

**TAXONOMIC REVISION OF THE GENUS *LIPARIS* RICH.
(ORCHIDACEAE) IN NEPAL**

A DISSERTATION

**SUBMITTED FOR THE PARTIAL FULFILLMENT OF M.SC
DEGREE IN BOTANY**

BY

EKATA DHAKAL

T.U REGD. NO. : 5-2-37-2136-2014

EXAM ROLL NO. : BOT 740/075



DEPARTMENT OF BOTANY

AMRIT CAMPUS

INSTITUTE OF SCIENCE AND TECHNOLOGY

TRIBHUVAN UNIVERSITY

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DECLARATION

Thesis entitled "**Taxonomic revision of the Genus *Liparis* Rich. (Orchidaceae) in Nepal**" which is being submitted to Department of Botany, Amrit Campus, Institute of Science and Technology (IOST), Tribhuvan University, Nepal for the partial fulfillment of M.Sc Degree in Botany, is a research work carried out by me under the supervision of Prof. Dr. Devendra M. Bajracharya, Amrit Campus, Department of Botany and co- supervised by Mrs. Rita Chhetri (Research officer, National Herbarium and Plant Laboratories (KATH)).

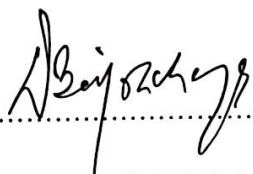
This research is original and has not been submitted earlier in part or full in this or any other form to any University or institute, here or elsewhere in whole or in part for a degree.

Ekata Dhakal

RECOMMENDATION

This is to recommend that "Ekata Dhakal" has carried out research entitled "Taxonomic Revision of the Genus *Liparis* Rich. (Orchidaceae) in Nepal" for the partial fulfillment of M.Sc degree in Botany under our supervision and this work has not been submitted for any other degree.

She has fulfilled all the requirements laid down by the Institute of Science and Technology (IOST), Tribhuvan University, Kirtipur for the submission of the dissertation for partial fulfillment of M.Sc in Botany.



Prof. Dr. Devendra M. Bajracharya

Supervisor

Professor

Amrit Campus

Department of Botany,

Tribhuvan University

Lainchaur, Kathmandu, Nepal



Mrs. Rita Chhetri

Co- Supervisor

Research officer

National Herbarium and

Plant Laboratories (KATH)

Government of Nepal

Godawari, Lalitpur, Nepal

April, 2023



Tribhuvan University
Institute of Science & Technology
AMRIT CAMPUS

P.O. Box No. 102, Thamel, Kathmandu, Nepal
Email: amritcampus@ntc.net.np

f. No.:

Date: April, 2023

LETTER OF APPROVAL

On the recommendaion of Prof. Dr. Devendra M. Bajracharya, this dissertation submitted by Ekata Dhakal entitled "**Taxonomic Revision of the Genus *Liparis* Rich. (Orchidaceae) in Nepal**" is forwarded by Department of Botany, Amrit Campus, T.U.

Associate. Prof. Dr. Sudha Joshi

External Examiner

Prof. Dr. Lokesh Ratna Shakya

Internal Examiner

Prof. Dr. Devendra M. Bajracharya

Supervisor

Dr. Laxmi Joshi Shrestha

Assistant professor

M.Sc Programme-Coordinator

Dr. Shila Singh

Associate professor

Head of Department

Date of oral examination: 15th May 2023

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Ekata Dhakal

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ABSTRACT

The genus *Liparis* Rich. (tribe Malaxideae) comprises over 400 terrestrial and epiphytic species with small pseudobulbs and thin coriaceous leaf mostly arising from the apex of pseudobulb. The members of *Liparis* are distributed widely in tropical, subtropical and temperate areas of the world. In Nepal, the genus is distributed throughout Western, Central and Eastern region of the country with altitudinal ranging from 400 to 3900m. The genus *Liparis* was kept close to other genera i.e. *Malaxis* and *Oberonia* by most of the taxonomists, the characters similar in between them were presence of basal leaves, leaves arising from the apex of the pseudobulb, plants without long stem, and presence of four pollinia in their column.

This revisionary work is mainly based on examination of herbarium specimens from National and International Herbaria and is also supported by observations of plants in nature during field visit. The characters studied are habit and habitat, shape and size of pseudobulb, phyllotaxy, leaves, inflorescence, bracts, flowers, sepals, petals, lip, column and capsules. Apart from morphology, cladistic and phenological study was also done. Additionally identification key, description, illustration and distribution map of each species are provided.

This study confirms the presence of 20 species *Liparis* i.e. *L. bootanensis*, *L. caespitosa*, *L. cathcartii*, *L. cordifolia*, *L. deflexa*, *L. elliptica*, *L. glossula*, *L. langtangensis*, *L. nervosa*, *L. odorata*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. plantaginea*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*, *L. stricklandiana*, *L. viridiflora* and one variety of the genus *L. nervosa* var. *khasiana*. These species are divided in 2 sections i.e. Mollifoliae and Corrifoliae. The cladistic analysis provides the inter-relationship between the species reported from Nepal and divided them into clades and subclades. Length of column, resupination of flowers and habitat are the diagnostic characters of *Liparis* which separate it from *Malaxis* and *Oberonia*. As this study will help to update the checklist and play a significant role in preparation of Flora of Nepal.

Keywords: Orchid, Taxonomy, Morphology, Cladistic, Phenology.

ACRONYMS AND ABBREVIATIONS

Herbaria

BM	British Museum of Natural History, London
BR	Meise Botanic Garden Herbarium, Belgium
CAL	Central National Herbarium, India
E	Royal Botanic Garden, Edinburgh
K	Royal Botanic Garden, Kew, London
KATH	National Herbarium and Plant Laboratories, Nepal
P	National d' Histoire Naturelle, France, Paris
TI	The Herbarium of the University of Tokyo, Japan
TUCH	Tribhuvan University Central Herbarium, Nepal
W	Natur Historisches Museum Wien, Austria, Vienna

Literatures

Ann. Bot. Gar. Calc.	Annals of Botanical Garden Calcutta
Ann. Check. Fl. Pl. Nepal	Annotated checklist of flowering plants of Nepal
Fl. China	Flora of China
Fl. pl. Nepal	Flowering plants of Nepal
Fl. Bhutan	Flora of Bhutan
Fl. Brit. India	Flora of British India
Gen. Sp. Orchid	Genera and species of Orchidaceous Plant
Orch. Nepal Himalaya	Orchids of Nepal Himalaya

Others

Approx.	Approximately
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Fig.	Figure
MOFSC	Ministry of Forest and soil conservation, Nepal
Platyglo	Platyglossum
Platysty	Platystylis
Rich.	Richard
RSM	Raman system Microscope
Subgen.	Subgenera
WCVP	World Checklist of Vascular Plants

Symbols

cm	Centimeter
mm	Millimeter
II	Second
III	Third
Cesti.	Cestichis
Corrif.	Corrifoliae
Mollif.	Mollifoliae
i.e.	that is
et al.,	and others

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Chapter 1

INTRODUCTION

1.1. Background

Orchidaceae shows a wide distribution from the equator to the Arctic Circle and from lowland areas to the snowline, but mostly its richness can be seen in the humid tropics and subtropics (Arditti, 1979). Orchidaceae is distributed throughout all continents except Antarctica and particularly numerous and diverse as epiphytes in the wet tropics. In the world as estimated 391,000 species of vascular plants are present among which 369,000 species i.e. 94% are flowering plants, according to a report by the Royal Botanic Garden, Kew (Willis, 2017). 880,984 species on 172 orders of flowering plants are reported upto now (World Flora Online, 2023).

Orchidaceae are the largest family of flowering plants, with an estimated 800 genera and at least 24,000 species (Govaerts, 2006). Orchidaceae, the most species rich family in the world has approx. 19,000 to 24,000 species (Catzal and Savelli, 2014). Orchidaceae is the largest family with 29,199 species (Govaerts *et al.*, 2017). But after some time orchidaceae becomes the second largest family in the world, with 28,237 number of species such that the largest family is Asteraceae (32,851 species) and third one is Fabaceae with 20,856 species (Shrestha, 2020).

As Nepal has high plant diversity, 458 taxa including 104 genera, 437 species, 16 varieties, 3 subspecies, forma and 18 endemic orchids are reported (Rokaya *et al.*, 2013). Orchidaceae is one of the major families among the higher flowering plants and comprises 8% i.e. 502 taxa belonging to 108 genera (Raskoti and Ale, 2019). Shrestha (2020) reported 112 genera and 480 species of Orchidaceae from Nepal.

Orchidales is kept close to the Burmanniales as they show most of the similar characters (Hutchinson 1923, Takhtajan 1980, Takhtajan 1997). Orchidales was kept with Lilliales in same subclass Liliidae (Cronquist, 1968). Dahlgren (1980) kept orchidales close to the philodrales than Burmanniales in superorder Liliiflorae. Orchidaceae is closely related to Burmanniaceae and both are derived from Lilliales (Dahlgren and Rasmussen, 1983). Seberg *et al.*, (2012) has done phylogenetic work on members of Asparagales using 3 plastid gene and 2 mitochondrial genes in which it was concluded Iridaceae and Orchidaceae which usually were placed in Lilliales are the members of Asparagales.

Orchidaceae shows a variety of uniqueness in adaptation and in morphological ways. Most species of Orchids are placed under CITES Appendix II and III (Gabel, 2006). Large number of members in the family and great controversy about phylogenetic relationships make it difficult to carry out different research activities in this family (Fay and Chase, 2009).

1.2. General morphology of Orchidaceae

Perennial herbs. Terrestrial or epiphytic, sometimes lithophytic as well. Rhizomes, tubers or rootstocks present, mostly tuberous roots in terrestrial and aerial roots in epiphytic. Sympodial or monopodial stem. Pseudobulbs or rhizomatous stem to corms. Leaves alternate to basal, sometimes reduced to scales, simple, entire, frequently fleshy or leathery, glabrous or very rarely hairy, sheathing at base. Inflorescence raceme, panicle, spike; erect or pendulous. Flowers mostly bisexual rarely unisexual, usually zygomorphic and resupinate with pedicel; ovary twisted. Sepals 3, usually free, distinct or connate, green or petaloid. Petals 3, 2 similar and one very different called lip, spur present or absent, colorful, variously lobed, sometimes with calli and attractively colored. Stamens 1 or 2 forming a structure called column; column short to long, occasionally winged, anthers opening by longitudinal slits; pollen united into 1-8 and form pollinia, rostellum present. Ovules numerous; ovary inferior, stigma various. Fruit capsule. Seed tiny and numerous, embryo minute, endosperm absent.

1.3. Genus *Liparis* Rich.

First protologue of *Liparis* was published in 1817 in (De Orchideis Europaeis annotations, 30(1817)) by Richard as ovary pedicellatum, Posterior labellum; recurved parts of flowers, column- slightly bent, thick at the bottom and winged at top. Anther marginal; pollen masses globose, based on the material (*L. loselii*) which is recognized as the type specimen of *Liparis*. Illustration was provided and parts such as anther locules and mostly the column is drawn and labelled.

Liparis is an orchid genus having few leaves and usually fairly small yellow- green or dull purple flowers in terminal racemes. Teoh (2016) worked on medicinal orchids of Asia and analyze different compounds obtained from various species of Orchids, among those species *Liparis* was first to be investigated for alkaloid and other many compounds. As *Liparis* and *Malaxis* are related genera both contain many compounds which have medicinal values. Mostly alkaloids extracted from *L. nervosa* shows inhibitory activity against bacteria and

fungi. Nine species of *Liparis* are used in China, among that six species are used as haemostatic.

Chase *et al.*, (2015), solve difficulties of the third group with naked pollinia i.e. *Malaxis*, *Liparis* and relatives; also give two subtribes of the tribe Malaxidieae i.e. Dendrobiinae and Malaxidinae. *Liparis* belongs to subtribe Malaxidinae. So the classification for genus *Liparis* is:

Angiosperm
 Monocots
 Aspurgales
 Orchidaceae
 Epidendroideae
 Malaxideae
 Malaxidinae
 Liparis Rich.

1.4. Statement of the problem

First monograph was published by Ridley (1886) in which he has recognized 110 species of *Liparis*. Hooker (1890) gave the description of genus and different species of the genus *Liparis*. Only some of the revisionary work has been done by different taxonomists such as, Tsutsumi *et al.*, (2007) in Japan, Averyanov *et al.*, (2016) in Vietnam and Terentieva *et al.*, (2020) in Amur region (Russia) based on morphological and molecular basis. No any revisionary work has been done in our region and in nearest areas, only some of the taxonomists such as Banerji and Thapa (1976), Banerji and Pradhan (1984), Raskoti (2009) has concentrated mainly on taxonomy of the regional orchid flora and included *Liparis* on it. Many taxonomists have provided the systematic position of the genus "*Liparis*". The genus is closely related to *Malaxis* and *oberonia*.

1.5. Objectives

The general objective of the current work is to revise the genus critically by analyzing morphological characters, geographical distribution in Nepal and extrapolate phylogenetic relationships.

The specific objectives of this study are as follows

1. To carry out taxonomic study of individual species.

2. To construct identification keys on the basis of reliable morphological characters.
3. To prepare the distribution map for all species based on collection, herbarium specimens and literatures.
4. To identify and solve nomenclature problem.
5. To perform the cladistic analysis of Nepalese *Liparis* based on morphological characters.

1.6. Limitation of the study

Some requirement was required to complete this study which is needed to be considered i.e. good quality of herbarium, type specimens in good condition, and appropriate laboratory facilities for anatomical, palynological and cytological study; available literatures and proper collection of plant specimens. But when this study was started all of these facilities were found in very poor condition and most of them were out of reach. So, the present study is mainly based on morphological characters only.

The areas mentioned in herbarium specimens were visited but no any species were reported from that area except few, it may be due to the collections were old, road construction, over grazing and construction of tourist attracted places with hotels and resorts in those area etc.

Due to many unfavorable circumstances and lack of access, herbarium deposited in some international herbaria can't be examined.

1.7. Systematic position of the genus *Liparis* rich.

The genus *Liparis* is one of the genus in tribe Malaxideae which include mostly two genera i.e. *Liparis* and *Malaxis*. Cameron (2005) had done phylogentic study of Malaxideae which show that *Liparis* is based on traditional morphological delimitations and are polyphyletic. Genera *Liparis* and *Malaxis* are closely related and distinguish by only few floral characters i.e. column is rather long, arching and flowers are resupinate in *Liparis*, while column often very short, erect and flowers are often not resupinate, with lip at top and plants are mostly terrestrial in *Malaxis*.

Cameron (2005) performed a molecular phylogenetic study for malaxideae, which includes *Liparis*, *Malaxis* and *Oberonia*, the conclusion was that the *Liparis* is not monophyletic because the other two genera i.e. *Malaxis* and *Oberonia* are nested within *Liparis*. This genus is still one of the most difficult genera among Orchidaceae in terms of Systematics (Terentieva *et al.*, 2020). While observing directly in nature and studying the herbaria or

literature, it has been found that there are considerable intraspecies variability in morphological parameters among different species of *Liparis* (Shibneva, 2007, 2011; Efimov, 2010).

Reichenbach (1852) placed the genus *Liparis* in Monandrae section.

Dressler & Dodson (1960) placed the genus within Epidendreae tribe and in Liparidinae subtribe.

Ames (1915) place *Liparis* in Monandrae and subtribe Liparidinae with *Malaxis* and *Oberonia* and *Hippeophyllum*.

Schlechter (1926) placed the genus *Liparis* on Monandrae tribe, Sub-tribe -4 Liparideae.

Dressler (1983) kept it in Epidendroideae and revised his work and gave a phylogenetic classification on Orchids in (Dressler, 1993) which is accepted by almost all taxonomists and in this genus *Liparis* is kept on Epidendroideae under cymbidioid phyllad.

Kores (1989) modified the classification given by Schlechter (1926) and Garay (1960, 1972) and placed *Liparis* with *Malaxis* and *Oberonia* in subfamily Epidendroideae, Tribe Epidendreae and Sub- tribe Liparinae.

Szlachetko (1995) placed the genus *Liparis* in subfamily Epidendroideae and tribe Malaxideae with *Malaxis* as a nearest genus.

Finally Chase *et al.*, (2015), has updated the classification and gave five subfamilies among which *Liparis* was placed in Subfamily Epidendroideae, Tribe Malaxideae and two subtribe of malaxideae was given among which it was kept in Malaxidinae with *Malaxis* and *Oberonia*.

1.8. Morphology of the genus *Liparis* Rich.

Terrestrial, epiphytic or lithophytic herbs. Pseudobulbs almost present. Leaves solitary, two or more than two, membranous, sheathing at base, jointed on sheath or pseudobulb. Inflorescence terminal raceme, erect, sometime pendulous, few to many flowered, laxly to densely arranged. Flowers small to medium sized. Sepals and petals erect or reflexed, margin mostly recurved; petals sometimes placed under the lip. Lip inferior, adnate to the base of the column, usually bilobed, callus present, usually reflexed from middle or below. Column slender incurved often winged at the apex or base. Pollinia present almost 4 in 2 pairs. Capsules mostly obovoid- ellipsoid.

1.9. Generic and sectional delimitation of *Liparis*

The genus *Liparis* was established by L.C Richards in 1817. Huge controversy was seen as this genus was found for the first time as the species *Loselii* and *Lillifolia*, which was included under *Malaxis*. Reichenbach (1828) changed the name to *Sturmia*, as the name *Liparis* was already in use for a genus of moths. But later this objection was considered invalid and the older name i.e. *Liparis* was retained. *Liparis* was derived from Greek word "Liparos" which refers to smooth, glossy and shiny leaves. *Liparis* is nearly related to *Microstylis* but distinguished by long and slender column not closely hold by lip (Riddley, 1886).

First monograph was done by Ridley (1886). He first proposed the sectional key and classified 110 species into subgenera Mollifoliae and Corrifoliae and them into different sections such as Mollifoliae into 2 sections i.e. Ellipticae and Ramosae, corrifoliae into 3 sections i.e. Platystylis, Distichae, Densiflorae.

King and Pantling (1898) have classified *Liparis* into two sections Mollifoliae and Corrifoliae on the basis of from where the leaves and inflorescence are produced.

Schlechter (1911-1914) classified *Liparis* into 4 subgenera i.e. Sturmia, Mesoneuron, Heteroblastos and Cestichis.

Smith (1933) has classified the genus into 5 sections i.e. Liparis, Distichon, Platystylis, Ensipes and Cestichis.

Seidenfaden (1976) listed 22 Malayan species of *Liparis* into three sections i.e. Liparis, Distichae, Corrifoliae and also mentioned that no any complete monograph has been done upto the date since Ridley (1886).

Garay and Gonzalez (1999) have classified the genus into 4 sugenera and kept them into 19 sections. Such as Subgenera Liparis into section Tipuloidea, Decumbentes, Liparis, Elatae, Phyllocardium, Otophyllum, Aphyllum, Ramosae and Rhachidibulbon; Subgenera Mesoneuron into sections Pleiophyllum, Platychilus, Genychilus; Subgenera Heteroblastos into section Choriostachys; subgenera Cestichis into sections Distichae, Platystylis, Genyglossum, Platyglossum, Blepharoglossum, Cestichis.

Pearce and Cribb (2002) had classified *Liparis* of Bhutan into 2 sections i.e. Liparis and Cestichis.

Yang (2006) has classified 46 species of *Liparis* of Taiwan into 3 sections i.e. Liparis, Corrifoliae and Distichae.

Tsutsumi (2007) has performed work on *Liparis* section *Liparis* and examined the phylogenetic relationship of 16 species of *Liparis* from Japan.

Ormerod (2012) has revealed 2 new distributional records and other five more species of section Ramosae from United States and New York.

Li (2020) has classified genus *Liparis* into 5 sections i.e. Cestichis, Platyglossum, Platystylis, Distichae, Blepharoglossum.

Ya *et al.*, (2021) reported that *Liparis* species found upto this date can be divided into two major clades i.e. one terrestrial and the other epiphytic; terrestrial one shows close relation with *Malaxis* due to the presence of conduplicate leaves while the other shows close relation with *Oberonia* due to the presence of duplicate and compressed leaves.

The present study divided the 22 genus and one variety into 2 different sections i.e. Mollifoliae and Coriifoliae on the basis of

Mollifoliae: Leaves membranous, large, contracted at the base into and continuous with long sheath

Coriifoliae: Leaves coriaceous, jointed to sheath or pseudobulb.

Following the treatment of King and Pantling (1898).

Table 1. Overview of most important infrageneric classification of genus *Liparis* Rich. (Orchidaceae)

S.N	Name of species	Ridley (1886)	Hook.f. (1890)	King& Pantl (1898)	Pearce& Cribb. (2002)	Yang (2006)	Li. L (2020)
1.	<i>L. bootanensis</i>	Corrif. Subgen.	Corif.	Corif.	Cesti.	Corrif.	Platyglo.
2.	<i>L. cespitosa</i>	Corrif. Subgen.	–	–	Cesti.	Distichae	Cesti.
3.	<i>L. cathcartii</i>	–	Mollif.	Mollif.	Liparis	–	–
4.	<i>L. cordifolia</i>	–	Mollif.	Mollif.	Liparis	Liparis	–
5.	<i>L. deflexa</i>	–	Mollif.	Mollif.	Liparis	–	–
6.	<i>L. elliptica</i>	Ellipticae	–	–	Cesti.	Corrif.	Cesti.
7.	<i>L. glossula</i>	Ellipticae	Mollif.	Mollif.	Liparis	–	–
8.	<i>L. langtangensis</i>	–	–	–	–	–	–
9.	<i>L. nervosa</i>	Elatae	–	–	Liparis	Liparis	–
10.	<i>L. nervosa var. khasiana</i>	–	–	–	Liparis	–	–
11.	<i>L. odorata</i>	Elatae	Mollif.	Mollif.	Liparis	Distichae	–
12.	<i>L. olivaceae</i>	Elatae	Mollif.	–	–	–	–
13.	<i>L. perpusilla</i>	–	Corrif.	Cesti.	Cesti.	–	–
14.	<i>L. petiolata</i>	Ellipticae	Mollif.	Mollif.	Liparis	–	–
15.	<i>L. plantaginea</i>	Corrif. Subgen.	Corrif.	Corrif.	Cesti.	–	–
16.	<i>L. platyrachis</i>	–	Corrif.	Corrif.	Cesti.	–	–
17.	<i>L. pygmaea</i>	–	–	Corrif.	Liparis	–	–
18.	<i>L. resupinata</i>	platystylis	Corrif.	–	Cesti.	–	Platysty.
19.	<i>L. rostrata</i>	–	Mollif.	–	–	–	–
20.	<i>L. stricklandiana</i>	Densiflorae	–	–	Cesti.	Distichae	Platyglo.
21.	<i>L. viridiflora</i>	Corrif. Subgen.	Corrif.	Corrif.	Cesti.	Corrif.	Cesti.

Abbreviation: Mollif. = Mollifolliae; Corrif = Coriifoliae; Cesti = Cestichis; platyglo= Platyglossum; Platysty = platystylis; subgen = subgenera.

Chapter 2

LITERATURE REVIEW

The literatures reviewed are classified under two categories:

2.1. *Liparis* outside Nepal

2.2. *Liparis* inside Nepal

2.1. *Liparis* outside Nepal

Reichenbach (1828) changed the name of *Liparis* Rich. to *Sturmia* Rchb. in his publication.

Lindley (1830-1840) published a description of many genus of orchids from his ten years work in many different parts of world among those 33 species were of *Liparis* Rich. and six species are common to Nepal i.e. *L. nervosa*, *L. odorata*, *L. olivaceae*, *L. plantaginea*, *L. viridiflora*, *L. cespitosa*.

Lindley (1846) placed orchids on their own subdivision as *Liparis* on subdivision Liparidae with *Sturmia*, *Alipsa* and *Cestichis*.

Reichenbach (1852) mentioned (*Sturmia* = *Liparis*) in his publication in *Annales botanices systematicae* and also classify orchids in 5 sections and again them into series as series in which *Liparis* and *Malaxis* are shown as close genus in *Monandrae*.

Parish (1883) reported 12 species of *Liparis* from Burma among which 2 species are those which are reported from Nepal i.e. *L. paradoxa* and *L. olivacea*.

Ridley (1886) in monograph of *Liparis* in which he has described 110 species of *Liparis* from different parts of the world among which only 9 species were same as the species reported from Nepal. They are *L. bootanensis*, *L. cespitosa*, *L. elliptica*, *L. glossula*, *L. resupinata*, *L. viridiflora*, *L. stricklandiana*, *L. nervosa*, *L. plantaginea*.

Hooker (1889) recorded further 19 species of *Liparis* among which eight species are common species reported from Nepal i.e. *L. cathcartii*, *L. glossula*, *L. cordifolia*, *L. rostrata*, *L. perpusilla*, *L. resupinata* and *L. platyrachis*, *L. olivaceae*.

Hooker (1890) in Volume 5 has classified the Orchideae in 5 tribes and has described 59 species of *Liparis* and also has mentioned doubtful and excluded species as well. Among the described species of *Liparis* only 12 species were same as those found in Nepal they are :- *L. perpusilla*, *L. platyrachis*, *L. resupinata*, *L. viridiflora*, *L. plantaginea*, *L. bootanensis*, *L. deflexa*, *L. olivaceae*, *L. cathcartii*, *L. rostrata*, *L. glossula*, *L. cordifolia* also some of them were collected from Nepal by Wallich.

King and Pantling (1898) described 22 species with their illustration from Sikkim Himalaya. Among them 12 species are similar to those species which are found in Nepal i.e. *Liparis cordifolia*, *L. cathcartii*, *L. deflexa*, *L. glossula*, *L. bituberculata*, *L. plantaginea*, *L. bootanensis*, *L. perpusilla*, *L. pygmaea*, *L. platyrachis*, *L. viridiflora*, *L. resupinata*.

Smith (1905) described 5 species of *Liparis* including *L. odorata* from Himalaya.

Santapu and Kapadia (1966) mentioned only 2 species of *Liparis* from Bombay among which only one species i.e. *L. nervosa* match with the species that are reported from Nepal.

Babu (1977) describe only one species of *Liparis* i.e. *Liparis viridiflora* from Dehradun.

Seidenfaden & Arora (1982) enumerated the orchids of Northwest Himalaya and gave 11 species of *Liparis* with other orchid species. All species of *Liparis* were same as those reported from Nepal such as *L. cespitosa*, *L. cordifolia*, *L. deflexa*, *L. glossula*, *L. nervosa*, *L. paradoxa* = *L. odorata*, *L. petiolata*, *L. platyrachis*, *L. resupinata*, *L. rostrata* and *L. viridiflora*.

Deva and Naithani (1986) described six species of *Liparis* from North West Himalaya which match the species found in Nepal are *L. cespitosa*, *L. cordifolia*, *L. deflexa*, *L. glossula*, *L. nervosa*, *L. paradoxa* which is now cited as *L. odorata*, *L. resupinata*, *L. rostrata*, *L. viridiflora*.

Pangtey *et al.*, (1991) reported 9 species of *Liparis* from Kumaun Himalaya among which all the species except one are found in Nepal, they are *L. cespitosa*, *L. deflexa*, *L. glossula*, *L. nervosa*, *L. platyrachis*, *L. resupinata*, *L. rostrata*, *L. viridiflora* and the one is *Liparis paradoxa* which is now cited as *L. odorata* by different publishers.

Chowdhery (1998) described and illustrated orchids of Arunachal Pradesh among them 18 species were of *Liparis* Rich. and from 18, 10 species are same as the species reported from

Nepal. They are *L. bootanensis*, *L. cespitosa*, *L. cathcartii*, *L. cordifolia*, *L. elliptica*, *L. nervosa*, *L. plantaginea*, *L. resupinata*, *L. stricklandiana*, *L. viridiflora*.

Bose *et al.*, (1999), described 42 species of *Liparis* Rich. from India. Among them distribution of 18 species can also be found in Nepal. They are *L. viridiflora*, *L. stricklandiana*, *L. rostrata*, *L. resupinata*, *L. pygmaea*, *L. platyrachis*, *L. plantaginea*, *L. petiolata*, *L. perpusilla*, *L. olivaceae*, *L. nervosa*, *L. glossula*, *L. deflexa*, *L. cordifolia*, *L. cathcartii*, *L. cespitosa*, *L. bootanensis*.

Singh *et al.*, (2001) listed two species of *Liparis* they are *L. nervosa* and *L. paradoxa* from Bihar.

Pearce and Cribb (2002) reported 28 species and two variety from Bhutan among which 18 species are the same species reported from Nepal. They are *L. bootanensis*, *L. cathcartii*, *L. cordifolia*, *L. cespitosa*, *L. deflexa*, *L. elliptica*, *L. glossula*, *L. nervosa*, *L. nervosa* var *khasiana*, *L. odorata*, *L. petiolata*, *L. pygmaea*, *L. perpusilla*, *L. plantaginea*, *L. platyrachis*, *L. resupinata*, *L. stricklandiana*, *L. viridiflora*.

Teoh (2005) mentioned only one species of *Liparis* i.e. *L. viridiflora* from Asia.

Huda (2007) has enumerated the list of genus in family Orchidaceae and has listed 4 species of *Liparis* from Bangladesh among which 3 species i.e. *L. nervosa*, *L. resupinata* and *L. viridiflora* were same as those reported from Nepal.

Tsutsumi *et al.*, (2007) has compare the seed morphology and phylogeny of 16 species of *Liparis* from Japan which also includes two species same as Nepal i.e. *L. nervosa* and *L. cordifolia*. *L. nervosa* was used as outgroup.

Fernando and Ormerod (2008) has prepared annotated checklist of Srilanka and reported 10 species of *Liparis* among which only 4 species of *Liparis* were similar as found in Nepal. They are *L. cespitosa*, *L. elliptica*, *L. nervosa*, *L. viridiflora*.

Jalal *et al.*, (2008) provided checklist of 237 species of orchids from the state of Uttarakhand, India among which they have listed 10 species of *Liparis* i.e. *L. cespitosa*, *L. cordifolia*, *L. deflexa*, *L. glossula*, *L. nervosa*, *L. paradoxa*, *L. platyrachis*, *L. resupinata*, *L. rostrata* and *L. viridiflora*.

Lin *et al.*, (2013) in "Flora of China" described 63 species of *Liparis* among which only 20 species of *Liparis* were similar as found in Nepal.

Yonzone *et al.*, (2013) reported 15 species with one variety from Darjeeling Himalaya of India. 11 species are same as those found in Nepal. They are *L. bootanensis*, *L. cespitosa*, *L. cathcartii*, *L. cordifolia*, *L. deflexa*, *L. odorata*, *L. nervosa*, *L. plantaginea*, *L. resupinata*, *L. platyrachis*, and *L. viridiflora*.

Chowdhery & Agrawal (2013) reported two species of *Liparis* i.e. *L. nervosa* and *L. viridiflora* from west Himalaya.

Singh and Jayanthi (2015) had mentioned 10 species of *Liparis* from Western Himalaya, India. The species are *L. cespitosa*, *L. cordifolia*, *L. deflexa*, *L. glossula*, *L. nervosa*, *L. odorata*, *L. platyrachis*, *L. resupinata*, *L. rostrata*, *L. viridifolia*.

Chowdhery (2015) mentioned that *Liparis* species was dominant in North- Western Himalaya with other 10 genus of orchids and also 51 species of *Liparis* were found in India.

Yonzone (2015) has studied the orchid flora of Darjeeling Himalaya and has reported 321 orchid species under 86 genera. Among those species only *Cymbidium* and *Liparis* were 2 genera which have both terrestrial and epiphytic habitat. He has enlisted 16 species of *Liparis*.

Barbhuiya and Salunkhe (2016) enlisted 4 species of *Liparis* from Maharashtra among which 3 species are same as found in Nepal the species that are same as that of Nepal are *Liparis nervosa*, *L. odorata*, *L. viridiflora*.

Maity *et al.*, (2019) has enumerated 529 orchid species under 132 genera from Sikkim. In which 27 species were of *Liparis* Rich. i.e. *L. bootanensis*, *L. cathcartii*, *L. cespitosa*, *L. cordifolia*, *L. deflexa*, *L. elliptica*, *L. glossula*, *L. nervosa*, *L. odorata*, *L. perpusilla*, *L. petiolata*, *L. plantaginea*, *L. platyrchis*, *L. pygmaea*, *L. resupinata*, *L. stricklandiana*, *L. viridiflora*.

Tetsana *et al.*, (2019) revised the genus *Liparis* from Thailand and reported 37 species among which only 9 species of *Liparis* are same as those reported from Nepal i.e. *L. bootanensis*, *L. cespitosa*, *L. elliptica*, *L. nervosa*, *L. odorata*, *L. petiolata*, *L. plantaginea*, *L. resupinata* and *L. viridiflora*.

Naresh swami has updated his application on 2019, in which he has mentioned around 1500 species of orchids. Among which 12 species were the species which were also reported from Nepal, they are *L. bootanensis*, *L. cathcartii*, *L. cespitosa*, *L. cordifolia*, *L. deflexa*, *L.*

elliptica, *L. odorata*, *L. perpusilla*, *L. petiolata*, *L. plantaginea*, *L. platyrachis*, and *L. resupinata*.

2.2. *Liparis* inside Nepal

D. Don (1825) mentioned the genus *L. petiolata* as *Acianthus petiolatus* and no any other *Liparis* genus were reported from Nepal.

Banerji and Thapa (1976) reported six species of *Liparis* from Nepal They are *L. cordifolia*, *L. glossula*, *L. platyrachis*, *L. resupianta*, (*L. togashii* synonym of *L. perpusilla*), *L. viridiflora*.

Hara *et al.*, (1978) reported 13 species are of *Liparis* Rich from Nepal. They are *L. bituberculata*, *L. cathcartii*, *L. cordifolia*, *L. glossula*, *L. nervosa*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*, *L. viridiflora*.

Banerji and Pradhan (1984) described 16 species of *Liparis* from Nepal Himalaya. They are *L. bootanensis*, *L. cespitosa*, *L. deflexa*, *L. nervosa*, *L. cathcartii*, *L. glossula*, *L. viridiflora*, *L. perpusilla*, *L. petiolata*, *L. resupinata*. *L. bituberculata*, *L. cordifolia*, *L. olivaceae*, *L. platyrachis*, *L. pygmaea*, *L. rostrata*

Malla *et al.*, (1986) has reported 4 species of *Liparis* i.e. *L. cordifolia*, *L. perpusilla*, *L. resupinata* and *L. viridiflora* from Kathmandu valley.

Banerji (1996) reported 6 species of *Liparis* from Nepal. They are *L. cordifolia*, *L. glossula*, *L. platyrachis*, *L. resupinata*, *L. togashii*, *L. viridiflora*.

Shrestha and Joshi (1996) mentioned *Liparis olivaceae* as an endemic species of Nepal and suspected to be extinct and known only from the type collection at Kew herbarium.

Rajbhandari *et al.*, (1999) give a list of number of orchid species and numbered 16 species of *Liparis* from Nepal and one as endemic species from Nepal.

Press *et al.*, (2000) has enlisted 13 species of *Liparis* from Nepal they are *L. bituberculata*, *L. cathcartii*, *L. cordifolia*, *L. glossula*, *L. nervosa*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*, *L. viridiflora*.

White and Sharma (2000) reported six species of *Liparis* Rich. i.e. *L. cespitosa*, *L. paradoxa*, *L. petiolata*, *L. resupinata*, *L. stricklandiana*, *L. viridiflora* from Tribhuvan rajpath and areas of Chitwan forest.

Singh and Bista (2001) enlisted 18 species of *Liparis* Rich from Nepal. They are *L. bituberculata*, *L. bootanensis*, *L. cespitosa*, *L. cathcartii*, *L. cordifolia*, *L. deflexa*, *L. glossula*, *L. longipes*=*L. viridiflora*= *L. nepalensis*= *L. petiolata*, *L. nervosa*, *L. odorata* = *L. nervosa*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*, *L. viridiflora*.

Amatya (2003) has contributed on Orchid flora of Dhading district (Central Nepal) and reported 52 orchid species among which two species were of *Liparis* i.e. *L. nervosa* and *L. deflexa*.

Subedi (2003) worked on Orchid flora of Seti and Marsyangdi river valley and reported 125 species of Orchids belonging to 51 genera among which 5 species was of *Liparis* i.e. *L. bootanensis*, *L. cordifolia*, *L. petiolata*, *L. plantaginea* and *L. resupinata*.

Rajbhandari and Dahal (2004) listed 17 species of *Liparis* from Nepal in their checklist. Species included are *L. bootanensis*, *L. cespitosa*, *L. cathcartii*, *L. deflexa*, *L. glossula*, *L. nervosa*, *L. odorata*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. plantaginea*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*, *L. viridiflora*.

Shakya and Bajracharya (2005) reported *L. nervosa* from Raja Rani (Morang district).

Ghimire (2008) listed 3 species of epiphytic *Liparis* which were found on different tree species from Nepal. The epiphytic species are *L. cespitosa*, *L. resupinata*, *L. viridiflora*.

Karkee (2008) has reported 107 species of Orchids belonging to 47 genera from Makalu Barun National Park among which 5 species were of *Liparis* i.e. *L. bootanensis*, *L. deflexa*, *L. nervosa*, *L. resupinata*, *L. viridiflora*.

Raskoti (2009) mentioned 15 species of *Liparis* with one variety. They are *Liparis bootanensis*, *L. cespitosa*, *L. campylostalix*, *L. cordifolia*, *L. deflexa*, *L. glossula*, *L. longipes*, *L. nervosa*, *L. nervosa* var. *Khasiana*, *L. odorata*, *L. perpusilla*, *L. petiolata*, *L. plantaginea*, *L. stricklandiana*, *L. viridiflora*.

Rajbhandari and Baral (2010) has listed 10 species i.e. *Liparis bootanensis*, *L. cespitosa*, *L. cathcartii*, *L. deflexa*, *L. glossula*, *L. nervosa*, *L. perpusilla*, *L. petiolata*, *L. resupinata*, *L. viridiflora* and 2 more species were added in Catalogue of Nepalese flowering plants Supplement 1 in Jan 2015 i.e. *L. ferruginea*, *L. langatgensis*.

Koirala *et al.*, (2010) documented 36 orchid species from Dolpa and doesnot reported single species of *Liparis*.

Raskoti and Ale (2012) reported *L. ferruginea* lindl. for first time in Nepal.

Rokaya *et al.*, (2013) has listed 19 species of *Liparis* with 1 subspecies and one variety. They are *L. cespitosa*, *L. cathcartii*, *L. campylostalix*, *L. deflexa*, *L. ferruginea*, *L. glossula*, *L. nervosa*, *L. nervosa var Khasiana*, *L. nervosa* subsp. *nervosa*, *L. odorata*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*. Also mentioned eighteen species are of endemic orchids among which *Liparis olivaceae* Lindl. is the one which is reported at the altitude of 1000m.

Shakya and Bajracharya (2013) reported 7 species are of *Liparis* Rich. In this study they have also mentioned that 3 species are terrestrial and the other 4 species were found as epiphytes. Species recorded in Shivapuri National Park were *L. bootanensis* , *L. cordifolia*, *L. nervosa*, *L. plantaginea*, *L. perpusilla*, *L. resupinata*, *L. viridifolia*.

Rajbhandari (2014) mentioned 252 epiphytic, 184 terrestrial and 14 species as saprophytic species of orchid among which 16 species are of *Liparis* i.e. *L. campylostalix*, *L. cathcartii*, *L. cespitosa*, *L. cordifolia*, *L. deflexa*, *L. ferruginea*, *L. glossula*, *L. langtangensis*, *L. nervosa*, *L. odorata*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*. He had also mentioned medicinal uses of 2 species of *Liparis* i.e. *L. nervosa* and *L. rostrata*.

Raskoti and Ale (2014) first described *L. langtagensis* from Nepal as endemic species of Nepal.

Rajbhandari (2015) mentioned 22 species of *Liparis* in his handbook. They are *L. bootanensis*, *L. campylostalix*, *L. cathcartii*, *L. cespitosa*, *L. cordifolia*, *L. deflexa*, *L. elliptica*, *L. ferruginea*, *L. langtangensis*, *L. glossula*, *L. nervosa*, *L. perpusilla*, *L. petiolata*, *L. odorata*, *L. olivacea*, *L. plantaginea*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*, *L. stricklandiana*, *L. viridiflora*.

Rajbhandari *et al.*, (2016) enumerated the list of endemic flowering plants of Nepal in which they have mentioned two endemic species of *Liparis* i.e. *L. langtangensis* and *L. olivaceae*.

Rajbhandari and Rai (2017) enlisted 17 species from Nepal. They are *L. bootanensis*, *L. cespitosa*, *L. cathcartii*, *L. cordifolia*, *L. deflexa*, *L. ferruginea*, *L. glossula*, *L. langtagensis*,

L. nervosa, *L. odorata*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. pygmaea*, *L. resupinata*, *L. rostrata*, *L. viridiflora*.

Shrestha *et al.*, (2018) has enlisted 22 species of *Liparis* from Nepal i.e. *L. bootanensis*, *L. cespitosa*, *L. campylostalix*, *L. cathcartii*, *L. cordifolia*, *L. deflexa*, *L. elliptica*, *L. ferruginea*, *L. glossula*, *L. langtagensis*, *L. nervosa*, *L. odorata*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. plantaginea*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*, *L. stricklandiana*, *L. viridiflora* and 2 varieties i.e. *L. nervosa var. nervosa*, *L. nervosa var. khasiana*.

Bhandari *et al.*, (2018) collected and listed 612 species of flowering plants from Panchase protected forest in which 122 species belongs to family Orchidaceae among this only 5 species were of *Liparis* i.e. *L. bootanensis*, *L. nervosa*, *L. petiolata*, *L. resupinata*, *L. viridiflora*.

Karki and Ghimire (2019) give a checklist of orchids of Suspa- Kshamawoti, Dolakha among which 3 species were of *Liparis*. They are *L. cathcartii*, *L. resupinata*, *L. viridiflora*.

Rajbhandari *et al.*, (2019) mentioned 5 species of *Liparis* from Nepal i.e. *L. langtagensis*, *L. odorata*, *L. olivacea*, *L. perpusilla*, *L. petiolata*.

Bhandari *et al.*, (2020) provided a checklist of 52 genera and 142 species of orchids from Panchase forest, Central Nepal among which five species were of *Liparis*, i.e. *L. bootanensis*, *L. nervosa*, *L. petiolata*, *L. resupinata* and *L. viridiflora*.

Shrestha *et al.*, (2022) has enlisted 22 species of *Liparis* from Nepal. They are *L. bootanensis*, *L. campylostalix*, *L. cathcartii*, *L. cespitosa*, *L. cordifolia*, *L. deflexa*, *L. elliptica*, *L. ferruginea*, *L. glossula*, *L. langtagensis*, *L. nervosa*, *L. odorata*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. plantaginea*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*, *L. somae*, *L. viridiflora*.

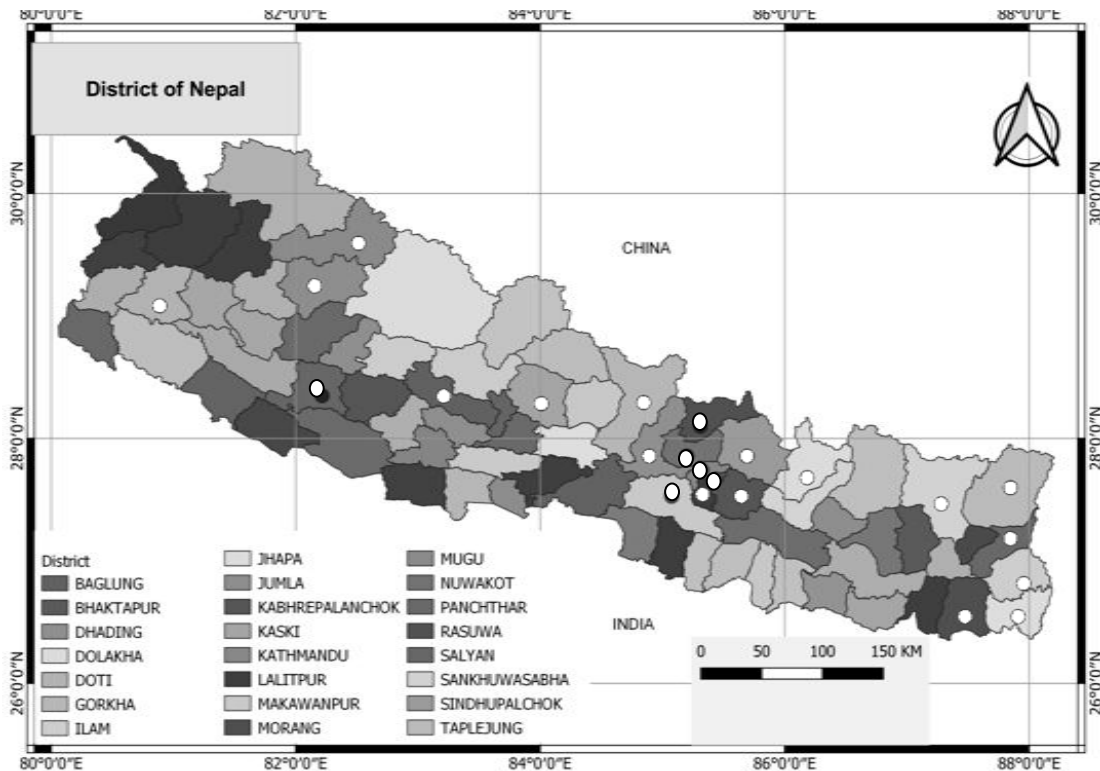
Samuel (2022) has enlisted the list of Orchids around Godawari and surrounding area. Only 4 species of were found they are *L. cordifolia*, *L. elliptica*, *L. nervosa*, *L. resupinata*.

Chapter 3

MATERIALS AND METHODS

3.1. Study area

The study area is Nepal. It is situated between China to its North and India to its East, West and South. It lies in between Eastern and Western Himalaya which cause high diversity of vegetation here. It lies between latitudes $27^{\circ} 42' 2.7684''$ N and longitude between $85^{\circ} 18' 0.5040''$ E. It covers an area of 1,47,516 sq km. Among the total area, 40.36% of Nepal's land area is covered with forest (DFRS, 2015). Stearn (1960) divided Nepal into three Phytogeographical regions i.e. West Nepal, Central Nepal and East Nepal.



Map.1: Map of Nepal showing the distribution of genus *Liparis* Rich.

The dot shows the presence of genus *Liparis* Rich. in that district.

It only occupies 0.1 % of the total earth's area and the elevation ranges from less than 100 m above sea level in terai to the highest point on the Earth, the summit of Mt. Everest at 8,848.86 m. With this elevation range and precipitation of 160 mm to over 5,000 mm, country has different climatic zones from tropical to nival zone i.e. tropical, subtropical,

temperate, subalpine, alpine and nival zone. Nepal's climate varies considerably both seasonally and according to the altitude. The monsoon of Nepal has made 2 clear wet and dry seasons as generally the monsoon begin from mid June and ends at beginning of September. The months of season also vary with altitude and slope of the mountain.

Nepal is topographically divided into 3 regions: The Himalaya to the north, the middle hills consisting of the Mahabharat range, the Churia hills and the terai to the south. The Himalaya and its foothill make up the northern border of the country and represent 16 % of the total land area. The middle hills cover about 65% of the total area and terai covers 17% of the total land area. Nepal has a very interesting and exciting biodiversity due to its unique geographical position and altitudinal variation.

3.2. Taxonomical Study

3.2.1. Selection of Characters

The taxonomic work of this genus was done by comparing different important characters. The characters selected are Pseudobulb, leaf, peduncle, inflorescence, bract, pedicel and ovary, sepal, petal, lip, column, capsule etc. Selections of these characters were done on the basis of different works which were done earlier by other scholars such as King and Pantling (1898), Pearce and Cribb (2002), Lin *et al.*, (2013) etc.

3.2.2. Collection and Preparation of Herbarium Specimens

Herbarium specimens deposited at KATH and TUCH were examined, from where information about location, flowering and fruiting season of the species was obtained. After that study was done by fresh collection of some species and other were done from herbarium deposited at international herbarium and using literatures as well.

It was difficult to work only from herbarium specimens. The collection of fresh plants species materials help to identify some of the distinguish characteristics. Fresh specimens were collected from Central Nepal. Altogether seven live species were found and collected. Photographs in their own habitat was taken, the characters were noted in field note, tagging of plant materials were done and rough illustration were also done from fresh specimens. Flowers were kept and preserved in tissue paper while other plant materials were pressed in newspaper for herbarium preparation. Collection was only done of one specimen from an area where more number of species was present. Finally well dried and complete specimens

were mounted using standard method of herbarium preparation by Bridson and Forman (1998), Maden (2004) etc.

3.2.3. Study of fresh plants

Plants were studied in the field as far as possible but after collection the part of plant such as flower and its all floral parts were studied using 20× 12 mm hand jewelry lens. Flowers were dissected under 2×20x magnification and all parts were studied so well. After this study, illustration was also done.

3.2.4. Identification

The herbarium specimens were identified with the help of available literatures. While some of the specimens were identified in the field with the help of literatures and remaining others were confirmed after the field visit by the help of illustration of other flora and by other literatures as well. The literatures used were Flora of British India (Hooker, 1890), The orchids of Sikkim Himalaya (King and Pantling, 1898), Orchids of Nepal (Banerji and Thapa, 1976), Orchids of Nepal Himalaya (Banerji and Pradhan, 1984), Orchid flora of North West Himalaya (Deva and Naithaini, 1986), Orchid flora of Arunachal Pradesh (Chowdhery, 2013), Flora of China (Lin, 2013) etc. Not only this but also the specimens were also confirmed by comparing the standard specimens that are deposited in different herbaria such as KATH, TUCH and different international herbaria such as Royal Botanic Garden, Kew, Orchis herbarium of Oakes, ames, The Natural History Museum, etc.

3.2.5. Study of herbarium specimens

Herbarium specimens were studied by visiting KATH and TUCH. While digital images of herbarium specimens deposited on international herbaria were studied. 105 specimens of 15 species, 1 and only photocopy of illustration, one type specimen and 2 unidentified species were studied on KATH by the help of Radial stereo- microscope of RSM- 4 Model. In TUCH 10 specimens of 5 species were studied. Virtual visit was done on different international herbaria such as BM, E, CAL, K etc.

3.2.6. Illustration and Photograph

Habit sketch of fresh plants were done regularly in the field to the greater extent. After collection the illustration was done when herbarium was prepared. While the illustrations of other species that can't be collected were done by using herbarium specimens deposited in

different herbaria. The illustration included habit sketch, leaf, flower, dorsal sepal, lateral sepal, petal, column and lip as far as possible. Photographs of live plant in their own habitat and also of herbarium deposited in different National herbarium i.e. KATH and TUCH were took.

3.2.7. Construction of Identification key

"Bracketed format" key was prepared. In the genus "*Liparis*", characters of flower were of greater importance. The characters that were used for identifying the genus was habit and habitat, plant height, pseudo bulb, petiole, leaf (number, shape, length and apex), inflorescence length, number of flower, length and shape of floral bracts, length of pedicel and ovary, color of flower, sepal, petal, lip and column shape and size and presence and absence of calli etc.

3.3. Cladistic analysis

This study aims to show the relationship among the orchid species "*Liparis*" that are found in Nepal. The cladistic analysis of the genus "*Liparis*" will be done based on its morphological characters. The cladistic analysis will be performed by using winclada (Nixon, K. C. 1999-2002) and Nona.

Firstly characters were recorded from own collection and different herbarium specimens and data matrix was prepared. Using data matrix character coding for character states were done and the data was kept on Winclada and then tree diagram was obtained by Nona. Single parsimony tree and bootstrap tree with bootstrap value were obtained.

Chapter 4

RESULT

4.1. Morphological Treatment

4.1.1. Habit and Habitat

The genus *Liparis* shows variation in their habitat as some species are terrestrial while some of them are epiphytes (**Table 2**). The size of the plant is variable among different species. They range from small in size to medium size herbaceous plant. The smallest *Liparis* species reported from Nepal is *L. pygmaea* i.e. 5-7 cm in height. The other species are larger in height up to 37 cm as well (**Table 2**) the size of leaf and pseudobulb also differ according to the species.

Eight species of *Liparis* are epiphytic in habitat and mostly recorded on the tree trunk of forest. They are hosted on some specific species such as *L. cespitosa* are mostly recorded on *Ehertia* tree, *L. elliptica* are seen on *Quercus* and *Rhododendron* tree, however *L. perpusilla* and *L. platyrachis* are seen on *Quercus* and *Castanopsis* tree. *L. viridifora* are recorded on *Shorea robusta*, *Schima wallichii*, *Rhododendron* and *Quercus* tree as well. *L. resupinata* is recorded from *Daphniphyllum* species, *Viburnum*, *Zyzyphus incurva* and *Castanopsis* tree as well. *L. stricklandiana* can be found in evergreen broadleaf and coniferous species. Some species also shows a combined habitat of terrestrial and lithophytic as well. The lithophytic species can be reported from the moist forest area in the exposed slopes as well. Generally the humid forest area are suitable for their growth and they mainly shows the distribution ranges from sub tropical region to the temperate region on Nepal (**Table 2**).

All the species under the genus are herbaceous. Field study reveals that the genus is typically found flourishing in the distributed forest patches alongside under the trees, exposed slopes of forest areas while some species only shows their distribution in typical forest i.e. *L. odorata* was only reported under the pine wood in pinus forest. Hence this species are seen flowering in the shady areas and on the edges of rocks or on the slopes and in the trees during the peak monsoon but month varies (**Table 2**).

Table 2. Comparative structure of Habit and Habitat, Plant height, distribution and Flowering time of *Liparis* Rich.

S. N	Name of the species	Habit or Habitat	Plant height	Distribution (m)	Flowering time	Habitat (Epiphytic)
1	<i>L. bootanensis</i>	Lithophytic/ Terrestrial herbs	9-37 cm	1800-2000	July- September	-
2	<i>L. cathcartii</i>	Terrestrial herbs	15-18 cm	3000	July	-
3	<i>L. cespitosa</i>	Epiphytic herb	5.4-10 cm	610-950	July- August	<i>Ehertia</i> tree
4	<i>L. cordifolia</i>	Lithophytic/ Terrestrial herbs	12-16 cm	1500-1650	October	-
5	<i>L. deflexa</i>	Terrestrial herbs	15-28 cm	1000-1100	July- August	-
6	<i>L. elliptica</i>	Epiphytic herb	25-27 cm	1300-2100	November- December	<i>Quercus</i> and <i>Rhododendron</i>
7	<i>L. nervosa</i> var. <i>khasiana</i>	Terrestrial herbs	12-24 cm	1576	July	-
8	<i>L. nervosa</i>	Terrestrial herbs	12-25 cm	950-2000	July- August	-
9	<i>L. glossula</i>	Terrestrial herbs	9-18 cm	1400-3500	July- August	-
10	<i>L. langtangensis</i>	Terrestrial herbs	15-25 cm	3700-3900	July	-
11	<i>L. odorata</i>	Terrestrial herbs	25-35 cm	755 -1590	July- August	-
12	<i>L. olivaceae</i>	Epiphytic herb	15-18 cm	2300	July	-
13	<i>L. perpusilla</i>	Epiphytic herb	5-8cm	1800-2800	August	<i>Quercus</i> and <i>Castonopsis</i>
14	<i>L. petiolata</i>	Terrestrial herbs	17-20 cm	1300-2500	June	-
15	<i>L. plantaginea</i>	Lithophytic/ Terrestrial herbs	25-27 cm	700-725	June-July	-
16	<i>L. platyrachis</i>	Epiphytic herb	10-15 cm	1400-1500	September	<i>Quercus</i> and <i>Castonopsis</i>
17	<i>L. pygmaea</i>	Lithophytic/ Terrestrial herbs	5-7 cm	3200-3500	June- July	-
18	<i>L. rostrata</i>	Terrestrial herbs	7-15 cm	2000-3000	July	-
19	<i>L. viridiflora</i>	Epiphytic herb	15-20 cm	1600	September- October	<i>Shorea robusta</i>
20	<i>L. resupinata</i>	Epiphytic herb	15-20 cm	1800-2600	February - March	<i>Daphniphyllum</i> , <i>Vibernum</i> , <i>Zyzyphus</i> and <i>Castonopsis</i>
21	<i>L. stricklandiana</i>	Epiphytic herb	23-30 cm	1300-2000	October- January	Evergreen broadleaf and coniferous tree

4.1.2. Pseudobulb

It is the most important, well developed and long-lived storage organs which can be found in all species of *Liparis*. Pseudobulb is of different shapes and sizes and varies according to the species. A few species such as *L. bootanensis*, *L. perpusilla*, *L. platyrachis*, *L. elliptica* and *L. plantaginea* have oblong to narrowly oblong pseudobulbs while most of the species such as *L. cathcartii*, *L. cespitosa*, *L. deflexa*, *L. glossula*, *L. langtangensis*, *L. nervosa* var. *khasiana*, *L. odorata*, *L. pygmaea*, *L. rostrata* and *L. cordifolia* have ovoid pseudobulbs. While other various types of pseudobulbs are seen in other species of *Liparis* (**Table 3**). In most of the species, the pseudobulb are densely or compactly arranged and are covered by white membranous sheath while in some species they are not arranged densely. In *L. rostrata* pseudobulbs are tufted on short rootstock.

Pseudobulbs not only vary in shape but they also vary in sizes as well. The pseudobulbs in this species range from 2 mm- 4.5 cm in length (**Table 3**). Smallest pseudobulb among different species of *Liparis* found in Nepal is reported in *Liparis cordifolia* (0.2-0.25 cm) while largest one is reported in *Liparis bootanensis* (3-4.5 cm).

4.1.3. Phyllotaxy

Leaf number and leaf arrangement vary among different species of *Liparis*. Some species such as *L. bootanensis*, *L. cespitosa*, *L. cordifolia*, *L. glossula*, have solitary leaf while other have two or more than two (**Table 3, Figure 1**).

In most of the species, leaves arise from the apex of the pseudobulb such as *L. bootanensis*, *L. cathcartii*, *L. deflexa*, *L. pygmaea* etc. In some of the species petiole works as a stem and the leaf are contracted into a petiole and covered by white membranous sheaths but some of the species are sessile (**Table 3, Figure 1**).

Table 3. Comparative structure of shape and size of pseudobulb, leaf number and presence and absence of petiole.

S.N	Name of species	Shape of pseudobulb	Size of pseudobulb	Leaf number	petiole/ sessile
1	<i>L. bootanensis</i>	Narrowly oblong	3-4.5 cm	1	Sessile
2	<i>L. cathcartii</i>	Ovoid	1.5-2.5 cm	2	sheathed
3	<i>L. cespitosa</i>	Ovoid	0.3-0.5 cm	1	petioled
4	<i>L. cordifolia</i>	Ovoid	0.2-0.25 cm	1	sheathed
5	<i>L. deflexa</i>	Ovoid	1.5-2.5 cm	2	sheathed
6	<i>L. elliptica</i>	Oblong	1.5-2.9 cm	2	sessile
7	<i>L. nervosa var khasiana</i>	Ovoid	1-1.5 cm	2-3	subsessile
8	<i>L. nervosa</i>	Narrowly ovoid	0.5-1 cm	2-3	Sessile
9	<i>L. glossula</i>	Ovoid	1.5-2 cm	1	sheathed
10	<i>L. langtangensis</i>	Ovoid	0.5-2.5 cm	2	petioled
11	<i>Liparis odorata</i>	Sub ovoid	0.9-1.8 cm	2- more	sheathed
12	<i>Liparis olivaceae</i>	Ovate- obtuse	1.3 cm	2	Sessile
13	<i>Liparis perpusilla</i>	Oblong	0.9-1 cm	3-5	Sessile
14	<i>Liparis petiolata</i>	Ovoid	1.8-2 cm	2	Sheathed
15	<i>Liparis plantaginea</i>	Narrowly ovoid-oblong	2-3.5 cm	2	Sheathed
16	<i>Liparis platyrachis</i>	Oblong	1-2 cm	3-5	Petioled
17	<i>Liparis pygmaea</i>	Narrowly ovoid	1-1.5 cm	2	Sheathed
18	<i>Liparis rostrata</i>	Ovoid	1.5-2 cm	2	Sheathed
19	<i>Liparis viridiflora</i>	Orbicular	1.5-4 cm	2	Petioled
20	<i>Liparis resupinata</i>	Sub- cylindric	2-2.5 cm	3-4	Subsessile
21	<i>Liparis stricklandiana</i>	Sub oblong	1.5-3 cm	2	Petioled

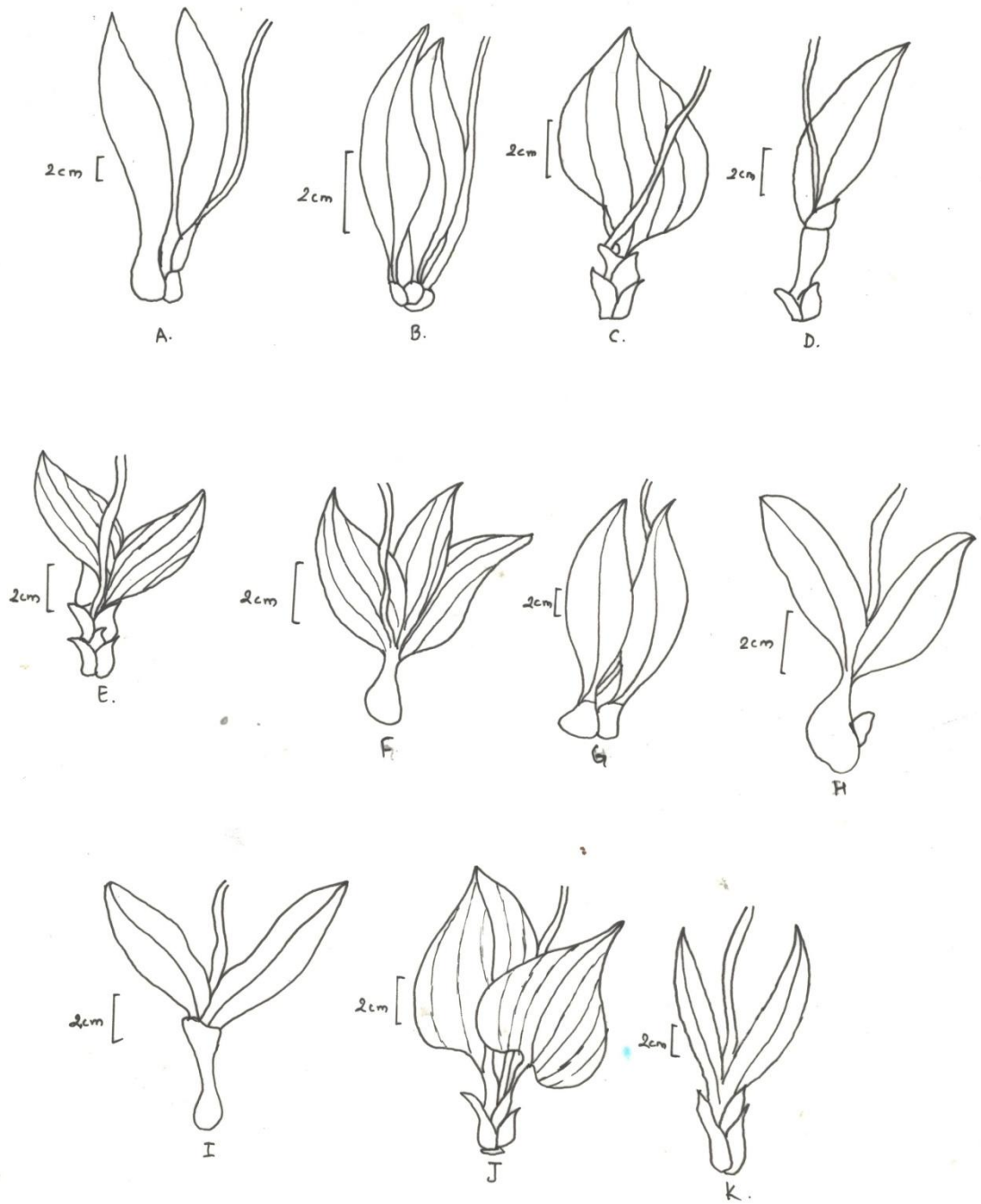


Fig. 1 Phyllotaxy of *Liparis* species A. *L. bootanensis*, B. *L. cespitosa*, C. *L. cordifolia*, D. *L. glossula*, E. *L. cathcartii*, F. *L. deflexa*, G. *L. elliptica*, H. *L. langtangensis*, I. *L. olivaceae*, J. *L. petiolata*, K. *L. plantaginea*,

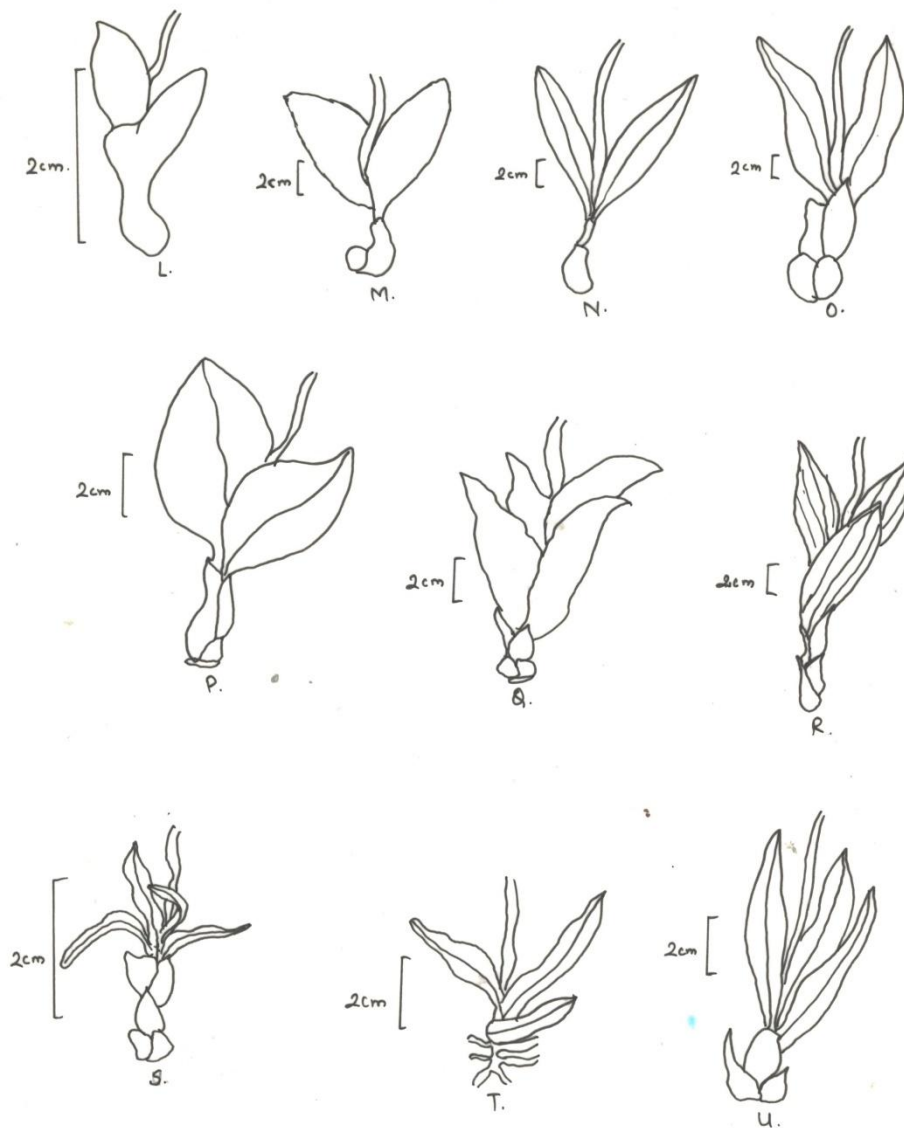


Fig. 1 Contd... L. *L. pygmaea*, M. *L. rostrata*, N. *L. viridiflora*, O. *L. stricklandiana*, P. *L. nervosa* , Q. *L. nervosa* var. *khasiana*, R. *L. odorata*, S. *L. perpusilla*, T. *L. platyrachis*, U. *L. resupinata*.

4.1.4. Leaves

Leaves of *Liparis* are thinly textured to coriaceous. The leaves of the species show variation in their shape, size, petiole etc.

Leaf shape in *Liparis* varies from ovate- lanceolate- elliptic- oblong. Most of the species have ovate leaf shape such as *L. cathcartii*, *L. deflexa*, *L. nervosa* var *khasiana*, *L. langtangensis*, *L. rostrata* and *L. pygmaea*. While others have broadly ovate, oblong or lanceolate to oblanceolate leaf shape (**Table 4, Figure 2**).

Length of leaf varies from species to species as smallest leaf can be found in *L. pygmaea* i.e. (0.8-1) cm, while largest leaf is found in *L. bootanensis* and *L. stricklandiana* which ranges up to 21.5 cm other species have leaf size in between 0.8- 21.5 cm (**Table 4**).

Presence and absence of petiole and also length in those species in which petioles are present also varies in different species of *Liparis*. In most of the species in which petiole present are sheathed and it is also covered by membranous sheaths. Only some species are sessile such as *L. bootanensis*, *L. elliptica*, *L. nervosa*, *L. nervosa* var *khasiana*, *L. olivaceae*, *L. perpusilla* and *L. resupinata* while petiole is present in other species of *Liparis* (**Table 3**).

Leaf apex of *Liparis* species varies according to the species, most of the species have acute leaf apex such as *L. bootanensis*, *L. cespitosa*, *L. cordifolia*, *L. elliptica*, *L. glossula*, *L. platyrachis*, *L. pygmaea* while acuminate leaf apex were seen in *L. deflexa*, *L. odorata*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. plantaginea*, *L. resupinata*, *L. stricklandiana* only some of them have obtuse apex such as *L. cathcartii*, *L. langtangensis* and *L. rostrata* and subacuminate leaf apex were seen on *L. nervosa* and *L. nervosa* var. *khasiana* (**Table 4**).

Leaf margin in most of the species of *Liparis* is entire but only few have different margins such as *L. resupinata* have slightly serrate leaf margin, *L. rostrata* have irregularly toothed margin and some have entire to slightly wavy margin.

Leaves of terrestrial genus were mostly broad and thin but the leaves present in epiphytic species are coriaceous, thick and narrow.

4.1.5. Inflorescence

Inflorescence in *Liparis* is always a terminal raceme. Some of the species have erect inflorescence while the others have pendulous inflorescence. Number of flowers varies from below 10 to more than 20 or more (**Table 4**). Arrangement of flowers can be seen arranged from laxly to densely flowered.

The peduncle in most of the species is winged and raceme of different species varies in size and number of flowers as well. Length of inflorescence varies in species from 2.5-30 cm as

well. Inflorescence of smallest length can be seen in *L. pygmaea* i.e. 4-5.5 cm while the longest one was reported in *L. stricklandiana* i.e. up to 30 cm. Other species has also variable in size of inflorescence (**Table 4**).

4.1.6. Bracts

Floral bracts are present in almost all the species of *Liparis* reported from Nepal, but few sterile bracts are also seen in some species when they are young. The shape of floral bracts shows some variation as they are triangular in some such as *L. langtangensis*, *L. stricklandiana*, *L. platyrachis*, *L. caespitosa* while other have lanceolate to ovate floral bracts. Most of the species have lanceolate floral bracts such as *L. bootanensis*, *L. cathcartii*, *L. deflexa*, *L. elliptica*, *L. odorata*, *L. olivaceae*, *L. perpusilla*, *L. petiolata*, *L. plantaginea*, *L. viridiflora* and *L. resupinata*.

Length of floral bracts also varies from 1 mm- 14 mm in length among different species while some species have longer floral bracts than pedicel and ovary i.e. *L. bootanensis*, *L. petiolata*, in some they are equal i.e. *L. caespitosa*, *L. elliptica*, *L. olivaceae*, *L. perpusilla*, *L. viridiflora* but in some species pedicel and ovary are longer than floral bracts they are *L. cathcartii*, *L. cordifolia*, *L. deflexa*, etc. (**Table 4, Figure 3**).

4.1.7. Flowers

Most of the species of *Liparis* have flowers arranged spirally on rachis but in some flowers are not arranged spirally. Flowers are usually resupinate and often translucent. The color flowers are different among different species of *Liparis* and it varies from dull yellow to dull green, brownish tinged with purple in some (**Table 5**).

Flowers are usually resupinate in this genus and are not so big but in some species flowers are so small that it becomes so hard to study with naked eye. Smallest flowers in *Liparis* are reported in *L. caespitosa*, other many species also have very small flowers. The flowers are not so long lived as they fall early when they become mature; also their development is almost similar.

Table 4. Comparative structure of Leaf (shape, length, apex); Number of flower, inflorescence length, Bract shape and length

S.N	Name of species	Leaf shape	Leaf length	Leaf apex	Leaf Margin	No. of flowers	Inflorescence length	Bract shape	Bract length
1	<i>L. bootanensis</i>	Oblanceolate	15-21.5 cm	acute	Entire	below 10	23 cm	Lanceolate	6-9 mm
2	<i>L. cathcartii</i>	ovate	5.9-7.5 cm	obtuse	Entire	below 10	4.6-8 cm	lanceolate	1-4 mm
3	<i>L. cespitosa</i>	oblong	3.5-6.5cm	acute	Entire	more than 10	2.5-4.5 cm	triangular	2-3mm
4	<i>L. cordifolia</i>	broadly ovate	6-10 cm	acute	Usually entire	below 10	7-15 cm	ovate	0.5-1.2 mm
5	<i>L. deflexa</i>	ovate	6-13 cm	acuminate	Entire	below 10	8-12 cm	lanceolate	4-5 mm
6	<i>L. elliptica</i>	elliptic	6-15cm	acute	Entire	more than 10	10-15 cm	lanceolate	4-5 mm
7	<i>L. nervosa var. khasiana</i>	ovate	7-10 cm	subacuminate	Entire to wavy	9-10 flowered	8-9 cm	lanceolate	4-7 mm
8	<i>L. nervosa</i>	ovate-elliptic	6-9.5 cm	subacuminate	Entire	more than 10	5-10 cm	deltoid	2-4mm
9	<i>L. glossula</i>	oblong	8-10 cm	acute	Entire	below 10	5-9 cm	lanceolate	6-14 mm
10	<i>L. langtangensis</i>	oblanceolate	5-6 cm	obtuse	Entire	below 10	11-15 cm	triangular	1-2 mm
11	<i>L. odorata</i>	lanceolate	12.5-18.9 cm	acuminate	Entire	more than 10	10.1-22.2 cm	lanceolate	5-6mm
12	<i>L. olivaceae</i>	lanceolate	5-9 cm	acuminate	Folded to entire	10	9-18 cm	lanceolate	3-4 mm
13	<i>L. perpusilla</i>	lanceolate	1.3-2.4 cm	acuminate	Entire	10	2.7-4 cm	lanceolate	2-3 mm
14	<i>L. petiolata</i>	broadly ovate	7.3-9.8 cm	acuminate	Entire	more than 10	5.4-14.9 cm	lanceolate	9-11 mm
15	<i>L. plantaginea</i>	oblong	13-15.5 cm	acuminate	Slightly crenate to entire	15-20 flowered	14-15 cm	lanceolate	8-9 mm
16	<i>L. platyrachis</i>	lanceolate	1-4 cm	acute	Slightly wavy to entire	8-15 flowered	6-7 cm	triangular	2-5 mm
17	<i>L. pygmaea</i>	ovate	0.8-1.1 cm	acute	Entire	2-4 flowered	4-5.5 cm	lanceolate	3-5 mm
18	<i>L. rostrata</i>	ovate	3-10 cm	obtuse	Entire	6-10 flowered	10-15 cm	ovate	1-1.5 mm
19	<i>L. viridiflora</i>	Oblanceolate	7-15.5 cm	apiculate	Entire	more than 10	8.5-20.5 cm	lanceolate	3-6 mm
20	<i>L. resupinata</i>	lanceolate	2.5-8 cm	acuminate	Slightly serrate	more than 10	3.5-12 cm	lanceolate	2-4 mm
21	<i>L. stricklandiana</i>	Oblanceolate	10-21.5 cm	acuminate	Wavy, entire	more than 10	12-30 cm	subulate	5-7 mm

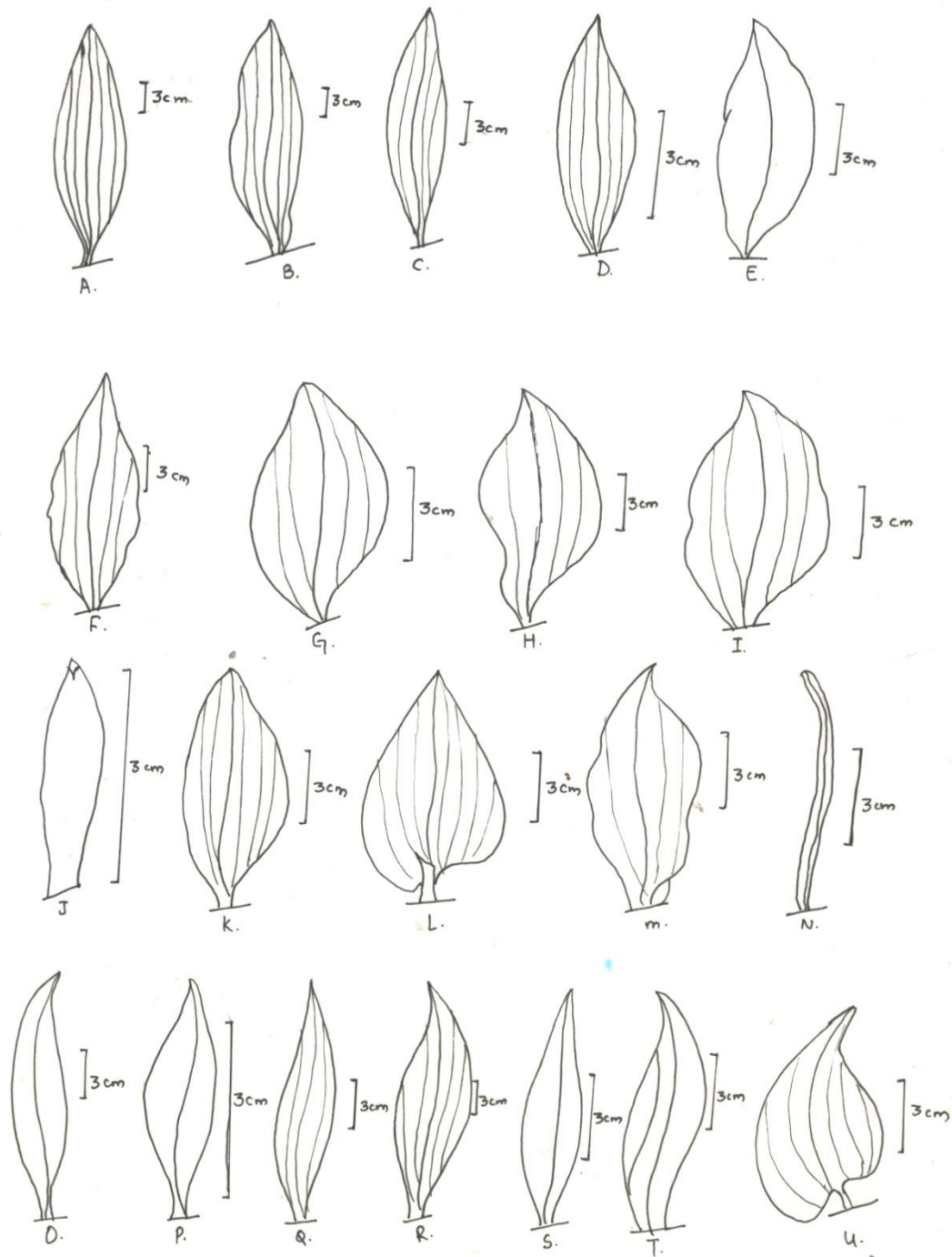


Fig. 2 Variation of leaf on different species of *Liparis* (A. *L. bootanensis*, B. *L. stricklandiana* and C. *L. viridiflora*) oblanceolate type, (D. *L. cespitosa*, E. *L. glossula* and F. *L. plantaginea*) oblong type, (G. *L. cathcartii*, H. *L. deflexa*, I. *L. nervosa* var. *khasiana*, J. *L. pygmaea*, K. *L. rostrata*, L. *L. petiolata*, M. *L. langtangensis*) ovate type, (N. *L. nervosa*, O. *L. elliptica*) elliptic type, (P. *L. platyrachis*, Q. *L. perpusilla*, R. *L. odorata*, S. *L. resupinata*, T. *L. olivacea*) lanceolate type, (U. *L. cordifolia*) broadly ovate.

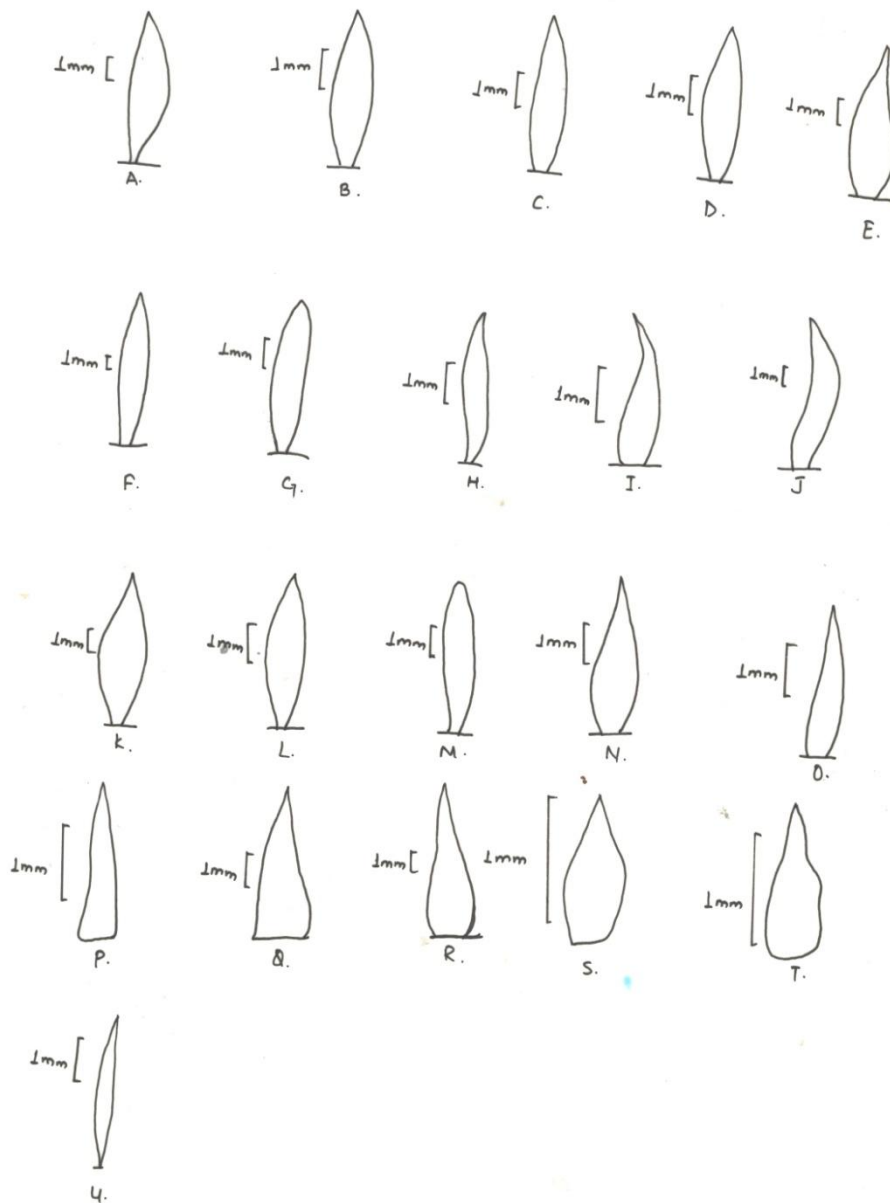


Fig. 3: Variation in floral bracts on different species of *Liparis* (A. *L. bootanensis*, B. *L. cathcartii*, C. *L. deflexa*, D. *L. elliptica*, E. *L. nervosa* var. *khasiana*, F. *L. glossula*, G. *L. odorata*, H. *L. olivaceae*, I. *L. perpusilla*, J. *L. petiolata*, K. *L. plantaginea*, L. *L. pygmaea*, M. *L. viridiflora*, N. *L. resupinata*) Lanceolate bracts, (O. *L. cespitosa*, P. *L. langtangensis*, Q. *L. platyrachis*, R. *L. stricklandiana*) Triangular bracts, (S. *L. cordifolia*, T. *L. rostrata*) ovate bracts, (U. *L. nervosa*) deltoid bracts.

4.1.8. Sepal

Sepals found in *Liparis* are in two forms i.e. dorsal sepal and lateral sepals. Sepals are mostly spreading. In most of the species dorsal and lateral sepals are not so similar in size i.e. *L. nervosa* and others (**Table 5**) but are similar in some of the species such as *L. elliptica*. Sepal length mostly varies from 1- more than 5 mm in length (**Table 5**). The sepals are turned downwards and the dorsal sepal is free but the lateral sepals are sometimes fused for at least part of their length. Margin of the sepals in almost all species of *Liparis* are revolute and with obtuse apex with 3- veined.

The lateral sepal in almost all species of *Liparis* lay parallel under the lip. The shape of sepals also varies from ovate- oblong or lanceolate to elliptic as well (**Table 5, Figure 4 and 5**).

4.1.9. Petals

Petals are free, mostly reflexed, and often linear and are unlike sepals. Petals in this species are spreading. Their shape mostly varies from linear (*L. bootanensis*, *L. cespitosa*, *L. nervosa* var. *khasiana*, *L. glossula*, *L. langtangensis*, *L. odorata*, *L. olivaceae*, *L. perpusilla* etc.) and filliform i.e. (*L. cathcartii*, *L. cordifolia*, etc) (**Table 5**). The length of petals also varies from species to species i.e. ranges from 2-8 mm in length (**Table 5**).

4.1.10. Lip

Lip present in *Liparis* species is often reflexed. They are ovate, oblong, or flabellate also they are entire or lobed in some. The lip of this *Liparis* species have basal callus in them but they lack spur.

The morphological variation is clearly seen in the lip of *Liparis* species. They vary on shape, size, margin, color and presence or absence of calli. The lip is shortly clawed in some species such as *L. langtagensis* and *L. plantaginea*. Shape of lip in some species are found flat, while in some it is decurved from middle or near the base (**Table 6**). Lip among the species also varies in margin as some have toothed, some have dentate and irregular but only some of them are regular in margin.

Presence of calli on the lip is its main feature but it is exceptional from some species as they don't have callus on their lip (**Table 6**). Number of callus in the species of *Liparis* in which callus are present is two, in some it is separated by septum, while in some they are indistinct. Lip is one of the most important taxonomical characters of *Liparis*.

Table 5. Comparative structure of Color of flower, Sepal (length and shape), Petal

S. N	Name of species	Color of flower	Dorsal sepal	Lateral Sepal	Shape of sepal	Shape of petal	Length of Petal
1	<i>L. bootanensis</i>	Yellow to pale brown	4-6×1-2.1 mm	3-5.5×1.1-2.3 mm	Lanceolate or ovate/oblong	linear	5-6.5 × 0.3 mm
2	<i>L. cathcartii</i>	Greenish- brownish	9-10×1-1.1 mm	8-9×ca. 2 mm	Oblique	Filliform	7.9×0.2 mm
3	<i>L. cespitosa</i>	White to green	2.5×0.3 mm	1.5×0.4 mm	Elliptic-oblong	linear	3-3.5mm
4	<i>L. cordifolia</i>	Green or pale green	6-7×1.5mm	5-5.6× ca. 1.3 mm	Lanceolate	linear	5-5.6×0.3 mm
5	<i>L. deflexa</i>	Yellowish green	8×0.9 mm	4×1.1 mm	Oblong	Filliform	5mm
6	<i>L. elliptica</i>	Pale yellowish to green	3-4×1-1.2 mm	3-4.5×1-1.5 mm	Oblong-lanceolate	Filliform	3-4.5×0.2mm
7	<i>L. nervosa var khasiana</i>	Purpule	3-4.5×1-1.5 mm	4-5×1.5-2 mm	Oblong-lanceolate	linear-oblong	4.5-5.5×0.5mm
8	<i>L. nervosa</i>	Greenish yellow or purpulish	8-9×0.5-1 mm	4-5×1.5-2 mm	Linear-ovate	Filliform	7-8×0.5mm
9	<i>L. glossula</i>	purpulish red	9-10×0.4-0.5 mm	10-11 ×0.6-0.7 mm	Oblong-lanceolate	linear	10-13 mm
10	<i>L. langtangensis</i>	Deep violet	6.8×0.5-1 mm	6-7 ×1-1.2 mm	Oblong-lanceolate	linear	9-10×0.7 mm
11	<i>L. odorata</i>	Greenish brown or reddish gren	6×1 mm	5×1.2 mm	ovate	linear	5×0.3mm
12	<i>L. olivaceae</i>	Yellowish to greenish	1.8 mm	1.5 mm	Linear-oblong or obtuse	linear	3 mm
13	<i>L. perpusilla</i>	Orange to yellow or pinkish	4 ×0.1 mm	3.5×0.5 mm	Broadly elliptic	linear	3.5-4 mm
14	<i>L. petiolata</i>	Pinkish green to yellowish red	9.5×1 mm	9 ×1.1 mm	Linear or lanceolate	linear	10×0.4 mm
15	<i>L. plantaginea</i>	Green	10-11×0.1-1 mm	7-9 ×1-1.1 mm	Lanceolate or oblong	linear	9-10×0.1 mm
16	<i>L. platyrachis</i>	Greenish- brownish yellow	0.5-1	1-1.1 mm	Oblique or elliptic	linear	2-2.5 ×0.3-0.4 mm
17	<i>L. pygmaea</i>	Yellowish	6-7×1.1-1.2 mm	6-7 ×1-2 mm	Oblong or linear	linear	5-8 mm
18	<i>L. rostrata</i>	Yellowish green to purpulish	5-8 ×1-2 mm	5-6 ×1-2.5 mm	Oblong or laneolate	Filliform	5-7×0.1 mm
19	<i>L. viridiflora</i>	Greenish white to yellowish	1.9-2.5 ×0.5-0.8 mm	1.9-2 ×0.9-10 mm	Oblong or subelliptic	linear	2-3×ca. 0.2 mm
20	<i>L. resupinata</i>	Pale greenish yellow orange or brick red	2 ×1.5 mm	3-4 ×0.9-1 mm	Oblong or elliptic	narrowly linear	2.1× 0.5 mm
21	<i>L. stricklandiana</i>	Greenish yellow	4-4.5 × 1.5-1.7	4-4.5 × 1.5-2 mm	Oblong - obovate	Filliform	4.5× ca. 0.5 mm

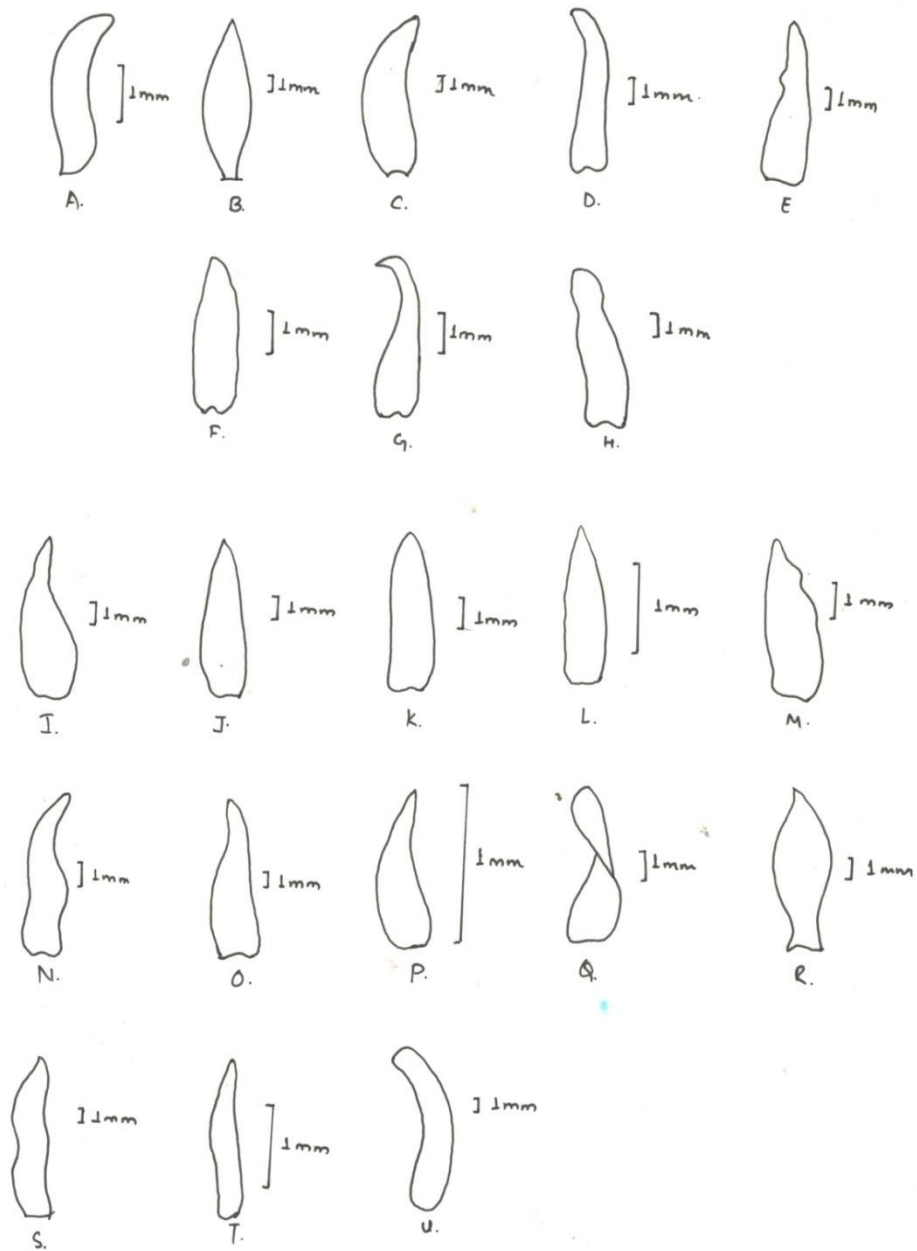


Fig. 4 variation in dorsal sepal on different species of *Liparis* A. *L. bootanensis*, B. *L. cathcartii*, C. *L. cespitosa*, D. *L. cordifolia*, E. *L. deflexa*, F. *L. elliptica*, G. *L. nervosa* var. *khasiana*, H. *L. nervosa*, I. *L. glossula*, J. *L. langtangensis*, K. *L. odorata*, L. *L. olivaceae*, M. *L. perpusilla*, N. *L. petiolata*, O. *L. plantaginea*, P. *L. platyrachis*, Q. *L. pygmaea*, R. *L. rostrata*, S. *L. viridiflora*, T. *L. resupinata*, U. *L. stricklandiana*

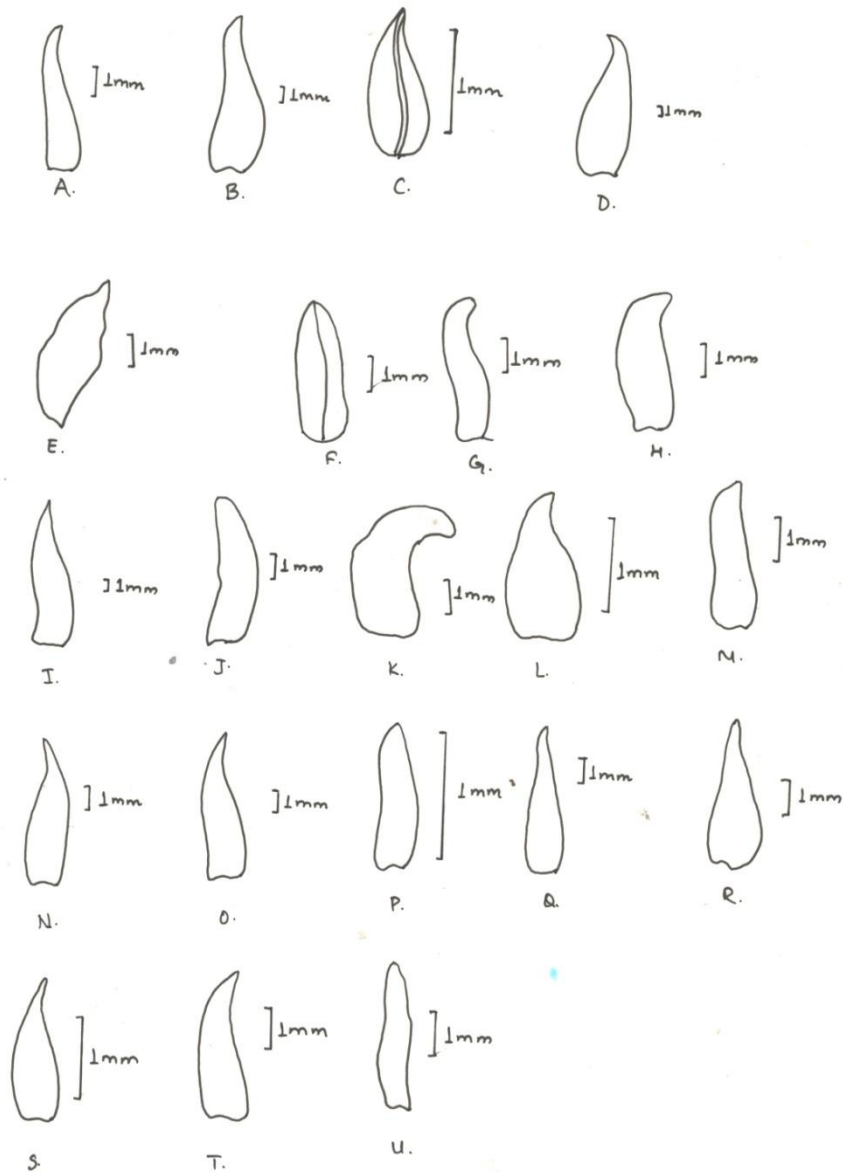


Fig. 5 variation in lateral sepal on different species of *Liparis* A. *L. bootanensis*, B. *L. cathcartii*, C. *L. cespitosa*, D. *L. cordifolia*, E. *L. deflexa*, F. *L. elliptica*, G. *L. nervosa* var. *khasiana*, H. *L. nervosa*, I. *L. glossula*, J. *L. langtangensis*, K. *L. odorata*, L. *L. olivaceae*, M. *L. perpusilla*, N. *L. petiolata*, O. *L. plantaginea*, P. *L. platyrachis*, Q. *L. pygmaea*, R. *L. rostrata*, S. *L. viridiflora*, T. *L. resupinata*, U. *L. stricklandiana*

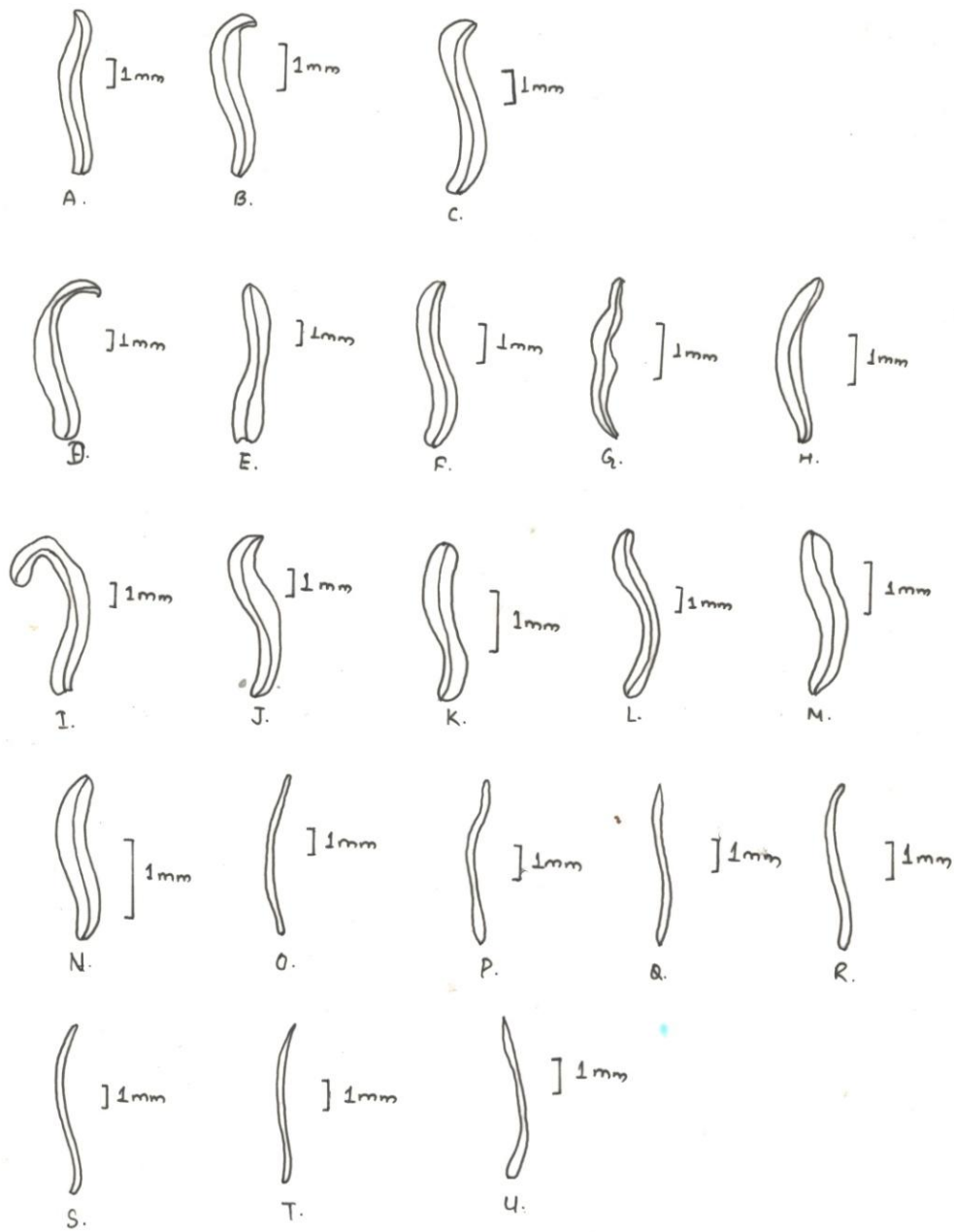


Fig. 6 variation in Petal on different species of *Liparis* (A. *L. bootanensis*, B. *L. cespitosa*, C. *L. nervosa* var. *khasiana*, D. *L. glossula*, E. *L. langtangensis*, F. *L. odorata*, G. *L. olivaceae*, H. *L. perpusilla*, I. *L. petiolata*, J. *L. plantaginea*, K. *L. platyrachis*, L. *L. pygmaea*, M. *L. viridiflora*, N. *L. resupinata*) Linear (O. *L. cathcartii*, P. *L. cordifolia*, Q. *L. deflexa*, R. *L. elliptica*, S. *L. nervosa*, T. *L. rostrata*, U. *L. stricklandiana*) Filliform

4.1.11. Column

Column is found incurved to arcuate or clavate and also erect in some of the species (Table 5). They are long and are clearly seen in flowers, they are mostly winged at apex only while some of them are not winged at apex (Table 6, Figure 8) as sometimes the wing are at base. Anther cap are attached by slender filament and are 2-locular.

Pollinia are found four in number in 2 pairs which are mostly waxy, ovoid, bilaterally flattened, among 2 pairs each pair contain a small viscidium and rostellum are thinly textured and blunt. Length of column varies in between different species of *Liparis* i.e. from 1-33 mm long as well (Table 6). Longest column are reported in *Liparis rostrata* i.e. 2-33 mm while smallest one was noted in *L. caespitosa* i.e. 1mm. Column is the most important character for this genus *Liparis*.

4.1.12. Fruit/ Capsule

Capsule found in all species of *Liparis* are different in some. They vary from obovoid, ellipsoid, oblong, globose, clavate to terete in shape. They are found in numerous numbers or sometimes few in a fruiting pedicel. The size of capsule differs and also depends on length of plants and flowers as well. In most of the species, the lip, petals and also sepal may remain for long with ripening capsule which helps in identification of the species. Capsule in *L. bootanensis* is obovoid- ellipsoid or clavate to terete and is of 8-9 mm in length. *L. caespitosa* has ellipsoid to globose capsule and is 3.8-4 mm in length. Capsule of *L. cathcartii* is ellipsoid to clavate and 11-12 mm in length. *L. cordifolia* have obovoid to ellipsoid capsule with length of 7-10mm. *L. deflexa* has obovoid- oblong capsule and are ca. 17 mm in length. *L. elliptica* has clavate or obovoid capsule and are 6-7 mm in length. *L. nervosa* has oblong to ellipsoid capsule and length varies from 14-16 mm. *L. odorata* has clavate to obovoid-oblong or ellipsoid as well and are 10-15 mm in length. *L. perpusilla* has ellipsoid capsule are are small in size i.e. 3-4mm. *L. petiolata* has clavate to terete also ellipsoid with length 10-15mm and only few capsules are seen, *L. plantaginea* has globose to obovoid with length of 15-17mm. *L. platyrachis*, *L. pygmaea* and *L. rostrata* has obovoid capsule with length of 5mm, 3mm and 8-9mm respectively. *L. resupinata* has obovoid- oblongoid capsule and with length of 5-8mm. *L. stricklandiana* has obovoid – ellipsoid capsule with length 10-11mm. *L. viridiflora* has globose to ellipsoid with length 4-5 mm. Capsules of other four species can't be studied due to lack of herbarium specimens deposited with capsules.

Table 6. Comparative structure of Lip and column of different species of *Liparis* Rich.

S.N	Name of species	Shape of lip	Calli	Column shape	Column (winged/wingless)	Column (length)
1	<i>L. bootanensis</i>	deflexed from below middle	2	curved	winged	3-5mm
2	<i>L. cathcartii</i>	deflexed from middle	2	arcuate	winged	3-3.5 mm
3	<i>L. cespitosa</i>	narrow base and decurved about the middle	2	slightly curved	winged	1mm
4	<i>L. cordifolia</i>	deflexed from the base	2	strongly curved about middle	winged	3-4mm
5	<i>L. deflexa</i>	flat	2	slightly curved	Wingless	4mm
6	<i>L. elliptica</i>	decurved about the middle	absent	erect	wingless	1.5 mm
7	<i>L. nervosa var khasiana</i>	decurved about the middle	2	curved	winged	2.5-3 mm
8	<i>L. nervosa</i>	decurved from middle	2	stout	winged	3-4 mm
9	<i>L. glossula</i>	deflexed about middle	absent	slightly curved	winged	3-4 mm
10	<i>L. langtangensis</i>	deflexed	absent	arcuate	winged	3-4mm
11	<i>L. odorata</i>	deflexed	2	slightly arcuate	winged	3-4 mm
12	<i>L. olivaceae</i>	flat	2	stout	winged	3-4 mm
13	<i>L. perpusilla</i>	deflexed at middle	2	erect	winged	1.5-2 mm
14	<i>L. petiolata</i>	flat	2	arcuate	winged	3 mm
15	<i>L. plantaginea</i>	decurved from base	2	slightly curved	winged	3-4mm
16	<i>L. platyrachis</i>	deflexed about middle	4	erect	winged	1-2 mm
17	<i>L. pygmaea</i>	slightly deflexed about middle	2	erect	winged	2-2.3 mm
18	<i>L. rostrata</i>	flat	absent	slightly arcuate	winged	2-3 mm
19	<i>L. viridiflora</i>	recurved from middle	absent	slightly curved	winged	2mm
20	<i>L. resupinata</i>	Forming epichile and hypochile	Present	erect	winged	2mm
21	<i>L. stricklandiana</i>	decurved from base	2	slightly arcuate	winged	3-3.5 mm

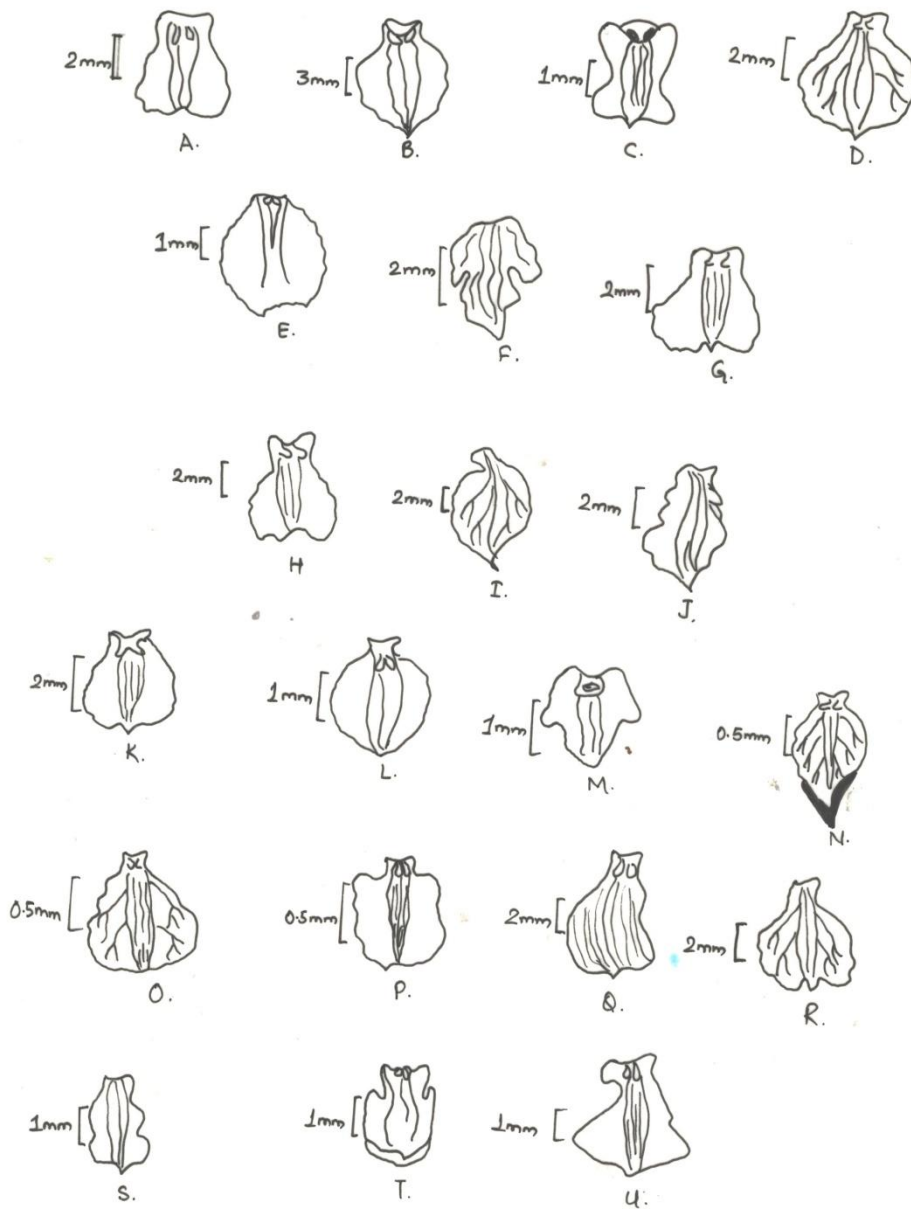


Fig. 7 variation in Lip on different species of *Liparis* A. *L. bootanensis*, B. *L. cathcartii*, C. *L. cespitosa*, D. *L. cordifolia*, E. *L. deflexa*, F. *L. elliptica*, G. *L. nervosa* var. *khasiana*, H. *L. nervosa*, I. *L. glossula*, J. *L. langtangensis*, K. *L. odorata*, L. *L. olivaceae*, M. *L. perpusilla*, N. *L. petiolata*, O. *L. plantaginea*, P. *L. platyrachis*, Q. *L. pygmaea*, R. *L. rostrata*, S. *L. viridiflora*, T. *L. resupinata*, U. *L. stricklandiana*

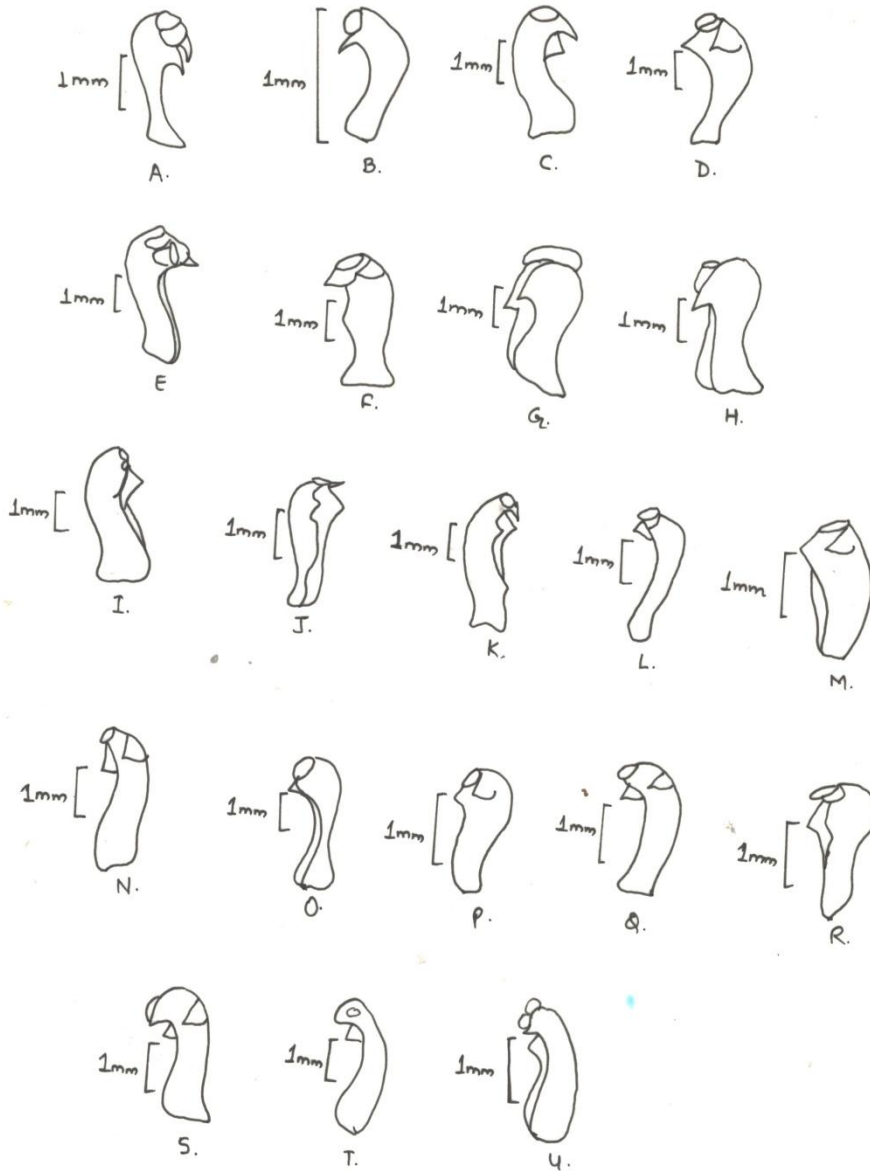


Fig. 8 variation in Column on different species of *Liparis* A. *L. bootanensis*, B. *L. cathcartii*, C. *L. cespitosa*, D. *L. cordifolia*, E. *L. deflexa*, F. *L. elliptica*, G. *L. nervosa* var. *khasiana*, H. *L. nervosa*, I. *L. glossula*, J. *L. langtangensis*, K. *L. odorata*, L. *L. olivaceae*, M. *L. perpusilla*, N. *L. petiolata*, O. *L. plantaginea*, P. *L. platyrachis*, Q. *L. pygmaea*, R. *L. rostrata*, S. *L. viridiflora*, T. *L. resupinata*, U. *L. stricklandiana*

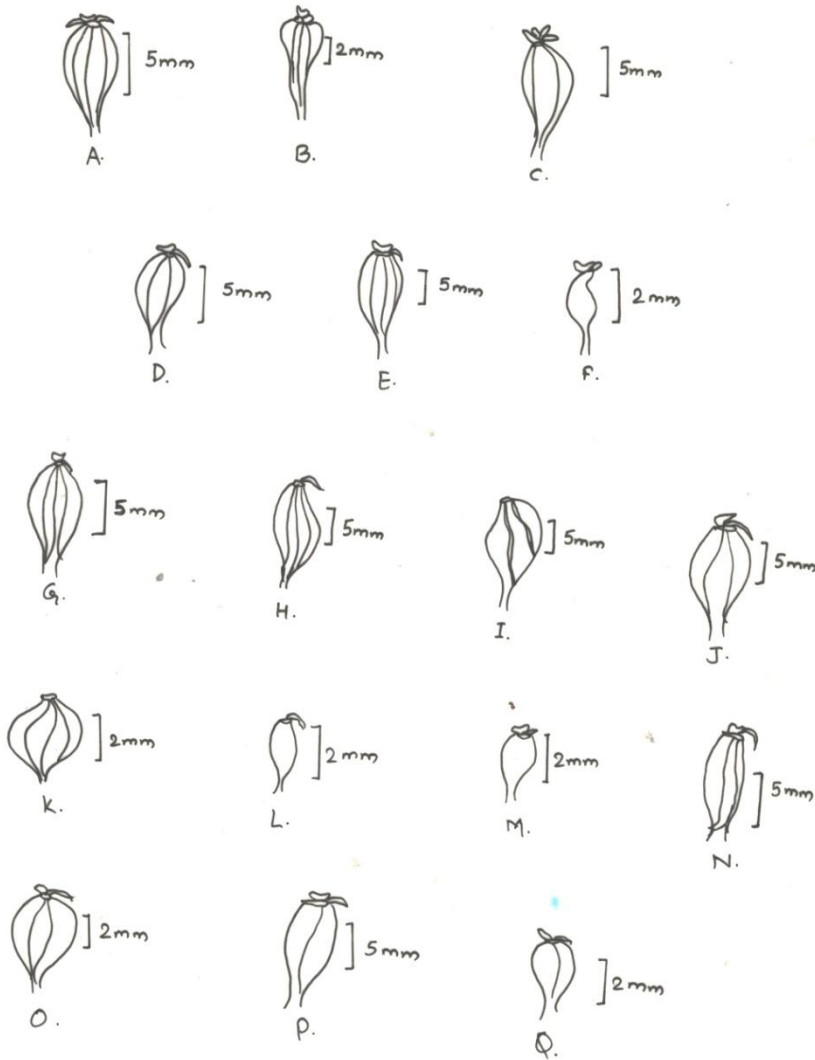


Fig. 9 variation in Capsule on different species of *Liparis* A. *L. bootanensis*, B. *L. cespitosa*, C. *L. cathcartii*, D. *L. cordifolia*, E. *L. deflexa*, F. *L. elliptica*, G. *L. nervosa*, H. *L. odorata*, I. *L. petiolata*, J. *L. plantaginea*, K. *L. platyrachis*, L. *L. pygmaea* M. *L. perpusilla*, N. *L. rostrata*, O. *L. resupinata*, P. *L. stricklandiana* Q. *L. viridiflora*

4.2. Taxonomic treatment

Liparis Richard, De Orchid. Eur: 21, 30, 38. (1817) nom. Cons.; Gen. Sp. Orchid: 26. (1840); J.D. Hooker, Fl. Brit.Ind.5: 691. (1890); King and Pantling, Ann. Bot. Gar. Calc. 8: 22. (1898); Banerji & Pradhan, Orch. Nepal Himalaya: 270. (1984); Chen *et al.*, Fl. China. 25: 211. 2009

Pseudorchis Gray in Nat. Arr. Brit. Pl. 2: 213 (1821 publ. 1822), nom. Illeg.

Empusa Lindl. in Bot. Reg. 10: t. 825 (1824)

Anistylis Raf. in Neogenyton: 4 (1825)

Sturmia Rchb. in Iconogr. Bot. Pl. Crit. 4: 39 (1826), nom. illeg.

Paliris Dumort. in Fl. Belg.: 134 (1827)

Empusaria Rchb. in Consp. Regn. Veg.: 69 (1828)

Platystylis Lindl. in Gen. Sp. Orchid. Pl.: 18 (1830), nom. illeg.

Mesoptera Raf. in Herb. Raf.: 73 (1833), nom. rej.

Platystyliparis Marg. in Richardiana 7: 35 (2006)

Ypsilorchis Z.J.Liu, S.C.Chen & L.J.Chen in J. Syst. Evol. 46: 623 (2008)

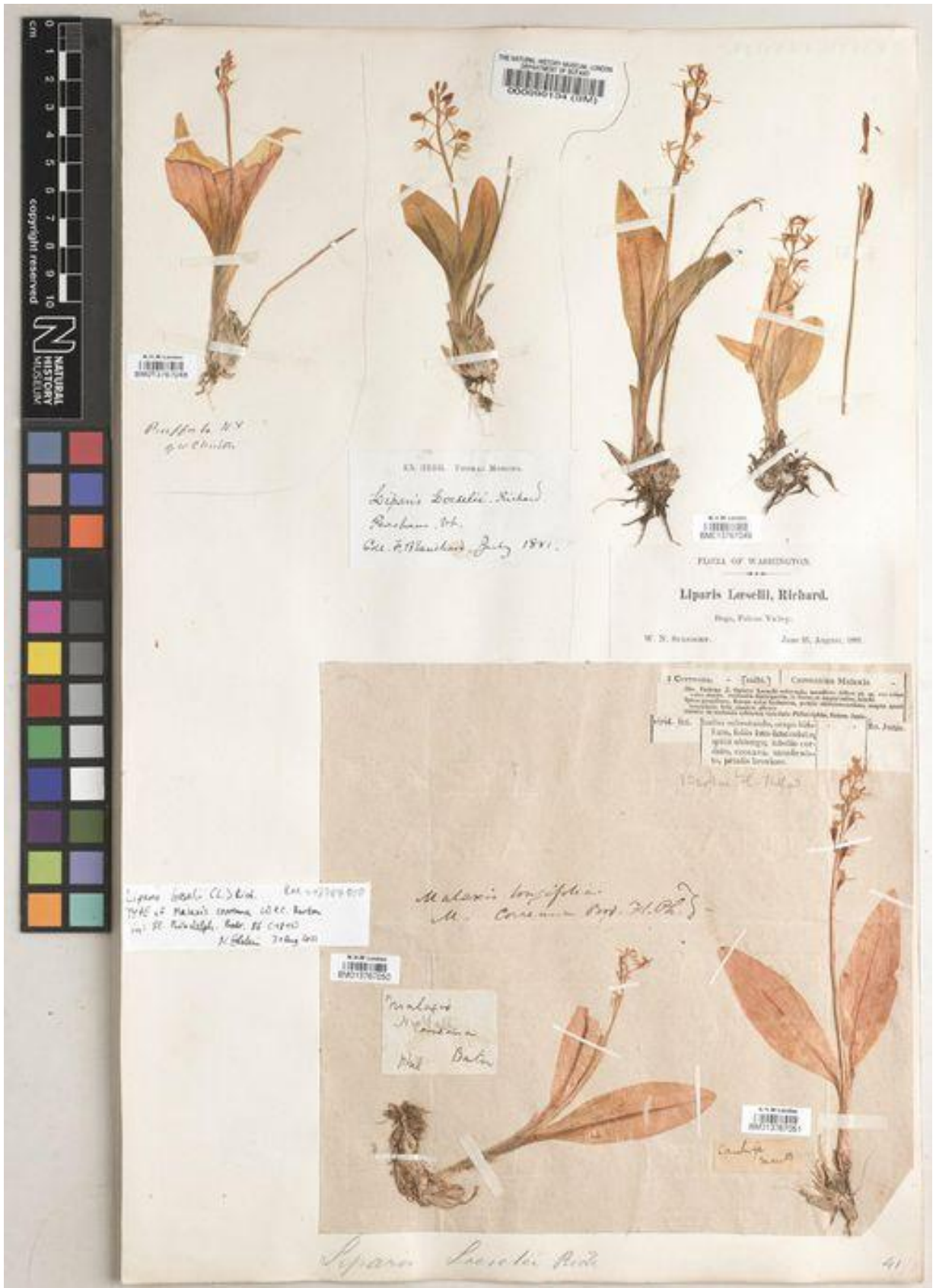
Blepharoglossum (Schltr.) L.Li in Pl. Syst. Evol. 306(3, 54): 6 (2020)

Herbs, terrestrial, epiphytic or lithophytic. Stem pseudobulbous, clustered or not. Leaves 1 to more, membranous, linear to ovate or elliptic, apex acute to acuminate, basal or cauline or arising from the apex of the pseudobulbs, sometimes articulate at base. Inflorescence erect to pendulous, racemose, laxly or densely many flowered; floral bracts small, persistent. Flowers usually resupinate, translucent, small or medium sized, yellow, green, orange, purple etc. Dorsal sepal free, lateral sepal sometimes fused, dorsal and lateral sepals are not so equal in all. Sepals spreading or recurved, the margins are always revolute. Petals much narrower than sepals, mostly narrower and unlike sepals, free, often reflexed. Lip adnate to the base of column, often reflexed, usually broad, flat or sometimes deflexed from the middle, ovate, oblong, entire or lobed, often calli present near the base, without spur. Column long, elongate, often arched or incurved- arcuate, clavate, usually winged at the apex and

sometimes at the base, compressed at the base; pollinia in 2 pairs, waxy, ovoid, blunt, anther terminal. Capsule globose to subglobose or ellipsoid.

Type: - *Liparis loeselii* (Linnaeus) Richard (*Ophrys loeselii* Linnaeus)

Note:- There was a huge controversy in this genus as this genus was named as *Loselii* and *Lillifolia* at first and was included under the genus *Malaxis*. Again in 1828, Reichenbach changed the name to *Sturmia*, as the genus of moth already has a name *Liparis*. But later this statement of Reichenbach was considered invalid and the older name i.e. *Liparis* was retained. As this genus shows close relation with *Malaxis* and *Oberonia* most of the species are moved in this genus including *Leptorkis*. *Liparis loeselii* is the species which is conserved as the type specimen of this genus *Liparis*.



Source: <https://www.gbif.org/occurrence/1056175077>

Photo 1:- Type specimen for *Liparis*

4.2.1. Taxonomic Key to the species

1 a. Plants terrestrial.....	2
b. Plants epiphytic.....	14
2. a. Leaf solitary.....	3
b. Leaves 2 or more than 2	5
3. a. Petiole absent, leaf oblanceolate, column with hook like triangular wings	1. <i>Liparis bootanensis</i>
b. Petiole present, leaf oblong or broadly ovate, column with simple wings	4
4. a. Leaf base subcuneate, floral bracts linear - lanceolate with purplish red flower, lip without calli	7. <i>Liparis glossula</i>
b. Leaf base cordate, floral bracts ovate with green or pale green flowers, lip with inconspicuous calli	4. <i>Liparis cordifolia</i>
5. a. Leaves more than two	6
b. Leaves two	9
6. a. Leaf lanceolate to oblanceolate, petals linear	7
b. Leaf ovate, petals filliform or oblong	8
7 a. Sepals ovate, calli present on lip	11. <i>Liparis odorata</i>
b. Sepals oblong to lanceolate, calli absent on lip	8. <i>Liparis langtangensis</i>
8. a. Petals filliform, lip oblong- obovate, apex truncate, column stout.....	9. <i>Liparis nervosa var. nervosa</i>
b. Petals linear- oblong, lip wedge shaped, obcordate, apex broad, column curved	10. <i>Liparis nervosa var. khasiana</i>
9 a. Lip with calli and winged column	10
b. Lip with or without calli, column winged or wingless.....	13

- 10 a. Leaf apex acuminate, inflorescence length 4-7 cm.....11
- b. Leaf apex obtuse or acute, inflorescence length 8-15 cm 12
11. a. Plant height less than 10 cm, column erect..... 17. *Liparis pygmaea*
- b. Plant height more than 10 cm, column arcuate..... 3. *Liparis cathcartii*
12. a. Lip with calli, column wingless 5. *Liparis deflexa*
- b. Lip without calli, column winged 19. *Liparis rostrata*
- 13 a. Lip decurved near the base, petals filliform to linear.....15. *Liparis plantaginea*
- b. Lip not decurved , petals always linear 14. *Liparis petiolata*
14. a. Leaf solitary 2. *Liparis cespitosa*
- b. Leaf 2 or more than 2 15
15. a. Leaves 2, leaf length 9 - 21.5 cm 16
- b. Leaves more than 2, leaf length 1-8 cm 19
16. a. Calli present, column 3-4 mm 17
- b. Calli absent, column 1.5-2 mm 18
17. a. Plant height below 20 cm, petiole absent, column rather stout slightly curved
..... 12. *Liparis olivaceae*
- b. Plant height above 20 cm, petiole present, column slightly arcuate
..... 20. *Liparis stricklandiana*
18. a. Leaf elliptic, petiole absent, column wingless..... 6. *Liparis elliptica*
- b. Leaf oblanceolate, petiole present, column winged..... 21. *Liparis viridiflora*
19. a. Plant height below 10 cm, petiole absent, flowers orange to yellow or pinkish
..... 13. *Liparis perpusilla*
- b. Plant height above 10 cm, petiole present, flowers greenish or yellowish 20

20. a. Leaf margin slightly serrate, lip forming two lateral splits
..... 18. *Liparis resupinata*

b. Leaf margin slightly wavy to entire, lip deflexed about middle
..... 16. *Liparis platyrachis*

4.2.2. Description of the species

1. *Liparis bootanensis* Griff., Not. Pl. Asiat. 3 : 278 (1851); Hooker, Fl. Brit. Ind. 5: 700. (1890); King and Pantling, Ann. Bot. Gar. Calc. 8: 30. (1898); Banerji & Pradhan, Orch. Nepal Himalaya: 272. (1984); Pearce & Cribb, Fl. Bhutan 3 (3): 204 (2002); Chen *et al.*, Fl. China. 25: 220. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1: 121 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 129 (2018); Shrestha *et al.*, Plants of Nepal: 105. (2022).

Liparis forbesii Ridl. in J. Linn. Soc., Bot. 22: 283 (1886)

Liparis lancifolia Hook.f. in Hooker's Icon. Pl. 19: t. 1855 (1889)

Leptorkis bootanensis (Griff.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Liparis amphibius Gagnep. in Bull. Mus. Natl. Hist. Nat., sér. 2, 21: 737 (1950)

Herbs, terrestrial or lithophytic, mostly found on exposed slopes and in the form of colony. Plant height 9-37 cm. Pseudobulb 3-4.5 cm, densely arranged, narrowly oblong, slightly tapering towards the end, sometimes covered by the sheaths of young growth. Leaf 15-21.5 × 2.5 – 3 cm, solitary, arising from the apex of the pseudobulb, blade oblong-lanceolate or oblanceolate, papery, apex acute - acuminate, leaf margin entire, petiole present only on matured leaf. Inflorescence 8-23 cm long, peduncle winged, rachis mostly pendulous, 5 to 9 flowered, floral bracts 6-9 mm long, linear-lanceolate. Flowers often yellowish to pale brownish; pedicel and ovary 5-10 mm. Dorsal sepal 4-6 × 1-2.1 mm, ovate-lanceolate to oblong, apex subacute to obtuse, sub reflexed. Lateral sepals 3-5.5 × 1.1-2.3 mm, obliquely oblong – lanceolate to elliptic, apex obtuse, revolute margin and lying parallel below. Petals 5-6.5 × 0.2-0.3 mm, linear, blunt, much decurved, revolute. Lip 4-5.1 × 3-4.5 mm, apical margin entire to slightly irregular, cuneately oblong, deflexed from below the middle, apex broad, truncate, 2 variously shaped calli at base. Column 3.1-5.1 mm, curved, thickened at base, hook like triangular wings. Capsule 8-9 × 4-5 mm, obovoid, clavate, terete to ellipsoid.

Type specimen: Bootan, 1460m, Griffith, 88, (K), K000873778. (Isotype).

Distribution: 1800-2000 m

Flowering: July- September

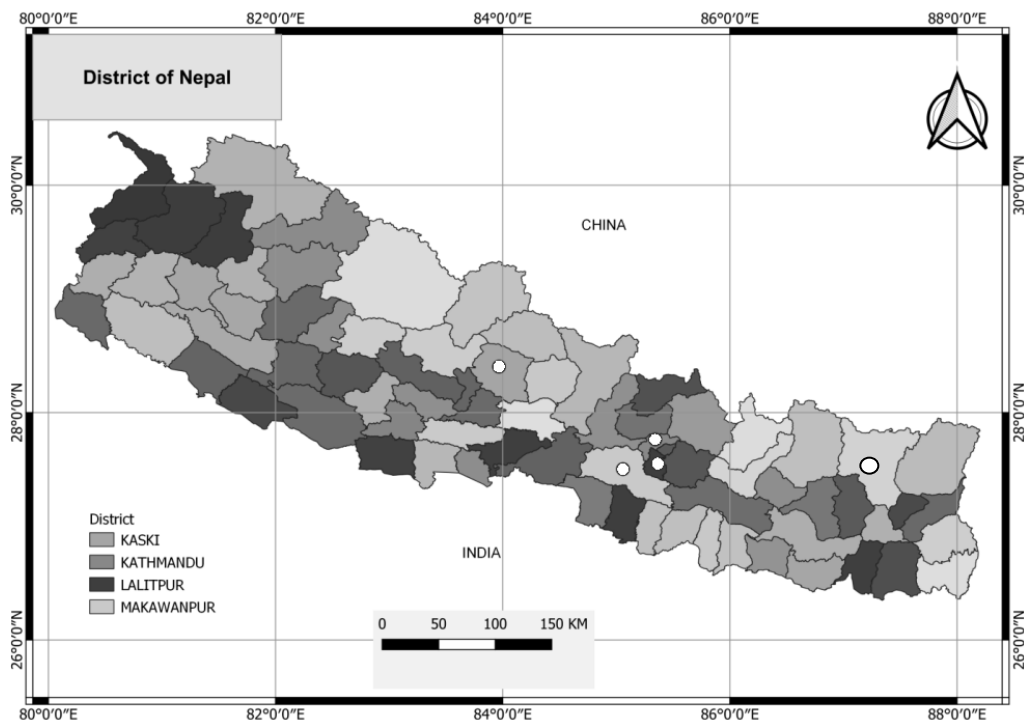
Fruiting: October- November

Specimens Examined: Central Nepal: Bagmati Province Kathmandu, PaniMuhan, 1887m, 09.07.2022, E. Dhakal, 20221 (ASCOL).

Central Nepal; Bagmati Province : Makawanpur, Chandragiri forest, 2100m, 10.07.2015, P. Bhandari *et al.*, C1001 (KATH). Kathmandu, Shivapuri, 7500ft, 07.1978, P. Pradhan, 573 (KATH) KATH 002801. Sundarijal – Chisapani, 2054ft, 9.11.2012, R. Chhetri *et al.*, 20121114 (KATH) KATH153025. Lalitpur, Bajrabarahi, 1400m, 21.07.1997, Siddi, 31(KATH) KATH002799. Kaski, Panchase dada, 2450m, 02.08.2002, L. R Shakya, R.P Chaudhary and A. Subedi, 972 (TUCH)., Kathmandu, Panimuhan, 1924m, 09.07.2022, E.Dhakal, 20221.

East Nepal; Province 1: Sankhuwasabha, near Mude, 1900m, 06.11.1998, D. Karkee, 774 (TUCH).

Bootan, 1460m, Griffith, 88, (K), K000873779. (Type).



Map.2: Distribution map of *Liparis bootanensis*

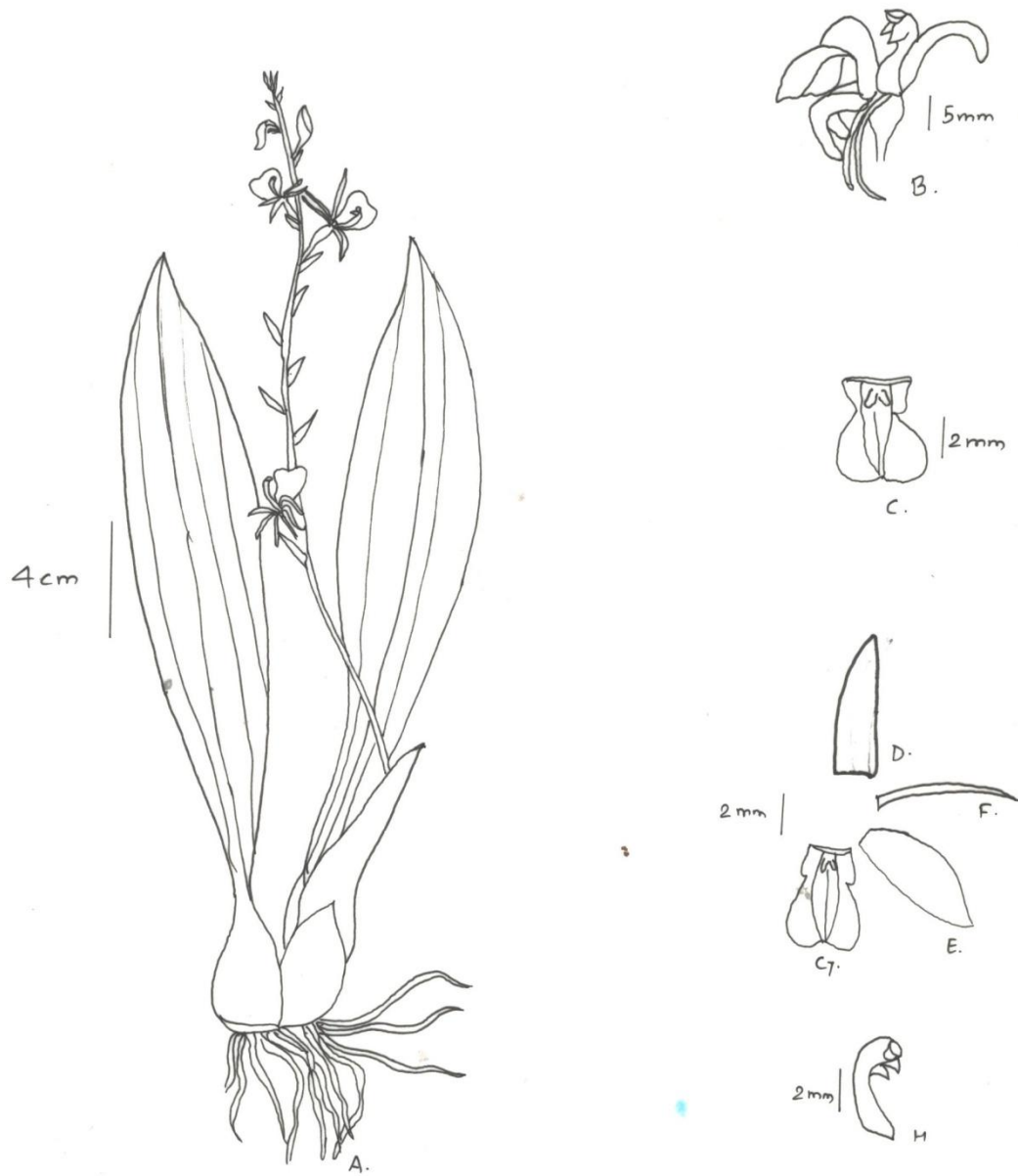


Fig. 10 *L. bootanensis* Griff. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (E. Dhakal 20221, ASCOL).

2. *Liparis cespitosa* (Lam.) Lindl. Bot. Reg. 11: t. 882 (1825); Banerji & Pradhan, Orch. Nepal Himalaya: 274. (1984); Deva & Naithaini, Orchid. Fl. North. West. Himalaya: 295 (1986); Chowdhery, orch. Fl. Arunachal Prad. :472. (1998); Pearce & Cribb, Fl. Bhutan **3** (3):204 (2002); Chen *et al.*, Fl. China. **25**: 222. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. **1**: 121 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. **1**: 129 (2018); Shrestha *et al.*, Plants of Nepal: 105. (2022).

Epidendrum cespitosum Lam. in Encycl. 1: 187 (1783) in Hist. Orchid.: t. 90 (1822)

Liparis minima (Blume) Lindl. in Gen. Sp. Orchid. Pl.: 32 (1830)

Leptorkis cespitosa (Lam.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Liparis prainii Hook.f. in Hooker's Icon. Pl. 19: t. 1857 (1889)

Cestichis cespitosa (Lam.) Ames in Orchidaceae 2: 132 (1908)

Liparis cespitosa var. *breviscapa* (Kerr) Seidenf. & Smitinand in Orch. Thail. (Prelim. List): 181 (1959)

Herbs, epiphytic mostly found on *Ehertia* tree, also common in mossy rock. Plant height 5.4-10 cm. Pseudobulb 3-5 mm, tufted, ovoid. Leaf 3.5-6.5 × 0.4-0.5 cm, solitary, blade oblong, linear, lanceolate or oblanceolate, apex acute- obtuse, margin entire, leaves are not contracted into a petiole, mostly petioled sometimes sessile. Inflorescence 2.5-4.5 cm long, as long as leaf, peduncle winged and without bracts, slightly longer than raceme, laxly flowered and flowers more than 10. Floral bracts 2-3 mm long, triangular apex acute. Flowers sepal and petal with white or green on two sides, very small, labellum brown; pedicel and ovary 2-2.2 mm. Dorsal sepal 2.5× 0.3 mm, elliptic- oblong, apex obtuse; lateral sepals 1.5 × 0.4 mm, reflexed. Petals 3-3.5 mm, longer than the sepals, linear, 1- veined, margin recurved. Lip 3 mm, narrow base and decurved about the middle, edges near the base, quadrate, indistinct basal callus, apex emarginated or truncate, margin entire or sometimes slightly crenulated. Column 1 mm, slightly curved, stout, winged and the base is slightly broad. Capsule 3.8- 4 mm, ellipsoid to globose or ovoid.

Type specimen: Indonesia, 800m, 15.05.1907., H. Alfred, 15868, (BR) (BR0000006572433). (Isotype).

Distribution: 610-950 m

Flowering: July- August

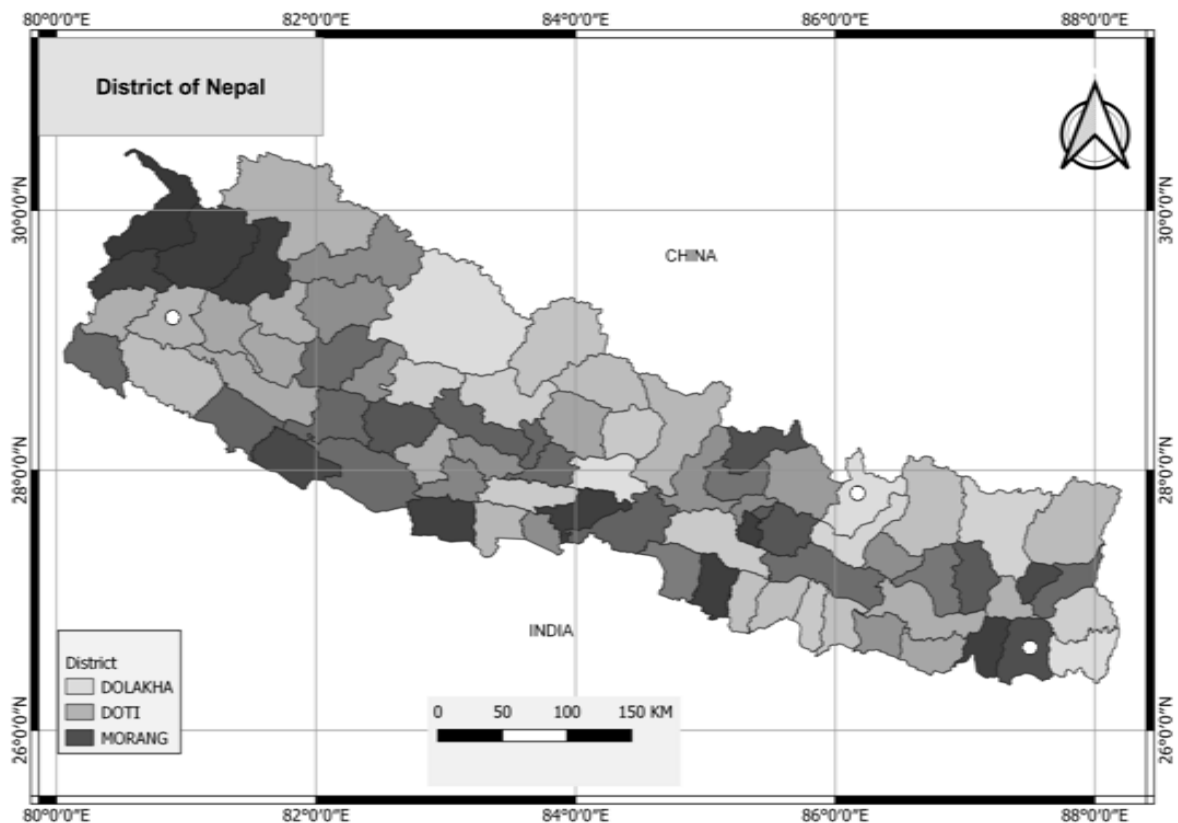
Fruiting: August- September

Specimens Examined: Central Nepal; Bagmati Province: Dolakha, near Torikhet, 950m, 13.07.1977, K.R Bhandari and B. Roy, 1256 (KATH) KATH002807.

East Nepal; Province 1: Morang, Rajapani, 570m, 04.09.1979, R.B Thapa, S. Magar and S. Tamang, 918 (KATH). Rajapani, 570m, 05.09.1979, R.B Thapa, S. Magar and S. Tamang, 919 (KATH) KATH002808.

Mount Khasia, 4-6000ft, 1915, J.D.H., VII, (K) (K000387844), (K000387809) (Isotype).

Indonesia, 800m, 15.05.1907., H.Alfred, 15868, (BR) (BR0000006572433). (Isotype).



Map.3: - Distribution map of *Liparis cespitosa*

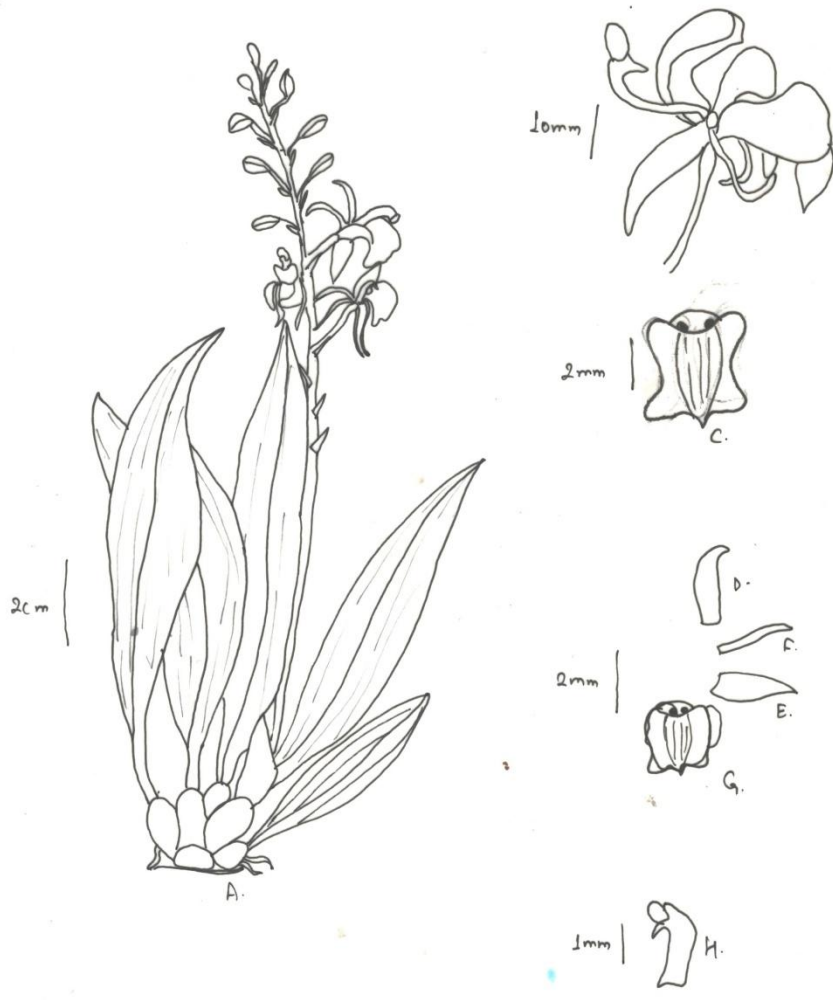


Fig. 11 *L. cespitosa* (Lam.) Lindl. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (J.D.H, VII, K000387844, K000387809).

3.*Liparis cathcartii* Hook.f. Hooker's Icon. Pl. 19: t. 1808 (1889); Hooker, Fl. Brit.Ind.**5**: 694. (1890); King and Pantling, Ann. Bot. Gar. Calc. **8**: 25. (1898); Hara et al., enumeration. F.P. Nepal.**1**:12. (1978); Banerji & Pradhan, Orch. Nepal Himalaya: 276. (1984); Press *et al.*, Ann. check. Fl. Pl. Nepal: 219. (2000) ; Pearce & Cribb, Fl. Bhutan **3** (3): 198 (2002); Chen *et al.*, Fl. China. **25**: 216. (2009) Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. **1**: 121 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. **1**: 129 (2018); Shrestha *et al.*, Plants of Nepal: 105. (2022).

Leptorkis cathcartii (Hook.f.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Herbs, terrestrial, mostly found on litter under Picea and Pine forest. Plant height 15-18 cm. Pseudobulb 1.5-2.5 cm, narrowly ovoid, covered by white membranous sheaths, stems arising from the base of the pseudobulb. Leaf 5.9-7.5 × 2.3-3.6 cm, two subopposite leaf, amplexicaul, blade ovate or ovate- oblong, margin entire, apex acute to obtuse, base contracted into a petiole, not articulate, petiole 2.8-4.5 cm, sheath like. Inflorescence 4-6.8 cm long, longer than leaves, winged, raceme laxly less than 10 flowered, peduncle cylindrical, floral bracts ca. 1-4 mm, lanceolate. Flowers greenish- brown sepals and petals brownish with deep purple brown veins at the base of lip. Pedicel and ovary 9-11 mm. Dorsal sepal 9-10 × 1-1.1 mm, inconspicuously 3- veined, apex obtuse; Lateral sepals slightly oblique 8-9 × ca. 2 mm. Petals 7.9 × ca. 0.2 mm, 1- veined, filliform, curved and reflexed. Lip 8-9 mm, deflexed from middle, base contracted usually with 2 short longitudinal lamellae, margin irregularly toothed, apex subtruncate or mucronate and calli present. Column 3-3.5 mm long, arcuate, 2 short wings at apex, base thickened and with two teeth. Capsule 11-12 mm, ellipsoid – clavate.

Type specimen: Sikkim, 8000ft, J.D.Hooker, 103 (K). K000387768 (Isotype).

Distribution: 3000 m

Flowering: July

Fruiting: August

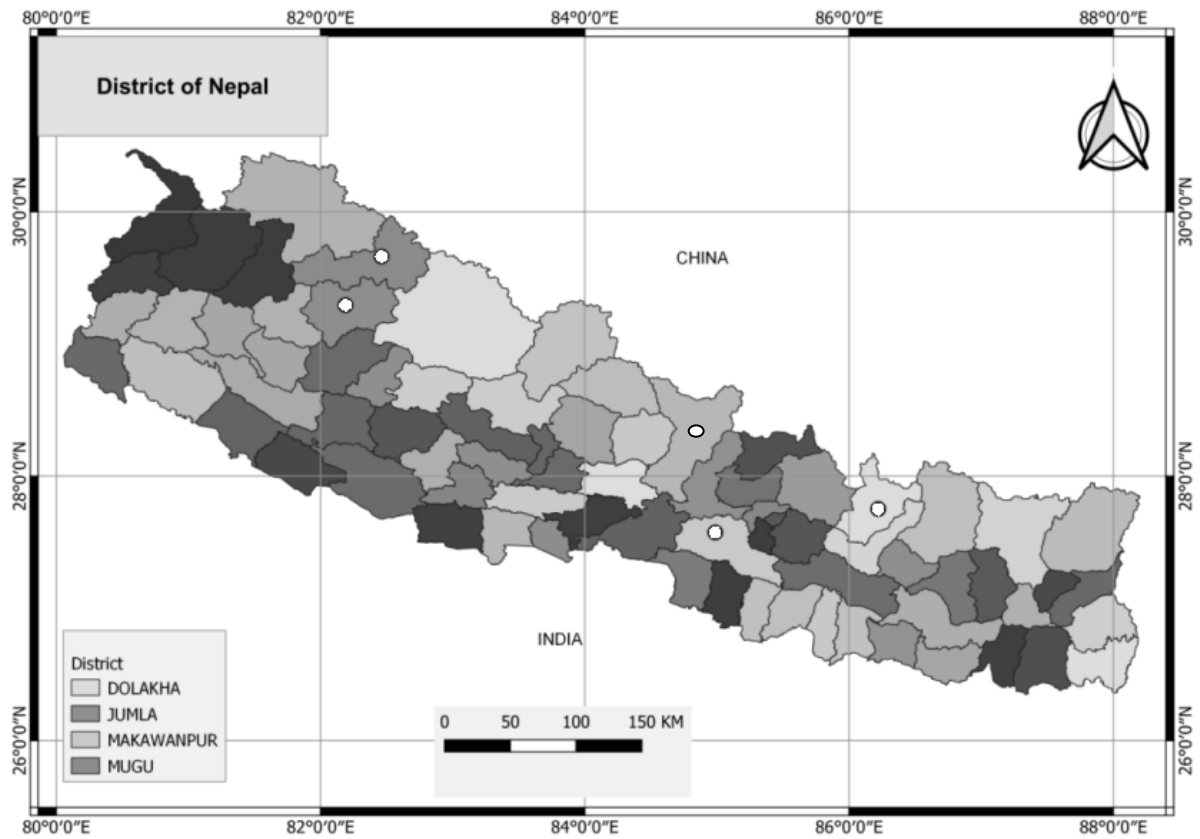
Specimens Examined: Central Nepal: Bagmati Province Kathmandu, PaniMuhan, 1887m, 09.07.2022, E. Dhakal, 20222 (ASCOL).

West Nepal: Karnali province; Jumla, Tharmare- Neurigad, 2740m, 06.08.1985, P. R Shakya, M.N Subedi, 8527 (KATH) KATH002813, KATH2811, KATH2812, KATH2810.

Mugu: Rara, 3100 m, 22.07.1979, K.R Rajbhandari and B. Roy, 3781 (KATH)
KATH002814.

Central Nepal: Bagmati Province; Makwanpur, Hetauda, 400 m, 05.06.2007, D.B Raskoti,
152 (KATH).

Sikkim, 8000ft, J.D.Hooker, 103 (K). K000873775 (Type).



Map.4: Distribution map of *Liparis cathcartii*

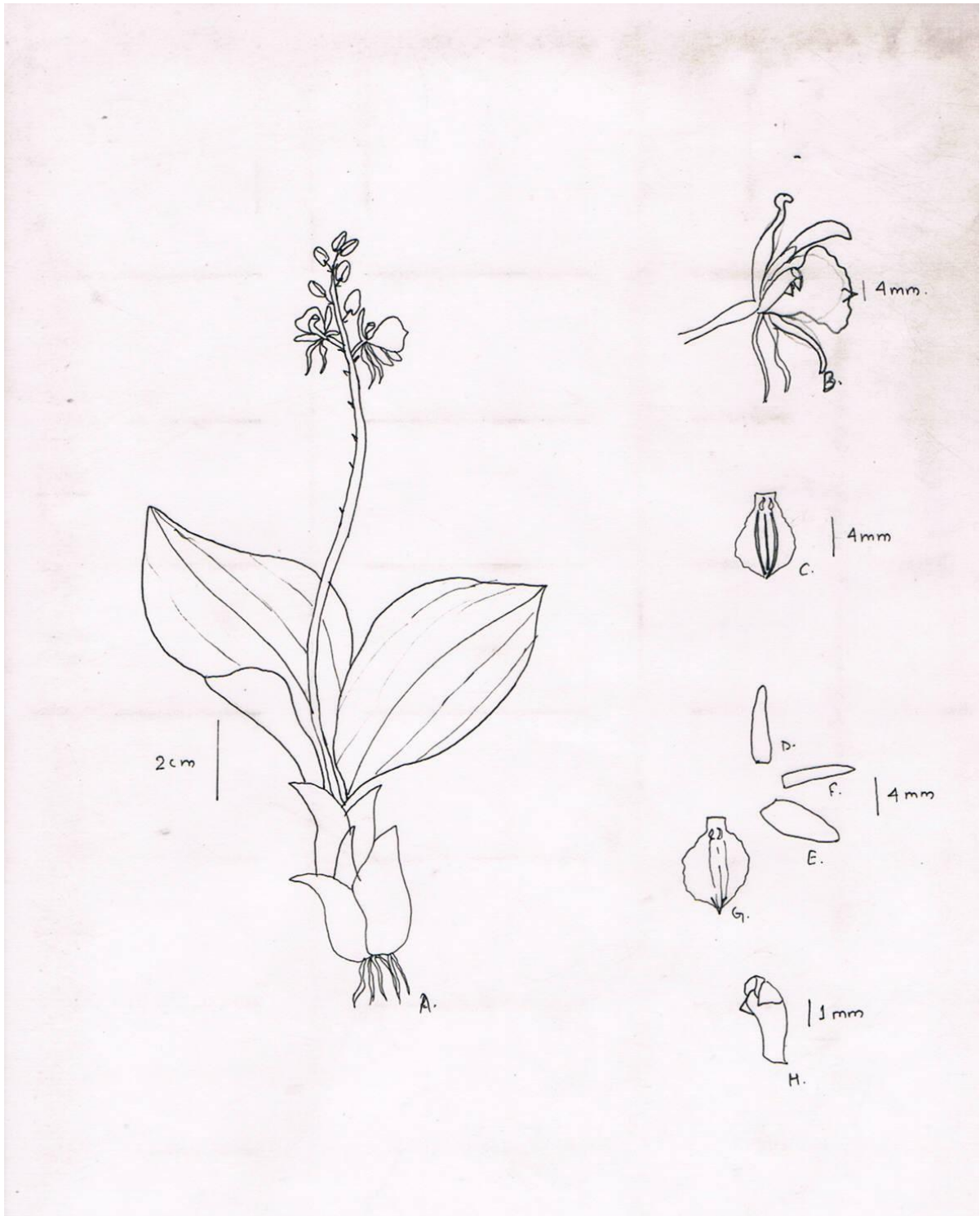


Fig. 12 *L.cathcartii*, Hook.f. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (C.B. Clarke, 35033A, K000387766, K000387767).

4. *Liparis cordifolia* Hook.f. Hooker's Icon. Pl. 19: t. 1811 (1889); Hooker, Fl. Brit. Ind. 5: 692. (1890); King and Pantling, Ann. Bot. Gar. Calc. 8: 24. (1898); Hara *et al.*, enumeration. F.P. Nepal. 1:12. (1978); Banerji & Pradhan, Orch. Nepal Himalaya: 270. (1984); Deva & Naithaini, Orchid. Fl. North. West. Himalaya: 295 (1986); Chowdhery, orch. Fl. Arunachal Prad. :472. (1998); Press *et al.*, Ann. check. Fl. Pl. Nepal:219. (2000); Pearce & Cribb, Fl. Bhutan 3 (3): 198 (2002); Chen *et al.*, Fl. China. 25: 214. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1 : 121 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 129 (2018); Shrestha *et al.*, Plants of Nepal: 105 (2022)

Leptorkis cordifolia (Hook.f.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Liparis keitaoensis Hayata in Icon. Pl. Formosan. 7: 40 (1918)

Liparis argentopunctata Aver. in Bot. Zhurn. (Moscow & Leningrad) 73: 106 (1988)

Herbs, terrestrial or lithophytic. Plant height 12-16 cm. Pseudobulbs 2-2.5 mm, clustered, ovoid, pointed having some scattered fibers at the base, enclosed by white membranous sheaths. Leaf 6-10 × 3.5-8 cm, solitary on a short stem, large, membranous or herbaceous, blade green, broadly or roundly ovate, cordate, distinctly 7- nerved, base cordate and decurrent to petiole, apex acute – acuminate, margin usually entire, base amplexicaul, not articulate, narrowed to the base to the long sheath, petiole 2-3cm, sheathed. Inflorescence 7-15 cm long, peduncle rather stout, angled when dry, longer than the leaf, narrow wings on both sides, raceme laxly flowered below 10, floral bracts 0.5-1.2 mm, ovate, acute apex, shorter than pedicel and ovary. Flowers green or pale green, often densely arranged; pedicel and ovary 5-8 mm. Dorsal sepal 6-7 × ca. 1.5 mm, 3- veined, linear – lanceolate, margin revolute, apex obtuse- acute; Lateral sepals 5-5.6 × ca. 1.3 mm, lanceolate, lying covered under the lip, subacute. Petals 6-7 × ca. 0.3 mm, filiform to linear, margin revolute. Lip 5-6 × 5 mm, deflexed from base, broadly elliptic, obtuse, green with brownish edges, narrow towards the base, a pair of inconspicuous calli present. Column 3-4 mm, slightly curved, rather stout, thickened at base, apex with 2 broad wings, base dilated. Capsule 7-10 mm, obovoid- ellipsoid.

Type specimen: Khasia, 4-5000ft, 105 (K). K000873773 (Isotype).

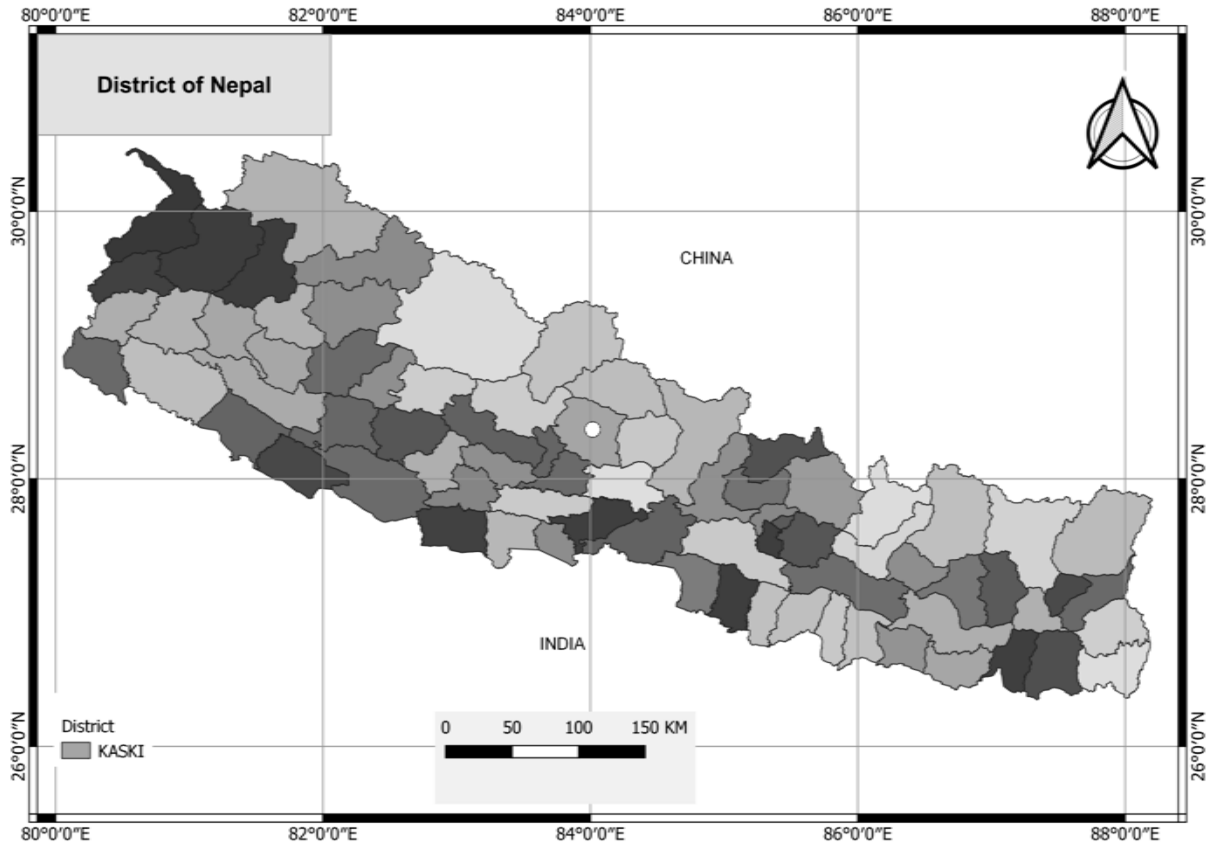
Distribution: 1500-1650 m

Flowering: October

Fruiting: December

Specimens Examined: C.Nepal: Gandaki Province; Kaski, Hyanja forest, 1650 m, 27.07.1999, Abishkar subedi, 237 (TUCH).

Khasia, 4-5000ft, 105 (K). K000873773 (Type).



Map.5: Distribution map of *Liparis cordifolia*

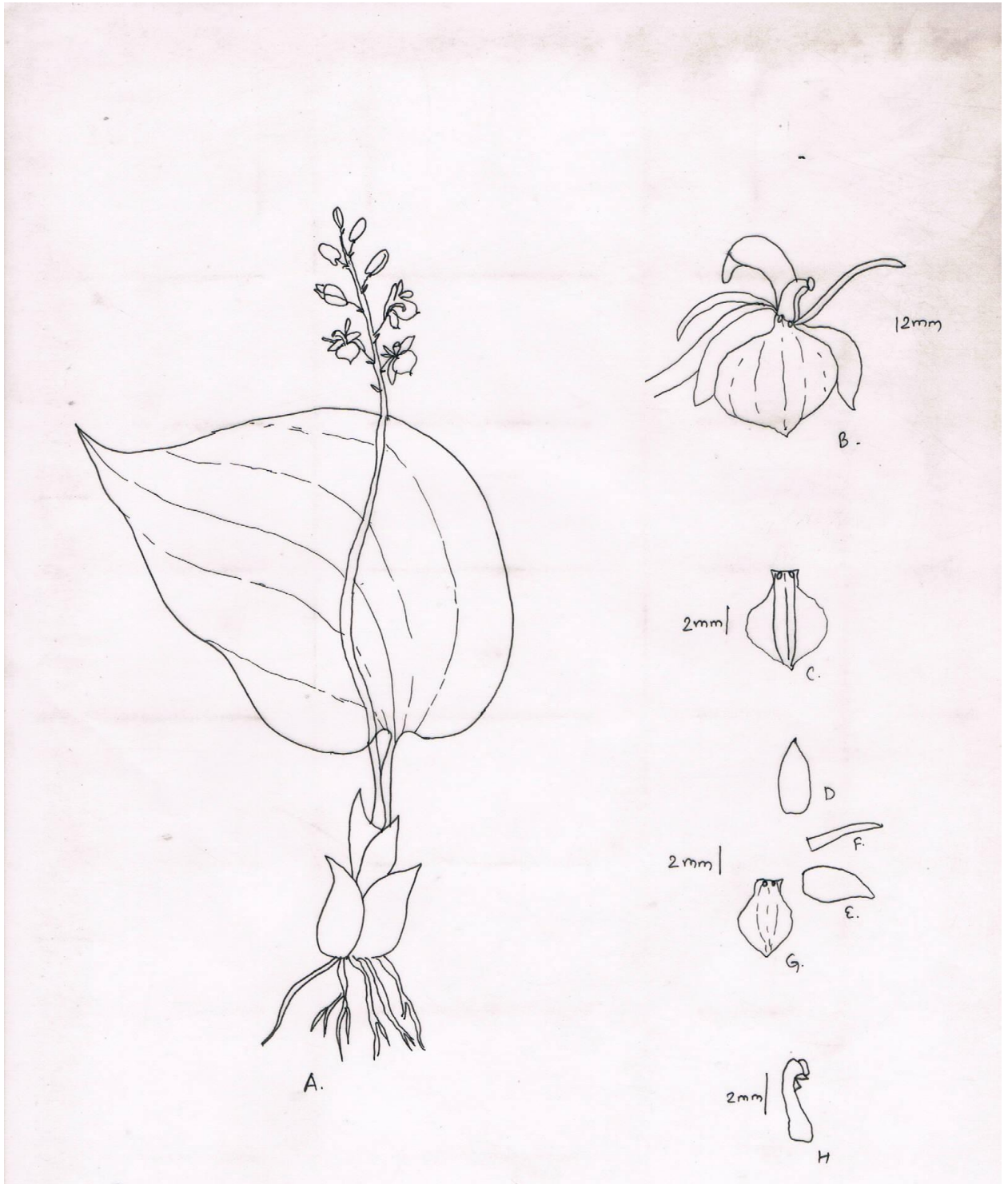


Fig. 13. *L. cordifolia* Hook.f. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (E. Dhakal, 2022, ASCOL)

5. *Liparis deflexa* Hook.f. Fl. Brit. India 5: 697 (1890); King and Pantling, Ann. Bot. Gar. Calc. 8: 25. (1898); Banerji & Pradhan, Orch. Nepal Himalaya: 278. (1984); Deva & Naithaini, Orchid. Fl. North. West. Himalaya: 299 (1986); Pearce & Cribb, Fl. Bhutan 3 (3): 198 (2002); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1: 121 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 129 (2018); Shrestha *et al.*, Plants of Nepal: 105 (2022)

Leptorkis deflexa (Hook.f.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Liparis prazeri King & Pantl. in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 582 (1897)

Liparis flavoviridis Blatt. & McCann in J. Bombay Nat. Hist. Soc. 35: 260 (1931)

Herbs, terrestrial in dry place. Plant height 15-28 cm. Pseudobulb 1.5-2.5 cm, sheathed, ovoid, stem slender arising from the pseudobulb. Leaves 6-13 × 1.8-5.5 cm, two, sub opposite, blade ovate- lanceolate or elliptic, margin entire, acuminate apex, scape tall, base sheathing, short unequal petioles, sheathed. Inflorescence 8-12 cm, longer than leaves, rachis winged, as equal to raceme, laxly flowered; floral bracts 4-5 mm, lanceolate, reflexed, half of the pedicel and ovary. Flowers small, in terminal raceme, below 10 flowered, yellowish green or dull yellow in color, resupinate; pedicel and ovary 6-8 mm. Dorsal sepal 8×0.9 mm, longer than lateral, oblong- lanceolate, apex acute; Lateral sepals 4 × 1.1 mm, oblong broader than the dorsal sepal, apex obtuse. Petals 5mm, filliform, narrowly oblong, apex same as sepal, obtuse, reflexed with recurved margins. Lip 4-4.5 × 3-4 mm, flat, orbicular to reniform, the apex very broad, alightly emarginated, calli two, just under the column. Column 4mm, slightly curved, wing absent at the apex of the column. Capsule 17mm, obovoid- oblong.

Type specimen: India, Darjelling, 1844, W. Griffith, s.n.. (K), K000873777 (Isotype)

Distribution: 1000-1100 m

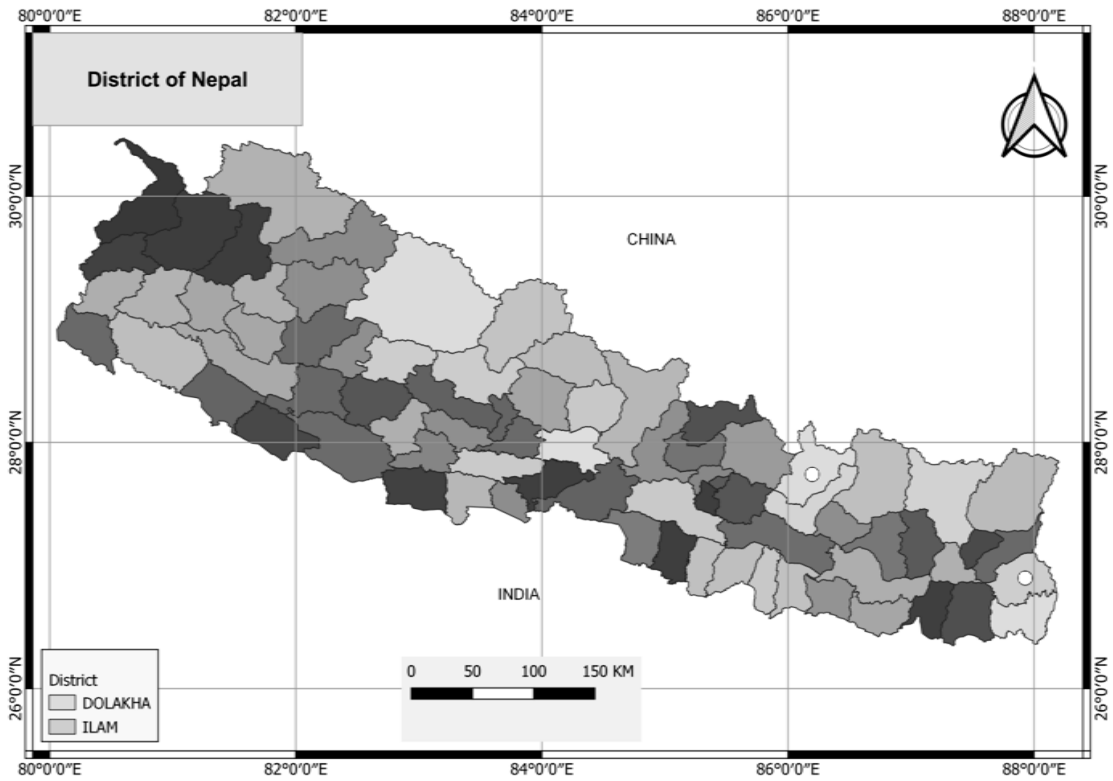
Flowering: July- August

Fruiting: September

Specimens Examined: **Central Nepal:** Bagmati Province; Dolakha, Salghari, Jungu, 1097m, 26.08.2018, Sangram Karki *et.al.*, J45 (KATH) KATH086701, KATH08669. Lothar, 1100ft/ 335m, 27.08.1967, P. R. Shakya, 9123 (KATH) KATH002817, KATH002816, KATH002818. Malepu, Lothar, 1100m, 27.08.1983, K.R RajBhandari, 9315 (KATH) KATH002819.

East Nepal: Province 1; Baluwabensi, Bumlingtar, 450m, 27.09.1999, D.B.Karkee, 879 (KATH). Illam, Godak, 1000m, 31.08.1979, R.B Thapa, S. Magar and S. Tamang, 912 (KATH) KATH002820, KATH002821, KATH002822.

India, Darjelling, 1844, W. Griffith, s.n.. (K), K000873777 (Type).



Map.6: Distribution map of *Liparis deflexa*

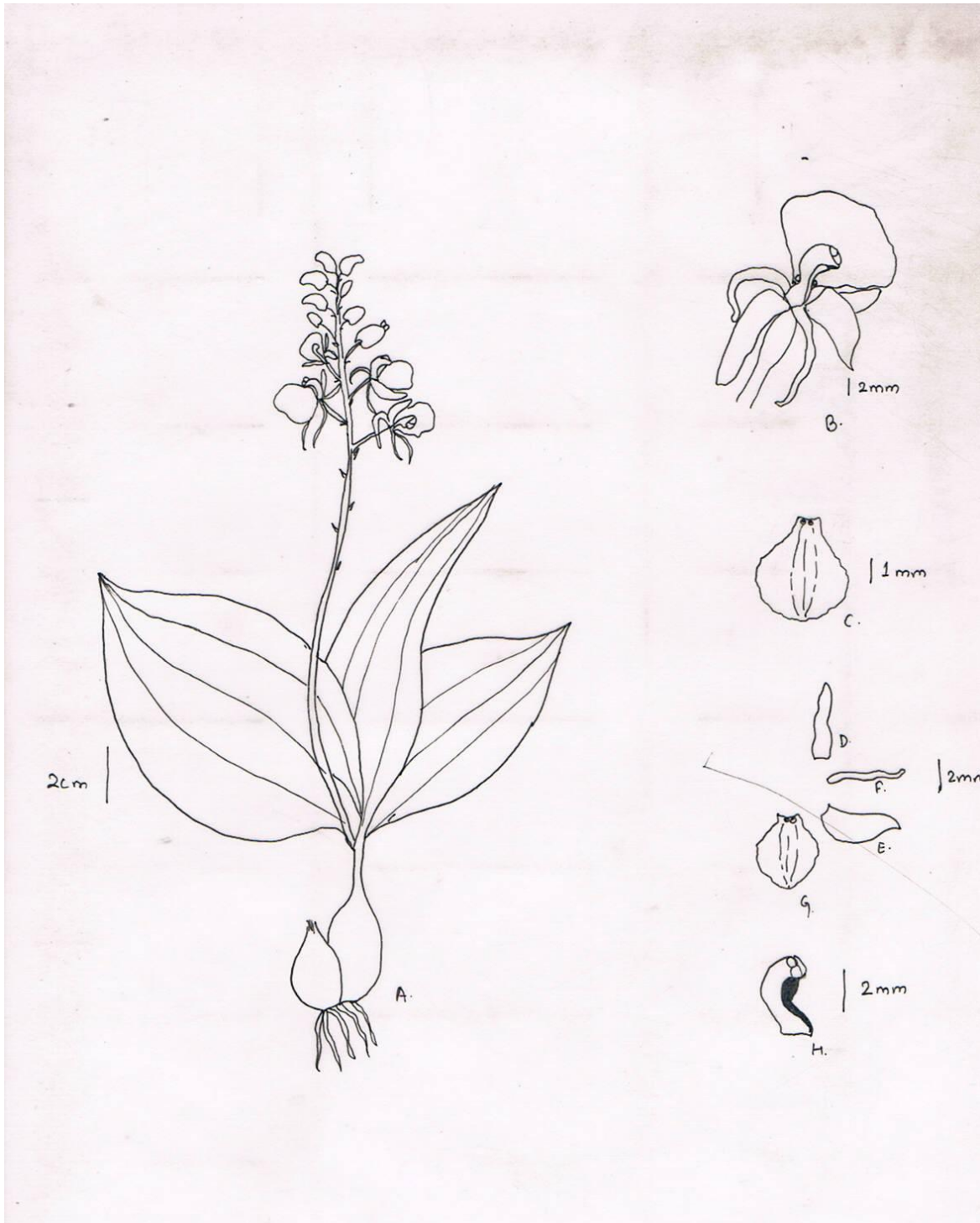


Fig. 14 *L. deflexa* Hook.f. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (Sangram Karki *et.al.*, J45, KATH086701).

6. *Liparis elliptica* Wight Icon. Pl. Ind. Orient. 5: t. 1735 (1851); Chowdhery, orch. Fl. Arunachal Prad. :476. (1998); Chen *et al.*, Fl. China. 25: 225. (2009); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 129 (2018); Shrestha *et al.*, Plants of Nepal: 105 (2022)

Liparis hookerae Ridl. in J. Linn. Soc., Bot. 22: 288 (1886)

Leptorkis elliptica (Wight) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Liparis lyonii (Ames) Ames in Orchidaceae 5: 81 (1915)

Cestichis elliptica (Wight) M.A.Clem. & D.L.Jones in Orchadian 15: 39 (2005)

Herbs, epiphytic. Plant height 25-27 cm. Pseudobulbs 1.5-2.9 cm, compactly arranged, oblong and are compressed. Leaves, 6-15 × 1.1-1.9 cm, two, elliptic to oblong, papery, apex acute to slightly acuminate, articulate, margin entire, base contracted into a very short petiole not even seen properly. Inflorescence 10-15 cm, arching to pendulous, peduncle somewhat compressed, rachis 4-9 cm, sterile bracts are present, more than 10 flowered, floral bracts 4-5 mm, lanceolate. Flowers pale yellowish to green, pedicel and ovary 4-6 mm. Dorsal sepal 3-4 × 1-1.2 mm, lateral sepals 3-4.5 × 1-1.5 mm, both almost equal, oblong- lanceolate, apex obtuse. Petals 3-4.5 × ca. 0.2 mm, linear or filiform. Lip 3-4 mm, nearly ovate, decurved about middle and folded margin at or above the middle, apex acuminate, calli not seen clearly. Column 1.5 mm, erect, wings are not present at the apex. Capsule 6-7 mm, clavate to obovoid.

Type specimen: Bolivia, Pinos bei Tarija, 11.07.1904., K-Fiebrig, 2634a (K). K000583622 (Isotype)

Distribution: 1300-2100 m

Flowering: November- December

Fruiting: February

Specimens Examined: Central Nepal: Bagmati Province; Shivapuri National Park area, 2056m, 05.12.2021, R. Duwal, P. Shakya, E. Dhakal, 20224 (ASCOL).

Brazil: Cut over gallery forest in deep valley, ca. 17 km, E. of Diamantia, 900m, 2.03.1970. H.S. Irwin *et al.*, 28030 (K), K000940647. Bolivia, Pinos bei Tarija, 11.07.1904., K-Fiebrig, 2634a (K). K000583622 (Isotype)

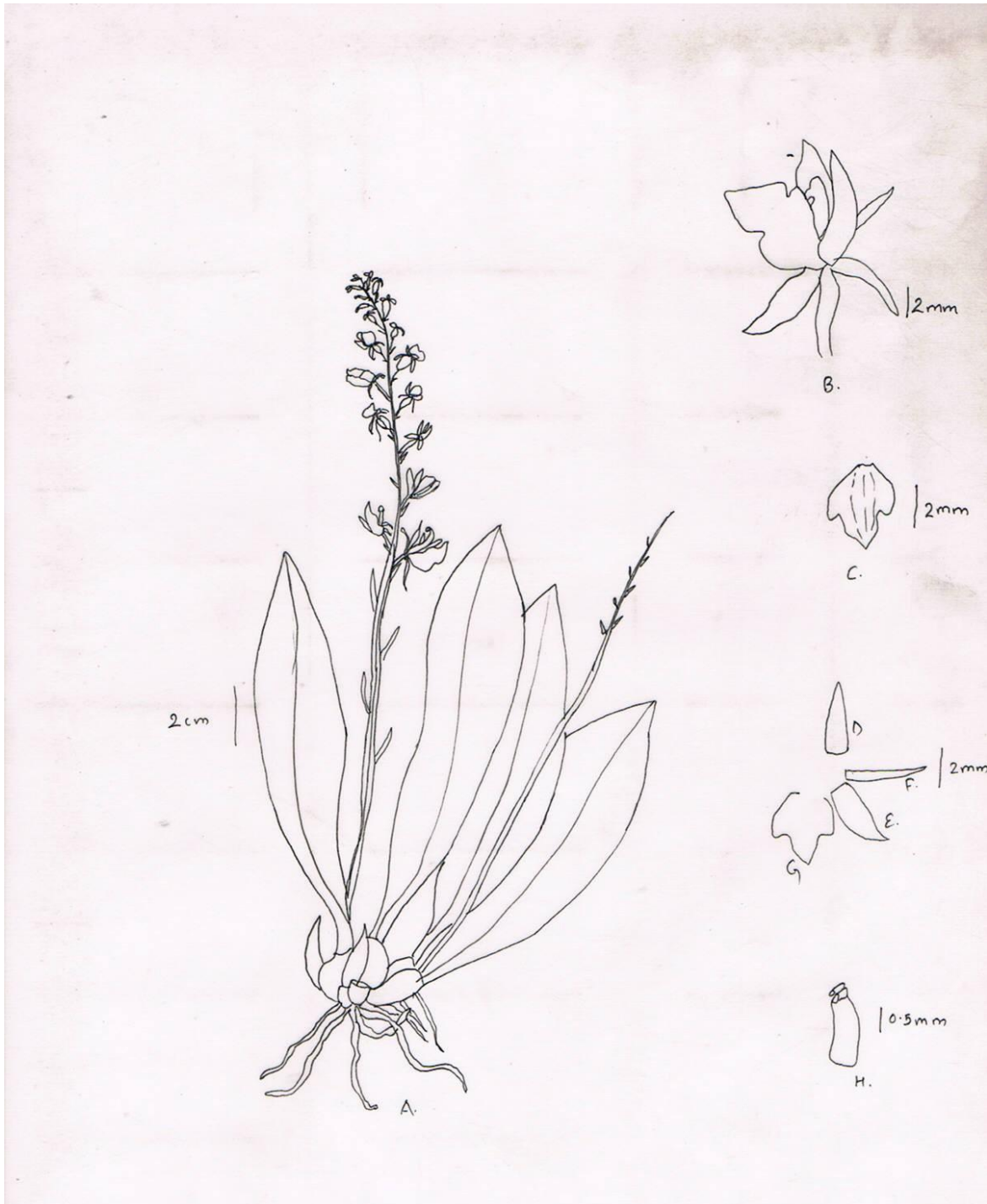
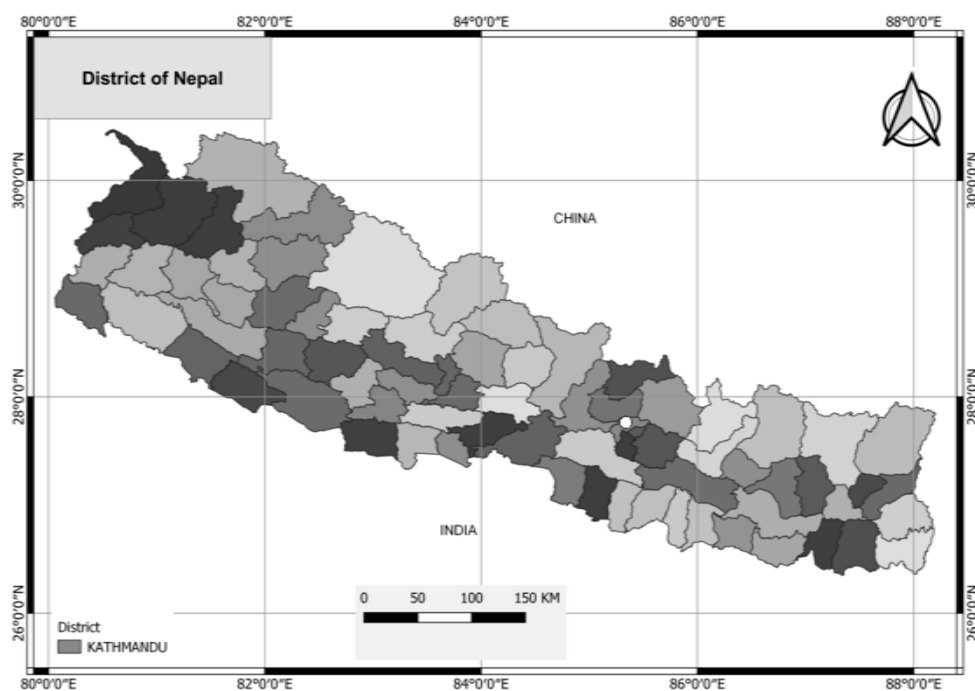


Fig. 15 *L. elliptica* Wight A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (R. Duwal, P. Shakya, E. Dhakal, 20224, ASCOL).



Map.7: Distribution map of *Liparis elliptica*

7. *Liparis glossula* Rchb.f. Linnaea 41: 44 (1876); Hooker's Icon. Pl. 19: t. 1809 (1889); Hooker, Fl. Brit.Ind.5: 693. (1890); King and Pantling, Ann. Bot. Gar. Calc. 8: 26. (1898); Hara *et al.*, enumeration. F.P. Nepal.1:12. (1978); Banerji & Pradhan, Orch. Nepal Himalaya: 280. (1984); Deva & Naithaini, Orchid. Fl. North. West. Himalaya: 299 (1986); Press *et al.*, Ann. check. Fl. Pl. Nepal: 219. (2000); Pearce & Cribb, Fl. Bhutan 3 (3): 199 (2002); Chen *et al.*, Fl. China. 25: 215. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1: 122 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 130 (2018); Shrestha *et al.*, Plants of Nepal: 106 (2022)

Leptorkis glossula (Rchb.f.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Herbs, terrestrial on shady places. Plant height 9-18 cm. Pseudobulb 1.5-2 cm, ovoid, clustered. Leaf 8-10 × 1.6-3 cm, solitary, blade oblong, apex acute to obtuse, base subcuneate, margin entire, leaf contracted into a petiole and covered by sheath, sometimes petioled. Inflorescence 5-9 cm, erect, peduncle slightly winged, laxly 8-9, flowered; floral bracts 6-14 mm, linear – lanceolate, shorter than pedicel and ovary. Flowers purplish red ; pedicel and ovary 11-16 mm. Sepals nearly equal, dorsal sepal 9-10 × 0.4-0.5 mm, oblong-lanceolate, acute apex, spreading Lateral sepals 10-11 × 0.6-0.7mm, lateral pairs lying parallel under the lip, revolute margin. Petals 10-13 mm, linear, reflexed. Lip 7-11 mm, obovate- oblong, cuspidate, deflexed about the middle, 3 lines as pinkish purple vein running

from base to apex, margin ciliate except at the base, base without calli. Column 3-4 mm, long, slightly curved, 2 short wings near at the apex, base dilated.

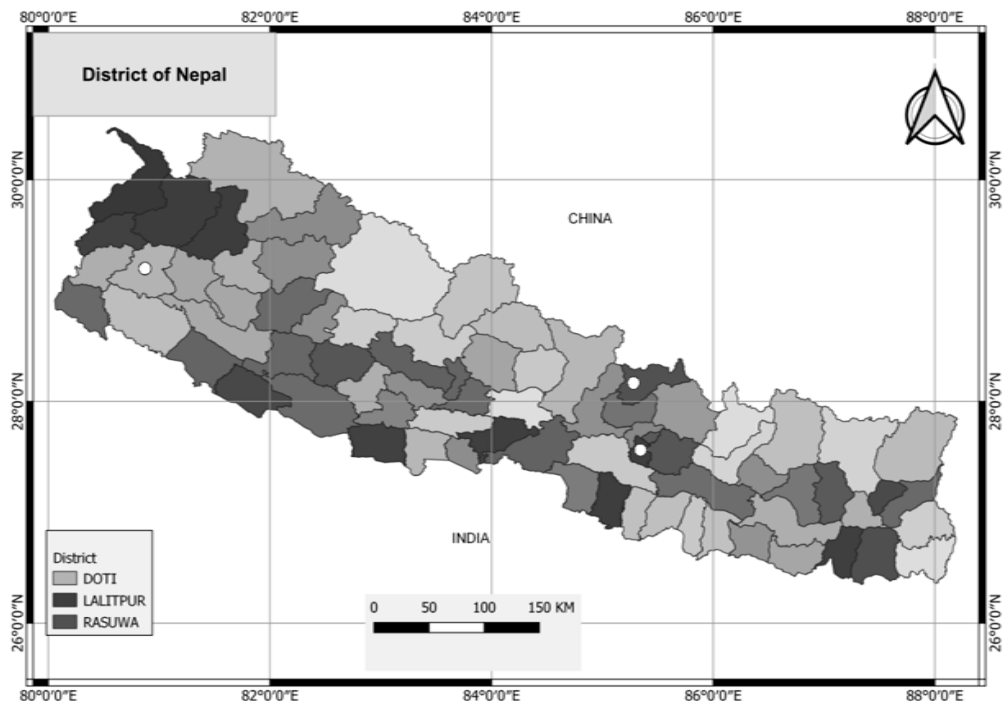
Type specimen: India, Sikkim Himalaya, Chumbi valley, 10,000 ft, July 1895, King and Pantling, 402. (AMES). (Isotype).

Distribution: 1400-3500 m

Flowering: July - August

Fruiting: September- October

Specimens Examined: **West Nepal:** Sudur-Paschim Province; Doti, Doti-Salimgadi, 2850m, 02.08.072, M.S. Bista and D.P Joshi, 171 (KATH) KATH002823. **Central Nepal:** Bagmati Province; Lalitpur, National Botanical Garden, 1400m, 02.08.1977, Shiva Magar (KATH). Rasuwa, Langtang, 12000ft, 15.07.1978, R.Rana *et al.*, 825 (KATH); Gumba, 3040m, 13.07.2001, G.D. Bhatta, D.B. Karkee, 120 (KATH); Yangin Kharka area, 12-14000 ft, 19.07.1967, Dr. Malla, 9057 (KATH) KATH002825, KATH002824, KATH 002826; On the way to Langtang, 18.07.1978 (KATH).



Map.8: Distribution map of *Liparis glossula*

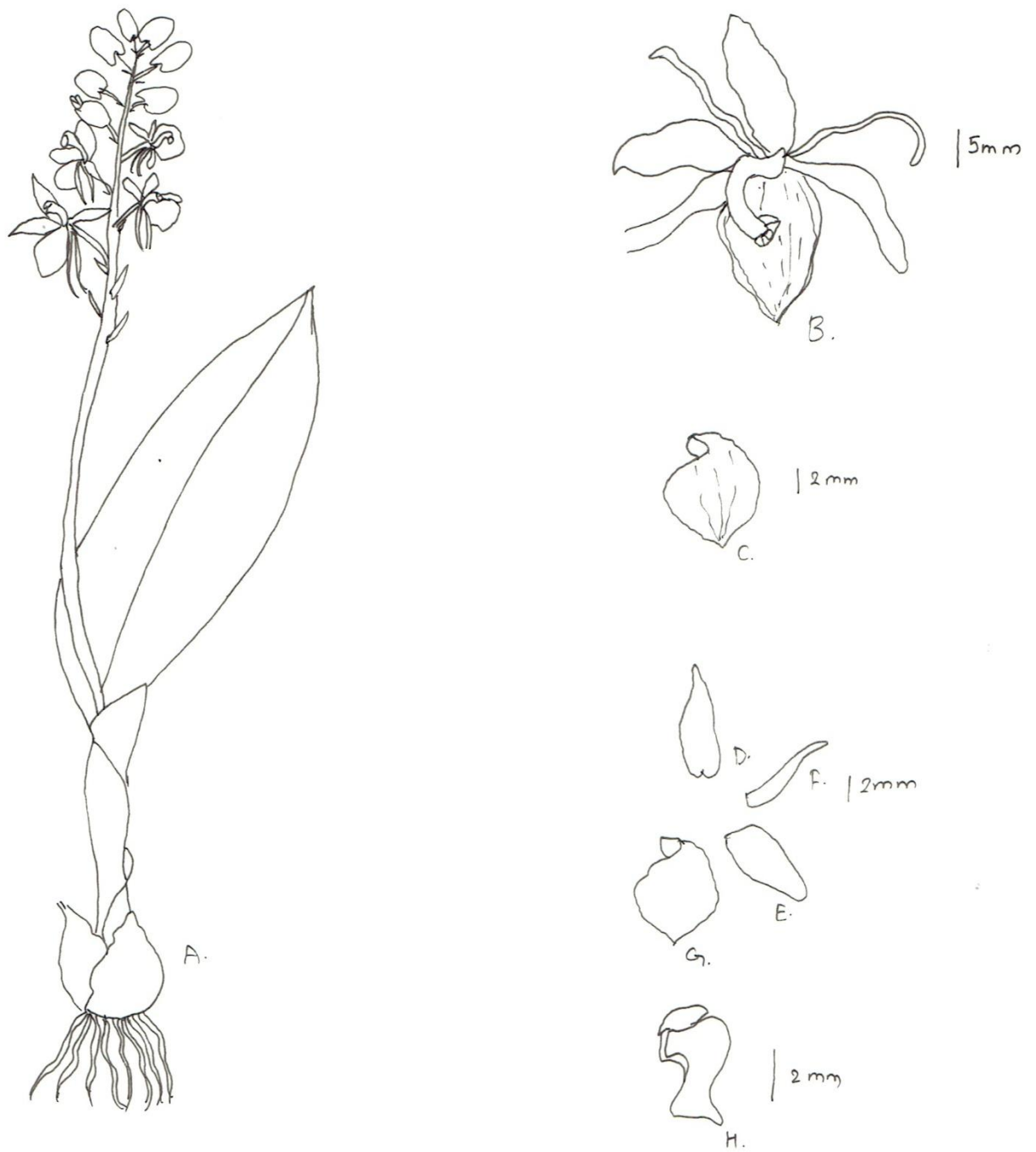


Fig. 16 *L. glossula* **Rchb.f.** A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (M.S. Bista and D.P Joshi, 171, KATH002823).

8. *Liparis langtangensis* Raskoti & Ale Novon 23: 83 (2014); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1 : 122 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 130 (2018); Shrestha *et al.*, Plants of Nepal: 106 (2022)

Herbs, terrestrial in shrub land below *Rhododendron lepidotum*. Plant height 15-25 cm tall. Pseudobulbs 0.5-2.5, ovoid, enclosed by white membranous sheaths. Leaf 5-6 cm, two leaves, blade lanceolate to oblanceolate, margin entire, apex acute to obtuse, leaf blade contracted into a petiole, petiole 3.5-5.5 cm. Inflorescence 11-15 cm, peduncle 8-7.5 cm, cylindrical and green in lower and light pink in upper, inflorescence rachis winged, 3-5 cm, laxly arranged with 3-8 flowered; floral bracts 1-2 mm, apex acute. Flowers 5 mm, deep violet, twisted basally, pedicel and ovary 11-14 mm. Dorsal sepal 6-8 x 0.5-1 mm; 3-veined, ligulate to lanceolate, erect, margins revolute, apex acute; lateral sepals 6-7 x 1-1.2 mm, 3-veined, obliquely oblong to lanceolate, spreading/ divaricated, revolute, acute. Petals 9-10 x 0.7 mm, deflexed, linear. Lip 5-6 x 3.4mm, cuneate, clawed, lip margin irregularly sub-rose, apex widely apiculate, emarginated, 5-veined, the two outer veins branching to the margins, lacking the callus. Column 3-4 mm, arcuate, basally dilate with 2 fleshy parallel thickened pads, the apex with sub quadrate wings.

Type specimen: Bagmati Province; Rasuwa, Kyangin Khark, Langtang National Park, 3700m-3900m, 26.07.2010, B.B. Raskoti, 300 (KATH). (Holotype)

Distribution: 3700-3900 m

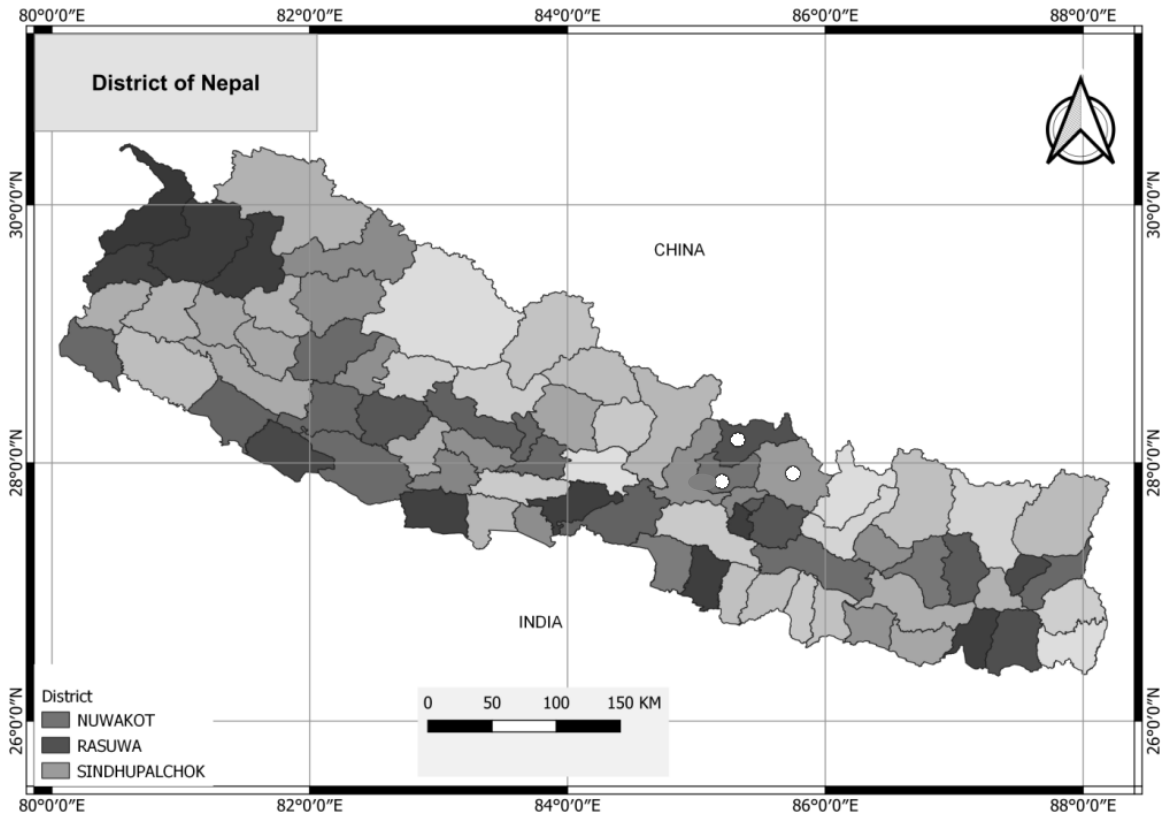
Flowering: July

Fruiting: August- September

Specimens Examined: C. Nepal: Bagmati Province; Rasuwa, Kyangin Khark, Langtang National Park, 3700m-3900m, 26.07.2010, B.B. Raskoti, 300 (KATH) KATH013437. (Holotype)

Note: *L. langtangensis*, is the endemic species to Nepal and was found, described and illustrated first time in Nepal by Raskoti and Ale. Holotype is stored in KATH. As the species was studied by personally visiting the herbarium, the notes given on protologue was matched somehow. As this species shows close relation with *L. campylostalix*, but are distinguished by their leaf shape and twisting of ovary and pedicel also the longer column. The column was found longer than *L. campylostalix* and the leaf was found lanceolate – oblanceolate but other characters can't be noted clearly due to poor condition of herbarium deposited as holotype. As

only 3 flowers were only present, which were not enough for the study of labellum and complete study of this species. The characters of leaf, column and the altitude proves that the species may be new to science as *L. campylostalix* is reported from altitude lower than it was found.



Map.9: Distribution map of *Liparis langtangensis*

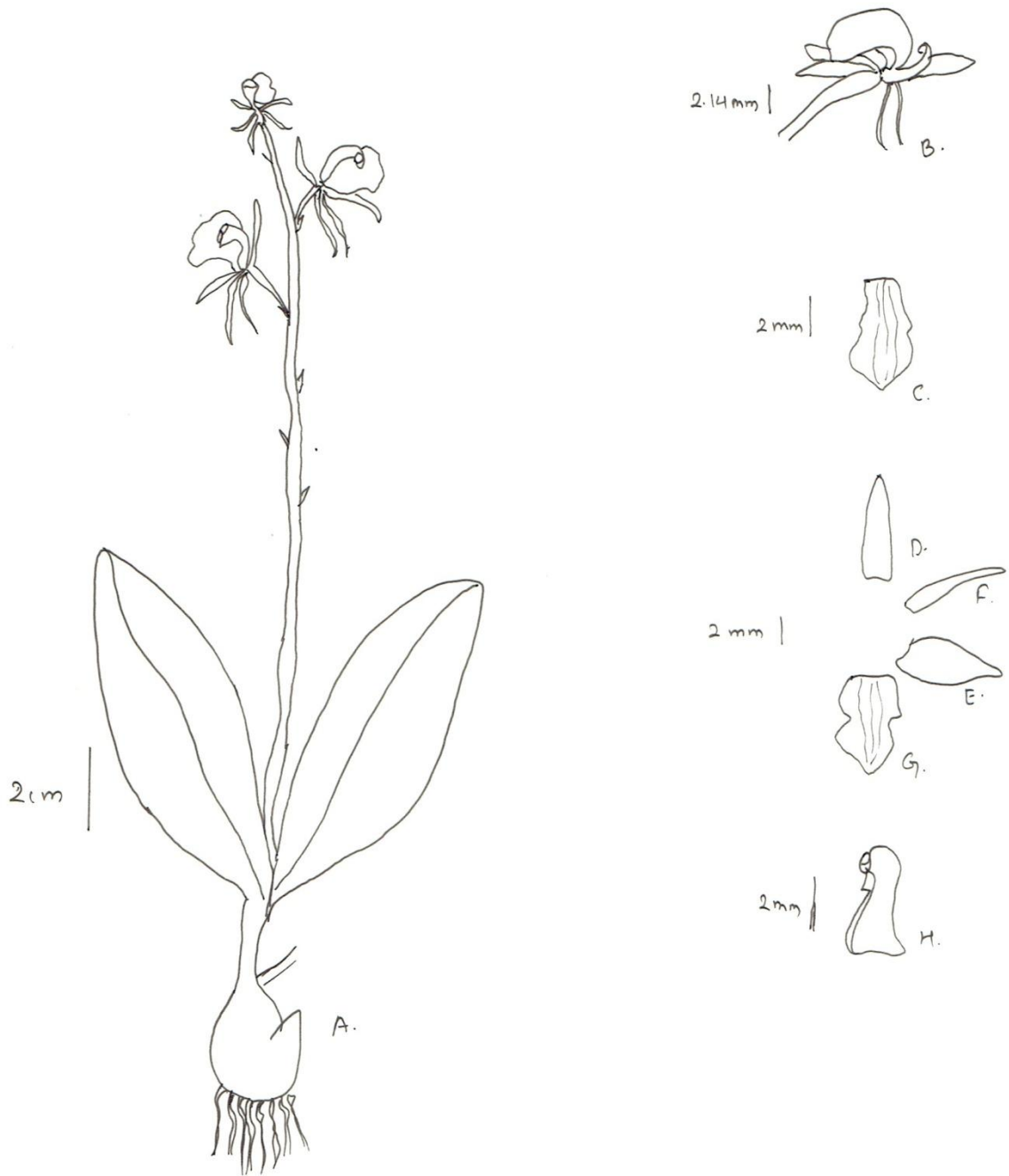


Fig. 17 *L. langtangensis* Raskoti & Ale A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (B.B. Raskoti, 300, KATH013437).

9. *Liparis nervosa* (Thunb.) Lindl. Gen. Sp. Orchid. Pl.: 26 (1830); Hara *et al.*, enumeration. F.P. Nepal.1:12. (1978); Banerji & Pradhan, Orch. Nepal Himalaya: 282. (1984); Deva & Naithaini, Orchid. Fl. North. West. Himalaya: 299 (1986); Chowdhery, orch. Fl. Arunachal Prad. :483. (1998); Press *et al.*, Ann. check. Fl. Pl. Nepal: 219. (2000); Pearce & Cribb, Fl. Bhutan 3 (3): 199 (2002); Chen *et al.*, Fl. China. 25: 218. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1 : 122 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. **1**: 130 (2018); Shrestha *et al.*, Plants of Nepal: 106 (2022)

Epidendrum nervosum (Thunb.) Thunb. in Trans. Linn. Soc. London 2: 327 (1794)

Malaxis nervosa (Thunb.) Sw. in Kongl. Vetensk. Acad. Nya Handl. 21: 235 (1800)

Leptorkis nervosa (Thunb.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Diteilis nervosa (Thunb.) M.A.Clem. & D.L.Jones in Orchadian 15: 40 (2005)

Herbs, terrestrial. Plant height 12-25 cm. Pseudobulbs 0.5-1cm, narrowly ovoid and small, stem erect bearing several sheaths. Leaves 6-9.5 × 3-4.1 cm, 2-3 in number, alternate, blade ovate- elliptic, margin entire, apex subacuminate, amplexicaul, long, not articulate, plicate; base contracted and petiole mostly sessile. Inflorescence 5-10 cm, rachis more than 10 flowered, compactly arranged, floral bracts 2-4mm, deltoid, apex acute, smaller than pedicel and ovary. Flower mostly greenish yellow with slightly purple lip or sometimes purple flower ; pedicel and ovary 9-11 mm. Dorsal sepal 8-9 × 0.5-1 mm, linear or broadly linear, margin revolute, apex obtuse; Lateral sepals 4-5 × 1.5-2 mm, narrowly ovate, slightly oblique, 3-veined, apex obtuse. Petals 7-8 × ca. 0.5 mm, 1-veined, reflexed, filliform,. Lip 6-6.5 × 4-4.5 mm oblong- obovate, apex truncate, emarginated, curved from middle, base narrowed and with 2 calli. Column 3-4 mm, rather stout, narrow wings present. Capsule 14-16 mm, oblong to elliptic.

Type specimen: Puerto Rico, Mayaguez, 30.10.1884, P. sitensis, 497, (K). K000583624 (Isotype)

Distribution: 950-2000 m

Flowering: July- August

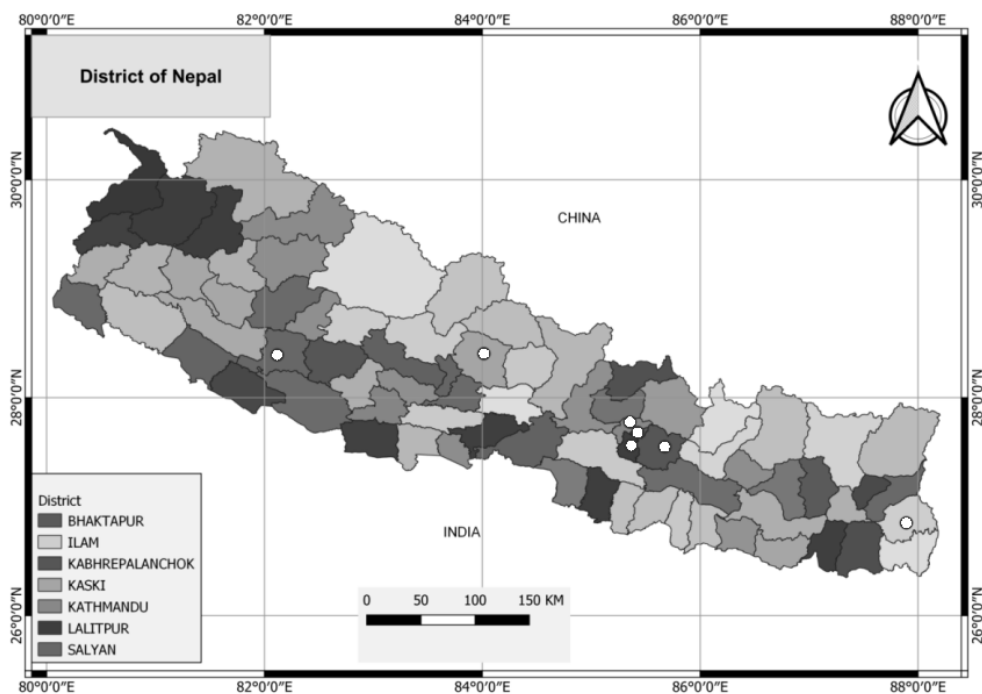
Fruiting: September- October

Specimens Examined: Virtual specimens: Central Nepal: Bagmati Province Kathmandu, PaniMuhan, 1887m, 09.07.2022, E. Dhakal, 20222 (ASCOL).

West Nepal: Karnali Province; Salyan, Jimali, 950m, 17.08.1979, K.R.RajBhandari and B.Roy, 4777 (KATH) KATH002827.

Central Nepal: Bagmati Province; Bhaktapur, Gokarna, 4400ft, 15.08.1966, P.Pradhan and R. Thapa, 6411 (KATH); Kaski, Panchase forest, 1300m, 27.06.2018, P.Bhandari, P1660 (KATH) KATH038031.; Lalitpur, Godawari, 1600m, 05.07.2005, S. dahal, 2003 (KATH) KATH002828. Kabhrepalanchowk, Dumreghari Leasehold forest, Baluwa VDC, 22.07.2001, S.R.Baral, 1105 (KATH). Dumreghari Leasehold forest, Baluwa VDC, 22.07.2001, S.R.Baral, 6411 (KATH). Dumreghari Leasehold forest, Baluwa VDC, 22.07.2001, S.R.Baral, 2003 (KATH), Gandaki Province; Kaski, Kaskikot VDC, Bhakunde, 28.07.1999, Abishkar Subedi, 239 (TUCH).

East Nepal :Province 1; Bumlingtar- Baluwabensi, 450m, 27.09.1999, D. Karkee, 862 (KATH). Illam, Rangapani, 550m, 11.09.1979, R.B Thapa *et al.*, 914 (KATH) KATH002830. Puerb Rico, Mayaguez, 30.10.1884, P. sitensis, 497, (K). K000583624 (Isotype).



Map.10: Distribution map of *Liparis nervosa*

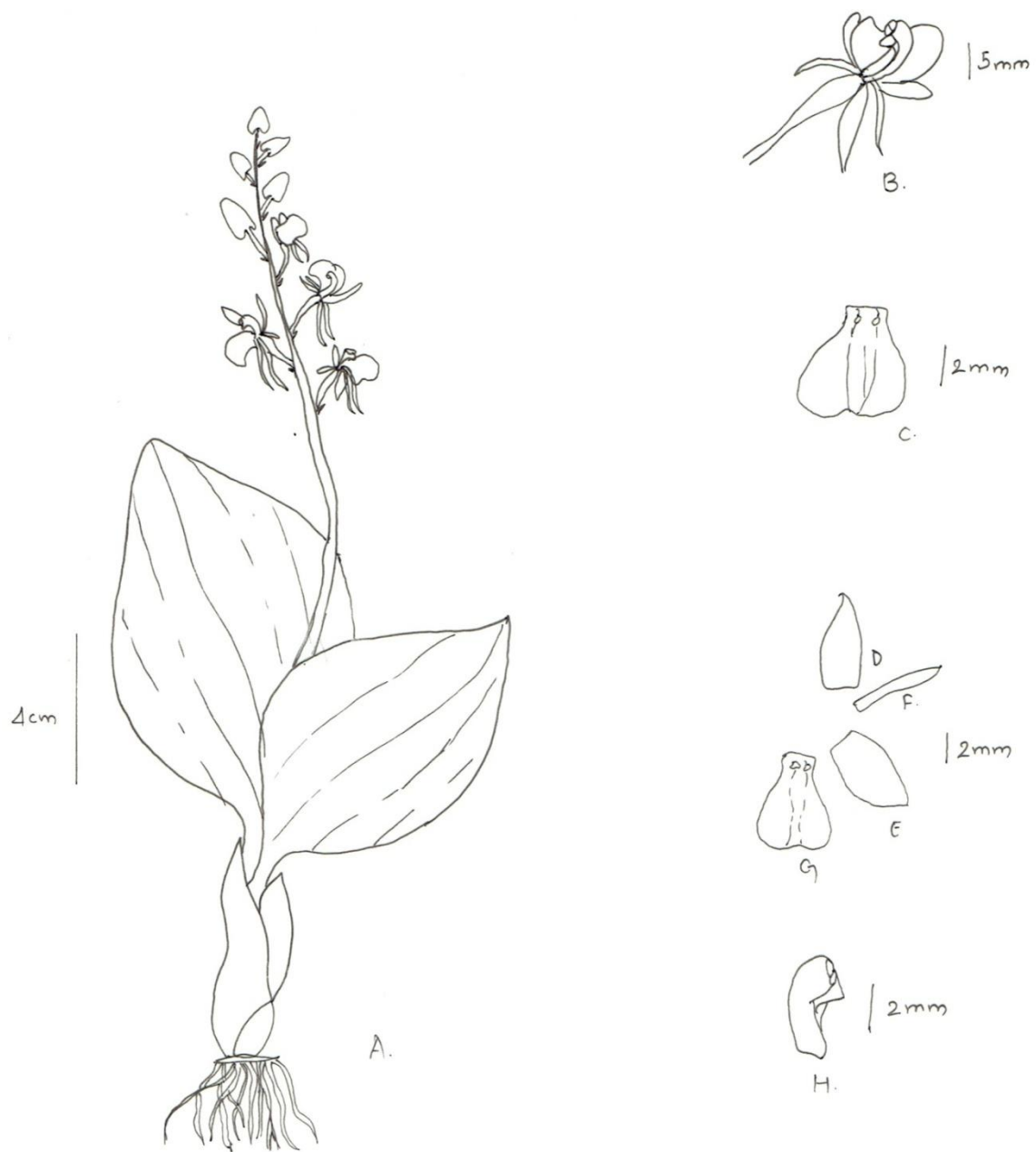


Fig. 18 *L. nervosa* (Thunb.) Lindl. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (E. Dhakal, 20222, ASCOL)

10. *Liparis nervosa* var. *hasiana* (Hook.f.) P.K.Sarkar J. Econ. Taxon. Bot. 5: 1008 (1984); Pearce & Cribb, Fl. Bhutan 3 (3): 200 (2002) Raskoti, Orchids of Nepal. 1-252: (2009); Wu.z. & Hong. D (eds), Fl. of China. 25: 1-570 (2009); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 130 (2018).

Liparis bituberculata var. *hasiana* Hook.f. in Fl. Brit. India 5: 696 (1890)

Liparis hasiana (Hook.f.) Tang & F.T.Wang in Acta Phytotax. Sin. 1: 76 (1951)

Liparis breviscapa A.P.Das & Lama in J. Econ. Taxon. Bot. 16: 226 (1992)

Herbs, terrestrial. Plant height 12-24 cm tall. Roots long, slender. Pseudobulb 1-1.5 cm, small, ovoid, sheathed, narrow. Leaves 7-10 × 4-4.5 cm, 2-3 in number, broadly ovate, apex subacuminate- acute, not amplexicaul, margin entire to wavy, shortly petiole to subsessile, sheathing at base. Inflorescence, 8-9 cm, 9-10 flowered, loosely arranged, Peduncle glabrous, no any sterile bracts present; floral bracts 4-7mm, small, ovate- lanceolate, apex acute. Pedicel and ovary, 0.6-1.1 cm long, slender, glabrous. Flower 8 mm across, uniformly purple, lip purple- brown. Dorsal sepal 3-4.5 × 1-1.5 mm, oblong- lanceolate, subacute; lateral sepals 4-5 × 1.5-2 mm, oblong, obtuse. Petals 4.5-5.5 × 0.5-0.8mm, linear- oblong. Lip 4-5 × 2-3 mm, simple, wedge shaped, decurved about the middle, obcordate, apex broad, broader at apex or 2-lobed, calli present at the base. Column 2.5-3 mm long, curved, winged at apex.

Type specimen: India, Khasia, Moflong, 1524-2134m, 1850.07.02, J.D.Hooker, T. Thomson, 1437 (K) K000387774, K000387773, K000387770, K000387771; Lindley No. 98. (Isotype).

Distribution: 1576 m

Flowering: July

Fruiting: October

Specimens Examined: Virtual specimen: **Central Nepal**, Bagmati Province; Bhaktapur; way to Nagarkot, 1576m, 16.07.2022, E.Dhakal. 20223. (ASCOL)

India, Khasia, Moflong, 1524-2134m, 1850.07.02, J.D.Hooker, T. Thomson, 1437 (K). K000387774

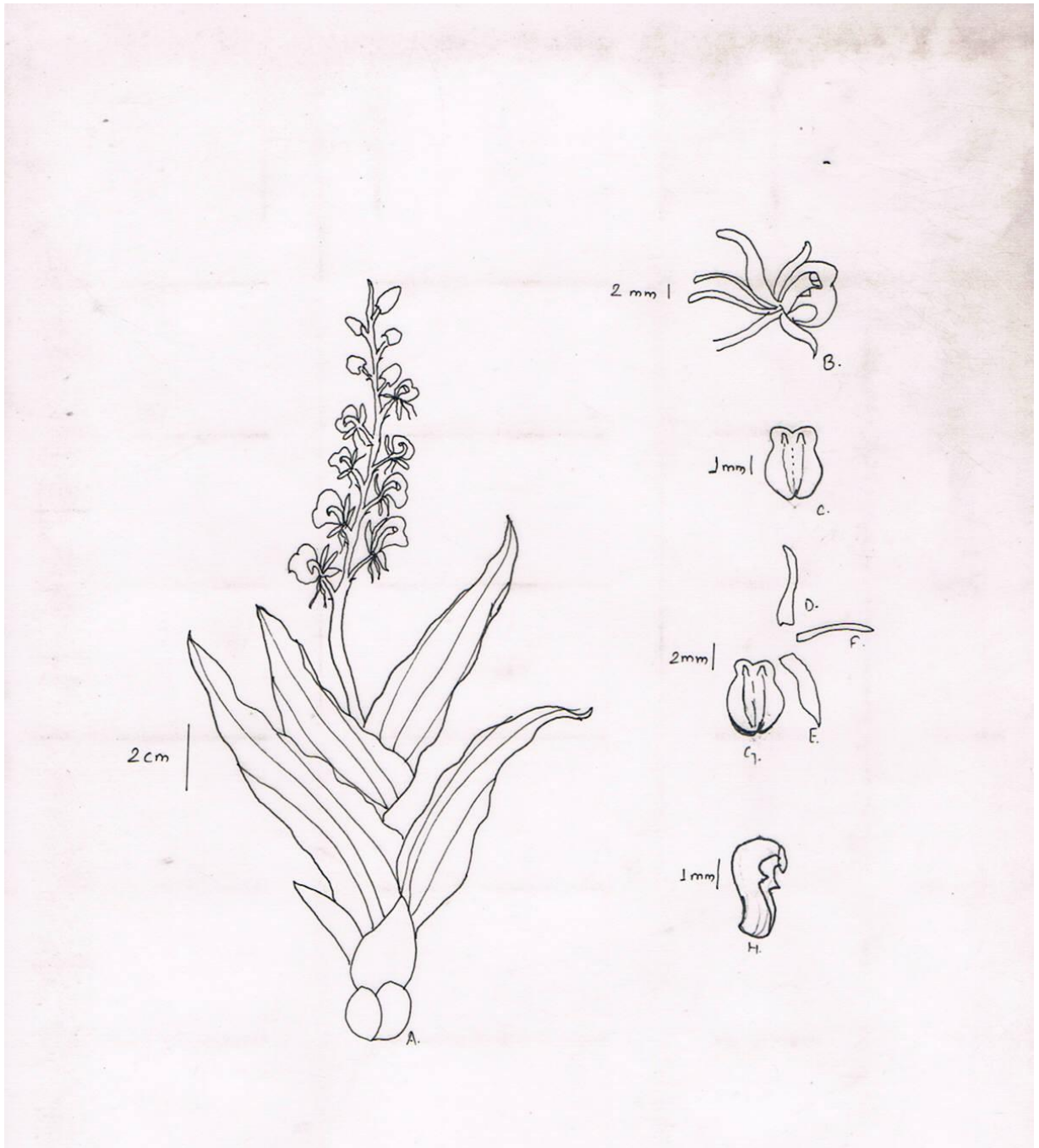
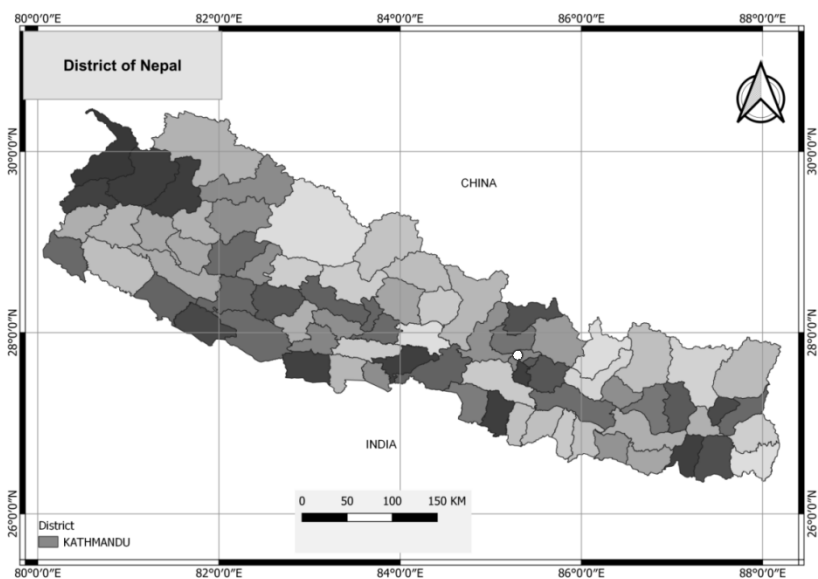


Fig. 19 *L. nervosa* var. *khasiana* (Hook.f.) P.K. Sarkar , A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (E.Dhakal. 20223, ASCOL)



Map.11: Distribution map of *Liparis nervosa var khasiana*

11. *Liparis odorata* (Willd.) Lindl. Gen. Sp. Orchid. Pl.: 26 (1830); Deva & Naithaini, Orchid. Fl. North. West. Himalaya: 301 (1986); Pearce & Cribb, Fl. Bhutan 3 (3): 201 (2002); Chen *et al.*, Fl. China. 25: 217. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1: 122 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. **1**: 130 (2018); Shrestha *et al.*, Plants of Nepal: 106 (2022)

Malaxis odorata Willd. in Sp. Pl. ed. 4: 4: 91 (1805)

Empusa paradoxa Lindl. in Bot. Reg. 10: t. 825 (1824)

Liparis paradoxa var. *parishii* Hook.f. in Fl. Brit. India 5: 698 (1890)

Leptorkis odorata (Willd.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Liparis simeonis Schltr. in Repert. Spec. Nov. Regni Veg. 20: 383 (1924)

Liparis tonkinensis Gagnep. in Bull. Soc. Bot. France 79: 167 (1932)

Herbs, terrestrial and mostly found on pinus forest and on exposed slopes. Plant height 25-35 cm. Pseudobulbs 0.9-1.8 cm, sub ovoid, enclosed by tubular sheath i.e. membranous. Leaves 12.5-18.9 x 2.25-3.2 cm, 2- more in number, blade lanceolate or oblong, margin entire, apex acuminate, base contracted into a petiole, petiole is sheathed. Inflorescence 10.1-22.2 cm, rachis several flowered; floral bracts 5-6 mm, lanceolate, spreading horizontally. Flowers reddish green or greenish brown; pedicel and ovary 8-9 mm. Dorsal sepal 6 x 1 mm, 3

veined, linear, margin revolute, apex obtuse; Lateral sepals 5 x 1.2 mm, ovate, slightly oblique, 3- veined. Petals 5x 0.3 mm, narrowly linear, slightly wider apex, single veined and margin revolute. Lip 4 x 2 mm deflexed with calli at the base. Column 3-4 mm, slightly arcuate, with narrow wings on both sides. Capsule 10-15 mm, clavate, obovoid to ellipsoid.

Type specimen: India, Sikkim Himalaya, Tropical valley, 1898/07-1898/09, R. Pantling, 228, (M). M0226380; China, August, 1919, Universitat Hamberg- Herbarium, HBG-501753 (Holotype)

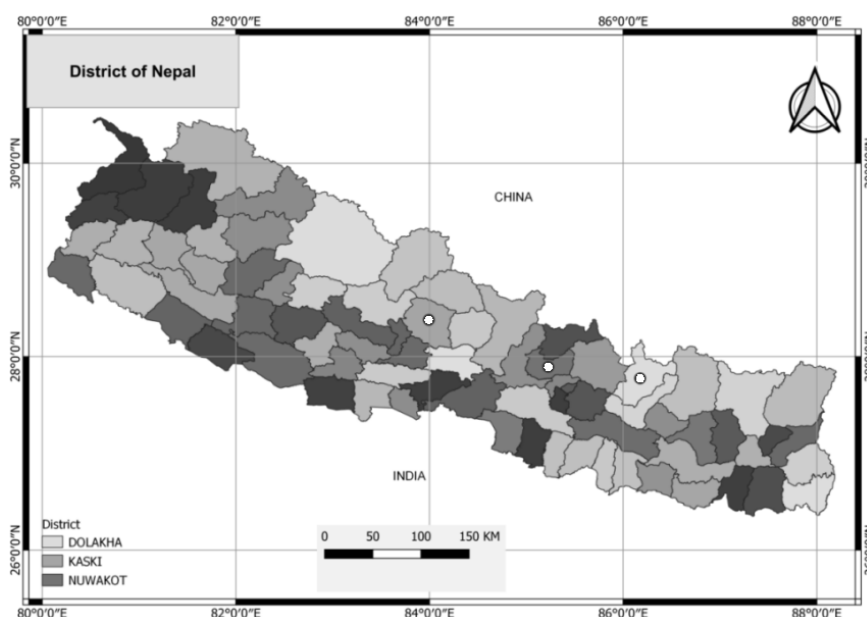
Distribution: 775-1590 m

Flowering: July – August

Fruiting: August- September

Specimens Examined: Virtual specimens; Bhaktapur, Way to Nagarkot, 1590m, 16.07.2022, E. Dhakal. 20225 (ASCOL).

C. Nepal: Bagmati Province; Dolakha, Salghari, Jungu, 1095m, 26.08.2016, Sangram karki, Ashish Dhital and Subash Kafle, J46 (KATH) KATH086217, KATH078334, KATH078335. Salghari, Jungu, 1095m, 26.08.2016, Sangram karki, Ashish Dhital and Subash Kafle, 10834 (KATH). Gandaki Province; Kaski, Pokhara- 21, Kharchyang near Ajihare, 755m, 26.07.2020, P. Bhandari, A. Bhandari and V. Bhandari, 20070601 (KATH) KATH086802. India, Sikkim Himalaya, Tropical valley, 1898/07-1898/09, R. Pantling, 228, (M). M0226380



Map.12: Distribution map of *Liparis odorata*

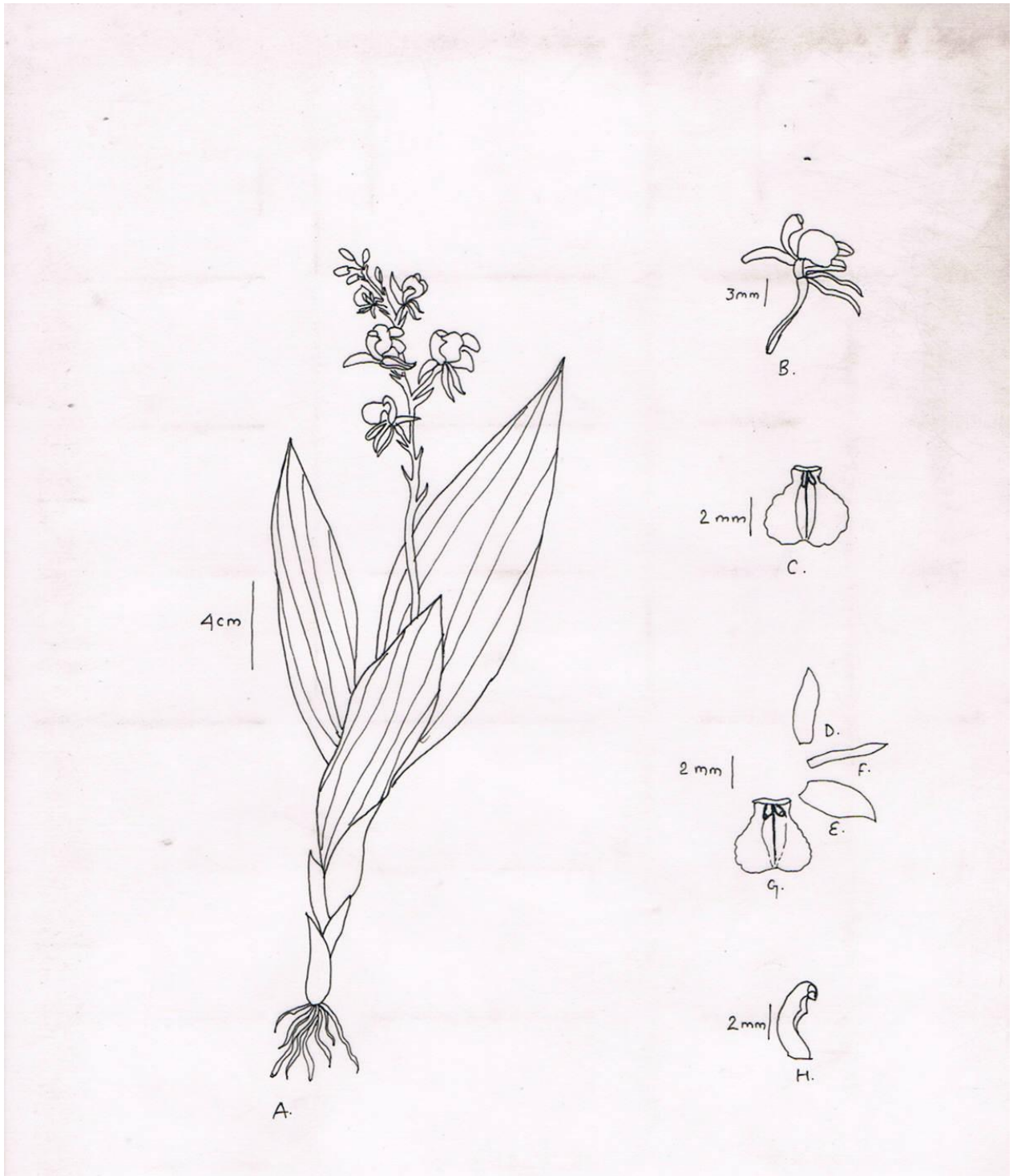


Fig. 20 *L. odorata* (Willd.) Lindl. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (E. Dhakal. 20225, (ASCOL).

12. *Liparis olivacea* Lindl. Gen. Sp. Orchid. Pl.: 27 (1830); Hooker's Icon. Pl. 19: t. 1813 (1889); Hooker, Fl. Brit. Ind. 5: 697. (1890); Hara *et al.*, enumeration. F.P. Nepal. 1: 12. (1978); Banerji & Pradhan, Orch. Nepal Himalaya: 270. (1984); Press *et al.*, Ann. check. Fl. Pl. Nepal: 219. (2000); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1: 123 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 130 (2018); Shrestha *et al.*, Plants of Nepal: 106 (2022)

Herbs, epiphyte. Plant height 15-18 cm. Pseudobulbs 1.3 × 0.5 cm, ovate-obtuse at the top, small, sheathed pseudostem with 1-2 membranous sheaths. Leaves 5-9 × 0.7-1.5 cm, two, subopposite, blade oblong-lanceolate with 4-5 veined, leaf folded in most, to entire, apex acuminate base contracted into a petiole, petiole short to sessile. Inflorescence 9-18 cm, raceme erect and many flowered, peduncle as equal to the raceme, few sterile bracts present; floral bracts 3-4 mm, lanceolate. Flowers yellowish to greenish; Pedicel and ovary 4-5 mm. Sepals linear to oblong or obtuse, 5-nerved dorsal sepal 5 mm long; lateral sepals 5 mm long present below the lip. Petals 5 mm long, linear, apex acute. Lip 2-4 × 1.8 mm long, flat, orbicular subcrenulate at apex, sub-orbicular, blunted with conical base, 2 calli present. Column 2-5 mm, rather stout slightly curved very narrow wings at tip.

Type specimen: Nepal, C. Nepal, 1812, N. Wallich, 1942, (K). K001114786. (Isotype)

Distribution: 2300 m

Flowering: July

Fruiting: August

Specimens Examined: Nepal, C. Nepal, 1812, N. Wallich, 1942, (K). K001114786. (Type)

Note: This species is endemic species of Nepal. Status of *L. olivacea* is suspected to be extinct as it is only known from the type collection at Kew herbarium.

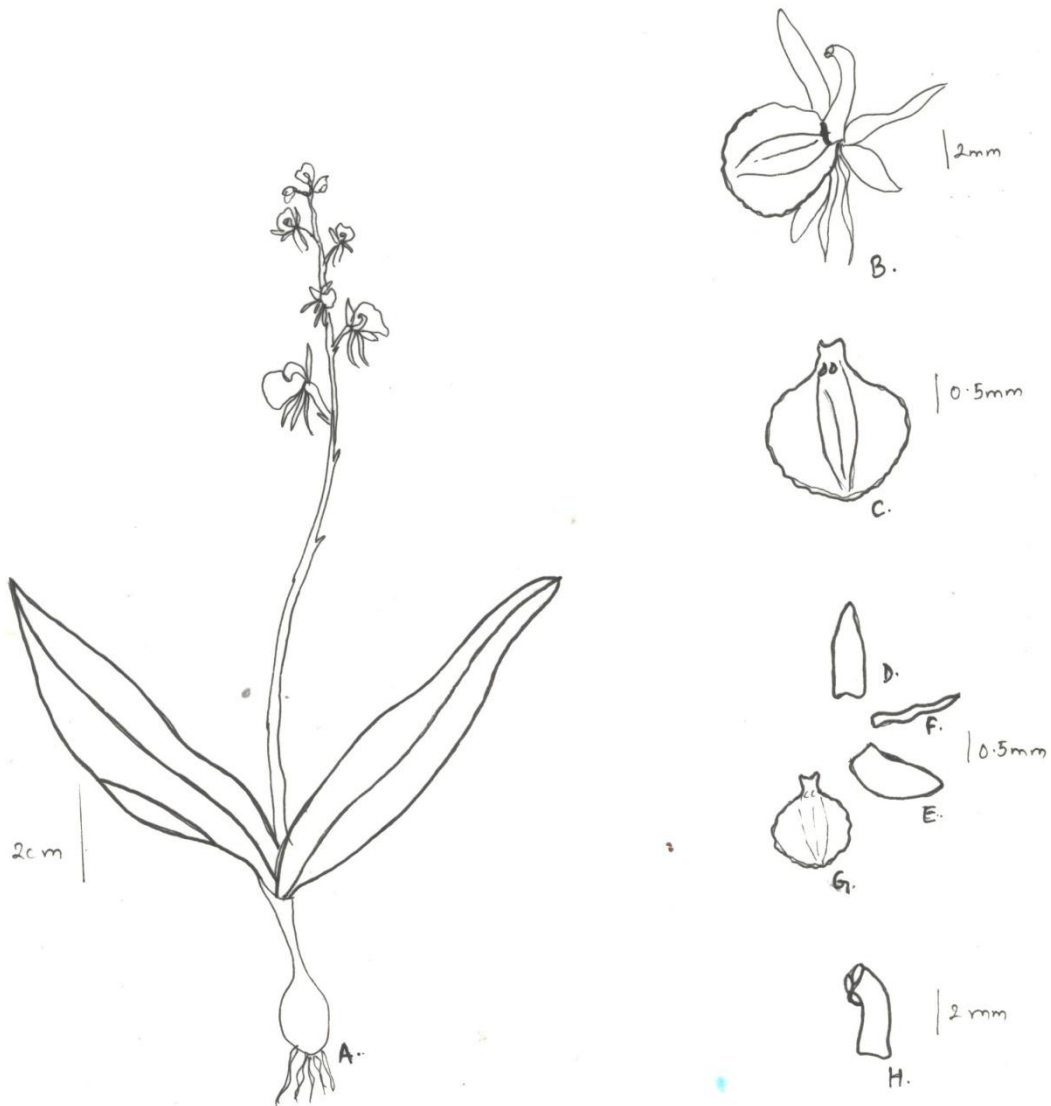
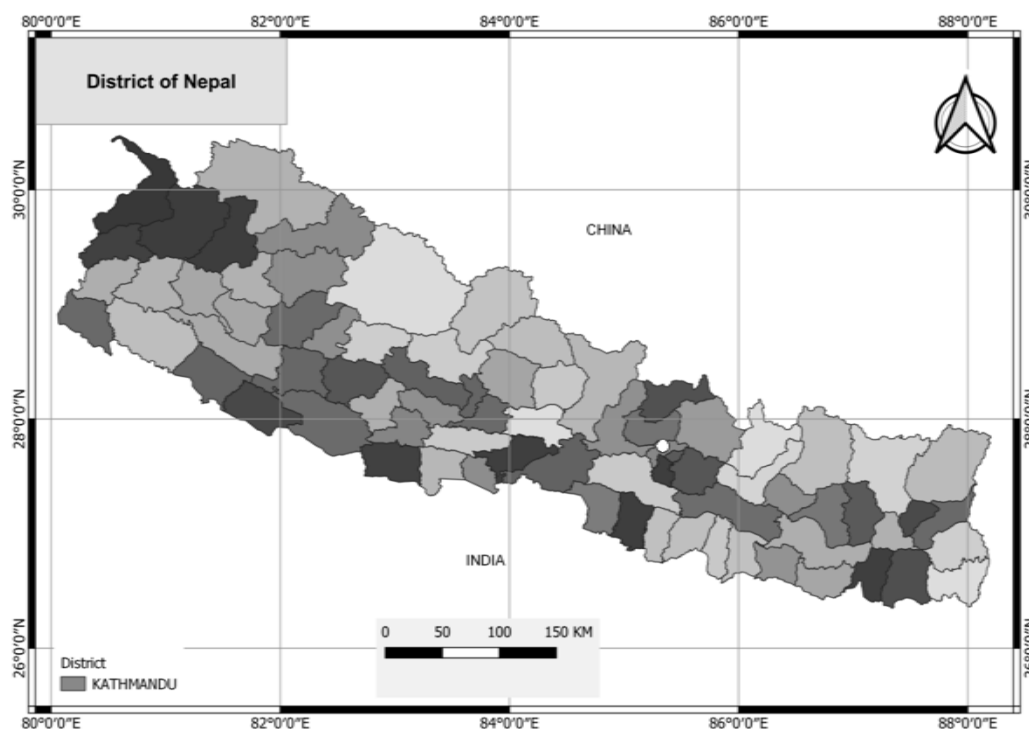


Fig. 21 *L. olivaceae* Wight. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (Wallich, 1942, K001114786)



Map.13: Distribution map of *Liparis olivaceae*

13. *Liparis perpusilla* Hook.f. Hooker's Icon. Pl. 19: t. 1856b (1889); King and Pantling, Ann. Bot. Gar. Calc. 8: 33. (1898); Hara *et al.*, enumeration. F.P. Nepal.1:12. (1978); Banerji & Pradhan, Orch. Nepal Himalaya: 284. (1984); Press *et al.*, Ann. check. Fl. Pl. Nepal: 219. (2000); Pearce & Cribb, Fl. Bhutan 3 (3): 208 (2002); Chen *et al.*, Fl. China. 25: 226. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1: 123 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 130 (2018); Shrestha *et al.*, Plants of Nepal: 106 (2022)

Leptorkis perpusilla (Hook.f.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Liparis togashii Tuyama in Fl. E. Himal.: 441 (1966)

Platystyliparis perpusilla (Hook.f.) Marg. in Richardiana 7: 39 (2007)

Herbs, epiphytic. Plant height 5-8 cm. Pseudobulb 9-10 × 2.5-3 mm, tufted, oblong. Leaf 1.3-2.4 cm × 0.1-0.3 cm, 3-5 in number, linear-lanceolate, acute-acuminate apex, margin entire, leaf narrowed to the base, sessile. Inflorescence 2.7-4 cm, erect, much longer than leaves, peduncles winged, laxly arranged many flowered; floral bracts 2-3 mm, lanceolate to linear shorter than ovary. Flowers orange-yellow or pinkish; pedicel and ovary 3-4 mm. Dorsal sepal 4×0.1 mm, lateral sepals 3.5 × 0.5 mm, broadly elliptic, margin recurved. Petals 3.5-4 mm, as long as the sepals, linear, reflexed. Lip 2 × 1.5 mm, quadrate with 2 rounded side

lobes, deflexed at middle, deeply grooved from the base to apex, having thin ridges running upward, a disc with a U- shaped callus near base and 2 calli present, base with a bit concentric nectar. Column 1.5-2 mm, long, erect or stout, base broad and apex with two broad wings. Capsule 3-4 mm, ellipsoid.

Type specimen: India, Sikkim, Tachony, 02.10.1845, 2438.40487728, J. D. Hooker (K). K000387840 (Isotype)

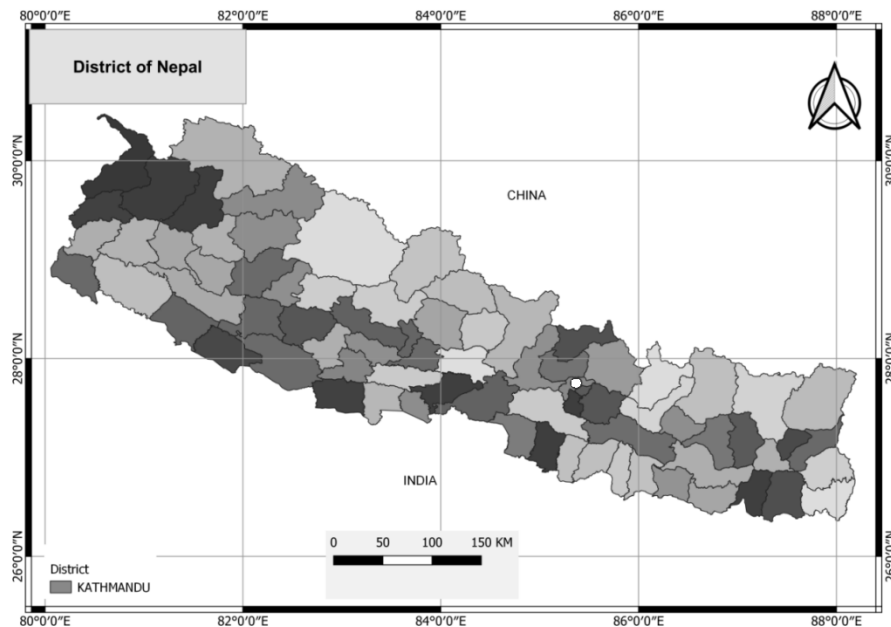
Distribution: 1800-2800 m

Flowering: August

Fruiting: September

Specimens Examined: Central Nepal: Bagmati Province; Kathmandu, Shivapuri, 2500m, 06.08.2016, P. Bhandari, M. Limbu, 1709 (KATH). Ganesh Himal (Ankhukhola), 2800m, 18.07.1992, W.J Baker, T.A Burkill, 79 (KATH) KATH002831. Bhorlang, 1800m, 20.08.1969, S.B.Malla, 16023 (KATH) KATH002832.

India, Sikkim, Tachony, 02.10.1845, 2438.40487728, J. D. Hooker (K). K000387840 (Type).



Map.14: Distribution map of *Liparis perpusilla*

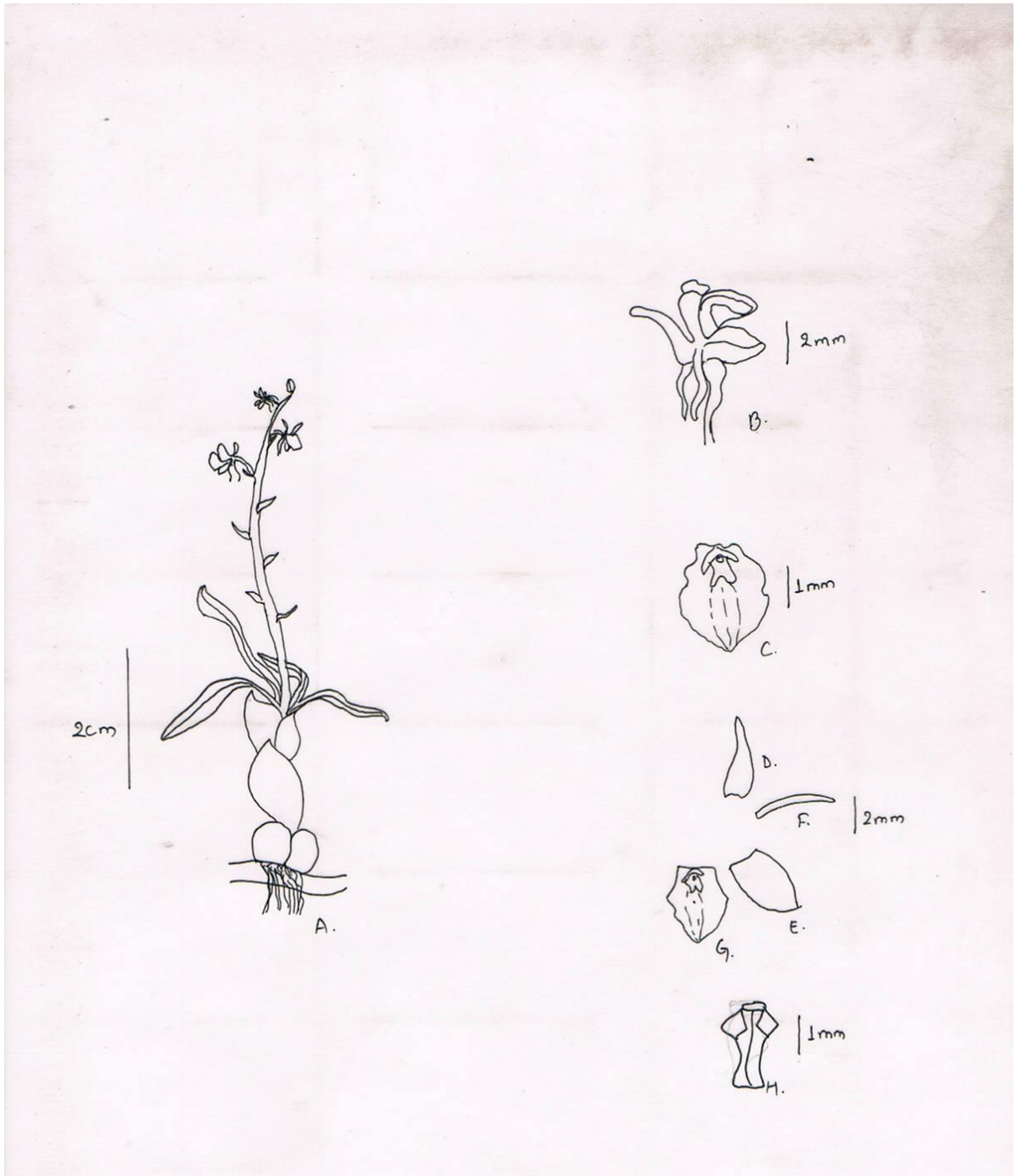


Fig. 22 *L.perpusilla* Hook.f. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (J. D. Hooker, K000387840).

14. *Liparis petiolata* (D.Don) P.F.Hunt & Summerh. Kew Bull. 20: 52 (1966); Hara *et al.*, enumeration. F.P. Nepal.1:13. (1978) Banerji & Pradhan, Orch. Nepal Himalaya: 286. (1984); Press *et al.*, Ann. check. Fl. Pl. Nepal:219. (2000); Pearce & Cribb, Fl. Bhutan 3 (3): 202 (2002); Chen *et al.*, Fl. China. 25: 220. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1: 123 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. **1**: 131 (2018); Shrestha *et al.*, Plants of Nepal: 106 (2022)

Liparis nepalensis Lindl. in Bot. Reg. 11: t. 882 (1825)

Acianthus petiolatus D.Don in Prodr. Fl. Nepal.: 29 (1825)

Liparis rupestris var. *purpurascens* Ridl. in J. Linn. Soc., Bot. 22: 268 (1886)

Liparis pulchella Hook.f. in Hooker's Icon. Pl. 19: t. 1810 (1889)

Liparis angkae Kerr in Bull. Misc. Inform. Kew 1927: 215 (1927)

Liparis taronensis S.C.Chen in Acta Phytotax. Sin. 31: 344 (1983)

Herbs, terrestrial. Plant height 17-20 cm. Pseudobulb 1.8-2 × 0.8-0.9 cm, running rhizome, ovoid, enclosed by white membranous sheaths. Leaf 7.3-9.8 × 4.8-4.9 cm, two in number, blade broadly ovate, membranous or herbaceous, margin crenate or nearly entire, apex acute – acuminate or nearly cuspidate, base cordate; petiole 4.5-7 cm, sheathed. Inflorescence 5.4-14.9 cm, upper part narrowly winged, rachis several to more than 10 flowered; floral bracts 9-11 mm, lanceolate. Flowers pinkish green to yellowish red, lip tinged with purplish green; pedicel and ovary 7-8 mm. Dorsal sepal ca. 9.5 × 1mm, linear- lanceolate, 3-veined, apex obtuse; lateral sepals 9×1.1 mm, narrowly oblique. Petals 10 × 0.4 mm, linear, single veined. Lip 1.3 × 0.6 cm, flat, apex mucronate, 2 calli at the base. Column ca. 3mm, arcuate, narrowly winged apex. Capsule 10-15 mm, clavate, terete to ellipsoid.

Type specimen: Nepal, Nepaul, 01.01.1821, N. Wallich, 1945 (G). G00354729 (Isotype).

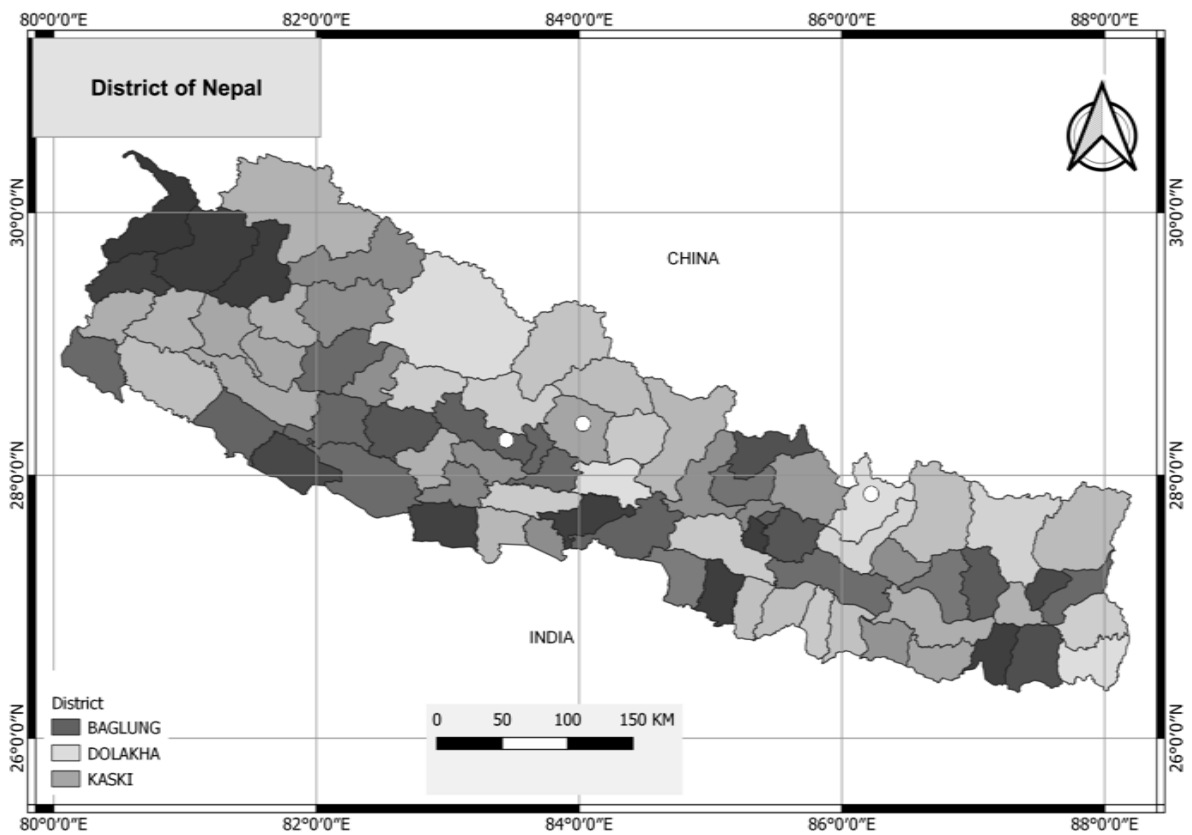
Distribution: 1300-2500m

Flowering: June

Fruiting: July

Specimens Examined: C. Nepal: Bagmati province; Dolakha, Khole-Jungu, 2160m, 28.08.2018, Sangram Karki, J47 (KATH) KATH086219, KATH086221. Gandaki Province; Kaski, Panchase, 2300-2450m, 18.08.2018, P.Bhandari, 1451 (KATH), Pothana (1970m), Bhichuk (Bhedi Kharka), 1790m, Tolka (Thoraka) (1750m), 1920m, 20.08.1988, 30150 (KATH) KATH017600. Baglung, Taman- Derbang, 1300m, 28.06.1979, H.K Sainju and S.R Tuladhar, 73/79 S.T. (KATH) KATH 002833, KATH002834, KATH002835.

Nepal, Nepaul, 01.01.1821, N. Wallich, 1945 (G). G00354729 (Isotype). India, 1945, Wallich (BM) BM000088562. (Isotype).



Map.15: Distribution map of *Liparis petiolata*

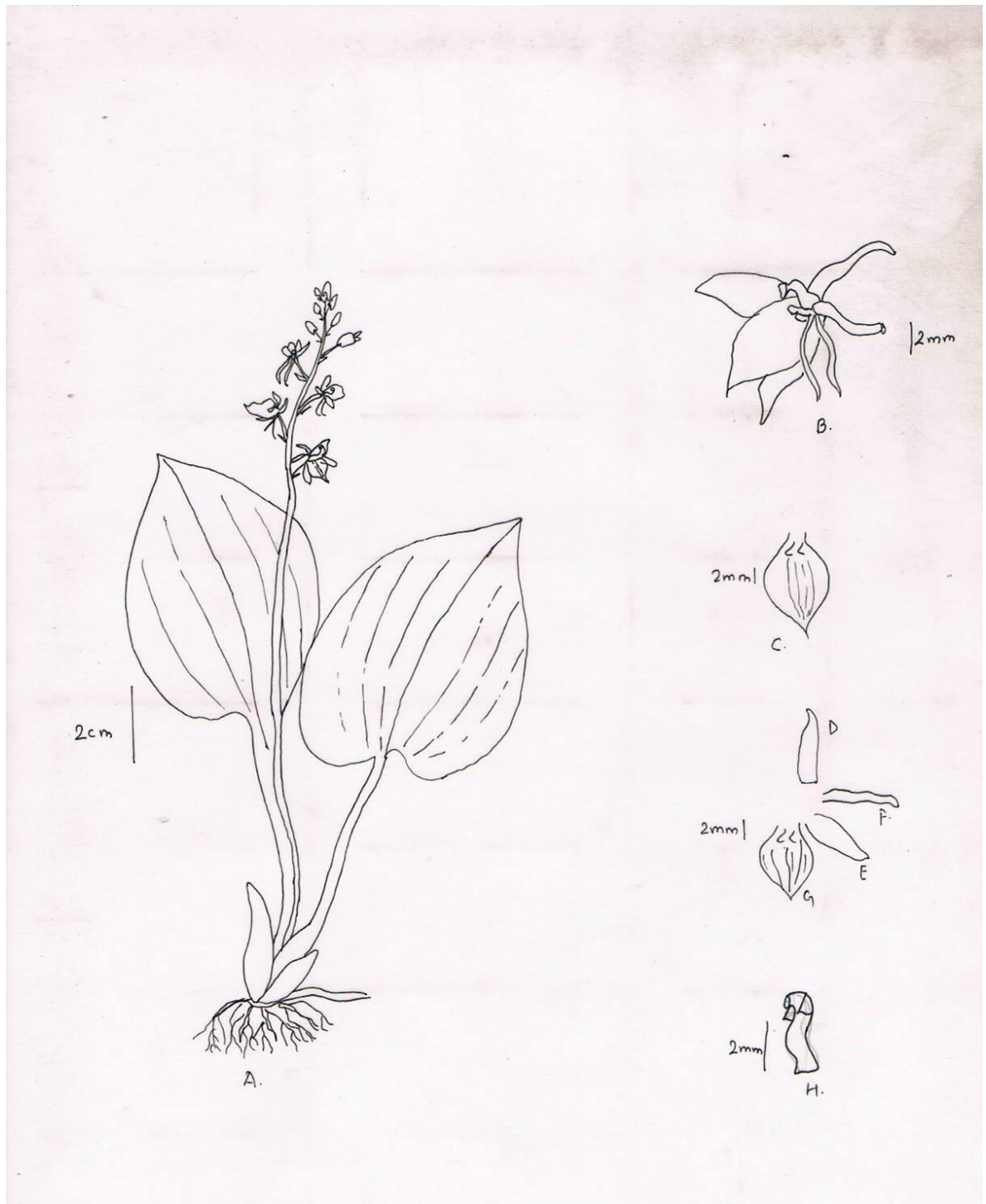


Fig. 23 *L. petiolata* (D. Don) P.F. Hunt & Summerh. A. Habit, B. Flower with pedicel and ovary, C, G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (P. Bhandari, 1451, KATH)

15. *Liparis plantaginea* Lindl. Gen. Sp. Orchid. Pl.: 29 (1830); Hooker, Fl. Brit. Ind. 5: 702. (1890); King and Pantling, Ann. Bot. Gard. Calc. 8: 29. (1898); Chowdhery, orch. Fl. Arunachal Prad. :483. (1998); Pearce & Cribb, Fl. Bhutan 3 (3): 208 (2002); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 131 (2018); Shrestha *et al.*, Plants of Nepal: 107 (2022)

Liparis selligera Rchb.f. in Linnaea 41: 42 (1876)

Liparis orbicularis Lodd. ex Hemsl. in Gard. Chron., n.s., 16: 592 (1881)

Leptorkis plantaginea (Lindl.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Stichorkis plantaginea (Lindl.) Marg., Szlach. & Kulak in Acta Soc. Bot. Poloniae 77: 39 (2008)

Herb, terrestrial or lithophytic. Plant height 25-27 cm. Pseudobulb 2-3.5 cm, large, narrowly ovoid- oblong, compressed, smooth and greenish. Pseudostem thick and strong, made up of four or five large acute sheaths. Leaves 13-15.5 × 2.5-3 cm, 2 in number, subopposite, linear to oblong or lanceolate, apex acute- acuminate, leaf narrowed at the base, faintly 5-6 nerved, margin slightly crenate to entire, sometimes sessile or petiole is enclosed by membranous sheaths. Inflorescence 14-15 cm, long, suberect, inflorescence somewhat as long as leaves; peduncle as equal to the raceme, compressed, winged and with linear – lanceolate, 1/2 bracts, raceme 15-20 flowered, rachis winged irregularly; Floral bracts 8-9 mm, lanceolate, smaller than the pedicel and ovary. Flowers green, 1-1.5 cm, long; Pedicel and ovary 1-1.3 cm. Dorsal sepal 10-11 × 0.1-1 mm, spreading, lanceolate, subacute apex with revolute margin; Lateral sepals 7-9 × 1-1.1 mm, oblong, subacute apex with revolute margin, lying parallel under the lip. Petals 9-10 × ca. 0.1 mm filiform to linear, decurved, revolute margin. Lip 1 × 0.9 cm large, flat, slightly concave, sub orbicular with minutely erose- dentate edges, decurved from the base and contracted into a shortly articulate claw bearing a callus. Column 3-4 mm, slightly curved with thickened bases and 2 very small angular wings at apex. Capsule 15-17 mm, globose to obovoid.

Type specimen: Malaysia, Gintea mountain, 07.1830, N. Wallich. (K). K00113256. (Isotype).

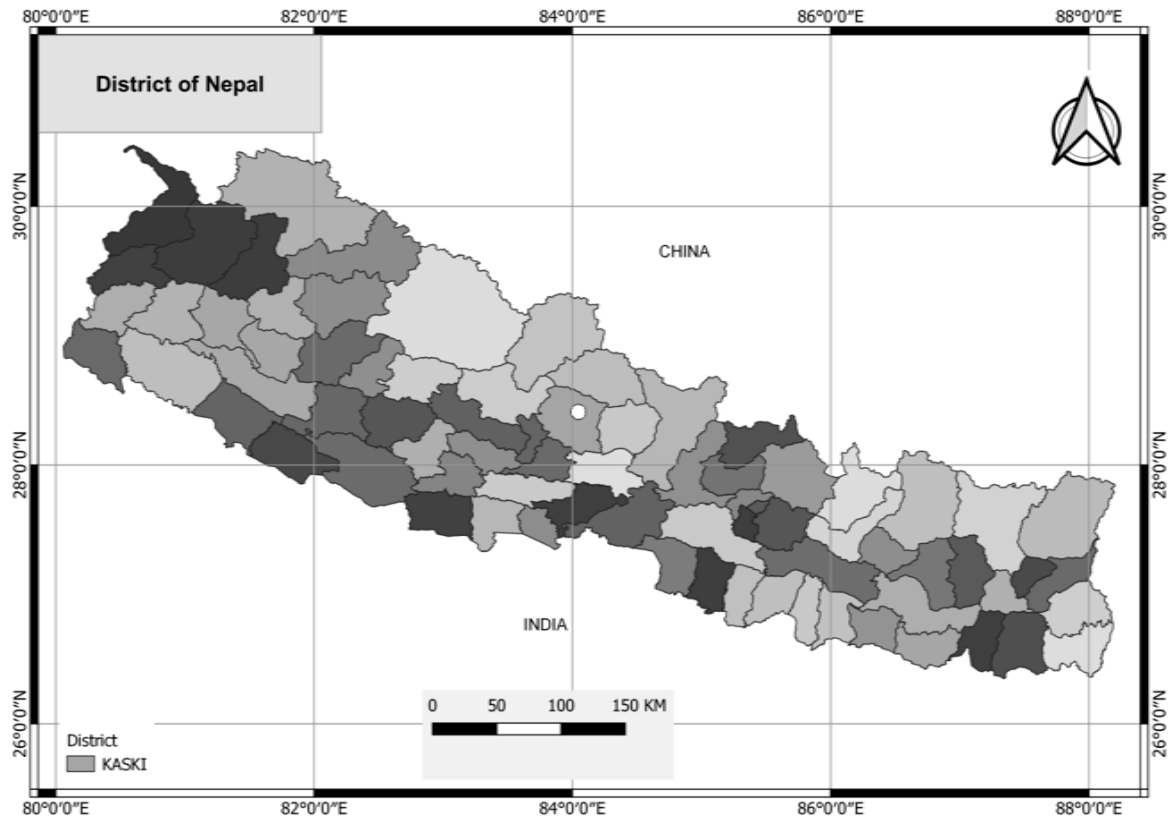
Distribution: 700-725 m

Flowering: June- July

Fruiting: August

Specimens Examined: Central Nepal: Gandaki Province; Kaski, Pokhara 21 Kharchyang, 700-725m, 28.06.2020, P. Bhandari *et al.*, 20062805 (KATH) KATH086912, KATH086913 .

Malaysia, Gintea mountain, 07.1830, N. Wallich. (K). K001132569



Map.16: Distribution map of *Liparis plantaginea*

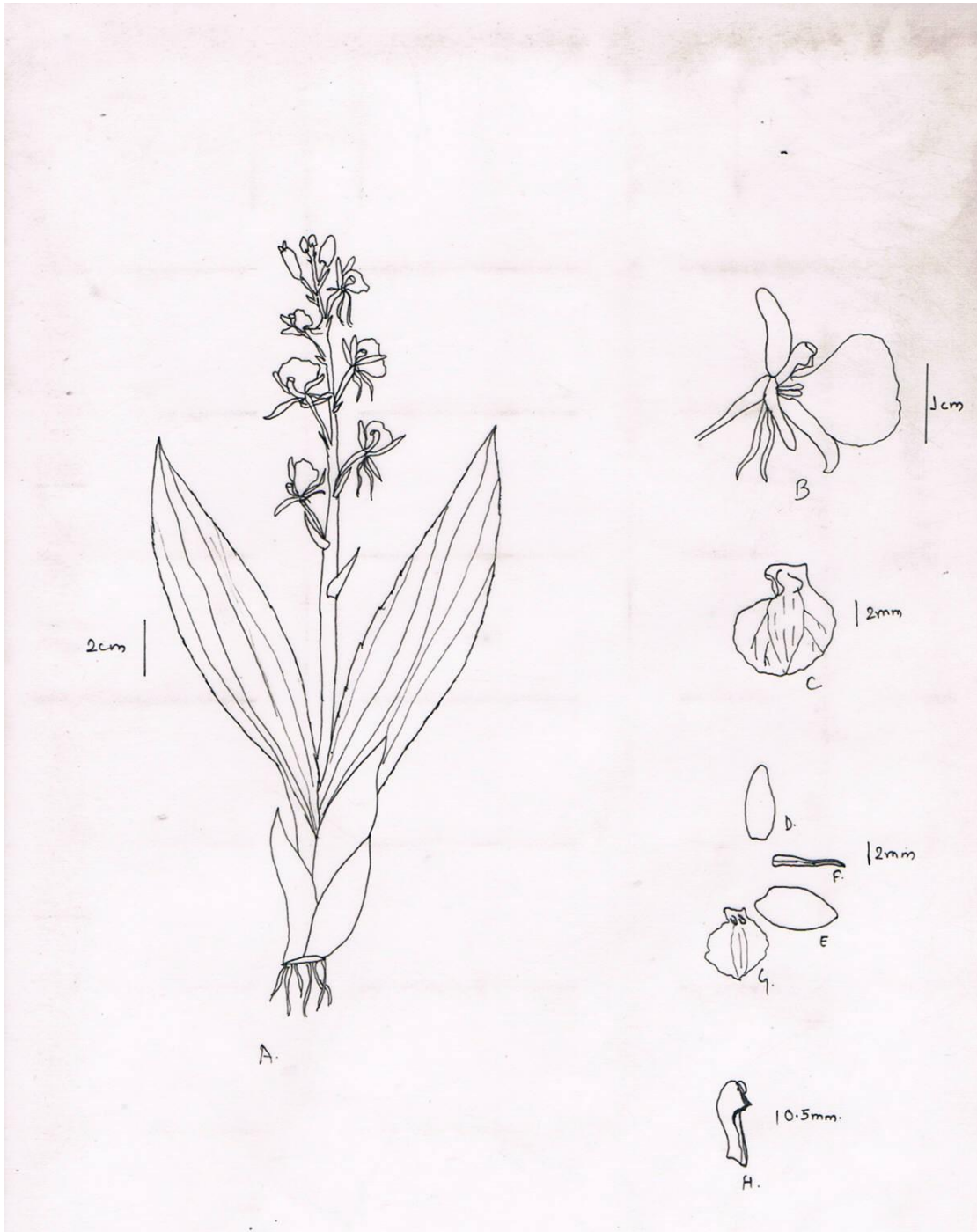


Fig. 24 *L. plantaginea* Lindl. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (P. Bhandari *et al.*, 20062805, KATH086912, KATH086913).

16. *Liparis platyrachis* Hook.f. Hooker's Icon. Pl. 19: t. 1890 (1889); Hooker, Fl. Brit.Ind.5: 706. (1890); King and Pantling, Ann. Bot. Gar. Calc. 8: 34. (1898); Hara *et al.*, enumeration. F.P. Nepal.1:13. (1978) Banerji & Pradhan, Orch. Nepal Himalaya: 270. (1984); Deva & Naithaini, Orchid. Fl. North. West. Himalaya: 305 (1986); Press *et al.*, Ann. check. Fl. Pl. Nepal: 219. (2000) Pearce & Cribb, Fl. Bhutan 3 (3): 209 (2002); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. **1**: 131 (2018); Shrestha *et al.*, Plants of Nepal: 107 (2022)

Leptorkis platyrachis (Hook.f.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Platystyliparis platyrachis (Hook.f.) Marg. in Richardiana 7: 39 (2007)

Herbs, epiphytic. Plant height 10-15 cm. Pseudobulb 1-2 cm, densely arranged, oblong, sheathed. Leaf 1-4 × 0.4-0.9 cm, 3-5 leaves, alternate, blade linear – lanceolate, acute apex, margin slightly wavy to entire, articulate base contracted into a short petiole. Inflorescence scape much elongated upto 6-7 cm, pendulous, peduncle mostly winged, raceme thicker than the peduncle, 8-15 flowered; floral bracts ca. 2-5 mm, subulate with acute apex, much shorter than pedicel and ovary. Flowers greenish – brownish yellow; pedicel and ovary 3-4 mm. Dorsal sepal 0.5-1 mm broad, elliptic, narrower than the lateral; lateral sepals 1-1.1 mm, oblique, their edges are much recurved. Petals 2-2.5 × 0.3-0.4 mm broad, linear, nearly as long as sepals, decurved edges revolute. Lip about half as long as sepals, deflexed about the middle, apex broad or round, calli present. Column 1-2mm, erect, upper part with a small triangular wing, base dilated. Capsule 5mm, obovoid.

Type specimen: Nepal, North of Pokhara, 23.04.1954, Stainton, Skyes & Williams, 5013 (BM). 000088680(BM). (Isotype)

Distribution: 1400-1500 m

Flowering: September

Fruiting: October

Specimens Examined: India: Sikkim Himalaya, 6000ft, 09.1895, R. pantling, 417 (K) K000387835.

Nepal, North of Pokhara, 23.04.1954, Stainton, Skyes & Williams, 5013 (BM). 000088680(BM)

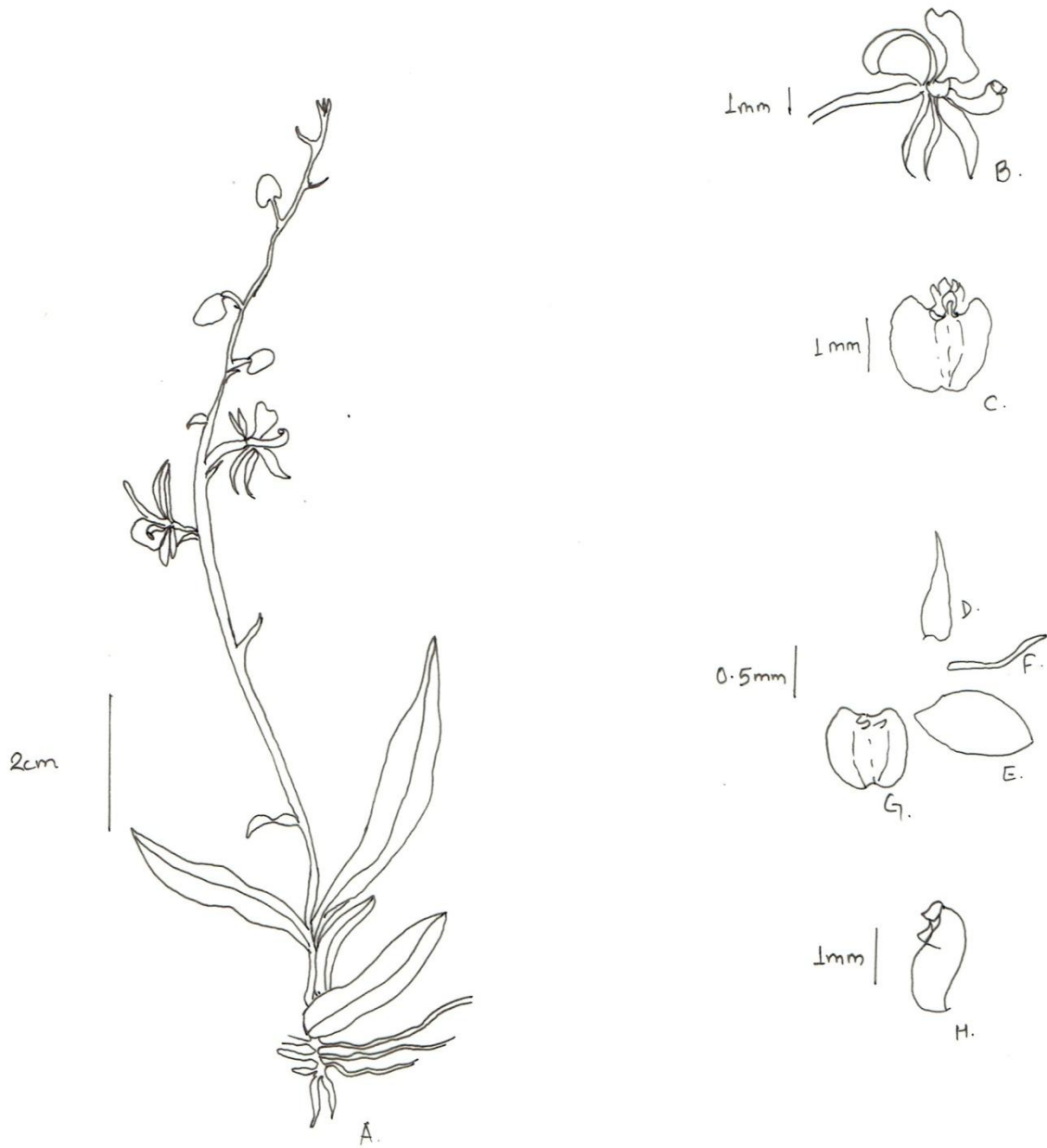
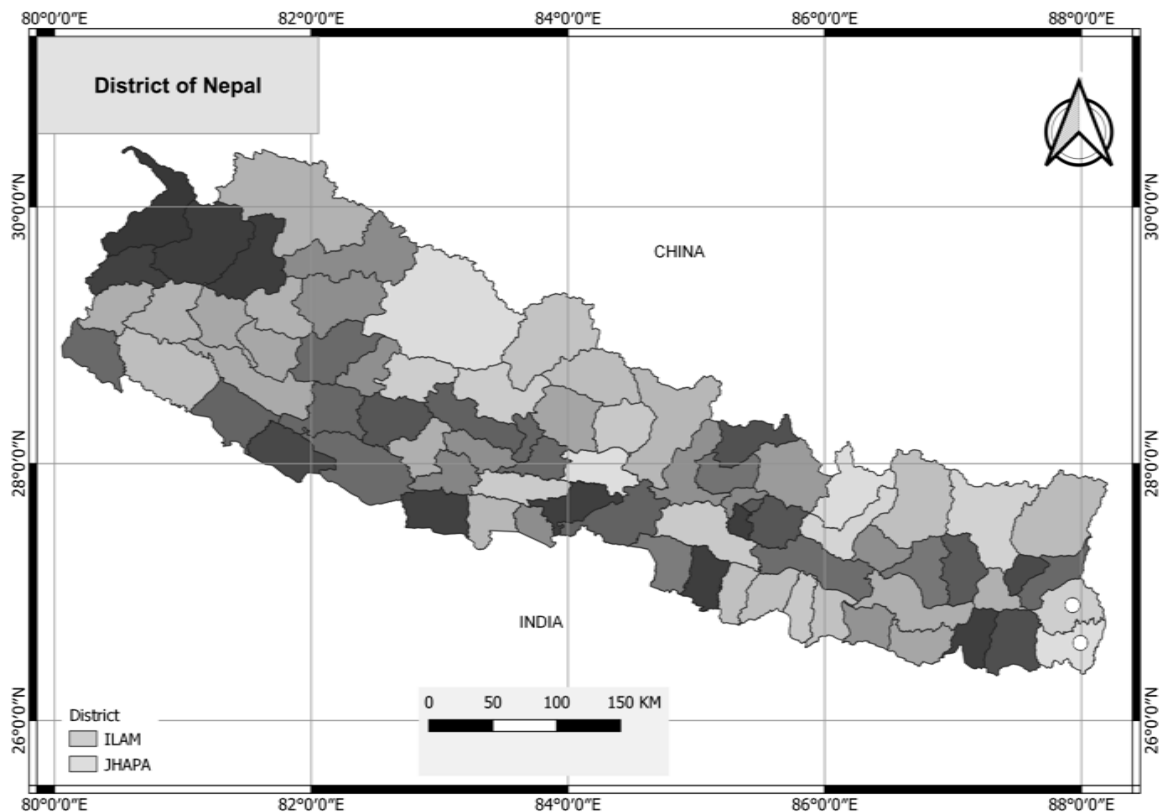


Fig. 25 *L. platyrachis* Hook.f. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (R. pantling, 417, K000387835).



Map.17: Distribution map of *Liparis platyrachis*

17. *Liparis pygmaea* King & Pantl. Ann. Roy. Bot. Gard. (Calcutta) 8: 34 (1898); Hara *et al.*, enumeration. F.P. Nepal.1:13. (1978)Banerji & Pradhan, Orch. Nepal Himalaya: 270. (1984); Press *et al.*, Ann. check. Fl. Pl. Nepal: 219. (2000) ; Pearce & Cribb, Fl. Bhutan 3 (3): 203 (2002) ; Chen *et al.*, Fl. China. 25: 218. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1 : 123 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 131 (2018); Shrestha *et al.*, Plants of Nepal: 107 (2022)

Herbs, terrestrial or lithophytic. Plant height ca. 5-7 cm, small. Pseudobulbs 1-1.5 × 0.2-0.5 cm, clustered, narrowly ovoid, enclosed by 2 or 3 membranous sheath. Leaf 8-11 × 3-4 mm, two in number, sub- opposite, blade ovate- elliptic, apex acute, margin entire, arising from the apex of the pseudobulb, base contracted into a petiole, sheathing, not articulate. Inflorescence 4-5.5 cm, erect, rather stout, ebracteate peduncle, rachis 1-1.5 cm, 2-4 flowered; floral bracts 3-5 mm, lanceolate, apex acute, subulate, less than the half of pedicel and ovary. Flowers yellowish; pedicel and ovary 4-8 mm. Dorsal sepal 6-7 × 1.1-1.2 mm, oblong, blunt, arching over column, apex obtuse; lateral sepals 6-7 × 1-2 mm parallel below the lip, linear. Petals 5-8 mm, linear, acute, margin reflexed. Lip 5-7 × 2-3 mm, oblong to obovate, slightly deflexed from about the middle, basal half concaved with entire or slightly

dentate edges, apiculate, bilobed callus. Column 2-2.3 mm, erect, slender with short wings near the apex, base slightly wide, flattened from back to front. Capsule 3mm, obovoid.

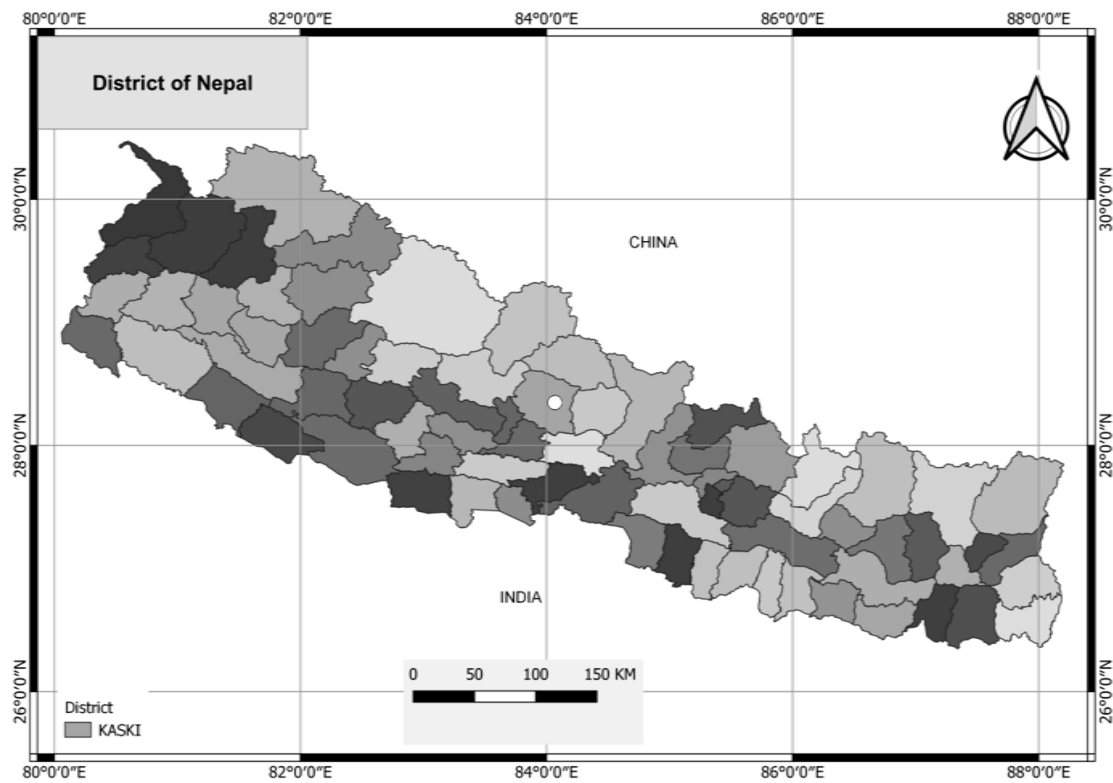
Type specimen: Sikkim Himalaya, Singalelah, 12000ft, 07.1896, R. pantling, 449 (P). P00338677. (Isotype)

Distribution: 3200-3500 m

Flowering: June- July

Fruiting: August -September

Specimens Examined: India: Sikkim Himalaya, Singalelah, 12000ft, 07.1896, R. Pantling, 449 (P). P00338677. (Isotype)



Map.18: Distribution map of *Liparis pygmaea*

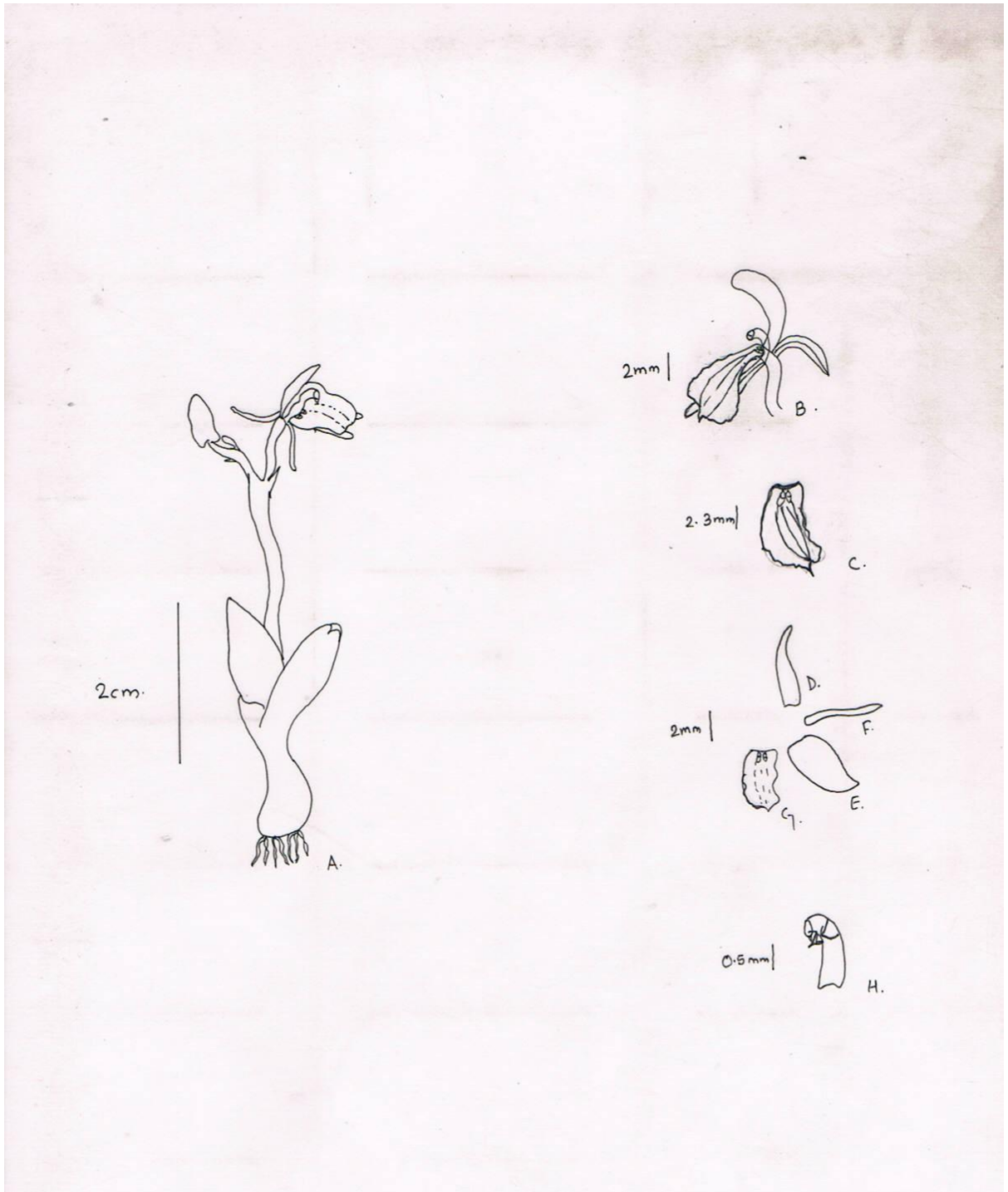


Fig. 26 *L. pygmaea* King & Pantl. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (R. pantling, 449, P00338677).

18. *Liparis resupinata* Ridl. J. Linn. Soc., Bot. 22: 290 (1886); Hooker's Icon. Pl. 19: t. 1888 (1889); King and Pantling, Ann. Bot. Gar. Calc. 8: 36. (1898); Hara *et al.*, enumeration. F.P. Nepal.1:13. (1978) Banerji & Pradhan, Orch. Nepal Himalaya: 288. (1984); Deva & Naithaini, Orchid. Fl. North. West. Himalaya: 305 (1986); Chowdhery, orch. Fl. Arunachal Prad. :487. (1998); Press *et al.*, Ann. check. Fl. Pl. Nepal:219. (2000) ; Pearce & Cribb, Fl. Bhutan 3 (3): 209 (2002) ; Chen *et al.*, Fl. China. 25: 227. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1 : 123 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 131 (2018); Shrestha *et al.*, Plants of Nepal: 107 (2022)

Leptorkis resupinata (Ridl.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Liparis ridleyi Hook.f. in Hooker's Icon. Pl. 19: t. 1887 (1889)

Liparis resupinata var. *ridleyi* King & Pantl. in Ann. Roy. Bot. Gard. (Calcutta) 8: 37 (1898)

Platystyliparis resupinata var. *ridleyi* (Hook.f.) Marg. in Richardiana 7: 39 (2007)

Herbs, epiphytic on evergreen Oak trees. Plant height 15-20 cm. Pseudobulb 2-2.5 × 0.3-0.5 cm, densely arranged, subcylindric, up above the middle usually with 3-4 leaves. Leaf 2.5-8 × 0.1-0.6 cm, blade narrowly oblong or linear to lanceolate, papery or membranous, margin slightly serrate, apex acuminate, articulate base, petioles contracted into base, subsessile. Inflorescence 3.5- 12 cm, arching or pendant, more than 10 flowers peduncle not winged, several sterile bracts present; floral bracts 2-4 mm, lanceolate. Flowers pale greenish yellow, orange or brick red when over mature; pedicel and ovary 4-6 mm. Dorsal sepal 2 × 1.5 mm, oblong or elliptic, carinate, 1- veined, apex obtuse; lateral sepals 3-4 × 0.9-1 mm, not carinate. Petals ca. 2.1 × 0.5 mm, narrowly linear, apex obtuse. Lip 2-3 mm, forming epichile and hypochile, with a bilobed callus in the base. Column ca. 2mm, erect, with 2 suborbicular wings on both sides. Capsule 5-8 mm, obovoid to oblongoid.

Type specimen: India, Darjelling, 844, W. Griffith, 986. (K). K000873786, K000873787, K000873788. (Isotype).

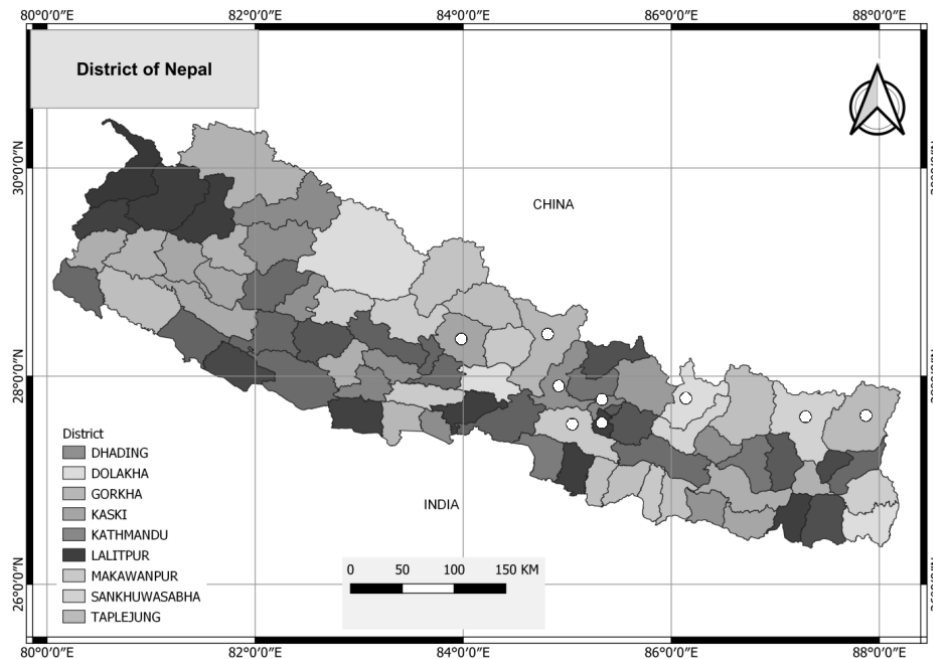
Distribution: 1800-2600 m

Flowering: February-March

Fruiting: March

Specimens Examined: Central Nepal: Gandaki Province; Gorkha, Ekle bhatti to Dyang; beyond Nayak, 1750m, 26.07.2008, Ikeda *et al.*, 20817053 (KATH). Bagmati Province; Dolakha, Suspa- Kshamawati, 2000m, 15.01.2016, P. Bhandari and S. Karki, D11 (KATH). Cheptu, Jungu, 1832m, 08.2018, Sangram Karki and Ashish Dhital, J70 (KATH) KATH 078330. Bagmati Dhading, Bhimbung lekh, 2000m, 02.12.1988, N. P. Manandhar, 12770 (KATH). Lalitpur, Phulchowki, 8500ft, 05.09.2024, Miss Manandhar and party, 8338 (KATH). Phulchowki kharighari,....., 19.03.1967, Miss Manandhar and party, 6823 (KATH). Phulchowki, 7500ft, 19.02.1978, P. Pradhan, 396 (KATH). Pharping and Godawari, 10.10.1981, G. Paudyal.. (TUCH). Kaski, Kande, 1700m,30.05.2001, ManiRaj Shrestha, 51A (TUCH). Bhadure- Tamagi forest, 15.08.1999, Abishkar Subedi, 250 (TUCH).

East Nepal : Province 1; Sankhuwasabha, Pokharigaon, 1650m, 06.12.1998, D.B Karkee, 752 (KATH), Taplejung, sewaden (2490m), Dongen (2260m), Mewakhola (2050m),- Papung (1940m), Suzuki, K.R. RajBhandari *et al.*, 9240179 (KATH) KATH 017585. Hurure, 2000m, 1991. P. R. Shakya, 9422 (KATH), Walung gimigaon, 4950ft, 07.11.1981, P. R Shakya, 7336 (KATH), Chichila- Hurure, 1950m, 08. XII. 1990, P.R Shakya, 9416 (KATH) KATH 002837, Arun valley, ridge SW of Bhotebas, 19.09.1911, D.G. long *et al.*, 57 (KATH). India, Darjelling, 844, W. Griffith, 986. (K). K000873786, K000873787, K000873788 (Type).



Map. 19: Distribution map of *Liparis resupinata*

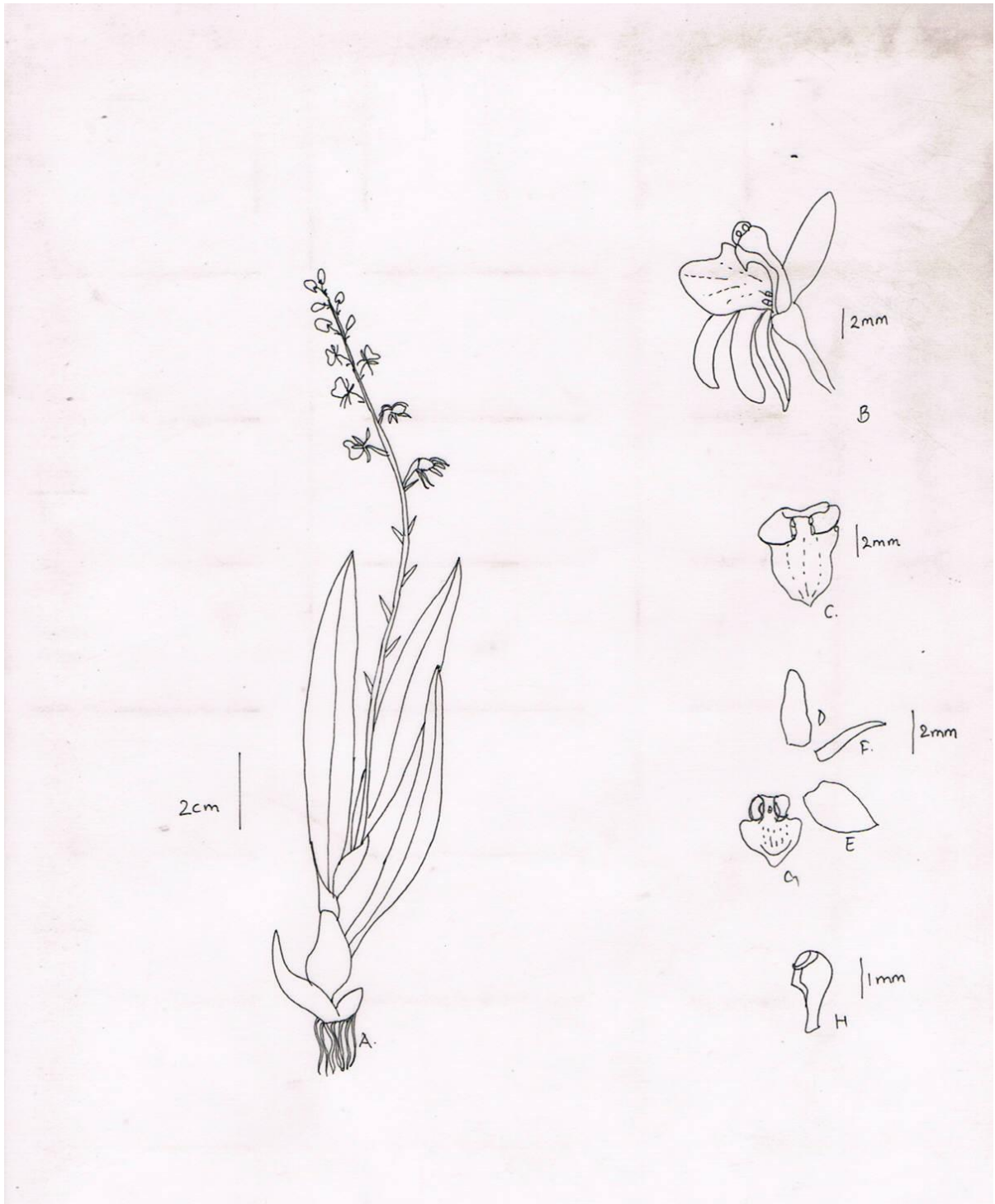


Fig. 27. *L. resupinata* Ridl. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (Suzuki, K.R. RajBhandari *et al.*, 9240179, KATH 017585).

19. *Liparis rostrata* Rchb.f. *Linnaea* 41: 44 (1876); Hooker's *Icon. Pl.* 19: t. 1813 (1889); Hooker, *Fl. Brit. Ind.* 5: 694. (1890); Hara *et al.*, enumeration. *F.P. Nepal* 1:13. (1978); Banerji & Pradhan, *Orch. Nepal Himalaya*: 270. (1984); Deva & Naithaini, *Orchid. Fl. North. West. Himalaya*: 305 (1986) Press *et al.*, *Ann. check. Fl. Pl. Nepal*: 219. (2000); Chen *et al.*, *Fl. China*. 25: 217. (2009); Rajbhandari & Rai, *Handbook. Fl. Pl. Nepal*. 1 : 124 (2017); Shrestha *et al.*, *Handbook. Fl. Pl. Nepal*. **1**: 131 (2018); Shrestha *et al.*, *Plants of Nepal*: 107 (2022)

Liparis diodon Rchb.f. in *Linnaea* 41: 43 (1876)

Leptorkis diodon (Rchb.f.) Kuntze in *Revis. Gen. Pl.* 2: 671 (1891)

Herbs, terrestrial. Plant height 7-15 cm. Pseudobulb 1.5-2 cm, ovoid, very small, enclosed by white membranous sheaths, tufted on short rootstock. Leaf 3-10 × 1.5-2 cm, two in number, opposite, blade ovate, membranous or herbaceous, margin entire, apex acute- obtuse, base contracted into a petiole, petiole sheath like 1-2 cm or longer, amplexicaul base with no articulation. Inflorescence ca. 10-15 cm long, 6-10 flowered, peduncle cylindrical, slightly compressed; floral bracts ca. 1-1.5 mm, ovate. Flowers yellowish green to purplish; pedicel and ovary 4-8 mm. Dorsal sepal 5-8 × 1-2 mm, 3-veined, narrowly oblong- lanceolate or obtuse; lateral sepals 5-6 × 1-2.5 mm, narrowly oblong or somewhat oblique. Petals 5-7 × 0.1-0.2 mm, 1-veined, filliform- linear. Lip 5-7 × 4-5 mm, broadly obovate to cordate, green flushed with purple, margin irregularly toothed, apex mucronate, base without callus. Column 2-3 mm, slightly arcuate, apex winged and base dilated. Capsule 8-9 mm, obovoid.

Type specimen: Nepal, S.E of Jumla, 9500ft, 24.07.1952, O. Polunin, W.R. Skyes & L.H.J Williams, 4892 (BM). 000088568 BM. (Isotype).

Distribution: 2000-3000 m

Flowering: July

Fruiting: September

Specimens Examined: Nepal, S.E of Jumla, 9500ft, 24.07.1952, O. Polunin, W.R. Skyes & L.H.J Williams, 4892 (BM). 000088568 BM.

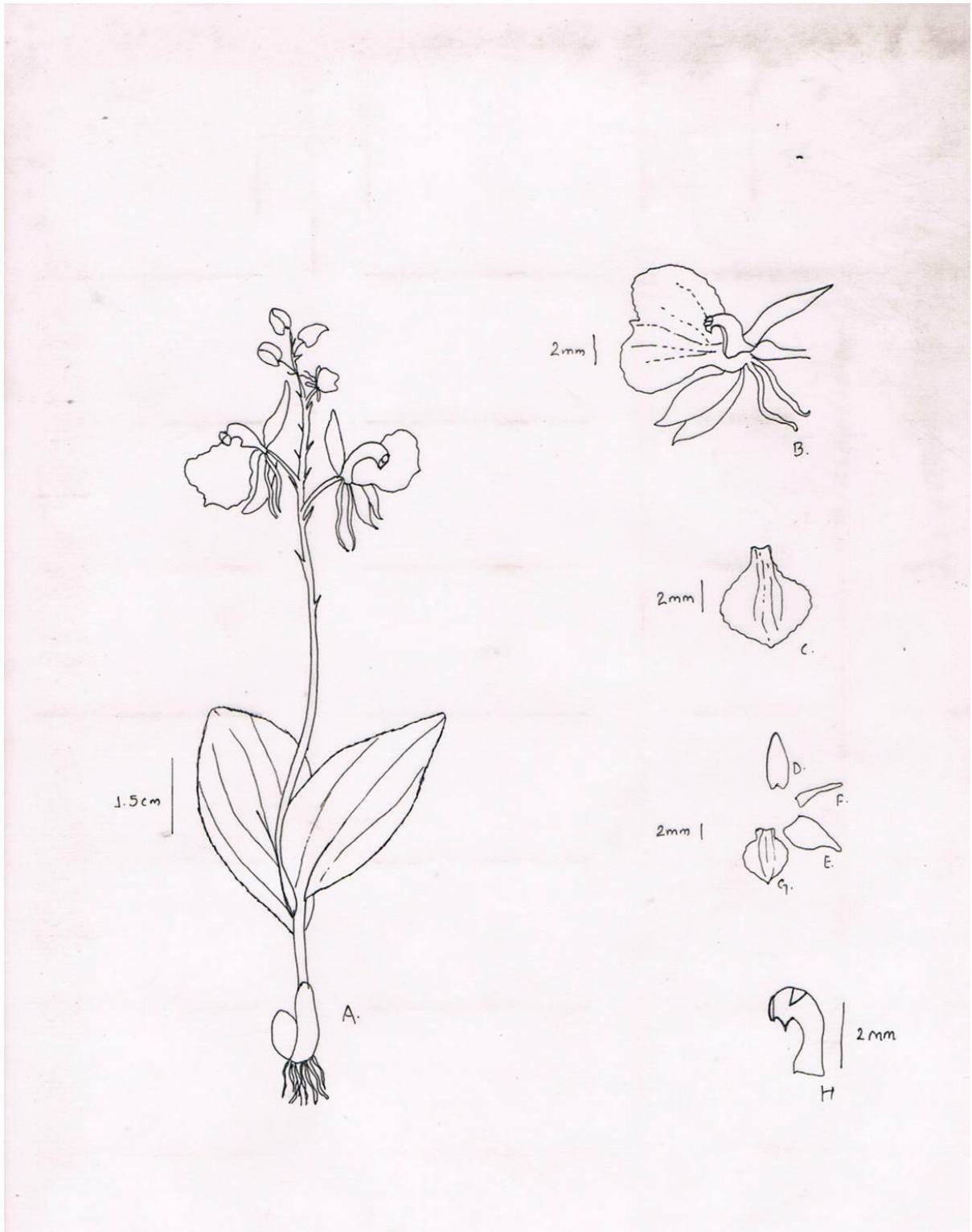
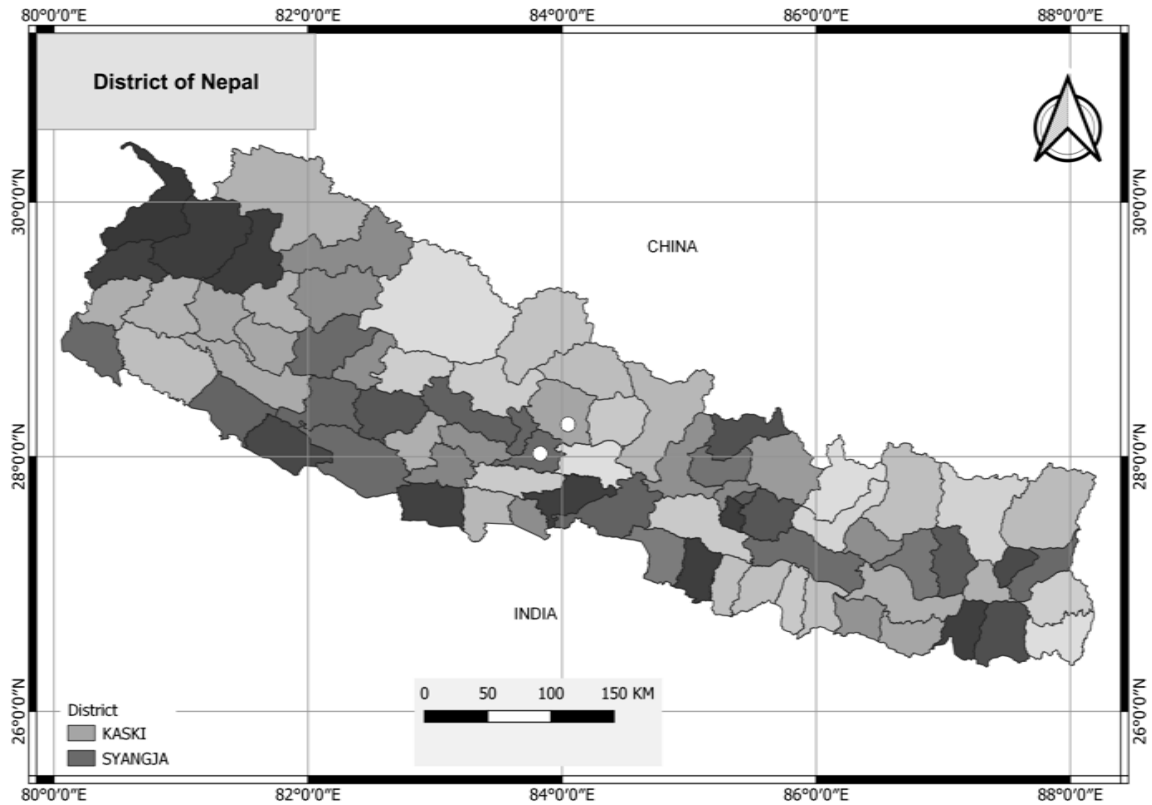


Fig. 28 *L. rostrata* Rchb.f. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (O. Polunin, W.R. Skyes & L.H.J Williams, 4892, 000088568 BM).



Map.20: Distribution map of *Liparis rostrata*

20. *Liparis stricklandiana* Rchb.f. Gard. Chron., n.s., 13: 232 (1880); Chowdhery, orch. Fl. Arunachal Prad. :487. (1998); Pearce & Cribb, Fl. Bhutan 3 (3): 210 (2002); Chen *et al.*, Fl. China. 25: 225. (2009); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 131 (2018);

Liparis dolabella Hook.f. in Hooker's Icon. Pl. 21: t. 2010 (1890)

Leptorkis dolabella (Hook.f.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Leptorkis griffithii (Ridl.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Liparis malleiformis W.W.Sm. in Notes Roy. Bot. Gard. Edinburgh 13: 212 (1921)

Liparis stricklandiana var. *longibracteata* S.C.Chen in Acta Phytotax. Sin. 21: 345 (1983)

Stichorkis stricklandiana (Rchb.f.) Marg., Szlach. & Kulak in Acta Soc. Bot. Poloniae 77: 39 (2008)

Herbs, epiphytic. Plant height 23-30 cm. Pseudobulb 1.5-3 × 0.5-1.2 cm, densely arranged, suboblong. Leaf 10-21.5 × 1-2.5, two leaves, blade oblanceolate, papery, acuminate apex, margin entire to wavy, articulate base, petiole 7-11 cm. Inflorescence 12-30 cm, peduncle winged, rachis 7-25 cm, more than 10- flowered; floral bracts 5-7 mm, subulate. Flowers greenish yellow; pedicel and ovary 7-11 mm. Dorsal sepal 4-4.5 × 1.5 -1.7 mm, oblong-obovate, margin revolute, apex obtuse; lateral sepals 4-4.5 × 1.5-2 mm, often slightly wider than the dorsal sepal. Petals 4.5 × ca. 0.5 mm, filliform, slightly widened towards apex. Lip 4-4.5 × 5-6 mm, decurved from base, apical margin irregularly serrulate, apex subtruncate to mucronate, oblate basal callus present, callus running forward becoming broad, short and stout at mid. Column 3-3.5 mm, slightly arcuate, slender, base slightly dilated, apex with narrow wings. Capsule 10-11 mm, obovoid to ellipsoid.

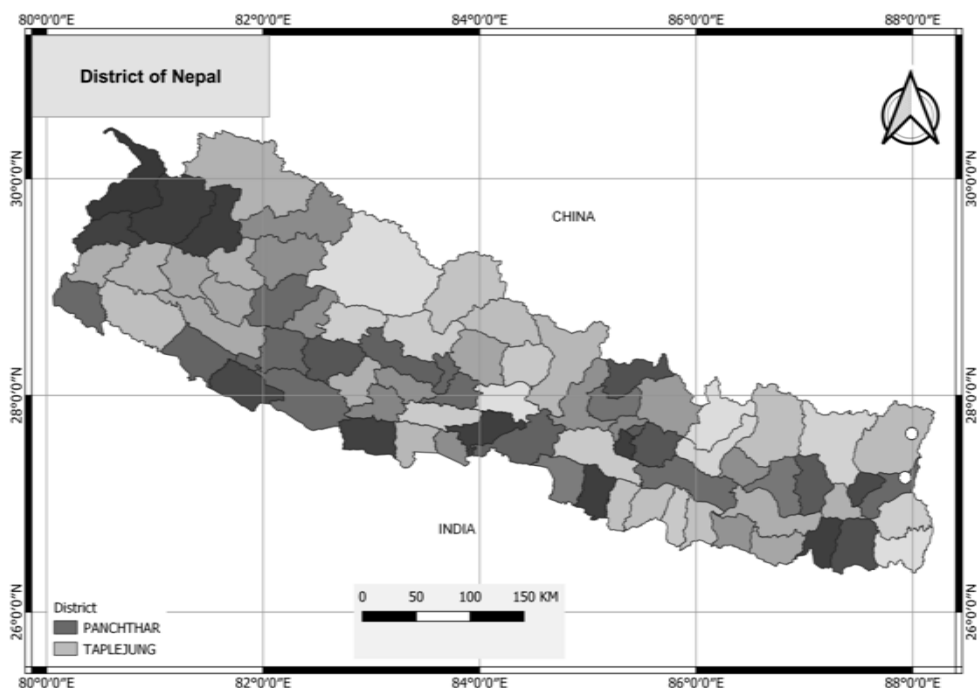
Type specimen: China, Yunnan, G. forest, 17679. (P). P00338657 (Isotype)

Distribution: 1300-2000 m

Flowering: October- January

Fruiting: March- May

Specimens Examined: East Himalaya, 03.1862, Ridley, 5069 (K) (K000387803), (K000387802); China, Yunnan, G. forest, 17679. (P). P00338657 (Isotype)



Map.21: Distribution map of *Liparis stricklandiana*

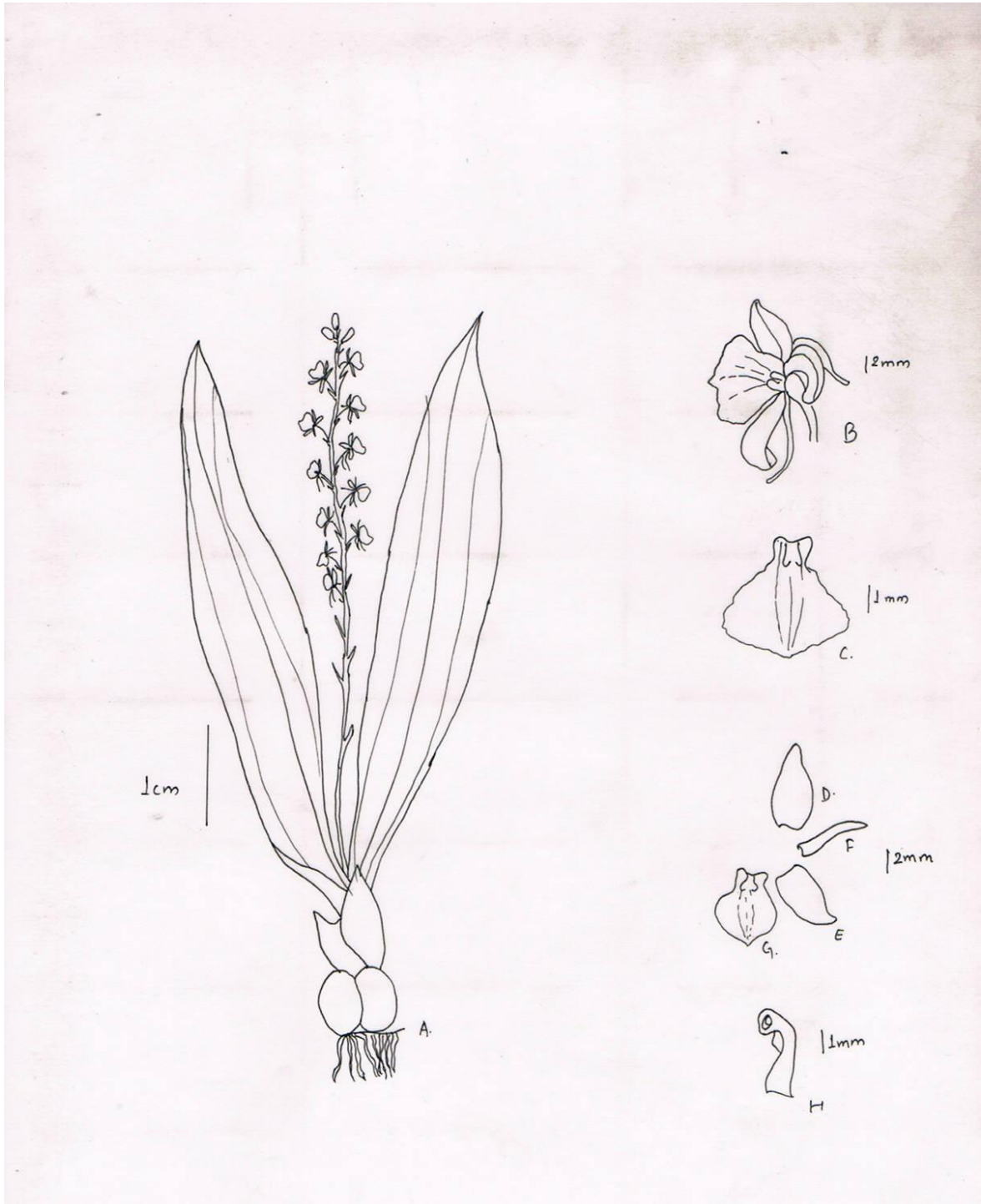


Fig. 29 *L. stricklandiana* Rchb.f. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (Ridley, 5069, K000387803, K000387802)

21. *Liparis viridiflora* (Blume) Lindl. Gen. Sp. Orchid. Pl.: 31 (1830); Hooker, Fl. Brit. Ind. 5: 704. (1890); King and Pantling, Ann. Bot. Gar. Calc. 8: 35. (1898); Hara *et al.*, enumeration. F.P. Nepal. 1: 13. (1978); Banerji & Pradhan, Orch. Nepal Himalaya: 290. (1984); Deva & Naithaini, Orchid. Fl. North. West. Himalaya: 307 (1986); Chowdhery, orch. Fl. Arunachal Prad. : 487. (1998) Press *et al.*, Ann. check. Fl. Pl. Nepal: 219. (2000); Pearce & Cribb, Fl. Bhutan 3 (3): 211 (2002); Chen *et al.*, Fl. China. 25: 224. (2009); Rajbhandari & Rai, Handbook. Fl. Pl. Nepal. 1 : 124 (2017); Shrestha *et al.*, Handbook. Fl. Pl. Nepal. 1: 131 (2018); Shrestha *et al.*, Plants of Nepal: 107. (2022)

Malaxis viridiflora Blume in Bijdr. Fl. Ned. Ind.: 392 (1825)

Liparis longipes Lindl. in Gen. Sp. Orchid. Pl.: 30 (1830)

Leptorkis viridiflora (Blume) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Liparis simondii Gagnep. in Bull. Mus. Natl. Hist. Nat., sér. 2, 21: 738 (1950)

Stichorkis viridiflora (Blume) Marg., Szlach. & Kulak in Acta Soc. Bot. Poloniae 77: 39 (2008)

Herbs, epiphyte. Plant height 15-20 cm. Pseudobulb 1.5-4×0.5-1.5 cm arranged closely, orbicular. Leaf 7-15.5 × 1.3-2.1 cm, oblanceolate, papery leaf, apex acuminate to apiculate, margin entire, arising from the apex of the pseudobulb, petiole 0.5-3 cm. Inflorescence 8.5-20.5 cm, at first erect but ultimately pendulous, longer than leaves, peduncle winged and bracteate, raceme longer than peduncle, many flowered; floral bracts 3-6 mm, linear-lanceolate. Flowers small, greenish white to slightly yellowish; pedicel and ovary 3-6 mm. Dorsal sepal 1.9-2.5 × 0.5-0.8 mm, sub elliptic to oblong, margin revolute, apex obtuse; lateral sepals 1.9-2 × 0.9-1.0 mm, slightly wider than dorsal sepal. Petals 2-3 × ca. 0.2 mm, linear, reflexed, acute- rounded. Lip 2-3 × ca. 1.5 mm, recurved from middle nearly ovate in outline, narrowed to the base, apex subacute, without callus. Column ca. 2mm, slightly curved, apex slightly winged, base slightly thickened. Capsule 3-5 mm, globose to ellipsoid.

Type specimen: India, Sikkim Himalaya, Valley of the zeesta; 10.1892., R. Pantling, 198 (P). P00338436 (Isotype).

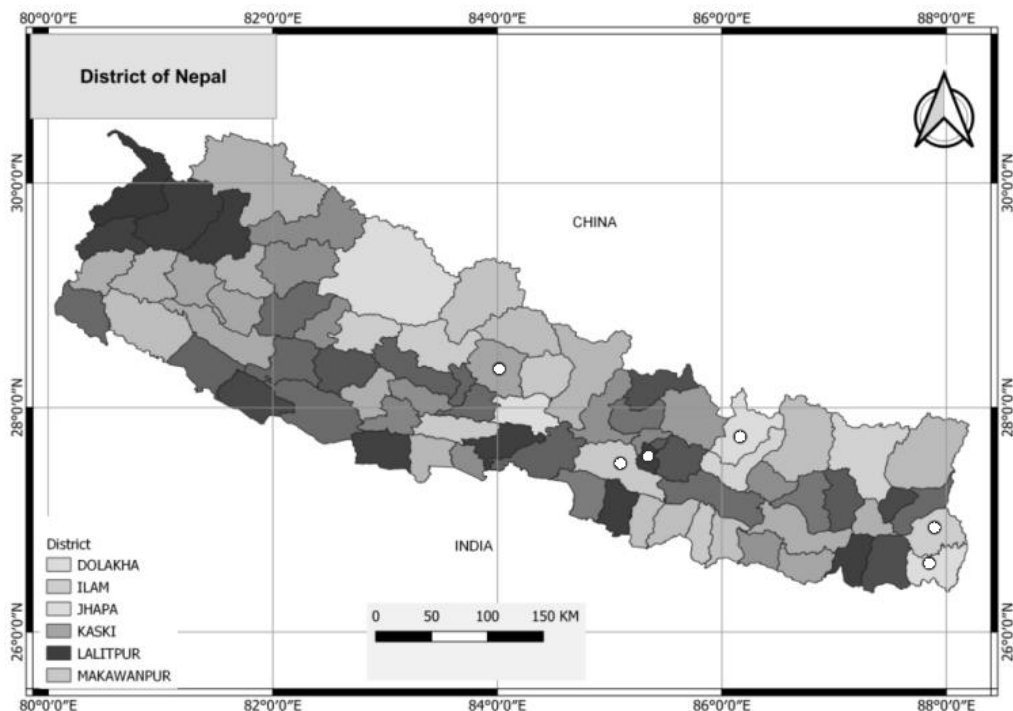
Distribution: 1600 m

Flowering: September- October

Fruiting: October- November

Specimens Examined: Central Nepal: Bagmati Province; Dolakha, Panikharka, Jungu, 1600m, 10.01.2018, Sangram Karki, Ashish P. Dhital, J48 (KATH) KATH 086226. Suspa-Kshmwati, 1650m, 15.01.2016. P. Bhandari and S. Karki, D02 (KATH) KATH038050. Makwanpur; Makwanpur gadi, 1600m, 24.09.1992, K.J.White, 16 (KATH) KATH002418. Lalitpur, Lelebhanjyang, 7000ft, 21.09.1977, Ram Bdr, 9576 (KATH) KATH002841. Gandaki Province; Kaski, Astam village forest, Dhital VDC, ca. 1550m, 17.07.2000, Abishkar Subedi, 429 (TUCH).

East Nepal: Province 1: Illam, RangaPani, 2000ft, 10.10.1977, P. Pradhan and K. R.RajBhandari and R. Niraula, 355 (KATH). Rangapani, 2000ft, 24.03.037, R.B Tamang, 129 (KATH). Rangapani, 550m, 23.11.1978. P. Pradhan , N. P Manandhar and N.A.Amatya, 678 (KATH). Koshi and Kankai mai, Sanguri bhanjyang, 4700ft, 02.10.072, T.B Shrestha and T.K Bhattacharya, 72-349 (KATH). Hedagna to Faksinda, 600m, 13.10.1999. D. Karkee, 940 (KATH). India, Sikkim Himalaya, Valley of the zeesta; 10.1892., R. Pantling, 198 (P). P00338436 (Isotype).



Map.22: Distribution map of *Liparis viridiflora*

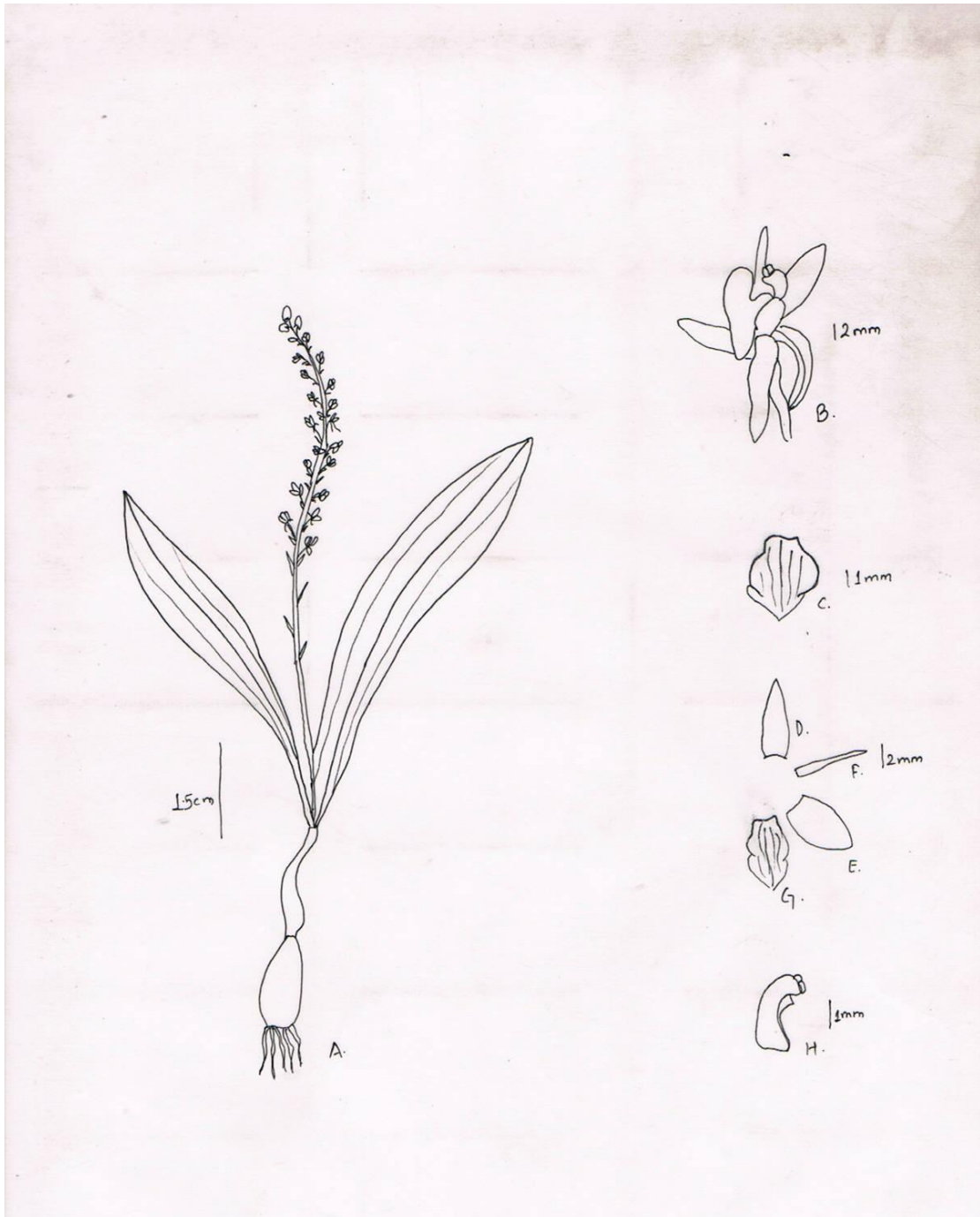


Fig. 30 *L. viridiflora* (Blume) Lindl. A. Habit, B. Flower with pedicel and ovary, C,G. Lip, D. Dorsal sepal, E. Lateral sepal, F. Petal, H. Column (P. Bhandari and S. Karki, D02, KATH038050).

4.2.3. Doubtful specimens

Liparis campylostalix Rchb.f. Linnaea 41: 45 (1876)

Record of this species is based on single herbarium specimen deposited on KATH (Raskoti and Ale). The specimen does not have flowers to confirm its presence in Nepal and also to compare with the description of this genus which is published already. There is necessity of collection of this plant from Nepal with flowers which could help to find the status of this species.

Liparis duthiei Hook.f. Icon. Pl. 19: t. 1857b (1889); King and Pantling, Ann. Bot. Gar. Calc. 8: 32 (1898).

Leptorkis duthiei (Hook.f.) Kuntze in Revis. Gen. Pl. 2: 671 (1891)

Kew herbarium has both herbarium and an image of illustration as a preserved material. The collection of herbarium are present in KATH of date about 1970s but the presence of this species is not included in almost all study done for Orchids in Nepal such as Hara *et al.*, (1978), Banerji (1996), Raskoti (2009), Rajbhandari and Rai (2019), Shrestha *et al.*, (2022). But King and Pantling (1898) have reported this species from Sikkim Himalaya. Plants of world online by Royal botanic garden, Kew mentioned that the species is native in Eastern Himalaya. Banerji and Pradhan (1984) in "The Orchids of Nepal Himalaya", Pangtey *et al.*, (1991) in "Orchids of Kumaun Himalaya" Pearce and Cribb (2002) in "The Orchids of Bhutan", Govaerts (2003) in "World Checklist of Monocotyledon database", Tetsana (2019) in "A taxonomic revision of *Liparis* (Orchidaceae, Epidendroideae: Malaxideae) in Thailand" have cited the species "*Liparis duthiei* as *Liparis cespitosa*."

Liparis ferruginea Lindl. Gard. Chron. 1848: 55 (1848)

This species is native to southeast of China, Malaya, Thailand, Vietnam and has a large difference in geographical area to Nepal.

Herbarium specimen of this species is deposited on KATH but the specimen has only one flower half leaf. The material is not enough to complete the taxonomical work on this species as the species was not recorded from Nepal before and after this collection. Also the most of the characters seen in the herbarium matches the characters of *Liparis odorata*.

Liparis somae Hayata. Icon. Pl. Formosan. 4: 33 (1914)

Liparis sikkimensis Lucksom & S.Kumar in J. Indian Bot. Soc. 73: 159 (1994)

The single herbarium of *L. somae* is deposited on KATH by B.B. Raskoti. He has collected it in 2017 in Palpa. The herbarium deposited doesnot contain a single flower in it so it is difficult to do taxonomical study if the plant was new to Nepal. Kew herbarium also doesnot have any of the herbarium of this genus deposited there. Beside that no any taxonomists have recorded this species from Nepal and mentioned it in their study such as Hara *et al.*, (1978), Banerji and Pradhan (1984), Raskoti (2009), Rajbhandari and Rai (2017), Rajbhandari *et al.*, (2019).

It has been described in "Flora of China", "The Orchids of Sikkim and North East Himalaya" and "World checklist of Monocotyledon database". But the publication of Nepal which have mentioned it is by Shrestha *et al.*, (2022) on the basis of same collection by Raskoti i.e. Lumbini Province, Palpa district, Kemarechhenda, Satyawati, 1000m, 25.09.2017. B.B. Raskoti 0050 (KATH) [KATH038912].

4.2.4. Excluded Specimens

Liparis bituberculata (Hook.) Lindl. Bot. Reg. 11: t.882 (1825)

This species is known as the synonym of *L. nervosa* subsp. *nervosa* (Plants of World Online). This species was enumerated by Hara *et al.*, (1978) and Press *et al.*, (2000).

The type specimen of *L. bituberculata* which was kept by Hooker was provided the name *L. nervosa* by H.B. Margonska in 2004.

Govaerts (2003), Luckson (2007) has cited this species as *L. nervosa* and *L. nervosa* subsp. *nervosa* in their publications as well. So this species is excluded or can be said renamed as *L. nervosa*.

I cannot study more to confirm that either the species *L. bituberculata* can be synonym of *L. nervosa* subsp. *nervosa* or not due to lack of herbarium specimens.

4.3. Sectional classification of genus

The presence of 22 species and one variety has been confirmed by this present study. They can be divided into two different sections i.e. Mollifoliae and corrifoliae on the basis of characters provided by King and Pantling (1898) such as :

Mollifoliae: Leaves membranous, large, contracted at the base and continuous with long sheath

Coriifoliae: Leaves coriaceous, jointed to sheath or pseudobulb.

Table 7: Overview of infrageneric classification of genus *Liparis* Rich. (Orchidaceae) from present study

S.N	Name of species	Present study
1.	<i>L. bootanensis</i>	Corrifoliae
2.	<i>L. cespitosa</i>	Corrifoliae
3.	<i>L. cathcartii</i>	Mollifoliae
4.	<i>L. cordifolia</i>	Mollifoliae
5.	<i>L. deflexa</i>	Mollifoliae
6.	<i>L. elliptica</i>	Corrifoliae
7.	<i>L. glossula</i>	Mollifoliae
8.	<i>L. langtangensis</i>	Corrifoliae
9.	<i>L. nervosa</i>	Mollifoliae
10.	<i>L. nervosa</i> var. <i>khasiana</i>	Mollifoliae
11.	<i>L. odorata</i>	Mollifoliae
12.	<i>L. olivaceae</i>	Mollifoliae
13.	<i>L. perpusilla</i>	Corrifoliae
14.	<i>L. petiolata</i>	Mollifoliae
15.	<i>L. plantaginea</i>	Corrifoliae
16.	<i>L. platyrachis</i>	Corrifoliae
17.	<i>L. pygmaea</i>	Corrifoliae
18.	<i>L. resupinata</i>	Corrifoliae
19.	<i>L. rostrata</i>	Mollifoliae
20.	<i>L. stricklandiana</i>	Corrifoliae
21.	<i>L. viridiflora</i>	Corrifoliae

4.4. Distribution and Phenology

4.4.1. Distribution of *Liparis* species in Nepal

4.4.1.1. Horizontal distribution

This work confirm that the distribution of *Liparis* throughout West, Central and East Nepal. *L. nervosa* is the only species which can be reported in all three geographical regions i.e. West, Central and East Nepal. Many species are reported whose distribution is only limited in the central Nepal only (**Table 7**).

L. rostrata is a single species which was reported from West Nepal only. There are seven species of *Liparis* whose distribution can be seen in Central and East Nepal (**Table 7**).

L. olivaceae was reported by Wallich (1812) and *L. langtangensis* was reported by Raskoti & Ale (2014) are the endemic species of Nepal. The distribution of genus mostly in the central and East Nepal suggests that *Liparis* species found favourable environment for their growth in Eastern part and Central Part and also may be due to many ecological factors.

4.4.1.2. Vertical distribution

This study shows that the altitudinal distribution of *Liparis* Rich. in Nepal is from 400m to 3500m above sea level. *L. cathcartii* is the species which can be reported from 400m to 3100m and have distribution from tropical to subalpine zone. Only few species were reported from tropical region and more than half species are reported from subalpine to temperate region of Nepal (Table 8).

Table 8: Horizontal distribution of *Liparis* in Nepal

S.N	Name of species	West	Central	East
1	<i>L. bootanensis</i>		✓ ☆	✓
2	<i>L. cathcartii</i>	✓	✓ ☆	
3	<i>L. caespitosa</i>		✓	✓
4	<i>L. cordifolia</i>		✓	✓
5	<i>L. deflexa</i>		✓	✓
6	<i>L. elliptica</i>		✓ ☆	
7	<i>L. nervosa</i> var <i>khaisana</i>		✓ ☆	
8	<i>L. nervosa</i>	✓	✓ ☆	✓
9	<i>L. glossula</i>	✓	✓	
10	<i>L. langtangensis</i>		✓	
11	<i>L. odorata</i>		✓ ☆	
12	<i>L. olivaceae</i>		✓	
13	<i>L. perpusilla</i>		✓	✓
14	<i>L. petiolata</i>		✓	
15	<i>L. plantaginea</i>		✓ ☆	
16	<i>L. platyrachis</i>		✓	
17	<i>L. pygmaea</i>		✓	
18	<i>L. rostrata</i>	✓		
19	<i>L. viridiflora</i>		✓	✓
20	<i>L. resupinata</i>		✓	✓
21	<i>L. stricklandiana</i>		✓	

☆=Distribution on the basis of personal collection during present study

✓=Distribution based on the survey of literatures and herbarium deposited in National and International herbaria

Table 9: Horizontal vs. Vertical distribution of *Liparis* in Nepal

S.N	Name of Species	Elevation (m)	Horizontal
1	<i>L. bootanensis</i>	1800-2000	CE
2	<i>L. cathcartii</i>	400-3100	WC
3	<i>L. cespitosa</i>	610-950	CE
4	<i>L. cordifolia</i>	1500-1650	CE
5	<i>L. deflexa</i>	1000-1100	CE
6	<i>L. elliptica</i>	1300-2100	C
7	<i>L. nervosa</i> var <i>khaisana</i>	1556	C
8	<i>L. nervosa</i>	950-2000	WCE
9	<i>L. glossula</i>	1400-3500	WC
10	<i>L. langtangensis</i>	3700-3900	C
11	<i>L. odorata</i>	775-1590	C
12	<i>L. olivaceae</i>	2300	C
13	<i>L. perpusilla</i>	1800-2800	CE
14	<i>L. petiolata</i>	1300-2500	C
15	<i>L. plantaginea</i>	700-725	C
16	<i>L. platyrachis</i>	1400-1500	C
17	<i>L. pygmaea</i>	3200-3500	C
18	<i>L. rostrata</i>	2000-3000	W
19	<i>L. viridiflora</i>	600-1600	CE
20	<i>L. resupinata</i>	1800-2600	CE
21	<i>L. stricklandiana</i>	1300-2000	C



4.4.2. Phenology

The phenology chart constructed below is based on the information provided on herbarium specimens by different collectors through the field visit. To give more precise information only relevant literatures are studied about the flowering and fruiting of the Nepalese species of *Liparis*. The flowering season of the genus mainly starts from June and up to March as well. The peak month of flowering is from June to August. Species such as *L. stricklandiana* has longest flowering period from October to January. But other some species shows the flowering period of three months i.e. *L. bootanensis*. The early bloomers start in June, they are *L. petiolata*, *L. plantaginea*, *L. pygmaea*. Whereas the peak period is considered from July to August, in this month most of the species such as *L. bootanensis*, *L. cathcartii*, *L. cespitosa*, *L. deflexa* etc. shows flowering.

Fruiting starts after the flowers get matured and after the month of flowering. Fruiting can be reported for one to three months as it depends on the species. Most of the species have one months of fruiting time such as *L. cathcartii*, *L. cespitosa*, *L. cordifolia*, *L. deflexa*, *L. elliptica*, *L. olivacea*, *L. perpusilla*, *L. petiolata*, *L. plantaginea*, *L. platyrachis*, *L. rostrata*, *L. viridiflora*, *L. resupinata* while other species have fruiting period of two months except *L. stricklandiana* (Table 9). Fruiting period of *L. stricklandiana* ends in three months which is the largest fruiting period among the species of *Liparis*.

Table 10:- Phenology chart showing Flowering and Fruiting months of different *Liparis* Species.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
<i>L. bootanensis</i>							Flowering	Flowering	Flowering	Fruiting	Fruiting	
<i>L. cathcartii</i>							Flowering	Fruiting				
<i>L. cespitosa</i>							Flowering	Flowering	Fruiting			
<i>L. cordifolia</i>										Flowering	Flowering	Fruiting
<i>L. deflexa</i>							Flowering	Flowering	Fruiting			
<i>L. elliptica</i>		Fruiting									Flowering	Flowering
<i>L. nervosa</i> var. <i>khaisana</i>							Flowering			Fruiting		
<i>L. nervosa</i>							Flowering	Flowering	Fruiting	Fruiting		
<i>L. glossula</i>							Flowering	Flowering	Fruiting	Fruiting		
<i>L. langtangensis</i>							Flowering	Fruiting	Fruiting			
<i>L. odorata</i>							Flowering	Flowering	Fruiting			
<i>L. olivaceae</i>							Flowering	Fruiting				
<i>L. perpusilla</i>								Flowering	Fruiting			
<i>L. petiolata</i>						Flowering	Fruiting					
<i>L. plantaginea</i>						Flowering	Flowering	Fruiting				
<i>L. platyrachis</i>									Flowering	Fruiting		
<i>L. pygmaea</i>						Flowering	Flowering	Fruiting	Fruiting			
<i>L. rostrata</i>							Flowering		Fruiting			
<i>L. viridiflora</i>									Flowering	Flowering	Fruiting	
<i>L. resupinata</i>		Flowering	Flowering	Fruiting								
<i>L. stricklandiana</i>	Flowering		Fruiting	Fruiting	Fruiting					Flowering	Flowering	Flowering

 Flowering time
 Fruiting time

Chapter 5

CLADISTIC STUDY

5.1. Cladistic analysis

Cladistic analysis is an important tool for understanding the evolutionary relationship between different plant species and is done by the help of cladogram. Generally a cladogram is a branching diagram which is used to depict phylogeny, and also shows the pattern of evolutionary relationship between taxa. The taxon in cladogram shows that they are closely related to each other when they are originated from a recent common ancestor and are related faraway to each other from a distant common ancestor (Strait, 2018). Cladistic analysis is most widely accepted approach for the system of classification in plant systematics. The present study attempts to provide cladistic analysis to classify Nepalese species of genus that based on morphological characters.

Cameron *et al.*, (1999) has performed cladistic analysis of 171 taxa which represent nearly all tribes and subtribes of Orchidaceae and classify the family into 5 primary monophyletic clades such as Apostasioid, Cyripedioid, Vanilloid, Orchidoid and epidendroid orchids.

Freudeustein and Ramussen (1999) performed cladistic analysis of Orchidaceae for 98 genera and found out the most traditionally recognized subfamilies supported as monophyletic including Apostasioideae, Cyperipediodeae, Spiranthoideae and Epidendroideae.

Yukawa *et al.*, (2007) use seed morphology of epiphytic and terrestrial species of *Liparis* in Japan to perform cladistic analysis.

Terentieva *et al.*, (2020) perform cladistic analysis of *Liparis* species in Amur region (Russia) and classify them into sister clades and sub clades.

5.2. Materials and Methods

5.2.1. Sampling

Recent revision attempts to analyze 21 species of *Liparis*. All the species found in Nepal are included in the study. Members of the genus *Liparis* showed considerable variation in vegetative and reproductive morphology. This analysis presents the interrelationship among closely related taxa. Out group was sampled as *Malaxis mucifera* because of its close relation with *Liparis* and is the genus reported in Nepal. The cladogram as bootstrap and Jackknife were obtained by using morphological data with NONA 2000 version.

5.2.2. Character and character code

The character and character- states chosen were based upon their evenness. Fourteen main characters were chosen from the description given in the result and in the taxonomic treatment of the genus. Only qualitative characters were chosen and overlapping characters were ignored. After identifying the character and character states, binary state character coding was done on Winclada (Kerwin 1999-2002) version and the tree for cladistic was analyzed from NONA.

Table 11: Data matrix for cladistic analysis of 21 species of *Liparis* Rich. in Nepal

		Characters													
S.N	Taxon	0	1	2	3	4	5	6	7	8	9	10	11	12	13
0	Outgroup(<i>M. Mucifera</i>)	1	2	1	2	0	1	1	1	0	0	0	0	0	0
1	<i>L. bootanensis</i>	1	2	1	1	2	0	1	0	1	0	1	1	1	0
2	<i>L. cathcartii</i>	1	1	1	2	0	0	0	1	1	1	1	1	1	1
3	<i>L. cespitosa</i>	0	0	1	1	0	1	0	2	0	0	1	0	1	0
4	<i>L. cordifolia</i>	1	1	1	1	0	0	1	1	1	1	1	1	1	1
5	<i>L. deflexa</i>	1	2	1	2	1	0	1	1	1	1	1	1	0	1
6	<i>L. elliptica</i>	0	2	0	2	1	1	1	2	0	1	0	0	0	0
7	<i>L. nervosa</i> var. <i>khasiana</i>	1	1	0	0	0	1	0	1	1	0	1	1	1	1
8	<i>L. nervosa</i>	1	1	0	0	0	1	0	1	0	1	1	1	1	1
9	<i>L. glossula</i>	1	1	1	1	0	0	0	1	1	0	0	1	1	1
10	<i>L. langtangensis</i>	1	1	1	2	0	0	1	1	1	0	0	1	1	0
11	<i>L. odorata</i>	1	2	1	0	1	1	1	1	1	0	1	0	1	1
12	<i>L. olivaceae</i>	0	1	0	2	0	1	1	2	0	0	1	1	1	1
13	<i>L. perpusilla</i>	0	0	0	0	0	1	0	2	0	0	1	0	1	0
14	<i>L. petiolata</i>	1	1	1	2	0	1	1	0	1	0	1	1	1	1
15	<i>L. plantaginea</i>	1	2	1	2	1	1	1	1	1	0	1	1	1	0
16	<i>L. platyrachis</i>	0	1	1	0	0	1	0	1	0	0	1	0	1	0
17	<i>L. pygmaea</i>	1	0	1	2	0	0	0	1	1	0	1	1	1	0
18	<i>L. rostrata</i>	1	1	1	2	0	0	1	1	1	1	0	1	1	1
19	<i>L. viridiflora</i>	0	1	1	2	1	1	1	2	0	0	0	0	1	0
20	<i>L. resupinata</i>	0	1	0	0	0	1	1	1	0	0	1	0	1	0
21	<i>L. stricklandiana</i>	0	2	1	2	1	1	1	1	0	1	1	1	1	0

Character and character states

0. Habit and Habitat (1) Terrestrial and (0) Epiphytic; **1. Plant height** (0) less than 10 cm, (1) 10-20 cm and (2) more than 20 cm; **2. Petiole** (0) sessile and (1) petiole; **3. Leaf number** (0) more than 2, (1) solitary and (2) 2 leaf; **4. Leaf length** (0) 1-10 cm, (1) 10-20 cm, (2) more than 20 cm; **5. Number of flowers** (0) 1-10, (1) 10- more; **6. Inflorescence** (0) Below 10 cm, (1) Above 10 cm; **7. Pedicel and Ovary** (0) less than floral bracts, (1) Greater than floral bracts, (2) As equal to floral bracts; **8. Sepal length** (0) 1-5 mm, (1) 5- more; **9. Petal shape** (0) Linear, (1) Filliform; **10. Calli on Lip** (0) Absent, (1) Present; **11. Column length** (0) 1-2 mm, (1) 2mm- more **12. Apex of column** (0) Wingless, (1) Winged **13. Phyllotaxy** (0) Corrifoliae (1) Mollifoliae

5.3. Results

Malaxis muscifera was taken as out group for genus *Liparis*. *Liparis* and *Malaxis* are closely related to each other (Szlachetko 1995). *Liparis* with their species forms different clades with most of the characters showing parallelism as they were tend to evolve by acquiring similar characteristics. Only a character of unique apomorphy is seen in *L. bootanensis* as it has shown specialized characters which are unique to *Liparis* species and the character is presence of hook like triangular wings in a column. Different subclades are seen, as the number present in upper side shows the characters that match while the number in the lower side shows the characters states among those species.

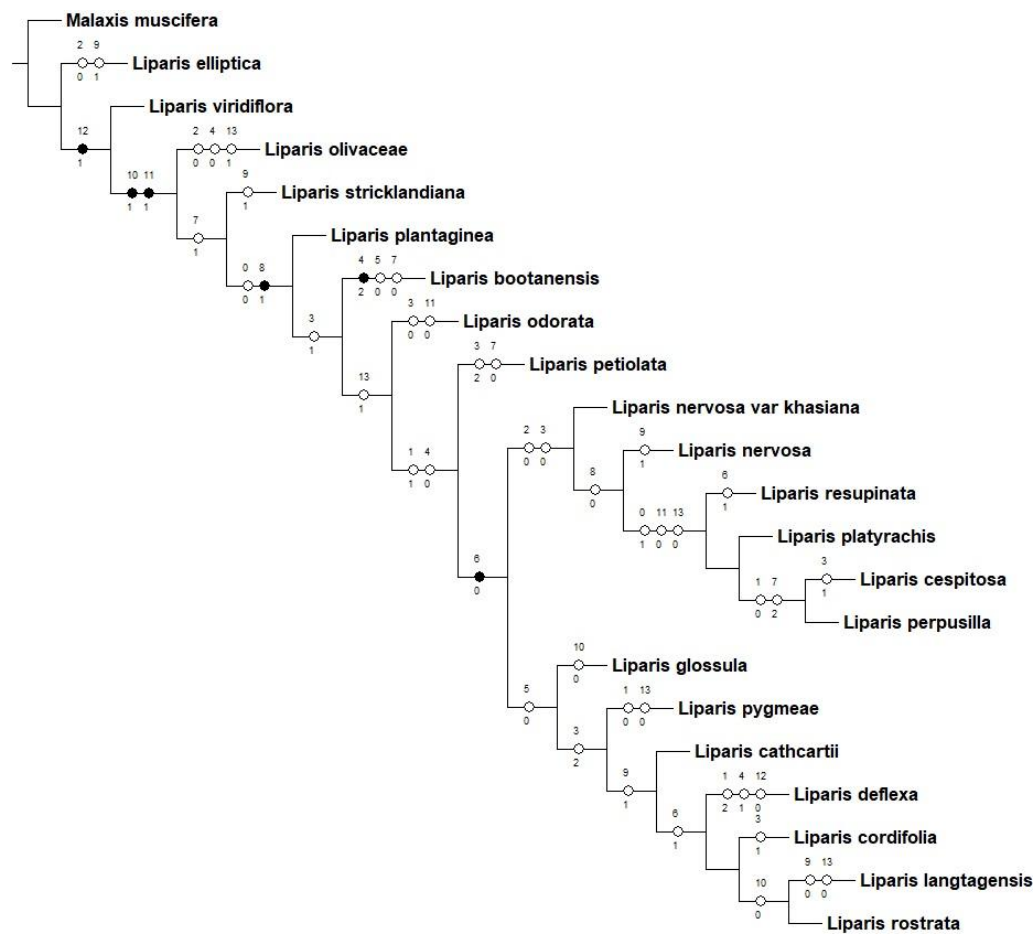
L. elliptica is seen as a nearest genus to *Malaxis mucifera*. On the term of origin it is known that the terrestrial species were the primitive species, but in this study it is seen that few epiphytic species such as *L. elliptica*, *L. viridiflora*, *L. olivacea* and *L. stricklandiana* shows their presence on first, it may be due to the characters that were choosen for obtaining this cladogram were not those which determine the characters of primitive and non- primitive species.

As *L. elliptica*, *L. viridiflora*, *L. olivacea* with *L. stricklandiana* shows closer relationship with each other as a sister clade. *L. petiolata* tends to provide two subclades in which subclade – I have species such as *L. nervosa* var. *khasiana*, *L. nervosa*, *L. resupinata*, *L. platyrachis*, *L. cespitosa* and *L. perpusilla* while sub-clade – II consists species such as *L. glossula*, *L. pygmaea*, *L. cathcartii*, *L. deflexa*, *L. cordifolia*, *L. langtangensis* and *L. rostrata*.

In subclade – I *L. nervosa* and *L. nervosa* var *khasiana*, *L. resupinata* and *L. platyrachis*, *L. cespitosa* and *L. perpusilla* shows close relation with each other. *L. cespitosa* and *L. perpusilla* have same phyllotaxy and also the other characters. On the other hand subclade-

II *L. glossula* shows a close relation with *L. pygmaea*, *L. cathcartii*, *L. deflexa* and *L. cordifolia*, while *L. langtangensis* is seen nearest to *L. rostrata*.

L. caespitosa and *L. perpusilla* are seen to be close species as they both have same deflexed lip with calli on it, linear petals, elliptic sepals and also the winged column but they differ with each other in their height, number of leaf and presence of petiole on the characters that were taken to complete this cladogram. *L. nervosa* and *L. nervosa* var. *khasiana* are similar in most of the way but differ in some which make it to be in variety such as they have different leaves, petals, lip and color of flower.



- = Unique apomorphy
- = Parallelsim

Fig. 31: A parsimony tree from NONA analysis. Number indicates the number of characters present in trees.

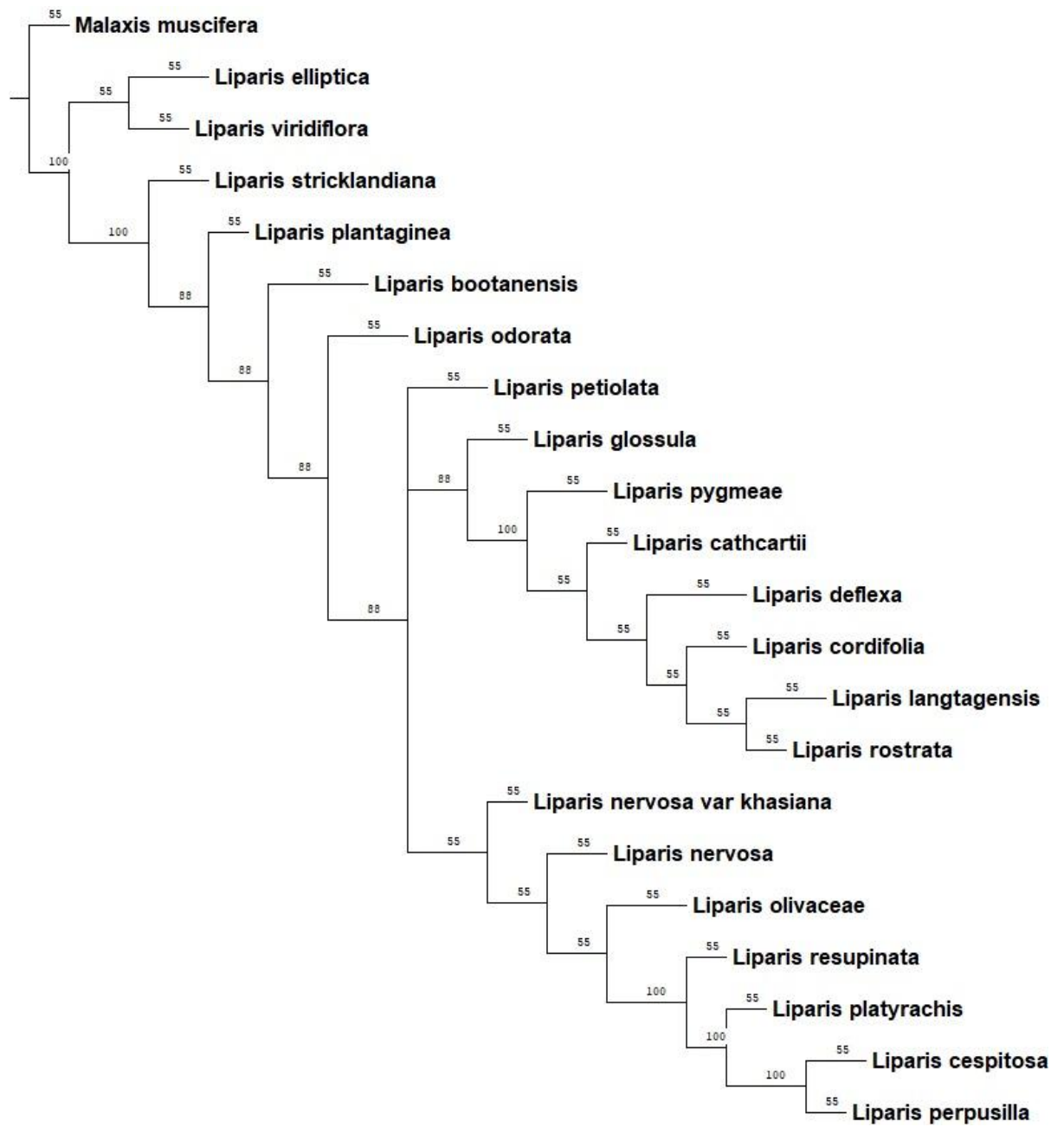


Fig. 32: Phylogenetic tree showing the relation between species of *Liparis* with bootstrap value.

Malaxis muscifera was taken as outgroup for *Liparis* and it shows close relation with *Liparis* species (Ya *et al.*, 2021). The bootstrap value of *Liparis* is 100% which support the hypothesis of monophyly in *Liparis*. *L. elliptica* has close relationship with *L. viridiflora*. As length of tree (L) was 83, Consistency index (Ci) i.e. the measure of an individual characters that fits on phylogenetic tree was 21 and Retention index (Ri) was 32.

L. stricklandiana, *L. plantaginea*, *L. bootanensis* and *L. odorata* acts as a sister clades with bootstrap value of 55%. *L. odorata* forms two subclades with nearest species as *L. petiolata*, *L. glossula*, *L. pygmaea*, *L. cathcartii*, *L. deflexa*, *L. cordifolia*, *L. langtangensis* and *L. rostrata* in first subclade i.e. subclade – I.

While the second subclade consists of species such as *L. nervosa* var. *khasiana* which is closest species to *L. nervosa*. *L. resupinata*, *L. platyrachis* and *L. olivaceae* tend to have similar characters which make them to be nearest genus. *L. cespitosa* and *L. perpusilla* were the closest genus with many similar characters and bootstrap value of 55%.

Chapter 6

DISCUSSION AND CONCLUSION

6.1. Discussion

The genus *Liparis* is large and diverse group of orchid with more than 320 species distributed worldwide from the tropics, subtropics to temperate and alpine regions (Li *et al.*, 2020). In Nepal the genus comprises more than 10 species that differ according to different taxonomists (Hara *et al.*, (1978), Banerji and Pradhan (1984), Rajbhandari *et al.*, (1999), Press *et al.*, (2000), Rajbhandari and Dahal (2004), Raskoti (2009), Rokaya *et al.*, (2013), Rajbhandari (2014), Shrestha *et al.*, (2018), Shrestha *et al.*, (2022)). Present study concludes 20 species and one variety of *Liparis* from Nepal. They are *L. bootanensis*, *L. caespitosa*, *L. cathcartii*, *L. cordifolia*, *L. deflexa*, *L. elliptica*, *L. glossula*, *L. langtangensis*, *L. nervosa*, *L. odorata*, *L. olivacea*, *L. petiolata*, *L. perpusilla*, *L. plantaginea*, *L. platyrachis*, *L. pygmaea*, *L. resupinata*, *L. rostrata*, *L. stricklandiana*, *L. viridiflora* and *L. nervosa* var. *khasiana*. Doubtful specimens were *L. duthiei*, *L. campylostalix*, *L. ferruginea* and *L. somae* and excluded specimen is *L. bituberculata*. Among 22 species 2 species shows endemism in their distribution they are *L. olivaceae* Lindl. and *L. langtangensis* Raskoti & Ale.

Liparis are perennial herbs with mostly diverse habitat such as epiphytic, terrestrial or sometimes lithophytic as well. Species richness is found high at 1000- 2000m, above sea level as mentioned by (Timisina *et al.*, 2015). Most of the genus are terrestrial, some epiphytic and some shows combined habitat as both terrestrial and lithophytic.

Pseudobulb found in *Liparis* varies in shape i.e. some of them have ovoid and most of them have oblong and size ranges from 0.2-4.5 cm in length. Number of leaf varies as some are solitary, and most of them have 2 or more than two leaves. Some of the species are petioled and the petiole is covered by sheath but some are sessile as well. Phyllotaxy differs according to the species i.e. in some of the species the leaves arise from the apex of the pseudobulb while in some petiole works as a stem i.e. leaves are contracted into a sheath. In accordance of phyllotaxy *Liparis* are divided into two sections by (King & pantling, 1898) i.e. Molifolliae and Corrifolliae, which is mainly based on monograph of *Liparis* (Ridley, 1886). Ridley (1886) has mentioned Monofolliae and Corrifolliae as subgenera and other sections within them.

Leaf present in *Liparis* varies according to the species i.e. oblanceolate, lanceolate, elliptic, oblong, ovate and broadly ovate. Leaf apex also varies from acute to acuminate and also obtuse and apiculate in some species.

Flowers of *Liparis* are arranged laxly to densely and the numbers also varies as some species have flowers less than 10, some have 10 or more than 10 as well. Bract length and bract shape was also studied and reported that length varies and some are smaller and some larger than pedicel and ovary. Shape also varies as some have lanceolate; some acute and only few have ovate and deltoid bracts. Flower color in *Liparis* are different according to the species i.e. the color ranges from yellow, pale brown, greenish, brownish and some have violet color as well. Shape and length of dorsal and lateral sepals also are the important characters that make the species different from each other i.e. most are lanceolate some of them are oblong and some are elliptic in shape. Size also differs and varies from 0.5-9 mm in length. Petals seen in *Liparis* species varies as linear and filliform also the size ranges from 2-10 mm as petals seen clearly while studying flower i.e. filliform strand with revolute margin in most of them.

The main characters seen in lip are color, the presence or absence of callus on the base of the lip, apex and margin, being flat or deflexed from middle or below and above the middle in some. Column in *Liparis* species varies according to their size, shape being erected to curved or arcuate and presence or absence of wings in their apex. Capsule doesnot show much variation as they are found as obovoid to ellipsoid or oblong in most of the species with 4 or 6 longitudinal slits.

This species are found highly distributed in central and after that in eastern and only some species are reported from west Nepal. Phenological study suggests that the peak time for flowering is at June, July and in August while peak time for fruiting is from September to December.

The cluster analysis of this study provides basic idea of relationship among this species reported from Nepal. The dendrogram shows *Malaxis* as outgroup as *Malaxis* and *Liparis* are close relatives (Cameron *et al.*, 2005). Lateral sepals of *L. odorata* are seen pendant below the lip, curving downwards; the inner margins are parallel but not closely aligned (Gloria *et al.*, 2011), it shows the close relation with *L. petiolata*. *L. langtangensis* have a cuneate corolla lip without a basal callus and presence of wings on the apex of column which is also seen on *L. rostrata* which make them closely related species. *L. cordifolia* and *L. rostrata* is superficially similar by a dilated base of column and differs on having obovate lip and toothlike projections in column (Raskoti & Ale, 2014) as they are also related closely.

From the overall study, the characters seen in genus *Liparis* are closely related with genus *Malaxis* than with genus *Oberonia* when compared with the characters of *Malaxis* and *Oberonia* presented on different publications. As many taxonomists have mentioned that *Liparis* is close relatives to *Malaxis* and *Oberonia*. Most of the characters of *Malaxis* and *Liparis* are same and are only differ by some characters such as length of column, resupination of flowers and habitat. *Malaxis* are always terrestrial, *Oberonia* are always epiphytic and *Liparis* are found in both habitat; column found is short and erect in *Malaxis*, long, mostly winged at apex and curved in *Liparis*, erect short and wings usually absent in *Oberonia*; flowers are not resupinate in *Malaxis* while flowers are resupinate in *Liparis* but the flower of *Oberonia* is so small i.e. 1-2 mm in diameter which is totally different with *Liparis* and *Malaxis*. Presence of four pollinia given by King and Pantling (1898), Plants without a long stem, basal leaves and leaves arising from the apex of pseudobulb Chen *et al.*, (2009) are the characters which make these three species to be related closely and also proves the statement given by many taxonomists true.

6.2. Conclusion

Different studies done in Nepal which have mentioned different number of *Liparis* but present study confirmed the presence of 20 species and 1 variety of *Liparis* in Nepal.

Morphological characters are considered as the most important characters for identification of the species and those species were classified into two sections i.e. Monofoliae and Corrifoliae on the basis of phyllotaxy of leaf. The morphological characters include habit, habitat, plant height, presence or absence of petiole, leaf no, length, no. of flowers, inflorescence length, pedicel and ovary, sepal length, Petals shape, calli on lip, column (length), column (winged or wingless) for the identification of the species.

The species was mostly reported in Central and East Nepal than in West Nepal. Among 23 species of *Liparis*, detail morphological study, with illustration, distribution map, phenology and cluster analysis was carried out from own collection of some species, along with photographs of virtual herbarium specimens from different International herbaria such as BM, K, P, etc physical visit to the National herbaria i.e. KATH and TUCH and also with the help of different literatures. Phenological study shows the peak flowering period from June-August and fruiting period September to November.

Cluster analysis helps in separating the species in two clades based on morphological characters. The genus *Liparis* is seen close relatives to *Malaxis*.

6.3. Recommendation

While studying herbarium specimens it was noticed that most of them were from central and east region of Nepal so west side also should be study properly. The locality where the species was reported in past were visit but now the species was not found in that place, it may be due to human destruction, construction of tourist attracted places in many locality etc so destruction of forest and habitat of different plants and animals should be managed otherwise many species will be in risk of being extinct in near future.

Lack of online taxonomic literatures causes difficulty in identification and nomenclature of the species so online access for students should be provided for literatures. Libraries lack recent taxonomic books in ASCOL, KATH, DPR, so library should be maintained properly with recent publications as well.

Lack of proper instruments, chemicals in department has cause many problems so it should be managed soon for future works as well.

Online protolouge are scattered in different publications, Plants of World Online, International Plant Name Index and Biodiversity Hertitage Library have provided great support but enough literatures are not present in Biodiversity Hertitage Library which causes difficulty while conducting work. Herbarium specimens deposited doesnt have flower in it as Orchid flower are so delicate, preservation with care should be done as soon as the plants are collected.

Type specimens also lack with so much information in National and International herbaria so many changes should have been done and it should be updated.

Chapter 7

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(www.naresh.org.in)

(<https://plants.jstor.org>)

(<http://apps.kew.org/herbcat/getImage.do>)

(<https://www.gbif.org>)

(<https://scholar.google.com>)

(<https://powo.science.kew.org>)

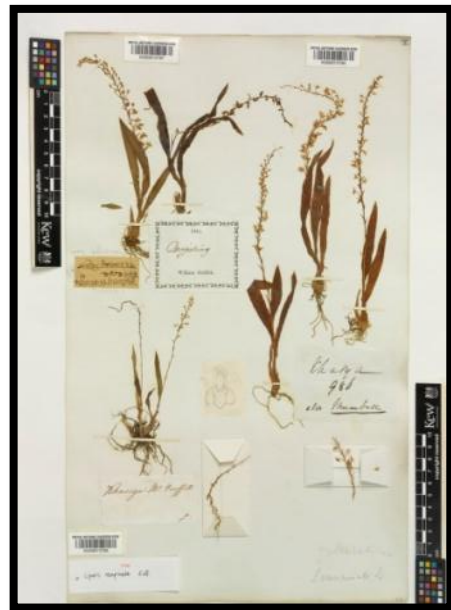
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(<https://wfoplantlist.org/plant-list/taxon/wfo-994999999-2022-12?page=1>)

Appendices
Appendix 1



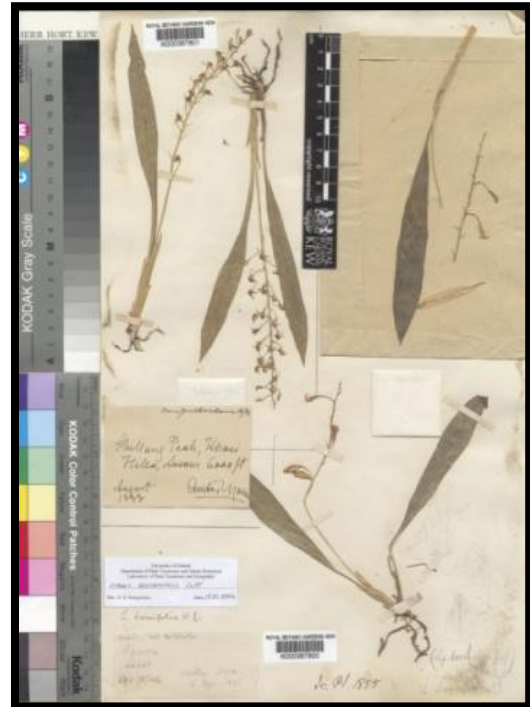
Liparis pygmaea (P)



Liparis resupinata (K)



Liparis viridiflora (P)



Liparis bootanensis (K)



Liparis langtangensis (KATH)



Liparis stricklandiana (P)



Liparis cespitosa (BR)



Liparis cathcartii (K)



Liparis cordifolia (K)



Liparis petiolata (G)



Liparis deflexa (K)



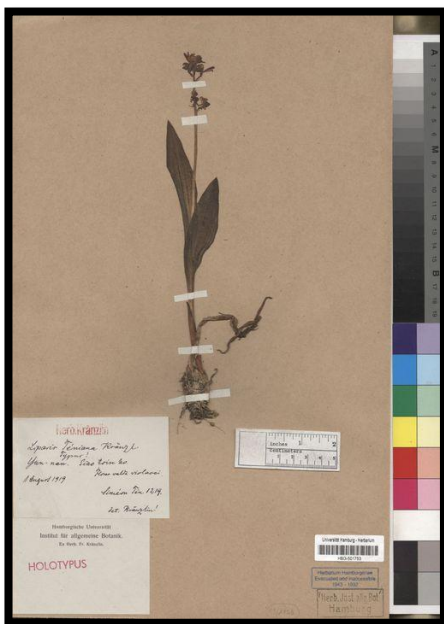
Liparis elliptica (K)



Liparis nervosa (G)



Liparis olivaceae (K)



Liparis odorata (M)

Photograph of type specimens of *Liparis* Rich. (Source: (<https://plants.jstor.org>), (<https://www.gbif.org>) and (<https://powo.science.kew.org>))

Appendix 2



Liparis bootanensis



Liparis nervosa



Liparis nervosa





Liparis odorata



Liparis nervosa var. *khasiana*

Photographs taken during field visit



Liparis cathcartii



Liparis elliptica



Liparis cordifolia

(Photo courtesy: La Dorcha Shrepa)



Liparis deflexa

(Photo courtesy: La Dorcha Shrepa)



Liparis elliptica



Liparis glossula

(Photo courtesy: La Dorchae Shrepa)



Liparis perpusilla



Liparis petiolata

(Photo courtesy: La Dorchae Shrepa)



Liparis resupinata

(Photo courtesy: La Dorchae Shrepa)