TAXONOMIC REVISION OF THE GENUS *Peristylus* Blume (ORCHIDACEAE) IN NEPAL

A DISSERTATION SUBMITTED TO THE

DEPARTMENT OF BOTANY

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BOTANY

BY

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DECLARATION

Thesis entitled "**Taxonomic Revision of the Genus *Peristylus* Blume (Orchidaceae) in Nepal"** which is being submitted to the Department of Botany, Amrit Campus, Tribhuvan University for the partial fulfillment of the requirements for the Master's degree in Botany, is a research work carried out by me under the supervision of Prof. Dr. Devendra Mananda Bajracharya, Department of Botany, Amrit Campus and Co-supervised by Dr. Tirtha Raj Pandey, Research Officer, National Herbarium and Plant Laboratories, Godawari.

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, for the award of any degree.

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RECOMMENDATION

This is to recommend that **Ms. Pushpa Shakya** has carried out research entitled **"Taxonomic Revision of the Genus *Peristylus* Blume (Orchidaceae) in Nepal"** for the partial fulfilment of Master's Degree in Botany under our supervision. To our knowledge, this work has not been submitted to any other degree.

She has fulfilled all the requirements laid down by Institute of Science and Technology, Amrit Campus, Lainchaur for the submission of dissertation for Master's Degree.

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LETTER OF APPROVAL

The M. Sc. Dissertation entitled **"Taxonomic Revision of the Genus *Peristylus* Blume (Orchidaceae) in Nepal"** Submitted by Ms. **Pushpa Shakya** to the Department of Botany, Amrit Campus, Tribhuvan University has been accepted for the partial fulfillment of the requirement for Master's Degree in Botany.

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Pushpa Shakya

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ABBREVIATIONS AND ACRONYMS

Acronyms	Description
A	Herbarium of Arnold Arboretum
BHL	Biodiversity Heritage Library
BM	Natural History Museum, London
BR	National Botanic Garden of Belgium
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Ca.	About
cm	Centimeter
E	Royal Botanic Garden Edinburgh
Enum. Fl. Pl. Nep.	Enumeration of Flowering plants of Nepal
et.al	et alia or 'and others'
Fig.	Figure
GIS	Geographic Information System
K	Royal Botanic Garden, Kew, London
KATH	National Herbarium and Plant Laboratories, Nepal
m	Meter
mm	Millimeter
No.	Number
Nom. Cons.	Name conserved (nomen conservandrum)
Nom. Illeg.	Illegitimate name (nomen illegitimum)
Nom. Nud.	name published without a description or diagnosis or reference to a description or diagnosis (nomen nudum)
s.n.	Without collection number (sino numero)
Sp	species
TI	The University of Tokyo, Japan
TUCH	Tribhuvan University Central Herbarium, Nepal
Var	Variety
WFO	World Flora Online

LIST OF FIGURES

Page No.

LIST OF MAPS

Page No.

LIST OF TABLES

Page No.

TABLE OF CONTENTS

Page No.

1. INTRODUCTION

1.1Background

Orchidaceae is a widespread, diverse and highly advanced family of flowering plants. They are perennial, terrestrial, epiphytic or saprophytic herbs which show a great diversity in flower structure, but their vegetative features are monotonously uniform (Dressler, 1993). They are characterized by distinct floral morphology like modified petals referred as lip, fusion or adnation of stamen filaments to style forming column, presence of rhizomes or tuberous root, stem forming pseudo bulbs bearing aerial assimilating roots, pollination mechanism and associated with fungal partners with miniscule seeds (Kumar *et al.*, 2007).

It is cosmopolitan in nature which is distributed in tropical and sub-tropical regions of the world. This family comprises of 736 genera and 27,000 species in the world (Chase *et al*., 2015; Govaerts *et al.,* 2018) whereas according to De (2021), 29,199 species of this family have been identified and accepted. It is the second largest family of the angiosperm in the world after Asteraceae with ornamental, medicinal value (Shrestha, 2020). Except in marine, they are found in wide range of ecological conditions due to which their species composition and their distribution has always been largely influenced by the environmental conditions associated with their altitude (Jacquemyn *et al.*, 2005; Acharya and Rokaya, 2010). All the orchids are listed in appendix II except those which are listed in appendix I (CITES 2021). However, it is the largest family in Nepal with 480 species belonging to 112 genera followed by Poaceae with 450 species and Asteraceae with 437 species (Shrestha, 2020) comprising 7.1% of total Nepal's angiosperms (Rokaya *et al.,* 2013) among which 18 species have known to be endemic (Rajbhandari, 2014) and distributed between 60 and 5200m above sea level in range of habitats from tropical low land to high Himalayan of Nepal (Rokaya *et al.,* 2013; Rajbhandari and Rai, 2017; Shrestha *et al.,* 2018; Bhandari *et al.,* 2020).

According to Royal Botanic Gardens, Kew (2009), it is estimated that more than 850 species of orchids are found in the Himalaya region. 239 species belonging to 72 genera are reported from Western Himalaya distributed from 300-4600m (Singh Jalal and Jayanthi, 2015). 372 species belonging to 98 genera are reported from Central Himalaya (Nepal) among which 65, 300 and 218 number of orchids are found in West, Central

and East regions of Nepal whereas 490 species belonging to 116 genera are reported from Eastern Himalaya (Acharya *et al.,* 2011).

In Himalaya region: Pearce and Cribb (2002) reported 369 species of orchids from Bhutan. Chen *et al.* (2009) reported 1388 species belonging to 194 genera of orchids from China. Rao (2010) listed 558 species belonging to 144 genera of orchids from Arunachal Pradesh of India. Rajbhandari and Rai (2017) reported 387 species under 97 genera of Orchids from Nepal whereas Shrestha (2020) reported 480 species under 112 genera of orchids from Nepal. Maity *et al.* (2019) reported 529 species under 132 genera of orchids from Sikkim. Aung *et al.* (2020) reported 1040 species of 151 genera of orchids from Myanmar.

1.2 Genus *Peristylus* Blume

Peristylus Blume is one of the genera belonging to the Orchidaceae family commonly called bog or rein orchids. The name of this genus is derived from the Greek word peri meaning 'around', stylos 'column', referring the arms on each side of the column.

This genus is small, usually terrestrial plants with ellipsoid tubers and characterized by having a leaf which can be clustered near base or middle or scattered on stem, small, pale green or white flowers with entire petal which is usually broader than the lateral sepals, lip 3-lobed, spur small, short or saccate and never exceeds ovary, column short with 2 separate stigma lobes, sectile pollinia and very closely related to *Herminium* and often included in *Habenaria* (Hooker, 1894; Bose *et al.,* 1999).

It is distributed from the Mascarenes, tropical and sub-tropical Asia to the Pacific region (Govaerts *et al.,* 2008). It is represented by 103 species in the world (Chase *et al.,* 2015; Govaerts *et al*., 2017) whereas it is widespread genus in Asia with about 70 species (Pridgeon *et al.,* 2001).

1.3 Systematic position of genus *Peristylus* Blume

Blume (1825) described the *Peristylus* for the first time in Bijdragen tot de flora van Nederlandsch Indie. Lindley (1832) put this genus under tribe Ophrydeae of family Orchidaceae but did not recognised this genus as separate genus and placed within *Habenaria, Platanthera* , *Herminium* and *Gymnadenia.* Lindley (1830-1840) again

placed this genus under the tribe Ophrydeae of family Orchidaceae. Reichenbach (1852) placed this genus under tribe Ophrydeae of Orchidaceae family.

Bentham (1861) placed the genus *Peristylus* within the genus *Habenaria* under tribe Ophrydeae of order Orchideae. Bentham and Hooker (1883) placed genus *Peristylus* under sub-tribe Habenarieae within the genus *Habenaria* of tribe Ophrydeae. Hooker (1894) placed this genus as a section (V) of genus *Habenaria* under Habenarieae sub-tribe of Ophrydeae tribe. Following Hooker (1894), King and Pantling (1898) also placed this genus as a section of genus *Habenaria* under tribe Ophrydeae. Kraenzlin (1897-1901) placed this genus under the section Habenarieae of tribe Ophrydeae. Smith (1905) placed this genus in the tribe Ophrydinae under sub-family Monandrae. Later, Duthiei (1906) also placed this genus as a section of genus *Habenaria* under tribe Ophrydeae following Hooker (1894). Ames (1915) also put this genus under the genus *Habenaria* among with *Platanthera.* Ridley (1924) also placed this genus under the tribe Ophrydeae, sub-tribe Habenariinae.

Schelecter (1926) kept this genus under the sub-family Orchidoideae, tribe Orchideae. Mansfeld (1937) again kept this genus under Ophrydeae tribe of Orchidaceae family. Holttum (1964) placed this genus under the sub-family Monandrae and sub-tribe Habenariinae. Dressler and Dodson (1960), Vermeulen (1966), Garay (1972) kept this genus under the sub-family Orchidoideae, tribe Orchideae.

Dressler (1981) placed this genus under sub-tribe Habenariinae of tribe Orchideae with Orchidoideae subfamily. Burns-Balogh and Funk (1986) kept this genus under the sub-family Orchidoideae, tribe Orchideae. Dressler (1986) also placed this genus under sub-family Orchidoideae of Orchidaceae family. Later, Dressler (1993) placed this genus under sub-tribe Habenariinae of tribe Orchideae with Orchidoideae sub-family. Smith (1991) placed this genus under the sub-family Orchidoideae of Orchidaceae family. Szlachetko (1995) placed the present genus under sub-tribe Hermininnae of sub-family Orchidoideae. Cameron *et al.* (1999) placed this genus under Orchidoid clade which represent the correponding sub-family.

Pridgeon *et al.* (2001) placed this genus under sub-tribe Orchidinae, tribe Orchideae and sub-family Orchidoideae. Pearce and Cribb (2002) placed this genus under tribe Orchideae of sub-family Orchidoideae. Chase *et al.* (2003) placed this genus under sub-tribe Orchidinae, tribe Orchideae and sub-family Orchidoideae. Rao (2010) placed this

genus in sub-tribe Hermiininae of tribe Orchideae under sub-family Orchidoideae following the Szlachetko (1995) classification. Bajracharya (2010) placed this genus under the sub-tribe Habenariinae of tribe Orchidoideae. Chase *et al.* (2015) and Barbhuiya and Salunkhe (2016) placed this genus under sub-tribe Orchidinae, tribe Orchideae and sub-family Orchidoideae. However, Orchidaceae family is kept in order Asparagales by classification of 'Angiosperm Phylogeny Group' (APG) and remained same in APG I, II, III and IV based on molecular study. But present study followed the classification of Chase *et al.* (2015) because this study is based on morphological variation.

1.4 Generic delimitation of genus *Peristylus*

Genus *Peristylus* was first described by Carl Ludwig Blume in 1825. Before that, it was usually kept or merged within the genus *Habenaria.* After introducing *Peristylus* as a genus, Lindley (1832) recast the genera of Ophrydeae tribe on the basis of naked pollen glands and distinguished only 4 genera *Habenaria, Platanthera, Herminium* and *Gymnadenia.* Later, Lindley (1830-1840) revised classification and introduced the genus *Peristylus* under tribe Ophrydeae and distinguished it from *Habenaria,* and *Herminium* on the basis of lip. *Habenaria*: lip free from column; *Peristylus*: lip with spur and *Herminium*: lip unarmed.

But Hooker (1894), King and Pantling (1978) did not follow *Peristylus* as a different entity and put *Peristylus* as one of the 10 sections under genus *Habenaria* under tribe Ophrydeae. Smith (1905) again revised the Orchidaceae and divides *Habenaria* into 3 genera- *Platanthera*, *Peristylus* and *Habenaria proper.* Duthie (1906) followed Hooker (1894) and recognised *Peristylus* as one of a section under the genus *Habenaria.*

Schlecter (1926) recognised *Peristylus* as distinct genera whereas Santapau and Kapadia (1960) regarded *Platanthera* and *Peristylus* as independent genera from *Habenaria*. Holttum (1964) again retained this genus along with *Platanthera* under *Habenaria.* While Hawkes (1965) mentioned closer relationship of *Peristylus* to *Herminium* R. Br. Blatter and McCann (1932) kept the genus *Platanthera* and *Peristylus* independent from the *Habenaria*. However, the differences between genus *Habenaria* and *Peristylus* have been a topic of debate to some extent.

Therefore, Seidenfaden (1977) put the light into genus *Peristylus* and again defined this genus on the basis of size of floral characters, position of stigma lobes and spur and also divided this genus into 4 sections on the basis of lip- 1. 3-lobed lip with a prominent median callus at the base of lip, 2. 3-lobed lip without a median callus, 3. 3-lobed lip where side-lobes are linear or thread like and 4. entire lip.

Similarly, *Herminium* has globose tubers, gibbous sac instead of spur, a narrow connective, and a stigma with separate lobes that are free from the base of lip, *Platanthera* has thick, fleshy roots (fusiform tuber), lip with slender and long spur, rarely separate and free stigma lobes, and a wide connective whereas *Peristylus* has globose tubers, a lip with spur which can range from sub-globose to slender-tubular, separate stigma lobes and fused to the base of lip and to the staminodes and a narrow connective and these are the morphological characters through which these 3 species can be distinguished (Raskoti *et al.,* 2016).

1.5 Statement of problem

The genus *Peristylus* is placed under the sub-family Orchidoideae, tribe Orchideae and sub-tribe Orchidinae in recent classification but traditionally *Peristylus* was included within the genus *Habenaria* in a broad view however recent authors have accepted the *Peristylus* as a separate genus.

Systematic position of many genera including *Peristylus* within sub-tribe Orchidinae are not or little known due to the morphological diversity, wide distribution range, homolpasy, as well as the overlapping morphological variation between genera in sub-tribe Orchidinae and also created complication in the delimitation and classification within the sub-tribe Orchidinae (Aceto *et al.,* 1999; Bateman *et al.,* 2003, 2009; Box *et al.,* 2008; Dresslor, 1981, 1993; Jin and Efimov, 2012; Luer, 1975; Pridgeon *et al.,* 2001; Soliva *et al.,* 2001; Tyteca and Klein, 2008; Chen *et al.*, 2009; Jin *et al.,* 2014).

Similarly, similarity with different genus like *Habenaria* wild., *Herminium* R. Br. and *Platanthera* Rich as well as lack of detailed taxonomic account of genus *Peristylus* has made its identification more complicated due to which many species of *Peristylus* were often included within *Habenaria, Herminium* and *Platanthera* (Kumar *et al.,* 2010). Therefore, the detailed taxonomic treatment of this genus is necessary for delimitation of taxa and easy identification.

1.6 Objectives

Different taxonomists had worked on orchids including *Peristylus* and reported different number of species in the genus *Peristylus* in Nepal which has provided the useful information about this genus from different regions of Nepal. However, lacking of detailed taxonomic treatment, illustrations, variable number of species reported by different authors did not provide the clear idea about this genus in Nepal. Similarity between different genera such as *Habenaria*, *Herminium* and *Platanthera* have always created complications in position of some species within this genus in Nepal. To overcome such problems, present study was undertaken.

The general objective of the study is to carry out taxonomic treatment of all species of genus *Peristylus* Blume of Nepal.

The specific objectives of the study are:

a. To study the morphological variations of each species of genus *Peristylus.*

b. To check and update the nomenclature of each species of genus *Peristylus.*

c. To list the synonyms, prepare illustrations and construct the taxonomic keys of species.

d. To study the distribution pattern and prepare distribution map of each species in Nepal.

e. To interpret the phylogenetic relationship within the species of genus *Peristylus.*

1.7 Limitations of study

Species within the genus *Peristylus* are extremely rare so, to trace down its location is very difficult. Therefore, only one species of this genus was collected as a live material and to preserve its parts was another difficult task as many species of this genus turn completely black after drying which reduces the number of morphological traits (Jin *et al.,* 2017). Therefore, it leads to complete dependency on the herbarium material present in KATH, TUCH and digital images of international herbaria for the study. Depending mostly or only on the herbarium specimens may definitely increase the error.

Similarly, herbarium specimens of some species such as *P. affinis, P. calcaratus, P. intrudens* and *P. parishii* are only one in number in KATH which is not enough for the taxonomic study as some specimens lack tubers or could not study the structure of flower through stereomicroscope. In such a case I completely followed the local flora.

P. richardianus reported in Nepal by Hara *et al.*, 1978; Banerji and Pradhan, 1984; Press *et al.*, 2000, could not be traced in living material as well as in National herbaria (KATH and TUCH). Herbarium specimen of this species from Nepal was also found deposited in TI but its digital image was not available in that site so, this one species could not be studied. Therefore, the major limiting factor in this study was limited time and resources due to which study was restricted to morphological characters of plants of herbarium specimens and the study of live specimens of all species of this genus was not possible due to its extreme rareness.

2. LITERATURE REVIEW

Peristylus in Nepal

Different authors have collected and studied orchids including genus *Peristylus* in Nepal and different checklists, local floras have been published till date. Major contributions on orchids including genus *Peristylus* in their number and position done by different authors in Nepal are as follows:

D. Don (1825) published the description of 766 species of phanerogams in '*Prodomus Florae Nepalensis*' which includes 52 species of orchids from Nepal. He not only described many new species but also formed new genera collected from Nepal. In monandrous orchids (Orchideae), he described 8 species of genus *Habenaria* (did not include *Peristylus* as different entity) collected from Nepal among which 2 species (*P. goodyeroides* and *P. affinis*) were misplaced in *Habenaria* and all these species were collected by Buchanan-Hamilton and Wallich from Nepal.

Hara *et al.* (1978) enumerated 90 genera and 315 species of orchids of Nepal among which 8 species belongs to genus *Peristylus (P. aristatus, P. constrictus, P. elisabethae, P. fallax, P. goodyeroides, P. hamiltonianus, P. lawii* and *P. richardianus*). Banerji and Pradhan (1984) mentioned 90 genera and 343 species of orchids with their description and illustration where species of genus *Peristylus* increased to 13 (*P. aristatus, P. constrictus, P. densus, P. elisabethae, P. fallax, P. goodyeroides, P. lawii, P. nematocaulon, P. parishii, P. prainii, P. albomarginata, P. hamiltonianus* and *P. richardianus*) in Nepal among which 10 species were studied by author through herbarium specimens as they have detailed description and 3 of them had only brief description. They also menitoned that *P. densus, P. parishii* and *P. prainii* as new record for Nepal at that time.

Press *et al.* (2000) reported 89 genera and 323 species of orchids where number of species of *Peristylus* were reported 9 (*P. aristatus, P. constrictus, P. elisabethae, P. fallax, P. goodyeroides, P. hamiltonianus, P. lawii, P. richardianus* and *P. superanthus*) then it was increased to 14 in updated online version (*P. affinis, P. aristatus, P. constrictus, P. densus, P. elisabethae, P. fallax, P. goodyeroides, P. hamiltonianus, P. lawii, P. parishii, P. prainii, P. richardianus, P. superanthus* and *P. tipuliferus*) from

Nepal. Rajbhandari and Dahal (2004) recorded 100 genera and 377 species among which 15 species (*P. affinis, P. aristatus, P. constrictus, P. densus, P. elisabethae, P. fallax, P. goodyeroides, P. hamiltonianus, P. lacertiferus, P. lawii, P. nematocaulon, P. parishii, P. prainii, P. richarcianus* and *P. superanthus*) belongs to genus *Peristylus* from Nepal.

Raskoti (2009) enumerated 302 species of orchids with its detailed description including 12 species (*P. affinis, P. aristatus, P. constrictus, P. elisabethae, P. fallax, P. goodyeroides, P. lacertiferus, P. lawii, P. mannii, P. nematocaulon, P. prainii* and *P. tentaculatus*) of *Peristylus* from Nepal with its coloured photographs. Bajracharya (2010) reported 5 species of this genus (*P. constrictus, P. goodyeroides, P. lawii, P. parishii* and *P. nematocaulon*) from Nepal. Rokaya *et al.* (2013) has reported 104 genera and 437 species which includes 19 (*P. affinis, P. aristatus, P. constrictus, P. densus, P. duthiei, P. elisabethae, P. fallax, P. goodyeroides, P. hamiltonianus, P. intrudens, P. lacertiferus, P. lawii, P. mannii, P. nematocaulon, P. parishii, P. prainii, P. richardianus, P. superanthus* and *P. tentaculatus*) species of genus *Peristylus* in Nepal. At that time, *P. duthiei* was transferred from *Herminium* while *P. chloranthus* was synonymous to *P. lacertiferus.*

Rajbhandari (2015) reported 20 species (*P. affinis, P. aristatus, P. constrictus, P. densus, P. duthiei, P. elisabethae, P. fallax, P. goodyeroides, P. hamiltonianus, P lacertifer, P. lawii, P. intrudens, P. mannii, P. nematocaulon, P. orbicularis, P. parishii, P. prainii, P. richardianus, P. superanthus* and *P. tentaculatus*) of this genus from Nepal. *P. orbicularis* was treated as *Herminium* by Hooker (1894) and later transferred to *Peristylus.* Rajbhandari and Rai (2017) reported 97 genera and 387 species where species of genus *Peristylus* was decreased to 11 (*P. constrictus, P. densus, P. goodyeroides, P. hamiltonianus, P. intrudens, P. lawii, P. parishii, P. prainii, P. richardianus, P. superanthus* and *P. tipuliferus*) from Nepal.

Shrestha *et al.* (2018) reported 111 genera and 476 species of orchids from Nepal among which 21 species (*P. affinis, P. aristatus, P. calcaratus, P. constrictus, P. densus, P. duthiei, P. elisabethae, P. fallax, P. goodyeroides, P. hamiltonianus, P. intrudens, P. lacertifer, P. lawii, P. mannii, P. nematocaulon, P. parishii, P. prainii, P. richardianus, P. superanthus, P. tentaculatus* and *P. tipuliferus*) belongs to this genus. Shrestha *et al.* (2022) reported the 13 species (*P. affinis, P. biermannianus, P. calcaratus, P. constrictus, P. densus, P. goodyeroides, P. hamiltonianus, P. intrudens,*

P. lawii, P. parishii, P. prainii, P. richardianus and *P. tipuliferus*) of *Peristylus* from Nepal.

West Nepal

Amatya (2005) reported 2 species of this genus (*P. affinis* and *P. goodyeroides*) from Doti District, Nepal. Raskoti *et al.* (2012) has reported the *Peristylus intrudens* as new records for Nepal which was collected from Pokharathok, Arghakhachi of Nepal. Rajbhandari *et al.* (2016) reported 3 species of this genus (*P. constrictus, P. densus* and *P.* goodyeroides) from Kailali, West Nepal. DNPWC (2019) reported 2 species (*P. duthiei* and *P. elisabethae*) from Api Nampa Conservation Area, Nepal. Recently, Buddha-Magar *et al.,* (2020) reported 4 species (*P. affinis, P. duthiei, P. fallax* and *P. lacertifer*) reported from Jaljala mountain of Rolpa district, Nepal.

Central Nepal

Malla *et al.* (1976) reported only 1 species of *Peristylus* (*P. g*oodyeroides) from Langtang area. Malla *et al.* (1986) reported 45 genera and 126 species of orchids among which 3 species (*P. constrictus, P. fallax, P. goodyeroides*) belong to genus *Peristylus* with its distribution place of collection in Kathmandu and has description of only one species i.e., *P. goodyeroides.* Ohba and Ikeda (1999) reported 1 species of this genus (*P. fallax*) from Ganesh Himal, Central Nepal. Subedi *et al.* (2007) reported 1 species of this genus (*P. aristatus)* from Panchase forest, Nepal. Rai *et al.* (2013) identified *Peristylus manni* as new record for Nepal from Gorkha district. Shakya and Bajracharya (2013) reported only 1 species of *Peristylus* from Shivapuri National Park (*Peristylus superanthus*). Bhandari *et al.* (2018) reported Orchidaceae as a dominant family with 49 genera and 125 species along with 1 species (*P. aristatus*) of this genus from Panchase forest of Nepal. Karki and Ghimire (2019) reported 69 species belonging to 33 genera from Suspa-Kshamawati, Dolakha among which only 1 species (*P. aristatus*) belonging to *Peristylus* was reported from there. Bhandari *et al.* (2020) reported 142 species with 52 genera including only 1 species (*P. aristatus*) of this genus from Panchase forest of Nepal. Ghimire *et al.* (2021) recorded 3 species (*P. constrictus, P. goodyeroides* and *P. prainii*) of *Peristylus* from Kailash sacred land of Nepal.

East Nepal

Banerji and Thapa (1969-1976) reported 55 genera and 196 species from the Eastern part of Nepal. It has described genus *Habenaria* with 19 species and its allies but excluded genus *Peristylus* and included some of the species (*H. aristata, H. bicornuta, H. fallax, H. goodyeroides*) in the genus *Habenaria* which were later transferred to genus *Peristylus.* Raskoti (2015) reported 13 new (records) species of orchids for flora of Nepal which includes 1 new record of genus *Peristylus* (*P. calcaratus*) from Illam district. Chaudhary *et al.* (2015) reported 6 species (*P. aristatus, P. fallax, P. goodyeroides, P. richardianus* and *P. tipuliferus*) from Kangchenjunga landscape of Nepal. Rajbhandari *et al.* (2020) also recorded 5 species (*P. densus, P. constrictus, P. goodyeroides, P. richardianus* and *P. tipulifer*) of *Peristylus* from province No. 1. of Nepal.

***Peristylus* in other countries**

Taxonomic studies done by different orchidologist on orchids near neighboring region or countries to Nepal have provided the important and useful information about this genus *Peristylus*. Some major publications done by different authors in regional floras and checklists in neighboring regions as well as in neighboring countries are:

Lindley (1832) reported the 10 species of *Herminium* which also includes the Wallich collection from Nepal where he transferred previously described *Habenaria affinis, Habenaria goodyeroides* to genus *Herminium* as *H. constrictum* and *H. goodyeroides.* Including these two species, *H. hamiltonianum* occur in Nepal. After that, Lindley (1830-1840) introduced the genus *Peristylus* and described 21 species of this genus in 'The genera and species of Orchidaceous plants' among which 5 (*P. aristatus, P. constricta, P. fallax, P. goodyeroides* and *P. hamiltonianus*) of them were same as species occur in Nepal and had examined the Wallich collection from Nepal.

Hooker (1894) divided the genus *Habenaria* into 2 groups under 10 sections and enumerated 106 species in *Habenaria* (did not count *Peristylus* as separate genus) and put *Peristylus* under section V with defining traits like entire petals, 3-partite lip with short and saccate lip. He described 22 species under the section V (*Peristylus)* from India among which 10 species occur in Nepal *(H. aristata, H. bicornuta, H. constricta, H. hamiltoniana, H. goodyeroides, H. lacertifera, H. lawii, H, parishii, H. prainii* and

H. tipulifera). Similarly, he also described the species such as *H. affinis* under section III (Trimeroglossa) and *H. nematocaulon* under section IV (Hologlossa) which was later known to be the species of genus *Peristylus* and occur in Nepal. However, the descriptions were not illustrated and the author almost completely relied on dry material. His contribution remained the earliest publication and much exploited for research study.

King and Pantling (1898) following the Hooker classification put the genus *Peristylus* under the section V of *Habenaria* and described the 9 species under this section among which 8 species of this genus occur in Nepal *(H. albomarginata, H. constricta, H. fallax, H. goodyeroides, H. goodyeroides Var. affinis*, *H. parishi*, *H. prainii* and *H. tentaculata*). Similarly, he also described the species such as *H. aristata* under section III (Trimeroglossa) and *H. nematocaulon* under section IV (Hologlossa) which was later known to be the species of genus *Peristylus* and occur in Nepal.

Prain (1903) had listed 17 species of *Habenaria* from Bengal where 4 species (*H. affinis, H. constricta, H. goodyeroides* and *H. lawii*) occur in Nepal and later known to be the species of *Peristylus.*

Duthiei (1906) also divided the genus *Habenaria* into 8 sections describing 31 species of this genus among which *H. constricta, H. fallax, H. elisabethae, H. lawii,* and *H. goodyeroides* were described under section V (*Peristylus*) from North West Himalayan and all species under section V occur in Nepal. Seidenfaden and Smitinand (1959) described 4 species (*P. chloranthus, P. goodyeroides, P. gracilis* and *P. prainii*) from Thailand among which 2 species (*P. goodyeroides* and *P. prainii*) occur in Nepal. Nasir and Ali (1972) reported 4 species of this genus from West Pakistan among which 2 species (*P. goodyeroides* and *P. pranii*) occur in Nepal.

Ohashi (1975) also put the *Peristylus* as one of the sections of *Habenaria* and described the 2 species under this section *(H. fallax and H. goodyeroides*) of this genus from Eastern Himalayan and occur in Nepal whereas he put and described *H. elisabethae* and *H. nematocaulon* in Hologlossa section which are also very common species to Nepal. Pradhan (1979) reported 25 species of this genus from India among which 11 species (*P. aristatus, P. constrictus, P. densus, P. elisabethae, P. fallax, P. goodyeroides, P. hamiltonianus, P. lawii, P. parishii, P. prainii* and *P. richardianus*) occur in Nepal. Deva and Naithani (1986) described *Peristylus* as the terrestrial orchid

with entire tuberoids and distinguishing features such as small greenish or white flowers which have entire or 3-partite lip consisting of short (rarely long), globose or cylindric spur. They gave the illustrated account of 239 orchid species among which 9 species belongs to genus *Peristylus* with their bracketed taxonomic keys and 7 species (*P. affinis, P. constrictus, P. duthiei, , P. elisabethae, P. fallax, P. goodyeroides* and *P. lawii*) occur in Nepal.

Chowdhery (1998) described 5 species (*P. affinis, P. fallax, P. goodyeroides, P. prainii* and *P. richardianus*) of this genus from Arunachal Pradesh with its illustration and all of them occur in Nepal. Bose *et al.* (1999) described the genus *Peristylus* as the genus which is closely related to *Herminium* and often included in *Habenaria.* Also mentioned that this genus is rare in collection and not popularly grown because of their insignificant flowers. They had described 19 species from India with its separate illustration among which 13 species (*P. aristatus, P. constrictus, P. densus, P. elisabethae, P. fallax, P. goodyeroides, P. lawii, P. mannii, P. parishii, P. prainii, P. richardianus, P. tentaculatus* and *P. tipuliferus*) occur in Nepal.

Pearce and Cribb (2002) described 13 species of this genus from Bhutan among which 12 species occur in Nepal and they are *P. affinis, P. constrictus, P. elisabethae, P. fallax, P. goodyeroides, P. hamiltonianus, P. lacertiferus, P. nematocaulon, P. parishii, P. prainii, P. superanthus* and *P. tipuliferus*. Similarly, Chen *et al.* (2009) described 21 species of this genus from China among which 13 (*P. affinis, P. calcaratus, P. constrictus, P.densus, P. elisabethae, P. fallax, P. goodyeroides, P. manii, P. nematocaulon, P. parishii, P. tentaculatus, P. lacertiferus* and, *P. lacertifer* var. *taiponensis*) of them are same as species found or occur in Nepal.

Rao (2010) described 10 species (*P. affinis, P. aristatus, P. constrictus, P. densus, P. fallax, P. goodyeroides, P. hamiltonianus, P. parishii, P. prainii* and *P. nematocaulon*) of this genus with its artificial taxonomic keys from Arunachal Pradesh among which all of them occur in Nepal. Swami (2016) described 7 species (*P. aristatus, P. biermaniannus, P. constrictus, P. duthiei, P. elisabethae, P. goodyeroides, P. fallax*) of this genus from Eastern Himalaya and all of them occur in Nepal. Singh Jalal and Jayanthi (2018) reported 32 genera with 106 species of orchids from Maharastra, India where he reported 6 species of genus *Peristylus* among which 4 species (*P. aristatus, P. constrictus, P. densus* and *P. lawii*) occur in Nepal.

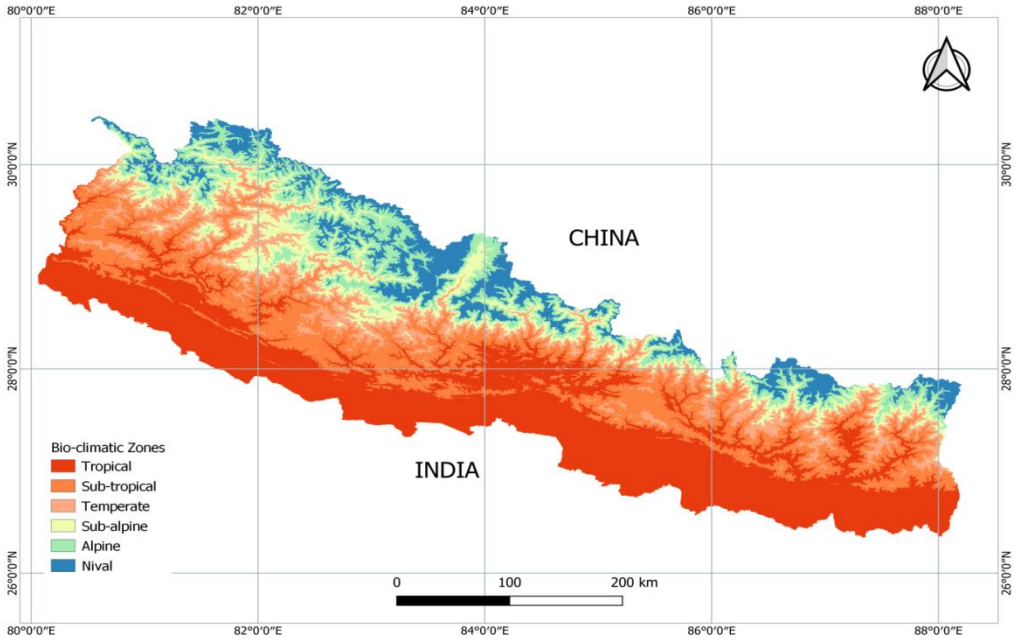
Maity *et al.* (2019) enumerated the 529 species under 132 genera with 13 species of genus *Peristylus* from Sikkim among which 10 species (*P. affinis, P. aristatus, P. biermannianus, P. constrictus, P. densus, P. fallax, P. goodyeroides, P. parishii, P. prainii* and *P. tipuliferus*) occur in Nepal. Aung *et al.* (2020) reported 10 species of *Peristylus* from Myanmar among which 9 species (*P. affinis, P. constrictus, P. densus, P. goodyeroides, P. lacertifer, P. parishii, P. prainii, P. tentaculatus* and *P. tipulifer*) occur in Nepal. Schuiteman *et al.* (2022) reported 26 species of *Peristylus* from India among which 15 species (*P. affinis, P. aristatus, P. biermannianus, P. constrictus, P. densus, P. goodyeroides, P. hamiltonianus, P. intrudens, P. lacertifer, P. lawii, P. parishii, P. prainii, P. richardianus, P. tentaculatus* and *P. tipulifer*) occur in Nepal.

But the molecular study done by Jin *et al.* (2014), Raskoti *et al.* (2016), Jin *et al.* (2017) and Raskoti *et al.* (2017) had suggested to transfer different members of *Peristylus* such as *P. albomarginata, P. duthiei, P. elisabethae, P. fallax* and *P. mannii* to the genus *Herminium* and *P. nematocaulon, P. orbicularis* and *P. superanthus* to *Platanthera* whereas some of the species of *Platanthera* such as *P. biermanniana* to genus *Peristylus.*

3. MATERIALS AND METHODS

3.1 Study area

Nepal is a landlocked country lies between 26°12’ to 30°27’N and 80°04’ to 88°12’E which covers the area of 147,516 km2 with diverse physiography whose altitude range from 60 to 8848.86m. It is located centrally in the Himalaya which is transitional zone for many floristic elements and about 6500 species of seed plants are known to occur. (Map 1)



Map 1: Map of Nepal, Study area.

Nepal is divided into 3 phytogeographic regions (Western, Central and Eastern) whereas it is broadly divided into 6 bioclimatic zones based on climate and vegetation and they are:

- Tropical zone (Below 1000m)
- Sub-tropical zone (1000-2000m)
- Temperate zone (2000-3000m)
- Sub-alpine zone (3000-4000m)
- Alpine zone (4000-5000m)
- Nival zones (above 5000m)

Topographically, Nepal has been divided into 3 ecological regions (Mountain, Hilly and Terai). The altitude in the mountainous region ranges from 4800 to 8839m above the sea level whereas the altitude in hilly region ranges from 610 to 4800m. In the terai region, temperature can go up to 44°C in summer and falls up to 5°C in winter. The temperature in the Hills and Mountains can go up to 41°C and 30°C respectively in summer and falls up to 3° centigrade and below 0° centigrade respectively in winter.

3.2 Protologue and Literature review

Protologue is a scientific publication in which a new species is described which helps in achieving nomenclature accuracy. The protologue of all the selected species of *Peristylus* Blume were consulted using TROPICOS, BHL, Journal, articles and floras. Similarly, if the protologue of certain species are inaccessible then the protologue of their synonyms were used. Usually, protologues are available in Latin languages so, the Latin languages were translated into English using Stearn (1985) as well as google translator.

Literature review provides a summary, description and critical evaluation of a topic so, literatures related with genus *Peristylus* Blume such as: Banerji and Pradhan (1984), Hooker (1894), King and Pantling (1898), Ohashi (1975), Pearce and Cribb (2002) and local floras such as Flora of Mustang, Flora of Langtang and Flora of Kathmandu were collected from the library as well as different articles, checklists related to this genus were collected from internet to gather the taxonomic information about this genus. Similarly, different online floras (Flora of China, Flora of Taiwan, Flora of Pakistan), were consulted.

3.3 Literature based character matrix

After reviewing and translation of protologue and different literatures, a character matrix from the above-mentioned literatures was prepared. It helps to know the distinguishing characters of the taxon easily and increases the accuracy of our study.

3.4 Selection of characters

Genus *Peristylus* is usually a terrestrial herb with presence of tubers, stem erect with few tubular sheathings at base and whorled or alternate leaves, resupinate flowers and 3-lobed lip. Vegetative as well as reproductive characters are indeed important characters in the genus *Peristylus.* The selection of characters was done based on the previous work done in this genus. Therefore, the literature review and literature-based character matrix helped to select the important characters within this genus. The characters such as: tuber, tubular sheaths, sterile bracts, leaves, floral bracts, sepals, petals, lip and spur were selected characters in this genus for the taxonomic study.

3.5 Collection of fresh plant specimens

First, permission letter was taken from Ministry of Forest and Soil conservation, Babarmahal, Kathmandu for the collection of live specimens. Field visits were done according to the records of herbarium specimens to collect the live specimens but it was very difficult to collect the plant species as its flowering season falls during the rainy time as well as being extremely rare species. Therefore, only one species was collected from field. Its photographs were taken in its natural habitat, field notes were taken and illustrations were made as far as possible. Then, the collected plant specimens were press, dried and herbarium specimens were prepared following Rajbhandari and Rajbhandary (2015). It was then deposited in Amrit Campus herbarium.

3.6 Study of herbarium specimens

Herbarium specimens of different species within the genus were studied by visiting KATH and TUCH. Specimens deposited were examined thoroughly using Radical stereo-microscope of RSM-4 model and different characters were studied as well as their character matrix were also prepared. Some characters such as column and pollinia and in case the certain characters like tuber which were not available in the specimens, then such characters were described by consulting secondary literatures like flora.

Similarly, specimens of Nepal available at international herbaria were also studied virtually as much as possible. For international herbaria, BM, K, E and TI were consulted virtually. Available digital images of international herbaria were studied as far as possible and finally one compiled character matrix of herbarium specimens was prepared for description. JSTOR and WFO were used for the type specimens and

synonyms of the species. Cullen (2006), Harris and Harris (1994) and Chen *et al.* (2009) glossary was used as reference for morphological description and botanical terminology respectively. Similarly, King and Pantling (1898), Banerji and Pradhan (1984) and Rajbhandari (2015) were consulted for the plant identification.

3.7 Illustration

Free hand illustrations of all the selected species were prepared on the basis of herbarium specimens as well as live specimens which include habit of the plant, flower, sepals, petals, lip and spur and their scaling was done.

3.8 Construction of identification keys

Based on the observed morphological characters and character states, bracketed identification keys were prepared for easy identification. Consistent characters of taxon were given more emphasis while preparing key.

3.9 Cladistic analysis

Cladistic analysis was performed based on morphological characters to find the maximum similarity among the species under the study. The characters were chosen based upon their consistency traced during their study and performed with the help of Winclada version 09.99 (Kervin 1999-2000). Simpson (2010) was used for its terminology.

3.10 Distribution map

All the herbarium records from KATH, TUCH as well as from international herbaria (E, K, BM and TI) were listed and an excel sheet was prepared. Herbarium records include the collection date, place of collection, its altitude and its latitude and longitude along with remarks. By collecting all the places of collection, its latitude and longitude, distribution map was prepared using QGIS 3.16.

4. RESULTS AND DISCUSSION

4.1 Morphology Treatment

Total 13 species of the genus *Peristylus* was morphologically treated. *P. tipuliferus* was studied through live as well as herbarium specimens and rest of the species were studied using herbarium specimens only.

4.1.1 Habit and habitat

All the species of *Peristylus* Blume are usually terrestrial herbs. Sometimes, *P. parishii* can be lithophytic in nature. Plant height also ranges from species to species. It could be as small as 9 cm in *P. prainii* and as long as 78cm in *P. goodyeroides.* Usually, species height ranges from 20-50 cm. (Table: 1)

These species can be found in shady, moist grassland, open humus covered slopes and in *Pinus* and *Rhododendron* Forest floor.

Table 1: Comparative study of plant height, tuber and tubular sheath in *Peristylus* Blume.

S. N.	Plant Names	Height	Tuber	Tuber size	Tubular sheaths(no) and length
1.	*P. affinis*	23cm	Cylindric-oblong	13X3mm	3 (1.5-5cm)
2.	*P. biermannianus*	12-25cm	Ovoid	7-8X3-6mm	2-3 (1-3cm)
3.	*P. calcaratus*	24cm	Oblong-ellipsoid	8X5mm	2 (12-15mm)
4.	*P. constrictus*	39-71cm	Cylindric-oblong	4-5X1.5-2cm	4-6 (5cm)
5.	*P. densus*	33-36cm	Ovoid	2X1cm	3 (1.5-5cm)
6.	*P. goodyeroides*	**30-78cm**	Cylindric-oblong	2-4.5X1cm	3-7 (1.5-8cm)
7.	*P. hamiltonianus*	25-35cm	Ovoid	13X8mm	3-5 (1.5-4.5cm)
8.	*P. intrudens*	25cm	Ovoid	10X15mm	1-2
9.	*P. lacertifer*	25-40cm	Oblong-ellipsoid	15X6mm	1-2
10.	*P. lawii*	11-26cm	Oblong-ellipsoid	15X8mm	3-5 (1-2.5cm)
11.	*P. parishii*	30-60cm	Oblong-ellipsoid	4X1.3-2cm	2 (15mm)
12.	*P. prainii*	**(9)18-51cm**	Oblong-ellipsoid	3X1.3cm	2-5 (2.5-4.5cm)
13.	*P. tipuliferus*	15-60cm	Ovoid	20X4-5mm	1-3 (1.5-3.5cm)

4.1.2 Tuber

Tubers are cylindric-oblong in *P. affinis, P. constrictus, P. goodyeroides* and oblong-ellipsoid in *P. calcaratus, P. lacertifer, P. lawii, P. parishii* and *P. prainii* while tubers are ovoid in *P. biermannianus, P. densus, P. hamiltonianus, P. intrudens* and *P. tipuliferus.* (Table 1)

4.1.3 Stem and tubular sheaths

All the species of this genus have erect, slender and glabrous stems except *P. parishii* which has sparse hair in its stem. Very few numbers of sheaths (2-3) are in *P. affinis, P. biermannianus, P. calcaratus, P. densus, P. intrudens, P. lacertifer P. parishii,* and *P. tipuliferus* whereas several (4-7) numbers of tubular sheaths are present in *P. constrictus, P. goodyeroides, P. hamiltonianus, P. lawii* and *P. prainii.* Its sizes vary from 1.5-8cm in length. (Table 1)

Table 2: Comparative study of structure of leaves in *Peristylus* Blume.

S.N.	Plant Names	Leaves no	Leaves arrangement	Leaves shape	Leaves margin	Leaves size (cm)
1.	*P. affinis*	3	Whorled in the middle	Elliptic-lanceolate	Entire	8X1.5
2.	*P. biermannianus*	3-4	Alternate	Elliptic-lanceolate	Entire	1.5-6X0.4-1.3
3.	*P. calcaratus*	2	Alternate	Elliptic-lanceolate	Entire	3-7.5X0.8-1.5
4.	*P. constrictus*	4-6	Whorled in the middle	Elliptic-lanceolate	Entire	4-13X3-6.5
5.	*P. densus*	4	Alternate	Elliptic-lanceolate	Entire	3.5-7X0.7-3
6.	*P. goodyeroides*	3-5	Whorled in the middle	Elliptic-lanceolate	Entire	2.5-15X1.2-7.4
7.	*P. hamiltonianus*	5-6	Whorled in the middle	Elliptic-lanceolate	**Crenulate**	3-6.5X0.5-2.5
8.	*P. intrudens*	3	Whorled in basal	Elliptic-lanceolate	Entire	3.5-6X0.8-1.2
9.	*P. lacertifer*	2	Whorled in basal	Elliptic-lanceolate	Entire	5-10X1-2
10.	*P. lawii*	3-5	Whorled in the middle	**Linear-lanceolate**	Entire	2.5-12.5X0.5-1
11.	*P. parishii*	4	Whorled in the middle	Elliptic-lanceolate	Entire	4-8X2-4
12.	*P. prainii*	4	Whorled in the middle	Elliptic-lanceolate	**Crenulate**	3-7X1-2.2
13.	*P. tipuliferus*	2-4	Alternate	Elliptic-lanceolate	Entire	2-10.2X0.4-2.5

4.1.4 Leaves

Leaves are usually amplexicaul, shortly petioled or sessile, ovate-lanceolate to ovate-elliptic, acuminate, acute apex, entire or crenulate margin, alternate, clustered around the middle or base of stem and scattered along the stem. Its number varies from 2-6. Leaves are alternate along the stem in *P. biermannianus, P. calcaratus, P. densus* and *P. tipuliferus* whereas leaves are whorled midway along the stem in *P. affinis, P. constrictus, P. goodyeroides, P. hamiltonianus, P. lawii, P. parishii, P. prainii.* Leaves are whorled near the base of stem in *P. intrudens* and *P. lacertifer.* Leaves have entire margin in all species of this genus except *P.*

hamiltonianus and *P. prainii* which has crenulate margin in its leaves. Similarly, all the species of this genus usually have elliptic-lanceolate leaves except *P. lawii* which has linear-lanceolate leaves. (Table 2)

4.1.5 Inflorescence and spike

In all species, inflorescence is racemose, spirally arranged flowers in it and has cylindric peduncle. The size of inflorescence is long and exceeds 20cm in *P. constrictus, P. densus, P. goodyeroides, P. lacertifer* and *P. tipuliferus* whereas the rest of the species has inflorescence less than or up to 20cm. Spike are sub-laxly to densely many flowered whose length ranges from 4-19cm. (Table 3)

Table 3: Comparative study of inflorescence, spike, sterile bracts and floral bracts in *Peristylus* Blume.

S.N.	Plants Name	Inflorescence size	Spike	Sterile bracts (no and size)	Floral bracts shape and size
1.	*P. affinis*	10cm	Laxly to densely flowered	2 (10X3mm)	Lanceolate (7-8X2mm)
2.	*P. biermannianus*	7-15cm	Laxly flowered	1 (1.1-2.5X0.2-0.4cm)	Lanceolate (8-15X2-3mm)
3.	*P. calcaratus*	16cm	Sub-densely flowered	6 (5-10X2-3mm)	Lanceolate (5X2mm)
4.	*P. constrictus*	25-34cm	Sub-densely to laxly flowered	3-13 (10-20X1-3mm)	Lanceolate (5-18X1-2mm)
5.	*P. densus*	10-30cm	Sub-densely to laxly flowered	1-3 (2.2-2.5X0.3-0.7cm)	Lanceolate (9-12X2-3mm)
6.	*P. goodyeroides*	12-34cm	Densely flowered	2-7 (1-5.5X0.2-2.4cm)	Lanceolate (7-16X1-3mm)
7.	*P. hamiltonianus*	6-15cm	Densely flowered	2 (11X2mm)	Lanceolate (11X2mm)
8.	*P. intrudens*	10-15cm	Laxly flowered	5 (15X3mm)	Lanceolate (10X2mm)
9.	*P. lacertifer*	10-21cm	Laxly flowered	4-5 (10X2mm)	Lanceolate (10X2mm)
10.	*P. lawii*	6-11.5cm	Laxly flowered	2-3 (0.9-2.7X0.1-0.2cm)	Ovate-lanceolate (7-11X1-3mm)
11.	*P. parishii*	4.5-20cm	Sub-densely to laxly flowered	1 (11x3mm)	Oblong-lanceolate (8-10X1mm)
12.	*P. prainii*	9-20cm	Sub-densely to laxly flowered	1-3 (0.9-2.2X0.1-0.4cm)	Oblong-lanceolate (5-8X1-2mm)
13	*P. tipuliferus*	15-22cm	Laxly flowered	1-4 (10-25X2-6mm)	Lanceolate (6-10X1-3mm)

4.1.6 Bracts

Bracts can be divided into sterile and floral bracts in this genus. Sterile bracts are present above the leaves of the plant and bracts of each flower represent the floral bracts.

Sterile bracts are usually lanceolate, acuminate with acute apex, sometimes foliaceous in nature. Usually, the size of sterile bracts diminishes towards inflorescence. Several sterile bracts (4-13) are present in *P. calcaratus, P. constrictus, P. goodyeroides, P. intrudens, P. lacertifer* and *P. tipuliferus* whereas very few sterile bracts (1-3) are present in *P. affinis, P. biermannianus, P. densus, P. hamiltonianus, P. lawii, P. parishii* and *P. prainii.* Some species such as *P. biermannianus, P. constrictus, P. densus* and *P. goodyeroides* have sterile bracts that are foliaceous in nature and also referred to leafy bracts which are derived from the leaves. (Table 3) (Fig. 1)

Floral bracts are usually lanceolate, acuminate with acute apex with all species except *P. lawii* which has ovate-lanceolate bracts and *P. parishii* and *P. prainii* which have oblong-lanceolate bracts. Species such as *P. constrictus, P. densus, P. goodyeroides, P. hamiltonianus, P. lawii* and *P. prainii* have floral bracts that are longer than ovary whereas rest of the species have floral bracts which are equaling or slightly longer than ovary. (Table 3) (Fig. 2)

4.1.7 Flower

Flowers are very small and range from 0.2-2.5cm across with white, green or yellowish green in colour. Large flowers are present in *P. constrictus* whose size can exceed 2cm compared to other species. Usually, *P. affinis, P. constrictus, P. hamiltoninanus, P. intrudens, P. lawii, P. prainii* have uniformly white coloured flowers whereas *P. biermannianus, P. calcaratus, P. densus, P. lacertifer, P. parishii,* and *P. tipuliferus* have usually yellowish green to green coloured flowered but *P. goodyeroides* has yellowish green to dirty white coloured flowers. Similarly, *P. goodyeroides* has mild sweet-scented flowers. (Table 4)

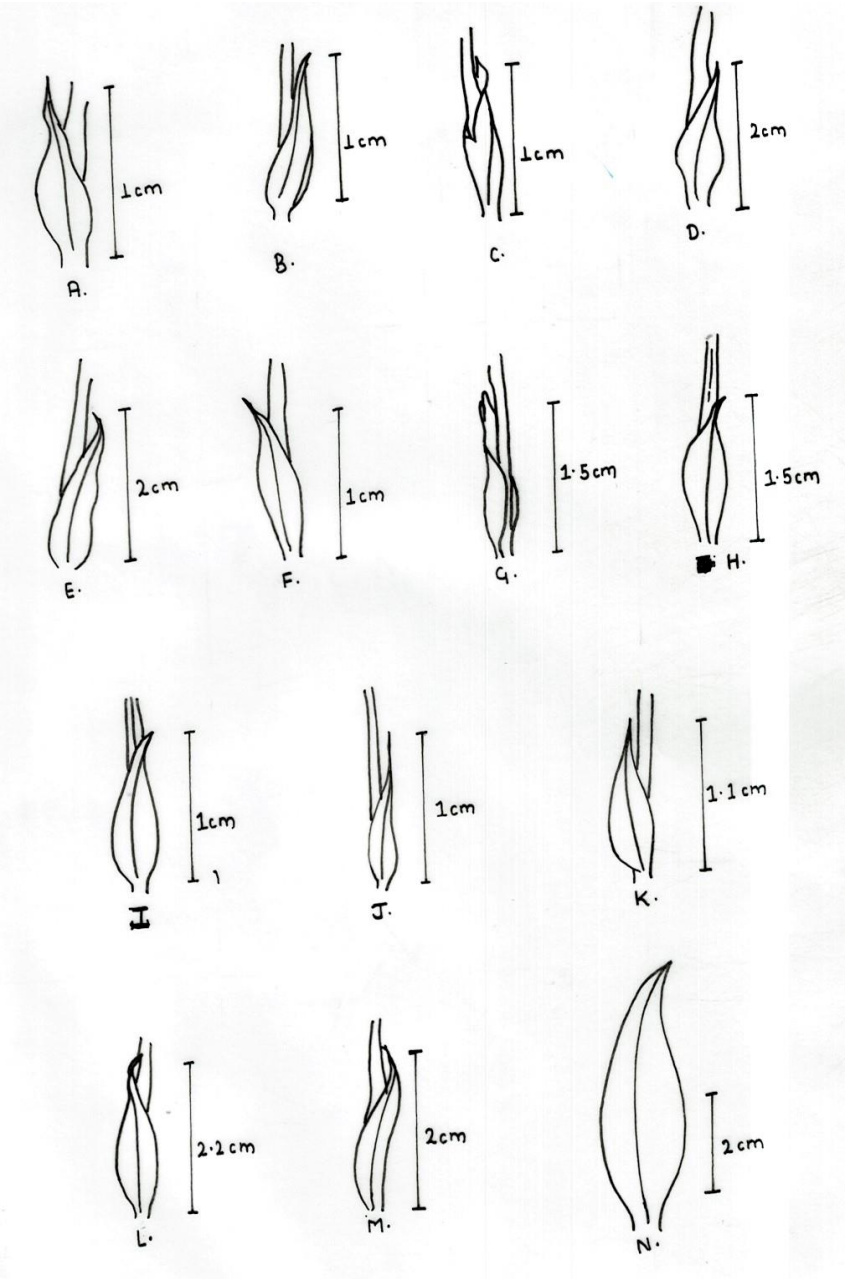


Fig. 1: Sterile bracts of genus *Peristylus.* A. *P. affinis* B. *P. biermannianus* C. *P. calcaratus* D. *P. constrictus* E. *P. densus* F. *P. goodyeroides* G. *P. hamiltonianus* H. *P. intrudens* I. *P. lacertifer* J. *P. lawii* K. *P. parishii* L. *P. prainii* M. *P. tipuliferus* N. Foliaceous bract

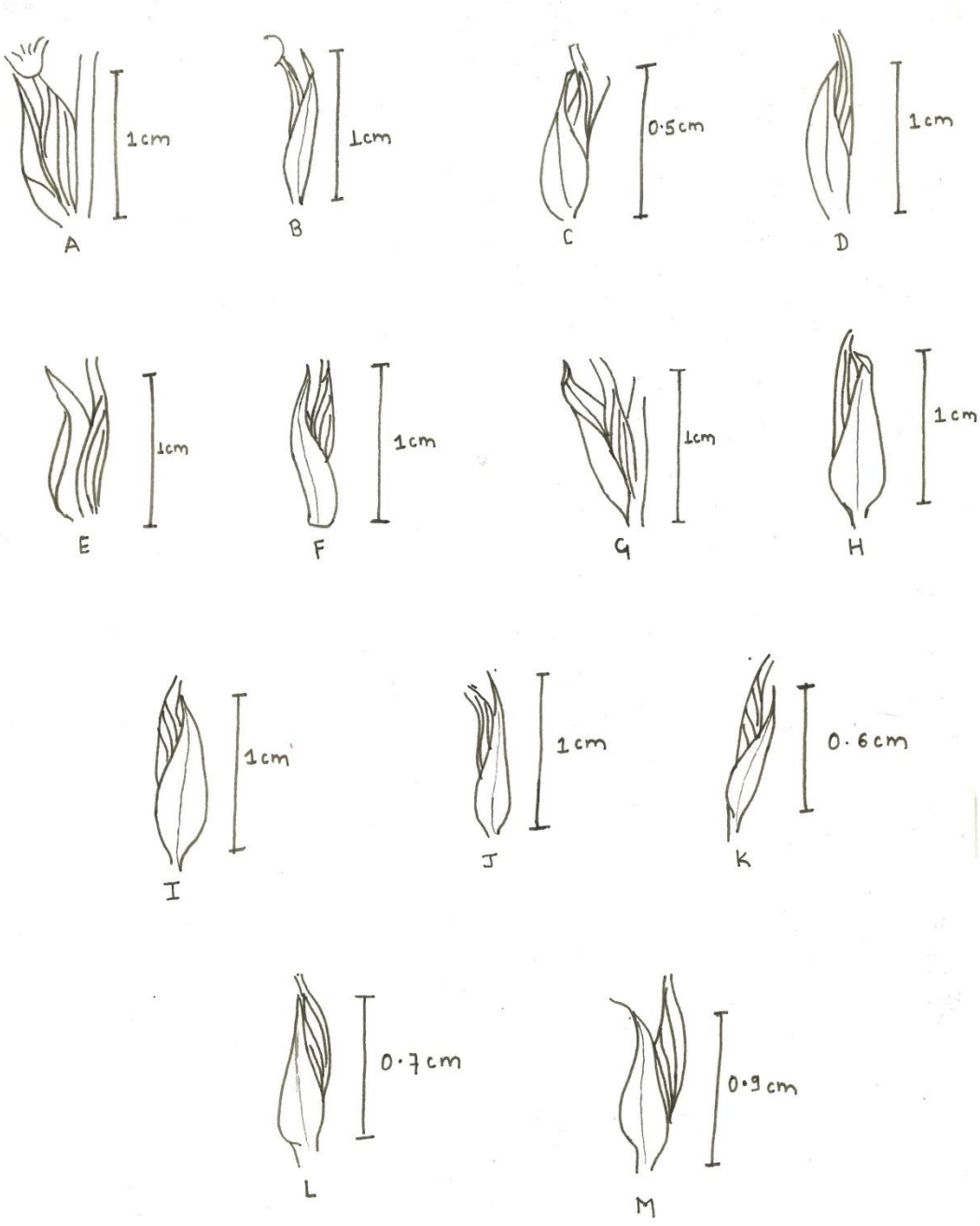


Fig. 2: Floral bracts of genus *Peristylus.* A. *P. affinis* B. *P. biermannianus* C. *P. calcaratus* D. *P. constrictus* E. *P. densus* F. *P. goodyeroides* G. *P. hamiltonianus* H. *P. intrudens* I. *P. lacertifer* J. *P. lawii* K. *P. parishii* L. *P. prainii* M. *P. tipuliferus*

4.1.8. Pedicel and Ovary

Pedicel and ovary are usually narrow, slender and glabrous, twisted and beaked in all species of this genus. Its length ranges from 4-15mm. It is very small and ranges up to 4mm in *P. prainii* and the rest of the species have pedicel and ovary exceeds 4mm in length. (Table 4) (Fig. 3)

4.1.9 Sepals

The number of sepals present in the species of this genus is 3 in which upper one is called dorsal sepal (1) and the lower one is known to lateral sepals (2). Dorsal sepal is erect and usually connivent with petals forming hood. Dorsal and lateral sepals are usually similar and sub-equal to each other. Their shape varies from ovate-lanceolate to oblong-lanceolate. Dorsal sepal can be as small as 2—4 X 1—2.5 mm in *P. affinis, P. biermannianus, P. calcaratus, P. densus, P. hamiltonianus, P. intrudens, P. lacertifer, P. lawii, P. prainii* and *P. tipuliferus.* It can be as long as 7—9 X2—3mm in *P. constrictus* whereas it is intermediate in *P. parishii* and *P. goodyeroides.* Lateral sepals are usually slightly oblique. Their shape also ranges oblong-lanceolate to ovate-lanceolate in all species of this genus. They are particularly turned downwards in *P. affinis,* spreading in *P. constrictus,* and spreading as well as turned downwards in *P. densus* but lateral sepals are turned or curved upwards in *P. biermannianus.* Their size also can be as small as 2.5—4 X 1—1.5mm in *P. affinis, P. biermannianus, P. calcaratus, P. densus, P. hamiltonianus, P. intrudens, P. lacertifer, P. lawii, P. prainii* and *P. tipuliferus.* It can be as long as 9—10 X 2—4mm in *P. constrictus* whereas they are intermediate in *P. parishii* and *P. goodyeroides* likewise in dorsal sepal. Lateral sepals are usually narrower than dorsal sepal in all species. (Table 4) (Fig. 4 and Fig. 5)

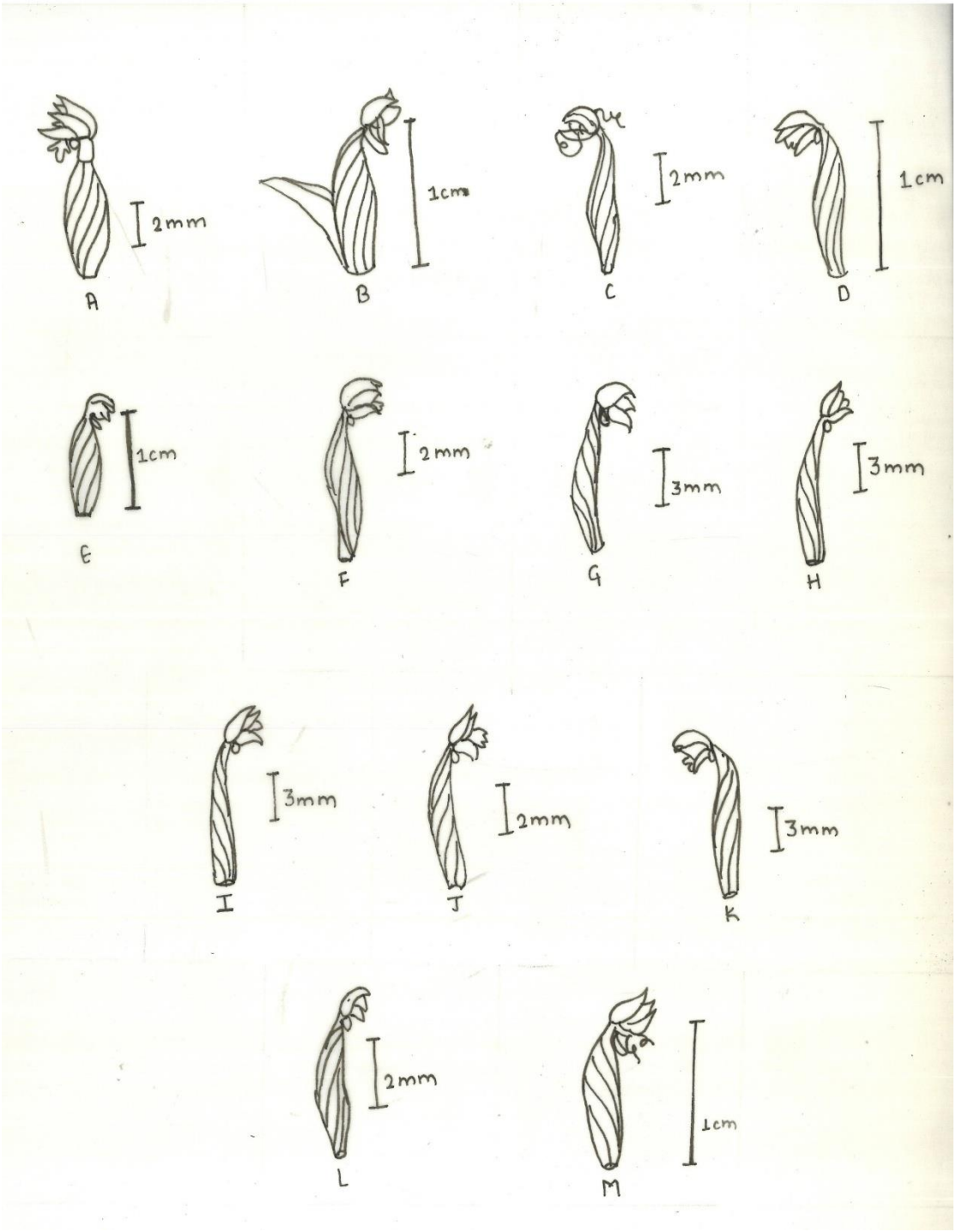


Fig. 3: Pedicel and ovary of genus *Peristylus.* A. *P. affinis* B. *P. biermannianus* C. *P. calcaratus* D. *P. constrictus* E. *P. densus* F. *P. goodyeroides* G. *P. hamiltonianus* H. *P. intrudens* I. *P. lacertifer* J. *P. lawii* K. *P. parishii* L. *P. prainii* M. *P. tipuliferus*

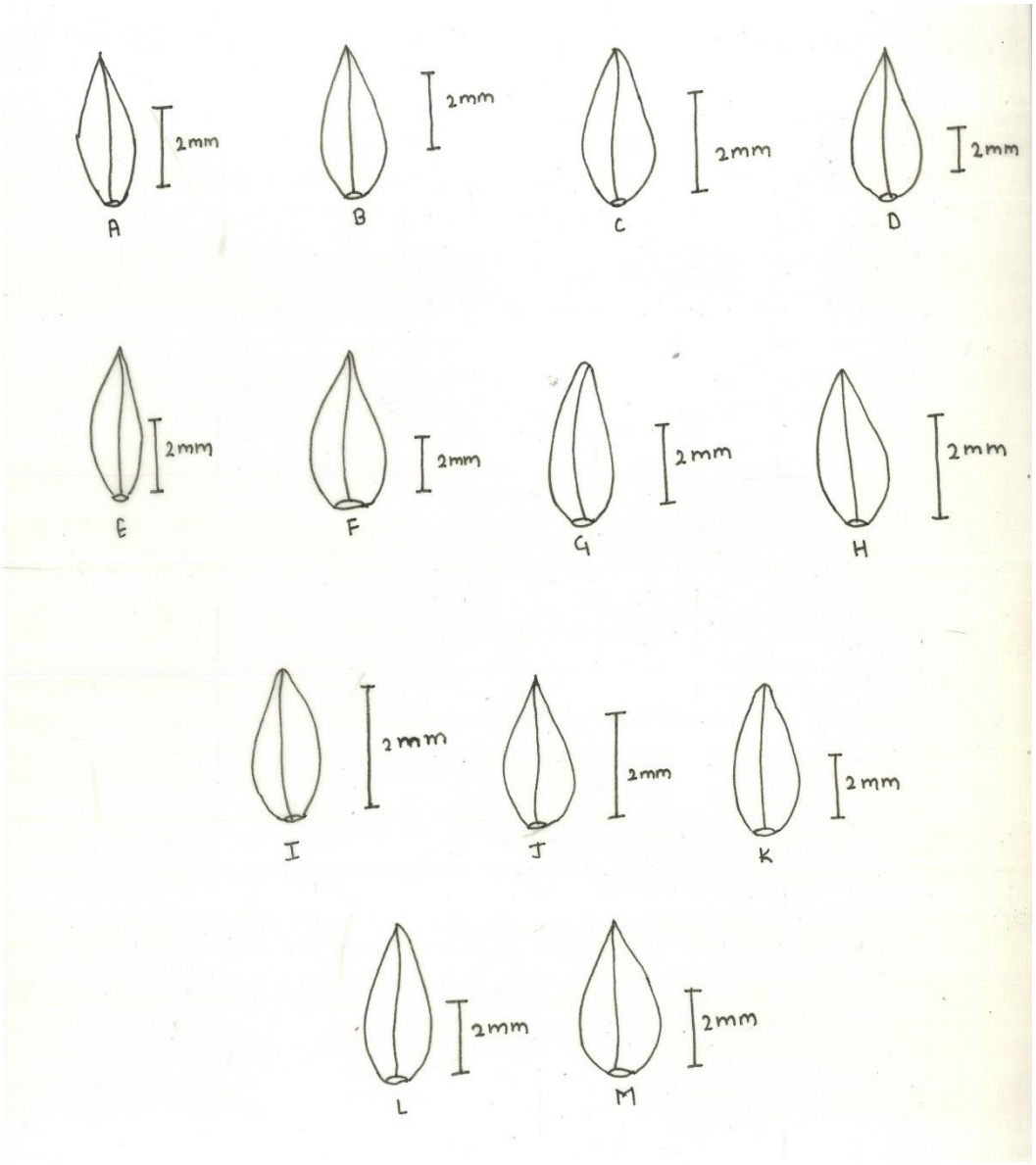


Fig. 4: Dorsal sepal of genus *Peristylus.* A. *P. affinis* B. *P. biermannianus* C. *P. calcaratus* D. *P. constrictus* E. *P. densus* F. *P. goodyeroides* G. *P. hamiltonianus* H. *P. intrudens* I. *P. lacertifer* J. *P. lawii* K. *P. parishii* L. *P. prainii* M. *P. tipuliferus*

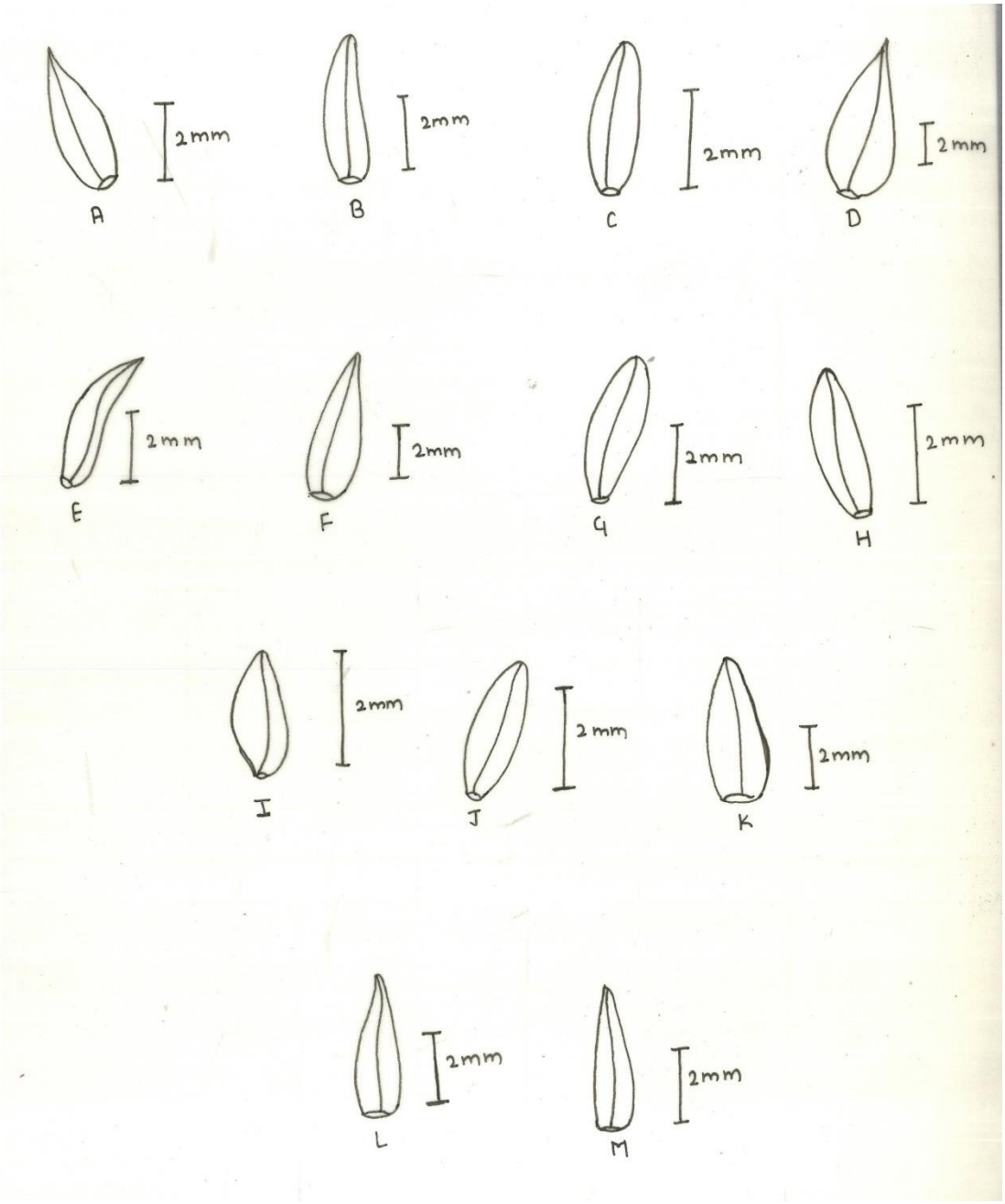


Fig. 5: Lateral sepals of genus *Peristylus.* A. *P. affinis* B. *P. biermannianus* C. *P. calcaratus* D. *P. constrictus* E. *P. densus* F. *P. goodyeroides* G. *P. hamiltonianus* H. *P. intrudens* I. *P. lacertifer* J. *P. lawii* K. *P. parishii* L. *P. prainii* M. *P. tipuliferus*

4.1.10 Petals

Petals are usually connivent with dorsal sepals forming hoods in all species of this genus. They are usually broader or similar to dorsal sepal so their shape also ranges from ovate-lanceolate to oblong-lanceolate and sizes ranges can be as small as 2—4 X 1—2.5mm in all species except *P. constrictus* whose sizes can be 8.5—10 X 2.5—5mm and intermediate in *P. goodyeroides* and *P. prainii.* (Table 4) (Fig. 6)

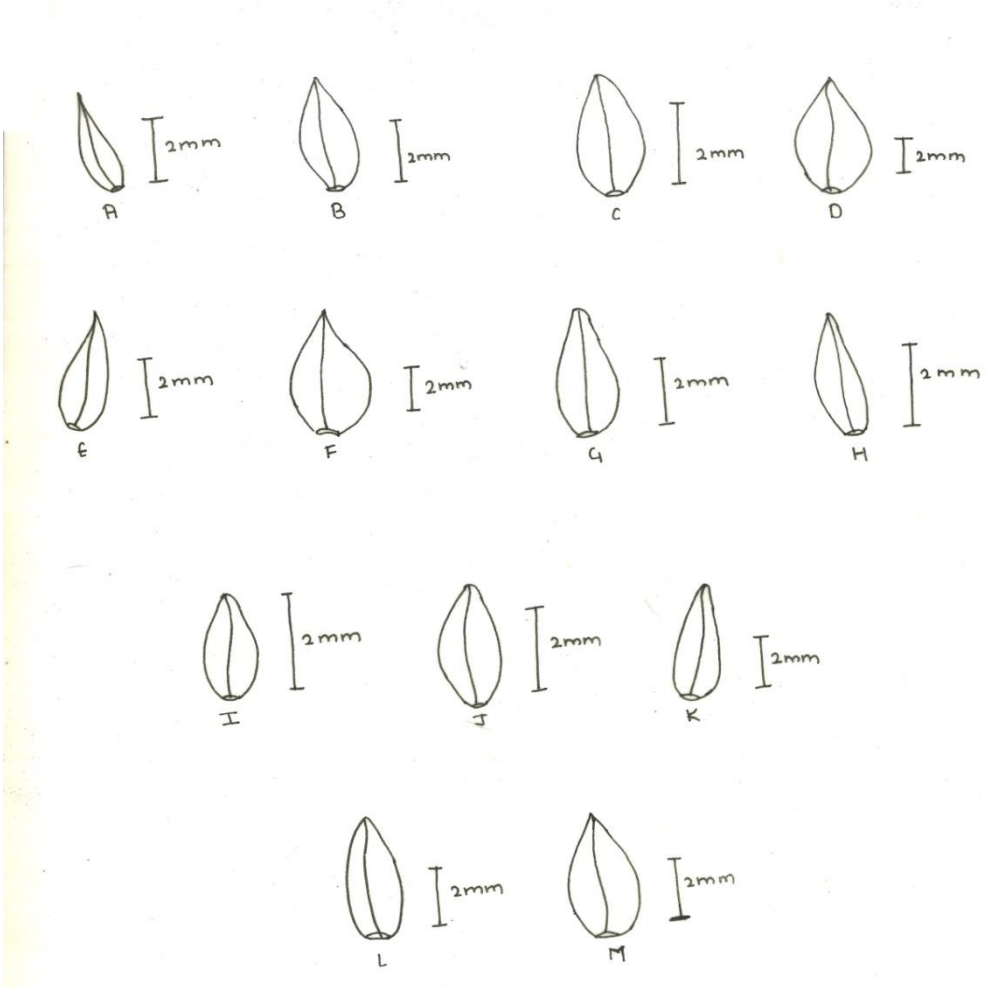


Fig. 6: Petal of genus *Peristylus.* A. *P. affinis* B. *P. biermannianus* C. *P. calcaratus* D. *P. constrictus* E. *P. densus* F. *P. goodyeroides* G. *P. hamiltonianus* H. *P. intrudens* I. *P. lacertifer* J. *P. lawii* K. *P. parishii* L. *P. prainii* M. *P. tipuliferus*

Table 4: Comparative study of flower, pedicel and ovary, sepals and petals in *Peristylus* Blume.

S. N.	Plants Name	Flower	Pedicel and ovary	Dorsal sepal shape and size	Lateral sepals shape and size	Petals shape and size
1.	*P. affinis*	White	7mm	Lanceolate (3-4X1mm)	Lanceolate (3X1mm)	Lanceolate (2-3X0.8mm)
2.	*P. biermannianus*	Green	7-9mm	Ovate-lanceolate (3-4X1-2mm)	Ovate-lanceolate (4-5X1mm)	Lanceolate (3X1mm)
3.	*P. calcaratus*	Green	6mm	Ovate (3X1.5mm)	Ovate (3X1.5mm)	Ovate (3X1.5mm)
4.	*P. constrictus*	White	9-10mm	Oblong-lanceolate (7-9X2-3mm)	Oblong-lanceolate (9-10X2-4mm)	Ovate-lanceolate (8.5-10X2.5-5mm)
5.	*P. densus*	Green	5-7mm	Elliptic-lanceolate (4X1.5mm)	Oblong-lanceolate (4X1mm)	Oblong-lanceolate (4X1.3mm)
6.	*P. goodyeroides*	Dirty-white	5-15mm	Ovate-lanceolate (3-7X2-4mm)	Ovate-lanceolate (3.5-6X1.7-2mm)	Oblong-lanceolate (3-5X3-4.4mm)
7.	*P. hamiltonianus*	White	5-8mm	Oblong (2.5-4X1mm)	Oblong (2.5-4X1mm)	Broadly oblong (2.5-4X1mm)
8.	*P. intrudens*	White	8-10mm	Oblong-ovate (3X1.5mm)	Oblong-ovate (2.5X1mm)	Oblong-ovate (2.5X1mm)
9.	*P. lacertifer*	Green	6-10mm	Oblong-ovate (2.5X1-1.5mm)	Oblong-lanceolate (2.3-3X1-1.5mm)	Oblong-lanceolate (2.3X1mm)
10.	*P. lawii*	White	6-8mm	Oblong (2-3X1.5-2mm)	Linear-oblong (2-3X1.3mm)	Broadly oblong (2-3X1.5mm)
11.	*P. parishii*	Green	8mm	Ovate (4-6X1.5-2mm)	Oblong (4-6X1.5mm)	Oblong-ovate (2-4X1.8mm)
12.	*P. prainii*	White	3-4mm	Ovate (3-4X1.5-2.5mm)	Oblong-ovate (3-4X1.5-2.5mm)	Oblong (3-4X1.5-2.5mm)
13.	*P. tipuliferus*	Green	7-13mm	Ovate (3-4X1.5-2mm)	Lanceolate (3.3-5X1-1.5mm)	Oblong (3.5-4X1-2.5mm)

4.1.11 Lip

Lips are 3-lobed in all species of this genus. The lip is deeply 3-lobed in *P. calcaratus, P. densus* and *P. tipuliferus.* It is 3-lobed near middle in *P. constrictus* whereas it is 3-lobed near apex in *P. affinis, P.goodyeroides, P. hamiltonianus, P. intrudens, P. lacertifer, P. lawii, P. parishii* and *P. prainii* but lip is obscurely 3-lobed in *P. biermannianus.* Similarly, lateral lobes of lip are spreading, filiform and curved upwards in *P. calcaratus* and *P. tipuliferus* whereas they are linear and spreading horizontally in *P. densus.* Lateral lobes of lip are linear, diverging, and longer than the mid-lobe in *P.constrictus* and *P. lacetifer* whereas they are diverging and equal in *P. goodyeroides* and shorter than mid-lobe in *P. affinis, P. hamiltonianus, P. intrudens, P. lawii, P. parishii* and *P. prainii* and minutely small in *P. biermannianus* and seemed to be spreading. The lateral lobes of lip are usually oblong in *P. affinis, P. goodyeroides, P. lawii, P. parishii* whereas they are triangular in *P. intrudens* and *P. prainii* and they are ovate-orbicular in *P. hamiltonianus.* Mid-lobe of lip is usually broader than

the lateral lobes and oblong-ovate in all species except in *P. hamiltonianus* and *P. prainii* which has ovate-orbicular and triangular midlobe respectively. This character is very helpful in delimiting the species of this genus. (Table 5) (Fig. 7)

4.1.12 Spur

Spurs are pendulous in all species of this genus. Spur are sub-globose or globose-saccate in *P. affinis, P. constrictus, P. goodyeroides, P. hamiltonianus, P. lawii, P. prainii.* It is usually clavate and cylindrical in *P. biermannianus, P. densus, P. parishii* and *P. tipuliferus* whereas it is ovoid or ovate in *P. calcaratus, P. intrudens* and *P. lacertifer.* Its size usually ranges from 1—3mm. This character is very useful for delimiting the species within the genus. (Table 6) (Fig. 8)

4.1.13 Column

The size of column usually varies from 0.6--2mm in all the species of this genus. The smallest column is found in *P. hamiltonianus* which is 0.6mm whereas largest column is found in *P. goodyeroides* which is 2mm and rest of the species has the column ranges from 0.8--1.5mm. Columns are usually short and broad in all the species of this genus. In *P. tipuliferus* column is short as well as depressed. (Table 6)

4.1.14 Pollinia

All the species of this genus have 2 pollinia with very short caudicles. Its shape ranges from obovoid or pyriform to ovoid. Species such as *P. affinis, P. biermannianus, P. constrictus, P. goodyeroides, P. parishii, P. prainii* and *P. tipuliferus* have obovoid or pyriform pollinia whereas species such as *P. lacertifer* has ovoid pollinia and *P. lawii* has clavate pollinia. (Table 6)

* Description of pollinia and column are consulted from literatures.

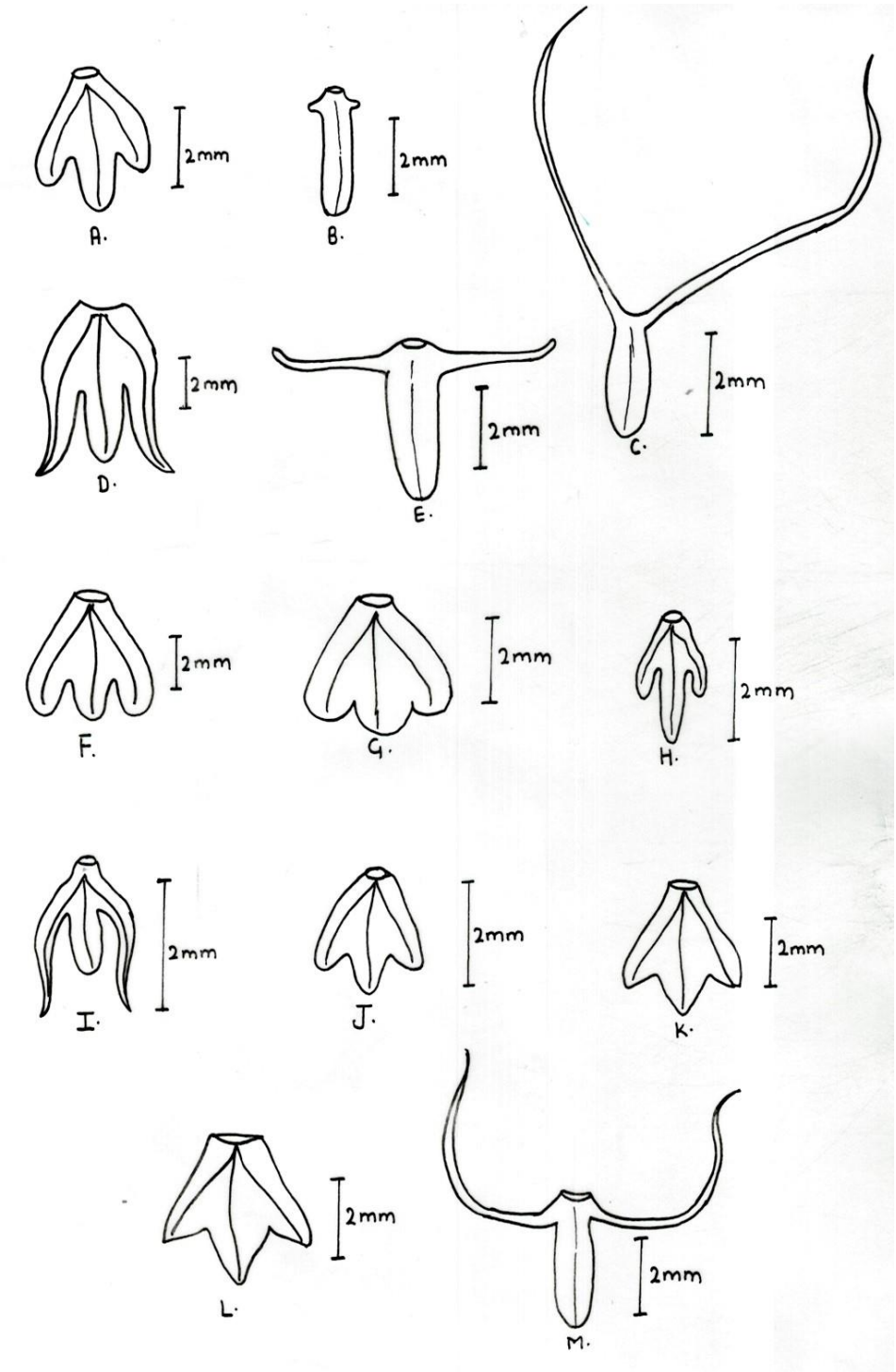


Fig. 7: Lip of genus *Peristylus.* A. *P. affinis* B. *P. biermannianus* C. *P. calcaratus* D. *P. constrictus* E. *P. densus* F. *P. goodyeroides G. P. hamiltonianus* H. *P. intrudens* I. *P. lacertifer* J. *P. lawii* K. *P. parishii* L. *P. prainii* M. *P. tipuliferus*

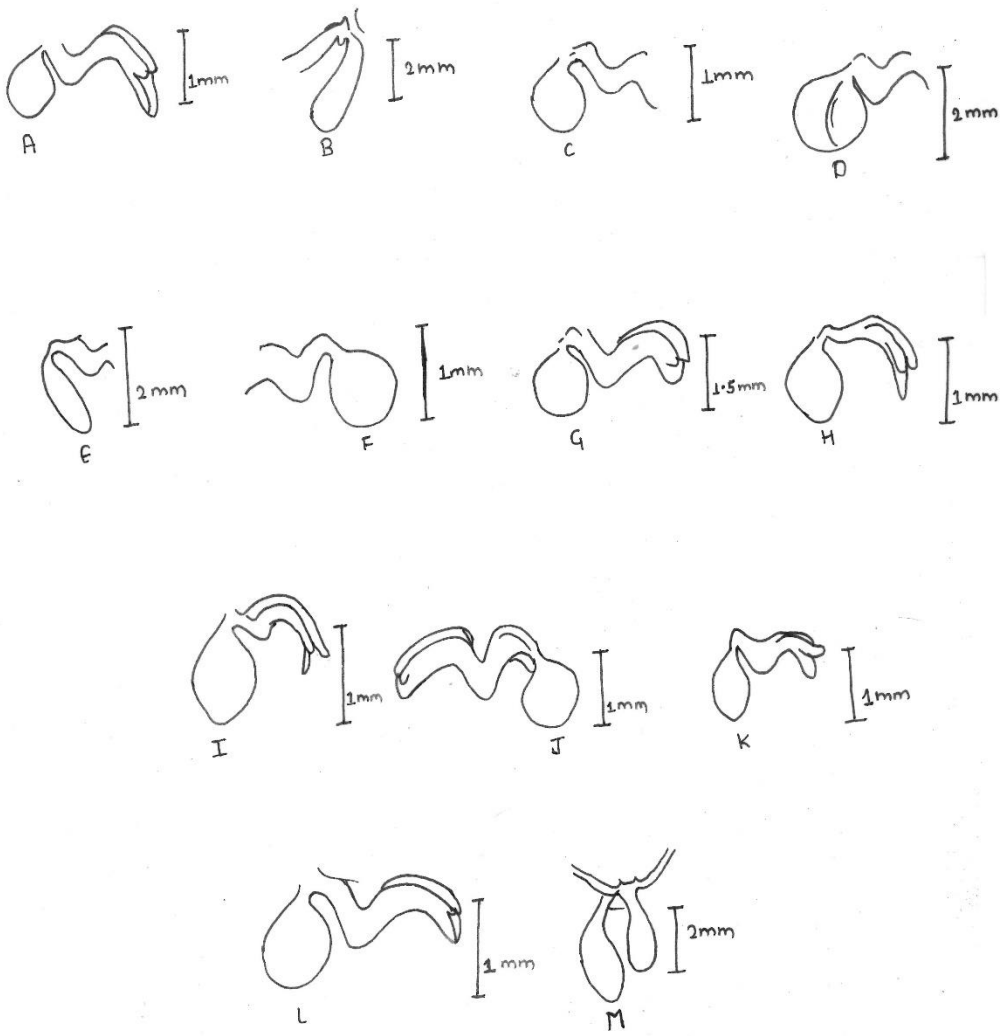


Fig. 8: Spur of genus *Peristylus.* A. *P. affinis* B. *P. biermannianus* C. *P. calcaratus* D. *P. constrictus* E. *P. densus* F. *P. goodyeroides G*. *P. hamiltonianus* H. *P. intrudens* I. *P. lacertifer* J. *P. lawii* K. *P. parishii* L. *P. prainii* M. *P. tipuliferus*

Table 5: Comparative study of lip structure in *Peristylus* Blume.

S. N.	Plant names	Lip	Lateral lobes of lip	Mid-lobe of lip
1.	*P. affinis*	3-lobed near apex	Diverging and not filiform	Longer than lateral lobes
2.	*P. biermannianus*	**Obscurely 3-lobed**	Spreading and not filiform	Longer than lateral lobes
3.	*P. calcaratus*	Deeply 3-lobed	Spreading and filiform	Shorter than lateral lobes
4.	*P. constrictus*	3-lobed near middle	Diverging and not filiform	Shorter than lateral lobes
5.	*P. densus*	Deeply 3-lobed	Spreading and not filiform	Longer than lateral lobes
6.	*P. goodyeroides*	3-lobed near apex	Diverging and not filiform	Equal to lateral lobes
7.	*P. hamiltonianus*	3-lobed near apex	Diverging and not filiform	Longer than lateral lobes
8.	*P. intrudens*	3-lobed near apex	Diverging and not filiform	Longer than lateral lobes
9.	*P. lacertifer*	3-lobed near apex	Diverging and not filiform	Shorter than lateral lobes
10.	*P. lawii*	3-lobed near apex	Diverging and not filiform	Longer than lateral lobes
11.	*P. parishii*	3-lobed near apex	Diverging and not filiform	Longer than lateral lobes
12.	*P. prainii*	3-lobed near apex	Diverging and not filiform	Longer than lateral lobes
13.	*P. tipuliferus*	Deeply 3-lobed	Spreading and filiform	Shorter than lateral lobes

Table 6: Comparative study of spur, column and pollinia in *Peristylus* Blume.

S. N.	Plant names	Spur (Size and shape)	Column	Pollinia
1.	*P. affinis*	1mm, saccate	0.8mm, short and broad	Pyriform
2.	*P. biermannianus*	2-3mm, clavate	Very short	Broadly pyriform
3.	*P. calcaratus*	1mm, ovate	1mm, very short	
4.	*P. constrictus*	2mm, globose	0.8-1.1mm, very short and broad	Oblong-ovoid
5.	*P. densus*	2mm, cylindric-oblong	1mm, very short	
6.	*P. goodyeroides*	1-2mm, globose	2mm, short and broad	Obovate or pyriform
7.	*P. hamiltonianus*	1.5-2mm, globose-saccate	0.6mm	
8.	*P. intrudens*	1mm, ovoid	1mm	
9.	*P. lacertifer*	1mm, ovoid	1-1.5mm	Ovoid
10.	*P. lawii*	1-2mm, globose-saccate	1mm	
11.	*P. parishii*	1-2mm, clavate	1mm	Pyriform
12.	*P. prainii*	1-2mm, globose-saccate	1mm, short and broad	Obovoid
13.	*P. tipuliferus*	2-3mm, clavate	1mm, short and depressed	Obovoid or pyriform

4.2 Taxonomic treatment

4.2.1 *Peristylus* Blume, Bijdr. Fl. Ned. Ind. 404 (1825), nom. Cons. Type: *Peristylus grandis* Bl. type cons. (lectotype)

Coeloglossum Lindl., Edwards's Bot. Reg. 20: t. 1701 (1834), nom. illeg.

Digomphotis Raf., Fl. Tellur. 2: 37 (1837)

Glossula Lindl., Bot. Reg. 10: t. 862 (1824)

Lindblomia Fr., Bot. Not. 1843: 134 (1843)

Plants terrestrial, small to medium-sized, often with subterranean tubers; tubers small, cylindric to ellipsoid. Stem erect, elongated, bladeless sheaths at base, few to many-leaved. Leaves usually broad and crowded, often spirally arranged, linear to broadly elliptic, glabrous, persistent, convolute, herbaceous, sessile, usually amplexicaul, rarely petiolate. Inflorescence terminal, few to many-flowered raceme. Flowers spirally arranged, resupinate, usually green, brownish, white or yellowish; pedicel and ovary usually erect, cylindric-fusiform, glabrous; sepals free; dorsal sepal and petals forming a hood over column; petals free, usually more or less intermediate in shape between the dorsal sepal and the lateral sepals. Lip 3-lobed, lateral lobes filiform to oblong, diverging or spreading; mid-lobe usually broader than lateral lobes, spurred; spur short, globose to elongated, clavate to narrowly tubular. Column short; stigmas 2; stigma arms 2, adnate to the base of the lip; pollinia 2, shortly clavate, sectile, caudicles present, viscidium present.

4.2.2 Synopsis of the classification of the genus *Peristylus* Blume

Family: Orchidaceae

Sub-Family: Orchidoideae

Tribe: Orchideae

Sub-Tribe: Orchidinae

Genus: *Peristylus* Blume

4.2.3 Key to species

1. Leaves alternate……...…..... 2
   Leaves whorled..……..……..... 5
2. Sterile bracts 1 or absent. Lip obscurely 3-lobed…….**2. *P. biermannianus***
   Sterile bracts (1)2-6. Lip distinctly 3-lobed……..…….. 3
3. Lateral lobes of lip linear, spreading horizontally…….……... **5. *P. densus***
   Lateral lobes of lip filliform, curved or spreading upwards….. 4
4. Petals ovate. Spur ovate……...…….**3. *P. calcaratus***
   Petals oblong. Spur clavate……..…….....**13. *P. tipuliferus***
5. Leaves 2 or 3; whorled near base……..…….…... 6
   Leaves more than 3; whorled near middle……...……..… 7
6. Flower white. Lateral lobes of lip triangular, shorter than mid-lobe.....**8. *P. intrudens***
   Flower green. Lateral lobes of lip linear, longer than mid-lobe.....**9. *P. lacertifer***
7. Leaves linear-lanceolate……..……...… **10. *P. lawii***
   Leaves elliptic-lanceolate……..... 8
8. Lip 3-lobed near middle; lateral lobes longer than mid-lobe.....9
   Lip 3-lobed near apex; lateral lobes equal or shorter than mid-lobe... 10
9. Flowers white, 1.6-2.5mm across. Petals ovate-lanceolate, 8.5-10mm.....…….....**4. *P. constrictus***
   Flowers ca. 5mm across. Petals oblong-lanceolate, 3-5mm.....**6. *P. goodyeroides***
10. Leaves margin crenulate.....11
    Leaves margin entire.....12
11. Lateral and mid-lobe of lip triangular.....…….……...**12. *P. prainii***
    Lateral and mid-lobe ovate-orbicular.....……...**7. *P. hamiltonianus***
12. Flowers green. Ebracteate or sterile bract 1; spur fusiform....**11. *P. parishii***
    Flower white. Sterile bracts 2; spur saccate…….....……..**1. *P. affinis***

4.2.4 Description of the species

1. ***Peristylus affinis*** (D.Don) Seidenf., *Dansk Bot. Ark*. 31(3): 48. 1977; D. Don, *Prodr. Fl. Nep*. 25. 1825; Hooker, *Fl. Brit. India*. 6:149. 1890; King and Pantling, *Ann. Roy. Bot. Gard*. (Calcutta) 8: 1898; Pearce and Cribb, *Fl. Bhutan.* 3:174 2002; Chen *et al., Fl. China.* 25:142. 2009.

Habenaria affinis D. Don, *Prodr. Fl. Nepal*. 25. 1825.

Gymnadenia affinis (D.Don) Rchb.f., *Otia Bot. Hamburg*. 33. 1878.

Peristylus goodyeroides var. *affinis* (D. Don) T.Cooke, *Fl. Bombay* 2: 712. 1908.

Type specimen: Central Nepal: *Bagmati Province*, Kathmandu District, Toka [Tokha], July 1821, *N. Wallich* 7066A [K000974271] (Lectotype: CAL, Isolectotypes: K-LINDL, K-W; designated by Prain in King & Pantl., *Orchids of Sikkim Himalaya*. 32.1898).

Plant ca. 23 cm tall. Tubers cylindric-oblong, ca. 13 X 3 mm. Stem with 3 tubular sheaths at base; sheaths 1.5--5 cm. Leaves 3 or 4, whorled at middle of stem, elliptic-lanceolate, ca. 8 X 1.5 cm, amplexicaul, acute, 5-veined, entire. Inflorescence 10 cm; spike 6 cm, laxly to densely many flowered. Sterile bracts 2, lanceolate, ca. 10 X 3 mm, acute, acuminate. Floral bracts lanceolate, 7—8 X 2 mm, as long as or slightly exceeding pedicel and ovary, acuminate. Flowers white, ca. 3 mm across; pedicel and ovary slender, glabrous, ca. 7 mm. Dorsal sepal lanceolate, 3--4 X ca. 1 mm, obtuse. Lateral sepals lanceolate, ca. 3 X 1 mm, turned downwards, obtuse. Petals green, as long as or slightly shorter than sepals, 2--3 X ca. 0.8 mm, obtuse. Lip oblong-obovate, ca. 3 X 2 mm, 3-lobed near apex; lateral lobes oblong, ca. 1.5 mm, shorter than mid-lobe, diverging; mid-lobe oblong, ca. 2 mm, broader than the lateral lobes. Spur saccate, ca. 1 mm. Column ca. 0.8 mm, short and broad. Pollinia pyriform. (Fig. 9)

Distribution: Nepal (Map 2), West Himalaya, East Himalaya, Assam-Burma, East Asia and South-East Asia

Altitudinal Range: 3100-3200m

Ecology: Grassland

Flowering time: September-October

Use: Ornamental

Notes: This species is very similar to the *Peristylus goodyeroides*. Hooker (1894) and King and Pantling (1898) had also described *Habenaria affinis* and *Habenaria goodyeroides* var. *affinis* under the sections Trimeroglossa and Peristylus respectively which is synonymous to this species. King and Pantling (1898) had also mentioned that typical difference between these two species (*P. goodyeroides* and *P. affinis*) are broadly the plant size which is way bigger in *P. goodyeroides* than *P. affinis* and the colour of flower which is usually yellowish green in *P. goodyeroides* and white in *P. affinis* which is also same for *Peristylus affinis* specimen present at KATH. While consulting type herbarium, King and Pantling (1898) mentioned that 7066B is really a *Peristylus constrictus* whereas 7066A suspected to be the mixture of two gatherings, one collected from Toka was *Peristylus affinis* and other from Puspulnath was *P. goodyeroides*. According to Hooker (1894), the side lobes of lip are slightly longer than mid-lobe whereas the specimen present at KATH has side lobes slightly shorter than mid-lobe. Different literatures such as Chen *et al.* (2009); Rao (2010) had mentioned the presence of papillose near the mouth of the spur as distinguishing characters of this species from *P. goodyeroides* but could not find presence of papillose in KATH herbarium specimen through stereomicroscope as single specimen was deposited at KATH with only one leaf. But Holotype at K, has a clustered 3 or 4 leaves and same mentioned in the different literatures such as Chen *et al*. (2009); Pearce and Cribb (2002).

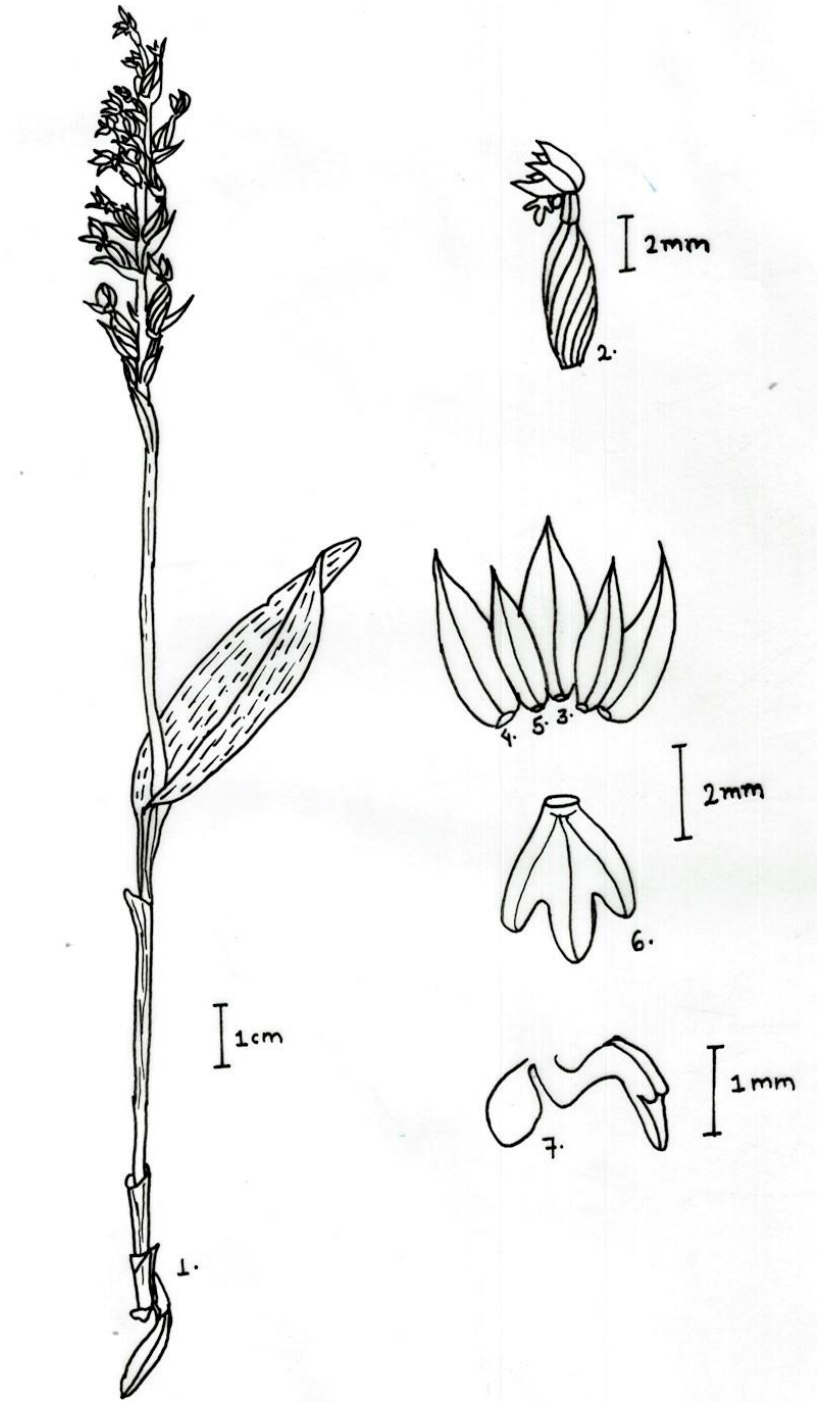
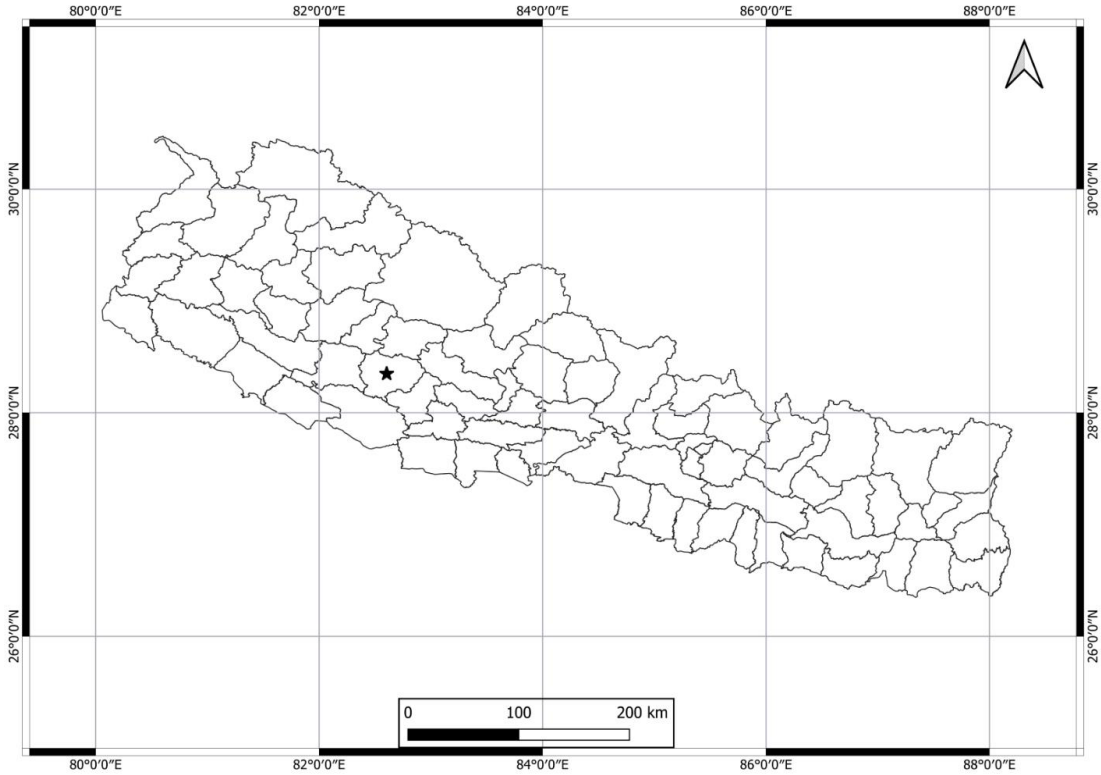


Fig. 9: *Peristylus affinis* (D. Don) Seidenfaden 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (S. Budha Magar, B.B. Magar and B. K. Magar 674, KATH).



Map 2: Distribution map of *Peristylus affinis* in Nepal.

Specimens examined

Western Nepal: *Lumbini Province*, Rolpa District, Thabang VDC, Mt. Jaljala, 3130m, 30/09/ 2014, *S. Budha Magar, B.B. Magar* and *B. K. Magar* 674 (KATH!).

2. ***Peristylus biermannianus*** (King et al Pantl.) X. H. Jin, Schuit. & W. T. Jin, *Molec. Phylogen. Evol*. 77: 51. 2014; Hara *et al.*, *Enum. Fl. Pl. Nep.* 1: 53. 1978; King & Pantling, *J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist.* 64: 343. 1895; King and Pantling, *Ann. Roy. Bot. Gard.* (Calcutta). 8:318. 1898; Pearce and Cribb, *Fl. Bhutan.* 3:186. 2002.

Habenaria biermanniana King & Pantl., *J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist.* 64: 343. 1895.

Platanthera biermanniana (King & Pantl.) Kraenzl., *Orchid. Gen. Sp*. 1: 636. 1899.

Type specimen: India, Sikkim Singalelah, 07/1896, *R. Pantling* 332 [K000247401] (Holotype: CAL; Isotype: K).

Plant 12--25 cm tall. Tubers cylindric-ovate or ovoid, 7--18 X 3--6 mm. Stem with 2-3 tubular sheaths at base; sheaths 1--3 cm. Leaves 3-4, alternate, elliptic-lanceolate, 1.5--6 X 0.4--1.3 cm, amplexicaul, acute, 3-veined, entire. Inflorescence 7--15 cm; spike 4-

-12 cm, laxly few to many flowered. Sterile bracts usually 1, lanceolate, 1.1--2.5 X 0.2--0.4 cm, acute, acuminate, foliaceous, sometimes absent. Floral bracts lanceolate, 8--15 X 2--3 mm, as long as or slightly exceeding pedicel and ovary, acuminate. Flowers green, 2--3 mm across; pedicel and ovary slender, glabrous, 7--9 mm. Dorsal sepal ovate-lanceolate, 3--4 X 1--2 mm, obtuse. Lateral sepals ovate-lanceolate, oblong, as long as or slightly longer than dorsal sepal, 4--5 X ca. 1 mm, curved upwards, obtuse. Petals lanceolate, ca. 3 X 1 mm, shorter than sepals, curved upwards, acute. Lip linear-oblong, 2--3 mm, obscurely 3-lobed; lateral lobes minute, tooth like; mid-lobe linear-oblong. Spur clavate, pendulous, ca. 2-3 mm. Column very short, arching to the entrance of the spur. Pollinia broadly pyriform. (Fig. 10)

Distribution: Nepal (Map 3) and East Himalaya

Altitudinal Range: 2300-3000m

Ecology: In mossy, Rhododendron Forest on mossy soil

Flowering time: August-November

Notes: King and Pantling (1898) described this species as *Habenaria biermanniana* under the section IV (Hologlossa) of genus *Habenaria* with distinguishing features of entire petals and narrow lip which can be entire or with minute basal lobes and have the spur as long as lip but later Kraenzlin (1897-1901) transferred it to the genus *Platanthera* with distingushing characters of average sized plant with anteriorly lobed petals and spur that is 3 times shorter than lip (latin translated). Recently, Molecular analyses of Jin *et al.* (2014) showed that this species resembles the species of *Peristylus* with its gross morphology as well as deeply nested within the *Peristylus* with robust support. According to the study of herbarium specimens of this species at KATH, presence of ovoid tuber, obscurely 3-lobed lip, and spur as long as lip fall under the overall characters of genus *Peristylus.*

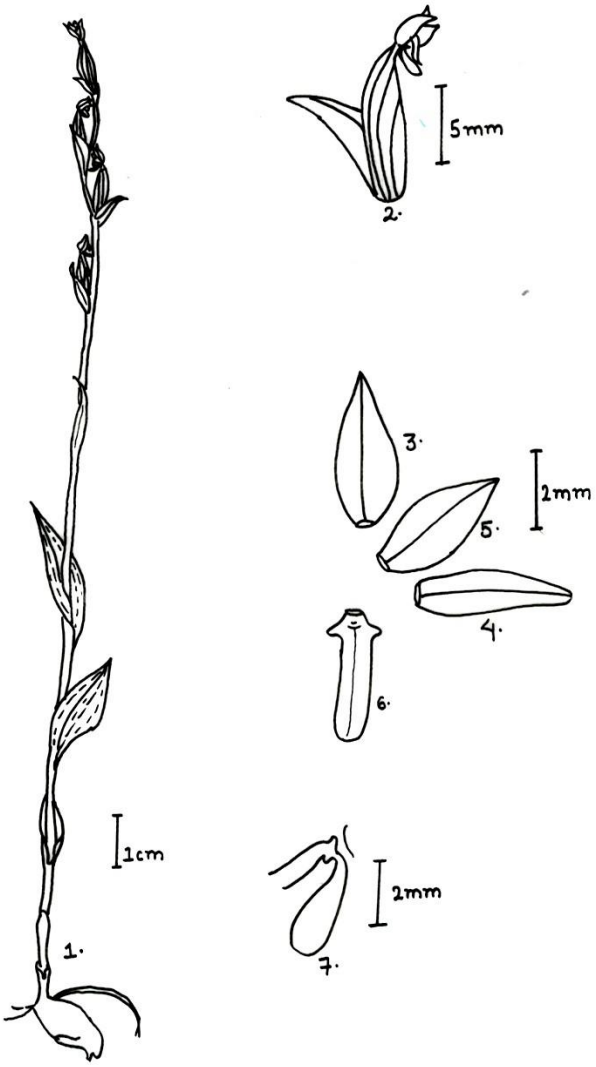
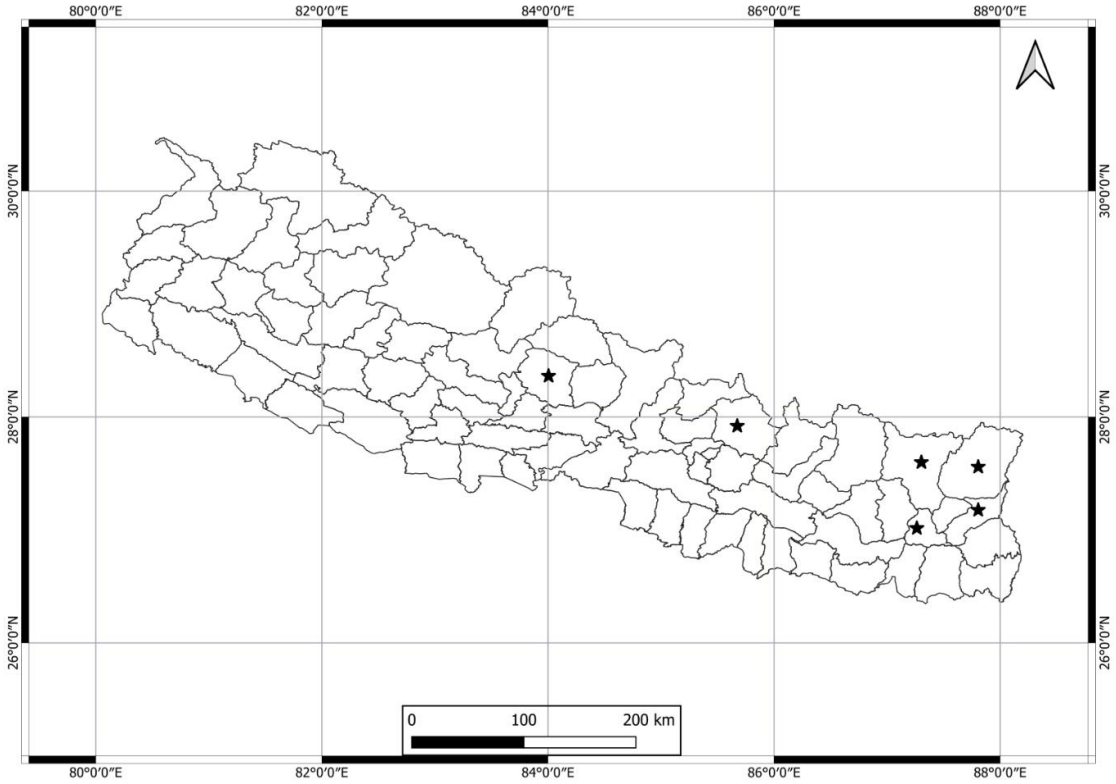


Fig. 10: *Peristylus biermannianus* (King and Pantl.) X. H. Jin. Schuit. And W. T. T. Jin 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (P. Bhandari & N.D. Sherpa 1686, KATH037982).



Map 3: Distribution map of *Peristylus biermannianus* in Nepal.

Specimens examined

Central Nepal: *Gandaki Province*, Kaski District, Panchase forest, 2350m, 08/08/2017, *P. Bhandari, G. Thapamagar* & *D. Pathak* P1704 (KATH!). *Bagmati Province*, Sindhupalchowk District, Tarke Ghyang, 28ºN 85º34'E, 3000m, 03/08/1986, *G. Mieche, S. Miehe* (K000480069).

Eastern Nepal: *Province 1*, Dhankuta District, Basantapur (N. of chitre) - Dorpani, 27º7'N 87º24'E, 2690m, 28/08/1989, *S. Crawford, C. Grey-wilson, D. Long, R. Mc. Beath, H. J. Noltie, M. Sinnott, M. Subedi, S. Zmarzty* 49 (KATH!, E00764310, K00480071); Sankhuwasabha District, West ridge, N.E. of Gupha Pokhari, 27º18'N 87º33'E, 2910m, 30/08/1989, *S. Crawford, C. Grey-wilson, D. Long, R. Mc. Beath, H. J. Noltie, M. Sinnott, M. Subedi&S. Zmarzty* 95 (KATH003079!, K000480070, E00764309); Taplejung District, Papung, 2300-2650m, 16/08/2016, *P. Bhandari* & *N. D. Sherpa* 1686 (KATH037982!); Panchthar District, 27º14N', 87º57'E, *H. Hara et al* 6304728 (TI).

3. ***Peristylus calcaratus*** (Rolfe) S. Y. Hu, *Quart. J. Taiwan Mus*. 26(3-4): 398. 1973; B. B. Raskoti, *Phytotaxa*, *233*(2), 179-184 (2015); Chen *et al.*, *Fl. China.* 25:139. 2009.

Glossula calcarata Rolfe, *Bull. Misc. Inform. Kew* 1913 (4): 145. 1913.

Platanthera pricei Hayata, *Icon. Pl. Formosan.* 4: 125. 1914.

Habenaria calcarata (Rolfe) Schltr., *Repert. Spec. Nov. Regni Veg. Beih.* 4: 124. 1919, nom. Illeg.

Type specimen: Hongkong, Lo Fau Shan, 08/07/1883, *C. Ford #* s.n. (K000827049).

Plant ca. 24 cm tall. Tuber oblong-ellipsoid, 8 X 5 mm. Stem with 2 tubular sheaths at base; sheaths 12—15 mm. Leaves 2, elliptic-lanceolate, alternate, upper one smaller, 3--7.5 X 0.8--1.5 cm, sessile, acute, 3-veined, entire. Inflorescence ca. 16 cm; spike ca. 5 cm, sub-densely many flowered. Sterile bracts 6, lanceolate, 5--10 X 2--3 mm, diminishing in size going towards inflorescence, acute, acuminate. Floral bracts lanceolate, ca. 5 X 2 mm, as long as or slightly shorter than pedicel and ovary, acuminate. Flowers yellowish green, 2 mm across; pedicel and ovary small, slender, ca. 6 mm. Equal dorsal and lateral sepals, ovate, ca. 3 X 1.5 mm, obtuse. Petals ovate, as long as sepals, obtuse. Lip deeply 3-lobed; lateral lobes are filiform, much longer than mid-lobe, spreading upwards, coiled at apex; mid-lobe oblong, broader, obtuse or round apex. Spur small, ovate, sub-globose, ca. 1 mm. Column ca. 1mm, very short. (Fig. 11)

Distribution: Nepal (Map 4), East Asia and South-East Asia

Altitudinal Range: 1900-2000m

Ecology: In grassland, humus covered slopes

Flowering time: August-September

Notes: KATH deposited only one specimen of this species which lacks tubers and has ovate spur. According to Thiselton-dyer (1898); Rolfe (1913); Hayata (1914); Chen *et al.* (2009), this species has oblong-ellipsoid tubers and fusiform or cylindrical spur. Similarly, this species present at KATH is more similar to *P. tipuliferus* but differs in the ovate spur. After deep study of the herbarium specimen of this species, I also found out that this species has longer lateral lobes of lip than *P. tipuliferus* as well as they spread upwards and curled more unlike in the *P. tipuliferus* where side lobes of lip spread gradually upwards and less curled which was also mentioned by Rolfe (1913) and Hayata (1914) stating that this species is similar to *Habenaria aristata* synonymous to *Peristylus tipuliferus (aristatus)* in this study and differs by having much more diverging lateral filiform-linear lobes and variously curled. Lateral lobes of this species are curled after drying the specimen.

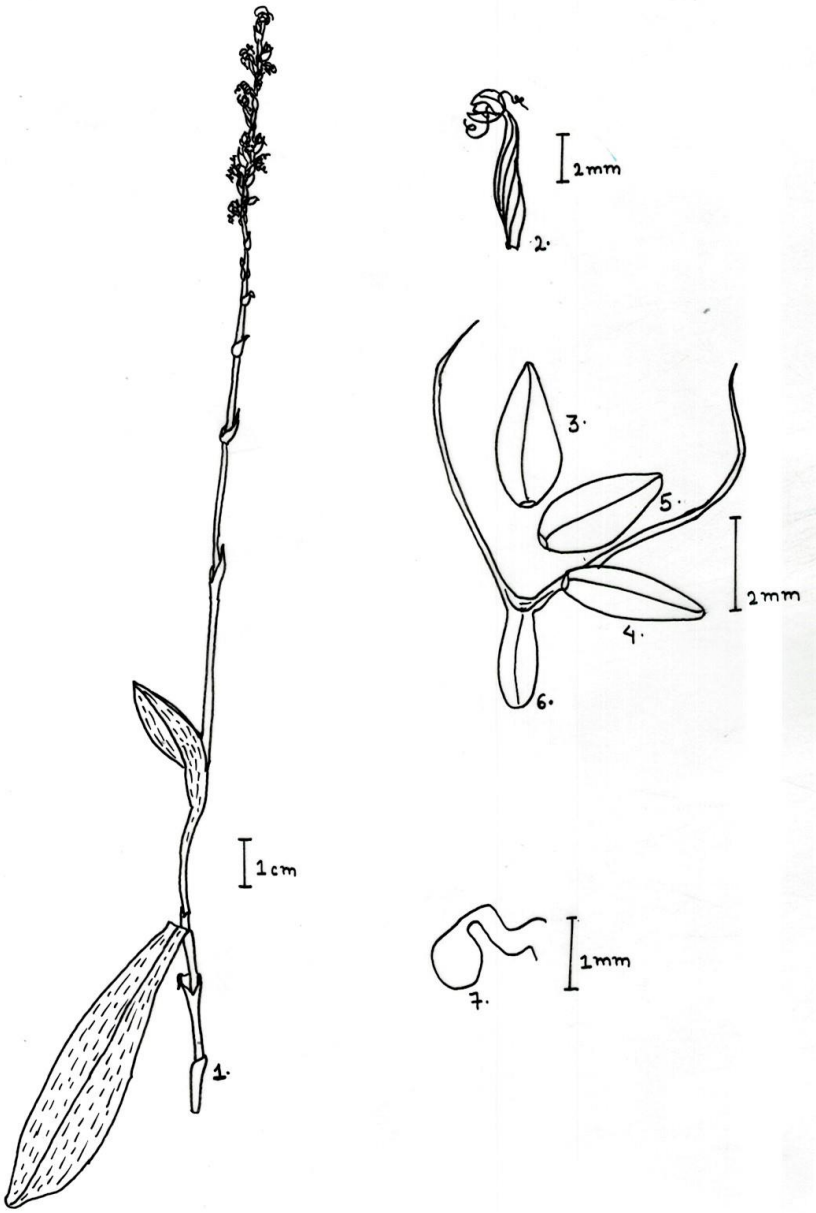
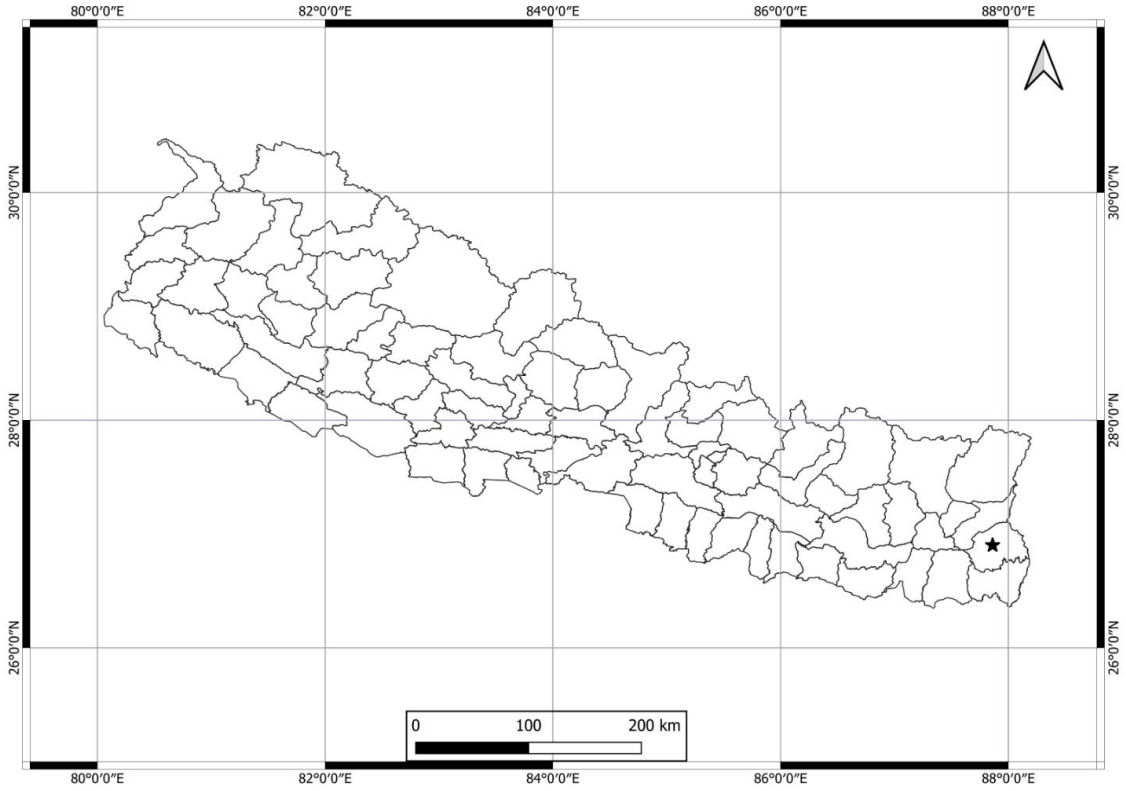


Fig. 11: *Peristylus calcaratus* (Rolfe) S. Y. Hu. 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. petal 6. Lip 7. Spur (B.B. Raskoti 9123, KATH038927).



Map 4: Distribution map of *Peristylus calcaratus* in Nepal.

Specimens examined

Eastern Nepal: *Province 1*, Illam District, on way to Maipokhari, 2000m, 21/08/2013, *B.B. Raskoti* 9123 (KATH038927!).

4. ***Peristylus constrictus*** (Lindl.) Lindl., *Gen. Sp. Orchid. Pl.* 300. 1835; Lindl., *Edwards's Bot. Reg*. 18: sub t. 1499. 1832; Hooker, *Fl. Brit. India* 6: 161. 1890; King and Pantling, *Ann. Roy. Bot. Gard.* (Calcutta) 8:325, 1898; Banerji & Thapa, *Orc. Nep.* 72. 1975; Hara *et al., Enum. Fl. Nep.* 1: 52. 1978; Press *et al., Ann. Check. Fl. Nep.* 222. 2000; Pearce and Cribb, *Fl. Bhutan.* 3: 175. 2002; Chen *et al., Fl. China.* 25:141. 2009

Herminium constrictum Lindl., *Edwards's Bot. Reg*. 18: sub t. 1499. 1832.

Platanthera constricta Lindl. ex Wall., *Numer. List: n.* 7037. 1832, nom. Nud.

Habenaria constricta (Lindl.) Hook.f., *Fl. Brit. India* 6: 161. 1890.

Type specimen: Myanmar, Moulmyne, 1827, *N. Wallich* 7043 (K000974162).

Plant 39--71 cm tall. Tubers cylindric-oblong, 4--5 X 1.5--2 cm. Stem slender with 4-6 overlapping tubular sheaths at base; sheaths 5 cm. Leaves 4--6, ovate-elliptic to elliptic-lanceolate, whorled near middle of the stem, shortly petioled, 4--13 X 3--6.5 cm, 5-

veined, acute, entire. Inflorescence 25--34 cm; spike 15--19 cm, slender, sub-densely to laxly many flowered. Sterile bracts 3--13, lanceolate, 10--20 X 1--3 mm, acuminate, lower foliaceous. Floral bracts lanceolate, 5--18 X 1--2 mm, acuminate, longer than the ovary. Flowers white, 1.6--2.5 cm across; pedicel and ovary narrow, 9--10 mm. Dorsal sepal brownish, oblong-lanceolate, 7--9 X 2--3 mm, sub-acute. Lateral sepals oblong-lanceolate, 9--10 X 2--4 mm, sub-acute, spreading. Petals pure white, obliquely ovate-lanceolate, 8.5--10 X 2.5--5 mm, sub-acute. Lip pure white, oblong-obovate, 10--14 X 4--5 mm, 3-lobed near middle; lateral lobes linear-lanceolate, weakly falcate, 6--7 mm, acute, diverging, much longer than mid-lobe; mid-lobe triangular, oblong-lanceolate, ca. 5 mm, obtuse, tapering, broader than lateral lobes. Spur globose-sub-globose, pendulous, ca. 2 mm, compressed. Column 0.8—1.1 mm, very short and broad. Pollinia oblong-ovoid to oblong-obovoid, short caudicles. (Fig. 12)

Distribution: Nepal (Map 5), West Himalaya, East Himalaya, Assam-Burma, South Asia, East Asia and South-East Asia

Altitudinal Range: 500-1600m

Ecology: Open slopes, shady forest floor

Flowering time: June-August

Use(s): Medicine and Food (tuber).

Notes: This species is very similar to *P. goodyeroides* in its gross morphology so, it can be misidentified with *P. goodyeroides.* King and Pantling (1898) mentioned that its allied species is *P. parishii.* However, it can differ from *P. goodyeroides* and *P. parishii* by having pure white petals and lip as well as longer linear side-lobes of lip.

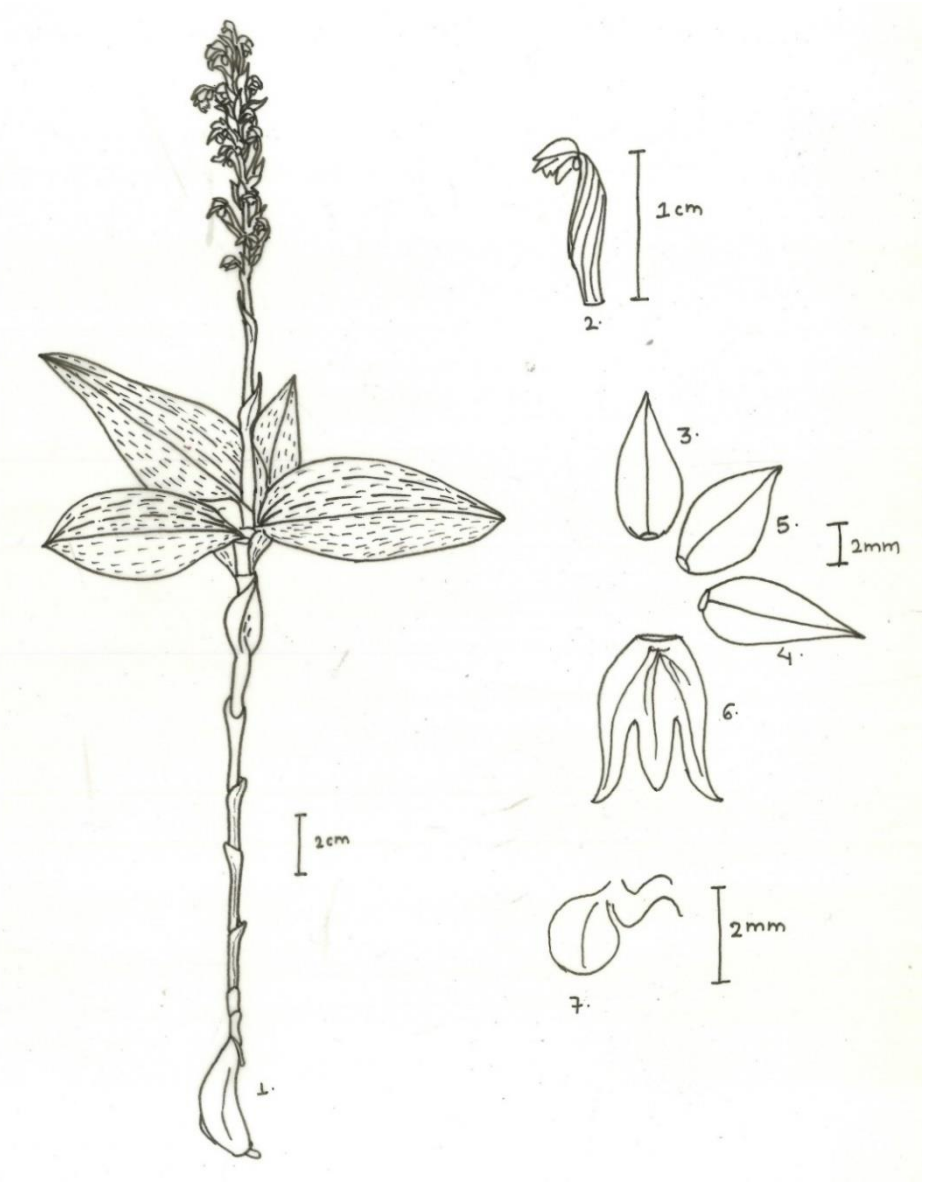
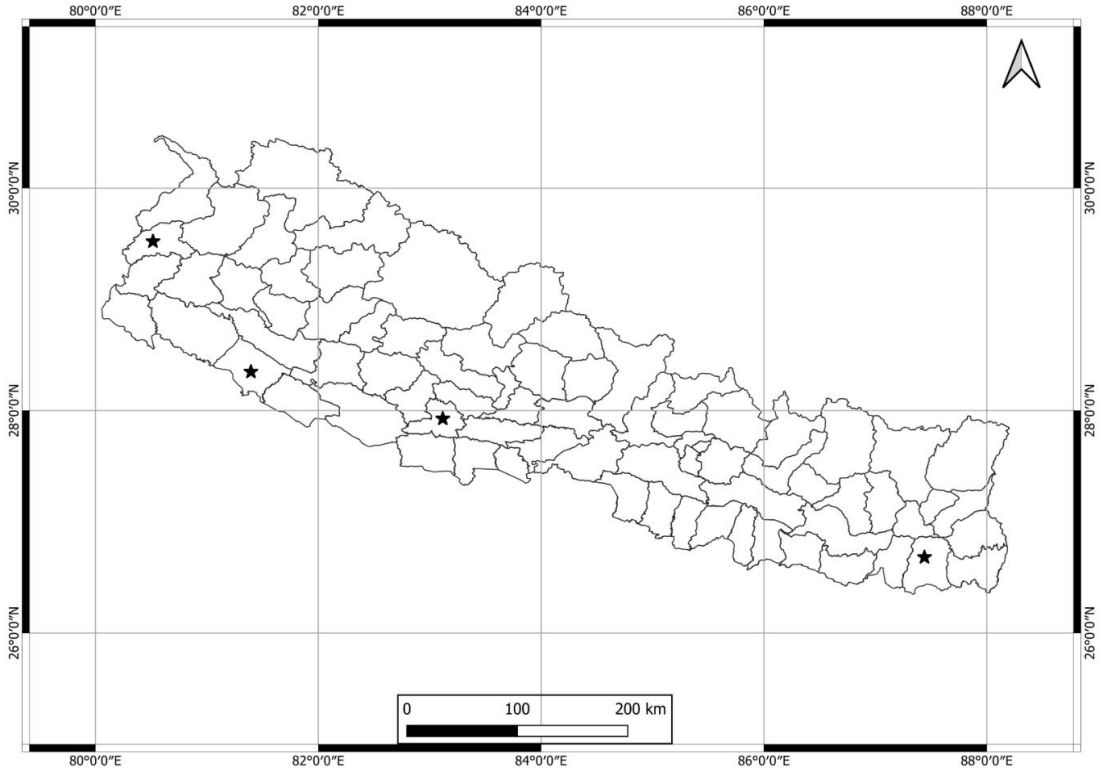


Fig. 12: *Peristylus constrictus* (Lindl.) Lindl. 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (B.B. Raskoti 199, KATH).



Map 5: Distribution map of *Peristylus constrictus* in Nepal.

Specimens examined

Western Nepal: *Sudurpashchim Province*, Baitadi District, Dhik God-Gokule, 600m, 12/07/ 1984, *P.R. Shakya, M.K. Adhikari* & *M.N. Subedi* 7833 (KATH003010!). *Lumbini Province*, Bardia District, Thadedamar-Neopana, 660m, 19/07/1985, *P.R. Shakya, M.N. Subedi*and *R. uprety* 8349 (KATH003011!).

Central Nepal: *Lumbini Province*, Arghakhanchi District, Pokharathok-9, 800m, *B.B. Raskoti* 199 (KATH).

Eastern Nepal: *Province 1*, Morang District, Raja Rani, 570m, *P. Pradhan* & *R. Niraula* 535 (KATH003012!, KATH003013!, KATH003014!).

5. ***Peristylus densus*** (Lindl.) Santapau & Kapadia, *J. Bombay Nat. Hist. Soc*. **57**: 128. 1960; Lindl., *Gen. Sp. Orchid. Pl*. 302. 1835; Banerji & Pradhan, *Orchids of Nepal Himalaya.* 96. 1984; Chen *et al., Fl. China.* 25:139. 2009.

Coeloglossum densum Lindl., *Gen. Sp. Orchid. Pl*. 302. 1835.

Habenaria neglecta King and Pantl., *J. Asiat. Soc. Bengal*, Pt. 2, Nat. Hist. 66: 603. 1897.

Peristylus neglectus (King and Pantl.) Kraenzl., *Orchid. Gen. Sp.* 1: 924. 1901.

Type specimen: India, Pulney Mountains, 15/09/1836, *R. Wight* 3076 (E00179165).

Plant 33--36 cm tall. Tubers sub-globose to ovoid-oblong, ca. 2 X 1 cm. Stem with 3 tubular sheaths at base; sheaths 1.5--5 cm. Leaves 4 rarely 5, oblong-lanceolate to elliptic-lanceolate, alternate, 3.5--7 X 0.7--3 cm, amplexicaul, acute, distinctly 3-veined, entire. Inflorescence 10--30 cm; spike 5--11 cm, laxly to sub-densely 5--9 flowered. Sterile bracts 1-3, lanceolate, 2.2--2.5 X 0.3--0.7 cm, acuminate, sometimes foliaceous, diminishing in size going upward. Floral bracts lanceolate, 9--12 X 2--3 mm, acuminate, longer than pedicel and ovary. Flowers green, ca. 8 mm across, pedicel and ovary 5--7 mm. Dorsal sepal elliptic-lanceolate, 4 X 1.5 mm, obtuse. Lateral sepals oblong-lanceolate, 4 X 1 mm, spreading, turned downwards, acute. Petals oblong-lanceolate, 4 X 1.3 mm, obtuse. Lip ca. 4 mm, deeply 3-lobed; lateral lobes linear, ca. 1.5 mm, spreading horizontally; mid-lobe oblong, ca. 2 mm, round apex, much broader than lateral lobes. Spur cylindric-oblong, pendulous, ca. 2 mm, apex slightly 2-lobed. Column ca. 1 mm, very short. (Fig. 13)

Distribution: Nepal (Map 6), E Himalaya, Assam-Burma, S Asia, E Asia and SE Asia

Altitudinal Range: 2100-2800 m

Ecology: On an open field

Flowering time: August-October

Notes: *P. densus* has scattered leaves on the stem, linear, thread like side-lobes of lip and clavate spur which is usually similar to *P. calcaratus* and *P. tipuliferus*. However, it can be differentiated from the *P. calcaratus* and *P. tipuliferus* by its shorter and horizontally straight (not curved) side-lobes of lip unlike the *P. calcaratus* and *P. tipuliferus*. Lindley (1830-1840) described this species as *Coeloglossum densum* as a new species by consulting Wallich specimens. Santapau and Kapadia (1960) also mentioned that this species has straight, linear side-lobes, longer and thinner than mid-lobe of lip and clavate spur as a distinguishing feature.

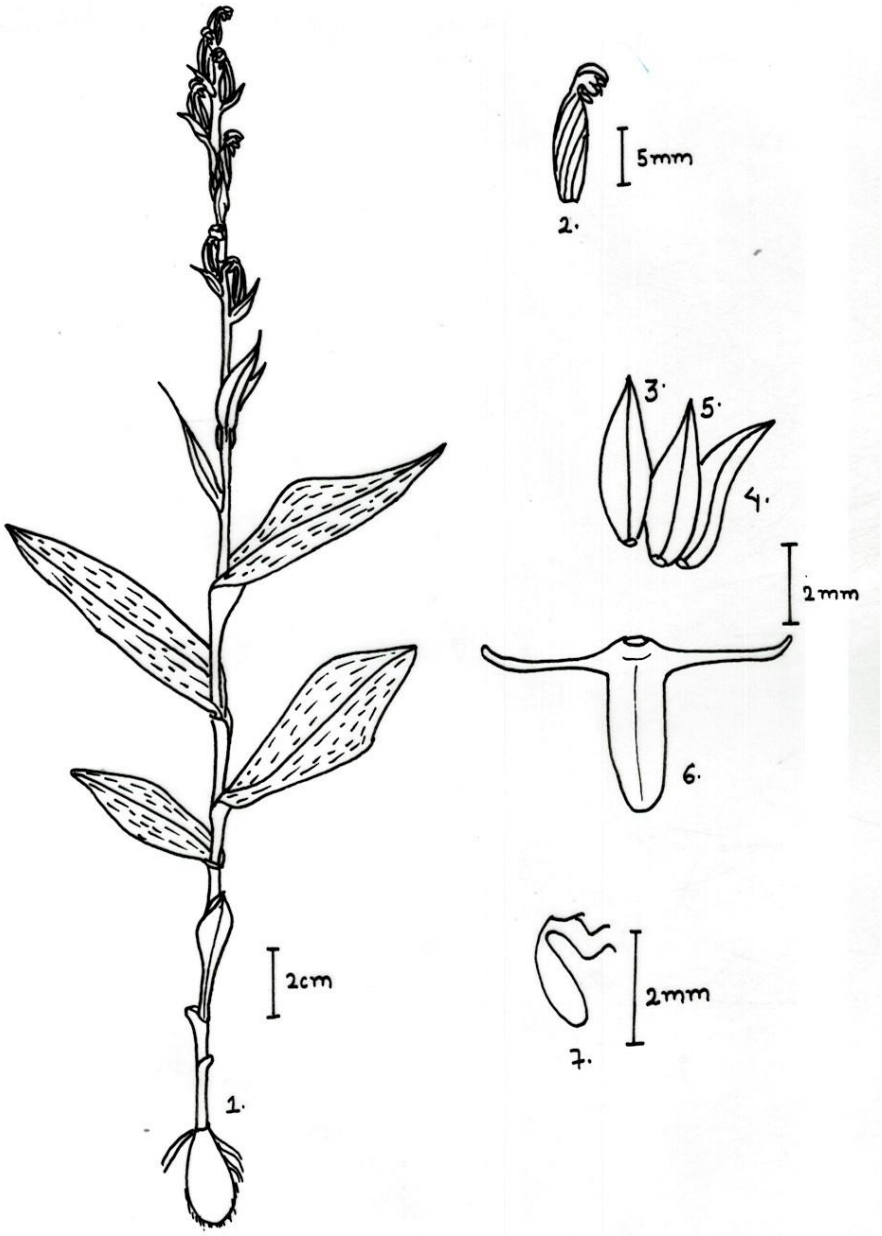
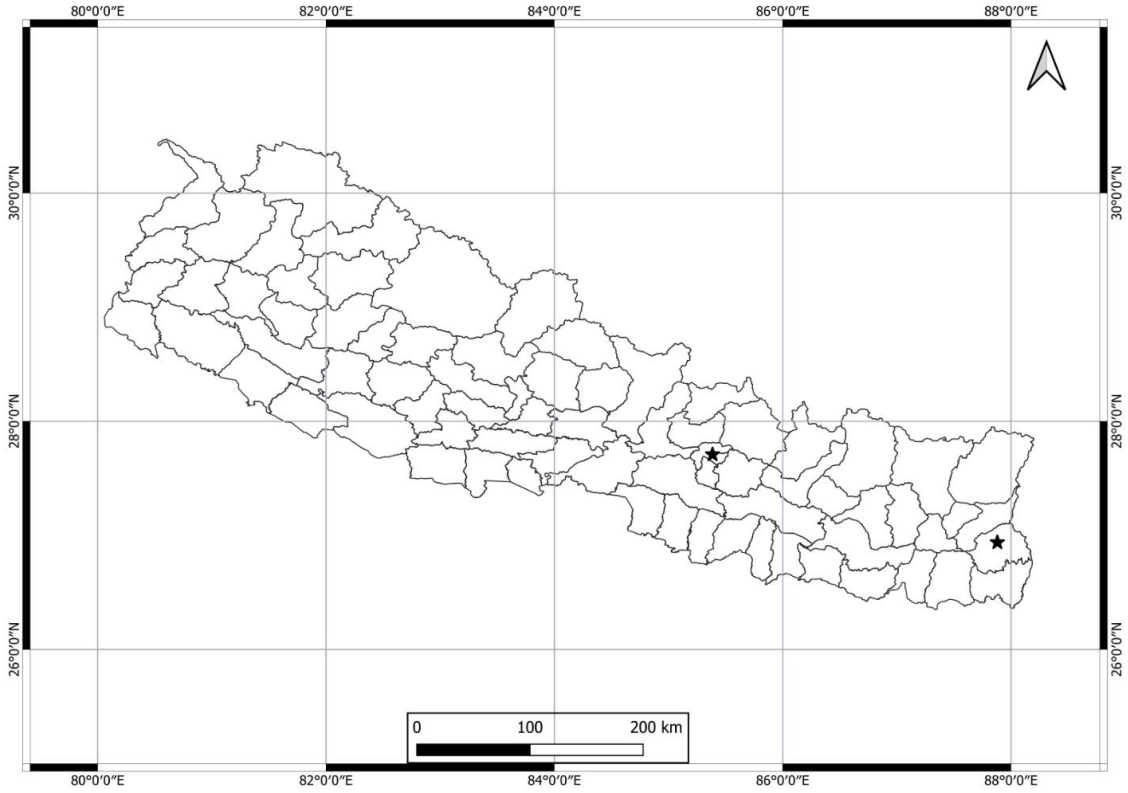


Fig. 13: *Peristylus densus* (Lindley) Santapau and Kapadia 1. Habit 2. Flower with pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (P.R. Shakya & P. Pradhan 9598, KATH003015).



Map 6: Distribution map of *Peristylus densus* in Nepal.

Specimens examined

Central Nepal: *Bagmati Province*, Kathmandu District, Chandragiri, 7000ft [2135m], 17/08/1977, *P.R. Shakya* & *P. Pradhan* 9598 (KATH003015!).

Eastern Nepal: *Province 1*, Ilam District, Hile – Chhintapu, 8900 ft. [2715m], 07/10/1977, *P Pradhan, K.R. Rajbhandari* & *R. Niraula* 292 (KATH003017!).

6. ***Peristylus goodyeroides*** (D.Don) Lindl. *Gen. Sp. Orchid. Pl*. 299. 1835; D. Don, *Prodr. Fl. Nepal*: 25. 1825; Hooker, *Fl. Brit. Ind.* 6: 161. 1890; King and Pantling, *Ann. Roy. Bot. Gard. (Calcutta)* 8: 326. 1898; Hara *et al., Enum. Fl. Nep.* 1: 52. 1978; Press *et al., An. Ann. Check. Fl. Nep.* 223. 2000; Pearce and Cribb, *Fl. Bhutan*. 3:178. 2002; Chen *et al.*, *Fl. China.* 25:141. 2009.

Habenaria goodyeroides D. Don, *Prodr. Fl. Nepal.* 25. 1825.

Habenaria goodyeroides var. *affinis* King and Pantl., *Ann. Roy. Bot. Gard. (Calcutta)* 8: 327. 1898.

Habenaria goodyeroides var. *formosana* Hayata, *Icon. Pl. Formosan.* 4: 126. 1914.

Type Specimen: Central Nepal: Nepalia [Nepal], *N. Wallich* 7066A (Lectotype: CAL, Isolectotypes: BM, K-LINDL, K-W; designated by Prain in King & Pantl. *Orchids of Sikkim Himalaya*. 327. 1898).

Plants 30--78 cm tall. Tubers cylindric-oblong to ellipsoid, 2--4.5 X ca. 1 cm. Stem with 3-7 tubular sheaths at base; sheaths 1.5--8 cm. Leaves 3-5, elliptic-lanceolate to oblong-elliptic, whorled at the middle of stem, 2.5--15 X 1.2--7.4 cm, acute, narrowed and shortly sheathing at base, 5 or 6 veined, entire. Inflorescence 12--34 cm; spike 8--16 cm, sub-densely or densely many flowered. Sterile bracts 2-7, lanceolate, 1—5.5 X 0.2—2.4 cm, acuminate. Floral bracts lanceolate, 7--16 X 1--3 mm, acuminate, longer than pedicel and ovary. Flowers ca. 5 mm across, yellowish-green to dirty white, mild sweet scented; pedicel and ovary narrow, slender, 5--15 mm. Dorsal sepal ovate-lanceolate, concave, 3--7 X 2--4 mm, acute to obtuse. Lateral sepals ovate-lanceolate, 3.5—6 X 1.7—2 mm, acute to obtuse, spreading. Petals oblong-lanceolate, 3--5 X 3--4.4 mm, obtuse or acute. Lip oblong-obovate, 4.5--5.5 X ca. 3.5 mm, 3-lobed near apex; lateral lobes oblong, linear-lanceolate, acute to obtuse, diverging, equal or slightly longer than mid-lobe; mid-lobe oblong, round apex, broader than lateral lobes. Spur globose, pendulous, 1—2 mm, groove at the middle. Column ca. 2 mm, short and broad. Pollinia 2, yellow, obovate or pyriform, short caudicles. (Fig. 14)

Distribution: Nepal (Map 7), West Himalaya, East Himalaya, Assam-Burma, South Asia, East Asia and South-East Asia

Altitudinal Range: 200-3600m

Ecology: In Pinus, Chir-pine forest, roadside slope, grassy open field, on moist ground, shady, rich humus, shady hill slope

Flowering time: March-December

Use: Medicine (whole plant).

Notes: *P. goodyeroides* is similar to *P. affinis* and *P. constrictus.* So, on critical examination of KATH herbarium specimens of *P goodyeroides,* it was found out that the plant size of this species is way bigger than *P. affinis* and has dense inflorescence as well. Similarly, lateral lobes of this species are somewhat equal to mid-lobe of lip unlike the *P. constrictus* which has way longer and linear lateral lobes of lip than the mid-lobe. Similarly, the flower colour of *P. goodyeroides* is usually yellowish green to

cream coloured whereas *P. affinis* has white flowers while *P. constrictus* has pure white petals and lip with brown sepals.

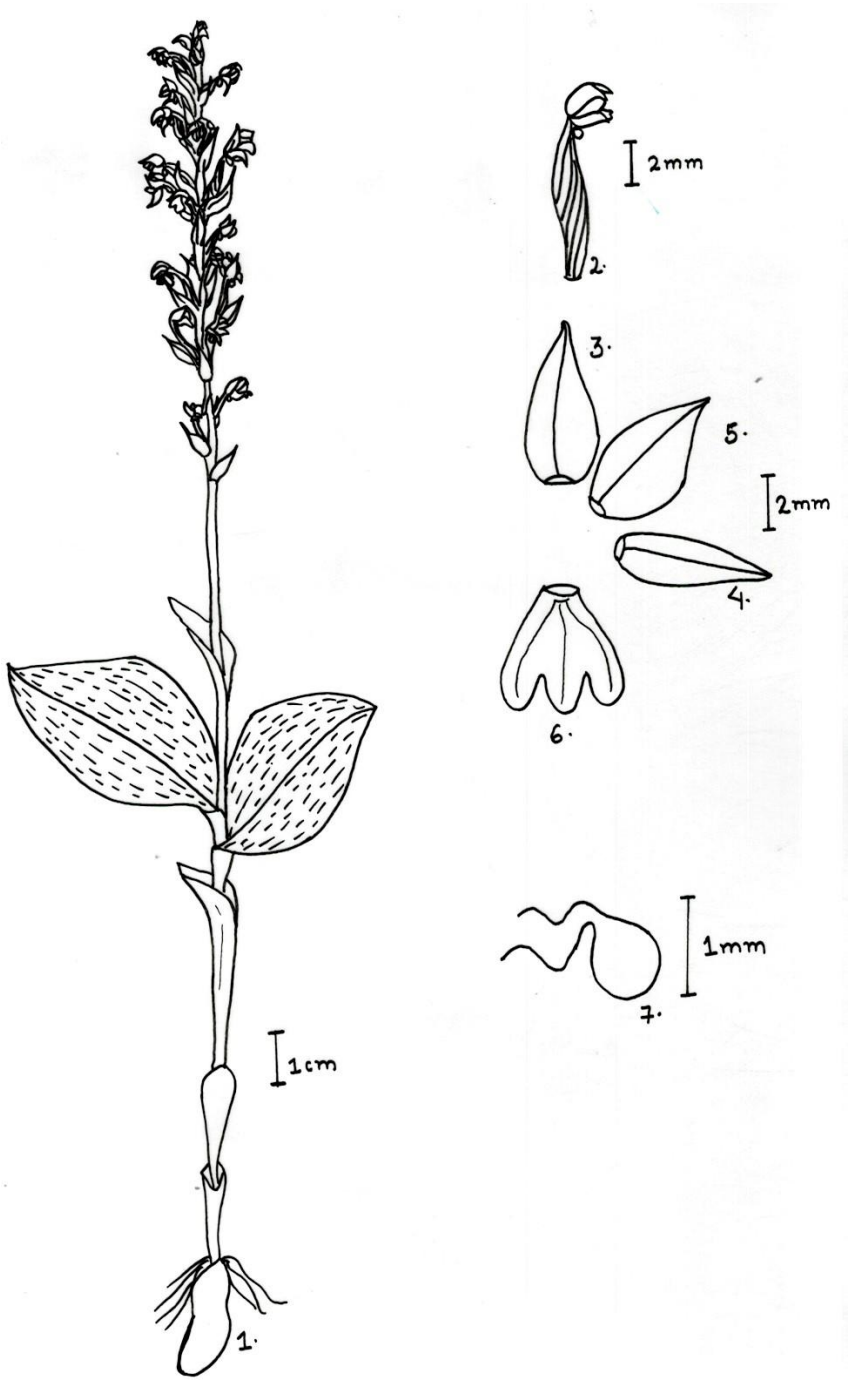
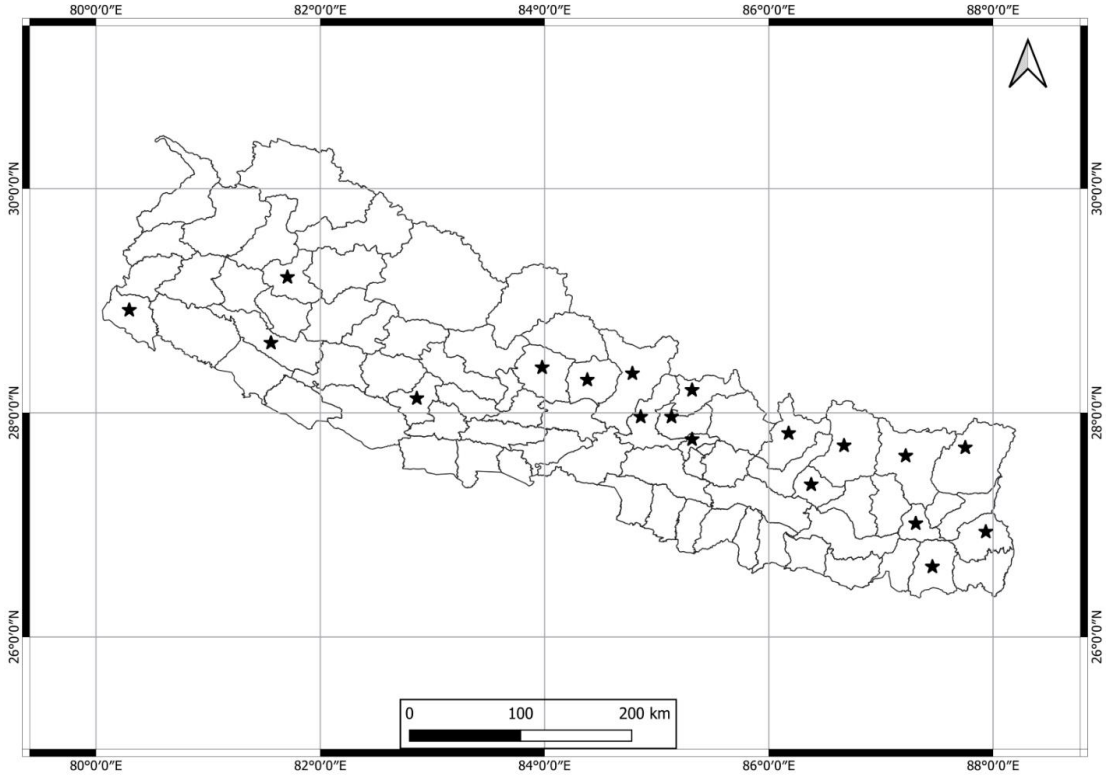


Fig. 14: *Peristylus goodyeroides* (D. Don) Lindley 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. petal 6. Lip 7. Spur (P.R. Shakya, M.N. Subedi & R. Uprety 8471, KATH003035).



Map 7: Distribution map of *Peristylus goodyeroides* in Nepal.

Specimens examined

Western Nepal: *Sudurpashchim Province*, Kanchanpur District, Lipna, 1000m, 08/08/1980, *K.R. Rajbhandari, P.M. Regmi* & *K.J. Malla* 5241 (KATH003033!, KATH003034!). *Karnali Province*, Surkhet District, Katukuwa-Ranimatta, 28º38'03"N 81º37'24"E to 28º13'51"N 84º52'23"E, 1380-2170m, 30/07/1991, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K.R. Rajbhandari, H. Takayama* & *K. Terada* 9193027 (KATH021513!, E00132756, TI); Surkhet District, Laade, 1640m, 23/07/1985, *P.R. Shakya, M.N. Subedi* & *R. Uprety* 8369 (KATH); Kalikot District, Badrigaon-Kota, 29º05'N, 81º36'E, 1330m, 810-1710m, 06/081991, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K.R. Rajbhandari, H. Takayama* & *K. Terada* 9160318 (KATH21493!, TI); Kalikot District, Chilkhaya-Khalagod, 1830m, 31/07/1985, *P.R. Shakya, M.N. Subedi*& *R. Uprety* 8471 (KATH003035!). *Lumbini Province*, Pyuthan District, Madi Khola near Pokhara, 4000ft [1219m], 18/06/1954, *J. D. Stainton, W. R. Sykes* and *L. H. J. Williams* 6437 (E00768666).

Central Nepal: *Gandaki Province*, Kaski District, Madi Khola, near Pokhara, 4000ft [1219m], 18/06/1954, *J. D. Stainton, W.R. Sykes* & *L.H.J. Williams* 6437 (E00768666); Kaski District, Birethati, 4000ft [1219.2m], 15/07/1964, *T. B. Shrestha* and *M. S. Bista* 1981 (KATH!); Lamjung District, Banjakhet, 835m, 7/08/1983, *N.P. Manandhar* 9511 (KATH!); Lamjung

District, Nagdi Village, 1000m, 06/11/2001, *A. Subedi, R. P. Chaudhary* and *L. R. Shakya* 821 (TUCH!); Gorkha District, Khorsanedanda-Macha khola, 28º08'53"N84º51'43"E to 28º13'51"N 84º52'23"E, 830-920m, 21/07/1994, *M. suzuki, N. Acharya, N. Fujii, L. Joshi, T. Kajita, N. Kondo, M. Mikage, S. Noshiro*& *K. Yoda* 9485095 (KATH021511!, E00132755). *Bagmati Province*, Dhading District, Ganesh Himal, 1400m, 88 (KATH!); Dhading District, 27º56'N, 85º02'E, 1310m, 15/07/1994, *M. Suzuki et al* 9485026 (TI); Rasuwa District, Syaprubesi-Syapru, 6-7000ft [1828-2133m], 25/07/1967, *S.B. Malla* 5477 (KATH!, BM000038999); Nuwakot District, Trishuli Bazaar, 25º55'47"N 85º08'43"E, 630m, 13/07/1994, *M. suzuki, N. Acharya, N. Fujii, L. Joshi, T. Kajita, N. Kondo, M. Mikage, S. Noshiro* and *K. Yoda* 9470005 (KATH021908!, E00132769, TI); Kathmandu District, Bhandarkhal, 10/06/1919, *J. Shrestha* et al. 676 (KATH!); Dolakha District, Mati-Kiratichhap, 4700ft [1432.56m], *P.R. Shakya, P. Pradhan, H. K. Sainju* & *N. Shrestha* 581 (KATH!); Dolakha District, Busti-Namdu, 3700ft [1130m], 20/07/1978, *P. R. Shakya, P. Pradhan, H.K. Sainju* and *N. Shrestha* 586 (KATH!); Dolakha District, Nagdaha-Thotneri, 1300m, 03/08/1977, *K.R. Rajbhandari* & *B. Roy*, 2033 (KATH!).

Eastern Nepal: *Province 1*, Solukhumbu District, Thorpe: Phurte Jungle, Thorpe Khola-Namche Bazaar, 27º48'42"N 86º41'45"E, 3536m, 14/09/2005, *M.F. Watson, K.R. Rajbhandari, K.K. Shrestha, D. Knott, C.A. Pendry, S.K. Acharya, U. Koirala, L.N. Manadhar, N. Mc. Cheyne, R.C. Poudel, S. Rajbhandary, &S. Vaidya* (KATH!, E00256112); Okhaldhunga District, Bhadaure, 2500ft [762m], 31/04/1923, *M.L. Banerji* & *P. R. Shakya* 5738 (KATH!); Sankhuwasabha District, Wabak Khola (Obak Khola), 1524m, 30/07/1971, *L.W. Beer, C.R. Lancaster & D. Morris* 9514 (BM000033346); Dhankuta District, Goli Kharka-Ramrista, 27º05'N 87º15'E,230-1230m, 24/07/1990, *M. Minaki, C. Yonebayashi, H. Takayama, H. Sugita, H. Yagi, M.N. Subedi* & *H. Ikeda* 9070025 (KATH021512!, TI); Dhankuta District, Palte, 5500ft [1676.4m], 30/07/1976, *N.P. Manandhar* 63 (KATH!); Morang District, Kanepokhari, 260m, 03/06/1974, *P. Pradhan, M.M. Amatya* & *R. Shrestha* 2174 (KATH); Morang District, Garoowa, 290m, 08/06/1974, *P. Pradhan, M.M. Amatya* & *Rajani* 184/74 (KATH!); Taplejung District, Tamur valley, Phembu, North of Taplejung, 4500ft [1372m], 03/08/1956, *J.D.A. Stainton* 1227 (E00768667); Ilam District, Chulachuli, 1000ft [304.8m], 28/05/1969, *T. B. Shrestha* & *M.S. Bista* 15271 (KATH!); Ilam District, Chisapani, 2400ft [731.52m], 12/06/1978, *P. Pradhan* & *R. Niraula* 519 (KATH003037!, KATH003038!, KATH003039!); Ilam District, Rangapani, 2000ft [609.6m], 10/06/1978, *P. Pradhan* & *R. Niraula* 509 (KATH!); Ilam District, Raja Rani, 570m, 14/06/1978, *P. Pradhan* & *R. Niraula* 535 (KATH!); Ilam District, Raja Rani, 570m, 14/06/1978, *P. Pradhan & R. Niraula* 539 (KATH!).

7. ***Peristylus hamiltonianus*** (Lindl.) Lindl., *Gen. Sp. Orchid. Pl.* 299. 1835; Hook.f., *Fl. Brit. India* 6: 160. 1894; Hara *et al.*, *Enum. Fl. Nep.* 1: 52. 1978; Press *et al.*, *Ann. Check. Fl. Nep.* 2000; Pearce and Cribb, *Fl. Bhutan.* 3: 178. 2002.

Orchis micranthema Buch. - Ham. ex Wall., *Numer. List* n. 7069. 1832, nom. Nud.

Herminium hamiltonianum Lindl., *Edwards's Bot. Reg.* 18: t. 1499. 1832.

Habenaria hamiltoniana (Lindl.) Hook.f., *Fl. Brit. India* 6: 160. 1894.

Type specimen: Eastern Nepal: *Province 1***,** Morang District, Morang hills, 28/07/1810, *W. Hamilton* 7069 [K000974163] (Leg.Buchanan-Hamilton s. n.) (Holotype: K-Lindl; Isotype: K-Wall).

Plant 25--35cm tall. Tubers 2, ovoid to cylindric, 13 X 8 mm. Stem with 3--5 tubular sheaths at base; sheaths 1.5--4.5 cm. Leaves 5-6, whorled around the middle of stem, broadly elliptic-lanceolate, 3--6.5 X 0.5--2.5 cm, amplexicaul, acuminate, acute, 3-veined, crenulate. Inflorescence 6 --15 cm; spike 3--10 cm, densely many flowered. Sterile bracts 2, lanceolate, ca. 11 X 2 mm. Floral bracts lanceolate, 11 X 2 mm, acuminate, longer than pedicel and ovary. Flowers small, white, ca. 4 mm across; pedicel and ovary 5--8 mm. Dorsal sepal oblong, 2.5--4 X ca. 1 mm, obtuse, erect. Lateral sepals oblong, similar to dorsal sepal, 2.5--4 X ca. 1 mm, obtuse. Petals broadly oblong, as long as sepals, obtuse, partially adnate to lip. Lip 3-lobed near apex, 1--1.5 mm. Lateral lobes ovate-orbicular, slightly shorter than the mid-lobe, diverging; mid-lobe ovate-orbicular, obtuse, broader than lateral lobes. Spur small, saccate, globose, pendulous, 1.5—2 mm. Column ca. 0.6 mm. (Fig. 15)

Distribution: Nepal (Map 8), Central and East Himalaya, Thailand

Altitudinal Range: 2000-2500m

Ecology: Riverine *Pinus wallichi* dominated open forest on open grassy slopes

Flowering time: July-August

Notes: *P. lawii* is the allied species of this species. Specimens deposited at KATH have broad elliptic-lanceolate leaves compared to its type specimen Wall. Cat. 7069 which has narrowly elliptic or linear-lanceolate leaves similar to *P. lawii*. But on the examination of herbarium specimens of *P. hamiltonianus* and *P. lawii* in KATH, it was found out that *P. hamiltonianus* has densely flowered inflorescence, lip shorter than sepals with orbicular side-lobes and mid-lobe similar to its type specimens and *P. lawii*

has laxly flowered inflorescence, lip somewhat equal to lip with oblong-linear side-lobes which differentiated these two species. Hooker (1894) also mentioned that *P. hamiltonianus* has a densely flowered inflorescence with shorter lip than sepals whereas *P. lawii* has laxly flowered inflorescence with lip equal to sepals. Similarly, Kandagatla *et al.* (2017) mentioned that *P. hamiltonianus* can be distinguished by *P. lawii* by having rounded lateral lobes of lip.

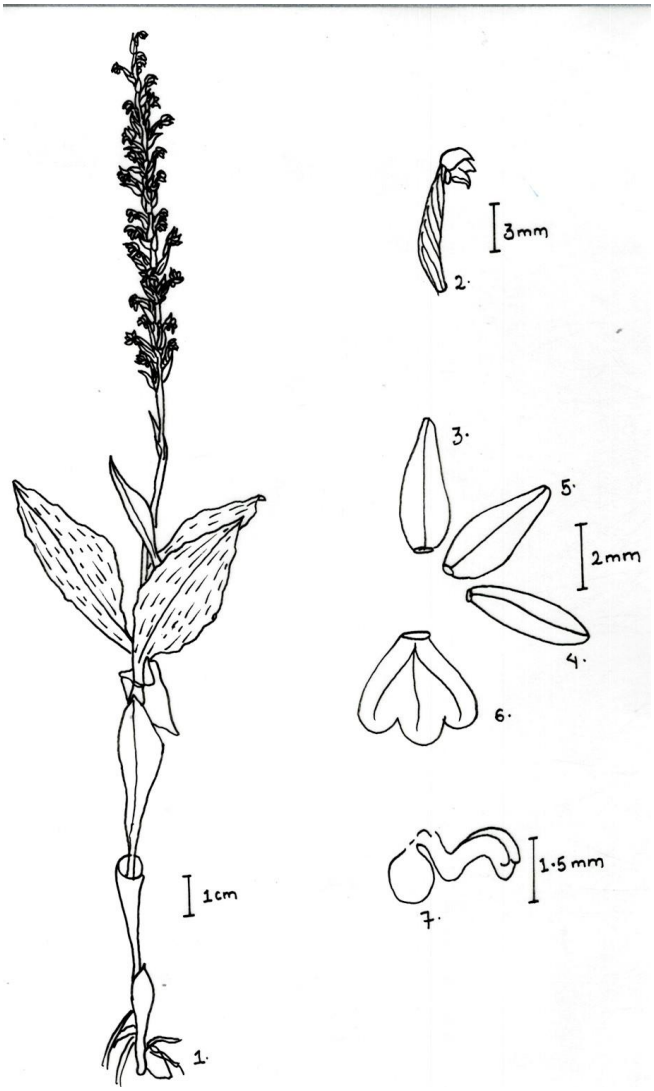
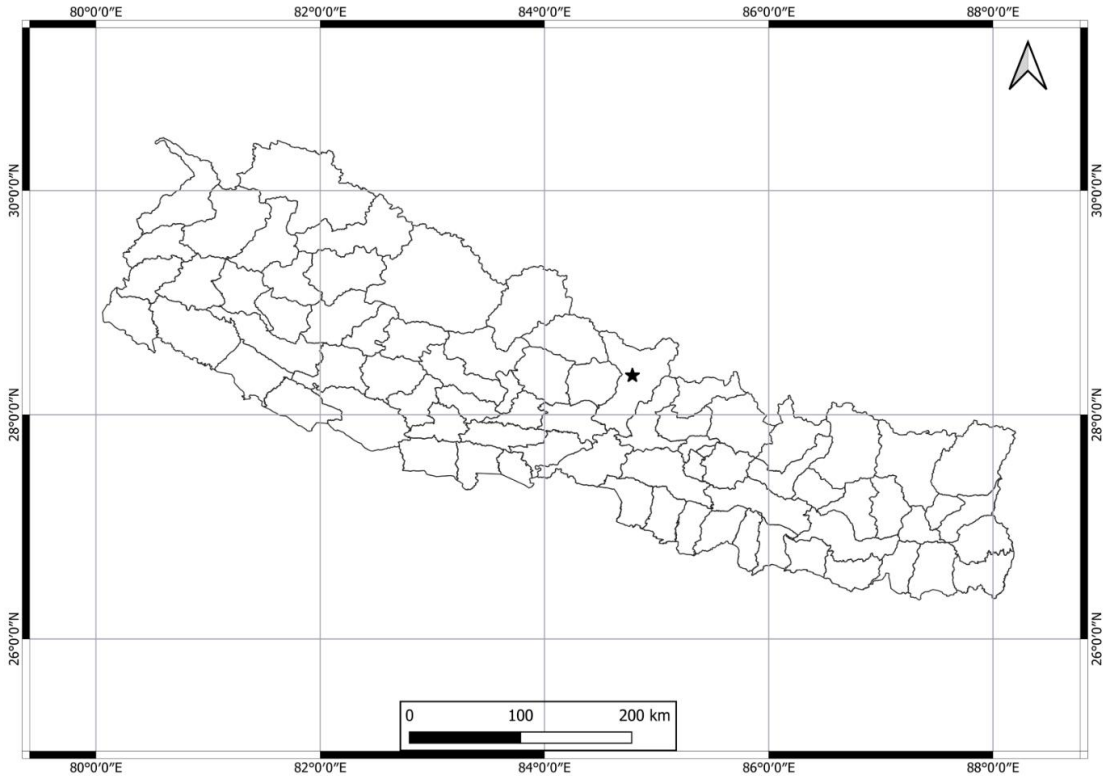


Fig. 15: *Peristylus hamiltonianus* (Lindl) Lindl. 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (H. Ikeda, T. Kawahara, O. Yano, N. Yamamoto, M.F. Watson, Z.H. Li, M.N. Subedi & S.K. Acharya 20817064, KATH013227, E00656213).



Map 8: Distribution map of *Peristylus hamiltonianus* in Nepal.

Specimens examined

Central Nepal: *Gandaki Province*, Gorkha District, Dyang-Ghap beyond Bihi, 28º31'44"N 84º50'15"E, 2130m, 30/07/2008, *H. Ikeda, T. Kawahara, O. Yano, N. Yamamoto, M.F. Watson, Z.H. Li, M.N. Subedi* & *S.K. Acharya* 20817064 (KATH013227!, E00656213).

8. ***Peristylus intrudens*** (Ames) Ormerod, *Taiwania* 56 (1): 46. 2011; Chen *et al., Fl. China.* 25:143. 2009; Raskoti *et al., Peristylus intrudens (Ames) Ormerod (Orchidaceae) – A New Record for Flora of Nepal,* 87: 137–139. 2012.

Habenaria intrudens Ames, *Sched. Orch*. 6: 1. 1923.

Peristylus spiranthes var. *Taipoensis* S. Y. Hu and Barretto, *Chung Chi J.* 13: 2. 1976.

Peristylus lacertifer var. *Taipoensis* (S. Y. Hu and Barretto) S. C. Chen, S. W. Gale and P. J. Cribb, *Fl. China* 25: 143. 2009.

Type specimen: China, New Territories, 25/08/1970, *S. Y. Hu* 10944 A00102885 (Isotype).

Plants ca. 25cm tall. Tubers fleshy ovoid, 10 X 15 mm. Stem erect, cylindrical with 1-2 tubular sheaths at base. Leaves 3, whorled near base of the stem, narrowly elliptic-lanceolate or sub-elliptic, 3.5—6 X 0.8--1.2 cm, sessile, acute, 4 or 5 veined, entire.

Inflorescence 10—15 cm; spike 4cm, laxly few flowered. Sterile bracts 5, lanceolate, ca. 15 X 3 mm, acuminate. Floral bracts lanceolate, ca. 10X 2 mm, as long as or slightly shorter than pedicel and ovary, acuminate, clasping. Flowers white, ca. 3 mm across, somewhat spirally arranged; pedicel and ovary ca. 8--10 mm. Dorsal sepal oblong-ovate, ca. 3 X 1.5 mm, acute. Lateral sepals similar to dorsal sepal, ca. 2.5 X 1 mm, acute. Petals as long as and similar to sepals, ca. 2.5 X 1 mm, acute. Lip oblong-ovate, ca. 2.5 mm, 3-lobed; lateral lobes triangular, shorter than mid-lobe; mid-lobe ovate, obtuse. Spur ovoid, ca. 1 mm. Column ca. 1 mm. (Fig. 16)

Distribution: Assam-Burma, South Asia, East Asia, South-East Asia, Nepal (Map 9)

Altitudinal Range: 800-900m

Ecology: Terrestrial on humid slopes, growing in partial shade. Occurs in tropical forest

Flowering time: August-September

Note: This species was not reported before 2012 in Nepal so, Raskoti *et al.* (2012) reported it as new records in Nepal and collected from Palpa District. Descriptions of tubers, inflorescence and column were also adopted from Raskoti *et al.* (2012) because tuber was missing in the herbarium specimens and inflorescence was not clearly seen through the stereo-microscope as KATH deposited only one specimen of this species. This species is closely related to *P. lacertifer* (Lindl.) J.J. Sm. but differs from it in having white flowers, shorter side lobes of lip and more elliptic petals.

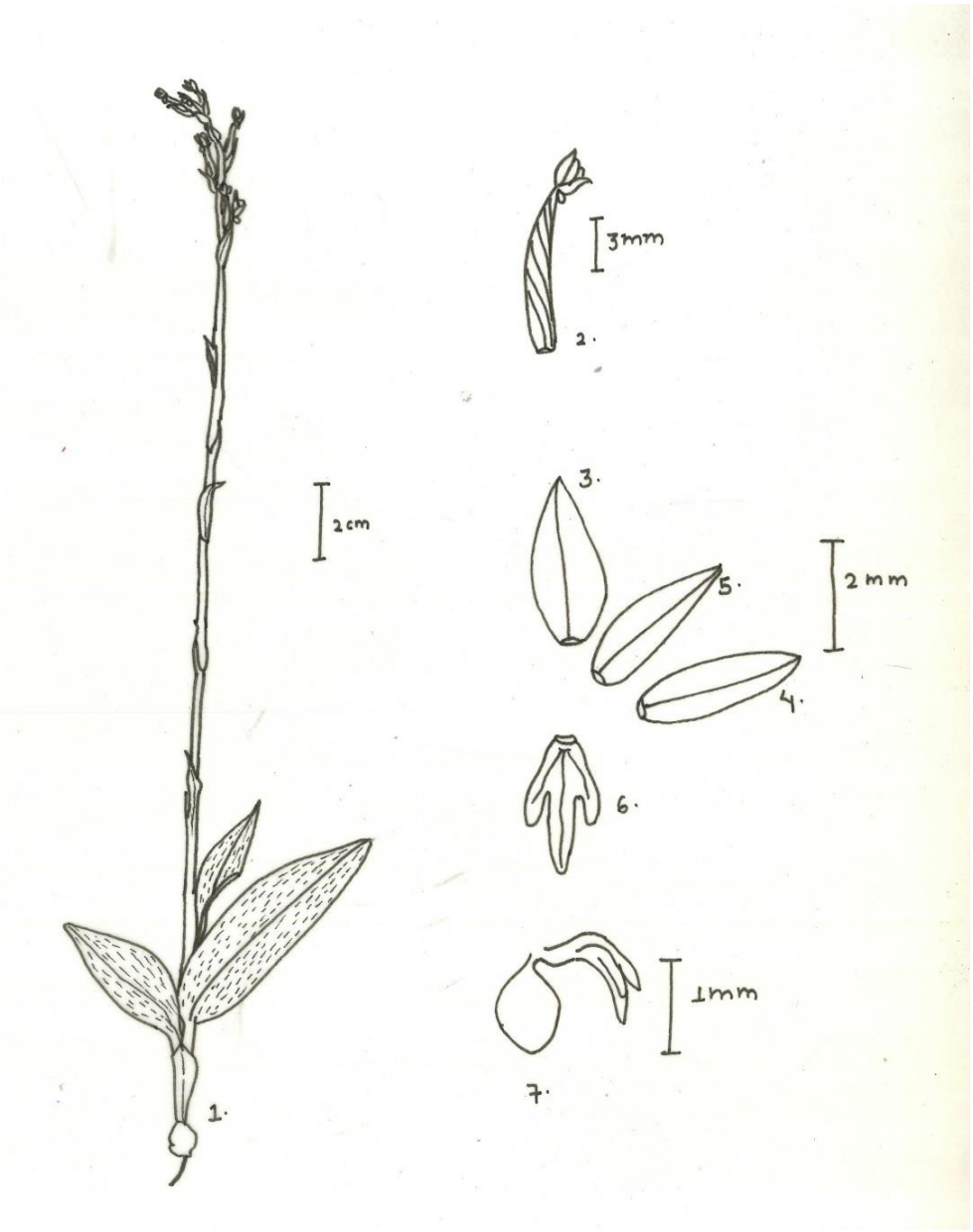
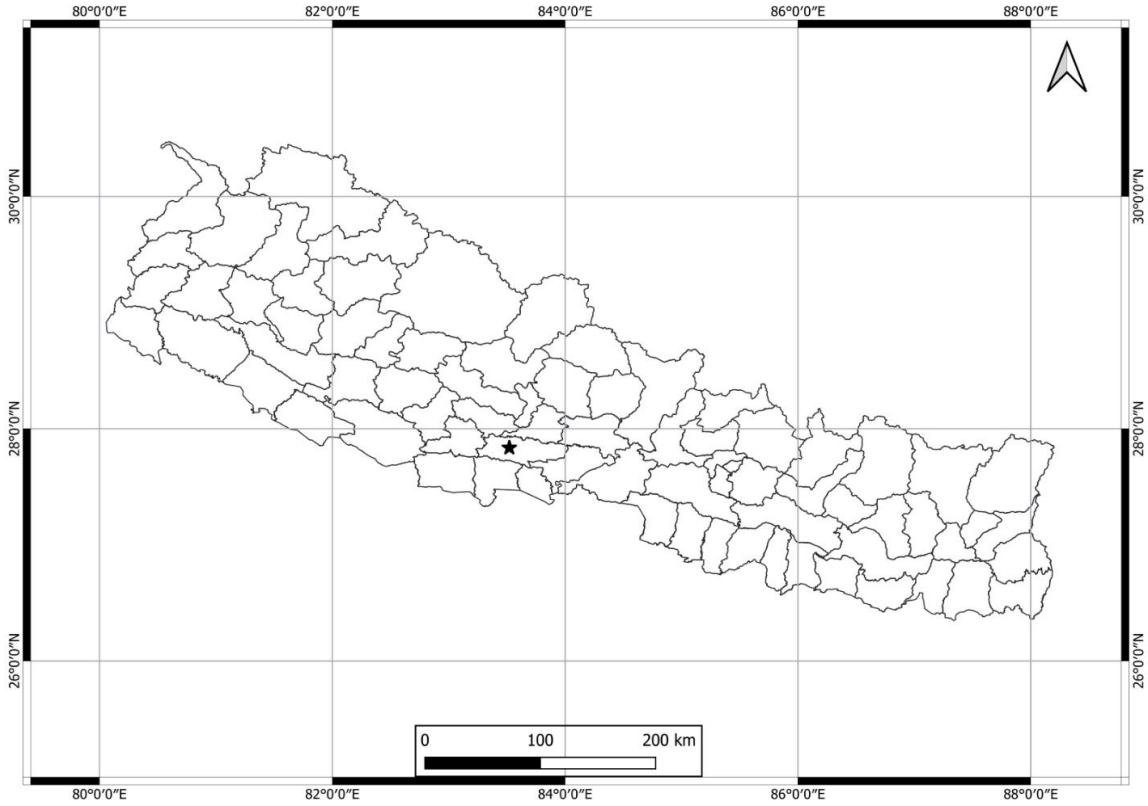


Fig. 16: *Peristylus intrudens* (Ames) Ormerod 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (B.B. Raskoti 268, KATH013226).



Map 9: Distribution map of *Peristylus intrudens* in Nepal.

Specimens examined

Central Nepal: *Lumbini Province*, Palpa District, Rajapani, 850m, 02/09/2007, *B.B. Raskoti* 268 (KATH013226!).

9. ***Peristylus lacertifer*** (Lindl.) J.J. Smith in *Bull. Jard. Bot. Buitenzorg ser*. 3, 9:23 (1927); Lindl., *Gen. Sp. Orchid. Pl.* 302. 1835; Hooker, *Fl. Brit. India.* 6:163. 1890; Rajbhandari and Dahal. *Botanica orientalis.* 4: 102-103. 2004; Pearce and Cribb, *Fl. Bhutan.* 3:179. 2002; Chen *et al., Fl. China.* 25:142. 2009.

Coeloglossum lacertiferum Lindl., *Gen. Sp. Orchid. Pl*. 302. 1835.

Coeloglossum acuminatum Lindl., *Gen. Sp. Orchid. Pl*. 302. 1835.

Habenaria lacertifera (Lindl.) Benth., *Fl. Hongk*. 362. 1861.

Type specimen: Myanmar, Tavoy, 19/08/1827, *N. Wallich* 7055 (Leg. W. Gomez) [K000974269] (Holotype: K-Lindl; Isotype: K-Wall).

Plant 25--40 cm tall. Tubers ellipsoid, 15 X 6 mm. Stem slender, glabrous, bracteate with 1-2 tubular sheath below leaves. Leaves 2 or 3, whorled near base of stem, linear-oblong or sub-elliptic, narrowly elliptic-lanceolate, 5--10 X 1--2 cm, sessile, acute, 4 or 5 veined, entire. Inflorescence 10--21 cm; spike 10--12 cm, slender, laxly many-

flowered. Sterile bracts 4 or 5, linear-lanceolate, 10 X 2 mm, acuminate. Floral bracts linear-lanceolate, 10 X 2 mm, acuminate, as long as or slightly shorter than pedicel and ovary, clasping. Flowers uniformly green, 3--4 mm across; pedicel and ovary slender, straight, 6--10 mm. Dorsal sepal ovate-oblong, ca. 2.5 X 1--1.5 mm, obtuse. Lateral sepals oblong-lanceolate, 2.3--3 X 1--1.5 mm, slightly oblique, acute. Petals as long as and similar to sepals, ca. 2.3 X 1 mm, acute. Lip 1.5 X 0.6 mm, 3-lobed, fleshy, presence of callus at base; lateral lobes linear, ca. 1 mm, acuminate, divergent; mid-lobe oblong, 0.5--0.8 mm, shorter than the lateral lobes, obtuse; spur ovoid, 1 X 0.5 mm, short stalked. Column 1--1.5 mm. Pollinia ovoid. (Fig. 17)

Distribution: Central Nepal (Map 10), India, China, Myanmar, Thailand, Malaysia, Indonesia

Altitudinal range: 200-3200 m

Ecology: Forest, grassy slopes

Flowering: August-September

Notes: Lindley (1830-1840) described this species as *Coeloglossum lacertiferum* and Bentham (1861) treated this species as *Habenaria lacertifera.* However, description of the *Habenaria tentaculata* in King and Pantling (1898) and Bose *et al.* (1999) is similar to *P. lacertifer* as they have mentioned that *H. lacertifera* as synonym of *H. tentaculata* having 2-3 leaves near base of the stem and linear side-lobes but the protologue (Botanical Register consisting of coloured figures of exotic plants, 1824) of *H. tentaculata* or *P. tentaculatus* has mentioned that this species has filiform side-lobes of lip whereas Bentham (1861) mentioned that *P. lacertifer* has the side-lobes of lip which are linear and diverging so, *H. tentaculata* in King and Pantling (1898) and Bose *et al.* (1999) were misidentified and should be a *P. lacertifer*.

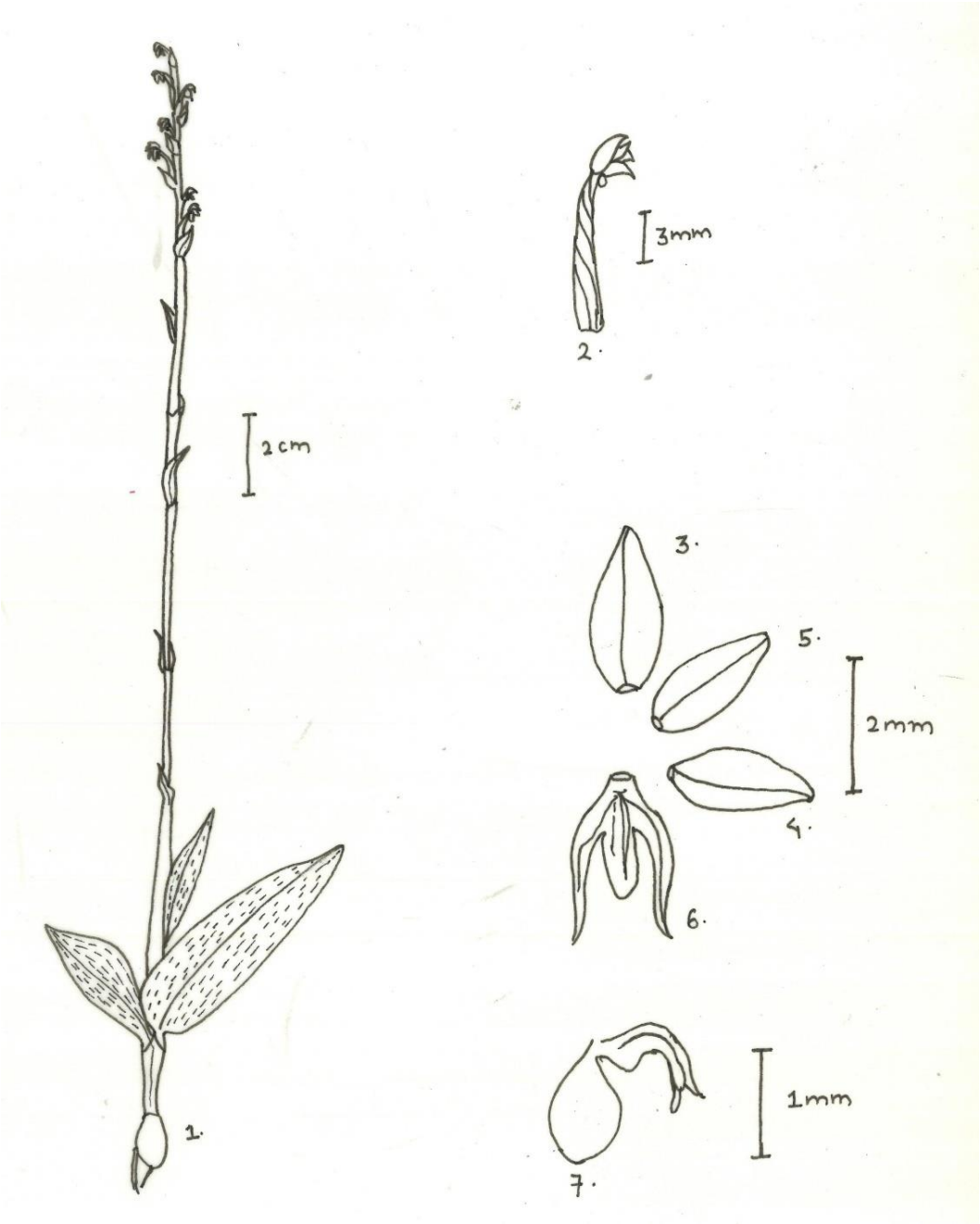
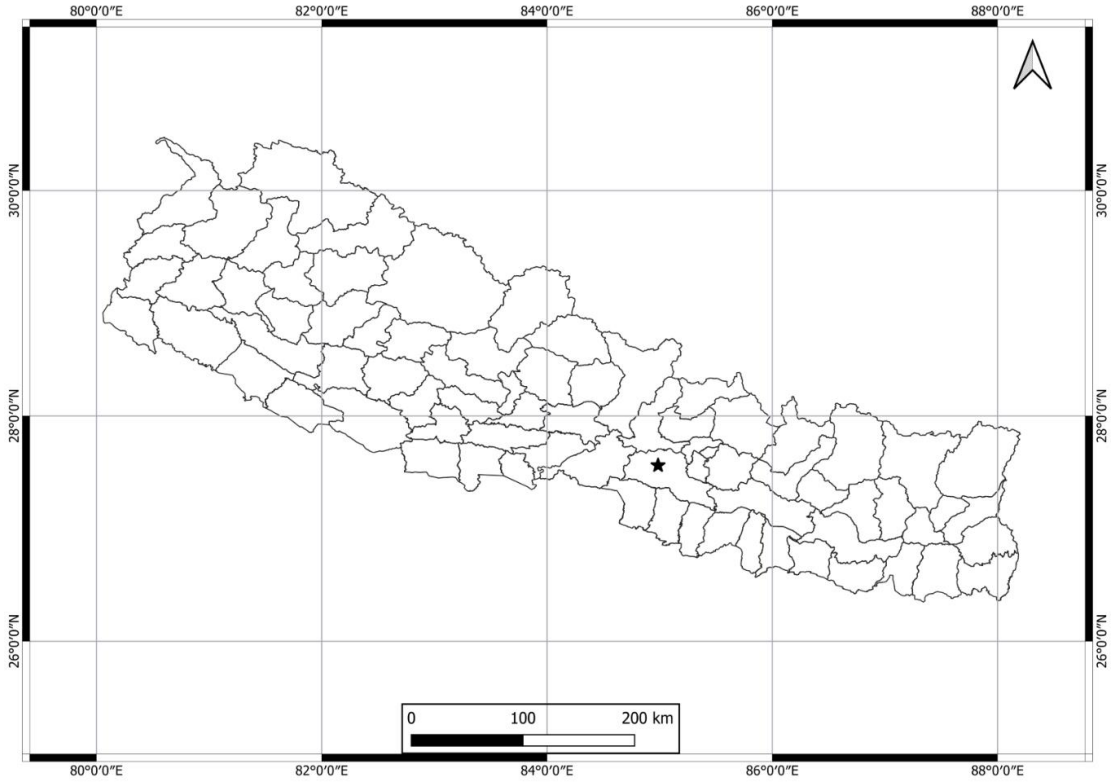


Fig. 17: *Peristylus lacertifer* (Lindl) J. J. Smith 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (N. Sharmas KATH?).



Map 10: Distribution map of *Peristylus lacertifer* in Nepal.

Specimens examined

Central Nepal: *Bagmati Province*, Makwanpur District, Sahid Samarak, Hetauda, 04/09/2003, *N. Sharmas.* (KATH?).

10. ***Peristylus lawii*** Wight, *Icon. Pl. Ind. Orient.* 5: t. 1698. 1852; Hooker, *Fl. Brit. India* 6: 162. 1894; Hara *et al., Enum. Fl. Pl. Nep.* 1: 53. 1978; Banerji & Pradhan, *Orchids of Nepal Himalaya.* 104. 1984; Press *et al., Ann. Check. Fl. Nep.* 223. 2002.

Habenaria lawii (Wight) Hook.f., *Fl. Brit. India* 6: 162. 1894.

Type specimen: India, Karnataka Belgaum, *J. S. Law* 68 [K000387583] (Holotype: K; Isotype: CAL).

Plant 11--26cm tall. Tubers 2, ellipsoid to cylindric, ca. 15 X 8 mm. Stem slender, glabrous, with 3-5 tubular sheaths at base; sheaths 1--2.5 cm. Leaves 3-5, whorled near the middle of stem, linear-lanceolate, 2.5--12.5 X 0.5--1 cm, shortly petiolate, membranous, acute, 3-veined, entire. Inflorescence 6--11.5 cm; spike 4.5--9.5 cm, laxly many flowered. Sterile bracts 2-3, linear-lanceolate, 0.9--2.7 X 0.1--0.2 cm. Floral bracts ovate-lanceolate, 7--11 X 1—3 mm, acuminate, longer than pedicel and ovary. Flowers uniformly white, 5 mm across; pedicel and ovary 6--8 mm. Dorsal sepal

oblong, 2--3 X 1.5--2 mm, ovate, obtuse. Lateral sepals similar to dorsal sepal, sub-falcately linear-oblong, 2--3 X 1.3 mm, obtuse. Petals broadly oblong, 2--3 X 1.5 mm, fleshy, obtuse. Lip broadly or obtusely 3-lobed, 2.8 X 2 mm; lateral lobes oblong-linear, ca. 1.3 mm, sub-acute, shorter than mid-lobe; mid-lobe oblong-ovate, round apex, broader and slightly longer than lateral lobes. Spur small, globose-saccate, 1--2 mm. Column 1 mm. (Fig. 18)

Distribution: Nepal (Map 11), West Himalaya, Assam-Burma and South Asia

Altitudinal Range: 400-1000m

Flowering time: June-September

Notes: *P. lawii* is an allied species of *P. hamiltonianus* and can be differentiated with each other by not having rounded lateral lobes of lip like *P. hamiltonianus* as well as it is very much similar to *P. goodyeroides* on the basis of its lip and spur structure and *P. affinis* on the basis of its flowers and hairy tubers (Kandagatla *et al.,* 2017). One major distinguishing feature of this species is having linear-lanceolate leaves whereas other species of this genus generally have elliptic-lanceolate leaves. According to Santapau and Kapadia (1960), this species lacks sterile bracts and has side-lobes of lip slightly longer than mid-lobe of lip but in KATH specimens, presence of sterile bracts and sidelobes are slightly shorter than mid-lobe of lip shows the variation within this species.

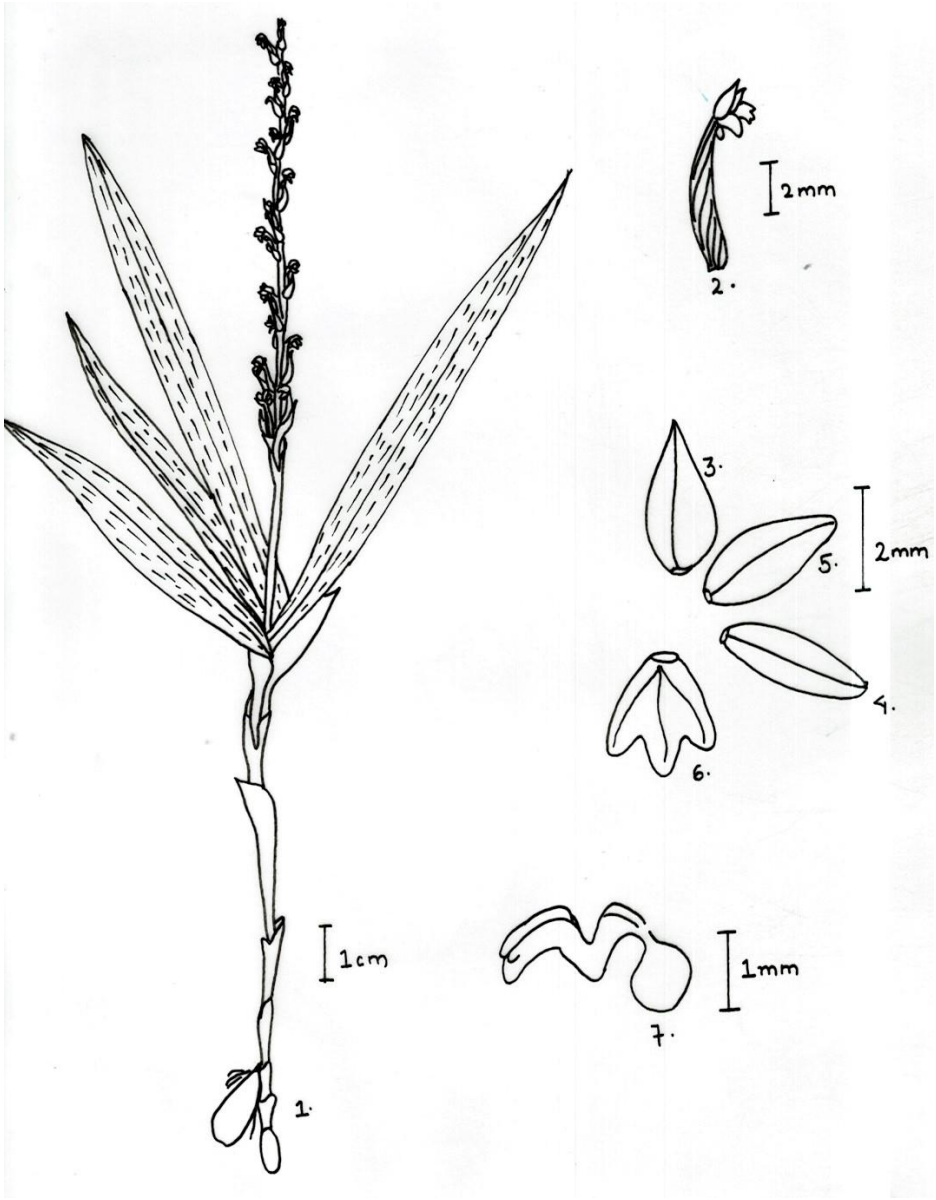
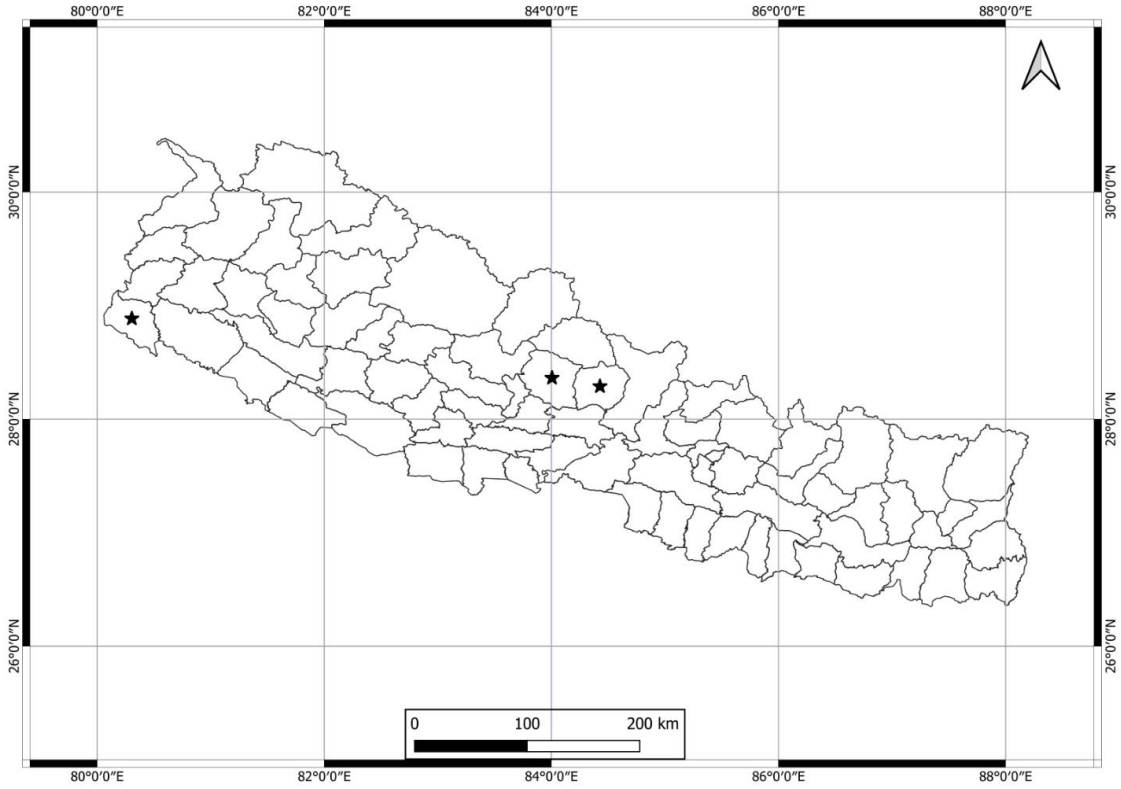


Fig. 18: *Peristylus lawii* Wight 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (K.R. Rajbhandari, P.M. Regmi & K.J. Malla 5212, KATH003040).



Map 11: Distribution map of *Peristylus lawii* in Nepal.

Specimens examined

Western Nepal: *Sudurpashchim Province*, Kanchanpur District, Belkot-Lipna, 900m, 12/08/1980, *K.R. Rajbhandari, P.M. Regmi & K.J. Malla* 5212 (KATH003040!).

Central Nepal: *Gandaki Province*, Kaski District, Pokhara, 3500ft [1067 m], 22/07/1954, O. *Polunin, W.R. Sykes* & *L.H.J. Williams* 6467 (E00833574); Kaski District, Phoolbari near seti river, Pokhara, 750m, 02/06/2000, *A. Subedi* 413 (TUCH!); Lamjung District, Besisahar village, 1000m, 20/07/2002, *A. Subedi* 966 (TUCH!). ……., Churiya hill, 2200ft [670.56m], 23/08/1967, *P.R. Shakya* 9358 (KATH003042!, KATH003041!).

11. ***Peristylus parishii*** Rchb.f., *Trans. Linn. Soc. London* 30 (1): 139. 1874; Hooker, *Fl. Brit. India* 6: 161. 1894; King and Pantling, *Ann. Roy. Bot. Gard.* (Calcutta). 8:323. 1898; Banerji & Pradhan, *Orchids of Nepal Himalaya*. 108. 1984; Pearce and Cribb, *Fl. Bhutan.* 3:180. 2002; Chen *et al.*, *Fl. China*. 25:142. 2009.

Habenaria parishii (Rchb.f.) Hook.f., *Fl. Brit. India* 6: 161. 1894.

Type specimen: 02/08/1868, *C.S.P. Parish* 216 (K000387508).

Terrestrial or lithophytic herb, 30--60 cm. Tubers ellipsoid to cylindric, ca. 4 X 1.3--2 cm. Stem slender, sparsely hairy, with 2 tubular sheaths at base; sheaths 15 mm. Leaves 4 or 5 rarely 3, whorled near the middle of stem, elliptic-lanceolate to ovate, 4--8 X 2--4 cm, acute, petiolate, distinctly 5-veins, entire. Inflorescence 4.5--20 cm; spike slender, laxly to sub-densely many flowered. Sterile bract 1, lanceolate, long, 11 X 3 mm. Floral bracts small, oblong-lanceolate, ca. 8—10 X 1 mm, acuminate, exceeding pedicel and ovary. Flowers green, ca. 5 mm across; pedicel and ovary ca. 8 mm. Dorsal sepal ovate, 4--6 X 1.5--2 mm, acute. Lateral sepals oblong, 4--6 X ca. 1.5 mm, obtuse. Petals ovate-oblong, 2--4 X 1.8 mm, obtuse. Lip ovate, 4--5 X ca. 2 mm, 3-lobed near apex; lateral lobes somewhat triangular, obtuse-oblong, ca. 1mm; mid-lobe ca. 1.5 mm, broader and longer than lateral lobes, obtuse. Spur clavate or fusiform, 1--2 mm, neck constricted. Column ca. 1 mm. Pollinia pyriform, short caudicles. (Fig. 19)

Distribution: Nepal (Map 12), Himalaya, Assam-Burma, South Asia, East Asia and South-East Asia

Altitudinal Range: 600-2000m

Flowering time: June-August

Notes: Presence of this species is based on herbarium no. 122 KATH from Ganesh Himal. This is mentioned as new record for Nepal by Banerji and Pradhan. The illustration in their book is much different from herbarium specimen 122 KATH. The above description is based on specimen consulted from other countries. Specimen 122 is very small in height as well as lacking tuber, tubular sheaths which do not give enough information for taxonomic study. Similarly, its flower colour mentioned on the herbarium specimens is white with narrowly ovate spur whereas different literatures such as Hooker (1894); King and Pantling (1898); Pearce and Cribb (2002) mentioned green colured flowered with fusiform spur of this species. King and Pantling (1898) also mentioned that *P. constrictus* and *P. goodyeroides* are its allied species. Therefore, similar characters like white flower and narrowly ovate spur show the close relationship with *P. constrictus* and *P. goodyeroides.* However, the presence of somewhat triangular side lobes of lip and inodorus flower (presence of fragrance not mentioned in the herbarium records) definitely inclined this specimen (122) more towards *P. parishii.*

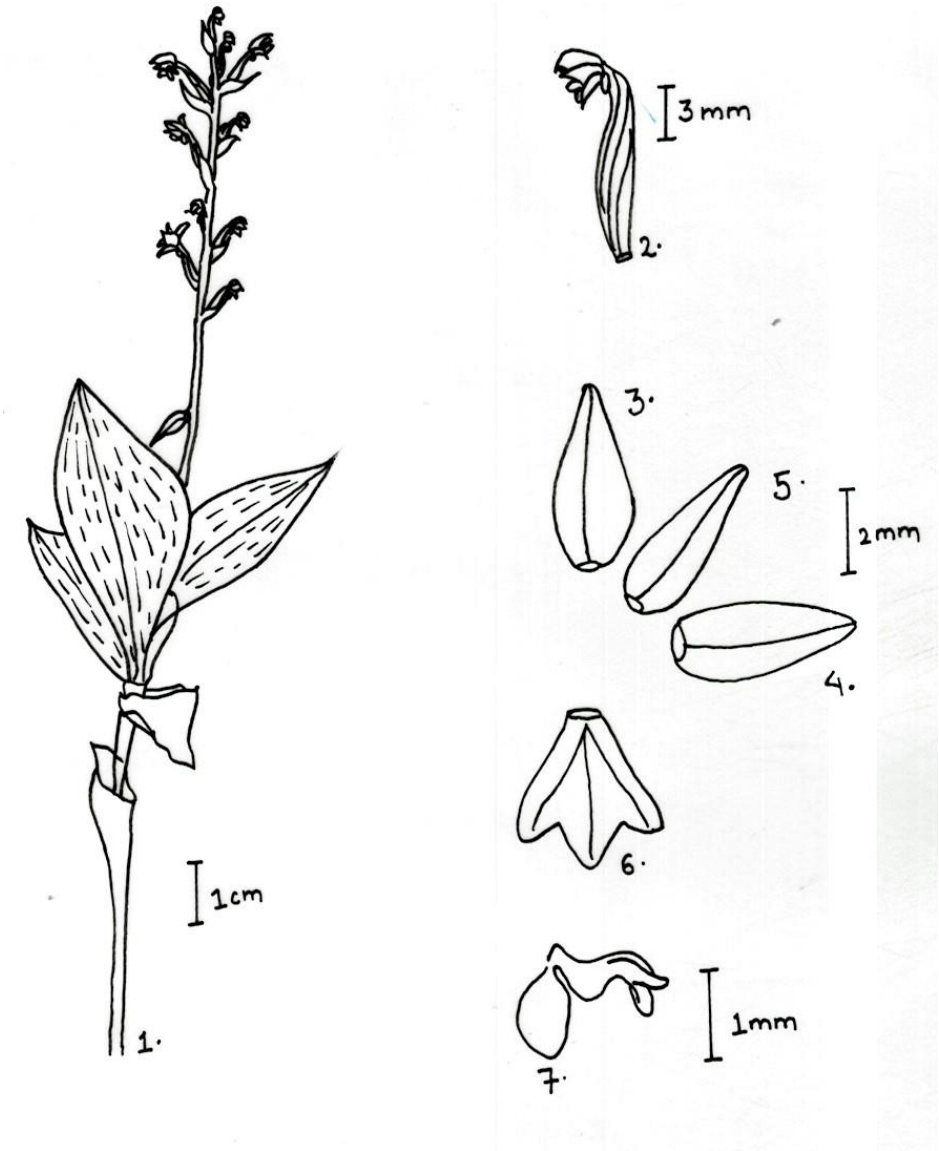
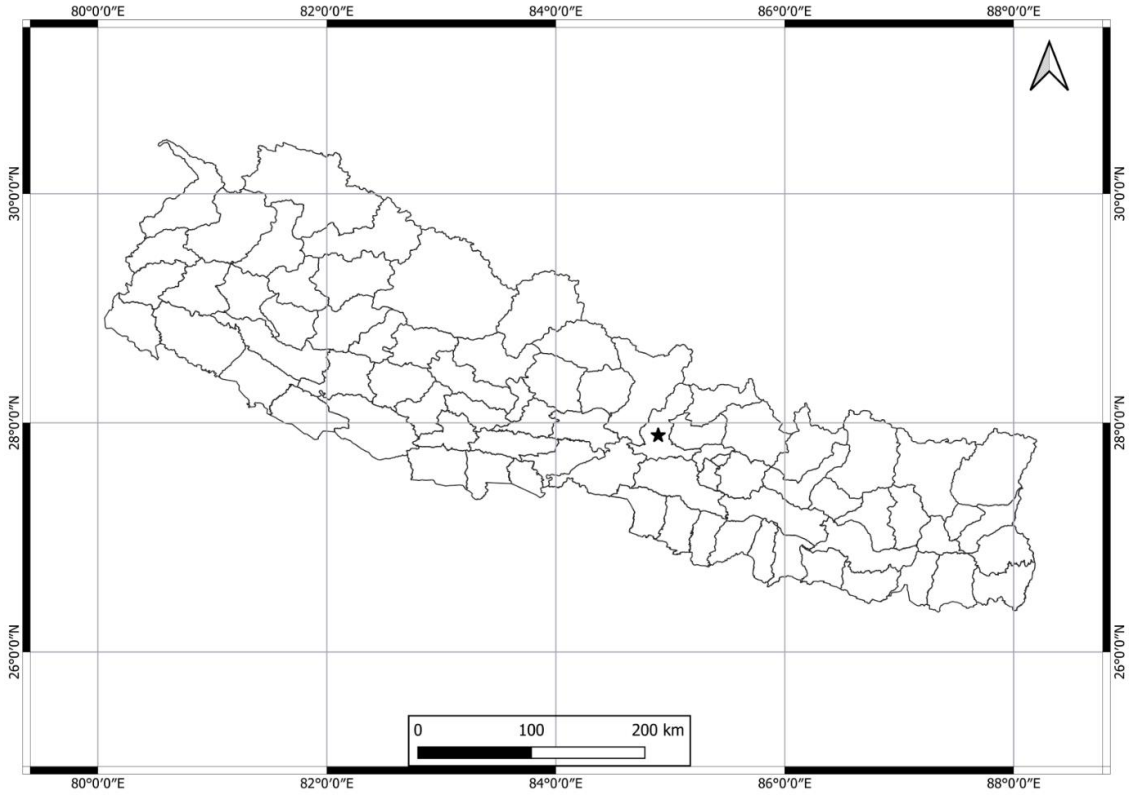


Fig. 19: *Peristylus parishii* Rchb. F. 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (W.J. Baker, T.A. Burkill, J.J. Miller & R. Shrestha 122, KATH003043).



Map 12: Distribution map of *Peristylus parishii* in Nepal.

Specimens examined

Central Nepal: *Bagmati Province***,** Dhading District, Ganesh Himal, Kashigaon-Keronja near Abuthumlekh, 1900m, 02/08/1992, *W.J. Baker, T.A. Burkill, J.J. Miller* & *R. Shrestha* 122 (KATH003043!).

12. ***Peristylus prainii*** (Hook.f.) Kraenzl., *Orchid. Gen. Sp*. 1: 514. 1898; Hook.f., *Fl. Brit. India* 6: 159. 1890; King and Pantling, *Ann. Roy. Bot. Gard.* (Calcutta). 8:329. 1898; Banerji & Pradhan, *Orchid of Nepal Himalaya*: 110. 1984; Pearce and Cribb, *Fl. Bhutan.* 3:181. 2002.

Habenaria prainii Hook.f., *Fl. Brit. India* 6: 159. 1890.

Type specimen: India, Nagaland Kohima, Naga Hills, 08/1886, *D. Prain* 42 [K000387511] (Holotype).

Plant (9--) 18—51 cm tall. Tubers 2, ellipsoid to cylindric, ca. 3 X 1.3 cm. Stem slender, with 2-5 tubular sheaths at base; sheaths 2.5--4.5 cm. Leaves usually 4, occasionally 3 or 5, whorled near middle of the stem, ovate-oblong to elliptic-lanceolate, 3--7 X 1--2.2 cm, acute, sessile, 5-veined, crenulate. Inflorescence 9--20 cm; spike slender, 5--10.5 cm, laxly to sub-densely many flowered. Sterile bracts 1-3, lanceolate, 0.9--2.2 X

0.1--0.4 cm, acuminate. Floral bracts oblong-lanceolate, 5--8 X 1—2 mm, acuminate, longer than pedicel and ovary. Flowers uniformly white, ca. 5--8 mm across; pedicel and ovary 3--4 mm. Dorsal sepal ovate, 3--4 X 1.5--2.5 mm, acute. Lateral sepals oblong-ovate, 3--4 X 1.5--2.5 mm, obtuse. Petals oblong, as long as sepals, apiculate, fleshy, obtuse. Lip oblong, 3--5 X 2--3.5 mm, 3-lobed near apex; lateral lobes oblong, ca. 1.6 mm, acute apex, slightly shorter than mid-lobe; mid-lobe somewhat triangular, ca. 2 mm, broader than lateral lobes, obtuse. Spur small, saccate-globose, pendulous, 1--2 mm, base broadly clawed. Column ca. 1 mm, short and broad. Pollinia obovoid, slender and short caudicles. (Fig. 20)

Distribution: Nepal (Map 13), East Himalaya, Assam-Burma, South Asia and South-East Asia

Altitudinal Range: 1200-2100m

Ecology: On open place, pasture

Flowering time: June-August

Note: This species is similar to *P. goodyeroides* in its gross morphological form. Hooker (1894); King and Pantling (1898); Pearce and Cribb (2002) had mentioned uniformly brownish green coloured flower. Similarly, Pearce and Cribb (2002) had mentioned that this species have pollinia not in a pouch like *P. goodyeroides* but KATH specimens have uniformly white flower and pollinia of that herbarium specimen could not be studied. However, presence of ellipsoid tuber, 3-5 whorled middle leaves and globose-saccate spur in the specimens are indicating that they are *P. prainii.*

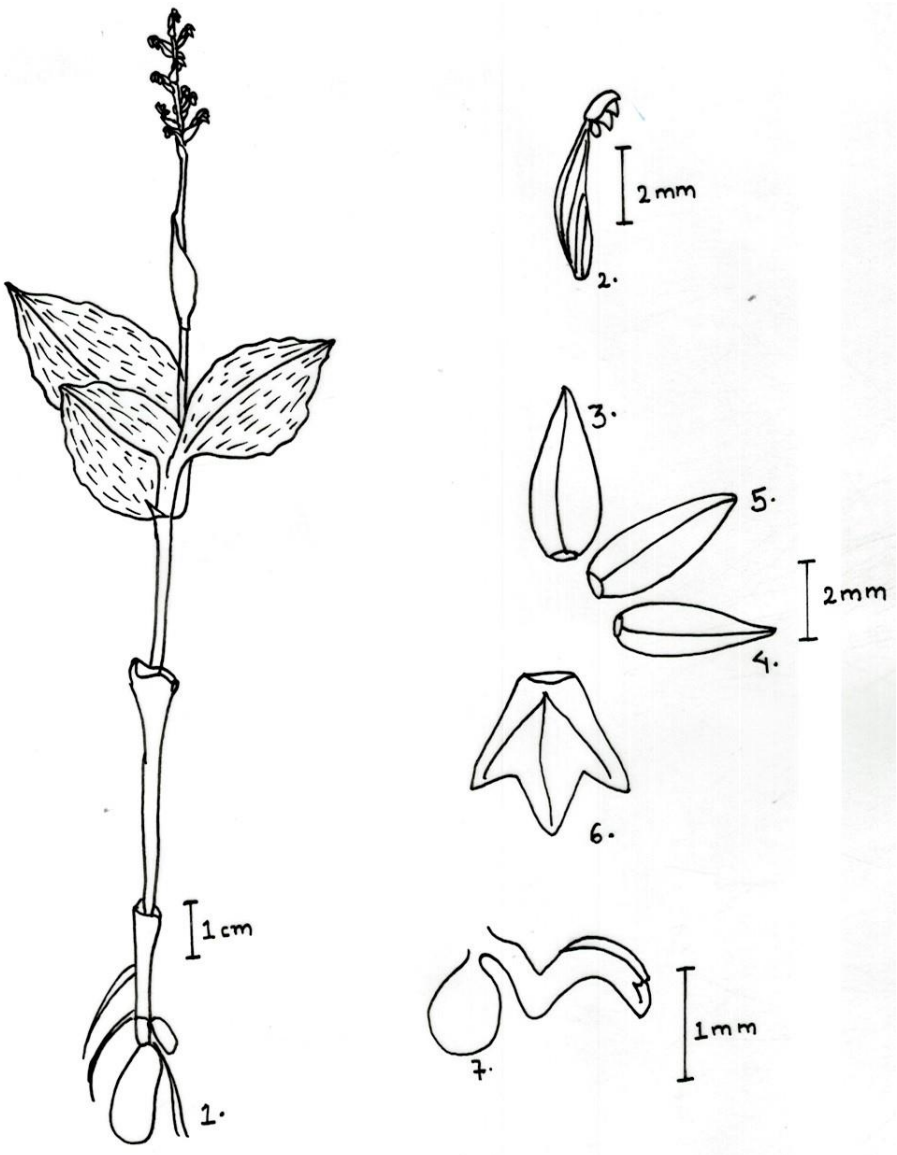
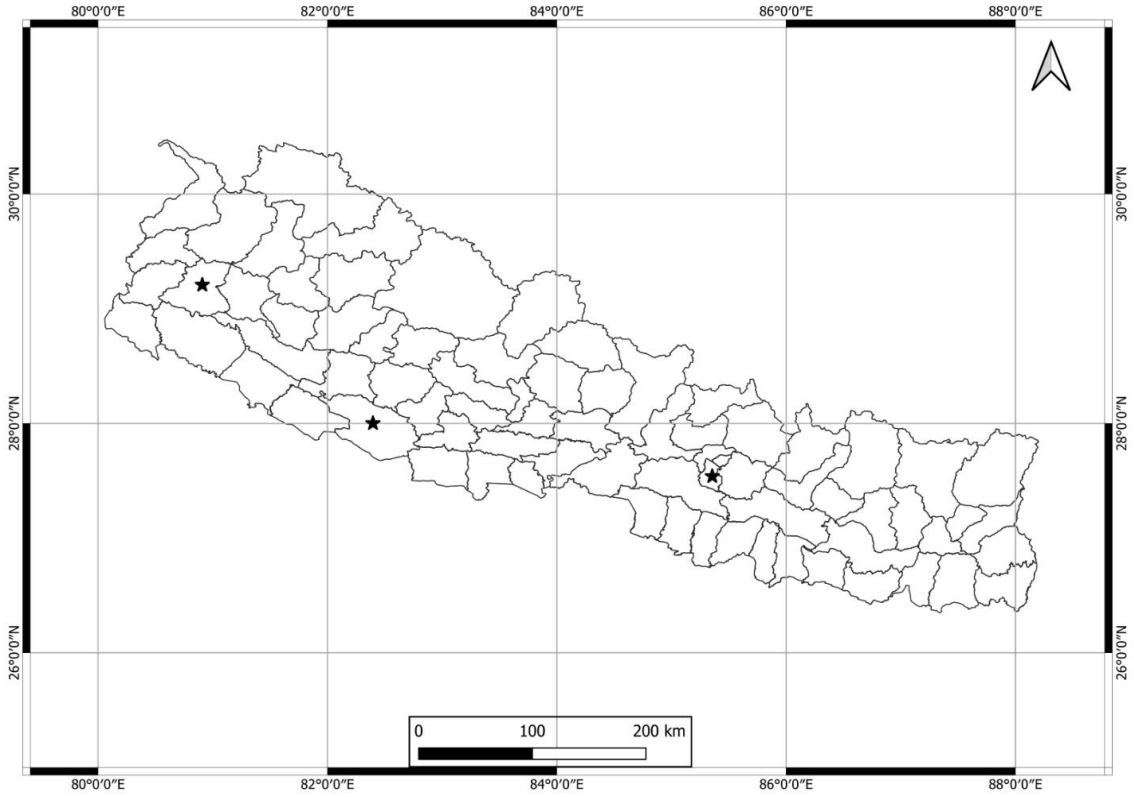


Fig. 20: *Peristylus prainii* (Hook. F.) Kraenzl. 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (M.S. Bista & D.P. Joshi 142, KATH003044).



Map 13: Distribution map of *Peristylus prainii* in Nepal.

Specimens examined

Western Nepal: *Sudur Paschim Province*, Doti District, Doti – Bajlekh, 2100m, 01/08/1972, *M.S. Bista* & *D.P. Joshi* 142 (KATH003044!). *Lumbini Province*, Dang District, Aambas, 1200m, 25/07/1981, *N.P. Manandhar* & *D.P. Joshi* 6166 (KATH!).

Central Nepal: *Bagmati Province*, Lalitpur District, Gothedanda (Pulchoki), 6500ft [1981.2m], 11/07/1978, Ram Bahadur 579 (KATH003046!).

13. ***Peristylus tipuliferus*** (C.S.P.Parish & Rchb.f.) Mukerjee, *Notes Roy. Bot. Gard. Endinburgh* 21: 153. 1953; Hooker, *Fl. Brit. India* 6:157. 1890; King and Pantling, *Ann. Roy. Bot. Gard.* (Calcutta). 8:324. 1898; Pearce and Cribb, *Fl. Bhutan.* 3:182. 2002; Raskoti *et al., Orc. Nepal.* 2009; Chen *et al., Fl. China.* 25:139. 2009.

Habenaria tipulifera C.S.P. Parish & Rchb.f., *Trans. Linn. Soc. London* 30:139. 1874.
Habenaria brandisii Hook. F., *Fl. Brit. India* 6: 160. 1890.

Peristylus brandisii (Hook. F.) Kraenzl., *Orchid. Gen. Sp.* 1: 506. 1898.

Peristylus aristatus auct. Non Lindl.

Type specimen: .....*s.coll* 232 (K000852823).

Plant 15--60 cm tall. Tubers cylindric-ovoid, ca. 20 X 4--5 mm. Stem slender, with 1-3 tubular sheaths at base, sheaths 1.5--3.5 cm. Leaves 2-4, alternate rarely whorled near base, elliptic-lanceolate to oblong-lanceolate, 2--10.2 X 0.4--2.5 cm, acute, sessile, 5-veined, shorter or as long as pedicel and ovary, entire. Inflorescence 15--22 cm; spike slender, 5--14 cm, laxly few to many flowered. Sterile bracts 1-4, lanceolate, 10--25 X 2--6 mm, acute, acuminate, diminishing in size going upward. Floral bracts lanceolate, 6--10 X 1--3 mm, acuminate, equaling to ovary. Flowers green, ca. 6 mm across; pedicel and ovary slender, narrow, 7--13 mm, glabrous. Dorsal sepal, ovate, 3--4 X ca. 1.5--2 mm. Lateral sepals, lanceolate, 3--3.5 X 1--1.5 mm, obtuse to sub-acute. Petals green, as long as sepals, oblong, 3.5--4 X 1--2.5 mm, falcate, obtuse. Lip ca. 4 mm, 3-lobed, red spots present inside; lateral lobes filiform, long, linear, 5--6 X 0.2 mm, spreading gradually, curved upwards; mid-lobe 2--3 mm, broader with obtuse apex, much shorter than lateral lobes. Spur clavate, curved and shorter than sepals, 2--3 mm, weakly 2-lobed. Column ca. 1 mm, very short, depressed. Pollinia small, obovoid or pyriform. (Fig. 21)

Distribution: Nepal (Map 14) and East Himalaya

Altitudinal Range: 1700-2400m

Ecology: Base of cliff, grassland

Flowering time: July-September

Note: *P. tipuliferus* and *P. tentaculatus* have been known as separate entities in the past. Seidenfaden (1977) separate these two species *P. tipuliferus* and *P. tentaculatus* on the basis of thickness of lip, length of side lobes (lip), arrangement and shape of leaves. However, under the study of large number of Thai specimens belonging to these species, Kurzweil (2008) considered these species as conspecific and synonymous with each other. Similarly, the similarities between *P. tipuliferus* and *P. aristatus* are undeniable. Hooker (1984) and King and Pantling (1898) mentioned that *P. aristatus* is allied to this species and Hooker (1894) mentioned that this species is very near to *P. aristatus,* differing in long narrow leaves and longer slender ovary whereas King and Pantling (1898) pointed out the *P. aristatus* is differed to *P. tentaculatus* by having radical leaves, lip having narrowed base with horizontal linear side lobes. However, the specimens deposited at KATH labelled as *P. aristatus* and *P. tipuliferus* did not have any morphological differences. All specimens have mostly alternate leaves, side lobes of lip are filliform, spreading, curved upwards and curled after drying the

specimens. Therefore, *P. aristatus* specimens mentioned at KATH herbarium are merged within *P. tipuliferus* and considered to be synonymous with one another.

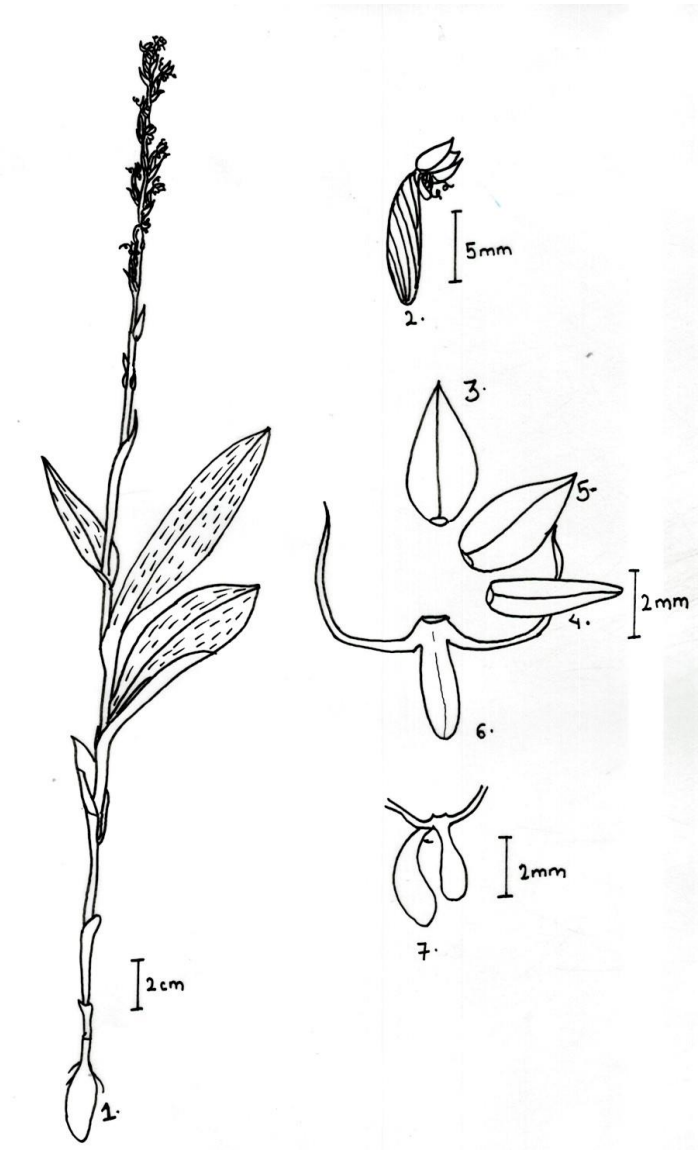
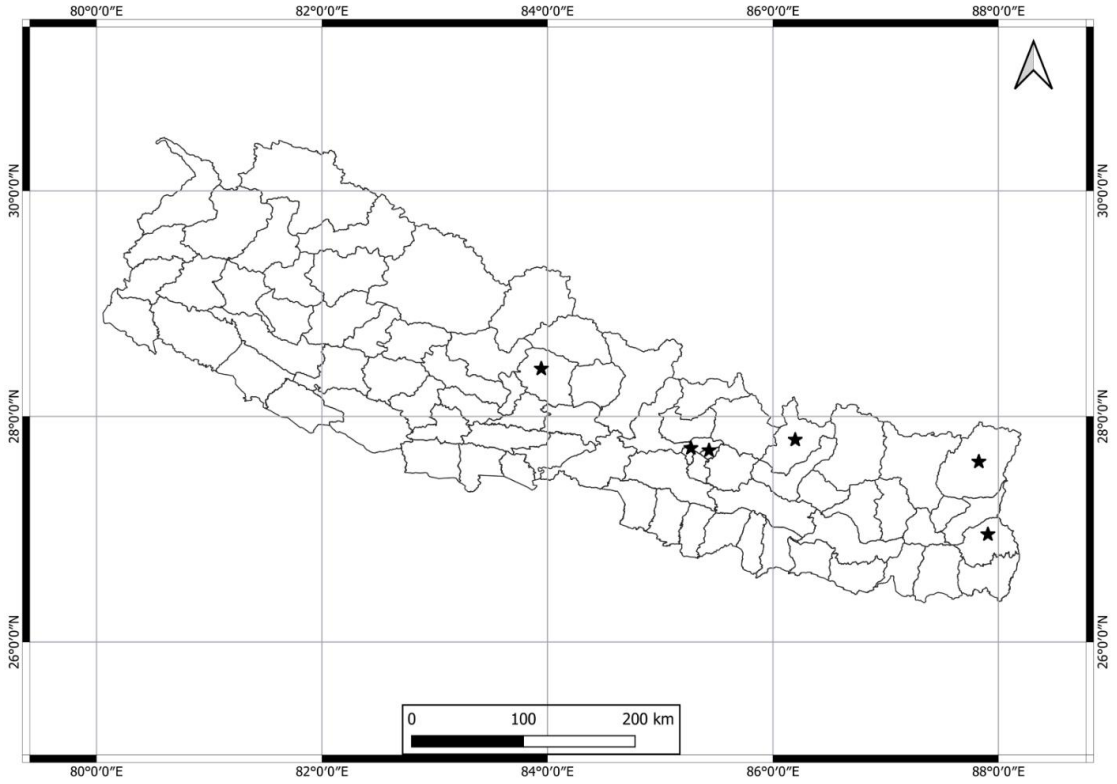


Fig. 21: *Peristylus tipuliferus* (C.S. P. Parish and Rchb. F.) Mukherjee 1. Habit 2. Flower with Pedicel and Ovary 3. Dorsal sepal 4. Lateral sepal 5. Petal 6. Lip 7. Spur (Sangram Karki & A.P. Dhital J55, KATH086223).



Map 14: Distribution map of *Peristylus tipuliferus* in Nepal.

Voucher specimens

Central Nepal: Kathmandu District, Gurje Vanjhyang, 27º49'N 85º19'E, 1970m, 26/08/2022, *P. Shakya, R. Duwal* and *M. Simkhada* PR0101.

Specimens examined

Central Nepal: *Gandaki Province*, Kaski District, Kalika temple, Kaskikot VDC, 1750m, 26/07/1999, *A. Subedi* 235 (TUCH!); Kaski District, Kande to Deurali village, 1800m, 28/08/2002, *A. Subedi* 980 (TUCH!). *Bagmati Province*, Dolakha District, Below saunedanda, Jungu, 2360m, 25/08/2018, *Sangram Karki* & *A.P. Dhital* J55 (KATH086223!); Bhaktapur District, Nagarkot, 1800m, 28/08/2007, *B.B.Raskoti*, 220 (KATH!).

Eastern Nepal: *Province 1*, Illam District, Kanyam, 29/08/1979, *R.B. Thapa, S. Tamang* & *S. Magar* 911 (KATH003009!); Taplejung District, Lower slopes Dobala Danda, above Yamphudin, 27º27'N 87º56'E,1930 m, 26/09/1989, *C. Grey-Wilson et al.* KEKE 975 (KATH003047!, E00833573).

4.2.5 Doubtfully recorded species

Peristylus richardianus Wight, *Icon. Pl. Ind. Orient.* 1697. 1852

Note: Specimen of this species is not available in KATH but it has been reported by Hara *et al.* (1978) and Banerji and Pradhan (1984). Similarly, its herbarium records are available in University of Tokyo (TI) which had been collected from Dhankuta in 1963 but its digital images are not accessible.

4.2.6 Excluded species

1. ***Herminium elisabethae*** (Duthie) Tang & F. T. Wang, *Bull. Fan Mem. Inst. Biol. Bot*. **7**: 129. 1936 =***Peristylus elisabethae*** (Duthie) R. K. Gupta, *Fl. Nainital*. 351. 1968

Notes: Duthiei (1906) described this species under section V (Peristylus) of *Habenaria.* Under the study of herbarium specimens of species of *P. elisabethae* whose gross morphology (ellipsoid-oblong tuber, distinctly 3-lobed lip and somewhat saccate or globose spur) are very similar to the genus *Peristylus* but presence of indistinct spur shows that this species is more inclined to *Herminium.* So, recent molecular analysis shows that this species actually belongs to *Herminium* and strongly nested within genus *Herminium* (Raskoti *et al.,* 2016, Jin *et al.,* 2017).

2. ***Herminium fallax*** **(**Lindl.) Hook.f., *Fl. Brit. India* 6**:** 129. 1890=***Peristylus*** **fallax** Lindl., *Gen. Sp. Orchid. Pl*. 298. 1835.

Notes: Lindley (1830-1840) treated this species as *Peristylus fallax* whereas Hooker (1894) put this species as *Herminium fallax* on the basis of its alpine habitat as well as presence of indistinct spur (saccate base) in lip. According to the Raskoti *et al.* (2016), it differs from typical members of *Peristylus* by its parallel locules and a stalked stigma that extends beyond the concave rostellum and molecular analysis done by Raskoti *et al.* (2016) and Jin *et al.* (2017) shows that this species actually belongs to *Herminium* as it was deeply nested with in the *Herminium* based on stigma lobes that are not attached to the base of lip and transferred it to the genus *Herminium.* So, following them, these species is excluded from this study.

3. ***Herminium josephi*** Rchb.f., *Flora* 55: 276. 1872; An enumeration of the flowering plants of Nepal, Vol 1, 1978=***Peristylus duthiei*** (Hook.f.) Deva & H. B. Naithani, *Orchid Fl. N. W. Himalaya* 181. 1986.

Notes: Same like in *P. fallax, P. duthiei* was also treated as *Herminium* by Hooker (1894) based on its alpine habitats. Hooker (1894) described *Herminium josephi* and *Herminium duthiei* as separate entity on the basis of its size of lip in which *H. Josephii* has its lip larger than sepals whereas *H. duthiei* has its lip as large as or smaller than sepals. It was also accepted by Banerji and Pradhan (1984) But Deva and Naithani (1986) transferred *H. duthiei* to genus *Peristylus* based on Seidenfaden (1977) section of *Peristylus* having simple lip with distinct globular spur and column similar to *Herminium.* Recent molecular analysis done by Raskoti *et al.* (2016) and Jin *et al.* (2017) suggested that these two species belong to genus *Herminium* same like Hooker (1894) and Raskoti *et al.* (2017) merged these two species as *H. josephii.* However, *H. josephii* has longer lip than its sepal as well as they are indistinctly 3-lobed, sub-crenulate as mentioned by King and Pantling (1898) with distinct globose-saccate spur and white coloured flower unlike *H. duthiei* which has lip shorter than sepals, entire oblong lip with spur and yellowish-green flower shows differences between these species.

4. ***Herminium mannii*** (Rchb.f.) Tang & F. T. Wang, *Bull. Fan Mem. Inst. Biol. Bot*. 7: 128. 1936=***Peristylus* mannii** (Rchb.f.) Mukerjee, *Notes Roy. Bot. Gard. Edinburgh* 21: 153. 1953.

Notes: It was first described as *Coeloglossum mannii* by Reichenbach in 1877. Tang and Wang (1936) kept this species under *Herminium.* Later it was transferred to *Peristylus* as it was very much similar to the genus *Peristylus.* Molecular analysis done by Raskoti *et al.* (2016) and Jin *et al.* (2017) shows that this species is nested within the genus *Herminium* which is characterized by small, horizontally positioned flowers, a lip with a short indistinct spur and belongs to the genus *Herminium.*

5. ***Platanthera nematocaulon*** (Hook.f.) Kraenzl., *Orchid. Gen. Sp*. 1: 942. 1900=***Peristylus nematocaulon*** (Hook.f.) M. L. Banerji & P.Pradhan, *Orchids Nepal Himalaya* 106. 1984.

Notes: Hooker (1894) put this species in the section IV (Hologlossa) of genus *Habenaria* on the basis of branched rootstock, habit and habitat instead of having minute flower and short spur like of section V (Peristylus). This species was first described and previously reported as *Platanthera juncea* (Inoue 1986c, Lang 1999,

Raskoti 2009, Effimov 2016). It was synonimised with *Peristylus nematocaulon* by Wood (1986) which was also accepted in Banerji and Pradhan (1984); Pearce and Cribb (2002) and Chen *et al.* (2009). Under the study of herbarium specimens of this species revealed that this species is characterized by having elongated and slender tuber like rootstock unlike in the genus *Peristylus.* Molecular analysis done by Bateman *et al.* (2003); Jin *et al.* (2014) and Jin *et al.* (2017) also shows that this species belongs to *Platanthera.* Therefore, this species has been excluded from the above study.

6. ***Platanthera orbicularis*** (Hook.f.) X.H.Jin, Schuit. & Raskoti, *Phytokeys* 79: 72. 2017=***Peristylus orbicularis*** (Hook.f.) Agrawala, H. J. Chowdhery & S. Choudhury, *KewBull*. 65(1): 106. 2010 (517).

Notes: This species was first reported as *Herminium orbiculare* in both Hooker (1894) and King and Pantling (1898) on the basis of small size of plant as well as spur very small like a sac. It was later transferred to genus *Peristylus* with new combination by Agrawala *et al.* (2010) but recent molecular analysis done by Jin *et al.* (2017) has shown that *P. orbicularis* is nested within the genus *Platanthera.*

7. **Platanthera *superantha*** (J.J.Wood) X.H.Jin, Schuit., Raskoti & Lu Q. Huang, *Cladistics* 32(2): 210. 2016=***Peristylus superanthus*** J. J. Wood, *Kew Bull*. 41(4): 811. 1986.

Notes: This species is very much similar to *P. nematocaulon* in gross morphology but differs in the resupination of flower. However, recent molecular analysis has shown that this species belongs to the genus *Platathera* and transferred it to the *Platanthera* (Raskoti *et al.,* 2016).

4.3 Distribution

4.3.1 Horizontal Distribution

From the study of herbarium specimens as well as the literature survey (local floras and checklist), 13 species are distributed in 31 districts of Nepal. Out of 13 species, *Peristylus affinis, P. constrictus* and *P. goodyeroides* are distributed in all three regions (Western, Central and Eastern) of Nepal. *P. biermannianus, P. densus, P. hamiltonianus, P. parishii* and *P. tipuliferus* are distributed in Central and Eastern Nepal whereas *P. lacertifer, P. lawii* and *P. prainii* are distributed in Western and Central Nepal. Similarly, *P. calcaratus* is distributed only in Eastern Nepal whereas *P. intrudens* is distributed only in Central Nepal. (Table 7)

Table 7. Horizontal distribution of *Peristylus* species in Nepal.

S.N.	Botanical name	Distribution in Nepal		
		West	Central	East
1.	*Peristylus affinis*	•Δ	•	•
2.	*Peristylus biermannianus*		Δ	Δ
3.	*Peristylus calcaratus*			Δ
4.	*Peristylus constrictus*	Δ	•Δ	•Δ
5.	*Peristylus densus*		•Δ	•Δ
6.	*Peristylus goodyeroides*	Δ	•Δ	•Δ
7.	*Peristylus hamiltonianus*		Δ	•
8.	*Peristylus intrudens*		Δ	
9.	*Peristylus lacertifer*	•	•Δ	
10.	*Peristylus lawii*	Δ	•Δ	
11.	*Peristylus parishii*		Δ	•
12.	*Peristylus prainii*l	•Δ	•Δ	
13.	*Peristylus tipuliferus*		•Δ	•Δ

• = Literature survey

Δ = Herbarium records (KATH, TUCH, BM, RBGE, KEW, TI)

4.3.2 Vertical Distribution

According to a literature survey and study of herbarium specimens, it is found out that the species of this genus usually distributed from sub-tropical to temperate regions except *P. goodyeroides* and *P. lacertifer* which are distributed from tropical to sub-alpine regions. Similarly, *P. affinis* is the species which is only found in the sub-alpine

region. *P. constrictus* and *P. parishii* are the species that are found from tropical to sub-tropical regions whereas *P. tipuliferus* is the species that is found from tropical to temperate regions. Similarly, *P. biermannianus, P. densus* and *P. hamiltonianus* are the species which are only found in temperate regions. *P. calcaratus* and *P. prainii* are the species that are only found in sub-tropical regions. *P. lawii* and *P. intrudens* are the species which are only found in tropical regions. Therefore, vertical distribution of different species of genus *Peristylus* shows that they usually distribute in (sub)tropical, to temperate region with few species distributing in alpine regions. (Table 8)

Table 8. Horizontal vs. Vertical distribution of *Peristylus* species in Nepal.

S.N.	**Botanical name**	**Horizontal Distribution**	**Vertical Distribution (m)**
1.	*Peristylus affinis*	West, Central and East	3100-3200
2.	*Peristylus biermannianus*	Central and East	2300-3000
3.	*Peristylus calcaratus*	Eastern Nepal	1900-2000
4.	*Peristylus constrictus*	West, central and East	500-1600
5.	*Peristylus densus*	Central and East	2100-2800
6.	*Peristylus goodyeroides*	West, Central and East	200-3600
7.	*Peristylus hamiltonianus*	Central and East	2000-2500
8.	*Peristylus intrudens*	Central	800-900
9.	*Peristylus lacertifer*	West and Central	200-3200
10.	*Peristylus lawii*	West and Central	400-1000
11.	*Peristylus parishii* .	Central and East	600-2000
12.	*Peristylus prainii*	West and Central	1200-2100
13.	*Peristylus tipuliferus*	Central and East	1700-2400

4.4 Flowering time

Present study revealed that flowering period of the genus *Peristylus* usually starts in the month of June and ends nearly at the ending of October or starting of November but according to the literature survey as well as herbarium specimens examination, *P. goodyeroides* has the longest flowering season at all which can be start from March and ends in December. Also, the flowering table shows that August to September is the peak flowering season for all the species of this genus. (Table 9)

Table 9. Flowering period of 13 species of *Peristylus* in Nepal.

S.N.	Name of species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.	*P. affinis*									■	■		
2.	*P. biermannianus*								■	■	■	■	
3.	*P. calcaratus*								■	■			
4.	*P. constrictus*						■	■	■				
5.	*P. densus*								■	■	■		
6.	*P. goodyeroides*			■	■	■	■	■	■	■	■	■	■
7.	*P. hamiltonianus*							■	■				
8.	*P. intrudens*								■	■			
9.	*P. lacertifer*								■	■			
10.	*P. lawii*						■	■	■	■			
11.	*P. parishii*						■	■	■				
12.	*P. prainii*						■	■	■				
13.	*P. tipuliferus*							■	■	■			

4.5 Discussion

Present study revealed that the genus *Peristylus* have 13 species in Nepal which is characterized by having oblong-ellipsoid to ovoid tuber with clustered or scattered leaves along the base or mid-way of the stem, distinct or obscured 3-lobed lip and somewhat globose- saccate or sometimes clavate spur and can be found usually in the tropical to temperate regions with some species extending to alpine regions.

Different species within this genus have different leaves distribution along the stem like *P. lacertifer* and *P. intrudens* have basal clustered leaves. *P. affinis , P. constictus, P. goodyeroides, P. hamiltonianus, P. lawii, P. parishii* and *P. prainii* have middle clustered leaves whereas *P. biermannianus, P. calcaratus* and *P. tipuliferus* have scattered leaves and this characters used to delimit the species within the species of the genus. The differences in the distribution of leaves along the stem is may be due to its growing altitude. According to Raskoti *et al.* (2016), alpine species usually have basal leaves whereas temperate to sub-alpine species mostly have cauline leaves and this kind of distribution of leaves are taxonomically important traits (Effimov, 2016).

From above taxonomic treatment of this genus, it can be concluded that genus *Peristylus* is found or distributed usually in tropical to temperate regions with some species such as *P. affinis* extending to alpine regions of Nepal same as in Jin *et al.* (2017) who concluded that this genus mainly occur in tropical to sub-tropical Asia with some species growing in alpine region. Similarly, In Orchidaceae family, most orchids flower once a year, which is the same for the species of this genus and fruiting usually starts right after the shedding of flowers. Present study revealed that flowering time of all species of this genus usually falls in June to October whereas its major peak time for flowering falls in August-September and for some species such as *P. goodeyroides* can be extend upto December. Differences in the flowering time of different species may be variation in the altitude. According to Effimov (2016), flowering time of majority of orchids spans May to September and species from lower altitude flower May to July whereas species from high altitude flower from August to september. Therefore, population of same species in different phytogeographical regions may have different flowering time and environmental factors such as temperature, sunlight, altitude etc always influenced the flowering time. Kumar *et al.* (2007) also mentioned that both external factor such as temperature, moisture, sunlight as well as internal factors (inherited factors) influenced orchid phenology.

7 species (*P. duthiei, P. elisabethae, P. fallax, P. mannii, P. nematocaulon, P. orbicularis* and *P. superanthus*) were excluded from the study because previously, these species were described within the genus *Peristylus* but the recent molecular study shows that *P. duthiei, P. elisabethae, P. fallax* and *P. mannii* belongs to genus *Herminium* whereas *P. nematocaulon, P. orbicularis* and *P. superanthus* belongs to genus *Platanthera* (Bateman *et al.*, 2003; Jin *et al.*, 2014; Raskoti *et al.*, 2016; Jin *et al.*, 2017).

Species within the genus *Peristylus* are extremely rare as well as its flowering season falls during the rainy season so, to trace down its location is very difficult which creates the problem in the field for collection. Therefore, only one species of this genus was collected as a live material and to preserve its parts was another difficult task as many species of this genus turn completely black after drying which reduces the number of morphological traits (Jin *et al.*, 2017). It shows that the major limiting factor on this study was almost complete dependency on the herbarium material present in KATH, TUCH and digital images of international herbaria for the study which may definitely increase the error.

Similarly, herbarium specimens of some species such as *P. affinis, P. calcaratus, P. intrudens* and *P. parishii* are only one in number in KATH which is not enough for the taxonomic study as some specimens lack tubers or could not study the structure of flower through stereomicroscope. So, in such a case I completely followed the local flora.

P. richardianus reported in by Hara *et al.*, 1978; Banerji and Pradhan, 1984; Press *et al.*, 2000, could not be traced in living material as well as in National herbaria (KATH and TUCH). Herbarium specimen of this species from Nepal was also found deposited in TI but its digital images were not available in that site. So, this one species could not be studied. Therefore, the present study was restricted to morphological characters of plants of herbarium specimens and the study of live specimens of all species of this genus was not possible due to its extreme rareness.

5. CLADISTIC STUDY

5.1 Cladistic analysis

Cladistic analysis is the analysis of hierarchically branching diagrams which estimate, with more or less informativeness and efficiency, one or more cladistic parameters (Nelson, 1979). Freudenstein and Rasmussen (1999) had undertaken cladistic analysis of orchids with 98 genera using 71 characters apomorphies based on previous character analysis and newly discovered variation. Jin *et al.* (2014, 2017), Raskoti *et al.* (2016) have undertaken the cladistic analysis on subtribe Orchidinae and genus *Herminium* based on molecular study (molecular markers and morphological characters) and they suggested to transfer some species of genus *Peristylus* such as: *Peristylus elisabethae, P. duthiei, P. fallax, P. josephii, P. nematocaulon, P. orbicularis, P. superanthus* to genus *Herminium* and *Platanthera* whereas they also demonstrated that *Platanthera biermanniana* belongs to genus *Peristylus* with its gross morphology.

Subedi (2003) performed morphological cladistic analysis on genus *Smilax* of Nepal Himalaya. Bajracharya and Shrestha (2004) used cladistic analysis in 40 species of Himalayan *Eria* based on 35 morphological, 3 anatomical and 2 cytological characters. Dangol (2006) performed cladistic analysis in sub-tribe Coelogyninae based on anatomical structure of leaf and root. Mishra, 2007 used cladistic analysis based on different morphological characters on *Hedychium* of Nepal.

Cladistic analysis of present study was carried out based on morphological characters that were observed in herbarium material as well as in live material.

5.2 Materials and Methods

5.2.1 Sampling

Present study revealed that 13 species of genus *Peristylus* (*P. affinis, P. biermannianus, P. calcaratus, P. constrictus, P. densus, P. goodyeroides, P. hamiltonianus, P. intrudens , P. lacertifer, P. lawii, P. parishii, P. prainii* and *P. tipuliferus*) are distributed in Nepal which shows different morphological variation within these 13 species of this genus. Therefore, 16 morphological characters of all taxon including outgroup were taken for cladistic analysis.

5.2.2 Characters and character state coding

First, character selection as well as coding was done based upon Lipscomb (1998). The characters and character states were chosen based upon their consistency traced during the study. For this study, *Herminium elisabethae* was chosen as outgroup based upon Raskoti *et al.* (2016) and Jin *et al.* (2017) as it was closely related genus to the *Peristylus.* After selection of character and its character state, multi-state coding was done. (Table 10)

Table 10. Data matrix of 13 species of *Peristylus* of Nepal.

		Characters															
No.	**Taxon**	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	Outgroup (*H. elisabethae*)	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
1	*P. affinis*	0	0	0	1	1	0	0	0	0	0	1	0	0	0	1	0
2	*P. biermannianus*	0	1	0	0	1	0	0	0	0	1	1	3	1	0	1	1
3	*P. calcaratus*	0	2	0	0	0	0	0	0	1	1	1	2	1	1	0	2
4	*P. constrictus*	1	0	1	1	1	0	0	1	1	0	1	1	0	0	0	0
5	*P. densus*	1	1	0	0	1	0	0	1	0	1	1	2	1	0	1	1
6	*P. goodyeroides*	1	0	1	1	1	0	0	1	1	0	1	0	0	0	2	0
7	*P. hamiltonianus*	1	1	1	1	1	1	0	0	0	0	1	0	0	0	1	0
8	*P. intrudens*	0	1	0	2	0	0	0	0	1	0	1	0	0	0	1	2
9	*P. lacertifer*	1	2	0	2	0	0	0	1	1	1	1	0	0	0	0	2
10	*P. lawii*	0	2	1	1	1	0	1	0	0	0	1	0	0	0	1	0
11	*P. parishii*	1	2	0	1	1	0	0	0	0	1	1	0	0	0	1	1
12	*P. prainii*	1	2	1	1	1	1	0	0	0	0	0	0	0	0	1	0
13	*P. tipuliferus*	1	1	0	0	1	0	0	1	1	1	1	2	1	1	1	1

Characters and character state: 0. Plant height: Less than 30cm=0, More than 30cm=1 1. Tuber: Oblong=0, Ovoid=1, Ellipsoid-2 2. Tubular sheaths: Less or equal to 3=0, More than 3=1 3. Leaves: Not clustered=0, Clustered near middle=1, Clustered near base=2 4. Number of leaves: 2-3 leaved=0, 4-6=1 5. Leaves margin: Entire=0, Wavy=1 6. Leaves shape: Elliptic-lanceolate=0, linear-lanceolate=1 7. Inflorescence: Less than 20cm=0, More than 20cm=1 8. Sterile bracts: Less or equal 3=0, More than 3=1 9. Flower: White=0, Green=1 10. Pedicel and Ovary: Less than 5mm=0, More than 5mm=1 11. Lip: 3-lobed near apex=0, 3-lobed near middle=1, Deeply 3-lobed=2, Obscurely 3-lobed=3 12. Lateral lobes of lip: Diverging =0, Spreading=1 13. Shape of lateral lobe: Not filiform=0, Filiform=1 14. Mid-lobe of lip: Shorter than lateral lobes=0, Longer than lateral lobes=1, Equal to lateral lobes=2 15. Spur: Globose-saccate=0, Clavate to cylindric-oblong=1, Ovoid=2

5.3 Results and Discussion

Cladogram: First data matrix was prepared using Winclada Version 1.00.08 (developed by K. Nixon in 1999) and that created data matrix was analyzed by applying heuristics method in Winclada. It generated trees with value of Consistency Index (Ci)=47, Retention Index (Ri)=62 and was then bootstrapped. (Fig. 22 and Fig. 23)

Morphological cladistic analysis of 13 species of genus *Peristylus* was done with outgroup *Herminium.* Jin *et al.* (2014) had suggested to transfer of some species to retain *Peristylus* as monophyletic genus whereas Jin *et al.* (2017) mentioned that this genus is monophyletic by excluding the misplaced species.

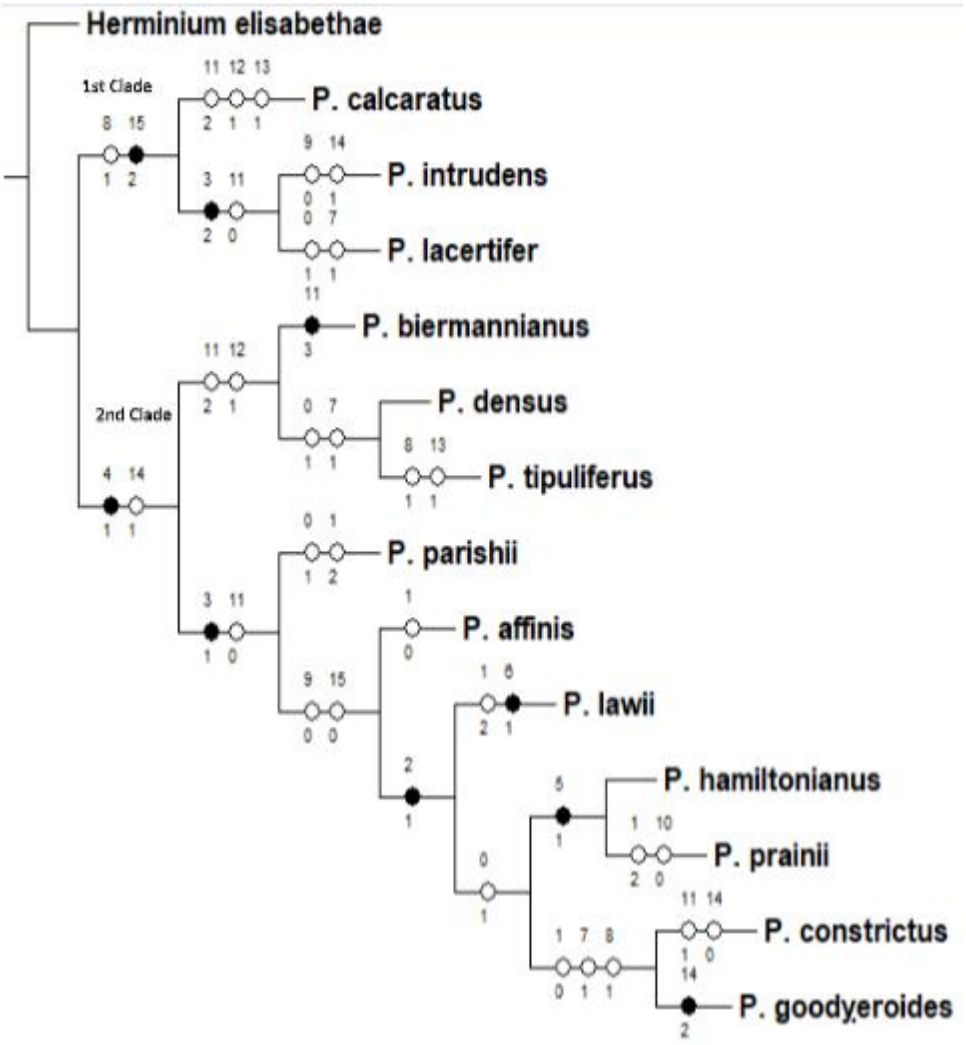


Fig. 22: A Single most parsimonous tree from Winclada analysis from Winclada version 1.00.08 (developed by K. Nixon in 1999). (Legends •- unique apomorphy, 0= parallelism. Upper tier number indicate the characters state and lower tier number indicate character code.)

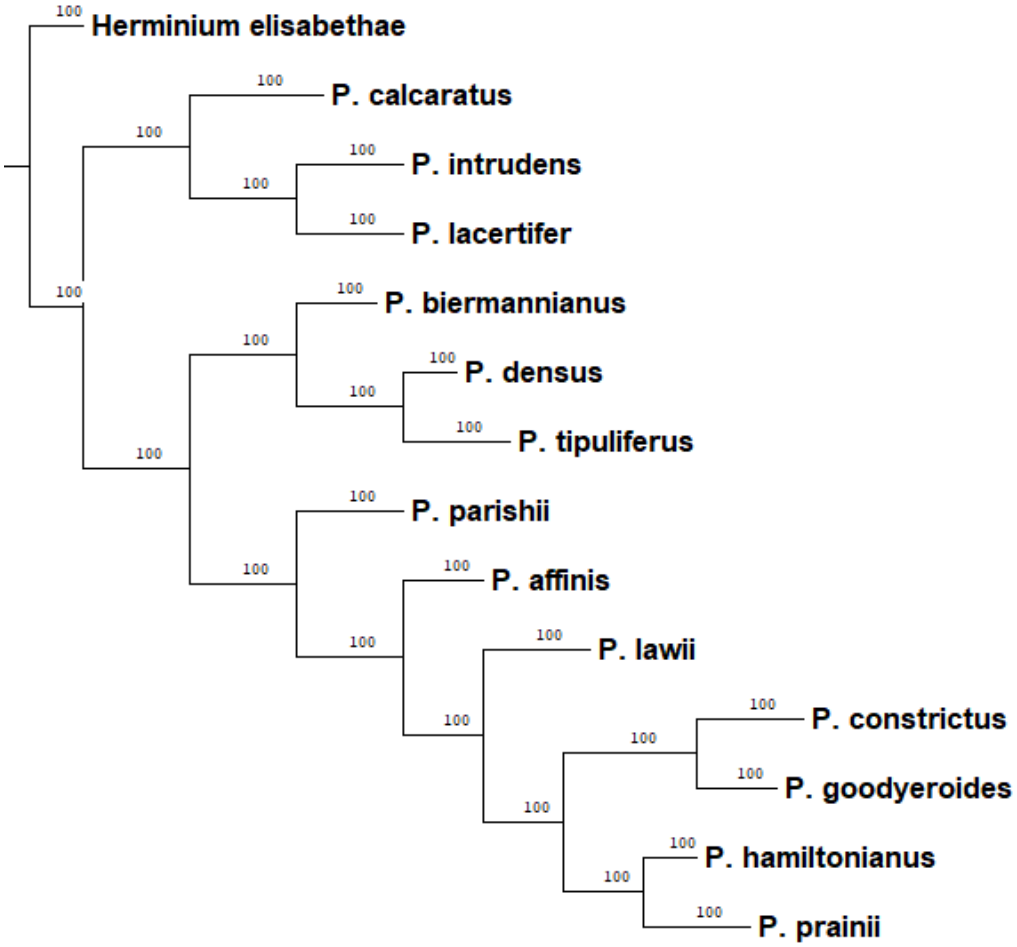


Fig. 23: Cladograms after bootstripe showing phylogenetic relationships among the species of genus *Peristylus* in Nepal.

Cladogram of the 13 species of genus *Peristylus* with outgroup *Herminium elisabethae* shows the 2 major clades on the tree based on spur and number of leaves. *P. calcaratus* formed the first clade paired with *P. intrudens* and *P. lacertifer* where the species of first clade have more than 3 sterile bracts and ovate spur. *P. calcaratus* subtends deeply 3-lobed lip with spreading and filiform lateral lobes whereas sub-clades formed by it subtends clustered basal leaves and lip 3-lobed near apex. Similarly, within the sister clades, *P. intrudens* has white flower and its mid-lobe is longer than lateral lobes of lip but *P. lacertifer* has green flower and its mid-lobe is shorter than lateral lobes of lip. Chen *et al.,* (2009) treated *P. intrudens* as *Peristylus lacertifer* var *taipoensis* and mentioned that *P. intrudens* differs from *P. lacertifer* in having white flowers, shorter lateral lobes of lip and more elliptic petals which is similar to this analysis. However, *P. calcaratus* shows closed affinity with *P. intrudens* and *P. lacertifer* by having ovate spur instead of having filiform side-lobes of lip like *P. tipuliferus.*

Second clade is formed by 2 sub-clades of *P. biermannianus* and *P. parishii.* 1st sub-clade is formed by *P. biermannianus* paired with sister-clade of *P. densus* and *P. tipuliferus* where all the species have deeply 3-lobed lip with spreading lateral lobes of lip except for the *P. biermannianus* which has obscurely 3-lobed-lip. Instead of having obscurely 3-lobed lip in *P. biermannianus,* it is close with *P. densus* and *P. tipuliferus* as all the species have clavate spur. Within the sister-clade, both species *P. densus* and *P. tipuliferus* have plant height more than 30cm and inflorescence more than 20cm. But *P. tipuliferus* differed from *P. densus* by having more than 3 sterile bracts and filiform lateral lobes of lip.

2nd sub-clade is formed by *P. parishii* along with 6 other species. All the species within this sub-clade subtend clustered middle leaves and lip 3-lobed near apex but *P. parishii* has plant height more than 30cm and ellipsoid tuber which differ it from rest of the species. Similarly, presence of clavate spur in *P. parishii* shows close affinity towards 1st sub-clade formed by *P. biermannianus.* King and Pantling (1898) had also mentioned that *P. contrictus* and *P. goodyeroides* are allied species of *P. parishii* and in this analysis also, *P. constrictus* and *P. goodyeroides* belongs to 2nd sub-clade formed by *P. parishii.*

Within 2nd sub-clade, *P. affinis* formed the clade paired with *P. lawii* along with 4 other species where all the species formed by the clade of *P. affinis* have white flower and globose-saccate spur. However, *P. affinis* has plant height less than 30cm which differ it from rest of the species in its clade. Hooker (1894) and King and Pantling (1898) mentioned that *P. affinis* is allied to the *P. goodyeroides* and typical difference between these two species (*P. goodyeroides* and *P. affinis*) are broadly the plant size which is way bigger in *P. goodyeroides* than *P. affinis* and the colour of flower which is usually yellowish green in *P. goodyeroides* and white in *P. affinis* and this is somewhat similar to this analysis.

Eventually *P. lawii* formed two sister clades within the 2nd sub-clade followed from *P. affinis* where all the species subtends more than 3 tubular sheaths. However, ellipsoid tuber and linear-lanceolate leaves differ *P. lawii* from other species of its sub-clades. All the species within the two sub-clades subtend plant height more than 30cm. First one sister clade is formed by *P. hamiltonianus* paired with *P. prainii* and these both species have crenulate margin leaves whereas *P. prainii* subtend ellipsoid tuber and pedicel and ovary less than 5mm which differ it from *P. hamiltonianus.* Second one is formed by *P. constrictus* paired with *P. goodyeroides* where both species have oblong

tuber with more than 3 sterile bracts and inflorescence which is more than 20cm. However, *P.constrictus* has lip 3-lobed near middle and mid-lobe shorter than lateral lobes of lip and *P. goodyeroides* has mid-lobe equal to lateral lobes of lip which differ them from each other. Kandagatla *et al.* (2017) had also mentioned that *P. lawii* is an allied species of *P. hamiltonianus* as well as it is very much similar to *P. goodyeroides* on the basis of its lip and spur structure and *P. affinis* on the basis of its flowers and hairy tubers. This analysis strongly supported that species within 2nd sub-clade are allied to each other.

6. CONCLUSION

The present study concluded that genus *Peristylus* is terrestrial orchids which is characterized by having oblong-ellipsoid to ovoid tuber with clustered or scattered leaves along the base or mid-way of the stem, distinct or obscured 3-lobed lip and somewhat globose- saccate or sometimes clavate spur and can be found usually in the tropical to temperate regions with some species extending to alpine regions.

Above study recognized 13 species within this genus in Nepal. These 13 species vary in morphological features from each other. They also vary in vegetative as well as in reproductive characters. The variations found in these species are mainly in tuber, tubular sheath, number and arrangement of leaves, sterile bracts (number and shape), flower, lip (lateral and mid-lobe) and spur. Orientation of leaves, flower colour, lip with its different shape and length of side-lobes and shape of spur have been taxonomically important traits to delimit the 13 species within this genus.

From this study, it is concluded that *P. calcaratus, P. densus* and *P. tipuliferus* have leaves which are widely spaced along the stem (not clustered). These 4 species have been divided on the basis of shape of spur. *P. calcaratus* has somewhat sub-globose or ovoid spur and rest of the species have clavate spur. *P. intrudens* and *P. lacertifer* have leaves which are clustered near base and can be divided on the basis of flower colour and the length of side-lobes of lip. Rest of the species (*P. affinis, P. constrictus, P. goodyeroides, P. hamiltonianus, P. lawii, P. parishii,* and *P. prainii*) have leaves which are clustered near the middle of the stem where *P. hamiltonianus, P. lawii, P parishii* and *P. prainii* have cylindric-oblong tuber and *P. affinis, P. constrictus* and *P. goodyeroides* have ovoid to ellipsoid tuber.

13 species have also shown variations in the reproductive structures as well. All the species usually have 3-lobed lip except *P. biermannianus* which is obscurely 3-lobed. Similarly, *P. calcaratus, P. tipuliferus* have filiform, long, spreading side-lobes of lip, *P. densus* has linear, horizontally spreading side-lobes of lip whereas the rest of the species does not have the filiform side-lobes and are diverging in nature. *P. biermannianus, P. densus, P. parishii* and *P. tipuliferus* have clavate spur whereas *P. calcaratus, P. intrudens* and *P. lacertifer* have ovate spur and rest of the species usually have globose-saccate spur.

In Nepal, it is found out that the flowering of this species usually starts from June and ends at October whereas peak season for flowering fall in the month of August-

September. It is also concluded that the flowering time is influenced by the variation of altitude. Out of 13 species, *P. goodyeroides* is the one species which has the longest flowering season.

It is also revealed that, out of 13 species, *Peristylus affinis, Peristylus constrictus* and *Peristylus goodyeroides* are distributed in all three regions (Western, Central and Eastern) of Nepal. *Peristylus biermannianus, Peristylus densus, Peristylus hamiltonianus, Peristylus parishii* and *Peristylus tipuliferus* are distributed in Central and Eastern Nepal whereas *Peristylus lacertifer, Peristylus lawii* and *Peristylus prainii* are distributed in Western and Central Nepal. Similarly, *Persitylus calcaratus* is distributed only in Eastern Nepal whereas *Peristylus intrudens* is distributed only in Central Nepal. These 13 species are distributed in 31 districts of Nepal from tropical to temperate region with *P. affinis* extending to alpine region.

Cladistic analysis of 13 species of genus *Peristylus* was carried out with the outgroup *Herminium elisabethae* and gave the phylogenetic relationship with 2 major clades among the 13 species based on number of leaves and spur.

Finally, it is also concluded that detailed description, illustrations, distribution, taxonomic keys will help in easy identification of the taxa.

7. RECOMMENDATION

Present study revealed and confirmed that the genus *Peristylus* consists of 13 species which are distributed from (sub) tropical to alpine regions. This study was mainly based on the herbarium specimens deposited in KATH and TUCH and even consulted with digital images of international herbaria because collections of live specimens from the field is very difficult as the species of this genus are extremely rare. Thus, full dependency on the herbarium material can definitely increase the error. Similarly, KATH deposits only one specimen of some species such as *P. affinis, P. calcaratus, P. parishii* which also lacks tuber, leaf or even important parts of flowers such as lip and spur. The above study shows that the *P. goodyeroides, P. constrictus* were collected in good number by earlier botanists as well as by collectors in the past but could not trace and found in some of those localities during current survey. This is may be due to climate change as well as heavy anthropogenic activities which also implies that these species are becoming locally extinct (Kumar *et al.,* 2007). It was found out that *P. richardianus* has been reported by Hara *et al.* (1978), Banerji and Pradan (1984) from Nepal but no herbarium specimens of this species could be studied from KATH and TUCH as well as from international herbaria. The present study is mainly based on and restricted to the morphological and phenological variation of the species due to the lack of fresh specimens from the field.

Therefore, It is recommended to collect fresh specimens carefully with tubers and preserve the flower of orchids in ethanol for further study as well as to make the herbarium specimens.

Collection, preservation of herbarium material and availability of digital images are very important for this kind of taxonomic study. Therefore, recommended to make the field note properly with correct information to increase its accuracy.

Increasing anthropogenic activities as well as climate change, species of this genus becoming locally extinct. Therefore, conservation of this genus is recommended.

Study of pollinia, stomatal morphology and molecular work in this genus is recommended which could have yielded interesting results and give useful information for the taxonomic work.

8. SUMMARY

The present study is conducted on **'Taxonomic Revision of the genus *Peristylus* Blume (Orchidaceae) in Nepal'**. This genus was first described by Carl Ludwig Blume in 1825. After the introduction of this genus also, some authors such as Bentham (1881), Hooker (1890), King and Pantling (1898), Duthiei (1906) etc. did not treat this genus as separate from the *Habenaria* and integrated within this genus in a broad view. However, Seidenfaden (1977) defined the genus *Peristylus* on the basis of size of floral characters, position of stigma lobes and spur and divided this genus into 4 sections on the basis of lip. Due to their morphological diversity, wide distribution range as well as intergrading and overlapping morphological variation between genera such as: *Habenaria, Herminium* and *Platanthera* had created complications and problems in the delimitations of this genus.

Different taxonomists had worked on orchids including *Peristylus* and reported different number of species in the genus *Peristylus* in Nepal which contributed in providing the useful data information about this genus from different regions of Nepal. However, lacking of detailed taxonomic treatment, illustrations, variable number of species reported by different authors did not provide the clear idea about this genus in Nepal.

The present work is mainly based on the morphological characters that were observed in the herbarium specimens (KATH, TUCH) and in live collection. Different literatures as well as herbarium specimens of international herbaria (E, K, TI, BM) were also consulted.

Current work confirmed the presence of 13 species of genus *Peristylus* in Nepal excluding 7 species which were known to be the species of *Peristylus* earlier and they are: *Peristylus affinis, P. biermannianus, P. calcaratus, P. constrictus, P. densus, P. goodyeroides, P. hamiltonianus, P. intrudens, P. lacertifer, P. lawii, P. parishii, P. prainii* and *P. tipuliferus. P. richardianus* kept as doubtful species as its herbarium specimens were not available but reported in earlier literatures.

Different morphological variations were shown by the species in this genus and some of them were useful in delimitation. Leaves are basal and clustered in *P. intrudens* and *P. lacetifer* whereas leaves are scattered in *P. calcaratus, P. densus* and *P. tipuliferus* and rest of the species has clustered leaves. Similarly, all the species have elliptic-

lanceolate leaves with entire margin except *P. lawii* which has linear-lanceolate leaves and *P. hamiltonianus* and *P. prainii* which have crenulate margin.

Usually, *P. affinis, P. constrictus, P. hamiltoninanus, P. intrudens, P. lawii, P. prainii* have uniformly white coloured flowers whereas *P. biermannianus, P. calcaratus, P. densus, P. lacertifer, P. parishii,* and *P. tipuliferus* have usually yellowish green to green coloured flowered but *P. goodyeroides* has yellowish green to dirty white coloured flowers.

Lips are 3-lobed in all species of this genus. The lip is deeply 3-lobed in *P. calcaratus, P. densus* and *P. tipuliferus.* It is 3-lobed near middle in *P. constrictus* whereas it is 3-lobed near apex in *P. affinis, P.goodyeroides, P. hamiltonianus, P. intrudens, P. lacertifer, P. lawii, P. parishii* and *P. prainii* but lip is obscurely 3-lobed in *P. biermannianus.* Similarly, lateral lobes of lip are spreading, filiform and curved upwards in *P. calcaratus* and *P. tipuliferus* whereas they are linear and sprading horizontally in *P. densus.* Lateral lobes of lip are linear, diverging, and longer than the mid-lobe in *P.constrictus* and *P. lacetifer* whereas they are diverging and equal in *P. goodyeroides* and shorter than mid-lobe in *P. affinis, P. hamiltonianus, P. intrudens, P. lawii, P. parishii* and *P. prainii* and minutely small in *P. biermannianus* and seemed to be spreading.

Spur are globose-saccate in *P. affinis, P. constrictus, P. goodyeroides, P. hamiltonianus, P. lawii, P. prainii.* It is usually clavate in *P. biermannianus, P. densus, P. parishii* and *P. tipuliferus* whereas it is ovate in *P. calcaratus, P. intrudens* and *P. lacertifer.*

Current study also shows that all the species in Nepal are terrestrial in nature and usually distributed from sub-tropical to temperate regions except *P. goodyeroides* and *P. lacertifer* which are distributed from tropical to sub-alpine regions and *P. affinis* which is only found in the sub-alpine region.

P. affinis, P. constrictus and *P. goodyeroides* are distributed in all three regions (Western, Central and Eastern) of Nepal. *P. biermannianus, P. densus, P. hamiltonianus, P. parishii* and *P. tipuliferus* are distributed in Central and Eastern Nepal whereas *P. lacertifer, P. lawii* and *P. prainii* are distributed in Western and Central Nepal. Similarly, *P. calcaratus* is distributed only in Eastern Nepal whereas *P. intrudens* is distributed only in Central Nepal.

The flowering period of this genus in Nepal starts in the month of June and ends nearly at the starting of November or in October whereas August to September is the peak of the flowering season for the species of this genus.

Current work has also established the cladistic analysis of 13 species of this genus with outgroup *Herminium elisabethae.* Cladogram of 13 species formed major 2 clades based on the leaves number and shape of the spur in the cladogram tree. It shows that *P. calcaratus* is more closely related to *P. intrudens* and *P. lacertifer*. *P. biermannianus* is closely related to *P. densus* and *P. tipuliferus* whereas rest of the species are close to each other.

9. REFERENCES

Aceto S, Caputo P, Cozzolino S, Gaudio L, Moretti A. 1999. Phylogeny and evolution of Orchis and allied genera based on ITS DNA variation: morphological gaps and molecular continuity. *Molecular Phylogenetics and Evolution* **13**: 67–76.

Acharya, K. P., & Rokaya, M. B. (2010). Medicinal orchids of Nepal: are they well protected? *Our Nature*, **8**(1): 82-91.

Acharya, K.P., Vetaas, O.R. & Birks, J.B. (2011). Orchid species richness along Himalayan elevational gradients. *Journal of Biogeography*, **38**(9): 1821-1833.

Agrawala, D. K., Chowdhery, H. J., & Chaudhury, S. (2010). New combinations in Indian Orchidaceae. *Kew Bulletin*, **65**(1): 105-106.

Amatya, G., (2005). Wild Orchid Flora of Doti District, Far Western Development Region of Nepal. Public Communication.

Ames, O. (1915). Orchidaceae: The genera and species of Philippine orchids. Boston. The Merry Mount Press, **5**: 12-17.

Angiosperm Phylogeny Group, T. (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnean Society, **141**(4): 399-436.

Angiosperm Phylogeny Group. (2009). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Botanical journal of the Linnean Society, **161**(2): 105-121.

Angiosperm Phylogeny Group, Chase, M. W., Christenhusz, M. J., Fay, M. F., Byng,J. W., Judd, W. S., Stevens, P. F. (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical journal of the Linnean Society, **181**(1): 1-20.

An updated online version of Press, J.R., Shrestha, K.K., & Sutton, D.A. (2000). *Annotated checklist of the flowering plants of Nepal*. Natural History Museum Publications, London, U.K. www.efloras.org.

Aung, Y. L., Mu, A. T., Aung, M. H., Liu, Q., & Jin, X. (2020). An annotated checklist of Myanmar orchid flora. *PhytoKeys*, **138**: 49.

Bajracharya, D. M. (2010). *Nepalese Orchids.* Maiya Devi Bajracharya, Ason Teaude tole, Kathmandu.

Bajracharya, D. M. and Shrestha, K. K. (2004). Cladistic view of Morphological diversity in the Himalayan *Eria* Lindl. (Orchidaceae). Proc. Of IV National conference of Science and Technology. March 23-26. 935-948.

Banerji, M. L., & Pradhan, P. (1984). *The orchids of Nepal Himalaya*. Cramer, 92-111.

Banerjii, M. L., & Thapa, B. B. (1969-1976). Orchids Of Nepal. *Journal of The Bombay Natural History Society.*

Barbhuiya, H. A., & Salunkhe, C. K. (2016). Orchids of Maharashtra, India: a review. *Richardiana*, **16**: 111-140.

Bateman, R. M., Hollingsworth, P. M., Preston, J., Yi-Bo, L. U. O., Pridgeon, A. M., & Chase, M. W. (2003). Molecular phylogenetics and evolution of Orchidinae and selected Habenariinae (Orchidaceae). *Botanical journal of the Linnean Society*, **142**(1): 1-40.

Bateman RM, James KE, Luo B, et al. 2009. Molecular phylogenetics and morphological reappraisal of the Platanthera clade (Orchidaceae: Orchidinae) prompts expansion of the generic limits of Galearis and Platanthera. *Annals of Botany*, **104**: 431–445.

Bentham, G. (1861). *Flora Hongkongensis: a description of the flowering plants and ferns of the island of Hongkong*. L. Reeve.

Bentham, G. & J. D. Hooker. (1883). *Genera Plantarum (Orchideae)*. L. Reeve, London, **3**: 460-636.

Bhandari, P., Budhamagar, S., & Shrestha, K. K. (2018). A checklist of flowering plants of Panchase Protected Forest, Kaski district, central Nepal. *Journal of Natural History Museum*, **30**: 55-84.

Bhandari, P., Shrestha, K., & Subedi, C. K. (2020). Orchids of Panchase Forest, Central Nepal: *A Checklist.Journal of Plant Resources*, **18**(1): 143-156.

Blatter, E., & McCann, C. (1932). Revision of the flora of the Bombay presidency. *Journal of Bombay Natural History Society*, **35**: 733-735.

Blume, C. L. (1825). *Bijdragen tot de flora van Nederlandsch Indië*. ter lands Drukkerij.

Bose, T. K., Bhattacharjee, S. K., Das, P., & Basak, U. C. (1999). *Orchids of India* (No. Ed. 2). Naya Prokash, 426-427.

Box, M. S., Bateman, R. M., Glover, B. J., & Rudall, P. J. (2008). Floral ontogenetic evidence of repeated speciation via paedomorphosis in subtribe Orchidinae (Orchidaceae). *Botanical Journal of the Linnean Society*, **157**(3): 429-454.

Budha-Magar, S., Bhandari, P., & Ghimire, S. K. (2020). Ethno-medicinal survey of plants used by Magar (Kham) community, Rolpa district, Western Nepal. *Ethnobotany Research and Applications*, **19**: 1-29.

Burns-Balogh, P., & Funk, V. A. (1986). A phylogenetic analysis of the Orchidaceae. Smithsonian Contributions to Botany.

Cameron, K. M., Chase, M. W., Whitten, W. M., Kores, P. J., Jarrell, D. C., Albert, V. A., & Goldman, D. H. (1999). A phylogenetic analysis of the Orchidaceae: evidence from rbcL nucleotide sequences. *American Journal of Botany*, **86**(2): 208-224.

Chase MW, Cameron KM, Barret RL, Freudenstein JV. (2003). DNA data and Orchidaceae systematics: a new phylogenetic classification. In: KW Dixon, SP Kell, RL Barret, Cribb PJ. eds. Orchid conservation. Kota Kinabalu: Natural History Publications, 69–89.

Chase, M. W., Cameron, K. M., Freudenstein, J. V., Pridgeon, A. M., Salazar, G., Van den Berg, C., & Schuiteman, A. (2015). An updated classification of Orchidaceae. *Botanical journal of the Linnean Society*, **177**(2): 151-174.

Chaudhary, R. P., Uprety, Y., Joshi, S. P., Shrestha, K. K., Basnet, K. B., Basnet, G., Shrestha, K. R., Bhatta, K. P., Acharya, K. P., & Chettri, N. (2015). Kangchenjunga Landscape Nepal: from conservation and development perspectives. *Kangchenjunga Landscape Nepal: from conservation and development perspectives.*

Chen, X. Q., Liu, Z. J., Zhu, G. H., Lang, K. Y., Ji, Z. H., Luo, Y. B., & Bell, A. (2009). Flora of China: Orchidaceae. Beijing: Science Press, **25**: 382-382.

Chowdhery, H. J. (1998). *Orchid Flora of Arunachal Pradesh: HJ Chowdhery*. Bishen Sing Mahendra Pal Singh, 574-581.

CITES (2021, Febrruary 14). CITES Appendices I, II and III, valid from 14.02.2021. Retrieved from https://cites.org/sites/default/files/eng/app/2021/E-Appendices-2021-02-14.pdf

Cullen, J. (2006). *Practical Plant identification: including a key to native and cultivated flowering plants in north temperate regions*. Cambridge University Press.

Dangol, G. (2006). Study of anatomical structure of leaf and root of tribe Coelogyninae Bentham (Orchidaceae) in Nepal. M. Sc. Thesis submitted to T. U., Nepal.

De, L. C. (2021). Studies on 75 (Seventy five) morphological characters in orchids. *International Journal of Botany Studies,* **6**: 557-568.

Deva, S., & Naithani, H. B. (1986). *Orchid Flora of North West Himalaya*. Print & Media Associates, 175-191.

DNPWC (2019). Biodiversity Profile of The Api Nampa Conservation Area, Nepal. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Dressler, R. L., & Dodson, C. H. (1960). Classification and phylogeny in the Orchidacea. *Annals of the Missouri Botanical Garden,* 25-68.

Dressler, R. L. (1981). *The orchids: natural history and classification*. Harvard University Press.

Dressler, R. L. (1986). Recent advances in orchid phylogeny. *Lindleyana,* **1**(1): 5-20.

Dressler, R. L. (1993). *Phylogeny and classification of the orchid family*. Cambridge University Press.

Don, D., (1825). *Prodromus florae nepalensis*. Don, D. (1825). *J. Gale, Londini*. Publication

Duthie, J. F. (1906). *The Orchids of the North-Western Himalaya*. J. Cramer, **9**: 174-195.

Efimov, P. R. (2016). A Revision of Platanthera (Orchidaceae; Orchidoideae; Orchideae) in Asia, *Phytotaxa,* **254**(1): 145-147.

Freudenstein, J. V., & Rasmussen, F. N. (1999). What does morphology tell us about orchid relationships? A cladistic analysis. *American Journal of Botany,* **86**(2): 225-248.

Garay LA. 1972. On the origin of the Orchidaceae, II. *Journal of the Arnold Arboretum*, **53**: 202–215.

Ghimire, S. K., Subedi, C.K, Budha Magar S., Adikari, M & Panday T. R. (2021) Flora of Kailash sacred landscape Nepal, An Annotated checklist- Vol I. Research Centre for Applied Science of Science and Techology (RECAST), Tribhuvan University.

Govaerts, R., Campacci, M. A, Baptista, D. H., Cribb, P. H., George, A., Kreuz, K. & Wood, J. (2008). *World Checklist of Orchidaceae*.

Govaerts, R., Bernet, P., Kratochvil, K., Gerlach, G., Carr, G., Alrich, P., & Kreuz, K. Wood. JJ (2017). *World Checklist of Orchidaceae*.

Govaerts, R., M.A. Campacci, D.H. Baptsta, P.J. Cribb, A. George, K. Kreutz & J.J. Wood. (2018). World Checklist of Orchidaceae.

Gupta, R. K. (1968). *A Hand Book of the flowering plants of Nainital, Flora Nainitalensis*. Navyug Traders, N. Delhi.

Hara, H., Stearn W. T., and Williams, L. H. J. (1978). *An Enumeration of the Flowering Plants of Nepal*. London: The British Museum (Natural History), 52-53.

Harris, J. G., & Harris, M. W. (1994). *Plant identification terminology: an illustrated glossary* (No. QK9 H37 2001). Utah: Spring Lake publishing.

Hawkes, A. D. (1965). Encyclopaedia of cultivated orchids, an illustrated descriptive manual of the members of the Orchidaceae currently in cultivation. Faber and Faber Ltd., London,

Hayata, B. (1914). Icones Plantarum Formosanarum IV. *Taihoku: Bureau of Productive Industries*. Government of Formosa, Taihoku, Japan.

Holttum, R. E. (1964). *A Revised Flora of Malaya: Orchids of Malaya*. US Government Printing Office.

Hooker, J. D. (1890). *The Flora of British India.* L. Reeve & Co., London, **5**: 910.

Hooker, J. D. (1894). *The Flora of British India*, Orchideae to Cyperaceae, part 17. L. Reeve & Co., London, **6**: 131-166.

Hu, S.Y. (1973) The Orchidaceae of China VI. *Quarterly Journal of the Taiwan Museum*, **26**: 373–406.

Inoue, K. (1986c) Notes on Asiatic species of Platanthera (Orchidaceae) (1) Two new species of Platanthera from Bhutan and China. *Journal of Japanese Botany*, **61**: 193–198.

Jacquemyn, H., Micheneau, C., Roberts, D. L., & Pailler, T. (2005). Elevational gradients of species diversity, breeding system and floral traits of orchid species on Reunion Island. *Journal of biogeography*, **32**(10): 1751-1761.

Jin, W. T., Jin, X. H., Schuiteman, A., Li, D. Z., Xiang, X. G., Huang, W. C., Li, J. W., & Huang, L. Q. (2014). Molecular systematics of subtribe Orchidinae and Asian taxa of Habenariinae (Orchideae, Orchidaceae) based on plastid matK, rbcL and nuclear ITS. *Molecular phylogenetics and evolution*, **77**: 41-53.

Jin, W. T., Schuiteman, A., Chase, M. W., Li, J. W., Chung, S. W., Hsu, T. C., & Jin, X. H. (2017). Phylogenetics of subtribe Orchidinaesl (Orchidaceae; Orchidoideae) based on seven markers (plastid matK, psaB, rbcL, trnL-F, trnH-psba, and nuclear nrITS, Xdh): implications for generic delimitation. *BMC plant biology*, **17**(1): 1-14.

Jin, X. H., & Efimov, P. (2012). *Platanthera ovatilabris* and *P. dulongensis* spp. nov. and new records of Platanthera (Orchidaceae, Orchidoideae) for Yunnan and Tibet, China. *Nordic Journal of Botany*, **30**(3): 291-298.

Kandagatla, R., Ragan, A., Suthari, S., & Raju, V. S. (2017). *Peristylus lawii* (orchidaceae) a new record for Telangana state. India. *Journal of Economic and Taxonomic Botany*.

Karki, S., and Ghimire, S. K. (2019). Orchids of Suspa-Kshamawoti, Dolakha-An annotated checklist. *Banko Janakari*, **29**(2): 28-41.

King, G., & Pantling, R. (1898). *The Orchids of the Sikkim-Himalaya*. Dehra Dun: Bishen Singh Mahendra Pal Singh, **8**: 305-330.

Kraenzlin, F. W. L. (1897-1901). Orchidacearum genera et species. Mayer & Müller, Berlin, **1**(1-16).

Kraenzlin, F. W. L. (1898). Orchidacearum genera et species. Mayer & Müller, Berlin.

Kraenzlin, F. W. L. (1900). Orchidacearum genera et species. Mayer & Müller, Berlin.

Kumar, P., Jalal, J., & Rawat, G. (2007). Orchidaceae, Chotanagpur, state of Jharkhand, India. *Check List*, **3**(4): 297-304.

Kumar, P., Rawat, G. S., & Jalal, J. S. (2010). *Peristylus sahanii*, a new species of Orchidaceae from India. *Kew Bulletin*, **65**(1): 101-104.

Kurzweil, H. (2008). Studies in the *Peristylus tentaculatus*-complex (Orchidaceae) in Thailand. *Gard. Bull. Singapore*, **60**: 45-54.

Lang, K. Y. (1999). Flora Republica Popularis Sinica. *Science Press*, Beijing, **17**(pl. 16): 7.

Lindley, J. (1832). Edwards's Botanical Register of Ornamental Flower-Garden and Shrubbery: Consisting of Coloured Figures of Plants and Shrubs, Cultivated in British Gardens. London. James Ridgway.

Lindley, J. (1830-1840). *The Genera and Species of Orchidaceous Plants*. London, Ridgways.

Lipscomb, D. (1998). Basics of cladistic analysis. *George Washington University*.

Luer CA. 1975. The native orchids of the United States and Canada excluding Florida. New York: New York Botanical Gardens.

Maity, D., Ghosh, J., Pradhan, N., Mukherjee, S. K., & amp; Maiti, G. G. (2019). Enumeration of Orchids of Sikkim. *Pleione*, **13**(2): 355-384.

Malla, S. B., Rajbhandari, S. B., Shrestha, T. B., Adhikari, P. M., Adhikari, S. R., & Shakya, P. R. (1986). *Flora of Kathmandu Valley*. Ministry of Forests and Soil Conservation-Department of Medicinal Plants.

Malla, S. B., Shrestha, A. B., Rajbhandari, S. B., Shrestha, T. B., & Adhikari, P. M. (1976). *Flora of Langtang and cross section vegetation survey (central zone)*. Department of Medicinal Plants, Thapathali, Kathmandu, Nepal.

Mansfeld, R. (1937). Über das System der Orchidaceae-Monandrae. *Notizblatt des Botanischen Gartens und Museums zu Berlin-Dahlem*, 666-676.

Mishra, S. (2007). *Taxonomy of the Genus Hedychium (Zingiberaceae) in Nepal* (Doctoral dissertation, Department of Botany).

Mukerjee, S. K. (1953). An enumeration of the orchids of Ukhrul, Manipur. *Notes Roy. Bot. Gard.* Edinburgh, **21**: 149-154.

Nasir, E., & Ali, S. I. (1972). *Flora of West Pakistan: an annotated catalogue of the vascular plants of West Pakistan and Kashmir*. Fakhri.

Nelson, G. (1979). Cladistic analysis and synthesis: principles and definitions, with a historical note on Adanson's Familles des Plantes (1763–1764). *Systematic Biology*, **28**(1): 1-21.

Ōba, H., & Ikeda, H. (1999). A contribution to the flora of Ganesh Himal, central Nepal. University Museum, University of Tokyo.

Ohashi, H. (1975). *Flora of Eastern Himalaya*. University of Tokyo Press.

Ormerod, P. (2011). Orchidaceous additions to the flora of China. Taiwania, **56**(1): 42-49.

Pearce, N. R., & Cribb, P. J. (2002). *The Orchids of Bhutan, Flora of Bhutan*. Edinburgh: Royal Botanic Garden Edinburgh, 173-183.

Pradhan, U. C. (1979). Indian Orchids Guide to Identification and Culture (Vol I). *Faridabad, India: Thomson Prass,*

Prain, D. (1903). Bengal plants. Vols. I and II, Calcutta.

Press, J. R., Shrestha, K. K., & Sutton, D. A. (2000). *Annotated checklist of the flowering plants of Nepal*. Natural History Museum Publications, 222-223.

Pridgeon AM, Cribb PJ, Chase MW, Rassmussen FN. 2001. *Genera orchidacearum (Vol. 2)*. Oxford: Oxford University Press.

Rai, S. K., Gajure, J. P., Shrestha, K. K., Scheidegger, C., and Shakya, L. R. (2013). *Peristylus manii* (H.G. Reichenbach) Mukerjee [Orchidaceae] - a new record for Nepal, Pleione, **7**(1): 250-252.

Rajbhandari, K. R., & Dahal, S. (2004). Orchids of Nepal: a checklist. *Botanica Orientalis: Journal of Plant Science*, **4**(1): 89-106.

Rajbhandari, K. R. (2014). Orchids of Nepal: Status, threat and conservation. Proc. Natl. Work. NTFP/MAPs sect.Action plant dev. Orchid. Department of Plant Resources, Ministry of Forest and Soil Conservation and central Department of Botany. Kathmandu, Nepal: Tribhuvan university, 1-40.

Rajbhandari, K. R. (2015). *A Handbook of the Orchids of Nepal*, Department of Plant Resources, MoFSC, Kathmandu.

Rajbhandari, K. R., & Rai, S. K. (2017). *A Handbook of the Flowering plants of Nepal*, vol. 1. Kathmandu, Nepal: Department of Plant Resources.

Rajbhandari, K. R., & Rajbhandary, S. (2015). Herbarium preparation and storage technique. *Taxonomic tools and flora writing*, 70-80.

Rajbhandari, K. R., Tamang, R., Chhetri, R., Khatri, S., Joshi, M. D., and Rai, S. K. (2020). *Floweing Plants of Province No. 1, East Nepal.* Ministry of Industry, Tourism, Forest and Environment, Province No. 1, Biratnagar, Nepal.

Rajbhandari, K. R., Thapa Magar, M. S., Kandel, D. R., & Khanal, C. (2016). Plant Resources of Kailali, West Nepal. *District Plant Resources Office, Kailali, Nepal*.

Rao, A. N. (2010). A review of Orchidoideae genera in Arunachal Pradesh (India). *Bull. Arunachal Forest Res*, **26**: 1-28.

Raskoti, B. B. (2009). *orchids of Nepal*. BB Raskoti and R. Ale. Quality printers, Kathmandu, Nepal.

Raskoti, B. B. (2015). A new species of *Gastrochilus* and new records for the orchids of Nepal, Phytotaxa, **233**(2): 179-184.

Raskoti, B. B., Ale, R., and Shrestha, K. (2012). *Peristylus intrudens* (Ames) Ormerod (Orchidaceae) - A New Record for Flora of Nepal, Journ*al of Japanese Botany,* **87**: 137-139.

Raskoti, B. B., Jin, W. T., Xiang, X. G., Schuiteman, A., Li, D. Z., Li, J. W., Huang, W. C., Jin, X. H. & Huang, L. Q. (2016). A phylogenetic analysis of molecular and morphological characters of H erminium (Orchidaceae, Orchideae): evolutionary relationships, taxonomy, and patterns of character evolution. *Cladistics,* **32**(2): 198-210.

Raskoti, B. B., Schuiteman, A., Jin, W-T., and Jin, X-H. (2017). A taxonomic revision of Herminium L. (Orchidoideae, Orchidaceae), *PhytoKeys*, **79**:1-74.

Reichenbach, H. G. (1852). *De Pollinis Orchidearum genesi ac structura, et de Orchideis in artem ac systema redigendis*. Sumpt F. Hofnester.

Reichenbach, H. G. (1874). IV. Enumeration of the Orchids collected by the Rev. EC Parish in the neighbourhood of Moulmein, with Descriptions of the new Species. *Transactions of the Linnean Society of London*, **30**(1): 133-155.

Reichenbach, H. G. (1872). Flora [Laelia jongheana].

Ridley, H. N. (1924). *The Flora of the Malay Peninsula: Monocotyledones (Vol. 4)*. L. Reeve & Company, Limited.

Rokaya, M. B., Raskoti, B. B., Timsina, B., and Münzbergová, Z. (2013). An Annotated Checklist of the orchids of Nepal, *Nordic Journal of Botany,* **31**: 511-550.

Rolfe, R. A. (1913). New Orchids: Decade 40. *Bulletin Miscellaneous Information*, 141-145.

Royal Botanic Gardens, Kew (2009). *Monocot Checklist.* Available at: http://apps.kew.org/wcsp/qsearch.do (accessed 10 January 2009).

Santapau, H., & Kapadia, Z. (1960). Critical notes on the Orchidaceae of Bombay State. *The Journal of the Bombay Natural History Society.* Verlag nicht ermittelbar.

Schlechter, F.R.R. 1926. Das system der Orchidacee. Notizbl. Bot. Gart. Berlin-Dahlem, **9**(88): 563–591.

Schuiteman, A., Kailash, B. R., & Shrestha, U. B. (2022). *A Checklist of the Orchidaceae of India.* Missouri Botanical Garden Press, 157-160.

Seidenfaden, G., 1977. Peristylus Bl. *Dansk Botanisk Arkiv*, **31**:27.

Seidenfaden, G., & Smitinand, T. (1959). *The orchids of Thailand*. Bangkok: Siam society, 47-52.

Shakya, L. R., and Bajracharya, D. M. (2013). Survey for the Orchids of Shivapuri National Park in Kathmandu (Nepal) and their conservation. *Pleione*, **7**(1): 39-45.

Shrestha, K. K., Bhattarai, S., & Bhandari, P. (2018). *Handbook of Flowering Plants of Nepal (Gymnosperms and Angiosperms: Cycadaceae-Betulaceae).* Scientific Publishers.

Shrestha, K. K. (2020). Flowering Plants of Nepal: Insight from Englerian to APG system; Plant Diversity in Nepal. *Botanical Society of Nepal*, 112-124.

Shrestha, K. K., Bhandari, P., and Bhattarai, S. (2022). *Plants of Nepal (Gymnosperms & Angiosperms)*. Scientific Publishers, Jodhpur, India (in Press).

Simpson, M. G. (2010). Plant Systematics. *Plant systematics.*, (Ed. 2).

Singh Jalal, J., & Jayanthi, J. (2015). An annotated checklist of the Orchids of Western Himalaya, India. *Lankesteriana*, **15**(1): 07-50.

Singh Jalal, J., & Jayanthi, J. (2018). An updated checklist of the orchids of Maharashtra, India. *Lankesteriana*, **18**(1): 23-62.

Smith, J. J. (1905). *Die orchideen von Java (Vol. 6).* EJ Brill, Leiden.

Smith, J. J. (1927). Die Orchideen von Java. Sechster Nachtrag. *Bulletin du Jardin Botanique de Buitenzorg*, ser, **3**(9), 23.

Smith, A. C. (1991). *Flora vitiensis nova. A new flora of Fiji (Vol. 5).* Addenda et corrigenda, index.

Soliva, M., Kocyan, A., & Widmer, A. (2001). Molecular phylogenetics of the sexually deceptive orchid genus Ophrys (Orchidaceae) based on nuclear and chloroplast DNA sequences. *Molecular Phylogenetics and Evolution*, **20**(1), 78-88.

Stearn, W. T. (1985). Botanical Latin. New Edition. *Trowbridge: Redwood Burn Ltd*.

Subedi, S. (2003). Revision of Genus *Smilax* L. (Smilacaceae) in Nepal. M. Sc. Thesis, Tribhuvan University, Kathmandu, Nepal.

Subedi, A., Subedi, N., & Chaudhary, R. P. (2007). Panchase forest: an extraordinary place for wild orchids in Nepal. *Pleione*, **1**: 23-31.

Swami, N. (2016). *Terrestrial orchids*. Ashoka Trust for Research in Ecology and the Environment (ATREE).

Szlachetko, D. L. (1995). Systema orchidalium. *Fragmenta Floristica et Geobotanica*, (suppl. 3).

Tang, T., & Wang, F. T. (1936). Contributions to the knowledge of eastern Asiatic Orchidaceae. *Bulletin Fan Memorial Institute of Biology Botany*, **10**: 28-31.

Thiselton-dyer, W. T. (1898). *Flora Of Tropical Africa (Vol. 7)*. L. Reeve; Kent.

Tyteca, D., & Klein, E. (2008). Genes, morphology and biology–The systematics of Orchidinae revisited. *J. Eur. Orch*, **40**(3): 501-544.

Vermeulen, P. (1966). The system of the Orchidales. *Acta Botanica Neerlandica*, **15**(1): 224-253.

Wight, R., & Roxburgh, W. (1852). Icones plantarum Indiae orientalis, or figures of Indian plants (Vol. 5). JB Pharoah for the author.

Wood, J. J. (1986). Notes on Asiatic and New Guinea Orchidaceae, *Kew Bulletin* **41**(4): 811-822.

APPENDIX I. PHOTOGRAPHS (including Type herbarium) OF DIFFERENT SPECIES OF *Peristylus* Blume.

P. goodyeroides (D. Don) Lindley

Photo provided by La. Dorche Sherpa

P. intrudens (Ames) Ormerod

Photo from Alappatt, 2017

P. lawii Wight

Photo from Kandagatla et al., 2017

P. tipuliferus (C. S. P. Parish and Rchb. f.) Mukherjee

(Type specimens)

P. affinis (D. Don) Seidenf. [BR]

P. biermannianus (King &Pantl) Jin et al. [K]

P. calcaratus (Rolfe) S. Y. [K]

P. constrictus (Lindl.) Lindl. [K]

P. densus (Lindl) Santapau & Kapadia [E]

P. goodyeroides (D. Don) Lindl. [K]

P. hamiltonianus (Lindl.) Lindl. [K]

P. intrudens (Ames) Ormerod [A]

P. lacertifer (Lindl.) J. J. Smith [K]

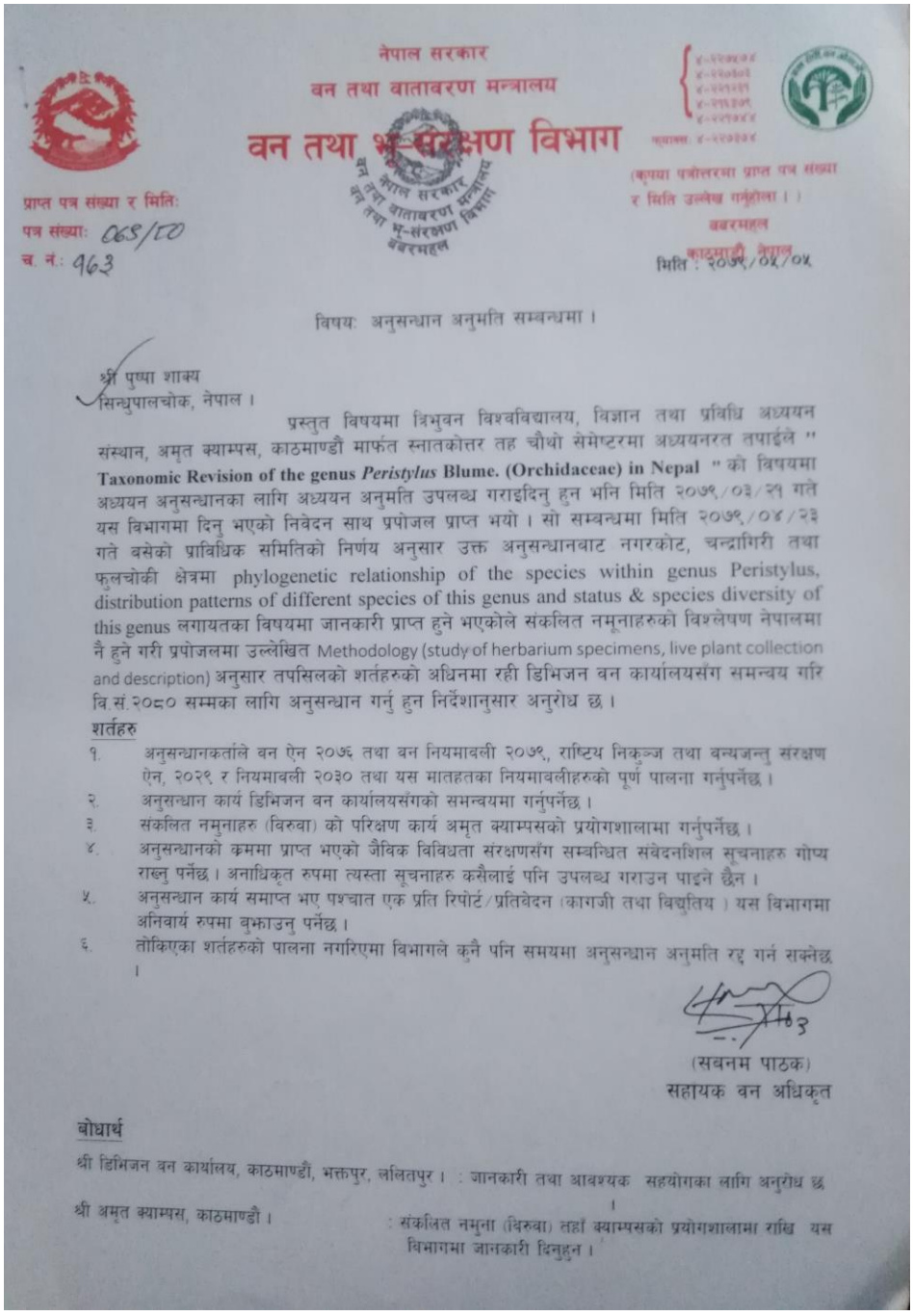
P. lawii Wight [K]

P. parishii Rchb. f. [K]

P. prainii (Hook. f) Kraenzl. [K]

P. tipuliferus (C. S. P. Parish & Rchb. f.) Mukherjee [K]

APPENDIX II. Permission letter for collection of genus *Peristylus* from Ministry of Forest and Soil Conservation, Babarmahal, Kathmandu.



नेपाल सरकार
वन तथा वातावरण मन्त्रालय
वन तथा भू-संरक्षण विभाग
बबरमहल
काठमाडौं, नेपाल

प्राप्त पत्र संख्या र मितिः
पत्र संख्याः ०६९/७०
च. नं.: ९६३

(कृपया पत्रोत्तरमा प्राप्त पत्र संख्या र मिति उल्लेख गर्नुहोला ।)

मितिः २०७९/०४/०५

विषयः अनुसन्धान अनुमति सम्बन्धमा ।

श्री पुष्पा शाक्य
सिन्धुपालचोक, नेपाल ।

प्रस्तुत विषयमा त्रिभुवन विश्वविद्यालय, विज्ञान तथा प्रविधि अध्ययन संस्थान, अमृत क्याम्पस, काठमाण्डौ मार्फत स्नातकोत्तर तह चौथो सेमेष्टरमा अध्ययनरत तपाईले " **Taxonomic Revision of the genus *Peristylus* Blume. (Orchidaceae) in Nepal** " को विषयमा अध्ययन अनुसन्धानका लागि अध्ययन अनुमति उपलब्ध गराइदिनु हुन भनि मिति २०७९/०३/२१ गते यस विभागमा दिनु भएको निवेदन साथ प्रपोजल प्राप्त भयो । सो सम्बन्धमा मिति २०७९/०४/२३ गते बसेको प्राविधिक समितिको निर्णय अनुसार उक्त अनुसन्धानबाट नगरकोट, चन्द्रागिरी तथा फुलचोकी क्षेत्रमा phylogenetic relationship of the species within genus Peristylus, distribution patterns of different species of this genus and status & species diversity of this genus लगायतका विषयमा जानकारी प्राप्त हुने भएकोले संकलित नमूनाहरुको विश्लेषण नेपालमा नै हुने गरी प्रपोजलमा उल्लेखित Methodology (study of herbarium specimens, live plant collection and description) अनुसार तपसिलको शर्तहरुको अधिनमा रही डिभिजन वन कार्यालयसँग समन्वय गरि वि.सं.२०८० सम्मका लागि अनुसन्धान गर्नु हुन निर्देशानुसार अनुरोध छ ।

शर्तहरु

१. अनुसन्धानकर्ताले वन ऐन २०७६ तथा वन नियमावली २०७९, राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण ऐन, २०२९ र नियमावली २०३० तथा यस मातहतका नियमावलीहरुको पूर्ण पालना गर्नुपर्नेछ ।
२. अनुसन्धान कार्य डिभिजन वन कार्यालयसँगको समन्वयमा गर्नुपर्नेछ ।
३. संकलित नमुनाहरु (बिरुवा) को परिक्षण कार्य अमृत क्याम्पसको प्रयोगशालामा गर्नुपर्नेछ ।
४. अनुसन्धानको क्रममा प्राप्त भएको जैविक विविधता संरक्षणसँग सम्बन्धित संवेदनशिल सूचनाहरु गोप्य राख्नु पर्नेछ । अनाधिकृत रुपमा त्यस्ता सूचनाहरु कसैलाई पनि उपलब्ध गराउन पाइने छैन ।
५. अनुसन्धान कार्य समाप्त भए पश्चात एक प्रति रिपोर्ट/प्रतिवेदन (कागजी तथा विद्युतिय) यस विभागमा अनिवार्य रुपमा बुझाउनु पर्नेछ ।
६. तोकिएका शर्तहरुको पालना नगरिएमा विभागले कुनै पनि समयमा अनुसन्धान अनुमति रद्द गर्न सक्नेछ ।

(सबनम पाठक)
सहायक वन अधिकृत

बोधार्थ

श्री डिभिजन वन कार्यालय, काठमाण्डौ, भक्तपुर, ललितपुर । : जानकारी तथा आवश्यक सहयोगका लागि अनुरोध छ ।

श्री अमृत क्याम्पस, काठमाण्डौ । : संकलित नमुना (बिरुवा) तहाँ क्याम्पसको प्रयोगशालामा राखि यस विभागमा जानकारी दिनुहुन ।