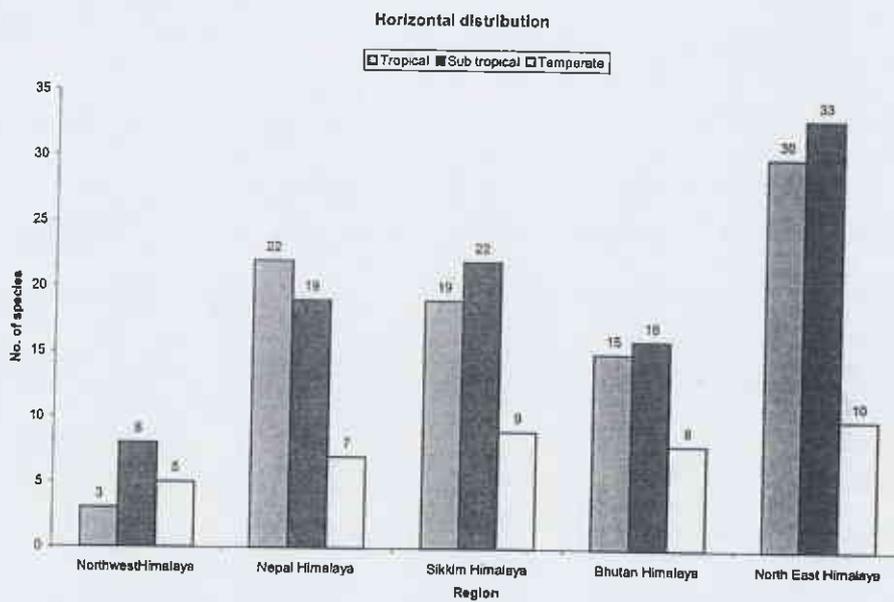


Fig. 78 B: Horizontal distribution of the genus *Eria* in the Himalayan region (Revised concept)

Distribution pattern of the species *Eria*

Distribution pattern of the genus *Eria* in the Himalayan region shows that *Eria coronaria*, *E. graminifolia* and *E. spicata* are distributed from North-west Himalaya to China, Taiwan, *Eria amica*, *E. apertiflora*, *E. bambusifolia*, *E. clavicaulis*, *E. muscicola*, *E. lasiopetala* and *E. tomentosa* are distributed from the Himalaya onward to Indo-pacific and Java, etc., some species like *E. bractescens*, and *E. biflora* cover wide range of distribution from Nepal Himalaya to Australia. *E. acervata* extended to Netherlands, whereas *E. occidentalis* is mainly concentrated in the Northwest Himalaya. Similarly, *E. baniaii*, *E. nepalensis* and *E. pokharensis* are concentrated in the Nepal Himalaya, *E. bhutanica* in the Bhutan Himalaya, *E. sikkimensis*, and *E. scabrilinguis* in the Sikkim Himalaya, and *E. arunchalensis*, *E. jengingensis*, *E. glandulifera* and *E. sharmae* are distributed only in the North-Eastern Himalaya. Some species such as *E. clavicaulis*, *E. globulifera*, *E. lacei*, and *E. pudica* are distributed from North-east Himalaya to east ward; *E. alba*, *E. connata*, *E. excavata* and *E. ferrugenea* are distributed only in the Himalaya region. The distribution pattern of *E. braccata* is interesting because this species is distributed in disjunction manner (Table13, 14).

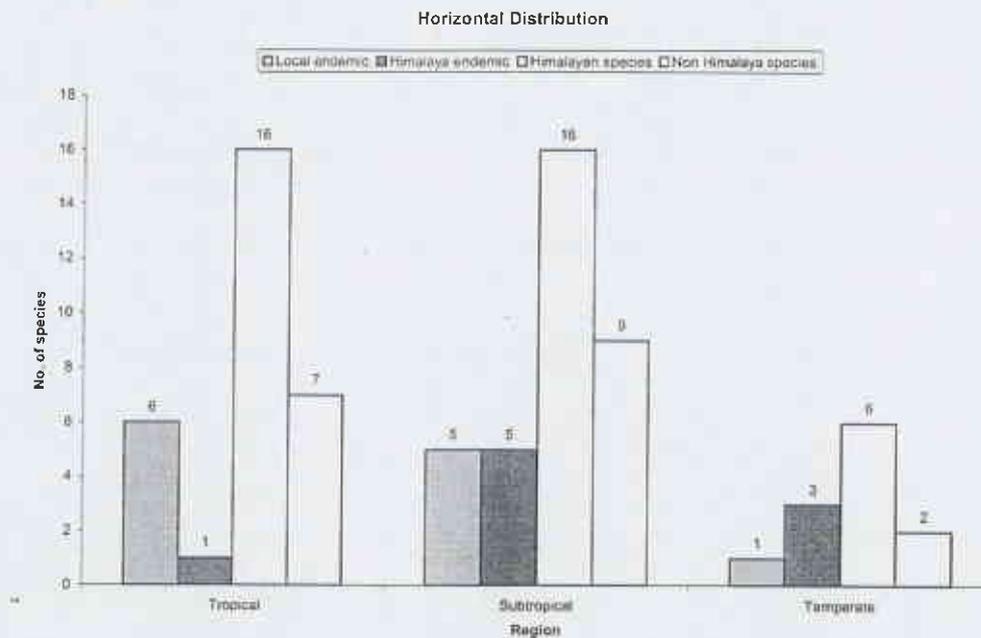


Fig. 78 C: Horizontal Distribution of *Eria* species, based on the climatic regions

The horizontal distribution analysis reveals that out of 49 species of Himalayan *Eria*, 44 species are distributed in this Eastern Himalaya diversity region and slowly decrease towards the Central and Western Himalayan diversity region (Fig. 78 A). Among them 38 species of *Eria* are mostly concentrated in the North-East Himalaya (Fig. 78 B). The local endemic species are higher in tropical region, Himalayan endemic in sub-tropical region; Himalayan species in tropical and sub-tropical region and Non-Himalayan species are higher in sub-tropical region (Fig. 78 B). In the tropical region of Himalaya, the number of local endemic and Himalaya species are high due to the riverine forest with humid and cool breeze climate (Fig. 78 C).

In the sub-tropical and temperate regions, the number of species is maximum in North-eastern Himalaya. It slowly decreases towards the west. This is, because sub-tropical region and temperate region of North East Himalaya is much moist and humid, and mountains are facing North-east, East and South-east. Whereas, in the North-west Himalaya, the climatic condition is dry and cool, and number of *Eria* species decreases simultaneously. The limit of distribution of genus *Eria* is up to Himachal Pradesh, beyond that, there is no record of *Eria* because of deep cutting of Indus river valley. It is an important barrier for the *Eria* and also for many other orchids in the Himalaya Mountains (Renz 1978, 1984; Deva & Naithani 1986).

From the critical study, based on the field observation and available literature, following results are obtained from data analysis of the species distributed in the various regions.

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 into upper tropical region	8 species
Extending from lower tropical - lower sub-tropical region	5 species
Extending from lower tropical - upper tropical region	8 species
Extending from upper tropical - lower sub- tropical region	5 species
Extending from upper tropical- upper sub- tropical region	2 species
Extending from lower sub-tropical - upper sub tropical region	17 species
Extending from lower -sub tropical into lower temperate Region	2 species
Extending from lower sub-tropical into lower temperate Region	14 species

The above mentioned data shows that maximum number of species is concentrated in lower sub-tropical region, whereas in the lower tropical and lower temperate region, the minimum number of species is recorded. It is very interesting to note that maximum numbers of species overlap in the lower sub-tropical and upper sub-tropical region rather than tropical to temperate region.

6.4.4 Climatic Distribution

Climatically, the area offer a diversity of gradients: cool moist climate in Arunachal Pradesh of Eastern Himalayan region and cold desert climate in Ladakh of Western Himalayan region, and cold dry climate of Tibetan plateau to sub-tropical Indo-Gangetic plains. The Himalaya acts as a barrier against monsoon wind of south wind and Siberian wind of North. The rainfall pattern varies and decreases from east to west. The understanding of distribution pattern of the genus *Eria* in the Himalaya region is better with the help of explored herbarium specimens of different herbaria such as K, BM, E, KATH, CAL, DD, TUCH, and the living collections (Fig. 79 A, B, C).

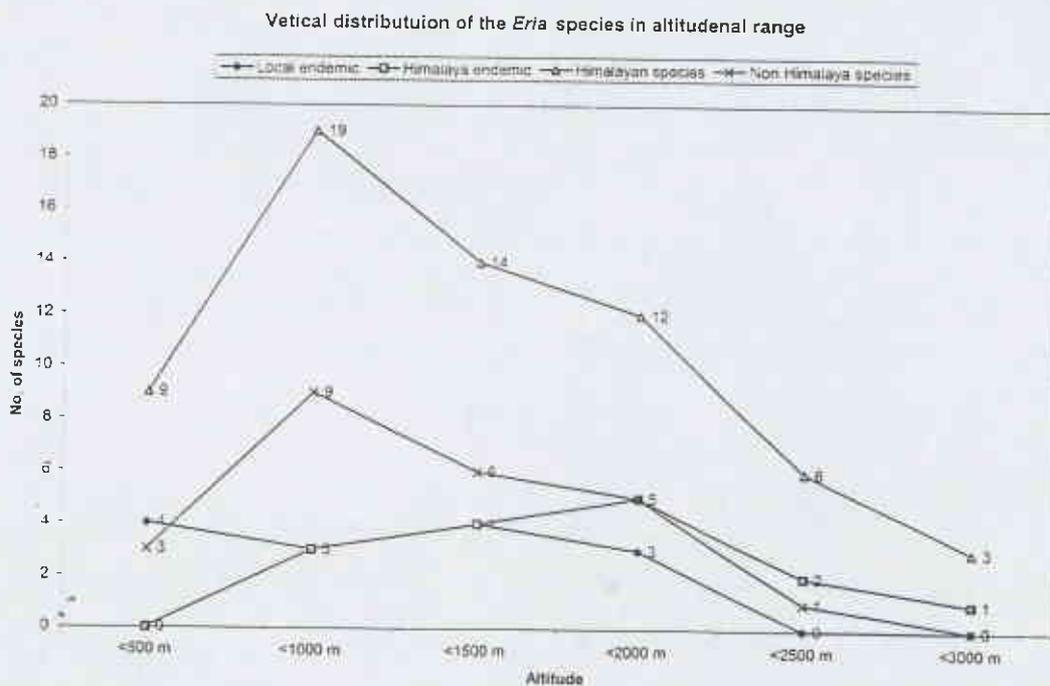


Fig. 79 A: Vertical Distribution of the *Eria* species in the altitudinal range

The local endemic is high in elevation between less than 500 m to 1500 m. Himalaya endemic is high at the elevation of above 2000 m, Himalaya species and non-Himalayan species are high at elevation below 1000 m. In general, *Eria* species are more commonly distributed at the elevation below 1500m (Fig. 79 A, B, and C).

Area wise, number of species is high at the elevation below 1500m in Western Himalayan region. In the Central Himalayan and Eastern Himalayan region the number of *Eria* species is higher in the elevation below 1000 m (Fig 79 B).

In the revised concept of regional wise distribution, number of *Eria* species is high at the elevation below 1500m in Northwest Himalayan region and Bhutan Himalaya. It is high in the elevation below 1000m in the Nepal Himalaya, Sikkim Himalaya and North-East Himalayan region.

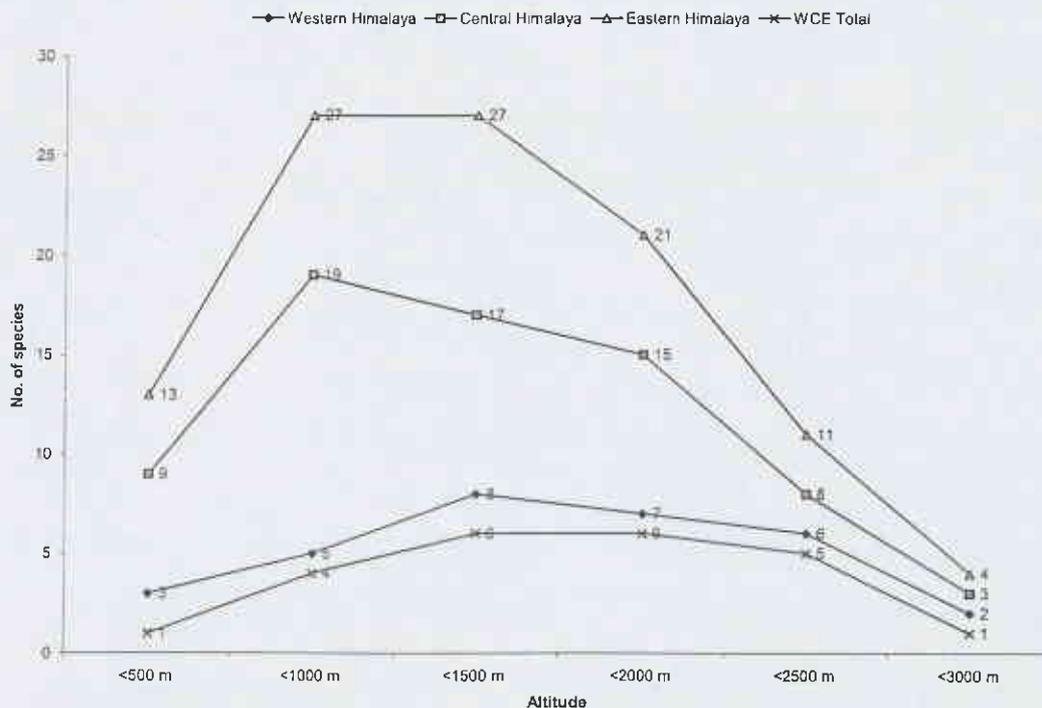


Fig: 79 B. Vertical Distribution of the genus *Eria* Lindl. in the Himalayan region

In the Himalaya, *Eria* species have been more frequently collected from the sub-tropical region than from the lower and higher altitude. Thus it indicates a fairly good coverage of field work at sub-tropical region (1000-2000m). The climatic condition of Himalaya also shows that north-east Himalaya is the centre of origin for *Eria*, due to high number of species and moist and humid climatic condition. It had been clearly pointed out that the eastern Himalaya, including N.E. India, forms the richest plant diversity centre in the Himalaya.

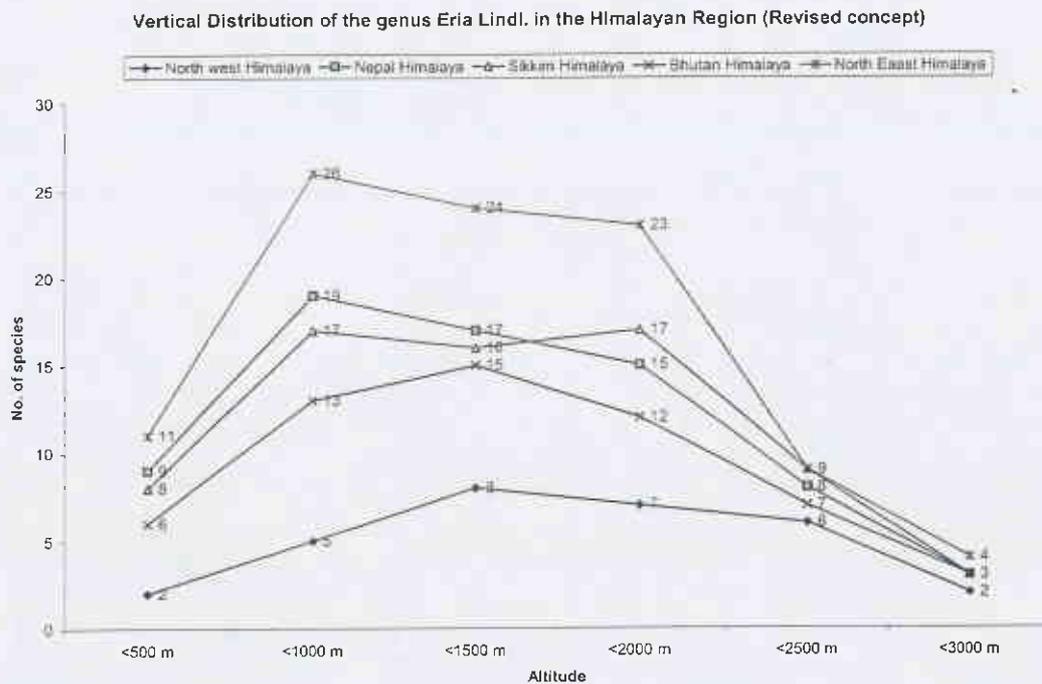


Fig: 79 C.) Vertical Distribution of the genus *Eria* Lindl. in the Himalayan Region (Revised concept)

6.4.5 Taxonomic Distribution

Distribution of Himalayan *Eria* at the sectional level has been analyzed (Table 18 A, B). The sections *Conchidium*, *Hymeneria*, *Trichosma*, *Pinalia*, *cylindrolobus* *Secundae*, and *Dendrolirium* are much diverse in Eastern Diversity Area (EDA) than other two areas. The sections *Conchidium*, *Hymeneria*, *Trichosma*, *Pinalia* and *Dendrolirium* are mainly distributed in EDA, but also sparsely represented in Central Diversity Area (WDA), and Western Diversity Area (CDA).

More than 75 percent of local endemic species are concentrated in EDA in the Himalaya due to climatic condition. It is remarkable that most of the endemic species lies in the sections *Hymeneria* *Cylindrolobus* and *Dendrolirium* sections. The sections *Conchidium*, *Trichosma*, *Dendrolirium*, *Hymeneria* and *Pinalia* are represented equally in all diversity area than other sections. None of the section exhibits a large numbers of species in WDA, than CDA and EDA.

It can be concluded that the EDA is more diverse area than other two. The CDA and WDA can be equivocally recognized at the specific and section levels are less diverse areas than EDA. So EDA can be considered as area of Himalaya diversity centre at the sectional and infra-species levels of the genus *Eria*.

Table: 15 A. Distribution of section of *Eria* in the Himalayan Region (Boarder concept)

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

(ABB: WDAH : Western Diversity Area; CDA : Central Diversity Area; EDA Eastern Diversity Area; E: Endemic species; H: Himalayan Species; HE: Himalayan Endemic species; N: Non Himalayan species)

Table: 15 B. Distribution of section of *Eria* in the Himalayan Region (Revised concept)

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

(ABB: 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).

Analysis of diversity area correlation, species correlation, climatic correlation and taxonomic correlation of the *Eria* in the Himalaya region, it is revealed that Himalayan species are originated from the North-East Himalaya region and migrate to northern and southern floristic region. Most of the Himalayan species are distributed in N.E. Himalaya via N Myanmar, Burma to (Tibet) China, N. Thailand, 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. Averyanov (2002) pointed out that floristic analysis reveals clear connection of Sikang-Yunnan and North Indochinese orchid's floras with flora of SE Himalaya. Other line of distribution is from N. E. Himalaya to westward through Bhutan, Sikkim, and Nepal via N.W. Himalaya up to Nederland, especially *E. acervata* (Vestweber 2002). The centre of diversity in Himalayan belt lies in N. Myanmar and SW China, however, there are no species of *Eria* in Pakistan, Iran, and Afghanistan. There is a marked increase in diversity from west to east, coinciding with an increase in rainfall and proximity to the centre of maximum diversity further east. It shows that *Eria* less concentrate in the Northern hemisphere than Southern parts of the world.

7. Conclusion

Eria Lindl., belonging to the family Orchidaceae, consists of about 404 species in the world and is distributed from Tropical Asia to Indo-pacific. Taxonomically, this group has received relatively little attention from taxonomists as a difficult group with the variation of vegetative and reproductive parts. The taxonomic work on this genus is incomplete due to similarity with nearest genus *Dendrobium* and *Trichotosia*, and lacking enough field observation and herbarium specimens in the Himalayan region. In the present study, the phylogentic relationship of the Himalayan *Eria* were documented by means of comprehensive methods involving gross morphology, leaf anatomy, seed morphology, palynology and biogeography-distribution of the *Eria* in the Himalayan region. The results have been summarized below:

1 Morphological Study

The systematic revision of the Himalayan genus *Eria* was made based on intensive literature survey, extensive field observation, examination of living materials, and herbarium specimens deposited in various herbaria of Nepal, India and the UK. The variation pattern of major gross morphological characters in the species was analyzed in detailed and their taxonomic significance was evaluated. The nature of pseudobulbs, inflorescence types, type of labellum and its ornamentation on the disc were particularly highlighted.

- I. The genus *Eria* was categorized into 12 sections viz.: *Eria*, *Conchidium* (Griff.) Lindl., *Xiphosium* Gibson ex Lindl., *Trichosma* Lindl., *Pannea* Pftzer, *Dendrolirium* (Bl.) Lindl., *Secundae* Leavitt, *Mycaranthers* Rchb.f., *Cylindrolobus* (Bl.) Lindl., *Bambusifoliae* Hook.f., *Hymenreia* Lindl. and *Pinalia* (Lindl.) Seiden.
- II. Section *Trichosma* was further divided into two series *Coelogyne* and *Clausae* ser. Nov. and Section *Dendrolirium* is also divided into two series *ferruginae* and *Pubescentae*.
- III. In present study five new species viz. *Eria nepalensis*, *E. bhutanica*, *E. baniaii*, *E. pokharensis*, and *E. sikkemensis* were recognized and described from the Himalayan region.
- IV. Five species viz. *E. apertiflora*, *E. bipunctata*, *E. clausa*, *E. concolor* and *E. obesa*, had recorded as new addition to the Flora of Nepal. *E. lohitisensis* was reduce as synonym as *E. glandulifera*.
- V. Four imperfectly known species *Eria acutifolia*, *E. oranta*, *E. sutepensis*, and *E. scrabiliguis* remained for further study. One species *E. discolor* evaluate as the separate genus *Callostylis* base on its labellum characters. The section *Trichotosia* was also evaluated as

separate genus *Trichotosia* based on it posses only hairy flower bracts and leaf sheath alone.

2 Micro-morphological Study

a. Stomata

Leaf surface of 28 species of *Eria* were examined with the help of Research Microscope (RM). Micro-morphological characters of the leaf surface of *Eria* show wide variation in the size, shape and the density of stomata. Two types of stomata elliptical and circular shaped stomata have been recorded. The circular type of stomata is recorded in *E. clausa*, and remaining species have elliptic type of stomata. There is much variation in the arrangement of subsidiary cells and surface sculpturing of epidermal cells. Out of 29 species of studied stomatal complex, five different types of stomata have been recognized according to the arrangement of subsidiary cells. Among the taxa studied **type A:** *E. clausa*, **type B:** *E. pannea*, **type C:** *E. muscicola*, **type D:** *E. apertifolia*, *E. graminifolia*, *E. stricta*, and *E. coronaria*, **type E:** *E. clavicaulis*, *E. bipunctata*, *E. lasiopetala*, *E. nepalensis*, *E. tomentosa*, *E. ferruginea*, *E. laniceps*, *E. merguensis*, *E. paniculata*, *E. concolor*, *E. pudica*, *E. bipunctata*, *E. clavicaulis*, *E. amica*, *E. bractescens*, *E. bambusifolia*, and *E. carinata*, **type F:** *E. excavata*, and **type G:** *E. spicata*, *E. vittata*

b. Silica bodies (Stegmata)

Among 28 species of taxa studied, silica bodies or stegmata had distinctly recorded in 22 species of *Eria*. Stegmata are absent in *E. muscicola*, *E. pannea*, and *E. carinata*, and not distinct in *E. coronaria* and *E. merguensis*. Remaining species of *Eria* viz. *E. clausa*, *E. apertifolia*, *E. graminifolia*, *E. stricta*, *E. clavicaulis*, *E. bipunctata*, *E. lasiopetala*, *E. nepalensis*, *E. tomentosa*, *E. ferruginea*, *E. laniceps*, *E. paniculata*, *E. concolor*, *E. pudica*, *E. bipunctata*, *E. clavicaulis*, *E. amica*, *E. bractescens*, *E. Excavata*, *E. spicata*, *E. vittata* possess spherical stegmata in the leaves. Moller & Rasmussen (1984) reported presence of stegmata in *E. muscicola*, but the present study confirms the absence of stegmata in *E. muscicola*. The stomata and stegmata on the leaf surface of Himalayan *Eria* seem to be significant for the understanding of supra and infraspecific relationship within *Eria*.

3. Seed morphology

- Seed morphology of 19 species of Himalayan *Eria* has been studied through Light Microscope (LM). The seeds of *Eria* are more or less uniform, minute, dust-like, measuring 148-220 µm long, 40-120 µm wide. The seeds are fusiform with narrow elongated testa cells and prominent raised fused anticlinal walls that run more or less straight or diagonal. "A" "B" and "D" type of seed shape are conformed in *Eria*. According to Dressler's classification (1993), three types

of seeds have confirmed in *Eria*, such as Vanda type, Epidendrum type, and Eulophia type (*E. clausa*).

An attempt had been made to arrange the species of *Eria* into six groups based on the study of seed characters of limited number of species. The seeds of *Eria* reflect taxonomically useful information at the section levels. **Type A:** *E. carinata*, **Type B:** *E. clausa*, **Type C:** *E. coronaria*, **Type D:** *E. muscicola*, *E. lasiopetala*, *E. tomentosa*, *E. ferruginea*, *E. pannea*, *E. bambusifolia*, *E. apertifolia*, **Type E:** *E. extinctoria*, *E. paniculata*, *E. excavata*, and **Type F:** *E. alba*. However, there is considerable variation in the micromorphological characters of the anticlinal walls and orientation of its testa walls. The seeds of *Eria* reflect taxonomic significance for the understanding of inter and intra specific relationship in *Eria*, and considerably helpful in the delimitation of closely related species.

Pollen morphology

Pollen morphology of 20 species of *Eria* have examined for the present study. The pollen grains remain in tetrads or are aggregated into large masses and covered by waxy coating. In *Eria*, the sculpturing pattern on the outer wall of pollen is smooth exine. The shape of tetrads shows remarkable variation among the species, mostly rhomboidal and inaperturate. The pollen size varies from 84-200µm. *Eria* pollen grains are adhered as "calymmate type" by observing through SEM and LM. As observed by SEM, the tectum surface of pollens are smooth in *Eria*, in *E. spicata*, *E. amica* and *E. alba* tectate is psilate, whereas in *E. bipunctata* tectate is scabrate and perforate in *E. lasiopetala*. Therefore, it is concluded that the pollen morphology data are significant to delimitation within species, however, pollen data do provide important information at the generic and subtribal levels.

4. Cladistic analysis

Based on the results of morphological, anatomical, palynological study and secondary data of keryo-morphological and cytological data, the characters were synthesized and analyzed by cladistic approach. The phylogenetic tree suggested that the genus *Eria* is polyphyletic the infraspecific phylogentic relationship of *Eria* were constant with current system of classification besides some groups; and vegetative characters are also useful characters for the phylogenetic analysis.

5. Biogeography

The Himalayan species of *Eria* are distributed at tropical to temperate region (500-3500 m). The distribution pattern of the Himalayan *Eria* show that *Eria coronaria*, and *E. spicata* are distributed from North-west Himalaya to China, Taiwan, where as species like *E. bractescens*, and *E. biflora* have covered the wide range of distribution from Himalaya to Australia and *E. acervata*

extended from Himalaya to Netherlands. Some of the species such as *Eria amica*, *E. apertiflora*, *E. bambusifolia*, *E. clavicaulis*, *E. lasiopetala*, *E. muscicola*, and *E. tomentosa* are distributed from Himalaya onward to Indo-pacific and Java in Southern hemisphere. Similarly, *E. clavicaulis*, *E. globulifera*, *E. lacei*, and *E. pudica* are distributed from North-east Himalaya to east ward, The distribution pattern of *E. braccata* is interesting because this species is distributed in disjunction manner from South India to North West Himalayan region.

The relationship between the species with climatic correlation, species and taxonomic correlation, the species diversity shows that number of species is high in Eastern Himalayan region, followed by Central and Western Himalayan region. The number of species is high due to its climatic factors on the eastern region, due to high relative humidity in the atmosphere, which is one of the important factors for rich growth of orchids than the western Himalayan region. The maximum number of species is concentrated in the sub-tropical region at 1000-1500 m. and abruptly decreases above 2000 m. Taxonomic correlation shows that most of sections of *Eria* are concentrated in the Eastern Himalaya, whereas the section *Xiphosium*, *Mycaranthus*, and *Secundae* is not recorded beyond Central Himalayan region in the west, and remaining the sections were distributed throughout the Himalayan region. In the sections *Conchidium*, *Dendrolirium*, *Hymeneria*, *Pinalia* and *Trichosma*, the number of species is high in Eastern Diversity Area (EDA), which is slowly decreased in Western and Central diversity areas. All the Himalayan species have distributed in the EDA. Species like *E. alba*, *E. excavata* and *E. graminifolia* are distributed only in WDA and CDA. Some of the species have distributed outside the Himalayan region, such as *Eria discolor*, *E. javanica*. Species like *E. extinctoria* is also distributed in disjunction manner from Burma to the Nepal Himalaya, there is no record of this species in between Burma to Nepal Himalaya, because this species is only reported from the Indo-Malayan region.

Biogeographical analysis reveals that the Himalayan species of *Eria* are originated from the North-East Himalaya region and migrated to the northern and southern floristic region. Most of the Himalayan *Eria* are distributed in N.E. Himalaya via N Myanmar, Burma to (Tibet) China, N. Thailand, Taiwan, Japan in one 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. Averyanov (2002) pointed out that floristic analysis reveals the clear connection of Sikang-Yunnan and North Indo-Chinese orchid floras with flora of SE Himalaya.

Present revision of *Eria* is mainly based on morphological characters, associated with some pollen and seed morphological characters, vegetative anatomy (including epidermal cells of leaves, stomata and stegmata) and bio-geographical analysis. Due to unavailability of facilities to perform modern approach such as Scanning Electronic Microscope (SEM), Transmission Electron

Microscope (TEM) and molecular systematic study (DNA finger prints, DNA sequences, etc.), the detailed study of the genus was not possible. Therefore, it is recommended to add more information on the genus by study of additional parameters using modern techniques. Probably a new classification scheme as well as phylogeny of the tree may be derived from the further research work on the genus.

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APPENDIX

1. Karyo- morphological data of the Himalayan *Eria*

Species	Areas	N	2n	References
<i>E. acervata</i>	NEI	20		Mehra & Sehgal 1975
	Thailand		38	Hasimoto & Tanaka 1983
	China		38	Li/X-I & R-y Chen 1989
	China		38	Li/X & Tanaka 1992
<i>E. alba</i>	NEI		36	Mehra & Sehgal 1974
	NWH		40	Vij & al. 1976a
<i>E. amica</i>	NWH	18		Mehra & Kashyap 1984b
	India	18		Mahra & Kashyap 1989
<i>E. bambusifolia</i>	NEI	20		Mehra & Sehgal 1974
	NEH		38	Vij & Shekhar 1983
	India		38	Hegde & Ingaihalli 1988
<i>E. biflora</i>	NEI	19		Mehra & Sehgal 1976
	NEI		42	Biswas 1980
	India	21		Mehra & Sehgal 1976
	India		46	Hasimoto & Tanaka 1983
<i>E. bractescens</i>	India		40	Sharma & Chatterji 1966
	NEH	20		Vij & Mehra 1976
	Thailand		38	Hasimoto & Tanaka 1983
<i>E. coronaria</i>	NEH	18		Mehra & Vij 1970,;1976;
	India		36	Chatterji 1965b, Shekhar 1984,
	NEI	17-19, 22-26		Mehra & Sehgal 1980 Mehra & Sehgal 1980
<i>E. crassicaulis</i>	NEI	19		Mehra & Sehgal 1976
	PI		24	Jorapur & Kulkarni 1979
	India		24+5B	Jorapur & Kulkarni 1979
	India		24+10B	Jorapur & Kulkarni 1980
	India		42	Singh 1981
<i>E. excavata</i>	NEH	20		Mehra & Vij 1970
	India		38	Biswas 1980
<i>E. ferruginea</i>	NEI		38	Biswas 1980
<i>E. graminifolia</i>	NEH	19		Mehra & Vij 1970;1976

	NEI		38	Biswas 1980
	India		42	Hasimoto & Tanaka 1983
<i>E. muscicola</i>	NEI	18		Mehra & Sehgal 1976
	NWH	18		Vij & Shekhar 1985
<i>E. paniculata</i>	NEH	19+0-2B		Vij & Shekhar (unpublished); Vij & Sood 1986
	NEI	19		Mehra & Sehgal 1976
<i>E. pannea</i>	NEH	18		Mehra & Vij 1970;1976
	Thailand		38	Hasimoto & Tanaka 1983
	China		38	Li/X-I&R-Y Chen 1989
<i>E. reticosa</i>	PI		42	Jorapur & Kulkarni, 1979,1980, Singh 1981
<i>E. spicata</i>	NEI	20		Mehra & Vij 1970;
	NEH,	20+2B		Mehra & Sehgal 1974
	India	18	38	Vij & Shekhar 1985 Chatterji 1965b;
	Thailand		38	Hasimoto & Tanaka 1983
	India			Mahra & Kashap 1989
<i>E. flava</i>	NWH		40	Vij & al. 1976a
	NEH		38	Biawas 1980
<i>E. stricta</i>	Thailand		40	Hasimoto & Tanaka 1983
<i>E. javanica</i>	Thailand		36	Hasimoto & Tanaka 1983
<i>E. corneri</i>	Japan		36	Hasimoto & Tanaka 1983
<i>E. rufinula</i>	Thailand		38	Hasimoto & Tanaka 1983
<i>E. ornate</i>	Thailand		38	Hasimoto & Tanaka 1983
<i>E. floribunda</i>	Thailand		38	Hasimoto & Tanaka 1983
<i>E. pachystachya</i>	Malaysia		38	Hasimoto & Tanaka 1983
<i>E. hyacinoides</i>	Malaysia		38	Hasimoto & Tanaka 1983
<i>E. ovata</i>	Japan		38	Hasimoto & Tanaka 1983
<i>E. tementosiflora</i>	Tiawan		38	Hasimoto & Tanaka 1983
<i>E. mysorensis</i>	India		38	Jorapur & Kulkarni 1979
<i>E. exilis</i>	India		38	Jorapur & Kulkarni 1979
<i>E. microchilos</i>	India		24+9B	Jorapur & Kulkarni 1979
<i>E. dalzellii</i>	India		24+5B	Jorapur & Kulkarni 1979

2. Checklist of the Himalayan genus *Eria* Lindl.

- Aerides lasiopetala* Willd.
= ***Eria lasiopetala*** (Willd.) Ormerod
- Coelegyne coronaria* Lindl.
= ***Eria coronaria*** (Lindl.) Rchb.f.
- Conchidium pusillum* Griff.
= ***Eria pusilla*** (Griff.) Lindl.
- Dendrobium ? pubescens* W. Hook.
= ***Eria lasiopetala*** (Willd.) Ormerod
- Dendrobium albdotomentosa* Blume
= ***Eria lasiopetala*** (Willd.) Ormerod
- Dendrobium braccatum* Lindl.
= ***Eria braccata*** Lindl.
- Dendrobium extensorium* Lindl.
= ***Eria extinctoria*** (Lindl.) Oliver
- Dendrobium floribundum* D. Don
= ***Eria paniculata*** Lindl.
- Dendrobium javanicum* Sw.
= ***Eria Javanica*** (Sw.) Blume
- Dendrobium muscicola* Lindl.
= ***Eria muscicola*** Lindl.
- Dendrobium subterrestre* Gagnep.
= ***Eria bractescens*** Lindl.
- Epidendrum flos aeris?* Koenig.
= ***Eria lasiopetala*** (Willd.) Ormerod
- Epidendrum tomentosum* Koenig.
= ***Eria tomentosa*** (Koenig.) Hook.f.
- Eria acervata*** Lindl.
- Eria affinis* auct. non Griff.
= ***Eria bractescens*** Lindl.
- Eria alba*** Lindl.
- Eria amica*** Rchb.f.
- Eria andersonii* Hook.f.
= ***Eria amica*** Rchb.f.
- Eria apertiflora*** Summerh.
- Eria arunchalensis*** N. A. Rao.
- Eria bambusifolia*** Lindl.
- Eria baniaii*** D. M. Bajracharya,
L. R. Shakya & M. K. Chettri,
- Eria bhutanica*** D. M. Bajracharya & K.K.
Shrestha
- Eria biflora*** Griff.
- Eria bipunctata*** Lindl.
- Eria braccata*** Lindl.
- Eria bractescens*** Lindl.
- Eria calamifolia* Hook.f.
= ***Eria pannea*** Lindl.
- Eria carinata*** Lindl.
- Eria clausa*** King & Pantl.
- Eria clavicaulis*** Wall. ex Lindl.
- Eria cochleata* Lindl.
= ***Eria javanica*** (Sw.) Blume
- Eria concolor*** Par. & Rchb.f.
- Eria confusa* Hook.f.
= ***Eria amica*** Rchb.f.
- Eria connata*** Joseph, Hedge &
Abbareddy
- Eria convallarioides* Lindl.
= ***Eria spicata*** (D. Don) Hands.-Mazz.
- Eria corneri*** Rchb.f.
- Eria corneri* var. *clausa* (King & Pantl.) A.
N. Rao
= ***Eria clausa*** King & Pantl.
- Eria coronaria*** (Lindl.) Rchb.f.
- Eria crassicaulis*** Hook. f.
- Eria cristata*** Rolfe
- Eria dillwynii* Hook. f.
= ***Eria bractescens*** Lindl.
- Eria elongata senu* Lindl.

= *Eria laniceps*. Rchb.f
Eria excavata Lindl.
Eria extingtoria (Lindl.) Oliver
Eria ferruginea Lindl.
Eria flava Lindl. Wall.
 = *Eria lasiopetala* (Willd.) Ormerod
Eria flava sensu Griff.
 = *Eria laniceps*. Rchb.f
Eria flava var. *elongata* Krzl.
 = *Eria laniceps*. Rchb.f
Eria flava var. *rubida* Lindl.
 = *Eria excavata* Lindl.
Eria fragrans Rchb. f.
 = *Eria Javanica* (Sw.) Blume
Eria glandulifera Deori & Phukan
Eria globulifera Seidenf.
Eria goldschmidtian Schltr.
 = *Eria corneri* Rchb.f.
Eria graminifolia Lindl.
Eria griffithii Rchb.f.
 = *Eria bractescens* Lindl.
Eria hindei Summerh.
 = *Eria pudica* Ridl.
Eria Javanica (Sw.) Blume
Eria jengingensis Hedge
Eria khasiana Lindl.
 = *Eria clavicaulis* Wall, ex Lindl.
Eria lacei. Summerh.
Eria laniceps. Rchb.f
Eria lasiopetala (Willd.) Ormerod
Eria lindleyana Griff.
 = *Eria obesa* Lindl.
Eria littoralis Teijsm & Binnend.
 = *Eria bractescens* Lindl.
Eria lohitisensis Rao & Haridarsan
 = *Eria glandulifera* Deori & Phukan
Eria merguensis Lindl.

Eria muscicola. var. *muscicola* (Lindl.)
 Lindl.
Eria nepalensis D. M. Bajracharya & K.
 K. Shrestha
Eria obesa Lindl.
Eria occidentalis Seidenf.
Eria paniculata Lindl.
Eria pannea Lindl.
Eria pokharensis D. M. Bajracharya, A.
 Subedi & K.K.Shrestha
Eria prainii Briq.
 = *Eria obesa* Lindl.
Eria pubescens (W. Hook.) Steud.
 = *Eria lasiopetala* (Willd.) Ormerod
Eria pudica Ridl.
Eria pulchella Griff.
 = *Eria bractescens* Lindl.
Eria pumila Lindl.
Eria pusilla (Griff.) Lindl.
Eria reticosa Wight
 = *Eria braccata* Lindl.
Eria rugosa (Blume) Lindl.
 = *Eria Javanica* (Sw.) Blume
Eria secundiflora Griff.
 = *Eria stricta* Lindl.
Eria septemlamella Hay.
 = *Eria corneri* Rchb.f.
Eria sharmae Chowdhaery, Giri & Pal
Eria Sikkimensis D. M. Bajracharya & K.
 .K. Shrestha
Eria spicata (D.Don) Hands.-Mazz.
Eria stellata. Lindl.
 = *Eria Javanica* (Sw.) Blume
Eria stricta Lindl
Eria suavis (Lindl.) Lindl.
 = *Eria coronaria* (Lindl.) Rchb.f.
Eria teretifolia Griff.

= **Eria pannea** Lindl.
Eria tomentosa (Koen.) Hook.f.
Eria uniflora Dalzell
 = **Eria braccata** Lindl.
Eria vittata Lindl.
Mycaranthes stricta (Lindl.) Wall. ex Lindl.
 = **Eria stricta** Lindl.
Octomeria alba Wall. ex. Lindl.
 = **Eria alba** Lindl.
Octomeria excavata Wall.
 = **Eria excavata** Lindl.
Octomeria flava Wall. ex Lindl.
 = **Eria lasiopetala** (Koenig.) Ormerod
Octomeria pubescens (Hook.) Spreng.
 = **Eria lasiopetala** (Kenig.) Ormerod
Octomeria spicata D.Don
 = **Eria spicata** (D.Don) Hands.-Mazz.
Pinalia leucantha Kuntze
 = **Eria alba** Lindl.
Pinalia acervata (Lindl.) Kuntze
 = **Eria acervata** Lindl.
Pinalia albidotomentosa (Blume) Kuntze
 = **Eria lasiopetala** (Willd.) Ormerod
Pinalia amica (Rchb.f.) Kuntze
 = **Eria amica** Rchb.f.
Pinalia bambusifoia (Lindl.) Kuntze
 = **Eria bambusifolia** Lindl.
Pinalia biflora (Griff.) Kuntze
 = **Eria Biflora** Griff.
Pinalia braccata (Lindl.) Kuntze
 = **Eria braccata** Lindl.
Pinalia bractescens (Lindl.) Kuntze
 = **Eria bractescens** Lindl.
Pinalia calaifolia (Hook.f.) Kuntze
 = **Eria pannea** Lindl.
Pinalia carinata (Lindl.) Kuntze

= **Eria carinata** Lindl.
Pinalia clavicaulis (Wall. ex Lindl.) Kuntze
 = **Eria clavicaulis** Wall ex Lindl.
Pinalia concolor (Par. & Rchb.f.) Kuntze
 = **Eria concolor** Par. & Rchb.f.
Pinalia confusa (Hook.f.) Kuntze
 = **Eria amica** Rchb.f.
Pinalia crassicaulis (Hook.f.) Kuntze
 = **Eria crassicaulis** Hook. f.
Pinalia excavata (Lindl.) Kuntze
 = **Eria excavata** Lindl.
Pinalia ferruginea (Lindl.) Kuntze
 = **Eria ferruginea** Lindl.
Pinalia fragrans (Rchb.f.) Kuntze
 = **Eria javanica** (Sw.) Bl
Pinalia graminifolia (Lindl.) Kuntze
 = **Eria graminifolia** Lindl.
Pinalia merguensis (Lindl.) Kuntze
 = **Eria merguensis** Lindl.
Pinalia paniculata (Lindl.) Kuntze
 = **Eria paniculata** Lindl.
Pinalia pannea (Lindl.) Kuntze
 = **Eria pannea** Lindl.
Pinalia pumila (Lindl.) Kuntze
 = **Eria pumila** Lindl.
Pinalia stricta (Lindl.) Kuntze
 = **Eria stricta** Lindl.
Pinalia vittata (Lindl.) Kuntze
 = **Eria vittata** Lindl.
Trichosma coronaria (Lindl.) Kuntze
 = **Eria coronaria** (Lindl.) Rchb.f.
Trichosma suavis Lindl.
 = **Eria coronaria** (Lindl.) Rchb.f.
Xiphosium acuminatum Griff.
 = **Eria carinata** Lindl.

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- Bajracharya, D. M.** 2001b. Distribution of Genus *Eria* Lindley (Orchidaceae) in the Himalayan Region. *Jour. Sci & Techn.* **3**: (2000) 51-54.
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Distribution of Genus *Eria* Lindley (Orchidaceae) in the Himalayan Region

D. M. Bajracharya

Amrit Campus, Tribhuvan University, Kathmandu

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Abstract

A revision of the genus *Eria* Lindl. (Orchidaceae) in the Himalaya has been undertaken to understand the distribution pattern based on the morpho-geographical characters. The herbarium specimens deposited at London and Kathmandu and living collection made from different localities of Nepal were thoroughly examined. It shows that Himalayan *Eria* is mostly concentrated in the north eastern Himalaya. Among 45 species recorded, 38 species were recorded from north eastern Himalayan region and 18 species from Nepal Himalaya. Among them seven species were local endemic, and three species were Himalaya endemic. Moreover most of the species were distributed between the altitudes of 500-2000 m altitude in the Himalaya.

Introduction

The genus *Eria* was first described by John Lindley in 1825 in Botanical Register under division Epidendreae based on the character with 8 pollinia and pubescent flowers. Later, Lindley (1830) had placed the genus under tribe Malaxideae, section Dendrobieae. This division is maintained as subfamily Epidendroideae in recent classification. Dressler (1981) placed under the Epidendreae sub clade Dendrobiod and tribe Epidendreae and sub tribe Eriinae. Later, Dressler (1993) gave new classification subfamily Epidendroideae, Epidendroid phylad Dendrobiod subclade, tribe Podochileae and sub tribe Eriinae. Szlachetko (1995) mentions in the subfamily Epidendroideae, tribe Podochileae and sub tribe Eriinae.

The genus *Eria* Lindl. is one of the larger aggregations of orchids into one genus in Orchidaceae. It is estimated that there are about 500 species of *Eria* in the world, (Summerhayes & Hunt 1973, Bechtel *et al.* 1981) but 350 species seems to be a more reasonable figure, which divided into thirteen-seventeen sections according to nature of pseudobulbs and leaf character

The general distribution of *Eria* was briefly touched by Seidenfaden (1982) who characterised the total range of the genus as Tropical Asia to Indo-pacific. It is spread across tropical Asia, from Himalaya, China, Philippines, Indonesia, and Papua New Guinea, Pacific Island to Fuji. The genus is recorded from hot humid coastal rainforest to the snow line of the Himalaya.

While establishing the genus *Eria*, Lindley (1830)

reported 8 species from the Himalaya. In 1859, Lindley revised *Eria* and recognized 63 species of which 13 species from the Himalaya. Since then, the number of *Eria* species went on increasing from the Himalaya with extensive exploration of the region by many botanists like J. D. Hooker (1890), recorded 94 species from British India among them 34 species from Himalaya, King and Pantling (1898) reported 21 species from Sikkim Himalaya. Duthie (1906) reported 3 species from North-West Himalaya. Kranzlin (1911) revised whole genus *Eria* and described more than two hundreds species of *Eria* from the World among them 34 from Himalaya. Mitra (1958) mention 22 species from Himalaya in East India. Seidenfaden and Smitinand (1958-1965) mentioned 17 species from Himalaya in Orchids of Thailand. Hara *et al.* (1978) enumerated 12 species from Nepal Himalaya. Seidenfaden (1982) mentioned 26 species from Himalaya in Orchids of Thailand. Banerjee and Pradhan (1984) recorded 14 species from Nepal Himalaya. Deva and Naithani (1986) recorded 9 species from North-west Himalaya; Rao (1986) recorded 29 species from Arunachal Pradesh. Rao and Haridasan (1989); Chowdhery, Giri and Pal (1993); Hedge (1993) added one new species each from Arunachal Pradesh. Chaudhary (1999) recorded 33 from Arunachal and Press *et al.* (2000) enumerated 12 species of *Eria* from Nepal.

A complete revisionary work on Himalaya was not done. Hence present revisionary work on 45 species of *Eria* is undertaken.

Basic concepts

The following basic concept has been chosen as the most convenient starting point for distribution analysis of *Eria* in Himalaya region on the basis of political boundaries.

North-west Himalaya: It starts from the border between Afghanistan to Garhwal-Kumamon.

Nepal Himalaya: It covers the Himalayan region of Nepal.

Sikkim Himalaya: It covers Himalayan region of Sikkim State of India.

Bhutan Himalaya: It covers the Himalayan region of Bhutan.

North-Eastern Himalaya: It covers the north eastern parts of India (Arunchal Pradesh) of India.

to understand the status and distribution base on the morph-geographical characters. Present study area included great Himalayan range from Afghanistan (west) to Arunchal (east).

Results and Discussion

Himalayan region is suitable home for orchids. Richness in Orchid diversity is due to topographical variation within short distance, various aspects of mountain slope and climatic variation due to influence of monsoon rain from east to west. There is dramatic drop in the number of orchid species in Central Himalaya (Nepal) as compared to eastern Himalaya (Sikkim) due to the barrier of high mountain of Shingalila range. In far North west Himalaya beyond Himalchal Pradesh of India is poor in orchids due to deep cutting of Indus River (Renz 1978, 1984, Deva & Naithani 1986).

The genus *Eria* is widely distributed in the Himalayan region. In the present study 45 species of *Eria* are recorded from Himalaya. Its distribution is poor in Bhutan, Nepal and north-west Himalaya than Sikkim Himalaya and North-east Himalaya. Where as Sikkim, Assam, Khasia, Arunachal Pradesh has largest concentration of *Eria* species in Eastern Himalaya, it shows the main centre point for *Eria* species in the Himalayan region. The number of *Eria* species is decreasing gradually towards west, (Fig. 1. a, b).

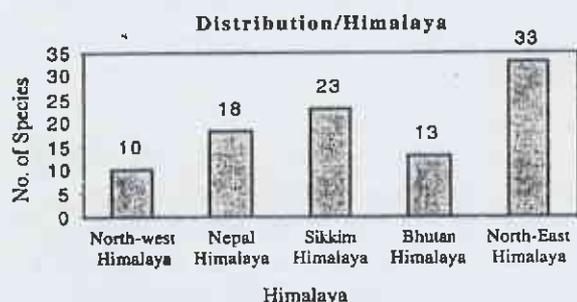


Fig. 1a. Number of *Eria* species in the Himalaya

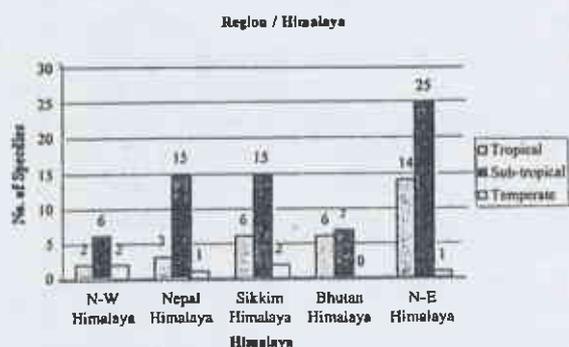


Fig. 1b. Number of *Eria* species by climate zone in the Himalaya

Methods

The distribution pattern of the *Eria* species in the Himalaya was done by observing the herbaria deposited in the different Herbaria such as Kew herbaria Kew (K), The Natural History Museum, London (BM), Edinburgh Herbaria Edinburgh (E), Central National Herbarium (CAL). National Herbaria Kathmandu (KATH) and Tribhuvan University central Herbaria (TUCH) and living collection were studied

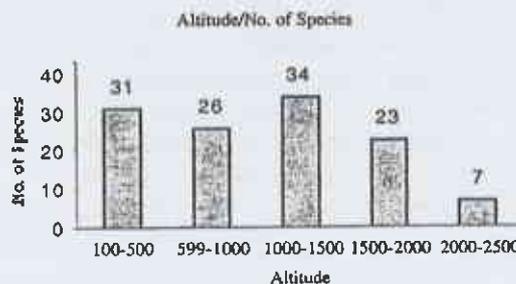


Fig. 2a. Number of *Eria* species by altitude in the Himalaya

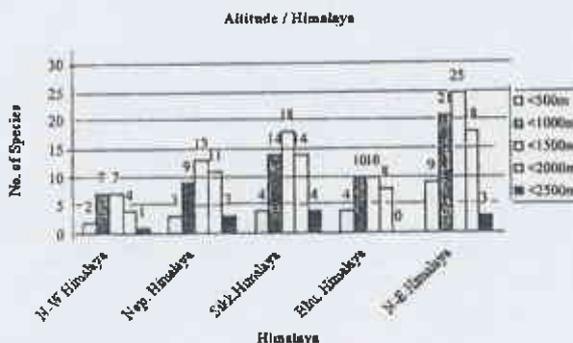


Fig. 2b. Number of *Eria* species by Himalaya

A comprehensive list of *Eria* species shows their distribution in the Himalayan region (Table: 1).

Table-1. Comparative distribution pattern of Genus *Eria* Lindl. in the Himalayan region.

Botanical name	Distribution	Altitude (m)	Flowering
<i>Eria acervata</i> Lindl.	Nepal-Sikkim Himalaya	500-1000	June-July
<i>Eria alba</i> Lindl. ♣	Kumaon-Sikkim Himalaya	1400-2300	July-Aug
<i>Eria amica</i> Lindl.	NWHimalaya-NE Himalaya	1400-1600	July-Aug
<i>Eria apertiflora</i> Summ.	Nepal-NE Himalaya	1600	Jul-Aug
<i>Eria arunachalensis</i> Roa ♦	NE Himalaya	1000-1200	July
<i>Eria bambusifolia</i> Lindl.	Sikkim - NE Himalaya	1000-2000	Oct.-Dec
<i>Eria biflora</i> Griff.	Nepal- NE Himalaya	1000-1300	Sept
<i>Eria bipunctata</i> Lindl.	Nepal- NE Himalaya	1000-1700	July-Aug
<i>Eria bractescens</i> Lindl.	Nepal- NE Himalaya	300-1000	April
<i>Eria carinata</i> Gib.	Nepal-NE Himalaya	1000-1800	Nov-Jan
<i>Eria clausa</i> King & Pantl.	Sikkim-NEHimalaya	1000-1600	Feb.-Mar
<i>Eria clavicaulis</i> Wall ex Lindl.	NE Himalaya	200-1000	July-Aug
<i>Eria connata</i> Joseph et al. ♦	NE Himalaya	1200-1500	Jul-Aug
<i>Eria corneria</i> Reichb.f	NE Himalaya	below 600	Aug-Sept
<i>Eria coronaria</i> (Lindl.) Reichb.	NWHimalaya- NE Himalaya	1000-1500	July-Aug
<i>Eria crassicaulis</i> Hk.f.	Sikkim- NE Himalaya	1300-1700	Oct.-Dec
<i>Eria cristata</i> Rolfe	NE Himalaya	1000-1500	Nov-Feb
<i>Eria discolor</i> Lindl.	Nepal- NE Himalaya	900-1200	June
<i>Eria excavata</i> Lindl. ex Hk.f.♣.	NWHimalaya - Sikkim Himalaya	1300-2000	June-July
<i>Eria extentoria</i> Oliver	Nepal	500-600	April
<i>Eria ferruginea</i> Lindl. ♣	NE Himalaya	1300-1600	April-May
<i>Eria globulifera</i> Seiden.	NE Himalaya	1000-1500	Jul-Aug
<i>Eria graminifolia</i> Lindl.	NWHimalaya- NE Himalaya	1600-2000	July-Aug
<i>Eria javanica</i> (Sm.) Bl.	Sikkim- NE Himalaya	500-1000	April-June
<i>Eria jengingensis</i> Hedge et al. ♦	NE Himalaya	650-850	March-June
<i>Eria lacei</i> Summ..	NE Himalaya	1100	March
<i>Eria laniceps</i> Reichb.f.	Sikkim- NE Himalaya	1000	Jan
<i>Eria lohitisensis</i> . Rao ♦	NE Himalaya	1500-1600	May-July
<i>Eria muscicola</i> Lindl.	NWHimalaya-NE Himalaya	1000-1800	August
<i>Eria merguensis</i> Lindl.	NE Himalaya	1000	Feb-March
<i>Eria obesa</i> Lindl.	NE Himalaya	2000-2300	June-July
<i>Eria occidentalis</i> Seiden. ♦	Western Himalaya	1200-1500	Jul-Aug
<i>Eria paniculata</i> Lindl.	Nepal-NE Himalaya	1000-1500	Jan-April
<i>Eria pannea</i> Lindl.	Sikkim-NE Himalaya	100-1000	May
<i>Eria pubescens</i> (Hk.) Steud.	NWHimalaya-NE Himalaya	100-1000	May-June
<i>Eria pudica</i> Ridl.	NE Himalaya	500-1200	June
<i>Eria pumila</i> Lindl.	Sikkim-NE Himalaya	200-500	August
<i>Eria pusilla</i> Lindl.	Sikkim-NE Himalaya	1000-1200	July-Aug
<i>Eria reticosa</i> Weight	Western Himalaya	1500-2300	Aug.
<i>Eria scabrilinguis</i> Lindl. ♦	Sikkim-NE Himalaya	Not known	April-June
<i>Eria sharmae</i> Chaudhary et al. ♦	NE Himalaya	450-500	June-July
<i>Eria spicata</i> (D.Don) Hands.-Mazz.	NWHimalaya-NE Himalaya	1000-1800	July-Aug
<i>Eria stricta</i> Lindl.	Nepal- NE Himalaya	300-1000	Feb.-Mar
<i>Eria tomentosa</i> Hk.f.	NE Himalaya	100-1000	July-Aug
<i>Eria vittata</i> Lindl.	Sikkim-NE Himalaya	1200-2000	Mar-April

(N.B: ♦ Local endemic species, ♣ Himalaya endemic.).

In the distribution pattern *Eria coronaria*, *E. muscicola*, *E. pubescens* and *E. spicata* are distributed from west to east and onward to Asia-Pacific and Java. Some species like *E. occidentalis* is mainly concentrated in the western Himalaya, whereas *E. arunchalensis*, *E. connata*, *E. jengingensis*, *E. lohitensis* and *E. sharmae* are distributed only in the North-eastern Himalaya. *E. alba*, *E. excavata* and *E. ferruginea* are only confined to the Himalaya. *E. clavicaulis*, *E. globulifera*, *E. lacei*, *E. pudica*, *E. biflora*, *E. bractescens*, *E. javanica* and *E. pannea* are distributed from Himalaya to eastward such as Burma, China, Indo China, Asia-Pacific, Papua New Guinea, Pacific Island to Java. The distribution pattern of *E. reticosa* is interesting because this species is distributed in a disjunctive manner i.e. it is reported from South India only.

The *Eria* species is widely distributed in sub-tropical region (1000-2000m) of the Himalaya. From the critical study based on the field observation and available literatures has yielded the following data analysis of the species distributed in the various zones.

Restricted to lower tropical zone (100 - 500m)	31 spp
Restricted to upper tropical zone (500 - 1000m)	26 spp
Restricted to lower sub-tropical zone (1000 - 1500m)	34 spp
Restricted to upper sub-tropical zone (1500 - 2000m)	23 spp
Restricted to lower temperate zone (2000 - 2500m)	7 spp

Among them some of the species are distributed in the short distance in the altitude range such as *Eria pumila* Lindl. (200-500m), *E. sharmae* (Chaudhary et al. (450-500m), *Eria extensoria* Oliver (500-600m), *E. jengingensis* Hedge (650-850), and *E. laniceps* Reichb. f (1000m), are distributed in tropical region. *E. lacei* Summ. (1100m), *E. pusilla* Lindl. (1000-1200m), *amica* Lindl. (1400-1600m), *E. lohitensis* Rao (1500-1600m), *E. apertiflora* Summ. (1600m) and *E. obesa* Lindl. (2000-2300m) in the Himalayan region.

Conclusion

From this work it is concluded that 34 species are distributed at altitude 1000-1500m. 36 species of *Eria* are in sub-tropical region in the Himalayan region. Among them 26 species are mostly distributed in Eastern Himalayan region including Sikkim, Assam, Bhutan and Arunachal Pradesh. *Eria amica* and *E. coronaria* are mostly distributed around 1500m in sub-tropical region of Himalayan region from west to east. In temperate region there are four species of *Eria* viz. *Eria alba*, *E. graminifolia*, *E. occidentalis* and *E. reticosa* among them *E. occidentalis* and *E. reticosa* are confined in North-west Himalaya only and *E. graminifolia* is distributed from west to east Himalayan region. There are 15 species of *Eria* in tropical region of the Himalaya and *Eria pubescens* is distributed only

from west to east Himalayan region. Some of the species are distributed in irregularly such as *E. apertiflora* and *E. extensoria* recorded from Nepal Himalaya, but its distribution is beyond the Himalaya region too. *E. scabrilinguis* Lindl. is endemic to Sikkim Himalaya, but its authentic specimens are not found in above Herbaria; therefore it could not say the actual distribution in the Himalayan region.

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The author acknowledges the Darwin Initiative (UK) for support to visit different herbaria of the UK (BM, K, and E.), Roy Vickery, the Natural History Museum (BM); Dr. Philip Cribb curator, and J. J. Wood, Orchid herbarium in Kew, UK (K) and Dr. M. Sanjappa, National Central Herbarium (CAL) are thankfully acknowledged for allowing me to study herbarium specimens in their care. I am also thankful to Dr K. K. Shrestha, Central Department of Botany TU, for the supervision of my Ph.D. work and A M Bania, Department of Botany, Amrit Campus for providing laboratory facilities for the work.

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Eria apertiflora Summerh. and *E. bipunctata* Lindl. (Orchidaceae),
New Records for the Nepal Himalaya

Devendra M. BAJRACHARYA

Department of Botany, Amrit Campus, Tribhuvan University,
Thamel, P. O. Box 102, Kathmandu, NEPAL

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Eria apertiflora Summerh. and *E. bipunctata* Lindl. (Orchidaceae) are reported as new to Nepal.

Key words: *Eria*, Flora of Nepal, Himalaya, Orchidaceae

The genus *Eria* Lindl. comprises about 370 species and is widely distributed in Asia, Africa and Asian-pacific. *Eria spicata* (D. Don) Hand.-Mazz. is widely distributed in the Himalayan region from Kumaon to Burma, whereas *E. apertiflora* Summerh. and *E. bipunctata* Lindl. are distributed in Sikkim, Assam, Khasia, Burma, and Thailand (Hooker 1890, Seidenfaden 1982). Despite of the wide distribution of *E. apertiflora* Summerh. and *E. bipunctata* Lindl. in the Himalayan region, these two species have not been recorded from the Nepal Himalaya (Hara et al. 1978, Banerjee & Pradhan 1984, Koba et al. 1999, Press et al. 2000). Now these species are recorded from Nepal Himalaya (Fig. 1).

Recently while revising the genus *Eria* Lindl. in the Himalayan region, number of herbarium specimens deposited in BM, K, E, KATH and TUCH herbaria, and materials collected from Ghodepani and Landruk, C. Nepal, were examined. Most of the Nepalese specimens of *E. apertiflora* Summerh. and *E. bipunctata* Lindl. were identified as *E. spicata* (D. Don) Hand.-Mazz., because they were closely allied to each other. The specimens of Stainton, Sykes and Williams 6397

and 6474 (BM) both were also identified as *E. spicata* (D. Don) Hand.-Mazz. When closely examined, these materials are confirmed as *E. bipunctata* Lindl. and the materials collected from Landruk and Ghodepani, viz. Nepal CN0109 and 0121, have been confirmed as *E. apertiflora* Summerh. and *E. bipunctata* Lindl., respectively (Table 1). Here, revised descriptions are provided for the two *Eria* species, *E. apertiflora* and *E. bipunctata*, in considering Nepalese materials.

***Eria apertiflora* Summerh.** in Kew Bull. 1929: 9 (1929); Seidenfaden in Opera Botanica 62: 123, fig. 74, pl. IXd (1982); 114: 191 (1992). [Fig. 2]

Epiphytic, 20–22 cm high. Pseudobulbs stem-like, slender, sympodial, 9.5–16 cm long, 4–6 nodes in pseudobulbs covered by leaf sheath. Leaf sheath 3, ovate, entire, acute, grayish green with white veins, abscission layer present. Leaves rolled around pseudobulbs, 4–5 in number, 13–16 cm × 2.8–3 cm, oblong-lanceolate, subcoriaceous, acute, with 9-veins. Scape 3–4 cm long, pubescent. Inflorescence 8–10 cm long, lateral, cylindrical, lax. Bracts 5–10 mm × 3 mm,

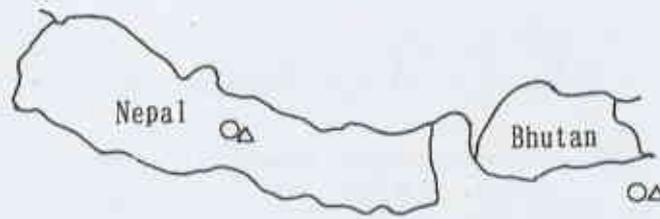


Fig. 1. *Eria apertiflora* Summerh. (○) and *E. bipunctata* Lindl. (△) in the Himalayan region.

Table 1. Comparison of characters among *Eria spicata*, *E. bipunctata* and *E. apertiflora*.

Characters	<i>Eria spicata</i> (D. Don) Hand.-Mazz.	<i>E. bipunctata</i> Lindl.	<i>E. apertiflora</i> Summerh.
Height	28-30 cm	20-22 cm	20-22 cm
Pseudobulb	10 × 2 cm, long or spindle shaped	4-6.6 × 1.5-2 cm, fusiform, compressed	9.5-16 cm, slender shaped.
Leaves	Elliptic-lanceolate, plicate, acute, 7-veins	Lanceolate, acute, 9-veins	Lanceolate, acute, 9-veins
Inflorescence	Spicate, raceme densely packed in a usually globular or ovoid in short cylindrical	Lateral, axillary, cylindrical, raceme, lax and long	Lateral, cylindrical, raceme, lax
Bracts	Ovate-lanceolate, acute, indumentum absent	Lanceolate acuminate, scattered indumentum along the edge	Ovate, acute, indumentum absent
Flower	Yellowish with purple tints, sub-globose, small flower	Creamy white with yellow patch at the tip, small flower	White with yellow at the tip, large flower
Sepals	Ovate, obtuse, yellowish white, sometimes with light purple dots on the tip	Ovate, obtuse, yellowish white	Ovate, acute, white
Petals	Oblong, obtuse, membranous	Lanceolate, acute	Elliptic-lanceolate, obtuse
Labellum	Fan shaped, uniformly widening from the base, not bilobulate	Rhomboid, trilobed, terminal lobe round, fleshy, convex, apex sinus with growth, lateral lobe. Triangular/round, spreading narrow base, purplish tint, lip distally yellow	Rhomboid, obtuse, terminal lobe of the lip yellow rarely purple, wavy margin, lateral lobe triangular, terminal lobe rhomboid, short pointed, deflexed, bilobed, white with yellow at the tip of the lip
Stigmatic cavity	Cordate, prominent	Oval, not lobed	Cordate, lobed at the base

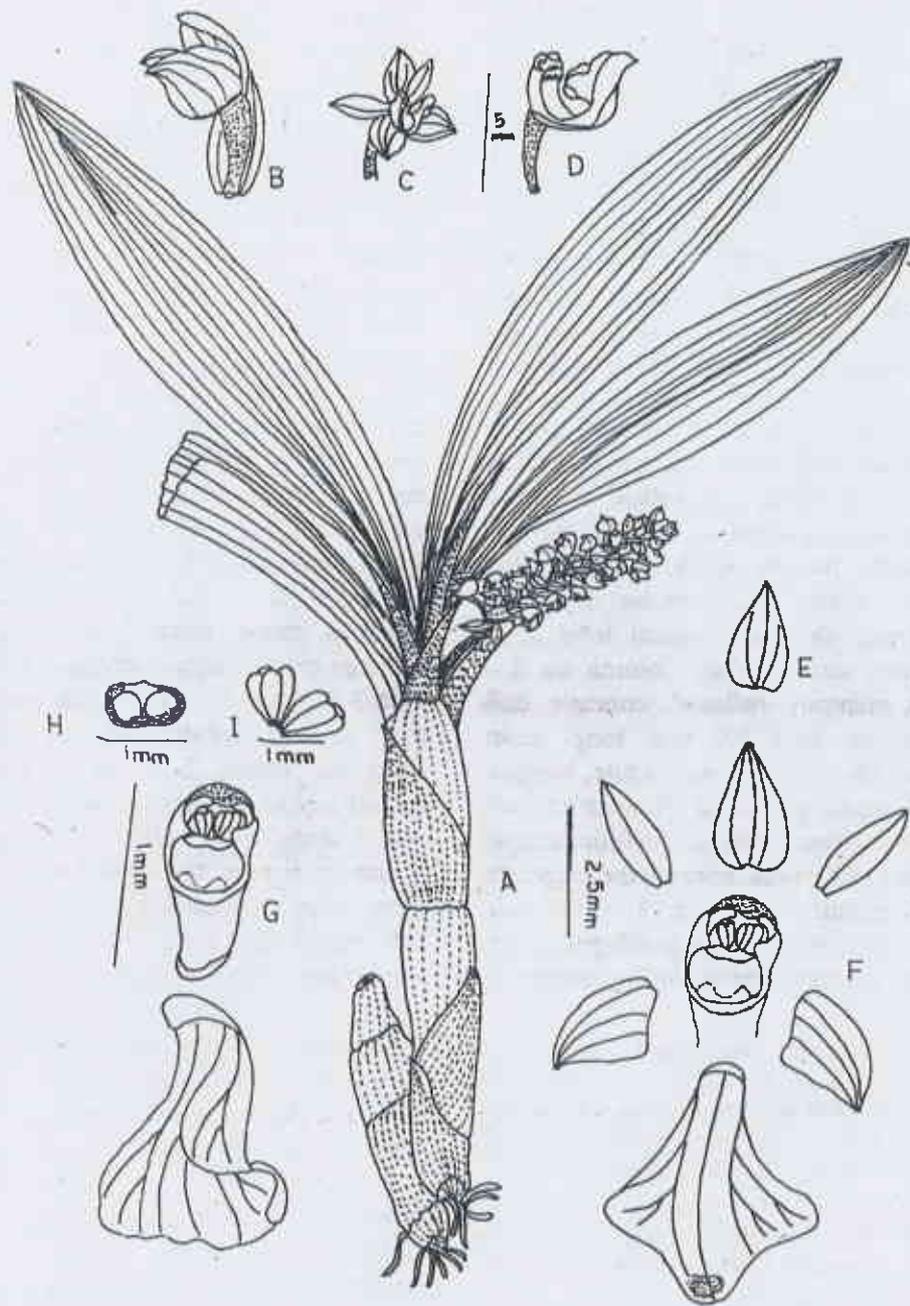


Fig. 2. *Eria apertiflora* Summerh. (D. M. Bajracharya CN0109). A: Habit. B: Bud. C: Single flower. D: Lateral view of column and labellum. E: Bract. F: Three sepals, two petals, labellum and column spreading. G: Column with labellum. H: Operculum. I: Pollinia.

ovate, acute, shiny, white with yellow stripe. Flowers 3–5 mm long, ca. 7 mm when flattened, white with yellow at the tip of the lip. Dorsal sepal 3.5–6.5 (–8) mm × 2–3 mm, lanceolate-ovate, obtuse, thick white, with 3-veins. Lateral sepals 4–6 mm × 2 mm, oblique-ovate, subfalcate, acute, white, glabrous, entire. Mentum reflexed, concave, 3 mm long from the foot of column to its tip. Petals ca. 3 × 1 mm, elliptic-lanceolate, obtuse, glabrous, thin, entire, white, edge thin, with 1-vein. Labellum 2.5–3 mm × 2 mm, when flattened 3.5–4 mm wide between tips of the lateral sides lobes, rhomboid, obtuse, thick at the tip, white with yellow at the tip, rarely purplish, relatively narrow at the base with 3-veins, margin wavy; terminal lobe 2.5–3 mm × 2 mm, thick, obtuse, triangular, short pointed, deflexed; lateral lobe 2.5–3 mm, obtuse, semicircular. Column ca. 1 × 0.75 mm, glabrous, reflexed, concave, dark brown dotted; foot 1.6 mm long, short. Operculum ca. 1 × 0.05 mm white, bilobed; pollinia 8, waxy, pyriform. Clinandrium collar like; rostellum ligulate. Visidium simple, single, ellipsoid, bent toward the stigmatic cavity. Stigmatic cavity ca. 1 × 0.5 mm, cordate shaped with two appendages inside. Pedicel ca. 2.5 mm long including ovary, pubescent.

Specimens examined: Nepal: Kaski, Central Nepal, Landruk, 1600 m, D. M. Bajracharya CN0109, 24 November 1997 (TUCH). Assam: Hinde s. n. (K, type, no. 32348); Khasia: Griffith s. n. (K, no. 5113). Khasia: J. D. Hooker & Thomson 211 (K). Burma: Moulmein. Parish 140 (K).

Distribution: Himalaya (Nepal to Assam), Thailand, Indo-China, Burma and Vietnam.

Flowering: November to January.

Eria bipunctata Lindl., Bot. Reg. Misc. 83 (1841). Hook.f., Fl. Brit. Ind. 5: 792 (1890). Kranzlin, in Engler A. (ed.), Pflanzenreich Hft. 50: 109 (1911); Seidenfaden in Opera Botanica 62: 123, fig. 73, pl. IXb (1982); 114: 190 (1992). [Fig. 3]

Epiphytic, 20–22 cm high. Pseudobulbs fusiform, compressed, sympodial, 4–6.5 cm × 1.5–2 cm, 4 or 5 nodes in pseudobulbs covered by leaf sheath. Leaf sheaths 3 or 4 in number, deltoid, entire, acute, abscission layer present. Leaves rolled around pseudobulbs, 8–15 cm × 2.5–3 cm, 5 or 6 in number, cauline, lanceolate, acute, subcoriaceous, attenuate, glabrous, entire, 9-veins. Scape 1–5.2 cm long. Inflorescence 4–8 cm long, lateral, raceme, lax. Bracts 4–6 mm × 2.5 mm, lanceolate, glabrous, translucent, acute, indumentum scattered along edge, lower bracts longer than pedicel including ovary, with 3-veins. Flower 5 × 2.5 mm across, 6 mm when flattened, creamy white with yellow patch at the tip of the lip. Dorsal sepal ca. 5 × 2.5 mm, ovate, obtuse, glabrous, entire, thick. Lateral sepals ca. 6 × 5 mm ovate, slightly oblique, acute, thick, with 3–5-veins. Mentum 5 mm long from the foot of the column to the tip, round, incurved. Petals 2.5–3 × 2 mm, ovate, membranaceous, obtuse, thin, glabrous, entire, 3-veins, white, edge thin. Labellum 4.5–5 mm × 5 mm, thick, trilobed with broad claw, short; terminal lobe thick, 2.5 mm × 2.5 mm, 5 mm wide between tip of lateral lobe when flattened down, triangular, apex sinus with outgrowth, entire, convex, with 3-veins; lateral lobes round or triangular, base spreading, narrow. Column 2 × 1 mm, reflexed, light brown; foot 3 mm long. Operculum light purple, ca. 1.5 mm. Pollinia 8, pyriform caudicle gelatinous membranaceous. Clinandrium collar like; rostellum ligulate. Visidium simple, ellipsoid. Stigmatic cavity oval shaped outside, entire, ca. 1.5 × 1 mm. Pedicel ca. 4–5 mm × 0.5 mm including ovary, pubescent.

Specimens examined: Nepal; Kaski, C. Nepal, Ghodepani, 1600 m, D. M. Bajracharya CN0121, 18 August 1997 (TUCH, KATH); Bakkri Kharka, Modi Khola 1700 m, Stainton, Sykes & Williams 6397, 17 July 1954 (BM); Puranchaur, Seti Khola 1100 m, Stainton, Sykes & Williams 6474, 24 July 1954 (BM). Assam: Khasia Gibson s. n. (K, type); Walter N. Koels

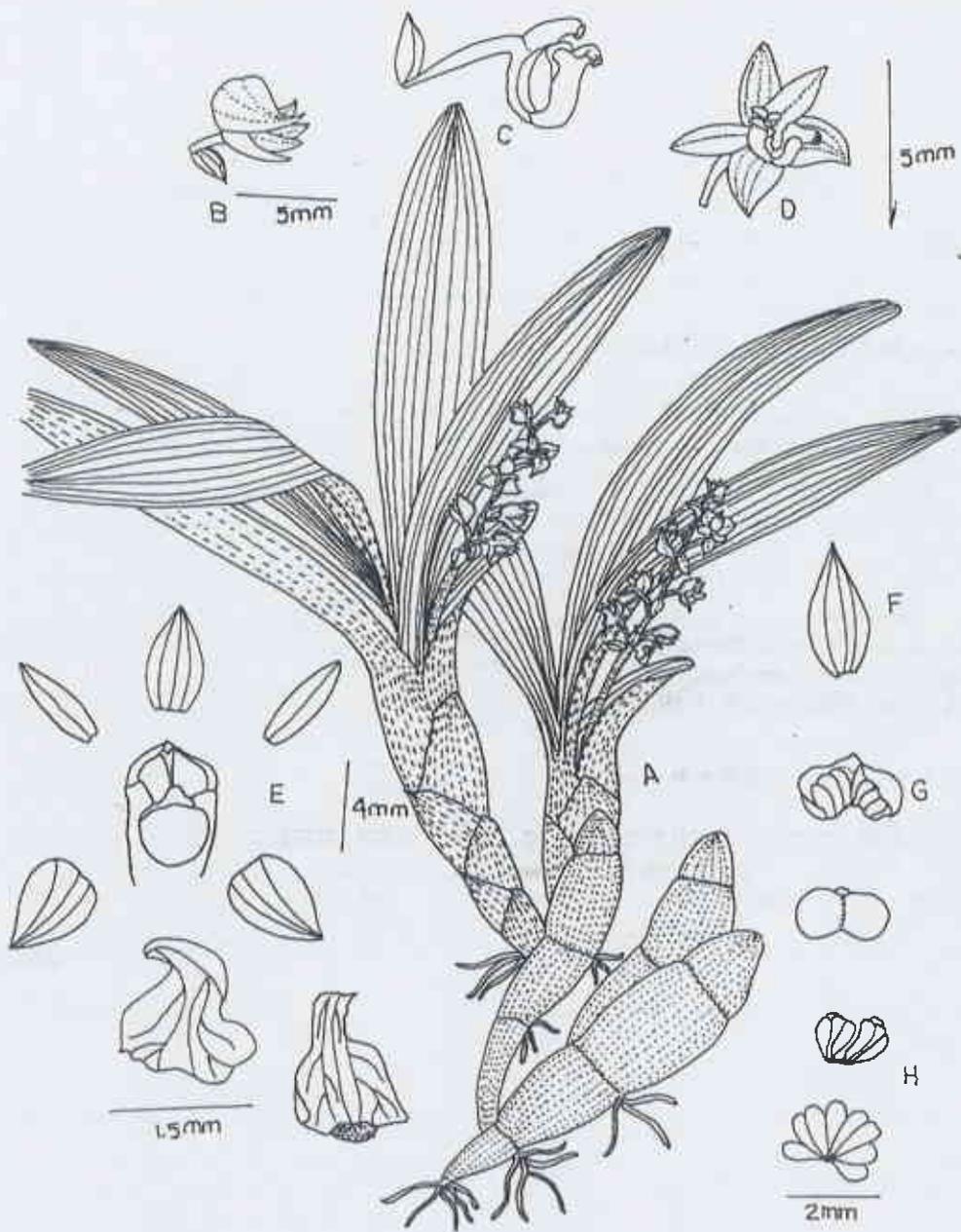


Fig. 3. *Eria bipunctata* Lindl. (D. M. Bajracharya CN0121). A: Habit. B: Bud. C: Lateral view of column and labellum. D: Single flower. E: Three sepals, two petals, labellum and column spreading. F: Bract. G: Operculum. H: Pollinia.

30544, 14 July 1952 (K).

Distribution: Himalaya (Nepal to Khasia), Thailand, Indo-China and Vietnam.

Flowering: July to September.

The author acknowledges the Darwin Initiative (UK) for support to visit herbaria in the UK (BM, K and E). Roy Vickery, Curator, the Natural History Museum (BM), Dr. Philip Cribb Curator and J. J. Wood, Orchid herbarium in Kew (K), are thankfully acknowledged for allowing me to study herbarium specimens in their care. I am also thankful to A. M. Singh Bania, Associate Professor, Department of Botany, Amrit Campus for providing laboratory facilities for the work.

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- Summerhayes V. S. 1929. *Eria apertiflora* sp. nov. Kew Bull. 1929: 9.
- D. M. バジラチャリヤ：ネパール新産オサラン属の2種について
オサラン属は西太平洋，アジア，アフリカに約370種が知られている。ロンドン自然史博物館，キュー植物園，エディンバラ植物園及びネパール国内の標本室のオサラン属の標本と野外調査によつて，ネパールには未記録の2種，*Eria apertiflora* Summerh. と *Eria bipunctata* Lindl. が産することが判ったので，詳細に記載して特徴を明らかにした。
(ネパール・トリブヴァン大学アムリト校)



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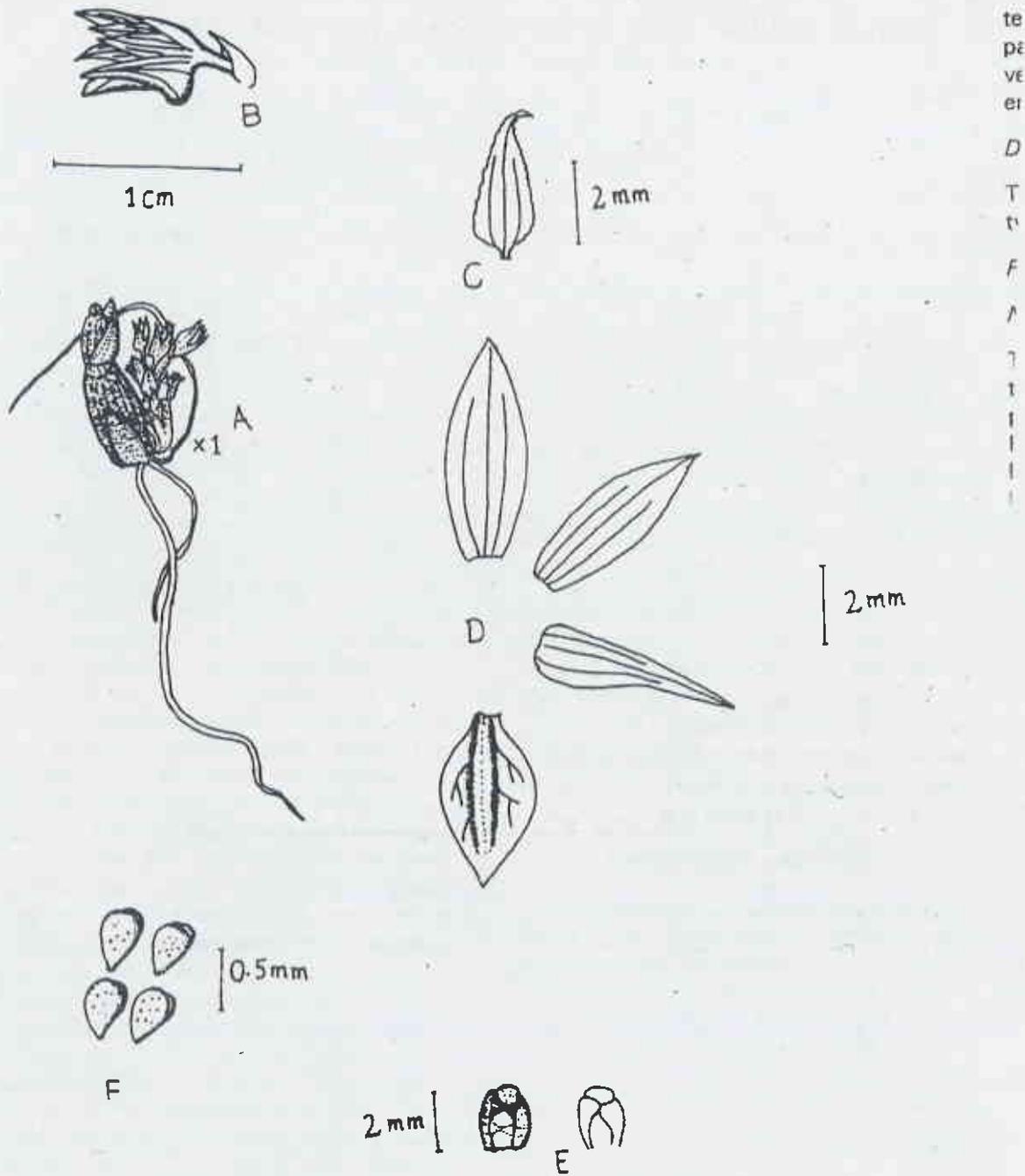


Fig. 1. *Eria baniaii* Bajracharya, Shakya et Chettri sp. nov : A, Habit of plant; B, Single flower; C, Bract; D, Sepal, petals, and labellum; E, Column; F, Pollinia.

ERIA BANIAII SP. NOV. (ORCHIDACEAE)-A NEW SPECIES FROM KATHMANDU VALLEY, NEPAL

Devendra M. Bajracharya, Lokesh R. Shakya, and Mukesh K. Chettri

Department of Botany, Amrit Campus, Tribhuvan University, Lainchour, Kathmandu, Nepal.

Abstract

Eria baniaii Bajracharya, Shakya et Chettri, a new species of epiphytic orchids from Kathmandu valley, Nepal is described and illustrated.

Introduction

The genus *Eria* Lindl. is one of the larger polymorphic genera of the family Orchidaceae. It comprise about 370 species (Pearce and Cribb, 2002) which have been divided into 13 - 17 groups according to the nature of the pseudobulbs and leaf characters (Seidenfaden, 1982, 1992; Seidenfaden and Wood, 1992).

During the revision of genus *Eria* Lindl. of the Himalayan region, a tiny species of *Eria* was collected from Godawari hill of Kathmandu valley. This species shows affinity with *Dendrobium* Sw. While examining the detailed morphological characters of the specimens, it was found to be a new *Eria* species (Fig. 1).

Species Description

Eria baniaii Bajracharya, Shakya et Chettri, sp. nov. (Fig. 1). *Eria obesa* Lindl. affinis set differt pseudobulbous parvulus cum siccitate vagina; cum vulgo florens post exutu foliis; erosus bractea; perianthium roseus, labellum simplex ovatus, acutus, tria roseus aequabilis calli inlabim pollinia octa cum glandulifii discoidous.

Typus

Nepal, Central Nepal, Kathmandu Valley, E. North facing slope Khani Gaon, Godavari,

1600 m., Bajracharya, Shakya, et Chettri CBS 150, 26 January 1993 (holotype, TUCH, isotype KATH)

Very small epiphytic herb, *Pseudobulbs* 3 x 0.5 cm with lower distinct and upper indistinct node gradually tapering towards the apex, many nerved membranous scales at nodes. *Leaves* (absent during flowering period). *Inflorescence* raceme, arising from the base of leafless pseudobulbs; 10 flowered, raceme as long as or slightly exceeds length of pseudobulbs. *Bracts* ovate-lanceolate, ca. 3 x 1.1 mm, acuminate, margin slightly erose. *Pedicele plus ovary* ca. 2-2.5 mm, glabrous and as long as bract. *Flowers* ca. 1-1.2 x 1.25 cm not well spreading, white with many pink veined. *Sepals* unequal; *dorsal sepal* oblong-lanceolate, ca. 6 mm long, lightly 3 nerved (pink) connate with column; *lateral sepals* oblong-lanceolate, ca. 5.5 mm long, falcate, acute, broad below, 2-nerved (pink), basally connate with other lateral sepals and column; *mentum* rounded. *Petals* oblong-lanceolate, ca. 5 mm long, obtuse, 3-nerved (pink), connate with column. *Labellum* entire, simple, ovate, ca. 4.5 x 3 mm, acute, more or less deltoid, disc with three pink calli, small nerve spreading from the calli, lower portion or labellum tapering and connate with column. *Column* short, ca. 2 mm long, flat with pink coloured margin, lateral margin folded forward, clinandrium

terminal, *Pollinia* 8, laterally flattened, in two pairs with glandular dotted, presence of very short caudicle, yellow. *Stigmatic cavity* entire.

Distribution

The species is so far known only from the type locality.

Flowering : April

Notes

This species is allied to *E. obesa* Lindl. due to presence of dry persistent sheaths on pseudobulbs and three light pink uniform keels on the labellum and it differs from latter in having small pseudobulbs, eroded bract (entire, simple, ovate, acute labellum and pink coloured sepals, petals and labellum. This species is also allied with *Dendrobium porphyrochilum* Lindl. in its vegetative characters like pseudobulbs, sepals, petals and labellum, and it is distinguished from *D. porphyrochilum* by the presence of 8 pollinia.

Etymology

The specific epithet of this orchid species is coined in honour of senior taxonomist and Associate Professor Mr. Amrit Man Singh

Bania, Head of Department of Botany, Amrit Campus for his valuable contribution in the field of Botany in Nepal.

Acknowledgements

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Eria nepalensis (Orchidaceae), a New Species from Nepal

Devendra M. BAJRACHARYA^a and Krishna K. SHRESTHA^b

^aAmrit Campus, Tribhuvan University, Lainchaur, Kathmandu, NEPAL;

^bCentral Department of Botany, Tribhuvan University, Kirtipur, Kathmandu, NEPAL

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A new species *Eria nepalensis* D.M.Bajracharya & K.K.Shrestha (Orchidaceae), belonging to the section *Dendrolirium*, is described and illustrated from Nepal.

Key words: *Eria*, Himalaya, new species, Orchidaceae, sect. *Dendrolirium*.

The genus *Eria* Lindl. is one of the largest genera of the family Orchidaceae, with an estimated 350 species worldwide, and divided into 13 to 17 groups according to the nature of pseudobulbs and leaves. During a revisionary study of *Eria* of the Himalayan region, we have collected a specimen from Royal Chitwan National Park, Sauraha, Chitwan, Central Nepal in 2000. We found that the specimen represents a new species closely allied to *E. latilabellis* Seid. and *E. lasiopetala* (Willd.) Ormerod, but distinct from them with several characters. The description of the new species is given below.

Eria nepalensis D.M.Bajracharya & K.K. Shrestha, sp. nov. [Fig. 1]

Affinis *Eria latilabellis* Seid. habitatio, sed bracteis oblongi-lanceolatis, naviculiformibus, extus viridibus, labello distincte trilobato diversa et affinis *E. lasiopetala* (Willd.) Ormerod, lobo medio labelli quadrangulati, emarginato vel bifido differt.

Type: NEPAL; Chitwan, Sauraha, Royal Chitwan National Park, alt. 200 m, 26 Feb. 2000, D. M. Bajracharya CN 260 (KATH-holotype; TUCH-isotype).

Epiphytic herbs, 15–17 cm high with dis-

tinct spreading rhizomes; pseudobulb ovate, laterally compressed, 4–5 cm long, 5–6 cm diameter, half of the pseudobulb covered by leaf sheaths; leaf sheaths membranaceous, reddish brown. Leaves 3, coriaceous, short petiolate, overlapping to the pseudobulbs, ovate-oblong, acute, narrow at base, 11–13 cm × 3.5–4.5 cm, 7–9-veined. From the base of the old pseudobulbs two shoots develop simultaneously, one sterile which will form next years pseudobulb, the other forming the 20 cm long stiffly erect inflorescence, scape covered by leaf sheaths at base, about 10 cm long, rachis cylindrical. Bract oblong-lanceolate, acute, glabrous, boat-shaped, 4 × 1.5 cm, green, coriaceous, longer than pedicel plus ovary. Pedicel plus ovary 2–2.5 (–3) cm long, covered by white tomentose hairs. Flowers yellow, 3–5 in number, opposite, decussate, lax in an inflorescence and tomentose. Sepals unequal, oblong-lanceolate, densely tomentose outside; dorsal sepal 1.7 × 0.5 cm, lanceolate, obtuse; lateral sepals 1 × 0.9 cm, falcate, oblong, acute. Petals 1 × 0.4 cm, parallel to column, obliquely lanceolate, obtuse, glabrous. Labellum distinctly tri-lobed, broadest, ca. 1.3 cm long, 0.6–0.7 cm broad at middle, terminal lobe rectangular, emarginate, bifid, recurved, cre-

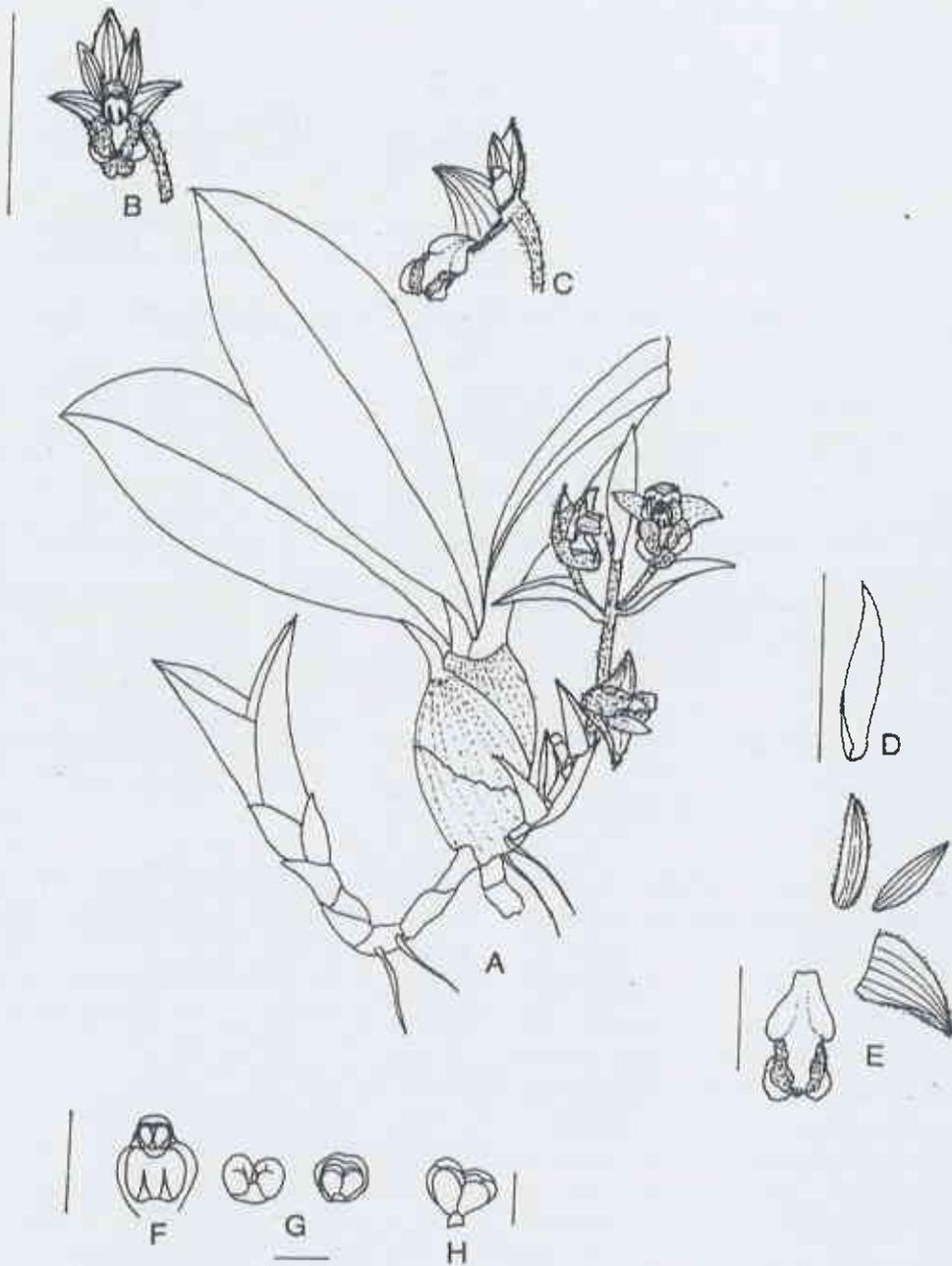


Fig. 1. *Eria nepalensis* D.M.Bajracharya & K.K.Shrestha. A: Habit. B: Opening of flower. C: Lateral view of flower. D: Bract. E: Spreading of dorsal sepal, lateral sepal, petal and labellum (from to bottom). F: Column. G: Operculum. H: Pollinia. Scales=4 cm for A-D; 1 cm for E; 4 mm for F; 1 mm for G-H.

Table 1. Comparison between *Eria nepalensis* and allied species in gross morphology

Characters	<i>E. latilabellis</i> Seid.	<i>E. lasiopetala</i> (Willd.) Ormerod	<i>E. nepalensis</i> sp. nov.
Pseudobulb	ovate, ca. 7 cm high	ovoid, compressed, fusiform-ellipsoid, 8–10 cm high	ovate, laterally compressed, ca. 4–5 cm high
Leaf	lanceolate, acute, 28 × 3.5 cm	oblong-lanceolate, acute, 7–16.5 × 2–5 cm	ovate-oblong, acute, 11–13 cm × 3.5–4.5 cm
Inflorescence	10–12-flowered, 12 cm long	6–9-flowered, 15 cm or above long	3–5-flowered, 10 cm long
Bract	narrow triangular, ca. 4 cm long, tomentose outside	lanceolate or oblong, 8–9 mm long	oblong-lanceolate, boat-shaped, 4 cm long, glabrous
Dorsal sepal	12 mm long	10–15 mm long	17 mm long
Labellum	side lobes not distinct	distinctly trilobed	distinctly trilobed
Terminal lobe	orbicular, slightly emarginate at apex, with triangular tip	oblong, acute	quadrangular, apex emarginate, or bifid, crenate
Lateral lobe	absent	short, truncate, erect	small, acute, erect
Stigmatic cavity	not known	entire, two flops at base of cavity	broad, two appendages inside cavity

nate, apiculate, epichile thickened at apex with a triangular callus and two kidney-shaped callus on both sides of epichile extending from base to junction of lateral lobe to terminal lobe, no other ornamentation on the disc; lateral lobes small, acute, erect, puberulous. Column ca. 0.4 cm, erect, glabrous, foot ca. 1 cm long; clinandrium collar-like. Operculum two loculate, globose; pollinia 8, laterally flattened, obovoid, attached with glandular caudicle. Rostellum simple, ligulate, bent towards stigmatic cavity. Viscidium ellipsoid; stigmatic cavity ca. 2 mm broad, two appendages present inside cavity.

Distribution: Nepal (known only from the type locality).

Flowering: August.

Eria nepalensis is related to *E. latilabellis*

Seid. and *E. lasiopetala* (Willd.) Ormerod, but it can be easily distinguished by the characters of pseudobulbs, inflorescence, and lobellum. The differences in these characters among the three species are shown in Table 1.

We are grateful to the Institute of Science and Technology (IOST) of Tribhuvan University for providing the financial support to carry out this work. We appreciate former head of Department and Associate Professor A. M. Singh Bania, Department of Botany, Amrit Campus, for providing laboratory facilities.

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D. M. バジラチャリヤ^a, K. K. シュレスタ^b:
 ネパール産の1新種, *Eria nepalensis* (ラン科)

ネパールから *Eria nepalensis* D.M.Bajracharya & K.K.Shrestha (ラン科) を記載した。 *E. nepalensis* は *E. latilabellis* Seid. からは、苞が楕円状披針形かつ船形で、外側が緑色で無毛であり、唇弁が明瞭に三裂することで区別される。また、 *E. lasiopetala*

(Willd.) Ormerod からは、唇弁の中央裂片が四角状で、先端が凹むか浅く二裂し、鋸歯があることで区別される。

^aネパール・トリブバン大学アムリト校、
^bネパール・トリブバン大学植物学部

ERIA BHUTANICA (ORCHIDACEAE), A NEW SPECIES FROM BHUTAN

DEVENDRA M. BAJRACHARYA¹ AND KRISHNA K. SHRESTHA²

Abstract. *Eria bhutanica*, a new species from Bhutan, is described and illustrated.

Keywords: Bhutan, *Eria*, Himalaya, new taxa, Orchidaceae.

The genus *Eria* Lindl. is one of the largest genera of Orchidaceae, with an estimated 500 species (Bechtel, Cribb and Launert, 1981). During a review study of *Eria* of the Himalayan region, and after a revision of the pertinent literature (Lindley, 1830–1840; Hooker, 1890; Kraenzlin, 1911; Tuyama, 1966; Seidenfaden,

1982), we examined an unidentified herbarium specimen at the Natural History Museum that was noticeably different from *Eria excavata* Lindl. and related species (Table 1). Here we describe it and illustrate it as a new species for the Himalayan region.

TABLE 1. Gross morphological differences between *Eria excavata* Lindl. and *E. bhutanica* D. M. Bajracharya & K. K. Shrestha.

Characters	<i>E. excavata</i>	<i>E. bhutanica</i>
Habit	to 15–17 cm	15–20 cm
Pseudobulbs	oblong, compressed	cylindrical
Leaves	elliptic-lanceolate	oblong-lanceolate
Scape	4–5 cm long	3–4 cm long
Inflorescence	4–7 flowered, 9–10 cm long, longer than leaf	5–7 flowered, 6–7 cm long, as long as leaf.
Bracts	6–6.5 × 1 mm, shorter than pedicel plus ovary	7 × 2 mm longer than pedicel plus ovary
Dorsal sepal	elliptic-lanceolate, acute	oblong-obtuse
Petals	elliptic-lanceolate	ovate
Labellum		
Length	5 mm long	5 mm long
lateral lobe	1.5 mm long, ovate	2 mm, ovate
Mesochile	3 mm thick	5.5 mm, thick
Terminal lobe	cuneiform, bilobulate, emarginate	rhomboid, bilobulate, emarginate
Column	excavate	not excavate
Stigmatic cavity	entire	entire
Pedicellate ovary	>1 cm long, white pubescent	<1 cm long, gray pubescent

The authors are grateful to the Darwin Initiative (UK) for supporting their visits to various herbaria in the UK (BM, K. E.) and to Roy Vickery, Curator, The Natural History Museum (BM) for his assistance in the herbarium.

¹ Amrit Campus, Lainchaur, Tribhuvan University, Kirtipur, Kathmandu, Nepal.

² Central Department of Botany, Tribhuvan University, Kirtipur, Kathmandu, Nepal.

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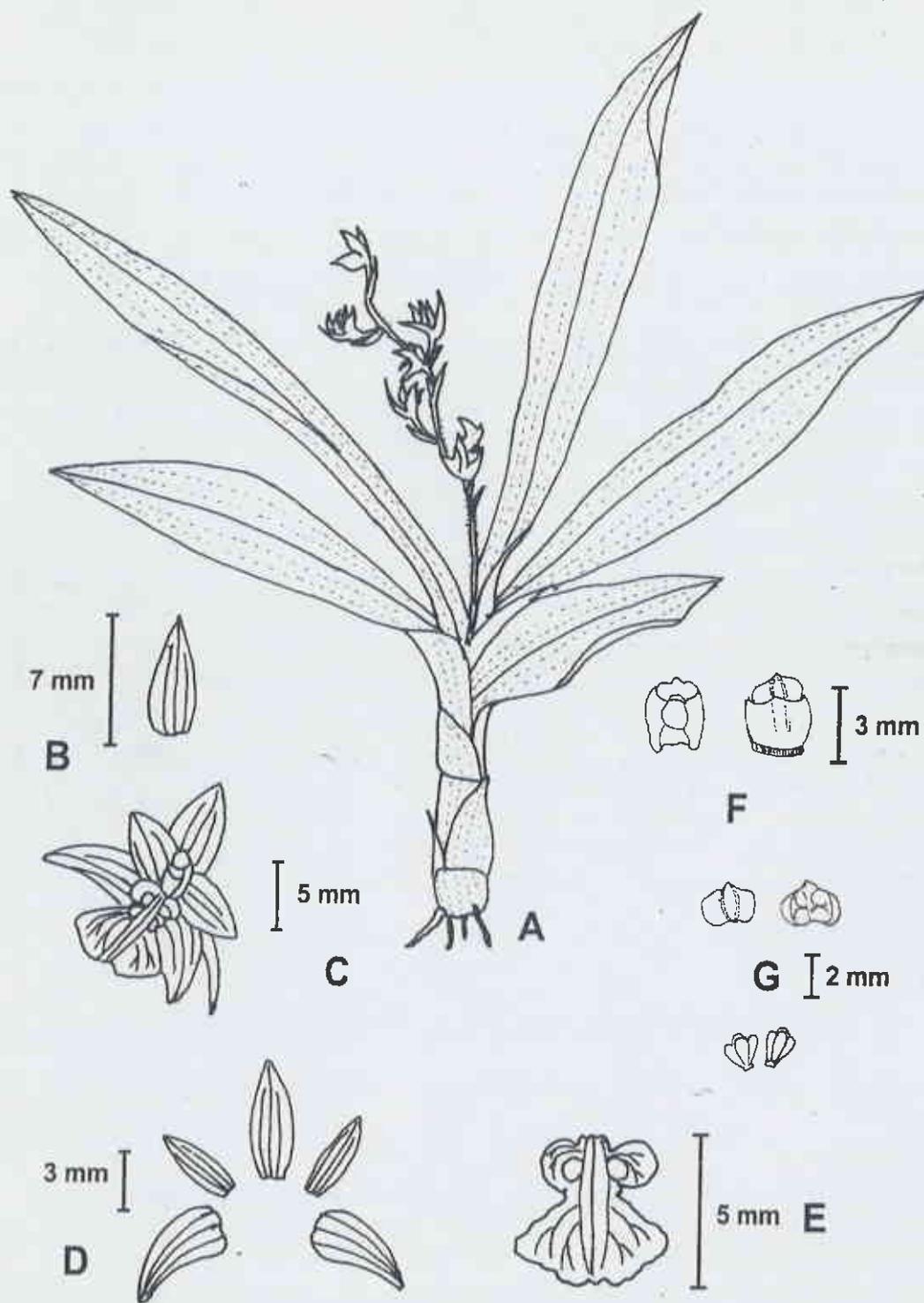


FIGURE 1. *Eria bhutanica* D. M. Bajracharya & K. K. Shrestha *sp. nov.* A, habit; B, floral bract; C, flower (spread); D, sepals and petals; E, labellum; F, column; G, anther and pollinia. Based on the holotype.

Eria bhutanica D. M. Bajracharya & K. K. Shrestha *sp. nov.* TYPE: BHUTAN. Retang-Tangchu, 7000 ft. [ca. 2100 m], 9 June 1969, S. Bowes Lyon 15000 (Holotype: BM).

Eria excavata Lindl. *valde affinis Eria bhutanica* *labelli, trilobii obrullati, lobo medio rhomboid, crunetii, tridentii et obtusibus, sinu minoribus, lobo lateralibus ovalii, tingens rubellus purpureus, et bicircular ridgeii inter latus lobii.*

Epiphytic herbs, ca. 15–20 cm tall. **Roots** from base of pseudobulb. **Pseudobulbs** 3–4 cm long, crowded on creeping root stock. ovoid, tapering apically, marked with vertical lines, clavate, sub-cylindrical, nodes of pseudobulbs 2, one node on erect portion. Leaf sheath per pseudobulb 2 or 3, ca. 20 × 5 mm, auriculate, thin, acute. **Leaves** 5, lanceolate, acute, folded, 8–15 × 1.3–1.5 cm, thin, glabrous, entire, 9-veined. **Scape** 3–4 cm long, pubescent. **Inflorescence** a raceme, terminal, 5–7 flowered, only one inflorescence emerging from pseudobulb, as long as leaf. **Bracts** ovate-lanceolate, acute, ca. 7 × 2 mm, white pubescent, yellowish. **Pedicel plus ovary** gray pubescent, ca. 9–10 mm long. **Flower** creamy white, pale yellow inside ca. 13 × 5 mm. **Dorsal sepal** oblong-elliptic, acute, ca. 6 × 3 mm, thin, entire, pubescent, 3-veined. **Lateral sepals** obliquely

oblong, acute, ca. 8 × 3 mm, pubescent, 3-veined, mentum absent. **Petals** ovate, acute, thin, glabrous, ca. 6 × 2 mm, white, 3-veined. **Labellum** obrullate, 3-lobed, ca. 5 × 3 mm, terminal lobe rhomboid, broad, crenate, tridentate, ca. 5.5 mm long, sinus shorter, obtuse; lateral lobes oval, ca. 2–2.5 × 2 mm, deflexed, tinged reddish purple, disc with two circular ridges between side lobes, base of lip round. **Column** ca. 3 × 1.5 mm, glabrous, curved, foot ca. 1.5 mm. **Clinandrium** collar like. **Anther** ca. 2 × 1 mm, purple red, bilobed, each lobe 4-chambered. **Pollinia** 8, broadly obovoid, caudicle waxy, viscidium simple, ellipsoid. **Rostellum** ligulate, bent. **Stigmatic cavity** ca. 1.5 × 1 mm, entire.

Distribution: Bhutan.

Flowering: June.

Etymology: Named after the country of origin, Bhutan, where the type specimen was collected.

Eria bhutanica is closely related to *E. excavata* Lindl. from which it can be easily distinguished by its obrullate, tri-lobed labellum with a broad, rhomboid, tridentate, cuneate terminal lobe and a short, obtuse sinus, the deflexed, reddish purple, ovate lateral lobes and the two circular ridges between the side lobes.

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Biogeography of the Genus *Eria* Lindley in the Himalaya Region

D. M. Bajracharya¹ & K. K. Shrestha²

¹ Botany Department, Amirt Campus, ² Central Department of Botany,
Tribhuvan University, Kirtipur

Abstract

In the floristic analysis, there are 43 species distributed in the Himalaya from west to east or vice versa of the present data relation to literature, field survey and herbarium specimens of the regions. The data suggested that the genus *Eria* is mostly distributed in the North-East Himalaya than other part of the Himalayan region. It is endowed with luxuriant and different type of vegetation, due to its conducive climatic and adophic factor s with sufficient rainfall.

Introduction

Bio-geographical analyses dealing with members of Orchidaceae are comparatively rare, probably because evolutionary interpretation must always be more speculative in the family, compare devoid of an informative fossil record, than in families, which such as a record is at hand. As it appears, apriority assumptions are always necessary when interpreting orchid distribution patterns. Fortunately, a priori assumptions can be qualified; *i.e.* if they are based on the observations on the distribution related families or floras in which an informative fossil record exists. I venture to carry out a simple bio-geographic analysis of *Eria* in the Himalayan region.

The varied forest types of Himalaya ranges are endowed with enormous floristic diversity. Out of 8000 species of Himalaya plants, 750 taxa of Orchidaceae are represented in the Himalaya. Over 600 taxa of Orchidaceae are dominates the Eastern Himalaya. The genus *Eria* Lindl. is one of the larger aggregations of orchids into one genus in Orchidaceae It has estimate about 400-500 species in the world, (Summerhayes & Hunt 1973; Bechtel, Cribb & Launert 1981) but 350 species seems to be a more reasonable figure. It is divided into thirteen-seventeen groups according to nature of pseudobulbs and leaf character among them 50 species of *Eria* is distributed in the Himalaya range. 32 species of *Eria* recorded from the North East frontier Area and Arunachal predesh of North-eastern Himalaya.

The genus has not revised over its entire area of distribution. Seidenfedan (1982) touched the general distribution pattern of *Eria*, who characterized the total range of the

genus as from Tropical Asia to Indo-pacific. It is spread across tropical Asia, from Himalaya, China, The Philippines, Indonesia, Papua New Guinea, and Pacific Island to Fuji. The genus is recorded from hot humid coastal rainforest to the snow line of the Himalaya.

Bio-geographic region:

The Himalaya lies on the bordering region of Boreal and Paleotropical floral region of the World (Good 1974). The mountain chains are lying across the path of monsoon wind. The Himalaya covered the about 8000-Km from west to east. The Himalaya Mountains enforces powerful isolation in the band-like migration from east to west or vice versa on the other. It lies from Tsango river basin to east 92° east longitude by warm and humid climate in the east and Nuristan Valley of river Kabul, Kurram, Kunar, Swat, Gilgit, Waziritan and southern slope and offsprurs of western Himalayan westwards approximately from 80° east longitude, which is at the average of 1000m above sea level. It is contrast to the other province, which is characterized by monsoon climate, which impact a definite character to its plants.

Recognizing the heterogeneous dispersion of the bio-diversity elements in the Himalaya, it is imperative to introduce the subject matter in bio-geographic context, based on geology, altitude, vegetation and spatial pattern of distribution the Himalaya is classified variously. Wadia (1975) categorized it in three broad regions: northern or Tibetan region, Central or Himalaya region and outer or sub-Himalaya region. Bordit (1961) and Mani (1990) also proposed a similar transition along horizontal gradient but with slightly differences in the length of various chains. Wadia also classified the Himalaya based on the altitude into Great Himalaya average 6,100; Lesser Himalaya 3,600-4000m; and outer Himalaya between 800-1,000m.

Biogeographically, the Himalaya is a complex region of the world. A sharp and distinct contrast characterized the eastern and western limit with blend of their element in the centre of the region. The region was influenced by different floristic elements such as Irano-Turanian, Euro-Siberian, Sahoo-Sindhian, Mediterranean Sino-Japanese, and Indo-Malayan.

Rodgers (1985) divided the Himalaya into five biotic provinces under two biogeographical regions: boreal and Indo-Malayan. He also proposed that Himalaya fall in the boreal region. Himalayas could be divided into two biogeographical regions, which have Sino-Siberian and Sino-Himalayan. The western and eastern flanks of the Himalaya are different.

The difference between the two flanks is about result of several factors. The western range lies at 36° north latitude and the area with low rainfall. These ranges descend as low as 2,135m in Kashmir. This affects the tree line vegetation, which is at an altitude of 3600m. On the other hand, eastern range lies at 27° north and is among the wettest region in the world. This area receives the full thrust of monsoon winds from Bay of Bengal, which are trapped in the Arunachal pradesh, in the corner where the Himalayan ranges bend southwards. The monsoon is intense here leading to erosion of much of Siwaliks in the east from Koshi to

Manas in Bhutan. Eastern range descends to 3,960 m the Kanchanjunga area. The tree line is higher 4,579 m in the eastern Himalaya.

The western Himalayan range is much wider and cooler with drier climate. In contrast the eastern range is among the wettest regions of the World with great bio-diversity. The western range have a vegetation of which is cool loving and drought resistant climatic dominated by conifers, legumes, grasses and Composite, where as in the eastern range harbour a wet humid sub-tropical vegetation rich in Magnolias, oaks, laurels, Rhododendron and large number of epiphytic orchids and ferns.

Material and Methods:

The biogeography and distribution pattern of the *Eria* species in the Himalaya is done by the observing the herbaria deposited in the different Herbaria such as Kew herbaria Kew (K), The Natural History Museum, London (BM), Edinburgh Herbaria Edinburgh (E), National Herbaria Kathmandu (KATH) Central National Herbarium (CAL) and Tribhuvan University central Herbaria (TUCH) and living collection were studied to understand the status and distribution base on the morph-geographical characters.

Vegetation

There have been many attempts to classification of the vegetation types Schweinfurth (1957) had made an excellent analysis of the flora of the Himalaya particularly regarding the horizontal and vertical distribution of the vegetation in the mountain system. However Champion and Seth (1968), Singh & Singh (1987) have also written about the forest vegetation of the Himalaya have made comprehensive and more popular attempt. Stainton (1972), Dobremez (1972) also described the vegetation type of Nepal Himalaya. It is the crossroad of Asiatic vegetation and meeting place of eastern and western Himalaya, vegetation.

An account of the bio-geographic condition and distribution of vegetation the whole Himalaya is divided in different segments as given below.

North-west Himalaya

The area covers Kashmir, Himachal Pradesh and parts of Utter Pradesh. Here, the East European and Mediterranean influence is discernible in conifers etc.

Western Himalaya

The range started from the Sutlej to the Gandaki in Nepal. There is a mixture of western and eastern elements, e.g. *Cederous deodara*, *Rhododendron sp.*

Central Himalaya

This area covers the entire country of Nepal, Sikkim into the hills of western Bengal in India and Bhutan. This is relatively moist area and there is some rhododendron.

Eastern Himalaya

This covers Central Bhutan and the whole of Arunchal Pradesh. Here warm-moist condition prevails. The tree line is high. There is considerable diversity in rhododendron

The following classification has been chosen as the most convenient starting point for bio-geographical analysis of *Eria* in Himalaya region on the basis of political boundaries.

North-west Himalaya: It starts from the border between Afghanistan to Garhwal - Kumanon.

Nepal Himalaya: It covers the western border Mahakali River in the west board to Machi River in the east of Nepal Himalaya.

Sikkim Himalaya: It lays the eastern part of west Bengal, and to western boarder between Sikkim and Bhutan Himalaya.

Bhutan Himalaya: It lies between the western boarder in of Sikkim Himalaya and Eastern boarder of North Eastern Himalaya.

North-Eastern Himalaya: it covers the Eastern parts of India included Arunchal Predesh and up to the border of Burma.

Largest concentration of Himalayan *Eria* species is however in Eastern Himalaya, i.e. Sikkim Himalaya, Arunchal predesh and Assam, Khasia; hills are the main centre point for Himalayan *Eria*. The Himalayan *Eria* is decrease slowly towards west, Nepal Himalaya, Bhutan Himalaya, and North-West Himalayan region beyond west there are no records of *Eria* from the Himalayan region. (Map Chart -1)

Basic concept and terminology:

The following classification has been chosen as the most convenient starting point for bio-geographical analysis of the genus *Eria*.

Endemic: Species restricted to the Himalaya.

Local endemic: species restricted to a single mountain range or to part of the Himalaya mountain range.

Himalaya endemic: species restricted to two or more near by Himalaya mountain range and only occurring in one or two of the main Himalaya.

Non-endemic: Species not restricted to the Himalaya region

Himalaya species: Species restricted to the Himalaya region but exhibiting more disjunction and / or wide distribution to the other region.

Admittedly, the name of the above categories do present a few shortcoming; for instance some "local endemic" have wider range than some "Himalaya endemic" but, after all these exceptions are few and the chronological concepts covered by the names are more important than the names themselves.

Result and Discussion

When the above results are compared, it is characteristics that the species *Eria amica*, *E. coronaria*, *E. pubescens*, *E. muscicola* and *E. spicata* are represent at least one of the area in the Himalaya, which defined by overlapping of the species. It is also characteristic that 5 of the 7 endemic species are lies to Eastern Himalayan region (Arunchal predesh). The Himalayan endemic are located within the boundaries of Himalayan region, which is defined by overlapping distribution in the small unit of Himalayan endemic species. It is also turns out that these areas of Himalayan species can be considered more generally as "Diversity area" and this lead directly to the overlapping distribution pattern of *Eria* in the Himalaya region.

Diversity Area Correlation:

In general, diversity of the area can be calculated very difficult to determine the actual correlation between species and the species. But just analyzed the distribution pattern of *Eria* in the Himalayan region following pattern of distribution is fine, which shows that Himalayan region as whole either divided into three or more segments.

Table: 1 a. Status of the genus *Eria* Lindl. in the Himalaya

Region Status	Western	Central	Eastern	Total
Local Endemic	1	0	4	5
Himalaya endemic	2	2	3	4
Himalayan species	6+1	15+3	26+5	27+7

Table: 1 b. Status of the genus *Eria* Lindl. in the Himalaya

Region Status	NW. Himal.	Nepal Himal.	Sikkim Himal.	Bhutan Himal.	Assam Area.	NE. Himal.	Total
Local endemic	1	0	1	0	1	4	7
Himal. Endemic	2	2	3	4	-	3	4
Himal. Sp.	6+1	18+1	20	20+1	27+2	25	26+5

Western Himalaya Diversity Area (WDA):

The western parts of the Himalaya covers constitute as western Diversity are which is separate from other diversity area of the Himalayan region. It is accumulate 10 species of *Eria* in this region. The table 1 A, B shows the same value of distribution such as this area accumulate 0.23% of local endemic 0.46% per cent Himalaya endemic, 1.62% Himalaya species. Most of this area is dry and cool. So that the number of species become decrease, besides that *Eria braccata* is distribution disjunction manner i.e., this plant is mostly distributed in the Southern India and Ceylon only but it appear in the Himalaya region which is one of the interest feature in the genus. There is less number of species is overlap in this area in climatic region than other diversity area. It shows that western Himalaya is less diverse than other Himalaya.

Central Himalaya Diversity Area (CDA):

Central diversity area accumulates 20 species of *Eria*. There is no local endemic plants, 0.93% of Himalaya endemic, 8.37% of Himalaya species are distributed in this area. Almost all the species are overlapping in this area so that number of species became increase than other. But if considered the central Himalaya is divided into small segments which shows the variation in the number of species such as 0.97% percent of Himalaya endemic, 9.27% Himalaya species are distributed in Nepal Himalaya. In Sikkim the number of species became increased due to the suitable condition of humid and moist condition of forest floor. Such as 0.55% of local endemic, 1.67% Himalaya endemic, 11.16 %Himalaya species. It also shows that the number of species decrease in Nepal Himalaya due to barrier of Singalila mountain acts as the main barrier between Nepal and Sikkim Himalaya for migration of the flora from east to west.

Eastern Himalaya diversity Area (EDA):

Eastern Himalaya diversity area accumulate 38 species of *Eria*, among them 3.53% of local endemic, 2.65% Himalaya endemic, 27.4 % percent Himalaya species are distributed in this area.

If we analyses distribution of genus *Eria* in the separate Himalaya it shows that 0.55% and 2.97% local endemic distributed in Sikkim and North East Himalaya, where s 1.63%, 1.67% and 2.23% of Himalaya endemic distributed in Sikkim, Bhutan and North east Himalaya. 10.6%, 11.2% and 18.6% of Himalayan species are distributed in Sikkim, Bhutan and Northeast Himalaya.

If it will be considered in the basic concept of classification of the Himalayan region, it shows that actual distribution of genus *Eria* in the Himalayan region.

North-West Himalaya Region:

The western parts of the Himalaya covers constitute as western Diversity area which is separate from other diversity area of the Himalaya. It is accumulate 10 species of *Eria* in this region. As this area accumulate 0.23% of local endemic 0.46% per cent Himalaya endemic, 1.62% Himalaya species.

Nepal Himalaya Region:

It lies in the central part of the Himalaya and covers as the constitute as Central Diversity area. Here is the mixing of both floristic components of Western and Eastern Himalaya. There are 20 species of genus *Eria* in this region among them there is no local endemic, 0.97% of Himalaya endemic, 9.27% of Himalaya species are distributed.

Sikkim Himalaya Region:

It lies in the eastern part of the Himalaya and covers it as constitute of Eastern Diversity area, which is separate from other diversity area of Western and Central Himalaya. There are 23 species of *Eria* among them 0.55 % of local endemic, 1.67 % of Himalaya endemic, 11.16% of Himalaya species are distributed.

Bhutan Himalaya Region:

It also lies in the eastern part of Eastern parts of the Himalaya, which is small area among the other area of Eastern Diversity area and less explore area in the Eastern Himalaya, so that the number of species is less than other area. There are only 23 species are recorded among the local endemic is absent, 2.13% of Himalaya endemic, 10.6 % Himalaya species are distributed.

Assam Area Region:

It also lies in the of Eastern parts of the Himalaya, which is covers un explored area and well preserved among the other area of Eastern Diversity area and less explore area in the Eastern Himalaya, but the number of species are high than western region of the Himalaya. There are only 30 species are recorded among the 0.7% of local endemic, no Himalaya endemic, 20.2 % Himalaya species are distributed.

North-East Himalaya Region:

It also lies is extremely east to the eastern Himalaya, which is covers un explored area and well preserved among the other area of Eastern Diversity area and less explore area in the Eastern Himalaya, but the number of species are high than western region of the Himalaya. There are only 32 species are recorded among the 2.90 % of local endemic, 2.18% of Himalaya endemic, 18.8 % Himalaya species and 6.97% of non-Himalaya endemic are distributed.

Species correlation:

In above observation, the distribution of genus *Eria* in the Himalayan are mostly concentrate in the North-east Himalaya due to humid and moist warm climatic condition than North-west Himalaya. Mountain area of Himalaya region is suitable habitat for Orchid flora. Orchid population is highly influence by typical monsoon climate, topographic variation and the direction of the mountain slope facing. Monsoon rainfall is greatly influence for luxuriant growth of the vegetation and provided shelter for all the orchids in the forest floor and with screening from the canopy.

Phyto-geographically, the forest vegetation of Bhutan, Sikkim and some parts of East Nepal also form an integrate part of the biome of Northeast Himalaya elements. This region forms the junction of migratory elements from the neighboring countries like Malaya, Thailand, Burma, China and Tibet.

Interesting Distribution pattern of the genus *Eria*

In the above distribution pattern of *Eria coronaria*, *E. graminifolia* 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 onward to Indo- pacific and Java etc., Some of the species like *E. bractescens*, *E. biflora* has covered the wide range of distribution from Nepal Himalaya to Australia. *E. occidentalis* is mainly concentrated in the western Himalaya, where as *E. arunchalensis*, *E. jengingensis*, *E. lohitensis* and *E. sharmae* are distributed only in the North-eastern Himalaya. Some of the species such as *E. clavicaulis*, *E. globulifera*, *E. lacei*, and *E. pudica* are distributed from North-east Himalaya to east ward. *E. alba*, *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 disjunction manner i.e. it is reported from South India only.

In the analysis shows that *Eria* species are mostly concentrated in the North-east Himalaya. Among the 25 Himalayan species 20 species are distributed in this area. Non-Himalayan species are more concentrated in Central Himalaya or Nepal Himalaya and slowly decrease in Sikkim and North-east Himalaya. It shows that species diversity.

From the critical study based on the field observation and available literatures has yielded the following data analysis of the species distributed in the various regions.

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 into upper tropical region	8 species
Extending from lower tropical - lower sub-tropical region	5 species
Extending from lower tropical - upper tropical region	8 species
Extending from upper tropical - lower sub- tropical region	5 species
Extending from upper tropical- upper sub- tropical region	2 species
Extending from lower sub-tropical - upper sub tropical region	17 species
Extending from lower -sub tropical into lower Temperate Region	2 species
Extending from lower sub-tropical into lower Temperate Region	14 species

Among them one species at 500m, three at 1000m, five at 1500m two in 2000m and one at 2500m distributed from North-west to North East Himalaya.

From the data, it seem that the maximum number of species is concentrated in lower sub-tropical region and temperate region, where as in the lower tropical and Coll. Temperate region the species are restricted to the minimum. It is very interesting to note that maximum numbers of species are overlap in the lower sub-tropical and upper sub-tropical or sub-tropical rather than in the tropical and Temperate Region.

The majority of wide spread *Eria* species in the Himalaya has been much more frequently collected at sub-tropical than lower and high altitude, thus it indicate a fairly good coverage of field work at sub-tropical or (1000-2000m). In the climatic condition of Himalaya also shows that north-east Himalaya is the centre area for *Eria* which are dominant in the number of species due to moist and humid climatic condition of the climate. It has been clearly pointed out that the eastern Himalaya including N.E. India forms the richest plant diversity centre in the Himalaya.

Taxonomic correlation:

The distribution of the section of the genus *Eria* in the Himalaya can be characterized and applying the three diversity area that were defined by overlapping distribution pattern of all Himalayan species of *Eria*.

The section *Hymeneria* is much diverse in EDA than other two areas. The section *Hymeneria* is mainly distributed in EDA, but also sparsely represented in CDA, and WDA. The three species *Eria alba*, *E. excavata*, and *E. ferrugenea* are distributed in the Himalaya region. Besides that remaining species are distributed outside the Himalaya or outside to the Himalaya such as *Eria discolor*, *E. javanica* and most of the Conchidium species as *Eria lacei*, *E. extensoria*, and *E. pusilla* are migrated from east to west because these species are Indo-Malayan species.

More than 75 percent of local endemic are concentrated on EDA in the Himalaya due to climatic condition. It is remarkable that most of the endemic species are lies in the section *Hymeneria*. This section *Hymeneria* and *Conchidium* are represented equally in all diversity area than other section. None of the section exhibit a large numbers of species in WDA, than CDA an EDA.

It can be concluded that the concept of EDA is more diverse area than other two. The CDA and WDA can be equivocally recognized at the specific and section levels are less diverse areas. So EDA contrite as area of Himalaya diversity centre at the sectional and intraspecies levels.

Table: 2 Distribution of section of *Eria* in Himalaya

Section	EDA	CDA	WDA	Total range
Eria	1	1	-	H
Conchidium	4	3	2	H,
Xiphosium	1	1	-	H
Trichosma	4	3	1	H
Strongyleria	1	1	-	H
Dendrolirium	4	3	1	H
Mycaranthus	1	1	-	H
Tylostylis	1	1	-	H
Cylindrolobus	6	1	-	H
Secundae	1	1	-	H
Bambusifolia	2	1	-	H
Hymeneria	10	6	4	E,H,
Pinalia	6	4	1	E,H,

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***Eria pokharensis* (Orchidaceae): A new species from the Nepal Himalaya**

Devendra M. Bajracharya¹, A. Subedi² & Krishna K. Shrestha²

¹Amrit Campus, Tribhuvan University, Lainchour; ²Central Department of Botany
Tribhuvan University, Kirtipur, Kathmandu, NEPAL.

Abstract:

Eria pokharensis D. M. Bajracharya, A. Subedi et K.K. Shrestha a new species from Nepal Himalaya is described and illustrated.

The genus *Eria* Lindl. is one of the largest genera of Orchidaceae, with an estimated 350 species worldwide, however, which can be divided into 13 to 17 groups according to the nature of the pseudobulb and leaf characters, seems to be a more reasonable figure.

During revision study of *Eria* Lindl. of the Himalayan region, We have collected specimens from Pokhara, Lumle, Gandaki Zone, by D. M. Bajracharya, and A. Subedi CN220 and CN350 in Nepal. On closely examined, these species are found closely allied to *Eria excavata*, but differ from *E. excavata* in several morphological characters (Table: 1). Hence we described and illustrated it as a new species to the Nepal Himalaya.

Eria pokharensis. D. M. Bajracharya, A. Subedi et K. K. Shrestha, *sp. nov.*

Eria pokharensis D. M. Bajracharya, A. Subedi et K. K. Shrestha *sp. nov.* quamis *E. excavata* sit simillima labelli quadragularis oblonga trilobii quum complanatus ca. 6mm, lebellum sine junctus super columie esursum minor, concavus, mid lobii crassus et planus quadragularis, circa longiores quam latus basi, trilobulii acutis erectuo curvus lobo lateralii orbiculii, erecto ciliatus flavidus cum roseus apexi, bicallii inter lateral lobii et convolutus

Type: Nepal: Lumle, Pokhara, Gadaki zone, D. M. Bajracharya, A. Subedi. CN220 (TYPUS); CN350, 14 April 2000. (**Holotype** : KATH !, **Isotype**: TUCH!).

Epiphytic orchid about high 7-12 cm. Root arises at the base of the pseudobulbs. Pseudobulbs clavate and club shaped, 3-4 cm x 2 cm long, covered by the leaf sheath in chain, wrinkle in the old pseudobulbs. Leaf sheath 4-5 in number, ca. 1-1.5 cm long, totally covered the pseudobulbs during young, membranous, green in young, and brown at old, deltoids, acute, thin, edge membranous, 8 veins. Leaves 4-5 in number, at the tip of the pseudobulbs, 4-6 x 0.9-10 cm, and oblong-lanceolate, acute, entire, thin, glabrous, folded leaves with 7 veins. Scape ca. 1-1.5 (-2) cm long, slightly pubescent. Inflorescence 2-3 cm, raceme, lax, terminal, arise from the middle of the leaf, 5-6 flowered. Bracts ca. 8-9 x 2 mm, triangular, acuminate, scattered hairs on the edge with 3-veins, shorter than pedicel plus ovary, in the dorsal surface finely pubescent. Pedicel plus ovary ca. 10-15 x 2 mm, erect, pubescent. Flower ca. 1-1.2 cm across, yellowish white, curved, rust pubescent at the base. Sepals obliquely oblong-ovate, pubescent, dorsal sepal: ca. 4-6 x 2-3 mm, yellowish white, ovate, obtuse, with 3-veins; lateral sepals ca. 6-7 x 3 mm, obliquely oblong, falcate, obtuse,

with 4-veins; mentum absent. Petals ca. 6-6.5 x 1.5-2 mm, lanceolate, thin, obtuse, and yellowish white, with 3-veins. Labellum rectangular, oblong, tri-lobed, ca.5 x 4 mm; when flattened ca.6 mm; lip without a joint arising above the column from the upward, curved, which is short, concave; terminal lobe thick, rectangular, ca.3.5 x 3.2 mm, about as long as broad at the base, thick and flat, tri-lobed, acute, up curved, sinus longer, acute; lateral-lobe circular, ca.1-1.5 x 1 mm, erect, hairy yellowish white with pink at the tip, two callii in between it and rolled. Column ca. 1.5 mm long, stout, glabrous curved, not excavate; foot short and reduced, lip is arise directly from the column. Clinandrium collar like. Operculum pea shaped, ca. 1.5 x 1.25 mm, glandular in outside. Pollinia 8, pyriform; caudicle glandular. Rostellum ligulate, bent towards the stigmata. Visidium simple and ellipsoid. Stigmatic cavity 1-1.5 x 0.5 mm, entire, pointed lobed inside the cavity.

Distribution: Pokhara valley, Nepal Central Himalaya.

Flowering: April-June

Etymology: The specific epithet of the new taxon *pokheransis* is based on the famous place of Pokhara, Nepal Himalaya. It was chosen because this species is presumed to be endemic to Nepal.

Eria pokharensis is closely affinity with to *E. excavata* Lindl., but it can easily distinguished by its labellum which is rectangular, oblong, tri-lobed, when flattened ca. 6 mm; terminal lobe thick and flat, rectangular, ca.3.5 x 3.2 mm, about as long as broad at the base, tri-lobulate, acute, up curved, sinus longer; lateral-lobe circular, ca.1-1.5 x 1 mm, erect, hairy yellowish white with pink at the tip, two callii in between it and roll inward; labellum arising directly from the column; column not excavate short; operculum pea shaped, glandular in outside. Pollinia pyriform; caudicle glandular.

Acknowledgement

The Institute of Science and Technology (IOST) of Tribhuvan University for provided the financial support to carry out this work, and A. M. Singh Bania, Associate Professor, Department of Botany, Amrit Campus for providing laboratory facilities for the work.

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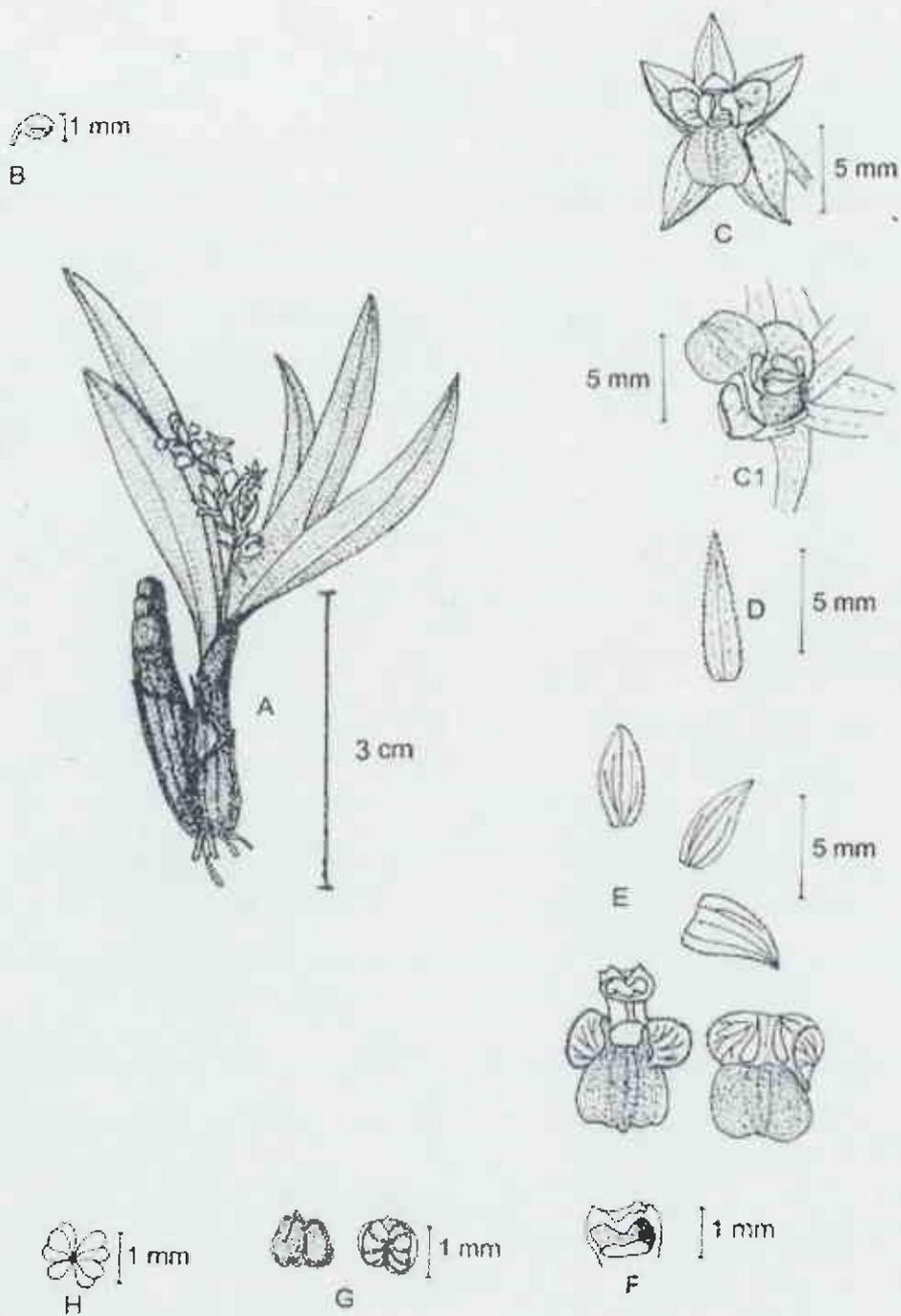


Fig 55. *Eria pokharensis* D. M. Bajracharya & al (*D. M. Bajracharya & A. Subedi* 220, KATH) A: Habit; B: flower; C & C₁: Lateral and front views of flower; D: Bract; E: Spreading of Sepal, Petal and Labellum; F: Column; G: Operculum; H: Pollinia.

Table: 1. Gross morphological differences between *E. excavata* and *E. pokharensis*

Character	<i>E. excavata</i> Lindl.	<i>E. pokharensis</i> Bajracharya, Subedi & Shrestha
Habit	15-17 cm	7-8 cm
Pseudobulbs	Oblong, compressed	Club shaped
Leaves	Elliptic- lanceolate	Oblong-lanceolate
Scape	4-5 cm, long	1-1.5(-2) cm
Inflorescence	4-7 flowered, 9-10 cm long, longer than leaf	3-4 flowered, 2-3 cm long, shorter than leaf
Bracts	6-6.5 x 1 mm, shorter than pedicel plus ovary	8-9 x 1 mm, shorter than ovary.
Dorsal sepal	Elliptic-lanceolate, acute	Ovate- obtuse,
Petals	Elliptic-lanceolate	Lanceolate
Labellum	5 mm long	4 mm long
Lateral lobe	1.5 mm, ovate	2.5 mm, semicircular, hairy
Mesochile	3 mm, thick	3.2 mm thick
Terminal lobe	Cuneriformed, bi-lobulate, emerginate	Rectangular, tri-lobulate,
Sinus	Shorter, obtuse	Longer, acute
Column	Excavate	Not excavate
Stigmatic cavity	Entire	Bi-lobed in side the cavity
Pedicel plus ovary	1 cm long, white pubescent	1-1.5 cm, erect, covered by white pubescent.

To
Devendra Mananda Bajracharya
Amrit Science Campus
Tribhuvan University
Kathmandu, Nepal

Dear Mr Bajracharya:

It is to be informed that your research paper entitled **Two new records of *Eria* Lindl. (Orchidaceae)** has been accepted for forthcoming issue of Himalayan Journal of Sciences . The presentation of the paper can be changed for space and beauty.

Thanking You.

Sincerely,



Arjun Adhikari
Executive Editor

2nd December, 2003

Two new records of *Eria* Lindl. (Orchidaceae) for Nepal

Devendra M. Bajracharya¹ & Krishna K. Shrestha²

¹Amrit Campus, Tribhuvan University, Lainchour, Kathmandu, ²Central Department of Botany, Tribhuvan University, Kirtipur, Nepal

Abstract

Eria concolor Par & Rchb.f. and *Eria obesa* Lindl., are recorded as new species of orchids from Nepal Himalaya.

Key words: *Eria*, New records, Orchidaceae, Nepal

Introduction

The genus *Eria* Lindl. is one of the larger polymorphic genera of the family Orchidaceae. It has about 404 species in the world (RBG, Kew, 2003) which are divided into thirteen to seventeen groups according to the nature of pseudobulbs and leaf characters (Seidenfaden 1982; Pearce & Cribb 2002).

During the revisionary work on the Himalayan genus *Eria* Lindl., we have examined several specimens of *Eria* deposited in the national (KATH, TUCH) and International herbaria (CAL, BM, K, and E). We have also examined the collection of Bajracharya *et al* 394 and 424 (TUCH) from East Nepal and identified. These specimens as *Eria concolor* Rchb.f. and *Eria obesa* Lindl.. We have cross-checked the deposited of these two species with the protologue texts of *Eria concolor* Par. & Rchb.f. (1874), *Tran. Linn. Soc.* **30**: 148 and *Eria obesa* Lindl. Wall Cat. N. 1976, 1829: in *Gen & Sp. Orch.*: 68. (1830) and the both type specimens are collected from Burma. *Eria concolor* Par. & Rchb. f. from Moulmein Parish 128. *Eria obesa* Lindl. from Altran, Martabon, Wall 1976, are deposited at Orchid Herbarium Royal Botanic Gardens, Kew (K). Based on these observations, these species are not reported earlier from Nepal. Therefore it is described and illustrated as here new to Nepal. Both the species are distributed in North East India, Burma, and Thailand.

Eria concolor Par. & Rchb.f. (1874), *Tran. Linn. Soc.* **30**: 148; Hooker, f., *Fl. Brit. Ind.* **5**: 798 (1890); Kranzlin in Engler A. (eds.) *Das Pflanzenreich Hfl.* **50**: 102 (1911); Seidenfaden, *Opera Botanica* **62**: 103 (1982).

Pinalia concolor (Par. & Rchb.f.) Kuntze, in *Revis. Gen. Pl.* **2**: 679(1891).

Epiphytic orchids 15-20 cm high. *Pseudobulbs* cylindrical, fusiform usually 3- 5 cm high, with 4-5 internodes, often swelling between nodes, when fresh bright green in color, *Pseudobulbs* covered