TAXONOMIC ACCOUNT OF THE GENUS CYPERUS L. (CYPERACEAE) OF NEPAL

A DISSERTATION SUBMITTED FOR THE PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE MASTER'S DEGREE IN BOTANY

Submitted by:

KAJOL BASUKALA

Plant Systematics and Biodiversity Conservation Unit

Exam Roll No.: Bot. 408/ 073

T.U. Regd. No.:5-2-20-15-2012

Batch No.: 2073/075

Submitted to:

Central Department of Botany

Tribhuvan University

Kirtipur, Kathmandu, Nepal

March 2022

DECLARATION

The dissertation entitled **"Taxonomic Account of the genus Cyperus L. (Cyperaceae) of Nepal"** which is being submitted to the Central Department of Botany, Institute of Science and Technology (IOST), Tribhuvan University, Nepal for the award degree of Master's in Botany (M.Sc.). It is a research work carried out by me under the supervision of Prof. Dr. Sangeeta Rajbhandary, Central Department of Botany, Tribhuvan University.

The research is original and has not been submitted earlier in part or full in this or any other form to any university or institution, here or elsewhere, for the award of any degree.

Date: 28th March 2022 ----------

Kajol Basukala

Central Department of Botany

Tribhuvan University

Kritipur, Kathmandu, Nepal.

RECOMMENDATION

It is hereby recommended that Mrs. Kajol Basukala, a M.Sc. Botany final year student at Tribhuvan University, Institute of Science and Technology, Kirtipur, Kathmandu, has carried out the dissertation work entitled **"Taxonomic Account of the genus Cyperus L. (Cyperaceae) of Nepal"** under my supervision. The entire work is based on the field work performed by the candidate and the work brings out useful findings. The dissertation is primarily based on the data collected by the student herself and the results of this work have not been submitted for any other academic degree.

This dissertation has been recommended for acceptance as a partial fulfillment of the requirement of Master's Degree in Botany at the Institute of Science and Technology, Tribhuvan University.

Supervisor

Prof. Dr. Sangeeta Rajbhandary

Central Department of Botany

TU, Kirtipur, Kathmandu

Date: 28th March 2022

LETTER OF APPROVAL

The M.Sc. dissertation entitled **"Taxonomic Account of the genus Cyperus L. (Cyperaceae) of Nepal"** submitted to the Central Department Botany, Tribhuvan University by **Mrs. Kajol Basukala** has been accepted for the partial fulfillment of the requirement of her Master's degree in Botany (Plant Systematics and Biodiversity Conservation unit).

EXAMINATION COMMITTEE

Supervisor

Prof. Dr. Sangeeta Rajbhandary

Central Department of Botany

TU, Kirtipur, Kathmandu

Head of Department

Prof. Dr. Ram Kailash Prasad Yadav

Central Department of Botany

TU, Kirtipur, Kathmandu

External Examiner

Prof. Dr. Mohan Siwakoti

Former Head of Central Department of Botany

TU, Kirtipur, Kathmandu

Internal Examiner

Asst. Prof. Deepak Pant

Central Department of Botany

TU, Kirtipur, Kathmandu

Date: 13th April 2022

ACKNOWLEDGEMENTS

Firstly, I would like to express my sincere gratitude and deep respect to my respected supervisor Prof. Dr. Sangeeta Rajbhandary, Central Department of Botany, Tribhuvan University for providing me an opportunity to carry out this research work under her supervision with constant encouragement, regular guidance, guidelines and support, throughout the research work from selection of topic to its completion.

I am grateful to Prof. Dr. Ram Kailash Prasad Yadav Head of Department, Central Department of Botany, Tribhuvan University for the administrative support. Also, thankful to all other faculties, administrative staffs and colleagues of CDB, TU for their direct and indirect help.

I owe a lot of thanks to Department of Plant Resources, Thapathali for providing research grant and financial support under the Global Taxonomic Initiative (GTI) which was really necessary and valuable for the field visit.

I am thankful to my respected teacher Prof. Dr. Suresh Kumar Ghimire, CDB, T.U. for his suggestions and granting permission to examine herbarium specimens of TUCH to conduct this research.

I sincerely thank the Department of National Park and Wildlife Conservation (DNPWC), Babarmahal Kathmandu, for providing me necessary permission letter for field visit to Chitwan National Park. I am indebted to Tribhuvan University Central Herbarium (TUCH) and National Herbarium and Plant Laboratories (KATH), Lalitpur for granting me permission to study the herbarium materials for identification of taxa.

My thanks also goes to my senior especially Mrs. Anjana Kharbuja, Mr. Prabin Bhandari, Mr. Prithivi Raj Gurung,

My deepest gratitude, respect and love goes to my parents and my husband Suman Potamahan for their ungrudging support as well as they are huge asset of my success and achievements. I am also grateful to my friends Manisha Timalsina, Suman Poudel, Himal Yonjan Tamang, Lesar Unat Basukala, Rojeena Basi, Yogendra Bikram Poudel and Rashika Kafle for continuous support and also for providing specimens and photographs.

Kajol Basukala

ABBREVIATIONS AND ACRONYMS

Anno. Check. Fl. Pl. Nepal	Annotated Checklist of Flowering Plants of Nepal
APG	Angiosperm Phylogeny Group
BM	The National History Museum, London
C	Botanical Museum and Herbarium, Copenhagen
CAL	Central National Herbarium, Calcutta
CDB	Central Department of Botany
E	Royal Botanical Garden, Edinberg
Enum. Fl. Pl. Nep	Enumeration of The Flowering Plants of Nepal
GZU	Herbarium GZU/ Karl-Franzens-Universität Graz
Herb Linn.	Linnean Herbarium
ICBN	International Code of Botanical Nomenclature
K	Royal Botanical Garden, Kew
KATH	National Herbarium and Plant Laboratories, Godawari
LD	Lund University Botanical Museum
LINN	Linnean Society of London Herbarium
NJ tree	Neighbour Joining Tree
P	The National Museum of Natural History, Paris
Sp. Pl.	Species Plantarum
TI	University Museum, University of Tokyo
TUCH	Tribhuvan University Central Herbarium

ABSTRACT

Taxonomy enhances the understanding and adds vital information to understand the status of the taxa in the form of protologue which in turn will be used in flora writing. The genus *Cyperus* which belongs to tribe Cypereae, subfamily Cyperoideae and family Cyperaceae is the largest genus in the family after *Carex*. In this study a taxonomic treatment of the 36 species of *Cyperus* occurring in Nepal is presented. The treatment is based on herbarium study and field work. Description of all the taxa are given, as well as discussions of morphology and taxonomy of genus. This study includes a dichotomous key for the identification of the species, as well as illustrations, descriptions, taxonomic comments and geographical distribution. The Distance-based Neighbor-Joining (NJ) analyses were conducted using PAUP* 4.0a169 (Swofford, 2002) for the construction of Dendrogram. The mean characters difference was used for distance measurement, branch length represents the distance between nodes and internode and close relationship between species. Based on herbarium record, species of *Cyperus* are distributed from East to Central to West of Nepal. Vertical distribution of genus ranges from subtropical to tropical zone (80-2700m). Phenological period start from April and ends to January and shows peak at the month from June to October. Present study focuses on the morphological characters (inflorescence, rachilla internode length, spike and spikelets arrangement, shape, size, glumes colour, shape, size, tip, venation, keel, margin, stamen, pistil, and nutlets shape, size, texture) which are of much taxonomically significant for the identification and delimitation of taxa within the genus.

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CHAPTER 1: INTRODUCTION

1.1 Background

Taxonomy of the taxa enhances the understanding and adds vital information to understand the status of the taxa in the form of protologue which in turn will be used in flora writing. A taxonomic revision is the novel analysis of the variation patterns in a particular taxon which is limited and largely confined to a comparison of the morphological and geographic data for a plant group. Revisions are presentations of new materials interpretations that have been integrated with previous knowledge through summary revaluation. It consists of re-descriptions or diagnoses of little known taxa, a list of synonyms, new combinations, new names etc. along with keys. Therefore, revision is commonly based on morphological and geographical evidence along with data available from literature reviews, field data, anatomical, cytological, paleo botanical, phytochemical, ecological, palynological, seed, stomata, etc. (Siwakoti and Rajbhandary, 2015). This work will be helpful in updating the information about plant, the enumeration and finding locality of species, preparing travel history maps and depositing new species in the herbarium.

Cyperaceae

Cyperaceae is a distinctive tribe with many unique features that distinguish sedges from grasses such as, three ranked leaves with closed sheaths, angular culm with solid pith, conspicuously bracteate inflorescence, sedge spikelet, consisting of a central axis bearing many sessile, distichous or spiral bracts, each subtending a single, reduced unisexual or bisexual flower, with perianth absent or reduced to bristles or scales, usually 3 stamens, and a 2 to 3-carpellate ovary, the fruit a 2- or 3-sided achene etc. from the grasses.

Cyperus L. The genus *Cyperus* L. (1753: 44) is mainly distributed in tropical and subtropical regions of the world and has about 700 species (Tucker and Simpson 2013)., In Nepal, there are 36 species (Rajbhandari and Rai., 2017) and 38 species (Shrestha *et al.,* 2018). They are annual or perennial and mostly aquatic plants, which grow in still or slow-moving water up to 0.5 m (Govaerts *et al.,* 2007). The genus can be recognised by its nature of inflorescence with conspicuous involucral bracts, absence of perianth and distichous spikelets with several fertile glumes.

Cyperus is taxonomically complex and the status of its infra-generic taxa is widely disputed among taxonomists. The difficulties of classifying the sedges are attributed to their substantially reduced floral and vegetative parts (Guarise and Vegetti, 2008; Gonzalez and Lo´pez, 2010). Kunth (1837) classified the species of Cyperus with a trifid style into 19 groups of unspecified rank, now usually treated at sectional level.

Cyperus sp are herbs, annual or perennial, with rhizomes or stolons. **Culms** caespitose or solitary, erect, usually 3-angled or acutely triquetrous, sometimes compressed triquetrous, stout or slender, leafy at basal part or at base. **Leaves** basal, 3-ranked, rarely without a blade; ligule absent. **Involucral bracts** leaflike, usually 2–10(–20 or more), at base of inflorescence. **Inflorescences** terminal, a simple or compound anthela, with several to many rays and usually with raylets (secondary rays); rays and raylets unequal or rarely equal in length or inflorescence capitate. **Spikelets** few to many in spikes, digitate clusters, or a capitulum at apex of rays, rarely single; rachilla not articulate at base, persistent, usually with narrow wings. **Glumes** distichous, rarely spirally imbricate; basal 1 or 2 glumes without a flower; remaining glumes each with a bisexual flower. **Perianth** bristles or scales absent. Stamens (1–)3. **Style** base not swollen; stigmas (2 or) 3, deciduous at maturity. **Nutlet** 3-sided, smooth, puncticulate, tuberculate, or rarely reticulately striate.

1.2 RESEARCH QUESTIONS

i. What is the status and distribution pattern of the species belonging to genus *Cyperus* in Nepal?
ii. What are the differences between the morphological and gross morphological characters among the species belonging to the genus *Cyperus* in Nepal?

1.3 JUSTIFICATION OF THE STUDY

Systematic study helps in preparing the national list of taxa under study, thus contributing for the flora of the country. The preliminary step in taxonomic studies is collection and deposition of specimens in herbaria which has been carried out by national and international researchers in Nepal since very long. So for proper understanding of ecological status and impacts of *Cyperus* on agricultural crops can only help through study about their distribution and proper identification of the species which are really problematic and species with conservation importance. In Nepal based

on records of the previous work and available literatures detail taxonomic work on genera *Cyperus* L. has not been carried out till date.

There is no detail comprehensive and compiled information on genus at a place. The present study attempts to make a detail taxonomic study on the genus *Cyperus* found in Nepal based on gross morphological details so as to assess their relationship as well as status and distribution pattern along the different range of elevation. The taxonomic study of these will also help to update several valid nomenclature changes made by taxonomists around the world and can be helpful in Flora writing, identification and enumeration of the species of the country. These genuses will also help to increase number of specimens in TUCH and KATH.

1.4 RESEARCH OBJECTIVES

The overall general objective of the present study is the taxonomic treatment of the genus *Cyperus* in Nepal and specific objectives are: -

i. To study gross morphological characters and comparative study of the genera *Cyperus* to produce a complete taxonomic account of all the species of Nepal.
ii. To analyze the taxonomic composition and distribution of the genus *Cyperus* in Nepal.
iii. To carryout cluster analysis of different taxa.

1.5 LIMITATIONS OF THE STUDY

Major limitations of this research works are:

i. Phylogenetic relationship is explaining through only morphological similarities which is quite impractical to say exactly the information is correct with certainty.
ii. Small plant size, small clustered spikelets and very small microscopic flower size challenges for proper and correct study of floral characteristics.
iii. Lack of sophisticated laboratory instruments to study proper microscopic as well as macroscopic character of seeds, pollen, ovary gives incomplete information about specimens for proper identification and comparison.
iv. Lack of proper idea and training for researcher to collect taxonomic information for such taxonomically challenging plant taxon raise problems for taxonomic expertise.
v. Non- availability of herbarium specimens and lack of information on TYPE specimens.

CHAPTER 2: LITERATURE REVIEW

2.1. Tribe Cypereaea

The family Cyperaceae has 5695 species in 98 genera, 2 subfamilies Mapanioideae (11 genera, 165 species) and Cyperoideae (95 genera, 5238 species) (Govaerts *et al.,* 2007; Muasya *et al.,* 2009), Cyperus belonging to the tribe Cypereae of the sub-family Cyperoides has 950species (APG IV 2016). Originally, this tribe only included the large genus *Cyperus* and its obvious relatives characterised by spikelets with a distichous glume arrangement and flowers lacking perianth (Clarke, 1908; Kükenthal, 1935–1936). In Cypereae, several groups are recognizable based on morphological characters like presence of deciduous spikelets (e.g., *Courtoisina*, *Kyllinga*, *Mariscus*) or dimerisation of the pistils (e.g. *Juncellus*, *Kyllinga*, *Pycreus*, *Queenslandiella*). These groups have often been treated as separate genera.

A major breakthrough in the circumscription of Cypereae arose from the studies of Van der Veken (1965) and Goetghebeur (1989), who showed that many other genera share a specific *Cyperus*-type embryo. This specific embryo type allows a natural delimitation of Cypereae, including also taxa with spirally arranged glumes or with highly specialized inflorescences.

2.2 History of infrageneric classification of Genera Cyperus L.

Cyperus Linnaeus, first published in the first edition of *Species Plantarum* 1:44, 1753. Name was derived from Greek: cyperus = edge, reference to the sharp leaf edge and sedges has edges. The first infrageneric classification of the genus is that of Nees (1834). He was the first to apply a sectional division in the genus *Cyperus*, and created eight sections. Often, his sections have incorrectly been assigned to Kunth (1837) as stated by Väre and Kukkonen (2006).

Kunth (1837) classified trifid style species of *Cyperus* into 19 groups of uncertain ranking groups, which are now generally considered at the section level and discussed the species of *Cyperus* with a bifid style separately.

Steudel (1854) divided *Cyperus* into three unnamed sections. The first section included species with a bifid style (*Pycreus*), “Section II”, split into 17 groups of unspecified rank, comprised the species with a trifid style (*Cyperus) and* third section held the

species with uncertain affinities. Both Kunth (1837) and Steudel (1854) recognised *Mariscus* and *Kyllinga Kyllingia* as segregate genera. Like Steudel (1854), Boeckeler (1868) treated *Kyllinga Kyllingia* as a separate genus, and included *Pycreus* with Eucyperus sections at the section level of the genus *Cyperus* but did not accept *Mariscus* at generic rank.

Clarke (1883, 1884, 1893, 1897, 1900, 1902, 1908), the founder of modern cyperology, originally considered *Cyperus* in a wide sense, but in his later publications he proposed the subdivision of *Cyperus* s.l. into seven distinct genera, i.e., *Cyperus*, *Courtoisina*, *Juncellus*, *Kyllinga*, *Mariscus*, *Pycreus* and *Torulinium*.

The last complete revision of *Cyperus* was published in the generic monograph of Kükenthal (1935–36). He delineated the sections by nature of branching of the compound inflorescence, extent of development of the rhizomes, and the number of stamens and carpels per flower and divided *Cyperus* s.l. into six subgenera (*C.* subg. *Eucyperus*, *Juncellus*, *Pycreus*, *Mariscus*, *Kyllinga*, and *Torulinium*) 61 sections and eight subsections. Kukenthal's sections need revision before a natural classification of the genus can be proposed.

Van der Veken (1965) studied the embryos of 132 species of *Cyperus* belonging to different subdivisions of the genus which revealed the presence of embryos of the *Cyperus* type in many taxa previously placed next to *Scirpus* (e.g., *Ascolepis*, *Ficinia*, *Isolepis*, *Lipocarpha*, *Kyllingiella*, and *Oxycaryum*). The inclusion of these genera in Cypereae has led to a more natural definition of this tribe. So far, all these genera have been considered separately from *Cyperus*, except for the treatment of *Lipocarpha* under *Cyperu*s by Koyama (1961). Kern (1974) only accepted *C.* subg. *Cyperus*, *Pycreus* and *Kyllinga* at subgeneric rank, as he considered *Juncellus*, *Mariscus*, and *Torulinium* too ill defined to be recognised as subgenera when dealing with the genus *Cyperus*.

Goetghebeur (1989) discussed the problems of names lectotypification related to the infrageneric classification of *Cyperus*. He specifically excluded *Cyperus* s.str from all taxa with laterally compressed nutlets, i.e. *Kyllinga*, *Pycreus* and *Queenslandiella*, and several highly specialised taxa, i.e., *Alinula*, *Courtoisina*, *Kyllingiella*, *Oxycaryum*, *Remirea* and *Sphaerocyperus*. However, he included segregated group such as *Anosporum*, *Galilea*, *Juncellus*, *Mariscus*, *Sorostachys* and *Torulinium*. Goetghebeur (1989) maintained this perspective in his treatment of the family Cyperaceae.

2.3 Systematics and phylogeny

Based on recent molecular phylogenetic studies Cyperaceae consist of 2 main clades i.e Ficinia clade and Cyperus clade, corresponding to two main subfamilies Cyperoideae and Mapanioideae (Simpson *et al.,* 2003, 2007, Muasya *et al.,* 2009). Studies on Cyperoideae have targeted phylogenetic relationships in Scirpeae (Muasya *et al.,* 2000b, Dhooge *et al.,* 2003) and Abildgaardieae (Ghamkhar *et al.,* 2007), and focused on genera Eleocharis (Roalson and Friar, 2000; Yano *et al.,* 2004), Isolepis (Muasya *et al.,* 2001a), *Cyperus* sensu lato (Muasya *et al.,* 2002) and Schoenoplectus (Yano and Hoshino, 2005).

Tribe Cypereae are resolved into a strongly supported Cyperus clade that is defined by the Cyperus-type embryo and absence of perianth segments. *Cyperus*, sensu stricto, is not monophyletic as other cyperoid genera are embedded within it. The cyperoid taxa resolve into two clades, which are diagnosed by the eucyperoid (C3) and chlorocyperoid (C4) anatomy. Key generic morphological characters are optimised on the phylogeny.

Older *Cyperus* was primarily paraphyletic (e.g. Muasya *et al.,* 2002; Larridon *et al.,* 2011a, b; Hinchcliff and Roalson 2013), but expanded over the years. Larridon *et al.,* (2013; see also Bauters *et al.,* 2014) suggested that the C_4 group was a monophyletic clade and was part of paraphyletic C_3 group, but the relationships along the spine of the C_4 clade were mostly supported (as in Reid *et al.,* 2017: good support for [*C. andinus* + *C. seslerioides*] as sister to the C_4 clade). The relationships of the remaining tribes were clarified by Muasya and Larridon (2021). Although *Ficinia* and *Isolepis* were sisters, they had little reconciliation of their mutual boundaries and benealth them were five small genera whose relationships differed entirely according to nuclear data.

Recent molecular phylogenetic studies have assumed that Cyperus s.l. (the Cyperus clade) includes paraphyletic Cyperus s. s as the core genus in which 13 segregate genera are rooted (Alinula J. Raynal, Androtrichum Brongn., Ascolepis Nees, Courtoisina, Kyllinga, Kyllingiella R.W. Haines and Lye, Lipocarpha R. Br., Oxycaryum Nees, Pycreus, Queenslandiella, Remirea, Sphaerocyperus Lye and Volkiella Merxm. and Czech) (Muasya *et al.,* 2002, 2009b; Simpson *et al.,* 2007; Huygh *et al.,* 2010; Reynders *et al.,* 2011; Larridon *et al.,* 2013). Currently, there are 13 isolated genera which have been officially known as Cyperus s.l. and received a new name (Larridon *et al.,* 2013,

2014; Bauters *et al.,* 2014; WCSP, 2019). It should be noted that most species of *Kyllinga* and *Pycreus* species have a synonym under Cyperus (Huygh *et al.,* 2010; Larridon *et al.,* 2011).

The present study also followed this classification and included in the taxonomic treatment the *Cyperus* s. s. species as treated by Goetghebeur (1989).

2.4 Delimitation of Genus Cyperus L.

Restriction of *Cyperus* L. within the *Cyperus* strain has not been agreed upon. Kükenthal (1936) and Haines and Lye (1983) accepted *Cyperus* sensu lato and treated some taxa, as infrageneric rank of *Kyllinga* Rottb. and Pycreus P. Beauv. On the other hand, Goetghebeur (1989) left *Kyllinga*, *Pycreus* and other taxa at generic level and proposed Cyperus sensu stricto which includes two subgenera: Cyperus (including the species with C4 photosynthetic pathway) and Anosporum (Nees) C.B. Clarke (including the species with C3 photosynthetic pathway). Recently, phylogenetic studies by Larridon *et al.,* (2011a, 2011b, 2011c, 2013) led to the proposal of a more complete taxonomy showing *Cyperus* is paraphyletic and the "Cyperus Clade" contains at least 13 genera. In the subclade of Cyperus C3, included the genera Courtoisina Soják, Oxycaryum Nees and Kyllingiella R.W. Haines and Lye; in the subclade of Cyperus C4, included nine genera, viz., Alinula J. Raynal, Ascolepis Nees ex Steud., Lipocarpha R. Br., *Kyllinga* Rottb., *Pycreus* P. Beauv., Queenslandiella Domin, Remirea Aubl., Sphaerocyperus Lye, and Volkiella Merxm. and Czech.

2.5. Taxonomy of Himalayan Cyperus L.

Historically, Linneaus (1753) first keyed and listed 81 species of sedges belonging to 5 genera. Then a global level comprehensive and critical floristic information on sedges are provided by Torrey (1836), Beetle (1946), Kuekenthal (1949), Kern (1974), Thomas (1998), Reznicek (1990), Govaerts *et al.,* (2007) etc. Cypereace is a taxonomically challenging and economically less important family, so less frequent records attempted by plant taxonomist in past. However, with the introduction of molecular technique and sophisticated modern laboratory equipments for micro-morphology study changes the classification to advance level in last two decades.

Altoghether, 104 genera and 5500 species of Cyperaceae have been recorded in the world (Simpson 2010). Catalogue of life have recorded 3941 species of *Cyperus*. They are the type genus of Cyperaceae, grasslike rhizomatous herbs cosmopolitan in distribution except the very cold regions. The first taxonomic treatment of sedge in India was given by C. B. Clarke (1894). In the "Flora of British India" (Hooker *et al.,* 1973), 449 species under 28 genera have been described. In "Flora of Bhutan" (Noltie., 1994) 25 species of *Cyperus* have been described with their proper taxonomic treatments and illustrations. In "Flora of Pakistan" (Qaiser and Ali., 2001) total of 50 species of *Cyperus* has been described; while in "Flora of China" 62 species of *Cyperus* were recorded with 8 endemics and 4 introduced species (Dai *et al.,* 2010).

In Nepal, there is lack of complete records about distribution and ecological records of *Cyperus* species from all over the country. Some of the remained species have only knowing from herbarium records. The recent publication about flora in Nepal "A Handbook of the Flowering Plants of Nepal" (Rajbhandari and Rai., 2017) 36 species of *Cyperus* have been described with their herbarium records of distribution within country, with their synonyms. However, in "Handbook of The Flowering Plants of Nepal" (Shrestha *et al.,* 2018) documented 38 species of *Cyperus* with their habitats, distribution range within Nepal and within world, their economic importance and their local names.

Different local floras of Nepal showed different level of taxonomic treatments during remote past in our country. In the "Flora of Phulchoki and Godawari" (Suwal, 1969) *Cyperus, kyllingia* and *Cyperus rotundus* have been described. In "Flora of British India" (Hooker *et al.,* 1973) 61 species of *Cyperus* have been described from Nepal. In "Flora of Langtang" (Malla *et al.,* 1976) *Cyperus niveus* has been described, while in "Flora of Kathmandu valley" (Malla *et al.,* 1986) 8 species of *Cyperus* have been described. The book about "Rare, Endemic and Endangered Plants of Nepal"(Shrestha and Joshi., 1996) described only *Cyperus trisulcus* and *Cyperus wallichiana* with giving endemic record for Nepal at that time.

According to Annotated checklist of flowering plants of Nepal there are 28 species of *Cyperus* (Press *et al.,* 2000) distributed from tropical to temperate zones in Nepal. They are as follows:

1. **Cyperus alulatus** Kern, ; Reinwardtia 1: 463 (1952).
2. **Cyperus castaneus** Willd., ; Sp. Pl. 1: 278 (1797).
3. **Cyperus compressus** L., ; Sp. Pl.: 46 (1753).
4. **Cyperus corymbosus** Rottb., ; Descr. Pl.: 19 (1772).
5. **Cyperus cuspidatus** Kunth, ; Nov. Gen. Sp. Pl. 1: 204 (1816).
6. **Cyperus difformis** L., ; Cent. Pl. 2: 6 (1756).
7. **Cyperus diffusus** Vahl, ; Enum. Pl. 2: 312 (1806).
8. **Cyperus digitatus** Roxb., ; Fl. Ind. 1: 209 (1820).
9. **Cyperus distans** L. f., ; Suppl. Pl.: 103 (1781)
10. **Cyperus eleusinoides** Kunth, ; Enum. Pl. 2: 39 (1837).
11. **Cyperus esculentus** L., ; Sp. Pl.: 67 (1753).
12. **Cyperus halpan** L., ; Sp. Pl.: 45 (1753).
13. **Cyperus imbricatus** Retz., ; Obs. Bot. 5: 12 (1789).
14. **Cyperus iria** L., ; Sp. Pl.: 45 (1753).
15. **Cyperus longus** L., ; Sp. Pl.: 45 (1753).
16. **Cyperus malaccensis** Lam., ; Tab. Encycl. 1: 146 (1791).
17. **Cyperus michelianus** (L.) Link, ; Hort. Bot. Berol. 1: 303 (1827).
18. **Cyperus niveus** Retz., ; Obs. Bot. 5: 12 (1788).
19. **Cyperus nutans** Vahl, ; Enum. Pl. 2: 363 (1806).
20. **Cyperus pangorei** Rottb., ; Descr. Pl.: 18 (1772).
21. **Cyperus pilosus** Vahl, ; Enum. Pl. 2: 354 (1806).
22. **Cyperus rotundus** L., ; Sp. Pl.: 45 (1753).
23. **Cyperus scariosus** R. Br., Prodr. 216. 1810.
24. **Cyperus tenuiculmis** Boeck., ; Linnaea 36: 286 (1870).
25. **Cyperus tenuispica** Steud., ; Synops. Pl. Glum. 2: 11 (1854).
26. **Cyperus trisulcus** D. Don, ; Prodr. Fl. Nepal.: 39 (1825).
27. **Cyperus tuberosus** Rottb., ; Descr. and Icon. Pl.: 28, t. 7, f. 1 (1773).
28. **Cyperus wallichianus** Spreng., ; Syst. Cur. Post.: 28 (1828).

According to A handbook of the Flowering Plants of Nepal (Rajbhandari and Rai., 2017) 36 species of *Cyperus* were listed, 11 extra added species are listed as follows:

1. **Cyperus compactus** Retz., Obs.Bot.5:10(1788).
2. **Cyperus cyperinus** (Retz.) J.V. Suringar, *Cyperus*, 154 (1898).
3. **Cyperus cyperoides** (L.) Kuntze, Revis. Gen. Pl. 3:333 (1898)
4. **Cyperus dubins** Rottb., Descr. Icon. Rar. Pl.: 20 (1773).
5. **Cyperus exaltatus** Retz., Obs. Bot. 5: 11 (1788).
6. **Cyperus fuscus** L., Sp. Pl. 1: 46 (1753).
7. **Cyperus microiria** Steud., Syn. Pl. Glumac. 2: 23 (1854).
8. **Cyperus paniceus** (Rottb.) Boeck. In Linnaea 36: 381 (1870).
9. **Cyperus platystylis** R. Br., Prodr. Fl.Nov. Holl.: 214 (1810).
10. **Cyperus procerus** Rottb., Descr. Icon. Rar. Pl.: 29(1773).
11. **Cyperus squarrosus** L., Cent. Pl. 2: 6 (1756).

Handbook of Flowering Plants of Nepal (Shrestha *et al.,* .2018) has listed 38 species three more species *Cyperus castaneus, Cyperus laxus* and *Cyperus involucratus.*

The present study is a detailed taxonomic treatment of 36 species of the genus Cyperus, which was listed in A Handbook of the Flowering Plants of Nepal (Rajbhandari and Rai 2017).

2.6. Economic Importance

The genus *Cyperus* has considerable economic importance as it provides food, fodder, fuel, medicines, weaving, perfumery materials etc., whereas some are serious agricultural weeds. *Cyperus corymbosus* is used for knitting ghunyu. *Cyperus digitatus* and *Cyperus platystylis* are used as rope to tie the food inside the banana leaves during Maghe Sankranti. The tuber of *Cyperus rotundus* is a medicinal herb traditionally used to treat various clinical conditions at home such loss of appetite, leprosy, fever, epilepsy, opthalmia, stomachic, diuretic, astringent, menstrual cycle disorder, beneficial in diarrhoea and eaten as food. *Cyperus malaccensis*, *Cyperus compressus* and *Cyperus iria* are used for making mats by the forest fringe people of Sunderban mangrove swamp and sale in local markets.

Tubers of *Cyperus esculentus* are used as stimulant and aphrodisiac. *Cyperus compactus, Cyperus platystylis* and *Cyperus distans* are used as ornamental and decorative purpose. Some Cyperus species are used as food and fodder for animals and most importantly they are good indicator of environmental damage especially for aquatic habitats since, they are sensitive to lowering of water tables and water pollution and observable declines in many species. Many flora workers have been attempting to document sedges for wildlife management in long runs.

CHAPTER 3: MATERIALS AND METHODS

3.1 Taxonomic Study

3.1.1 Protologue and literature review

Protologues are the first validly published, original description of the taxon. It refers to all the original materials associated with a newly published name, including its description or diagnosis and others elements like illustrations, synonymy, distributional data, citations of specimens, etc. Protologue and Type specimens of Genus *Cyperus* L. were consulted for Nomenclatural accuracy and species identification.

Literature review is basis for every research and is also an essential part of taxonomic revision as it delimits the taxon being studied. It provides a taxonomic history for taxon under study and thus clarifies the major taxonomic problems within a group. Different floras of the countries and both printed and online literatures were reviewed.

3.1.2 Literature based character matrix

After reviewing the protologue texts and different literatures, character matrix was prepared as it helps in distinguishing characters of the taxon as well as to separate the herbarium specimens into different piles according to the characters. These groups are then arranged according to the level of categories which may be on the basis of nomenclature, also under the species or similar species under the genus and similar genus under family, etc. It substantially increased the confidence and accuracy of the study and gave idea of modern systematic study.

3.1.3 Collection and preparation of herbarium specimens

Plant specimens at the stage of flowering and fruiting were collected with proper photographs and herbarium were prepared following the standard method of Bridson and Forman (1989); Siwakoti and Rajbhandary (2015). Along with the photographs, field notes of all the species were recorded in the field and also tagging and numbering were done. The important points to be noted while preparing the field notes like collection number, date of collection, locality, altitude, latitude, longitude, phenology, remarks, etc were noted. The essential equipment and requirements such as field note book, pencil, camera, altimeter, GPS, collection bags, plant press, newspaper, digger,

secateurs, tags and hand lens were used in the field. Herbarium sheets, labels, needle, thread, glue and envelops for spikelets were used for the preparation of herbarium specimens.For the collection of specimens, different places of the country such as Boson, Sagarmatha National Park, Gorkha, Barpark, Taulihawa, Banaganga River, Jagadispur Taal, Kapilvastu, Chitwan (Sauraha, Kasaura, Bishhazari taal, Tikauli taal), Parsa, Bhaktapur (Changunarayan Temple, Khwopasi, Salinadi, Namobuddha, Nala, Bajrayogini, Panauti, Banepa, Dudhikhel, Sanga) were visited at different time intervals.

3.1.4 Identification of specimens

Identification of the species were done by consulting standard literatures like Flora of Kathmandu Valley (Malla *et al.,* 1986), Flora of China (Dai *et al.,* 2010). Flora of British India (Hooker *et al.,* 1973), Flora of Bhutan (Noltie., 1994) etc as well as by the help of the expert along with the identification keys. Identification was also done by the comparing with the specimens deposited at TUCH (Tribhuvan University, Central Herbarium) and KATH (National Herbarium and Plant Laboratories, Nepal) and compared with digital photographs of herbarium specimens of E, K, TI, BM and CAL. Terminology for the study was followed from the book by Harris and Harris (2000).

3.1.5 Morphological study

Herbarium specimens from personal collection, specimens deposited at KATH and TUCH and digital photographs of herbarium specimens of E, BM, CAL, TI and K were examined during the research work. A multitude of characters from vegetative (life forms, root, culm, leaf and inflorescence) and reproductive (spikelets) parts were observed minutely with the help of dissecting microscope, stereomicroscope and compound microscope. Morphology of the herbarium was studied by soaking the plant parts (root, culm, leaf blades) in water for overnight and some were kept in warm water for a few minutes for the purpose of softening and measurement. Only mature parts of the plants were focused for the measurement of the characters. The parts of the studied herbarium specimens were kept in small envelope and attached to the respective herbarium sheets (Siwakoti and Rajbhandary, 2015).

Root system

Roots help to delimit annual or perennial species. They were observed carefully and the nature of rhizome and stolon were also properly studied.

Culm

As culm is the major characters of the delineation of species; their nature, shape, height and texture were studied properly.

Leaf

Leaf sheath: Type and texture of leaf sheath were studied.

Leaf blade: It is one of the major distinguishing characters to differentiate species among the genus. Leaf blade's shape, size, apex, base, margin and texture were studied properly.

Inflorescense

Inflorescense is also important characters for proper identification of the species. Types, shape, size of the inflorescense were observed.

Rachis

Rachis is one of the major taxonomic characters. Presence absence of wings, shape, surface and margins of rachis were also studied.

Spikelets

Along with the above characters, spikelets also play vital role in delineation of the species. Shape and size of spikelets, glumes, and florets were studied with the help of stereo-microscope in the magnification 25X and 50X along with photographs

Nutlets

Nutlets play a vital role in delineation of the species. Shape, size, colour and texture of nutlets were studied with the help of microscope using oculometer and stereo-microscope.

Measurement of the floral parts was done in following way:

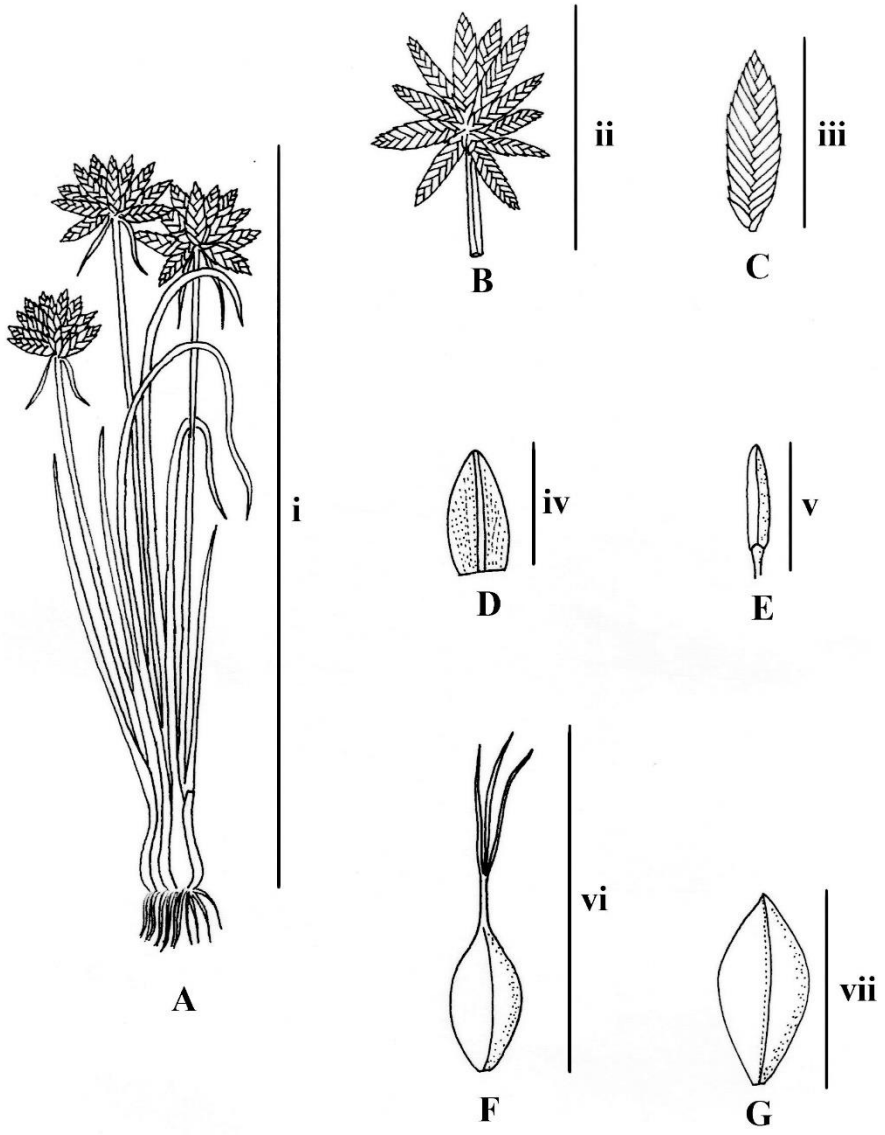

Figure 1. Skecth of *Cyperus niveus* showing the way of measuring dimensions of floral parts. A. Habit sketch i: Height of plant, B. Spike ii: length of Spike, C. Spikelet iii: length of spikelet, D. Glume iv: length of Glume, E. Anther v: Length of Anther, F. Fruiting pistil vi: length of pistil and G. Nutlet vii: length of Nutlets.

3.1.6 Construction of identification keys

Artificial keys were prepared for the easy identification of species based on observed characters. Keys were prepared in a 'Bracketed Format'.

3.1.7 Illustration, photography, and preparation of distribution map

Freehand illustrations were prepared based on herbarium specimens and voucher specimens studied. The illustration includes habit sketch, inflorescence, spikelets, glume, anther and nutlet. Photographs of plant plantsding vegetative and reproductive parts are representative species were captured. Distribution map of all the species of prinent study were wasared using ArcGIS Version 10.0. on the basis of the herbarium record and personal collection.

3.2. Cluster Analysis: Dendrogram

Cluster analysis was done based on gross morphological i.e., vegetative and reproductive characteristics both qualitative and quantitative characteristics in order totoaximum similarities among the species. To perform cluster analysis of 36 species, in total 36 characters were used. Dendrogram was constructed on the species level. Throughout the analysis, both two-state and multi-state coding was done as per the requirement and the characters were given the equal weightage. The results of cluster analysis were based on phenotypic similarity and obtained in the form of dendrogram. Hierarchical cluster analysis was done using the Distance-based Neighbor-Joining (NJ) analyses PAUP* 4.0a169 (Swofford, 2002) for the construction of Dendrogram. The mthe ean characters difference was used for distance measurement, branch length represents the distance between nodes and internode and close relationship between species.

On the basis of gross morphological characters including both qualitative and quantitative characters, cluster analysis were performed to find the similarity among the species. The characters were given the equal weightage. Dendrogram were made of all the species of *Cyperus* found in Nepal.

3.3 Phenology

Phenology is the calendar of periodic life cycle events and how these are influenced by seasonal and inter annual variations in climate, as well as habitat factors. Phenologies

of selected species were studied. Also, it is study of seasonal change in plants such as flowering, fruiting especially their timing and relationship with climate and weather. In present study, records for phenology were done on the basis of herbarium specimens and literatures.

CHAPTER 4: RESULTS

4.1 Taxonomic Study

4.1.1 Range of morphological characters in genera Cyperus L.

The morphology of the plants has been studied from the herbarium specimens deposited at KATH and TUCH, collections from different places of Nepal, digital photographs and different available literatures. The ranges of gross morphological characters of species of genus *Cyperus* L. found in Nepal are as follows:

4.1.1.1 Life forms

Cyperus show a range of diversity in life forms mostly annual or perennial herbs which are shown in appendix 1. The species are ubiquitous occupying a range of habitats like paddy fields, edges of streams, roadsides, lakes, forest areas essentially wetland areas during rainy seasons.

Out of 36 species of *Cyperus,* 2 species *C. digitatus* and *C. exaltatus* attain height of 1.5 meter; 7 species i.e., *C. compactus, C. corymbossus, C. eleusinoides, C. longus, C. malaccensis, C. nutans* and *C. pangorei* attain height of 1m and rest of species never exceeds 1m. All species are herbs with different lifeforms.

4.1.1.2 Root system

The annuals are always with fibrous roots and perennials with short or long creeping rhizomes detail shown in appendix 1. The rhizomes are usually small and woody, but sometimes a long creeping or emitting stolons which often bear tubers (*Cyperus esculentus* and *Cyperus rotundus).* The rhizomes and stolons are technically an underground system and often clothed with fibrous remains of old leaf sheaths.

Out of 36 species of *Cyperus*, 11 species *C. alulatus, C. compressus, C. cuspidatus, C. difformis, C. fuscus, C. haspan, C. iria, C. michelianus, C. microiria, C. squarrosus* and *C. tenuispica* are annual with fibrous root and remaining 25 species are perennial with rhizomatous root.

4.1.1.3 Culm

The stems are known as culms and are usually tufted but occasionally solitary. The culms solid, tufted, slightly thick or flaccid, compressed triquetrous, smooth with few leaves at basal part detail shown in appendix 1. Culm is terete in *C. compactus*, lower

terete to upper triquetrous in *C. corymbossus* and *C. pangorei* remaining 33 species has triquetrous stem.

4.1.1.4 Leaves

Leaves are usually 3 ranked when the culms are trigonous or triquetrous, usually in a basal cluster, but at times a few or almost all cauline detail leaves characters are shown in appendix 2. In Cyperaceae leaves are differentiated into leaf blade and leaf sheath. The ligule (a projection at the top of the sheaths) is generally absent.

A. **Leaf Sheath:** Leaf sheaths are usually closed. Leaf sheath colour varies from reddish brown to purpulish brown to brownish colour and sometimes with reddish tint. Its size varies from 0.7--40cm. Margin opening varies from straight to oblique or concave. Out of 36 species 10 species *C. alulatus, C. difformis, C. distans, C. eleusinoides, C. esculentus, C. iria, C. longus, C. microiria, C. nutans* and *C. pangorei* have margin straight open and remaining 26 species have obliquely open margin.

B. **Leaf Blade:** Leaf blades 1--9, are sessile, shorter to much longer than culms. In some species the leaves are reduced to basal sheaths only (*C. corymbossus* and *C. pangorei*). The shape of leaf blades is flat, plicate and stiff with margin smooth to scabrous. The size of leaf blades varies from 1.7--119.5X0.1--3cm with acute and scabrous apex. Out of 36 species 11 species *C. compressus, C. cuspidatus, C. fuscus, C. haspan, C. malaccensis, C. michelianus, C. niveus, C. pangorei, C. procerus, C. rotundus* and *C. squarrosus* has smooth margin while the remaining species have scabrous margin. Leaves surface with brown dots and stripe on maturation.

4.1.1.5 Inflorescence

The inflorescence in this family is constituted by the arrangement of spikelets wherein the inconspicuous minute flowers are arranged. Detail characteristics and variation of inforescence within the species are shown in appendix 3 to 9 and plate 1 to 3. Inflorescences terminal, a simple or compound anthela, with several to many rays and usually with raylets (secondary rays); rays and raylets unequal or rarely equal in length or inflorescence capitates and are usually subtended by foliaceous or glumaceous involucral bracts. Out of 36 species simple anthelodium is present in 12 species, compound anthelodium is present in 16 species and decompound anthelodium is

present in 6 species; like *C. diffusus, C. distans, C. iria, C. diffusus, C, pilosus, C. platystylis* and *C. tenuispica.*

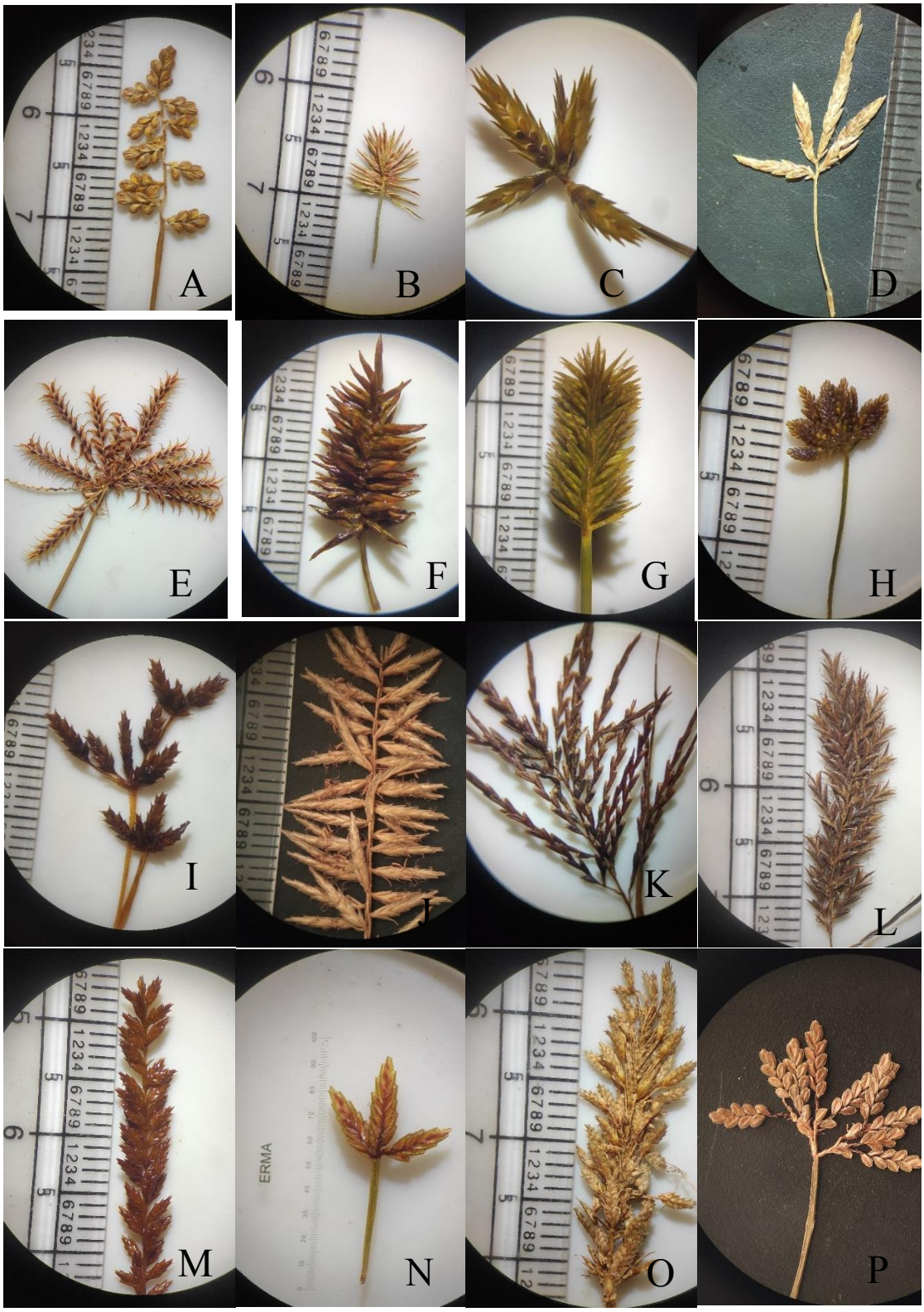

Plate 1: Variation in inflorescence of *Cyperus* between the species **A**. *C. alulatus;* **B.** *C. compactus;* **C.** *C. compressus;* **D.** *C. corymbosus;* **E.** *C. cupidatus;* **F.** *C. cyperinus;* **G.** *C. cyperoides;* **H.** *C. difformis;* **I.** *C. diffuses*; **J.** *C. digitatus;* **K.** *C. distans;* **L.** *C. eleusinoides;* **M.** *C. exaltatus;* **N.** *C. haspan;* **O.** *C. imbricatus* and **P.** *C. iria.*

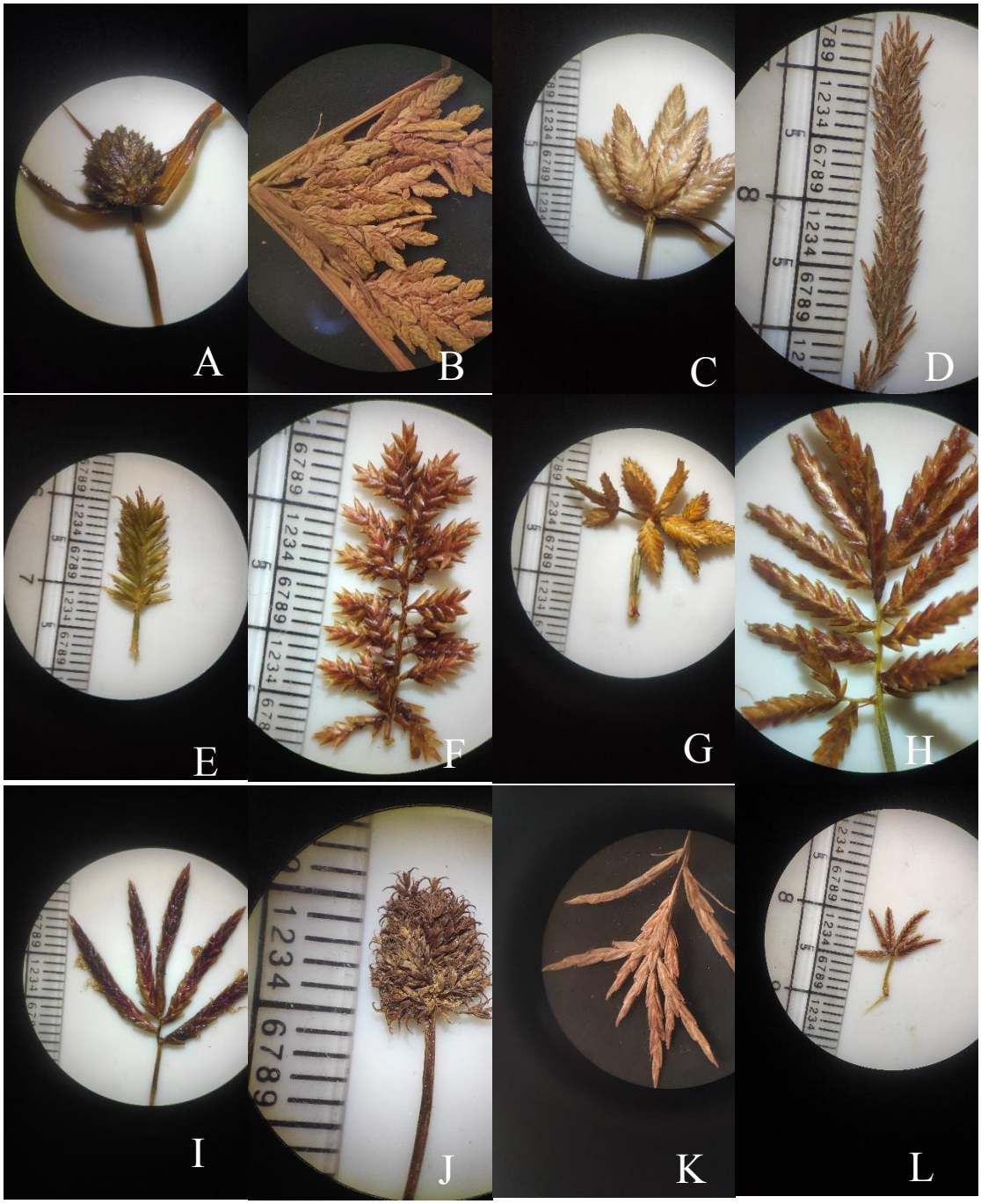

Plate 2: Variation in inflorescence of *Cyperus* between the species **A**. *C. michelianus;* **B.** *C. microiria***;** **C.** *C. niveus;* **D.** *C. nutans;* **E.** *C. paniceus;* **F.** *C. pilosus*; **G.** *C. platystylis;* **H.** *C. procerus;* **I.** *C. rotundus;* **J.** *C. squarrosus;* **K.** *C. tenuiculmis.* and **L.** *C. tenuispica.*

The floral parts of the sedge inflorescence are detailed below.

A. Prophylls: Prophylls are small scale like organs varying in form and size, attached to different parts in the inflorescence which are shown in appendix 4. 2 species *C. michelianus* and *C. niveus* has prophyll in reduced form. Cladoprophyll is absent in 9 species *C. compressus, C. cuspidatus, C. cyperinus, C. dubius, C. michelianus, C. niveus, C. paniceus* and *C. squarrosus.*

B. Spike: An inflorescence having stalked flowers arranged singly along an elongated unbranched axis, with the flowers at the bottom opening first shown in appendix 4. Spike in sedges vary in number, shape and size. 1 to more than 50 spike are arranged capitately in *C. cuspidatus, C. difformis, C. dubius, C. michelianus* and *C. niveus* to spirally to digitately in almost all species at the apex, shape vary from globose to broadly ovoid to oblong-obovoid to cylindric to narrowly cylindric.

C. Spikelets: Spikelets in sedges vary in their size, shape, colour and arrangement which are shown detail in appendix 5 and plate 4 to 6. Each spikelets is generally subtended by a prophyll and below that a bract or cladoprophyll. Each spikelets consists of one to more than 90 tiny flowers subtended by small scales called glume. The glumes and flowers are arranged radially *in C. compactus*, spirally in *C. cyperinus, C. cyperoides, C. eleusinoides, C. imbricatus, C. nutans, C. paniceus* and *C. squarrosus*, at the apex of capitulum *in C. difformis, C. diffuses, C. dubius, C. fuscus,* sub distichously in *C. alulatus, C. corymbosus, C. distans* and *C. exaltatus, distichously in C. esculentus, C. iria, C. malaccensis, C. microiria, C. pangorei, C. pilosus, C. procerus, C. rotundus* and *C. tenuiculmis* and digitately in *C. compressus, C. cuspidatus, C. digitatus, C. haspan, C. longus, C. platystylis* and *C. tenuispica*.

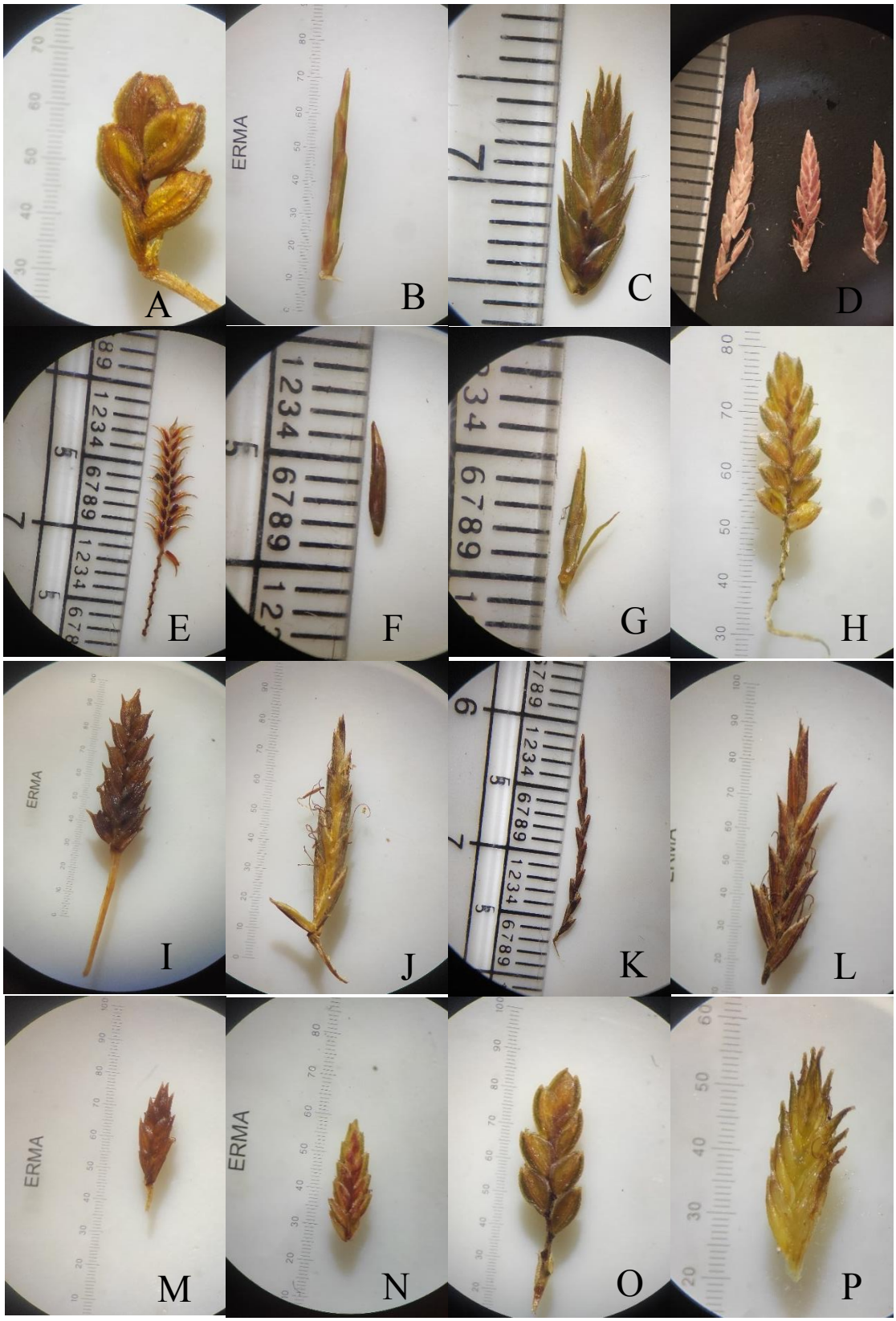

Plate 3: Variation in spikelets of genus *Cyperus* between the species **A**. *C. alulatus;* **B.** *C. compactus;* **C.** *C. compressus***;** **D.** *C. corymbosus;* **E.** *C. cupidatus;* **F.** *C. cyperinus;* **G.** *C. cyperoides;* **H.** *C. difformis;* **I.** *C. diffuses*; **J.** *C. digitatus;* **K.** *C. distans;* **L.** *C. eleusinoides;* **M.** *C. exaltatus;* **N.** *C. haspan;* **O.** *C. imbricatus* and **P.** *C. iria.*

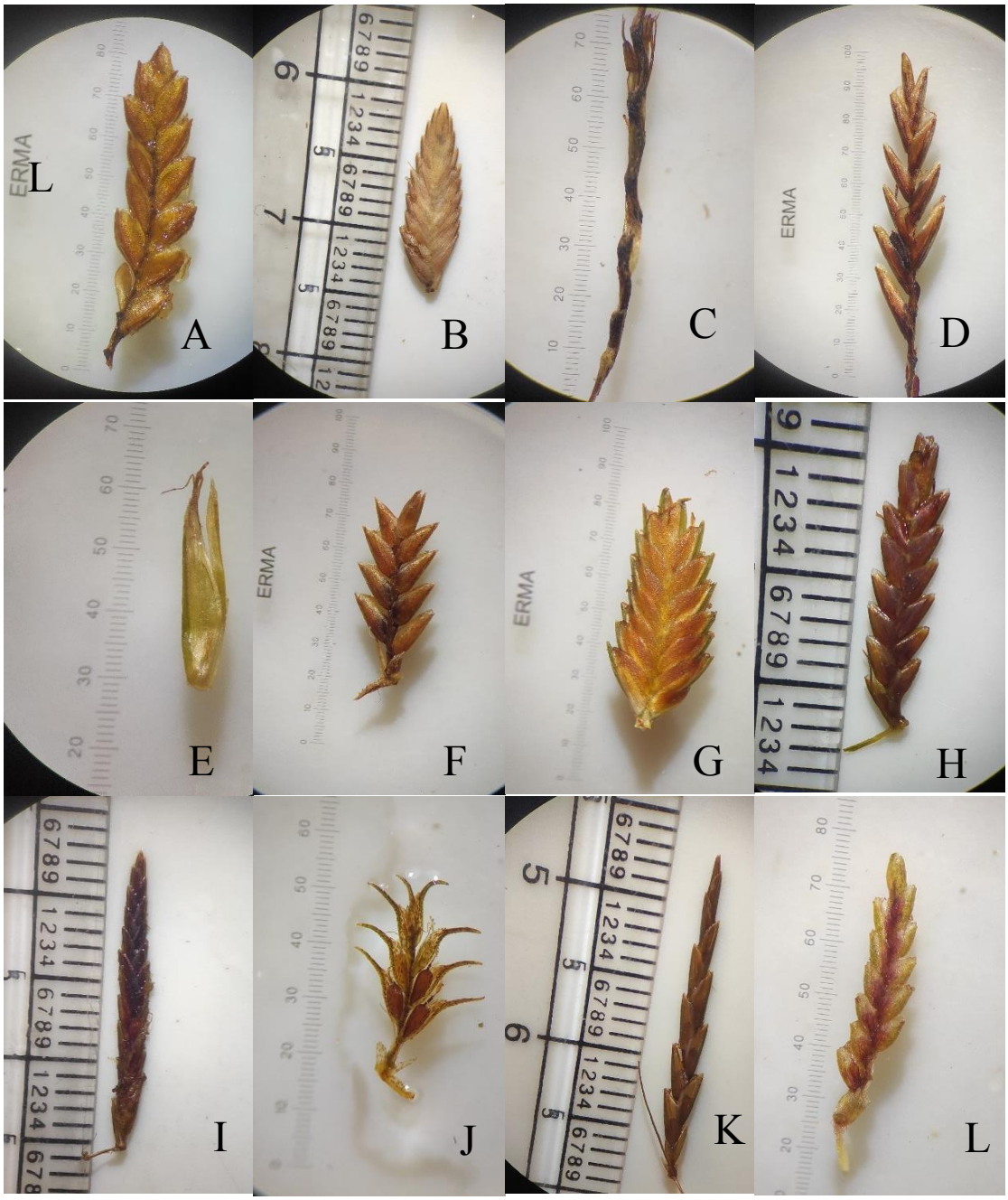

Plate 4: Variation in spikelets of genus *Cyperus* between the species **A**. *C. microiria;* **B.** *C. niveus;* **C.** *C. nutans;* **D.** *C. pangorei;* **E.** *C. paniceus;* **F.** *C. pilosus*; **G.** *C. platystylis;* **H.** *C. procerus;* **I.** *C. rotundus;* **J.** *C. squarrosus;* **K.** *C. tenuiculmis.* and **L.** *C. tenuispica.*

i. **Rachilla:** The main axis of a spikelet is called rachilla. It may be persistent or deciduous and winged or wingless and vary in shape, size and colour detail are shown in appendix 6 and plate 7 to 9. Out of 36 species 7 species *C. compressus, C. cuspidatus, C. esculentus, C. exaltatus, C. longus, C. nutans* and *C. pilosus* have solid zigzag rachilla while remaining 29 species have solid straight rachilla. 4 species *C. compactus, C. cyperinus, C. cyperoides* and *C. paniceus* have reduced rachilla, 7 species *C. difformis, C. dubius, C. exaltatus, C. imbricatus, C. michelianus, C. squarrosus* and *C. tenuispica* has internode length less than 0.5mm while remaining 25 species have internode upto 0.5mm and more than that. 10 species *C. alulatus, C. difformis, C. fuscus, C. haspan, C. iria, C. longus, C. microiria, C. platystylis, C. squarrosus* and *C. tenuispica* have wingless rachilla while remaining 26 species have winged rachilla.

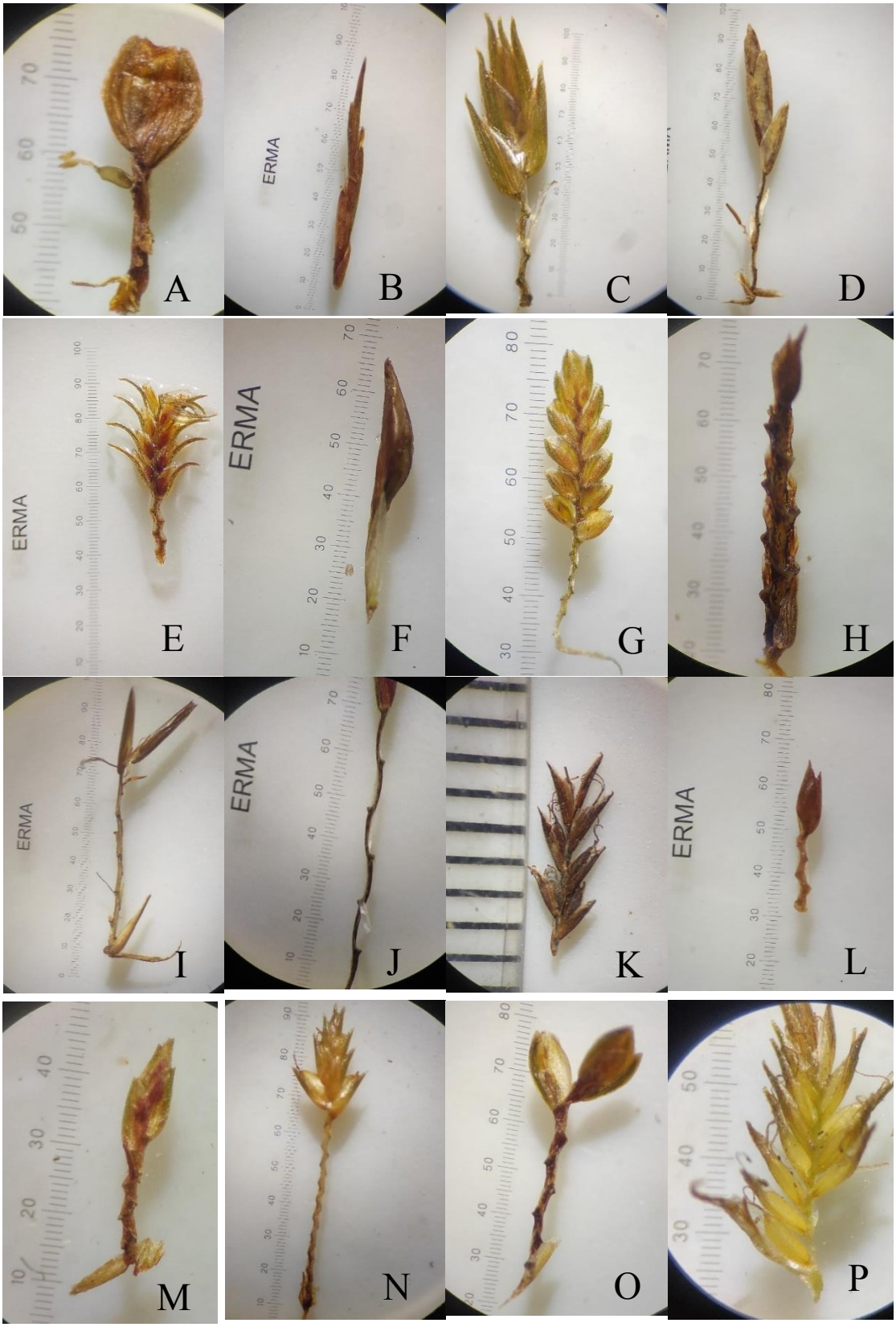

Plate 5: Variation in rachilla internode of *Cyperus* between the species **A**. *C. alulatus;* **B.** *C. compactus;* **C.** *C. compressus;* **D.** *C. corymbosus;* **E.** *C. cupidatus;* **F.** *C. cyperinus;* **G.** *C. difformis;* **H.** *C. diffuses*; **I.** *C. digitatus;* **J.** *C. distans;* **K.** *C. eleusinoides;* **L.** *C. exaltatus;* **M.** *C. haspan;* **N.** *C. imbricatus;* **O.** *C. iria* and **P.** *C. michelianus.*

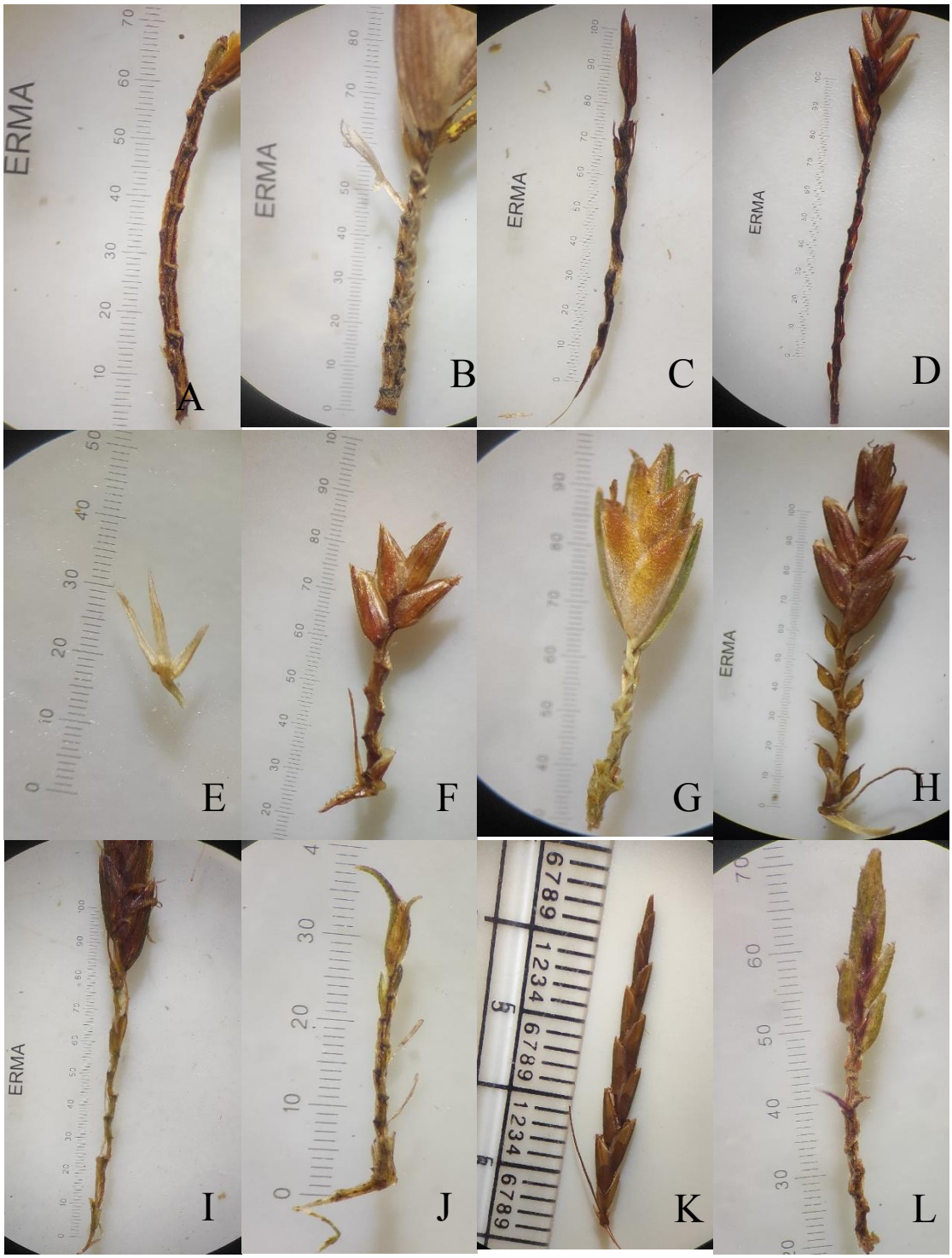

Plate 6: Variation in rachilla internode of *Cyperus* between the species **A**. *C. microiria;* **B.** *C. niveus;* **C.** *C. nutans;* **D.** *C. pangorei;* **E.** *C. paniceus;* **F.** *C. pilosus*; **G.** *C. platystylis;* **H.** *C. procerus;* **I.** *C. rotundus;* **J.** *C. squarrosus;* **K.** *C. tenuiculmis.* and **L.** *C. tenuispica.*

ii. **Glumes:** Glumes exhibit variation in their number, arrangement, size, shape, colour, nervation, apex etc detail are shown in appendix 7 and plate 10 to 11. It may be arranged spirally, distichously or subdistichously. The shape of the glumes can be lanceolate in *C. cyperoides, C. distans, C. michelianus* and *C. niveus*, ovate in *C. alulatus, C. C. compressus, C. diffuses, C. dubius, C. exaltatus, C. fuscus, C. imbricatus, C. pilosus, C. platystylis* and *C. rotundus*, obovate *in C. difformis, C. microiria and C. procerus, narrowly oblong in C. compactus, C. longus, C. pangorei* and *C. squarrosus,* fusiform terete in *C. corymbosus.* The apex can be acute *in C. compressus, C. digitatus, C. eleusinides* and *C. michelianus,* acuminate, obtuse *in C. compactus, C. cyperinus, C. cyperoides, C. difformis, C. dubius, C. exaltatus, C. fuscus, C. imbricatus, C. longus, C. nutans, C. pangorei, C. paniceus, C. pilosus, C. platystylis, C. rotundus, C. squarrosus* and *C. tenuiculmis,* rounded *in C. alulatus, C. corymbosus, C. diffuses, C. distans, C. haspan, C. iria, C. malaccensis, C. microiria, C. niveus* and *C. procerus,* truncate in *C. cuspidatus, C. esculentus* and *C. tenuispica*. The apex extension of glume is mucronate *in C. compressus, C. corymbosus, C. difformis, C. digitatus, C. eleusinoides, C. esculentus, C. exaltatus, C. haspan, C. imbricatus, C. microiria, C. nutans, C. pilosus, C. platystylis, C. rotundus* and *C. tenuiculmis,* modified into recurved arista *in C. cuspidatus, C. diffuses, C. michelianus, C. squarrosus* and *C. tenuispica* and remaining species has no such extension. The colour varies from stramineous to different shades of brown. All species has green keeled on back with 3--17 veined.

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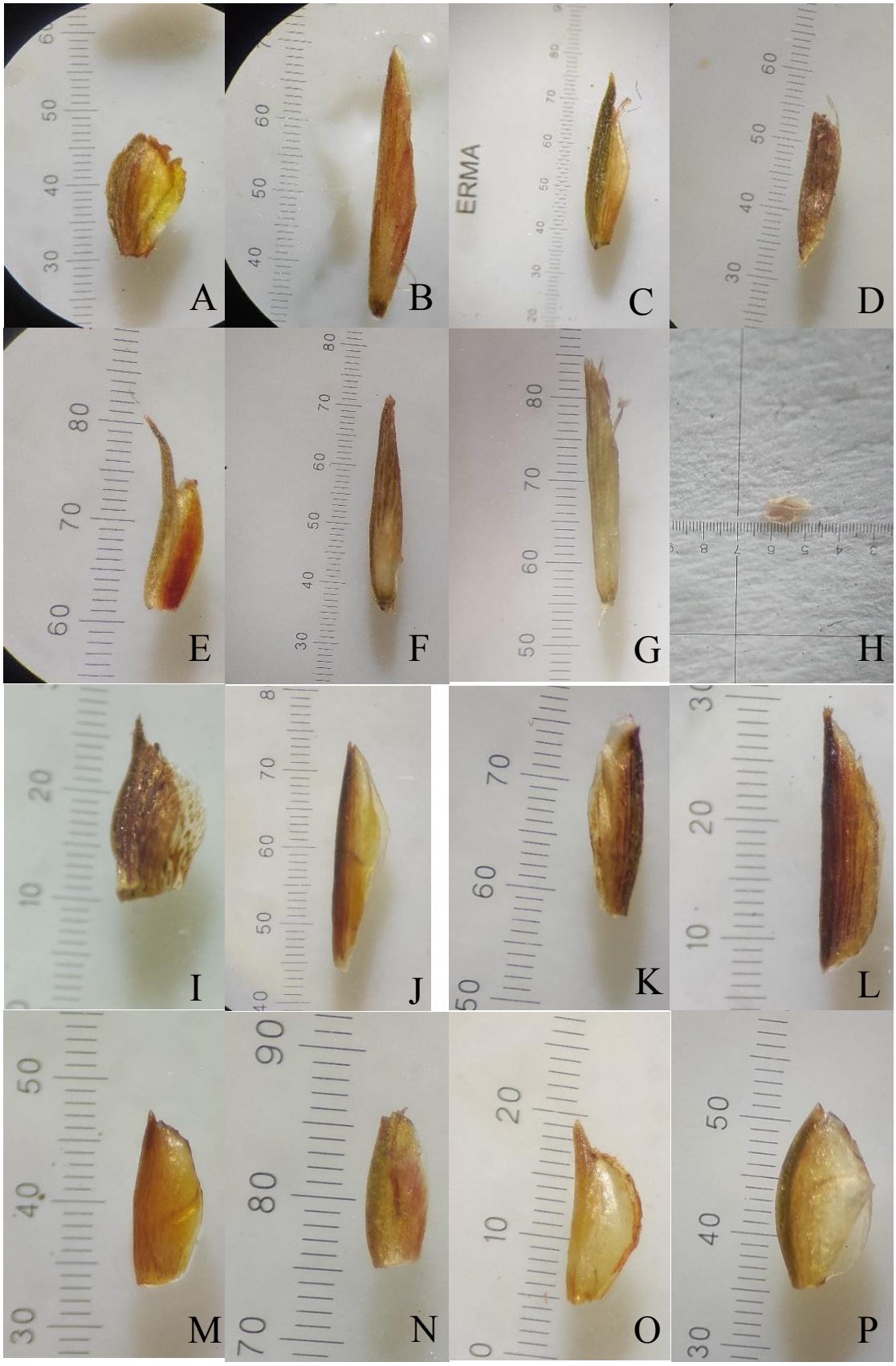


Plate 7: Variation in glume of *Cyperus* between the species **A**. *C. alulatus;* **B.** *C. compactus;* **C.** *C. compressus***;** **D.** *C. corymbosus;* **E.** *C. cupidatus;* **F.** *C. cyperinus;* **G.** *C. cyperoides,* **H.** *C. difformis,* **I.** *C. diffuses*, **J.** *C. digitatus,* **K.** *C. distans,* **L.** *C. eleusinoides;* **M.** *C. exaltatus,* **N.** *C. haspan;* **O.** *C. imbricatus* and **P.** *C. iria.*

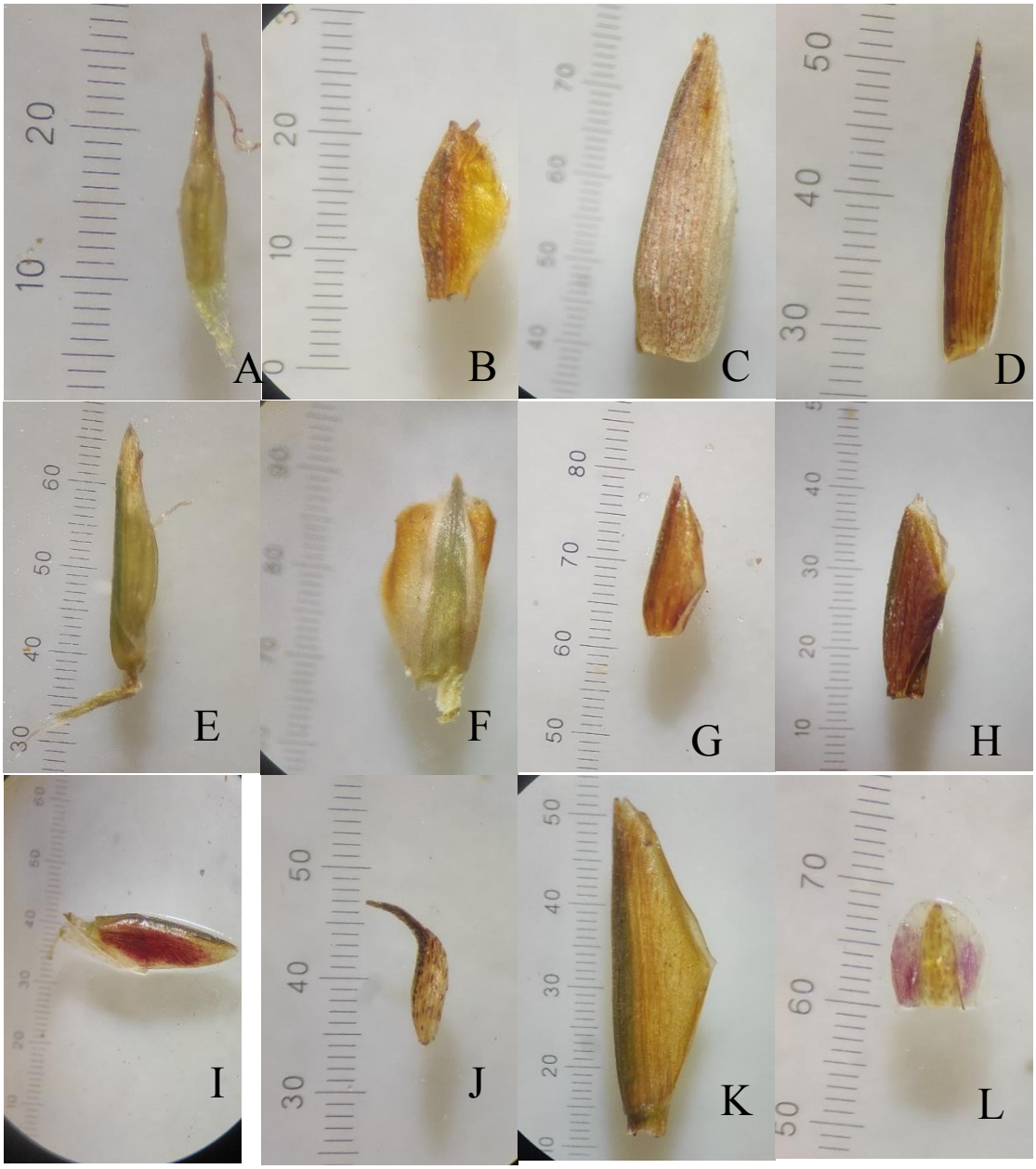


Plate 8: Variation in glume of *Cyperus* between the species **A**. *C. michelianus,* **B.** *C. microiria***, C.** *C. niveus,* **D.** *C. nutans,* **E.** *C. paniceus,* **F.** *C. platystylis*, **G.** *C. pilosus,* **H.** *C. procerus,* **I.** *C. rotundus,* **J.** *C. squarrosus,* **K.** *C. tenuiculmis.* and **L.** *C. tenuispica.*

iii. **Flowers:** The flowers are minute and inconspicuous detail characteristics are shown in appendix 8 and 9.

   a. **Anther:** The number of stamens varies from number 2 in species *C. difformis, C. dubius, C. michelianus* and *C. squarrosus* to 3 in remaining species detail are shown in appendix 8, the shape varies from ellipsoid in 3 species *C. haspan, C. michelianus* and *C. squarrosus* and remaining has linear anther, the size of anthers varies from 0.1--2.2X0.1--0.19mm, nature of connective appendages and connective are not prominent in 4 species *C. difformis, C. digitatus, C. microiria* and *C. tenuispica*. The style can be uniformly slender, thickened towards base and hence with a pyramidally thickened base in most tristigmatic species (Eleocharis sp.).

   b. **Gynoecium:** The gynoecium consists of a single compound pistil of usually 2 (*C. michelianus*), 2-3 (*C. haspan* and *C. squarrosus*) and 3 carpels (remaining species) detail are shown in appendix 8, a single style usually with 2 or 3 lobes or branches, and a superior ovary with single locule containing a basal ovule. *C. platystylis* has hispidulous style surface which distinguish it from other species.

iv. **Fruits:** The fruits in Cyperaceae are one seeded, indehiscent and usually known as Nut or achenes. The Nut is sessile or subsessile or rarely stipitate detail characteristics variation in shape, size, colour and texture are shown in appendix 9 and plate 12 to 13. It can be lenticular, planoconvex or trigonal in the shape. Variation in colour, shape, size, base and apex is the most studied key characteristics of nutlets for delimit of species within genus *Cyperus* L. The nutlet morphological characters like shape, size of Cyperaceae are of taxonomic significance, and can be used in its classification (Patil and Prasad, 2016). The most studied nutlets diagnostic characteristic for delimit of species are shape, colour, size, base and apex. The morphologically similar species *C. haspan* and *C. tenuispica*, *C. nutans and C. eleusinoides*, *C. cyperoides, C. cyperinus* and *C. pilosus* are delimited by the variation in nutlet size and texture.

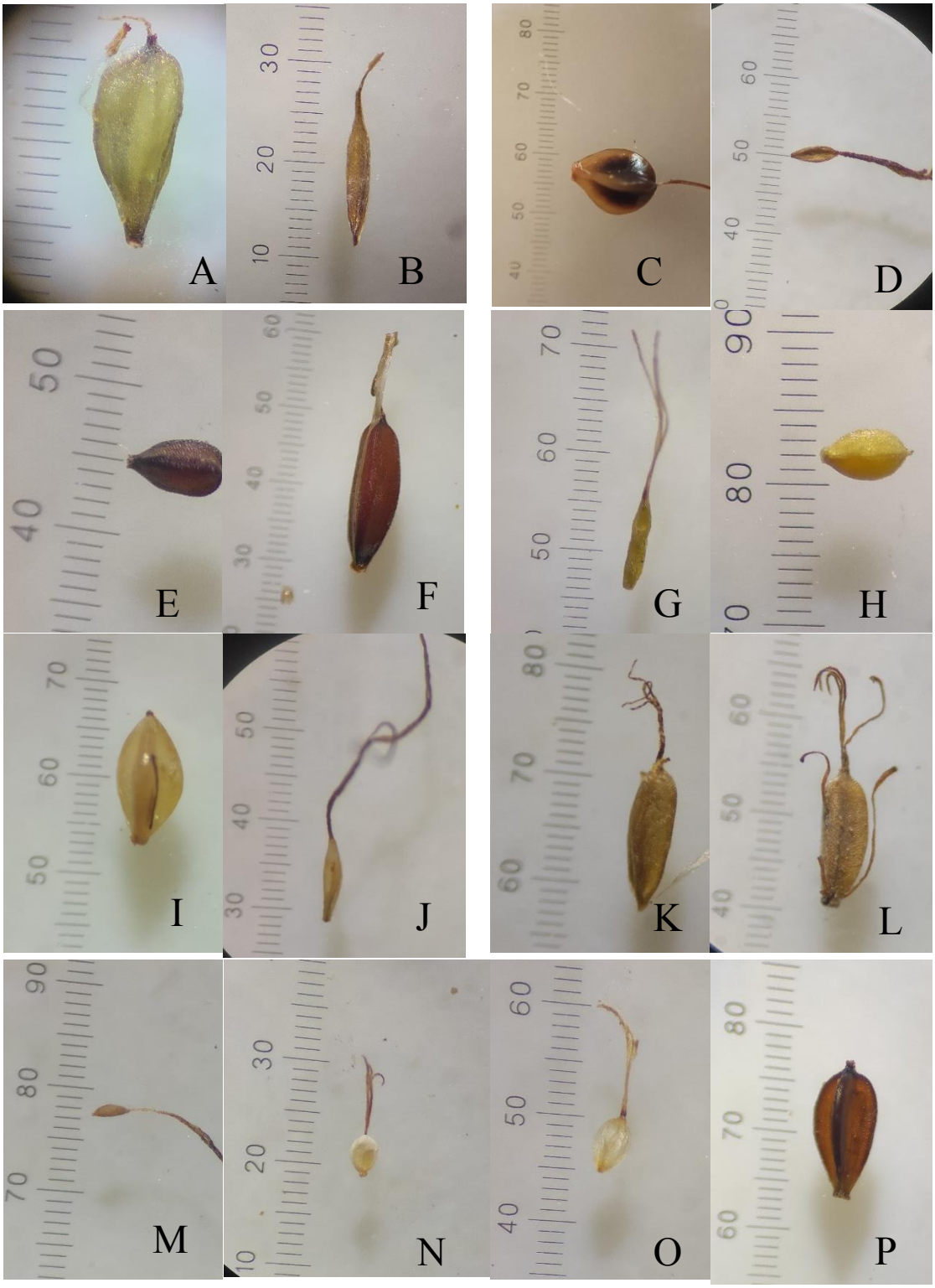


Plate 9: Variation in nutlets of *Cyperus* between the species **A**. *C. alulatus;* **B.** *C. compactus;* **C.** *C. compressus***;** **D.** *C. corymbosus;* **E.** *C. cupidatus;* **F.** *C. cyperinus;* **G.** *C. cyperoides;* **H.** *C. difformis;* **I.** *C. diffuses*; **J.** *C. digitatus;* **K.** *C. distans;* **L.** *C. eleusinoides;* **M.** *C. exaltatus;* **N.** *C. haspan;* **O.** *C. imbricatus* and **P.** *C. iria.*

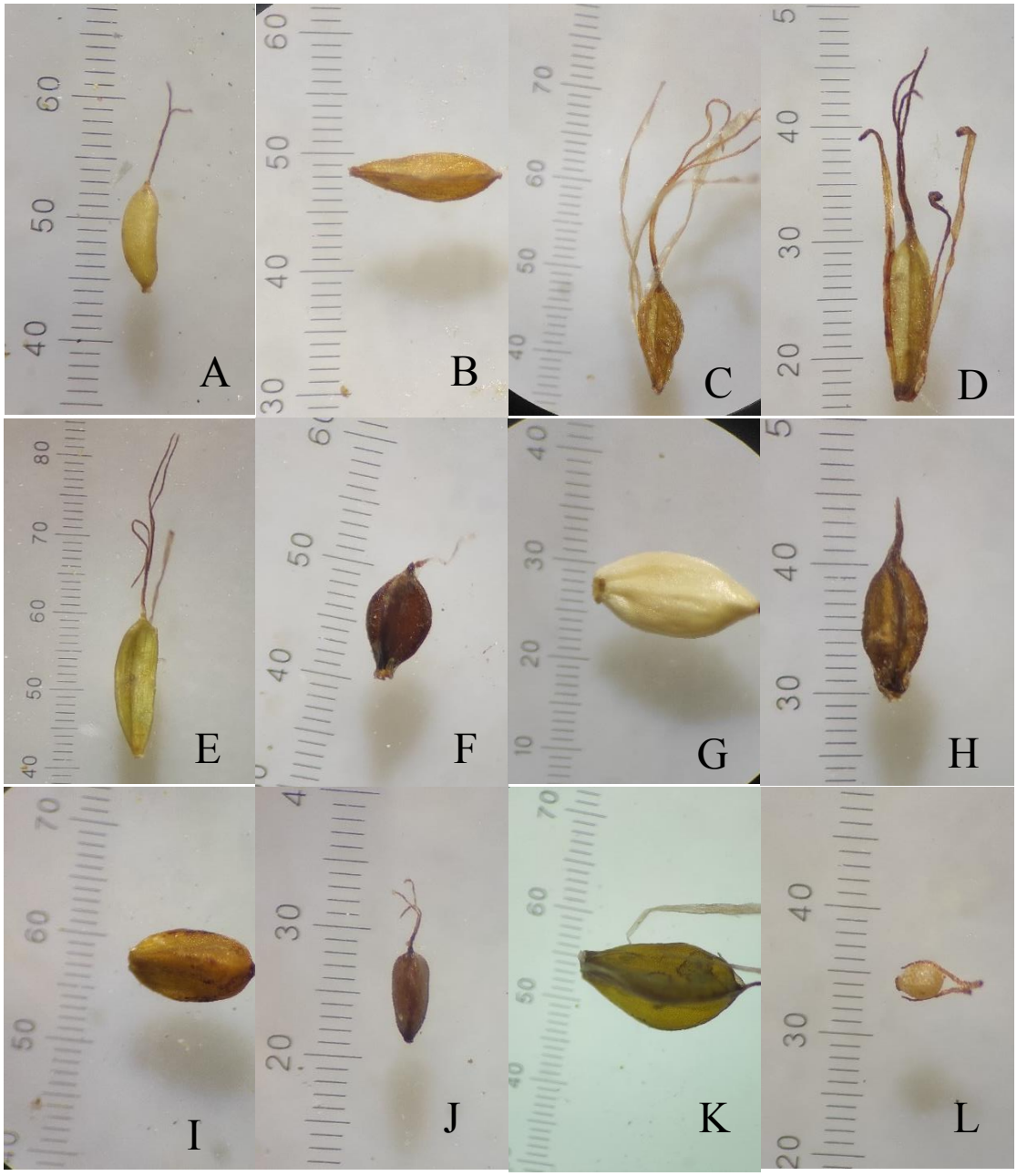


Plate 10: Variation in nutlets of *Cyperus* between the species **A**. *C. michelianus;* **B.** *C. microiria;* **C.** *C. niveus;* **D.** *C. nutans;* **E.** *C. paniceus;* **F.** *C. platystylis*; **G.** *C. pilosus;* **H.** *C. procerus;* **I.** *C. rotundus;* **J.** *C. squarrosus;* **K.** *C. tenuiculmis.* and **L.** *C. tenuispica.*

4.2 Taxonomic treatment

The detailed taxonomic treatment on the external morphology of the genus *Cyperus* and their 36 species are prepared with necessary illustrations, photographs and key. The primary source of information has been derived from field and the herbarium of the species of the genera *Cyperus* L. For the taxonomic treatment I have followed Goetghebeur (1989) his generic delimitation of genus *Cyperus* include *Mariscus* but not *Pycreus* and *Kyllinga*.

Cyperaceae

Stem mostly scapose, solid, trigonous, without hairs, but scabrous along edges, often cylindrical, smooth. Leaves in three ranks, mostly basal or subbasal, with sheaths, with or without ligules, blades usually glabrous but apex and margin barbed; blades reduced in several groups. Infloresence a spike, multiple spike or large compound, type umbellate, paniculate, spicate, corymb etc, crateriform anthelodium. Rachilla persistent or deciduous and winged or wingless, Glumes spirally or distichously arranged. Fruit nut-like.

Key to Genus

1a. Flowers unisexual; nut enclosed by utricle…….....….**Carex**

1b. Flowers bisexual; nut not enclosed by utricle …….....2

2a. Flowering glumes distichously arranged 3

2b. Flowering glumes spirally arranged……..……...6

3a. Spikelets 1-2 flowered…….…….....**Kyllinga**

3b. Spikelets more than 2-flowered.....4

4a. Stigma 2, nut flattened……..…..…….....**Pycreus**

4b. Stigma 3, nut triquetrous 5

5a. Rachilla of spikelet deciduous…….....**Marisus**

5b. Rachilla of spikelet persistent…….....**Cyperus**

6a. Stem leafless……..……..…...**Eleocharis**

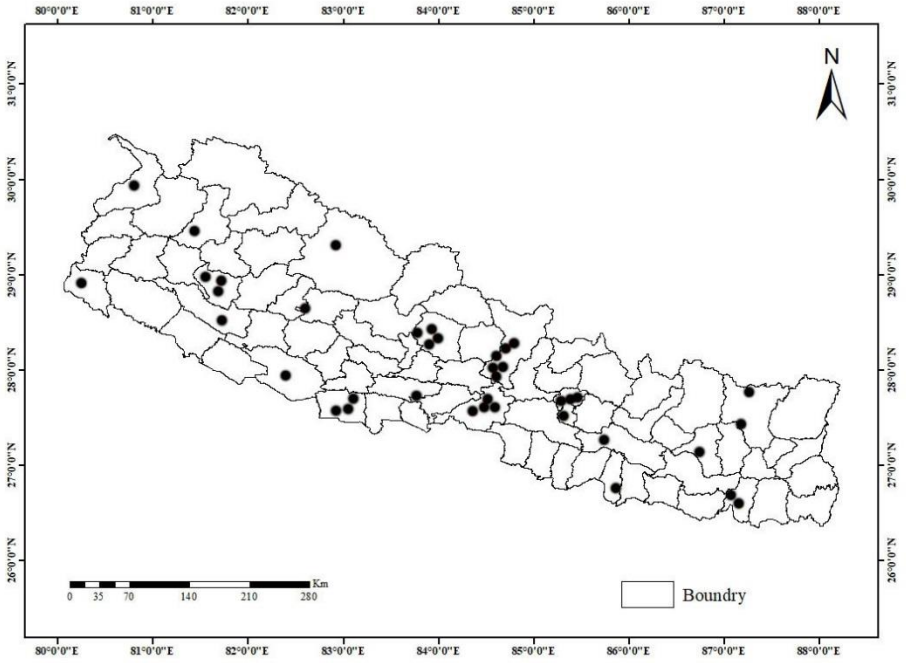
6b. Stem leafy at base……...……..…….....**Lipocarpha**

Genus Cyperus L.

Herbs, annual or perennial, with rhizomes or stolons. Culms caespitose or solitary, erect, usually 3-angled or acutely triquetrous, sometimes compressed triquetrous, stout or slender, leafy at basal part or at base. Leaves basal, 3-ranked, rarely without a blade; ligule absent. Involucral bracts leaflike, usually 2–10(–20 or more), at base of inflorescence. Inflorescences terminal, a simple or compound anthela, with several to many rays and usually with raylets (secondary rays); rays and raylets unequal or rarely equal in length or inflorescence capitate. Spikelets few to many in spikes, digitate clusters, or a capitulum at apex of rays, rarely single; rachilla not articulate at base, persistent, usually with narrow wings. Glumes distichous, rarely spirally imbricate; basal 1 or 2 glumes without a flower; remaining glumes each with a bisexual flower. Perianth bristles or scales absent. Stamens (1–)3. Style base not swollen; stigmas (2 or) 3, deciduous at maturity. Nutlet 3-sided, smooth, puncticulate, tuberculate, or rarely reticulately striate.

Type Species: Lectotype: *Cyperus esculentus* L. (designated by Britton 1907: 4, 6)

Distribution: The genus *Cyperus* are distributed throughout the sub-tropical to the tropical regions of the whole world. Among 36 species, the maximum species are found in Holartic and Paleotropic kingdom. Among them 5 species were common in Eastern Asiatic region. In Nepal, according to flora of Kathmandu valley *Cyperus pilosus,* in flora of China *Cyperus elusinoides* and in both Handbook of flowering plants of Nepal and A Handbook of flowering plants of Nepal *Cyperus niveus* respectively have highest elevatinal range 2900m of distribution. The lowest elevation range of distribution is 80m which is dominated by *Cyperus exaltatus*, *Cyperus platystylis* and *Cyperus procerus* respectively. They are mostly cosmopolitan in distribution and rarely endemic. *Cyperus trisulcus* and *Cyperus wallichianus* are endemic to Nepal while remaining species are cosmopolitan in distribution.



Map 1. Map showing the distribution of all species of *Cyperus* along the country.

Key to the Species

1a. Annual, Fibrous root……2

1b. Perennials, Rhizomatous root……...10

2a. Inflorescence capitate or globose with sessile spike……...3

2b. Inflorescence capitate or globose with elongated spike ……...5

3a. Trisulcus and globose inflorescence presence……**C. trisulcus**

3b. Trisulcus and globose inflorescence absence ……4

4a. Spikelets more than 20, 3-6 flowers, rachilla internode 0.3mm, glumes 2-4.2mm, densely imbricate, apex obtuse, 5-17 veined, nut dark grayish brown, obovoid to elliptic, 1.5-2.2mm…….....**C. dubius**

4b. Spikelets 53-106, 21- 34 flowers, rachilla internode 0.2mm, glumes 0.2mm, spirally imbricate, apex elongated into recurved mucronate, 3-veined, nut yellowish, narrowly oblong, 0.83-0.98mm…….....…**C. michelianus**

5a. Glume without extended awn or arista…….....6

5b. Glume with extended awn or arista ……7

6a. Spikelets 40-50, 3-4mm; 7-13 flowered, rachilla internode 0.2mm, glume 0.55mm, style 0.02mm, nut 0.56-0.6mm……..…….. **C. difformis**

6b. Spikelets 3-12, 3-10mm; 8-34 flowered, rachilla internode 0.5mm, glume 0.9-1.3mm, style 0.3-0.4mm, nut 0.7-0.9mm.…….……. **C. fuscus**

7a. Glume apex mucronate to cuspidate…….…….....8

7b. Glume apex mucronate not cuspidate…….…….…….9

8a. Spikelets persistent, 7-22, digitately arranged at the apex of ray, 3mm, 6-23 flower, rachilla solid zigzag, winged, glume deciduous, apex recurved awn 0.35-4mm, 3 veined, anther 3, nut-brown in mature……...….....……..... **C. cuspidatus**

8b. Spikelets falling as a unity, 12-31, densely spirally arranged at the apex of ray, 3-5mm; 7-11 flowered, rachilla solid straight, wingless, glume persistent, apex recurved arista 0.4-0.55mm, 3-7 veined, anther 1-2, nut greyish in mature…..…. **C. squarrosus**

9a. Spikelets 4-5, 0.6-1.6cm, 5-18 flowered, rachilla internode 1-1.5mm, solid zigzag, winged, glume pale yellow on sides, 3-5mm, apex awn 0.4-0.9mm, keeled, nut 1.5mm, dark brown…….....…… **C. compressus**

9b. Spikelets 7-12, 0.5-1.3cm; 3-23 flowered, rachilla internode 1mm, solid straight, wingless, glume yellowish white on sides, 3.8-3.9cm, apex subobtuse, not keeled, nut 1.33mm, yellowish brown…….……...…...……. **C. niveus**

10a. Culm terete……....11

10b. Culm triquetrous……...15

11a. Inflorescence globose to subglobose…….....…**C. compactus**

11b. Inflorescence anthelate…….…...…...……...…...12

12a. Culm sometimes obscurely septate …….....….…..... **C. corrymbosus**

12b**.** Culm not septate…….……...13

13a. Leaf with long blade…….....….....16

13b. Leaf bladeless……...……14

14a. Glume oval……. **C. wallichianus**

14b. Glume linear oblong……. **C. pangorei**

15a. Involucral bracts longer than inflorescence, nutlet very small …...…**C. tenuispica**

15b. Involucral bracts shorter than inflorescence, nutlet 0.4–0.5 mm wide.....**C. haspan**

16a. Inflorescence bract equal in length……17

16b. Inflorescence bract unequal in length ……...18

17a.Spikelets slightly turgid, rachilla winged, glumes 7 veined, nut blackish in colour……...…...…...……...……. **C. diffuses**

17b.Spikelets compressed, rachilla wingless, glumes 3-5 veined, nut yellowish white…….....…..…**C. platystylis**

18a. Rachilla of spikelets deciduous……...…….…….……19

18b. Rachilla of spikelets persistent…….…….……...…….…….....21

19a. Spike long rayed, 2-3 fertile flower, nut 1.2-1.7mm…….……...…**C. cyperoides**

19b. Spike reduced, 1-4 fertile flower, nut 1.4-2.05mm…..…….....20

20a. Spike 9-10, spikelets 35-50, 2-4 fertile flower, nut 1.75-2.05mm…… **C. cyperinus**

20b. Spike 7-10, spikelets 26-40, 1 fertile flower, nut 1.4-2.03mm…….…. **C. paniceus**

21a. Spikelets in digitate form……...….22

21b. Spikelets in distichous to sub distichous form…….24

22a. Spike cylindrical with spikelets spirally arranged……..…….…. **C. imbricatus**

22b. Spikelets rarely cylindrical……23

23a. Rachilla solid straight, internode 0.7mm, glume 27-3mm, apex acute, 3-5 veined, nut 1.33-1.5X0.4-0.53mm, greyish brown……...……**C. digitatus**

23b. Rachilla solid zigzag, internode 0.4mm; glume 1.28-1.43mm, apex obtuse, 5 veined, nut 0.28-0.5X0.13-0.15mm, greyish ……...…….……**C. exaltatus**

24a. Spike rachis hispidulous…….……...25

24b. Spike rachis not- hispidulous……26

25a. Spike rachis laxly hispidulous, glume subdensely arranged, 3 veined, 2.03-2.7mm, nut 1.25-1.5X0.28-0.68mm, black colour……..…..…….…….... **C. procerus**

25b. Spike rachis densely hispidulous, glume densely arranged, 7 veined, 1.58-1.6mm, nut 0.95-1X0.45-0.6mm, yellowish green colour……..…. **C. pilosus**

26a. Glume apex obtuse or rounded.....**C. malaccensis**

26b. Glume apex acute…….....……..….27

27a. Rahilla wingless…….....…...28

27b. Rachilla winged…….....…...30

28a..Spike reflexed, nearly spirally arranged, spinulose at keel surface ……**C. alulatus**

28b.Spike suberect, digitately arranged, not spinulose at keel surface ……....29

29a.Spike 6-10, spikelets 7-30, 0.4-1cm, 5-14 flowered, glume 1.7X 0.9mm, nut 1.3X0.7mm……**C. iria**

29b.Spike 4, spikelets 10-19, 7-8mm, 11-15 flowered, glume 1.5X0.8mm, nut 1.25X0.35mm.…… **C. microiria**

30a. Rhizomes without tuber or stolon……..…..……31

30b. Rhizome with short stolons……..…..……..34

31a. Nutlets oblong to ellipsoid……..……....….……...…32

31b. Nutlets obovoid……..……..……..…….…...33

32a. Inflorescense simple anthelodium, spike 2-4 number, spikelets 0.8-1.3cm, 1.5-2mm wide, 3-9 flowered, rachilla internode 1.5-2mm, wing brownish colour, glume straw colour, 3-4mm, wide 1mm, 7 veined, nut brownish yellow, 1.68X0.85-0.88mm……... **C. tenuiculmis**

32b. Inflorescense compound anthelodium, spike 4-6 number, spikelets 1.3-1.6cm, 1mm wide, 11-13 flowered, rachilla internode 1.2mm, wing white colour, glume reddish brown colour, 1.63mm, wide 5mm, 3-5 veined, nut greenish brown to blackish brown, 1.23X0.45mm…….....……. **C. distans**

33a. Spikelets laxly arranged, 0.5-0.9cm, wide 1.5mm, 7-9 flowered, rachilla internode 0.7mm, solid zigzag, nut dark brown colour……..…. **C. nutans**

33b. Spikelets densely spreading, 0.7-1.1cm, wide 2-2.5mm, 9-12 flowered, rachilla internode 0.8mm, solid straight, nut black colour……...… **C. eleusinoides**

34a. Rhizome without tubers…… ……..…… **C. longus**

34b. Rhizome with tubers……..…… ……..……..……. 35

35a. Spike 4-5 number, obovoid, spikelets 2-6, 5-12 flowered, rachis solid straight, glume reddish brown to castaneous, 3 veined, nut 1.25-1.5X0.28-0.68mm. **C. rotundus**

35b. Spike 20 number, ovoid, spikelets 14, 5-20 flowered, rachis solid zigzag, yellow to golden or pale brown, 5-9 veined, nut 2-2.2X0.7-0.8mm……..…**C. esculentus**

Description of the Species:

1. Cyperus alulatus J. Kern, Reinwardtia 1; 463(1952). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepa1: 107 (1978). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al*., A Hand. Fl. Pl. Nep. 1: 237 (2018).

Type Specimen: Holotype: India, Punjab, Drummond 24733 (BO) **Isotype:** K.

Annual, height 4cm to 21.5cm. Fibrous reddish brown colour roots. Stem rigid, erect, 21.5--36.5 X1mm tufted, compressed triquetrous, smooth with basal leaves. Leaf sheath reddish brown to brownish purple, closed, eligulate, 1--6.5 cm, mouth margin obliquely open; leaf blade linear-lanceolate, 5, 2--18.5 X 0.3cm, flat or slightly keeled, with brown dots and stripes, margins smooth, apex acute, scabrous. Involucral bracts 6 to 7, leaflike, 3.3--17.5 X 0.3cm, midvein acute adaxially, entire margin spinulose at tip. Inflorescense compound anthela, 6.1--7.8 X 5.5--7.7cm; primary rays 7--8number, 0.5--7.7cm; secondary rays 1--3 number, 2.3--3mm; raylets 1--3number, 0.3--2.5cm, alternately distichously arranged, hispidulous raylets; tubular prophyll of primary ray 0.8--1.7cm; secondary ray 0.2--0.3cm; cladoprophyll of primary ray 0.2--2.2cm and secondary ray 1.1--3cm. Spikes cluster of 2--5, 1.4--2.3 X 0.6--1cm, loose spirally arranged, spreading at almost right angles. Spikelets 1--18, 4--5 X 2.5mm, sub distichously arranged, linear, subcompressed with 3--7 flowers; Rachis solid straight quadrangular, brown colour with 0.5mm internode and wingless rachilla. Glume yellowish brown on sides, laxly imbricate, ovate or sub-orbicular, 1.53--1.7 X 0.78--1.1mm, 3 nerved with a rib like lateral nerve on either side of the mid nerve, strongly keeled, with spinulose-ciliate on the keel, rounded apex, margin widely leathery, hard, brown. Stamens 3, yellowish, anther linear, 0.2 X 0.1mm, connective prominent beyond anther 0.3--1.3mm. Style 0.1mm; Stigmas 3, 0.5mm. Nutlet greyish brown, obovoid, 0.6--1.45 X 0.6--0.7mm, trigonous, base cuneate (0.13mm), apex attenuate, finely reticulate.

Distribution Range: Pakistan, India, Nepal (Map 1) Afghanistan, West Himalaya.

Altitude: 1100m

Ecology: Roadside, Moist place

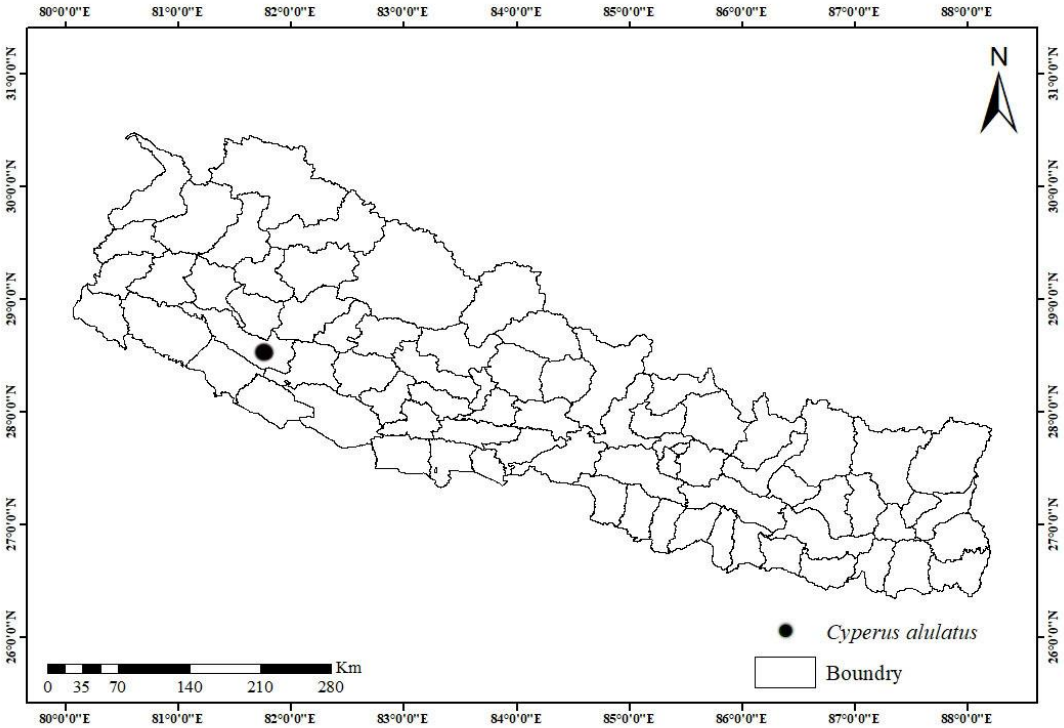
Flowering and Fruiting: September

Voucher Specimen: Surkhet District, Surkhet- Katukuwa, 1100m, 20th July 1991, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamote, K.R. Rajbhandari, H. Takayama* and *K. Terada* 9170019 (KATH)

Note: Looks similar to C. iria.

Specimens examined:

West Nepal: Surkhet district, Surkhet – Katukua, 1100m, 1991.7.29, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K.R. Rajbhandari, H. Takayama* and *K. Terada* 9170019(KATH, TI).



Map 2. Distribution of *Cyperus alulatus* in Nepal based on herbarium records.

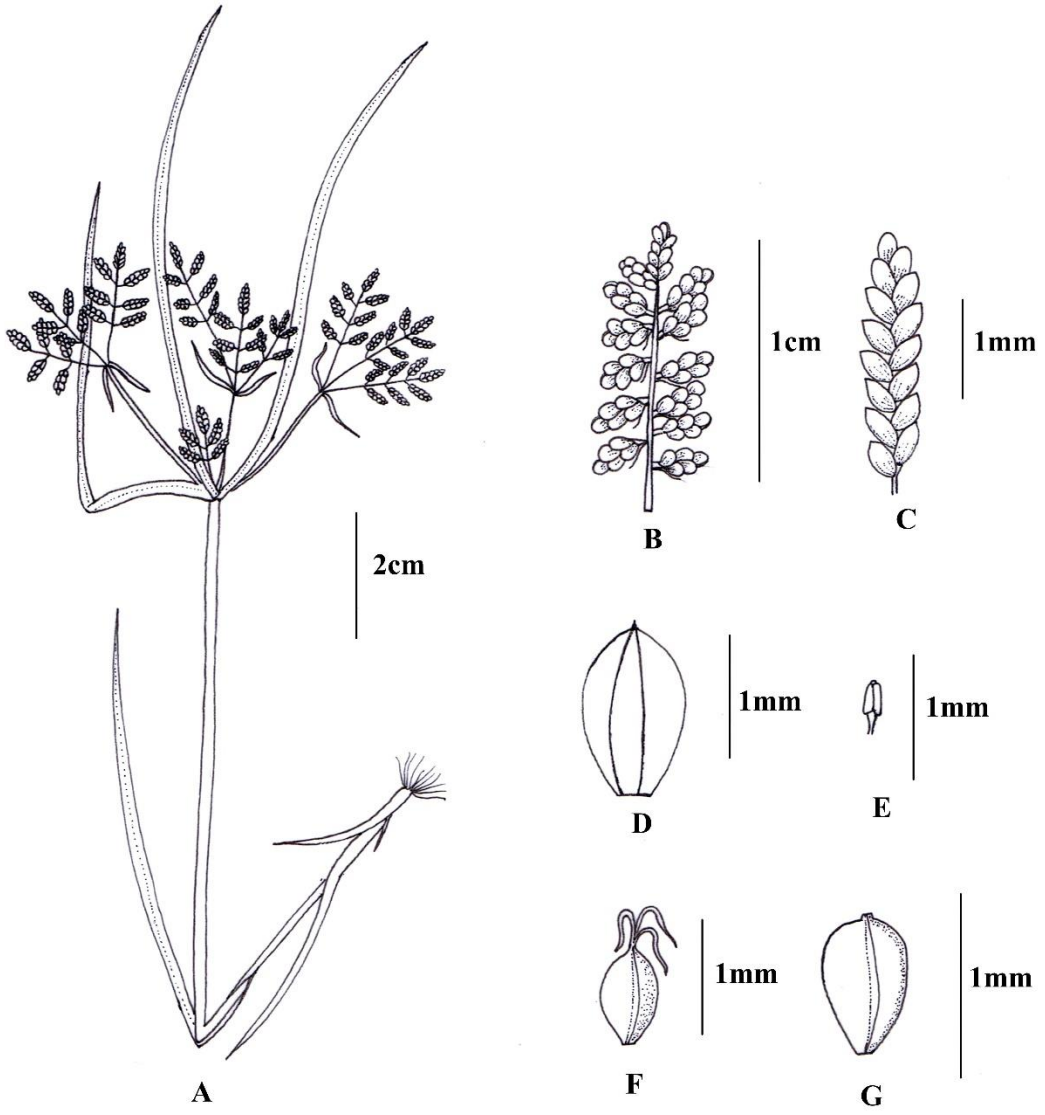


Figure 2: Cyperus alulatus Kern.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Suzuki et al., 9170019 KATH).

2. Cyperus compactus Retz. Obs. Bot. 5:10 (1788). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1:90 (2010). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha et.al., A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus dilutes Vahl, Enum. Pl.2;357(1806).

Cyperus spinulosus Roxb., Fl. Ind.ed.2,1:203(1832).

Mariscus compactus (Retz) Druce in Rep.Bot. Exch.Club Brist.isles 1916:634(1917). Koyama in Hara *et al.,* Enum.Flow.Pl. Nepal 1: 116(1978).

Mariscus dilutes (Yahl) Nees in Wight, Contrib. Bot. Ind: 90 (1834).

Mariscus giganteus Boeck., Flora 42 :443 (1859).

Marscus microcephalus J. and C. Presl, Rel. Haenk. 1:182(1828).

Type Specimen: Jawa, 1867, H. Zollinger 190. **Isotype:** K.

Perennials, height 74--121cm. Rhizomes short, covered with reddish brown scales. Culm sparsely tufted, 21.5--36 X 0.1cm tall, terete, stout, glabrous, with conspicuously transverse vein, base slightly swollen with basal leaves. Leaf sheath closed, purpulish brown, 1.5-- 9.5cm, obliquely open margin; leaf blade 2--8, 15--111.5cm, acute apex, abaxially midvein with conspicuously transverse veins, margin scabrous. Involucral bracts 8 (4 long and 4 small), leaflike, 3.9--78cm X 4--9mm, acute adaxially, vein acute. adaxially, margin spinulose. Inflorescence compound to decompound anthela, 6.1--7.8 X 5.5--7.7cm; primary rays 7--9, 0.4-- 22.5cm; secondary rays or spikes 3--16,1--4.5cm, 0.8--1.6 X 1--2.5cm, nearly globose-half globosely arranged; raylets sessile or 1--8,0.5cm; alternately arranged, glabrous; tubular prophyll of primary ray 0.4--3.3cm; secondary ray 0.3--0.4cm; cladoprophyll 0.7--9cm; Spikelets clusters of 6-38 radially spreading, subulate shape, 6.4--15mm X 0.5--1.5mm, compressed, lanceolate with 3-9 flowers, detach whole spikelet at maturity; Rachilla winged, internodal gap 0.8mm, rachilla wings white and hyaline. Glumes conspicuous green in middle to the redhhish brown on both surfaces, narrowly oblong, cymbiform, 1.53--1.7 X 0.78 --1.1mm, very closed packly arranged, 5--7 veined, green keeled, apex obtuse, margin narrowly scabrous, whole spikelet dehiscence at maturity. Stamens 3, yellowish linear, 0.6--0.7 X 0.13mm, connective prominent beyond anther 0.7-- 3mm. Style 0.6 --1.2mm; Stigmas 3, slender, 1.2--2.3mm. Nutlet yellowish brown-brownish, narrowly oblong, 2

X 0.2--0.35mm, trigonous, base cuneate (0.15mm), mucronate (0.18--0.15mm), finely reticulate.

Distribution Range: Pakistan, India, China, Nepal (Map 3), Srilanka, Myanmar, Cambodia, Laos, Vietnam, S.E. Asia, Australia

Altitude: 150-300m

Ecology: Occurs in forest margins, alpine meadows, hills, waste areas, riverbanks

Flowering and Fruiting: June-December

Local Name: Moothe

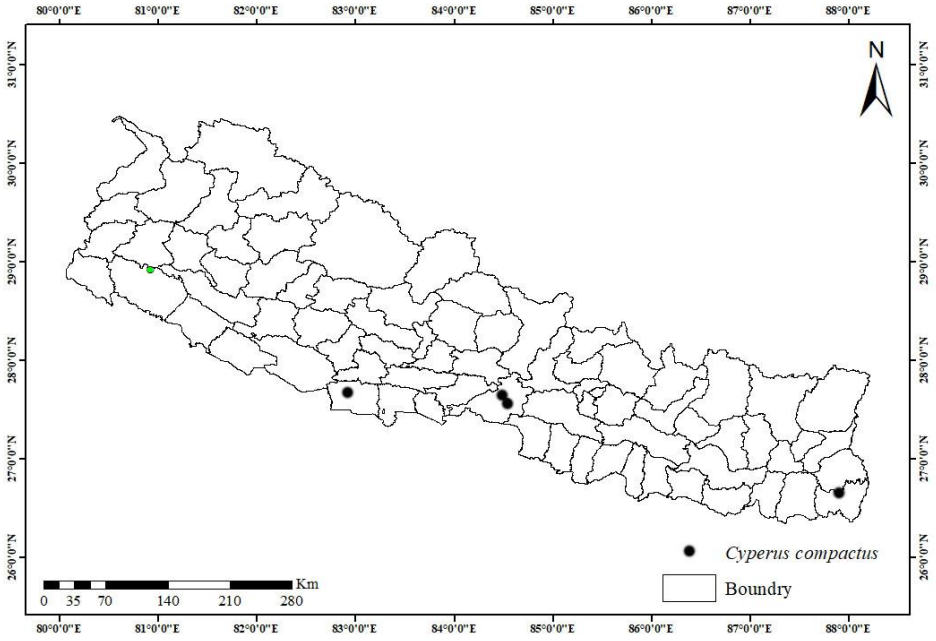
Voucher specimen: Chitwan, Tikauli Taal, Chitwan National Park, 166m, 24th August 2019, *K. Basukala* and *S. Potamahan* KB09 (TUCH).

Specimens examined:

West Nepal: Kanchanpur district, Mahendranagar, 160m,1980.9.20, *L.P. Kattel* and *K.J. Malla* 2 (KATH). Kapilbastu district, Dhupahi, 200m, 1992.11.9, *P.P. Kurmi* KB347 (KATH).

Central Nepal: Chitwan, Harinari, 166m, 27th August 2019, *K. Basukala* and *S. Potamahan* KB106 (KATH). Chitwan, Tikauli taal, 175m, 28th August 2019, *K. Basukala* and *S. Potamahan* KB109 (KATH). Makwanpur, Hetauda, 345m, 11th February 2018, *M. Timalsina, S. Khatri* and *K. Basukala* (KATH).

East Nepal: Jhapa district, Suroonga - Sanichare, 200-250m,1997.6.7, *P. Pradhan, M. M. Amatya* and *R. Shrestha* 138/74 (KATH).



Map 3. Distribution of *Cyperus compactus* in Nepal based on herbarium records.

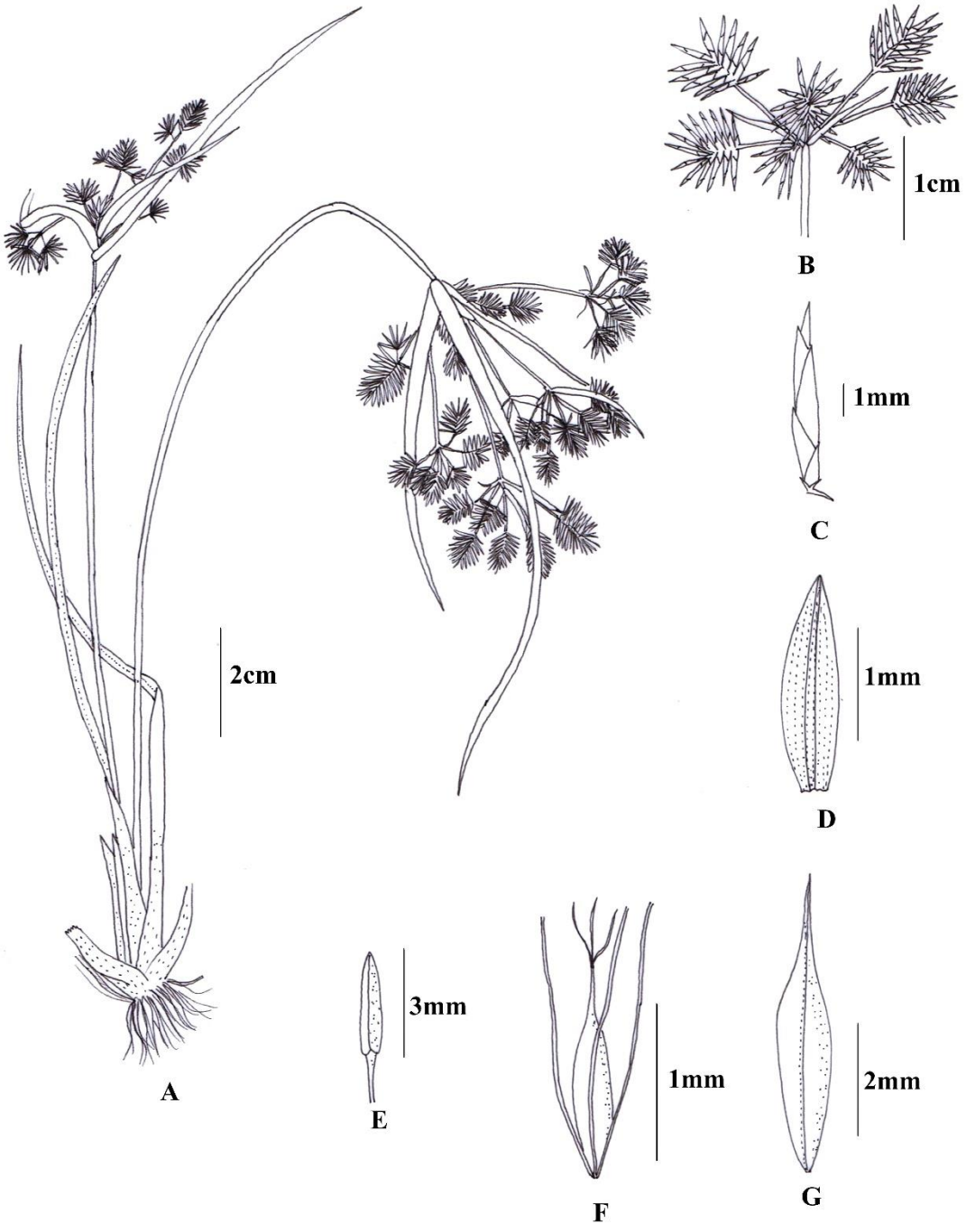


Figure 3: Cyperus compactus Retz.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB09 TUCH).

3. Cyperus compressus L., Sp. Pl.: 46 (1753). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 107 (1978). Rajbhandari in Rajbhandari and Baral, Cat.Nep. Fl. Pl. 1: 90(2010). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha et.al., A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus pectinatus Roxb., Fl. Ind. 1: 195 (1820).

Type Specimen: Clayton 598 (BM-000051698). **Lectotype**: BM

Annual, height 7--40cm. Root fibrous straw yellow colour. Culm tufted, 7--35cm, triquetrous, slender, smooth, base with few basal leaves. Leaf sheath closed, eligulate, purpulish brown, 1.5--7.2cm, mouth margin obliquely open; leaf blade flat sometime plicate, 4, 5--31 X 0.2cm, keeled, margin slightly revolute, smooth, apex acute and scabrous. Involucral bracts 9 (6 long, 3 short), leaflike, 4.7--33.7 X 0.2cm, vein acute adaxially, revolute. Inflorescence simple anthela; rays 5 -- 6, 0.5--5.1cm, with one spike; tubular prophyll 6--8mm. Spikes digitately arranged 5--6, 1.2 X 1.6cm, broadly ovoid to subflabelliform in outline. Spikelets 4--5 densely and nearly digitately arranged, compressed, narrowly linear-oblong, 0.6--1.6 X 3--4mm, with 5--18 flowers, dehiscence from base to apex; Rachis solid zigzag, quadrangular, 1--1.5 X 0.6mm with winged rachilla. Glume conspicuous green in middle to pale yellow in sides, tightly imbricate, ovate attenuate, 3--5 X 1--1.2mm 7 veined, keeled, apex acute with straight and long mucro (awn 0.4--0.9mm). Stamens 3; anthers linear, 0.75 X 0.2mm; connective 3mm, reddish yellow colour, apex reddish, ovate, ca. 0.1 mm. Style 1--2mm; Stigmas 3, 0.8--1mm. Nutlet dark brown, obovate 1.5 X 0.95--1.1mm, 3sided, slightly concave on 3 sides, rugose surface.

Distribution Range: Africa, Afganisthan, Pakistan, India, Nepal (Map 4), Bhutan Bangladesh, Sri Lanka, China, Japan, Myanmar, Laos, Vietnam, S. E. Asia, Australia.

Altitude: 150 - 2000m

Ecology: Roadsides, field edges and beside rivers;

Flowering: June-October / Fruiting: October-December

Local Name: Jhusuna

Uses: Medicine whole plant, Forage

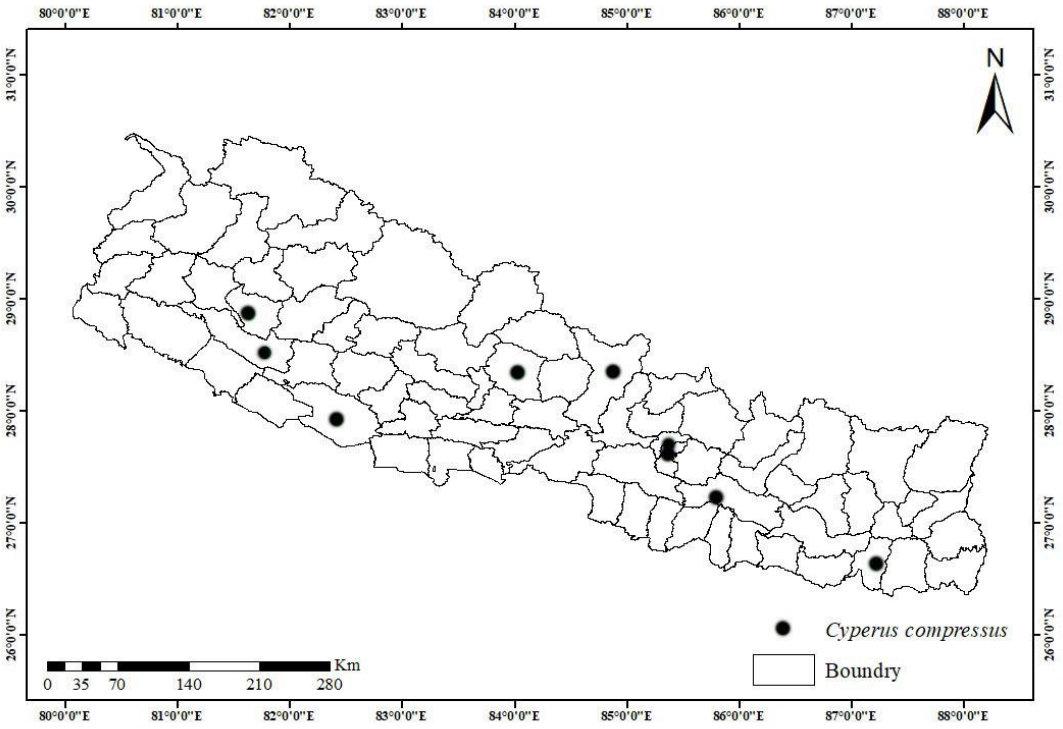
Voucher Specimen: Bhaktapur, Kasan, 1252m, 5th November 2020, K. Basukala KB24 (TUCH).

Specimens examined

West Nepal: Dailekh district, Dungesar - Shristhan, 700m, 1991. 8.1, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K.R. Rajbhandari, H. Takayama* and *K. Terada* 9170157 (TI). Kapilvastu, Taulihawa, 87m, 22nd August 2019, *K. Basukala* and *S. Potamahan* KB118 (KATH).

Central Nepal: Kaski district, Pokhara, 800m, 1982.8.30, *K. R. Rajbhandari* and *K. J. Malla* 6323 (KATH). Kathmandu Champadevi Kirtipur, 2155m, 6th July 2019, *K. Basukala* KB014 (KATH). Gorkha, 1087m, 8th July 2019, *K. Basukala* and *S. Potamahan* KB114 (KATH). Gorkha, Salbutephat, 1001m, 8th July 2019, *K. Basukala* and *S. Potamahan* KB115 (KATH). Tanahu, 12 Kilo bazar, 437m, 9th July 2019, *K. Basukala* and *S. Potamahan* KB117(KATH).

East Nepal: Sunsari district, Trijuga, Koshi Tappu Wildlife Reserve, 1993.5.27, *P.R. Shakya*, *R. Manandhar* and *P. Shrestha* 43 (KATH).



Map 4. Distribution of *Cyperus compressus* in Nepal based on herbarium records.

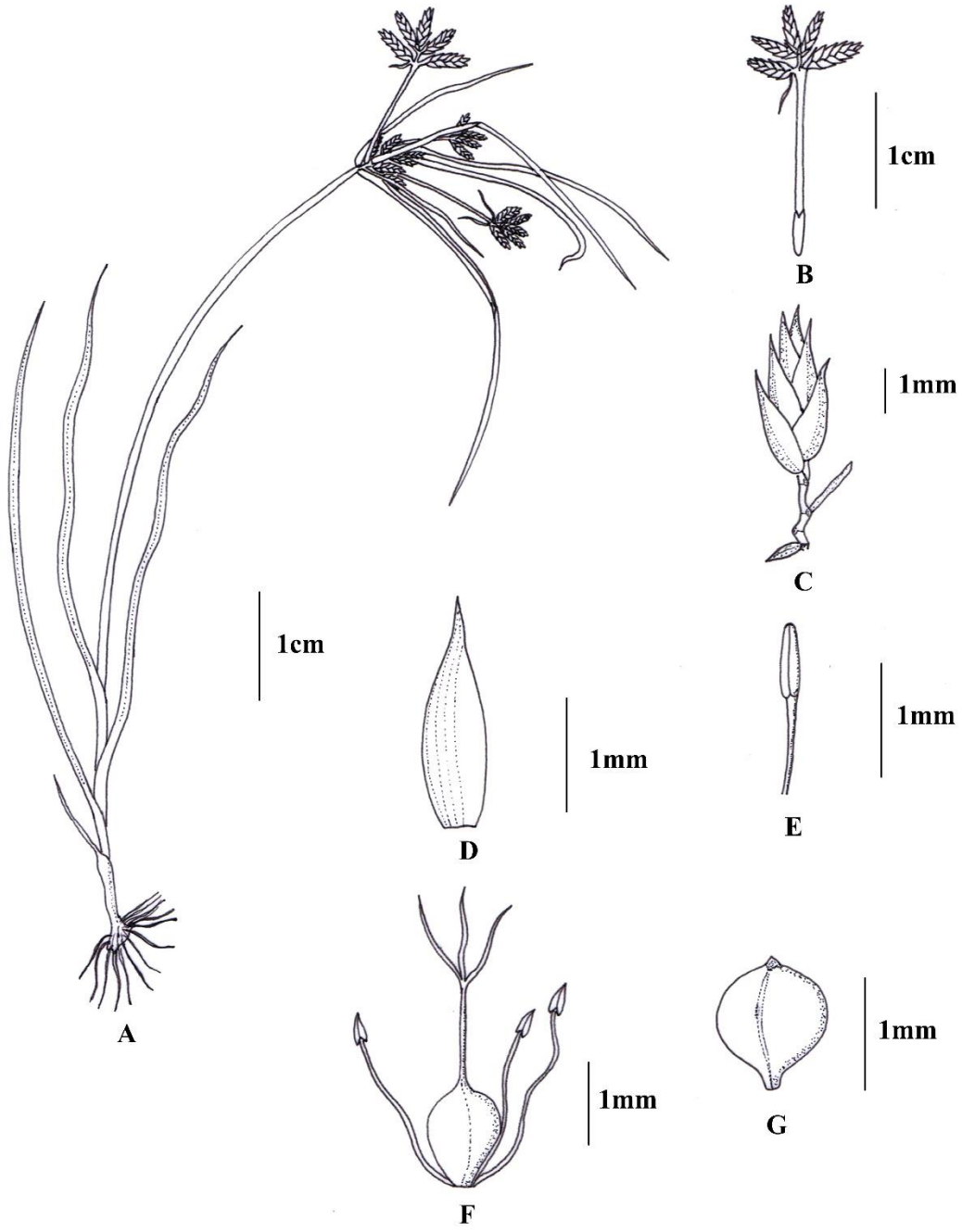


Figure 4: Cyperus compressus L.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume **E** Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala K, KB24 TUCH).

4. Cyperus corymbosus Rottb., Descr. Pl.: 19 (1772). Koyama in Hara et. al., Enum. Flow. Pl. Nepal 1: 107 (1978). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1:90(2010) (Plate 118). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha et.al., A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus bengalensis Spreng., Neue Entdeck.Pflanzenk.3:101(1822),

Cyperus nudus Roxb., Fl.Ind.ed.1832,1:209(1832)

Type Specimen: J.G. König s.n. C10010143. **Holotype:** C

Perennial, 115 --136cm height. Rhizome woody, 4 to 5mm diameter. Culm, single 107--121cm, stout, trigonous at the top, very obscurely transverse-septate, reduced basal leaves. Leaf sheath greyish green with reddish tint, 5.5--15.5cm, oblique mouth margin; leaf blade 1, 12--14.5 X 0.2--0.4cm, margin smooth, acute apex, scabrous. Involucral bracts 3, 3.5--11 X 1--3.5mm, foliose, margin revolute, keeled and apex scabrous. Inflorescence compound anthelodium; primary rays 7, 0.5--9.8cm, secondary rays 5, 0.2--2.5cm; raylets distichously arranged, 5--13, 0.6--1.7cm. reddish brown; tubular prophyll 3--8mm, cladoprophyll 5--9mm. Spikes 4-5, digitately reflexed, 5 X 4.5cm. Spikelets 5--13, sub distichously laxly to densely arranged spikelets, compressed linear, 0.6--15 X 1--1.2mm. 12--22 flowered; Rachis solid straight with internode 0.7--1 X 0.2mm, winged rachilla. Glume straw colour on sides, loosely imbricate, fusiform, terete, 2--2.3 X 0.6mm, apex sub obtuse, mucronate, cymbiform, vein not pronounced, hardly keeled, margin widely scabrous. Stamens 3, linear, 0.95--1.1 X 0.13mm, connective 1.13--1.6mm. Style 0.7--1.2mm; Stigmas 3 [4], 0.6--3.6mm. Nutlet yellowish, plano-convex, 0.63--0.78X 0.213mm, trigonous, apex mucronate base cuneate, finely reticulate.

Distribution Range: Pakistan, India, Nepal (Map 5), Sri Lanka, China, Myanmar, Camboidia, Laos, Vietnam, S.E. Asia, Australia

Altitude: 150-300m

Ecology: Flooded river banks

Flowering: June.

Local Name: Mothe

Uses: The dried culms are used in basketry, hats, matting and making ropes

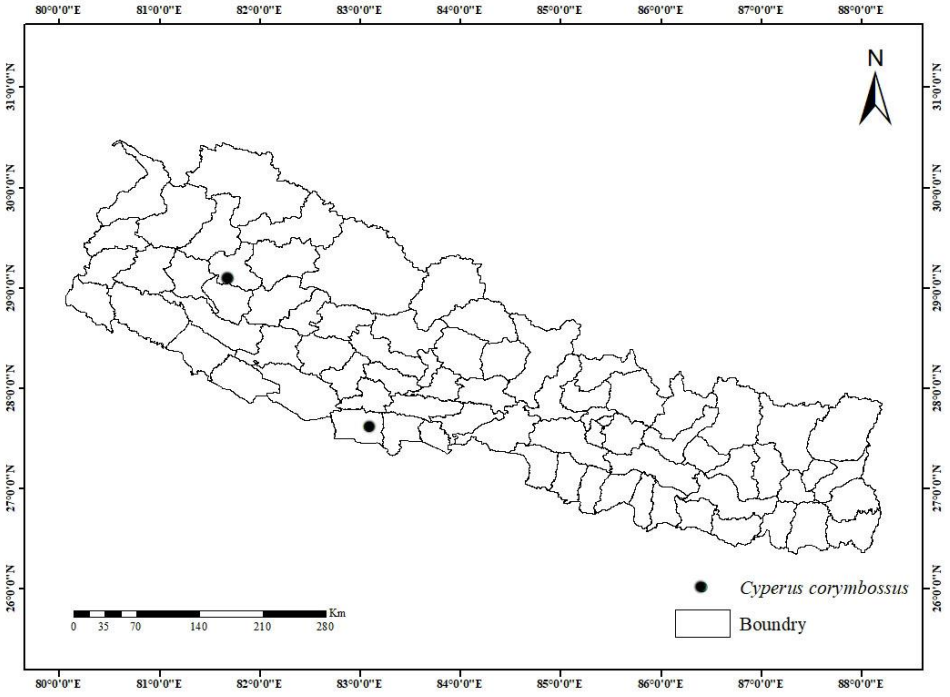
Note: C. corymbosus is distinguish by other plant with cylindrical stem, reduced leaf and umbel like compound inflorescence

Voucher specimen: Kapilvastu, Jagadispur Taal, 84m, 21st August 2019, K. Basukala and S. Potamahan KB05 (TUCH).

Specimens examined

West Nepal: Kalikot district, Khallagad-Talaserogaon, 1400m, 1979.7.10, *K.R. Rajbhandari* and *B. Roy* 3121 (KATH). Kapilvastu, Jagdispur taal, 84m, 24th August 2019, *K. Basukala* and *S. Potamahan* KB84 (KATH).

Central Nepal: Kapilbastu district, Jagadispur Tal, 85m, 2007.4.5, *S.R. Baral, L. Joshi, A.P. Bhattarai* and *P.P. Kurmi* 10110 (KATH). Bara, Pipara Simara, 123m, 11th February 2018, *M. Timalsina* and *K. Basukala* (KATH).



Map 5. Distribution of *Cyperus corymbosus* in Nepal based on herbarium records.

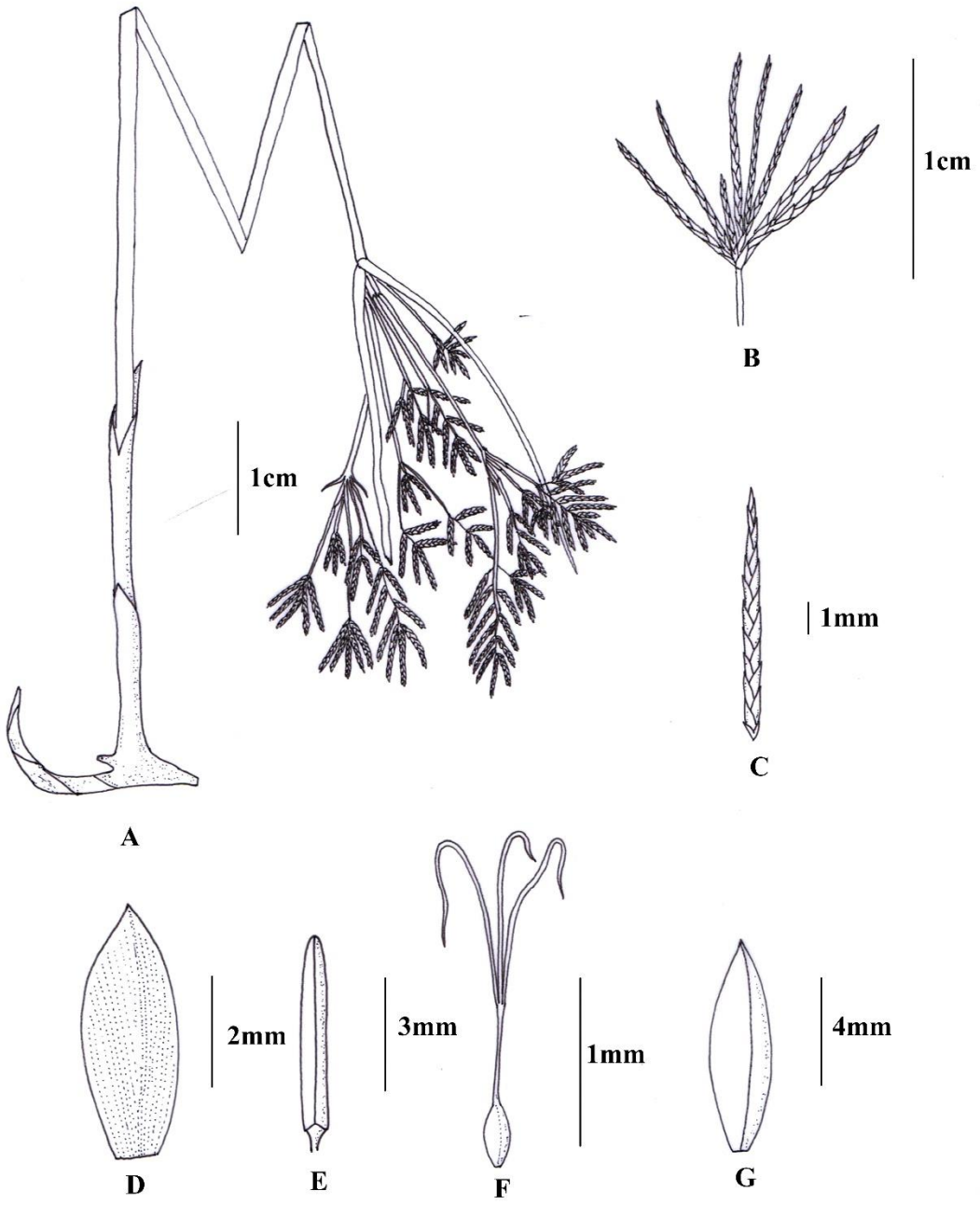


Figure 5: Cyperus corymbosus Rottb.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB05 TUCH).

5. Cyperus cuspidatus Kunth in Humboldt *et al.,* Nov. Gen. Sp. 1, ed. 4:204 (1816). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 107 (1978). Rajbhandari in Rajbhandari and Baral, Cat.Nep. Fl. Pl. 1: 91(2010). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus angustifolius Buch. -Ham. ex Wall., Numer. List: 117. n. 3376A (1831)

Cyperus angustifolius Buch. -Ham. ex Nees in Wight. Contrib. Bot. Ind.: 79 (1834)

Cyperus capitatus Retz., Obs. Bot. 4:9 (1768)

Cyperus cuspidatus Kunth forma *angustifolius* Kuek. in Engler., Pfl. - reich IV- 20. HT. 101: 264 (1936)

Cyperus setifolius D. Don, Prodr. Fl. Nepal: 38 (1825)

Type Specimen: Phillippines, 1841, H. Cuming 676. **Isotype**: K

Annual, height 3 to 29cm. Roots fibrous. Culms caespitose, 2.2--25cm X 0.5--0.8mm, triquetrous, smooth. Leaf sheath reddish violent colour, 1.5--4cm, margin mouth obliquely open; leaf blade 2--3, 2.8--8.5x 0.1m, margin revolute, smooth, apex scabrous. Involucral bracts foliose, 6 to 7, 1.2--8.6 X 0.09--0.1cm. Inflorescence simple anthela, rays 6--7, 0.8--3.5cm; tubular prophyll 2-4mm. Spikes cluster of 6--7 digitatetly arranged at apex of rays, 1.8--1X 0.5--0.6cm; Spikelets clusters of 7--22 capitate at the apex of ray, linear, 3--9 X 0.8--1mm, obliquely when matured, 6--23 flowered; Rachis solid zigzag quadrangular, internode 0.3-- 0.7X0.3mm, winged rachilla. Glume reddish brown on sides, laxly imbricate, oblong ovate, 1.5X0.6mm, apex truncate with strongly recurved awn of 0.8mm length, 3 veined, green keeled. Stamens 3; anther linear, 0.1mm, connective 0.1mm. Style 0.38mm; Stigmas 3, 0.3mm. Nutlet yellowish green in inmature and brown in mature, obovoid, 0.6X0.25mm, triquetrous, apex mucronate base cuneate, granulate or tubercles surface.

Distribution Range: Pantropical: Asia, Africa, America and Australasia, Nepal (Map 6).

Altitude: 400 to 2300m.

Ecology: Sand at river margins, grasslands at water margins, wastelands, mountain slopes, forests, fields edges and beside rivers

Flowering and Fruiting: July - October (-November)

Uses: Fodder

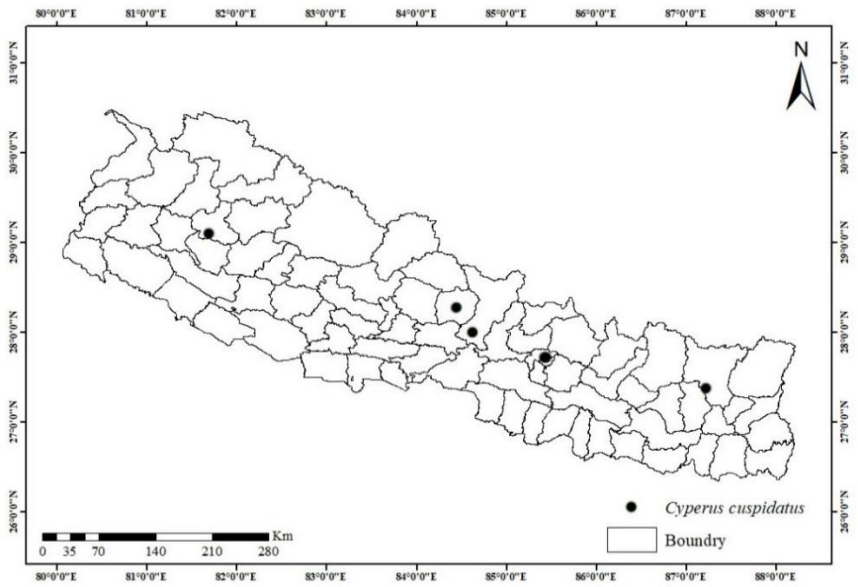
Voucher Specimen: Gorkha, Batasechowk, 1165m, 8th July 2019, K. Basukala and S. Potamahan KB01 (TUCH).

Specimens examined

West Nepal: Kalikot District, Chaukhebada – Badarigaon, 2320-1320m, 1991.8.5, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K.R. Rajbhandhari, H. Takayama* and *K. Terada*.

Central Nepal: Nepalia, N. Wallich s.n. (BM, E, Syntype of *Cyperus setifolius*). Lamjung district, Simalchour- Bhote Odar, 800m, 1983.8.11, *K.R. Rajbhandari* 9248B (KATH). Gorkha, Salbutephat, 1001m, 8th July 2019, *K. Basukala* and *S. Potamahan* KB123 (KATH). Gorkha, Batasechok, 1165m, 8th July 2019, *K. Basukala* and *S. Potamahan* KB121 (KATH). Sindhupalchok, Thangpaldhap, 4100m, 11th August 2019, *K. Basukala* and *S. Potamahan* KB015 (KATH). Chitwan, Kasara, 173m, 27th August 2019, *K. Basukala* and *S. Potamahan* KB127(KATH). Bhaktapur, Changu Naya Khariya, 1441m, 15th September 2019, *K. Basukala* and *S. Potamahan* KB017(KATH).

East Nepal: Sankhuwasabha district, Bungling, 440m, 1989.9.14, *K.R. Rajbhandari* 13571B (KATH).



Map 6. Distribution of *Cyperus cuspidatus* in Nepal based on herbarium records.

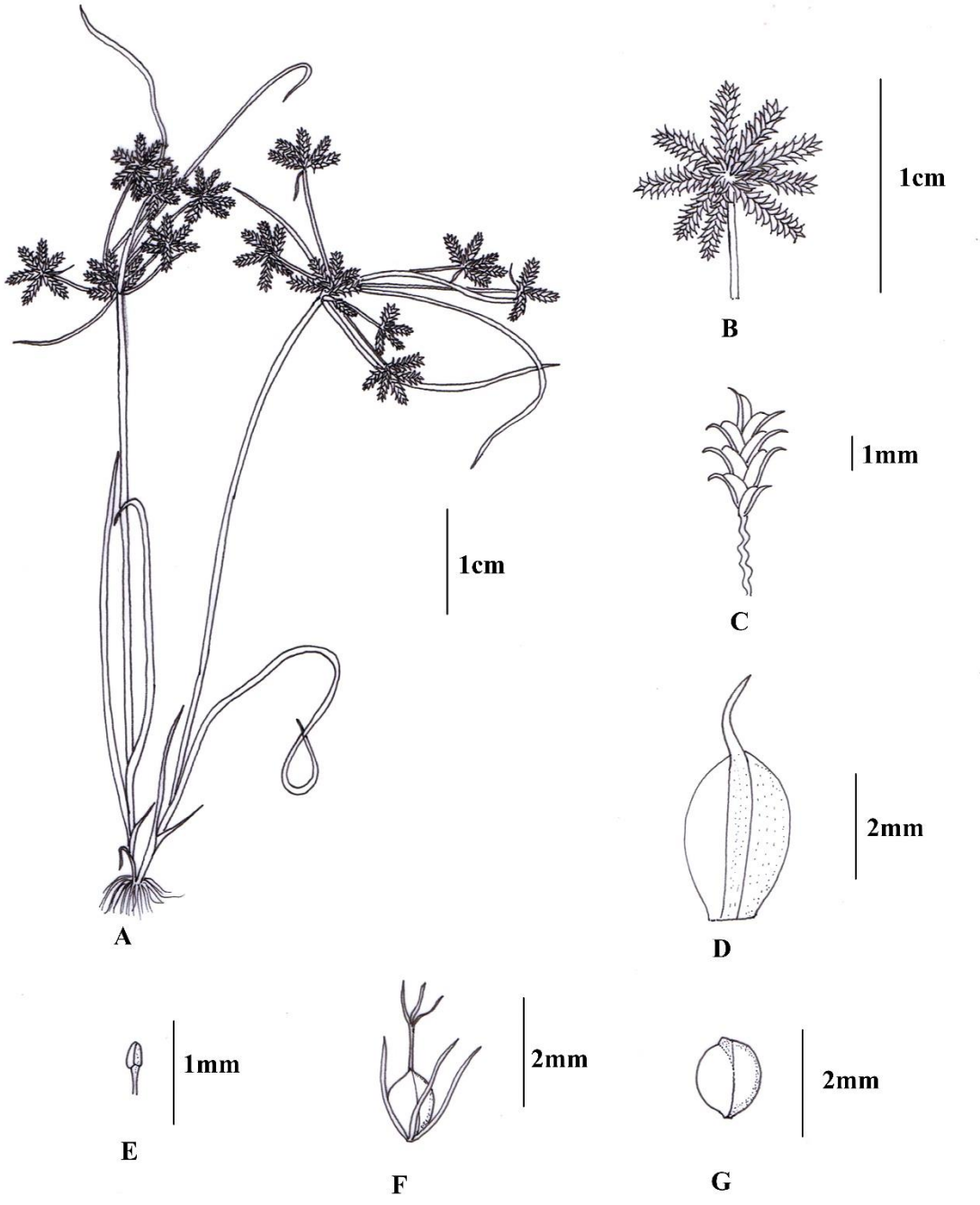


Figure 6: Cyperus cuspidatus Kunth.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB01 TUCH).

6. Cyperus cyperinus (Retz.) J. V. Suringar, Cyperus, 154 (1898). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1: 91 (2010) (Plate 118). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha et.al., A Hand. Fl. Pl. Nep. 1: 237 (2018).

Kyllinga cyperinus (Retz.) Obs. Bot. 6: 21 (1791)

Mariscus cyperinus (Retz.) Vahl, Enum. Pl.2: 377 (1806). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 116 (1978).

Type Specimen: Indonesia, C.L. Blume s.n. L0042375. **Type:** K

Perennials, height 9.6--32cm. Rhizomes short. Culms scattered, 8.5--29 X0.4cm, stout acutely triquetrous, smooth with basal few leaves. Leaf sheath purpulish brown, 2.5--5.5cm, mouth margin concave opening; leaf blade 3--6, 12.3-- 26.5 X 0.4cm, plicate at basal part and spreading at apical part, abaxially midvein and margin scabrous. Involucral bracts 7--9, 3--13.5 X 1--4mm, acute adaxially, revolute. Inflorescence simple anthela, 2.5--3.5cm X 3.7-- 4.5cm; rays 9--10, 0.2--1.8cm; tubular prophyll 2mm. Spikes 9--10, oblong-obovoid, 1-- 1.3cmX0.8--2.1cm. Spikelets 35--50 more than that, densely or spirally arranged, erect spreading, compressed, narrowly linear-ovoid, base subtruncate, 4--7 X 1--1.2mm, 2--4 flowered; Rachis lanceolate, broad wings of rachis 2.4mm connects two flower. Glumes brown on sides, elliptic, tightly imbricate, oblong lanceolate, 3.55-- 3.75 X 0.65--0.75mm, vein several with middle 3 conspicious green, keeled, apex obtuse, margin involute. Stamens 3; dark brown, anthers broadly linear, 0.68 X 0.113--0.15mm; connective 1.13--1.6mm prominent beyond anthers. Style 0.43--1.05mm; Stigmas 3, 1.25--1.7mm. Nutlet dark greyish brown, narrowly oblong, 1.75--2.05 X 0.63--0.68mm, trigonous, base cuneate 0.2mm, apex mucronate 0.18mm, granulated.

Distribution Range: Africa, Afganisthan, India, Nepal (Map 7), Bhutan Bangladesh, Sri Lanka, China, Japan, Myanmar, Laos, Vietnam, S. W. Asia, Australia. S. E. Asia.

Altitude: 1000 to 1700m

Ecology: wet places, grasslands

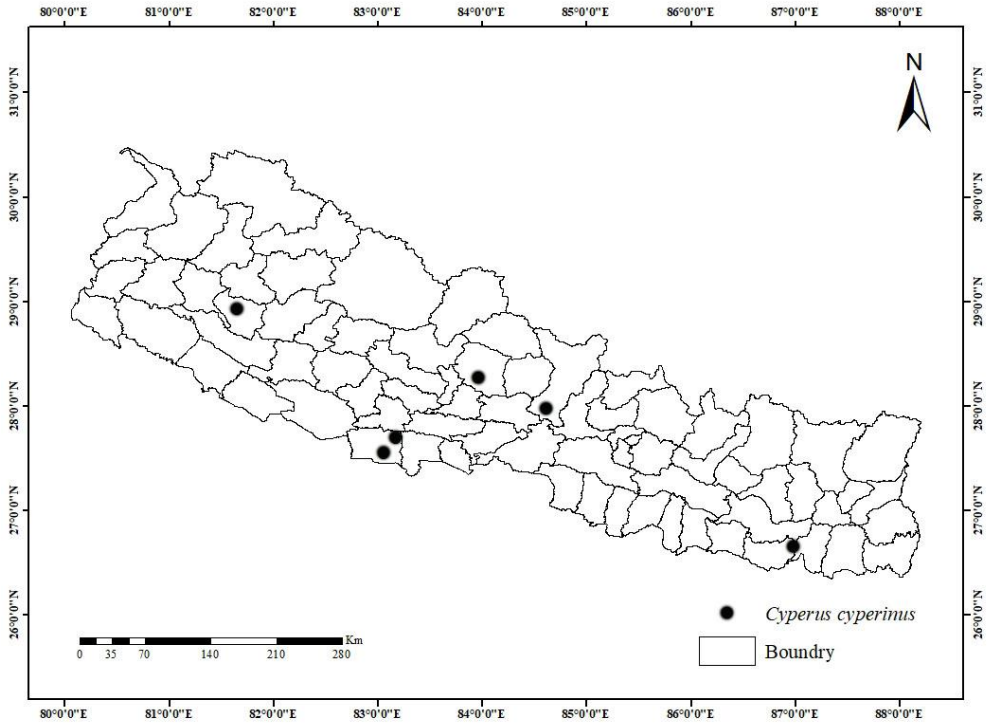
Flowering and fruiting: April - September.

Uses: Fodder

Voucher Specimen: Gorkha, Rangrung Khola, on the way to Barpark, 806m, 10th July 2019, K. Basukala and S. Potamahan KB03 (TUCH).

Specimens examined

Central Nepal: Kaski district, Pokhara – Surkhet, 1000m 1983.7. 6, *K. R. Rajbhandari* 7212 (KATH). Gorkha, Rangrung khola way to Barpark, 806m, 10th July 2019, *K. Basukala* and *S. Potamahan* KB019 (KATH).



Map 7. Distribution of *Cyperus cyperinus* in Nepal based on herbarium records.

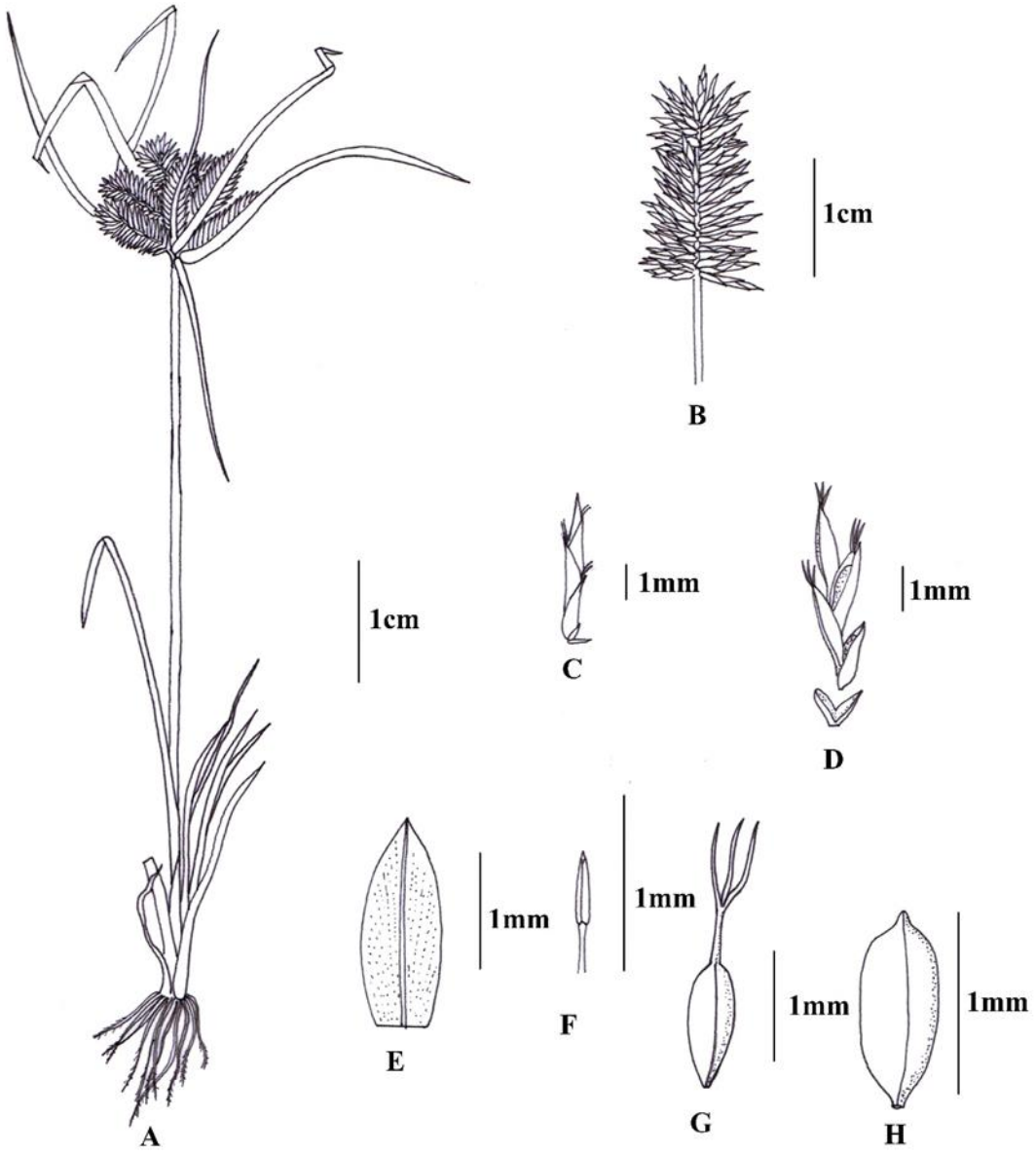


Figure 7: Cyperus cyperinus (Retz.) J.V. Suringar.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D** Spikelet showing rachilla and glume arrangement, **E**. Glume, **F**. Anther **G**. Fruiting Pistil, **H**. Nutlet. (Based on Basukala et al., KB03 TUCH).

7. Cyperus cyperoides (L.) Kuntze, Revis. Gen. Pl. 3: 333 (1898). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1: 91 (2010). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha et.al., A Hand. Fl. Pl. Nep. 1: 237 (2018).

Scirpus cyperoides L., Mant. Pl. Alt. 181 (1771).

Kyllinga sumatrensis Retz., Obs. Bot. 4: 13 (1786).

Kyllinga umbellate Rottb., Descr. Icon. Rar.Pl. 15(1773).

Mariscus sieberianus Nees ex Steud., Synops. Pl. Glum. 2:61 (1855).

Mariscus sumatrensis (Retz.) T. Koyama, Gard. Bull. Singap. 30: 154 (1977).

Mariscus sumatrensis (Retz.) J. Raynall, Adansonia n.s. 15: 110 (1975).

Type Specimen: Sudan, 1869, G. Schweinfurth, 1502. **Type:** K.

Perennials, height 25.7--67cm. Rhizomes short. Culms laxly tufted, 21--61.3X0.3cm, acutely triquetrous, smooth, base swollen with many leaves. Leaf sheath purpulish brown, 1.5--7.5cm, mouth margin concave opening; leaf blade 7--9, 7.7--24.5X0.4cm, apex acute long attenuate, abaxially midvein and margin scabrous. Involucral bracts 7--12, 3.8--32.3 X 1--5mm, acute adaxially, revolute. Inflorescence simple anthela, 6--8.6cm X 3.5-- 6.4cm; rays 13--17, 0.5--3.6cm; tubular prophyll 4--6mm, cladoprophyll 1.1--1.7cm. Spikes 13--17, cylindric, 1.2--2 X 0.8-- 1cm. Spikelets 80--90, densely or spirally arranged, spreading to reflexed, compressed, narrowly linear-ovoid, base subtruncate, 4--5X0.5--0.8mm, 2--3 flowered; Rachis lanceolate, broad wings of rachis 0.8--1mm connects two flower. Glumes brown on sides, elliptic, tightly imbricate, oblong lanceolate, 2.85--3.23X0.53mm, vein several with middle 3 conspicious green, keeled, apex obtuse, margin involute. Stamens 3; dark brown, anthers broadly linear, 0.65--0.7X0.15--0.18mm; connective prominent beyond anthers. Style 0.38--1.13mm; Stigmas 3, 1.85--2mm. Nutlet yellowish green in young to dark brown in mature, narrowly oblong, 1.2--1.7X0.25--0.28mm, trigonous, apex apiculate 0.18mm, granulated or minutely punctuate.

Distribution Range: Africa, Afganisthan, Pakistan, India, Nepal (Map 8), Bhutan, Sri Lanka, China, Japan, Myanmar, Laos, Vietnam, S. E. Asia, Australia.

Altitude: 150 to 2600m

Ecology: Roadsides, field- borders and fields; 150-2600m.

Flowering and Fruiting: April - December

Uses: Used as vermifuge and fodder

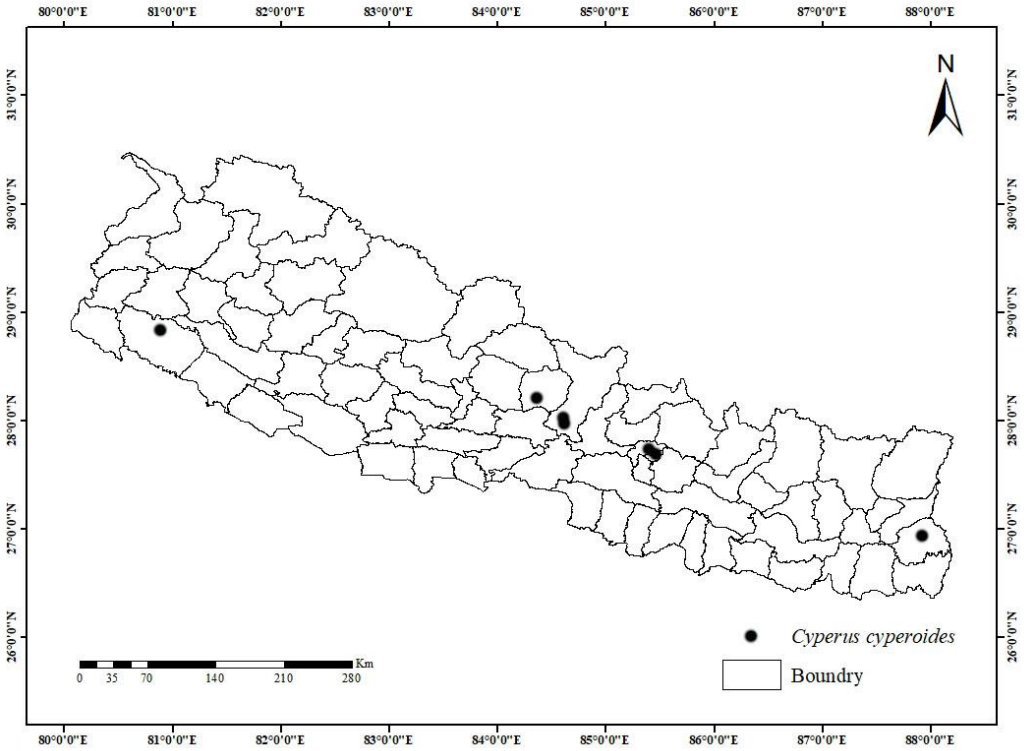
Voucher Specimen: Bhaktapur, Changunarayan, 1356.7m, 15th August 2020, *K. Basukala* and *S. Potamahan* KB20 (TUCH).

Specimens examined

West Nepal: Kailali district, Sahjipur, 1300m, 1976.6.20, H. Tabaha, *K. R. Rajbhandari* and *K. Tsuchiya* 138 (KATH)

Central Nepal: Lamjung district, Jagat, 1300m, 1983.8.8, *K.R. Rajbhandari* 9153 (KATH). Kavre, Khopasi, 1447m, 15th June 2019, *K. Basukala* and *S. Potamahan* KB023(KATH). Bhaktapur, Changu Mangaltar, 1445m, 15th August 2020, *K. Basukala* and *S. Potamahan* KB026(KATH). Bhaktapur, Sudal-8, 1402.1m, 14th September 2020, *K. Basukala* and *S. Potamahan* KB028(KATH).

East Nepal: Ilam district, Mai Khola, 2000ft., 1969.6.1, *T.B. Shrestha* 14363 (KATH).



Map 8. Distribution of *Cyperus cyperoides* in Nepal based on herbarium records.

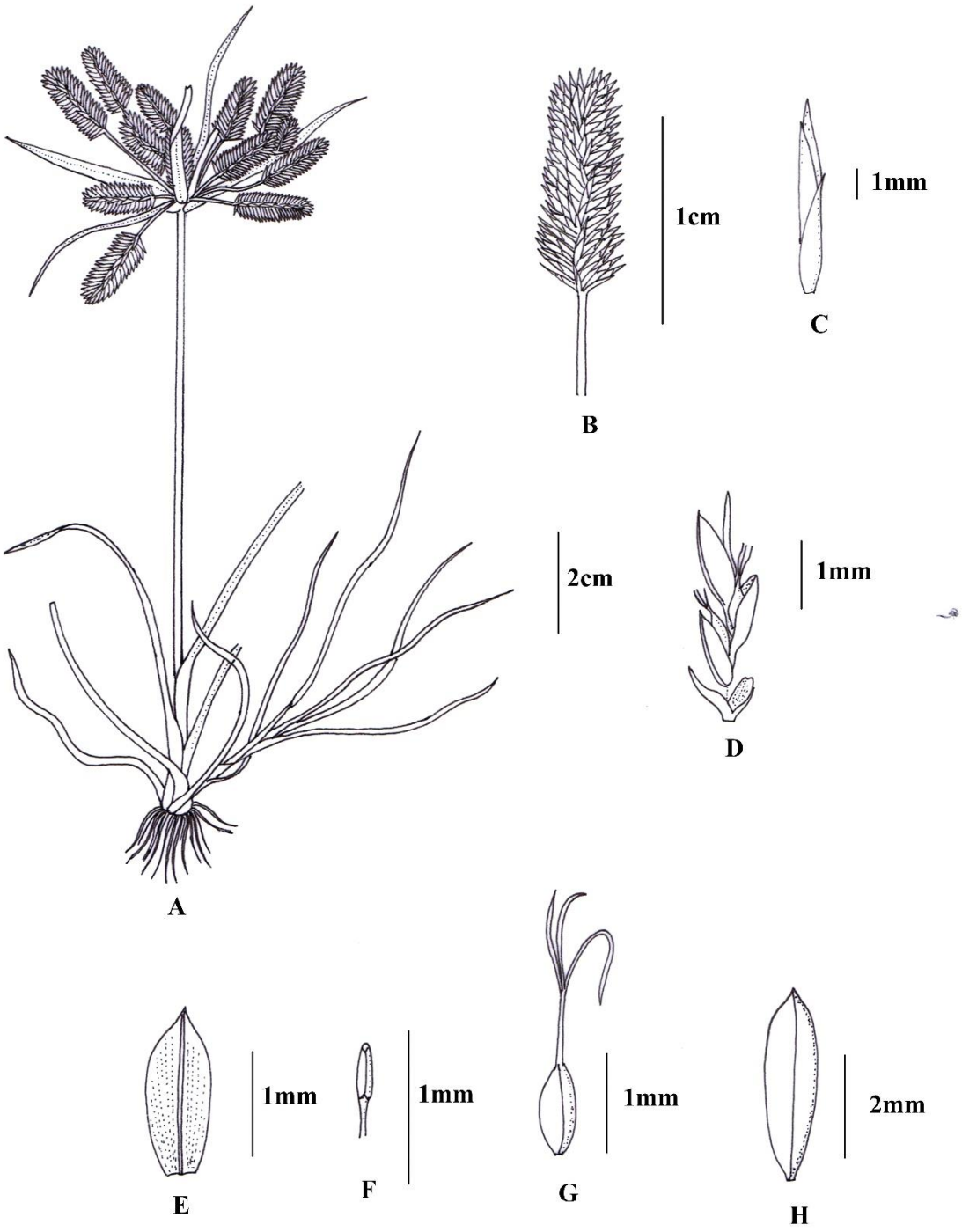


Figure 8: Cyperus cyperoides (L.) Kuntze, Revis.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D** Spikelet showing rachilla and glume arrangement, **E**. Glume, **F**. Anther **G**. Fruiting Pistil, **H**. Nutlet. (Based on Basukala et al., KB21 TUCH).

8. Cyperus difformis L., Cent. Pl. 2: 6 (1756). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1; 107 (1978). Rajbhandari in Rajbhandari and Baral, Cat.Nep. Fl. Pl. 1: 91(2010) (Plate 119). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et.al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus oryzetorum Steud., Syn.Pl. Glumac.2: 24 (1854)

Type Specimen: Anon., s.n. LINN-HL70-10. **Lectotype:** LINN

Annual, height 11.5--40cm. Roots fibrous, reddish brown colour. Culm densely tufted, 4.5 --35cm tall, tufted, flaccid, compressed triquetrous, smooth, basal part with few leaves. Leaf sheath yellow brown with reddish tint, 1.8--6.1cm, mouth margin straight open; leaf blade 2, 3.2--29X0.2--0.3cm, apex acute, scabrous, abaxially midvein and margin smooth. Involucral bracts 3, 0.8--5.5X1.2--3.5cm, acute adaxially, revolute. Inflorescence simple anthela, 6--8.6cm X 3.5-- 6.4cm; rays 4--6, 0.2--4cm; tubular prophyll 3mm, cladoprophyll 1.3cm. Spikes 4--6, capitate, 2.1--2.5X0.5--1.4cm; Spikelets 40--51 more than that, aggregated at the apex into a capitulum, compressed orbicular, narrowly ovoid-linear, 3--4X1mm, 7--13 flowered; Rachis solid straight, internode 0.2mm, wingless rachilla. Glumes yellowish green on sides, closely imbricate, obovate, rounded, 0.55X0.35mm, 3 veined keeled, apex obtuse emarginated short mucro 0.025mm, margin narrowly scabrous. Stamens 3; yellwish green, ellipsoid, 0.31mmX0.38mm; connective not prominent beyond anthers. Style 0.02mm; Stigmas 3, Nutlet yellowish, narrowly obovate elliptic, 0.56--0.6X0.25--0.33mm, trigonous, base barely stipulate to cuneate, apex apiculate, rugose texture.

Distribution Range: Europe, Africa, Afganisthan, Pakistan, India, Nepal (Map 9), Bhutan Bangladesh, Sri Lanka, China, Japan, Myanmar, Laos, Vietnam, S. E. Asia, Australia, Korea, Vietnam.

Altitude: 100 to 2700m

Ecology: Grassland, damp roadsides, field edges and beside rivers

Flowering and Fruiting: June - October

Uses: Fodder

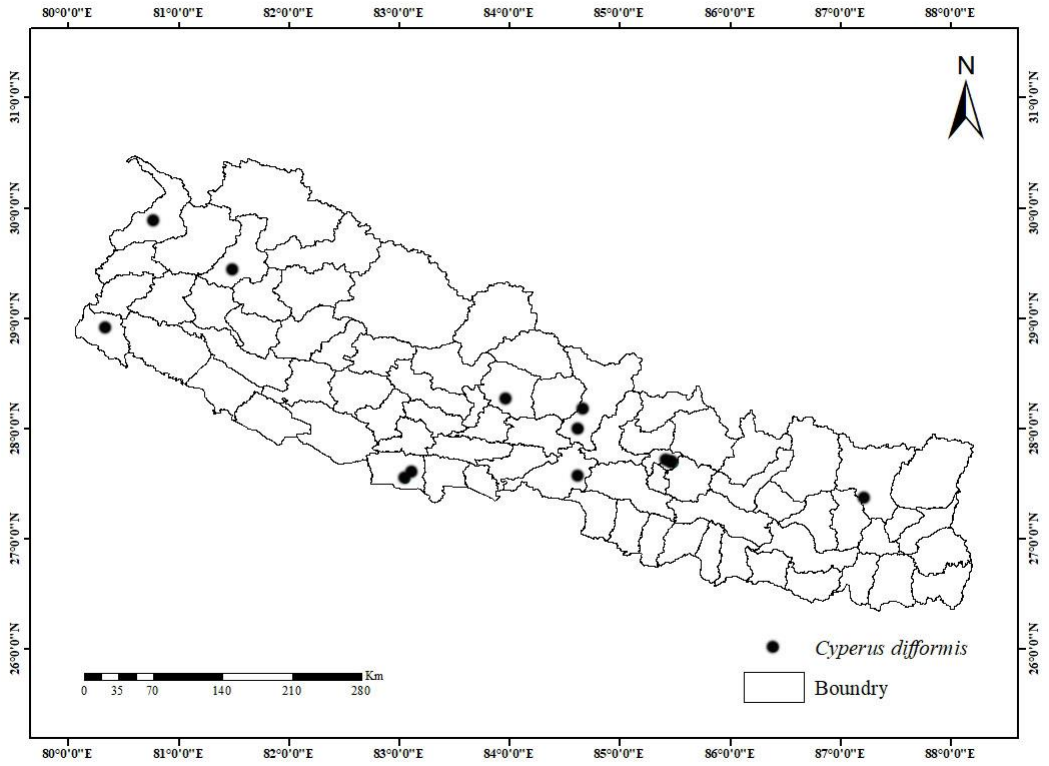
Voucher Specimen: Bhaktapur, Kasan, 1252.2m, 23rd August 2019, *K. Basukala* KB08 (TUCH).

Specimens examined

West Nepal: Kanchanpur District, Mahendranagar, 160m, 1980. 8. 3, *K.R. Rajbhandari, P.M. Regmi* and *K. J. Malla* 5010 (KATH)

Central Nepal: Chitwan District, Sauraha, 240m, 1978. 5. 11, *H. Tabaha, K. R. Rajbhandari* and *Y. Shimizu* 9753 (TI). Gorkha, Salbutephat, 1001m, 8th July 2019, *K. Basukala* and *S. Potamahan* KB130 (KATH). Gorkha, Batasechok, 1165m, 8th July 2019, *K. Basukala* and *S. Potamahan* KB127 (KATH). Bhaktapur, Kalighat, 1441m, 5th November 2020, *K. Basukala* KB030(KATH).

East Nepal: Nepal, Norkett 6644 (BM).



Map 9. Distribution of *Cyperus difformis* in Nepal based on herbarium records.

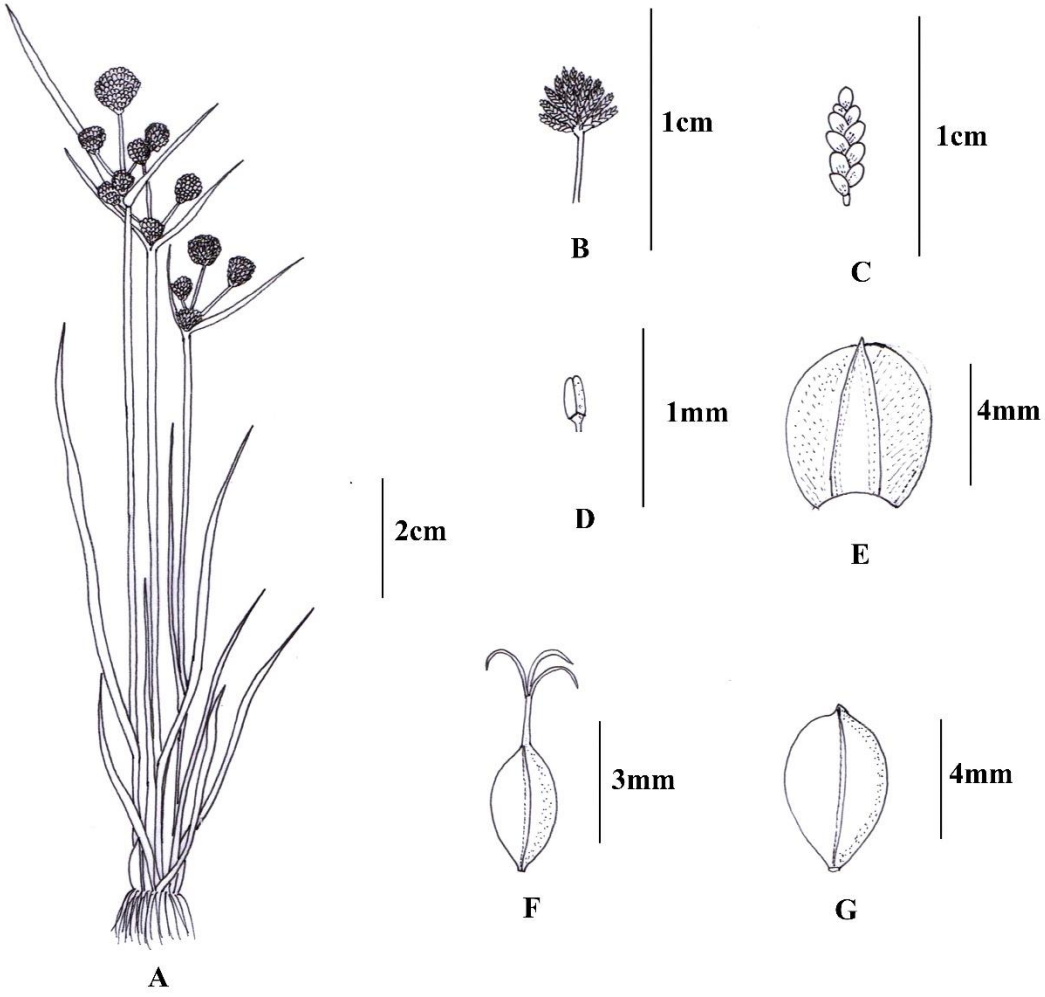


Figure 9: Cyperus difformis L.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala K., KB08 TUCH).

9. Cyperus diffusus Vahl, Enum. Pl. 2: 321 (1805). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 107 (1978). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et.al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus buettneri Boeck., Beitr. Cyper. 1: 3 (1888).

Cyperus laxus Lam., Tabl. Encycl. 1: 146 (1791). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1: 92 (2010).

Type Specimen: India, C10010239. **Holotype:** C

Perennials, height 27--37.5 cm. Rhizomes short, hardened. Culm solitary, 24--32 cm tall, triquetrous, smooth, several leaved at basal part. Leaf sheath pale green to reddish brown, 4-- 4.3cm, mouth margin obliquely open; leaf blade 6--7, flat, 12--55cm, acute apex, margin scabrous. Involucral bracts 7--8, foliose, 3.8--33X0.1--0.5cm, acute adaxially, revolute. Inflorescence a decompound anthela 3--7 X 6.8--10cm; primary rays 10 pair, 0.8--4.5cm; secondary rays 3--7 pair, 0.5--1.8mm; tertiary rays or raylets 1--5, 2--7mm; digitately arranged; tubular prophyll of primary rays 3--4mm; secondary rays 2mm, cladoprophyll secondary rays 0.6--1cm. Spikes 3--10, digitate, 2.1--2.5X3.5--4.5cm; Spikelets 1--5, aggregated digitately at the apex of spike, slightly turgid, linear oblong, 3-7X2mm, 6--13 flowered; Rachis solid, quadrangular, internode 0.5mm with winged rachilla 1mm. Glume redhhish brown on sides, laxly imbricate, broadly ovate, 1.58--1.63X0.58--0.8mm, 7--11 veined, keeled, apex rounded with recurved mucro (0.25mm--0.28mm). Stamens 3; anthers linear, 0.33X0.25mm, connective 0.53mm; Style very short,0.3mm; Stigmas 3, 0.45--0.5mm. Nutlet yellowish in inmature to dark brown in mature, ellipsoid, 1.28--1.45X 0.48--0.7mm, trigonous, base slightly cuneate (0.05mm), apex apiculate (0.075mm), surface reticulate.

Distribution Range: India, Nepal (Map 10), Bhutan, Sri Lanka, China, Myanmar, Vietnam, S. E. Asia, Australia,

Altitude: 150m to 1600m

Ecology: Wet ground

Flowering and Fruiting: June - September

Uses: Fodder

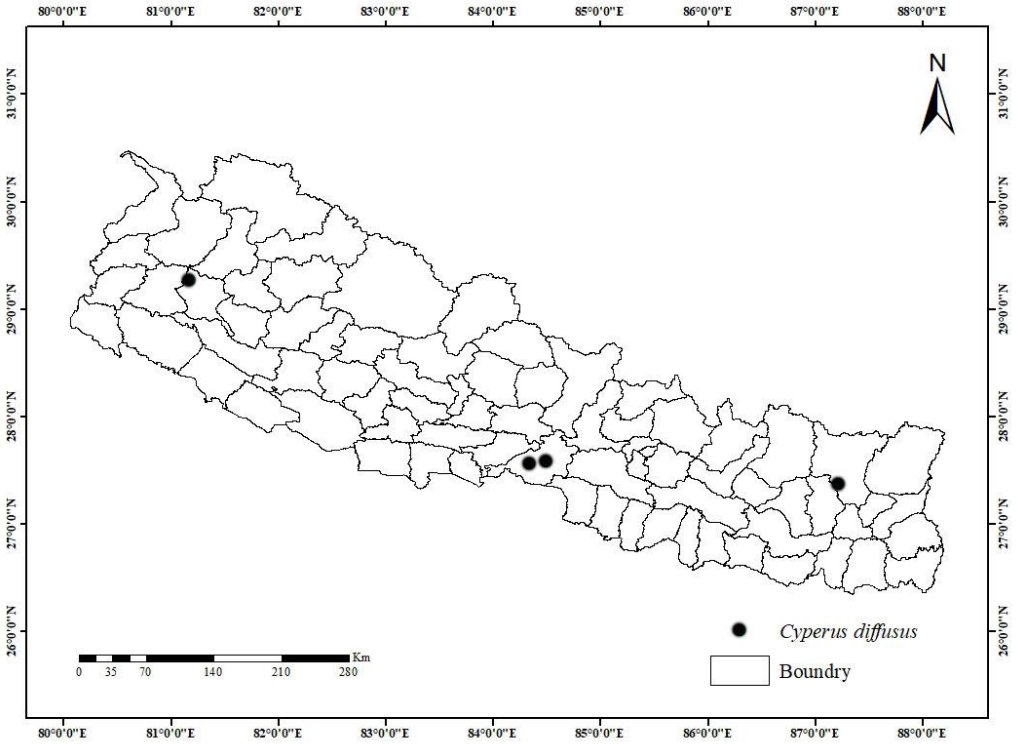
Voucher Specimen: Chitwan, Kasara, Chitwan National Park, 166m, 27th August 2019, *K. Basukala* and *S. Potamahan* KB10 (TUCH).

Specimens examined

West Nepal: Bajura district, Tolebhir – Berma, 1535 am, 1991.8.9, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K. R. Rajbhandari, H. Takayama* and *K. Terada* 9193910 (TI).

Central Nepal: Chitwan district, Sauraha – Devi Tal, 160m, 1996.6.21, *M. Mikage, N. Acharya, T. Kurosawa, P. Lacoul* and *A. Takahashi* 9614241 (KATH). Chitwan, Ghaireghari Kasara, 166m, 27th August 2019, *K. Basukala* and *S. Potamahan* KB70(KATH).

East Nepal: Sankhuwasabha district, Sedua – Num, 1590 -1540m, 1988.8.2, *M. Suzuki, T. Maeda, N. Naruhashi, R. Watanabe, M. N. Subedi, M. Minaki, S. Noshiro* and *H. Ikeda* 8821199 (KATH).



Map 10. Distribution of *Cyperus diffusus* in Nepal based on herbarium records.

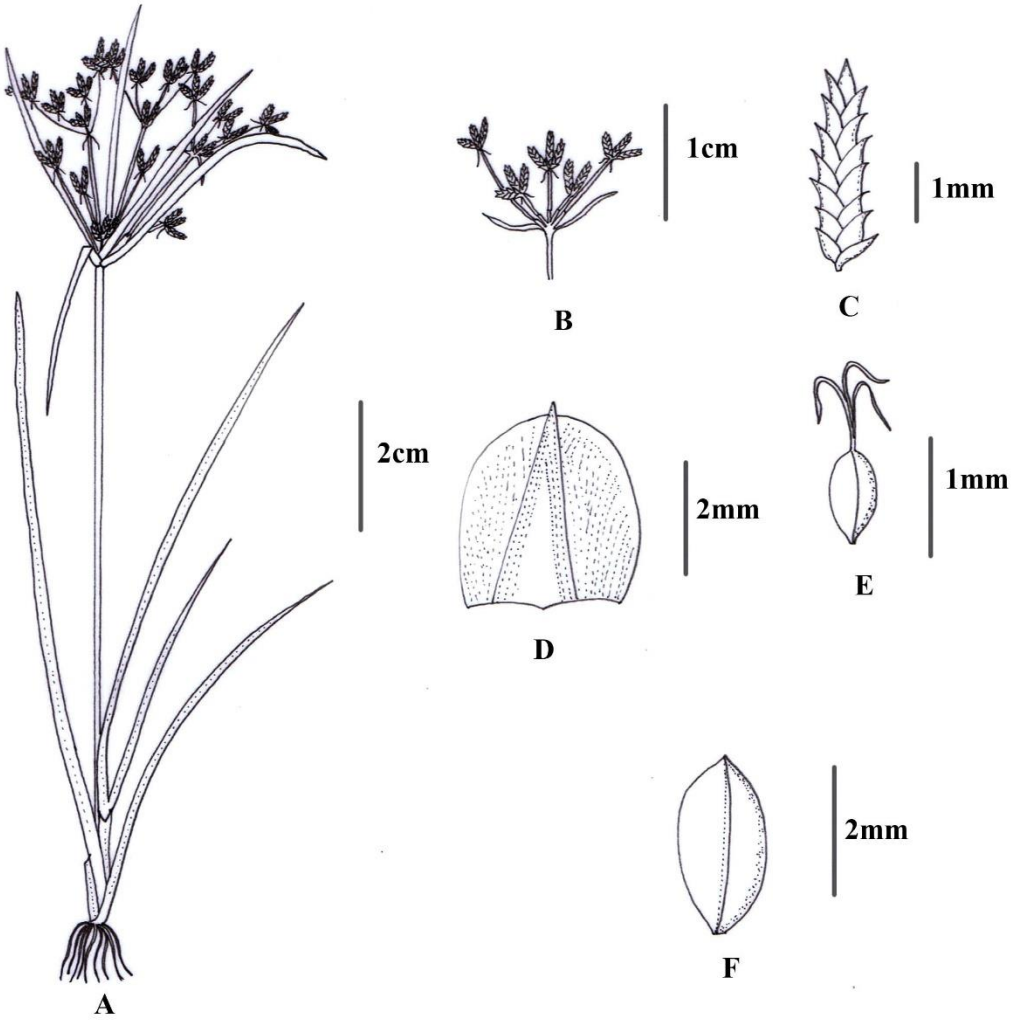


Figure 10: Cyperus difusus Vahl.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **G**. Fruiting Pistil, **F** Nutlet. (Based on Basukala et al., KB10 TUCH).

10. Cyperus digitatus: Roxb., Fl. Ind. 1: 209 (1820). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 107 (1978). Rajbhandri in Rajbhandari and aral, Cat. Nep. Fl. Pl. 1: 91 (2010). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et.al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus glomeratus Roxb. Ex Arn., Contr. Bot. India: 85 (1834)

Cyperus tuberiferus Steud., Nomencl. Bot.ed. 2, 1:474 (1840).

Type Specimen: Type: "East India", Roxburgh; ex Hrb. Forsyth in Hrb. Bentham, (K!).

Perennials, height 126cm to 1.5m. Rhizomes hard woody. Culms tufted, 103.5--108cm X0.4--1.4cm, tall, triquetrous, stout, basal with few leaves. Leaf sheath reddish brown, 2.5--7.5cm, mouth margin obliquely open; leaf blade 2, flat, 87--120cm, acute apex, margin scabrous. Involucral bracts 9, foliose, 7.5--61X0.1--1cm, acute adaxially, revolute. Inflorescence a compound anthela 23X14cm; primary rays 10, 3--18cm; secondary rays or raylets 4--7 pair, 1--1.5cm, digitately arranged; tubular prophyll of primary rays 2--3cm; secondary rays 5--7mm, cladoprophyll primary rays 1.5--3.8cm. Spikes 4--7, digitate, cylindric, at apex of raylet, sessile, 4.5--5.2X1.6--2cm; Spikelets 14--53 aggregated laxly at the apex of spike, compressed, linear- narrowly ovoid, 1--1.4X0.1--0.2cm, 13--17 more than that flowered; Rachis solid, quadrangular, internode 0.7mm with winged rachilla 1mm. Glume reddish brown on sides, densely imbricate, ovate-elliptic, 2.7--3.013X0.65--0.68mm, 3--5 veined, keeled, apex acute, mucronate (0.8--01mm). Stamens 3; anthers linear, 0.98X0.13mm. Style long, 1.25mm; Stigmas 3, 0.75--1.5mm. Nutlet greyish brown, oblong-ellipsoid, 1.33--1.5X0.4--0.53mm trigonous, apex apiculate (0.08mm to 0.13mm), surface rugose.

Distribution Range: Africa, Pakistan, India, Nepal (Map 11), Bangladesh, Sri Lanka, China, Myanmar, Vietnam, S. E. Asia, Australia, Vietnam, America

Altitude: 250-1100m.

Ecology: Marshy place, edge of stream

Flowering and Fruiting: July - December

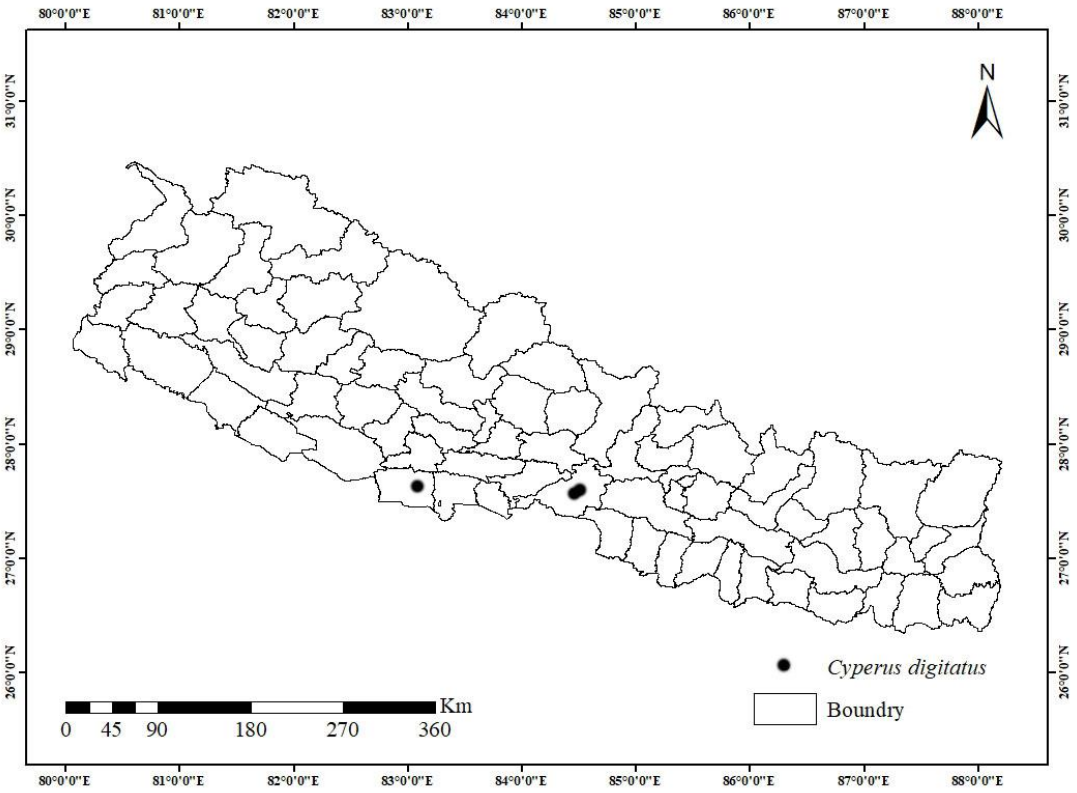
Uses: Fodder

Voucher Specimen: Chitwan, Budhi Rapti river, Chitwan National Park, 167m, 31st August 2019, *K. Basukala* and *S. Potamahan* KB14 (TUCH).

Specimens examined

West Nepal: *O. Polunin, W.R. Sykes* and *L.H.J. Williams* 1266 (BM).

Central Nepal: Chitwan District, near Sauraha Camp, 250m, 1976.7.3, *R. G. Troth* 895 (KATH). Chitwan, Budhi Rapti River, 167m, 24th August 2019, *K. Basukala* and *S. Potamahan* KB65(KATH).



Map 11. Distribution of *Cyperus digitatus* in Nepal based on herbarium records.

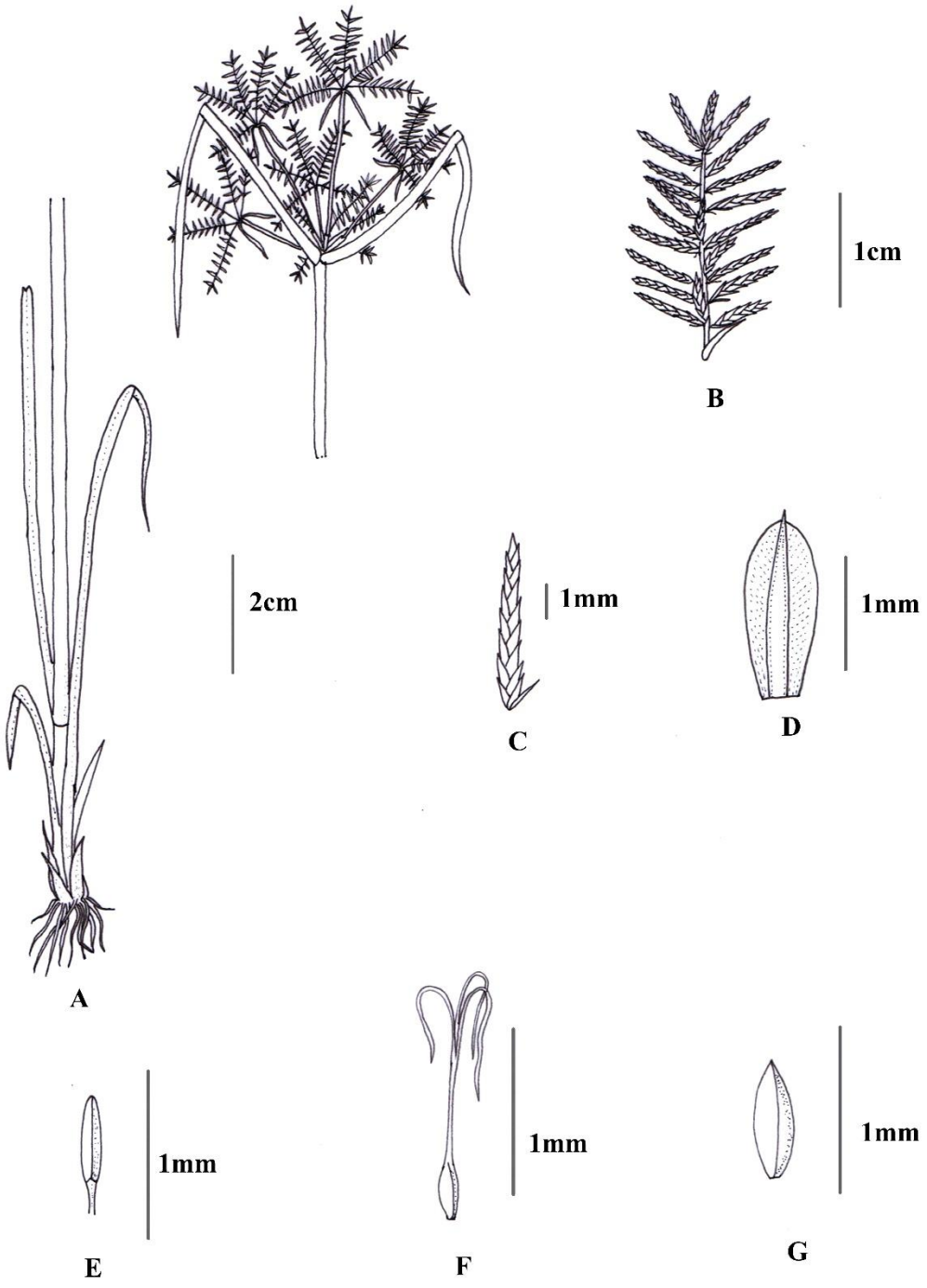


Figure 11: Cyperus digitatus Roxb.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB14 TUCH).

11. Cyperus distans: L.f., Suppl. Pl. 103 (1782). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 107 (1978). Rajbhadari and Baral, Cat. Nep. Fl. Pl. 1: 91 (2010). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Type Specimen: Bahia, P. Salzmann s.n. K 000188731. **Holotype:** K

Perennials, height 20--60cm. Rhizomes hard woody. Culms single or tufted, 28.5--39cm X0.2 -- 0.4cm, triquetrous, basal with few leaves. Leaf sheath "grey to dark purple" 2.5--8.5cm, mouth margin straight open; leaf blade 4--5, flat, 15--49X0.4--0.6cm, acute apex, margin scabrous. Involucral bracts 7, foliose, 2--40X0.2--0.65cm, acute adaxially, revolute. Inflorescence decompound anthela 12X6cm; primary rays 10--14, 0.5--18.5cm; secondary rays 4--6, 0.3--5.2cm,tertiary rays or raylets 3--5, 0.8--1.5mm, alternately distichous; tubular prophyll of primary rays 1.6--3cm; secondary rays 0.7cm, tertiary rays 0.2cm, cladoprophyll primary rays 5.6--7.7cm, secondary rays 1.7--7.7cm, tertiary rays 2.5cm. Spikes 4--6, subflabelliform, 4.3--4.2 X 3--4.1cm; Spikelets 8--18, sub distichous, laxly arranged, subterete linear, 1.3--1.6 X 0.1cm, acute apex, obliquely spreading, 11--13 flowered; Rachis solid, dark brown, internode 1.2mm, rachilla wings white hyaline, lanceolate 0.8--1mm. Glume redhhish brown on sides, laxly imbricate, ovate-elliptic, 1.63X 0.5mm, 3--5 veined, keeled, apex rounded. Stamens 3; anthers linear, 0.6mm, connective 1.48--1.53mm. Style 0.75mm; Stigmas 3, 0.3mm. Nutlet yellowish green to brown, oblong-ellipsoid, 1.23X0.45mm trigonous, apex apiculate and base cuneate, granulated.

Distribution Range: Africa, India, Nepal (Map 12), Bhutan, Cambodia, China, Japan, Myanmar, Laos, Vietnam, S. E. Asia, S. W. America, Australia, Vietnam, Loas.

Altitude: 500-1100m.

Ecology: Weed on roadside and field-edges

Flowering and Fruiting: July - August

Uses: Fodder

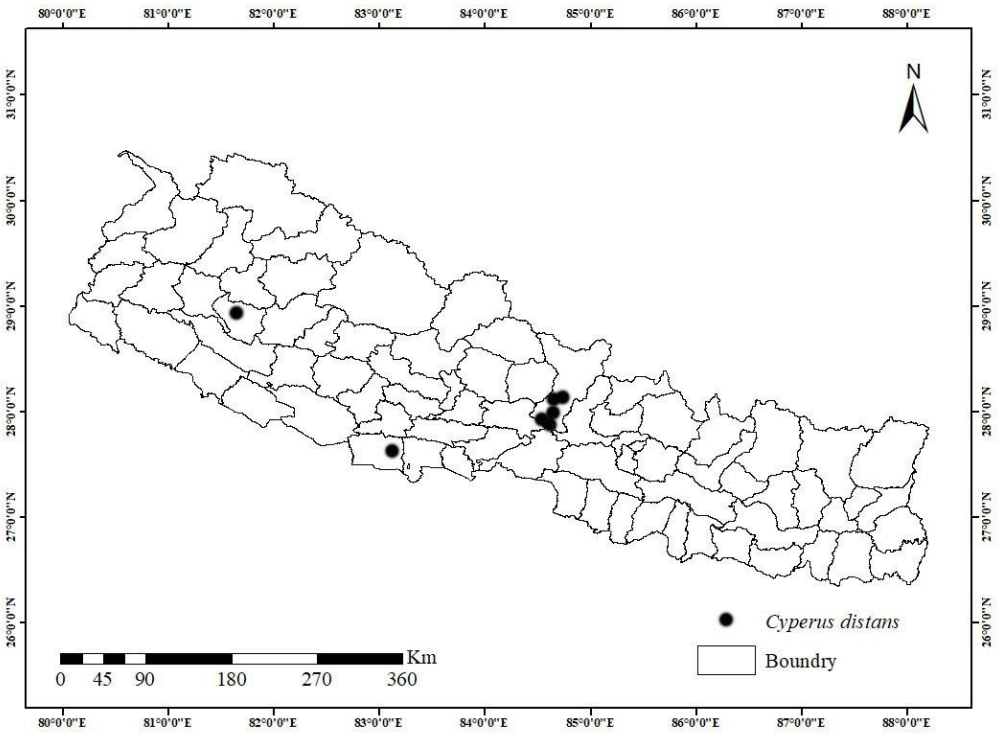
Voucher Specimen: Gorkha, 12 kilo Bazar, 437m, 9th July 2019, *K. Basukala* and *S. Potamahan* KB02 (TUCH).

Specimens examined

West Nepal: Dailekh district, Ranimatta – Dungesar, 700m, 1991.7.31, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K.R. Rajbhandari, H. Takayama* and *K. Terada* 9170149 (TI). Kapailvastu, Bikuli, 87m, 23rd August 2019, *K. Basukala* and *S. Potamahan* KB28(KATH).

Central Nepal: Sangru – Koprang, 740m, 1970.1.11, *H. Kanai* 670613 (KATH). Tanahu, 12 Kilo bazar, 437m, 9th July 2019, *K. Basukala* and *S. Potamahan* KB32(KATH). Sindupalchok, Bhotang, 1810.7m, 11th August 2019, *K. Basukala* and *S. Potamahan* KB008 (KATH). Chitwan, Kasara, 163m, 24th August 2019, *K. Basukala* and *S. Potamahan* KB38(KATH).

East Nepal: Sankhuwasabha district, Manebhanjyang - Chandanpur, 1000m, 1989.9.13, *K. R. Rajbhandari* 13542 (KATH).



Map 12. Distribution of *Cyperus distans* in Nepal based on herbarium records.

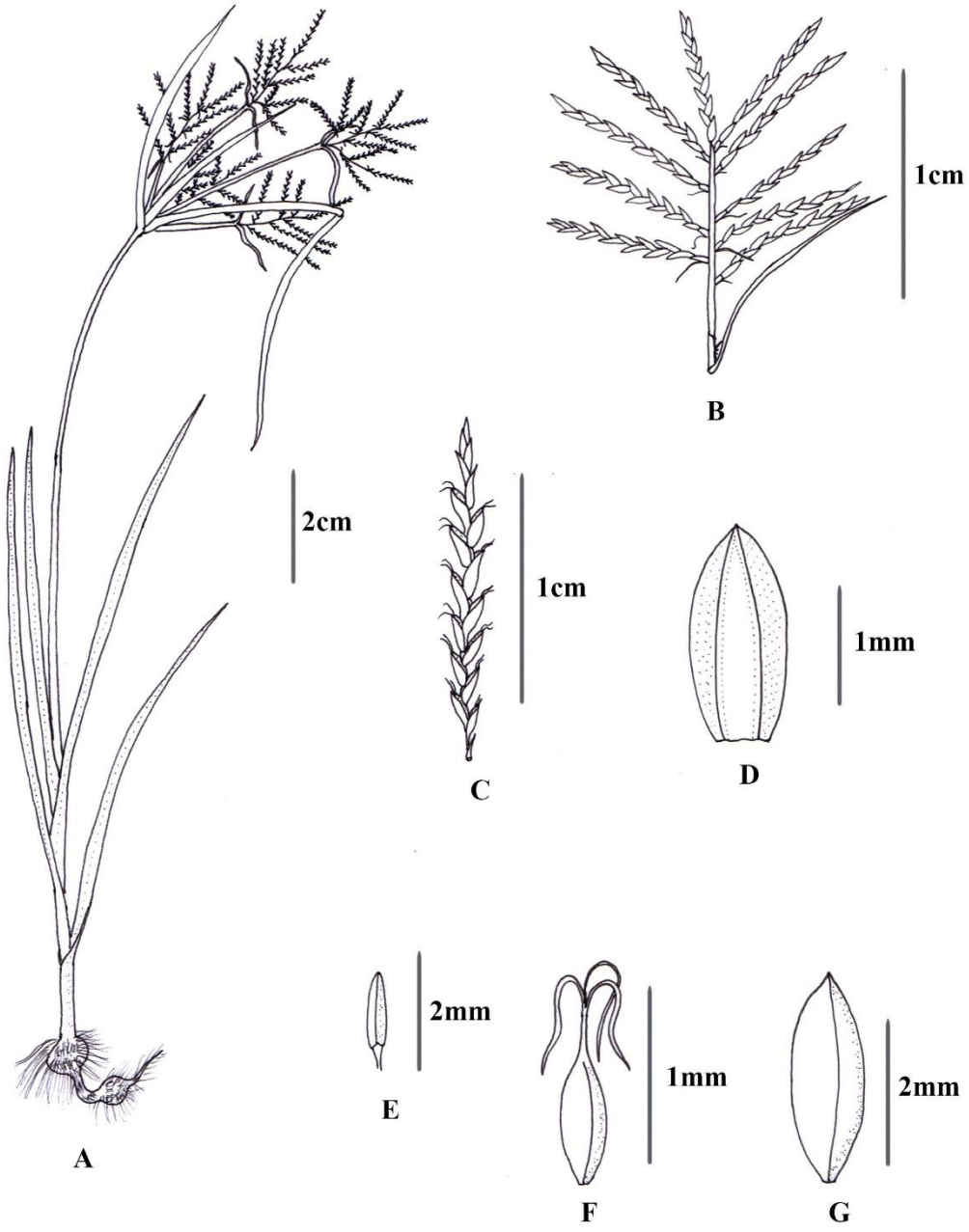


Figure 12: Cyperus distans L. f.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB02 TUCH).

12. Cyperus dubius Rottb., Descr.Icon. Rar. Pl.: 20 (1773). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha et.al., A Hand. Fl. Pl. Nep. 1: 237 (2018). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha et.al., A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus capitellatus Schult., Mant. 2: 101 (1824)

Cyperus coloratus Vahl, Enum. Pl. Obs. 2: 312 (1805)

Cyperus daphaenus Ridl., J. Bot. 22: 16 (1884)

Kyllinga triceps Rottb., Descr. Icon. Rar. Pl.: 14 (1773). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 115 (1978).

Mariscus dregeanus Kunth, Enum. Pl. 2: 120 (1837).

Mariscus dregeanus Kunth var. *buchananii* C. B. Clarke, Fl. Cap. 7: 188 (1897)

Type Specimen: India Nandharadah, 1th October 1874, J. P. Rottler s.n. (K).

Perennials. Rhizomes short. Culms densely tufted, 8--40X0.2 cm tall, slender, compressed triquetrous, longitudinally sulcate, base swollen into a bulb shape and clothed with many brown rudimentary leaf sheaths. Leaf sheath brownish membranous, mouth margin oblique; leaf blade 5--30X0.2--0.4cm, flaccid, flat, scabrid on margin and mid rib. Involucral bracts 3-6, leaflike, 4--15X0.1--0.35cm pendent after anthesis. Inflorescences simple anthela, solitary greenish or dirty whitebhead, capitate, subglobose, 5--16X5--15 mm, with 1-3 spikes. Spike capitates or subglobose, 1.2--5X0.07--0.2cm. Spikelets densely clustered, slightly turgid, compressed, ovoid to narrowly ovoid, 3--7 X1--2 mm, 3--6 flowered; Rachilla broadly winged. Glumes pale to greenish on both surfaces but middle green, densely imbricate, broadly ovate, ca.2--4.2X1.4--2.5mm, densely brown punctate, 15-17 veined. Stamens (2 or)3; anthers linear-oblong, ca. 0.5 mm; connective prominent beyond anthers. Style of medium length; Stigmas 3. Nutlet dark grayish brown, obovoid to ellipsoid, ca. 1.5--2.2X0.6--1 mm, trigonous, densely punctuate.

Distribution Range: Old world tropics from Africa to North Australia.

Altitude: 900m

Ecology: Weed on roadside and open places.

Flowering and Fruiting: September-November

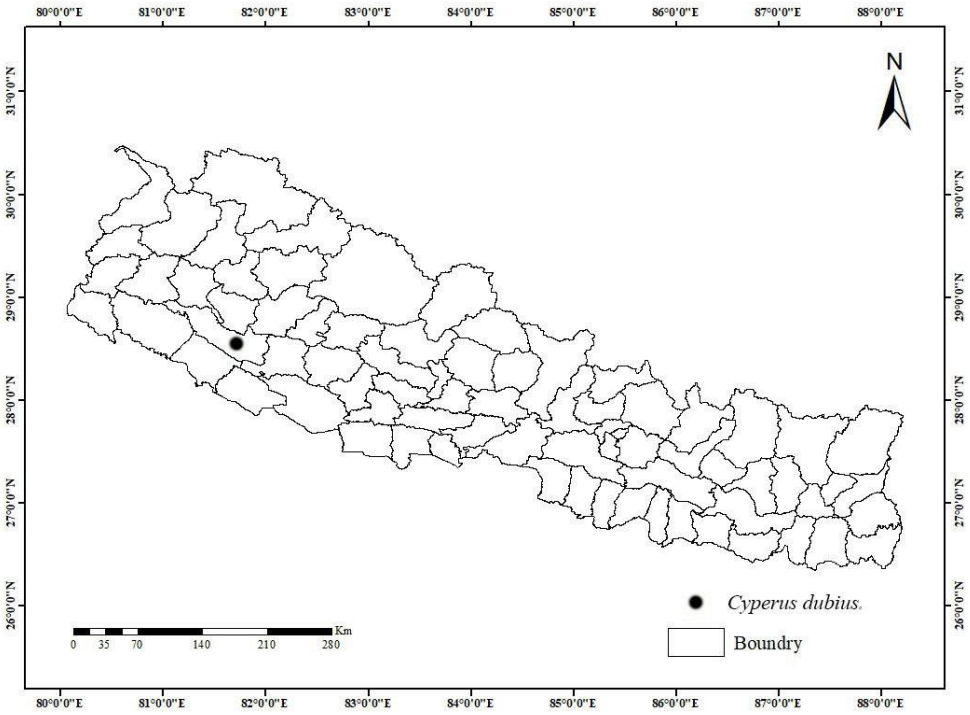
Uses: Used as cattle fodder

Note: Differ from kyllinga have 5-6 fertile white flower.

Specimens examined

West Nepal: Surkhet district, Surkhet – Katukuwa, 900m, 1991. 7. 29, *M. Suzuki, H. Hatta, N. Kurosaki, M Mikage, F. Miyamoto, K. R. Rajbhandhari, H. Takayama* and *K. Terada* 9170021(TI)

East Nepal: Nepal, *Poelt* s. n. (M)



Map 13. Distribution of *Cyperus dubius* in Nepal based on herbarium records.

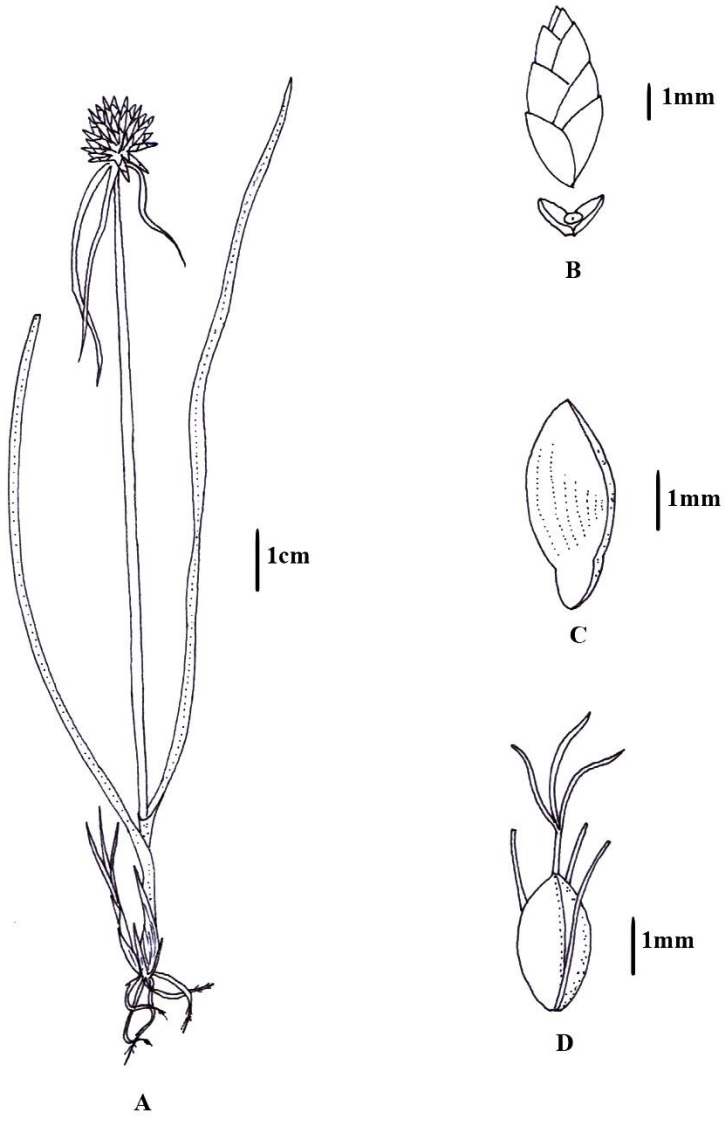


Figure 13: Cyperus dubius Rottb.; **A**. Habit Sketch, **B**. Spikelet, **C**. Glume, **D**. Nutlet, (Based on P. Vonter K000592553 K).

13. Cyperus eleusinoides: Kunth, Enum. Pl. 2: 39 (1837). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 107 (1978) (Plate 119). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017).

Cyperus mysurensis Heyne ex Wall., Numer. List: 116, n. 3346B (1831).

Cyperus nutans Vahl subsp. *eleusinoides* (Kunth) T. Koyama, Gard. Bull. Singapore 30: 136 (1977). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1: 92 (2010).

Cyperus nutans Vahl subsp. *eleusinoides* (Kunth) Haines, Bot. Bihar Orissa 5: 898(1924).

Type Specimen: Ethiopia, 4th April 1839, Schimper 1021. **Isolectotype:** K

Perennials, height 87.7cm--1m. Rhizomes short, surculose. Culms single or tufted, 68cm, triquetrous, stout, basal with few leaves. Leaf sheath brownish colour 7--23cm, mouth margin straight open; leaf blade 4, flat, 52.8--64X0.7--1cm, acute apex, margin scabrous. Involucral bracts 8, foliose, 5--42X0.2--0.9cm, acute adaxially, revolute. Inflorescence compound anthela 20.5X8cm; rays 11, 2.9--13.5cm; raylets 3--6, digitately arranged, 0.5--2.3cm; tubular prophyll of primary rays 0.09--2.3cm; secondary rays 0.5cm, cladoprophyll primary rays reduced form, secondary rays 3--4.2cm, below spikelets 1.9cm. Spikes 3--6, oblong to cylindric, 2.1--3.6X0.5cm; Spikelets cluster of 12--24, densely arranged spirally in different rows, linear-oblong, 0.7--1.1X0.2-- 0.25cm, 9--12 flowered; Rachis solid, dark brown, internode 0.8mm, rachilla wings white hyaline, caducous. Glume redhhish brown on sides, laxly imbricate, ovate-elliptic, 1.88--2.13X0.5--0.6mm, 7veined, keeled, apex mucronate(0.18mm). Stamens 3; anthers linear, 1.53X0.15mm, connective 0.98mm. Style 0.4mm; Stigmas 3, 1.18--1.38mm. Nutlet yellowish in inmaatur to dark brown in mature, obovoid, 1.33--1.45X0.4--0.43mm, trigonous, base cuneate (0.15mm), apex apiculate, rugose.

Distribution Range: Cambodia, India, Indonesia, Japan (Ryukyu Islands), Kashmir, Laos, Myanmar, Nepal (Map 14), Pakistan, Papua New Guinea, Philippines, Sri Lanka, Thailand, Vietnam; tropical Africa, SW Asia, tropical Australia.

Altitude: 100 to 1800m

Ecology: weed in fields and cultivated ground, Forests, mountain slopes, sunny water margins, wet places in valleys

Flowering and Fruiting: Aug–Dec.

Uses: Fodder

Note: Looks similar to *C. nutans* flowers smaller than nutans.

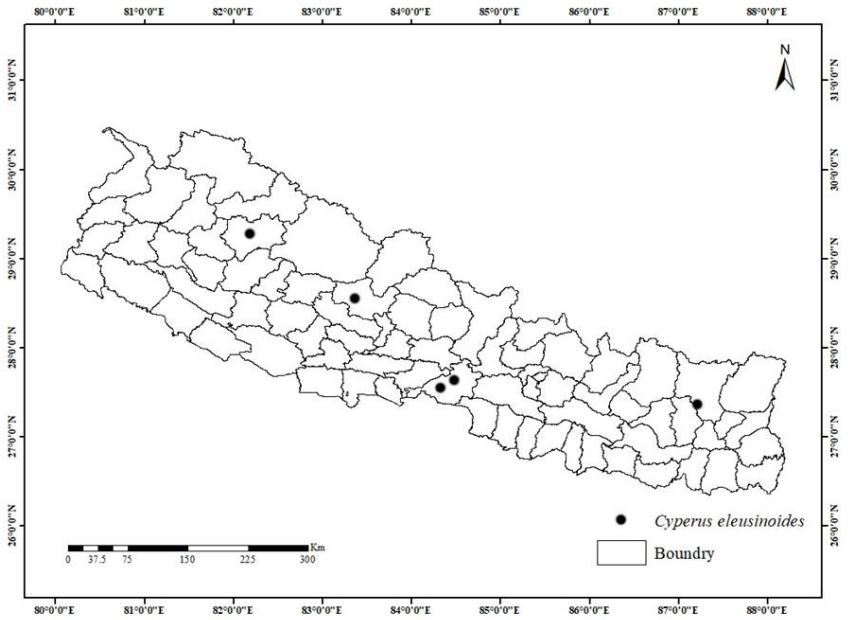
Voucher Specimen: Chitwan, Kasara, Chitwan National Park, 150m, 27th August 2019, *K. Basukala* and *S. Potamahan* KB11 (TUCH).

Specimens examined

West Nepal: Jumla District, Ratopani, 1333m, 1976.8.22, *H. tabata, K. R. Rajbhandari* and *Y. Shimizu* 2797 (TI).

Central Nepal: Myagdi district, Muri – Dhola Khola, 1760m, 1996.9.5, *M. Mikage, R, hirano, N. Kondo, R. Lacoul, C. Mohri, A. Takahashi* and *K. Yonekura* 9682251 (KATH). Chitwan, Kasara, 163m, 24th August 2019, *K. Basukala* and *S. Potamahan* KB83(KATH).

East Nepal: Sankhuwasabha district, Ramrista – Khahare, 360- 390m, 1988.7.4, *M. Suzuki, T. Maeda, N. Naruhashi, R. Watanabe, M. N. Subedi, M. Minaki, S. Noshiro* and *H. Ikeda* 8880132 (KATH).



Map 14. Distribution of *Cyperus eleusinoides* in Nepal based on herbarium records.

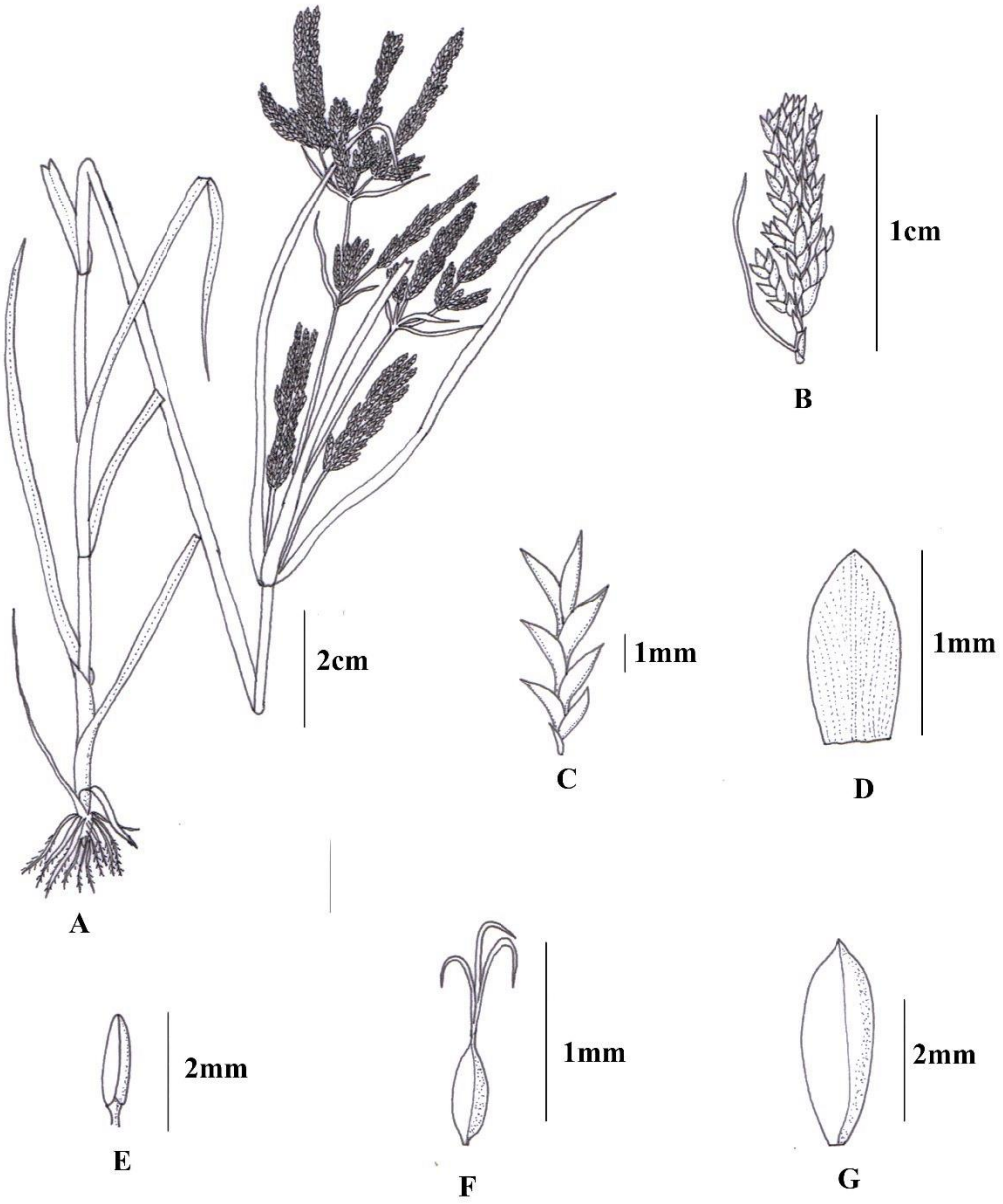


Figure 14: Cyperus eleusinoides Kunth.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB11 TUCH).

14. Cyperus esculentus: L., Sp. Pl.: 67 (1753). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 107 (1978). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1: 91 (2010). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Type Specimen: South Africa, 1875, A. Rehmann 4776. **Syntype:** K

Perennials. fibrous root, stolons several to c. 10 to 20cm and tubers 15mm, ellipsoid to globose, covered by greyish-brownish scales. Culm solitary, 10--80X0.2--0.3cm tall, slender, compressed triquetrous, slender at top, smooth, with several basal leaves. Leaf sheath yellowish or greyish brown, 50mm, mouth margin straight open; leaf blade 30X0.2--0.6cm, flaccid, flat, scabrid on margin and mid rib. Involucral bracts 2-6, leaflike, 30X0.5cm. Inflorescences simple or compound anthela; rays 5--10, 8--12cm; tubular prophyll 2 veined, c.1.5mm, base swollen; cladoprophyll 2mm. Spikes ovoid, with more than 20, 15X1.5mm. Spikelets clusters of 14 laxly arranged, distichous, subcompressed, linear to oblong, 1--1.5X1--1.8mm, oblique at maturity, 5--20 flowered; Rachis compressed, slightly zigzagging, internodes c. 1 mm, rachilla broadly winged. Glumes yellowish to golden or pale brown, laxly imbricate, ovate to ovate-elliptic, 2.2–2.6 mm, 5--9veined, keeled, apex subobtuse, truncate and mucronate, margin apically white hyaline, Stamens 3; anthers linear; connective prominent beyond anthers into small ovoid appendage. Style long; Stigmas 3, long, linear. Nutlet brownish gray, ellipsoid, ca. 2--2.2X 0.7--0.8mm, shiny, obtusely trigonous, papillate reticulate surface.

Distribution Range: South Europe, Africa, India, Nepal (Map 15), America

Altitude: 100m to 2300m

Ecology: Wet field, Moist place

Flowering and Fruiting: April - July

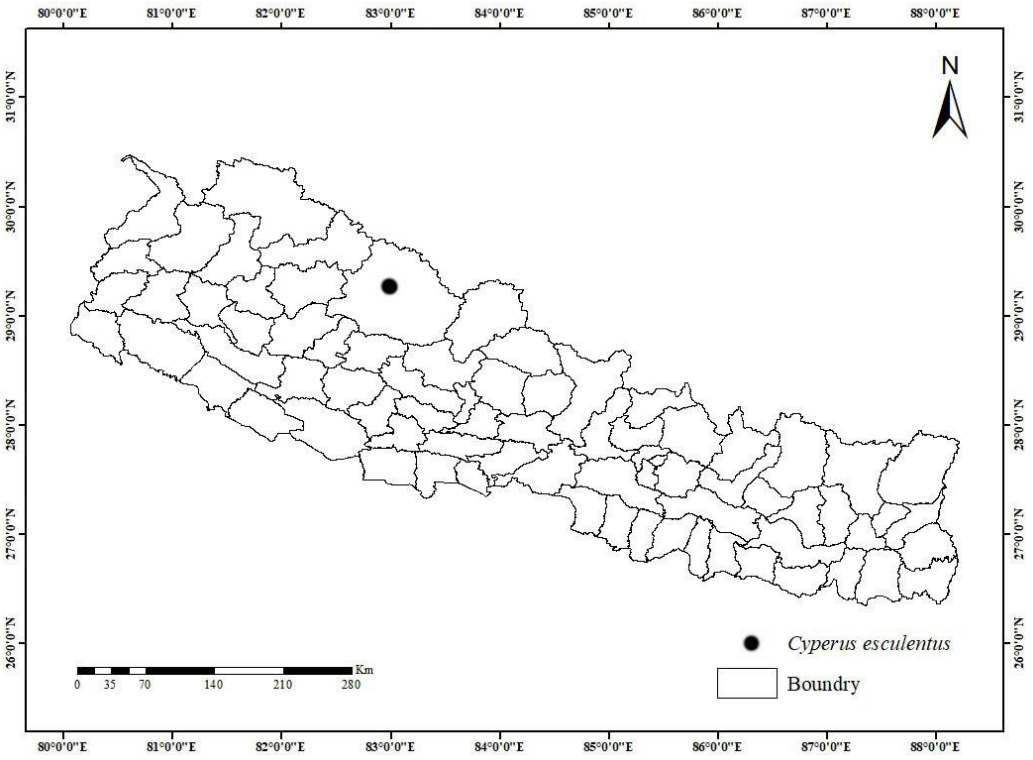
Uses: Fodder

Voucher Specimen: Kapilvastu, Jahadi, Taulihawa, 93m, 21st August 2019, *K. Basukala* and *S. Potamahan* KB06 (TUCH).

Specimens examined

West Nepal: Dolpa district, near Tribikot, 7500ft., 1952.7.17*, O. Polunin, W.R. Sykes and L. H. J. Williams* 2489 (KATH).

Central Nepal: Nepal, *J. Makin* 193 (BM). Kapilvastu, Jahadi, Taulihawa, 93m, 21st August 2019, *K. Basukala* and *S. Potamahan* KB135(KATH).



Map 15. Distribution of *Cyperus esculentus* in Nepal based on herbarium records.

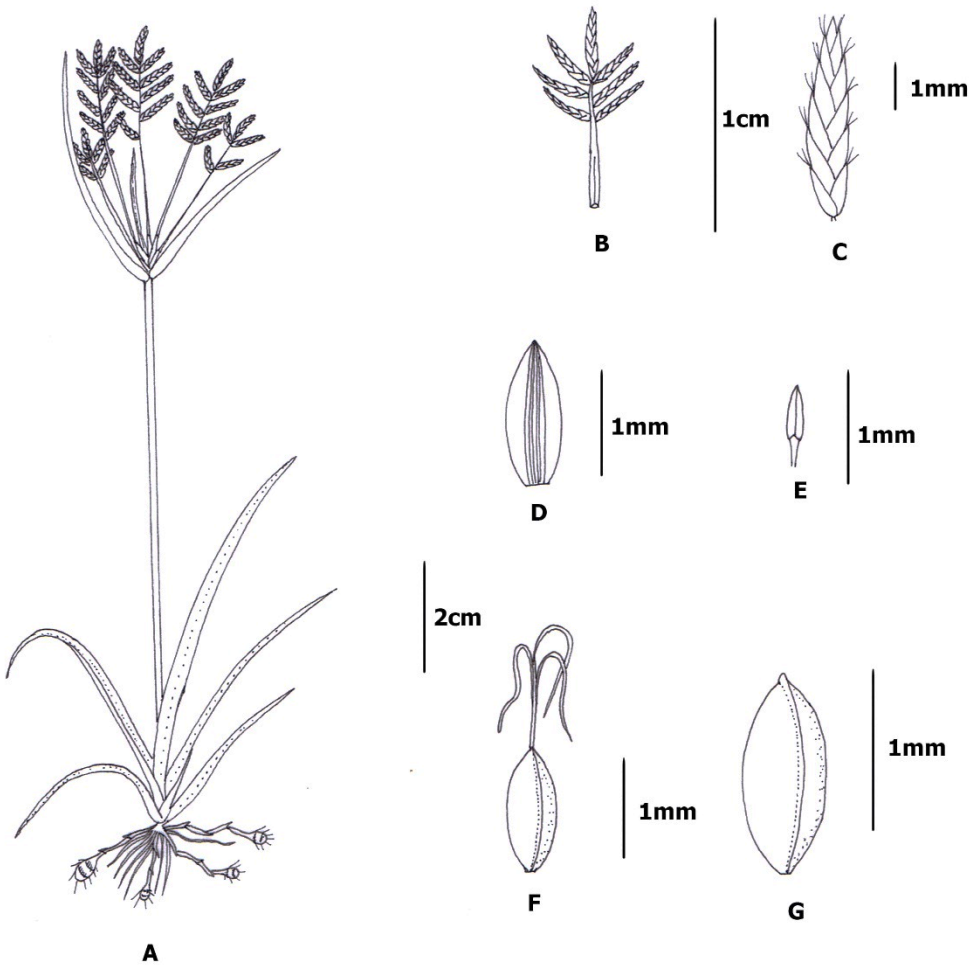


Figure 15: Cyperus esculentus L.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB06 TUCH).

15. Cyperus exaltatus Retz., Obs. Bot. 5: 11(1788). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1: 91 (2010). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Type Specimen: India, J.G. König s.n. LD1291907. **Type:** LD

Perennials, height 59cm--1.5m. Rhizomes thick woody. Culms 59--109.2X0.3--0.7cm tall, stout, triquetrous, smooth, basally with leaves. Leaf sheath yellowish brown to purple, 8.5--18.4cm, mouth margin oblique open; leaf blade 6, 76X0.4--0.6cm, flaccid, flat, scabrid on margin and mid rib. Involucral bracts 10, leaflike, 8--76X1.5--0.6cm. Inflorescences compound anthela 25X19.5cm; primary rays 12, 3.9--15cm; secondary rays or raylets 7--14, digitately, 2.4--4.5cm; tertiary rays or spikes 3--5,sessile, narrowly cylindric, 4.1--4.5X2.1--3.3m; tubular prophyll primary rays 1.7cm, secondary ray 5mm, tertiary rays 1--2mm; cladoprophyll secondary rays 8, 1.8--5.7cm, tertiary rays 1, 1--1.8cm. Spikelets clusters of 14--67, sub distichous to decussate, laxly to densely arranged, narrowly oblong ovoid, acute, compressed, 3X1mm, obliquely spreading, 7--9 flowered; Rachis solid zigzag, internodes 0.4mm, rachilla winged, white, linear, narrow, hyaline. Glumes dark reddish brown in middle to yellowish brown hyaline on both surfaces, slightly densely imbricate, ovate, concave, rounded, 1.28--1.43X 0.48--0.6mm, 5 veined, keeled, apex obtuse, mucronate (0.1 to 0.23mm), not excurved. Stamens 3; anthers linear, 0.25-0.36mX0.06mm, connective 0.2--0.13. Style 0.53--0.65 mm; Stigmas 3, 0.65--0.73mm. Nutlet yellowish green to greyish in mature, obovoid to ellipsoid, 0.28--0.5X 0.13--0.15mm, trigonous, elliptic, almost smooth.

Distribution Range: Africa, Pakistan, India, Nepal (Map 16), Bangladesh, Sri Lanka, China, Japan, Myanmar, Thailand, Vietnam, Malaysia, Philippines, Australia.

Altitude: 80 - 200m

Ecology: Moist places

Flowering and Fruiting: Jun - Nov

Uses: Fodder

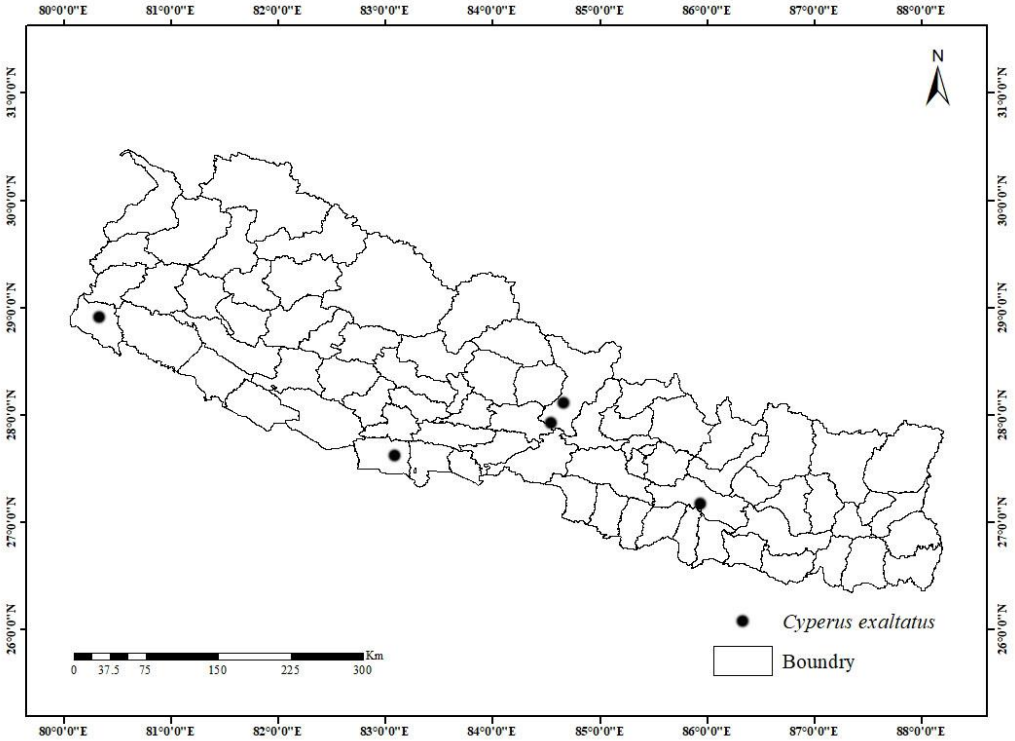
Note: Pedunculated spikelet, laxly arranged

Voucher Specimen: Kapilvastu, Banganga river, Jitpur, Taulihawa, 78m, 21st August 2019, *K. Basukala* and *S. Potamahan* KB07 (TUCH).

Specimens examined

West Nepal: Kanchanpur district, Mahendranagar, 160m, 1980.8.3, *K. R. Rajbhandari, P. M. Regmi* and *K. J. Malla* 5001 (KATH).

Central Nepal: Sindhuli district, Khirenigaon, 500ft., 1975.12.21, *P.R. Shakya* and *K. R. Rajbhandari* (KATH). Tanahu, 3 Kilo bazar, 325m, 11th July 2019, *K. Basukala* and *S. Potamahan* KB52(KATH).



Map 16. Distribution of *Cyperus exaltatus* in Nepal based on herbarium records.

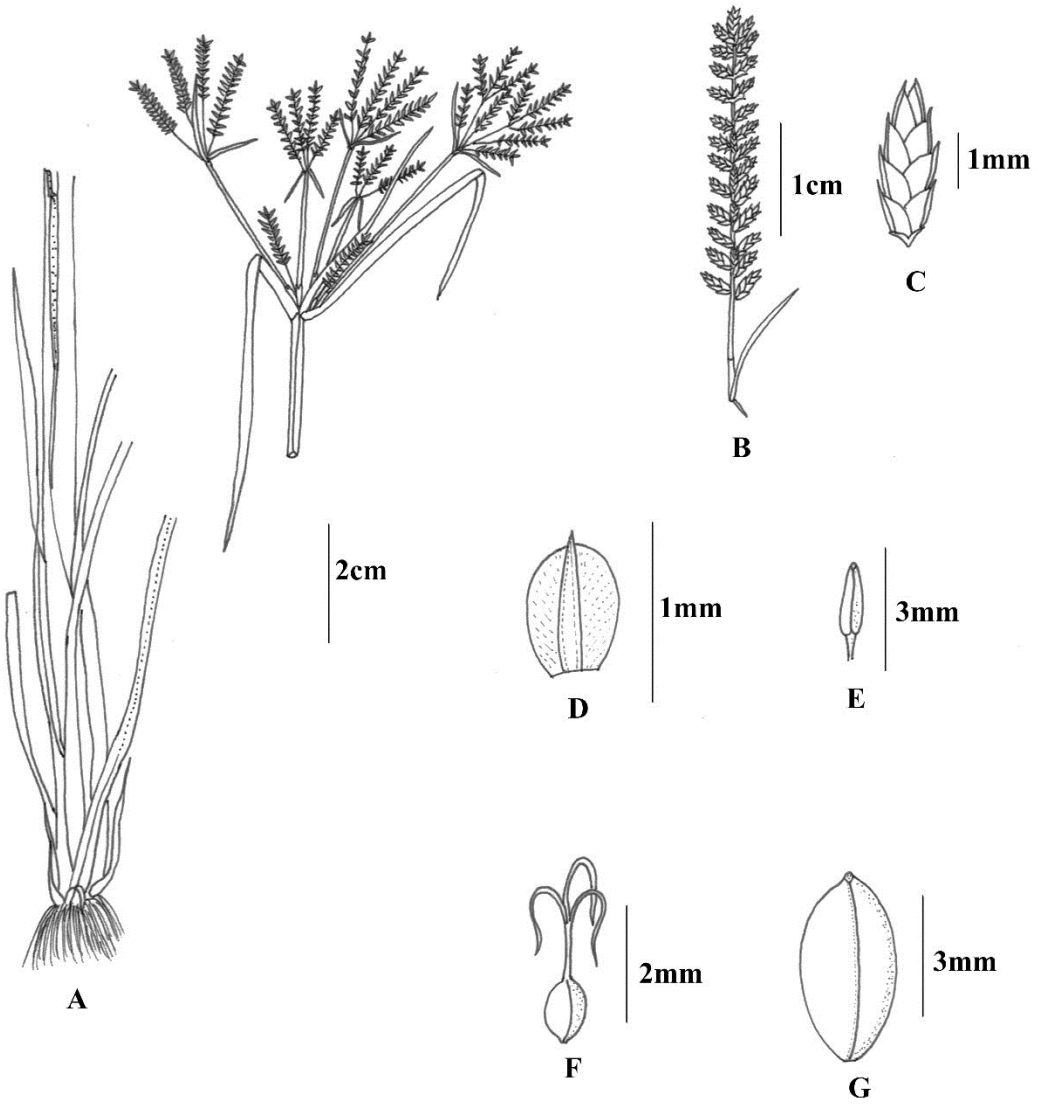


Figure 16: Cyperus exaltatus Retz.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB07 TUCH).

16. Cyperus fuscus L., Sp. Pl. 1:45 (1753). Rajbhandari *et. al.,* Cat. Nep. Fl.pl. Suppl.1: 20 (2015). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus virescens Hoffm., Deutschl. Fl. Ed. 2, 1 (1): 21 (1791).

Type Specimen: Bosnia and Herzegovina, 1886-08, Conrath, Paul, **Holotype:** GZU

Annuals. Roots fibrous. Culms caespitose, 2--30X0.6 to 1.5cm, tall, slender, compressed triquetrous, soft, smooth, basally few leaved. Leaf sheath brown or reddish brown, mouth margin concave; leaf blade shorter than to sometimes subequaling culm, 4--10X2--4 mm wide, long, flat, trigonous, apex acute, scabrous, margin smooth. Involucral bracts 2 or 3, leaflike, 3--20X0.15--0.3mm. Inflorescence a compound or sometimes simple anthela; primary rays 1–5, 0.2--3cm, secondary rays 5mm. Spikes 50, 3--15X1.5--2 mm, compressed, tight, with 10-40 glumes. Spikelets 3--12, densely arranged spikelets, very narrowly ovoid to linear, slightly compressed, 3--10X0.6--1mm, 8--34 flowered; Rachis laterally compressed or quadrangular, brown or, usually, dark reddish brown, shiny, almost straight, internodes c. 0.5 mm, rachilla wingless. Glumes purplish brown, brownish, brown, or pale yellowish on both surfaces but middle yellowish green, slightly laxly imbricate, broadly ovate, cymbiform, ca.0.9--1.3X1mm, obscurely 3veined, apex obtuse. Stamens 2; anthers ca.1mm, ellipsoid; connective not prominent beyond anthers. Style short 0.3--0.4mm; Stigmas 3,0.3mm. Nutlet yellowish brown or light brown, ellipsoid, 0.7--0.9X0.4mm, trigonous, base barely stipelike to narrowly cuneate, apex acute and apiculate, surface glabrous, granulated texture.

Distribution Range: Europe, Africa, Afganisthan, Pakistan, India, Nepal (Map 17), China, Mongolia, Laos, Vietnam, C. Asia, S. W. Asia, Thailand.

Altitude: 1300 - 1400m

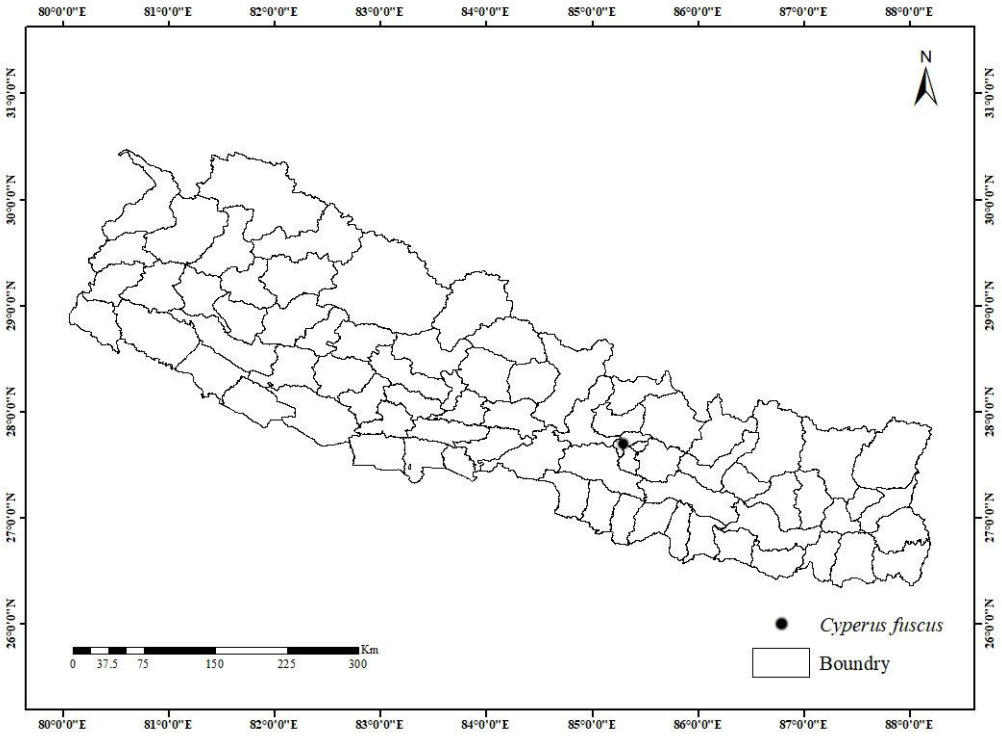
Ecology: River bank

Flowering and Fruiting: Jun - Oct

Uses: Fodder

Specimens examined

Central Nepal: Kathmandu district, Kathmandu, 1310m, 1971.9.287, *N. P. Manadhar* 4721 (KATH).



Map 17. Distribution of *Cyperus fuscus* in Nepal based on herbarium records.

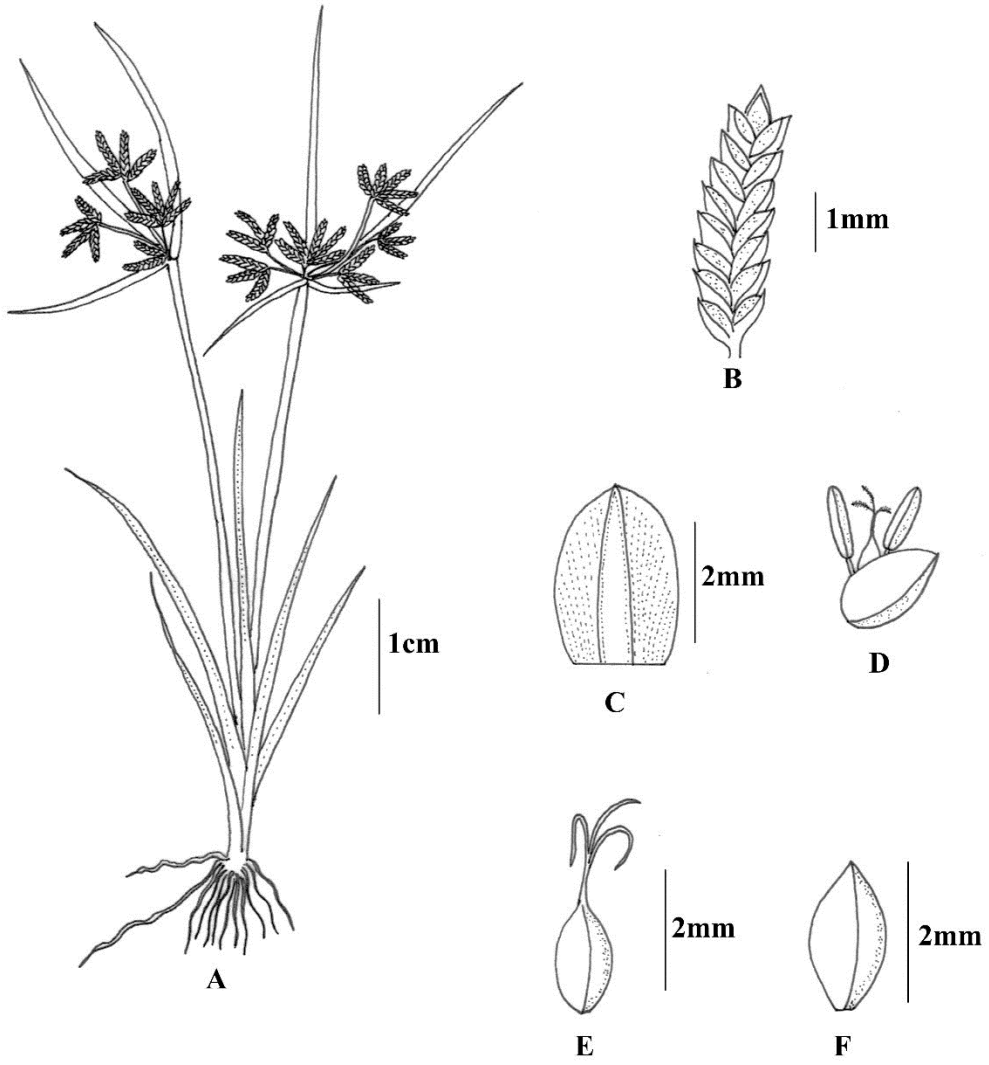


Figure 17: Cyperus fuscus L.; **A**. Habit Sketch, **B**. Spikelet, **C**. Glume,**D.** flower showing anther and stigma, **E**. Fruiting Pistil, **F**. Nutlet. (A Based on Dr. Fr. Nebelek SAV0004178 and B, C, D, and F based on Dai et al. 2010)

17. Cyperus haspan L., Sp. Pl. 1: 45 (1753). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1; 107 (1978). Rajbhandari in Rajbhandari and Baral, Cat.Nep. Fl. Pl. 1: 92(2010). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Type specimen: 1753, BM000621655 **Lectotype:** BM

Annual, height 19.8--26cm. Roots fibrous, reddish. Culm single or tufted, 16.8--21.2X0.1--0.2cm diam., sharply trigonous, flaccid, slender, smooth. Leaf sheath reddish brown in lowerside to yellowish green at top, 1.7cm to 6cm, mouth margin oblique; leaf blade 1, 4.8--9.5X0.2--0.3cm, acute apex, margins and keel smooth, apex acute, slightly scabrous. Involucral bracts 2, foliose, 2.3--9X0.1--0.2cm, acute adaxially, apex scabrous. Inflorescence compound anthela 6.3--7.5 X 3.5--8cm; primary ray 11--15, 0.8--6cm; secondary rays 3--7, 0.5--1.2cm; tertiary rays 2--6, 2--4mm; raylets 2--6, digitately arranged, 2--4mm; tubular prophyll primary rays 3mm, secondary rays 6mm; cladoprophyll reduced form. Spikes 3--7, digitate, 1.9--3.5X 0.6--1cm. Spikelets cluster of 2-6 digitately arranged at apex of ray, compressed, linear to narrowly linear ovoid, 2--4X 0.6--1mm, 5--13 flowered; Rachis solid, straight, tetraangular, reddish brown, internode 0.5mm, wingless rachilla. Glume reddish brown on sides, densely imbricate, oblong ovate to subelliptic, 0.88--0.93X 0.2--0.31mm, 2--3 veined, keeled, apex rounded to subtruncate, mucronate. Stamens 3, narrowly oblong, 0.25mm, connective 0.8mm. Style 0.25mm; Stigmas 3, 0.3--0.33mm. Nutlet whitish to yellowish in colour, broadly obovoid, 0.33--0.35X 0.23--0.25mm, trigonous, base cuneate, apex mucronate, tuberculate or granuated.

Distribution Range: Africa, S.W., India, Nepal (Map 18), Bhutan, Srilanka, China, Korea, Japan, Myanmar, Vietnam, S.E. Asia, Australia, America

Altitude: 1000m to 1800m

Ecology: sand by river margins, swamps, ditch margins in valleys, wastelands, wet places, along trails, dry fields, paddy fields

Flowering and Fruiting: July - November

Local Name: Moothe

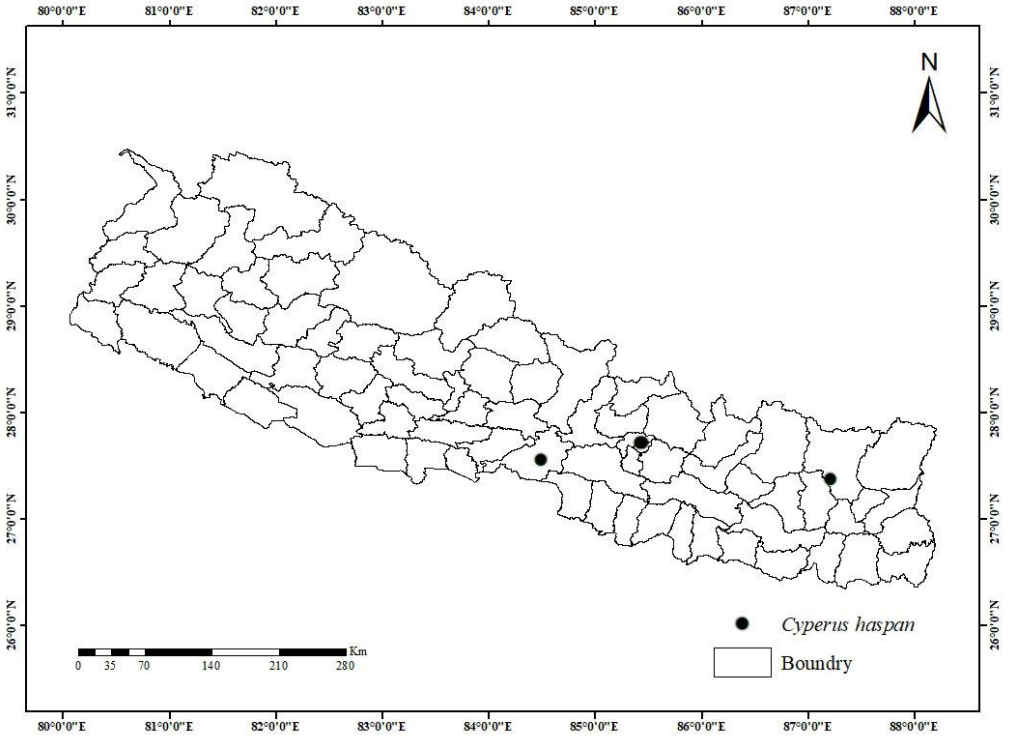
Uses: Salt is prepared from the ashes of the plant, Smoke from the pith of the plant is used as a febrifuge.

Voucher Specimen: Bhaktapur, Mangaltar Changunarayan, 1445m, 15th September 2019, *K. Basukala* and *S. Potamahan* KB16 (TUCH).

Specimens examined:

Central Nepal: Dolakha district, Kirantichhap, 1350m, 1977.8.2, *K. R. Rajbhandari* and *B. Roy* 2373(KATH). Gorkha, Salbutephat, 1001m, 8th July 2019, *K. Basukala* and *S. Potamahan* KB001(KATH). Bhaktapur, Changu Mangaltar, 1445m, 15th September 2019, *K. Basukala* and *S. Potamahan* KB006(KATH). Sindhupalchok, Dudhauli, 131m, 6th November 2020, *R. Kafle* and *K. Basukala* (KATH).

East Nepal: Sankhuwasabha district, Sedua-Tashigaon, 1730m, 1990.8.2*, M. Minaki, C. Yonebayashi, F. Miyamoto, H. Takayama, H. Sugita, H. Yagi, M. N. Subedi* and *H. Ikeda* 9070113(TI).



Map 18. Distribution of *Cyperus haspan* in Nepal based on herbarium records.

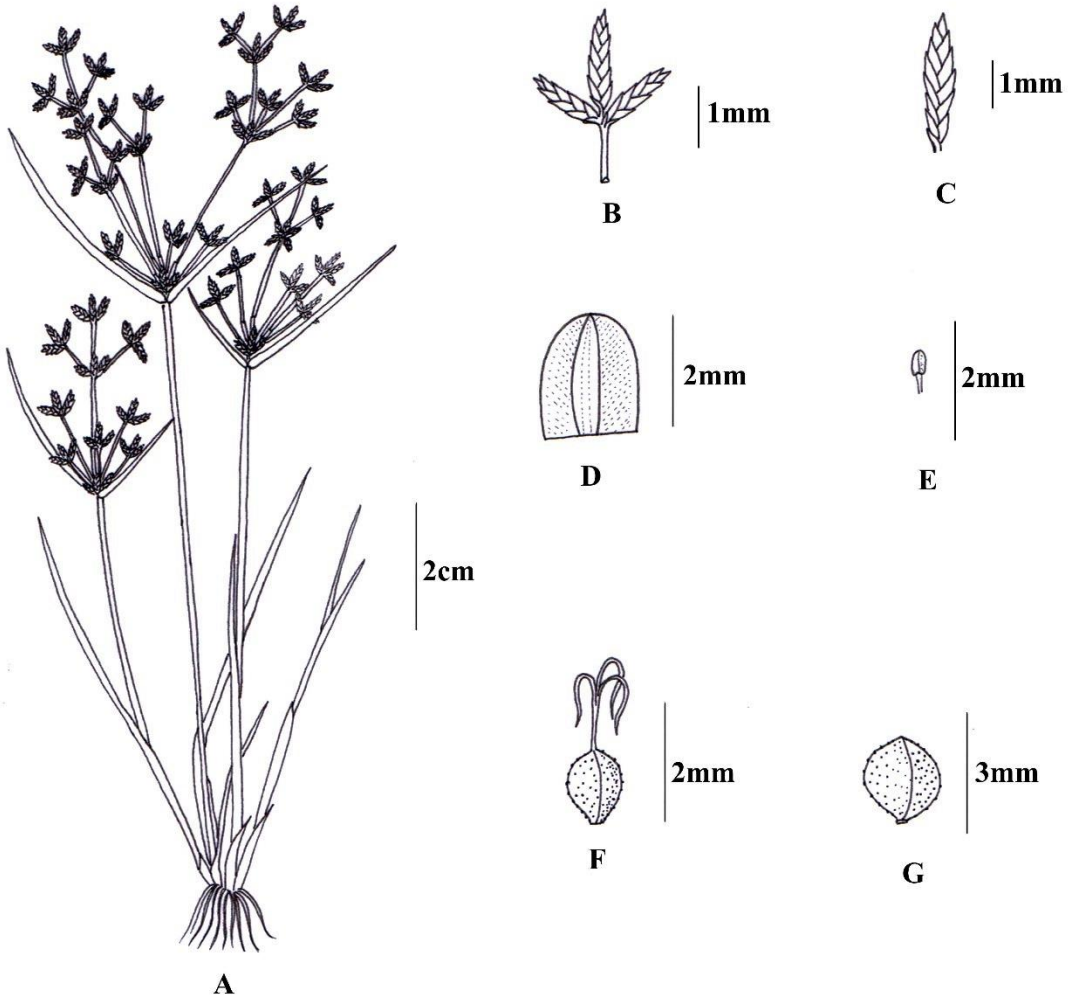


Figure 18: Cyperus haspan L.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB16 TUCH).

18. Cyperus imbricatus Retz., Observ. Bot. 5: 12 (1788). Koyama in Hara *et al.,* Enum. Flow.Pl. Nepal 1: 107 (1978). Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1: 92 (2010) (Plate 120). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus radiates Vahl, Enum. Pl. 2: 369 (1806).

Type Specimen: India, J. G. König, s.n. LD1281107. **Holotype:** LD.

Perennial, height 68--86.7cm. Rhizome short, ascending or horizontal, with tillers. Culm 58.3--79.5X0.3--0.4cm, trigonous, stout, smooth, with basal leaves. Leaf sheath reddish brown or dark brown, 2--21cm, mouth margin oblique; leaf blade 17-83X0.5cm, flat or folded, keeled, margins narrowly recurved, margins and keel towards apex scabrous, apex trigonous, acute, scabrous apex acute, margin scabrous. Involucral bracts 6, 5.8--57.3X 0.1--0.7cm, acute adaxially, margin revolute. Inflorescence compound anthela ,9.3--14.4X 5.5--6cm; primary rays 6--10, 2--10.8cm, secondary rays 6--10, 0.5--1.2cm, tertiary rays 2--3, sessile; raylets 6--10, digitately arranged, 0.5--1.2cm; tubular prophyll primary rays 1.5cm, secondary rays 2--4mm; cladoprophyll 0.4--2.7cm. Spikes 6-10, digitate, 1.7--3.3X0.2--0.6cm. Spikelets cluster of 7-11, spirally arranged, erect, linear, 2--4X1.5mm, 7--11 flowered; Rachis solid straight, internode 0.3mm, winged rachilla, lanceolate. Glume pale to brownish yellow on sides, densely imbricate, ovate, 1.18--1.33X0.25--0.7mm, 3--5 veined, not keeled, apex obtuse to retuse, mucronate (0.25mm to 0.3mm). Stamens 3, linear 0.23--0.3X0.1--0.13mm. Style 0.5 to 0.55mm; Stigmas 3, 0.23--0.35mm. Nutlets yellowish to greyish green colour, oblong, 0.65--0.7X0.33--0.38mm, triginous, apex rounded, base not cuneate, reticulate surface.

Distribution Range: Africa, S.W. Asia, Afghanistan, Pakistan, India, Nepal (Map 19), Bangladesh, China, Myanmar, Laos, Vietnam, S.E. Asia, America

Altitude: 100m to 200m

Ecology: Shallow water of ponds, shady moist places

Flowering and Fruiting: June - October

Local Name: Moothe

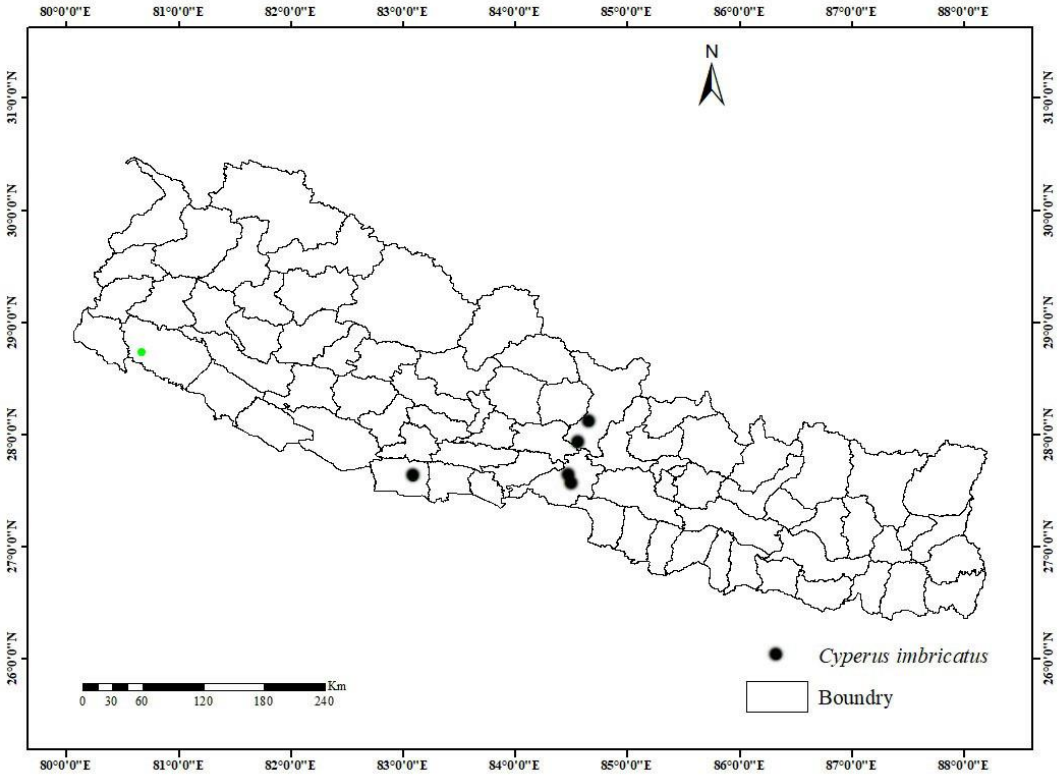
Use: The crushed rhizome is used as an aphrodisiac, he outer portions of the stems are stripped, dried in the shade, and used for weaving mats, mattings, and screens.

Voucher Specimen: Gorkha, 3 Kilo Bazar way to Gorkha, 325m, 11th July 2019, *K. Basukala* and *S. Potamahan* KB04 (TUCH).

Specimens examined:

West Nepal: Kanchanpur district, Royal Suklaphanta Wildlife Reserve, Pipariya along Mahakali river, 1996.10.9 *M. Mikage, N. Acharya, T. Kurosawa, P. Lacoul, A. Takahashi* and *K. Yada* 9689172(TI). Kapilvastu, Banganga river, 78m, 22nd August 2019, *K. Basukala* and *S. Potamahan* KB47(KATH).

Central Nepal: Chitwan district, Chitwan National Park, W of Suraha,140m,2004.11.22, *C.A Pendry, A. Giri, N, Pandey* and *M. Siwakoti* DNEP2B61 (KATH). Tanahu, 3 Kilo bazar, 325m, 11th July 2019, *K. Basukala* and *S. Potamahan* KB45(KATH).



Map 19. Distribution of *Cyperus imbricatus* in Nepal based on herbarium records.

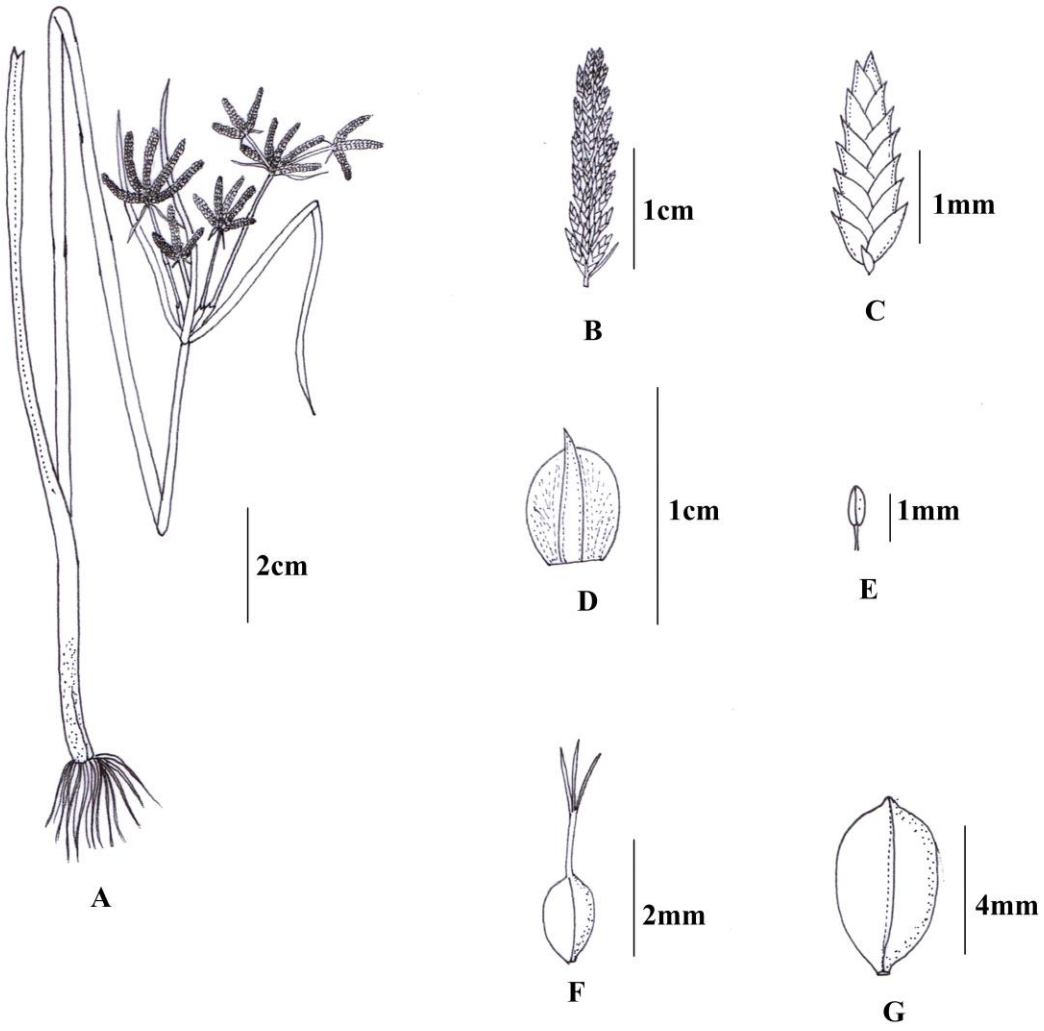


Figure 19: Cyperus imbricatus Retz.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB04 TUCH).

19. Cyperus iria L., Sp. Pl.: 45 (1753). Koyama in Hara *et al.* Enum. Flow. Pl. Nepal 1; 107 (1978). Rajbhandari in Rajbhandari and Baral, Cat.Nep. Fl. Pl. 1: 92(2010). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus diaphaniria Steud., Syn. Pl. Glumac. 2: 23 (1854).

Cyperus microlepis Baker, Fl. Mauritius: 410 (1877).

Type Specimen: Australia, 1874, Gosse 11. **Syntype:** K

Annual, height 20--80cm. Root fibrous. Culm tufted, compressed triquetrous, 15--52X1--3mm, slender to slightly stout, striated, with basal leaves. Leaf sheath brownish purple, 3--13.5cm, mouth margin straight open; leaf blade 3--4, 6--34X 0.3--0.35cm, margins and keel towards the apex scabrous. Involucral bracts 6--8, 2.2--32X0.3--0.4cm, acute adaxially, revolute. Inflorescence decompound anthela, 4.5--20X4--9.5cm; primary rays 6--10, 1.2--16.5cm; secondary rays 3--6, 0.2--0.5mm, tertiary rays sessile, distichously arranged; tubular prophyll primary rays 1.4--2mm, secondary rays 1--3mm; cladoprophyll primary rays 1.4--8mm, secondary rays 4--5mm. Spikes 6--10, digitately arranged, 0.8-16.6X0.5mm. Spikelets cluster of 7--30, laxly arranged, compressed, linear-oblong, obtuse, 0.4mm to 1.1cmX2mm, 5--14 flowered; Rachis solid, straight, internode 0.5--0.7mm, wingless rachilla. Glume yellowish brown, shiny, loosely imbricae, elliptic-obovate, obtuse, cymbiform, 1.5--1.53cmX0.08cm, apex rounded, mucronate, 3 veined, strongly keeled, margin scarious. Stamens 3, elliopsoid, connective not prominent beyond anthers; Style 0.05mm; Stigmas 3, 0.19mm. Nutlet yellowish green in immature and brown in mature, obovoid, 1.4--1.43X0.068cm, faces narrowly elliptic, apex acute and base stalk of 0.05 mm, reticulate.

Distribution Range: Africa, Afghanistan, Pakistan, India, Nepal (Map 20), Bhutan Bangladesh, Sri Lanka, China, Japan, Myanmar, Laos, Vietnam, S. E. Asia, S. W. Asia, Australia, Korea, Vietnam, Laos, Pacific islands.

Altitude: 200 - 1800m

Ecology: weed in fields and cultivated ground

Flowering and Fruiting: June - Nov

Uses: Medicinal (whole plants), Forage, Mats (culm)

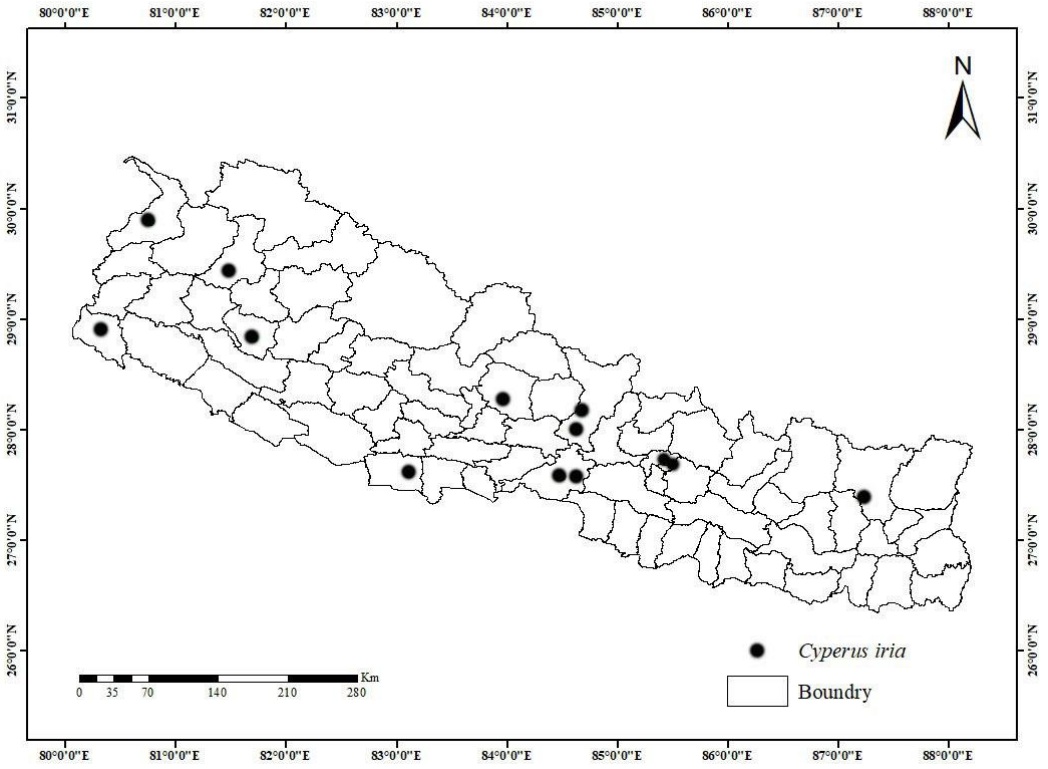
Voucher Specimen: Bhaktapur, Kasan, 1252.2m, 16th August 2020, *K. Basukala* KB20 (TUCH).

Specimens examined

West Nepal: Dailekh district, Belpata – Shristhan, 700m, 1991. 8.1, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K.R. Rajbhandari, H. Takayama* and *K. Terada* 9170176 (TI).

Central Nepal: Chitwan District, Sauraha, 240m, 1978. 5. 11, *H. Tabaha, K. R. Rajbhandari* and *Y. Shimizu* 9750 (TI). Bhaktapur, Kalighat, 1441m, 5th November 2020, *K. Basukala* KB035(KATH).

East Nepal: Sankhuwasabha district, Khandbari – Manebhanjyang, 1100m, 1989. 9. 13, *K. R. Rajbhandari* 13535(KATH).



Map 20. Distribution of *Cyperus iria* in Nepal based on herbarium records.

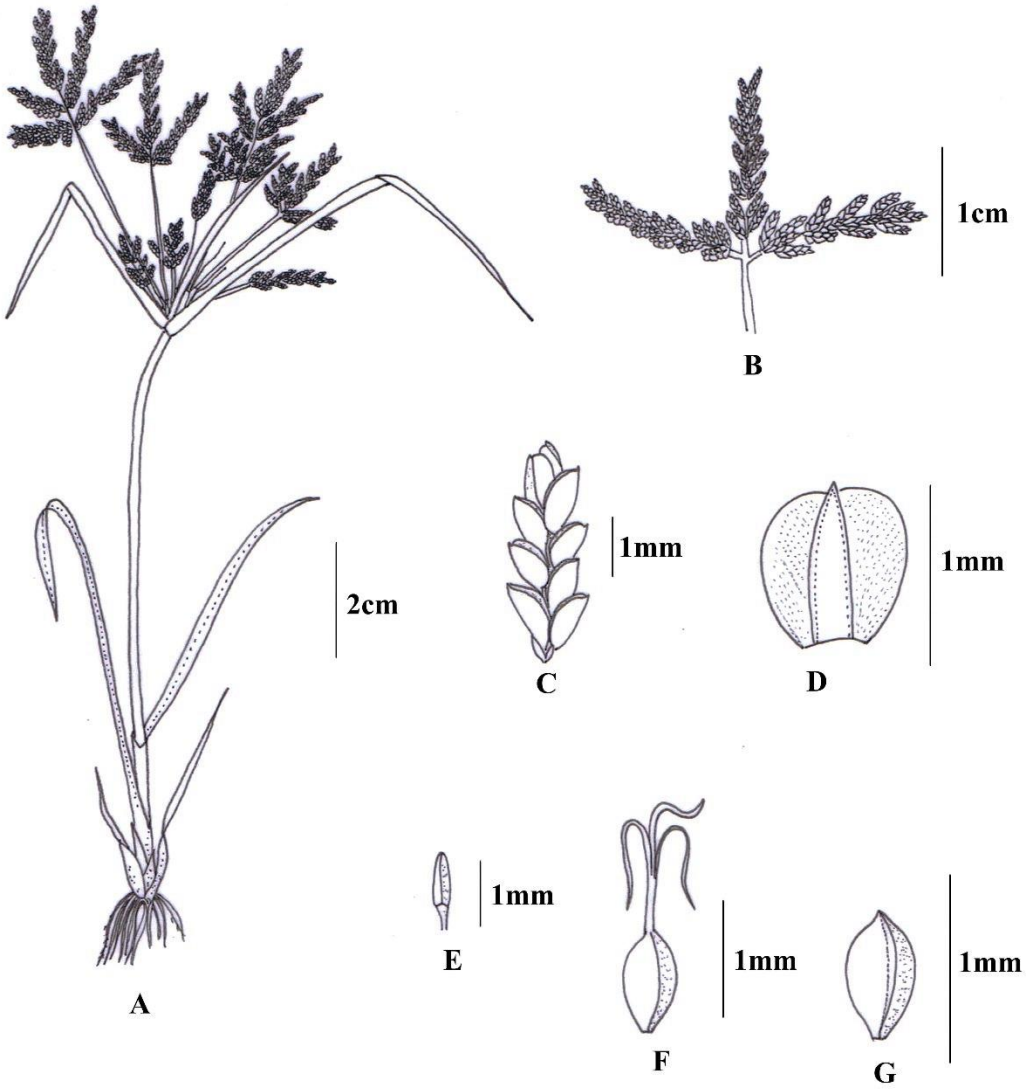


Figure 20: Cyperus iria L.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala. K., KB20 TUCH).

20. Cyperus longus L., Sp. Pl.: 45 (173). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 107 (1978). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Type Specimen: BM001067029 **Type:** BM

Perennial, 80-100 cm. Rhizomes short with short stolons, with rather thick horizontal, often curved, scale-covered stolons and only slightly swollen culm bases. Culm tufted, 25--100X 0.19--0.4cm, trigonous above terete below, glabrous. Leaf sheath shealth brown or reddish-brown, lowest bladeless, upper yellowish or with reddish tint, mouth margin straight open; leaf blade 50X0.7cm, acute apex, margin scabrous, revolute. Involucral bracts 3--7, 6--28X2--5.4cm, erect or spreading, acute adaxially, scabrid on margin and midrib. Inflorescence simple to compound anthela, rather narrow anthelodium; primary rays 4--15, 1 sessile to 0.5 to 10cm long peduncle; raylets 10cm; glume-like tubular prophyll c. 1.5 mm, scarious, brown, two nerved; glume-like bract c. 1.5 mm. Spikelets 3 to 15 digitately arranged per spike, linear-lanceolate, 8--25X 1.2--2mm, 8--20 flowered; Rachis compressed, quadrangular, slightly zigzagging, wingless rachilla. Glume light to dark reddish brown with a narrow uncoloured margin and a greenish midrib ending below the obtuse tip, ovate, cymbiform, 2 --3.5X 1.4--1.7mm, keeled, margin scabrous. Stamens 3, 1.4--2.2mm, connective 1.5--3.8mm; Stigmas 3. Nutlet grey brown, obovoid or ellipsoid, 1.4--1.6X0.5--0.75mm, trigonous, almost smooth or finely reticulate.

Distribution Range: Europe, Africa, Afghanistan, Pakistan, India, Nepal (Map 21).

Altitude: 800m

Ecology: Moist ground

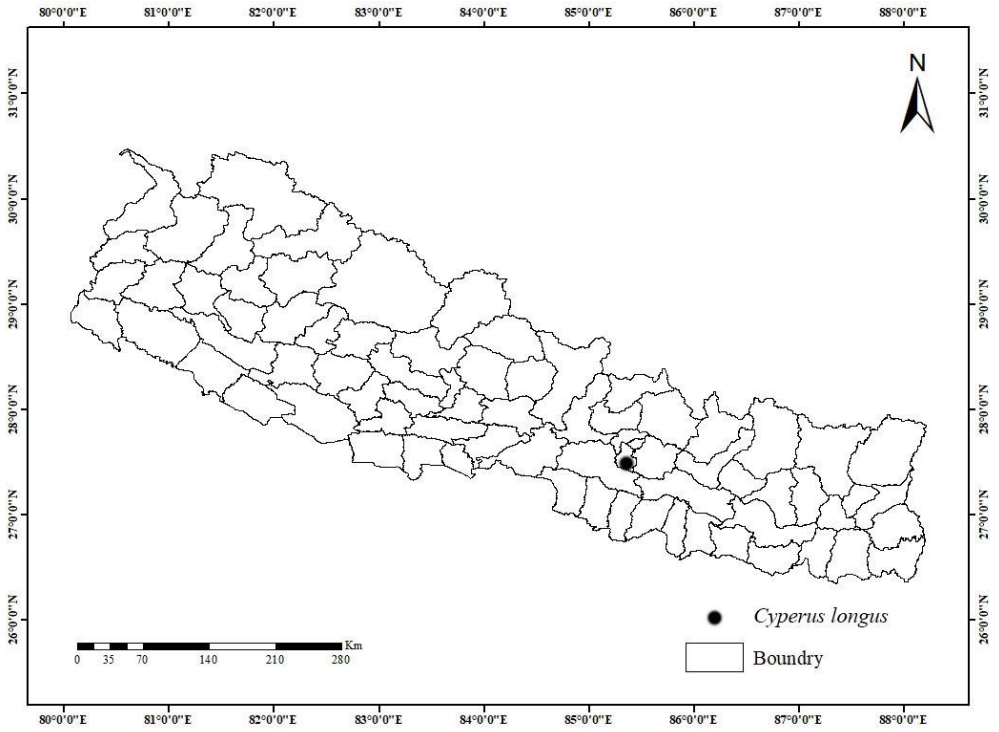
Flowering and Fruiting: June - October

Uses: Leaves are used in basketry and for weaving hats, matting, root The root and stem have the scent of violets and are used in perfumery and fibre obtain from plant is used in paper making.

Note: Both root and stem have a sweet moss-like perfume, resembling that as the violet but not so pure. Aroma becomes more fragile with age.

Specimens examined

Central Nepal: Nepal, *O. Polunin, W.R. Sykes* and *L.H.J. Williams 5843 (BM).*



Map 21. Distribution of *Cyperus longus* in Nepal based on herbarium records.

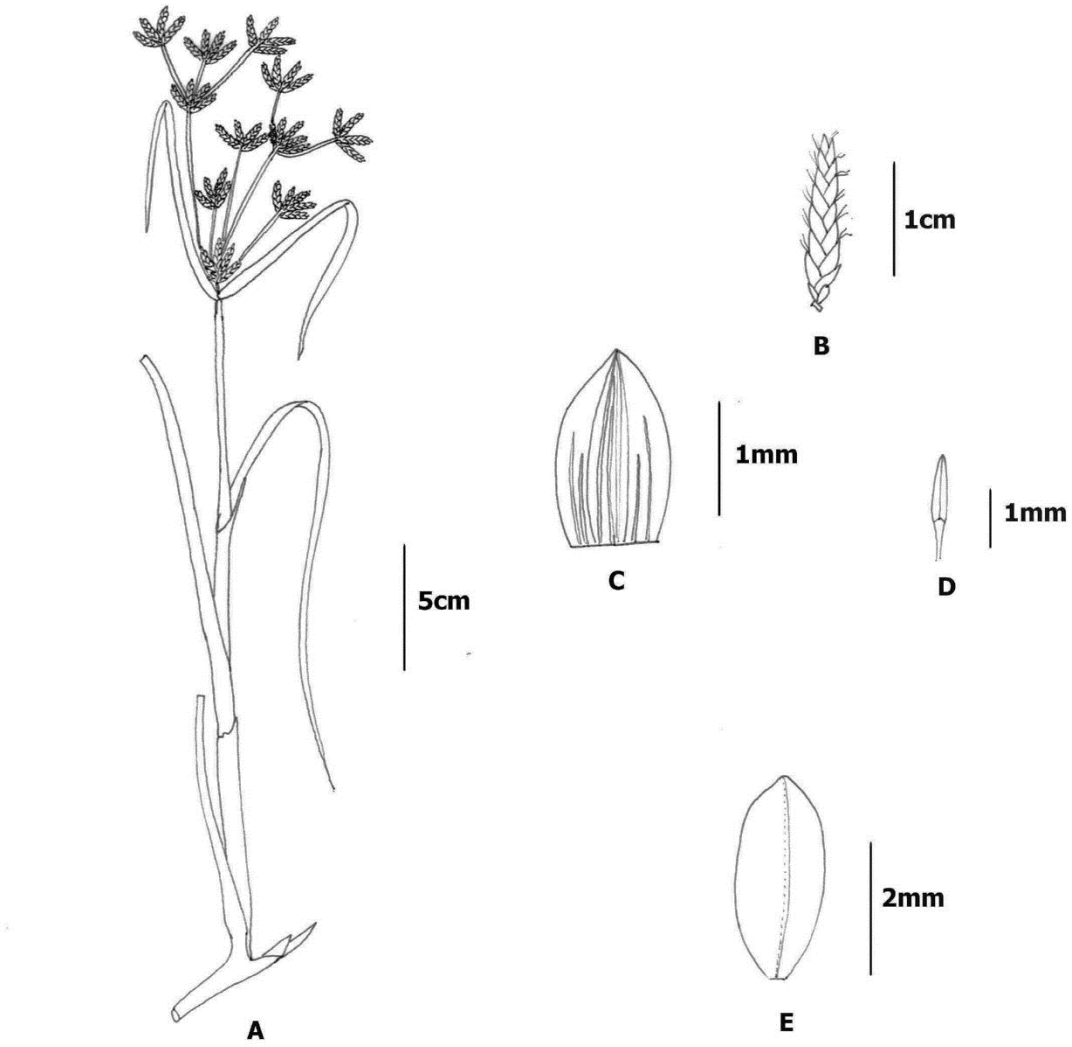


Figure 21: Cyperus longus L.; **A**. Habit Sketch, **B**. Spikelet, **C**. Glume, **D**. Anther, **E**. Nutlet. (Based on Drege., K00032733K).

21. Cyperus malaccensis Lam., Tab. Encycl. 1: 146 (1791). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 107 (1978). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus wallichii Nees, Contr. Bot. India 83 (1834).

Type Specimen: India, P00587042, **Isotype:** P

Perennial, Rhizome long, woody, rarely with thin and short stolons. Culm erect, 0.5--1.5 mX4--6 mm, sharply trigonous, sides concave above, base brown. Leaf sheath sheaths few, grey-brown or reddish, up to more than 30 cm, lowest bladeless; leaf blade 1-3, short, up to 3 X4--10mm, apex acute, margin smooth. Involucral bracts 3-4, 20cm, foliose. Inflorescence simple or compound, more than 20cm diameter; primary rays 10, 7--9cm; spreading, tubular prophylls up to c.8 mm, bi-nerved, blunt, base spongy, glume-like bract c. 1 mm, acute. Spikes cluster of more than 15 spikes in almost digitately pedunculate, 10--25X1.5--2 mm. Spikelets cluster of 5--10 laxly arranged, slightly turgid, linear, 0.8--2.5(–3) cmX0.15mm, 10--14 flowered; Rachis almost straight, quadrangular with sharp, narrowly winged rachilla, white, hyaline. Glumes reddish brown but margin yellowish to straw-coloured, oblong to elliptic, cymbiform when fresh, 2--2.5mm, laxly arranged, 7--9 veined, apex obtuse to rounded, margin involute at maturity, scarious. Stamens 3, 1.4--2.2mm, connective 1.5--3.8mm. Stigmas 3, slender. Nutlet black in mature to dark brown in immature, narrowly oblong, 1.7--2X0.5mm, trigonous, slightly compressed, glossy, very finely reticulate or minutely punctuate.

Distribution Range: S.W. Asia, Pakistan, India, Nepal (Map 22), Sri Lanka, China, Japan, Myanmar, Vietnam, S.E. Asia, Australia.

Altitude: 100 to 700m

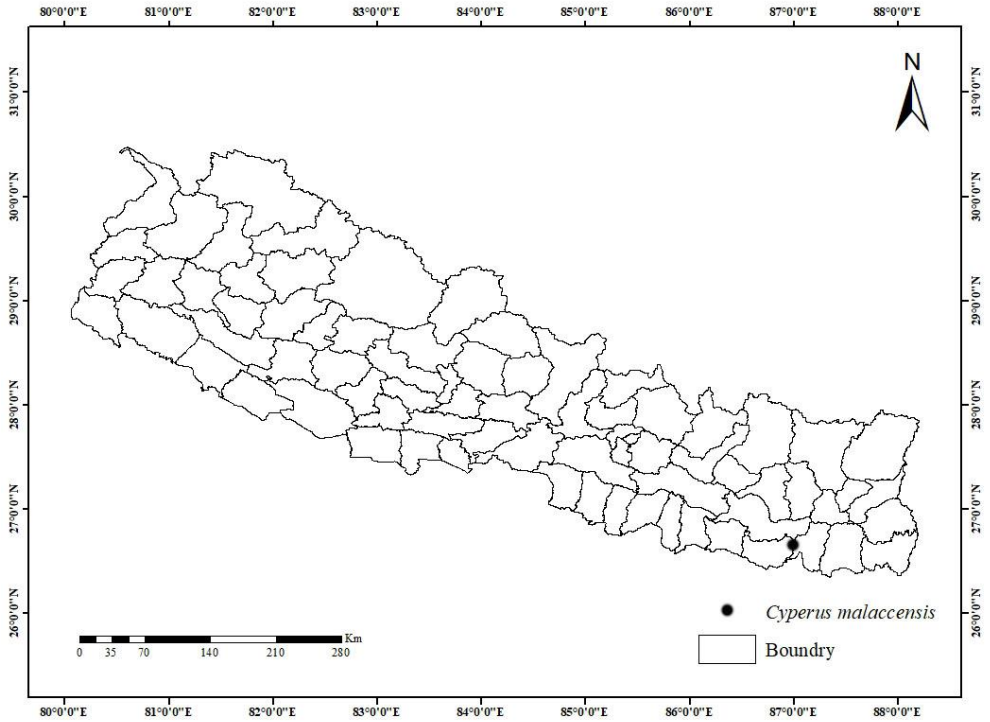
Ecology: Wet ground

Flowering and Fruiting: June - November

Uses: Culm are used for making ropes, baskets, mats, hats and slippers, pieces of stems are plaited in ropes to attract fry which are planted in fish ponds.

Specimens examined:

East Nepal: Sunsari district, Koshi Tappu Wildlife Reserve, Simana – Kanchanpur, 1995.10.22, *Mikage et al.,* 9550655 (TI).



Map 22. Distribution of *Cyperus malaccensis* in Nepal based on herbarium records.

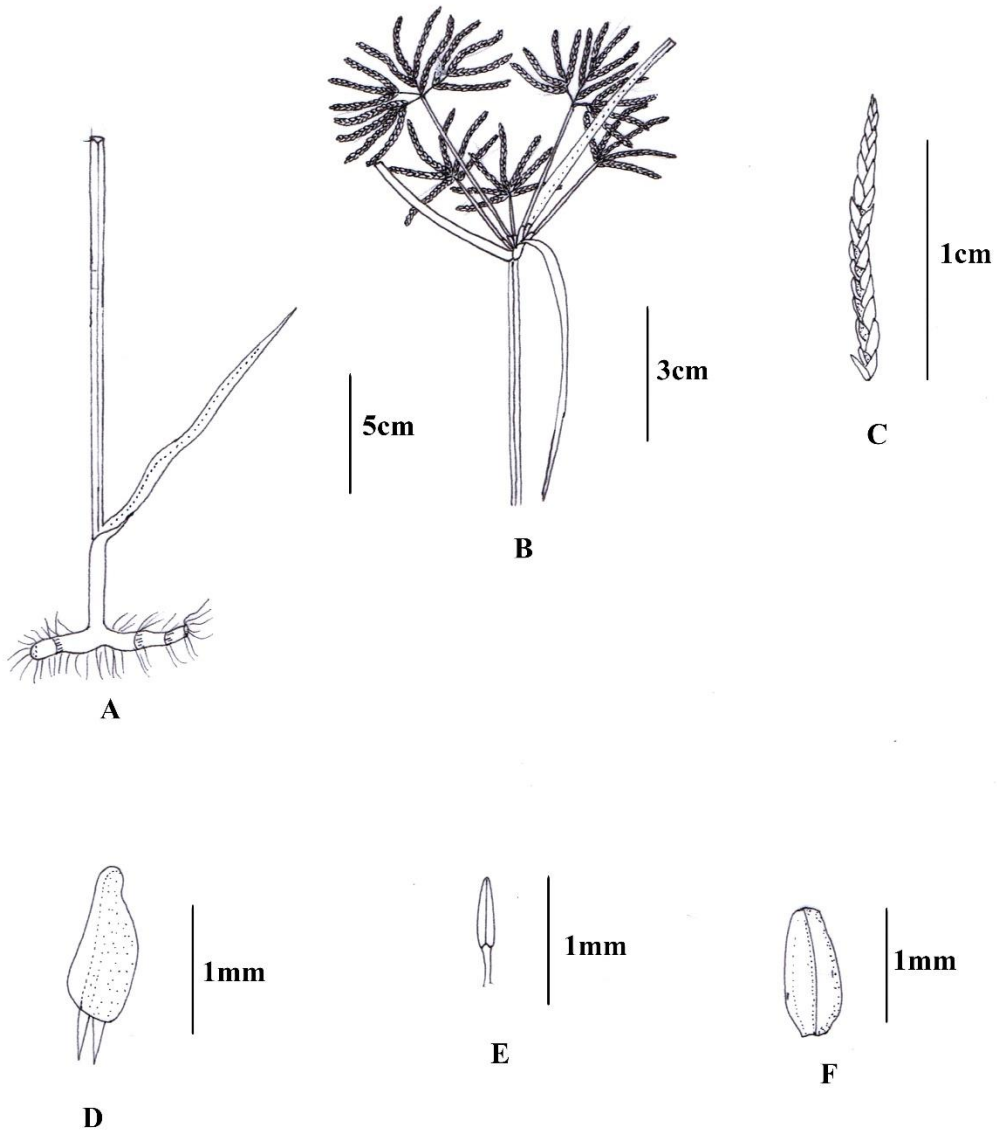


Figure 22: Cyperus malaccensis Lam.; **A**. Habit Sketch, **B**. Spikelet, **C**. Glume, **D**. Anther, **E**. Fruiting Pistil, **F.** Nutlet. (Based on S.coll., K000309407 K).

22. Cyperus michelianus (L.) Link, Hort. Bot. Berol. 1: 303 (1827). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 108 (1978). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Scirpus michelianus L., Sp. Pl. 1; 52 (1753).

Annual, height 5.2--7.5cm. Root fibrous, straw yellow colour. Culms densely tufted, 4.5--7X0.1cm tall, compressed triquetrous, smooth, base not swollen, few leaved. Leaf sheath reddish brown, 0.07--1.4cm, mouth margin oblique; leaf blade 2, 1.7--4X1.5--0.2cm, apex acute, slightly scabrous. Involucral bracts 6--7, 0.8--6X0.2cm, broad base, acute adaxially. Inflorescences simple anthela, capitates or globose, 0.7--1.5X0.6--1cm. Spike single globose, 1.5--7X 0.6--1cm. Spikelets cluster of 53 to 106 more than that densely arranged, compressed, ovoid to narrowly oblong ovoid, 2--7X1mm, 21--34 flowered; Rachis solid straight, yellowish, internode 0.2mm, winged rachilla. Glumes yellowish white on sides to yellowish brown to reddish brown in middle, spirally imbricate, oblong lanceolate, 1.43--1.55X0.3--0.5mm, 3 veined, keeled, apex elongated into recurved mucronate. Stamens 2, 0.4mm, linear. Style 0.48mm; Stigmas 2, 0.3--0.38mm. Nutlet yellowish colour, narrowly oblong, 0.83--0.98X0.23--0.28mm, trigonous, plano convex, apex apiculate, base cuneate, smooth, finely reticulate.

Distribution Range: Europe, Africa, Russia, S.W. Asia, Pakistan, India, Nepal (Map 23), China, Korea, Japan, Myanmar, Laos, Vietnam, S.E. Asia, Australia.

Altitude: 100 to 200m

Ecology: Wet places, rice fields, sides of Tikauli Lake (CNP).

Flowering and Fruiting: June - November

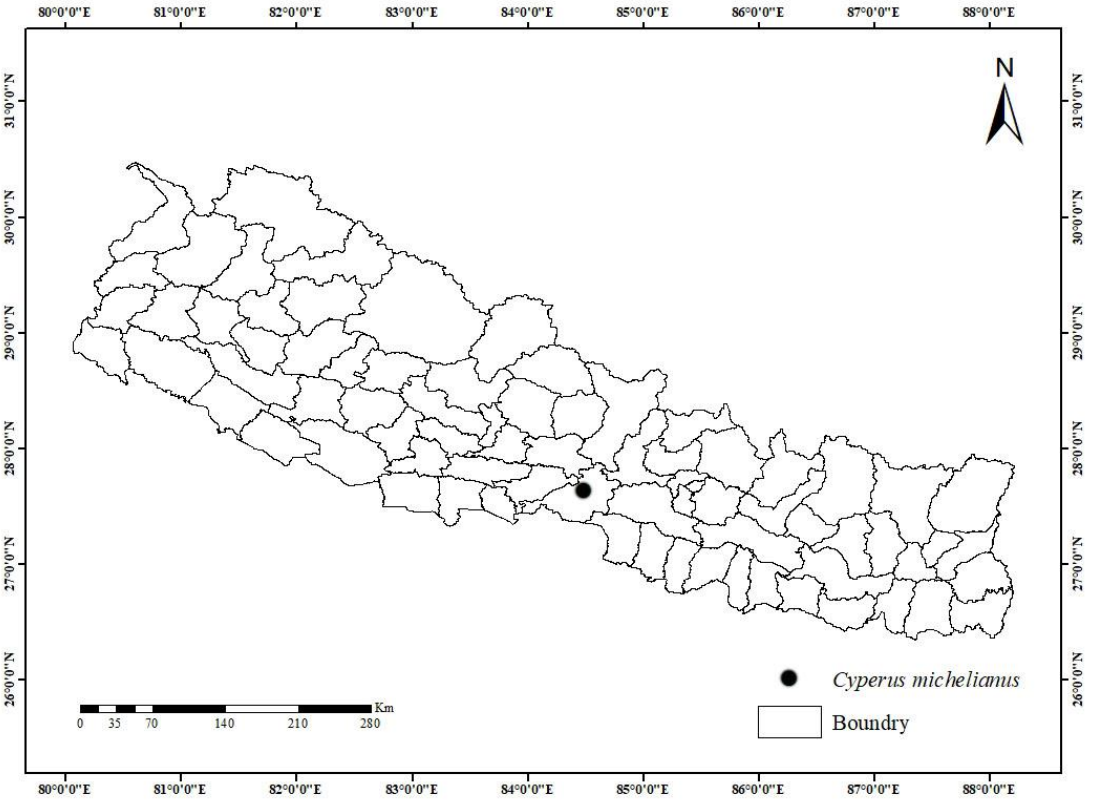
Uses: Used as fodder

Voucher Specimen: Chitwan, Tikauli Taal, Chitwan National Park, 175m, 28th August 2020, *K. Basukala* and *S. Potamahan* KB14 (TUCH).

Specimens examined

East Nepal: *Nepal, H. Hara, H. Kanai, S. Kurosawa, G. Murata, M. Togashi* and *T. Tuyama* 6300936 (TI).

Central Nepal: Chitwan, Tikauli taal, 175m, 28th August 2019, *K. Basukala* and *S. Potamahan* KB60 (KATH).



Map 23. Distribution of *Cyperus michelianus* in Nepal based on herbarium records.

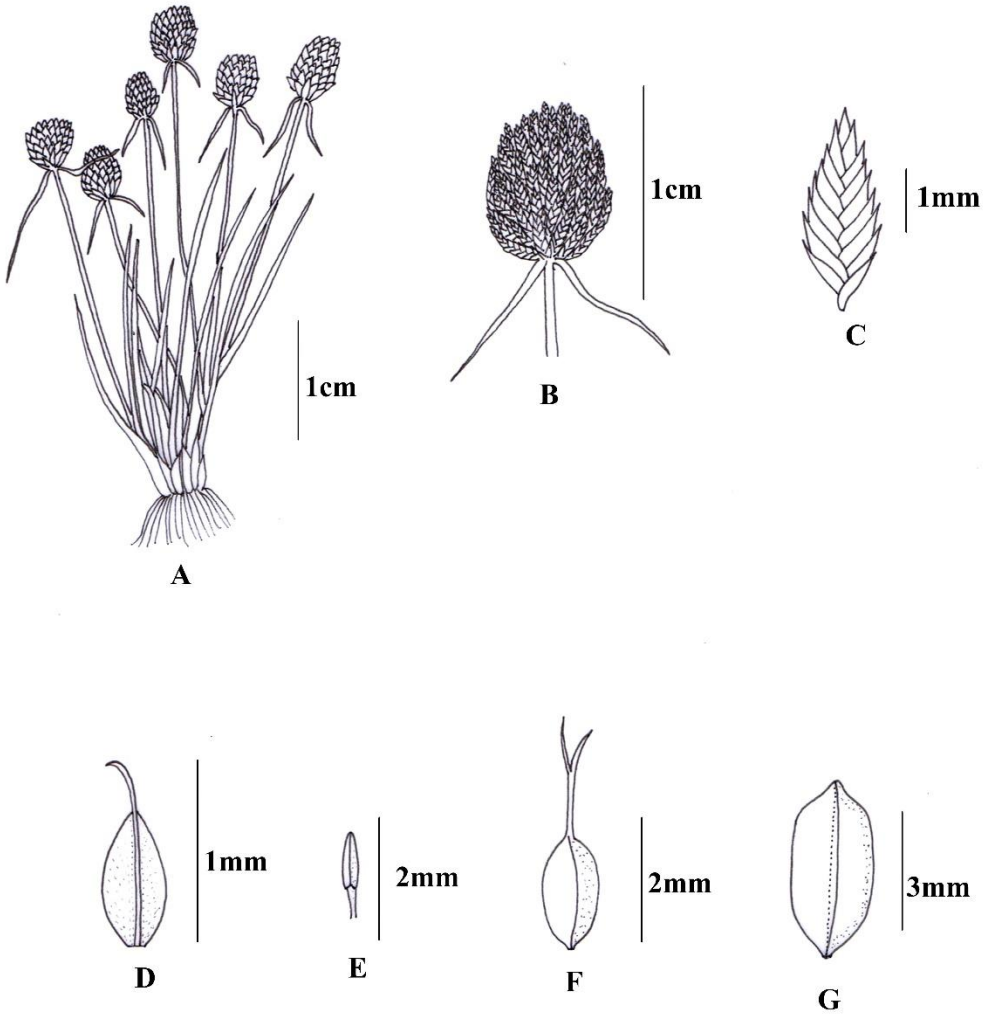


Figure 23: Cyperus michelianus (L.) Link.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume,**E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB14 TUCH).

23. Cyperus microiria Steud., Syn. Pl. Glumac. 2: 23(1854). Rajbhandhari *et al.,* Cat. Nep. florus. Suppl. 1: 20 (2015). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus palviflorus Nees in Wight, Contr. Bot. India: 87 (1834).

Type Specimen: Japan, H. Zollinger, s.n. P00587043. **Lectotype:** P.

Annual, height 12--14cm. Root fibrous. Culm tufted, compressed triquetrous, 8.5--12cm, slender to slightly stout, striated, with basal leaves. Leaf sheath purpulish brown, 1.5--2.5cm, mouth margin straight open; leaf blade 3--4, 5--7cm, margins and keel towards the apex scabrous. Involucral bracts 3--4, 2.9--4.2cm, acute adaxially, revolute. Inflorescence compound anthela, 2.3--4X1.8--6.2cm; rays 5--9, digitately. Spikess 4, digitately arranged, 1.5--1.8X0.9--1.7cm, Spikelets cluster of 10--19 laxly arranged, compressed, linear-very narrowly linear oblong, obtuse, 7--8X2mm, 11--15 flowered; Rachis solid, straight, internode 0.5mm, wingless rachilla. Glume yellowish brown, shiny, loosely imbricae, broadly obovoid, 1.53--1.7cmX0.08-0.085cm, apex rounded, mucronate, 3 veined, keel spinulose, margin scarious. Stamens 3, oblong, 0.3X 0.08mm, connective not prominent beyond anthers. Style very short; Stigmas 3, short. Nutlet yellowish brown, oblong- obovoid, 1.42X 0.8mm, faces narrowly elliptic, base truncate, apex obtuse round 0.075mm, reticulate.

Distribution Range: India, Nepal (Map 24), China, Korea, Japan, Vietnam. (East Asia. Naturalized in U.S.A. and Europe)

Altitude: 100 to 200m

Ecology: Open moist place.

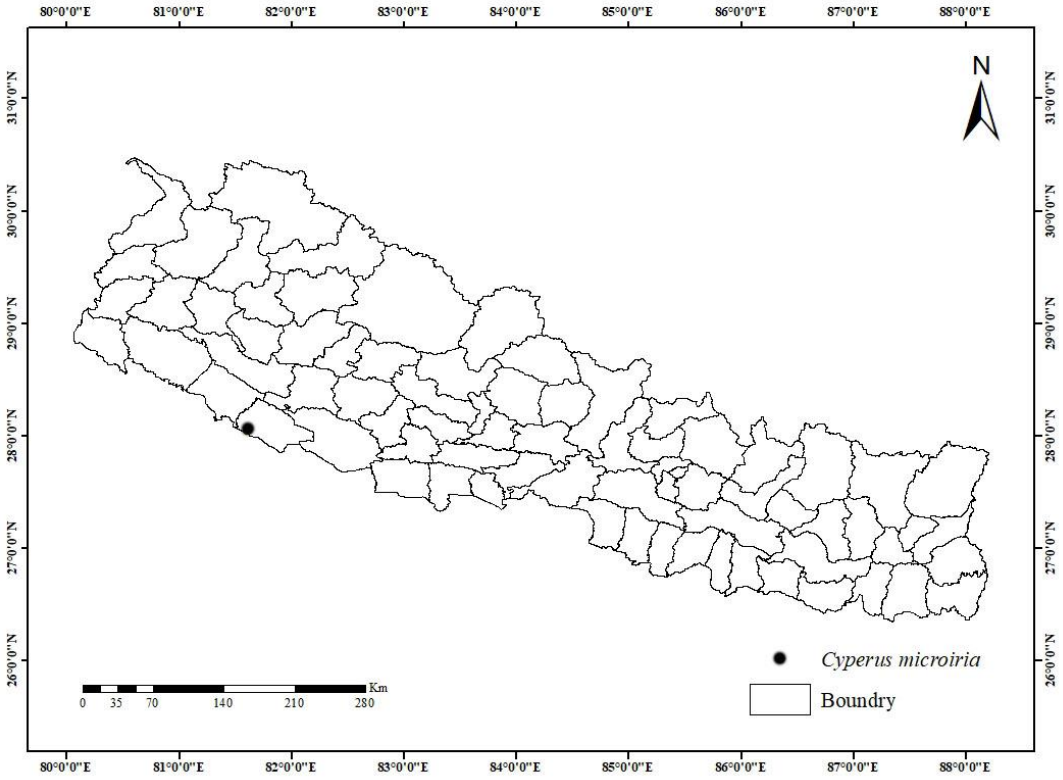
Flowering and Fruiting: August - October

Uses: Used as fodder.

Note: Differ from iria in having very narrowly linear oblong spikelets and 11- 15 flower.

Specimens examined

West Nepal: Banke district, Nepalgunj, *S. A. Siddiqui* 2266 (KATH).



Map 24. Distribution of *Cyperus microiria* in Nepal based on herbarium records.

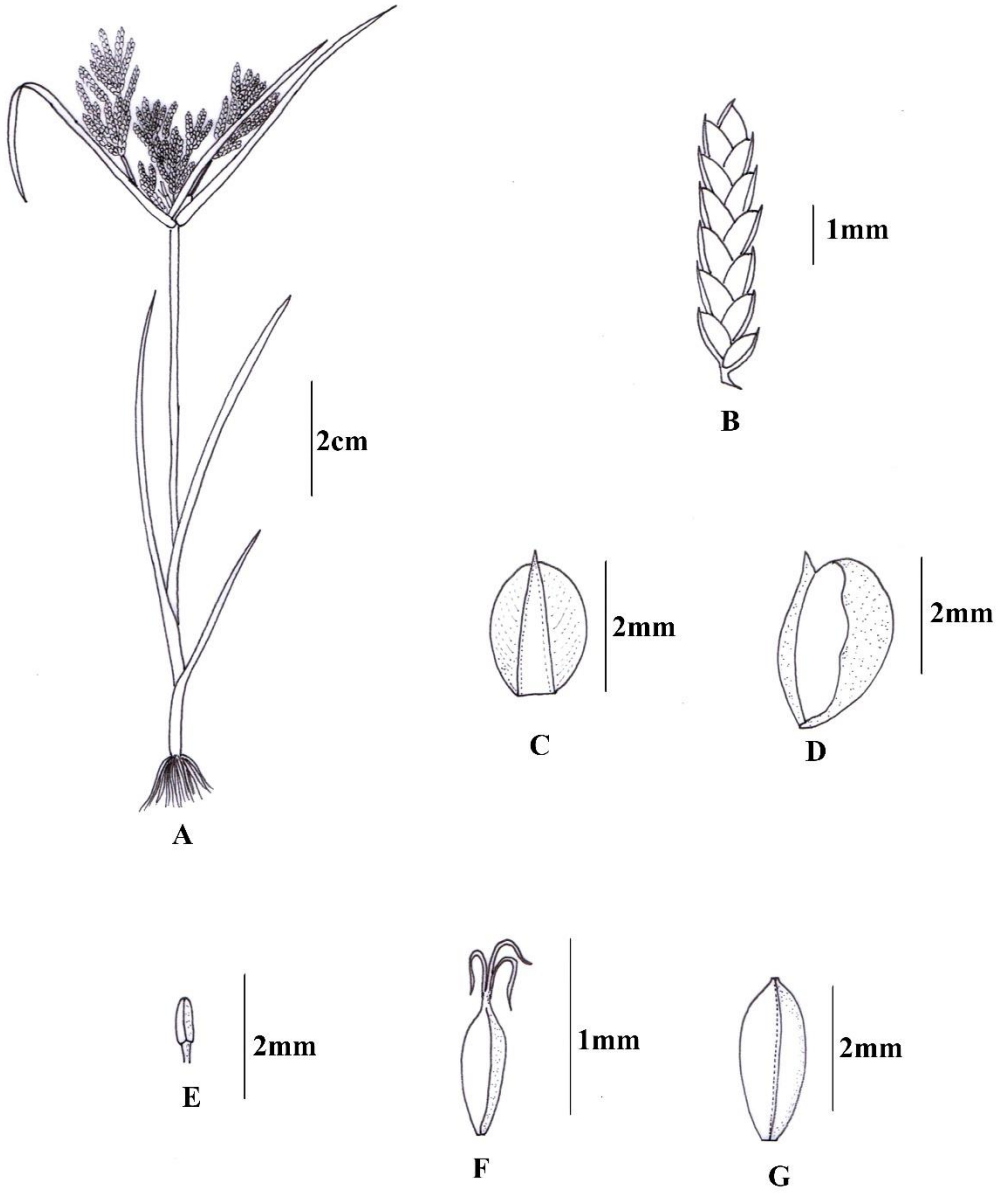


Figure 24: Cyperus microiria Steud.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Poudel YB., JF160YB TUCH).

24. Cyperus niveus Retz., Obs. Bot. 5: 12 (1788). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 108 (1978). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1: 92 (2010) (Plate 120). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Type Specimen: India, König, J.G, LD1293287. **Lectotype:** LD.

Perennials, height 14.2--27.5cm. Rhizomes very short, woody, creepy, thickened. Culms tufted, 12.5--26.3cm, triquetrous, smooth, base slightly swollen into a bulb shape. Leaf sheath reddish brown, 20-40mm, mouth margin concave; leaf blade 3.3--40X1--2mm, apex acute, margin smooth, revolute. Involucral bracts 2--3, 1--16.7X0.05--0.2mm, leaflike, involute. Inflorescences simple anthela, capitate, 0.8--2.3X0.9--1.6cm. Spikelets with 7-12, densely arranged at the apex into a capitulum, compressed, narrowly oblong-ovoid to narrowly ovoid, 5--1.3X0.2--0.42cm, 3-23flowered; Rachis solid, straight, quadrangular, internode 1mm, wingless rachilla. Glume yellowish white on sides to conspicuos green in middle, densely imbricate, ovate lanceolate, 3.8--3.9X 0.19--0.2cm, 4-6 veined, not keeled, apex subobtuse, margin white hyaline. Stamens 3, linear-oblong, 1.8--1.98X0.14-- 0.16mm. Style 1.5mm; Stigmas 3, 1.25--1.38mm. Nutlet yellowish brown, broadly obovoid, 1.33X0.75mm, trigonous, base cuneate(0.13mm), densely to slightly prominently punctuate or rugose.

Distribution Range: C. Asia, India, Nepal (Map 25), Bhutan, China, Laos, Vietnam, Myanmar, Cambodia.

Altitude: 400m to 2900m.

Ecology: Burnt forest ground and grassland

Flowering and Fruiting: Sept - Oct

Common name: White Mothe

Uses: Fodder

Note: Have a pleasant aroma.

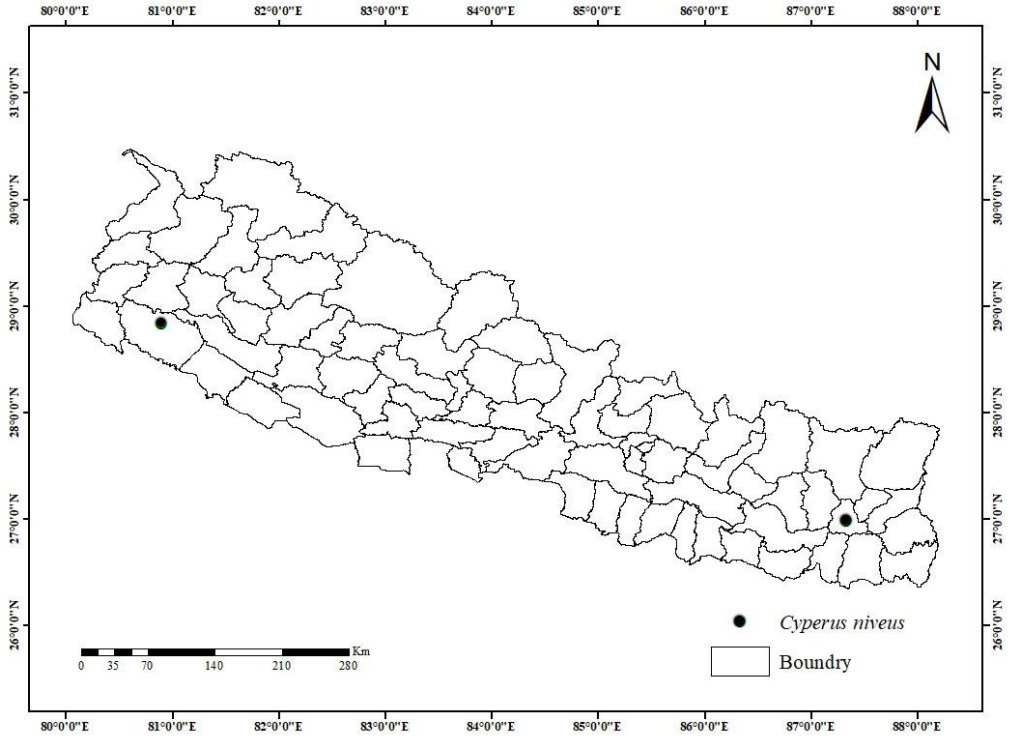
Voucher Specimen: Kapilvastu, 152m, 15th October 2020, *Y. B. Poudel* YB25 (TUCH).

Specimens examined

West Nepal: Dailekh district, Dungesar – Shristhan, 700m, 1991. 8.1, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K.R. Rajbhandari, H. Takayama* and *K. Terada* 9170170 (TI). Kapilvastu, 152m, 15th October 2020, *YB. Poudel* (KATH).

Central Nepal: 60 km west of Kathmandu, 900m, 1989. 8. 25, *C. Grey – Wilson, S. Zmarzty, M. Sinnott, D. Long, R. McBeath, H. Noltie* and *M. Subedi* 12 (KATH). Sindhupalchok, Ratmate near Kartha Dudhauli, 131m, 6th November 2020, *R. Kafle* and *K. Basukala* (KATH).

East Nepal: Nepal, J. D. A. Stainton 1800 (BM).



Map 25. Distribution of *Cyperus niveus* in Nepal based on herbarium records.

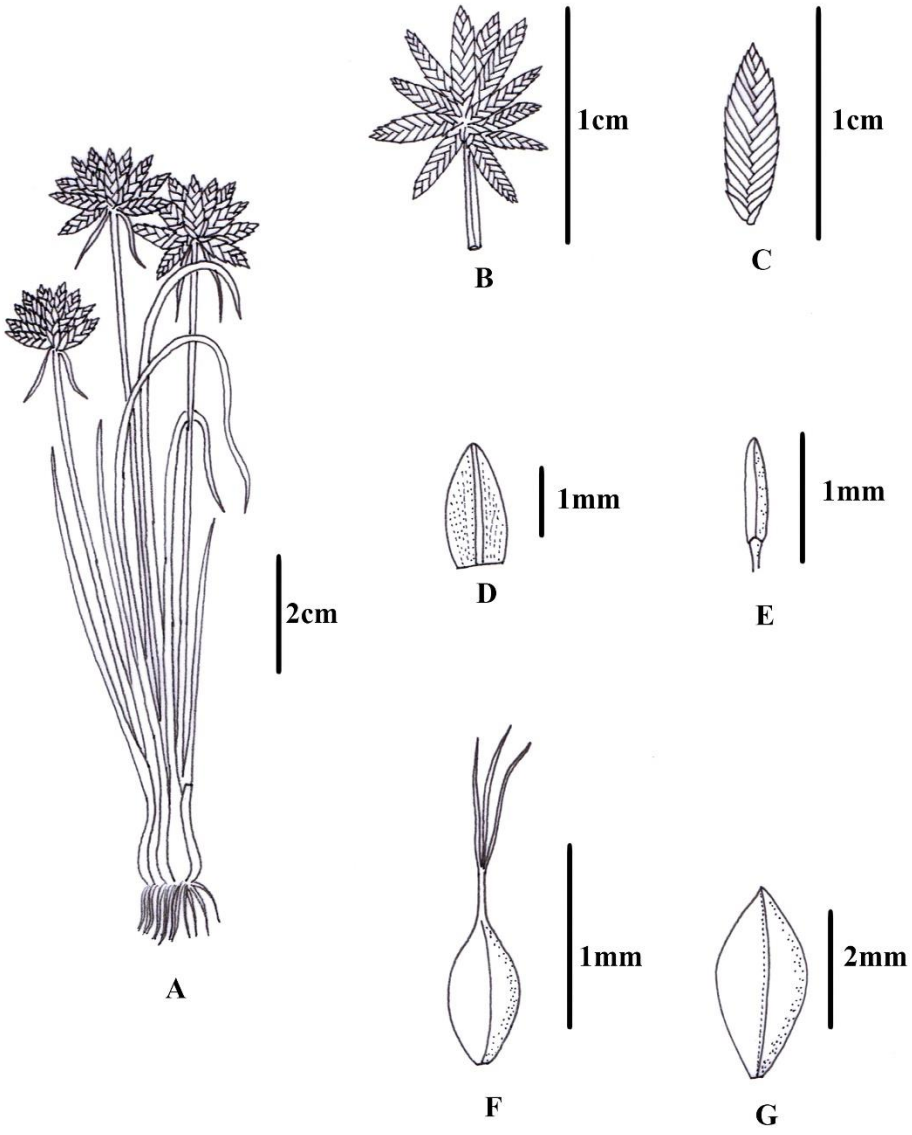


Figure 25: Cyperus niveus Retz.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Poudel YB., YB25 TUCH).

25. Cyperus nutans Vahl., Enum. Pl. 2: 363 (1805). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1; 107 (1978). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Type Specimen: India, König, J.G., C10010266. **Holotype:** C.

Perennial, height 62cm-1m. Rhizomes short, hardened, covered with ascending reddish brown coloured scales. Culm scattered, 42--63.3X0.2--0.3cm, compressed, triquetrous, stout, basalpart with few leaves. Leaf sheath straw yellow colour to reddish brown colour 3.5--17.2cm, mouth margin straight open; leaf blade 20--82X0.5--0.6mm, apex acute, margin scabrous. Involucral bracts 8--10, 3.5--22.5X0.1--0.5cm, abaxially serrulate, margin scabrous. Inflorescence compound anthela 19.5X13cm, primary rays 11--12, 1--14.5cm; secondary rays 1-8 or spikes, 0.3--2.7cm, tertiary rays [2], sessile; tubular prophyll primary rays 1.7--2.5cm, secondary rays 4mm; cladoprophyll primary rays 1.5--3.5cm, secondary rays 1cm. Spikes 1--8, cylindric, 2.8X0.7cm. Spikelets clusters of 15--25, densely arranged, linear to narrowly linear ovoid, 5--9X1.5mm, suberect, 7--9 flowered; Rachis solid, zigzag, reddish brown, internode 0.7mm, rachilla flexulose, with white and hyaline wings. Glume dark brown in middle to redhhish brown in sides, laxly imbricate, elliptic, 1.75--2.15X0.4--0.65mm, 7 veined, reddish brown keel, apex mucronate. Stamens 3, linear-oblong, 0.5X0.15mm, connective 0.75--1.5mm. Style 0.43--0.55mm; Stigmas 3, 0.8--1.13mm. Nutlet yellowish green in immature to black colour in mature, oblong to obovoid-oblong, 1.25--1.38X0.43--0.45mm, trigonous, rugose, densely and slightly prominent punctuate.

Distribution Range: Africa, India, Nepal (Map 26), Bhutan, Sri Lanka, China, Laos, Vietnam, S. E. Asia, Australia, Vietnam, Papua New Guinea.

Altitude: 300m to 2600m

Ecology: Wet grassland, river margin

Flowering and Fruiting: May - Oct

Uses: Fodder

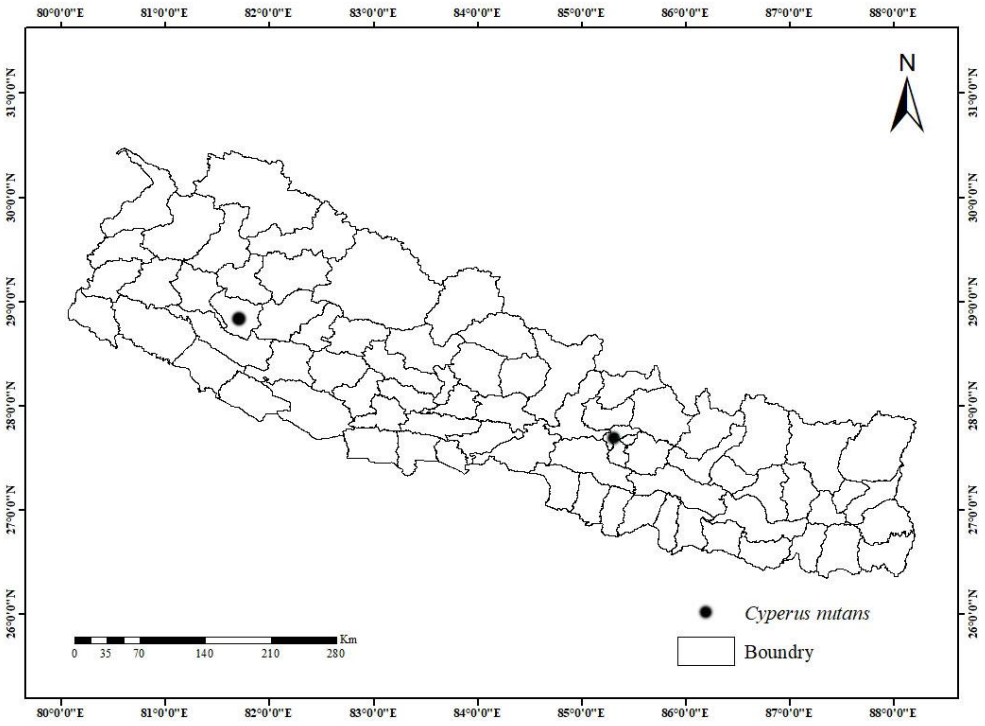
Voucher Specimen: Chitwan, Kasara, Chitwan National Park, 150m, 27th August 2020, *K. Basukala* and *S. Potamahan* KB12 (TUCH).

Specimens examined

West Nepal: Dailekh district, Dungesar – Shristhan, 700m, 1991. 8.1, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K.R. Rajbhandari, H. Takayama* and *K. Terada* 9170170 (TI).

Central Nepal: 60 km west of Kathmandu, 900m, 1989. 8. 25, *C. Grey – Wilson, S. Zmarzty, M. Sinnott, D. Long, R. McBeath, H. Noltie* and *M. Subedi* 12 (KATH). Chitwan, Kasara, 150m, 27th August 2019, *K. Basukala* and *S. Potamahan* KB73(KATH).

East Nepal: Nepal, *J. D. A. Stainton* 1800 (BM).



Map 26. Distribution of *Cyperus nutans* in Nepal based on herbarium records.

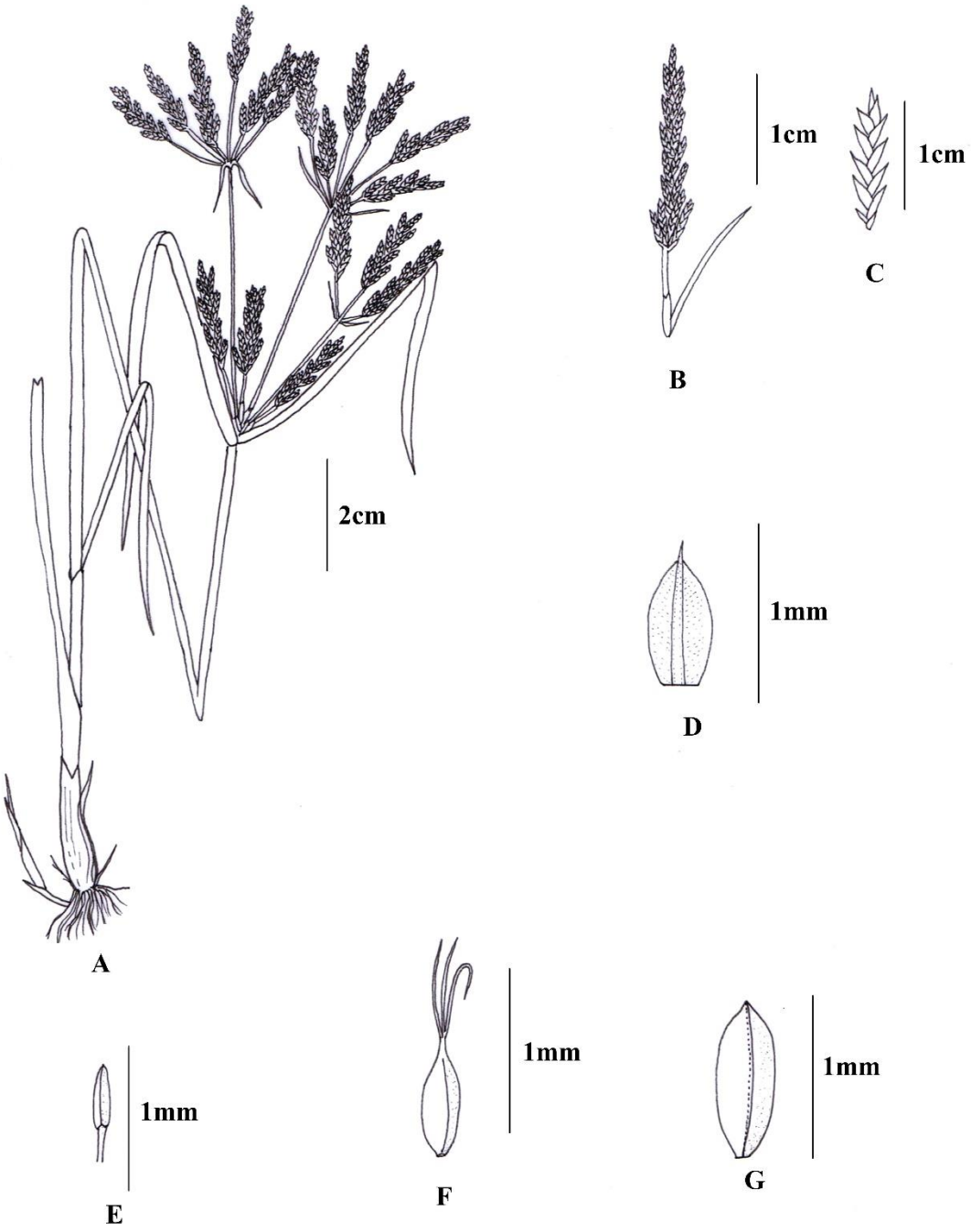


Figure 26: Cyperus nutans Vahl.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB12 TUCH).

26. Cyperus pangorei Rottb., Descr. Pl. Rar. 18 (1772). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 108 (1978). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1: 20 (2015). *Cyperus tegetus* Roxb., Fl. Ind. 1: 211 (1820). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Type Specimen: König, J.G., s.n. C10010283. **Isotype:** C.

Perennial, Rhizomes short, creeping, 3-4 mm diameter, with short stolons. Culm 50--120X0.3--0.5cm, tall, stout, obtusely 3 angled. Leaf sheath greenish grey or reddish brown, soft, margin mouth straight open: leaf blade 15X0.4cm, apex acute scabrous, margin smooth. Involucral bracts 2-5, 35cm, margins recurved, slightly scabros, apex long attenuate, scabrous. Inflorescence compound anthelodium 6.5 to 20cm; primary rays 5-15, secondary rays 40mm, tertiary rays 1--3, 18mm; raylets 4-10, glume like prophyll bi-nerved with spongy basis, tubular prophyll c.15mm, glume like bract c. 2.5mm, 2nd: 8mm. Spikes 4--15, digitately arranged, widly conical, 14--25X0.2cm. Spikelets compressed, laxly arranged, linear, 8--10mmX1.5mm, 12--30 flowered; Rachis quadrangular, internodes 0.8--1X0.5mm, widely winged rachilla. Glume reddish brown on side, slightly compressed, rather narrow or linear oblong, papery, 2--3mm, 3-5 veined, not keeled, apex acute or obtuse, margin scaroius, slightly revolute at maturity. Stamens 3, linera -oblong, apex sometimes setiferous, connective not prominent beyond anther. Style medium length; Stigmas 3. Nutlet dark brown, obovoid-oblong or ellipsoid, 1.5X0.5mm, 3 sided, finely papillose or densely puncticulate.

Distribution Range: Pakistan, India, Nepal (Map 27), Bhutan, Sri Lanka, China, Myanmar.

Altitude: 150m to 1200m

Ecology: wet ground, Open place

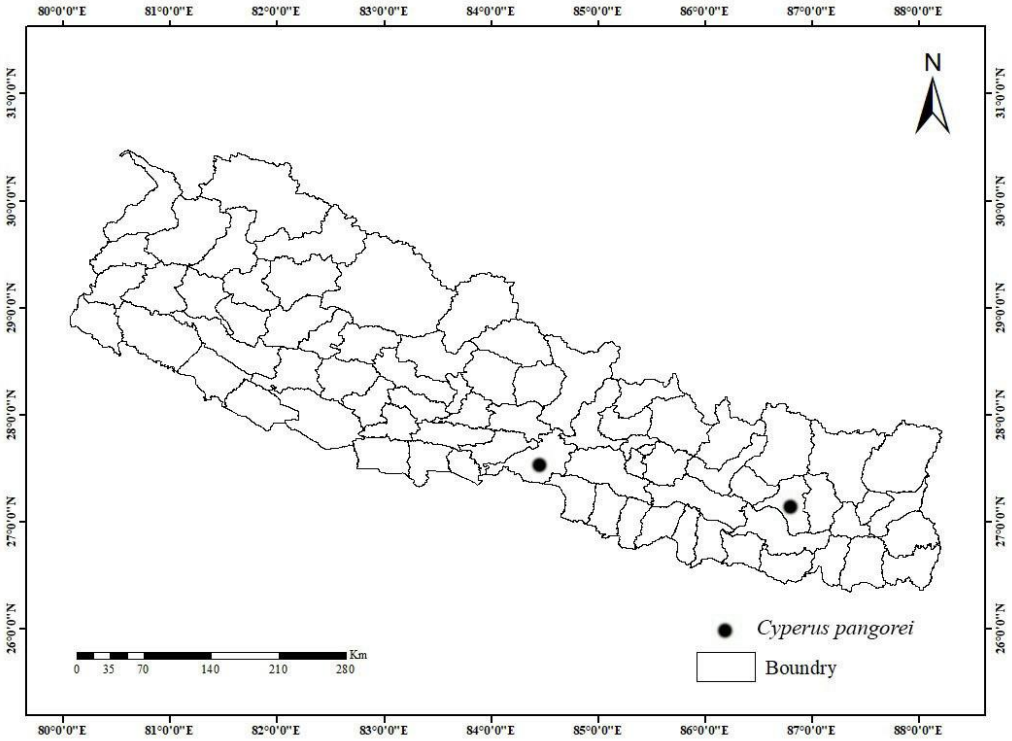
Flowering and Fruiting: Oct - Jan

Uses: Fodder

Specimens examined

Central Nepal: Chitwan district, Sauraha – Devi Tal, 160m, 1996.1.21, *M. Mikage, N. Acharya, T. Kurosawa, P. Lacoul* and *A. Takahashi* 9611040 (KATH).

East Nepal: Khotang district, Dihigaon – Regmitar, 250m, 1995.10.27, *Mikage et al.,* . 9550696 (TI).



Map 27. Distribution of *Cyperus pangorei* in Nepal Based on Herbarium records.

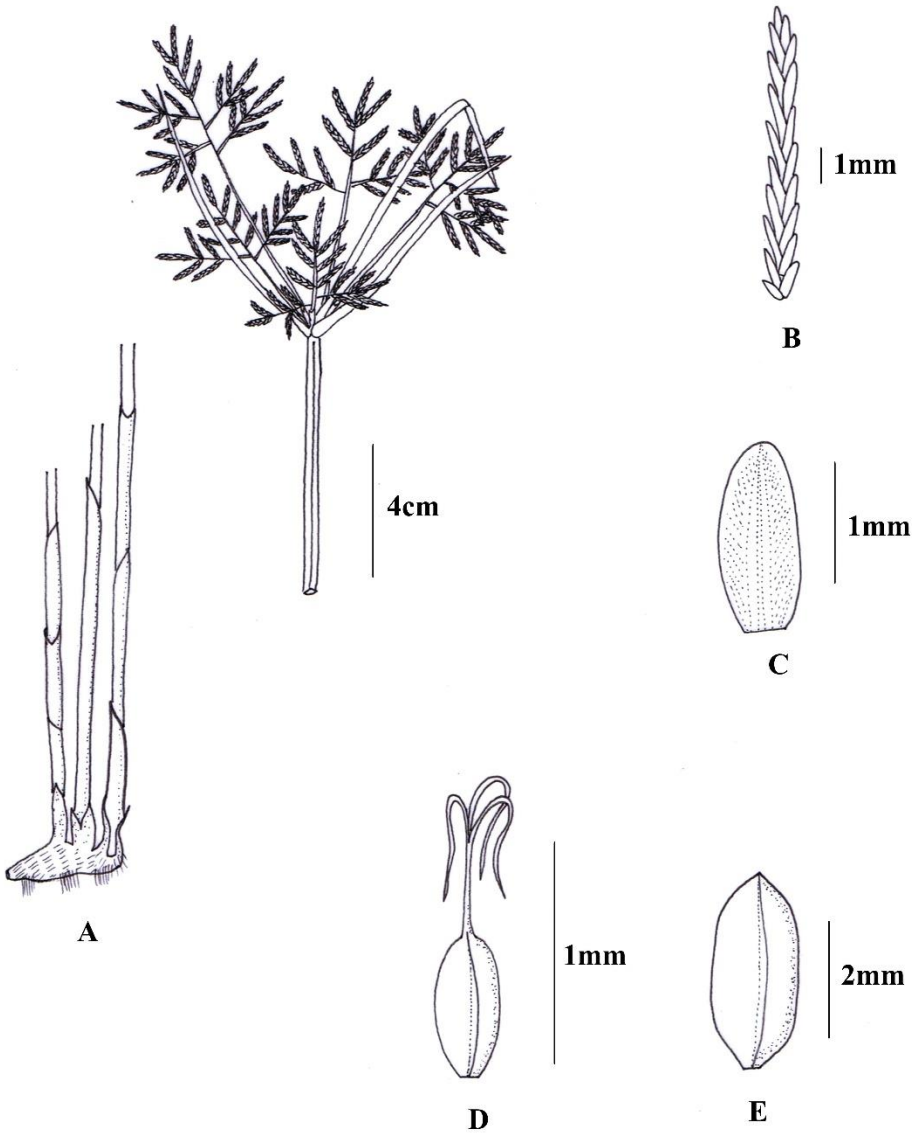


Figure 27: Cyperus pangorei Rottb.; **A**. Habit Sketch, **B**.Spikelet, **C**. Glume, **D**. Fruiting Pistil, **E**. Nutlet. (Based on Konig J.G., C10010283 C).

27. Cyperus paniceus (Rottb.) Boeck. In Linnaea 36: 381 (1870). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Kyllinga panicea Rottb., Descr. and Icon. Pl.: 15, t. 7, f.1 (1773).

Mariscus paniceus (Rottb.) Vahl, Enum. Pl. 2:373 (1806).

Mariscus panceus (Rottb.) Vahl var. *roxburghianus* C.B. Clarke in Hooker, Fl. Brit. India 6:621 (1893).

Type Specimen: Sudan, 1871, G.A. Schweinfurth 187. P00569044. **Isotype:** P.

Perennials, height 20--32cm. Rhizomes short. Culms laxly tufted, 17--38.5X1.5cm, acutely triquetrous, smooth, base with few leaves. Leaf sheath purpulish brown, 1--7.5cm, mouth margin concave opening; leaf blade 5, 6.5--25cm, apex acute long attenuate, abaxially midvein and margin scabrous. Involucral bracts 7--9, 1--19.5 X 0.2cm, acute adaxially, revolute. Inflorescence simple anthela, 2.9--3 X 2.2--2.5cm; rays 7--10, 0.5--0.8cm; tubular prophyll 3--4mm. Spike 7--10, cylindric, 1--1.7X0.5--0.9cm. Spikelets 26--40 more than that, densely or spirally arranged, spreading to reflexed, compressed, narrowly linear-ovoid, base subtruncate, 3--3.5X0.5mm, 1 fertile flower; Rachilla winged. Glumes pale yellow on sides, elliptic, tightly imbricate, oblong lanceolate, 3.25--3.5X0.73--1mm, vein several with middle 3 conspicious green, keeled, apex acute, margin involute. Stamens 3; dark brown, anthers broadly linear, 0.88--0.113mm; connective prominent beyond anthers. Style 0.5 --0.78mm; Stigmas 3, 1.13--1.7mm. Nutlet yellowish green in young to dark brown in mature, narrowly oblong, 1.4--2.63X0.25--0.85mm, trigonous, apex apiculate, elongated, granulated or minutely punctuate

Distribution Range: Nepal (Map 28), India, Sri Lanka, Malaysia.

Altitude: 800m

Ecology: Moist ground

Flowering and Fruiting: May-July

Uses: Fodder

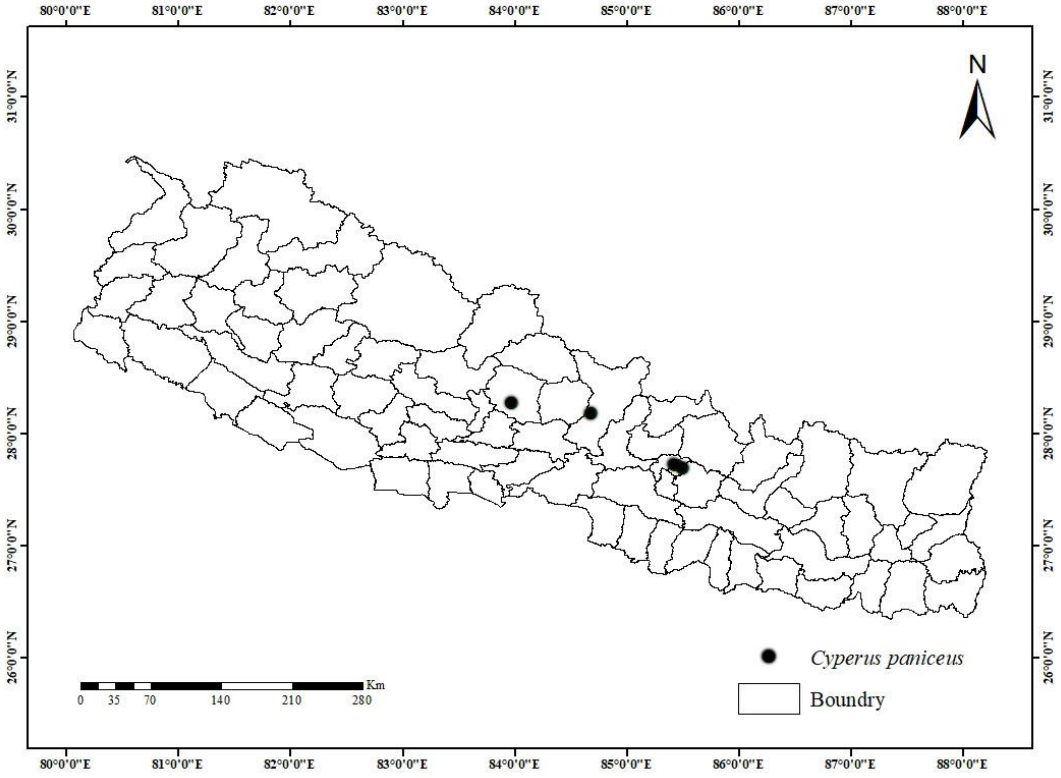
Note: Only one fertile flower

Voucher Specimen: Bhaktapur, Kasan, 1252.2m, 26th October 2020, *K. Basukala* KB22 (TUCH).

Specimens examined

Western Nepal: Kapilvastu, Taulihawa, 87m, 22nd August 2019, *K. Basukala* and *S. Potamahan* KB126(KATH).

Central Nepal: Nepal, *N. Wallich* 3437A (K). Gorkha, Rangrung khola way to Barpark, 806m, 10th July 2019, *K. Basukala* and *S. Potamahan* KB020 (KATH). Bhaktapur, Manohora khola Changu, 1441m, 15th August 2020, *K. Basukala* and *S. Potamahan* KB021(KATH). Chitwan, Tikauli taal, 175m, 28th August 2019, *K. Basukala* and *S. Potamahan* KB125 (KATH).



Map 28. Distribution of *Cyperus paniceus* in Nepal based on herbarium records.

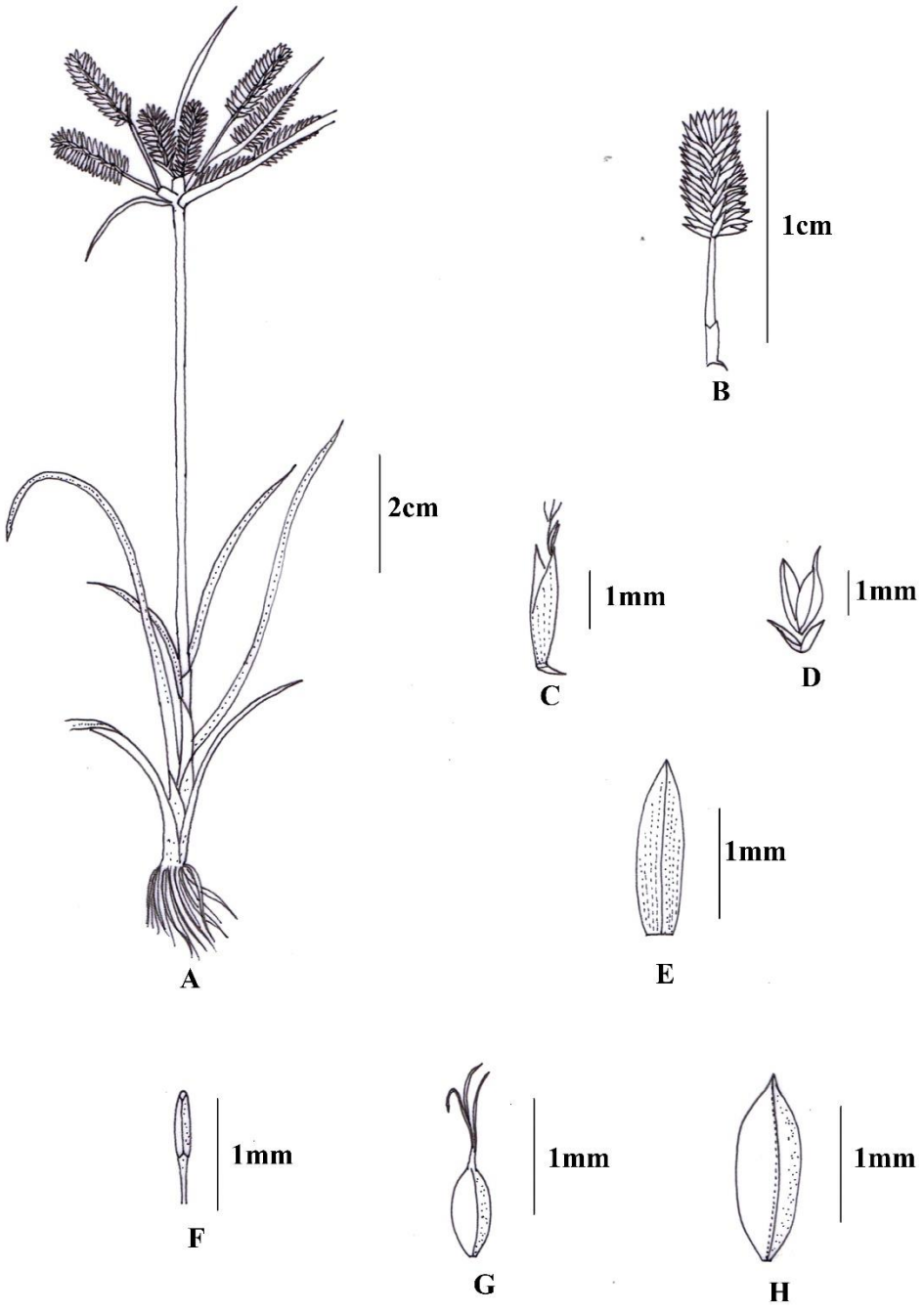


Figure 28: Cyperus paniceus (Rottb.) Boeck.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D** Spikelet showing rachilla and glume arrangement, **E**. Glume, **F**. Anther **G**. Fruiting Pistil, **H**. Nutlet. (Based on Basukala et al., KB22 TUCH).

28. Cyperus pilosus Vahl; Enum. Pl. 2: 354 (1805). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1; 107 (1978). Rajbhandari in Rajbhandari and Baral, Cat.Nep. Fl. Pl. 1: 92(2010). *Cyperus* paniculatus D. Don, Prodr. Fl. Nepal.: 39 (1825). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus obliquus Nees in Wight, Contrib. Bot. Ind.: 86 (1834)

C. pilosus var. *obliquus* (Nees) C. B. Clarke; J. Linn. Soc. Bot. 21:151 (1884)

Type Specimen: India, C10010289. **Holotype:** C.

Perennial, height 28.5--54cm. Rhizome with slender stolons and reddish brown fibrous root. Culm scattered, 25.5--48.5X0.2--0.4cm, acutely triquetrous, stout, with leaves at basal part. Leaf sheath dark brown to brownish colour, 2.5--10cm, mouth margin obliquely open; leaf blade 3--4, 13--34X0.4--0.8cm, apex acute, margin serrulate scabrid. Involucral bracts 3--5, 2.7--23.7X0.1--5.5mm, margin serrulate scabrid. Inflorescence umbel decompound anthela 3--15.5X3.3--7cm; rays 5--7, 0.5--5cm; raylets 2-5, digitately arranged, broadly triangular in outline, 1.4--2.8cm, hispidulous; tubular prophyll primary rays 0.4--1.1cm, secondary rays 2mm; cladoprophyll 0.09--1.1cm, reddish brown colour. Spikes 2--5, digitately arranged, 3.9--3.2cm. Spikelets cluster of 6--36, laxly distichous arranged, slightly turgid, narrowly linear ovoid to linear, 5--6X2mm, 7--9 flowered; Rachis solid, zigzag, reddish brown colour, internode 0.5mm, winged rachilla. Glume reddish brown on sides, densely imbricate, broadly ovate, 1.58--1.6X0.55--0.73mm, 7 veined, keel inconspicuous, apex acute, mucronate (0.13mm). Stamens 3, linear to oblong, 0.4--0.45X0.13mm, connective 1.58--1.6 mm. Style 0.4mm, Stigmas 3, 0.75mm. Nutlet black in mature to dark brown in immature, broadly obovoid, 0.95--1X0.6--0.45mm, trigonous, broadly obovoid, apex mucronate (0.13 to 0.18mm) base cuneate (0.1 to 1.13mm), granulated.

Distribution Range: India, Nepal (Map 29), Bhutan, Bangladesh, Sri Lanka, China, Myanmar, Vietnam, S.E. Asia, Australia.

Altitude: 150m to 1500m

Ecology: Sparse forests, forest margins, grasslands on slopes, marshes, meadows, river margins, wet places, paddy fields, water margins, along trails, parks

Flowering and Fruiting: Aug - Nov.

Uses: Used as green manure in rice field.

Note: Rachis densely hispidulous, nutlets yellowish green colour.

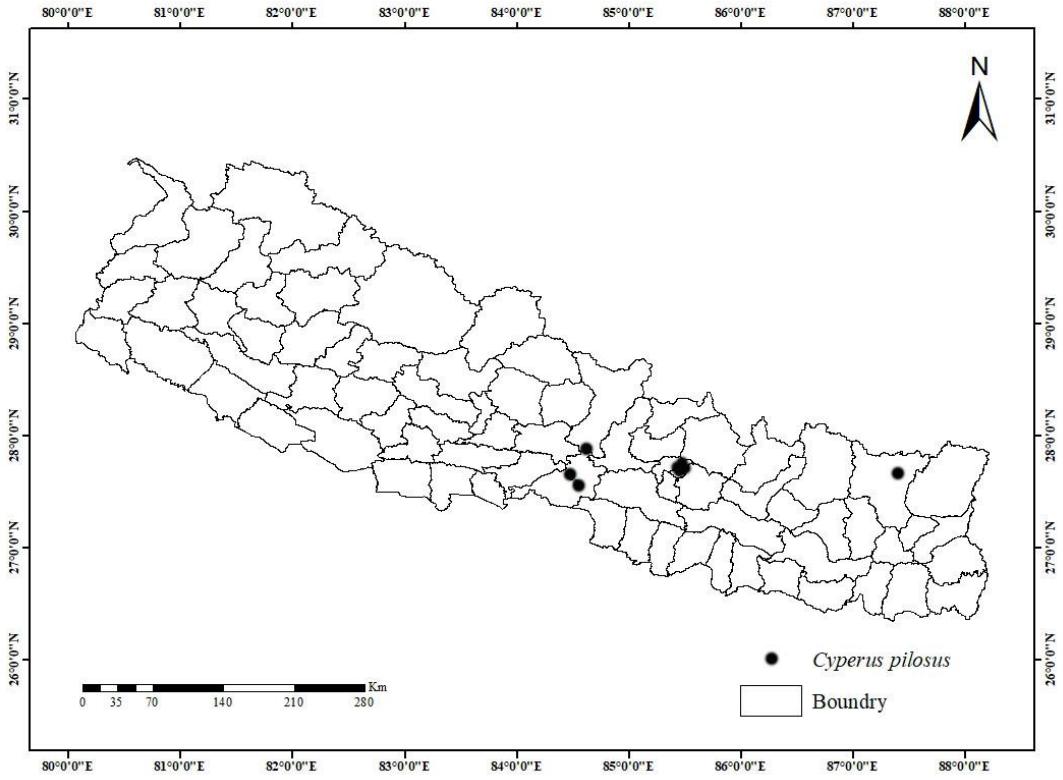
Voucher Specimen: Bhaktapur, Manohara khola, Changunarayan, 1441m, 15th August 2020, *K. Basukala* KB19 (TUCH).

Specimens Examined:

West Nepal: Dadeldhura district, Jogbura - Mauri, 400m, 1980. 8. 14, *K.R. Rajbhandari, P.M. Regmi* and *K. J. Malla* 5340 (KATH).

Central Nepal: Sindhuli district, Khirenigaon, 180m, *K.R. Rajbhandari,* and *P. R. Shakya* 3360 (KATH). Bhaktapur, Manohara khola, Changunarayan, 1441m, 15th August 2020, *K. Basukala* KB19 (TUCH).

East Nepal: Sankhuwasabha district, Manebhanjyang – Chandanpur, 1000m, 1989. 9. 13, *K.R. Rajbhandari*, 13541 (KATH).



Map 29. Distribution of *Cyperus pilosus* in Nepal based on herbarium records.

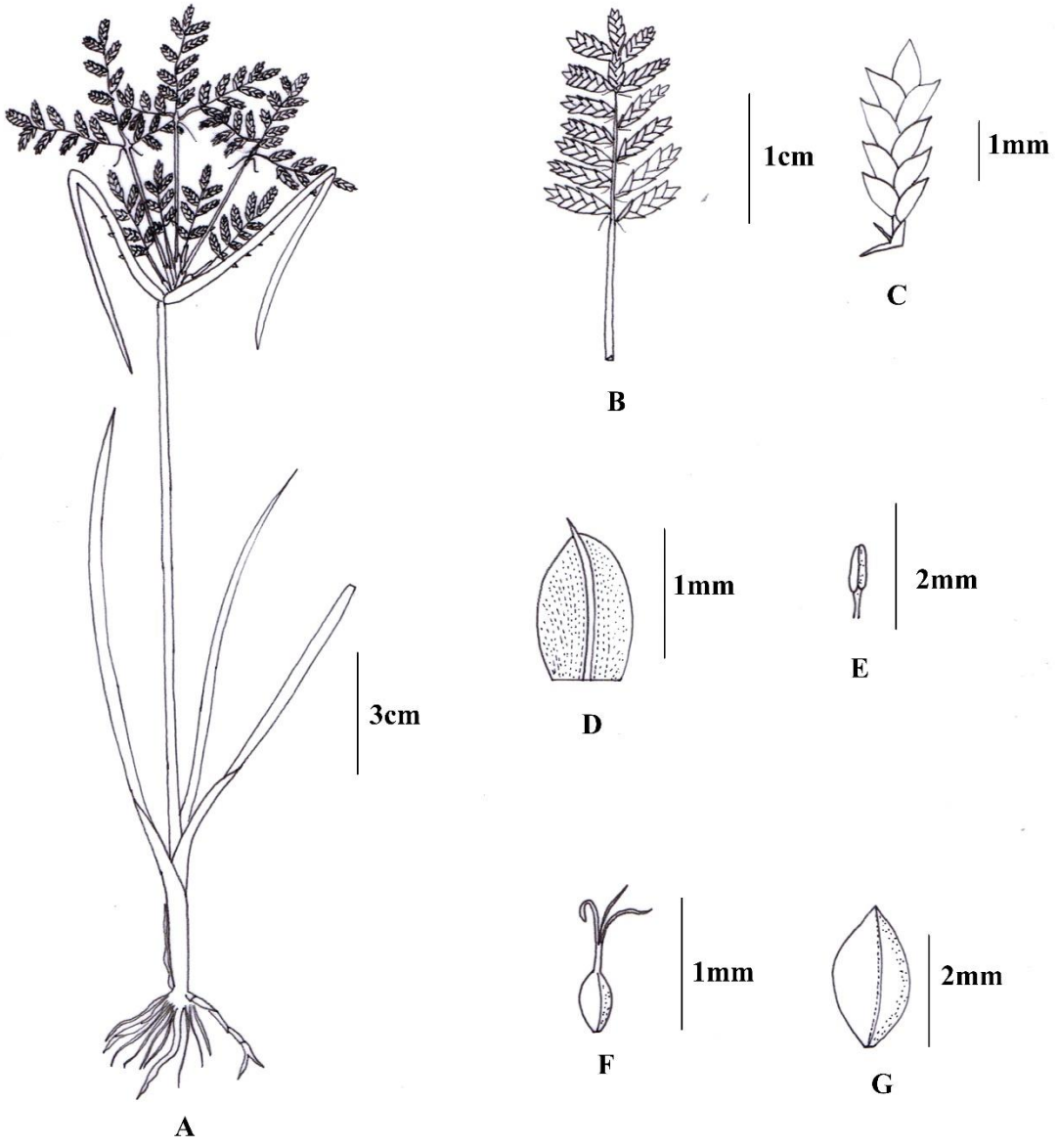


Figure 29: Cyperus pilosus Vahl.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala. K., KB19 TUCH).

29. Cyperus platystylis R. Brown, Prodr. Fl. Nov. Holl.: 214 (1810). Rajbhandari in Rajbhandari and Baral, Cat.Nep. Fl. Pl. 1: 90(2010). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus fluitans Buch-Ham. ex C.B. Clarke, J. Linn. Soc. Bot. 21: 118 (1884)

Cyperus pallidus Nees in Wight, Contr. Bot. India: 79 (1834).

Perennials, height 50--90cm. Rhizomes short, reddish brown, with fibrous root. Culm tufted, 44.5X4cm, acutely triquetrous, stout, scabrid on apical angles, with leaves at basal part. Leaf sheath reddish brown to brownish yellow colour 9--16cm, mouth margin oblique open; leaf blade 5, flat plicate, stiff 50X0.5--0.9cm, apex acute, margin serrulate scabrous. Involucral bracts 5, 7.3--33.5X0.3-0.6cm, acute adaxially, margin serrulate scabrid, revolute. Inflorescence umbel decompound anthela 4.5--9.6cm; primary rays 10, 2--4cm, secondary rays 5--10, 0.7--1cm; raylets 3--4, 4--5mm, digitately, broadly triangular in outline; tubular prophyll primary rays 1.3--2X0.1cm, secondary rays 5mm, tertiary rays 2--3mm; caldoprophyll primary rays 5--8mm, secondary rays 3mm, tertiary rays 2--3mm. Spikes 3-4, digitate, 1.2--1.8X0.8cm. Spikelets clusters of 3-7, digitately arranged at the apex of raylets, compressed, narrowly oblong- ovoid, 4--7X2--2.5mm, 13-14 flowered; Rachis solid, straight, yellowish brown, internode 0.5mm, winged rachilla. Glume conspicuous green in middle and yellowish brown on both sides, densely imbricate, broadly ovate, 2.1--2.18X1.25--1.85mm, 3 veined, keel abaxially greenish, apex acute to obtuse, mucronate (0.2mm). Stamens 3, narrowly oblong, 0.7mm, connective 1.88mm to 2.55mm; Style 0.83mm, hispidulous; Stigmas 3, 0.33 to 0.38mm. Nutlet yellowish white, ellipsoid to ovoid-ellipsoid, 1.78--1.83X0.75--1.05mm, trigonous, compressed, with concave sides, shiny, apex acuminate (0.1mm), finely reticulate.

Distribution Range: Taiwan, Bangladesh, India, Indonesia, Malaysia, Myanmar, Nepal (Map 30), Papua New Guinea, Sri Lanka, Thailand, Vietnam; Australia.

Altitude: 80m to 500m

Ecology: Wet ground, Banks of Ponds, field edges and beside rivers

Flowering: May-Nov / Fruiting: Oct-Jan

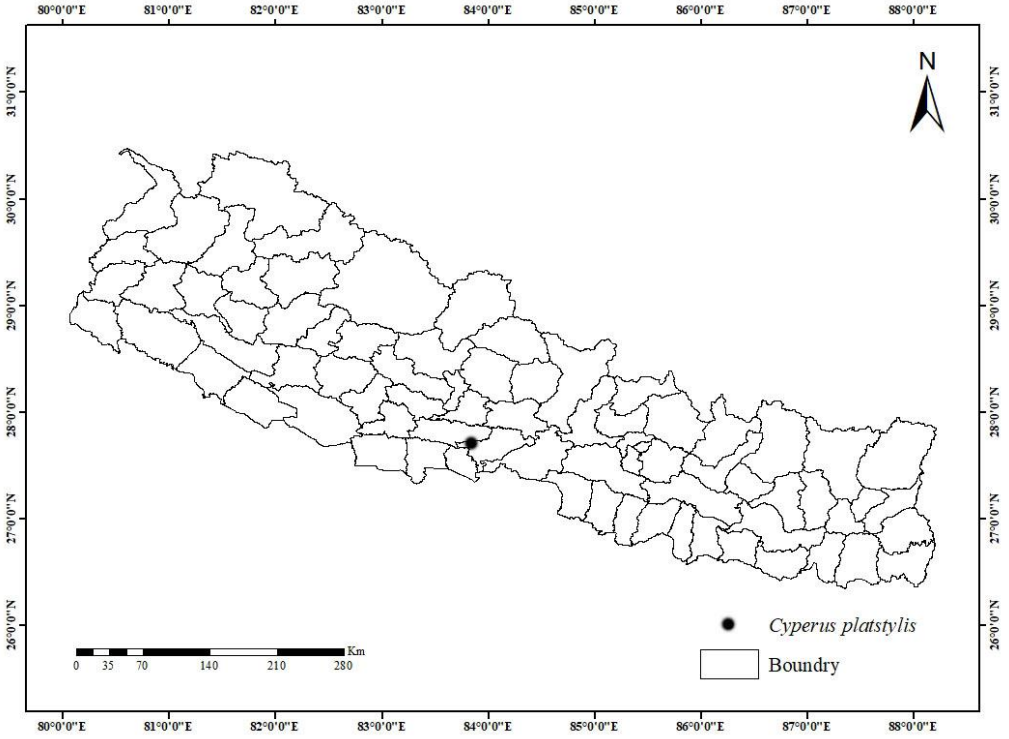
Uses: Used as a rope to tie the food (inside the banana leaves during Maghe Sankranti.

Note: Involucral bract equal in length.

Voucher Specimen: Chitwan, Bishazari taal, Bharatpur, Chitwan National Park, 286m, August 2020, *S. Poudel* (TUCH).

Specimens examined:

Central Nepal: Central Nepal – Chitwan District, Bees Hajar Tal, Chitwan National Park Buffer Zone, 80m, 2004.11.24, *C.A. Pendry, A. Giri, N. Pandey* and *M. Siwakoti* DNEP2 B 111(KATH). Chitwan, 167m, 4th August 2020, *K. Basukala* and *S. Potamahan* KB26 (KATH).



Map 30. Distribution of *Cyperus platystylis* in Nepal based on herbarium records.

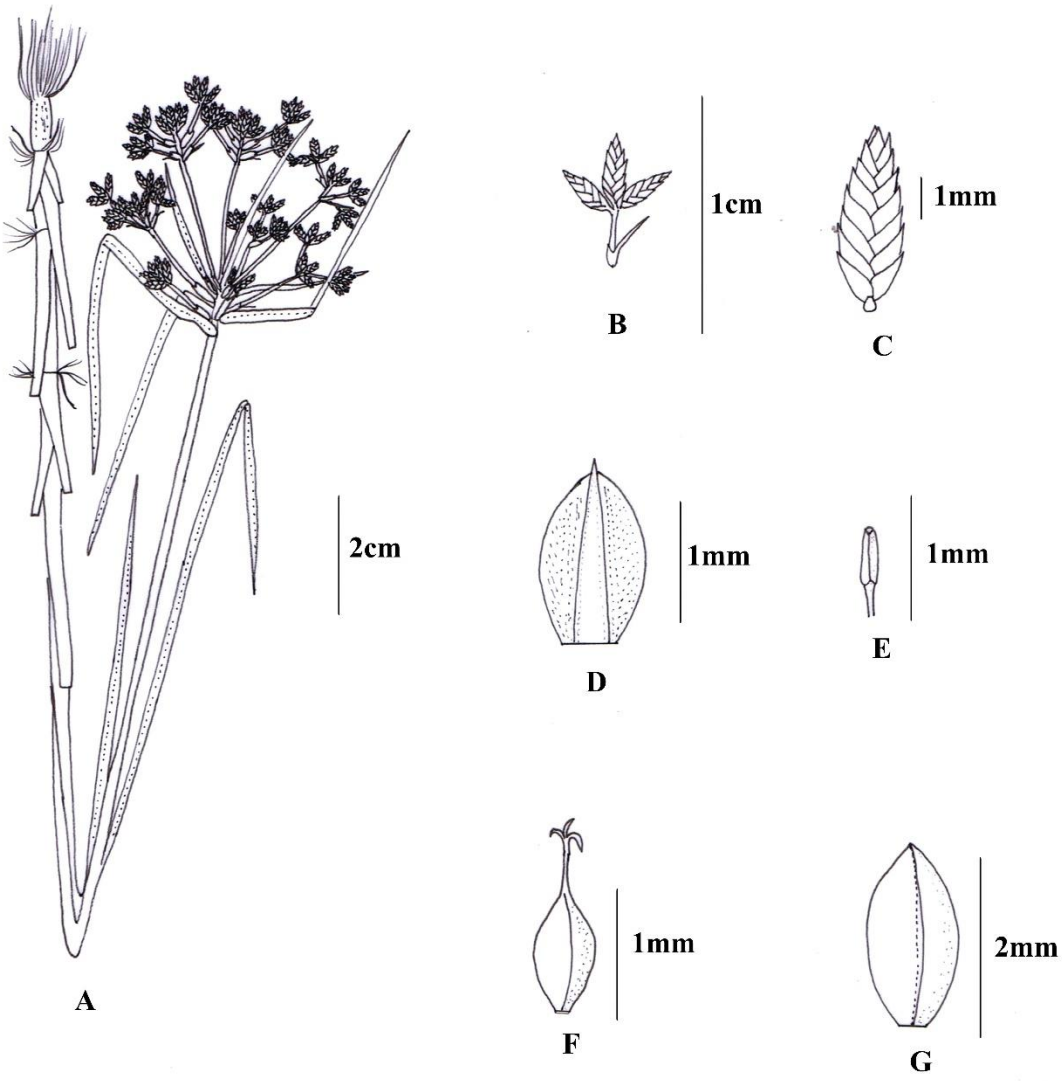


Figure 30: Cyperus platystylis R. Brown.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Fruiting Pistil, **F**. Nutlet. (Based on Poudel . S., TUCH).

30. Cyperus procerus Rottb., Descr. Icon. Rar. Pl.: 29 (1773). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1. 93(2010). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus carnosus B. Heyne ex Wall. Numer. List No. 355A (1831).

Cyperus griffithianus Boeck. Linnaea 35: 601 (1868).

Mariscus thwaitesii Livera, Ann. Roy. Bot. Gard. (Peradeniya) 11: 103 (1928).

Perennial, height 30--91.7cm more than that. Rhizomes with long stolon covered with brownish yellow scale and fibrous root. Culm, scattered, 28--78.7X0.25--0.6cm, triangular, stout, acutely triquetrous, with leaves at basal part. Leaf sheath reddish brown, 6--17cm, mouth margin oblique open; leaf blade 3-4, flat plicate, 19.4--45X0.5--0.9cm, acute apex, smooth margin. Involucral bracts 3, 2.2--26X0.5--1cm, acute adaxially. Inflorescence simple or compound anthela, 8.2--18.2X10.5--12.2cm; primary rays 3-7, 0.5--10.2cm; raylets 1--3, alternately distichous, broadly triangular in outline, hispidulous, 0.5cm; tubular prophyll 0.2--1.1cm; cladoprophyll of rays 0.3--1.2cm, raylets 2--3mm. Spikes 1-3, broadly ovoid, 2.5-- 4X2.9--5cm, Spikelets cluster of 4-20 more than that laxly arranged, slightly turgid, narrowly linear -ovoid or linear-ovoid, 2.2--2.3X3--4mm, 15 to 25 more than that, obliquely spreading; Rachis solid, straight, reddish brown. 0.7X0.6mm, rachilla winged, white, narrow, hyaline. Glume reddish brown on sides, densely imbricate, broadly ovate, 2.4--2X0.9--1.03mm, 9 veined, keeled, apex obtuse, margin involute. Stamens 3, linear, 0.93--1.08X0.15mm, connective 1mm. Style 1.88mm; Stigmas 3, 1.25--1.3mm. Nutlet yellowish brown to brown in mature, obovoid, 1.08--1.38X0.4--0.55mm, trigonous, apex attenuate, base cuneate, rugose, punctuate.

Distribution Range: Madagascar, India, Nepal (Map 31), Bangladesh, Sri Lanka, China, Myanmar, Cambodia, Laos, Vietnam, S. E. Asia, Australia.

Altitude: 80m to 200m

Ecology: wet places

Flowering and Fruiting: Jun - Oct

Uses: Fodder

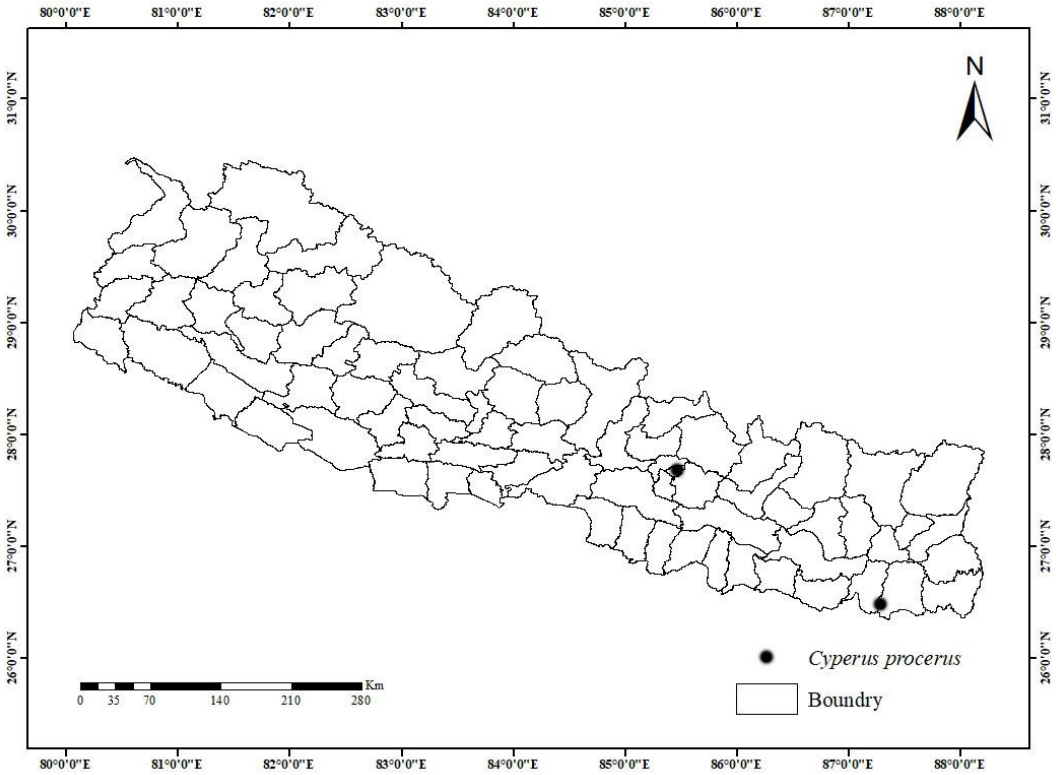
Note: Spike rachis hispidulous.

Voucher Specimen: Bhaktapur, Baghiswori, 1279.04m, 10th September 2020, *K. Basukala* and *S. Potamahan* KB23 (TUCH).

Specimens examined

East Nepal: Morang district, Boratnagar, 1991.10.15, *M. Siwakoti* 42 (KATH).

Central Nepal: Bagiswori, Bhaktapur, 1278m, 10th September 2020, *K. Basukala* and *S. Potamahan* KB201 (KATH).



Map 31. Distribution of *Cyperus procerus* in Nepal based on herbarium records.

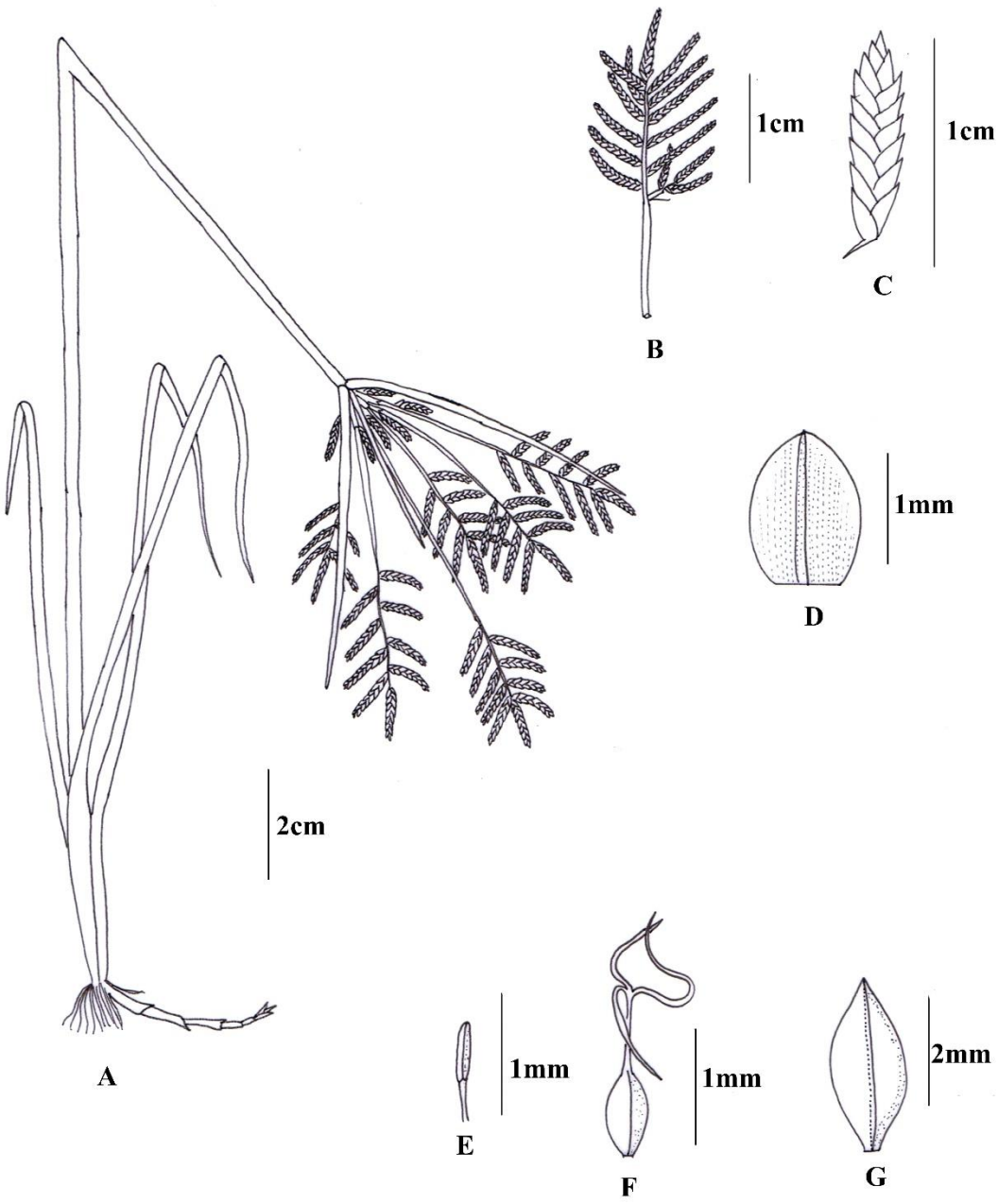


Figure 31: Cyperus procerus Rottb.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB23 TUCH).

31. Cyperus rotundus L., Sp. Pl. 1:45 (1753). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 108 (1978). Rajbhandari in Rajbhandari and Baral, Ct. Nep. Fl. Pl.1: 93 (2010). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus bifax C.B. Clarke, Bull. Misc. Inform. Kew, Addit. Ser.8: 13(1908)

Cyperus tuberosus Rottb., Descr. Icon. Rar. Pl. 28 (1773)

Type Specimen: BM000621233. **Lectotype:** BM.

Perennial, height 7.3--46cm more than that. Rhizome dark brown woody, with many slender stolons and ellipsoidal nut like tubers. Culm scattered, solitary, 5.4--38X0.1--0.2cm, slightly slender, triquetrous, smooth, base swollen into tuber, leaves at basal part. Leaf sheath reddish brown 0.8--6.8cm, mouth margin oblique open; leaf blade flat, 4. 4--9X0.2cm, acute apex, margin smooth. Involucral bracts 3, 1.2--8.3X0.1--0.2cm, acute adaxially, margin revolute. Inflorescence simple anthela, 1.8--8X5cm; rays 4--5, 0.3--6cm; raylets 2--6, digitately, tubular prophyll 3--5mm; cladoprophyll 5--6mm. Spikes 4--5, obdeltoid, digitate, 0.9--2X0.4--3.2cm. Spikelets clusters of 2--6, laxly arranged, compressed, linear, 1--3X0.18--0.2cm, 5--22 flowered; Rachis solid, straight, internode 0.5mm, rachilla winged, broad, hyaline. Glume reddish brown on sides, subdensely imbricate, ovate to oblong-ovate, 2.63--2.7X0.73--0.78mm, 3 veined, keeled, apex acute to obtuse and muticous, margin revolute. Stamens 3, linear, 1.2--1.55X0.14--0.19mm, connective 0.95mm. Style 0.83mm to 2.13mm; Stigmas 3, 0.25--1.38mm. Nutlet yellowish green, obovoid-oblong, 1.25--1.5X0.28--0.68mm, trigonous, puncticulate or reticulate.

Distribution Range: Bhutan, Korea, Europe, Australia, America, Srilanka Africa, S.W. Asia, Afghanistan, Pakistan, India, Nepal (Map 32), China, Myanmar, Vietnam

Altitude: 300m to 2400m

Ecology: Grasslands, stream margins, along trails, sandbanks, ditch margins, water margins in valleys, paddy field margins

Flowering and Fruiting: May - November

Use: *Cyperus rotundus* is a medicinal herb traditionally used to treat various diseases at home such as diarrhoea, diabetes, pyresis, inflammation, malaria, and stomach and bowel disorders.

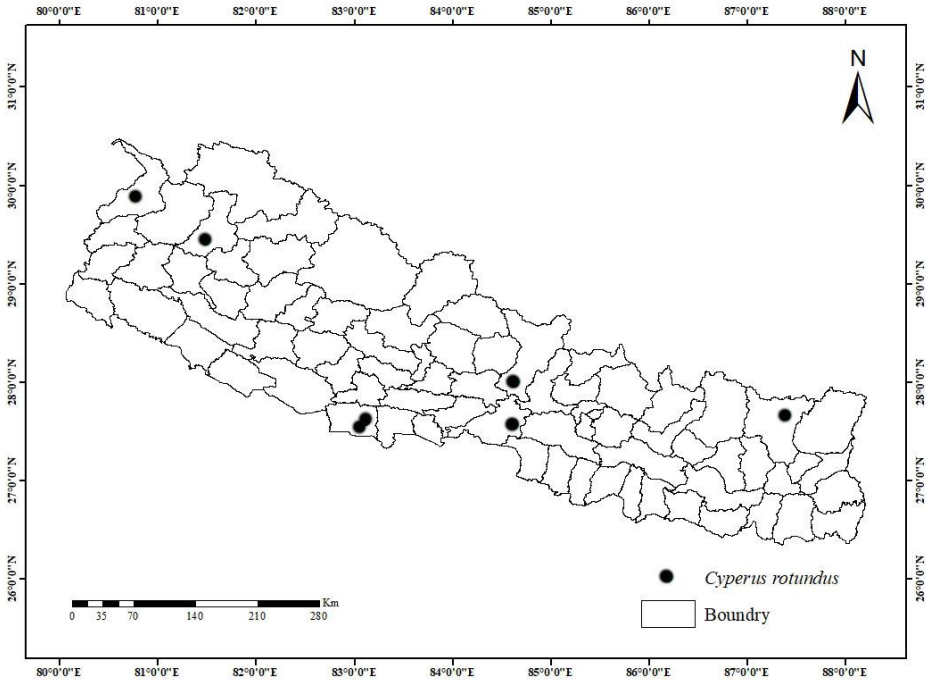
Voucher Specimen: Bhaktapur, Kasan, 1252.2m, 21st October 2020, *K. Basukala* KB15(TUCH).

Specimens examined:

West Nepal: Kalikot, district and Bajura, district, Phukgad Tolebhir, 880m 1991.8.8, *M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K. R. Rajbhandari, H. Takayama* and *K. Terada* 9193536 (TI).

Central Nepal: Makawanpur district, Deurali Danda, Kulekhani, 5000ft., 1975.10.8, *K. R. Rajbandari, P. M. Regmi* and *N.K. Bhusal* 75/923(KATH). Bhaktapur, Kasan, 1252.2m, 21st October 2020, *K. Basukala* KB155 (KATH).

Eastern Nepal: Dhankuta district, Hile - Gholikharka, 1910-1300m, 1988.7.2, *M. Suzuki, T. Maeda, N. Naruhashi, R. Watanabe, M. N. Subedi, M. Minaki, S. Noshiro* and *H. Ikeda* 8820006 (KATH).



Map 32. Distribution of *Cyperus rotundus* in Nepal based on herbarium records.

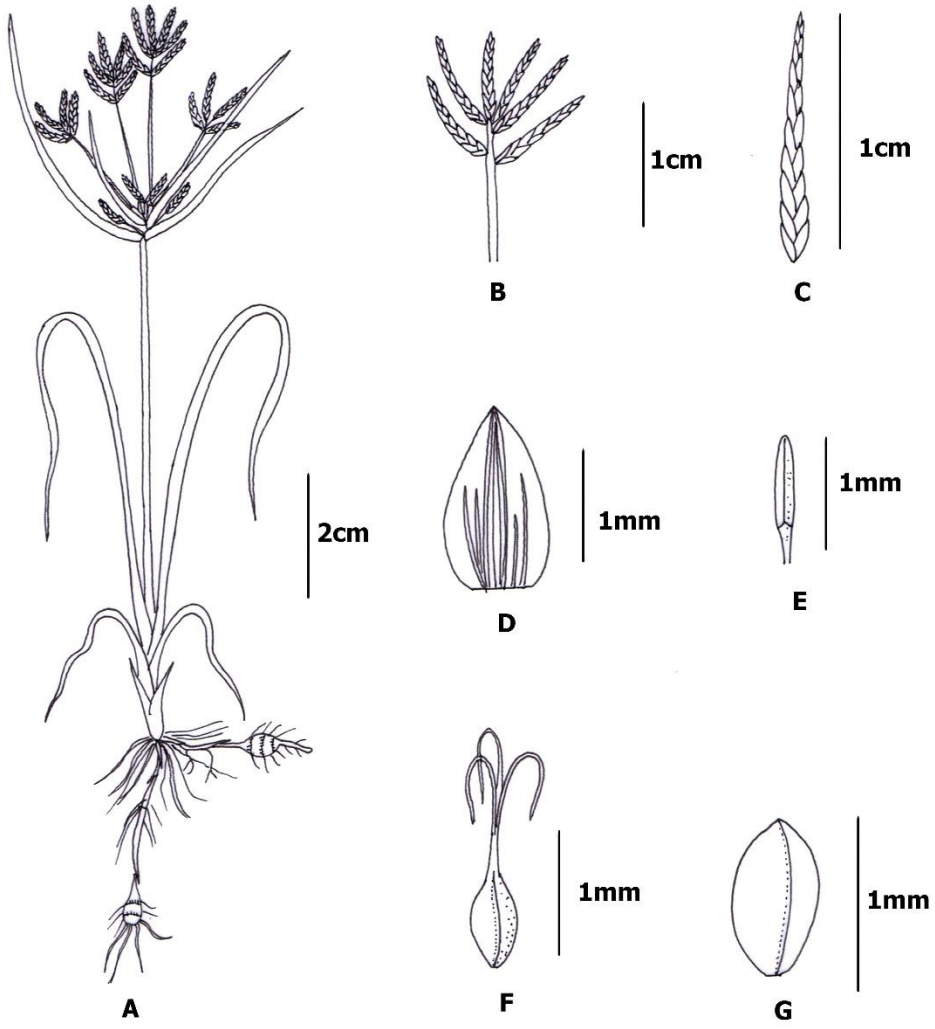


Figure 32: Cyperus rotundus L.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala. K., KB21 TUCH).

32. Cyperus squarrosus L., Cent. Pl. 2: 6 (1756). Rajbhandari in Rajbhandari and Baral, Cat. Nep. Fl. Pl. 1:93 (2010). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus aristatus Rottb, Descr. And Icon. Pl.:23, t. 6. f. 1 (1773).

Cyperus versicolor Nees in Wight, Contr. Bot. India: 78 (1834).

Mariscus aristatus (Rottb.) Cherm, Bull. Soc. Bot. France 85: 366 (1938).

Mariscus squarrosus (L.) C.B. Clarke in Hooker, Fl. Brit. India 6: 623 (1893).

Type Specimen: Anon. s.n. LINN-HL70-8. **Lectotype:** LINN.

Annuals, height 6.8--11.3cm, Root fibrous, straw yellow to reddish brown. Culm scattered or sparsely tufted, 4.5--7.7X0.1cm sharply trigonous, greyish green colour, basally with several leaves. Leaf sheath reddish brown colour, 1.8--2.6cm, mouth margin concave opening; leaf blade 7, 3--10X0.1--0.2cm, acute apex, margin smooth, slightly revolute. Involucral bracts 3-4, 1.2--8.3X0.1--0.2cm, acute adaxially, margin revolute. Inflorescence simple anthela 2.1--4.2X1.8--4cm; rays 3-5, 5mm to 3. 6cm, digitately, oblong cylindrical in outline; tubular prophyll 3mm. Spikes 3-5, digitate, 0.4-1X0.5-0.6cm. Spikelets cluster of 12 to 31, densely spirally arranged, yellowish green to reddish brown, reflexed, flat, slightly compressed, linear oblong to oblong, 3--5X1--1.5mm, squarrose with recurved glume-apices, 7-11 flowered; Rachis solid, straight, reddish brown, internode 0.3mm, wingless rachilla. Glume purpulish brown on sides, green strongly excurrent midrib laxly arranged, ovate oblong, cymbiform, 0.83--0.88X0.23--0.28mm, 3-7veined, keel abaxially conspicuous, apex extending into recurved arista (0.4 to 0.55mm), margin scabrous. Stamens 1-2, linear ellipsoid, 0.23 X 0.1mm, connective 0.43-0.9mm. Style 0.3--0.43mm, hairy; Stigmas 3, 0.25mm. Nutlet yellowish brown in immature to dark greyish colour in mature, obovoid oblong, 0.68--0.7X0.3mm, 3 sided, minutely papillose, apex truncate and apiculate, granulated.

Distribution Range: Europe, Africa, S. W. Asia, Afghanistan, Pakistan, India, Nepal (Map 33), Bhutan, Bangladesh, Sri Lanka, China, Myanmar, Vietnam, S. E. Asia, Australia, America. (USA, Mexico, West Indies, Bermuda, Central America, South America, Asia, Africa, Indian Ocean Islands, Pacific Islands, Australia. Naturalized in Europe.)

Altitude: 1600m to 2700m

Ecology: Mossy boulder, in damp roadsides and as a weed in wastelands

Flowering and Fruiting: Sept - Oct

Uses: Fodder

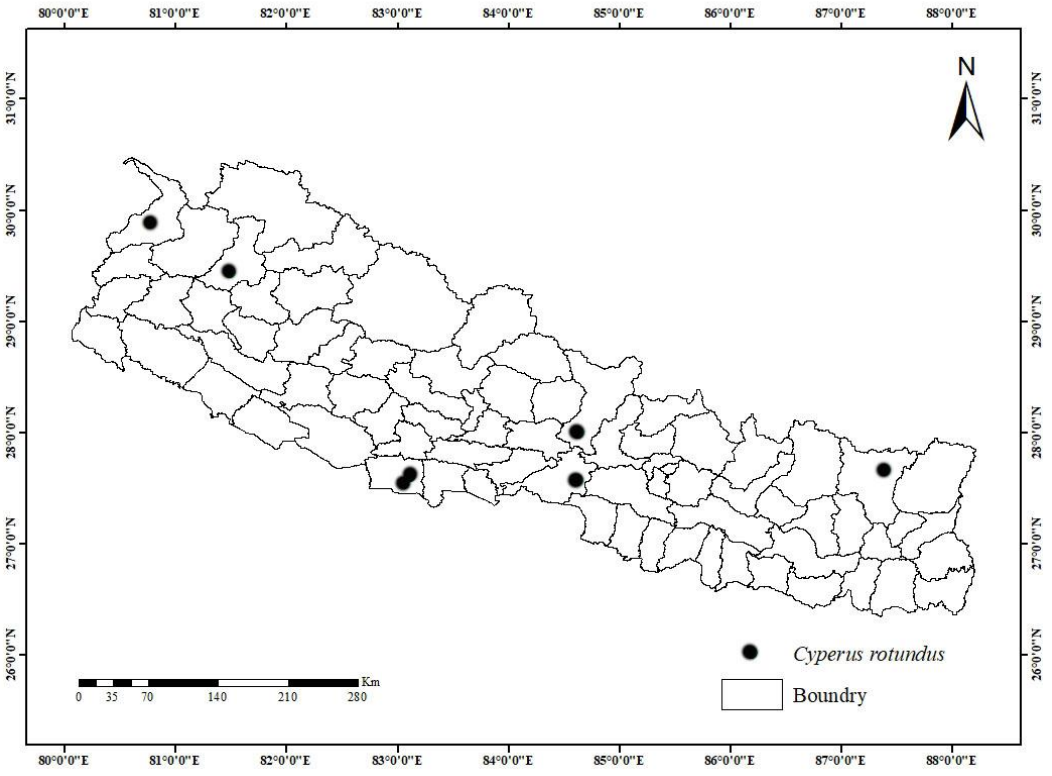
Note: Spikelets falling as a unity, densely spirally arranged at the apex of ray.

Voucher Specimen: Chitwan, Tikauli Taal, Chitwan National Park,175m, 28th August 2020, *K. Basukala* and *S. Potamahan* KB13 (TUCH).

Specimens examined

West Nepal: Darchula district, Ralpa – Tangbang, 2000m, 1980.8.26. *K. R. Rajbhandari* and *K. J. Malla* 5603(KATH).

Central Nepal: Myagdi district, Sikha – Tatopani, 1600m, 1983.7.15, *K. R. Rajbhandari* 7789 (KATH). Chitwan, Kasara, 175m, 28th August 2020, *K. Basukala* and *S. Potamahan* KB27(KATH).



Map 33. Distribution of *Cyperus squarrosus* in Nepal based on herbarium records.

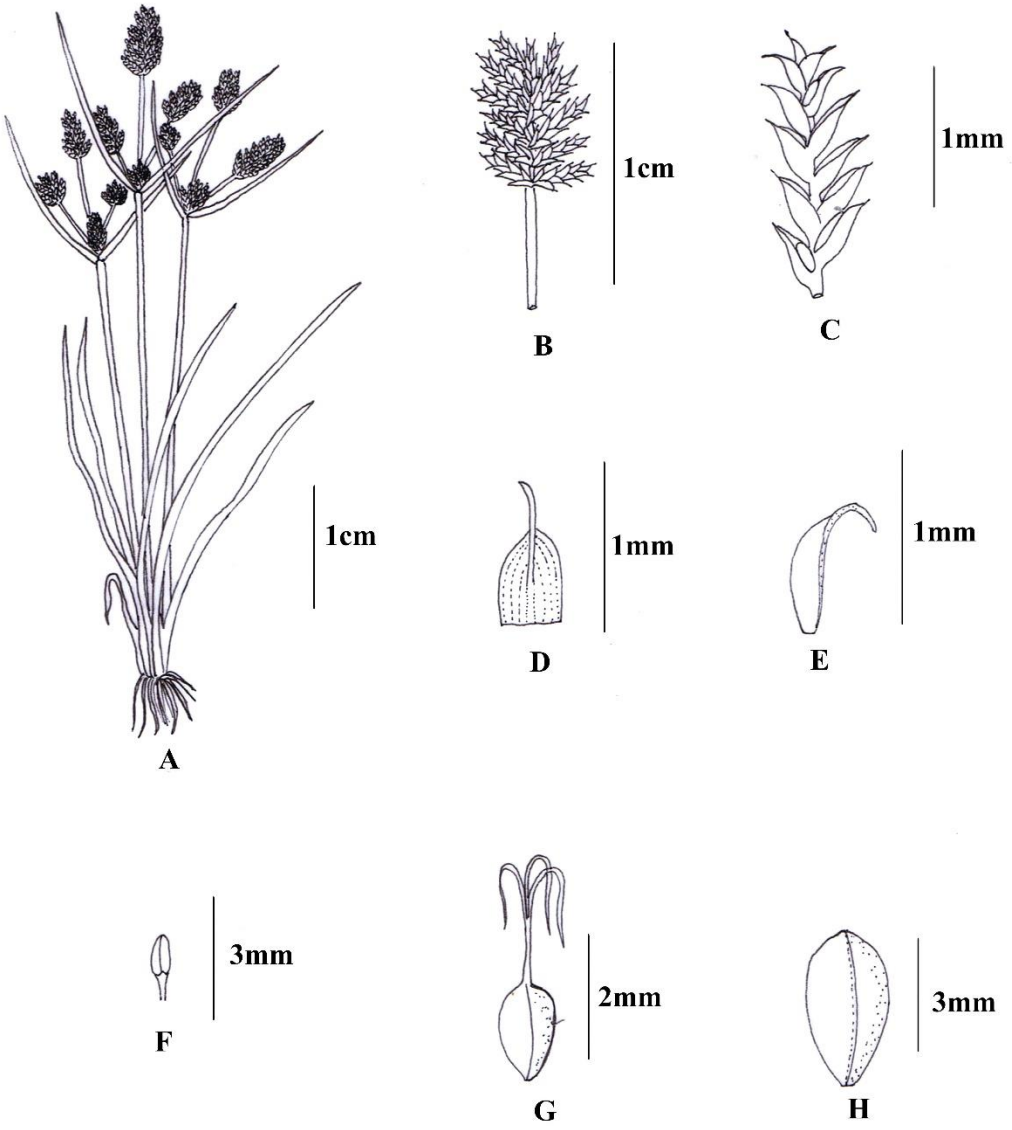


Figure 33. Cyperus squarrosus L.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume dorsal view,**E**. Glume side view, **F**. Anther, **G**. Fruiting Pistil, **H**. Nutlet. (Based on Basukala et al., KB13 TUCH).

33. Cyperus tenuiculmis Boeck, Linnaea 36: 286 (1870). Koyama in Hara *et al.,* Enum. Flow. Pl. Nepal 1: 108 (1978). Rajbhandari in Rajbhandri and Baral, Cat. Nep. Fl. Pl. 1: 93 (2010). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus bracteatus Steud., Syn. Pl. Glumac. 2: 93(2010).

Cyperus hexastachyus Nees in Wight, Contr. Bot. India: 82 (1834).

Type Specimen: Zambia, 19th January 1959, E.A. Robinson 3243. **Isotype:** K.

Perennial, height 7--38.5cm. Root Fibrous, yellowish straw colour to brownish with yellow colour beads. Culm laxly tufted, 5.5--29cm, slender, basally with several leaves, basally slightly swollen. Leaf sheath brownish colour, 1.8--8.8cm; leaf blade 8, 3.2--39X0.12--0.5mm, apex acute scabrous, margin scabrous revolute. Involucral bracts 6, 2.5--21.9X0.4--0.5cm, acute adaxially, margin revolute. Inflorescence simple or compound anthela, 9.5--4cm; rays 6--8, 2--6.6cm; raylets 1--2; digitate, 5mm; tubular prophyll primary rays 1.3cm, secondary rays 5mm; cladoprophyll primary rays 1.7cm, secondary rays 2.2cm. Spikes 2--4, digitate, 2.5--3.4X0.7--2.5cm. Spikelets cluster of 4--15, laxly arranged, subquadrangular, narrowly linear ovoid to linear, 0.8--13X1.5--2mm, 3--9 flowered; Rachis, straight, reddish brown, internode 1.5--2mm, rachilla flexuose, rachilla winged, caduceus. Glume reddish brown with a green strongly excurrent midrib, laxly imbricate, elliptic, obovate, obtuse tip, 3--4mmX1mm, 7 veined, green keeled apex obtuse, margin involute. Stamens 3, linear, 1--1.5X0.18mm, connective 0.48mm; Style 0.9--1.05mm; Stigmas 3, 2.13mm. Nutlet greenish yellow to brownish yellow colour, oboviod to elliptic, 1.68X0.85--0.88mm, concave on 3 sides, apex obtuse, base stalk 0.13mm, reticulate.

Distribution Range: Africa, India, Nepal (Map 34), Bhutan, China, Japan, Cambodia, Laos, Vietnam, Myanmar, S. E. Asia, Australia, Pacific islands.

Altitude: 150m to 2500m

Ecology: Open grass slopes

Flowering and Fruiting: May - Nov

Uses: Fodder

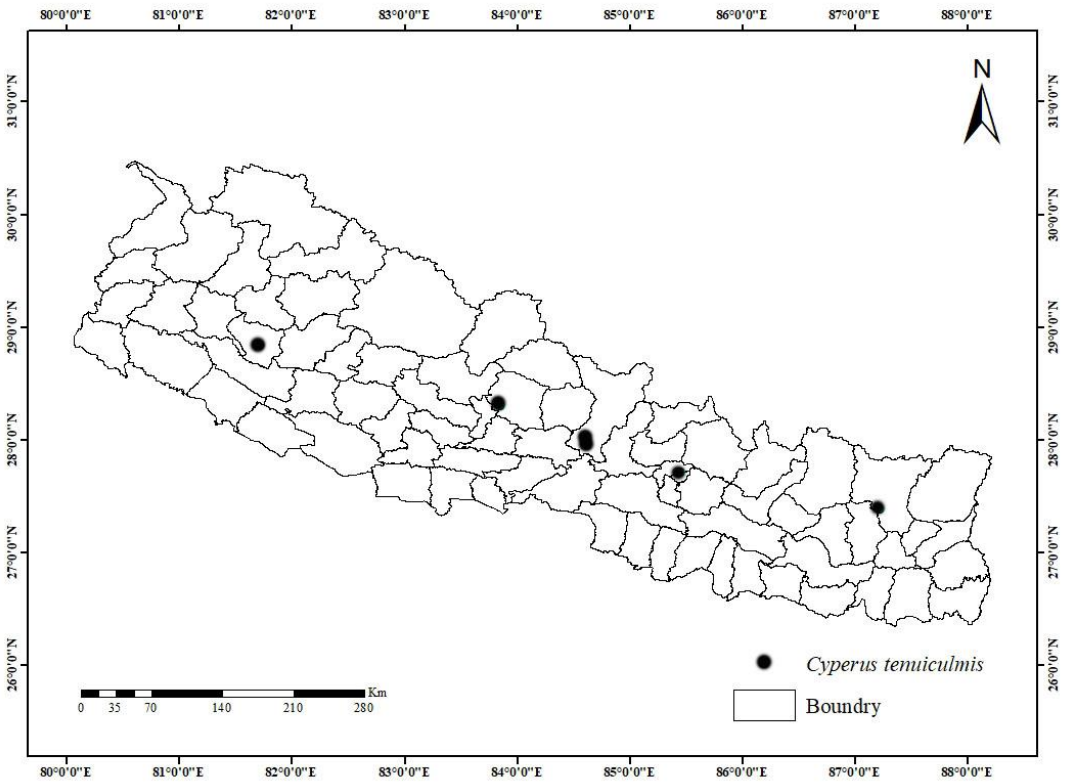
Voucher Specimen: Kathmandu, Bajrayogini, 11th September 2019, *K. Basukala* KB15(TUCH).

Specimens examined

West Nepal: Dailekh district, Silangi bazaar – Panipokhari, 1450m, 1991. 8.3*, M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamoto, K.R. Rajbhandari, H. Takayama* and *K. Terada* 9170215 (TI).

Central Nepal: Kaski district, Lyawode Phedi – Dhampus, 1300m, 1983.7.7, *K. R. Rajbhandari* 7247(KATH). Gorkha, Batasechok, 1165m, 8th July 2019, *K. Basukala* and *S. Potamahan* KB86 (KATH). Kathmandu Bajrayogini, 11th September 2019, *K. Basukala* KB012 (KATH).

East Nepal: Sankhuwasabha district, Khandbari – Manebhanjyang, 1100m, 1989.9.13, *K. R. Rajbhandari* 13536 (KATH).



Map 34. Distribution of *Cyperus tenuiculmis* in Nepal hased on herbarium records.

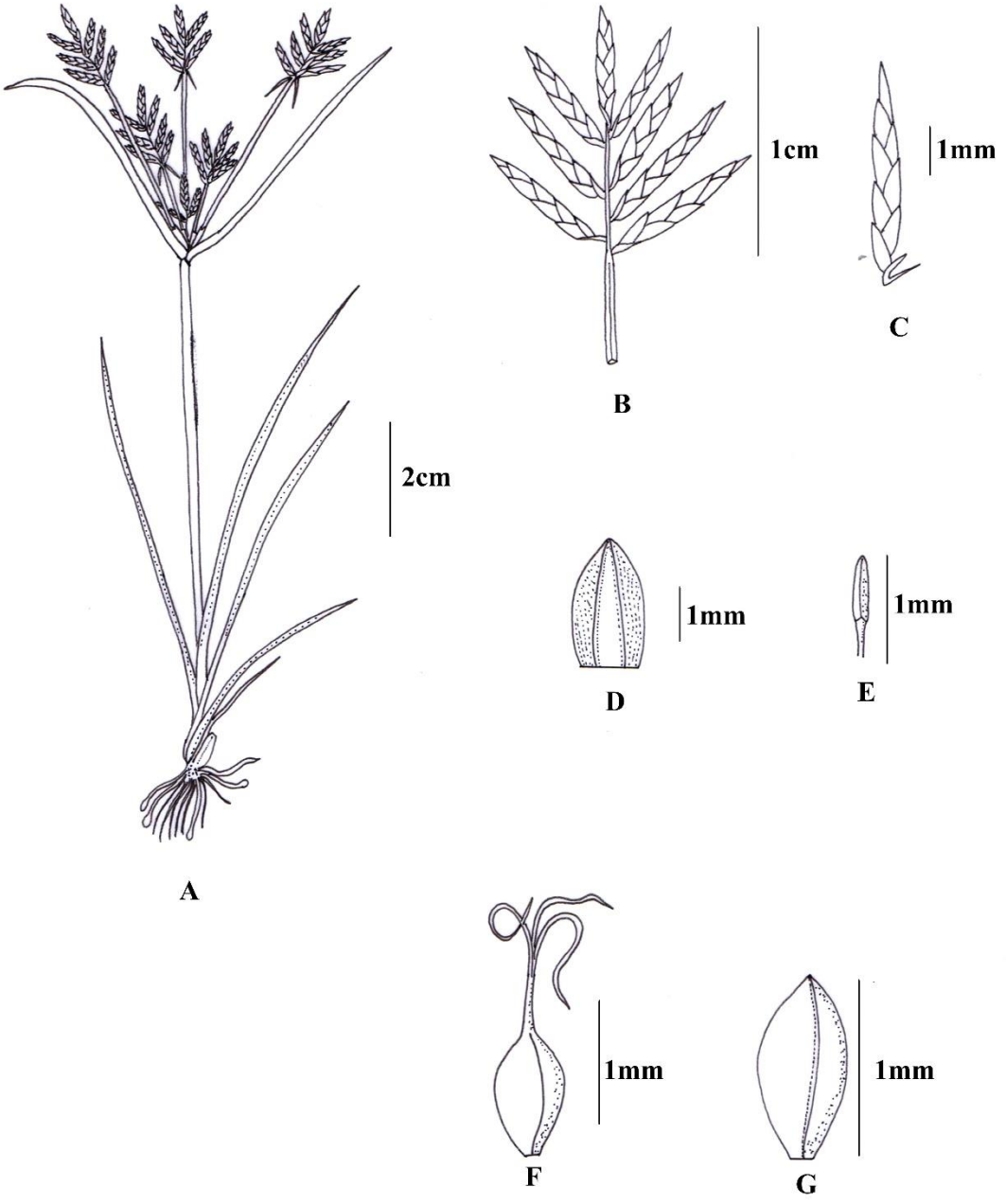


Figure 34: Cyperus tenuiculmis Boeck.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala.K., KB15 TUCH).

34. Cyperus tenuispica Steudel, Syn. Pl. Glumac. 2: 11 (1854). Koyama in Hara *et al*., Enum. Flow. Pl. Nepal 1; 107 (1978). Rajbhandari in Rajbhandari and Baral, Cat.Nep. Fl. Pl. 1: 91(2010). Rajbhandari *et al.,* Cat. Nep. Fl. Pl. Suppl. 1: 20 (2015). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Cyperus delicatulatus Steid., Syn. Pl. Glumac. 2: 21 (1854).

Type Specimen: India, F. Metz., P00587068. **Holotype:** P.

Annual, height 19.8--29cm. Roots fibrous, reddish. Culm densely tufted, 14.5--23.4cm, sharply trigonous, flaccid, slender, smooth. Leaf sheath reddish brown in lowerside to yellowish green at top, 4--7cm, mouth margin oblique; leaf blade 2, 2.4--32.3X0.2--0.4, acute apex, margins and keel smooth, apex acute, slightly scabrous. Involucral bracts 2, foliose, 3.2--15.5X0.1--0.3cm, acute adaxially, apex scabrous. Inflorescence compound anthela 4.5--17 X5--9cm; primary ray 13--17, 0.6--8cm; secondary rays 5--7, 0.5--2cm; tertiary rays 3--5, 2--4mm; raylets 5--7, digitately arranged, 0.3--2cm; tubular prophyll primary rays 2-7mm, secondary rays 2-3mm; cladoprophyll 2.5mm smaller than prophyll 2 in number, green to reddish brown in colour, recurved. Spikes 5--7, digitate, 2.4--6X 1--1.5cm. Spikelets cluster of 5--13 digitately arranged at apex of ray, compressed, linear to narrowly linear ovoid, 1--6X 0.5--1mm, 5--20 flowered; Rachis solid, straight, tetraangular, reddish brown, internode 0.2-0.25mm, wingless rachilla. Glume reddish brown on sides, densely imbricate, elliptic to suboblong, 0.98--1.08X 0.33--0.5mm, vein inconspicuous, slightly keel at tip, apex obtuse to subtruncate, slightly excurved or recurving. Stamens 1 or 2, narrowly oblong, 0.35mm X 0.1mm, connective (versatile) 1mm. Style 0.3mm; Stigmas 3, 0.45--0.5mm. Nutlet whitish yellow in colour, obovoid, 0.38--0.45X0.2--0.3mm, trigonous, base cuneate, apex mucronate, tuberculate or granulated.

Distribution Range: Nepal (Map 35), Bhutan, India, Indonesia, S Japan, Kashmir, Korea, Laos, Malaysia, Myanmar, Pakistan, Philippines, Sri Lanka, Tajikistan, Thailand, Uzbekistan, Vietnam; tropical Africa, Australia, Indian Ocean islands.

Altitude: Below 100m to 500 m.

Ecology: Sparse forests, along trails, wet places, pond/paddy fields

Flowering and Fruiting: September - November

Uses: Fodder

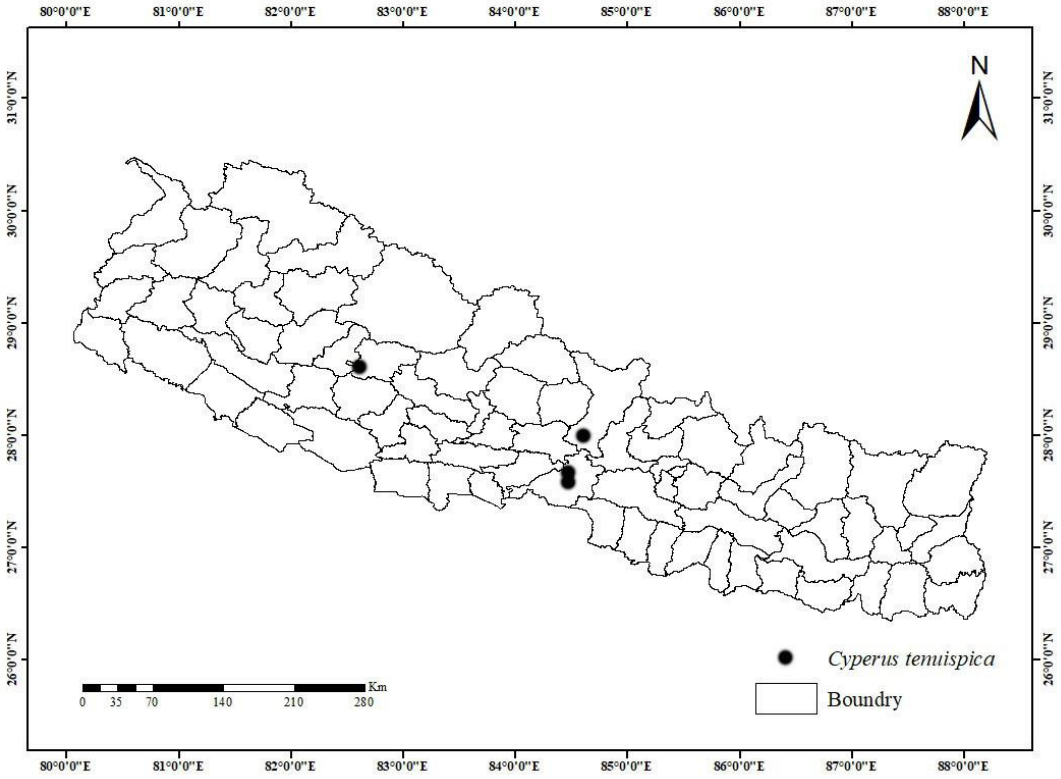
Voucher Specimen: Bhaktapur, Mangaltar Changunarayan, 1441m, 15th September 2019, *K. Basukala* and *S. Potamahan* KB17 (TUCH).

Specimens examined

West Nepal: Rukum District, Gijagaon, 1100m, 1982. 9. 18, *K.R. Rajbhandari* and *K. J. Malla* 6539 (KATH)

Central Nepal: Chitwan District, Sauraha – Nandan taal,160m – 150m, 1996.1.18. *M. Mikage*, *N. Acharya, T. Kurosawa, P. Lacoul, A. Takahashi* and *K. Yoda* 9614187 (TI). Bhaktapur, Changu Mangaltar, 1441m, 15th September 2019, *K. Basukala* and *S. Potamahan* KB63(KATH).

East Nepal: Tamur river between Chhiruwa and Hellok, 1400m, 1989.9.4, *C. Grey-Wilson, S. Zmarzty, M. Sinnott, D. Long, R. McBeath, H. Noltie* and *M. Subedi* 209 (KATH).



Map 35. Distribution of *Cyperus tenuispica* in Nepal based on herbarium records.

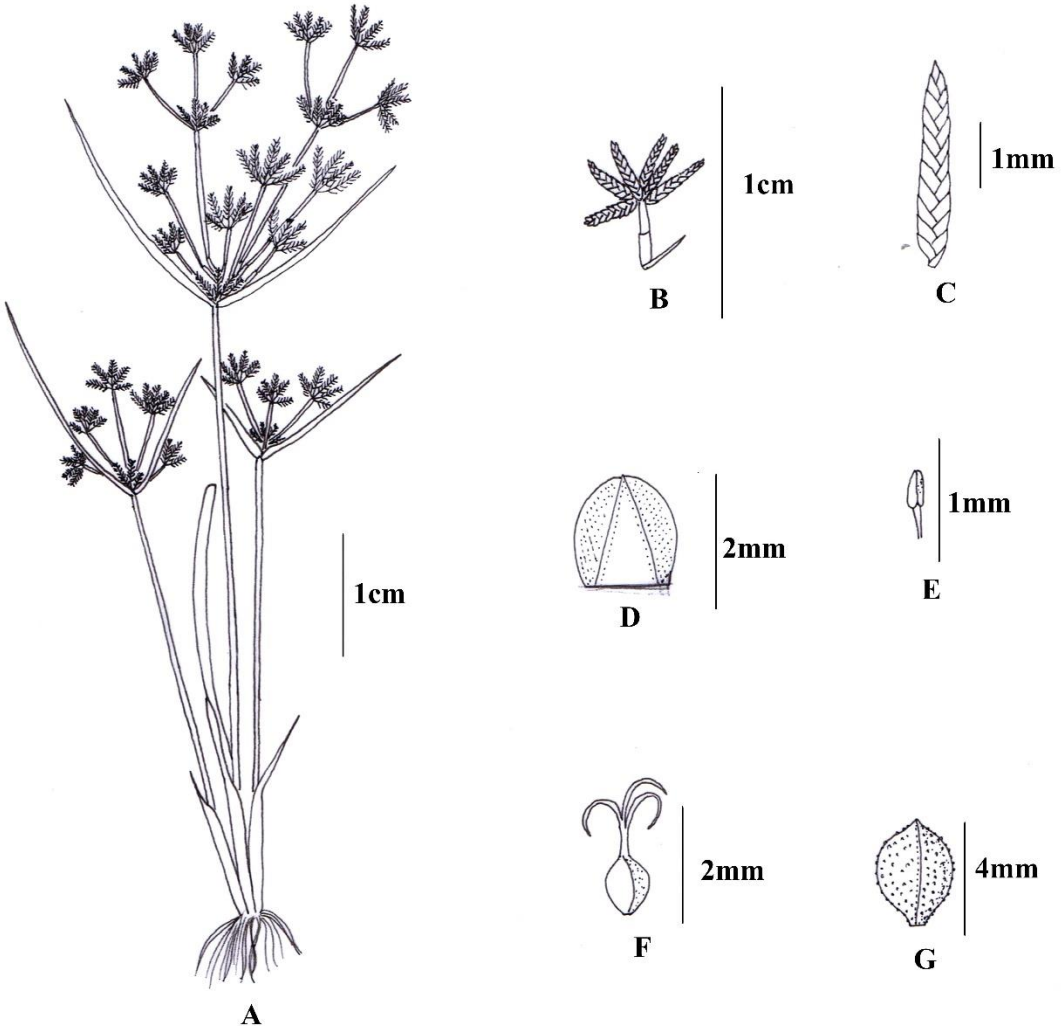


Figure 35: Cyperus tenuispica Steud.; **A**. Habit Sketch, **B**. Spike, **C**. Spikelet, **D**. Glume, **E**. Anther, **F**. Fruiting Pistil, **G**. Nutlet. (Based on Basukala et al., KB17 TUCH).

35. Cyperus trisulcus D. Don, Prodr. Fl. Nepal.: 39 (1825). Koyama in Hara *et al.,* ENUM. Flow. Pl. Nepal 1:108 (1978). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017). Shrestha *et. al.,* A Hand. Fl. Pl. Nep. 1: 237 (2018).

Type Specimen: Not found.

Culm shorter, Leaves linear, margin scabrous. Inflorescence or umbella 5- rayed the envelope is much shorter, spikelets oval-oblong, obtuse, crowded together, Glume oblong, rounded, slightly oblongata, margin revolute.

Distribution Range: Endemic to Nepal

Specimens examined

Central Nepal: Nepal, N. Wallich s.n. (BM, syntype).

36. Cyperus wallichianus Spreng., Syst. Veg. 4(2): 28 (1827). Koyama in Hara *et al*., Enum. Flow. Pl. Nepal 1: 108 (1978). Rajbhandari and Rai, Hand. Fl. Pl. Nep. 1: 206 (2017).

Cyperus pulcher D. Don, Prodr. Fl. Nepal.: 38 (1825).

Type Specimen: Not found.

Culm trigonous, upper corner scabrous, leafless, base sheathed. Inflorescence compound, 5 rayed, an umbrella longer, linear, green, keeled, margin revolute, scabrid. spikelets linear, Glume mid rib chestnut margin green, tip hyaline white, oval, rounded, striped, smooth, 5-nerved, subpentaphyllisbales.

Distribution Range: Endemic to Nepal

Specimens examined

Central Nepal: Nepal, N. Wallich s.n. (BM, syntype of *Cyperus pulcher*).

4.3. Hierarchical Cluster Analysis

Hierarchical Clustering analysis is an algorithm used to group the data points with similar properties. This analysis was performed to analyse the relationship between the species with the help of discrete characters and character states that are variable within the species. Characters, character states and data matrix were shown in the table 1 below.

Table 1: Characters and Characters coding for Hierarchical Cluster Analysis.

S.N	Characters	Coding
1.	Height of plant	0= Less than 100cm, 1= 100cm or more
2.	Habitat	0= Annual , 1= Perennial
3.	Root	0= Fibrous , 1= Rhizomatous
4.	Culms	0= Tufted, 1= Scattered
5.	Culm size	0 = Less than 100cm, 1 = 100cm or more
6.	Culms angle	0= Triquetrous, 1=Cylindrical or lower cylindrical to upper triquetrous
7.	Culms with basal leaf	0 = With several basal leaves, 1 = Reduced basal leaves
8.	Leaf sheath type	0 = Ligulate, 1 = Eligulate
9.	Leaf sheath size	0 = Less than 5cm, 1 = 5cm or more
10.	Leaf sheath margin	0= Obliquely open, 1= Straightly open
11.	Leaf blade number	0= Less than 3, 1= More than 3
12.	Leaf blade size	0= Less than 20cm, 1= 20cm or more
13.	Leaf blade apex	0 = Acute, 1= Obtuse
14.	Leaf blade Margin	0= Smooth, 1= Scabrous
15.	Involucral bract number	0= less than 6, 1= more than 6
16.	Incolucral bract size	0= Less than 15cm, 1= 15cm or more
17.	Inflorescense type	0= Simple anthela, 1= Compound anthella, 2= Decompound anthela
18.	Primary rays number	0= less than 8, 1= more than 8
19.	Secondary rays	0 = Present, 1 = Absent
20.	Tertiary rays	0 = Present, 1 = Absent
21.	Rays surface	0 = Glabrous, 1 = Hispidous
22.	Raylets number	0 = Less than 3, 1= 3 or more
23.	Raylets arrangement	0 = Alternately distichous, 1 = Digitately arranged
24.	Raylet size	0 = Less than 1cm , 1 = 1cm or more
25.	Raylet surface	0 = Glabrous, 1= Hispidulous
26.	Prophyll	0 = Less than 5mm, 1 = 5mm or more
27.	Cladoprophyll	0 = Less than 1 cm, 1 = 1cm to 3cm, 2 = more than 3cm
28.	Spikes arrangement	0= Capitate, 1= Cylindric 2= Digitate
29.	Spikes number	0= Less than 5, 1= 5 or more
30.	Spikes size	0= Less than 3cm , 1= 3cm or more
31.	Spikelets arrangement	0 = Spirally, 1= Capitulum, 2 = Distichously
32.	Spikelets number	0= Less than 10, 1= 10 or more

33.	Spikelets shape	0= Linear, 1= Oblong, 2= Ovoid, 3 = Subulate
34.	Spikelet size	0= Less than 5mm, 1= 5mm or more
35.	Flower number	0=Less than 10, 1= More than 10
36.	Rachilla	0=Winged, 1= Winged less
37.	Rachis shape	0 = Zigzag, 1= Straight
38.	Rachilla internode length	0 = Less than 0.5mm, 1 = 0.5mm or more
39.	Glumes arrangement	0 = Laxly imbricate, 1 = Tightly imbricate, 1= Spirally
40.	Glumes colour	0= Pale yellow, 1= Brown to purpulish
41.	Glumes shape	0= Ovate, 1 = oblong, 2 = Elliptic, 3 = Lanceolate, 4 = obovoid
42.	Glume size	0 = Less tham 3mm, 1= 3mm or more
43.	Glumes apex	0= Acute, 1= Obtuse, 2 = Rounded, 3 = Truncate
44.	Glume apex extension	0 = Mucronate, 1 = Recurved arista, 2 = Both absent
45.	Vein number	0 = Less than 3 number , 1= More than 3 number
46.	Keel	0 = Present, 1 = Absent
47.	Keel surface	0 = Smooth surface, 1 = Spinulose –ciliate on the surface
48.	Stamen number	0=less than 3, 1= 3in number
49.	Stamen shape	0 = Linear oblong, 1= Ellipsoid
50.	Stamen size	0 = Less than 1mm 1 = 1mm or more
51.	Stamen connection	0 = Prominent beyond anthers, 1= not Prominent
52.	Style size	0 = Less than 1mm, 1 = 1mm or more
53.	Style surface	0 = glabrous, 1 = hispidulous
54.	Stigma number	0 = 2 number, 1 = 3 number
55.	Stigma size	0 = Less than 1.5, 1 = 1.5 to 3mm, 2 = More than 3mm
56.	Nutlet colour	0 = Light brown to yellow, 1 = Dark brown or blackish brown, 2 = Black, 3 = Greyish brown, 4 = Grey
57.	Nutlet shape	0 = Ovoid, 1= Obovoid, 2 = Oblong, 3 = Elliptic, 4 = Plano convex
58.	Nutlet length	0 = 0.2mm to 0.78mm, 1 = 0.78mm to 1.56mm, 2 = 1.56mm to 2.34mm
59.	Nutlet width	0 = 0.1mm to 0.43mm, 1 = 0.43mm to 0.86mm, 2 = 0.86mm to 1.29mm
60.	Nutlet apex	0 = Attenuate, 1 = Apiculate, 2 = Mucronate, 3 = Obtuse
61.	Nutlet base	0 = With small stipe, 1 = Without small stipe
62.	Nutlet texture	0 = Reticulate, 1= Rugose, 2 = Granulate

NJ tree

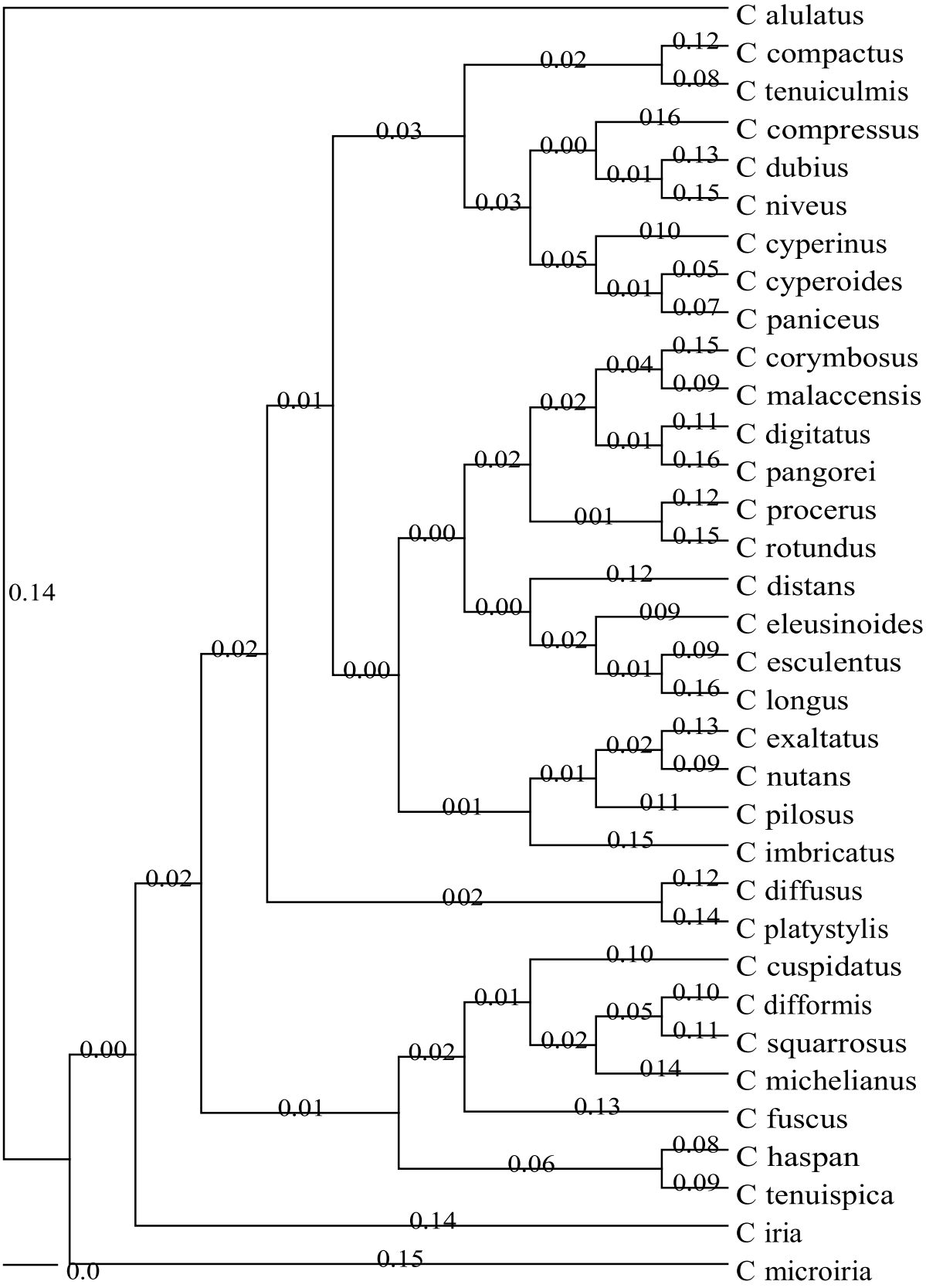


Figure 36. Distance based Neighbour-Joining tree, showing the distance and closest relationship between the neighbours species of genus *Cyperus*.

Neighbor-Joining tree

Distance-based Neighbor-Joining (NJ) analyses were conducted using PAUP* 4.0a169 (Swofford, 2002). A single optimal NJ tree was drawn for the objective function of weighted least square with power equal to 1. The tree was drawn with negative branch lengths without affecting the tree score calculation. The mean character difference was used for distance measure. And out of the total 62 characters studied, 46 characters were weighted equal to 1, 10 characters were weighted equal to 0.5, 3 characters were weighted equal to 0.33 and the final 3 characters were weighted equal to 0.25. The NJ tree represents a cladogram with branch length representing only the distance between nodes and end taxa.

NJ tree shows 4 main clades having many subclusters. *C. alulatus* acts as a sister group to all the species. In Clade 1, *C. haspan* and *C. tenuispica* (having anthelate inflorescence) and *C. difformis* and *C. squarrosus* (having capitate inflorescence) show close affinities. Similarly, clade 2 kept 2 species, *C. diffusus* and *C. platystylis* (having equal length involucral bract) together. Likewise, in clade 3, *C. exaltatus* and *C. nutans* (having compound inflorescence and obovoid nutlets in both), *C. esculentus* and *C. longus* (having compound inflorescence and solid zigzag rachilla), *C. procerus* and *C. rotundus* (having distichously arranged linear spikelets), *C. digitatus* and *C. pangorei* (having solid straight, winged rachilla in both) and *C. corymbosus* and *C. malaccensis* (having digitately arranged spike and distichously arranged, linear spikelets) shows less mean character difference so, weighted together. Furthermore, in clade 4, the Mariscus group (*C. cyperinus, C. cyperoides* and *C. paniceus* having deciduous rachilla), *C. dubius* and *C. niveus* (having capitate or globose inflorescence and brown colour, obovoid nutlets) and *C. compactus* and *C. tenuiculmis* (having reddish-brown glume with obtuse apex and brownish-yellow nutlets) shows close affinities between each other.

RESULTS

Relationship across the taxa based on NJ tree showed a weighted tree score of 3.76073 with a standard deviation of 13.94%.

4.4 Distribution Pattern of Cyperus L. in Nepal.

Table 2: Distribution pattern of 36 species of genus *Cyperus* L. found in Nepal.

Distribution Pattern of *Cyperus*	Species
Widely distributed	*C. iria, C. difformis, C. pilosus, C. rotundus, C. cuspidatus, C. compactus, C. compressus, C. cyperoides, C. distans, C. eleusinoides, C. niveus, C. nutans, C. tenuiculmis, C. tenuispica, C. diffuses*
Eastern Species	*C. malaccensis*
Central species	*C. paniceus, C. longus, C. platystylis, C. trisulcus, C. wallichianus,*
Western species	*C. alulatus, C. microiria*
East Central species	*C.pangorei, C. haspan, C. fuscus,C. michelianthus, C. procerus*
Central Western species	*C. corymbosus, C. cyperins, C. esculents, C. exaltatus, C. squarrosus, C. digitatus, C. imbricatus*
East Western	*C. dubins*

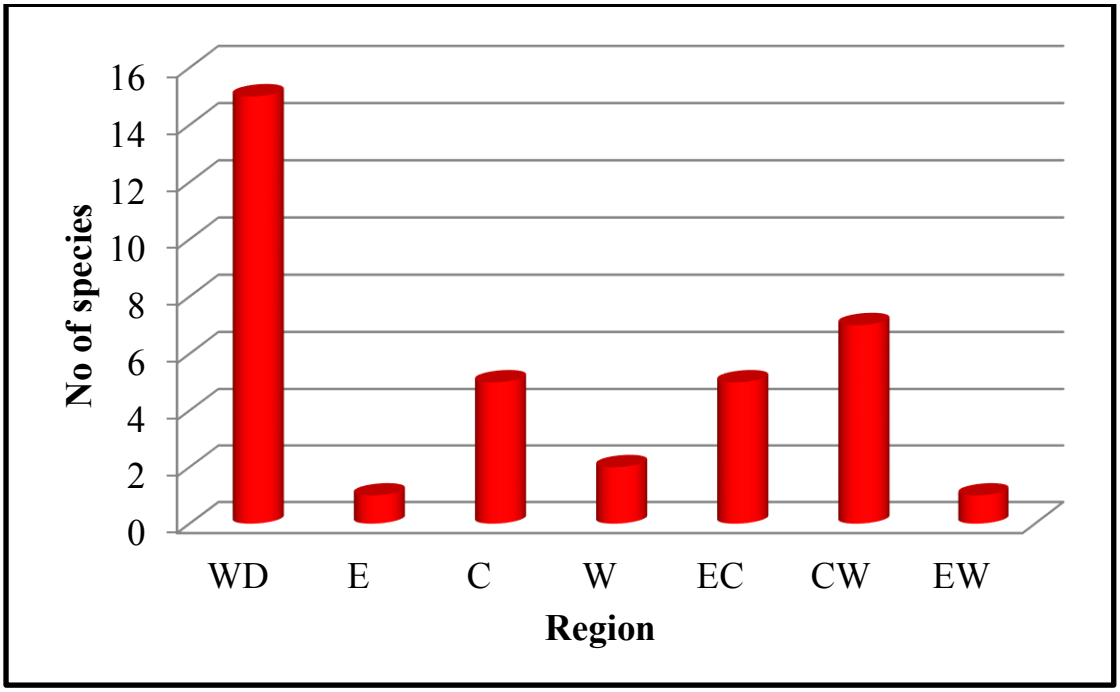


Fig 37: Distribution pattern of species of genus *Cyperus* L. in Nepal.

4.5 Flowering and Fruiting Phenology

Phenological period is taken as overall flowering and fruiting period and exact time of discrimination between flowering and fruiting period are less known. Here, by analysing the month of specimens collection deposited at TUCH, KATH, personal observation and with the help of different literatures the average month of phenological period has been recorded. The phenological period starts from April and Culminates in the month of January, with the peak at the month of June to October during which almost all species are in flowering. *Cyperus cyperinus*, *Cyperus cyperoides* and *Cyperus esculentus* showing ealier flowering from April and *Cyperus pangorei* and *Cyperus platystylis* showing late flowering to January.

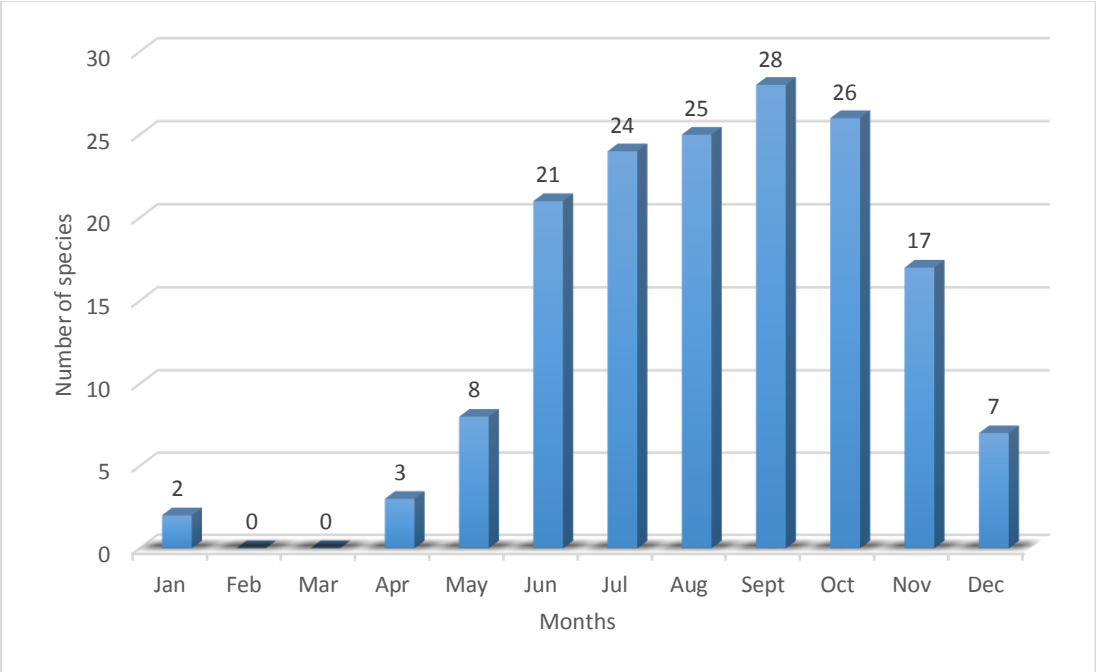


Fig 38: Phenology. No. of flowering and fruiting species at different months.

Table 3: Phenology (Flowering and Fruiting months of 34 species of the Genus *Cyperus* L.)

SN	Name of species	Flowering-Fruiting Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	*C. alulatus*	Sept.									■			
2	*C. compactus*	Jun-Dec						■	■	■	■	■	■	■
3	*C. compressus*	Jun-Dec						■	■	■	■	■	■	■
4	*C. corymbosus*	Jun.						■						
5	*C. cuspidatus*	Jul-Nov							■	■	■	■	■	
6	*C. cyperinus*	Apr-Sept				■	■	■	■	■	■			
7	*C. cyperoides*	Apr-Dec				■	■	■	■	■	■	■	■	■
8	*C. difformis*	Jun-Oct						■	■	■	■	■		
9	*C. diffusus*	Jun-Sept						■	■	■	■			
10	*C. digitatus*	Jul-Dec						■	■	■	■	■	■	■
11	*C. distans*	Jul-Aug							■	■				
12	*C. dubius*	Sep-Nov									■	■	■	
13	*C. eleusinoides*	Aug-Dec								■	■	■	■	■
14	*C. esculentus*	Apr-Jul				■	■	■	■					
15	*C. exaltatus*	Jun-Nov						■	■	■	■	■	■	
16	*C. fuscus*	Jun-Oct						■	■	■	■	■		
17	*C. haspan*	Jul-Nov							■	■	■	■	■	
18	*C. imbricatus*	Jun-Oct						■	■	■	■	■		
19	*C. iria*	Jun-Nov						■	■	■	■	■	■	
20	*C. longus*	Jun-Oct						■	■	■	■	■		
21	*C. malaccensis*	Jun-Nov						■	■	■	■	■	■	
22	*C. michelianthus*	Jun-Sept						■	■	■	■			
23	*C. microiria*	Aug-Oct								■	■	■		
24	*C. niveus*	Sept-Oct									■	■		
25	*C. nutans*	May-Oct					■	■	■	■	■	■		
26	*C. pangorei*	Oct-Jan	■									■	■	■
27	*C. paniceus*	May-Jul					■	■	■					
28	*C. pilosus*	Aug-Nov								■	■	■	■	
29	*C. platystylis*	May-Jan	■				■	■	■	■	■	■	■	■
30	*C. procerus*	Jun-Oct						■	■	■	■	■		
31	*C. rotundus*	May-Nov					■	■	■	■	■	■	■	
32	*C. squarrosus*	Sept-Oct									■	■		
33	*C. tenuiculmis*	May-Nov					■	■	■	■	■	■	■	
34	*C. tenuispica*	Sept-Nov									■	■	■	

CHAPTER 5. DISCUSSION

5.1 Taxonomy of Genus *Cyperus* L.

In the present study, 36 species of Genus *Cyperus* L. from Nepal are described. Among them 28 species have been collected and remaining species were studied from herbarium specimen deposited at different national herbaria. In the plant systematics morphological characters including vegetative and reproductive characters are of great importance. Vegetative as well as reproductive characters of plant specimens from the personal collections and specimens deposited at different national herbaria were used for delineating taxa with in the genus. All these characters are proved to be useful for identification and delineation of the taxa. Also, variations among these characters in the species has been analysed and their taxonomic significant has been evaluated.

Persistent of glumes among deciduous rachilla was the most widely used distinguishing features for separating *Mariscus* from *Cyperus* (Raynal 1981). Molecular data confirmed that *Mariscus* is fully nested in C4 *Cyperus* and not worthy of generic recognition (Larridon *et al.,* 2011b). Recent molecular phylogenetic analyses (e.g. Simpson *et al.,* 2007, Muasya *et al.,* 2009a, Larridon *et al.,* 2011a, 2013), *Cyperus* s.l. or the *Cyperus* clade is a monophyletic clade containing a paraphyletic genus *Cyperus* s.s. encompassing at least 12 isolated genera (i.e. *Alinula, Ascolepis, Kyllinga, Lipocarpha, Pycreus, Queenslandiella, Remirea, Sphaerocyperus* and *Volkiella*) following the classification of Goetghebeur 1989 and Govaerts *et al.,* 2007.

5.2. Vegetative characters

Cyperus is ubiqiletous in distribution mostly mostly aquatic plants, which grow in still or slow-moving water. (Govaerts *et al.,* 2007). Cyperus is a morphologically coherent genus, readily recognizable by the distichous arrangement of the scales on the axis of the spikelets (Tucker 1983). Lifeforms exist in two forms annual with fibrous root and perennial with scaly rhizomes. Out of 36 species 11 species are annual while remaining are perennial. Tuberiferous stolon occur only in *C. esculentus* and *C. rotundus* (Tucker 1983). *C. digitatus*, *C. exaltatus* and *C. malaccensis* attain maximum height of 1.5m while *C. fuscus* attain lowest height of 3cm. These character are supported by Noltie (1994) and Dai *et al.,* (2010).

Culm terete in *C. compactus*, lower terete to upper triquetrous in *C. corymbossus* and *C. pangorei* remaining 31 species has triquetrous stem. Many species have scabrous or scabrellate culms due to presence of crystalline prickles on the surface. The base of culm is thick and indurated in many species.

In some species the leaves are reduced to basal sheaths only (*C. corymbossus* and *C. pangorei*) while others have leaves nearly equal to or greater. Leaf blade shape is same flat, plicate and stiff in all while margin vary from smooth to scabrous.

5.3. Reproductive characters

Inflorescence is called an anthella (Kukenthal) which plays the important role in delimitation of the genus *Cyperus* within the species, out of 34 species 8 species have capitate anthelodium while remaining 16 species have compound to decompound anthelodium. Lateral branching of rays are subtended by leaflike involucral bract. Having equal length involucral bracts differentiates C. *diffuses* and *C. platystylis* from other species (Tucker 1983). Small scale like prophylls is attached to different parts in the inflorescence. Several species in Cyperus s. l., formerly grouped together in Mariscus, have spikelets with an adaxial swelling body (pulvinus) at the prophyll base. Swelling of this callus causes divergence of the spikelet from the rachis (Vrijdaghs *et al.,* 2011).

Spikes mostly cylindrical in *C. digitatus, C. exaltatus* and *C. imbricatus* while others species have broadly ovoid, ellipsoid, narrowly cylindrical spike. Hispidulos spike rachis in *C. procerus* and *C. pilosus* differentiates these from others. Number of spike varies from single to more than 20.

Spikelets arrangement like digitate, sub distichous to distichous has been considered as key characters to differentiates species. According to Noltie (1994) Mariscus group *C. cyperoides, C. cyperinus* and *C. paniceus* are delimited on the basis of presence of number of fertile flower. *Mariscus* group have deciduous rachilla of spikelets while others species have persistent rachilla these main key characters of rachilla include winged or wingless, internode shape, internode length and internode colour. 10 species *C. alulatus, C. difformis, C. fuscus, C. haspan, C. iria, C. longus, C. microiria, C. platystylis, C. squarrosus* and *C. tenuispica* have wingless rachilla while remaining 26 species have winged rachilla. Out of 34 species 7 *species C. compressus, C. cuspidatus,*

C. esculentus, C. exaltatus, C. longus, C. nutans and *C. pilosus* have solid zigzag rachilla while remaining 27 species have solid straight rachilla. 4 species *C. compactus, C. cyperinus, C. cyperoides* and *C. paniceus* have reduced rachilla, 7 species *C. difformis, C. dubius, C. exaltatus, C. imbricatus, C. michelianus, C. squarrosus* and *C. tenuispica* has internode length less than 0.5mm while remaining 25 species have internode upto 0.5mm and more than that. These characteristics were similar with the study of Clarke (1894), Noltie (1994), Ali and Qaiser (2001) and Dai *et al.,* (2010) with slight variation in size.

Glumes are membranous bract surrounding the spikelets. The peculiar characteristics of glumes that delimit taxa are variation in number, arrangement, size, shape, colour, nervation and apex. The shape of the glumes is lanceolate in *C. cyperoides, C. distans, C. michelianus* and *C. niveus*, ovate in *C. alulatus, C. C. compressus, C. diffuses, C. dubius, C. exaltatus, C. fuscus, C. imbricatus, C. pilosus, C. platystylis* and *C. rotundus*, obovate *in C. difformis, C. microiria and C. procerus, narrowly oblong in C. compactus, C. longus, C. pangorei* and *C. squarrosus,* fusiform terete in *C. corymbosus.* The apex is acute *in C. compressus, C. digitatus, C. eleusinides* and *C. michelianus,* acuminate, truncate in *C. cuspidatus, C. esculentus* and *C. tenuispica* and obtuse in remaining species. The apex extension of glumes is mucronate *in C. compressus, C. corymbosus, C. difformis, C. digitatus, C. eleusinoides, C. esculentus, C. exaltatus, C. haspan, C. imbricatus, C. microiria, C. nutans, C. pilosus, C. platystylis, C. rotundus* and *C. tenuiculmis,* modified into recurved arista *in C. cuspidatus, C. diffuses, C. michelianus, C. squarrosus* and *C. tenuispica* and remaining species has no such extension. The colour varies from stramineous to different shades of brown. All species has green keeled on back with 3--17 veined. These above characters were similar with Dai *et al.,* (2010) and Ali and Qaiser (2001) with slight variation in size.

Stamen or anther are male reproductive characters which shape, size and colour, connective prominenet beyond anther plays vital role in delimitation of taxa. Stamen number varies from 2 to 3 *C. difformis, C. dubius, C. fuscus, C. michelianthus* and *C. squarrosus* have 2 stamens while reaming species have 3 stamens.

Carpel is female reproductive characters. One of the peculiar characteristics of genus *Cyperus* is having a superior ovary with single locule containing a basal ovule. *C. platystylis* has hispidulous style surface which distinguish it from other species.

Variation in size of style; size and number of stigma delimits the species with in genus *Cyperus*. This character was similar with Clarke (1894), Noltie (1994), Ali and Qaiser (2001) and Dai *et al.,* (2010).

Achene morphological characters like shape, size, of Cyperaceae are of taxonomic significance, and can be used in its classification (Patil and Prasad, 2016). The most studied nutlets diagnostic characteristic for delimit of species are shape, colour, size, base and apex. The morphologically similar species *C. haspan* and *C. tenuispica*, *C. nutans and C. eleusinoides*, *C. cyperoides, C. cyperinus* and *C. pilosus* are delimited by the variation in nutlet size and texture. Detail study was done by using stereomicroscope with photographs. These characteristics were similar with Clarke (1894), Malla *et al.,* (1986), Noltie (1994), Ali and Qaiser (2001), Dai *et al.,* (2010), Patil and Prasad (2016).

5.4. Distribution

Based on herbarium record, species of *Cyperus* are distributed from East to Central to West of Nepal. Distribution pattern of *Cyperus* (Figure 37) shows only 15 (*C. iria, C. difformis, C. pilosus, C. rotundus, C. cuspidatus, C. compactus, C. compressus, C. cyperoides, C. distans, C. eleusinoides, C. niveus, C. nutans, C. tenuiculmis, C. tenuispica* and *C. diffuses*) widely distributed species, only one species in Eastern (C. malaccensis) and east western (C. dubius) and highest number of species range in Central Western part i.e 7 (*C. corymbosus, C. cyperins, C. esculents, C. exaltatus, C. squarrosus, C. digitatus, C. imbricatus*). This is due to less exploration of the species in other areas. Vertical distribution of genus ranges from subtropical to tropical zone (80-2700m). Circular spots on the map represents the collection localities. The main hotspot areas of genus *Cyperus* like Jagadispur taal is under construction planning for making Buddha stupa in middle of taal and streams that distribute water from taal to field has done JCB also most use of herbicides has noticed in paddy field which results in extinct of most species from this area. *Cyperus iria, Cyperus difformis* and *Cyperus rotundus* are the ubiquitous species which are affecting paddy field the most.

5.5. Hierarchical cluster analysis

The Distance-based Neighbour-Joining Hierarchical cluster analysis (Figure 36) was done by using PAUP* 4.0a169 software. This unrooted neighbour joining tree or dendrogram shows 4 main clades having many clusters and subclusters. *C. alulatus* act

as a sister group to all the species. *C. iria* and *C. microiria* shows very close relationship only variation in nutlets differentiates these species. Clade 1 is divided into two cluster A and B. Cluster A includes 2 species *C. haspan* and *C. tenuispica* having anthelate inforescense and Cluster B includes 4 species *C. cuspidatus, C. difformis, C. squarrossus* and *C. michelianthus* having capitate inforescense. Similarly, Clade 2 includes 2 closely related species *C. diffusus* and *C. platystylis* having equal length involucral bract distinghuish these species from others. In the same way, Clade 3 is further divided into Cluster A and Cluster B. Cluster B is further divided into Subclusters A and B, Cluster A consist of 4 species *C. exaltatus, C. nutans, C. pilosus* and *C. imbricatus* arrangement of spikelets differentiates these species and Cluster B consist 4 species in Subcluster A (*C. distans, C. eleusionoides, C. esculentus* and *C. longus* having dark brown obovoid to ellipsoid nutlets*)* and 6 species in Subcluster B (*C. corrymbosus, C. malaccensis, C. digitatus, C. pangorei, C. procerus* and *C. rotundus* having solid straight rachis and winged rachilla*)* species in each respectively. Furthermore, Clade 4 is also divided into two cluster A and B, Cluster A with two Subcluster A with mariscus group (*C. cyperinus, C. cyperoides* and *C. paniceus* having deciduous rachilla) and Subcluster B with *C. compressus, C. dubius* and *C. niveus* having capitate or globose inflorescence. Cluster B consist of 2 species *C. compactus* and *C. tenuiculmis* having reddish-brown glume with obtuse apex and brownish-yellow nutlets in both. The closeness between two clusters and sub clusters is due to less mean characteristics difference between species sharing more similar characteristics between them.

5.6. Flowering and fruiting phenology

Maximum number of species in fowering or fruiting period arein the month of June to October. From the month of February to March, there is no flowering or fruiting. *Cyperus cyperinus*, *Cyperus cyperoides* and *Cyperus esculentus* shows ealier flowering from the month of April.

5.7. Nomenclature Changes

In "Flora of Kathmandu Valley" (Malla *et al.,* 1986) 8 species of *Cyperus* (*C. aristatus, C. difformis, C. haspan, C. iria, C. niveus, C. pilosus, C. rotundus* and *C. tenuispica*) have been described. In the annotated checklist of the flowering plants of Nepal, (Press *et al.,* 2000) 28 species of cyperus were listed. But in the recently published book "A

Handbook of Flowering Plants of Nepal" (Rajbhandari and Rai., 2017) 36 species of *Cyperus* have been described with their herbarium records of distribution within the country, with their synonyms. Among 36 species 11 extra species (*C. compactus, C. cyperinus, C. cyperoides, C. dubius, C. exaltatus, C. fuscus, C. microiria, C. paniceus, C. platystylis, C. procerus* and *C. squarrosus)* was added and 3 species (C. castaneus, C. scariosus and *C. tuberosus)* was omitted. In this Mariscus group has been included in *Cyperus* genera. However, "Handbook of The Flowering Plants of Nepal" (Shrestha *et al.,* 2018) documented 38 species of *Cyperus* with their habitats, distribution range within Nepal and within the world, their economic importance and their local names. Among 38 species 3 extra species (*C. castaneus, C. laxus* and *C. involucratus*) were listed and one species (*C. eleusinoides*) was skipped. This whole dissertation is based on Rajbhandari *et al.,* (2017) in which 36 species of *Cyperus* were well described and treated taxonomically.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Present study describes 36 species of *Cyperus C. alulatus, C. compactus, C. compressus, C.corymbosus, C. cuspidatus, C. cyperinus, C. cyperoides, C. difformis, C. diffusus, C. digitatus, C. distans, C. dubius, C. eleusinoides, C. esculentus, C. exaltatus, C. fuscus, C. haspan, C. imbricatus, C. iria, C. longus, C. malaccensis, C. michelianus, C. microiria, C. niveus, C. nutans, C. pangorei, C. paniceus, C. pilosus, C. platystyis, C. procerus, C. rotundus, C. squarrosus, C. tenuicumis, C. tenuispica, C. trisulcus* and C. wallichianus. Out of 36 species listed in "A handbook of the Flowering Plants of Nepal" (Rajbhandari and Rai., 2017) only 34 species are studied comparatively with diagnostic characteristics while two species *C. trisucus* and *C. wallichianus* were not studied well due to non- availabitity of herbarium specimens in the herbaria.

Many morphological characters including vegetative and reproductive characters is the best practice for taxonomic treatment of particular group of plants. The characters incude life forms, leaf (leaf sheath, leaf blade shape, size, apex, margin, surface), inflorescence, spike (shape, size) spikelet (shape, size, arrangement), glume (colour, shape, size, arrangement, apex, vein number, keeled, margin), stamen, pistil, nut (colour, shape, size, texture). The hierarchical analysis has proved to generate the methods for delimitation of taxa and generating basic idea on relationship among the taxa based on morphological characters. Variation in inflorescense type, stamen and stlye number, surface, nutlets colour, shape, size and texture are the most diagnostic features for delimitation of the genus *Cyperus.*

Cyperus is ubiquitous species distributed throughout the tropical and subtropical region of the world. Mostly, grown near the paddy field have great fodder and medicinal value too. Based on herbarium record, species of *Cyperus* are distributed from East to Central to West of Nepal. Based on literatures and herbarium specimens, vertical distribution of genus ranges from subtropical to tropical zone (80-2700m).

Phenological data shows the phenological period of most of the species starts from April and ends to January. Maximum number of species in flowering or fruiting period

are in the month of June to October. From the month of February to March, there is no flowering or fruiting is observed in comparision to other remaining months.

6.2 Recommendation

The present study is based on the herbarium specimen housed at different herbaria and also with the personal collection from the Eastern, Central and Western Nepal. There are possibilities of finding new species if extensive explorations are carried out in Nepal.

1. Lack of printed and online taxonomic literature has cause difficulty in finding protologue so, libraries should be updated and new publication containing standard taxonomic journal should be included.
2. There are lack of detail information on the labels of many specimens deposited at KATH and TUCH so, labels containing most of the information on the herbarium specimens should be maintained.
3. Some of the specimens which are reported from Nepal by foreign collectors are deposited in the herbaria in the foreign countires and even their duplicates are not in Nepal. It is therefore, recommended that plant quarantine office and Department of plant resources must work with the herbaria of Nepal and confirm the specimens which got out of country have their duplicate in Nepal.
4. *Cyperus* species (*C. digitatus, C. platystylis, C. corymbosus, C. malaccensis, C. compressus, C. iria, C. compactus, C. rotundus* and *C. esculentus)* which is considered as weed have many medicinal, economic and ornamental values but due to maximum use of herbicides and unkown about its value most species are lost so, awareness campaign shoud be organised.
5. Molecular research is need to resolve the taxonomic limitation.

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APPENDICES

Appendix 1. Vertical and Horizontal distribution of genus *Cyperus* L. in Nepal.

S.N.	Name of plant species	Altitudinal range	Distribution in Nepal
1	*Cyperus alulatus*	1100m	West Nepal
2	*Cyperus compactus*	150-345m	W,C,E Nepal
3	*Cyperus compressus*	87-2155m	W,C,E Nepal
4	*Cyperus corymbosus*	84-1400m	W,C Nepal
5	*Cyperus cuspidatus*	400-4100m	E,W,C Nepal
6	*Cyperus cyperinus*	806-1700m	W,C Nepal
7	*Cyperus cyperoides*	150-2600m	E,W,C Nepal
8	*Cyperus difformis*	100-2700m	E,W,C Nepal
9	*Cyperus diffuses*	150-1600m	E,W,C Nepal
10	*Cyperus digitatus*	167-1100m	W,C Nepal
11	*Cyperus distans*	500-1100m	E,W,C Nepal
12	*Cyperus dubins*	87-1811m	W,E Nepal
13	*Cyperus eleusinoides*	300-1800m	E,W,C Nepal
14	*Cyperus esculentus*	93-2300m	W,C Nepal
15	*Cyperus exaltatus*	80-325m	W,C Nepal
16	*Cyperus fuscus*	1300-1445m	E,C Nepal
17	*Cyperus haspan*	1000-1800m	E,C Nepal
18	*Cyperus imbricatus*	78-200m	W,C Nepal
19	*Cyperus iria*	200-1800m	E,W,C Nepal
20	*Cyperus longus*	800m	C Nepal
21	*Cyperus malaccensis*	100-700m	E,Nepal
22	*Cyperus michelianus*	100-200m	E Nepal
23	*Cyperus microiria*	100-200m	W,Nepal
24	*Cyperus niveus*	400-2900m	E,W,C Nepal
25	*Cyperus nutans*	150-2600m	E,W,C Nepal
26	*Cyperus pangorei*	150-1200m	C,E Nepal
27	*Cyperus paniceus*	87-1441m	W, C Nepal
28	*Cyperus pilosus*	150-1500m	E,W,C Nepal
29	*Cyperus platystylis*	80-500m	C,Nepal
30	*Cyperus procerus*	80-1278m	C, E Nepal
31	*Cyperus rotundus*	300-2400m	E,W,C Nepal
32	*Cyperus squarrosus*	175-2700m	W,C Nepal
33	*Cyperus tenuiculmis*	150-2500m	E,W,C Nepal
34	*Cyperus tenuispica*	150-1441m	E,W,C Nepal
35	*Cyperus trisulcus*	1300m	C Nepal
36	*Cyperus wallichianus*	800m	C Nepal

E=Eastern, C=Central and W=Western Nepal m = Meter

Source: Based on A handbook of the Flowering Plants of Nepal (Rajbhandari and Rai.

Appendix 2: Comparative study of lifeforms, plant height and culm angle of *Cyperus* L.

SN	Name of species	Life form	Plant height(cm)	Culm angle
1	*C. alulatus*	Annual, Fibrous root	21.5-4	Triquetrous
2	*C. compactus*	Perennial, Rhizomatous root	74-120.3	terete (cylindrical)
3	*C. compressus*	Annual, Fibrous root	7-40	Triquetrous
4	*C. corymbosus*	Perennial, Rhizomatous root	115-136	lower terete to upper trigonous
5	*C. cuspidatus*	Annual, Fibrous root	3-29	Triquetrous
6	*C. cyperinus*	Perennial, Rhizomatous root	9.6-31.6	Triquetrous
7	*C. cyperoides*	Perennial, Rhizomatous root	25.7-67	Triquetrous
8	*C. difformis*	Annual, Fibrous root	11.5-39.5	Triquetrous
9	*C. diffuses*	Perennial, Rhizomatous root	27-37.5	Triquetrous
10	*C. digitatus*	Perennial, Rhizomatous root	125.3-150	Triquetrous
11	*C. distans*	Perennial, Rhizomatous root	20-60	Triquetrous
12	*C. dubius*	Perennial, Rhizomatous root	8-40	Triquetrous
13	*C. eleusinoides*	Perennial, Rhizomatous root	87.7-100	Triquetrous
14	*C. esculentus*	Perennial, Rhizomatous root	10-85	Triquetrous
15	*C. exaltatus*	Perennial, Rhizomatous root	59-150	Triquetrous
16	*C. fuscus*	Annual, Fibrous root	3-35	Triquetrous
17	*C. haspan*	Annual, Fibrous root	19.8-26	compressed triquetrous
18	*C. imbricatus*	Perennial, Rhizomatous root	68-86.7	Triquetrous
19	*C. iria*	Annual, Fibrous root	20-80	Triquetrous
20	*C. longus*	Perennial, Rhizomatous root	100	Triquetrous
21	*C. malaccensis*	Perennial, Rhizomatous root	50-150	Triquetrous
22	*C. michelianthus*	Annual, Fibrous root	5.2-7.5	Triquetrous
23	*C. microiria*	Annual, Fibrous root	12-14	Triquetrous
24	*C. niveus*	Perennial, Rhizomatous root	14.2-27.5	Triquetrous
25	*C. nutans*	Perennial, Rhizomatous root	62-100	compressed triquetrous
26	*C. pangorei*	Perennial, Rhizomatous root	50-125	Triquetrous
27	*C. paniceus*	Perennial, Rhizomatous root	20-31.9	compressed triquetrous
28	*C. pilosus*	Perennial, Rhizomatous root	28.5-54	compressed triquetrous
29	*C. platystylis*	Perennial, Rhizomatous root	50-90	compressed triquetrous
30	*C. procerus*	Perennial, Rhizomatous root	30-91.7	compressed triquetrous
31	*C. rotundus*	Perennial, Rhizomatous root	7.3-46	compressed triquetrous
32	*C. squarrosus*	Annual, Fibrous root	6.8-11.3	Triquetrous
33	*C. tenuiculmis*	Perennial, Rhizomatous root	7-38.5	Triquetrous
34	*C. tenuispica*	Annual, Fibrous root	19-28.5	Triquetrous

Appendix 3. Comparative study of Leaf sheath and Leaf blade of *Cyperus* L.

SN	Name of species	Leaf sheath			Leaf blade		
		Colour	**Size(cm)**	**Margin**	**Size(cm)**	**Number**	**Margin**
1	*C. alulatus*	reddish brown to brownish purple	1-6.5	striaght opening	2-18.5X0.3	3	scabrous
2	*C. compactus*	purpulish brown	1.5-9.5	oblique opening	15-111.5X0.4-0.7	2-8	scabrous
3	*C. compressus*	purpulish brown	1. 5-7.2	oblique opening	5-31X0.2	4	smooth
4	*C. corymbosus*	greyish green to brownish, with reddish tint	5.5-15.5	oblique opening	12-14.5X0.2-0.4	1	scabrous
5	*C. cuspidatus*	redhhish violent brown	1.5-4	oblique opening	2.8-8.5X0.1	2-3	smooth
6	*C. cyperinus*	purpulish brown	2.5-5.5	concave opening	12.3-26.5X0.4	3-6	scabrous
7	*C. cyperoides*	purpulish brown	1.5-7.5	concave opening	7.7-24.5X0.3-0.6	7-9	scabrous
8	*C. difformis*	green or yellow brown, with reddish tint	1.8-6.1	striaght opening	3.5-29X0.2-0.3	2	scabrous
9	*C. diffusus*	pale green to reddish brown	4-4.3	oblique opening	12-54.5X0.1-0.2	6-7	scabrous
10	*C. digitatus*	reddish brown colour	2.5-7.5	oblique opening	87-119.5X0.4-3	2	scabrous
11	*C. distans*	grey to dark purple (or black on old stem)	2.5-8.5	striaght opening	15-49X0.4-0.6	4-5	scabrous
12	*C. dubius*	brownish memebranous	7-23	oblique opening	5-30X0.15-0.35	4-5	scabrous
13	*C. eleusinoides*	brownish colour	20-40	striaght opening	52.8-64X0.7-1	4	scabrous
14	*C. esculentus*	yellowish or greyish brown, sometimes with redhish tint	5	striaght opening	30X0.2-0.6	6	scabrous
15	*C. exaltatus*	yellowish brown to purple	8.5-18.4	oblique opening	76X0.4-0.6	6	scabrous
16	*C. fuscus*	brown or reddish brown	1.7-6	concave opening	4-10X0.2-0.4	2-3	smooth
17	*C. haspan*	reddish brown in lowerside to yellowish green at top	2-20.8	oblique opening	4.8-9.5X0.2-0.3	1	smooth

18	*C. imbricatus*	reddish brown to dark brown	8.5-18.4	oblique opening	17-83X0.5	6	scabrous
19	*C. iria*	shealth reddish brown to brownish purple	3-13.5	striaght opening	6-34X0.3-0.35	3-4	scabrous
20	*C. longus*	brown or reddish-brown, with reddish tint	5-10	striaght opening	50X0.7	2-3	scabrous
21	*C. malaccensis*	grey-brown or reddish, lowest bladeless	30	oblique opening	3X0.4-1	1-3	smooth
22	*C. michelianthus*	shealth reddish brown to brownish purple	0.7-1.4	oblique opening	1.7-4X0.15-0.2	2	smooth
23	*C. microiria*	reddish brown	1.5-2.5	striaght opening	5-7X0.2	3-4	scabrous
24	*C. niveus*	reddish brown	20-40	oblique opening	3.3-39.9X0.1-0.2	2-3	smooth
25	*C. nutans*	straw yellow colour to reddish brown colour	3.5-17.2	striaght opening	20-81.5X0.5-0.6	4	scabrous
26	*C. pangorei*	grey or greenish grey, sometimes slightly reddish	20	striaght opening	15X0.4	1	smooth
27	*C. paniceus*	reddish brown colour	1-7.5	oblique opening	6.5-25.1X0.3-0.5	5	scabrous
28	*C. pilosus*	dark brown to brownish colour	2.5-10	oblique opening	13-34X0.4-0.8	3-4	scabrous
29	*C. platystylis*	reddish brown to brownish yellow colour	9-16	oblique opening	50X0.5-0.9	5	scabrous
30	*C. procerus*	reddish brown	6-17	oblique opening	19.4-45X0.5-0.9	3-4	smooth
31	*C. rotundus*	reddish brown	8-6.8	oblique opening	4.4-9X0.2	5-6	smooth
32	*C. squarrosus*	reddish brown colour	1.8-2.6	concave opening	3-10X0.1-0.2	7	smooth
33	*C. tenuiculmis*	brownish colour	1.8-8.8	oblique opening	3.2-39X0.12-0.5	8	scabrous
34	*C. tenuispica*	reddish brown to purpulish brown	4-7	oblique opening	2.4-32.3X0.2-0.4	2	scabrous

Appendix 4. Comparative study of Involucral bract and Inflorescence of *Cyperus* L.

SN	Name of species	Involucral bract		Inflorescence
		Number	Length(cm)	
1	*C. alulatus*	6-7	3.3-17.5X0.3	compound anthelodium
2	*C. compactus*	8	3.9-78X0.4-0.9	simple anthelodium
3	*C. compressus*	6	4.7-33.7X0.2	compound anthelodium
4	*C. corymbosus*	3	3.5-10.4X0.1-0.35	simple anthelodium
5	*C. cuspidatus*	6-7	1.2-8.6X0.09-0.1	simple anthelodium
6	*C. cyperinus*	7-9	3-13.5X0.1-0.4	simple anthelodium
7	*C. cyperoides*	7-12	3.8-32.3X0.1-0.5	simple anthelodium
8	*C. difformis*	3	1-13.2X0.1-0.4	simple anthelodium
9	*C. diffuses*	7-8	4-30.5X0.3-0.8	compound anthelodium
10	*C. digitatus*	9	7.5-61X0.1-1	decompound anthelodium
11	*C. distans*	7	2-40X0.2-0.65	decompound anthelodium
12	*C. dubius*	3-6	4-15X0.05-0.35	simple anthelodium
13	*C. eleusinoides*	8	5-42X0.2-0.9	compound anthelodium
14	*C. esculentus*	2-6	30-0.5X0.1-0.2	compound anthelodium
15	*C. exaltatus*	10	8-7 5.5X0.6-1.5	compound anthelodium
16	*C. fuscus*	2-3	3-20X0.15-0.3	simple anthelodium
17	*C. haspan*	2	2.3-9X0.1-0.2	compound anthelodium
18	*C. imbricatus*	6	5.8-57.3X0.1-0.7	decompound anthelodium
19	*C. iria*	6-8	2.2-32X0.3-0.4	compound anthelodium
20	*C. longus*	3-7	6-28X0.2-0.54	compound anthelodium
21	*C. malaccensis*	3-4	20X0.2-1	compound anthelodium
22	*C. michelianthus*	6-7	0.8-6X0.2	simple anthelodium
23	*C. microiria*	3-4	2.9-4.2X0.3-0.4	simple anthelodium
24	*C. niveus*	2-3	1-16.7X0.05-0.2	compound anthelodium
25	*C. nutans*	8-10	3.5-22.5X0.1-0.5	compound anthelodium
26	*C. pangorei*	2-5	35X0.1-0.35	compound anthelodium
27	*C. paniceus*	7-9	1-19.5X0.2	simple anthelodium
28	*C. pilosus*	3-5	2.7-23.7X0.1-0.55	decompound anthelodium
29	*C. platystylis*	5	7.3-33.5X0.3-0.6	compound anthelodium
30	*C. procerus*	3	2.2-26X0.05-1	simple anthelodium
31	*C. rotundus*	3	1.2-8.3X0.1-0.2	simple anthelodium
32	*C. squarrosus*	3-4	1.2-8.5X0.1-0.2	simple anthelodium
33	*C. tenuiculmis*	6	2. 5-21.9X0.4-0.5	decompound anthelodium
34	*C. tenuispica*	2	3.2-15.5X0.1-0.3	compound anthelodium

Appendix 5: Comparative study of Prophyll, Cladoprophyll and Spikes of *Cyperus* L.

SN	Name of species	Prophyll	Cladoprophyll	Spikes		
		Size(mm)	Size(mm)	Number	Shape	Size(mm)
1	*C. alulatus*	pri:8-17, sec: 2-3	pri: 2-22, sec: 11-30	2-5	nearly spiral, reflexed	14-23X6-10
2	*C. compactus*	pri:4-33, sec: 3-4	7-90	3-16	nearly globose to half globose	8-16X10-25
3	*C. compressus*	6-8	reduced form	5-6	broadly ovoid to in outline subflabelliform	12X16
4	*C. corymbosus*	3-8	5-9	4-5	digitately reflexed	50X45
5	*C. cuspidatus*	2-4	reduced form	6-7	digitate or capitate	6-18X5-10
6	*C. cyperinus*	2	reduced form	9-10	oblong-obovoid	10-13X8-21
7	*C. cyperoides*	4-6	11-17	13-17	cylindric	12-20X8-10
8	*C. difformis*	3	13	4-6	Capitate	8-30X5-14
9	*C. diffusus*	pri:3-4, sec: 2	sec: 6-10	3-10	Digitate	21-25X35-45
10	*C. digitatus*	pri:20-30 sec: 5-7	15-38	4-7	cylindric, at apex of raylet, sessile	45-52X16-20
11	*C. distans*	pri:16-30, sec:7, ter:2	pri: 56-77, sec: 17-27, ter: 25	4-6	broadly oviod to in outine subflabelliform	43X30-41
12	*C. dubius*	2-4	reduced form	1-3	capitate or sub globose	12-50X2-7
13	*C. eleusinoides*	pri:0.9-23, sec:5	sec: 30-42	3-6	oblong to cylindric	21-36X5
14	*C. esculentus*	1.5	2	>20	Ovoid	15X1.5
15	*C. exaltatus*	pri:17, sec: 5, ter:1-2	sec: 18-57, ter: 10-18	3-5	cylindric or narrowly cylindric	41-45X21-33
16	*C. fuscus*	3	reduced form	50	compressed, tight	3-15X1.5-2
17	*C. haspan*	pri:3, sec: 6	3	3-7	Digitate	19-35X6-10

18	*C. imbricatus*	pri:15, sec: 2-4	4-27	6-10	Cylindric	17-33X2-6
19	*C. iria*	pri:2-1.4, sec: 1-3	pri:8-1.4, sec: 4-5	6-10	digitate, suberect	8-65X5
20	*C. longus*	1.5	1.5	>10	Digitate	10-150X10-50
21	*C. malaccensis*	8	1	>15	digitately pedunculate.	10-25X1.5-2
22	*C. michelianthus*	Reduced	reduced form	1	capitate or sub globose	15-70X6-10
23	*C. microiria*	8	16	4	digitate, suberect	1.5-1.8X0.9-1.7cm
24	*C. niveus*	Reduced	reduced form	1	Capitate	7-10X4-5
25	*C. nutans*	sec:17-25, ter: 4	pri: 15-35, sec: 10	1-8	Cylindric	28 X7
26	*C. pangorei*	15	2.5-8	4-15	digitately arranged, widely conical	14-25X2
27	*C. paniceus*	3-4	reduced form	7-10	Cylindric	10-17X5-9
28	*C. pilosus*	pri: 4-1.1, sec: 2	0.9-11	2-5	Digitate	39X32
29	*C. platystylis*	pri:13-20, sec: 5, ter: 2-3	pri:5-8, sec:3, ter: 2-3	3-4	Digitate	12-18X8
30	*C. procerus*	2-11	pri:3-12, sec:2-3	1-3	broadly ovoid	25-40X29-50
31	*C. rotundus*	3-5	5-6	4-5	obdeltoid, digitate	9-20X4-32
32	*C. squarrosus*	3	reduced form	Fews	Capitate	4-10X5-6
33	*C. tenuiculmis*	pri:13, sec: 5	pri:17, sec:22	2-4	Digitate	25-34X7-25
34	*C. tenuispica*	pri: 2-7, sec: 2-3	2.5	5-7	Digitate	24-10X60-150

Apendix 6: Comparative study of Spikelets of *Cyperus* L.

SN	Name of species	Spikelets			
		Number	**Arrangement**	**Shape**	**Size(mm)**
1	*C. alulatus*	1-18	sub distichous, laxly	Linear	4-5X2.5
2	*C. compactus*	6-38	radially spreading	subulate,	6.4-50X0.5-1.5
3	*C. compressus*	4-5	densely and nearly digitately	narrowly linear to oblong blunt	6-16X3-4
4	*C. corymbosus*	5-13	sub distichous, laxly to densely	Linear	6-150X1-1.2
5	*C. cuspidatus*	7-22	digitately	Linear	3-9X0.8-1
6	*C. cyperinus*	35->50	densely spirally	narrowly linear-ovoid, to linear oblong	4-7X1-1.2
7	*C. cyperoides*	80->90	spirally spreading to reflexed	narrowly linear-ovoid	4-5X0.5-0.8
8	*C. difformis*	40->51	aggregated at the apex into a capitulum	narrowly oviod to linear	3-4X1
9	*C. diffusus*	1-5	aggregated at the apex of tertiary rays	oblong to linear-oblong	3-7X2
10	*C. digitatus*	14-53	sub distichously , laxly	linear to narrowly ovoid	10-14X1-2
11	*C. distans*	11-18	sub distichous, laxly, spicate	linear	13-16X1
12	*C. dubius*	> 20	densely clustered into capitulum	ovoid to narrowly ovoid to lanceolate	3-7X1-2
13	*C. eleusinoides*	12-24	densely, spirally in different rows	linear-oblong	7-11X2-2.5
14	*C. esculentus*	14	laxly, distichous, spicate	linear to oblong	1-15X1-1.8
15	*C. exaltatus*	14-67	sub distichous to decussate, laxly to densely	narrowly oblong ovoid, acute	3X1
16	*C. fuscus*	3-12	densely	very narrowly ovoid to linear	3-10X1.2X1.5
17	*C. haspan*	2-6	digitately	linear to narrowly linear ovoid	2-4X0.6-1

18	*C. imbricatus*	7-11	spicate spiraly	erect, linear	2-4X1.5
19	*C. iria*	7-30	spicate,laxly, distichously	linear-oblong, oblong ovoid	0.4-11X2
20	*C. longus*	3-15	digitately	linear-lanceolate	8-25X1.2-2
21	*C. malaccensis*	5-10	laxly, distichously	linear	8-25X1.5
22	*C. michelianthus*	53->106	densely, sessile	ovoid to narrowly oblong ovoid	2-7X1
23	*C. microiria*	10-19	laxly, distichously	linear-very narrowly linear oblong,	7-8X2
24	*C. niveus*	7->12	densely at the apex into a capitulum	narrowly oblong ovoid to ovoid	5-13X2-4.2
25	*C. nutans*	15- >25	laxly	linear to narrowly linear ovoid	5-9X1.5
26	*C. pangorei*	4-9	laxly, distichously	linear	8-10X1.5
27	*C. paniceus*	26->40	spreading to reflexed	narrowly linear ovoid	3-3.5X0.5
28	*C. pilosus*	6-36	laxly, distichous	narrowly linear ovoid to linear	5-6X2
29	*C. platystylis*	3-7	digitatetely	narrowly oblong- ovoid	4-7X2-2.5
30	*C. procerus*	4->20	laxly, distichous	narrowly linear -ovoid or linear-ovoid	2.2-2.3X3-4
31	*C. rotundus*	2-6	spicate, laxly, distichous	Linear	10-30X1.8-2
32	*C. squarrosus*	12->31	densely spirally	flat, linear oblong to oblong	3-5X1-1.5
33	*C. tenuiculmis*	4-15	spicate, laxly, distichous	narrowly linear ovoid to linear	0.8-13X1.5-2
34	*C. tenuispica*	5-13	digitately	narrowly linear ovoid to linear	1-6X0.5-1

Appendix 7: Comparative study of Number of flower and Rachilla of *Cyperus* L.

SN	Name of species	Number of flower	Rachis		
			Internode length(mm)	Shape	Wing
1	*C. alulatus*	3-7	0.5	solid straight	wingless
2	*C. compactus*	3-9	0.8	winged form	winged
3	*C. compressus*	5-18	1-1.5	solid zigzag	winged
4	*C. corymbosus*	12-22	0.7-1	solid straight	winged
5	*C. cuspidatus*	6-23	0.3-0.7	solid zigzag	winged
6	*C. cyperinus*	2-4	2.4	winged form	winged
7	*C. cyperoides*	2-3	0.8-1	winged form	winged
8	*C. difformis*	7-13	0.2	solid straight	wingless
9	*C. diffusus*	6-13	5.7	solid straight	winged
10	*C. digitatus*	13-17	0.7	solid straight	winged
11	*C. distans*	11-13	1.2	solid straight	winged
12	*C. dubius*	3-6	0.3	solid straight	winged
13	*C. eleusinoides*	9-12	0.8	solid straight	winged
14	*C. esculentus*	5-20	0.5	slightly zigzag	winged
15	*C. exaltatus*	7-9	0.4	solid zigzag	winged
16	*C. fuscus*	8-34	0.5	solid straight	wingless
17	*C. haspan*	5-13	0.5	solid straight	wingless
18	*C. imbricatus*	7-11	0.3	solid straight	winged
19	*C. iria*	5-14	0.5-0.7	solid straight	wingless
20	*C. longus*	8-20	0.5	slightly zigzag	winged
21	*C. malaccensis*	10-14	0.5	solid straight	winged
22	*C. michelianthus*	21-34	0.2	solid straight	winged

23	*C. microiria*	11-15	0.5	solid straight	wingless
24	*C. niveus*	3-23	1	solid straight	wingless
25	*C. nutans*	7-9	0.7	solid zigzag	winged
26	*C. pangorei*	12-30	0.8-1	solid straight	winged
27	*C. paniceus*	1	reduced form	reduced form	winged
28	*C. pilosus*	7-9	0.5	solid zigzag	winged
29	*C. platystylis*	13-14	0.5	solid, straight	wingless
30	*C. procerus*	15-25	0.7	solid straight	winged
31	*C. rotundus*	5-22	0.5	solid straight	winged
32	*C. squarrosus*	7-11	0.3	solid, straight	wingless
33	*C. tenuiculmis*	3-9	1.5-2	solid, straight	winged
34	*C. tenuispica*	5-20	0.2-0.25	solid, straight	wingless

Appendix 8: Comparative study of Glume of *Cyperus* L.

SN	Name of species	Glumes						
		Colour	**Shape**	**Size (mm)**	**Arrangement (imbricate)**	**Apex**	**Vein number**	**Keel**
1	*C. alulatus*	yellowish brown	ovate or sub orbicular	1.53-1.7X0.78-1.1	laxly	Rounded	3	spinulose keeled
2	*C. compactus*	reddish brown	narrowly oblong, cymbiform	2.9-4.5X0.63-0.68	densely	obtuse	5-7	green keeled
3	*C. compressus*	pale yellow	ovate, attenuate	3-5X1-1.2	tightly	acute with long mucro (0.4 to 0.9mm)	7	Keeled
4	*C. corymbosus*	straw-color	fusiform, terete	2-2.3X0.6	loosely	sub obtuse, mucronate	inconspicuous	hardly keeled
5	*C. cuspidatus*	mid reddish brown side straw colour	ellipsoid to oblong ovate	0.85X0.33	laxly	truncate with strongly recurved awn (0.35 to 4mm)	3	green keeled
6	*C. cyperinus*	purplish red or reddish brown	elliptic, oblong lanceolate	3.55-3.75X0.65-0.75	tightly	obtuse, not mucronate	mid 3	green keeled
7	*C. cyperoides*	pale yellow to reddish brown	oblong, lanceolate	2.85-3.23X0.53	tightly	obtuse, not mucronate	mid 3	green keeled
8	*C. difformis*	yellowish green	obovate, rounded, concave	0.55X0.35	closely	obtuse emarginate (short mucro) 0.025mm	3	keeled
9	*C. diffusus*	Brown	broadly ovate to orbicular-ovate	1.58-1.63X0.58-0.8	laxly	rounded with recurved mucro (0.25mm to 0.28mm)	7-11	green keeled
10	*C. digitatus*	mid reddish brown side straw colour	ovate to elliptic	2.7-3.013X0.65-0.68	densely	acute, mucronate (0.08mm to 0.1mm)	3-5	green keeled
11	*C. distans*	reddhsh brown	ovate to elliptic	1.63X0.5	laxly	Rounded	3-5	green keeled
12	*C. dubius*	pale greenish	broadly ovate, strongly concave	2-4.2X1.4-2.5	densely	Obtuse	5-17	green keeled
13	*C. eleusinoides*	mid reddish brown side straw colour	ovate-elliptic	1.88-2.13X0.5-0.6	laxly	acute, mucronate(0.18mm)	7	green keeled
14	*C. esculentus*	pale yellow	ovate to ovate-elliptic, cymbiform	2.2-2.6	laxly	subobtuse, truncate and mucronate	5-9	lightly keeled

15	*C. exaltatus*	mid reddish brown side straw colour	ovate, concave, rounded	1.28-1.43X0.48-0.6	densely	obtuse, mucronate (0.1 to 0.23mm)	5	green keeled
16	*C. fuscus*	mid greenish yellow side reddish brown	broadly ovate, cymbiform	0.9-1.3X1	laxly	Obtuse	3	keeled
17	*C. haspan*	reddish brown	oblong ovate to subelliptic	0.88-0.93X0.2-0.31	densely	rounded to subtruncate, mucronate	2-3	green keeled
18	*C. imbricatus*	mid brown side pale to brownish yellow	Ovate	1.18-1.33X0.25-0.7	densely	obtuse to retuse, mucronate(0.25mm to 0.3mm)	3-5	not keeled
19	*C. iria*	yellowish -brown, shiny	elliptic-obovate, obtuse, cymbiform	15-15.3X0.8	loosely	rounded or obtuse	3	strongly keeled
20	*C. longus*	light to dark reddish brown	ovate, cymbiform, blunt	2-3.5X1.4-1.7	laxly	Obtuse	very slender	green keeled
21	*C. malaccensis*	mid reddish brown side straw colour	oblong-elliptic, cymbiform	2-2.5	laxly	obtuse to rounded	7-9	Keeled
22	*C. michelianthus*	mid reddish brown side yellowish whie	oblong lanceolate	1.43-1.55X0.3-0.5	spirally	elongated into recurved mucronate	3	green keeled
23	*C. microiria*	yellowish brown	broadly obovate	15.3-17X0.8-0.85	laxly	rounded, mucronate	3	spiny keeled
24	*C. niveus*	yellowish white	ovate lanceolate	38-3.9X1.93-2	densely	Subobtuse	mid 1,4-6 side	not keeled
25	*C. nutans*	mid dark brown side reddish brown	Elliptic	1.75-2.15X0.4-0.65	laxly	acute, mucronate	7	Keeled
26	*C. pangorei*	reddish brown	narrow-linear oblong	2-3	slightly	acute or obtuse	3-5	not keeled
27	*C. paniceus*	pale yellow	Elliptic	3.25-3.5X0.73- 1	tightly	acute, not mucronate	mid 3	Keeled
28	*C. pilosus*	White	broadly ovate	1.58-1.6X0.55-0.73	densely	acute, mucronate (0.13mm)	7	Unconspicious
29	*C. platystylis*	mid reddish brown side yellowish	broadly ovate	2.1-2.18X1.25-1.85	densely	acute to obtuse, mucronate (0.2mm)	3	Keeled

		brown						
30	*C. procerus*	reddish brown	broadly ovate	2.4-2X0.9-1.03	densely	Obtuse	9	green keeled
31	*C. rotundus*	reddish brown	ovate to oblong-ovate	2.63-2.7X0.73- 0.78	subdensely	acute to obtuse and muticous	3	Keeled
32	*C. squarrosus*	purpulish brown	ovate oblong, cymbiform	0.83-0.88X0.23-0.28	laxly	extending into recurved arista (0.4 to 0.55mm)	3-7	Keeled
33	*C. tenuiculmis*	reddish brown	elliptic, obovate	3-4X1	laxly	Obtuse	7	green keeled
34	*C. tenuispica*	yellowish brown	elliptic to suboblong	0.98-1.08X0.33-0.5	lax, closely	obtuse to truncate, slightly recurving	inconspicuous	keeled

Appendix 9: Comparative study of floral parts of *Cyperus* L.

SN	Name of species	Androecium			Gynoecium		
		Stamen			Style	Stigma	
		Number	Connective	Anther size(mm)	Size(mm)	Number	Size(mm)
1	*C. alulatus*	3	Prominent	0.2X0.1	0.1	3	0.5
2	*C. compactus*	3	prominent	0.6-0.7 X 0.13	0.6-1.2	3	1.2-2.3
3	*C. compressus*	3	prominent	0.75X 0.2	1-2	2	0.8-1
4	*C. corymbosus*	3	prominent	0.95-1.1 X 0.13	0.7-1.2	3 [4]	0.6-3.6
5	*C. cuspidatus*	3	prominent	0.1	0.38	3	0.3
6	*C. cyperinus*	3	prominent	0.68X 0.113-0.15	0.43-1.05	3	1.25-1.7
7	*C. cyperoides*	3	prominent	0.65-0.7X 0.15-0.18	0.38-1.13	3	1.85-2
8	*C. difformis*	2	not prominent	0.31X 0.038	0.02	3	
9	*C. diffuses*	3	prominent	0.33 X 0.025	short 0.3	3	0.45-0.5
10	*C. digitatus*	3	not prominent	0.98X 0.13	long 1.25	3	0.75-1.513
11	*C. distans*	3	prominent	6	0.75	3 [2]	0.3
12	*C. dubius*	2 to 3	prominent		medium size	3	
13	*C. eleusinoides*	3	prominent	0.55-1.33 X 0.15	0.4	3	1.18-1.38
14	*C. esculentus*	3	prominent		much shorter than nut	3	linear, long
15	*C. exaltatus*	3	prominent	0.25-0.36 X 0.06	0.53-0.65	3	0.65-0.73

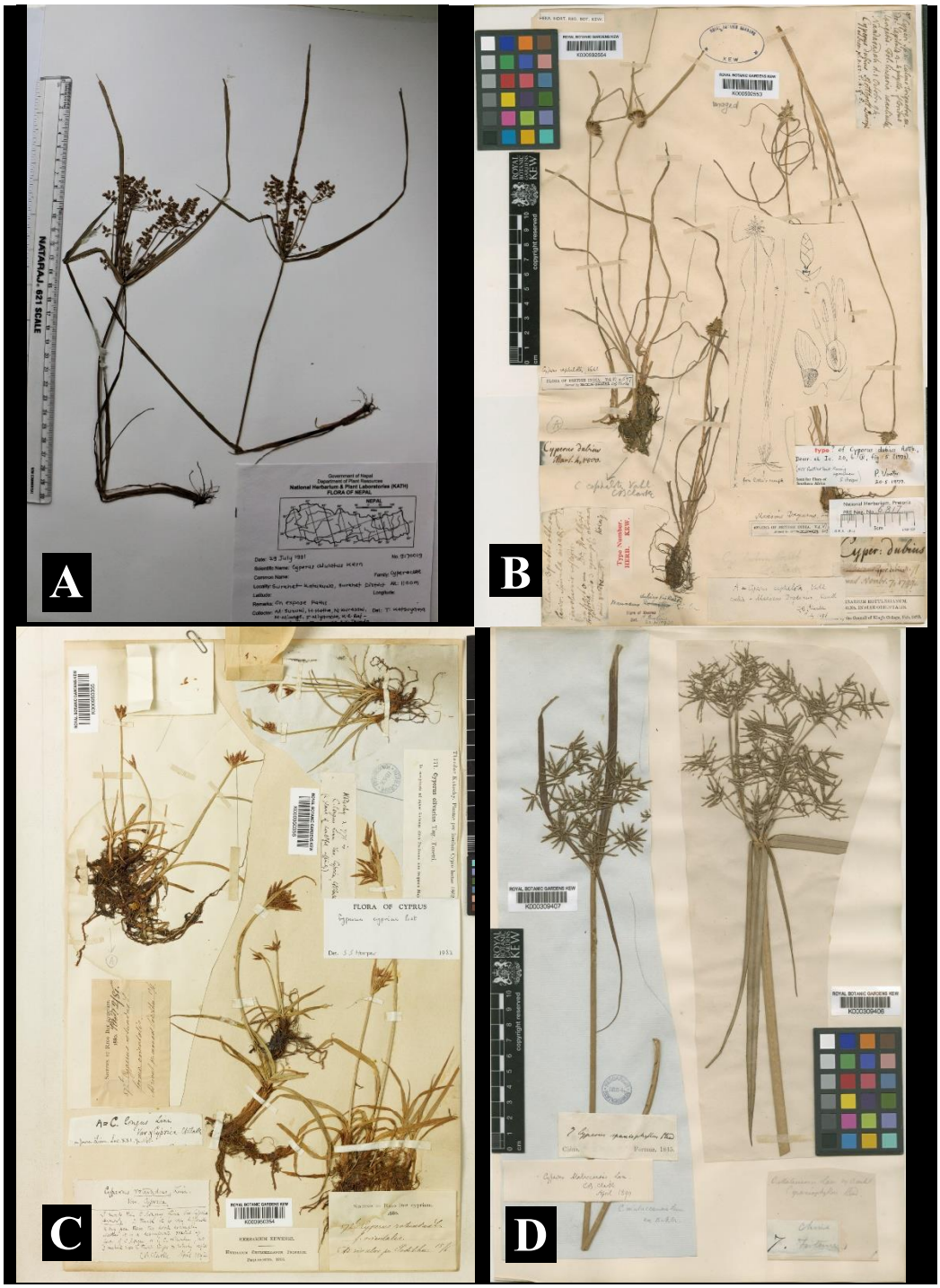
16	*C. fuscus*	2	not prominent		0.3-0.4, short	3 [2]	0.3
17	*C. haspan*	3	prominent	0.25	0.25	2-3	0.3-0.33
18	*C. imbricatus*	3	prominent	0.23-0.3X 0.1-0.13	0.5-0.55	3	0.23-0.35
19	*C. iria*	3	prominent		0.05	3	0.19
20	*C. longus*	3	prominent	1.4-2.2		3	
21	*C. malaccensis*	3	prominent	1	short	3	Slender
22	*C. michelianthus*	2	prominent	0.4	0.48	2	0.3-0.38
23	*C. microiria*	3	not prominent	0.3X0.08	very short	3	Short
24	*C. niveus*	3	not prominent	1.8 -1.98X 0.14-0.16	1.5	3	1.25-1.38
25	*C. nutans*	3	prominent	0.5X 0.15	0.43-0.55	3	0.8-1.13
26	*C. pangorei*	3	prominent		medium length	3	
27	*C. paniceus*	3	prominent	0.88-0.113	0.5-0.78	3	1.13-1.7
28	*C. pilosus*	3	prominent	0.4-0.45 X 0.13	0.4	3	0.75
29	*C. platystylis*	3	prominent	0.75	0.83, hairy style	3	0.33-0.38
30	*C. procerus*	3	prominent	0.93-1.08 X 0.15	1.88	3	1.25-1.3
31	*C. rotundus*	3	prominent	1.2-1.55X 0.14-0.19	0.83-2.13	3	0.25-1.38
32	*C. squarrosus*	1—2	prominent	0.23 X 0.1	0.3-0.43	2-3	0.25
33	*C. tenuiculmis*	3	prominent	1-1.5 X 0.18	0.9-1.05	3	3. 25-3.33
34	*C. tenuispica*	3	not prominent	0.35X 0.1	0.3	3	0.45-0.5

Appendix 10: Comparative study of Achene of *Cyperus* L.

SN	Name of species	Fruit			
		Nutlet			
		Colour	**Shape**	**Size(mm)**	**Texture**
1	*C. alulatus*	greyish brown	Obovoid	0.6-1.45X0.6-0.7	finely reticulate
2	*C. compactus*	yellowish brown to brownish	narrowly oblong	2X0.2-0.35	Reticulate
3	*C. compressus*	dark brown	Obovate	1.5X0.95-1.1	Rugose
4	*C. corymbosus*	Yellowish	Obovoid	0.63-0.78X0.213	Reticulate
5	*C. cuspidatus*	Brown	Obovoid	0.6X0.25	Granulate
6	*C. cyperinus*	dark greyish brown	narrowly oblong	1.75-2.05X0.63-0.68	Granulate
7	*C. cyperoides*	dark brown	narrowly oblong	1.2-1.7X0.25-0.28	Granulate
8	*C. difformis*	yellowish brown	obovate elliptic	0.56-0. 6X0.25-0.33	Granulate
9	*C. diffusus*	black	Ellipsoid	1.28-1.45X0.48-0.7	Rugose
10	*C. digitatus*	greeyish brown	oblong- ellipsoid	1.33-1.5X0.4-0.53	Granulate
11	*C. distans*	blackish brown	oblong to ovate	1.23X0.45	Granulate
12	*C. dubius*	dark greyish brown colour	obovoid to elliptic	1.5-2.2X0.6-1	Rugose
13	*C. eleusinoides*	dark brown	Obovoid	1.33-1.45X0.4-0.43	Rugose
14	*C. esculentus*	dark brown or brownish grey	Ellipsoid	2-2.2X0.7-0.8	Reticulate
15	*C. exaltatus*	greyish	obovoid to ellipsoid	0.28-0.5X0.13-0.15	Reticulate
16	*C. fuscus*	yellow brown or light brown	ellipsoid or convex	0.7-0.9X0.4	very finely reticulate

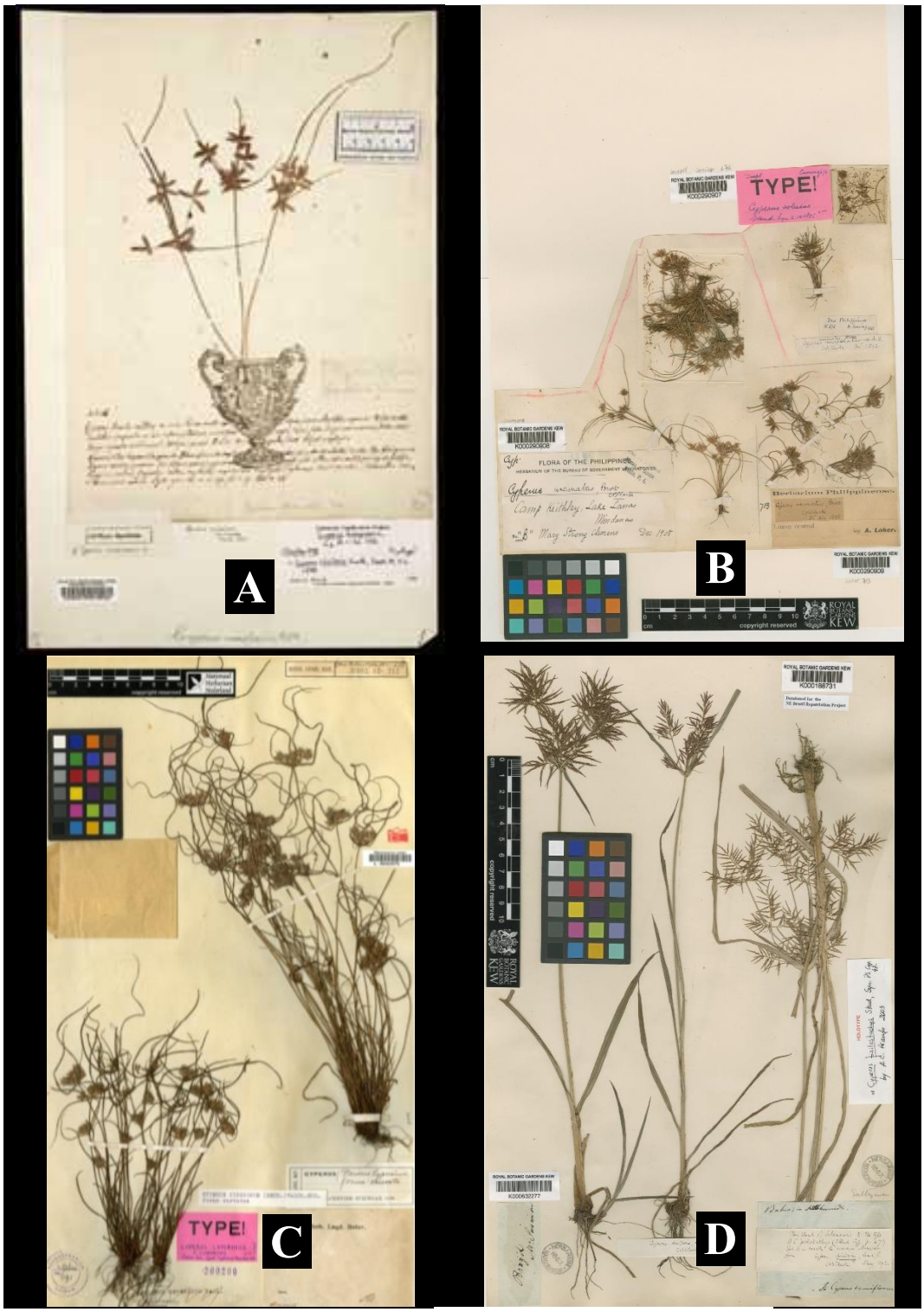
17	*C. haspan*	whitish to yellowish	broadly obovoid	0.33-0.35X0.23-0.25	Rugose
18	*C. imbricatus*	yellowish to brownish	Oblong	0.65-0.7X0.33-0.38	Granulate
19	*C. iria*	brown	Obovoid	1.4-1.43X0. 68	Reticulate
20	*C. longus*	grey brown	obovoid or ellipsoid	1.4-1.6X0.5-0.75	finely reticulate
21	*C. malaccensis*	black	narrowly oblong	1.7-2X0.5	very finely reticulate
22	*C. michelianthus*	yellowish	narrowly oblong	0.83-0.98X0.23-0.28	finely reticulate
23	*C. microiria*	yellowish brown	oblong- obovoid	1.25X0.35-0.4	Reticulate
24	*C. niveus*	yellowish brown	broadly obovoid	1.33X0.75	Rugose
25	*C. nutans*	black	oblong to obovoid	1.25-1.38X0.43-0.45	Rugose
26	*C. pangorei*	dark brown	obovoid-oblong	1.5X0.5	Rugose
27	*C. paniceus*	dark brown	narrowly oblong	1.4-2.63X0.25-0.85	Granulate
28	*C. pilosus*	dark brown	broadly obovoid	0.95-1X0. 6-0.45	Granulate
29	*C. platystylis*	yellowish white	ellipsoid to ovoid	1.78-1.83X0.75-1.05	Reticulate
30	*C. procerus*	yellowish brown to brown	Obovoid	1.08-1.38X0.4-0.55	Rugose
31	*C. rotundus*	yellowish green	obovoid-oblong	1.25-1.5X0.28-0.68	Reticulate
32	*C. squarrosus*	dark greyish	obovoid oblong	0. 68-0.7X0.3	Granulate
33	*C. tenuiculmis*	brownish yellow	oboviod	1. 68X0.85-0.88	Reticulate
34	*C. tenuispica*	whitish yellow	Oboviod	0.38-0.45X0.2-0.3	Rugose

APPENDIX 11: Photographs of some Herbarium Specimen examined for study.



A. Cyperus alulatus J. Kern, Reinwardtia: Surkhet- Katukuwa, Surkhet District, 1100m, 29th July 1991, M. Suzuki, H. Hatta, N. Kurosaki, M. Mikage, F. Miyamote, K.R. Rajbhandari, H. Takayama and K. Terada, 9170019 (KATH).
B. Cyperus dubius Rottb., Descr.Icon. Rar. Pl.: India Nandharadah, 1th October 1874, J. P. Rottler s.n. (K).
C. Cyperus longus L., Sp. Pl.: Cyprus, 15th June 1880, P. Sitensis and G. Rigo 872. (K).
D. Cyperus malaccensis Lam., Tab. Encycl: China, 1845, S. Collins s.n. (K).

APPENDIX 12: Photographs of Type Specimens



VA. Cyperus compressus L., Sp. Pl.: Clayton 598 (BM-000051698). **Lectotype**: BM

B. Cyperus cuspidatus Kunth, Nov. Gen. Sp Pl.: Phillippines, 1841, H. Cuming 676. **Isotype**: K

C. Cyperus cyperinus (Retz). Valck. Sur.: Indonesia, C.L. Blume s.n. L0042375. **Type:** K

D. Cyperus distans L.f., Suppl. Pl.: Bahia, P. Salzmann s.n. K 000188731. **Holotype:**

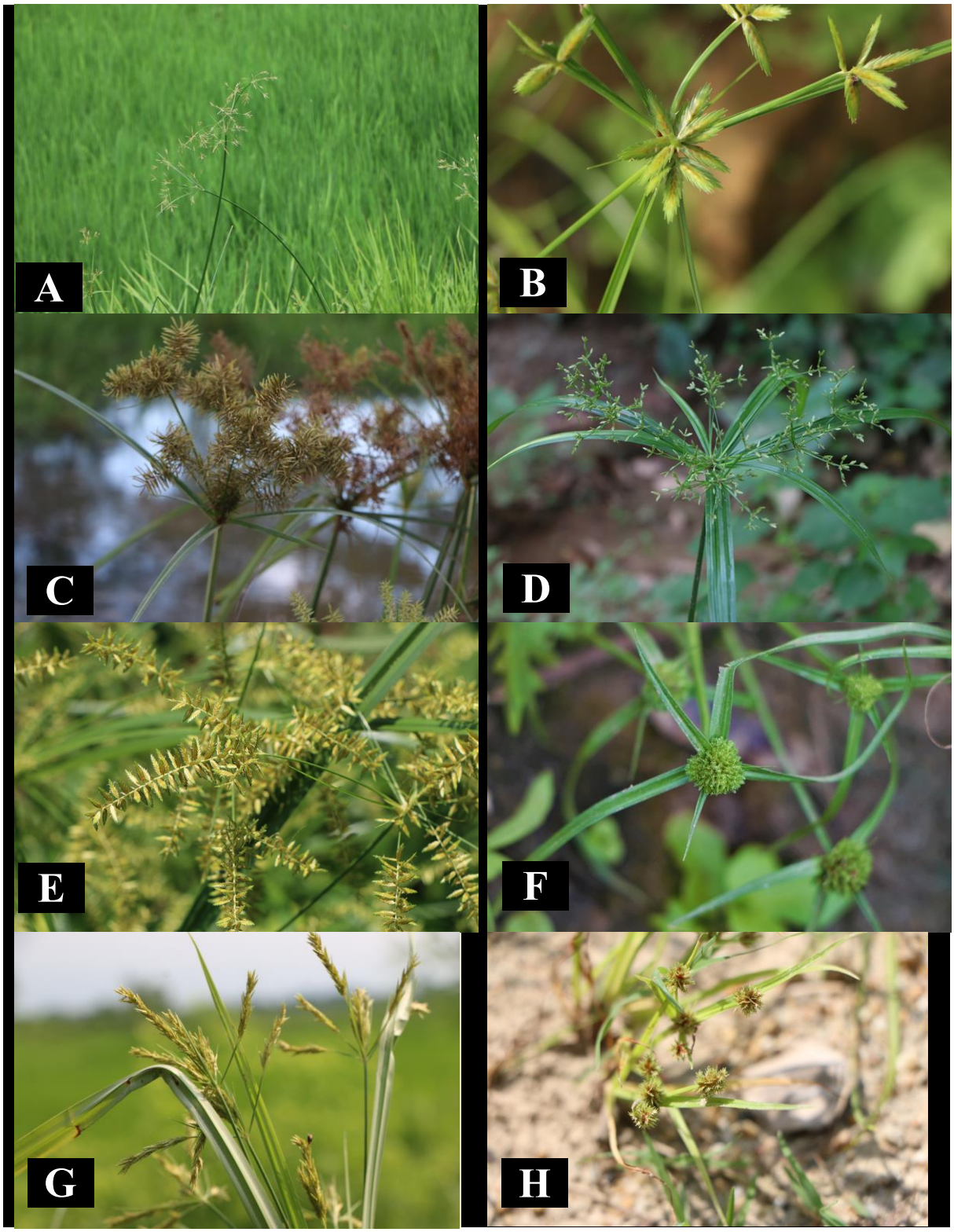
A. Cyperus compactus Retz. Obs. Bot.: Jawa, 1867, H. Zollinger 190. **Isotype:** K

B. Cyperus esculentus L., Sp. Pl.: South Africa, 1875, A. Rehmann 4776. **Syntype:** K

C. Cyperus fuscus L., Sp. Pl.: Bosnia and Herzegovina, 1886-08, Conrath, Paul, s.n. **Holotype:** GZU

D. Cyperus imbricatus Retz.: Phillippines, 4th May 1976, A. Loher 727, **Isotype:** K

APPENDIX 13: Photographs of Habitat



A. C. compressus L., Sp. Pl., **B. C. corymbosus** Rottb., **C. C. digitatus** Roxb. Fl. Ind., **D. C. diffusus** Vahl, ; Enum. Pl., **E. C. exaltatus** Retz., Obs., **F. C. michelianus** (L.) Link, Hort. Bot. Berol. **G. C. nutans** Vahl, Enum. Pl. and **H. C. squarrosus** L., Cent. Pl.

APPENDIX 14: Photographs of Collection, Study and Local Interaction for Identification

A, B and **C** Collection of plant specimen in Chitwan, 12 Kilo Bazar and Baghiswori respectively: **D** and **E.** Study of Plant specimen in KATH and TUCH: **F.** Interaction with Local Chaudhary Peoples in Chitwan near Rapti River.