

# **Taxonomic Study of the Families Iridaceae, Colchicaceae, Melanthiaceae of Nepal and their Distribution Pattern**

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**(Plant Systematics and Biodiversity Unit)**

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# TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF BOTANY

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## RECOMMENDATION

This is to certify that M. Sc. Dissertation work entitled "**Taxonomic Study of the families Iridaceae, Colchicaceae, Melanthiaceae of Nepal and their Distribution Pattern**" has been carried out by **Ms. Til Kumari Thapa** under my supervision. This entire work is based on the herbarium specimen from different national and international herbaria. The work has not been submitted for any other academic degree. I recommend this dissertation work to be accepted as a partial fulfillment for Master's Degree in Botany at Institute of Science and Technology, Tribhuvan University.



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LETTER OF APPROVAL

KIRTIPUR, KATHMANDU  
NEPAL

This dissertation work submitted by Ms. Til Kumari Thapa entitled “**Taxonomic Study of the families Iridaceae, Colchicaceae, Melanthiaceae of Nepal and their Distribution Pattern**” has been accepted as a partial fulfillment for her Master’s Degree in Botany (Plant Systematics and Biodiversity). I am thankful to Prof. Dr. Krishna Kumar Shrestha, former Head of Central Department of Botany, Tribhuvan University and Editor of “Flora of Nepal” for his invaluable suggestions and guidance. I am also thankful to all the team members of Flora of Nepal Project too. As this work has been carried out in the context of Flora of Nepal Vol.10 (Part I).

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Date: 12<sup>th</sup> December, 2014

**Til Kumari Thapa**

## ACRONYMS AND ABBREVIATIONS

Anno. Check. Fl. Pl.	Nepal Annotated Checklist of Flowering Plants of Nepal.
BM	Natural History Museum
Bull.	Bulletin
c.	About (approximate)
C	Central
ca.	Circa(about)
CDB	Central Department of Botany
cm.	Centimeter
E	Eastern
E	Royal Botanic Garden, Edinburgh, UK
e.g.	<i>exempli gratia</i> or „for example“
ed.	Edition
eds.	Editors
Enum. Fl. Pl. Nep.	Enumeration of the Flowering Plants of Nepal
<i>et. al</i>	<i>et alia</i> or “and others”
Fig.	Figure
Fl. Bhutan	Flora of Bhutan
Fl. Brit. Ind.	Flora of British India
Fl. China	Flora of China
Fl. E. Himal.	Flora of Eastern Himalaya
Fl. Himalaya	Flowers of Himalaya
i.e.	<i>id est</i> : that is
IUCN	The world Conservation Union
J. Jap. Bot.	Journal of Japanese Botany
J. Linn. Soc.,Bot.	Journal of the Linnean Society, Botany
J. Plant Res.	Journal of Plant Resources
KATH	National Herbarium and Plant Laboratories, Godavari
Kew Bull.	Kew Bulletin
mm.	Milimeter
Nom. Cons.	Nomen Conservandum (singular); Nomina Conservanda (plural)
p., pp.	Page, pages

Sp. Pl.	Species Plantarum
Syst. Biol.	Systematic Biology
TI	University Museum, University of Tokyo
TUCH	Tribhuvan University Central Herbarium
var.	Variety
Viz.	Videlicet: namely
Vol.	Volume
W	Western

## ABSTRACT

Present study based on Angiosperm Phylogeny Group (APG III) system of classification of families Iridaceae, Colchicaceae and Melanthiaceae as a part of work of Flora of Nepal Vol. 10(Part I) consists of 8 genera and 19 species from Nepal. The present work is based on the morphometric evaluation of herbarium specimens deposited at different herbaria as BM, E, KATH, TUCH and TI. Predictive distribution modeling of the three families as Iridaceae, Colchicaceae and Melanthiaceae were done based on the presence only data from herbarium records and bioclimatic variables from WORLDCLIM using software DIVA-GIS 7.5 version. The species of families Colchicaceae, Iridaceae and Melanthiaceae possesses wide variation in the vegetative and reproductive characters. The species of family Iridaceae are delineated mostly on the basis of its floral characters i.e. falls having beard or ridges or simple. The species of family Colchicaceae are delineated on the basis of the chemical colchicines, while the species of family Melanthiaceae are delineated on the basis of their leaf, extrorse anthers and ovaries often with three distinct stigmas. The dendrogram based on cluster analysis of three families showed two distinct clusters. Cluster 1 consists of two families Colchicaceae and Melanthiaceae. These two families are closely related with each other and derived from the single family Liliaceae previously. Cluster 2 shows the species of family Iridaceae which are distinct from the rest of two families on the basis of its sword shaped leaves, three extrorse anthers and inferior ovary. Predictive current potential distribution of species of three families indicated that species of Colchicaceae are distributed in the Central and Eastern region of Nepal. The species of family Iridaceae are distributed in the North-Western region of Nepal and the species of family Melanthiaceae are distributed in the Mid-Western and Eastern region of Nepal.

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# 1. INTRODUCTION

## 1.1 Background

### 1.1.1 Iridaceae

The monocot family Iridaceae comprises approximately 2050 species distributed among 67 genera worldwide (Goldblatt *et al.*, 2008), representing one of the largest families of the superorder Lilliales (*sensu* Dahlgren, Clifford and Yeo, 1985). Iridaceae belongs to the order Asparagales, taking its name from the Irises, the largest and best known genus in Europe (Goldblatt, 1990). The genus *Iris* dates from 1753, when it was coined by Swedish botanist, Carl Linnaeus (Goldblatt, 1990). Its name derives from the Greek goddess, Iris, who carried messages from Olympus to earth along a rainbow, whose colours were seen by Linnaeus in the multi-hued petals of many of the species (Goldblatt, 1990).

Family Iridaceae was recognized to accommodate the genera comprising the petaloid monocots (Dahlgren and Rasmussen, 1983). More than 1/2 the species of the family Iridaceae in the world belonging to 6 genera: *Gladiolus* (255), *Iris* (ca. 225), *Moraea* (200), *Romulea* (90), *Geissorhiza* (85), *Crocus* (80), and *Sisyrinchium* (ca. 80).

The Iridaceae differentiated in the late Cretaceous, about 82 million years ago and diverged from the next most closely related family, the Doryanthaceae during the Campanian. The family is said to have originated in Antarctica-Australasia, although its subsequent radiation occurred elsewhere, notably in southern Africa and temperate and highland of South America at the end of the Eocene or later (Goldblatt *et al.*, 2008). The Neotropics are considered the second most important centre of diversity for this family with 250 known species and 30 genera (Eggers *et al.*, 2010; Judd *et al.*, 2008). *Iris* arose in the eastern and southern regions of Asia during the lower Tertiary (Rodionenko, 1987).

Iridaceae are usually perennial herbs with sword-shaped unifacial leaves; the inflorescence is a spike or panicle of solitary flowers, or forms a monochasial cyme or raceme and the flower has only three stamens, each opposite to an outer tepal (Goldblatt and Manning, 2008).

Members of Iridaceae occur in a great variety of habitats. About the only place they do not grow is in the sea itself, although *Gladiolus gweinzii* occurs on the seashore just above the

high tide mark within reach of the spray. Most species are adapted to seasonal climates that have a pronounced dry or cold period unfavourable for plant growth and during which the plants dormant. As a result most species are deciduous. Evergreen species are restricted to subtropical forests or savannah, temperate grasslands and perennially moist fynbos. A few species grow in marshes or along streams and some even grow only in the spray of seasonal waterfalls (Goldblatt, 1990).

Predictive models of species geographic distributions are important for a variety of applications in ecology and conservation (Graham *et al.*, 2004). Species distribution modelling can be a valuable and cost-effective tool for understanding a species occurrence probability with given environmental data, especially in poorly-surveyed regions of the least known species (Acevedo *et al.*, 2007; Guisan *et al.*, 2006; Zhang *et al.*, 2012). Knowledge about distribution and ecological features of the plants helps to decrease over exploitation by encouraging sustainable and discrete collection of plants from the world (Bhattacharya and Sharma, 2008).

### **1.2.1 Statement of the Problem**

The position of the *Iridaceae* within *Asparagales* at first seems difficult to justify on the basis of morphology (Goldblatt, 2000). Despite the lack of clear cut morphological links to *Asparagales*, multiple gene sequence analyses place *Iridaceae* well within this order (Chase *et al.*, 1995a, 2000; Fay *et al.*, 2000). The family occupies an isolated position among the well-resolved clades of the *asparagoids* and probably represents a relatively ancient divergence from the rest of the order (Goldblatt *et al.*, 1998).

*Iridaceae* was traditionally referred with *Liliaceae* where as (Cronquist, 1988) retained it as a part of *Liliales*. Hutchinson, 1934, 1973 assigned *Iridaceae* to its own separate order, *Iridales* and (Takhtajan, 1969) to *Iridales* together with the saprophytic herbaceous families *Geosiridaceae*, *Burmanniaceae* and *Corsiaceae*. Dahlgren and Clifford, 1982 classification of *Liliiflorae* (with much emphasis on seed characters) assigned *Iridaceae* to *Liliales* but subdivided *Liliaceae* into smaller families in a different order, *Asparagales*. (Cronquist, 1988) regarded *Iridaceae* (together with other families, such as *Agavaceae*) as “derived directly” from *Liliaceae sensu lato*, which includes many *Asparagales* and many authors have regarded the “pachycaul” *Dracaena*-type habit with secondary thickening growth present in a few genera of *Iridaceae* and several families of *Asparagales* as important for the natural

classification of this group (Waterhouse, 1987). The Angiosperm Phylogeny Group in 1998 and 2003 (APG I and APG II, respectively) system of flowering plant classification organizes flowering plants into a "selected number of monophyletic suprafamilial groups" and placed Iridaceae in the order Asparagales, which was part of a clade called "Non Commelinoid Monocots".

The position of *Iris* in different classification systems was confusing. Most classifications of *Iris* are based on morpho-anatomical features, ecological features, and cytogenetic analysis (Rodionenko 1987; Doronkin 1987, 1990). The extreme diversity of morpho-ecological characteristics, the evidence of convergent evolution in many traits used for systematic reconstructions, and a particularly complex pattern of chromosomal variation (Goldblatt *et al.*, 1997) make the study of the evolutionary and systematic relationships of *Iris* species complicated. Consequently, no consensus classification of *Iris* species has been constructed to date.

In regard to Nepalese species of family Iridaceae no work has been carried out extensively to date. The present work based on morphological characters has little tried to solve the problem in the case of family Iridaceae.

### 1.1.2 Colchicaceae

Liliaceae in the past was treated as a moderately large family consisting of about 280 genera and nearly 4,000 species in the world (Cronquist, 1981). Only since the modern taxonomic systems (APG), based on phylogenetic principles has been possible to recognize all its constituents and separate them leaving a relatively small modern family. The most current classification (APG, 1998) recognizes the following nine families: Alstroemeriaceae, Campynemataceae Dumort, **Colchicaceae**, Liliaceae, Luzuriagaceae Kunth, **Melanthiaceae** Batsch, Philesiaceae Dumort, Ripogonaceae, and Smilacaceae Vent.

Colchicaceae is moderate sized family within Liliales, comprising around 19 genera and 250 species of rhizomatous or cormous perennials distributed through the temperate and tropical areas of Africa, Europe, Asia, Australia and North America (Nordenstan, 1998) and are estimated to be crown age of early Oligocene ca. 34 m.y. (Vinnersten & Bremer 2001). No species occur in South and Central America (Vinnersten and Manning, 2007). The pattern indicates an early Gondwanan distribution, but a previous study (Vinnersten and Bremer,

2001) showed that the family is much younger. The family was first described by De Candolle (1805) for the six genera, *Bulbocodium* (now included in *Colchicum*), *Colchicum*, *Merendera*, *Erythronium*, *Tofieldia* and *Veratrum*. Most authors however, continued to include it within a widely circumscribed Liliaceae.

Members of Colchicaceae are known to contain the alkaloid colchicine, regarded as the biological hallmark of the family (Vinnersten & Larsson 2010; Wildman & Pursey 1968). Family Colchicaceae are characterised by septicidal capsule, a tripartite style and extrorse anthers (Baker, 1879). Colchicaceae are long-lived cormose or rhizomatous geophytes with rather large flowers with six, usually free tepals, each more or less enveloping a stamen and nectaries on the base of filaments or tepals (Nordenstam, 1998).

### **1.2.2 Statement of the Problem**

The family Colchicaceae has undergone several taxonomic changes since its description by de Candolle in 1805. Baker (1879, 1897, 1898) included Colchicaceae in the family Liliaceae *sensu lato*, a heterogenous group (Dahlgren *et al.*, 1985) that included many other distantly related families in the sense of recent phylogenetic classification such as APG III (2009). In the first comprehensive monographic treatment of Liliaceae, Baker (1879) considered Colchicaceae as one of the three main suborders or divisions of the family Liliaceae based upon variation in structure of fruit, style and anthers. Suborder a included members of the family Liliaceae *sensu stricto* characterised by loculicidal capsule, an undivided style and introrse anthers. Suborder b included members of the family Colchicaceae characterised by septicidal capsule, a tripartite style and extrorse anthers. Suborder c included members of the family Asparagaceae characterised by baccate fruits. Based on these differences, Baker (1897, 1898) treated Colchicaceae, Asparagaceae and Liliaceae *sensu strict* as suborders or series of the family Liliaceae. He subdivided Colchicaceae into two tribes: Anguillarieae D. Don, characterised by bulbs or corms as its rootstock, a loculicidal to septicidal capsule and perianth segments narrowed into a distinct claw and Uvularieae A. Gray, characterised by a tuberous rootstock or creeping rhizome and a loculicidal capsule. From its establishment, there were two conflicting opinions: whether to treat Colchicaceae as a subfamily of Liliaceae (Baker 1879, 1897, 1898), or as a separate family (de Candolle 1805; Dahlgren *et al.*, 1985). The problem with Colchicaceae at this stage was therefore, mainly of rank rather than circumscription.

### 1.1.3 Melanthiaceae

Melanthiaceae comprise 11–16 genera and ca.154–201 species in the world are predominately woodland and alpine perennial herbs occurring in the temperate zones occasionally extending to Arctic zones of the Northern Hemisphere (APG 2009; Tamura 1998; Zomlefer *et al.*, 2001, 2003). The crown age for Melanthiaceae is estimated to be 42m.y. (Vinnersten & Bremer, 2001). Melanthiaceae comprise five tribes as Helioniadeae (*Helonias*, *Heloniopsis*, *Ypsilandra*); Chionographideae (*Chinographis*, *Chamaelirium*); Melanthieae (*Amianthium*, *Anticlea*, *Melanthium*, *Schoenocaulon*, *Stenanthium*, *Toxicoscordion*, *Veratrum* and *Zigadenus*); Xerophylleae (*Xerophyllum*) and Parideae (*Paris*, *Pseudotrillium*, *Trillium/Trillidium*) of mainly perennial herbs that are morphologically characterized by extrorse anthers and three styles (Zomlefer 1997).

Along with many other lilioid monocots, early authors considered members of this family to belong to the family Liliaceae, in part because both their sepals and petals closely resemble each other and are often large and showy like those of lilies (Zomlefer *et al.*, 2001) while some more recent taxonomists have placed them in a family Trilliaceae.

### 1.2.3 Statement of the Problem

The taxonomic history of this group of lilies has been problematic, to say the least (Zomlefer 1997), but appears to be well defined morphologically by extrorse anthers and three styles (again, these characters occur elsewhere in Liliales). Tamura (1998) did not include Trilliaceae (Zomlefer 1996; Tamura 1998) in his treatment. Trilliaceae resolves as embedded within Melanthiaceae in many molecular analyses (Rudall *et al.*, 2000).

The melanthioid genera (Melanthiaceae sensu Tamura, 1998) usually have been placed (often as a subfamily) within the Liliaceae *s.l.* (e.g., Engler, 1888; Hutchinson, 1934, 1959, 1973; Takhtajan, 1980; Thorne, 1983; Cronquist, 1988).

The systematics of Trilliaceae is not resolved, despite a long history of study and the distinctiveness of the group. One major question regards generic delineation in Trillaceae is the traditional generic split between *Trillium* and *Paris* valid or should all species be placed in single genus.

### **1.3 Objectives**

Realizing limited work on these families Iridaceae, Colchicaceae and Melanthiaceae, present work has been undertaken. The objectives of the present study are:

- To undertake taxonomic study of the families Iridaceae, Colchicaceae and Melanthiaceae of Nepal.
- To assess the status and distribution of the families Iridaceae, Colchicaceae and Melanthiaceae in the Nepal Himalayas.

### **1.4 Limitations**

Taxonomic literature and herbarium specimens are the most important factors determining the quality of any taxonomic research work. However, both taxonomic literature and herbarium specimens are quite limited in our herbaria and country as well. Due to lack of replicate specimens of some of the specimens it was hard to make its floral study. The flowers of the family Iridaceae were extremely in poor condition too. Due to lack of many specimens from Nepal, study was done with the help of photographs from E, BM and some of them downloaded from TI herbaria as well. Because of shortage of time, it was not possible to study specimens from the other herbaria.

## 2. LITERATURE REVIEW

### 2.1 History of Classification of the Family Iridaceae, Colchicaceae and Melanthiaceae

#### 2.1.1 Iridaceae

The family name Iridaceae is attributed to Antoine Laurent de Jussieu's (1789) *Genera Plantarum*, in *Horto Regio Parisiensi exaratom*, and is a conserved name, so that even if an earlier name were to be discovered for the family, Iridaceae would remain valid. The family has been accepted in all major classification systems of the 20th century. Members of Iridaceae are typically characterized by the possession of isobilateral, equitant leaves, styloid crystals, inferior ovaries, and flowers with three stamens. Iridaceae was traditionally referred with Liliaceae where as Cronquist (1988) retained it as a part of Liliales.

The order Asparagales has only recently been recognized in classification systems, with the advent of phylogenetics. Older systems based on morphology placed many of the species now included in Asparagales into the lily family (Liliaceae); where other families were recognized these were generally placed into the old order Liliales: a very large order which was used for almost all monocotyledons with colourful tepals and without starch in their endosperm (the lilioid monocots). The Liliales was difficult to divide into families because morphological characters were not present in patterns that clearly demarcated groups. Thus, the Wettstein system (1935), did not recognise the Asparagales, and placed many of the plants involved in an order called 'Liliiflorae'. The widely used Cronquist system of (1968–1988) also did not recognise Asparagales, using instead the very broadly defined order Liliales. The boundaries of the Asparagales and of its families have undergone a series of changes in recent years; future research may lead to further changes and ultimately greater stability.

In Dahlgren, Clifford, and Yeo's (1985) synthesis, the lilioid monocotyledons are recognized as two orders, the Asparagales, (31 families) and Liliales (10 families) that have evolved many traits in parallel. Two of the most important and consistent characters separating these two orders are the presence of septal nectaries in the ovary and phytomelan in the seed coat of Asparagales. Perigonal nectaries and the absence of phytomelan characterize the Liliales. In Dahlgren *et al.*, (1985) synthesis, superorder Liliiflorae encompasses 5 orders: Dioscoreales, Asparagales, Melanthiales, Burmanniales and Liliales. Thirty-one families

were included in Asparagales by Dahlgren *et al.*, 1985. Iridaceae classified with Liliales by Dahlgren *et al.*, 1985 are now known to belong to Asparagales. Conversely, several families treated by Dahlgren *et al.*, 1985 within Asparagales have been moved to Liliales.

Iridaceae resolves in an isolated position near base of the higher asparagoids. (Dahlgren *et al.*, 1985) classified the Iridaceae in Liliales near Colchicaceae on the basis of their extrorse anthers, non-phytomelanous seeds, mottled tepals, perigonal nectaries and nuclear endosperm development. Perigonal nectaries are now known to represent an independent, derived state in Iridaceae as are mottled tepals and septal nectaries are the ancestral state for the family (Goldblatt *et al.*, 1998). Seven subfamilies are recognized by (Goldblatt *et al.*, 2008, Goldblatt and Manning, 2008) for Iridaceae as: Isophysidoideae (1genus: 1species), Patersonioideae (1genus: 21 Species), Geosiridoideae (1 genus: 1 species), Aristeoideae (1 genus: ca. 55 species), Nivenioideae (3 genus: 15 species), Crocoideae (29 genus: ca. 1032 species), Iridoideae (29 genus: ca. 890 species). Within the Asparagales, a precise understanding of the relationships among the basal, “lower” families is still elusive (Chase *et al.*, 2000; Fay *et al.*, 2000). Adhering to Huber ’ s (1969) earlier ideas, (Dahlgren *et al.*, 1985) considered Asparagales a monophyletic group separate from Liliales. Finally, APG (Angiosperm Phylogeny Group, 2009) kept family Iridaceae in the order Asparagales.

### 2.1.2 Colchicaceae

The taxonomic history of the family began in 1805 when de Candolle was the first to use the family name Colchicaceae, in the *Flore Francaise*. He included six genera: *Bulbocodium*, *Colchicum*, and *Merendera*, which are still members of the family, and *Erythronium*, *Tofieldia*, and *Veratrum*, today assigned to Liliaceae, Tofieldiaceae, and Melanthiaceae, respectively. Bentham and Hooker, 1883 treated Colchicaceae in three different tribes: Colchiceae (*Colchium*, *Synsiphon*, now included in *Colchium* and *Merendera*); Anguillarieae (*Androcymbium*, *Anguillarea*, now included in *Wurmbea*), *Baeometra*, *Burchardia*, *Iphigenia*, *Onixotis* and Uvularieae (*Disporum*, *Gloriosa*, *Littonia*, *Sandersonia*, *Tricyrtis* and provisionally *Walleria*); the latter two genera are now placed in Liliaceae and Tecophilaeaceae respectively.

In the following 100 to 150 years, all these genera were mostly treated as a part of Liliaceae *sensu lato* (*s.l.*). Nordenstam, 1982 summarized the taxonomic history of Colchicaceae and suggested some new tribal delimitation. He merged Neodregeae and Wurmbeae into one

tribe, the Anguillareae, recognized by sessile flowers and ebracteate spicate inflorescences.

### **2.1.3 Melanthiaceae**

De Jussieu (1789) treated the genera of Melanthiaceae under family Liliaceae. The melanthioid genera (Melanthiaceae *sensu* Tamura, 1998) usually have been placed (often as a subfamily) within the Liliaceae (Engler, 1888; Hutchinson, 1934, 1959, 1973; Takhtajan, 1980; Thorne, 1983; Cronquist, 1988). Critical studies by Dahlgren and associates (Dahlgren and Clifford, 1982; Dahlgren, Clifford, and Yeo, 1985) established numerous segregate families formerly included within the broadly defined, polyphyletic Liliaceae. Berg (1962) reported that *Trillium* and *Paris* as well as *Scilla* display similar embryological traits. Contrary to earlier authors, Dahlgren *et al.*, (1985) did not unite Liliaceae and Trilliaceae, within the order Liliales. They placed Trilliaceae in the order Dioscoreales. Trilliaceae resolves as embedded within Melanthiaceae in many molecular analyses (Rudall *et al.*, 2000). Based on molecular evidence, the APG (1998) includes Trillaceae in Melanthiaceae as tribe Parideae under the principle of monophyly.

## **2.2. PHYLOGENY**

### **2.2.1 Iridaceae**

The Iridaceae differentiated in the late Cretaceous, about 82 million years ago, and diverged from the next most closely related family, the Doryanthaceae, during the Campanian (Goldblatt *et al.*, 2008). Phylogenetic analysis (cladistics) has become the standard methodology for testing hypotheses of phylogeny among organisms in systematic biology. The phylogenetic relationships of the Iridaceae only began to be explored seriously after the Swedish botanist Rolf Dahlgren began to refine the classification of the monocotyledons in the 1980s. Dahlgren and his collaborators (e.g, Dahlgren and Rasmussen, 1983; Dahlgren *et al.*, 1985) first recognized two and then three orders to accommodate the families and genera comprising what are loosely called the petaloid monocots, Asparagales, Liliales, and Melanthiales. The status of the first two orders has since been confirmed by molecular studies (Chase *et al.*, 1995). The Melanthiales have however proven heterogeneous, including some families (Melanthiaceae) nested in the Liliales but Tofieldiaceae (formerly Tofieldieae) fall in Alismatales and the affinities of Nartheciaceae (Narthecieae) may lie with Dioscoreales (Chase *et al.*, 1995; Goldblatt, 1995; Angiosperm Phylogeny Group, 1998).

The composition of Asparagales and Liliales, as circumscribed by (Dahlgren *et al.*, 1985), has broadly been confirmed by subsequent molecular study. However, the affinities of the Iridaceae assigned to Liliales by (Dahlgren *et al.*, 1985) largely on the basis of mottled tepals and perigonal nectaries are contradicted by molecular data. The family is nested among some basal families of Asparagales. The position of the Iridaceae within Asparagales at first seems difficult to justify on the basis of morphology. Most Asparagales with dry fruits have seeds with a black seed coat (with a layer of phytomelan), extrorse anthers, and septal nectaries.

### **2.2.2 Colchicaceae**

The closest relatives of Colchicaceae are Alstroemeriaceae, which have most of their species in South America and which were the subject of recent phylogenetic and biogeographic work (Chacon *et al.*, 2012a). The closest relatives of the Alstroemeriaceae-Colchicaceae clade are the Petermanniaceae (Fay *et al.*, 2006), a monotypic family of rhizomatous woody climbers restricted to temperate rainforests in east Australia (Conran and Clifford, 1998).

Previous molecular-phylogenetic work on the Colchicaceae led to the recognition of six small tribes: Burchardieae, Uvularieae, Tripladenieae, Iphigenieae, Anguillarieae, and Colchiceae (Vinnersten and Reeves, 2003; Vinnersten and Manning, 2007).

Although several studies have been done on both Liliaceae and Colchicaceae, the taxonomic treatment of several genera within Colchicaceae is still considered to be ambiguous (Manning *et al.*, 2007; Persson 2007; Vinnersten & Manning, 2007; Vinnersten & Reeves, 2003). The APG III system, of 2009 (unchanged from the APG systems, of 1998 and 2003) does recognize the family Colchicaceae and places it in the order Liliales in the clade monocots and regards the family as including some two hundred species of herbaceous perennials with rhizomes or corms.

### **2.2.3 Melanthiaceae**

According to analyses of molecular data (Chase *et al.*, 1995, 2000; Rudall *et al.*, 2000; APG, 1998; Soltis *et al.*, 2000), the family is paraphyletic with *Trillium* (Trilliaceae) embedded within it as the sister group of *Xerophyllum* (Zomlefer, 1996). This surprising relationship between the Trilliaceae and Melanthiaceae is supported by other molecular studies by (Davis, 1995) and (Kato *et al.*, 1995). Currently, this expanded circumscription has the morphological support of extrorse anthers and ovaries often with three distinct styles (Rudall *et al.*, 2000) and merits further study. Alternatively, other botanists have suggested segregate

familial status for the well-defined “tribal”: Chionographidaceae, Heloniadaceae, Xerophyllaceae (Takhtajan, 1994, 1997; Zomlefer, 1997a) along with the segregate Trilliaceae, leaving a very restricted Melanthiaceae consisting of only tribe Melanthieae. Based on these data, the Trilliaceae have been submerged within the Melanthiaceae by the (APG, 1998).

### **2.3. Himalayan Iridaceae, Colchicaceae and Melanthiaceae**

The Himalayan region is a major hotspot of biodiversity. The Himalaya is a 2,400km long and 250-350km wide mountain range stretching from northern Myanmar in the east to Pamir Knot on the Afghan border in the west; at its highest point (Mount Everest), it reaches up to 8,848m (Valdiya, 1998). It lies between the Indo-Gangetic plain in the south and the Tibetan Plateau in the north. The Himalayan range includes about 30 peaks exceeding 7,600m altitude and resulted from rapid mountain-building tectonic forces and vigorous erosion processes (Gurung, 1999), which have led to a complex topography of high mountains and narrow ridges traversed by extremely deep river gorges. Recognizing the heterogenous dispersion of the bio-diversity elements in the Himalaya, based on geology, altitude, vegetation and spatial pattern of distribution, the Himalaya is classified variously. Longitudinally the Himalaya are divided into three parts as: Western Himalaya, the Indus river marks the western boundary which includes Pakistan, Jammu and Kashmir, Himanchal Pradesh and Uttaranchal Pradesh upto the western border of Nepal; Central Himalaya, includes whole of Nepal and Sikkim and Eastern Himalaya covers the kingdom of Bhutan and the Indian state of Arunachal Pradesh (Zurick *et al.*, 2005)

Out of total 10,000 species of flowering plants, 31.6% species are endemic to the Himalaya (Conservation International, 2012). The Nepal Himalaya lies along the central part of the Himalayan range. In mountainous areas, such as the Himalayas, the maximum number of endemic species is expected to occur at high elevations, due to isolation mechanisms (Shrestha and Joshi, 1996).

#### **2.3.1 Iridaceae**

Hooker (1894) described three genera of family Iridaceae into two tribe in “Flora of British India”. He placed *Belamcanda* and *Crocus* into tribe Sisyrinchieae and *Iris* into tribe Moreae. He described thirteen species of *Iris* and one species of *Crocus* viz., *Iris aitchisoni*, *Iris ensata*, *Iris spuria*, *Iris aurea*, *Iris wattii*, *Iris milesii*, *Iris nepalensis*, *Iris gilgitensis*, *Iris kumaonensis*, *Iris goniocarpa*, *Iris duthieii*, *Iris hookeriana*, *Iris clarkei* and *Crocus sativus*.

Collett (1921) reported two species of *Iris* as *Iris nepalensis* and *Iris kumaonensis* in “Flora Simlensis”.

Noltie (1994) described five genera of family Iridaceae in “Flora of Bhutan” viz., *Belamcanda*, *Crococima*, *Elutherine*, *Gladiolus* and *Iris*. He reported seven species of *Iris* viz., *Iris tectorum*, *Iris germanica*, *Iris goniocarpa*, *Iris kemaonensis*, *Iris dolichosipon*, *Iris decora* and *Iris clarkei*.

Zhao Yutang *et al.*, (2000) described three genera of family Iridaceae in “Flora of China” viz., *Belamcanda*, *Crocus* and *Iris*. They reported sixty species of *Iris* among them following five species are reported in Nepal, viz., *Iris decora*, *Iris collettii*, *Iris goniocarpa*, *Iris kemaonensis* and *Iris clarkei* and two species of *Crocus* viz., *Crocus sativus* and *Crocus alatavicus*, among these two species only *Crocus sativus* is reported from Nepal.

Ali (2000) described six genera of family Iridaceae in “Flora of Pakistan” viz., *Crocus*, *Freesia*, *Gladiolus*, *Iris*, *Ixia* and *Moraea*. The genus *Iris* divided into five subgenus viz., *Hermodactyloides* (*Iris reticulata*), *Scorpiris* (*Iris aitchisonii*, *Iris stocksii* and *Iris platyptera*), *Nepalensis* (*Iris decora*), *Iris* (*Iris kashmiriana*, *Iris germanica*, *Iris falcifolia*, *Iris hookeriana* and *Iris kemaonensis*) and *Lamiriris* (*Iris milesii*). Among these three species *Iris decora*, *Iris germanica* and *Iris kemaonensis* is found in Nepal. Two species of *Crocus* were reported as *Crocus sativus* and *Crocus korolkowii* and only *Crocus sativus* reported from Nepal.

Many attempts have been made to document the regional flora of Nepal from ancient time. Some of them are as follows:

Hara (1966) described two genera and two species under family Iridaceae as *Belamcanda chinensis* and *Iris clarkei* in “The Flora of Eastern Himalaya”.

Malla *et al.*, (1976) reported one species of *Iris* as *Iris decora* under family Iridaceae in “Flora of Langtang”.

Hara (1978) reported six species of *Iris* in family Iridaceae viz., *Iris germanica*, *Iris kemaonensis*, *Iris staintonii*, *Iris decora*, *Iris goniocarpa* and *Iris clarkei* in “An Enumeration

of the Flowering Plants of Nepal”.

Polunin and Stainton (1984) reported three genera viz., *Belamcanda*, *Crocus* and *Iris* under family Iridaceae and nine species of *Iris* viz., *Iris lactea*, *Iris spuria*, *Iris clarkei*, *Iris decora*, *Iris milesii*, *Iris goniocarpa*, *Iris kemaonensis*, *Iris hookeriana* and *Iris germanica* and one species of *Crocus sativus* and one species of *Belamcanda chinensis* in “Flowers of the Himalaya”.

Press *et al.*, (2000) reported two genera viz., *Belamcanda* and *Iris* under family Iridaceae and six species of *Iris* viz., *Iris clarkei*, *Iris decora*, *Iris germanica* var. *nepalensis*, *Iris goniocarpa*, *Iris kemaonensis*, *Iris staintonii* and *Belamcanda chinensis* in “Annotated Checklist of Flowering Plants of Nepal”.

Ohba and Sharma (2008) described two genera viz., *Belamcanda* and *Iris* under family Iridaceae and two species of *Iris* viz., *Iris goniocarpa* and *Iris kemaonensis* and *Belamcanda chinensis* in “Flora of Mustang”.

Rajbhandari *et al.*, (2010) reported two genera viz., *Belamcanda* and *Iris* under family Iridaceae and four species of *Iris* viz., *Iris clarkei*, *Iris decora*, *Iris kemaonensis* and *Iris staintonii* and *Belamcanda chinensis* in “Catalogue of Nepalese Flowering Plants”.

Chhetri and Bhattarai (2013) documented three species of *Iris* as *Iris staintonii*, *Iris kemaonensis* and *Iris clarkei* from Upper Manaslu.

### **2.3.2 Colchicaceae and Melanthiaceae**

Hooker (1894) divided the family Liliaceae in 3 series, 16 tribes and described 120 species under 35 genera in “Flora of British India”. He placed *Heterosmilax* and *Smilax* into tribe Smilaceae; *Asparagus* into tribe Asparagaceae; *Polygonatum*, *Smilacina* and *Streptopus* into tribe Polygonateae; *Theropogon* into tribe Convallarieae; *Aspidistra*, *Gonioscypha* and *Tupistra* into tribe Aspidistreae; *Hemerocallis* into tribe Hemerocalleae; *Cordyline* and *Dracaena* into tribe Dracaeneae; *Asphodelus*, *Chlorophytum*, *Dianella* and *Eremurus* into tribe Asphodelae; *Allium* into tribe Allieae; *Dipcadi*, *Scilla* and *Urginea* into tribe Scilieae; *Fritillaria*, *Gagea*, *Lilium*, *Lloydia* and *Tulipa* into tribe Tulipeae; *Colchicum*, *Merendera* into tribe Colchiceae; *Iphigenia* into tribe Anguillaridae; *Tofieldia* into tribe Nartheciae;

*Disporum*, *Gloriosa* and *Tricyetis* into tribe Uvularieae; *Clintonia*, *Paris* and *Trillium* into tribe Medeoleae. Among these genera, *Disporum*, *Gloriosa* and *Iphigenia* are placed into separate family Colchicaceae and genera like *Paris* and *Trillium* are placed into separate family Melanthiaceae.

Noltie (1994) described genera like *Paris*, *Trillidium* and *Trillium* under family Trilliaceae; *Alertis*, *Tofieldia* and *Ypsilandra* under family Melanthiaceae; *Gloriosa* under family Colchicaceae and genera like *Clintonia*, *Disporum*, *Streptopus* and *Tricyrtis* under family Uvulariaceae in “Flora of Bhutan.” Now, rearrangement of these genera occurs as *Paris*, *Trillidium* and *Ypsilandra* into family Melanthiaceae and *Disporum* and *Gloriosa* under family Colchicaceae.

Chen *et al.*, (2000) described 57 genera and 726 species under Liliaceae in “Flora of China”. Among all these genera *Disporum*, *Gloriosa* and *Iphigenia* is separate into the family Colchicaceae and *Paris*, *Trillium* and *Ypsilandra* separated into the family Melanthiaceae.

Collett (1921) described 18 genera under family Liliaceae in “Flora Simlensis” viz., *Allium*, *Asphodelus*, *Asparagus*, *Dipcadi*, *Disporum*, *Gloriosa*, *Gagea*, *Fritillaria*, *Iphigenia*, *Lilium*, *Lloydia*, *Paris*, *Polygonatum*, *Smilacina*, *Smilax*, *Trillium*, *Tulipa* and *Urginea*. Among these, now *Paris* and *Trillium* are treated under family Melanthiaceae and *Disporum* and *Gloriosa* are treated under family Colchicaceae.

Many attempts have been done to explore the regional flora of Colchicaceae and Melanthiaceae in different time period as follows:

Hara (1966) described 18 genera and 38 species under family Liliaceae in “Flora of Eastern Himalaya” viz., *Aletris*, *Allium*, *Asparagus*, *Campylandra*, *Chlorophytum*, *Disporum*, *Hemerocallis*, *Ophiopogon*, *Paris*, *Peliosanthes*, *Polygonatum* and *Smilacina*. Among these genera, *Paris* placed under family Melanthiaceae and *Disporum* under family Colchicaceae.

Malla *et al.*, (1976) reported 12 genera and 20 species under family Liliaceae in “Flora of Langtang” viz., *Alertis*, *Allium*, *Asparagus*, *Clintonia*, *Disporum*, *Fritillaria*, *Gloriosa*, *Lilium*, *Notholirion*, *Paris*, *Polygonatum*, *Smilacina* and *Theropogon*. Among these genera *Disporum* and *Gloriosa* are placed under family Colchicaceae and *Paris* under family Melanthiaceae.

Malla *et al.*, (1986) reported 10 (*Allium*, *Asparagus*, *Cardiocrinum*, *Campylandra*, *Chlorophytum*, *Disporum*, *Lilium*, *Ophiopogon*, *Paris* and *Polygonatum*) genera and 16 species under family Liliaceae in “Flora of Kathmandu Valley”. But now, the genus *Disporum* is treated under the family Colchicaceae and *Paris* under the family Melanthiaceae.

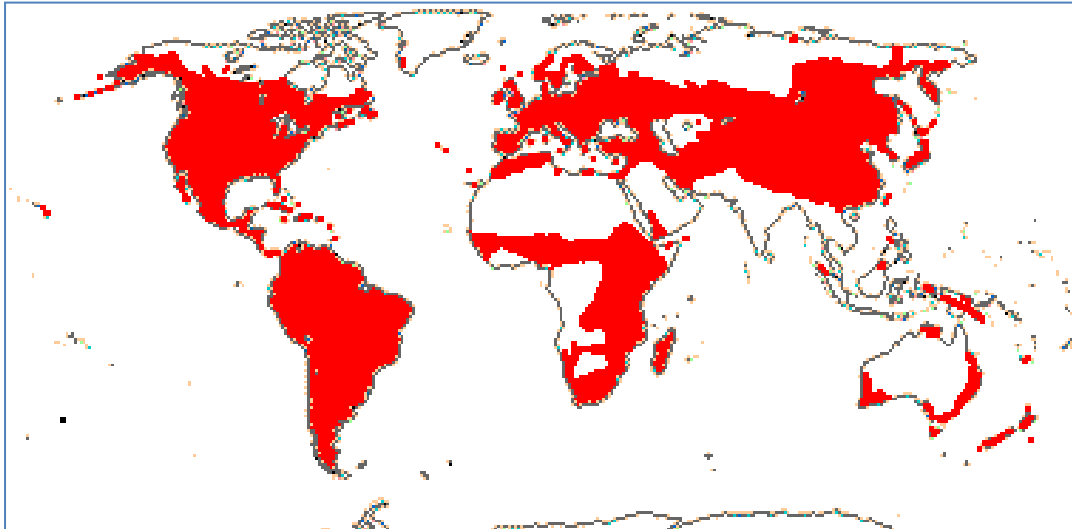
Press *et al.*, (2000) reported 33 genera and 97 species under the family Liliaceae in “Annotated Checklist of Flowering Plants of Nepal”. The genus are *Aloe*, *Aletris*, *Asparagus*, *Campylandra*, *Cardiocrinum*, *Chlorophytum*, *Clintonia*, *Dianella*, *Disporum*, *Dipcadi*, *Fritillaria*, *Gagea*, *Gloriosa*, *Helonias*, *Hemerocallis*, *Iphigenia*, *Lilium*, *Lloydia*, *Maianthemum*, *Notholirion*, *Ophiopogon*, *Paris*, *Peliosanthes*, *Polygonatum*, *Smilax*, *Streptopus*, *Theropogon*, *Tofieldia*, *Tricyrtis*, *Trillidium*, *Tupistra* and *Urginea*. Among these, recent classification system placed *Disporum*, *Gloriosa* and *Iphigenia* into the family Colchicaceae and *Paris*, *Trillidium* and *Helonias* under the family Melanthiaceae.

## **2.4 Distribution and Ecology of Iridaceae, Colchicaceae and Melanthiaceae**

### **2.4.1 Iridaceae**

The Iridaceae differentiated in the late Cretaceous, about 82 million years ago (Goldblatt *et al.*, 2008). The Iridaceae are worldwide in distribution and originated in Antarctica-Australasia, although its subsequent radiation occurred elsewhere, notably in southern Africa and temperate and highland South America (Fig.1) at the end of the Eocene or later (Goldblatt *et al.*, 2008). Irises arose in the eastern and southern regions of Asia during the lower Tertiary (Rodionenko, 1987).

Members of Iridaceae occur in a great variety of habitats and most species are adapted to seasonal climates that have a pronounced dry or cold period unfavourable for plant growth and during which the plants dormant (Goldblatt, 1990). As a result most species are deciduous while, evergreen species are



restricted to subtropical forests or savannah, temperate grasslands and perennially moist fynbos.

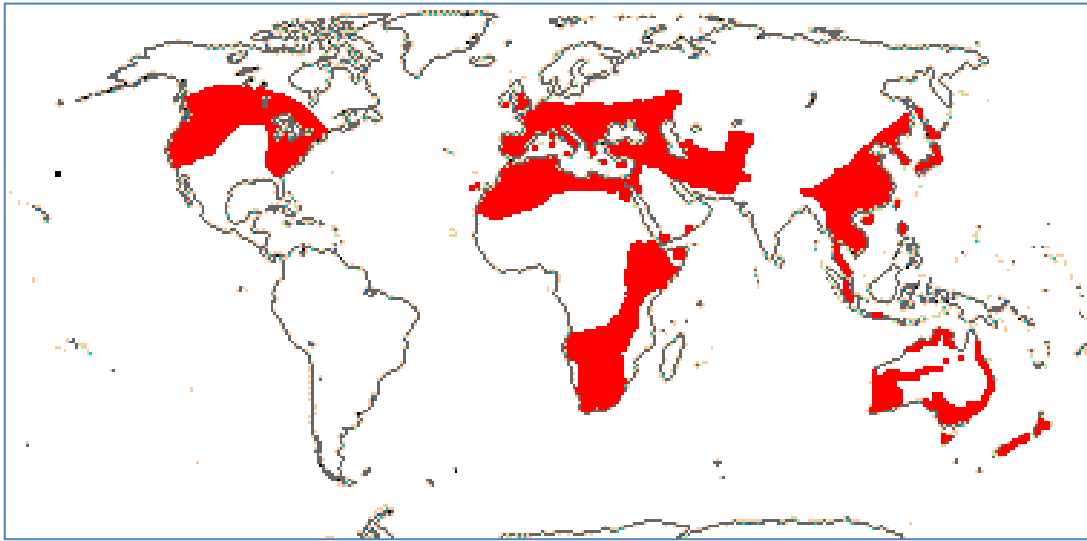
**Fig. 1** World map of Iridaceae (Source: Stevens 2001, onwards).

A few species grow in marshes or along streams and some even grow only in the spray of seasonal waterfalls (Goldblatt, 1990). The above ground parts (leaves and stems) of deciduous species die down when the bulb or corm enters dormancy. At this time the plants are dormant and their bulbs or corms are able to survive the heat of the fires underground. With the arrival of the first rains, the dormant corms are ready to burst into growth, sending up flowers and stems before they can be shaded out by other vegetation. Many grassland and fynbos irids flower best after fires and some fynbos species will only flower in the season after a fire (Goldblatt, 1990).

#### **2.4.2 Colchicaceae**

To fully understand and appreciate the biogeographic and evolutionary patterns of Colchicaceae in different continents, a molecular systematic probe into when and where important divergence events happened has recently been advocated (Vinnersten & Bremer, 2001). A biogeographical and molecular dating analysis of the phylogeny of the order Liliales indicates that the split between Colchicaceae and its sister families (Alstroemeriaceae and Luzuriagaceae) represents a vicariance event following the disintegration of the Australian-Antarctican-South American link in the early Oligocene, about 34 million years ago (Vinnersten & Bremer, 2001). Colchicaceae originated in Australia, first reached Asia and

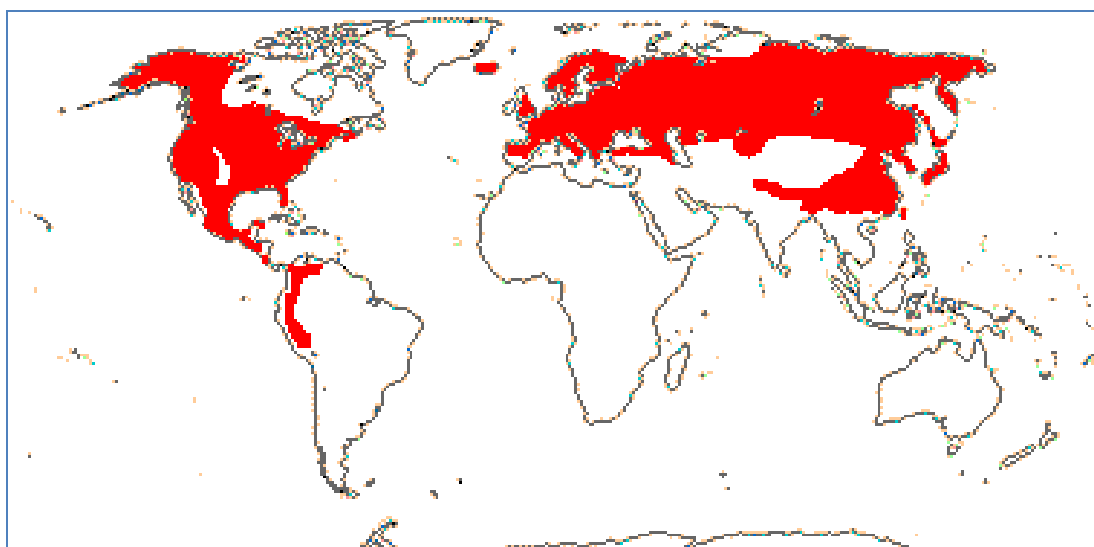
North America, and later Africa from where they expanded to Europe and also dispersed back to Australia (Fig 2).



**Fig. 2** World map of Colchicaceae (Source: Stevens 2001, onwards).

### **2.4.3 Melanthiaceae**

Melanthiaceae species are of predominately woodland and alpine perennial herbs occurring in the temperate zones occasionally extending to Arctic zones of the Northern Hemisphere (APG 2009; Tamura 1998; Zomlefer *et al.*, 2001, 2003) (Fig 3). The crown age for Melianthiaceae is estimated be 42 m.y. (Vinnersten & Bremer, 2001).



**Fig. 3** World map of Melanthiaceae (Source: Stevens 2001, onwards).

The plants of family Melanthiaceae likes moist, damp, and shady places (such as under deciduous trees) and thrives well in places with moist and humus rich soil under canopy of forest in full shade to partial shade (Jha *et al.*, 2010). Soil nutrients like organic matter, nitrogen and phosphorus were found in higher levels in areas where the plant of Melanthiaceae was absent (Jha *et al.*, 2010).

### 3. MATERIALS AND METHODS

#### 3.1 Taxonomic study

Morphological characters are found to be very important characters for identification. The taxonomic treatment of the family Iridaceae, Colchicaceae and Melanthiaceae has been done only with the help of gross morphological characters of specimens housed at different national and international herbaria as E(UK), BM(UK), TI(Japan), TUCH and KATH (Nepal) (acronyms in accordance with Holmgren *et al.*, 1990). Morphological study was carried out with the help of a checklist of species made through an exhaustive literature review of floras, checklists and journal articles covering the study region and adjacent areas.

The work is mainly based on the study of herbarium materials at National Herbarium and Research Centre, Godwari (KATH) and Tribhuvan University Central Herbarium (TUCH). The deposited herbarium at BM and E were examined with the help of high resolution digital images and some of the specimens were examined with the help of scanned herbarium downloaded from Flora of Nepal Database (TI). The morphological characters were examined with the help of stereomicroscope and compound microscope. All flower measurements were made in the mature parts. The information about the flower colour of the herbarium specimens was based on the collector's notes. After examining all the specimens, the detail reproductive and morphological characters of the specimens were entered into the excel sheet. Recorded characters were then compared and a set of characters which were unique and best described the particular species were chosen for the descriptions and also to produce dichotomous keys. The final descriptions were then checked and updated with all the available specimens.

All the available information in the herbarium sheets were noted as phenology, altitudinal range, date, ecology, latitude, longitude, remarks, etc. in the final description along with original author citation, synonyms, etc. List of herbarium specimens observed were listed according to the developmental region from west to east.

Finally, free hand illustrations were made for all species which included habitat, floral parts, fruits, roots, etc. Only habit sketch were drawn of the specimens which were not available in the herbarium but available in the form of digital and scanned images. Distribution maps were made with the help of ArcGIS Version 9.3, based on specimen label geographic data.

The present work has been carried out as the contribution to “The Flora of Nepal”, vol. 10 part 1. The work has aimed to attempt according to modern classification system i.e. APG system following the guideline for “Flora of Nepal” vol. 10 part 1.

### **3.2 Cluster analysis: Dendrogram**

A dendrogram (from Greek *dendron* "tree" and *gramma* "drawing") is a tree diagram frequently used to illustrate the arrangement of the clusters produced by hierarchical clustering. Present study attempts the cluster analysis of the Nepalese species on the basis of reproductive and morphological characters. Altogether sixteen vegetative and reproductive characters were taken for genera of Iridaceae, Colchicaceae and Melanthiaceae to perform cluster analysis. Dendrogram were constructed on the generic level because character coding of three families were done combinely. Character coding was done based upon (Evans *et al.*, 2000). Both two state coding and multistate coding was done per the requirement throughout analysis. The characters and character states were chosen based upon their consistency of characters. The details of the character coding are given in APPENDIX (3) . Statistical software SPSS 16.0 for windows was used for dendrogram construction. The details of analysis consisting variables entry and data are given in APPENDIX (3).

### **3.3 Phenology**

Phenology is the study of periodic plant life cycle events and how these are influenced by seasonal and interannual variations in climate, as well as habitat factors (such as elevation). The word is derived from the Greek (*phaino*), "to show, to bring to light, make to appear (*logos*), amongst others "study, discourse, reasoning and indicates that phenology has been principally concerned with the dates of first occurrence of biological events in their annual cycle. Phenological records can be a useful proxy for temperature in historical climatology, especially in the study of climate change and global warming. In this study all the phenological records were done on the basis of herbarium specimens and related literatures.

### **3.4 Species Distribution Modeling**

#### **3.4.1 Data sources: climatic and species data**

Total locality records of families Iridaceae (220), Colchicaceae (127) and Melanthiaceae (188, Paris=130) of altogether 535 points of 19 species were used for distribution modeling.

*Paris polyphylla* of family Melanthiaceae which has been listed in the vulnerable category is also used for distribution modeling separately. All these locality records were obtained from the herbarium specimens housed at different herbaria as BM, E, KATH, TI and TUCH. A set of 19 BIOCLIM variables for Nepal were extracted from WORLDCLIM (<http://www.worldclim.org>) (Hijmans *et al.*, 2005). All Bioclim layers consist of continuous data on precipitation, temperature and seasonality variables. WORLDCLIM contains Bioclim data at a spatial resolution of 2.5 arc sec (~5km<sup>2</sup>) obtained by interpolation of climatic station records from 1950-2000.

### **3.4.2 Data cleaning**

The initial record of presence points of Iridaceae, Colchicaceae and Melanthiaceae were 535, after removing the multiple records the points were georeferenced using ArcGIS 9.3 and still duplicate records were cleaned 2min grid within each cell in order to minimize the spatial autocorrelation. The points were cleaned separately for each family. After removing the duplicate points, the final points for Iridaceae(61), Colchicaceae(46), Melanthiaceae(56) and Paris(43).

### **3.4.3 Distribution modeling**

Species distribution models (SDMs) are numerical tools that combine observations of species occurrence or abundance with environmental estimates. They are used to gain ecological and evolutionary insights and to predict distributions across landscapes, sometimes requiring extrapolation in space and time. SDMs are now widely used across terrestrial, freshwater, and marine realms.

DIVA-GIS is a free and open source geographic information system (GIS) to make maps of species distribution data and analyze these data. DIVA-GIS were specifically developed at CIP for use with genebank data such as available through national or international gene-bank documentation systems and SINGER. It consist many useful tools such as Grid Calculator (multiplying, adding rasters), Neighbourhood (changing raster resolution) and Geo-reference Image. DIVA-GIS also has an Ecological Niche Modeling tool which can be used to predict modeling with the use of Bioclim and Domain algorithms. Software DIVA-GIS provide an easy way to do the species distribution.

In this study BIOCLIM model of DIVA-GIS 7.5 (a free Geographic Information System) was used for distribution modeling of 3 families (comprising 16 species) of Iridaceae, Colchicaceae and Melanthiaceae and species of one genus Paris singly using 19 climatic variables derived from WORLDCLIM. BIOCLIM predicts suitability areas only in the neighbourhood of occurrence records. BIOCLIM uses presence only data for distribution modeling. Based on climatic features of the data point locations it attempts to identify suitable and unsuitable areas in which the organism is likely to occur.

The environmental suitability value for each species was ranked under five classes that range from 0-35 percentile with different colour. The colour indicated by brown i.e. percentile value  $\leq 0$  means not suitable for species to occur. The dark green colour i.e. percentile value 0-2.5 indicated low suitability of species to occur. Similarly, light green colour with percentile value of 2.5-5 indicated the medium suitability of species to occur while, yellow colour with suitability value 5-10 indicated high suitability of species to occur. Similarly, light yellow colour with percentile value 10-20 indicated very high suitability of species to occur. Finally, dark red color with percentile value 20-35 indicated excellent suitability of species to occur.

**Table 1:** Species richness class with suitability value.

Colour	Class	Suitability(Percentile)
	Not suitable	$\leq 0$
	Low	0-2.5
	Medium	2.5-5
	High	5-10
	Very high	10-20
	Excellent	20-35

## 4. RESULTS

### 4.1. Range of morphological characters in the family Iridaceae, Colchicaceae and Melanthiaceae

The primary source of information about the morphology of the characters has been studied from the herbarium specimens and various available literatures. For the species whose specimens were not available in the herbarium of Nepal, secondary sources of information and digital photo images have been used. Following are the gross morphology of the species and genera of Iridaceae, Colchicaceae and Melanthiaceae found in Nepal.

#### 4.1.1 Iridaceae

##### 4.1.1.1 Habitat

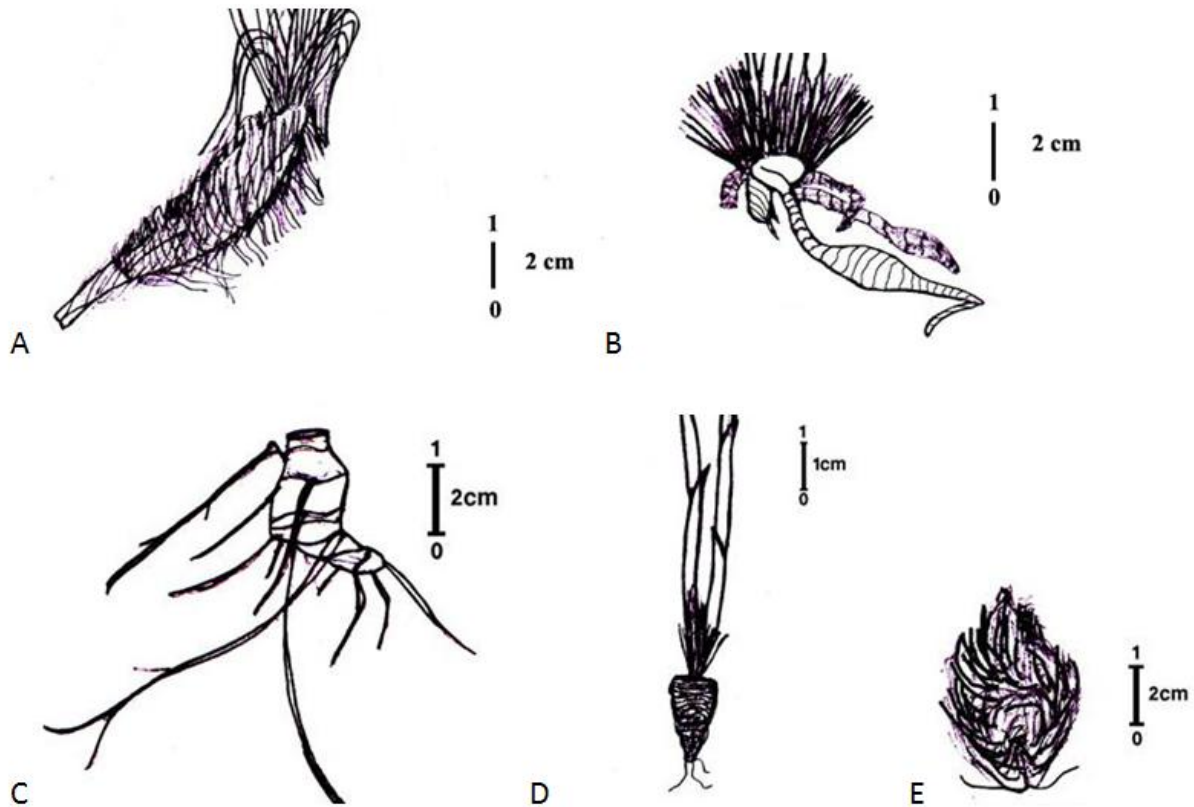
The plants of Iridaceae are perennial terrestrial herbs growing on sunny pebbly place on glacial moraine as *Iris kemaonensis*; on moist and shady places under conifer *Juniperus indica* scrub and *Quercus lanuginosa* forest as *Iris decora*; among dense dwarf bushes of *Juniperus* and *Rhododendron* and on open hillside as *Iris gonioarpa*; on moist slope along with *Berberis* bushes and grass meadow as *Iris clarkei*; on open grazed slopes as *Iris staintonii*, on deforested land as *Iris domestica* and open *Quercus-Pinus* forest as *Iris collettii*.

##### 4.1.1.2 Habit

The plants of Iridaceae are perennial herbs as *Iris decora*, *Iris germanica*, *Iris kemaonensis*, *Iris staintonii*, *Iris clarkei*, *Iris gonioarpa*, *Iris collettii*, *Iris domestica* and *Crocus sativus*.

##### 4.1.1.3 Root

The roots of Iridaceae are short or long rhizomes or bulbs, sometimes with swollen storage roots. Roots fleshy and rhizome knobbly in *Iris kemaonensis*, *Iris domestica*; roots slender, rhizome very short and erect in *Iris gonioarpa*; rhizome thick, swollen, fusiform, tuberous and vermiformes in *Iris collettii*; roots swollen, tuberous, finger like, many, white fleshy as *Iris decora*; rhizomes slender and spreading in *Iris clarkei*; rhizome erect, slender, very short in *Iris germanica*; rhizome very compact knob-like one or two in number in *Iris staintonii* and corm enclosing in many membranous, coriaceous or fibrous tunics in *Crocus sativus*.



**Fig. 4.** Types of rhizome in Iridaceae: A. Rhizome (*Iris clarkei*); B. Rhizome (*Iris decora*); C. Rhizome (*Iris domestica*); D. Rhizome (*Iris staintonii*); E. Corm (*Crocus sativus*).

#### 4.1.1.4 Stem

Aerial stem developed much shorter or longer than leaves in all genera and species of *Iris*. Aerial stem not developed in *Crocus sativus*. The flowering stem may be solid, hollow, single or may be branched.

#### 4.1.1.5 Leaves

Leaves usually narrow, with parallel veins sheathing bases, mostly basal, 2-ranked, often oriented edgewise to aerial stem, sword-shaped to linear. Leaves yellowish green, linear, midvein obscure, apex acute in *Iris germanica*; leaves yellowish green, linear, grass-like in *Iris goniocarpa*; leaves not fully developed at flowering, short, blunt-tipped and apiculate, pale green, mature leaves linear, tapering to acute apex in *Iris kemaonensis*; leaves linear strongly ribbed in *Iris decora*; leaves linear, shining green on upper surface, greyish beneath in *Iris clarkei*; leaves basal, grayish green, linear or sword shaped in *Iris collettii*; Leaves long, linear, exceeding flowering stem, pale green in *Iris staintonii*; leaves few, all basal, green, linear, adaxially with pale, median stripe, base surrounded by membranous, sheathlike leaves in *Crocus sativus*.

#### 4.1.1.6 Inflorescence

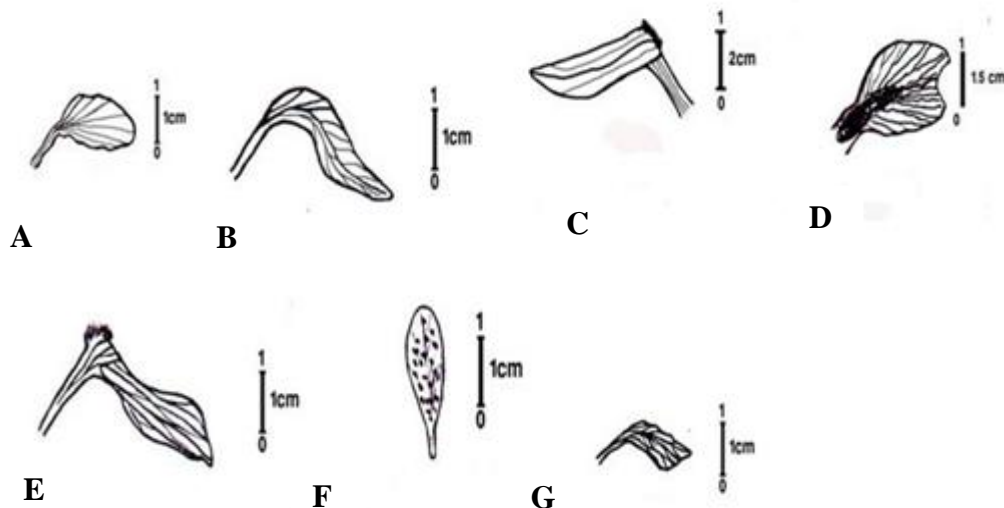
The inflorescence of Iridaceae arranged in racemes, panicles or solitary. Flower stem robust upto two branches, spathes 1-2-flowered, apex recurved, acuminate in *Iris germanica*; spathes single-flowered, enclosing perianth tube in *Iris goniocarpa*; flower stem hidden by bract-like leaves, spathe single-flowered, shorter than tube in *Iris kemaonensis*; flower stems rather slender, spathes 1-2-flowered, linear-lanceolate, very thin in *Iris decora*; flower stem solid, exceeding leaves, sometimes simple, usually with one branch, spathes 1-2-flowered, pedicels carrying flowers almost free of spathes in *Iris clarkei*; flowering stems simple, spathes 3, green, lanceolate, 2-4-flowered, violet in *Iris collettii*; flowering stems leafless or 1 or 2-leaved, spathes 2, green, lanceolate, 1-flowered, apex recurved, acuminate in *Iris goniocarpa*; spathe single-flowered in *Iris staintonii*; flowers 1 or 2, fragrant in *Crocus sativus*.

#### 4.1.1.7 Flowers

The flower colour vary according to the species as pale bluish to lavender to deep reddish purple in *Iris decora*; lilac purple as *Iris kemaonensis* and *Crocus sativus*; bluish violet in *Iris clarkei*, *Iris collettii* and *Iris germanica*; mauve in *Iris staintonii* and *Iris goniocarpa* while reddish orange in *Iris domestica*.

#### 4.1.1.8 Sepals

Fall blades shallowly deflexed, mauve-purple, mottled darker, obovate with central beard of club-shaped, yellow-tipped, unicellular hairs in *Iris goniocarpa*; fall blades reflexed, dark crimson-purple, obovate, gradually narrowed into haft, with central beard of yellow, multicellular hairs in *Iris germanica*; falls blade haft cuneate, beard of dense white hairs tipped with yellow or orange in *Iris kemaonensis*; falls blade broadly lanceolate, haft with deeper reddish purple veins and central ridge which is brownish yellow at base, yellowish to pale mauvish-white on blade in *Iris decora*; fall blades deflexed, dark blue to purple, with white or greenish-yellow tinged patch at base, oblong, not bearded in *Iris clarkei*; fall blades spreading, elliptic-obovate, crest orange, in *Iris collettii*; falls usually mauve, with central white ridge as *Iris staintonii*; outer and inner segments similar equal or sub-equal without crest or beard in *Crocus sativus* and *Iris domestica*.



**Fig. 5** Types of Falls (sepals) in Iridaceae: A. ridge (*Iris clarkei*); B. ridge (*Iris decora*); C. beard (*Iris germanica*); D. beard (*Iris goniocarpa*); E. beard (*Iris kemaonensis*); F. simple (*Iris domestica*); G. ridges (*Iris staintonii*).

#### 4.1.1.9 Petals

Standards erect, paler than falls, obovate, haft short, channeled in *Iris germanica*; standards spreading, blades narrowly oblong, abruptly contracted into very narrow claw in *Iris goniocarpa*; standards erect, blade ovate-oblong, abruptly contracted into haft in *Iris kemaonensis*; standards spreading in same plane as falls in *Iris decora*; standards horizontal or recurved, lanceolate, acute, abruptly narrowed into very narrow, channeled haft in *Iris clarkei*; standard erect, oblanceolate in *Iris collettii*; standard spreading, oblong, apex retuse or truncate in *Iris goniocarpa*; outer and inner segments similar equal or sub-equal in *Crocus sativus* and *Iris domestica*.

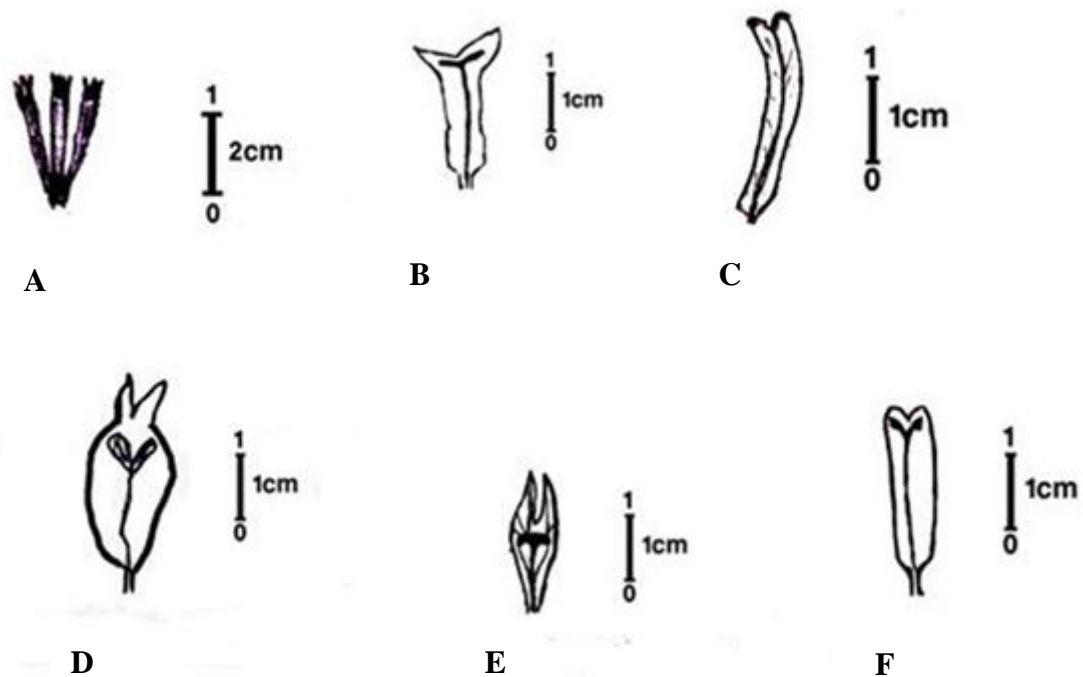
#### 4.1.1.10 Stamens

Stamens (2 or) 3, opposed to style branches and appressed to them in *Iris clarkei*, *Iris collettii*, *Iris decora*, *Iris germanica*, *Iris goniocarpa*, *Iris kemaonensis* and *Iris staintonii*. In *Iris domestica* stamens are inserted at base of the perianth segments, while in *Crocus sativus* stamens are inserted in the throat of perianth tube.

#### 4.1.1.11 Ovary

Ovary is usually inferior, 3-loculed with few to many ovules and axile placentation. Style is three colored, expanded, with branched petaloid arching over stamens, apex of branches

extended as two lobes (crests) projecting beyond flap like with abaxial stigma in *Iris clarkei*, *Iris collettii*, *Iris decora*, *Iris domestica*, *Iris germanica*, *Iris goniocarpa*, *Iris kemaonensis* and *Iris staintonii*, while style is deep red in *Crocus sativus*.



**Fig. 6** Types of Stigmatic flap: A. (*Crocus sativus*); B. (*Iris clarkei*); C. (*Iris domestica*); D. (*Iris goniocarpa*); E (*Iris staintonii*); F. (*Iris kemaonensis*).

#### 4.1.1.12 Fruit

The fruit of Iridaceae is a loculicidal capsule. Capsule of varying shapes as globose, ellipsoid or cylindrical, apex beaked or not in species of *Iris* while capsule small, ellipsoid or oblong-ellipsoid in *Crocus sativus*. Capsule oblong-ellipsoid, 3-angled, 6-veined in *Iris clarkei*; capsule ellipsoid to ovoid, apex shortly pointed in *Iris decora*; capsule green, ovoid, apex shortly beaked in *Iris collettii*; capsule ellipsoid, 3-angled, apex shortly beaked in *Iris goniocarpa*; capsule globose, shortly beaked in *Iris kemaonensis* and capsule not beaked in *Iris domestica*.

#### 4.1.1.13 Seeds

Seeds are with or without aril and wings in Iridaceae. Seeds pyriform, flattened and D-shaped or irregularly angled, sometimes arillate in species of *Iris* and fertile seeds are not produced in *Crocus sativus*. Seeds are semi-orbicular, flat in *Iris clarkei*; while seeds are black-brown, arillate in *Iris collettii*; obovoid, dark brown with small, pale aril in *Iris kemaonensis*; obovoid, dark brown, aril whitish, equaling seed in *Iris decora* and black and glossy in *Iris*

*domestica*.

#### 4.2.1 Taxonomic Treatment of Iridaceae

Perennial terrestrial herbs with various roostock as rhizome, corms or bulbs. Leaves usually narrow, often distichous and equitant, sheathing bases, usually sword shaped to linear, parallel veined. Inflorescence generally racemose or paniculate or reduced to 1-3 flowers, subtended by 2 bracts (spathe). Flowers actinomorphic or zygomorphic, bisexual. Perianth superior, petaloid, segments 6-biseriate, imbricating, arranged in 2 whorls, inner and outer tepals equal or differing in size or colour, free or united into a basal solid hypanthium, well developed or reduced, tube filiform. Outer segments are known as falls and the inner ones as standard. Stamens 3, epigynous, or adnate to the outer perianth-segments, anthers often narrow, extrose. Ovary inferior, mostly 3-locular axile placentation, style simple, stigmas trifid, simple or petaloid or variously cleft; ovules many, 2-seriate, anatropous. Fruit trigonous, 3-celled and loculicidal capsule. Seeds many, globose to ellipsoid or pyriform, testa thin or coriaceous and sometime arillate.

A cosmopolitan family of 92 genera and ca.1800 species, mainly in S. Africa, Asia and Europe. In Nepal three genera and 10 species.

Note: *Gladiolus hybridus* C. Morren. is cultivated in Nepal, but it is not naturalize and there is no herbarium specimens collected from Nepal. It is therefore included in the key but not treated further. While *Crocus sativus* L. is also cultivated but single herbarium specimen is available in TUCH, so it is least explained.

#### Key to Genera

- 1a. Stamens opposite to and shorter than the petaloid style-arms .....**1. Iris**
- b. Stamens alternating with the style-arms.....**2**
- 2a. Hypanthial tube straight, single flowered.....**2. Crocus**
- b. Hypanthial tube bent or curved, many flowered.....**3. Gladiolus**

#### **1. Iris** L., *Sp. Pl.* 1:38 (1753).

Perennial herbs. Rootstock bulbous or creeping, sometimes with swollen storage roots. Stems erect, solitary or many, simple or branched. Leaves mostly basal, flat, equitant, ensiform, sword shaped to linear. Bracts 2 or more, subtending 1 or more flowers. The inflorescence

arranged in racemes, panicles or solitary. Flower stem branched or simple, flowers terminal, solitary or in few-flowered groups, sessile or shortly pedicellate. Perianth segments 6, connate at base with the hypanthium, forming a short to well-developed tube, dimorphic. Outer 3 perianth segments(sepals) are largest, stipitate, reflexed and known as falls, usually differentiated into basal glabrous or beared claw and a lamina which may have a beard or cockscome-like crest or unicellular papillae or only a smooth ridge. Inner 3 perianth segments (petals) are usually smaller, suberect or reflexed and known as standard. Colour variation is very pronounced, either the whole flower is of uniform colouring or bicoloured. Falls are normally darker. Stamens 3 inserted at the base of the outer segments, filaments free, anthers linear, basifixed. Ovary tri-gonous, style stout, stigmas petaloid, arching over the stamens as a flap (petal like) and 2-cleft. Capsule coriaceous, 3 or 6-ribbed, many seeded. Seeds flat or globose, arillate or non-arillate.

Worldwide ca.300 species, mainly distributed in Europe, Asia, N. Africa and N. America. Eight species in Nepal. One of which is endemic to Nepal.

### Key to species

- 1a. Inner and outer perianth segments similar, flower reddish orange with dark spots.....**1. I. domestica**
- b. Inner and outer perianth segments different, flower pale violet, purple to lilac.....**2**
- 2a. Falls with a raised ridge or crest.....**3**
- b. Falls with a beard of orange or yellow hairs.....**5**
- 3a. Flowering stem always simple, very short less than 10cm or not emerging from ground.....**2. I. collettii**
- b. Flowering stem sometimes branched, more than 10cm.....**4**
- 4a. Rhizome swollen, numerous, finger like, falls with central yellow ridge.....**3. I. decora**
- b. Rhizome compact, one or two knob like, falls with central white ridge.....  
.....**4. I. staintonii**
- 5a. Flowering stem and leaves not well developed, capsule born at ground level.....**5. I. kemaonensis**
- b. Flowering stem and leaves well developed.....**6**
- 6a. Robust plant, leaves 3-3.5cm wide, sword shaped.....**6. I. germanica**
- b. Plants slender, leaves narrow.....**7**

- 7a. Flowering stem solid, leaves erect, grass like, capsule tapering to pointed apex.....**7. I. gonicarpa**
- b. Flowering stem hollow, leaves linear, capsule abruptly contracted at top and bottom.....**8. I. clarkei**

**1. Iris domestica** (L.) Goldblatt & Mabb., *Novon* **15**(1): 129, f. 1 (2005).

*Epidendrum domesticum* L., *Sp. Pl.* 952 (1753)

*Belamcanda chinensis* (L.) Redoute., *Liliac.* **3**(21): pl. 121 (1805)

Nepali Name: Tyangpatre

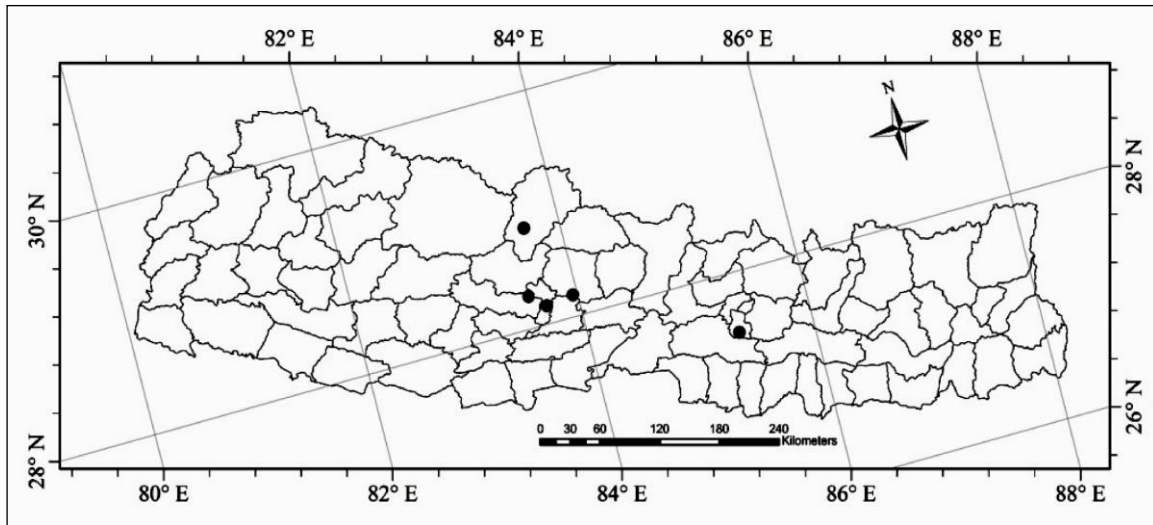
Perennial herb, 20--95 cm tall. Stem 3--5 mm in diameter at base. Rhizome horizontal, pale brown, fleshy and rhizome knobbly. Stem 0.3--1cm in diameter. Stem usually 3-5 branched. Leaves cauline, 2-ranked, oriented edgewise to aerial stem, sword-shaped, cauline leaves mostly sessile. Leaf blades narrowly lanceolate, half or equalling stem, glaucous, 40--45(--10) X 1--2 cm. midvein obscure, margin entire, apex acuminate. Inflorescence racemose with 3-6 flowered. Pedicels slender, ca. 2--3 cm, conspicuously elongated at maturity. Spathes two, more or less similar. Tepals 6, sub-equal, spreading, free, weakly differentiated into limb and claw, ascending proximally, spreading distally, lanceolate ca. 15--20 X 5--7 mm with a light pink to orange base with speckles of orange to scarlet pigmentation, entire margin. Stamens inserted at base of perianth segments, stamens 1.5--2 cm, anthers ca. 1cm, filament ca. 0.5 cm. Ovary narrowly ovoid, 3-angled ca. 0.2--0.3 cm, style equaling perianth segments, lobes spreading, style 3-angled proximally, branches ca. 0.2cm. Capsule ca. 2.5--3 X 1--1.5cm, apex not beaked. Seeds globose, smooth, shiny black ca. 4--5 mm in diameter.

**Distribution:** Nepal, W Himalaya, E Himalaya, E Asia, Assam-Burma, N. Asia, SE Asia (as an escape from cultivation).

**Altitudinal Range:** 1300-2300m

**Ecology:** On deforested land.

**Flowering:** June-August. **Fruiting:** July-September.

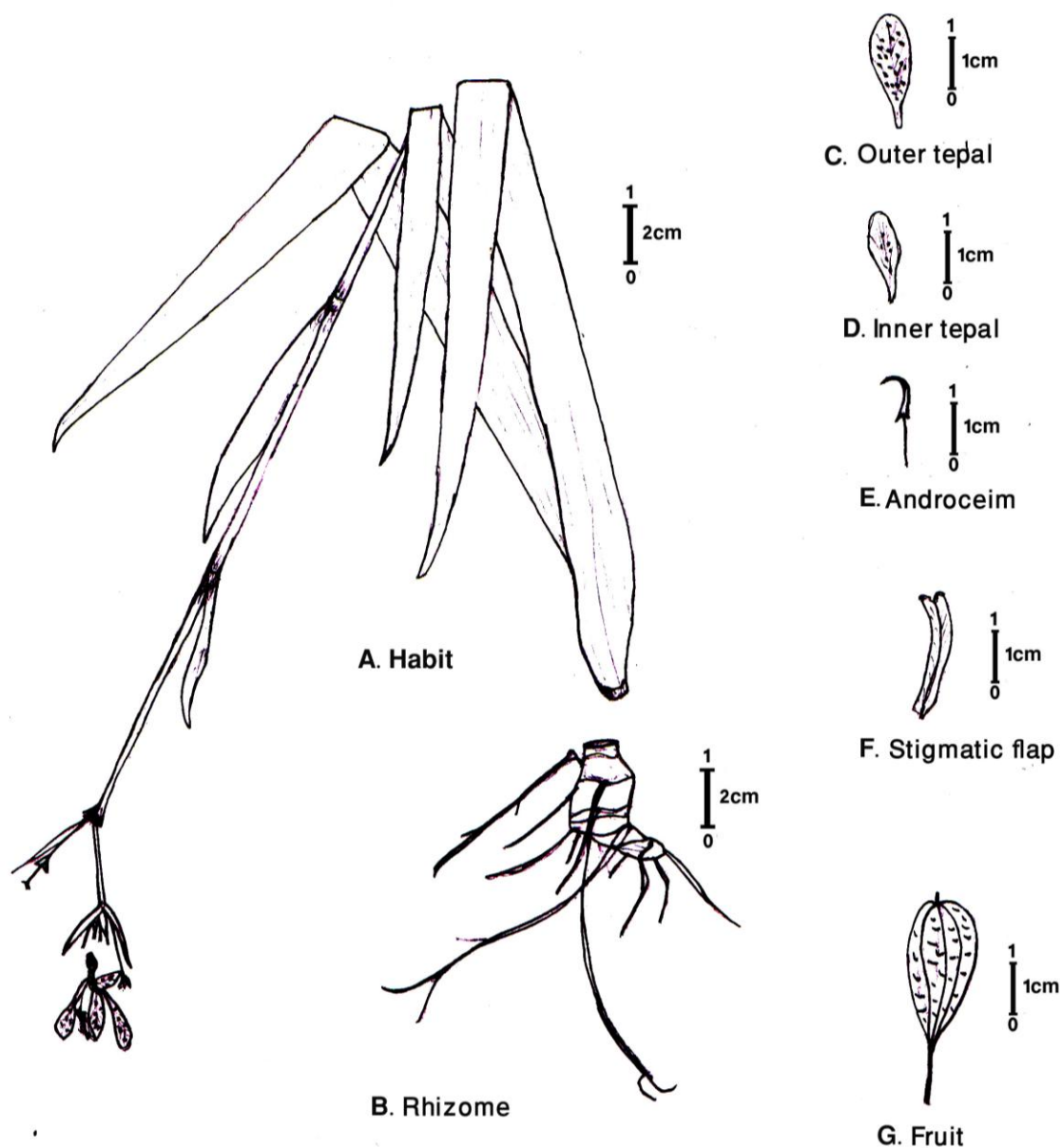


**Note:** Rhizomes are used as medicine.

**Fig 7.** Distribution map of *Iris domestica* based on herbarium specimens.

### **Specimens examined**

**Central Nepal:** Baglung, Tagum, 1818-1660m, 24-9-1976, H.Tabata, K.R. Rajbhandari and K.Tsuchiya, 3927(KATH); Myagdi, Sikha, 2000m, 1-9-1983, N.P.Manandhar, 10308(KATH); Parbat, Sikha, 1400m, 22-7-1979, D.P.Joshi and T.K.Bhattacharya, 74/1896(KATH); Kaski, Pardi, 720m, 4-6-1986, N.P.Manandhar and L.P. Khanal, 10809(KATH); Lalitpur, Chesapani, 4000ft, 12.7.1987, Manandhar and Party, 7111(TUCH).



**Fig. 8. *Iris domestica* L.;** **A.** Habit sketch (based on N.P. Manandhar, 10308 KATH); **B.** Rhizome ( based on N.P. Manandhar and L.P. Khanal, 10809 KATH); **C.** Outer tepal; **D.** Inner tepal; **E.** Androecium (based on N.P. Manandhar, 10308 KATH); **F.** Stigmatic flap (based on D.P.Joshi and T.K.Bhattacharya, 74/1896 KATH); **G.** Fruit (based on H.Tabata, K.R. Rajbhandari and K.Tsuchiya, 3927 KATH).

2. ***Iris collettii*** Hook.f., *Bot. Mag.* **129**: pl. 7889 (1903).

**Type specimen:** China, East of the Yangtze bend, *Kingdon-Ward, F.* **Holotype: E.**

Perennial herbs, ca. 6 X 1 cm tall, densely tufted. Stem 1--5 mm in diameter at base. Roots thick, swollen, fusiform, tuberous and vermiformes. Leaves basal, grayish green, linear or sword-shaped, 20--65 cm X 3--5 mm, veins 2 or 3, base surrounded by brown fibres remaining of old leaves. Flowering stems very simple, very short less than 10cm or not emerging from ground. Spathes 3, green, lanceolate, 1--2 cm, apex acuminate. Inflorescence 2-4-flowered, violet, 2--3 cm in diameter. Perianth tube short and slender. Perianth separated into inner and outer tepals. Outer tepals (falls) spreading, broad, elliptic-obovate, 2--2.5 cm, crest orange, low, inner segments (standards) narrow, erect, oblanceolate, 1.7--2 cm. Stamens ca.1 cm, opposed to style branches and appressed to them, anthers yellow. Style branches erect, ca. 2 cm, branched petaloid arching over stamens, apex of branches extended as two lobes (crests) projecting beyond flap like with abaxial stigma. Capsule green, ovoid, 1.5--2 X 1.3-1.5 cm, apex shortly beaked. Seeds black-brown, arillate.

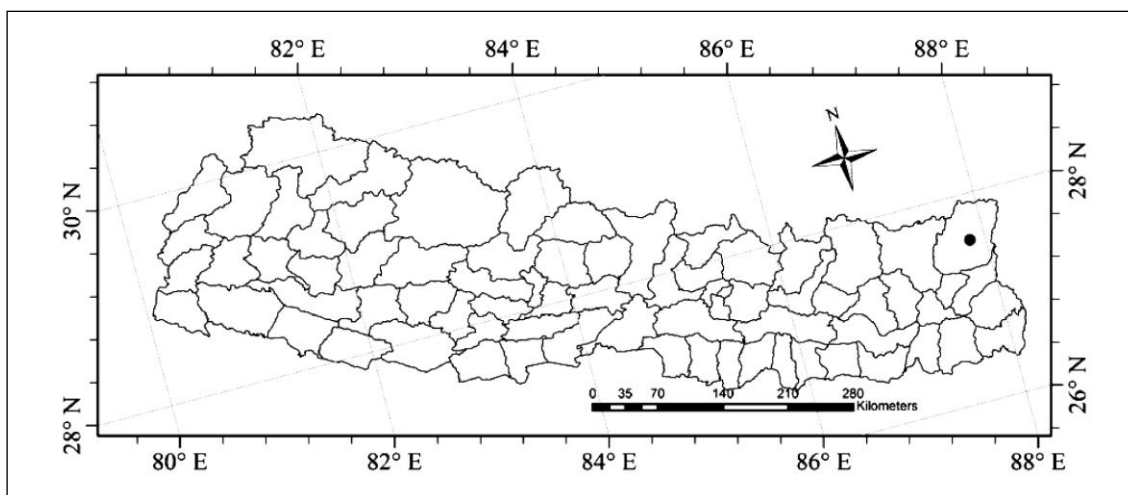
Note: Herbarium specimen of *Iris collettii* was not available in our National herbarium, so description based on the digital image from Royal Botanical Garden, Kew (K) and secondary literature.

**Distribution:** Nepal, Tibetan Plateau, E Asia, SE Asia, Assam-Burma and E Himalaya.

**Altitudinal Range:** 1700-3700m

**Ecology:** Open *Quercus-Pinus* forest.

**Flowering:** May-June. **Fruiting:** July-August.

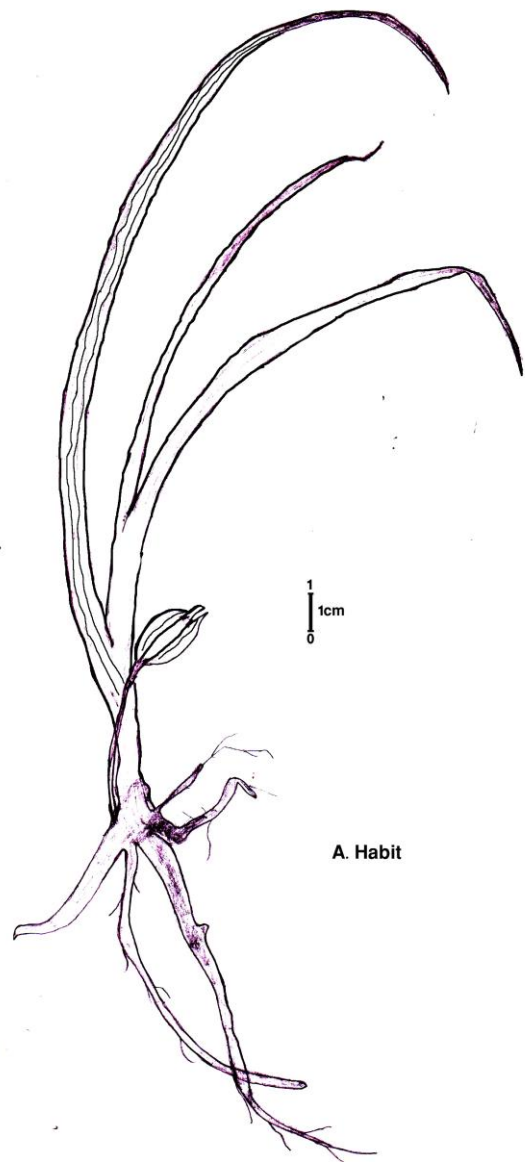


**Fig. 9.** Distribution map of *Iris collettii* based on herbarium specimens.

**Specimens examined**

**Digital Photograph of Herbarium seen.**

**East Nepal:** Taplejung, Ghunsa khola S.W. of Amjilassa, 2500m, 5.9.89, Keke, 265 (E).



**Fig. 10.** *Iris collettii* Hook.f; **A.** Habit sketch (based on Keke, 265 E).

**3. *Iris decora*** Wall., *Pl. Asiat. Rar.* **1(4)**: 77, t. 86 (1830).

*Iris nepalensis* D. Don., *Prodr. Fl. Nepal.* 54 (1825).

*Iris sulcata* Wall., *Numer. List* 5049 (1831).

**Nepali Name:** Padam Pushkar

**Type specimen:** Nepal, *Central:* Makwanpur, Ekdanta and near Bhimphedi, *Wallich* s.n.

**Syntype:** K

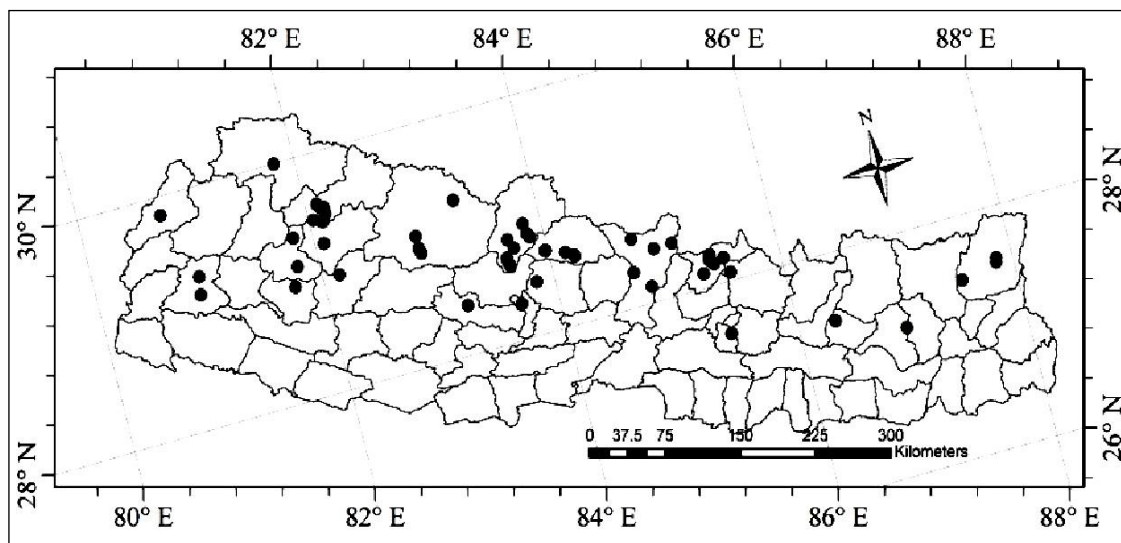
Perennial herbs, 17--31 cm tall, often branched. Stem 1--5 mm in diameter at base. Roots swollen, tuberous, finger like, many, white fleshy, densely covered by remains of old leaves. Leaves linear, thin, strongly ribbed, 20--40 X 0.3--1 cm. Bracts slender, acuminate, keeled, generally 1-2-flowered. Pedicel ca. 7.5--10 cm long. Flowers 1--5 cm in diameter, shortly pedicelled. Perianth-tube slender, pale bluish-lavender to deep reddish purple. Outer tepals (falls) ca. 5 X 2.5 cm, blade of sepals broadly oblong, as long as the claw, haft with deeper reddish purple veins and central ridge which is brownish yellow at base, yellowish to pale mauvish-white on blade. Inner tepals (standards) narrowly lanceolate, bent outwards and downwards like falls, tube 3.5--6.5 cm long. Filaments white, slightly violet tinged, anthers cream colored, violet-tinged at the base. Ovary 3-sided, each side slightly concave. Style broadly lobed, pale-violet, toothed at edges, crest triangular erect, exceeding falls and standards, whitish or yellowish orange at tips, stigma deeply bilobed. Capsule long, trigonal, grooved at sides, tip pointed. Seeds dark brown small, round, aril as large or larger than seed.

**Distribution:** Nepal, Tibetan Plateau, E Asia, Assam-Burma.

**Altitudinal Range:** 1800-4000m.

**Ecology:** On moist and shady places under conifer forest as *Juniperus indica* scrub and *Quercus lanuginosea* forest.

**Flowering:** May-July. **Fruiting:** July-August.



**Fig. 11.** Distribution map of *Iris decora* based on herbarium specimens.

### **Specimens examined**

**West Nepal:** Darchula, Chhety, 9500ft, 20.6.1965, T.B.Shrestha, 4224(KATH); Doti, Napani, 2310m, 30.6.1976, H.Tabata, K. R.Rajbhandari and K. Tsuchiya, 806(KATH); Humla, Simikot, 3880m, 21.6.2008, C.A.Pendry, S.Baral, S.Noshiro, S.Rajbhandary, P.P.Kumi, B.Dell, B.Adhikari, JRSA 244 (KATH); Mugu, Rara, 9700ft, 4.7.1968, Dr.S.B.Malla, 10785(KATH); Jumla, Chautha, 2940m, 6.6.2008, C.A.Pendry, S.Baral, S.Noshiro, S.Rajbhandary, P.P.Kumi, B.Dell, B.Adhikari, JRSA70(KATH); Dolpo, Dunai, 2424m, 12.9.1976, H. Tabata,K. R.Rajbhandari and K. Tsuchiya, 3428(KATH).

### **Digital Photograph of Herbarium seen.**

**West Nepal:** Mugu, Tibrikot, 8500ft, 3.6.1966, T.B.Shrestha, 5070(BM); Dolpa, Suli gad, 10,000ft, 23.6.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 2296(E).

**Central Nepal:** Rasuwa, Langtang, c.12500ft, 25.6.65, Schilling, Sayar, Bista, 430(KATH); Sindhupalchok, Helambu, 3600m, J.J.Metz, 40(KATH); Ramechhap, Lophragaon to Dhobigaon, 2300m, 11.8.1977, K.R.Rajbhandari,B.Roy, 2225(KATH).

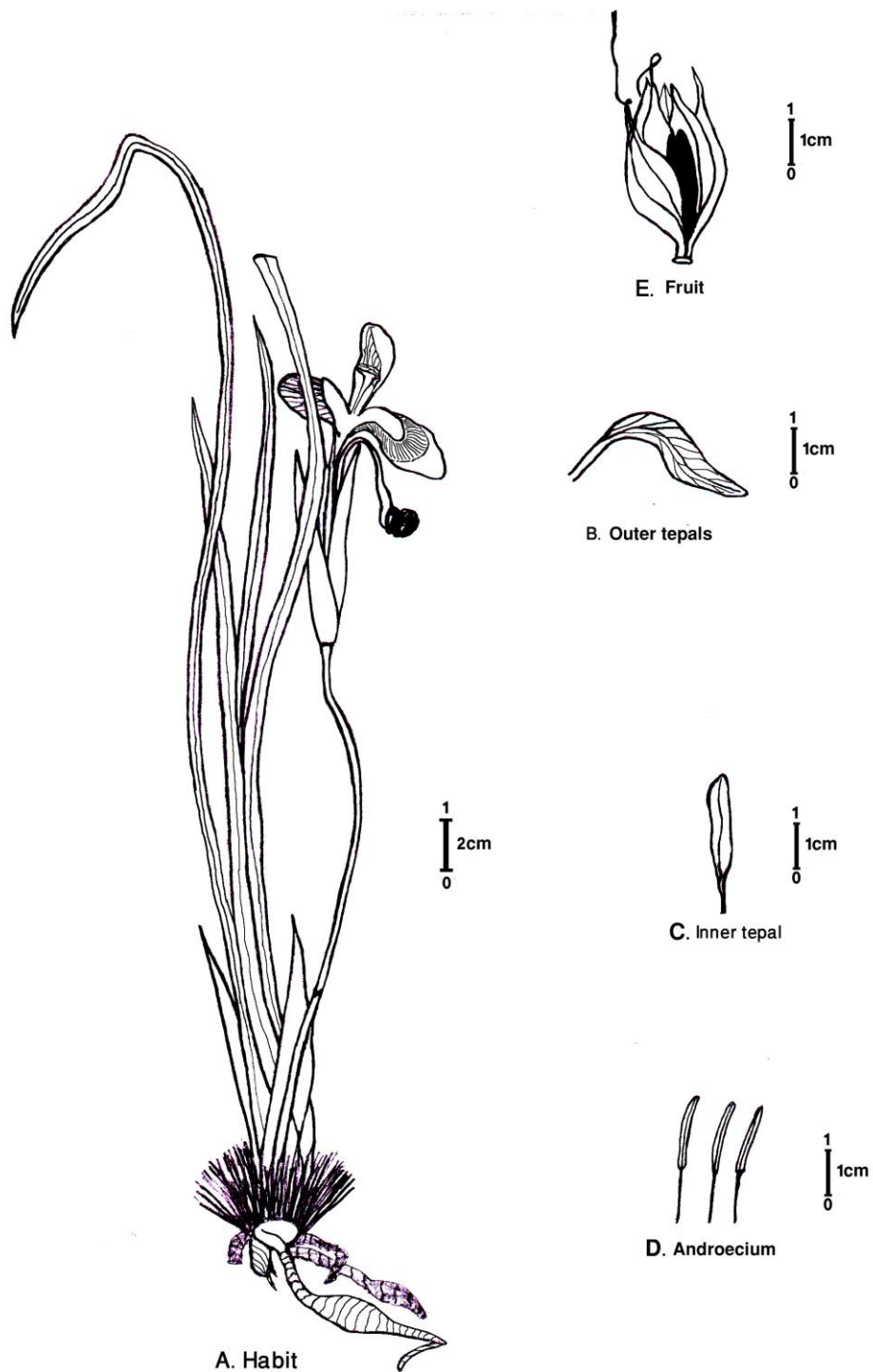
**Digital Photograph of Herbarium seen.**

**Central Nepal:** Mustang, Lete, 9000ft, 9.6.1964, Stainton, Skyes and Williams, 1038(BM); Mustang, Tukucha, Kali Gandaki, 8,500ft, 6.6.1954, Stainton, Skyes and Williams, 5612(E); Rasuwa, Langtanag, 11,000ft, 25.6.1949, O.Polunin, 576(BM); Rasuwa, Langtang- Birdim, 10,500ft, 28.6.1949, O.Polunin, 670(BM).

**East Nepal:** Sankhuwasabha, Chepuwa to Honggaon, 8000ft, 15.5.1965, Dr.Banerji, Upadhaya, Baskota, 3492(KATH).

**Digital Photograph of Herbarium seen.**

**East Nepal:** Dhankuta, Arun valley, Chyamtang, 8,000ft, 24.5.1956, J.D.A.Stainton, 410(E); Taplejung, kanchenjunga, Amjilosa, 2490m, 13.6.1991, R.J.D.Mc Beath, 2530(E).



**Fig 12. *Iris decora* Wall.;** **A.** Habit sketch (based on Dr.S.B.Malla, 10785 KATH); **B.** Outer tepal, **C.** Inner tepal and **D.** Stamens (based on John J.Metz., 40 KATH); **E.** Fruit (based on R.J.D.Mc Beath, 2530 E).

4. *Iris staintonii* H.Hara, *J. Jap. Bot.* **49**: 203, f. 5 (1974).

**Type specimen:** Nepal, West: Gorkha, Ganesh Himal, Abuthum lekh, *Stainton, J.D.A.* 3960

**Holotype:** BM

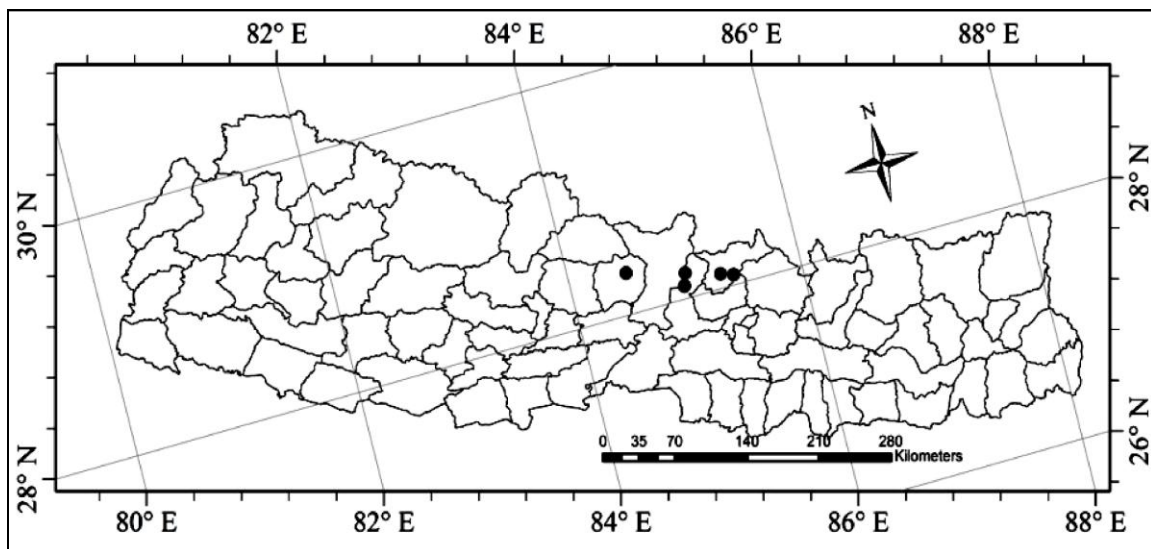
Perennial herb, ca. 10.5--13 cm tall. Stem 2--5 mm in diameter at base. Rhizome very compact, knob-like, one or two in number, upper parts covered with fibrous brown scaly leaves. Leaves usually four, external leaf sheathing subtending 1--6 X 1--2 mm long, obtuse apex. Innermost leaf long, linear, 10--24 cm X 1--5 mm, exceeding flowering stem, pale green, 3--5 nerved, entire margin and acute apex. Flower stem slender, lacking ornamentation, bract simple, not well developed usually with one branch. Spathes single-flowered, pedicel 2--3 cm. Flowers to 4cm diameter, tube ca. 1--2 cm, slender above gradually increased lobes, ovate-spathulate or funnel-shaped. Fall blades deflexed, usually mauve, 1.5--2 cm X 5 mm, falls with central white ridge. Standards horizontal, 1--1.5 cm X 5mm, lanceolate, abruptly narrowed into very narrow channeled haft. Style branches broad and pointed at tips into two, ca. 2 X 0.5 cm, lobes ovate. Anthers mauve ca. 5 mm, filament slender, ca. 0.5--1 cm. Capsule oblong.

**Distribution:** Endemic to Nepal.

**Altitudinal Range:** 3500-4300m.

**Ecology:** Abundant on open grazed slopes.

**Flowering:** June-July. **Fruiting:** August-September.



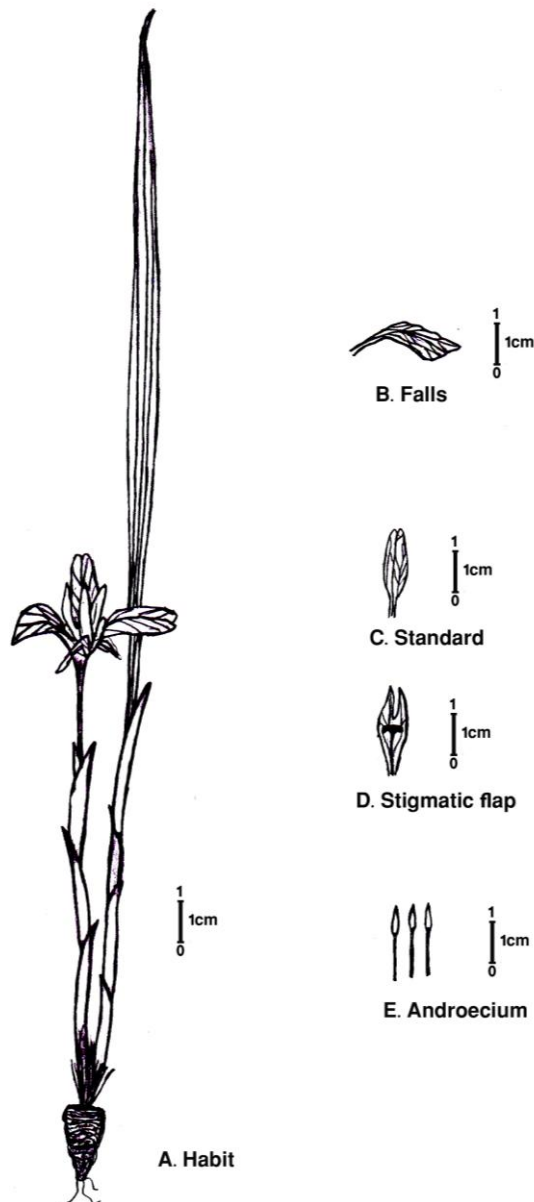
**Fig. 13.** Distribution map of *Iris staintonii* based on herbarium specimens.

## Specimens examined

**Central Nepal:** Gorkha, S. of Ganesh Himal, Abuthum Lekh, 11,000ft, 19.6.1975, John.D.A.Stainton, 7873(KATH); Rasuwa, Gosaikunda, 14000ft, 2048-3-3, Sujata, (TUCH); Rasuwa, Gosaikunda, 4268m, 18.6.1991, Mini (TUCH); Rasuwa, Gosaikunda, 4268m, 18.6.1991, Neena.K, (TUCH); Rasuwa, Dhunche, 17.6.1991, Bindu Pokharel, (TUCH).

## Digital Photograph of Herbarium seen.

**Central Nepal:** Gorkha, S.of Himal chuli,on the track to Dudh Pokhari, 12000ft, 10.6.1975, J.D.A.Stainton, 7364(E); Gorkha, Ganesh Himal, Abuthum lekh, 3506m, 9.7.1962, J.D.A. Stainton, 3960 (BM).



**Fig. 14** *Iris staintonii*  
H. Hara; **A.** Habit sketch, **B.** Falls (Outer tepals), **C.** Standard (Inner tepals), **D.** Stigmatic flap and **E.** Stamens (based on J.D.A.Stainton, 7873 KATH).

5. *Iris kemaonensis* Wall. ex Royle, *III. Bot. Himal. Mts.* 1(10): 372 (1839).

*Iris kingiana* Foster., *Gard. Chron.* 1: 611 (1887).

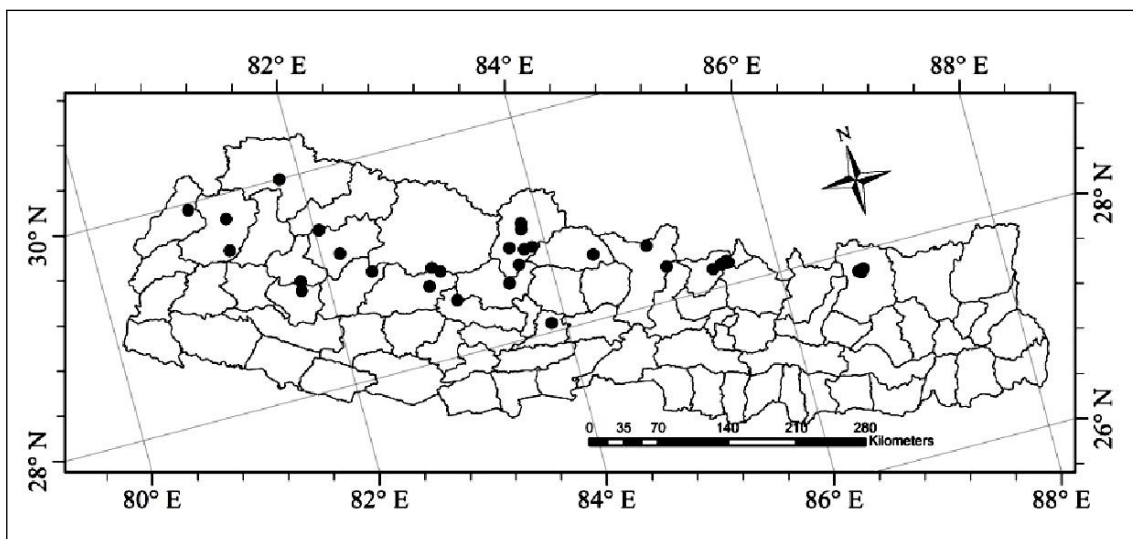
Perennial herb, ca. 10--14 cm tall. Stem 1--10 mm in diameter at base. Roots fleshy, rhizome knobby. Leaves linear not fully developed at flowering, short, blunt-tipped and apiculate, pale green, mature leaves linear, tapering to acute apex, 8--10 cm X 3--6 mm. Peduncle (stem) usually short. Bracts 2-3 in number, ca. 4--5.5 cm X 0.5--1 cm, acuminate, broad, sheathing the base of hypanthium tube. Pedicel long, ca. 1.5 cm. Flower stem hidden by bract-like leaves, spathes single-flowered, shorter than tube. Flower 4--5 cm in diameter, lilac purple with darker blotches, hypanthial tube 4.5--6.5 cm. Falls wide, 4.5 X 2.5 cm, haft cuneate, beard of dense white hairs tipped with yellow or orange. Standards narrow, ca. 4 X 1.5 cm, erect, obovate. Stamens ca. 2--2.3 cm, filaments blue, anthers lavender. Style branches ca. 3 X 0.5 cm, crest small, triangular, crenate, stigma entire. Capsule 2--2.5 cm, globose, almost sessile at ground level, tapering to a pointed tip, dehiscence longitudinal. Seeds pyriform, brown red, with milky yellow aril.

**Distribution:** Nepal, E Himalaya, W Himalaya and N. Asia.

**Altitudinal Range:** 2500-4300m

**Ecology:** On sunny pebbly place on glacial moraine.

**Flowering:** May-June. **Fruiting:** June-August.



**Fig. 15.** Distribution map of *Iris kemaonensis* based on herbarium specimens.

### **Specimens examined**

**West Nepal:** Bajhang, North of Chainpur, 11400ft, 19.5.1965, T.B.Shrestha, 4125(KATH); Humla, MDR-Simikot Lagna, above Simikot, 4030m, 20.6.2008, C.A.Pendry, S.Baral, S. Noshiro, S.Rajbhandary, P.P.Kumi, B.Dell, B.Adhikari, JRSA197(KATH); Rukum, Kawa Lekh, 3620m, 18.5.1971, P.R.Shakya and D.P.Joshi, 546(KATH).

### **Digital Photograph of Herbarium seen.**

**West Nepal:** Darchula, Nampa Khola, 11,300ft, 14.6.53, J.B.Tyson, 32(BM); Dailekh, Pulanto Dara, 10,500ft, 28.4.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 869(BM).

**Central Nepal:** Gorkha, Between Sama and Samko Ghorepani and Sikha, 3490m, 2.6.1983, P.R.Shakya, M.K.Adhikari, M.N.Subedi, 7717(KATH); Rasuwa, Bagmati zone, Kyanjin Gompa (3800m), 3850m, 21.5.2001, S.Akiyama, M.Amano, C.Mouri, M.N.Subedi, H.Tsukaya and Yonekura, 20100483(KATH); Rasuwa, Kyangjin, 3750m, 17.5.1985, K.R.Rajbhandari, I.Sharma and M.Kayastha, 10617(KATH).

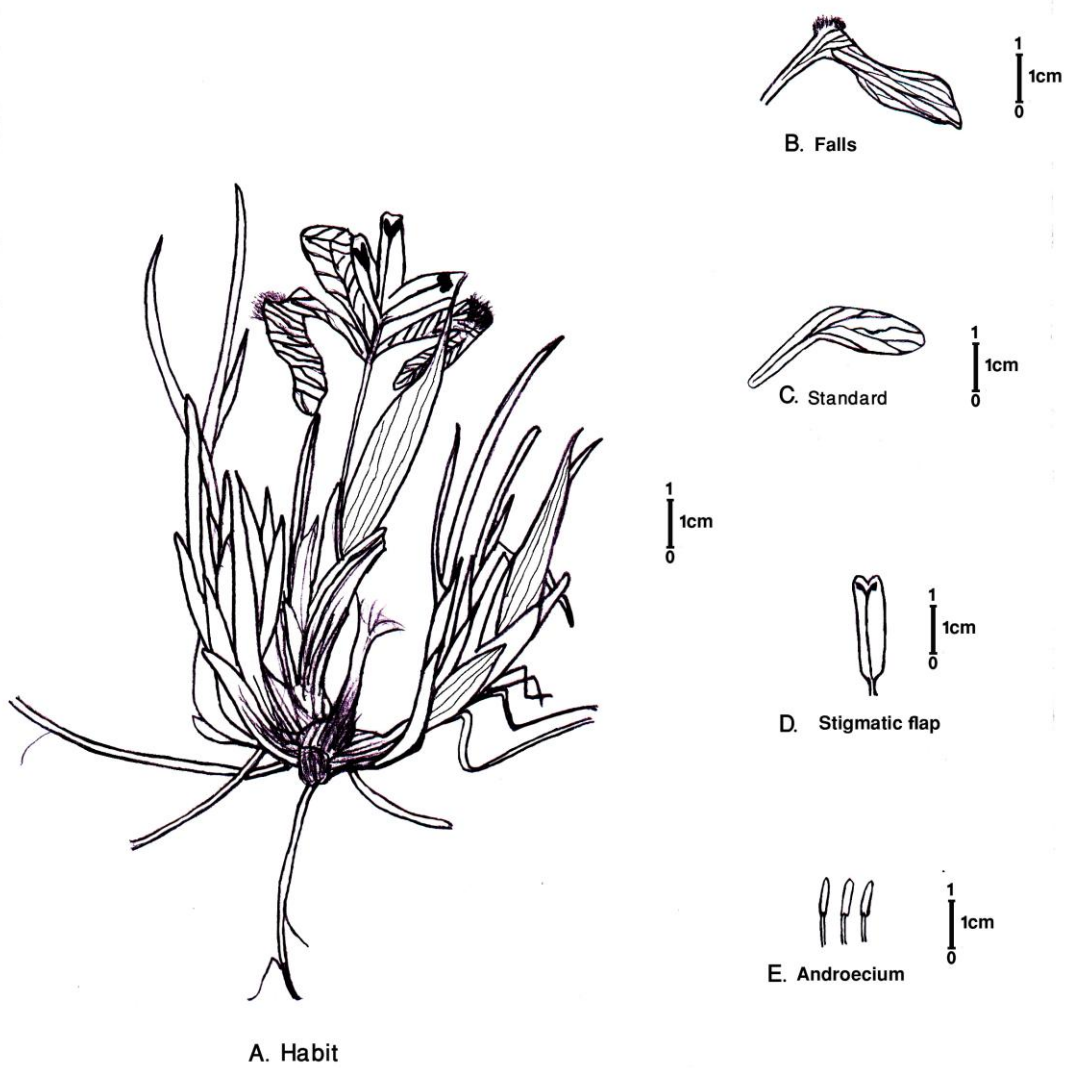
### **Digital Photograph of Herbarium seen.**

**Central Nepal:** Baglung, Burtibang, 12,500ft, 28.4.1954, Stainton, Skyes and Williams, 2648(BM); Rasuwa, Langtang village, 3400m, 25.4.1992, D.G.Long and S.E.Mc.Dermott, 21961(E); Banepa, Dhuli, 3700m, 14.05.71, J.F.Dobremez, 2214(BM).

**East Nepal:** Solukhumbu, Namchabazar to Thangboche, 11825-11200-12500ft, 16.4.58, S.R. Rolla, 13729(KATH).

### **Digital Photograph of Herbarium seen.**

**East Nepal:** Solukhumbu, Khoomjung, 11000ft, 1930, Capt. Lall Dhwoj, 655(BM); Solukhumbu, South of Namche Bazar, 11,100ft, 1.4.1966, E.Onyon, 1(BM); Solukhumbu, Dudh Koshi valley: Larja Dobhan to Namche Bazar: slope upto Namche Bazar, trail from Lukla, 3200m, 10.5.2004, M.F. Watson, K.R.Rajbhandari, D.Knott, A.G. Miller, B.Adhikari, K.Maden, V. Manandhar, R.Uprety, DNEP 147(E).



**Fig.16. *Iris kemaonensis* Wallich ex Royle; A. Habit sketch, B. Falls (Outer tepals), C. Standards (Inner tepals), D. Stigmatic flap and E. Stamens (based on S.Akiyama,M.Amano, C.Mouri, M.N.Subedi, H.Tsukaya and Yonekura, 20100184 KATH).**

6. *Iris germanica* L., *Sp. Pl.* 1: 38 (1753).

*Iris germanica* L. var. *nepalensis* (Lindl.) Herb., *Edwards's Bot. Reg.* 26(Misc.): 34 (1840).

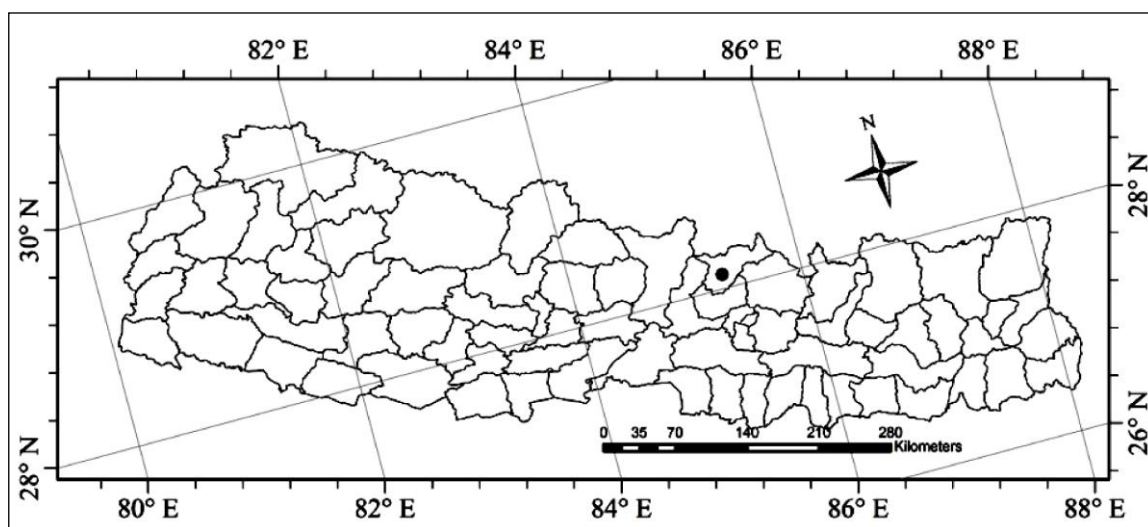
**Type specimen:** Netherlands: Cultivated materials from the garden of George Clifford III: Hartekamp Garden, Holland, *Clifford, G.* **Lectotype:** BM.

Perennial herb, 12--32(--120) cm, robust plant. Stem 3--5 mm in diameter at base. Rhizomes erect, slender, very short, branched. Leaves of non-flowering shoots well developed, ensiform, yellowish green, linear, sword shaped, 30--35 X 3--3.5 cm, midvein obscure, acute apex. Flowering stems well developed, leafless or 1 or 2 short leaved, with upto two branches. Spathes 2, green, lanceolate, 3--4 X 0.5--1 cm, 1-2- flowered at apex, recurved apex, acuminate. Flowers violet, 2--3 cm in diameter, pedicel short or absent. Perianth tube slender, 1--2 cm. Falls (outer segments) broad, ca. 2--3 X 0.5--1 cm, with deep purple mottling, obovate to elliptic, beard of white-based, yellow-tipped hairs, apex retuse or truncate. Standards (inner segments) spreading, oblong 1.8--2.2 cm X ca.5 mm, apex retuse or truncate. Stamens ca. 1cm, anthers yellow. Ovary 1--1.5 cm, style branches ca.1.5 cm. Capsule ellipsoid, 3-angled, apex shortly beaked.

**Distribution:** Cultivated in the Himalaya.

**Altitudinal Range:** 3000m

**Flowering:** May- June. **Fruiting:** August- September.



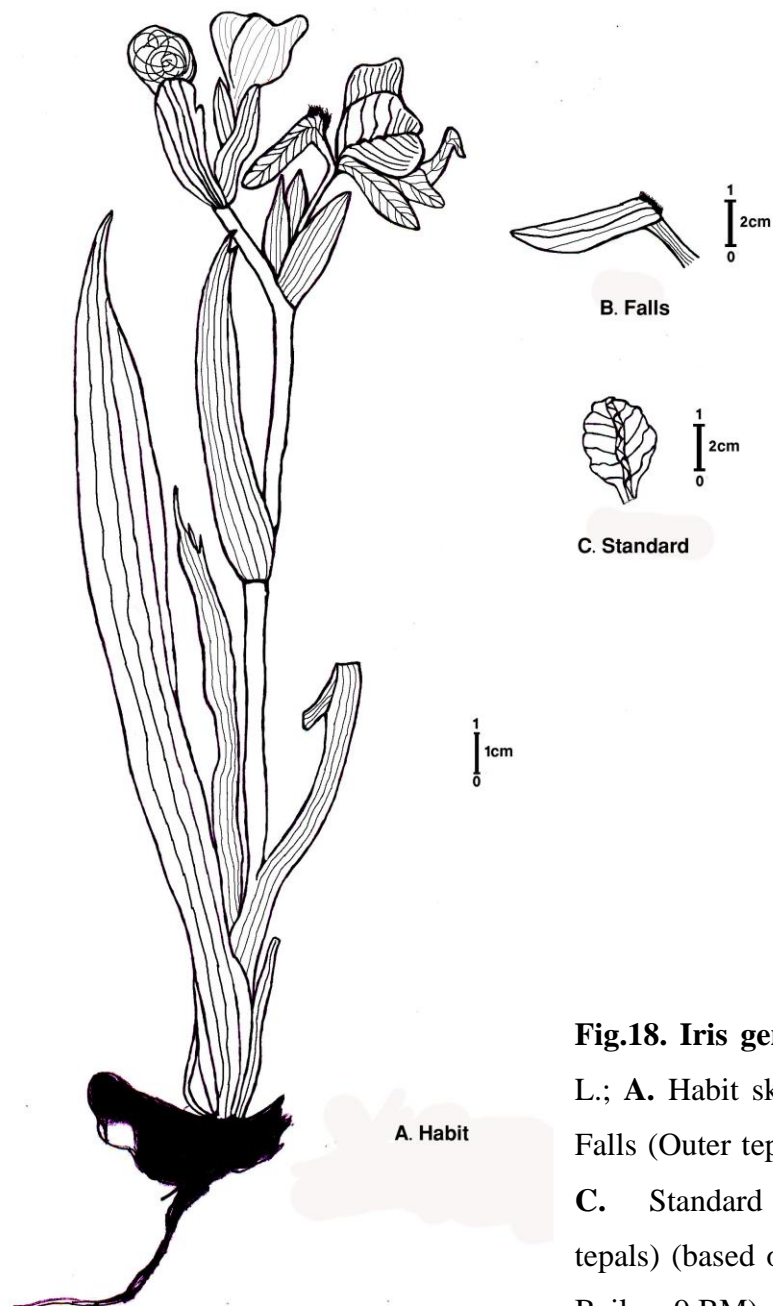
**Fig. 17.** Distribution map of *Iris germanica* based on herbarium specimens.

**Note:** Cultivated in Himalaya. Recorded from most parts of the world, though not known in the wild. Due to lack of herbarium specimens detail study cannot be done. Description based on the photo image from BM and secondary literature.

**Specimens examined**

**Digital Photograph of Herbarium seen.**

**Central Nepal:** Rasuwa, Bharkhu, 9.6.35, F.M.Bailey's collectors, 9(BM); Tarna-Cyang, 28.8.1978, F.M.Bailey, 66 (BM)



**Fig.18. *Iris germanica* L.;** **A.** Habit sketch, **B.** Falls (Outer tepals) and **C.** Standard (Inner tepals) (based on F. M. Bailey, 9 BM).

**7. *Iris goniocarpa* Baker, *Gard. Chron.*, n.s. **6**: 479 (1876).**

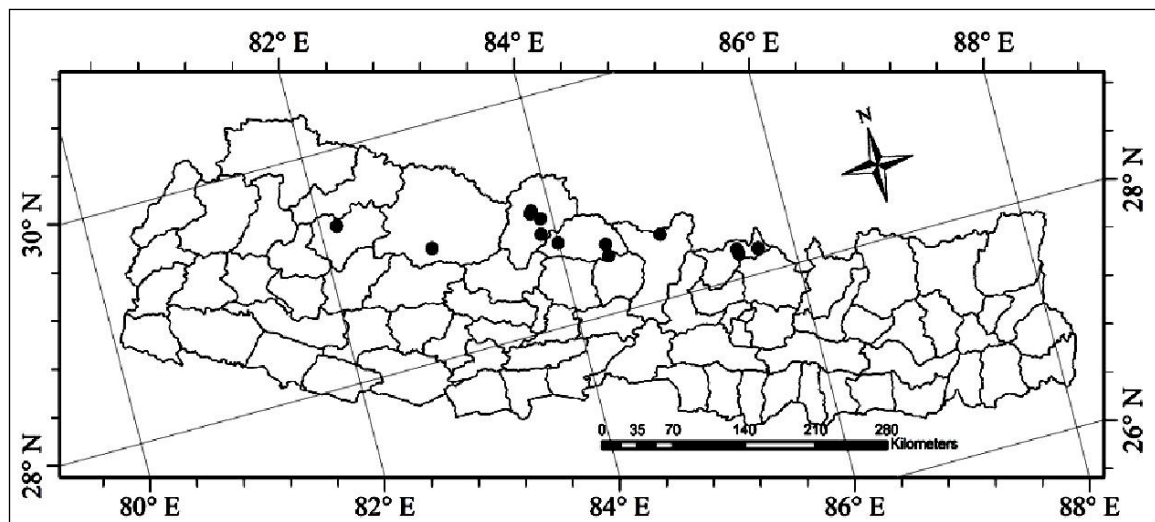
Perennial herb, 20--45 cm, slender. Stem 1--2 mm in diameter at base. Rhizomes erect, very short, compact, stems tufted, subtended by reticulate fibrous remains of old brown leaves at base of stem. Leaves yellowish green, linear, narrow, 20--60 cm X 1--5 mm, midvein obscure, apex acute, grass-like, long, exceeding the flower stem. Flowering stem leafless or 1 or 2-leaved, spathes 2, green, lanceolate, 4--5 cm X 6--8 mm, 1-flowered, apex recurved, acuminate, enclosing perianth tube which is 2--3 cm. Flowers ca. 4--5 cm in diameter. Falls broad, shallowly deflexed, mauve-purple, with deep purple mottling, obovate to elliptic, with central beard of club-shaped, white-based, yellow-tipped unicellular hairs, retuse apex. Standards narrow, spreading above, blades narrowly oblong, 2--2.5 cm X ca. 4--5 mm, abruptly contracted into very narrow claw, apex retuse or truncate. Stamens ca. 1.8 cm, anthers orange. Ovary 10--15 mm, style branches into lobes, ca.10 mm. Capsule ellipsoid, apex shortly beaked, opening by lateral slits, enclosed by persistent papery spathes.

**Distribution:** Nepal, Tibetan Plateau, N Asia, Assam-Burma and E Himalaya.

**Altitudinal Range:** 3600-4400m.

**Ecology:** Among dense dwarf bushes of *Juniperus* and *Rhododendron* and on open hillside.

**Flowering:** May-June. **Fruiting:** July-August.



**Fig. 19.** Distribution map of *Iris goniocarpa* based on herbarium specimens.

**Specimens examined**

**West Nepal:** Dolpa, Gomba, 2700m, 16.4.1973, Einarsson, Skarby, Wetterhall, 352 (KATH).

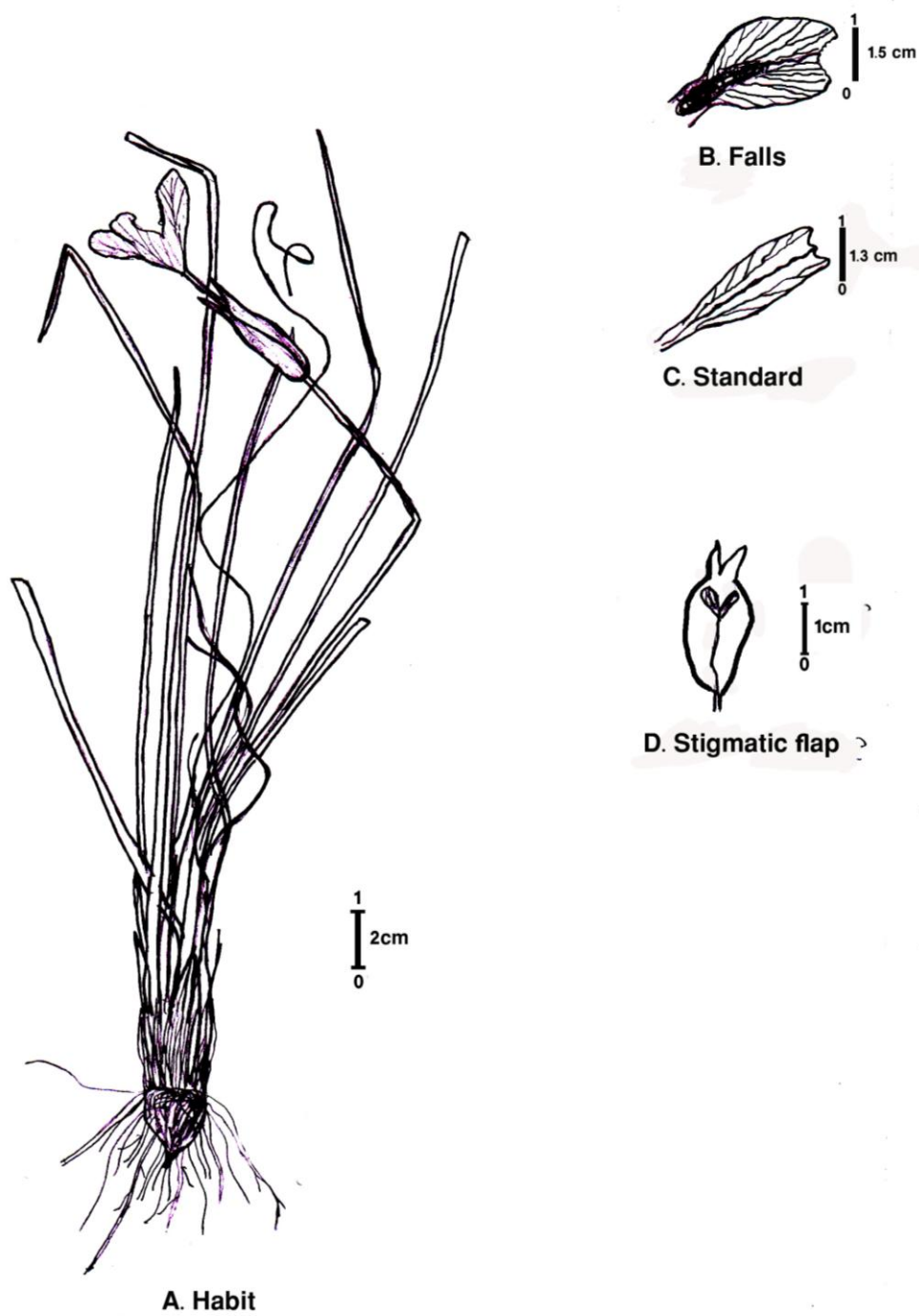
**Digital Photograph of Herbarium seen.**

**West Nepal:** Jumla, 12,500ft, 11.7.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 4551 (BM).

**Central Nepal:** Manang, Kaisang to Tilicho, 3800m, 29.6.1975, D.P.Joshi and T.K.Bhattacharya, 75/3058(KATH).

**Digital Photograph of Herbarium seen.**

**Central Nepal:** Mustang, Muktinath (3650m)-Jharkot (3500m), 12.9.1999, S.Ishizawa, M.N.Subedi, Y.Iokawa and Y.Takahashi, 99912007(TI); Mustang, Marsiandhi valley, 13,000ft, 6.6.1950, D.G.Lowndes, 946(BM); Mustang, Thinigaon, Muktinath Himal, 14,000ft, 21.6.1954, Stainton, Skyes and Williams, 1267(BM); Manang, Jargeng khola, 14,000ft, 22.6.1950, D.G.Lowndes, 1050(BM); Manang, Kone Khola, Marsyandi valley, 14,000ft, 26.7.1983, R.J.D.Mc Beath, 1494(E); Manang, Jargeng khola, 4420m, 3.7.1950, D.G.Lowndes, 1118 (BM); Gorkha, Sringi Himal. Shiar Khola, 12800ft, 28.5.1953, P.C.Gardner, 620(BM); Rasuwa, Langsisa Kharka, c.14,500ft, 15.6.1949, O.Polunin, 331(BM); Rasuwa, Langtang, 14,000ft, 7.7.1975, J.D.A.Stainton, 7423(BM); Rasuwa, Glacier valley, 13,200ft, 13.6.1950, D.G.Lowndes, 981(BM).



**Fig. 20. *Iris goniocarpa* Baker; A.** Habit sketch (based on D.P.Joshi and T.K.Bhattacharya, 75/3058 KATH); **B.** Falls (Outer tepals), **C.** Standards (Inner tepals), **D.** Stigmatic flap (based on D.G.Lowndes, 1118 BM).

8. *Iris clarkei* Baker ex Hook.f., *Fl. Brit. India* 6(18): 275 (1892).

*Iris himalaica* Dykes *Gard. Chron. III*, 45: 3, 36 (1909).

**Nepali Name:** Bojho jhar

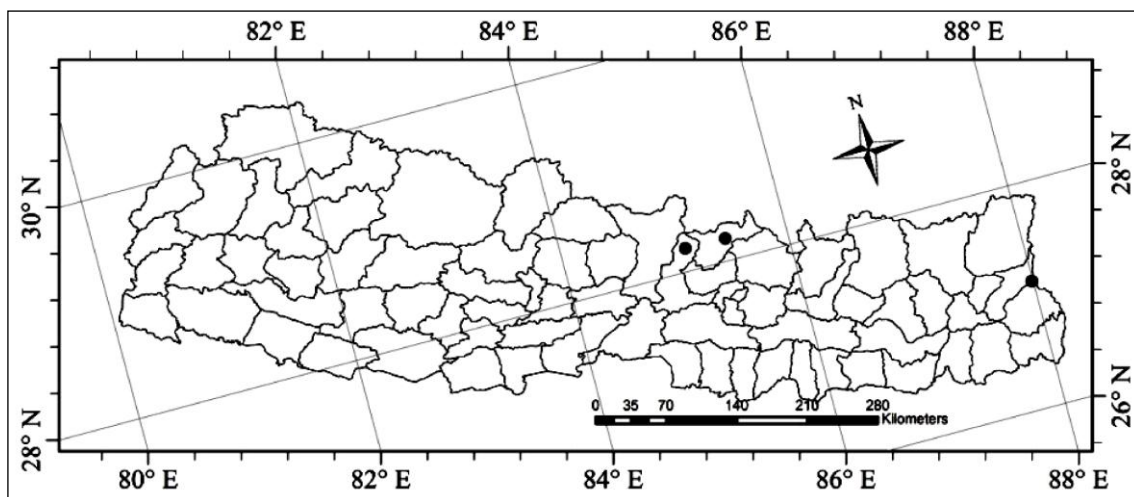
Perennial herb, 27--30 cm tall, stout. Stem 3--10 mm in diameter at base. Rhizomes slender, spreading, upper parts clothed with brown, fibrous remains of old leaves. Leaves linear, ensiform, strongly striate, ca. 19--23 cm X 1-5 mm, shining green on upper surface, greyish beneath. Flower stem hollow, exceeding leaves, sometimes simple, usually with one branch. Spathes 3, green, broadly lanceolate, 1-2-flowered. Pedicels 4--8 cm carrying flowers almost free of spathes. Flowers bluish violet, ca. 9 cm diameter, tube ca.1--1.6 cm, funnel-shaped. Falls blade deflexed, dark blue to purple hair on central, with white or greenish-yellow tinged at base, oblong, 3--4 cm X 5--1.5 mm. Standard blade horizontal or recurved, lanceolate, acute, abruptly narrowed into very narrow, channeled haft. Anthers whitish-mauve or cream. Style branches broad, forming flattened top to flower, lobes half-ovate. Capsule oblong-trigonal, abruptly contracted at top and bottom, ca. 3.6--5.5 cm, opening from top. Seeds flattened, D-shaped or round, flanged, dark brown.

**Distribution:** Nepal, Tibetan Plateau, E Himalaya, Assam-Burma and E Himalaya.

**Altitudinal range:** 3000-3060m.

**Ecology:** On moist slope along with *Berberis* bushes and grass meadow.

**Flowering:** June-July. **Fruiting:** August-September.



**Fig. 21.** Distribution map of *Iris clarkei* based on herbarium specimens.

**Specimens examined**

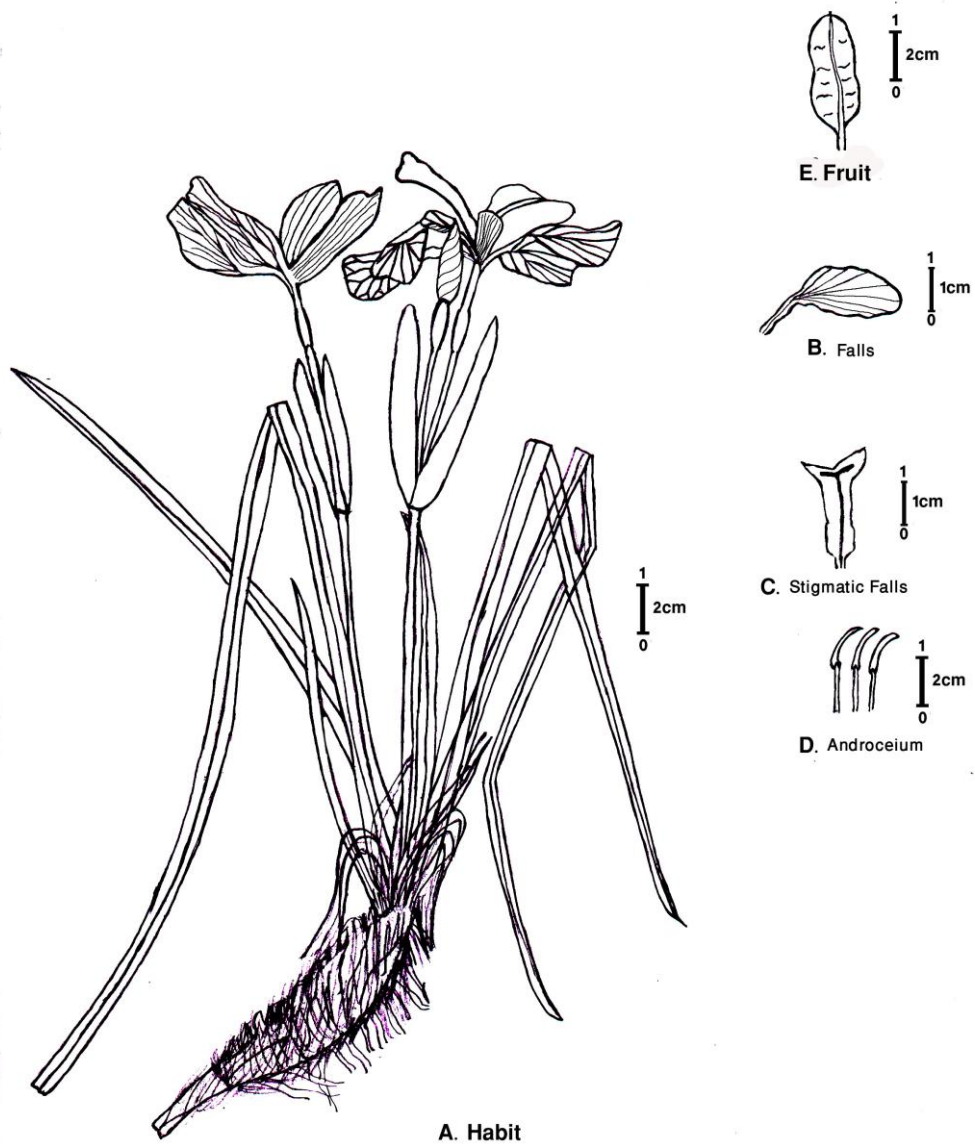
**Central Nepal:** Dhading, Ankhu Khola, 10,000ft, 15.6.1962, J.D.A.Stainton, 3844(KATH);  
Rasuwa, Singhoma-Khengja, 10450-11750ft, 2.6.1958, S. R. Rolla, 17212(KATH).

**Digital Photograph of Herbarium seen.**

**Central Nepal:** Khoreak, 3963-4878m, 1927, Capt. Lall Dhwoj, 13 (BM).

**Digital Photograph of Herbarium seen.**

**East Nepal:** Pachthar, Chandu, 3550m, 9.6.2007, K.K.Shrestha, S.Rajbhandary, K.Humagain  
and N.B.Khatri Chhetri, LKSRA78(E).



**Fig. 22. *Iris clarkei* Baker; A. Habit sketch, B. Falls (Outer tepals), C. Stigmatic flap and D. stamens (based on J.D.A.Stainton, 3844 KATH); E. Fruit (based on Capt. Lall Dhwoj, 13 BM).**

**Crocus** L., *Sp. Pl.* 1:36.1753.

Herbs small, perennial, cormous. Corms oblate, covered with a tunic. Leaves few, all basal, green, linear, pale below, median stripe, base surrounded by membranous, sheath-like leaves. Aerial stem not developed. Flowers emerging from ground with peduncle and ovary subterranean. Perianth white, yellow or lilac to dark purple; tube long, slender, segments similar, equal or sub-equal. Stamens inserted in throat of perianth tube. Style 1, slender, distally with 3 to many branches. Capsule small, ellipsoid or oblong-ellipsoid.

**Distribution:** 80 species worldwide and 1 species from Nepal.

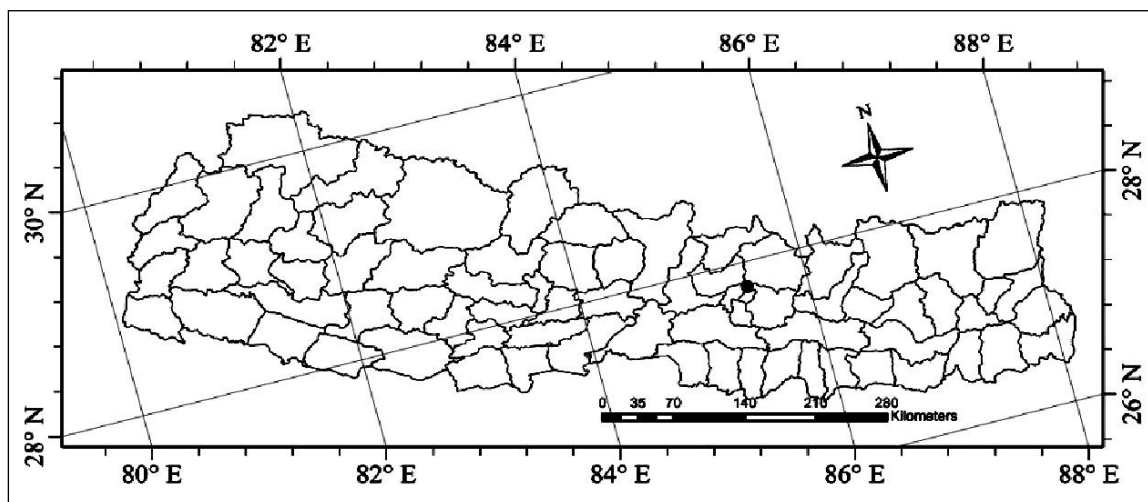
**1. *Crocus sativus* L., *Sp. Pl.* 1:36.1753.**

Perennial herb, ca. 14--16 cm. Stem ca. 2 mm in diameter at base. Corm ca. 4 cm in diameter, tunic light yellow or yellowish brown, reticulate fibrous. Leaves 10--13 cm X 1--2 mm. Flowers 1 or 2, fragrant. Perianth purple, segments oblanceolate, 8-10cm, obtuse apex. Stamens ca. 3 cm, anthers yellow, apex slightly curved, pointed. Style 3-branched at apex, branches recurved, deep red, 3cm or more. Fertile seeds not produced.

**Distribution:** Cultivated widely throughout main Kashmir valley, China, probably of hybrid origin in E Mediterranean region.

**Altitudinal Range:** 2000m

**Flowering:** October-December. **Fruiting:** December.

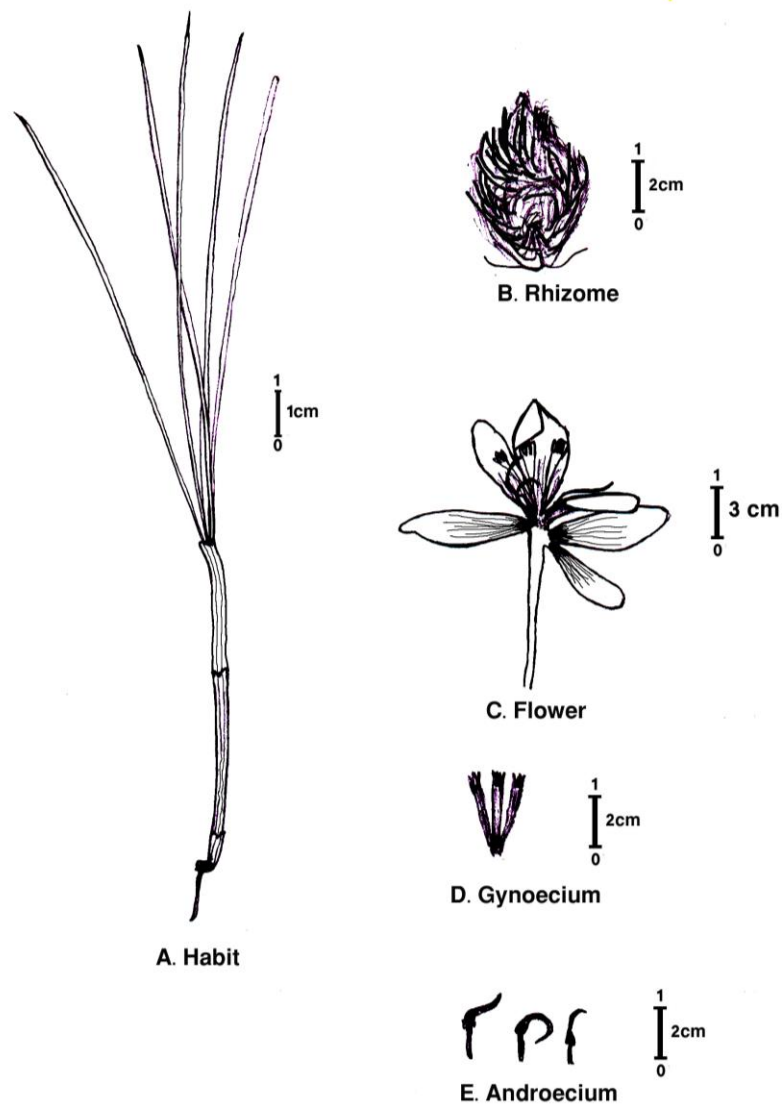


**Fig. 23.** Distribution map of ***Crocus sativus*** based on herbarium specimens.

**Note:** The style and stigmas are used medicinally in cooking and in the preparation of saffron dye. It is a cultivated species so, least explained.

**Specimens examined**

**Central Nepal:** Kathmandu, Manichur, 2000m, 10-6-047, K.Bhattarai (TUCH).



**Fig.24. *Crocus sativus* L.;** A. Habit sketch (based on K. Bhattarai, TUCH).

## **4.1.2 Colchicaceae**

### **4.1.2.1 Habitat**

The plants of Colchicaceae are perennial terrestrial herbs growing between rocks in damp sandy soils among mosses on open mixed woodland and shrubland with *Pinus roxburghii*, *Abies* as *Iphigenia indica*; on open but moist place as *Gloriosa superba*; under semi-shaded in mixed broad leaved forest, *Oak-Rhodendron* forest as *Disporum cantoniense* and on damp shady places as *Disporum calcaratum*.

### **4.1.2.2 Habit**

The plants of Colchicaceae are twinning perennials with stoloniferous tubers as *Gloriosa superba* and erect herb as *Disporum cantoniensis*, *Disporum calcaratum* and *Iphigenia indica*.

### **4.1.2.3 Roots**

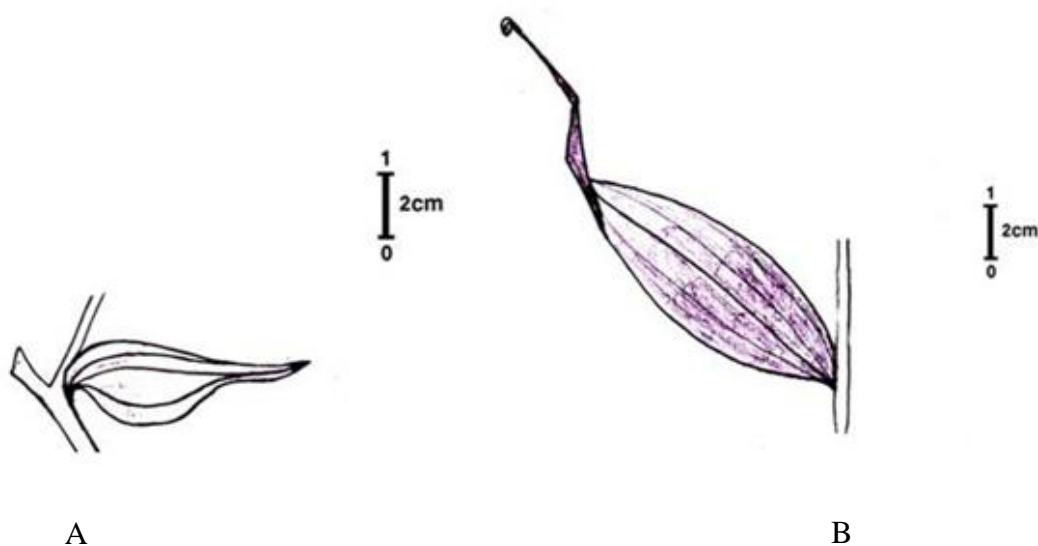
The roots of Colchicaceae are stoloniferous, tuberous corm. Roots stout tuberous in *Gloriosa superba*; rootstock creeping in *Disporum cantoniensis* and *Disporum calcaratum* while corm in *Iphigenia indica*.

### **4.1.2.4 Stems**

Aerial stem well developed in all genera as aerial stem twinning and branched in *Gloriosa superba*, stem dichotomously branched in *Disporum cantoniensis* and *Disporum calcaratum*, and erect in *Iphigenia indica*.

### **4.1.2.5 Leaves**

Leaves alternate, few, linear, sessile, long, acuminate, midvein conspicuous, base sheathing and clasping, lower leaves longer while upper leaves are shorter in *Iphigenia indica*; leaves simple, alternate or occasionally opposite, sessile or shortly petiolate, lanceolate to ovate-lanceolate, apex cirrhose as *Gloriosa superba*; leaves lanceolate to narrowly oblanceolate, sessile or sub-sessile or base cuneate into short petiolate, finely acuminate as *Disporum cantoniense* and leaf blade broad, oblong-lanceolate, sessile or short petiolate in *Disporum calcaratum*.



**Fig. 25.** Types of leaf tip in Colchicaceae: **A.** Simple (*Disporum cantoniense*); **B.** cirrhone (*Gloriosa superba*).

#### 4.1.2.6 Inflorescence

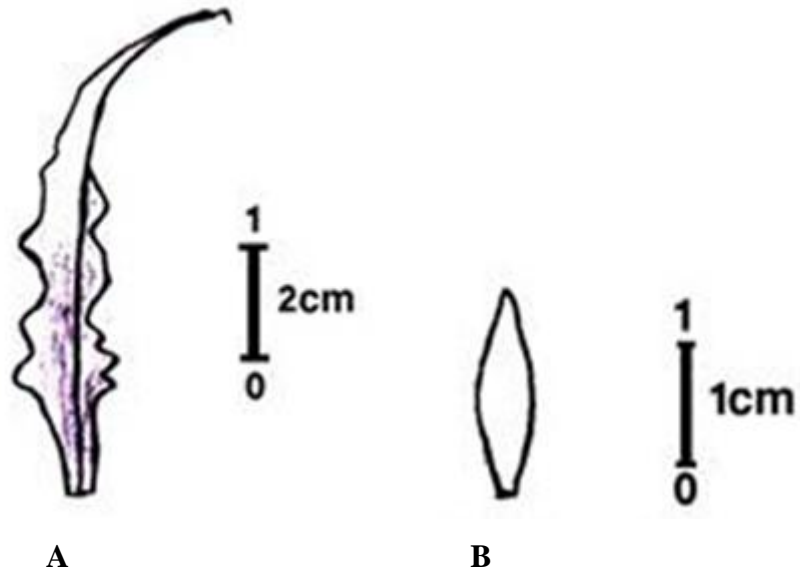
Inflorescence 3-5 flowered in a terminal raceme, bracts linear or subulate, leafy as *Iphigenia indica*; terminal, flower born singly in axils of leaf-like bracts, pedicellate, pedicel long, recurved at apex as *Gloriosa superba*; 3-7 flowered, peduncle distinct, fascicles inserted opposite leaves on upper part of stem as *Disporum cantoniense* and *Disporum calcaratum*.

#### 4.1.2.7 Flowers

Flowers large, showy noddling, born singly in axils of leaf-like bracts in *Gloriosa superba*; occasionally flowers born singly or 3-7 flowered in *Disporum cantoniensis* and *Disporum calcaratum*; flowers solitary or several in a terminal corymb, small in *Iphigenia indica*.

#### 4.1.2.8 Tepals

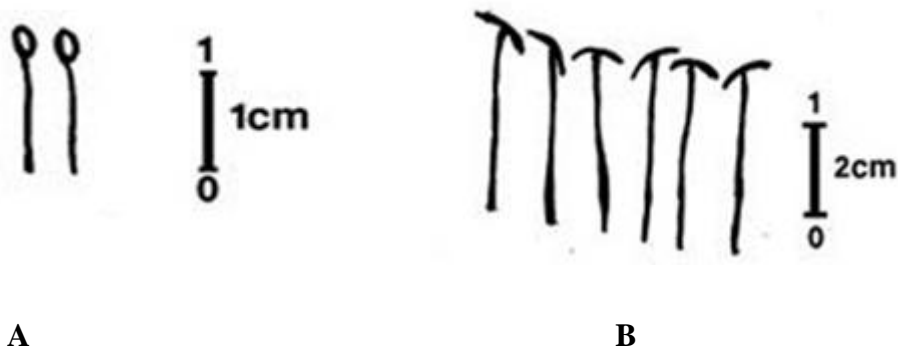
Tepals strongly reflexed, bright red, linear to oblanceolate, margins curved and wavy in *Gloriosa superba*; tepals white, greenish, yellow, pink, dark red, or dark purple often saccate or spurred at base, spreading, narrow, clawed, usually cauducous in *Disporum calcaratum* and base gibbous-spurred in *Disporum cantoniensis*; tepals dark purple, linear to narrowly oblanceolate in *Iphigenia indica*.



**Fig. 26.** Types of tepals in Colchicaceae: **A.** Wavy (*Gloriosa superba*); **B.** Simple (*Disporum cantoniense*).

#### 4.1.2.9 Stamens

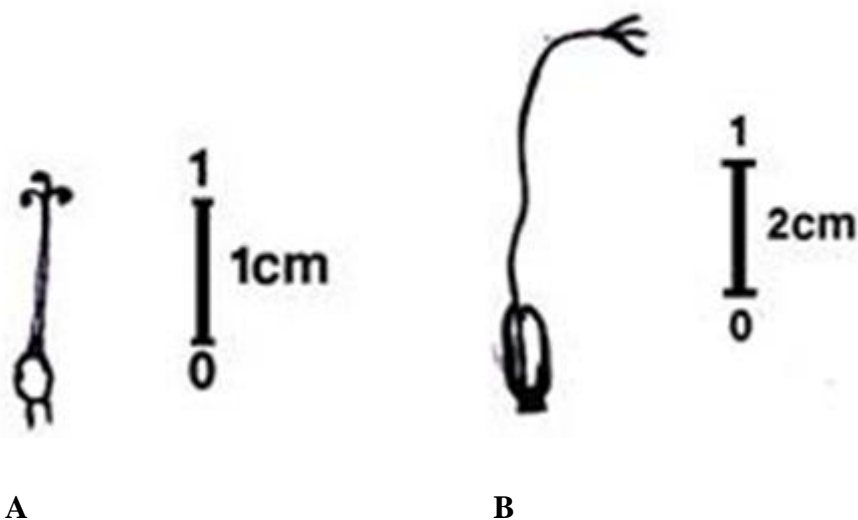
Stamens 6, filaments free, anthers basifixed or dorsifixed, extrose in Colchicaceae. Stamen inserted at the base of tepals, anthers versatile in *Gloriosa superba*; filaments usually slightly flat, dorsifixed, extrose, in *Disporum cantoniense* and *Disporum calcaratum*; stamen shorter than the oblong ovary, filaments papillose in *Iphigenia indica*.



**Fig. 27.** Types of Androecium in Colchicaceae: **A.** Dorsifixed (*Disporum cantoniense*); **B.** Versatile (*Gloriosa superba*).

#### 4.1.2.10 Ovary

Ovary superior, 3-loculed, style slender in Colchicaceae. Ovules many per locule, style long, filiform, apically 3-lobed, strongly reflexed at base in *Gloriosa superba*; style filiform, divided into 3 stigmatic lobes recurved at apex in *Disporum cantoniense* and *Disporum calcaratum* and ovules many per locule, style short, apically 3-lobed, recurved in *Iphigenia indica*.



**Fig.28.** Types of gynoecium in Colchicaceae: **A.** Stigmatic lobe recurved (*Disporum cantoniense*); **B.** Stigmatic lobe simple (*Gloriosa superba*).

#### 4.1.2.11 Fruit

Fruit a capsule or berry in Colchicaceae. Capsule obovoid to oblong, obtuse at both ends, deep purple to black in colour in *Iphigenia indica*; capsule black, linear-oblong in *Gloriosa superba*; fruit a black berry in *Disporum cantoniense* and *Disporum calcaratum*.

#### 4.1.2.12 Seeds

Seeds subglobose, testa appressed brown in *Disporum cantoniense*, *Disporum calcaratum* and *Iphigenia indica*; seeds globose in *Gloriosa superba*.

### 4.2.2 Taxonomic Treatment of family Colchicaceae

Perennial herbs with stoloniferous, tuberous, creeping or tunicate corm. Leaves various, basal or cauline, linear, lanceolate or oblong-lanceolate, inserted opposite or alternate, simple, sessile or short petiolate, apex sometime cirrhose (i.e. forming a tendril). Scale leaves may be present at the base of stem. Inflorescence axillary or terminal, racemose, born on a leafy stem

or leafless scape of single or consisting of 1-few flower. Flower actinomorphic, bisexual, hypogynous, variously coloured with long or short pedicel and bract may be present or absent. Perianth petaloid, usually 6-merous in 2 series, imbricate rarely valvate in bud, segments free or united. Stamen 6, inserted opposite of perianth segments, filaments free or adnate to perianth, anthers oblong to linear, often versatile, usually two lobed, usually dehiscent longitudinally. Ovary superior, 3-celled, axile placentation, ovules 2 or more, style usually simple, often long, stigma 3. Fruit a capsule or berry. Seeds 1 or more, globose or flattened with abundant endosperm and small embryo.

Colchicaceae is moderate sized family of 19 genera and 250 species, tropical to temperate. In Nepal three genera and 4 species.

### Key to Genera

- 1a. Leaf linear, rootstock a tunicate corm.....**1. Iphigenia**
- b. Leaf lanceolate, rootstock tuberous or creeping.....**2**
- 2a. Stem twinning, leaves cirrhmose, fruit a loculicidal capsule .....**2. Gloriosa**
- b. Stem erect, leaves simple, fruit a berry .....**3. Disporum**

#### **1. Iphigenia** Kunth. *Enum. Pl.* 1 : 212 (1833).

Perennial herb. Small corm covered with a tunic. Stem simple, erect, slender, leafy. Leaves few, cauline, scattered, narrow, linear, sessile. Flowers solitary or several in a terminal corymb, small, erect, bract leaf-like, pedicel long. Perianth or tepals 6-merous, stellate, deciduous, petaloid, segments equal, spreading or recurved, clawed, deciduous, usually cauducous. Stamens 6, hypogynous, inserted at base of tepals, filaments very short, slightly flat, anthers oblong, versatile, extrose. Ovary sessile, 3-loculed, ovoid to oblong, ovules many per locule, style minute, connate at the base, short, apically 3-lobed, recurved, adaxially stigmatic. Fruit a loculicidal 3-valved capsule. Seeds many, subglobose, testa thin, brown, appressed, albumin fleshy, embryo small.

#### **1. Iphigenia indica** (L.) A. Gray ex Kunth. *Enum. Pl.* 1 : 213 (1833).

*Melanthium indicum* L., *Mant. Alt.* 2: 226. (1771).

Perennial herb, 20--40(--10) cm. Stem 1--3 mm in diameter at base, erect, rigid, strict, or flexuous, usually minutely papillose. Corm narrowed into a short neck, tunicate with pale brown sheaths, sub-globose, 5--10 mm in diam. Leaves alternate, few, linear, sessile, long,

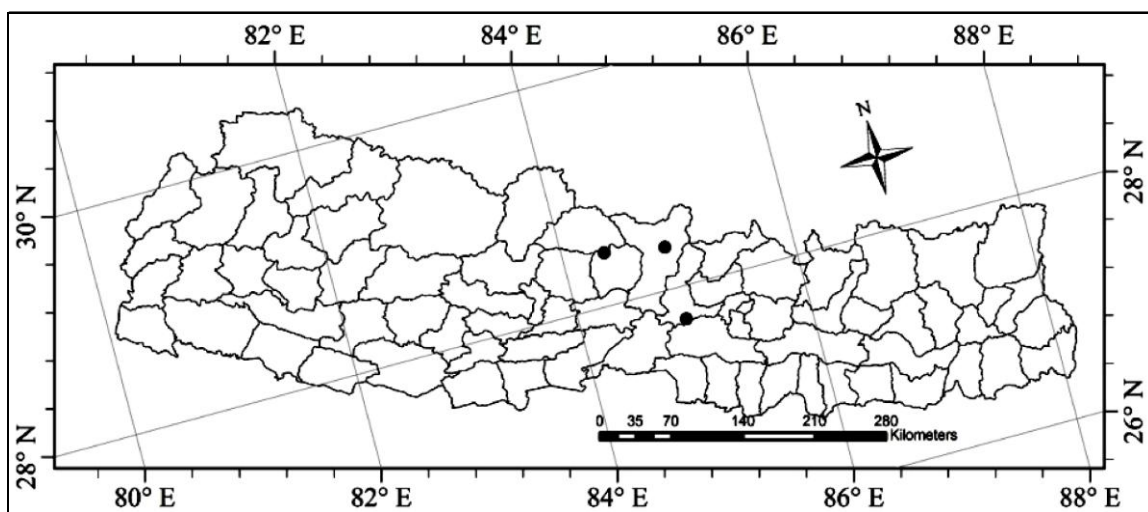
acuminate, midvein conspicuous, base sheathing and clasping, lower leaves longer while upper leaves are shorter, ca. 10--15 cm X 3-5 mm. Inflorescence 3-5 flowered in a terminal raceme, bracts linear or subulate, leafy, 1--4 cm X 2--4 mm, pedicel 1.5--4 cm long. Perianth purplish, sometimes almost black. Tepals dark purple, linear to narrowly oblanceolate, clawed, spreading and reflexed, ca. 3--5 X 0.7--1 mm. Stamen shorter than the oblong ovary, filaments papillose, anthers ca.1mm. Ovary 3-loculed, ovules many per locule, style short, apically 3-lobed, recurved. Capsule obovoid to oblong, obtuse at both ends, deep purple to black in colour, 5--7 X 1-3 mm. Seeds small.

**Distribution:** Nepal, Assam-Burma, E Asia, SE Asia, S Asia, Africa.

**Altitudinal Range:** 1800-2000 m.

**Ecology:** Growing between rocks in damp sandy soils among mosses on open mixed woodland and shrubland with *Pinus roxburghii*, *Abies*.

**Flowering:** June-July. **Fruiting:** July- August.



**Fig.29.** Distribution map of *Iphigenia indica* based on herbarium specimens.

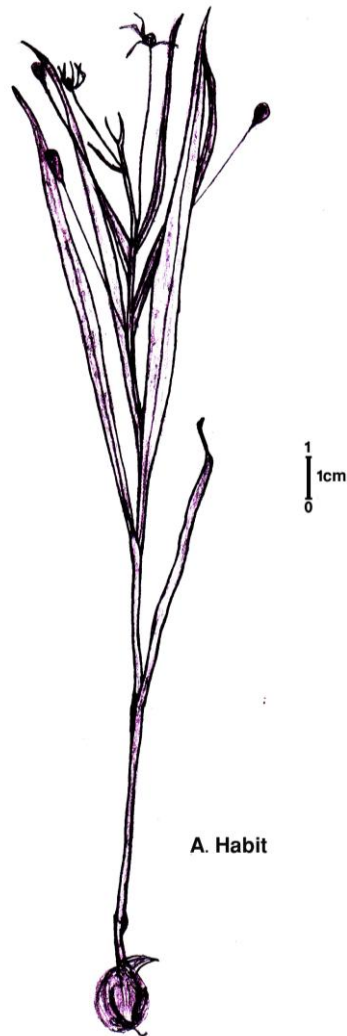
#### **Specimens examined**

**Central Nepal:** Makwanpur, Bhumithan, 6200ft, 1.8.1979, S.Dhakal and N.Dabadi, 836 (KATH).

#### **Digital Photograph of Herbarium seen.**

**Central Nepal.** Gorkha, Marsyandi Khola, Tal (1620m)-Jagat(1300m), 1400m, 8.8.1983, H.Ohba, H.Kanai, M.Wakabayashi, M. Suzuki and S.Akiyama, 8311100 (TI); Gorkha, Jagat

to Philim, 1330m, 28.7.2008, H.Ikeda, T.Kawahara, O. Yano, N.Yamamoto, M.F.Watson, Z.H.Li, M.N.Subedi and S.K.Acharya, 20815036 (E); Gorkha, Marsyandi Khola, Tal(1620m)-Jagat(1300m), 1400m, 8.8.1983, H.Ohba,H.Kanai, M.Wakabayashi, M. Suzuki and S.Akiyama, 8311100 (E).



**Fig. 30. *Iphigenia indica* L. A. Habit sketch (based on H.Ohba, H.Kanai, M.Wakabayashi, M.Suzuki and S.Akiyama, 8311100 TI)**

## 2. *Gloriosa* L., *Sp. Pl.* 1: 305 (1753).

Twinning perennial herbs with stout tuberous, naked rhizome. Stem branched, herbaceous, leafy, usually elongated. Leaves scattered, simple, cauline, alternate, opposite or whorled, lanceolate, costate, sub-sessile to sessile, cordate, nerves parallel, main vein distinct, apex elongate, spiral, functioning as a tendril with entire margin. Inflorescence terminal, racemose. Flowers few, large, showy, bright red to yellow, born singly in axils of leaf-like bracts, pedicellate, pedicel long, recurved at apex. Perianth petaloid, persistent, segments 6, sub-equal, hypogynous, free, strongly spreading or reflexed, narrow, margins usually undulate or waved. Stamen 6, hypogynous, filaments free, filiform, inserted at base of tepals, anthers linear, dorsifixed, versatile, slits extrose or dehiscing extrosely. Ovary superior, narrowly ellipsoid, 3-loculed, ovules many per locule, style long, filiform, apically 3-lobed, adaxially stigmatic. Fruit a large, coriaceous, septicidal capsule. Seeds globose to sub-globose, testa spongy, bright red, embryo cylindrical in horny endosperm.

**Distribution:** Worldwide about 5 species from South and tropical Africa, tropical Asia. One species from Nepal.

### 1. *Gloriosa superba* L., *Sp.Pl.* 1: 305 (1753).

**Nepali name:** Nepali kewara

Twinning, perennial herb, ca.75--110(--25) cm. Stem 2--6 mm in diameter at base. Root stock tuberous, solid, white, naked in a chain of fleshy arched tubers, pointed at each end, bifurcately branched, budding from the convexity above. Stem herbaceous, cylindrical, branched above, leafy. Leaves 10--18 cm X 1.5--4 cm, simple, alternate or occasionally opposite, sessile or shortly petiolate, variable in breadth, many nerved, lanceolate to ovate-lanceolate, apex cirrhose, scale leaves 5--12.5 X 1 cm. Flowers nodding, large, axillary, solitary, pedicels long, 7--17 cm X 0.1 cm, tip deflexed. Tepals reflexed, bright red above the lower third, golden yellow below it as are the margins and midrib, linear-oblong, 4--9.5 X 0.4-1 cm, margins curved and wavy. Stamen 6, slightly shorter than the perianth, filaments stout, golden yellow, 2.5 cm long, anthers ca. 1 cm. Style filiform, 3-lobed, 4--6.5 cm X 3 mm long, stigma lobes 6--7 mm. Capsule black, linear-oblong, Ca. 5--5.6 X 2 cm in diameter, seed globose, ca. 3 mm.

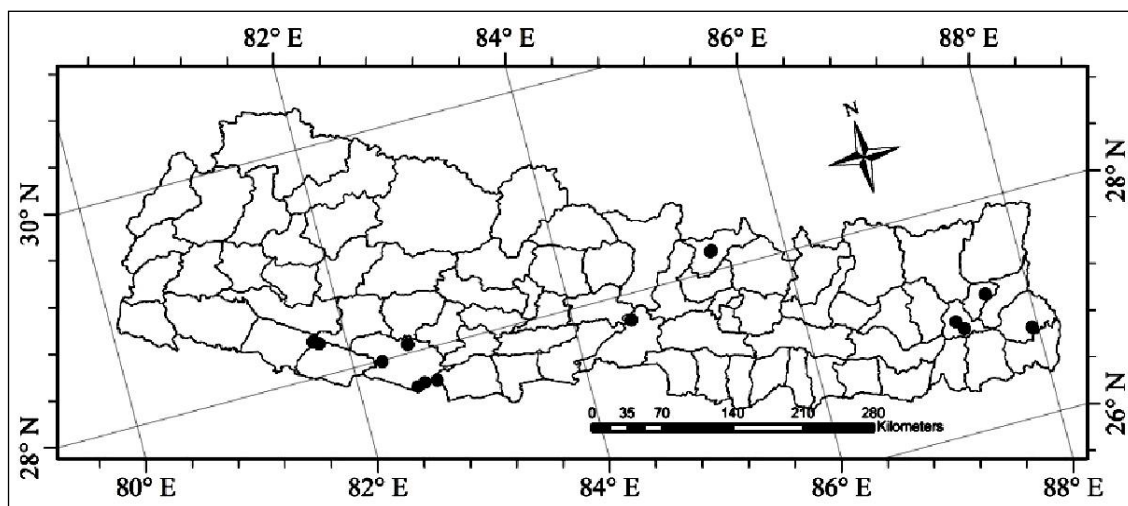
**Distribution:** Nepal, SE Asia, Assam-Burma, S Asia, E Asia, SW Asia.

**Altitudinal Range:** 400-2200m.

**Ecology:** Small herb on open but moist place.

**Flowering:** July- August. **Fruiting:** August- September.

**Note:** Tubers are poisonous. The rhizomes are rich in the alkaloid colchicines



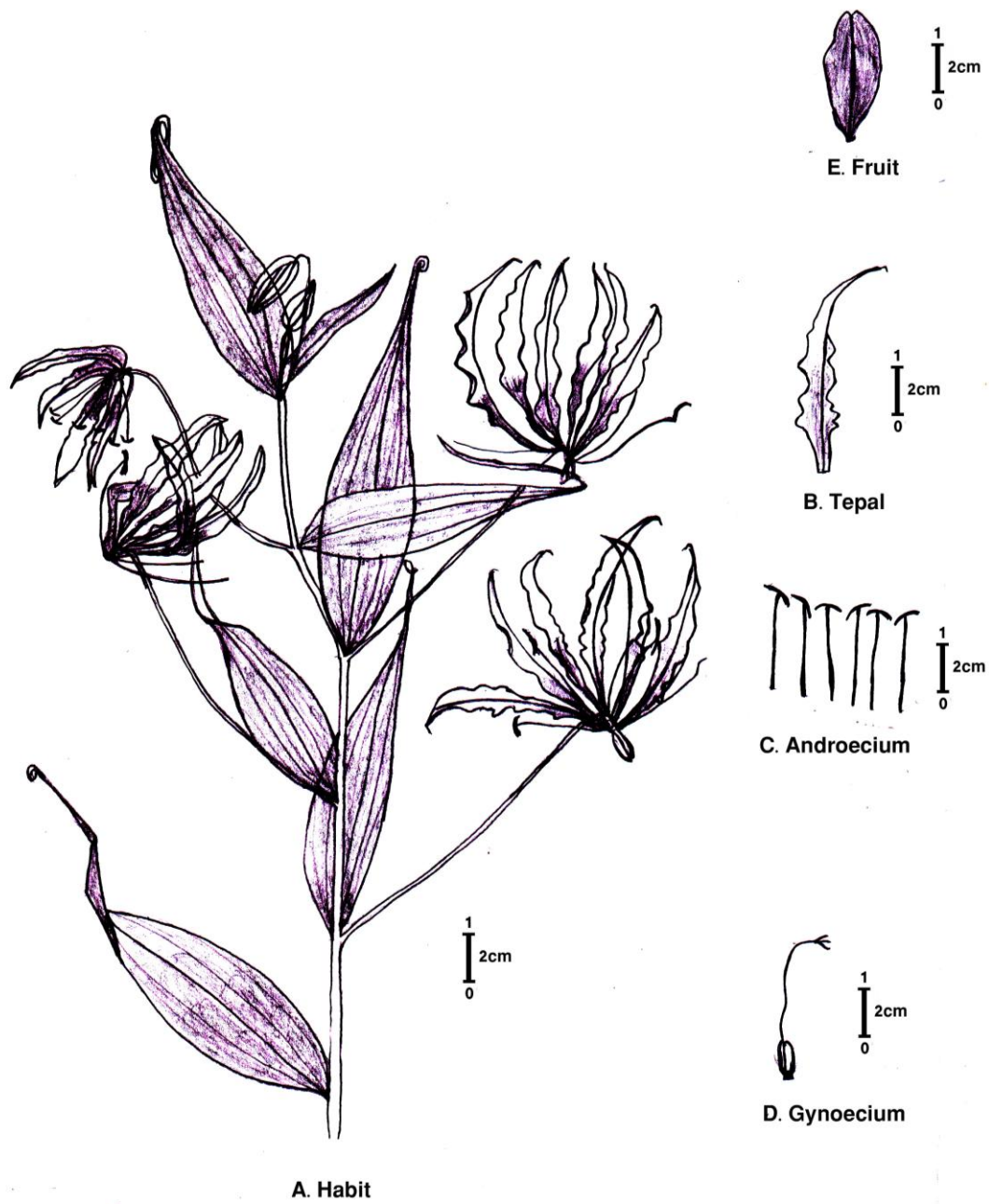
**Fig. 31.** Distribution map of *Gloriosa superba* based on herbarium specimens.

### **Specimens examined**

**West Nepal:** Baitadi, Dhap, 600m, 12.7.1984, P.R.Shakya, H.K.Adhikari and N.N. Subedi, 7834(KATH); Salyan, Bangad, 520m, 11.10.1982, K.R.Rajbhandari and K.J.Malla, 6955(KATH); Banke, Lokhana, 600ft, 10.4.039, U.R.Poudyal, 4230(KATH); Banke, Kohalpur, 600ft, 16.4.039, U.R.Poudyal, 4265(KATH); Dang, On way to Koilabash, 1000 to 2000ft, 15.8.'68, Dr.Malla, 14019 (KATH); Dang, Chorkholi, 1,000ft, 25.4.037, Bhattacharya, 363(KATH).

**Central Nepal:** Rasuwa, Very near to Syrubensi, 5500ft, 21.7.67, Dr.Malla, 9071(KATH); Chitwan, Rampur, 600ft, 21.5.042, T.K. Bhattacharya, 5556(KATH).

**East Nepal:** Taplejung, Teku Nala (800m)-Tamur Bridge (300m)-Dhara Pani (1000m), 300-1000m, 4.9.1977, H.Ohashi, H.Kanai, H.Ohba and Y.Tateishi, 771373(KATH); Dhankuta, Mulghat, 750m, 29.7.1976, N.P.Manandhar, 31(KATH); Dhankuta, 4,000ft, 6.7.1969, T.B.Shrestha, 16073 (KATH).



**Fig. 32. *Gloriosa superba* L. A. Habit sketch, B. Tepals, C. Stamens and D. Gynoecium** (based on P.R. Shakya, H.K.Adhikari and N.N. Subedi, 7834 KATH); **E. Fruit** (based on H.Ohashi, H.Kanai, H.Ohba and Y.Tateishi, 771373 KATH).

**3. Disporum** Salisb. ex D. Don, *Prodr. Fl. Nepal.* 50.1825.

Perennial herb, rootstock creeping, fleshy, sometimes long stoloniferous, often glabrous, sometimes scabrous. Stem erect, angular, leafy, with sheathing membranous scale on lower part and simple sessile alternate leaves on upper part with dichotomously branched stem. Leaves alternate, very shortly petiolate, sometimes sessile, linear to lanceolate, strongly nerved. Inflorescence terminal or pseudolateral, solitary or in few-flowered, pedicels stout, decurved, bract absent. Flowers bisexual, often noddling, sometimes horizontal, tubular-campanulate. Tepals 6, free, white, greenish, yellow, pink, dark red, or dark purple, deciduous, costate, often saccate or spurred at base. Stamens 6, hypogynous, inserted at base of tepals above top of spur or sac, filament short, usually slightly flat, anthers basifixed to innate, extrose. Ovary superior, 3-loculed, ovules 2-6 per locule. Style filiform, divided into 3 stigmatic lobes recurved at apex. Fruit a black berry, dark blue to black. Seeds globose or ovoid.

**Distribution:** Worldwide 20 species mainly Asiatic and N. American. Two species in Nepal.

**Key to species**

- 1a. Tepals long spurred, often slightly recurved.....**2. D. calcaratum**  
b. Tepals shortly spurred, spurs gibbous.....**1. D. cantoniense**

**1. Disporum cantoniense** (Lour.) Merr., *Phillip. J. Sci.* **15** (3) : 229 (1920).

*Fritillaria cantoniensis* Lour., *Flora Cochinchinensis* **1**: 206 (1790).

*Disporum cantoniense* f. *parviflorum* (Wall.) H.Hara, *Bull. Univ. Mus. Univ. Tokyo.* 31:186 (1988).

*Disporum cantoniense* var. *parviflorum* (Wall.) H.Hara, in *Fl. E. Himal.* 407 (1966).

**Nepali name:** Mhajari

**Type specimen:** Nepal, **Central:** Makwanpur, Chitlang, *Buchanan-Hamilton* s. n., 10 Apr 1802. **Holotype:** BM

Perennial herb, 80--115 cm tall. Stem 1-5mm in diameter at base. Rootstock creeping, thick, without stolon. Stem erect, angular, leafy, dichotomously branched above, branches ascending, scale leaves 4-5 in number 2.5--6 cm X 1--2 cm, loosely sheathing, brownish, membranous. Leaves lanceolate to narrowly oblanceolate, 7--9 X 1.5--2 cm, sessile or subsessile or base cuneate into short petiolate 4--5 mm, finely acuminate, strongly-nerved, main

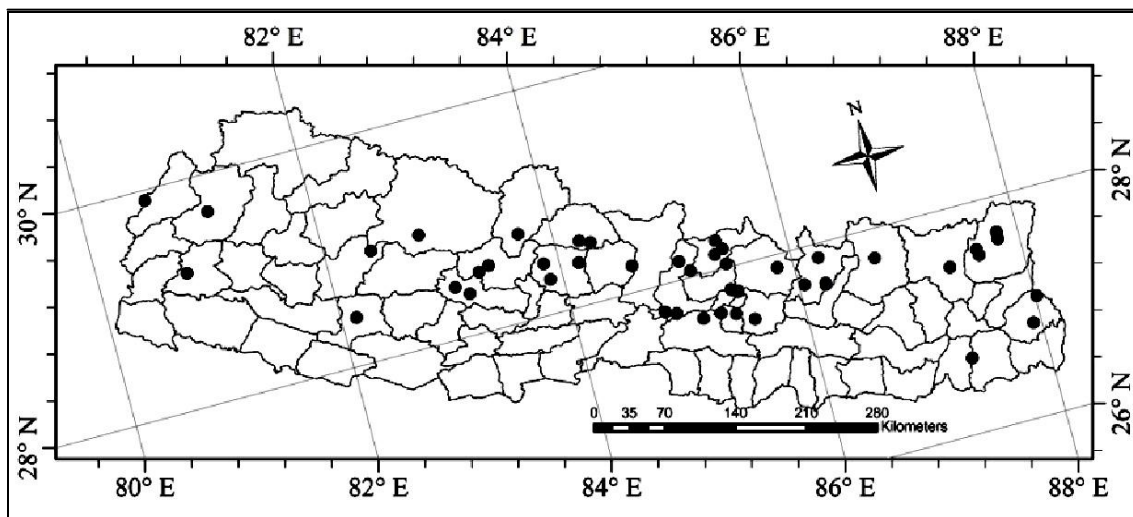
veins raised. Inflorescence 3-7 flowered, peduncle distinct, fascicles inserted opposite leaves on upper part of stem, pedicel papillose, 1--2 cm long, becoming rigid and deflexed in fruit. Flowers slightly opening, perianth campanulate, deciduous, segments 6, erect, purplish, oblong to lanceolate 5--15 X 2--4 mm, papillose, base gibbous-spurred, spurs 2--3 mm. Stamens 6, hypogynous, 8--15mm, filaments 2--8 mm, anthers 2--4 mm, dorsifixed, extrose. Ovary ca.3 X 1 mm, 3-celled, style 7--15 mm, stigmas 3 short. Fruit a black berry, 3-seeded, 5 X 5 mm in diameter. Seeds subglobose, testa appressed, brown.

**Distribution:** Nepal, Tibetan-Plateau, E Himalaya, Assam-Burma, SE Asia, E Asia.

**Altitudinal Range:** 1100-2900m.

**Ecology:** Herb under semi-shaded in mixed broad leaved forest, *Oak-Rhodendron* forest.

**Flowering:** May-July. **Fruiting:** August-October.



**Fig. 33.** Distribution map of *Disporum cantoniense* based on herbarium specimens.

#### **Specimens examined**

**West Nepal:** Darchula, Hakarigad-Khandeshori Khatoli, Harna, 2000m, 18.7.1984, P.R.Shakya, H.K.Adhikari and N.N. Subedi, 7909'A'(KATH); Bajhang, Bauli Gad, 2300m, 04.05.73, J.F.Dobremez, 19755(KATH); Doti, Below Ghanteshwor, 2550m, 3.5.1971, P.R.Shakya and D.P.Joshi, 460(KATH).

#### **Digital Photograph of Herbarium seen.**

**West Nepal:** Dolpa, Tarap khola gaon, 8,000ft, 24.4.1954, Stainton, Sykes, Williams, 182(E);

Banke, Near Darma, Tanke Khola, 7-8000ft, 20.5.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 4130(E).

**Central Nepal:** Manang, Timang Kharka, 2500m, 19.8.1974, Joshi and Bhattacharya, 74/2570(KATH); Kaski, Pokhara, Suiket(1230), Pathana(Dhampus)(2050), 1900m, 7.7.1983, H.Obha, H.Kanai, M.Wakabayashi, M.Suzuki and S. Akiyama, 8310124(KATH); Gorkha, Near Hindung, 2000m, 23.5.73, Shaky and Bhattacharya, 2269(KATH); Shyanja, Wangsing vdc, 1900m, 9.6.2013, Thapa, T.K., 5 (TUCH); Dhading, Mathilo orbang, 870m, 19.11.1989, N.P.Manandhar, 16166(KATH); Makwanpur, Daman, 2250m, 28.5.1986, N.K.Bhattacharya, 86/274(KATH); Rasuwa, Syapruagaun, 2850m, 1.6.1993, N.P.Manandhar, 193-93(KATH); Nuwakot, Tharupati pass, 3300m, 24.5.1993, N.P.Manandhar, 135-93(KATH); Kathmandu, Champadevi, 1400-1800m, 6.7.2002, Maniraj, Prem, Sandesh, Dinesh, Sajan, Sawilk, Roshan, Binaya, Bigya, Lokendra, Gyanraj, 211(TUCH); Kathmandu, Sundarijar, 1950, 13.2.1969, H.Kanoi, 21(KATH); Lalitpur, Phulchoki, 2300m, 23.5.1967, D.H.Nicolson, 3358(KATH); Kabre, Okwuni, 1990m, 3.5.1979, N.P.Manandhar and M.K.Adhikari, 1342(KATH); Dolakha, Charikot, 2000m, 11.7.1977, K.R.Rajbhandari and B.Roy, 1178(KATH).

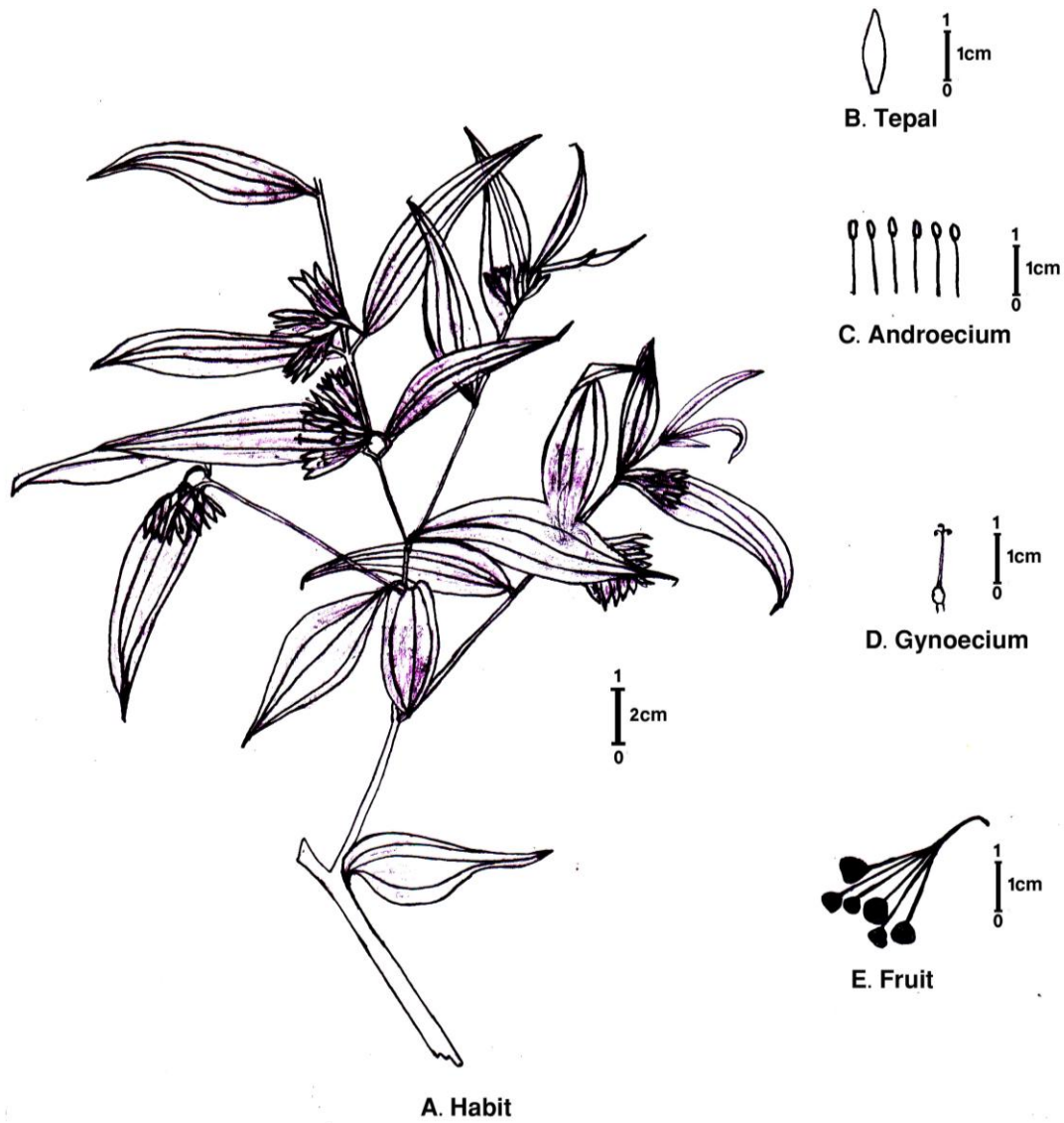
**Digital Photograph of Herbarium seen.**

**Central Nepal:** Baglung, Okhaldhungagaon, S.of Dhorpatan, 9,500ft, 1.5.1954, Stainton, Sykes, Williams, 390(E); Mustang, Lete, Kali gandaki valley, 8,000ft, 5.6.1954, Stainton, Sykes, Williams, 5634(E); Rasuwa, Between Bharkhu and Syabru, 2100m, 22.4.1992, D.G.Long and S.E. Mc Dermott, 21929(E); Sindhupalchok, N.of Jumling, 1809m, 10.8.2011, M.F.Watson, C.A.Pendry, D.A.Gray, R.S.Dani and N.Phuyal, EKSIN37(E).

**East Nepal:** Solukhumbu, Above Giovane, 2250m, 18.5.1973, Shaky and Bhattacharya, 2140(KATH); Dharan, Dharan-Sanguri, 3800ft, 2.5.1961, T.B.Shrestha and William, 12349(KATH); Ilam, Dhudadanda, Saktim, 2000ft, 10.6.1974, P.Pradhan, M.M.Amatya and R.Shrestha, 224/74(KATH); Taplejung, Taplejung Pati(2310)-Jongim(2550m)-Wolangchung Gola(3110m), 2310-3110m, 24.5.1992, M.Suzuki, N.Acharya, S.Akiyama, H.Koba, S. Noshiro and K.R. Rajbhandari, 9262181(KATH).

**Digital Photograph of Herbarium seen.**

**East Nepal:** Solukhumbu, Dudh koshi valley: Ghat to Phakding: trail from Lukla to Namche Bazar, 2650m, 9.5.2004, M.F.Watson, K.R.Rajbhandari, D.Knott, A.G.Miller, B.Adhikari, K.Maden, V.Manandhar, R.Uprety, DNEP135(E).



**Fig. 34. *Disporum cantonensis* (Lour.) Merr.** A. Habit sketch, B. Tepals, C. Stamens and D. Gynoecium (based on T.B. Shrestha and William, 12349 KATH); E. Fruit (based on P.R.Shakya, H.K. Adhikari and N.N. Subedi, 7909'A' KATH).

**2. *Disporum calcaratum*** D. Don, *Proc. Linn. Soc. Lond.* **1** : 45 (1839).

*Disporum hamiltonianum* D. Don, *Proc. Linn. Soc. Lond.* **1**: 45 (1839).

*Uvularia calcarata* Wall. *Numer. List.* 5087 (1831-32).

**Type specimen:** Nepal, **Central:** Nepalia, Wallich 5088B, ann. 1821. **Syntype:** BM

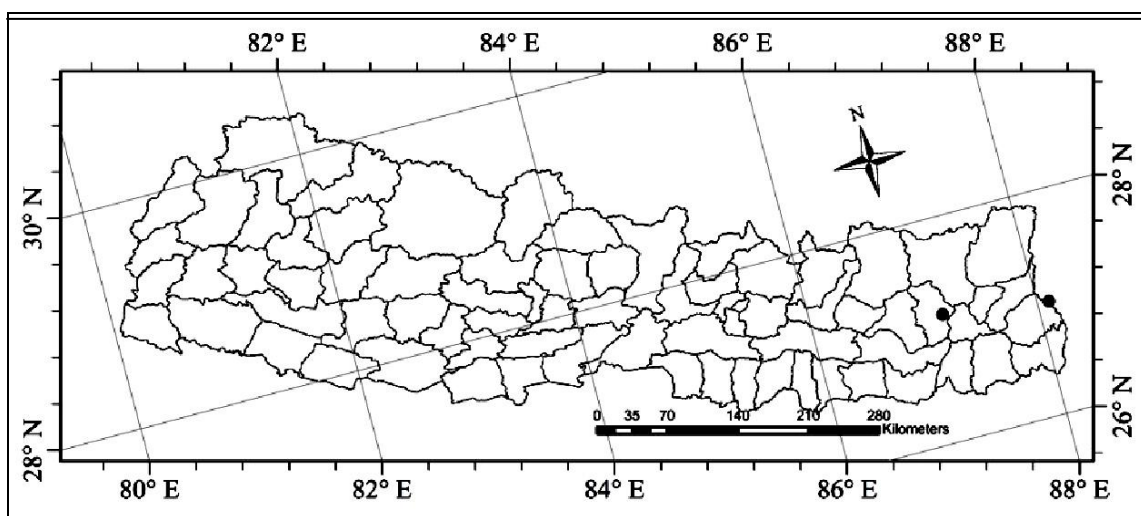
Perennial herb, 50--120 cm. Stem 2--5 mm in diameter at base. Rootstock creeping, slightly flexuous. Stem dichotomously branched, leafy, angular. Leaf blade broad, oblong-lanceolate, 8--13 X 3--5 cm, sessile or short petiolate, 5--6 mm, entire margin, strongly-nerved, main veins raised, acute apex. Inflorescence pseudolateral, umbellate, 3-10-flowered, peduncle short, sometimes distinct, pedicel 2--2.5 cm, ridged, usually minutely papillose on ridges. Flowers campanulate, usually narrow, white greenish or purplish; tepals often purple, sometimes often pink to dark red, lanceolate-oblong, acuminate, 1--2 cm X 2--4 mm, base long spurred, spurs straight or sometimes slightly recurved, cylindric. Filaments five times as long as anther. Stamens 1.1--1.8 cm, filaments 7--13 mm, anthers 4--5 mm. Ovary 2.5--3 mm. Style slender, rarely exserted, 5--9 mm. Fruit a black berry, 3-seeded, ca. 1 X 1 cm in diameter.

**Distribution:** Nepal, SE Asia, Assam-Burma, E Himalaya,

**Altitudinal Range:** 1100-2900m.

**Ecology:** On damp shady places.

**Flowering:** June–July. **Fruiting:** August–November.

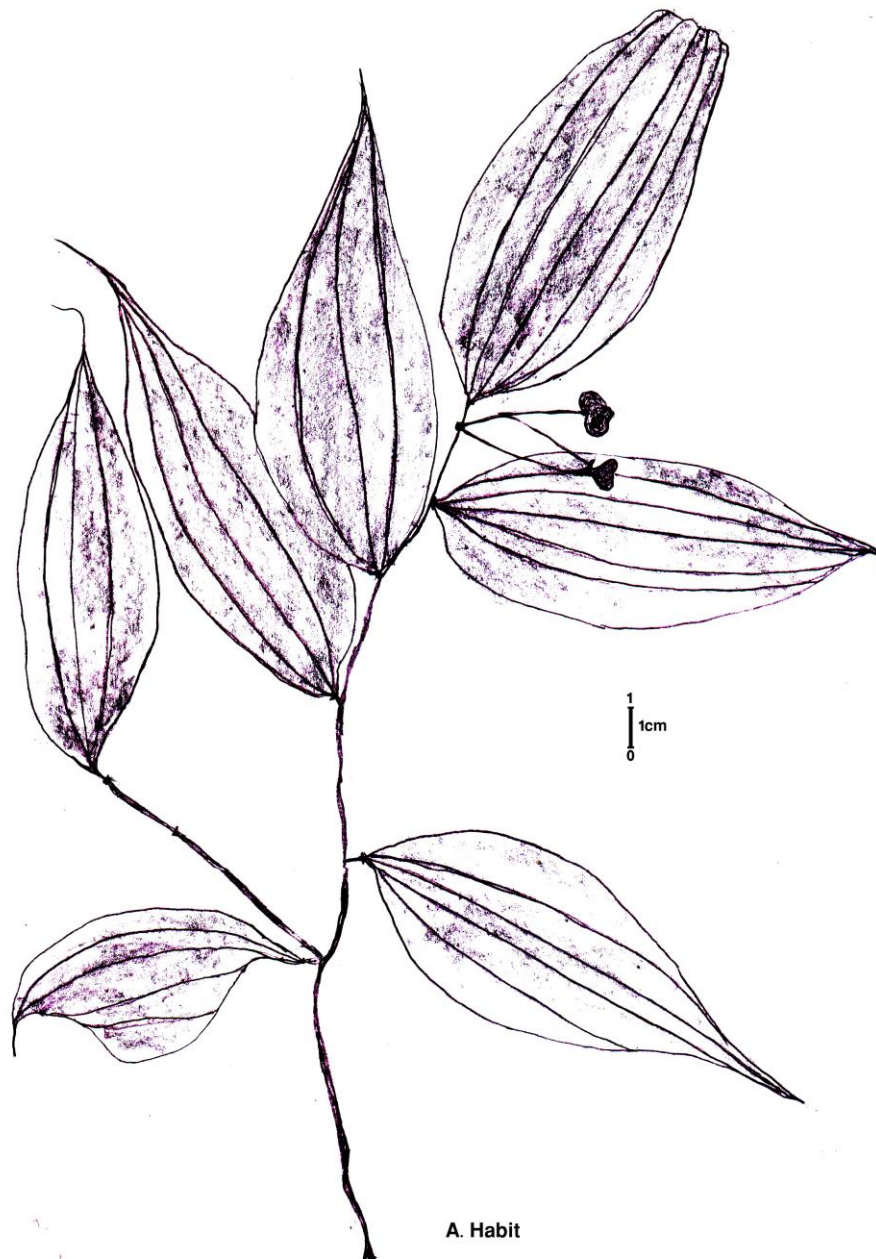


**Fig. 35.** Distribution map of *Disporum calcaratum* based on herbarium specimens.

**Specimens examined**

**Digital Photograph of Herbarium seen.**

**East Nepal:** Dhankuta, Arun valley, Num., 5,000ft, 29.6.1956, J.D.A.Stainton, 779(E); Ilam, Jogmai vdc, Bie to Chitre, 2443m, 12.8.2007, R.M.Kunwar, M.K.Dhamala, J.Pandey, N.B.Khatri Chhetri, Y.R.Poudel and R.K.Rai, LKSRC 241(E).



**Fig. 36. *Disporum calcaratum* D. Don.;** A. Habit Sketch (based on J. D.A. Stainton, 779 E).

### **4.1.3 Melanthiaceae**

#### **4.1.3.1 Habitat**

The plants of Melanthiaceae are perennial terrestrial herbs growing on shady places under growth in the field of bamboos, epiphytes on stem of *Schima wallichii*, *Rhododendron barbatum* as *Trillium govanianum*; on open *Kobresia* grassy slope as *Ypsilandra yunnanensis*; in forest floor of broad leaved forest as *Paris marmorata*; in deep shade on forest floor of Mixed deciduous and Coniferous forest with *Tsuga dumosa* and *Arundinaria* scrub as *Paris mairei*; on damp and shady place in the forest floor of *Rhododendron*, *Acer*, *Abies*, oak and conifer forest as *Paris polyphylla*; in clearing forest as *Paris thibetica*.

#### **4.1.3.2 Habit**

The plants of Melanthiaceae are perennial rhizomatous, unbranched, erect herbs.

#### **4.1.3.3 Roots**

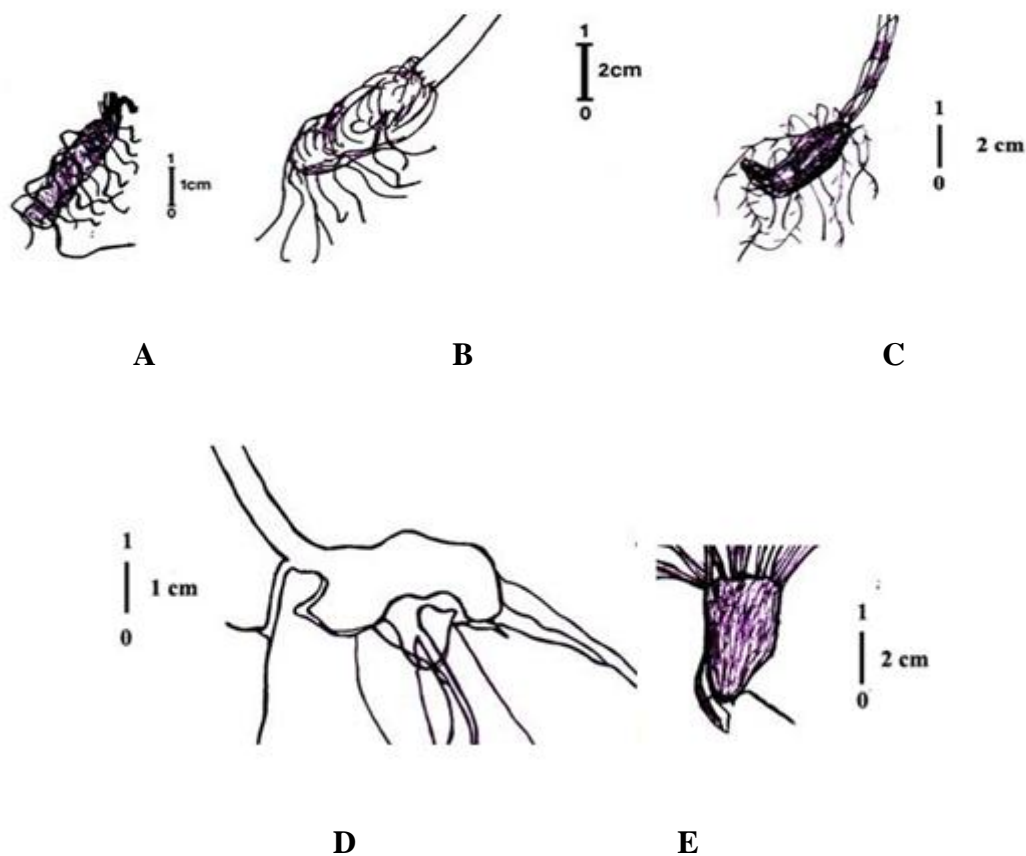
The roots of Melanthiaceae are rhizomatous. Rhizome annulate, light reddish white in *Paris marmorata*; thick, as a size of small potato in *Paris polyphylla*; thickened or slender rhizome in *Paris thibetica*; stout rhizomes in *Trillium govanianum* and short, thickened, slightly fleshy rhizome in *Ypsilandra yunnanensis*.

#### **4.1.3.4 Stems**

Aerial stem well developed, unbranched and erect in all genera of Melanthiaceae.

#### **4.1.3.5 Leaves**

Leaves simple bearing in a whorl with unbranched stem, mainly in a basal rosette, linear to oblanceolate, flat and grass-like or ensiform and distichous in Melanthiaceae. Leaves terminal, whorl of 4-12 lanceolate to ovate, petiolate or sessile in upper parts in species of *Paris*; leaves 3, in a terminal whorl at or above the middle of the stem, sessile or shortly petiolate in *Trillium govanianum*; leaves in a basal rosette, oblanceolate or basally gradually narrowed to a petiole in *Ypsilandra yunnaniensis*.



**Fig. 37.** Types of Rhizome in Melanthiaceae: **A.** (*Trillium govanianum*); **B.** (*Paris tibetica*); **C.** (*Paris polyphylla*); **D.** (*Paris marmorata*); **E.** (*Ypsilandra yunnanensis*).

#### 4.1.3.6 Inflorescence

Inflorescence a terminal, spike-like raceme on leafless scape in Melanthiaceae. Inflorescence 5-17 flowered, rather narrow, densely cylindric in *Ypsilandra yunnanensis*; inflorescence bearing single, terminal flower in *Trillium govanianum* and species of *Paris*.

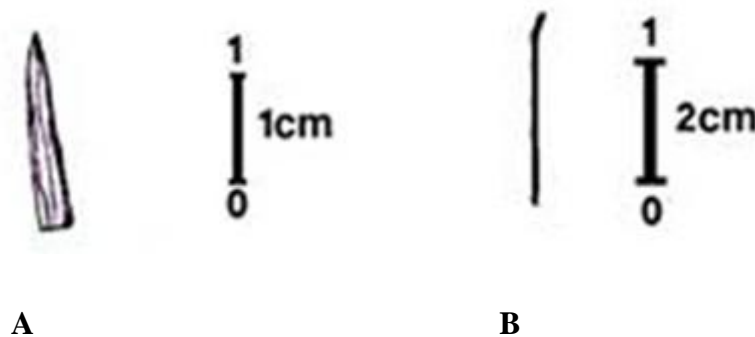
#### 4.1.3.7 Flowers

Flowers terminal, bisexual, actinomorphic, solitary or spike in Melanthiaceae. Flowers many, bisexual, usually nodding at anthesis, ascending in fruit, spreading funnel form in *Ypsilandra yunnanensis*; flower single, bisexual, terminal, sessile or pedicellate in *Trillium govanianum* and species of *Paris*.

#### 4.1.3.8 Tepals

Tepals 6, free or fused to ovary below in Melanthiaceae. Outer tepals 3, adaxially green with white markings, abaxially purple-red, narrowly lanceolate, inner tepals purple and slightly

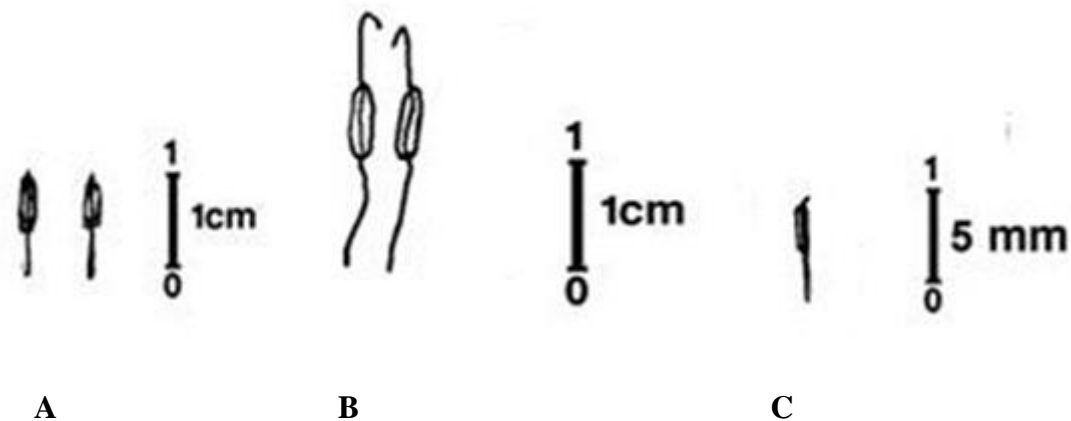
widened distally, green proximally, filiform-linear in *Paris marmorata*; outer tepals 5-8, green, oblong-lanceolate, inner ones equalling or longer than outer ones, filiform in *Paris mairei*; outer tepals 4-6, large, leaf-like, green or yellow-green, narrowly ovate-lanceolate to lanceolate, inner ones equalling number of outer tepals, usually yellow-green, narrowly linear, shorter or longer than outer ones, filiform in *Paris polyphylla*; outer tepals 4 or 5, green, lanceolate, acuminate, inner tepals present, narrowly linear and equalling number or longer than of outer tepals, filiform in *Paris thibetica*; tepals reflexed, outer three sometimes slightly wider, linear, acute, inner tepals narrower brownish-grey in *Trillium govanianum* and tepals spatulate or oblanceolate to elliptic in *Ypsilandra yunnanensis*.



**Fig. 38.** Types of petals in Melanthiaceae: **A.** Linear (*Trillium govanianum*); **B.** Filiform (*Paris polyphylla*).

#### 4.1.3.9 Stamens

Stamens equal in number of tepals, anthers basifixed, extrose in Melanthiaceae. Stamens twice number of sepals 6-8, filaments shorter, connective inconspicuous not produced into apiculus in *Paris marmorata*; stamens 10--16 cm, filaments usually 5--8 mm, free portion of connective 0.5--1 mm in *Paris mairei*; stamens twice as many as outer tepals, 8-10 or sometimes more, filaments 2--8 mm, connective apiculus 0.4--1 mm in *Paris polyphylla*; filaments 3--4 mm, anthers 6--10 mm, having long free portion of connectives (at least 3.5mm and often equalling or even exceeding the anthers in *Paris thibetica*; stamens as long as tepals, filaments short, apiculate in *Trillium govanianum*; stamen inserted on base of tepals, stamens shorter than tepals, anthers usually reniform in *Ypsilandra yunnaniensis*.



**Fig. 39.** Types of androecium in Melanthiaceae: **A.** (*Paris polyphylla*); **B.** (*Paris tibetica*); **C.** (*Trillium govanianum*).

#### 4.1.3.10 Ovary

Ovary superior or partly inferior of 3-6 locules, style divided at apex into stigmatic lobes, ovules 2-many per locule, axile placentation in Melanthiaceae. Ovary slightly 3-lobed, deeply emarginated at apex, stigma lobes recurved, divided almost to base in *Ypsilandra yunnanensis*; ovary narrowly ellipsoid to narrowly ovoid, smooth, purple-red, stigma 3-lobed in *Trillium govanianum*; ovary green, subglobose, style short, stigma 3-lobed in *Paris marmorata*; ovary purple-red, conical-ovoid, 1-loculed, style short, stigma lobes 5-8 in *Paris mairei*; ovary sub-globose, ribbed, 1-loculed, sometimes tuberculate, style short, stigma lobes usually 4 in *Paris polyphylla*; ovary green, ovoid-globose, 1-loculed, inconspicuously 5-ribbed, style very short, stigma lobes usually 4 or 5 in *Paris tibetica*.

#### 4.1.3.11 Fruit

Fruit a loculicidal capsule. Capsule broadly obovoid, slightly longer than persistent tepals in *Ypsilandra yunnanensis*; fruit a berry, dark purple to black in *Trillium govanianum*; capsule deep purple in *Paris marmorata* and *Paris mairei*; capsule green, globose, sometimes tuberculate in *Paris polyphylla*; capsule ovoid-globose in *Paris tibetica*.

#### 4.1.3.12 Seeds

Seeds sometimes with fleshy sarcotesta or often with terminal projections in Melanthiaceae. Seeds yellowish-brown, linear, acute membranous projection at apex in *Ypsilandra yunnanensis*; seeds enveloped by red, succulent aril in *Paris polyphylla*; seeds black, enveloped by red, succulent, crested aril in *Paris tibetica*; seeds wholly evolved by red aril in *Paris mairei*.

### 4.2.3 Taxonomic treatment of family Melanthiaceae

Perennials rhizomatous herb with fibrous rootstock or creeping. Stem simple, unbranched and cylindrical with simple leaves bearing in a whorl of 3-12. Leaves mainly in a basal rosette, linear to oblanceolate, flat and grass-like or ensiform, distichous and petiolate. Inflorescence a terminal, spike-like raceme on leafless scape. Flowers terminal, bisexual, hypogynous or semi-epigynous, actinomorphic, solitary or spike, bracts absent or present and bracteoles present or absent. Perianth 3-10-merous in two whorls, segments (tepals) free or fused to ovary below, with all segments similar or outer sepaloid and inner petaloid or filiform. Stamens 6 or equal in number of tepals, filaments free, anthers basifixed, dehiscent inwards or outwards, connectives sometimes prolonged upward. Ovary superior or partly inferior of 3-6 locules or unilocular, apex sometimes with thickened rim, style fused or separated into stigmatic lobes. Ovules 2-many per locule. Fruit a berry or capsule. Seeds sometimes with fleshy sarcotesta or often with terminal projections.

**Distribution:** Melanthiaceae is a family of 11-16 genera worldwide. In Nepal three genera and 6 species.

#### Key to Genera

- 1a. Leaves in a basal rosette, flower in a spike .....**1. Ypsilandra**
- b. Leaves in a whorl of 3-12 near top of stem, flower solitary.....**2**
- 2a. Leaves three per whorl terminally, sepals and petals similar.....**2. Trillidium**
- b. Leaves more than three per whorl, sepals leafy, petals filiform.....**3. Paris**

#### 1. **Ypsilandra** Franch, Nouv. Arch. Mus. Hist. Nat., 10 (2) : 93 (1887).

Perennial herbs, with a short, thickened, slightly fleshy rhizome, glabrous. Leaves in a basal rosette, linear to oblanceolate, or basally gradually narrowed to a petiole. Scape arising from axils of lateral leaves, erect, simple, with several to many scaly leaves. Inflorescence a terminal raceme, 2-30-flowered, bract absent. Flowers bisexual, usually nodding at anthesis, ascending in fruit, spreading funnel form. Tepals 6, persistent, free to base, with a nectary gland basally on adaxial side. Stamen 6, rather long, free from tepals or inserted on base of tepals, inner one basally adnate to ovary, outer ones free. Anthers usually reniform, basifixed, with confluent locules. Ovary superior, strongly 3-lobed, 3-loculed, ovules many per locule. Style 1, very short with three recurved stigmatic lobes or long with stigma lobes very short.

Fruit a loculicidal capsule, 3-lobed apically. Seeds numerous, linear, narrowly fusiform, both ends caudate with long terminal projections.

**Distribution:** Worldwide five species. One species from Nepal.

1. ***Ypsilandra yunnanensis*** W.W.Sm. & Jeffrey, *Notes Roy. Bot. Gard. Edinburgh* 9 (42): 143 (1916).

*Ypsilandra yunnanensis* var. *himalaica* H. Hara., *Enum. Fl. Pl. Nepal* 1: 80 (1978).

**Type specimen:** *Nepal, Central:* Lamjung, Rambrong, Lamjung Himal, 13,500 feet, Stainton, Sykes and Williams 6090, 03 Jul 1954. **Holotype:** BM.

Perennial herb ca. 12 cm tall with a short, thickened rhizome. Stems ca. 1 mm in diameter at base. Leaves 6-9, basal rosette, linear to lanceolate or oblanceolate or spatulate, 2--9 X 1--3.5 cm, relatively thick-textured, veins many, parallel, basally gradually narrowed to a 0.7--4 cm X 3--5 mm petiole. Scape arising from axils of lateral leaves, erect, simple, 5--16 cm, much longer than basal leaves, oblong, apiculate, sometimes recurved, margins membranous. Inflorescence 5-17 flowered, rather narrow, densely cylindric. Pedicel 1--3 mm, lowest 2 with minute bracteoles. Tepals pale blue, whitish or reddish-brown, persistent, spatulate or oblanceolate to elliptic, blunt, 4--5 X 1--2 mm. Stamens shorter than tepals, filaments 2.5--3 mm. Ovary slightly 3-lobed, slightly inflated locules, deeply emarginated at apex, stigma lobes recurved, divided almost to base. Capsule broadly obovoid, slightly longer than persistent tepals. Seeds yellowish-brown, linear, acute membranous projection at apex.

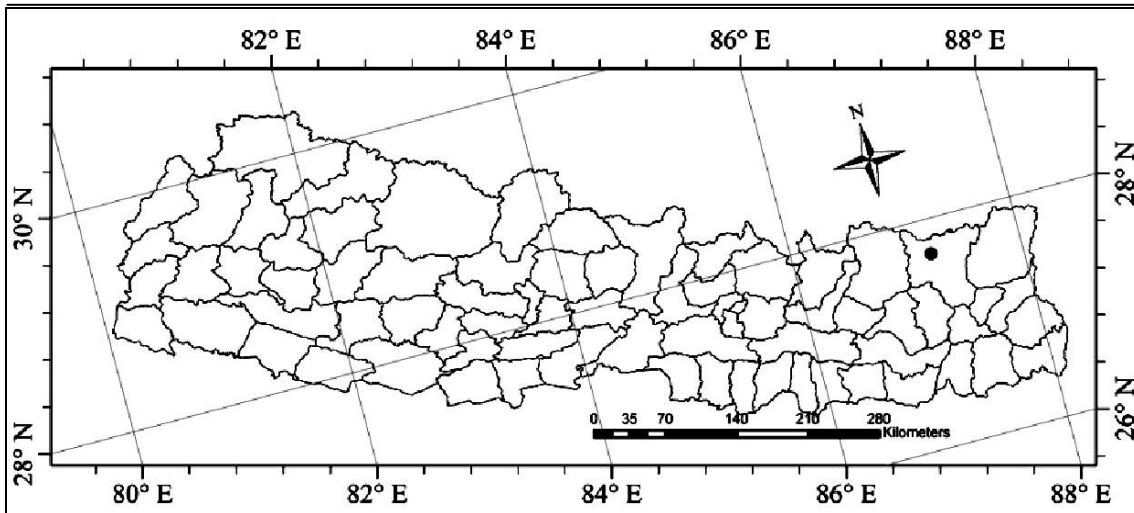
Note: Herbarium specimens were not available at KATH and TUCH, description based on the digital image downloaded from TI and secondary literature.

**Distribution:** Nepal, Tibetan-Plateau, Assam-Burma, E Himalaya.

**Altitudinal Range:** 2700-4100m

**Ecology:** On open Kobresia grassy slope.

**Flowering:** June-July. **Fruiting:** August-October.

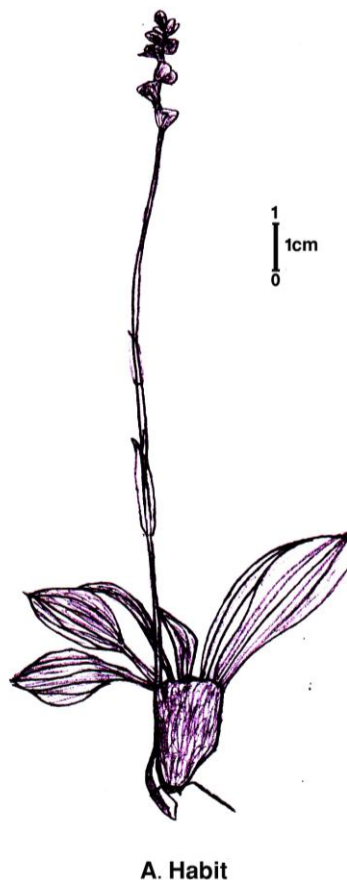


**Fig. 40.** Distribution map of *Ypsilandra yunnanensis* based on herbarium specimens.

**Specimens examined**

**Digital Photograph of Herbarium seen.**

**East Nepal:** Sankhuwasabha, Cha Ding Kharka (3970m)-Tutu La(4070)-Thulo Pokhari (4030m)-Shipton Pass (Keke La)(4120m)-(Kauma)(3500m), 3500-4120m, 30.7.1988, M.Suzuki, N.Naruhashi, N.Kurosaki, Y.Kadota, M.N.Subedi, M.Minaki, S.Noshiro, H.Ikeda, 8821028(TI).



**Fig.41. *Ypsilandra yunnanensis* W.W.Sm. & Jeffrey; A. Habit sketch (based on M.Suzuki, N. Naruhashi, N.Kurosaki, Y.Kadota, M.N.Subedi, M.Minaki, S.Noshiro, H.Ikeda, 8821028 TD).**

**2. *Trillium* L., *Sp. Pl.* 1 : 339 (1753).**

Perennial herbs with stout, horizontal, creeping, annulate rhizome. Stem erect, simple, base sheathed with a few brown scale-like leaves. Leaves 3, in a terminal whorl at or above the middle of the stem, sessile or shortly petiolate, rhombic-orbicular to ovate, with 3-5 main and anastomosing veinlets. Flower single, bisexual, terminal, sessile or pedicellate. Perianth persistent, tepals 6, in 2 whorls, free, spreading; outer one usually green, persistent, inner ones petaloid, rose purple to white, slightly narrower than outer, withering or deciduous after anthesis. Stamens 6, attached at the base of tepals, filament short, anthers basifixed, linear with very short connective prolonged upward, dehiscing inward. Ovary superior, ovoid to

sub-globose, 3-loculed, ovules several to many per locule. Style short, deeply 3-lobed often to a base, arms recurved within. Fruit a berry, globose to ovoid. Seeds several to many, ovoid, small.

**Distribution:** Worldwide about 46 species. One species from Nepal.

**1. *Trillium govanianum*** Wall. ex Royle, *Ill. Bot. Himal. Mts.* 1: 384, pl. 93, f. 1 (1839).

*Trillidium govanianum* (Wall. ex D. Don) Kunth., *Enum. Pl.* 5: 120 (1850).

Perennial herb 14--35 cm tall with slightly elongate, terete creeping rhizome. Stem 1--4 mm in diameter at base. Stem erect, solitary. Scale leaves pale brown at the base of stem. Leaves lanceolate to ovate, acuminate, base truncate to shallowly cordate, 3.4--9.5 X 1.8--8.5 cm, shortly petiolate, 2--15 mm, main veins 3. Pedicel 4--18 mm, erect, straight, not greatly lengthening in fruit. Tepals 6, reflexed, outer three sometimes slightly wider, linear, acute, 1--1.5 cm X 4--5 mm, inner tepals narrower 1--1.5 cm X 1--3 mm, very similar to outer ones in shape or subequal, greenish or reddish to blackish purple. Stamens as long as tepals, filaments short 1.5--3 mm, anther 1--2 mm, apiculate. Ovary narrowly ellipsoid to narrowly ovoid, smooth, 1.5--8 X 2--6 mm, purple-red, stigma 3-lobed, 3--4 mm. Fruit a berry ca. 8--15 mm, dark purple to black.

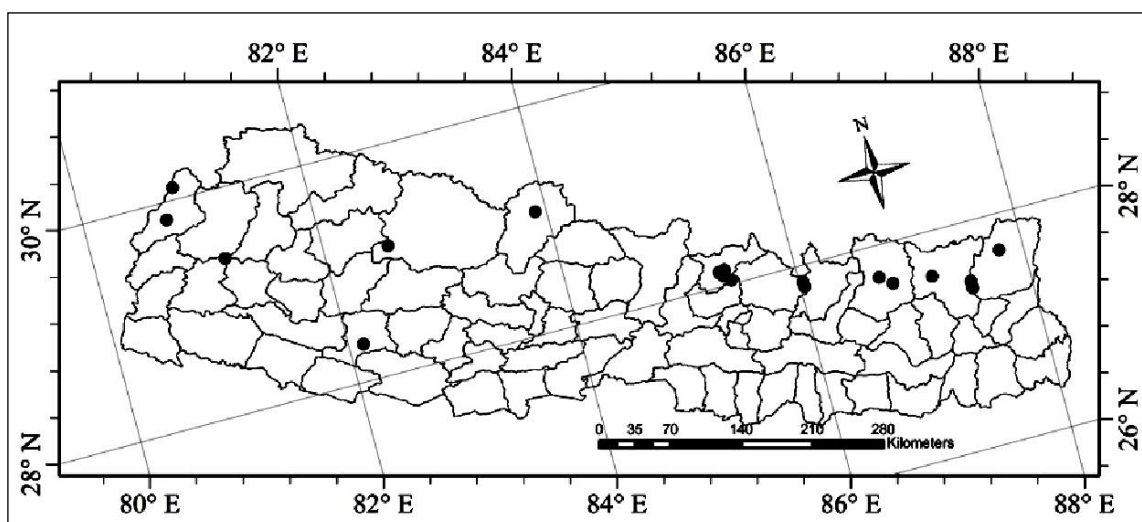
Note: Roots are used as medicine.

**Distribution:** Nepal, Tibetan-Plateau, W Himalaya, E Himalaya.

**Altitudinal Range:** 2700-4000m.

**Ecology:** Shady places under growth in the field of bamboos, epiphytes on stem of *Schima wallichii*, *Rhododendron barbatum*.

**Flowering:** Mar-July. **Fruiting:** July-August.



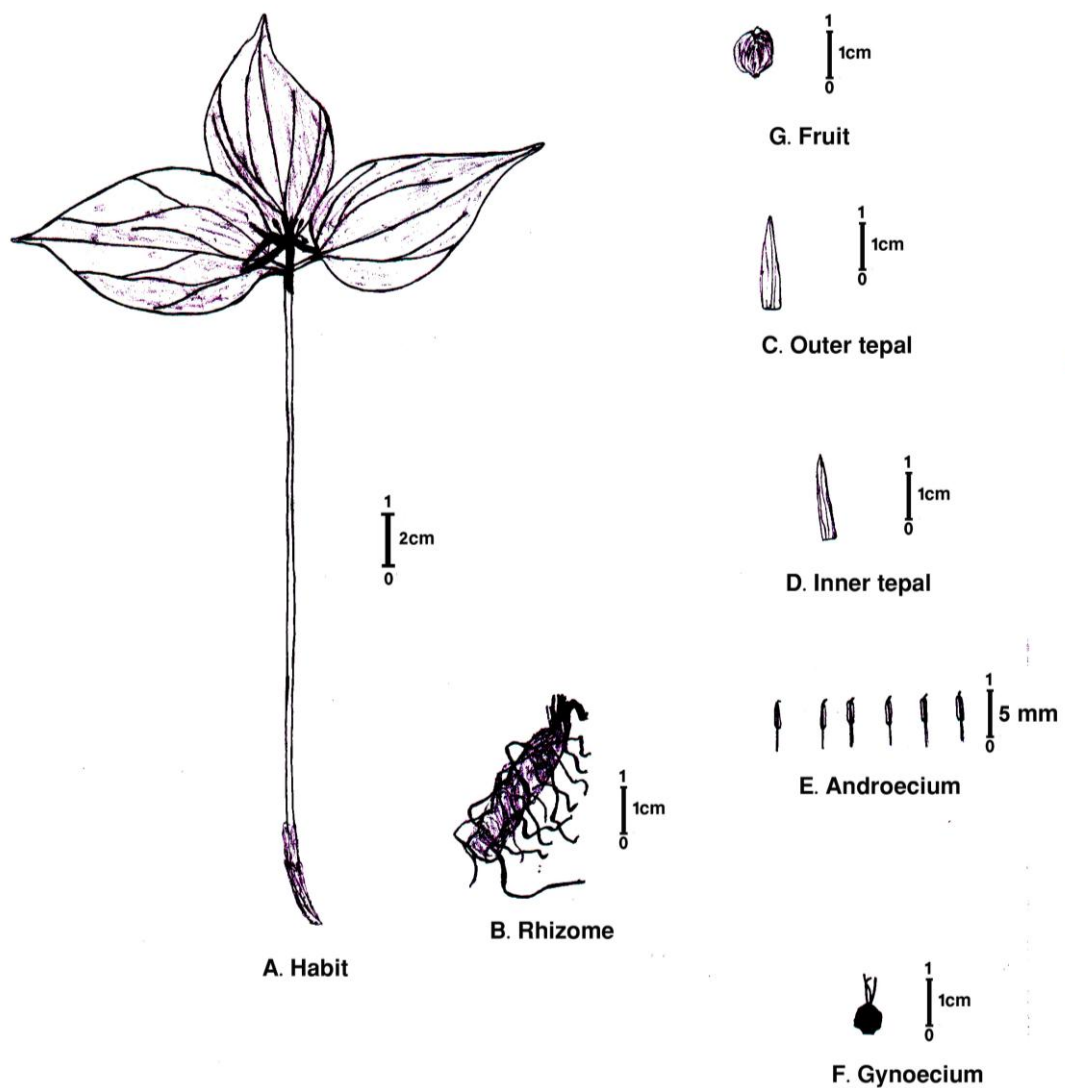
**Fig. 42.** Distribution map of *Trillium govanianum* based on herbarium specimens.

### Specimens examined

**West Nepal:** Darchula, Chheti-Mechchra, 2840m, 22.7.1984, P.R.Shakya; M.K.Adhikari and N.N.Subedi, 9988(KATH); Darchula, Bramha Lekh, 3200m, 17.5.1971, P.R.Shakya, D.P.Joshi, 532(KATH); Doti, Khaptad, 9975ft, 31.4.1965, T.B.Shrestha, 4047(KATH); Doti, Khaptad, 3,000m, 7.4.1984, P.Pradhan, R.Uprety, N.Pradhan and N.Dabadi, 1226(KATH); Doti, Khaptad, 3090m, 12.7.1976, H.Tabata, K.R.Rajbhandari, K.Tsuchiya, 1156(KATH); Jumla, Dori Lekh, 3500m, 27.5.1980, P.R.Shakya and B.Roy, 5368(KATH); Salyan, 1500m, 15.3.1976, R.G.Ray, 389(KATH).

**Central Nepal:** Mustang, Samargaon, 3600m, 5.8.1974, Mr.D.P.Joshi, 795(KATH); Rasuwa, Cholangpati, 3542m, 9.9.2013, Ghimire, S., Thapa, T.K., Rana, H.K., Rana, N. and Joshi, L. 2 (TUCH); Rasuwa, Dhunche-Dimsa, 2965m, 8.7.2006, B.B.Kunwar, 88(TUCH); Rasuwa, Cholangpati, 3500m, 9.7.2006, T. N.Balbase, 41(TUCH); Rasuwa, Syabru(2240m)—Shin Gompa(3200m), 3210m, 31.5.1985, M.Suzuki and S.Noshiro, 541040(KATH); Rasuwa, Chandanbari, 3200m, 10.5.1985, K.R.Rajbhandari, I. Sharma and M.Kayastha, 10488(KATH); Rasuwa, Gossainkunda, Phulung Ghyang(Singh Gombe), 3200m, 8.5.1967, D.H.Nicolson, 3307(KATH); Rasuwa, Chandanbari-Laurivinayak, 3630m, 9.7.2006, N.P.Pokhrel, 66(TUCH); Nuwakot, Therapati, 10,000ft, 31.1.019, Dr.P.N.Sulwal and A.B.Shrestha, 775(KATH); Dolakha, Kalinchowk, 3000m, 3.7.1990, N.K.Bhattarai, 90/360(KATH); Ramechhap, Serdingma(3400)-Dubikharka(3720), 3400-3700m, 7.7.1985, H.Obha.T.Kikuchi, M.Wakabayashi, M.Suzuki, N.Kurosaki, K.R.Rajbhandari and S.K.Wa, 8570255(KATH).

**East Nepal:** Solukhumbu, Tate-Hesingnasa, 1100ft, 28.5.58, S.R.Rolla, 14152(KATH); Solukhumbu, Around Rangdu Kharka, 3270m, 9.8.1997, M. Wakabayashi, M. Amano, M. Mori, K. R. Rajbhandari and K. Shinozaki, 30179 (KATH); Sankhuwasabha, Below Walung, 780m, 22.3.1989, T.B.Shrestha and P.R.Shakya, S.N(KATH); Shankhuwasabha, Koshi zone, Phemathang Kharka (Tematan Kharka) (3380)--Barun Khola (3170)—Numbuk (Mumbuk) (3500)--Cha Ding Kharka (3970), 1970-3100m, 29.7.1988, M. Suzuki, N. Naruhashi, N. Kurosaki, Y. Kadota, M. N. Subedi, M. Minkai, S. Noshiro, H. Ikeda, 8821000 (KATH); Taplejung, Olancgchung Gola, KCA, 3200m, 2.5.2000, S. Sherpa, 19 (TUCH); Tehrathum, Giddle to Jaljale, 12,000ft, 22.7.1971, T.B. Shrestha and D. P. Joshi, 249 (KATH).



**Fig. 43. *Trillium govanianum* Wall. ex Royle; A. Habit sketch, B. Rhizome C. Outer tepal, D. Inner tepal, E. Stamens and F. Gynoecium (based on K.R.Rajbhandari, I.Sharma and M.Kayastha, 10488 KATH).**

### 3. *Paris* L., *Sp. Pl.* 1 : 367 (1753).

Perennial herb, with creeping thick rhizome bearing annular scars. Stem erect, simple, with basal scale leaves and terminal whorl of 4-12, lanceolate to ovate petiolate or sessile leaves in upper parts. Flowers single, bisexual, terminal, pedicellate. Number of floral parts inconsistent, even in a single population. Outer tepals 4-10, herbaceous, persistent, leafy, free and green, rarely white, ovate to lanceolate. Inner tepals usually same number as outer tepals, filiform, yellowish, green or purplish. Stamens usually twice number of sepals, filaments narrow, flat, attached at base of tepals, anthers basifixed with two lateral locules, connective often prolonged as an apiculus. Ovary superior, oblong-globose, angled, truncate with thickened rim at apex, 1-loculed with parietal placentation or 4-10-loculed with axile placentation, style short, thick, divided into stigmatic lobes at apex. Fruit a berry or berry like capsule. Seeds with fleshy, red scarlet sarcotesta.

**Distribution:** Worldwide 24 species mainly from Europe and Temperate Asia. Four species in Nepal.

#### Key to Species

- 1a. Plant ht. up to 20cm, leaves marked with white.....**1. *P. marmorata***
- b. Plant ht. more than 20cm, leaves without marking.....**2**
- 2a. Plant pubescent, free portion of connective 0.5-1mm.....**2. *P. mairei***
- b. Plant glabrous, free portion of connective more than 1mm.....**3**
- 3a. Anthers with short apiculi 0.4-1mm.....**3. *P. polyphylla***
- b. Anthers with long apiculi ca. 3.5mm often equalling or even exceeding the anthers.....**4. *P. thibetica***

**1. *Paris marmorata*** Stearn, *Bull. Brit. Mus. (Nat. Hist.) Bot.* 2(3): 79, pl. 8, f. 11 (1956).

*Paris polyphylla* Sm. subsp. *marmorata* (Stearn) H. Hara., *J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot.* 10 (10): 176 (1969).

Annual small, herb, ca. 20 cm tall, small, erect with 3 X 1.5 cm long annulate rhizome. Stem ca.5 mm in diameter at base, light reddish white in colour. Leaves fewer 4-7, oblanceolate to elliptic, smaller 6--9 X 1--1.5 cm, often variegated with whitish markings along the veins, margins wavy, upper surface dark green, lower surface dark purplish, petiole very short,

base cuneate. Peduncle 1--2 cm. Outer tepals 3, adaxially green with white markings, abaxially purple-red, narrowly lanceolate, 4--5 cm X 5--10 mm, inner tepals purple and slightly widened distally, green proximally, filiform-linear. Stamens twice number of sepals 6-8, filaments shorter, 2.5--3.5 mm, anthers 1.5--2.5 mm, connective inconspicuous not produced into apiculus. Ovary green, subglobose. Style short, stigma 3-lobed. Capsule deep purple. Fruit dark red in colour.

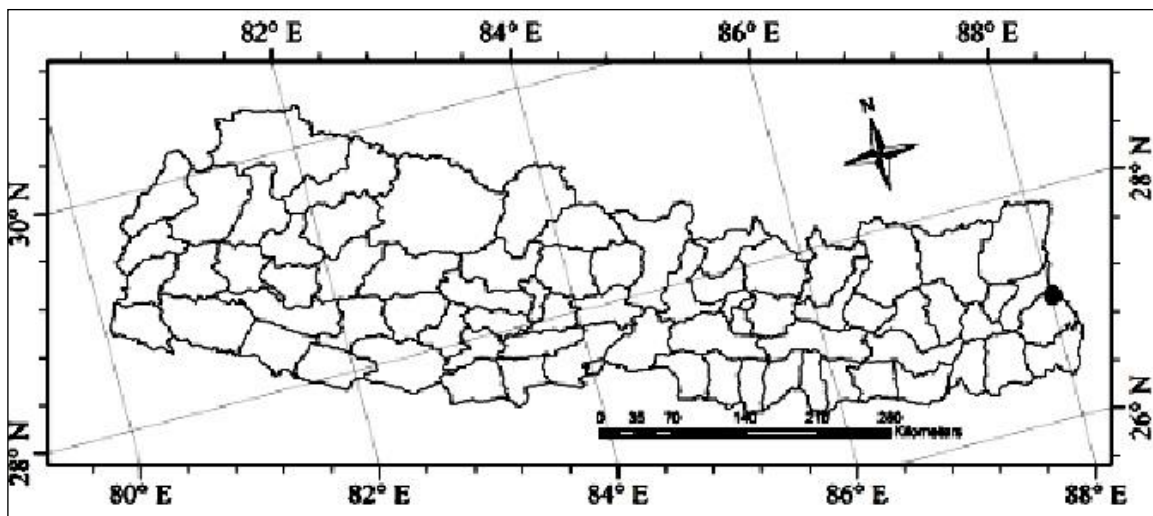
Note: Herbarium specimens not available in KATH and TUCH, so description based on digital image from E and secondary literature as Flora of China and Flora of Bhutan.

**Distribution:** Nepal, E Himalaya, Tibetan Plateau, W Himalaya.

**Altitudinal Range:** 2800-3000m.

**Ecology:** In forest floor of broad leaved forest.

**Flowering:** June-August. **Fruiting:** August-November.

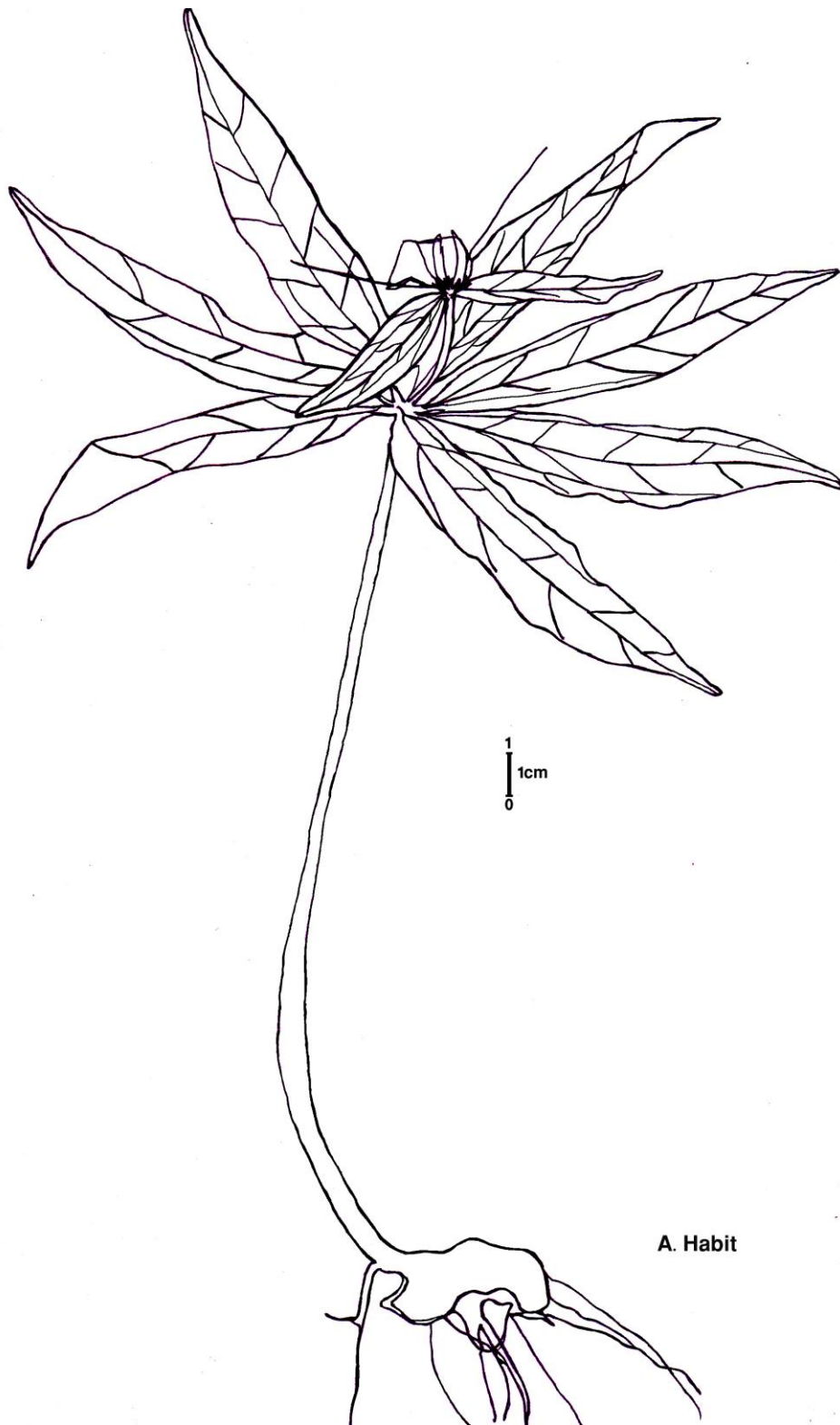


**Fig. 44.** Distribution map of *Paris marmorata* based on herbarium specimens.

**Specimens examined**

**Digital Photograph of Herbarium seen.**

**East Nepal:** Illam, Kali Pokhari to Hangetham, 2845m, 16.6.2007, B.Adhikari, R.C.Poudel, R.M.Kuwar, K.Humagain, J. Pandey and N.B.Khattri Chhetri, LKSRB123(E).



**Fig. 45.** *Paris marmorata* Stearn; A. Habit sketch (based on B.Adhikari, R.C.Poudel, R. M. Kuwar, K. Humagain, J. Pandey and N. B. Khatri Chhetri, LKSRB123 E).

2 **Paris mairei** H. Lev., *Repert. Spec. Nov. Regni Veg.* 11 (286-290): 302 (1912).

*Paris violacea* H. Lev., *Repert. Spec. Nov. Regni Veg.* 11 (286-290): 302 (1912).

*Daiswa violacea* (H. Lev) Takht., *Brittonia* 35(3): 266 (1983).

Annual herb, papillose- pubescent, 20--25(--1m) cm tall, erect with 1--2 cm thick, annulate rhizome. Stem 3--5 mm in diameter at base, stem often red in colour. Leaves fewer 5-9, ovate to oblanceolate , 5--14 X 2--5 cm , leaf blade deep green, tinged with pale green along veins, base cuneate or sub-rounded, entire margin. Outer tepals 5-8, green, oblong-lanceolate, inner ones equaling or longer than outer ones, filiform. Stamens 10--16 cm, filaments usually 5--8 mm, anthers 7--9 mm, free portion of connective 0.5--1 mm, apex acute. Ovary purple-red, conical-ovoid, 1-loculed. Style short, stigma lobes 5-8. Capsule purple. Seeds wholly evolved by red aril.

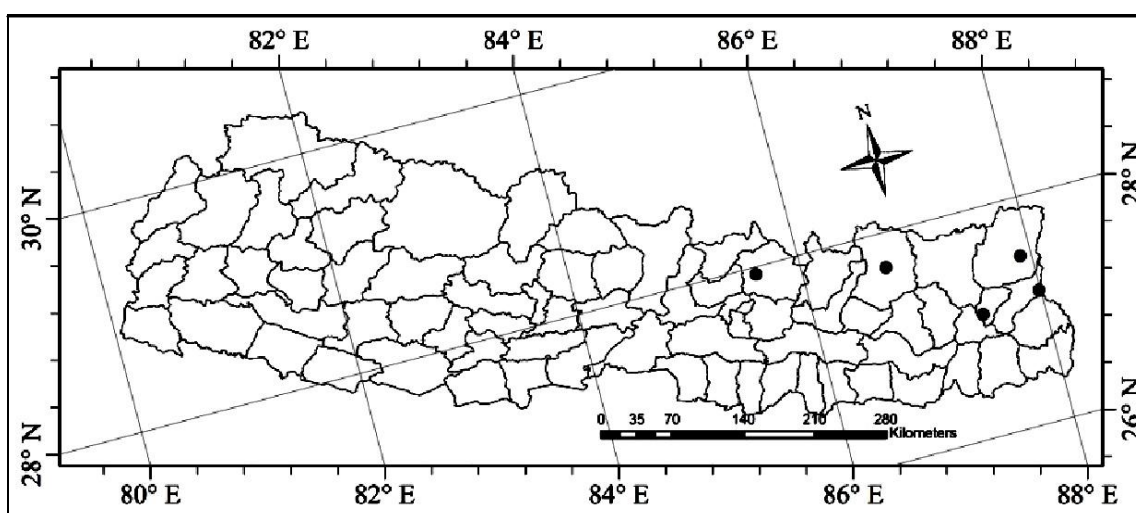
**Note:** Herbarium specimens not available in KATH and TUCH, so description based on digital image from E and secondary literature as Flora of China and Flora of Bhutan.

**Distribution:** Nepal, E Asia, Tibetan Plateau.

**Altitudinal Range:** 2400-3000m.

**Ecology:** In deep shade on forest floor of Mixed deciduous and Coniferous forest with *Tsuga dumosa* and *Arundinaria* scrub.

**Flowering:** May-July. **Fruiting:** August-September.



**Fig. 46.** Distribution map of **Paris mairei** based on herbarium specimens.

### **Specimen examined**

#### **Digital Photograph of Herbarium seen.**

**Central Nepal:** Sindhupalchok, Thangpaldhap, 8000ft, 21.4.31, K.N.Sharma, 245(E).

#### **Digital Photograph of Herbarium seen.**

**East Nepal:** Solukhumbu, Dudh Koshi valley: Ghat to Phakding: trail from Lukla to Namache Bazar, 2830m, 8.5.2005, M.F.Watson, K.R.Rajbhandari, D.Knott, A.G.Miller, B.Adhikari, K.Maden, V.Manandhar, R.Uprety, DNEP19 (E); Panchthar, Prangbung vdc: Tal Kharka, 2684m, 2.10.2007, R.M.Kunwar, M.K.Dhamala, J.Pandey, N.B.Khatri, Y.R. Poudel and R.K.Rai, LKSRD 345(E).

### **3 Paris polyphylla Sm. Cycl. 26: 2 (1813).**

Paris polyphylla Sm. var. polyphylla (unknown original publication detail).

Paris polyphylla Sm. var. wallichii H. Hara., *in Fl. E. Himal.* 3rd. Rep.134 (1975).

#### **Nepali name:** Satuwa

Perennial herb, 8--89 cm tall with 1-2cm thick, annulate rhizome, sometime as large as a small potato. Leaves 6-10(7), petiole 0.5--17 cm; leaf blade variable, usually oblong to lanceolate, finely acuminate, 6.5--17.5 X 2--5.5 cm, base rounded to cuneate, entire margin. Peduncle 2-7.2cm, erect. Outer tepals 4-6, large, leaf-like, leaf like green or yellow-green, narrowly ovate-lanceolate to lanceolate, 6--7.5 cm X 1.5--2 cm, inner ones equaling number of outer tepals, usually yellow-green, narrowly linear, shorter or longer than outer ones, filiform 2.7--5 cm long and 1--1.5 mm wide. Stamens twice as many as outer tepals, 8-10 or sometimes more, filaments 2--8 mm, anther lobes 1--7 mm, connective apiculus 0.4--1 mm. Ovary sub-globose, ribbed, 1-loculed, sometimes tuberculate. Style short, base enlarged, purple to white, stigma lobes usually 4 and 2--4 mm. Capsule green, globose, sometimes tuberculate. Seeds 8 X 3 mm enveloped by red, succulent aril.

**Note:** Roots are highly used in medicine. *Paris polyphylla* is listed under vulnerable category (V) by IUCN and CAMP.

**Type specimen:** Nepal, **Central:** Narainhetty, *Buchanan-Hamilton* s.n., 13 Mar 1803.

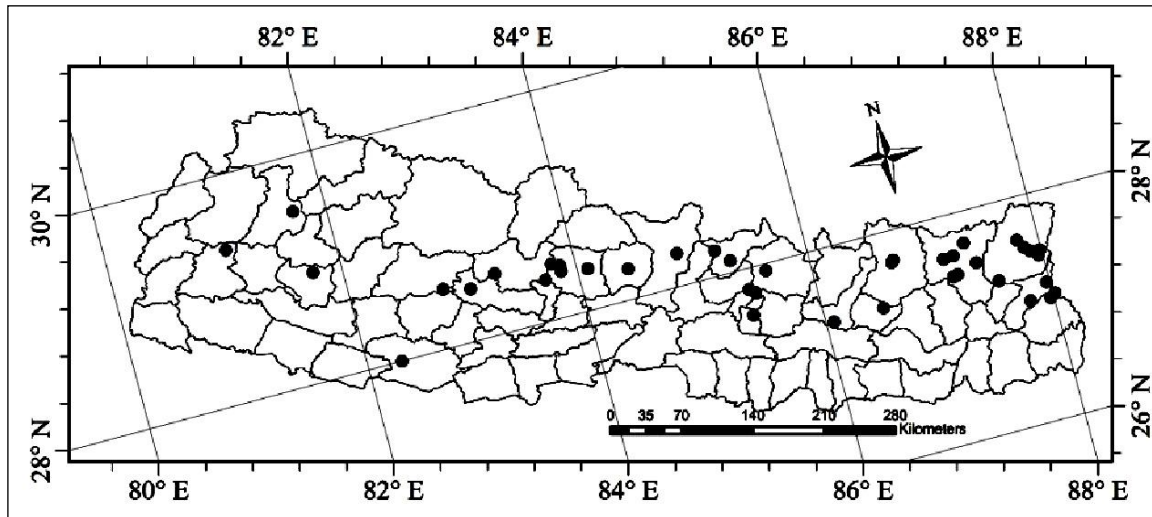
**Holotype:** LINN-SM.

**Distribution:** Nepal, W Himalaya, E Himalaya, SE Asia, Assam-Burma, E Asia.

**Altitudinal Range:** 1800-3500m.

**Ecology:** Herb on damp and shady place in the forest floor of *Rhododendron*, *Acer*, *Abies*, oak and conifer forest.

**Flowering:** June-August. **Fruiting:** August-November.



**Fig. 47.** Distribution map of *Paris polyphylla* based on herbarium specimens.

#### **Specimens examined**

**West Nepal:** Doti, Napani, 6000ft, 2.9.1981, K.J.Malla, 538(KATH).

#### **Digital Photograph of Herbarium seen.**

**West Nepal:** Kalikot, Dillikot, 8,000ft, 19.4.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 3919(E); Dailekh, Punga Lekh, Pulanto Dara, 9,500ft, 19.4.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 788(E).

**Central Nepal:** Kaski, Between Ghorepani and Sikha, 7000ft, 7.10.1976, H.Tabata, K.R.Rajbhandari, K. Tsuchiya and Y.Konno, 6090(KATH); Kaski, Lebron, 2100m, 16.10.1982, K.R.Amatya, T.K.Rajbhandari and T.Shrestha, 59(KATH); Kaski, Banthauri, 2600m, 24.5.1992, N.P.Manadhar and S.K.Acharya, 173/92(KATH); Shyangja, Pokhari danda(Chitre), 2133m, 24.9.1962, Shrestha and Upadhaya, 623(KATH); Rasuwa, Deurali, Dhunche, 2200m, 27.6.2003, P.P.Kurmi and G.D.Bhatta, 200375(KATH); Rasuwa, Near

Kyatang, 2740m, 18.5.1979, N.P.Manandhar and M.K.Adhikari, 1549(KATH); Sindhupalchok, Melamchi Bridge, 2300m, 15.6.1986, N.K.Bhattarai, 86/364(KATH); Kathmandu, Manichour Danda, 2200m, 14.3.1975, Joshi and Rajbhandari, 75/575(KATH); Kathmandu, Shivapuri, 2743m, 17.4.1975, I.Bajracharya and T. Bahadur, 46(KATH); Lalitpur, Phulchoki, 2000m, 10.6.1969, H.Kanai, 11879(KATH); Ramechhap, Shivalaya to Gorjang, 1800-1900m, 12.4.1996, I.Sharma,M.N.Subedi and M.P.Pudasaini, 44(KATH).

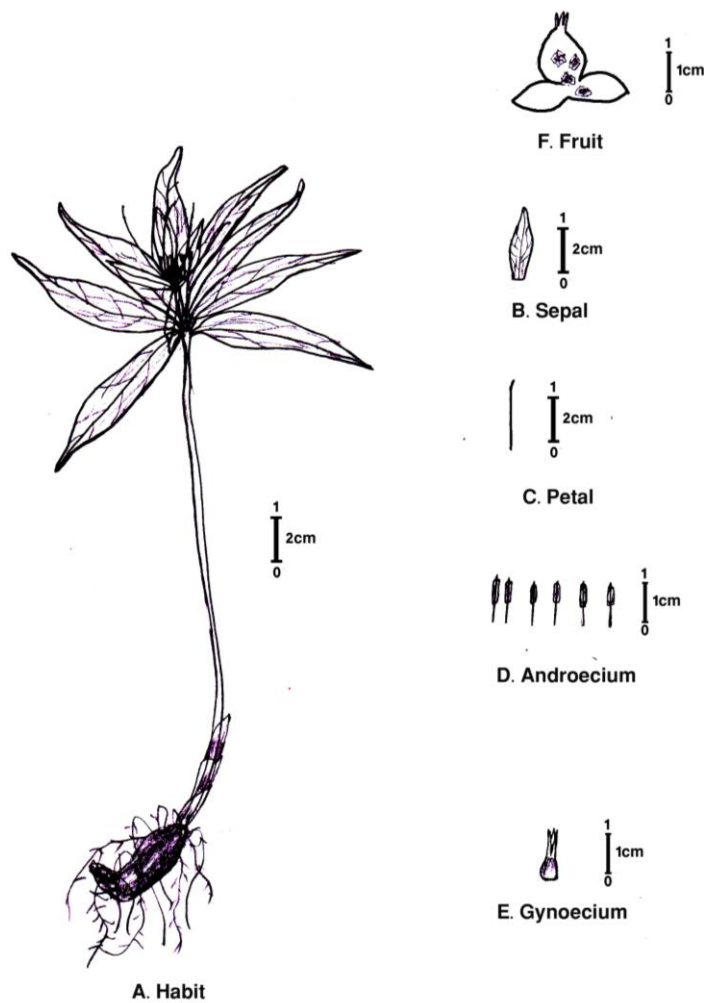
**Digital Photograph of Herbarium seen.**

**Central Nepal:** Baglung, Okhaldhungagaon, s. of Dhorpatan, 8,000ft, 30.4.1954, Stainton, Sykes and Williams, 342(E); Kaski, Hills north of Pokhara, 7,000ft, 17.4.1954, Stainton, Sykes and Williams, 4862(E); Sindhupalchok, Thangpaldhap, 8,000ft, 21.4.31, K.N.Sharma, 248(E).

**East Nepal:** Solukhumbu, Tate-Hesingnasa, 11000ft, 28.5.58, S.R.Rolla, 14154(KATH); Okhaldhunga, Maily, 2200m, 28.5.1979, N.P.Manandhar and M.R.Adhikari, 1823(KATH); Sankhuwasabha, Hobula dada, 3070m, 13.6.94, P.R.Shakya and K.K.Dangol, 10086(KATH); Sankhuwasabha, Lungmuchi, 2600m, 13.4.1991, P.R.Shakya, 9728(KATH); Taplejung, 7000ft, 11.1963, A.V.Upadhaya, 1630(KATH); Pachthar, Sole, 2300m, 9.4.1967, D.H.Nicolson, 3198(KATH); Pachthar, Tal Kharka, 7700ft, 9.4.1967, Dr.S.B.Malla, 7702(KATH).

**Digital Photograph of Herbarium seen.**

**East Nepal:** Sankhuwasabha, 1970m, 23.9.1991, D.G.Long, R.J.D.McBeath, D.R.McKean, D.A.H.Rae, N.P.Bhattarai, 187(E); Dhankuta, Arun valley:Maghang khola, E. of Num., 8,000ft, 4.5.1956, J.D.A.Stainton, 206(E).



**Fig.48. Paris polyphylla** Sm.. **A.** Habit sketch, **B.** Sepal, **C.** Petal, **D.** Stamens and **E.** Gynoecium (based on P.R.Shakya, 9728 KATH); **F.** Fruit (based on A.V.Upadhyay, 1630 KATH).

**4. Paris thibetica** Franch., *Nouv. Arch. Mus. Hist. Nat.*, ser. 2, **10**: 184 (1888).

*Paris polyphylla* Sm. var. *appendiculata* H. Hara., *Fl. E. Himal.* **1**: 410–411 (1966).

Perennial herb, 47--55 cm tall with thickened or slender rhizome. Stem 0.7--10 mm in diameter at base. Leaves 7-12, lanceolate to narrowly elliptic, 11--14 X 3--4 cm, glabrous; petiole usually very short, 5--10 mm, base cuneate. Pedicel ca. 14cm long, erect. Outer tepals 4 or 5, green, lanceolate, acuminate, 5--7.5 X 1.5--2.5 cm. Inner tepals present, narrowly linear and equaling number or longer than of outer tepals, filiform. Stamen twice number of sepals, 8-10, filaments 3--4 mm, anthers 6--10 mm, having long free portion of connectives (at least 3.5mm and often equaling or even exceeding the anthers). Ovary green, ovoid-globose, 1-loculed, inconspicuously 5-ribbed. Style very short, stigma lobes usually 4 or 5.

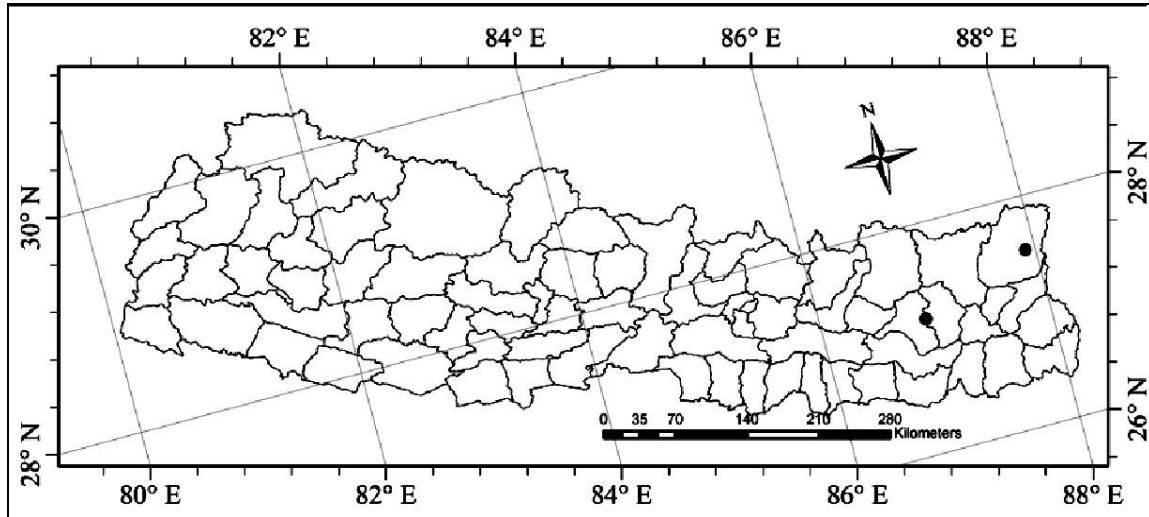
Capsule ovoid-globose. Seeds black, enveloped by red, succulent, crested aril.

**Distribution:** Nepal, Assam-Burma, E Himalaya, E Asia.

**Altitudinal Range:** 3000-3500m

**Ecology:** In clearing forest.

**Flowering:** June-August. **Fruiting:** Aug-Nov.

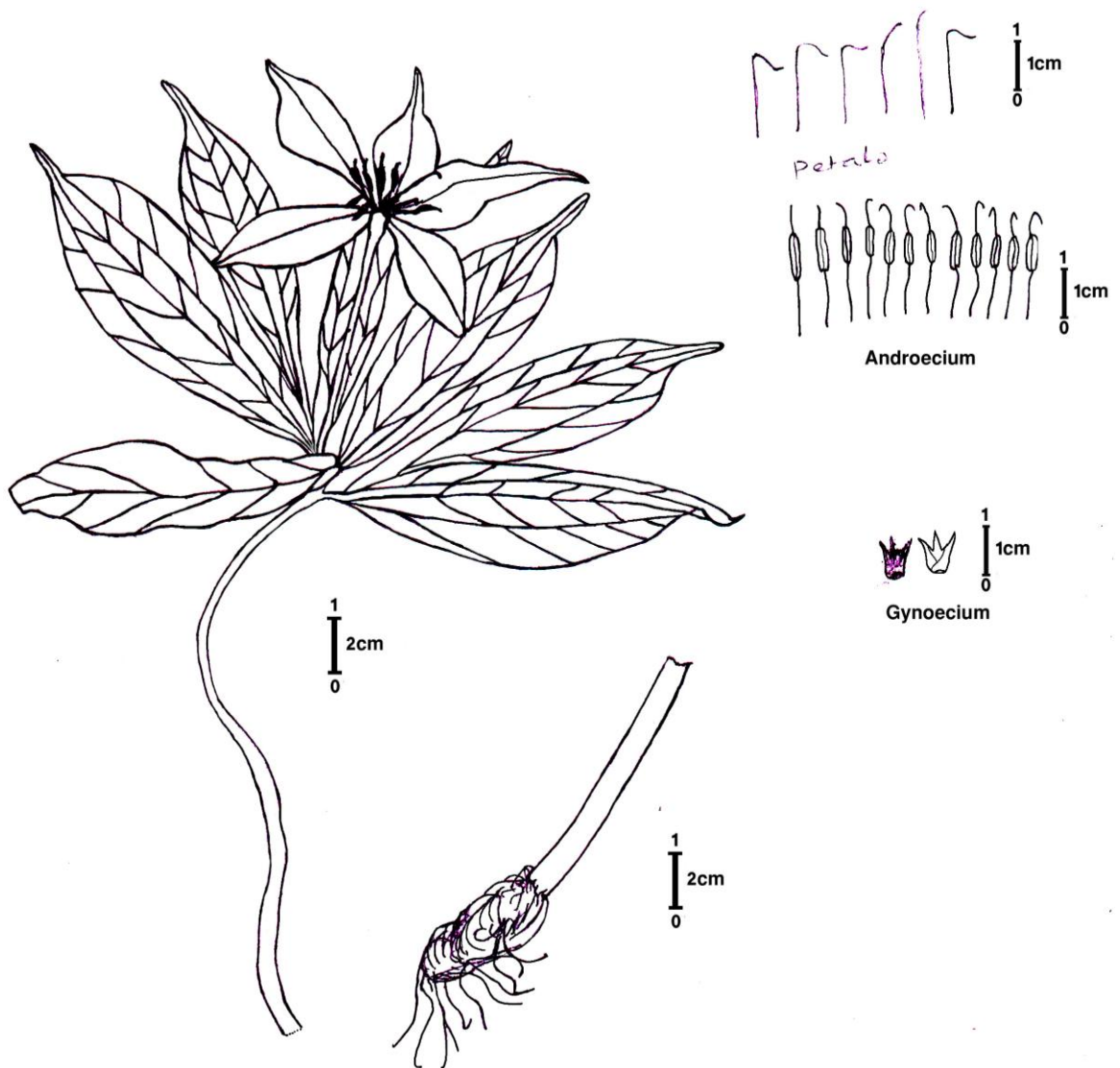


**Fig. 49.** Distribution map of *Paris thibetica* based on herbarium specimens.

#### **Specimens examined**

#### **Digital Photograph of Herbarium seen.**

**East Nepal:** Dhankuta, Arun valley, Chhoyang Khola, W. of Num., 10,500ft, 23.6.1956, J.D.A.Stainton, 751(E); Taplejung, Dorongden(2890m)-Deurali(3310m)- Amji Khola(2320m), 2900-3300m, 12.6.1992, S.Noishiro, N.Acharya, S.Akiyama, 9240736(E).



**Fig. 50. *Paris thibetica* Franch. A. Habit sketch, B. Rhizome, C. Petals, D. Stamens and E. Gynoecium (based on J.D.A.Stainton, 751 E).**

### 4.3 Hierarchical Cluster Analysis

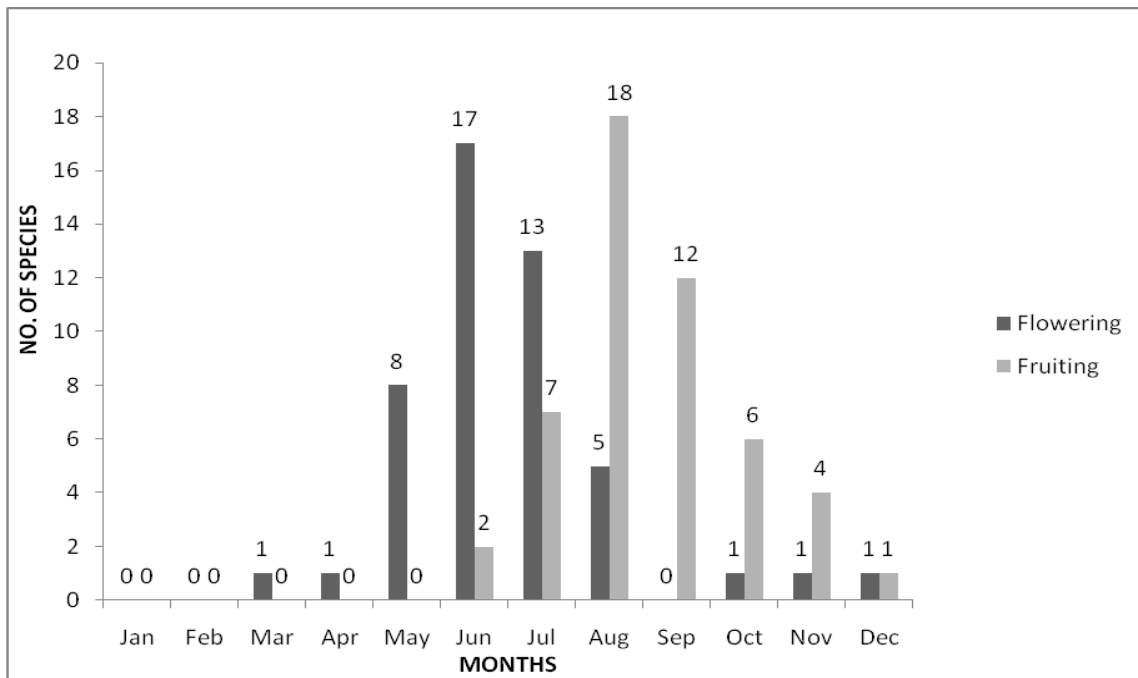
Cluster analysis is a convenient method for identifying homogenous groups of objects called clusters. Hierarchical cluster analysis for the phenotypic similarity was done with the help of characters and character state variation within the species. The characters and character states coded were shown in the (table 2) and (Appendix 3) below.

**Table 2:** Characters and character state coding

S.N	Characters	Character states
1	Rhizome	Cormous=0, Rhizomatous=1
2	Leaves shape	Linear=0, Lanceolate=1
3	Bracts	Present=0, Absent=1
4	Leaves attachment	Sessile=0, Petiolate=1
5	Leaves orientation	Basal=0, Cauline=1
6	Flower stem	Branched=0, Simple=1
7	Inflorescence	1-Few flowered=0, Single flower=1
8	Perianth	Connate=0, Free=1
9	Tepals	Similar=0, Different=1
10	Stamens	3=0, More than 3=1
11	Ovary	Superior=0, Inferior=1
12	Style colour	Petalloid=0, Sepaloid=1
13	Style shape	Lobed=0, Slender=1
14	Style size	Short=0, Long=1
15	Stigma	Recurved=0, Simple=1
16	Fruit	Capsule=0, Berry=1

Dendrogram (Fig. 51) of three families were generated with the help of character coded in the (Appendix 3). The coded characters given in the (Appendix 3) generated the dendrogram.





**Fig. 52.** Phenology. No. of flowering and fruiting species at different months.

The early flowering occurs in the family Melanthiaceae of species *Trillium govanianum* and late flowering starts in the family Iridaceae of species *Crocus sativus*. The early fruiting occurs in *Iris kemaonensis* and *Trillium govanianum* and late fruiting occurs in *Crocus sativus*. By the beginning of November to mid November, most of the plant part dies out and all seeds get dispersed. Before the plant dies and after the seed gets matured, bud sprouts on rhizome which remains underground for the whole winter until the next germination period (sprouting season).

**Table 3:** Phenology (flowering and fruiting months of 19 species of families Colchicaceae, Iridaceae and Melanthiaceae).

Taxa	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Crocus sativus</i>										→	→	→
<i>Iris clarkei</i>						→	→	→	→			
<i>Iris collettii</i>					→	→	→	→	→			
<i>Iris decora</i>					→	→	→	→	→			
<i>Iris domestica</i>					→	→	→	→	→			
<i>Iris germanica</i>					→	→	→	→	→			
<i>Iris goniocarpa</i>					→	→	→	→	→			
<i>Iris kemaonensis</i>					→	→	→	→	→			
<i>Iris staintonii</i>					→	→	→	→	→			
<i>Disporum calcaratum</i>						→	→	→	→	→	→	→
<i>Disporum cantoniense</i>					→	→	→	→	→	→	→	→
<i>Gloriosa superba</i>						→	→	→	→	→	→	→
<i>Iphigenia indica</i>						→	→	→	→	→	→	→
<i>Paris mairei</i>					→	→	→	→	→	→	→	→
<i>Paris marmorata</i>						→	→	→	→	→	→	→
<i>Paris polyphylla</i>						→	→	→	→	→	→	→
<i>Paris thibetica</i>						→	→	→	→	→	→	→
<i>Trillium govanianum</i>			→	→	→	→	→	→	→	→	→	→
<i>Ypsilandra yunnaniensis</i>						→	→	→	→	→	→	→

**Note:** Upper arrow shows the flowering and lower arrow shows the fruiting of respective species.

#### 4.5 Species Distribution in Himalayan Region

Out of total 19 species of Colchicaceae, Iridaceae and Melanthiaceae, the Nepal Himalaya consists all the 19 species while the species distribution varies according to the different Himalaya. After Nepal Himalaya, the more number of species are found in the North-East Himalaya and Sikkim Himalaya i.e. 11. Similarly, Bhutan Himalaya has 10 species and North-West Himalaya has 9 species.



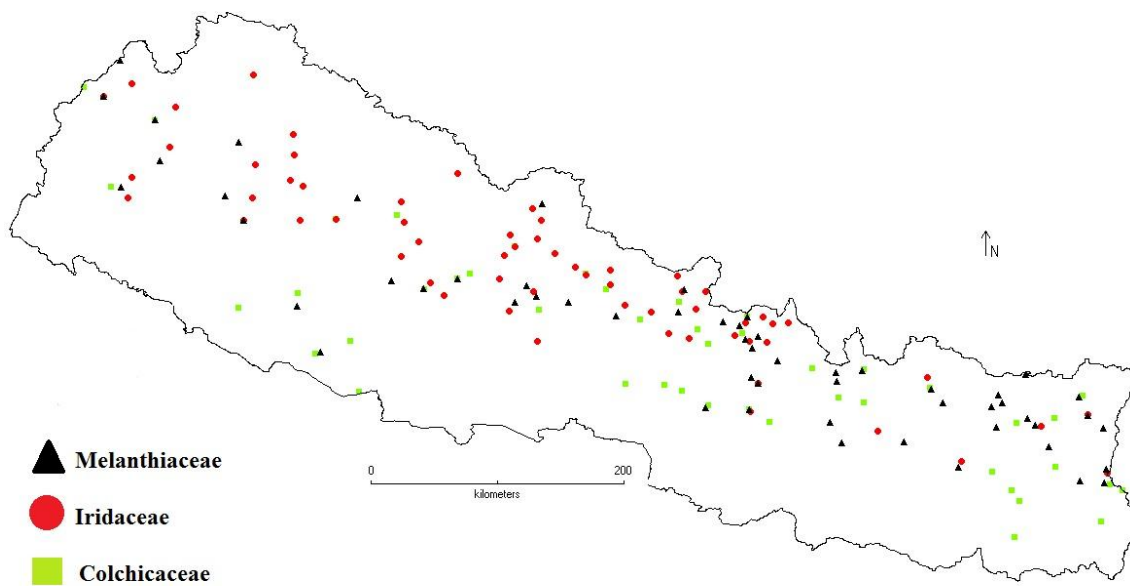
**Fig. 53.** Distribution of species along the Himalayan Region.

**Note:** **North-West Himalaya:** It starts from the border between Afghanistan to Garhwal-Kumauon; **Nepal Himalaya:** It covers the western border Mahakali River in the west board to Mechi River in the east of Nepal Himalaya; **Sikkim Himalaya:** It extends from the Eastern border of Nepal and West Bengal to Western border between Sikkim and Bhutan Himalaya; **Bhutan Himalaya:** It lies between the Western border of Sikkim Himalaya and Eastern border of North East Himalaya; **North-East Himalaya:** It covers the Eastern parts of India including Meghalaya, Arunachal Pradesh and upto the border of Burma.

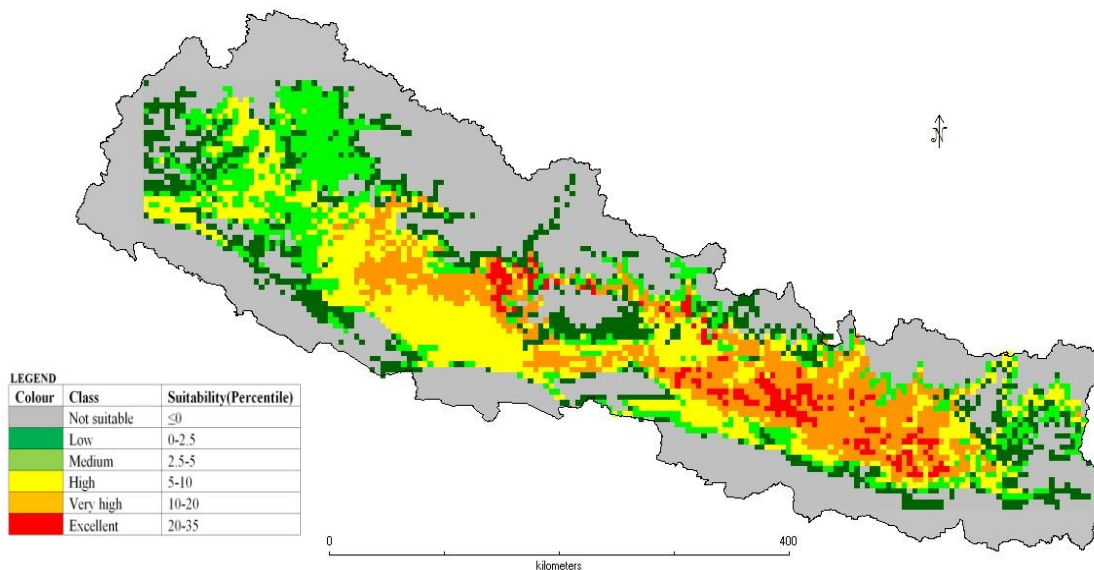
#### 4.6. Species Distribution Modeling

Among three families as Colchicaceae, Iridaceae and Melanthiaceae, most of the species are concentrated in the central region of Nepal (Fig. 54). The species of Melanthiaceae are distributed in the Central and North-Eastern region of Nepal. The model best explained the distribution of the Melanthiaceae species in the Mid-Western and Eastern part of Nepal with the high percentile value of 20-35. The model in (Fig. 56) predicted the species of family Iridaceae are distributed in the North-Western and Central part of Nepal than in the Eastern part. The distribution model of the family Iridaceae best explained the percentile value of 20-35 in the North-Western region of Nepal. Similarly, the species of Colchicaceae are distributed in the Central and Eastern region of Nepal. The potential distribution model also shows the species distribution in the Central and Eastern region of Nepal with high percentile value of 20-35. The potential distribution model shows the distribution pattern of *Paris*

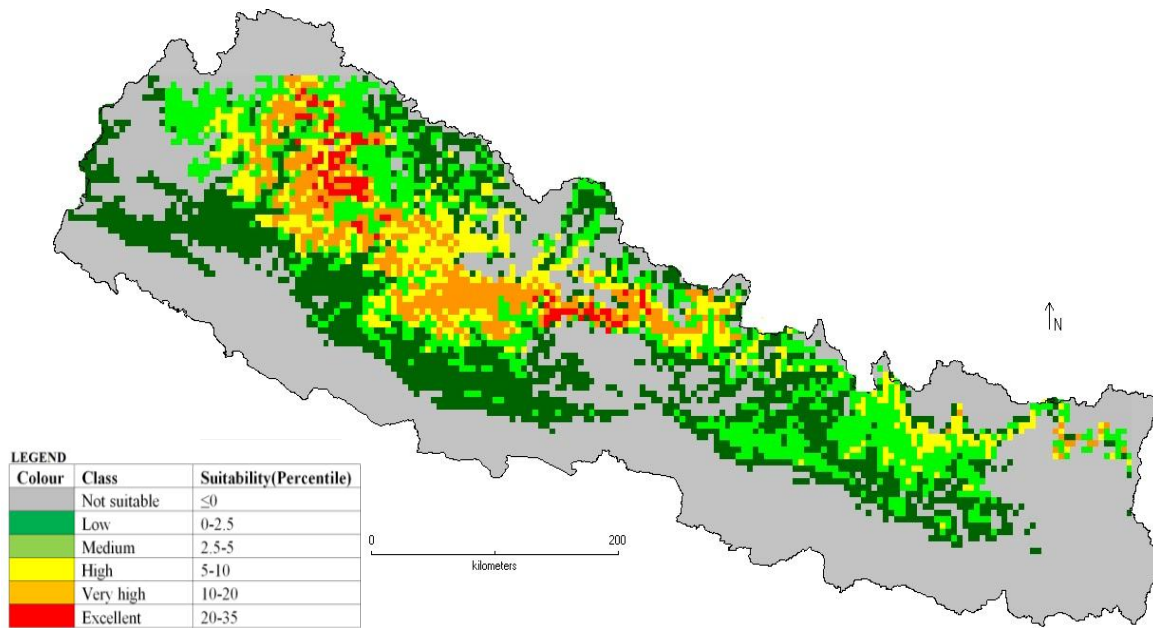
*polyphylla* in the Western and Central region of Nepal with high percentile value of 20-35 as in (Fig. 57).



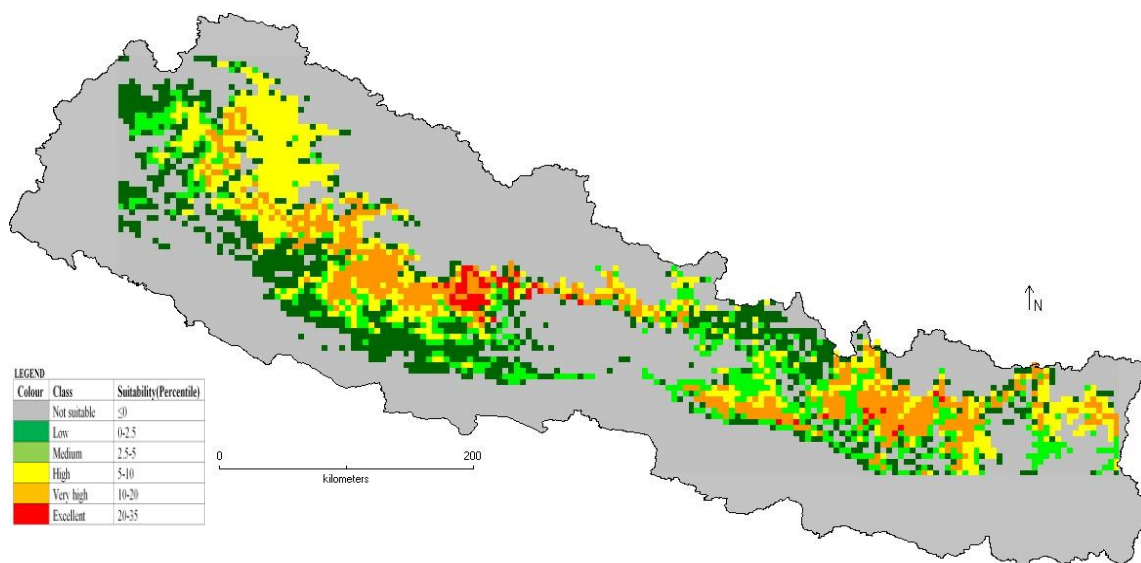
**Fig.54.** Overall distribution pattern of families Colchicaceae, Iridaceae and Melantheriaceae based on herbarium records.



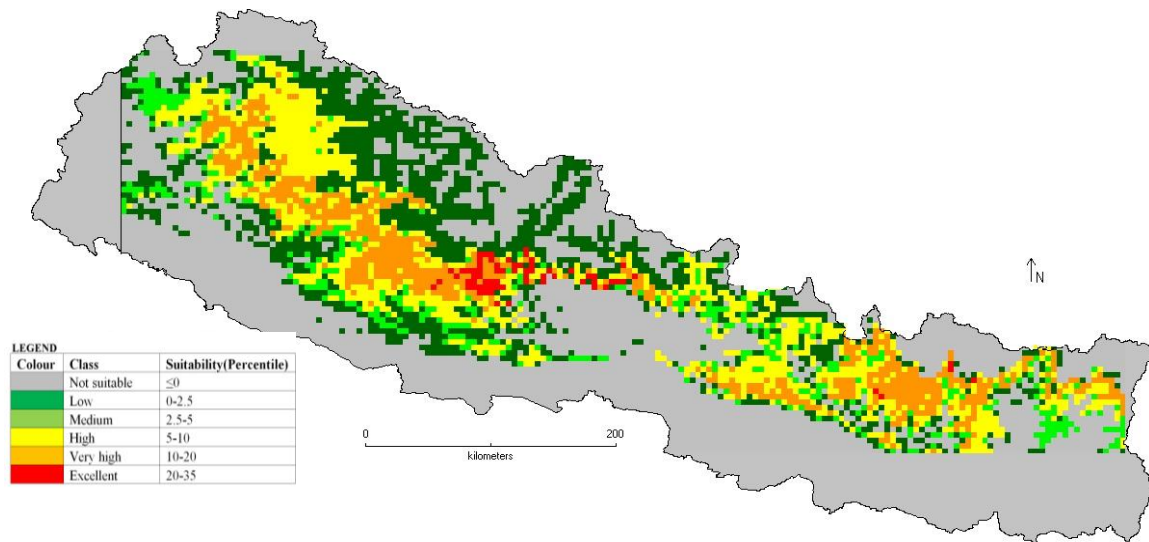
**Fig.55.** Current potential distribution of family Colchicaceae in Nepal.



**Fig.56.** Current potential distribution of family Iridaceae in Nepal.



**Fig.57.** Current potential distribution of family *Paris polyphylla* (Melanthiaceae) in Nepal.



**Fig.58.** Current potential distribution of Melanthiaceae in Nepal.

## 5. DISCUSSION

### 5.1 Taxonomy of families Colchicaceae, Iridaceae and Melanthiaceae

In the present study, an overview of the current taxonomic status of eight genera, 19 species of three families viz., Colchicaceae, Iridaceae and Melanthiaceae is shown. Morphological characters (vegetative and reproductive) is the main characters of plant systematics (Endress *et al.*, 2000). The taxonomic treatment of the family Iridaceae, Colchicaceae and Melanthiaceae has been done with the help of only gross morphological characters of specimens housed at different national and international herbaria. These morphological characters are justified to a large extent in the present work in species identification and delimitation. The variation pattern of major gross morphological characters in the species is analyzed and their taxonomic significance is evaluated.

#### 5.1.1 Iridaceae

The plants of Iridaceae are perennial terrestrial herbs growing on sunny pebbly place on glacial moraine as *Iris kemaonensis*; on moist and shady places under conifer *Juniperus indica* scrub and *Quercus lanuginosea* forest as *Iris decora*; among dense dwarf bushes of *Juniperus* and *Rhododendron* and on open hillside as *Iris gonioarpa*; on moist slope along with *Berberis* bushes and grass meadow as *Iris clarkei*; on open grazed slopes as *Iris staintonii*, on deforested land as *Iris domestica* and open *Quercus-Pinus* forest as *Iris collettii*.

The roots of Iridaceae are short or long rhizomes or bulbs, sometimes with swollen storage roots. Roots fleshy and rhizome knobby in *Iris kemaonensis*, *Iris domestica*; roots slender, rhizome very short and erect in *Iris goniocarpa*; rhizome thick, swollen, fusiform, tuberous and vermiformes in *Iris collettii*; roots swollen, tuberous, finger like, many, white fleshy as *Iris decora*; rhizomes slender and spreading in *Iris clarkei*; rhizome erect, slender, very short in *Iris germanica*; rhizome very compact knob-like one or two in number in *Iris staintonii* and corm enclosing in many membranous, coriaceous or fibrous tunics in *Crocus sativus*.

Leaves usually narrow, with parallel veins sheathing bases, mostly basal, 2-ranked, often oriented edgewise to aerial stem, sword-shaped to linear. Leaves yellowish green, linear, midvein obscure, apex acute in *Iris germanica*; leaves yellowish green, linear, grass-like in

*Iris goniocarpa*; leaves not fully developed at flowering, short, blunt-tipped and apiculate, pale green, mature leaves linear, tapering to acute apex in *Iris kemaonensis*; leaves linear strongly ribbed in *Iris decora*; leaves linear, shining green on upper surface, greyish beneath in *Iris clarkei*; leaves basal, grayish green, linear or sword shaped in *Iris collettii*; Leaves long, linear, exceeding flowering stem, pale green in *Iris staintonii*; leaves few, all basal, green, linear, adaxially with pale, median stripe, base surrounded by membranous, sheathlike leaves in *Crocus sativus*.

The inflorescence of Iridaceae arranged in racemes, panicles or solitary. Flower stem robust upto two branches, spathes 1-2-flowered , apex recurved, acuminate in *Iris germanica*; spathes single-flowered, enclosing perianth tube in *Iris goniocarpa*; flower stem hidden by bract-like leaves, spathe single-flowered, shorter than tube in *Iris kemaonensis*; flower stems rather slender, spathes 1-2-flowered, linear-lanceolate, very thin in *Iris decora*; flower stem solid, exceeding leaves, sometimes simple, usually with one branch, spathes 1-2-flowered, pedicels carrying flowers almost free of spathes in *Iris clarkei*; flowering stems simple, spathes 3, green, lanceolate, 2-4-flowered, violet in *Iris collettii*; flowering stems leafless or 1 or 2-leaved, spathes 2, green, lanceolate, 1-flowered, apex recurved, acuminate in *Iris goniocarpa*; spathe single-flowered in *Iris staintonii*; flowers 1 or 2, fragrant in *Crocus sativus*.

The falls (outer tepals) and standard (inner tepals) are found to be most important reproductive character for taxonomic treatment of family Iridaceae. The variation are found in the shape, size, orientation and ornamentation of sepals. Fall blades shallowly deflexed, mauve-purple, mottled darker, obovate with central beard of club-shaped, yellow-tipped, unicellular hairs in *Iris goniocarpa*; fall blades reflexed, dark crimson-purple, obovate, gradually narrowed into haft, with central beard of yellow, multicellular hairs in *Iris germanica*; falls blade haft cuneate, beard of dense white hairs tipped with yellow or orange in *Iris kemaonensis*; falls blade broadly lanceolate, haft with deeper reddish purple veins and central ridge which is brownish yellow at base, yellowish to pale mauvish-white on blade in *Iris decora*; fall blades deflexed, dark blue to purple, with white or greenish-yellow tinged patch at base, oblong, not bearded in *Iris clarkei*; fall blades spreading, elliptic-obovate, crest orange, in *Iris collettii*; falls usually mauve, with central white ridge as *Iris staintonii*; outer and inner segments similar equal or sub-equal without crest or beard in *Crocus sativus* and *Iris domestica*.

Style, stigma and ovary are also important in delimitation of species in Iridaceae as ovary inferior, 3-loculed; ovules few to many; placentation axile. Style with three colored, expanded, petaloid branches, arching over stamens, apex of branches extended as two lobes (crests) projecting beyond flap like, abaxial stigma as in *Iris clarkei*, *Iris collettii*, *Iris decora*, *Iris domestica*, *Iris germanica*, *Iris goniocarpa*, *Iris kemaonensis* and *Iris staintonii* while deep red in *Crocus sativus*.

In the family Iridaceae, *Iris domestica* (blackberry lily, leopard flower, leopard lily) is an ornamental plant. Flowers give way to pear-shaped seed pods which split open when ripe (late summer), with each pod revealing a blackberry-like seed cluster, hence the common name of blackberry lily. Spotting on the flowers gives rise to the additional common name of leopard lily. As a result of DNA sequence evidence, Peter Goldblatt and David Mabberley (2005), the sole species *Belamcanda chinensis* in the genus *Belamcanda* was transferred to the genus *Iris* and renamed *Iris domestica*, published in the journal *Novon* 15: 128. This is supported by (Tillie *et al.*, 2000) as they nested *Belamcanda* in genus *Iris* according to molecular data. "The eastern Asian genus *Belamcanda* (Iridaceae: Irideae), with its sole species, *B. chinensis*, the leopard or blackberry lily, has long been understood to be most closely related to *Iris dichotoma* (syn. *Pardanthopsis dichotoma*), but has nevertheless been maintained as a separate genus because of its distinctive floral, fruit, and seed morphology. Not only does consistent taxonomic treatment of genera of the Iridaceae require that *Belamcanda* be transferred to *Iris*, but taxonomy should follow the principle of monophyly, which requires that *Belamcanda* and any other genus nested in *Iris* be treated as members of that genus. Regardless of its correct botanical name, this plant is very similar in appearance to an *Iris* plant, with flat, sword-like leaves arranged in a fan on a small tuberous rhizome. The flowers, however, are very different in appearance from typical *Iris* flowers. The flowers are typically orange spotted with red, although yellow-flowered varieties are in cultivation.

Bentham and Hooker (1894) placed genus *Belamcanda* into tribe Sisyrinchieae. He delineated the genus *Belamcanda* from genus *Iris* on the basis of stamens alternating with the style-arms in "The Flora of British India". Polunin and Stainton (1984) also delimited genus *Belamcanda* from genus *Iris* on the basis of having all petals equal and stamens alternating in the genus *Belamcanda* in "Flowers of the Himalaya". Noltie (1994) also treated *Belamcanda* as separate genera in the family Iridaceae. He delimited the genera *Belamcanda* from *Iris* on

the basis of inner and outer whorls of perianth segments which are strongly differentiated in the genus *Iris* whereas the perianth segments are more or less similar in the case of *Belamcanda* in “Flora of Bhutan”. Zhao Yutang *et al.*, (2000) also treated genus *Belamcanda* separately within the family Iridaceae. He delineated genus *Belamcanda* from genus *Iris* on the basis of style arms which are branched, petaloid and inner and outer segments differing greatly in *Iris* whereas style branches slender and outer and inner arms more or less similar in *Belamcanda* in “Flora of China”. In the present work this has been also described as *Iris domestica*.

Bentham and Hooker (1894) described thirteen species of *Iris* viz., *Iris aitchisoni*, *Iris ensata*, *Iris spuria*, *Iris aurea*, *Iris wattii*, *Iris milesii*, *Iris nepalensis*, *Iris gilgitensis*, *Iris kumaonensis*, *Iris goniocarpa*, *Iris duthieii*, *Iris hookeriana* and *Iris clarkei* in “Flora of British India”. He delineated the species within the genera on the basis of rootstock i.e., rootstock a coated bulb or corm in *Iris aitchisoni* and rootstock stout, prostrate and creeping in the species as *Iris ensata*, *Iris spuria*, *Iris aurea*, *Iris wattii*, *Iris milesii*, *Iris nepalensis*, *Iris gilgitensis*, *Iris kumaonensis*, *Iris goniocarpa*, *Iris duthieii*, *Iris hookeriana* and *Iris clarkei*. Among these species, only *Iris nepalensis*, *Iris kumaonensis*, *Iris goniocarpa* and *Iris clarkei* are reported from Nepal. Bentham and Hooker (1894) also treated *Crocus* and *Belamcanda* in the same tribe Sisyrinchieae. *Crocus* have rootstock a tunicate corm; stem 0 and perianth-tube long whereas rootstock creeping; stem erect; perianth-tube very short in *Belamcanda*. The taxa are delineated with each other on the basis of above characters. This is also true in “Flora of China” where the species *Crocus sativus* are characterized by the purple perianth, style 3-branched at apex, branches deep red. *Crocus* are distinguished from rest of genera in Iridaceae in having corm with fibrous scales, flowers stalkless with long stalk corolla tube Polunin and Stainton (1984) in “Flowers of the Himalaya” as well.

Polunin and Stainton (1984) described nine species of *Iris* viz., *Iris lactea*, *Iris spuria*, *Iris clarkei*, *Iris decora*, *Iris milesii*, *Iris goniocarpa*, *Iris kemaonensis*, *Iris hookeriana* and *Iris germanica*. The species are delineated on the basis of falls. Falls smooth above, without a bearded or crest in *Iris lactea*, *Iris spuria* and *Iris clarkei* and falls with a raised ridge or crest in *Iris decora* and *Iris milesii* whereas falls with a beard of orange or yellow hairs in *Iris goniocarpa*, *Iris kemaonensis*, *Iris hookeriana* and *Iris germanica*. Among these nine species, only five species are reported from Nepal as *Iris clarkei*, *Iris decora*, *Iris goniocarpa*, *Iris kemaonensis* and *Iris germanica*. Noltie (1994) reported seven species of *Iris* viz., *Iris*

*tectorum*, *Iris germanica*, *Iris goniocarpa*, *Iris kemaonensis*, *Iris dolichosipon*, *Iris decora* and *Iris clarkei*. The species are delineated on the basis of falls with central beared of single-celled or multicellular hairs or with feathery white petaloid crest in species as *Iris tectorum*, *Iris germanica*, *Iris goniocarpa*, *Iris kemaonensis* and *Iris dolichosipon* and falls without beared or white petaloid crest in species like *Iris decora* and *Iris clarkei*. Among these seven species only five species are reported from Nepal as *Iris germanica*, *Iris goniocarpa*, *Iris kemaonensis*, *Iris decora* and *Iris clarkei*. Zhao Yutang *et al.*, (2000) described sixty species of *Iris* among them following five species are reported in Nepal, viz., *Iris decora*, *Iris collettii*, *Iris goniocarpa*, *Iris kemaonensis* and *Iris clarkei*, which have been described in the present study.

### 5.1.2 Colchicaceae

The plants of Colchicaceae are perennial terrestrial herbs growing between rocks in damp sandy soils among mosses on open mixed woodland and shrubland with *Pinus roxburghii*, *Abies* as *Iphigenia indica*; on open but moist place as *Gloriosa superba*; under semi-shaded in mixed broad leaved forest, Oak-Rhodendron forest as *Disporum cantoniense* and on damp shady places as *Disporum calcaratum*.

Leaves alternate, few, linear, sessile, long, acuminate, midvein conspicuous, base sheathing and clasping, lower leaves longer while upper leaves are shorter in *Iphigenia indica*; leaves simple, alternate or occasionally opposite, sessile or shortly petiolate, lanceolate to ovate-lanceolate, apex cirrhose as *Gloriosa superba*; leaves lanceolate to narrowly oblanceolate, sessile or sub-sessile or base cuneate into short petiolate, finely acuminate as *Disporum cantoniense* and leaf blade broad, oblong-lanceolate, sessile or short petiolate in *Disporum calcaratum*.

Inflorescence 3-5 flowered in a terminal raceme, bracts linear or subulate, leafy as *Iphigenia indica*; terminal, flower born singly in axils of leaf-like bracts, pedicellate, pedicel long, recurved at apex as *Gloriosa superba*; 3-7 flowered, peduncle distinct, fascicles inserted opposite leaves on upper part of stem as *Disporum cantoniense* and *Disporum calcaratum*.

Tepals are found to be the most important reproductive character for taxonomic treatment of family Colchicaceae as tepals strongly reflexed, bright red, linear to oblanceolate, margins curved and wavy in *Gloriosa superba*; tepals white, greenish, yellow, pink, dark red, or dark

purple often saccate or spurred at base, spreading, narrow, clawed, usually cauducous in *Disporum calcaratum* and base gibbous-spurred in *Disporum cantoniense*; tepals dark purple, linear to narrowly oblanceolate in *Iphigenia indica*.

The position of stamens also plays vital role in the taxonomic treatment as stamens 6, filaments free, anthers basifixed or dorsifixed, extrose in Colchicaceae. Stamen inserted at the base of tepals, anthers versatile in *Gloriosa superba*; filaments usually slightly flat, dorsifixed, extrose, in *Disporum cantoniense* and *Disporum calcaratum*; stamen shorter than the oblong ovary, filaments papillose in *Iphigenia indica*.

The variation are also found in the stigma, style and ovary as ovary superior, 3-loculed, style slender in Colchicaceae. Ovules many per locule, style long, filiform, apically 3-lobed, strongly reflexed at base in *Gloriosa superba*; style filiform, divided into 3 stigmatic lobes recurved at apex in *Disporum cantoniense* and *Disporum calcaratum* and ovules many per locule, style short, apically 3-lobed, recurved in *Iphigenia indica*.

Hooker (1894) divided the family Liliaceae in 3 series, 16 tribes and described 120 species under 35 genera in “Flora of British India”. The genera like *Disporum*, *Gloriosa* and *Tricyrtis* are placed into tribe Uvularieae and *Iphigenia* into tribe Anguillarieae. The tribe Anguillarieae and Uvularieae are delineated on the basis of the following characters as rootstock a tunicate corm, stem 1 or more leaved, anthers dehiscing extrorsely and style 3 in tribe Anguillarieae. Whereas, rootstock tuberous or creeping, stem leafy, leaves not sheathing, flower axillary and anthers dehiscing extrorsely in tribe Uvularieae. The genus in tribe Uvularieae are delineated on the basis of stem twinning and fruit loculicidal in *Gloriosa* and stem erect and fruit a berry in *Disporum*. Single species as *Gloriosa superba* described in “Flora of British India” which is also reported from Nepal. Among three species of *Disporum* as *Disporum calcaratum*, *Disporum pullum*, *Disporum leschenaultianum* only two species are reported from Nepal and out of two species of *Iphigenia* as *Iphigenia indica* and *Iphigenia pallida* of which only *Iphigenia indica* are recorded from Nepal.

Noltie (1994) described *Gloriosa* under family Colchicaceae and genera like *Clintonia*, *Disporum*, *Streptopus* and *Tricyrtis* under family Uvulariaceae. The characters like twinning stem with alternate leaves having cirrhose apex i.e. forming a tendril and strongly reflexed tepals made the single genus *Gloriosa* to be placed into the family Colchicaceae in “Flora of Bhutan”. The tepals with saccate or spurred at base delineated the genus *Disporum* from rest

of genus in the family Uvulariaceae in “Flora of Bhutan”. Single species of *Gloriosa* i.e., *Gloriosa superba* reported from Bhutan which is also reported from Nepal too. Three species of *Disporum* are described in “Flora of Bhutan” as *Disporum calcaratum*, *Disporum pullum*, *Disporum leschenaultianum* and only two species as *Disporum calcaratum* and *Disporum pullum* are reported from Nepal. The three species of *Disporum* are delineated on the basis of branched or unbranched stem and saccate or spurred tepals in “Flora of Bhutan”.

Chen *et al.*, (2000) treated genera *Disporum*, *Gloriosa* and *Iphigenia* in the family Liliaceae in “Flora of China”. Perianth segments straight, leaves straight at apex in *Iphigenia* while perianth segments strongly reflexed, leaves with an apical tendril in *Gloriosa* and perianth segments basally saccate or spurred in *Disporum* are the characteristic features that delineated the genera with each other in “Flora of China”. Among 14 species of *Disporum* in “Flora of China” only 2 species are described from Nepal as *Disporum calcaratum* and *Disporum cantoniensis*. The species are delineated on the basis of the inflorescence orientation and tepals in “Flora of China”. Only single species of *Iphigenia* and *Gloriosa* are described which is also reported from Nepal and described in the present study.

### 5.1.3 Melanthiaceae

The plants of Melanthiaceae are perennial terrestrial herbs growing on shady places under growth in the field of bamboos, epiphytes on stem of *Schima wallichii*, *Rhododendron barbatum* as *Trillium govanianum*; on open *Kobresia* grassy slope as *Ypsilandra yunnanensis*; in forest floor of broad leaved forest as *Paris marmorata*; in deep shade on forest floor of Mixed deciduous and Coniferous forest with *Tsuga dumosa* and *Arundinaria* scrub as *Paris mairei*; on damp and shady place in the forest floor of *Rhododendron*, *Acer*, *Abies*, oak and conifer forest as *Paris polyphylla*; in clearing forest as *Paris thibetica*.

Leaves simple bearing in a whorl with unbranched stem, mainly in a basal rosette, linear to oblanceolate, flat and grass-like or ensiform and distichous in Melanthiaceae. Leaves terminal, whorl of 4-12 lanceolate to ovate, petiolate or sessile in upper parts in species of *Paris*; leaves 3, in a terminal whorl at or above the middle of the stem, sessile or shortly petiolate in *Trillium govanianum*; leaves in a basal rosette, oblanceolate or basally gradually narrowed to a petiole in *Ypsilandra yunnanensis*.

Inflorescence a terminal, spike-like raceme on leafless scape in Melanthiaceae. Inflorescence 5-17 flowered, rather narrow, densely cylindric in *Ypsilandra yunnanensis*; inflorescence bearing single, terminal flower in *Trillium govanianum* and species of *Paris*.

Tepals 6, free or fused to ovary below in Melanthiaceae. Outer tepals 3, adaxially green with white markings, abaxially purple-red, narrowly lanceolate, inner tepals purple and slightly widened distally, green proximally, filiform-linear in *Paris marmorata*; outer tepals 5-8, green, oblong-lanceolate, inner ones equalling or longer than outer ones, filiform in *Paris mairei*; outer tepals 4-6, large, leaf-like, green or yellow-green, narrowly ovate-lanceolate to lanceolate, inner ones equaling number of outer tepals, usually yellow-green, narrowly linear, shorter or longer than outer ones, filiform in *Paris polyphylla*; outer tepals 4 or 5, green, lanceolate, acuminate, inner tepals present, narrowly linear and equaling number or longer than of outer tepals, filiform in *Paris tibetica*; tepals reflexed, outer three sometimes slightly wider, linear, acute, inner tepals narrower brownish-grey in *Trillium govanianum* and tepals spatulate or oblanceolate to elliptic in *Ypsilandra yunnanensis*.

Hooker (1894) divided the family Liliaceae in 3 series, 16 tribes and described 120 species under 35 genera in "Flora of British India". He placed *Clintonia*, *Paris* and *Trillium* into tribe Medeoleae. Rootstock short or creeping, stem simple, leaves radical or whorled, flowers solitary or umbelled and anthers dehiscing extrorsely are the characters that delimit the tribe Medeoleae from the rest of tribe. The two genera *Paris* and *Trillium* in the tribe Medeoleae are delineated on the basis of leaf feature; leaves 3 in a whorl, flowers solitary in *Trillium* and leaves 4 or more in a whorl in *Paris* in "Flora of British India". Single species of *Paris* as *Paris polyphylla* reported in "Flora of British India" which is also described from Nepal. Two species of *Trillium* as *Trillium govanianum* and *Trillium tschonoskii* are reported and delimited on the basis of petiole size and shape of leaves in "Flora of British India". Among two only *Trillium govanianum* are reported from Nepal.

Noltie (1994) described *Paris*, *Trillium* and *Trillidium* in family Trilliaceae and *Ypsilandra* under family Melanthiaceae. Noltie (1994) treated the *Trillium* and *Trillidium* as two separate genera but according to APG (2009) *Trillidium* are treated in the same genus *Trillium*. The two genera *Paris* and *Trillium* are delineated on the basis of leaves and petals. Petals filiform in *Paris* and sepals and petals almost similar in *Trillium*. So, *Paris* and *Trillium* should be treated in the same family under different genera. Two species as *Paris polyphylla* and *Paris violacea* and five varieties of *Paris* are described by Noltie (1994). However, *Paris violacea*

are treated as *Paris polyphylla* var. *marmorata* (Press *et al.*, 2000). Five varieties of *Paris polyphylla* are as *Paris polyphylla* var. *polyphylla*, *Paris polyphylla* var. *wallichii*, *Paris polyphylla* var. *pubescens*, *Paris polyphylla* var. *appendiculata*, *Paris polyphylla* var. *brachystemon* by Noltie (1994). These varieties are separated on the basis of size, margin of leaf, plant ht. and anthers. These varieties are treated as four species as *Paris polyphylla*, *Paris marmorata*, *Paris mairei* and *Paris tibetica* in Nepal which is supported by Chen *et al.*, (2000) in Flora of China. *Trillium* and *Trillidium* are delimited on the basis of petal colours as reddish purple in *Trillidium* and white or purplish in *Trillium*. One species of *Trillium* as *Trillium tschonoskii* var. *himalaicum* and one species of *Trillidium* as *Trillidium govanianum* are described among which only *Trillidium govanianum* are reported from Nepal. Leaves oblanceolate, flowers commonly reddish-brown or pale blue are the characteristic features that delineate the genus *Ypsilandra* from rest of the genera in family Melanthiaceae. *Ypsilandra yunnanensis* var. *himalaica* is only described from “Flora of Bhutan” which is also reported from Nepal.

Chen *et al.*, (2000) placed *Paris*, *Trillium* and *Ypsilandra* under family Liliaceae in “Flora of China”. These genera are delineated on the basis of the root characters that are not bulbiferous or cormous, but often producing rhizomes or underground organs. Leaves 4-15 in one whorl and inner perianth segments much narrower than outer ones in *Paris* and leaves in a whorl, inner perianth segments little narrower than outer ones in *Trillium* and leaves not in one whorl, inflorescence racemose or spicate, anthers basifixed, usually reniform in *Ypsilandra* are the characters that delineate the genera with each other within the family in “Flora of China”. 22 species of *Paris* are reported in “Flora of China” among which only four species is described from Nepal. The characters like rhizome leaves, ovary and fruit are used to segregate the species. Four species of *Trillium* are described in “Flora of China”. The four species are delineated on the basis of stems, leaves and inner tepals. Among which only one species *Trillium govanianum* are reported from Nepal. They delineated the species on the basis of stamens, style and stigma characters in “Flora of China”. Five species of *Ypsilandra* are described by Chen *et al.*, (2000). Among them only one species as *Ypsilandra yunnanensis* are reported from Nepal.

Out of total 19 species of Colchicaceae, Iridaceae and Melanthiaceae, the Nepal Himalaya consists all the 19 species while the species distribution varies according to the different Himalaya. Among all these species, other species has wider distribution while *Iris staintonii*

are narrow endemics and found only in Nepal.

Hierarchical cluster analysis shows two main clusters. The first cluster is further divided into two sub clusters. The first sub cluster of cluster first represents the family Melanthiaceae, which further divides into two, one branch carrying *Paris* and *Trillium* and another branch carrying the *Ypsilandra*. *Paris* and *Trillium* are rhizomatous and leaves in a upper whorl while *Ypsilandra* are cormous and leaves in a basal whorl. *Paris* and *Trillium* lies close to each other because they shares maximum characters (Zomlefer, 1996). Noltie (1994) also treated *Paris* and *Trillium* in the family Trilliaceae and *Ypsilandra* in the family Melanthiaceae in “Flora of Bhutan”. The second subcluster of first cluster represents the family Colchicaceae, which further divides into two and first branch carrying *Disporum* and *Gloriosa* and second branch carrying the genus *Iphigenia*. *Disporum* and *Gloriosa* showed maximum similarity of characters. The dendrogram obtained by this result is also supported by molecular studies (Chase *et al.*, 1995; Rudall *et al.*, 1997). However, (Nordenstam, 1982) treated all these three genera *Disporum*, *Gloriosa* and *Iphigenia* in the same tribe, Iphigeneae. But, (Noltie, 1994) treated single genera *Gloriosa* in the family Colchicaceae and *Disporum* in the family Uvulariaceae on the basis of leaf characters.

The second cluster represents the family, Iridaceae which further divides into two subclusters as *Iris* and *Crocus*. The first sub cluster of second cluster represents all species of *Iris* which are rhizomatous and second sub cluster of second cluster represents the species of *Crocus* which are cormous. Zhao *et al.*, (2000) also used these characters to separate these genera in “Flora of China”. So, *Iris* and *Crocus* lies in the same clade because they shares maximum characters with each other.

Regarding the phenology, the flowering period is usually in May and peaks at June and July, some species also flowers at the end month of the year as October and November. Fruiting starts from June and peaks at August and lasts upto December as well. This indicates that rainfall is the most important climatic factor for flowering and fruiting. The observations are supported by (Noltie, 1994), (Chen *et al.*, 2000), (Zhao *et al.*, 2000), (Ali *et al.*, 2001).

Regarding the distribution, the species occurred in the East to West of Nepal. More species are found in the Eastern and Central region of Nepal than Western region. The altitudinal range ranges from tropical (400m) to alpine zone (>4000m) (Press *et al.*, 2000). The species of family Iridaceae favours in the temperate to alpine zone (1300-4400m) while, the species

of Colchicaceae favours in the tropical to temperate zone (400-2900m) and the species of family Melanthiaceae favours from sub-tropical to sub-alpine zone(1800-4100m) (Appendix 4).

## 5.2 Species Distribution Modeling

The species of three families *viz.*, Colchicaceae, Iridaceae and Melanthiaceae shows different distribution pattern. The suitability value of potential distribution model varies according to three different families. The adaptation to seasonal habitats limits the distribution of species in different regions (West-East) of Nepal (Rajbhandary *et al.*, 2010). As for the species, the available data was only presence data. As the absence data is not generally available as the accuracy of it could not be sure. The areas with high percentile value indicates the high probability of species to occurred in the respected site and its surrounding areas and the sites with low percentile value indicates low probability of species to occur in that site. It can be only assumed that the areas with high percentile value are due to high exploration or field visit in that area. But, it could not tell that a species is not present only because it has not been observed. Maybe the species is hard to be found, or the living place is difficult for people to get there (Wu Yun, 2006).

The percentile value ranges from (0-35). The percentile value <0 indicated that climatic factors of actual distribution (based on collection records) do not match with mapping site. The climatic factors where suitability percentile values are highest (20-35) matches with the climatic conditions of actually accuring data points.

The species of Colchicaceae are distributed in the Central and Eastern region of Nepal. The potential distribution model also shows the species distribution in the Central and Eastern region of Nepal with high percentile value of 20-35. The species of Melanthiaceae are distributed in the Central and North-Eastern region of Nepal. The model best explained the distribution of the Melanthiaceae species in the Mid-Western and Eastern region of Nepal with the high percentile value of 20-35. These two families shows the overlapping pattern in the distribution. The origin of the monsoon rains is the Bay of Bengal and hence the intensity of the rains decreases and its altitudinal onset increases as one travels from east to west across Nepal (Lillieso *et al.*, 2005). The west to east increase in the species of Melanthiaceae and Colchicaceae is correlated with this increased intensity of the monsoon in the east.

*Paris polyphylla* being highly medicinal and threatened commercially is listed under vulnerable category (V) by IUCN and CAMP. So, it is modeled separately to observe the current potential distribution pattern. Knowledge about distribution and ecological features of the plants helps to decrease over exploitation by encouraging sustainable and discrete collection of medicinal plant from the world (Bhattacharya and Sharma, 2008). A total of 138 native vascular plants taxa are threatened in Nepal, including over 50 species of medicinal plants (CAMP 2001, Tandon *et al.* 2001). The potential distribution model shows the distribution pattern of *Paris polyphylla* of family Melanthiaceae in the Western and Central part of Nepal with high percentile value of 20-35. Overharvesting in the past, unscientific collection of rhizome (in which all the underground parts are removed without leaving any fragment), harvesting of plant before seed maturity, lower number of viable seed production and long dormancy of seeds or very poor seed germination seems to be the major threats to the plant regeneration. As a consequence, population is declining day by day. People are aware of the declining population of *Paris polyphylla* but they are unaware about its sustainable harvest (Jha. *et al.*, 2010).

The model predicted the species of family Iridaceae are distributed in the North-Western and Central region of Nepal than in the Eastern region. The distribution model of the family Iridaceae best explained the percentile value of (20-35) in the North-Western region of Nepal. The occurrence of several species in the West of Nepal highlights the ability of species to cope with marked seasonality in precipitation and prolonged periods of drought. The above ground parts (leaves and stems) of deciduous species die down when the bulb, corm or rhizome enters dormancy. The plants thus survive periods that are unfavourable for growth by retreating underground. With the arrival of the first rains, the dormant corms or rhizomes are ready to burst into growth, sending up flowers and stems before they can be shaded out by other vegetation (Goldblatt, 1990).

Most parts of the central and middle belts of Nepal are climatically suitable for species of these 3 families, where they are widely distributed due to moderate rainfall and temperature.

## 6. CONCLUSION AND RECOMMENDATION

### 6.1 CONCLUSION

Present study based on APG system described eight genera and 19 species under three families Iridaceae, Colchicaceae and Melanthiaceae. The Iridaceae family includes *Iris decora*, *Iris kemaonensis*, *Iris goniocarpa*, *Iris germanica*, *Iris collettii*, *Iris staintonii*, *Iris clarkei*, *Iris domestica* and *Crocus sativus*. The family Colchicaceae includes *Disporum cantoniense*, *Disporum calcaratum*, *Gloriosa superba* and *Iphigenia indica*. The family Melanthiaceae includes *Paris mairei*, *Paris marmorata*, *Paris polyphylla*, *Paris tibetica*, *Trillium govanianum* and *Ypsilandra yunnanensis*. One genera of Iridaceae as *Gladiolus* is excluded from study because it is hybrid and it is also not reported in Annotated Checklist of Flowering Plants of Nepal (Press *et al.*, 2000) and Catalogue of Nepalese Flowering Plants-I (Rajbhandari *et al.*, 2010).

Morphological characters are found to be very important characters for identification of the taxa at interspecific level. The characters includes shape, size and orientation of leaves, tepals, position of stamen, number of stigma lobes and fruits are useful for the separation of the species.

Regarding the distribution, the species are distributed from East to West but, more species are reported from East and Central region of Nepal, while least species are recorded from West Nepal. Vertical distribution of the species ranges from tropical alpine region of the country. The species of family Iridaceae favours in the temperate to alpine zone (1300-4400m) while, the species of Colchicaceae favours in the tropical to temperate zone (400-2900m) and the species of family Melanthiaceae favours from sub-tropical to sub-alpine zone (1800-4100m). Most species are recorded in temperate and sub-alpine zone and less from tropical and alpine zone.

Phenological study also shows that the flowering periods of the most species are usually May and peaks at June and July, some species also flowers at the end month of the year as October and November. Fruiting starts from June and peaks at August and lasts up to December as well. Similarly, cluster analysis (dendrogram) seems to be one of the particular methods for separating the genera of three families based on the morphological characters.

Species of three families are distributed from tropical to alpine zone from East to West region of Nepal. However, members under three families differ in their suitability value for potential distribution.

The current potential distribution model of family Colchicaceae shows the species distribution in the Central and Eastern region of Nepal. While the species of family Melanthiaceae shows the distribution in Mid-Western and Eastern region of Nepal. The family Iridaceae shows the distribution in the North-Western part of Nepal. Among these three families, family Colchicaceae favours more humid and wetter condition than other two families.

DIVA-GIS is a free and open source geographic information system (GIS) that analyze data using geographic co-ordinates of the collection sites which predicts the current distribution. Species distribution models can provide valuable information about where species are likely to be found. Species distribution modeling can be a useful tool for data exploration to help identify potential knowledge gaps and provide direction to fieldwork design. Current potential distribution model has provided new localities for future expeditions and explorations of families Colchicaceae, Iridaceae and Melanthiaceae.

The systematic study helps in updating the enumeration of taxa, nomenclature changes, distribution, synonym, morphological changes, etc. From the present study all those recent changes has been noticed and treated accordingly.

## **6.2 RECOMMENDATIONS**

As the present study is solely based on the herbarium specimens housed at different herbaria, there are possibilities of finding new species if extensive explorations are carried out in Nepal. Western region of Nepal is relatively less explored than the Eastern and Central region (based on herbarium specimens), therefore exploration on the Western region is necessary.

The new method of collection should be implemented to improve the collections in the herbaria. The future collections would be improved if more material per specimen were collected, plants should be collected with more consistency, expanded notes so to make more observations on the plants. There is lack of detail information on herbarium labels of many specimens housed at National herbaria (KATH and TUCH). Such information is vital for systematic revision. Therefore, it is recommended that labels containing most of the

information about the species should be maintained for any future collections.

There are some specimens, which are reported by foreign collectors and are deposited in herbaria outside Nepal but their duplicates are not in Nepal. It is therefore recommended that Plant Quarantine Office and Department of Plant Resource must work with herbaria of Nepal and confirm that the specimens, which go out of Nepal, have their duplicate in Nepal. There are also some specimens which are reported in Checklist and Catalogue but the specimens are not deposited or are in very poor conditions.

Protologue text, i.e. the original description of the species, first publication in international taxonomic journal, is the key source for the proper identification of taxa. Because of unavailability of the standard taxonomic journals and various international publications, great difficulty was faced while obtaining the protologue texts. Our libraries should be updated and new publications containing standard taxonomic journals should be included in the library so, that future generations will not suffer.

No proper information on the TYPE specimens could be found. There must some mechanism for easy access to the TYPE specimens.

As the distribution maps are based on the collection localities of available herbarium specimens, they can be improved in the future for under collected species.

More work should be carried out in the distribution pattern of the species, which help to protect them from threatened and extinction.

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\* **Orginal literature not seen.**

## APPENDICES

### APPENDIX 1

List of 19 bioclimatic variables used for predicting the species distribution  
<http://www.worldclim.org/bioclimate>

<b>Bioclimatic Variables</b>	
<b>Derived from max &amp; min temperature</b>	BIO1 = Annual Mean Temperature
	BIO2 = Mean Diurnal Range (Mean of monthly (max temp -min temp))
	BIO3 = Isothermality (P2/P7) (* 100)
	BIO4 = Temperature Seasonality (standard deviation *100)
	BIO5 = Max Temperature of Warmest Month
	BIO6 = Min Temperature of Coldest Month
	BIO7 = Temperature Annual Range (P5-P6)
	BIO8 = Mean Temperature of Wettest Quarter
	BIO9 = Mean Temperature of Driest Quarter
	BIO10 = Mean Temperature of Warmest Quarter
	BIO11 = Mean Temperature of Coldest Quarter
<b>Derived from precipitation</b>	BIO12 = Annual Precipitation
	BIO13 = Precipitation of Wettest Month
	BIO14 = Precipitation of Driest Month
	BIO15 = Precipitation Seasonality (Coefficient of Variation)
	BIO16 = Precipitation of Wettest Quarter
	BIO17 = Precipitation of Driest Quarter
	BIO18 = Precipitation of Warmest Quarter
	BIO19 = Precipitation of Coldest Quarter

## APPENDIX 2

### Remaining Herbarium Specimens Examined for the Study.

#### *Iris decora*

**West Nepal:** Mugu, Maharigaon valley, 2591m, 19.6.1966, Mr T.B.Shrestha, 5121 (KATH); Mugu, Sukha-Daha-Rara, 2500m, 8.8.1985, P.R.Shakya, M.N.Subedi and G.Uprety, 8564 (KATH); Mugu, Rara, 2900m, 10.10.1981, N.P.Manandhar, D.P.Joshi, 8158 (KATH); Mugu, Rara, 2957m, 4.7.1968, Dr.S.B.Malla, 10785 (KATH); Jumla, Chotra-Manigaon, 2820m, 29.6.1987, N.K.Bhattarai and M.N.Subedi, 87/261 (KATH); Jumla, Chilkhaya, 1900m, 8.7.1979, K.R.Rajbhandari, B.Roy, 3056 (ATH); Dailekh, Bhabasen-Mabu pass, 2600m, 6.7.1979, K.R.Rajbhandari, B.Roy, 2920 (KATH).

#### **Digital Photograph of Herbarium seen.**

**West Nepal:** Dolpa, Tingjegaon, 5060.98m, 19.6.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 1160 (BM); Dolpa, 3048.78m, 26.5.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 4172 (BM); Dipayal, Sialgadhi, ca. 500m, 11.7.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 106 (BM); Mugu, Dhunsi, 2439.02m, 16.2.1979, F.M.Bailey's collectors, 86 (BM); Mugu, Durpa, north of Lagna, 3048m, 26.5.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 4172 (E); Jumla, North side of Tila river, 2317.07m, 4.7.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 4435 (BM); Jumla, 7500m, 5.5.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 911 (BM); Jumla, South bank of Tila river, 2317m, 4.7.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 4435 (E); Jumla, 2286m, 5.5.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 911 (E); Jumla, 2317.07m, 6.7.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 4467 (BM); Jajarkot, 2800m, 2.7.1973, S.Einarsson, L. Skarby, B.Wetterhall, 1479 (BM).

**Central Nepal:** Baglung, Sehragaon, 2500m, 22.5.1973, S.Einarsson, L. Skarby, B.Wetterhall, 183 (BM); Mustang, Muktinath, 3750m, 14.7.2000, I.Sharma, 40098 (KATH); Manang, Chame-Pisang, 2730-3230m, 12.7.1973, D.P.Joshi and M.M. Amatya, 73/532 (KATH); Gorkha, Gup, 2120m, 6.6.1983, P.R.Shakya, M.N.Subedi and M.K.Adhikari, 7766 (KATH); Rasuwa, Thale-Dhunche, 2000m, 3.6.1969, H.Kanai, 67381 (KATH); Rasuwa, Dhunche-Bhargava, 1829m, 9.7.1967, Dr.Malla, 6589 (KATH); Rasuwa, Near Langtang valley, 2988m, 14.7.1967, Dr.Malla, 9034 (KATH); Rasuwa, Langtang valley, 3600m, 28.4.1994, K.Panta, 30/52 (TUCH); Lalitpur, Phulchoki, 2988m, 4.7.1968, 10584 (KATH); Sindhupalchok, helambu, 4100-4850m, 16.7.1973, D.P.Joshi and M.M. Amatya, 73/658

(KATH).

**Digital Photograph of Herbarium seen.**

**Central Nepal:** Baglung, Near Gurjakhani, 2591m, 9.6.1954, Stainton, Skyes and Williams, 3084 (E); Mustang, Lete, 9000ft, 9.6.1964, Stainton, Skyes and Williams, 1038 (BM); Mustang, Taglung (S. of Tukucha) Kali Gandaki, 3506m, 20.10.1954, Stainton, Skyes and Williams, 8202 (E); Mustang, Ghasa, Tukucha, Kali Gandaki, 3048m, 4.7.1954, Stainton, Skyes and Williams, 1542 (E); Mustang, Gnyu pass(4100m)-Chhengar (3700m)-Muktinath (3650m) 3650-4100, 14.7.2000, Y.Iokawa, M.N.Subedi, Y.Takahashi and K.Kano, 20020203 (E); Mustang, Tukucha, Kali Gandaki, 2591m, 6.6.1954, Stainton, Skyes and Williams, 5612 (E); Mustang, Tukucha, Kali Gandaki, 2896m, 13.6.1954, Stainton, Skyes and Williams, 1112 (E); Mustang, Khangsar, 3810.98m, 25.6.1950, D.G.Lowndes, 1058 (BM); Mustang, Taglung(S. of Tukucha) Kali Gandaki, 3506.1m, 20.10.1964, Stainton, Skyes and Williams, 8202 (BM); Mustang, Ghasa, Tukucha, Kali Gandaki, 3048.78m, 4.7.1964, Stainton, Skyes and Williams, 1542 (BM); Mustang, Kali Gandaki, 2378.05m, 13.7.1977, G.Miehe, 122 (BM); Mustang, Tukucha, Kali Gandaki, 2896.34m, 13.6.1954, Stainton, Skyes and Williams, 1112 (BM); Mustang, Central Nepal, Cha Lungpa, nr.Sangda, 4451.22m, 18.8.1977, G.Miehe, 513 (BM); Manang, On ridge above lower Pisang, 3521m, 4.6.2009, N.Ross, S.Ghimire, M.Merello, L.Joshi, B.Koirala, S.Lo, A.Paudel, S.Sharma, TUCH-MO 32 (E); Manang, Nyeshang, upper Marsyandi area, near Khangsar, 4.6.1996, Sykes, WR250/96 (E); Gorkha, Namrung to Lho: near Lihi, 2870m, 1.8.2008, H.Ikeda, T.Kawahara, O.Yano, N.Yamamoto, M.F.Watson, Z.H.Li, M.N. Subedi and S.K.Acharya, 20817080 (E); Gorkha, Khangsar, Marsyandi valley, 3658.5m, 23.7.1983, R.J.D.Mc Beath, 1473 (E); Gorkha, Khangsar, 3810.9m, 25.6.1950, D.G.Lowndes, 1058 (E); Rasuwa, Near Langtang valley, 2988m, 14.7.1967, Dr.Malla, 9033 (BM); Rasuwa, Dhunche-Bhargava, 1829.27m, 9.7.1967, Dr.S.B.Malla, 6589 (BM); Rasuwa, Shiar Khola, Near Tumje, 2591.46m, 21.5.1953, P.C.Gardner, 537 (BM); Rasuwa, Langtang, 3506.1m, 22.6.1949, O.Polunin, 516 (BM); Rasuwa, Langtang- Birdim, 3201.22m, 28.6.1949, O.Polunin, 675 (BM).

**Digital Photograph of Herbarium seen.**

**East Nepal:** Taplejung, Amjilasa (2390m)-bend of Ghunsa Khola (2480m)- Yanjolarcha Khola (2450m)-Gyabla(2630m), 5.6.1992, S.Noshiro, S.Akiyama and N.Acharya, 9240527 (E).

### **Iris kemaonensis**

**West Nepal:** Rukum, Jangla area, 4116m, 31.5.1966, Dr.T.B.Shrestha, 5054 (KATH).

#### **Digital Photograph of Herbarium seen.**

**West Nepal:** Mugu, Durpa, north of Margor Lagna, 3048m, 26.5.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 4173 (E); Jumla, Sialgarhi, near Chaudhabise Khola, 3353m, 16.5.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 2050 (E); Dailekh, Pulanto Dara, 3201m, 28.4.1952, O.Polunin, W.R.Sykes and L.H.J.Williams, 869 (BM); Rukum, Near Maikot, 2591m, 8.10.1954, Stainton, Skyes and Williams, 4754 (E).

**Central Nepal:** Mustang, Dhawalagiri zone, SW of Jharkot (3450), ridge betn Jhong Khola and Panda Khola, 3690m, 25.9.1995, M.F. Watson, K.R.Rajbhandari, D.Knott, A.G. Miller, B.Adhikari, K.Maden, V. Manandhar, R.Uprety, 9550428 (KATH); Gorkhali Lekh, 3500m, 1.9.1990, N.K.Bhattarai, 90/1190 (KATH); Mustang, On the way to Muktinath, 4.7.1992, S.Bhattarai, I.Sharma, D.P.Joshi and R.Joshi 35/92 (KATH); Gorkha, Ganesh Himal, Shiar Khola, 4420m, 21.4.1953, P.C.Gardner, 473 (KATH); Rasuwa, Bagmati zone, Langtang (3380), Kyanjin (3800), 20.5.2001, S.Akiyama, M.Amano, C.Mouri, M.N.Subedi, H.Tsukaya and Yonekura, 20100363 (KATH); Rasuwa, Bagmati zone, Kyanjin Gompa (3800m)-Langtang (3380m), 22.5.2001, S.Akiyama, M.Amano, C.Mouri, M.N.Subedi, H.Tsukaya and Yonekura, 20100210, (KATH); Rasuwa, Kyangjin, 3800m, 23.6.1986, N.K.Bhattarai, 86/465, (KATH); Rasuwa, Bagmati zone, around Kyanjin Gompa, 3800m, 21.5.2001, S.Akiyama, M.Amano, C.Mouri, M.N.Subedi, H.Tsukaya and Yonekura, 20100184 (KATH).

#### **Digital Photograph of Herbarium seen.**

**Central Nepal:** Mustang, Thinigaon, Muktinath Himal, 4268m, 23.6.1954, O.Polunin, W.R. Sykes and L.H.J. Williams, 1358 (E); Mustang, East of Chalike Pahar, 4115m, 25.9.1954, O.Polunin, W.R.Sykes and L.H.J.Williams, 4596 (E); Mustang, Tukucha, Kali Gandaki, 3658m, 16.6.1954, Stainton, Skyes and Williams, 1177 (E); Mustang, Tukucha, Kali Gandaki, 3658m, 16.6.1954, Stainton, Skyes and Williams, 1177 (BM); Mustang, Muktinath himla, 4268m, 23.6.1954, Stainton, Skyes and Williams, 1358 (BM); Mustang, SW of Jharkot (3450-3830m), ridge between Jhong Khola and Panda Khola, 3450-3830m, 25.9.1995, M.Mikage, N.Anjiki, N.Kondo and K.Yonekura, 9550428 (BM); Mustang, Kali Gandaki, ESE Thini, 3993m, 18.7.1977, G.Miehe, 203 (BM); Mustang, Cha Lungpa,

nr.Sangda, 4451m, 18.8.1977, G.Miehe, 514 (BM); Mustang, Marsyangdi valley, 3963m, 6.6.1950, D.G.Lowndes, 949 (BM); Gorkha, Ganesh Himal, Shiar Khola 4420m, 21.4.1953, P.C.Gardner, 473 (BM); Gorkha, North of Shringi Himal, 3963m, 13.6.1953, P.C.Gardner, 686 (BM); Rasuwa, Langtang, 3353m, 20.4.1962, S.Bowes Lyon, 53 (BM); Rasuwa, Langtang, 3658m, 7.6.1949, O.Polunin, 170 (BM); Rasuwa, Langtang, 3658m, 7.6.1949, O.Polunin, 170 (E); Rasuwa, Langtang (3380m)-Kyanjin Gompa (3800m) 20.5.2001, S.Akiyama, M.Amano, C.Mouri, M.N.Subedi, H.Tsukaya and Yonekura, 20100363 (E).

**East Nepal:** Solukhumbu, Sagarmatha, Dudh Koshi Valley, Larja Dobhan to Namche Bazar, Slope to Namche Bazar, trail from Lukla, 3200m, 10.5.2004, DNEP 147 (KATH).

**Digital Photograph of Herbarium seen.**

**East Nepal:** Solukhumbu, Khumjung, 3353m, 1930, Capt. Lall Dhwoj, 655 (BM).

**Gloriosa superba**

**West Nepal:** West: Chhota santalia, 600m, 27.8.1981, T.K. Bhattacharya, 3947 (KATH); Banke, Nepaljung, 500m, 22.8.1996, 1094 (KATH); Dang, Koilabas, 31.8.1974, R.B.Thakuri, 203 (KATH); Smlibas, 6.8.1980, Bhattacharya, 169 (KATH); Dang, Koilabas, 230m, 26.8.1982, N.P.Manandhar, N.K.Bhattarai, 418 (KATH); Smlibas, 800m, 29.8.1979, Bhattacharya, Malla, 2933 (KATH); Dang, Koilabas, 300m, 10.10.1992, P.P.Kurmi, 333 (KATH).

**Central Nepal:** Rasuwa, just north of Syprubensi, 1524m, 24.6.1985, H.Van T.and Irene S.Cotter, J.B. Hankay Rai, Prem Kumar Rai, N107 (KATH).

**Disporum cantoniense**

**Digital Photograph of Herbarium seen.**

**West Nepal:** Rukum, Kawa: Khater Dara, 2439m, 26.4.1952, O.Polunin, W.R.Sykes and L.H.J. Williams, 865 (E).

**Central Nepal:** Myagdi, Dhawalagiri zone, Myagdi Dist:Boghara (2010m)-Lipshe (1840m)-Lapche Kharka (2060m), Darbang (2360m) 1840m, 7.9.2180 M.Mikage, R.Hirano, N.Kondo, C.Mohrt, A.Takahashi and K.Yonekura, 9682363 (KATH); Kaski, Hinko, 2650m, 21.6.1975, D.P.Joshi, T.K. Bhattacharya, 75/2859 (KATH); Manang, Chame, 2680m, 12.8.1983, N.P.Manandhar, 9791 (KATH); Rasuwa, Syapruagaun, 2850m, 1.6.1993, N.P.Manandhar, 193-73 (KATH); Rasuwa, Sherpagaon, 2600m, 7.12.2000, Sugata Pokharel

(TUCH); Rasuwa, Near Chantang, 3048m, 13.5.1965, Dr.Banerji, Upadhaya and Basukala, 3486 (KATH); Nuwakot, Dhaibungkot and Ramche-(between) 2134m, 1.6.1949, O.Polunin, 43 (TUCH); Dhading, Lapa, 2100m, 1.6.1973, Shaky and Bhattacharya, 2415 (KATH); Dhading, Mathilo orbang 870m, 14.11.1989, N.P. Manandhar, 14166 (KATH); Kathmandu, Hattiban, 29.5.1979, 29 (TUCH); Kathmandu, Sundarijal, 1950m, 13.2.1969, H.Kanoi 21 (KATH); Forest above Rukana, 2744m, 10.5.1965, Dr.Banerji,Upadhaya Basukala, 3434 (KATH); Kathmandu, Dhunge (Mainchur), 1828m, 11.6.1964, Dr. S.B.Malla, 10612 (KATH); Kathmandu, Shivapuri forest, 2133m, 7.9.2000, Mr.Feil and P.N.Suwal(Jr), 68 (KATH); Bhuktani (1250)-Hulkigan (1240) (1240-1350), 8.1.1970, H.Kanai, 670563 (KATH); Lalitpur, Ghumarichok, Galin, 1982, 28.4.1967, B.B.Basukala, 5999 (KATH); Lalitpur, Phulchoki, 8.6.1990, Uttam (TUCH); Lalitpur, Ghumarichok, Galim, 1981m, 28.4.1967, B.B.Basukala, 5999 (KATH); Lalitpur, Mt. Phulchoki, 2320m, 16.5.2001, S.Akiyama, M.Amano, C.Mouri, M.N.Subedi, H.Tsukaya and Yonekura, 20100402 (KATH); Makwanpur, Lothe, 3048m, 27.8.1967, P.R.Shakya, 9135 (KATH); Makwanpur, Daman, 2250m, 28.5.1986, N.K.Bhattarai, 86/274 (KATH); Dolakha, Jiri, 1810m, 25.4.1978, I.Sharma, H.K.Saigu, A.Karki, 78/230 (KATH); Dolakha, Simi gaun, 1860m, 21.5.1979, N.P.Manandhar, 1673 (KATH); Dolakha, Jiri, 1810m, 25.4.1978, I. Sharma, H.K. Saigu, A. Karki, 78/230 (KATH).

#### **Digital Photograph of Herbarium seen.**

**Central Nepal:** Baglung, Near Bongakhani, 2134m, 3.5.1954, Stainton, Sykes, Williams, 2676 (E); Baglung, Lumsung, 2134m, 27.8.1954, Stainton, Sykes, Williams, 4053 (E); Mustang, Lete, S.of Tukucha, Kali gandaki, 2591m, 6.6.1954, Stainton, Sykes, Williams, 993 (E); Kaski, South-west Rambrong, 2439m, ,26.4.1954, Stainton, Sykes, Williams, 5087 (E).

**East Nepal:** Solukhumbu, Above Giovane, 2250m, 18.5.1973, Shaky and Bhattacharya, 2140 (KATH); Dharan, Dharan-Sanguri, 1159m, 2.5.1961, T.B.Shrestha and William, 12349 (KATH); Taplejung, Sewaden (2490m)-Dongen (2260m), Mewa khola bridge (2050m)-Papung (1940m), 18.5.1992, M. Suzuki, N. Acharya, S. Akiyama, H. Koba, S. Noshiro and K.R. Rajbhandari, 9262128 (KATH); Taplejung, Mechi zone, Taplejung Pati (2310)-Jongim (2550m)-Wolangchung Gola (3110m) 2310-3110m, 24.5.1992, M.Suzuki, N.Acharya, S.Akiyama, H.Koba, S. Noshiro and K.R. Rajbhandari, 9262181 (KATH); Ghada chaur (Phulch), 2438m, 18.5.1967, 6886 (KATH).

**Digital Photograph of Herbarium seen.**

**East Nepal:** Taplejung, Tamur valley, Mewa Khola, S.of Topke Gola, 2439m, 17.5.1956, J.D.A.Stainton, 346 (E); Ilam, Hangetham to Gairibas, 2172m, 17.5.2007, B. Adhikari, R.C. Poudel, R.M. Kuwar, K. Humagain, J. Pandey and N.B. Khatri Chhetri, LKSRB161 (E).

**Paris polyphylla**

**West Nepal:** Darchula, Brahma lekh, 3250m, 19.5.1971, P. R. Shakya and D. P. Joshi, 558 (KATH); Bajhang, Bauli Gad, 2300m, 4.5.73, J.F.Dobremez, 2052(KATH); Bajura, Khaptad-Kanda, 2600m, 28.8.1991, K. R. Rajbhandari, 15664 (KATH); Doti, Napani, 1829m, 2.9.1981, K.J.Malla, 538(KATH); Bajura, Khaptad-Kanda, 2600m, 28.8.1991, K.R.Rajbhandari, 15664(KATH); Jumla, Chaukebada(2340)- Haudi(1870)-Sukativ(1640)-Battis(1600)-Tila Khola(900)-Badarigon(1330), 900-2340m, 5.8.1991, M.Suzuki, H. Hatta, N.Kurosaki, F. Mikkage, K.R. Rajbhandari, H. Takyama and Terada, 9160305(KATH); Bajhang, Bauli Gad, 2300m, 4.5.1973, J.F.Dobremez, 2052 (KATH); Dang, 23.5.1974, J. F. Dobremez and N. P. Manandhar, 74/825 (KATH);

**Digital Photograph of Herbarium seen.**

**West Nepal:** Doti, Khaptad National park. Trail from Jhigrana to Bichpani, 2270m, 1.7.2009, H. Ikeda, S. Noshiro, M. Amano, T. Tanaka, N. Yamamoto, C. A. Pendry, B. Dell, Y. Wang, G. D. Bhatta and A. P. Bhattarai, 20911022 (E).

**Central Nepal:** Parbat, Panchase, 2300m, 8.1.2057, K. Roka, 103(TUCH); Parbat, Panchase, 2300m, 20.4.2000, Bijaya Aryal, P05 (TUCH); Kaski, Banthauri, 2600m, 24.5.1992, N. P. Manadhar and S. K. Acharya, 175/92 (KATH); Kaski, Hinko to South Annapurna 2700m, 18.6.1976, D. P. Joshi, T. K. Bhattacharya, 75/2820 (KATH); Kaski, Hinko to South Annapurna, 2700m, 18.6.1975, Joshi and Bhattacharya, 75/2819(KATH); Kaski, Odena lekh, 2300m, 19.3.1974, D.P.Joshi and M.M. Amatya, 74/1609(KATH); Gorkha, Uhiya, 10.4.1996, Chitra Bdr B.K., 429 (TUCH); Kaski, Ghada Deorali-Banthanti chaur (Phulch), 2500m, 11.7.1983, K.R.Rajbhandari, 7571 (KATH); Gorkha, Ekle Ghar(1620m)-Sharyung(2000m)-Anga(2140m)-Lokpa(1900m)-Sardu Khola(1800m), 25.7.1994, M.Suzuki, N.Acharya, N.Fujii, L.Joshi, T.Kajita, N.Kondo, M.Mikage, S.Noshiro and K.Yoda, 9485139(KATH). Kaski, Lebron, 2100m, 16.10.1982, K. R. Amatya, T. K. Rajbhandari and T. Shrestha, 59 (KATH); Rasuwa, Deurali,Dhunche, 2200m, 27.6.2003, P.P Kurmi, G.D.Bhatta, 200375(KATH); Rasuwa, Syaprubensi, 6700ft, 12.7.67, D.Malla, 6599(KATH);

Rasuwa, Chandanbari, 3200m, 10.5.1985, K.R.Rajbhandari, I.Sharma and A.Kayastha, 10489(KATH); Rasuwa, Dhunche-Deurali, 2180m, 27.4.2001, L. Joshi, V. Manandhar and M. Ghimire, 20015 (KATH); Rasuwa, Khamjing, 2000m, 26. 6. 1986, N. K. Bhattarai, 86/512 (KATH); Rasuwa, Dhunche-Deurali, 2180m, 15.4.2001, L. Joshi, V. Manandhar and M. Ghimire, 20015 (KATH); Rasuwa, Syapru village, 2850m, 30.5.1993, N. P. Manandhar, 162-93 (KATH); Rasuwa, Syaprubensi, 1829m, 12.7.1967, D. Malla, 6599 (KATH); Rasuwa, Khanjing, 2000m, 26.6.1986, N. K. Bhattarai, 86/512 (KATH); Makwanpur, Simbhanjyang, 2400m, 29.5.1986, N.K.Bhattarai, 86/169(KATH); Dolakha, Charikot-Kalinchok, 8,000ft, 15.9.1964, Dr.Banerji, Shrestha and Upadhyaya, 2745(KATH); Dolkha, Near Deurali, 2360m, 22.6.1994, I.Sharma, M.N.Subedi and P.P.Kurmi, 36(KATH); Dolkha, Simigaon, 1860m, 21.5.1979, N.P.Manandhar and M. K. Adhikari, 1663 (KATH); Below Singla, C.N., 2800m, 21.5.1973, Shaky and Bhattacharya, 2247 (KATH); Banglep, 3150m, 25.5.1973, P. R. Shakya and T. K. Bhattacharya, 2325 (KATH); Bhangyang, 19.5.1973, Shakya and Bhattacharya, 2194 (KATH).

**Digital Photograph of Herbarium seen.**

**Central Nepal:** Baglung, Near Lumsung, 2743m, 25.4.1954, Stainton, Sykes and Williams, 2591 (E); Kaski, Bhurungdi Khola, 2286m, 21.5.1954, Stainton, Sykes and Williams, 5356 (E); Sindhupalchok, Thangpaldhap, 2439m, 5.8.1974, K. N. Sharma, 245 (E).

**East Nepal:** Solukhumbu, Tate-Hesingnasa, 3354m, 28.5.1958, Seshagiri Rao Rolla, 14154 (KATH); Sankhuwasabha, Chichila, 1900m, L. P. Baral, R. P. Chaudhary, H. D. Lekhak and team, 367(TUCH); Taplejung, Near Taplejung, 2134m, 11.1963, A. V. Upadhyay, 1630 (KATH); Taplejung, Simbua Kh;below Tarangdi. 2950m, 22.9.1989, C Grey-Wilson, Sue Zmarzty, Mike Sinnott, David Long, Ron Mc Beath, Henry Noltie, Mahendra Subedi, 871 (KATH); Eastern Flank Buje Danda, 2590m, 4.10.1989, C Grey-Wilson, Sue Zmarzty, Mike Sinnott, David Long, Ron Mc Beath, Henry Noltie, Mahendra Subedi, 1211 (KATH); Taplejung, Yamfudin/Chairam, 3049m, 10.9.1978, D. L. Binns and Party, BMW16 (KATH).

**Digital Photograph of Herbarium seen.**

**East Nepal:** Solukhumbu, Dudh Koshi valley: Ghat to Phakding:trail from Lukla to Namache Bazar, 2600m, 9.5.2004, M. F. Watson, K. R. Rajbhandari, D. Knott, A. G. Miller, B. Adhikari, K. Maden, V. Manandhar, R. Uprety, DNEP124 (E); Sankhuwasabha, Slopes between Hatiya and Arun River, steep wooded rocky slope; damp shady bank, 1550m, 13.9.1991, D. G. Long, R. J. D. Mc Beath, D. R. McKean, D. A. H. Rae, N. P. Bhattarai, 757

(E); Sankhuwasabha, Slopes between Hatiya and Arun River, steep wooded rocky slope; damp shady bank, 1550m, 13.9.1991, D. G. Long, R. J. D. McBeath, D. R. McKean, D. A. H. Rae, N. P. Bhattarai, 757, (E); Sankhuwasabha, Chyangrma(2170m)-Chhokam Khola(2620m)-Camp Site(3140m), 3150m, 21.8.1998, S.Noshiro, N.Acharya, K.Kobayashi, Y.Omori, K.Shinozaki and H.Tsukaya, 9810111(E); Illam, Chauri Chowk; Near Mai Khola, 3059m, 15.6.2007, B. Adhikari, R. C. Poudel, R. M. Kuwar, K. Humagain, J. Pandey and N. B. Khatri Chhetri, LKSRB97 (E); Illam, Mabu vdc, Dobate, 2665m, 3.9.2007, R. M. Kunwar, M. K. Dhamala, J. Pandey, N. B. Khatri, Y. R. Poudel and R. K. Rai, LKSRC193 (E); Eastern Flank Buje Danda, 2600m, 4.10.1989, Keke, 1200 (E); Taplejung, Ramsyang Pati (2310m)-Jongim (2550)-Wolangchung Gola (3110m) 2310-3110m, 24.5.1992, M. Suzuki, N. Acharya, S. Akiyama, H. Koba, S. Noshiro and K. R. Rajbhandari, 9262182 (E); Taplejung, Simbua Khola; below Tarangdi, 2950m, 22.9.1989, Keke, 871 (E).

### APPENDIX 3

Data matrix for Cluster Analysis.

Taxon	Character coding															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<i>Iris</i>	1	0	0	0	0	1	0	0	1	0	1	0	0	1	1	0
<i>Crocus</i>	0	0	0	0	0	1	0	0	0	0	1	0	1	1	1	0
<i>Disporum</i>	1	1	1	1	1	0	0	1	0	1	0	1	1	1	0	1
<i>Gloriosa</i>	0	1	1	1	1	0	0	1	0	1	0	1	1	1	0	0
<i>Iphigenia</i>	0	1	0	0	1	1	0	1	0	1	0	1	1	0	0	0
<i>Paris</i>	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1
<i>Trillium</i>	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1
<i>Ypsilandra</i>	1	1	1	1	0	1	0	1	1	1	0	1	1	0	0	0

### APPENDIX 4

Vertical and horizontal distribution of family Iridaceae, Colchicaceae and Melanthiaceae

S.No.	Taxon	Vertical distribution	Horizontal distribution
1	<i>Crocus sativus</i>	2000	C
2	<i>Iris clarkei</i>	3000-3060	CE
3	<i>Iris collettii</i>	1700-3700	E
4	<i>Iris decora</i>	1800-4000	WCE
5	<i>Iris domestica</i>	1300-2300	WC
6	<i>Iris germanica</i>	3000	C
7	<i>Iris goniocarpa</i>	3600-4400	WC
8	<i>Iris kemaonensis</i>	2500-4300	WCE
9	<i>Iris staintonii</i>	3500-4300m	C
10	<i>Disporum calcaratum</i>	1100-2900	E
11	<i>Disporum cantoniense</i>	1100-2900	WCE
12	<i>Gloriosa superba</i>	400-2200	WCE
13	<i>Iphigenia indica</i>	1800-2000	C
14	<i>Paris mairei</i>	2400-3000	CE
15	<i>Paris marmorata</i>	2800-3000	E
16	<i>Paris polyphylla</i>	1800-3500	WCE
17	<i>Paris thibetica</i>	3000-3500	E
18	<i>Trillium govanianum</i>	2700-4000	WCE
19	<i>Ypsilandra yunnaniensis</i>	2700-4100	E

## APPENDIX 5

### CHECKLIST

(\* indicates cultivated and ! indicates the doubtful species)

**Colchicaceae** de Candolle

**Disporum** Salib.

**Disporum calcaratum** D. Don, *Proc. Linn. Soc. Lond.* **1** : 45 (1839).

*Disporum hamiltonianum* D. Don, *Proc. Linn. Soc. Lond.* **1**: 45 (1839) = **Disporum calcaratum**

*Uvularia calcarata* Wall. *Numer. List.* 5087 (1831-32) = **Disporum calcaratum**

**Distribution:** Nepal, SE Asia, Assam-Burma, E Himalaya.

**Altitudinal Range:** 1100-2900m.

**Ecology:** On damp shady places.

**Flowering:** June–July. **Fruiting:** August–November.

**Disporum cantoniense** (Lour.) Merr., *Phillip. J. Sci.* **15**(3): 229 (1920).

*Fritillaria cantoniensis* Lour., *Flora Cochinchinensis* **1**: 206 (1790).

*Disporum cantoniense* f. *parviflorum* (Wall.) H.Hara, *Bull. Univ. Mus. Univ. Tokyo.* 31:186 (1988) = **Disporum cantoniense**

*Disporum cantoniense* var. *parviflorum* (Wall.) H.Hara, in *Fl. E. Himal.* 407 (1966) =

**Disporum cantoniense**

**Distribution:** Nepal, Tibetan-Plateau, E Himalaya, Assam-Burma, SE Asia, E Asia.

**Altitudinal Range:** 1100-2900m.

**Ecology:** Herb under semi-shaded in mixed broad leaved forest, *Oak-Rhodendron* forest.

**Flowering:** May–July. **Fruiting:** August–October.

**Gloriosa** L.

**Gloriosa superba** L., *Sp. Pl.* **1** : 305 (1753).

**Distribution:** Nepal, SE Asia, Assam-Burma, S Asia, E Asia, SW Asia.

**Altitudinal Range:** 400-2200m.

**Ecology:** Small herb on open but moist place.

**Flowering:** July- August. **Fruiting:** August- September.

Note: The rhizomes are rich in the alkaloid colchicine.

**Iphigenia** Kunth. *Enum. Pl.* **1** : 212 (1833).

**Iphigenia indica** (L.) A. Gray ex Kunth, *Enum. Pl.* **1** : 213 (1833).

*Melanthium indicum* L., *Mant. Alt.* **2**: 226. (1771) = **Iphigenia indica**

**Distribution:** Nepal, Assam-Burma, E Asia, SE Asia, S Asia, Africa.

**Altitudinal Range:** 1800-2000 m.

**Ecology:** Growing between rocks in damp sandy soils among mosses on open mixed woodland and shrubland with *Pinus roxburghii*, *Abies*.

**Flowering:** June–July. **Fruiting:** July- August.

Melanthiaceae Batsch ex Borkh.

**Paris L.**

**Paris mairei** H. Lev., *Repert. Spec. Nov. Regni Veg.* **11** (286-290): 302 (1912).

*Paris violacea* H. Lev., *Repert. Spec. Nov. Regni Veg.* **11** (286-290): 302 (1912) = **Paris mairei**

*Daiswa violacea* (H. Lev) Takht., *Brittonia* **35**(3): 266 (1983) = **Paris mairei**

**Distribution:** Nepal, E Asia, Tibetan Plateau.

**Altitudinal Range:** 2400-3000m.

**Ecology:** In deep shade on forest floor of Mixed deciduous and Coniferous forest with *Tsuga dumosa* and *Arundinaria* scrub.

**Flowering:** May-July. **Fruiting:** August-September.

**Paris marmorata** Stearn, *Bull. Brit. Mus. (Nat. Hist.) Bot.* **2**(3): 79, pl. 8, f. 11 (1956).

*Paris polyphylla* Sm. subsp. *marmorata* (Stearn) H.Hara., *J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot.* **10**(10): 176 (1969) = **Paris marmorata**

**Distribution:** Nepal, E Himalaya, Tibetan Plateau, W Himalaya.

**Altitudinal Range:** 2800-3000m.

**Ecology:** In forest floor of broad leaved forest.

**Flowering:** June-August. **Fruiting:** August-November.

**Paris polyphylla** Sm. *Cycl.* **26**: 2 (1813).

*Paris polyphylla* Sm. var. *polyphylla* (unknown original publication detail) = **Paris polyphylla**

*Paris polyphylla* Sm. var. *wallichii* H. Hara., *in Fl. E. Himal.* 3rd. Rep.134 (1975) = **Paris polyphylla**

**Distribution:** Nepal, W Himalaya, E Himalaya, SE Asia, Assam-Burma, E Asia.

**Altitudinal Range:** 1800-3500m.

**Ecology:** Herb on damp and shady place in the forest floor of *Rhododendron*, *Acer*, *Abies*, oak and conifer forest.

**Flowering:** June-August. **Fruiting:** August-November.

**Paris thibetica** Franch., *Nouv. Arch. Mus. Hist. Nat.*, ser. 2, **10**: 184 (1888).

*Paris polyphylla* Sm. var. *appendiculata* H. Hara., *Fl. E. Himal.* **1**: 410-411 (1966) = **Paris thibetica**

**Distribution:** Nepal, Assam-Burma, E Himalaya, E Asia.

**Altitudinal Range:** 3000-3500m

**Ecology:** In clearing forest.

**Flowering:** June-August. **Fruiting:** Aug-Nov.

**Trillium L.**

**Trillium govanianum** Wall. ex Royle, *Ill. Bot. Himal. Mts.* **1**: 384, pl. 93, f. 1 (1839).

*Trillidium govanianum* (Wall. ex D. Don) Kunth., *Enum. Pl.* **5**: 120 (1850) = **Trillium govanianum**

**Distribution:** Nepal, Tibetan-Plateau, W Himalaya, E Himalaya.

**Altitudinal Range:** 2700-4000m.

**Ecology:** Shady places under growth in the field of bamboos, epiphytes on stem of *Schima wallichii*, *Rhododendron barbatum*.

**Flowering:** Mar-July. **Fruiting:** July-August.

**Ypsilandra** Franch.

**Ypsilandra yunnanensis** W.W.Sm. & Jeffrey, *Notes Roy. Bot. Gard. Edinburgh* **9**(42): 143 (1916).

*Ypsilandra yunnanensis* var. *himalaica* H. Hara., *Enum. Fl. Pl. Nepal* **1**: 80 (1978) =

**Ypsilandra yunnanensis**

**Distribution:** Nepal, Tibetan-Plateau, Assam-Burma, E Himalaya.

**Altitudinal Range:** 2700-4100m

**Ecology:** On open Kobresia grassy slope.

**Flowering:** June-July. **Fruiting:** August-October.

**Iridaceae** Jussieu

\* **Crocus** L.

**Crocus sativus** L., *Sp. Pl.* **1**: 36 (1753).

*Crocus officinalis* (L.) Honck., *Syn. Pl. Germ.* **1**: 273 (1792) = **Crocus sativus**

**Distribution:** Cultivated widely throughout main Kashmir valley, China, probably of hybrid origin in E Mediterranean region.

**Altitudinal Range:** 2000m

**Flowering:** October-December. **Fruiting:** December.

**Note:** The style and stigmas are used medicinally in cooking and in the preparation of saffron dye. It is a cultivated species so, least explained.

\***Gladiolus** L.

**Gladiolus hybridus** C. Morren., *Ann. Soc. Roy. Agric. Gand.* **3**: t. 815 (1874).

**Iris** L.

**Iris clarkei** Baker ex Hook.f., *Fl. Brit. India* **6**(18): 275 (1892).

*Iris himalaica* Dykes *Gard. Chron. III*, **45**: 3, 36 (1909) = **Iris clarkei**

Nepal, Tibetan Plateau, E Himalaya, Assam-Burma and E Himalaya.

**Altitudinal range:** 3000-3060m.

**Ecology:** On moist slope along with *Berberis* bushes and grass meadow.

**Flowering:** June-July. **Fruiting:** August-September.

**!Iris collettii** Hook.f., *Bot. Mag.* **129**: pl. 7889 (1903).

**Distribution:** Nepal, Tibetan Plateau, E Asia, SE Asia, Assam-Burma and E Himalaya.

**Altitudinal Range:** 1700-3700m

**Ecology:** Open *Quercus-Pinus* forest.

**Flowering:** May-June. **Fruiting:** July-August.

**Iris decora** Wall., *Pl. Asiat. Rar.* **1**(4): 77, t. 86 (1830).

*Iris nepalensis* D.Don., *Prodr. Fl. Nepal.* 54 (1825) = **Iris decora**

*Iris sulcata* Wall., *Numer. List* 5049 (1831) = **Iris decora**

**Distribution:** Nepal, Tibetan Plateau, E Asia, Assam-Burma.

**Altitudinal Range:** 1800-4000m.

**Ecology:** On moist and shady places under conifer forest as *Juniperus indica* scrub and *Quercus lanuginosa* forest.

**Flowering:** May-July. **Fruiting:** July-August.

**Iris domestica** (L.) Goldblatt & Mabb., *Novon* **15**(1): 129, f. 1 (2005).

*Epidendrum domesticum* L., *Sp. Pl.* 952 (1753) = **Iris domestica**

*Belamcanda chinensis* (L.) Redoute., *Liliac.* **3**(21): pl. 121 (1805) = **Iris domestica**

**Distribution:** Nepal, W Himalaya, E Himalaya, E Asia, Assam-Burma, N. Asia, SE Asia (as an escape from cultivation).

**Altitudinal Range:** 1300-2300m

**Ecology:** On deforested land.

**Flowering:** June-August. **Fruiting:** July-September.

**Note:** Rhizomes are used as medicine.

\***Iris germanica** L., *Sp. Pl.* **1**: 38 (1753).

*Iris germanica* L. var. *nepalensis* (Lindl.) Herb., *Edwards's Bot. Reg.* **26**(Misc.): 34 (1840) =

**Iris germanica**

**Distribution:** Cultivated in the Himalaya.

**Altitudinal Range:** 3000m

**Flowering:** May- June. **Fruiting:** August- September.

**Iris goniocarpa** Baker, *Gard. Chron.*, n.s. **6**: 479 (1876).

**Distribution:** Nepal, Tibetan Plateau, N Asia, Assam-Burma and E Himalaya.

**Altitudinal Range:** 3600-4400m.

**Ecology:** Among dense dwarf bushes of *Juniperus* and *Rhododendron* and on open hillside.

**Flowering:** May-June. **Fruiting:** July-August.

**Iris kemaonensis** Wall. ex Royle, *III. Bot. Himal. Mts.* **1**(10): 372 (1839).

*Iris kingiana* Foster., *Gard. Chron.* **1**: 611 (1887) = **Iris kemaonensis**

**Distribution:** Nepal, E Himalaya, W Himalaya and N. Asia.

**Altitudinal Range:** 2500-4300m

**Ecology:** On sunny pebbly place on glacial moraine.

**Flowering:** May-June. **Fruiting:** June-August.

**Iris staintonii** H.Hara, *J. Jap. Bot.* **49**: 203, f. 5 (1974).

**Distribution:** Endemic to Nepal.

**Altitudinal Range:** 3500-4300m.

**Ecology:** Abundant on open grazed slopes.

**Flowering:** June-July. **Fruiting:** August-September.

## APPENDIX 6

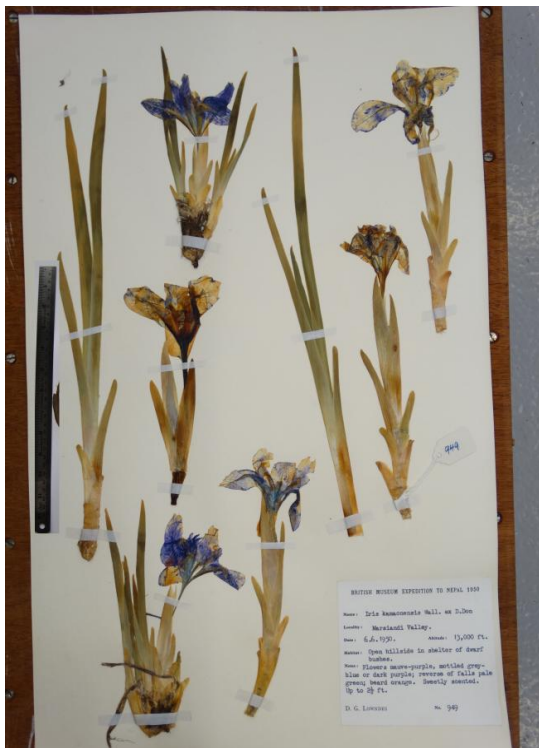
### Photographs of some Herbarium Specimen Examined



A. *Iris decora*



B. *Iris domestica*



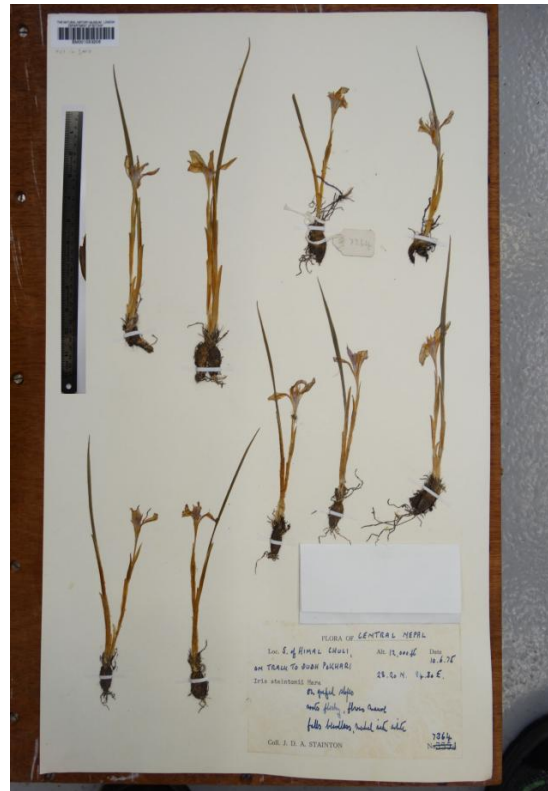
C. *Iris kemaonensis*



D. *Iris goniocarpa*



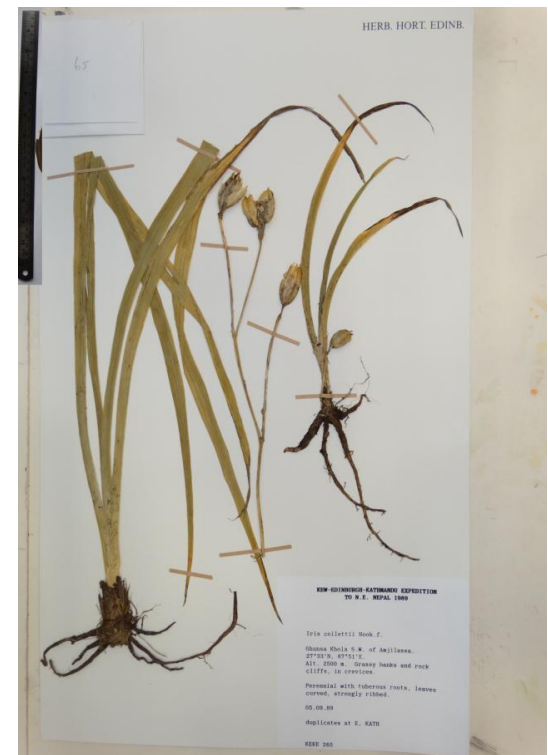
E. *Iris germanica*



F. *Iris staintonii*

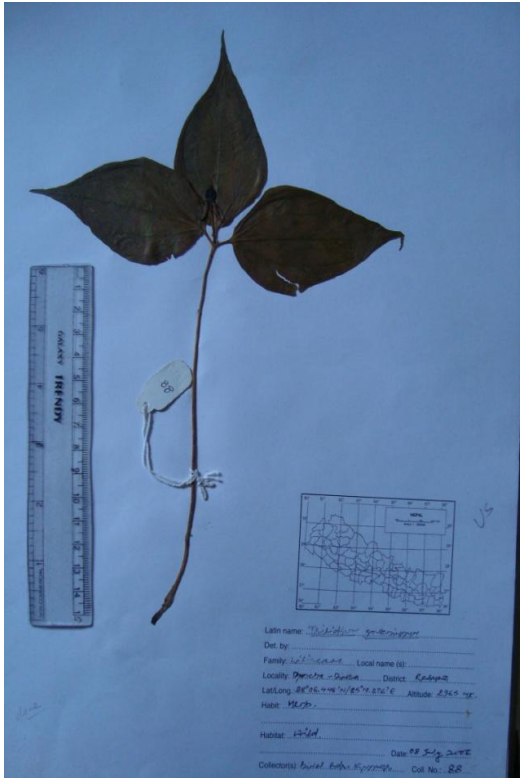


G. *Crocus sativus*



H. *Iris collettii*





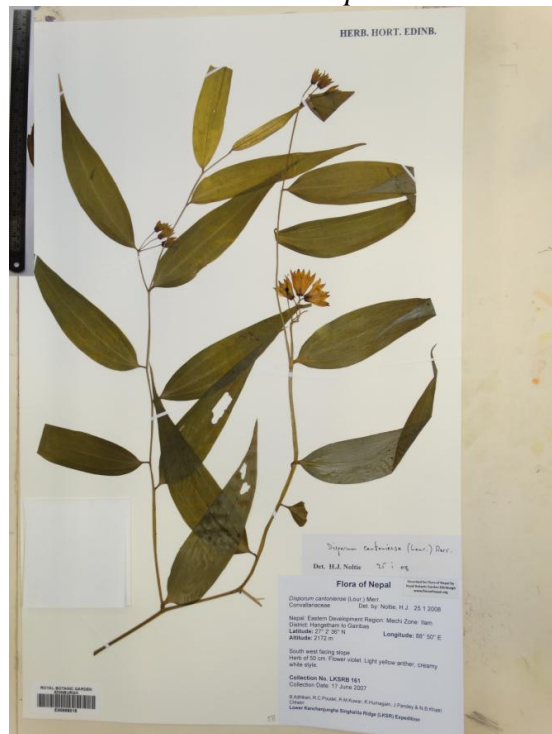
*M. Trillium govanianum*



*N. Gloriosa superba*



*O. Iphigenia indica*



*P. Disporum cantoniense*

## APPENDIX 7

### Character Matrix

S	SCIENTIFIC NAME	F/ DATE	PAR COLL.NO.	CO Lc	locality	DISTRIC	Latitude	LAT(Decimal de	Longitude	LONG(De	ALT(m)	COLLECTORS
1	Paris polyphyll Sm. Var.polyphylla(KATH)	M 9.4.1967	East 7702		Tal Khar	Pachtha	27-04'22.62"	27.073	87-47'34.54"	87.793	2348	Dr.S.B.Malla
2	Paris polyphylla Sm.var wallichii(KATH)	M 18.6.1975	Wes 75/2819		Hinko tc	Kaski	28-26'57.36"N	28.449	83-51'37.97"E	83.861	2700	Joshi and Bhattacharya
3	Paris polyphylla var.polyphylla(KATH)	M 16.10.1967	Wes 59	Se	Lebron	Kaski	28-21'25.17"N	28.357	84-05'26.76"E	84.091	2100	K.R.Amatya,T.K.Rajbhandari and T.Shrestha
4	Paris polyphylla var.polyphylla(KATH)	M 16.10.1967	Wes 59	Se	Lebron	Kaski	28-21'25.17"N	28.357	84-05'26.76"E	84.091	2100	K.R.Amatya,T.K.Rajbhandari and T.Shrestha
5	Paris polyphylla var.polyphylla(KATH)	M 24.5.1997	Wes 173-92		Banthar	Kaski	28-23'49.03"N	28.397	83-51'30.86"E	83.859	2600	N.P.Manandhar and S.K. Acharya
6	Paris polyphylla var.polyphylla(KATH)	M 24.5.1997	Wes 173-92		Banthar	Kaski	28-23'49.03"N	28.397	83-51'30.86"E	83.859	2600	N.P.Manandhar and S.K. Acharya
7	Paris polyphylla var.polyphylla(KATH)	M 24.5.1997	Wes 173-92		Banthar	Kaski	28-23'49.03"N	28.397	83-51'30.86"E	83.859	2600	N.P.Manandhar and S.K. Acharya
8	Paris polyphylla var.polyphylla(KATH)	M 12.4.1997	Cent 44		Shivalay	Ramech	27-20'34.30"N	27.343	86-04'05.48"E	86.068	1800-15	I.Sharma,M.N.Subedi and M.P.Pudasaini
9	Paris polyphylla var.polyphylla(KATH)	M 12.4.1997	Cent 44		Shivalay	Ramech	27-20'34.30"N	27.343	86-04'05.48"E	86.068	1800-15	I.Sharma,M.N.Subedi and M.P.Pudasaini
#	Paris polyphylla var.polyphylla(KATH)	M 12.4.1997	Cent 44		Shivalay	Ramech	27-20'34.30"N	27.343	86-04'05.48"E	86.068	1800-15	I.Sharma,M.N.Subedi and M.P.Pudasaini
#	Paris polyphylla var.polyphylla(KATH)	M 12.4.1997	Cent 44		Shivalay	Ramech	27-20'34.30"N	27.343	86-04'05.48"E	86.068	1800-15	I.Sharma,M.N.Subedi and M.P.Pudasaini
#	Paris polyphylla var.polyphylla(KATH)	M 13.4.1997	East 9728		Lunglucl	Sankhu	27-31'19.08"	27.522	87-24'49.35"E	87.414	2600	P.R.Shakya
#	Paris polyphylla var.polyphylla(KATH)	M 13.4.1997	East 9728		Lunglucl	Sankhu	27-31'19.08"	27.522	87-24'49.35"E	87.414	2600	P.R.Shakya
#	Paris polyphylla Sm.var wallichii(KATH)	M 4.5.1973	Wes 2052		Bauli Ga	Bajhang	29.67	29.670	81.10	81.100	2300	J.F.Dobremez
#	Paris polyphylla Sm.var wallichii(KATH)	M 15.9.1967	Cent 2745	Satur	Chariko	Dolakha	27-47'04.37"N	27.785	86-02'11.84"E	86.037	2439	Dr.Banerji, Shrestha and Upadhya
#	Paris polyphylla Sm.var wallichii(KATH)	M 15.9.1967	Cent 2745		Chariko	Dolakha	27-47'04.37"N	27.785	86-02'11.84"E	86.037	2439	Dr.Banerji, Shrestha and Upadhya
#	Paris polyphylla Sm.var wallichii(KATH)	M 15.9.1967	Cent 2745		Chariko	Dolakha	27-47'04.37"N	27.785	86-02'11.84"E	86.037	2439	Dr.Banerji, Shrestha and Upadhya
#	Paris polyphylla Sm.var wallichii(KATH)	M 18.6.1975	Wes 75/2819		Hinko tc	Kaski	28-26'57.36"N	28.449	83-51'37.97"E	86.037	2700	Joshi and Bhattacharya
#	Paris polyphylla Sm.var wallichii(KATH)	M 18.6.1975	Wes 75/2820		Hinko tc	Kaski	28-26'57.36"N	28.449	83-51'37.97"E	86.037	2700	D.P.Joshi, T.K. Bhattacharya
#	Paris polyphyll Sm. Var. wallichii Hara(KATH)	M 15.9.1967	Cent 2745		Chariko	Dolakha	27-47'04.37"N	27.785	86-02'11.84"E	86.037	2439	Dr.Banerji, Shrestha and Upadhya
#	Paris polyphyll Sm. Var. wallichii Hara(KATH)	M 15.9.1967	Cent 2745		Chariko	Dolakha	27-47'04.37"N	27.785	86-02'11.84"E	86.037	2439	Dr.Banerji, Shrestha and Upadhya
#	Paris polyphyll Sm. Var. wallichii Hara(KATH)	M 15.9.1967	Cent 2745		Chariko	Dolakha	27-47'04.37"N	27.785	86-02'11.84"E	86.037	2439	Dr.Banerji, Shrestha and Upadhya
#	Paris polyphyll Sm. Var. wallichii Hara(KATH)	M 15.9.1967	Cent 2745		Chariko	Dolakha	27-47'04.37"N	27.785	86-02'11.84"E	86.037	2439	Dr.Banerji, Shrestha and Upadhya
#	Paris polyphyll Sm. Var. wallichii Hara(KATH)	M 15.9.1967	Cent 2745		Chariko	Dolakha	27-47'04.37"N	27.785	86-02'11.84"E	86.037	2439	Dr.Banerji, Shrestha and Upadhya

Photographs of Type Specimens



A. *Spigelia indica*



B. *Disporum calcaratum*



C. *Disporum cantoniense*



D. *Iris staintonii*



