

Studies on Sedges & Grasses of South Gujarat

Volume: 1 & 2

A Thesis

Submitted to

*The Maharaja Sayajirao University of Baroda, Vadodara
in Partial Fulfillment of the Requirements for the Degree of*

**DOCTOR OF PHILOSOPHY
in
BOTANY**



By

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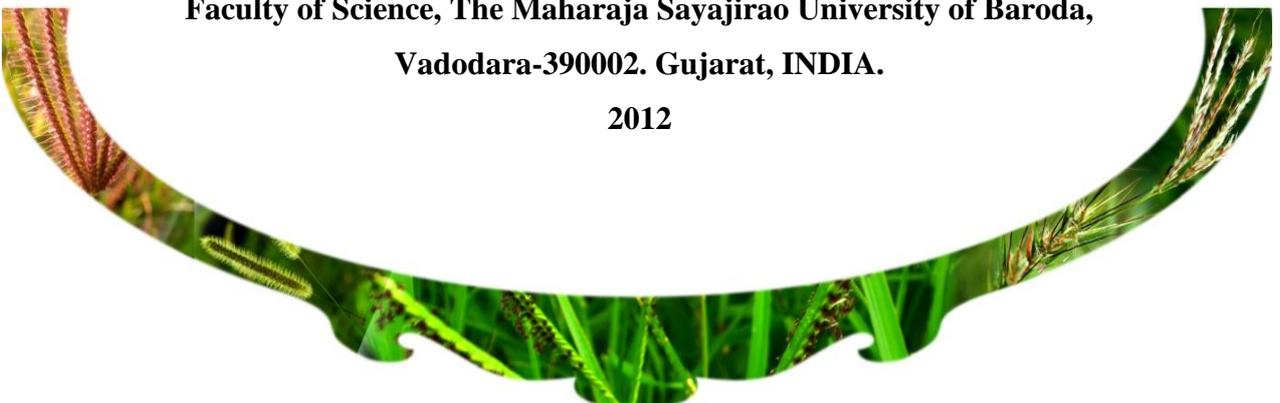
By

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2012





DEPARTMENT OF BOTANY
Faculty of Science
The M. S. UNIVERSITY OF BARODA
VADODARA- 390 002, Gujarat, (INDIA)

Date: 31st May, 2012

CERTIFICATE

The thesis entitled ‘Studies on Sedges & Grasses of South Gujarat’ submitted by Ms. Rinku Jitendrakumar Desai contains the original research work carried out by her in the Department of Botany, The Maharaja Sayajirao University of Baroda. It has been prepared in accordance with the University norms under my direct supervision. It is further certified that this work has not been submitted earlier to any other University/ Institute for any degree.

Dr. Vinay M. Raole
Ph. D. Guide

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A single man cannot surround an anthill!

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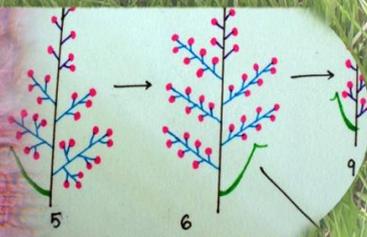
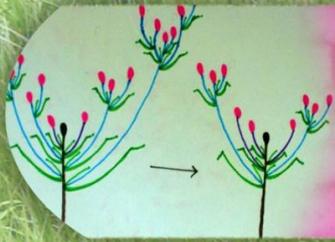
Abbreviations

Abbreviation	Explanation
al.	alii: others
aff.	Affinis: having affinity with but not identical to
auct.	of author
auct., non.	auctorum, non:of authors, not (of), used for a name that has been mistakenly applied
Blatt. & McC.	The Bombay Grasses, Blatter & McCann 1935
<i>Bor</i>	<i>Grasses of India, Burma, Ceylon & Pakistan, Bor 1960</i>
cit.	citatus: cited
comb.	combinatio: combination
comb. nov.	Combination nova, new combination
cons.	conservandus: to be conserved
Cook	The aquatic and wwetland plants of India, Cook C. D. K. 2006
<i>Cooke</i>	The Flora of Presidency of Bombay, Cooke T. 1958 (Revised ed. Of 1902-08)
etc.	et cetera: and the rest
e.g.	exempli gratia: for example
fig.	Figure
Hooker f.	Flora of British India, Hooker f.
hort.	hortorum: of gardens
ICBN	International Code of Botanical Nomenclature
i.e.	id est: that is

IPNI	International Plant Nomenclatural Institute
Karthik. <i>et al.</i>	Florae innumeratio Indicae: Monocotyledons, Karthikeyan et al. 1989
Lakshmi. <i>in</i> Sharma <i>et al.</i>	<i>Flora of Maharashtra state, Monocotyledons, Lakshminarasimhan in Sharma et al. 1996.</i>
Mya	millions of years ago
nom. cons.	nomen conservandum: name conserved in ICBN
nom. illeg.	nomen illegitimum: illegitimate name
nom. inval.	invalid name
nom. nud.	nomen nudum: name without a description
nom. provis.	nomen provisorium: provisional name
nom. rej.	nomen rejiciendum: name rejected in ICBN
nov.	novus: new
nov. sp.	nova species new species
op. cit.	opere citato publication cited (but not page)
p.p.	pro parte: partly
<i>Pandey in Shetty & Singh</i>	<i>Flora of Rajasthan, vol 3, Poaceae, Pandey in Shetty & Singh 1993</i>
<i>Parmar in Shetty & Singh</i>	<i>Flora of Rajasthan, vol 3, Cyperaceae, Parmar in Shetty & Singh 1993</i>
Prasad & Singh	Sedges of Karnataka, Prasad & Singh, 2002
<i>Roy in Singh et al.</i>	<i>Flora of MadhyaPradesh, Vol 3- Cyperaceae, Roy in Singh et al. 2001</i>
Shah	Flora of Gujarat State, Shah G. L. 1978
<i>Shetty in Singh et al.</i>	<i>Flora of MadhyaPradesh, Vol 3- Poaceae, Shetty in Singh et al. 2001</i>

<i>S. Gujarat</i>	<i>South Gujarat</i>
s.l.	sensu lato: in the broad sense
sp.	Species
sp. nov.	species nova new species (preferred to nov. sp.)
spp.	Species, species (plural), used in referring to several species of a genus
s.s.	sensu stricto: in the narrow sense
ssp. or subsp.	Subspecies
syn.	Synonymum, synonym
tab.	tabula plate, illustration
vol.	volume: volume
viz.	videlicet: namely

Chapter: 1



‘The first step in wisdom is to know the things themselves; this notion consists in having the true idea of the object; objects are distinguished and known by their methodical classification and appropriate naming; therefore Classification and Naming will be the foundation of our Science.’

– Linnaeus

1.1 General Introduction

The Rio Earth Summit held in 1992 emphasized the need to conserve the biodiversity of the globe, especially the tropics. A thorough investigation of flora has become an urgent necessity not only because of the economic and ecological importance of biodiversity but also because of accelerated genetic erosion occurring as a consequence of the destruction of the forests and other habitats. May (1999) in his work clearly mentions that ‘the task of inventorying is sometimes mistaken for stamp collection but, such information is prerequisite to proper formulation of taxonomic, phylogenetic and ecological questions, and essential for assigning the proprieties in conservation biology’.

One of the main scientific challenges of the 21st century is to understand the extent of biodiversity change that results from human expansion, and whether this change is detrimental to the functioning of the biosphere and the well-being of human society (Dirzo & Raven 2003, Naeem 2009). With continued habitat destruction and ongoing global change, humans are undeniably a prominent part of every ecosystem on the planet. As such, human activities, behavior, and economy must be explicitly incorporated into the equation to be able to achieve a more sustainable future. Land cover change and loss of habitats is the core of estimates for global and regional extinction rates (Lawton & May 1995, Pimm *et al.* 1995, Pimm & Raven 2000). As the human footprint continues to spread across all parts of the planet, many biodiversity studies have shifted focus to more applied realms to ask not just how biodiversity is distributed, but how it is changing, and what we can do to minimize or mitigate these changes. Recently, the field has shifted from one of preservation to one of active restoration and conservation amid multiple uses (Rosenzweig 2003).

One of the most important reasons to include ecological information in species descriptions is to enable future workers to find the organism again. Even if the type locality is turned into a shopping mall, good habitat data may help locate the other populations of the species somewhere else in the area. Workers wanting to find additional specimens to use in systematic studies or biological research will also greatly appreciate any information on months of peak abundance, reproductive season and other features. The meaningful conservation activity involves a thorough understanding of biodiversity of a particular region.

“Until you know what grows and lives in a particular place, and recognize its position in the biosphere, you can neither exploit nor conserve those biological resources properly”.

- D. Galloway

Ecological data related to habitat in taxonomic descriptions can give conservation biologists the information they need to locate protected sites for long-term species management and protection. Information on distributions and habitat preference of native species is invaluable when an exotic species is introduced into an area. Demographic data is also critical to understand conservation needs and documenting the impact of environmental change. For example, mulga communities of south Queensland, Australia have considerable modification through continuous grazing and extensive vegetation clearance, which are proved responsible for the decrease in species richness in vine, forb and graminoid life forms over last 60 years (Wang *et al.* 2011).

The *taxonomic urgency* is the important paradigm created by the combination, in our century of extinctions, of the taxonomic gap and of the *biodiversity crisis* (Dubois 2010). It requires an increased effort by biologists to discover in the field, collect, store in permanent collections, study, describe and name the still unknown living species of the planet, which are counted in millions, before they are extinct. Plant taxonomy, the science of classifying and naming the plants antedate recorded history, but now a days it also developed and expanding as a biological enquiry system to understand the plant life as a whole. It is in this spirit, coordinated efforts from few other disciplines also reveal the factors responsible for the enhanced or reduced diversity in the local as well as global level. Taxonomy, systematics, evolutionary biology, ecology, conservation/ restoration studies represents distinct and somewhat independent scientific endeavors but it is clear that the processes within each area are strongly connected. Evolutionary studies need good taxonomy; ecological studies need good understanding of the evolutionary relationships and conservation studies need good understanding of taxonomy, evolution as well as ecology (Raven *et al.* 2011).

By any reckoning the sedges & grasses are a successful members in which three themes constantly persist:

- their adaptability to changeable environment
- their ability to coexist with grazing herbivores and with man, and
- their possession of a distinctive life form, in which fidelity to a single architectural scheme is counterbalanced by the endless ingenuity of its variations.

ranks between the family and genus without any specific diagnostic characters. Bentham in 1881 grouped 13 tribes in 2 subfamilies and Kunth (1833) described 13 tribes with no subfamilies. Bentham & Hooker (1883) have used the same arrangement of the tribes which was modified later by Haeckle (1889), Stapf (1934) and Hitchcock (1935). Moreover, Duval-Jouve (1875), Holm (1891), Lohaus (1905) had also contributed many characters of taxonomic significance in addition to morphological studies. Bor in 1960 has given an empirical account on the grasses of India, Burma, Ceylon and Pakistan. In recent years Clayton & Renvoize (1986) published '*Genera Graminum*' by including almost all the available literature at that time. Tzevlev & Michealova (1989) has given the comprehensive account on grasses and their evolution and included data of morphology, micromorphology, cytology and distribution for the genera. Watson & Dallwitz (1992 onwards) combined all the information in Grass genera of the World. In concern with systematic biology grass systematics has progressed in large leaps caused by newer approaches collaborating with the existing ones and supported from the results of bioinformatics.

In last decades Kellogg (2001), Clark (2004) and Hilu (2007) gave the historical account on systematics wherein all the aspect of grass research has taken into account. Due to gathering of large set of data grasses have been included in 2 clades, BEP and PACCMAD (GPWG 2001, Sanchez-Ken *et al.* 2007, Bouchenak-Khelladi *et al.* 2009). PACCMAD grasses have affinity towards C₄ photosynthesis. The direct effect of the C₄ pathway is to reduce photorespiration and saturate photosynthesis with CO₂, which has allowed C₄ grasses to colonize open and drier habitats under water stress, high temperatures and light intensity, thus making them better adapted to warmer and dryer climate in tropical subtropical regions (Sage 2004, Osborne & Frekelton 2009, Edwards & Smith 2010). Extant C₄ grass diversity is upwards of 4500 species, and C₄ grasses dominate many important ecosystems and contribute 20–25% of terrestrial primary productivity (Still *et al.* 2003). The first transition from C₃ to C₄ photosynthesis for family Poaceae was occurred around 32.0–25.0 mya in the subfamily Chloridoideae (Christin *et al.* 2008a, b).

Cyperaceae is the 7th one in terms of the number of species and genera and c. 5,500 species of 109 genera, making them the third largest monocot family (Muasya *et al.* 2009a&b, Simpson *et al.* 2011). The first evolutionary dating evidence indicating that the cyperoid clade had a west Gondwanan origin ca. 100–120 mya and that the split of Cyperaceae from Juncaceae occurred around 65–80 mya and is resolved as a sister to Juncaceae, with Mapanioideae (Bremer 2002, Goetghebeur 1998). They are more or less cosmopolitan in distribution with hotspots of diversity in north-eastern South America, eastern and southern Africa, South and

Southeast Asia and Australasia (Govaerts *et al.* 2007). According to Besnard *et al.* (2009), the first appearance of C₄ photosynthesis in Cyperaceae probably occurred between 19.6 ± 4.9 and 10.1 ± 3.6 mya in *Bulbostylis* DC., with the other C₄ appearances occurring during the last 12 Ma, making C₄ sedges generally younger than C₄ grasses. Although sedges generally occupy wetter habitats than grasses, many C₄ sedges occupy seasonally dry habitats as it raises the water-use efficiency might have contributed to the colonization of drier habitats. Because of their ecological significance in wetlands and the important role in food chain of dry grasslands, knowledge of the biodiversity and evolution of this Cyperaceae is very valuable (Larridon 2011).

Cyperaceae is known to humans since the usage of *Cyperus papyrus*. Earliest scientific reference to sedges found in the work of Linnaeus (1753). Later works of Vahl (1805), Brown (1810), Pax (1888a&b), Palla (1889) were given different treatment to the sedges diversity. The presence of Kranz anatomy has been used in the classification of *Cyperus* since Rikli (1895), long before the discovery of the C₄ photosynthetic pathway. However, Clarke (1908), Kukenthal (1936), Beetle (1940, 1944), Koyama (1958) and Kern (1962) remained loyal to the linnean concept. Gotegebeur (1986, 1998) provided historical and nomenclatural information for each genus under 4 subfamilies, namely Cyperoideae, Caricoideae, Sclerioideae and Mapanioideae. Haines & Lye (1983) and Tucker (1987) also commented on generic circumscription of sedge genera. Goetghebeur (1989), Soros & Bruhl (2000), Muasya *et al.* (2002), Bruhl & Wilson (2007) and Besnard *et al.* (2009) confirmed that the C₄ photosynthetic pathway arose at least four separate times in Cyperaceae. Bruhl (1995) described all the sedge genera under 2 subfamilies, i.e. Cyperoideae and Caricoideae. In 2007, Govaerts *et al.* published the world checklist of Family Cyperaceae. In the last ten years several phylogenetic studies have used morphological, molecular and combined morphological & molecular data to understand the interrelationships within and between the genera and species (Simpson 1995, Muasya *et al.* 2002, 2009 a & b; Tucker 2007, Simpson *et al.* 2007, Vrijdaghs *et al.* 2009, 2011).

‘There is no question that species have objective reality and that they also have evolutionary reality’.

– Stuessy

Evolutionary biology of flowers has undergone a revolution in the past twenty years. It began with the recovery of excellently preserved Cretaceous fossil flowers and was followed by the improvement of molecular techniques and their application in developmental genetics and systematics, which opened new avenues for evolutionary flower research. In turn, these new fields stimulated comparative floral studies, and traditional approaches in concert with the new

ones are now greatly needed. The most recent, but now rather dated, general treatments of morphological inflorescence classification by an author writing in English were provided by Rickett (1944, 1955). Wilhelm Troll (1897-1978) was a prominent and influential plant morphologist of this century. He and his collaborators were responsible for great advancements in comparative morphological especially floral studies with typological concept (Troll 1964, Weberling 1965, 1989). Afterwards number of researchers has segregated numerous genera, species and subspecies on the basis of vegetative and reproductive morphological features. Various aspects of diversity of floral structures were discussed and reviewed by Endress (1994, 1997, 2010). During last 20 years Vegetti and his colleagues were reintroduced the Troll's typological system for inflorescence architectural studies in Cyperaceae (Vegetti 1992b, 1994, 2002, 2003; Ahumada & Vegetti 2009, Lucero & Vegetti 2012) and Poaceae (Rua 1993, 1996; Vegetti & Anton 1995, 1996; Vegetti 1999, Vegetti & Weberling 1996, Rua & Weberling 1998, Liu *et al.* 2005, Reinheimer & Vegetti 2008, Perrata *et al.* 2009, Reutemann *et al.* 2009, Tivano *et al.* 2009). Phylogenetic hypotheses based on molecular and other data sets have also been used to elucidate the evolution of structural and functional aspects of flowers within families and genera (Doust & Kellogg 2002a&b, Malcomber *et al.* 2006, Mc Steen 2006, Liu *et al.* 2007, Guarise & Vegetti 2008a&b, Naczi 2009, Reinheimer *et al.* 2009, Chemisquy *et al.* 2010, Jung & Choi 2010a&b). In recent works, Reinheimer & Kellogg (2009) have also described that the palea expression is more useful for the classification based on MADS Box Genes in grasses over ovule expression. Scanning electron microscopy has become an indispensable tool for developmental and functional floral studies have yielded new insights into the variability and stability of organ initiation patterns and are used for phylogenetic studies in last few years (Vrijdaghs *et al.* 2004, 2005, 2010; Zanotti *et al.* 2010). In addition to that, some overlooked morphological characters such as structure of the ligule (Chaffey 1984, 1994), lodicules (Guedes & Dupuy 1976, Wang & Li 1989) and epidermal of lemma are also gain the some importance in grass taxonomy.

In early part of the 19th century leaf anatomical as well as micromorphological characters are also utilized for segregating the lower taxonomic categories. General anatomical and micromorphological features for monocots have been described by Metcalfe (1954, 1960, 1963, 1971) and Metcalfe & Chalk (1950, 1965). It is a well established fact that, foliar anatomy and epidermal features are very important in sedge and grass systematics and utilized for characterization of broad groups, within subfamilies and tribes (Palmer *et al.* 1981, 1985, 1986, 1988; Renvoize 1982a&b, 1983, 1985 a & b, 1986, 1987 a&b; Govindrajalu 1966, 1969 a & b). Hilu (1984) observed definite differences in leaf epidermises and suggested that

micromorphological variations exist within the genus. Most of the characters are further described and explained by numerous researchers; such as stomata (Stebbins & Khush 1961), Cuticle (Watson 1942), hooks and papillae (Teresa & Bisby 2003, Yang *et al.* 2008), microhairs (Tateoka *et al.* 1959, Amarasinghe & Watson 1990), silica cells (Krishnan *et al.* 2001, Madella *et al.* 2003, Lu & Lui 2003, Fahmy 2007, Prychid *et al.* 2003). In recent years even micromorphological features of floral bracts of grasses i.e., lemma and palea (Snow 1996, Acedo & Llamas 2001) and achene of sedges (Menapace & Wujek 1987, Lui 1999, Zhang *et al.* 2004, Prata *et al.* 2008, Carlos *et al.* 2012) has also been used to access systematic relationship.

Quicke (1993) defines a *taxonomic character* as “any physical structure (macroscopic, microscopic or molecular) or behavioral system that can have more than one form (character state), the variation in which potentially provides phylogenetic information.” As a result, along with many species awaiting description and naming, there are many others that have been described and named more than once. Some taxonomists while working on local floras match the specimens with those in the herbarium to determine identity mechanically and would often miss the hidden characters and variability. Contrary to most fields of modern biological research, it is the legacy literature and data which is prevalent in Taxonomy. The code that governs the naming of plants (The International Code of Botanical Nomenclature, Greuter 2000) stipulates that the earliest name given to a species in its particular Genus takes prevalence over all subsequent names. A good number of ‘replacement taxa’ were cited which refer to pairs of species of a genus with continuous range of distribution. Although, the codes are intended to stabilize the system of nomenclature, occasionally names must be changed. Some name changes result from scientific progress, increasing our knowledge of the group as a result of more research. Molecular work may also show genetic divergences between what were previously considered to be morphotypes of a single species. Increasing biological familiarity may show that what had once been considered to be a single species is actually several morphologically similar sibling species. For example, while inclusion of *Brachiaria* into *Urochloa*, 3 species of *Brachiaria* having spikelets disarticulating above the glumes with inconspicuous callus and chartaceous to cartilaginous, shiny, smooth, muticous upper lemma are named as *Moorochloa* Veldk., *gen. nov.* and rest other shifted to *Urochloa* based on the morphological and molecular analyses (Nguyen 1966, Webster 1988, Veldkamp 1996 a&b). When using the classification of Goetghebeur (1998), the generic limits in the *Cyperus* clade are notoriously controversial. It comprises a paraphyletic *Cyperus* s.s. as the core genus, in which 13 segregate genera are nested. These segregated genera (*Alinula* J.Raynal,

Androtrichum (Brongn.) Brongn., *Ascolepis* Nees ex Steud., *Courtoisina* Soják, *Kyllinga* Rottb., *Kyllingiella* R.W.Haines & Lye, *Lipocarpha* R.Br., *Oxycaryum* Nees, *Pycreus* P.Beauv., *Queenslandiella* Domin, *Remirea* Aubl., *Sphaerocyperus* Lye and *Volkiella* Merxm. & Czech) were created because their species diverged significantly from typical *Cyperus* with respect to vegetative, floral and anatomical characters (Muasya *et al.*, 2009b).

At the opposite extreme, further research may show that what were described as separate species may turn out to represent intraspecific variation between populations of the same species. eg. *From Hooker (1897) to recent work of Yadav (2010) including all the floras (Karthikeyan et al. 1989, Laxminarshimhan 1996, Pandey 1993, Roy 2001) considered Diplachne fusca as a valid name, but Phillips (1982) included genus Diplachne under Leptochloa and study was supported by the cladistic analysis of Snow (1997, 1998) and Clayton et al. (2011).*

In Indian plant taxonomy, what needed is more elaborate description encompassing a complete range of variations with illustrations of all species. The vegetative characters, neglected in the past, and others if any, should be studied to check whether any of them constitute more striking characters to enhance our understanding on floras. We should persist in our efforts to recognize our species on a morphological basis. Earlier provincial floras, in contrast, supplemented each other in furnishing information. For e.g., ‘The Flora Presidency of Madras’ (Gamble 1915) is known for elaborately written generic keys and generic descriptions; on the other hand ‘The Flora of Presidency of Bombay’ (Cooke 1902-08), present species descriptions in greater detail. Such floras in combination to-date work so effectively and only very few floras can match them in their utility, but the line drawings and photographs were missing in both.

‘While skill at drawing, or a steady hand, may help a person create an illustration, his skill will be of little help if he lacks the quality of careful observation, of attention to every detail of his subject; accuracy is the most sought after virtue in biological illustration.’

–Downey & Kelly

The most important rule on illustrating taxonomic descriptions is, *Just do it!* Illustration is not an addition to your description. It is an integral part of it. For e.g., The Caterpillar Tractor Company’s 800-word vocabulary manuals would not have worked nearly so well, if they had not included in them illustrated lists of parts and detailed diagrams of all the equipment (Kirkman 1992). In addition to above, color photographs can draw proper attention to the whole organism. They can put it in context within its environment, and they may make it possible for later researchers to make identifications in the field without collecting or harming

the organism. In many cases new collecting techniques and new technology have led to a dramatic increase in the number of species described for a group of organisms. For example, A survey of the BIOSIS© database (Winston & Metzger 1998) showed that the third of all taxonomic papers published over the last 28 years contain at least one new species is described.

In recent years, BSI has already started working on AICOPTAX, as they have found that there is genuine need to update the knowledge about various plant groups and correct the errors committed due to various limitations such as lack of access to study the plants in the fields and lack of good and adequate collections at hand. Some species are known to science only from one or few collections which are insufficient to give a full picture of their variation, population structure and distribution. Furthermore, a good percentage of named species cannot be recognized on the basis of existing literature and hence need redescription. A recent scrutiny of duplicates of some rare species listed through Red Data Books revealed that many of them were not collected after their type collections. Thus the existence of such species seems to be either restricted to tiny pockets of type localities or they appeared as freaks or had vanished because of inviable population strengths.

In spite of luxuriant vegetation and rich biodiversity, study area remained seriously neglected at the hands of botanists, which is evident from the earlier patchy investigations far from the satisfactory. 'The Flora of the Presidency of Bombay' (Cooke 1902-08) and 'The flora of Gujarat state' (Shah 1978) are the usual authority that is consulted by researchers as well as general taxonomists and students for the study and identification of flowering plants of the region, which was published almost a century or half a century ago. During last 50 years several nomenclatural changes, arrangement and addition or deletion of taxa were made by botanists. Floristic studies are playing a vital role by providing basic data about taxa, characters, traits, distributions and rarity.

In general sedges and grasses are remarkably similar, but in details they show an immense diversity and are also difficult as well as challenging groups. Hence, their correct identification and classification is possible only by a study of many minute characteristics. Therefore, I have tried to approach the studies of grasses and sedges from the south Gujarat region from documentation, taxonomy and micromorphological angle. Furthermore, in the present work each and every essential morphological character were observed and recorded. The observation also supported by the photographs and line drawings of each organ especially the reproductive parts of the plant i.e. Inflorescence, Spikelets, Florets, and Flower. The above observations and

findings are also supported by the micromorphological characters to assess the similarities and variations within the species.

1.2 Study Area

South Gujarat also known as *Deccan Gujarat* is a region in **Indian** state of **Gujarat**. The region is divided into two parts: Western Part and Eastern Part. The western part is almost coastal and is known as *Kantha Vistar* means costal region in Gujarati and The eastern part is also known as *Dungar Vistar* almost hilly which ranges from 100 to 1000 meters ranges with the highest peak at **Saputara** in **The Dangs** District. **Surat** is the largest city in this region as result of which it happens to be the Headquarter of South Gujarat region, which is also second largest city of Gujarat and eighth largest city in India. The five Districts in this region are **Surat, Navsari, Dangs, Valsad** and the newly formed **Tapi District**.

1.2.1. Geography

Going through the geography of South Gujarat, one would know that Gujarat is home to many different topographical features and landscapes. It deals with the climate and natural features, rivers, dams, national parks, etc. South Gujarat comprising the region below the river Tapi and spreads between $72^{\circ}40'18'' - 74^{\circ}02'59''$ E longitude & $21^{\circ}27'15'' - 20^{\circ}04'12''$ N latitude and covers an area of 14,820.26 sq. km.. The total area of about 14820.26 sq. km. is bounded in the north by Narmada and Bharuch districts of Gujarat state, Madhya Pradesh in the east, Maharashtra in south and the long shore of Arabian Sea in the west (Plate 1, fig.1).

Topography of Gujarat shows a wide range of physical features ranging from drainage, soil to coastal and marine environment, etc. it is characterized by the small hilly tracts especially on eastern side due to which distinctive vegetational patterns can noticed from west to east. Thus spread over a vast area, the topography is divided into 3 major regions, namely: hills, plains and coastal areas. The wet rugged east and plains, which stretch from Sahyadris to west coast, provide a large area suitable for forests. Barring a few high hills in the east and south, most of the area is made up of a series of flat-topped low hills. The elevation of these hills varies from 105 m in the west to 1,317 m above mean sea level on the eastern border. South Gujarat is rich in wetland resources, which are present in the form of salt marshes, creeks, mudflats, estuaries, swamps, reservoirs, waterfalls, etc.; of which Ukai reservoir, Gira & Girmal waterfalls and Purna & Verna estuaries are the major one. The major rivers in this region, viz. Tapi, Mindhola, Purna, Ambika, Auranga, Kaveri, Par, Kolak, Damanganga and their tributaries, are mainly controlled by major lineaments (Plate 2, fig.1). The geography would be incomplete

without a reference to its dams. Some major dams are built on the rivers Tapi i.e. Ukai and Kakrapar and Damanganga dam on Damanganga river.

National Park and Wild Life Sanctuary are also the constituent of the geography. The Western Ghats biogeographical province of protected area, which includes Vansda National Park and Purna Wildlife Sanctuary having unique and rich biodiversity and considered to be one of major biodiversity hotspots in India. Total area under forest in Gujarat was about 18,648.51 sq. km. of which 30% were found in these regions (Census data 2001).

Vansda National Park, a protected area representing the thick woodlands is situated in the Navsari District. Established in 1979 as a National Park, the deciduous forest area having groves of 'Katas' and 'Manvel' bamboo owes its beauty to no felling of trees since 1952. Lofty and luxuriant trees clothing the valleys and hills holding a wealth of wildlife, graceful streams are spreads roughly 24 km² in area. Vansda, the town from which the name of the park is derived, is an important trading place for the surrounding area where the majority of the population is represented by adivasis who belong to Bhil, Gamit, Warli, Kokni, Kunbi and Dangi tribes. Nestled in the Western Ghats or Sahyadri range, it has a unique flavour of flora and fauna population. It has mainly moist - dry deciduous forest and bamboos, tall teak trees, orchids, mango groves and gigantic creepers are the predominant in the forest. Even a rotting log is decorated with ferns and mushrooms. At present the Vansda National Park has more than 250 species of rare wild animals. Small creatures with their amazing diversity are the real treasures. Among these are butterflies, spiders, insects, centipedes, millipedes and snails. Diversity of frogs and toads ensure that the snakes continue to thrive here. National park boasts a good diversity of birds and mammals such as the Leopard, Hyena, Jungle Cat, Mongooses, Macaques, Barking Deer, Four-horned antelopes and Spotted Deer in this part of the State.

Purna Wild Life Sanctuary, where luxuriant dense forests with thick bamboo brakes enchant visitors. The Sanctuary is a part of dense moist deciduous forests in Western Ghats in northern part of the Dangs district and supports gamut of flora and fauna of very high evolutionary value. The area covering 160.8 sq. km is a reserved forest, which has been notified as Sanctuary in July 1990 for conserving diverse biological resources. Different types of forests that constitute varied habitats are moist mixed deciduous forest, moist teak forest and bamboo brakes. 'Mahal' forest in the Protected Area is one of the best forests in the State. About 700 identified plant species with dominance of grasses and broad-leaved plants in high density and diversity are found in the Sanctuary.

1.2.2. Geology

The basaltic flows of Deccan Trap form the oldest rock type within the limits of the study area. They are somewhat weathered with numerous joints and fractures. They are exposed in the form of isolated hills in the southern part of the area and also occupy the riverbeds. Dykes of basalts and dolerites are cutting across the traps. The tertiary sediments are nowhere encountered, though their sporadic outcrops are reported from north of the study area. The older alluvium probably of Late Pleistocene age, consists of silty clay and forms the main soil horizon 50 to 250m thick. Its top surface up to considerable depths is invariably contained a thick line crust and plenty of lime. The materials of the present day floodplains constitute the newer alluvium. Its occurrence is restricted to the flanks of the major rivers and constitutes a very fertile land. The older and newer alluvium has more lime and less organic matter as compared to newer alluvium. All coastal deposits are of Holocene age, and comprise sandy beaches, bars spits, barriers and dune ridges. On the landward side there is an extensive development of estuaries mudflats which are made up of fine-grained particles of silt and clays with a considerable percentage of biogenic matter. Dangs is covered by Deccan Lava flows as horizontally bedded sheets. Hence flat topped hills are common in the area which is characteristic of the trappean country. At places, the trap contains iron and traces of feldspar and hornblende, producing the red, sharp gravel covering many hillsides (Khanchandani 1970).

1.2.3. Soil

Climate, topography, soil characteristics forms the basic vegetational pattern in the forest and surrounding areas. Considering these factors soil characteristics like soil colour, depth, texture, drainage and salinity were studied/referenced from the study area. Area covers almost all the types of soils, ranging from cotton black - alluvial - brown -calcareous - sandy soils including hilly tracts and coastal belts (Plate 2, fig. 2).

Dominantly the soils are very deep, well drained, fine-medium textured (clayey to loamy clay), slightly alkaline and slight to strong saline. The area behind the shoreline is covered by a thick alluvium and this extensive alluvial deposit owes their origin to the various larger rivers and their tributaries flowing from the east. Once these rivers leave the trappean highlands and emerge on the alluvial plain, they show gentle slopes. Near the coastline, their courses are controlled by shoreline landforms. The lower most reaches of these rivers are tidal and they fan out to form extensive mudflats. The soil in the valleys is mostly black cotton soils composed mainly of clay mineral. The texture is clay loam and the soil is fertile. It contains high amounts of alumina, lime and magnesia, with a variable amount of low nitrogen and phosphorus. On the slopes of the hill is red soil, which is light and porous and contains no soluble salt (Patel,

1971). The agricultural soils are mildly acidic to neutral with the pH value ranging from 6.7 to 7 and moderately rich in organic Carbon (WWF-India, 2005).

The Soils in western side are dominantly very deep followed by moderately deep and in eastern part soils are dominantly shallow followed by moderately shallow. The Soils in Surat, Navasari and Valasad District dominantly distributed to very deep soil depth class followed by shallow depth Moderately deep soil are also observed, Where as in Tapi district the soil depth are dominantly shallow followed by very deep. In Dang district the soils are dominantly distributed in shallow soil depth class. In Tapi and Dang district soil salinity is moderate. The Soil salinity in Surat, Navasari and Valasad belongs to slight to strong salinity class.

- Older alluvium: these are essentially the ancient flood plains and coalesced alluvial fans and represent the alluvium deposition that must have commenced during Pleistocene. These fluvial deposits are made up of alluvium older in comparison to the recent flood plain deposits. The precise age of these plains is not clear.
- Relict older alluvium: the relicts or islands of this alluvium within the tidal flats isolated from the main body of the alluvium plains, provide an excellent example of extension of alluvial plain far into continental shelf, its unequal erosion during a phase of lower sea-level and which finally got submerged under the sea.
- Newer alluvium or flood plains: recent or present day alluvial deposition is restricted to the flanks of the various rivers which during seasonal floods, overflow their channels and inundate the low-lying areas.
- Natural levees: these are very prominent along the big rivers especially river Tapi and Purna. It occurs as low-lying ridges of overbank deposits. In many places these levees have been branched by strong flood currents.
- Meanders: meandering courses are exhibited very clearly by all rivers, and Tapi, Mindhola and Ambica have very prominent entrenched their own alluvium from 6-10 meters.
- River mouth bars: Kadia bet is an excellent example for the river mouth bar in river Tapi and also another river mouth bars developing in front of river Mindhola and Purna.
- Islands and point bars: these are conspicuous in all rivers; among them the Tapi has developed it of impressive dimensions. These landforms perpetually change their configuration depending on water velocity and sediment discharge.
- Abandoned channels: these are very prominent features and indicate a shifting fluvial regime. The density of abandoned channels increases conspicuously on approaching the shoreline.
- Mudflats: behind the barrier ridge complex towards the landsides, the marshy lands occupy vast areas right from Tapi to Auranga comprising of high Marshes (raised mudflats) and

low marshes (present day mudflats). These marshes are highly dissected by large number of tidal inlets.

- Beaches and dunes: in general, the recent sand deposits are composed to very fine –coarse sands, moderately sorted and show good stratification. Erosion of the terrestrial environment provides great amount of sediments and most of which are carried seawards by rivers for its disposal to the beach and beyond. An important source of beach and near-shore materials is the reworking and shoreward movement of sediments from the inner shelf. This is of great significance as the present high sea level has drowned a number of offshore bars/beaches.

1.2.4. Climate:

Talking about the climate and natural feature of Gujarat has diverse climatic conditions. Some of the important features of the climate and natural features are temperature and humidity. In south Gujarat, one can find a moist weather owing to the Arabian Sea and the Gulf of Cambay.

- Winters (November - February) are mild, pleasant and dry. The day temperature is around 83° F and at night is 53° F.
- Summers (March - May) are hot and semi dry to low humid. The temperature in day is 115°F, whereas the night temperature is 90°F
- Monsoon (June - September) is generally extremely humid. The temperature at day is 100° F but at night is 80° F. Study area receives 70-150 cm/yr of rainfall. Sometimes, due to heavy rainfall, severe flood occurs in some parts of the region.

1.2.5 General Vegetation Pattern:

Study area forms the meeting point of Western Ghats, Gengatic plains and Deccan peninsula biogeographical region along with coastal belts (Rodger, Panwar & Mathur 2000). The unique geographic position coupled with climatic variability has enabled many unique and diverse biotic elements to flourish in the area. Total area under forest in Gujarat was about 18,648.51 sq. km. of which 30% were found in these regions (Plate 1 fig. 2; Census data 2001). Songadh-Vyara, Saputara, Dharmapur, Kaprada are the important places of botanical interest in south Gujarat. The forests of the Dangs, Tapti and eastern Valsad belong to the subgroup of South Indian moist deciduous forest, and within this are more specifically classified as moist teak forests (Champion & Seth 1968). The forests are known to be the richest in Gujarat and contain many invaluable timber species as well as medicinally important species. Presently Dangs occupy about 30% of the forest area of Gujarat and generate 50% of its forest revenue

and flora of Dangs is richest in Gujarat. Teak (*Tectona grandis*) is the most dominant species occurs throughout the area.

Champion and Seth (1968) have classified the state forests in to 23 forest types for the state (SFR 2009). Gujarat state has 4 sub-groups of forests which belong to different regions of the state as the major factor influencing them is the climate; of which 3 are occur in the study area, namely:

3B- South Indian moist deciduous forests

4B- Swamps / tidal forests / mangroves

5A- Southern tropical dry deciduous forests

Sub-types with the type and their distributions are given below:

3B- South Indian moist deciduous forests

The forest of this type is recorded in the part of MP, MH, Kerala, Karnataka, Tamilnadu and S. Gujarat. Closed high forest, commonly 30m or more in height, the dominant species mostly deciduous, though some evergreen dominants are included. Few evergreen trees are developed in the lower storey giving forests as a whole a more or less evergreen appearance for most of the year. It may be said that typical rainfall for the type is 120-200cm with dry seasons of 4-5 months, with a longer dry season range extends to still higher rainfall as in case of forests of s. Gujarat.

Tectona grandis, *Adina cordifolia*, *Dalbergia latifolia*, *Madhuca indica*, *Shoerea robusta*, *Anogeissus latifolia*, *Butea monosperma*, *Diospyros melanoxylon*, *Mitragyna parviflora*, *Terminalia* spp. *Lagerstroemia* spp., *Pterocarpus marsupium*, *Oroxylum indicum*, *Albizia lebback*, *Emblica officinalis*, etc. The common woody climbers found in these areas are *Dioscorea* spp., *Hiptage benghalensis*, *Mucuna pruriens*, etc. A number of bryophytes, pteridophytes, epiphytes and terrestrial orchids further enrich the phytodiversity of these beautiful forests. The ground flora is dominated mainly by shade loving species of *Abutilon*, *Cassia*, *Cleome*, *Euphorbia*, *Curcuma*, *Amorphophallus*, *Colocasia*, *Costus*, *Cichorium*, *Neuracanthus*, etc. All shade loving grasses are found in these regions with dominance of *Dendrocalamus strictus*, *Bambusa arundinacea*.

3B/C_{1b} – Moist teak forests: Valsad, Dangs, Navsari

Typical rainfall in such type of forests is 160-250cm with moderately deep loamy soil. Teak constitutes fair to medium (10-25%) proportion of population which supports dense undergrowth (Plate 3 fig. A-E).

3B/C_{1c}- slightly moist teak forests: Surat, Tapi

Such type of forest occurs in area having typical rainfall of 120-160 cm with moderately deep loamy soil. Teak constitutes medium to high (20-60%) proportion of population which supports moderate undergrowth (Plate 3 fig. F-I).

3B/C₂- southern moist mixed deciduous forests: Surat, Tapi, Valsad, Dangs

Such type of forest occurs in area of moist or slightly moist teak forests having rainfall of 120-250 cm with moderately deep loamy soil. Teak is present occasionally (Plate 3 fig. J-O).

3B/2S₁- southern secondary moist deciduous forests: Surat, Navsari, Valsad, Dangs

The forest is very similar to moist deciduous forest but the original climax vegetation is modified due to direct and indirect human action. Such forests have few or no big trees. Scattered survivors of primary forests are occasionally encountered especially in damp hollows. Deciduous shrubs and thin grass form the ground cover with annual burning. Canopy composition is almost similar to moist mixed deciduous forest with poor regeneration of evergreen species (Plate 3 fig. P-R).

4B- Swamp or Tidal forest

Majority of tidal forests are mangrove scrubs with average height of 3-6m.

4B/TS₁- Mangrove scrub: Surat, Navsari & Valsad

Mangrove patch near the mouth of Tapi, Purna, Ambica & Auranga rivers expanded due to plantation and natural regeneration. Dense mangrove forest patches of *Sonneratia apetala*, *Avicennia alba*, *Acanthus ilicifolius* and *Avicennia marina* (Plate 4 fig. A). Coastal /Marshy vegetation is dominated by *Sesuvium portulacastrum*, *Scirpus maritimus*, *Salvadora persica*, *Prosopis chilensis*, *Cressa cretica*, *Alternanthera sessilis*, *Ipomoea pes-carprae*, *Heliotropium* spp., *Boerhaavia diffusa*, *Acacia nilotica*, *Cocos nucifera*, *Phoenix sylvestris*, *Borassus flabellifer*, *Sesuvium portulacastrum*, *Suaeda fruticosa*, *S. nudiflora*, *Arthrocnemum indicum* and few species of *Cassia*. Salt tolerant grasses and sedges like *Aeluropus logopoides*, *Sporobolus maginatus*, *Leptochloa fusca*, *Scirpus subulatus*, *Cyperus esculentus*, *Bulboschoenus maritimus* and few species of *Fimbristylis* & *Eragrostis* are found to be common in these regions (Plate 4 fig. B-C).

5A- Southern tropical dry deciduous forest

Most of the trees are dry deciduous during the dry season, usually for several months. The number of species is much less than in moist deciduous forests. Bamboos are often present but not luxuriant and an undergrowth of shrubs is usually present. The typical rainfall for the type is 75-125cm. it merges into thorn forests whenever the rainfall drops below 75cm. the forest can be divided in to 2 classes, according to the presence and absence of Teak. *Terminalia*

crenulata, *Terminalia bellarica*, *Anogeissus latifolia*, *Embllica officinalis*, *Dalbergia latifolia*, *Cassia fistula*, *Mitragyna parvifolia*, *Diospyros melanoxylon*, *Boswellia serrata*, *Butea monosperma*, *Holoptelea integrifolia*, *Zizyphus spp.*, *Dendrocalamus strictus* etc. are main species of this type. This type of forest occurs in area of Surat and Tapi district.

5A/C₃- Southern dry mixed deciduous forest: Surat and Tapi

Floristically this type differs from the dry teak forest due to absence of teak. Thorny plants occur and tend to increase in proportion with the heavy grazing and fire etc. Bamboo is often absent and usually of poor quality when present. This type occurs in area having rainfall between 80-110cm. shallow soil, well-drained hill sides or undulating ground s are typical, and it is often difficult to decide whether the occurrences of the type is due to site or climate. Forest fire is frequent phenomena in the area (Plate 3 fig. I).

5/E₉- Dry Bamboo forest: Tapi

Only one species, *Dendrocalamus strictus* occurs and forms culms of relatively low height but often dense brake. This occurs mainly on dry hill sides with rainfall of about 90cm. the soil remain dry for the most of the year and often shallow and stony.

5/IS₁- Dry tropical rivarine forest

Narrow along the hilly section of the longer streams in the dry deciduous forest widening as valleys get broader extend into the moist deciduous type. The foliage of the dominants is more or less evergreen in general. Moisture content in the soil of this type of forest remains high (Plate 3 fig. M-N).

Apart from above mentioned subgroups aquatic vegetation and grasslands are also found locally in the area.

Aquatic vegetation comprises free floating, submerged, rooted and emerged plant species occurring in / surrounding the lakes, ponds, canals, reservoirs, etc. distributed throughout the area which provide variable emporia for hydrophytes. It includes *Azolla pinnata*, *Eichhornia crassipes*, *Pistia stratiotes*, *Spirodela polyrrhiza*, *Lemna spp.*, *Wolffia arrhiza*, *Utricularia gibba*, *Hydrilla spp.*, *Ipomoea spp.*, *Limnophyton spp.*, *Limnumthemum spp.*, *Nymphoea spp.*, *Ammania spp.*, *Cyperus exaltatus*, *Fimbristylis dichotoma*, *Polygonum glabrum*, *P. barbatum*, *Sphaeranthus indicus*, *Argemone maxicana*, *Alternanthera sessilis*, *Amaranthus spinosus*, *Mollugo cerviana*, *Sida acuta*, *Tephrosia purpurea*, *Canscora diffusa*, *Leucas spp.*, *Achyranthes aspera*, *Triumfetta pentandra*, *Xanthium strumarium*, *Exacum pedunculatum*, *Colocasia spp.*, *Rotala spp.*, *Cassia spp.*, *Eriocaulon spp.*, *Typha angustate*, etc. Grasses dominated in these regions are *Paspalidium spp.*, *Paspalum spp.*, *Saccharum spontaneum*, *Urochloa spp.*, *Echinochloa spp.*, *Coix spp.*, etc (Plate 4 fig. D-F).

Grasslands

UNESCO defines grassland as 'land covered with herbaceous plants with less than 10% tree and shrub cover.' Grasslands in the wider sense are among the largest ecosystems in the world covering an estimated area of about 52.5 million sq. km. or 40.5% of terrestrial area. Peninsular regions of India are generally covered by savannas. Savanna is grassland with scattered individual trees or shrubs. They are mostly found in warm and hot climates where the annual rainfall varies between 500-1000mm. The total area under grassland in India is estimated at 3.9% or 12 million ha.

Indian Council of Agricultural Research conducted grassland surveys and classified the grass cover of India into 5 major types (Dibadghao & Shankarnarayan 1973):

1. *Sehima-Dichanthium* type
2. *Dichanthium-Cenchrus-Lasiurus* type
3. *Phragmites-Saccharum-Imperata* type
4. *Themeda-Arundinella* type
5. Temperate and alpine cover

In the semi-arid and the arid regions like western India including Gujarat, grasslands are the most important natural eco-systems for the livelihood security of the pastoral communities and also for conserving the biodiversity of the region. These grasslands are known as Vidis/ Bids/ Rakhal and of *Dichanthium-Cenchrus-Lasiurus* type. The grassland in western India is an intermediate stage between forest or thorn forest or woodland on one hand and desert on the other. Total grassland cover in Gujarat was 1482 sq. km, which occupy 7.45% of total forest cover.

1.3 Historical background and Previous work on Grasses & Sedges in south Gujarat:

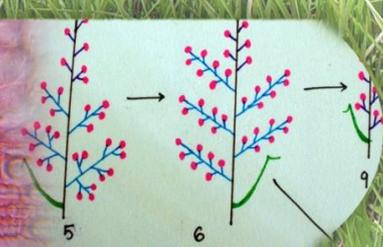
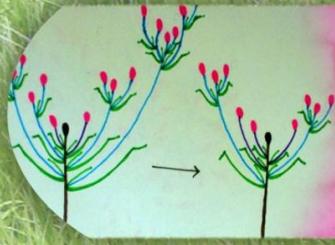
In spite of luxuriant vegetation and rich biodiversity occur in the study area, stray references are found to the plants of the study area in well known floras by Cooke (1902-1908) and Blatter & Mc Cann (1934,1935) followed by the work of Kapadia (1952); Sabnis (1962, 1967); Chavan & Sabnis (1963); Patel (1965); Parabia (1974) and Shah (1978). Jain (1963), Santapau & Shah (1965) and Shah & Suryanarayana (1967, 1969) contributed their knowledge on the flora of The Dangs forest. Floristic accounts on Parnera hills, Pardi and Udwada forest were studied by More (1960) and on Vyara and Surat forest by Shah & Patel (1973) and Joshi (1980). Chavan & Sabnis (1961) and Shah, Parabia & Bhatt (1974) added some more information to the sedges of the Gujarat state. Gandhi & Yusufzi (1999) compiled the information given by earlier workers on grasses of the Gujarat state grazed by the cattle. From all the above literature it is clear that there are number of areas which have not been botanically explored from South Gujarat except Dangs. But, the rise and fall in the number of species reported from the Dangs forests by the earlier workers convinced that our existed knowledge of Cyperaceae from the Dangs and other districts of South Gujarat are still limited. As the grasses are remarkably similar with an immense diversity and distribution and difficult to correct identification it has been neglected and there were no field reports on the sedge and grass flora has been taken out from the study area after the publication of the 'Flora of Gujarat state' (Shah 1978).

1.4 Objectives

The main objectives of the present work are –

- ↳ Plant Collection, Identification, Documentation and Distribution pattern.
- ↳ Detailed morphological character assessment and Comparison with the available literature.
- ↳ Line drawing at greater details especially of inflorescence, spikelet and floret.
- ↳ Micromorphological studies pertaining to leaf.
- ↳ Record significant characters which can be utilized for taxonomic considerations
- ↳ To prepare the artificial key with the help of inflorescence architecture and foliar micromorphology

Chapter: 2



The present work is a result of intimate association with the sedge and grass flora of the region for three years. Some pioneering work was already attempted which gave the impetus and a background for further research. The problem has been tackled at various phases according to the convenience.

2.1 Collection and Preservation of Samples–

Extensive as well as intensive collections of the plant materials were made by undertaking several tours to various localities the work period in different seasons. During field works general vegetational patterns, grass species and their associates were studied and collected for documentations. The collected specimens were photographed in the field using digital camera (Cannon 500D & Olympus FE 5010) and finally made into herbarium specimens by standard preparation method, which are being deposited in the BARO herbarium (Department of Botany, The Maharaja Sayajirao University of Baroda, Vadodara).

2.2 Morphological Studies –

Detailed morphological study was carried out under dissecting binocular microscope. Different morphological (vegetative and floral) characters were observed. The morphological characters of each species were studied and 5-7 specimen of each species were observed for morphological studies. For the correct measurement of the spikelet and its parts a Stereo microscope was used. Spikelets have been studied preferably in fresh condition or if dried, after soaking in warm water. Most of the materials could be identified satisfactorily with the help of existing herbarium materials and available literature (Clayton & Renvoize 1986, Hooker 1894 & 1897, Cooke 1902-08 (Rept. Ed. 1958), Blatter & Mc Cann 1934 & 1935, Shah 1978, Cook 1996, Watson & Dallwitz 2002 onwards).

For inflorescence architectural studies, terminologies proposed by Vegetti (2003) for cyperaceae and Liu *et al.* (2005) and Vegetti (1999) for the poaceae with additional contributions as well as modifications taken into account. Literature survey was taken up subsequently and libraries of well-known botanical institutes were consulted. The difficulties and otherwise doubtful material, after formal examination was referred to experts in different herbaria within the country as well as abroad and determinations were confirmed or checked accordingly. Short tours were also undertaken to bridge the gaps in the desired material.

2.3 Foliar Epidermal Studies –

For micro morphological studies, the leaves from the middle of the culms were used throughout the preparation (Hilu & Randall 1984). The epidermal peels were taken out by the standard method and stained it with the saffranin and phenol to be mounted in glycerin (Johnston & Watson 1976). Observations were carried out with the help of compound microscope. Figures of observed characters were drawn as well as photographed using Leica DME research microscope using ×40 objective. Measurements of all the epidermal components were done by standard micrometry. Terminology and classification for the epidermal cells are followed after Metcalfe (1960, 1971).

Quantitative and qualitative results of micromorphological studies are summarized in a tabular format and presented in Chapter Result. Measurements for cell constituents have been given comprehensively, whenever the major difference were noticed it is indicated as L for lower/abaxial and U for upper/adaxial epidermises.

Compilation phase-

Information collected during 2.1-2.3 phase has been compiled during the concluding year and is presented in this work. After a detailed survey on sedges and grasses, present work records 182 species from Poaceae and 63 species of Cyperaceae. It is not possible to attempt any new classification of sedges and grasses on the basis of present observations of limited material and therefore, the best given by Goetghebour (1998) in the '*Genera Cyperaceum*' and Clayton & Renvoize (1989) in '*Genera Graminum*' has been adopted respectively. The IPNI system and available standard literature has been mainly followed for correcting nomenclature and the names used for them in Flora of India (Hooker, 1894 & 1897), The flora of the Presidency of Bombay (Cooke 1958), the Bombay grasses (Blatter & Mc Cann 1934 & 1935) and Flora of Gujarat (Shah 1978) has been cited.

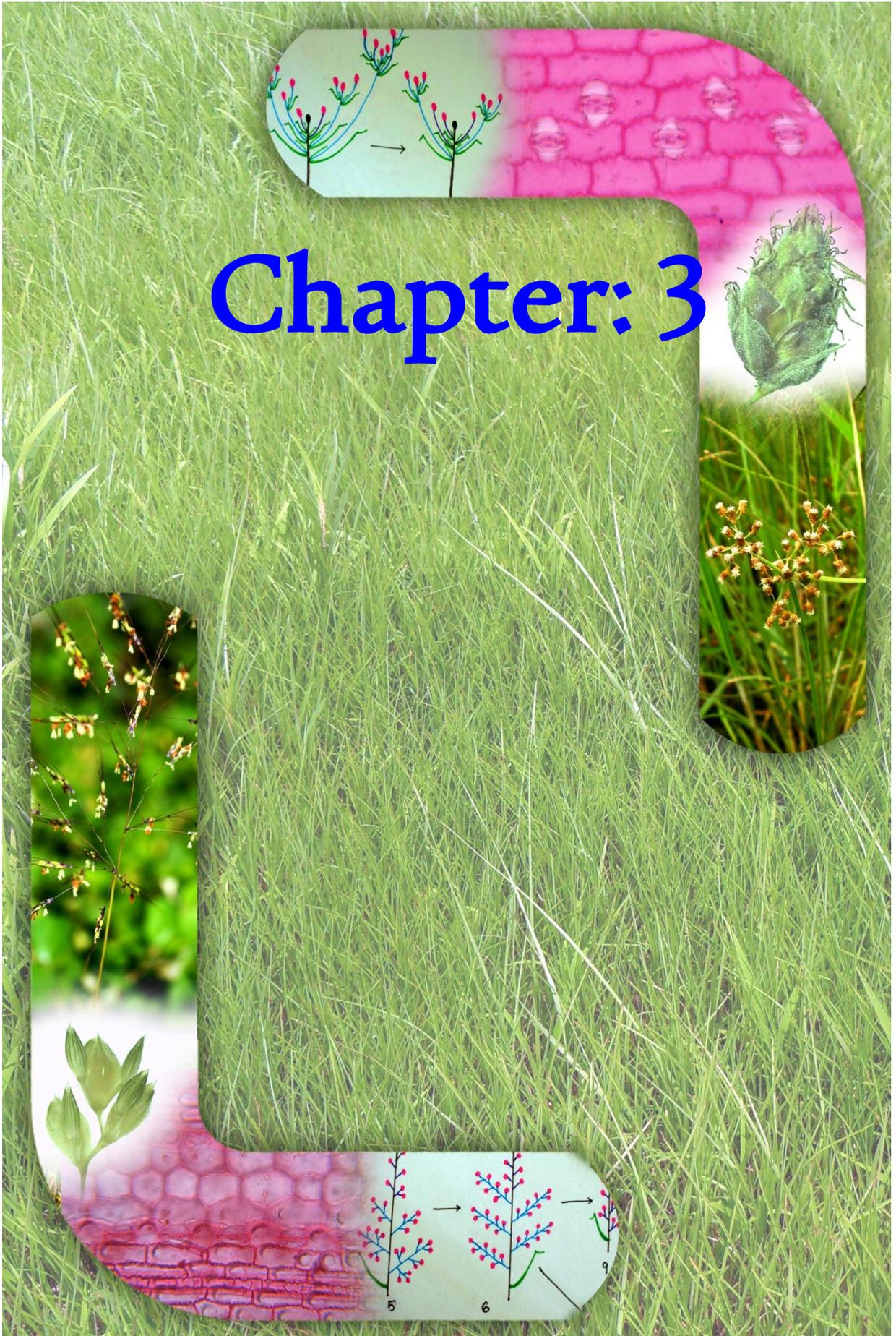
An attempt has been made to propose hypothetical evolutionary pathway for the grasses and sedges based on synflorescence architecture. Suitable keys are provided for all the tribes and genera described in the text after following Bor (1960) and Goetghebour (1998). After detailed observations of inflorescence architecture and micromorphological characters, artificial keys for genera and species have been prepared. Descriptions with line drawings of all the species has been purposely given to bring out the variability. Considering the growth habit, different individuals of the same species have been referred to annuals or perennials. The description is followed by ecological notes, phenology and finally by citation of the specimens deposited in BARO herbarium. The citation of the specimens has been done District wise. In nomenclatural notes, the critical remarks have been provided in order to bring out variations and other

controversial points. Due to nomenclatural changes of certain species, subspecies and varieties were merged into one another and it has been also cited after correct name, as it has been collected and studied but not has valid rank.

Latitudes, longitudes and altitudes of each surveyed localities are summarized in Appendix 1.

Occurrences of each taxa in different talukas of districts are provided in Appendix 2 & 3.

Chapter: 3



Detailed morphological study was carried out under dissecting binocular microscope. Different morphological (vegetative and floral) characters and variations were observed and recorded. The following morphological characters of each species were studied.

4.1 Family: Poaceae (R. Brown) Barnhart

4.1.1 General morphology

Habit: An annual or perennial herb, with stems radiating in all directions from a centre. The plant is fixed to the soil by a tuft of fibrous roots all springing from the bases of the stems. In addition to this crown of fibrous roots, there may be roots at the nodes of some of the prostrate or decumbent branches (Plate 7-A-B).

Culm: The stem consists of nodes and internodes. The internodes are cylindrical and somewhat flattened on the side towards the axillary bud. When young they are completely covered by the leaves and the older ones have only their lower portions covered by the leaf-sheaths. Plant height, pubescence of culms, texture of nodes and internodes were noticed. Branches grow upwards through the sheath and emerge at its mouth as aerial branches. Such branches are called intravaginal branches or stems. But, in some grasses axillary buds, instead of growing straight up through the sheath, pierce the leaf-sheath, come out and then they grow out as branches. Branches that pierce through the sheaths are called extravaginal branches. Nodes may be pale or coloured, glabrous, hairy or bearded with long hairs. Perennial grasses have creeping stems and stolons, while others may have rhizomes.

Leaf: At the base of shoots abortive leaves or rudimentary sheaths are occur called scales. The first leaf occurring in every branch on the side next to the main shoot and it is a two-keeled membranous structure resembling somewhat the palea found in the spikelets of grasses called the prophyll or prophyllum. The ordinary foliage leaves consists of the two parts, the leaf-sheath and the leaf-blade. At the junction of these two parts there is a very thin narrow membrane with fine hairs on its free margin. This is called the ligule. It is a distinct membrane narrow or broad, with an even, truncate or erose margin, or finely ciliate. Sometimes, in addition to the ligule, other appendages may also be present called an auricle. Just above the ligule and at the base of the leaf-blade there is a colourless narrow zone. This is called the collar. The leaf-sheath is attached at its base to the node and it is slightly swollen just above the place of insertion. It covers the internode, one margin being inside and the other outside. The surface of the sheath is glabrous or sparsely covered with long hairs springing from small tubercles. The outer margin of the sheath bears fine hairs all along its length. The leaf-blade is broadly lanceolate, linear, ovate or oblong. Its base is rounded, cuneate or cordate and the

margin wavy, especially so towards the base. On the margin towards the base long hairs are seen, and some of these arise from small tubercles. The margin has a hyaline border which is very minutely serrate. There is a distinct midrib and, on holding the leaf against the light, four or five small veins come in to view. In the spaces between these veins lie many fine veins. All the veins run parallel from the base to the apex. At the base of the blade the veins get into the leaf-sheath and therefore the sheath becomes striated.

Inflorescence: Inflorescences appear at the free ends of branches. Every branch sooner or later terminates in an inflorescence which is a compound raceme. Length, type, shape of inflorescence varies from species to species. It may be open, contracted, cylindrical or ovate. There are usually five or six racemes in the inflorescence. Main axis of the spikelet upon which the glumes and florets are distichously arranged is called Rachilla/Joints, which bears unilaterally two rows of bud-like bodies.

Spikelet: The bud-like bodies are the units of the inflorescence and they are called spikelets. Spikelet is the unit of inflorescence and depicts variations in rachilla, glumes, lemma, palea, lodicules, stamens and pistil. The spikelets are softly hairy or glabrous and are shortly stalked or sessile. The pedicels of spikelets are hairy and sometimes one or two long hairs are also found on them. Shape, size, pairing, pedicelled or sessile nature of spikelets was noticed (Plate 7-C-G).

Glumes: Each of the spikelets consists of two bracts, inserted just above one another and designated lower and upper glume. Shape, size, textures, nature, number of nerves of both the glume are used in species identification.

Lemma & Palea: Shape, length, width, texture, keeled or not keeled, number of nerves of lemma and palea were noticed. The lower lemma contains no flower in it, but occasionally there may be in its axil three stamens. In mature spikelets the grain which is free is enclosed by the upper lemma and its palea. The upper lemma is membranous when young, but later on it becomes thick, coriaceous and rugose at the surface. Just opposite to it there is a flat structure with two nerves, similar to the glume in texture. This is called the upper palea. The fourth glume and its palea adhere together by their margins.

Flower: Inside the fourth glume and between it and the palea there are three stamens and an ovary with two styles ending in feathery stigmas. Just in front of the ovary and outside the stamens two very small scale-like bodies are found. These are the lodicules. They are fleshy/membranous and well developed in flowers that are about to open. Number, size and colour of stamens, stigma and lodicules vary within/between the genera (Plate 7-G-H).

Fruit: Caryopsis (Plate 7-I)

4.1.2 Key for the Tribes and Genera

The purpose of a key is to enable identification, and it should not be a vehicle for expressing systematic opinions. First, good systematic characters are very often poor or even unusable key characters, and second, classifications are all too frequently subject to modification.

–Quicke

KEY TO TRIBES

1. Spikelets 1-many flowered, breaking up at maturity above the persistent glumes, or if falling entire then not 2-flowered with upper floret bisexual and the lower male or barren; spikelets usually laterally compressed or terete

2. Tall woody arborescent or shrubby bamboos; leaf-blades flat, lanceolate, many-nerved with transverse veins, usually with a petiole-like base and articulated with the sheath; lemmas several, 5-many nerved, awnless; lodicules usually 3.

Tribe BAMBUSEAE

2. Perennial or annual herbs with herbaceous culms; leaf-blades sessile and not articulated with the sheath

3. Ovary with a fleshy, hairy apical appendage, the styles arising from beneath it

Tribe TRITICEAE

3. Ovary without a fleshy hairy apical appendage; styles terminal

4. Spikelets containing 1 fertile floret (except *Tetrapogon*) with or without 1 or 2 male or barren florets below it or 1 or more above

5. Glumes very minute or suppressed

Tribe ORYZEAE

5. Glumes usually well-developed, or at least the upper; palea usually 2-nerved and hyaline; stamens 3 or fewer

6. Inflorescence of racemes or spikes, these solitary, digitate or scattered along an axis, rarely a dense ovoid, spike like panicle

Tribe CHLORIDEAE

6. Inflorescence a panicle, either open or contracted and spike-like

7. Spikelets 1-flowered

Tribe ARISTIDEAE

7. Spikelets 2-3-flowered (the two lower florets may be reduced to minute chaffy scales at the base of the Upper lemma)

Tribe ARUNDINELLEAE

4. Spikelets containing 2 or more fertile florets, rarely 1 but this succeeded by several sterile lemmas reduced to a clavate mass

8. Tall reed-like grasses with large plumose panicles

Tribe ARUNDINEAE

8. Slender grasses without large plumose panicles

9. Spikelets 2-flowered, both of the lemmas hardened or leathery **Tribe ISACHNEAE**

9. Spikelets nearly always 3- or more flowered; lemmas membranous

Tribe ERAGROSTIDEAE

1. Spikelets 2-flowered, falling entire at maturity, with the upper floret bisexual and the lower male or barren and in the latter case often much reduced; spikelet's usually dorsally compressed

10. Spikelets solitary, rarely paired with the spikelets all alike; glumes usually membranous, the lower mostly smaller or sometimes suppressed; upper lemma papery to polished and stony, usually awnless

Tribe PANICEAE

10. Spikelets typically paired with 1 sessile and the other pedicelled, those of each pair usually dissimilar (the pedicelled sometimes much reduced), rarely with the spikelets all alike; glumes as long as the spikelets and enclosing the florets, \pm rigid and firmer than the hyaline or membranous lemmas; upper lemma often with a geniculate awn

Tribe ANDROPOGONEAE

KEY TO GENERA

Tribe BAMBUSEAE Nees

Shrubs or trees, very rarely perennial herbs, arising from underground rhizomes; culms erect or sometimes climbing, 0.5-5 m high or rarely more, bearing sheaths with reduced blades. Leaf-blades flat, usually linear to oblong-lanceolate, many-nerved with transverse connections, mostly with a false petiole which is articulated with the sheath; ligule short, scarious. Inflorescence a panicle or raceme, the spikelets often aggregated into dense clusters. Spikelets all alike, 1-many flowered, usually disarticulating below the lemmas at maturity, the rachilla prolonged or not; glumes commonly 2, sometimes more and then grading indistinctly into lemmas, often with secondary spikelets in their axils from which a complex cluster is built up; lemmas resembling the glumes and exerted from them, awnless or rarely awned from the tip, 5-many-nerved, herbaceous to coriaceous; paleas 2-keeled, keel less or suppressed; lodicules usually 3; stamens usually 3 or 6 (rarely numerous), the filaments free or connate; stigmas 1-3. Found in forests and woodlands in tropical and warm temperate regions.

Some bamboos flower every year, but many flower gregariously in cycles of up to 60 years. Gregarious flowering is often associated with sporadic flowering of isolated culms in the intervening years, and is usually followed by the death of the plant.

1. Culms 20-25m tall, semisolid, basal nodes with short and stout roots, rachilla internodes very short, not disarticulating; spikelets in dense clusters along the panicle branches

Dendrocalamus Nees

1. Culms 25-35m tall, hollow, basal node with fibrous roots, rachilla internodes elongate, up to half the length of the lemma, promptly or tardily disarticulating; spikelets clustered or in an open compound leafy panicle; with thorny branches or shrubby
- Bambusa** Schreber

Tribe ORYZEAE Dumort.

Annual or perennial herbs, usually aquatic. Leaf-blades are linear or sometimes broad and falsely petiolate; ligule membranous. Inflorescences are of pedicelled spike-lets in open or contracted panicles. Spikelets all alike, bisexual, 1-flowered or 3-flowered with the 2 lower florets reduced to narrow glume-like lemmas, disarticulating above the glumes at maturity; glumes almost suppressed, often discernible as obscure lips at the tip of the pedicel; lemma chartaceous or coriaceous, \pm laterally flattened, 3-9-nerved, awnless or awned from the tip; palea similar in shape and texture to the lemma; lodicules 2, bilobed or entire; stamens usually 6. Found in tropical and warm temperate regions throughout the world.

1. Leaf-blades ovate-oblong with inflated sheaths; a floating grass

Hygroryza Nees

1. Leaf-blades linear, acute or acuminate; sheaths not inflated; aquatic grasses

Oryza L.

Tribe TRITICEAE Dumort.

Annual or perennial herbs. Leaf-blades linear, often with small auricles; ligule membranous. Inflorescence a spike, the spikelets or clusters of 2-3(-7) spikelets alternating on opposite sides of a tough or fragile rachis. Spikelets all alike or the lateral spikelets of a cluster shortly pedicelled and male or barren and much reduced, usually laterally compressed, 1-many-flowered; rachilla disarticulating below each floret, sometimes the spikelet and its supporting internode falling entire. but the rachilla and rachis tough in cultivated cereals; glumes persistent, well-developed, as long as or shorter than the spikelet, sometimes narrow and awn-like; lemmas coriaceous, 5-9-nerved, awnless or with a straight or curved awn from the tip; palea hyaline, as long as the lemma; lodicules 2; stamens 3; ovary with a hairy apical appendage. Found in temperate regions generally, including the main temperate cereals and many weeds of cultivation

Glumes and lemmas keeled on the back; caryopsis free between the lemma and palea (easily removed)

Triticum L.

Tribe ARUNDINEAE Dumort.

Perennials or rarely annuals, sometimes tall weeds or tussock grasses. Leaf-blades narrowly linear or setaceous, occasionally flat; ligule a short scarious membrane or a line of hairs. Inflorescence an open or contracted panicle, sometimes large and plumose. Spikelets bisexual or the uppermost reduced, rarely unisexual and dioecious, laterally compressed, 2-10-flowered; rachilla disarticulating beneath each floret, often produced and crowned with a rudimentary floret, sometimes long-villous; glumes persistent, hyaline to scarious or subherbaceous; lemmas membranous to coriaceous, 1-many-nerved, \pm hairy or occasionally long-villous, entire or 2-lobed, awnless or awned from the tip or sinus, the lobes also often aristate; awn geniculate with a twisted column, sometimes straight; palea hyaline, shorter than or nearly as long as the lemma; lodicules 2-3; stamens 2-3, often minute; stigmas 2. Cosmopolitan in distribution.

1. Ligule membranous; lemmas hairy all over the back; rachilla glabrous

Arundo Tourn. ex L.

1. Ligule a line of hairs; lemmas glabrous, rachilla long villous

Phragmites Adans.

Tribe ARISTIDEAE C. E. Hubbard

Annual or perennial herbs or occasionally suffrutices. Leaf-blades terete or linear; ligule a fringe of hairs. Inflorescence an open or contracted panicle. Spikelets all alike, bisexual, 1-flowered, disarticulating above the glumes at maturity, the rachilla not produced beyond the floret; glumes scarious, usually exceeding the lemma; lemma \pm indurated at maturity, terete and clasping the caryopsis, prolonged into a well-developed callus below, 1-3-nerved, the nerves converging upwards and produced into an awn; awn 3-branched (rarely the lateral branches absent), the branches sometimes separated from the lemma by a twisted column, articulated or not; palea much shorter than the lemma; lodicules 2 or 0; stamens 3 or 1. Found in tropics and subtropics, often in dry climates or on poor soils.

Awn 3-branched, central-branch glabrous

Aristida L.

Tribe ERAGROSTIDEAE Stapf

Annual or perennial herbs. Leaf-blades narrow; ligule ciliate or a ciliate membrane, rarely completely membranous. Inflorescence an open or contracted panicle, or of 1-sided spikes or racemes, these digitate or scattered along an axis, rarely solitary; rhachis tough. Spikelets all alike, 1-many-flowered with the upper-most florets reduced (rarely 1-flowered), usually

strongly laterally compressed, rarely terete; rhachilla usually disarticulating below each floret, but a variety of other modes of abscission also occur; glumes persistent or not, membranous to coriaceous, mostly shorter than the spikelet; lemmas membranous to cartilaginous, typically 3-nerved (sometimes multi-nerved), entire, emarginate or 2-lobed, awnless or awned from the tip; palea hyaline, usually falling with the lemma, sometimes persistent; lodicules 2; anthers 2-3. Found throughout the tropics.

1. Lemmas 5-9(multi)-nerved

Aeluropus Trin.

1. Lemmas 1-3-nerved

2. Spikelets 1-flowered, lemmas 1-nerved

Sporobolus R.Br.

2. Spikelets 2-many-flowered, lemmas typically 3-nerved

3. Lemmas usually entire at the apex, obtuse, acute or acuminate, sometimes mucronate, or if 2-toothed (*Acrachne*) then glabrous near the margins and along the side nerves

4. Glumes aristate or aristate-acuminate; spikelets sessile on the flattened branches of a narrow panicle, 2-3-flowered

Dinebra Jacq.

4. Glumes obtuse, acute or acuminate, rarely the upper awned but the spikelets then in digitate spikes (*Dactyloctenium*)

5. Internodes of the rachilla bearded at the tip with long hairs up to half the length of the lemma; spike-lets sub-sessile or shortly pedicelled on the erect branches of a contracted elongated panicle

Halopyrum Stapf

5. Internodes of the rachilla glabrous or only shortly hairy

6. Spikelets in open, contracted or spike-like panicles, rarely in solitary second spikes

7. Inflorescence a panicle or spike-like panicle

Eragrostis Wolf

7. Inflorescence a solitary spike

Eragrostiella Bor

6. Spikelets sessile or very shortly pedicelled, loosely to densely imbricate in digitate or racemosely arranged spikes or spike-like racemes, very rarely in solitary spikes

8. Axis of the spikes terminating with a sharp point; upper glume mucronate or awned; spikes digitate

Dactyloctenium Willd.

8. Axis and branches of the inflorescence ending in a spikelet

9. Spikelets falling entire at maturity from the axis of straight spikes, the latter numerous and crowded into a long narrow dense panicle; glumes 1-nerved

Desmostachya (Hook.f.) Stapf

9. Spikelets breaking up at maturity; spikes few to several

10. Spikes usually in pseudowhorls or scattered; lemmas with the lateral nerves running out into minute teeth and the middle nerve into a mucro or short awn

Acrachne Wright & Arn. ex Chiov.

10. Spikes digitate or subdigitate; lemmas entire **Eleusine** Gaertn.
3. Lemmas usually emarginate or 2-4-toothed or lobed at the apex, rarely entire but then hairy along the nerves, frequently mucronate or awned
11. Spikelets in panicles or in racemosely arranged spikes or spike-like racemes **Leptochloa** P. Beauv.
11. Spikelets in solitary terminal second spikes **Tripogon** Roem. & Schult.

Tribe CHLORIDEAE Dumort.

Annual or perennial herbs. Leaf-blades narrow, usually flat; ligule a fringe of hairs or membranous. Inflorescence of 1-sided spikes, these usually solitary, digitate or scattered along an axis, very rarely a dense spike-like panicle; rachis of the spike tough, rarely fragile or deciduous as a whole. Spikelets usually bisexual and all alike, 1-several-flowered but only 1 of the florets bisexual, usually disarticulating above the glumes at maturity, mostly laterally compressed; bisexual floret solitary, or with 1 or more male or barren florets above it, sometimes also with barren florets below; glumes herbaceous to hyaline, laterally compressed and often keeled, 1-3-nerved, sometimes awned, unequal or subequal, shorter than the floret or enclosing it, the lower glume adaxial; lemma membranous to chartaceous, 3-nerved (with few exceptions), the lateral nerves near the margin and often ciliate, entire, emarginate or 2-lobed, awned or awnless; palea hyaline, mostly shorter than the lemma; lodicules 2, rarely absent; stamens 3. Occur throughout the tropics.

1. Inflorescence of pedunculate groups of spikelets secund and distant on a tough solitary axis **Melanocenchris** Nees
1. Inflorescence not as above; spikelets densely biseriate, sessile
2. Spikelets 1-flowered, bisexual, usually without sterile florets above, sometimes a tiny vestigial floret present on the rachilla extension
3. Spikelets awnless **Cynodon** Rich.
3. Spikelets awned **Enteropogon** Nees
2. Spikelets obviously several-flowered, the lower 1-2 (-4) bisexual; rachilla produced and bearing 1-several empty lemmas
4. Fertile florets 2-4; spikes 1-3 **Tetrapogon** Desf.
4. Fertile floret solitary, rarely 2 or 3; spikes 4 or more **Chloris** O. Swartz

Tribe ZOYSIEAE Benth.

Annual or perennial herbs. Leaf-blades flat or convolute; ligule a line of hairs or a membranous rim. Inflorescence a many sided cylindrical spike or false spike, the spikelets single or in

clusters of 2-5, these often heteromorphous or with involucre glumes, the spikelets or the spikelet clusters (modified racemes) falling entire from the tough main axis at maturity. Spikelets bisexual, 1-flowered, without rudimentary florets, sometimes \pm reduced; glumes papyraceous to coriaceous, often asymmetrical, smooth or variously ornamented, awned or awnless, the upper as long as the spikelet, the lower often shorter or suppressed; lemma hyaline, 1-3-nerved, entire, awned or awnless; palea hyaline, usually a little shorter than the lemma; lodicules 2 or 0; stamens 2 or 3; stigmas 2. Found mostly in tropics.

- | | |
|---|----------------------|
| 1. Spikelets with slender awns | Perotis Ait. |
| 1. Spikelets without awns | |
| 2. Clusters of spikelets sessile; glumes with rows of hooked spines | Tragus Haller |
| 2. Clusters of spikelets pedunculate; glumes glabrous | Zoysia Willd. |

Tribe PANICEAE R. Br.

Annual or perennial herbs. Leaf-blades usually flat and linear to lanceolate; ligule membranous or a row of hairs, rarely absent. Inflorescence an open, contracted or spike-like panicle, or composed of racemes arranged digitately or racemosely, sometimes the spikelets subtended or surrounded by reduced bristle-like branches. Spikelets all alike, solitary or inconspicuously paired, mostly dorsally compressed, 2-flowered, falling entire at maturity, commonly. awnless; glumes membranous or herbaceous, the lower usually shorter than the upper and sometimes much reduced or absent; lower floret male or barren, the lemma similar to the upper glume; upper floret bisexual, the lemma and palea \pm indurated, sometimes mucronate, typically hard and shining like a little cowrie shell; lodicules usually 2; stamens 3.

Genera \pm 86; throughout the tropics, extending into warm temperate regions.

- | | |
|---|-----------------------------|
| 1. Spikelets not subtended by bristles | |
| 2. Inflorescence an open or spike-like panicle, occasionally condensed about the primary branches | Panicum L. |
| 2. Inflorescence consisting of 1-sided spikes or racemes, these either digitate or scattered along a central axis, rarely solitary; the racemes sometimes with short secondary branchlets or with the spikelets long-pedicelled and distant | |
| 3. Lower glume awned | Oplismenus P. Beauv. |
| 3. Lower glume at most with a short awn-point | |
| 4. Spikelet with a bead-like swelling at its base, formed from the swollen lowest rachilla-internode covered by the thin lower glume | Eriochloa Kunth |
| 4. Spikelet passing smoothly into the pedicel without a bead-like swelling | |

5. Upper lemma coriaceous to crustaceous, with narrow inrolled margins clasping only the edge of the palea

6. Lower glume absent

Paspalum L.

6. Lower glume present

7. Racemes 4-rowed, the spikelets in clusters of 2 or more; spikelets gibbously plano-convex, cuspidate to awned; upper lemma acute, muticous; upper palea acute **Echinochloa** P. Beauv.

7. Racemes mostly 1-2-rowed, the spikelets single or paired (rarely more)

8. Upper palea acute, its tip reflexed; lower glume turned away from the rachis

Paspalidium Stapf

8. Upper palea obtuse, its tips not reflexed

9. Spikelets disarticulating above the glumes, callus inconspicuous. Upper lemma chartaceous to cartilaginous, shiny, smooth, muticous **Moorochloa** Veldkamp

9. Spikelet disarticulating below the glumes, callus distinct. Upper lemma indurated, dull, coarsely to finely transversely rugose, apiculate to mucronate **Urochloa** P. Beauv.

5. Upper lemma chartaceous to cartilaginous

10. Upper lemma with narrow inrolled margins clasping the palea, its tip awned

Alloteropsis Presl

10. Upper lemma with thin flat margins covering most of the palea, awnless

Digitaria Hall.

1. Spikelets, or some of them, subtended by 1-many bristles or spines

11. Bristles persisting on the axis after the spikelets have fallen

Setaria P. Beauv.

11. Bristles or spines falling with the spikelets

12. Involucral bristles free throughout, ± filiform

Pennisetum Rich.

12. Involucral bristles flattened and connate below, commonly forming a cup

Cenchrus L.

Tribe ISACHNEAE Benth.

Annuals or perennials, usually with low herbaceous culms. Leaf-blades linear to lanceolate or ovate; ligule a line of hairs. Inflorescence a panicle, a raceme, or several racemes scattered along a central axis. Spikelets all alike, small, awnless, 2-flowered with the florets similar or dissimilar, the lower male or bisexual, the upper female or bisexual (very rarely 1-flowered, or with a third, barren floret); rhachilla disarticulating above the glumes and usually between the florets, the glumes persistent or, more often, deciduous soon after the florets have fallen; glumes equal, from half to as long as the spikelet, membranous, 3-9-nerved, rarely nerveless or 1-nerved; lemma firmly membranous to chartaceous or coriaceous, nerveless or obscurely 5-7-

nerved, the upper often smaller and firmer in texture than the lower; palea as long as the lemma or slightly shorter; lodicules 2; stamens 2-3. Found in tropics, principally in Asia.

Spikelet morphology recalls that of *Panicaceae*, and *Isachneae* may perhaps be regarded as a precursor of that tribe.

Upper lemma coriaceous, glumes deciduous

Isachne R.Br.

Tribe ARUNDINELLEAE Stapf.

Annual or perennial herbs. Leaf-blades linear or sometimes linear-lanceolate, usually flat; ligule very short, membranous to ciliate. Inflorescence a panicle, often large, the spikelets often associated in clusters of 3. Spikelets lanceolate, all alike, 2-flowered, the lower floret male or barren, the upper bisexual with an obtuse to pungent callus at the base, the rachilla disarticulating between the florets or beneath each floret; glumes persistent, usually unequal the upper exceeding the florets, membranous to coriaceous, often brown and beset with tubercle-based hairs; lower lemma similar to the glumes, 3-7-nerved, accompanied by a narrow palea; upper lemma \pm terete, smaller than the lower, firm in texture, 5-11-nerved, sometimes decorated with tufts of hair, 2-toothed at the tip, the teeth sometimes produced into bristles, awned from the sinus; awn geniculate with a twisted column, usually deciduous above the base and usually flattened in cross-section; palea-keels often winged; lodicules 2, cuneate; stamens 2-3. Found in tropics.

The tribe is allied to *Panicaceae*, as is suggested by the sexual dimorphism of the two florets, as well as by the leaf-anatomy. However, there are anatomical features which also suggest a relationship with *Arundineae*.

Lemma of upper floret glabrous or scabrid, minutely 2-lobed at the tip

Arundinella Raddi

Tribe ANDROPOGONEAE Dumort.

Annual or perennial herbs. Leaf-blades usually flat and linear; ligule scarious or membranous, a line of hairs or absent. Inflorescence composed of fragile (very rarely tough) racemes, these sometimes in a large panicle, but usually solitary, paired or digitate, terminating the culm or axillary and numerous, in the latter case each true inflorescence subtended by a modified leaf-sheath (spatheole) and often aggregated into a leafy false panicle. Racemes bearing the spikelets in pairs (rarely singly or in threes, but usually terminating in a triad), nearly always with one sessile and the other pedicelled, these sometimes alike but usually dissimilar, the sessile being bisexual and the pedicelled male or barren (very rarely the sexes reversed), rarely the spikelets unisexual with the sexes in separate parts of the same inflorescence or in different inflorescences; occasionally with 1 or more of the lowermost pairs in a raceme (homogamous

pairs) alike, infertile and persistent for some time after the other spikelets have fallen. Sessile spikelet 2-flowered, falling entire at maturity with adjacent internode and pedicel (the pedicelled spikelet usually falling separately); glumes usually as long as the spikelet and \pm hardened, the lower very variable in shape and ornamentation, the upper usually boat-shaped and fitting between the internode and pedicel; lower floret male or barren, the lemma membranous or hyaline and awnless, the palea usually suppressed if floret barren; upper floret bisexual (rarely male or female), with or without a spirally twisted and geniculate awn from the membranous or hyaline lemma; palea shorter than the lemma, frequently absent; lodicules 2; stamens mostly 3; stigmas 2. Pedicelled spikelet sometimes similar to the sessile, but commonly male or barren, awnless, and smaller or even vestigial (though occasionally large and colorful); rarely the pedicel absent or fused to the internode. Found throughout the tropics, extending into warm temperate regions.

1. Spikelets solitary; rachis filiform, not jointed **Dimeria** R.Br.
1. Spikelets in pairs, rarely in threes; one sessile and other pedicelled
2. Spikelets all bisexual or one bisexual spikelet paired with a male or barren one
3. Pedicels and rachis internodes slender, filiform or linear, rarely thickened upwards but then with the upper lemma awned
4. Spikelets of each pair alike, at least one of them pedicelled
5. Spikelets in \pm ample panicles or compound racemes arranged along a central axis
6. Panicle spike-like, silvery, not obviously composed of racemes **Imperata** Cyr.
6. Panicle open or contracted, if racemose the component racemes distinct
7. Rachis of racemes fragile; one spikelet of a pair sessile **Saccharum** L.
7. Rachis of racemes tough, not breaking up; both spikelets of a pair Pedicelled **Spodiopogon** Trin.
5. Spikelets in racemes, these solitary or several, the latter digitate or subdigitate
8. Raceme solitary
9. Lower glume broadly truncate; pedicelled spikelet much reduced **Apocopsis** Nees
9. Lower glume not truncate, pedicelled spikelet developed **Pogonatherum** P. Beauv.
8. Racemes 2 or more **Eulalia** Kunth
4. Spikelets of each pair different, sometimes the pedicelled much reduced or rarely suppressed but then the spikelets all alike
10. Racemes arranged in a panicle with its common axis longer than the lowest raceme, not supported by spathes

11. Sessile spikelets dorsally compressed
12. Pedicels and rachis internodes with a translucent or balsamiferous median line; racemes of 1-2(-8) Sessile spikelets **Capillipedium** Stapf
12. Pedicels and rachis internodes solid **Sorghum** Moench
11. Sessile spikelets laterally compressed or terete **Chrysopogon** Trin.
10. Racemes solitary, paired or subdigitate, often supported by spathes
13. Upper lemma awned from low down on the back **Arthraxon** P. Beauv.
13. Upper lemma awned from the tip or the sinus of the 2-toothed tip, rarely awnless
14. Awn from the tip of the narrow Upper lemma, or if lemma awnless then racemes with an involucre composed of 2 homogamous pairs of spikelets
15. Racemes composed of many pairs of spikelets, spikelets closely imbricating
16. Callus pungent **Heteropogon** Pers.
16. Callus obtuse
17. Pedicels and rachis internodes with a translucent **Bothriochloa** Kuntze
17. Pedicels and rachis internodes solid **Dichanthium** Willemet
15. Racemes composed of 1-4 sessile spikelets, spikelets loose
18. Raceme 2 homogamous pairs of spikelets forming an involucre
19. Homogamous spikelets all pedicelled; sessile spikelet solitary (rarely a second present) with 2 pedicelled spikelets; raceme deciduous below the homogamous spikelets, these and the sessile spikelets falling as a unit **Iseilema** Anders.
19. Homogamous spikelets sessile, persistent; sessile spikelets 1-4, each with its pedicelled attendant, the sessile spikelets separately deciduous **Themeda** Forssk.
18. Raceme without involucre spikelets **Pseudanthistiria** (Hack.) Hooker f.
14. Awn from the sinus of the 2-toothed Upper lemma, or if lemma awnless then racemes reduced to 3 heteromorphous spikelets enclosed in a boat-shaped spathe
20. Racemes 1-noded, reduced to three heteromorphous spikelets enclosed in a boat-shaped spathe **Apluda** L.
20. Racemes many-noded, not contained in a boat-shaped spathe
21. Lower floret of sessile spikelet male or with a well-developed palea
22. Racemes paired or digitate, rarely solitary but then the upper glume awnless **Ischaemum** L.
22. Racemes solitary; glumes conspicuously winged, the upper awned
23. Ligule a row of hairs, Glumes without tufts of hairs **Sehima** Forssk.
23. Ligule membranous, lower glume two and upper with a tuft of hairs **Triplopogon** Bor

21. Lower floret of sessile spikelet barren and reduced to a lemma
24. Racemes deflexed at maturity; leaves aromatic **Cymbopogon** Spreng.
24. Racemes not deflexed; leaves not aromatic **Andropogon** L.
3. Pedicels and rachis internodes stout, 3-angled, rounded or flattened and thickening upwards; upper lemma awnless
25. Spikelets similar, rachis tough **Hemarthria** R. Br.
25. Spikelets dissimilar, rachis breaking up
26. Spikelets solitary, sessile, the pedicelled suppressed or rudimentary **Ophiuros** Gaertn. f.
26. Spikelets paired, one sessile and other pedicelled
27. Sessile spikelet broadly winged on keels of lower glume **Glyphochloa** W. D. Clayton
27. Sessile spikelets not winged, if winged narrowly at apex only
28. Pedicels distinct; Lower glume of sessile spikelet rough **Mnesithea** Kunth
28. Pedicels fused to the internodes, rarely wanting; Lower glume of sessile spikelet smooth **Rottboellia** L.f.
2. Spikelets unisexual, the sexes in separate inflorescences or in different parts of the same inflorescence
29. Male and female spikelets in separate inflorescence **Zea** L.
29. Male and female spikelets in different parts of the same inflorescence
30. Female spikelets completely enclosed in a metamorphosed leaf-sheath (cupule) which takes the form of a spherical or cylindrical osseous or ivory bead-like structure **Coix** L.
30. Female spikelets not enclosed in a cupule as above
31. Lower glume of the female spikelet 3-lobed **Trilobachne** Schenk ex Henrard
31. Lower glume of the female spikelet not lobed, 2-3 toothed **Chionachne** R.Br.

Legends for plates 8-189:

- LG: Lower Glume
- UG: Upper Glume
- LL: Lower Lemma
- L1: Lemma of First floret (L2, L3...)
- P1: Palea of First floret (P2, P3...)
- LP: Lower Palea
- UP: Upper Palea
- Lo: Lodicules
- G: Gynoecium
- S: Stamens

The literature on species concepts is vast, dispersed, and varied. The only thing generally agreed upon is that variation in phenetic parameters is not continuous and that character states are not combined randomly. . . . Most practicing taxonomists take for granted that species can be recognized by inspection, though inspection sometimes has to be extremely close.

– Andersson

4.1.3 Description of Species studied

1. **Dendrocalamus strictus** (Roxb.) Nees in *Linnaea* 9: 476. 1835; *Hooker f.* 7:404. 1897; *Blatt. & McC.* 285. 1935; *Cooke* 3:572. 1958; *Bor* 487. 1960; *Shah* 2:809. 1978; *Karthik. et al.* 276. 1989; *Pandey in Shetty & Singh* 3:1014. 1993; *Lakshmi. in Sharma et al.* 449. 1996; *Roy in Singh et al.* 403. 2001.

Perennial; caespitose. Rhizomes short. Culms erect; up to 20 m long; 2.5–7.5 cm diam.; woody; without nodal roots, or with prop roots. Culm-internodes terete; solid; 30–45 cm long. Culm-nodes swollen. Lateral branches dendroid. Branches many; with one branch dominant; thinner than stem. Culm-sheaths deciduous, 10–20 cm long, coriaceous, hispid, hairy throughout, with dark brown hairs, auriculate, ciliate on shoulders. Culm-sheath blade lanceolate; acuminate. Ligule an eciliate membrane. Leaf-blade base with a brief petiole-like connection to sheath. Leaf-blades linear or lanceolate; 2.5–25×2–5 cm; with distinct cross veins; scabrous; rough adaxially, pubescent abaxially or on both sides, margins scabrous. Leaf-blade apex acuminate. Synflorescence bractiferous, clustered at the nodes, in globose clusters, 1.5–4 cm long, dense, with glumaceous subtending bracts, with axillary buds at base of spikelet, prophyllate below lateral spikelets, leafless between clusters. Fertile spikelets sessile, comprising 2–3 fertile florets; without rachilla extension. Spikelets lanceolate; laterally compressed; 10–13 mm long; breaking up at maturity; disarticulating below each fertile floret. Rachilla internodes suppressed between florets. Glumes persistent; similar; shorter than spikelet. Lower glume ovate; chartaceous; without keels, acuminate, 5–6×3–3.5 mm. Upper glume ovate; chartaceous; without keels, acuminate, 7.5–8×3.5–4 mm. Fertile florets increasing in size upwards. Upper lemma ovate; 9–10×6–7 mm long, 9–11-veined, chartaceous, without keel, acuminate, awned. Principal lemma awn pungent; 2 mm long overall. Palea ovate; 8.5–9×2–2.5 mm, chartaceous, 4–6-veined, 2-keeled, keels ciliate. Lodicules absent. Anthers 6, 5 mm long, filament 8–9 mm long. Stigmas 1. Ovary umbonate; pubescent on apex.

Plate 8.

Flowering & Fruiting: November–March.

Habitat: Throughout, escape from gardens

Distribution: Africa, eastern Asia, India, Indo-China, and Malesia. INDIA: Throughout on drier hills. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 484, 496, 492

2. **Bambusa bambos** (L.) Voss in *Vilm. Blumengärtn. ed. 3 1: 1189. 1895*; *B. arundinacea* Willd. in *Sp. Pl. 2: 245 1799*; *Hooker f. 7:395. 1897*; *Blatt. & McC. 283. 1935*; *Cooke 3:569. 1958*; *Karthik. et al. 274. 1989*; *Shah 2:787. 1978*; *Pandey in Shetty & Singh 3:984. 1993*; *Lakshmi. in Sharma et al. 412. 1996*; *Roy in Singh et al. 373. 2001*.

Perennial; caespitose. Rhizomes short. Culms erect; 20–30 m long; 10–15 cm diam.; woody; with root thorns from the nodes. Culm-internodes terete, glaucous, distally pruinose. Culm-nodes pubescent, hairs brown. Lateral branches dendroid. Branch complement one-three, in a clump, with 1 branch dominant, thinner than stem. Culm-sheaths deciduous, glabrous. Culm-sheath ligule 1–2 mm high, ciliolate. Culm-sheath blade triangular, erect, hispid, acute. Leaf-sheaths glabrous, outer margin hairy. Leaf-sheath oral hairs setose, pale, 4–6 mm long, auricles erect. Ligule an eciliate membrane. Leaf-blade lanceolate, 7–18 × 1–2 cm, base broadly rounded, with a brief petiole-like connection to sheath, petiole 0.3–0.5 cm long, apex acuminate. Synflorescence not seen. **Plate 9.**

Flowering & Fruiting: January - April.

Habitat: In moist deciduous forests; escape from gardens

Distribution: western Indian ocean, India, Indo-China, Malesia, Mesoamericana and northern South America. INDIA: Throughout the plains & low hills. S. GUJARAT: Dangs & Tapi.

3. **Hygroryza aristata** (Retz.) Nees ex Wight & Arn. in *Edinburgh New Philos. J. 15: 380. 1833*; *Hooker f. 7:95. 1897*; *Blatt. & McC. 27. 1935*; *Cooke 3:563. 1958*; *Bor 597. 1960*; *Shah 2:833. 1978*; *Karthik. et al. 228. 1989*; *Pandey in Shetty & Singh 3:1061. 1993*; *Lakshmi. in Sharma et al. 449. 1996*; *Roy in Singh et al. 450. 2001*.

Perennial. Stolons present. Culms prostrate; 5–20 cm long; spongy; rooting from lower nodes. Leaf-sheaths inflated; longer than adjacent culm internode. Ligule an eciliate membrane. Leaf-blades floating; elliptic or oblong or ovate; base cordate 2.5–5 × 1–1.5 cm. Synflorescence a panicle. Panicle open; pyramidal; 3–5 cm long. 1° panicle branches whorled at lower nodes. Spikelets solitary; all fertile, pedicelled, comprising 1 fertile florets, without rachilla extension. Spikelets lanceolate; laterally compressed; 6–8 mm long; falling entire. Floret callus elongated; 2–10 mm long. Glumes both absent or obscure. Upper lemma linear, 7–8 × 3–4 mm, chartaceous, keeled; 5 -veined, midvein ciliate, margins ciliate, apex acuminate; awned; 1 -awned. Principal lemma awn 5–15 mm long overall. Palea lanceolate, 7–8 × 2.5–3 mm, chartaceous, 5 -veined, 1-keeled, keels ciliate. Lodicules 2. Anthers 6, 5mm long; ovary minute, style and stigma 20 mm long overall. **Plate 10.**

Flowering & Fruiting: September-December.

Habitat: In Ponds

Distribution: China, eastern Asia, India and Indo-China. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 19, 321, 672

4. **Oryza glaberrima** Steud. in *Syn. Pl. Glumac. 1: 3* 1853; *Bor 604*. 1960; Karthik. *et al.* 241. 1989; *Roy in Singh et al.* 474. 2001.

Annual. Culms erect, or geniculately ascending; 90–150 cm long. Leaf-sheaths glabrous. Ligule an eciliate membrane; 1.5–2 mm long; truncate. Leaf-blades 20–30×1–1.5 cm wide. Leaf-blade apex acute. Synflorescence a panicle. Panicle open; linear; equilateral, or nodding. 15–25 cm long. 1° panicle branches appressed, or ascending. Panicle branches angular; scaberulous. Spikelets solitary, all fertile, pedicelled. Pedicels linear, angular, scaberulous, tip cupuliform; bibracteate. Fertile Spikelets comprising basal sterile florets; 1 fertile florets; without rachilla extension. Spikelets elliptic or oblong; laterally compressed; 6–7 mm long; persistent on plant. Spikelet callus glabrous. Glumes both absent or obscure. Basal sterile florets similar; barren; without significant palea. Lemma of lower sterile floret lanceolate; 2–4 mm long; 2-2.5×0.8-1 mm, membranous, 1 -veined; without lateral veins; acute. Lemma of upper sterile floret lanceolate, 2-2.5×0.8-1 mm, membranous. Upper lemma elliptic, laterally compressed, 6-7×3.5-4 mm, coriaceous, keeled, 5 -veined, midvein ciliate, margins involute, apex muticous. Palea elliptic, 6-7×3-3.5 mm, coriaceous, 3 -veined, 1-keeled, keels smooth, acute. Lodicules 2; membranous. Anthers 6, 3 mm long. Ovary 2 mm long, style & stigmas 2 mm long overall. **Plate 11.**

Flowering & Fruiting: August-October.

Habitat: Cultivated in agricultural fields.

Distribution: West-central tropical Africa & China. INDIA: Introduced. S. GUJARAT: Valsad, Dangs. **New records for the State.**

Voucher specimen: RJD/ 395, 722, 735, 802

5. **Oryza latifolia** Desv. in *J. Bot. Agric. 1: 77*. 1813; *Hooker f. 7:92*. 1897; *Bor 605*. 1960; Karthik. *et al.* 241. 1989; *Lakshmi. in Sharma et al.* 545. 1996.

Perennial. Rhizomes short. Culms erect; 1–3 m long. Culm-nodes glabrous. Leaf-sheaths 20–50 cm long; smooth. Ligule an eciliate membrane; 1–7 mm long; obtuse. Leaf-blades lanceolate; 25–72×1–4 cm. Synflorescence a panicle. Panicle open; oblong; 20–50 cm long; contracted about 1° branches. 1° panicle branches whorled at most nodes; 14–25 cm long. Panicle branches angular. Spikelets appressed; solitary, all fertile, pedicelled. Pedicels linear; angular; 1–6 mm long; tip cupuliform and lobed. Fertile Spikelets comprising 2 basal sterile florets; 1 fertile florets; without rachilla extension. Spikelets oblong; laterally compressed; 5–9 mm long; 2.5–2.8 mm wide; falling entire. Spikelet callus glabrous; base truncate. Glumes both absent or obscure. Basal sterile florets similar; barren; without significant palea. Lemma of lower sterile floret linear, 1.5-1.7×0.5-0.8 mm, 1 -veined. Lemma of upper sterile floret linear, 1.7-2×0.5-0.8 mm. Upper lemma oblong; laterally compressed, 5-6×4-4.5 mm, coriaceous, keeled, 5 -veined, midvein spinulose, granulose, margins interlocking with palea margins, apex muticose to awned; awn 1–5 mm long overall. Palea elliptic, coriaceous, 3 -veined, 1-keeled, keels spinulose, granular, acute, 4-4.5×2-2.5 mm. Lodicules 2; membranous. Anthers 6; 3.5–4 mm long. Ovary 1mm long, style short, Stigmas 2. **Plate 12.**

Flowering & Fruiting: August-November.

Habitat: Field margins.

Distribution: Mexico. South America. South Asia. INDIA: Introduced. S. GUJARAT: Valsad
New records for the State.

Voucher specimen: RJD/ 73, 106, 736

6. **Oryza rufipogon** Griff. in *Not. Pl. Asiat.* 3: 5. 1851; *Bor* 605. 1960; Karthik. *et al.* 241. 1989; *Oryza nivara* Sharma & Shashtri in *Ind. J. Genetics & Pl. Breeding* 25(2):161. 1965; *Shah* 2:845. 1978; Karthik. *et al. op. cit.* 241; Pandey in Shetty & Singh 3:1079. 1993; Lakshmi. in Sharma *et al.* 545. 1996; Roy in Singh *et al.* 457. 2001.

Perennial. Rhizomes elongated; spongy. Culms geniculately ascending, or decumbent; up to 1 m long; spongy. Leaf-sheaths smooth; glabrous on surface. Leaf-sheath auricles erect. Ligule an eciliate membrane; 1.5 cm long; lacerate. Leaf-blades 20–40×0.5–1 cm; scabrous. Synflorescence a panicle. Panicle open; linear; nodding; 10–20 cm long. 1° panicle branches appressed; simple. Panicle branches scabrous. Spikelets appressed; solitary, all fertile, pedicelled. Pedicels linear; angular; tip cupuliform. Fertile spikelets comprising 2 basal sterile florets; 1 fertile florets; without rachilla extension. Spikelets oblong; laterally compressed; 8–10×2–2.5 mm; falling entire. Rachilla internodes elongated below proximal fertile floret. Rachilla elongation stout; 0.5 mm long. Glumes both absent or obscure. Basal sterile florets similar; barren; without significant palea. Lemma of lower sterile floret linear or oblong, 2–2.5×0.5–0.8 mm, 1 –veined, without lateral veins. Lemma of upper sterile floret linear or oblong 2.5–3×0.5–0.8 mm. Upper lemma oblong; laterally compressed; 8–10×2.5–3 mm, coriaceous, keeled, 5 –veined, midvein spinulose, scaberulous- reticulate, margins interlocking with palea margins, apex awned; 1 -awned. Principal lemma awn 60–90 mm long overall; limb scabrous. Palea elliptic, 7–9×1.5–2 mm, coriaceous, 3 –veined, 1-keeled, scabrous, apex acute-muticous, or awned; awns 0–6 mm long. Lodicules 2; membranous. Anthers 6; 5 mm long. Ovary 1mm long, style & stigmas 4 mm long overall. **Plate 13.**

Flowering & Fruiting: July-October.

Habitat: In seasonal waterbodies.

Distribution: China, eastern Asia, Asia-tropical, Australia, South America. INDIA: Cultivated throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 11, 38, 658

7. **Oryza sativa** L. in *Sp. Pl.* 333 1753; *Hooker f. f.* 7:92. 1897; *Blatt. & McC.* 274. 1935; *Cooke* 3:565. 1958; *Bor* 605. 1960; *Shah* 2:845. 1978; Karthik. *et al.* 241. 1989; Pandey in Shetty & Singh 3:1140. 1993; Lakshmi. in Sharma *et al.* 545. 1996; Roy in Singh *et al.* 475. 2001.

Annual. Culms erect, or geniculately ascending; 45–180 cm long; 3–20 -noded. Leaf-sheaths smooth; glabrous on surface. Leaf-sheath auricled. Ligule an eciliate membrane; 1.5–3 cm long; entire, or lacerate; acute. Leaf-blades 10–60×0.5–2 cm; scaberulous; margins scabrous, acute. Synflorescence a panicle. Panicle open; lanceolate; equilateral, or nodding; 20–50 cm long. 1° branches appressed, or ascending, or spreading, angular, scaberulous. Spikelets solitary, all fertile, pedicelled. Pedicels linear; angular; 2–4 mm long; scaberulous; tip

cupuliform; bibracteate. Fertile Spikelets comprising 2 basal sterile florets; 1 fertile florets; without rachilla extension. Spikelets elliptic, or oblong; laterally compressed; 8–11×2.5–3.5 mm; persistent. Spikelet callus glabrous; base truncate; attached obliquely. Glumes both absent or obscure. Basal sterile florets similar; barren; without significant palea. Lemma of lower sterile floret lanceolate, 3-3.5×1-1.5 mm, membranous, without lateral veins, emarginate. Lemma of upper sterile floret lanceolate, 2.5-3×0.8-1 mm, membranous. Upper lemma elliptic; laterally compressed; 7-9×3.5-4 mm, coriaceous, keeled, 5 –veined, midvein ciliate, hairy above, glabrous-hispid, margins involute, apex rostrate; muticous, or awned; 1 -awned. Principal lemma awn 0–80 mm long overall, limb scabrous. Palea elliptic, 6-7×2-3 mm, coriaceous, 3-veined, 1-keeled, keels scabrous, apex acute. Lodicules 2; membranous. Anthers 6; 5 mm long. Ovary 1mm long, style & stigmas 4 mm long overall. **Plate 14.**

Flowering & Fruiting: Throughout the year.

Habitat: Cultivated in agricultural fields.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Cultivated throughout. S. GUJARAT: Cultivated throughout.

Voucher specimen: RJD/ 30, 43, 720

8. **Triticum aestivum** L. in *Sp. Pl.* 85 1753; *Blatt. & McC.* 279. 1935; *Bor* 679. 1960; *Shah* 2:880. 1978; *Pandey in Shetty & Singh* 3:1140. 1993; *Lakshmi. in Sharma et al.* 634. 1996; *Roy in Singh et al.* 541. 2001; *T. vulgare* Vill. in *Hist. Pl. Dauph.* 2: 153. 1787; *Hooker f.* 7:367. 1897; *T. sativum* Lam. in *Fl. Franc.* 3:625. 1778; *Cooke* 3:574. 1958.

Annual; caespitose. Culms 60–100 cm long. Nodes glabrous. Leaf-sheaths glabrous-pubescent. Leaf-sheath oral hairs ciliate, auricles falcate. Ligule an eciliate membrane; 1 mm long. Leaf-blades 8–50×1–1.5 cm; pubescent. Synflorescence composed of racemes. Racemes 1; single; linear; bilateral; 5–18 cm long. Rachis tough; flattened; ciliate on margins, internodes 2–3 mm long. Spikelet packing broadside to rachis, ascending; solitary. Fertile spikelets sessile, comprising 2–4 fertile florets, with rudimentary florets at the apex. Rachilla internodes 1–1.2 mm long. Spikelets ovate, laterally compressed, 10–15×9–18 mm, persistent. Glumes similar, shorter than spikelet. Lower glume ovate, 7-10×3-4 mm, coriaceous, keeled above, winged on keel; 5–7 –veined, glabrous, apex muticous. Upper glume ovate, 6-8×3-4 mm, 2-keeled, 5–9 –veined, lateral veins divergent at apex, glabrous, apex with a unilateral tooth. Upper lemma ovate, 8-12×3-4 mm, chartaceous, keeled above, 7–9 –veined, apex muticous or awned; 1 -awned. Principal lemma awn 10–100 mm long overall. Palea 2 –veined, keels winged, ciliolate, 8-10×3-5 mm. Apical sterile florets resembling fertile though underdeveloped. Anthers 3, 1 mm long. Ovary with a fleshy appendage below style insertion; pubescent on apex. **Plate 15.**

Flowering & Fruiting: Throughout the year.

Habitat: Cultivated in agricultural fields.

Distribution: Europe, Africa tropical, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Cultivated throughout. S. GUJARAT: Cultivated throughout.

Voucher specimen: RJD/ 514, 555, 591

9. **Arundo donax** L. in *Sp. Pl.* 81 1753; *Hooker f.* 7:302. 1897; *Blatt. & McC.* 204. 1935; *Cooke* 3:574. 1958; *Bor* 413. 1960; *Shah* 2:787. 1978; *Karthik. et al.* 187. 1989; *Pandey in Shetty & Singh* 3:982. 1993; *Lakshmi. in Sharma et al.* 411. 1996; *Roy in Singh et al.* 371. 2001.

Perennial. Rhizomes elongated. Culms erect; reed-like; 1–5 m long. Leaves cauline. Ligule a ciliolate membrane. Leaf-blades drooping; 30–90 × 1–10 cm, smooth, attenuate. Synflorescence a panicle, contracted, oblong, up to 1m long. 1° panicle branches profusely branched, scaberulous. Spikelets solitary, fertile, pedicelled, comprising 2–4 fertile florets; with a barren rachilla extension. Spikelets cuneate, laterally compressed, 10–18 mm long; breaking up at maturity; disarticulating below each fertile floret. Floret callus pilose; obtuse. Glumes persistent, similar, reaching apex of florets. Lower glume lanceolate, 12–17 × 2–2.5 mm, membranous, 1-keeled, 3–5 -veined, apex acute. Upper glume lanceolate; 10–15 × 1.5–2 mm, membranous; 1-keeled, 3–5-veined, apex acute. Upper lemma lanceolate, 3–9 × 1.5–2.5 mm, membranous, without keel; 3 -veined, surface villous, hairy below, hairs 5–8 mm long, apex acute-acuminate; muticous, or mucronate; mucro up to 2mm long. Palea 0.5 × 0.7 mm, 2-veined. Palea keels ciliolate. Lodicules 2. Anthers 3; 3–5 mm long. Ovary, style & stigmas 5 mm long overall. **Plate 16.**

Flowering & Fruiting: November-January.

Habitat: In waterlogged areas.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Surat.

Voucher specimen: RJD/ 178, 386, 737

10. **Phragmites australis** (Cav.) Trin. ex Steud. in *Nomencl. Bot. ed. 2, 2: 324. 1841*; *Karthik. et al.* 247. 1989; *P. communis* Trin. in *Fund. Agrost.* 134. 1820; *Hooker f.* 7:303. 1897; *Cooke* 3:569. 1958; *Bor* 416. 1960; *Pandey in Shetty & Singh* 3:1097. 1993.

Perennial. Rhizomes elongated. Culms erect; reed-like; 1–6 m long. Leaves cauline. Leaf-sheaths loose. Ligule a ciliate membrane. Leaf-blades deciduous; 20–60 × 8–32 cm; glabrous, attenuate, filiform. Synflorescence a panicle; bearing juvenile spikelets at emergence. Panicle open; oblong; dense; 10–60 × 5–18 cm. 1° panicle branches profusely branched; bearing spikelets almost to the base. Spikelets solitary, fertile, Pedicelled; pedicels filiform. Fertile spikelets comprising 1 basal sterile & 3–7 fertile florets; with diminished florets at the apex. Spikelets cuneate; laterally compressed; 12–18 mm long; breaking up at maturity; disarticulating below each fertile floret. Floret callus elongated; 1–1.25 mm long; bearded; hairs 8–10 mm long. Glumes persistent, similar, shorter than spikelet, gaping. Lower glume lanceolate; 4–5 × 0.8–1 mm, membranous, without keels, 3–5 -veined, apex acute. Upper glume lanceolate; 6–8 × 0.8–1 mm, membranous, without keels, 3–5 -veined, apex acute-muticous.

Basal sterile florets male or barren, with palea, persistent. Lemma of lower sterile floret similar to Upper lemma; lanceolate; 10-11×1-1.5 mm, membranous; 3–5-veined, acuminate. Upper lemma lanceolate, 10-12×1-1.5 mm, membranous, without keel, 1–3 –veined, acuminate. Palea 4-5×1.5-2 mm, 2 –veined, keels scaberulous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2. Anthers 3, 2 mm long. Ovary 0.7-0.9 mm long, style & stigmas 2-2.5 mm long overall. **Plate 17.**

Flowering & Fruiting: December - March.

Habitat: Common along the river banks.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, North America, South America. INDIA: North-West India & C. Himalaya. S. GUJARAT: Surat, Tapi, Navsari. **New records for the State.**

Voucher specimen: RJD/ 75, 282, 476

11. **Phragmites karka** (Retz.) Trin. ex Steud. in *Nomencl. Bot. ed. 2, 2: 324 1841*; *Hooker f. 7:304. 1897*; *Blatt. & McC. 202. 1935*; *Cooke 3:527. 1958*; *Bor 416. 1960*; *Shah 2:857. 1978*; *Karthik. et al. 247. 1989*; *Pandey in Shetty & Singh 3:1098. 1993*; *Roy in Singh et al. 496. 2001*; *P. vallatorius* (Pluk. ex L.) Veldkamp in *Blumea 37: 233. 1992*; *Lakshmi. in Sharma et al. 569. 1996.*

Perennial. Rhizomes elongated. Culms erect; reed-like; 2–10 m long. Leaves cauline. Leaf-sheaths loose. Ligule a ciliate membrane. Leaf-blades deciduous; 30–80×1–4 cm; scaberulous; rough abaxially, attenuate; hardened. Synflorescence a panicle; bearing juvenile spikelets at emergence. Panicle open; oblong; dense; 30–50×10–20 cm. 1° panicle branches profusely branched; naked below. Spikelets solitary, fertile, pedicelled. Pedicels filiform. Fertile Spikelets comprising 1 basal sterile & 2–5 fertile florets; with diminished florets at the apex. Spikelets cuneate; laterally compressed; 9–12 mm long; breaking up at maturity; disarticulating below each fertile floret. Floret callus elongated; 0.5–1 mm long; bearded; hairs 3-5 mm long. Glumes persistent, similar, shorter than spikelet, gaping. Lower glume elliptic, 4-5×1.5-2 mm, membranous, without keels, 3–veined, apex acute. Upper glume elliptic, 6-7×1-1.5 mm, membranous, without keels, 3–5 –veined, apex mucicose. Basal sterile florets male or barren; with palea; persistent. Lemma of lower sterile floret similar to Upper lemma, elliptic, 15-16×1.5-2 mm, membranous, 3–5–veined, acuminate. Upper lemma lanceolate, 12-15×1.5-2 mm, membranous, without keel, 1–3-veined, apex acuminate. Palea 3-5×0.5-1 mm, 2 –veined, keels scaberulous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2. Anthers 3, 3 mm long. Ovary 1mm long, style & stigmas 4 mm long overall. **Plate 18.**

Flowering & Fruiting: August-September.

Habitat: Near seasonal water edges

Distribution: Africa, Asia-temperate, Asia-tropical, Australia. INDIA: Throughout. S. GUJARAT: Navsari.

Voucher specimen: RJD/ 571, 719

12. **Aristida adscensionis** L. in *Sp. Pl.* 82 1753; *Hooker f.* 7:224. 1897; *Blatt. & McC.* 209. 1935; *Cooke* 3:529. 1958; *Bor* 407. 1960; *Shah* 2:778. 1978; *Karthik. et al.* 183. 1989; *Pandey in Shetty & Singh* 3:973. 1993; *Lakshmi. in Sharma et al.* 392. 1996; *Roy in Singh et al.* 362. 2001.

Annual or perennial. Culms erect or geniculately ascending or decumbent; 15–90 cm long. Culm-internodes distally glabrous, nodes glabrous. Ligule a fringe of hairs. Leaf-blades flat, or conduplicate; 5–20 × 0.1–0.4 mm. Synflorescence a panicle. Panicle open, or contracted; elliptic; 10–30 cm long; evenly contracted 1° branches. Spikelets solitary, fertile, pedicelled, comprising 1 fertile florets; without rachilla extension. Spikelets lanceolate; subterete; 6–12 mm long; breaking up at maturity; disarticulating below each fertile floret. Floret callus elongated; 0.5 mm long; pilose; obtuse. Glumes persistent, similar, shorter than spikelet; thinner than Upper lemma. Lower glume lanceolate, 4-5 × 0.8-1 mm, scarious, 1-keeled, 1 –veined, apex acute. Upper glume lanceolate; 7-9 × 0.8-1 mm, scarious, 1-keeled, 1 –veined, apex dentate. Upper lemma elliptic, laterally compressed, 10-12 × 1.5-2 mm, coriaceous, keeled, 3 –veined, margins convolute, covering most of palea, apex acute, awned; 3 -awned. Principal lemma awn with 10-20 mm long, persistent. Lateral lemma awns 5–15 mm long, shorter than principal. Palea 1-1.5 × 0.8-1 mm; without keels. Anthers 3, 3-5 mm long. Ovary 1mm long, style & stigmas 6 mm long overall. **Plate 19.**

Flowering & Fruiting: August-January.

Habitat: Common in all habitats.

Distribution: Southern Europe, tropical Africa, Asia-temperate, Asia-tropical, USA, Mexico, South America. INDIA: Throughout the drier parts. S. GUJARAT: Throuout.

Voucher specimen: RJD/ 117, 184, 569

13. **Aristida funiculata** Trin. & Rupr. in *Sp. Gram. Stipac.* 159 1842; *Hooker f.* 7:226. 1897; *Blatt. & McC.* 214. 1935; *Cooke* 3:531. 1958; *Bor* 410. 1960; *Shah* 2:779. 1978; *Karthik. et al.* 184. 1989; *Pandey in Shetty & Singh* 3:974. 1993; *Lakshmi. in Sharma et al.* 392. 1996; *Roy in Singh et al.* 364. 2001.

Annual; caespitose. Culms 15–50 cm long; wiry, internodes glabrous. Ligule a fringe of hairs. Leaf-blades flat, or conduplicate; 4–10 × 0.1–0.2 cm. Synflorescence a panicle, open; linear; 5–15 cm long. Spikelets solitary, fertile, pedicelled, comprising 1 fertile florets, without rachilla extension. Spikelets lanceolate; subterete; 20–30 mm long; breaking up at maturity; disarticulating below each fertile floret. Floret callus elongated, 2 mm long, pilose, pungent. Glumes persistent, similar, exceeding apex of florets, thinner than Upper lemma. Lower glume linear, 8-10 × 1-1.5 mm, membranous, 1-keeled, 1 –veined, apex attenuate. Upper glume linear, 6-10 × 1-1.5 mm, membranous, 1-keeled, 1 –veined, apex attenuate-aristate. Upper lemma elliptic, subterete, 10-14 × 1.5-2 mm, coriaceous, without keel, 3 –veined, scabrous, rough above, margins convolute, covering most of palea, apex awned; 3 -awned. Principal lemma awn 3-branched; with 35–45 mm long limb, with twisted column, deciduous, abscissing from top of lemma. Lateral lemma awns 20–35 mm long, shorter than principal awn. Palea 1-1.5 × 0.8-1 mm, without keels. Anthers 3, 1 mm long. Ovary 1mm long, style & stigmas 2 mm long overall. **Plate 20.**

Flowering & Fruiting: September-November.

Habitat: Common on drier and rocky grounds and hills.

Distribution: Africa, western Asia and Arabia, India and Indo-China. INDIA: Peninsular and NW India. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 79, 396, 598

14. **Aristida setacea** Retz. in *Observ. Bot.* 4: 22 1786; *Hooker f.* 7:225. 1897; *Blatt. & McC.* 211. 1935; *Cooke* 3:529. 1958; *Bor* 412. 1960; *Shah* 2:781. 1978; *Karthik. et al.* 184. 1989; *Pandey in Shetty & Singh* 3:978. 1993; *Lakshmi. in Sharma et al.* 397. 1996; *Roy in Singh et al.* 364. 2001.

Perennial; caespitose. Culms erect; 50–120 cm long. Leaf-sheaths glabrous. Ligule a fringe of hairs. Leaf-blades filiform; flat or convolute; 20–40×2–2.5 cm; scabrous. Synflorescence a panicle, contracted; linear, or lanceolate; 15–40 cm long. Spikelets solitary, fertile, pedicelled, comprising 1 fertile florets; without rachilla extension. Spikelets lanceolate; subterete; 12–15 mm long; breaking up at maturity; disarticulating below each fertile floret. Floret callus elongated, 1.5 mm long, pubescent, pungent. Glumes persistent, similar, reaching apex of florets, thinner than Upper lemma. Lower glume oblong, 10-12×1-1.5 mm, scarious, 1-keeled, 1-veined, apex attenuate; awned; 1-awned, awn 2 mm long. Upper glume oblong, 12-15×1-1.5 mm, scarious, 1-keeled, 1-veined, apex dentate; awned; 1-awned, awn 2–5 mm long. Upper lemma linear, subterete, 10-12×1-1.5 mm, coriaceous, without keel, 3-veined, margins convolute, covering most of palea, apex acute, 3-awned. Principal lemma awn 15–30 mm long overall, persistent. Lateral lemma awns subequal to principal. Palea 1-1.5×1-1.3 mm, without keels. Anthers 3, 3 mm long. Ovary 1mm long, style & stigmas 2 mm long overall. **Plate 21.**

Flowering & Fruiting: September-January.

Habitat: Occasional on drier grounds.

Distribution: Africa: western Indian ocean. Asia-tropical: India, Indo-China, and Malesia. INDIA: East, West to South India. S. GUJARAT: Suart & Tapi.

Voucher specimen: RJD/ 268, 383, 642

15. **Aeluropus lagopoides** (L.) Thwaites in *Enum. Pl. Zeyl.* 374. 1864; *Bor* 487. 1960; *Shah* 2:775. 1978; *Karthik. et al.* 179. 1989; *Pandey in Shetty & Singh* 3:969. 1993; *Lakshmi. in Sharma et al.* 389. 1996; *A. villosus* Trin. ex C. A. Mey. in *Verz. Pfl. Cauc.* 18. 1831; *Hooker f. f.* 7:334. 1897; *Cooke* 3:567. 1958; *A. repens* (Desf.) *Parl.* in *Fl. Ital.* 1:462. 1848; *Blatt. & McC.* 260. 1935.

Perennial, caespitose. Rhizomes elongated, scaly, hairy. Stolons absent or present. Butt sheaths villous. Culms geniculately ascending or erect, 3–20 cm long. Leaves cauline, distichous. Leaf-sheaths loose, open for most of their length, 0.3–1 cm long, longer than internode, without keel, indistinctly veined, glabrous or pilose, outer margin glabrous, hyaline. Ligule a ciliolate membrane. Leaf-blade base broadly rounded, symmetrical, lanceolate, 0.2–3×0.2–0.4 mm, coriaceous; stiff; glaucous, midrib indistinct. Leaf-blade surface ribbed; scabrous; rough,

glabrous, margins entire, scaberulous, apex acuminate, pungent. Synflorescence composed of racemes. Peduncle 0.5–3 cm long, pubescent above. Racemes single, oblong-globose, 0.5–2 cm long. Spikelet packing, crowded regular, 2 –rowed, solitary, sessile, comprising 0–1 basal sterile & 4–12 fertile florets, with diminished florets at the apex. Spikelets oblong, laterally compressed, 3–6 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes persistent, similar, shorter than spikelet. Lower glume elliptic, 2-2.5×0.8–1 mm, chartaceous, keeled, 6 –veined, villous, acute. Upper glume elliptic, 2.8-3×1-1.5 mm, chartaceous, keeled, 7-9 –veined, villous, acuminate-mucicose. Basal sterile florets barren; without significant palea. Upper lemma elliptic, 2.5–3×0.8–1 mm, chartaceous, keeled, 11-15-veined, lateral veins prominent, villous, hairs tubercled, apiculate, 2.5–3×1-1.5 mm, hyaline, 2 –veined, hairy on back and on flanks. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy, ciliate. Anthers 3, 1–1.5 mm long. Ovary 0.5 mm long, style & stigmas 3 mm long overall. **Plate 22.**

Flowering & Fruiting: October-February.

Habitat: Throughout along sea coast.

Distribution: southeastern Europe, tropical Africa, western Asia. INDIA: Peninsular to east India. S. GUJARAT: Valsad, Suarat, Navsari.

Voucher specimen: RJD/ 340, 389, 422, 478, 524

16. ***Acrachne racemosa*** (Heyne ex Roth) Ohwi in *Bull. Tokyo Sci. Mus.* 18: 1. 1947; Bor 487. 1960; Shah 2:775. 1978; Karthik. *et al.* 178. 1989; Lakshmi. in Sharma *et al.* 388. 1996; Roy in Singh *et al.* 356. 2001; Pandey in Shetty & Singh 3:969. 1993; *E. verticillata* Roxb. in *Fl. Ind.* 1:346 1820; Hooker *f.* 7:295. 1897; Blatt. & McC. 260. 1935.

Annual, caespitose. Culms geniculately ascending, 15–75 cm long. Lateral branches sparse. Leaf-sheaths as wide as blade at the collar, keeled. Ligule a ciliolate membrane. Leaf-blades 10–55×0.5–1.5 mm, glabrous-sparsely hairy, margins cartilaginous, apex attenuate, filiform. Synflorescence composed of racemes. Racemes 3–25, borne along a central axis, in several whorls, unilateral, 1.5–10 cm long. Peduncle 0–15 cm long. Rachis angular, terminating in a sterile spikelet. Spikelet packing broadside to rachis, appressed, in pairs, sessile. Apical sterile spikelets rudimentary; 1 in number. Fertile spikelets comprising 6–14 fertile florets, with diminished florets at the apex, oblong, laterally compressed, 5-7×2.5-4 mm, breaking up at maturity, rachilla persistent, tough. Rachilla internodes 0.1 mm long, visible between lemmas. Glumes deciduous, similar, shorter than spikelet. Lower glume lanceolate, 1.5-2×0.5-0.7 mm, membranous, keeled, 1–veined, apex acuminate-mucronate. Upper glume ovate, 3-4×0.8-1 mm, membranous, keeled, 1–veined, scabrous, apex entire, acuminate-mucronate. Fertile florets recurved at tip. Upper lemma ovate, laterally compressed, ovate, 3-4×1.5-2 mm, membranous; yellowish green, keeled, 3–veined, lateral veins excurrent, scaberulous, apex awned; Principal lemma awn 0.3–1 mm long overall. Palea ovate, 2-2.5×1-1.2 mm, 2 –veined, keels scabrous, apex dentate. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3, 0.4 mm long. Stigmas 2, laterally exerted, 1mm long.

Plate 23.

Flowering & Fruiting: August-November.

Habitat: Throughout.

Distribution: tropical Africa, western Asia, Australia, South America. INDIA: Throughout the plains. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 329, 377, 671

17. *Dactyloctenium aegyptium* (L.) Willd. in *Enum. Pl.* 1029. 1809; *Blatt. & McC.* 262. 1935; *Bor* 489. 1960; *Shah* 2:808. 1978; *Karthik. et al.* 204. 1989; *Lakshmi. in Sharma et al.* 445. 1996; *Roy in Singh et al.* 401. 2001; *Pandey in Shetty & Singh* 3:1012. 1993; *Cynosurus aegyptius* (L.) *Desf.* in *Fl. Atlant. 1:* 85. 1798; *Hooker f.* 7:295. 1897; *Cooke* 3:560. 1958.

Annual, mat forming, or caespitose. Culms geniculately ascending or decumbent, stolon present, 5–100 cm long, rooting from lower nodes. Ligule a ciliate membrane. Leaf-blades 5–30×0.5–1 cm, margins tuberculate-ciliate, apex acuminate. Synflorescence composed of racemes. Racemes 3–9, Digitate, spreading, unilateral, 1–8 cm long. Rachis deciduous from axis, flattened, terminating in a barren extension, extension bristle-like. Spikelet packing broadside to rachis, crowded, appressed to rachilla, regular, 2 –rowed, solitary, sessile, comprising 3–4 fertile florets, with diminished florets at the apex. Spikelets ovate, laterally compressed, 3.5×3–4 mm, breaking up at maturity, disarticulating above glumes. Glumes persistent, dissimilar, shorter than spikelet. Lower glume ovate, 2–2.5×1.5–1.7 mm, 1-keeled, 1 –veined, apex acute. Upper glume oblong, 2–2.5×1.5–1.7 mm, membranous, 1-keeled, 1 –veined, apex obtuse, 1 –awned; awn subapical, 3.5–4.5 mm long. Upper lemmas gibbous, ovate, 2–2.5×2.5–3 mm, membranous, keeled, 3–veined, lateral veins obscure, apex cuspidate or mucronate. Paleas 2–2.5×2–2.5 mm, 2 –veined, keels narrowly winged. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2. Anthers 3 per floret, 1–2 mm long. Ovary 0.5 mm long, style & stigmas 2 mm long overall. **Plate 24.**

Flowering & Fruiting: July-November.

Habitat: Water edges; escape from gardens

Distribution: Tropical Europe, Asia-temperate, Asia-tropical, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 7, 239, 721, 795

18. *Dactyloctenium aristatum* Link in *Hort. Berol. 1:* 59. 1827; *Bor* 489. 1960; *Karthik. et al.* 204. 1989; *Lakshmi. in Sharma et al.* 445. 1996; *Roy in Singh et al.* 402. 2001; *Pandey in Shetty & Singh* 3:1013. 1993; *Eleusine aristata auct. non Ehrenb. ex Boiss.* in 1859; *Hooker f.* 7:296. 1897.

Annual, caespitose. Culms decumbent, 4–15 cm long. Ligule an eciliate membrane. Leaf-blades 1–8×0.2–0.7 cm, margins tuberculate-ciliate, apex acuminate. Synflorescence composed of racemes. Racemes 1(-2), digitate, unilateral, 0.5–2 cm long. Rachis deciduous from axis, flattened, terminating in a barren extension, extension bristle-like. Spikelet packing broadside to rachis, crowded, regular, 2 –rowed, solitary, sessile, comprising 2–3 fertile florets,

with diminished florets at the apex. Spikelets ovate, laterally compressed, breaking up at maturity, disarticulating above glumes. Glumes persistent, dissimilar, shorter than spikelet. Lower glume ovate, 1.5-2×1.5-1.7 mm, 1-keeled, 1 –veined, apex acute. Upper glume oblong, 2-2.5×1.5-1.7 mm, membranous, 1-keeled, 1 –veined, apex obtuse, 1 –awned; awn subapical, 2-3 mm long. Upper lemmas gibbous, ovate, 2-2.5×2.5-3 mm, membranous, keeled, 3 –veined, lateral veins obscure, apex cuspidate or mucronate. Paleas 2-2.5×2-2.5 mm, 2 –veined, keels narrowly winged. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2. Anthers 3 per floret, 1-2 mm long. Ovary 0.5 mm long, style & stigmas 2 mm long overall. **Plate 25.**

Flowering & Fruiting: July-October.

Habitat: Sandy and rocky soils.

Distribution: tropical Africa, Arabia, India. INDIA: N. W. & S. India. S. GUJARAT: Throughout, not common. **New records for the State.**

Voucher specimen: RJD/ 50, 223, 324

19. *Dactyloctenium scindicum* Boiss. in *Diagn. Pl. Orient. II, 4: 131. 1859; Blatt. & McC. 264. 1935; Bor 489. 1960; Shah 2:809. 1978; Karthik. et al. 204. 1989; Lakshmi. in Sharma et al. 447. 1996; Roy in Singh et al. 402. 2001; Pandey in Shetty & Singh 3:1013. 1993; Eleusine aristata Ehrenb. Ex Biond. in Fl. Orient. 5: 557. 1881; Hooker f. 7:296. 1897; Cooke 3:572. 1958.*

Perennial, mat forming. Stolons present. Butt sheaths thickened and forming a bulb. Culms decumbent, 12–65 cm long. Ligule a ciliolate membrane. Leaf-blades flat or conduplicate; 1–11 ×0.2–0.5 cm, glaucous, margins tuberculate-ciliate, apex acuminate. Synflorescence composed of racemes. Racemes 3–6, digitate, incurved, unilateral, 1–2.5 cm long. Rachis deciduous from axis, flattened, terminating in a barren extension, extension bristle-like. Spikelet packing broadside to rachis, crowded, regular, 2 –rowed, solitary, sessile, comprising 2-3 fertile florets, with diminished florets at the apex. Spikelets ovate, laterally compressed, breaking up at maturity, disarticulating above glumes. Glumes persistent, dissimilar, shorter than spikelet. Lower glume ovate, 1.8-2×1.7-2 mm, 1-keeled, 1 –veined, apex acute. Upper glume oblong, 1.5-1.7×1.7-2 mm, membranous, 1-keeled, 1 –veined, apex obtuse, 1 –awned; awn subapical, 1-1.5 mm long. Upper lemmas gibbous, ovate, 3-3.5×2.5-3 mm, membranous, keeled, 3 –veined, lateral veins obscure, apex cuspidate or mucronate. Paleas 2-2.5×1.8-2 mm, 2 –veined, keels narrowly winged. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2. Anthers 3 per floret, 0.8 mm long. Ovary 0.5 mm long, style & stigmas 1-1.5 mm long overall. Flowering & Fruiting: Throughout the year. **Plate 26.**

Habitat: Sandy soils, near sea coast.

Distribution: northeast tropical Africa, Arabia, India. INDIA: N. W. India. S. GUJARAT: Valsad, Navsari, Surat.

Voucher specimen: RJD/ 221

20. **Desmostachya bipinnata** (L.) Stapf in *Fl. Cap.* 7: 632. 1900. *Blatt. & McC.* 244. 1935; *Bor* 491. 1960; *Shah* 2:809. 1978; *Lakshmi. in Sharma et al.* 449. 1996; *Roy in Singh et al.* 404. 2001; *Pandey in Shetty & Singh* 3:1015. 1993; *Eragrostis cynosuroides* (Retz.) P. Beauv. in *Ess. Agrost.* 71, 162. 1812; *Hooker f.* 7:324. 1897; *Cooke* 3:550. 1958.

Perennial; caespitose; clumped densely. Rootstock stout forming large leafy tussocks, also with widely spreading scaly rhizomes; stolons covered with shining sheaths. Culms erect, 50–100 cm long. Leaves mostly basal. Leaf-sheaths as wide as blade at the collar, smooth, glabrous on surface. Ligule a ciliate membrane. Leaf-blades convolute, 45-55×0.4–1 cm, coriaceous, stiff, glaucous, surface ribbed, margins scabrous, apex attenuate, filiform. Synflorescence composed of racemes, narrowly pyramidal, 25-35×2–3 cm. Racemes numerous, borne along a central axis, closely spaced in a multilateral false spike, spreading, oblong, unilateral, 1–2 cm long. Central rachis semiterete, puberulous. Spikelet crowded, spreading, solitary, sessile, 2-seriate, deflexed, pale brown or purplish, shining, comprising up to 30 fertile florets, with diminished florets at the apex. Spikelets oblong, laterally compressed, compressed strongly, 15-25×10-15 mm, falling entire. Rachilla internodes eventually visible between lemmas. Glumes similar, shorter than spikelet. Lower glume ovate, 0.6-0.7×0.5 mm, membranous, keeled, 1-veined, apex acute. Upper glume ovate, 1.2-1.5×1 mm, membranous, 1-keeled, 1-veined, apex acute. Lemma ovate, laterally compressed; 1.5–1.8×1-1.2 mm, membranous, keeled, 3-veined, lateral veins obscure, apex acute. Palea oblong, 1.5–1.8×1.5-2 mm, 2-veined, keels scaberulous, apex 2-fid. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3; linear, 1mm long. Ovary 0.5mm, Stigmas 2; 1 mm long, laterally exerted. **Plate 27.**

Flowering & Fruiting: June-November.

Habitat: Throughout.

Distribution: tropical Africa, Asia-temperate, Asia-tropical. INDIA: Throughout plains. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 31, 427, 594

21. **Desmostachya pingalaiae** Raole & R.J. Desai *Nordic J. Bot.* 26: 196. 2008.

Perennial; rootstock stout, creeping; stolons covered with shining sheaths; culms tufted, smooth, erect, stout, 50-70 cm height; nodes glabrous; internodes 7-12 cm long; leaves rigid, linear, acuminate, tips filiform, entire, glabrous; leaf sheath 8-9 cm long, basal fascicled, 20-30 cm; ligules hairy; inflorescence paniculate, erect, narrowly pyramidal, 25-30 cm long; peduncle terete, glabrous; rachis many, short, 2-3 cm long; spikelets sessile, crowded, 2-seriate, deflexed, oblong-ovate, compressed, pale brown and often tinged violet-purple, shining, 1.5×0.7 mm, up to 8-flowered. Lower glume keeled, 1-nerved, 0.8×0.7 mm; upper glume ovate, acute, coriaceous, 1-nerved, 1.2×1 mm; lemma ovate, acute, margin hairy, 3-nerved, 1.5×1.2 mm; palea lanceolate, acuminate, 2-nerved, 1.5×0.7 mm; stamens three, anthers yellow-pale brown, 1 mm, filament 1 mm; ovary globose-ellipsoid, hyaline-opaque, 0.5 mm; style long, bifid; stigma whitish, style and stigma 1 mm; caryopsis ellipsoid-subglobose. **Plate 28.**

Flowering & Fruiting: June-November.

Habitat: Throughout.

Distribution: So far known only from the Gujarat, India. Here it is locally common on edges of agricultural fields, waste lands and hillocks. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 23, 145, 443

22. **Dinebra retroflexa** (Vahl) Panz. in *Denkschr. Königl. Akad. Wiss. München* 4: 270. 1814; Blatt. & McC. 264. 1935; Bor 491. 1960; Shah 2:816. 1978; Karthik. et al. 210. 1989; Pandey in Shetty & Singh 3:1031. 1993; Lakshmi. in Sharma et al. 470. 1996; Roy in Singh et al. 414. 2001. *D. arabica* Jacq. in *Fragm. Bot.* 77. 1809; Hooker f. 7:297. 1897; Cooke 3:562. 1958.

Annual, caespitose. Culms 10–72 cm long. Leaf-sheaths glandular. Ligule a ciliolate membrane, lacerate. Leaf-blades 5–22×0.4–0.8 cm, glabrous, apex acuminate. Synflorescence composed of racemes. Racemes numerous, borne along a central axis, deflexed, spreading, linear, unilateral, 08–4 cm long, bearing 2–20 fertile spikelets, simple. Peduncle 8–24 cm long. Rachis deciduous from axis, narrowly winged, flattened. Spikelet packing broadside to rachis, appressed, solitary, sessile, comprising 2–3 fertile florets, with diminished florets at the apex. Spikelets laterally compressed, 5–7 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes persistent, similar, exceeding apex of florets, firmer than Upper lemma, recurved at apex. Lower glume elliptic, 4.5-5×0.8-1 mm, coriaceous, 1-keeled, 1 –veined, vein scabrous, apex caudate. Upper glume elliptic, 5-6.5×1.5-2 mm, coriaceous, 1-keeled, 1 –veined, vein scabrous, apex caudate. Upper lemma ovate, 1.8-2×0.7-1 mm, membranous, lightly keeled, 3 –veined, lateral veins close to margins, margins pubescent, apex emarginate. Palea 1.2-1.5×0.7-1 mm, 2 –veined, keels pubescent. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.5 mm long. Ovary 0.5 mm long, style & stigmas 1mm long overall. **Plate 29.**

Flowering & Fruiting: July-September.

Habitat: Throughout.

Distribution: Tropical Africa, Asia-temperate, Asia-tropical, Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 10, 582, 676

23. **Eleusine indica** (L.) Gaertn. in *Fruct. Sem. Pl.* 1: 8. 1788; Hooker f. 7:293. 1897; Blatt. & McC. 259. 1935; Cooke 3:560. 1958; Bor 493. 1960; Shah 2:819. 1978; Karthik. et al. 212. 1989; Pandey in Shetty & Singh 3:1036. 1993; Lakshmi. in Sharma et al. 473. 1996; Roy in Singh et al. 419. 2001.

Annual, caespitose. Culms geniculately ascending or decumbent, slender, 15–102 cm long. Leaves mostly basal. Leaf-sheaths keeled, outer margin hairy. Ligule an eciliate membrane, truncate. Leaf-blades conduplicate, 5–35×0.3–0.8 cm. Synflorescence composed of racemes. Peduncle glabrous at raceme base. Racemes 1–12, digitate, unilateral, 3-15 cm long. Rachis

wingless, flattened. Spikelet packing broadside to rachis, regular, 2-rowed, appressed, sessile, comprising 3–9 fertile florets, with diminished florets at the apex. Spikelets elliptic, laterally compressed, 4–7 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes persistent, similar, shorter than spikelet. Lower glume lanceolate, 2.5–2.8×1.2–1.5 mm, membranous, 1-keeled, winged on keel, 1-veined, apex acute. Upper glume elliptic, 2.8–3×1.8–2 mm, membranous, 1-keeled, winged on keel, 5–7-veined, apex acute. Upper lemma lanceolate, 3.5–3.8×1–1.2 mm, membranous; 7-veined, apex acute. Palea 1.8–2×0.8–1 mm, 2-veined. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 1 mm long. Ovary 0.5 mm long, style & stigmas 0.5 mm long overall. **Plate 30.**

Flowering & Fruiting: Throughout the year.

Habitat: Throughout.

Distribution: Europe, Asia-temperate, Asia-tropical, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 12, 162, 171.

24. **Eleusine coracana** (L.) Gaertn. in *Fruct. Sem. Pl. 1: 8. 1788. Hooker f. 7:294. 1897; Blatt. & McC. 260. 1935; Cooke 3:561. 1958; Bor 492. 1960; Shah 2:819. 1978; Karthik. et al. 212. 1989; Pandey in Shetty & Singh 3:1035. 1993; Lakshmi. in Sharma et al. 475. 1996; Roy in Singh et al. 418. 2001.*

Annual, caespitose. Culms erect, 50–140 cm long, up to 2 cm diam. Leaves mostly basal. Leaf-sheaths keeled, outer margin hairy. Ligule a ciliolate membrane. Leaf-blades conduplicate, 25–70×0.6–1.2 cm. Synflorescence composed of racemes. Peduncle glabrous, pilose above. Racemes 4–7, digitate, erect, linear or oblong, incurved, unilateral, 3–10 cm long. Rachis wingless, flattened. Spikelet packing broadside to rachis, crowded, regular, 2-rowed, sessile, comprising 3–9 fertile florets, with diminished florets at the apex, ovate, laterally compressed, 7–10×2.5–3 mm, persistent on plant. Glumes similar, shorter than spikelet. Lower glume lanceolate, 2.2–2.5×1.2–2.5 mm, membranous, 1-keeled, winged on keel, 1–3-veined, apex acute. Upper glume elliptic, 3.5–3.8×3–3.5 mm, membranous, 1-keeled, winged on keel, 5–7-veined, apex acute. Upper lemma lanceolate, 3.5–4×3.5–4 mm, membranous, 3–5-veined, apex acute. Palea 3.5–4×3.5–4 mm, 2-veined, winged on keel. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 1 mm long. Ovary 0.5 mm long, style & stigmas 1.5 mm long overall. **Plate 31.**

Flowering & Fruiting: August- January.

Habitat: Cultivated or escape.

Distribution: Northern and central Europe, Africa, Asia-temperate, Asia-tropical, Australia. INDIA: Cultivated throughout. S. GUJARAT: Cultivated.

Voucher specimen: RJD/ 129, 425, 626

25. **Eragrostiella brachyphylla** (Stapf) Bor in *Ind. Forester* 66:270. 1940 & Bor 494. 1960; Shah 2:821. 1978; Karthik. *et al.* 215. 1989; Pandey in Shetty & Singh 3:1040. 1993; Lakshmi. in Sharma *et al.* 477. 1996; Roy in Singh *et al.* 424. 2001; *Eragrostis brachyphylla* Stapf in *Hooker f.* 7:327. 1897; Blatt. & McC. 241. 1935.

Perennial, caespitose. Butt sheaths persistent and investing base of culm, with compacted sheaths. Culms erect, 15–50 cm long, 2-3-noded. Culm-nodes glabrous. Lateral branches lacking. Leaves mostly basal, without demarcation between sheath and blade. Leaf-sheath oral hairs lacking. Ligule a ciliate membrane. Leaf-blades flat, or conduplicate, 5–15×0.15–0.3 cm, coriaceous, glaucous, glabrous, margins cartilaginous, scabrous, apex obtuse. Synflorescence composed of racemes. Racemes 1, single, erect, unilateral, 8–20×0.5–0.7 cm. Rachis angular. Spikelet packing broadside to rachis, crowded, regular, 2-rowed, ascending, solitary, sessile, comprising 12-20 fertile florets, with diminished florets at the apex. Spikelets elliptic or oblong, laterally compressed, 6–10×1.5–2.5 mm, breaking up at maturity, rachilla persistent, retaining paleas. Glumes lower persistent, upper deciduous, similar, shorter than spikelet. Lower glume lanceolate or ovate, 1.5–2×1–1.2 mm, membranous, 1-keeled, 1-veined, vein scaberulous, apex acute. Upper glume oblong or ovate, 1.5–2×1.5–2 mm, membranous, 1-keeled, 1-veined, obtuse. Upper lemma ovate, dorsally straight along back, 1.5–2×1.5–2 mm, cartilaginous, pallid, keeled, 3-veined, apex obtuse. Palea ovate, 1.5–1.7×1–1.5 mm, 2-veined, keels winged, narrowly winged, ciliolate, glabrous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 1.5 mm long. Ovary 0.2 mm long, style & stigmas 1 mm long overall. **Plate 32.**

Flowering & Fruiting: August-November.

Habitat: In sandy-rocky soils, river banks.

Distribution: endemic to India. INDIA: E., W. & S. India. S. GUJARAT: Surat.

Voucher specimen: RJD/ 251, 424, 587

26. **Eragrostis amabilis** (L.) Wight & Arn. in *Cat. Indian Pl.* 2: 105 1834; *E. tenella* (L.) Roem. & Schult. in *Syst. Veg.* 2: 576. 1817; *Hooker f.* 7:315. 1897; Blatt. & McC. 232. 1935; Bor 513. 1960; Karthik. *et al.* 217. 1989; Pandey in Shetty & Singh 3:1051. 1993; Lakshmi. in Sharma *et al.* 489. 1996; Shah 2:826. 1978; Roy in Singh *et al.* 436. 2001; *E. tenella* var. *breviculmis* Stapf in *Hooker f. op.cit.* 316; *E. tenella* var. *plumosa* (Retz.) Stapf in *Hooker f. op.cit.* 316; Cooke 3:545. 1958; Blatt. & McC. *op.cit.* 232.

Annual, caespitose. Culms geniculately ascending or decumbent, 6–50 cm long. Ligule a fringe of hairs. Leaf-blades 4–12×0.1–0.3 cm. Synflorescence a panicle. Panicle open, pyramidal, 5–18 cm long. 1° panicle branches spreading. 1° branches glandular, bearded in axils. Spikelets solitary, pedicelled, comprising 4–8 fertile florets, with diminished florets at the apex. Spikelets ovate or obovate, laterally compressed, 1.5–2.5 mm long, breaking up at maturity, disarticulating below each fertile floret. Rachilla internodes definite. Glumes deciduous, similar, shorter than spikelet. Lower glume ovate, 0.6-0.8×0.5 mm, 1-keeled, 1-veined, apex acute. Upper glume ovate, 0.8-1×0.5 mm, 1-keeled, 1-veined, apex acute. Upper lemma ovate, 1–1.2×1–1.2 mm, membranous, keeled, 3-veined, apex obtuse. Palea 0.8×0.5 mm, 2-veined, keels ciliate, hairs 0.1–0.3mm. Apical sterile florets resembling fertile though

underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.5 mm long. Ovary 0.2 mm long, style & stigmas 0.5 mm long overall. **Plate 33.**

Flowering & Fruiting: August-November.

Habitat: Throughout.

Distribution: Africa, Asia-temperate, Asia-tropical, North America, South America. INDIA: Cultivated throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 97, 418, 706

27. **Eragrostis ciliaris** (L.) R.Br. in *Narr. Exped. Zaire* 478. 1818; *Hooker f.* 7:314. 1897; *Blatt. & McC.* 231. 1935; *Bor* 506. 1960; *Shah* 2:823. 1978; *Karthik. et al.* 215. 1989; *Pandey in Shetty & Singh* 3:1045. 1993; *Lakshmi. in Sharma et al.* 482. 1996; *Roy in Singh et al.* 431. 2001. *E. ciliaris* var. *brachystachya* Boiss. in *Fl. Orient.* 5: 582 1884; *Hooker f. op.cit.* 315; *Cooke* 3:545. 1958; *Shah op. cit.* 823.

Annual, caespitose. Culms erect, 5–40 cm long. Ligule a fringe of hairs. Leaf-blades 2–12×0.1–0.5 cm. Synflorescence a panicle. Panicle spiciform, linear or oblong, continuous or interrupted, 1–20 cm long. Spikelets solitary, pedicelled, comprising 6–12 fertile florets, with diminished florets at the apex, ovate, laterally compressed, 2–4.5 mm, breaking up at maturity, disarticulating below each fertile floret. Glumes deciduous, similar, shorter than spikelet. Lower glume lanceolate, 0.7–1×0.5–0.7 mm, 1-keeled, 1-veined, apex acute. Upper glume lanceolate, 0.7–1×0.5–0.7 mm, 1-keeled, 1-veined, apex acute. Upper lemma elliptic or oblong, 0.9–1.5×0.7–1 mm, membranous, keeled, 3-veined, apex mucous. Palea 0.9–1.5×0.7–1 mm, keels tuberculate ciliate, hairs 0.6–0.7 mm. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.5 mm long. Ovary 0.2 mm long, style & stigmas 1 mm long overall. **Plate 34.**

Flowering & Fruiting: August-November.

Habitat: Throughout.

Distribution: Africa, Asia-temperate, Asia-tropical, North America, South America. INDIA: Throughout plains. S. GUJARAT: Throughout.

Voucher specimen: RJD/ : 113, 583, 609

28. **Eragrostis japonica** (Thunb.) Trin. in *Mém. Acad. Imp. Sci. St.-Pétersbourg, Sér. 6, Sci. Math.* 1: 405 1830; *Bor* 506. 1960; *Shah* 2:825. 1978; *Karthik. et al.* 216. 1989; *Pandey in Shetty & Singh* 3:1047. 1993; *Lakshmi. in Sharma et al.* 484. 1996; *Roy in Singh et al.* 433. 2001; *E. diarrhena* (Schult. & Schult.f.) Steud. in *Syn. Pl. Glumac.* 1: 266 1854; *Bor op.cit.* 507; *Shah op. cit.* 824; *Shetty op. cit.* 432; *E. diplachnoides* Steud. in *Syn. Pl. Glumac.* 1: 268 1854; *Bor op.cit.* 508; *E. interrupta sensu Stapf* in *Hooker f.* 7:316. 1897; *Blatt. & McC.* 233. 1935; *E. interrupta* var. *diarrhena* (Schult.) *Stapf* in *Hooker f. op.cit.* 316; *E. interrupta* var. *diplachnoides* (Steud.) *Stapf* in *Hooker f. op.cit.* 316; *E. interrupta* var. *koenigii* *Stapf* in *Hooker f. op.cit.* 316; *Cooke* 3:546. 1958; *E. interrupta* var. *tenuissima* *Stapf* in *Hooker f. op.cit.* 316.

Annual, caespitose. Culms erect, 10–150 cm long. Ligule a ciliolate membrane, truncate. Leaf-blades 3–30×0.2–0.5 cm. Synflorescence a panicle. Panicle open; linear or ovate; 4–50 cm long; contracted about 2° branches. 1° panicle branches ascending or spreading, 3–14 cm long. Spikelets solitary, pedicelled, comprising 6–12 fertile florets, with diminished florets at the apex, oblong, laterally compressed, 2–2.5 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes persistent, similar, shorter than spikelet. Lower glume ovate, 0.4–0.7×0.3–0.5 mm, 1-keeled, 1-veined, apex acute. Upper glume ovate, 0.7–1×0.5–0.7 mm, 1-keeled, 1-veined, apex acute. Upper lemma ovate, 0.7–1×0.5–0.7 mm, membranous, keeled, 3-veined, apex obtuse. Palea 0.7–0.8×0.5–0.7 mm, 2-veined, keels scaberulous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.5 mm long. Ovary 0.5 mm long, style & stigmas 0.8–1 mm long overall. **Plate 35.**

Flowering & Fruiting: October-February.

Habitat: Throughout.

Distribution: Europe, Asia-temperate, Asia-tropical, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 67,120, 144, 342, 375, 401, 452

29. **Eragrostis minor** Host in *Fl. Austriaca* 1: 135. 1827; Hooker f. 7:321. 1897; Blatt. & McC. 288. 1935; Cooke 3:548. 1958; Karthik. et al. 217. 1989; Pandey in Shetty & Singh 3:1048. 1993; Lakshmi. in Sharma et al. 484. 1996; *E. poaeoides* P. Beauv. in *Ess. Agrostogr.* 162. 1812; Bor 512. 1960; Shah 2:826. 1978; Roy in Singh et al. 435. 2001; *E. pappiana* Chiov. in *Ann. Ist. Bot. Roma* 8: 371. 1908; Bor op.cit. 511.

Annual, caespitose. Culms geniculately ascending, 6–40 cm long, glandular, glands wart-like. Ligule a fringe of hairs. Leaf-blades 3–12×0.1–0.5 cm. Leaf-blade margins glandular. Synflorescence a panicle. Panicle open, ovate, dense or loose, 4–20 cm long, branches stiff, glandular. Spikelets solitary, pedicelled; pedicels oblong, 1–3 mm long, or glandular. Fertile spikelets comprising 6–20 fertile florets, with diminished florets at the apex, oblong, laterally compressed, 5–7×1.2–1.5 mm; breaking up at maturity, rachilla persistent, retaining paleas. Rachilla internodes definite. Glumes deciduous, similar, shorter than spikelet. Lower glume ovate, 1–1.3×0.5–0.7 mm, eglandular, 1-keeled, 1–3-veined, apex acute. Upper glume ovate, 1.8–2×0.8–1 mm, eglandular, 1-keeled, 1-veined, apex acute. Upper lemma ovate or orbicular, 1.5–2×1–1.2 mm, chartaceous, grey or purple, keeled, 3-veined, apex obtuse-acute. Palea 2-veined, 1.2–1.5×0.5–0.7 mm, keels scabrous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.3 mm long. Ovary 0.2 mm long, style & stigmas 0.5 mm long overall. **Plate 36.**

Flowering & Fruiting: September-March.

Habitat: In sandy soils, occasional.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 137, 455, 499

30. **Eragrostis nutans** (Retz.) Nees ex Steud. in *Nomencl. Bot. ed. 2, 1: 563. 1840*; Blatt. & McC. 237. 1935; Cooke 3:560. 1958; Bor 511. 1960; Shah 2:825. 1978; Karthik. et al. 217. 1989; Pandey in Shetty & Singh 3:1049. 1993; Lakshmi. in Sharma et al. 485. 1996; Roy in Singh et al. 434. 2001; *E. elegantula* Nees ex Steud. in *Syn. Pl. Glum. 1:266. 1854*; Hooker f. 7:318. 1897; *E. stenophylla* auct. non Hochst. ex Miq. in 1851; Hooker f. op. cit. 318; Cooke op. cit. 547.

Perennial, caespitose. Culms erect or geniculately ascending, 30–80 cm long, nodes glabrous. Lateral branches sparse. Leaf-sheath oral hairs bearded, 3–4 mm long. Ligule a fringe of hairs. Leaf-blades 9–18×0.2–0.5 cm, scaberulous, apex acuminate. Synflorescence a panicle. Panicle spiciform, lanceolate, 10–22×2–4 cm. 1° panicle branches 3–8 cm long, scabrous. Peduncle smooth. Spikelets solitary, pedicelled; pedicels 1.5–3 mm long, scabrous. Fertile Spikelets comprising 10–20 fertile florets, with diminished florets at the apex, linear, laterally compressed, 3–10×1–1.5 mm, breaking up at maturity, rachilla persistent, retaining paleas. Rachilla internodes 0.3 mm long. Glumes deciduous, similar, shorter than spikelet. Lower glume ovate, 0.8–1×0.5 mm, 1-keeled, 1-veined, apex acute. Upper glume ovate, 1–1.3×0.7–1 mm, 1-keeled, 1-veined, apex acute. Upper lemma ovate, 1.3–1.5×2–2.2 mm, chartaceous, keeled, 3-veined, apex acute. Palea 1–1.3×0.5–0.7 mm, keels scaberulous, ciliolate. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.2 mm long. Ovary 0.2 mm long, style & stigmas 0.5 mm long overall. **Plate 37.**

Flowering & Fruiting: August–November.

Habitat: Throughout in sandy soils.

Distribution: China and eastern Asia, India, Indo-China, Malesia, and Papuasia, southeast USA. INDIA: W. E. & S. India. S. GUJARAT: Valsad, Dangs, Navsari.

Voucher specimen: RJD/ 404, 611, 650

31. **Eragrostis papposa** (Desf. ex Roem. & Schult.) Steud. in *Nomencl. Bot. ed. 2, 1: 564. 1840*; Hooker f. 7:322. 1897; Blatt. & McC. 240. 1935; Bor 511. 1960; Karthik. et al. 217. 1989; Pandey in Shetty & Singh 3:1050. 1993.

Perennial, short-lived, cushion forming or caespitose. Butt sheaths glabrous. Culms erect or geniculately ascending, 10–40 cm long. Ligule a fringe of hairs. Leaf-blades flat or involute, 2–15×0.1–0.2 cm, stiff, glaucous. Synflorescence a panicle, panicle open, ovate, 3–15 cm long. Spikelets solitary, pedicelled; pedicels filiform, eglandular. Fertile Spikelets comprising 5–18 fertile florets, with diminished florets at the apex, linear, laterally compressed, 4–8 mm long, breaking up at maturity, rachilla persistent, retaining paleas. Rachilla internodes eventually visible between lemmas. Glumes deciduous, similar, shorter than spikelet. Lower glume lanceolate, 0.5–0.7×0.5–0.7 mm, hyaline, without keels, 1-veined, apex acute. Upper glume ovate, 0.8–1×0.5–0.7 mm, 1-keeled, 1-veined, apex acute. Upper lemma elliptic or orbicular, 1–1.3×0.5–0.7 mm, membranous, keeled, 3-veined, apex obtuse. Palea 1–1.3×0.5–0.7 mm, keels scaberulous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.5 mm long. Ovary 0.5 mm long, style & stigmas 0.5 mm long overall.

Flowering & Fruiting: March-September.

Habitat: Throughout.

Distribution: Southwestern Europe, northeast tropical Africa, western Asia, Arabia, India and Indo-China. INDIA: N. W. India. S. GUJARAT: Navsari, Valsad. **New records for the State.**

Voucher specimen: RJD/ 14, 403, 577, 615

32. **Eragrostis pilosa** (L.) P.Beauv. in *Ess. Agrostogr.* 71. 1812; *Hooker f.* 7:323. 1897; *Blatt. & McC.* 241. 1935; *Cooke* 3:550. 1958; *Bor* 512. 1960; *Shah* 2:825. 1978; *Karthik. et al.* 217. 1989; *Pandey in Shetty & Singh* 3:1050. 1993; *Lakshmi. in Sharma et al.* 487. 1996; *Roy in Singh et al.* 435. 2001. **Plate 38.**

Annual, caespitose. Culms erect or geniculately ascending, 12–40 cm long. Ligule a fringe of hairs. Leaf-blades 2–20×0.1–0.4 cm. Synflorescence a panicle, panicle open, 4–25 cm long. 1° panicle branches whorled at lower nodes, eglandular, bearded in axils. Spikelets solitary, pedicelled, comprising 4–14 fertile florets, with diminished florets at the apex. Spikelets linear, laterally compressed, 3–7×0.7–1.2 mm, breaking up at maturity, rachilla persistent. Glumes deciduous, dissimilar, shorter than spikelet. Lower glume ovate, 0.5×0.3 mm, hyaline, without keels, 0-1-veined, apex acute. Upper glume ovate, 1-1.2×0.5-0.7 mm, hyaline, 1-keeled, 1-veined, apex acute. Upper lemma ovate, 1.2-1.5×0.7-0.9 mm, membranous, keeled, 3 -veined. Lemma apex obtuse or 2-fid. Palea 1-1.2×0.5-0.7 mm, 2-veined, keels scaberulous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.3 mm long. Ovary 0.2 mm long, style & stigmas 0.5 mm long overall.

Flowering & Fruiting: August-February.

Habitat: Throughout.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 119, 167, 476

33. **Eragrostis tremula** Hochst. ex Steud. in *Syn. Pl. Glumac.* 1: 269. 1854; *Hooker f.* 7:320. 1897; *Blatt. & McC.* 239. 1935; *Cooke* 3:549. 1958; *Bor* 514. 1960; *Shah* 2:826. 1978; *Karthik. et al.* 218. 1989; *Pandey in Shetty & Singh* 3:1052. 1993; *Lakshmi. in Sharma et al.* 491. 1996; *Roy in Singh et al.* 437. 2001.

Annual, caespitose. Culms erect or geniculately ascending, 20–80 cm long. Leaves mostly basal. Ligule a fringe of hairs. Leaf-blades 4–20×0.3–0.5 cm, apex attenuate. Synflorescence a panicle. Panicle open, ovate, effuse, 7–30 cm long, branches flexuous, eglandular, bearded in axils. Spikelets solitary, pedicelled, pedicels filiform, eglandular. Spikelets comprising 20–60 fertile florets, with diminished florets at the apex. Spikelets linear, laterally compressed, 5–25×1.5–2 mm, breaking up at maturity, rachilla persistent, retaining paleas. Rachilla internodes obscured by lemmas. Glumes persistent, similar, shorter than spikelet. Lower glume ovate, 1-1.2×0.5-0.7 mm, membranous, 1-keeled, 1-veined, apex acute. Upper glume ovate,

1.5-2×0.7-1 mm, membranous, 1-keeled, 1-veined, apex acute. Upper lemma ovate, 2-2.2×2-2.2 mm, membranous, purple, keeled, 3-veined, apex obtuse. Palea 2-veined, 1.8-2×1.5-1.7 mm, keels scabrous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 2 per floret, 0.3 mm long. Ovary 0.2 mm long, style & stigmas 0.5 mm long overall. **Plate 39.**

Flowering & Fruiting: August-December.

Habitat: Throughout.

Distribution: Africa, western Asia and Arabia, India and Indo-China. INDIA: Throughout. S. GUJARAT: Tapi, Surat.

Voucher specimen: RJD/ 20, 353, 400

34. **Eragrostis unioides** (Retz.) Nees ex Steud. in *Syn. Pl. Glumac. 1: 264. 1854; Blatt. & McC. 235. 1935; Bor 515. 1960; Shah 2:827. 1978; Karthik. et al. 218. 1989; Pandey in Shetty & Singh 3:1053. 1993; Lakshmi. in Sharma et al. 491. 1996; Roy in Singh et al. 438. 2001. E. amabilis Stapf in Hooker f. 7:317. 1897; Cooke 3:546. 1958.*

Annual or perennial, short-lived; caespitose. Culms geniculately ascending or decumbent, 5–40 cm long, rooting from lower nodes. Ligule a fringe of hairs. Leaf-blades 3–12×0.2–0.6 cm. Synflorescence a panicle, panicle open, elliptic, 5–18×2–6 cm. Spikelets solitary, pedicelled, pedicels 2–10 mm long, comprising up to 90 fertile florets, with diminished florets at the apex. Spikelets ovate, laterally compressed, 4–12×2–3.4 mm, breaking up at maturity, rachilla, persistent, shedding paleas. Rachilla internodes obscured by lemmas. Glumes deciduous, similar, shorter than spikelet. Lower glume lanceolate, 1-1.2×0.5-0.7 mm, 1-keeled, 1 –veined, vein scabrous, apex acute. Upper glume ovate, 1.2-1.5×0.5-0.7 mm, keeled, 1 –veined, apex acute. Upper lemma ovate, 1.3-1.5×0.7-1 mm, membranous, red or purple, keeled, 3 –veined, apex acute. Palea 1-1.2×0.5-0.7 mm, 2-veined, keels scaberulous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.3 mm long. Ovary 0.2 mm long, style & stigmas 0.8 mm long overall. **Plate 40.**

Flowering & Fruiting: August-November.

Habitat: Throughout.

Distribution: Africa, Asia-tropical, Australia, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 13, 153, 228, 377

35. **Eragrostis viscosa** (Retz.) Trin. in *Mém. Acad. Imp. Sci. St.-Pétersbourg, Sér. 6, Sci. Math. 1:397. 1831; Blatt. & McC. 233. 1935; Bor 515. 1960; Shah 2:827. 1978; Karthik. et al. 218. 1989; Pandey in Shetty & Singh 3:1053. 1993; Lakshmi. in Sharma et al. 493. 1996; Roy in Singh et al. 438. 2001; E. tenella var. viscosa (Retz.) Stapf in Hooker f. 7:320. 1897; Cooke 3:546. 1958.*

Annual, caespitose. Culms erect, 10–40 cm long. Leaf-sheaths viscid. Ligule a fringe of hairs. Leaf-blades 4–10×0.2–0.5 cm, viscid. Synflorescence a panicle, panicle open, oblong, 4–15

cm long, branches glandular, viscid, bearded in axils. Spikelets solitary, pedicelled, comprising 4–8 fertile florets, with diminished florets at the apex. Spikelets ovate or obovate, laterally compressed, 1.5–2.5 mm long, breaking up at maturity, disarticulating below each fertile floret. Rachilla internodes definite. Glumes deciduous, similar, shorter than spikelet. Lower glume ovate, 0.8-1×0.5-0.7 mm, 1-keeled, 1 -veined, apex acute. Upper glume ovate, 1-1.2×0.5-0.7 mm, 1-keeled, 1 -veined, apex acute. Upper lemma ovate, 1.2-1.5×1–1.2 mm, membranous, keeled, 3 -veined, apex obtuse. Palea 0.8-1×0.5 mm, 2-veined, keels ciliate, hairs 0.1–0.3mm. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.5 mm long. Ovary 0.2 mm long, style & stigmas 0.5 mm long overall. **Plate 41.**

Flowering & Fruiting: August-November.

Habitat: Throughout in sandy soils.

Distribution: Africa, Arabia, India, China, Malesia, Mexico, South America. INDIA: Throughout. S. GUJARAT: Throughout, not common.

Voucher specimen: RJD/ 419, 573, 644

36. **Halopyrum mucronatum** (L.) Stapf in *Hooker f.'s Icon. Pl. 25: t. 2448. 1897; Blatt. & McC. 31. 1935; Bor 161. 1960; Shah 2:830. 1978; Karthik. et al. 225. 1989; Pandey in Shetty & Singh 3:1057. 1993; Lakshmi. in Sharma et al. 491. 1996; Rottboellia compressa L. f. in Suppl. 114. 1781; Hooker f. 7:153. 1897; Cooke 3:470. 1958.*

Perennial, caespitose. Butt sheaths scarious, glabrous, stolons present. Culms erect, 40–100 cm long, wiry, branches sparse. Leaves basal and cauline. Leaf-sheaths glabrous. Ligule a fringe of hairs. Leaf-blades curled, involute, 8–20×0.2–0.5 cm, stiff, glaucous, ribbed, apex attenuate. Synflorescence composed of racemes. Racemes 3–10, borne along a central axis, erect, unilateral, 2–8 cm long, bearing 3–7 fertile spikelets on each. Peduncle 10–40 cm long. Rachis angular. Spikelet packing broadside to rachis, lax, ascending, solitary, pedicelled; pedicels linear, 1.5–6 mm long, comprising 8–25 fertile florets, with diminished florets at the apex. Spikelets ovate, laterally compressed, 12–20×5–7 mm, breaking up at maturity, disarticulating below each fertile floret. Rachilla internodes 0.5 mm long, obscured by lemmas, villous with 3–5 mm long hairs. Floret callus bearded, hairs 2-3mm long. Glumes persistent, similar, shorter than spikelet. Lower glume lanceolate, 7–9×2.5-3 mm, coriaceous, 3-veined, apex acute. Upper glume lanceolate, 7–9×2.5-3 mm, coriaceous, villose in lower parts, 7-9-veined, apex acute. Upper lemma lanceolate, 8–10×3.5-4 mm, coriaceous, keeled above, 3-veined, apex dentate, mucronate. Palea 1 length of lemma, hyaline, 2 -veined, keels scaberulous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 3 mm long. Ovary 1 mm long, style & stigmas 2.5 mm long overall. **Plate 42.**

Flowering & Fruiting: October-November

Habitat: In coastal areas and saline soil

Distribution: Africa, western Asia and Arabia, India. INDIA: W.-S. India. S. GUJARAT: Suart.

Voucher specimen: RJD/ 347, 351, 369

37. **Leptochloa fusca** (L.) Kunth in *Révis. Gramin. 1: 91 1829*; *Diplachne fusca* (L.) Stapf in *Fl. Cap. 7: 591. 1900*; *Hooker f. 7:329. 1897*; *Blatt. & McC. 246. 1935*; *Cooke 3:552. 1958*; *Bor 492. 1960*; *Shah 2:816. 1978*; *Karthik. et al. 211. 1989*; *Pandey in Shetty & Singh 3:1031. 1993*; *Lakshmi. in Sharma et al. 491. 1996*; *Roy in Singh et al. 415. 2001*.

Perennial. Culms decumbent, 30–200 cm long, rooting from lower nodes. Ligule an eciliate membrane, acute. Leaf-blades flat or convolute, 12–40×0.3–0.5 cm, stiff, grey-green, midrib widened, surface scabrous, apex attenuate. Synflorescence composed of racemes. Racemes 10–30, borne along a central axis, erect, straight, unilateral, 5–15 cm long, Peduncle 10–30 cm long. Rachis semiterete. Spikelet packing broadside to rachis, lax, solitary, pedicelled; pedicels filiform, 0.5–1.5 mm long, comprising 6–11 fertile florets, with diminished florets at the apex. Spikelets elliptic, laterally compressed, up to 15 mm long, breaking up at maturity, disarticulating below each fertile floret. Rachilla internodes eventually visible between lemmas. Floret callus evident, pubescent, disarticulating obliquely. Glumes persistent, similar, shorter than spikelet. Lower glume lanceolate, 2-2.6×0.7-1 mm, keeled, 1 –veined, scabrous, apex acute. Upper glume oblong, 3.3–3.5×0.8-1.2 mm, membranous, keeled, 1 –veined, apex obtuse or acute. Upper lemma oblong, 3-4×1.2-1.5 mm, membranous, dark green or grey, 3 –veined, veins close to margins, margins pilose, apex mucronate or awned, awn 0.3–1 mm long overall. Palea 2.5-3×0.8-1 mm, 2-veined. Palea keels scabrous. Palea surface pubescent; hairy on flanks. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 1 mm long. Ovary 0.5 mm long, style & stigmas 1 mm long overall. **Plate 43.**

Flowering & Fruiting: August-January.

Habitat: In marshy areas.

Distribution: Africa, Asia-temperate, India, Indo-China, Malesia, Papuasias, Australia. North America, South America. INDIA: Upper gangetic plains to southwards. S. GUJARAT: Surat, Navsari, Valsad.

Voucher specimen: RJD/ 293, 336, 552

38. **Leptochloa panicea** (Retz.) Ohwi in *Bot. Mag. (Tokyo) 55: 311. 1941*; *Bor 514. 1960*; *Shah 2:841. 1978*; *Karthik. et al. 235. 1989*; *Pandey in Shetty & Singh 3:1072. 1993*; *Roy in Singh et al. 459. 2001*; *L. filiformis sensu Hooker f. 7:298. 1897*; *L. contracta Blatt. & McC. 239. 1935*; *Lakshmi. in Sharma et al. 535. 1996*.

Annual, caespitose. Butt sheaths herbaceous, green. Culms decumbent, 15–100 cm long. Leaf-sheaths pilose. Ligule an eciliate membrane. Leaf-blades 5–25×0.2–0.7 cm, sparsely hairy with tubercle-based hairs, apex attenuate. Synflorescence composed of racemes. Racemes numerous, borne along a central axis, straight, unilateral, 3–15 cm long. Peduncle 10–30 cm long. Rachis semiterete. Spikelet packing broadside to rachis, regular, 2 –rowed, solitary, sessile, comprising 2–4 fertile florets, with diminished florets at the apex. Spikelets elliptic,

laterally compressed, 1.8–2.5 mm long, breaking up at maturity, disarticulating below each fertile floret. Rachilla internodes eventually visible between lemmas. Glumes persistent, dissimilar, shorter than spikelet. Lower glume lanceolate, 2.5–3×0.8–1 mm, membranous, 1-keeled, 1 –veined, apex acute. Upper glume elliptic, 1–1.5×0.5–0.7 mm, membranous, 1-keeled, 1 –veined, apex mucronate. Upper lemma oblong, 0.8–1.2×0.7–1 mm long, membranous, keeled, 3 –veined, midvein pubescent, surface puberulous, apex obtuse. Palea 2-veined, 0.8–1.2×0.5–0.7 mm, keels ciliolate. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.3 mm long. Ovary 0.5 mm long, style & stigmas 0.7 mm long overall. **Plate 44.**

Flowering & Fruiting: August–December.

Habitat: As a weed in moist places and agricultural fields.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 288, 497, 662

39. **Tripogon jacquemontii** Stapf in *Bull. Misc. Inform. Kew.* 1892:85. 1892; *Hooker f.* 7:286. 1897; *Cooke* 3:559. 1958; *Blatt. & McC.* 268. 1935; *Bor* 522. 1960; *Shah* 2:879. 1978; *Pandey in Shetty & Singh* 3:1132. 1993; *Lakshmi. in Sharma et al.* 628. 1996; *Roy in Singh et al.* 540. 2001.

Perennial, caespitose. Culms erect, 12–60 cm long, nodes glabrous. Leaf-sheaths 3–7 cm long, keeled, veined, glabrous. Ligule a ciliate membrane. Leaf-blades filiform, involute, 3–10×0.1–0.3 cm, stiff, glaucous, glabrous, apex acute. Synflorescence composed of racemes. Racemes 1, single, straight, unilateral, 5–22 cm long. Rachis flattened. Spikelet packing broadside to rachis, regular, 2-rowed, appressed, solitary, sessile, comprising 6–25 fertile florets, with diminished florets at the apex. Spikelets linear, laterally compressed, 15–20×3.5–4 mm, breaking up at maturity, disarticulating below each fertile floret. Floret callus bearded. Glumes persistent, similar, shorter than spikelet. Lower glume lanceolate, asymmetrical, 3–3.5×1–1.2 mm, membranous, 1-keeled, 1 –veined, apex with a unilateral tooth. Upper glume oblong, 3–3.5×0.8–1 mm, membranous, 1-keeled, 1 –veined, apex mucronate. Upper lemma ovate, 3.5–3.8×1.2–1.5 mm, membranous, 3 –veined, apex 2 –fid, awned, awn from a sinus, 1.5–2.5 mm long overall. Palea 3.5–3.8×1–1.2 mm, 2 –veined, keels scaberulous. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 1.5 mm long. Ovary 0.5 mm long, style & stigmas 2 mm long overall. **Plate 45.**

Flowering & Fruiting: August–September.

Habitat: On rocky soils.

Distribution: Endemic to India. INDIA: Penninsular region. S. GUJARAT: Tapi, Suarat & Dang.

Voucher specimen: RJD/ 774, 789, 804

40. **Tripogon filiformis** Nees ex Steud. *Syn. Pl. Glumac. 1: 301. 1854; Hooker f. 7:288. 1897; Blatt. & McC. 269. 1935; Bor 521. 1960; Lakshmi. in Sharma et al. 628. 1996;*

Perennial, caespitose. Culms erect, 25–50 cm long. Ligule a ciliolate membrane. Leaf-blades filiform, convolute, 5–17×0.1–0.3 cm. Synflorescence composed of racemes. Racemes single, straight or flexuous, unilateral, 10–40 cm long. Rachis angular. Spikelet packing broadside to rachis, regular, 2–rowed, appressed, solitary, sessile, comprising 5–30 fertile florets, with diminished florets at the apex. Spikelets elliptic or oblong, laterally compressed, 5–10 mm long, breaking up at maturity, disarticulating below each fertile floret. Rachilla internodes glabrous. Floret callus bearded. Glumes persistent, similar, shorter than spikelet. Lower glume lanceolate, asymmetrical, 3–3.5×1–1.2 mm, membranous, 1-keeled, 1-veined, apex obtuse. Upper glume lanceolate 4–4.5×1–1.2 mm, membranous, 1-keeled, 1-veined, apex emarginated or mucronate. Upper lemma lanceolate or elliptic, 2.5–2.8×1.2–1.5 mm, membranous, without keel, 3-veined, apex dentate, 4-fid, awned, 3-awned. Principal lemma awn from a sinus, straight, 3–7 mm long overall. Lateral lemma awns arising on apex of lobes, 0.5–2 mm long. Palea 2–2.5×1–1.2 mm, 2-veined. Apical sterile florets resembling fertile though underdeveloped. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 1.5 mm long. Ovary 0.5 mm long, style & stigmas 2 mm long overall. **Plate 46.**

Flowering & Fruiting: August–September.

Habitat: On rocks, cliffs between the rocks, rocky river banks.

Distribution: China, India, Indo-China, and Malesia. INDIA: Peninsular & N.E. India. S. GUJARAT: Tapi & Dangs. **New record for the State.**

Voucher specimen: RJD/ 226, 233, 567

41. **Sporobolus coromandelianus** (Retz.) Kunth *Révis. Gramin. 1:68. 1829; Hooker f. 7:252. 1897; Blatt. & McC. 228. 1935; Cooke 3:542. 1958; Bor 627. 1960; Shah 2:870. 1978; Karthik. et al. 264. 1989; Pandey in Shetty & Singh 3:1119. 1993; Lakshmi. in Sharma et al. 610. 1996; Roy in Singh et al. 529. 2001.*

Annual, caespitose. Culms geniculately ascending, 5–25 cm long. Ligule a fringe of hairs. Leaf-blades 2–10×0.2–0.5 cm, margins ciliate, hairy at base. Synflorescence a panicle. Panicle open, ovate, 2–6 cm long. 1° panicle branches spreading, whorled at most nodes. Spikelets solitary, pedicelled, comprising 1 fertile florets, without rachilla extension, lanceolate, subterete, 1.2–1.7 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes deciduous, dissimilar, reaching apex of florets. Lower glume ovate, 0.5–0.7×0.5 mm, hyaline, 1-veined, apex obtuse. Upper glume oblong, 1.5–1.7×1–1.2 mm, membranous, grey, 1-veined, smooth, apex acute. Upper lemma oblong, 1.5–1.7×1–1.2 mm, membranous, grey, without keel, 1-veined, scaberulous, apex acute. Palea 1.5–1.7×1–1.2 mm, 2-veined, keeled. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.5 mm long. Ovary 0.5 mm long, style & stigmas 1 mm long overall. **Plate 47.**

Flowering & Fruiting: July–January.

Habitat: Predominant in marshy and moist soil, agricultural fields, waste lands.

Distribution: Africa, western Asia, Arabia, China, Australia. INDIA: Throughout in plains and coast. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 37, 692

42. **Sporobolus diandrus** (Retz.) P.Beauv. *Ess. Agrostogr.* 26. 1812; *S. diander* (Retz.) P. Beauv. *Ess. Agrostogr.* 26, 147 & 178. 1812; *Hooker f.* 7:247. 1897; *Blatt. & McC.* 221. 1935; *Cooke* 3:539. 1958; *Bor* 629. 1960; *Shah* 2:870. 1978; *Pandey in Shetty & Singh* 3:1120. 1993; *Roy in Singh et al.* 529. 2001; *S. indicus* var. *diander* Karthik. *et al.* 264. 1989.

Perennial, caespitose. Butt sheaths herbaceous. Culms erect, 15–90 cm long. Ligule a fringe of hairs. Leaf-blades convolute, 10–25×0.2–0.5 cm, apex attenuate. Synflorescence a panicle. Panicle open, lanceolate, 10–20 cm long, contracted about 1° branches. 1° panicle branches spreading, bearing spikelets almost to the base, branches glabrous in axils. Spikelets solitary, pedicelled, pedicels linear. Fertile spikelets comprising 1 fertile florets, without rachilla extension, lanceolate, subterete, 1.2–1.6 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes deciduous, similar, shorter than spikelet, thinner than Upper lemma. Lower glume oblong, 0.5×0.5 mm, 0-veined, apex obtuse. Upper glume oblong, 0.8–1×0.5 mm, hyaline, 1-veined, apex acute. Upper lemma ovate, 1.5–1.8×0.5–0.7 mm, membranous, 1-veined, apex acute. Palea 1–1.5×0.5–0.8 mm, 2-veined. Lodicules 2, cuneate, fleshy. Anthers 2 per floret, 0.5 mm long. Ovary 0.5 mm long, style & stigmas 1 mm long overall. **Plate 48.**

Flowering & Fruiting: August-December.

Habitat: In open grass lands.

Distribution: Northeast tropical Africa, Asia-temperate, Asia-tropical, Mesoamericana. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 758, 775, 805

43. **Sporobolus ioclados** (Trin.) Nees *Fl. Afr. Austral. Ill.* 161. 1841; Karthik. *et al.* 264. 1989; *Pandey in Shetty & Singh* 3:1122. 1993; *Lakshmi. in Sharma et al.* 614. 1996.

Perennial, caespitose. Butt sheaths herbaceous. Culms erect, up to 70 cm long. Ligule a fringe of hairs. Leaf-blades flat, 2–30×0.2–0.5 cm, margins cartilaginous, glabrous or sparsely ciliate. Synflorescence a panicle. Panicle open, pyramidal, 8–30 cm long. 1° panicle branches spreading, whorled at most nodes; 3–10 cm long, branches glabrous in axils. Spikelets solitary, pedicelled, comprising 1 fertile florets, without rachilla extension, lanceolate, subterete, 1.5–2 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes deciduous, similar, shorter than spikelet. Lower glume oblong, 0.5–0.8×0.4–0.5 mm, membranous, 1-veined, apex obtuse. Upper glume oblong, 0.8–1×0.5–0.8 mm, membranous, grey, 1-veined, smooth, apex acute. Upper lemma oblong, 1.5–1.7×0.5–0.8 mm, membranous, grey, 1-veined, scaberulous, apex acute. Palea 1.5–1.7×0.5–0.8 mm, 2-veined. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.7 mm long. Ovary 0.5 mm long, style & stigmas 1 mm long overall. **Plate 49.**

Flowering & Fruiting: August-October.

Habitat: Waste lands, open grasslands, rocky and moist soil, on river banks.

Distribution: Tropical Africa, western Asia and Arabia, India. INDIA: N. W. India. S. GUJARAT: Throughout. **New record for the State.**

Voucher specimen: RJD/ 26, 606, 680

44. **Sporobolus marginatus** Hochst. ex A.Rich. *Tent. Fl. Abyss.* 2:397. 1850; *Bor* 632. 1960; *Shah* 2:872. 1978; *Karthik. et al.* op. cit. 264; *Roy in Singh et al.* 530. 2001; *S. arabicus sensu Hooker f.* 7:252. 1897; *Blatt. & McC.* 227. 1935; *Cooke* 3:541. 1958.

Perennial, caespitose. Butt sheaths herbaceous, stolons present. Culms erect, 20–80 cm long. Ligule a fringe of hairs. Leaf-blades flat, 8-30×0.2–0.8 cm, margins cartilaginous, glabrous. Synflorescence a panicle. Panicle open or contracted, pyramidal, 4-15 cm long. 1° panicle branches spreading, whorled at most nodes, 3–8 cm long, branches glabrous in axils. Spikelets solitary, pedicelled, comprising 1 fertile florets, without rachilla extension, lanceolate, subterete, 2-2.5×0.8-1 mm, breaking up at maturity, disarticulating below each fertile floret. Glumes deciduous, dissimilar, reaching apex of florets. Lower glume oblong, 0.7-1×0.5-0.7 mm, membranous, without keels, apex obtuse. Upper glume oblong, 2.2–2.5×0.8-1 mm, membranous, grey, 1-veined, smooth, apex acute. Upper lemma oblong, 1.8–2×0.5-0.8 mm, membranous, grey, 1-veined, scaberulous, apex acute. Palea 1.8-2×0.8-1 mm, 2-veined. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 1.5 mm long. Ovary 0.5 mm long, style & stigmas 1 mm long overall. **Plate 50.**

Flowering & Fruiting: August-December.

Habitat: common along the sea coast.

Distribution: Tropical Africa, western Asia and Arabia, India. INDIA: N. W. India. S. GUJARAT: Suart, Navsari, Valsad.

Voucher specimen: RJD/ 431, 605, 607

45. **Sporobolus tenuissimus** (Schrank.) Kuntze *Revis. Gen. Pl.* 3(2):369. 1898; *Bor* 514. 1960; *Karthik. et al.* 265. 1989; *Pandey in Shetty & Singh* 3:1123. 1993; *Lakshmi. in Sharma et al.* 615. 1996; *Roy in Singh et al.* 531. 2001; *S. minutiflorus* (Trin.) Link *Hort. Berol.* 1:88. 1827; *Hooker f.* 7:248. 1897; *Blatt. & McC.* 223. 1935; *Cooke* 3:540. 1958.

Annual. Culms geniculately ascending, 10-50 cm long. Ligule a fringe of hairs. Leaf-blades 5–20×0.2–0.6 cm. Synflorescence a panicle. Panicle open, oblong, effuse, 10–40 cm long, branches capillary, 2-6 cm long, glabrous in axils. Spikelets solitary, pedicelled; pedicels filiform. Spikelets comprising 1 fertile florets, without rachilla extension, lanceolate, subterete, 0.8–1 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes deciduous, dissimilar, shorter than spikelet, gaping. Lower glume oblong, 0.1–0.3×0.4-0.5 mm, membranous, 1-veined, apex erose. Upper glume ovate, 0.5-0.7×0.5-0.7 mm, membranous, 1-veined, apex acute. Upper lemma ovate, 0.8–1×0.5-0.7 mm, membranous, 1-

veined, apex acute. Palea 0.7-1×0.5-0.7 mm, 2-veined. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.5 mm long. Ovary 0.5 mm long, style & stigmas 0.5 mm long overall. **Plate 51.**

Flowering & Fruiting: February - April.

Habitat: Water edges; escape from gardens

Distribution: Africa, Arabia, India, Malesia, Mexico. INDIA: Peninsular India. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 192, 215, 548

46. **Sporobolus virginicus** (L.) Kunth *Révis. Gramin. 1: 67. 1829; Hooker f. 7:249. 1897; Blatt. & McC. 249. 1935; Bor 634. 1960; Shah 2:872. 1978; Karthik. et al. 265. 1989; Lakshmi. in Sharma et al. 615. 1996.*

Perennial, mat forming. Rhizomes elongated. Culms 5–30 cm long. Leaves distichous. Ligule a fringe of hairs. Leaf-blades convolute, 2–10×0.2–0.4 cm, stiff, apex pungent. Synflorescence a panicle. Panicle spiciform, linear, 2–10×0.5–1 cm. 1° panicle branches appressed, 0.5–1.5 cm long, branches glabrous in axils. Spikelets solitary, pedicelled, comprising 1 fertile florets, without rachilla extension. Spikelets lanceolate, subterete, 1.7–2 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes deciduous, similar, reaching apex of florets. Lower glume lanceolate, 1-1.5×0.5-0.7 mm, membranous, apex acute. Upper glume ovate, 1.7-2×0.8-1 mm, membranous, 1-3-veined, apex acute. Upper lemma ovate, 1.7–2×0.7-1 mm, membranous, 1-veined, apex acute. Palea 1.5-1.7×0.8-1 mm, 2-veined. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.5 mm long. Ovary 0.5 mm long, style & stigmas 0.5 mm long overall. **Plate 52.**

Flowering & Fruiting: August-December.

Habitat: In moist places.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Peninsular regions. S. GUJARAT: Surat, Navsari, Valsad.

Voucher specimen: RJD/ 445, 603, 636

47. **Chloris barbata** Sw. *Fl. Ind. Occid. 1: 200 1797; Hooker f. 7:292. 1897; Blatt. & McC. 256. 1935; Cooke 3:557. 1958; Bor 465. 1960; Shah 2:789. 1978; Karthik. et al. 197. 1989; Pandey in Shetty & Singh 3:998. 1993; Lakshmi. in Sharma et al. 425. 1996; Roy in Singh et al. 387. 2001.*

Perennial, caespitose. Culms geniculately ascending, 20–100 cm long, branches sparse. Leaf-sheaths keeled. Ligule a ciliolate membrane, truncate. Leaf-blades 8–20×0.2–0.8 cm, surface scaberulous, apex attenuate, filiform. Synflorescence composed of racemes. Racemes 5–20, digitate, unilateral, 3–8 cm long. Rachis subterete. Spikelet packing broadside to rachis, solitary, sessile, comprising 1 fertile florets, with diminished florets at the apex, laterally compressed, 2.5–3.5 mm long, breaking up at maturity, disarticulating below each fertile floret. Floret callus bearded. Glumes persistent, similar, thinner than Upper lemma, gaping. Lower glume lanceolate, 0.5-1 mm, membranous, 1-keeled, 1-veined, apex acute. Upper glume

lanceolate, 1.5-1.8×0.8-1 mm, membranous, 1-keeled, 1-veined, setaceously attenuate. Upper lemma obovate, laterally compressed, elliptic, 2.2-2.5×1.2-1.5 mm, cartilaginous, pallid, keeled, 3-veined, surface with conspicuous apical hairs, margins pubescent, hairs 1.5–4 mm long; apex obtuse, awned, 1-awned, awn subapical; 3–6 mm long overall. Apical sterile florets 2 in number, barren, oblong, 1–1.5 mm long. Apical sterile lemmas glabrous awned, 1-awned, awns subapical, 2–4 mm long, 1 per spikelet in number. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.8 mm long. Ovary 0.5 mm long, style & stigmas 1.5 mm long overall. **Plate 53.**

Flowering & Fruiting: July-April.

Habitat: Common in plains.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, Mexico, South America. INDIA: Throughout inn plains. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 231, 498, 564

48. **Chloris quinquesetica** Bhide *J. Proc. Asiat. Soc. Bengal* 8: 311. 1912; Blatt. & McC. 257. 1935; Bor 466. 1960; Shah 2:799. 1978; Karthik. *et al.* 197. 1989; Pandey in Shetty & Singh 3:1000. 1993; Lakshmi. in Sharma *et al.* 427. 1996.

Perennial. Stolons present. Culms geniculately ascending or decumbent, 5-25 cm long, rooting from lower nodes. Ligule a ciliolate membrane. Leaf-blades 7–15×0.2–0.4 cm, scaberulous, glabrous, hairy abaxially, apex attenuate. Synflorescence composed of racemes. Peduncle hirsute above. Racemes 3–8, digitate, ascending, unilateral, 1–3 cm long. Rachis villous on surface. Spikelet packing broadside to rachis, solitary, sessile, comprising 1 fertile florets, with diminished florets at the apex, laterally compressed, 3–3.5 mm long, breaking up at maturity, disarticulating below each fertile floret. Floret callus bearded. Glumes persistent, similar, thinner than Upper lemma, gaping. Lower glume lanceolate, 1.7-2×0.7-1 mm, membranous, 1-keeled, 1-veined, apex acute. Upper glume lanceolate, 2.5-2.8×0.8-1 mm, membranous, 1-keeled, 1-veined, setaceously attenuate. Upper lemma obovate, laterally compressed, elliptic, 2.2-2.5×1.5-2 mm, cartilaginous, pallid, keeled, 3-veined, surface with conspicuous apical hairs, margins pubescent, hairs 1.5–4 mm long; apex obtuse, awned, 1-awned, awn subapical; 4-8 mm long overall. Apical sterile florets 3-4 in number, barren, oblong, 1-1.5 mm long. Apical sterile lemmas glabrous awned, 1-awned, awns subapical, 2-6 mm long, 1 per spikelet in number. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.8 mm long. Ovary 0.5 mm long, style & stigmas 1.5 mm long overall. **Plate 54.**

Flowering & Fruiting: September- December.

Habitat: Near sea coast.

Distribution: Arabia & India. INDIA: N. W. India. S. GUJARAT: Surat, Navsari, Valsad.

Voucher specimen: RJD/ 338, 534, 568

49. ***Chloris virgata*** Sw. *Fl. Ind. Occid.* 1: 203. 1797; *Hooker f.* 7:291. 1897; *Blatt. & McC.* 255. 1935; *Bor* 468. 1960; *Shah* 2:799. 1978; *Karthik. et al.* 197. 1989; *Pandey in Shetty & Singh* 3:1001. 1993; *Lakshmi. in Sharma et al.* 427. 1996; *Roy in Singh et al.* 388. 2001.

Annual, caespitose. Culms geniculately ascending or decumbent, 30–120 cm long, rooting from lower nodes. Leaf-sheaths keeled. Ligule a ciliolate membrane. Leaf-blades 10–30×0.2–0.8 cm, apex attenuate. Synflorescence composed of racemes. Racemes 4–12, digitate, spreading, unilateral, 2–10 cm long. Spikelet packing broadside to rachis, solitary, sessile, comprising 1 fertile florets, with diminished florets at the apex, laterally compressed, 2.5–3.5 mm long, breaking up at maturity, disarticulating below each fertile floret. Floret callus bearded. Glumes persistent, similar, thinner than Upper lemma, gaping. Lower glume lanceolate, 1.5–1.8×0.5–0.8 mm, membranous, 1-keeled, 1-veined, apex acute. Upper glume lanceolate, 2.5–2.8×0.8–1 mm, membranous, 1-keeled, 1-veined, setaceously attenuate or awned, awn 1.5 mm long. Upper lemma obovate, laterally compressed, elliptic, 2.5–3×1.2–1.5 mm, cartilaginous, pallid, keeled, 5-veined, surface with conspicuous apical hairs, margins pubescent, hairs 1.5–4 mm long; apex obtuse, awned, 1-awned, awn subapical; 8–12 mm long overall. Apical sterile florets 2 in number, barren, oblong, 1–1.5 mm long. Apical sterile lemmas glabrous awned, 1-awned, awns subapical, 2–6 mm long, 1 per spikelet in number. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 0.4 mm long. Ovary 0.3 mm long, style & stigmas 1 mm long overall. **Plate 55.**

Flowering & Fruiting: August–December.

Habitat: Common on graasy hills.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout the hotter parts. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 224, 536, 732

50. ***Cynodon barberi*** Rang. & Tadul. in *JBNHS* 24:846. 1916; *Bor* 469. 1960; *Shah* 2:807. 1978; *Karthik. et al.* 203. 1989; *Pandey in Shetty & Singh* 3:1011. 1993; *Lakshmi. in Sharma et al.* 442. 1996; *Roy in Singh et al.* 399. 2001.

Perennial. Stolons present. Culms geniculately ascending, 15–40 cm long, rooting from lower nodes, nodes glabrous. Leaf-sheaths 1–1.5 cm long, keeled. Ligule a ciliolate membrane. Leaf-blades linear or lanceolate, 1–6×0.3–0.4 cm, glabrous, sparsely hairy adaxially, margins scaberulous, apex acute. Synflorescence composed of racemes. Racemes 4–7, digitate, unilateral, 1–3 cm long. Rachis narrowly winged, flattened, bases pubescent. Spikelet packing broadside to rachis, regular, 2-rowed, appressed, solitary, sessile, comprising 1 fertile florets, without rachilla extension, oblong, laterally compressed, 2.5–3 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes deciduous, similar, reaching apex of florets, thinner than Upper lemma. Lower glume oblong, 1.5–2×0.7–1 mm, membranous, 1-keeled, 1-veined, apex acute. Upper glume oblong, 2.2–2.5×1–1.2 mm, membranous, 1-keeled, 1-veined, apex acute, muticous. Upper lemma ovate, laterally compressed, 2–2.2×2–2.2 mm, cartilaginous, keeled, 3-veined, hairy on veins, hairs clavate, apex acute. Palea 1.5–

1.8×0.8-1 mm, 2-veined, keels ciliolate. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 1.5 mm long. Ovary 0.8 mm long, style & stigmas 1.5 mm long overall. **Plate 56.**

Flowering & Fruiting: February - April.

Habitat: As a weed in agricultural fields on hills.

Distribution: Endemic to India. INDIA: S. W. India. S. GUJARAT: Surat.

Voucher specimen: RJD/ 767, 768

51. **Cynodon dactylon** (L.) Pers. *Syn. Pl. 1: 85. 1805; Hooker f. 7:288. 1897; Blatt. & McC. 249. 1935; Cooke 3:554. 1958; Bor 469. 1960; Shah 2:808. 1978; Karthik. et al. 203. 1989; Pandey in Shetty & Singh 3:1011. 1993; Lakshmi. in Sharma et al. 442. 1996; Roy in Singh et al. 400. 2001.*

Perennial, mat forming. Rhizomes elongated. Stolons present. Culms geniculately ascending, 8–40 cm long. Ligule a ciliolate membrane. Leaf-blades flat or conduplicate, 1–8×0.2–0.4 cm, glaucous, scaberulous, sparsely hairy. Synflorescence composed of racemes. Racemes 4–6, digitate, unilateral, 1.5–6 cm long. Rachis flattened. Spikelet packing broadside to rachis, regular, 2-rowed, appressed, solitary, sessile, comprising 1 fertile florets, without rachilla extension, oblong, laterally compressed, 2-2.5 mm long, breaking up at maturity, disarticulating below each fertile floret. Glumes deciduous, similar, reaching apex of florets, thinner than Upper lemma. Lower glume oblong, 1-1.2×0.5 mm, membranous, 1-keeled, 1-veined, apex acute. Upper glume oblong, 1.5-1.7×0.5-0.7 mm, membranous, 1-keeled, 1-veined, apex acute. Upper lemma ovate, laterally compressed, 2-2.2×1-1.2 mm, cartilaginous, keeled, 3-veined, hairy on veins, apex acute. Palea 1.8-2×0.8-1 mm, 2-veined, keels ciliolate. Lodicules 2, cuneate, fleshy. Anthers 3 per floret, 1.5 mm long. Ovary 0.7 mm long, style & stigmas 1.5 mm long overall. Flowering & Fruiting: Throughout the year. **Plate 57.**

Habitat: Common everywhere.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, New Zealand, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 36, 247, 313

52. **Enteropogon dolichostachyus** (Lag.) Keng *Clav. Gen. Sp. Gram. Prim. Sin. 197. 1957; Chloris dolichostachya* Lag. *Gen. Sp. Pl. 5. 1816; Bor 466. 1960; Shah 2:798. 1978; Karthik. et al. 197. 1989; Pandey in Shetty & Singh 3:999. 1993; Lakshmi. in Sharma et al. 426. 1996; Roy in Singh et al. 387. 2001; C. incompleta* Roth. *Nov. Pl. Sp. 60. 1821; Hooker f. 7:290. 1897; Cooke 3:290. 1958; Blatt. & McC. 255. 1935.*

Perennial, caespitose. Culms geniculately ascending, up to 150 cm long. Leaf-sheaths outer margin hairy. Ligule a fringe of hairs. Leaf-blades flat or involute, 12–30 cm long×0.6-0.8 cm, glaucous, margins scabrous. Synflorescence composed of racemes. Racemes 4–10, digitate, drooping, unilateral, 10–20 cm long. Rachis angular. Spikelet packing broadside to rachis, regular, 2-rowed, appressed, solitary, sessile. Fertile spikelets comprising 1 fertile florets, with diminished florets at the apex. Spikelets elliptic, dorsally compressed, 5-6 mm long, breaking up at maturity, disarticulating below each fertile floret. Floret callus evident,

pilose. Glumes persistent, dissimilar, shorter than spikelet, thinner than Upper lemma, gaping. Lower glume lanceolate, 2.5-2.7×0.5 mm, membranous, 1-veined, vein scaberulous, apex acuminate. Upper glume lanceolate; 5-6×1-1.2 mm, membranous, 1-veined, vein scaberulous, mucronate. Upper lemma elliptic, dorsally compressed, 5-5.5×0.8-1 mm, coriaceous, keeled, 3-veined, midvein scaberulous, lateral veins excurrent, scaberulous, apex awned 8 mm long overall. Palea 2-veined, keels scaberulous, 5-5.2×0.8-1 mm. Apical sterile florets 1 in number, lanceolate, 2 mm long. Apical sterile lemmas awned, 1-awned, awn 5-6mm long. Lodicules 2. Stamens 3, anther 2mm long. Ovary 0.5mm long, style & stigma 2mm long overall. **Plate 58.**

Flowering & Fruiting: August-December.

Habitat: Occasional in shady forests.

Distribution: Asia-temperate, Asia-tropical, Australia. INDIA: Throughout in plains. S. GUJARAT: Dangs.

Voucher specimen: RJD/ 622, 659, 760

53. **Tetrapogon tenellus** (Roxb.) Chiov. *Annuario Reale Ist. Bot. Roma* 8: 352. 1908; *Bor* 475. 1960; *Shah* 2:873. 1978; Karthik. *et al.* 267. 1989; *Pandey in Shetty & Singh* 3:1028. 1993; Lakshmi. *in Sharma et al.* 618. 1996; *Roy in Singh et al.* 532. 2001; *Chloris tenella* J.Koenig ex Roxb. *Fl. Ind.* 1: 330. 1820; Hooker f. 7: 290. 1897; *Cooke* 3:291. 1958; *Blatt. & McC.* 254. 1935.

Perennial, short-lived, caespitose. Culms erect or geniculately ascending, 10-35 cm long. Ligule a ciliolate membrane. Leaf-blades 3-10×0.2-0.4 cm, apex attenuate. Synflorescence composed of racemes. Racemes single, ascending, unilateral, 3-5 cm long. Rachis angular. Spikelet packing broadside to rachis, regular, 2-rowed, ascending, solitary. Fertile spikelets sessile, comprising 3-4 fertile florets, with diminished florets at the apex. Spikelets cuneate, laterally compressed, 4-6 mm long, breaking up at maturity, disarticulating above glumes but not between florets. Floret callus pilose. Glumes persistent, similar, shorter than spikelet, thinner than Upper lemma, gaping. Lower glume lanceolate, 3-3.5×1-1.2 mm, membranous, 1-keeled, 1-veined, apex setaceously attenuate. Upper glume lanceolate, 4-4.5×1.2-1.5 mm long, membranous, 1-keeled, 1-veined, setaceously attenuate. Upper lemma obovate, 4.5-5×2-2.2 mm, coriaceous, keeled, 3-veined, midvein eciliate, margins ciliolate, apex awned, awn subapical, 4-7 mm long overall. Palea 4-4.5×1.2-1.5 mm, 2-veined, keels ciliolate. Apical sterile florets 1-2 in number, barren, in a clump, cuneate. Apical sterile lemmas muticous-awned. Lodicules 2. Stamens 3, anther 2mm long. Ovary 0.8mm long, style & stigma 3mm long overall. **Plate 59.**

Flowering & Fruiting: August-December.

Habitat: Occasional in saline areas.

Distribution: Africa, Arabia. India. INDIA: Peninsular & N. W. India. S. GUJARAT: Surat.

Voucher specimen: RJD/ 362, 501, 655

54. **Melanocenchris jacquemontii** Jaub. & Spach *Ill. Pl. Orient.* 4: 36 1851; *Bor* 473. 1960; *Shah* 2:842. 1978; Karthik. *et al.* 237. 1989; *Pandey in Shetty & Singh* 3:1074.

1993; Lakshmi. in Sharma et al. 437. 1996; Roy in Singh et al. 462. 2001; *Gracilea Shetty leana* Hooker f. 7:284. 1897; Blatt. & McC. 248. 1935; Cooke 3:553. 1958.

Annual. Culms geniculately ascending or decumbent, 6–15 cm long. Ligule a fringe of hairs. Leaf-blades filiform, 2–7×0.1–0.2 cm. Synflorescence composed of racemes. Racemes 4–10, borne along a central axis, distant, spreading, cuneate, unilateral, 0.8–1 cm long, bearing few fertile spikelets, bearing 1–2 fertile spikelets on each. Peduncle 2.5–6 cm long. Rachis deciduous from axis, flattened, terminating in a barren bristle like extension. Spikelets appressed, solitary, sessile. Apical sterile spikelets barren, 2–4 in number, cuneate, dorsally compressed, 7–9 mm long, falling entire, deciduous with accessory branch structures. Fertile Spikelets comprising 1 fertile florets, with diminished florets at the apex. Glumes collateral, similar, shorter than spikelet. Lower glume linear, 2.5–3×0.5–0.8 mm, coriaceous, 3-veined, villous, glume apex awned, 1-awned, awn 5–7 mm long. Upper glume oblong, 3–4×1.2–1.5 mm, coriaceous, with hyaline margins, margins ciliolate, 3-veined, villous, apex awned, 1-awned, awn 4–6 mm long. Upper lemma elliptic, 5.5–6×1.5–2 mm, membranous, much thinner on margins, keeled, 3-veined, apex 3-fid, awned, 3-awned, 2–2.5 mm long overall, lateral awns arising on apex of lobes, shorter than principal. Palea 3–3.5×1–1.2 mm, 2-veined, apex 2-fid. Apical sterile florets 2–4 in number, dissimilar. First apical floret male, ovate, 2.5–3 mm long, muticous. Apical sterile florets barren, cuneate, 1.2 mm long. Apical sterile lemmas truncate. Lodicules 2. Stamens 3, anther 1mm long. Ovary 0.5mm long, style & stigma 1.5mm long overall. **Plate 60.**

Flowering & Fruiting: August–December.

Habitat: Common on rocky soil.

Distribution: Northeast tropical Africa, western Asia. INDIA: Throughout in drier parts. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 255, 623, 667

55. **Perotis indica** (L.) Kuntze *Revis. Gen. Pl.* 2: 787. 1891; Blatt. & McC. 220. 1935; Bor 611. 1960; Shah 2:856. 1978; Karthik. et al. 246. 1989; Pandey in Shetty & Singh 3:1096. 1993; Lakshmi. in Sharma et al. 568. 1996; Roy in Singh et al. 493. 2001; *Anthoxanthum indicum* L. *Sp. Pl.* 28. 1753; Hooker f. 7:98. 1897; Cooke 3:538. 1958.

Annual; caespitose. Culms geniculately ascending, 10–40 cm long. Ligule an eciliate membrane. Leaf-blades lanceolate or ovate, 1–3×0.2–0.7 cm. Synflorescence composed of racemes. Racemes 1, single, multilateral, 8–15 cm long. Spikelet packing crowded or contiguous, irregular. Spikelets ascending, solitary, pedicelled, pedicels oblong, 0.2 mm long, comprising 1 fertile florets, without rachilla extension. Spikelets linear, subterete, 1.5–2 mm long, falling entire. Spikelet callus oblong, 0.2–0.5 mm long. Glumes similar, exceeding apex of florets, firmer than Upper lemma. Lower glume lanceolate, 1.5–1.7×1–1.2 mm, membranous, 1-veined, hispidulous, apex awned, awn 8–15 mm long. Upper glume lanceolate, 1.5–1.7×1–1.2 mm, membranous, 1-veined, hispidulous, apex awned, 8–15 mm long. Upper lemma lanceolate, 1–1.5×0.5–0.7 mm, hyaline, 1-veined, apex acute. Palea 0.5–0.7 ×0.5mm, hyaline. Lodicules 2. Stamens 3, anther 1.5mm long. Ovary 0.5mm long, style & stigma 2mm long overall. **Plate 61.**

Flowering & Fruiting: August-October.

Habitat: Roadsides, weedy places, on sandy soil.

Distribution: Africa, China and eastern Asia, India, China, Malesia, Australia. INDIA: Throughout in plains. S. GUJARAT: Surat, Tapi.

Voucher specimen: RJD/ 354, 407, 512

56. **Tragus mongolorum** Ohwi *Acta Phytotax. Geobot.* 10: 268. 1941; *T. roxburghii* Panigrahi *Kew Bull.* 29: 496 1974; Pandey in Shetty & Singh 3:1131. 1993; Lakshmi. in Sharma et al. 624. 1996; Roy in Singh et al. 538. 2001; *T. recemosus* Hooker f. 7:288. 1897; Cooke 3:535. 1958; *T. biflorus* (Roxb.) Schult. *Sys. Veg.* 2. Mant. 205. 1824; Bor 682. 1960; Shah 2:877. 1978; *Nazia racemosa* auct. non O. Ktze. 1891; Blatt. & McC. 269. 1935.

Annual, caespitose. Culms 10–25 cm long. Ligule a fringe of hairs. Leaf-blades 1–4×0.3–0.6 mm. Synflorescence composed of racemes, subtended by an inflated leaf-sheath. Racemes numerous, borne along a central axis, closely spaced, in a multilateral false spike, spreading, cuneate, 0.4–0.9 cm long, bearing 2 fertile spikelets on each. Peduncle 2–7 cm long. Rachis evident, deciduous from axis, subterete, terminating in a barren subulate extension. Raceme-bases linear, 0.5–1.5 mm long, pubescent, hairy in axils. Spikelets solitary, sessile. Apical sterile spikelets rudimentary. Fertile Spikelets comprising 1 fertile florets, without rachilla extension. Spikelets lanceolate, dorsally compressed, 4–4.5 mm long, falling entire, deciduous with accessory branch structures. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume ovate, 0.5–1 mm long, hyaline, veinless, apex acute. Upper glume elliptic, 4–4.5×1.5–2 mm long, membranous, 5-veined, veins thickened, surface with hooked spines, apex acuminate. Upper lemma elliptic, dorsally compressed, 2–2.5×1–1.2 mm, membranous, 3-veined, apex acuminate. Palea ovate, 2–2.5×0.7–1 mm, 2-veined. Lodicules 2; cuneate; fleshy. Lodicules 2. Stamens 3, anther 0.8–1mm long. Ovary 0.2mm long, style & stigma 2mm long overall. **Plate 62.**

Flowering & Fruiting: July-October.

Habitat: Hill slopes, roadsides.

Distribution: Europe, Africa, Asia-temperate, USA, southern & western South America. INDIA: Throughout in drier plains. S. GUJARAT: Suart, Tapi.

Voucher specimen: RJD/ 234, 474, 500

57. **Zoysia matrella** (L.) Merr. *Philipp. J. Sci.*, C 7:230. 1912; Bor 684. 1960; Shah 2:882. 1978; Lakshmi. in Sharma et al. 632. 1996; *Z. pungens* Willd. in *Ges. Naturf. Fr. Berlin Neue Schr.* 3:441. 1801; Hooker f. 7:99. 1897; Cooke 3:537. 1958; *Osterdamia matrella* (L.) O. Ktze. *Rev. Gen. Pl.* 2:781. 1891; Blatt. & McC. 219. 1935.

Perennial, mat forming. Rhizomes elongated. Stolons present. Culms prostrate, 5–20 cm long, wiry. Leaf-sheaths longer than internode, glabrous. Ligule a ciliate membrane. Leaf-blades filiform or linear, involute, 2–10×0.1–0.3 cm. Synflorescence composed of racemes. Racemes single, multilateral, 0.5–4 cm long. Spikelets ascending, solitary, pedicelled, pedicels 0.3–1

mm long. Fertile Spikelets comprising 1 fertile florets, without rachilla extension, lanceolate to ovate, laterally compressed, 2–2.5 mm long, falling entire. Lower glume absent. Upper glume lanceolate to ovate, 2-2.5×1.2-1.5 mm, exceeding apex of florets, firmer than Upper lemma, shiny, coriaceous, without keels, 3-5-veined, apex acute or mucicous. Upper lemma oblong; 2–2.2×1-1.2 mm, hyaline, 1-veined, apex emarginate. Palea hyaline, 0.5mm long. Lodicules 2. Stamens 3, anther 1.5mm long. Ovary 0.5mm long, style & stigma 3mm long overall. **Plate 63.**

Flowering & Fruiting: July-October.

Habitat: lawn grass, escape from garden.

Distribution: West tropical Africa, China, eastern Asia, Asia-tropical, Australia, Mexico, South America. INDIA: Cultivated throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 143, 530, 718

58. **Alloteropsis cimicina** (L.) Stapf *Fl. Trop. Afr.* 9:487 1919; *Blatt. & McC.* 129. 1935; *Bor* 276. 1960; *Shah* 2:775. 1978; *Karthik. et al.* 181. 1989; *Pandey in Shetty & Singh* 3:970. 1993; *Lakshmi. in Sharma et al.* 389. 1996; *Roy in Singh et al.* 357. 2001; *A. cimicinus* (L.) P. Beauv. *Ess. Agrost.* 12. 1812; *Hooker f.* 7:64. 1897; *Cooke* 3: 441. 1958.

Annual, caespitose. Culms erect or geniculately ascending, 15–120 cm long, nodes bearded. Leaf-sheaths loose, open for most of their length, 5–12 cm long, striately veined, hirsute, with tubercle-based hairs. Ligule a fringe of hairs. Leaf-blade lanceolate or ovate, base amplexicaul, 3–15×0.5–2 cm, midrib evident, surface ribbed, glabrous, margins tuberculate-ciliate, apex acute. Synflorescence composed of racemes. Racemes 4–11, digitate or borne along a central axis, unilateral, 7–25 cm long. Peduncle 1–10 cm long, puberulous. Rachis angular, scabrous on surface. Raceme-bases filiform 10–30 mm long, hairy at base. Spikelet packing irregular, ascending, in pairs or clustered at each node. Fertile spikelets pedicelled, 2–4 in the cluster, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets ovate, dorsally compressed, 3–4×2-2.5 mm, falling entire. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume ovate, 2–2.2×1-1.5 mm, membranous, 3-veined, apex acuminate. Upper glume ovate, 3–3.5×3-3.5 mm, cartilaginous, 5-veined, margins ciliate, hairs 1–2mm, purple coloured, apex acuminate. Basal sterile florets male, with palea. Lemma of lower sterile floret ovate, 3–3.2×2-2.5 mm, membranous, 5-veined, acute. Lower Palea 3-3.2×2-2.5 mm, membranous, 2-veined, toothed. Upper lemma oblong or ovate, 2.5-3×1.5-1.7 mm, chartaceous, 5-veined, margins involute, apex awned, 1-awned. Palea 1.5-2×1-1.5 mm, chartaceous, glabrous, apex entire. Lodicules 2. Stamens 3, anther 1mm long. Ovary 0.5mm long, style & stigma 1.5-2mm long overall, purple coloured. **Plate 64.**

Flowering & Fruiting: Throughout the year.

Habitat: In plains & Foot hills

Distribution: Tropical Africa, China. Asia-tropical, Australia, southeast USA. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 6, 562, 698

59. **Echinochloa colona** (L.) Link *Hort. Berol.* 2: 209 1833; *Blatt. & McC.* 148. 1935; *Bor* 308. 1960; *Shah* 2:817. 1978; *Karthik. et al.* 211. 1989; *Pandey in Shetty & Singh* 3:1032. 1993; *Lakshmi. in Sharma et al.* 472. 1996; *Roy in Singh et al.* 416. 2001; *Panicum colonum* L. *Syst. Nat. ed. 10.* 2: 870; *Hooker f.* 7:32. 1897; *Cooke* 3:447. 1958.

Annual, caespitose. Culms geniculately ascending or decumbent, 10–100 cm long. Leaf-sheaths glabrous on surface. Ligule absent. Leaf-blades 5–30×0.2–1 cm. Synflorescence composed of racemes. Racemes borne along a central axis, ascending or appressed, unilateral, 0.5–3 cm long, simple. Peduncle 1–10 cm long. Rachis angular. Spikelet packing crowded, regular, 4-rowed, in pairs or clustered at each node. Fertile spikelets sessile-subsessile, 2–4 in the cluster, subequal, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets orbicular, slightly dorsally compressed, gibbous, acuminate, 2.5–3×1.2–1.5 mm, falling entire. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume ovate, 1.3–1.8×1.2–1.5 mm, membranous, pallid, 3-veined, scabrous, apex acute. Upper glume ovate, membranous, 2.5–3×1.5–1.7 mm, pallid, 5-veined, pubescent, apex cuspidate. Basal sterile florets male, with palea. Lemma of lower sterile floret similar to upper glume, ovate, 2.5–3×2.2–2.5 mm, membranous, 5–7-veined, pubescent, acute. Lower Palea 1.8–2×1.2–1.5 mm, membranous, 2-veined, toothed. Upper lemma ovate, gibbous, 2–2.2×1–1.5 mm, indurate, much thinner above, shiny, 5-veined, margins involute, apex acute, laterally pinched. Palea reflexed at apex, 2–2.2×1–1.5 mm, indurate. Lodicules 2. Stamens 3, anther 1.5mm long. Ovary 0.5mm long, style & stigma 2mm long overall, purple-white coloured.

Plate 65.

Flowering & Fruiting: Throughout the year.

Habitat: Common in all habitats.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 21, 61, 112, 561

60. **Echinochloa crus-galli** (L.) P.Beauv. *Ess. Agrostogr.* 53. 1812; *Blatt. & McC.* 150. 1935; *Bor* 310. 1960; *Karthik. et al.* 211. 1989; *E. crus-galli* var. *submutica* Neilr. *Fl. Neid. Ost.* 31. 1859; *Bor op. cit.*; *Panicum crus-galli* L. *Sp. Pl.* 56. 1753; *Hooker f.* 7:30. 1897; *Shah* 2:817. 1978; *Pandey in Shetty & Singh* 3:1033. 1993; *Lakshmi. in Sharma et al.* 472. 1996; *Roy in Singh et al.* 417. 2001.

Annual, caespitose. Culms geniculately ascending or decumbent, 30–120 cm long. Leaf-sheaths glabrous on surface. Ligule absent. Leaf-blades 8–20×0.8–1 cm. Synflorescence composed of racemes. Racemes 5–15, borne along a central axis, ascending, unilateral, 4–15 cm long, with branchlets at base of longer racemes. Peduncle 6–22 cm long. Rachis angular, with scattered hairs, scabrous on margins. Fertile spikelets sessile and Pedicelled, crowded, irregular, 2–4-rowed, subequal. Pedicels oblong, 0.5–1 mm long. Fertile spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension, elliptic, dorsally compressed, gibbous, acuminate, 3–4 mm long, falling entire. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume oblate, 2–2.2×1.8–2 mm, without keels, 3-veined,

scabrous, apex cuspidate. Upper glume ovate, membranous, without keels, 3.2-3.5×1.8–2 mm, 5-veined, hispid, apex cuspidate-awned, awned 2mm long. Basal sterile florets male, with palea. Lemma of lower sterile floret similar to upper glume, ovate, 3–3.2×1.8–2 mm, membranous, 7-9-veined, hispid, awned, awn terminal, 1–5 mm long. Lower Palea 3-3.2×1.2-1.5 mm, membranous, 2-veined, toothed. Upper lemma ovate, gibbous, 3.2-3.5×1.5-1.8 mm, indurate, much thinner above, yellow, shiny, 5-veined, margins involute, acute, laterally pinched. Palea reflexed at apex, 3–3.2×1.2–1.5 mm, indurate. Lodicules 2. Stamens 3, anther 1.5mm long. Ovary 0.5mm long, style & stigma 2mm long overall, purple coloured. **Plate 66.**

Flowering & Fruiting: August-November.

Habitat: In moist places, water margin, damp places

Distribution: Europe, Asia-temperate, Indo-China, Malesia, and Papuasias, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 105, 190, 617

61. *Echinochloa crus-pavonis* (Kunth) Schult. *Mant.* 2:269 1824; *Bor* 310. 1960; Karthik. *et al.* 211. 1989; *Pandey in Shetty & Singh* 3:1034. 1993; *Panicum crus-galli* Hooker *f.* 7:30. 1897, *pro parte non L.* 1753.

Perennial. Culms geniculately ascending or decumbent, robust, up to 2m long, rooting from lower nodes. Leaf-sheaths smooth. Ligule absent. Leaf-blades 15–60×0.5–2.5 cm. Synflorescence composed of racemes. Racemes numerous, borne along a central axis, unilateral, 4–20 cm long, 2° branched, 2° branches racemulose. Peduncle 10–30 cm long. Rachis angular. Spikelet packing 4-rowed, solitary or clustered at each node. Fertile spikelets sessile, 2–4 in the cluster, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, gibbous, acuminate, 3–5 mm long, falling entire. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume ovate, clasping, 2-2.2×1.8–2 mm, membranous, 3–5-veined, surface hispid, apex acute. Upper glume ovate, membranous, 5-veined, 3.2-3.5×1.8–2 mm, hispid, apex cuspidate-awned, awn 2-4 mm long. Basal sterile florets male or barren, with palea. Lemma of lower sterile floret similar to upper glume, ovate, 2.2-2.5×1.8–2 mm, membranous; 5-7-veined, hispid, awned, awn 5-15 mm long. Lower Palea 2.2-2.5×1-1.2 mm, membranous, 2-veined, toothed. Upper lemma ovate, gibbous, 3-3.2×1.5-1.8 mm, indurate, much thinner above, shiny, 5-veined, margins involute, apex acuminate, laterally pinched. Palea reflexed at apex, indurate, 2.2-2.5×1-1.5 mm. Lodicules 2. Stamens 3, anther 1.5mm long. Ovary 0.8-1mm long, style & stigma 2mm long overall, purple coloured. **Plate 67.**

Flowering & Fruiting: September-December.

Habitat: River banks.

Distribution: Africa, China, Asia-tropical, Australia, New Zealand, North America, South America. INDIA: E. & S. India. S. GUJARAT: Surat. **New report for the state.**

Voucher specimen: RJD/ 242, 391, 696

62. **Echinochloa frumentacea** Link *Hort. Berol.* 1: 204 1827; *Bor* 311. 1960; *Shah* 816. 1978; *Karthik. et al.* 211. 1989; *Pandey in Shetty & Singh* 3:1034. 1993; *Lakshmi. in Sharma et al.* 473. 1996; *Roy in Singh et al.* 417. 2001; *E. colona* var. *frumentacea* (Link) *Ridl. Fl. Mal. Penin.* 5: 223. 1925; *Blatt. & McC.* 149. 1935; *Panicum crus-galli* var. *frumentaceum* *Hooker f.* 7:31. 1897; *P. stagninum* var. *frumentaceum* *Trim. Cat. Ceyl. Pl.* 104. 1885; *Cooke* 3:447. 1958.

Annual. Culms erect, robust, 30–150 cm long. Leaf-sheaths glabrous on surface. Ligule absent. Leaf-blades 10–30×0.5–2 cm. Synflorescence composed of racemes. Racemes numerous, borne along a central axis, closely spaced, unilateral, 1–3 cm long, simple. Peduncle 6–20 cm long. Rachis angular, pilose on surface. Spikelet packing crowded, 4–6-rowed, in pairs or clustered at each node. Fertile spikelets sessile, 2–4 in the cluster. Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets orbicular, slightly dorsally compressed, gibbous, acuminate, 3–3.5×2–2.5 mm, persistent. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume ovate, 1–1.5×2–2.5 mm, membranous, pallid, 3–5-veined, pubescent, apex acute. Upper glume ovate, membranous, pallid, 5-veined, pubescent, apex cuspidate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret similar to upper glume, ovate, 3–3.5×2–2.5 mm, membranous, 7-veined, pubescent, acute. Lower Palea 2.5–2.7×1.2–1.5 mm, membranous, 2-veined, toothed. Upper lemma ovate, gibbous, 3–3.2×1–1.5 mm, indurate, much thinner above, shiny, 5-veined, margins involute, apex acute, laterally pinched. Palea reflexed at apex, 3–3.2×1–1.5 mm, indurate. Lodicules 2. Stamens 3, anther 1.5mm long. Ovary 0.5mm long, style & stigma 2mm long overall, purple coloured. **Plate 68.**

Flowering & Fruiting: November-February.

Habitat: In Agricultural fields.

Distribution: Tropical Africa, Asia-temperate, India, Australia, southern South America. INDIA: Throughout. S. GUJARAT: Cultivated in Valsad & Dangs.

Voucher specimen: RJD/ 238, 786

63. **Echinochloa stagnina** (Retz.) P.Beauv. *Ess. Agrostogr.* 161. 1812; *Blatt. & McC.* 151. 1935; *Bor* 311. 1960; *Shah* 2:818. 1978; *Karthik. et al.* 211. 1989; *Pandey in Shetty & Singh* 3:1034. 1993; *Lakshmi. in Sharma et al.* 473. 1996; *Roy in Singh et al.* 417. 2001; *Panicum stagninum* *Retz. Obs. Bot.* 5:17. 1789; *Cooke* 3:446. 1958; *P. crus-galli sensu Hooker f.* 7:30. 1897.

Perennial. Rhizomes elongated. Culms decumbent or prostrate, 30–200 cm long, spongy, rooting from lower nodes, Leaf-sheaths glabrous on surface. Ligule a fringe of hairs. Leaf-blades 10–45×0.3–2 cm. Synflorescence composed of racemes. Racemes borne along a central axis, simply spaced, flexuous, unilateral, 2–8 cm long, simple. Peduncle 6–15 cm long. Rachis angular. Spikelet packing irregular, 4-rowed, in pairs, sessile, comprising 1 basal sterile & 1 fertile florets, without rachilla extension, elliptic, dorsally compressed, gibbous, acuminate, 3–4 mm long, falling entire. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume oblate, 2–2.2×1.8–2 mm, without keels, 3-veined, scabrous, apex cuspidate. Upper glume ovate, membranous, without keels, 3.2–3.5×1.8–2 mm, 5-veined,

hispid, apex cuspidate-awned, awned 2mm long. Basal sterile florets male, with palea. Lemma of lower sterile floret similar to upper glume, ovate, $3-3.2 \times 1.8-2$ mm, membranous, 7-9-veined, hispid, awned, awn terminal, 1-5 mm long. Lower Palea $3-3.2 \times 1.2-1.5$ mm, membranous, 2-veined, toothed. Upper lemma ovate, gibbous, $3.2-3.5 \times 1.5-1.8$ mm, indurate, much thinner above, yellow, shiny, 5-veined, margins involute, acute, laterally pinched. Palea reflexed at apex, $3-3.2 \times 1.2-1.5$ mm, indurate. Lodicules 2. Stamens 3, anther 1.5mm long. Ovary 0.5mm long, style & stigma 2mm long overall, purple coloured. **Plate 69.**

Flowering & Fruiting: February - April.

Habitat: In moist damp places.

Distribution: Africa, India, Indo-China, Malesia, and Papuasias. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 28, 76, 93, 181, 766

64. **Eriochloa procera** (Retz.) C.E.Hubb. *Bull. Misc. Inform. Kew* 1930: 256; *Bor* 312. 1960; *Lakshmi. in Sharma et al.* 494. 1996; *Shah* 2:828. 1978; *Karthik. et al.* 219. 1989; *Pandey in Shetty & Singh* 3:1055. 1993; *Roy in Singh et al.* 440. 2001; *E. polystachya* Hooker f. 7:92. 1897; *Cooke* 3:461. 1958; *E. ramosa* O. Kuntze *Rev. Gen. Pl.* 2: 775. 1891; *Blatt. & McC.* 131. 1935.

Annual. Culms erect or geniculately ascending, 20-100 cm long. Ligule a fringe of hairs. Leaf-blades $5-30 \times 0.2-0.6$ cm. Synflorescence composed of racemes. Racemes 3-10, borne along a central axis, unilateral, 2-15 cm long. Peduncle 4-20 cm long. Rachis angular, puberulous on surface. Spikelet packing regular, 2-rowed, in pairs, pedicelled, pedicels free, oblong, glabrous. Fertile spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets lanceolate, dorsally compressed, acuminate, 3-4 mm long, falling entire, callus globular, incorporating lowest rachilla internode with adnate lower glume, glabrous. Glumes one the lower absent or obscure, exceeding apex of florets, thinner than Upper lemma. Upper glume elliptic, $3-3.5 \times 1.5-2$ mm, membranous, 5-veined, pubescent, apex acuminate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret similar to upper glume, elliptic, $3-3.5 \times 1.5-2$ mm, 5-veined, pubescent, acute. Upper lemma elliptic, $2-2.5 \times 1-1.5$ mm, indurate, without keel, surface granulate, margins involute, mucronate. Palea involute, $1.8-2 \times 1-1.2$ mm, indurate. Lodicules 2. Stamens 3, anther 1.5mm long. Ovary 0.5mm long, style & stigma 2mm long overall, purple coloured. **Plate 70.**

Flowering & Fruiting: February - April.

Habitat: Water edges, margin of agricultural fields, waste lands,

Distribution: Africa, China, eastern Asia, Asia-tropical, Australia, northern South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 40, 283, 311, 421

65. **Moorochloa eruciformis** (Sm.) Veldkamp *Reinwardtia*. 12:139. 2004; *Brachiaria eruciformis* (Sm.) Griseb. In *Ledeb. Fl. Ross.* 4:469. 1853; *Bor* 493. 1960; *Shah* 2:791. 1978; *Karthik. et al.* 190. 1989; *Lakshmi. in Sharma et al.* 416. 1996; *Panicum isachne*

Roth ex R. & S. Syst. Veg. 2:458. 1817; Hooker f. 7:28. 1897; Cooke 3:448. 1958; B. isachne (Rith ex R. & S.) Stapf in Fl. Trop. Afr. 9:552. 1919; Blatt. & McC. 133. 1935; Pandey in Shetty & Singh 3:988. 1993; Roy in Singh et al. 379. 2001.

Annual, caespitose. Culms decumbent, slender, 10–40 cm long. Ligule a fringe of hairs. Leaf-blades linear or lanceolate, 2–15×0.2–0.6 cm, glabrous or pubescent. Synflorescence composed of racemes. Racemes 3–14, borne along a central axis, unilateral, 0.5–2.5 cm long. Peduncle 1–8 cm long. Rachis wingless, angular. Spikelet packing adaxial, regular, 2-rowed, solitary. Fertile spikelets sessile, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets elliptic, slightly dorsally compressed, acute, 1.5–2 mm long, falling entire, readily shedding fertile florets. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume ovate, 0.2–0.5×0.5 mm, membranous, without keels, veinless, glabrous, apex truncate. Upper glume oblong, membranous, 1.5–2×0.7–1 mm, 5-veined, villous, apex acute. Basal sterile florets male, with palea. Lemma of lower sterile floret similar to upper glume, oblong, 1.5–2×1–1.2 mm, membranous, 5-veined, glabrous, acute. Lower Palea 0.7–1×0.5–0.7 mm, membranous, 2-veined, toothed. Upper lemma elliptic, 1–1.2×0.5–0.7 mm, indurate, shiny, smooth, margins involute, apex obtuse. Palea involute, 1–1.2×0.5–0.7 mm, indurate, without keels. Lodicules 2. Stamens 3, anther 0.6mm long. Ovary 0.2mm long, style & stigma 1mm long overall, purple coloured. **Plate 71.**

Flowering & Fruiting: August-February.

Habitat: Common everywhere.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, Caribbean and southern South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 48, 150, 397, 791

66. **Oplismenus burmannii** (Retz.) P. Beauv. *Ess. Agrostogr. 54. 1812; Hooker f. 7:68. 1897; Blatt. & McC. 154. 1935; Cooke 3:443. 1958; Bor 317. 1960; Shah 2:843. 1978; Karthik. et al. 240. 1989; Pandey in Shetty & Singh 3:1076. 1993; Lakshmi. in Sharma et al. 541. 1996; Roy in Singh et al. 469. 2001.*

Annual. Culms prostrate, 10–60 cm long, rooting from lower nodes. Ligule a ciliate membrane. Leaf-blade lanceolate or ovate, base asymmetrical, 1–9×0.5–2 cm, venation with obscure cross veins, surface hirsute or glabrous, apex acute. Synflorescence composed of racemes. Racemes 3–8, borne along a central axis, unilateral, 0.5–2 cm long. Peduncle 2–10 cm long. Rachis angular, pilose on surface. Spikelet packing contiguous, in pairs, sessile and pedicelled, 2 in the cluster, subequal, pedicels oblong. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets lanceolate, laterally compressed, 2–2.5 mm, falling entire, in pairs, pairs 0.5–2mm apart. Glumes similar, shorter than spikelet, thinner than Upper lemma. Lower glume ovate, herbaceous, 1.5–1.7×0.7–1 mm, 1-keeled, 5-veined, apex awned, 1-awned, awn 2.5–8 mm long, scaberulous. Upper glume ovate, herbaceous, 1-keeled, 5–7-veined, pubescent, awned, awn 1–4 mm long. Basal sterile florets barren without significant palea. Lemma of lower sterile floret ovate, 2–2.5×1.2–1.5 mm, membranous, 1-keeled, 7–11-veined, pubescent, without emarginated, mucronate-aristate, arista 1mm long. Upper lemma oblong, dorsally compressed, 1.2–1.7×0.8–1.2 mm,

coriaceous, shiny, 5-veined, margins involute, apex acute. Palea involute, coriaceous, 1.2–1.7×0.8–1.2 mm. Lodicules 2. Stamens 3, anther 1mm long. Ovary 0.3mm long, style & stigma 2mm long overall, purple coloured. **Plate 72.**

Flowering & Fruiting: August-December.

Habitat: Common in all the shady spots of various habitats.

Distribution: Africa, Caucasus, Arabia, Asia-tropical, Australia, Mexico, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 262, 296, 309

67. **Oplismenus compositus** (L.) P.Beauv. *Ess. Agrostogr.* 54. 1812; *Hooker f.* 7:66. 1897; *Blatt. & McC.* 152. 1935; *Cooke* 3:442. 1958; *Bor* 317. 1960; *Shah* 2:844. 1978; *Karthik. et al.* 240. 1989; *Pandey in Shetty & Singh* 3:1077. 1993; *Lakshmi. in Sharma et al.* 542. 1996; *Roy in Singh et al.* 469. 2001.

Perennial. Culms prostrate, 30–150 cm long, rooting from lower nodes. Leaf-sheaths pilose. Ligule a ciliate membrane. Leaf-blade base asymmetrical, lanceolate or ovate, 2–16×1–4 cm, venation with obscure cross veins, apex acuminate. Synflorescence composed of racemes. Racemes 4–12, borne along a central axis, unilateral, 2.5–11 cm long. Central Synflorescence axis 5–25 cm long. Rachis angular, pilose on surface. Spikelet packing lax, regular, 2-rowed, in pairs, pairs 4–12mm apart. Fertile spikelets sessile and pedicelled, subequal, pedicels oblong. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension, lanceolate, laterally compressed, 3.5–4 mm long, falling entire. Glumes dissimilar, shorter than spikelet, thinner than Upper lemma. Lower glume ovate, herbaceous, 2–2.2×1–1.2 mm, 1-keeled, 5-veined, glabrous, margin hairy, apex acute, 1-awned, awn 4–10 mm long, viscid. Upper glume ovate, herbaceous, 2.2–2.5×1.2–1.5 mm, 1-keeled, 5–7-veined, pubescent, apex awned, awn 0.2–2 mm long. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret ovate, 3–3.5×2–2.2 mm, membranous, keeled, 7–9-veined, glabrous, emarginated, mucronate. Upper lemma oblong, dorsally compressed, 3–3.2×1–1.2 mm, coriaceous, shiny, 5-veined, margins involute, apex acute. Palea involute, coriaceous, 2–2.5×1–1.2 mm. Lodicules 2. Stamens 3, anther 2mm long. Ovary 1mm long, style & stigma 3mm long overall, purple coloured. **Plate 73.**

Flowering & Fruiting: August-October.

Habitat: In forest undergrowth.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, Mexico, South America. INDIA: Throughout. S. GUJARAT: Throughout, occasional.

Voucher specimen: RJD/ 264, 295, 725

68. **Panicum antidotale** Retz. *Observ. Bot.* 4: 17. 1786; *Hooker f.* 7:52. 1897; *Blatt. & McC.* 163. 1935; *Cooke* 3:453. 1958; *Bor* 322. 1960; *Shah* 2:847. 1978; *Karthik. et al.* 241. 1989; *Pandey in Shetty & Singh* 3:1081. 1993; *Lakshmi. in Sharma et al.* 547. 1996.

Perennial. Rootstock evident. Rhizomes short. Culms erect or geniculately ascending, up to 2m long, woody, nodes swollen, lateral branches sparse. Ligule a fringe of hairs. Leaf-blades 6–30 × 0.3–1.4 cm, midrib conspicuous, apex attenuate. Synflorescence a panicle. Panicle open, oblong, 10–30 cm long, contracted about 1° branches. 1° panicle branches whorled at most nodes, 5–15 cm long. Spikelets solitary, pedicelled, pedicels 0.5–2 mm long, scaberulous. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, acute, 2.2–2.5 mm, falling entire. Glumes reaching apex of florets, thinner than Upper lemma. Lower glume ovate, membranous, 0.7-1 × 1-1.2 mm, much thinner on margins, 3–5-veined, apex acute. Upper glume ovate, 2.2-2.5 × 1.2-1.5 mm, membranous, with hyaline margins, 7–9-veined, apex acute. Basal sterile florets barren, with palea. Lemma of lower sterile floret similar to upper glume, ovate, 2.2-2.5 × 1-1.5 mm, membranous, 5-7-veined, acute. Palea of lower sterile floret 2-2.2 × 0.8-1 mm, membranous, hyaline, acute. Upper lemma oblong, dorsally compressed, 1.5–1.7 × 0.8-1 mm, indurate, pallid, shiny, margins involute, apex acute. Palea involute, indurate, 1.5–1.7 × 0.8-1 mm. Lodicules 2. Stamens 3, anther 1mm long. Ovary 0.3mm long, style & stigma 1mm long overall, purple coloured. **Plate 74.**

Flowering & Fruiting: September-December.

Habitat: Common in wet places.

Distribution: Tropical Africa, western Asia, Arabia, Asia-tropical, Australia, Mexico, South America. INDIA: Soth to Gangetic plains, N. W. India. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 87, 248, 281, 290

69. ***Panicum curviflorum*** Hornem. *Hort. Bot. Hafn. Suppl.*: 116. 1819; *P. trypheron* Mant. 2: 244. 1824; *Hooker f.* 7:47. 1897; *Blatt. & McC.* 158. 1935; *Cooke* 3:452. 1958; *Bor* 331. 1960; *Shah* 2:849. 1978; *Karthik. et al.* 243. 1989; *Pandey in Shetty & Singh* 3:1086. 1993; *Lakshmi. in Sharma et al.* 553. 1996.

Annual, caespitose. Culms erect or geniculately ascending, 8-20 cm long, nodes glabrous. Leaves mostly basal. Leaf-sheaths hispid with tubercle-based hairs, margin hairy. Ligule a fringe of hairs. Leaf-blades linear-lanceolate, 4-10 × 0.4–0.8 cm, surface hispid with tubercle-based hairs, apex abruptly acute. Synflorescence a panicle. Panicle open, ovate, effuse, 10–25 cm long. 1° panicle branches drooping, 2–10 cm long. Spikelets solitary, pedicelled, pedicels 1–10 mm long, scabrous. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets elliptic or oblong, dorsally compressed, acuminate, 2.5–2.8 mm long, falling entire. Glumes reaching apex of florets, thinner than Upper lemma, gaping. Lower glume ovate, 1.2–1.5 × 2-2.2 mm, membranous, 5-veined, apex cuspidate. Upper glume lanceolate, 2–2.2 × 2-2.2 mm, membranous, 9-11-veined, apex acuminate-cuspidate. Basal sterile florets barren, with palea. Lemma of lower sterile floret similar to upper glume, ovate, 2.2–2.7 × 1.5-2 mm, membranous, 9-11-veined, acute. Palea 2.2–2.7 × 1-1.2 mm, membranous, hyaline, acute. Upper lemma oblong, dorsally compressed, 1.5–1.7 × 1.5-1.7 mm, indurate, pallid, shiny, 7–9-veined, involute, apex obtuse. Palea involute, indurate, 1.5–1.7 × 0.8-1mm. Lodicules 2. Stamens 3, anther 1.5mm long. Ovary 0.5mm long, style & stigma 1-1.5mm long overall, purple coloured. **Plate 75.**

Flowering & Fruiting: August-November.

Habitat: In wet lands.

Distribution: China and eastern Asia, India, Indo-China, Malesia and Papuaia. INDIA: Southwards to Gangetic plains. S. GUJARAT: Surat.

Voucher specimen: RJD/ 191, 357, 752, 786

70. ***Panicum notatum*** Retz. *Observ. Bot.* 4:18. 1786; *Bor* 701. 1960; *Shah* 2:848. 1978; *Karthik. et al.* 243. 1989; *Pandey in Shetty & Singh* 3:1084. 1993; *Lakshmi. in Sharma et al.* 550. 1996; *Roy in Singh et al.* 478. 2001; *P. montanum Roxb. Fl. Ind.* 1:315. 1820; *Hooker f.* 7:53. 1897; *Blatt. & McC.* 164. 1935; *Cooke* 3:454. 1958.

Perennial. Culms decumbent or rambling, 30–200 cm long, rooting from lower nodes, nodes glabrous, branches ample. Leaf-sheaths without keel, glabrous on surface, outer margin hairy. Ligule a ciliolate membrane. Collar glabrous. Leaf-blades lanceolate, 8-20×1–5 cm, base cordate, glabrous or sparsely hairy, margins scabrous. Synflorescence a panicle. Panicle open, ovate, 10–40 cm long, 1° panicle branches spreading, branches scabrous, glabrous in axils. Spikelets solitary, pedicelled, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, acute, 3.2-3.5×1.2-1.5 mm, falling entire. Glumes reaching apex of florets, thinner than Upper lemma. Lower glume ovate, 1-1.5×2.2-2.5mm, membranous, 5-7-veined, glabrous, apex obtuse. Upper glume ovate, membranous, 9-11-veined, 3.2-3.5×1-1.5 mm, glabrous, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret similar to upper glume, ovate, 3.2-3.5×1-1.5 mm, membranous, 7-9-veined, acute. Palea 3–3.2×1-1.2 mm, membranous, hyaline, acute. Upper lemma elliptic, dorsally compressed, 2.2-2.5×1-1.2 mm, indurate, dark brown, shiny, margins involute, apex obtuse. Palea involute, indurate, 2.2-2.5×1-1.2 mm. Lodicules 2. Stamens 3, anther 1.5mm long. Ovary 0.3mm long, style & stigma 1.5mm long overall, red coloured. **Plate 76.**

Flowering & Fruiting: August-December.

Habitat: In Undergrowth of forest, moist places.

Distribution: China and eastern Asia, India, Indo-China, and Malesia. INDIA: Throughout the hilly parts, S. GUJARAT: Dangs.

Voucher specimen: RJD/ 773, 787, 806

71. ***Panicum paianum*** Naik et Patunkar, *Patunkar Grasses of Marathwada* 157. 1980; *Lakshmi. in Sharma et al.* 551. 1996.

Annual. Culms erect or geniculately ascending, 10-60 cm long, rooting from lower nodes. Leaf-sheaths puberulous, with tubercle-based hairs. Ligule a fringe of hairs. Leaf-blades linear or lanceolate, 4–12×0.5–1 cm, glabrous or pubescent, apex acute. Synflorescence a panicle. Panicle open, pyramidal, effuse, 5-20 cm long, branches capillary, hairy, scabrous. Fertile Spikelets solitary, comprising 1 basal sterile & 1 fertile florets, without rachilla extension, pedicelled, pedicel tip oblique. Spikelets lanceolate, dorsally compressed, acute, 2–2.2×1-1.2 mm, falling entire. Glumes reaching apex of florets, thinner than Upper lemma, gaping. Lower

glume clasping, 0.8-1×1-1.5 mm, membranous, 5-veined, apex obtuse. Upper glume ovate, 2-2.2×1.2-1.5 mm, membranous, 9-11-veined, apex acute. Palea 1.5-2×0.8-1 mm, membranous, hyaline, acute. Basal sterile florets male or barren, with palea. Lemma of lower sterile floret similar to upper glume, oblong, 1.2-1.5×1-1.2 mm, membranous, 7-veined, acute, oblong, dorsally compressed, indurate, 3-5-veined, smooth, margins involute, apex obtuse. Palea involute, indurate, 1.2-1.5×1-1.2 mm. Lodicules 2. Stamens 3, anther 1mm long. Ovary 0.3mm long, style & stigma 2mm long overall, purple coloured. **Plate 77.**

Flowering & Fruiting: August-December.

Habitat: Water edges or Wet lands.

Distribution: Endemic to India. INDIA: Western parts. S. GUJARAT: Valsad. **New records for the State.**

Voucher specimen: RJD/ 779, 780, 786, 790

72. **Panicum paludosum** Roxb. Fl. Ind. 1:310. 1820; Blatt. & McC. 162. 1935; Bor 329. 1960; Shah 2:848. 1978; Karthik. et al. 243. 1989; Pandey in Shetty & Singh 3:1084. 1993; Lakshmi. in Sharma et al. 550. 1996; Roy in Singh et al. 478. 2001; P. proliferum auct. non Lam. 1797; Hooker f. 7:50. 1897; Cooke 3:454. 1958. **Plate 78.**

Perennial. Culms erect or geniculately ascending, 20-150 cm long, spongy, rooting from lower nodes, nodes glabrous. Leaf-sheaths loose, glabrous on surface. Ligule a fringe of hairs. Leaf-blade linear or lanceolate, flat, 15-30×0.6-1.5 cm, base broadly rounded or cordate, apex acute. Synflorescence a panicle. Panicle open, oblong or ovate, 10-30 cm long. 1° panicle branches whorled at lower nodes, 1-10 cm long. Spikelets appressed, solitary, pedicelled, pedicels 2-8 mm long, scaberulous, lanceolate, dorsally compressed, 2.5-3×0.7-1 mm, acute, falling entire. Fertile spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes reaching apex of florets, thinner than Upper lemma. Lower glume orbicular, 2-2.2×1-1.2 mm, hyaline, 5-7-veined, apex obtuse or acute. Upper glume lanceolate, membranous, 2.5-3×1.2-1.5 mm, 5-7-veined, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret similar to upper glume, lanceolate, membranous, 3-veined, acute. Upper lemma oblong, dorsally compressed, indurate, 2-2.2×0.7-1 mm, pallid, shiny, margins involute, apex acute. Palea involute, indurate, lanceolate, 2-veined, 1.5-1.7×0.7-1 mm. Lodicules 2. Stamens 3, anther 1-1.2mm long. Ovary 0.5mm long, style & stigma 1mm long overall, red coloured.

Flowering & Fruiting: August-September

Habitat: Along the streams and river banks of rocky soils.

Distribution: Western and eastern Asia, India, Indo-China, Malesia, and Papuasias, Australia.

INDIA: Throughout. S. GUJARAT: Dangs.

Voucher specimen: RJD/ 290, 771, 778

73. **Panicum psilopodium** Trin. Gram. Panic. 217. 1826; Hooker f. 7:46. 1897; Blatt. & McC. 158. 1935; Cooke 3:456. 1958; Bor 329. 1960; Shah 2:848. 1978; Karthik. et al. 243. 1989; Pandey in Shetty & Singh 3:1084. 1993; Lakshmi. in Sharma et al. 551. 1996; Roy in Singh et al. 480. 2001.

Annual. Culms erect, 5–30 cm long. Culm-nodes glabrous, branches ample. Leaf-sheaths glabrous. Ligule a ciliate membrane. Collar glabrous. Leaf-blades 3–15×0.4–1.2 cm, glabrous, base broadly rounded, apex acuminate. Synflorescence a panicle. Panicle contracted, oblong, nodding, 4–20 cm long, 1° panicle branches appressed, 2–12 cm long, scabrous. Spikelets solitary, pedicelled, elliptic, dorsally compressed, acute, 2.5–3.5 mm long, persistent, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes reaching apex of florets, thinner than Upper lemma. Lower glume ovate, 1–1.2×2–2.5 mm, membranous, 3–5-veined, apex acute. Upper glume ovate, 2.8–3.2×1.2–1.5 mm, membranous, 11–13-veined, apex acute. Basal sterile florets barren, with palea. Lemma of lower sterile floret similar to upper glume, ovate, 2.8–3×1.2–1.5 mm, membranous, 9–11-veined, acute. Palea 2.5–2.7×0.6–0.8 mm, membranous, hyaline, acute. Upper lemma elliptic, dorsally compressed, 2–2.2×0.8–1 mm, indurate, dark brown, shiny, 7–9-veined, margins involute, apex acute. Palea involute, indurate, 2–2.2×0.6–0.8 mm. Lodicules 2. Stamens 3, anther 1.5–2 mm long. Ovary 0.3 mm long, style & stigma 1.5 mm long overall, red coloured. **Plate 79.**

Flowering & Fruiting: August–January.

Habitat: Common in wet places, waste lands, agricultural fields, roadsides.

Distribution: Asia-temperate, India, Indo-China, Malesia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 2, 92, 270, 763

74. ***Panicum repens*** L. *Sp. Pl. ed. 2. 87. 1762*; *Hooker f. 7:49. 1897*; *Bor 330. 1960*; *Karthik. et al. 243. 1989*; *Pandey in Shetty & Singh 3:1085. 1993*; *Lakshmi. in Sharma et al. 553. 1996*; *Roy in Singh et al. 480. 2001.*

Perennial. Rhizomes elongated. Stolons absent or present. Culms erect or geniculately ascending, 30–100 cm long. Ligule a ciliate membrane. Leaf-blades erect, flat or convolute, 5–25×0.2–1 cm, coriaceous, stiff, glaucous, apex acuminate or attenuate. Synflorescence a panicle. Panicle open, oblong, 5–30 cm long. Spikelets solitary, ovate, dorsally compressed, acute, 2.5–3 mm long, falling entire, pedicelled, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume 1.5–1.7×2–2.2 mm, hyaline, 5–7-veined, veins obscure, apex obtuse. Upper glume ovate, 2.5–2.7×2–2.5 mm, membranous, 7–9-veined, apex acute. Basal sterile florets male, with palea. Lemma of lower sterile floret similar to upper glume, ovate, 2.5–2.7×2–2.2 mm, membranous, 5–7-veined, acute. Palea 2–2.2×0.8–1 mm, membranous, hyaline, toothed. Upper lemma oblong, dorsally compressed, 2.2–2.5×1.8–2 mm, indurate, pallid, shiny, margins involute, apex obtuse. Palea involute, indurate, 2–2.2×1.5–1.8 mm. Lodicules 2. Stamens 3, anther 1–1.5 mm long. Ovary 0.5 mm long, style & stigma 1.5 mm long overall, purple coloured. **Plate 80.**

Flowering & Fruiting: July– October.

Habitat: Road sides, Margin of agricultural fields.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, South America. INDIA: Throughout the hotter parts. S. GUJARAT: Dangs. **New records for the State.**

Voucher specimen: RJD/ 629, 753, 776

75. **Panicum sumatrense** Roth *Syst. Veg.* 2:434. 1817; *Bor* 701. 1960; *P. miliare* Lam. *Illustr.* 1: 173. 1791; *Hooker f.* 7:46. 1897; *Blatt. & McC.* 160. 1935; *Cooke* 3:456. 1958; *Shah* 2:849. 1978; *Karthik. et al.* 243. 1989; *Pandey in Shetty & Singh* 3:1085. 1993; *Lakshmi. in Sharma et al.* 553. 1996; *Roy in Singh et al.* 480. 2001.

Annual. Culms erect or geniculately ascending, 30–140 cm long. Culm-internodes distally pubescent or hispid, nodes glabrous. Leaf-sheaths hispid. Ligule a ciliate membrane. Leaf-blades 10–20×0.6–2 cm, glabrous or pubescent. Synflorescence a panicle. Panicle contracted, obovate, 5–20 cm long, glabrous in axils. Spikelets solitary, ovate, slightly dorsally compressed, 2.5–3 mm long, persistent, pedicelled, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes similar, reaching apex of florets, thinner than Upper lemma. Lower glume ovate, 1–1.2×1.5–2 mm, membranous, 5–7-veined, apex acute. Upper glume ovate, membranous, 2.5–2.7×1–1.5 mm, 9–11-veined, apex acuminate. Basal sterile florets barren, with palea. Lemma of lower sterile floret similar to upper glume, ovate, 2–2.2×0.8–1 mm, membranous; 7–11-veined, acuminate. Palea 2–2.2×0.6–0.8 mm, membranous, hyaline, toothed. Upper lemma oblong, dorsally compressed, 1.5–1.7×1–1.2 mm, indurate, yellow, shiny, margins involute, apex obtuse. Palea involute, indurate, 1.5–1.7×1–1.2 mm. Lodicules 2. Stamens 3, anther 0.5–0.8mm long. Ovary 0.3mm long, style & stigma 1mm long overall, red coloured. **Plate 81.**

Flowering & Fruiting: August-January.

Habitat: Agricultural fields, escape.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, USA, South America. INDIA: Throughout the hotter parts. S. GUJARAT: Cultivated throughout.

Voucher specimen: RJD/ 136, 349, 697, 806

76. **Paspalidium flavidum** (Retz.) A.Camus *Fl. Indo-Chine* 7:419. 1922; *Blatt. & McC.* 141. 1935; *Bor* 333. 1960; *Shah* 2:850. 1978; *Karthik. et al.* 244. 1989; *Pandey in Shetty & Singh* 3:1088. 1993; *Lakshmi. in Sharma et al.* 555. 1996; *Roy in Singh et al.* 483. 2001; *Panicum flavidum* Retz. *Obs. Bot.* 4:15. 1786; *Hooker f.* 7:28. 1897; *Cooke* 3:445. 1958.

Perennial, caespitose. Culms erect or geniculately ascending; 3–100 cm long. Ligule a fringe of hairs. Leaf-blades 5–20×0.4–1 cm. Synflorescence composed of racemes. Racemes 4–12, borne along a central axis, distant, appressed, unilateral, 1–3 cm long. Peduncle 15–30 cm long. Rachis narrowly winged, angular, terminating in a barren extension, extension flattened. Spikelet packing abaxial, regular, 2-rowed, spreading, solitary. Fertile spikelets sessile, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets ovate, laterally compressed, gibbous, acute, 3–3.5 mm long, falling entire. Glumes similar, shorter than spikelet, thinner than Upper lemma. Lower glume orbicular, 1.5–1.7×1.5–1.7 mm, membranous, 3–5-veined, apex obtuse. Upper glume orbicular, 2–2.2×2.2–2.5 mm, cartilaginous, 7-veined, apex obtuse. Basal sterile florets male, with palea. Lemma of lower sterile floret ovate, 3–3.5×1.2–1.5 mm, cartilaginous, 5-veined, apex obtuse. Palea 3–3.5×2.5–2.7 mm, membranous, hyaline, toothed. Upper lemma ovate, laterally compressed, gibbous, 2.7–3×2.5–2.7 mm, indurate, granulate and striate, margins involute, apex acute. Palea

reflexed at apex, indurate, 2.5–2.7×1.7–2 mm. Lodicules 2. Stamens 3, anther 2–2.5mm long. Ovary 1mm long, style & stigma 2mm long overall, white coloured. **Plate 82.**

Flowering & Fruiting: February - April.

Habitat: Common in wet places.

Distribution: Western Africa, Asia-temperate, Asia-tropical, Australia. INDIA: Throughout the plains. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 25, 190, 543

77. **Paspalidium geminatum** (Forssk.) Stapf *Fl. Trop. Afr.* 9:583. 1920; *Blatt. & McC.* 142. 1935; *Bor* 333. 1960; *Shah* 2:851. 1978; *Karthik. et al.* 244. 1989; *Pandey in Shetty & Singh* 3:1088. 1993; *Lakshmi. in Sharma et al.* 556. 1996; *Roy in Singh et al.* 483. 2001; *P. paspaloides* Pers. *Syn.* 1:81. 1805; *Hooker f.* 7:30. 1897; *P. fluitans* Retz. *Obs. Bot.* 3:8. 1783; *Cooke* 3:446. 1958.

Perennial, mat forming. Rhizomes elongated, spongy. Culms prostrate, up to 2m long, spongy, rooting from lower nodes. Ligule a fringe of hairs. Leaf-blades flat or conduplicate, 5–35×0.5–1.5 cm, apex acuminate. Synflorescence composed of racemes. Racemes borne along a central axis, appressed, unilateral, 0.5–4 cm long. Peduncle 5–30 cm long, flattened. Rachis narrowly winged, with sharp-edged midrib, angular, 0.5–1 mm wide, terminating in a barren extension, extension inconspicuous. Spikelet packing abaxial, regular, 2-rowed, appressed, ovate, dorsally compressed, 2–2.5 mm long, solitary or in pairs, sessile, 1–2 in the cluster, falling entire. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes dissimilar, shorter than spikelet, thinner than Upper lemma. Lower glume orbicular, 0.5–0.8×0.5–0.7 mm, membranous, pallid, 3–5-veined, apex truncate. Upper glume elliptic, 2–2.5×1.5–1.7 mm membranous, 5-veined, apex acute. Basal sterile florets male, with palea. Lemma of lower sterile floret similar to upper glume, elliptic, membranous, 2.5–3×1.5–2 mm, 5-veined, acute. Palea 2.5–3×1.5–2 mm, 2-veined, membranous, hyaline, toothed. Upper lemma elliptic, 2–2.5×1–1.5 mm, indurate, shiny, 5-veined, granulose, unwrinkled or rugulose, margins involute, apex acute. Palea reflexed at apex, indurate, 2–2.5×1–1.5 mm. Lodicules 2. Stamens 3, anther 2mm long. Ovary 0.5mm long, style & stigma 2mm long overall, white coloured. **Plate 83.**

Flowering & Fruiting: August–November.

Habitat: Water edges, River beds, seasonal water bodies.

Distribution: Africa, western Asia and Arabia, Asia-tropical, North America, South America. INDIA: Cultivated throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 39, 91, 94, 491

78. **Paspalum distichum** L. *Syst. Nat. ed. 10* 2:855. 1759; *Hooker f.* 7:12. 1897; *Blatt. & McC.* 136. 1935; *Cooke* 3:460. 1958; *Bor* 338. 1960; *Shah* 2:852. 1978; *Karthik. et al.* 244. 1989; *Lakshmi. in Sharma et al.* 558. 1996; *P. paspalodes* (Michx.) Scribn. *Mem. Torrey Bot. Club* 5:29 1894; *Pandey in Shetty & Singh* 3:1014. 1990.

Perennial, mat forming. Stolons present. Culms decumbent, 8–60 cm long. Ligule an eciliate membrane. Leaf-blades flat or convolute, 3–14×0.3–0.8 cm. Synflorescence composed of

racemes. Racemes 2–3, paired, unilateral, 2–8 cm long. Rachis narrowly winged, 2–3mm wide. Spikelet packing abaxial, regular, 2-rowed, solitary, sessile, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets ovate, dorsally compressed, turgidly plano-convex, acute, 3–4 mm long, falling entire. Glumes reaching apex of florets, thinner than Upper lemma. Lower glume lanceolate or ovate, 1–1.5×0.3–5 mm, hyaline, 0–1-veined. Upper glume elliptic, 3.5–4×1.5–2 mm, coriaceous, 3–5-veined, surface puberulous, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret similar to upper glume, elliptic, 3.5–4×1.5–2 mm, coriaceous, 3–5-veined, apex acute. Upper lemma ovate, gibbous, 3–3.5×1.2–1.5 mm, indurate, pallid, margins involute, apex acute. Palea involute, indurate, 3–3.5×1.2–1.5 mm. Lodicules 2. Stamens 3, anther 2mm long. Ovary 1mm long, style & stigma 2mm long overall, purple coloured. **Plate 84.**

Flowering & Fruiting: February - April.

Habitat: In moist places.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 100, 546, 704

79. **Paspalum longifolium** Roxb. *Fl. Ind.* 1:280. 1820; *Hooker f.* 7:92. 1897; *P. longifolium* Roxb. var. *longifolium* Bor 339. 1960; *Shah* 2:852. 1978; *Karthik. et al.* 244. 1989.

Perennial, caespitose. Culms erect, 50–130 cm long, nodes glabrous. Leaf-sheaths keeled, glabrous on surface, outer margin glabrous or hairy. Ligule an eciliate membrane. Leaf-blades 6–20×0.3–1 cm, surface glabrous or hirsute, margins scabrous. Synflorescence composed of racemes. Racemes 2–5, digitate or borne along a central axis, spreading, unilateral, 1–8 cm long. Peduncle 4–10 cm long. Rachis broadly winged, with sharp-edged midrib, 4–6mm wide, scabrous on margins. Spikelet packing regular, 4-rowed, in pairs, obovate, dorsally compressed, plano-convex, obtuse, 2–2.7 mm long, falling entire, pedicelled, pedicels oblong, 0.3–0.8 mm long. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Lower glumes absent or obscure. Upper glume ovate, reaching apex of florets, thinner than Upper lemma chartaceous, 2.5–2.8×2–2.2 mm, 3-veined, puberulous, apex obtuse. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret similar to upper glume, ovate, chartaceous, 2.5–2.8×2–2.2 mm, 3-veined, glabrous, obtuse. Upper lemma elliptic, or obovate; gibbous; 2–2.2×2–2.2 mm, 3-veined, indurate, dark brown, shiny, margins involute, apex obtuse. Palea involute, indurate, 2–2.2×2–2.2 mm, 2-veined. Lodicules 2. Stamens 3, anther 3mm long. Ovary 0.5mm long, style & stigma 3mm long overall, purple coloured. **Plate 85.**

Flowering & Fruiting: August–October.

Habitat: Moist waste land.

Distribution: China and eastern Asia, Australia. INDIA: N. E. & Penninsular regions. S. GUJARAT: Valsad.

Voucher specimen: RJD/ 200, 266, 554

80. **Paspalum scrobiculatum** L. *Mant. Pl. 1: 29. 1767; Hooker f. 7:10. 1897; Blatt. & McC. 136. 1935; Cooke 3:460. 1958; Bor 340. 1960; Shah 2:853. 1978; Karthik. et al. 244. 1989; Pandey in Shetty & Singh 3:1091. 1993; Lakshmi. in Sharma et al. 561. 1996; Roy in Singh et al. 487. 2001; P. commersonii* Lam. *Illustr. 1:175.1791; Bor op. cit. 335; P. orbiculare* G. forst. *Fl. Insul. Austral. Prodr. 7. 1786; Bor op. cit.; P. cartilagineum* J. S. ex C. B. Presl, *Rel. Haenk. 1:216. 1830; Bor op. cit. 338.*

Perennial, mat forming or caespitose. Culms erect or geniculately ascending, 10–80 cm long, 1–6 mm diam., rooting from lower nodes. Leaf-sheaths mostly shorter than internode. Ligule an eciliate membrane. Leaf-blade base simple, 5–40×0.3–1.5 cm, apex attenuate, filiform. Synflorescence composed of racemes. Racemes 1–2, digitate or borne along a central axis; unilateral, 2–10 cm long. Peduncle 1–8 cm long. Rachis broadly winged, with sharp-edged midrib, 2–3 mm wide. Spikelet packing abaxial, regular, 2-rowed, solitary, pedicelled; pedicels oblong. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension, obovate or orbicular, dorsally compressed, plano-convex, obtuse, 2.5–3 mm long, falling entire. Lower glumes absent or obscure. Upper glume ovate, reaching apex of florets, thinner than Upper lemma chartaceous, 2.5–2.8×2–2.2 mm, 5-veined, puberulous, apex obtuse. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret similar to upper glume, ovate, chartaceous, 2.5–2.8×2–2.2 mm, 7-veined, glabrous, obtuse. Upper lemma elliptic, or obovate; gibbous; 2–2.2×2–2.2 mm, indurate, 5-veined, dark brown, shiny, margins involute, apex obtuse. Palea involute, indurate, 2–2.2×2–2.2 mm, 2-veined. Lodicules 2. Stamens 3, anther 3mm long. Ovary 0.5mm long, style & stigma 3mm long overall, white coloured. **Plate 86.**

Flowering & Fruiting: August-October.

Habitat: Water edges.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Suart, Tapi, Dangs.

Voucher specimen: RJD/ 259, 307, 560

81. **Paspalum vaginatum** Sw. *Prodr. Veg. Ind. Occ. 21. 1788; Blatt. & McC. 139. 1935; Bor 341. 1960; Shah 2:853. 1978; Karthik. et al. 245. 1989; Pandey in Shetty & Singh 3:1014. 1993; Lakshmi. in Sharma et al. 561. 1996; Roy in Singh et al. 489. 2001; P. distichium auct pl. non L. 1753 nom. conf. Hooker f. 7:12. 1897.*

Perennial, mat forming. Stolons present. Culms decumbent, up to 60 cm long. Ligule an eciliate membrane. Leaf-blades flat or convolute, 2.5–15×0.3–0.8 cm. Synflorescence composed of racemes. Racemes 2-3, paired or digitate, unilateral, 1.5–7.5 cm long. Rachis narrowly winged, angular, 1–2 mm wide. Spikelet packing abaxial, regular, 2-rowed, solitary, elliptic, strongly dorsally compressed, plano-convex, acute, 3–4 mm long, falling entire, sessile. Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Lower glume absent or obscure. Upper glume elliptic, reaching apex of florets, thinner than Upper lemma, 3.5–4×1.5–2 mm, membranous, 3-5-veined, glabrous, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret similar to upper glume, elliptic, 3.5–3.7×1.5–1.8 mm, membranous, 3-5-veined, acute. Upper lemma ovate, 3–3.2×1–

1.5 mm, indurate, pallid, margins involute, apex acute. Palea involute, indurate, $2.5-3 \times 1-1.2$ mm, 2-veined. Lodicules 2. Stamens 3, anther 2mm long. Ovary 1mm long, style & stigma 2mm long overall, purple coloured. **Plate 87.**

Flowering & Fruiting: September-January.

Habitat: Water edges.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Gangetic plains & peninsular India.. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 289, 750, 777

82. *Setaria intermedia* (Roth.) R. & S. *Syst. Veg.* 2:489. 1817; *Hooker f.* 7:79. 1897; *Blatt. & McC.* 174. 1935; *Cooke* 3:436. 1958; *Karthik. et al.* 258. 1989; *Pandey in Shetty & Singh* 3:1112. 1993; *Lakshmi. in Sharma et al.* 593. 1996; *Roy in Singh et al.* 518. 2001; *S. tomentosa* (Roxb.) *Kunth Rev. Gram.* 1:47. 1829; *Bor* 365. 1960; *Shah* 2:865. 1978.

Annual, caespitose. Culms 25–120 cm long. Ligule a fringe of hairs. Leaf-blades spreading, plicate, $5-25 \times 0.5-3$ cm, flaccid. Synflorescence a panicle. Panicle open, pyramidal, 2–15 cm long, contracted about 1° branches. 1° panicle branches bearing spikelets almost to the base, sterile at the tips. Panicle branches 2-rowed, pubescent or pilose. Spikelets subtended by an involucre, composed of bristles, 5–10 mm long, persistent, flexible, glabrous. Fertile spikelets sessile, 2-3 in the cluster, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets elliptic, slightly dorsally compressed, 2–2.5 mm long, falling entire. Glumes reaching apex of florets, thinner than Upper lemma. Lower glume orbicular, $1-1.2 \times 1-1.2$ mm, hyaline, 3-veined, apex obtuse or acute. Upper glume elliptic, membranous, $1.5-1.7 \times 1.5-2$ mm, 5–7-veined, apex acute. Basal sterile florets barren, with palea. Lemma of lower sterile floret elliptic, $2-2.2 \times 1.5-1.7$ mm, membranous, 5-veined, acute. Palea $1.5-1.7 \times 0.7-1$ mm, membranous, 2-veined, toothed. Upper lemma ovate, dorsally compressed, gibbous, $1.7-2 \times 1.5-1.7$ mm, indurate, rugose, margins involute. Palea involute, indurate, $1.5-1.7 \times 1-1.2$ mm, rugose. Lodicules 2. Stamens 3, anther 0.8mm long. Ovary 0.3mm long, style & stigma 1mm long overall, purple coloured. **Plate 88.**

Flowering & Fruiting: July-December.

Habitat: In hedges, forest undergrowth.

Distribution: Tropical Africa, India. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 81, 614, 666

83. *Setaria italica* (L.) P.Beauv. *Ess. Agrostogr.* 51. 1812; *Hooker f.* 7:78. 1897; *Blatt. & McC.* 175. 1935; *Cooke* 3:437. 1958; *Bor* 362. 1960; *Shah* 2:486. 1978; *Karthik. et al.* 258. 1989; *Roy in Singh et al.* 518. 2001.

Annual. Culms erect, robust, 50–120 cm long. Leaf-sheaths outer margin hairy. Ligule a fringe of hairs. Leaf-blades $15-45 \times 0.8-2.5$ cm, scaberulous, margins cartilaginous, apex attenuate. Synflorescence a panicle. Peduncle antrorsely scabrous above. Panicle spiciform, linear or oblong, continuous or interrupted, equilateral or nodding, $10-30 \times 0.8-2.4$ cm. 1° panicle branches accrescent to a central axis, with evident branchlets on axis. Panicle axis villous.

Spikelets subtended by an involucre, composed of bristles, 4–16 mm long, persistent, 2–5 in principal whorl, flexible, antrorsely scaberulous. Fertile spikelets elliptic, dorsally compressed, 1.5–2 mm long, persistent, sessile and pedicelled, 2–4 in the cluster. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes shorter than spikelet, thinner than Upper lemma. Lower glume ovate, 0.5×0.5 mm, hyaline, 1–3-veined, apex acute. Upper glume elliptic, 1.7–2×1–1.2 mm, membranous, 5-veined, apex obtuse or acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret elliptic, membranous, 2–2.2×1–1.5 mm, 5-veined, obtuse or acute. Palea hyaline, veinless, 0.7×0.5 mm. Upper lemma elliptic, dorsally compressed, gibbous, 2–2.2×1–1.2 mm, indurate, unwrinkled, margins involute. Palea involute, indurate, 1.7–2×1.5–1.8 mm, 2-veined. Lodicules 2. Stamens 3, anther 0.8mm long. Ovary 0.5mm long, style & stigma 1mm long overall, purple coloured. **Plate 89.**

Flowering & Fruiting: August–October.

Habitat: Cultivated, escape.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, USA, South America. INDIA: Cultivated throughout. S. GUJARAT: Cultivated in highlands.

Voucher specimen: RJD/ 285, 495, 656

84. **Setaria parviflora** (Poir.) M.Kerguelen *Lejeunia* 120:161. 1987; *S. pallide-fusca* (Schumach.) Stapf & C.E.Hubb. *Bull. Misc. Inform. Kew* 1930:259. 1930; *Bor* 363. 1960; *Pandey in Shetty & Singh* 3:1113. 1993; *Roy in Singh et al.* 519. 2001.

Annual, Matforming. Culms prostrate or geniculately ascending, 5–20 cm long, nodes glabrous. Ligule a ciliolate membrane or a fringe of hairs. Leaf-blades 1–8×0.4–1 cm. Synflorescence a panicle. Panicle spiciform, linear, 0.5–3 cm long. 1° panicle branches accrescent to a central axis, with evident branchlets on axis. Panicle axis pubescent. Spikelets subtended by an involucre, composed of bristles, free throughout, 3–12 mm long, persistent, few, in one whorl, 6–8 in principal whorl, flexible, antrorsely scaberulous. Fertile spikelets ovate, dorsally compressed, gibbous, 2–2.5mm long, falling entire, pedicelled, pedicels oblong, 1 in the cluster. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes shorter than spikelet, thinner than Upper lemma. Lower glume orbicular, 1–1.2×1–1.5 mm, membranous, 3–5-veined, apex acute. Upper glume ovate, 1.5–1.7×1–1.2 mm, membranous, 5-veined, apex acute. Basal sterile florets male or barren, with palea. Lemma of lower sterile floret ovate, 2–2.2×1–1.5 mm, membranous, 5-veined, sulcate, acute. Palea 1.8–2×1–1.2 mm, membranous, 2-veined, toothed. Upper lemma ovate, 2–2.2×1–1.2 mm, dorsally compressed, gibbous, indurate, 5-veined, rugose, margins involute. Palea involute, indurate, 1.7–2×1–1.2 mm, 2-veined. Lodicules 2. Stamens 3, anther 0.5mm long. Ovary 1mm long, style & stigma 1.5mm long overall, purple coloured. **Plate 90.**

Flowering & Fruiting: July–September.

Habitat: Occasional in moist places.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 123, 553, 756

85. **Setaria plicata** (Lam.) Cooke 3:434. 1958; Blatt. & McC. 171. 1935; Bor 364. 1960; Karthik. et al. 259. 1989; Lakshmi. in Sharma et al. 593. 1996; Roy in Singh et al. 518. 2001; *Panicum plicatum* Lam. Encycl. 4:736. 1797; Hooker f. 7: 55. 1897.

Perennial, caespitose. Culms erect or decumbent, robust, 45–130 cm long, 3–6 mm diam. Culm-nodes pubescent. Leaf-sheaths keeled, pilose with tubercle-based hairs, outer margin hairy, oral hairs ciliate. Ligule a fringe of hairs. Leaf-blade base tapering to the midrib, lanceolate, tapering towards sheath, plicate, 10–40×1–3 cm, papillose, rough & hairy on both sides, apex attenuate. Synflorescence a panicle. Panicle open, ovate, dense, axis scabrous, 15–30 cm long. 1° panicle branches ascending, 4–8 cm long, sterile at the tips. Panicle branches flexuous, pubescent in axils. Spikelets subtended by an involucre, composed of bristles, persistent, flexible, glabrous. Fertile spikelets pedicelled, 1 in the cluster, pedicels reduced to a stump. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension, oblong or ovate, dorsally compressed, acute, 2.5–3 mm long, falling entire. Glumes shorter than spikelet, thinner than Upper lemma. Lower glume orbicular, 0.5-1×1.2-1.7 mm, membranous, much thinner on margins, 3-veined, apex obtuse. Upper glume oblong, 2-2.2×1.2-1.7 mm, membranous, with chartaceous margins, 7-veined, apex acute. Basal sterile florets male or barren, with palea. Lemma of lower sterile floret membranous, 2.2-2.7×1.2-1.7 mm, 5-veined. Palea hyaline, veinless, 1.2-1.7×0.5-0.7 mm. Upper lemma elliptic, 2-2.2×1.5-1.7 mm, dorsally compressed, gibbous, rugose, margins involute, apex apiculate. Palea hyaline, 2-veined, indurate, apiculate, 2-2.2×1.5-1.7 mm. Lodicules 2. Stamens 3, anther 1-1.5mm long. Ovary 0.5mm long, style & stigma 1.5mm long overall, purple coloured. **Plate 91.**

Flowering & Fruiting: September-December.

Habitat: Forest undergrowth.

Distribution: China and eastern Asia, India, Malesia and Papuasia. INDIA: Penninsular & N. E. India. S. GUJARAT: Dangs, Tapi. **New records for the State.**

Voucher specimen: RJD/ 291, 394, 713

86. **Setaria pumila** (Poir.) Roem. & Schult. Syst. Veg. 2:891 1817; Karthik. et al. 259. 1989; Lakshmi. in Sharma et al. 595. 1996; *S. glauca non (L.) P. Beauv.* 1812; Hooker f. 7:78. 1897; Cooke 3:435. 1958; Blatt. & McC. 172. 1935; Bor. op. cit. 360; Shah 2:864. 1978; Pandey op.cit. 1111; Shetty op. cit. 517.

Annual, caespitose. Culms geniculately ascending, 15–80 cm long, nodes glabrous. Ligule a ciliolate membrane or a fringe of hairs. Leaf-blades 3–30×0.4–1 cm. Synflorescence a panicle. Panicle spiciform, linear, 3–15 cm long. 1° panicle branches accrescent to a central axis, with evident branchlets on axis. Panicle axis pubescent. Spikelets subtended by an involucre, composed of bristles, free throughout, 3–12 mm long, persistent, few, in one whorl, 6–8 in principal whorl, flexible, antrorsely scaberulous. Fertile spikelets ovate, dorsally compressed, gibbous, 2.5–3 mm long, falling entire pedicelled, 1 in the cluster, pedicels oblong. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes shorter than spikelet, thinner than Upper lemma. Lower glume orbicular, 1.5-1.7×2-2.2 mm, membranous, 3-5-veined, apex acute. Upper glume ovate, 1.7-2×2-2.2 mm, membranous, 5-veined, apex acute. Basal sterile florets male or barren, with palea. Lemma of lower sterile

floret ovate, 2.5-2.7×2-2.2 mm, membranous, 7-veined, sulcate, acute. Palea 1.8-2.2×1.2-1.5 mm, membranous, 2-veined, toothed. Upper lemma ovate, 2-2.2×1-1.2 mm, dorsally compressed, gibbous, indurate, 5-veined, rugose, margins involute. Palea involute, indurate, 1.2-1.7×1.8-2 mm, 2-veined. Lodicules 2. Stamens 3, anther 0.5mm long. Ovary 1mm long, style & stigma 1.5mm long overall, purple coloured. **Plate 92.**

Flowering & Fruiting: July-November.

Habitat: Common in all habitats.

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 4, 23, 728

87. **Setaria verticillata** (L.) P.Beauv. *Ess. Agrostogr.* 51. 1812; *Hooker f.* 7:80. 1897; *Blatt. & McC.* 174. 1935; *Cooke* 3:436. 1958; *Bor* 365. 1960; *Shah* 2:865. 1978; *Karthik. et al.* 259. 1989; *Pandey in Shetty & Singh* 3:1114. 1993; *Lakshmi. in Sharma et al.* 595. 1996; *Roy in Singh et al.* 519. 2001.

Annual, caespitose. Culms decumbent, up to 100 cm long. Leaf-sheaths outer margin hairy. Ligule a ciliate membrane. Leaf-blades 5–30×0.5–2 cm, flaccid, pilose. Synflorescence a panicle. Panicle spiciform, linear, continuous or interrupted, 4–15 cm long. 1° panicle branches with evident branchlets on axis. Panicle axis hispidulous. Spikelets subtended by an involucre; involucre composed of bristles, 3–8 mm long, persistent, 1–4 in principal whorl, flexible, retrorsely scaberulous. Fertile spikelets 1–3 in the cluster, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, 1.5–2.5 mm long, falling entire. Glumes reaching apex of florets, thinner than Upper lemma. Lower glume ovate, 0.8-1×1.2-1.7 mm, hyaline, 1-3-veined, apex acute. Upper glume ovate, 2-2.2×1.5-1.8 mm, membranous, 5-veined, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret ovate, 1.5-1.8×1.5-1.8 mm, membranous, 5-veined, acute. Upper lemma ovate, dorsally compressed, gibbous, 2.2-2.5×1.8-2.2 mm, indurate, rugose, margins involute. Palea involute, indurate, 2-2.2×1.5-1.8 mm, 2-veined. Lodicules 2. Stamens 3, anther 1mm long. Ovary 0.5mm long, style & stigma 1.5-2mm long overall, purple coloured. **Plate 93.**

Flowering & Fruiting: July-December.

Habitat: In hedges and shady grounds

Distribution: Europe, Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 17, 359, 444

88. **Urochloa distachya** (L.) T.Q.Nguyen *Novosti Sist. Vyssh. Rast.* 3:13. 1966; *Brachiaria distachya* (L.) Stapf *Fl. Trop. Afr.* 9:565. 1919; *Bor* 281. 1960; *Shah* 2:791. 1978; *Karthik. et al.* 190. 1989; *Lakshmi. in Sharma et al.* 415. 1996; *Panicum distachyum* L. *Mant.* 183. 1771; *Hooker f.* 7:37. 1897; *Pandey in Shetty & Singh* 3:987. 1993; *Roy in Singh et al.* 379. 2001; *Digitaria distachya* (L.) Pers. *Syn. Pl.* 1:85. 1805.

Annual, mat forming. Culms prostrate, 8–25 cm long. Ligule a fringe of hairs. Leaf-blades linear or lanceolate, 2–8×0.3–0.8 cm. Synflorescence composed of racemes. Racemes 2–3, borne along a central axis, unilateral, 1–3 cm long. Peduncle 1–4 cm long. Rachis narrowly winged, glabrous on margins. Spikelet packing adaxial, regular, 2-rowed, solitary, sessile, comprising 1 basal sterile florets, 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, acute, 3.5–4×2–2.5 mm, falling entire. Rachilla internodes elongated between glumes. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume ovate, clasping, 1.5–2×2–2.5 mm, membranous, 7–9-veined, apex obtuse. Upper glume oblong, 3.2–3.5×2–2.5 mm, membranous, 7-veined, apex acute. Basal sterile florets barren, with palea. Lemma of lower sterile floret similar to upper glume, oblong, 3–3.5×1.5–2 mm, membranous, 5-veined, acute. Lower Palea 2.2–2.5×0.7–1 mm, membranous, 2-veined, obtuse. Upper lemma elliptic, 2.2–2.5×1–1.2 mm, indurate, rugulose, margins involute, apex acute. Palea involute, indurate, rugose, 2.2–2.5×1–1.2 mm. Stamens 3, anther 1.5 mm long. Ovary 0.5 mm long, style & stigma 2–2.5 mm long overall, purple coloured. **Plate 94.**

Flowering & Fruiting: August–November.

Habitat: Moist- shaded places in plains.

Distribution: Tropical Africa, Asia-tropical, Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/

89. ***Urochloa mutica*** (Forssk.) T.Q.Nguyen *Novosti Sist. Vyssh. Rast.* 3: 13. 1966; *Brachiaria mutica* (Forssk.) Stapf *Fl. Trop. Afr.* 9:526. 1919; *Blatt. & McC.* 134. 1935; *Bor* 284. 1960; *Shah* 2:791. 1978; Karthik. *et al.* 190. 1989; *Lakshmi. in Sharma et al.* 416. 1996; *Panicum muticum* Forssk. *Fl. Aegypt.-Arab.* 20. 1775; *Hooker f.* 7:34. 1897; *Cooke* 3:456. 1958.

Perennial. Culms rambling, up to 2 m long, rooting from lower nodes. Ligule a fringe of hairs. Leaf-blades 10–30×1–2 cm. Synflorescence composed of racemes. Racemes 5–20, borne along a central axis, unilateral, 10–20 cm long, simple or secondarily branched. Peduncle up to 20 cm long. Rachis broadly winged, 1 mm wide, scabrous on margins. Spikelet packing irregular, in pairs, sessile and pedicelled, 2 in the cluster, pedicels bearing a few hairs. Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, acute, 3–4 mm long, falling entire. Rachilla internodes brief up to lowest fertile floret. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume ovate, 0.5–0.7×0.7–1 mm, membranous, 3-veined, apex acute. Upper glume oblong, 3–3.2×2–2.5 mm, membranous, 5–7-veined, apex acute. Basal sterile florets male, with palea. Lemma of lower sterile floret 3–3.2×2–2.5 mm, oblong, similar to upper glume, 5-veined, acute. Lower Palea 3–3.2×1–1.5 mm, membranous, 2-veined, toothed. Upper lemma elliptic, 2.5–2.7×1–1.2 mm, indurate, surface rugulose, margins involute, apex mucicous. Palea involute, indurate, rugose, 2–2.2×1–1.2 mm, 2-veined. Lodicules 2. Stamens 3, anther 3 mm long. Ovary 1 mm long, Style & Stigma 3 mm long overall, purple coloured. **Plate 95.**

Flowering & Fruiting: August–November.

Habitat: Banks of the permanent & seasonal water bodies.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 92, 177, 296

90. **Urochloa panicoides** P.Beauv. *Ess. Agrostogr.* 52. 1812; *Bor* 372. 1960; *Shah* 2:880. 1978; *Pandey in Shetty & Singh* 3:1135. 1993; *Lakshmi. in Sharma et al.* 630. 1996; *Roy in Singh et al.* 542. 2001; *Panicum javanicum* Poir. *In Lam. Encycl.* 4:274. 1816; *Hooker f.* 7:35. 1897; *Cooke* 3:450. 1958; *U. helopus* (Trin.) Stapf. *In Prain FL. Trop. Afr.* 9:595. 1920; *Blatt. & McC.* 146. 1935; *U. marathensis* Henr. *in Meded Rijks.-Herb. Leiden* 43:2. 1922; *Blatt. & McC. op. cit.* 147; *U. panicoides* var. *marathensis* (Henrard) *Bor op. cit.* 372; *U. panicoides* var. *pubescens* (Kunth) *Bor op. cit.* 372; *Shah op. cit.* 881; *U. panicoides* var. *velutina* (Henrard) *Bor op. cit.* 373.

Annual, caespitose. Culms geniculately ascending or decumbent, up to 100 cm long, rooting from lower nodes. Ligule a fringe of hairs. Leaf-blade linear or lanceolate, base amplexicaul, 4–15×0.5–2 cm, glabrous or pubescent, margins tuberculate-ciliate, hairy at base. Synflorescence composed of racemes. Racemes 2–7, borne along a central axis, unilateral, 1–5 cm long. Peduncle 1–9 cm long. Rachis narrowly winged, 1-1.2mm wide, angular, glabrous on surface or with scattered hairs. Spikelet packing abaxial, regular, 2–rowed, in pairs, sessile and pedicelled, pedicels bearing a few hairs. Fertile Spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension, elliptic, strongly dorsally compressed, plano-convex, acute, 3.5–4 mm long, falling entire. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume ovate, clasping, 1-1.5×1.5-2 mm, membranous, 3–5-veined, pubescent, apex acute. Upper glume elliptic, 3.5-4×2.5-2.7 mm, membranous, 7–9-veined, pubescent, apex acuminate. Basal sterile florets male or barren, with palea. Lemma of lower sterile floret similar to upper glume, elliptic, 3.2-3.5×2-2.2 mm, membranous, 5–veined, pubescent, eciliate on margins, acuminate. Lower Palea 3-3.2×2-2.2 mm, membranous, 2-veined, acute. Upper lemma orbicular, dorsally compressed, 3-3.2×2-2.2 mm, indurate, rugulose, margins involute, apex mucronate, mucro 0.3–1 mm long overall. Palea 2-2.2×1-1.5 mm, rugulose, 2-veined, acute. indurate. Lodicules 2. Stamens 3, anther 2mm long. Ovary 0.5mm long, style & stigma 3mm long overall, purple coloured. **Plate 96.**

Flowering & Fruiting: February - April.

Habitat: On low hillocks, as a weed in cultivated and fallow fields.

Distribution: Northern and central Europe, Africa, western Asia, Arabia, China, India, Australia, Mexico, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 85, 102, 249, 305, 493, 549, 754

91. **Urochloa ramosa** (L.) T.Q.Nguyen *Novosti Sist. Vyssh. Rast.* 3: 13. 1966; *Brachiaria ramosa* (L.) Stapf *Fl. Trop. Afr.* 9: 542. 1919; *Blatt. & McC.* 134. 1935; *Bor* 284. 1960; *Shah* 2:792. 1978; *Karthik. et al.* 191. 1989; *Lakshmi. in Sharma et al.* 417. 1996; *Panicum ramosum* L. *Mant.* 1:29. 1767; *Hooker f.* 7:36. 1897; *Cooke* 3:449. 1958; *Pandey in Shetty & Singh* 3:990. 1993; *Roy in Singh et al.* 380. 2001.

Annual, caespitose. Culms up to 100 cm long. Ligule a fringe of hairs. Leaf-blades 5–25×0.4–1.5 cm. Synflorescence composed of racemes. Racemes 3–15, borne along a central axis, unilateral, 1–8 cm long, simple or with branchlets at base of longer racemes. Peduncle 5–15 cm long. Rachis wingless, angular. Spikelet packing adaxial, irregular, 2-rowed, appressed, in pairs, elliptic, slightly dorsally compressed, acute, 2.5–3.5 mm long, falling entire, pedicelled, pedicels linear, 1–2 mm long. Fertile spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume ovate, clasping, 1.5-2×2-2.2 mm, membranous, 3-5-veined, apex obtuse or acute. Upper glume ovate, 3-3.5×2-2.2 mm, membranous, 5–7-veined, glabrous, apex acute. Basal sterile florets barren, with palea. Lemma of lower sterile floret similar to upper glume, ovate, 3-3.5×2-2.2 mm, membranous, 5-veined, glabrous, acute. Lower Palea 3-3.2×2-2.2 mm, membranous, 2-veined, acute. Upper lemma ovate, 2.5-2.8×1.5-1.8 mm, indurate, dark brown, rugose, margins involute, apex acute. Palea involute, indurate, 2-2.5×1.5-1.7 mm, 2-veined. Lodicules 2. Stamens 3, anther 1mm long. Ovary 1mm long, style & stigma 1.5mm long overall, purple coloured. **Plate 97.**

Flowering & Fruiting: February - April.

Habitat: Common in all habitats.

Distribution: Africa, Asia-temperate, India, Indo-China, Malesia, Australia, southeast USA. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 29, 542, 689

92. **Urochloa reptans** (L.) Stapf *Fl. Trop. Afr.* 9: 601. 1920; *Blatt. & McC.* 144. 1935; *Pandey in Shetty & Singh* 3:991. 1993; *Roy in Singh et al.* 380. 2001; *Brachiaria reptans* (L.) C.A.Gardner & C.E.Hubb. *Hooker f.'s Icon.* 3363. 1938; *Bor* 285. 1960; *Shah* 2:792. 1978; *Karthik. et al.* 191. 1989; *Lakshmi. in Sharma et al.* 417. 1996; *Panicum prostratum* Lam. *Illustr.* 1:171. 1791; *Hooker f.* 7:33. 1897; *Cooke* 3:448. 1958.

Annual. Culms decumbent, up to 60 cm long, rooting from lower nodes. Ligule a fringe of hairs. Leaf-blades lanceolate, 2–8×0.5–1.5 cm. Synflorescence composed of racemes. Racemes 5–10, borne along a central axis, unilateral, 1–4 cm long. Peduncle 1–8 cm long. Rachis wingless, angular. Spikelet packing crowded, regular, elliptic, slightly dorsally compressed, acute, 1.5–2.2 mm long, falling entire, 2-rowed, in pairs, sessile and pedicelled, pedicels ciliate. Fertile spikelets comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume orbicular, clasping, 0.5-0.7×1.5-2 mm, hyaline, 1-3-veined, apex obtuse or acute. Upper glume ovate, 2-2.2×1-1.5 mm, membranous, 7-veined, glabrous, apex acute. Basal sterile florets male, with palea. Lemma of lower sterile floret similar to upper glume, ovate, 2-2.2×1-1.2 mm, membranous, 5-veined, glabrous, acute. Lower Palea 1.5-2×1-1.5 mm, membranous, 2-veined, acute. Upper lemma elliptic, 1-1.2×0.7-1 mm, indurate, dark brown, rugose, margins involute, apex acute. Palea involute, indurate, 1-1.2×0.5-0.7 mm, 2-veined. Lodicules 2. Stamens 3, anther 1mm long. Ovary 0.5mm long, style & stigma 1-1.5mm long overall, purple coloured. **Plate 98.**

Flowering & Fruiting: February - April.

Habitat: Common in all habitats.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 1, 327, 550

93. **Digitaria albudense** (Roem. & Schult.) Veldk. in *Blumea* 21:53. 1973; Karthik. *et al.* 207. 1989; Pandey in Shetty & Singh 3:1023. 1993; Lakshmi. in Sharma *et al.* 461. 1996; Roy in Singh *et al.* 409. 2001; *Paspalum pedicellare* Trin. ex Hooker f. 7:19. 1897; *D. pedicellaria* (Trin. ex Hook. f.) Prain Beng. Pl. 1181. 1903; Blatt. & McC. 126. 1935; Cooke 3:458. 1958; *D. granularis* (Trin. ex Spr.) Henr. *Monogr. Gen. Digitaria* 302. 1950; Bor 301. 1960; Shah 2:809. 1978.

Annual. Culms decumbent, 15–60 cm long, rooting from lower nodes. Leaf-sheaths pilose with tubercle-based hairs. Ligule an eciliate membrane, truncate. Leaf-blades linear, 5–10×0.3–0.5 cm, flaccid, scaberulous, glabrous, margins scaberulous, apex attenuate, filiform. Synflorescence composed of racemes. Racemes 3–7, Digitate, unilateral, 3–8 cm long. Peduncle 2–7 cm long. Rachis angular, scabrous on margins. Spikelet packing lax, spreading, in pairs or in threes, pedicelled, pedicels filiform, scabrous, tip widened. Spikelets fertile, elliptic, dorsally compressed, acute, 1.7–2.2 mm, falling entire, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Lower glumes absent or obscure. Upper glume lanceolate, 1.5–1.7×1–1.2 mm, membranous, 5–veined, hairy between veins, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret elliptic, 2–2.2×1–1.2 mm, membranous, 5–veined, hairy between veins, obtuse. Upper lemma elliptic, 1–1.5×0.5–0.7 mm, cartilaginous, much thinner on margins, dark brown, 3–veined, striate, margins flat, covering most of palea, apex apiculate. Palea cartilaginous, 1–1.2×0.5 mm, apiculate. Lodicules 2. Stamens 3, anther 0.4mm long. Ovary 0.3mm long, style & stigma 0.8mm long overall, purple coloured. **Plate 99.**

Flowering & Fruiting: August–October.

Habitat: In open fallow fields, grass lands.

Distribution: China, India, Malesia, Papuasias. INDIA: Throughout. S. GUJARAT: Surat.

Voucher specimen: RJD/ 782, 783, 807

94. **Digitaria bicornis** (Lam.) Roem. & Schult. *Syst. Veg.* 2: 470. 1817; Bor 299. 1960; Karthik. *et al.* 207. 1989; Pandey in Shetty & Singh 3:1024. 1993; Lakshmi. in Sharma *et al.* 462. 1996; Roy in Singh *et al.* 409. 2001; *D. biformis* Willd. *Enum. Pl.* 92. 180; Bor *op. cit.* 299; Shah 2:813. 1978; *Paspalum heteranthum* Hooker f. 7:16. 1897.

Annual. Culms decumbent, 10–35 cm long, rooting from lower nodes. Leaf-sheaths pilose, with tubercle-based hairs. Ligule an eciliate membrane, truncate. Leaf-blades elliptic, 3–12×0.2–0.8 mm. Leaf-blade surface scaberulous, pilose with tubercle-based hairs, margins scabrous, apex acute. Synflorescence composed of racemes. Racemes 2–4, paired or digitate, straight, unilateral, 3–10 cm long. Rachis narrowly winged, angular, scabrous on margins.

Spikelets in pairs, heteromorphic, pedicelled, pedicels scabrous, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, acute, 3-4×1-1.2 mm, falling entire. Glumes two, dissimilar, thinner than Upper lemma. Lower glume ovate, 3-3.5×1-1.2 mm, 3-veined, apex obtuse. Upper glume lanceolate, membranous, 5-veined, glabrous, margins ciliate, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret elliptic, 3.5-4×2.5-3 mm, membranous, 5-veined, with thickened veins, ribbed, pilose, hairy between veins, ciliate on margins, acute. Upper lemma elliptic, 3-3.5×1-1.2 mm, cartilaginous, much thinner on margins, light brown, 3-veined, smooth, margins flat, covering most of palea, apex acute. Palea cartilaginous, 3-3.5×1-1.2 mm, 2-veined, acuminate. Lodicules 2. Stamens 3, anther 1mm long. Ovary 0.5mm long, style & stigma 1.5mm long overall, purple coloured. **Plate 100.**

Flowering & Fruiting: August-October.

Habitat: In wet & humid places along streams or water bodies.

Distribution: North Africa, China, eastern Asia, Asia-tropical, Australia, Mexico, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 50, 287, 625

95. **Digitaria ciliaris** (Retz.) Koeler *Descr. Gramin.* 27. 1802; Karthik. *et al.* 207. 1989; Pandey in Shetty & Singh 3:1025. 1993; Lakshmi. in Sharma *et al.* 462. 1996; Roy in Singh *et al.* 410. 2001; *D. biformis* Willd. *Enum. Pl.* 92. 180; Bor 493. 1960; *Paspalum sanguinale* Lam. var. *ciliare* (Retz.) Hooker f. 7:15. 1897; *D. sanguinalis* var. *ciliaris* Prain Beng. Pl. 1181. 1903; Cooke 3:457. 1958; *D. marginata* var. *fimbriata* (Link) Stapf Fl. Trop. Afr. 9: 40. 1919; Blatt. & McC. 125. 1935; *D. adscendens* (H. B. & K.) Henrard *Blumea* 1:92. 1934; Bor *op. cit.* 289; Shah 2:812. 1978; *D. adscendens* ssp. *crysolephara* (Fig. & de Not.) Henr. In *Monogr. Gen. Digitaria* 998. 1950; Bor *op. cit.* 299.

Annual. Culms decumbent, 20–150 cm long. Ligule an eciliate membrane. Leaf-blades up to 25×1.5 cm. Synflorescence composed of racemes. Racemes 2–15, digitate, unilateral, 6–22 cm long. Central Synflorescence axis 2-15 cm long. Rachis narrowly winged, angular, with scattered hairs, scabrous on margins. Spikelet packing contiguous, appressed, in pairs, pedicelled, all alike, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, acute, 3.5–4 mm long, falling entire. Glumes dissimilar, thinner than Upper lemma. Lower glume if present, 0.5-1mm long, membranous, truncate. ovate, Upper glume lanceolate, 3-3.5×1-1.2 mm, 3-veined, apex acuminate. Lemma of lower sterile floret elliptic, 3.5-4×3-3.5 mm, 7-veined, membranous, hairy between veins, eciliate on margins, apex acute. Basal sterile florets barren, without significant palea. Upper lemma elliptic, 3–3.7×1-1.2 mm, cartilaginous, much thinner on margins, dark brown, 3-veined, margins flat, covering most of palea, ciliate, apex acute. Palea 3-3.5×1-1.2 mm, 2-veined, cartilaginous. Lodicules 2. Stamens 3, anther 1mm long. Ovary 1mm long, style & stigma 2mm long overall, purple coloured. **Plate 101.**

Flowering & Fruiting: August-October. 144, 703, 738

Habitat: Common in forest undergrowth, wastelands, road sides, moist places.

Distribution: Southeastern Europe, Africa, Asia-temperate, Asia-tropical, Australia, New Zealand, Mexico, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 144, 489, 703, 738

96. **Digitaria longiflora** (Retz.) Pers. Syn. Pl. 1:85. 1805; Blatt. & McC. 127. 1935; Cooke 3:458; Bor 302. 1960; Shah 814. 1978; Karthik. *et al.* 208. 1989; *Pandey in Shetty & Singh* 3:1026. 1993; *Lakshmi. in Sharma et al.* 463. 1996; *Roy in Singh et al.* 411. 2001; *Paspalum longiflorum* Retz. Obs. 4:15. 1786; Hooker f. 7:17. 1897; Cooke 3:458. 1958.

Annual or short-lived, mat forming. Stolons present. Culms rambling, 10–30 cm long. Leaf-sheaths glabrous or hirsute. Ligule an eciliate membrane. Leaf-blades 2–9×0.1–0.5 cm, glabrous or hirsute. Synflorescence composed of racemes. Racemes 2–4, paired or digitate, unilateral, 1–6 cm. Rachis broadly winged, with rounded midrib. Spikelets 3 in the cluster, pedicelled, pedicels unequal. Spikelets elliptic, dorsally compressed, 1.2–1.8 mm long, falling entire, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Lower glumes absent. Upper glume elliptic, reaching apex of florets, thinner than Upper lemma, membranous, 1.2–1.7×0.7–1 mm, 7-veined, pubescent with verruculose hairs, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret elliptic, membranous, 1.2–1.5×0.7–1 mm, 7-veined, puberulous with verruculose hairs, acute. Upper lemma elliptic, 1.2–1.5×0.5–0.7 mm, cartilaginous, much thinner on margins, pallid or light brown, margins flat, covering most of palea, apex acute. Palea cartilaginous, elliptic, 1–1.2×0.5–0.7 mm, 2-veined, acute. Lodicules 2. Stamens 3, anther 0.6mm long. Ovary 0.4mm long, style & stigma 1–1.5mm long overall, purple coloured. **Plate 102.**

Flowering & Fruiting: August–October.

Habitat: In forest undergrowth of rocky habitats.

Distribution: Africa, China, eastern Asia, Asia-tropical, Australia, southeast USA, South America. INDIA: Throughout. S. GUJARAT: Valsad.

Voucher specimen: RJD/ 792, 797, 809

97. **Digitaria setigera** Roth. *Syst. Veg.* 2:474. 1817; Bor 305. 1960; Shah 2:815. 1978; Karthik. *et al.* 208. 1989; *Pandey in Shetty & Singh* 3:1028. 1993; *Lakshmi. in Sharma et al.* 463. 1996; *Roy in Singh et al.* 411. 2001; *Paspalum sanguinale* var. *extensum* Hooker f. 7:15. 1897; *D. microbachne* (C.Presl) Henrard *Meded. Rijks-Herb.* 61: 13. 1930; Bor *op. cit.* 302; Blatt. & McC. 129. 1935; Shah *op.cit.* 814.

Annual. Culms decumbent, 20–80 cm long. Ligule an eciliate membrane. Leaf-blades linear or lanceolate, 4–25×0.4–1.5 cm. Synflorescence composed of racemes. Racemes 3–15, digitate or borne along a central axis, unilateral, 4–15 cm long. Peduncle 3–12 cm long. Rachis narrowly winged, angular, glabrous with scattered hairs, scabrous on margins. Spikelet in pairs, pedicelled, pedicels unequal. Fertile Spikelets lanceolate, dorsally compressed, 2.5–3 mm long, falling entire, comprising 1 basal sterile & 1 fertile florets, without rachilla

extension. Glumes shorter than spikelet, thinner than Upper lemma. Lower glumes absent or obscure. Upper glume ovate, membranous, 2-2.2×0.5-0.8 mm, 3-veined, pubescent, apex acute. Basal sterile florets barren without significant palea. Lemma of lower sterile floret elliptic, membranous, 3-3.5×1.5-1.7 mm, 5-7-veined, pubescent, ciliate on margins, acute. Upper lemma elliptic, 2.7-3×1-1.2 mm, cartilaginous, much thinner on margins, grey or light brown, margins flat, covering most of palea, apex acute. Palea cartilaginous, 2.5-3×1-1.2 mm, 2-veined, acute. Lodicules 2. Stamens 3, anther 1mm long. Ovary 0.5mm long, style & stigma 1.5mm long overall, purple coloured. **Plate 103.**

Flowering & Fruiting: August-October.

Habitat: In wet & moist places along the streams and water bodies.

Distribution: Africa, China and eastern Asia, Asia-tropical, Australia, New Zealand, Mexico, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 35, 416, 440

98. **Digitaria stricta** Roth *Syst. Veg.* 2:474. 1817; *Bor* 305. 1960; Karthik. *et al.* 209. 1989; Lakshmi. in Sharma *et al.* 465. 1996; *Paspalum shettyleanum* Nees ex Hooker *f.* 7:18. 1897; *D. shettyleana* (Nees ex Hook.f.) Prain *Bengal Pl.* 2: 1182. 1903; Blatt. & McC. 127. 1935; Cooke 3:459. 1958; Shah 2:815. 1978; Pandey in Shetty & Singh 3:1029. 1993; Roy in Singh *et al.* 412. 2001.

Annual; caespitose. Culms geniculately ascending, 20-40 cm long. Leaf-sheaths hirsute with tubercle-based hairs. Ligule an eciliate membrane, truncate. Leaf-blades 4-30×0.2-0.8 cm, hirsute with tubercle-based hairs, apex acuminate. Synflorescence composed of racemes. Racemes 3-12, digitate, unilateral, 4-17 cm long. Peduncle 1-5 cm long. Rachis narrowly winged, angular, scabrous on margins. Spikelets 3 in the cluster, pedicelled, pedicels scabrous, bearing a few hairs, hairy at tip with 0.2-1 mm long hairs, tip cupuliform. Spikelets oblong, dorsally compressed, obtuse, 1-1.2 mm long, falling entire, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Lower glumes absent. Upper glume elliptic, membranous, 1-veined, pubescent with capitate hairs, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret elliptic, membranous, 0.5×0.3 mm, 5-veined, pubescent, hairy between veins with capitate hairs, acute. Upper lemma elliptic, 1-1.5×0.7-1 mm, cartilaginous, much thinner on margins, dark brown or black, 3-veined, margins flat, covering most of palea, apex apiculate. Palea cartilaginous, 2.5-3×1-1.2 mm, 2-veined, apiculate. Lodicules 2. Stamens 3, anther 0.5mm long. Ovary 0.2mm long, style & stigma 0.5mm long overall, purple coloured. **Plate 104.**

Flowering & Fruiting: July-October.

Habitat: In open wastelands in rocky-gravelly habitats.

Distribution: Arabia, China, eastern Asia, India and Indo-China. INDIA: Throughout hilly parts of India. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 269, 486, 585

99. **Digitaria violascens** Link *Hort. Berol. 1: 229. 1827; Hooker f. 7:92. 1897; Bor 307. 1960; Karthik. et al. 209. 1989; Roy in Singh et al. 412. 2001.*

Annual, mat forming. Culms geniculately ascending, 7–20 cm long. Ligule an eciliate membrane. Leaf-blades 3–8×0.3–0.7 cm. Synflorescence composed of racemes. Racemes 2-5, digitate, unilateral, 2-5 cm long. Peduncle 1–5 cm long. Rachis broadly winged, angular, scabrous on margins. Spikelets 3 in the cluster, pedicelled, pedicels scabrous, bearing a few hairs, hairy at tip with 0.2–1 mm long hairs, tip cupuliform. Spikelets oblong, dorsally compressed, obtuse, 1–1.2 mm long, falling entire, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Lower glumes absent. Upper glume elliptic, membranous, 1-veined, pubescent with verruculose hairs, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret elliptic, membranous, 0.5×0.3 mm, 5-veined, pubescent, hairy between veins with verruculose hairs, acute. Upper lemma elliptic, 1–1.5×0.7-1 mm, cartilaginous, much thinner on margins, dark brown or black, 3-veined, margins flat, covering most of palea, apex apiculate. Palea cartilaginous, 2.5–3×1-1.2 mm, 2-veined, apiculate. Lodicules 2. Stamens 3, anther 0.5mm long. Ovary 0.2mm long, style & stigma 0.5mm long overall, purple coloured. **Plate 105.**

Flowering & Fruiting: July-October.

Habitat: In open wastelands in rocky-gravelly habitats.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, New Zealand, USA, South America. INDIA: Throughout rocky-moist places. S. GUJARAT: Throughout. **New record for the state.**

Voucher specimen: RJD/ 318, 488, 563

100. **Cenchrus biflorus** Roxb. *Fl. Ind. 1: 238. 1820; Bor 287. 1960; Karthik. et al. 196. 1989; Lakshmi. in Sharma et al. 419. 1996; Shah 2:795. 1978; Pandey in Shetty & Singh 3:993. 1993; Roy in Singh et al. 384. 2001; Cenchrus catharticus Delile Index Seminum (MPU) 1838:4. 1839; Hooker f. 7:90. 1897; Cooke 3:433. 1958; Blatt. & McC. 186. 1935.*

Annual, caespitose. Culms geniculately ascending, 5–30 cm long. Internodes unequal, the upper longer, channelled; nodes constricted, purple, glabrous. Lateral branches ample, extravaginal, arising mostly from lower culm, with subequal branches. Leaves basal and cauline. Leaf-sheaths loose, open for most of their length with flat margins, longer than internode, keeled, scaberulous, glabrous. Leaf-sheath oral hairs bearded. Ligule a fringe of hairs. Collar pubescent. Leaf-blades linear or lanceolate, 2–15×0.2–0.8 cm, scaberulous, puberulous, margins scaberulous, blade apex acuminate, base broadly rounded or cordate. Synflorescence a panicle. Panicle spiciform, linear, 2–10 cm long. 1° panicle branches accrescent to a central axis with sessile scars on axis. Panicle axis angular, scabrous, bearing deciduous spikelet clusters. Spikelets subtended by an involucre, composed of bristles, 0.5–1 mm connate into a disc below ovate, up to 10mm long, base obconical, base glabrous, deciduous with the fertile spikelets; in two with an outer whorl of thinner bristles, 7–15 in principal whorl, inner bristles longer than outer, 5–8 mm long, flattened, grooved on the face, rigid, retrorsely scaberulous, ciliate, spinose. Fertile spikelets sessile, 1–3 in the cluster,

comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets ovate, dorsally compressed, acuminate, 3–5 mm long, falling entire, deciduous with accessory branch structures. Glumes shorter than spikelet, thinner than Upper lemma. Lower glume lanceolate, 2–2.5×1.2–2.5 mm, membranous, 1-veined, apex obtuse-acute. Upper glume ovate, 2.5–3×1.7–2 mm, membranous, 3–5-veined, apex obtuse-acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret similar to upper glume, ovate, 3–3.5×1.7–2 mm, membranous, 5-veined, acute. Upper lemma ovate, 3.5–4×1.7–2 mm, coriaceous, much thinner on margins, 5-veined, margins flat, apex acute. Palea 3–3.5×1.7–2 mm, coriaceous, 4-veined, apex toothed, membranous. Anthers 3, 3mm long, brown; anther tip smooth. Ovary glabrous, 1mm long; stigmas 2mm long; styles 2.2 mm long. **Plate 106.**

Flowering & Fruiting: August-December.

Distribution: Africa, Asia-temperate, India, Australia. INDIA: Throughout hotter parts. S. GUJARAT: Throughout.

Habitat: In sandy soil.

Voucher specimen: RJD/ 341, 358, 853

101. **Cenchrus ciliaris** L. *Mant. Pl. 2: 302 1771; Bor 287. 1960; Shah 2:796. 1978; Karthik. et al. 196. 1989; Pandey in Shetty & Singh 3:994. 1993; Shetty Lakshmi. in Sharma et al. 421. 1996; in Singh et al. 384. 2001; P. cenchroides* L. C. Rich. *In Pers. Syn. 1:72. 1805; Hooker f. 7:88. 1897; Cooke 3:432. 1958; P. ciliare* (L.) Link *Hort. Berol. 1: 213. 1827; Blatt. & McC. 116. 1935; C. pennisetiformis* Hochst. & Steud. *Nomencl. Bot. (ed. 2) 1:317. 1840; Bor op. cit. 289; Shah op. cit. 796; Karthik. et al. op. cit. 196; Lakshmi. op. cit. 421; Pandey op. cit. 994.*

Perennial, caespitose. Rhizomes short. Butt sheaths distinctly ribbed, pubescent. Culms geniculately ascending, 10–50cm long, wiry. Lateral branches sparse, extravaginal. Leaves basal and cauline. Leaf-sheaths loose, open for most of their length, with flat margins, 5–10 cm long, shorter than internode, keeled, striately veined, scaberulous, pilose; outer margin hairy. Leaf-sheath oral hairs scanty. Ligule a fringe of hairs. Collar glabrous. Leaf-blades 3–25×0.4–1 cm. Leaf-blade venation distinct, midrib conspicuous, prominent beneath, scaberulous, sparsely hairy with tubercle-based hairs, margins unthickened, glabrous or ciliate, apex acuminate. Synflorescence a panicle. Panicle spiciform, linear to oblong, 2–14 cm long. 1° panicle branches accrescent to a central axis, with sessile scars on axis. Panicle axis angular, puberulous, bearing deciduous spikelet clusters. Spikelets subtended by an involucre, composed of bristles 0.5mm connate into a disc below, 6–12 mm long, base obconical, deciduous with the fertile spikelets, numerous, with an outer whorl of thinner bristles, inner bristles longer than outer, with one conspicuously longer bristle, 6–15 mm long, flattened, without grooves, flexible, antrorsely scaberulous, ciliate. Fertile spikelets sessile, 1–4 in the cluster, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets lanceolate, dorsally compressed, acute, 2–4 mm long, falling entire, deciduous with accessory branch structures. Glumes similar, subequal, shorter than spikelet, thinner than Upper lemma. Lower glume ovate, hyaline, 1-veined, apex acute. Upper glume ovate, hyaline, 1–3-veined, apex acute. Basal sterile florets barren, with or without significant palea. Palea if present, ovate, chartaceous, 2-veined, apex acute. Lemma of lower sterile floret ovate, membranous,

3.2–3.5×1.7–2 mm, 5-veined, acute-toothed. Upper lemma ovate, dorsally compressed, lanceolate, 3.5–5×1.2–1.7 mm, chartaceous, pallid, 5-veined, margins covering most of palea, apex acute. Palea ovate, chartaceous, 2-veined, apex acute. Lodicules 2, cuneate, membranous. Anthers 3, 2mm long, anther tip smooth. Ovary glabrous, 0.5mm long; stigmas 2mm long; styles 2.5 mm long, connate below. **Plate 107.**

Flowering & Fruiting: August-March.

Habitat: Common in sandy habitats & road sides.

Distribution: Southeastern Europe, tropical Africa, Asia-temperate & tropical, Australia, North America, western South America. INDIA: Cultivated throughout. S. GUJARAT: Surat.

Voucher specimen: RJD/ 811, 826, 827

102. **Cenchrus setigerus** Vahl *Enum. Pl. 2: 395 1806; Bor 290. 1960; Shah 2:796. 1978; Karthik. et al. 196. 1989; Pandey in Shetty & Singh 3:996. 1993; Lakshmi. in Sharma et al. 421. 1996; Roy in Singh et al. 385. 2001.; C. biflorus auct. non Roxb. 1820; Hooker f. 7:89. 1897; Cooke 3:433. 1958; Blatt. & McC. 185. 1935.*

Perennial, caespitose. Butt sheaths thickened and forming a bulb. Culms geniculately ascending, 5–80 cm long. Ligule a fringe of hairs. Leaf-blades 2–20×0.2–0.7 cm. Synflorescence a panicle. Panicle spiciform, linear, 4–12 cm long. 1° panicle branches accrescent to a central axis, with sessile scars on axis. Panicle axis angular, bearing deciduous spikelet clusters. Spikelets subtended by an involucre. Involucre composed of bristles, connate into a cup below, with 1–3mm connate, oblate, 3–7 mm long, base obconical, bristles deciduous with the fertile spikelets, in one whorl or with an outer whorl of thinner bristles, inner bristles longer than outer, with one longest bristle emergent, 5–7 mm long, flattened, grooved on the face, rigid, antrorsely scaberulous, ciliate, spinose. Fertile spikelets sessile, 1–3 in the cluster, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Spikelets ovate, dorsally compressed, acuminate, 3–5mm long, falling entire, deciduous with accessory branch structures. Glumes shorter than spikelet, thinner than Upper lemma. Lower glume ovate, 1.2–1.5×1.5–1.7 mm, hyaline, 1–3-veined, apex obtuse. Upper glume ovate, 2–2.5×1.5–2 mm, hyaline, 1-veined, apex obtuse or acute. Basal sterile florets barren, with palea. Lemma of lower sterile floret oblong, 4.2–4.5×2–2.5 mm, membranous, 5-veined, emarginated, truncate. Palea 4.2–4.5×2–2.5 mm mm, toothed, membranous, coriaceous. Upper lemma ovate, 5–5.2×2–2.5 mm, coriaceous, much thinner on margins, 5–7-veined, margins flat, apex mucronate. Palea 1.2–1.5×0.5–0.7 mm, toothed, membranous, coriaceous. Lodicules absent. Anthers 3, 2mm long, anther tip smooth. Ovary glabrous, 0.5mm long; stigmas 1.5mm long; styles 2mm long, connate below. **Plate 108.**

Flowering & Fruiting: August-November.

Habitat: In waste lands & fellow fields.

Distribution: Africa, Asia-temperate, India, Indo-China, Australia, Brazil. INDIA: Throughout hotter parts. S. GUJARAT: Surat.

Voucher specimen: RJD/ 109, 481, 541

103. ***Pennisetum glaucum*** (L.) R.Br. *Prodr. Fl. Nov. Holl.* 195. 1810; *P. americanum* (L.) Leake *Z. Naturwiss.* 79: 52. 1907; Karthik. *et al.* 245. 1989; Lakshmi. *in Sharma et al.* 566. 1996; Pandey *in Shetty & Singh* 3:1140. 1993; *P. typhoideum* L.C. Rich. *In Pers. Syn. Pl.* 1:72. 1805; Hooker *f.* 7:82. 1897; Cooke 3:432. 1958; *P. typhoides* (Burm.f.) Stapf & C.E.Hubb. *Bull. Misc. Inform. Kew* 1933: 271. 1933; Bor 350. 1960; Shah 2:856. 1978; Roy *in Singh et al.* 492. 2001; *P. spicatum* (L.) Körn. *Handb. Getried.* 1: 284. 1885; Blatt. & McC. 182. 1935.

Annual. Culms erect, robust, 1.5–3m long, nodes bearded. Ligule a fringe of hairs. Leaf-blades 50–100×1–7 cm. Synflorescence a panicle. Peduncle pubescent above. Panicle spiciform, linear, or elliptic, 6–20 cm long. 1° panicle branches accrescent to a central axis, with lateral stumps on axis. Panicle axis terete, pubescent. Spikelets subtended by an involucre, composed of bristles, bristles persistent, numerous, with an outer whorl of thinner bristles, inner bristles longer than outer, 5–6 mm long, terete, flexible, ciliate. Fertile spikelets obovate, dorsally compressed, 1–3 in the cluster, 4–5 mm long, base bluntly stipitate, stipe 1–2mm long, comprising 1 basal sterile & 1 fertile florets, without rachilla extension, persistent. Lower glumes membranous, 0.5-1×0.5-1 mm, shorter than spikelet, thinner than Upper lemma, veinless, apex obtuse. Upper glume oblong, 1.5-2.5×1-1.5 mm, membranous, shorter than spikelet, thinner than Upper lemma, 3-veined, apex truncate. Basal sterile florets male or barren, with palea. Lemma of lower sterile floret lanceolate or oblong, 3.5–4.5×1.5-2 mm, chartaceous, 5-veined, ciliate on margins, obtuse. Upper lemma oblong, 3–3.5×1.5-2 mm, coriaceous, 5–7-veined, margins flat, pubescent, apex emarginate. Palea oblong, 3–3.5×2-2.5 mm, coriaceous, 5–7-veined, margins flat, pubescent, apex emarginate. Lodicules absent. Anthers 3, 2-2.5mm long, tip penicillate. Ovary glabrous, 0.5mm long; stigmas 1mm long; styles 1.5 mm long, entirely connate. **Plate 109.**

Flowering & Fruiting: July-October.

Habitat: Cultivated in agricultural fields, escape.

Distribution: Eastern Europe, Africa, Asia-temperate, India, China, Australia, Caribbean. INDIA: Cultivated throughout. S. GUJARAT: Cultivated.

Voucher specimen: RJD/ 83, 271, 592

104. ***Pennisetum hohenackeri*** Hochst. *ex Steud. Syn. Pl. Glum.* 1:103. 1854; Bor 344. 1960; Shah 2:854. 1978; Karthik. *et al.* 245. 1989; Pandey *in Shetty & Singh* 3:1092. 1993; Lakshmi. *in Sharma et al.* 564. 1996; Roy *in Singh et al.* 490. 2001; *P. alopecuroides* Nees *ex Steud. Syn. Pl. Glum.* 1:102. 1854; Hooker *f.* 7:84. 1897; Cooke 3:430. 1958; Blatt & McC. 178. 1935.

Perennial, caespitose, clumped densely. Culms erect, 50–180cm long. Leaf-sheaths keeled. Ligule a fringe of hairs. Leaf-blades conduplicate, 15–40×0.2–0.6 mm, stiff, ribbed. Synflorescence a panicle. Peduncle scaberulous above, glabrous. Panicle spiciform, linear, 8–20cm long. 1° panicle branches accrescent to a central axis, with sessile scars on axis. Panicle axis angular, scaberulous, glabrous, bearing deciduous spikelet clusters. Spikelets subtended by an involucre, composed of bristles, deciduous with the fertile spikelets, numerous, with one conspicuously longer bristle, 6–20 mm long, terete, flexible, glabrous. Fertile spikelets

lanceolate, dorsally compressed, 6-7 mm long, sessile, 1 in the cluster, oblong, 6-8 mm long, base bluntly stipitate, comprising 1 basal sterile & 1 fertile florets, without rachilla extension, falling entire, deciduous with accessory branch structures. Glumes dissimilar, shorter than spikelet, thinner than Upper lemma. Lower glume ovate, hyaline, 1-1.2×1-1.2 mm, 0-1-veined, apex obtuse or acute. Upper glume elliptic or ovate, 3.5-4×1-1.5 mm, membranous, 3-5-veined, apex acute. Basal sterile florets male or barren, without significant palea. Lemma of lower sterile floret oblong, 3.5-4.5×1.5-2 mm, membranous, 9-11-veined, obtuse or acute. Upper lemma ovate, 6.5-7×1.5-2 mm, membranous, 5-7-veined, margins flat, acute. Palea 6-6.5×1.5-1.7 mm, membranous, 4-veined, acute. Lodicules absent. Anthers 3, 5-6 mm long, anther tip smooth. Ovary glabrous, 0.5mm long; stigmas 2mm long; styles 2.5 mm long, connate below. **Plate 110.**

Flowering & Fruiting: September-March.

Habitat: In wet-moist places along the streams.

Distribution: East tropical Africa, India. INDIA: Peninsular & N.W. India. S. GUJARAT: Dangs.

Voucher specimen: RJD/ 810, 835, 836

105. **Pennisetum orientale** Rich. *Syn. Pl. 1: 72 1805; Hooker f. 7:86. 1897; Cooke 3:431. 1958; Blatt. & McC. 179. 1935; Bor 345. 1960; Karthik. et al. 246. 1989; Pandey in Shetty & Singh 3:1093. 1993; Lakshmi. in Sharma et al. 564. 1996; Roy in Singh et al. 491. 2001.*

Perennial, caespitose. Rhizomes short. Culms erect or geniculately ascending, 40-170 cm long, woody. Ligule a fringe of hairs. Leaf-blades flat or convolute, 20-40×0.7-1.5 cm, scaberulous. Synflorescence a panicle. Panicle spiciform, linear, 8-20 cm long. 1° panicle branches accrescent to a central axis, with sessile scars on axis. Panicle axis angular, puberulous, bearing deciduous spikelet clusters. Spikelets subtended by an involucre, composed of bristles, with 1-2 conspicuously longer bristle, 15-25 mm long, deciduous with the fertile spikelets, numerous, terete, flexible, plumose, base bluntly stipitate, base 0.5-1.5 mm long. Fertile spikelets sessile and, 1 sessile & 1-2 pedicelled, lanceolate, dorsally compressed, 4.5-5.5 mm long, comprising 1 basal sterile & 1 fertile florets, without rachilla extension, falling entire, deciduous with accessory branch structures. Glumes dissimilar, shorter than spikelet, thinner than Upper lemma. Lower glume oblong, membranous, apex acuminate. Upper glume oblong, 3-3.2×1-1.2 mm, membranous, 0-1-veined, apex obtuse. Basal sterile florets male, with palea. Lemma of lower sterile floret elliptic, chartaceous, attenuate, 5-5.5×1.5-2 mm, 5-veined. Palea chartaceous, 4.5-5×1.2-1.5 mm, 2-veined. Upper lemma lanceolate, 5-5.5×1.5-2 mm, chartaceous, margins flat, apex setaceously attenuate. Palea chartaceous, 4.5-5×1.2-1.5 mm, 2-veined. Lodicules absent. Anthers 3, anther tip apiculate, 2mm long. Ovary glabrous, 0.5mm long; stigmas 6mm long; styles 2.5 mm long, completely connate. **Plate 111.**

Flowering & Fruiting: September-December.

Habitat: Common in forest undergrowth on hills, escape from garden.

Distribution: Northeast tropical Africa, Asia-temperate, India, Malesia, Papuasias, Caribbean.
INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 304, 547, 685

106. **Pennisetum pedicellatum** Trin. *Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat.* 3(2): 184. 1834; *Hooker f.* 7:86. 1897; *Cooke* 3:431. 1958; *Blatt. & McC.* 180. 1935; *Bor* 346. 1960; *Shah* 2:855. 1978; *Karthik. et al.* 246. 1989; *Pandey in Shetty & Singh* 3:1094. 1993; *Lakshmi. in Sharma et al.* 564. 1996; *Roy in Singh et al.* 491. 2001.

Annual. Culms geniculately ascending, 30–150 cm long, branches ample. Ligule a ciliate membrane. Leaf-blades 8–25 × 0.4–1.5 cm. Synflorescence a panicle. Panicle spiciform, linear, 5–15 cm long. 1° panicle branches accrescent to a central axis, with sessile scars on axis. Panicle axis with briefly decurrent ribs, glabrous, bearing deciduous spikelet clusters. Spikelets subtended by an involucre, composed of bristles, deciduous with the fertile spikelets, numerous, 15–25 in principal whorl, with one conspicuously longer bristle, 10–22 mm long, terete, flexible, woolly. Fertile spikelets 1–5 in the cluster, 4–5 mm long, 1 sessile and other pedicelled, pedicels 0.5–1.5 mm long. Fertile spikelets lanceolate, dorsally compressed, deciduous with accessory branch structures, comprising 1 basal sterile & 1 fertile florets, without rachilla extension. Glumes dissimilar, reaching apex of florets, thinner than upper lemma. Lower glume lanceolate or oblong, 1.5–2 × 0.5–1 mm, hyaline, pubescent, apex emarginate. Upper glume ovate, membranous, 4–4.5 × 1.5–2 mm, 5-veined, pubescent, margins ciliate, apex mucous. Basal sterile florets male or barren, with palea. Lemma of lower sterile floret similar to upper glume, oblong, membranous, 3–3.5 × 1.5–2 mm, 5-veined, puberulous, 3-fid. Upper lemma lanceolate, 2.5–3 × 1–1.5 mm, coriaceous, 3-veined, margins flat, apex obtuse. Palea lanceolate, 2.5–3 × 1–1.5 mm, coriaceous, 3-veined, margins flat, apex obtuse. Lodicules absent. Anthers 3, 2 mm long, anther tip smooth. Ovary glabrous, 0.7 mm long; stigmas 4 mm long; styles 1.5 mm long, connate entirely. **Plate 112.**

Flowering & Fruiting: September–December.

Habitat: On rocky habitats.

Distribution: Africa, Asia-tropical, Australia, Brazil. INDIA: Throughout. S. GUJARAT: Surat, Tapi.

Voucher specimen: RJD/ 189, 252, 485

107. **Pennisetum polystachion** (L.) Schult. *Mant.* 2: 146. 1824; *Karthik. et al.* 246. 1989; *Pandey in Shetty & Singh* 3:1095. 1993; *Roy in Singh et al.* 492. 2001; *P. polystachion* subsp. *setosum* (Sw.) *Brunken Bot. J. Linn. Soc.* 79: 63. 1979; *Bor* 346. 1960; *P. setosum* (Sw.) *Rich. Syn. Pl.* 1: 72 1805; *Hooker f.* 7:87. 1897; *Cooke* 3:431. 1958; *Blatt. & McC.* 180. 1935; *Bor* 348. 1960; *Karthik. et al. op.cit.* 246; *Lakshmi. in Sharma et al.* 566. 1996; *Shah* 2:856. 1978.

Annual or perennial, caespitose. Culms geniculately ascending, 30–120 cm long, branches ample. Ligule a ciliate membrane. Leaf-blades 10–40 × 0.3–1.6 cm. Synflorescence a panicle. Panicle spiciform, linear, 5–20 cm long. 1° panicle branches accrescent to a central axis, with

sessile scars on axis. Panicle axis with briefly decurrent ribs, glabrous, bearing deciduous spikelet clusters. Spikelets subtended by an involucre, composed of bristles, with an outer whorl of thinner bristles, 8–12 mm long, bristles deciduous with the fertile spikelets, numerous, with one conspicuously longer bristle, terete, flexible, ciliate. Fertile spikelets lanceolate, dorsally compressed, 2.5–3 mm long, sessile or pedicelled, 1–4 in the cluster, comprising 1 basal sterile & 1 fertile florets, without rachilla extension, falling entire, deciduous with accessory branch structures. Lower glumes absent or obscure. Upper glume shorter than spikelet, thinner than Upper lemma, ovate, 4–4.5×1–1.2 mm, membranous, 3–5-veined, apex acute or mucicous. Basal sterile florets male, with palea. Lemma of lower sterile floret lanceolate, 3–3.5×1–1.5 mm, chartaceous, 5–7-veined, acuminate, 3-fid. Palea lanceolate, membranous, 2-veined, 2–2.5×0.5–1 mm. Upper lemma lanceolate, 2–2.5×1–1.2 mm, coriaceous, 3-veined, margins flat, eciliate, apex acuminate. Palea lanceolate, membranous, 2-veined, 2–2.2×0.5–1 mm. coriaceous. Lodicules absent. Anthers 3, 2mm long, anther tip smooth. Ovary glabrous, 1mm long; stigmas 3mm long; styles 1mm long, connate below. **Plate 113.**

Flowering & Fruiting: July–October.

Habitat: In open waste lands & fellow fields.

Distribution: Africa, Asia-temperate, Asia-tropical, southeast USA, Mexico, South America. INDIA: Peninsular, C. E. India. S. GUJARAT: Surat.

Voucher specimen: RJD/ 276, 593, 483, 694, 714, 729

108. **Pennisetum purpureum** Schumach. *Beskr. Guin. Pl. 44. 1827; Blatt. & McC. 184. 1935; Bor 348. 1960; Shah 2:855. 1978; Karthik. et al. 246. 1989; Pandey in Shetty & Singh 3:1095. 1993; Lakshmi. in Sharma et al. 566. 1996; Roy in Singh et al. 492. 2001.*

Perennial. Stolons present. Culms erect or geniculately ascending, robust, up to 6 m long. Ligule a fringe of hairs. Leaf-blades 30–80×2–4 cm, margins cartilaginous, scaberulous. Synflorescence a panicle. Peduncle pubescent above. Panicle spiciform, linear, 7–25 cm long. 1° panicle branches accrescent to a central axis, with lateral stumps on axis; axis terete, pubescent, bearing deciduous spikelet clusters. Spikelets subtended by an involucre, composed of bristles, with an outer whorl of thinner bristles, 8–12 mm long, bristles deciduous with the fertile spikelets, numerous, with one conspicuously longer bristle, terete, flexible, ciliate. Fertile spikelets lanceolate, dorsally compressed, 2.5–3 mm long, sessile or pedicelled, 1–4 in the cluster, comprising 1 basal sterile & 1 fertile florets, without rachilla extension, falling entire, deciduous with accessory branch structures. Glume shorter than spikelet, thinner than Upper lemma. Lower glumes 0.5×0.2 mm, membranous, apex acute. Upper glume ovate, 1–1.5×1–1.2 mm, membranous, 1-veined, apex acute. Basal sterile florets male, with palea. Lemma of lower sterile floret lanceolate, 4–4.5×2–2.5 mm, chartaceous, 5–veined, acute 3-fid. Palea lanceolate, membranous, 2-veined, 6–6.5×0.7–1.2 mm. Upper lemma lanceolate, 5–6×2–2.2 mm, coriaceous, 5–7-veined, margins flat, eciliate, apex acuminate. Palea lanceolate, membranous, 2-veined, 5–5.2×1.5–2 mm. coriaceous. Lodicules absent. Anthers 3, 3–4mm long, anther tip penicillate. Ovary glabrous, 1.5mm long; stigmas 6mm long; styles 3mm long, connate below. **Plate 114.**

Flowering & Fruiting: September-November.

Habitat: In margin and water channels along the agricultural fields.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, southeast USA, Mexico and South America. INDIA: Introduced. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 49, 273, 556

109. **Isachne globosa** (Thunb.) Kuntze *Revis. Gen. Pl.* 2: 778. 1891; *Bor* 580. 1960; *Shah* 2:834. 1978; *Karthik. et al.* 230. 1989; *Pandey in Shetty & Singh* 3:1063. 1993; *Lakshmi. in Sharma et al.* 510. 1996; *Roy in Singh et al.* 451. 2001; *I. australis* R.Br. *Prodr. Fl. Nov. Holl.* 196. 1810; *Hooker f.* 7:14. 1897; *Cooke* 3:439. 1958; *Blatt. & McC.* 188. 1935; *I. dispar* Trin. *Sp. Gram.* 1: t. 86. 1827; *Hooker f.* 7:26. 1897; *Bor* 580. 1960; *Shah* 2:834. 1978; *Karthik. et al. op. cit.* 230; *Lakshmi. in Sharma et al.* 509. 1996.

Annual or perennial. Culms geniculately ascending or decumbent, 10–90 cm long, rooting from lower nodes. Leaf-sheaths glabrous, outer margin hairy. Ligule a fringe of hairs. Leaf-blade linear or lanceolate, 1–10×0.4–2 cm, base cuneate or broadly rounded, margins cartilaginous, scaberulous. Synflorescence a panicle, open, 3–20 cm long, branches capillary. Spikelets solitary, pedicelled, pedicels filiform; orbicular, dorsally compressed, 1.5–2.5 mm long, comprising 1 basal sterile & 1 fertile florets, without rachilla extension, disarticulating below each fertile floret. Glumes deciduous, similar, reaching apex of florets, thinner than Upper lemma. Lower glume elliptic to orbicular, 1.8–2.2×1.8–2.2 mm, membranous, 7–9-veined, puberulous, apex obtuse. Upper glume ovate, 1.8–2.2×1.8–2.2 mm, membranous, 5–7-veined, puberulous, apex obtuse. Basal sterile florets male, with palea. Lemma of lower sterile floret elliptic to ovate, 1.8–2.2×1.8–2.2 mm, chartaceous, glabrous. Palea coriaceous, 2-veined, 1.5–1.8×1.5–1.8 mm, obtuse. Upper lemma orbicular, 1.5–1.8×1.5–1.8 mm, coriaceous, 3–5-veined, glabrous, margins involute, apex obtuse. Palea coriaceous, 2-veined, 1.5–1.8×1.5–1.8 mm, obtuse. Lodicules 2. Anthers 3, 1.5mm long. Ovary glabrous, 0.5mm long, stigmas 1.5mm long, styles 1mm long. **Plate 115.**

Flowering & Fruiting: February - April.

Habitat: In wet & marshy habitats along the streams, moist grounds.

Distribution: Asia-temperate, India, Indo-China, Malesia, Australia and New Zealand. INDIA: Throughout hotter parts. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 140, 141, 187, 509, 522, 566

110. **Arundinella ciliata** (Roxb.) Nees ex Miq. *Nieuwe Verh. Eerste Kl. Kon. Ned. Inst. Wetensch. Amsterdam III*, 4: 30 1851; *Bor* 421. 1960; *Blatt. & McC.* 194. 1935; *Karthik. et al.* 186. 1989; *Lakshmi. in Sharma et al.* 403. 1996; *Roy in Singh et al.* 369. 2001; *A. agrostoides* *Hooker f.* 7:71. 1897; *Cooke* 3:523. 1958.

Annual. Culms erect, 20–60 cm long, internodes distally pilose, nodes bearded. Leaf-sheaths longer than internode, pilose with tubercle-based hairs, outer margin hairy. Ligule a ciliolate membrane. Leaf-blade base broadly rounded, oblong, 7–15×0.5–1.5 cm, flaccid, surface

pilose, with tubercle-based hairs, apex acute. Synflorescence a panicle. Panicle contracted, linear, 5–12 cm long, contracted about 1° branches, 1–5 cm long. Panicle axis scabrous, pilose with tubercle-based hairs. Spikelets in pairs, pedicelled, pedicels glabrous. Spikelets lanceolate, laterally compressed, 3.5 mm long, breaking up at maturity, comprising 1 basal sterile & 1 fertile florets, without rachilla extension, disarticulating below each fertile floret, callus bearded. Glumes persistent, dissimilar, reaching apex of florets, thinner than Upper lemma. Lower glume elliptic, 1.8–2×1-1.2 mm, membranous, 1-keeled, 3-veined, pilose with tubercle-based hairs, apex caudate. Upper glume elliptic, 3–4×1-1.2 mm, membranous, 1-keeled, 5-veined, pilose with tubercle-based hairs, apex caudate. Basal sterile florets male, with palea. Lemma of lower sterile floret similar to upper glume, elliptic or oblong, 2–2.2×1-1.2 mm, membranous, keeled, 3-veined, acute. Palea membranous, lanceolate, 1.5–1.7×0.5-0.7 mm, toothed, with auriculate flaps. Upper lemma elliptic or oblong, 1–1.5×0.5-0.7 mm, coriaceous, margins involute, interlocking with palea keels, apex dentate, 1-awned, awn from a sinus, geniculate, 5–7mm long overall, with twisted column. Palea with auriculate flaps, coriaceous, 1–1.2×0.5-0.7 mm, 2-veined. Lodicules 2, cuneate, fleshy. Stamens 3, 1mm long. Ovary 0.2mm, style 0.8mm, stigmas 2, 1mm long. **Plate 116.**

Flowering & Fruiting: August-October.

Habitat: In moist, open plains along the streams.

Distribution: Endemic to India. INDIA: Peninsular India. S. GUJARAT: Navsari, Valsad, Dangs. **New records for the State.**

Voucher specimen: RJD/ 98, 159, 595

111. **Arundinella pumila** (Hochst.) Steud. *Syn. Pl. Glumac. 1: 114. 1854; Bor 402. 1960; Shah 2:786. 1978; Karthik. et al. 187. 1989; Pandey in Shetty & Singh 3:982. 1993; Lakshmi. in Sharma et al. 407. 1996; Roy in Singh et al. 370. 2001; A. tenella* Steud. *Nomencl. Bot. ed. 2, 1: 143. 1840; Hooker f. 7:71. 1897; Cooke 3:522. 1958; Blatt. & McC. 193. 1935; A. metzii* Hochst. *ex Miq. in Verh. Konink. Nederl. Inst. 3(4):31. 1851; Hooker f. op.cit.; Cooke 3:523. 1958; Blatt. & McC. 195. 1935; Bor 423. 1960; Shah 2:785. 1978; Karthik. et al. op.cit. 186; A. pygmaea* Hooker f. *op.cit.; Cooke 3:522. 1958; Blatt. & McC. 194. 1935; Bor 423. 1960; A. lawii* Hook.f. *in Trim. Handb. Fl. Ceyl. 5:180. 1900; Cooke op.cit. 523; Blatt. & McC. op. cit. 195.*

Annual. Culms erect or geniculately ascending, 5–50 cm long, 1–3 –noded, nodes pubescent. Leaf-sheaths outer margin hairy. Ligule an eciliate membrane. Leaf-blades lanceolate, 3–15×0.5–2 cm, flaccid, glabrous or sparsely hairy. Synflorescence a panicle, open, effuse, 3–25 cm long. 1° panicle branches profusely divided, branches capillary, scaberulous. Spikelets solitary, pedicelled; pedicels filiform, 1.5–8 mm long. Spikelets ovate, laterally compressed, 1.5–2 mm long, comprising 1 basal sterile & 1 fertile florets, without rachilla extension, disarticulating below each fertile floret, callus pubescent. Glumes persistent, dissimilar, exceeding apex of florets, thinner than Upper lemma, gaping. Lower glume ovate, 1–1.5×0.7–1 mm, membranous, 1-keeled, 3-veined, apex acuminate. Upper glume ovate, 1.5–2 mm long, membranous, 1-keeled, 3–5-veined, surface glabrous, apex acuminate. Basal sterile florets male with palea. Lemma of lower sterile floret similar to upper glume, ovate, 1.2–1.5×0.8–1 mm, membranous, 1-keeled, 3-veined, acute. Palea with auriculate flaps, 1–1.2×0.5-0.7 mm,

coriaceous, 2-veined. Upper lemma ovate, 1–1.2×0.5–0.7 mm, coriaceous, 1-veined, margins involute, interlocking with palea keels, apex dentate, 1-awned, from a sinus, geniculate, 2–4 mm long overall, with twisted column. Palea with auriculate flaps, 1–1.2×0.5–0.7 mm, coriaceous, 2-veined. Lodicules 2, cuneate, fleshy. Stamens 2–3, 0.5mm long. Ovary 0.5mm, style 1mm, stigmas 2, 1mm long. **Plate 117.**

Flowering & Fruiting: August–October.

Habitat: In moist, shady and rocky habitats.

Distribution: Tropical Africa, Arabia, India, Indo-China and Malesia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 158, 169, 256

112. **Eulalia fimbriata** (Hack.) Kuntze in *Revis. Gen. Pl.* 2:775. 1891; Blatt. & McC. 53. 1935; Bor 155. 1960; Karthik. et al. 220. 1989; Lakshmi. in Sharma et al. 495. 1996; *Pollinia fimbriata* Hack. in DC. Mon. Phan. 6:164. 1889; Hooker f. 7:112. 1897; Cooke 3:468. 1958; Pandey in Shetty & Singh 3:1055. 1993.

Annual. Butt sheaths glabrous. Culms 30–60 cm long, internodes smooth, nodes glabrous. Leaf-sheaths glabrous. Ligule a ciliolate membrane. Leaf-blades 15–25×0.4–0.6 cm, sparsely hairy adaxially. Synflorescence composed of racemes. Racemes 2–6, 2.5–7.5 cm long. Rachis fragile at the nodes, ciliate on margins; internodes linear, tip transverse. Spikelets in pairs. Spikelets all fertile, 2 in the cluster -sessile and pedicelled. Pedicels linear, angular, ciliate 2.5mm long. Sessile spikelets lanceolate, dorsally compressed, 4mm long, falling entire, deciduous from the base or with accessory branch structures. Spikelet callus pilose, hairs white. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume lanceolate, cartilaginous, 3.5–4×0.7–1mm, 2-keeled above, veins ciliate, apex dentate. Upper glume elliptic, 3.5–4×0.7–1mm, margins ciliate, apex muticous. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong, 2–2.5×0.5–0.7mm, hyaline, ciliate on margins. Upper lemma oblong, 2–2.5×0.5 mm long, hyaline, without keel, apex 2-fid, 1 -awned. Principal lemma awn from a sinus, geniculate, 11–15mm long with twisted column, glabrous. Palea absent or minute. Lodicules 2, cuneate, fleshy. Stamens 3, 2.5mm long. Ovary 0.5mm, style 0.5mm, stigmas 2, 1mm long. Pedicelled spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Similar to sessile spikelet, slightly longer. **Plate 118.**

Flowering & Fruiting: November–January.

Habitat: Rocky plateaus, on hills.

Distribution: India, Indo-China and Malesia. INDIA: South India, Himalaya. S. GUJARAT: Navsari, Dangs, Valsad. **New records for the State.**

Voucher specimen: RJD/ 62, 199, 589

113. **Eulalia trispicata** (Schult.) Henrard in *Blumea* 3:453. 1940; Bor 157. 1960; Shah 2:828. 1978; Karthik. et al. 221. 1989; Pandey in Shetty & Singh 3:1056. 1993; Lakshmi. in Sharma et al. 496. 1996; Roy in Singh et al. 442. 2001; *E. argentea* (Trin.)

Brongn. *Voy. Monde Phan.*: 92 1831; Blatt. & McC. 52. 1935; *Pollinia argentea* Trin. in *Bull. Acad. Sci. Petersb.* 1:71. 1836; Hooker f. 7:111. 1897; Cooke 3:467. 1958.

Perennial, caespitose, clumped densely. Butt sheaths glabrous. Culms erect, 35–200 cm long. Ligule a ciliate membrane. Leaf-blades 10–45×0.4–1cm, linear, glabrous. Synflorescence composed of racemes, peduncle glabrous, pubescent above. Racemes 2–16, 5–15 cm long. Rachis fragile at the nodes, villous on margin, hairs white, internodes linear, 2.5mm long. Spikelets all fertile, 2 in the cluster -sessile and pedicelled. Pedicels linear, angular, villose, 2.5mm long. Fertile spikelets comprising 1 basal sterile florets; 1 fertile florets; without rachilla extension. Sessile spikelets elliptic-lanceolate, dorsally compressed, 4mm long, falling entire, deciduous from the base or with accessory branch structures. Spikelet callus pilose, hairs white. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, coriaceous, much thinner above, dark brown, 3.5-4×0.7-1mm, 2-keeled above, veins ciliate, apex acute, pilose. Upper glume oblong, 3.5-4×0.7-1mm, 1-veined, pilose, margins ciliate, apex muticous. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong, 2-2.5×0.5-0.7mm, hyaline, ciliate on margins. Upper lemma oblong, 2-2.5×0.5 mm long, hyaline, without keel, apex 2-fid, 1 -awned. Principal lemma awn from a sinus, geniculate, 11–15mm long with twisted column, glabrous. Palea absent or minute. Lodicules 2, cuneate, fleshy. Stamens 3, 2.5mm long. Ovary 0.5mm, style 0.5mm, stigmas 2, 1mm long. Pedicelled spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Similar to sessile spikelet, slightly longer. **Plate 119.**

Flowering & Fruiting: August-February.

Habitat: Wastelands, road sides and grasslands.

Distribution: China, India, Indo-China, Malesia, Papuasia, Australia. INDIA: Throughout. S. GUJARAT: Occasional.

Voucher specimen: RJD/ 206, 215, 538, 705

114. ***Imperata cylindrica*** (L.) Raeusch. *Nomencl. Bot. ed.* 3:10. 1797; Blatt. & McC. 42. 1935; Bor 169. 1960; Shah 2:833. 1978; Karthik. *et al.* 229. 1989; Pandey in Shetty & Singh 3:1062. 1993; Lakshmi. in Sharma *et al.* 505. 1996; Roy in Singh *et al.* 451. 2001; *I. arundinacea* Cirillo *Pl. Rar. Neapol.* 2: XXVI. 1792; Hooker f. 7:106. 1897; Cooke 3:464. 1958.

Perennial. Rhizomes elongated, scaly. Culms erect, up to 30 cm long. Leaves mostly basal. Ligule a ciliolate membrane. Leaf-blades erect, flat or convolute, 3–10×0.2–0.8 cm, stiff, margins scabrous. Synflorescence a panicle with branches tipped by a raceme, panicle spiciform, linear, 2–8 cm long. 1° panicle branches appressed to a central axis, with evident branchlets on axis. Racemes bearing few fertile spikelets. Rachis tough, subterete, internodes filiform, 1 mm long, glabrous. Spikelets in pairs, both fertile and pedicelled. Pedicels filiform, unequal, 0.5-1mm. Fertile spikelets comprising 1 basal sterile florets and 1 fertile florets, both similar, without rachilla extension. Spikelets lanceolate, subterete, 2–2.5 mm long, falling entire. Spikelet callus bearded, callus hairs white, 2–3 length of spikelet. Glumes similar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 2-2.2×1-1.2mm, membranous, without keels, 5–7-veined, hairy below, apex truncate. Upper glume oblong, 2-

2.2×1-1.2mm, membranous, without keels, 5–7–veined, hairy below, apex truncate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong-ovate, 1.2-1.8×1-1.2mm, hyaline, 1-veined, erose, acute. Upper lemma ovate, 1.2-1.5×0.5-0.7mm, hyaline, without keel, 0 –veined, apex acute. Palea hyaline, 0.5-0.7×0.5-0.7mm, 0-veined, without keels. Lodicules 2, cuneate. Anthers 2; 2-3 mm long. Ovary, 0.5mm, style 1.5 mm long, stigmas 2, 1.5mm long, terminally exserted. **Plate 120.**

Flowering & Fruiting: August-February.

Habitat: On the banks, in river beds.

Distribution: Europe, tropical Africa, Asia-temperate, Asia-tropical, Australia, New Zealand, southeast USA and Mexico. INDIA: Hotter parts of India. S. GUJARAT: Surat.

Voucher specimen: RJD/ 104, 540, 604

115. **Pogonatherum paniceum** (Lam.) Hack. in *Allg. Bot. Z. Syst.* 12: 178. 1906; *Bor* 202. 1960; Karthik. *et al.* 251. 1989; *Lakshmi. in Sharma et al.* 572. 1996; *Roy in Singh et al.* 497. 2001; *P. saccharoideum* P.Beauv. *Ess. Agrostogr.* 177. 1812; *Hooker f.* 7:141. 1897; *Blatt. & McC.* 25. 1935; *Cooke* 3:484. 1958.

Perennial, mat forming. Culms prostrate, 15–60 cm long, wiry. Lateral branches ample. Ligule a ciliolate membrane. Leaf-blades 2–6×0.3–0.8cm. Synflorescence composed of racemes, terminal and axillary; axillary synflorescences present throughout the plant, similar to terminal. Peduncle flexuous. Racemes 1, single, straight or arcuate, 2–5cm long. Rachis fragile at the nodes, subterete, villous on margins, internodes linear, 2mm long. Spikelets in pairs, fertile spikelets sessile and pedicelled. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic, laterally compressed, 2.5–3 mm long, falling entire, deciduous from the base and with accessory branch structures. Spikelet callus bearded, base obtuse, hairs white, 1-2mm long. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume elliptic, 2.5-2.8×1.2-1.5mm, cartilaginous, keeled, pubescent, apex truncate. Upper glume elliptic, 2-2.5×1-1.5mm, apex awned, awn 15–20 mm long. Basal sterile florets male, with palea. Lemma of lower sterile floret oblong, 1.8-2×1-1.2mm, hyaline, 0-veined. Palea hyaline, without keels. Upper lemma oblong, 2-2.2×1-1.2mm, hyaline, without keel, 1-veined, apex awned. Principal lemma awn from a sinus, flexuous, 18–22 mm long overall. Palea hyaline, hairy at apex, without keels. Lodicules absent. Anthers 2, 1.5-2 mm long. Ovary, 0.3mm, style 1mm long, stigmas 2, 1.5mm long, terminally exserted. Pedicelled spikelet similar to sessile, except lower sterile lemma minute, absent, without palea; pedicels linear, villous. **Plate 121.**

Flowering & Fruiting: February - April.

Habitat: On rocks, near river, escape from garden.

Distribution: Eastern Africa, Asia-temperate, Asia-tropical, Australia. INDIA: Throughout hilly parts. S. GUJARAT: Navsari.

Voucher specimen: RJD/ 390, 410, 442

116. **Saccharum bengalense** Retz. *Observ. Bot.* 5:16. 1789; *Shah* 2:860. 1978; *Karthik. et al.* 255. 1989; *S. arundinaceum* Hooker f. 7:119. 1897; *Bor* 211. 1960; *Cooke* 3:465. 1958; *Karthik. et al. op.cit.* 255; *Pandey in Shetty & Singh* 3:1103. 1993; *Roy in Singh et al.* 506. 2001; *S.munjia* Roxb. *Fl. Ind.* 1: 246. 1820; *Blatt. & McC.* 48. 1935.

Perennial, caespitose. Culms erect, robust, 150–300 cm long. Ligule an eciliate membrane. Leaf-blades 45–90×0.5–1cm, glaucous, midrib widened, apex acuminate. Synflorescence a panicle with branches tipped by a raceme. Peduncle glabrous. Panicle open, linear or oblong, 20–75×10 cm. Racemes 2–5 cm long. Rachis fragile at the nodes, subterete, pilose on surface, hairs 5–7 mm long, internodes linear. Spikelets in pairs, all fertile, sessile and pedicelled, heteromorphic (upper glume of pedicelled spikelet villous), subequal. Pedicels linear, ciliate, with 5–6 mm long hairs. Fertile Spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets lanceolate, dorsally compressed, 3.5–5.5 mm long, falling entire, deciduous from the base or with accessory branch structures. Spikelet callus bearded, base truncate, callus hairs white. Glumes dissimilar, firmer than Upper lemma. Lower glume lanceolate, membranous, much thinner above, 5-5.5×1-1.2mm, 2-keeled, villous, margins ciliate, hairs 4–9 mm long, apex dentate. Upper glume lanceolate, 4.5-5×1-1.2mm, membranous, much thinner above, without keels, glabrous (sessile) or villous (pedicelled), apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret elliptic or oblong, hyaline, 4-4.5×0.8-1mm, ciliolate on margins, acuminate. Upper lemma lanceolate or ovate, hyaline, apex acuminate or mucronate. Palea minute, villose at apex. Lodicules 2, cuneate. Anthers 3, 1.5 mm long. Ovary 0.7mm, style 0.5 mm long, stigmas 2, 1mm long, terminally exserted. Pedicelled similar to sessile but smaller, only upper glume differ. **Plate 122.**

Flowering & Fruiting: December-February.

Habitat: in clumps along road sides.

Distribution: East Africa, western Asia, India, Indo-China and Malesia. INDIA: Throughout. S. GUJARAT: Surat.

Voucher specimen: RJD/ 565, 599, 657

117. **Saccharum officinarum** L. *Sp. Pl.* 54. 1753; *Hooker f.* 7:118. 1897; *Blatt. & McC.* 46. 1935; *Cooke* 3:466. 1958; *Bor* 212. 1960; *Shah* 2:860. 1978; *Karthik. et al.* 255. 1989; *Pandey in Shetty & Singh* 3:1140. 1993; *Lakshmi. in Sharma et al.* 583. 1996; *Roy in Singh et al.* 506. 2001.

Perennial, caespitose. Culms erect, robust, 200–600 cm long. Culm-internodes solid, yellow or mid-green or purple. Leaf-sheaths loose. Ligule a ciliolate membrane. Leaf-blades linear, 70–150×3–8cm, glaucous. Leaf-blade midrib conspicuous, scaberulous, apex acuminate. Synflorescence a panicle with branches tipped by a raceme. Peduncle glabrous, pubescent above. Panicle open, pyramidal, dense, 40–60 cm long. 1° panicle branches whorled at most nodes, 5–10 cm long, glabrous or puberulous, bearded in axils. Racemes 5–10 cm long. Rachis fragile at the nodes, subterete, glabrous on margins, internodes filiform, 4–6 mm long. Spikelets in pairs, all fertile, sessile and pedicelled, similar, subequal in length. Pedicels

filiform, glabrous. Spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets lanceolate, dorsally compressed, 3–4 mm long, falling entire, deciduous from the base, or with accessory branch structures. Spikelet callus bearded, hairs white, 7–12 mm long. Glumes similar, firmer than Upper lemma. Lower glume lanceolate, 3–3.5×1–1.5mm, membranous, much thinner above, 2-keeled, 4-veined, apex acute. Upper glume lanceolate, membranous, much thinner above, 3–3.2×1–1.2mm, without keels, 3-veined, margins ciliolate, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 3–3.2×1–1.2mm, hyaline, 1-veined, ciliate on margins, acute. Upper lemma present or absent, linear, 1–1.5×1–1.2mm, hyaline, 0-veined. Palea absent. Lodicules 2, membranous, glabrous. Anthers 3, 1.5 mm long. Ovary 0.5mm, style 0.5mm long, stigma 2, 1mm long. **Plate 123.**

Flowering & Fruiting: December - April.

Habitat: Cultivated in agricultural fields.

Distribution: Europe, Asia-temperate, Asia-tropical, Australia, southeast USA and Mexico, South America. INDIA: Cultivated throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 257, 539, 596

118. **Saccharum ravennae** (L.) L. *Syst. Veg. ed. 13* 2:88. 1774; *Blatt. & McC.* 50. 1935; *Bor* 213. 1960; Karthik. *et al.* 255. 1989; *Pandey in Shetty & Singh* 3:1104. 1993; *Lakshmi. in Sharma et al.* 583. 1996; *Erianthus ravennae* (L.) P.Beauv. *Ess. Agrostogr.* 14. 1812; *Hooker f.* 7:212. 1897; *Sedgwick JBNHS* 23(1): 110–117. 1914; *Cooke* 3:466. 1958; *Bor op.cit.* 151. *E. elephantinus* *Hooker f. op. cit.* 122.

Perennial, caespitose. Culms erect, 100–450 cm long, internodes solid. Leaf-sheaths hirsute. Ligule a ciliate membrane. Leaf-blade base tapering to the midrib, blades 30–100×0.5–2cm. Synflorescence a panicle with branches tipped by a raceme. Peduncle glabrous. Panicle open, elliptic, 25–70 cm long. 1° panicle branches 10–20 cm long. Racemes 1.5–3 cm long. Rachis fragile at the nodes, subterete, villous on margins, hairs 3–6 mm long, internodes filiform, 2.5mm long. Spikelets in pairs, all fertile, sessile and pedicelled, subequal. Pedicels filiform, 2mm long. Fertile Spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, acuminate, 3–6mm long, falling entire, deciduous from the base, or with accessory branch structures. Spikelet callus bearded, base truncate, hairs white, 2–4 mm long. Glumes exceeding apex of florets, firmer than Upper lemma. Lower glume elliptic, 4–5×1–1.2mm, membranous, 2-keeled, 4-veined, glabrous, apex dentate. Upper glume lanceolate, 4–5×1–1.2mm, membranous, 1-keeled, 3-veined, glabrous, apex mucicose. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 4–4.2×0.5–0.8mm, hyaline, 3-veined, ciliate on margins, acute. Upper lemma lanceolate, 2–2.5×1–1.2mm, hyaline, apex awned. Principal lemma awn apical, flexuous, 4–7 mm long overall, clearly exserted from spikelet. Palea 2–2.5×0.5–0.7mm, hyaline. Lodicules 2, membranous, glabrous. Anthers 3, 1.5 mm long. Ovary 0.5mm, style 1mm long, stigma 2, 2mm long. **Plate 124.**

Flowering & Fruiting: December-February.

Habitat: In large tufts along road sides.

Distribution: Europe, northeast tropical Africa, Asia-temperate, India and Indo-China, southwest USA. INDIA: North-West-South India. S. GUJARAT: Surat, Tapi, Valsad.

Voucher specimen: RJD/ 426, 449, 461

119. **Saccharum spontaneum** L. *Mant. Pl.* 2:183. 1771; *Hooker f.* 7:118. 1897; *Cooke* 3:465. 1958; *Blatt. & McC.* 45. 1935; *Bor* 214. 1960; *Shah* 2:860. 1978; *Karthik. et al.* 256. 1989; *Pandey in Shetty & Singh* 3:1104. 1993; *Lakshmi. in Sharma et al.* 583. 1996; *Roy in Singh et al.* 506. 2001.

Perennial. Rhizomes elongated. Culms erect, robust, 100–400 cm long, internodes solid. Ligule a ciliolate membrane. Leaf-blade base simple or tapering to the midrib. Leaf-blades 50–200×0.5–3cm. Synflorescence a panicle with branches tipped by a raceme. Peduncle hirsute above. Panicle open, ovate, dense. 20–50 cm long. Panicle axis hirsute. Racemes 3–15 cm long. Rachis fragile at the nodes, subterete, pilose. Rachis internodes filiform, 7 mm long. Spikelets in pairs, all fertile, sessile and pedicelled, subequal. Pedicels filiform, ciliate, 3mm long. Fertile Spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets lanceolate, dorsally compressed, 4-5×1.5-2mm, falling entire, deciduous from the base or with accessory branch structures. Spikelet callus bearded, base truncate, hairs white, 5-8 mm long. Glumes similar, firmer than Upper lemma. Lower glume lanceolate, 4-5×1.5-2mm, coriaceous, much thinner above, 2-keeled, margins ciliate, apex acuminate. Upper glume lanceolate, 4-5×1.5-2mm, coriaceous, without keels, 1-veined, margins ciliate, apex acute, acuminate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 3-3.5×1-1.2mm, hyaline, 0-veined, acute. Upper lemma linear, 2-2.5×0.3-0.5mm, hyaline, 0-veined. Palea absent. Lodicules 2, membranous, glabrous. Anthers 3, 1.5 mm long. Ovary 1mm, style 2mm long, stigma 2, 2mm long. **Plate 125.**

Flowering & Fruiting: August-February.

Habitat: Water edges, wet lands.

Distribution: Southeastern Europe, Africa, Asia-temperate, Asia-tropical, Australia, Mesoamericana. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 124, 344, 409

120. **Spodiopogon aristatus** *sp. nov.* R. J. Desai & Raole *Kew Bull.* 2. 2012
(Published online)

Perennial. Culms slender, creeping and rooting at the base, 40-80 cm tall, leafy; nodes glabrous; internodes 4-10 cm long. Leaf sheath compressed, loose, 3-8 cm long, sparsely hairy, glabrescent; auricles membranous, confluent with ligule; ligule a ciliate membrane, 1.5-2 mm long, 2- or 3-partite; pseudo-petioles 1-8 cm long, blades elliptic-lanceolate, flat, acuminate, sparsely hairy on both sides, with a distinct white coloured midrib, 5-15×1.5-3 cm; uppermost leaf often reduced to a lanceolate spathe partially enclosing base of raceme, spathe 5-10 × 0.4-0.8 cm. Synflorescence terminal and axillary, 5-12 cm long; erect, densely flowered; rachis jointed, articulated below callus, villous, hairs 4-5 mm long, whitish or purplish. Sessile

spikelet elliptic, up to 9 mm long including ciliate callus. Lower glume broadly ovate, toothed at apex, both lobes aristate, 6-7-nerved, hairy, 6-7×3-3.5 mm. Upper glume broadly ovate, aristate, arista 1-3 mm long, 7-nerved, nerves raised, midvein ciliate, 8-9×3.5-4 mm. Lower lemma oblong-lanceolate, toothed, hyaline, glabrous, 2-nerved, 5-5.5×2-2.5 mm. Lower palea hyaline, oblong, truncate, nerveless, glabrous, 4-4.5×1.5-2 mm. Floret male, stamens 3, anther 3-3.5 mm long, filament short. Upper lemma deeply cleft into 2 acute lanceolate lobes, hyaline, 5-5.5×1-1.5 mm, awn up to 18-22 mm long, bent, twisted, scabrid or with papillae like projections. Upper palea wedge shaped, hyaline, truncate, glabrous, 2.5-3×2-2.5 mm. Floret bisexual, stamens 3, anthers 2.5-3 mm long, styles 2, ca. 3 mm long, stigmas plumose, purplish, 2-2.5 mm long; caryopsis laterally compressed, glabrous, shiny, hilum basal and embryo reaching to middle of grain, pale white-brown, 2-2.5×0.5-0.8 mm. Pedicellate spikelets shorter than the sessile, up to 6-6.5 mm long, obliquely ovoid, pedicel like rachis, 4-4.5 mm long, thick, clavate, villous, hairs 4-5 mm long, whitish or purplish, confluent with thick callus; articulation below callus. Lower glume broadly ovate, 5-6×2.5-3 mm, 6 or 7-nerved, hairy, apex dentate. Upper glume broadly ovate, 6-6.5×3-3.5 mm, 7-nerved, nerves raised, midvein ciliate, arista 0.5-2 mm long. Lower lemma oblong-lanceolate, acute, hyaline, glabrous, 1-nerved, 5-5.5×2-2.5 mm, epaleate. Floret sterile. Upper lemma deeply cleft into 2 acute lanceolate lobes, hyaline, 4.5-5×1-1.5 mm, awn up to 18-22 mm long, bent, twisted, scabrid or with papillae like projections. Upper palea wedge shaped, hyaline, truncate, glabrous, 2.5-3×2-2.5 mm. Floret bisexual; stamens 3, anthers 2.5-3 mm long, styles 2, ca. 3 mm long, stigmas plumose, purplish, 2-2.5 mm long; caryopsis laterally compressed, glabrous, shiny, hilum basal and embryo reaching to middle of grain, pale white-brown, 2-2.5×0.5-0.8 mm. **Plate 126.**

Flowering & Fruiting: September-December.

Habitat: On shady hill slopes

Distribution: Endemic to India. INDIA: Gujarat. S. GUJARAT: Dangs, Tapi, Valsad and hills of Surat, Navsari. **New Species of Plat World.**

Voucher specimen: RJD/ 241, 258, 280, 741

121. **Spodiopogon rhizophorus** (Steud.) Pilg. *Nat. Pflanzenfam. ed. 2 14e:119. 1940; Bor 246. 1960; Shah 2:868. 1978; Karthik. et al. 264. 1989; Pandey in Shetty & Singh 3:1117. 1993; Lakshmi. in Sharma et al. 608. 1996; Roy in Singh et al. 526. 2001; S. albidus Benth. J. Linn. Soc., Bot. 19: 66. 1881; Hooker f. 7:108. 1897; Blatt. & McC. 51. 1935; Cooke 3:464. 1958.*

Perennial. Culms stout, creeping and rooting at the base, 40-160 cm tall, leafy; nodes glabrous; internodes 4-10 cm long. Leaf sheath compressed, loose, 8-15 cm long, hispid, glabrescent; auricles membranous, confluent with ligule; ligule membrane, up to 4mm long, 2- or 3-partite; pseudo-petioles 1-8 cm long, blades elliptic-lanceolate, flat, acuminate, sparsely hairy on both sides, with a distinct white coloured midrib, 4-27×0.5-3 cm; uppermost leaf often reduced to a lanceolate spathe partially enclosing base of raceme, spathe 5-10×0.4-0.8 cm. Synflorescence terminal and axillary, 5-18 cm long, erect, densely flowered; rachis jointed, articulated below callus, villous, hairs 3-5 mm long, whitish yellow. Spikelets in pairs, sessile and pedicelled, unequal. Sessile spikelet elliptic, up to 6mm long including ciliate callus. Lower glume broadly ovate, toothed at apex, both lobes aristate, 7-9-nerved, hairy, 5-5.5×3-3.2 mm. Upper glume

broadly ovate, aristate, acute-mucronate, 9-13-nerved, nerves raised, midvein ciliate, 5.5-6×3-3.5 mm. Lower lemma oblong-lanceolate, toothed, hyaline, glabrous, 0-nerved, 3-3.5×1-2mm. Lower palea hyaline, oblong, truncate, nerveless, glabrous, 2-2.5×1.5-2 mm. Floret male, stamens 3, anther 3-3.5 mm long, filament short. Upper lemma deeply cleft into 2 acute lanceolate lobes, hyaline, 3-3.5×1-1.5 mm, awn up to 10-12 mm long, bent, twisted, scabrid or with papillae like projections. Upper palea wedge shaped, hyaline, acute, glabrous, 2.5-3×2-2.5 mm. Floret bisexual, stamens 3, anthers 2.5-3 mm long, styles 2, ca. 3 mm long, stigmas plumose, purplish, 2-2.5 mm long. Pedicellate spikelets similar and shorter than the sessile, up to 5 mm long. Pedicel like rachis, 2.5-3 mm long, thick, clavate, villous, hairs 4-5 mm long, whitish, confluent with thick callus; articulation below callus. **Plate 128.**

Flowering & Fruiting: September-December.

Habitat: On shady hill slopes

Distribution: Endemic to India. INDIA: Penninsulæ and North-West India. S. GUJARAT: Dangs, Tapi, Valsad.

Voucher specimen: RJD/ 177, 411, 473, 746

122. **Apocopsis vaginatus** Hack. in *Oesterr. Bot. Z.* 41:8. 1891; *Blatt. & McC.* 26. 1935; *Cooke* 3:485. 1958; *Bor* 96. 1960; *Shah* 2:777. 1978; *Karthik. et al.* 183. 1989; *Lakshmi. in Sharma et al.* 391. 1996; *Roy in Singh et al.* 361. 2001; *A. wightii* Nees ex Thw. var. *vaginata* (Hack.) *Hooker f. f.* 7:150. 1897.

Annual. Culms geniculately ascending or decumbent, 5–20 cm long. Leaf-sheaths inflated, pilose, with tubercle-based hairs. Ligule an eciliate membrane. Leaf-blades linear or lanceolate, 2–5×0.2–0.5cm, flaccid, midrib keeled beneath, pilose with tubercle-based hairs, tuberculate-ciliate, apex acute. Synflorescence composed of racemes, subtended by a spatheole, enclosed. Peduncle glabrous. Racemes 2, paired, erect, 1–2 cm long. Rachis fragile at the nodes, subterete, ciliate on margins, hairs brown, 2.5 mm long; internodes linear, 1.5mm long. Spikelets appressed, in pairs. Fertile spikelets sessile; companion sterile spikelets pedicelled, represented by barren pedicels, pedicels adnate at the base to lower glume of sessile spikelet, linear, 1.5 mm long, ciliate, with hairs. Fertile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong, dorsally compressed, 3.5–4 mm long, falling entire, deciduous with accessory branch structures. Glumes dissimilar, firmer than Upper lemma. Lower glume oblong, 3.5-4×1.5-1.7 mm, chartaceous, much thinner above, without keels, 7-veined, veins falling short of apex, pilose, apex truncate. Upper glume oblong, 3-3.5×1.5-2mm, chartaceous, light brown, 3-veined, pilose, apex truncate. Basal sterile florets male, without palea. Lemma of lower sterile floret oblong, 3-3.2×1-1.2 mm, hyaline, 0-veined, truncate. Upper lemma oblong, 3.5-4×0.5-0.7 mm, hyaline, without keel, 1-veined, apex 2-fid, awned. Principal lemma awn from a sinus, geniculate, 20–26 mm long overall, puberulous. Palea hyaline, 2-2.2×1.5-1.7 mm, 0-veined, without keels. Lodicules absent. Anthers 2, 1 mm long. Stigma 2, 7 mm long, style short, ovary 1mm long. **Plate 129.**

Flowering & Fruiting: November-February.

Habitat: Grasslands on rocky hills.

Distribution: India and Indo-China. INDIA: Throughout. S. GUJARAT: Valsad.

Voucher specimen: RJD/ 207, 366, 632

123. **Bothriochloa pertusa** (L.) A. Camus in *Ann. Soc. Linn. Lyon n.s.*, 76: 164. 1931; *Bor* 109. 1960; *Shah* 2:790. 1978; Karthik. *et al.* 189. 1989; Roy in Singh *et al.* 378. 2001; *Andropogon pertusus* (L.) Willd. *Sp. Pl.* 4: 922. 1806; *Hooker f.* 7:173. 1897; *Cooke* 3:497. 1958; *Amphilopis pertusa* (L.) Nash *ex Stapf in Agric. News W. Indies* 15:179. 1916; *Blatt. & McC.* 84. 1935; *Dichanthium pertusum* (L.) Clayton *Kew Bull.* 32:4. 1977; *Lakshmi. in Sharma et al.* 459. 1996.

Perennial, mat forming, stolons present. Culms erect or geniculately ascending, 20–60 cm long, rooting from lower nodes; nodes bearded. Ligule a ciliolate membrane. Leaf-blades 5–30×0.3–0.5cm, glabrous. Synflorescence composed of racemes. Racemes 3–12, 2–7 cm long, main axis 1–3 cm long. Rachis fragile at the nodes, flattened, villous on margins, internodes linear, 2mm long. Spikelets in pairs, fertile sessile and sterile pedicelled. Fertile spikelets comprising 1 basal sterile florets; 1 fertile florets; without rachilla extension. Sessile spikelets elliptic, dorsally compressed, 3.5–4mm long, deciduous with accessory branch structures, callus pilose. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma, shiny. Lower glume elliptic, 3.5–4×1–1.5mm, cartilaginous, without keels, 7–9-veined, 1–3 pitted, hairy at base, margins ciliate. Upper glume lanceolate, 1-keeled. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong, hyaline, 2–2.2×0.8–1mm, truncate. Upper lemma linear, 1.8–2 mm long, hyaline, without keel, apex awned. Principal lemma awn apical, geniculate, 12–18mm long overall, glabrous. Palea absent or minute. Lodicules 2, membranous. Anthers 3, 1.5 mm long. Stigma 2, 1.5 mm long, style 0.8mm long, ovary 0.5mm long. Pedicelled spikelets well-developed, male, elliptic, 3.5–3.8mm long. Pedicels linear, flattened, 2mm long, villous. Glumes pitted, 1–2 pits, glabrous, 3.5–4×1–1.2 mm, ciliate on margins. Lower lemma oblong, hyaline, 2–2.2×0.8–1mm, truncate, without palea. Upper floret lacking. **Plate 130.**

Flowering & Fruiting: July- February.

Habitat: Common in all habitats.

Distribution: Africa, China, India, Malesia, Australia, southeast USA, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 184, 531, 679

124. **Capillipedium assimile** (Steud.) A. Camus in *Lecomte Fl. Gen. del' Indo-China* 7:314, 1922; *Blatt. & McC.* 80. 1935; *Bor* 110. 1960; *Shah* 2:793. 1978; Karthik. *et al.* 194. 1989; Roy in Singh *et al.* 382. 2001; *Andropogon assimilis* Steud. In *Zoll. Syst. Verz.* 58. 1854; *Hooker f.* 7:179. 1897; *Cooke* 3:502. 1958; *Dichanthium assimile* (Steud.) Deshpande in *Fl. India Fasc.* 15:6. 1984; *Pandey in Shetty & Singh* 3:1017. 1993; *Lakshmi. in Sharma et al.* 453. 1996.

Perennial. Culms decumbent, 30–80 cm long, rooting from lower nodes; nodes bearded. Ligule a ciliolate membrane. Leaf-blades linear or lanceolate, 6–20×0.3–0.6cm, flaccid, midrib widened. Synflorescence a panicle with branches tipped by a raceme. Panicle open, oblong, 5–12 cm long. 1° panicle branches whorled at lower nodes, capillary, glabrous in axils, or

bearded in axils. Racemes bearing 5–6 fertile spikelets on each. Rachis fragile at the nodes, subterete, ciliate on margins, linear, 1.5 mm long. Spikelets in pairs, fertile spikelets sessile, Companion spikelets pedicelled sterile. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic or oblong, dorsally compressed, 3 mm long, deciduous with accessory branch structures, callus bearded. Lower glumes dissimilar, firmer than Upper lemma, ovate, 3-3.2×1-1.5mm, chartaceous, keeled, 7-veined, densely villose, margin villous. Upper glume lanceolate, chartaceous, 3-3.2×1-1.2mm, margins hyaline, 1-keeled, 3-veined. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret obscure. Upper lemma linear, 2-3 mm long, hyaline, without keel, awned. Principal lemma awn geniculate, 12–18 mm long overall, glabrous. Palea oblong, obtuse, hyaline, 0.8-1×0.5-0.8 mm. Lodicules 2, cuneate, fleshy. Stamens 3, 2mm long. Ovary 0.5mm, style 0.5mm, stigmas 2, 1mm long. Pedicelled spikelets well-developed, containing empty lemmas, lanceolate, shorter than fertile, separately deciduous. Pedicels linear, 1.5 mm long, ciliate. Lower glumes 7-veined, lanceolate, cartilaginous, villose, 3.2-3.7×0.7-1mm. Upper glume elliptic, 3.2-3.7×0.7-1mm, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret barren or absent. Upper lemma oblong, 3.2-3.7×0.7-1mm long, hyaline, without keel, apex truncated. Palea linear, 2.2-2.5×0.5mm, hairy at apex. Stamens 3, 2.5 mm long. **Plate 131.**

Flowering & Fruiting: August-December.

Habitat: On open hills.

Distribution: China, eastern Asia, India, Malesia, southwestern Pacific. INDIA: Throughout. S. GUJARAT: Valsad.

Voucher specimen: RJD/ 829, 830, 841

125. **Capillipedium filiculme** (*Hook. f.*) Stapf in Hooker f. IC. Pl. subtab. 3085.1922; *Blatt. & McC.* 82. 1935; *Bor* 111. 1960; *Shah* 2:794. 1978; Karthik. *et al.* 194. 1989; *Roy in Singh et al.* 382. 2001; *Andropogon filiculmis* Hooker f. 7:181. 1897; *Cooke* 3:501. 1958; *Dichanthium filiculme* S.K.Jain & Deshp. *Bull. Bot. Surv. India* 20: 134. 1978 publ. 1979; *Pandey in Shetty & Singh* 3:1018. 1993; *Lakshmi. in Sharma et al.* 454. 1996.

Annual. Culms rambling, weak, 30–80 cm long, rooting from lower nodes; nodes bearded. Ligule an eciliate membrane. Leaf-blades 2–5×0.4–0.8 cm, apex acuminate. Synflorescence a panicle with branches tipped by a raceme. Panicle open, oblong, 3–10 cm long, branches capillary. Racemes bearing 1–3 fertile spikelets on each. Rachis fragile at the nodes, subterete, ciliate on margins, linear, 1.5 mm long. Spikelets in pairs, fertile spikelets sessile, Companion spikelets pedicelled sterile. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic or oblong, dorsally compressed, 3 mm long, deciduous with accessory branch structures, callus bearded. Lower glumes dissimilar, firmer than Upper lemma, ovate, 3-3.2×0.8-1mm, chartaceous, keeled, 7-veined, glabrous, margin villous. Upper glume lanceolate, chartaceous, 3-3.2×0.8-1mm, margins hyaline, 1-keeled, 3-veined. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret obscure. Upper lemma linear, 2-3 mm long, hyaline, without keel, awned. Principal lemma awn geniculate, 15–20 mm long overall, glabrous. Palea oblong, obtuse, hyaline, 0.8-

1×0.5-0.8 mm. Lodicules 2, cuneate, fleshy. Stamens 3, 2mm long. Ovary 0.5mm, style 0.5mm, stigmas 2, 1mm long. Pedicelled spikelets well-developed, containing empty lemmas, lanceolate, shorter than fertile, separately deciduous. Pedicels linear, 1.5 mm long, ciliate. Lower glumes 5-veined, lanceolate, cartilaginous, 3-3.2×0.7-1mm. Upper glume elliptic, 3-3.2×0.7-1mm, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret barren or absent. Upper lemma oblong, 2.5-3×0.8-1 mm long, hyaline, without keel, apex truncated. Palea absent. Stamens 3, 2.5 mm long. **Plate 132.**

Flowering & Fruiting: November-March.

Habitat: Occasional on rocky plateaus.

Distribution: Endemic to India. INDIA: Penninsular India. S. GUJARAT: Surat, Tapi.

Voucher specimen: RJD/ 821, 832, 848

126. **Capillipedium huegelii** (Hack.) A.Camus *Rev. Bot. Appl. Agric. Colon. 1: 306* 1921; *Blatt. & McC. 81. 1935; Bor 111. 1960; Shah 2:794. 1978; Karthik. et al. 194. 1989; Roy in Singh et al. 382. 2001; Andropogon huegelii* Hack. *Monogr. Phan. 6:492. 1889; Hooker f. 7:180. 1897; Cooke 3:501. 1958; Dichanthium huegelii* (Hack.) S.K.Jain & Deshp. *Bull. Bot. Surv. India 20: 135. 1979; Pandey in Shetty & Singh 3:1019. 1993; Lakshmi. in Sharma et al. 545. 1996.*

Annual. Culms decumbent, 30–100 cm long, rooting from lower nodes. Culm-nodes bearded. Leaf-sheath oral hairs ciliate. Ligule a ciliolate membrane. Leaf-blades 10–15×0.8–1.5cm, scabrous. Synflorescence a panicle with branches tipped by a raceme. Panicle open, oblong, 8–20 cm long. Racemes 0.7-1 cm long, bearing 2–3 fertile spikelets on each. Rachis ciliate on margins. Rachis internodes linear, 2.5 mm long. Spikelets in pairs. Fertile spikelets sessile with companion pedicelled sterile spikelet. Fertile Spikelets comprising 1 basal sterile florets; 1 fertile florets; without rachilla extension. Sessile spikelets oblong, dorsally compressed, 3-4×1-1.2 mm, deciduous with accessory branch structures. Spikelet callus pilose. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 3-4×1-1.2 mm, membranous, without keels, 7-veined, hairy below, obtuse. Upper glume lanceolate, 3-4×1-1.2 mm, 1-keeled, 3-veined, muticose. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong, hyaline, without vein. Upper lemma linear, hyaline, 1-1.2×1-1.2 mm, without keel, veinless, apex awned. Principal lemma awn geniculate, 20-25 mm long overall, with twisted column, glabrous. Palea absent or minute. Lodicules 2, cuneate, fleshy. Stamens 3, 2mm long. Ovary 0.5mm, style 1mm, stigmas 2, 1.5mm long. Pedicelled spikelets well-developed, male, lanceolate, 3.5–4 mm long, separately deciduous. Pedicels linear, 2.5 mm long, ciliate. Lower glumes 9 -veined, pubescent, lanceolate, cartilaginous, 3.5-4×0.7-1mm. Upper glume elliptic, 3.5-4×0.7-1mm, margins ciliate, apex muticous. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret barren or absent. Upper lemma oblong, 2.5-3×0.5 mm long, hyaline, without keel, apex truncated. Palea absent. Stamens 3, 2.5 mm long. **Plate 133.**

Flowering & Fruiting: August-February.

Habitat: Common in all habitats.

Distribution: Endemic to India. INDIA: Central to Southwards India. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 111, 212, 535

127. **Chrysopogon fulvus** (Spreng.) Chiov. in *Fl. Somalia* 1: 327. 1929; *Bor* 116. 1960; *Shah* 2:801. 1978; Karthik. *et al.* 197. 1989; *Pandey in Shetty & Singh* 3:1003. 1993; *Lakshmi. in Sharma et al.* 430. 1996; *Roy in Singh et al.* 390. 2001; *Andropogon monticola* Schult. & Schult.f. *Mant.* 3: 665. 1827; *Hooker f.* 7:192. 1897; *Cooke* 3:505. 1958; *C. montanus* Trin. *Neue Entdeck. Pflanzenk.* 2: 93. 1821; *Blatt. & McC.* 70. 1935.

Perennial. Culms geniculately ascending, 20–100cm long. Leaves mostly basal. Ligule a ciliolate membrane. Leaf-blades 2–15×0.2–0.5cm, glabrous, apex acute. Synflorescence a panicle with branches tipped by a raceme. Panicle open, ovate, 5–12 cm long. Panicle branches capillary, whorled at most nodes, villous, hairy at tip. Racemes bearing a triad of spikelets, 1 fertile sessile spikelet and 2 sterile pedicelled one. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong, laterally compressed, 6–8mm long, falling entire, deciduous with accessory branch structures, callus cuneate, pilose, base pungent, callus hairs red-brown. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 7-7.5×2-2.5 mm, cartilaginous, hairy at apex. Upper glume lanceolate, 7.5-8×3-3.2 mm, 1-keeled, vein ciliate in the middle with fulvous hairs, awned, awn 6–10 mm long, hispidulous. Basal sterile florets barren. Lemma of lower sterile floret lanceolate, hyaline, 1-veined, 6-6.5×1-1.5 mm. Palea similar to lemma. Upper lemma oblong, hyaline, 7-7.2×2-2.5 mm, without keel, apex dentate, awned. Principal lemma awn from a sinus, geniculate, 25–35 mm long overall, pubescent. Palea hyaline, lanceolate. Lodicules 2, membranous. Anthers 3, 4 mm long. Stigma 2, 4 mm long, style 0.5mm long, ovary 0.5mm long. Pedicelled spikelets well-developed, male, lanceolate, 5–6 mm long, separately deciduous. Pedicels linear, 3mm long, with dark brown hairs. Glumes chartaceous, lower glume awned, 5–6 mm long awn. Lemmas enclosed by glumes, muticous, 4mm long, membranous, margin ciliate. Stamens 3, 4mm long. **Plate 134.**

Flowering & Fruiting: November-March.

Habitat: Occasional on rocky plateaus.

Distribution: India, Indo-China, and Malesia. INDIA: Warmer parts of India. S. GUJARAT: Surat, Tapi.

Voucher specimen: RJD/ 60, 126, 210

128. **Chrysopogon polyphyllus** (Hack.) Blatt. & McCann *J. BNHS* 32: 416. 1928 & 77, t.43. 1935; *Bor* 118. 1960; Karthik. *et al.* 198. 1989; *Pandey in Shetty & Singh* 3:1138. 1993; *Lakshmi. in Sharma et al.* 433. 1996; *Andropogon polyphyllus* Hack. ex *Hooker f.* 194. 1897; *Shah* 2:801. 1978; *Roy in Singh et al.* 391. 2001.

Perennial. Culms 60–90 cm long. Culm-internodes glabrous. Lateral branches ample. Ligule a ciliolate membrane. Leaf-blades 5-25×0.3-0.8cm, coriaceous, stiff, glaucous, apex acuminate.

Synflorescence a panicle with branches tipped by a raceme. Panicle open, ovate, 8–12 cm long. Panicle branches capillary, whorled at most nodes, 0.6–1.2 cm long, villous, hairy at tip. Racemes bearing a triad of spikelets, 1 fertile sessile spikelet and 2 sterile pedicelled one. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong, laterally compressed, 6–8mm long, falling entire, deciduous with accessory branch structures, callus cuneate, pilose, base pungent, callus hairs yellow. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 4.5–5×0.7–1 mm, cartilaginous, hairy at apex. Upper glume lanceolate, 5.5–6×1.2–1.5 mm, 1-keeled, vein ciliate in the middle, awned, awn 2–4 mm long. Basal sterile florets barren. Lemma of lower sterile floret lanceolate, hyaline, 1-veined, 4–4.2×1–1.5 mm. Palea similar to lemma. Upper lemma oblong, hyaline, 3.5×0.5 mm, without keel, apex dentate, awned. Principal lemma awn from a sinus, geniculate, 8–15 mm long overall, pubescent. Palea hyaline, lanceolate. Lodicules 2, membranous. Anthers 3, 1 mm long. Stigma 2, 2 mm long, style 1mm long, ovary 0.5mm long. Pedicelled spikelets well-developed, male, lanceolate, 4–5 mm long, separately deciduous. Pedicels linear, 2.5mm long, villous, with yellow hairs. Glumes chartaceous. Lemmas enclosed by glumes, muticous, 3–3.5mm long, membranous, margin ciliate. Stamens 3, 1mm long. **Plate 135.**

Flowering & Fruiting: December-February.

Habitat: On rocky river banks.

Distribution: Endemic to India. INDIA: Central to southwards. S. GUJARAT: Surat.

Voucher specimen: RJD/ 363, 378, 627

129. **Chrysopogon serrulatus** Trin. in Mem. Acad. Sci. Petersb. (Ser.6) 2:318. 1832; *Bor* 118. 1960; *Shah* 2:802. 1978; *Karthik. et al.* 198. 1989; *Pandey in Shetty & Singh* 3:1004. 1993; *Lakshmi. in Sharma et al.* 433. 1996; *Roy in Singh et al.* 391. 2001; *Andropogon monticola* Schult. var. *trinii* Hooker f. 7:193. 1897; *C. montanus* Trin. var. *serrulatus* (Trin.) Stapf in *Prain. Fl. Trop. Afr.* 9:160. 1917; *Blatt. & McC.* 70. 1935.

Perennial, caespitose. Culms erect, 40–150 cm long. Ligule a fringe of hairs. Leaf-blades 10–30×0.3–1cm, glabrous or sparsely hairy, apex acute. Synflorescence a panicle with branches tipped by a raceme. Panicle open, ovate, 5–12 cm long. Panicle branches capillary, whorled at most nodes, villous, hairy at tip. Racemes bearing a triad of spikelets, 1 fertile sessile spikelet and 2 sterile pedicelled one. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong, laterally compressed, 6–8mm long, falling entire, deciduous with accessory branch structures, callus cuneate, pilose, base pungent, callus hairs yellow. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 6–6.5×1–1.5 mm, cartilaginous, 7-veined, hairy at apex. Upper glume lanceolate, 6–6.5×1–1.5 mm, 1-keeled, vein ciliate in the middle, awned, awn 4–7 mm long. Basal sterile florets barren. Lemma of lower sterile floret lanceolate, hyaline, 1-veined, 4–4.5×1–1.2 mm. Palea similar to lemma. Upper lemma oblong, hyaline, 3–3.5×0.5–0.8 mm, without keel, apex dentate, awned. Principal lemma awn from a sinus, geniculate, 18–25 mm long overall, pubescent. Palea hyaline, lanceolate. Lodicules 2, membranous. Anthers 3, 4 mm long. Stigma 2, 4 mm long, style 0.5mm long, ovary 0.5mm long. Pedicelled spikelets well-

developed, male, lanceolate, 5-6 mm long, separately deciduous. Pedicels linear, 2.5mm long, with yellow-brown hairs, hairy all along but hairs longer above. Glumes chartaceous, pubescent, lower glume 7-veined, awned, 1-2 mm long awn. Lemmas enclosed by glumes, paleate, muticous, 3-4mm long, membranous, margin ciliate. Stamens 3, 4mm long. **Plate 136.**

Flowering & Fruiting: September-December.

Habitat: Rocky river beds.

Distribution: Africa, western Asia, India, Indo-China, and Malesia. INDIA: North-East and West India. S. GUJARAT: Dangs.

Voucher specimen: RJD/ 815, 816, 817

130. **Chrysopogon zizanioides** (L.) Roberty *Bull. Inst. Franç. Afrique Noire, A 22: 106. 1960; Vetiveria zizanioides* (L.) Nash *Fl. S.E. U.S. 67. 1903; Blatt. & McC. 65. 1935; Bor 258. 1960; Shah 2:882. 1978; Karthik. et al. 273. 1989; Pandey in Shetty & Singh 3:1137. 1993; Lakshmi. in Sharma et al.632. 1996; Roy in Singh et al. 545. 2001; Andropogon squarrosus* L. f. *Suppl. Pl. 433. 1781; Hooker f. 7:186. 1897; Cooke 3:511. 1958.*

Perennial, caespitose. Roots aromatic, rhizomes short. Culms erect, 150–300 cm long. Ligule a fringe of hairs. Leaf-blades 30–100×0.4–1cm, stiff, margins scabrous. Synflorescence a panicle with branches tipped by a raceme. Panicle open, 15–50 cm long. Primary panicle branches whorled at most nodes, simple. Racemes 4–8 cm long, bases filiform, glabrous. Rachis fragile at the nodes, internodes filiform, tip cupuliform. Spikelets appressed, in pairs, fertile spikelets sessile, sterile spikelets pedicelled; pedicels filiform, 4-4.5mm long. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets linear, laterally compressed slightly, 3.5-4 mm long, deciduous with accessory branch structures, callus glabrous. Glumes dissimilar, reaching apex of florets, firmer than Upper lemma. Lower glume lanceolate, 3.5-4×1-1.2mm, coriaceous, without keels, 5-veined, veins spinose. Upper glume lanceolate, chartaceous, 3.5-4×1-1.2mm, 1-keeled, vein spinulose, muticous, winged. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong, 3-3.5×1-1.2mm, hyaline, 2-veined, ciliolate on margins. Upper lemma oblong, 3-3.5×1-1.2mm, hyaline, 1-veined, apex muticous. Palea 2mm long, hyaline, 0-veined, without keels. Lodicules 2, membranous. Anthers 3, 2mm long. Stigma 2, 1 mm long, style 1mm long, ovary 0.5mm long. Pedicelled spikelets well-developed, male, linear, 2-3mm long, dorsally compressed, as long as fertile, separately deciduous, smaller and similar to sessile. **Plate 137.**

Flowering & Fruiting: August-February.

Habitat: Common along water edges.

Distribution: Africa, China, eastern Asia, Asia-tropical, southeast USA, Mexico, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 57, 334, 433

131. **Dichanthium annulatum** (Forssk.) Stapf *Fl. Trop. Afr.* 9: 178. 1917; *Blatt. & McC.* 94. 1935; *Bor* 133. 1960; *Shah* 2:810. 1978; Karthik. *et al.* 205. 1989; *Pandey in Shetty & Singh* 3:1017. 1993; *Lakshmi. in Sharma et al.* 452. 1996; *Roy in Singh et al.* 405. 2001; *Andropogon annulatus* Forssk. *Fl. Aegypt.-Arab.* 173 173. 1775; *Hooker f.* 7:196. 1897; *Cooke* 3:508. 1958.

Perennial, caespitose. Culms decumbent, 25–100 cm long. Ligule an eciliate membrane. Leaf blades 3–30×0.2–0.7mm. Synflorescence composed of racemes. Peduncle glabrous. Racemes 1–15, 3–7cm long. Rachis fragile at the nodes, subterete, ciliate on margins, filiform. Spikelets in pairs, fertile sessile and sterile pedicelled. Fertile Spikelets comprising 1 basal sterile florets and 1 fertile florets; without rachilla extension. Sessile spikelets oblong, dorsally compressed, 3–4 mm long, falling entire, deciduous with accessory branch structures, callus pilose. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 3–3.5×0.8–1mm, cartilaginous, without keels, pubescent below, margins ciliate, apex obtuse-acute. Upper glume lanceolate, 2–2.5×0.8–1mm, 1-keeled, 3-veined, ciliolate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret hyaline, 0-veined, apex hairy. Upper lemma linear, hyaline, without keel, 1-veined, awned. Principal lemma awn apical, geniculate, 18–25 mm long overall. Palea absent or minute. Lodicules 2, membranous. Anthers 3, 2mm long. Stigma 2, 1mm long, style 0.5mm long, ovary 0.5mm long. Pedicelled spikelets well-developed, male, smaller than fertile, similar to sessile, separately deciduous; pedicels filiform, 1mm long, ciliate; lemma awnless, anthers 3. **Plate 138.**

Flowering & Fruiting: August-February.

Habitat: Common in all habitats.

Distribution: Africa, Asia-temperate & tropical, Australia, south-central USA, Mexico, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 53, 303, 319, 428

132. **Dichanthium caricosum** (L.) A.Camus *Bull. Mus. Natl. Hist. Nat.* 27: 549. 1921; *Blatt. & McC.* 92. 1935; *Bor* 134. 1960; *Shah* 2:810. 1978; Karthik. *et al.* 206. 1989; *Pandey in Shetty & Singh* 3:1018. 1993; *Lakshmi. in Sharma et al.* 545. 1996; *Roy in Singh et al.* 405. 2001; *Andropogon caricosus* L. *Sp. Pl. ed. 2* 1480 1763; *Hooker f.* 7:196. 1897; *Cooke* 3:507. 1958.

Perennial. Culms decumbent, 25–180 cm long. Ligule an eciliate membrane. Leaf-blades 3–30×0.7–1cm. Synflorescence composed of racemes. Peduncle glabrous. Racemes 1–10, 3–10cm long. Rachis fragile at the nodes, subterete, ciliate on margins, internodes filiform. Raceme-bases filiform, glabrous. Spikelets in pairs, fertile sessile, sterile pedicelled. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic or obovate, dorsally compressed, 3–4 mm long, falling entire, deciduous with accessory branch structures, callus pilose. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume elliptic or obovate, 3.5–4×1–1.5mm, chartaceous, much thinner above, without keels, hairy below, 9-nerved, margins ciliate, apex obtuse. Upper glume lanceolate, 3.5–4×1–1.2mm, 3-nerved, 1-keeled. Basal sterile florets barren, without significant palea Lemma of lower sterile floret hyaline, 2.5–3×1–1.2mm. Upper lemma linear,

hyaline, without keel, 1-veined, awned. Principal lemma awn apical, geniculate, 20-30mm long overall. Palea absent or minute. Lodicules 2, membranous. Anthers 3, 2 mm long. Stigma 2, 2 mm long, style 1mm long, ovary 0.5mm long. Pedicelled spikelets well-developed, similar to sessile, barren or male, smaller than fertile, separately deciduous; pedicels filiform, 1.5mm long, ciliate; lemmas awnless. **Plate 139.**

Flowering & Fruiting: August-December.

Habitat: Common in all habitats.

Distribution: Africa, Asia-temperate & tropical, Australia and South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 114, 202, 374

133. **Dichanthium foveolatum** (Delile) Roberty in *Monogr. Syst. Andropog. du Globe* 163 1960; Pandey in Shetty & Singh 3:1019. 1993; Lakshmi. in Sharma et al. 455. 1996; *Andropogon foveolatus* Delile *Descr. Egypte, Hist. Nat. 2: 160. 1813; Hooker f. 7:168. 1897; Cooke 3:496. 1958; Eremopogon foveolatus (Del.) Stapf in Prain, Fl. Trop. Afr. 9:183. 1917; Blatt. & McC. 96. 1935; Bor 148. 1960; Shah 2:828. 1978; Karthik. et al. 218. 1989; Roy in Singh et al. 439. 2001.*

Perennial, caespitose. Butt sheaths pubescent. Culms geniculately ascending, 15–100 cm long, wiry. Ligule a ciliolate membrane. Leaf-blades flat or convolute, 1–15×0.2–0.5cm. Synflorescence composed of racemes, subtended by a spatheole, enclosed. Spatheole linear, 3.5–5 cm long, herbaceous. Peduncle pubescent above. Racemes single, 1.5–4.5 cm long. Rachis fragile at the nodes, flattened, villous on margins, internodes linear, 2mm long. Spikelets in pairs, fertile sessile and sterile pedicelled. Fertile spikelets comprising 1 basal sterile florets; 1 fertile florets; without rachilla extension. Sessile spikelets elliptic, dorsally compressed, 3.5–4mm long, deciduous with accessory branch structures, callus pilose. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma, shiny. Lower glume elliptic, 2-2.5×1-1.5mm, cartilaginous, without keels, 4-veined, 1pitted, margins ciliate. Upper glume lanceolate, 1-keeled, 2-2.5×1-1.5mm, 3-veined. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong, hyaline, 2-2.2×0.8-1mm, truncate. Upper lemma linear, 1.8-2 mm long, hyaline, without keel, apex awned. Principal lemma awn apical, geniculate, 18-22mm long overall, glabrous. Palea absent or minute. Lodicules 2, membranous. Anthers 3, 1.5 mm long. Stigma 2, 1.5 mm long, style 0.8mm long, ovary 0.5mm long. Pedicelled spikelets well-developed, male, elliptic, 3.5-3.8mm long. Pedicels linear, flattened, 2mm long, villous. Glumes pitted, glabrous, 2.5-3×1-1.2 mm, ciliate on margins. Lower lemma oblong, hyaline, 1.5-2×0.5-0.8mm, truncate, without palea. Upper floret lacking. **Plate 140.**

Flowering & Fruiting: August-October.

Habitat: Grassy hills and plains.

Distribution: Africa, western Asia, Arabia, India and Indo-China. INDIA: throughout drier parts. S. GUJARAT: Navsari, Surat, Tapi.

Voucher specimen: RJD/ 58, 601, 647

134. **Dichanthium mccannii** Blatt. in JBNHS 32:357. 1927; Bor 135. 1960; Karthik. *et al.* 206. 1989; *Lakshmi. in Sharma et al.* 457. 1996.

Annual, caespitose. Culms erect, 20–75 cm long. Culm-nodes bearded. Lateral branches sparse. Leaf-sheaths glabrous, outer margin hairy. Ligule an eciliate membrane. Leaf-blades linear-lanceolate, 6–12×0.5–1.2cm, pilose, with tubercle-based hairs. Synflorescence composed of racemes. Racemes 1–8, 3–6cm long. Rachis fragile at the nodes, subterete, ciliate on margins, filiform. Spikelets in pairs, fertile sessile and sterile pedicelled. Fertile Spikelets comprising 1 basal sterile florets and 1 fertile florets; without rachilla extension. Sessile spikelets oblong, dorsally compressed, 3–3.5 mm long, falling entire, deciduous with accessory branch structures, callus pilose. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 3-3.2×1-1.5mm, cartilaginous, without keels, pubescent below, margins with tubercled hairs, apex obtuse. Upper glume lanceolate, 2.5-3×0.8-1mm, 1-keeled, 3-veined, ciliolate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret hyaline, 0-veined. Upper lemma linear, hyaline, 2mm long, without keel, 1-veined, awned. Principal lemma awn apical, geniculate, 18–25 mm long overall. Palea absent or minute. Lodicules 2, membranous. Anthers 3, 2mm long. Stigma 2, 1.5mm long, style 0.5mm long, ovary 0.5mm long. Pedicelled spikelets well-developed, male, smaller than fertile, similar to sessile, separately deciduous; pedicels filiform, 1.5mm long, ciliate; lemma awnless, anthers 3. **Plate 141.**

Flowering & Fruiting: August-December.

Habitat: Rocky river beds.

Distribution: Endemic to India. INDIA: Endemic to Maharashtra. S. GUJARAT: Throughout. **New records for the State.**

Voucher specimen: RJD/ 818, 819, 822

135. **Sorghum bicolor** (L.) Moench in *Methodus* 207. 1794; Bor 228. 1960; *Shah* 2:866. 1978; Karthik. *et al.* 260. 1989; *Pandey in Shetty & Singh* 3:1140. 1993; *Lakshmi. in Sharma et al.* 600. 1996; *Roy in Singh et al.* 522. 2001; *Andropogon sorghum Brot. Fl. Lusit.* 1:88. 1804; *Hooker f.* 7:183. 1897; *Cooke* 3:511. 1958; *S. vulgare Pers. Syn. Pl.* 1:107. 1805; *Blatt. & McC.* 274. 1935.

Annual. Culms erect, robust, 100–600 cm long, nodes glabrous. Ligule an eciliate membrane. Leaf-blade base broadly rounded, 30–100×1-4cm. Synflorescence a panicle with branches tipped by a raceme. Peduncle straight or deflexed. Panicle open or contracted, lanceolate or ovate, equilateral or nodding, 8-30 cm long. 1° panicle branches appressed or spreading, not whorled, branches pubescent. Racemes bearing few fertile spikelets, 1–6 fertile spikelets on each. Rachis tough, ciliate on margins, internodes linear, 0.5–5 mm long. Spikelets in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong or ovate or orbicular, dorsally compressed, 5–6 mm long, persistent, callus pilose. Glumes dissimilar, with lower wider than upper, exceeding apex of florets, firmer than Upper lemma, gaping. Lower glume ovate, 5-5.5×3-3.2mm, chartaceous, 13-15-veined, pallid or red, 2-keeled, keeled, pilose, apex

obtuse. Upper glume ovate, 5-5.2×2.5-3mm, chartaceous, 1-keeled, 5-7-veined, pubescent, margins ciliate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret elliptic, 4-4.2×3-3.2mm, hyaline, 2-veined, ciliolate on margins. Upper lemma obovate, 3-3.5×3-3.5mm, hyaline, 1-veined, margins ciliate, apex 2-fid, awned. Principal lemma awn from a sinus, geniculate, 4-7mm long overall. Palea hyaline, 3mm long, ciliated. Lodicules 2, membranous, ciliate. Anthers 3, 3mm long. Stigma 2, 1.5mm long, style 1mm long, ovary 0.5mm long. Pedicelled spikelets well-developed, barren or male, lanceolate, separately deciduous. Pedicels filiform, ciliate, 2mm long. Glumes herbaceous, muticous, 5-9 nerved, pubescent. Florets rudiment or absent. **Plate 142.**

Flowering & Fruiting: October-February.

Habitat: Cultivated in agricultural fields.

Distribution: Europe, tropical Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Cultivated throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 54, 402, 471

136. **Sorghum halepense** (L.) Pers. in *Syn. Pl. 1: 101. 1805; Blatt. & McC. 5. 1935; Bor 222. 1960; Shah 2:867. 1978; Karthik. et al. 261. 1989; Pandey in Shetty & Singh 3:1115. 1993; Lakshmi. in Sharma et al. 598. 1996; Roy in Singh et al. 523. 2001; Andropogon halepensis* (L.) Brot. *Fl. Lusit. 1:89. 1804; Hooker f. 7:182. 1897; Cooke 3:502. 1958; S. miliaceum* (Roxb.) Snowden in *J. Linn. Soc. 55:207. 1955; Bor op. cit. 223.*

Perennial. Rhizomes elongated, scaly. Culms erect or geniculately ascending, 50-300 cm long. Culm-nodes pubescent. Ligule a ciliolate membrane. Leaf-blades 25-80×1-6cm, margins scaberulous. Synflorescence a panicle with branches tipped by a raceme. Panicle open, pyramidal, 10-55 cm long. 1° panicle branches whorled at most nodes. Racemes 1.2-2.5 cm long, bearing few fertile spikelets, bearing 1-5 fertile spikelets on each. Racemes bearing few fertile spikelets, 1-6 fertile spikelets on each. Rachis fragile, ciliate on margins, internodes filiform, 0.5-5 mm long. Spikelets in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong or ovate or orbicular, dorsally compressed, 2-3mm long, persistent, callus pilose. Glumes dissimilar, with lower wider than upper, exceeding apex of florets, firmer than Upper lemma, gaping. Lower glume ovate, 2.5-3×1.2-1.5mm, chartaceous, 5-veined, pallid, 2-keeled, pilose, apex dentate. Upper glume ovate, 3-3.2×1.5-1.7mm, chartaceous, 1-keeled, 3-veined, margins ciliate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret elliptic, 2.2-2.5×1-1.2mm, hyaline, 2-veined, ciliolate on margins. Upper lemma obovate, 2-2.2×1-1.2mm, hyaline, 1-veined, margins ciliate, apex 2-fid, awned. Principal lemma awn from a sinus, geniculate, 5-9mm long overall. Palea hyaline, 1.5mm long, ciliated. Lodicules 2, membranous, hairy. Anthers 3, 2mm long. Stigma 2, 1.5mm long, style 1mm long, ovary 0.5mm long. Pedicelled spikelets well-developed, male, lanceolate, separately deciduous, similar to sessile one. Pedicels filiform, ciliate, 3mm long. Lower lemma awnless. **Plate 143.**

Flowering & Fruiting: Throughout year.

Habitat: Common near wet places.

Distribution: Europe, Africa, Asia-temperate & tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 44, 350, 436

137. **Apluda mutica** L. in *Sp. Pl.* 82. 1753; *Bor* 93. 1960; *Shah* 2:776. 1978; *Karthik. et al.* 183. 1989; *Pandey in Shetty & Singh* 3:972. 1993; *Lakshmi. in Sharma et al.* 390. 1996; *Roy in Singh et al.* 360. 2001. *A. varia* Hack. in A. DC. Monogr. Phan. 6: 196. 1889; *Hooker f.* 7:150. 1897; *Cooke* 3:474. 1958; *A. varia* ssp. *aristata* Hack. *op. cit. Blatt. & McC.* 29. 1935.

Perennial. Culms decumbent or prostrate, 30–300 cm long, rooting from lower nodes. Ligule a ciliolate membrane. Leaf-blade base tapering to the midrib, blades 5–25×2–10 cm, apex attenuate, filiform. Synflorescence compound, paniculate, 5–40 cm long, lax, composed of racemes, terminal and axillary, subtended by a spatheole. Spatheole ovate, 3.5–10 cm long, membranous. Rachis obsolete. Racemes single, bearing a triad of spikelets, fertile spikelets sessile, 2 sterile spikelets pedicelled. Pedicels flattened, subequal, 3–4 mm long. Pedicelled spikelets rudimentary and well-developed in unequal pair, barren or male, lanceolate, dorsally compressed, 3–4 mm long, separately deciduous. Glumes herbaceous, acute, 5-nerved. Lemmas 2, developing, enclosed by glumes, muticous. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong, laterally compressed, 4–6 mm long, deciduous with accessory branch structures, callus oblong, 0.5–1 mm long. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume lanceolate, 5–5.5×1–1.5 mm, coriaceous, keel near apex, winged narrowly, apex dentate. Upper glume lanceolate, gibbous, 5–5.2×1.5–1.8 mm, chartaceous, 1-keeled, 5-veined, veins scaberulous, apex acute. Basal sterile florets male, with palea. Lemma of lower sterile floret oblong, 4–4.2×1–1.3 mm, hyaline, 3-veined, acute. Palea similar to lemma, 2–2.2×1–1.2 mm. Upper lemma oblong, 3–3.5×2.2–2.5 mm, hyaline, without keel, 3-veined, apex 2-fid, awned. Principal lemma awn from a sinus, geniculate, 8–12 mm long overall. Palea hyaline, 1.5 mm long, 0-veined, without keels. Lodicules 2, membranous. Anthers 3, 2.5 mm long. Stigma 2, 1.5 mm long, style 1 mm long, ovary 0.5 mm long. **Plate 144.**

Flowering & Fruiting: August–February.

Habitat: Common weed in all habitats.

Distribution: Northeast Africa, Asia-temperate & tropical, Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 89, 154, 220, 345

138. **Ischaemum afrum** (J.F.Gmel.) Dandy *Fl. Pl. Sudan* 3:476. 1956; *I. pilosum* (Klein ex Willd.) Wight *Madras J. Lit. Sci.* 3:138. 1835; *Hooker f.* 7:130. 1897; *Blatt. & McC.* 14. 1935; *Cooke* 3:479. 1958; *Bor* 183. 1960; *Shah* 2:837. 1978; *Karthik. et al.* 232. 1989; *Pandey in Shetty & Singh* 3:1068. 1993; *Lakshmi. in Sharma et al.* 523. 1996; *Roy in Singh et al.* 454. 2001.

Perennial, caespitose. Rhizomes elongated, scaly. Culms tufted, rooting below, 20–60 cm tall, leafy, compressed; nodes glabrous, internodes ribbed. Leaf sheath compressed, loose, 8–14 cm long; ligule membranous, 0.5 cm long; blades linear-lanceolate, glabrous, flat, acuminate, margin scabrid, with a distinct white coloured midrib, 8–50×2–10 cm; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2–5, pale yellow, 10–15 cm long; rachis fragile at the nodes, subterete, villous on margins. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 7 mm. Sessile spikelets shorter than the sessile, rudimentary or well-developed, up to 6–6.5 mm long, 4 mm long, thick, terete, villose. Lower glume linear, ciliate, margin incurved by a laterally expanded wing, pale yellow, 4-nerved, 6–6.5×2–2.5 mm. Upper glume ovate-lanceolate, 7-nerved, ciliate in nerve, 6–6.5×3–3.2 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 2-nerved, 5–5.5×1.5–2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 4–4.5×0.7–1 mm. Upper lemma oblong, apex 2-fid, 3-nerved, scabrid, ciliate, hyaline, 5–5.5×2–2.5 mm, awned. Principal lemma awn geniculate, 7–8 mm long all over. Upper palea lanceolate with broad base, hyaline, scabrid to glabrous, 5–5.2×1–1.5 mm. Stamens 3, anthers 2 mm long. Ovary 0.5 mm long, style 1.5 mm long, stigma 1.5 mm long. Pedicellate spikelets shorter than the sessile, rudimentary or well-developed, up to 6–6.5 mm long, 4 mm long, thick, terete, villose. Lower glume linear, ciliate, margin incurved by a laterally expanded wing, pale yellow, 4-nerved, 6–6.2×2–2.5 mm. Upper glume ovate-lanceolate, 7-nerved, ciliate in nerve, 6–6.2×3–3.2 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 2-nerved, 5–5.2×1.5–1.7 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 4–4.2×0.7–1 mm. Upper lemma oblong, apex 2-fid, 3-nerved, scabrid, ciliate, hyaline, 5–5.2×2–2.2 mm. Upper palea lanceolate with broad base, hyaline, scabrid to glabrous, 5–5.2×1–1.5 mm. Stamens 3, anthers 2 mm long. **Plate 145.**

Flowering & Fruiting: July-February.

Habitat: Common in wet soils.

Distribution: Africa, India. INDIA: Penninsular-Central India. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 3, 432, 456

139. **Ischaemum barbatum** Retz. *Observ. Bot.* 6:35. 1791; *Bor in Kew Bull.* 15:411. 1961; Karthik. *et al.* 231. 1989; Lakshmi. *in Sharma et al.* 515. 1996; *I. aristatum* Linn. *Sp. Pl.* 1049. 1753; *Cooke* 3:958. 1958; *Blatt. & McC.* 11. 1935; *I. aristatum* var. *barbatum* Hack. *in DC. Monogr. Phan.* 6:203. 1889; *Hooker f.* 7:127. 1897; *I. goebelii* Hack. *in Oestr. Bot. Zeit.* 51:149. 1901; *Bor* 179. 1960; *Shah* 2:836. 1978.

Perennial, caespitose. Rhizomes elongated, scaly. Culms erect or geniculately ascending, rooting below, 15–60 cm tall, leafy, compressed; nodes glabrous, internodes ribbed. Leaf sheath compressed, loose, 8–14 cm long; ligule an eciliate membranous, 2–3.5 mm long; blades linear-lanceolate, glabrous, flat, acuminate, margin scabrid, with a distinct white coloured midrib, 10–20×0.5–1 cm; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2, paired, appressed back to back, 3–7 cm long; rachis fragile at the nodes,

angular, villous on margins. Rachis internodes columnar, 4.5-5 mm long, flat and forming a U or V shape with the pedicel in rear view, tip cupuliform. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 7 mm. Sessile spikelets elliptic, up to 7 mm long including 0.5–0.75 mm long ciliate callus. Lower glume cartilaginous for $\frac{2}{3}$ of its length from base, pale yellow, villose all over, concave, crossed by 1–2 smooth ridges, the upper $\frac{1}{3}$ flattened, thinner, membranous, obtuse, with 12-15-nerve, margin narrowly incurved and winged, 6.8-7×3–3.2 mm. Upper glume oblong-lanceolate, keeled, keel with a narrow ciliate wing below the apex, rigid, 6–6.2×3–3.5 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 3-nerved, 5–5.2×2–2.2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 5–5.2×1–1.2 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, hyaline, 4–4.2×1–1.2 mm, bisexual, awn reaching up to 20 mm, geniculate, scabrid. Upper palea lanceolate with a broad base, hyaline, toothed, glabrous, 4–4.5×1–1.2 mm. Stamens 3, anthers 3.0 mm long. Ovary 1 mm long, style 1.5 mm long, stigmas 2–2.5 mm long. Pedicellate spikelets shorter than the sessile, up to 5–5.5 mm long, obliquely ovoid, pedicel rachis like, 1.5 mm long, thick, clavate, angular, confluent with the bristly thick callus. Lower glume linear, villose, margin incurved by a laterally expanded wing, lower cartilaginous portion with 1-2 transverse ridges, 9–12-nerved, 5–5.2×1.5–1.8 mm. Upper glume ovate-lanceolate, 1-nerved, ciliate in nerve, 5–5.2×2–2.2 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 3-nerved, 4–4.5×1–1.2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 4–4.2×1–1.2 mm. Upper lemma oblong, slightly notched at the apex, 2-nerved, scabrid, ciliate, hyaline, 3.5–3.8×1.2–1.5 mm, male. Upper palea lanceolate with broad base, hyaline, obtuse, scabrid to glabrous, 3–3.2×0.5–0.7 mm. Stamens 3, anthers 3.0 mm long. Ovary 1 mm long, style 1.5 mm long, stigmas 2–2.5 mm long. **Plate 146.**

Flowering & Fruiting: September-December.

Habitat: On rocky hills.

Distribution: West tropical Africa, Asia-temperate & tropical, Australia. INDIA: West, North-East India. S. GUJARAT: Valsad.

Voucher specimen: RJD/ 95, 520, 702

140. **Ischaemum bombaiense** Bor *JBNHS* 49:165. 1950 & 178. 1960; Karthik. *et al.* 231. 1989; Pandey in Shetty & Singh 3:1065. 1993; Lakshmi. in Sharma *et al.* 515. 1996.

Annual, caespitose. Rhizomes elongated, scaly. Culms erect or geniculately ascending, rooting below, 15–60 cm tall, leafy, compressed; nodes glabrous, internodes ribbed, lateral branches sparse. Leaf sheath compressed, loose, pilose, with tubercle-based hairs, ligule an eciliate membranous, 2–3mm long; blades linear-lanceolate, flat, hairy on both sides with tubercle-based hairs, acuminate, margin scabrid, with a distinct white coloured midrib, 6–12×0.5-1cm; pseudo-petiole present, pubescent; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2, paired, appressed back to back, 5–8 cm long; rachis fragile at the nodes,

angular, villous on margins. Rachis internodes cuneate, 6-7 mm long, flat and forming a U or V shape with the pedicel in rear view, tip cupuliform. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 10 mm. Sessile spikelets elliptic, up to 10 mm long including 0.5–0.75 mm long ciliate callus. Lower glume cartilaginous for $\frac{2}{3}$ of its length from base, pale yellow, shiny, concave, crossed by 3-6 smooth ridges, the upper $\frac{1}{3}$ flattened, thinner, membranous, obtuse, with green veins, 7–12-nerved, margin narrowly incurved and winged, 8.5–9×3–3.5 mm. Upper glume oblong-lanceolate, keel with a narrow ciliate wing below the apex, rigid, 7–7.5×3–3.2 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 0-nerved, 7–7.2×2–2.2 mm, male. Lower palea hyaline, lanceolate, glabrous, 7–7.2×2–2.2 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, margin entire, hyaline, keeled, 5–5.2×1.5–1.8 mm, bisexual, awn reaching up to 18 mm long or more, bent, twisted, scabrid or with papillae-like projections. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 6–6.2×2–2.2 mm; stamens 3, anthers 3.0 mm long. Ovary 1 mm long, style 1.5 mm long, stigmas 2–2.5 mm long. Pedicellate spikelets shorter than the sessile, up to 6–6.5 mm long, obliquely ovoid, 1 mm long, thick, clavate, angular, confluent with the bristly thick callus. Lower glume linear, but upper half expanded obliquely by a broad wing below the tip, ciliate, margin incurved by a laterally expanded wing, pale greenish yellow, lower cartilaginous portion with 3–5 transverse ridges, 9–12-nerved, 7–7.2×2.5–2.8 mm. Upper glume ovate-lanceolate, 1-nerved, ciliate in nerve, 7–7.2×2–2.2 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 0-nerved, 7–7.2×2–2.2 mm, male. Lower palea hyaline, lanceolate, glabrous, 6.5–7×2–2.2 mm. Upper lemma oblong, acuminate, 0-nerved, scabrid, hyaline, 7–7.2×2–2.2 mm, male. Upper palea lanceolate with broad base, hyaline, obtuse, scabrid to glabrous, 6–6.2×2–2.2 mm. Stamens 3, anthers 2.5 mm long. Ovary 1 mm long, style 1.5 mm long, stigma 2–2.5 mm long. **Plate 147.**

Flowering & Fruiting: September-December.

Habitat: On rocky soils

Distribution: Endemic to India. INDIA: Maharashtra. S. GUJARAT: Surat. **New records for the State.**

Voucher specimen: RJD/ 652, 742, 748, 769

141. **Ischaemum diplopogon** Hooker f. 7:129. 1897; *Blatt. & McC.* 14. 1935; *Cooke* 3:478. 1958; *Bor* 178. 1960; *Shah* 2:836. 1978; *Karthik. et al.* 231. 1989; *Pandey in Shetty & Singh* 3: 1066. 1993; *Lakshmi. in Sharma et al.* 516. 1996.

Annual, caespitose. Rhizomes elongated, scaly. Culms erect or geniculately ascending, rooting below, 30–50 cm tall, leafy, compressed; nodes glabrous, internodes ribbed, lateral branches ample. Leaf sheath compressed, loose, glabrous, ligule an eciliate membranous, 2–3 mm long; blades linear-lanceolate, flat, acuminate, margin scabrid, with a distinct white coloured midrib, 6–15×0.5–1.5 cm; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2, paired, appressed back to back, 2–8 cm long; rachis fragile at the nodes, angular, villous on margins. Rachis internodes clavate, 7 mm long, flat and forming a U or V shape with the pedicel in rear view, tip cupuliform. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 5–6 mm. Sessile spikelets elliptic, up to 6 mm long

including 0.5 mm long ciliate callus. Lower glume cartilaginous for $\frac{1}{3}$ of its length from base, pale yellow, shiny, concave, upper $\frac{2}{3}$ flattened, thinner, membranous, apex 2-partite, keeled, keel hairy, 4-nerved, margin narrowly incurved, 5.5–6×1.5–1.8mm. Upper glume oblong-lanceolate, gibbous and villose at middle, apex 3-partite, 6–6.2×1–1.2 mm, awned, awn 8–10mm long. Lower lemma ovate-lanceolate, acute, hyaline, 3-nerved, 4–4.2×1–1.2mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 3.5–3.8×0.7–1 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, hyaline, 3.5–3.8×1.8–2 mm, bisexual, awn reaching up to 18 mm, geniculate, scabrid. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 2–2.2×0.7–1 mm; stamens 3, anthers 1.5 mm long. Ovary 1 mm long, style 1 mm long, stigmas 1 mm long. Pedicellate spikelets shorter than the sessile, up to 5 mm long, 2.5 mm long, thick, clavate, angular, confluent with the bristly thick callus. Lower glume linear, but middle part expanded obliquely by a broad wing, margin incurved by a laterally expanded wing, pale greenish yellow, 9-nerved, 5.5–6×1.5–1.8 mm. Upper glume ovate-lanceolate, 1-nerved, ciliate in nerve, 4.5–5×1.5–1.8 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 3-nerved, 3.5–3.8×1–1.2 mm, male. Stamens 3, anthers 2.5 mm long. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 2.2–2.5×0.7–1 mm. Upper lemma oblong, slightly notched at the apex, 2-nerved, scabrid, ciliate, hyaline, 3–3.2×1–1.2 mm, male. Upper palea minute or absent.

Plate 148.

Flowering & Fruiting: September-December.

Habitat: Rocky river beds, wet hill slopes.

Distribution: Endemic to India. INDIA: Endemic to Penninsular India. S. GUJARAT: Dangs.

Voucher specimen: RJD/ 854, 855, 870, 884

142. **Ischaemum indicum** (Hout.) Merr. in J. Arnold Arbor. 19:320. 1938; *Bor* 180. 1960; *Shah* 2:836. 1978; *Karthik. et al.* 231. 1989; *Pandey in Shetty & Singh* 3:1066. 1993; *Lakshmi. in Sharma et al.* 517. 1996; *Roy in Singh et al.* 453. 2001; *I. ciliare Retz. Obs. Bot.* 6:36. 1791; *Hooker f.* 7:133. 1897; *Blatt. & McC.* 18. 1935; *Cooke* 3:481. 1958; *I. aristatum auct. non L.* Sp. Pl. 1049. 1753; *Hooker f. op. cit.* 126; *Cooke op. cit.* 476; *Blatt. & McC. op. cit.* 11.

Perennial, mat forming. Stolons present. Culms prostrate or geniculately ascending, rooting below, 25–80 cm long, leafy, compressed; nodes glabrous, internodes ribbed, lateral branches sparse. Leaf sheath compressed, loose, pilose, ligule an eciliate membranous, 1–2mm long; blades linear-lanceolate, flat, hirsute, hairy on both sides, acuminate, margin scabrid, 15–25×0.2–0.5cm; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2, paired, appressed back to back, 2–6 cm long; rachis fragile at the nodes, angular, villous on margins. Rachis internodes oblong, 2.5–3mm long, flat and forming a U or V shape with the pedicel in rear view, tip cupuliform. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 5 mm. Sessile spikelets elliptic, up to 5 mm long including 0.5–0.75 mm long ciliate callus. Lower glume concave, membranous, 2-fid, 7–9-nerved, margin broadly winged in upper half on both sides, 5–5.5×2–2.5 mm. Upper glume oblong-lanceolate, keel with hairs below the apex, rigid, 6–6.5×3–3.2 mm, awned awn 2mm long.

Lower lemma ovate- lanceolate, acuminate, hyaline, ciliate, 5-nerved, 4.5–4.8×1–1.5 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 4–4.2×2–2.2 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, margin serrate, hyaline, 4–4.2×1.5–1.8 mm, bisexual, awn reaching up to 12 mm, geniculate, scabrid. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 3.5–4×1–1.2 mm. Stamens 3, anthers 2 mm long. Ovary 1 mm long, style 1.5 mm long, stigmas 5.5 mm long. Pedicellate spikelets shorter than the sessile, up to 4 mm long, pedicel 1.5 mm long, thick, clavate, angular, confluent with the bristly thick callus. Lower glume linear, but upper half expanded obliquely by a broad wing below the tip, margin incurved by a laterally expanded wing, pale greenish yellow, lower cartilaginous portion with 3–5 transverse ridges, 9–12-nerved, 6–6.2×2.5–2.8 mm. Upper glume oblong-lanceolate, keel with hairs below the apex, rigid, 4–4.5×3–3.2 mm, awned awn 1mm long. Lower lemma ovate- lanceolate, acuminate, hyaline, ciliate, 1-nerved, 4–4.2×1–1.5 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 3–3.2×2–2.2 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, margin serrate, hyaline, 3–3.2×1.5–1.8 mm, bisexual, awn reaching up to 10 mm, geniculate, scabrid. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 3.5–4×1–1.2 mm. Stamens 3, anthers 2 mm long. Ovary 1 mm long, style 1.5 mm long, stigmas 5.5 mm long. **Plate 149.**

Flowering & Fruiting: August-February.

Habitat: Common weed in all habitats.

Distribution: Africa, Asia-temperate & tropical, northern South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 80, 118, 275

143. **Ischaemum molle** Hook.f. *Fl. Brit. India* 7:128. 1897; *Blatt. & McC.* 13. 1935; *Cooke* 3:477. 1958; *Bor* 183. 1960; *Shah* 2:837. 1978; *Karthik. et al.* 232. 1989; *Pandey in Shetty & Singh* 3:1067. 1993; *Lakshmi. in Sharma et al.* 523. 1996.

Perennial, Annual, caespitose. Rhizomes elongated, scaly. Culms erect or geniculately ascending, rooting below, 25–140 cm tall, leafy, compressed; nodes bearded, internodes ribbed, lateral branches ample. Leaf sheath compressed, loose, pilose, with tubercle-based hairs, ligule an eciliate membranous, 2–3mm long; blades linear-lanceolate, flat, hairy on both sides with tubercle-based hairs, acuminate, margin scabrid, with a distinct white coloured midrib, 12–25×0.5–1.5cm; pseudo-petiole present, pubescent; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2, paired, appressed back to back, 4–12 cm long; rachis fragile at the nodes, angular, villous on margins. Rachis internodes oblong, 3–4 mm long, flat and forming a U or V shape with the pedicel in rear view, tip cupuliform. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 6 mm. Sessile spikelets elliptic, up to 7 mm long including 0.5–0.75 mm long ciliate callus. Lower glume cartilaginous for $\frac{2}{3}$ of its length from base, pale yellow, shiny, concave, crossed by 2–3 smooth ridges, densely villose, the upper $\frac{1}{3}$ flattened, thinner, membranous, obtuse, with green veins, 7–12-nerved, 6.5–6.8×3–3.2 mm. Upper glume oblong-lanceolate, keel with a narrow ciliolate wing below the apex, rigid, 6–6.2×3–3.2 mm. Lower lemma ovate- lanceolate,

acuminate, hyaline, ciliate, 3-nerved, 6–6.2×2–2.2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 6–6.2×2–2.2 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, margin serrate, hyaline, keeled, 4–4.2×1.5–1.8 mm, bisexual, awn reaching up to 15 mm, geniculate, scabrid. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 5–5.2×2–2.2 mm; stamens 3, anthers 3.0 mm long. Ovary 1 mm long, style 1.5 mm long, stigmas 2–2.5 mm long. Pedicellate spikelets shorter than the sessile, up to 6–6.5 mm long, obliquely ovoid, 2 mm long, thick, clavate, angular, confluent with the bristly thick callus. Lower glume linear, ciliate, margin incurved by a laterally expanded wing, pale yellow, lower cartilaginous portion villose, 9–12-nerved, 6–6.2×2.5–2.8 mm. Upper glume ovate-lanceolate, 1-nerved, ciliate in nerve, 2-partite, 6–6.2×2–2.2 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 3-nerved, 6–6.2×2–2.2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 6–6.2×2–2.2 mm. Upper lemma oblong, slightly notched at the apex, 2-nerved, scabrid, ciliate, hyaline, 6–6.2×2–2.2 mm, male. Upper palea lanceolate with broad base, hyaline, obtuse, scabrid to glabrous, 5–5.2×2–2.2 mm. Stamens 3, anthers 2.5 mm long. Ovary 1 mm long, style 1.5 mm long, stigma 2–2.5 mm long. **Plate 150.**

Flowering & Fruiting: October-February.

Habitat: Common in all habitat.

Distribution: Arabia, India and Indo-China. INDIA: Penninsular-Central India. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 95, 163, 458

144. **Ischaemum muticum** L. *Sp. Pl.* 1049 1753; *Hooker f.* 7:132. 1897; *Bor* 183. 1960; *Karthik. et al.* 232. 1989.

Perennial, mat forming. Stolons present. Culms prostrate or rambling, rooting below, 15–40 cm tall, leafy, compressed; nodes glabrous, internodes ribbed, lateral branches sparse. Leaf sheath compressed, loose, pilose; ligule an eciliate membranous, 1mm long; blades linear-lanceolate, flat, acuminate, margin scabrid, with a distinct white coloured midrib, 6–12×0.5–1.5cm; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2, paired, appressed back to back, 2–5 cm long; rachis fragile at the nodes, angular, villous on margins. Rachis internodes columnar, 3 mm long, flat and forming a U or V shape with the pedicel in rear view, tip cupuliform. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 5mm. Sessile spikelets elliptic, up to 5 mm long including 0.5–0.75 mm long ciliate callus. Lower glume cartilaginous for $\frac{2}{3}$ of its length from base, shiny, concave, crossed by 2–3 nodular ridges, the upper $\frac{1}{3}$ flattened, thinner, membranous, obtuse, with green veins, 9–11-nerved, 5.2–5.5×1–1.2 mm. Upper glume oblong-lanceolate, keel with a narrow ciliolate wing below the apex, 3–5.2×1.5–1.8mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 3-nerved, 4.5–4.8×1–2.2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 4.5–4.8×1.5–2 mm. Upper lemma 2-fid, acute lobes, hyaline, 4–4.5×1.5–1.8 mm, bisexual, awn less. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 4–4.2×1–1.2 mm. Stamens 3,

anthers 2.5 mm long. Ovary 0.5 mm long, style 2.5 mm long, stigmas 2mm long. Pedicellate spikelets similar to sessile. **Plate 151.**

Flowering & Fruiting: October-February.

Habitat: On hill tops, rare.

Distribution: Eastern Temperate Asia, Asia-tropical, Australia. INDIA: South India. S. GUJARAT: Valsad. **New records for the State.**

Voucher specimen: RJD/ 127, 578, 665

145. **Ischaemum rugosum** Salisb. *Icon. Stirp. Rar. 1:1. 1791; Hooker f. 7:127. 1897; Blatt. & McC. 12. 1935; Cooke 3:477. 1958; Bor 184. 1960; Shah 2:838. 1978; Karthik. et al. 233. 1989; Pandey in Shetty & Singh 3:1068. 1993; Lakshmi. in Sharma et al. 524. 1996; Roy in Singh et al. 454. 2001.*

Annual, caespitose. Rhizomes elongated, scaly. Culms erect or geniculately ascending, rooting below, 15–100 cm tall, leafy, compressed; nodes glabrous, internodes ribbed, lateral branches sparse. Leaf sheath compressed, loose, pilose, ligule an eciliate membranous, 2–3mm long; blades linear-lanceolate, flat, hairy, acuminate, margin scabrid, with a distinct white coloured midrib, 5-20×0.3-1.5cm; pseudo-petiole present, pubescent; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2, paired, appressed back to back, 3–8 cm long; rachis fragile at the nodes, angular, villous on margins. Rachis internodes cuneate, 7 mm long, flat and forming a U or V shape with the pedicel in rear view, tip cupuliform. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 7 mm. Sessile spikelets elliptic, up to 7 mm long including 0.5–0.75 mm long ciliate callus. Lower glume cartilaginous for $\frac{2}{3}$ of its length from base, pale yellow, shiny, concave, crossed by 3-6 smooth ridges, the upper $\frac{1}{3}$ flattened, thinner, membranous, obtuse, with green veins, 7–12-nerved, margin narrowly incurved and winged, 6.5–6.8×3–3.2 mm. Upper glume oblong-lanceolate, keel with a narrow ciliolate wing below the apex, rigid, 6–6.2×3–3.2 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 0-nerved, 6–6.2×2–2.2 mm, male. Lower palea hyaline, lanceolate, glabrous, 6–6.2×2–2.2 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, margin entire, hyaline, keeled, 4–4.2×1.5–1.8 mm, bisexual, awn reaching up to 18 mm, geniculate, scabrid. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 5–5.2×2–2.2 mm; stamens 3, anthers 3.0 mm long. Ovary 1 mm long, style 1.5 mm long, stigmas 2–2.5 mm long. Pedicellate spikelets shorter than the sessile, up to 6–6.5 mm long, obliquely ovoid, rachis pedicel-like, 1 mm long, thick, clavate, angular, confluent with the bristly thick callus. Lower glume linear, but upper half expanded obliquely by a broad wing below the tip, ciliate, margin incurved by a laterally expanded wing, pale greenish yellow, lower cartilaginous portion with 3–5 transverse ridges, 9–12-nerved, 6–6.2×2.5–2.8 mm. Upper glume ovate-lanceolate, 1-nerved, ciliate in nerve, 6–6.2×2–2.2 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 0-nerved, 6–6.2×2–2.2 mm, male. Lower palea hyaline, lanceolate, glabrous, 6–6.2×2–2.2 mm. Upper lemma oblong, acuminate, 0-nerved, scabrid, hyaline, 6–6.2×2–2.2 mm, male. Upper palea lanceolate with broad base, hyaline,

obtuse, scabrid to glabrous, 5–5.2×2–2.2 mm. Stamens 3, anthers 2.5 mm long. Ovary 1 mm long, style 1.5 mm long, stigma 2–2.5 mm long. **Plate 152.**

Flowering & Fruiting: September-February.

Habitat: Common in all habitats.

Distribution: Africa, Asia-temperate & tropical, Australia, Mexico, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 162, 216, 733

146. **Ischaemum santapau** Bor in *JBNHS* 49: 167. 1950 & 185. 1960; *Shah* 2:838. 1978; Karthik. *et al.* 233. 1989; *Lakshmi. in Sharma et al.* 524. 1996.

Annual, caespitose. Rhizomes elongated, scaly. Culms erect or geniculately ascending, rooting below, 85–160 cm tall, leafy, compressed; nodes glabrous, internodes ribbed, lateral branches ample. Leaf sheath compressed, loose, pilose, ligule an eciliate membranous, 2–3 mm long; blades linear-lanceolate, flat, scabrous, acute, margin scabrid, with a distinct white coloured midrib, 8–20×0.5–1 cm; pseudo-petiole present, pubescent; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2, paired, appressed back to back, 4–6 cm long; rachis fragile at the nodes, angular, villous on margins. Rachis internodes linear, 3–4 mm long, flat and forming a U or V shape with the pedicel in rear view, tip cupuliform. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 6 mm. Sessile spikelets elliptic, up to 5 mm long including 0.5–0.75 mm long ciliate callus. Lower glume cartilaginous for $\frac{2}{3}$ of its length from base, shiny, concave, crossed by 3–4 minute constriction, the upper $\frac{1}{3}$ flattened, thinner, membranous, obtuse, with green veins, 5–7-nerved, 5.2–5.5×1.2–1.5 mm. Upper glume oblong-lanceolate, 5–5.2×1.5–1.8 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 3-nerved, 4.5–4.8×1–1.2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 4–4.5×1–1.2 mm. Upper lemma 2-fid, acute lobes, hyaline, 4–4.2×1.5–1.8 mm, bisexual, awn reaching up to 8 mm, straight, scabrid. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 3–3.5×0.7–1 mm. Stamens 3, anthers 2.5 mm long. Ovary 0.5 mm long, style 2.5 mm long, stigmas 2 mm long. Pedicellate spikelets shorter than the sessile, up to 5 mm long, obliquely ovoid, pedicel 4.5 mm long, thick, clavate, angular, confluent with callus. Lower glume linear, but upper half expanded obliquely by a broad wing below the tip, ciliate, margin incurved by a laterally expanded wing, cartilaginous, 5–7-nerved, 4.5–4.8×1–1.5 mm. Upper glume ovate-lanceolate, 1-nerved, 4–4.5×1–1.5 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 3-nerved, 4–4.2×1–1.2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 3–3.2×1–1.2 mm. Upper lemma oblong, slightly notched at the apex, 2-nerved, scabrid, ciliate, hyaline, 4–4.2×0.8–1 mm, male. Upper palea lanceolate with broad base, hyaline, obtuse, scabrid to glabrous, 3–3.2×0.5–0.8 mm. Stamens 3, anthers 2.5 mm long. Ovary 1 mm long, style 1.5 mm long, stigma 2–2.5 mm long. **Plate 153.**

Flowering & Fruiting: September-February.

Habitat: On rocky river banks

Distribution: Endemic to India. INDIA: Maharashtra. S. GUJARAT: Tapi, Dang.

Voucher specimen: RJD/ 517, 558, 646

147. **Ischaemum sayajiraoi** Raole & R. J. Desai Kew Bull. 64:303. 2011.

Annual. Culms tufted or creeping and rooting below, 50–150 cm tall, leafy, compressed; nodes glabrous, uppermost pubescent; internodes ribbed, compressed, 10–20 cm long. Leaf sheath compressed, loose, 10–20 cm long, sparsely hairy, hairs deciduous; auricles membranous, confluent with the ligule; ligule membranous, 0.5–1 cm long, 2-partite; pseudopetioles 2 mm long, blades linear-lanceolate, glabrous, flat, acuminate, margin scabrid, with a distinct white coloured midrib, 25–50×1.5–2 cm; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes, spatheole 5–10×0.4–0.8 cm long. Synflorescences terminal and axillary, axis 10–20 cm long; erect, pale yellow, 10–15 cm long; rachis trigonous, ciliate on the dorsal angle. Spikelets reaching 7 mm, linear-oblong, pedicel of the Pedicellate spikelet less than $\frac{1}{3}$ the length of the sessile one. Sessile spikelets elliptic, up to 7 mm long including 0.5–0.75 mm long ciliate callus. Lower glume cartilaginous for $\frac{2}{3}$ of its length from base, pale yellow, shiny, concave, crossed by 5–8 smooth ridges, the upper $\frac{1}{3}$ flattened, thinner, membranous, obtuse, with green veins, 7–12-nerved, margin narrowly incurved and winged, 6.5–6.8×3–3.2 mm. Upper glume oblong-lanceolate, 2-partite at maturity, keeled, keel with a narrow ciliolate wing below the apex, rigid, 6–6.2×3–3.2 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 3-nerved, 6–6.2×2–2.2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 6–6.2×2–2.2 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, margin serrate, hyaline, keeled, 4–4.2×1.5–1.8 mm, bisexual, awn reaching up to 18 mm long or more, bent, twisted, scabrid or with papillae-like projections. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 5–5.2×2–2.2 mm; stamens 3, anthers 3.0 mm long, stigmas dark purple 2–2.5 mm long; caryopsis oblong, dorsally compressed, ventral groove absent, glabrous, shining, hilum basal and embryo reaching to the middle of the grain, pale white-brown, 2.5–3×1 mm. Pedicellate spikelets shorter than the sessile, up to 6–6.5 mm long, obliquely ovoid, pedicel 1 mm long, thick, clavate, angular, confluent with the bristly thick callus. Lower glume linear, but upper half expanded obliquely by a broad wing below the tip, ciliate, margin incurved by a laterally expanded wing, pale greenish yellow, lower cartilaginous portion with 3–5 transverse ridges, 9–12-nerved, 6–6.2×2.5–2.8 mm. Upper glume ovate-lanceolate, 1-nerved, ciliate in nerve, 2-partite, 6–6.2×2–2.2 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 3-nerved, 6–6.2×2–2.2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 6–6.2×2–2.2 mm. Upper lemma oblong, slightly notched at the apex, 2-nerved, scabrid, ciliate, hyaline, 6–6.2×2–2.2 mm, male. Upper palea lanceolate with broad base, hyaline, obtuse, scabrid to glabrous, 5–5.2×2–2.2 mm. Stamens 3, anthers 2.5 mm long. Ovary 1 mm long, style 1.5 mm long, stigma 2–2.5 mm long, dark purple. Caryopsis lanceolate, dorsally compressed, ventral groove absent, glabrous, hilum basal and embryo reaching to the middle of the grain, reddish, 2.2–2.5×0.5 mm. **Plate 154.**

Flowering & Fruiting: August-February.

Habitat: On the banks of water channels.

Distribution: Endemic to India. INDIA: Gujarat. S. GUJARAT: Tapi, Dangs. **New Species to the Plant World.**

Voucher specimen: RJD/ 32, 33, 166, 518, 523

148. **Ischaemum semisagittatum** Roxb. *Fl. Ind. 1:320. 1820; Hooker f. 7:130. 1897; Blatt. & McC. 15. 1935; Cooke 3:479. 1958; Bor 185. 1960; Shah 2:838. 1978; Karthik. et al. 233. 1989; Lakshmi. in Sharma et al. 527. 1996.*

Annual. Rhizomes elongated, scaly. Culms decumbent, rooting below, 25–60 cm tall, leafy, compressed; nodes glabrous, internodes ribbed, lateral branches sparse. Leaf sheath compressed, loose, pilose, ligule an eciliate membranous, 3mm long; blades lanceolate-elliptic, flat, hairy, acuminate, margin scabrid, with a distinct white coloured midrib, 4–8×1–1.5cm; pseudo-petiole absent in upper leaves and present in lower ones; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2, paired, appressed back to back, 2–6 cm long; rachis fragile at the nodes, angular, villous on margins. Rachis internodes inflated, 3 mm long, flat and forming a U or V shape with the pedicel in rear view, tip cupuliform. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 6 mm. Sessile spikelets elliptic, up to 6 mm long including 0.5–0.75 mm long ciliate callus. Lower glume cartilaginous for $\frac{2}{3}$ of its length from base, shiny, concave, crossed by 5–8 smooth ridges, the upper $\frac{1}{3}$ flattened, thinner, membranous, obtuse, with green veins, 7–12-nerved, margin narrowly incurved and winged, 5.5–5.8×2–2.2 mm. Upper glume oblong-lanceolate, keeled, keel with a narrow ciliolate wing below the apex, rigid, 5–5.2×1.5–1.8 mm. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 5-nerved, 5–5.2×2–2.2 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 4–4.5×2–2.2 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, margin serrate, hyaline, keeled, 4–4.5×1.5–1.8 mm, bisexual, awn reaching up to 15 mm, scabrid, geniculate. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 4–4.2×1–1.2 mm. Lodicules 2, membranous. Stamens 3, anthers 1.5 mm long. Ovary 1 mm long, style 1.5 mm long, stigmas 1.5 mm long. Pedicellate spikelets similar to sessile. **Plate 155.**

Flowering & Fruiting: September-February.

Habitat: Common in all habitats.

Distribution: Endemic to India. INDIA: Penninsular India. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 183, 193, 382,739

149. **Ischaemum travancorense** Stapf ex C.E.C.Fisch. *Bull. Miss. Inform. Kew 1933: 353. 1933; Bor 186. 1960; Karthik. et al. 233. 1989; Lakshmi. in Sharma et al. 530. 1996; I. aristatum ssp. rottleri Hooker f. 7:127. 1897.*

Perennial. Culms decumbent or rambling, rooting below, 25–160 cm long, leafy, compressed; nodes glabrous, internodes ribbed, lateral branches sparse. Leaf sheath compressed, loose, pilose, ligule an eciliate membranous, 3–5mm long; blades lanceolate-elliptic, flat, hairy, acuminate, margin scabrid, with a distinct white coloured midrib, 4–22×0.5–1cm; pseudo-

petiole present, pubescent; the uppermost leaves often reduced to a lanceolate spathe partially enclosing the base of the racemes. Synflorescences terminal and axillary, composed of racemes. Racemes 2, paired, appressed back to back, 8-15 cm long; rachis fragile at the nodes, angular, glabrous on margins. Rachis internodes oblong, 4-5 mm long, flat and forming a U or V shape with the pedicel in rear view, tip cupuliform. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled, reaching upto 10 mm. Sessile spikelets elliptic, up to 5 mm long including 0.5-0.75 mm long ciliate callus. Lower glume concave, membranous, 7-9-nerved, margin broadly winged in upper half on one sides, 5-5.5×2-2.5 mm. Upper glume oblong-lanceolate, keel with hairs below the apex, rigid, 6-6.5×3-3.2 mm, awned awn 2mm long. Lower lemma ovate- lanceolate, acuminate, hyaline, ciliate, 5-nerved, 4.5-4.8×1-1.5 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 4-4.2×2-2.2 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, margin serrate, hyaline, 4-4.2×1.5-1.8 mm, bisexual, awn reaching up to 8 mm, geniculate, scabrid. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 3.5-4×1-1.2 mm. Stamens 3, anthers 2 mm long. Ovary 1 mm long, style 1.5 mm long, stigmas 5.5 mm long. Pedicellate spikelets shorter than the sessile, up to 4 mm long, pedicel 1.5 mm long, thick, clavate, angular, confluent with the bristly thick callus. Lower glume linear, but upper half expanded obliquely by a broad wing below the tip, lower cartilaginous portion with 3-5 transverse ridges, 9-12-nerved, 6-6.2×2.5-2.8 mm. Upper glume oblong-lanceolate, keel with hairs below the apex, rigid, 4-4.5×3-3.2 mm, awned awn 1mm long. Lower lemma ovate-lanceolate, acuminate, hyaline, ciliate, 1-nerved, 4-4.2×1-1.5 mm, male. Lower palea hyaline, lanceolate, expanded by hyaline wing below the tip, glabrous, 3-3.2×2-2.2 mm. Upper lemma deeply cleft into 2, acute, lanceolate lobes, margin serrate, hyaline, 3-3.2×1.5-1.8 mm, bisexual, awn reaching up to 10 mm, geniculate, scabrid. Upper palea lanceolate with a broad base, hyaline, obtuse, scabrid-glabrous, 3.5-4×1-1.2 mm. Stamens 3, anthers 2 mm long. Ovary 1 mm long, style 1.5 mm long, stigmas 5.5 mm long. **Plate 156.**

Flowering & Fruiting: September-December.

Habitat: Near water edges.

Distribution: Endemic to India. INDIA:Endemic to Kerala. S. GUJARAT: Surat. **New records for the State.**

Voucher specimen: RJD/ 34, 47

150. **Sehima nervosum** (Rottler) Stapf *Fl. Trop. Afr.* 9: 36. 1917; *Blatt. & McC.* 21. 1935; *Bor* 218. 1960; *Shah* 2:862. 1978; *Karthik. et al.* 258. 1989; *Pandey in Shetty & Singh* 3:1108. 1993; *Lakshmi. in Sharma et al.* 589. 1996; *Roy in Singh et al.* 513. 2001; *Ischaemum laxum* R.Br. *Prodr. Fl. Nov. Holl.* 205. 1810; *Hooker f.* 7:136. 1897; *Cooke* 3:482. 1958.

Perennial, caespitose. Culms erect, 30-100 cm long, wiry. Ligule a fringe of hairs. Leaf-blades 5-40×0.2-0.8cm, glaucous, apex attenuate, filiform. Synflorescence composed of racemes. Racemes single, straight, 5-12 cm long. Rachis fragile at the nodes, flattened, ciliate on margins, internodes cuneate. Spikelets squeezed between internode and pedicel, in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Pedicelled spikelets well-developed, containing empty lemmas or male, lanceolate, dorsally compressed, 6-9 mm long, separately deciduous.

Pedicels cuneate, flattened, ciliate, tip rectangular, 5mm long. Glumes coriaceous, 7-8×1.5-2mm, 5-7-veined, ciliate on margins, acute, muticous. Lemmas 2, enclosed by glumes, 4-6×1-1.5mm, 3-veined, ciliate on margins, muticous, paleate, male. Stamens 3, anther 4mm long. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic, laterally compressed, 6-10 mm long, deciduous with accessory branch structures; callus square, pilose, inserted. Glumes dissimilar, exceeding apex of florets, firmer than lemma. Lower glume elliptic, asymmetrical, 8.5-9×1.8-2mm, coriaceous, much thinner above, 2-keeled, keeled dorsally below, flaring to lateral above, winged narrowly near apex, lateral veins branching above, intercarinal veins prominent above, deeply depressed, apex 2-fid. Upper glume elliptic, 6-7×2.5-3mm, chartaceous, 1-keeled, margins ciliate, apex awned; awn 14-18 mm long. Basal sterile florets male, with palea. Lower lemma oblong, 6-6.5×1.8-2mm, hyaline, 2-veined, ciliate on margins. Palea 6-6.5×1-1.5mm, hyaline, hairy, without keels, male. Stamens 3, anther 4mm long. Upper lemma lanceolate, 5-5.5×1.5-2mm, hyaline, without keel, 3-veined, margins ciliate, apex 2-fid, awned. Principal lemma awn from a sinus, geniculate 30-40 mm long overall with twisted column, hairy on the spiral. Palea 5-5.5×1-1.2mm, hyaline, hairy, without keels. Lodicules 2, membranous. Stamens 3, anthers 4 mm long. Ovary 0.8 mm long, style 2 mm long, stigmas 3 mm long. **Plate 157.**

Flowering & Fruiting: September-December.

Habitat: Hilly grass lands.

Distribution: Africa, Asia-temperate & tropical, Australia. INDIA: North-West to Penninsular India. S. GUJARAT: Tapi.

Voucher specimen: RJD/ 235, 312, 454

151. **Sehima sulcatum** (Hack.) A. Camus in Bull. Mus. His. Nat. Paris 27:373. 1921; Blatt. & McC. 23. 1935; Bor 219. 1960; Shah 2:863. 1978; Karthik. et al. 258. 1989; Pandey in Shetty & Singh 3:1109. 1993; Lakshmi. in Sharma et al. 590. 1996; Roy in Singh et al. 514. 2001; *Ischaemum sulcatum* Hack. in DC. Monogr. Phan. 6:248. 1889; Hooker f. 7:137. 1897; Cooke 3:483. 1958.

Perennial, caespitose. Culms 50-120 cm long, nodes glabrous. Ligule a fringe of hairs. Leaf-blades 8-28×0.2-0.5 cm, glabrous, margins scabrous, apex acuminate. Synflorescence composed of racemes, racemes single, 4-9 cm long. Rachis fragile at the nodes, semiterete, ciliate on margins, internodes columnar, 4-4.5 mm long. Spikelets appressed, in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Sessile spikelets comprising 1 basal sterile florets, 1 fertile florets, without rachilla extension. Spikelets lanceolate, dorsally compressed, 10-11 mm long, deciduous with accessory branch structures. Spikelet callus glabrous, base inserted. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume lanceolate, 10-11×1.5-1.8 mm, coriaceous, much thinner above, 2-keeled above, 5-veined, lateral veins branching above, intercarinal veins prominent above, convex and with a longitudinal median groove, apex 2-fid, setaceously attenuate. Upper glume lanceolate, chartaceous, 1-keeled above, keel winged, 3-5-veined, apex acute, awned, awn 20-25 mm long. Basal sterile florets male, with palea. Lemma of lower sterile floret lanceolate, 5-5.2×0.8-1mm, hyaline, 2-veined, ciliate on margins. Palea of lower sterile floret similar to lemma. Upper lemma oblong, 5-5.2×1.5-1.8 mm, hyaline, without keel, 3-veined, ciliate, apex

lobed, 2-fid, awned. Principal lemma awn from a sinus, geniculate, 40–55 mm long overall, hairy. Palea 2–2.2×0.5–0.8 mm, hyaline. Lodicules 2, membranous. Stamens 3, anthers 2mm long. Ovary 2 mm long, style 2mm long, stigmas 2mm long. Pedicelled spikelets well-developed, male, lanceolate, dorsally compressed, 10–13 mm long, separately deciduous. Pedicels cuneate, flattened, ciliate, 4mm long. Lower glume lanceolate, 12–13×1.5–1.8 mm, coriaceous, much thinner above, 2-keeled above, 5-veined, apex setaceously attenuate, margin villose. Upper glume lanceolate, chartaceous, 3-veined, apex acuminate. Basal sterile florets male, without palea. Lemma of lower sterile floret lanceolate, 4.5–5×0.8–1mm, hyaline, 2-veined. Upper lemma oblong, 2–2.2×0.5–0.8 mm, hyaline, 0-veined. Palea 2–2.2×0.5–0.8 mm, hyaline. Stamens 3, anthers 2mm long. **Plate 158.**

Flowering & Fruiting: September–December.

Habitat: Hilly grass lands.

Distribution: India and Indo-China. INDIA: Penninsular to Central India. S. GUJARAT: Tapi.

Voucher specimen: RJD/ 860, 867, 883

152. **Triplopogon ramosissimus** (Hack.) Bor *Kew Bull.* 9:501. 1954 & 255. 1960; *Shah* 2:878. 1978; *Karthik. et al.* 270. 1989; *Lakshmi. in Sharma et al.* 625. 1996; *Ischaemum ramosissimus* Hack. in *DC. Monogr. Phan.* 6:249. 1889; *Hooker f.* 7:137. 1897; *I. spathiflorum* Hook.f. *op. cit.* 138; *Cooke* 3:481. 1958; *Sehima spathiflorum* (Hook. f.) *Blatt. & McC. in J. BNHS* 32:23. 1927 & 274. 1935.

Annual. Culms erect, 60–180 cm long, with prop roots. Ligule an eciliate membrane, 1.5 mm long. Leaf-blade base pseudo petiolate, blades lanceolate, 30–60×1.5–4 cm, flaccid, pubescent, margins scaberulous. Synflorescence compound, composed of racemes, terminal and axillary, subtended by a spatheole. Spatheole linear, 6–8 cm long, herbaceous. Racemes 1, 4–5 cm long. Rachis fragile at the nodes, flattened, ciliate on margins, internodes linear, 4.5mm long. Spikelets in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Fertile Spikelets comprising 1 basal sterile florets, 1 fertile florets, without rachilla extension. Spikelets oblong, laterally compressed, 8–10 mm long, deciduous with accessory branch structures, callus pubescent. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 6.5–7×1.2–1.5 mm, coriaceous, with a longitudinal median groove, with marginal tufts of hair, apex toothed. Upper glume oblong, coriaceous, keeled near apex, 9-veined, with a dorsal tuft of hairs, apex mucronate. Basal sterile florets male, with palea. Lemma of lower sterile floret elliptic, 5–5.5×0.8–1mm, hyaline, 3-veined. Palea hyaline, obtuse, 3.5–4×0.5 mm. Upper lemma oblong, 4.5–4.8×0.5–0.7 mm, hyaline, 3-veined, apex 2-fid, awned. Principal lemma awn from a sinus, geniculate, 15–10 mm long overall, pubescent. Palea hyaline, obtuse, 3–3.5×0.5–0.7mm. Lodicules 2, membranous. Stamens 3, anthers 2mm long. Ovary 1.5 mm long, style 2mm long, stigmas 1mm long. Pedicels linear, flattened, 3.5 mm long, ciliate. Pedicelled spikelets well-developed, containing empty lemmas, lanceolate, as long as fertile, separately deciduous. Glumes linear-lanceolate, coriaceous, distinctly 6–8 veined, pilose, or dentate. Lemmas and paleas enclosed by glumes, membranous, similar to that of sessile one. Anthers 3. 2mm long. **Plate 159.**

Flowering & Fruiting: September–December.

Habitat: Rocky river beds, hill slopes.

Distribution: Endemic to India. INDIA: Endemic to Penninsular India. S. GUJARAT: Dangs.

Voucher specimen: RJD/ 472, 515, 451, 861

153. **Dimeria ornithopoda** Trin. *Fund. Agrost.* 167. 1820; *Hooker f.* 7:104. 1897; *Cooke* 3:462. 1958; *Blatt. & McC.* 8. 1935; *Bor* 142. 1960; *Shah* 2:815. 1978; *Karthik. et al.* 210. 1989; *Pandey in Shetty & Singh* 3:1031. 1993; *Lakshmi. in Sharma et al.* 468. 1996; *Roy in Singh et al.* 413. 2001.

Annual. Culms erect, 20–50 cm long, nodes bearded. Leaf-sheaths keeled, pilose, with tubercle-based hairs. Ligule a ciliolate membrane, 0.5 mm long. Leaf-blades 2–4×0.1–0.3cm, midrib prominent beneath, scaberulous, hairy on both sides, with tubercle-based hairs, margins tuberculate-ciliate, apex acuminate. Synflorescence composed of racemes, subtended by an inflated leaf-sheath. Racemes 2–3, paired, erect, unilateral, 3–6 cm long. Rachis flattened, scaberulous. Spikelet packing crowded, regular, 2-rowed, appressed, solitary, pedicelled. Pedicels reduced to a stump, flattened. Spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong, laterally compressed strongly, 2–3mm long, falling entire, callus base obtuse. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume linear, 1.5–1.8×0.3–0.5 mm, chartaceous, much thinner on margins, 1-keeled, surface scabrous, margins ciliate, apex acute. Upper glume elliptic, chartaceous, 1.8–2×0.5–0.7 mm, with hyaline margins, without keels, wingless, scabrous, margins ciliate, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 2–2.2×0.5–0.7 mm, hyaline. Upper lemma elliptic, 1–1.5×0.5–0.7 mm, hyaline, without keel, 1-veined, apex dentate, 2-fid, awned. Principal lemma awn from a sinus, geniculate, 5–7 mm long overall, glabrous. Palea absent or minute. Stamens 2, anthers 0.5mm long. Ovary 0.3 mm long, style 0.2mm long, stigmas 0.5mm long. **Plate 160.**

Flowering & Fruiting: August-February.

Habitat: Common in monsoonal grasslands.

Distribution: Asia-temperate & Asia-tropical, Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 160, 355, 470

154. **Dimeria stapfiana** C.E.Hubb. ex Pilg. *Nat. Pflanzenfam. ed. 2 14e:* 109. 1940; *Bor* 144. 1960; *Karthik. et al.* 210. 1989; *Lakshmi. in Sharma et al.* 9. 1996; *Woodrowia diandra* Stapf in *Hook. Ic. Pl. t.* 2447. 1897; *Hooker f.* 7:241. 1897; *Cooke* 3:533. 1958; *Dimeria diandra* Stapf ex Bhide in *J. Proc. Asiat. Soc. Bengal (N. S.)* 7:516. 1911 non Griff. 1851; *Blatt. & McC.* 9. 1935.

Annual. Culms erect, slender, 10–45 cm long, nodes bearded, lateral branches sparse. Leaf-sheaths pilose with tubercle-based hairs. Ligule a ciliolate membrane, 1 mm long. Leaf-blades 3–7×0.2–0.5cm, scabrous, hairy on both sides with tubercle-based hairs, margins scabrous, tuberculate-ciliate, apex acute. Synflorescence composed of racemes, racemes 4–7, unilateral, 3–10 cm long. Rachis subterete, glabrous on margins. Spikelet packing lax, regular, 2-rowed,

spreading, solitary, pedicelled. Pedicels clavate, flattened, 1mm long, glabrous. Spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic, laterally compressed, compressed strongly, 4–5mm long, falling entire, callus oblong, 0.5 mm long, bearded. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 3–3.5×0.5–0.7 mm, coriaceous, much thinner on margins, 1-keeled, pubescent, apex obtuse. Upper glume elliptic, 4–4.2×1.5–1.7 mm, coriaceous, with hyaline margins, 1-keeled, winged on keel, winged above, wing corky, pilose, hairy at apex, acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 1.5–1.7×1.7–2 mm, hyaline, ciliate on margins. Upper lemma elliptic, 3–3.2×1–1.5 mm, hyaline, without keel, 1-veined, apex 2-fid, awned. Principal lemma awn from a sinus, geniculate, 10–14 mm long overall, glabrous. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 2mm long. Ovary 1mm long, style 1mm long, stigmas 1mm long. **Plate 161.**

Flowering & Fruiting: September-February.

Habitat: Hilly grasslands.

Distribution: Endemic to India. INDIA: Maharashtra. S. GUJARAT: Valsad. **New records for the State.**

Voucher specimen: RJD/ 107, 201, 691

155. **Andropogon pumilus** Roxb. *Fl. Ind.* 1:277. 1820; *Hooker f.* 7:170. 1897; *Blatt. & McC.* 93. 1935; *Cooke* 3: 495. 1958; *Bor* 93. 1960; *Shah* 2:776. 1978; *Karthik. et al.* 182. 1989; *Pandey in Shetty & Singh* 3:971. 1993; *Lakshmi. in Sharma et al.* 390. 1996; *Roy in Singh et al.* 359. 2001.

Annual. Culms geniculately ascending, 10–45 cm long, nodes glabrous. Ligule an eciliate membrane. Leaf-blades 7.5–12×0.2–0.4cm, glabrous, apex acuminate. Synflorescence compound paniculate, 3–10 cm long, lax, composed of racemes, terminal and axillary, subtended by a spatheole. Spatheole linear, 0.5–2 cm long. Racemes 2, paired, deflexed, 1.3–2 cm long. Rachis tough, deciduous from axis, ciliate on margins, internodes cuneate, 2.5 mm long, internode tip crateriform, with simple rim. Raceme-bases flattened, subequal, 1 mm long, shortly 4-lobed, persistent. Spikelets squeezed between internode and pedicel, in pairs. Pedicelled spikelets sterile, single. Pedicels oblong, 2.5 mm long, ciliate. Pedicelled spikelets well-developed, glumes chartaceous, keeled, 3-veined, acute, containing empty lemmas or male, lanceolate, dorsally compressed enclosed by glumes, 3–3.5×1–1.2 mm, shorter than fertile, persistent. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets linear, dorsally compressed, 3–4 mm, falling entire, deciduous with accessory branch structures, callus pubescent, base inserted. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume linear, 3–3.5×1–1.5 mm, coriaceous, 2-keeled, keeled dorsally, depressed, apex dentate. Upper glume lanceolate, chartaceous, keeled above, mucronate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret linear, 2–2.5×0.5–1 mm, hyaline, 2-veined. Upper lemma linear, hyaline, without keel, dentate, awned. Principal lemma awn from a sinus, geniculate, 10–14 mm long overall, with twisted column. Palea hyaline, 2–2.5×0.5 mm, 0-veined, without keels.

Lodicules 2, membranous. Stamens 3, anthers 2mm long. Ovary 0.5mm long, style 1.5mm long, stigmas 1mm long. **Plate 162.**

Flowering & Fruiting: August-February.

Habitat: Moist plains, grasslands.

Distribution: India and Indo-China. INDIA: Throughout drier parts of India. S. GUJARAT: Navsari, Valsad.

Voucher specimen: RJD/ 24, 138, 174, 463, 624

156. **Arthraxon hispidus** (Thunb.) Makino *Bot. Mag. (Tokyo)* 26:214. 1912; *Bor* 99. 1960; Karthik. *et al.* 184. 1989; *Pandey in Shetty & Singh* 3:979. 1993; *Lakshmi. in Sharma et al.* 398. 1996; *Roy in Singh et al.* 366. 2001; *A. ciliaris* P. Beauv. *Ess. Agrost.* 111, 152, t.11.f. 6. 1812; *Hooker f.* 7:145. 1897; *Cooke* 3:489. 1958; *A. brevistaratus* Hack. in *DC. Monogr. Phan.* 6:350. 1889; *Hooker f. op. cit.*; *Bor op. cit.* 99; *A. quartinianus* (A.Rich.) Nash *N. Amer. Fl.* 17: 99. 1912; *Blatt. & McC.* 78. 1935; *Bor op. cit.* 102; *Shah* 2:748. 1978; *Shetty op. cit.* 368.

Annual, mat forming. Culms rambling, slender, 7–80cm long, rooting from lower nodes, internodes 1–6 cm long, nodes pubescent. Leaf-sheaths glabrous on surface or pilose, outer margin glabrous or hairy. Ligule a ciliolate membrane, 0.5–1 mm long. Leaf-blade base amplexicaul, blades lanceolate or ovate, 2–8×0.3–2.5 cm, glabrous, sparsely hairy, margins tuberculate-ciliate at base, apex acute. Synflorescence composed of racemes, racemes 4–15, 1.5–5 cm long. Rachis fragile at the nodes, ciliate on margins, internodes filiform to linear, 3–5 mm long. Spikelets solitary, pedicelled; pedicels linear, 3 mm long, ciliate. Spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets lanceolate, laterally compressed, 5-6 mm long, falling entire, deciduous with accessory branch structures. Spikelet callus pubescent, base truncate. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume lanceolate, 5–5.5×1-1.2 mm, chartaceous, keel near apex, 7-9-veined, vein scaberulous, convex. Upper glume lanceolate, chartaceous, 5.5–6×1-1.2 mm, keeled above, 3-veined, vein scaberulous, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 2–2.5×0.5-0.7 mm, hyaline, obtuse. Upper lemma lanceolate, 2–2.5×0.5-1 mm, hyaline, without keel, 1-veined, apex acute, awned. Principal lemma awn dorsal, geniculate, 13-15 mm long overall, with twisted column. Palea absent or minute. Anthers 2, 0.8–1 mm long. Lodicules 2, membranous. Stamens 3, anthers 2mm long. Ovary 0.5mm long, style 0.5mm long, stigmas 0.7mm long. **Plate 163.**

Flowering & Fruiting: August-January.

Habitat: On hills and plains.

Distribution: Africa, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 151, 139, 693

157. ***Arthraxon inermis*** Hook.f. *Fl. Brit. India* 7: 145. 1897; *Hooker f.* 7:145. 1897; *Blatt. & McC.* 74. 1935; *Cooke* 3:487. 1958; *Bor* 100. 1960; *Shah* 2:782. 1978.

Annual, mat forming. Culms rambling, 20–60 cm long, rooting from lower nodes, lateral branches ample. Leaf-sheaths pilose. Ligule a ciliolate membrane. Leaf-blade base amplexicaul, blades lanceolate, 2–5×0.4–1.2 cm, flaccid, glabrous or pilose, apex acuminate. Synflorescence composed of racemes, racemes 2–6, 1.5–5 cm long. Rachis fragile at the nodes, glabrous on margins, internodes filiform, 2.5 mm long. Spikelets solitary, sessile, comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets lanceolate, laterally compressed, 3.5–4 mm long, falling entire, deciduous with accessory branch structures. Spikelet callus glabrous. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume lanceolate, 3–3.5×1–1.2 mm, chartaceous, 6-veined, hairy above, without keels. Upper glume lanceolate, chartaceous, 1-keeled, 3-veined, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong, hyaline, 2–2.5×0.7–1mm, 0-veined. Upper lemma lanceolate, 2mm long, hyaline, without keel, 1-veined, apex acute, awned. Principal lemma awn dorsal, geniculate, 7–8 mm long overall, with twisted column, glabrous. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 0.5mm long. Ovary 0.5mm long, style 0.5mm long, stigmas 0.5mm long. **Plate 164.**

Flowering & Fruiting: August-December.

Habitat: On hills and hill slopes.

Distribution: Endemic to India. INDIA: Cultivated throughout. S. GUJARAT: Valsad, Navsri, Dangs.

Voucher specimen: RJD/ 628, 743, 751

158. ***Arthraxon lanceolatus*** (Roxb.) Hochst. *Flora* 39:188. 1856; *Blatt. & McC.* 75. 1935; *Cooke* 3: 487. 1958; *Bor* 100. 1960; *Shah* 2:783. 1978; *Karthik. et al.* 185. 1989; *Pandey in Shetty & Singh* 3:979. 1993; *Lakshmi. in Sharma et al.* 400. 1996; *A. serrulatus* Hochst. *op. cit. p.p.*; *Hooker f.* 7:170. 1897.

Annual. Stolons present. Culms decumbent, 20–80 cm long, nodes glabrous. Ligule an eciliate membrane. Leaf-blade base broadly rounded, blades lanceolate, 1–5×0.2–0.8cm, margins tuberculate-ciliate, hairy at base, apex acuminate. Inflorescence composed of racemes. Racemes 2–4, paired, 2–5 cm long. Rachis fragile at the nodes, ciliate on margins, internodes linear, 2.5–3 mm long. Spikelets in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets lanceolate, laterally compressed, 6–7 mm long, falling entire, deciduous with accessory branch structures, callus pubescent, base truncate. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume lanceolate, 6.5–7×1–1.5 mm, chartaceous, 2-keeled, 5–7-veined, flat, spinose, rough on flanks, apex acute. Upper glume lanceolate, chartaceous, 6–6.5×2–2.2 mm, 1-keeled, keeled above, 3-veined, surface scabrous, rough at apex, margins ciliate, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 3–3.5×0.7–1 mm, hyaline, 0-veined. Upper lemma lanceolate, 5 mm long, hyaline, without keel, 1-veined, apex 2-fid, awned. Principal lemma awn dorsal, geniculate, 10–14 mm long overall, with twisted column, glabrous. Palea

absent or minute. Lodicules 2, membranous. Stamens 3, anthers 2mm long. Ovary 0.5mm long, style 0.5mm long, stigmas 1mm long. Pedicelled spikelets well-developed, male, lanceolate, 7 mm long, shorter than fertile. Pedicels linear, 1.5-2 mm long, ciliate. Glumes keeled, 6-7-veined, 5-5.5×1-1.2 mm, membranous. Lemmas 2, enclosed by glumes, hyaline, 2-2.5mm long. Stamens 3, anthers 2mm long. **Plate 165.**

Flowering & Fruiting: February - April.

Habitat: Water edges; escape from gardens

Distribution: South Africa, India and Indo-China. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 842, 850, 858

159. **Arthraxon lancifolius** (Trin.) Hochst. *Flora* 39: 188.1856; *Bor* 100. 1960; *Blatt. & McC.* 77. 1935; *Shah* 2:783. 1978; *Karthik. et al.* 185. 1989; *Pandey in Shetty & Singh* 3:980. 1993; *Lakshmi. in Sharma et al.* 402. 1996; *Roy in Singh et al.* 367. 2001; *A. microphyllus sensu Hooker f.* 7:147. 1897; *Cooke* 3:488. 1958.

Annual, mat forming. Culms rambling, slender, 5-30 cm long. Ligule a ciliate membrane. Leaf-blade base cordate, blades lanceolate or ovate, 1-4×0.3-1cm, flaccid. Synflorescence composed of racemes, racemes 2-9, 1-2 cm long. Rachis fragile at the nodes, ciliate on margins, hairs lengthening towards internode tip, internodes linear, 1.5 mm long. Spikelets in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets linear, laterally compressed, 3-5 mm long, falling entire, deciduous with accessory branch structures, callus pubescent, base truncate. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma, lanceolate, 4.5-5×1-1.2 mm, chartaceous, keeled, convex. Upper glume lanceolate, chartaceous, 2-2.5×0.7-1mm, 1-keeled, keeled above, apex acute, awned, awn 1-3 mm long. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong, 3mm long, hyaline, 0-veined, obtuse. Upper lemma lanceolate, hyaline, without keel, 1-veined, apex acute, awned. Principal lemma awn dorsal, geniculate, 6-8 mm long overall. Palea absent or minute. Lodicules 2, membranous. Stamens 2, anthers 0.5mm long. Ovary 0.5mm long, style & stigmas 0.5mm long. Pedicelled spikelets developed, barren, lanceolate, 2 mm long, shorter than fertile; pedicels filiform, 0.7-1 mm long; florets absent, lower lemma rarely present. **Plate 166.**

Flowering & Fruiting: August-December.

Habitat: On hills, hill slopes, old walls.

Distribution: Africa, Arabia, China, India, Indo-China, Malesia, and Papuaasia. INDIA: Throughout. S. GUJARAT: Tapi, Valsad, Dangs.

Voucher specimen: RJD/ 323, 147, 695

160. **Arthraxon nudus** (Steud.) Hochst. In *Flora* 39:188. 1856; *Bor* 101. 1960; *A. ciliaris* subsp. *nudus* (Steud.) Hack. *Bull. Herb. Boissier* 7:527. 1899. *A. hispidus* var. *nudus* (Steud.) Ohwi *Bull. Tokyo Sci. Mus.* 18:1. 1947.

Annual, mat forming. Culms rambling, 30–60 cm long, rooting from lower nodes, nodes pubescent, lateral branches ample. Leaf-sheaths 2–3 cm long, pilose, outer margin hairy. Ligule a ciliolate membrane, 2 mm long. Leaf-blade base amplexicaul, blades lanceolate or ovate, 1–8×3–20cm, margins scaberulous, ciliate, apex acuminate. Synflorescence composed of racemes. Racemes 4–9, borne along a central axis, 1–5 cm long. Rachis fragile at the nodes, glabrous on surface, glabrous on margins, internodes linear, 4 mm long. Spikelets in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Pedicelled spikelets represented by barren pedicels. Pedicels linear, 2–3 mm long, glabrous. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets lanceolate, laterally compressed, 4 mm long, falling entire, deciduous with accessory branch structures. Spikelet callus glabrous, base truncate. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume lanceolate, 3.5–4×1–1.2 mm, chartaceous, keel near apex, 7–9-veined, vein scaberulous, convex. Upper glume lanceolate, chartaceous, 1-keeled, keeled above, 3-veined, vein scaberulous, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 2–2.5×0.5–0.7 mm, hyaline, obtuse. Upper lemma lanceolate, 2–2.5×0.5–1 mm, hyaline, without keel, 1-veined, apex acute, awned. Principal lemma awn dorsal, geniculate, 7–9 mm long overall, with twisted column. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 2mm long. Ovary 0.5mm long, style 0.5mm long, stigmas 1mm long. **Plate 167.**

Flowering & Fruiting: August–November.

Habitat: Shady hill slopes, forest understorey.

Distribution: Arabia, China, India, Indo-China and Malesia. INDIA: Cultivated throughout. S. GUJARAT: Dangs. **New records for the State.**

Voucher specimen: RJD/ 881, 882, 846, 855

- 161. Cymbopogon flexuosus** (Nees ex Steud.) W. Watson *Gaz. N. W. Ind.* 392 1882; *Bor* 127. 1960; Karthik. *et al.* 201. 1989; Lakshmi. *in Sharma et al.* 438. 1996; *C. travancorensis* *Bor J. Bombay Nat. Hist. Soc.* 52:174. 1954; *Bor op. cit.* 132; *Andropogon nardus* subsp. *flexuosus* (Nees ex Steud.) Hack. *Monogr. Phan.* 6:603 603. 1889; *Hooker f.* 7:207. 1897.

Perennial, caespitose. Rhizomes short. Butt sheaths persistent. Culms erect, 200–300 cm long, internodes glabrous, nodes glabrous. Leaf-sheaths glabrous, oral hairs pubescent, auricles erect. Ligule an eciliate membrane, 2–5 mm long, scarious. Leaf-blades 50–100×0.8–1.5cm, glaucous, aromatic, scaberulous, margins scabrous, apex attenuate. Synflorescence compound, paniculate, 20–60 cm long, lax, composed of racemes, terminal and axillary, subtended by a spatheole, enclosed. Spatheole elliptic, 1–2 cm long. Peduncle 0.3 cm long, pilose above. Racemes 2, paired, erect or deflexed, 1–2 cm long. Rachis fragile at the nodes, semiterete, glabrous, ciliate on margins, internodes linear, 2.5–3 mm long, tip cupuliform, bases subequal, pubescent. Spikelets in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets lanceolate, dorsally compressed, 5–6 mm long, falling entire, callus pubescent, base inserted. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume lanceolate, 5.5–6×1.5–1.7mm, chartaceous, 2-keeled, narrowly winged on keel, vein scabrous,

intercarinal veins distinct, 2-3 in number, flat, smooth. Upper glume lanceolate, 5-5.2×1.5-1.7mm, keeled above, 3-veined, vein scabrous, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 4.5-4.7×0.7-1mm, hyaline, 2-veined, ciliolate on margins. Upper lemma lanceolate, hyaline, without keel, apex 2-fid, awned. Principal lemma awn from a sinus, geniculate, 10–15 mm long overall, glabrous. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 2.5mm long. Ovary 0.5mm long, style 1.5mm long, stigmas 2mm long. Pedicelled spikelets well-developed, male, equalling fertile. Pedicels linear, semiterete, 3mm long, ciliate. Companion sterile spikelets well-developed, male, elliptic, 5 mm long, shorter than fertile, deciduous with the fertile. Glumes chartaceous, acute, muticous, 4.5-5×1-1.5mm, keeled above. Lemmas enclosed by glumes, herbaceous, 4mm long, male. Stamens 3, anther 2.5mm long. **Plate 168.**

Africa: western Indian ocean. Asia-temperate: China. Asia-tropical: India, Indo-China, Malesia, and Papuaia.

Flowering & Fruiting: February - April.

Habitat: Escape from gardens, cultivated in home gardens.

Distribution: Africa, China, eastern Asia, Asia-tropical, Australia, Mexico, South America. INDIA: Throughout hotter parts. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 89, 115

162. **Cymbopogon martini** (Roxb.) W. Watson *Gaz. N. W. Ind.* 392. 1882; *Blatt. & McC.* 104. 1935; *Bor* 129. 1960; Karthik. *et al.* 202. 1989; *Lakshmi. in Sharma et al.* 439. 1996; *Andropogon schoenanthus* var. *martini* (Roxb.) Benth. *Fl. Austral.* 7: 534. 1878; *Hooker f.* 7:204. 1897; *Shah* 2:806. 1978; *Pandey in Shetty & Singh* 3:1010. 1993; *Roy in Singh et al.* 397. 2001.

Perennial, caespitose. Rootstock evident. Culms erect, 80–300 cm long. Ligule an eciliate membrane, 1.5–3 mm long. Leaf-blade base cordate, blades linear or lanceolate, 25–50×1–3 cm, glaucous, aromatic, margins scabrous, apex attenuate, filiform. Synflorescence compound, paniculate, 15–30 cm long, dense, composed of racemes, terminal and axillary, subtended by a spatheole, enclosed. Spatheole lanceolate or elliptic, 2–4 cm long, red. Peduncle pubescent above. Racemes 2, paired, deflexed, 1.5–2 cm long. Rachis fragile at the nodes, semiterete, pubescent on surface, ciliate on margins, internodes linear, tip cupuliform, bases subequal. Spikelets in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Pedicels linear, semiterete, ciliate, hairy on surface and margins. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong, dorsally compressed, 4–4.5 mm long, falling entire, deciduous with accessory branch structures, callus base inserted. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume lanceolate, 4-4.5×1-1.5mm, chartaceous, 2-keeled, keeled laterally, winged on keel, intercarinal veins distinct, with groove. Upper glume lanceolate, 4-4.5×1-1.5mm, 1-keeled, apex acute. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, hyaline, 3.5-4×1-1.2mm. Upper lemma lanceolate, hyaline, without keel, apex 2-fid, awned. Principal lemma awn from a sinus, geniculate, 12–18 mm long overall, glabrous. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 2mm long. Ovary

0.5mm long, style 1mm long, stigmas 1mm long. Pedicelled spikelets well-developed, equalling fertile, male, lanceolate, 4-4.5 mm long, deciduous with the fertile. Glumes chartaceous, 4-4.5×1-1.5mm, distinctly 8-veined, acute-muticous. Lemmas enclosed by glumes, membranous 3.5-4×1-1.5mm. Stamens 3, anthers 2mm long. **Plate 169.**

Flowering & Fruiting: February - April.

Habitat: Occasional on drier wastelands.

Distribution: Eastern Africa, China, India, Indo-China, Malesia, Australia. INDIA: Throughout warmer parts. S. GUJARAT: Tapi, Surat.

Voucher specimen: RJD/ 124, 223, 559, 570

163. **Heteropogon contortus** (L.) P.Beauv. ex Roem. & Schult. *Syst. Veg.* 2: 836. 1817; *Blatt. & McC.* 109. 1935; *Bor* 163. 1960; *Shah* 2:831. 1978; *Karthik. et al.* 226. 1989; *Pandey in Shetty & Singh* 3:1059. 1993; *Lakshmi. in Sharma et al.* 503. 1996; *Roy in Singh et al.* 448. 2001; *Andropogon contortus* L. *Sp. Pl.* 1045. 1753; *Hooker f.* 7: 199. 1897; *Cooke* 3:510. 1958.

Perennial, caespitose. Culms erect, 20–140 cm long, internodes solid, nodes black, lateral branches ample. Leaf-sheaths keeled. Ligule a fringe of hairs, 1 mm long. Leaf-blades 8–25×0.2–1cm, ribbed, apex abruptly acute. Synflorescence composed of racemes. Peduncle scabrous. Racemes single, erect, unilateral, 3–10 cm long. Rachis fragile at the nodes, glabrous on margins, internodes linear. Spikelets appressed, in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets linear, subterete, 5–7mm long, falling entire with accessory branch structures, callus linear, 2–3 mm long, bearded, base pungent, callus hairs red-brown. Glumes dissimilar, with lower wider than upper, exceeding apex of florets, firmer than Upper lemma. Lower glume linear, 6.5-7×1.8-2mm, coriaceous, dark brown, without keels, 9-veined, puberulous, apex obtuse. Upper glume linear, 5.5-6×1.2-1.5mm, coriaceous, without keels, obtuse. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret linear, 3-3.5×0.8-1mm, hyaline. Upper lemma linear, 4-4.5mm long, membranous, 1-veined, apex entire, awned. Principal lemma awn apical, geniculate, 70–100 mm long overall, with twisted column, pubescent. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 3mm long. Ovary 1mm long, style 2mm long, stigmas 6-7mm long. Pedicelled spikelets well-developed, larger than fertile, male, lanceolate, asymmetrical, dorsally compressed, 5–8 mm long, separately deciduous. Pedicels oblong, semiterete, 1-1.5mm long. Glumes chartaceous, 6-7×1.5-1.8mm, winged on margins, distinctly veined, tuberculate on margin, glabrous or pubescent, acute. Lemmas 2, membranous, acute, ciliate on margin, 5-5.5×1-1.2mm, enclosed by glumes. Stamens 3, anthers 3mm long. **Plate 170.**

Flowering & Fruiting: August-February.

Habitat: Common in all habitats.

Distribution: Europe, Africa tropical, Asia-temperate, Asia-tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 15, 51, 300, 176, 521, 635

164. **Heteropogon ritchiei** (Hook.f.) Blatt. & McCann *J. Bombay Nat. Hist. Soc.* 32:623. 1928 & 108. 1935; *Bor* 165. 1960; *Shah* 2:831. 1978; Karthik. *et al.* 227. 1989; *Lakshmi. in Sharma et al.* 504. 1996; *Andropogon ritchiei* Hooker f. 7:201. 1897; *Cooke* 3:509. 1958.

Annual. Culms 90–200 cm long. Leaf-sheaths keeled, glabrous. Ligule an eciliate membrane, 4–6 mm long, brown. Leaf-blades 15–45×0.8–1cm, sparsely hairy on both sides, margins serrulate, apex acuminate. Synflorescence composed of racemes. Racemes single, erect, unilateral, 3–7 cm long. Rachis fragile at the nodes, internodes linear. Spikelets appressed, in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets linear, subterete, 5–6 mm long, falling entire with accessory branch structures, callus linear, 2 mm long, bearded, base pungent, callus hairs dark brown. Glumes dissimilar, with lower wider than upper, exceeding apex of florets, firmer than Upper lemma. Lower glume linear, 5-5.5×1.8-2mm, coriaceous, dark brown, without keels, pubescent, apex truncate, 6-veined. Upper glume linear, coriaceous, 5-5.5×1.2-1.5mm, without keels, muticous. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 3-3.5×1-1.2mm, hyaline, 0-veined. Upper lemma linear, 4mm long, membranous, 1-veined, apex entire, awned. Principal lemma awn apical, geniculate, 40–50 mm long overall, with twisted column, pubescent. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 3mm long. Ovary 0.5mm long, style 1mm long, stigmas 2mm long. Pedicelled spikelets well-developed, larger than fertile, male, lanceolate, dorsally compressed, 6–10mm long, longer than fertile, separately deciduous. Pedicels oblong, semiterete, 2-3mm long. Glumes chartaceous, 7-8×1.5-2mm, acute, hairy winged on margins. Lower glume tuberculate-setose on margin, hairs yellowish-brown, 4–5mm long. Lemmas 2, enclosed by glumes, membranous, lanceolate, 5.5-6×0.8-1mm, hyaline. Stamens 3, anthers 3.5–4 mm long. **Plate 171.**

Flowering & Fruiting: September-February.

Habitat: Occasional on shady hills.

Distribution: Endemic to India. INDIA: Penninsular India. S. GUJARAT: Valsad.

Voucher specimen: RJD/ 179, 254, 675

165. **Iseilema laxum** Hack. *Monogr. Phan.* 6:682. 1889; Hooker f. 7:218. 1897; *Cooke* 3:516. 1958; *Blatt. & McC.* 113. 1935; *Bor* 188. 1960; *Shah* 2:840. 1978; Karthik. *et al.* 233. 1989; *Pandey in Shetty & Singh* 3:1069. 1993; *Lakshmi. in Sharma et al.* 533. 1996; *Roy in Singh et al.* 456. 2001.

Perennial, mat forming, or caespitose. Culms geniculately ascending, 20–60 cm long, nodes glabrous. Ligule a ciliate membrane. Leaf-blades 2–15×0.2–0.5cm, glaucous, apex abruptly acute. Synflorescence compound, linear, 3–20 cm long, composed of racemes, terminal and axillary, deciduous as a whole, subtended by a spatheole, enclosed. Spatheole lanceolate, 1–1.5 cm long, herbaceous, without tubercles, glabrous. Racemes single, oblong, bearing few

spikelets, 1 fertile spikelets on each. Spikelets in threes, basal paired, fertile spikelets sessile, 2 sterile spikelets pedicelled, subtended by 4 involucrel spikelets. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, 5–6 mm long, falling entire, deciduous with accessory branch structures, callus bearded. Glumes dissimilar, firmer than Upper lemma. Lower glume elliptic, 5.5-6×1-1.2mm, cartilaginous, without keels, apex dentate, 2-fid. Upper glume lanceolate, 5-5.5×1-1.2mm, coriaceous, 3-veined, apex acuminate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret hyaline, oblong, truncate, 2.5mm long. Upper lemma linear, membranous, 1-veined, apex entire, awned. Principal lemma awn geniculate, 8–13 mm long overall, with twisted column, glabrous. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 2-3mm long. Ovary 1.5mm long, style 2mm long, stigmas 4-5mm long. Pedicelled spikelets well-developed, male, lanceolate, 5–6 mm long, separately deciduous. Glumes cartilaginous, glabrous, muticous, 5-5.5×1-1.2mm, lemmas absent or minute. Stamens 3, anthers 2-3mm long. Involucrel spikelets well-developed, 4 in number, with both pairs arising at about the same level, pedicelled, deciduous with the fertile, male, lanceolate, 4–6 mm long. Pedicels filiform. Glumes herbaceous, ciliate on margins, lanceolate, 5-5.5×1.5-2mm, without florets. Stamens 3, anthers 2-3mm long. **Plate 172.**

Flowering & Fruiting: August-February.

Habitat: Common in all habitats.

Distribution: India and Indo-China. INDIA: Central to southwards India. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 44, 208, 465

166. **Iseilema prostratum** (L.) Andersson in *Nova Acta Regiae Soc. Sci. Upsal. III*, 2:251. 1856; *Bor* 188. 1960; *Shah* 2:840. 1978; *Karthik. et al.* 233. 1989; *Pandey in Shetty & Singh* 3:1070. 1993; *Lakshmi. in Sharma et al.* 533. 1996; *Roy in Singh et al.* 457. 2001; *I. wightii* (Steud.) Andersson *Nova Acta Regiae Soc. Sci. Upsal. III*, 2: 251. 1856; *Hooker f.* 7: 218. 1897; *Cooke* 3:516. 1958; *Blatt. & McC.* 113. 1935.

Perennial, mat forming, or caespitose. Culms geniculately ascending, 10–60 cm long, nodes bearded. Ligule a ciliate membrane. Leaf-blades 3–20×0.2–0.6cm, apex abruptly acute. Synflorescence compound, linear, 5–30 cm long, composed of racemes, terminal and axillary, deciduous as a whole, subtended by a spatheole, enclosed. Spatheole lanceolate, 0.7–1.2 cm long, herbaceous, tuberculate on midnerve. Racemes single, oblong, bearing few spikelets, 1 fertile spikelets on each. Rachis internodes linear. Spikelets in threes, basal paired, fertile spikelets sessile, 2 sterile spikelets pedicelled, subtended by 4 involucrel spikelets. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic, dorsally compressed, 5mm long, falling with accessory branch structures. Glumes dissimilar, firmer than Upper lemma. Lower glume elliptic, 5-5.5×1.5-2mm, cartilaginous, without keels. Lower glume lanceolate, 2-veined, apex dentate. Upper glume lanceolate, coriaceous, 3-veined, apex acuminate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret hyaline, 2.5-3×0.5mm. Upper lemma linear, membranous, 1-veined, apex entire, awned. Principal lemma awn geniculate, 10–16 mm long overall, with twisted column, awn glabrous. Palea absent or minute. Lodicules 2, membranous.

Stamens 3, anthers 2-3mm long. Ovary 1.5mm long, style 2mm long, stigmas 4-5mm long. Involucral spikelets well-developed, 4 in number, with both pairs arising at about the same level, pedicelled, deciduous with the fertile, male, 4-5 mm long. Pedicels filiform. Glumes herbaceous, ciliate on margins, lanceolate, 4-4.5×1.5-1.8mm, without florets. Stamens 3, anthers 2-3mm long. Pedicelled spikelets well-developed, male, lanceolate, 5 mm long, separately deciduous. Glumes cartilaginous, 5-5.5×1.5-2mm, glabrous, muticous, hairy on margin. Lemmas enclosed by glumes, hyaline, lanceolate, 4mm long. Stamens 3, anthers 2-3mm long. **Plate 173.**

Flowering & Fruiting: August-February.

Habitat: Common in all habitats.

Distribution: India and Indo-China. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 18, 528, 671

167. **Pseudanthistiria heteroclita** (Roxb.) Hooker f. 7:219. 1897; Blatt. & McC. 121. 1935; Bor 203. 1960; Shah 2:858. 1978; Karthik. et al. 252. 1989; Lakshmi. in Sharma et al. 573. 1996.

Annual, mat forming. Culms geniculately ascending or decumbent, 20–120 cm long, wiry, rooting from lower nodes, lateral branches sparse. Leaf-sheaths glabrous on surface. Ligule an eciliate membrane. Leaf-blades 15–30×0.3–0.8cm, flaccid, pilose with tubercle-based hairs, margins glabrous-ciliate. Synflorescence compound, fasciculate, 12–30 cm long, composed of racemes, terminal and axillary, subtended by a spatheole, enclosed. Spatheole lanceolate, 0.7–1.5 cm long, membranous, tuberculate, setose. Racemes single, 6–8 mm long, bearing few spikelets, 2 fertile spikelets on each. Rachis fragile at the nodes, internodes linear. Spikelets in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Pedicels linear, 1.5mm long. Pedicelled spikelets well-developed, lanceolate, empty or male, 4–5 mm long, longer than fertile, separately deciduous, callus oblong, 0.5 mm long. Glumes cartilaginous, 3.5-4×0.7-1mm, tuberculate, ciliate on margins, muticous. Lemma if present, enclosed by glumes, male. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong, dorsally compressed, 3–3.5 mm long, falling entire, deciduous with accessory branch structures, callus pilose. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 3.2-3.5×0.7-1mm, cartilaginous, 5-veined, without keels, hispidulous, apex obtuse. Upper glume oblong, 3.2-3.5×0.5-0.7mm, acute, 3-veined, membranous, 1-keeled. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong, 1 mm long, hyaline. Upper lemma oblong, apex entire, awned. Principal lemma awn geniculate, 18–25 mm long overall, with twisted column, glabrous. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 1mm long. Ovary 0.5 mm long, style and stigma 2mm long. **Plate 174.**

Flowering & Fruiting: August-February.

Habitat: On hills, hill slopes.

Distribution: China & India. INDIA: Penninsular and North-East India. S. GUJARAT: Dangs, Valsad, Surat.

Voucher specimen: RJD/ 172, 291, 537,590

168. **Themeda laxa** (Andersson) A. Camus *Bull. Mus. Natl. Hist. Nat.* 26: 423. 1920; *Blatt. & McC.* 3. 1935; *Cooke* 3:517. 1958; *Bor* 251. 1960; *Shah* 2:874. 1978; *Karthik. et al.* 268. 1989; *Pandey in Shetty & Singh* 3:1129. 1993; *Lakshmi. in Sharma et al.* 622. 1996; *Roy in Singh et al.* 535. 2001; *Anthistiria laxa* Andersson *Act. Sci. Upsal. (Ser. 3)* 2:243. 1856; *Hooker f.* 7:213. 1897.

Perennial, caespitose. Culms erect, 60–120 cm long, lateral branches ample. Ligule absent. Leaf-blades 7–15×0.3–0.5cm, surface pilose, sparsely hairy, margins scabrous, ciliate. Synflorescence compound, paniculate, composed of racemes, terminal and axillary, subtended by a spatheole, enclosed. Spatheole lanceolate, 2.5–4 cm long, scarious, without tubercles, glabrous. Racemes bearing few spikelets, 1 fertile spikelets on each. Rachis fragile at the nodes. Spikelets in threes, basal paired, subtended by 4 involucrel spikelets. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rhachilla extension. Spikelets elliptic, subterete, 5mm long, falling entire with accessory branch structures, callus cuneate, 0.5 mm long, pubescent, callus hairs dark brown. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 5-5.5×1.2-1.5mm, coriaceous, without keels, 9-veined, surface scabrous, apex truncate. Upper glume oblong, coriaceous, 5-5.5×1.2-1.5mm, pubescent above, 3-veined. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret linear, 3-3.5×1-1.2mm, hyaline. Upper lemma linear, 4 mm long, hyaline, without keel, 1-veined, apex entire, awned. Principal lemma awn apical, geniculate, 30-40 mm long overall, with twisted column, hispidulous. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 1.5mm long. Ovary 1mm long, style and stigma 5-6 mm long. Pedicelled spikelets well-developed, containing empty lemmas or male, linear, 5-6 mm long, shorter than fertile, separately deciduous, callus linear, 2–3 mm long. Glumes herbaceous, 5.5-6×1-1.2mm, ciliate on margins, acute. Lemmas 2, 2.5-3×0.5-0.7mm, enclosed by glumes, hyaline, lanceolate. Stamens 3, anthers 2mm long. Involucrel spikelets pedicelled, 2 in the cluster, well-developed, 4 in number, with both pairs arising at different level, subsessile, barren or male, oblong, 5–6 mm long, larger than fertile. Glumes tuberculate on margins, 5-6×1-1.2mm, herbaceous, ciliate on margins, lower glume mucicous and winged. Lemmas 2, 2.5-3×0.5-0.7mm, enclosed by glumes, hyaline, lanceolate. Stamens 3, anthers 2mm long. **Plate 175.**

Flowering & Fruiting: August-February.

Habitat: Drier rocky areas.

Distribution: Endemic to India. INDIA: South-Central India. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 222, 230

169. **Themeda quadrivalvis** (L.) Kuntze *Revis. Gen. Pl.* 2:793. 1891; *Blatt. & McC.* 118. 1935; *Bor* 252. 1960; *Shah* 2:875. 1978; *Karthik. et al.* 268. 1989; *Pandey in Shetty & Singh* 3:1130. 1993; *Lakshmi. in Sharma et al.* 622. 1996; *Roy in Singh et al.*

536. 2001; *Anthistria ciliata* L. f. *Suppl.* 113. 1781; *Hooker f.* 7:213. 1897; *T. ciliata* (L. f.) *Hack. in DC. Monogr. Phan.* 6:664. 1889; *Cooke* 3:565. 1958.

Annual. Culms erect or geniculately ascending, 30–200 cm long, with prop roots, nodes glabrous. Leaf-sheaths keeled. Ligule an eciliate membrane, 2–2.5 mm long. Leaf-blades 7–30×0.3–0.8cm, scaberulous, glabrous or pilose, margins scabrous, apex acuminate. Synflorescence compound, fasciculate, 15–50 cm long, composed of racemes, terminal and axillary, subtended by a spatheole, enclosed. Spatheole lanceolate, 7.5–16 cm long, scarious, red, tuberculate, glabrous. Peduncle 1.3 cm long. Racemes bearing few spikelets, 1 fertile spikelets on each. Rachis fragile at the nodes. Spikelets in threes, basal paired, subtended by 4 involucrel spikelets. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rhachilla extension. Spikelets elliptic, subterete, 5mm long, falling entire with accessory branch structures, callus cuneate, 0.5 mm long, pubescent, callus hairs dark brown. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 4-4.5×1.5-2mm, coriaceous, without keels, 9-veined, surface scabrous, apex truncate. Upper glume oblong, coriaceous, 5-5.2×1-1.2mm, 3-veined. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret linear, 3-3.5×1-1.2mm, hyaline. Upper lemma linear, 4 mm long, hyaline, without keel, 1-veined, apex entire, awned. Principal lemma awn apical, geniculate, 30-40 mm long overall, with twisted column, hispidulous. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 2mm long. Ovary 1mm long, style and stigma 4-5 mm long. Pedicelled spikelets well-developed, containing empty lemmas or male, linear, 5-6 mm long, shorter than fertile, separately deciduous, callus linear, 1-2mm long. Glumes herbaceous, 5.5-6×1-1.2mm, ciliate on margins, acute. Lemmas 2, 2.5-3×0.5-0.7mm, enclosed by glumes, hyaline, lanceolate. Stamens 3, anthers 2mm long. Involucrel spikelets pedicelled, 2 in the cluster, well-developed, 4 in number, with both pairs arising at different level, subsessile, barren or male, oblong, 5–6 mm long, larger than fertile. Glumes tuberculate on margins, 5-6×1-1.2mm, herbaceous, ciliate on margins, lower glume muticous and winged. Lemmas 2, 2.5-3×0.5-0.7mm, enclosed by glumes, hyaline, lanceolate. Stamens 3, anthers 2mm long. **Plate 176.**

Flowering & Fruiting: August-February.

Habitat: Water edges; escape from gardens

Distribution: Africa, Asia-temperate & tropical, Australia, USA, Caribbean and southern South America. INDIA: Throughout. S. GUJARAT: Throughout drier parts.

Voucher specimen: RJD/ 214, 459, 857

170. ***Themeda tremula*** (Nees ex Steud.) *Hack. Monogr. Phan.* 6:667. 1889; *Blatt. & McC.* 119. 1935; *Cooke* 3:515. 1958; *Bor* 254. 1960; *Shah* 2:875. 1978; *Karthik. et al.* 269. 1989; *Lakshmi. in Sharma et al.* 545. 1996; *Anthistria tremula* Nees ex Steud. *Syn. Pl. Glum.* 1:401. 1855; *Hooker f.* 7:214. 1897.

Perennial. Culms decumbent, slender, 25–200 cm long, without nodal roots. Ligule a ciliolate membrane. Leaf-blades 8–30×0.3–0.8cm. Synflorescence compound, fasciculate, 5–30 cm, composed of racemes, terminal and axillary, subtended by a spatheole, enclosed. Spatheole lanceolate, 1–2 cm long, scarious, green-grey, without tubercles or tuberculate, glabrous or

pilose. Racemes single, oblong, bearing few spikelets, 2 fertile spikelets on each. Rachis fragile at the nodes, internodes linear. Spikelets in pairs, fertile spikelets sessile, sterile spikelets pedicelled, subtended by 4 involucrel spikelets. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic, subterete, 3–3.5 mm long, falling entire, deciduous with accessory branch structures, callus bearded, callus hairs red. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume oblong, 3-3.2×1-1.2 mm, coriaceous, without keels, with a longitudinal median groove, 8-veined, pubescent, hairs red, apex obtuse. Upper glume oblong, 5-5.2×2-2.2 mm, 3-veined, similar to lower. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, hyaline, 2.5-2.7×0.5-0.7 mm, glabrous. Upper lemma linear, hyaline, without keel, 1-veined, apex entire, awned. Principal lemma awn apical, geniculate, 25–35 mm long overall, with twisted column, puberulous. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 1.5 mm long. Ovary 0.5 mm long, style and stigma 2 mm long. Pedicelled spikelets well-developed, male, lanceolate, 6–8 mm long, longer than fertile, separately deciduous, callus linear, 1.5 mm long. Glumes lanceolate, 6.5-7×1.5-2 mm, hairy on margin, lower glume keeled. Lemmas enclosed by glumes, membranous, 5-5.2×1-1.2 mm. Involucrel spikelets well-developed, 4 in number, subsessile, elliptic, 6–8 mm long, larger than fertile. Glumes tuberculate; lower glume mucous, 6-7×2-2.2 mm, herbaceous, lanceolate, margin hairy. Lemma of lower sterile floret male, oblong, 5-5.2×2-2.2 mm, membranous, hyaline, margin hairy. Stamens 3, anther 3.5 mm long. Pedicels oblong, 0.5 mm long. **Plate 177.**

Flowering & Fruiting: August-February.

Habitat: Shady hill tops and hill slopes

Distribution: Endemic to India. INDIA: Penninsular India. S. GUJARAT: Valsad, Navsari, Dangs.

Voucher specimen: RJD/ 161, 190, 460, 747

171. **Themeda triandra** Forssk. *Fl. Aegypt.-Arab.* 178. 1775; *Blatt. & McC.* 115. 1935; *Bor* 254. 1960; *Shah* 2:876. 1978; *Karthik. et al.* 269. 1989; *Pandey in Shetty & Singh* 3:1130. 1993; *Lakshmi. in Sharma et al.* 623. 1996; *Roy in Singh et al.* 536. 2001; *Anthistiria imberbis* Retz. *Obs. Bot.* 3:11. 1783; *Hooker f.* 7:211. 1897; *T. imberbis* (Retz.) *Cooke* 3:993. 1958.

Perennial, caespitose. Culms erect, 20–200 cm long. Ligule a ciliolate membrane. Leaf-blades 7–25×0.3-1 cm. Synflorescence compound, fasciculate, 10–30 cm long, composed of racemes, terminal and axillary, subtended by a spatheole, enclosed. Spatheole lanceolate, 1.5–3.5 cm long, scarious, brown-red, with tubercles. Racemes single, bearing few spikelets, 1 fertile spikelets on each. Rachis fragile at the nodes. Spikelets in threes, basal paired. Fertile spikelets sessile, 2 sterile spikelets pedicelled, subtended by 4 involucrel spikelets. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic, subterete, 4–6 mm long, falling entire, deciduous with accessory branch structures, callus linear, 1-2 mm long, bearded, base pungent, callus hairs red. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma, shiny. Lower glume oblong, 5-5.2×2-2.2 mm, coriaceous, dark brown, without keels, 9-11-veined, apex obtuse. Upper glume oblong, 5-

5.2×1.2-1.5 mm, 3-veined. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate, 3.5-3.7×0.5-0.7mm, hyaline, 0-veined. Upper lemma linear, 4mm long, hyaline, without keel, 1-veined, apex entire, awned. Principal lemma awn apical, geniculate, 30–50 mm long overall, with twisted column, hispidulous. Palea absent or minute. Lodicules 2, membranous. Stamens 3, anthers 2mm long. Ovary 0.4 mm long, style and stigma 2mm long. Pedicelled spikelets well-developed, male, elliptic, 4-6mm long, as long as fertile, separately deciduous, callus linear, 1-2mm long, Glumes smooth, 4-4.2×1-1.2 mm, herbaceous, glabrous. Lemmas 2, enclosed by glumes, oblong-lanceolate, 4-4.2×1-1.2 mm, membranous, hyaline, glabrous, male. Stamens 3, anther 2mm long. Involucral spikelets well-developed, 4 in number, with both pairs arising at about the same level, subsessile, 4-6mm long, equalling fertile. Pedicels oblong, 0.3mm long. Glumes tuberculate, 4-5×1-1.2 mm, glabrous, 7-9 veined, herbaceous, muticous. Lemmas 2, oblong-lanceolate, 4-4.2×1-1.2 mm, membranous, hyaline, glabrous, male. Stamens 3, anther 2mm long. **Plate 178.**

Flowering & Fruiting: August-February.

Habitat: Common in all habitats.

Distribution: Africa, Asia-temperate & tropical, Australia and New Zealand. INDIA: Throughout warmer parts. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 41, 212, 568

172. *Glyphochloa forficulata* (C. E. C. Fisch.) Clayton in *Kew Bull.* 35:815. 1981; Karthik. *et al.* 225. 1989; Lakshmi. in *Sharma et al.* 500. 1996; *Manisuris forficulata* C. Fisch. In *Kew Bull.* 1933:355. 1933; Bor 192. 1960; Roy in *Singh et al.* 461. 2001; *Rottboelia divergens auct. non Hack.* 1889; *Hooker f.* 7:155. 1897; *Cooke* 3:470. 1958; *Peltophorus divergens Blatt. & McC.* 34. 1935.

Annual. Culms tufted, very slender, 5-20 cm. long, terete, softly hairy; nodes 2-5, glabrous. Leaves basal and cauline, hirsute from minute tubercles; sheaths lax, compressed, striate; ligules membranous, rounded, short; blades narrowly linear, acuminate, 5-10×0.3-0.5 cm. Synflorescence composed of racemes, subtended by an inflated leaf-sheath. Racemes terminal, solitary, spiciform, 2-8 cm. long; joints of the rachis 2.5-3 mm. long, subclavate usually glabrous, apex with a tuft of long hairs, disarticulating together with both spikelets. Spikelets appressed to the rachis, straw-coloured or pale-brown, the upper part and awns sometimes purple-tinged. Sessile spikelet with a very short glabrous callus. Lower glume coriaceous, oblong-lanceolate, acute, 2.5-3.5 mm. long (excluding the awns), terminating in two diverging, ascendingly barbellate, often unequal awns, 6.5-8.5 mm long, back convex, 4-6-nerved, grooved, with 5-9 marginal spinules with ciliate tips bent forwards at nearly right angles, the marginal spinules connected by regular rows of spinules, the spinules fused together into continuous or discontinuous crenelated and ciliate laminae, the upper portion of the back narrowly inflexed, winged margins, the wings membranous, more or less crescent shaped and continued onto the basal part of the awns, their margins minutely ciliate. Upper glume chartaceous - membranous, elliptic-lanceolate, acuminate, convex, 2.8-3×1-1.5 mm, minutely puberulous on lower half, margins inflexed. Lemma of lower sterile floret 2.5-3×1.5 mm long, hyaline, lanceolate, margins ciliolate, empty. Palea membranous, lanceolate 2×0.7 mm. Upper lemma 2-2.5×1-1.2 mm, hyaline, lanceolate, margins ciliolate, containing a bisexual flower.

Palea membranous, lanceolate 1.5×0.5 mm. Lodicules 2, membranous. Stamens 3, anthers 0.6-0.8 mm long. Ovary 0.4 mm long, style and stigma 1.5 mm long. Pedicelled spikelet with a pedicel similar to and completely fused with the joint of the rachis, as long as rachis, apex not ciliate; glumes subcoriaceous, glabrous, lower lanceolate, acute, convex, $2.5-3.5 \times 1-1.2$ mm, with a terminal, ascendingly barbellate 8-10 mm long awn, 5-7-nerved, one margin broadly winged, the wing continued onto the lower part of the awn; upper glume boat-shaped, acute, $2.5-3 \times 1-1.2$ mm, terminated into slender, often curved arista, 1-3 mm long, keel winged above, wing oblong, continued onto the lower half of the arista or higher, margin entire, truncate, rounded at the apex; lemmas and palea seen in lower spikelets only; lemmas if present hyaline, paleate or not, empty. **Plate 179.**

Flowering & Fruiting: August-December.

Habitat: Small pockets on Lateritic plateaus.

Distribution: Endemic to India. INDIA: Madhya Pradesh to downwards. S. GUJARAT: Dangs. **New Genus Records for the State.**

Voucher specimen: RJD/ 874, 875, 877

173. **Hemarthria compressa** (L.f.) R.Br. *Prodr. Fl. Nov. Holl.* 207. 1810; *Blatt. & McC.* 31. 1935; *Bor* 161. 1960; *Shah* 2:830. 1978; Karthik. *et al.* 226. 1989; *Pandey in Shetty & Singh* 3:1058. 1993; *Lakshmi. in Sharma et al.* 502. 1996; *Roy in Singh et al.* 447. 2001; *Rottboellia compressa* L.f. *Suppl. Pl.* 114. 1782; *Hooker f.* 7:153. 1897; *Cooke* 3:470. 1958.

Perennial. Stolons present. Culms prostrate, 50–100 cm long, rooting from lower nodes, lateral branches ample. Leaf-sheaths 2.5–3 cm long. Ligule a ciliate membrane. Leaf-blades $2-15 \times 0.2-0.5$ cm, glabrous, apex acuminate. Synflorescence composed of racemes, subtended by an inflated leaf-sheath. Racemes single, terete, 2–8 cm long. Rachis fracturing into irregular segments, flattened, glabrous on margins, internodes columnar, 3.5 mm long, adherent to upper glume of sessile spikelet, tip oblique, flat. Spikelets in pairs, sessile and pedicelled. Pedicels fused to internode, united wholly, oblong, flattened, tip rectangular. Pedicelled spikelets well-developed, male or bisexual, lanceolate, 4–5 mm long, longer than fertile, deciduous with the fertile, callus truncate. Glumes herbaceous, acute, 7-veined, $4-4.5 \times 1-1.2$ mm, upper glume keeled. Lemmas 2, oblong, $2.5-3.5 \times 1-1.2$ mm, enclosed by glumes, hyaline. Palea minute, hyaline, 1 mm long. Anthers 3; 2.8 mm long. Lodicules 2, membranous. Stamens 3, anthers 1.5 mm long. Ovary 0.5 mm long, style and stigma 3 mm long. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets elliptic or oblong, dorsally compressed, 3–4 mm long, falling entire, deciduous with accessory branch structures, callus cuneate, glabrous, base truncate, attached obliquely. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume elliptic or oblong, $3.2-3.5 \times 1.2-1.5$ mm, herbaceous, winged narrowly, 9-12-veined, flat, apex emarginate. Upper glume oblong, $3.2-3.5 \times 1.2-1.5$ mm, membranous, 3-5-veined, apex keeled. Basal sterile florets male, with or without palea. Lemma of lower sterile floret oblong, $2.5-3 \times 1-1.2$ mm, hyaline, obtuse. Upper lemma oblong, hyaline, $2.5-2.8 \times 1-1.2$ mm, without keel, 2-veined, apex obtuse. Palea minute, hyaline, 1 mm long. Lodicules 2, membranous. Stamens 3, anthers 1.5 mm long. Ovary 0.5 mm long, style and stigma 3 mm long. **Plate 180.**

Flowering & Fruiting: August-December.

Habitat: Near water edges and wet areas.

Distribution: Asia-temperate & tropical. INDIA: Throughout in moist places. S. GUJARAT: Tapi, Valsad, Surat, Navsari.

Voucher specimen: RJD/ 74, 331, 467, 731

174. **Mnesithea clarkei** (Hack.) De Koning & Sosef in *Blumea* 31:290. 1986; Karthik. *et al.* 238. 1989; Lakshmi. in *Sharma et al.* 538. 1996; *Coelorachis clarkei* (Hack.) Blatt. & McCann in *JBNHS* 32: 33. 1927 & 274. 1935; *Rottboellia clarkei* Hack. *Oesterr. Bot. Z.* 41:8. 1891; *Hooker f.* 7:156. 1897; *Cooke* 3:472. 1958; *Manisuris clarkei* (Hack.) *Bor Rec. Bot. Surv. India* 16: 357. 1953; *Bor* 191. 1960; *Shah* 2:842. 1978; *Pandey in Shetty & Singh* 3:1014. 1993.

Annual. Culms erect, 20–160 cm long. Culm-nodes pubescent. Ligule a ciliolate membrane. Leaf-blade base broadly rounded, blades lanceolate, 10–15×0.8–1.5cm. Leaf-blade surface pilose with tubercle-based hairs, apex acuminate. Synflorescence compound, paniculate, composed of racemes, terminal and axillary, subtended by a spatheole, embraced at base by subtending leaf. Spatheole linear or lanceolate, 2–3 cm long. Racemes single, 1.3–2.5 cm long. Rachis fragile at the nodes, semiterete, ciliate, internodes pyriform, 1.5–2 mm long, tip transverse, crateriform, with simple rim. Spikelets appressed, in pairs, sessile and pedicelled. Pedicels inflated, semiterete, 1.2–1.5 mm long, tip cupuliform. Pedicelled spikelets well-developed, bisexual or male, ovate, 1.5–2.5 mm long, separately deciduous. Glumes cartilaginous, 1.8-2×1-1.2 mm, ovate, 3-5-veined, lower glume winged on keels. Lemmas 2, lanceolate, 1.5mm long, hyaline, 0-veined. enclosed by glumes. Palea minute, hyaline, 1mm long. Lodicules 2, membranous. Stamens 3, anthers 0.5 mm long. Ovary 0.3 mm long, style and stigma 0.8mm long. Sessile spikelets comprising 1 basal sterile florets, 1 fertile florets, without rachilla extension. Spikelets obovate, dorsally compressed, 1.5-2mm long, falling entire, deciduous with accessory branch structures, callus glabrous, base truncate, with central peg, attached transversely. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume obovate, gibbous, 1.5-1.8×1-1.2 mm, coriaceous, winged on keel, winged broadly all along, 3–5-veined, pubescent below, margins ciliolate, apex obtuse. Upper glume oblong, membranous, 1.5-1.8×1-1.2 mm, 1-keeled, winged on keel, winged broadly all along, 1-veined. Basal sterile florets barren, with palea. Lemma of lower sterile floret oblong, 1.5-1.8×0.7-1 mm, hyaline, 0-veined. Upper lemma oblong, 1.5-1.8×0.7-1 mm, hyaline, without keel, 0-veined. Palea minute, hyaline, 1mm long. Lodicules 2, membranous. Stamens 3, anthers 0.5 mm long. Ovary 0.3 mm long, style and stigma 1 mm long. **Plate 181.**

Flowering & Fruiting: August-December.

Habitat: On moist hill tops.

Distribution: Endemic to India. INDIA: Penninsular, Central-East India. S. GUJARAT: Valsad.

Voucher specimen: RJD/ 204, 219, 845

175. **Mnesithea granularis** (L.) De Koning & Sosef in *Blumea* 31:295. 1986; *Lakshmi. in Sharma et al.* 539. 1996; *Hackelochloa granularis* (L.) Kuntze *Revis. Gen. Pl.* 2: 776. 1891; *Bor* 159. 1960; *Shah* 2:829. 1978; *Karthik. et al.* 238. 1989; *Pandey in Shetty & Singh* 3:1057. 1993; *Roy in Singh et al.* 446. 2001; *H. porifera* (Hack.) *Rhind. Grass. Burma* 77. 1945; *Bor op. cit.* 160; *Manisuris granularis* (L.) L. f. *Nov. Gram. Gen.* 40. 1779; *Hooker f.* 7:159. 1897; *Blatt. & McC.* 32. 1935; *Cooke* 3:473. 1958; *M. porifera* Hack. in *Oesterr. Bot. Zeitschr.* 41:48. 1891; *Hooker f. op. cit.* 160.

Annual. Culms erect, 5–100 cm long. Culm-nodes bearded. Leaf-sheaths loose or inflated, hirsute with tubercle-based hairs. Ligule a ciliolate membrane. Leaf-blade base cordate, blades linear to lanceolate, 2–15×0.4–1.5cm, hirsute with tubercle-based hairs, margins ciliate. Synflorescence compound, composed of racemes, terminal and axillary, subtended by a spatheole, exerted or embraced at base by subtending leaf. Spatheole linear. Racemes single, 0.5–5 cm long. Rachis fragile at the nodes, flattened, internodes oblong, 1–1.2 mm long, adherent to upper glume of sessile spikelet, tip transverse, crateriform. Spikelets appressed, in pairs, sessile and pedicelled. Pedicels fused to internode, united basally, oblong. Pedicelled spikelets well-developed, ovate, dorsally compressed, 1.5mm long, deciduous with the fertile. Glumes herbaceous, 1.2-1.5×0.5-0.8 mm, winged on keels, distinctly 5-veined, glabrous, entire, muticous. Basal sterile florets barren, with palea. Lemma of lower sterile floret oblong, 0.8-1×0.5-0.7 mm, hyaline, 0-veined. Upper lemma oblong, 0.5-0.8×0.5-0.7 mm, hyaline, without keel, 0-veined. Palea minute, hyaline, 0.5mm long. Lodicules 2, membranous. Stamens 3, anthers 0.5 mm long. Ovary 0.3 mm long, style and stigma 1 mm long. Sessile spikelets orbicular, dorsally compressed, 1-1.2mm long, falling entire, deciduous with accessory branch structures, callus base truncate, with central peg, attached transversely. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume orbicular, 1.2-1.5×0.7-1 mm, cartilaginous, indurate, without keels, 9-veined, warty on veins, surface rugose, apex obtuse. Upper glume oblong, 1-1.2×0.5-0.7 mm, without keels, 1-veined, apex obtuse. Basal sterile florets barren; without significant palea. Basal sterile florets barren, with palea. Lemma of lower sterile floret oblong, 0.8-1×0.5-0.7 mm, hyaline, 0-veined. Upper lemma oblong, 0.5-0.8×0.5-0.7 mm, hyaline, without keel, 0-veined. Palea minute, hyaline, 0.5mm long. Lodicules 2, membranous. Stamens 3, anthers 0.5 mm long. Ovary 0.3 mm long, style and stigma 1 mm long. **Plate 182.**

Flowering & Fruiting: August- February.

Habitat: Occasional in all habitats.

Distribution: Africa, Asia-temperate & tropical, Australia, North America, South America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 152, 322, 434, 580

176. **Ophiuros exaltatus** (L.) Kuntze *Revis. Gen. Pl.* 2: 780. 1891; *Bor* 199. 1960; *Shah* 2:843. 1978; *Karthik. et al.* 240. 1989; *Pandey in Shetty & Singh* 3:1076. 1993; *Lakshmi. in Sharma et al.* 541. 1996; *Roy in Singh et al.* 468. 2001; *O. corymbosus* (L.f.) C.F.Gaertn. *Suppl. Carp.* 2:4. 1805; *Hooker f.* 7:160. 1897; *Blatt. & McC.* 40. 1935; *Cooke* 3:468. 1958.

Perennial. Culms robust, 120–300 cm long, lateral branches ample. Leaf-sheaths pilose with tubercle-based hairs, outer margin hairy. Ligule an eciliate membrane. Leaf-blades elliptic, 50–100×1–4cm, pilose, margins spinulose. Synflorescence compound, fasciculate, 10–30 cm long, composed of racemes, terminal and axillary, subtended by a spatheole. Spatheole linear, 3–6 cm long. Racemes single, smoothly terete, bilateral, 7–10 cm long. Rachis fragile at the nodes, subcylindrical, excavated, internodes oblong, 3.5–4 mm long, tip transverse, crateriform. Spikelet packing abaxial, regular, 2-rowed, sunken, fertile spikelets sessile, sterile spikelets pedicelled. Pedicelled spikelets represented by barren pedicels. Pedicels fused to internode, united wholly. Sessile spikelets comprising 1 basal sterile florets, 1 fertile florets, without rachilla extension. Spikelets oblong, dorsally compressed, 3–4 mm long, falling entire, deciduous with accessory branch structures, callus base truncate, with central peg, attached transversely. Glumes dissimilar, reaching apex of florets, firmer than Upper lemma. Lower glume oblong, 3.2–3.5×2–2.5 mm, coriaceous, without keels, 7–9-veined, smooth or areolate, apex obtuse. Upper glume elliptic, membranous, 3–5-veined, apex obtuse. Basal sterile florets barren, with palea. Lemma of lower sterile floret ovate, 2.5–2.8×1.2–1.5 mm, 3-veined, acute, hyaline. Palea hyaline, ovate, 2–2.2×1–1.2 mm, without keel. Upper lemma of lower sterile floret ovate, 2.5–2.8×1.2–1.5 mm, 3-veined, acute, hyaline. Palea hyaline, ovate, 2–2.2×1–1.2 mm, without keel. Lodicules 2, membranous. Stamens 3, anthers 1.5 mm long. Ovary 0.5 mm long, style and stigma 1.5mm long. **Plate 183.**

Flowering & Fruiting: August-February.

Habitat: Common in all habitats.

Distribution: China, India, Malesia, Papuasias, Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 27, 55, 149

177. **Rottboellia cochinchinensis** (Lour.) Clayton *Kew Bull.* 35:817. 1981; *R. exaltata auct., non.* (L.) L.f. *Nov. Gram. Gen.* 40. 1779; Hooker f. 7:156. 1897; *Blatt. & McC.* 38. 1935; Cooke 3:473. 1958; *Bor* 270. 1960; *Shah* 2:859. 1978; Karthik. *et al.* 255. 1989; *Pandey in Shetty & Singh* 3:1102. 1993; *Lakshmi. in Sharma et al.* 635. 1996; *Roy in Singh et al.* 503. 2001.

Annual. Culms erect, 50–300 cm long, with prop roots, lateral branches ample. Leaf-sheaths hispid, with tubercle-based hairs. Ligule a ciliolate membrane, 1 mm long, truncate. Leaf-blades 15–45×0.5–2cm, scaberulous, apex acuminate. Synflorescence composed of racemes, terminal and axillary, subtended by an inflated leaf-sheath, exerted or embraced at base by subtending leaf. Peduncle antrorsely scabrous above, widened at apex. Racemes single, erect, smoothly terete, unilateral, 3–15 cm long. Rachis fragile at the nodes, subcylindrical and excavated, 2–3.5 mm wide, glabrous, terminating in a sterile spikelet, internodes oblong, 4–7mm long, tip transverse, crateriform, with simple rim. Spikelet packing abaxial, regular, sunken, in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Pedicelled spikelets well-developed, containing empty lemmas, ovate, dorsally compressed, 4–5 mm long, deciduous with the fertile. Pedicels fused to internode, united wholly, oblong, flattened, 3–5mm long. Glumes indurate, 4–4.5×2–2.5 mm, distinctly veined, smooth, glabrous, obtuse, muticous, lower glume winged on margins. Lemmas enclosed by glumes, membranous, hyaline, 2-

2.5mm long, barren. Sessile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets ovate, dorsally compressed, gibbous, 3.5–5 mm long, falling entire, deciduous with accessory branch structures, callus glabrous, base truncate, with central peg, attached transversely. Glumes dissimilar, with lower wider than upper, reaching apex of florets, firmer than Upper lemma. Lower glume ovate, 4-4.5×2-2.5 mm, indurate, winged on keel, 11-13-veined, apex emarginate. Upper glume ovate, gibbous, 4-4.2×2-2.5 mm, chartaceous, winged on keel, winged all along, 11-veined, apex acute. Basal sterile florets male, with palea. Lemma of lower sterile floret ovate, 4.2-4.5×1-1.5 mm, hyaline, 3-veined, acute. Palea membranous, 4.2-4.5×1-1.2 mm, lanceolate, hyaline. Upper lemma oblate, laterally compressed, gibbous, 3.2-3.5×2-2.5 mm, hyaline, lightly keeled, 1-veined, apex acute. Palea elliptic, 3.2-3.5×1-1.5 mm, hyaline, 0-veined, without keels, apex acute. Lodicules 2; oblong; 2 mm long; fleshy. Lodicules 2, membranous. Stamens 3, anthers 1mm long. Ovary 1 mm long, style and stigma 2 mm long. **Plate 184.**

Flowering & Fruiting: August-December.

Habitat: Shady moist places.

Distribution: Africa, Asia-temperate, Asia-tropical, North America, South America. INDIA: Throughout warmer parts. S. GUJARAT: Dangs.

Voucher specimen: RJD/ 820, 831, 842, 843

178. **Zea mays** L. *Sp. Pl.* 971. 1753; *Hooker f.* 7:102. 1897; *Blatt. & McC.* 2. 1935; *Cooke* 3:574. 1958; *Bor* 270. 1960; *Shah* 2: 882 1978; *Karthik. et al.* 274. 1989; *Pandey in Shetty & Singh* 3:1140. 1993; *Lakshmi. in Sharma et al.* 635. 1996; *Roy in Singh et al.* 545. 2001.

Annual. Culms erect, 100–300 cm long, with prop roots, internodes solid. Ligule an eciliate membrane. Leaf-blades linear or lanceolate, 25–10×2–10cm. Monoecious with male and female spikelets in different Synflorescences. Female synflorescence composed of racemes, axillary, subtended by a spatheole, enclosed. Spatheole elliptic, herbaceous. Racemes single, multilateral. Rachis enlarged into a woody cob. Spikelet packing crowded, regular, 4–11-rowed, sunken, in pairs, sessile. Spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets obovate, dorsally compressed, persistent on plant. Glumes similar, reaching apex of florets, firmer than Upper lemma. Lower glume oblate, 1 length of spikelet, scarious, of similar consistency above, without keels, 0-veined, margins ciliate. Upper glume oblate, scarious, of similar consistency above, without keels, 0-veined, margins ciliate. Basal sterile florets barren, with or without significant palea. Lemma of lower sterile floret ovate, membranous, 0-veined. Upper lemma orbicular, membranous, without keel, 0-veined, florets female. Lodicules absent, Stigmas 2, terminally exerted, papillose. Styles connate below. Male Synflorescence terminal, unlike female, of racemes along a central axis. Male spikelets distinct from female. Male spikelet glumes 2, 7-9 veined, up to 12 mm long, wingless, muticous. Lemmas 3–5-veined; muticous, male. Lodicules 2. Anthers 3. **Plate 185.**

Flowering & Fruiting: Throughout the year.

Habitat: Cultivated in Agricultural fields.

Distribution: Europe, Africa, Asia-temperate & tropical, Australia, North America, South America. INDIA: Cultivated throughout. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 232, 842, 859

179. **Chionachne gigantea** (J.Koenig) Veldkamp *Blumea* 47(3):559. 2002; *Chionachne koenigii* (Spreng.) Thwaites *Enum. Pl. Zeyl.* 357. 1864; *Bor* 262. 1960; *Shah* 2:797. 1978; *Karthik. et al.* 196. 1989; *Pandey in Shetty & Singh* 3:997. 1993; *Lakshmi. in Sharma et al.* 422. 1996; *Roy in Singh et al.* 386. 2001; *Polytoca barbata* (Roxb.) Stapf in *Hooker f.* 7:102. 1897; *Blatt. & McC.* 6. 1935; *Cooke* 3:519. 1958.

Perennial. Culms erect, 80–200 cm long, nodes bearded. Leaf-sheaths hispid with tubercle-based hairs. Ligule a ciliate membrane. Leaf-blades 25–60×0.6–2 cm, hispid with tubercle-based hairs. Monoecious, with male and female spikelets in the same Synflorescence. Synflorescence compound, paniculate, composed of racemes, terminal and axillary, subtended by a spatheole, embraced at base by subtending leaf. Spatheole lanceolate, 1–2 cm long, scarious. Racemes single, 2.5–4 cm long, bearing few spikelets, 1 fertile female spikelets on each and 4–8 male spikelets. Rachis fragile at the nodes, subterete, internodes linear, bearing a sterile companion laterally, tip cupuliform. Sexes segregated on bisexual branches, with male above. Spikelets embracing internode, solitary or in pairs. Female fertile spikelets sessile, sterile spikelets pedicelled, absent or rudimentary. Male spikelets sessile and pedicelled, 1–2 in a cluster. Pedicels fused to internode, united wholly. Female spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong, dorsally compressed, 4–6 mm long, falling entire, deciduous with accessory branch structures, callus base truncate with central peg. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma, shiny. Lower glume elliptic, indurate, pallid, without keels, surface not waisted, apex obtuse. Upper glume elliptic, membranous, margins ciliate. Basal sterile florets barren, with or without significant palea. Lemma of lower sterile floret oblong, hyaline, 3–5-veined. Upper lemma lanceolate, hyaline, without keel, 3-veined, apex truncate, female. Palea hyaline, without keels. Lodicules absent. Ovary 1 mm long, style and stigma 2 mm long. Male spikelets distinct from female, with pedicels fused to rachis, 6–8.5 mm long. Male spikelet glumes 2, 7–8×3–4mm, ovate, acute, concave, pubescent. Lemmas lanceolate, hyaline, membranous, acute-acuminate, 3–5-veined, paleate. Lodicules 2, cuneate. Stamens 3, 4–6mm long. **Plate 186.**

Flowering & Fruiting: August-December.

Habitat: Grasslands, wastelands, fallow fields.

Distribution: India, Indo-China and Malesia. INDIA: Throughout warmer parts. S. GUJARAT: Throughout.

Voucher specimen: RJD/ 148, 194, 196

180. **Trilobachne cookei** (Stapf) Schenck ex Henr. In *Meded. Rijksherb.* 67:4. 1931; *Bor* 268. 1960; *Shah* 2:877. 1978; *Karthik. et al.* 270. 1989; *Lakshmi. in Sharma et al.* 625. 1996; *Polytoca cookei* Stapf in *Hooker f. IcPl.* 24:2333. 1894; *Hooker f.* 7:101. 1897; *Blatt. & McC.* 5. 1935; *Cooke* 3:519. 1958.

Annual. Culms 100–250 cm long, nodes pubescent. Ligule an eciliate membrane. Leaf-blades lanceolate, 20–50×2–6cm, pilose with tubercle-based hairs, margins scabrous. Monoecious, with male and female spikelets in the same synflorescence. Synflorescence composed of racemes, axillary, subtended by a spatheole, embraced at base by subtending leaf. Spatheole lanceolate, herbaceous. Racemes single, 2–3 cm long, bearing few spikelets, 1–4 female spikelets on each and 4–10 male spikelets. Rachis fragile at the nodes, subterete, pilose on surface, internodes oblong, bearing a sterile companion laterally, tip cupuliform. Sexes segregated on bisexual branches with male above. Spikelets embracing internode, in pairs, fertile spikelets sessile, sterile spikelets pedicelled. Male spikelets sessile and pedicelled, 2 in a cluster. Pedicels fused to internode, united wholly. Sterile spikelets well-developed, comprising 2 unequal glumes without lemmas, lanceolate, 4–6 mm long, separately deciduous. Female spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Spikelets oblong, dorsally compressed, 6–7 mm long, falling entire, deciduous with accessory branch structures, callus base truncate with central peg. Glumes dissimilar, exceeding apex of florets, firmer than Upper lemma. Lower glume elliptic, indurate, much thinner above, pallid, without keels, winged on margins, winged above, pubescent, apex 3-fid. Upper glume elliptic, coriaceous, apex acuminate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret oblong, cartilaginous, acute. Upper lemma oblong, hyaline, without keel, apex acute, female. Palea hyaline, without keels. Lodicules absent. Ovary 1 mm long, style and stigma 2 mm long. Male Synflorescence of subdigitate racemes. Male spikelets distinct from female, with free pedicels, 5–6 mm long. Male spikelet glumes 2 lanceolate, acuminate, pubescent, many nerved, hyaline inflexed margin. Lemma shorter than glumes, glabrous, hyaline, 3–5-veined. Stamens 3, 4 mm long. **Plate 187.**

Flowering & Fruiting: August- November.

Habitat: Moist shady forest, hill slopes

Distribution: Endemic to India. INDIA: Penninsular India. S. GUJARAT: Dangs.

Voucher specimen: RJD/ 851, 854, 856

181. **Coix aquatica** Roxb. *Fl. Ind. ed. 1832. 3: 571. 1832; Hooker f. 7:100. 1897; Bor 264. 1960; Karthik. et al. 199. 1989; Pandey in Shetty & Singh 3:1005. 1993; Lakshmi. in Sharma et al. 437. 1996; Roy in Singh et al. 393. 2001.*

Annual. Culms rambling, 60–150 cm long, spongy, nodes glabrous. Ligule an eciliate membrane, 1 mm long. Leaf-blade base cordate, blades linear, 8–45×0.8–2cm, glandular, pilose with tubercle-based hairs, margins ciliate, apex acuminate. Monoecious, with a male and a female synflorescence subtended by the same spatheole. Synflorescence compound, paniculate, prophyllate below lateral spikelets female Synflorescence. Synflorescence composed of racemes, axillary, deciduous as a whole, subtended by a spatheole, exserted male or enclosed female. Spatheole ovate and beaked, 10–11 cm long, indurate. Peduncle straight, 3–7cm long, glabrous, widened at apex, disarticulating below uppermost sheaths. Racemes single, bearing a triad of spikelets. Rachis obsolete. Male spikelets sessile or pedicelled, 2–3 in a cluster. Female Spikelets in threes, 1 fertile spikelets sessile, 2 sterile spikelets pedicelled. Fertile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Sterile spikelets represented by barren pedicels. Pedicels linear, 7–8 mm long.

Spikelets ovate, dorsally compressed, 8–9 mm long, falling entire, deciduous with accessory branch structures. Glumes dissimilar, reaching apex of florets, similar to Upper lemma in texture. Lower glume lanceolate or oblong, 8–9 mm long, chartaceous, without keels, apex cuspidate. Upper glume oblong, hyaline, 1-keeled, vein grooved on either side, apex cuspidate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate or oblong, membranous, 5-veined, acuminate. Upper lemma lanceolate or oblong, 7.5–8.5 mm long, membranous, 5-veined, with 2 longitudinal grooves, apex acuminate, female. Palea hyaline, 2-veined, without keels. Lodicules absent female. Styles connate below. Ovary 1 mm long, style and stigma 2 mm long. Male Synflorescence unlike female, a single raceme. Spikelets distinct from female, 2-flowered, elliptic, 11–12×4–6mm. Glumes 2, subequal, winged, muticous. Lemma hyaline, muticous, paleate. Lodicules 2, cuneate. Anthers 3; 6–6.5 mm long. Stigmas 2; papillose. **Plate 188.**

Flowering & Fruiting: November-February.

Habitat: Water edges; escape from gardens

Distribution: China, India and Australia. INDIA: Penninsular and central India. S. GUJARAT: Throughout. **New records for the State.**

Voucher specimen: RJD/ 56, 69, 197

182. **Coix lacryma-jobi** L. *Sp. Pl.* 972 1753; *Hooker f.* 7:100. 1897; *Blatt. & McC.* 3. 1935; *Cooke* 3:517. 1958; *Bor* 164. 1960; *Shah* 2:802. 1978; *Karthik. et al.* 199. 1989; *Pandey in Shetty & Singh* 3:1006. 1993; *Lakshmi. in Sharma et al.* 438. 1996; *Roy in Singh et al.* 394. 2001.

Annual. Culms 90–250 cm long. Ligule an eciliate membrane. Leaf-blade base cordate, blades linear, 10–50×2–5cm. Monoecious, with a male and a female synflorescence subtended by the same spatheole. Synflorescence compound, paniculate, prophyllate below lateral spikelets female Synflorescence. Synflorescence composed of racemes, axillary, deciduous as a whole, subtended by a spatheole, exserted male or enclosed female. Spatheole ovate and beaked, 8–9 cm long, indurate. Peduncle straight, 3–7cm long, glabrous, widened at apex, disarticulating below uppermost sheaths. Racemes single, bearing a triad of spikelets. Rachis obsolete. Male spikelets sessile or pedicelled, 2–3 in a cluster. Female Spikelets in threes, 1 fertile spikelets sessile, 2 sterile spikelets pedicelled. Fertile spikelets comprising 1 basal sterile florets and 1 fertile florets, without rachilla extension. Sterile spikelets represented by barren pedicels. Pedicels linear, 6–7 mm long. Spikelets ovate, dorsally compressed, 7–8 mm long, falling entire, deciduous with accessory branch structures. Glumes dissimilar, reaching apex of florets, similar to Upper lemma in texture. Lower glume lanceolate or oblong, 7–8 mm long, chartaceous, without keels, apex cuspidate. Upper glume oblong, hyaline, 1-keeled, 11-veined, vein grooved on either side, apex cuspidate. Basal sterile florets barren, without significant palea. Lemma of lower sterile floret lanceolate or oblong, membranous, 5-veined, acuminate. Upper lemma lanceolate or oblong, 6–7 mm long, membranous, keeled, 3–5-veined, with 2 longitudinal grooves, apex acuminate, female. Palea hyaline, 2-veined, without keels. Lodicules absent female. Styles connate below. Ovary 1 mm long, style and stigma 2 mm long. Male Synflorescence unlike female, a single raceme. Spikelets distinct from female, 2-flowered, elliptic, 8–10×2–3mm. Glumes 2, wingless, up to 10 mm long, elliptic-lanceolate,

acute, concave, many-veined, muticous. Lemma oblong-lanceolate, hyaline, paleate, 3–5 –veined, muticous. Lodicules 2, cuneate. Anthers 3; 5–6 mm long. Stigmas 2; papillose. **Plate 189.**

Flowering & Fruiting: November-February.

Habitat: Seasonally fludded channels, moist places.

Distribution: Europe, Africa, Asia-temperate & tropical, southeast USA, Mexico, South America. INDIA: Throughout hotter parts of India. S. GUJARAT: Surat, Navsari, Tapi.

Voucher specimen: RJD/ 64, 185, 469

4.2 Family: Cyperaceae A. L. Juss.

4.2.1 General morphology

Habit. Small to tall, annual or perennial, terrestrial or halophytic, rhizomatous to stoloniferous herbs (Plate 190-A).

Culms. Scapose or 1-few noded, usually (sub) trigonous to (sub)terete in cross section, more rarely compressed, winged or 3- to 6-angular, smooth or scabrid.

Leaves. (Sub)basal or 1-few cauline, (spiro)tristichous or more rarely (spiro)distichous; comprising a blade and sheath but sometimes only sheath present; sheath open or closed; ligule often present or absent, sometimes on opposite side to leaf blade; leaf blade usually linear, ensiform or terete

Inflorescence. Terminal, more rarely pseudolateral; Inflorescences are generally either unbranched or very shortly branched and spicate or capitate in appearance to prominently branched and paniculate or anthelate, spicate or capitate (often in combinations), more rarely reduced to a single spikelet; with variations around these. Involucral bracts 1 to several, leaflike or glumelike. Branching from the axil of normal bracts or prophylls; lower bract sometimes culm-like and erect (Plate 190-A-B).

Spikelets. The basic unit of the inflorescence in most Cyperaceae is the spikelet. This comprises a very short to elongated axis, which subtends one to many and scalelike bracts, referred as glumes. glumes membranous to leathery, spirally arranged or 2-ranked, each subtending a single flower. Each glume subtends and partially hides a single very small, bisexual or unisexual flower. Rachilla persistent or deciduous (Plate 190-C).

Flowers. Flowers bisexual or unisexual with plants monoecious or rarely dioecious. Perianth absent or reduced to bristles or scales. Hypogynous scales 0-(1-)3-6(-many), often bristle-like and retrorsely scabrid, more rarely laminar, sometimes with highly elaborated forms, usually deciduous with the fruit, rarely persistent on the rachilla. Stamens usually 3 (often reduced to 1 or 2) or 4 to 6 or even more numerous and anthers basifixed. Pistil superior, usually 3-carpellate, sometimes 2-carpellate. Ovary 2- or 3-carpellate, unilocular, with a single ovule; Style with 2 or 3 stigmatic branches, rarely more; base often conspicuously thickened and persistent, sometimes persistent and variously shaped in fruit (Plate 190-D).

Fruit: Fruit usually a hard 2- or 3-sided nutlet, surface smooth or variously minutely patterned, usually ovate, elliptic, or obovate in outline and (sub)trigonous or lenticular in cross section; surface smooth, reticulate or rugose, sometimes partially or completely enclosed by an enlarged basal prophyll (utricle). For accurate identification of Cyperaceae good fruiting material should be used wherever possible. Indeed this is essential in certain genera, such as *Fimbristylis* and *Scleria* (Plate 190-E-G).

The use of keys in identification is old indeed. Much of Aristotle's classification of animals was presented in the form of simple dichotomous alternatives. –Mayr

4.2.2 Key for the Tribes and Genera

KEY TO TRIBES

- | | |
|---|------------------------------|
| 1. Flower unisexual | Tribe SCLERIEAE |
| 1. At least some flowers bisexual | |
| 2. Glumes of the spikelets spirally arranged | |
| 3. Perianth bristles present | |
| 4. Terminal 1 or 2 flowers sterile or subtending rudimentary ovaries and functional stamens | Tribe RHYNCHOSPOREAE |
| 4. Lowermost 2 flowers sterile and others fertile | Tribe SCIRPEAE |
| 3. Perianth bristles absent | Tribe FIMBRISTYLIDEAE |
| 2. Glumes of the spikelets distichously arranged | Tribe CYPEREAE |

KEY TO GENERA

Tribe: SCLERIEAE Kunth ex Fenzl

Small to medium, erect, perennial or annual herbs of grasslands, open woods, fens, and shores. Roots fibrous; rhizomes regularly present in many species, simple or branched. Culms trigonous, glabrous, pubescent, or scabrellate, sometimes bulbous basally. Basal leaves bladeless or nearly so; sheaths 3-angled, glabrous or more often scabrellate or pubescent; blades lanceolate to linear or filiform, flat to slightly conduplicate. Inflorescences paniculate, 1 to several, lateral and terminal; bracts leaf like but shorter than or equaling the cauline leaves; rays trigonous. Spikelets 1-6, lanceolate to linear or oblong. Glumes 1-6, ovate-deltoid, conspicuously medially 1-nerved, glabrous or pubescent. Flowers imperfect; carpellate flower(s) 1 (or 2), borne at the base of the spikelets or in separate spikelets. Perianth bristles lacking. Stamens 1-3; anthers narrowly ellipsoid to linear, the apices of the connectives frequently prolonged as slender, subulate, reddish appendages. Styles slender, glandular; stigmas 3, capillary, shorter than the styles. Achenes roundly trigonous to terete, globose to ellipsoid, the apex broadly rounded or apiculate, the base sessile to broadly stipitate, the surface smooth, reticulate, trabeculate, rugose, glabrous, or pubescent.

Flowers unisexual

Scleria Berg.

Tribe: RHYNCHOSPOREAE Nees

Small to large, caespitose or single-stemmed, perennial herbs of moist open woods, bogs, ditches. Roots fibrous; rhizomes or stolons present. Culms trigonous, subtrigonous, or terete, glabrous, leafy. Leaves numerous, basal, cauline, or both; basal leaves with blades flat to conduplicate or involute-filiform. Inflorescences terminal, fasciculate or cymose; bracts 1-6, leaf-like; rays slender, terete, smooth or scabrellate; heads loosely to densely ovoid or capitate. Spikelets solitary, globose, ellipsoid, or slenderly lanceolate, the 1-5 basal scales sterile. Glumes spirally arranged, closely imbricate, ovate to lanceolate, the midvein most conspicuous. Flowers perfect, terminal 1 or 2 scales sterile or subtending rudimentary ovaries and functional stamens. Perianth bristles lacking or 1-30, smooth, barbed, or plumose, persistent. Stamens 1-12; filaments capillary or ribbon like; anthers elliptic to oblong, the apices of the connectives prolonged or not. Styles glabrous; the stigmas longer than, equaling, or much shorter than the style. Achenes lenticular, ovoid to slenderly ellipsoid, crowned with a pyramidal to subulate tubercle shorter than to 3 times longer than the body of the achene, the base sessile to conspicuously stipitate, the lateral edges often raised to form a conspicuous ridged margin, the surface alveolate to cancellate, transversely rugulose or not.

Spikelets usually with bisexual and male flowers

Rhynchospora Vahl

Tribe: SCIRPEAE Kunth ex Dumort.

Small to medium-sized perennials or annuals of shallow fresh or tidal waters, disturbed moist soils, moist woodlands, marshes, open mountaintops. Roots fibrous; annual or perennial, with short, branched rhizomes or not, producing loose to dense tussocks of culms. Culms trigonous or terete, smooth throughout or scabrellate distally. Leaves all basal or scattered along the culm; sheaths closed, smooth or sometimes with conspicuous cross veins, greenish white, reddish brown, or blackish; blades flat, conduplicate, subterete or absent. Involucral leaves (1 or) 2-10, the blades resembling cauline ones but sheaths generally much shorter, or the longest nearly vertical and simulating a continuation of the culm. Inflorescences compound, in many species reduced to glomerulate clusters or heads, in some to a cluster of several more or less sessile spikelets or a single sessile spikelet; prophylls of the rays tubular, rays smooth, or scabrellate distally or throughout, terete. Spikelets ovoid to linear-oblong. Glumes 20-100, spirally arranged and closely imbricate, with 2 lowermost sterile and others fertile, all deciduous at maturity. Flowers perfect. Perianth bristles 3-6(-8) or lacking, smooth or retrorsely scabrellate, deciduous or remaining attached to the mature achene. Stamens (2 or) 3;

anthers broadly ellipsoid to narrowly linear, the apices of the connectives in some species prolonged as subulate appendages. Styles capillary; stigmas 2 or 3, about equaling the style in length. Achenes lenticular to trigonous, slightly to strongly dorsiventrally flattened, the base stipitate or cuneate, the apex apiculate, beaked, or entire, the surface essentially smooth, finely pitted, reticulate, or rugulose.

1. Perianth bristles present, 3 inner ones squamellate **Fuirena** Rottb.

1. Perianth bristles present but not as above, or absent

2. Inflorescence a single spikelet **Eleocharis** R. Br.

2. Inflorescence up to 3 spikelets or capitate or anthelodium

3. At least 2 involucre bracts over 1.5 cm, longest involucre bract leaf like, erect to spreading and inflorescence terminal

Scales retrose barbed, small or as long as nut **Bolboschoenus** Asch. ex Palla

Scales hairy ribbon like, longer than nut and exerted from spikelets **Eriophorum** L.

3. One involucre bract over 1.5 cm, longest involucre bract erect, culm like and apparently continuous with culm, inflorescence appearing to be lateral

4. Inflorescence unbranched **Schoenoplectiella** Lye

4. Inflorescence branched **Schoenoplectus** (Reichb.) Palla

Tribe: FIMBRISTYLIDEAE Vahl

Small to medium annual or perennial herbs, sometimes rhizomatous. Culms usually tufted, slender, 3- or 5- angled or flattened. Leaves basal, sometimes reduced to bladeless sheaths; blades linear to filiform, usually dorsiventral and canaliculated, often cellular-reticulate on upper surface, rarely ensiform; ligules if present membranous or of a fringe of pubescence. Inflorescence terminal, simple to decompose, rarely capitate or a single terminal spikelet. Spikelets solitary or fascicled, ovoid, ellipsoid or subglobose, terete or flattened, bearing several to many flowers; glumes spirally arranged or lower ones or all distichous. Flowers bisexual, without hypogynous bristles; stamens 1-3; style-base enlarged, not persistent on achene. Achenes biconvex or trigonous, the surface reticulate or verruciferous, or with both reticulation and verrucae, sometimes stipitate.

1. Leaf sheath without long silky hairs at apex; nutlets without persistent style base

Fimbristylis Vahl

1. Leaf sheath with long silky hairs at apex; nutlets with persistent style base

Bulbostylis Kunth

Tribe: CYPEREAE Dumort.

Rhizome present or absent. Culms triquetrous, rarely cylindric. Leaves graminiform, basalmost sheaths usually bladeless. Bracts leaf-shaped. Anthela terminal, simple or compound, with several to many first order or second order rays; rays long or short. Spikelets 2 to many in spikes, digitate or capitate at apex of rays, rarely single; rachilla not articulate, only articulate at base, or articulate at base of each scale, usually deciduous at articulation, winged or wingless; scales distichous, alternate, rarely spirally arranged, gradually deciduous from base to apex or persistent at rachilla and deciduous with rachilla; basal most 2 scales usually without flower; remaining scales each with a bisexual flower. Flowers without hypogynous bristles or scalelike perianth parts. Stamens 1-3; connective usually prominent on apex of anther, sometimes laxly bristly. Style base not swollen; stigmas 1-3. Achene trigonous or biconvex, not stipitate or very shortly stipitate, surface smooth, various striate, or punctulate.

1. Stigmas 3, rarely 2; nutlets trigonous, rarely biconvex with 1 side facing spikelet axis.

2. Annual or perennial; glumes not winged

Cyperus L.

2. Annual; glumes prominently winged

Courtoisina J. Sojak

1. Stigmas 2; nutlets 2-sided with 1 margin facing spikelet axis.

3. Spikelets with more than 2 glumes

4. Spikelet axis and glumes persistent

Pycneus Beauv.

4. Spikelet axis deciduous with persistent glumes

Queenslandiella Dom.

3. Spikelets with 1 or 2 glumes

Kyllinga Rottb.

'Objects without names cannot well be talked about or written about; without descriptions they cannot be identified and such knowledge as may have accumulated regarding them is sealed'.

– Gahan

4.2.3 Description of species studied

1. ***Courtoisina cyperoides*** (Roxb.) Soják *Cas. Nár. Mus., Odd. Prír. 148: 193. 1979 publ. 1980*; Prasad & Singh 67. 2002; *Courtoisina cyperoides* (Roxb.) Nees *Linnaea 9: 286. 1834*; *Hooker 6: 625. 1894*; Blatter & Mc Cann *JBNHS 37(3): 536. 1934*; Cooke. 3:391. 1958; *Cyperus pseudokyllingoides* Kük. *Pflanzenr. IV, 20(101): 14. 1935*; Shah 2: 734. 1978; *Verma in Singh et al. 278. 2001*; *Indocourtoisina cyperoides* (Roxb.) Bennet & Raizada *Ind. Forest. 107: 432 1981*; Karthik. *et al. 57. 1989*; *Lakshmi. in Sharma et al. 327. 1996*; *Mariscus cyperoides* (Roxb.) A. Dietr. *Sp. Pl. 2: 348. 1832*; *Parmar in Shetty & Singh 3:937. 1993*; Cook 164. 2006.

Annual, 10-40 cm tall, tufted, slightly slender, compressed, obtusely 3-angled, smooth. Leaves several, basal shorter than to equaling culm; sheath short, usually split; leaf blade 7-30×2-3 mm, flat, margin spinulose. Involucral bracts 4-7, leaflike, basal 2 or 3 longer than inflorescence. Inflorescence a compound anthela; 1° branches 3-7, 4-5 cm long, unequal in length, each with 3-6 2° branches; 0.2-1.5 cm. Spikes globose, 5-9 mm in diam., with 6-15 densely clustered spikelets. Spikelets broadly ellipsoid to ellipsoid, 4×1.5-2 mm, strongly compressed, 2-flowered. Glume-like bracts 2, 2 mm long, aristate, glume-like prophyll 1.5 mm, blunt, bi-nerved; glumes yellowish brown, boat-shaped, 3.5-4×1.5-2 mm, membranous, laterally 1-veined, keel glaucous, broadly winged, and extending into an apical mucro. Stamens 3; anthers oblong. Style short; stigmas 3, slightly longer than style. Nutlet dark reddish brown, narrowly oblong, 3-sided with sharp angles, 2.7-3 mm, densely punctulate, apex acuminate.

Plate 191.

Flowering & fruiting: June-September.

Habitat: Grass fields, wastelands, wet sandy ground, along the river banks, ditch margins, agricultural fields, road sides.

Distribution: South Asia, Tropical Africa, Madagascar. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 186, 330, 637

2. ***Cyperus alternifolius*** subsp. ***flabelliformis*** Kük., *Pflanzenr. IV.20, 101: 193. 1936. C. alternifolius* Baker *J. Linn. Soc., Bot. 21: 450. 1885*; *C. involucratus* Rottb. *Descr. Pl. Rar. 22 1772*; Prasad & Singh 99. 2002; *C. flabelliformis* Rottb. *Descr. Icon. Rar. Pl. 42. 1773*; Shah 2:726. 1978; Karthik. *et al. 45. 1989*; Cook 113. 2006.

Tufted perennial, 50-150 cm. Rhizome rather short, horizontal. Stem 4-7 mm diam., obtusely trigonous, smooth to finely scabrous. Leaf blades reduced; sheaths to more than 30 cm,

coriaceous, upper yellowish or grey, lower reddish brown or black brown, mouth margin oblique; blades 0. Inflorescence a compound anthelodium, 3-13 cm; bracts 18-22, to more than 30 cm, to 15 mm wide, foliose or upper filiform, green or greyish-green, acute, flat, margins narrowly recurved, margins and main nerves smooth or variously scabrous; primary branches up to 10 cm, spreading, smooth or slightly scabrous, almost terete, tubular prophyll green or brownish, basal part spongy; secondary anthelodia 10-30 mm, with bracts to 5 mm; tertiary anthelodia occasional; cluster of spikes 5-10 mm, globose, with 5-25 spirally arranged spikes; spikes 3.5-9x2 mm, with 7-30 closely imbricating glumes, glume-like bract scarious, 1.2 mm, glume-like prophyll bi-nerved, rounded, 1.2 mm; rachis four-angled, 0.5 mm wide, internodes 0.5 mm, not markedly winged; glumes 1.5 mm, broadly elliptic, lanceolate to elliptic, mid-nerve pronounced, barely reaching apex, margins scarious, colourless or pale brown. Stamens 3. Nut 0.6-1x0.3-0.5 mm, broadly ellipsoid or obovoid, trigonous, light brown or dark greyish brown, finely papillose. **Plate 192.**

Flowering & Fruiting: February - April.

Habitat: Water edges; escape from gardens

Distribution: Native of Arabia and tropical Africa, often cultivated as ornamental throughout the world. INDIA: Cultivated throughout. S. GUJARAT: Throughout.

Voucher specimens

3. **Cyperus alulatus** J.Kern *Reinwardtia* 1: 463. 1952; Shah 2: 720. 1978; Karthik. *et al.* 43. 1989; *Parmar in Shetty & Singh* 3:897. 1993; *Lakshmi. in Sharma et al.* 278. 1996; *Verma in Singh et al.* 256. 2001; Prasad & Singh 75. 2002. Cook 103. 2006.

Annual, 12-50 cm. Roots numerous, glabrous. Stem 1-2.5 mm diam., sharply trigonous, smooth. Leaves shorter than to equalling stem; sheaths 25-45 mm, yellowish or grey, wide, mouth margin deeply concave; blades up to 15x2 cm, flat or slightly keeled, margins smooth, apex acute, scabrous. Inflorescence a simple or compound anthelodium, 4-17 cm, 1° branches 6-10, up to 15 cm, 2° branches up to 3.5 cm, tubular prophyll loosely sheathing, to 15 mm; lowest 4-6 bracts foliose, more than 20 cm. Cluster of 6-16 spikes in loose spirals; spikes 4-10x2-2.5 mm, spreading at almost right angles, glume-like bract 1-1.5 mm, glume-like prophyll 1 mm, blunt, bi-nerved; rachis 4-angled, compressed; glumes 1-2 mm, keel scabrous or smooth, sides prominently nerved, margins leathery, hard, brown. Stamens 2, anthers c. 1 mm; Style 0.5 mm long; stigmas 3, short. Nut 1.5x0.8 mm, plano-convex, sharply triangular, from brown to dark-brown, finely reticulate. **Plate 193.**

Flowering & fruiting: September-October.

Habitat: Grass fields, wastelands, wet sandy ground, along the river banks, ditch margins, agricultural fields, road sides.

Distribution: Afghanistan, Pakistan, NW and C India. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 225, 373, 506

4. **Cyperus arenarius** Retz. *Observ. Bot.* 4: 9. 1786; *Hooker* 6: 602. 1894; Cooke. 3:338. 1958; Blatter & Mc Cann JBNHS 37(2): 261. 1934; Shah 2: 720. 1978; Karthik. *et al.* 43. 1989; *Parmar in Shetty & Singh* 3:897. 1993; *Lakshmi. in Sharma et al.* 279. 1996; Prasad & Singh 79. 2002. Cook 104. 2006.

Perennial, 6-20 cm. Rhizome long creeping, deep in sand, 1 mm diam. Roots thin, not tomentose. Stem 1 mm diam., almost terete, smooth. Leaves equalling the stem; sheaths 2-4 cm, strongly nerved, rigid, with brown veins, disintegrating into fibres with age, mouth margin straight; blades 5-15×0.3 cm, stiff, curved, greyish green, semicircular, margins slightly scabrous, apex blunt or acute, slightly scabrous. Inflorescence 2 cm long, capitate like anthelodium, with 5 to more than 20 spikes, seldom with some elongated branches; bracts 1-3 foliose, up to 5-8 cm, rigid, sheath-less, one often as continuation of stem; spikes 8-20 mm, ovoid, compressed, glume like bracts 5 mm, lanceolate, glume-like prophyll 4 mm, widely ovate, with scarious margins, blunt; glumes 14-24, closely imbricating, caducous, 3-4×1.5-2 mm, rounded on back, pale brown, mucronate, sides with 4-5 obscure nerves, which often reddish brown, margins scarious; rachis zigzagging, 1 mm wide, minutely winged. Stamens 3. Style 1 mm long; stigmas 3, equaling to style. Nut 1.5-1.7×1.3 mm, obovoid, plano-convex, compressed, brown or dark brown, almost smooth, glossy. **Plate 194.**

Flowering & fruiting: December - March.

Habitat: Coastal sands and sandy river beds

Distribution: Coast of warmer part of the World. INDIA: Throughout east and west coastline. S. GUJARAT: Coast of Suart, Navsari and Valsad.

Voucher specimens: 608, 675, 712

5. **Cyperus bulbosus** Vahl *Enum. Pl.* 2: 342. 180; *Hooker* 6: 611. 1894; Blatter & Mc Cann JBNHS 37(2): 269. 1934; Cooke. 3:384. 1958; Shah 2: 722. 1978; Karthik. *et al.* 44. 1989; *Parmar in Shetty & Singh* 3:899. 1993; *Lakshmi. in Sharma et al.* 279. 1996; *Verma in Singh et al.* 258. 2001; Prasad & Singh 81. 2002.

Perennial, 10-30 cm, often forming small tufts; stolons thin, ephemeral. Roots fibrous. Stem 0.5-1.5 mm diam., sharply trigonous, smooth; base swollen, often with remains of bulbil, 8-12 mm, with dark black-brown scales. Leaves numerous, shorter to much longer than the stem; sheaths to 8 cm, yellowish, grey or brownish, soft, mouth margin slightly concave; blades to more than 20×0.3 cm, keeled, revolute, green or greyish-green, margins smooth, apex trigonous or flat, very long attenuate, acute, scabrous. Inflorescence a much reduced anthelodium or multiple spike, 3-9 cm, 1° branches few and short, each ending with compact cluster of 3-10 spirally arranged spikes, or basal part often two spikes close together (on a short branch) and supported by thin foliose bract longer than the spike; at base of branches tubular prophyll up to 7 mm; bracts up to 12 cm, several foliose, thin, clearly spaced. Spike 12-15×1.5 mm, slightly compressed, brown; rachis winged; glumes 3-3.5×3 mm, back rounded, mid-nerve reddish-brown, apex acute, sides with 6-7 prominent nerves, margins scarious. Style 1.5-2 mm long; stigmas 3, short. Nut 1.3-1.5×0.7 mm, trigonous, plano-convex, obovoid, grey, finely reticulate. **Plate 195.**

Flowering & fruiting: August-September.

Habitat: On damp sandy soil in arid regions, frequent near sea and sandy riverbanks.
Distribution: Africa, South Asia and Australia. INDIA: Throughout east and west coastline. S. GUJARAT: Coast of Suart, Navsari and Valsad.

Voucher specimens: 78, 633, 669

6. **Cyperus compactus** Retz. *Observ. Bot.* 5: 10. 1788; Shah 2: 722. 1978; Verma in Singh *et al.* 259. 2001; *C. dilutus* Vahl *Enum. Pl.* 2: 357. 1805; Cooke. 3:389. 1958; *Mariscus microcephalus* J.Presl & C.Presl *Reliq. Haenk.* 1: 182. 1828; Hooker 6: 611. 1894; *M. compactus* (Retz.) Bold. *Zakfl. Java* 77. 1916; Blatter & Mc Cann JBNHS 37(3): 535. 1934; Karthik. *et al.* 62. 1989; Parmar in Shetty & Singh 3:937. 1993; Lakshmi. in Sharma *et al.* 334. 1996; Prasad & Singh 253. 2002; Cook 163. 2006.

Perennial, caespitose, 40-90 cm; with tillers. Culm 2.5-4 mm diam., obtusely trigonous, smooth. Leaves equalling or longer than stem; sheaths up to 20 cm, yellow-brown, often with reddish tint, soft, mouth margin somewhat concave; blades to more than 80×0.5-1 cm wide, greyish green, keeled, margins slightly revolute, margins and keel smooth or slightly scabrous, apex long-attenuate, trigonous, scabrous or nearly smooth. Inflorescence an anthelodium, 8-20 cm diam., 1° branches 5-10, up to 10 cm, spreading, bracts 3-5 foliose, up to 50 cm; 2° anthelodia up to 5 cm diam., rounded with 3-5 bracts up to 30 mm; tubular prophyll up to 15 mm, yellow-brown, bi-nerved, nerves with flat, scabrous arista up to 4 mm; 3° anthelodia may be present; cluster of spikes 7-16 mm, nearly globose, with from 30 to more than 50 spreading, spirally arranged spikes, occasionally two sessile closely together. Spikes 5-7.5×0.5-10 mm, terete, brown, with 7 glumes, lowest sterile, remaining fertile; rachis widely winged; glume-like bract 1 mm, brown, acute; glume-like prophyll 0.8 mm; glumes 2-3×1.5-2 mm, with rounded back, brown or reddish brown, mid-nerve ending in notched apex, sides nerved, margins narrowly scarious. Stamens 3. Style 2 mm long; stigmas 3, equaling to style. Nut 2.3-2.4×0.3-0.4 mm, trigonous, slightly curved, plano-convex, brown, with persistent style-base c. 0.4 mm, finely reticulate and papillose. **Plate 196.**

Flowering & fruiting: September-November.

Habitat: In and around rice fields.

Distribution: South Asia. INDIA: Throughout east and west coastline. S. GUJARAT: Found at 2 localities of Valsad only.

Voucher specimens: 453, 513, 631

7. **Cyperus compressus** L. *Sp. Pl.* 46. 1753; Hooker 6: 605. 1894; Blatter & Mc Cann JBNHS 37(2): 262. 1934; Cooke. 3:379. 1958; Shah 2: 723. 1978; Karthik. *et al.* 44. 1989; Parmar in Shetty & Singh 3:900. 1993; Lakshmi. in Sharma *et al.* 280. 1996; Verma in Singh *et al.* 259. 2001; Prasad & Singh 85. 2002. Cook 106. 2006.

Annual, 3-30 cm, forming small tufts. Culm 0.5-2 mm diam., sharply trigonous, smooth. Leaves from half to slightly shorter than stem; sheaths up to 5 cm, lowest blade-less, greenish grey, yellowish or often slightly brownish, soft, mouth margin wide, slightly concave; blades up to 16×0.3 cm, folded, keeled, margins slightly revolute, smooth, apex acute, scabrous.

Inflorescence a simple anthelodium, up to 10 cm, or single cluster of spikes, 1° branches 0-7, up to 9 cm, tubular prophyll up to 8 mm; lowest 3-5 bracts foliose, 3-20 cm; cluster of spikes 10-20 cm, with 3-9 digitately arranged spikes; spikes 8-20×4 mm, compressed, ovoid or elongate ellipsoid, green to yellowish brown, glume-like bract 2.7 mm, acute, glume-like prophyll 1.7 mm, blunt; rachis compressed, 0.7 mm wide, narrowly winged, grey; glumes 4 mm, arista 0.5-0.7 mm, sides with 4-6 prominent nerves, grey, brown-dotted, margins scarious. Stamens 3. Style 1.5-2 mm long; stigmas 3, equaling to style. Nut 1.5-1.7×1.2 mm, obovoid, plano-convex, rather sharply trigonous, yellowish brown, smooth. **Plate 197.**

Flowering & fruiting: August-December.

Habitat: Weed in grasslands, road sides, waste places and fallow rice fields, etc.

Distribution: Pantropical, except Australia. INDIA: Throughout east and west coastline. S. GUJARAT: Throughout.

Voucher specimens: 122, 356, 508

8. **Cyperus corymbosus** Rottb. *Descr. Icon. Rar. Pl.* 42. 1773; *Hooker* 6: 612. 1894; Blatter & Mc Cann JBNHS 37(2): 270. 1934; Cooke. 3:383. 1958; Shah 2: 723. 1978; Karthik. *et al.* 44. 1989; *Parmar in Shetty & Singh* 3:901. 1993; *Lakshmi. in Sharma et al.* 280. 1996; *Verma in Singh et al.* 261. 2001; Prasad & Singh 86. 2002; Cook 109. 2006.

Perennial, 80-120 cm. Rhizome horizontal, 4-5 mm diam., woody. Culm 3-5 mm diam., trigonous above, smooth. Leaves reduced; sheaths to 30 cm, greyish green or brownish, often with reddish tint, mouth margin oblique; blades occasionally to 8×0.4 cm, rigid, smooth or slightly scabrous. Inflorescence a conical compound anthelodium, 10-20 cm; bracts 3-5 foliose, shorter than inflorescence, up to 16×6 cm, margins slightly recurved, margins and keel scabrous, apex smooth or slightly scabrous, rather obtuse; 1° branches 5-12, up to 13 cm; tubular prophyll up to 2 cm; 2° anthelodia to 8 cm, bracts up to 1.5 cm, as long as 2° tubular prophyll, 2° branches up to 5 cm, 3° anthelodia occasional, 3° branches 1-3, to 15 mm; cluster of spikes up to 20 x 30 mm, with 5-15 spikes, spikes reflexed; spikes 5-25 x 1 mm, with 8-22 glumes, fusiform, terete, glume-like bract 1.5 mm, glume-like prophyll 1.5 mm, with spongy basis; rachis quadrangular, 0.2 mm wide, winged; glumes 2-2.5×1.5 mm, loosely imbricating, straw coloured to reddish brown, mid-nerve not pronounced, apex rounded mucronate, margins widely scarious. Anthers 1 mm. Style 1-1.5 mm long; stigmas 3, equaling to style. Nuts 1.5-1.7×0.5-0.7 mm, oblong, sharply trigonous, yellowish brown, smooth. **Plate 198.**

Flowering & fruiting: June-September.

Habitat: Flooded river banks.

Distribution: Tropical and subtropical regions of Asia, Africa and America. INDIA: Throughout east and west coastline. S. GUJARAT: Throughout.

Voucher specimens: 507, 900, 905

9. **Cyperus difformis** L. *Cent. Pl. II* 6. 1756; *Hooker* 6: 598. 1894; Blatter & Mc Cann JBNHS 37(2): 259. 1934; Cooke. 3:376. 1958; Shah 2: 725. 1978; Karthik. *et al.* 44.

1989; *Parmar in Shetty & Singh* 3:902. 1993; *Lakshmi. in Sharma et al.* 280. 1996; *Verma in Singh et al.* 263. 2001; Prasad & Singh 88. 2002. Cook 109. 2006.

Annual, 25-60 cm. Roots reddish-brown. Culm 3 mm diam., sharply trigonous, smooth. Leaves shorter than stem; sheaths to 10 cm, green or yellow-brown, mouth oblique; ligule 1 mm, papery; blades up to 50×0.3-0.5 cm, keeled, margins smooth, apex trigonous, scabrous. Inflorescence of 1-7 globose anthelodium, nearly sessile or peduncles to 3 cm; digitately branching and rebranching, with 100 or more sessile spikes. Bracts 2-4, lowest 2-3 foliose, to 20 cm or more, sheath-less. Spikes 2-5×1 mm, with 5-20 flowers; glumes 1×1.5 mm, blunt, wider than long, midnerve strong, sides brown or dark brown, margins narrowly scarious; rachis compressed, slightly zigzagging. Stamens 2. Style 2 mm long; stigmas 3, equaling to style. Nut 0.5 mm, obovoid, sharply trigonous, papillose, yellowish. **Plate 199.**

Flowering & fruiting: July – October.

Habitat: Rice fields, ditches, irrigation channels, grassy swamps.

Distribution: Common weed in tropical and subtropical areas of all continents. INDIA: Throughout east and west coastline. S. GUJARAT: Throughout.

Voucher specimens: 77, 279, 348

10. **Cyperus dives** Delile *Descr. Egypte, Hist. Nat.* 149. 1813; *C. exaltatus* var. *dives* (Delile) C.B. Clarke *J. Linn. Soc. Bot.* 21: 187. 1884; *Hooker* 6: 617. 1894; Blatter & Mc Cann *JBNHS* 37(2): 276. 1934; *Cooke.* 3:386. 1958; *Shah* 2: 725. 1978; *Karthik. et al.* 45. 1989; *Lakshmi. in Sharma et al.* 285. 1996; Prasad & Singh 96. 2002.

Perennial, 60-100 cm. Rhizome short, horizontal, covered by brown scales, with tillers. Culm 2-4 mm diam., trigonous, smooth. Leaves basal, about equaling stem length; sheaths up to 20 cm, yellowish-green or brown, soft, mouth margin concave; blades to more than 50 cm, flat or folded, keeled, margins slightly revolute, apex acute, trigonous, scabrous. Inflorescence a compound anthelodium, 10-20 cm; lowermost bracts 6-9 foliose, up to 60 cm; 1° branches mostly 6-9, up to 19 cm, tubular prophyll up to 25 mm, bi-nerved, with two aristae; 2° anthelodia 25-50 mm; 3° anthelodia common, 25-30 mm; cluster of spikes pedunculate or sessile, 15-45 mm, with 20-100 spirally arranged, reflexed spikes. Spikes 3-8 x 1.5-2 mm, ovoid, compressed, glume-like bract 1.5 mm, narrow, acute, glume-like prophyll bi-nerved, 1.5 mm; rachis flat, reddish-brown, not winged; glumes 2×2 mm, 6-10 in each spike, cymbiform, mucronate, 0.2 mm, glossy, reddish brown, margins narrowly scarious. Stamens 3. Style 2 mm long; stigmas 3, equaling to style. Nut 0.5-0.6×0.3-0.4 mm, obovoid, trigonous, yellow-brown, shiny, very finely reticulate. **Plate 200.**

Flowering & fruiting: October-November.

Habitat: River shores or in shallow water

Distribution: Tropical Africa, Madagascar, Pakistan, India, Vietnam. INDIA: Throughout east and west coastline. S. GUJARAT: Throughout.

Voucher specimens: 892

11. **Cyperus esculentus** L. *Sp. Pl.* 45. 1753; *Hooker* 6: 616. 1894; Blatter & Mc Cann JBNHS 37(2): 274. 1934; Shah 2: 725. 1978; Karthik. *et al.* 45. 1989; *Parmar in Shetty & Singh* 3:903. 1993; *Lakshmi. in Sharma et al.* 285. 1996; *Verma in Singh et al.* 266. 2001; Prasad & Singh 94. 2002. Cook 111. 2006.

Perennial, 30-80 cm. Base of stem slightly swollen, with stolons, up to 20 cm, tuber up to 15 mm diam., round or elongate, rooting, covered by greyish-brown scales. Culm 2-3 mm diam., trigonous, smooth. Leaves shorter than culm; sheaths 3-7 cm, yellowish or greyish brown, sometimes with reddish tint, mouth margin nearly straight; blades up to 30×0.5 mm, yellow-green, keeled, margin slightly revolute, smooth or towards apex scabrous, apex acute, trigonous, scabrous. Inflorescence an anthelodium, 1° branches more than 10, to 80 mm; lowest 2-3 bracts leaf-like, up to 30×0.5 cm wide, sheath less; 1° branches end with often more than 20 spreading spikes in irregular spiral, but small 2° anthelodia frequent. Spikes up to 15×1.5 mm, elongating after flowering, with 5-12 flowers; glume-like bract 2 mm, glume-like prophyll two-veined, 1.5 mm, base swollen; rachis compressed, slightly zigzagging, winged; glumes 2.5-3 mm, cymbiform, blunt, yellow-brown, with 5-9 conspicuous veins, mid-vein strong, with short mucro below glume apex, margins scarious. Stamens 3. Style short; stigmas 3, 4-5 mm long. Nut 1.5 mm, ovoid or obovoid, obtusely trigonous, yellow-brown or dark-brown, surface reticulate-papillose. **Plate 201.**

Flowering & fruiting: April-July.

Habitat: Sandy river-sides, humid forests; irrigated fields.

Distribution: As a weed in all continents; formerly cultivated in the Mediterranean. INDIA: Throughout east and west coastline. S. GUJARAT: Throughout.

Voucher specimens: 168, 653, 740

12. **Cyperus exaltatus** Retz. *Observ. Bot.* 5: 11. 1788; *Hooker* 6: 617. 1894; Blatter & Mc Cann JBNHS 37(2): 275. 1934; Cooke. 3:386. 1958; Shah 2: 725. 1978. Karthik. *et al.* 45. 1989; *Parmar in Shetty & Singh* 3:904. 1993; *Lakshmi. in Sharma et al.* 285. 1996; *Verma in Singh et al.* 266. 2001; Prasad & Singh 95. 2002; Cook 111. 2006.

Perennial, more than 1 m. Rhizome short, horizontal or ascending. Culm 3-5 mm diam., trigonous, smooth. Leaves up to as long as culm; sheaths up to 30 cm, brown, green or yellowish green, soft, mouth margin slightly concave; blades 50 cm or longer, 3-10 mm wide, flat or folded, keeled, margins recurved, smooth or scabrous, apex trigonous, barbed. Inflorescence a compound anthelodium, conical, up to 30 cm; bracts up to 7, leaf-like, 2-4, up to more than 50×0.1 cm; 1° branches 8-12, up to 20 cm, tubular prophyll up to 30 mm, bi-nerved, often with two aristas up to 10 mm; 2° anthelodia up to 10 cm, with up to more than 10 secondary branches, with several foliose bracts, shorter than anthelodium; some 1° and most of 2° branches ending with cluster of spikes, sometimes with small 3° anthelodia; cluster of spikes 25-50×10-20 mm, with 20-60 spirally aranged spikes; spikes 5-14×1.5-2 mm, compressed, with 8-34 glumes; glume-like bract, 0.8-1.3 mm, sometimes filiform, up to 10 mm; glume-like prophyll, 1.5 mm, bi-nerved; glumes 2.8 mm, keeled, midnerve strong, green, mucro 0.5 mm, sides brown or dark brown, with 2-3 rather distinct nerves, glossy, margins narrowly scarious; rachis flat, quadrangular, 0.3 mm wide, internodes 0.3-0.5 mm, narrowly winged. Stamens 3.

Style 2 mm long; stigmas 3, equaling to style. Nut c. 0.5×0.3 mm, ellipsoid or ovoid, trigonous, whitish or yellowish brown, finely reticulate or almost smooth. **Plate 202.**

Flowering & fruiting: September-November.

Habitat: Ditches, irrigation channels, rice fields.

Distribution: Tropical Africa, SE Asia to southern Australia. INDIA: Throughout east and west coastline. S. GUJARAT: Throughout.

Voucher specimens: 429, 616, 727, 889

13. **Cyperus iria** L. *Sp. Pl.* 45. 1753; *Hooker* 6: 606. 1894; Blatter & Mc Cann JBNHS 37(2): 264. 1934; Cooke. 3:380. 1958; Shah 2: 728. 1978; Karthik. *et al.* 45. 1989; *Lakshmi. in Sharma et al.* 287. 1996; *Verma in Singh et al.* 269. 2001; Prasad & Singh 100. 2002; Cook 114. 2006; *C. iria* var. *paniciformis* (Franch. & Sav.) Clarke in *Hooker op. cit.* 607; *Parmar in Shetty & Singh* 3:906. 1993; *C. paniciformis* Franch. & Sav. *Enum. Pl. Jap.* 2: 537. 1878; *Hooker op. cit.* 607; Shah *op. cit.* 728.

Annual, 20-70 cm, solitary or forming small tussocks. Rhizome small. Stem 2-3 mm diam., trigonous, smooth. Leaves up to equalling stem; sheaths 20 cm, soft, yellow brown, mouth margin straight; blades more than 30×0.5 cm wide, flat, keeled, green or greyish green, margins slightly revolute, margins and keel towards the apex scabrous, apex acute, scabrous. Inflorescence a compound or decomposed anthelodium, 5-20 cm; 4-6 bracts foliose, much longer than inflorescence, more than 25 cm; 1° branches up to 15 cm, rigid; 2° anthelodium 2-5 cm; 3° anthelodium 2-3 cm; cluster of spikes 1-4 cm, spikate, erect, lax, with 40 spikes; spikes 3.5-5×2 mm, compressed, lax, with 5-20 flowers, parallel to branches, glume-like bract 1 mm, glume-like prophyll scarious, bi-nerved; rachis 0.4 mm wide, 4-angled, flat, brown, narrowly winged; glumes 1.5-2×2 mm, cymbiform, keeled, mucronate, sides nerveless, yellow-brown, shiny, margins scarious. Stamens 2; Style very short; stigmas 3. Nut 1.2×0.6 mm, rather sharply trigonous, ellipsoid, brown or dark brown, finely papillose. **Plate 203.**

Flowering & fruiting: May - October.

Habitat: In fields, borders of irrigation ditches

Distribution: Weed in Old World tropics and subtropics; most common in SE Asia, Africa, Madagascar; Australia and Pacific Islands; the Americas. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 118, 464, 503

14. **Cyperus microiria** Steud. *Syn. Pl. Glumac.* 2: 23. 1854; *Cyperus iria* var. *parviflorus* Miq. *Fl. Ned. Ind.* 3: 270. 1856; *C. iria* L. var. *iria* *Parmar in Shetty & Singh* 3:906. 1993

Annuals. Roots fibrous. Culms tufted, 5-30 cm tall, slightly slender, acutely triquetrous, smooth, base several leaved. Leaves shorter than or equaling culm; sheath purplish brown; leaf blade flat. Involucral bracts 3 or 4, leaflike, longer than inflorescence. Inflorescence a compound anthela; rays 5-9, mostly up to 13 cm, unequal in length. Spikes ovoid, broadly ovoid, or subconic, 2-4 × 1-3 cm, with few spikelets. Spikelets slightly laxly arranged, linear to very narrowly linear-ovoid, 0.6-1.5×0.15 cm, obliquely spreading to spreading, 8-24-flowered;

rachilla wings white, narrow, straight, hyaline. Glumes straw-colored to pale, lax, broadly obovate, 1.5×1.5 mm, membranous, sides nerveless, green, keel abaxially extended beyond apex into a mucro, apex rounded. Stamens 2; anthers oblong, 0.2-0.4 mm. Style very short; stigmas 3, short. Nutlet dark brown, oblong-obovoid, 1.2-1.5×0.5 mm, nearly as long as subtending glume, 3-sided, densely prominently punctulate. **Plate 204.**

Flowering & fruiting: August-October.

Habitat: Forests, under shrubs, grasslands on mountain slopes, wet places by river margins, ditch margins, water margins, seashores, along trails, paddy fields.

Distribution: India, Japan, Korea, Thailand, Vietnam, S Australia and North America. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 335, 423, 505

15. **Cyperus michelianus** subsp. **pygmaeus** (Rottb.) Asch. & Graebn. *Syn. Mitteleur. Fl.* 2(2): 273. 1904; Shah 2: 730. 1978; *C. pygmaeus* Rottb. *Descr. Icon. Rar. Pl.* 20. 1773; Cooke. 3:373. 1958; *Parmar in Shetty & Singh* 3:911. 1993; *Verma in Singh et al.* 281. 2001. Prasad & Singh 121. 2002; Cook 122. 2006; *Juncellus pygmaeus* (Rottb.) C.B. Clarke in *Hooker* 6: 596. 1894; Karthik. *et al.* 58. 1989; *Lakshmi. in Sharma et al.* 328. 1996; *J. michelianus* (Linn.) Blatter & Mc Cann JBNHS 37(1): 33. 1934.

Tufted, annual, 3-22 cm. Roots fibrous. Stem 0.7-1.2 mm diam., trigonous, smooth. Leaves as long as stem; sheaths up to 5 cm, wide, soft, grey-brown or often reddish, mouth margin concave or almost straight; blades to 5-10×0.1-0.3 cm wide, grey green, flat or folded, keeled, margins often recurved, smooth or scabrous, apex trigonous, acute, scabrous. Inflorescence 7-17 mm diam., a regularly globose head of 5-9 globose, sessile, spirally arranged partial inflorescences, tightly pressed together and separately indistinguishable; 4-7 bracts foliose, up to 7 cm, much exceeding length of inflorescence, reflexed; partial inflorescences formed by 10-40 sessile spikes, tightly spirally arranged; spikes 2.5-3.5×0.8-1.4 mm, narrowly obovoid, compressed, with 20-28 glumes, glume-like bract long-awned, glumes distichously arranged, 1.5-2×1.5 mm, narrowly cymbiform, mid-nerve green, prominent, raised, 1-3 nerved on both sides, margins scarious, brownish towards the apex. Flowers mostly bisexual; stamens 1-0; stigmas 2. Nut 1-1.1 ×0.4 mm, ellipsoid, lenticular or plano-convex, not winged, yellow-brown, papillose and finely reticulate. **Plate 205.**

Flowering & fruiting: June - September.

Habitat: Alluvial river banks, in ponds after drying

Distribution: Tropical Africa & Europe, SE Asia, Madagascar and Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 439, 619, 701

16. **Cyperus nutans** var. **eleusinoides** (Kunth) Haines *Bot. Bihar Orissa* 5: 898. 1924; Shah 2: 731. 1978; Karthik. *et al.* 46. 1989; *Lakshmi. in Sharma et al.* 289. 1996; *Verma in Singh et al.* 275. 2001; Cook 117. 2006; *C. eleusinoides* Kunth *Enum. Pl.* 2: 39 1837; *Hooker* 6: 608. 1894; Cooke. 3:381. 1958; Blatter & Mc Cann JBNHS 37(2):

267. 1934; *C. nutans* subsp. *eleusinoides* (Kunth) T.Koyama *Gard. Bull. Singapore* 30: 136. 1977; *Parmar in Shetty & Singh* 3:909. 1993; Prasad & Singh 112. 2002

Perennials. Rhizomes short. Culms up to 1 m tall, stout, 3-angled, smooth, base swollen into a tuber shape, with leaves at basal part. Leaves shorter than culm; sheath long, brown; leaf blade 6-12 mm wide, flat, margin scabrous. Involucral bracts 5 or 6, basal 2 or 3 longer than inflorescence. Inflorescence a compound or decompound anthela; 1° branches 6-12, up to 18 cm, each with 3-6 2° branches; up to 4 cm, unequal in length. Spikes oblong to cylindrical, 1-3×0.4-1 cm, with very many spikelets. Spikelets densely arranged in several rows, linear-oblong, 4-8×2 mm, 6-12-flowered; rachilla wings white, hyaline, caducous. Glumes pale and brown striate or brown, lax, ovate-elliptic, 2×1.5 mm, membranous, 5-7-veined, keel green, apical margin white hyaline, apex mucronate. Stamens 3; anthers linear, connective prominent beyond anthers. Style short; stigmas 3, 2-2.5 mm long. Nutlet dark brown, obovoid, triquetrous, 1-1.2×0.5 mm, obscurely densely punctate. **Plate 206.**

Flowering & fruiting: August-December.

Habitat: Forests, mountain slopes, sunny water margins, near irrigation channels.

Distribution: Tropical Africa, SW Asia, tropical Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 240, 544, 899

17. **Cyperus nutans** Vahl var. **nutans**. Shah 2: 731. 1978; Karthik. *et al.* 46. 1989; *Lakshmi. in Sharma et al.* 289. 1996; *Verma in Singh et al.* 275. 2001; Cook 117. 2006; *C. nutans* Vahl *Enum. Pl.* 2: 363. 1805; *Hooker* 6: 607. 1894; *Cooke.* 3:381. 1958; *Blatter & Mc Cann JBNHS* 37(2): 266. 1934; *Cyperus nutans* Vahl subsp. *nutans* *Parmar in Shetty & Singh* 3:908. 1993; Prasad & Singh 111. 2002.

Perennials. Rhizomes short, hardened. Culms scattered, 75-120 cm tall, stout, compressed 3-angled, smooth, with leaves at basal part. Leaves shorter than culm; leaf blade 6-12 mm wide, flat, margin scabrous. Involucral bracts 4-8, leaf like, basal 3 or 4 usually longer than inflorescence, 1-1.5 cm wide, abaxially serrulate apically on 2 lateral veins, margin scabrous. Inflorescence a compound anthela; 1° branches 8-10, up to 16 cm, each with 4-10 2° branches. Spikes cylindrical, 2-5×0.4-0.7 cm, with laxly arranged spikelets. Spikelets linear to narrowly linear-ovoid, 5-11×1.5 mm, suberect, 6-10-flowered; rachilla flexuose, wings white and hyaline. Glumes yellowish on both surfaces and rusty brown striate, lax, elliptic, 3×2 mm, spreading after anthesis, membranous, 7-9-veined, keel reddish brown, apex mucronate. Stamens 3; anthers linear-oblong; connective prominent beyond anthers. Style very short; stigmas 3, slender, up to 3 mm, exerted. Nutlet dark brown when mature, oblong to obovoid-oblong, 1.5-2×0.5 mm; 3-sided, densely and slightly prominently punctate. **Plate 207.**

Flowering & fruiting: May-October.

Habitat: Sparse forests, grasslands on mountain slopes, water margins in valleys, wet places, river margins.

Distribution: South Asia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 157, 620, 681

18. **Cyperus paniceus** (Rottb.) Boeckeler *Linnaea* 36: 381. 1870; *Mariscus paniceus* (Rottb.) Vahl *Enum. Pl.* 2: 373 1805; *Hooker* 6: 620. 1894; Blatter & Mc Cann JBNHS 37(3): 533. 1934; *Karthik. et. al.* 63. 1989; *Parmar in Shetty & Singh* 3:938. 1993; *Verma in Singh et al.* 275. 2001; Prasad & Singh 261. 2002; Cook 165. 2006.

Perennial, caespitose, up to 40 cm. Rhizome short, 2-3 mm thick, clothed with dark brown fibers; stolons long, slender, 0.5 mm thick, covered with reddish-brown numerous scales. Culm very slender, 0.5 mm diam., trigonous, smooth. Leaves equaling or shorter than stem; sheaths up to 15 cm, often with reddish tint, mouth margin somewhat concave; blades to more than 80×0.5 cm, keeled, margins slightly revolute, margins and keel smooth or slightly scabrous, apex long-attenuate. Inflorescence an capitate-anthelodium, up to 1-2 cm, 1° branches 3-10, bracts 3-5 foliose, up to 15 cm; tubular prophyll up to 10 mm, yellow-brown, bi-nerved, nerves with flat. Spikes sessile to sub sessile, 10×6 mm, cylindrical, up to 30 spreading, spirally arranged spikelets bearing 1 nut, rachis widely winged; glume-like bract 1 mm, brown, acute; glume-like prophyll 0.8 mm. Glumes 2, lower bearing nut and upper sterile, 2.5-4×0.5 mm, with rounded back, pale green, mid-nerve ending in notched apex, margins narrowly scabrous. Stamens 3, anther 1 mm long. Style 1.5-2 mm long; stigmas 3, equaling to style. Nut 2-2.2×0.5-0.7 mm, trigonous, slightly curved, plano-convex, brown, with persistent style-base 0.4 mm, finely reticulate and papillose. **Plate 208.**

Flowering & fruiting: July-November.

Habitat: Occasional in moist shady areas in semi evergreen forests.

Distribution: Sri Lanka to Vietnam. INDIA: Throughout the warmer parts. S. GUJARAT: Throughout.

Voucher specimens: 862, 888, 891

19. **Cyperus pangorei** Rottb. *Descr. Icon. Rar. Pl.* 31. 1773; Shah 2: 732. 1978. *Karthik. et al.* 46. 1989; *Parmar in Shetty & Singh* 3:909. 1993; *Lakshmi. in Sharma et al.* 291. 1996; *Verma in Singh et al.* 275. 2001; Prasad & Singh 113. 2002; Cook 118. 2006; *C. tetegum* Roxb. *Fl. Ind.* 1: 211. 1820; *Hooker* 6: 613. 1894; *Cooke.* 3:384. 1948

Perennials. Rhizomes short, creeping. Culms 50-90 cm tall, stout, obtusely 3-angled, smooth. Leaves basally with a brown long sheath, apically bladeless or with a short blade. Involucral bracts 3-5, leaf like, longer than inflorescence. Inflorescence a decompound or compound anthela; 1° branches 5-7, up to 5 cm, unequal, each with 3-8 2° branches. Spikes broadly ovoid, 1-2×0.1-0.2 cm, with 4-15 spikelets. Spikelets laxly arranged, linear, 8-20×1.5 mm, slightly compressed, obliquely spreading, 6-30-flowered; rachilla wings reddish brown, linear-oblong. Glumes lower 2 sterile & smaller in size, rest other fertile, reddish brown on both surfaces but middle green, lax, oblong, 2-3×2 mm, papery, 3-5-veined, not keeled, margin slightly revolute at maturity, apex obtuse-acute. Stamens 3; anthers linear; connective prominent beyond anther, apex sometimes setiferous. Style of medium length; stigmas 3. Nutlet dark brown, obovoid-oblong, 1/2 as long as subtending glume, 3-sided, densely punctulate. **Plate 209.**

Flowering & fruiting: November-January.

Habitat: Flooded river margins, water margins

Distribution: NE India, Myanmar, Nepal, Pakistan, Sri Lanka. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 146, 380, 890

20. **Cyperus pulcherrimus** Willd. ex Kunth *Enum. Pl.* 2: 35. 1837; Blatter & Mc Cann JBNHS 37(2): 259. 1934. *Karthik. et al.* 47. 1989.

Annual, 25-60 cm. Roots reddish-brown. Culm 3 mm diam., sharply trigonous, smooth. Leaves shorter than stem; sheaths to 10 cm, green or yellow-brown, mouth oblique; ligule 1 mm, papery; blades up to 50×0.3-0.5 cm, keeled, margins smooth, apex trigonous, scabrous. Inflorescence of 1-7 globose anthelodium, nearly sessile or peduncles to 3 cm; digitately branching and rebranching, with 100 or more sessile spikes. Bracts 2-4, lowest 2-3 foliose, to 20 cm or more, sheath-less. Spikes 2×1 mm, with 5-20 flowers; glumes 0.7×1.2 mm, blunt, wider than long, midnerve strong, sides dark purple, margins narrowly scarious; rachis compressed, slightly zigzagging. Stamens 2. Style 2 mm long; stigmas 3, equaling to style. Nut 0.5 mm, obovoid, sharply trigonous, papillose, yellowish. **Plate 210.**

Flowering & fruiting: July – October.

Habitat: River beds.

Distribution: Common weed in tropical and subtropical areas of all continents. INDIA: Throughout east and west coastline. S. GUJARAT: Only from the Ambika riverbeds at Anaval.

Voucher specimens: 405, 420, 630

21. **Cyperus rotundus** subsp. **retzii** Kük. *Pflanzenr.* IV, 20(101): 114. 1935; *C. tuberosus sensu* C. B. Clarke in *Hooker* 6: 616. 1894 non *Rottb.* 1773; *C. bifax* C.B. Clarke *Kew Bull., Addit. Ser.* 8: 13. 1908; *Karthik. et al.* 43. 1989; Cook 105. 2006.

Perennials. Rhizomes stoloniferous; stolons long and creeping, terminated by a tuber. Culms solitary, rarely few laxly tufted, 30-75 cm tall, slender, triquetrous, smooth, basally with several leaves. Leaves shorter than culm; sheath reddish brown, eventually disintegrating into fibers; leaf blade medium green, 5-10 mm wide, base flat or slightly folded. Involucral bracts 4-5, leaf like, equaling inflorescence. Inflorescence a compound anthela; 1° branches 2-6, up to 18 cm, unequal in length, 2° anthelodia 3-6 mm. Spikes with 5-12 laxly arranged spikelets. Spikelets linear, 1-2×0.15-0.2 cm, obliquely spreading, 8-20-flowered; rachilla wings white, broad, hyaline. Glumes brownish yellow to straw-colored on both surfaces, broadly ovate, 4-5×3 mm, membranous, conspicuously 9-11 veined, margin hyaline, apex acute. Stamens 3; anthers linear; Style short; stigmas 3, much longer, 4-5 mm. Nutlet oblong-obovoid, ca. 1/2 as long as subtending glume, 3-sided, punctulate. **Plate 211.**

Flowering & fruiting: July – October.

Habitat: River beds.

Distribution: S & SE Asia, Australia. INDIA: South India. S. GUJARAT: Occasional in wet soils. **New record for the State.**

Voucher specimens: 227, 637, 682

22. **Cyperus rotundus** L. subsp. **rotundus**; Shah 2: 735. 1978; Karthik. *et al.* 47. 1989; Lakshmi. *in Sharma et al.* 293. 1996; Verma *in Singh et al.* 282. 2001. Prasad & Singh 123. 2002; *C. rotundus* L. *Sp. Pl.* 45 1753; Hooker 6: 614. 1894; Blatter & Mc Cann JBNHS 37(2): 273. 1934; Cooke. 3:385. 1958; Parmar *in Shetty & Singh* 3:911. 1993; Cook 123. 2006.

Perennial, 15-40 cm. Rhizome dark brown, woody; stolons numerous, long-creeping, strong, 1-1.5 mm diam., producing tubers, 20×9 mm, dark brown. Culm 1-2.5 mm diam., trigonous, green, smooth. Leaves shorter than stem; sheaths to 10 cm, wide, acute, grey-brown or brown, sometimes with reddish tint, mouth margin lingulate; blades to 30×0.1-0.45 cm, grey-green or green, flat or folded, slightly keeled, margins smooth or towards the apex barbed, apex long-attenuate, acute, trigonous, scabrous. Inflorescence an anthelodium, 4-10 cm; 2-3 lowermost bracts foliose, longer than inflorescence; 1° branches 5-8, more than 5 cm long; 2° branches 2.5-5 cm; clusters of spikes 1.5-4 cm, of 5-7 spikes on slightly elongated axis, sometimes nearly digitately; spikes 10-40×0.15-0.2 cm, up to 40 glumes, glume-like bract 2 mm, glume-like prophyll 1.9-2.4 mm, bi-nerved, sterile; spike rachis 4-angled, 0.5 mm wide, winged; glumes 2.5-4 mm, cymbiform, rather closely imbricate, obtuse, dark reddish brown, or grey-brown, nerveless, margin narrowly or sometimes widely scarious, towards apex embracing nut. Stamens 3; anthers linear; style 2-3 mm; stigmas 3, much longer, 2-3 mm. Nut 1.3-1.8×0.7-1 mm, ellipsoid or obovoid, trigonous, brown to blackish brown, clearly or obscurely reticulate papillose. **Plate 212.**

Flowering & fruiting: April - October.

Habitat: Shores, wet meadows, ditches, rice fields, moist road sides, waste places

Distribution: Tropical and subtropical areas of all continents. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 16, 103, 175

23. **Cyperus squarrosus** L. *Cent. Pl. II* 6. 1756; Shah 2: 736. 1978; *C. aristatus* Rottb. *Descr. Icon. Rar. Pl.* 22. 1773. Hooker *op. cit.* 606; Blatter & Mc Cann JBNHS 37(2): 263. 1934; Cooke. 3:380. 1958; *Mariscus squarrosus* (L.) C.B. Clarke *in Hooker* 6: 623. 1894; Karthik. *et al.* 64. 1989. Parmar *in Shetty & Singh* 3:939. 1993; Lakshmi. *in Sharma et al.* 341. 1996; Verma *in Singh et al.* 283. 2001; Prasad & Singh 263. 2002; Cook 166. 2006.

Tufted annual, 5-20 cm. Culm 0.5-1.5 mm diam., sharply trigonous, or even winged, greyish-green, smooth. Leaves basal or subbasal, from half to as long as stems; sheaths 0.7-5 cm, reddish or yellowish brown or greenish, mouth margin slightly concave; blades up to 10×0.1-0.3 cm, greyish-green, keeled, margins smooth, slightly revolute, apex acute and slightly scabrous or smooth. Inflorescence a small multiple spike, up to 5 cm, seldom a single cluster of

spikes; clusters rounded or elongated, with 2 to more than 30 spirally arranged spikes; 1° branches 0-4, up to 4.5 cm, tubular prophyll often reddish, up to 5 mm; 2-3 bracts foliose, up to 10 cm, longer than inflorescence. Spikes reflexed, flat, ovoid, to 7×2.5-3 mm, 6-10 flowers; glume-like bract 0.5-1 mm, acute, glume-like prophyll scarious, 2-veined, from 0.7-1 mm; rachis compressed, 4-angled, green, later reddish-brown; glumes 1.5-2.3 mm, cymbiform, sometimes keeled, not truncate, mid-nerve green, extending into recurved arista up to 0.7 mm, sides pale greenish or reddish brown, with 3(-4) nerves, scarious. Stamens 2; style very short; stigmas 3, short. Nut 0.7-1 mm, obovoid, trigonous, brown or dark brown, papillose. **Plate 213.**

Flowering & fruiting: August – September.

Habitat: Open moist ground, grasslands, on rocks and sand, also as weed.

Distribution: S Africa, Madagascar, Pakistan, India and China to Australia, Americas. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 284, 441, 535

24. **Cyperus tenuispica** Steud. *Syn. Pl. Glumac.* 2: 11. 1854; Shah 2: 736. 1978; *Parmar in Shetty & Singh* 3:913. 1993; *Lakshmi. in Sharma et al.* 296. 1996; *Verma in Singh et al.* 284. 2001; Prasad & Singh 130. 2002; *Karthik. et al.* 48. 1989; Cook 125. 2006; *C. flavidus* C.B. Clarke *J. Linn. Soc. Bot.* 20: 287. 1883; *Hooker* 6: 600. 1894; *Cooke.* 3:375. 1958 *C. flavidus* auct. non Retz. *Observ. Bot.* 5: 13. 1788; *Blatter & Mc Cann JBNHS* 37(2): 259. 1934

Annual, 10-15 cm, forming small tufts. Culm 0.5-1.3 mm diam., 3-5-angular, smooth. Leaves shorter than stem, soon withering; sheaths green or red, soft, lower blade-less, mouth oblique or, when leaf blade present, rather straight; blades up to 6×0.1-0.2 cm wide, yellow-green, flat or folded, soft, rather acute, margins and keel smooth, apex barbed. Inflorescence a compound anthelodium, 2-7 cm; bracts few, one or two foliose, up to more than 10 cm; 1° branches 10, up to 7 cm; 2° anthelodium 1-2 cm, almost spherical, 2° branches 0.5-1.5 cm; cluster of spikes at the tip of all of the 2° branches, with 2-10 sessile spikes; spikes 2-8×1 mm, compressed, with 10-30 glumes; glume-like bract 0.8 mm, cymbiform, glume-like prophyll clasping, 0.6 mm, scarious, sterile; rachis 4-angled, 0.4 mm wide, green or reddish, hardly winged; glumes 1 mm, closely imbricate, cymbiform, recurving, obtuse, mid-nerve area green, slightly keeled near the apex, sides reddish brown, margins narrowly scarious. Stamens 3, style 1 mm; stigmas 3, equal to style, 1 mm. Nut 0.4-0.5 mm, almost spherical to obovoid, obtusely trigonous, white or yellowish, papillose or tuberculate. **Plate 214.**

Flowering & fruiting: September - December.

Habit: Marshlands, river banks, weed in rice fields

Distribution: Tropical Africa & Asia, E. Africa. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 260, 446, 610

25. **Cyperus tuberosus** Rottb. *Descr. Icon. Rar. Pl. 28. 1773*; *Hooker 6: 616. 1894*; Cooke. 3:385. 1958; *Parmar in Shetty & Singh 3:913. 1993*; *C. rotundus* subsp. *tuberosus* (Rottb.) Kük. *Pflanzenr. IV, 20(101): 113. 1935*; Shah 2: 735. 1978. Karthik. *et al.* 47. 1989; *Lakshmi. in Sharma et al. 295. 1996*; *Verma in Singh et al. 282. 2001*; Prasad & Singh 124. 2002.

Perennials. Rhizomes stoloniferous; stolons long and creeping, terminated by a tuber. Culms solitary, rarely few laxly tufted, 20-55 cm tall, slender, triquetrous, smooth, basally with several leaves. Leaves shorter than culm; sheath reddish brown, eventually disintegrating into fibers; leaf blade medium green, 3-6 mm wide, base flat or slightly folded. Involucral bracts 2 or 3, leaf like, shorter than or equaling inflorescence. Inflorescence a simple or rarely compound anthela; rays 2-6, up to 8 cm, unequal in length. Spikes obdeltoid, with 6-12 laxly arranged spikelets. Spikelets linear, 0.8-2×1.5-2 cm, obliquely spreading, 8-20-flowered; rachilla wings white, broad, hyaline. Glumes brownish yellow to straw-colored on both surfaces but keel green, broadly ovate to elliptic, 3.5-4 mm, membranous, conspicuously 7-veined, margin white hyaline, apex rounded. Stamens 3; anthers linear. Style of medium length; style very short; stigmas 3. Nutlet oblong-obovoid, 1/2 as long as subtending glume, 3-sided, punctulate. **Plate 215.**

Flowering & fruiting: June-July.

Habitat: Open grasslands, along trails, sandy shores, gardens.

Distribution: India, Japan, Malaysia, Sri Lanka; Africa, SW Asia, Indian Ocean islands. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 8, 316, 370

26. **Kyllinga brevifolia** Rottb. *Descr. Icon. Rar. Pl. 13. 1773*; Blatter & Mc Cann JBNHS 37(1): 25. 1934; Shah 2: 722. 1978. Karthik. *et al.* 60. 1989; *Parmar in Shetty & Singh 3:932. 1993*; *Lakshmi. in Sharma et al. 329. 1996*; Prasad & Singh 234. 2002; Cook 156. 2006; *Cyperus brevifolius* (Rottb.) Hassk. *Cat. Hort. Bot. Bogor. 24. 1844*; *Hooker 6: 588. 1894*; *Verma in Singh et al. 256. 2001*.

Perennials. Rhizomes slender, long creeping, clothed with brown, membranous scales, internodes 1-2.5 cm, with 1 culm at each node. Culms serially arranged, sometimes also laxly tufted, 2-30 cm tall, compressed 3-angled, smooth, base not swollen, with 4 or 5 leaf sheaths. Leaves shorter to slightly longer than culm; sheaths brown, mouth obliquely truncate, apex acuminate, basal 2 bladeless, apical 2 or 3 with a blade; leaf blade 5-15×0.2-0.4 cm, flaccid, flat, midvein and apical margin spinulose. Involucral bracts 3, leaflike, longest erect to oblique or horizontal. Spike 1, globose to ovoid-globose, 5-11×4-10 mm, with numerous densely arranged spikelets. Spikelets narrowly oblong-ovoid to narrowly ovoid, 3×1 mm, compressed, 2-flowered. Glumes white and rusty brown maculate or rarely straw-colored, ovate, 2.5-3 mm, keel spinulose or not, veins 2 or 3 on each side of keel, apex with a strict or recurved mucro. Stamens 1; anthers linear, 0.7 mm. Style long; stigmas 2, as long as style. Nutlet obovoid-oblong, 1-1.5 mm, biconvex, densely punctate. **Plate 216.**

Flowering & fruiting: May-October.

Habitat: Under shrubs or forests, grasslands, swamps, meadows, mountain slopes, valleys, wet places along trails, ditch margins, shallow water, river margins, wet places at seashores, paddy field margins.

Distribution: Pantropic. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 116, 399, 406

27. **Kyllinga bulbosa** P.Beauv. *Fl. Oware 1: 11. 1805; Parmar in Shetty & Singh 3:933. 1993; Prasad & Singh 236. 2002; K. triceps* Rottb., *Descr. Icon. Rar. Pl. 14. 1773 nom. illegit; Hooker 6: 587. 1894; Cooke. 3:391. 1958; Blatter & Mc Cann JBNHS 37(1): 23. 1934; K. tenuifolia* Steud., *Syn. Pl. Cyperac.: 69. 1855 nom. illegit; Karthik. et al. 61. 1989; Lakshmi. in Sharma et al. 330. 1996; Cook 156. 2006; Cyperus triceps* (Rottb.) Endl., *Cat. Hort. Vindob. 1:94. 1842, nom. illegit.; Shah 2: 737. 1978; Verma in Singh et al. 284. 2001.*

Perennials. Rhizomes short. Culms tufted, 5-30 cm tall, compressed 3-angled, smooth, base swollen, bulbous, and clothed with persistent brown leaf sheath remains splitting into fibers. Leaves shorter than culm; leaf blade 2-3 mm wide, flaccid, folded or flat, apical margin sparsely denticulate. Involucral bracts 3, leaf like, much longer than inflorescence, horizontal, downward reflexed after anthesis. Spikes usually 3, with numerous spikelets congested into a capitate shape; middle spike broadly ovoid, 5-6 mm; lateral spikes globose, 3-4 mm. Spikelets radially arranged, oblong, 2-2.5 mm, 1-flowered. Glumes 2, greenish yellow to white, ovate-ellipsoid, 2×1 mm, concave, keel abaxially green, veins 3 or 4 on each side of keel, apex mucronate. Stamens 2. Style short; stigmas 2, equal to style. Nutlet yellowish brown, oblong, 2/3-3/4 as long as subtending glume, compressed plano-convex, with punctate processes. **Plate 217.**

Flowering & fruiting: July-October.

Habitat: Common in wet places at field margins.

Distribution: Bangladesh, India, Myanmar, Pakistan, Sri Lanka, Thailand, Vietnam; tropical Africa, E Australia and Malaysia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 245, 479, 572

28. **Pycneus flavidus** (Retz.) T.Koyama *J. Jap. Bot. 51: 316. 1976; Karthik. et al. 65. 1989; Prasad & Singh 270. 2002; Cook 168. 2006; Cyperus globosus* All. *Fl. Pedem. 1: 49 1785; Cooke 3:370. 1958; P. capillaris* (J.König ex Roxb.) Nees ex C.B.Clarke *Hooker 6: 591 1894; P. flavidus* var. *strictus* (Lam.) Karthikeyan *et al. 65. 1989; P. globosus* Rchb. *Fl. Germ. Excurs. 140(10). 1831; Blatter & Mc Cann JBNHS 37(1): 29. 1934.*

Tufted, small annual, or sometimes caespitose perennial, 15-50 cm. Stem 1-2 mm diam., trigonous, basal parts almost terete, grooved, otherwise smooth. Leaves shorter than stem; sheaths 2-8 cm, brown or yellow-brown, mouth margin straight; blades up to 15 cm, 1-3 mm wide, flat or folded, margins involute, smooth, apex long, trigonous, acute, scabrous.

Inflorescence anthelodium, up to 5 cm; 1-2 bracts foliose, to 10-15 cm; 1° branches to 5 cm, tubular prophyll brown or yellowish. Spikes 8-30×2-2.5 mm, compressed, with up to 50 glumes, glume-like bract 2.5 mm, glume-like prophyll 2.5 mm, blunt, basal part adaxially swollen; rachis quadrangular, almost straight, brown, lateral sides deeply concave, margins sharp; glumes 2.5×1.5 mm, cymbiform, blunt, mid-vein area green, sides reddish brown, margins widely scarious. Stamens 2. Nut 0.8-1 mm, ellipsoid or obovoid, bi-convex, with a short stipe, apiculate, brown, reticulate, and often papillose. **Plate 218.**

Flowering & fruiting: July - August.

Habitat: Along rivers and streams.

Distribution: S. Europe, S. Asia and Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 237, 457, 894

29. **Pycreus malabaricus** Clarke in J. Linn. Soc. 34:12. 1898; Blatter & Mc Cann JBNHS 37(1): 28. 1934; Karthik. *et al.* 65. 1989; Prasad & Singh 275. 2002; *Cyperus malabaricus* (Clarke) Cooke in Fl. Pres. Bombay 2:856. 1908 & 3:369. 1958

Annual, caespitose, 5-60 cm. Stem 0.5-1.5 mm diam., obtusely trigonous below, smooth. Leaves shorter than stem; sheaths 20-50 mm, reddish-brown or brown, mouth margin slightly concave; blades up to 10-15×0.1-0.2 cm, flat, grey-green, margins slightly involute, margins and midvein below scabrous, acute apex. Inflorescence a globose cluster of spikes or a small anthelodium, 1° branches up to 4 cm, cluster of spikes with 100 spikes, 1.5-3 cm; bracts 3-4 foliose, up to 15 cm; tubular prophyll brown. Spikes 5-15×2.5 mm, compressed, with up to 40 glumes; glume-like prophyll basally swollen; rachis quadrangular, almost straight, angles sharp, not winged, glumes 2.5-3×1.5 mm, cymbiform, blunt mucronate, sides deepred-brown, margins scarious. Stamens 2. Style 1 mm, Stigma bifid, as long as style. Nut 1-1.2 mm, globose or ellipsoid, stipitate, compressed, from yellow-brown to dark-brown, reticulate with areole twice as long as wide or more, lower ends of areole at same horizontal level. **Plate 218.**

Flowering & fruiting: August - September.

Habitat: Moist alluvial grasslands on rocky plateaus

Distribution: S India-Myanmar. INDIA: Western Peninsula. S. GUJARAT: Throughout.

Voucher specimens: 487, 532, 893

30. **Pycreus membranaceus** (Vahl) Govind. *Proc. Ind. Acad. Sci., Pl. Sci.* 100: 424. 1990; *Cyperus pumilus* var. *membranaceus* (Vahl) C.B. Clarke *J. Linn. Soc., Bot.* 21: 44. 1884; Shah 2: 734. 1978. *P. pumilus* var. *membranaceus* (Vahl) Karthik. *et al.* 66. 1989; Parmar in Shetty & Singh 3:943. 1993; Lakshmi. in Sharma *et al.* 352. 1996.

Annual, 4-10 cm, forming small tufts. Roots fibrous. Stem 0.3-0.5 mm diam., trigonous, smooth. Leaves shorter than the stem; sheaths up to 20 mm, soft, green or grey-green, mouth margin slightly concave; blades up to 70 x 0.5-1.5 mm, flat or folded, slightly keeled, margins narrowly recurved, smooth, apex long, trigonous, acute, scabrous. Inflorescence a single

cluster of spikes, or more often a small anthelodium, with 1-4 elongated 1° branches up to 25 mm; cluster of spikes 10-20 mm diam., of 5-12 digitately arranged spikes; bracts 1-3 foliose, up to 50 mm, spreading; spikes 4-10×2-3 mm, with 12-40 glumes; glume-like bract 1.3 mm, glume-like prophyll 1 mm; rachis 0.5 mm diam., almost quadrangular, with triangular, glumes loosely arranged to show rachilla; glumes 1.4-1.8×1 mm, widely cymbiform, mid-nerve green, later brown, mucro 0.4 mm, apex obtuse, sides without nerves, yellow-brown, margins scarious. Stamens 2. Style 1.5 mm, Stigma bifid, as long as style. Nut 0.6-0.7×0.3-0.4 mm, lenticular, obovoid or ellipsoid, edges rounded, yellowish brown to dark brown or sometimes white, finely reticulate with conspicuous papilla in each areole. **Plate 220.**

Flowering & fruiting: August-September.

Habitat: Waste lands near wet areas

Distribution: S. Asia, N. Australia, W Indies and Florida. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 896, 897, 898

31. **Pycreus pumilus** (L.) Nees *Linnaea* 9: 283. 1834; *Hooker* 6:591. 1894; Blatter & Mc Cann JBNHS 37(1): 31. 1934; Prasad & Singh 279. 2002; Cook 170. 2006; *Cyperus pumilus* L. *Cent. Pl. II* 6. 1756; Cooke 3:370. 1958; *Verma in Singh et al.* 280. 2001; *C. pumilus* L. var. *pumilus*. Shah 2: 734. 1978; *P. pumilus* var. *pumilus*. Karthik. *et al.* 66. 1989; *Parmar in Shetty & Singh* 3:944. 1993; *Lakshmi. in Sharma et al.* 352. 1996.

Annual, 4-10 cm, forming small tufts. Roots fibrous. Stem 0.3-0.5 mm diam., trigonous, smooth. Leaves shorter than the stem; sheaths up to 20 mm, soft, green or grey-green, mouth margin slightly concave; blades up to 7×0.5-1 cm, flat or folded, slightly keeled, margins narrowly recurved, smooth, apex long, trigonous, acute, scabrous. Inflorescence a single cluster of spikes or more often a small anthelodium, with 1-4 elongated 1° branches up to 25 mm; cluster of spikes 10-20 mm diam., of 5-12 digitately arranged spikes; bracts 1-3 foliose, up to 5 cm, spreading; spikes 4-10×2-3 mm, with 12-40 glumes; glume-like bract 0.5 mm, glume-like prophyll 1 mm; rachis 0.5 mm diam., almost quadrangular, with triangular, scarious appendages as remains of fallen glumes; glumes 2.5×2 mm, widely cymbiform, mid-nerve green, later brown, mucro 0.2 mm, apex obtuse, sides with 1-2 weak nerves, yellow-brown, margins scarious. Stamens 2. Style 1.5 mm, Stigma bifid, as long as style. Nut 0.6-0.7×0.3-0.4 mm, lenticular, obovoid or ellipsoid, edges rounded, yellowish brown to dark brown or sometimes white, finely reticulate with conspicuous papilla in each areole. **Plate 221.**

Flowering & fruiting: August-September.

Habitat: Wet areas of Waste lands, rice fields, along shore-lines

Distribution: Sri Lanka, Indo-China, Malesia, Tropical Africa & Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 66, 306, 494, 600

32. **Pycreus sanguinolentus** (Vahl) Nees *Linnaea* 9: 283 1834; *Hooker* 6: 590. 1894; Blatter & Mc Cann JBNHS 37(1): 28. 1934; Karthik. *et al.* 66. 1989; *Parmar in Shetty*

& Singh 3:944. 1993; Lakshmi. in Sharma et al. 352. 1996; Prasad & Singh 282. 2002; Cook 171. 2006; *Cyperus sanguinolentus* Vahl Enum. Pl. 2: 351 1805; Cooke 3:359. 1958; *C. sanguinolentus* Vahl subsp. *sanguinolentus*. Shah 2: 735. 1978; Verma in Singh et al. 283. 2001.

Small annual or perennial, 10-30 cm; plants single or in small tufts. Roots fibrous; stem base in older plants decumbent and rooting. Culm 0.5-1.5 mm diam., trigonous, smooth. Leaves shorter than stem; sheaths up to 5 cm, soft, grey brown, sometimes slightly reddish, mouth margin almost straight; blades up to 12×1-3 cm wide, green, flat or folded, keeled, straight or falcate, margins narrowly recurved, smooth, apex obtuse, flat or trigonous, smooth. Inflorescence one single digitate, rather loose cluster of 3-12 spikes, or with 1° branches up to 15 mm; bracts 1-3 foliose, up to 10 cm, spreading, with spongy, undifferentiated tissue in their axils; spikes 5-15×2.5-3 mm, with 8-18 glumes, somewhat turgid; glume-like bracts 2.2 mm, glume-like prophyll 1.6 mm; rachis 0.5 mm diam., almost quadrangular, with scarious, triangular appendage present on both sides; glumes 1.5-2 mm, cymbiform, mid-nerve area green or later yellow brown, on both sides wide reddish marginal zone, sides nerve-less or with 1-2 inconspicuous nerves. Stamens 3. Style 1 mm, Stigma bifid, as long as style. Nut 1.3-1.6×0.9-1 mm, lenticular, ellipsoid or obovoid, brown or dark brown, finely reticulate and often papillose, glossy. **Plate 222.**

Flowering & fruiting: July - September.

Habitat: Swamps, wet meadows, also rice fields

Distribution: Throughout the warmer parts of Asia, Africa and Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 392, 785, 895

33. **Queenslandiella hyalina** (Vahl) Ballard *Hooker f.'s Icon. Pl. 33: t. 3208. 1933*; Karthik. et al. 67. 1989; Lakshmi. in Sharma et al. 353. 1996; Prasad & Singh 285. 2002; *Cyperus hyalinus* Vahl Enum. Pl. 2: 320. 1805; Cooke 3:369. 1958; Shah 2: 727. 1978; *Pycreus pumilus* sensu C. B. Clarke in *Hooker 6: 591. 1894*; *P. hyalinus* (Vahl) Domin *Biblioth. Bot. 85: 417. 1916*; Blatter & Mc Cann *JBNHS 37(1): 31. 1934.*

Loosely caespitose aromatic annual herb. Roots fibrous, brown. Stems glabrous, trigonous, 3-14x0.2 cm. Leaves basal; base sheathing; blades 4-15x0.2-0.5 cm. 1° inflorescence bracts 4, mostly exceeding rays, longest to 12×0.2-0.4 cm. Inflorescence anthelate; rays 3-8, longest 2.54 cm long; spikes rarely with short basal branch, mostly pedunculate, oblong-ovate, 12-20×15 mm, with 12 mostly divaricate spikelets; rachis grooved, winged. Bracteoles narrowly triangular to aristate, 2.2mm long, membranous. Spikelet prophylls rounded to acute, 0.7- 1.4 mm long, membranous. Spikelets laterally compressed, narrowly ovate to elliptic, 4.1-5.7×1.9-2.2 mm, deciduous; rachilla winged, 0.5 mm wide, membranous. Floral scales 4-7, imbricate, broadly ovate, 2.1-2.4 mm long, mucronate, membranous; keel green, scabrid wings; yellowish to whitish to pale green; lateral nerves 6. Stamens 2; anthers narrowly oblong, 0.4-0.5 mm long. Style bifid, divided, ¾ of its length. Achene brown, broadly oblong to suborbicular, 0.1- 0.4×1.0-1.1 mm, plano compressed, 0.3mm thick, gibbous, truncate minutely punctulate. **Plate 223.**

Flowering & fruiting: September-November.

Habitat: Wet places, often in paddy fields, river margins, sandy soils.

Distribution: Sri Lanka, Indo-China, Malesia, Tropical East Africa and Australia. INDIA: Peninsular and Eastern India. S. GUJARAT: Throughout.

Voucher specimens: 482, 724, 639

34. **Bulbostylis barbata** (Rottb.) C.B. Clarke in *Hooker 6: 651. 1894*; Blatter & Mc Cann JBNHS 37(4): 764. 1934; Shah 2: 712. 1978; Karthik. *et al.* 33. 1989; *Parmar in Shetty & Singh 3:889. 1993*; *Lakshmi. in Sharma et al. 272. 1996*; *Verma in Singh et al. 238. 2001*; Prasad & Singh 47. 2002; *Stenophyllus barbatus* (Rottb.) T.Cooke 2:887. 1908 & 3: 401. 1958.

Annual, 5-25 cm, forming small tufts. Roots fibrous. Stem c. 0.25 mm diam., 4-6-angled, grooved, smooth, grey-green. Leaves to c. half of stem length; sheaths 5-30 mm, grey or yellowish brown, soft, mouth oblique, margin densely fringed with white hairs, 1 mm; blades 0.5 mm wide, but inrolled and resembling stems, grey green, margins minutely scabrous, apex channelled, acute, scabrous. Inflorescence 5-10 mm diam., of tight group of 3-20 sessile or subsessile spikes; bracts 1-2(-4), lowest leaf-like, green, to 20 mm, very fine, acute, scabrous, finally reflexed. Spikes 3.5×1.5 mm; bracts glume-like, 3 mm, incl. arista 1.5 mm; prophylls, c. 1 mm, scarious, bi-nerved; glumes 3-6 per spike, spirally arranged, 1.5-2 mm, acute or acuminate, mid-nerve area green, strongly keeled, scabrous, mid-nerve and two strong side-nerve extend into mucro, up to 0.3 mm, sides scarious, brown, smooth or with scattered prickles, glossy, margin towards apex fringed. Stamens 1-2, anther 1 mm. Nut 0.6-0.7×0.5-0.6 mm, obovoid, sharply triangular, sides very finely papillose, white, glossy. **Plate 224.**

Flowering & Fruiting: August -September.

Habit: In moist sand, in fields.

Distribution: Widely distributed in warm regions of the old world and southern U.S.A. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 253, 475

35. **Fimbristylis alboviridis** C.B. Clarke in *Hooker 6: 638. 1894*; Shah 2: 742. 1978; Karthik. *et al.* 50. 1989; *Lakshmi. in Sharma et al. 305. 1996*; *Verma in Singh et al. 296. 2001*; Prasad & Singh 157. 2002; Cook 136. 2006.

Annuals with fibrous roots. Stems slender, tufted, compressed, angular, glabrous, 20-50cm long, 0.5-1 mm thick. Leaves half as long as the stem, often slightly falcate, flat, acute, glabrous, scabrid on margin, 1-2 mm wide; sheaths up to 5 mm long; Ligule fringe of short hairs. Inflorescence simple anthelodium with few to several spikelets, 2-7 cm long. Involucral bracts 1-2, suberect, overtopping the inflorescence, up to 10 cm long. 1° rays few, suberect, compressed, smooth, up to 5 cm long. Spikelet solitary, terete, ovoid-oblong, acute, densely many flowered, brownish-red, 5-7×2.5 mm; rachilla narrowly winged. Glumes spiral, subchartaceous, broadly ovate, mucicose or apiculate, 1-3-nerved, keeled, glabrous, brownish with hyaline basal and margins, 2×1.5 mm. Stamen 1, anther 0.5 mm long, filament elongate

up to 1.5 mm. Ovary 0.5-0.7 mm long; Style slender, flat, slightly dilated at base, ciliated at upper portion, 1 mm long; Stigmas 2, shorter than style. Nut biconvex, obovate, shortly stipitate, verrucose, 10-12 rowed on each face, epidermal cells transversely elliptic or oblong, cream coloured, 1-1.25×0.7-0.9 mm. **Plate 225.**

Flowering & fruiting: September-October.

Habitat: Grass fields, wastelands, roadsides

Distribution: South and South-east Asia. INDIA: Western peninsula, Central and north-east India, Andaman and Nicobar Islands. S. GUJARAT: Surat, Navsari, Valsad.

Voucher specimens: 371, 435, 660

36. **Fimbristylis argentea** (Rottb.) Vahl in *Enum. Pl.* 2: 294. 1805; Hooker 6: 640. 1894; Blatter & Mc Cann JBNHS 37(3): 541. 1934; Cooke 3:395. 1958; Shah 2: 743. 1978; Karthik. *et al.* 51. 1989; Parmar in Shetty & Singh 3:921. 1993; Lakshmi. in Sharma *et al.* 305. 1996; Verma in Singh *et al.* 297. 2001; Prasad & Singh 160. 2002; Cook 137. 2006.

Small tufted perennials with short rhizome 4-20 cm high. Stems slightly compressed, trigonous, striate, 0.5-1 mm thick. Leaves shorter than the inflorescence, narrowly linear, subacute, canaliculate, scabrous on margins, 0.5-1 mm wide; sheath papery, much broader than the blades; Ligule absent. Inflorescence a capitulum of few to many spikelets, globose, 6-15 mm across. Involucral bracts 2-4, narrowly linear, canaliculate, lower most 2-3 times longer than the inflorescence, 0.8-4 cm long. Spikelets sessile, oblong-ovoid-linear, angular, densely many flowered, 4-6×1.5-2 mm; Rachilla narrowly winged. Glumes membranous, spiral, broadly ovate, obtuse, apiculate, 3-nerved, faintly keeled, 1×1 mm. Stamen 1, filament flat, elongated up to 1.2 mm; anther 0.5 mm long, ovary broadly oblong, 0.4 mm long. Ovary 0.3 mm long; style flat, dilated at the base, minutely ciliated towards apex, 0.8 mm long; stigmas 2, scabrous, 0.6 mm long. Nut biconvex, obovate, apiculate, smooth, cream coloured, 0.6×0.5 mm. **Plate 226.**

Flowering & fruiting: June-April.

Habitat: Wet sandy grounds of grass fields, along the sea shores, wastelands, swampy areas

Distribution: Sri Lanka, Malesia, Thailand, Mauritius, Indo-China. INDIA: Western peninsula, Central and North-East India. S. GUJARAT: Surat.

Voucher specimens: 112, 209, 388

37. **Fimbristylis bisumbellata** (Forssk.) Bubani in *Dodecanthea* 30. 1850; Shah 2: 743. 1978; Karthik. *et al.* 51. 1989; Parmar in Shetty & Singh 3:921. 1993; Lakshmi. in Sharma *et al.* 306. 1996; Verma in Singh *et al.* 297. 2001. Prasad & Singh 162. 2002; Cook 137. 2006; *F. dichotoma* auct. non Vahl, 1806; Hooker 6:635. 1894; Cooke 3:394. 1958.

Annuals with fibrous roots. Stems slender, tufted, striate, triangular, glabrous 3-25 cm long, 0.5-1 mm thick. Leaves half as long as the stem, often slightly falcate, flat, acute, glabrous,

scabrid on margin, 0.8-2 mm wide; Sheaths up to 5 cm long; Ligule fringe of short hairs. Inflorescence simple-compound anthelodium with few to several spikelets, 2-7 cm long. Involucral bracts 4-5, overtopping or shorter than the inflorescence, 1-8 cm long. Primary rays 8-10, smooth, up to 3 cm long. Spikelet solitary, angled, ovoid-ellipsoidal, acute, many flowered, brownish-red, 3-4×1.5-2 mm; rachilla winged. Glumes spiral, membranous, broadly ovate, acute-mucronate, 3-nerved, keeled, glabrous, brownish with hyaline basal and margins, 1.5×2 mm. Stamen 1, anther 0.5 mm long; filament elongate up to 1.2 mm long. Ovary 0.5-0.8 mm long; style slender, ciliated, slightly dilated at base, ciliated at upper portion, 1 mm long; stigmas 2, shorter than style, recurved at later stage. Nut biconvex, obovate, shortly stipitate, verrucose, 5-9 rowed on each face, epidermal cells impressed, cream coloured, 0.7×0.4 mm. **Plate 227.**

Flowering & fruiting: July-November.

Habitat: Grass fields, wastelands, wet sandy ground, along the river banks, agricultural fields.

Distribution: Widely distributed in the old world tropics, extending to the Mediterranean region of Europe. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 332, 466, 749

38. **Fimbristylis cymosa** R.Br. in *Prodr. Fl. Nov. Holl.* 228. 1810; Shah 2: 744. 1978; Karthik. *et al.* 51. 1989; *Parmar in Shetty & Singh* 3:922. 1993; *Lakshmi. in Sharma et al.* 307. 1996; Prasad & Singh 171. 2002; Cook 140. 2006; *F. spathacea* Roth in *Hooker* 6: 640. 1894; Blatter & Mc Cann JBNHS 37(3): 543. 1934; Cooke 3:396. 1958

Perennial with short rhizome. Stems slender, tufted, terete, striate, glabrous, 15-45 cm long, 1-2.5 mm thick. Leaves densely tufted, coriaceous, much shorter than the stem, canaliculate, flat, acute, glabrous, scabrid on margin, 4-15 cm long, 2-3 mm wide; Sheaths 1-3 cm long; Ligule absent. Inflorescence compound-fasciculate anthelodium with several spikelets, 3-7 cm long. Involucral bracts 2-3, overtopping-shorter than the inflorescence, 0.5-4 cm long. Primary rays few, smooth, up to 3 cm long. Spikelet solitary, often clustered, ovoid-ellipsoidal, obtuse, slightly angled, many flowered, brownish, 2-7×2-3 mm; rachilla winged. Glumes spiral, membranous, broadly ovate, obtuse-acute, 3-nerved, faintly keeled, glabrous, brownish with hyaline basal and margins, 1.5-2×1-1.2 mm. Stamen 2, anther 0.7 mm long, filament elongate up to 2 mm long, connective apiculate. Ovary oblong, 0.5 mm long; Style slender, glabrous, slightly dilated at base, ciliated at upper portion, 0.5-0.7 mm long; Stigmas 2, 0.8-1 mm long. Nut biconvex, obovate, shortly stipitate, warty, cream-black coloured, 1×0.7 mm. **Plate 228.**

Flowering & fruiting: July-December.

Habitat: Grass fields, wastelands, wet sandy ground, along the river banks, agricultural fields.

Distribution: Pantropic. INDIA: Western peninsula, East India, Andaman & Nicobar Islands S. GUJARAT: Surat.

Voucher specimens: 278, 365, 381, 788, 834.

39. **Fimbristylis dichotoma** (L.) Vahl in *Enum. Pl.* 2: 287. 1805; Shah 2: 744. 1978; Karthik. *et al.* 51. 1989; Parmar in Shetty & Singh 3:923. 1993; Lakshmi. in Sharma *et al.* 307. 1996; Verma in Singh *et al.* 298. 2001; Prasad & Singh 172. 2002; Cook 141. 2006; *F. podocarpa* Nees *Contr. Bot. India* 98. 1834; Hooker 6: 638 1894; *F. dichotoma* var. *pluristriata* (C.B. Clarke) Napper *Kew Bull.* 25: 437. 1971; Cooke 3:396. 1958; Shah *op. cit.* 744; *F. diphylla* (Retz.) Vahl in Hooker *op. cit.* 636; *F. diphylla* var. *annua* (All.) C.B. Clarke in Hooker *op. cit.* 637; *F. diphylla* var. *pluristriata* C.B. Clarke in Hooker *op. cit.* 637; *F. annua* var. *paucispiculata* Blatter & Mc Cann *JBNHS* 37(3): 544. 1934.

Perennial with short woody rhizome. Stems stout, tufted, angular, striate, glabrous, 15-65 cm long, 1-2 mm thick. Leaves flat, coriaceous, acute, glabrous, scabrid on margin, 4-40 cm long, 1.5-3 mm wide; sheaths 0.5-18 cm long, glabrous-pubescent, Ligule a dense fringe of short hairs. Inflorescence simple-compound anthelodium with few-several spikelets, 3-7 cm long. Involucral bracts 2-5, lower one overtopping the inflorescence, 0.5-5 cm long. Primary rays few, striate, up to 3 cm long. Spikelet solitary, ovoid-ellipsoidal, acute, terete, many flowered, brownish, 4-7×2-4 mm; rachilla winged. Glumes spiral, chartaceous, broadly ovate, mucronate, 3-nerved, keeled, glabrous, dark brown, 5-3×1.5-2 mm. Stamen 1-2, anther 0.7-1 mm long, filament elongate up to 3 mm long. Ovary oblong, 0.5 mm long; Style flat, slightly dilated at base, ciliated, 1-1.5 mm long; Stigmas 2, 0.8-1.5 mm long. Nut biconvex, obovate, shortly stipitate, trabaculate, 8-10 rows on each surface, cream coloured, 1-1.2×0.7-1 mm.

Plate 229.

Flowering & fruiting: April-December.

Habitat: Grass fields, wastelands, wet sandy ground, along the river banks, agricultural fields, road sides.

Distribution: Throughout the warmer part of world. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 125, 243, 581

40. **Fimbristylis ferruginea** (L.) Vahl in *Enum. Pl.* 2: 291. 1805; Hooker 6: 638. 1894; Blatter & Mc Cann *JBNHS* 37(3): 544. 1934; Cooke 3:396. 1958; Shah 2: 745. 1978. Karthik. *et al.* 52. 1989; Parmar in Shetty & Singh 3:924. 1993; Lakshmi. in Sharma *et al.* 309. 1996; Verma in Singh *et al.* 301. 2001; Prasad & Singh 181. 2002; Cook 142. 2006.

Perennial with short woody rhizome. Stems stiff, tufted, angular, striate, glabrous, 25-75 cm long, 1-2 mm thick. Leaves cauline, much shorter than stem, coriaceous, acute, glabrous, scabrid on margin, 7-40 cm long, 1-2 mm wide; sheaths glabrous, shining brown, 0.5-18 cm long; Ligule a dense fringe of short hairs. Inflorescence mostly simple-compound anthelodium with few-several spikelets, 3-10 cm long. Involucral bracts 3-4, lower one shorter than the inflorescence, dilated at the base, up to 5 cm long. Primary rays few, striate, compressed, up to 10 cm long. Spikelet solitary, ovoid-ellipsoidal, acute, terete, many flowered, dull brown, 4-15×3-5 mm; rachilla winged. Glumes spiral, membranous, ovate-oblong, obtuse-acute, 1-nerved, keeled, pubescent on upper half, dark brown, 5-6×2-3 mm. Stamen 3, anther 1.5-2

mm long, filament elongate up to 4 mm long. Ovary oblong, 0.7-1 mm long; Style flat, faintly dilated at base, ciliated, 3 mm long; Stigmas 2, 1.5-2 mm long. Nut biconvex, broadly obovate, compressed, distinctly stipitate, smooth, cream coloured, 1-1.5×0.7-1 mm. **Plate 230.**

Flowering & fruiting: Throughout the year.

Habitat: Saline area near brackish water, mudflats, in salt pans, wet sandy ground, along the river banks.

Distribution: Pantropic. INDIA: Throughout except north-east regions. S. GUJARAT: Surat, Navsari, Valsad.

Voucher specimens: 217, 263, 612

41. **Fimbristylis ferruginea** var. **ferruginea** Vahl; *F. sieberiana* Kunth Enum. Pl. 2:237. 1837; Shah 2: 748. 1978; Karthik. *et al.* 55. 1989; *Parmar in Shetty & Singh* 3:928. 1993; *Lakshmi. in Sharma et al.* 317. 1996; Prasad & Singh 205. 2002; Cook 148. 2006.

Perennial with short woody rhizome. Stems stiff, tufted, striate, glabrous, 25-65 cm long, 1-1.5 mm thick. Leaves cauline, shorter than stem, coriaceous, acute, glabrous, scabrid on margin, up to 40 cm long, 1-2 mm wide; sheaths membranous-papery, glabrous, 0.5-18 cm long; Ligule a fringe of short hairs. Inflorescence mostly simple-compound anthelodium with few-several spikelets, 2-8 cm long. Involucral bracts 2-3, lower one equaling or overtopping the inflorescence, up to 10 cm long. Primary rays few, striate, compressed, up to 5 cm long. Spikelet solitary, ovoid, acute, terete, densely many flowered, brownish, 5-10×2-4 mm; rachilla winged. Glumes spiral, membranous, ovate-oblong, obtuse-apiculate, 1-nerved, keeled, pubescent at apex, dark brown, 3-4×2.5-3 mm. Stamen 3, anther 1-1.5 mm long, filament elongate up to 4 mm long. Ovary oblong, 1 mm long; Style flat, faintly dilated at base, ciliated, 2-2.5 mm long; Stigmas 2, 1-1.5 mm long. Nut biconvex, oblong-obovate, compressed, distinctly stipitate, smooth-verrucose, epidermal cells impressed, cream coloured, 1.5×1 mm. **Plate 231.**

Flowering & fruiting: March-June.

Habitat: Saline marshy area, muddy shores water bodies, irrigated areas, along the river banks.

Distribution: Asia and Africa. INDIA: Penninsular, North & North-West India. S. GUJARAT: Surat, Navsari, Valsad.

Voucher specimens: 385, 423, 634

42. **Fimbristylis littoralis** Gaudich. in *Voy. Uranie* 413. 1829; Shah 2: 746. 1978; Karthik. *et al.* 53. 1989; *Lakshmi. in Sharma et al.* 312. 1996; *Verma in Singh et al.* 303. 2001; Prasad & Singh 186. 2002; Cook 143. 2006; *F. miliacea* (L.) *sensu* Vahl in *Enum. Pl.* 2: 267 1805; *Hooker* 6: 644. 1894; *Cooke.* 3:397. 1958; *Parmar in Shetty & Singh* 3:925. 1993.

Annuals or short-lived perennials. Stems tufted, glabrous, 4-angled, 10-45 cm long, 1-2 mm thick. Leaves flat, shorter than stem, coriaceous, acuminate, striate, grooved on upper surface, scabrid on margin, up to 40 cm long, 1-3 mm wide; upper leaves reduced to sheaths, sheaths membranous-papery, glabrous, up to 12 cm long; Ligule absent. Inflorescence mostly

compound anthelodium with numerous spikelets, 2-10 cm long. Involucral bracts 3-5, much shorter than the inflorescence, up to 3 cm long. Primary rays several, angled, scabrid, up to 5 cm long. Spikelet solitary, globose-subglobose, obtuse, terete, densely many flowered, brownish, 3-5×2-3 mm; rachilla not winged. Glumes spiral, membranous, boat-shaped, ovate, obtuse-muticous, 1-nerved, faintly keeled, dark brown streaks on both the sides of keel and hyaline on margins, 1-1.5×0.5-0.8 mm. Stamen 2, anther 0.5 mm long, filament elongate up to 1 mm long. Ovary oblong, 0.3-0.5 mm long; Style triquetrous, thickened towards base, ciliated towards apex, 0.5-0.8 mm long; Stigmas 3, ciliolate, as long as style. Nut trigonous, obovoid, umbonulate at apex, faintly stipitate, verrucose, epidermal cells transversely linear-oblong, cream coloured, 0.6-0.7×0.4 mm. **Plate 232.**

Flowering & fruiting: Throughout the year.

Habitat: common on edges of ponds, near streams and canals, roadsides ditches, other moist and swampy areas, common weed in paddy fields.

Distribution: Pantropical. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 244, 462, 364

43. **Fimbristylis merrillii** J.Kern in *Blumea* 8: 135 1955. Mistry & Almeida J. Eco. Tax. Bot. (1987) 9: 403; Karthik. *et al.* I (Addenda & Corrigenda). 1989; Prasad & Singh 189. 2002; *Lakshmi. in Sharma et al.* 313. 1996.

Annuals with fibrous roots. Stems slender, tufted, striate, compressed-angular, glabrous, scabrous at apex, 7-20 cm long, 0.7-1.5 mm thick. Leaves mostly basal, shorter than the stem, flat, linear, acuminate, glabrous, scabrid on margin, 3-15 cm long, 0.7-1.5 mm wide; Sheaths striate, puberulous near apex; Ligule a dense fringe of short hairs. Inflorescence simple anthelodium with 3-few spikelets, up to 3 cm long. Involucral bracts 1-3, overtopping or shorter than the inflorescence, puberulous on dilated base, 1-3.5 cm long. Primary rays 2-6, smooth, up to 2 cm long. Spikelet solitary, terete, ovoid-oblong-linear, acute, densely many flowered, brownish, 3-4×1.5-2 mm; rachilla narrowly winged. Glumes spiral, subchartaceous, broadly ovate, acute-apiculate, 3-nerved, faintly keel, glabrous, sides without nerves, 1.5-2×1.2-1.5 mm. Stamen 1-2, anther 0.5 mm long; filament elongate up to 2.5 mm long. Ovary 0.5-0.8 mm long; style flat, ciliated, slightly dilated at base, glabrous or ciliated at upper portion, 1 mm long; stigmas 2, shorter than style. Nut biconvex, obovate, shortly stipitate, minutely umbonulate, trabaculate, 7-10 rowed on each face, epidermal cells oblong, cream coloured, 1×0.8 mm. **Plate 233.**

Flowering & fruiting: July-November.

Habitat: Grass fields, wastelands, along the river banks, agricultural fields.

Distribution: South China, Thailand, Malesia, Queensland. INDIA: Western India. S. GUJARAT: Surat, Navsari, Valsad, Dangs. **New record for the State.**

Voucher specimens: 188, 246, 466, 784, 795

44. **Fimbristylis ovata** (Burm.f.) J. Kern in *Blumea* 15: 126. 1967; Shah 2: 747. 1978; Karthik. *et al.* 54. 1989; *Parmar in Shetty & Singh* 3:925. 1993; *Lakshmi. in Sharma et*

al. 316. 1996; Verma in Singh *et al.* 304. 2001; Prasad & Singh 195. 2002; Cook 145. 2006; *F. monostachya* (L.) Hassk. in Hooker 6: 649. 1894; Blatter & Mc Cann JBNHS 37(3): 548. 1934; Cooke 3:399. 1958.

Perennial with short rhizome. Stems slender, tufted, sulcate, trigonous, scabrous on edges, 10-65 cm long, 0.5-1 mm thick. Leaves very narrow, much shorter than the stem, flat with incurved margins, acuminate, glabrous, scabrid on margin, 4-25 cm long, 0.5-1.2 mm wide; Sheaths up to 5 cm long; Ligule absent. Inflorescence terminal unispiculate, sometimes proliferated in to 2-3 peduncled spikelets. Involucral bracts 2-3, very small, scale like, mid-nerve elongate to aristate apex; up to 1 cm long. Spikelet ovate-pyriform, acute, compressed, 8-20 flowered, greenish, 6-15×3-5 mm; rachilla prominently winged. Glumes distichous and becoming spiral in later stage, membranous, broadly ovate, acute-mucronate, 3-nerved, strongly keeled, greenish, 3-5×3-4 mm. Stamen 3, anther 1.5-2 mm long, filament elongate up to 5 mm long, connective apiculate. Ovary oblong, 1 mm long; Style triquetrous, glabrous, thickened at base, ciliated, 3 mm long; Stigmas 3, shorter than style, 0.5-1.5 mm long. Nut trigonous, pyriform, truncate with umbonate apex, shortly stipitate, warty, epidermal cells isodiametric in many rows, greyish, 2.5-3×1.5 mm. **Plate 234.**

Flowering & fruiting: May-December.

Habitat: Grass fields, overgrazed and sunny grasslands, stony grounds, shady places along road sides, agricultural fields.

Distribution: Pantropic. INDIA: Throughout the warmer parts S. GUJARAT: Navsari, Valsad.

Voucher specimens: 265, 640, 678

45. ***Fimbristylis polytrichoides*** (Retz.) R.Br. in *Prodr. Fl. Nov. Holl.* 226. 1810; Hooker 6: 632. 1894; Blatter & Mc Cann JBNHS 37(3): 540. 1934; Cooke 3:393. 1958; Shah 2: 747. 1978; Karthik. *et al.* 54. 1989; Lakshmi. in Sharma *et al.* 316. 1996; Verma in Singh *et al.* 304. 2001; Prasad & Singh 199. 2002; Cook 145. 2006.

Perennial with short rhizome and fibrous roots. Stems slender, tufted, erect, glabrous, sulcate, subterete-trigonous, 3-30 cm long, 0.5-1 mm thick. Leaves much shorter than the stem, canaliculate, acuminate, glabrous, scabrid on margin, 2-15 cm long, 0.5-1.2 mm wide; Sheaths up to 5 cm long; Ligule a row of short hairs. Inflorescence terminal unispiculate. Involucral bracts glume like, papery, oblong-lanceolate, 3×1 cm long, mucronate with 3-mid veins, often leafy, 0.5-2 mm. Spikelet terete, ovate-elliptic, acute-obtuse, densely many flowered, greenish-pale brown, 5-9×2-4 mm; rachilla narrowly winged. Glumes imbricate-spiral, membranous, oblong-ovate, obtuse-acute-apiculate, 3-nerved, faintly keeled, greenish, 2.5-3×1-1.2 mm. Stamen 1-2, anther 1 mm long, filament elongate up to 2 mm long, connective apiculate. Ovary oblong-obovate, 0.6 mm long; Style slightly dilated at the base, 1 mm long; Stigmas 2, ciliated, 1-1.5 mm long. Nut obovate, biconvex, shortly stipitate, verruculose, warty, greyish black, 1×0.8 mm. **Plate 235.**

Flowering & fruiting: August-December.

Habitat: Wet saline areas near sea, salt pans.

Distribution: Tropical Asia, Africa, Australia. INDIA: Western peninsular, Central and eastern India. S. GUJARAT: Navsari, Valsad.

Voucher specimens: 337, 641, 700

46. **Fimbristylis quinquangularis** (Vahl) Kunth in *Enum. Pl.* 2: 229. 1837; *Hooker* 6: 644. 1894; Blatter & Mc Cann JBNHS 37(3): 547. 1934; Cooke 3:397. 1958; *Parmar in Shetty & Singh* 3:926. 1993; *F. miliacea* (L.) Vahl in *Enum. Pl.* 2: 267. 1805; *Hooker op. cit.* 644; Blatter & Mc Cann *op. cit.* 546; Shah 2: 746. 1978; Karthik. *et al.* 53. 1989; *Lakshmi. in Sharma et al.* 315. 1996; *Verma in Singh et al.* 303. 2001; Prasad & Singh 193. 2002; Cook 144. 2006.

Annuals with fibrous roots. Stems tufted, glabrous, erect, 4-5 angled, striate, 10-60 cm long, 0.8-1.5 mm thick. Leaves basal, flat, shorter or as long as stem, coriaceous, acute, striate, scabrid on margin, 1-2.5 mm wide; sheaths, sheaths papery, glabrous, up to 1-9 cm long; Ligule absent. Inflorescence mostly compound-decompound anthelodium with numerous spikelets, 2-10 cm long. Involucral bracts 3-6, much shorter than the inflorescence, up to 0.6-3.5 cm long. Primary rays several, compressed, scabrid, up to 5 cm long. Spikelet solitary, ovoid, acute, angled, many flowered, brownish, 2-4×1.5-2 mm; rachilla prominently winged. Glumes spiral, membranous, ovate, obtuse-apiculate, 1-nerved, keeled, dark brown streaks on both the sides of keel and hyaline on margins, 1.5-2×1-1.5 mm. Stamen 1, anther 0.5 mm long, filament elongate up to 1.5 mm long. Ovary oblong, 0.4-0.5 mm long; Style triquetrous, thickened towards base, ciliated towards apex, 0.5-0.7 mm long; Stigmas 3, ciliolate, longer than style. Nut trigonous, obovoid-globose, umbonulate at apex, faintly stipitate, verrucose, epidermal cells transversely linear-oblong, white-cream coloured, 0.7-0.8×0.4-0.5 mm. **Plate 236.**

Flowering & fruiting: October-January.

Habitat: common on edges of ponds, near streams and canals, roadsides ditches, other moist and swampy areas, common weed in paddy fields.

Distribution: Sri Lanka, South China, Formosa, Malesia, Tropical Africa, Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 189, 376, 525

47. **Fimbristylis schoenoides** (Retz.) Vahl in *Enum. Pl.* 2: 286. 1805; *Hooker* 6: 634. 1894; Blatter & Mc Cann JBNHS 37(3): 541. 1934; Cooke 3:394. 1958; Shah 2: 743. 1978; Karthik. *et al.* 54. 1989; *Parmar in Shetty & Singh* 3:927. 1993; *Lakshmi. in Sharma et al.* 317. 1996; *Verma in Singh et al.* 304. 2001; Prasad & Singh 202. 2002; Cook 147. 2006.

Perennial with short rhizome. Stems slender, densely tufted, striate-sulcate, 5-40 cm long, 0.3-1 mm thick. Leaves filiform, much shorter than the stem, acuminate, glabrous, scabrid on margin, 6-15 cm long, 0.5-1 mm wide; Sheaths 2-5 cm long; Ligule a fringe of short hairs. Inflorescence terminal unispiculate, often 2-3 peduncled spikelets. Involucral bracts glume like, ovate-triangular, apiculate, scabrous on margins, 2×1 mm long, often leafy, up to 6 mm long. Spikelet ovoid, acute, compressed, many flowered, greenish, 4-6×3-5 mm; rachilla prominently winged. Glumes spiral, membranous, broadly ovate, apiculate, 5-7-nerved, strongly keeled, with brown spots towards center, 3×2.5 mm. Stamen 3, anther 1 mm long,

filament elongate up to 4 mm long, connective mucronate. Ovary oblong, 0.5 mm long; Style flat, dilated at base, ciliated, 1.5 mm long; Stigmas 2, shorter than style, 0.5-1 mm long. Nut biconvex, obovate, stipitate, verrucose, epidermal cells isodiametric in many rows, brownish white, 1-1.5×1.5-1.8 mm. **Plate 237.**

Flowering & fruiting: August-January.

Habitat: Grass fields, open forest areas, shady places along road sides, agricultural fields.

Distribution: Sri Lanka, China, Malesia, Thailand, Formosa and Tropical Australia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 190, 372, 415, 519

48. **Fimbristylis tenera** Schult. In *Mant.* 2: 57. 1824; Shah 2: 748. 1978; Karthik. *et al.* 55. 1989; *Lakshmi. in Sharma et al.* 319. 1996; *Verma in Singh et al.* 308. 2001; Prasad & Singh 210. 2002; *F. tenera* var. *oxylepis* (Steud.) C.B. Clarke in *Hooker* 6: 642. 1894; Blatter & Mc Cann JBNHS 37(3): 546. 1934; *Parmar in Shetty & Singh* 3:929. 1993; *F. monticola* Hochst. Ex Steud. in *Cooke* 3:399. 1958.

Annuals with fibrous roots. Stems slender, tufted, triangular, glabrous, 10-35 cm long, 0.2-0.5 mm thick. Leaves up to half the length of the stem, flat, acuminate, glabrous, scabrid on margin, 4-20 cm long, 0.5-1 mm wide; sheaths up to 4 cm long, papery; Ligule absent. Inflorescence simple anthelodium with few-several spikelets, up to 5 cm long. Involucral bracts 3-4, lower one overtopping the inflorescence, 1-10 cm long. Primary rays few, striate, up to 3 cm long. Spikelet solitary, ovate-lanceolate, acute, angled, many flowered, brownish, 4-7×1.5-2 mm; rachilla winged. Glumes spiral, chartaceous, broadly triangular-ovate, acute-mucronate, 3-nerved, keeled, membranous towards margins, minutely puberulous at apex, brown, 2.5×2 mm. Stamen 1, anther 0.7 mm long, filament elongate up to 2 mm long. Ovary oblong-obovoid, 0.5 mm long; Style triquetrous, slightly dilated at base, 1-1.5 mm long; Stigmas 3, scabrous, 0.5 mm long. Nut trigonous with convex faces, obovoid, shortly stipitate, verruculose, sub-tuberculate, with 8-10 series of transversely hexagonal epidermal cells, whitish, 0.8-1×0.5-0.8 mm. **Plate 238.**

Flowering & fruiting: July-December.

Habitat: Grass fields, wastelands, wet sandy ground, along the river banks, agricultural fields, road sides.

Distribution: Sri Lanka and tropical Africa. INDIA: Western Peninsula, Central and North India. S. GUJARAT: Throughout.

Voucher specimens: 165, 367, 643

49. **Fimbristylis tetragona** R.Br. *Prodr. Fl. Nov. Holl.* 226. 1810; *Hooker* 6: 631. 1894; Blatter & Mc Cann JBNHS 37(3): 539. 1934; *Cooke* 3:393. 1958; Shah 2: 749. 1978; Karthik. *et al.* 55. 1989; *Parmar in Shetty & Singh* 3:930. 1993; *Lakshmi. in Sharma et al.* 319. 1996; *Verma in Singh et al.* 308. 2001; Prasad & Singh 211. 2002; Cook 149. 2006.

Perennial with short rhizome. Stems slender, densely tufted, erect, glabrous, quadrangular, 7-50 cm long, 0.5-1 mm thick. Leaves much reduced to sheaths, sheaths 2-3, 3-10 cm long, sometimes uppermost with short lanceolate blade. Inflorescence terminal unispiculate. Spikelet ebracteate, ovoid-spherical, terete, obtuse, densely many flowered, dark brown, 5-10×4-6 mm; rachilla narrowly winged. Glumes imbricate-spiral, membranous, oblong-ovate, obtuse-acute, 5-nerved, faintly keeled, usually with brownish lines in the centre, hyaline towards margins, lower empty, 3-3.5×1.5-2.5 mm. Stamen 1-2, anther 1-1.5 mm long, filament elongate up to 3 mm long, connective apiculate. Ovary oblong, 1 mm long; Style slightly dilated at the base, minutely ciliate, 1 mm long; Stigmas 2, 0.5 mm long. Nut oblong-cylindrical, with persistent style and staminal filaments, obtuse, slightly curved, shortly stipitate, trabeculate, light yellow, 2×0.5 mm. **Plate 239.**

Flowering & fruiting: August-February.

Habitat: Open wet places, in and around rice fields, along with short grasses in wet soil.

Distribution: Sri Lanka, Nepal, South China, Malesia, Thailand, Indo-China, Formosa, Tropical Australia. INDIA: Throughout. S. GUJARAT: Valsad.

Voucher specimens: 361, 645, 661

50. **Fimbristylis umbellaris** (Lam.) Vahl in *Enum. Pl. 2: 291. 1805*; Cook 150. 2006; *F. globulosa* var. *torresiana* (Gaudich.) C.B. Clarke in *Hooker 6: 645. 1894*. Karthik. *et al.* 51. 1989.

Annuals or short-lived perennials. Stems tufted, glabrous, 4-angled, 10-45 cm long, 1-2 mm thick. Leaves reduced to sheaths covering the basal portion of the stem, sometimes with a very short appendage like blade, sheaths membranous-papery, glabrous, up to 15 cm long; Ligule absent. Inflorescence mostly compound anthelodium with numerous spikelets, 2-10 cm long. Involucral bracts 3-5, much shorter than the inflorescence, up to 3 cm long. 1° rays several, angled, scabrid, up to 5 cm long. Spikelet solitary, globose-subglobose, obtuse, terete, densely many flowered, brownish, 3-5×2-3 mm; rachilla not winged. Glumes spiral, membranous, boat-shaped, ovate, obtuse-muticous, 1-nerved, faintly keeled, dark brown streaks on both the sides of keel and hyaline on margins, 1-1.5×0.5-0.8 mm. Stamen 1-2, anther 0.3-0.5 mm long, filament elongate up to 1 mm long. Ovary oblong, 0.3-0.5 mm long; Style triquetrous, thickened towards base, ciliated towards apex, 0.5-0.8 mm long; Stigmas 3, ciliate, as long as style. Nut trigonous, obovoid, umbonulate at apex, faintly stipitate, verrucose, epidermal cells transversely linear-oblong, cream coloured, 0.6-0.7×0.4 mm. Tufted perennial, 20-50(-120) cm. Rhizome short. Stem 1-5 mm diam, obtusangular, smooth. Cauline leaves reduced to blade-less, obliquely truncate sheaths; ligule absent; blades of basal leaves flat or canaliculate, c. 1.5 mm wide. Inflorescence a small or compound anthelodium, to 10 cm, with to 40 spikes; bracts to 1 cm; primary branches to 10, to 5 cm; spikes 4-8×3-4 mm, globose or ovoid, terete, obtuse, rachilla narrowly winged; glumes 2-2.7 mm, ovate, with rounded apex and margins widely hyaline. Stamens 2-3, anthers c. 0.5 mm; stigmas 3(-2). Nut 0.7-1×0.6-0.8 mm, trigonous (or biconvex), verruculose. **Plate 240.**

Flowering & fruiting: Throughout the year.

Habitat: common on edges of streams and canals, roadsides ditches.

Distribution: From Sri Lanka and Pakistan to S. China, Japan, to Malesia and the Pacific islands. INDIA: Endemic to Kerala. S. GUJARAT: Tapi. **New record for the State.**

Voucher specimens: 267, 648, 781

51. **Bolboschoenus maritimus** (L.) Palla *Syn. Deut. Schweiz. Fl. ed. 3: 2532. 1904*; *S. maritimus* L. *Sp. Pl. 51. 1753*; Hooker 6: 658. 1894; Blatter & Mc Cann JBNHS 37(4): 768. 1934; Cooke 3:407. 1958; Cook 96. 2006. *Schoenoplectus maritimus* (L.) Lye *Blyttia* 29: 145. 1971; *Lakshmi. in Sharma et al. 365. 1996*; *B. maritimus* (L.) Palla var. *maritimus. Parmar in Shetty & Singh 3:888. 1993*; *B. maritimus* (L.) Palla subsp. *maritimus. Prasad & Singh 43. 2002*; *Scirpus maritimus* var. *maritimus. Verma in Singh et al. 327. 2001.*

Rhizomes creeping, terminated by a small ovoid tuber. Culms 25-150 cm tall, 3-angled, smooth. Leaf sheath fronts with veinless triangular to rhombic area at summit; leaf blade linear, 2-12 mm wide, flat, stiff, apical ones longer or as long as culm. Involucral bracts 2 or 3, leaflike, overtopping inflorescence. Inflorescence an anthelodium, 1° branches more than 10, to 80 mm; lowest 2-3 bracts leaf-like, up to 30×0.5 cm wide, sheath less; 1° branches end with often more than 20 spreading spikes in irregular spiral, but small 2° anthelodia frequent. Spikelets ovoid to narrowly ovoid, 10-16×3.5-7 mm, many-flowered. Glumes bright orangish brown to stramineous, oblong-ovate, 5-8 mm, membranous, abaxially pubescent, 1-veined costa excurrent into a 1-3 mm awn, apex 2-cleft. Perianth bristles 6, 1/2 as long as nutlet, retrorsely scabrous, usually not persistent on nutlet. Stamens 3; anthers linear-oblong, 2-4 mm; connective apex conic, 0.5 mm. Style slender; stigmas 2, as long as style. Nutlet dark brown, broadly obovoid, 2.5 mm, biconvex, shiny, apex rounded to truncate. **Plate 241.**

Flowering & Fruiting: June-September.

Habitat: Coastal marshes; near sea level.

Distribution: Throughout. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 88, 292, 511, 761

52. **Eleocharis atropurpurea** (Retz.) J.Presl & C.Presl *Reliq. Haenk. 1: 196. 1828*; Hooker 6: 627. 1894; Blatter & Mc Cann JBNHS 37(3): 537. 1934; Cooke 3:403. 1958; Shah 2: 738. 1978; Karthik. *et al. 48. 1989*; *Parmar in Shetty & Singh 3:915. 1993*; *Lakshmi. in Sharma et al. 298. 1996*; *Verma in Singh et al. 286. 2001*; Prasad & Singh 140. 2002; Cook 127. 2006.

Annual, 2-15 cm, forming small tufts. Roots fibrous. Stem 0.3-0.5 mm diam., with 5-6 obtuse angles separated by deep grooves. Lower closed sheath 3-5 mm, brown or reddish, upper to 10 mm, green or grey green, base often reddish, with 5-6 green nerves, mouth oblique; blades absent. Spike 2-7×1-3 mm, ovoid or globose, with c. 30 or more glumes in five spiral rows, all fertile; basal glume not distinct or slightly larger and with more pronounced mid-nerve than in other glumes; glumes 1.1-1.6 mm, cymbiform, with prominent, green mid-nerve not quite reaching obtuse apex, sides brown or dark reddish brown, nerves obscure or missing, margins more or less scarious. Perianth bristles rising from white collar, 4-7 or 0, to as long as nut, white or pale brownish; stamens 1-2, anthers 0.3-0.5 mm. Nut 0.6-0.8×0.5-0.6 mm, obovoid, bi-convex, apex rounded, basal part gradually tapering, obscurely or finely reticulate, finally

black, glossy; stylopodium much wider than long, 0.1×0.3 mm, white, clearly constricted from nut. **Plate 242.**

Flowering & Fruiting: September - October.

Habitat: Rice fields, wet meadows.

Distribution: Pantropical and extending into S Europe, Mediterranean regions, tropical Africa, Madagascar, India, Malaysia, Australia, N and S America. INDIA: Western Peninsula and NE India. S. GUJARAT: Throughout.

Voucher specimens: 173, 213, 297

53. **Eleocharis dulcis** (Burm.f.) Trin. ex Hensch. *Vita Rumphii* 186. 1833; Shah 2: 738. 1978; Karthik. *et al.* 49. 1989; *Parmar in Shetty & Singh* 3:916. 1993; *Lakshmi. in Sharma et al.* 299. 1996; *Verma in Singh et al.* 288. 2001; Prasad & Singh 142. 2002; Cook 128. 2006; *E. plantaginea* (Retz.) Roem. & Schult. *Syst. Veg.* 2: 150. 1817; Hooker 6: 625. 1894; Blatter & Mc Cann JBNHS 37(3): 537. 1934; Cooke 3:402. 1958

Perennial, forming small tufts, sterile stems to 140 cm. Rhizome short, emitting white stolons which end in a spherical, edible tuber. Stem 3-5 mm diam., terete, with conspicuous septae 2-5 cm apart, often with less pronounced septa between. Sheaths absent (in specimens studied). Spike 20-50 x 7-10 mm; two basal glumes green, lower almost completely clasping, upper opposite, smaller; glumes 6.5-8 mm, finally yellowish grey, cymbiform, with clear mid-nerve, other nerves obscure, margin scarious, 0.5 mm wide, apex rounded. Perianth bristles 6-8, rigid, yellowish, equalling nut; stamens 3; stigmas 2 or 3. Nut 2-2.3 x 1.6-1.8 mm (without stylopodium), thickly bi-convex, spherical or obovoid, brown or yellow-brown, shiny, surface finely reticulate, with 0.5 mm stipe, apical annulus bordering style base; stylopodium 1 x 0.8 mm. conical, flat or shallowly trigonous, brown or dark brown, often with remains of whole style attached. **Plate 243.**

Flowering & Fruiting: September.

Habitat: In shallow water, ponds

Distribution: Africa, SE Asia, Australia, Pacific Islands; frequently cultivated. INDIA: Western Peninsula and NE India. S. GUJARAT: Throughout.

Voucher specimens: 438, 516

54. **Eleocharis geniculata** (L.) Roem. & Schult. *Syst. Veg.* 2: 150. 1817; Shah 2: 739. 1978; Karthik. *et al.* 49. 1989; *Parmar in Shetty & Singh* 3:916. 1993; *Lakshmi. in Sharma et al.* 299. 1996; *Verma in Singh et al.* 289. 2001; Prasad & Singh 143. 2002; Cook 129. 2006; *Scirpus geniculatus* L. *Sp. Pl.* 48. 1753; Hooker 6: 627. 1894; Cooke 3:404. 1958;

Tufted annual, 12-25 cm. Roots white, fibrous. Stem 0.5-1 mm diam., green, with 5-6 obtuse angles separated by deep grooves. Open sheaths c. 5 mm, wide, scarious; lower closed sheath to 15 mm, reddish brown or green, mouth oblique, upper to 50 mm, green or basal parts reddish, with 5 nerves, mouth oblique, margin narrowly scarious; blades 0 or minute tip. Spike

3-6×3-4 mm, ovoid or globular, with 50 or more very closely imbricating glumes; basal glume fertile, not distinct from other glumes or its mid-nerve more pronounced and stronger; glumes 1.7-2.2 mm, not in protruding spiral rows, cymbiform, rounded, mid-nerve not very distinct, not reaching apex, sides grey brown, margins narrowly scarious. Perianth bristles 6-8, as long as or longer than nut, brown; stamens 2-3, anthers 0.5-0.7 mm; stigmas 2. Nut 0.8-1×0.6-0.8 mm (excl. stylopodium), obovoid, bi-convex, apex rounded, basal part gradually tapering, obscurely reticulate, glossy, finally black; stylopodium 0.1-0.2×0.3-0.4 mm, much wider than long, white, clearly constricted from nut. **Plate 244.**

Flowering & Fruiting: April -June.

Habitat: Rice fields, marshlands, wet meadows;

Distribution: Pantropical extending into subtropics. INDIA: Peninsula and NE India. S. GUJARAT: Throughout.

Voucher specimens: 155, 164, 726

55. **Eriophorum comosum** (Wall.) Nees *Contr. Bot. India* 110. 1834; Hooker 6: 664. 1894; Blatter & Mc Cann JBNHS 37(4): 771. 1934; Cooke 3:411. 1958; Shah 2: 739. 1978; Karthik. *et al.* 50. 1989; *Parmar in Shetty & Singh* 3:917. 1993; *Lakshmi. in Sharma et al.* 301. 1996; *Verma in Singh et al.* 291. 2001

Rhizomes short, stout. Culms densely tufted, obtusely 3-angled or rarely cylindric, 14-78 cm tall, 1-2 mm thick, smooth, clothed at base with black to brown leaf sheaths. Leaves many, overtopping inflorescence; leaf blade linear, 0.5-1 mm wide, margin involute and scabrous, gradually tapering and setaceous toward apex. Involucral bracts leaf like, overtopping inflorescence; bracts lanceolate, margin scabrous, apically setaceous. Inflorescence a large compound or decompound anthela, 6-22 cm. Spikelets many, solitary or a cluster of 2 or 3, oblong but ellipsoid at anthesis, 6-12 mm. Glumes brown, ovate-lanceolate, 2.3-3 mm, membranous, keel green, excurrent into a mucro at acute to obtuse apex; basal 4 glumes empty. Perianth bristles many, surpassing glume at maturity, 7 mm, smooth. Stamens 2; anthers purplish black, narrowly ovoid, apex mucronate. Style shorter than nutlet; stigmas 3. Nutlet narrowly oblong, 2.5 × 0.5 mm (including beak), compressed 3-sided. **Plate 245.**

Flowering and fruiting: May-November.

Habitat: Crevices on rock or cliffs, grassland slopes;

Distribution: Afghanistan, Bangladesh, Bhutan, N India, Indonesia (Java), Kashmir, N Myanmar, Nepal, Pakistan, Vietnam; SW Asia. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 122, 277, 710

56. **Fuirena ciliaris** (L.) Roxb. *Hort. Bengal.* 81. 1814; Blatter & Mc Cann JBNHS 37(4): 772. 1934; Shah 2: 750. 1978; Karthik. *et al.* 56. 1989. *Parmar in Shetty & Singh* 3:930. 1993; *Lakshmi. in Sharma et al.* 323. 1996; *Verma in Singh et al.* 310. 2001; Prasad & Singh 221. 2002; Cook 153. 2006; *F. glomerata* Lam. *Tabl. Encycl.* 1: 150. 1791; Hooker 6: 666. 1894; Cooke 3:412. 1958.

Annuals. Rhizomes short. Culms tufted, 7–40 cm tall, 3-angled, striate-sulcate, pubescent, clothed at base with 1 or 2 bladeless pubescent leaf sheaths. Cauline leaves with sheath 1–3.5 cm; ligule rust-colored to reddish, 1–2 mm, membranous, mouth truncate; leaf blade linear, 5–15 × 3–7 mm, flat, soft, 3-costate, surfaces and margin ± pubescent, apex acuminate. Involucral bracts leaflike, surpassing inflorescence; bractlets setaceous, sheathless. Inflorescences with 1–3 clusters of spikelets, interrupted, glomerulate, 1–3 cm wide, bearing 3–15 spikelets; peduncles single, mostly enclosed in bractlet sheaths. Spikelets ovoid to oblong, 5–8 × 2.5–3 mm, many flowered, covered with woolly hairs. Glumes basally yellowish brown, apically grayish black, obovate, 1.2–2 mm, thinly membranous, abaxially pilose, apex obtuse, emarginate, and with a 3-veined costa excurrent into a recurved 1–1.5 mm awn. Perianth bristles 6; 3 outer bristles needlelike, occasionally much reduced, retrorsely scabrous; 3 inner bristles brownish, with subquadrate blades abruptly narrowed at base to a distinct ca. 0.3 mm stalk, apex mucronulate. Stamens 3; anthers oblong, 0.2–0.3 mm. Ovary white, oblong, 3-sided; style brownish, 3–4 × as long as ovary; stigmas 3, 1/3–1/2 as long as style. Nutlet brownish, shortly stipitate, obovoid, 1 mm, 3-sided. **Plate 246.**

Flowering & Fruiting: July–December.

Habitat: Wet places, often in paddy fields, river margins.

Distribution: SE Asia; Africa, Australia. INDIA: Throughout the warmer parts. S. GUJARAT: Throughout.

Voucher specimens: 236, 325, 654

57. **Fuirena cuspidata** (Roth) Kunth *Enum. Pl. 2: 187. 1837*; Prasad & Singh 223. 2002; *Scirpus cuspidatus* Roth *Nov. Pl. Sp. 31. 1821*; *F. wallichiana* Kunth *Enum. Pl. 2: 182. 1837*; Hooker 6: 640. 1894; Blatter & Mc Cann *JBNHS 37(4): 772. 1934*; Cooke 3:395. 1958; Karthik. *et al. 56. 1989*; Parmar in Shetty & Singh 3:931. 1993; Lakshmi. in Sharma *et al. 325. 1996*; Verma in Singh *et al. 311. 2001*; Cook 155. 2006.

Perennial with creeping rhizome, stem robust, many closely arising from the rhizome, triquetrous, 10-90 × 0.15-0.3 cm, glabrous. Lowest leaves reduced to bladeless sheaths or with very small lamina. Upper leaves well-developed, linear, narrowed to an acute apex, 4-15 × 0.2-0.5 cm, with a prominent midrib and recurved margins below; sheaths striate and glabrous to puberulous towards mouth. Inflorescence usually a terminal clusters of 3-few spikelets, often with 1-2 axillary peduncled clusters. Bracts 2-3, lowest usually overtopping the inflorescence. Spikelets terete, oblong, 6-10 × 4-5 mm, many flowered. Glumes oblong, obtuse at apex, with a subapical awn, 3.5-4 × 1.5-2 mm, puberulous on the outer surface towards apex, ciliolate near the margin. Perianth bristles absent, scales absent. Stamens 3, filaments elongate up to 3 mm, anthers minutely apiculate at the apex, 1.5-2 mm long. Style 1.8-2 mm long; stigmas 3, as long as style. Nut trigonous, broadly obovoid, with a pubescent conical apex, shortly stalked, 1 × 0.6 mm, with prominent angles and 3 vertical lines on the faces, ultimately dark brown, 7-9 vertical rows on each faces, epidermal cells transversely oblong. **Plate 247.**

Flowering & fruiting: October-August.

Habitat: Seasonal water-logged areas, banks and marshy areas near ponds.

Distribution: Endemic to India. INDIA: Central, NW and Western Peninsula. GUJARAT: Vadodara. **New record for the State.**

Voucher specimens: 71, 651, 717

58. **Schoenoplectiella articulata** (L.) Lye in *Lidia* 6: 20 2003; *Scirpus articulatus* L. *Sp. Pl.* 47. 1753; Hooker 6: 565. 1894; Blatter & Mc Cann JBNHS 37(4): 767. 1934; Cooke 3:406. 1958; Shah 2: 754. 1978; Verma in Singh et al. 321. 2001; *Schoenoplectus articulatus* (L.) Palla *Bot. Jahrb. Syst.* 10: 299. 1888; Karthik. et al. 68. 1989; Parmar in Shetty & Singh 3:946. 1993; Lakshmi. in Sharma et al. 357. 1996; Prasad & Singh 300. 2002; Cook 175. 2006.

Plants 30-85 cm tall (including involucre bract). Rhizomes shortly creeping. Culms densely tufted, 12-30 cm tall, 5-7 mm thick, terete, transversely septate, clothed at base with 1 or 2 bladeless leaf sheaths. Leaf sheaths 10-25 cm, terete, obliquely truncate at mucronate mouth. Involucre bract 1, erect, culmlike, usually longer than culm, with many transverse septate nodes. Inflorescence a pseudolateral head with many spikelets. Spikelets sessile, ovoid, 7-9 × 4-4.5 mm, many flowered. Glumes brownish yellow with dark brown lines, deltoid-ovate, 5-5.5 mm, concave, thinly membranous, veins many and ± conspicuous, apex with a costa excurrent into a mucro. Perianth bristles absent. Stamens 3; stigmas 3. Nutlet yellowish gray at maturity, obovoid, 2-2.2 mm, 3-sided, smooth. **Plate 248.**

Flowering and fruiting: May-July.

Habitat: Moist places, pond margins.

Distribution: India, Indonesia, Nepal, Papua New Guinea, Philippines, Sri Lanka, Thailand, Vietnam; Africa, N Australia, Indian Ocean islands, Madagascar. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 218, 437, 510

59. **Schoenoplectiella lateriflora** (J.F.Gmel.) Lye in *Lidia* 6: 25. 2003; *Scirpus supinus* auct. non L. 1753; Hooker 6: 655. 1894; Blatter & Mc Cann JBNHS 37(4): 766. 1934; Cooke 3:406. 1958; *S. lateriflorus* J.F.Gmel. *Syst. Nat.* 2: 127. 1791; Shah 2: 756. 1978; Verma in Singh et al. 324. 2001. *Schoenoplectus lateriflorus* (J.F.Gmel.) Lye *Bot. Not.* 124: 290. 1971; Karthik. et al. 69. 1989; Lakshmi. in Sharma et al. 361. 1996; Prasad & Singh 305. 2002; Cook 178. 2006; *S. supinus* subsp. *lateriflorus* (J.F.Gmel.) Soják *Cas. Nár. Mus., Odd. Prír.* 141: 62. 1972; Parmar in Shetty & Singh 3:950. 1993.

Annual, 5-30 cm, forming tufts. Root system fibrous, small. Stem 0.8-2 mm diam., terete or distal parts obscurely trigonous, grooved, green or greyish green, smooth. Sheaths up to 65 mm, 2-3, lowest short, ephemeral, bearing an occasional flower in its axil, upper longer, mouth oblique, margin widely scarious; ligule up to 0.8 mm, scarious; blades reduced to mucro or, in uppermost sheath, most often green, up to 50 mm. Inflorescence 7-20 mm diam., congested to spherical group of (1-)3-15 spikes, sessile or occasionally one or a few spikes pedunculate; lowest bract 2-16 cm, terete, apex rather obtuse, smooth, other bracts seldom green and longer

than their spike. Spikes 5-12 mm, ovoid; glumes rather tightly imbricating, 2.1-2.7 mm, cymbiform, towards apex slightly keeled, smooth, mucro c. 0.3 mm, sides obscurely nerved, brown or colourless, scarious, margin smooth or minutely fringed. Perianth bristles reduced, 3-4 occasionally elongated, unequal, longest shorter than nut; stamens 3, anther 0.5-0.7 mm; stigmas 3. Nut 1.3-1.6×1-1.3 mm, widely obovoid, apiculate, trigonous, surface conspicuously transversely rugulose with very fine longitudinal striations, glossy, black brown. **Plate 249.**

Flowering & fruiting: July - August.

Habitat: On wet disturbed ground by standing water, at pools, in rice fields;

Distribution: Europe, N. Africa, Turkey, Caucasus, S Siberia, Kazakhstan, Iran, Pakistan to Far East. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 68, 170, 317, 384

60. **Schoenoplectiella mucronata** (L.) J.Jung & H.K.Choi in J. Pl. Biol. 53(3): 230. 2010; *Schoenoplectus mucronatus* (L.) Palla in *Bot. Jahrb. Syst.* 10: 299. 1888; Karthik. *et al.* 69. 1989; *Parmar in Shetty & Singh* 3:949. 1993; Prasad & Singh 309. 2002; Cook 178. 2006; *Scirpus mucronatus* L. *Sp. Pl.* 50. 1753; *Verma in Singh et al.* 328.2001; Hooker 6: 657. 1894; Blatter & Mc Cann JBNHS 37(4): 770. 1934; Cooke 3:409. 1958; *S. triangulatus* Roxb. *Fl. Ind.* 1: 219. 1820; Shah 2: 758. 1978; *Lakshmi. in Sharma et al.* 365. 1996.

Perennial, 50-125 cm. Rhizome creeping or stoloniferous, 2-4 mm diam., brown or reddish brown. Stem 2-6(-10) mm diam., distal parts sharply, proximal parts obtusely trigonous, smooth, glaucous green. Sheaths 3, ephemeral, green or often with reddish tint, mouth deeply oblique, margins widely scarious; blades mostly reduced to mucro, uppermost up to 50 mm, channelled, smooth, apex obtusely pointed. Inflorescence of (1-)3-7 sessile spikes, 15-25 mm diam., or a multiple spike; lowest bract to c. 35 mm, trigonous, smooth; primary branches 0-7, up to 30 mm, each with (1-)2-4 sessile spikes. Spikes 8-12×4-7 mm, ovoid; glumes rather loosely imbricate, 3-4.1 mm, cymbiform, mid-nerve mostly smooth, mucro barbed, up to 0.8 mm, sides inconspicuously nerved, brown or yellowish brown, smooth, apex rounded, often truncate, margins scarious, ciliate. Perianth bristles 4-6, about equalling nut; stamens 3, anthers 1.5-2 mm; stigmas 2. Nut 2.2-3.2×1.3-2 mm, ellipsoid or ovoid, bi-convex or almost plano-convex, smooth, yellow brown, glossy. **Plate 250.**

Flowering & Fruiting: May - July.

Habitat: Alluvial meadows, by rivers and lakes, rice fields.

Distribution: Europe to Japan, China and Taiwan, from Caucasus to Tadjikistan, Pakistan and N. India; Egypt, S. Africa. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 343, 649, 690, 886

61. **Schoenoplectus litoralis** subsp. **thermalis** (Trab.) S.S.Hooper in *Fl. Hassan Distr.* 698. 1976; *Scirpus litoralis* Schrad. *Fl. Germ.* 1: 142. 1806; Blatter & Mc Cann JBNHS 37(4): 770. 1934; *Verma in Singh et al.* 326. 2001; *S. litoralis* sensu Clarke in Hooker 6: 659. 1894; Cooke 3:408. 1958; *S. litoralis* var. *subulatus* (Vahl) Chiov. *Pl.*

Nov. Aethiop. 16. 1928; Shah 2: 756. 1978; *Schoenoplectus litoralis* subsp. *subulatus* (Vahl) Soják *Cas. Nár. Mus., Odd. Prír.* 141: 62. 1972; Karthik. *et al.* 69. 1989; *Parmar in Shetty & Singh* 3:948. 1993; *Lakshmi. in Sharma et al.* 363. 1996; Prasad & Singh 306. 2002.

Perennial, 60-120 cm. Rhizome 2 mm diam., short, stoloniferous. Stem 3-6 mm diam., from sharply trigonous to obtusely trigonous above and terete below, smooth, green. Sheaths up to 25 cm, green, smooth, scarious side sometimes reddish, mouth deeply oblique with widely scarious margins; ligule 0.5-1 mm, scarious, margin smooth; blades mostly reduced, some up to 15 cm, sometimes longer, up to 5 mm wide, obtusely pointed, keeled, thick or channelled, margins smooth. Inflorescence a multiple spike or anthelodium, 2-9 cm; lowest bract to more than 12 cm, erect, trigonous in transverse section, edges smooth; primary branches 2-14, to 70 mm, smooth or slightly scabrous; tubular prophyll to 10 mm, mouth oblique or bilobed; secondary multiple spikes 30-40 mm diam., with 3-8 mostly solitary and pedunculate spikes, to 15 mm, with occasional tertiary multiple spikes of 3-4 spikes; tertiary branches up to 10 mm. Spikes as a rule solitary, occasionally 2 together, 7-18 x 3-5 mm, ovoid; glumes 3-4 mm, cymbiform, apex rounded, mucro to 0.7 mm, slightly recurved, sides obscurely nerved, brown, margins widely scarious. Perianth bristles 4, upper half plumose; stamens 3, anther 2 mm; stigmas 2. Nut 1.6-2.3 x 1.1-1.7 mm, obovoid, apiculate, bi-convex or almost plano-convex, mat or semi-glossy, very finely reticulate, dark brown. **Plate 251.**

Flowering & Fruiting: (February-) March - July.

Habitat: In shallow water; in ditches and rivers.

Distribution: Africa, Madagascar, Italy, Arabia, from Iran to Pakistan, India, Thailand, Australia, New Guinea, Micronesia; reported from Japan (Okinawa). INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 339, 352, 379

62. **Scleria parvula** Steud. *Syn. Pl. Glumac.* 2: 174. 1855; Hooker 6: 640. 1894; Cooke 3:395. 1958; Shah 2: 743. 1978; Karthik. *et al.* 72. 1989; *Parmar in Shetty & Singh* 3:951. 1993; *Lakshmi. in Sharma et al.* 373. 1996; *Verma in Singh et al.* 336. 2001; *S. tessellata* Willd. *Sp. Pl. IV:* 315. 1805; Blatter & Mc Cann JBNHS 37(4): 776. 1934.

Annuals. Roots fibrous. Rhizomes short or not well developed, thick. Culms tufted, 40-60 cm tall, slender, 3-angled, smooth, glabrous. Leaves cauline; sheaths at culm base glabrous, barely winged, bladeless or with a short blade; sheaths at middle and apical part of culm narrowly winged, villous and more densely so near contraligules; contraligule semicircular, apex obtuse; leaf blade linear, 3.5-5.5 mm wide but apically attenuate, papery, both surfaces hairy or only on 2 lateral veins of abaxial surface, margins scabrous, apex slightly obtuse to acute. Involucral bracts leaflike, basalmost to 20 cm, sheathing, opening of sheath with dense brown pubescence; bractlets setaceous, as long as or slightly longer than spikelet. Inflorescences paniculate, with 2-4 branches; branches 1.2-3 cm, distant, with few spikelets. Spikelets narrowly ovoid, 4-5 mm, mostly unisexual; female spikelets with 2-3 glumes and 1 female flower; male spikelets with 2-3 or more glumes. Glumes deeply straw-colored to brownish purplish, ovate to lanceolate, keeled, apex acute and apiculate. Perianth lobes acute at apex.

Male flowers: stamens 2 or 3. Female flowers: ovary subspherical, glabrous. Disk yellowish white, 1/4-1/3 height of nutlet, slightly 3-lobed; lobes ovoid-triangular to subglobose, margin reflexed, apex acute. Nutlet subspherical to obovoid-spherical, 2.8-3 × 1.8-2 mm, pitted with regular longitudinally elongate lacunae, glabrous, apex with a yellowish white tip. **Plate 252.**

Flowering and fruiting: July-October.

Habitat: Slopes, valleys, wastelands, paddy fields

Distribution: Bhutan, Cambodia, India, Japan, Korea, Laos, Nepal, Papua New Guinea, Philippines, Sri Lanka, N Thailand, Vietnam; tropical Africa. INDIA: Throughout. S. GUJARAT: Throughout.

Voucher specimens: 156, 195, 315, 745

63. **Rhynchospora wightiana** (Nees) Steud. *Syn. Pl. Glumac.* 2: 148. 1855; Hooker 6: 669. 1894; Cooke 3:415. 1958; Shah 2: 752. 1978; Blatter & Mc Cann JBNHS 37(4): 774. 1934; Karthik. *et al.* 68. 1989; *Lakshmi. in Sharma et al.* 355. 1996; *Verma in Singh et al.* 318. 2001; Prasad & Singh 293. 2002.

Annuals, with fibrous roots. Culms solitary or tufted, erect, 12-45 cm high, slender, trigonous below, compressed towards apex, striate, glabrous. Leaves basal; blades linear, 5-15 × 0.2-0.3 cm, scaberulous at margin near apex, gradually tapering to an acuminate apex, coriaceous; sheath-mouth truncate. Infl orescence capitate, subglobose to globose, 1-1.5 × 1-1.5 cm, dense, brown. Involucral bracts 4-6, patent or reflexed, 2-6 cm long, densely ciliate at the dilated base, rigid. Spikelets many, sessile, linear-lanceolate, 6-7 mm long, compressed, 2-flowered; lower flower female; upper one male. Glumes 6 or 7, sub distichous; sterile glumes broadly ovate to oblong-ovate, 1-3 mm long, acute, faintly keeled; female fertile glume broadly ovate, 5-6 mm long, acuminate, keeled; male fertile glume lanceolate, acute. Bristles in the female flower 6, rigid, antrorsely scabrid, 5 of them *c.* 6 mm long; shorter one 3-4 mm long; bristles in male flower 0-4, 4-5 mm long. Style-base compressed, triangular, 1.5-2 × 0.8-1 mm, obtuse, scabrid. Nut oblong, 1.8-2 × 1-1.2 mm, compressed, covered by white-papillose tubercles, brown to black, margins bordered by a whitish line; epidermal cells minute, isodiametric. **Plate 253.**

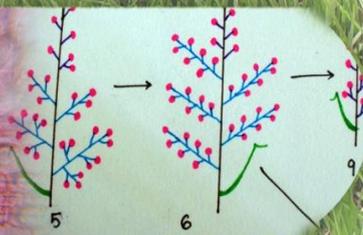
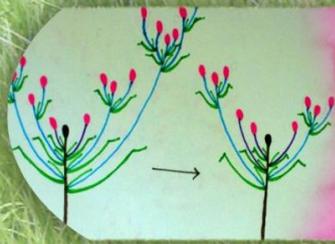
Flowering & Fruiting: August – November.

Habitat: Grasslands and low hill slopes.

Distribution: Indonesia, SW Pacific Islands, Sri Lanka and Vietnam. INDIA: Western Peninsula. S. GUJARAT: Throughout.

Voucher specimens: 286, 294, 688, 869

Chapter: 4



‘With the vast increase in numbers of known forms of plants & animals and with the change in concepts of classification brought about by acceptance of the theory of evolution, the mechanics of modern taxonomy have become so complex as to discourage the beginning student.’

– Schenk & McMasters

4.1 Introduction

Plants can be vastly dissimilar due to its inflorescence structure and position (Lazarides 1997). An inflorescence is defined as ‘The shoot system which serves for the formation of flowers and modified accordingly’ (Troll 1965). Although flowers have been in center of interest in many disciplines of plant science, including morphological, developmental, functional, biological, ecological and evolutionary aspects; inflorescences architecture remain neglected since last two decades. Plant architecture is primarily determined by ‘patterns of branching’. Vegetative branching patterns plays a major role in determining overall biomass of the plant as well as the production of number of inflorescences, while inflorescence branching patterns (architecture) influence the number of seeds that each flower will bear (Zhao *et al.* 2006, Doust 2007). Of these, vegetative branching is much more variable and responding quickly to changes in environmental conditions, while inflorescence branching is less variable or rather constant, and is often used as a source of taxonomic characters for separating species and genera (Clayton & Renvoize 1986).

“When the leaves developed as floral bracts instead of foliage leaves, then we use the term ‘inflorescence’ to distinguished the flower bearing part of the plant from vegetative parts”.

- Goebel (1931) and modified by Mora-Osejo (1987)

A system of flower bearing branches and their position on the plant is called as ‘Synflorescence’ (Troll 1953). The term ‘inflorescence’ is deliberately kept rather imprecise in order to have a convenient word, for each inductive attempt at the analysis of an unknown inflorescence system. On the other hand, use of the term ‘synflorescence’ requires the analysis of structure of a given inflorescence within the context of the whole branching system of a taxon and its allies (Webberling 1992). Synflorescence, not only determine the external appearance to a great extent, but also at the same time provide important criteria for their relationships. It must therefore be established which part of the flower corresponds to one another within a plant and between different plants, before any assertions can be made about

which modifications distinguished on the inflorescence of one plant, from that of another. The basis for such procedure is therefore, the recognition of general regularities of structure which dominate the diversity of angiosperm inflorescence.

The synflorescences of Cyperaceae and Poaceae are extremely polymorphic due to differences in the degree of development of its different parts and without using typologically based method the attention can easily be distracted during the comparison of synflorescence. In this context, the typology-based system was developed and well described by Troll and Weberling (Troll 1964, Weberling 1965, 1983, 1985, 1989; Troll & Weberling 1989; Weberling & Troll 1998) and later on Kukkonen (1986) utilized it more for describing the inflorescence of monocots. Troll (1969) was the first to apply these analyses to the family Poaceae with descriptive and typological view points. Because Troll's works were published in German, they did not get proper attention at a world scale. The most recent, but now rather dated, general treatments of morphological classification of inflorescence in English were provided by Webberling (1992). Later on it was followed and reestablished by Vegetti and his co-workers (Vegetti 1992, 1994, 1999a & b, 2002, 2003; Vegetti & Weberling 1996, Vegetti & Anton 1995, 1996; Ahumada & Vegetti 2009, Lucero & Vegetti 2012, Reinheimer & Vegetti 2008) with additional contributions (Liu *et al.* 2005, Perrata *et al.* 2009, Reutemann *et al.* 2009, Tivano *et al.* 2009) for synflorescence studies in Cyperaceae and Poaceae. Recently, Grass Phylogeny Working Group (2001) is also used structure and development of grass inflorescence as a major source of morphological marker. Liu *et al.* (2007) reported that inflorescence morphology is highly congruent with phylogenetic history for subfamily Chloridoideae. On the contrary morphological and molecular studies in Paniceae (Doust & Kellogg 2002, Doust *et al.* 2007, Salariato *et al.* 2010) proved that inflorescence morphology is highly variable, and is partially correlated with plastid or nuclear phylogenies of the group. Such understanding may lead to new insights into the direction of future breeding efforts as well as outlining the lineage specific constraints that may limit such efforts (Doust 2007). Consequently, it can provide new data to integrate into future taxonomic and phylogenetic investigations.

4.2 Synflorescence Architecture

Plants of sedges and grasses are composed of shoots of consecutive order of ramification and terminate in an inflorescence (Moore & Mooser 1995). According to the typological system of, each one of these shoots constitutes inflorescences and the entire system is called synflorescence (Troll 1964). In the synflorescence two principal parts are recognized: proximal portion is the trophotagma (TT) and the distal one is unit of inflorescence (UIF) (Vegetti &

Muller-Doblies 2004). The trophotagma has an innovation zone (IZ) at/near the base of shoot, which bears proximally cataphylls and foliage leaves, and comprised of a basal zone of short internodes (SIZ) and a distal zone of long internodes (LIZ) (Rua & Weberling 1998, Tivano *et al.* 2009). In perennial Poaceae, the SIZ behaves principally as an innovation zone that is silleptic (development of flowers on parental and axillary shoots within the same vegetative period) or cataleptic (flower development on branches delayed) (Camara-Hernandez & Rua 1991, Rua 1999, Vegetti 2003). The LIZ can constitute an inhibition zone (HZ), an extension of the enrichment zone (EZ) or a region that behaves in part as HZ and in part as EZ (Rua & Weberling 1998), and is characterized by the absence of axillary axes, the presence of leaves with sheaths and well-developed blades.

The main florescence (HF) and paraclades (Pc) of various magnitudes make up the enrichment zone (EZ) or paracladial zone. The enrichment axes originating in the distal region of the LIZ normally bears a prophyll and developed leaves called trophotagma (Rua & Weberling 1998, Vegetti & Weberling 1996) and terminate in an UIF similar to that of the relative mother axis that supports them. These axes have been denominated 'paraclades of the trophotagma' (Vegetti & Muller-Doblies 2004), 'long paraclades of second order' (Weberling *et al.* 1993) or 'paraclades with trophotagma' (Vegetti & Weberling 1996). From the axillary buds of the trophotagma of these enrichment axes, new axes of similar structure can be originated. In this mode, the LIZ can contribute to increase the number of flowering branches of the plant (Rua & Weberling 1998). Based on the presence and absence of trophotagma, Keng (1986) proposed two types of inflorescence. One is the true inflorescence, has a continuous main axis and grows from a determinate portion (usually distal) on plant. The second is so-called false one, has blooming leafy branch/trophotagma and not the inflorescence proper. It has a jointed axis with spikelets attached to the nodes and spikelets grow indeterminately on the nodes of any branching axis or even main culm.

The unit of inflorescence (UIF) is composed of group of flowers (terminal spikelet, HF) on indefinite growth axis, thus the synflorescence is polytelic, such as those found in monocots (Camara-Hernandez & Rua 1991, Camara-Hernandez & Miente-Alzogaray 1994, Troll 1966, Vegetti 1991). It has both homocladic inflorescences (Rua 1999), which are always unispiculate (only HF), and heterocladic inflorescences (Rua 1999), formed by the HF and the PZ. In a heterocladic inflorescence the distal Pc are lateral (homothetic i.e. HF absent & all racemes of the same axial order) or terminal raceme (heterothetic i.e. HF present & racemes of different axial orders; Troll 1964, Rua 1999). In grasses and sedges, UIF has been described as a compound multiple spike because of the indeterminate nature of the ultimate inflorescence units or as a compound, paniculate inflorescence, essentially a panicle of spikelets, where

spikelets functionally replace the individual flowers of a ‘panicle’ (Raynal 1971, Weberling 1992, Kukkonen 1994, Goetghebeur, 1998). In his treatment of inflorescences, Troll (1964) proposed that the panicle gives rise to the anthela, by lengthening of paraclades over main axis. For polytelic inflorescences he coined the terms ‘paniculodium’, and ‘anthelodium’ respectively for cyperoid taxa.

In a paracladial zone (PZ), paraclades as a rule originate from the axils of a leaf (phyllome). This leaf is called ‘subtending leaf or bract or spathe or pherophyll’ (from the Greek “pherein” -to carry, to bear). Thus, a pherophyll is defined by its position, and not by its shape. Pherophylls are not restricted to inflorescences, but are of general occurrence in a ramifying flowering plant. The first phyllome on each lateral branch commonly remains small and has the shape of bracts, called ‘prophyll or bracteole or spatheole’ (Endress 2010). Both bracts and prophylls may be foliaceous, laminar, setiform, tubular (cladoprophyll) or glumaceous, according to their position and function. At the base of the prophylls (of spikelets and/or inflorescence branches), a swelling body or pulvinus is present (Haines 1967). This play a role in the expansion of the paraclades or spikelets, and it related to wind pollination. Thus, each paraclade (Pc) possesses a short hypopodium (internode between the bract subtending the spikelet and the prophyll), a prophyll (pr), and a long epipodium (internode between the prophyll and the second glume) and ends in a coflorescence (Cof, terminal spikelet of the paraclade).

In addition to above, PZ comprises two subzones; a short distal paracladial subzone (sPcZ) that bears sPc reduced to its Cof in the distal region below the HF, and a long paracladial subzone (lPcZ) that also bears lPc of different branching degrees. Branching degree decreased distally along the lPcZ, until paraclades are reduced to Cof in the sPcZ (Vegetti 2003). For a proper interpretation of the inflorescence, it is important to know the inflorescence ramification pattern (Haines 1966, Meert & Goetghebeur 1979, Vegetti & Tivano 1991) and the branch position in the inflorescences (Guarise & Vegetti 2007). In the inflorescence, three types of branching can be observed;

- Normal branching: the branch is produced by an axillary bud of a bract
- Prophyllar branching: the branch is produced by a prophyllar bud
- Accessory branching: new branches are observed between an axillary branch and its bract. These accessory branches lack their own subtending bract; because of this, only one bract protects this entire ramification.

The initiation and differentiation of the primary branches may be acropetal or basipetal (Reinheimer *et al.* 2005, 2009; Liu *et al.* 2007). When the initiation and differentiation of primary branches is acropetal, the inflorescence is non-truncated whereas, when primary

branch initiation is acropetal and differentiation is basipetal, the inflorescence meristem stops its activity after generating the most distal branch results in to truncated inflorescences (Reinheimer *et al.* 2005, 2009). Indeed, the presence or absence of a terminal flower doesn't modify the homology relationships among the remaining parts of the inflorescence (Kunze 1989). The acropetal initiation and differentiation of primary branches produces homogenized and non-homogenized inflorescences; while species with basipetal differentiation of the primary branches (regardless of whether initiation is acropetal or basipetal) always show homogenized inflorescences (Perrata *et al.* 2009). In this context, Sell (1980), suggested that the enrichment axes flower basipetally while the inflorescence branches develop acropetally. Probably it is basipetal along the main axis due to that, it occurs at the same time as the inflorescence emerges from the last protective vegetative leaf (Allard 1982, Anton 1982).

Reinheimer *et al.* (2009) have correlated the acropetal initiation of primary branches with the presence of a determinate symmetry type; and the basipetal initiation of primary branches with an unstable symmetry, i.e., the existence of different types of symmetry among inflorescences within one species. As regards she recognized, three different types of inflorescence symmetry based on the distribution of 1°Pc on the main axis, i.e.: spiral symmetry (1°Pc are initiated around the main axis); unilateral symmetry (1°Pc are formed in two rows on one side of the main axis); and bilateral symmetry (1°Pc are initiated on two sides of the main axis). Kellogg (2006) considers that the variations observed in the phyllotaxis of the primary inflorescence branches and in the inflorescence symmetry should be further looked into in future developmental studies. Besides that, paraclades of the 2nd order or above can show the same phyllotaxis pattern as the main axis (homodromic arrangement) or the arrangement can differ from the main axis (antidromic arrangement).

It is accepted that the spikelet is composed of an indefinite axis (rachilla), which bears flowers in lateral position. Although it is often hard to rule out the possibility of a tiny residual inflorescence meristem; in this case the 'terminal' flower would actually be lateral (Malcomber *et al.* 2006). Spikelets of most species belonging to subfamily Panicoideae are strikingly homogeneous: they bear two glumes followed by two florets. The distal floret is usually perfect, whereas the proximal may be either male or sterile, and then usually reduced to an empty lemma (Clayton & Renvoize 1986). Because panicoid male florets arise from an early abortion of the gynoecium, both male and sterile flowers can be regarded as 'incomplete' ones (Butzin 1965, Roux & Kellogg 1999). Thus, the panicoid spikelets are acrotonic, i.e. the development of their distal lateral meristems are favored over the remaining ones and flowering is basipetal (Rua 1999). Prolongation of the main axis beyond the distal floret indicates racemization, then the spikelets become mesotonic, i.e. the more developed florets

are located at a middle position due to reduction or abortion of proximal florets, a feature shared by the eragostoid genera (Lui *et al.* 2005, 2007). Acrotonic spikelets could have been derived from mesotonic ones by evolutionary loss of the portion just above the more developed floret (Rua 2003). The occurrence of a prolongation of the rachilla beyond the distal floret in some panicoid spikelets (Butzin 1965) also supports this hypothesis.

4.3 Family Poaceae

Summarizing all the above facts and different structural patterns recorded in the members of the poaceae it is easy to delimit the synflorescence. In recent years, many morphological details have been investigated in an attempt to discover reliable indicator of relationships among the taxa. Though, its value is quite relevant at phylogenetic and classification studies very few researchers has utilized them. A comparative typological analysis and exact nature of synflorescence has been used by Vegetti & Anton (1995, 2000) and suggested different hypothetical processes responsible for various synflorescence diversity within the family. Therefore, after following Liu *et al.* (1995) and Vegetti (1999), the attempt has been made to describe the synflorescence in presently studied grasses.

There are four major type of inflorescence are observed as Paniculate (P), Raceme (R), Digitate (D) and Spike (S). Furthermore, all are divided into their subtypes and categories.

A. Paniculate inflorescence (P-type): It is a kind of non-truncated and non-homogenized inflorescences in which long-paraclades length decreases towards the apex ends regularly in a main florescence. Based on truncation, homogenization and trophotagma region P-type is further divided into 5 main subtypes and their categories.

1). P₁-subtype: The short-paraclades and the successive order long-paraclades are completely non-homogenized. The IP_c (third order) or higher order long paraclades develop from the proximal portion of the basal long-paraclades. All florescences are without trophotagma and possess Pedicellate with homo-/heterogamous spikelets. The inflorescence may be truncated or not.

- a) Non-truncated with homogamous spikelets: *Urochloa ramosa*, *U. reptans*, *Panicum*, *Isachne*, *Arundinella*, *Arundo*, *Phragmites*, *Oryza*, *Aristida*, *Eragrostis*, *Sporobolus*
- b) Truncated with homogamous spikelets: *Oplismenus*, *Setaria*, *Pennisetum*, *Cenchrus*
- c) Truncated with heterogamous spikelets: *Saccharum*, *Spodiopogon*, *Chrysopogon*, *Sorghum*, *Imperata*

2). P₂- subtype: The short-paraclades and the successive order long paraclades are partially homogenized. The lgPc (second order) develop from primary long-paraclades. All florescences with homo-/heterogamous spikelets with or without trophotagma region. The inflorescence may be truncated or not.

- a) Non-truncated with homogamous spikelets and without trophotagma: *Hygroryza*, *Aeluropus*, *Desmostachya*, *Halopyrum*, *Leptochloa*, *Sporobolus*, *Alloteropsis*, *Moorochloa*, *Digitaria albudense*, *Echinochloa*
- b) Truncated with homogamous spikelets and without trophotagma: *Urochloa*, *Dinebra*, *Eriochloa*
- c) Non-truncated with heterogamous spikelets and without trophotagma: *Dimeria*, *Arthraxon*, *Eulalia*, *Bothrichloa*, *Dichanthium*, *Capillipedium*, *Ischaemum afrum*

3). P₃-subtype: The short-paraclades and the successive order paraclades are almost fully homogenized and truncated. The lgPc develop from primary long-paraclades. All florescences are sessile homogamous spikelets without trophotagma region.

Paspalidium

4). P₄-subtype: Long paracladia with bracts and prophylls (trophotagma) shows a variable degree of branching bearing homogamous or heterogamous spikelets.

- a) Inflorescences have further axes or viable buds in the axils of the bracts and prophylls, and also in basal bracts in the pseudospikelet, allowing indeterminate growth, which can lead to dense spherical clusters of homogamous pseudo-spikelets: *Bambusa*, *Dendrocalamus*
- b) Trophotagma remains leafy on hermaphrodite spikes (true inflorescence type) borne at each node of the main axis to give appearance of false-panicle: *Ophiuros*, *Dichanthium foveolatum*, *Glyphochloa*, *Hemarthria*, *Heteropogon*, *Triplopogon*, *Mnesithea*, *Rottboelia*, *Apocopis*, *Sehima*, *Pogonatherum*
- c) Trophotagma remains leafy on hermaphrodite racemes (true inflorescence type) borne at each node of the main axis to give appearance of false-panicle: *Ischaemum*, *Apluda*, *Andropogon*, *Cymbopogon*, *Pseudoanthristria*, *Iseilema*, *Themeda*.

5). P₅-subtype: Long paracladia with bracts and prophylls shows a variable degree of branching bearing heterogamous and unisexual spikelets or inflorescence only.

- a) Trophotagma turns in to hard nut-like structure to protect female flower in monoecious inflorescence: *Chionachne*, *Trilobachne*, *Coix*.

- b) Trophotagma remain herbaceous and very well developed to protect female inflorescence in dioecious inflorescence: *Zea*

B. Digitate inflorescence (D-type): The main axis of the inflorescence appears truncated above the long-paraclades, thus only homogenized IgPc (second order) long paraclades remain. Therefore, such inflorescences achieve a distinctive digitate-subdigitate appearance. On the basis of truncation of HF and Cof it divided into two main subtypes and their categories.

1). D₁ subtype: Non-truncated long-paraclades end in a Spikelet.

- a) Number of long paraclades varies from 4 to 12: *Digitaria, Acrachne, Eleusine, Chloris, Enteropogon*
- b) Number of long paraclades is 2-3: *Digitaria setigera*
- c) A single truncated long-paraclade: *Tetrapogon tenellus*

2). D₂ subtype: Truncated long-paraclades end in a blind extension of LP-axes.

- a) Number of long paraclades varies from 4 to 12: *Dactyloctenium, Paspalum longifolium, Cynodon.*
- b) Number of long-paraclades is 2-3: *Paspalum*
- c) A single truncated long-paraclade: *Dactyloctenium aristatum*

C. Racemose inflorescence (R-type): It is a kind of homogenized inflorescences in which homogenized short-paraclades or spikelet pairs (lgPc in a strict sense) are arranged along the main axis, all florescences are pedicelled spikelets without trophotagma region. Based on presence or absence of lPc it divides into two subtypes.

1). R₁ subtype: The paracladial zone is composed only by 7 to 42 short-paraclades only.

- a) Nontruncated homogamous with all pedicelled spikelets: *Perotis, Zoysia, Tripogon*
- b) Nontruncated homogamous with pedicelled spikelet pair: *Tragus*

2). R₂ subtype: The paracladial zone is composed only by 5 to 10 long-paraclades and 20-40 short paraclades with truncation: *Melanocenchris*

D. Spicate inflorescence (S-type): It is a kind of homogenized inflorescence in which homogenized short-paraclades are arranged along the main axis, and all florescences are homogamous sessile spikelets without trophotagma. On the basis of truncation of HF it divided into two subtypes.

1). **S₁ subtype:** Non truncate: *Eragrostiella*, *Tripogon*

2). **S₂ subtype:** Truncate: *Triticum*

4.4 Family Cyperaceae

The inflorescence has proved to be a major source of reliable diagnostic traits to study the Cyperaceae, which provides the diversification of many taxa, and its significant values for phylogenetical analyses (Tucker & Grimes 1999, Liu *et al.* 2005, Rua & Aliscioni 2002, Tortosa *et al.* 2004, Urdampilleta *et al.* 2005). Thus, in last few years the inflorescence of Cyperaceae is being studied by many cyperologists. However, the use of the inflorescences as characters for the division of the genera has been criticized by several authors (Goetghebeur 1989, Muasya *et al.* 2002). Earlier, numerous terminologies have been suggested by many workers creating problems in understanding the exact nature of the inflorescence. However, comparative typological analysis started with the work of Troll (1964) and Weberling (1989), and revised recently by Rua (1999) and Vegetti (2003). The establishment of homologies among different types of inflorescences is one of the main concerns of the cyperologists (Raynal 1971, Eiten 1976, Reutemann *et al.* 2009). Furthermore, Guarise & Vegetti (2008a) has given the hypothetical processes responsible for the structural diversity of inflorescence within the family cyperaceae.

There are four major type of inflorescence are observed as Paniculodium (P), Anthelodium (A), Capitate (C), Spike (S) and Unispicate (U). Furthermore, they are divided in to various subtypes.

A. Paniculodium (P): Conical indeterminate inflorescence; the terminal spikelet and the distal branches emerge distinctly higher than the proximal branches. In the panicula of spikelets, the branches may have their internodes more or less lengthened or completely shortened, looking like lateral capitula or heads.

1). **Inflorescence with unisexual flowers (P₁ subtype):** Heterogamous flowers: *Scleria*

2). **Inflorescence with bisexual flowers (P₂ subtype):** Homogamous flowers: *Fuirena*

B. Anthelodium (A): It is a cymose corymb, crateriform indeterminate inflorescence, with the terminal spikelet and the short and distal branches hidden among the long and proximal ones, which overtop them. The anthela of spikelets may be simple, compound, and decomposed depending on the branching order with expanded epipodium (either first, second, or third and above, respectively).

1). Decompound anthelodium (A₁ -subtype): The short-paraclades and the successive order long-paraclades are completely non-homogenized. The lPc (third order) or higher order long paraclades develop from the proximal portion of the basal long-paraclades: *C. alulatus*, *C. dives*, *C. exaltatus*, *C. iria*, *C. nutans*, *C. pangorei*, *C. rotundus* ssp. *retzii*, *F. umbellaris*, *F. littoralis*, *F. quinquangularis*, *Bolboschoenus*, *Eriophorum*

2). Compound anthelodium (A₂ -subtype): The short-paraclades and the successive order long paraclades are partially homogenized. The lgPc (second order) develop from primary long-paraclades: *F. cymosa* ssp. *cymosa*, *F. tenera*, *C. compactus*, *C. esculentus*, *C. corymbosus*, *C. difformis*, *C. compressus*, *C. microiria*, *C. pangorei*, *C. pulcherrimus*, *C. rotundus* ssp. *rotundus*, *C. tenuispica*, *C. tuberosus*, *Courtoisina*, *Pycreus*

3). Simple anthelodium (A₃ -subtype): The short-paraclades and primary long paraclades are partially homogenized: *C. paniceus*, *C. squarrosus*, *C. bulbosus*, *F. alboviridis*, *F. merrilli*, *F. schoenoides*, *F. ferruginea* var. *ferruginea*, *F. alboviridis*, *F. bisumbellata*, *F. ferruginea*, *F. dichotoma*, *Schoenoplectiella lateriflora*, *Schoenoplectus littoralis*

4). Fasciculate (A₄ -subtype): It developed form the above mentioned anthelodia by the decrease in internodal length of main axis and paracladia: *F. cymosa* ssp. *cymosa*, *C. bulbosus*, *C. arenarius*, *Bulbostylis*

C. Capitata (C): Indeterminate inflorescence, similar to a capitulum or head, due to a pronounced shortening of the internodes on the main axis and branches of different order. In some cases, there is also a reduction of the branching degree.

F. argentea, *Rhynchospora*, *Schoenoplectiella*

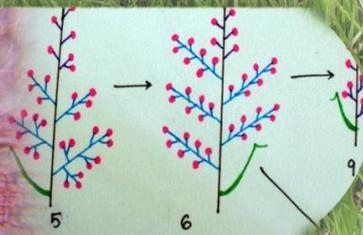
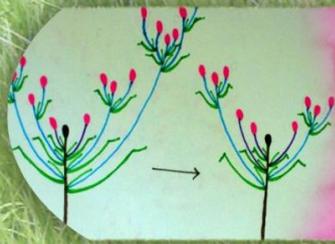
D. Unispicate (U): It is a kind of inflorescence in which glumes are directly arranged along the main axis, and all florescences are homogamous. The inflorescence lacks branches and consists of the terminal spikelet only.

K. brevifolia, *F. ovata*, *F. polytrichoides*, *F. tetragona*, *F. schoenoides*, *Eleocharis*

E. Spike of spikelets (S): Indeterminate inflorescence with spikelets disposed sessile on the main axis: *Kyllinga bulbosa*

Chapter: 5

Foliar



General Micromorphological Features

Family Poaceae and Cyperaceae are the most diverse in their morphological features and used since Linnaeus (1753) for demarcating different genera and species. Since ages, floral morphology is used for taxonomic affinities. Early part of the 19th century anatomical as well as micromorphological characters are also utilized for segregating the lower taxonomic categories. In the recent years, non reproductive organs are also used for identification and segregation. Among non-reproductive organs, leaf is the most widely used in plant taxonomy (Stebbins & Khush 1961). Microscopic features such as, roughness, venations, epidermal cells, stomata, cuticle, surface contours and ornamentation (hairs, papillae, trichomes) are in use (Avdulov 1931, Prat 1932, 1936). General anatomical and micromorphological features for monocots have been described by Metcalfe & Chalk (1964). Metcalfe (1960) in his work pointed out that the epidermal characters are quite useful in systematics; such as, epidermal cell shape, size, subsidiary cells of stomata, trichomes, microhairs and silica bodies (phytoliths). Numerous researchers have described detailed features of numerous genera and species.

Information on foliar micromorphology can shed more light on structural features and their possible functional attributes. Environmental conditions may affect plant micro morphology and has been reported earlier for grasses with relation to numerous abiotic stresses. The impact of environmental pollution on plants is well documented (Halloy 1996, Lakshmi 2010), and its relationship with the stomata, epidermal cells and trichomes has been utilized to understand the impact on the herbaceous plant taxa (Singh *et al.* 1995, Weyers & Travis 1981).

It is well established that foliar anatomy and epidermal features are very important in sedge and grass systematics and utilized for characterization of broad groups, within subfamilies and tribes (Palmer *et al.* 1981, 1983, 1985, 1986, 1988; Renvoize 1982 a, b; 1983, 1985, 1986 a, b; Govindrajalu 1966 a&b, 1969. 1986a, b; 1974). Initially, much of the literature based on the representative taxa of major groups. However, Hilu (1984) observed species specific differences in leaf epidermises and suggested that micromorphological variations exist within the genus. Most of the characters are further described and explained by numerous researchers; such as stomata, trichomes (Metcalfe 1960), microhairs (Tateoka *et al.* 1959, Amarasinghe & Watson 1990), silica cells (Krishnan *et al.* 2001, Prychid *et al.* 2003). In recent years even micromorphological features of floral bracts of grasses i.e., lemma and palea (Snow 1996, Acedo & Lamma 2001) and achene of sedges (Menapace & Wujek 1987, Zhang *et al.* 2004, Maximiano *et al.* 2012) has been used to access systematic relationship.

5.2 Family Poaceae

The epidermis of grasses is made up of cells of two distinct types. The larger cells are commonly referred to as long cells because they elongate horizontally and are parallel with the long axis of the leaf (Metcalf 1960). These cells usually constituted slightly less than half of the total epidermal cells present. Long cells are frequently referred to as fundamental elements, undifferentiated cells, or ordinary epidermal cells (Ellis 1979). In grasses, short cells produced cork-silica cell pairs, three types of prickles, macrohairs, bicellular trichomes, or stomata (McWhorter *et al.* 1993). Short cells are products of asymmetric division of intercalary meristem cells (Kaufman *et al.* 1970) which gives rise to all cells except long cells.

Epidermal features of grass leaves are utilized well by Prat (1932, 1936), Tateoka *et al.* (1959), Stebbins & Khush (1961) and Jacques-Felix (1962) with the help of light microscopy. Later Palmer (1976) described the grass cuticle is also well suited for diagnostic features. Livingston & Clayton (1980) have shown that there is high correlation between the percentage of C₄ grasses and temperature in East Africa. Voluminous work on Poaceae has been very well done by Metcalf (1960), Palmer *et al.* (1981, 1983, 1985, 1986, 1988) and Renvoize (1982 a, b, 1983, 1985, 1986 a, b) with describing characteristic features of tribes. Epidermises, long cells, short cells or silica cells, microhairs, macrohairs, prickles, papillae and stomata are variable and usually used for demarcating the subfamilies as well as tribes. During the course of present investigations, I could get the representative taxa of 11 tribes for their micromorphological characterization with the help of light microscopy. Variations in following characters are observed and recorded:

- a. Surface view of the epidermal peel depicts numerous types of intercostal **long cells**. Size, shape, orientation, nature of anticlinal and periclinal walls is proving to be useful. Numerous variations as well as intermediary types are also noticed and utilized for reorganization purpose.
- b. Adaxial surfaces contained many **bulliform cells**, a specialized type of long cell, which often appear in clusters of 5-15. In few members it is found to be present in the abaxial surface as well. These cells often are much larger than ordinary long cells and always with smooth walled hexagonal-cubical in shape. Sometimes impossible to distinguish from ordinary long cells in surface view.
- c. **Short cells** usually find above the veins but intercostal short cells are also observed. It may be solitary or in pairs (cork-silica pairs) or in 3-5 cells in rows. The distribution of short cells silica bodies along with its shape are important for taxonomic consideration.

- d. **Macrohairs** vary in length, thickness, rigidity, flexibility and bending pattern. Moreover, the attachment of the hairs is diagnostic characters i.e. basal cell numbers, superficial, sunken or tubercled.
- e. **Microhairs:** two major groups of microhairs are recorded; one celled & two celled. Here shape of the distal cell, their diameter and relative length with proximal cell are useful diagnostic feature.
- f. **Prickles** may be small or large and are varying in shape and degree of infatuation such as angular, hook, unpointed, and interlocking.
- g. **Papillae** are the ornamentation on epidermal long cells, sometimes found to be present on the subsidiary cells of stomata. Their size, shape and structure are also variable.
- h. Shapes of the subsidiary cells are responsible for the shape of the **stomata**. It can be triangular, parallel, low-dome and high-dome type. Mostly single type of stomata is recorded from the single plant or epidermis, but 2-3 are also noticed in few members.

5.3 Family Cyperaceae

Regarding sedges, earliest reference date back to 1906 by Plowman wherein anatomy and phylogeny of cyperaceae has been described. In general sedges are quite similar in their micromorphological characteristic features. Perusal of literature depicts very less number of works on the members of family cyperaceae. Earliest reference and generalized features are reported in the work of De-Almuida & Ramaswamy (1948), Metcalfe (1964) and Monoyer (1983). Although Duvel-Jouve way back in 1872 has given the epidermal silica cells account and later on Haberlandt (1914) has given a peculiar silicified conical process in Cyperaceae. Soni *et al.* (1972) also reported that silicon occurred in silica cells before cell death in internodes of *Cyperus*. In recent years anatomical and micromorphological characters has been described by Ahuja (1962), Mehra & Sharma (1965), Sharma & Mehra (1972) and Govindrajalu (Govindrajalu 1966 a&b, 1969. 1986a, b; 1974) for the south Indian members of sedges. In recent years stray reference of micromorphological studies of cyperaceae have been reported in relationship to the environment and physiological processes (Chapin 1981 a&b, Standley 1986). Bhrul (1995) has used the anatomical and micromorphological characters in his classification but reference to large number of species could not met with it. Similar to grasses, sedges are also constitutes long cells, silica cells, stomatal complexes, papillae, prickles and macrohairs.

Table 1 & Plate 262: Foliar micromorphological features of Tribe Bambuseae & Arundineae

Plant name	<i>Bambusa arundinacea</i>	<i>Dendrocalamus strictus</i>	<i>Arundo donax</i>	<i>Phragmites australis</i>	<i>Phragmites karka</i>
Figure No.	A,B, C, D, E	F, G, H, I	J, K, L	M, N, O	P, Q, R
Long cell					
Size (μ)	75-120×16-22	70-100×13-17	70-180×6-18	74-160×10-18	68-172×6-15
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	L:Absent U:Elongate-saddle	Absent	Elliptical	Crescent	Crescent
Costal :Type & Size(μ)	Saddle 7-15×15-23	Saddle 7-15×15-23	Dumbbell 15-22×12-18	Saddle 12-20×4-14	Saddle 12-20×4-14
Si-Cr pairs	Present	Present	Absent	Absent	Absent
Prickle					
Costal(μ)	L: 35-50×20-30	30-100×17-35	L: 17-32×16-20	L: 36-50×18-24	L:30-40×16-20
Intercostal(μ)	35-50×20-30	30-40×15-20	Absent	Absent	Absent
Hooks	Absent	Absent	U:Present	Present	Present
Macrohair	Absent	Absent	Absent	Absent	Absent
Microhair					
-No. of cells	Bicellular	L:Bicellular	Bicellular	Bicellular	Bicellular
-Type	Bambusoid	Bambusoid	Arundo	Arundo	Arundo
-size (μ)	200-270×8-10	180-240×7-10	48-55×5-8	24-28×4-5	20-22×3-4
Papillae/cell	L: 4-10,1-2row	L:3-7, 1-row	Absent	Absent	Absent
Stomatal complex					
-Subsidiary cell type	Triangular-low dome	L:Triangular- low dome	Triangular-low dome	Low dome-triangular	Low dome-triangular
-Size(μ)	30-40×20-35	26-35×14-17	28-36×15-22	32-35×14-22	30-35×10-20
-No. of Papillae overarching the stoma	Covered by 4 papillae(each in 2 lobe)	Covered by 8 finger like papillae	Absent	Absent	Absent
Margin	Long angular prickled	Long angular prickled	Angular prickled	Short angular prickled	Long and short angular prickled

Figure legends: Plate 262

A, F, J, M, P: Adaxial surface (Bar=30 μ)

B, G, K, N, Q: Abaxial surface (Bar=30 μ)

C, H, L, O, R: Margin

I: Long prickles

D, E: Crystals

Table 2 & Plate 263: Foliar micromorphological features of Tribe Oryzeae

Plant name	<i>Hygorrhiza aristata</i>	<i>Oryza glaberrima</i>	<i>Oryza latifolia</i>	<i>Oryza rufipogon</i>	<i>Oryza sativa</i>
Figure No.	A,B, C, D	E, F, G, H	I, J, K, L	M, N, O,P	Q, R, S, T
Long cell					
Size (μ)	21-35×15-30	30-80×14-18	30-50×12-15	35-45×12-15	30-50×15-20
Shape	L:Rectangular U:Hexagonal	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Tall narrow	Absent	Absent	Absent	Absent
Costal :Type & Size(μ)	Oryza 9-11×16-25	Oryza 10-12×20-28	Oryza-Nodular 6-10×12-16	Oryza 6-10×10-14	Oryza 6-10×10-14
Si-Cr pairs	Absent	Absent	Absent	Absent	Absent
Prickle					
Costal(μ)	L: Absent U: 40-70×30-35	70-85×24-32	L: 72-80×20-28 U:Absent	L: Absent U: 40-50×14-20	40-55×12-18
Intercostal(μ)	Absent	U:9-11×16-25	Absent	20-24×10-12	22-26×10-12
Hooks	Absent	Present	Present	Present	Present
Macrohair	Absent	Absent	U:Present	Absent	Absent
Microhair					
- No. of cells	Unicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Sporobolus	Loudtia	Loudtia	Loudtia	Loudtia
-Size (μ)	6-8×2-4	30-35×6-9	30-35×6-9	32-35×3-5	32-35×3-5
Papillae/cell	Numerous L: Aggregated	Numerous L: Variable size	Numerous L: Variable size	Numerous L: Variable size	Numerous L: Variable size
Stomatal complex					
-Subsidiary cell type	Triangular	Triangular	Triangular	Triangular	Triangular
-Size(μ)	20-26×15-20	15-20×12-15	15-20×12-15	21-24×18-20	18-22×14-18
-No. of Papillae overarching the stoma	Absent	6	6-8	4-6	4
Margin	Angular prickled				

Figure legends: Plate 263

A, E, I, M, Q: Adaxial surface (Bar=30 μ)

B, F, J, N, R: Abaxial surface (Bar=30 μ)

C, G, L, P: Margin

D, S: Prickles; T: Prickle base

K, O: Silica bodies

H: 6 Papillae overarching stomata

Table 3 & Plate 264: Foliar micromorphological features of Tribe Triticeae & Aristideae

Plant name	<i>Triticum aestivum</i>	<i>Aristida adscensionis</i>	<i>Aristida funiculata</i>	<i>Aristida setacea</i>
Figure No.	A,B, C, D	E,F, G, H	I,J, K	L,M, N
Long cell				
Size (μ)	95-160×12-18	90-140×8-15	120-200×10-16	80-120×6-12
Shape	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Slightly sinuous	Sinuous	Sinuous	Sinuous
Short cell / Silica cell				
Intercostal	Absent	Absent	Crescent-Elongate	Elongate
Costal : Type & Size(μ)	Elongated sinuous 30-40×12-18	Dumbbell 16-27×7-10	Dumbbell 18-30×7-12	Dumbbell 14-22×6-10
Si-Cr pairs	Absent	Absent	Present	Absent
Prickle				
Costal(μ)	37-48×14-17	L:50-56×10-12 U:45-70×12-20	L:Absent U:58-80×15-20	L:Absent U:58-90×15-25
Intercostal(μ)	37-48×14-17	Absent	Absent	Absent
Hooks	Absent	Absent	Absent	Absent
Microhair				
- No. of cells	Absent	Bicellular	Bicellular	Bicellular
-Type	-	Loudtia	Loudtia	Loudtia
-Size (μ)	-	17-20×5-7	19-21×3-5	15-18×4-6
Macrohair	Absent	Absent	Absent	Absent
Papillae /cell	Absent	Absent	Absent	Absent
Stomatal complex				
-Subsidiary cell type	Low dome	Triangular- low dome	Triangular- low dome	Triangular- low dome
-Size(μ)	42-50×18-20	25-30×18-20	28-32×18-22	30-36×20-24
-No. of Papillae over arching the stoma	Absent	Absent	Absent	Absent
Margin	Small angular prickled	Small angular prickled	Small angular prickled	Small angular prickled

Figure legends: Plate 264

A, E, I, L: Adaxial surface (Bar=30 μ)

B, F, J, M: Abaxial surface (Bar=30 μ)

D, G, K, N: Margin

C, H: Prickles

Table 4 & Plate 265: Foliar micromorphological features of Tribe Eragrostideae

Figure legends: Plate 265

Plant name	<i>Aeluropus logopoides</i>	<i>Arachne racemosa</i>	<i>Dactyloctenium aegypticum</i>	<i>Dactyloctenium aristatum</i>	<i>Dactyloctenium indicum</i>
Figure No.	A,B, C, D	E ,F, G,	H, I, J	K, L, M	N, O, P
Long cell					
Size (μ)	20- 50×5-9	50-80×10-20	60-120 ×12-18	40- 90×8-11	58-115×7-12
Shape	Rectangular	Rectangular	Rectangular	Hexagonal	Hexagonal
Cell wall	Sinuuous	Sinuuous	Slight sinuous	Slight sinuous	Slight sinuous
Short cell / Silica cell					
Intercostal	Absent	Absent	Absent	Absent	Absent
Costal : Type & Size(μ)	Tall narrow-Cubical-Cross 10-12×7-9	Saddle-Dumbbell 12-15×7-10	Saddle 10-12×7-9	Saddle 9-12×7-9	Saddle 11-12×8-10
Si-Cr pairs	Present	Absent	Absent	Absent	Absent
Prickle					
Costal(μ)	40-100×7-12	Absent	Absent	Absent	Absent
Intercostal(μ)	Absent	L: Absent U: 45-55× 15-17	Absent	L: Absent U: 132-180× 20-32	L: Absent U: 80-110× 15-17
Hooks	Absent	Absent	Absent	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Chloris	Chloris	Chloris	Chloris	Chloris
-Size (μ)	21-27×13-18	15-20×10-12	17-20×10-12	15-18×8-10	15-17×9-10
Macrohair	Absent	Tuberclad hair	Absent	Absent	Tuberclad hairs
Papillae/cell	1	Absent	L:1, large	L:1, large	L:1, large
Stomatal complex					
-Subsidiary cell type	Triangular	Low dome	Triangular	Triangular	Triangular
-Size(μ)	10-16×7-10	15-20×10-12	19-22×11-16	17-24×9-13	18-22×10-15
-No. of Papillae overarchng the stoma	1-Partially covered	Absent	Absent	Absent	Slightly covered from both sides
Margin	Angular prickled	Angular prickled	Tuberclad hairs	Tuberclad hairs	Tuberclad hairs

A, E, H, K, N: Adaxial surface (Bar=30 μ)

B, F, I, L, O: Abaxial surface (Bar=30 μ)

D, J, M: Margin

C: Silica cells

G, J, M, P: Macrohairs

D: Prickles

Table 5 & Plate 266: Foliar micromorphological features of Tribe Eragrostideae (Contd.)

Plant name	<i>Desmostachya bipinnata</i>	<i>Desmostachya pingalaiae</i>	<i>Dinebra retroflexa</i>	<i>Eleusine coracana</i>	<i>Eleusine indica</i>
Figure No.	A,B, C	D, E F	G, H, I	J, K, L	M, N, O
Long cell					
Size (μ)	30-50×5-8	30-40×10-12	30-75 ×12-15	35-40×10-12	60-115 ×12-15
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Crescent-Elongated	Absent	Cubical	Cubical-crescent	Cubical-crescent
Costal : Type & Size(μ)	Saddle 5-8 × 8-10	Saddle 5-8 × 8-10	Dumbbell-Nodular 12-15 × 10-12	Saddle 5-6 × 9-10	Saddle 7-8 × 10-11
Si-Cr pairs	Present	Present	Present	Absent	Absent
Prickle					
Costal(μ)	L: 40-50×10-12, U: Absent	Absent	15-21×9-12	L:Absent U:62-87 × 7-8	L:Absent U:35-67 × 6-10
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Absent	Absent	Present	Absent	Absent
Macrohair	Absent	Absent	Absent	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Chloris	Chloris	Chloris	Chloris	Chloris
-Size (μ)	23-25 × 5-8	20-25×5-8	27-30×12-15	12-15 × 8-10	15-18 × 6-9
Papillae/cell	Absent	U: 1, L: Absent	1	Absent	Absent
Stomatal complex					
-Subsidiary cell type	Triangular-low dome	Triangular	Triangular-low dome	Triangular	Triangular
-Size(μ)	12-17 × 10-12	15-17 × 12-15	12-15 × 10-12	26-30 × 25-27	25-27 × 21-27
-No. of Papillae overarching the stoma	Absent	Papillae touches the stomata	Papillae touches the stomata	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Smooth

Figure legends: Plate 266

A, D, G, J, M: Adaxial surface (Bar=30 μ)

B, E, H, K, N: Abaxial surface (Bar=30 μ)

F, L, O, R: Margin

C: Prickles

I: Silica cells

Table 6 & Plate 267: Foliar micromorphological features of Tribe Eragrostideae (Contd.)

Plant name	<i>Eragrostiella brachyphylla</i>	<i>Eragrostis amabilis</i>	<i>Eragrostis ciliaris</i>	<i>Eragrostis japonica</i>	<i>Eragrostis minor</i>
Figure No.	A,B, C	D, E, F,	G, H, I	J, K, L, M	N, O, P
Long cell					
Size (μ)	45-70×14-18	35-40×4-5	72-125×16-20	105-140×18-20	60-85×16-20
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Elongate	Elongate	Elongate - Crescent	Elongate-Acutely angled	Elongate-Crescent
Costal : Type & Size(μ)	Cubical-Saddle 18-20×20-25	Saddle-Cross 10-20×12-15	Saddle-Cross 7-12×10-12	Saddle-Cross-Dumbbell 12-20×8-10	Saddle-Cross 8-10×10-12
Si-Cr pairs	Absent	Absent	Present	Absent	Present
Prickle					
Costal(μ)	Absent	L: Absent U:55-70×16-20	L: Absent U:40-50×18-22	L: Absent U:30-35×14-18	L: Absent U:25-40×16-20
Intercostal(μ)	Absent	Absent	Absent	L: Absent U:18-25×10-12	Absent
Hooks	Absent	Absent	Absent	Absent	Absent
Macrohair	Absent	Absent	Absent	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Chloris	Eragrostis	Eragrostis	Eragrostis	Eragrostis
-Size (μ)	18-20×15-18	55-62×10-12	65-75×8-10	68-72×7-9	48-52×7-10
Papillae/cell	4-10, 1-2 row	Absent	Absent	Absent	Absent
Stomata					
-Subsidiary cell type	Low dome	Low dome	Low dome-Triangular	Low dome	Low dome
-Size(μ)	22-26×18-20	18-24×16-20	20-24×15-20	22-24×16-18	20-24×14-18
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled with Tubercled hair

Figure legends: Plate 267

A, D, G, J, N: Adaxial surface (Bar=30 μ)

B, E, H, K, O: Abaxial surface (Bar=30 μ)

C, F, I, M, P: Margin

L: Acutely angled silica cells

Table7 & Plate 268: Foliar micromorphological features of Tribe Eragrostideae (Contd.)

Plant name	<i>Eragrostis nutans</i>	<i>Eragrostis papposa</i>	<i>Eragrostis pilosa</i>	<i>Eragrostis tremula</i>	<i>Eragrostis uniolooides</i>	<i>Eragrostis viscosa</i>
Figure No.	A,B, C	D, E, F	G, H, I	J, K, L	M, N, O	P, Q, R
Long cell						
Size (μ)	35-50×12-15	90-165×12-17	80-140×10-14	45-96×8-12	45-70×12-18	40-75×6-7
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell						
Intercostal	Absent	Elongate	Elongate	Absent	Saddle-Elongate	Absent
Costal : Type & Size(μ)	Elongate-Saddle 2-6×12-15	Saddle-cross-dumbbell 15-30×10-12	Acutely angled-Dumbbell 7-12×12-14	Saddle 3-5×10-12	Saddle-cross-dumbbell 5-20×10-12	Saddle 3-5×10-12
Si-Cr pairs	Absent	Present	Absent	Present	Present	Absent
Prickle						
Costal(μ)	L: Absent U: 22-40×15-18	L:absent U:32-40×10-15	L: Absent U: 15-20×12-14	L: Absent U: 45-52×14-17	L: Absent U: 35-42×12-15	L: Absent U: 20-35×12-16
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent	Absent
Macrohair	Absent	Absent	Absent	Absent	Absent	Absent
Microhair						
-No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Eragrostis	Eragrostis	Eragrostis	Panicoid	Panicoid	Eragrostis
-Size (μ)	37-58×4-5	50-55×8-10	45-50×5-7	38-42×3-4	30-34×3-4	32-36×4-7
Hooks	Absent	Absent	Absent	Absent	Absent	Absent
Papillae/ce ll	Absent	Absent	Absent	Absent	Absent	Absent
Stomata						
-Subsidiary cell type	Low dome	Triangular-low dome	Triangular-low dome	Triangular-low dome	Triangular-low dome	Triangular
-Size(μ)	20-30×15-18	22-30×18-20	14-18×12-14	10-18×12-14	12-18×12-14	12-18×16-20
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 268

A, D, G, J, M, P: Adaxial surface (Bar=30 μ)

B, E, H, K, N, Q: Abaxial surface (Bar=30 μ)

C, F, I, L, O, R: Margin

Table 8 & Plate 269: Foliar micromorphological features of Tribe Eragrostideae (Contd.)

Plant name	<i>Halopyrum mucronatum</i>	<i>Leptochloa fusca</i>	<i>Leptochloa panicea</i>	<i>Tripogon filiformis</i>	<i>Tripogon jacquemontii</i>
Figure No.	A,B, C	D, E, F,	G, H, I	J, K, L, M	N, O, P, Q
Long cell					
Size (μ)	25-40×7-8	45-60×10-14	40-62×12-18	75-110×14-18	60-95×12-16
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Slightly sinuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Absent	Elongate-saddle	Elongate-saddle	Absent	Elongate-saddle
Costal : Type & Size(μ)	Saddle-cubical 2-4×4-6	Saddle 3-5×10-12	Dumbbell-nodular 10-15×10-14	Saddle 4-7×12-14	Saddle 4-7×12-14
Si-Cr pairs	Present	Present	Present	Present	Present
Prickle					
Costal(μ)	L: Absent U: 38-54×8-12	25-32×14-17	14-20×10-16	L: Absent U: 35-48×10-12	L: Absent U: 33-40×8-10
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Absent	Absent	Present	Absent	Absent
Macrohair	Absent	Absent	Absent	Absent	Absent
Microhair					
- No. of cells	Not seen	Bicellular	Bicellular	Bicellular	Bicellular
-Type	-	Chloris	Chloris	L: Chloris U:Eragrostis	L: Chloris U:Eragrostis
-Size (μ)	-	16-18×7-8	24-28×14-16	L:16-20×8-10 U:24-28×8-10	L:28-36×10-14 U:42-50×15-18
Papillae/cell	1 large	1	1	L: Absent, U:1	L: Absent, U:3-5
Stomatal complex					
-Subsidiary cell type	Absent	Triangular-low dome	Triangular-low dome	Triangular-low dome	Triangular-low dome
-Size(μ)	-	14-18×12-16	16-18×14-16	16-24×14-21	20-24×18-22
-No. of Papillae overarchng the stoma	-	Papillae touches the stomata	Papillae touches the stomata	Absent	Absent
Margin	Smooth	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 269

A, D, G, J, N: Adaxial surface (Bar=30 μ)

B, E, H, K, O: Abaxial surface (Bar=30 μ)

C, F, I, M, Q: Margin

L, P: Prickles

Table 9 & Plate 270: Foliar micromorphological features of Tribe Eragrostideae (Contd.)

Plant name	<i>Sporobolus coromandelianus</i>	<i>Sporobolus diandrus</i>	<i>Sporobolus ioclados</i>	<i>Sporobolus marginatus</i>	<i>Sporobolus tenuissimus</i>	<i>Sporobolus virginicus</i>
Figure No.	A, B, C, D	E, F, G	H, I, J, K	L, M, N, O	P, Q, R	S, T, U, V
Long cell						
Size (μ)	30-85×10-15	45-70× 12-16	95-120× 12-15	35-74× 14-18	65-105× 12-15	40-85× 16-20
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell						
Intercostal	Absent	Elongate-Saddle	Elongate-Saddle	Round-Saddle	Elongate-Saddle	Round-Saddle
Costal : Type & Size(μ)	L: Saddle 6-8×10-14 U:Saddle-Cross 8-12×10-14	L: Saddle 8-10×6-8 U:Cross-Dumbbell 20-28×6-8	L: Saddle 8-10×6-8 U:Cross-Dumbbell 20-28×6-8	Round-Saddle - Cross 8-12×8-12	L: Saddle 8-10×6-8 U:Cross-Dumbbell 20-28×6-8	Round-Saddle - Cross-Dumbbell 8-16×8-12
Si-Cr pairs	Present	Present	Present	Present	Present	Present
Prickle						
Costal(μ)	Absent	L:Absent U:10-15× 4-5	L:Absent U:15-20× 7-10	L:Absent U:18-24× 6-9	L:Absent U:18-22× 10-12	L:Absent U:24-30× 12-18
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent	Absent
Macrohair	Tubercled hairs	Absent	Absent	Absent	Absent	Absent
Hooks	Absent	Absent	Absent	Absent	Absent	Absent
Microhair						
- No. of cells	Bicellular	Unicellular	Unicellular	Unicellular	Bicellular	Bicellular
-Type	Chloris	Sporobolus	Sporobolus	Sporobolus	Chloris	Chloris
-Size (μ)	18-20×8-12	14-16×8-10	16-18×8-9	18-22×20-24	16-18×8-9	30-36×18-22
Papillae/cell	L: Absent U: 1	L: Absent U: 1	L: Absent U: 1	L: Absent U: 1-2	L: Absent U: 1	L: Absent U: 2-5
Stomatal complex						
-Subsidiary cell type	Triangular-low dome	Triangular	Triangular-low dome	Low-Tall dome	Triangular-Low-Tall dome	Triangular
-Size(μ)	20-24×14-18	22-38×18-22	26-30×14-18	22-28×14-24	12-18× 10-18	22-26×16-20
-No. of Papillae overarching the stoma	Touches the stomata	Touches the stomata	Touches the stomata	Partially covered	Touches the stomata	Partially covered
Margin	Angular prickled	Smooth	Smooth	Smooth	Smooth	Smooth

Figure legends: Plate 270

A, E, H, J, L, O, P, S, U: Adaxial surface (Bar=30 μ)

B, F, I, M, Q, T: Abaxial surface (Bar=30 μ)

D, G, K, N, R, V: Margin

C: Macrohairs

Table 10 & Plate 271: Foliar micromorphological features of Tribe Cynodonteae

Plant name	<i>Chloris barbata</i>	<i>Chloris quinquesetifera</i>	<i>Chloris virgata</i>	<i>Cynodon barberi</i>	<i>Cynodon dactylon</i>	<i>Enteropogon dolichostachyus</i>
Figure No.	A, B, C,	D, E, F	G, H, I	J, K, L, M	N, O, P, Q	R, S, T
Long cell						
Size (μ)	42-53×7-12	15-40×10-14	15-30×10-12	35-50×10-15	35-50×10-15	40-60×8-12
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell						
Intercostal	Absent	Absent	Absent	Absent	Absent	Tall-narrow
Costal : Type & Size(μ)	Saddle 8-12×10-12	Saddle 8-12×10-12	Saddle 8-12×10-12	Saddle 6-10×10-12	Saddle 6-10×10-12	Saddle-Cross 9-12×11-15
Si-Cr pairs	Absent	Absent	Absent	Absent	Absent	Present
Prickle						
Costal(μ)	L: Absent U: 18-20×6-12	18-30×10-14	L: Absent U: 14-18×8-12	L: Absent U: 40-42×10-13	L: Absent U: 40-42×10-13	25-40×10-18
Intercostal(μ)	L: Absent U: 8-10×4-5	Absent	Absent	Absent	Absent	Absent
Hooks	L: Present U: Absent	L: Present U: Absent	L: Present U: Absent	Absent	Absent	Absent
Macrohair	Absent	Absent	Absent	Tuberclcd hair	Absent	Absent
Microhair						
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Chloris	Chloris	Chloris	Chloris	Chloris	Chloris
-Size (μ)	15-17×12-15	14-15×2-3	14-15×2-3	20-26×8-10	20-26×8-10	15-20×7-8
Papillae/cell	3-6	2-5	L:1, U:0	1	1	1
Stomatal complex						
-Subsidiary cell type	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular-Tall dome
-Size(μ)	15-18×10-15	16-20×12-16	16-20×12-16	15-16×11-12	15-16×11-12	15-20×14-17
-No. of Papillae over arching the stoma	Absent	Touches the stomata	Touches the stomata	Slightly covered	Slightly covered	Slightly covered
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 271

A, C, D, G, J, N, R: Adaxial surface (Bar=30 μ)

B, E, H, K, O, S: Abaxial surface (Bar=30 μ)

F, I, M, Q, T: Margin

L: Macrohairs

P: Prickles & silica bodies

Table 11 & Plate 272: Foliar micromorphological features of Tribe Cynodonteae (Contd.)

Plant name	<i>Tetrapogon tenellus</i>	<i>Melanocenchris jacquemontii</i>	<i>Perotis indica</i>	<i>Tragus mongolorum</i>	<i>Zoysia matrella</i>
Figure No.	A,B, C, D	E ,F, G, H	I, J, K	L, M, N	O, P, Q
Long cell					
Size (μ)	62-95×10-16	35-40×4-5	30-40×6-7	40-70×7-12	20-25×6-7
Shape	Rectangular	Rectangular	Rectangular	Hexagonal	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	L: Cubical U:Absent	Absent	Absent	Absent	Tall narrow-elongate
Costal: Type & Size(μ)	Saddle 12-13×8-16	Cresentric saddle 14-18×16-20	Dumbbell-Nodular 28-36×5-9	Saddle 7-12×7-10	Saddle 8-10×10-12
Si-Cr pairs	Present	Absent	Absent	Absent	Present
Prickle					
Costal(μ)	L: Absent U: 40-50×12-15	L:Absent U:180-240×14-20	Absent	Absent	L:Absent U:26-32×10-14
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Absent	Absent	Absent	U:present	Absent
Macrohair	Tuberclcd hair	Absent	Absent	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Chloris	Eragrostis	Chloris	Eragrostis	Eragrostis
-Size (μ)	80-95×12-16	120-140×14-18	14-18×3-5	28-32×8-10	22-26×6-8
Papillae /cell	1	1	Absent	L:Absent, U:1	3-7
Stomatall complex					
-Subsidiary cell type	Triangular	Triangular	Triangular	Triangular	Triangular
-Size(μ)	20-22×14-16	24-28×12-16	16-20×12-15	15-22×10-14	18-20×10-12
-No. of Papillae overarching the stoma	Absent	Partially covered	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled with Tuberclcd hairs	Angular prickled	Tuberclcd hair	Smooth

Figure legends: Plate 272

A, E, I, L, O: Adaxial surface (Bar=30 μ)

B, F, J, M, P: Abaxial surface (Bar=30 μ)

C, G, K, N, Q: Margin

D: Base of tuberclcd macrohairs

H: Eragrostis microhair & Prickles

Table 12 & Plate 273: Foliar micromorphological features of Tribe Paniceae

Figure legends: Plate 273

Plant name	<i>Alloteropsis cimicina</i>	<i>Echinochloa colona</i>	<i>Echinochloa crus-galli</i>	<i>Echinochloa crus-pavonis</i>	<i>Echinochloa frumetacea</i>	<i>Echinochloa stagnina</i>
Figure No.	A, B, C	D, E, F	G, H, I, J	K, L, M	N, O, P	Q, R, S
Long cell						
Size (μ)	60-115×15-18	56-94×15-18	64-115×16-20	30-85×15-28	58-90×14-18	45-125×12-20
Shape	Rectangular	Rectangular-Hexagonal	Rectangular	Rectangular-Cubical	Rectangular	Rectangular-Cubical
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell						
Intercostal	Absent	Absent	Absent	Absent	Tall narrow	Tall narrow
Costal : Type & Size(μ)	Nodular 24-38×6-8	Dumbbell-Nodular 15-18×6-8	Cross-Dumbbell-Nodular 8-22×6-12	Cross-Dumbbell-Nodular 6-18×6-10	Dumbbell-Nodular 10-16×6-8	Dumbbell-Nodular 12-18×8-12
Si-Cr pairs	Absent	Present	Present	Present	Present	Present
Prickle						
Costal(μ)	L: Absent U: 21-26×9-12	Absent	Absent	L:Absent U:10-15×4-5	L:Absent U:72-80×10-14	L:Absent U:42-56×10-12
Intercostal(μ)	Absent	Absent	34-38×4-6	28-34×4-6	Absent	Absent
Hooks	Absent	Absent	Present	Present	Present	Absent
Macrohair	Absent	Absent	Absent	Tubercled hairs	Absent	Absent
Microhair						
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Echinochloa	Echinochloa	Echinochloa	Echinochloa	Echinochloa
-Size (μ)	60-64×6-8	24-28×6-9	20-22×5-7	24-28×5-7	20-26×5-8	22-26×6-8
Papillae/cell	Absent	1	1	1	1	1
Stomatal complex						
-Subsidiary cell type	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular
-Size(μ)	24-30×15-18	30-38×18-20	34-38×20-24	36-40×20-22	34-38×18-20	36-42×18-22
-No. of Papillae overarchng the stoma	Absent	Absent	Absent	4	4	Absent
Margin	Angular prickles & Tubercled hair	Angular prickles	Angular prickles	Small angular prickles	Angular prickles	Angular prickles

A, D, G, K, N, Q: Adaxial surface (Bar=30 μ)

B, E, H, L, O, R: Abaxial surface (Bar=30 μ)

C, F, I, M, P, S: Margin

J: Prickles & Intercostal Macrohairs

Table 13 & Plate 274: Foliar micromorphological features of Tribe Paniceae (Contd..)

Figure legends: Plate 274

Plant name	<i>Eriochloa procera</i>	<i>Moorochloa eruciformis</i>	<i>Oplismenus burmanii</i>	<i>Oplismenus compositus</i>	<i>Panicum antidotale</i>	<i>Panicum curviflorum</i>
Figure No.	A,B, C	D, E, F, G	H, I, J	K, L, M	N, O, P	Q, R, S
Long cell						
Size (μ)	78-134×10-14	62-125×11-17	54-105×24-32	46-92×24-36	62-125×8-12	96-140×12-15
Shape	Rectangular	Rectangular	Rectangular-Cubical	Rectangular-Cubical	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell						
Intercostal	Tall narrow	Absent	Absent	Absent	Elongate	Elongate
Costal : Type & Size(μ)	Dumbbell-nodular 16-24×3-5	Dumbbell-Cross 12-17×5-8	Dumbbell-nodular 16-24×4-7	Dumbbell-nodular 16-24×4-7	Dumbbell-Cross 10-14×5-8	Dumbbell-Cross 12-20×6-8
Si-Cr pairs	Present	Absent	Absent	Absent	Present	Absent
Prickle						
Costal(μ)	Absent	Absent	Absent	Absent	Absent	Absent
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent	Absent
Hooks	Present	Present	Absent	Absent	Present	Absent
Macrohair	Absent	Tubercled hairs	Long hair with 2 celled base	Long hair with 2 celled base	Absent	Absent
Microhair						
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Echinochloa	Panicoid	Echinochloa	Echinochloa	Panicoid	Panicoid
-Size (μ)	40-52×6-8	12-15×3-5	40-52×6-8	46-54×6-8	35-37×5-7	54-60×7-10
Papillae/cell	Absent	Absent	Absent	Absent	Absent	Absent
Stomatal complex						
-Subsidiary cell type	Triangular	Triangular-low dome	Triangular-low dome	Triangular-low dome	Triangular-low dome	Triangular
-Size(μ)	32-36×14-18	22-27×15-17	28-32×15-18	32-36×15-18	21-37×12-17	12-18×15-18
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Cris-cross Angular prickles	Angular prickled	Angular prickled	Angular prickles	Angular prickled

A, D, H, K, N, Q: Adaxial surface (Bar=30 μ)

B, E, I, L, O, R: Abaxial surface (Bar=30 μ)

C, G, J, M, P, S: Margin

F: Macrohairs

Table 14 & Plate 275: Foliar micromorphological features of Tribe Paniceae (Contd..)

Figure legends: Plate 275

Plant name	<i>Panicum notatum</i>	<i>Panicum paianum</i>	<i>Panicum paludosum</i>	<i>Panicum psilopodium</i>	<i>Panicum repens</i>	<i>Panicum sumatrense</i>
Figure No.	A, B, C	D, E, F	G, H, I	J, K, L	M, N, O	P, Q, R
Long cell						
Size (μ)	52-105×12-17	92-146×12-15	110-140×12-15	115-160×12-15	96-140×12-15	110-140×12-15
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell						
Intercostal	Absent	Elongate	Elongate	Elongate	Elongate	Elongate
Costal : Type & Size(μ)	Dumbbell-nodular 16-30×6-8	Cross-Dumbbell 16-24×7-10	Cross-Dumbbell 12-20×6-8	Cross-Dumbbell 12-20×6-8	Dumbbell-nodular 16-24×6-8	Cross-Dumbbell 12-20×6-8
Si-Cr pairs	Present	Present	Absent	Absent	Absent	Absent
Prickle						
Costal(μ)	Absent	Absent	Absent	Absent	Absent	Absent
Intercostal(μ)	Absent	Absent	L:Absent U:20-30×10-12	L:Absent U:24-30×12-15	Absent	L:Absent U:20-30×10-12
Hooks	Absent	Absent	Absent	Absent	Present	Absent
Macrohair	Absent	Absent	Absent	Absent	Long hair with 2-3 celled base	Absent
Microhair						
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid
-Size (μ)	120-132×8-10	40-46×6-8	38-42×6-8	42-46×6-8	54-60×7-10	42-46×6-8
Papillae /cell	Absent	L:Absent U:1-2	L:Absent U:3-8	L:Absent U:3-8	Absent	L:Absent U:3-8
Stomatal complex						
-Subsidiary cell type	Triangular-low dome	Triangular-low dome	Triangular-low dome	Triangular-low dome	Triangular-Tall dome	Triangular-low dome
-Size(μ)	28-32×15-18	26-32×15-18	22-28×15-18	24-30×15-18	12-18×15-18	24-30×15-18
-No. of Papillae	Absent	Absent	Absent	Absent	Absent	Absent
Margin	Large angular prickled	Minute angular prickled	Angular prickled	Minute angular prickled	Angular prickled	Angular prickled

A, D, G, J, M, P: Adaxial surface (Bar=30 μ)

B, E, H, K, N, Q: Abaxial surface (Bar=30 μ)

C, F, I, L, O, R: Margin

Table15 & Plate 276: Foliar micromorphological features of Tribe Paniceae (Contd..)

Plant name	<i>Paspalum longifolium</i>	<i>Paspalum paspaloides</i>	<i>Paspalum scrobiculatum</i>	<i>Paspalum vaginatum</i>	<i>Paspalidium flavidum</i>	<i>Paspalidium geminatum</i>
Figure No.	A, B, C, D	E, F, G	H, I, J	K, L, M	N, O, P	Q, R, S
Long cell						
Size (μ)	45-115×22-38	65-120×18-24	45-94×18-40	72-140×22-30	75-120×24-30	130-185×20-28
Shape	Rectangular-cubical	Rectangular	Rectangular-cubical	Rectangular	Rectangular-Hexagonal	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell						
Intercostal	Elongate-crescent	Elongate-cross	Elongate-cross	Absent	Tall narrow-cross	Tall narrow-cross
Costal : Type & Size(μ)	Dumbbell-Nodular 22-30×8-10	Dumbbell-Nodular 12-15×6-8	Dumbbell-Nodular 8-12×5-6	Dumbbell-Nodular 22-30×8-10	Dumbbell-cross 15-22×6-8	Dumbbell-cross 18-24×10-12
Si-Cr pairs	Present	Present	Present	Present	Present	Present
Prickle						
Costal(μ)	Absent	Absent	Absent	Absent	Absent	L:Absent U:30-45×15-18
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent	Absent
Hooks	Present	Absent	Absent	Absent	L:Absent U:Present	Absent
Macrohair	Absent	Absent	Absent	Absent	Absent	Absent
Microhair						
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid
-Size (μ)	28-35×6-7	32-38×7-9	32-36×5-7	38-46×8-10	36-40×6-8	30-36×6-8
Papillae /cell	Absent	L:Absent, U:1	L:Absent, U:1	1	L:Absent U:1, minute	L:Absent U:1
Stomatal complex						
-Subsidiary cell type	Triangular	Parallel-Triangular	Triangular	Parallel- Tall dome	Parallel-triangular	Triangular-low dome
-Size(μ)	28-32×20-24	25-28×15-12	18-25×18-20	28-32×18-26	30-36×24-30	30-34×27-30
-No. of Papillae overarching the stoma	Absent	Absent	Absent	L:Absent U:Partially covered	Absent	Absent
Margin	Angular pricked	Angular pricked	Angular pricked	Angular pricked	Angular pricked	Angular pricked

Figure legends: Plate 276

A, E, H, K, N, Q: Adaxial surface (Bar=30 μ)

B, F, I, L, O, R: Abaxial surface (Bar=30 μ)

C, G, J, M, P, S: Margin

D: Hooks & Microhairs

Table 16 & Plate 277: Foliar micromorphological features of Tribe Paniceae (Contd..)

Plant name	<i>Setaria italica</i>	<i>Setaria parviflora</i>	<i>Setaria plicata</i>	<i>Setaria pumila</i>	<i>Setaria tomentosa</i>	<i>Setaria verticillata</i>
Figure No.	A, B, C, D	E, F, G	H, I, J, K	L, M, N	O, P, Q, R	S, T, U, V
Long cell						
Size (μ)	82-170× 12-17	90-166× 30-40	115-220× 17-25	115-210× 30-40	80-185× 20-28	75- 135×17-25
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Slightly sinuuous	Slightly sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell						
Intercostal	Absent	Absent	Absent	Absent	Absent	Absent
Costal : Type & Size(μ)	Cross- dumbbell 12-17×5-7	Dumbbell - nodular 27-32×10- 12	Dumbbell - nodular 12-20×4-5	Cross- dumbbell 16-28×10- 12	Nodular- dumbbell 12-20×4-7	Nodular- dumbbell 12-20×7- 10
Si-Cr pairs	Absent	Absent	Absent	Absent	Absent	Absent
Prickle						
Costal(μ)	30-42×15- 22	L:Absent U:18-22× 7-9	25-32×12- 115	22-28×8- 10	50-55×20- 22	44-52×17- 25
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent	Absent
Hooks	Present	Absent	Absent	Present	Present	Present
Macrohair	Tubercled hairs	Absent	Tubercled hairs	Tubercled hairs	Tubercled hairs	Tubercled hairs
Microhair						
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid
-Size (μ)	60-67×5-8	64-68×8- 10	65-67×5-7	60-68×8- 10	60-64×5-8	67-72×6-8
Papillae /cell	Absent	Absent	Absent	Absent	Absent	Absent
Stomatal complex						
-Subsidiary cell type	Triangular- Low dome	Parallel	Triangular- Tall dome	Triangular- Low dome	Low -Tall dome	Low -Tall dome
-Size(μ)	20-25×10- 17	25-30×17- 20	20-35×17- 28	25-30×20- 26	17-25×15- 20	25-30×17- 25
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 277

A, E, H, L, O, S: Adaxial surface (Bar=30 μ)

B, F, I, M, P, T: Abaxial surface (Bar=30 μ)

D, G, K, N, R, V: Margin

C, J, Q, U: Macrohairs

Table 17 & Plate 278: Foliar micromorphological features of Tribe Paniceae (Contd..)

Plant name	<i>Urochloa distachya</i>	<i>Urochloa mutica</i>	<i>Urochloa panicoides</i>	<i>Urochloa ramosa</i>	<i>Urochloa reptans</i>
Figure No.	A,B, C	D, E, F	G, H, I, J	K, L, M	N, O, P
Long cell					
Size (μ)	110-260×12-20	56-142×14-20	80-144×16-20	72-104×14-18	68-98×12-15
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Cubical-elongate	Cubical-elongate	Absent	Elongate-cross	Elongate-cross
Costal : Type & Size(μ)	Cross-Dumbbell 15-18×5-7	Dumbbell-nodular 18-22×7-10	Dumbbell-nodular 15-22×7-12	Dumbbell-nodular 21-26×6-8	Dumbbell-nodular 12-16×6-8
Si-Cr pairs	Present	Absent	Absent	Present	Absent
Prickle					
Costal(μ)	Absent	L: Absent U:22-28×10-14	Absent	Absent	Absent
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Present	Present	Present	Present	Present
Macrohair	Absent	Absent	2-basal celled & tubercle hair	1-2-basal celled hair	3-basal celled hair
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid
-Size (μ)	15-17×5-7	40-46×7-10	20-24×5-7	48-52×6-8	45-50×9-11
Papillae/cell	Absent	Absent	Absent	Absent	Absent
Stomatal complex					
-Subsidiary cell type	Low dome-Triangular	Low dome-Triangular	Triangular	Triangular	Triangular
-Size(μ)	22-27×16-20	28-36×16-22	25-32×17-22	20-24×14-18	18-24×12-15
-No. of Papillae overarchng the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 278

A, D, G, K, N: Adaxial surface (Bar=30 μ)

B, E, H, L, O: Abaxial surface (Bar=30 μ)

C, F, I, M, P: Margin

J: Macrohairs

Table 18 & Plate 279: Foliar micromorphological features of Tribe Paniceae (Contd..)

Plant name	<i>Digitaria albudense</i>	<i>Digitaria bicornis</i>	<i>Digitaria longiflora</i>	<i>Digitaria marginatus</i>	<i>Digitaria setigera</i>
Figure No.	A, B, C	D, E, F	G, H, I	J, K, L	M, N, O
Long cell					
Size (μ)	45-112 × 20-40	45-80 × 18-24	50-115 × 17-20	35-80 × 15-30	40-112 × 10-25
Shape	Rectangular	Rectangular	Cubical-Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Absent	Absent	Absent	Absent	Absent
Costal : Type & Size(μ)	Dumbbell 10-12 × 5-7	Dumbbell 12-20 × 7-12	Cross-Dumbbell 7-16 × 7-10	Dumbbell-nodular 12-25 × 7-12	Dumbbell-nodular 12-15 × 7-10
Si-Cr pairs	Absent	Absent	Absent	Absent	Absent
Prickle					
Costal(μ)	L: Absent U: 40-50 × 7-9	20-37 × 12-20	Absent	L: 37-70 × 17-20 U: Absent	L: 22-30 × 10-12 U: Absent
Intercostal(μ)	Absent	Absent	Absent	Absent	Present
Hooks	Absent	Present	Present	Present	Present
Macrohair	Absent	Absent	Absent	Absent	Tubercled hair
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Echinochloa	Echinochloa	Echinochloa	Echinochloa	Echinochloa
-Size (μ)	20-24 × 5-7	57-65 × 5-7	50-62 × 5-7	57-65 × 5-7	50-57 × 5-7
Papillae /cell	Absent	L: Absent U: 1-2, large	Absent	1-2, large	Absent
Stomatal complex					
-Subsidiary cell type	Low dome	Triangular-low dome	Triangular-low dome	Triangular-low dome	Triangular-low dome
-Size(μ)	30-32 × 17-22	36-42 × 30-35	25-30 × 12-17	30-40 × 30-35	30-40 × 17-20
-No. of Papillae over arching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 279

A, D, G, J, M: Adaxial surface (Bar=30 μ)

B, E, H, K, N: Abaxial surface (Bar=30 μ)

C, F, I, L, O: Margin

Table19 & Plate 280: Foliar micromorphological features of Tribe Paniceae (Contd..)

Plant name	<i>Digitaria stricta</i>	<i>Digitaria violascens</i>	<i>Cenchrus biflorus</i>	<i>Cenchrus ciliaris</i>	<i>Cenchrus setigerus</i>
Figure No.	A,B, C	D, E, F	G, H, I, J	K, L, M	N, O, P
Long cell					
Size (μ)	42-62 × 10-12	55-150x10-25	60-135×16-20	65-130×12-17	60-155×15-20
Shape	Hexagonal-Rectangular	Hexagonal-Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Slightly sinuous	Slightly sinuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Absent	Absent	Elongate	Absent	Absent
Costal: Type & Size(μ)	Dumbbell-nodular 15-17x5-7	Cross-Dumbbell 10-15x7-12	Cross-Dumbbell 8-14x6-10	Dumbbell-nodular 12-17x7-12	Dumbbell-nodular 17-22x6-10
Si-Cr pairs	Absent	Absent	Present	Present	Present
Prickle					
Costal(μ)	L: Absent U: 30-35x10-12	L: Absent U: 22-25x10-12	30-34 × 21-24	30-35 × 22-25	35-48 × 17-22
Intercostal(μ)	Absent	Absent	24-27 × 8-10	20-35 × 8-12	17-25 × 8-12
Hooks	Absent	Absent	Present	Present	Present
Macrohair	Tuberclad hairs	Absent	Absent	Long hairs with 6-10 celled base	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Loudetia	Echinochloa	Panicoid	Panicoid	Panicoid
-size (μ)	58-72x5-7	55-62x5-7	46-52x4-6	25-32 × 5-7	20-28x4-6
Papillae/cell	Absent	Absent	Absent	Absent	Absent
Stomatal complex					
-Subsidiary cell type	Triangular-Parallel	Triangular-Parallel	Triangular	Triangular-low dome	Triangular-low dome
-Size(μ)	17-25x12-15	27-32x12-17	28-32x18-22	30-34x16-20	32-36x14-20
-No. of Papillae overarchng the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 280

A, D, G, K, N: Adaxial surface (Bar=30 μ)

B, E, H, L, O: Abaxial surface (Bar=30 μ)

C, F, J, M, P: Margin

I: Prickles & Hooks

Table 20 & Plate 281: Foliar micromorphological features of Tribe Paniceae (Contd..)

Plant name	<i>Pennisetum americanum</i>	<i>Pennisetum hohenackeri</i>	<i>Pennisetum oriente</i>	<i>Pennisetum polystachion</i>	<i>Pennisetum pedicellatum</i>
Figure No.	A, B, C	D, E, F	G, H, I	J, K, L	M, N, O
Long cell					
Size (μ)	85-154×22-26	65-90×12-16	52-125×15-18	80-140×16-22	94-156×18-22
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Tall narrow - elongate	Tall narrow - elongate	Tall narrow - cross	Absent	Absent
Costal : Type & Size(μ)	Dumbbell-Nodular 10-20×6-10	Cubical-cross 7-10×6-8	Dumbbell-Nodular 14-17×4-7	Dumbbell-Nodular 10-16×4-6	Dumbbell-Nodular 12-24×5-7
Si-Cr pairs	Present	Present	Present	Absent	Absent
Prickle					
Costal(μ)	L: Absent U: 30-42×10-15	L: Absent U: 12-15×5-7	L: Absent U: 32-38×8-10	L: Absent U: 38-50×5-10	L: Absent U: 35-42×8-10
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Present	Present	Present	Present	Present
Macrohair	Absent	Absent	Absent	Absent	Absent
Microhair					
- No. of Cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid
-Size (μ)	57-62×6-8	44-52×5-7	56-64×6-8	42-50×5-7	48-54×6-8
Papillae/cell	Absent	Absent	Absent	Absent	Absent
Stomatal complex					
-Subsidiary cell type	Triangular- tall dome	Triangular- low dome	Triangular	Triangular- low dome	Triangular-low dome
-Size(μ)	30-34×26-34	22-28×18-22	28-34×16-24	30-34×18-22	24-30×16-22
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular pricked	Angular pricked	Angular pricked	Angular pricked	Angular pricked

Figure legends: Plate 281

A, D, G, J, M: Adaxial surface (Bar=30 μ)

B, E, H, K, N: Abaxial surface (Bar=30 μ)

C, F, I, L, O: Margin

Table 21 & Plate 282: Foliar micromorphological features of Paniceae (Contd.), Isachneae & Arundinelleae

Plant name	<i>Pennisetum purpureum</i>	<i>Pennisetum setosum</i>	<i>Isachne globosa</i>	<i>Arundinella ciliata</i>	<i>Arundinella pumila</i>
Figure No.	A,B, C	D, E, F, G	H, I, J, K	L, M, N, O	P, Q, R
Long cell					
Size (μ)	68-125×15-18	125-180×22-28	28-68×18-40	120-225×15-22	105-164×24-32
Shape	Rectangular	Rectangular	Rectangular-Hexagonal	Rectangular	Rectangular-Hexagonal
Cell wall	Sinuuous	Sinuuous	Smooth	Sinuuous	Slightly sinuuous
Short cell / Silica cell					
Intercostal	Elongate	Absent	Absent	Absent	Absent
Costal : Type & Size(μ)	Dumbbell-cross 8-20×8-10	Dumbbell-Nodular 8-14×4-6	Saddle 6-10×6-8	Dumbbell-cross 18-32×6-10	Dumbbell-cross 6-12×5-8
Si-Cr pairs	Present	Absent	Absent	Present	Present
Prickle					
Costal(μ)	L: Absent U: 42-65×15-18	L: Absent U: 38-44×10-14	42-68×25-36 (covered with epidermal cells)	Absent	Absent
Intercostal(μ)	Absent	Absent	32-54×28-32	Absent	Absent
Hooks	Present	Present	Absent	Present	Absent
Macrohair	Long hair with 4-6 basal cells	Long hair with 6-10 basal cells	Absent	Tuberclcd hairs	Long hair with 4-8 basal cells
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Zizania	Panicoid	Panicoid
-Size (μ)	34-40×8-10	48-52×6-8	22-26×8-10	28-34×6-8	32-38×4-6
Papillae/cell	Absent	Absent	1	Absent	Absent
Stomatal complex					
-Subsidiary cell type	Triangular	Triangular-low dome	Low dome	Triangular-low dome	Triangular-Tall dome
-Size(μ)	24-30×18-22	30-34×18-22	38-44×20-24	28-34×16-24	24-30×20-28
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular pricked	Angular pricked	Angular pricked	Angular pricked	Angular pricked

Figure legends: Plate 282

A, D, H, L, P: Adaxial surface (Bar=30 μ)

B, E, I, M, Q : Abaxial surface (Bar=30 μ)

C, F, K, N, R: Margin

G, O: Macrohairs

J: Costal prickle covered by long cells & saddle silica cells

Table 22 & Plate 283: Foliar micromorphological features of Tribe Andropogoneae

Plant name	<i>Eulalia fimbriata</i>	<i>Eulalia trispica</i>	<i>Pogonatherum saccharoideum</i>	<i>Spodiopogon aristatus</i>	<i>Spodiopogon rhizophorus</i>
Figure No.	A,B, C	D, E, F	G, H, I	J, K, L, M	N, O, P, Q
Long cell					
Size (μ)	112-256×24-28	95-170×22-24	64-96×22-26	95-140×40-48	104-160×40-48
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Absent	Tall-narrow	Absent	Absent	Absent
Costal : Type & Size(μ)	Dumbbell-nodular 30-38×6-9	Dumbbell-cross 10-18×10-14	Saddle-Cross-dumbbell 12-24×18-22	Nodular 24-34×6-8	Nodular 24-34×6-8
Si-Cr pairs	Absent	Absent	Absent	Absent	Absent
Prickle					
Costal(μ)	L: Absent U:46-80×20-26	L: Absent U: 36-48×14-18	60-88×22-26	L: Absent U:40-48×28-32	L: Absent U: 40-48×28-32
Intercostal(μ)	Absent	Absent	Absent	L:52-64×22-28 U: Absent	L:52-64×22-28 U: Absent
Hooks	Absent	Present	Absent	Absent	Absent
Macrohair	L:Absent U:Tuberclcd hairs	Absent	Absent	5-9 basal celled hairs	5-9 basal celled & Tuberclcd hairs
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Panicoid	Echinochloa	Echinochloa
-Size (μ)	40-46×8-10	44-50×8-10	36-40×6-8	40-46×8-10	40-46×8-10
Papillae/cell	Absent	Absent	2-7	Numerous	Numerous
Stomatal complex					
-Subsidiary cell type	Triangular	Triangular	Triangular	Triangular-Tall dome	Triangular
-Size(μ)	38-42×26-30	32-38×26-30	30-34×28-32	30-34×32-38	32-38×24-28
-No. of Papillae overarchng the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 283

A, D, G, J, N: Adaxial surface (Bar=30 μ)

B, E, H, K, O: Abaxial surface (Bar=30 μ)

C, F, I, L, O: Margin

M, P: Macrohairs

Table 23 & Plate 284: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Imperata cylindrica</i>	<i>Saccharum bengalense</i>	<i>Saccharum officinarum</i>	<i>Saccharum ravennae</i>	<i>Saccharum spontaneum</i>
Figure No.	A, B, C	D, E, F	G, H, I, J	K, L, M	N, O, P
Long cell					
Size (μ)	35-80×8-15	80-150×11-17	32-170×12-17	65-170×10-15	80-152×12-14
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Absent	Tall narrow-cubical	Tall narrow - crescent	Tall narrow - crescent	Tall narrow – crescent
Costal : Type & Size(μ)	Dumbbell 10-15×5-7	Dumbbell - nodular 12-25×4-7	Cross-dumbbell 12-18×8-10	Cross-dumbbell 18-24×12-17	Nodular - dumbbell 28-36×9-12
Si-Cr pairs	Present	Absent	Present	Present	Present
Prickle					
Costal(μ)	Absent	Absent	Absent	L: 25-34×12-15	L: 35-57×12-15 (Interlocking) U: Absent
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Absent	Present	Present	Present	Present
Macrohair	Absent	Absent	Tubercled hairs	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Echinochloa	Panicoid	Zizania	Panicoid	Panicoid
-Size (μ)	22-26×6-7	55-70×6-8	35-40×5-7	58-76×6-8	52-65×5-7
Papillae /cell	Absent	L: 1 U: Absent	Absent	Absent	Absent
Stomatal complex					
-Subsidiary cell type	Triangular	Low dome-triangular	Tall dome-triangular	Triangular	Low dome-triangular
-Size(μ)	18-22×18-20	28-36×16-22	34-40×24-32	30-40×18-24	28-32×15-22
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Large angular prickled	Angular prickles with tubercled hairs	Angular prickled	Large angular prickled

Figure legends: Plate 284

A, D, G, K, N: Adaxial surface (Bar=30 μ)

B, E, H, L, O: Abaxial surface (Bar=30 μ)

C, F, J, M, P: Margin

I: Macrohairs

Table 24 & Plate 285: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Apocopis vaginatus</i>	<i>Capillipedium assimile</i>	<i>Capillipedium filiculme</i>	<i>Capillipedium huegelii</i>	<i>Sorghum bicolor</i>
Figure No.	A, B, C, D	E, F, G	H, I, J	K, L, M	N, O, P
Long cell					
Size (μ)	95-130×20-26	75-150×18-24	56-140×16-22	78-136×16-22	72-180×20-26
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Absent	Crescent	U:Cross-crescent	Absent	Crescent
Costal : Type & Size(μ)	Dumbbell-nodular 16-28×12-14	Dumbbell-nodular 20-34×10-12	Dumbbell-nodular 18-26×10-12	Dumbbell-nodular 18-26×10-12	Dumbbell-cross 22-25×7-10
Si-Cr pairs	Absent	Absent	U:Present	Absent	Present
Prickle					
Costal(μ)	Absent	25-45×16-20	48-60×14-18	48-60×14-18	L:Absent U:15-35×12-15
Intercostal(μ)	Absent	Absent	L:Absent U:54-68×14-18	L:Absent U:32-40×12-16	L:Absent U:38-46×12-18
Hooks	Absent	Absent	Absent	Absent	Present
Macrohair	Tuberclcd hair	Absent	Absent	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Arundo	Arundo	Arundo	Panicoid
-Size (μ)	28-32×6-8	44-50×6-8	52-60×8-10	52-60×8-10	35-40×8-10
Papillae/cell	1	3-7	5-10	5-10	Absent
Stomatal complex					
-Subsidiary cell type	Triangular	Triangular	Triangular	Triangular	Triangular
-Size(μ)	28-32×20-24	26-30×20-24	26-30×18-22	26-30×18-22	30-34×18-22
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 285

A, E, H, K, N: Adaxial surface (Bar=30 μ)

B, F, I, L, O: Abaxial surface (Bar=30 μ)

D, G, J, M, P: Margin

C: Macrohairs

Table 25 & Plate 286: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Sorghum halepense</i>	<i>Chrysopogon fulvus</i>	<i>Chrysopogon polyphyllus</i>	<i>Chrysopogon serrulatus</i>	<i>Chrysopogon zizanioides</i>
Figure No.	A,B, C	D, E, F, G	H, I, J, K	L, M, N	O, P, Q
Long cell					
Size (μ)	95-210×22-30	45-140×28-34	60-140×24-30	60-160×22-28	75-140×18-25
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Tall-narrow	Crescent-Cross	Cross	Cross	Cross -tall narrow
Costal : Type & Size(μ)	Cross-dumbbell 22-25×7-10	Cross-cubical 12-15×8-11	Cross- cubical 12-15×8-11	Cross- cubical 12-15×8-11	Cross-dumbbell 8-15×11-15
Si-Cr pairs	Present	Present	Present	Present	Present
Prickle					
Costal(μ)	15-35×12-15	54-82×16-20	L:42-65×20-24 U: Absent	Absent	Absent
Intercostal(μ)	Absent	L:Absent U:54-82×16-20	Absent	Absent	Absent
Hooks	Absent	Present	Present	Present	Absent
Macrohair	Absent	Absent	Absent	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid
-Size (μ)	35-40×7-10	45-52×6-8	30-34×5-7	30-38×5-7	32-38×7-10
Papillae/cell	Absent	L:Absent U: 1-2, large	L:Absent U: 1-2, large	L:Absent U: 1-2, large	L:Absent U: 1, large
Stomata					
-Subsidiary cell type	Triangular	Low dome-triangular	Low dome-triangular	Low dome-triangular	Triangular
-Size(μ)	27-32×15-20	32-40×15-18	32-37×15-18	34-40×18-24	27-32×13-22
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 286

A, D, H, L, O: Adaxial surface (Bar=30 μ)

B, E, I, M, P: Abaxial surface (Bar=30 μ)

C, G, K, N, Q: Margin

F, J: Prickles

Table 26 & Plate 287: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Bothriochloa pertusa</i>	<i>Dichanthium annulatum</i>	<i>Dichanthium caricosum</i>	<i>Dichanthium foveolatum</i>	<i>Dichanthium mccannii</i>
Figure No.	A,B, C	D, E, F	G, H, I	J, K, L, M	N, O, P
Long cell					
Size (μ)	90-180×10-18	75-160×10-18	90-180×10-18	72-190×16-22	74-140×16-20
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Tall narrow	Tall narrow	Tall narrow	Tall narrow	Tall narrow
Costal : Type & Size(μ)	Dumbbell-nodular 16-24×12-16	Nodular - Dumbbell 18-30×12-16	Dumbbell-cross 12-20×12-16	Cross-dumbbell 11-12×8-11	Dumbbell-nodular 16-30×12-16
Si-Cr pairs	Present	Absent	Present	Present	Absent
Prickle					
Costal(μ)	L:Absent U:20-28×12-16	24-36×16-20	L:18-25×12-16 U:Absent	27-35×12-15	L: 24-32×14-18 U:Absent
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Present	Absent	Present	Present	Present
Macrohair	Absent	Absent	Absent	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Panicoid	Panicoid	Loudetia
-Size (μ)	36-42×8-10	48-56×8-10	40-48×8-10	18-20×6-7	58-72×8-10
Papillae/cell	L: 4-8 U: Absent	L: 1 U: Absent	Absent	1	L: 1-4 U: Absent
Stomata					
-Subsidiary cell type	Triangular-low dome	Triangular-low dome	Triangular	Triangular	Triangular-low dome
-Size(μ)	22-28×12-20	18-25×16-20	20-24×16-20	36-40×20-25	24-30×14-20
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Small angular prickles	Cris-cross Small angular prickles	Cris-cross Small angular prickles	Small angular prickles	Small angular prickles

Figure legends: Plate 287

A, D, G, J, N: Adaxial surface (Bar=30 μ)

B, E, H, K, O: Abaxial surface (Bar=30 μ)

C, F, I, M, P: Margin

L: Long papillate long cells

Table 27 & Plate 288: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Apluda mutica</i>	<i>Ischaemum afrum</i>	<i>Ischaemum barbatum</i>	<i>Ischaemum bombaiense</i>	<i>Ischaemum diplopogon</i>
Figure No.	A,B, C	D, E, F	G, H, I	J, K, L	M, N, O
Long cell					
Size (μ)	65-96×28-36	76-100×14-20	65-120×12-20	80-200×24-30	96-150×20-28
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Absent	Absent	Crescent	Absent	Crescent
Costal : Type & Size(μ)	Nodular 20-55×6-8	Dumbbell 20-33×10-12	Cross-Dumbbell - Nodular 10-17×6-7	Dumbbell - cross 10-20×10-13	Dumbbell - cross 34-42×12-16
Si-Cr pairs	Absent	Absent	Absent	Absent	Absent
Prickle					
Costal(μ)	30-45×22-28	26-40×20-26	Absent	Absent	L:Absent U:72-86×14-20
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Absent	Present	Absent	Absent	Absent
Macrohair	Absent	Absent	Absent	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Arundo	Panicoid	Chloris	L:Chloris U:Panicoid	L: Chloris U: Zizania
-Size (μ)	34-42×5-7	42-47×6-8	12-17×6-8	L:29-32×10-13 U:43-50×6-8	L:18-20×6-7 U:34-38×6-7
Papillae/cell	Absent	Absent	L:3-5, 1 row U:Absent	L: 4-8, 1-row U:Absent	L: 2-5, 1-row U:Absent
Stomatal complex					
-Subsidiary cell type	Triangular-tall dome	Triangular	Triangular	Triangular -low dome	Low dome
-Size(μ)	30-35×22-28	30-35×18-27	20-24×20-24	36-40×16-30	36-40×18-24
-No. of Papillae overarchng the stoma	Absent	Absent	Absent	L:4	L:4
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 288

A, D, G, J, M: Adaxial surface (Bar=30 μ)

B, E, H, K, N: Abaxial surface (Bar=30 μ)

C, F, I, L, O: Margin

Table 28 & Plate 289: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Ischaemum indicum</i>	<i>Ischaemum molle</i>	<i>Ischaemum muticum</i>	<i>Ischaemum rugosum</i>	<i>Ischaemum santapau</i>
Figure No.	A,B, C, D	E, F, G, H	I, J, K, L	M, N, O, P	Q, R, S, T
Long cell					
Size (μ)	50-100×20-28	86-116×26-32	60-90×15-30	86-100×22-30	80-130×38-42
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Absent	Absent	Absent	L:Absent U: Cubical	Cubical
Costal : Type & Size(μ)	Cross-dumbbell 13-17×6-7	Dumbbell 16-17×6-10	Cross - dumbbell 6-17×10	Cross-dumbbell 10-27×13-17	Cross-dumbbell 16-26×13-16
Si-Cr pairs	Absent	Absent	Absent	Absent	Absent
Prickle					
Costal(μ)	Absent	Absent	Absent	Absent	Absent
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Present	Absent	Absent	L:Present U:Absent	L:Present U:Absent
Macrohair	L:Tuberclad hair	Tuberclad hair	L:Tuberclad hair	U:Tuberclad hair	L:Tuberclad hair
Microhairs					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Chloris	Zizania	L: Zizania U: Chloris	L: Chloris & Panicoid U:Panicoid	L: Chloris U: Panicoid
-Size (μ)	20-23×6-7	30-34×6-7	L:18-20×6-7 U:34-37×6-7	Ch:20-24×7-8 P:35-39×7-8	L: 18-27×10-12 U:33-63×6-7
Papillae/cell	12-22, 2-3 row	L:4-7, 1-row	L:3-5, 1-row	L:4-10, 1-row	L:3-5, 1-row
Stomatal complex					
-Subsidiary cell type	Triangular	Triangular-Low dome	Triangular	Triangular	Triangular
-Size(μ)	23-27×23-27	23-33×16-23	17-20×26-28	30-36×26-33	26-40×26-28
-No. of Papillae overarching the stoma	Absent	L:4	Absent	L: 4	L: 4
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 289

A, E, I, M, Q: Adaxial surface (Bar=30 μ)

B, F, J, N, R: Abaxial surface (Bar=30 μ)

D, G, L, P, T: Margin

C, H, K, S: Macrohairs

O: Panicoid microhair

Table 29 & Plate 290: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Ischaemum sayajiraoi</i>	<i>Ischaemum semisegittatum</i>	<i>Ischaemum travancorensis</i>	<i>Sehima nervosum</i>	<i>Sehima sulcatum</i>
Figure No.	A, B, C	D, E, F	G, H, I	J, K, L	M, N, O
Long cell					
Size (μ)	75-116 × 20-30	40-83 × 16-24	86-132 × 38-46	76-100 × 14-20	76-100 × 14-20
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Smooth-Sinuuous	Smooth-Sinuuous	Smooth-Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	L: Absent U: Cubical	Absent	L: Cubical U: Absent	Absent	Absent
Costal : Type & Size(μ)	Cross-dumbbell 10-17 × 17-20	Cross -Dumbbell 6-17 × 6-7	Cross-dumbbell 16-26 × 16-17	Dumbbell 20-33 × 10-12	Dumbbell 20-33 × 10-12
Si-Cr pairs	Absent	Absent	Absent	Absent	Absent
Prickle					
Costal(μ)	Absent	Absent	Absent	26-60 × 20-26	26-60 × 20-26
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Absent	Absent	Absent	Present	Present
Macrohair	U: Tubercled hair	Absent	Absent	Absent	Absent
Microhair					
-No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	L: Zizania U: Panicoid	L: Chloris U: Zizania	L: Chloris U: panicoid	Panicoid	Panicoid
-Size (μ)	L: 23-26 × 10-12 U: 33-36 × 10-12	L: 22-26 × 10-12 U: 26-30 × 6-7	L: 28-32 × 10-12 U: 42-50 × 10-12	42-47 × 6-8	42-47 × 6-8
Papillae/cell	L: 5-10, 1 row	L: 4-8, 1 row	L: 3-5, 1-row	Absent	Absent
Stomatal complex					
-Subsidiary cell type	Triangular - Low dome	Triangular	Triangular- Tall dome	Triangular	L: Triangular
-Size(μ)	26-33 × 16-20	20-24 × 16-20	23-33 × 33-36	30-35 × 18-27	30-35 × 18-27
-No. of Papillae overarchng the stoma	L: 4	Absent	L: 4	Absent	Absent
Margin	Wavy angular hairs	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 290

A, D, G, J, M: Adaxial surface (Bar=30 μ)

B, E, H, K, N: Abaxial surface (Bar=30 μ)

C, F, I, L, O: Margin

Table 30 & Plate 291: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Triplopogon ramosissimus</i>	<i>Dimeria ornithopoda</i>	<i>Dimeria stapfiana</i>	<i>Andropogon pumilus</i>
Figure No.	A,B, C, D	E, F, G, H	I, J, K, L	M, N, O
Long cell				
Size (μ)	64-122×22-26	50-124×26-30	78-168×24-28	120-184×30-38
Shape	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell				
Intercostal	Cubical	Absent	Tall narrow	Cross-crescent
Costal : Type & Size(μ)	Cross-dumbbell-nodular 8-28×10-14	Dumbbell 20-32×12-14	Cross-dumbbell-nodular 10-32×10-14	Dumbbell-cross 20-38×15-20
Si-Cr pairs	Absent	Absent	Absent	Present
Prickle				
Costal(μ)	Absent	Absent	Absent	L:Absent U:50-76×15-20
Intercostal(μ)	Absent	Absent	Absent	Absent
Hooks	Present	Absent	L:Absent U:Present	Absent
Macrohair	Tuberclcd hairs	Tuberclcd hairs	Tuberclcd hairs	Absent
Microhair				
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	L:Zizania U: Panicoid	L:Zizania U: Panicoid	Panicoid
-Size (μ)	54-60×10-12	L:12-15×6-8 U:40-46×6-8	L:12-15×6-8 U:40-46×6-8	45-50×8-10
Papillae /cell	L:3-6 U:Absent	L:3-6 U:Absent	L:2-8 U:Absent	Absent
Stomatal complex				
-Subsidiary cell type	Triangular	L:Triangular	L:Triangular	Triangular-Tall dome
-Size(μ)	30-34×24-30	30-34×26-30	34-38×24-28	30-34×30-38
-No. of Papillae overarching the stoma	Absent	L: 4	L: 4	Absent
Margin	Angular prickled	Tuberclcd hairs	Angular prickled	Angular prickled

Figure legends: Plate 291

A, E, I, M: Adaxial surface (Bar=30 μ)

B, F, J, N: Abaxial surface (Bar=30 μ)

H, L, O: Margin

G, K: Macrohairs

C, D: Silica cells

Table 31 & Plate 292: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Arthraxon hispidus</i>	<i>Arthraxon inermis</i>	<i>Arthraxon lanceolatus</i>	<i>Arthraxon lancifolius</i>	<i>Arthraxon nudus</i>
Figure No.	A,B, C	D, E, F	G, H, I, J	K, L, M	N, O, P, Q
Long cell					
Size (μ)	104-178×22-28	64-126×30-34	64-98×26-30	84-170×28-32	62-104×28-34
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Tall narrow-cross	Tall narrow	Absent	Absent	Elongate-cubical
Costal : Type & Size(μ)	Cross-dumbbell 18-26×6-8	Cross-dumbbell 8-14×6-8	Cross-dumbbell 10-20×8-10	Cross-dumbbell 8-18×6-8	Cross-dumbbell 5-8×4-6
Si-Cr pairs	Present	Present	Absent	Absent	present
Prickle					
Costal(μ)	Absent	Absent	Absent	Absent	Absent
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Absent	Absent	Absent	Present	Absent
Macrohair	Absent	6-8 basal celled hairs	6-8 basal celled hairs	2-basal celled hairs	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid
-Size (μ)	38-42×6-8	36-42×7-9	32-38×6-8	38-44×6-8	36-40×6-8
Papillae /cell	Absent	1	1	1	1, large
Stomatal complex					
-Subsidiary cell type	Triangular - low dome	Triangular	Triangular	Triangular	Triangular - low dome
-Size(μ)	34-38×26-32	36-40×32-36	34-38×26-30	34-40×32-38	32-38×22-28
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickles with tubercled hairs	Angular prickled	Angular prickles with tubercled hairs	Angular prickled	Angular prickled

Figure legends: Plate 292

A, D, G, K, N: Adaxial surface (Bar=30 μ)

B, E, H, L, O: Abaxial surface (Bar=30 μ)

C, F, I, M, P: Margin

J: Macrohairs

Q: Dumbbell silica cells

Table 32 & Plate 293: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Cymbopogon flexuosus</i>	<i>Cymbopogon martinii</i>	<i>Heteropogon contortus</i>	<i>Heteropogon ritchei</i>	<i>Iseilema laxum</i>	<i>Iseilema prostratum</i>
Figure No.	A,B, C	D, E, F	G, H, I, J	K, L, M	N, O, P	Q, R, S
Long cell						
Size (μ)	90-154×22-30	65-110×20-26	70-125×16-20	82-140×16-20	45-70×12-15	60-130×10-15
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell						
Intercostal	Tall narrow-crescent	Tall narrow-crescent	Cross	Absent	Tall narrow	Tall narrow-cubical
Costal : Type & Size(μ)	Dumbbell-nodular 14-22×9-12	Dumbbell-nodular 20-28×16-20	Dumbbell-nodular 18-35×9-12	Dumbbell-nodular 26-35×7-9	Dumbbell 18-28×12-16	Dumbbell-nodular 22-32×10-12
Si-Cr pairs	Present	Present	Absent	Absent	Absent	Absent
Prickle						
Costal(μ)	40-50×4-5	90-125×24-30	62-90×7-9	32-46×21-25	L: Absent U: 21-26×12-16	L: Absent U: 24-30×10-16
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent	Absent
Hooks	Present	L:Absent U:Present	Present	Present	Present	L:Absent U: Present
Macrohair	Absent	Absent	Tuberclcd hairs	Absent	Absent	Absent
Microhair						
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Zizania	Panicoid	Panicoid	Panicoid	Panicoid
-Size (μ)	56-62×6-8	35-42×10-12	70-85×6-8	66-74×7-9	60-66×6-8	54-62×6-8
Papillae/cell	Absent	L:1, U:Absent	1	Numerous, small	1	1
Stomatal complex						
-Subsidiary cell type	Triangular	Triangular-Tall dome	Triangular-low dome	L:Low dome-triangular	Triangular-low dome	Triangular-low dome
-Size(μ)	28-36×22-28	34-44×22-30	28-32×21-25	26-32×14-20	22-28×14-20	26-32×14-20
-No. of Papillae	Absent	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled	Angular prickled

Figure legends: Plate 293

A, D, G, K, N, Q: Adaxial surface (Bar=30 μ)

B, E, H, L, O, R: Abaxial surface (Bar=30 μ)

C, F, I, M, P, S: Margin

J: Macrohairs

Table 33 & Plate 294: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Pseudoanthriscia heteroclita</i>	<i>Themeda laxa</i>	<i>Themeda quadrivalvis</i>	<i>Themeda tremula</i>	<i>Themeda triandra</i>
Figure No.	A,B, C, D	E, F, G, H	I, J, K	L, M, N	O, P, Q
Long cell					
Size (μ)	140-182×18-24	176-220×20-28	196-262×28-36	116-220×30-38	160-212×24-32
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Crescent	Crescent	Crescent	Crescent	Crescent
Costal : Type & Size(μ)	Dumbbell-nodular 28-40×12-15	Dumbbell-nodular 24-34×10-12	Dumbbell-nodular 28-36×9-12	Dumbbell-nodular 22-36×10-12	Dumbbell-nodular 26-38×9-12
Si-Cr pairs	Absent	Absent	Absent	Absent	Absent
Prickle					
Costal(μ)	L:Absent U:46-58×18-20	L:Absent U:50-62× 18-22	L:Absent U:56-64×16-20	L:Absent U:50-58×16-20	60-75×20-26
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	Absent	Absent	Absent	Absent	Absent
Macrohair	Tuberclcd hairs	Absent	Absent	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Panicoid	Panicoid	Panicoid	Panicoid	Panicoid
-Size (μ)	60-68×5-8	72-80×6-8	84-92×6-8	40-48×6-8	72-80×6-8
Papillae /cell	Numerous, 1-2 rows	Numerous, 1-2 rows	Numerous, 1-2 rows	Numerous, 1-2 rows	Numerous, scattered
Stomatal complex					
-Subsidiary cell type	Triangular	Triangular-low dome	Triangular-low dome	Triangular	Triangular
-Size(μ)	30-34×28-32	36-40×28-34	40-46×32-40	38-44×34-42	36-40×30-36
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Angular prickles	Angular prickles with tuberclcd hairs	Angular prickles	Long Angular prickles	Angular prickles

Figure legends: Plate 294

A, E, I, L, O: Adaxial surface (Bar=30 μ)

B, F, J, M, P: Abaxial surface (Bar=30 μ)

C, G, K, N, Q: Margin

D, H: Macrohairs

Table 34 & Plate 295: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Mnesithea clarkei</i>	<i>Glyphochloa forficulata</i>	<i>Mnesithea granularis</i>	<i>Hemarthria compressa</i>	<i>Ophiuros exaltatus</i>	<i>Rottboellia cochinchinensis</i>
Figure No.	A, B, C, D	E, F, G	H, I, J, K	L, M, N	O, P, Q	R, S, T
Long cell						
Size (μ)	150-240×30-38	75-170×36-40	165-220×32-38	75-120×38-44	95-120×28-34	120-212×34-40
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuous	Sinuous	Sinuous	Sinuous	Sinuous	Sinuous
Short cell / Silica cell						
Intercostal	Crescent	Cross-crescent	Cross	Cross-tall narrow	Cross-crescent	Crescent
Costal : Type & Size(μ)	Cross-dumbbell 18-26×12-15	Cross-dumbbell 12-20×10-12	Cross-dumbbell-nodular 16-30×12-15	Cross 12-18×12-15	Cross-dumbbell 14-22×12-15	Cross-dumbbell 18-26×12-15
Si-Cr pairs	Absent	Present	Present	Present	Present	Present
Prickle						
Costal(μ)	Absent	Absent	Absent	Absent	Absent	L:Absent U:72-98×34-42
Intercostal	Absent	Absent	Absent	Absent	Absent	Absent
Hooks	Absent	Absent	Absent	Present	Absent	Absent
Macrohair	Tuberclad hairs	Tuberclad hairs	Tuberclad hairs	Absent	Absent	Absent
Microhair						
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Zea	Zea	Zea	Zea	Zea	Zea
-Size (μ)	42-48×10-12	34-42×8-10	42-48×10-12	32-38×8-10	40-48×10-12	42-48×10-12
Papillae/ cell	Absent	Absent	Absent	Absent	Absent	Absent
Stomatal complex						
-Subsidiary cell type	Triangular-low dome	Triangular-low dome	Triangular	Triangular	Low dome	Triangular
-Size(μ)	40-48×32-38	36-40×33-36	38-46×40-44	40-46×42-46	38-44×28-32	40-44×36-40
-No. of Papillae	Absent	Absent	Absent	Absent	Absent	Absent
Margin	Tuberclad hair with angular prickles	Tuberclad hair with angular prickles	Tuberclad hair with angular prickles	Small angular prickles	Tuberclad hair with angular prickles	Long angular prickles

Figure legends: Plate 295

A, E, H, L, O, R: Adaxial surface (Bar=30 μ)

B, F, I, M, P, S: Abaxial surface (Bar=30 μ)

D, G, K, N, Q, T: Margin

C, J: Macrohairs

Table 35 & Plate 296: Foliar micromorphological features of Tribe Andropogoneae (Contd..)

Plant name	<i>Zea mays</i>	<i>Chionachne koenigii</i>	<i>Trilobachne cookie</i>	<i>Coix aquatica</i>	<i>Coix lacryma-jobi</i>
Figure No.	A,B, C	D, E, F, G	H, I, J, K	L, M, N, O	P, Q, R, S
Long cell					
Size (μ)	108-156×28-32	130-174×34-40	112-146×18-24	120-150×12-15	90-135×30-36
Shape	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Cell wall	Sinuuous	Sinuuous	Sinuuous	Sinuuous	Sinuuous
Short cell / Silica cell					
Intercostal	Crescent	Crescent	Absent	Cross-crescent	Cross-crescent
Costal : Type & Size(μ)	Cross 8-18×12-18	Cross 50-54×38-46	Dumbbell-nodular 38-46×10-12	Cross-dumbbell 21-25×12-15	Cross-dumbbell 21-25×27-30
Si-Cr pairs	Present	Present	Absent	Present	Present
Prickle					
Costal(μ)	Absent	Absent	Absent	L: Absent U: 30-45×12-15	L: Absent U: 25-40×10-14
Intercostal(μ)	Absent	Absent	Absent	Absent	Absent
Hooks	L:Absent U:Present	Absent	Absent	Absent	Absent
Macrohair	Tuberclad hairs	Tuberclad hairs	Long hairs with 2-4 basal cells	Absent	Absent
Microhair					
- No. of cells	Bicellular	Bicellular	Bicellular	Bicellular	Bicellular
-Type	Zea	Zea	Zea	Zea	Zea
-Size (μ)	40-48×8-10	60-68×12-15	56-62×10-12	60-70×8-10	45-50×7-8
Papillae /cell	Absent	Absent	Absent	Absent	Absent
Stomatal complex					
-Subsidiary cell type	Triangular-low dome	Triangular-low dome	Triangular-low dome	Triangular-low dome	Triangular-low dome
-Size(μ)	40-44×30-34	50-54×34-40	48-56×24-22	45-52×18-22	45-52×30-32
-No. of Papillae overarching the stoma	Absent	Absent	Absent	Absent	Absent
Margin	Large Angular prickled hair	Large Angular prickled	Large Angular prickled	Small Angular prickled	Small Angular prickled

Figure legends: Plate 296

A, D, H, L, P: Adaxial surface (Bar=30 μ)

B, E, I, M, Q: Abaxial surface (Bar=30 μ)

C, F, K, O, S: Margin

G, J: Macrohairs

N, R: Long prickles

Table 36: Foliar micromorphological features of members of Cyperaceae

(AB: Abaxial epidermis, AD: Adaxial epidermis, R: Rectangular, C: Cubical, H: Hexagonal, Pr: Present, A-pr: Angular prickled, Sm: Smooth, LD: Low Dome, T: Triangular, TD: Tall Dome, P: Parallel, C: Conical, C+S: Conical with satellites, CA: Stalked Conical, N: Nodular, LC: Long Cell)

Character	Epidermal cell Shape		Silica bodies		Prickle		Papillae	Stomata		Margin
	AB	AD	Type	No/Cell	AB	AD		Type	Rows betn veins	
Taxon name	AB	AD	Type	No/Cell	AB	AD		AB	AB	
<i>Courtoisina cyperoides</i>	R	C-R	N	2-3	-	-	-	LD-P	6-12	A-pr
<i>Cyperus alulatus</i>	R	R	C	4-10	-	-	-	LD-P	1-3	Sm
<i>Cyperus arenarius</i>	R	C	C	4-10	-	-	-	LD	1-2	Sm
<i>Cyperus bulbosus</i>	R	C	C	4-10	-	Pr	-	T	1-2	A-pr
<i>Cyperus compactus</i>	R	R-C	C	4-10	-	Pr	-	T	2	Sm
<i>Cyperus compressus</i>	R	R-C	C+S	3-8	-	-	-	TD	2	Sm
<i>Cyperus corymbosus</i>	R-C	R-C	-		-	Pr	-	T-LD	2-5	A-pr
<i>Cyperus difformis</i>	R	R-C	-		-	-	-	TD	3-6	A-pr
<i>Cyperus dives</i>	R	R	-		-	Pr	-	LD-T	3-7	A-pr
<i>Cyperus esculentus</i>	R	R	CA	4-8	-	-	-	LD	2-6	Sm
<i>Cyperus exaltatus</i> var. <i>exaltatus</i>	R	R	-		-	Pr	-	T	2-6	A-pr
<i>Cyperus involucratus</i>	R	R	C+S	3-8	Pr	Pr	-	LD-P	3-6	A-pr
<i>Cyperus iria</i>	R	R	LC	1	-	-	-	T	2-7	A-pr
<i>Cyperus microiria</i>	R-C	R	C	4-10	-	Pr	-	T-TD	1-2	A-pr
<i>Cyperus nutans</i> var. <i>eleusinoides</i>	R	R-C	-		-	Pr	-	T-LD	1-5	A-pr
<i>Cyperus nutans</i> var. <i>nutans</i>	R	R-C	C+S	1-2	-	Pr	-	T-LD	2-6	A-pr
<i>Cyperus pangorei</i>	R	R	-		-	Pr	-	T	1-3	A-pr
<i>Cyperus paniceus</i>	R	R	C	4-10	-	Pr	-	T-LD	0-2	Sm
<i>Cyperus pulcherrimus</i>	R-C	R-C	-		-	-	-	T-LD	6-12	Sm
<i>Cyperus pygmaeus</i>	R	R	C	4-10	-	-	-	LD	1-2	A-pr
<i>Cyperus rotundus</i> ssp. <i>retzii</i>	R	R-C	-		-	Pr	-	LD	2-4	Sm
<i>Cyperus rotundus</i> ssp. <i>rotundus</i>	R	R	-		-	-	-	LD	1-4	A-pr
<i>Cyperus tuberosus</i>	R	R	-		-	-	-	T-LD	2-3	A-pr
<i>Cyperus squarrosus</i>	R	R	C+S	3-8	-	-	Pr	T-TD	1-3	Sm
<i>Cyperus tenuispica</i>	R-C	R	N	2-3	-	-	-	LD-P	5-8	A-pr
<i>Kyllinga brevifolia</i>	R	R	C	4-10	-	-	-	T	1-2	A-pr
<i>Kyllinga bulbosa</i>	R	R	C	4-10	-	-	-	T-TD	2-3	Sm
<i>Pycreus flavidus</i>	R	R	C+S	3-8	-	-	-	LD	1-3	Sm
<i>Pycreus malabaricus</i>	R	R	C	4-10	-	-	-	LD	1-2	Sm
<i>Pycreus membranaceus</i>	R	R	C	4-10	-	-	-	LD	1-2	Sm
<i>Pycreus pumilus</i>	R	R-C	C	4-10	-	-	-	T-LD	1-3	Sm
<i>Pycreus sanguinolentus</i>	R	R	LC & C+S	1 & 3-8	-	-	-	LD-P	1-3	Sm
<i>Queenslandiella hyalina</i>	R	R	LC & C	1 & 4-10	-	-	-	T	1-3	Sm

Table 37: Foliar micromorphological features of members of Cyperaceae

Character	Epidermal cell Shape		Silica bodies		Prickle		Papillae	Stomata		Margin
	AB	AD	Type	No./Cell	AB	AD		Type	Rows between veins	
Taxon name	AB	AD	Type	No./Cell	AB	AD		AB	AB	
<i>Bulbostylis barbata</i>	R	R	LC	-	-	-	-	LD-T	1-3	A-pr
<i>Fimbristylis alboviridis</i>	R	R-C-H	-		-	-	-	LD-P	1-3	A-pr / Sm
<i>Fimbristylis argentea</i>	R	R	N	2-3	Pr	-	-	LD-P	1-2	A-pr
<i>Fimbristylis bisumbellata</i>	R-C	R-C	-		-	-	-	LD	2-3	A-pr
<i>Fimbristylis cymosa</i> ssp. <i>cymosa</i>	R-C	R-C	-		-	-	-	LD	1-2	A-pr
<i>Fimbristylis dichotoma</i>	R	R-C	N	2-3	-	-	-	T-LD	2-4	Hairy
<i>Fimbristylis ferruginea</i>	R	R-C	N	2-3	-	-	-	T-LD	1-2	A-pr
<i>Fimbristylis ferruginea</i> var. <i>ferruginea</i>	R-C	C	C	1	-	-	Pr	T-LD	2-6	A-pr
<i>Fimbristylis littoralis</i>	R	R-H	C	2	Pr	Pr	-	T-LD	3-7	A-pr
<i>Fimbristylis merrillii</i>	R	R	N	2-3	-	-	-	T-TD	2-6	A-pr
<i>Fimbristylis ovata</i>	R	R	CA	4-8	-	-	-	LD	1-2	A-pr
<i>Fimbristylis polytrichoides</i>	R	R	C	2-4	-	-	-	LD-P	1-2	Sm
<i>Fimbristylis quinquangularis</i>	R	R	-		-	-	-	LD	2-4	A-pr
<i>Fimbristylis schoenoides</i>	R	R	-		-	-	-	LD-T	1-2	Sm
<i>Fimbristylis tenera</i>	R	R	-		-	Pr	-	LD-T	1-2	A-pr
<i>Fimbristylis umbellaris</i>	R	R	-		-	-	-	T-LD	2-3	A-pr
<i>Bulboschoenus maritimus</i>	R	R	CA & C+S	1-3 & 3-8	-	-	-	T-LD	4-8	A-pr
<i>Fuirena ciliaris</i>	R	R-C	C+S	3-8	-	-	-	LD	10-15	Hairy
<i>Fuirena cuspidata</i>	R-C	R-C	-		-	-	-	T	5-15	Sm
<i>Schoenoplectus litoralis</i> subsp. <i>thermalis</i>	R	R	-		-	-	-	P	1-2	Sm
<i>Schoenoplectiella lateriflora</i>	R	R	CA	4-8	-	-	-	T-LD	1-2	Sm
<i>Scleria parvula</i>	R-C	R	C	4-10	-	-	Pr	T-LD	6-10	A-pr
<i>Rhynchospora wightiana</i>	R	R	CA	4-8	-	-	-	T	1-4	A-pr
<i>Eriophorum comosum</i>	R-C	C	C+S	1	Pr	-	-	T	1-3	A-pr

Legends for Plate 298:

- A. Abaxial epidermis of *Cyperus pangorei* showing triangular stomata in 1-2 row & rectangular long cells
- B. Abaxial epidermis of *Cyperus arenarius* showing triangular stomata in 1-2 row, rectangular long cells & 3-4 conical silica bodies/cell on veins
- C. Abaxial epidermis of *Cyperus difformis* showing tall-dome stomata in more than 4 rows & rectangular long cells
- D. Abaxial epidermis of *Cyperus microiria* showing triangular-tall dome stomata in 1-2 row, rectangular long cells & 4-8 conical silica bodies/ cell on veins
- E. Abaxial epidermis of *Cyperus compressus* showing tall-dome stomata in 2 rows, rectangular long cells & 3-6 silica bodies with satellites/ cell on veins
- F. Abaxial epidermis of *Cyperus alternifolius* showing low-dome stomata in more than 5 rows, rectangular long cells & costal prickle
- G. Abaxial epidermis of *Cyperus compactus* showing triangular stomata in 1-2 row, rectangular long cells & 3-6 silica bodies with satellites/ cell on veins
- H. Abaxial epidermis of *Bolboscheonus maritimus* showing triangular stomata in 6-8 rows & rectangular long cells
- I. Abaxial epidermis of *Cyperus iria* showing triangular stomata in 6-8 rows & rectangular long cells
- J. Abaxial epidermis of *Shoenoplectiella litoralis* ssp. *thermalis* showing parallel-sided stomata in 1 row & rectangular long cells
- K. Abaxial epidermis of *Fuirena ciliaris* showing low-dome stomata in 10-12 rows, rectangular long cells & long macrohairs near veins
- L. Abaxial epidermis of *Fuirena cuspidata* showing triangular stomata in 6-7 rows, appearing different than other due to specialized arrangement of underlying mesophyll cells & cubical- rectangular long cells; stomata close-up in Fig T
- M. Abaxial epidermis of *Rhynchospora wightiana* showing triangular stomata in 1 row, rectangular long cells & stalks conical silica bodies at sinuosites of walls on veins
- N. Abaxial epidermis of *Fimbristylis ferruginea* var. *ferruginea* showing triangular stomata in more than 3 rows, rectangular long cells & papillae in inerstomatal cells
- O. Abaxial epidermis of *Scleria parvula* showing triangular stomata in more than 3 rows, rectangular long cells & papillae in inerstomatal cells

P-S: Stomatal complex with different type of subsidiary cells; P: Triangular, Q: Low-dome; R: Tall-dome; S: Parallel sided

Bar=30μ

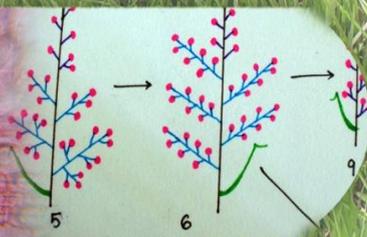
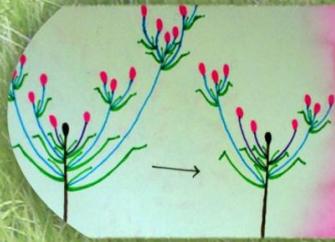
Legends for Plate 299:

- A. Abaxial epidermis of *Eriophorum comosum* showing triangular stomata in 2-3 rows, rectangular long cells & single conical silica body with satellites/cell on vein
- B. Abaxial epidermis of *Fimbristylis polytrichoides* showing low-dome stomata in 1 row, rectangular long cells & 3-4 conical silica bodies/cell on veins
- C. Abaxial epidermis of *Pycreus sanguinolentus* showing parallel sided stomata in 1 row, rectangular long cells & 3-8 conical silica bodies with satellites/cell on vein
- D. Adaxial epidermis of *Fimbristylis littoralis* showing absence of stomata, rectangular long cells & costal and abundant intercostal prickles
- E. Adaxial epidermis of *Cyperus alternifolius* showing rarely present stomata & rectangular long cells & 3-6 silica bodies with satellites/ cell on veins
- F. Adaxial epidermis of *Scleria parvula* showing low-dome stomata in more than 5 rows & rectangular long cells
- G. Adaxial epidermis of *Fimbristylis alboviridis* showing absence of stomata & cubical-rectangular-hexagonal long cells
- H. Adaxial epidermis of *Cyperus corymbosus* showing absence of stomata, cubical-rectangular long cells & costal prickles
- I. Adaxial epidermis of *Fuirena ciliaris* showing absence of stomata, rectangular-cubical long cells & long macrohairs
- J. Adaxial epidermis *Pycreus flavidus* of showing absence of stomata, rectangular long cells & smooth margin
- K. Adaxial epidermis of *Cyperus compressus* showing 2-3 rows stomata, rectangular long cells & smooth margin
- L. Adaxial epidermis of *Fuirena ciliaris* showing long hairs on margin
- M. Adaxial epidermis of *Scleria parvula* showing angular prickles on margin
- N. Adaxial epidermis of *Cyperus iria* showing large angular prickles on margin
- O. Adaxial epidermis of *Fimbristylis ferruginea* var. *ferruginea* showing angular prickles on margin

P-R: Types of Silica bodies; P: Conical, Q: Conical with satellites; R: Stalked conical at sinuosities of walls

Bar=30μ

Chapter: 6



'Of course speculation is in order in a Discussion, but it must be reasonable, firmly founded on observation, and subject to test, if it is to get past a responsible editorial board.'
–Woodford

6.1 Distribution Patterns

Flora of British India (Hooker 1894, 1897), Flora of the Presidency of Bombay (Cooke 1902-08) and grasses and sedges of Bombay presidency (Blatter & McCann 1934, 1935) are considered being the base for understanding the distributional status and biogeographical spectrum of the present taxa for the western India. Patel (1965) has described about the ecology and habitat of the grasses from the Gujarat state, while Sabnis (1967) and Parabia (1974) gave detailed account on sedges. In addition to that, Shah has compiled all the earlier reports and published Flora of Gujarat state in 1978, wherein he has given the details regarding the vernacular name, descriptions, phenology and distributional status. After Shah (1978) there were no reports about the increase or decreases in the species diversity of both the families except Joshi (1980), Meena (2004), Raole & Desai (2011) and Desai & Raole (2010, 2011, 2012a,b,c,d) in which 2 species and 30 new records were added to the state flora. Moreover, in recent literatures the reassessment of floristic diversity has been reviewed and suggested the conservation measures with specific reference to the Gujarat state (Pandey & Singh 1999, Dixit 2001, Singh & Parabia 2003, Meena 2004). In Meena & Pandey (2004) species number of both the families was raised without giving any details. Biological spectrum of the past and present works has given an idea of changes occurred and going in the study area. While comparing the flora of Gujarat and presently recollected plant species, extension of distribution, discovery and rediscovery of few noteworthy sedges and grasses from the study area. Hence, in this study the sedge and grass spectrum of south Gujarat has been included to give authenticity to support the reassessments.

During the present exploration, 63 species of 15 genera from Cyperaceae and 184 species of 75 genera from Poaceae has been collected and utilized for the further analyses. The highest species diversity is noticed in the Surat district as it shows members of all the 11 tribes of grasses and 6 of sedges followed by Tapi, Valsad, Dangs, Navsari (Plate 300, Appendix 2 & 3). Highest species number belongs to the tribe Cypereae and Andropogoneae, whereas least is from Sclerieae, Rhynchosporeae and Triticeae from the family Cyperaceae and Poaceae respectively.

'The laws of biology are written in the language of diversity'

- E. O. Wilson

Shah (1978) mentioned the distribution patterns of sedges and grasses viz., common, throughout, occasional, common to specific regions, restricted or rare. Moreover, it is worth mentioning about the genera and species which were not noticed or collected during field works for the present study. During the course of time, 23 sedges and 32 grasses are unable to notice / collected which were earlier reported as rare, restricted to single locality/collection or distributed throughout (Patel 1965, Shah & Suryanarayana 1969, Shah 1978, Joshi 1980). Worldwide it is well accepted that biodiversity has been threatened by habitat clearing, destruction and fragmentation. It is also widely accepted that native vegetation clearance is closely associated with land degradation, which causes enormous loss of biodiversity locally due to vegetation changes over periods of 40–100 years (Kwiatkowska 1994, Fischer & Stocklin 1997, Wang *et al.* 2011). Of the total 55 non collected species 17 species were mentioned to be endemic to the district Dangs. Vegetation clearance in the Dangs has been widespread and gradually becoming intensive in the last 20 years when zoom cultivation was introduced at large scale and that may be the reason of loss of these species (Plate 301 A-F, J & K-L). Evidence of erosion, increasing mining sites, bare ground increase indicating serious and extensive land degradation has been experienced in eastern Surat (especially in Mangrol tehsil, Plate 301 G-H) and Tapi (Plate 301 I), Valsad (Plate 301 M-N) district as well. Certain taxa have endemic population at particular ecological niche along with the inadequate reproductive mechanism. May be due to these reasons the taxa with rare and restricted distribution category are not been able to collect after repeated fieldworks of the mentioned locality during the flowering and fruiting season. Hence, I would like to shift them in to threatened or extinct category from endemics.

Moreover, Shah (1983) suggested the restricted distribution of few sedges and grasses only from the Dangs and South Gujarat of which *Cyperus compactus*, *C. malabaricus*, *Queenslandiella hyalinus*, *Schoenoplectus mucronatus*, *Panicum paludosum*, *Chrysopogon serrulatus*, *Capillipedium assimile*, *Arthraxon quartinianus* are still can be consider as restricted; while *Themeda tremula*, *T. laxa*, *Isachne globosa*, *Pennisetum purpureum* and *Eulalia argentea* are commonly noticed (Appendix 2). In addition to that, formerly Shah (1978) reported 14 grass taxa only from Saurashtra, north and central Gujarat, but during present investigation these were collected from South Gujarat also, which suggests these taxa extending throughout the State. In the recent report of Singh & Parabia (2003) *Aleuropus lagopoides* reported as rare in Gujarat, but it is found to be flourished well on the coastal belt

in the study area. Marine grass taxa such as *Urochondra setulosa* and *Spinifex littoralis* were earlier reported from the sea coast of Surat in 1980 by Joshi. But, now a day's Hajira and Dumas are highly affected by industrialization causes extinction of species from that area (Plate 301 O-R).

It is worth mentioning about the two grasses viz., *Sporobolus tenuissimus* and *Saccharum ravennae* which were not mentioned in the Flora of Gujarat state (Shah 1978); although they were reported in the earlier works of Shah & Suryanarayana (1969) and Saxton & Sedgwick (1914) from Dangs and Ahmedabad respectively. Now, in present study former one noticed and collected from all the districts of south Gujarat and later one found on the road sides of Surat, Tapi and Valsad districts (Appendix 2). Therefore, both are believed to be rediscovering after @ 50 and 100 years respectively.

Besides these, present investigations added 2 new species to the plant world, 1 new genus 25 species from the family Poaceae and 4 species of Cyperaceae to the state flora of Gujarat and listed in Conclusion (Raole & Desai 2011, Desai & Raole 2010, 2011, 2012a,b,c,d). Most of the new state reports were already found in the neighboring states i.e., Maharashtra, Madhya Pradesh and Rajasthan. When the diversity of grasses and sedges compared with them, higher similarities found with the Maharashtra followed by Madhya Pradesh and Rajasthan. On this note, one can say that the south Gujarat is the meeting point of gangtic plains, Deccan peninsular & Western Ghats and influenced by its vegetation (Plate 299: Roger, Panwar & Mathur 2000).

The general pattern of vegetation in the study area varies district wise due to fluctuation in abiotic factors such as- climate, soil, topography, rainfall etc. and biotic pressure. In this context, Dixit (2001) reassessed vegetation patterns and quoted that in Surat and Tapi districts the open-dense forest becoming non forest and Dangs, Valsad and Navsari had open forest from dense forest from 1991 to 1997. Decrease in dense forest cover may responsible for the spreading of grasslands to enhance the species diversity. This observation is in support of change in biodiversity with the climate variation by Whyte (1978).

Analytical method and Similarity Index:

In the present study I have also tried to understand the floristic composition and diversity change over 30 years. In case of plant diversity many studies indicate the native species diversity may decline due to vegetation changes; at the same time, diversity may enhance due

to the transport as well as transfer of seeds and plantlets from nearby areas, phenomenon is observed in the present study. Therefore, Sorensen coefficient, based on presence–absence data, was applied to measure similarity or dissimilarity between the numbers of species, including genus and family recorded in the recent surveys and @30 years ago (Pielou 1984).

The Sorensen Similarity Index (ISS) formula is,

$$\text{ISS} = \frac{2C}{A+B}$$

where A is the number of species recorded during the recent surveys, B is the number of species recorded 30 years ago and C is the number of shared species. Values approaching zero indicate lower similarity; values approaching one indicate higher similarity. An ISS @ 0.70 is considered to indicate high similarity (Magurran 2004).

For documentation, I have considered Shah's flora (1978) as a base, which mentioned about 241 & 112 species for Gujarat state from Poaceae & Cyperaceae, respectively. During the course of time I am able to collect 182 grasses and 63 sedge species, of which 153 grasses and 59 sedges considered to be native as they were mentioned in the Gujarat flora. The ISS for family Poaceae (1.04) and Cyperaceae (0.74) indicate the high similarity with the native flora of Gujarat state point out that, even after the addition and deletion of number of species, there is no change recorded in the basic composition (native flora) of the study area. At the same time it is not claimed to have a complete data as well as related information for both the families in this work, as the interior and inaccessible remote areas of very dense forests are yet to be explored in all the seasons.

Diversity across the Districts:

In the present study grasses and sedges have been considered for documentation purpose during the extensive field work. I have been able to collect 182 grasses of 11 tribes from the region. Out of that 140 are recorded from the Surat and 139 from Dangs and Valsad, while Tapi and Navsari have 124 and 116 taxa respectively (Appendix 3). District Valsad has been divided into 5 tehsils of which Dharpur (123) and Kaprada (117) are most diverse followed by Valsad (108) and Pardi (102), while Umargam (91) is the least one. District Dangs as a whole consider as tehsil also, which is highly diversified and depicting members from almost all the tribes except Arundineae, tribe with marshy grasses. Just like Valsad, Navsari district also consist of 5 tehsils, of which Vansda is most diversified and Gandevi & Navsari least one. By & Large, the number of species does not differ much, as total number reported in the rage of 92-99. Among all Jalalpor and Navsari tehsils are the unique one due to presence of all the 3 taxa of tribe Arundineae. 9 tehsils forms the district Surat, highly diversified geography

supports the highest number of grasses from all the 11 tribes from 5 tehsils, rest other lack Arundineae members. Umarpada tehsil consist of variable habitats suitable for grasses and having the highest number of grass taxa (Table 38).

Tribe cyperaceae constitutes 5 tribes in the present study and members from all are recorded from all five district. Diversity and distribution of sedges also depict, Surat is the highly diversified and Tapi is the least one. In the Surat district except tribe Rhynchosporae (only in 4 tehsils), all the other members of tribes are noticed from all the tehsils. In the district Tapi Songadh, Vyara, Valod and Uchchal show highest number of all the tribes. Rocky plateaus of Dangs do not support the marshy sedges and having almost least numbers i.e. only 42 out of 62. Within the district Navsari, Vansda (35) have the members from all the 5 tribes, while due to marshy areas Jalalpore (37) and Navsari (39) tehsils depict highest number of species and lack the members from highlands i.e. tribe Rhynchosporae. District Valsad also follows the pattern of Navsari and highest number collected from Valsad tehsil (43) only (Table 38). Dangs consider to be harboring most rare/restricted members of the cyperaceae, as these members were able to collect from 1-2 locations only. 6 species belonging to *Cyperus* are reported from 4-7 localities, 3 species of *Fimbristylis*, one species from each, *Eleocharis* and *Schoenoplectus* are having localized distribution at 6-7 localities. Rest others are recorded from all over the regions. Earlier reports of Shah (1983) mentioned about 3 species under rare-restricted category, which are enhanced to 11 in present study. By and large, grasses having the wide distribution throughout the region. Out of 184 species, 44 species are noticed from 1-3 localities only. Comparison with earlier literature, only 2 are considering being rare and restricted in distribution, viz. *Cyperus compactus* and *Schoenoplectus mucronatus*. Dangs has highest number of rare/restricted taxa followed by Surat (14) and Valsad (13), while Tapi and Navsari depict 6 and 3 species respectively. On the basis of present study, number of going to enhanced up to 31. Already out of 44 species, 13 are reported for the first time for the Gujarat state.

Table: 38 Species Diversity for the District (Numbers in bracket indicate collected taxa)

Tribe Name	Valsad	Dangs	Navsari	Surat	Tapi
Family: POACEAE					
Bambuseae (2)	2	2	2	2	2
Oryzeae (5)	5	4	4	3	2
Triticeae (1)	1	1	1	1	1
Arundineae (3)	0	0	3	2	0
Aristideae (3)	3	3	3	3	3
Eragrostideae (32)	27	22	23	30	20
Cynodonteae (11)	5	6	5	10	11
Paniceae (51)	41	44	33	36	35
Isachneae (1)	1	1	1	1	1
Arundinelleae (2)	2	2	1	1	1
Andropogoneae (71)	52	54	40	51	48
Total (182)	139	139	116	140	124
Family: CYPERACEAE					
Cypereae (32)	25	25	23	26	23
Fimbristylideae (17)	15	11	14	16	11
Scirpeae (9)	7	3	7	7	2
Sclerieae (1)	1	1	1	1	1
Rhynchosporae (2)	1	2	1	1	2
Total (62)	49	42	46	51	39
Grand Total (Out of 247)	188	181	162	191	163

Species - Area Relationship:

Connor & McCoy (2001) have given species-area relationship. According to them this relationship is 'the simple observation of number of biological species found in a region is a positive function of the area of a region.' This relationship can be depicted graphically as species-area curve or species-area model. Species-Area relationships appear to be ubiquitous and can be observed at every level from microscope to natural field studies. As the '*area perse*' hypothesis is based on the assumption of the abundance, its probabilities and its stochastic expression for the area. Habitat diversity, edge effect, resources concentration and exclusive mechanism for '*area perse*' give the species area relationship. Given this assumption large area would have more species than the smaller areas, because more species would persist in large areas and not becoming an extinct. The above hypothesis suggests the co-relationships between species richness in the areas under studies. (At the same time the relationship can give us an idea of the diversity and distributional status of the taxa in question.)

For the present study, two main variables have used i.e. 1). Total numbers of species occur in the total area of Gujarat state, and 2). Total number of species occur in the total study area. In the present study documentation of sedges and grasses, south Gujarat consist of 63 and 184 species, while 241 and 112 species respectively, from the Gujarat state.

	Gujarat	South Gujarat	%
Area (sq. km.)	196024	14820.2	7.56
Cyperaceae	112	63	56.25
Poaceae	241	182	75.51
Total Species	353	245	69.40

The above tabular representation suggest that the study area supports high species diversity as the geographical area is quite less (7.56%), still it harbors 245 species out of 353 from sedges and grasses (69.40%). In addition to that, as we are moving from sea coast to hilly terrains, the variability is enhancing. Though, comparison with the earlier reports suggests that I am unable to locate/collect 55 species but, gather 32 new species from both the families, due to numerous environmental and physio-chemical variations present in the area.

6.2 Plant Morphology

Grasses and sedges are the world dominating families and recorded from almost all the habitats. Reference to both gets since the mankind has started collecting the food and fodder (Mitra & Mukherjee 2005). Morphological markers are helpful in identification and classification, but the variability in characters is noticed below tribal level. In the pre-molecular era, evaluation of structural similarities as potential synapomorphies was the only method for determining phylogenetic relationships. This was central to comparative morphology. However, the search for structural similarities is still necessary and helpful. The role of morphology in plant systematics has changed in the present molecular era. In addition, one should not forget that new classifications (APG 1998, 2003), shaped by molecular results, are built on the shoulders of those whose classifications were primarily based on morphology (Endress 2002).

Roxburgh's flora (1853) is the 1st compilation of Indian plants. Hooker's flora (1866) is the foundation of the Indian botany. Moreover, Cooke's flora (1902-08) is the prime source of the vegetational components of western India. Bor (1960) is the father of Indian grasses and in recent years Kabeer & Nair (2008), Yadav (2010) have revised and added new genera and species to the Indian data base. Wadoodkhan (1998), Prasad & Laxminarsimhan (2002) are the main workers for the sedges of India.

6.1.1 Family Poaceae

Grasses -an annual or perennial herbs (except woody bamboos)- shows great diversity of the shape, size, texture on vegetative as well as reproductive shoots, due to which morphology of the grasses are admired by most of the earlier workers for its simple plan along with altered and changing simple structure into little or more complex one.

The vegetative shoot has subterranean parts having roots and rhizome which also depict numerous variations as they may show fibrous to aerial/stilt roots (Plate 302 A&B). The aerial parts of the plant depict the culms which are separated by nodes and internodes. Most of the time nodes at the base give rise to roots. Nodes are primordial of the bud, leaf as well as the vertical system. Mostly they are glabrous (Plate 302 E), but hairs are also found in some cases like *Dichanthium* (Plate 302 F). Internodes are hollow with exceptions such as solid in *Saccharum* and other like *Zea*, *Sorghum*, *Andropogon* show white pith. Moreover, some culms are soft and juicy (*Eleusine*, *Dactyloctenium*), while some are becoming solid due to deposition of silica as in *Bambusa*, *Dendrocalamus*, *Zea*, *Oryza*, *Echinochloa*, etc. (Bennett & Sangster 1982, Li & Tian 1997). In almost all the genera and species in this work are depicted the

presence of silica in the vegetative (stem, leaves) and reproductive organs. This can be recorded with the help of silica bodies and their variability at structural level. Culms are terete and glabrous in most of the members or hairy as in *Aristida*. Branching at the base of grass stem is called 'tillering' or 'stooling' (Tivano *et al.* 2009). In most of the presently studied grasses tillering is recorded except tufted ones. It can be intravaginal (Chloridoideae and panicoid grasses, Plate 302 D) or extravaginal (Arundinoideae, Plate 302 C).

Leaves of the grasses consist of the sheath, the ligule and the leaf blade. Sheath originates from the node of the stem such as *Hygroryza* where it is inflated, firmly compressed and sharply keeled. In some members sheath is ridged, hairy or tubercled (*Rottboelia*, *Glyphochloa*, *Trilobachne*- Plate 302 G). In some members sheath acts as a spathe (members of anthistiriineae, Plate 303-30), as well as metamorphosed into involucre as in *Coix* (Jain & Banerjee 1974, Plate 303-36). Utility of the ligule has been described by Chaffey (1982, 1983, 1984, 1994). The Ligule may be delicate membranous (*Eleusine*), chartaceous (*Themeda*), or even hairy (*Eragrostis*) (Plate 302 I-P), or even absent in *Echinochloa* (Plate 302 H). Leaf blades are peculiar being free depict lot of variations due to adaptations to range of climate and habitats. By and large, flat dark green in coloured leaves are observed in forest and forest margins while, glaucous light green and folded or rolled in open areas. The surface is mostly more hairy or coriaceous on upper side and smooth on lower side. Most of the leaves show the hairs on the lamina as well as margins, which may be one celled or even, elongated with tubercled base as in *Dactyloctenium*, *Glyphochloa*, etc. When considering leaf characters leaf base, lamina apices, surfaces, margin and texture plays a major role. Leaves in some members auricled (*Oryza*, Plate 302 L), attenuated (*Arthraxon*, *Capillipedium*), cordate-sagitate (*Ischaemum*) at the base. In few members when the blades joined the sheath it is termed as a petiole (*I. semisegittatum*, *Spodiopogon*) or pseudopetiole (*Apluda*, *I. sayajiraoi*). Moreover, in few members lower leaves are petiolate and upper ones are sessile. The lamina of the leaves is folded, convolute or pleated at young stage and at maturity becomes flat. Most of the members depict acute-acuminate apex and very scabrid. The vascular system as a rule on the surface is the veins. The midrib is always definite and occasionally broad as in *Saccharum*. Lateral veins are of two types: a). Diverge at the base and comes together at the tip, and b). Diverge at the base & proceed in straight lines. Cross nerves are also noticed.

Inflorescence in grass may be terminal or/and axillary. There are four major type are observed in the presently studied taxa: Panicle (P), Raceme (R), Digitate (D) and Spike (S). In the present work I have observed and record inflorescence morphology for 182 species and 75

genera belonging to 11 tribes of the family Poaceae. Subfamily Panicoideae and Chloridoideae constitutes all major type of inflorescence, Pooideae have only 2 types where as Bambusoideae have only one type (For details-chapter 4).

Spikelets in grasses are sessile or pedicelled; solitary (*Panicum*, Plate 303-17), paired (Andropogoneae members, Plate 303-21 to 24, 26, 32, 33) or in triad (*Chrysopogon*, Plate 303-25; *Coix*, Plate 303-36); dorsally compressed (Andropogoneae) or laterally compressed (*Chrysopogon*). In *Pennisetum* & *Cenchrus* (Plate 303-20) group of spikelets falls from the inflorescence called fascicles, formed by the numerous sterile bristles/paraclades (Doust & Kellogg 2002b). Majority of the members depict the rachilla as rudiment of the floret (Plate 303-27, 29). Rachilla may be clavate (*Mnesithea*, *Glyphochloa*; Plate 303-33, 34), terete (Paniceae, Plate 303-18), triangular (Andropogoneae, Plate 303-24, 28), flat (*Eragrostis*; Plate 303-6), hairy (*Phragmites*, Plate 303-3) and saccate (*Rottboelia*, *Ophiuros*, Plate 303-32). It may shows rachilla disarticulation (*Ischaemum*, Rottboelinae members), while some shows spikelet disarticulation (*Chloris*, *Eragrostis*). Most of the members depict both Lower and Upper glumes while, *Zoysia*, *Digitaria* and *Paspalum* show only one. Glumes may be hyaline (Aristideae) and coriaceous (Andropogoneae). Lower glume in number of genera from Andropogoneae are ornamented with crustaceous (*Chionachne*, Plate 303-35), sculptured (*Mnesithea*, Plate 303-33), grooved (*Ischaemum*, Plate 303-26), pitted (*Dichanthium pertusum* and *Bothrichloa*, Plate 303-22), serrate (*Arthraxon*, Plate 303-29) or provided with appendages (*Glyphochloa*, Plate 303-34). Apex of the glume has a lobes/tooth (*Tripogon*), arista (*Spodiopogon aristatum*, Plate 303-23), obtuse (*Paspalum*, *Isachne*, *Setaria*, *Paspalidium*; Plate 303-14, 16), acute (*Panicum* Plate 303-17), acuminate (*Eriochloa*, *Alloteropsis*; Plate 303-12) or awned (*Oplismenus*, Plate 303-15).

Lemmas are mostly hyaline in nature and the lower one may be absent or much reduced. Upper lemma is generally awned in Andropogoneae, but absent in others. In Paniceae lemmas generally take up the function of protection hence are firmer and coriaceous-chartaceous (*Setaria*, Plate 303-16). In Paniceae lemma is rarely awned except *Oplismenus* (Plate 303-15), but mucronate in *Urochloa*. In *Aristida*, *Halopyrum*, etc. callus of lemma is sharp and barbed. The palea in grasses is 0-2 nerved and hyaline but it chartaceous nature with 3-5 nerves was recorded in *Oryza* (Plate 303-2). Awn may be terminal or dorsal, between clefts or base reduced hyaline lower part. The flower is comprises lodicules, stamens and Gynoecium. Lodicules are generally 2 in number but 3 (*Dendrocalamus*) were also recorded or it may be absent as in case of *Pennisetum*. It may be fleshy or membranous; truncate, acute or cuneate; with or without hairs. Generally grasses bears 3 stamens, but some grasses shows 2

(*Sporobolus diander*) or 6 (*Oryza*, *Dendrocalamus*) also. The ovary may be globose, oblong to ovoid, narrow and elongate. It looks monocarpellary but vascular system proved it as tricarpellary. In *Zea* and *Dendrocalamus* there is a single style, rest other shows 2 styles and 2 feathery stigmas.

6.1.2 Family Cyperaceae

Members of the Cyperaceae have typical morphological features and divided into underground parts, culm, leaves and synflorescence. Annuals are with tufts (*K. bulbosa*, *Fimbristylis*) and perennial with long creeping rhizome. Rhizomes are thin-small (*K. brevifolia*), woody (*C. nutans*), stoloniferous (*C. rotundus*, *F. cuspidata*) or tuberosus (*B. maritimus*, *C. tuberosus*, *C. esculentus*). Culms can be capillary/terete (*Eleocharis*, *Schoenoplectiella*), without or with nodes (*Fuirena*, *Scleria*) or septate (*E. dulcis*, *Schoenoplectiella*), triquetrous (*Cyperus*, *Courtoisina*, *S. mucronatus*). Leaves are generally sessile, coriaceous, shorter or longer than culm, spiral or three ranked, expanded or cauline in nature, mostly eligulate or ligulate (*Fimbristylis* spp., *Scleria*, Plate 304-F) in nature. In *Eleocharis*, *F. umbellaris*, *F. tetragona*, *Schoenoplectus* and *Schoenoplectiella* leaf blade is absent leaving sheaths only. Margin of the leaves are plicate, flat, revolute, conduplicate or revolute. Leaf sheaths are noticed with variable coloured (green-purple-red-black-hyaline). Mouth of the leaf base may be concave, truncate or convex.

Inflorescences are terminal, more rarely pseudolateral (*F. ovata* - Plate 304-B, *Schoenoplectus* and *Schoenoplectiella*); paniculate, spicate, anthelate, or capitate, more rarely reduced to a single spikelet (some species of *Fimbristylis*, *Eleocharis*). In Cyperaceae spikelet comprises one - many glumes, distichous (Cypereae, Plate 304-A) or spirally arranged (Fimbristylideae, Scirpeae, Plate 304-C). Vrijdaghs *et al.* (2011) & Muasya *et al.* (2001) was explained the segregation of genera from *Cyperus* s.l. base on the nature of rachilla. Similar kinds of observations were recorded and it was found to be persistent in *Pycneus* and deciduous in *Courtoisina*, *Kyllinga*. Further rachilla may be winged or not (Plate 304-D-E). Glumes exhibits important taxonomic character and variations is noticed in their arrangement, number, shape, colour, size and nerves.

Flowers are mostly bisexual, but unisexual one is recorded in *Scleria*. Hypogynous scales are absent in Cypereae and Fimbristylideae but it is used for identification in Scirpeae. They are 0-3-6-many, often bristle-like and antrosely (*Rhynchospora*) or retrorsely scabrid (*S. mucronatus*, *B. maritimus*, *Eleocharis*), more rarely laminar (*Eriophorum*) or feathery (*S. littoralis*),

sometimes wedge shaped (*Fuirena ciliaris*), usually deciduous with the fruit, rarely persistent on the rachilla (Browning 1992). Stamens are usually 3 and often reduced to 1- 2 or 6. Pistil is 2-3-carpellate, accordingly style with 2 or 3 stigmatic branches; style base often conspicuously thickened and persistent (*Bulbostylis*). *Rhynchospora* is unique due to presence of single stigma. A nutlet (achene) usually ovate, elliptic, or obovate in outline and trigonous (*Cyperus*) or lenticular (*Pycneus*) in cross section; surface smooth, reticulate or rugose; stipitate or not (Plate 304-G-O; Goetghebeur & Coudijzer 1984, Tucker & Miller 1990). It is seated on cuplike structures (disc) as in *Scleria*. Colour of the achene is also variable and can also be helped in species identification.

6.3 Synflorescence Architecture

Bradford (1998) has discussed the limitations of typological system of the inflorescences but, understanding of typological studies can give some guidelines to understand the changes occurring in family Poaceae. In Poaceae few to one spikelet are noticed in different form, due to which high diversity and high degree of ramification has been noticed by Bor (1960) and Vegetti & Anton (1996). The structure and general shape of the synflorescence result from the activity of its meristem, which determines the number, size and relative disposition of its branches (Guarise & Vegetti 2007). Number of researches were suggested the importance of inflorescence architecture as an important character to collaborate with molecular characters in phylogenetic studies. Morphological and molecular studies in PCK clade (Doust & Kellogg 2002 a&b, Doust *et al.* 2007) showed that inflorescence morphology is highly variable, and is only partially correlated with plastid or nuclear phylogenies of the group. On the contrary, Liu *et al.* (2007) reported, for subfamily Chloridoideae, that inflorescence morphology is highly congruent with phylogenetic history and later proven by Reinheimer & Vegetti (2008) and Salariato *et al.* (2010) for tribe Paniceae. Most of the authors have described panicle, raceme and spike as the inflorescence in number of grasses, but according to Kellogg (2006) 'panicle' is too emprises term to describe the diversity of these inflorescences. In recent years numerous authors highlighted a complexity of grass and sedge inflorescence and raise the objection to the panicle as it is the 'panicle of raceme' or 'spike of spikelets'. In the morphology of inflorescence, homologies are always concern for their phylogenetic analyses and instead of inflorescence; the synflorescence term is used in recent literatures. In recent years Vegetti and his coworkers have described general typological structure as well as development of synflorescence in poaceae and cyperaceae along with the hypothetical evolutionary trends (Vegetti & Anton 1995, 2000; Guarise & Vegetti 2008a).

Indian agrostologists & cyperologists were reported and described number of new plant species or addition to the flora of Indian subcontinents. By and large, these studies never applied the inflorescence architecture and its variations in greater details. In order to understand the significance of morphological analyses of synflorescence related to Indian taxa it has been incorporated in the objective for establishing similarities and differences between and within tribes and to suggest some evolutionary trends for both the families.

6.3.1 Family Poaceae

Subfamily Bambusoideae: Tribe Bambuseae shows inflorescence with prophylls and bracts and is called false one (Vegetti & Weberling 1996). Detailed inflorescence structure, including an analysis following the topologies and was covered in depth in Stapleton (1997). The bamboo inflorescence is interpreted there as a modification of a simple polytelic synflorescence. In case of both i.e. *Dendrocalamus* and *Bambusa*, inflorescences are generally fully bracteate, with all axes subtended by a large bract, and each axis bearing a prophyll at the point of branching (P_{4a}). Many of these bracteate inflorescences also have further axes or viable buds in the axils of the bracts and prophylls, and also in basal bracts in the pseudospikelet, allowing indeterminate growth, which can lead to dense spherical clusters (Plate 306 Q). Capitulate panicle with narrow, 1-keeled prophylls found in case of *Dendrocalamus* whereas spicate panicle with broad, 2-keeled prophylls are present in *Bambusa*. In the tribe Oryzeae 4 species were studied, of which 3 species has been reported earlier by Vegetti (2000) and Ikeda *et al.* (2004), except *O. glaberrima*. Paniculate (P_{1a}) type of synflorescence is noticed in all the 4 species. Furthermore, *Hygroryza* as a genus is also reported for the first time for its inflorescence architecture and it shows P_{2a} type.

Subfamily Pooideae: Tribe Triticeae represented by single genus and species, i.e. cultivar *Triticum aestivum* which has been grouped under truncated spike (S₂, Plate 307 N) as mentioned in Perrata *et al.* (2009). For tribe Arundineae *Arundo donax* and 2 species of *Phragmites* (Plate 305 A) have been studied and classified under non truncated panicle (P_{1a}). Under tribe Aristideae, 3 species of *Aristida* has been studied and grouped under P_{1a}.

Subfamily Chloridoideae: Inflorescence structure of Tribe Chloridoideae and its evolutionary significance is described in the works of Liu *et al.* (2005). Although numerous genera and species from different parts of the world have been studied, many of the Indian species are not yet reported. Almost all the type of inflorescences is seen within tribe Eragrostideae. Subtribe Monanthochloinae is represented by a single species *Aeluropus lagopoides* possess P_{2a} type of synflorescence whose IPC length are extremely reduce and appears globose head (Plate 305 J). Earlier same type has been observed for *A. littoralis* by Liu *et al.* (2005). For subtribe Eleusineae *A. racemosa* (D_{1a}), *D. aegypticum* (D_{2a}), *D. bipinnata* (P_{2a}), *D. retroflexa* (P_{1b}, Plate 305 H), *Eleusine* (D_{1a}, Plate 307 A), *L. fusca* (P_{2a}) and *E. amabilis* (P_{1a}, Plate 305 B) are also mentioned in the works of Liu *et al.* (2005, 2007) and present observations are in accordance with that only. In addition to that inflorescence structure of *D. pingalaiae* (P_{2a}), *E. brachyphylla* (S₁), remaining species of *Eragrostis* (P_{1a}, Plate 305 D), *L. panicea* (P_{2a}), and both the species of *Tripogon* (S₁, Plate 307 I) are depicted the similar nature. *D. aristatum*

shows D₆ type with only one truncated IPc (Plate 307 H) which can be useful for the species characterization. Although studies on the tribe Eragrostideae especially on genus *Eragrostis* were many (Borre & Watson 1997, Peterson *et al.* 2007) but studies pertaining to the inflorescence architecture is scarce, rather Lui *et al.* (2005) only. Subtribe Sporoboloneae represents 5 species of *Sporobolus* and all are showing P_{1a} type of synflorescence (Plate 305 E), of which *S. tenuissimus* and *S. virginicus* were already studied by Liu *et al.* (2005) and present observations are also in conformity with it.

Raceme and Digitate type of inflorescence with its subtype are common in Tribe Cynodonteae. Almost all the presently studied members of subtribe Chloridinae are mentioned in the works of Liu *et al.* (2005, 2007) and are characterized by digitate inflorescence only (Plate 307 B, G). Subtribe Boutelouinae represent a single genera and species i.e. *Melanocenchris jaquemontii* and showing R₃ subtype (Plate 307 L). The truncation of IPc and sPc were also recorded in the same. In addition to that, within subtribe Zoysinae different species of *Tragus* (Plate 307 K) and *Zoysia* are already reported by Liu *et al.* (2005), but presently studied species is also in accordance with it and depict raceme (R₄ and R_{1a} respectively) inflorescence. Furthermore, R_{1a} subtype is also noticed in *Perotis indica* (Plate 307 J), which is not mentioned in earlier report.

Subfamily Panicoideae: Tribe Paniceae characterized by paniculate inflorescence with variable degree of truncation and homogenization. General inflorescence pattern of PCK clade is described by Reinheimer & Vegetti (2008), but most of the presently studied taxa are not mentioned in their work. *Alloteropsis cimicina* shows paniculate (P_{2a}) inflorescence. Out of 6 species of *Urochloa* studied, except *U. reptans* all are described in the work of Reinheimer & Vegetti (2008) and results are in line with them. Although, the general typology is panicle for all the species of *Urochloa*, they are grouped 4 different subgroups i.e. *U. mutica* (P_{1a}), *U. distachya* and *U. panicoides* (P_{1b}), *U. ramosa* and *U. reptans* (P_{2a}). Furthermore, *Moorochloa eruciformis* (P_{2a}) and *Eriochloa procera* (P_{2b}, Plate 305 G) are also described by Reinheimer & Vegetti (2008) and present results are in conformity with it. All the 5 species of *Echinochloa* (P_{2a}, Plate 305 F), both the species of *Oplismenus* (P_{1b}) and 8 species of *Panicum* (P_{1a}) are studied first time and are showing a single type of paniculate inflorescence. Within the genus *Paspalum*, *P. longifolium* (Rua 1996; Plate 307 E), *P. distichium* and *P. vaginaum* (Aliscioni & Denham 2008) are described earlier and present observations are in line with it. Furthermore, *P. scrobiculatum* is described first time and D_{2b} types were noticed (Plate 307 F). *Paspalidium flavidum* and *P. geminatum* (Plate 305 I) are also mentioned in the works of Rua (1993). Inflorescence structure of *Setaria italica*, *S. parviflora* and *S. verticillata* (Plate 307 K) are studied by Doust & Kellogg (2002 a&b), Doust (2007) and Peusiero & Vegetti (2001). Rest

other species does not have any information and P_{1b} is noticed in all the species studied with variable degree of abortion and truncation of the spikelets and paracladia, a common feature observed for the genus. 'In the *Paspalidium* 1° paracladia alternate on one or opposite sides of common axis, but in looser and denser inflorescence this become obscure and intermediately forms are present. As *Paspalidium* cannot delimited satisfactorily, it reduced to *Setaria*'-stated in the research article by Veldkamp (1994). In the present study, I have recorded that in *Paspalidium* only 1° and 2° paracladia are present and only main axis and 1° paraclades forms truncated bristles (Plate 305 I), also reported by Rua (1993). On the other side *Setaria* depict 8° degree of branches, of which 3-8 gets truncated and forms the bristles (Plate 307 K), also noticed by Doust & Kellogg (2002b). Therefore, I am unable to accept the Veldkamp's inclusion of *Paspalidium* in to *Setaria* (1994). Subtribe Digitarinae is studied first time from inflorescence typological view and it is characterized by digitate type with 2-10 IPC and possess D_{1a} & b (Plate 307 C, D) subtypes. Subtribe Cenchrinae represents only 2 genera i.e. *Cenchrus* and *Pennisetum*. In earlier report of Doust & Kellogg (2002a), *C. setigerus* and *P. glaucum* has been studied for its inflorescence development. Rest other species were showed overall similarity with the earlier reports and depict P_{1b} type with truncated paracladia as involucre bristles (Plate 305 L). Tribe Isachneae (Plate 305 C) and Arundinellae are represents non truncated panicle (P_{1a}) and studied first time.

Tribe Andropogoneae in particular depict great variations of their inflorescence and the range of various architecture of its complex inflorescence is described formerly by Vegetti (1992a, 1997 a&b, 1998, 1999) and established similarities and differences between and within the group. Unlike other tribes, in Andropogoneae each short paracladium is composed of a pair of heterogamous spikelets, because these are short paracladia of second grade, members are quite distinct due to presence of specialized truncated panicle with or without trophotagma. Subtribe Saccharinae includes *Eulalia*, *Imperata*, *Saccharum* and *Spodiopogon*. Out of these genera reference to *Imperata* met with the Vegetti (1998), rest others are reporting as preliminary observations. Both the species of *Eulalia* depict P_{2c} whereas *Saccharum* and *Spodiopogon* show P_{1c} type. As these genera are consider being primitive, rachis and pedicels are thin, free and very pilose. Truncated raceme (R_{1c}) is noticed in the case of *Apocopsis vaginata* from subtribe Germainiinae. Subtribe Sorghinae comprise 5 genera, of which *Bothriochloa pertusa* and *Sorghum* spp. (Plate 306 A) are mentioned in earlier works (Camara-Hernandez & Gambina 1990, Vegetti 1992a). P_{1c} and P_{2c} inflorescence subtypes are recorded in all the studied species of *Capillipedium*, *Chrysopogon* (Plate 306 B) and 3 species of *Dichanthium* (Plate 306 C), respectively. Furthermore, *D. foveolatum* was classified under P_{4b} type as it shows trophotagma.

Subtribe Ischaeminae represented by 15 species of 4 genera i.e. *Apluda mutica*, 11 species of *Ischaemum*, 2 species of *Sehima* and *Triplopogon ramossisimus*. *Apluda* shows well developed trophotagma regions and classified under P_{4c} type. There are 2 types of inflorescence recorded for the genus *Ischaemum*, i.e. P_{2c} and P_{4c} (Plate 306 I) and *I. afrum* and rest others classified under them respectively; of which *I. semisegittatum* is included in the work of Vegetti (1998). P_{4c} type noticed in both the species of *Sehima* and in *Triplopogon* (Plate 306 J). Two species of *Dimeria* has been studied for subtribe Dimeriinae, of which *D. ornithopoda* P_{2c} & P_{4c} subtype (Plate 306 D), and observations are parallel with the Vegetti (1998). Moreover, *D. stapfiana* possesses P_{2c} type of inflorescence. In addition to that, as each paracladium consists of only one homogamous spikelet (instead of two, Plate 306 E) in *Dimeria*, it should be considered as a best candidate to study transitory development processes (Butzin 1979, Vegetti 1998, 1999).

In the subtribe Andropogoninae, *A. pumilus* (Plate 306 G) and 2 species of *Cymbopogon* depict P_{4c} type. Furthermore, all the 5 species of *Arthraxon* showed P_{2c} type and are studied for the first time. Moreover, *A. nudus* depict truncated pedicelled spikelet, leaving remnants as pedicel (Plate 306 F). For the subtribe Anthistiriinae, 4 genera and 10 species has been studied, of which *Heteropogon contortus*, *Themeda* and *Iseilema* met with the report of Vegetti (1997a). The general pattern of inflorescence for *Themeda* (Plate 306 L), *Iseilema* and *Pseudoanthistria* were observed and recorded under P_{4c} type. Moreover, architecture of *Heteropogon* (P_{4c} type) is in accordance with Vegetti (1997a) and Roux & Kellogg (1999).

For subtribe Rottboelliinae references related to *Mnesithea* (*Coelorachis*) and *Rottboelia* inflorescence architecture get in the work of Vegetti (1997b). All the 5 genera with single species depict P_{4b} type (Plate 306 I). In Addition, *Coelorachis*, *Hackelochloa* and *Mnesithea* show inter and infrageneric variability in inflorescence and other characters and treated/merged in the single genera *Mnesithea* by Veldkamp *et al.* (1986), supported by the present observations.

Both the genera of subtribe Chionachne depict over all similarities and classified under P_{5a} subtype (Plate 306 M). *Chionachne*, as a genus is under the revision by Veldkamp (2004) and pinpointed the special characterization, i.e. *Chionachnae* lacks prophylls and bracts and seen in coicinae; but, in the present study prophylls and bracts were noticed and recorded in both subtribes (Plate 254 F). Furthermore, *Coix* from subtribe Coicinae show prophyllar region of paracladia as trophotagma (Plate 306 N) as described by Jacques-Felix (1961) and Vegetti (1999); while *Zea* from subtribe Tripsacinae possess unisexual inflorescence on proximal (female) and distal (male) part of the plant (Plate 306 P).

It is well known fact that, the grass synflorescences are polymorphic in nature because the degree of development and different process are involved gives the specific inflorescence to the individual plant taxa. The present diversity is the result of certain specific processes such as- truncation, reduction, racemization, elongation as well as homogenization of various organs, terms coined by Sell (1969), and the explained for the poaceae by Vegetti & Anton (2000). These processes, through successive steps, occurred in monotelic panicle (primitive synflorescence in angiosperm) to produced polytelic one.

The inflorescence which has been proposed as the most primitive in the family is a relatively small polytelic panicle like branching system made up of 1° and 2° paracladia, each one standing single at the nodes (Stebbins 1982). In all the species the general typological structure is following the developmental pattern suggested by Perrata *et al.* (2009). Apical reduction of axes seems to be a widespread evolutionary trend among Poaceae (Butzin 1979). Although the evolutionary pathway depicted seems plausible, it could have taken place in a more complex way. In order to understand the wide diversification leading from the original panicle to the different types of inflorescence, it is necessary to analyze different processes that have taken place throughout the evolutionary history of the tribes or family (Vegetti & Anton 1995, 1996, 2000; Liu *et al.* 2005). These processes have operated independently or combined in different ways and principally, they have affected 2 areas: the main florescence (HF) and the paracladial zones (lPc & sPc).

Processes in the Poaceae synflorescences:

Process A: Increase in the degree of ramification of the long paracladia: Below the HF there are sPc preceded by lPc in a successive order. Here, there is only one paracladium per node, i.e. spiral or alternate arrangement.

Process B: Reduction in the degree of ramification or simplification of Inflorescence

This process appears when none of the 1°Pc ramify above 2° or even reduced to Cof.

Process C: Development of higher number of branching per node

Pc are arise from 2 different way: A monophyad pattern, means that only one branch is formed at a time (Troll 1964). If the enrichment axes do branch, either a paniculate branching pattern (branches generated from the leaf axillary buds), or a cymose branching pattern (branches generated from the axillary buds of the prophyll) may occur called pleiophyad pattern (Souza-Chies *et al.* 2006). Gram (1961) assumed two processes for this, i.e., in some nodes the 1° axis of paracladia produces a simple or double rhipidium- a cymose partial inflorescence with a monochasial branching pattern (Weberling 1992)- in which the basal internodes remain

undeveloped causing the branches to have a common origin; or another type of reductive processes operates which results in the abbreviation of some of the internodes length between successive IPc of the inflorescence axis, leading to the formation of pseudovercils or even verticils.

Process D: Partial sterility of IPc

This process occurs when some axes do not develop florescence and remain sterile (e.g. Bristle clade).

Process E: Homogenization

Reinheimer *et al.* (2005, 2009) and Reinheimer & Vegetti (2008) found three different degrees of homogenization (i.e., degree of similarity among branches): (1) non-homogenized (2) partially homogenized, and (3) fully homogenized. In fully homogenized inflorescences, the degree of ramification is the same along primary branches. On the other hand, partially homogenized inflorescences have primary branches with a different degree of ramification, in relation to their placement in proximal, middle or distal regions. Although the number of branches per inflorescence resulted highly variable within species, the degree of homogenization was constant. According to the ancestral state reconstruction and the transition rates, the process of homogenization appears favored over the process of de-homogenization (Salariato *et al.* 2010).

Process F: Truncation of the main florescence (HF)

When the terminal spikelet is not developed, the main axis remains sterile at its apical end. In such cases, either the lateral spikelet adopts a pseudo-terminal position or the axis may continue to grow to produce sterile apex.

Process G: Second degree truncation

Phenomenon occurs when the distal sPc does not develop on the homogenized panicle.

Process H: Truncation of Cof

When the terminal spikelet is not developed, the IPc remains sterile at its apical end. In such cases, either the lateral spikelet adopts a pseudo-terminal position or the axis may continue to grow to produce sterile apex.

Process I: Truncation of the distal IPc

This process affects the distal region of main axis. It leads to single IPc when the reduction reaches to its maximum.

Process J: Complete truncation of IPc: inflorescence composed of sPc only.

Process K: Truncation of spikelet

When the spikelet pair suffered from truncation, it leaves the remnants of an axis or reduced to single spikelet in extreme cases.

Process L: Reduction in the basal internodal length of Cof

It results in to the sessile spikelet /spike from the Pedicelled spikelet /raceme type.

Process M: Reduction in the number of IPC

Process N: Branching of sPc

The pair of spikelets is a short branch meristem that produces a single lateral meristem and then terminates in a spikelet. The sessile spikelet is lateral and the pedicellate one is terminal (Cámara-Hernández & Gambino 1990, Vegetti 1991, 1999; Vollbrecht *et al.* 2005, Wu & McSteen 2007, Salariato *et al.* 2010). In the Paniceae tribe, which is sister to Andropogoneae, most species have single spikelets, but a few species produce paired spikelets (Rua & Weberling 1998, Kellogg 2000, Kellogg *et al.* 2004, Reinheimer 2007, Reinheimer & Vegetti 2008). Therefore, the paired spikelet appears to be evolutionarily derived (Malcomber *et al.* 2006).

Process O: Development of trophotagma

In grasses, the pherophylls of spikelets, rather than flowers, are seemingly missing (Vegetti & Weberling 1996), but rudiments are present in early development (Ahmad *et al.* 2009). Mutants of the gene *tassel sheath* lead to loss of bract suppression (Whipple *et al.* 2010). Development of long paracladia with trophotagma may occur by activation of the axillary buds of the leaves located in the distal portions of the main axis. Malcomber *et al.* (2006) consider that some species, particularly in Bambuseae and in Andropogoneae, develop spathes subtending parts of the inflorescence. In the Andropogoneae inflorescences, the spathaceous bracts are not inflorescence branch subtending bracts, rather, each of them is the distal vegetative leaf located below each inflorescence. Some Andropogoneae show an inflorescence reduction and an increase in the number of enrichment shoots; as a result, numerous leaves appear in the floriferous shoots which do not form the numerous inflorescences (the terminal and axillary inflorescences) (Vegetti 1991, 1999). These bracts show variations in form, size and colour (Clayton & Renvoize 1986).

Process P: Loss of one sex organ in distal paraclades

Process Q: Loss of one sex organ in proximal paraclades

Stebbins (1982) described Gramineae as the most difficult one to understand the proper phylogenetic interpretation, as the steps from panicle to spike has taken place more than once among the family members. Typical grass inflorescence described as panicle, raceme, digitate or spike, but when the diversity of the inflorescence taken into consideration they are forming numerous subtypes and on the basis of that number of grass taxa can be grouped. Vegetti & Anton (1995, 1996) described the evolutionary trends in grass inflorescence and considered

panicle as a most primitive inflorescence having primary as well as secondary branches (Paracladia-Pc) present at the node, which has been followed in the present work for depicting the trends of evolution within the presently studied taxa and described diagrammatically in Plate 308 & 309.

According to Sell (1969, 1976) and Maresquelle (1970), due to distal homogenization of Pc and the truncation of the apical flower led to the development of spikelet terminating the main axis and each one of the Pc of inflorescence. The pseudospikelet of Bambusoideae could be considered as a midway step during the transformation of monotelic inflorescence to polytelic one, wherein distal part homogenization of the inflorescence is not complete in such a way that the proximal bracts of the pseudospikelet, instead of being axillary flower, subtend a branch repeating the structure of pseudospikelet (Soderstrom 1981).

In the present studies, panicle (Plate 308-1) has been recorded in *Oryza*, *Aristida*, *Eragrostis*, *Sporobolus*, *Panicum* and *Arundinella*. Due to racemization of IPc along with development of higher number of branches per node it becomes panicle with pseudo-verticel branches (Plate 308-2), recorded in *Phragmites*, *Arundo*, *Eragrostis*, *Sporobolus* and *Isachne*. The genus *Oplismenus* and *Setaria* shows a reduction of spikelet development (HF & Cof), which can result in the complete loss or sterility of some paracladia and shortened internodes in some part of the main axis and paracladia (Plate 308-3). Further development of higher number of branches per node causes the verticel paraclades as observed in *S. verticillata*. After that the base of 2° axis expands laterally as there is little/no elongation of each axis. This makes it appear, as all axes are emerging from the enlarged base in concentric rings, as observed in *Pennisetum* and *Cenchrus* (Plate 308-4).

As a result of reduction in the degree of ramification and truncation of HF in *Hygrorhiza*, *Urochloa ramosa* and *U. reptans* panicle gets more simplified with evident branching (Plate 308-5). Further the processes continue and owing to complete homogenization of paraclades inflorescence (Plate 308-6) in *Digitaria albudense*, *Moorochloa*, *Alloteropsis*, *Leptochloa*, *Desmostachya* and *Halopyrum* are recorded. Moreover, reduction in the length of IPc inflorescence looks like condensed head as in *Aleuopus*. By and large, reduction in degree of IPc continues leads to raceme, noticed in *Zoysia* and *Perotis* (Plate 308-18, 19) and further due to reduction in basal internode of Cof gives rise spike of *Tripogon* (Plate 308-20). At the same time, along with the formerly explained process, truncation of HF and reduction in internodal length of Cof in homogenized panicle resulted in to 2 sessile spikelets per IPc, as in *Tragus* (Plate 308-21). In addition to above inflorescence of *Triticum* is a truncated spike (Plate 308-14), can be originated from raceme because of truncation of HF or Cof.

Another group of related genera may originate after homogenization & reduction in degree of lPc and reduction in internodal of Cof, resulted in panicle with sessile spikelets (Plate 308-9). 2 hypothetical lines are originating leading to digitate inflorescences. The first line (Plate 308-10 to 12) is the result of Truncation of distal region of sPc & lPc as recorded in *Acrachne*, *Eleusine*, *Chloris* and *Enteropogon* (Plate 308-16). Due to reduction in number of long paracladia inflorescence resulted in to 3-2-1 lpc (*Urochloa panicoides*, *U. distachya*, *Tetrapogon*; Plate 308-17, 18). Another line (Plate 308-14 to 27) originates due to truncation of HF and Cof as observed in *Paspalidium* (Plate 308-13). In addition to truncation of sPc and reduction in internodal length of main axis gives rise to digitate with verticel branches (*Dactyloctenium*, Plate 308-14). Further, truncation of distal lpc continues may formulate inflorescence with of 4-6 lPc, as observed in *Cynodon* (Plate 308-15). If reduction in number of lPc continued (4-2-1), may result in to inflorescence with single lPc (*Paspalum*, *D. aristatum*; Plate 308-22, 23).

In the recent years with the help of developmental studies few researchers reported development of inflorescence. According to them, the apical meristem splits, before its elongation, into two meristems: one against the last leaf primordium and the other one opposite. Each apical meristem may develop into a raceme. Sometimes, only the distal meristem develops into a raceme, while the proximal lateral meristem remains arrested with only two lateral, flat appendages, that later become basal scales. Other cases of 1-raceme inflorescence do not show any remnant of a second meristem nor lateral appendages. However, differences in growth between paired racemes in *P. scrobiculatum*, as well as the eventual presence of basal scales in one raceme, suggest that the initial ramification of the apical meristem is not a true case of dichotomy but, a very reduced form of normal branch production. Different authors have interpreted those basal scales as reduced racemes (i.e., primary branches; Chase 1929, Sendulsky & Burman 1978, Rua & Weberling 1995), while others have understood those scales as bracts (Denham *et al.* 2002, Zuloaga & Morrone 2005). Early stages of *P. scrobiculatum* inflorescences show that basal scales derive from two flat expansions on each side. It may either develop or not into a raceme, and that they are very much like the initial shape of the prophyll on the first basal most primary branch. Based on timing and position of primary branch initiation and morphology it has been suggested that basal scales are modified and homologous to the prophyll primordium of a lateral raceme that may either develop or not (Rua & Aliscioni 2002, Zanotti *et al.* 2010).

Although, the truncation and homogenization of HF, lPc as well as sPc leads to synflorescence of Andropogoneae; the development of trophotagma (bracts and prophylls) can be considered

as a prime importance for the evolutionary processes (Vegetti & Anton 2000). Moreover, tribe Andropogoneae also depicts the process of sterilization in highly advanced taxa. Owing to this, it is always placed at latter stage in the classification.

The structure and organization of spikelets in the inflorescence are the most relevant morphological characters. Some members of Poaceae, sPc generally consist of two consecutive axes, each one bearing a terminal spikelet, and so there is a spikelet pair on each node along the synflorescence main axis or on lPc. The two spikelets represent different orders of branching, because of this, these short paracladia are of second grade (Vegetti 1999, Perrata *et al.* 2009). Spikelet pairs are very significant for grass systematics and evolution, and their production is an important synapomorphy, particularly for the tribes Andropogoneae (Roux & Kellogg 1999, Kellogg 2000; Plate 309-26) and Paniceae (Kellogg 2000, Kellogg *et al.* 2004, Doust & Kellogg 2002a&b; Plate 308-7, 8). That change of spikelet orientation has been explained by means of two hypotheses:

(1) the rotation hypothesis, which states that there is a 180° rotation of the pedicel, which lacks morphological support (Clifford 1987, Crins 1991) and

(2) the differential abortion hypothesis, which states that there is a differential abortion of the pedicellate abaxial spikelets and is based on typological analysis without any developmental support (Cámara-Hernández & Rua 1991, Rua 1993).

Recently, the developmental analysis on structural homologies in Paniceae supports that spikelet orientation results from a differential reduction/abortion of either the pedicellate or the sessile spikelet primordia (Zannotti *et al.* 2010).

One of the most advanced and complex inflorescence is reported and observed in tribe Andropogoneae. Due to branching of sPc (as described above) and complete homogenization gives rise to panicle of Andropogoneae (Plate 309-26) with paired spikelets from the simplest panicle with a single spikelet. In this case, synflorescence consists of a main axis (rachis) which bears a variable number of branches with a pair of spikelets. The basal branches are profusely ramified, but a less complex system is seen towards the apex and at last, at the apical zone of the inflorescence pairs of spikelets are directly disposed on the main axis, with a single one spikelet in an apparently terminal position at the uppermost node. It is observed in genera like *Saccharum*, *Sorghum*, *Spodiopogon* and *Imperata* (Plate 309-26, 27). In *Capillipedium* and *Chrysopogon*, the middle and proximal portions the primary branches present a peculiar pseudoverticillate arrangement. This is due to the lack of an intercalary development at determinate levels of the main axis, as it was pointed out by Gram (1961) and Vegetti (1986). Later on reduction reaches to its extreme and forming panicle (*Eulalia*, *Dichanthium*,

Arthraxon, *Bothrichloa*, *Ischaemum afrum*; Plate 309-28) to raceme (*Pogonatherum*-comprises sPc only; Plate 309-30).

In addition to above, at each node of the synflorescence in which a long paracladium develops a distinctive branching system, its architecture being as follows: the axillary bud gives rise to a primary IPc which, in its turn contains an adaxial prophyll placed between the axis & the ramification and a changing number of bracts. Very close to the prophyll a new IPc' develops. Its position leads to the supposition that in the primary IPc the first bract is missing but its axillary bud develops, thus forming this new IPc' with its prophyll. Therefore, in each node, protected by the perophylls, a complex cymose ramification system develops, which consists of a group of paracladia of successive order (IPc, IPc', 1P"; 1Pc''') and their prophylls (Plate 309- 31 to 32, 33 to 34). Thus, along the main axis and each paracladium the branching is monopodial; but at the level of each node the resulting ramification system is sympodial, as long as the terminal bud gives rise to a floriferous shoot. *Ischaemum*, *Andropogon*, *Cymbopogon* (Plate 309-32) and members of Rottboellinae (Plate 309-34, 35) were distinguished as having a reduced inflorescence (spike/raceme) and a proliferation of branching. Even in some instances this ramification system comes to appear as a panicle, which is therefore called false panicle. It is a specialized branch system where only the ultimate units (spike/raceme) are considered to be true inflorescences (Clayton 1969, 1972).

When the branched sPc (spikelet pair) had suffered from truncation of terminal spikelet of primary axis, it leaves the remnants of an axis, as observed in *Arthraxon nudus*. If, the truncation affects the primary axis as well, then there is a solitary spikelet on each rachis node (Vegetti 1998). In *Dimeria* each short paracladium consists of only one spikelet (coflorescence), where in each paracladium consists of only one homogamous spikelet (instead of two). Owing to that, Butzin (1979) and Vegetti (1999) suggested that genus *Dimeria* should be considered as a best candidate to study transitory development processes. In the least modified genera the spikelets are alike, but there is a progressive loss of function in the pedicelled spikelet, coupled with a tendency for the pedicel to take part in the investment of the sessile spikelet; in extreme cases the pedicel becomes flattened and fused to the internode. In inflorescences of members of Rottboellinae, pedicels decrease in length from the apex to the base, where finally both spikelets of the pair are inserted at the same level. The pedicelled spikelet generally corresponds to the more reduced structure in comparison to the sessile one. If such tendencies are stressed, it is to be expected that those parts that are more reduced would disappear, and the ones that are more developed are simplified (Vegetti & Anton 1995). So the pedicelled spikelet would not have developed and the sessile one would have been either sterile

or staminate as described for *Sorghum halepense* by Camara-Hernandez & Gambino (1990) Pers. and recorded during present studies in *Arthraxon*, *Dimeria*, *Ischaemum*, etc.

The most characteristic feature is the occurrence of paired heterogamous spikelets on fragile racemes. Variation in synflorescence of Andropogoneae generally initiates in the proximal nodal region and the greatest development recorded at 2nd and 3rd node, and then it reduced acropetally, as a consequence the pair of spikelets is borne directly on the principle axis. A second characteristic feature noticed in the tribe is a progressive reduction in size of the inflorescence, accompanied by prophyllar branching and modification of the subtending leaves. Thus, the large terminal panicle of the least modified genera gives way to a profusion of short racemes or raceme-pairs, each partially enclosed by an inflated bladeless sheath, and all crowded towards the top of the culm to form a complex leafy branch system which imitates a true panicle. The system of ramification & reduction in length of LPc, truncation in internode of Cof and loss of female sex organ results into the pair of spikelets in the proximal region (forming involucre spikelets; Plate 309-36, 37). Investment of the sessile spikelet is augmented in certain genera by the modification of the lowermost spikelets in the raceme to form involucre scales. Distal region do not get affected during these process resulted in 1-2 heterogamous pairs of spikelets and 2 homogamous pairs of spikelets as in *Themeda* & *Iseilema*. At the same time, another process gets involved related to sPc i.e. branching forms triples of spikelets instead of pairs. In triplets reduction of pedicelled spikelets results in to a single sessile and 2 pedicels in the proximal portion (Plate 309-38). Reduction in the internodal length of cof in distal portion simultaneously forms the sessile triplets. By and large, after this the loss of female at distal portion and male at proximal portion leads to formation of unisexual spikelets (*Chionachne* and *Trilobachne*; Plate 309-39). Due to combination of both processes and loss of Cof in proximal portion only one female and several male spikelets are noticed in the synflorescence (*Coix*; Plate 309-40).

Floral development in the monoecious grass *Zea mays* L. has been studied extensively (Sundberg & Orr 1996, Bommert *et al.* 2005). The two florets in each tassel spikelet are staminate. Although the two florets in each ear spikelet are female, the proximal floret aborts during development so that at maturity the ear spikelets contain only one floret each. All floral meristems initiate all floral organs, including stamens and gynoecia. The stamen primordia then cease growth in pistillate (ear) florets, whereas gynoecium development is arrested in staminate (tassel) florets. The formation of unisexual flowers from a bisexual meristem requires the action of sex determination genes i.e. *tasselseed* and *ts1* & *ts2* for suppression of Gynoecium and stamens respectively (Dellaporta & Caldero'n-Urrea 1993, Irish 1997).

Morphologically, *Zea* forms two distinct types of inflorescences after the transition to flowering, and the transformation of panicle in to the compact seed head becomes more complex. Proliferations of a leaf within the inflorescence take place and separates out the male and female spikelets. Male inflorescence remains paniculate but in female inflorescence spikelets become sessile on the rachis due to truncation of internodes of Cof (Plate 308-24; 306-O). Truncation of distal homogenized part and the complete homogenization of the remaining IPc lead to the structure of female inflorescence. In this case, solitary sessile pistillate spikelets are a consequence of early abortion of the pedicelled spikelet primordium from each pair (Sundberg & Orr 1990). Truncation of main axis and distal portion of IPc and homogenization, could have originate the panicle of male inflorescence (Plate 309-25; 306-P). In recent report (Williams 2008), this transformation has explained on the basis of apical dominance which is always controlled by the molecular development.

6.3.2 Family Cyperaceae

The inflorescence has proved to be a major source of reliable diagnostic traits to study the Cyperaceae, which provides the diversification of many taxa, and its significant values for phylogenetical analyses (Tucker & Grimes 1999, Tortosa *et al.* 2004, Urdampilleta *et al.* 2005). Thus, in last few years the inflorescence of Cyperaceae is being studied by many cyperologists. However, the use of the inflorescences as characters for the division of the genera has been criticized by several authors (Goetghebeur 1989, Muasya *et al.* 2002). Earlier, numerous terminologies have been suggested by many workers creating problems in understanding the exact nature of the inflorescence. However, comparative typological analysis started with the work of Troll (1964) and Weberling (1989), and revised recently by Rua (1999) and Vegetti (2003). The establishment of homologies among different types of inflorescences is one of the main concerns of the cyperologists (Raynal 1971, Eiten 1976, Reutemann *et al.* 2009). Furthermore, Guarise & Vegetti (2008a) has given the hypothetical processes responsible for the structural diversity of inflorescence within the family cyperaceae.

Subfamily Cyperoideae: In the tribe Cypereae studies on inflorescences of *Cyperus s.l.* are rare (Heinzen & Vegetti 1994, Perreta & Vegetti 2002) and they include few species, without implementing a comparative study within infrageneric categories except Guarise & Vegetti (2008b). To solve the taxonomic problems and the relationships in *Cyperus*, a precise morphological study at the level of species is required (Muasya *et al.* 2000). Vrijdaghs *et al.* (2010) has given general model for spikelet structure and development. In the present work 31 members of tribe Cypereae belonging to *Cyperus* (23), *Courtoisina* (1), *Kyllinga* (2), *Pycreus*

(4) and *Queenslandiella* (1) are evaluated for their inflorescence architecture. All the genera depict Anthelodium of lax or congested type (Plate 310 E-I), except *Kyllinga*, which have spike inflorescence (Plate 310 L). Reports for species of all the above mentioned genera were not mentioned in any of the earlier works. In the species of Cypereae, the normal paraclades are disposed in an antidromic arrangement and have normal ramifications, as already been observed in other species of Cyperaceae. The prophyllar productions increase the development of the PZ and the number of spikelets of the inflorescence (Kukkonen 1986, Meert & Goetghebeur 1979, Vegetti 1994).

In earlier works *Abildgaardia*, *Bulbostylis* and *Fimbristylis* are included in tribe Abildgaardeae, which is now renamed as Tribe Fimbristylideae Vahl (Ghamkhar *et al.* 2007). Reutemann *et al.* (2009) described it as a problematic tribe due to non agreement on its infrageneric divisions at morphological level. Molecular phylogeny also reported about the close relation of *Abildgaardia* and *Fimbristylis*, than *Bulbostylis* (Mausaya *et al.* 2009, Simpson *et al.* 2007). Earlier Yano & Hosino (2006) also included *A. ovata* as *F. ovata*, on the basis of chromosomal and molecular dataset. From all the species studied only *F. dichotoma* and *F. ovata* are met in the works of Reutemann *et al.* (2009), rest other are reported for the first time. Variations in the structure of the unit of inflorescences of studied and recorded. Most of the members have lax anthelodium type (Plate 310 C) but, *F. polytrichoides*, *F. tetragona* (Plate 310 S), *F. ovata* (Plate 310 T) and *F. schoenoides* constitutes unispicate one, while *F. argentea* depicted capilulum (Plate 310 Q). Furthermore, 3 type of inflorescence- anthelodium (lax and congested) and fasciculate (Plate 310 J) are noticed in *F. cymosa* ssp. *cymosa* R. Br., due to which sometimes it is misidentified as *F. cymosa* ssp. *umbellato-capitata* (Hbd.) T. Koyama but, stigma number and achene shape used to separate them (Wagner *et al.* 1999). At the same time in *F. schoenoides*, unispicate and bispicate inflorescence were noticed and in *F. alboviridis* simple anthelodium of both types i.e. HF+sPc and HF+sPc+lPc were noticed. In the inflorescences of *Fimbristylis*, the homodromic arrangement is more frequent with normal branching is observed, although *Bulbostylis* additionally shows prophyllar branching with congested anthelodium (Plate 310 K).

In the tribe Scripeae, *Scirpus s.l.* has been segregated in different genera, on the basis of ovoid tubers, eligulate leaves and 1° bracts which include *Bolboschoenus*, *Schoenoplectus* and *Schoenoplectiella* of the present study (Jung & Choi 2010). Moreover, in the present study species of *Eleocharis* and *Fuirena* and *Eriophorum* are also reported from the Scirpeae. Floral ontogeny of *Eriophorum* and *Scirpus* has been described by Vrijdaghs *et al.* (2005), wherein other than synflorescence, perianth structure has been used to segregate the taxa. Earlier works of Jung & Choi (2010, 2011), inflorescence morphology as well as molecular phylogeny are

given taxonomic significance for different species of *Scirpus s.l.* from Korea. In their work reference to *B. maritimus*, *S. mucronatus* (Plate 310 P) are met, rest other are reported for the 1st time. Inflorescence architecture of genus *Bolboschoenus* and *Eriophorum* (Plate 310 D) is found to be lax decomposed antherodium while *Fuirena* have paniculate type (Plate 310 B). Except *Eleocharis* (unispicate) rest other possess pseudolateral inflorescence (Plate 310 M-P). **Subfamily Caricoideae:** *Scleria parvula* and *Rhynchospora whigtiana* are the sole representative in the present study for the tribe Sclerieae and Rhynchosporae, respectively. Ahumada & Vegetti (2009) has given the inflorescence structure of *Scleria*, but presently studied species was not included, and it depicted presence of different pistillate and staminate flowers on paniculodium with prophyllar branches (Plate 310 A). The inflorescence of *Rhynchospora* has been described by Lucero & Vegetti (2012) & in *R. whigtiana* it is found to be fully homogenized capitate type (Plate 310 R).

Homogenization, truncation and racemization are the three main processes in cyperaceae. This conclusion is supported by phylogenetic studies based on molecular (Muasya *et al.* 1998, Plunkett *et al.* 1995), morphological (Bruhl 1995, Simpson 1995) and combined data analysis (Muasya *et al.* 2000b). In all the species most of the processes described by Guarise & Vegetti (2008a) have been recorded. The process may be due to individual effect or the combination. Effect of the processes is same as explained for family Poaceae.

Processes in the Cyperaceae synflorescences:

Process A: Development of the Pc in the axils of the upper leaves of the long-internode zone (i.e. Pc with UIF).

Process B: Inhibition of the development of Pc from the axils of the upper leaves of the long-internode zone (i.e. Pc with UIF).

Process C: Upright positioning of the lowermost primary bract and Pc, continuing the direction of the stem: By this process, the inflorescence is bent over, suggesting a lateral position (pseudo-lateral inflorescence), phenomenon called 'Metatopies' (Troll 1964).

Process D: Development of Pc below the main florescence in the UIF.

Process E: Increase of the number of Pc of the UIF.

Process F: Increase of branching degree.

Process G: Increase of the internodal growth of the Pc

Process H: Reduction of the internodal growth of the Pc

Process I: Reduction of the number of Pc of the UIF.

Process J: Diminishing of branching degree.

Process K: Inhibition of the development of the long-Pc in the UIF; the UIF is formed by short-Pc only (constituting a spike of spikelets).

Process L: Inhibition of the development of the Pc: the UIF is formed by the main florescence only (sometimes, when there is not long-Pc subzone, this process represents the inhibition of the short-Pc subzone).

Process M: Truncation of the region of short paracladia of the UIF.

Process N: Truncation of the distal region of the long Pc of the UIF.

Raynal (1971), Goetghebeur (1998) and Guarise & Vegetti (2007) considered the panicle as the basic cyperaceous inflorescence which can be modified through the elongation or contraction of the internodes in various reduction trends. Leafy stems, evenly spaced equal inflorescence branches and distal branches emerge distinctly higher than the proximal branches together with spikelets of many bisexual florets spirally arranged with few or no sterile glumes each flower with a perianth enclosed by closely enfolded glume suggest a peculiarly specialized type of panicle, rather than a relatively primitive form, suggested by Mattfeld (1938). The paniculodium, evolved early in basal groups of the family, as in species of *Fuirena* and *Scleria*. Furthermore, *Fuirena* have bisexual spikelets (Plate 311-1) where as unisexual spikelets are found on *Scleria* only (Plate 311-2).

Indeterminate inflorescence with the terminal spikelet and short distal branches which overtopped by proximal long branches called anthelodium, is results from the inhibited lengthening of the main axis internodes and the distal branch epipodium, with an important development of the basal branch epipodium. The anthela of spikelets may be simple (Plate 311-5), compound (Plate 311-4) or decomposed (Plate 311-3), depending on the branching order with expanded epipodium (either first, second or third, fourth and above, respectively). This variation in the form of the anthela of spikelets has been described in species of *Cyperus* (Wilson 1991, Guaglianone 1996, Guarise & Vegetti 2007, 2008) and *Fimbristylis* (Reutemann *et al.* 2009). Generally, there is a gradual transition in the number of spikelets in each inflorescence and in the branching order of the inflorescence branches. The branching degree becomes distally reduced and the branches become progressively shorter toward the apex. In many inflorescences of Cyperaceae, most of the primary branches have a lower similar order of branching, except for the very distal ones, which are reduced either to the minimum branching degree or to the terminal spikelet. These inflorescences with many branches of similar branching order are homogenized inflorescences. The variations in the anthela of spikelets depend on the length of the epipodium of their branches. The internode growth from

the inflorescence branch axes (except the epipodium) affects the inflorescence shape, especially in the manner in which branches group in the distal portion of an inflorescence branch with a developed epipodium; these groups can be simply described as a contracted head or glomerulous (*C. squarrosus*, *C. difformis*), lax (*C. esculentus*) or congested spikes (*C. arenarius*, *C. bulbosus*, *Bulbostylis*; Plate 311-6). Guarise & Vegetti (2008) have suggested presence of one or another type of ramification pattern within species and varieties for *Cyperus* sect. *Luzuleoidei*. In the same manner, during the present work ramification (branching) from the axil of normal bracts (*Cyperus* and *Fimbristylis*) or mixed type (*C. difformis* and *C. pulcherrimus*) was recorded.

Inflorescence with spikelets disposed sessile on the main axis called spike of spikelets. The spike of spikelets is composed of spikelets with perfect flowers in *Schoenoplectiella* and *Schoenoplectus* (Plate 311-11+12) and *Kyllinga bulbosa* (Plate 311-8). In a few Cyperaceae, the inflorescence meristem does not produce branches, which means the inflorescence has a single terminal spikelet termed unispicate inflorescence (Goetghebeur 1998, Vegetti 2003). In the present study, *F. tetragona*, *F. polytrichoides*, *F. schoenoides* (Plate 311-9), *Eleocharis* (Plate 311-10) and *F. ovata* (Plate 311-13) depict such type of synflorescence. Pronounced shortening of the internodes on the main axis and branches of different order results into head / capitulum (*F. argentea*, *K. brevifolia*, *R. wightiana*; Plate 311-7). In some cases, there is also a reduction of the branching degree. A capitate inflorescence may derive from a paniculodium, an anthelodium, or from a spike of spikelets because of the reduction of the internode length of the main axis and the inflorescence branches (Reutemann *et al.* 2012). In that process the inflorescence meristem produces lateral meristems that may behave either wholly as spikelet meristem and, consequently, do not produce other branches and end immediately in a spikelet. There is no reason to suppose that the reverse pathway might happen to produce a type of inflorescence with an epipodium developed from any more congested form (Guarise & Vegetti 2007).

Understanding of typological studies can give some guideline to understand the changes occurring in architectural pattern of synflorescence. Careful comparative morphological studies indicate that much of the inflorescence variations are occur in the genera and species of grasses and sedges are due to changes in the numbers of orders of branches, position of the flowers, amount of axis /paracladial elongation and development of branches with trophotagma.

6.4 Nomenclatural notes

6.4.1 Family Poaceae

- **Phragmites karka** (Retz.) Trin. ex Steud.

Veldkamp (1992) has given a new combination after taken in to consideration all similar looking tall grasses and named as *Phragmites vallatoria* (Plunk. ex L.) Veldkamp. Linnaeus (1753) made the combination *Arundo vallatoria* Plunk. and was followed by De l'Obel for *P. australis*. According to Plukenet (1700) it was either *A. donax* or *P. australis* from India orientalis from Alexander Brown. Since, there is a problem regarding the identity of this species, in the present study it is mentioned as *P. karka* instead of *P. vallatoria*, as it is accepted name by grass genera of the world (Watson & Dallwitz 2002 onwards).

- **Eragrostis japonica** (Thunb.) Trin.

I am able to collect 3 species of Bor (1960) i.e. *E. japonica*, *E. diarrhena* and *E. diplachnoides*. According to Hooker (1897) *E. interrupta* has 3 varieties named *E. diarrhena*, *E. diplachnoides* and *E. koenigii*. Later Bor (1960) in his work has included variety *E. diarrhena* and *E. koenigii* as a one and raised *E. diplachnoides* as a species. Moreover, from the beginning *E. japonica* treated as a species only. In the recent works or Floras like Karthikeyan et al. (1989), Laxminarshimhan (1996), Pandey (1993) and Roy (2001) has considered *E. diarrhena* and *E. diplachnoides* as a synonym of *E. japonica*. All of them do not showing any characteristic difference in spikelet structure, I have also treated *E. diarrhena* and *E. diplachnoides* as the synonym of *E. japonica* only as it is accepted name (Watson & Dallwitz 1992 onwards). But, in the flora of Gujarat state, Shah (1978) treated *E. diarrhena* and *E. japonica* as a species and *E. diplachnoides* was not mentioned. So, if consider them as different species, *E. diplachnoides* turned out to be a new record for the state.

- **Leptochloa fusca** (L.) Kunth

From Hooker (1897) to recent work of Yadav (2010) including all the floras (Karthikeyan et al. 1989, Laxminarshimhan 1996, Pandey 1993, Roy 2001) considered *Diplachne fusca* as a valid name, but Phillips (1982) included genus *Diplachne* under *Leptochloa* and study was supported by the cladistic analysis of Snow (1997, 1998) and even mentioned in kew grass data base (Watson & Dallwitz 1992 onwards). Hence, genus *Diplachne* is treated as a *Leptochloa* in the present study.

- **Sporobolus ioclados** (Trin.) Nees

Initially, two variations of *Sporobolus* has been collected from two different habitats and identified as *S. marginatus* (post monsoon; exclusive marshy) and *S. ioclados* (late monsoon; everywhere in wasteland) based on length of lower and upper glume (Blatter & Mc Cann 1935). Flora of Rajasthan (Pandey 1993) and Maharashtra (Laxminarshimhan 1996) treated *S. marginatus* as synonym of *S. ioclados*. Karthikeyan et al. (1989) also do the same. In the work of Bor (1960), Shah (1978) and Roy (2001) *S. marginatus* was treated as species without mentioning *S. ioclados*. Hence, *S. ioclados* reported as a new state record (Desai & Raole 2012b). Furthermore, both the species shows different micromorphological features. Although, the name *S. ioclados* is accepted only in kew database (Watson & Dallwitz 1992 onwards), I have treated them as a distinct species in present work.

- **Brachiaria** (Trin.) Griseb. / **Urochloa** P. Beauv. / **Moorochloa** Veldkamp

Nguyen (1966) and Webster (1987, 1988) have argued that there is no significant difference between *Urochloa* and the vast majority of species usually included in *Brachiaria*. They transferred the species they were treating (those from Vietnam and Australia, respectively) to *Urochloa*. *Brachiaria eruciformis* remained the sole species in their concept of '*Brachiaria* s.str.' followed to them, there has been an increasing tendency to combine both genera under *Urochloa*, which is the earlier name over the last 35 years. Appropriate combinations have been published for the Asian, Australian, African and New World species; e.g. Morrone & Zuloaga (1992, 1993) for America. For indian species all the floras (Karthikeyan et al. 1989, Laxminarshimhan 1996, Pandey 1993, Roy 2001) and checklists treated them as separate genera except Yadav (2010). This then leaves *B. eruciformis* and relatives without a generic name as it was not included under any name in Trinius' original concept (1826) of the generic basionym *Panicum* L. sect. *Brachiaria* Trin., and the description of a new genus for them would be required. Therefore, nomenclatural committee suggested to Veldkamp to do so (Brummitt 1998); in response to the proposal of conservation of *Brachiaria* against *Urochloa* (Veldkamp 1996a&b). So, the 3 species having spikelets disarticulating above the glumes with inconspicuous callus and chartaceous to cartilaginous, shiny, smooth, muticous upper lemma are named as *Moorochloa* Veldk., gen. nov. (Veldkamp 2004). Based on that in the present work *B. eruciformis* treated as *M. eruciformis* and rest other species of *Brachiaria* merged under *Urochloa*.

- ***Paspalidium* Stapf versus *Setaria* P. Beauv.**

Veldkamp (1994) in his work of notes *Paspalidium* and *Setaria* of south-east Asia mentioned that 'As *Paspalidium* cannot be delimited satisfactorily as it shows intermediate forms, it reduced to *Setaria*'. But, arrangement of primary branches secund on the main axis of inflorescence in *Paspalidium*, while in *Setaria* primary branches will originate on all sides of the main axis, i.e. quaquaversal arrangement (Webster 1987, 1994). In addition to supportive evidences from the inflorescence architecture of earlier works (Doust & Kellogg 2002a&b, Peusiero & Vegetti 2001, Rua 1993) as well as present study, I have treated both as a separate genus.

- ***Panicum psilopodium* Trin.**

In recent nomenclatural edition of Checklist of monocots (Clayton *et al.* 2011), *Panicum psilopodium* has been included in *P. sumatrense*, while treated as separate species in earlier 2010 edition. As *P. sumatrense* is cultivated and having 10-30 cm long, contracted only terminal panicle in contrast to wild, 5-20cm long, spreading, terminal and axillary panicle of *P. psilopodium*, merging of both the species not considered and described as different species in the present work and different floras as well (Karthikeyan *et al.* 1989, Laxminarshimhan 1996, Pandey 1993, Roy 2001).

- ***Setaria parviflora* Veldkamp**

Both the species i.e. *S. pumila* and *S. pallidifusca* and treated as a one or *S. pallidifusca* as synonym of *S. pumila* in many floras and publications (Karthikeyan *et al.* 1989, Laxminarshimhan 1996, Pandey 1993, Roy 2001). Although both looks similar on first view, after critical examination and literature suggest that the basal portion of *S. pallidifusca* is rhizomatous turned perennial one and should be considered under the *S. parviflora*, renamed by Veldkamp (1994) and other works (Doust 2007).

- ***Cenchrus* L. versus *Pennisetum* Rich.**

Corell & Johanston (1970) suggested the unification of *Cenchrus* and *Pennisetum*, where as no. of workers suggested there is no distinguishing feature between numbers of species earlier included in *Cenchrus* and *Pennisetum*. The degree of fusion of Bristles is commonly used to separate these genera (Clayton & Renvoize 1986, Watson & Dallwitz 1992 onwards). As the degree of fusion is properly recorded in *Cenchrus* (new world species) but, in old world species distinction is less obvious Clins (1991). Hence, Webster suggested that both should be separated as there are certain characters are not capable enough to separate out both the genera.

In recent years Chemisquy *et al.* (2010) suggested the unification of *Pennisetum* and *Cenchrus* by giving no. of evidences from morphological characters and molecular data along with the ploidy level. Moreover, they have given the supportive evidences on the basis of morphological and developmental synapomorphies. But, till today none of the author send any proposal related to merging of both the genera in too *cenchrus* to the nomenclatural committee nor accepted by the Grass data base (*Clayton et al. 2011*) Therefore, in the present study both are treated as separate genus.

- **Arundinella pumila L.**

Numerous variations of *Arundinella* are collected and recorded from different localities, which were previously treated as *A. pumila* (proper), *A. metzii* and *A. pygmaea*. Besides the size of the plant, inflorescence and spikelets they are not delimited satisfactorily and treated as a synonym of *A. pumila*, also mentioned in recent floras (*Karthikeyan et al. 1989, Laxminarshimhan 1996, Pandey 1993, Roy 2001*).

- ***Bothrichloa* Kuntze / *Capillipedium* Stapf/ *Dichanthium* Willemet**

In the recent floras these three genera were interchanging their position at nomenclatural level (*Karthikeyan et al. 1989, Laxminarshimhan 1996, Pandey 1993, Roy 2001, Yadav 2010*). In the present work inflorescence architecture of 3 species of *Capillipedium*, 4 species of *Dichanthium* and *Bothrichloa pertusa* has been studied and it differs greatly; as *Capillipedium* show panicle (P_{1b}) and Digitate (D_{1b}) was noticed in other 2 genera. Furthermore, *D. foveolatum* depict single long paracladia with trophotagma regions and grouped in P_{4b} type. Considering these I have in opinion to keep all the genera separately.

- **Chrysopogon Trin. versus Vetiveria Bory**

In literature of Hackle (1889) close relationship of *Vetiveria* and *Chrysopogon* was already mentioned as both were hardly distinct and united by intermediate species. His view was accepted by Roberty (1960) and he reduced both into *Chrysopogon*. Later on Veldkamp (1999) also well discussed all the intermediate forms and inflorescence in details and merged *Vetiveria* into the *Chrysopogon*. Although the Indian *Vetiveria* and *Chrysopogon* clearly distinct (*Karthikeyan et al. 1989, Laxminarshimhan 1996, Pandey 1993, Roy 2001*), but following their wide view in the present work *Vetiveria* merged into *Chrysopogon*.

- **Coelorachis** Brongn. and **Hackelochloa** Kuntze versus **Mnesithea** Kunth

As mentioned before Heidweiller & Van der Klaauw (msc.) had observed that there are a number of other species in this alliance, which more or less often have triplets of spikelets in their racemes. These have sometimes indeed been included in *Mnesithea* (Camus 1919), while others have regarded them as belonging to *Coelorachis*. In present collection I have observed fascicles of raceme having paired spikelets in *C. clarkei*. Various authors have claimed that they consist of a fused (in *Mnesithea*) against a free stipe (in *Coelorachis*), and fasciculate against solitary racemes. It is a variable one in *Coelorachis* as a genus and also within *Mnesithea laevis* as a species, and then said that closer scrutiny might show the unreliability of it, although it has been always been treated as a prime one when subdividing the complex (Clayton 1973, Jacques-Félix 1962, Stapf 1919). It will have become clear that the only character which apparently remained to distinguish *Coelorachis* and *Mnesithea* is both inter- & infrageneric variable. By the absence of any other unassailable feature it is therefore impossible to maintain as separate one. Therefore *Coelorachis* is included in *Mnesithea* (Veldkamp *et al.* 1986).

Hackelochloa has never been subjected to a critical analysis as to its generic status and always identified with the *Mnesithea* due to overall similarities. The structure of the raceme looks different because of the slightly oblique articulation, absence of a well-developed cavity for the sessile spikelet and lower glume sculptures. So, in our opinion *Hackelochloa* considered as *Mnesithea* as suggested by Veldkamp *et al.* (1986).

6.4.2 Family Cyperaceae

- **Cyperus s.l.**

Cyperus is morphologically quite coherent and recognized on the basis of distichous scales/glumes in form of spikelet. Traditional infrageneric classification of genus *Cyperus* include most recent comprehensive revision of genus six sub-genera, i.e., *Cyperus*, *Mariscus*, *Torulanium*, *Pycreus*, *Juncellus* and *Kyllinga*, which are segregated on the basis of habit, general inflorescence form, spikelet form & articulation mode, number of style branches, fruit (achene) shape, achene orientation, number of flowers & fruits per spikelet (Kukenthal 1936, Tucker 1987). Although Kukenthal and Fernandez treated the genus in a broad sense, some others followed Clarke (1908) and recognized as genus. *Cyperus* depict deciduous glumes on persistent rachilla with trigonous achene, while *Mariscus* depict the scales even after fallen from the rachis. *Pycreus* and *Juncellus* are segregated on the basis of achene morphology i.e.

laterally and dorsiventrally compressed, respectively. While, recently described *Cyperus sensu lato* has *Cyperus sensu stricto* as the core genus, in which the thirteen derived genera (*Alinula*, *Androtrichum*, *Ascolepis*, *Courtoisina*, *Kyllinga*, *Kyllingiella*, *Lipocarpha*, *Oxycaryum*, *Pycreus*, *Queenslandiella*, *Remireia*, *Sphaerocyperus* and *Volkiella*) are embedded; which differ in one or more gross morphological characters (Muasya *et al.* 2009). In 2000, Carter & Mears have given the proper identity to *Cyperus hyalinus* as a new genus, *Queenslandiella hyalina* on the reports of Govindrajalu (1975) and Haines & Lye (1983). As the specimen depict open anthelate inflorescence, presence of compressed spikelets with multiple flowers & fruits and lenticular achene. Moreover, the specimens show the presence of persistent scales with disarticulating spikelets. At the same time, *Courtoisina* has been changed as a nomenclatural necessity by Sojak (1979) and confer to the generic rank by Lye (Bhrul 1995).

- ***Fimbristylis ovata*** (Burm.f.) J.Kern

Abildgaardia and *Fimbristylis* have posed difficulties for morphological delimitation (Bruhl 1995, Goetghebeur 1998, Goetghebeur & Coudijzer 1984). Recently, molecular phylogenetic analyses of the family Cyperaceae (Muasya *et al.* 1998, 2000, 2009; Simpson *et al.* 2007) depict *Abildgaardia* and *Fimbristylis* as more closely related to each other than to the genus *Bulbostylis*—an observation also shared by Ghamkhar *et al.* (2007). Moreover, Molecular analyses indicated strong support for inclusion of *Abildgaardia ovata* as *F. ovata* and accepted as *F. ovata* only (Yano & Hoshino 2006, Govaerts *et al.* 2007).

- ***Scirpus s.l.***

Reichenbach (1846) reported *Scirpus* subgenus *Schoenoplectus*. Palla (1888a) transferred the rank of *Schoenoplectus* from a subgenus to a genus. He combined 17 species to *Schoenoplectus* in the same year (Palla 1888b). The species of this genus share several morphological characteristics, namely ligulate leaves, a culm-like primary bract, and pseudo-lateral branched inflorescence. The species of this genus had been considered as *Schoenoplectus s.l.* until Lye (2003) recognized the polyphyly. As a result, Lye (2003) described a new genus, *Schoenoplectiella* Lye, based mainly on the *rbcL* data presented in Muasya *et al.* (1998, 2000b) and combined ITS and *trnL-F* data (Young *et al.* 2002), to segregate all the annual taxa previously part of *Schoenoplectus*. Most recent plant taxonomists consider *Scirpus* as a polyphyletic group (Takhtajan 2009, Simpson *et al.* 2003) and exclude *Schoenoplectus* from *Scirpus* on the basis of eligulate leaves, several leafy 1° culm like bracts and ovoid tubers along with inflorescence with numerous spikelets. At the same time,

Schoenoplectiella has been segregated on the basis of culm like bract with branched inflorescence (Jung & Choi 2010, 2011).

As mentioned above, *Schoenoplectiella* differs from *Schoenoplectus s.str.* in its morphology, in so far as having unbranched inflorescence, *Schoenoplectiella lateriflora* (J.F.Gmel.) Lye clearly prophyllar branched inflorescence has been recorded (Plate 310 N), similar to *Schoenoplectus litoralis* subsp. *thermalis* (Trab.) S.S.Hooper. Therefore, the inclusion of *S. lateriflora* in *Schoenoplectiella* was invalid (Govearts et al. 2011), and it should be shifted to *Schoenoplectus*.

6.5 Foliar Micromorphology

The works of Metcalfe & Chalk (1950, 1965), Metcalfe (1954, 1960, 1963, 1971) are considered to be the standard references for all anatomical and micromorphological works in plant sciences, wherein generalized foliar micromorphological pattern of only abaxial epidermises of grasses and sedges were described. Later on, Palmer & Tucker (1981, 1983), Palmer *et al.* (1985), Palmer & Gerbeth-Jones (1986, 1988) have described East African grasses in different publications for specific tribes. In their reports they have given the characteristic pattern, SEM photographs along with the magnification only. Soon after, Clayton & Renvoize (1986) used micromorphological features to solve the taxonomic problems.

In recent years, anatomy and micromorphology of grasses has gained the importance due to their specificity at tribe, family, generic level. Watson & Dallwitz (1992) have utilized data of abaxial leaf surfaces only at generic level. They have given the structural diversity as well as measurements of some epidermal characters including cells, nature of the walls, stomata, microhairs, silica bodies and papillae for abaxial leaf surfaces only. But, their voluminous work did not pay any attention to some epidermal ornamentation such as, prickles, hooks, macrohairs and margin, as these characters are helpful for identification of certain genera and species.

From Indian sub-continental view, very few reports are there viz., Basappa *et al.* (1986), Krishnan *et al.* (2001), etc., who have described and used different characters for specific genera and species of grasses. At the same time, Ahuja (1962) was the pioneer, who studied the foliar epidermises of few sedges of India, but empirical works of Govindrajalu (1968-74) on south Indian sedges cannot be forgotten. These information have been compiled for different genera and used for the comparison with the present observations of both leaf surfaces. Wherever other reports are available in literature then it has been used at particular genera also.

6.5.1 Family Poaceae

Based on present observations of abaxial and adaxial surfaces of grass leaves generalized pattern has been studied and summarized in the Tables 1-35 along with photographs on Plates 262-296. Both the epidermises shows great qualitative and quantitative variations in their constitutes like- long cells, short cells, silica cells, stomatal complexes, papillae, prickles, hooks, microhairs, macrohairs and margins. Only qualitative data are discussed here in detail, as it is much more consistences for a species, while quantitative data shows many variations along with different environmental gradients and developmental stages.

Tribe Bambuseae

Tribe has been reported in the works of Wu (1962), Metcalfe (1960) and Renvoize (1985a). In their works generalized pattern was described based on 48 genera, of which 2 are included in the present study, i.e. *Bambusa* and *Dendrocalamus*. Both the genera show overall similarities with earlier works. Recently Yang *et al.* (2008) has utilized the papillae in foliar micromorphological characters for understanding the relationships between woody bamboos of Asian tropics. Our observations related to *Dendrocalamus* and *Bambusa* in accordance with them, i.e. 4 papillae overarching the stomata in *Bambusa* and 8 in *Dendrocalamus* (Plate 262 A-I; Table 1).

Tribe Oryzeae

Metcalfe (1960) and Zhang *et al.* (1998) has given the generalized pattern for the tribe and genera, while recent studies are based on silica bodies/phytolith for genus *Oryza* (Pearsall *et al.* 1995, Wang *et al.* 1998). Previous works of Nwokeocha (1996) was on the leaf micromorphology of *O. punctata* only. Perusal of literature suggested that the genus *Hygroryza* were not studied earlier for their foliar epidermis. On the basis of epidermal cell shape, papillae and microhairs both the genera can be segregated. In *Hygroryza* epidermal cells are uniform, mostly cubical, irregularly arranged with compactly encircled papillae on adaxial and hexagonal with regular arrangement in files on abaxial surfaces with uniformly scattered papillae. Microhairs mostly unicellular, sporobolus type observed intermittently. Prickles are found only on veins and of sporadic in nature. Silica cells are of crescent and oryza type on intercostals and costal zones respectively (Plate 263 A-D; Table 2). Whereas in *Oryza*, two types of epidermal cells i.e. rectangular and hexagonal were recorded on adaxial surface and only rectangular shape are recorded on abaxial surface. Papillae of various sizes are also noticed in 1-2 rows. Loudetia type of microhairs is noticed on both the surfaces. Small and

pointed prickles present on the midvein while hooked on intercostals zone. Silica cells are of oryza type i.e. vertical dumbbell. Nodular type of silica cells and trichomes are noticed only from the epidermal peels of *O. latifolia*. Lower leaf surface of *O. rufipogon* and *O. sativa* depict the presence of 3 sizes of papillae (Plate 263 E-T; Table 2).

Tribe Triticeae

Triticum aestivum is the sole representative of the tribe. General outline is in accordance with the earlier report of Metcalfe (1960). Previously Inflorescence micromorphology along with silica deposits are utilized for wide variety of disciplinary researches (Ball *et al.* 1999, Tubb *et al.* 1993). Present observation varies from the earlier reports owing to presence of prickles and absence of crown cells (Plate 26 A-D; Table 3).

Tribe Arundineae

Tribe includes 2 genera viz. *Arundo* and *Phragmites*. Both are quite different from one another at epidermal long cells and microhair types. Previous reports for the tribe are found in Metcalfe (1960), Renvoize (1986a) and Ahmed (2009). In the Khan's report microhairs are found in *Arundo* only, and absent in *Phragmites*, but during the present investigations arundo type of microhairs recorded in both the genera, which was also reported by Prat (1936) (Plate 262 J-R; Table 1).

Tribe Aristideae

Previously it has been worked out by Metcalfe (1960), Tateoka *et al.* (1959), Renvoize (1985b), Ahmed (2009). During the present study only loudetia type of microhairs, low dome-triangular stomata and dumbbell shaped silica bodies were recorded in all the 3 studied species of *Aristida* (Plate 264 E-N; Table 3). From the present work only *A. adscensionis* had been earlier studied by Gill & Mehesh (1993) from Nigeria, rest 2 are studied for the first time.

Tribe Eragrostideae

Tribe Eragrostideae is divided in to three sub-tribes in the present work, i.e. Monanthochloinae, Eleusinae and Sporobolinae. Former works of Metcalfe (1960) and Renvoize (1983) are related to generalized structure, leaf blade anatomy and micromorphology. All the 12 genera of 3 subtribes look quite similar in their structure and nature depicting overall similarities with the earlier reports.

Subtribe: Monanthochloinae

Aeluropus lagopoides is the sole representative of the subtribe in the present work and it was earlier studied by Renvoize (1983). Epidermal cells of both the surfaces do not show any

variation as both shows rectangular, sinuous type. Intercostals zone depicts the presence of tall and narrow silica cells. Costal zone showed the presence of cubical-narrow-dumbbell shaped silica cells on upper epidermis while saddle-cross shaped are on lower epidermis. Triangular stomata are of common occurrence roofed with long papillae. Microhairs are of bicellular chloris type. Leaf margin are with angular prickles (Plate 265 A-D; Table 4).

Sub tribe: Eleusinae

Zhang & Cai (2005) and Ahmed *et al.* (2011) were reported foliar micromorphology of some members of Sub tribe Eleusinae under tribe Eragrostideae from China and Pakistan respectively. Epidermal long cells in all the species of different genera in the tribe are with thin sinuous or moderately thick sinuous walls are mostly alternate with silicified crescent-elongate-tall narrow-cubical-saddle-acutely angled silicified short cells. About half of the species depict presence of cork cells (1-3) along with silicified short cell in the costal as well as intercostal zones forming silica-cork pairs (Plate 265-269; Table 4-8). Moreover, in *Halopyrum* long cells are thickened on their outer tangential walls (Plate 269 A-B). In the present study, except *Eragrostis* and *D. bipinnata* all other genera having small-large papillae present on the long cells, but it was earlier reported in case of *Dactyloctenium aegyptium* only (Ahmed *et al.* 2011). All the species studied are amphistomatic, but *Halopyrum* is unique due to absence of stomata on both the surfaces (Plate 269 A-B). Subsidiary cells of stomata are low dome shaped, tall dome shaped or triangular in shape. The genus *Eragrostis* is recognized by bicellular microhairs with hemispherical distal cell (Amarasinghe & Watson 1990). In the present findings subtribe shows vast variations in microhair types, i.e. *Eragrostis* shows eragrostis and panicoid type; *Desmostachya* portray eragrostis type; *Acrachne*, *Dactyloctenium* and *Eleusine* represent unicellular sporobolus type, whereas *Tripogon* and *Leptochloa* depict chloris type (Plate 265-269; Table 4-8). In contrary to that, Ahmed *et al.* (2011) reported microhairs in *Dactyloctenium aegyptium* and *D. bipinnata* only, while in other species microhairs are found absent. Friere *et al.*, (2005) reported that *Eleusine indica* is characterized by pear like sporobolus type microhair, which was confirmed by the present work. As silica bodies on the costal regions are cubical-saddle shaped in all the species except *Acrachne*, *Dinebra* and few spp. of *Eragrostis* in which cross-dumbbell shaped are found. Bibi *et al.*, (2007) reported that silica bodies are absent in *Eleusine indica*, but saddle shaped silica bodies are observed during present work (Plate 266 M-N; Table 5). In terms of exodermic appendages tubercled macrohairs are recorded from *D. indicum* and *A. racemosa* only (Plate 265 G, P). Frequently distributed prickles are noticed in *D. bipinnata*, *Dinebra*, *Eragrostiella*, few spp. of *Eragrostis*, *Halopyrum*, *Leptochloa* and *Tripogon*. In opposite to that, prickles were reported only from *E. papposa* as reported by Ahmed *et al.* (2011). Hooks are frequent in the

intercostals regions of *E. coracana*, *Dinebra*, *Leptochloa* and few spp. of *Eragrostis*. Leaf margin shows angular prickles, but *E. minor* and *Dactyloctenium* shows tubercled hairs as well (Plate 265 J, M; 267 P). Moreover, leaf anatomical characters for *Dactyloctenium aegypticum* and both the species of *Eleusine* were earlier described by Ogundipe & Olatunji (1991) and present reports are in accordance with it.

Subtribe: Sporobolinae

Six species of *Sporobolus* are studied for the subtribe in the present work. All the species depict unipapillate long cells (except *S. virginicus*), saddle-cross-dumbbell silica cells, silica-cork pairs, prickled adaxial surface and angular prickled margin. Mensah & Gill (1997) have reported that, subsidiary cells of the stomata varied from triangular to low dome shape in the abaxial surface while it was low dome shape in the abaxial surfaces in Sporoboleae, which is conform by present analyses. Only *S. margiantus* shows tall-low-dome shaped stomata along with triangular types. Three species depict bicellular chloris type and rest other with unicellular sporobolus type of microhairs, *S. coromandellianus* is unique due to presence of tubercled hairs on both the surfaces (Plate 270; Table 9).

Tribe: Cynodonteae

Tribe is divided in to three sub-tribes in the present work, i.e. Chloridinae, Boutelouinae and Zoysinae. All the 7 genera of 3 subtribes look quite similar in their structure and nature. Except *Melanocenchris*, all the other genera were mentioned in the former works of Metcalfe (1960) was related to generalize structure of leaf blade anatomy and micromorphology.

Subtribe: Chloridinae

Recently Ahmed *et al.* (2012) describe the role of leaf epidermis in species identification of tribe Chlorideae from Pakistan. In his work only *Chloris barbata*, *Enteropogon dolichostachys* and *Cynodon dactylon* were mentioned from the presently studied taxa. The foliar epidermal studies show that all intercostal long cells on abaxial and adaxial surface are with sinuous walls. In *Tetrapogon cenchriformis* irregular sinuous walls are observed (Ahmad *et al.* 2012), which is not recorded in *T. tenellus* (Plate 272 A-B). In addition to that long cells possess 2-6 papillae in *Chloris*, where as others have unipapillate cells. Subsidiary cells are triangular shaped in all the species, except high dome shaped in *Enteropogon*. Ahmad *et al.* (2012) observed that in *C. dactylon* showed triangular and low to high dome shaped subsidiary cells and micro hairs are not observed abaxially, but stomata are with triangular subsidiary cells, silica bodies are saddle shaped, and chloris type microhairs with hemispherical distal cells are present (Plate 271 N-P; Table 10), similar observation shared by Chaudhary *et al.* (2001) and Freire *et al.* (2005). All the species have saddle shaped silica bodies as according to Prat (1934,

1961) and Johnston & Watson (1976), but *Enteropogon* shows the presence of cross silica bodies as well (Plate 271 R). Thus, the feature of stomata and silica bodies are characteristics of this species. Moreover, prickles are recorded from all the studied species but, hooks are from the species of *Chloris* only (Plate 271; Table 10), whereas tubercled hairs from *Cynodon barberi* and *T. tenellus* only.

Subtribe: Boutelouinae

Melanocentris jacquemontii is the sole representative of the subtribe in the present study. Presence of crescentic saddle shaped silica bodies along with long eragrostis type of microhairs are the distinguishing characters (Plate 272 E-H; Table 11), which help to separate Boutelouinae from other two subtribes.

Subtribe: Zoysinae

Clayton & Richardson (1972) described the generalized features for the tribe Zoysieae and generalize pattern of epidermises are in accordance with it. Metcalfe (1960) observed two species of *Tragus* in which microhairs and macrohairs were absent, but Grob (1896) observed microhairs and same observation was made by Schweickerdt (1941) for African species. Tateoka *et al.* (1959) also reported microhairs with hemispherical distal cell in *T. bertironianus* but not seen in the same species by Metcalfe (1960). Similarly, presently studied species *T. mongolorum* (= *T. racemosus*) shows presence of bicellular eragrostis type of microhairs (Plate 272 L; Table 11), which was reported to be absent by Clayton & Richardson (1972). Hence presence of microhairs is not a constant character in the genus *Tragus*. According to Metcalfe (1960) presence of saddle shaped silica bodies refer to chloridoid type of leaf and is characteristic of various species in the tribe Zoysieae, but *Perotis* depict presence of dumbbell-nodular shaped silica bodies in the present study (Plate 272 J; Table 11). In the study of Ogundipe (1991), *P. indica* depict presence of short cells along with long cells in inter-coastal region and tall-low dome shaped stomata, where as short cells are found to be absent and only triangular stomata are noticed in the present study (Plate 272 I-J).

Tribe: Paniceae

Sub-tribes Setariinae, Digitariinae and Cenchrinae are represented for the tribe Paniceae in the present work. All the 13 genera and 52 species studied, showed common structural pattern as described in the former works of Metcalfe (1960) and Renvoize (1987b). Members of tribe Paniceae are used as a good fodder for cattle and according to Herrera (1985), complexity of silica bodies is greatest in Panicoideae which have a long history of vertebrate grazing and grow in regions which have more incidences of grazers. Diversity is observed in the form of

silica bodies in different taxa of the tribe Paniceae as dumb bell shaped, cross shaped, tall narrow, elongate, intermediate between cross and dumb bell shaped. In addition to that, even in one species and on the same leaf, more than one form of silica bodies are present. Subsidiary cells of the stomata are low domed – triangular in shape. Bicellular microhairs of Panicoid or echinochloa type are noticed in all the taxa (Plate 273-282 A-G; Table 12-21), apparent which is the characteristic of this tribe (Metcalf 1960).

Subtribe: Setariinae

In the members of Setariinae, intercostal zone is of uniform nature having slightly rectangular or hexagonal, sinuous walled epidermal long cells with intermittent short cells. Bicellular microhairs and triangular stomata are of common occurrence. Short cells are infrequent, solitary, rarely paired, scattered, with or without an associated silica cell. Costal zone also depict uniform nature of dumbbell-nodular silica cells. Angular prickled margin is regularly noticed (Plate 273-278; Table 12-17). Foliar epidermal studies of different genera are recorded in the earlier works of Ogundipe & Olatunji (1989, 1991), Ogie-Odia *et al.* (2010), Lu *et al.* (2009), Shaheen *et al.* (2011a, b, c), Ahmed *et al.* (2011), and Shaheen *et al.* (2012a, b) wherein *Echinochloa*, *Urochloa*, *Paspalum*, *Setaria*, *Panicum*, *Cenchrus*, *Setaria*, and *Pennisetum* are reported.

Moorochloa eruciformis and *Alloteropsis cimicina* are found to be unique due to criss-cross arrangement of angular prickles (Plate 274 G) and tubercled hairs on the margin (Plate 273 C), respectively. Macrohairs with variable number of basal cells are noticed in *U. panicoides*, *U. reptans*, *U. ramosa* (Plate 278 G-P), *P. repens* (Plate 275 M) and species of *Oplismenus* (Plate 274 H, I, K, L), only. Metcalfe (1960) did not observe any macrohairs in *U. reptans*, but in this study macrohairs were observed in the intercostal zone of both the epidermis (Plate 278 N, O), which was also noticed by Shaheen *et al.* (2011b). In *U. distachya* macrohairs were not recorded (Plate 278 G, P), similar observation in the findings of Sharma & Kaur (1983), but found to be present in the study of Shaheen *et al.* (2011b). In 1991, Ogundipe & Olatunji performed the systematic anatomy in *Brachiaria* (= *Urochloa*), where they pointed out that the absence of papillae and presence of dermal appendages are useful in specie characterization, which are also noticed in the present research. Hooks and prickles are recorded in few taxa from the subtribe. Moreover, hooks are recorded in *S. italic* (Plate 277 A, B), which are absent in the earlier report of Lu *et al.* (2009) and Ahmed *et al.* (2011). Papillae are noticed from *Echinochloa*, *Paspalum*, *Paspalidium* and 4 species of *Panicum* only (Plate 273, 275, 276; Table 12, 14, 15).

Subtribe: Digitariinae

Genus *Digitaria* is the sole representative of sub tribe. Observations of 7 species of *Digitaria* depicted overall uniformity in epidermal peel characteristic features. Earlier Gillani *et al.* (2002) reported the foliar epidermal studies for the *Digitaria*. From the present study, *D. bicornis* and *D. longiflora* are not met with it. Slightly sinuous rectangular long cells, triangular-low dome and parallel types of stomata are of common occurrence along with Echinochloa type of bicellular microhairs. Most of the species does not show presence of exodermic ornamentation except hooks and angular prickled margin (Plate 279-280 A-F; Table 18-19). Large 1-2 papillae present in the long cell of *D. bicornis* and *D. marginatus* only. *D. setigera* and *D. stricta* are exceptions due to presence of long tubercled macrohairs. Only *D. stricta* depict loudetia type of microhairs (Plate 280 A-B).

Subtribe: Cenchrinae

General micromorphological characters are uniform in nature in 3 species of *Cenchrus* and 7 species of *Pennisetum*. In *Cenchrus* subsidiary cells are also triangular and low-tall dome shaped and long cells are with sinuous or slightly sinuous walls (Plate 280 G-P; Table 19). Microhairs are bicelled panicoid type. Macrohairs are not seen in all the three species of *Cenchrus* by Ahmed *et al.* (2011), but long macrohairs with 6-8 basal cells are noticed from *C. ciliaris*. In the study of Shaheen *et al.* (2011c) microhairs were absent in *C. ciliaris*, but panicoid type is recorded in the present study. Moreover, he was noticed short cells with rounded papillae in the intercostal region of *P. orientale*, which is not recorded in the present study (Plate 281 G-H). *P. hohenackeri* is one of its kinds to depict cubical-cross silica bodies in coastal region (Plate 281 E; Table 20) while rest other depicts dumbbell-nodular type. For the *Pennisetum*, Shaheen *et al.* (2012a) stated that ‘the different kinds of long cells have been used in the solution of taxonomic problems, although he also pointed out that this character should not be used isolated manner, since intermediate forms can be used, but in the present study all the species shows rectangular shaped long cells with sinuous periclinal wall (Plate 281, 282 A-G; Table 20-21).

One of the interesting observations has been recorded for *Pennisetum setosum* and *P. polystachion*. In recent literature and nomenclature *P. setosum* is considered as synonym of *P. polystachion*, but micromorphologically both individuals depict huge variations in terms of size of the long cells and presence or absence of long macrohairs on upper epidermis (Plate 281 J, 282 G; Table 20-21). Therefore, I am of the opinion to keep both names as valid one.

Tribe: Isachneae

In the intercostal regions the terms long and short cells are not applicable as all the epidermal cells, other than the guard cells and subsidiary cells, are approximately equal in size. Similar to

this, there is no distinction into long-and short-cells in the intercoastal region, where the cells are similar in shape and size to those of the upper epidermis. Long finger-like papillae projecting from the epidermal cells are of common occurrence (Plate 282 H-I; Table 21). Epidermal cells of this kind have been reported for the genera *Coelachne* and *Heteranthoecia* (Metcalf 1960) and in *Hubbardia* (Clifford 1967). According to Dahlgren & Clifford (1982) surface, sculpture, shape, size and distribution pattern of silica bodies on grass epidermis are variable in different species, and these variations are considered of great taxonomic value. Although, Isachneae belongs to panicoideae it shows saddle shaped silica bodies, character of chloridoid grasses (Metcalf 1960). In addition to that, prickles on the veins bear a sheath of epidermal cells, almost $\frac{3}{4}$ of its length, becoming an identifying feature among all the studied grasses (Plate 282 J; Table 21).

Tribe Arundinellae

General characteristic feature of tribe are in accordance with the formerly described by Renvoize (1982b). The two-celled panicoid of type microhairs, cross-dumbbell-shaped siliceous cells and the tubercled long hairs, epidermal features are belong to the panicoid type (Plate 282 L-R; Table 21), according to Prat's (1936) classification; but, Renvoize (1982b), observed square-oblong shaped silica cells in *Arundinella*. According to Watson and Dallwitz (1992 onwards), the wall morphology (degree of sinuosity) has also been found as an important systematic feature and is applied here for identifying the presently studied species. *A. ciliata* have rectangular sinuous long cells, whereas *A. pumila* exhibits rectangular-hexagonal, smooth-slightly sinuous wall (Plate 282 L, M, P, Q).

Tribe: Andropogoneae

Tribe Andropogoneae is the largest one as it harbors 33 genera and 72 species of 11 sub-tribes, of which only 25 species has referenced earlier. All the studied members for the present work showed a common structural pattern of the family Poaceae. In earlier times, Metcalfe (1960) and Renvoize (1982b) examined leaf-blade anatomy of each of the 86 genera of the tribe Andropogoneae. Several studies related to different genera of the tribe were reported by Hilu (1984), Davila & Clarke (1990), McWhorter *et al.* (1993), Abid *et al.* (2007), Folorunso & Oeytunji (2007), Desai *et al.* (2009) and Ullah *et al.* (2011). This silica perform various functions like mechanical stability, pathogen, insect, herbivore and drought resistance, facilitation of light and alleviation of nutrient deficiency (Ma 2004, Epstein & Bloom 2005, Motomura *et al.* 2006). Shape of silica bodies is a valuable character because a great variety of shape occurs (Clifford & Watson 1977). In the present studies, different kinds of silica bodies

are found in different taxa, such as dumbbell, cross, saddle, rounded, tall and narrow and some intermediate types. Likewise, microhairs also depict the range of variations in their shape, size and types.

Metcalf (1960) reported that guard cells of stomata are dumb cell shaped however there are some variations in shape of subsidiary cells. The dumbbell shaped stomata of grasses are generally believed to represent a more evolutionary advanced form than kidney shaped stomata (Palevitz 1981), of which the tall dome shaped subsidiary cells is a primitive character over low dome and triangular one (Shouliang *et al.* 1996). As the tribe considers being an advanced one, almost all the members depict triangular-low domed subsidiary cells. (Plate 283-296; Table 22-35)

Subtribe: Saccharinae

As a rule, grass leaf epidermises depict rectangular long cells with sinuous walls, bicellular panicoid type microhairs and triangular- low domed stomata and cross-dumbbell-nodular type of silica along with the angular prickled margin (Metcalf 1960; Plate 283-284, Table 22-23). In intercostal zone rectangular profusely sinuous long cells with numerous small papillae and echinochloa type of bicellular microhairs are noticed in *Spodiopogon* only (Plate 283 J, K, N, O). *Pogonatherum* (Plate 283 G, H) and *S. bengalense* (Plate 284 D) is unique due to presence of 2-7 and single large papillae on the long cells, respectively. Only, *S. officinarum*, both the species of *Spodiopogon* and abaxial surface of *E. fimbriata* showed long macrohairs with 4-8 celled-tubercled bases. *S. spontaneum* get segregated on the basis of interlocking prickles on lower epidermis only (Plate 284 O), which was not mentioned in the earlier works of Ullah *et al.* (2011). All the species of *Saccharum* and *E. trispicata* show presence of cuboidal-crescent-tall narrow type of intercostal short cells, hooks and bicellular panicoid microhairs except *S. officinarum*, where in zizania type of microhairs are noticed (Plate 284 G, H). Except, *S. officinarum*, *S. benghalense* and *I. cylindrica* prickles are noticed on the costal zone. Renvoize (1982b) reported that lower epidermis of *Eulalia* does not shows stomata, which differs in present findings as both the species depict the presence of stomata with triangular subsidiary cells (Plate 283 B, E). Rest other characters are in accordance with the former reports.

Subtribe: Germainiinae

Apocopis vaginatus is the only studied species, depicting presence of hexagonal-rectangular sinuous-smooth walled long cells having large single papillae. Triangular stomata and bicellular panicoid microhairs are recorded. Dumbbell-nodular silica cells are noticed. For exodermic ornamentation long tubercled macrohairs are abundantly noticed on both the surfaces (Plate 285 A-D, Table 24).

Subtribe: Sorghinae

Micromorphologically all species are uniform in nature. Rectangular long cells with sinuous wall, tall narrow-cross shaped silica with cork cells, panicoid bicellular microhairs and triangular-low dome shaped stomata are of common occurrence in the intercostal region. Cross-dumbbell-nodular shaped silica cells are common along with the prickles on the costal zone (Plate 285 E-O, 286, 287; Table 24-26). Papillae are present in almost all the species except *D. caricosum* and both the species of *Sorghum*. *C. fulvus* is separates out on the basis of irregular sinuosities of upper epidermal cells (Plate 286 D). Only *C. serrulatus* and *C. zizanioides* do not showed costal prickles. Observations for *C. zizanioides* (= *Vetiveria zizanioides*) are met with the earlier report of Kammathy (1968). The difference in shape of subsidiary cells can be used to differentiate genus *Bothriochloa* from *Dichanthium*, as these genera look similar morphologically (Ahmed 2009), but no such remarkable differences found in the present study. In the presently studied taxa, *Bothriochloa* depict 4-8 papillae on abaxial surface, while 0-1 found in *Dichanthium* (except *D. mccannii*), which may help to segregate both the genera (Plate 287; Table 26). Vickery (1935) and Metcalf (1960) did not find bicellular microhairs in members of the genus *Capillipedium*, but in the present study (Plate 285 E, F, H, I, K, L; Table 24) and in the report of Faruqi (1961) microhairs are recorded on both the epidermises. In addition to that *Capillipedium* depict the presence of arundo type of microhairs, while panicoid type is recorded in others, which can be the characteristic feature for the genus.

Subtribe: Ischaeminae

Micromorphologically *Apluda mutica*, 13 species of *Ischaemum* and both the species of *Sehima* depict overall similarity in major characteristic features. Intercostal zone and costal zone are uniform in nature in terms of rectangular sinuous papillate long cells, cross-dumbbell-nodular shaped silica cells and triangular-low domed stomata. *A. mutica* is unique owing to presence of arundo type of microhairs and tall domed stomata along with non papillate long cells. Ullah *et al.* (2011) reported cross-dumbbell shaped silica bodies and panicoid microhairs in *Apluda*, but in present findings only long nodular silica cells are recorded on the costal region along with arundo type microhairs (Plate 288 A-B; Table 27). Abaxial surface of all the species of *Ischaemum* depict presence of 2-8 papillae, but *I. indicum* depicts numerous small sized papillae on both epidermises (Plate 289 A, B) and *I. afrum* is exception due to its absence (Plate 288 D, E). Four papillae are present on the stomatal apparatus in all the *Ischaemum* spp. except *I. semisegittatum*, *I. indicum* and *I. muticum*. It is also not recorded from *A. mutica* and *Sehima* spp. Costal zone is also peculiar in *Sehima*, *Apluda*, *I. afrum* and *I. diplopogon* as prickles are observed (Plate 288-290, 291 A-D; Table 27-30). Long tubercled macrohairs are

recorded from the *I. indicum*, *I. muticum*, *I. molle*, *I. rugosum* & *I. santapau* and hooks from the *I. indicum*, *I. rugosum*, *I. afrum*, *I. santapau* & *I. conjugatum*.

Although type of microhairs is found to be the diagnostic characters and it is constant within the species or even in genera and tribe, *Ischaemum* shows great diversity within/between the species (Amarasinghe & Watson 1990). Panicoid type of microhairs is present in the upper epidermis of all the species, except *I. semisegittatum*, *I. mole*, *I. muticum*, *I. diplopogon* and *I. barbatum*. Along with that, in *I. barbatum*, *I. bombaiense*, *I. diplopogon*, *I. indicum*, *I. muticum*, *I. rugosum*, *I. santapui*, *I. semisegittatum* and *I. travencorensis* chloris type bicellular microhairs are noticed only on the lower epidermises. At the same time zizania type microhairs are observed in *I. sayajiraoi*, *I. molle*, *I. semisagittatum*, *I. muticum* and *I. diplopogon* (Plate 288-290; Table 27-29). Presence of different kind of microhairs in *I. rugosum* was reported by Metcalfe (1960) and Ullah *et al.* (2011), but not mentioned in the works of Renvoize (1982b).

Subtribe: Dimeriinae

Genus *Dimeria* is the sole representative for the subtribe in the present study. Both the species are showing similarity in intercostal as well as costal zones, in general. Rectangular sinuous long cells with papillae are noticed on lower epidermis. Leaves are hypostomatic and triangular stomata are of common occurrence having 4 papillae on sides of the guard cells on lower epidermises. Costal zone has cross-dumbbell-nodular silica cells. For exodermic ornamentation long tubercled macrohairs are in abundance. *D. ornithopoda* depict tubercled hairs on margins, whereas in *D. stapfiana* angular prickled margins are noticed. At the same time micromorphological observation of *D. ornithopoda* and *D. stapfiana* wherein bicellular panicoid and zizania (chloridoid) type microhairs are observed from upper and lower epidermises respectively (Plate 291 E-L; Table 30). Similar note was given in the reports of Renvoize (1982b) for 29 species.

Subtribe: Andropogoninae

Micromorphologically all species are uniform in nature. Rectangular long cells with sinuous wall, dumbbell-cross shaped silica cells, panicoid bicellular microhairs and triangular-low dome shaped stomata are of common occurrence (Plate 291 M-O, 292, 293 A-F; Table 30-32). In *Andropogon* and *C. martinii* subsidiary cells of stomata are high domed along with triangular shaped. Only in *C. martinii* zizania type of microhairs are recorded (Plate 293 D-F), but Ullah *et al.* (2011) recorded single celled panicoid type, an questionable observation, as panicoid type are bicellular (Metcalfe 1960). Single papillae are present in almost all the species of *Arthraxon* except *A. hispidus* and absent in rest other genera. Renvoize (1982b) was not recorded microhairs in *Arthraxon*, but it is of bicellular panicoid type in all the studied 5

species (Plate 292; Table 31). Folorunso & Oeytunji (2007) studied two species of *Cymbopogon* and also observed that silica bodies are mostly cross shaped and it is the characteristic of most of the species of this tribe, but it is found to be dumbbell-nodular in the present findings (Plate 293 A, B, D, E). Margins are of angular prickles and in *A. hispidus* and *A. lanceolatus* tubercled hairs are also present with it.

Subtribe: Anthistiriinae

Leaves are hypostomatic and triangular-low dome shaped stomata along with papillate interstomatal cells are observed. Rectangular sinuous long cells with numerous papillae are noticed in all the species, except *Iseilema* and *H. contortus*, wherein cells are unipapillate. Panicoid type of microhairs, dumbbell-nodular silica cells on both the surfaces and prickles on upper surfaces are noticed (Plate 293 G-S, 294; Table 32-33). Angular prickled margins are of common occurrence, except *T. laxa* and *H. contortus*, in which tubercled hairs are also noticed. In addition to that, *H. contortus* (Plate 293 J) and *Pseudoanthriscia* (Plate 294 D) depict long tubercled macrohairs in intercostal region. Only *H. contortus* depict presence of cross silica bodies in the intercostal region, similar observation shared with Bibi *et al.* (2007) and rest other depict crescent-tall narrow shaped.

Subtribe: Rottboelliinae

Six different genera with single species form the subtribe Rottboelliinae in the present investigation. All the members depict sinuous rectangular long cells interrupted by cork-silica pairs, zea type of microhairs and triangular-low domed stomata (Plate 295; Table 34). Silica bodies and their associated epidermal pattern can be very useful in grouping of Poaceae to tribes and genera (Prat 1960, Hubbard 1948), and the evolutionary trend in silica bodies is from dumb bell to cross shaped (Shouliang *et al.* 1996), following this all the members of this subtribe depict dominantly cross shaped silica bodies, in the costal as well as intercostal zones. Along with that dumbbell shaped silica bodies are also seen in the costal region. Long tubercled macrohairs are noticed from *Mnesithea* and *Glyphochloa* (Plate 295 C, F, J). Hooks are recorded from the *Hemarthria* and costal prickles from *Rottboelia* only. Observations of *Hemarthria* are varying from the earlier report of Ullah *et al.* (2011), in terms of hooks, microhair, prickles and stomata (Plate 295 L, M). Generally tubercled hairs are present along the margin, but *Hemarthria* and *Rottboelia* showed angular prickles only.

Subtribe: Tripsacinae

Zea mays is the sole representative of Tripsacinae. Intercostal long-cells having markedly sinuous walls with zea type microhairs and crescent shaped silica-cork pairs. Subsidiaries of stomata are triangular-low domed. Costal silica bodies conspicuously in long rows and cross shaped. Hooks are found on adaxial surface along with long tubercled macrohairs. Margin of

the *Zea* is unique due to presence of large angular prickles, seems to be hairs. (Plate 296 A-C; Table 35)

Subtribe: Chionachninae

Chionachne and *Trilobachne* together form the subtribe for the present study. Both the genera follow the similar pattern of the tribe Andropogoneae (Renvoize 1982b). Intercostal long-cells having markedly sinuous walls are interrupted by *zea* type microhairs. Subsidiaries of stomata are triangular-low domed. Costal silica bodies are conspicuously in long rows and cross shaped in *Chionachne* (Plate 296 E) while dumbbell-nodular in *Trilobachne* (Plate 296 H). Silica cork pairs in intercostal region are found in *Chionachne* only. Both depict the presence of long macrohairs, but basal cells vary. Margins are of angular prickled. Both the genera are not studied earlier in this view point. (Plate 296 D-K; Table 35)

Subtribe: Coicinae

Genus *Coix* is the single representative of Cocinae having two species for the present work. Triangular- low domed stomata, long cells, *zea* type microhairs and cork silica pairs seen among both species studied could not adequately distinguish between *C. aquatica* and *C. lacryma-jobi*. But, type and arrangement of silica cells, arrangement of the angular hairs and prickle hairs showed significant differences between *C. aquatica* and *C. lacryma-jobi*. These observations were already reported in the work of Desai *et al.* (2009). The characters of diagnostic importance in the identification of *C. aquatica* are long and sharply pointed prickle hairs present in adaxial epidermis only while with blunt apex in *C. lacryma-jobi* (Plate 296 N, R). The diagnostic characters for *C. lacryma-jobi* are the cross shaped silica cells over and between the veins in the abaxial epidermis which were absent in *C. aquatica*. Adaxial epidermis of *C. lacryma-jobi* and both the epidermis of *C. aquatica* shows presence of dumbbell shaped silica cells over the veins only (Plate 296 L, M, P, Q). These micromorphological characters clearly separate the two species of *Coix*. Krishanan *et al.* (2001) has already classified the south Indian grasses on the basis of silica bodies.

In general, epidermises of grass leaves are convenient for studying differentiation because the cells are arranged in longitudinal files. In some of these files, asymmetric divisions produce short cells that go on to make stomata. The alternation of epidermal long and short cells apparently reflects a change in the place of activity of a developmental program, which must have occurred in the common ancestor of the Poaceae. With this change in position, the short cells became the sites of silica deposition. Evolutionary novelty may have been produced by use of an old developmental mechanism in a new position (Kellogg 2000).

Leaf structural characteristics associated with the ability of a plant to withstand dry conditions are referred to as xeromorphic characteristics; these include reduced transpiration area, thickened leaves and epidermis, increased vascular tissue area, and decreased cell size and intercellular spaces (Oppenheimer 1960). In addition to that, Stace (1965) found that epidermal cells are large on leaves of plants from more humid and shady areas and smaller in dry areas and soil and plants grown in higher altitude. Mettenius (1865) found that all cells were straight-sided when young, and the first sign of undulation always occurred in the region of the free walls. Explanations have been given for the wavy nature of the anticlinal walls of the epidermal cells. One of the explanations for this phenomenon relates the undulations to the development of stress during the differentiation of the leaf (Avery 1933). Another concept is that the waviness is caused by the method of hardening of the differentiating cuticle and it is also affected by environmental conditions prevailing during leaf development (Areschoug 1897). As the leaves reach maturity differences may be observed corresponding to the different habitats under which they were grown. In leaves of dark shade, the cuticle hardens much less rapidly than in stronger light and therefore the waviness is much more pronounced (Watson 1942). Numerous investigators are also agreed as to the greater tendency toward waviness on the lower side of the leaf. In this context, epidermal cells of shade loving grasses like- *Oplismenus* (Plate 274 H, K), *Panicum notatum* (Plate 275 A) and *Spodiopogon* (Plate 283 J, N) species depict the cells with higher width and deeply sinuous walls over the other grasses. Bicellular microhairs are nearly procumbent on young leaves, and as leaves age they lie against the leaf surface and discharge a mucilage-type secretion. All components in the secretion have not been identified but it contains carbohydrates, including callose. Moreover, apical or cap cell of bicellular trichomes stained positively for lipid, protein and polysaccharide (Paul *et al.* 1992). These components usually associated with "walling off responses"; e.g., those associated with injured plant tissues. Moreover, in plants growing in saline habitats, it acts as salt glands which provide the mechanism for removal of excess salts (Lipshchitz & Waisel 1974). In many cases, survival of plants in saline habitats may depend on their ability to reduce the salt content of plants, which exerts toxic effects and inhibits growth of plants. In general, in salt tolerant grasses salt exclusion taken place through efficient secretion by a large number of salt glands (Hannon & Barber 1972, Yeo 1983). Till the date, it has been reported in over 30 Chloridoid and Eragrostoid grass species (Waisel 1972, Lipshchitz & Waisel 1974, Taleisnik & Anton 1988, Oross & Thomson 1982). However, According to Metcalfe (1964) and other reports (Amarasinghe & Watson 1990) presence of microhairs are the universal character of grasses and it was observed in all the presently studied taxa on both the epidermises. But, the frequency of microhairs are seem to be more in the grasses from coastal areas than the hilly

terrains one, which may correlate with the above mentioned salt tolerant adaptations. To establish such relation detailed investigations are warranted.

Font Quer (1975) defines papillae as the simplest of trichomes, characterized by wall projection followed by the protoplast of epidermal cells. In the species of *Paspalidium*, *Paspalum*, *Echinochloa*, *Oryza* and *Isachne* (Plate 263, 273, 276, 282) presence long finger-like papillae on the epidermal cells occur, indicate swampy or aquatic habitats (Clifford 1967). Esau (1977) reported that, trichomes are commonly found on the leaves of plant growing in more stressed habitats, and papillae, especially overarching ones, could perhaps play a similar role in reducing the transpiration gradient. In this context, during present investigations taxa collected from comparatively drier and rocky areas (Andropogoneae members) and saline area (Eragrostoid –except Eragrostis- and chloridoid members) shows higher prickles and papillae overarching stomata. Furthermore, with increasing habitat elevation, the distributional patterns of the papillae above and around stomatal apparatus become more complicated and packed tightly to reduce water loss and increase water use efficiency (Yang *et al.* 2008), as it was observed in *Bambusa* and *Dendrocalamus* during present study (Plate 262 A, B, F, G).

In grasses, spacing between stomatal complexes is maintained by the specification of adjacent cell files, which begin with an asymmetric division toward the leaf apex for all cells in the file. One of the cells produced by the asymmetric division differentiates directly into a guard mother cell, which before dividing again signals the neighboring cells in adjacent cell files to divide asymmetrically toward the same. These divisions produce subsidiary cells important for stomatal action. Subsequently, the guard mother cell makes a single symmetric division and differentiates two guard cells in a distinctive dumbbell shape (Gallagher & Smith 2000). Guard cells with this shape require less water to open than those with a kidney shape (Raschke 1979), so they may be an adaptation to drought conditions. Unlike this, the *pan1* mutant occasionally fails to produce proper asymmetric divisions that give rise to abnormal short cell patterning (Peterson *et al.* 2010). Such kind of short cells are frequently recorded in species of *Eragrostis* (Plate 267 L), *Urochloa* (Plate 278), *Saccharum* (Plate 284), *Zea* and scarcely in almost all the species.

Hetherington & Woodward (2003) have suggested that selection for optimal stomatal size relates to survival in shaded and in drought habitats, large stomata being favored in the former and small in the latter. In addition to that, Aasamaa *et al.* (2001) and Hodgson *et al.* (2010) described that small stomata tend to show greater water-use efficiency. This finding is also supported by the present analysis, as species from dry or saline habitats tend to have smaller stomata than similar species from more mesic-humid environments. An increase in stomatal

density and decrease in stomatal size under salinity has been also reported in studies of Kemp & Cunningham (1981), Gill & Dutt (1982), Akram *et al.* (2002) and Hameed *et al.* (2009). This may be responsible for reducing water loss through leaf surfaces, and would therefore be critical under physiological drought.

In 1996, Harrison emphasized that silica in plants is closely connected to cell wall proteins and suggested the involvement of combination of biomolecules in the formation of biogenic silica. During the absorption of water through their roots, it is absorbed in the form of monosilicic acid and deposited in various plant cells such as bulliform cells, silica short cells, prickles and even in extreme cases in long cells also. These silicified cells are called as phytoliths (Madella 2004). Typical silica short cell silicification did not differ due to leaf positions and sections, probably because these cells are predetermined to be silicified and the silica deposition occurred very early in leaf development (Honaine & Osterrieth 2011). Moreover, bulliform cells lose water more rapidly than ordinary long cells to facilitate leaf folding during periods of water stress and accumulate higher amount of silica than the other cells (Tischler & Voigt 1990, Sangster & Parry 1969). Silicon which is taken up by the plant from the soil is beneficial as it improves pest and pathogen resistance, drought, heavy-metal tolerance, crop quality and yield of the plants. One function is that of providing support to the leaf other than that due to the presence of cellulose and lignin in the cell walls (Kaufman *et al.* 1969, Takahashi 1974). This support function afforded by *Oryza*, in which silicified bulliform cells and dumbbell shaped short silica bodies found in the vertical alignment (Plate 263), in contrast to other taxa; and due to that leaves are more erect.

Studies on *Cynodon* and *Panicum* positive correlation between leaf width with a higher mesophyll and lower fiber levels suggests that wider leaf blades have higher cell content levels related to the higher digestibility of the leaf (Hanna *et al.* 1976, Batistoti *et al.* 2012). Therefore, this morphological trait leaf width can be a reliable phenotypic indicator for selecting forage quality.

6.4.2 Family Cyperaceae

Based on present observations of abaxial and adaxial surfaces of leaves generalized pattern has been described. Similar to grasses, sedges are also constitutes long cells, silica cells, stomatal complexes, papillae, prickles and macrohairs; but there were no much variations recorded qualitatively and quantitatively as seen in grasses. Therefore, to avoid monotony only qualitative data are represented in Table 36 & 37 and only selective photos are mounted on Plate 297 & 298.

Quantitatively size of stomatal complexes ranges between $30-45 \times 24-30 \mu$ (triangular), $33-45 \times 15-21 \mu$ (low-dome), $18-24 \times 24-30 \mu$ (tall-dome), $27-36 \times 27-36 \mu$ (parallel sided). Rectangular long cells varies from $30-110 \times 15-24 \mu$, while $36-60 \times 24-30 \mu$ are recorded for cubical one.

Tribe Cypereae

Members of the tribe are initially worked out by Ahuja (1962) and Govindrajalu (1969a, 1974). In their publications they have described micromorphology along with the anatomy of culm and leaf. Out of presently studied 24 species of *Cyperus*, only 7 were reported in their works. *Courtoisina* and both the species of *Kyllinga* also have a reference in earlier work (Govindrajalu 1969b, 1974) but *Pycneus* and *Queenslandeliella* are studied for the first time along with rest other 17 spp. of *Cyperus*. Most of the members depict rectangular cells on lower epidermises except *C. corymbosus*, *C. microiria* and *C. pulcherrimus* and *C. tenuispica*; while, upper epidermises depict the presence of cubical-rectangular cells in 10 taxa. Moreover, only cuboidal cells are reported in *C. arenarius* and *C. bulbosus*, others have depicted rectangular cells. In terms of stomata both the epidermises depict lower dome–triangular subsidiary cells except *Courtoisina*, *C. alulatus*, *C. tenuispica*, *C. involucratus* and *P. sanguinolentus* depict parallel subsidiary cells along with low dome ones. Further, 11 spp. of *Cyperus* and *Kyllinga* spp., shows triangular–tall dome shaped. In most of the member number of stomatal rows between veins ranges from 1-6, but 5-8 rows recorded in *C. tenuispica*, 6-12 in *C. pulcherrimus* and *Courtoisina*.

By and large, 5-12 conical silica bodies per cell are most common. Furthermore, many conical with satellites are also reported from 6 species. Nodular bodies are noticed in *Courtoisina* and *C. tenuispica*. In *C. nutans*, *C. compressus*, *C. involucratus*, *C. squarrosus*, *P. flavidus*, and *P. sanguinolentus* depict conical bodies with satellites. In addition to above, stalked conical bodies on sinuosities of anticlinal walls are noticed in *C. esculentus* only. Reference to such silica bodies could not found in the earlier reports. Prickles are recorded on adaxial surfaces in few species of *Cyperus* only; only *C. involucratus* showed prickles on both the surfaces. Margins are of angular prickled or smooth. *C. squarrosus* found to be unique in having papillae on both the epidermises.

Out of previously studied 10 species, observations for 8 species are in accordance with the earlier reports. The only difference found in *C. compressus*, wherein Ahuja (1962) reported low domed stomata and hairs on adaxial surface, which are found to be absent in present investigations (Table 36). Likewise, Govindrajalu (1969a) observed prickles with tannin containing bases in *K. brevifolia* which were also not recorded in the present study.

Tribe Fimbristylideae

Sharma & Mehra (1972) have delineated few species of *Fimbristylis* on the basis of anatomical characters and reported 8 species of Uttar Pradesh, rest 6 are studied for the first time. In their work they have given some importance to leaf epidermal studies and reported presence of hairs on *F. bisumbellata* which has not been recorded in present study. Moreover, *F. littoralis* shows prickles on both the surfaces but, *F. tenera* and *F. argentea* have its presence only on the adaxial surface. Cubical cells along with rectangular one are observed in lower epidermis of *F. bisumbellata*, *F. cymosa*, *F. ferruginea* var. *ferruginea* only, all others are depict Rectangular cells files. Upper epidermises depict the presence of cubical and rectangular cells in 5 spp. of *Fimbristylis*, while hexagonal cells are recorded from *F. littoralis* only. Moreover, *F. ferruginea* var. *ferruginea* is one of its kinds to show papillae in the interstomatal cells of abaxial epidermises. In terms of stomata both the epidermis depict low dome –triangular –tall domed subsidiary cells except *F. alboviridis*, *F. polytrichoides* and *F. argentea* which depict parallel subsidiary cells along with low dome ones. Stomata are generally recorded in 1-3 files between veins, but in *F. ferruginea* var. *ferruginea* and *F. merrillii* it was observed up to 6 rowed. In addition to that, lower epidermis of *F. bisumbellata* depicts stomata in 2-3 rows near the margin only, a character of upper epidermis. Silica bodies are recorded in very few members. Nodular bodies are recorded in *F. argentea*, *F. merrilli*, *F. dichotoma* and *F. ferruginea*; while, conical are noticed in *F. ferruginea* var. *ferruginea*, *F. littoralis* and *F. polytrichoides*. In terms of silica bodies *F. ovata* is unique due to presence of stalked conical bodies at sinuation of anticlinal walls. Margins of most of the species are angular prickles or smooth except *F. dichotoma*, shows long hairs.

Tribe Scirpeae

10 species belonging to *Eleocharis*, *Eriophorum*, *Fuirena*, *Schoenoplectus* and *Schoenoplectiella* are analysed here for its foliar micromorphological studies, of which 3 species of *Eleocharis*, *S. mucronatus* and *S. articulata* do not shows presence of leaf blade, hence micromorphological studies were not performed. Moreover, except both the species of *Fuirena* rest other genera are not mentioned in earlier reports. By and large our observations for *Fuirena* are in accordance with Govindrajalu (1969a) except macrohairs of *F. cuspidata* are not found in present study.

In terms of stomata both the epidermises in all species depict low dome–triangular subsidiary cells. *Schoenoplectus littoralis* ssp. *thermalis* is unique due to parallel sided (Plate 297 J, S). Adaxial epidermis of all the species depict the presence of stomata near the margins only, but in *B. maritimus* it has been recorded throughout the epidermis. In most of the species numbers

of stomatal rows between veins on abaxial surfaces ranges from 1-6, but 5-8 rows are also recorded in *B. maritimus*, while *Fuirena* (Plate 297 H, K) can be segregated due to presence of 8-15 stomatal rows. Stomatal apparatus in *F. cuspidata* appeared different due to inner pore of the stomata which is astroporous (Plate 297 L, T), because of the peculiar alignment of the underlying subjacent lobed mesophyll cells with sinuous walls, where as stellate mesophylls are present in other species (Govindrajalu 1968a). Stalked conical silica bodies on sinuation of anticlinal walls are noticed in *B. maritimus* and *F. ciliaris*, not mentioned in earlier report; while 3-8 conical bodies with satellites are observed in *B. maritimus* and *S. lateriflora* (Table 37). *Eriophorum* is unique due to presence of only one conical bodies with satellites (Plate 298 Q). Margins of *F. ciliaris* depict the presence of long hairs (Plate 298 L), smooth were noticed in *Schenoplectus* and angular prickled in *B. maritimus*. Moreover, In *F. ciliaris* hairs are recorded on both the epidermal peels also (Plate 297 K; 298 I).

Tribe Sclerieae

Scleria parvula is the lone member belonging to the Sclerieae. Foliar micromorphological features are first time described here. In terms of stomata triangular-tall dome shaped subsidiary cells recorded throughout both the epidermises. Number of stomatal rows varies from 6-12. 4-10 conical silica bodies per cell are of common occurrence over the veins. Margins are of angular prickled. In addition to above, papillae are recorded in the interstomatal cells of both the epidermal peels (Plate 297 O; 298 F, M).

Tribe Rhynchosporeae

Leaf epidermises of *Rhynchospora wightiana* are studied in detail and described here. Rectangular epidermal cells are noticed in *Rhynchospora* (Plate 297 M). In terms of stomata both the epidermis depict triangular shaped subsidiary cells with 1-4 stomatal rows on abaxial epidermis while, adaxial surface depicting the presence of stomata near the margins only. In addition to above, 4-8 stalked conical bodies on sinuation of anticlinal walls are noticed in *Rhynchospora* (Plate 298 R). Angular prickles are present along the margins.

In family Cyperaceae, silica cells are one of the main characteristic features. Therefore, in number of reports the number, position, size are utilized for delimiting genera and species. In present study, only 41 species of 6 tribes shows presence of prominent silica cells. Seven types of silica bodies are recorded. By and large, 5-12 conical silica bodies per cell are most common. Hart (1990) recorded a conical hat shaped silica bodies-a character of sedge- in species of Mimosaceae, Proteaceae and Casuarinaceae, growing in a humid coastal area near

Sydney. Furthermore, stalked conical bodies on sinuation of anticlinal walls are noticed. Reference to such silica bodies could not be found in the earlier reports.

In general, herbaceous perennial plants including grasses and sedges, characterizing the growth and survival of herbaceous plants in arid environments has often emphasized physiological processes affecting water use during periods of active plant growth (Maroco *et al.* 1997, Fernandez & Reynolds 2000). However, an equally important component of fitness in these environments may be their ability to avoid or postpone lethal dehydration when stomatal conductance is low. Survival of aboveground meristems through drought periods allows rapid canopy redevelopment when soil water is sufficient for high stomatal conductance (Burgess 1995). An increased leaf and tiller shedding, depth of water extraction, leaf water storage in specialized bulliform cells and decreased lethal cellular relative water content may affect dehydration avoidance in plants (Chaves *et al.* 2002), these may be the reason of survival and dominance of grasslands over earth's surfaces.

**Key for the species studied based on
Inflorescence architecture and Foliar Micromorphology**

Family: Poaceae R. Brown

Tribe: Bambuseae Nees.

- | | |
|--|-------------------------------|
| 1. Papillae over arching stomata are 8 | <i>Bambusa arundinacea</i> |
| 1. Papillae over arching stomata are 4 | <i>Dendrocalamus strictus</i> |

Tribe: Oryzeae Dumort.

- | | |
|---|----------------------------|
| 1. Microhairs unicellular, papillae numerous & scattered | <i>Hygrorhiza aristata</i> |
| 1. Microhairs bicellular, papillae of variable sizes & 1-2 rows | |
| 2. Internodal length of main axis between successive Pc is ≥ 5 | <i>Oryza latifolia</i> |
| 2. Internodal length of main axis between successive Pc is < 5 | |
| 3. Order of ramification of Pc $\leq 2^\circ$ | <i>Oryza rufipogon</i> |
| 3. Order of ramification of Pc $> 2^\circ$ | |
| 4. Papillae over arching stomata 6 | <i>Oryza glaberrima</i> |
| 4. Papillae over arching stomata 4 | <i>Oryza sativa</i> |

Tribe: Triticeae Dumort.

- | | |
|---|--------------------------|
| Costal silica cells elongate sinuous, microhairs absent | <i>Triticum aestivum</i> |
|---|--------------------------|

Tribe: Arundineae Dumort.

- | | |
|--|-----------------------------|
| 1. Costal silica cells Dumbbell shaped | <i>Arundo donax</i> |
| 1. Costal silica cells Saddle shaped | |
| 2. Rachis hairs ≥ 10 mm | <i>Phragmites australis</i> |
| 2. Rachis hairs < 10 mm | <i>Phragmites karka</i> |

Tribe: Aristideae Hubb.

- | | |
|--|------------------------------|
| 1. Inflorescence compact/cylindrical Panicle | <i>Aristida adscensionis</i> |
| 1. Inflorescence lax Panicle | |
| 2. Silica-Cork pairs present | <i>Atistida funiculata</i> |
| 2. Silica-Cork pairs absent | <i>Aristida setacea</i> |

Tribe: Eragrostideae Stapf

1. Inflorescence Panicle or Digitate
2. Inflorescence Digitate
3. Truncation of Cof on IPc present
4. IPc more than 1
5. Tubercled hairs & inter-coastal prickles present on leaf *Dactyloctenium indicum*
5. Tubercled hairs & inter-coastal prickles absent on leaf *Dactyloctenium aegypticum*
4. IPc only 1 *Dactyloctenium aristatum*
3. Truncation of Cof on IPc absent
6. Papillae present *Acrachne racemosa*
6. Papillae absent
7. Leaf margin smooth, long cells >60 μ *Eleusine indica*
7. Leaf margin angular prickled, long cells <60 μ *Eleusine coracana*
2. Inflorescence Panicle
8. Truncation of Cof on IPc present *Dinebra retroflexa*
8. Truncation of Cof on IPc absent
9. Inflorescence non homogenized
10. Spikelet 1-flowered
11. Microhairs bicellular chloris type
12. Inflorescence with verticel Pc, tubercled hairs on leaf margin
Sporobolus coromandelianus
12. Inflorescence with spiral Pc, smooth leaf margin
13. Stomata Triangular and partially covered by papillae, 2-5 papillae /cell
Sporobolus virginicus
13. Stomata tall-domed and not covered, 1 papillae /cell *Sporobolus tenuissimus*
11. Microhairs unicellular sporobolus type
14. Interstomatal silica rounded with saddle, stomata partially covered
Sporobolus marginatus
14. Interstomatal silica elongated with saddle & dumbbell, stomata not covered
15. Long cells > 70 μ *Sporobolus ioclados*
15. Long cells < 70 μ *Sporobolus diandrus*
10. Spikelet 2-many flowered
11. Panicle with spiral 1°Pc
12. Panicle compact-cylindrical, order of ramification up to 2° *Eragrostis ciliaris*
12. Panicle lax, order of ramification more than 2°

13. Microhairs panicoid type
14. Intercostal silica cells present *Eragrostis unioloides*
14. Inter costal silica cells absent *Eragrostis tremula*
13. Microhairs eragrostis type
15. Tubercled hairs present on leaf margin *Eragrostis minor*
15. Tubercled hairs absent on leaf margin
16. Silica-cork pairs present *Eragrostis papposa*
16. Silica-cork pairs absent
17. Stomata low-domed *Eragrostis nutans*
17. Stomata triangular *Eragrostis viscosa*
11. Panicle with fasciculate/pseudovertical 1°Pc
18. Inter coastal prickles present *Eragrostis japonica*
18. Inter coastal prickles absent
19. Costal silica cell dumbbell only *Eragrostis pilosa*
19. Costal silica cells saddle-cross shaped only *Eragrostis amabilis*
9. Inflorescence fully homogenized
20. Panicle condensed, head like *Aeluropus logopoides*
20. Panicle lax
21. Length of 1°Pc up to 2cm
22. Papillae present on upper epidermis, prickles absent *Desmostachya bipinnata*
22. Papillae absent, prickles present on lower epidermis *Desmostachya pingalaieae*
21. Length of 1°Pc more than 2cm
23. Internode between successive pair of spikelet is >1cm *Halopyrum mucronatum*
23. Internode between successive pair of spikelet is <1cm
24. Coastal silica bodies saddle shaped *Leptochloa fusca*
24. Coastal silica bodies dumbbell-nodular shaped *Leptochloa panicea*
1. Inflorescence Spike
25. Papillae 5-10/cell, microhairs only chloris type on both epidermises
Eragrostiella brachyphylla
25. Papillae 1-5/cell, microhairs chloris or eragrostis type, different on epidermises
26. Papillae 3-5/cell, elongate-saddle intercostal silicacells present
Tripogon jacquemontii
26. Papillae 1/cell, intercostal silica cells absent *Tripogon filiformis*

Tribe: Cynodonteae Dumort.

1. Inflorescence digitate

- 2. IPc more than 1
- 3. Truncation of Cof on IPc present
- 4. Tubercled hairs present *Cynodon barberi*
- 4. Tubercled hairs absent *Cynodon dactylon*
- 3. Truncation of Cof on IPc absent
- 5. Intercostal silica cells present, hooks absent *Enteropogon dolichostachyus*
- 5. Intercostal silica cells absent, hooks present
- 6. Intercostal prickles present *Chloris barbata*
- 6. Intercostal prickles absent
- 7. Papillae 1/cell *Chloris virgata*
- 7. Papillae 2-5/cell *Chloris quinquesetica*
- 2. IPc only 1 *Tetrapogon tenellus*
- 1. Inflorescence raceme
- 8. Inflorescence with IPc, silica bodies crescentric saddle *Melanocenchris jacquemontii*
- 8. Inflorescence without IPc, silica bodies simple saddle, dumbbell, nodular
- 9. Spikelets in pairs, tubercled hairs present on margin *Tragus mongolorum*
- 9. Spikelets solitary, tubercled hairs absent on margin
- 10. Silica cells dumbbell shaped, papillae absent, tubercled hairs present on margin *Perotis indica*
- 10. Silica cells saddle shaped, 3-7 papillae/cell, smooth margin *Zoysia matrella*

Tribe: Paniceae R. Br.

- 1. Inflorescence Panicle
- 2. Panicle with or without truncation, if truncated Pc not compact
- 3. IPc without truncation
- 4. Panicle partially homogenized
- 5. Spikelets pedicelled, unevenly dispersed on IPc *Alloteropsis cimicina*
- 5. Spikelets sessile, 2-rowed
- 6. Long cells papillate
- 7. Tubercled hairs present *Echinochloa crus-pavonis*
- 7. Tubercled hairs absent
- 8. Intercostal prickles present *Echinochloa crus-galli*
- 8. Intercostal prickles absent

9. Hooks present	<i>Echinochloa frumetacea</i>
9. Hooks absent	
10. Costal prickles present on upper epidermis	<i>Echinochloa stagnina</i>
10. Costal prickles absent on upper epidermis	<i>Echinochloa colona</i>
6. Long cells non papillate	
11. Margin with cris-cross angular prickles	<i>Moorochloa eruciformis</i>
11. Margin with unidirectional angular prickles	
12. Macrohairs with 1-2 basal cells	<i>Urochloa reptans</i>
12. Macrohairs with 3 basal cells	<i>Urochloa ramosa</i>
4. Panicle non-homogenized	
13. Macrohairs with 2-3 basal cells	<i>Panicum repens</i>
13. Macrohairs absent	
14. Papillae present on upper epidermis	
15. Papillae 1-2/cell	<i>Panicum paianum</i>
15. Papillae 3-8/cell	
16. Margin smooth	<i>Panicum psilopodium</i>
16. Margin angular prickled	
17. Internodal growth of main axis between successive Pc \geq 4-5cm	<i>Panicum paludosum</i>
17. Internodal growth of main axis between successive Pc <4-5cm	<i>Panicum sumatrense</i>
14. Papillae absent on upper epidermis	
18. Long cells deeply sinuous, Internodal growth of main axis between successive Pc \geq 4-5cm	<i>Panicum notatum</i>
18. Long cells moderately sinuous, Internodal growth of main axis between successive Pc <4-5cm	
19. Silica-cork pairs present	<i>Panicum antidotale</i>
19. Silica-cork pairs present	<i>Panicum curviflorum</i>
3. lPc with truncated Cof or HF	
20. Panicle homogenized	
21. Partial homogenized panicle	
22. Spikelets 4-rowed	<i>Eriochloa procera</i>
23. Spikelets 2-rowed	
24. Tubercled hairs and macrohairs with 2-basal cells present	<i>Urochloa panicoides</i>
24. Tubercled hairs and macrohairs with 2-basal cells absent	

25. Pc with 2° ramification, lPc only 2-4 on main axis *Urochloa distachya*
25. Pc up to 5° ramification, lPc more than 5 on main axis *Urochloa mutica*
21. Fully homogenized panicle
26. Internodal length of main axis between successive lPc more than length of lPc
Paspalidium flavidum
26. Internodal length of main axis between successive lPc less than length of lPc
Paspalidium geminatum
20. Panicle non-homogenized
27. Ramification of Pc $\leq 5^\circ$
28. Degree of ramification up to 2° only *Oplismenus burmanii*
28. Degree of ramification 4°-5° *Oplismenus compositus*
27. Ramification of Pc $> 5^\circ$
29. Panicle lax & pyramidal
30. Stomata low-tall domed, costal prickles $\geq 30\mu$ long *Setaria intermedia*
30. Stomata triangular-tall domed, costal prickles $< 30\mu$ long *Setaria plicata*
29. Panicle compact & cylindrical
31. 1° Pc verticel on main axis *Setaria verticillata*
31. 1° Pc spiral on main axis
32. Tubercled hairs present on leaf
33. Degree of ramification 7°-8° *Setaria italica*
33. Degree of ramification 3°-5° *Setaria pumila*
32. Tubercled hairs absent on leaf *Setaria parviflora*
2. Panicle truncated, truncated Pc condensed and forming cup like structure
34. Costal and intercostal prickles on both epidermises present
35. Macrohairs present *Cenchrus ciliaris*
35. Macrohairs absent
36. Intercostal silica cells absent *Cenchrus biflorus*
36. Intercostal silica cells present *Cenchrus setigerus*
34. Costal prickles on upper epidermis only, intercostal prickles absent
37. Macrohairs present
38. Macrohairs with 4-6 basal cells *Pennisetum purpureum*
38. Macrohairs with 6-10 basal cells or absent *Pennisetum polystachion*
37. Macrohairs absent
39. Silica-cork pairs absent *Pennisetum pedicellatum*
39. Silica-cork pairs present

40. Costal silica cells cubical-cross shaped	<i>Pennisetum hohenackeri</i>
40. Costal silica cells dumbbell-nodular shaped	
41. Intercostal silica cells tall narrow-cross shaped	<i>Pennisetum orientale</i>
41. Intercostal silica cells tall narrow-elongate shaped	<i>Pennisetum glaucum</i>
1. Inflorescence digitate	
42. Digitate truncated	
43. IPc more than 3	<i>Paspalum longifolium</i>
43. IPc 2-3	
44. Scales present near origin of IPc	<i>Paspalum scrobiculatum</i>
44. Scales absent near origin of IPc	
45. Intercostal silica cells present, papillae only on upper epidermis	<i>Paspalum vaginatum</i>
45. Intercostal silica cells absent, papillae on both epidermises	<i>Paspalum paspaloides</i>
42. Digitate non- truncated	
46. Spikelets all pedicelled	<i>Digitaria albudense</i>
46. Spikelets one pedicelled and one sessile	
47. Costal prickles absent	<i>Digitaria longiflora</i>
47. Costal prickles present	
48. Microhairs loudetia type	<i>Digitaria stricta</i>
48. Microhairs echinochloa type	
49. Tubercled hairs present	<i>Digitaria setigera</i>
49. Tubercled hairs absent	
50. Stomata triangular-parallel sided	<i>Digitaria violascens</i>
50. Stomata triangular-low domed	
51. Costal prickles on both epidermises	<i>Digitaria bicornis</i>
51. Costal prickles on upper epidermis only	<i>Digitaria ciliaris</i>

Tribe: Isachneae Benth.

Epidermal cells cubical-hexagonal, not differentiated in long cell & short cell

Isachne globosa

Tribe: Arundinelleae Stapf

1. Hooks and tubercled hairs present, long cells rectangular	<i>Arundinella ciliata</i>
1. Hooks and tubercled hairs absent, long cells hexagonal	<i>Arundinella pumila</i>

Tribe: Andropogoneae Dumort.

1. Inflorescence without trophotagma
2. Inflorescence non-homogenized
3. Order of ramification up to 5°
4. Macrohairs present on leaves
5. Panicle lax, pyramidal
6. Tubercled hairs present, stomata triangular only *Spodiopogon rhizophorus*
6. Tubercled hairs absent, stomata triangular & tall-domed *Spodiopogon aristatus*
5. Panicle compact, cylindrical *Imperata cylindrica*
4. Macrohairs absent on leaves
7. Spikelets in pairs, costal silica bodies dumbbell-nodular
8. Intercostal prickles absent *Capillipedium assimile*
8. Intercostal prickles present
9. Intercostal silica-cork pairs present *Capillipedium filiculme*
9. Intercostal silica-cork pairs absent *Capillipedium huegelii*
7. Spikelets in triplets, costal silica bodies cross-cubical
10. Long intercostal prickles present *Chrysopogon fulvus*
10. Long intercostal prickles absent
11. Costal prickles present on lower epidermis *Chrysopogon polyphyllus*
11. Costal prickles absent on lower epidermis
12. Hooks present on leaf epidermis *Chrysopogon serrulatus*
12. Hooks absent on leaf epidermis *Chrysopogon zizanioides*
3. Order of ramification more than 5
13. Spikelet & pedicel villous, spikelets deciduous
14. Tubercled hairs present
14. Tubercled hairs absent
15. Silica-cork pairs & costal prickles present *Saccharum officinarum*
16. Interlocking prickles present on lower epidermis *Saccharum spontaneum*
16. Prickles present but not interlocking one *Saccharum ravennae*
15. Silica-cork pairs & costal prickles absent *Saccharum bengalense*
13. Spikelet & pedicel pubescent, at least sessile spikelets persistent
2. Inflorescence homogenized
14. Inflorescence raceme *Pogonatherum paniceum*
14. Inflorescence panicle
15. Papillae present on leaf epidermises

16. Prickles present on both epidermises
17. Long macrohairs present
18. Macrohairs with 2-basal cells *Arthraxon lancifolius*
18. Macrohairs with 6-8-basal cells
19. Silica-cork pairs present, margin with angular prickles *Arthraxon inermis*
19. Silica-cork pairs absent, margin with tubercled hairs *Arthraxon lanceolatus*
17. Long macrohairs absent
20. Margin with tubercled hairs, papillae absent *Arthraxon hispidus*
20. Margin with angular prickles, papillae present *Arthraxon nudus*
16. Prickles present only on lower epidermis
21. Papillae on lower epidermis 4-8/cell
22. Tubercled hairs absent on leaves *Bothriochloa pertusa*
22. Tubercled hairs present on leaves
23. Intercostal silica cells & hooks present *Dimeria stapfiana*
23. Intercostal silica cells & hooks absent *Dimeria ornithopoda*
21. Papillae on lower epidermis 0-1/cell
24. Papillae absent on lower epidermis *Dichanthium caricosum*
24. Papillae absent on lower epidermis
25. Hooks present *Dichanthium mccannii*
25. Hooks absent *Dichanthium annulatum*
15. Papillae absent on leaf epidermises
26. Costal prickles present on both epidermises *Ischaemum afrum*
26. Costal prickles present on upper epidermis only
27. Tubercled hairs present, intercostal silica cells absent *Eulalia fimbriata*
27. Tubercled hairs absent, intercostal silica cells present *Eulalia trispica*
1. Inflorescence with trophotagma
28. At least one spikelet bisexual
29. Involucral spikelets present on proximal part of raceme
30. Papillae 1/cell
31. Hooks present on lower epidermis *Iseilema laxum*
31. Hooks absent on lower epidermis *Iseilema prostratum*
30. Papillae numerous/cell
32. Papillae scattered in cell, costal prickles present on both epidermises *Themeda triandra*
32. Papillae scattered in cell, costal prickles present on both epidermises

33. Leaf margin with tubercled hairs *Themeda laxa*
33. Leaf margin with Angular prickles
34. Stomata triangular only *Themeda tremula*
34. Stomata triangular-low domed *Themeda quadrivalvis*
29. Involucral spikelets absent on raceme
35. Raceme with only one IPc
36. Internodal length of 1° more than 2 cm
37. Tubercled macrohairs present
38. Papillae on both epidermises small & numerous *Ischaemum indicum*
38. Papillae on lower epidermis only, 2-8/cell in one row
39. Microhairs zizania type only on both epidermises
39. Microhairs of different types on different epidermises
40. Microhairs of panicoid type present
41. Hooks present on epidermises
42. Microhairs chloris + panicoid type on lower epidermis, panicoid type on upper epidermis
- Ischaemum rugosum*
42. Microhairs chloris type on lower epidermis, panicoid type on upper epidermis
- Ischaemum santapaui*
41. Hooks absent on epidermises *Ischaemum sayajiraoi*
40. Microhairs of panicoid type absent *Ischaemum muticum*
37. Tubercled macrohairs absent
43. Prickles on upper epidermis present *Ischaemum diplopogon*
43. Prickles on upper epidermis absent
44. Microhairs chloris type only on both epidermises *Ischaemum barbatum*
44. Microhairs of different types on different epidermises
45. Microhairs of chloris & zizania types *Ischaemum semisegettatum*
45. Microhairs of chloris & panicoid types
46. Intercostal silica cells present on lower epidermis *Ischaemum travancorense*
46. Intercostal silica cells absent on lower epidermis *Ischaemum bombaiense*
36. Internodal length of 1° more than 2 cm
47. Costal prickles & hooks present
48. Microhairs zizania type, papillae on lower epidermis present
- Cymbopogon martinii*
48. Microhairs panicoid type, papillae on lower epidermis absent
- Cymbopogon flexuosus*

47. Costal prickles & hooks absent *Andropogon pumilus*
35. Raceme with sPc only, lPc absent
48. Spikelets in triplets *Apluda mutica*
48. Spikelets in pairs
49. Raceme with 2-3 pairs of sPc only *Pseudoanthriscia heteroclita*
49. Raceme with more than 3 pairs of sPc only
50. Pedicelled spikelet truncated *Apocopis vaginatus*
50. Pedicelled spikelet well developed
51. Papillae present on leaf epidermises
52. Papillae only 1/cell, large & completely covered stomata *Dichanthium foveolatum*
52. Papillae 1-numerous, not at all covered stomata
53. Intercostal silica cells & tubercled macrohairs present, papillae 1/cell *Heteropogon contortus*
53. Intercostal silica cells & tubercled macrohairs absent, papillae numerous/cell *Heteropogon ritchei*
51. Papillae absent on leaf epidermises
54. Tubercled hairs on margin present
55. Long macrohairs present
56. Silica-cork pairs present
57. Number of raceme per node less than 5
58. Tubercled hairs present on epidermises *Glyphochloa forficulata*
58. Tubercled hairs absent on epidermises
59. Leaves amphistomatic *Sehima nervosum*
59. Leaves hypostomatic *Sehima sulcatum*
58. Number of raceme per node more than 5 *Mnesithea granularis*
56. Silica-cork pairs absent *Mnesithea clarkei*
55. Long macrohairs absent *Ophiuros exaltatus*
54. Tubercled hairs on margin absent
60. Hooks present, costal prickles absent *Ophiuros exaltatus*
60. Hooks absent, costal prickles present *Rottboellia cochinchinensis*
35. All spikelets unisexual
61. Inflorescence bisexual
62. Bract remain herbaceous throughout
63. Female spikelets 2-3 at proximal of axial inflorescence and terminal male inflorescence panicle *Trilobachne cookie*

63. Female spikelet only one at proximal of axial inflorescence and terminal male inflorescence raceme *Chionachne koenigii*
62. Bract forming the nutty involucre around female spikelet
64. Costal prickles with sharp pointed tip & frequent *Coix aquatica*
64. Costal prickles with blunt tip & occasional *Coix lacryma-jobi*
61. Inflorescence unisexual *Zea mays*

Family: Cyperaceae Juss. (Based on Inflorescence architecture, Glume & Achene morphology and Foliar Micromorphology)

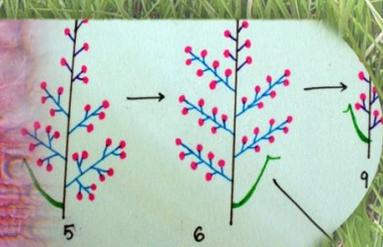
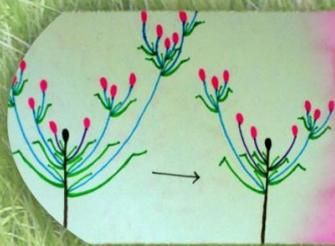
1. Inflorescence Paniculodium
2. Spikelets unisexual *Scleria parvula*
2. Spikelets bisexual
3. Mesophyll cells astroporous gives different appearance of stomata, culm trigonous, perianth scales absent *Fuirena cuspidata*
3. Mesophyll cells reticulately arranged gives different appearance of stomata, culm terete, 3 perianth scales present *Fuirena ciliaris*
1. Inflorescence other than Paniculodium
4. Inflorescence Anthelodium
5. Inflorescence terminal
6. Anthelodium fasciculte *Bulbostylis barbata*
6. Anthelodium lax
7. Glumes spirally arranged
8. Perianth scales present
9. Perianth scales ribbon like *Eriophorum comosum*
9. Perianth scales retroely barbed *Bulboschoenus maritimus*
8. Perianth scales absent
10. Anthelodium decompounds
11. Prickles present, silica bodies 2/cell, conical *Fimbristylis littoralis*
11. Prickles absent, silica bodies absent
12. Achene trigonous, leaf blades well developed *Fimbristylis quinquangularis*
12. Achene lenticular, leaf blades absent *Fimbristylis umbellaris*
10. Anthelodium simple-compound
13. Prickles present *Fimbristylis tenera*
13. Prickles absent
14. Leaf margin hairy *Fimbristylis ovata*
14. Leaf margin angular prickled
15. Papillae 1-2/cell *Fimbristylis ferruginea* var. *ferruginea*
15. Papillae absent
16. Anthelodium compound *Fimbristylis cymosa*
16. Anthelodium simple
17. Spikelets on inflorescence 2-4 only *Fimbristylis merrillii*

17. Spikelets on inflorescence more than 4
18. Stomata on lower epidermis are marginal only *Fimbristylis bisumbellata*
18. Stomata on lower epidermis spread all over
19. Stomata parallel-low domed, silica bodies nodular *Fimbristylis alboviridis*
19. Stomata triangular- low domed, silica bodies absent *Fimbristylis ferruginea*
7. Glumes distichously arranged
20. Only 2 flower per spikelet *Courtoisina cyperoides*
20. More than 2 flowers per spikelet
21. Achene trigonous & dorsi-ventral compressed
22. Prickles present
23. Prickles present on both epidermises *Cyperus involucratus*
23. Prickles present only on upper epidermises
24. Stomata 0-3 rowed between veins
25. Margin smooth
26. Inflorescence with 1° Pc only
27. Silica bodies conical with satellites *Cyperus squarrosus*
27. Silica bodies conical only *Cyperus paniceus*
26. Inflorescence with more than 1° Pc
28. Silica bodies present *Cyperus compactus*
28. Silica bodies absent *Cyperus rotundus* Subsp. *retzii*
25. Margin angular prickled
29. Anthelodium congested *Cyperus bulbosus*
29. Anthelodium lax
30. Anthelodium simple *Cyperus microiria*
30. Anthelodium decomounds *Cyperus pangorei*
24. Stomata 3-6 rowed between veins
31. Silica bodies conical with satellites *Cyperus nutans* var. *nutans*
31. Silica bodies absent
32. Anthelodium congested *Cyperus nutans* var. *eleusinoides*
32. Anthelodium lax
33. Glumes acute *Cyperus corymbosus*
33. Glumes mucronate
34. Glumes up to 15 per spikelet *Cyperus exaltatus* var. *exaltatus*
34. Glumes more than 15 per spikelet *Cyperus dives*
22. Prickles absent

35. Margin smooth
36. Anthelodium simple
37. Anthelodium congested *Cyperus arenarius*
37. Anthelodium lax *Cyperus compressus*
36. Inflorescence compound
37. Glomerules of spikelets present *Cyperus pulcherrimus*
37. Glomerules of spikelets absent
38. Silica bodies conical at situation of anticlinal walls *Cyperus esculentus*
38. Silica bodies conical only *Cyperus alulatus*
35. Margin angular prickled
39. Silica bodies present
40. Silica bodies nodular, stomata low domed-parallel *Cyperus tenuispica*
40. Silica bodies of long cells, stomata triangular *Cyperus iria*
39. Silica bodies absent
37. Glomerules of spikelets present *Cyperus difformis*
37. Glomerules of spikelets absent
38. Stomata low domed-triangular *Cyperus tuberosus*
38. Stomata low domed *Cyperus rotundus* Subsp. *rotundus*
21. Achene lenticular & laterally compressed
39. Inflorescence congested *Queenslandiella hyalina*
39. Inflorescence lax
40. Silica bodies conical only
41. Long cells rectangular-cubical, stomata triangular-low domed *Pycnus pumilus*
41. Long cells rectangular, stomata low domed only
42. Plants up to 15cm only, inflorescence compact anthelodium *Pycnus membranaceus*
42. Plants more than 15cm, inflorescence simple anthelodium *Pycnus malabaricus*
40. Silica bodies conical with satellites
43. Inflorescence simple anthelodium only, glumes yellow-straw coloured *Pycnus flavidus*
43. Inflorescence capitate or simple anthelodium, glumes red coloured *Pycnus sanguinolentus*
5. Inflorescence pseudolateral
44. Perianth scales present *Schoenoplectus litoralis* subsp. *thermalis*
44. Perianth scales absent *Schoenoplectiella lateriflora*

4. Inflorescence other than anthelodium
45. Inflorescence is of spikes
46. Inflorescence spike of spikelets *Kyllinga bulbosa*
46. Inflorescence unispicate
47. Inflorescence pseudolateral *Fimbristylis ovata*
47. Inflorescence terminal
48. Glumes arranged distichously, bracts foliaceous
49. Stomata triangular *Kyllinga brevifolia*
49. Stomata low-domed *Cyperus pygmaeus*
48. Glumes arranged spirally, bracts glumaceous or absent
50. Leaf blades well developed, flat
51. Silica bodies conical, 2-4/cell *Fimbristylis polytrichoides*
51. Silica bodies absent *Fimbristylis schoenoides*
50. Leaf blades absent
52. Perianth scales absent *Fimbristylis tetragona*
52. Perianth scales present
53. Perianth scales smaller than achene *Eleocharis atropurpurea*
53. Perianth scales longer than achene
54. Spike up to 0.7cm, glumes 0-1 nerved *Eleocharis geniculata*
54. Spike more than 0.7cm, glumes 7-11 nerved *Eleocharis dulcis*
45. Inflorescence capitate
46. Glumes arranged distichously *Cyperus pygmaeus*
46. Glumes arranged spirally
47. Perianth scales absent *Fimbristylis argentea*
47. Perianth scales present
48. Inflorescence terminal *Rhynchospora wightiana*
48. Inflorescence pseudolateral
49. Inflorescence at proximal node on terete culm, perianth scales absent *Schoenoplectiella articulata*
49. Inflorescence at distal node on triquetrous culm, perianth scales present *Schoenoplectiella mucronata*

Chapter: 7



7.1 Documentation and Distribution

Floral diversity of grasses and sedges in south Gujarat is relatively high. Shah (1978) has recorded a total of 241 species belonging to 95 genera of poaceae and 112 species belonging to 11 genera of cyperaceae. During the course of time author is able to collect 182 grasses and 63 sedge species, of which 153 grasses and 59 sedges considered to be native as they were mentioned in the Gujarat flora. The ISS index for family Poaceae (1.04) and Cyperaceae (0.74) indicate the high similarity with the native flora of Gujarat state point out that, even after the addition and deletion of number of species, there is no change in the basic composition (native flora) of the study area.

New species described:

During the course of present study, lots of specimens were matching with any other known species and hence they were sent to the various experts from different institutions along with detailed descriptions and illustrations for confirming their identity. As a result, two of those were found to be new to plant science. These are:

1. *Ischaemum sayajiraoi* Raole & R. J. Desai (Raole & Desai, 2011c)
2. *Spodiopogon aristatum* R. J. Desai & Raole (Desai & Raole, 2012)

Other additions:

As mentioned earlier a detailed of newly collected specimens lead to certain very interesting findings. As per present study there are 4 species from Cyperaceae and 24 species from Poaceae are being reported for the first time from the state (Desai & Raole, 2010a, 2011a, 2011b, 2011d) and are listed here:

Family Cyperaceae

1. *Fimbristylis umbellaris* (Lam.) Vahl
2. *Fimbristylis merrillii* Kern
3. *Fuirena wallichiana* Kunth.
4. *Cyperus rotundus* ssp. *retzii* Kük.

Family Poaceae

5. *Arthraxon nudus* (Nees ex Steudel) Hochstette
6. *Arundinella ciliata* Nees ex Miq.
7. *Coix aquatica* Roxb.
8. *Dactyloctenium aristatum* Link

9. *Dichanthium mccannii* Blatter
10. *Digitaria violascens* Link.
11. *Dimeria stapfiana* C.E.Hubb. ex Pilger.
12. *Echinochloa crus-pavonis* Schultes (H. B. & K.) Schultes
13. *Eragrostis papposa* (Desf. ex Roem. & Schult.) Steud.
14. *Eulalia fimbriata* (Hack.) O. Ktze.
15. *Glyphochloa forficulata* (Fischer) W. D. Clayton
16. *Ischaemum bombaiense* Bor
17. *Ischaemum muticum* L.
18. *Ischaemum travancorense* Stapf ex Fischer
19. *Oryza latifolia* Desv.
20. *Oryza glaberrima* Steud.
21. *Panicum paianum* Naik & Patunkar
22. *Panicum repens* L.
23. *Phragmites australis* (Cav.) Trin. ex Steud.
24. *Saccharum ravennae* (L.) L.
25. *Sporobolus ioclados* (Trin.) Nees
26. *Sporobolus minutiflorus* Link.
27. *Setaria plicata* (Lam.) T. Cooke
28. *Tripogon filiformis* Nees ex Steud

Rediscovery

Moreover, during this investigation I could able to collect -

1. *Sporobolus tenuissimus* (Schrank.) Kuntze
2. *Saccharum ravennae* L.

Former one noticed and collected from all the districts of south Gujarat and later one found on the road sides of Surat, Tapi and Valsad districts. Both are believed to be rediscovery after @ 50 and 100 years respectively.

7.2 Synflorescence Architecture

Morphological and developmental studies of vegetative and reproductive forms or structures are essential to interpret the characteristic pattern in the plant world. By keeping this view in mind here structure of the Synflorescence has been analyzed for grasses and sedges in adult inflorescence and numerous variations has been observed. Diversity in their structure is the

result of the developmental processes and pattern due to meristematic activities at different level, and is finally determines the no., size and the arrangement of different branches.

In Poaceae, the general inflorescence structure is a compound spike. The so-called spikelets are spikes in the general inflorescence terminology. Grass inflorescences are so diverse because of the arrangement of spikelets into complex inflorescences. The spikelets can be arranged in spikes or racemes, or, again, in more complex patterns, such as forming a “panicle” of spikelets. Such panicles of spikelets are also common in Cyperoideae of Cyperaceae.

In grasses, truncation is a very common process which is frequently associated with homogenization, and both processes account for much of the diversity among grass inflorescences. However, while most inflorescences show varying degrees of homogenization in Cyperaceae, truncation is not common in this family. In those few species of Cyperaceae where truncation does occur, inflorescences are homogenized. Although, the truncation and homogenization of HF, lPc as well as sPc leads to synflorescence; the development of trophotagma (bracts and prophylls) can be considered as a prime importance for the evolutionary processes.

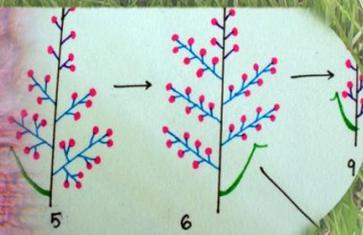
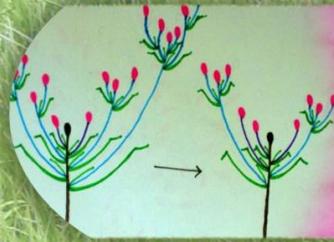
The broad diversity shown by inflorescences can be explained by the analysis of some processes that operate in different ways, either combined or independently. The paniculodium appears to be the basic structure from which all the other forms were derived. Out of that processes like- reduction/elongation of the internodes, branch development, reduction/development of foliar structures, homogenization and truncation of HF & Pc are mainly responsible for the structure and evolution of synflorescence within the family/tribe/genus. Although evidence seems to show that reduction is the most frequent way of modification in the inflorescences (UIF), the possibility of the occurrence of amplification processes within or between taxonomic groups must not be neglected.

Mature inflorescences are seen only at a single stage of development, and this may not be sufficient to understand their morphological diversification and relationships. Therefore, it may be preferable to look for homologies during the development of an inflorescence rather than in the mature form. To define developmental homologies and to evaluate evolutionary diversification, we must trace developmental characters based on an explicit phylogenetic hypothesis. Accurate assessments of developmental and phylogenetic homology will impact estimates of the inflorescence diversification as well as our perception of the evolutionary processes through which they have arisen. Hence, the detailed developmental and molecular studies are warranted.

7.3 Foliar Micromorphology

In all totality 63 species of sedges are studied here, out of them 32 members has been mentioned in earlier works by any context. Therefore, 31 are considered to be studied for the first time for their foliar micromorphological characterization. Likewise, out of 182 species of poaceae studies, reference for @90 (± 5) were mentioned in the earlier works and rest other 90 are also considered to be studied for the first time for their foliar micromorphological characterization. Even references for genera like *Scleria*, *Schoenoplectiella*, *Glyphochloa*, *Trilobachne*, *Eragrostiella*, *Pogonatherum*, *Pseudoanthristria* (even not in sedge/Grass genera of the world) were also not available, and are reported for the first time.

Chapter: 8



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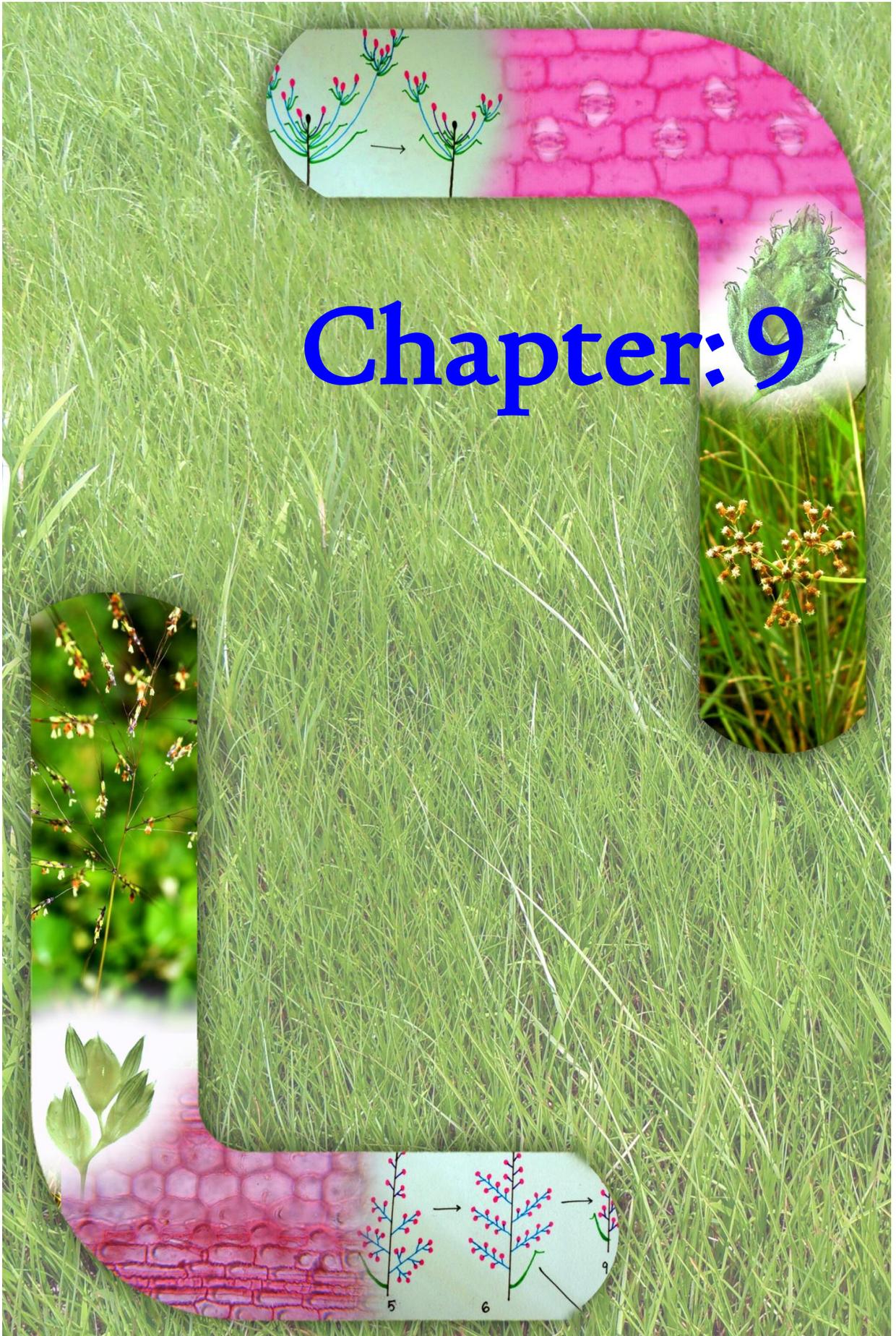
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(Note: *Original not Referred)

Chapter: 9



Appendix 1: Latitude, Longitude and Elevation reading for the localities visited

Locality	Latitude, Longitude and Elevation	Locality	Latitude, Longitude and Elevation
Dangs			
Junu devdahad	N20 48.023 E73 35.456 179m	Gadvihir	N20 45.589 E73 54.233 601 m
kudkas	N20 47.357 E73 31.150 145m	Kalibel	N20 54.854 E73 35.371 198 m
Chichi- gaontha	N20 47.355 E73 31.294 150m	Kanja	N21 15.531 E73 22.399 73 m
Kukadnakhi	N20 48.062 E73 32.112 168m	Karadiamba	N20 46.261 E73 54.502 630 m
Nadagkhadi	N20 48.182 E73 36.461 205m	Lavchali	N20 52.209 E73 45.262 319 m
Pimpri	N20 47.540 E73 34.590 184m	Mahal	N20 54.930 E73 40.289 223 m
Waghai	N20 45.573 E73 29.551 120m	Karanjwel	N21 00.638 E73 27.542 131 m
Ahwa	N20 39.493 E73 45.142 479m	Kotamba	N20 48.738 E73 44.957 457 m
Bhavandagad	N20 46.485 E73 37.113 193m	Netrang gam	N21 16.034 E73 01.997 43 m
Bhawadi	N20 48.180 E73 32.110 179m	Nimpada	N20 45.491 E73 55.074 628 m
Chiktia	N20 47.521 E73 37.157 189m	Ranikhet	N20 46.195 E73 44.549 513 m
Devdahad	N20 48.550 E73 36.131 192m	Pipaldahad	N20 53.774 E73 49.047 375 m
Ambapada	N20 44.479 E73 30.012 135 m	Pandva	N20 44.718 E73 49.416 552 m
Barkhandia	N20 41.308 E73 30.546 159 m	Singhana	N20 58.537 E73 47.301 395 m
Chirapada	N20 46.161 E73 40.033 322 m	Subir	N20 55.698 E73 46.440 421 m
Jakhana	N20 37.438 E73 44.314 459 m	Sabridham temple	N20 55.579 E73 48.441 471 m
Kahadolghodi	N20 39.444 E73 45.210 485 m	Waghai	N20 46.131 E73 30.258 157 m
Bharadi	N20 46.067 E73 48.273 658 m	Maharaichond	N20 40.184 E73 39.301 323 m
Gadad	N20 44.588 E73 54.711 616 m	Nanapada	N20 41.384 E73 33.412 181 m
Bhujad	N20 57.241 E73 36.342 302 m	Nani waghai	N20 44.025 E73 29.597 125 m
Bhenskatri	N20 56.407 E73 32.023 141 m	Saputara	N20 37.264 E73 43.201 518 m
Dhubadia	N20 52.763 E73 45.631 278 m	Shamgahan	N20 37.279 E73 43.204 514 m
Girmal fall	N20 58.348 E73 43.339 300 m	Sakarpatal	N20 41.302 E73 30.542 159 m
Chinchli	N20 44.479 E73 52.229 623 m	Bardipada	N20 58.584 E73 37.441 199 m

Surat & Tapi

Alvu	N21 03.155 E73 11.274	44 m	Aasarma	N21 27.406 E73 03.672	68 m
Anaval	N20 52.496 E73 15.591	76 m	Baleshwar	N21 07.385 E72 58.401	28 m
Bhimpor	N21 04.862 E72 43.934	10 m	Bilwan	N21 25.635 E73 34.697	262 m
Dumas	N21 04.864 E72 42.830	13 m	GIPCLBrick station	N21 23.998 E73 07.003	54 m
Gothan	N21 17.760 E72 51.990	4 m	Jab village grazing	N21 17.668 E73 12.356	94 m
Hajira	N21 05.600 E72 38.568	8m	Kathwada rlwy tract	N21 26.815 E72 59.680	62 m
Hansot	N21 34.090 E72 48.992	10 m	Limbervan	N21 26.350 E73 31.007	236 m
Kamroli	N21 25.199 E72 42.415	7 m	Kukeri	N20 48.695 E73 11.313	76 m
Karchelia	N20 58.562 E73 09.502	39 m	Mandan	N21 27.361 E73 20.568	158 m
Kawas	N21 10.723 E72 40.044	18 m	Nandol	N21 26.345 E73 15.556	110 m
Mahamadpor	N21 20.727 E72 45.569	5 m	Pada	N21 27.680 E73 21.757	140 m
Mahuva	N21 01.413 E73 08.743	35 m	Panvadi	N21 05.431 E73 23.209	85 m
Mandroi	N21 26.058 E72 43.993	8 m	Mosali	N21 27.756 E73 06.237	73 m
Mindhi	N21 23.126 E72 42.028	7 m	Pataldevi	N21 26.477 E73 15.534	129 m
Mora	N21 09.628 E72 38.421	20 m	Tadkeshwardegraded	N21 22.080 E73 04.507	55 m
Pardi	N20 30.524 E72 56.788	28 m	Unai	N20 51.366 E73 20.192	90 m
Soyani	N21 08.505 E73 01.782	24 m	Tadkeshwar-mandvi	N21 22.328 E73 03.043	36 m
Sunwali	N21 09.788 E72 37.251	10 m	Venjali	N21 26.666 E73 29.805	234 m
Tarsadi	N21 03.144 E73 07.944	39 m	Kakarapar Backside	N21 14.006 E74 19.453	77 m
Umara	N20 53.990 E73 15.111	73 m	Vadpada	N21 25.082 E73 36.222	277 m
Vanta	N21 05.791 E72 43.587	9 m	Kadodara	N21 10.874 E72 57.838	23 m
Ghamroad	N19 30.936 E73 00.210	30 m	Amlidem	N21 24.497 E73 23.617	140 m
Bijalwadi	N21 31.127 E73 26.568	190 m	Narayanpura	N21 16.418 E73 49.649	138 m
Bunadha	N21 24.644 E73 23.455	109 m	Nevala	N21 28.087 E74 06.368	142 m
Chandrabala	N21 34.112 E73 05.170	38 m	Umargot	N21 26.251 E73 30.570	233 m
Gopalia	N21 25.475 E73 25.170	144 m	Umarkhadi	N21 34.417 E73 22.481	125 m
Kevdi	N21 34.252 E73 26.462	159 m	Umarpada	N21 27.220 E73 28.450	213 m
Limdha	N21 23.261 E73 22.001	89 m	Varjakhan	N21 15.030 E73 17.293	37 m
Kadod Tapi bank	N21 13.208 E73 13.174	56 m	Wadi	N21 34.578 E73 21.215	105 m
Bardoli-unai	N20 57.823 E73 29.837	130	Valia	N21 34.208 E73 09.341	53 m

Navsari						
Pipalgabhan	N20 42.110 E73 05.337	23 m		Karad	N20 50.233 E72 56.271	7 m
Alipore	N20 45.830 E73 03.456	22 m		Kothmadi	N20 55.137 E72 51.264	10 m
Aeru	N20 55.293 E72 53.961	28 m		Kumbhalav	N20 50.594 E72 50.579	0 m
Gatudia khadi	N20 54.550 E72 49.442	14 m		Matwad	N20 55.022 E72 49.270	9 m
Khara Abrama	N20 50.922 E72 54.774	32 m		Motikarad	N20 50.400 E72 56.226	7 m
Matwad	N20 55.101 E72 49.536	8 m		Onjal	N20 50.332 E72 50.452	0 m
Moti Pethan	N20 55.212 E72 52.648	16 m		Pethan	N20 55.128 E72 52.270	15 m
Sarav	N20 50.495 E72 55.660	20 m		Punee	N20 54.396 E73 04.504	26 m
Kharsad	N20 50.426 E72 55.817	18 m		Salej	N20 54.018 E72 58.316	12 m
Aat	N20 52.787 E72 51.446	10 m		Samapor	N20 54.076 E72 48.442	4 m
Aat	N20 53.347 E72 51.870	19m		Gatudia khadi	N20 54.559 E72 49.148	10 m
Abrama	N20 51.479 E72 54.271	7 m		Samarawadi	N20 49.179 E72 58.558	6 m
Aeru	N20 55.184 E72 54.058	13 m		Samrolee	N20 45.377 E73 02.231	12 m
Amalsad	N20 48.389 E72 57.206	11 m		Vedcha	N20 54.044 E72 58.018	11 m
Andhkeshwar	N20 49.326 E72 57.010	13 m		Chikhli	N20 46.461 E73 03.445	27 m
Ashtgam	N20 54.384 E73 04.392	29 m		Dabhlai	N20 54.395 E73 04.502	26 m
Bhunvadi	N20 54.384 E73 04.549	31 m		Dandi	N20 53.190 E72 48.214	0 m
Bhunwadi	N20 54.318 E73 04.123	25 m		Dandi beach	N20 53.131 E72 47.563	3 m
Butlav	N20 54.106 E73 03.453	28 m		Italva	N20 55.380 E72 54.224	14 m
Kanera-Masa	N20 48.547 E72 53.255	10 m		Juha	N20 54.415 E73 00.357	13 m
Valsad						
Udwada	N20 29.357 E72 51.809	13 m		Kharvel	N20 37.183 E73 05.831	44 m
Tarmalia	N20 28.483 E73 04.150	40 m		Mandwa	N20 23.040 E73 09.647	112 m
Talavchora	N20 43.469 E73 03.412	22 m		Pathree(2)	N20 34.798 E72 58.543	55 m
Segva	N20 37.482 E73 02.237	34 m		Pathree (1)	N20 34.604 E72 59.260	71 m
Sarigam	N20 16.254 E72 50.268	36 m		Pindwal	N20 29.528 E73 20.906	518 m
Paria	N20 24.386 E72 58.023	65 m		Ranvery	N20 30.022 E73 19.861	501 m
Pathree(1)	N20 34.359 E72 59.250	24 m		Sadakpore	N20 44.328 E73 04.738	25 m
Rabdee	N20 28.481 E73 01.152	40 m		Sindhubar	N20 31.047 E73 15.791	122 m

Vaskui	N20 58.056 E73 09.795	43 m	Ukta	N20 30.405 E73 17.751	408 m
Chawsala	N20 20.601 E73 15.185	388 m	Vad	N20 40.732 E73 05.617	28 m
Dabkhal	N20 20.571 E73 14.502	359 m	Vankal	N20 34.723 E73 11.645	85 m
Dungri	N20 42.000 E72 59.236	49 m	Wilson hill	N20 30.404 E73 21.139	609 m
Gotan	N20 20.177 E73 15.356	408 m	Dharasana	N20 41.348 E72 55.355	13 m
Kaprada	N20 20.719 E73 11.246	348 m	Dholai	N20 43.969 E72 54.321	4 m
Kumbharia	N20 30.512 E72 59.190	31 m	Dungari	N20 41.601 E72 56.995	22 m
Mandwa	N20 23.040 E73 09.647	113 m	Goiyadi-Bhathl	N20 44.681 E72 57.192	34 m
Matuniya	N20 21.675 E73 11.246	128 m	Kakwadi	N20 42.432 E72 54.557	42 m
Nanapondha	N20 24.357 E73 08.003	75 m	Sarikhurd	N20 47.556 E72 57.173	14 m
Sukhesh	N20 29.710 E73 01.157	41 m	Utadi	N20 42.044 E72 55.079	18 m
Ambatalat	N20 34.648 E73 13.412	95 m	Atgam	N20 38.240 E73 01.556	27 m
Arnai	N20 26.456 E73 08.614	67 m	Balda	N20 30.385 E72 58.106	26 m
Barumal	N20 31.550 E73 13.897	98 m	Nani pathree	N20 34.354 E72 59.250	23 m
Dharampur	N20 32.172 E73 10.137	32m	Ohond	N20 44.582 E72 57.002	2 m
Gardia	N20 34.067 E73 00.884	41 m	Panchlai	N20 30.077 E73 00.136	32 m
Kakadkuva	N20 27.453 E73 08.879	59 m	Motichanvai	N20 33.560 E72 58.164	20 m
Karanjwerry	N20 33.441 E73 11.985	76 m	Bhilad	N20 16.252 E72 53.017	29 m
Kadavia	N20 22.042 E72 50.374	8 m	Dhanoli	N20 16.251 E72 53.016	29 m
Parnera bottom	N20 33.351 E72 56.884	49 m	Fanasakaladu	N20 18.421 E72 50.272	47 m
Parnera foothill	N20 33.436 E72 56.880	49 m	Gadria	N20 34.350 E72 59.257	24 m
Parnera middle	N20 33.141 E72 56.914	153 m	Ghej	N20 42.074 E73 03.292	22 m
Parnera top	N20 32.992 E72 56.893	204 m	Gundlav	N20 37.359 E73 01.436	31 m
Jampor	N20 22.401 E72 49.358	0 m	Bagwada, Arjungadh	N20 25.822 E72 54.987	23 m

Appendix 2 District & Tehsil wise Occurrences of Grasses

G. No	Sp. No.	Taxon name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Subfamily: Bambusoideae Asch. & Graeb.																												
A	Tribe : Bambuseae Nees.																											
		Subtribe: Bambusinae Presl																										
1	1	<i>Bambusa arundinacea</i> (Retz.) Willd.	✓	✓	✓				✓													✓		✓		✓	✓	
2	2	<i>Dendrocalamus strictus</i> (Roxb.) Nees	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
B	Tribe: Oryzeae Dumort.																											
3	3	<i>Hygrorhiza aristata</i> (Retz.)Nees ex W.& A.					✓		✓	✓						✓					✓							
4	4	<i>Oryza glaberrima</i> Steud.	✓	✓	✓																							
5	5	<i>Oryza latifolia</i> Desv.	✓	✓	✓		✓	✓	✓																			
	6	<i>Oryza rufipogon</i> Griff.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	7	<i>Oryza sativa</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Subfamily: Pooideae Macfarlane & Watson																												
C	Tribe: Triticeae Dumort.																											
6	8	<i>Triticum aestivum</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
D	Tribe: Arundineae Dumort.																											
7	9	<i>Arundo donax</i> L.										✓	✓		✓													
8	10	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.										✓	✓	✓	✓	✓	✓				✓							
	11	<i>Phragmites karka</i> (Retz.) Trin. ex Steud.										✓	✓															
E	Tribe: Aristideae Hubb.																											
9	12	<i>Aristida adscensionis</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	13	<i>Atistida funiculata</i> Trin. & Rupr.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	14	<i>Aristida setacea</i> Retz.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Subfamily: Chloridoideae Rouy																												
F	Tribe: Eragrostideae Stapf																											
		Subtribe: Monanthochloinae Potztal																										
10	15	<i>Aeluropus logopoides</i> (L.) Trin. ex Thwaites						✓				✓	✓	✓	✓													

		Subtribe: Anthistiriinae Presl																							
63	163	<i>Heteropogon contortus</i> (L.) P. Beauv. Ex R. & S.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	164	<i>Heteropogon ritchei</i> (Hk. f.) Blatter & McCann		✓	✓																				
64	165	<i>Iseilema laxum</i> Hack.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	166	<i>Iseilema prostratum</i> (L.) Andersson	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
65	167	<i>Pseudoanthriscia heteroclita</i> (Roxb.) Hk. f.	✓	✓	✓			✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓	
66	168	<i>Themeda laxa</i> (Andersson) A. Camus	✓	✓	✓											✓	✓	✓	✓			✓	✓	✓	✓
	169	<i>Themeda quadrivalvis</i> (L.) Ketz.														✓	✓					✓	✓	✓	✓
	170	<i>Themeda tremula</i> (Nees ex Steud.) Hack.	✓	✓	✓				✓	✓														✓	✓
	171	<i>Themeda triandra</i> Forssk.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Subtribe: Rootboelliinae Presl																							
67	172	<i>Glyphochloa forficulata</i> (C. E. C. Fisch.) Clayton	✓																						
68	173	<i>Hemarthria compressa</i> (L.f.) R.Br.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
69	174	<i>Mnesithea clarkei</i> (Hack.) Blatt. & McCann		✓																					
	175	<i>Mnesithea granularis</i> (L.) Kuntze	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
70	176	<i>Ophiuros exaltatus</i> (L.) Kuntze	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
71	177	<i>Rottboellia cochinchinensis</i> (Lour.) Clayton	✓																						
		Subtribe: Tripsacinae Dumort.																							
72	178	<i>Zea mays</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Subtribe: Chionachninae Clayton																							
73	179	<i>Chionachne koenigii</i> (Spreng.) Thwaites	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
74	180	<i>Trilobachne cookie</i> (Stapf) Schenck ex Henr.	✓																						
		Subtribe: Coicinae Reichenb.																							
75	181	<i>Coix aquatica</i> Roxb.	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓								
	182	<i>Coix lacryma-jobi</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

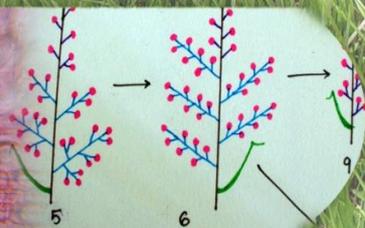
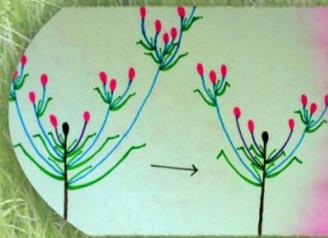
Appendix 3 District & Tehsil wise Occurrences of Sedges

G. No	Sp. No.	Taxon name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Subfamily: Cyperoideae																												
Tribe: Cypereae																												
1	1	<i>Courtoisina cyperoides</i> (Roxb.) Soják	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
2	2	<i>Cyperus alulatus</i> J. Kern	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	3	<i>Cyperus arenarius</i>				✓	✓	✓				✓	✓	✓	✓													
	4	<i>Cyperus bulbosus</i> Vahl.															✓	✓	✓	✓	✓	✓	✓	✓				
	5	<i>Cyperus compactus</i> Retz.						✓																				
	6	<i>Cyperus compressus</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	7	<i>Cyperus corymbosus</i> Rottb.	✓	✓					✓											✓			✓			✓	✓	
	8	<i>Cyperus difformis</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	9	<i>Cyperus dives</i> Delile																	✓	✓	✓	✓	✓	✓				
	10	<i>Cyperus esculentus</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	11	<i>Cyperus exaltatus</i> var. <i>exaltatus</i> Retz.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	12	<i>Cyperus involucratus</i> Vahl.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	13	<i>Cyperus iria</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	14	<i>Cyperus microiria</i> Steud.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	15	<i>Cyperus nutans</i> var. <i>eleusinoides</i> (Kunth) Haines	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	16	<i>Cyperus nutans</i> var. <i>nutans</i> (Kunth) Haines	✓						✓							✓	✓											
	17	<i>Cyperus pangorei</i> Rottb.	✓	✓					✓											✓			✓			✓	✓	
	18	<i>Cyperus paniceus</i> (Rottb.) Boeckeler	✓						✓																			
	19	<i>Cyperus pulcherrimus</i> Willd. ex Kunth																					✓					
	20	<i>Cyperus pygmaeus</i> Rottb.				✓					✓	✓					✓	✓					✓			✓		
	21	<i>Cyperus rotundus</i> Subsp. <i>retzii</i> Kük.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	22	<i>Cyperus rotundus</i> Subsp. <i>rotundus</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	23	<i>Cyperus squarrosus</i> L.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Tribe: Scirpeae																							
8	51	<i>Eleocharis atropurpurea</i> (Retz.) Presl	✓	✓																			
	52	<i>Eleocharis geniculata</i> (L.) R. & S.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	53	<i>Eleocharis dulcis</i> (Burm. f.) Trin.					✓				✓							✓	✓	✓	✓	✓	
9	54	<i>Eriophorum comosum</i> Wall. ex Nees	✓																		✓		✓
10	55	<i>Bulboschoenus maritimus</i> (L.) Palla				✓	✓	✓		✓	✓	✓	✓	✓	✓	✓							
11	56	<i>Fuirena ciliaris</i> (L.) Roxb.	✓	✓	✓				✓	✓							✓	✓		✓	✓		✓
	57	<i>Fuirena cuspidata</i> Knuth.	*																				
12	58	<i>Schoenoplectus litoralis</i> subsp. <i>thermalis</i> (Trab.) S.S.Hooper					✓	✓						✓	✓	✓	✓						
13	59	<i>Schoenoplectiella articulata</i> (L.) Lye				✓	✓					✓	✓										
	60	<i>Schoenoplectiella lateriflora</i> (Gmel.) Lye					✓					✓	✓	✓									
	61	<i>Schoenoplectiella mucronata</i> (L.) J.Jung & H.K.Choi																			✓		
Subfamily: Caricoideae																							
Tribe: Sclerieae																							
14	62	<i>Scleria parvula</i> Steud.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tribe: Rhynchosporaeae																							
15	63	<i>Rhynchospora wightiana</i> (Nees) Steud.	✓	✓	✓				✓									✓	✓	✓	✓	✓	✓

**Fuirena cuspidata* collected from Vadodara District

Chapter: 10



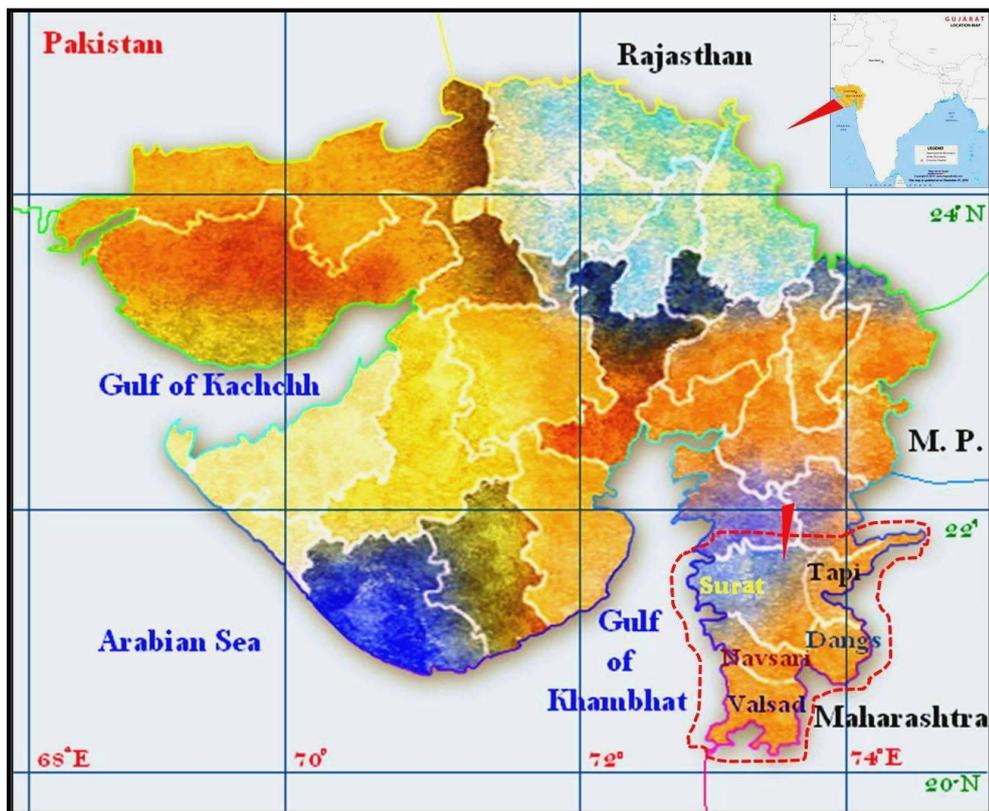


Figure 1: Map of Gujarat state showing relative position of Study Area

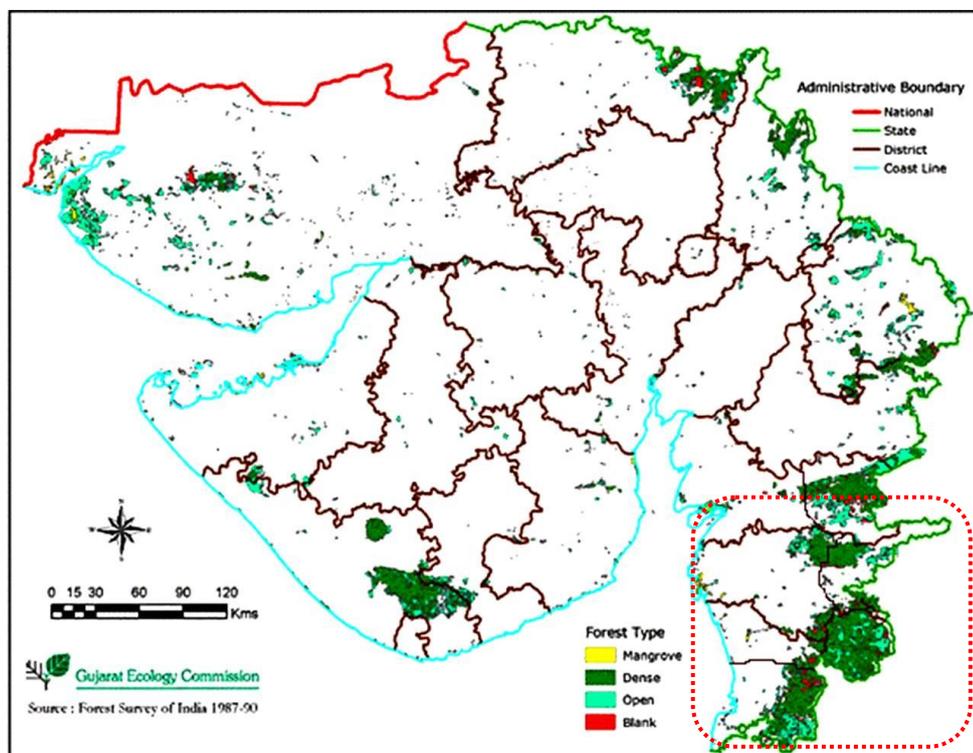


Figure 2: Forest Cover in Gujarat (Forest Survey of India 1987-90)

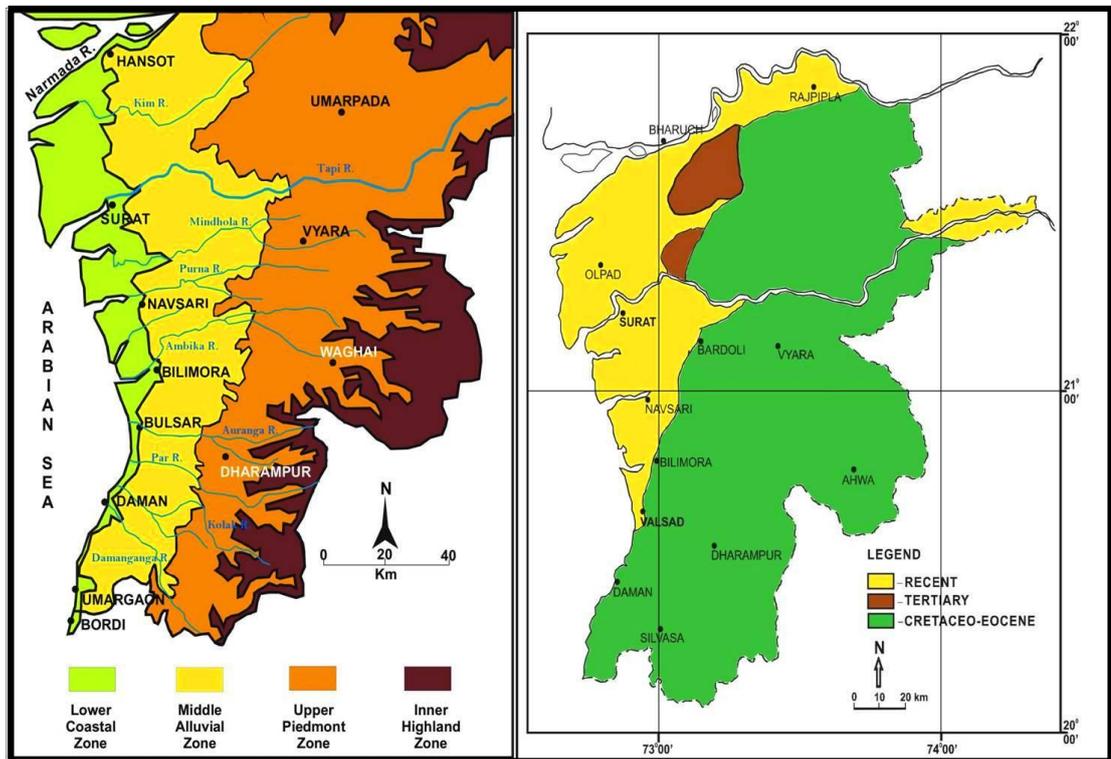


Figure 1: Rivers and topographic map of South Gujarat (Left), Geological Map of South Gujarat (Right) (after GSI, 1986)

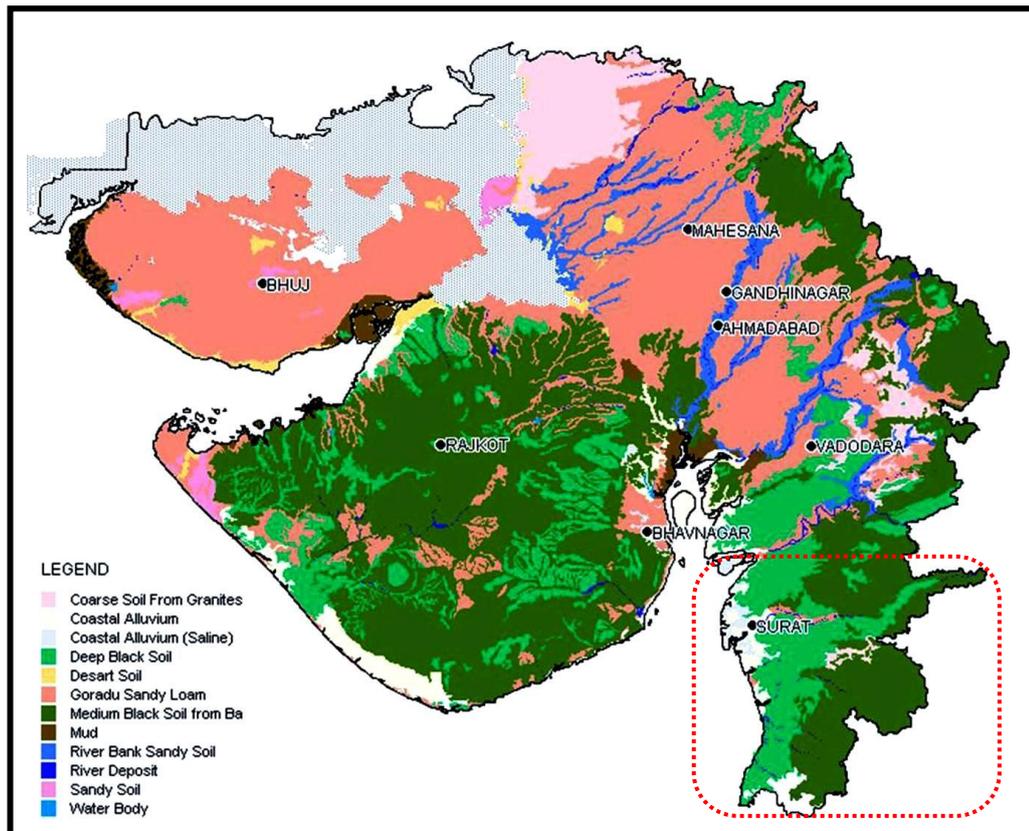
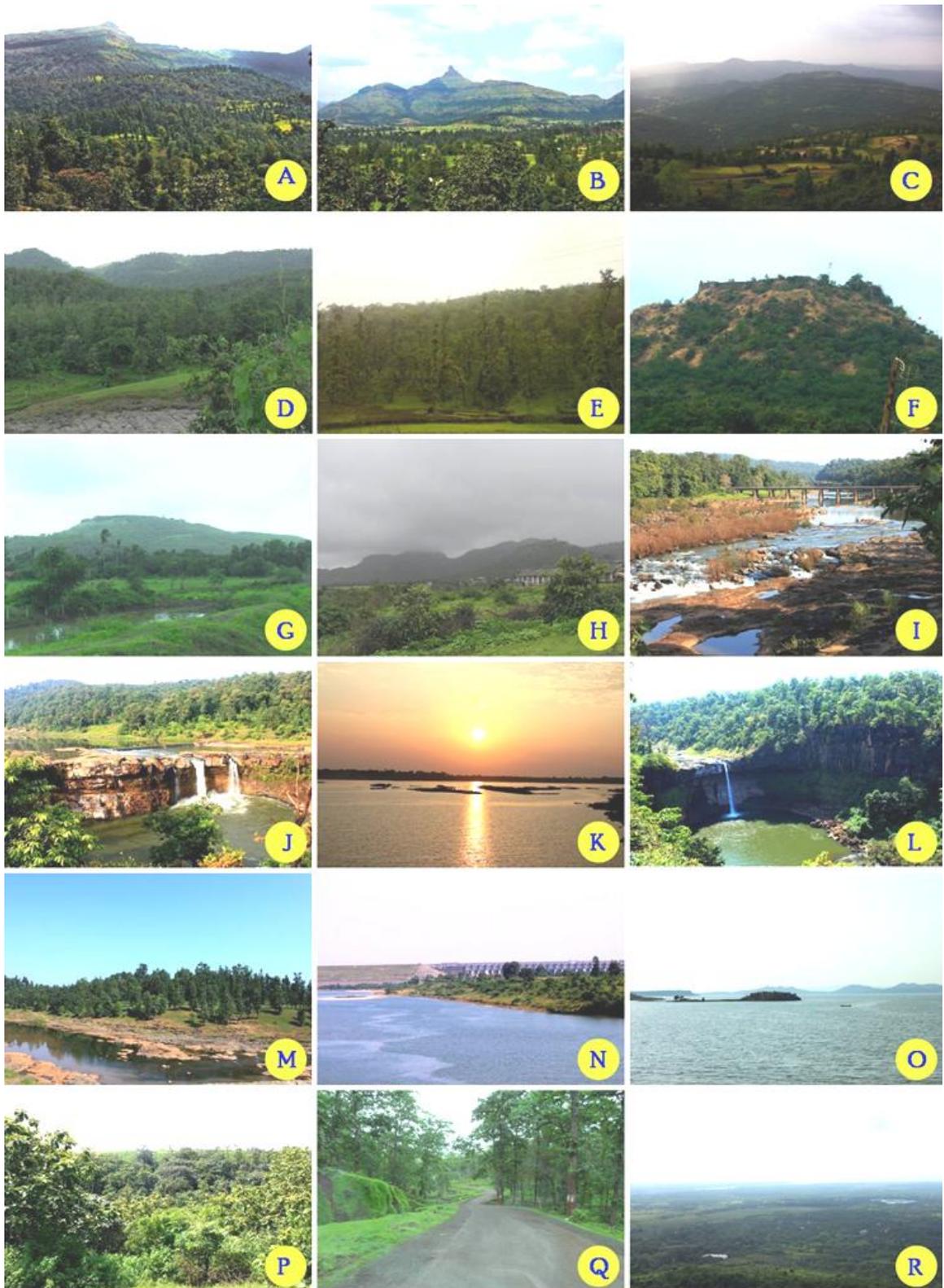
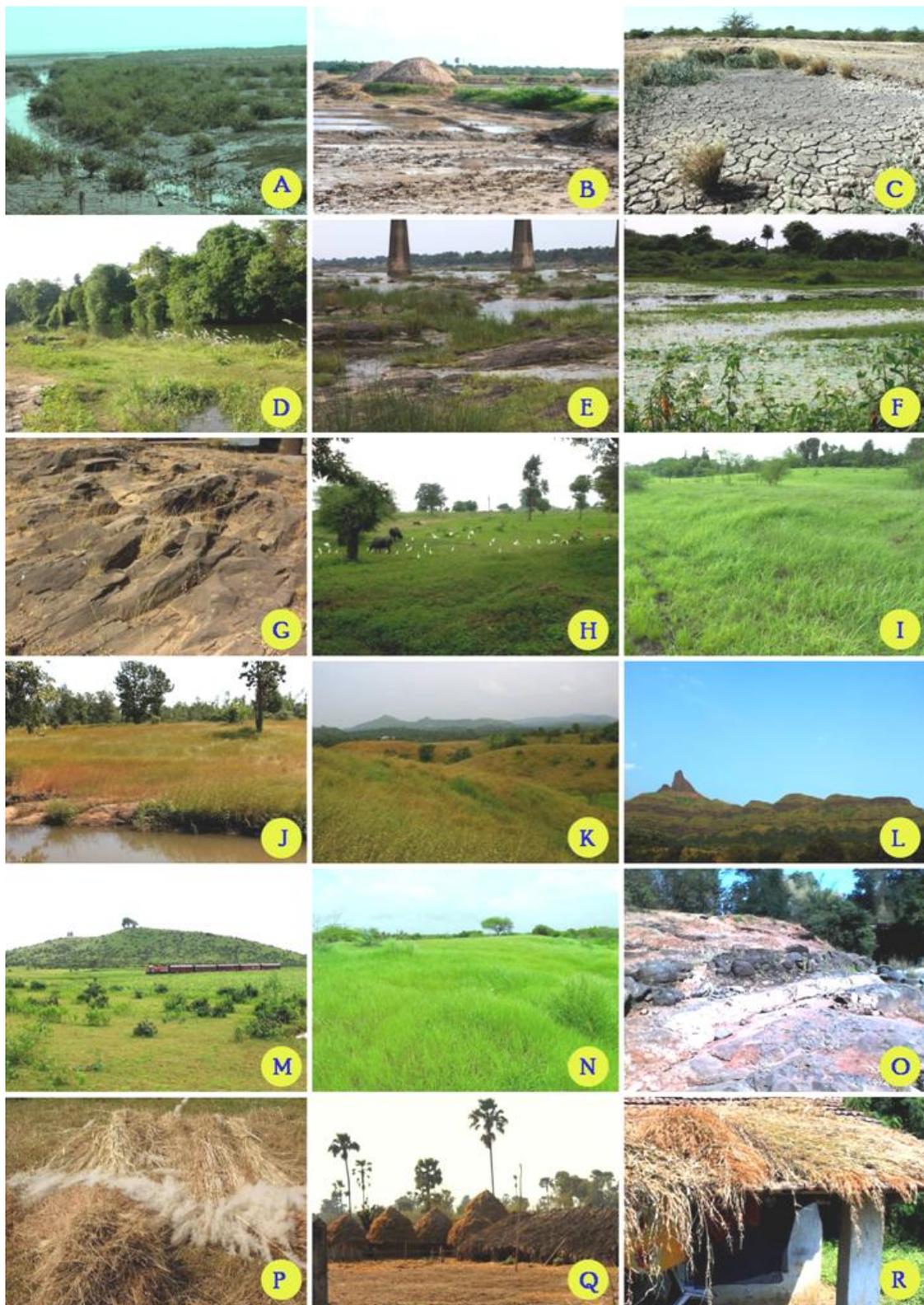


Figure 2: Soil Map of Gujarat State

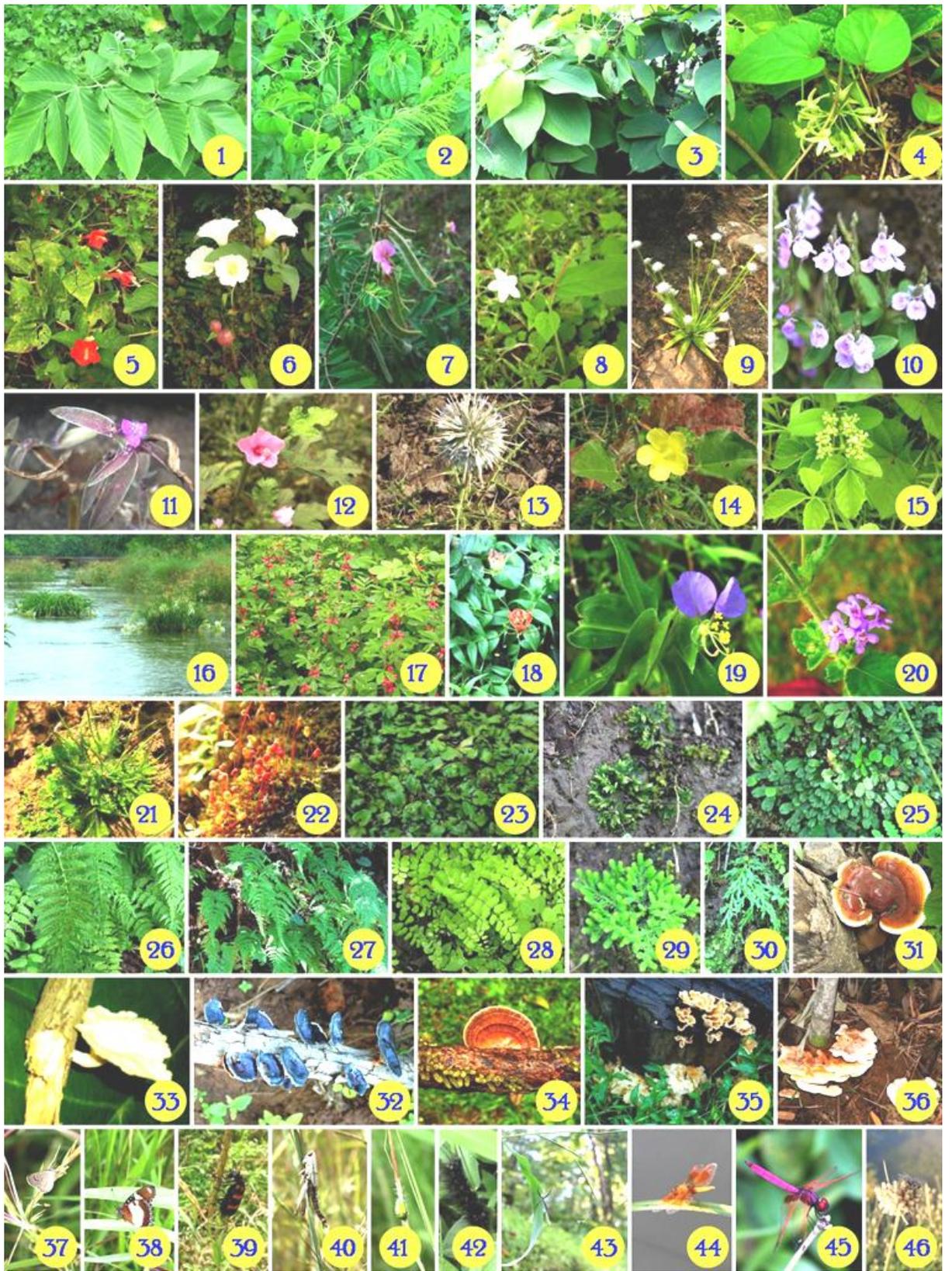


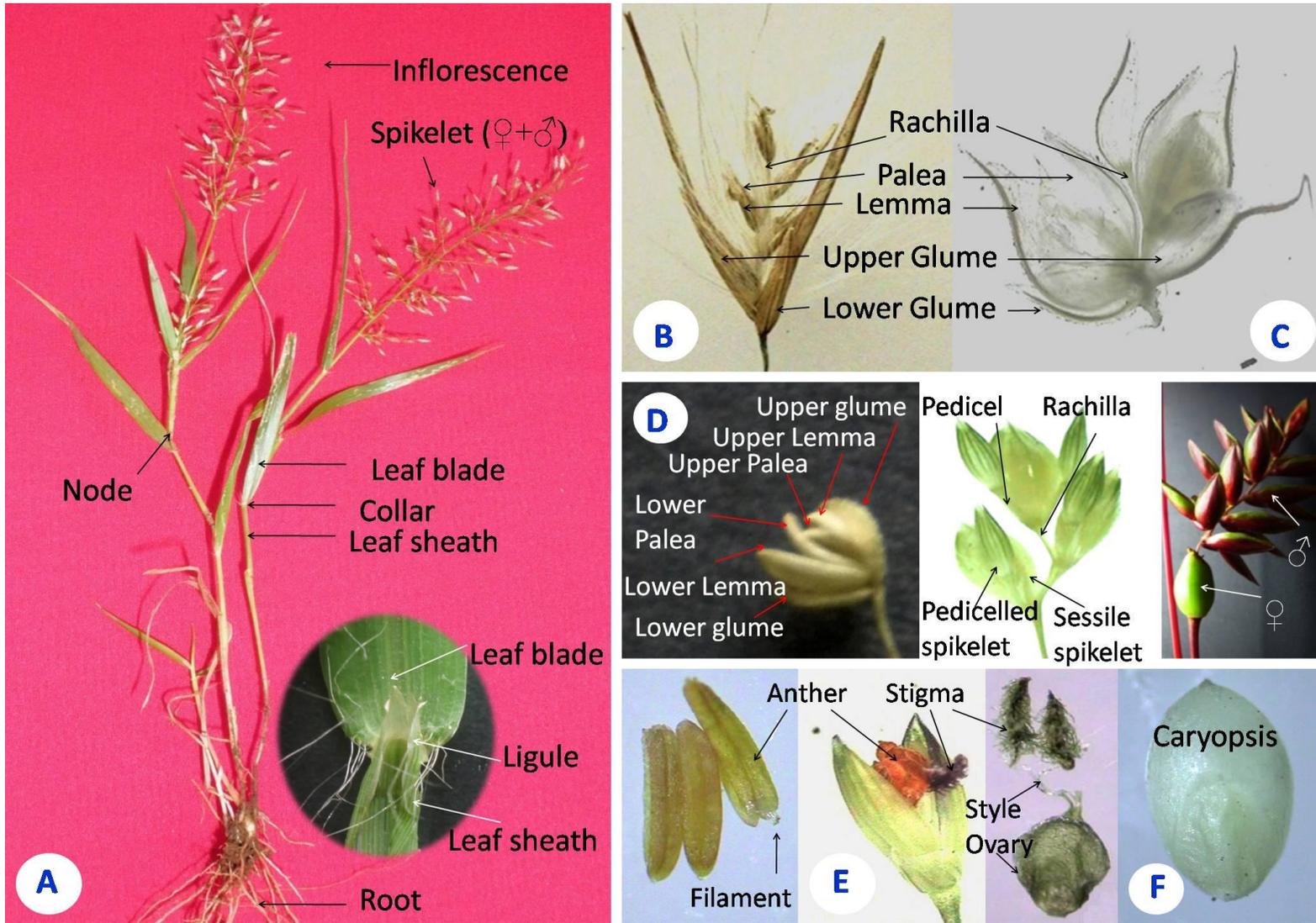
A, B D & F: Moist deciduous forest in Dangs, C: Moist deciduous forest view from Wilson hills, Dharmpur, F: Dry deciduous forest of Songarh, G & H: Moist deciduous forest at Saputara hills, I: Dry deciduous forest near Khapri river, Dangs, J: Gira Waterfall, K: Sunset at Nizar River Tapti, L: Girmal Waterfall, M: Teak Forest at the banks of river Ambika, N: Ukai Dam on river Tapti, O: Ukai Reservoir in river Tapti, P: Mixed deciduous forest on Parnera hill, Q: Road side forest in Dangs, D: Panoramic view of Valsad from Parnera hills



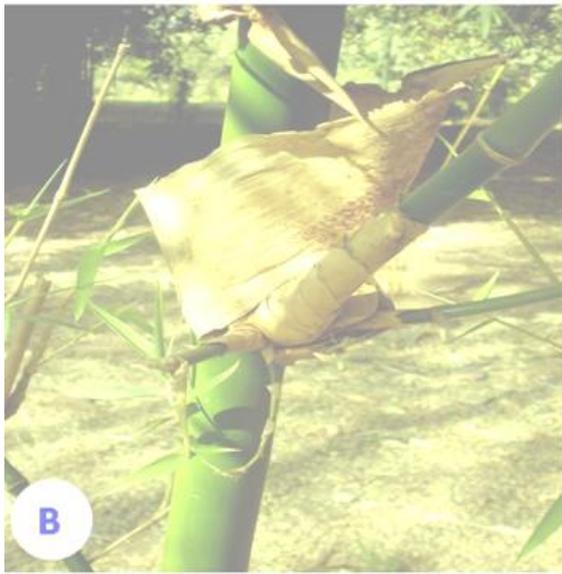
A: Mangroove forest at Dumas, Surat; B: Salt pans at Dharasana, Valsad; C: *Leptochloa fusca* in saline habitat at Mandroi, Surat; D: Rivarine vegetation of Mindhola river; E: Sedges and grasses on riverbed of Tapti at Mandvi, Surat; F: Vegetation around Pond at Anaval; G: Pre monsoon view of rocky riverbed of Ambika; H-I: Early monsoon grasslands- H: Umarpada, Surat, I: Pardi, Valsad; J-L: Post monsoon grasslands- J: Girmal, Dangs, K: Karajwerry, Valsad, L: grassy hilltops at Chinchli, Dangs; M-N: Mid monsoonal grasslands- M: Umarpada, Surat, N: Samapor, Navsari; O: Dangs in Summer; P-Q: Drying of grasses for Forage- *Saccharum spontaneum*, *Themeda* spp, *Ischaemum* spp.



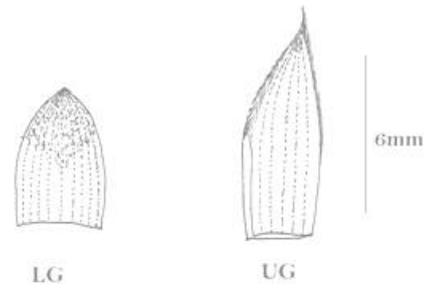
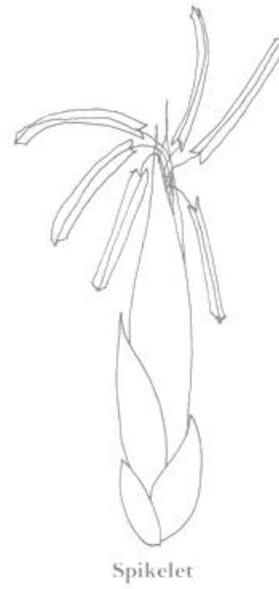




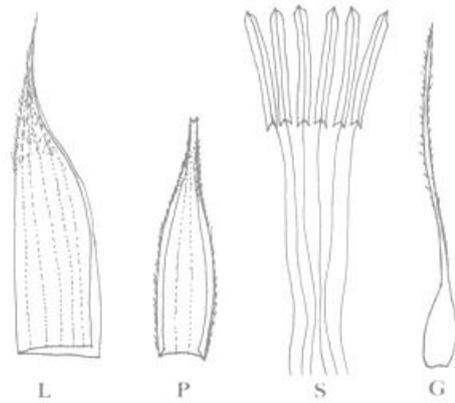
A. Habit of Grass plant; **B & C.** Arundinoid and Chloridoid spikelet showing various parts of florets (Glumes, lemma, palea & rachilla); **D.** Panicoid and Andropogonoid spikelets and unisexual spikelet of *Coix* (left to right); **E.** Parts of flower, Stamens and Pistil; **F.** Caryopsis



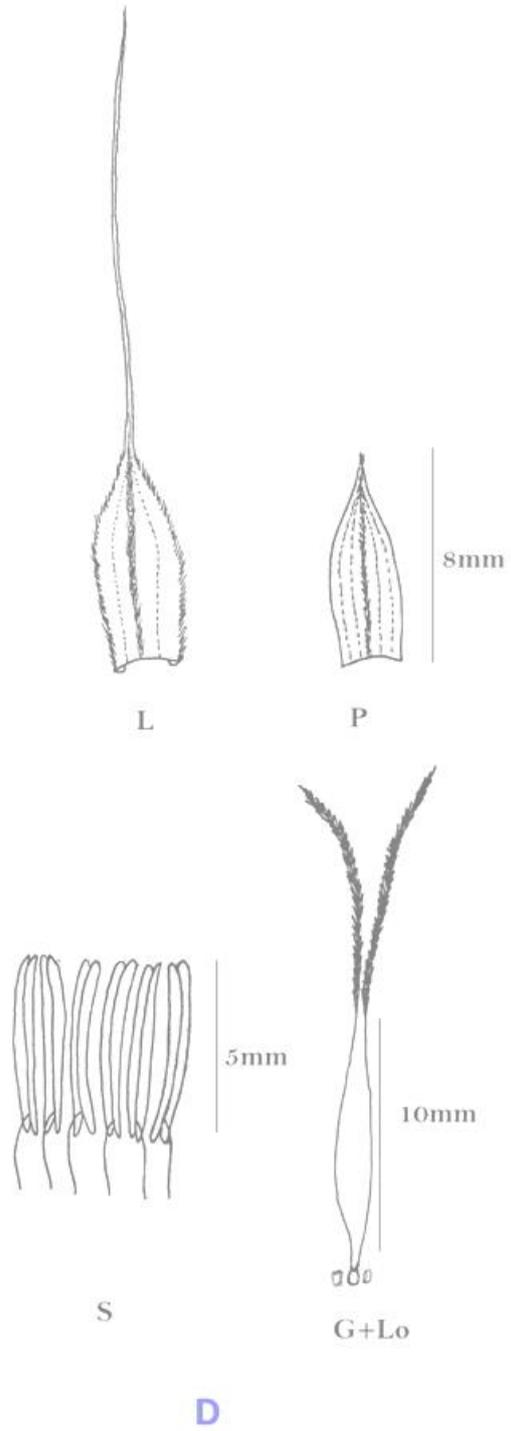
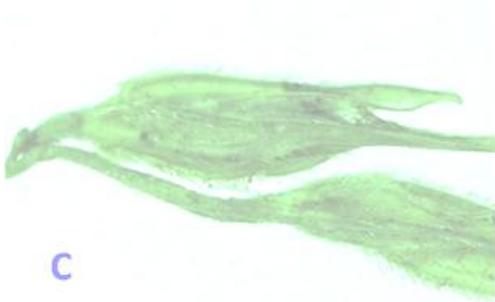
A: Habit; B&C: Close-up of Bracts; D: Infected fungi; E: Culm base covered with roots



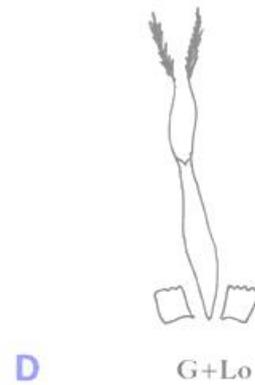
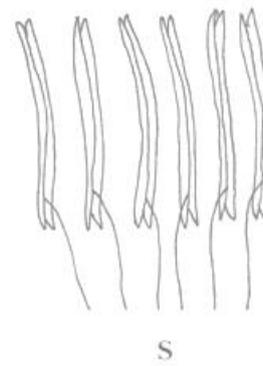
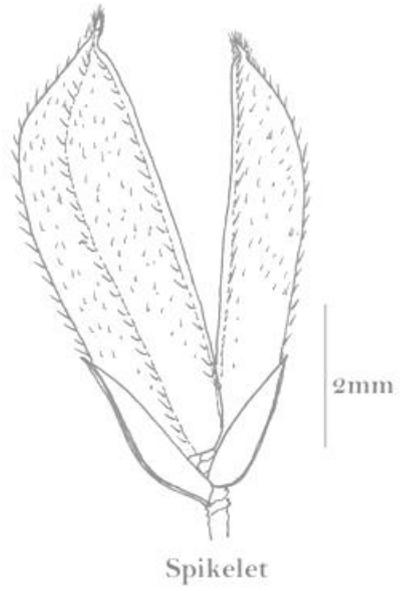
D



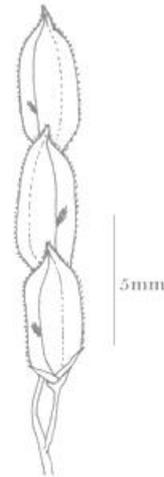
A: Habit; B: Close-up of Inflorescence; C: Leaf base details; D: Line drawing



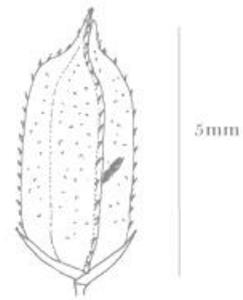
A: Habit; B: Close-up of Inflorescence; C: Spikelet; D: Line drawing



A: Habit; B: Drying of paddy after cultivation in field; C: Close-up of Inflorescence; D: Line drawing

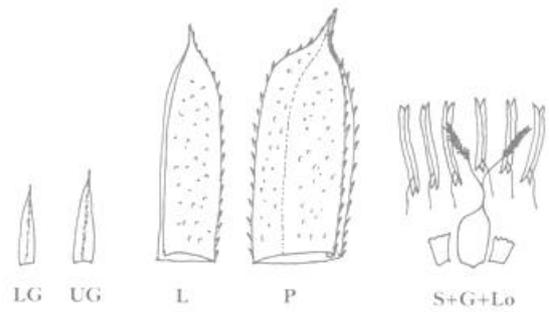


Part of Inflorescence

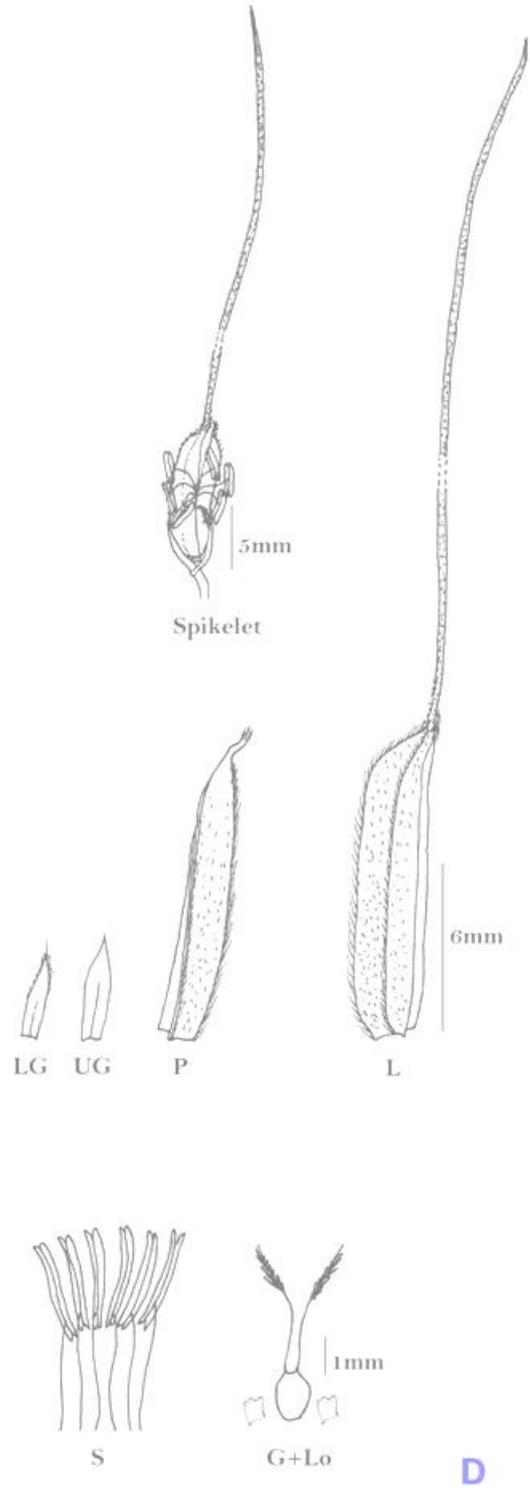


Spikelet

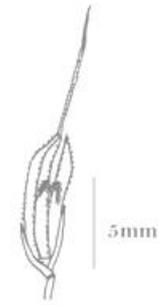
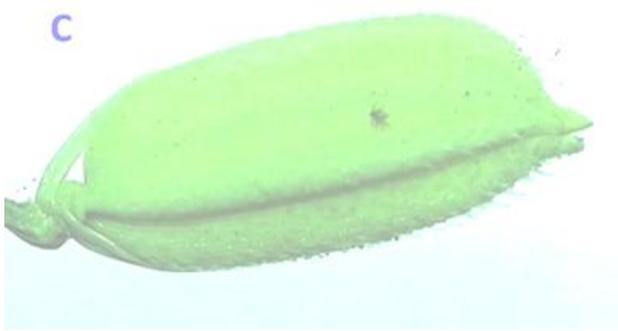
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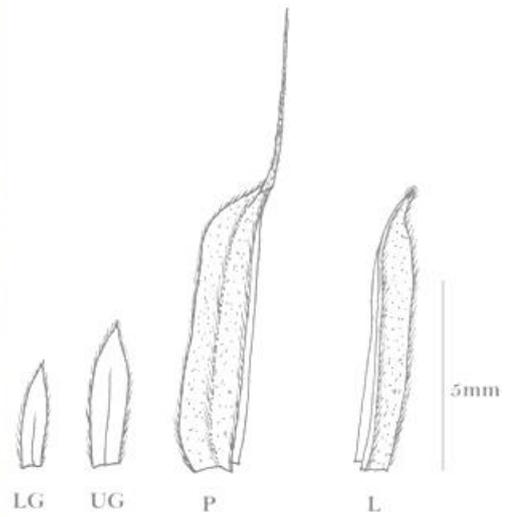
A: Habit; B: Inflorescence; C: Spikelet; D: Line drawing



A: Habit; B: Spikelet; C: Close-up of Inflorescence; D: Line drawing



Spikelet



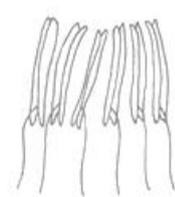
LG

UG

P

L

5mm



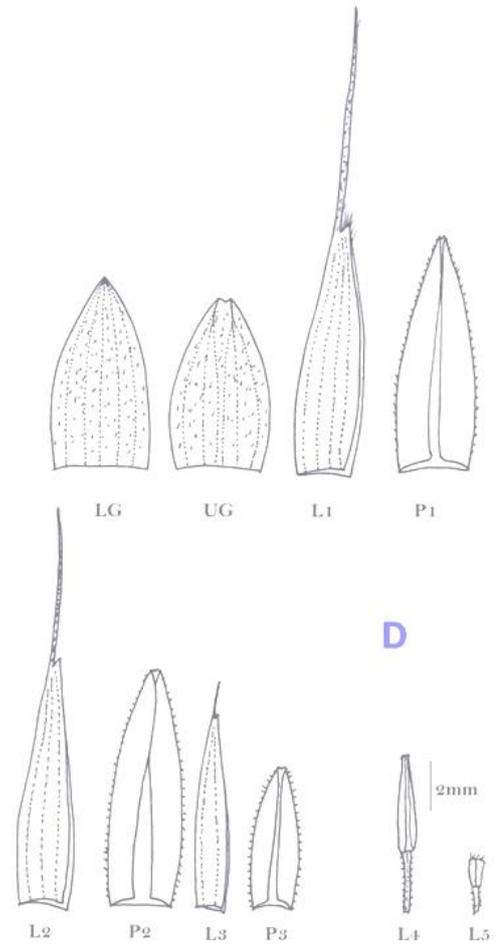
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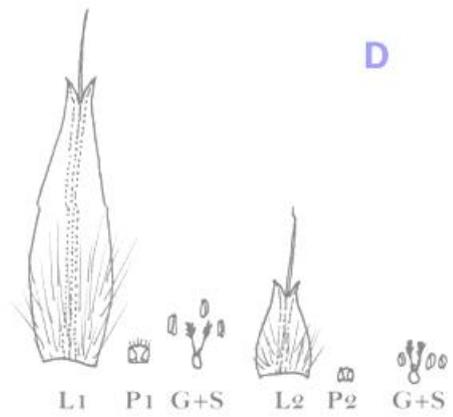
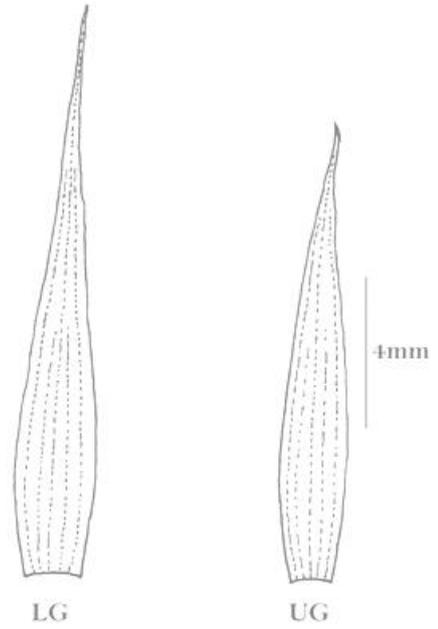
G+Lo

D

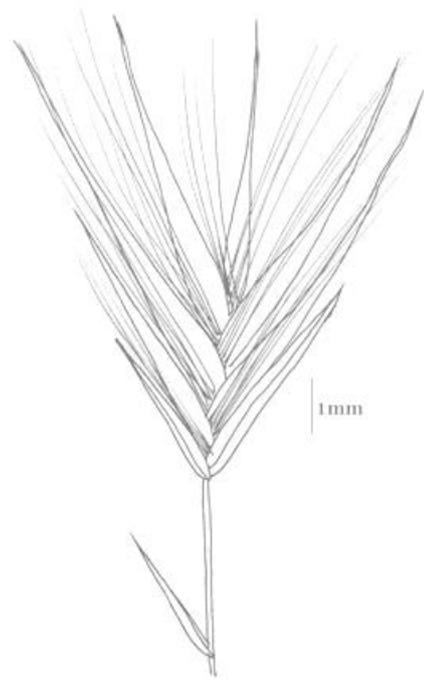
A: Habit; B: Inflorescence; C: Spikelet; D: Line drawing



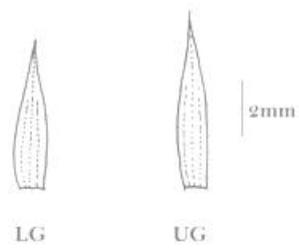
A&B: Habit; C: Inflorescence; D: Line drawing



A: Habit; B: Close-up of Inflorescence; C: Extra-vaginal shoot; D: Line drawing



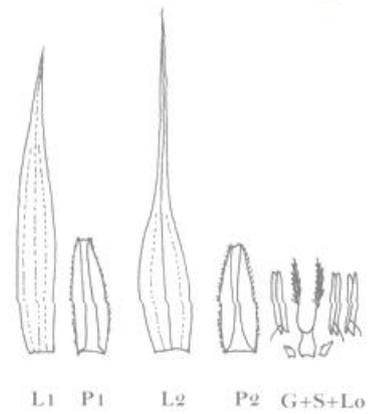
Spikelet



LG

UG

D



L1

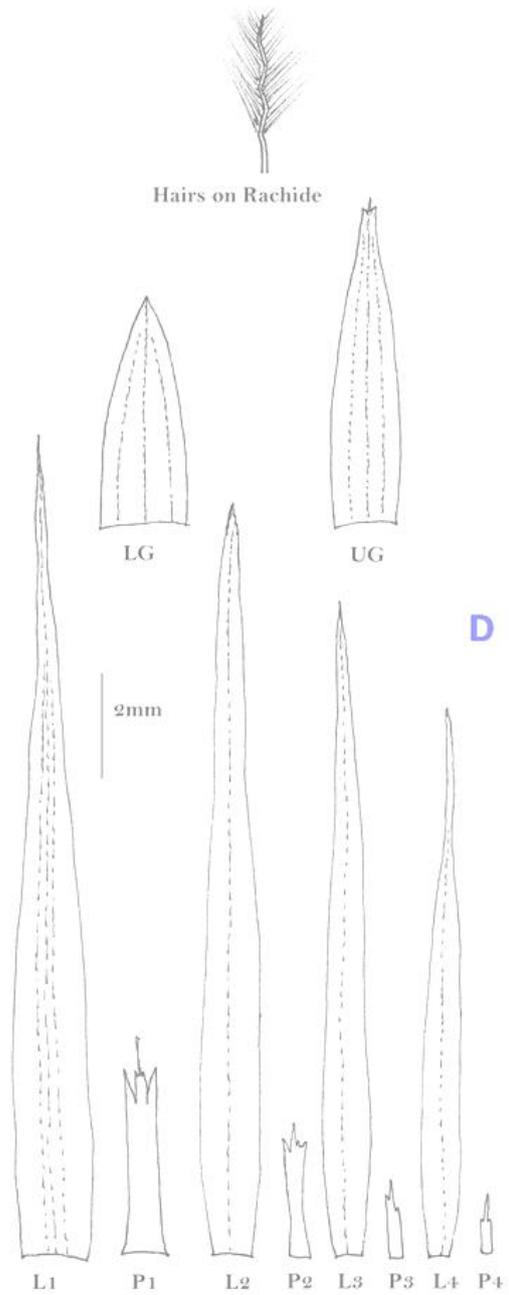
P1

L2

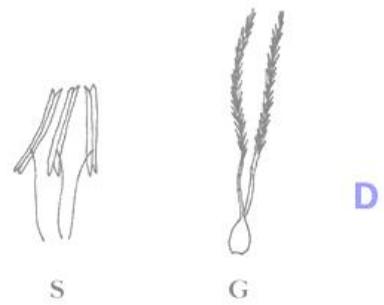
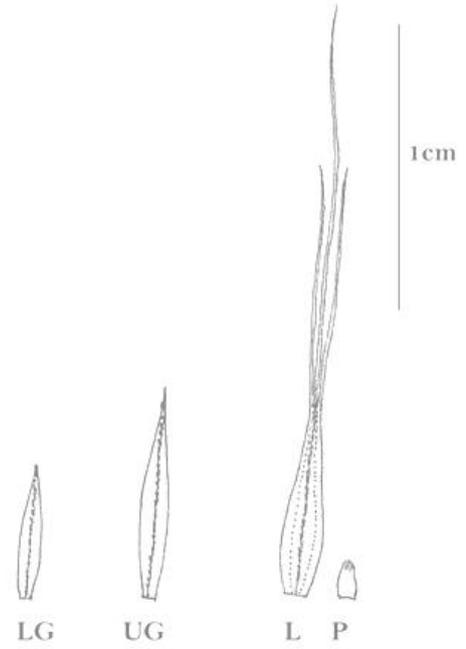
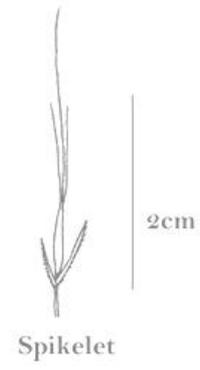
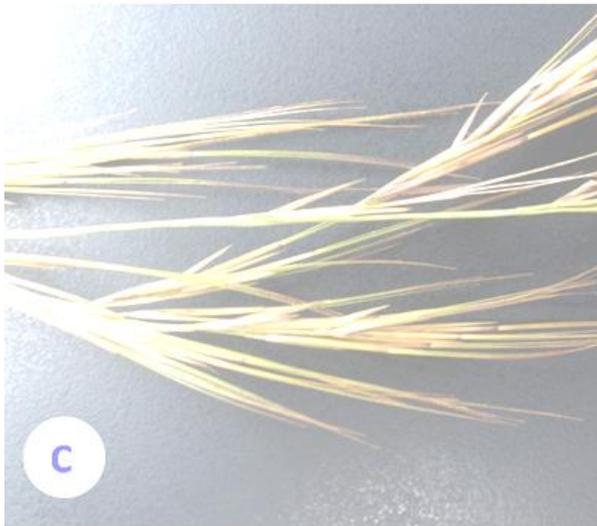
P2

G+S+Lo

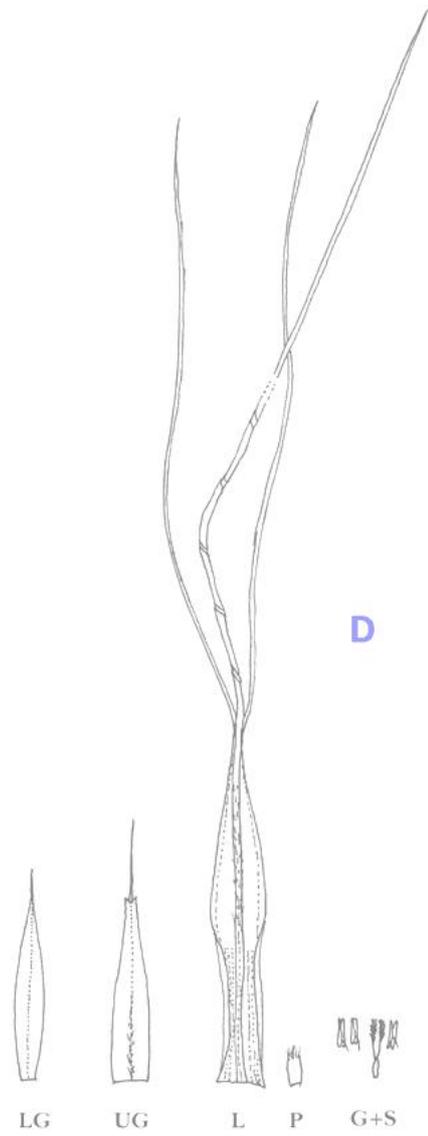
A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



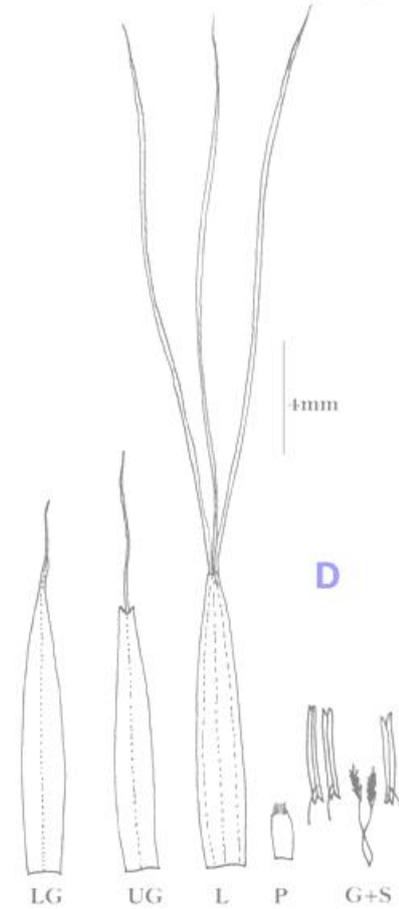
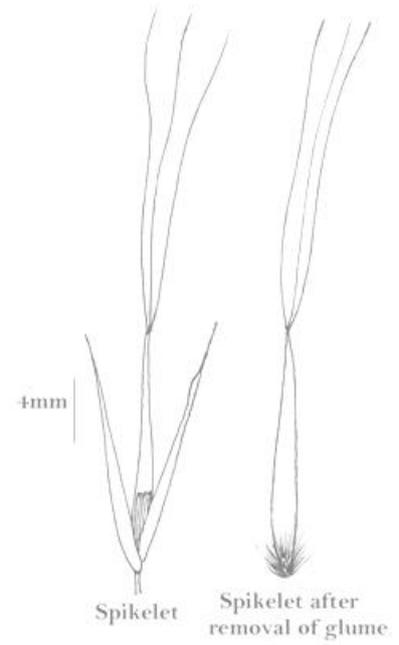
A: Habit; B: Extra-vaginal shoots; C: Close-up of Inflorescence; D: Line drawing



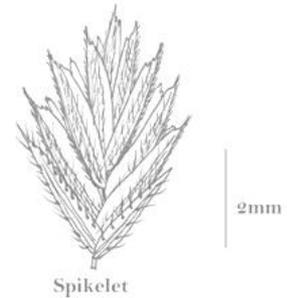
A&B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



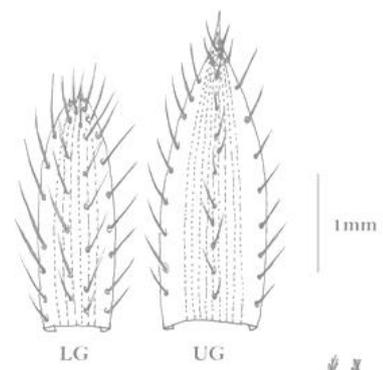
A: Habit; B&C: Close-up of Inflorescence; D: Line drawing



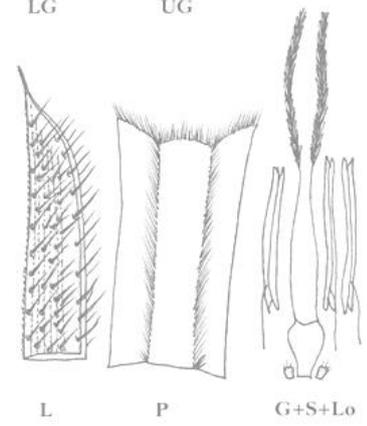
A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



2mm

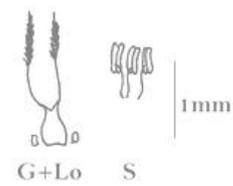
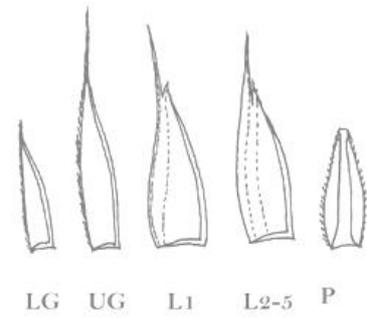
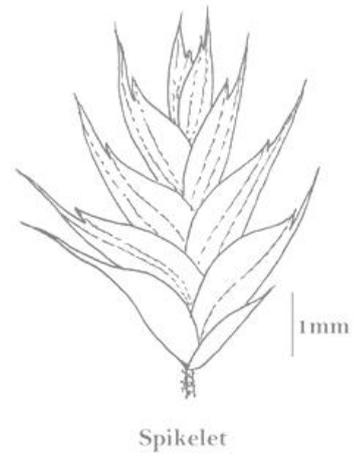
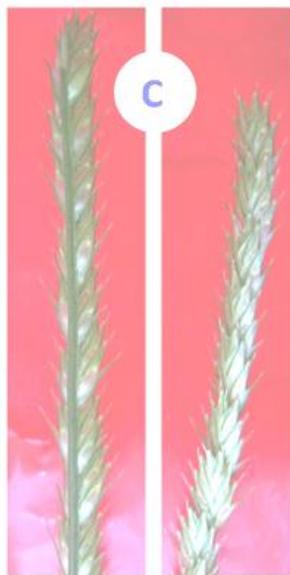
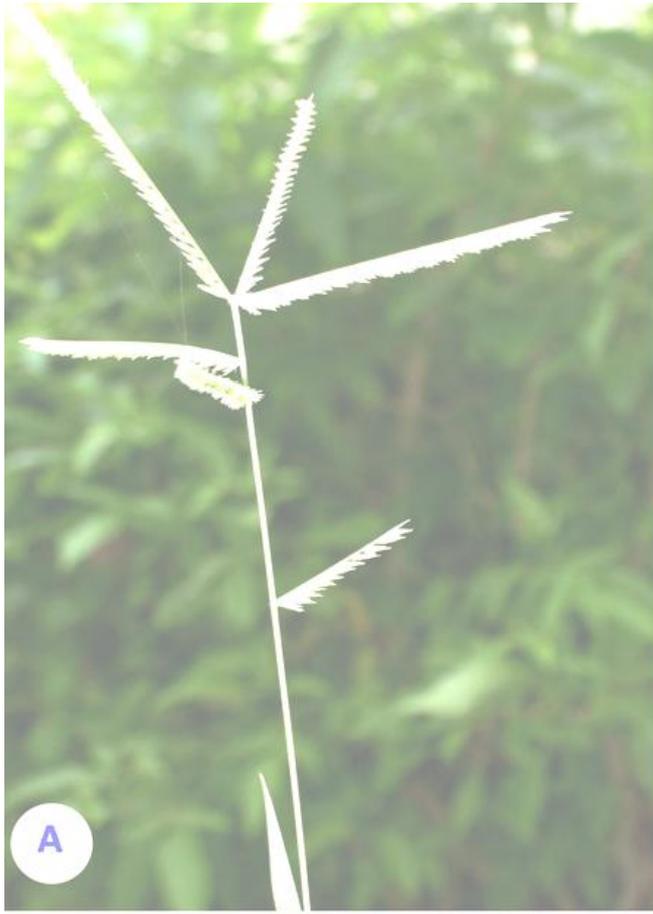


1mm



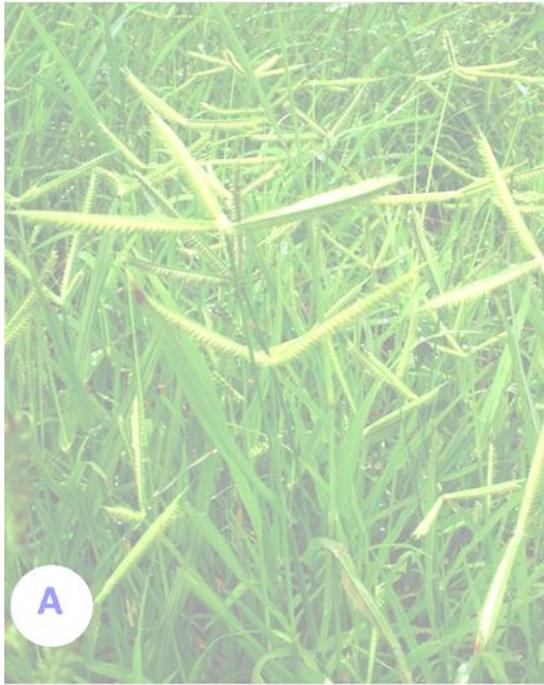
D

A&B: Habit; C: Close-up of Inflorescence; D: Line drawing

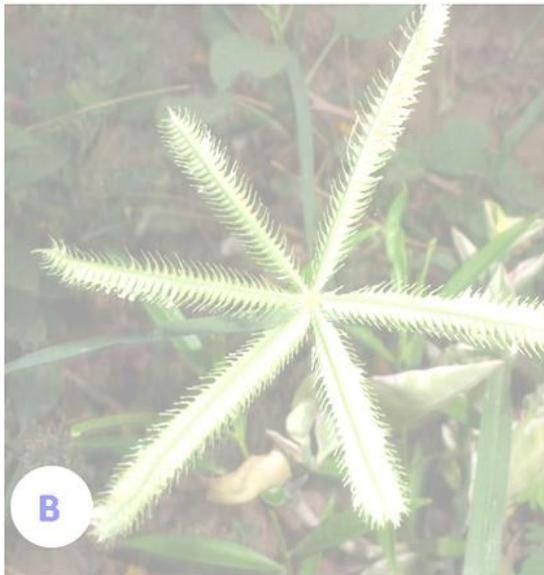


D

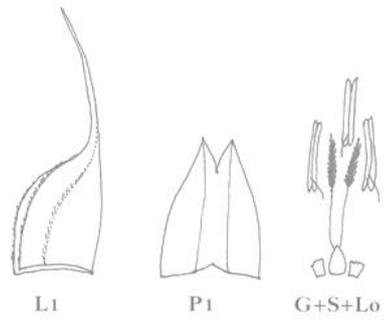
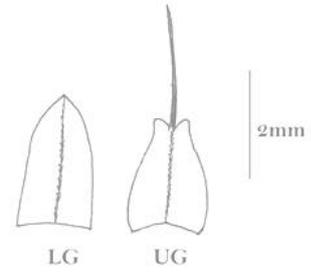
A&B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



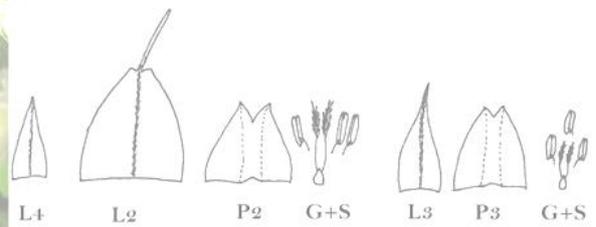
A



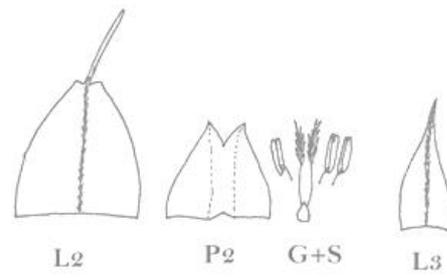
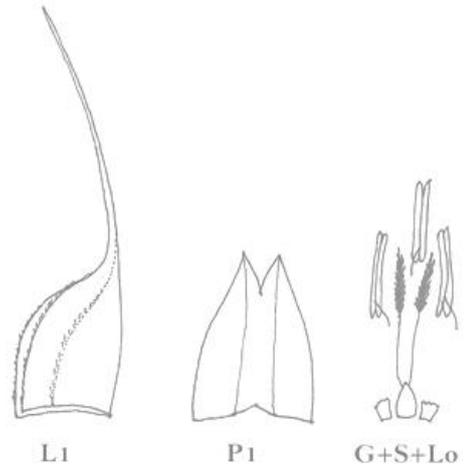
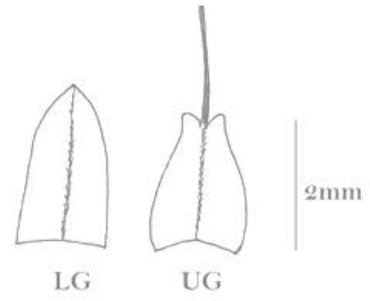
B



C



A: Habit; B: Inflorescence; C: Line drawing

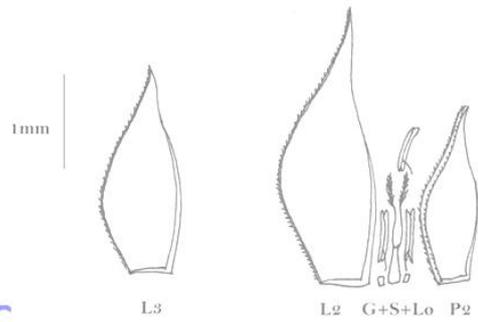
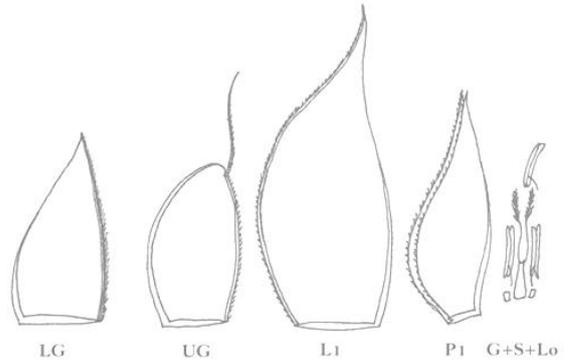


D

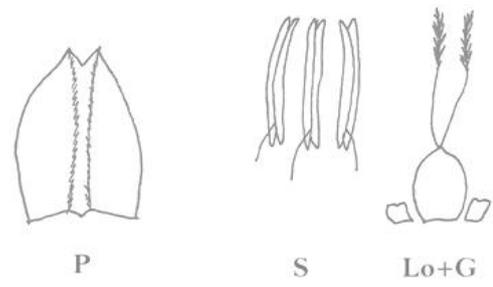
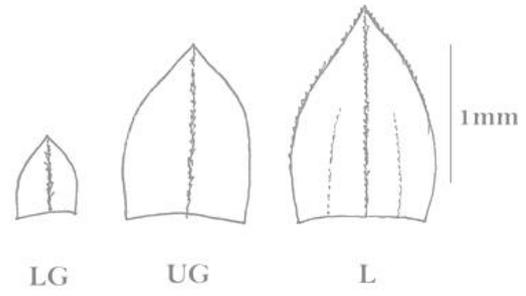
A: Habit; B: Close-up of Inflorescence; C: Spikelet; D: Line drawing



Spikelet after removal of glumes

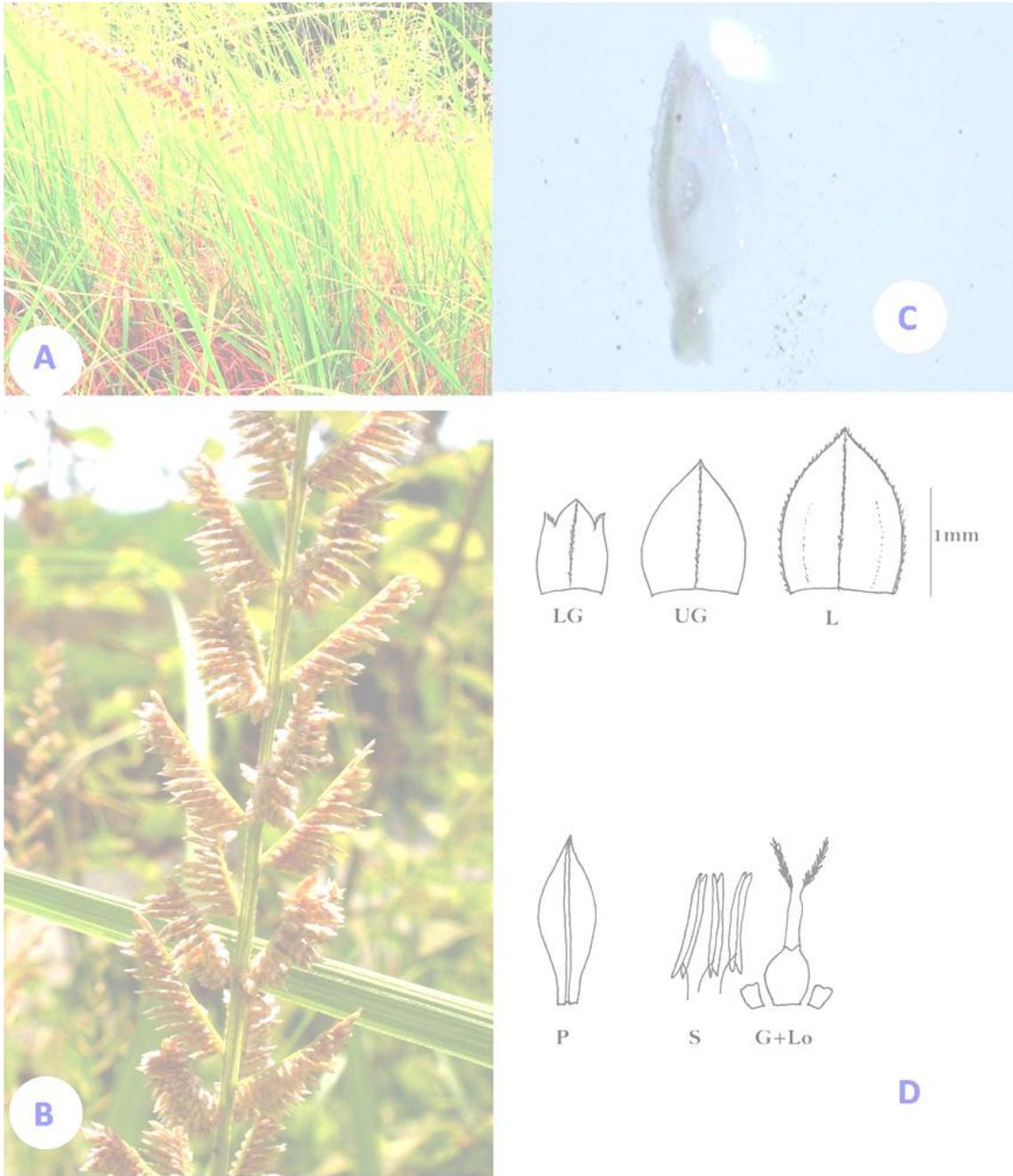


A: Habit; B: Close-up of Inflorescence; C: Line drawing



C

A: Habit; B: Close-up of Inflorescence; C: Line drawing



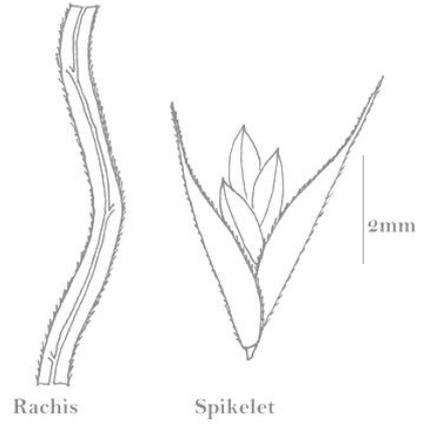
A: Habit; B: Close-up of Inflorescence; C: lower glume; D:Line drawing



A



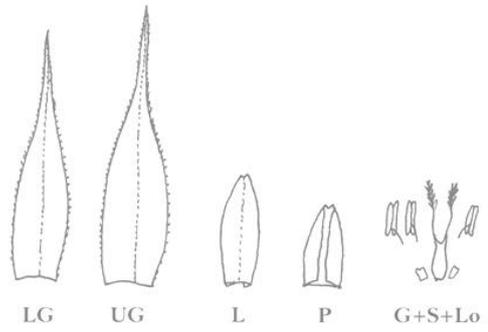
B



Rachis

Spikelet

2mm



LG

UG

L

P

G+S+Lo

C



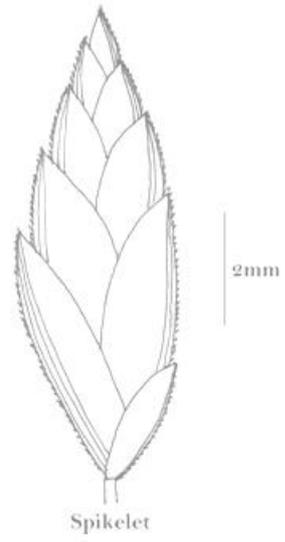
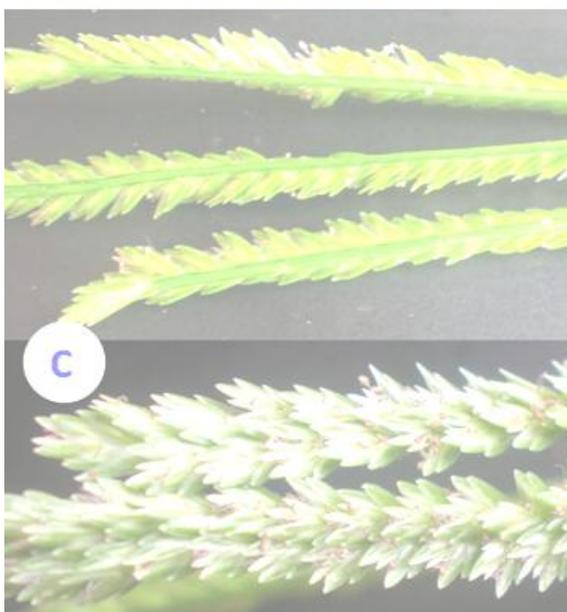
L2

P3

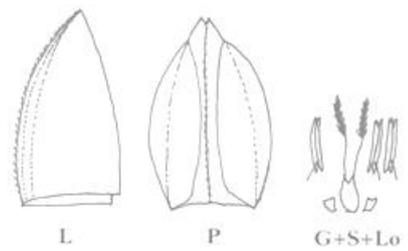
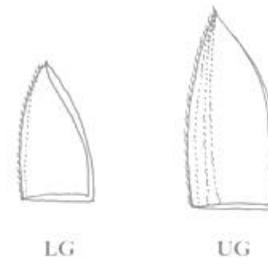
G+S+Lo

L3

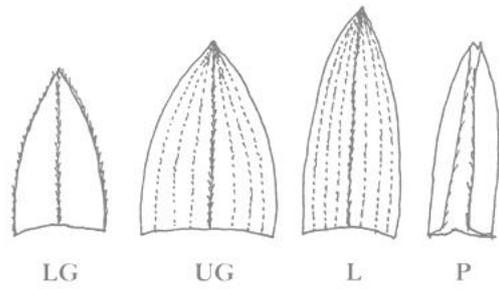
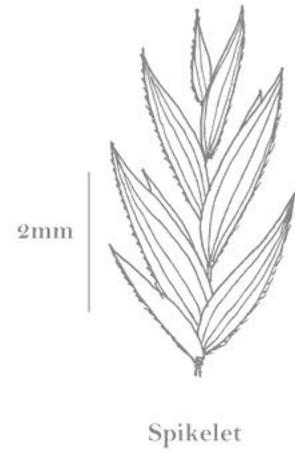
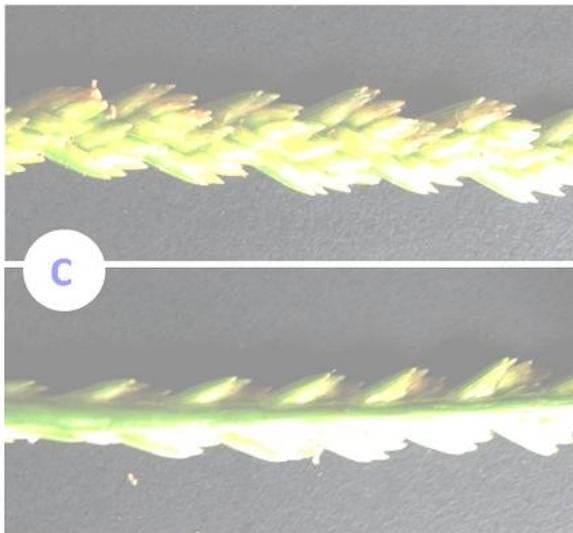
A: Habit; B: Close-up of Inflorescence; C: Line drawing



D

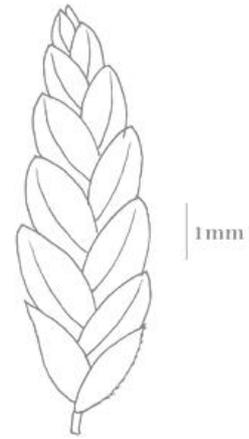


A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing

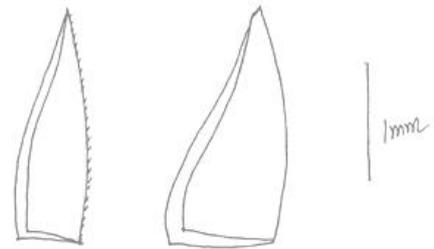


D

A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing

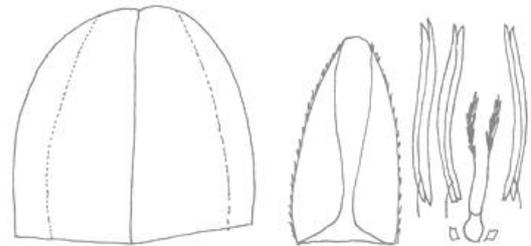


Spikelet



LG

UG



L

P

G+S+Lo

C

A: Habit; B: Close-up of Inflorescence; C: Line drawing



A



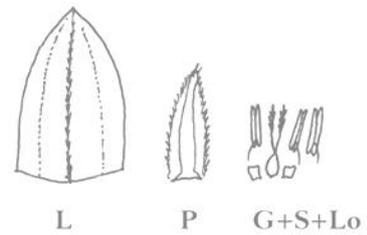
B



Spikelet



LG UG



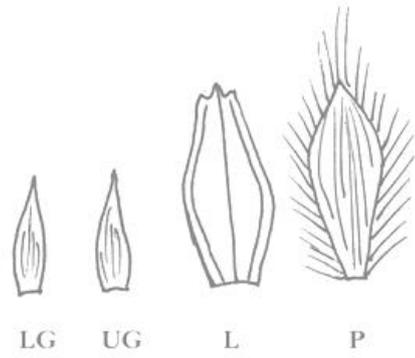
L P G+S+Lo

C

A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing



Spikelet

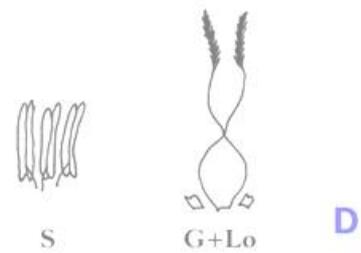
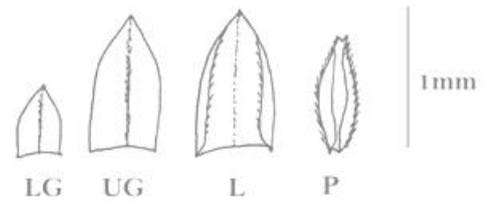


C

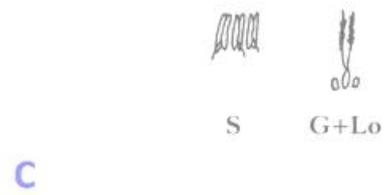
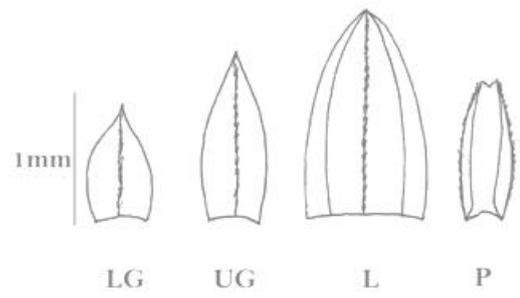
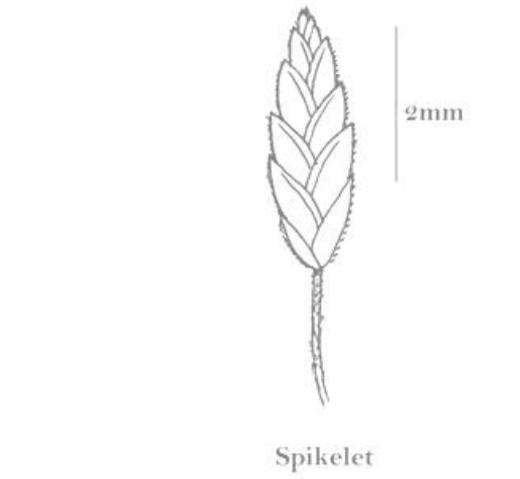
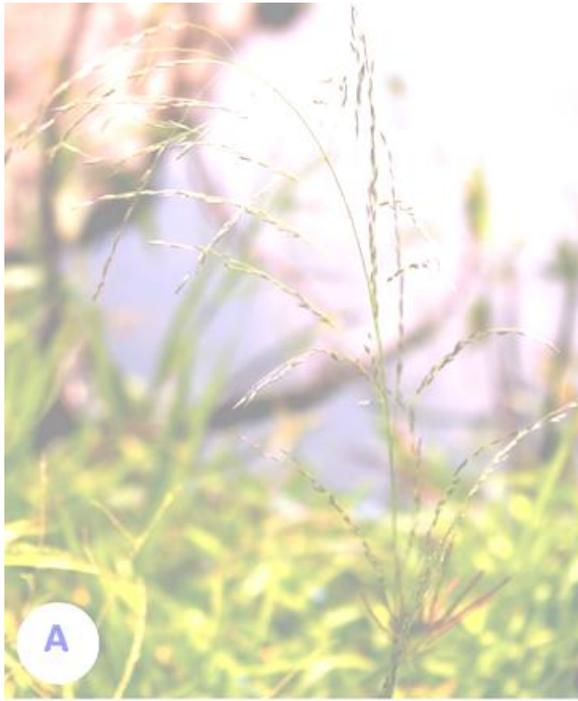
A: Habit; B: Inflorescence; C: Line drawing



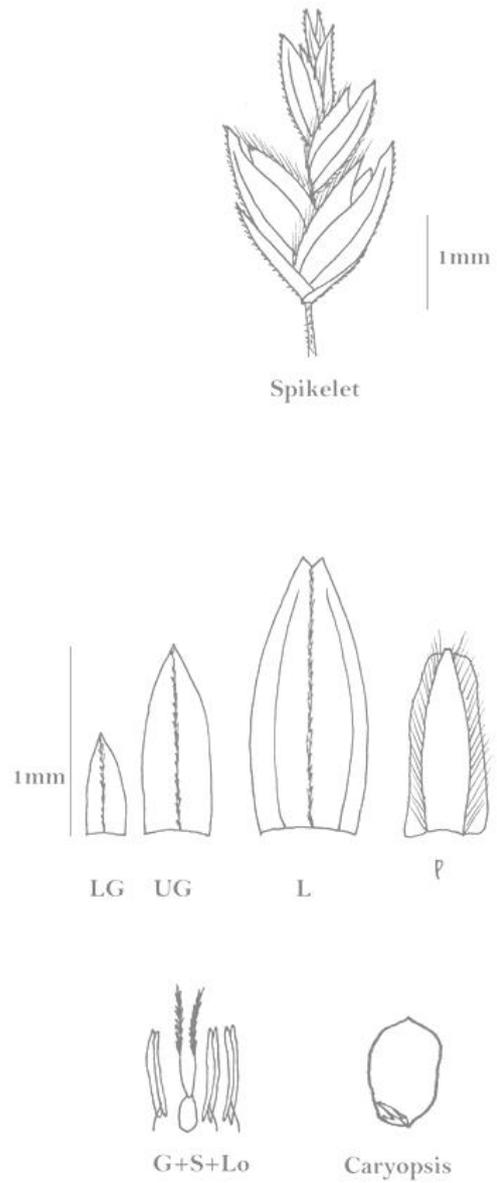
Spikelet



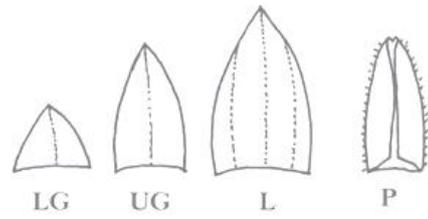
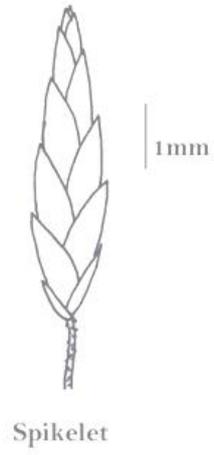
A&B: Habit; C: Inflorescence; D: Line drawing



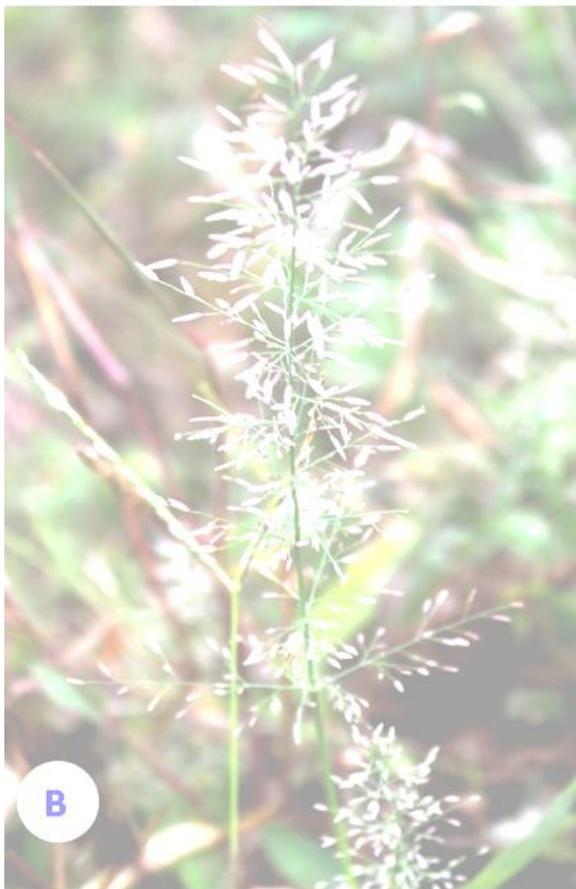
A: Habit; B: Inflorescence; C: Line drawing



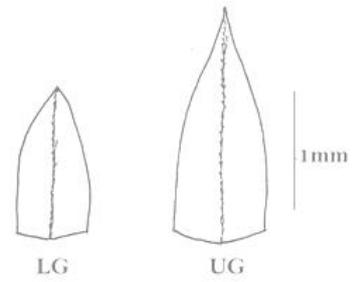
A: Habit; B: Close-up of Inflorescence; C: Line drawing



A: Habit; B: Inflorescence; C: Line drawing

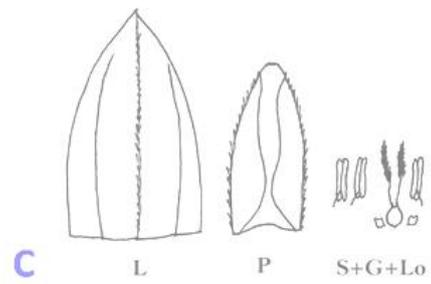


Spikelet



LG

UG



L

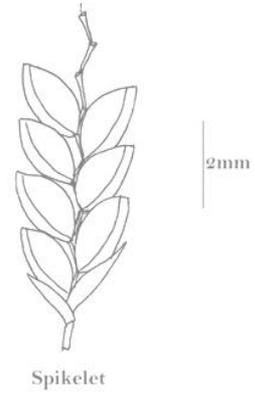
P

S+G+Lo

A: Habit; B: Inflorescence; C: Line drawing

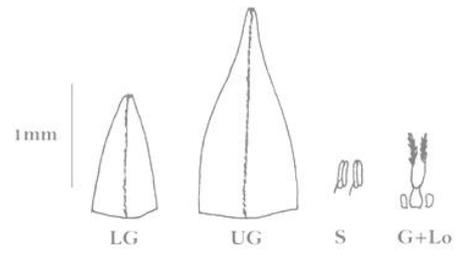


A



Spikelet

B

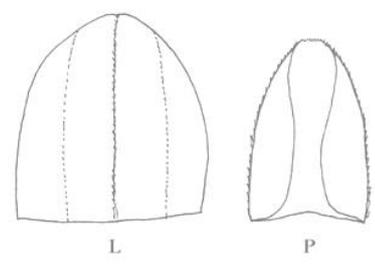


LG

UG

S

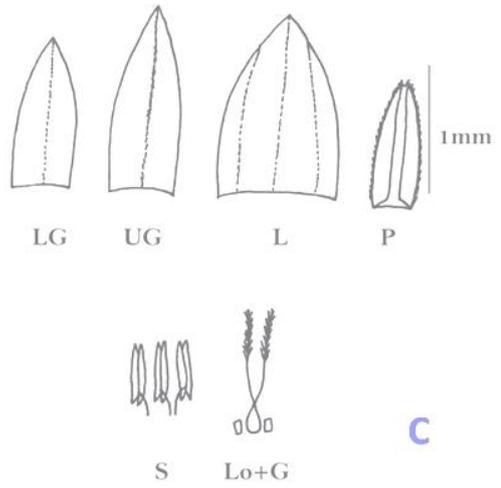
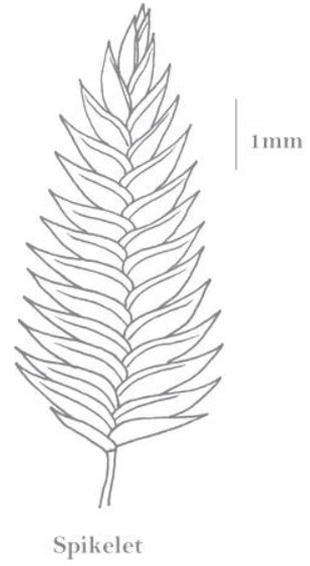
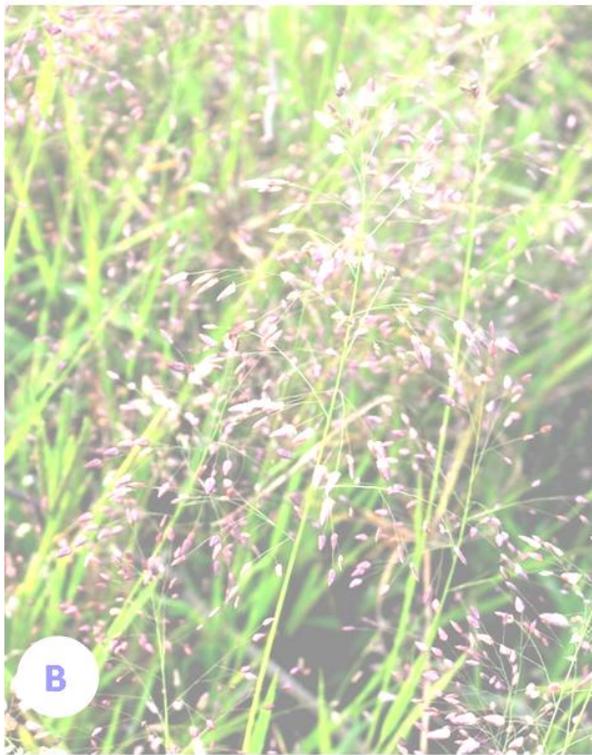
G+Lo



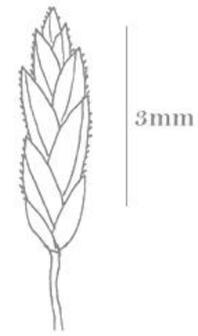
L

P

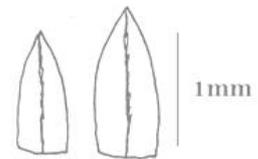
A: Inflorescence; B: Line drawing



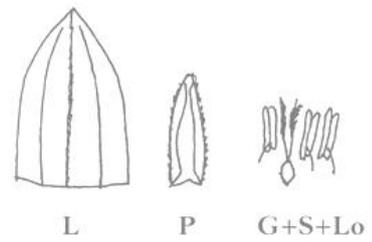
A: Habit; B: Inflorescence; C: Line drawing



Spikelet



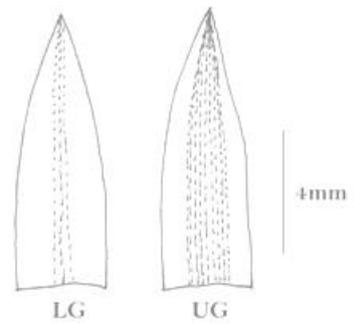
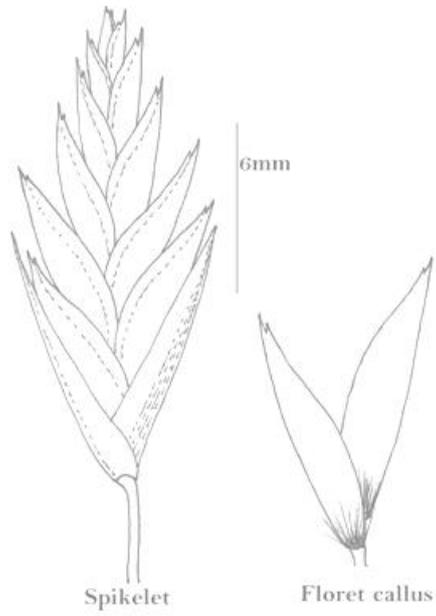
LG UG



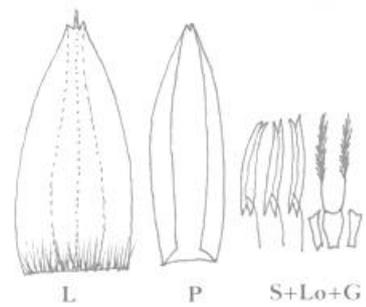
L P G+S+Lo

C

A: Habit; B: Inflorescence; C: Line drawing



D



A: Habit; B: Close-up of Inflorescence; C: Spikelet; D: Line drawing



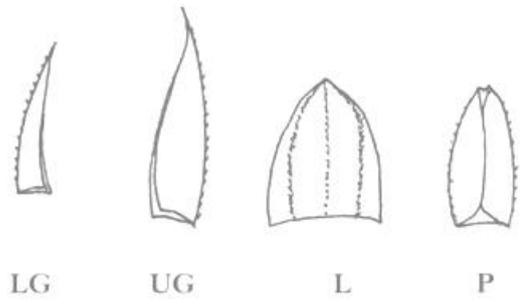
D



A&B: Habit; c: Inflorescence; C: Line drawing



Spikelet with Rachis

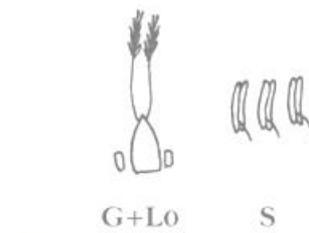


LG

UG

L

P

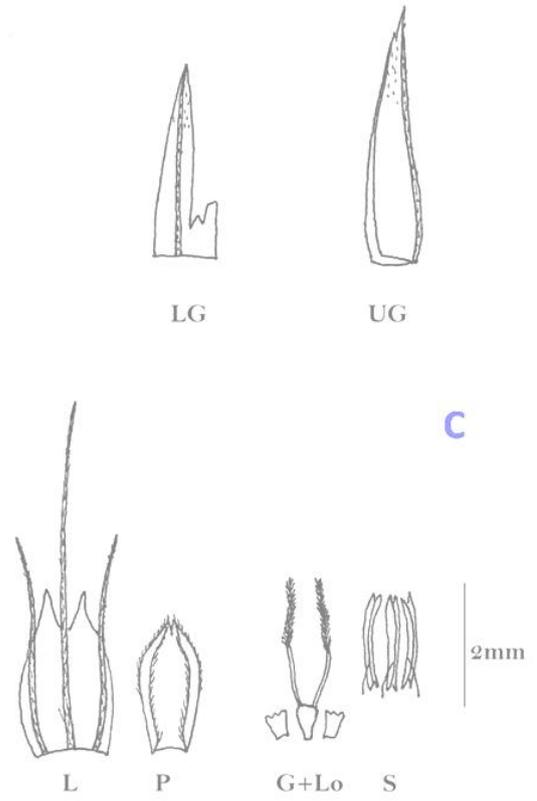


C

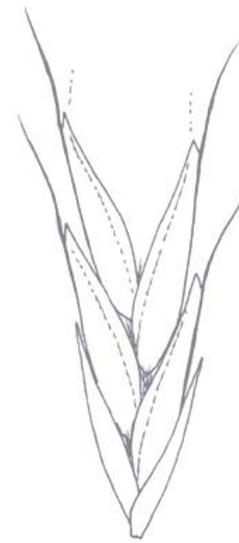
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S

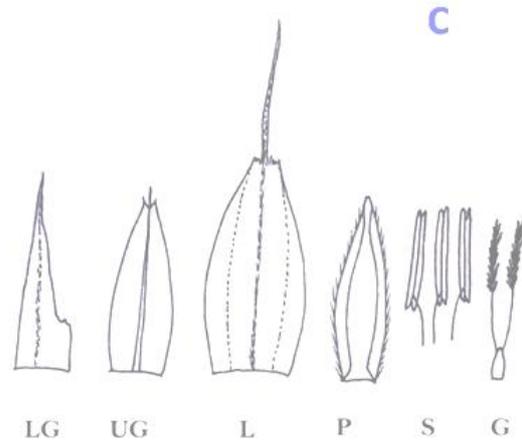
A: Habit; B: Inflorescence; C: Line drawing



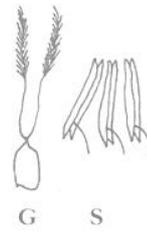
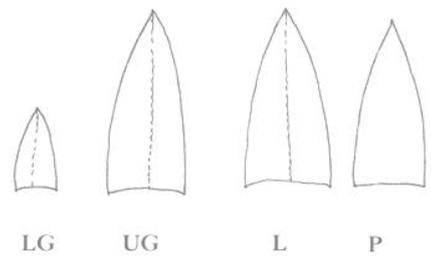
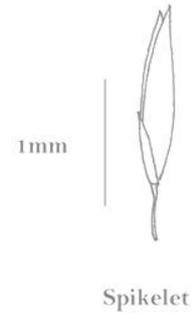
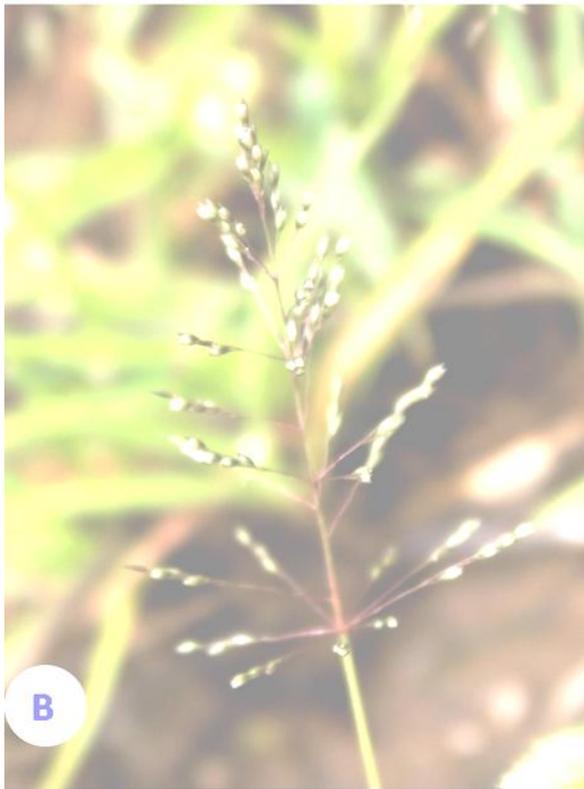
A: Habit; B: Close-up of Inflorescence; C: Line drawing



Spikelet

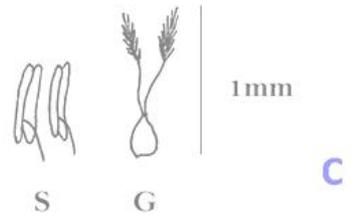
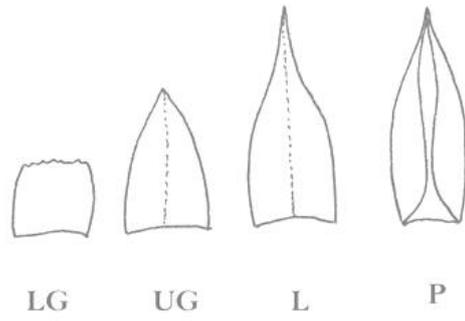
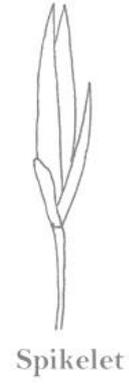
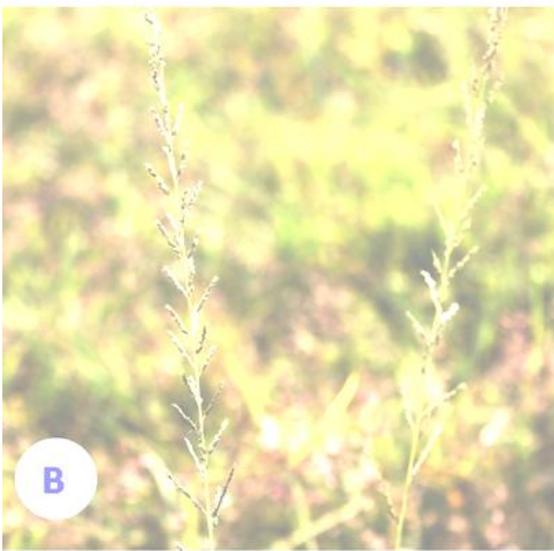


A: Habit; B: Close-up of Inflorescence; C: Line drawing

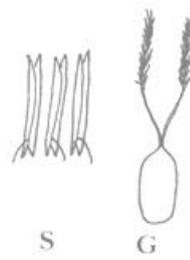
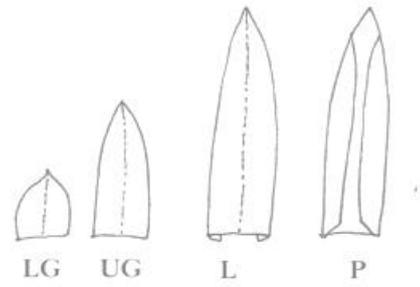
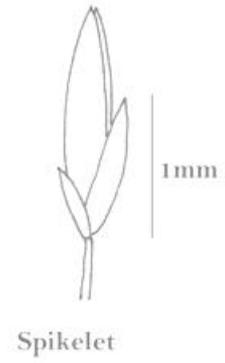


C

A: Habit; B: Inflorescence; C: Line drawing

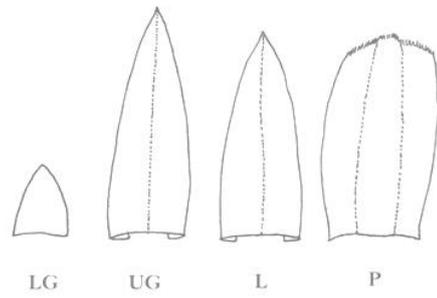
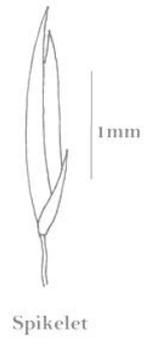
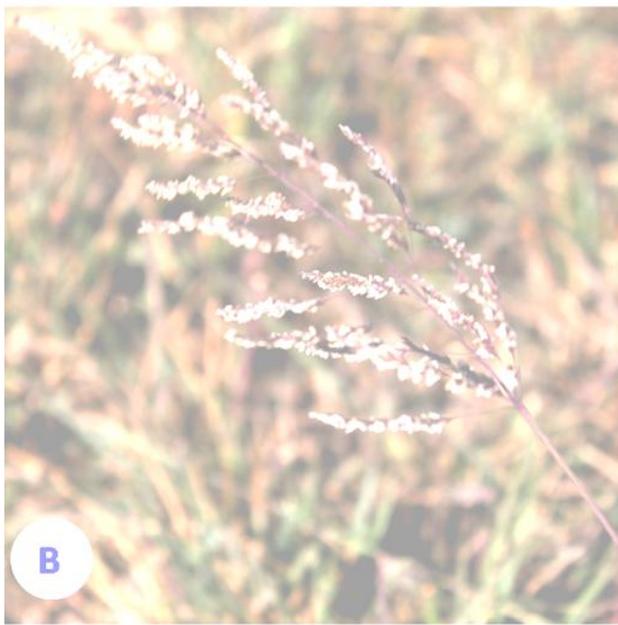


A: Habit; B: Inflorescence; C: Line drawing



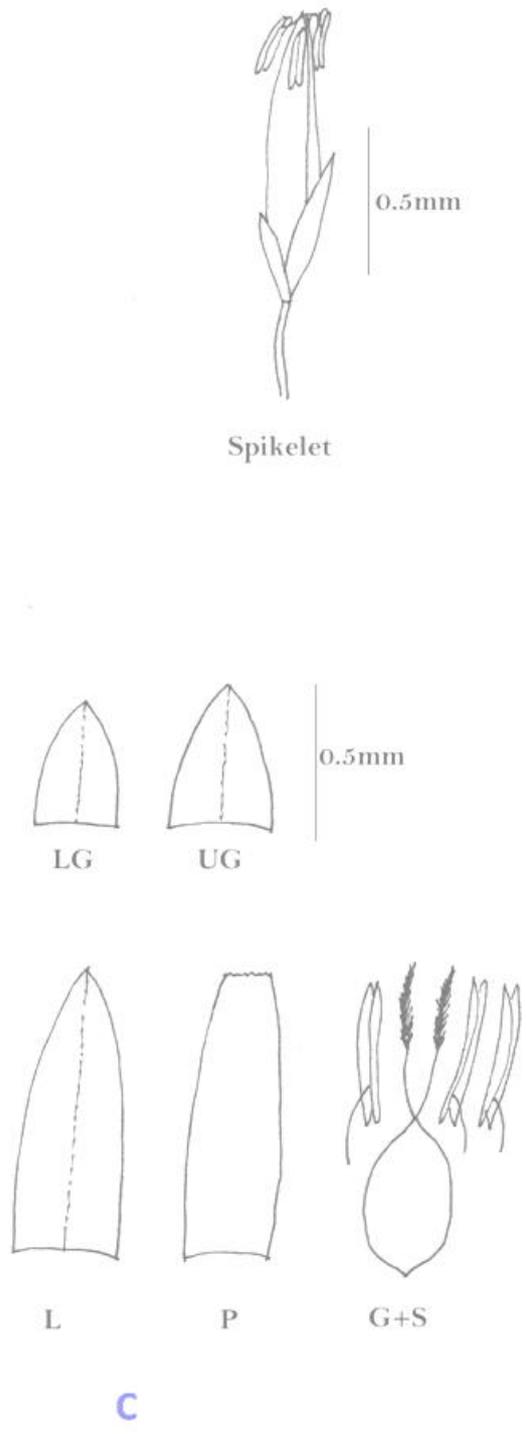
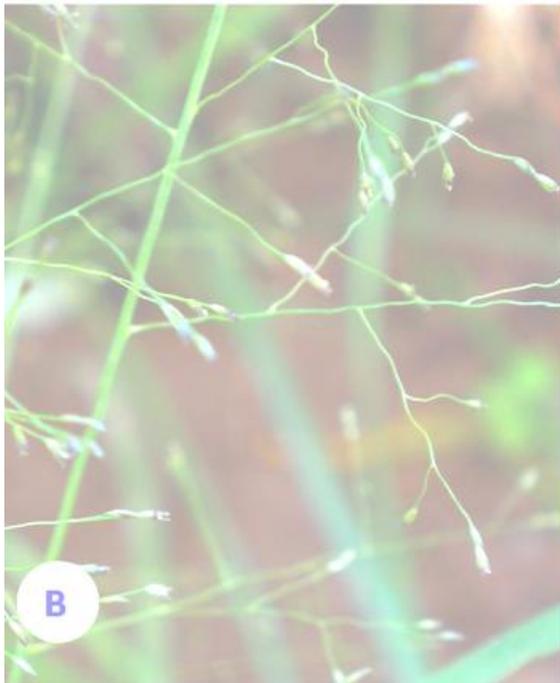
C

A: Habit; B: Inflorescence; C: Line drawing

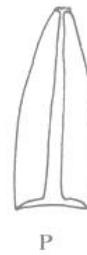
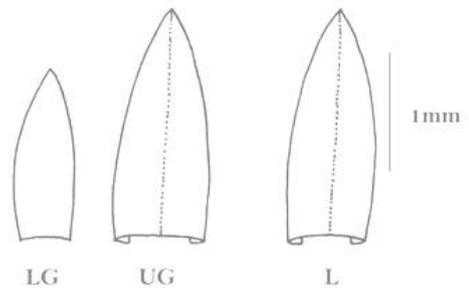


C

A: Habit; B: Inflorescence; C: Line drawing

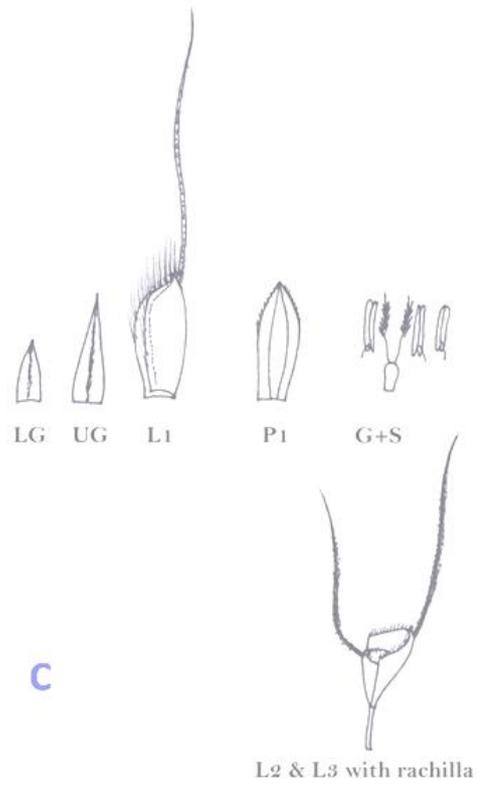
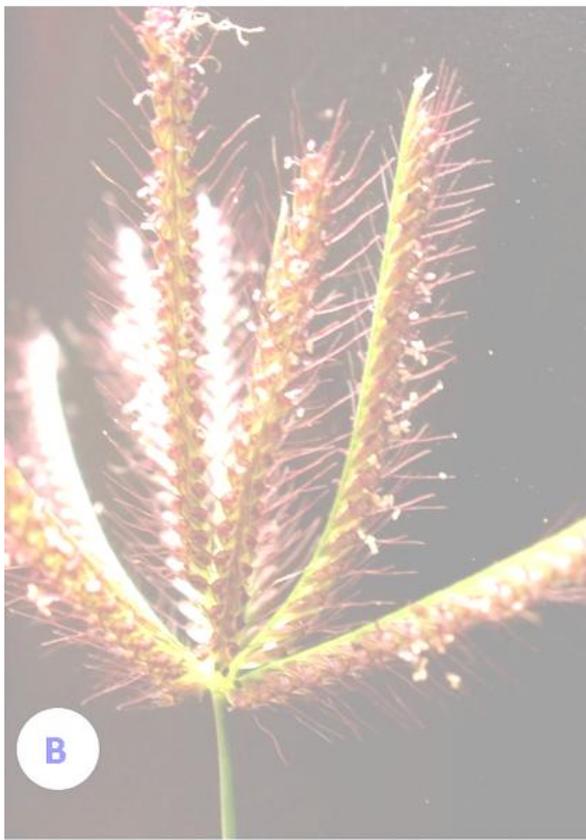
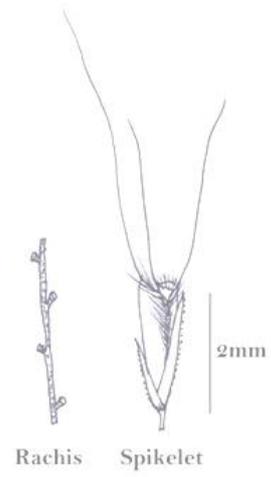


A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing

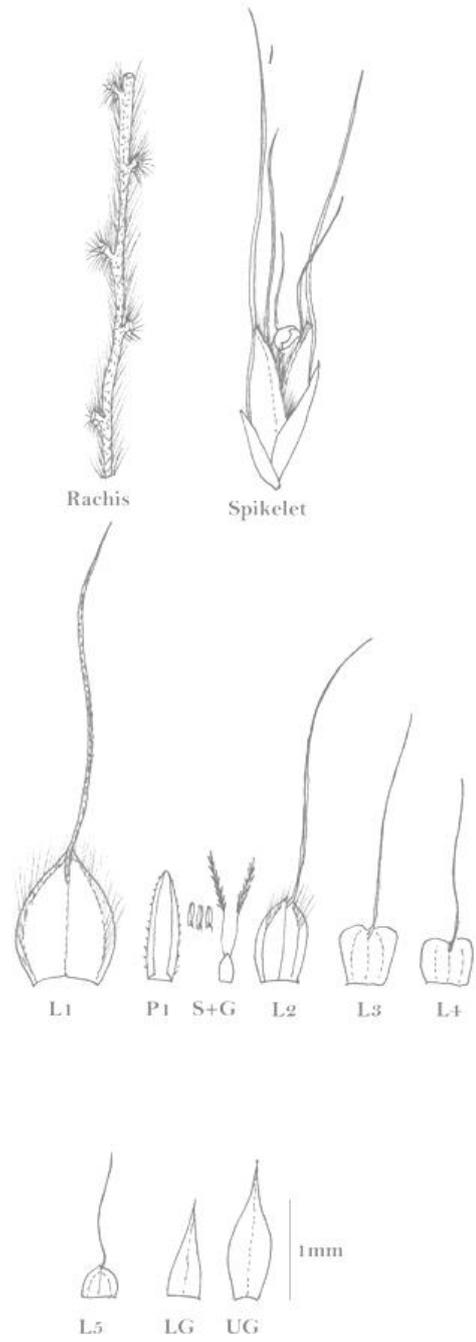


C

A: Habit; B: Inflorescence; C: Line drawing

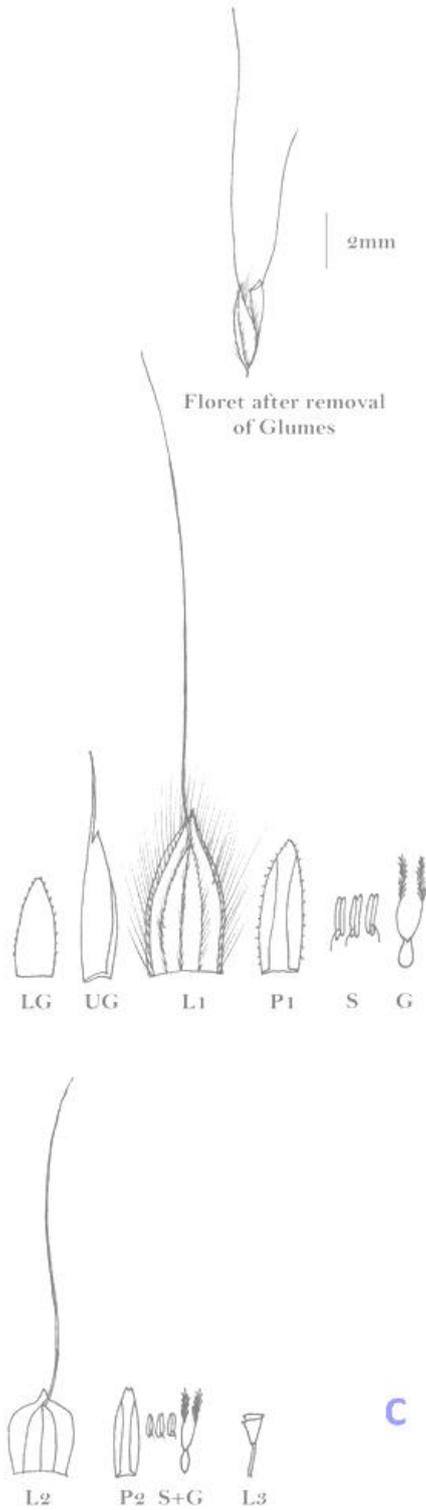
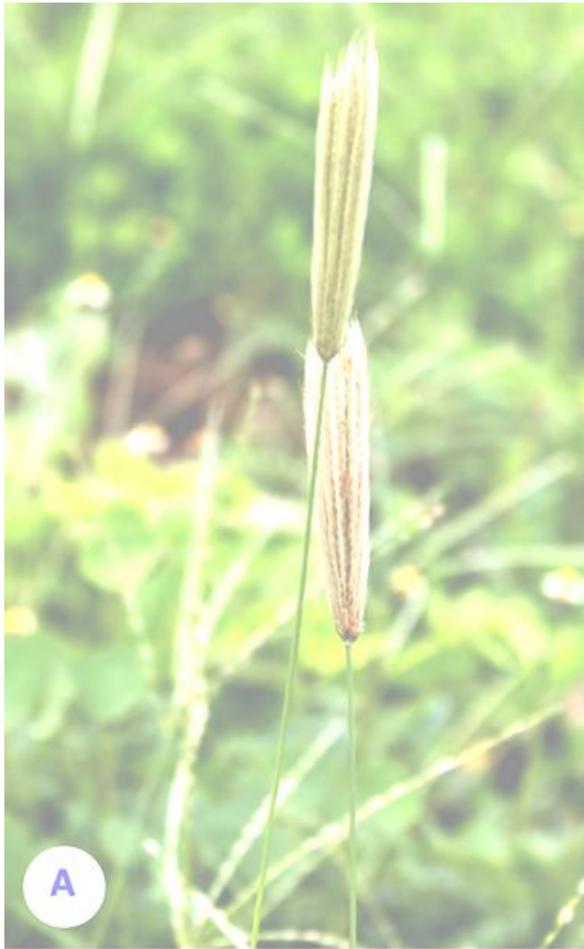


A: Habit; B: Close-up of Inflorescence; C: Line drawing

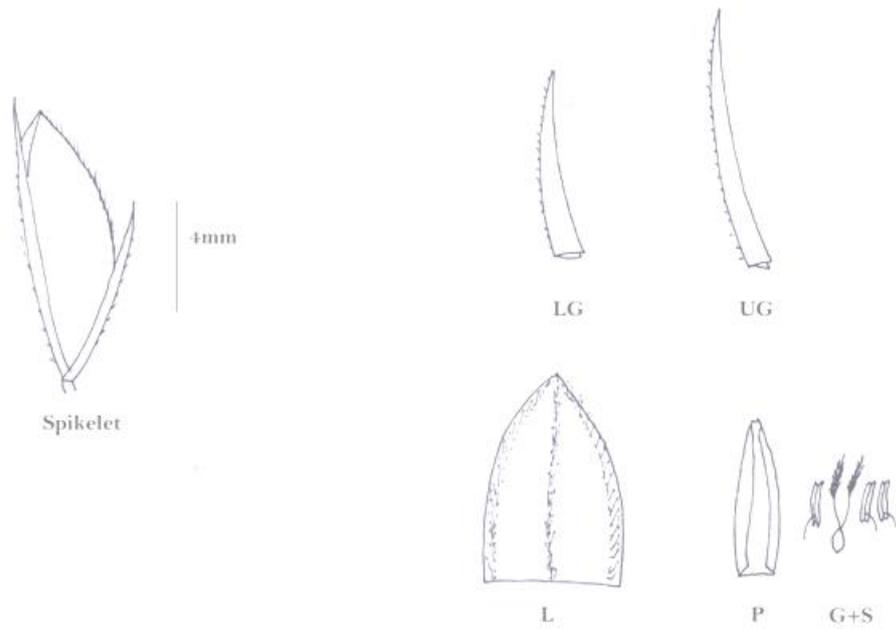


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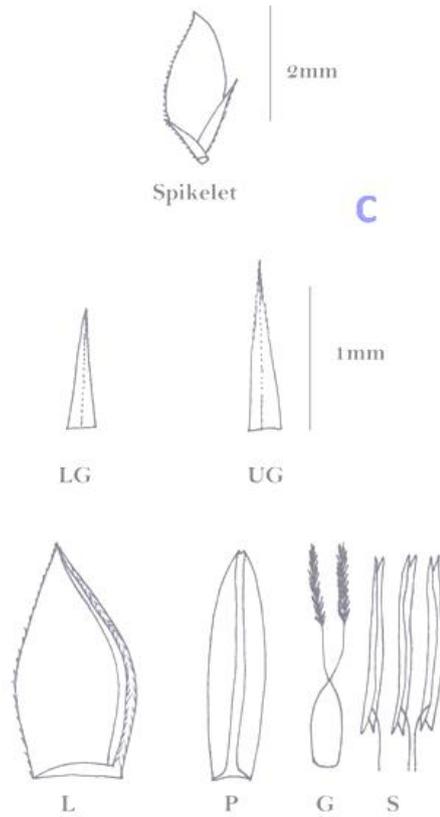
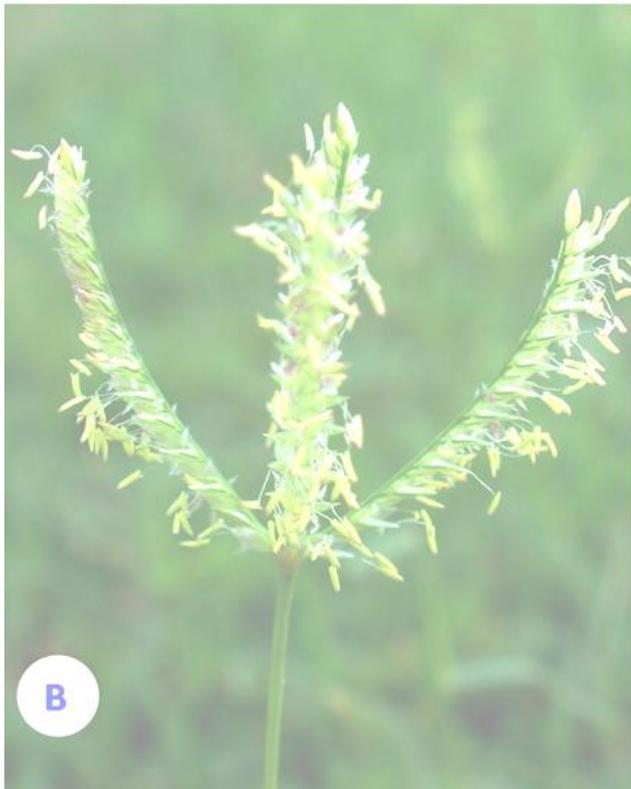
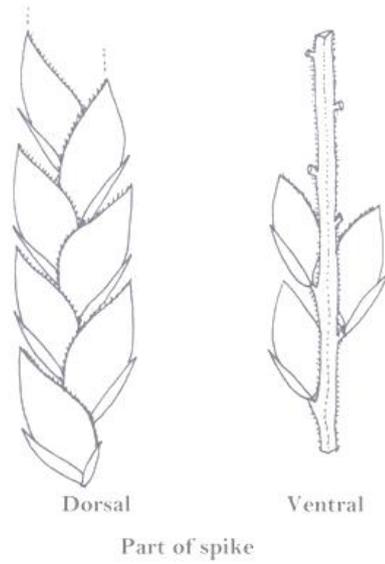
A&B: Habit; C: Line drawing



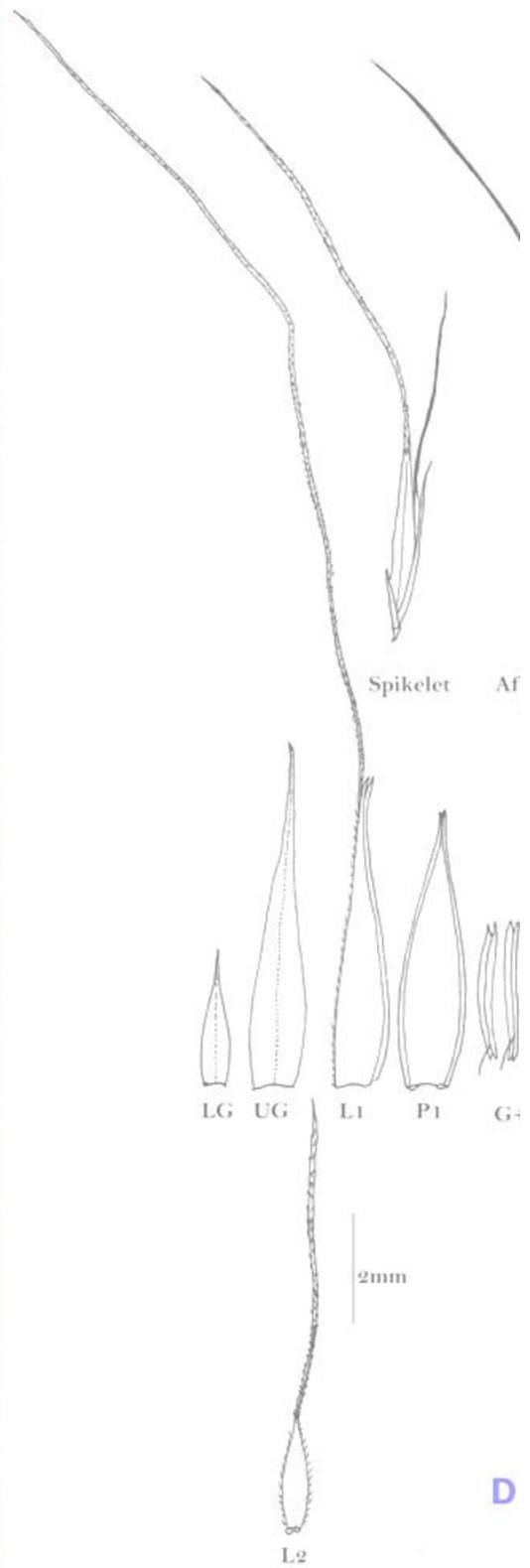
A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing



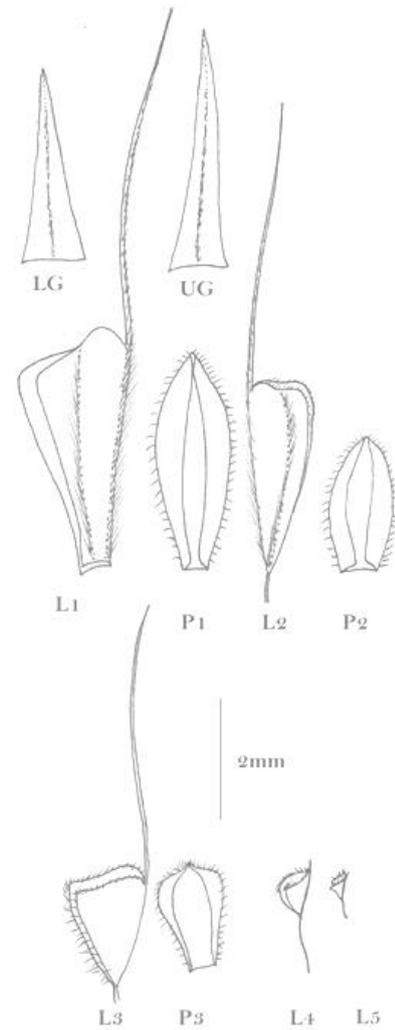
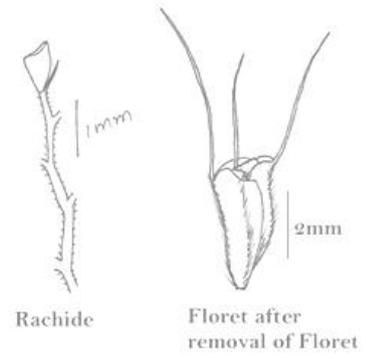
A: Habit; B: Line drawing



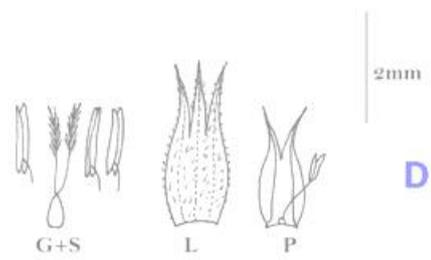
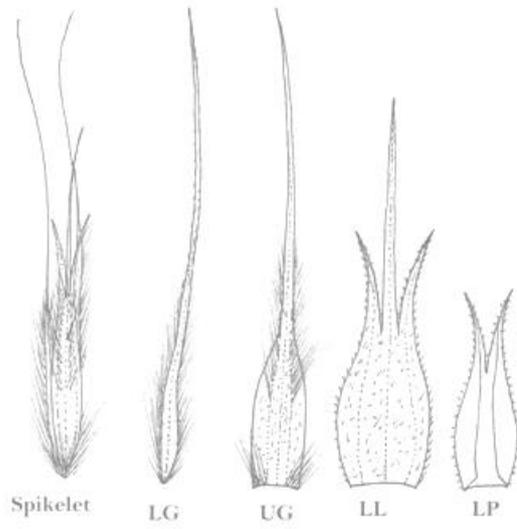
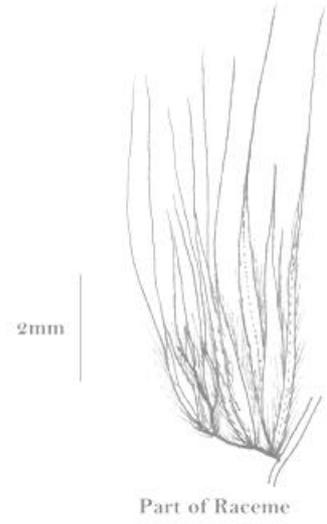
A: Habit; B: Close-up of Inflorescence; C: Line drawing



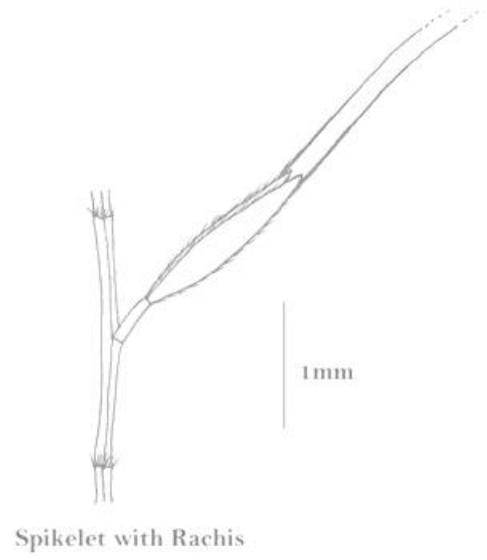
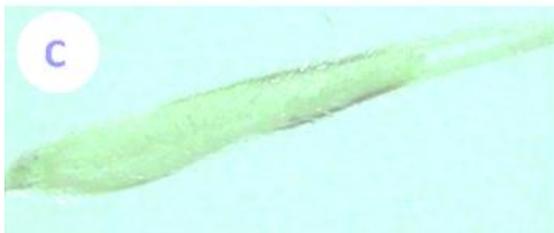
A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



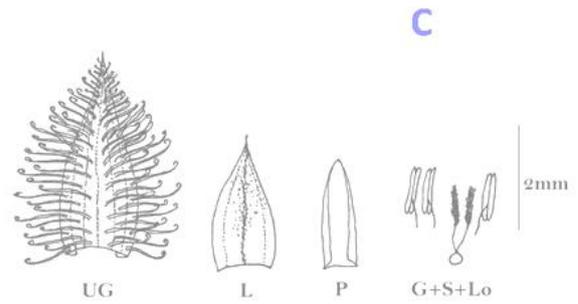
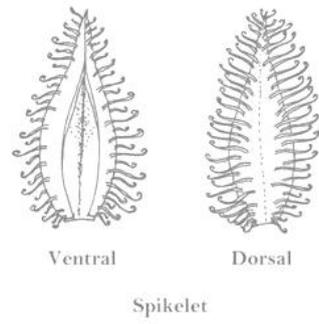
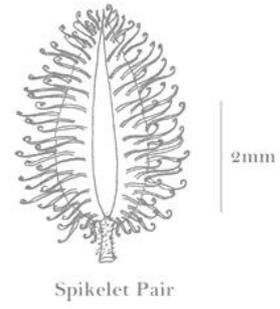
A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing



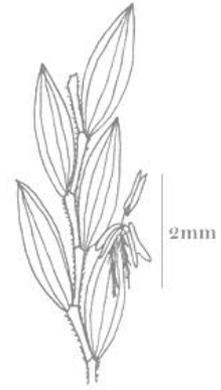
A&B: Habit; C: Close-up of Inflorescence; D: Line drawing



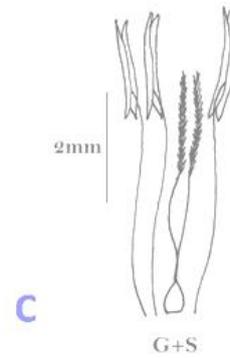
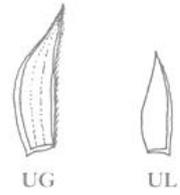
A: Inflorescence; B: Close-up of Inflorescence; C: Spikelet; D: Line drawing



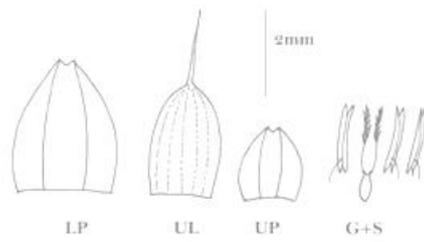
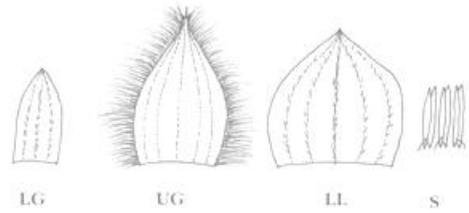
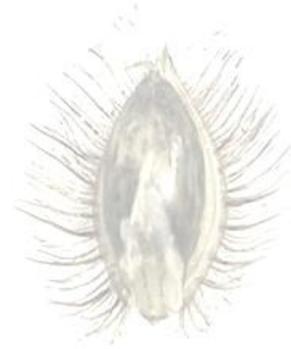
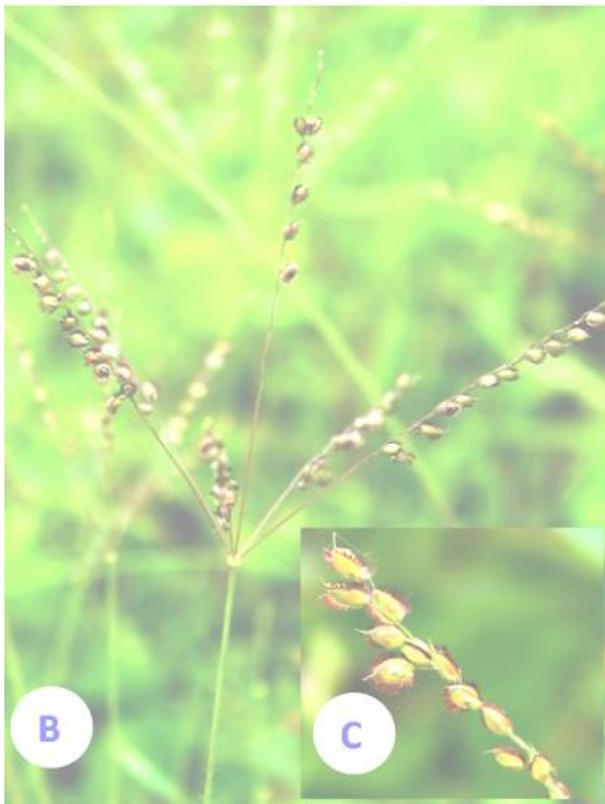
A: Habit; B: Close-up of Inflorescence; C: Line drawing



Part of Raceme



A: Habit; B: Close-up of Inflorescence; C: Line drawing

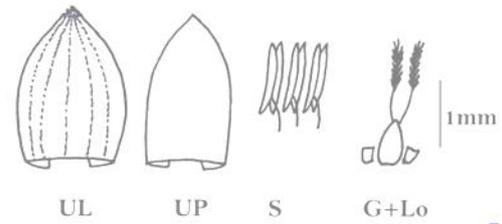
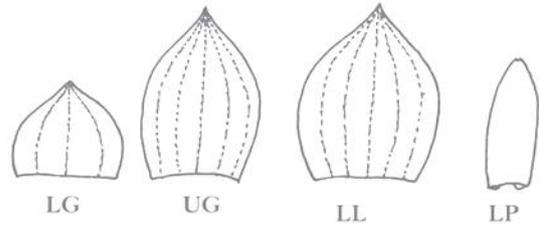


D

A: Habit; B&C: Inflorescence; D: Line drawing

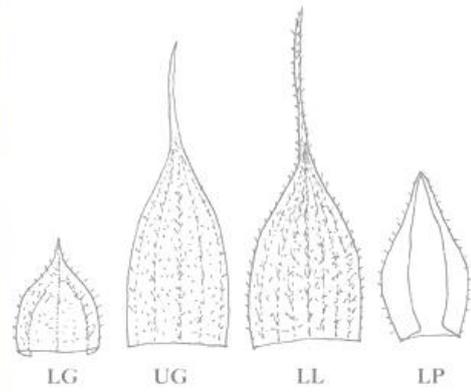
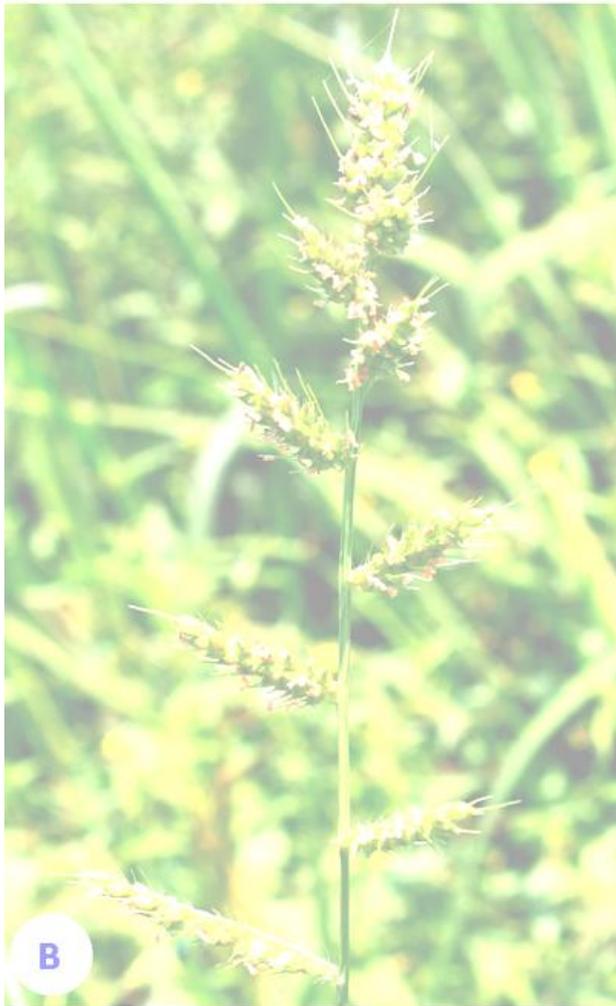
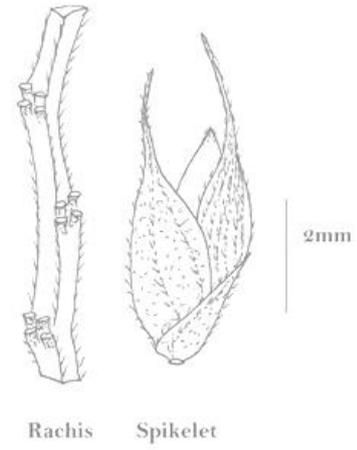


Spikelet

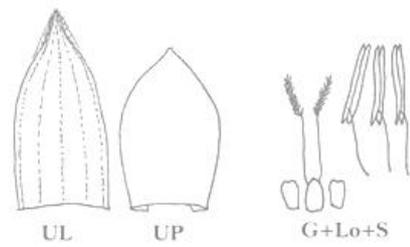


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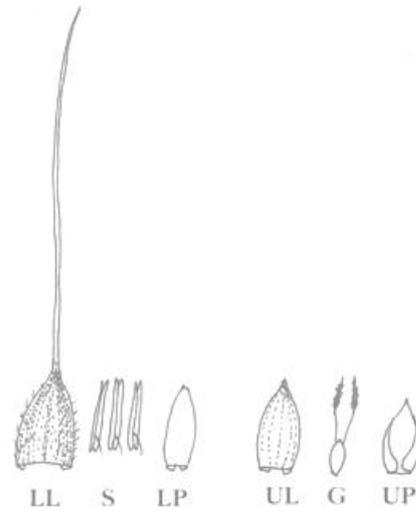
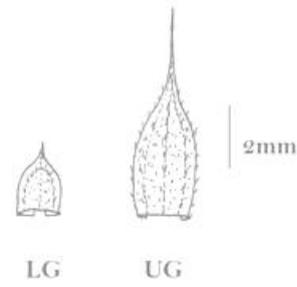
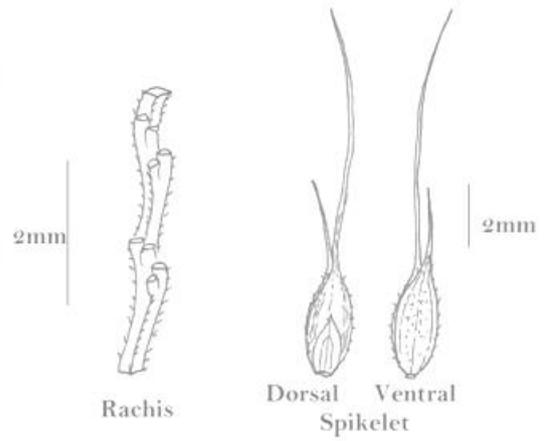
A: Habit; B: Close-up of Inflorescence; C: Line drawing



C

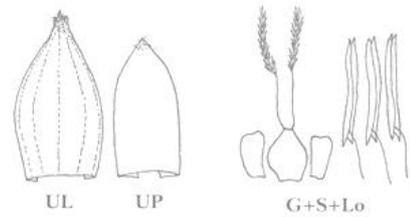
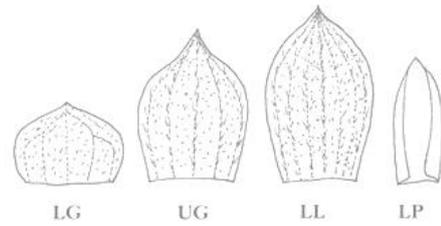
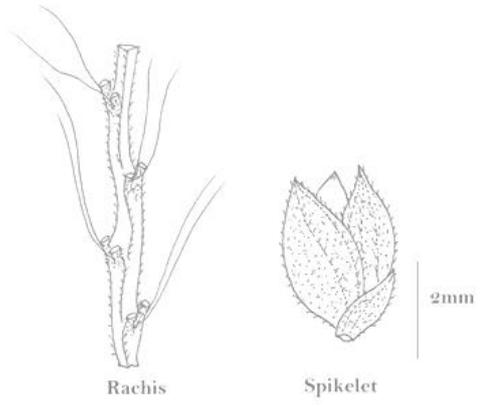


A: Habit; B: Inflorescence; C: Line drawing

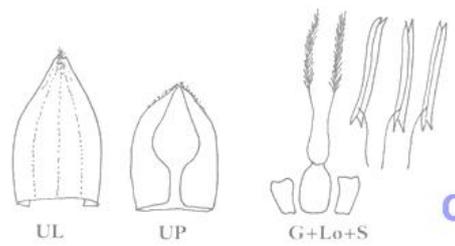
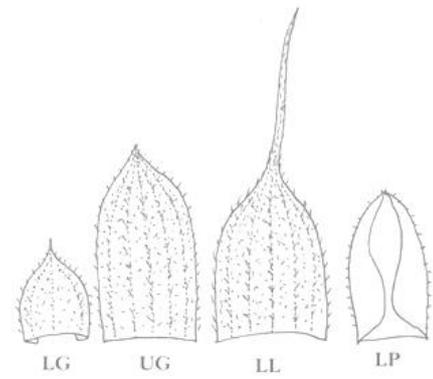
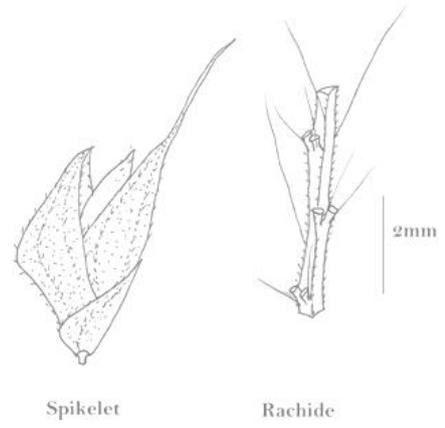


D

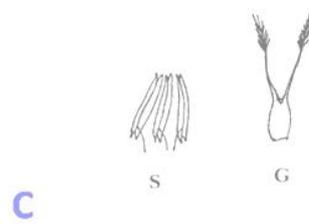
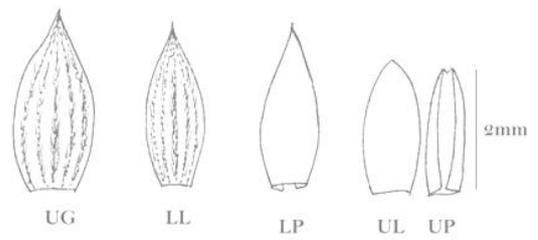
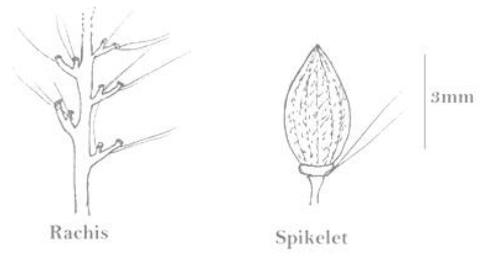
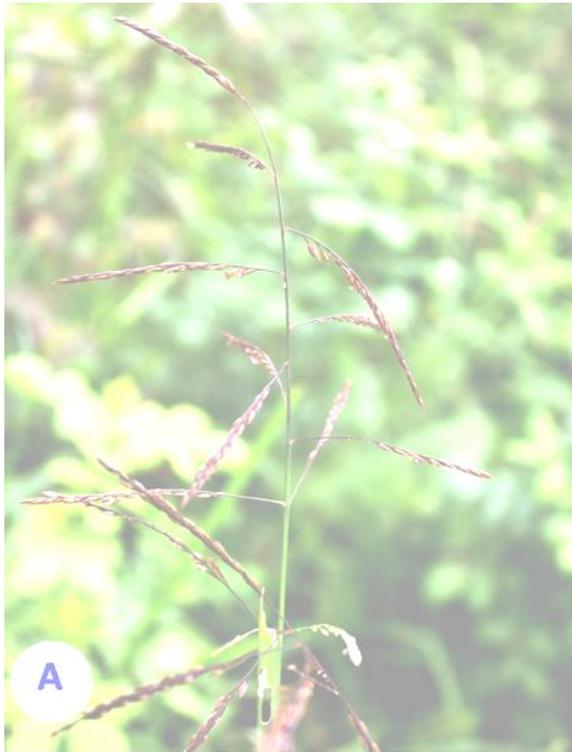
A: Habit; B: Close-up of Inflorescence; C: Spikelets; D: Line drawing



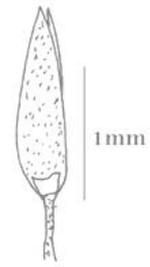
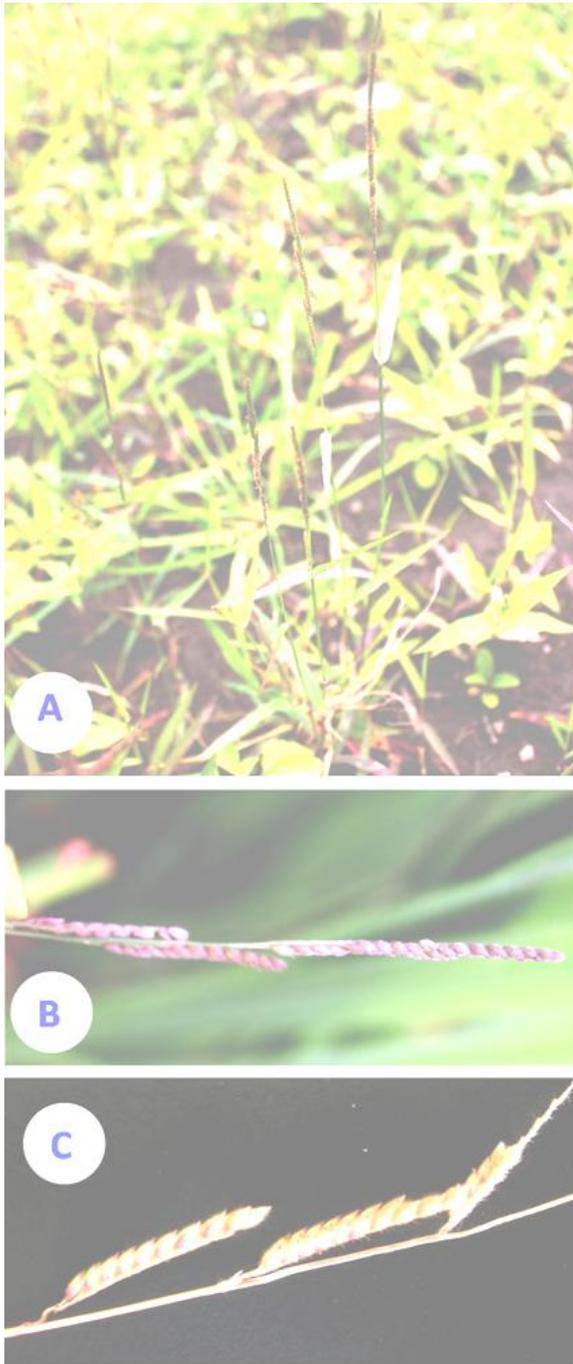
A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing



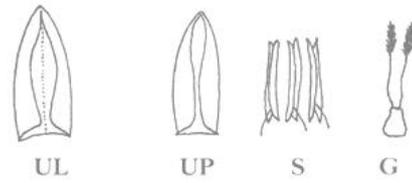
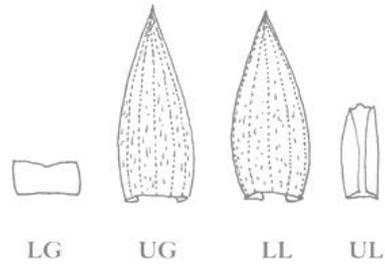
A: Habit; B: Close-up of Inflorescence; C: Line drawing



A: Inflorescence; B: Habit; C: Line drawing

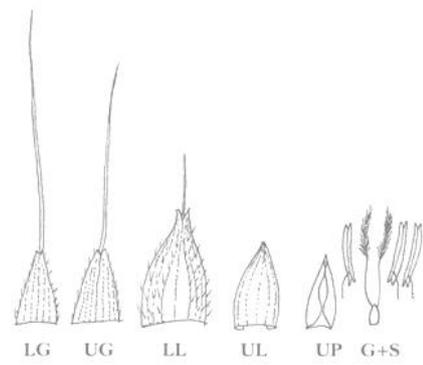
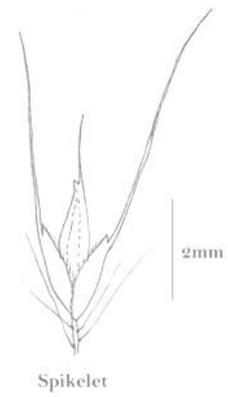


Spikelet



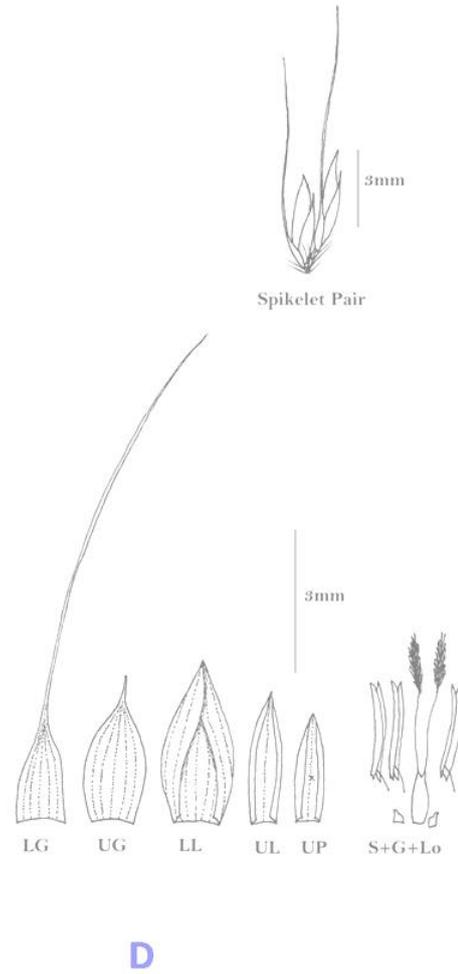
D

A: Habit; B&C: Close-up of Inflorescence; D: Line drawing

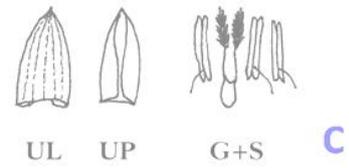
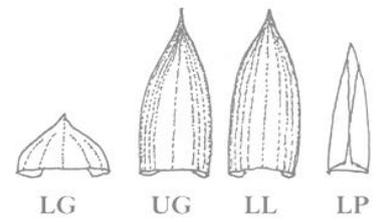
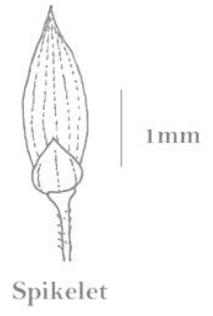


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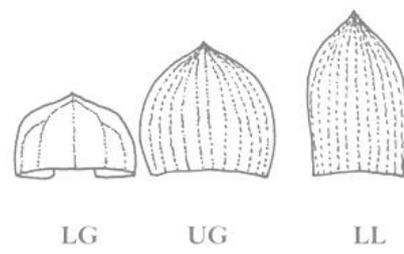
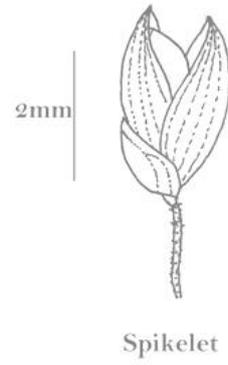
A: Habit; B: Close-up of fungi infected Inflorescence; C: Inflorescence; D: Line drawing



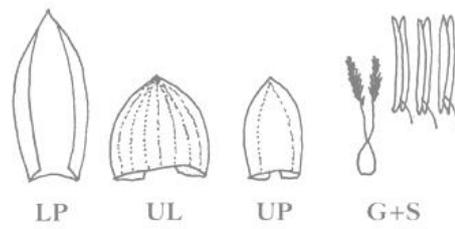
A: Habit; B&C: Close-up of Inflorescence; D: Line drawing



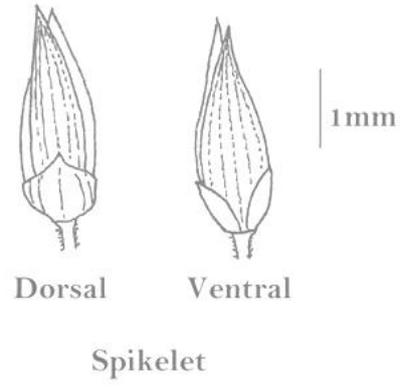
A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing



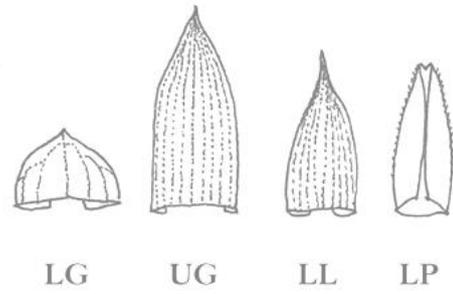
C



A: Habit; B: Inflorescence; C: Line drawing



Spikelet



C



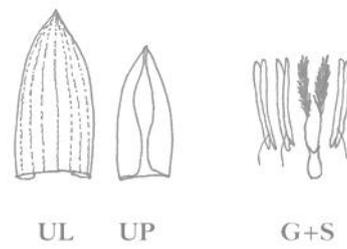
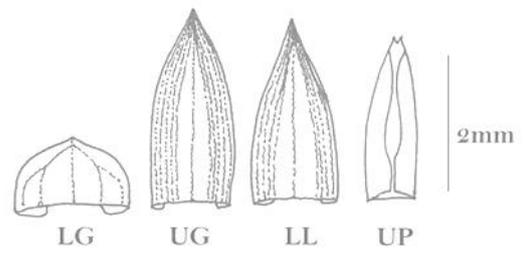
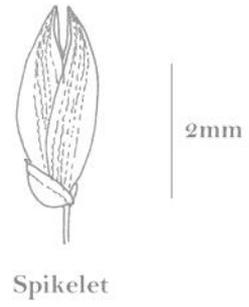
A: Habit; B: Inflorescence; C: Line drawing



A

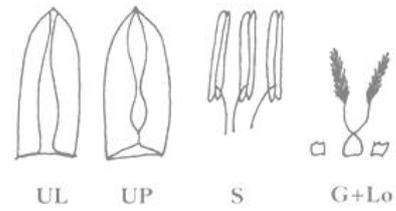
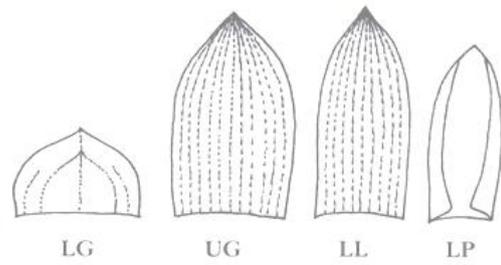
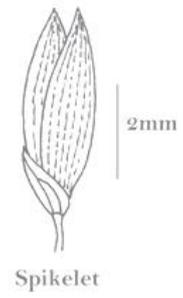


B



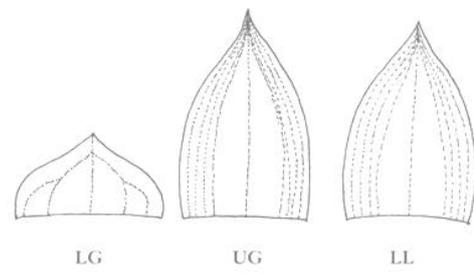
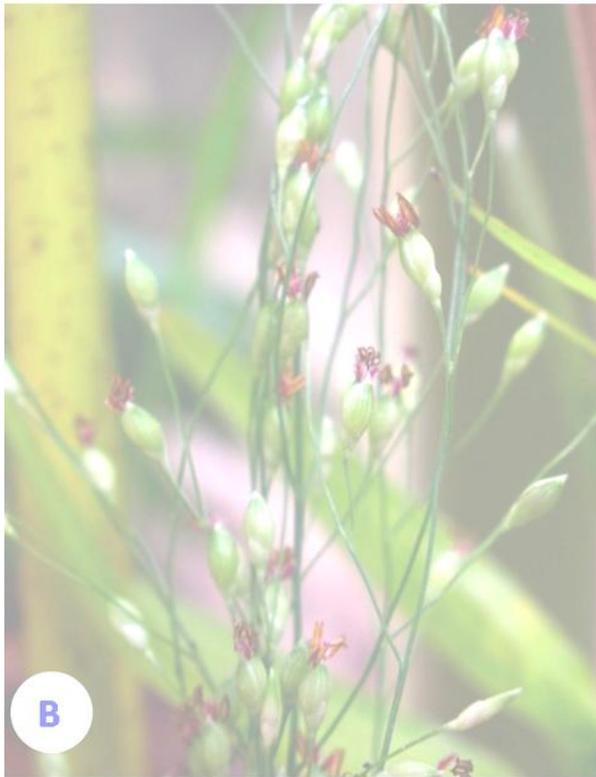
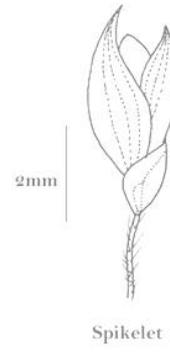
C

A&B: Habit; C: Line drawing

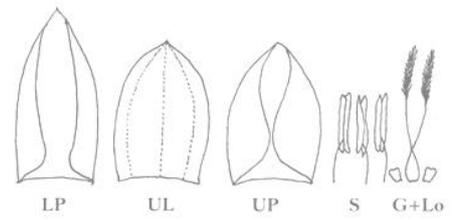


C

A: Habit; B: Inflorescence; C: Line drawing



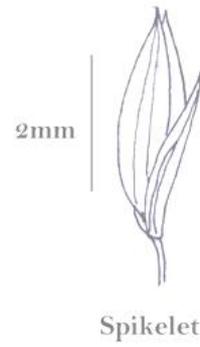
C



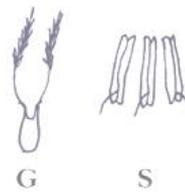
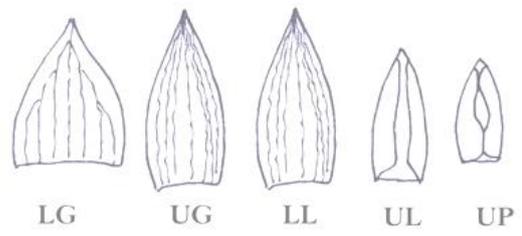
A: Habit; B: Close-up of Inflorescence; C: Line drawing



A



B



C

A: Habit; B: Inflorescence; C: Line drawing

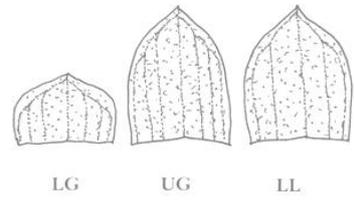


A



Spikelet

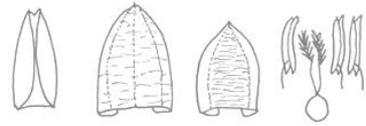
B



LG

UG

LL



LP

UL

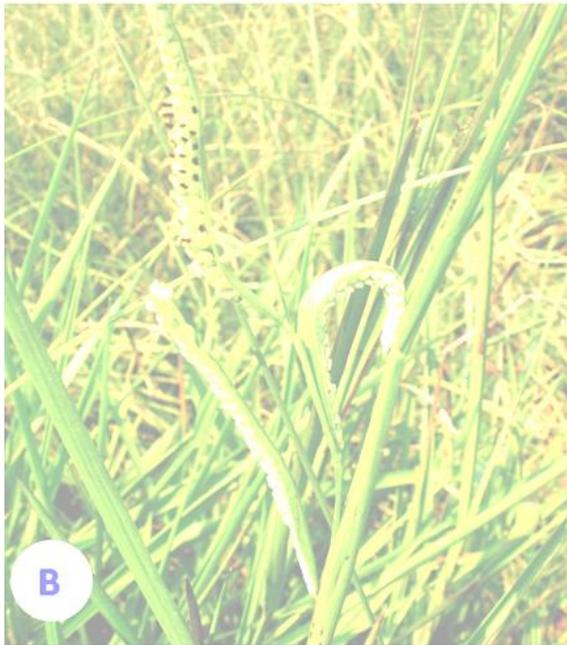
UP

G+S

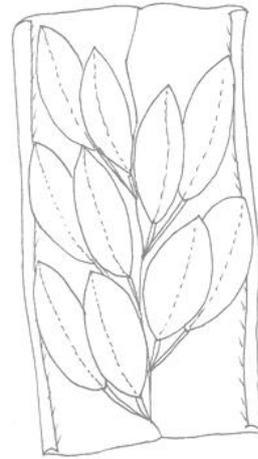
A: Inflorescence; B: Line drawing



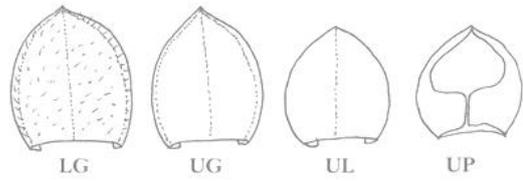
A



B



Spikelets with Rachis

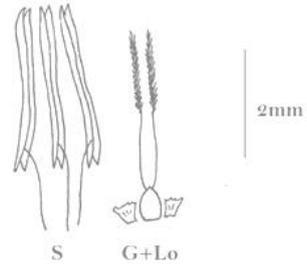


LG

UG

UL

UP



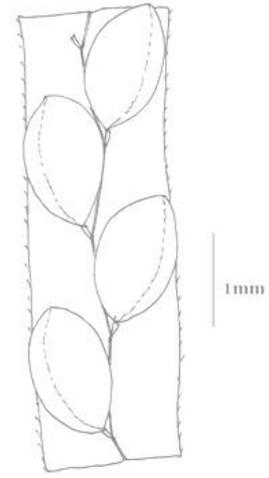
S

G+Lo

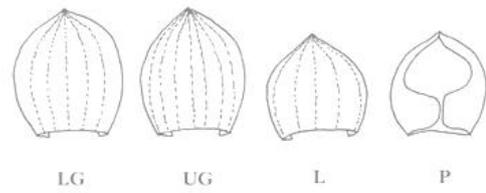
2mm

C

A&B: Inflorescence; C: Line drawing



Spikelets with Rachis

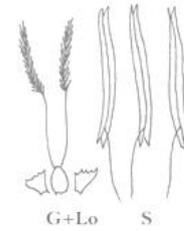


LG

UG

L

P

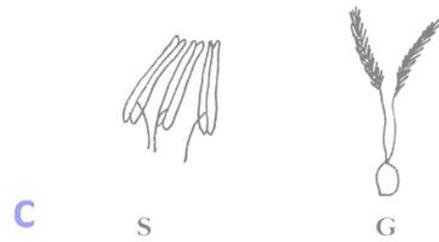
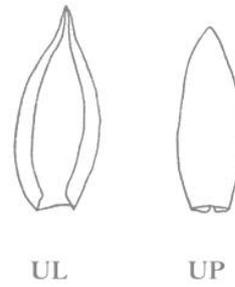
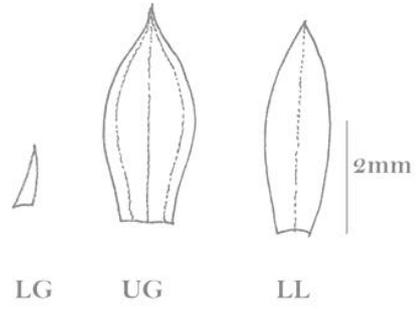


G+Lo

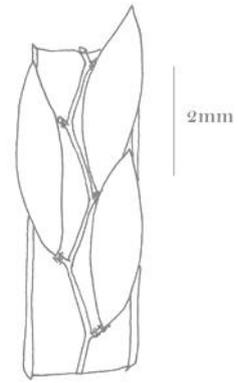
S

D

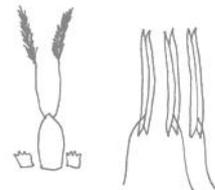
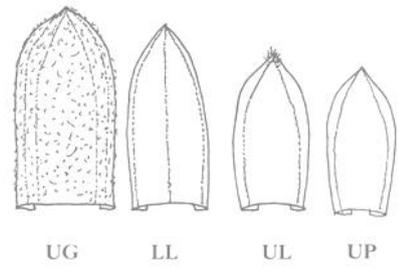
A: Inflorescence; B&C: Close-up of Inflorescence; D: Line drawing



A: Habit; B: Close-up of Inflorescence; C: Line drawing



Part of Spike

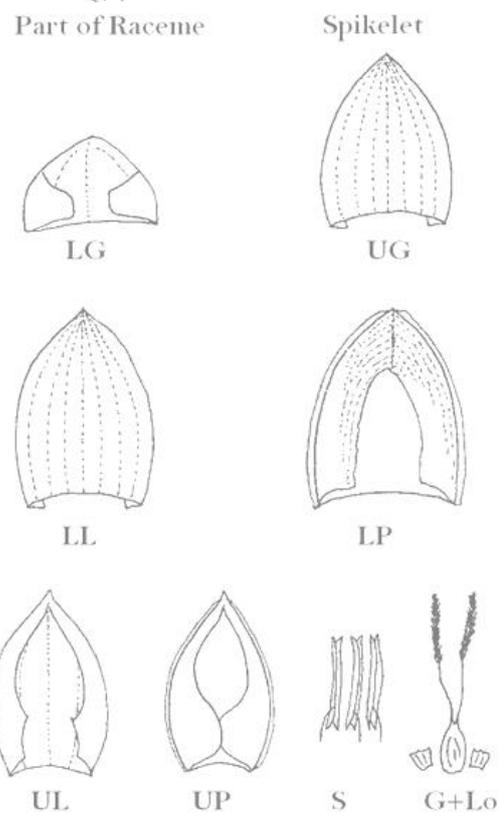
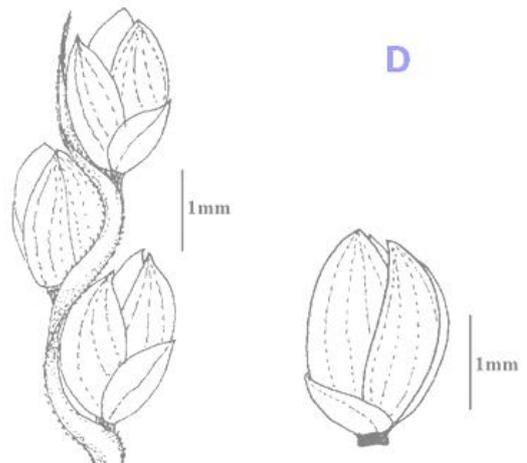


G+Lo

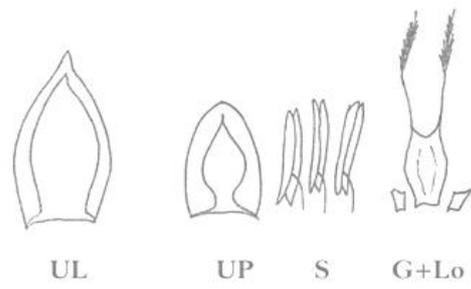
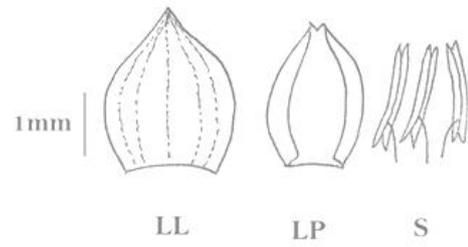
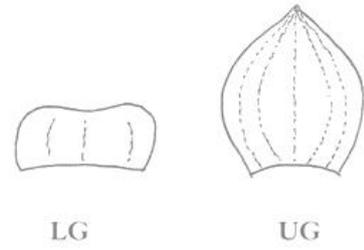
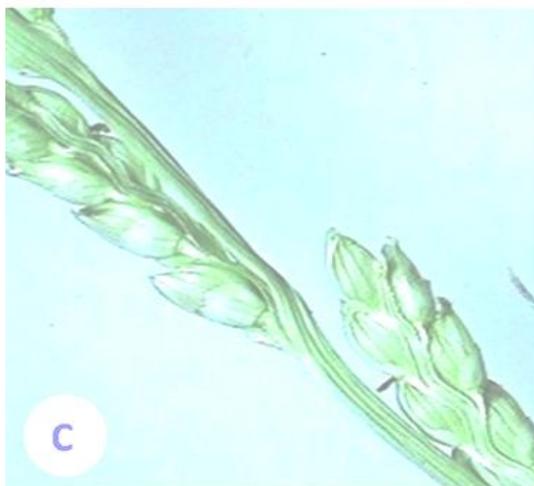
S

C

A: Habit; B: Inflorescence; C: Line drawing

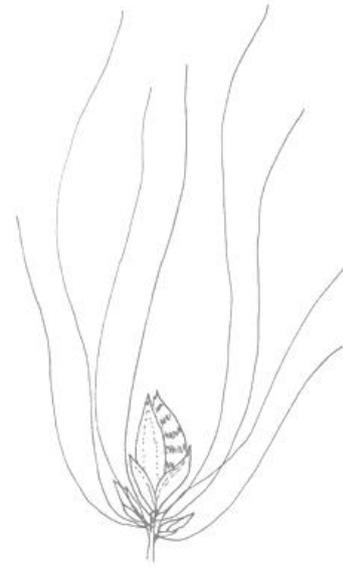


A: Habit; B&C: Close-up of Inflorescence; D: Line drawing

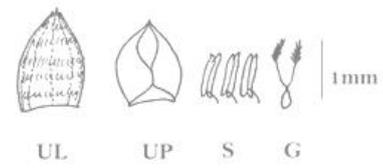
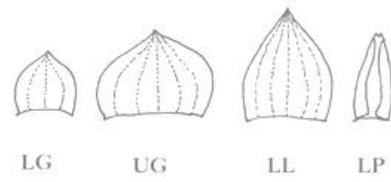


D

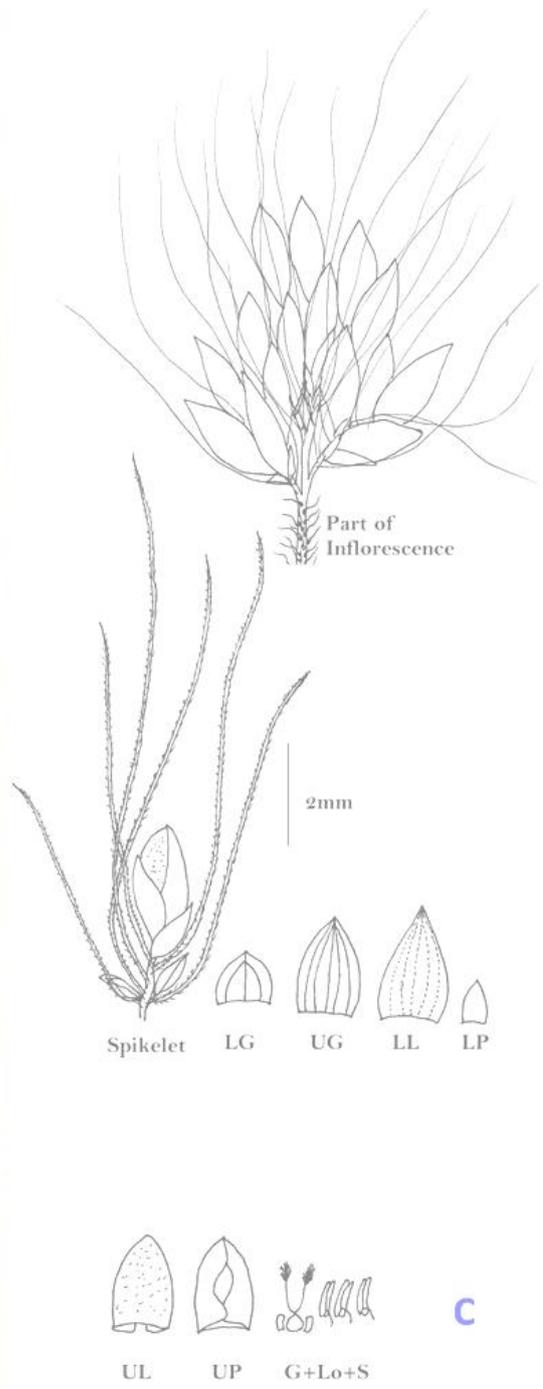
A: Inflorescence; B&C: Close-up of Inflorescence; D: Line drawing



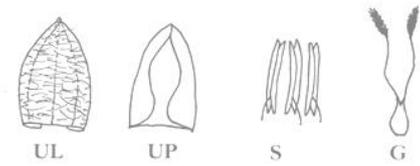
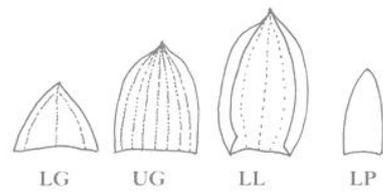
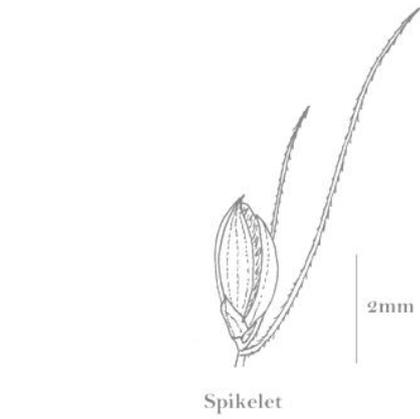
Spikelet



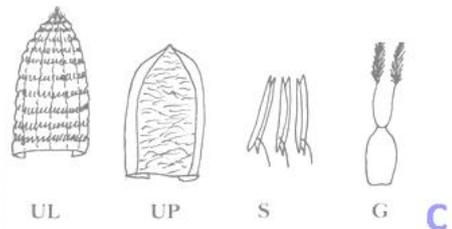
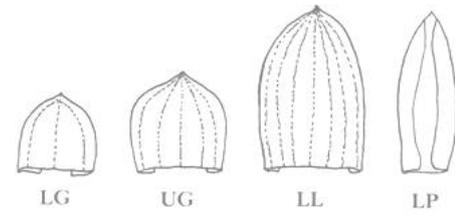
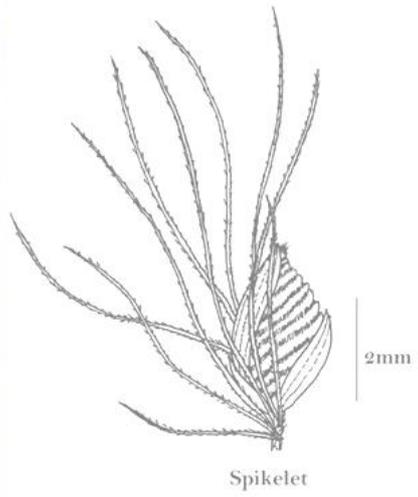
A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



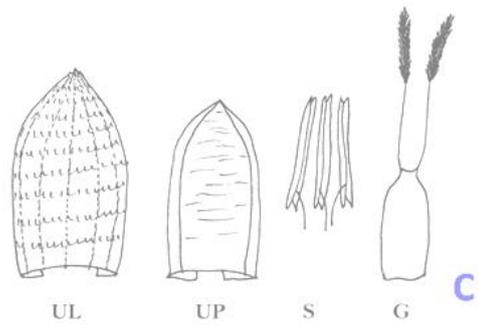
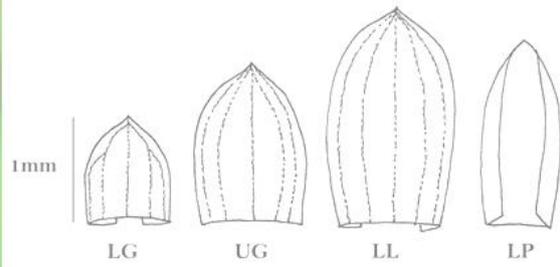
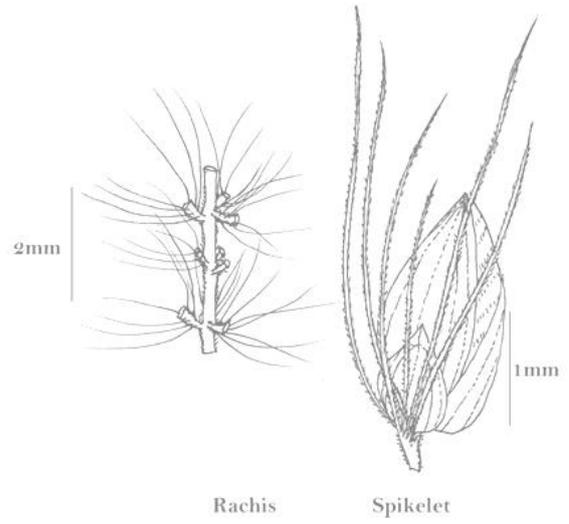
A: Habit; B: Close-up of Inflorescence; C: Line drawing



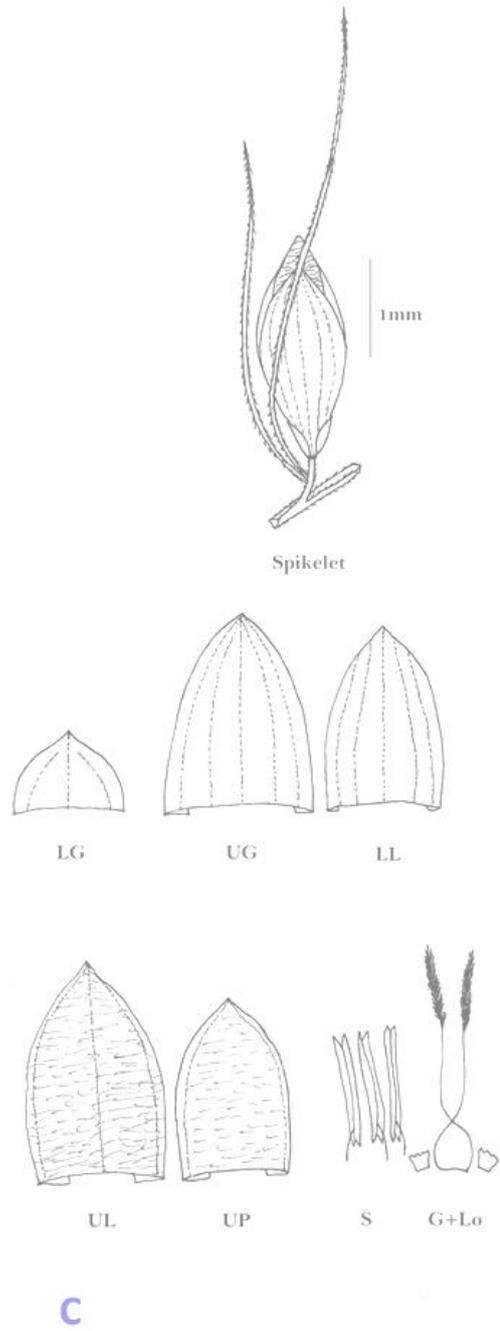
A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing



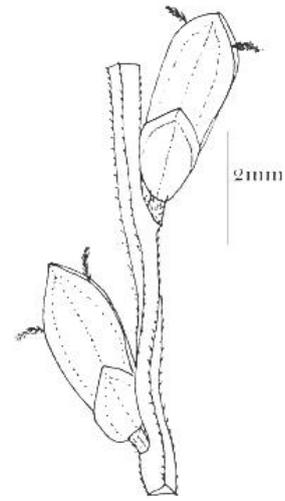
A: Habit; B: Close-up of Inflorescence; C: Line drawing



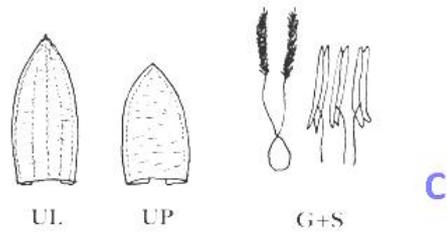
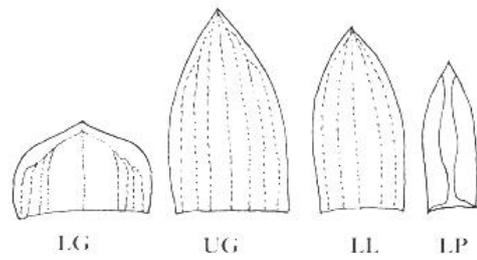
A: Habit; B: Close-up of Inflorescence; C: Line drawing



A: Habit; B: Close-up of Inflorescence; C: Line drawing



Spikelet with Rachis



A: Habit; B: Inflorescence; C: Line drawing



Rachis

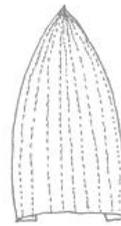


Spikelet

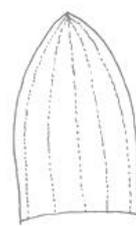
2mm



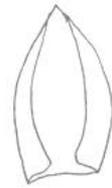
LG



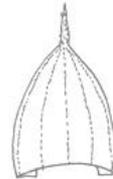
UG



LL



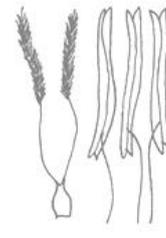
UL



UL



UP



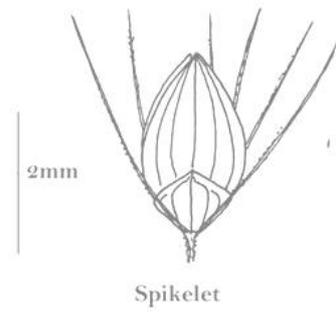
G+S

D

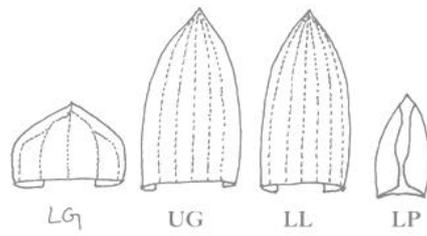
A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



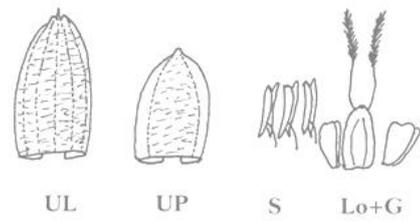
A



B

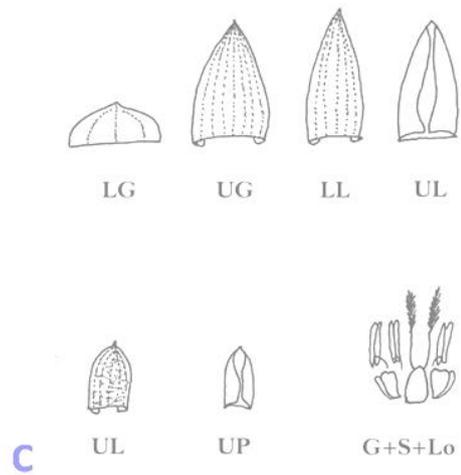
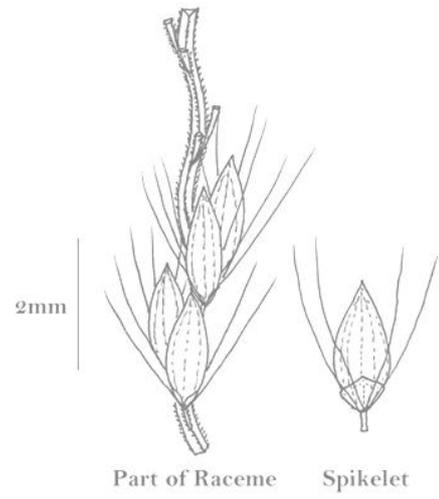


C

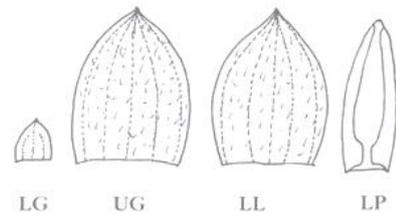
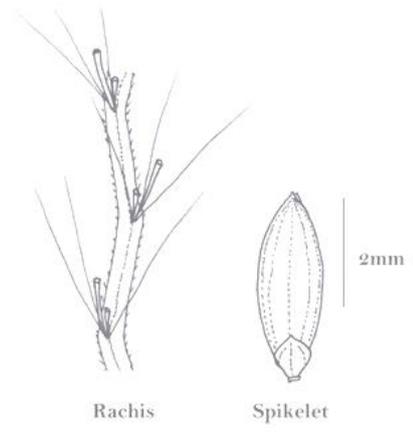
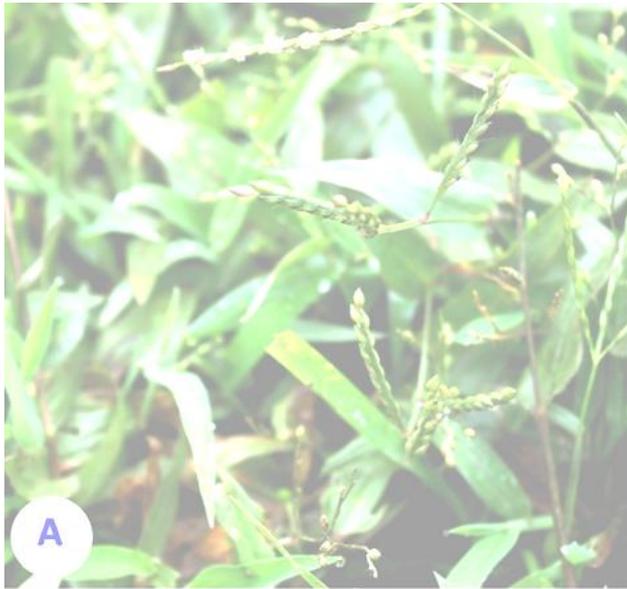


D

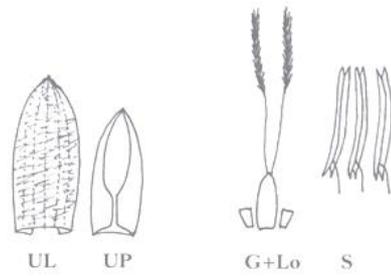
A: Habit; B&C: Close-up of Inflorescence showing variations in hairs of rachis; D: Line drawing



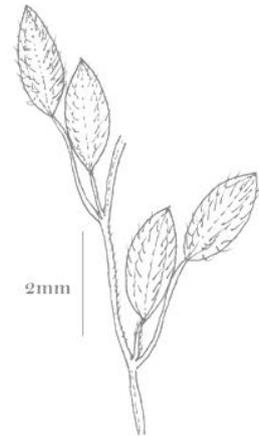
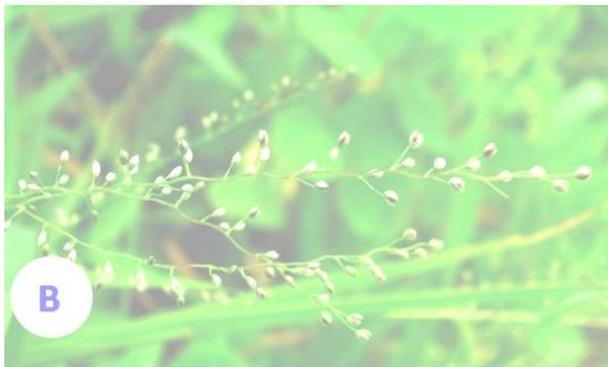
A: Habit; B: Inflorescence; C: Line drawing



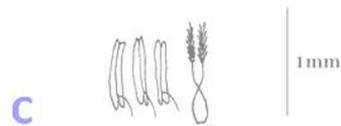
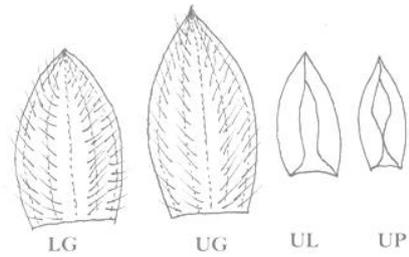
C



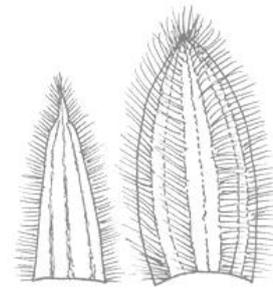
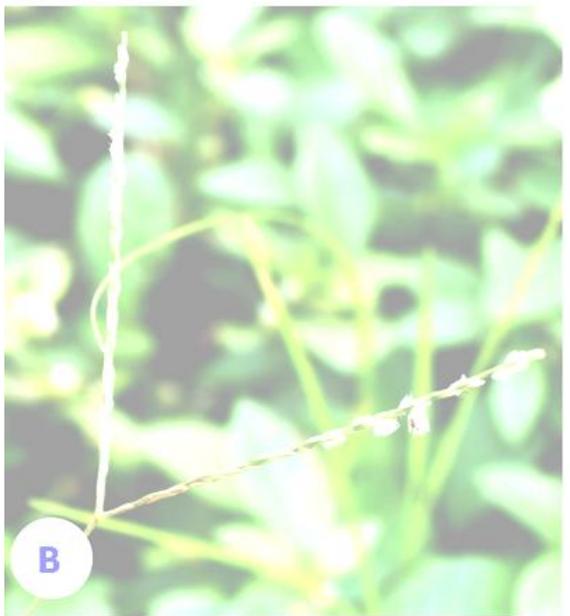
A: Habit; B: Inflorescence; C: Line drawing



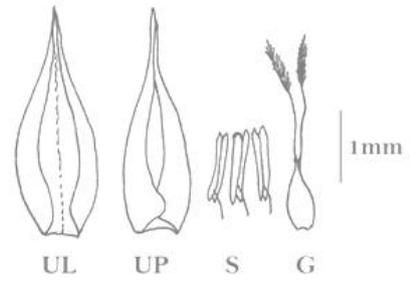
Spikelets with Rachis



A: Habit; B: Close-up of Inflorescence; C: Line drawing

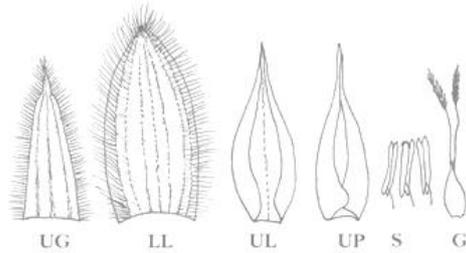


UG LL



UL UP S G

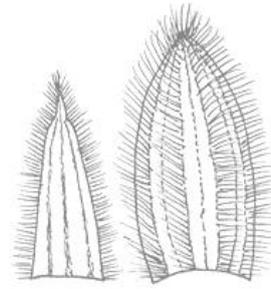
Pedicelled Spikelet **C**



UG LL UL UP S G

Sessile Spikelet

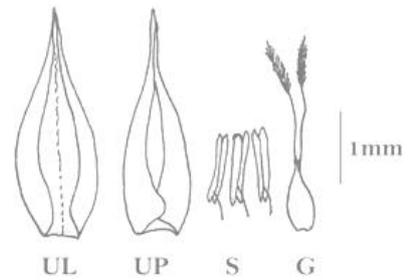
A: Habit; B: Inflorescence; C: Line drawing



UG

LL

D



UL

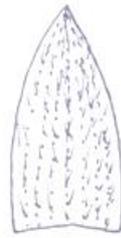
UP

S

G

1mm

A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



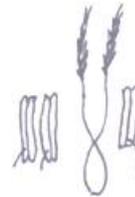
UG



LL



UL



G+S



UP

1mm

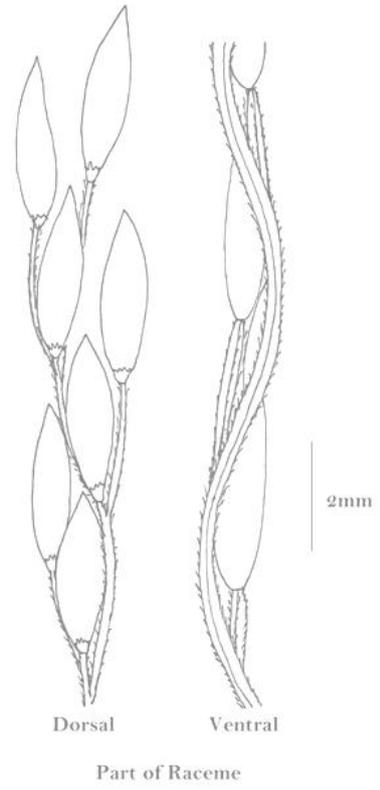
A: Habit; B: Inflorescence; C: Line drawing



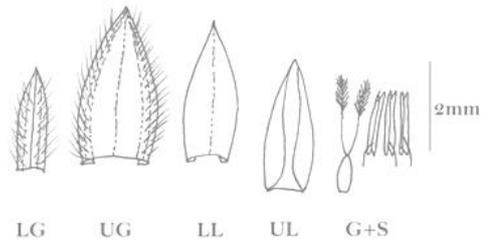
A



B



C



A: Habit; B: Inflorescence; C: Line drawing



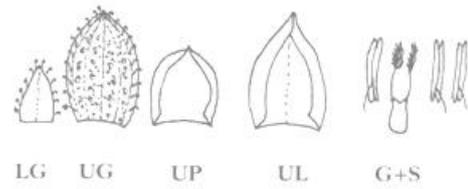
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Spikelets with Rachis



B



LG UG UP UL G+S

E

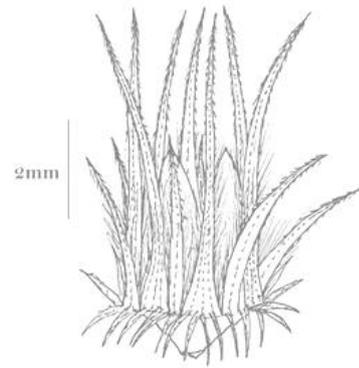
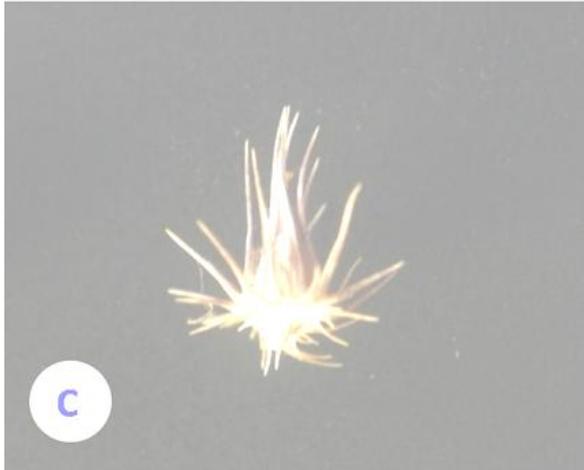


C

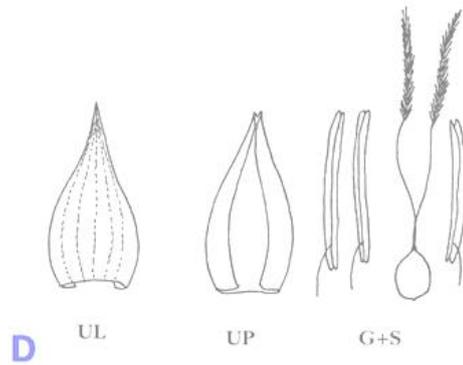
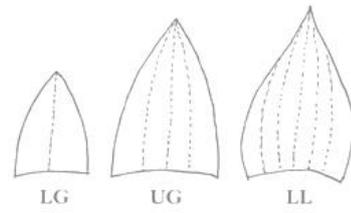


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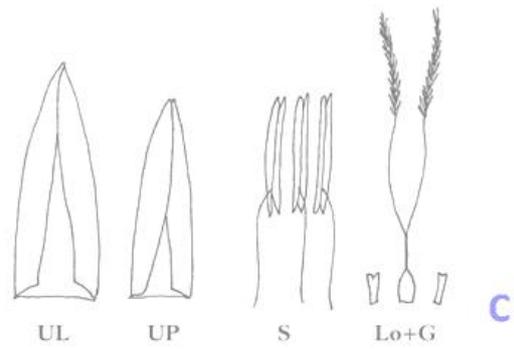
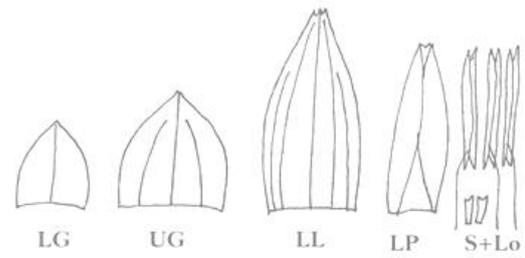
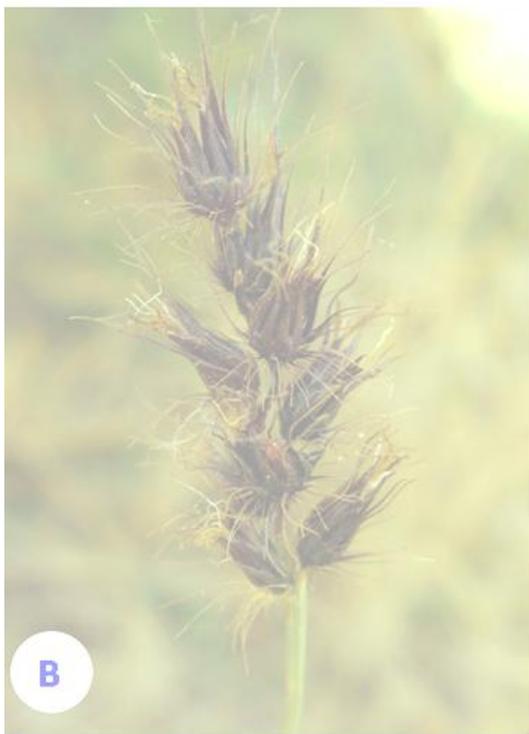
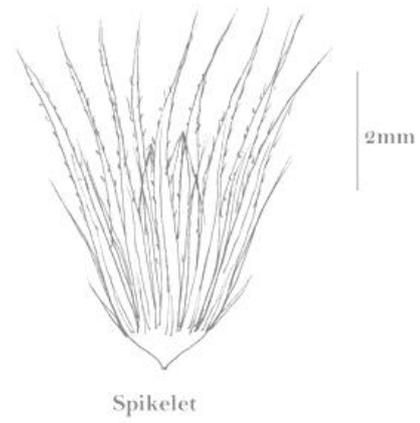
A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Spikelets showing variations in hairs of the spikelets; E: Line drawing



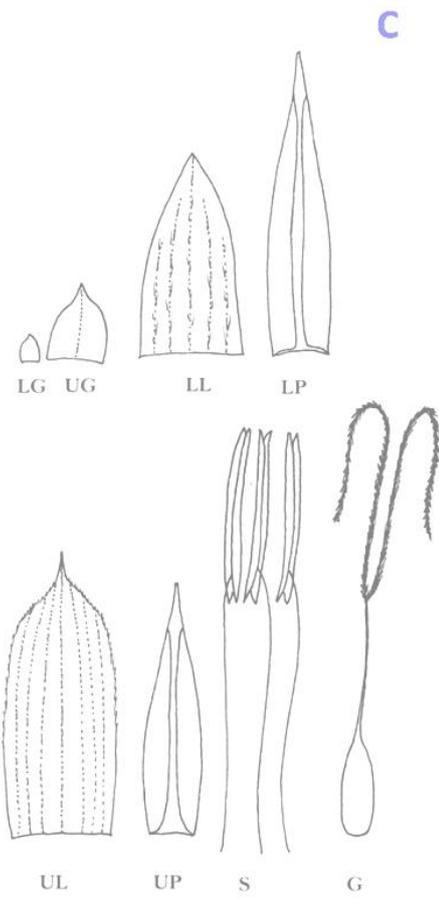
Spikelet Cluster



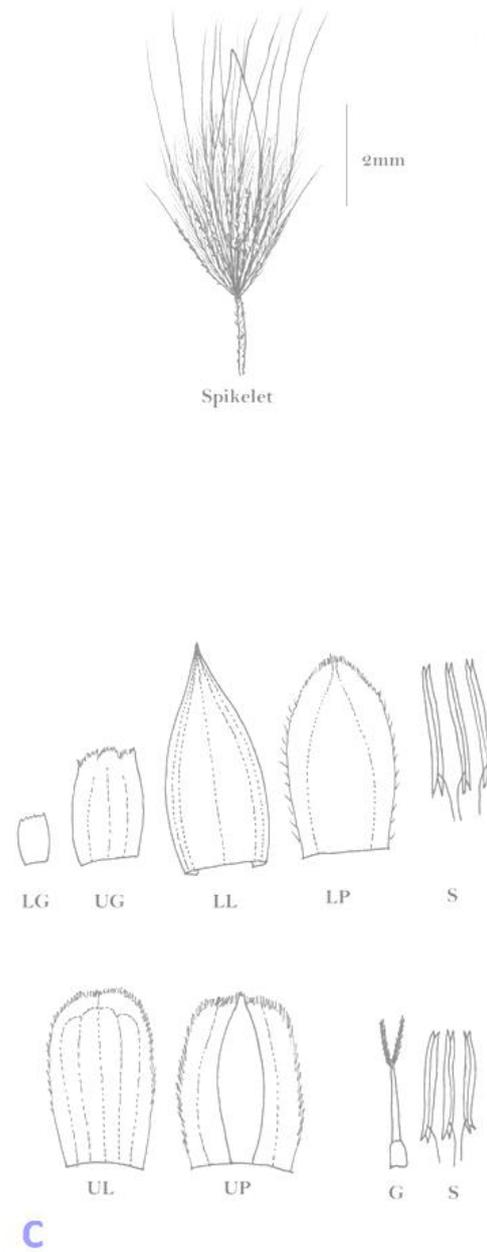
A: Habit; B: Close-up of Inflorescence; C: Spikelet with Involucral bristles; D: Line drawing



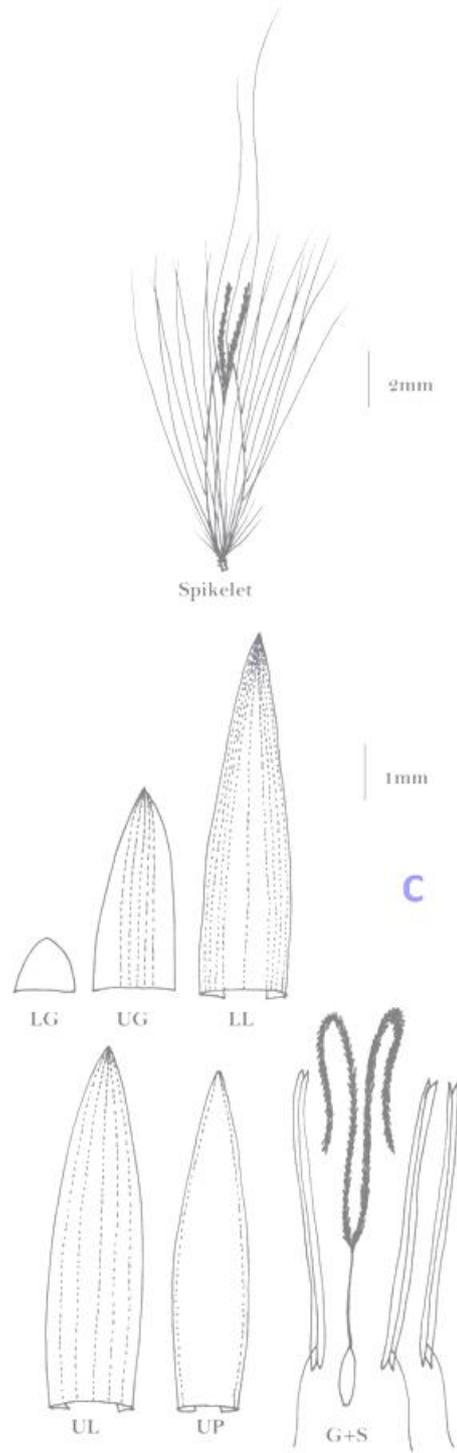
A: Habit; B: Close-up of Inflorescence; C: Line drawing



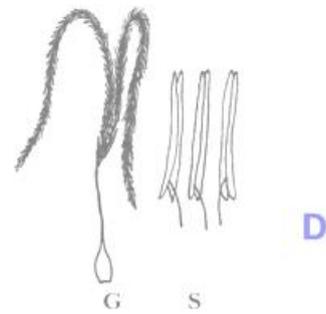
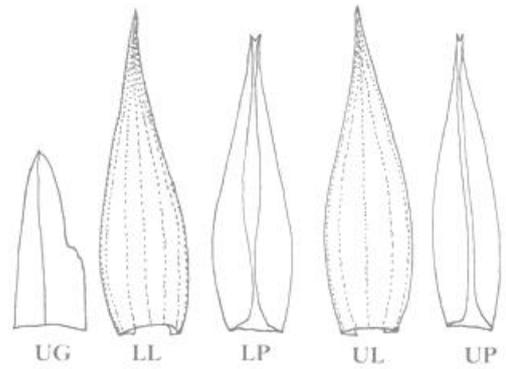
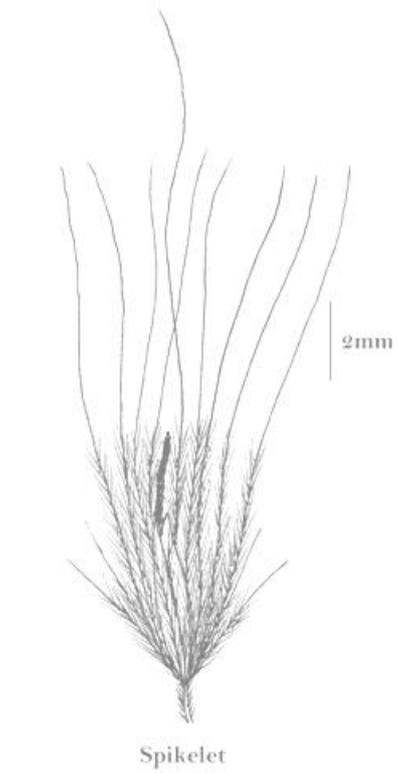
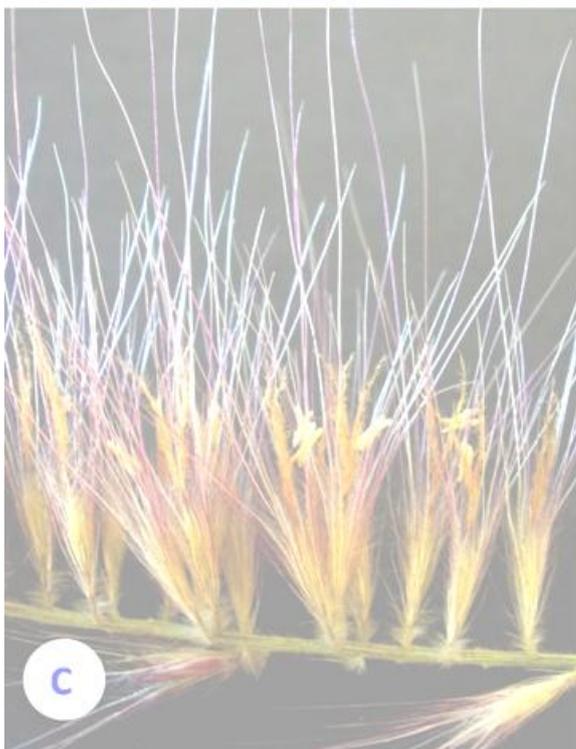
A: Habit; B: Close-up of Inflorescence; C: Line drawing



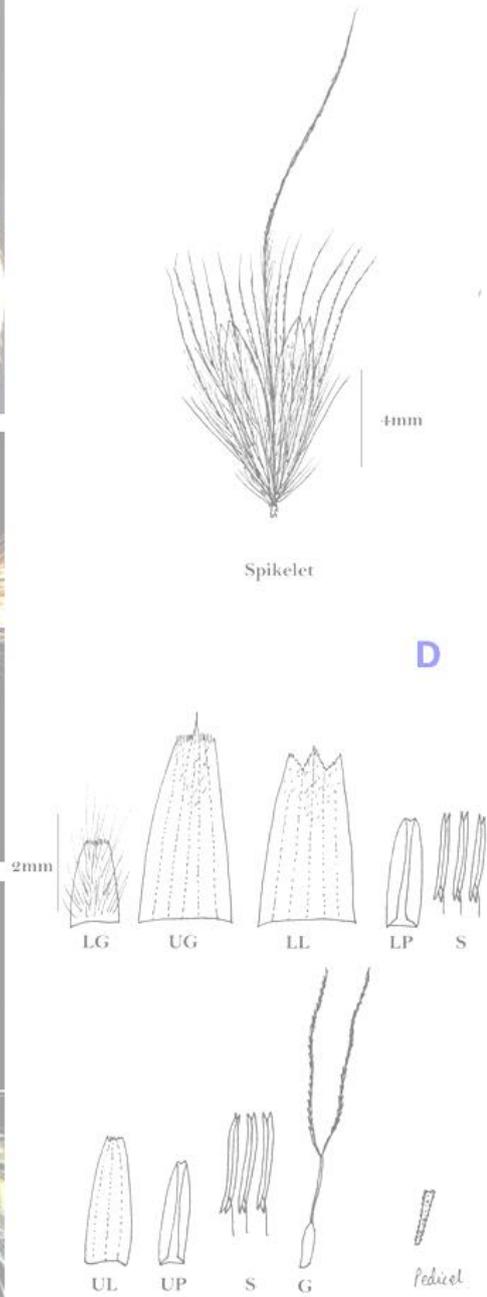
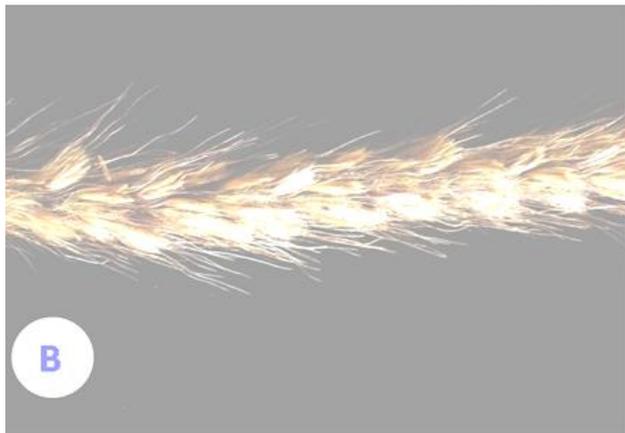
A: Habit; B: Inflorescence; C: Line drawing



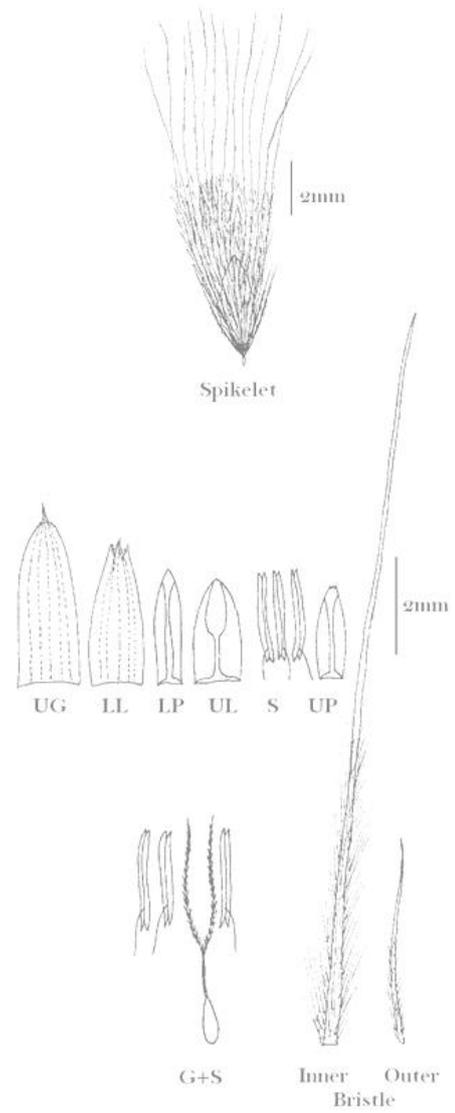
A: Habit; B: Close-up of Inflorescence; C: Line drawing



A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing

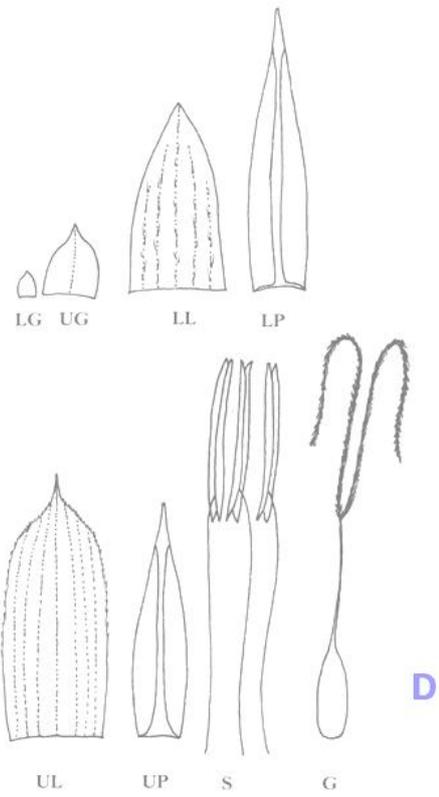
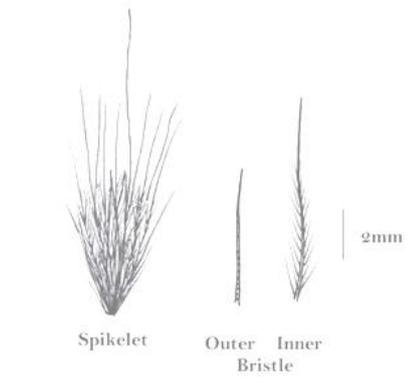


A: Inflorescence; B&C: Close-up of Inflorescence; D: Line drawing

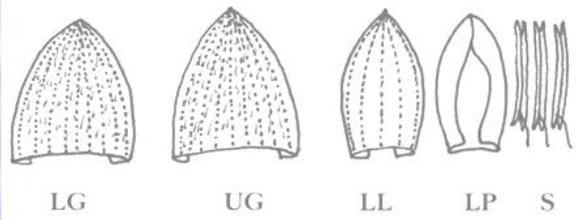


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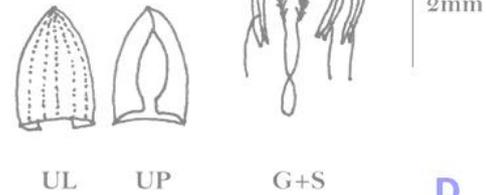
A: Habit; B: Inflorescence; C: Line drawing



A: Habit; B&C: Inflorescence; D: Line drawing

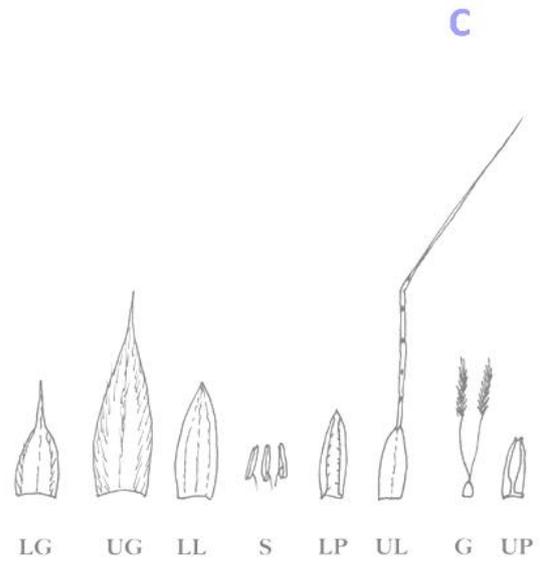
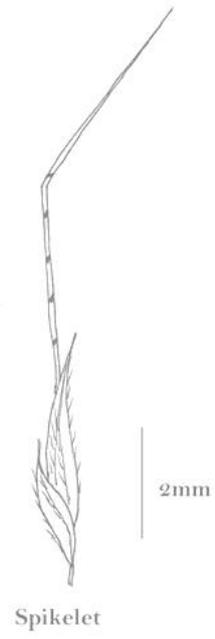
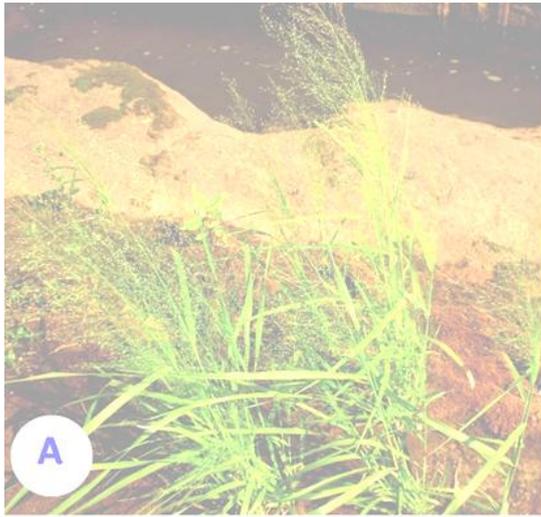


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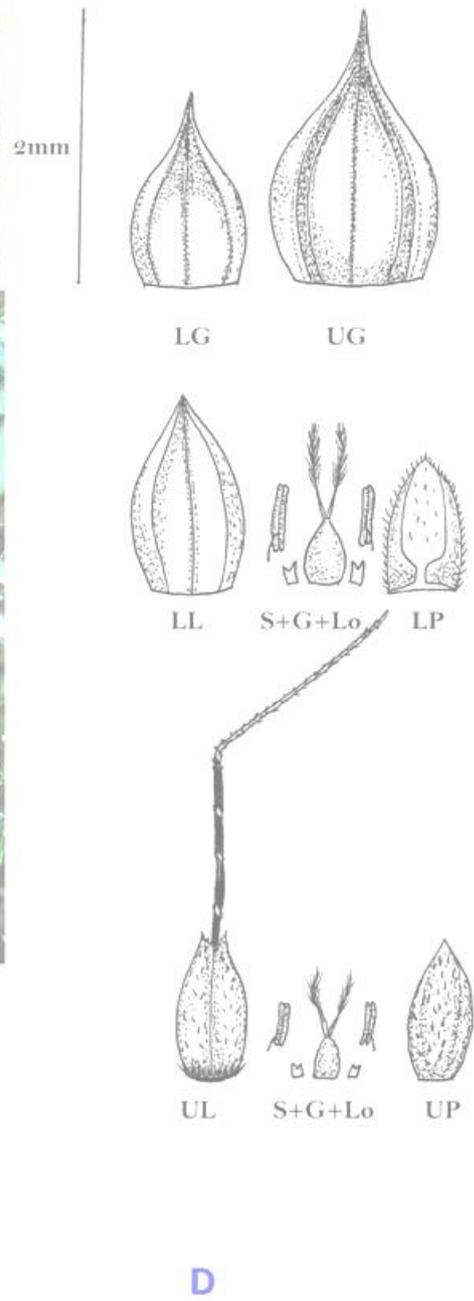


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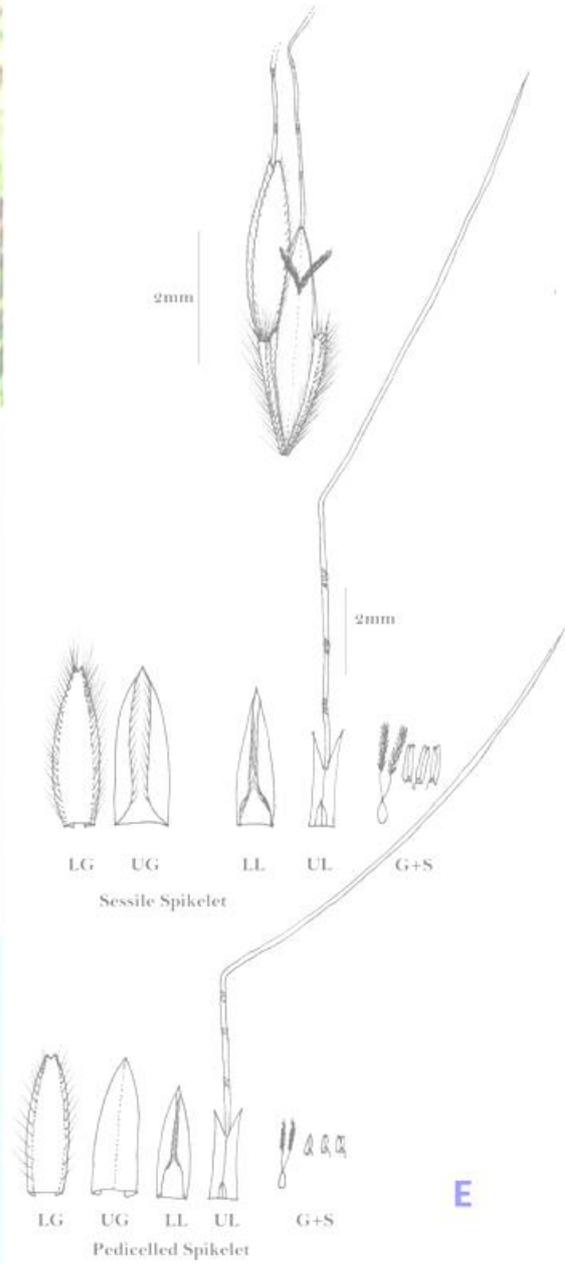
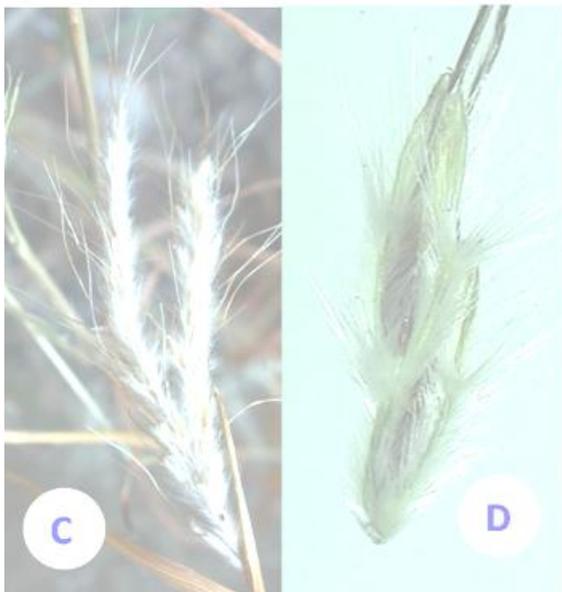
A: Habit; B: Inflorescence; C: spikelet showing pseudovivipary; D: Line drawing



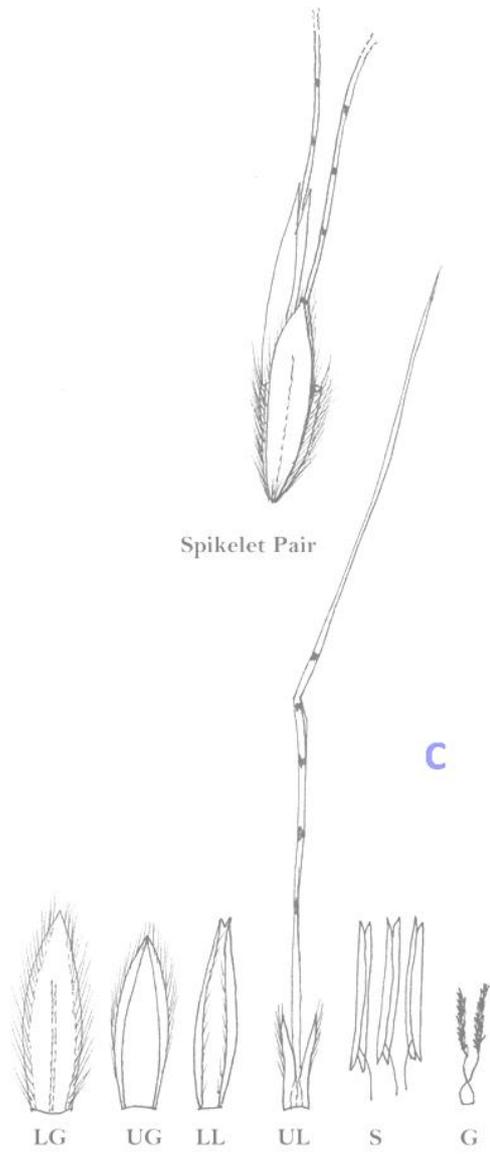
A: Habit; B: Close-up of Inflorescence; C: Line drawing



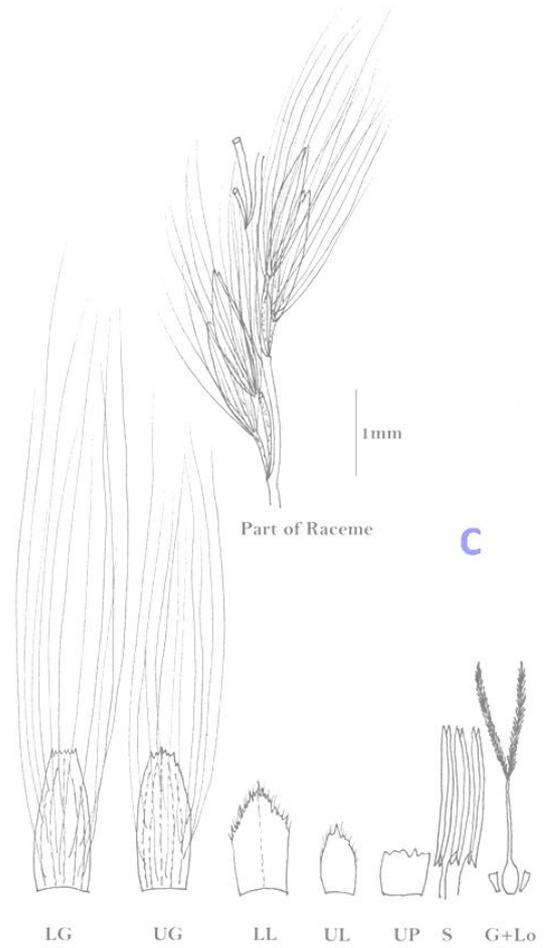
A-C: Inflorescence; D: Line drawing



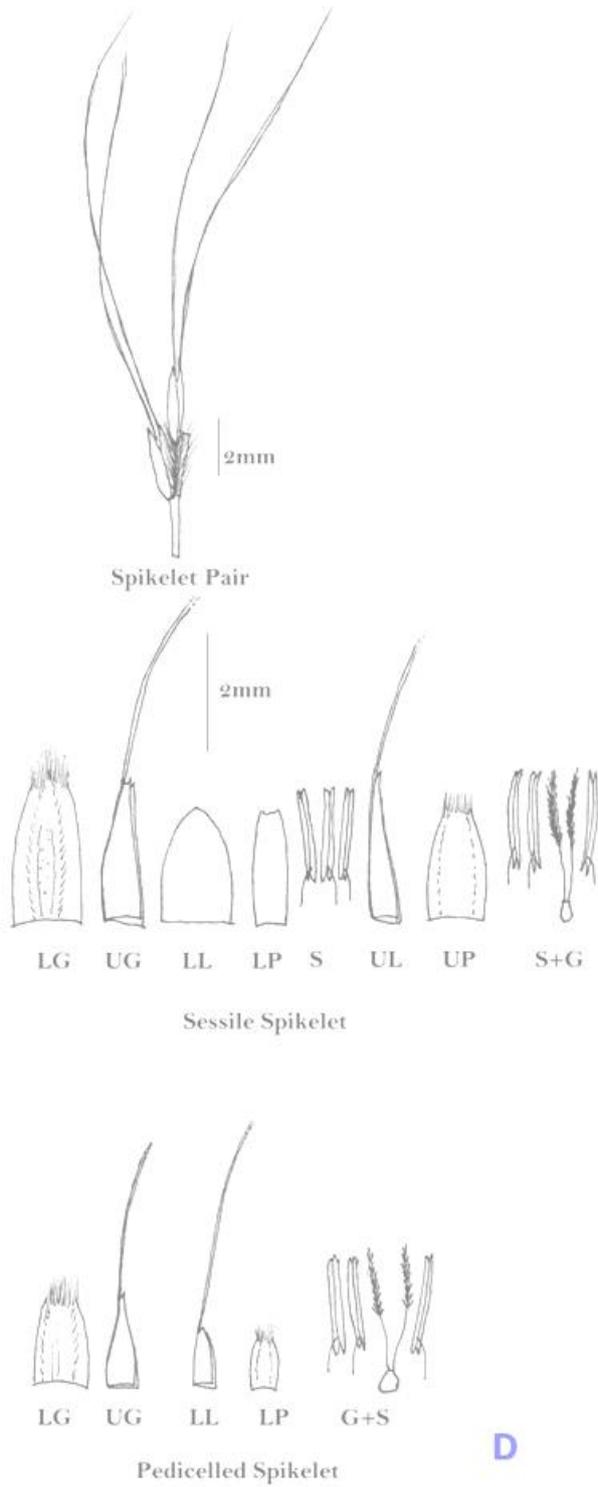
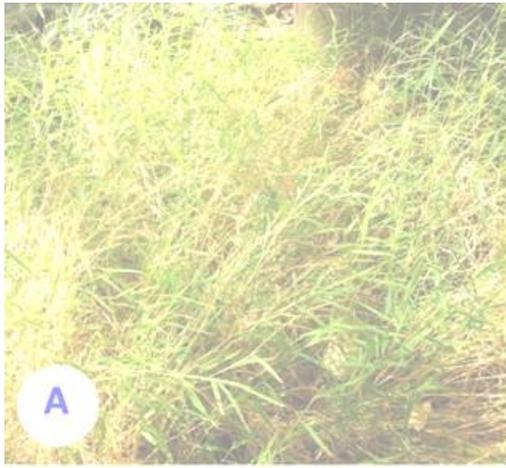
A: Habit; B&C: Close-up of Inflorescence; D: Spikelet pair; E: Line drawing



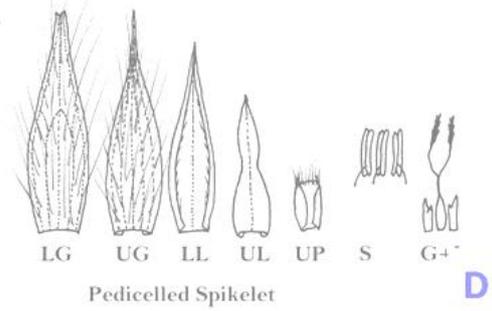
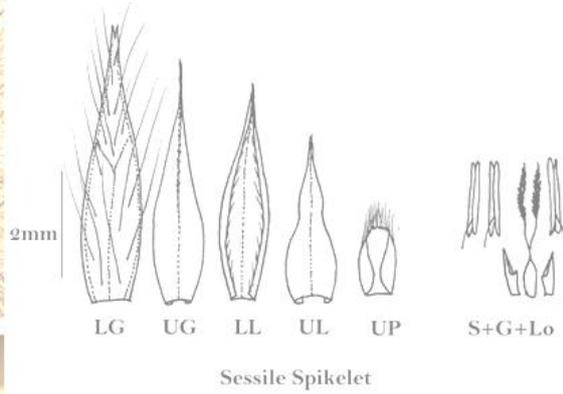
A: Habit; B: Inflorescence; C: Line drawing



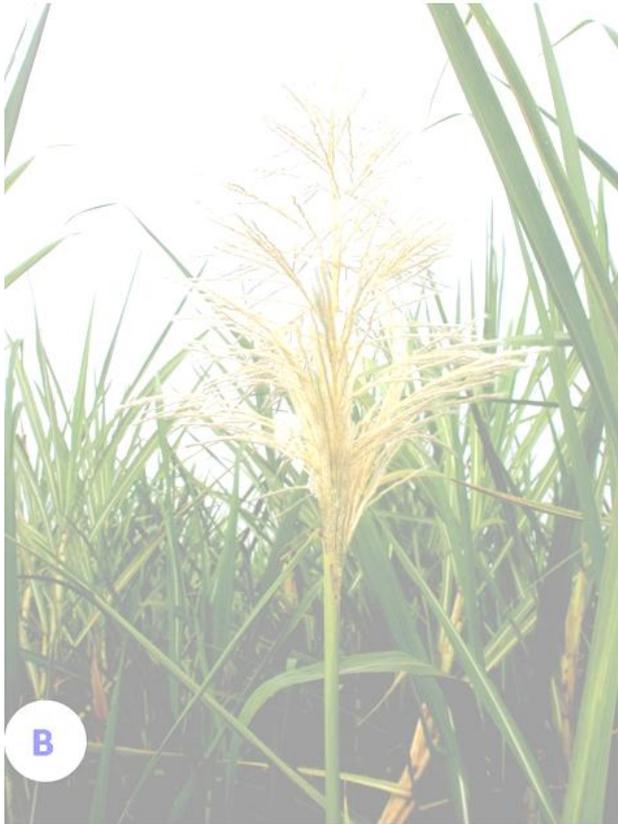
A: Habit; B: Inflorescence; C: Line drawing



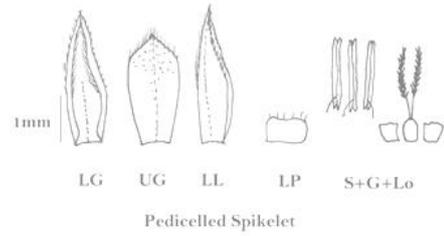
A: Habit; B&C: Inflorescence; D: Line drawing



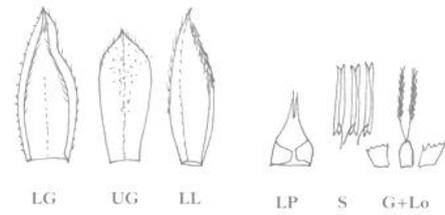
A: Inflorescence; B&C: Close-up of Inflorescence; D: Line drawing



Spikelet Pair



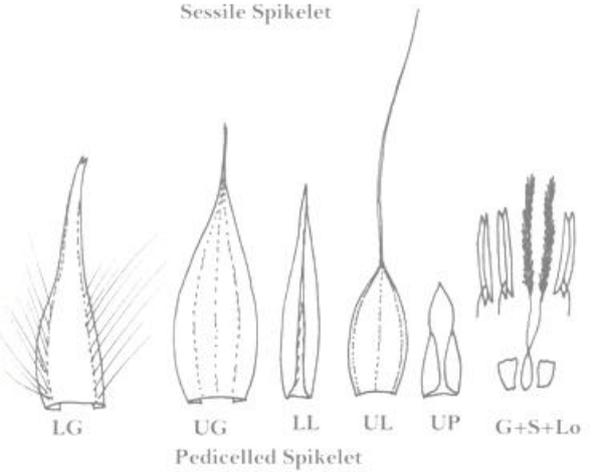
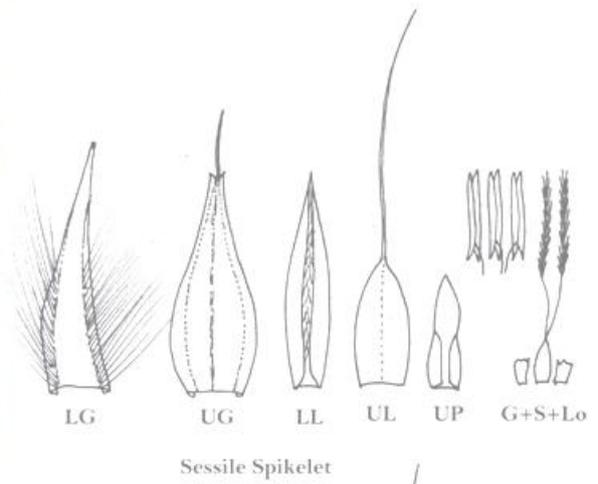
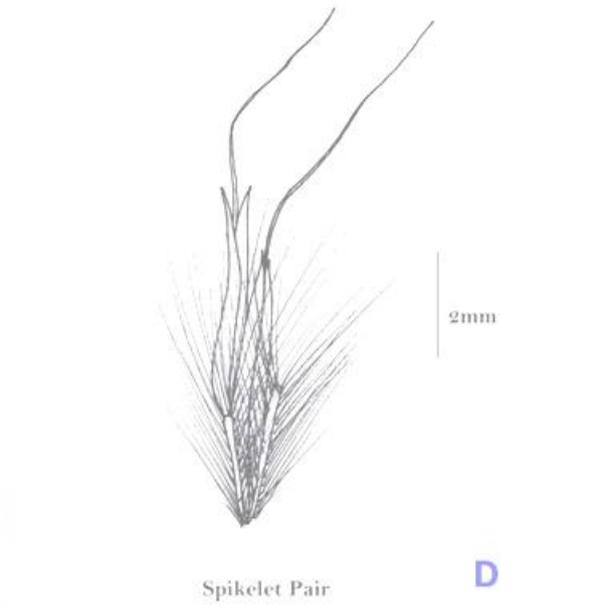
Pedicelled Spikelet



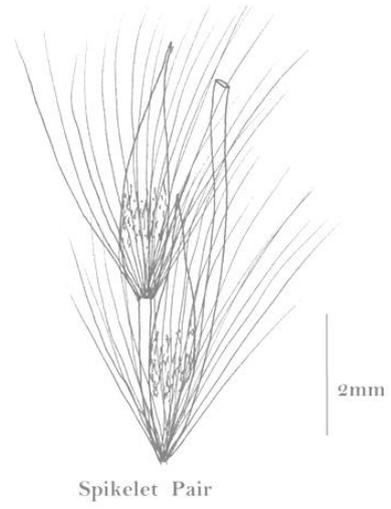
Sessile Spikelet

C

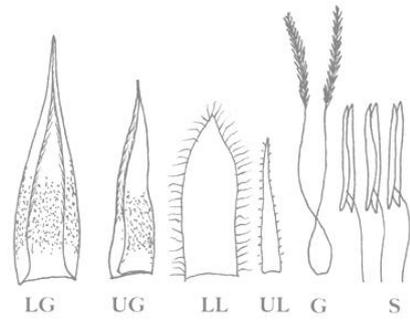
A: Habit; B: Inflorescence; C: Line drawing



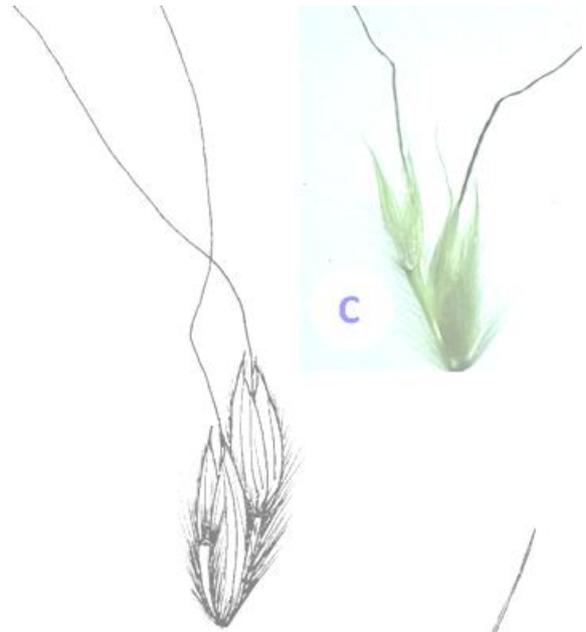
A: Habit; B&C: Close-up of Inflorescence; D: Line drawing



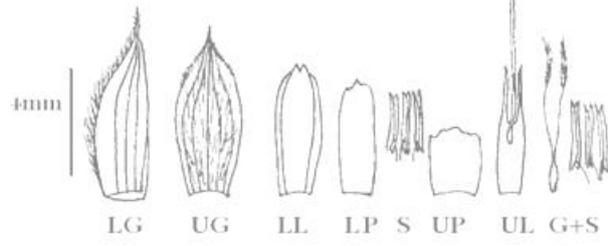
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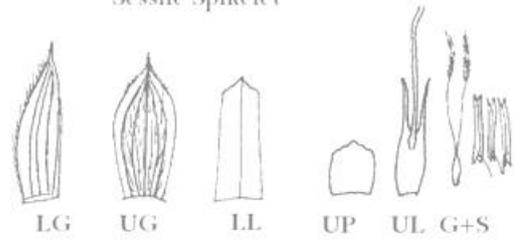
A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



Spikelet Pair

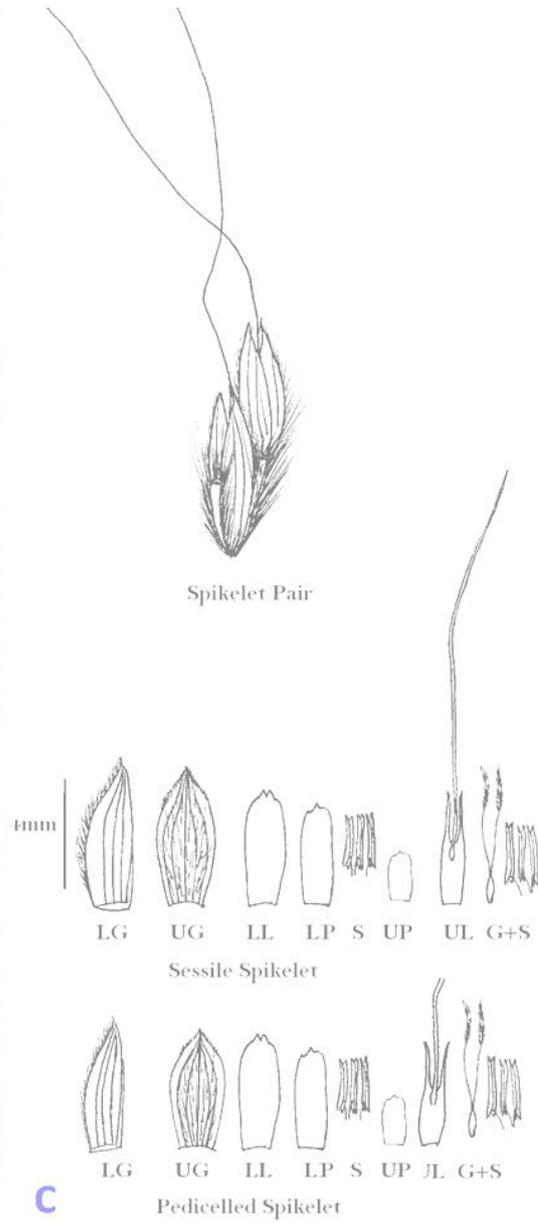


Sessile Spikelet



Pedicelled Spikelet

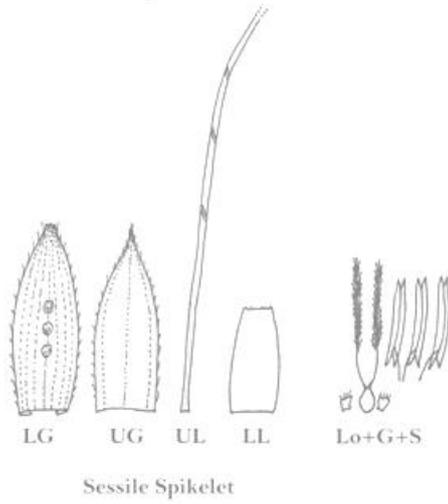
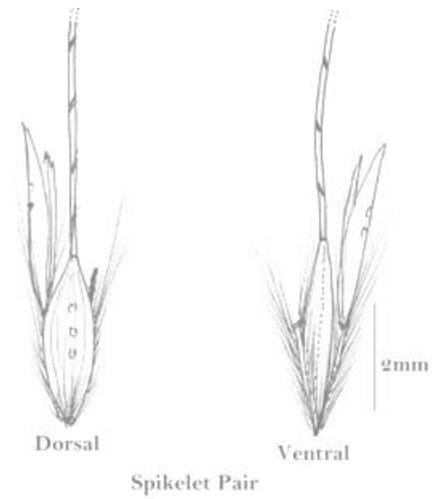
A: Habit; B: Inflorescence; C: Spikelet pair; D: Line drawing



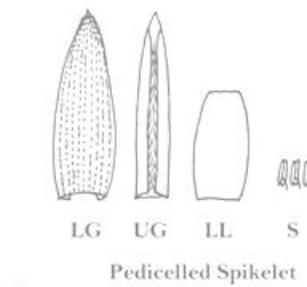
A: Habit; B: Inflorescence; C: Line drawing



A&B: Habit; C: Close-up of Inflorescence; D: Spikelet; E: Line drawing

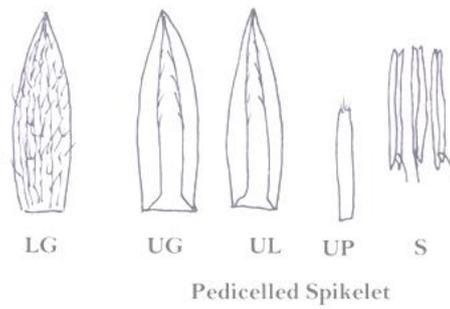
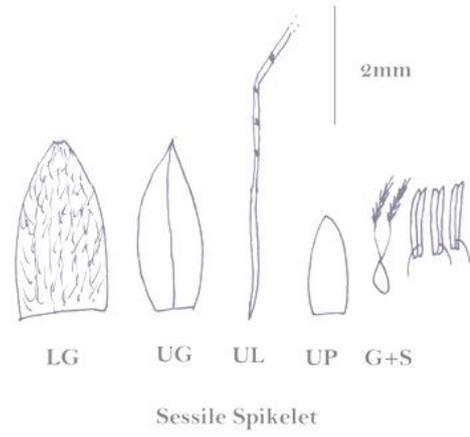


D



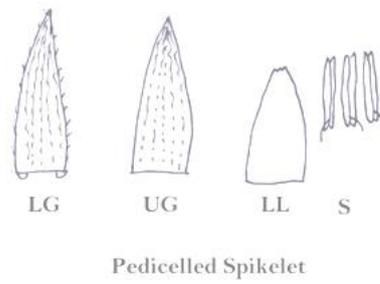
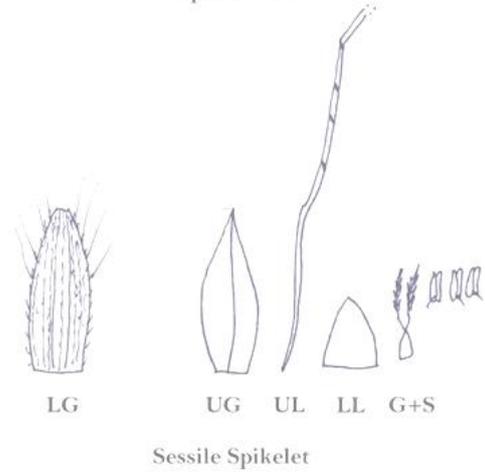
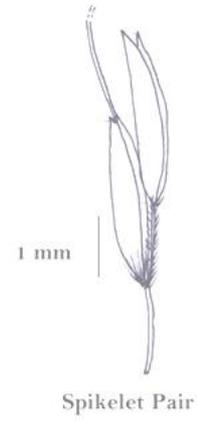
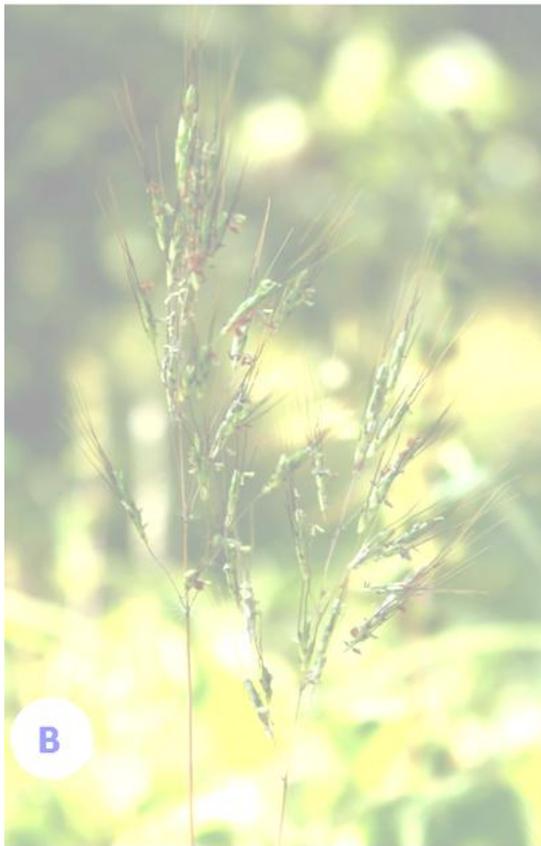
E

A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Spikelet pairs; E: Line drawing



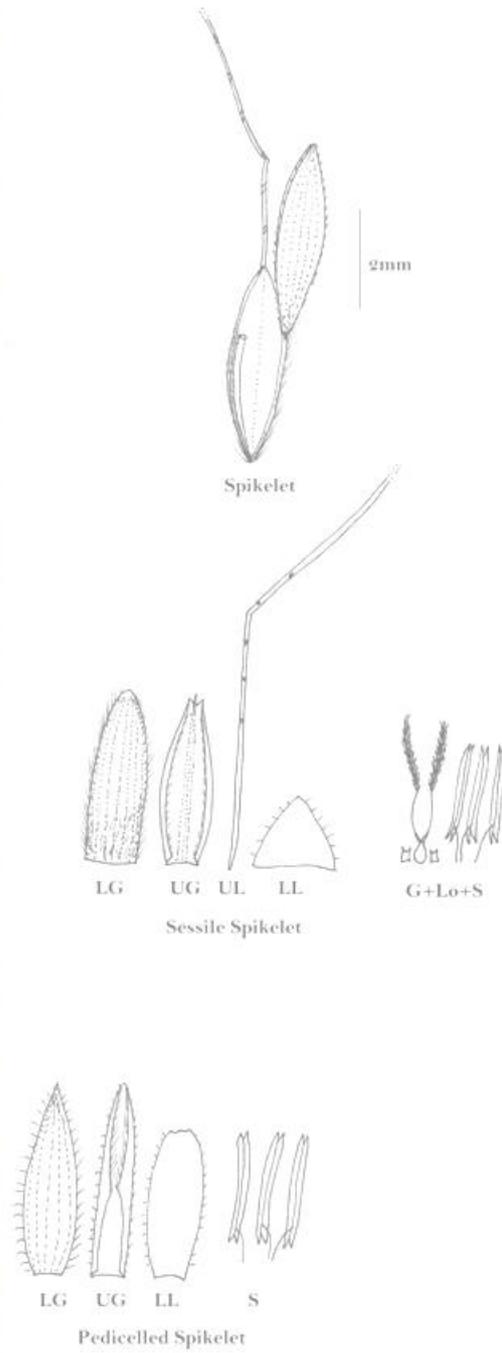
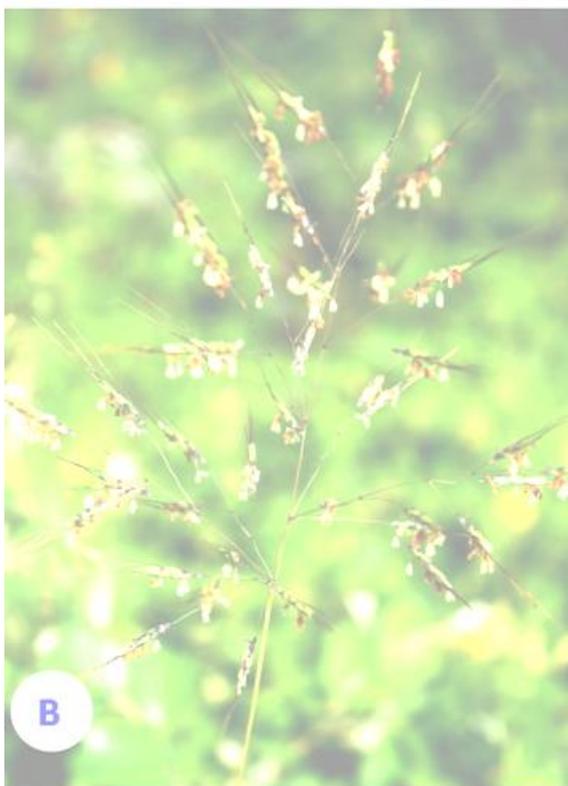
C

A: Habit; B: Inflorescence; C: Line drawing



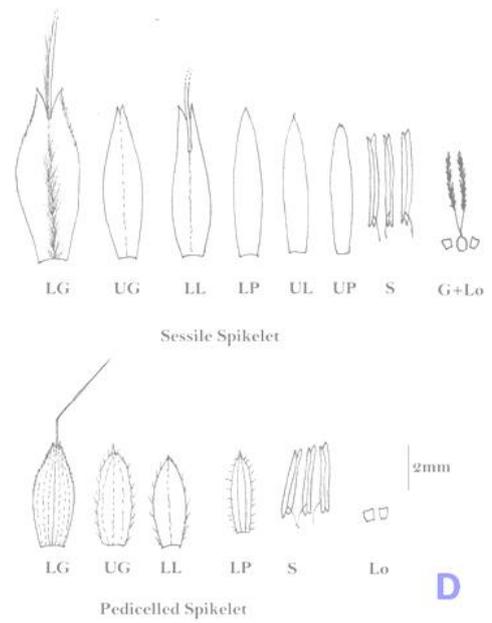
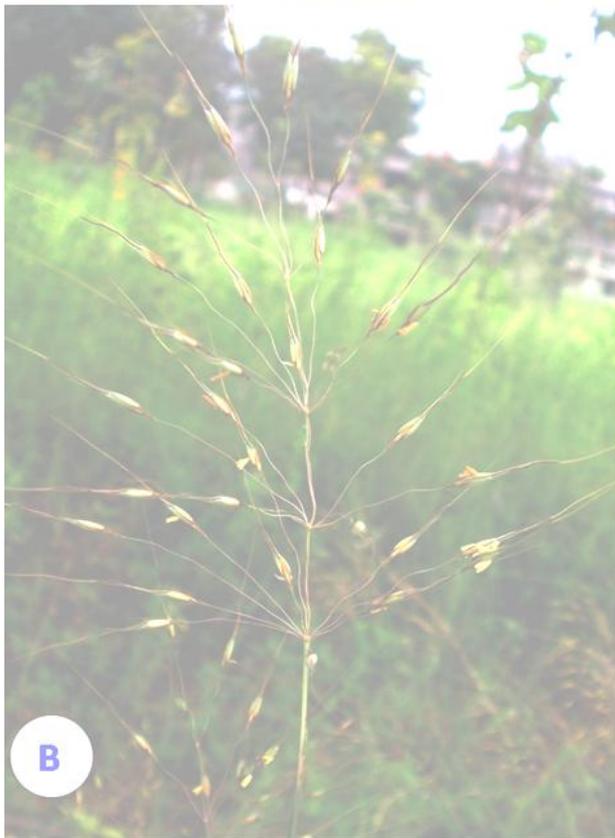
C

A&B: Inflorescence; C: Line drawing

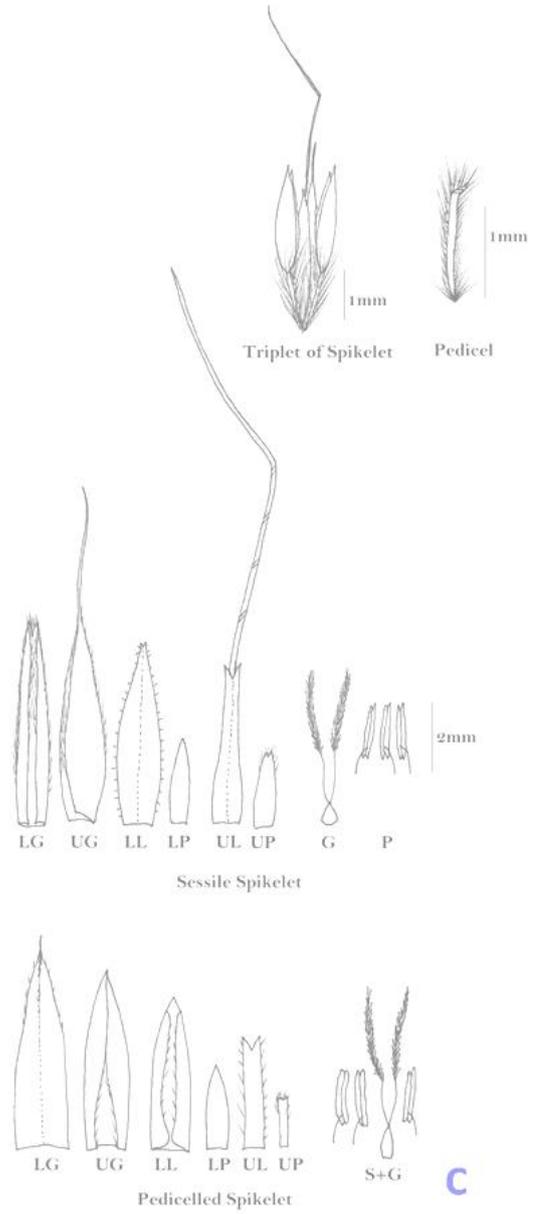
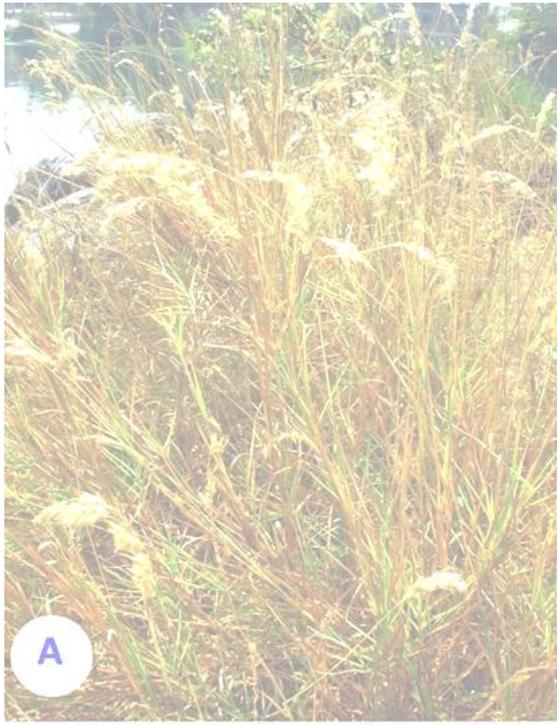


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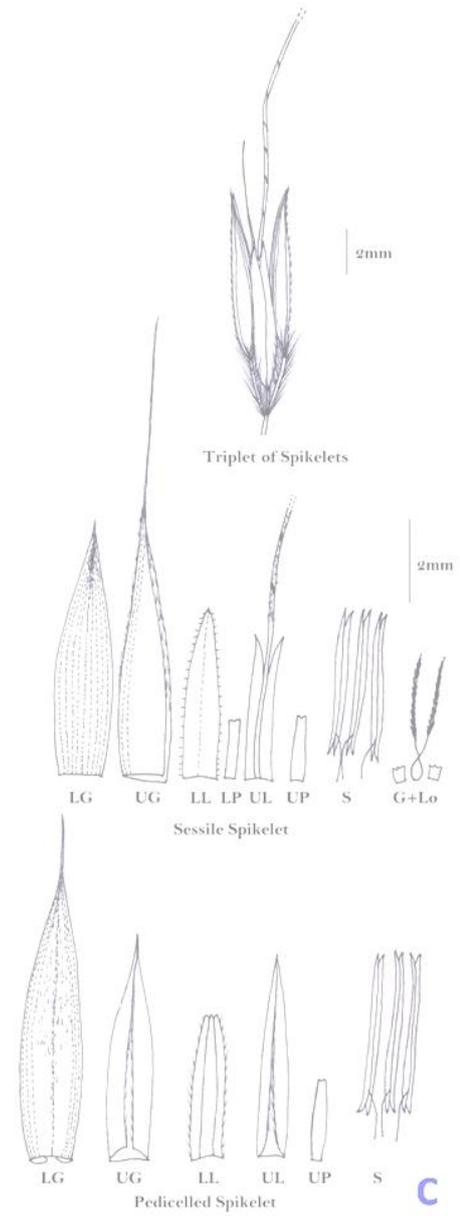
A: Inflorescence; B: Inflorescence; C: Line drawing



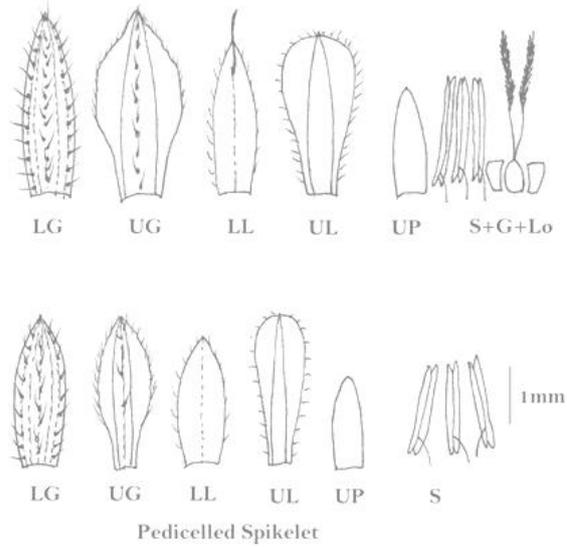
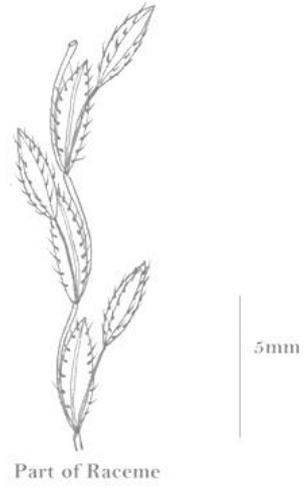
A: Habit; B: Inflorescence; C: Spikelets; D:Line drawing



A: Habit; B: Inflorescence; C: Line drawing

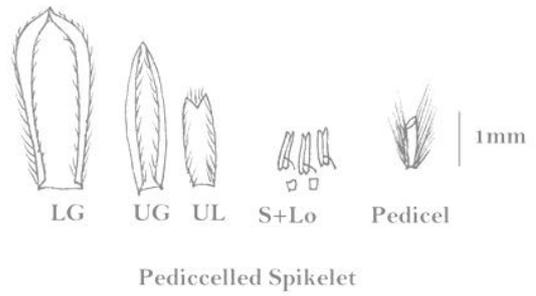
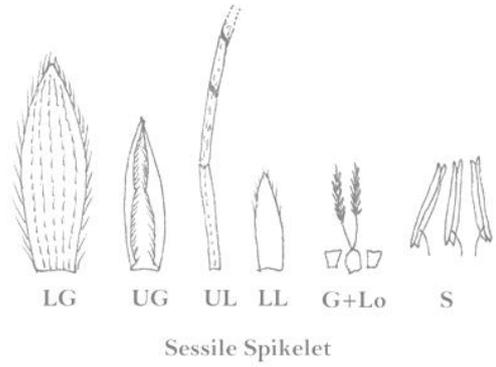
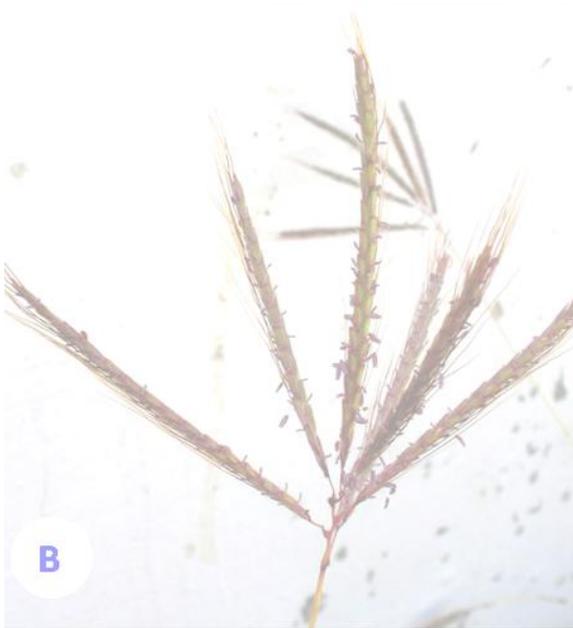


A: Habit; B: Inflorescence; C: Line drawing

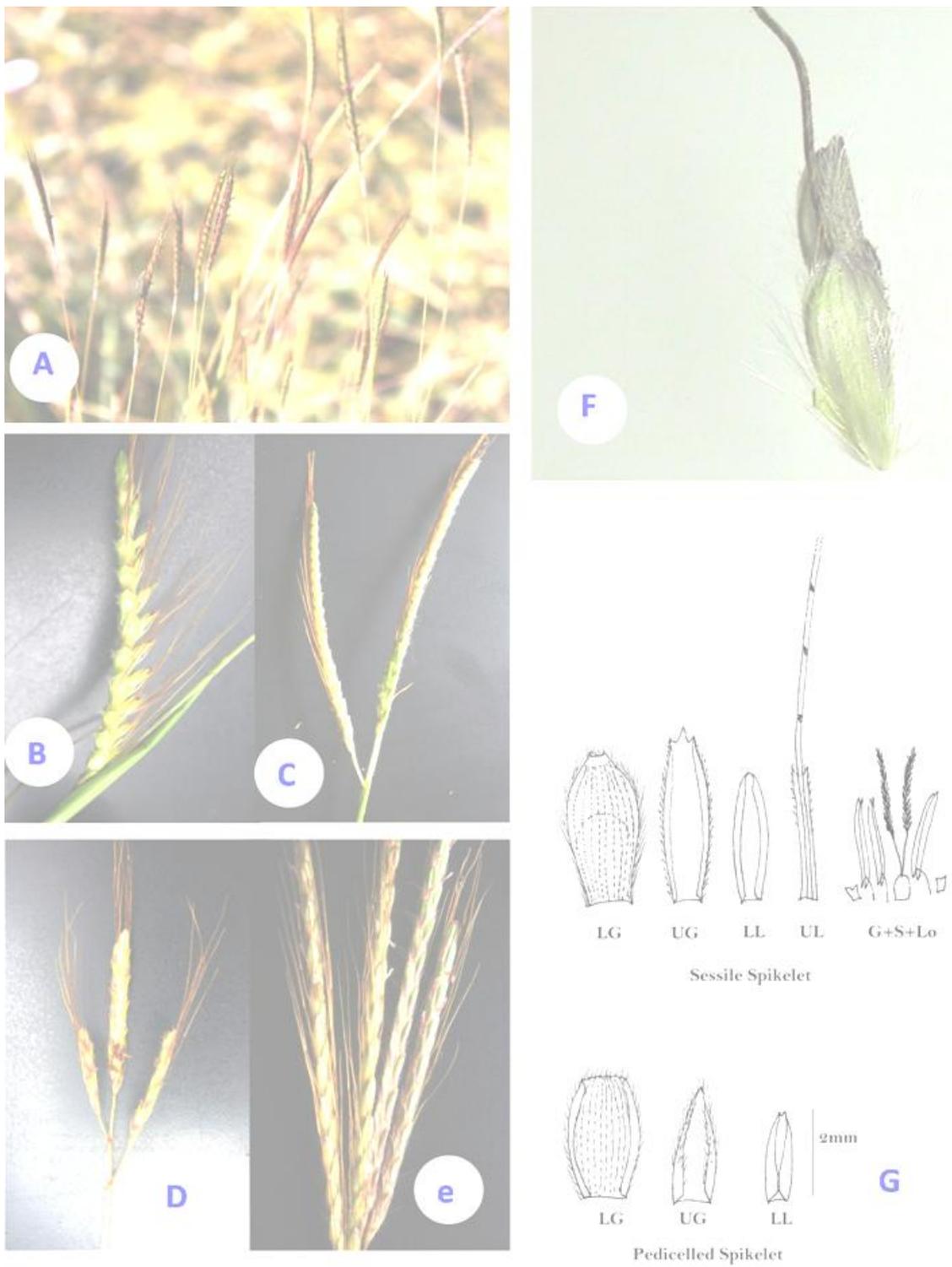


C

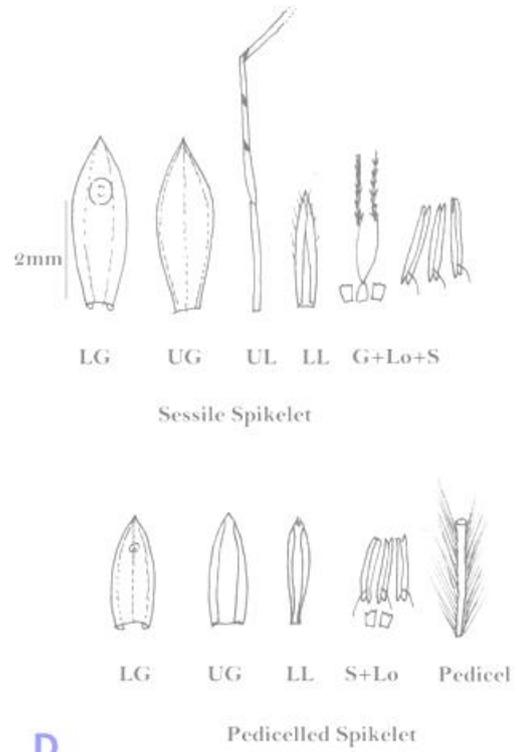
A: Habit; B: Inflorescence; C: Line drawing



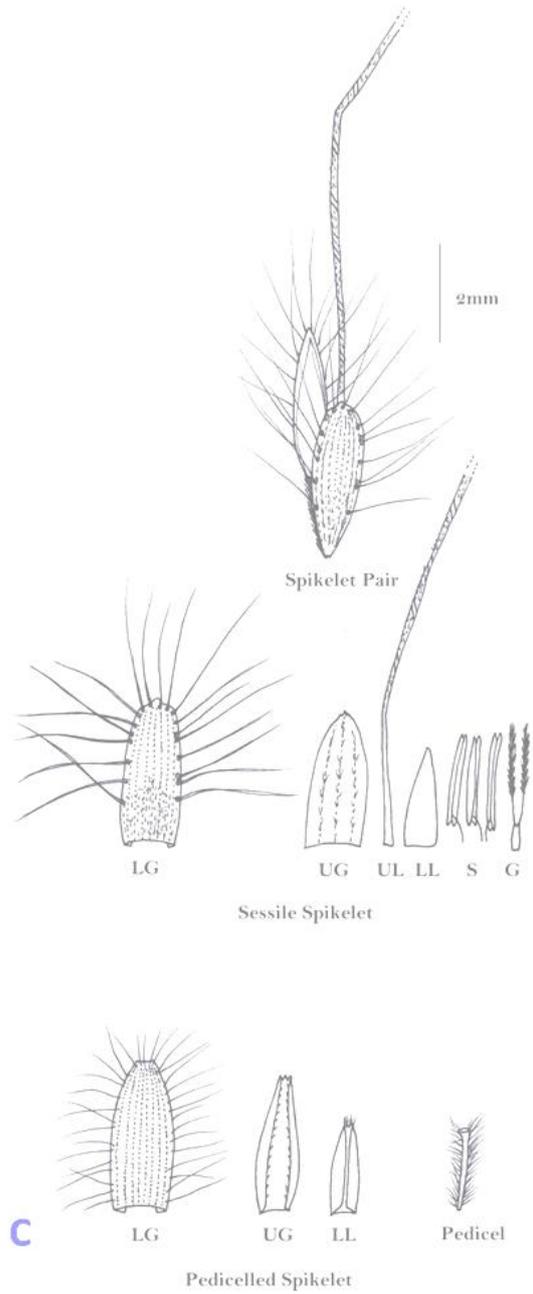
A: Habit; B: Inflorescence; C: Line drawing



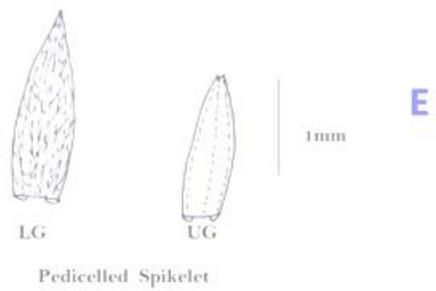
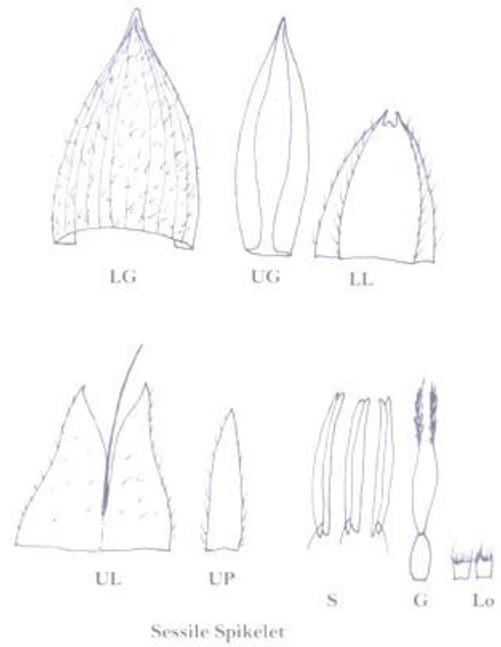
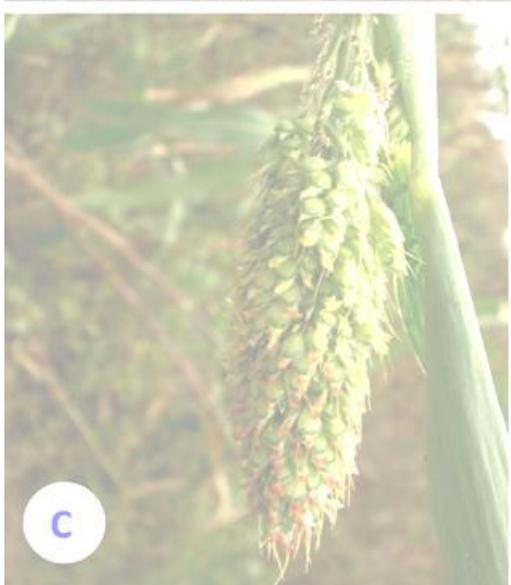
A: Habit; B-e: Variations of Inflorescence; F: Spikelts; G: Line drawing



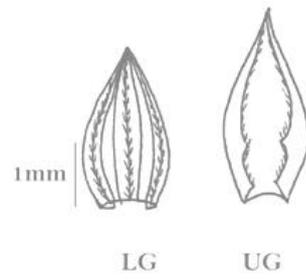
A: Habit; B&C: Inflorescence; D: Line drawing



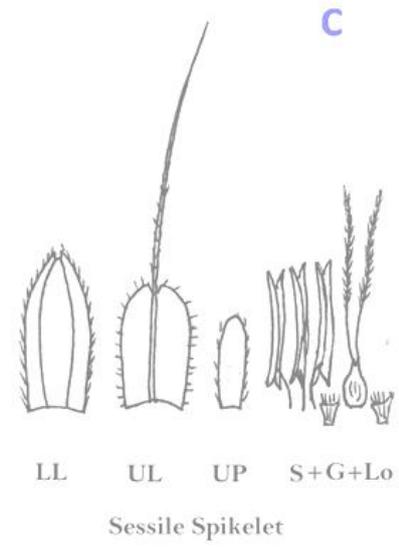
A: Habit; B: Inflorescence; C: Line drawing



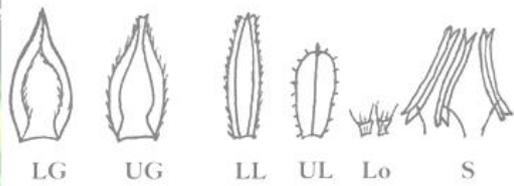
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LG UG

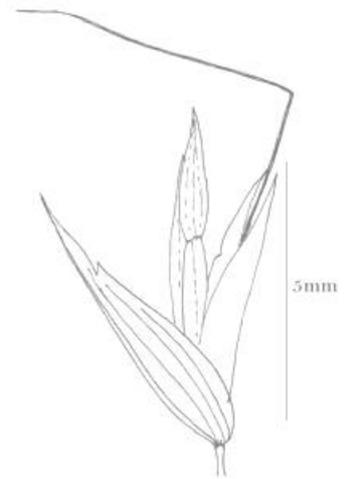


LL UL UP S+G+Lo
Sessile Spikelet

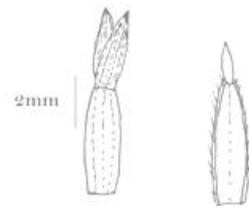


Pedicelled Spikelet

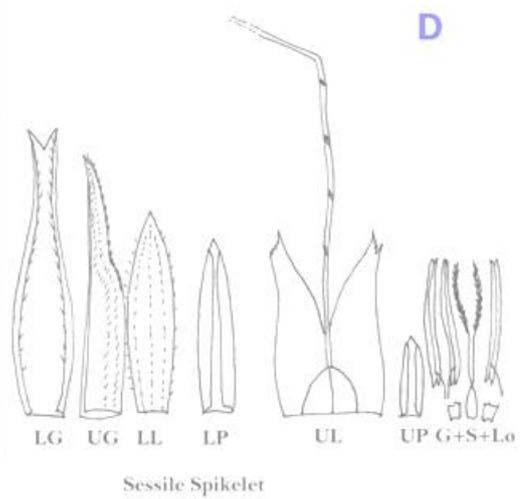
A: Habit; B: Inflorescence; C: Line drawing



Raceme with Spathe

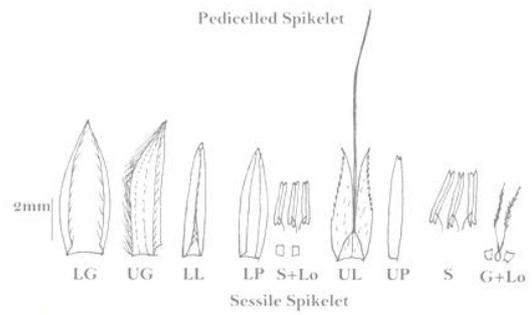
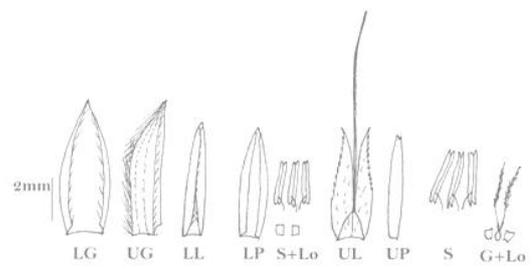


Pedicelled Spikelet



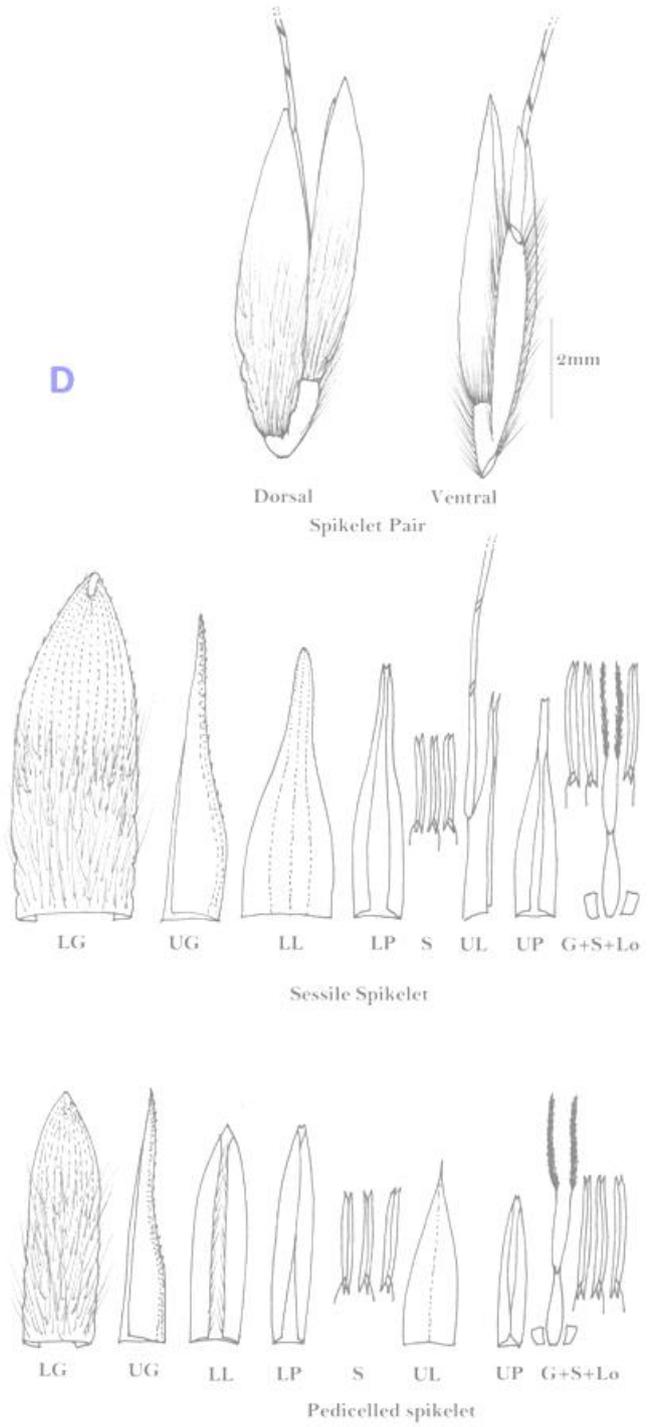
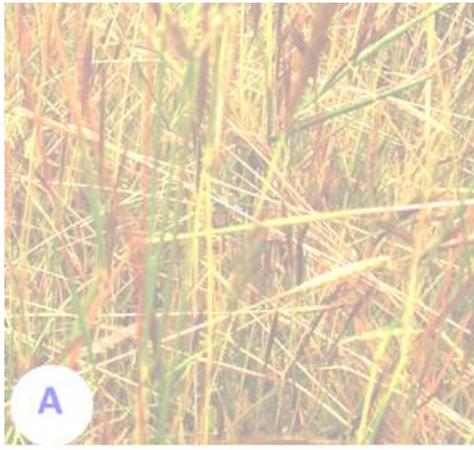
Sessile Spikelet

A: Habit; B: Inflorescence; C: Spikelets with spatheole; D: Line drawing

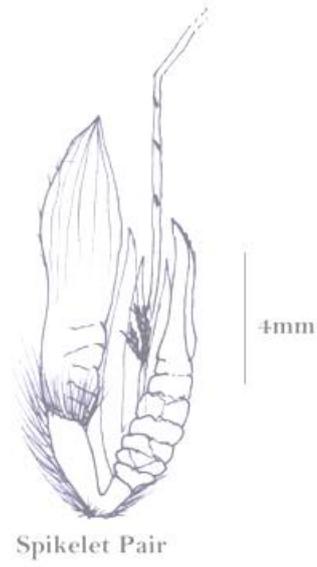


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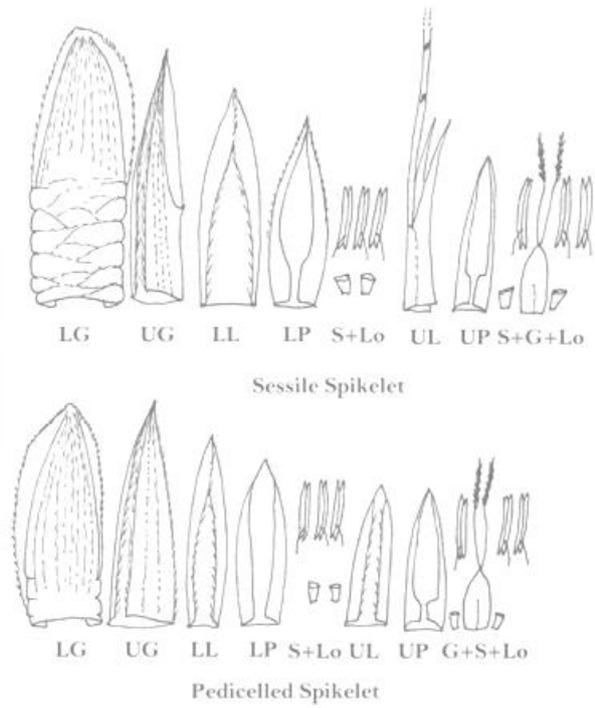
A: Habit; B: Inflorescence; C&D: Close-up of Inflorescence; E: Line drawing



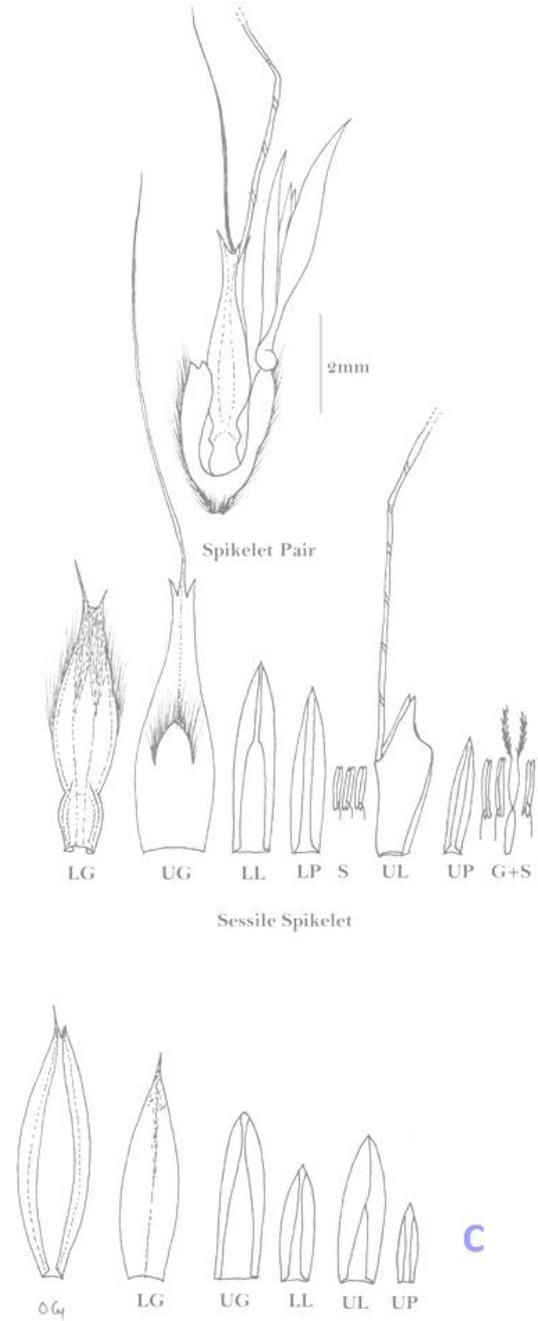
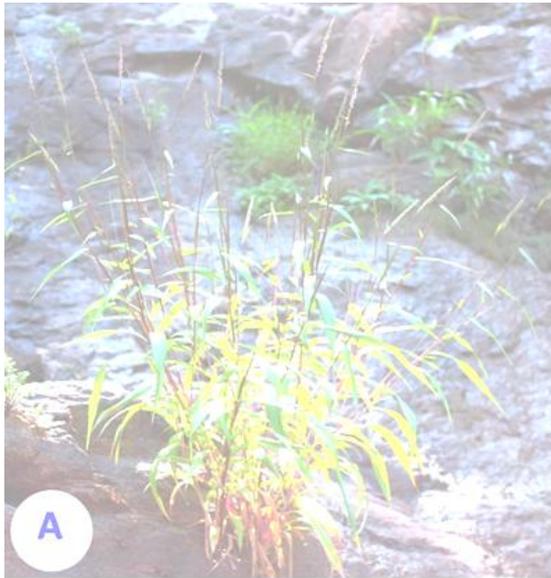
A&B: Habit; C: Inflorescence; D: Line drawing



C



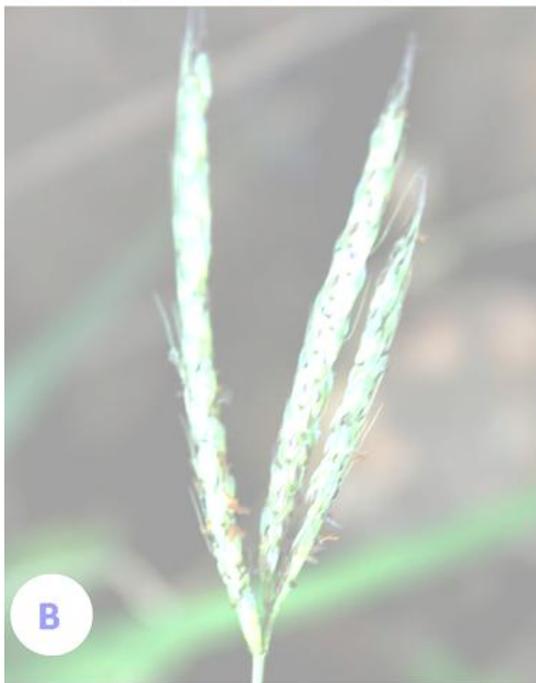
A: Inflorescence; B: Close-up of Inflorescence & hirsute leaf base; C: Line drawing



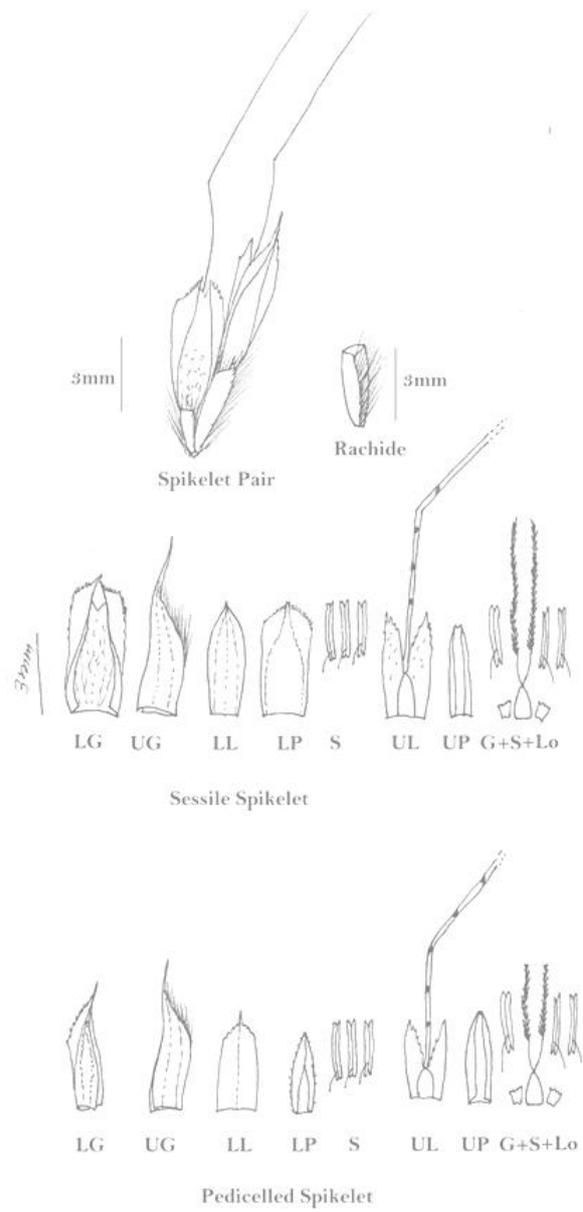
A: Habit; B: Inflorescence; C: Line drawing



A

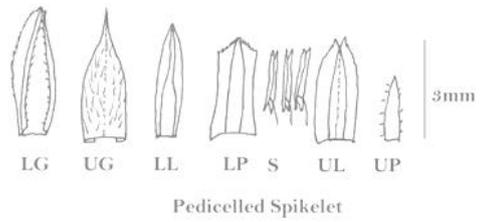
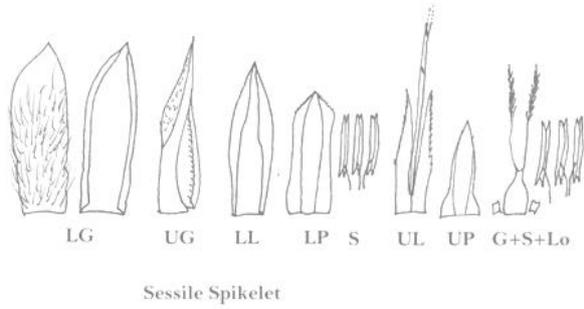
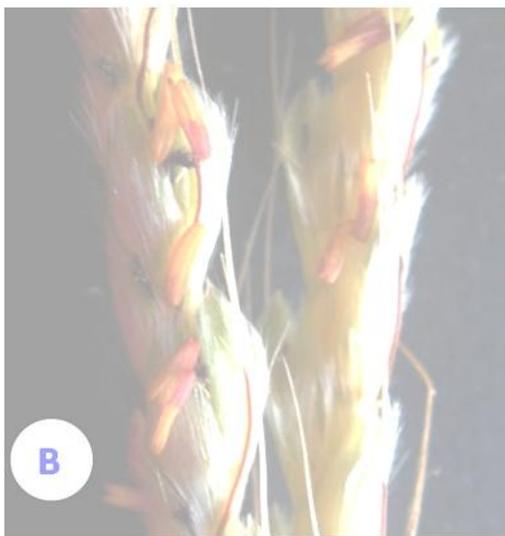


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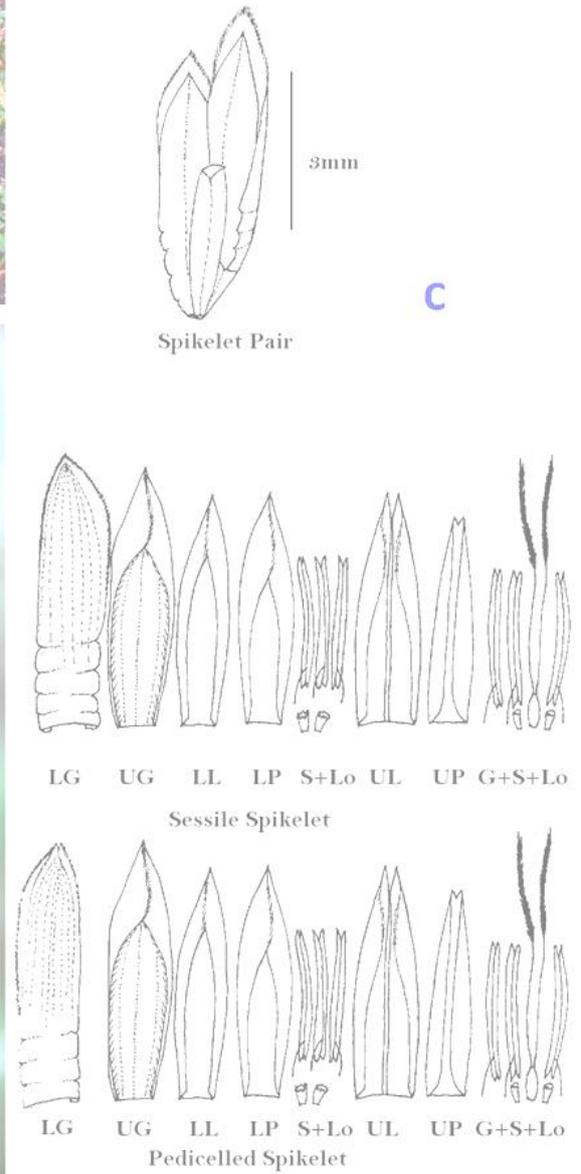
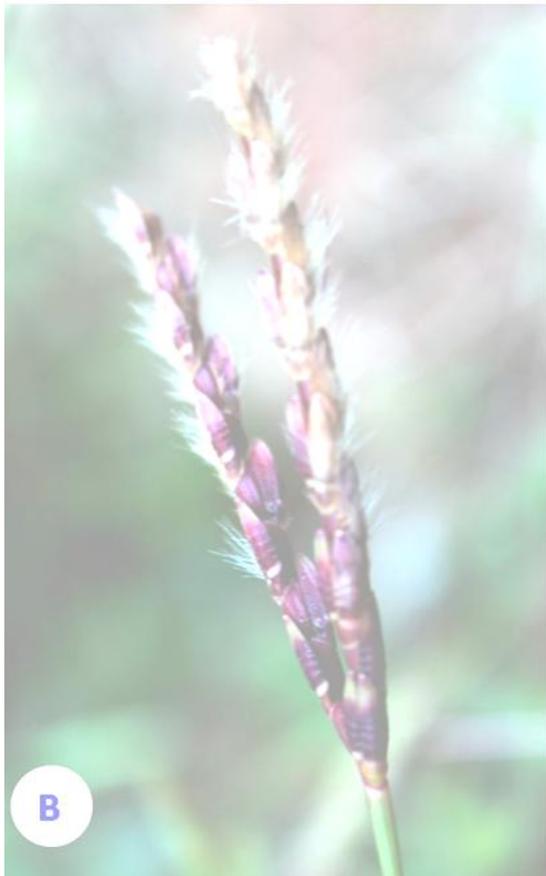


C

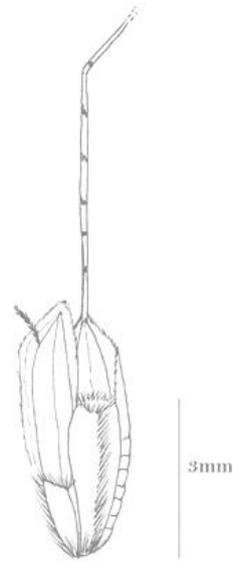
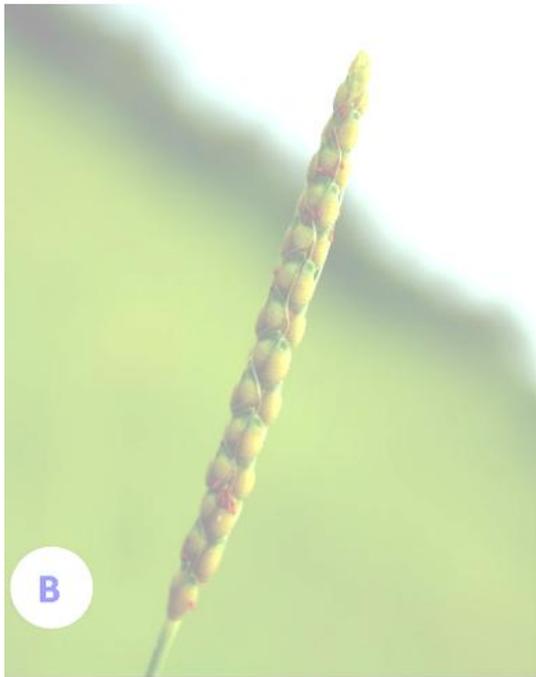
A: Habit; B: Inflorescence; C: Line drawing



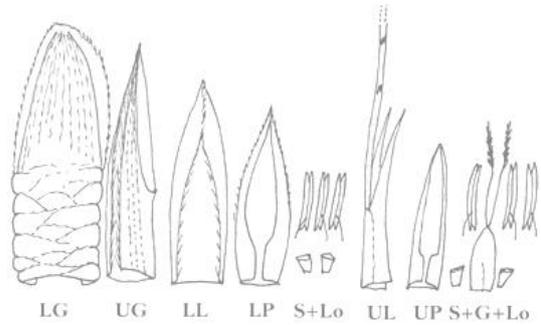
A: Habit; B: Close-up of Inflorescence; C: Line drawing



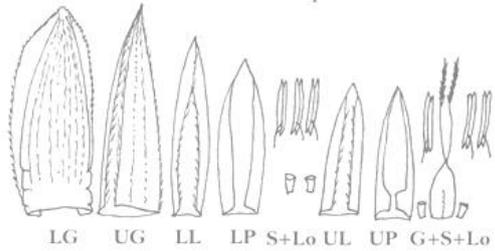
A: Habit; B: Close-up of Inflorescence; C: Line drawing



Spikelet Pair



Sessile Spikelet



Pedicelled Spikelet

A: Habit; B&C: Inflorescence; D: Line drawing



A: Habit; B: Close-up of Inflorescence; C: Pseudopetiole; D: Bipartite ligule

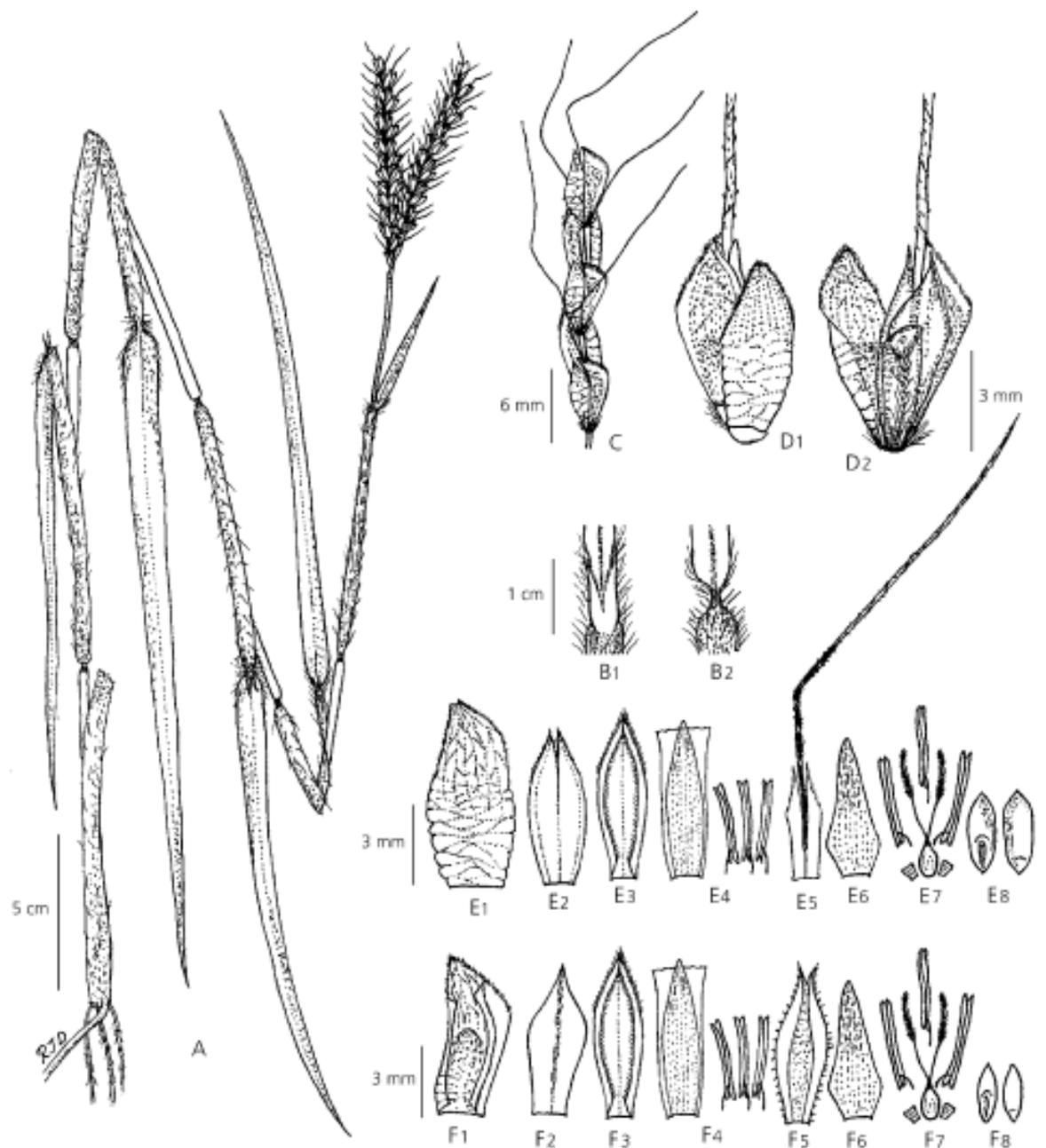
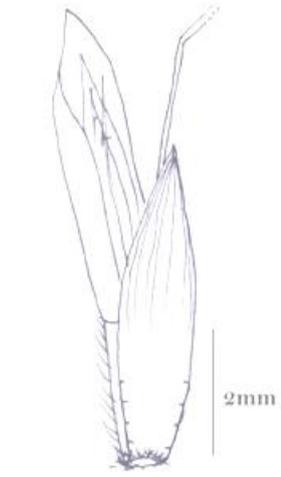
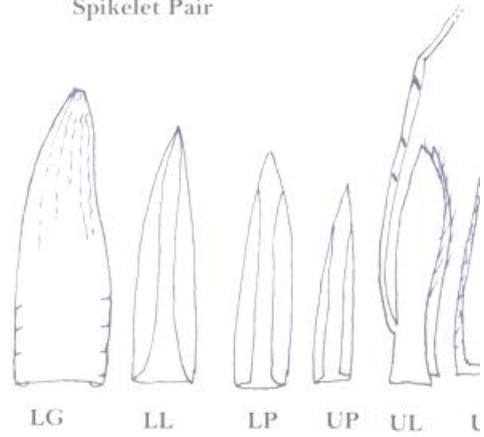


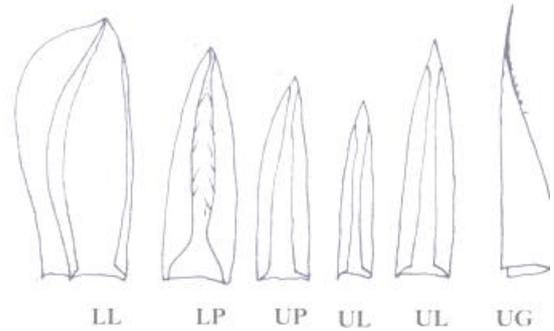
Fig. 1. *Ischaemum sayajiroi*/ A habit; B₁ ligule; B₂ pseudopetiole; C portion of raceme; D₁ sessile and pedicellate spikelet (dorsal view); D₂ sessile and pedicellate spikelet with rachide (ventral view); E sessile spikelet: E₁ lower glume; E₂ upper glume; E₃ lower lemma; E₄ lower palea with stamens; E₅ upper lemma; E₆ upper palea; E₇ gynoecium with lodicules and stamens; E₈ caryopsis (dorsal and ventral view); F pedicellate spikelet: F₁ lower glume; F₂ upper glume; F₃ lower lemma; F₄ lower palea with stamens; F₅ upper lemma; F₆ upper palea; F₇ gynoecium with lodicules and stamens; F₈ caryopsis (dorsal and ventral view). All from R. J. Desai 32. DRAWN BY R. J. DESAI.



Spikelet Pair

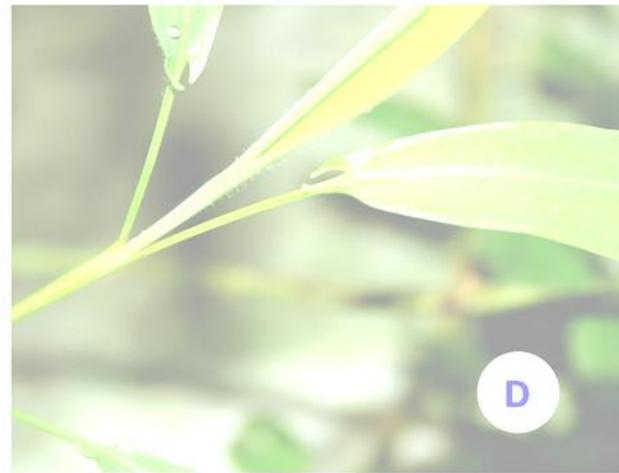
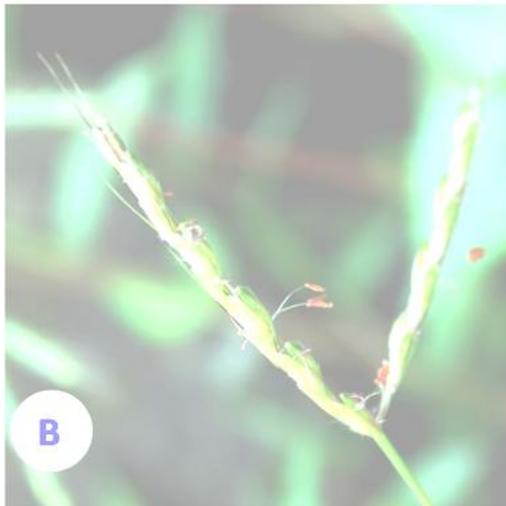
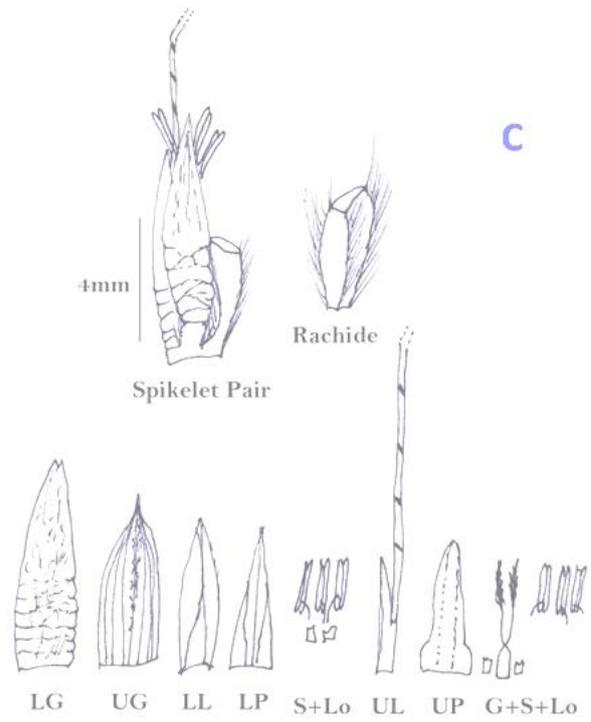


Sessile Spikelet

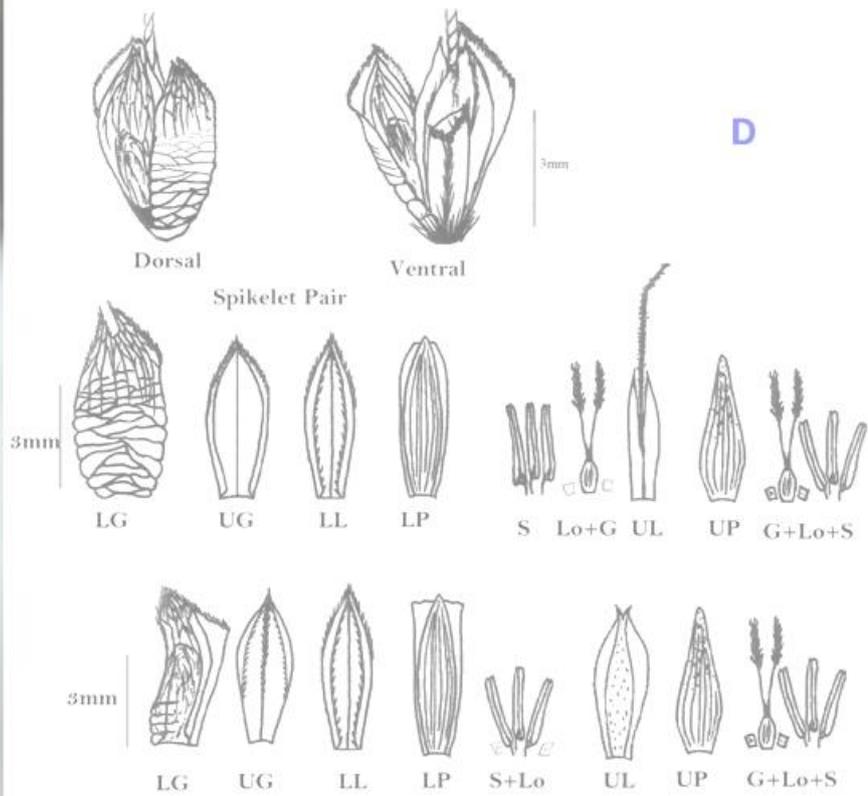
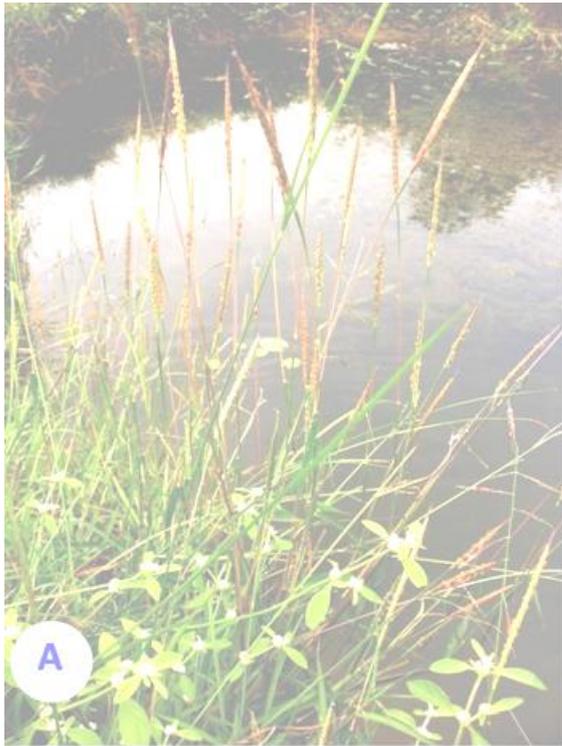


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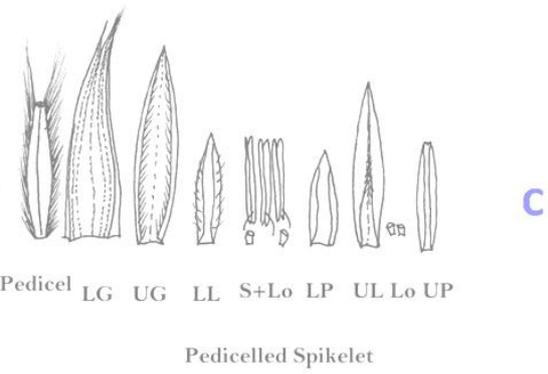
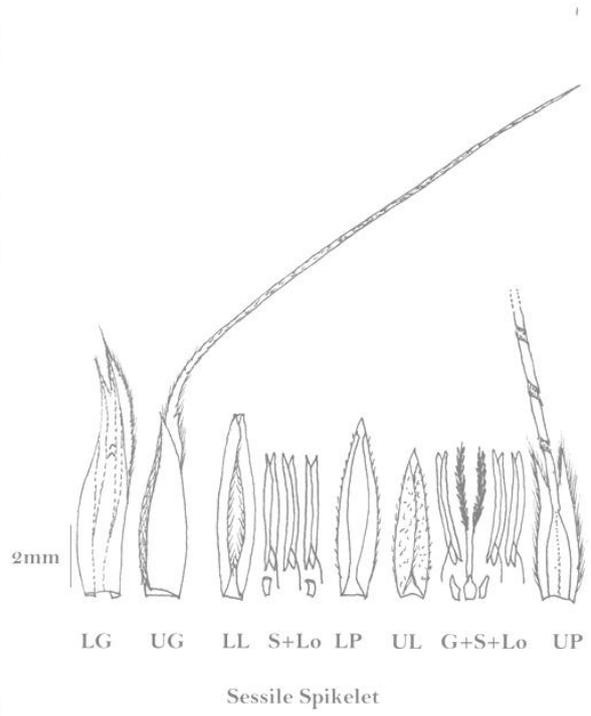
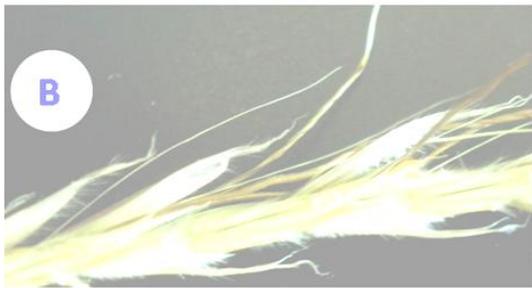
A: Habit; B: Inflorescence; C: Spikelets; D: Line drawing



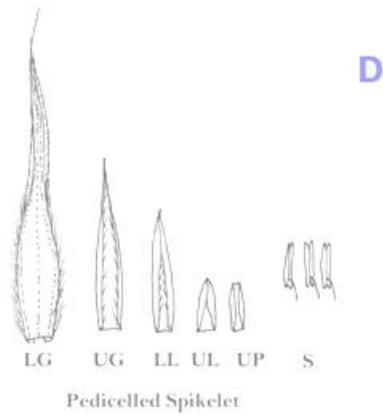
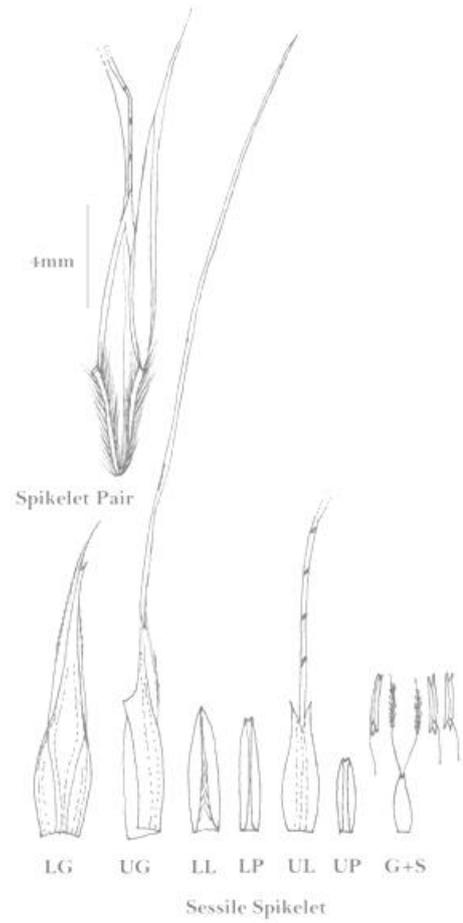
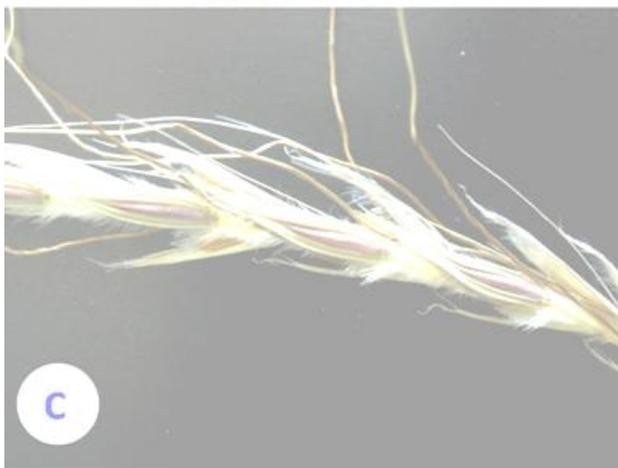
A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing; D: sagittate leaf showing pseudopetiole



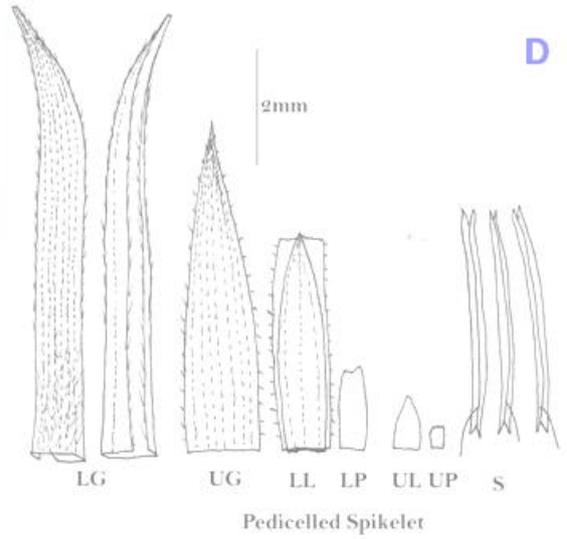
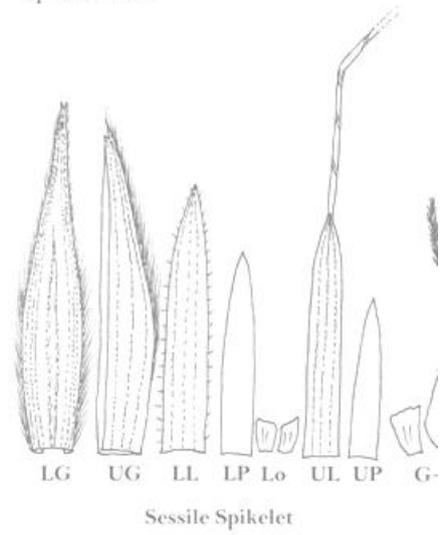
A: Inflorescence; B&C: Close-up of Inflorescence; D: Line drawing



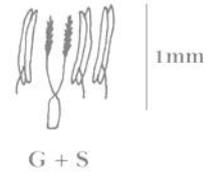
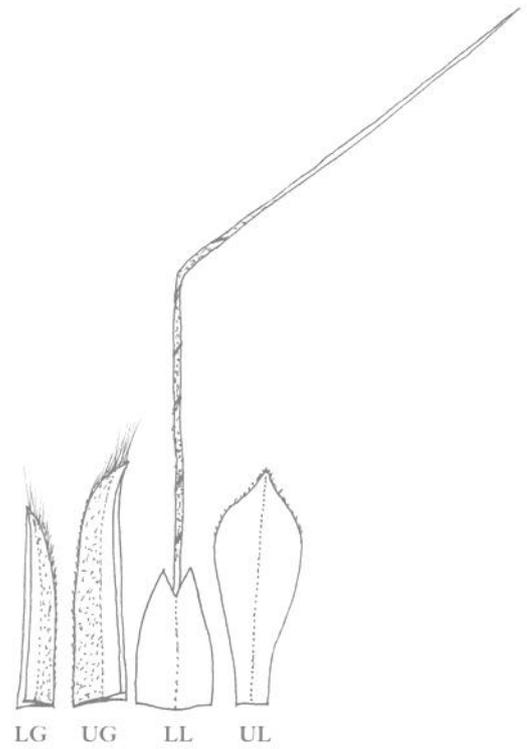
A: Habit; B: Close-up of Inflorescence; C: Line drawing



A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing

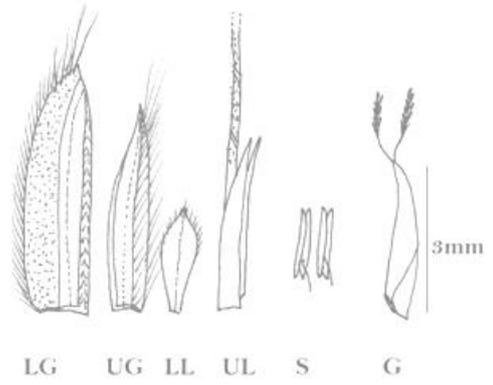
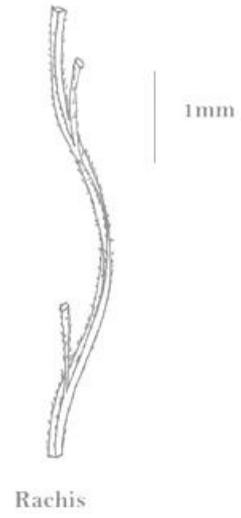


A: Habit; B: Close-up of Inflorescence; C: Spikelets; D: Line drawing



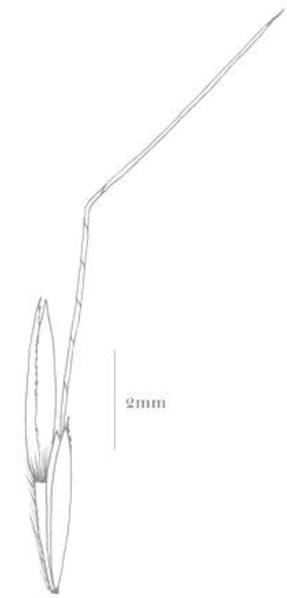
C

A: Habit; B: Inflorescence; C: Line drawing

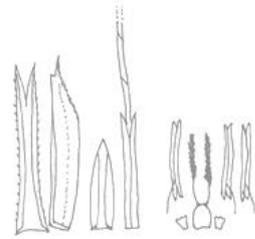


C

A: Habit; B: Inflorescence; C: Line drawing

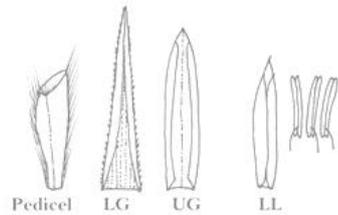


Spikelet Pair



LG UG LL UL G+S+Lo

Sessile Spikelet

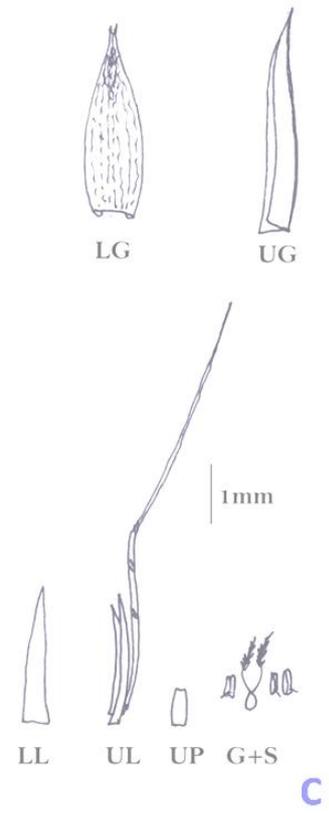


Pedicel LG UG LL

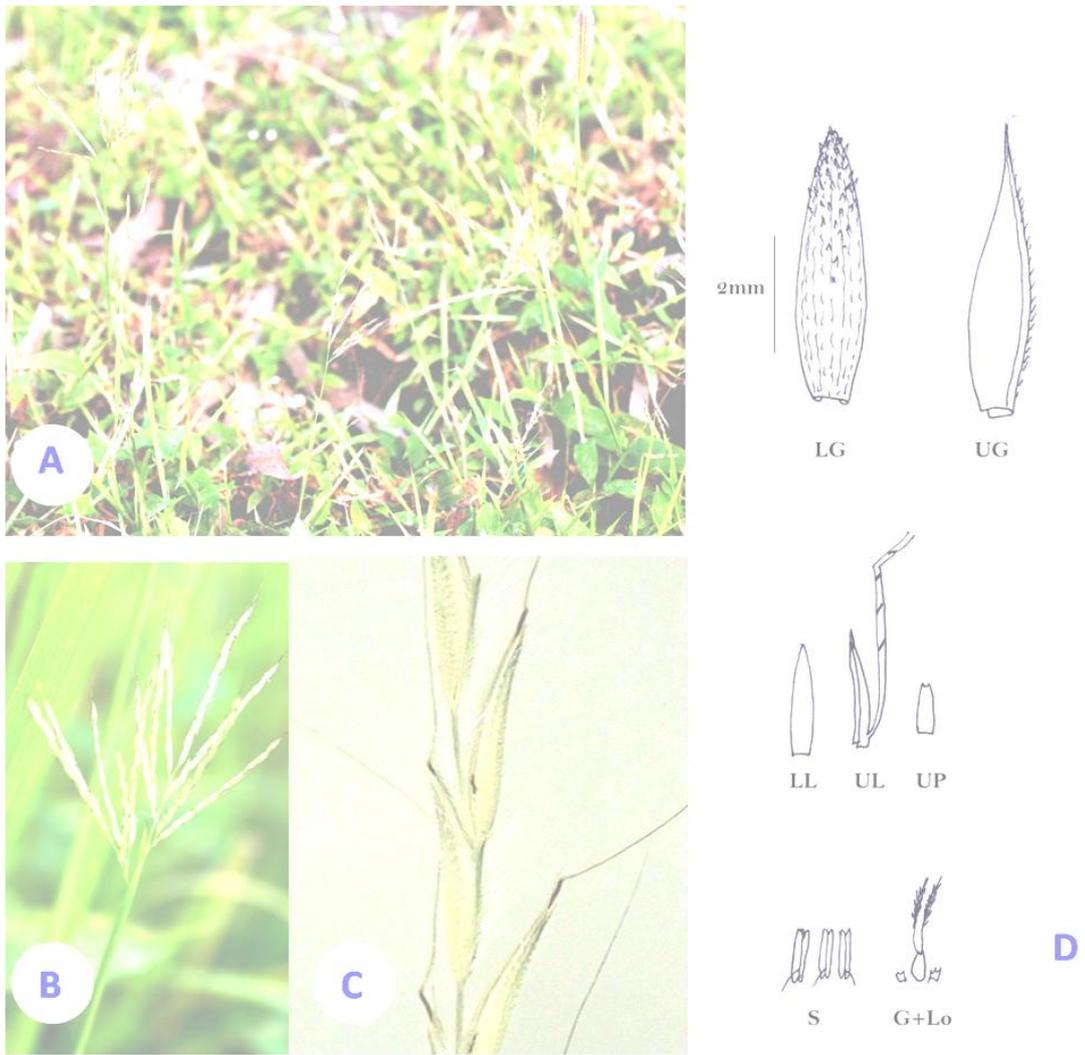
Pedicelled Spikelet

C

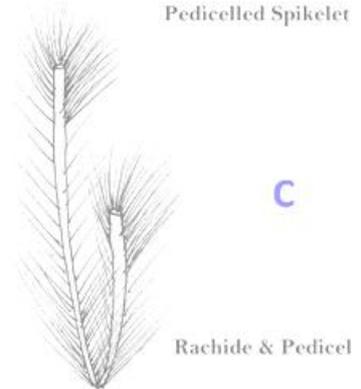
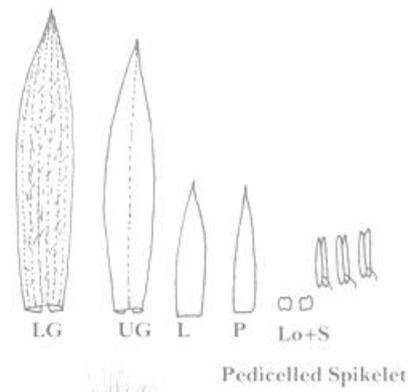
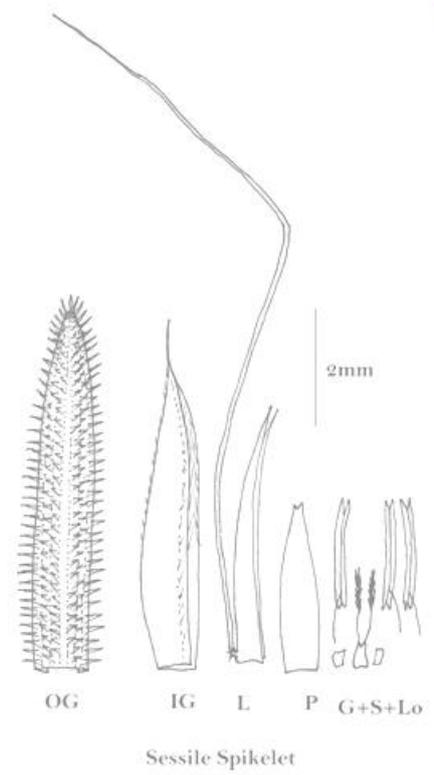
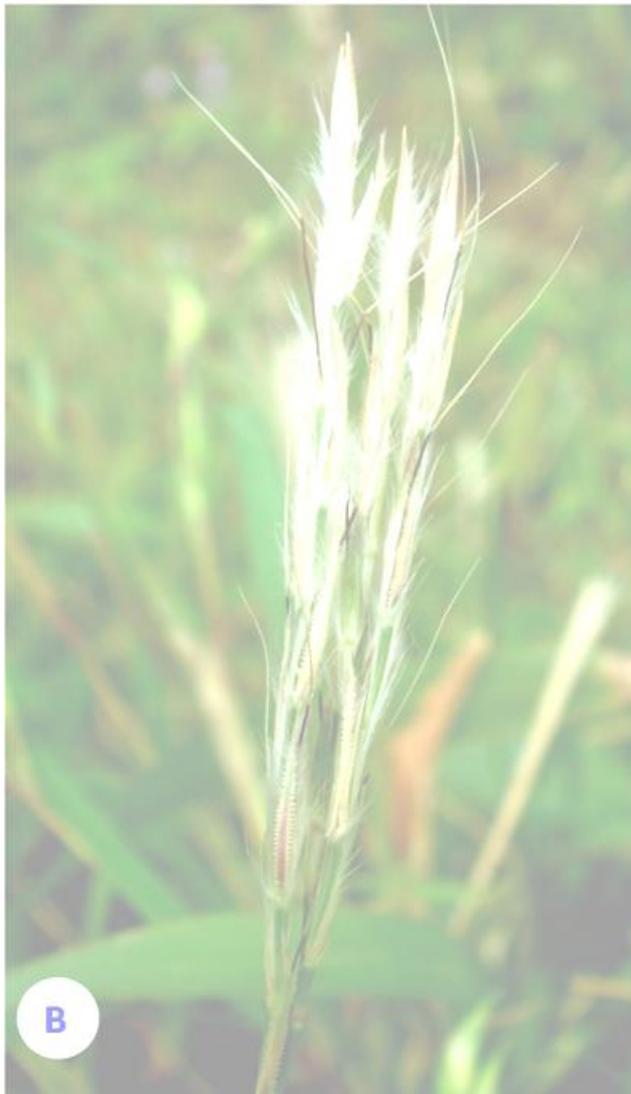
A: Habit; B: Inflorescence; C: Line drawing



A: Habit; B: Inflorescence; C: Line drawing



A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



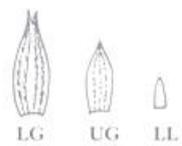
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Spikelet pair



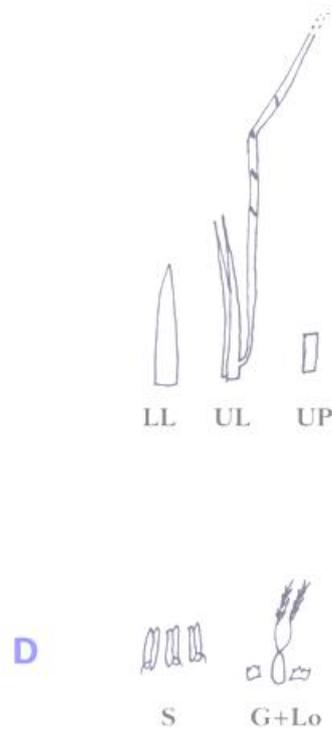
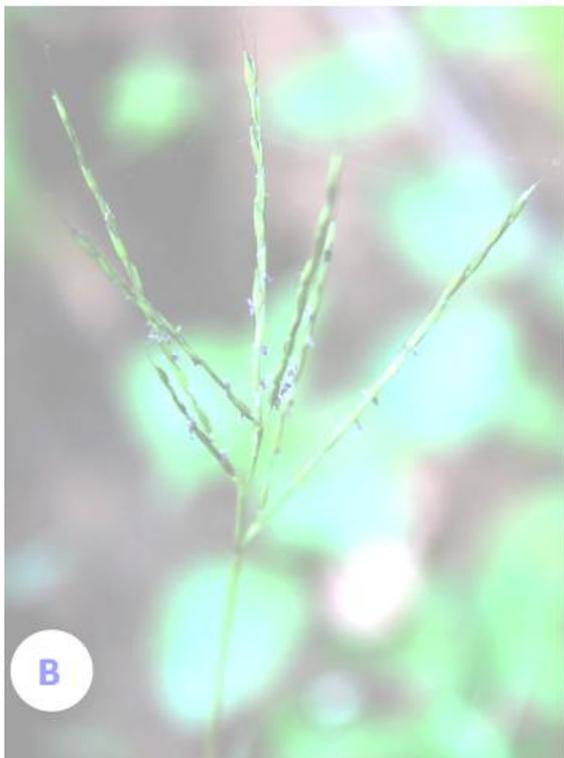
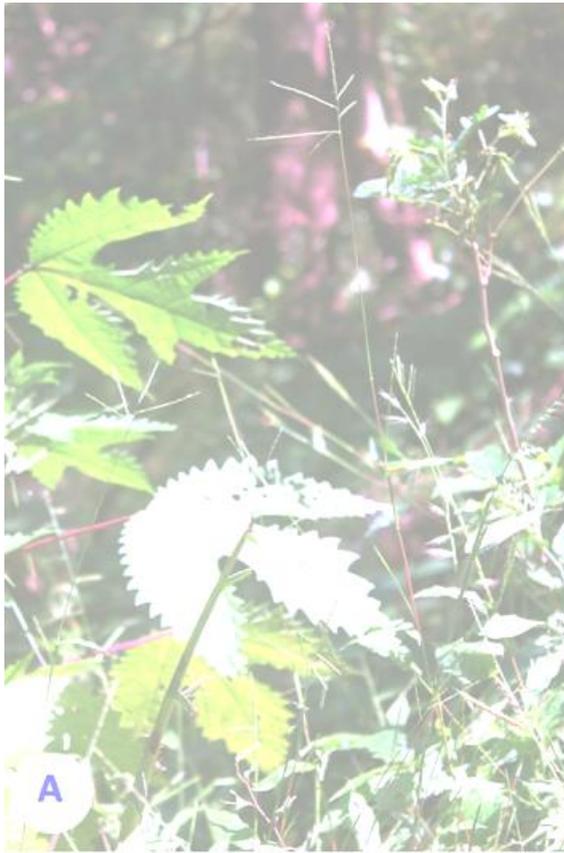
Sessile Spikelet



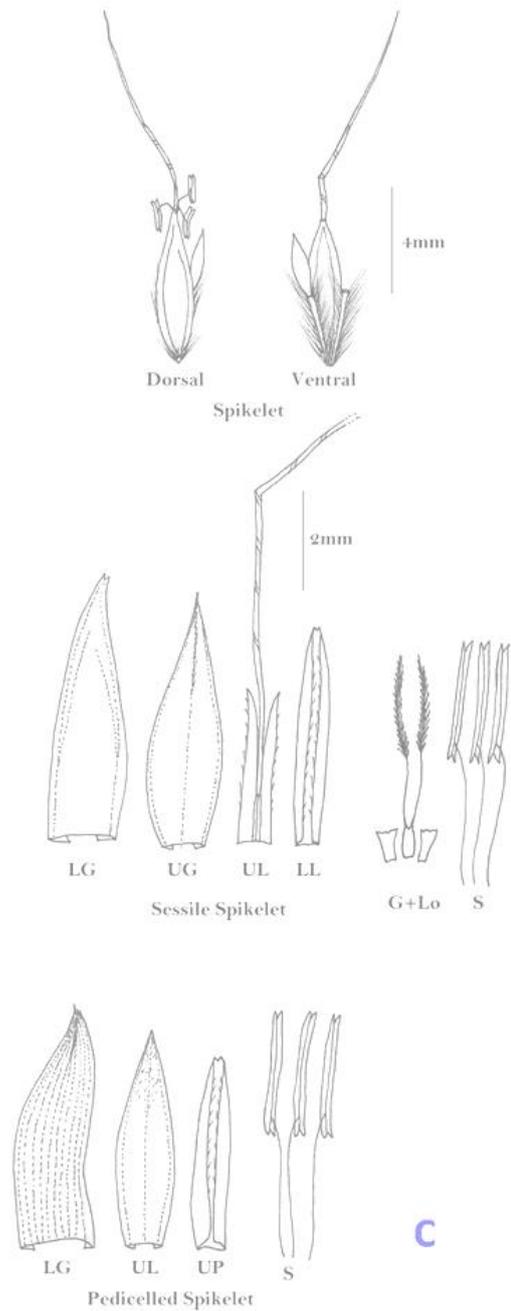
Pedicelled Spikelet

C

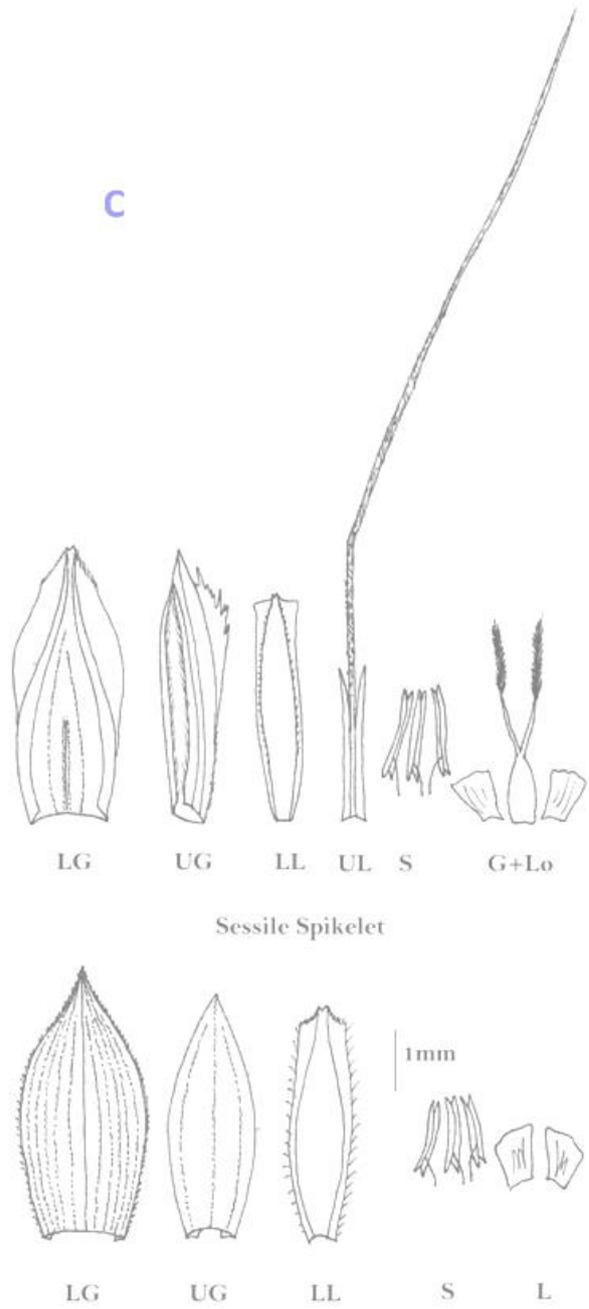
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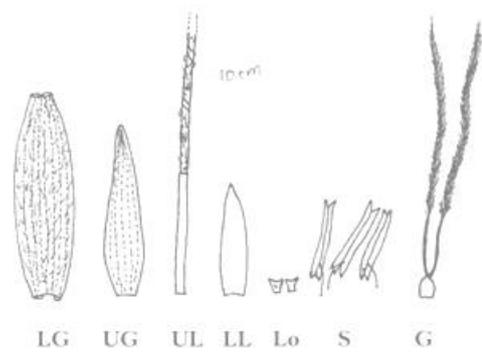
A: Habit; B: Inflorescence; C: Spikelet; D: Line drawing



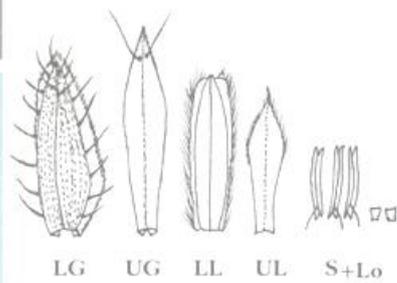
A: Habit; B: Close-up of Inflorescence; C: Line drawing



A: Habit; B: Close-up of Inflorescence; C: Line drawing

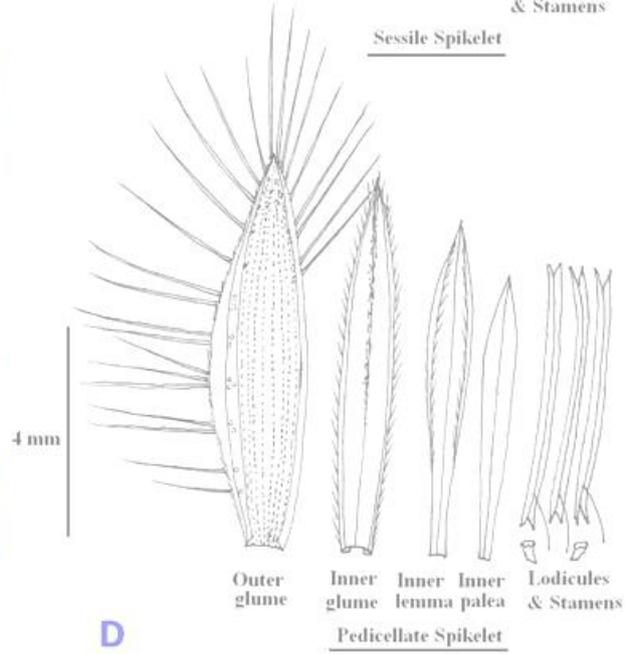
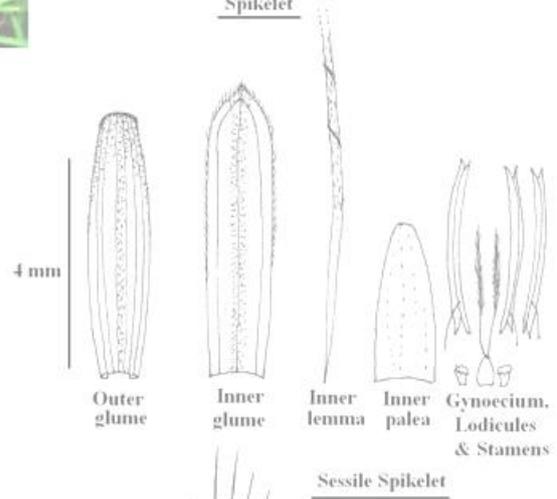
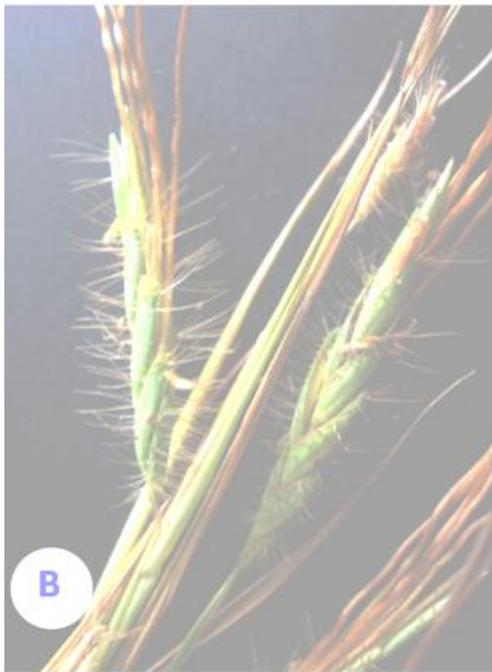
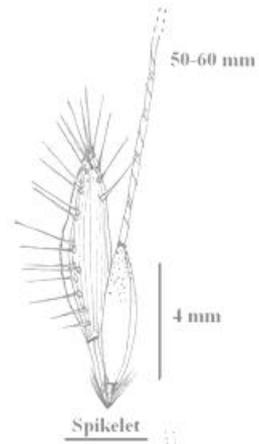


Sessile Spikelet

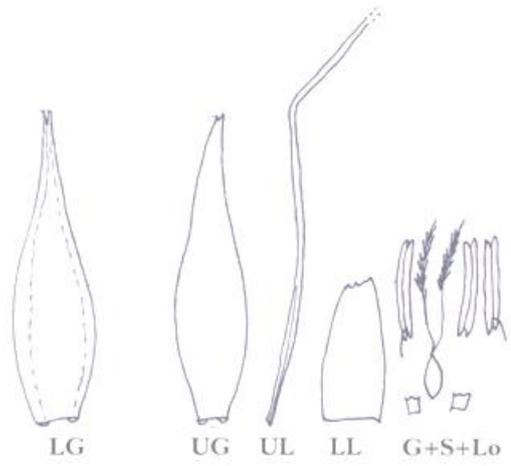
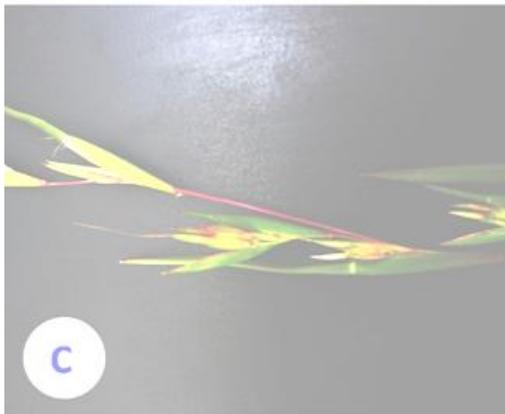
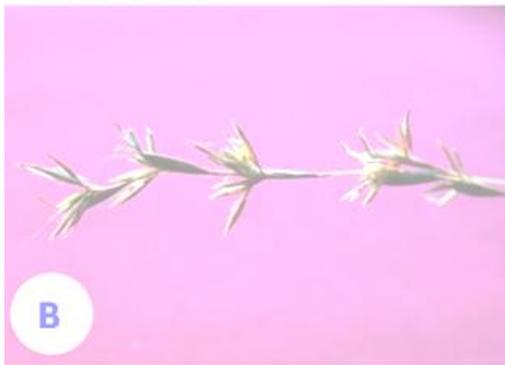


Pedicelled Spikelet

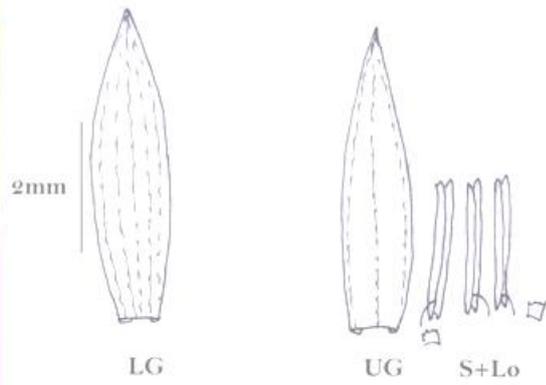
A: Habit;; B: Close-up of Inflorescence; C: Spikelet pair; D:Line drawing



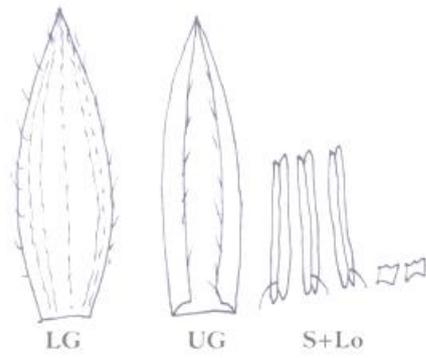
A: Inflorescence; B&C: Close-up of Inflorescence; D: Line drawing



Sessile Spikelet



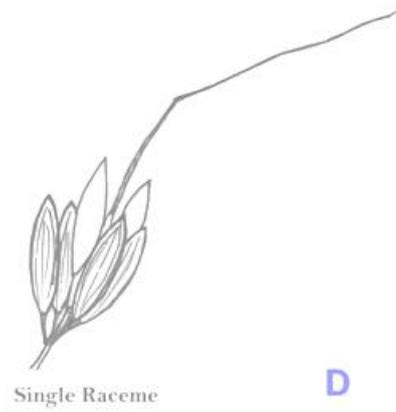
Pedicelled Spikelet



Involucral Spikelet

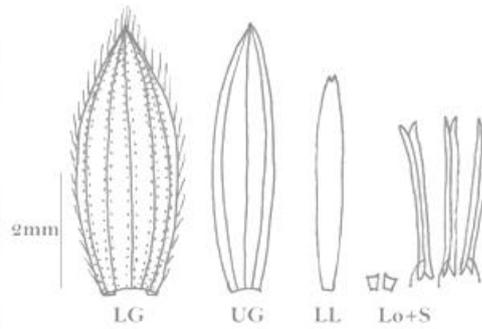
D

A&B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing

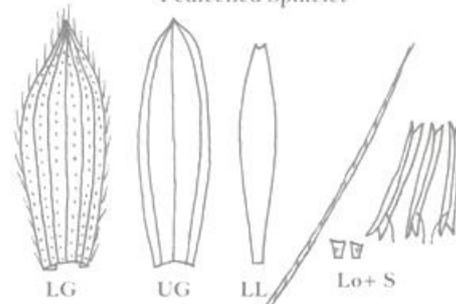


Single Raceme

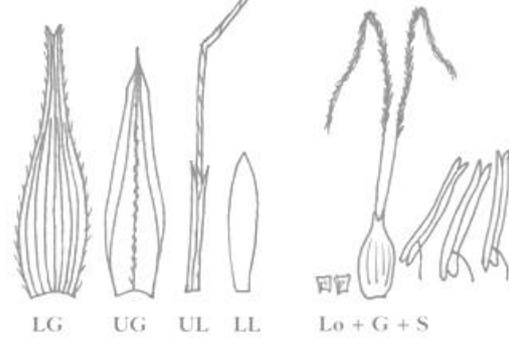
D



Pedicelled Spikelet

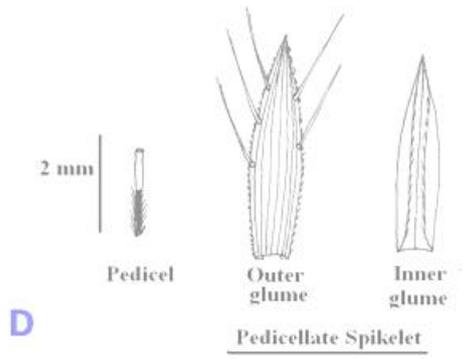
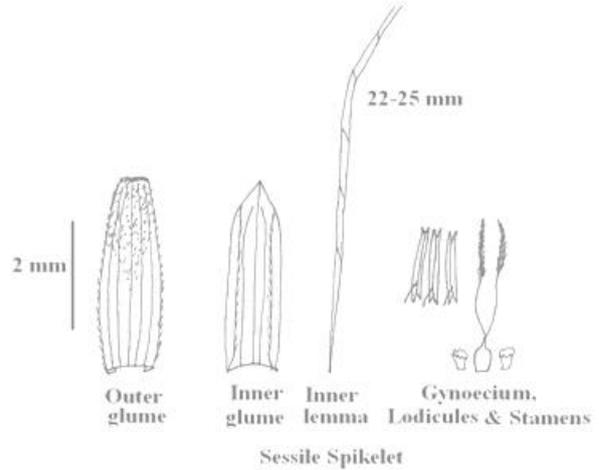
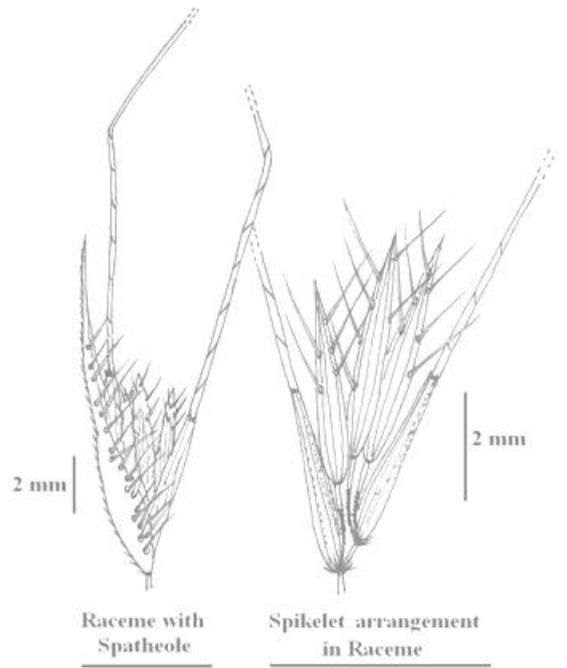


Involueral Spikelet

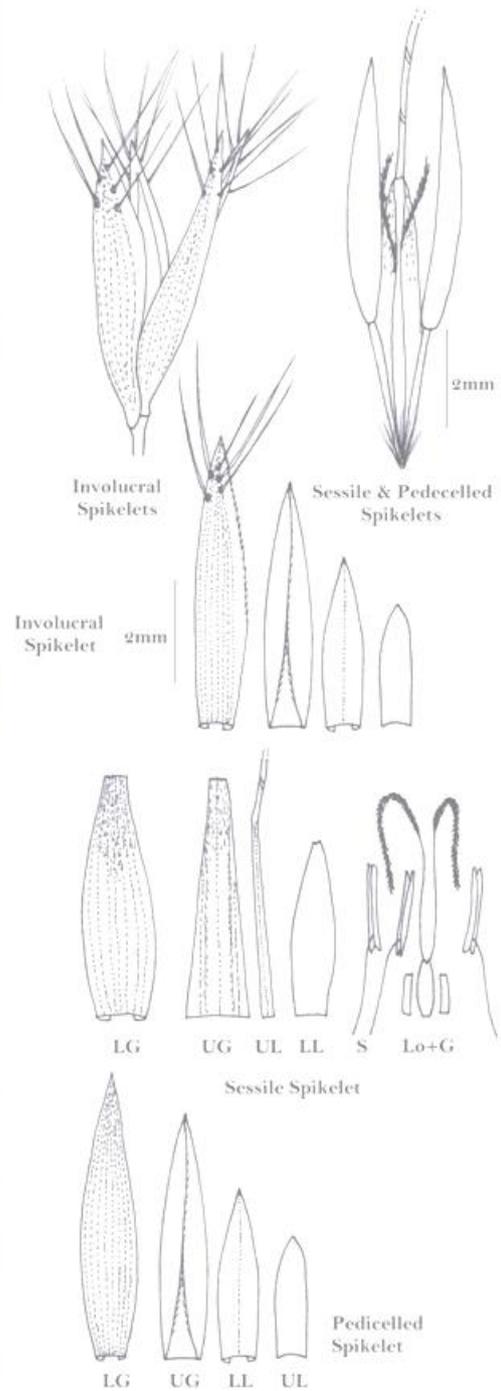


Sessile Spikelet

A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing

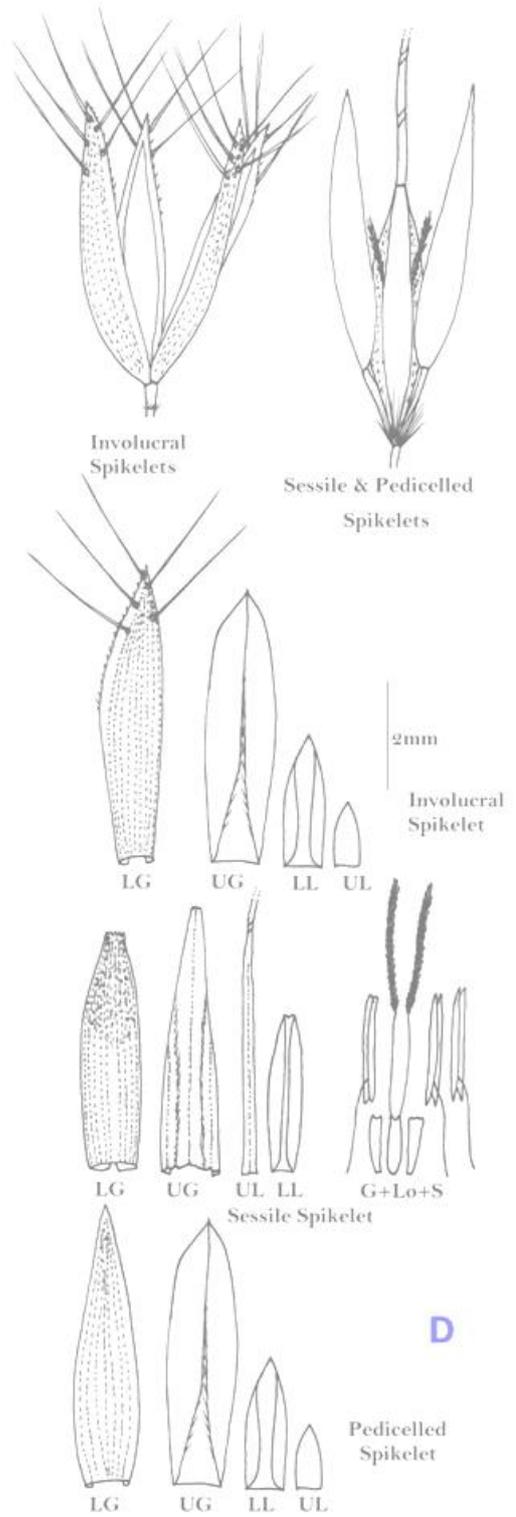
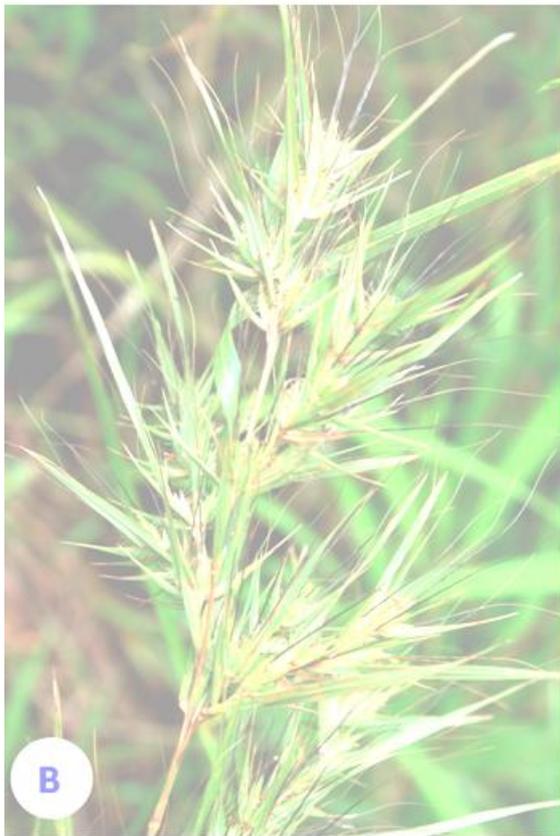


A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing

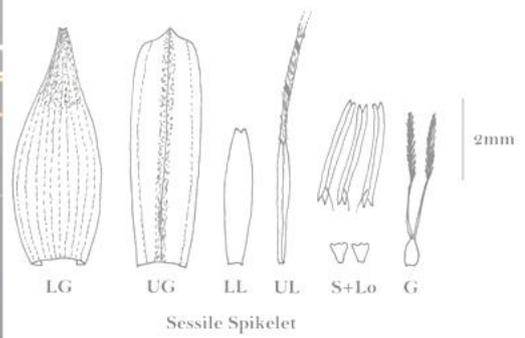
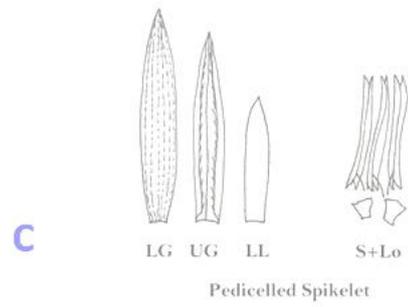
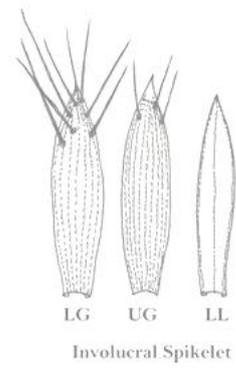
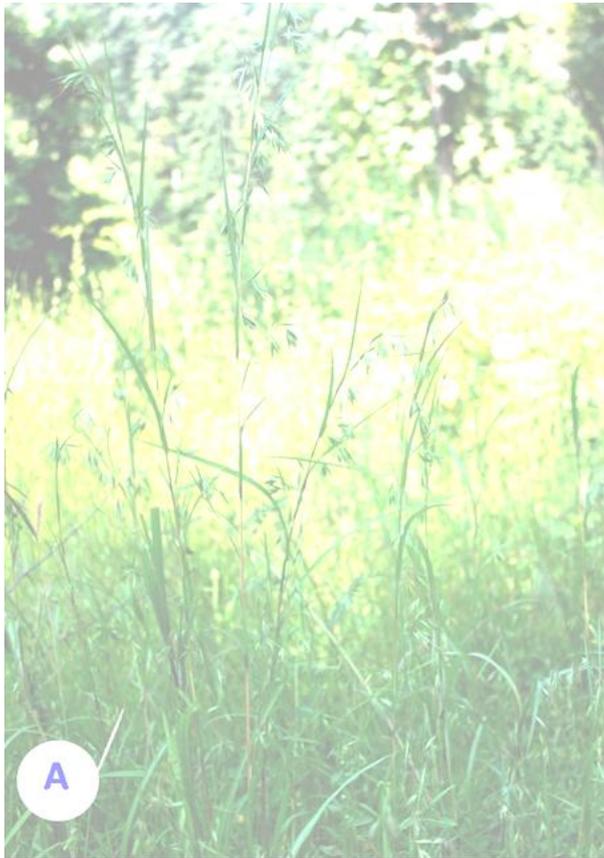


D

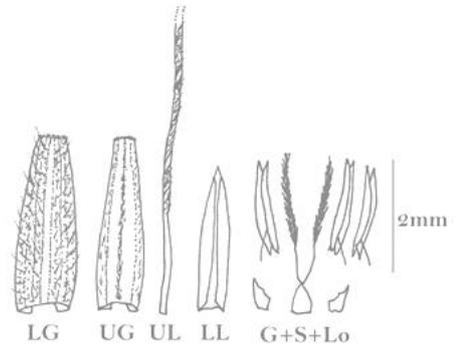
A&C: Inflorescence; B: Close-up of Inflorescence; D: Line drawing



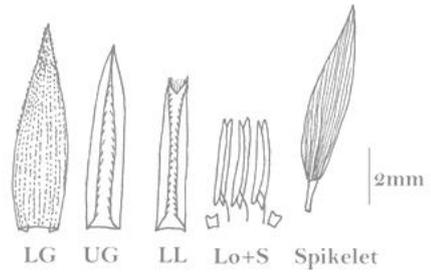
A: Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



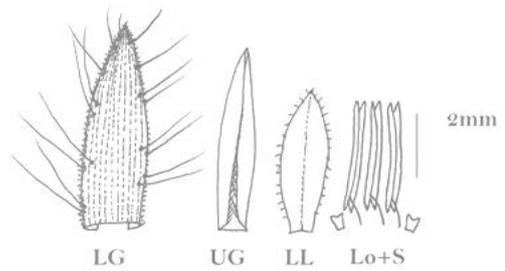
A: Habit; B: Close-up of Inflorescence; C: Line drawing



Sessile Spikelet

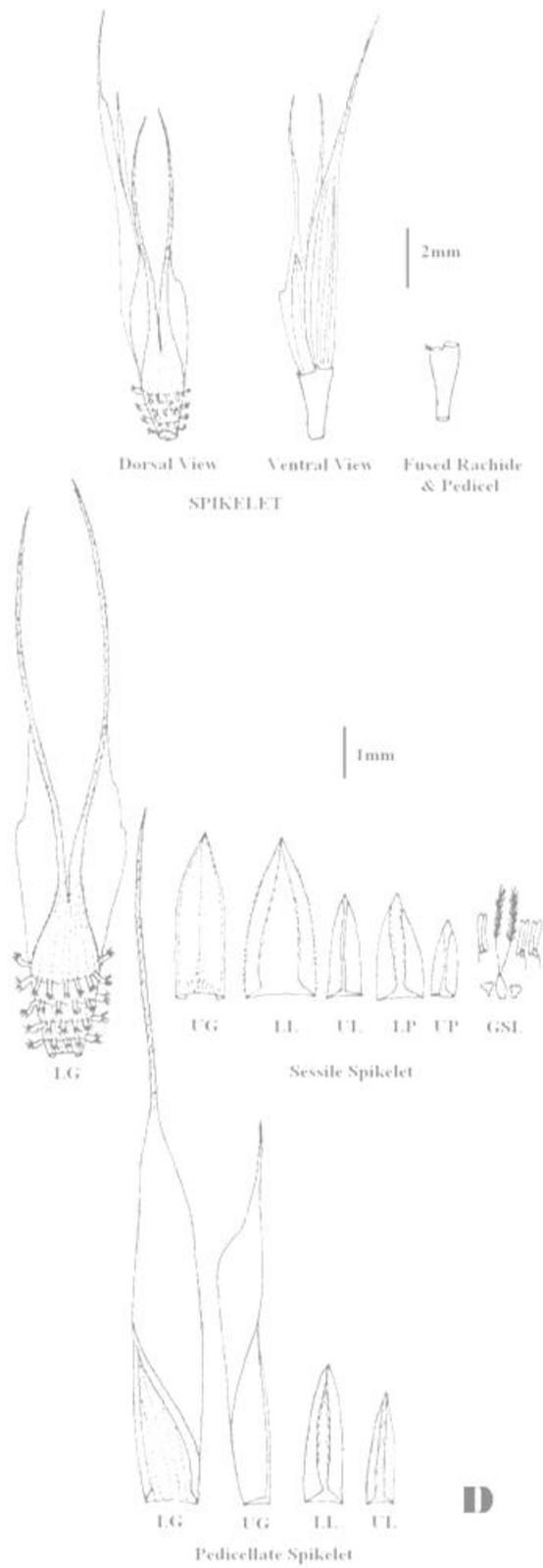
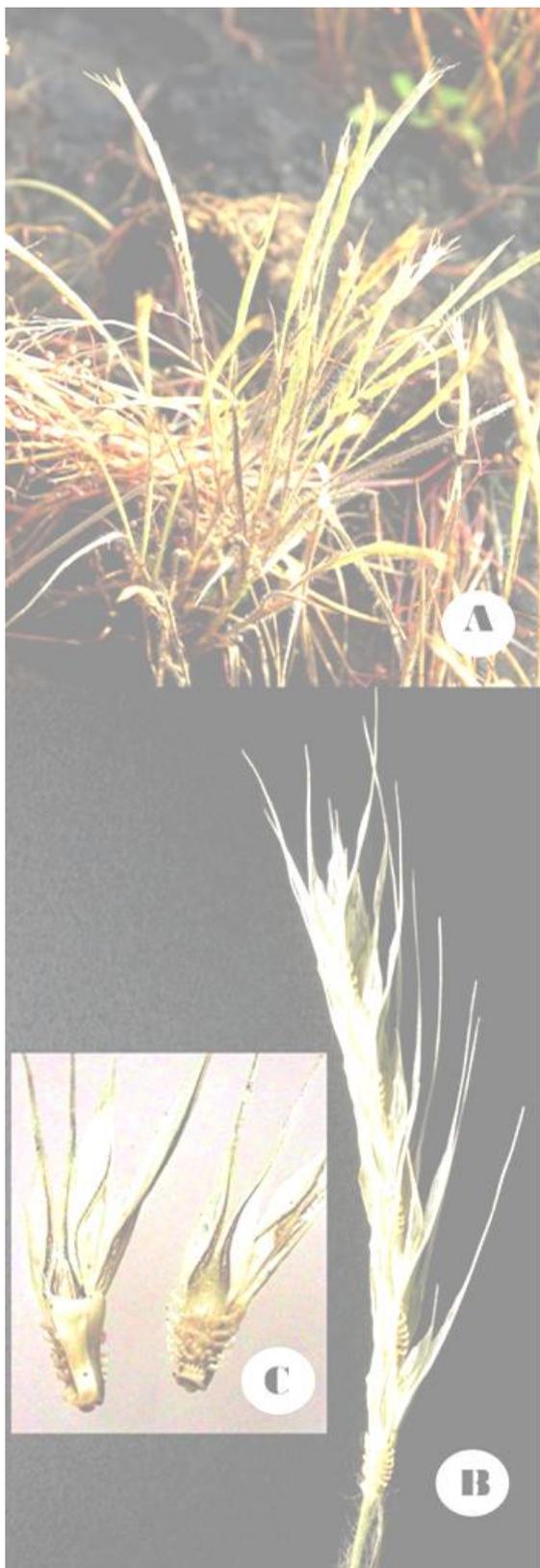


Pedicelled Spikelet

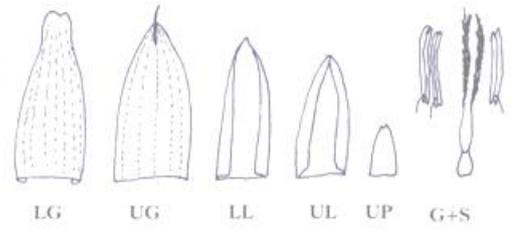


Involucrel Spikelet

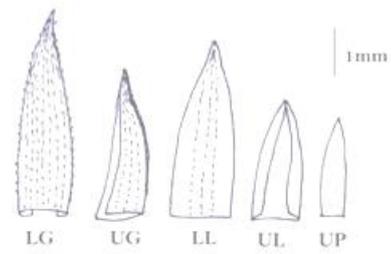
A:Habit; B: Close-up of Inflorescence; C: Line drawing



A: Inflorescence; B: Close-up of Inflorescence; C: Spikelet pairs; D: Line drawing



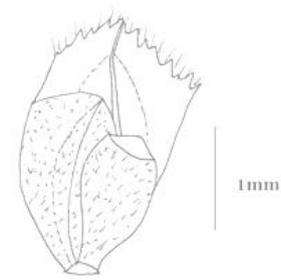
Sessile Spikelet



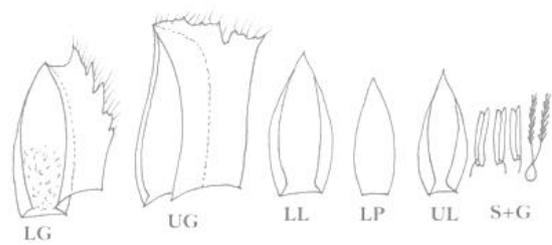
Pedicelled Spikelet

D

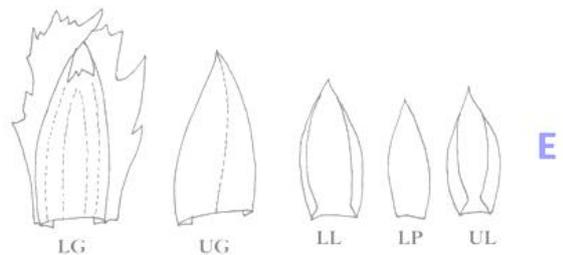
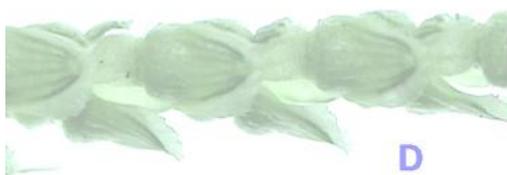
A: Inflorescence; B&C: Close-up of Inflorescence; D: Line drawing



Spikelet Pair
(Ventral view)

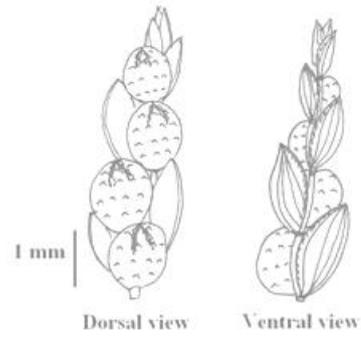
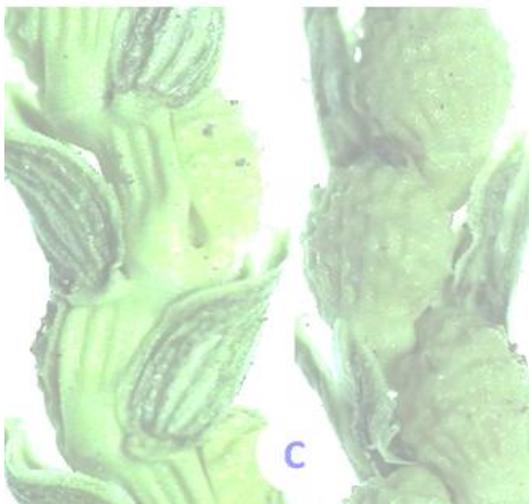
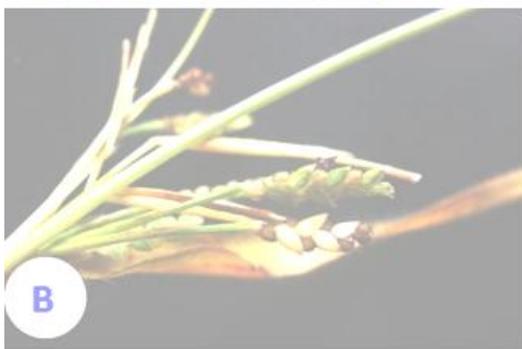


Sessile Spikelet



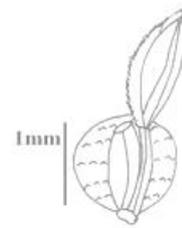
Pedicelled Spikelet

A&B: Inflorescence; C&D: Close-up of Inflorescence; E: Line drawing

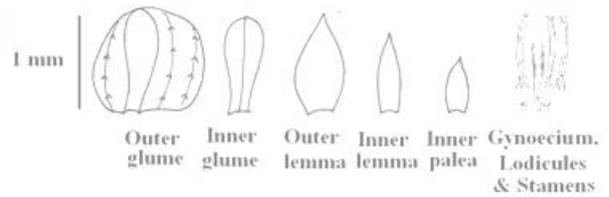


Dorsal view Ventral view

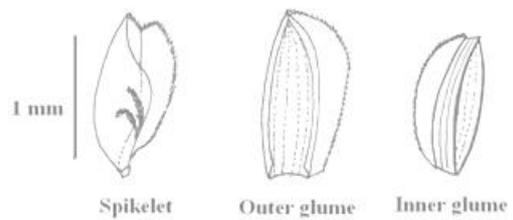
Spike



Spikelet
Ventral view



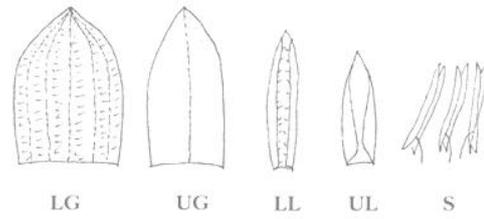
Sessile Spikelet



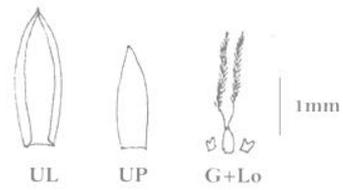
Pedicellate Spikelet

D

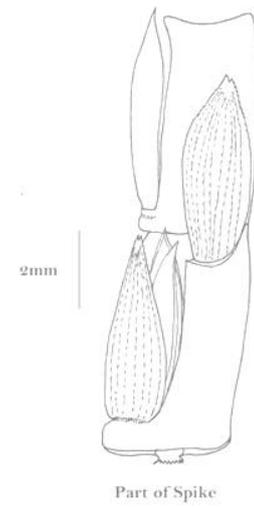
A:Habit; B: Inflorescence; C: Close-up of Inflorescence; D: Line drawing



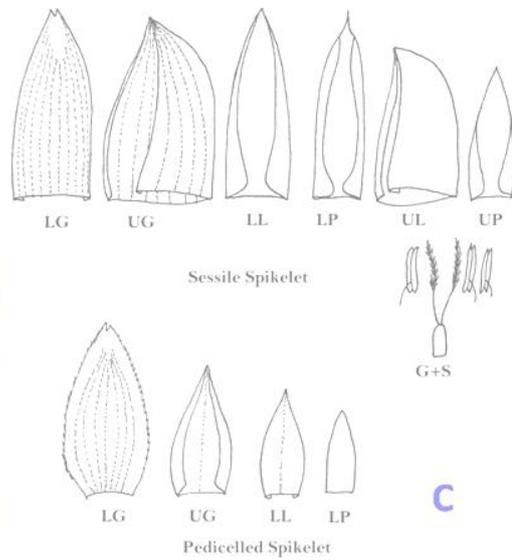
Sessile Spikelet



A:Habit; B: Inflorescence; C: Close-up of inflorescence; D:Line drawing



Part of Spike

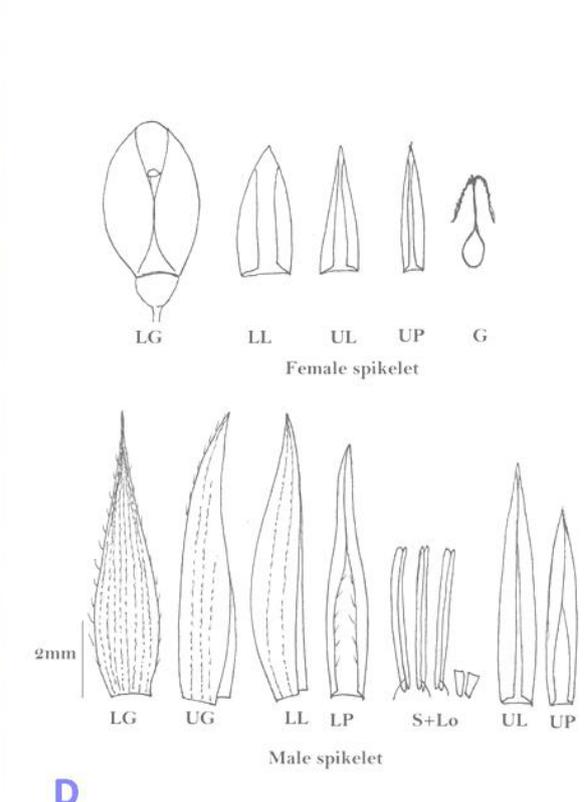


C

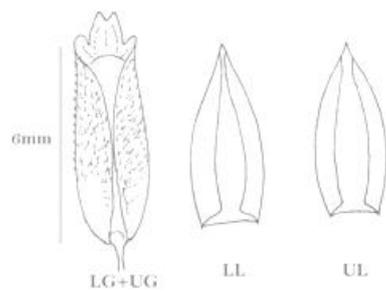
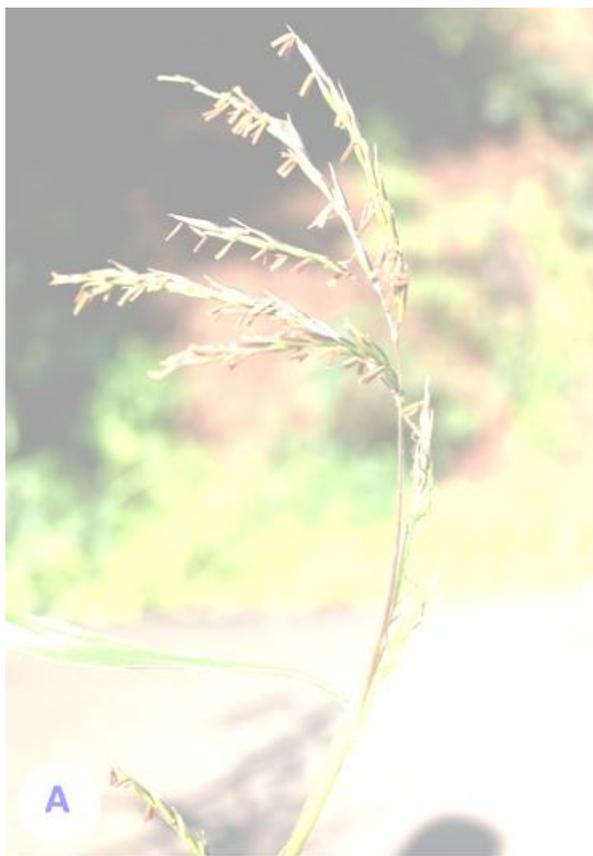
A: Habit; B: Close-up of Inflorescence; C: Line drawing



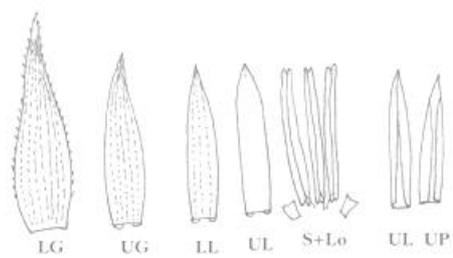
A: Habit; B: Male Inflorescence; C: Male and female spikelet on same inflorescence; D&E: Female Inflorescence



A: Inflorescence; B&C: Close-up of Inflorescence; D: Line drawing



Female Spikelet



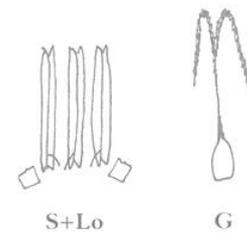
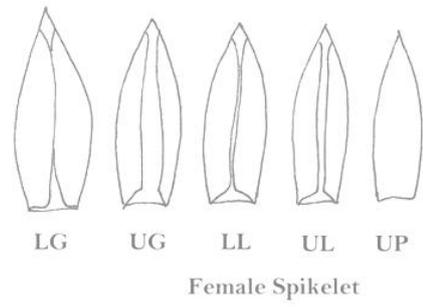
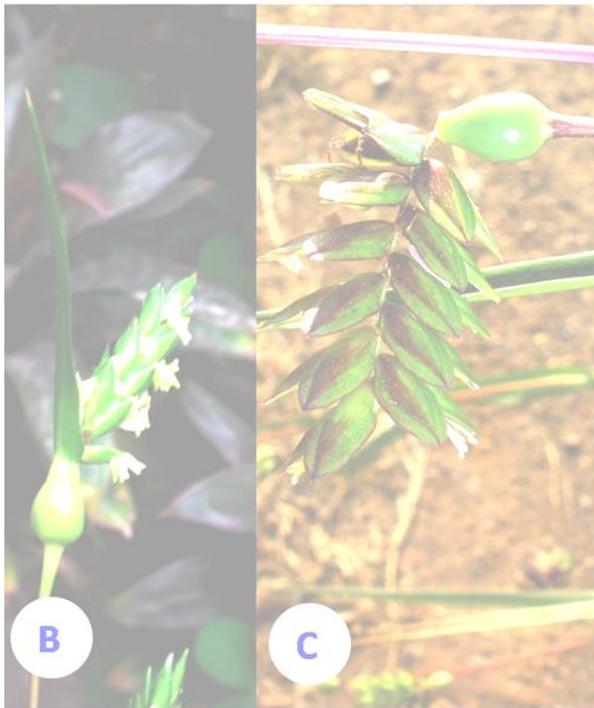
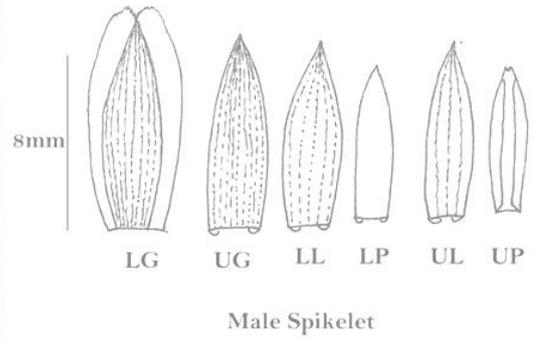
Male Spikelet

E



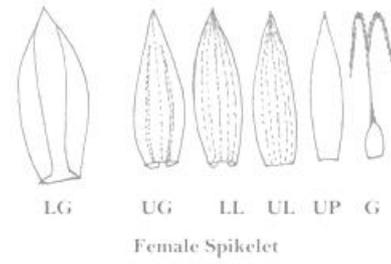
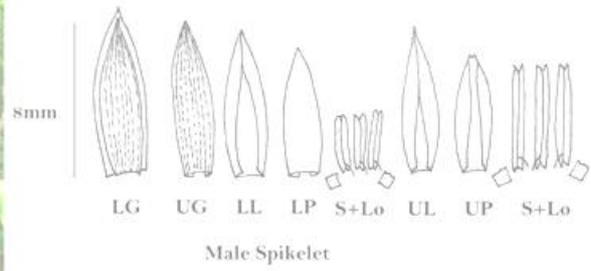
D

A & B: Inflorescence; C: Close-up of Inflorescence; D: Female spikelets; E: Line drawing

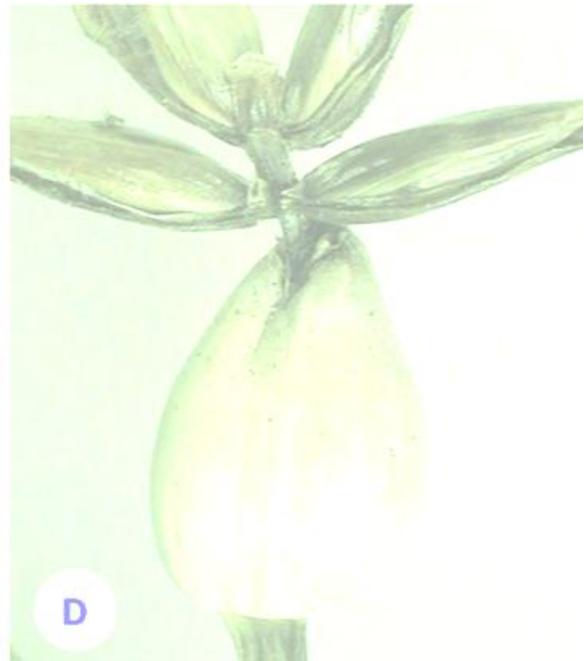


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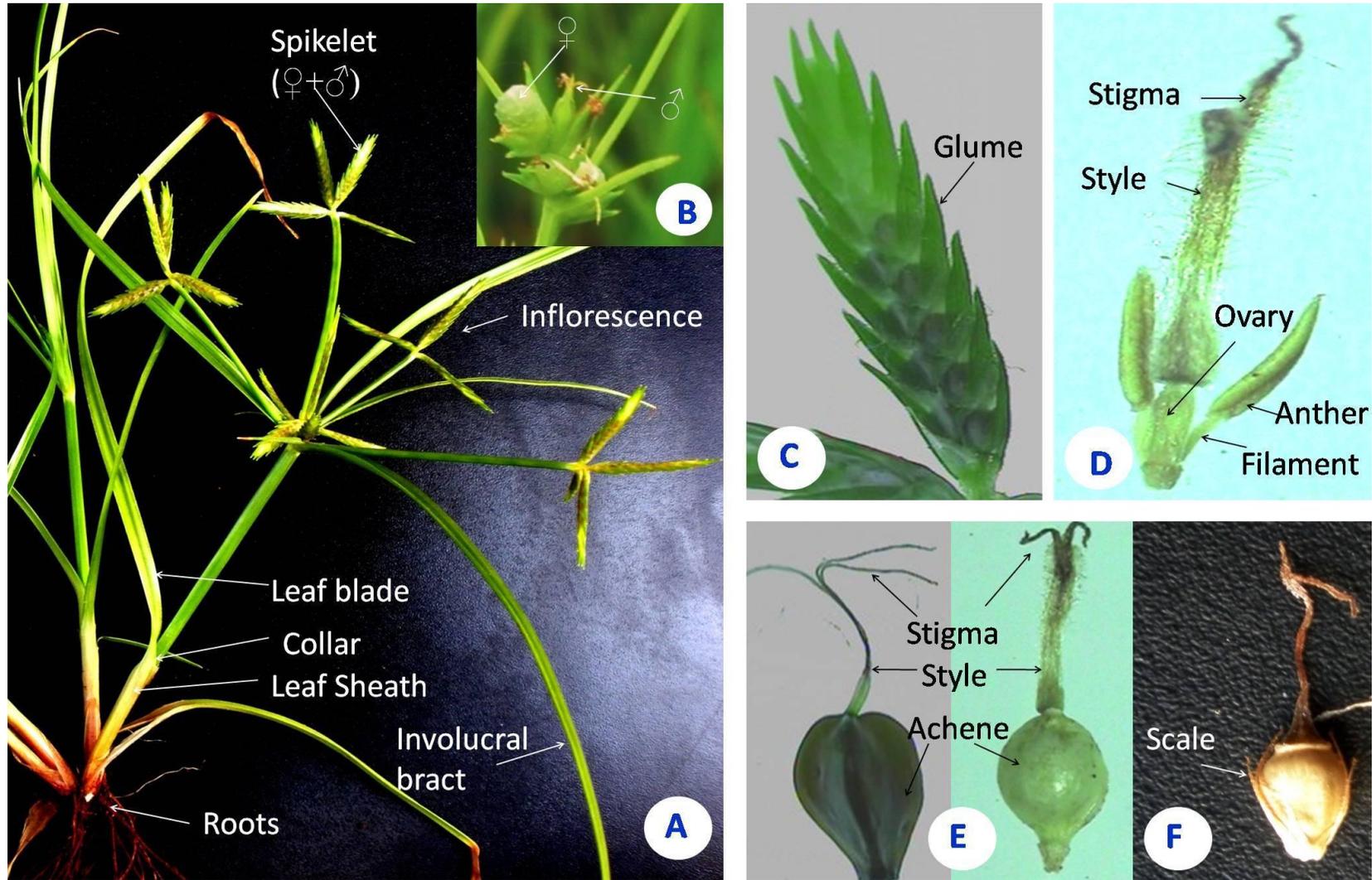
A: Habit; B&C: Close-up of Inflorescence; D: Line drawing



A

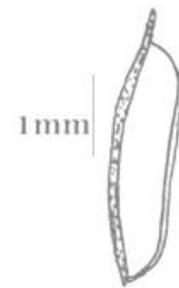
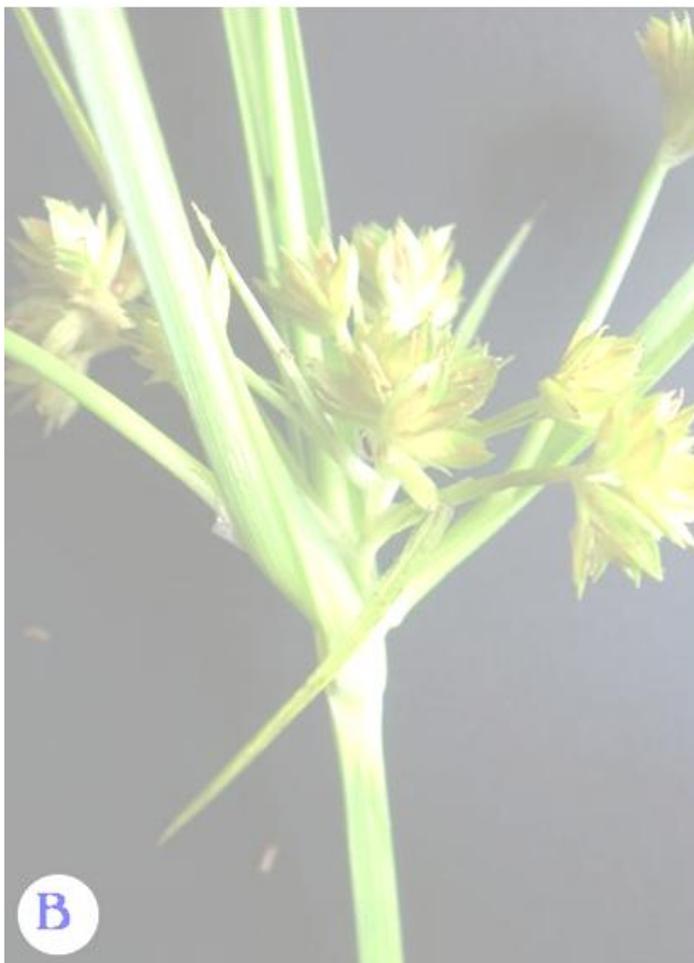


A: Habit & Line drawing; B: Inflorescence; C: Close-up of Inflorescence; D: False involucres around female inflorescence

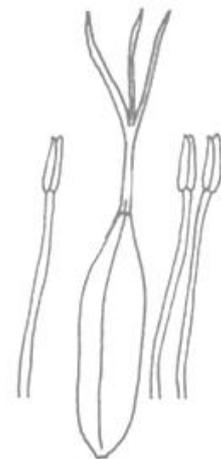




Spikelet



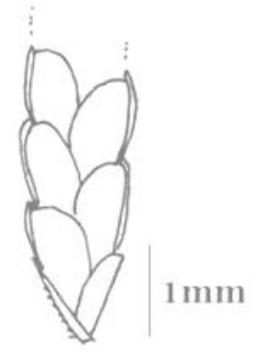
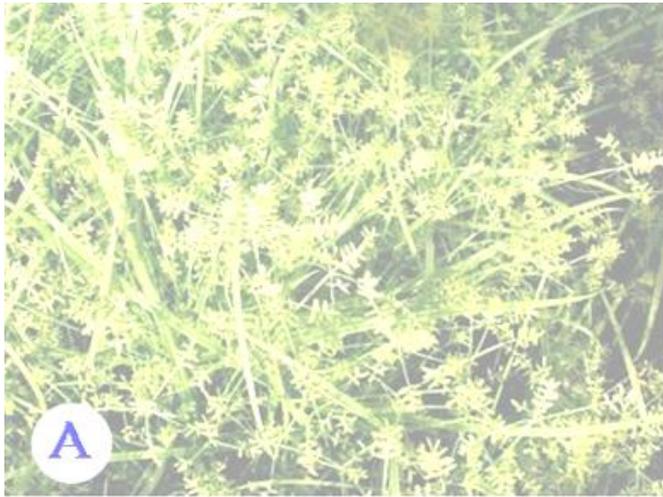
Glume



Pistil & Stamens

C

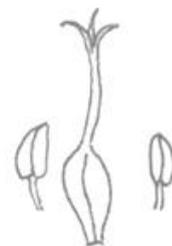
A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing



Spikelet

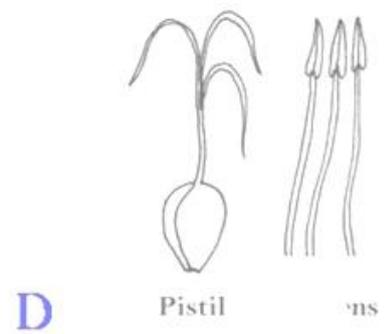
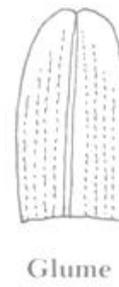
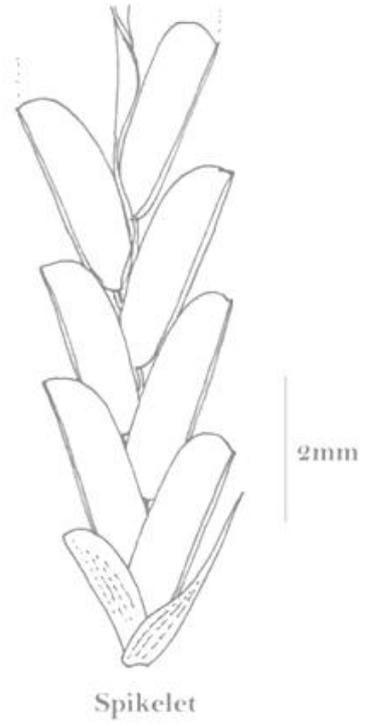
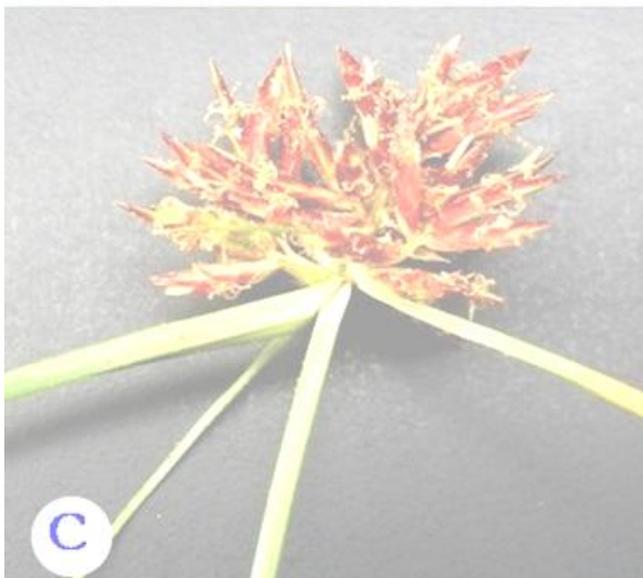
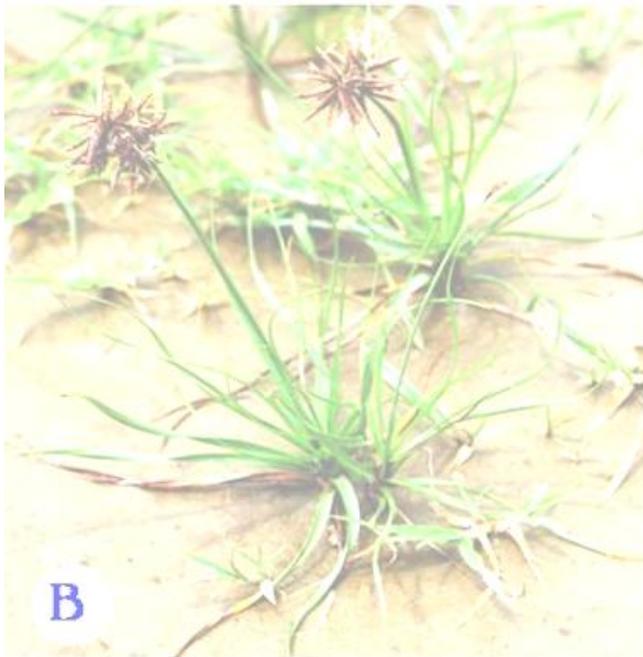


Glume

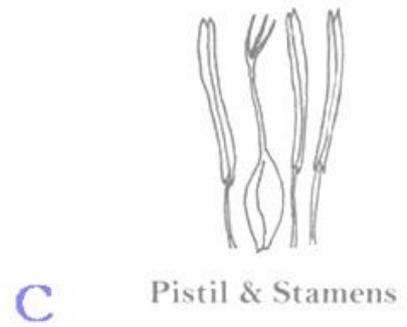
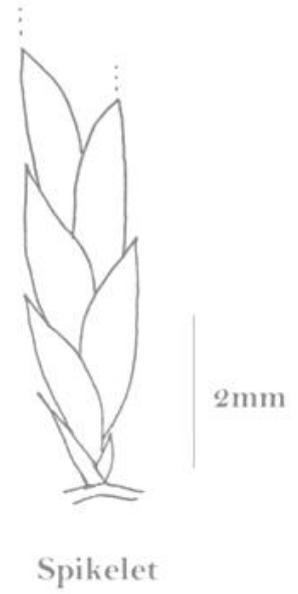


D **Pistil & Stamens**

A: Plant Habit; B: Inflorescence; C: Close-up of Inflorescence; D : Line drawing



A: Plant Habit; B: Inflorescence; C: Close-up of Inflorescence; D : Line drawing



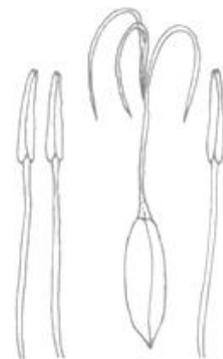
A: Inflorescence; B: Close up of the Inflorescence; C: Line Drawing



Spikelet



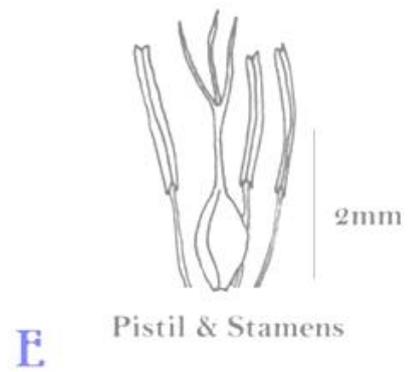
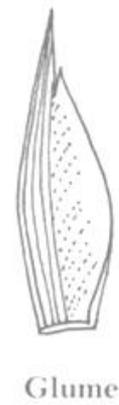
Glume



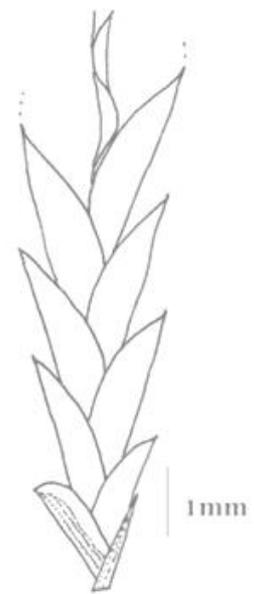
Pistil & Stamens

D

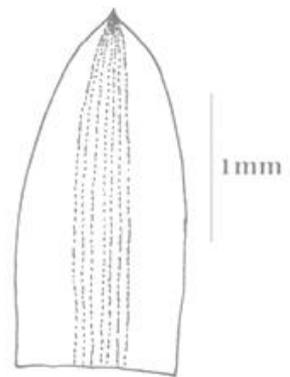
A:Plant Habit; B: Inflorescence; C: Close-up of Inflorescence; D : Line drawing



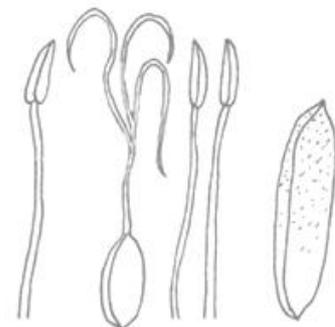
A: Plant Habit; B: Close-up of Inflorescence ; C: Spikelet; D : Achene with Style and Stigma; E: Line Drawing



Spikelet



Glume

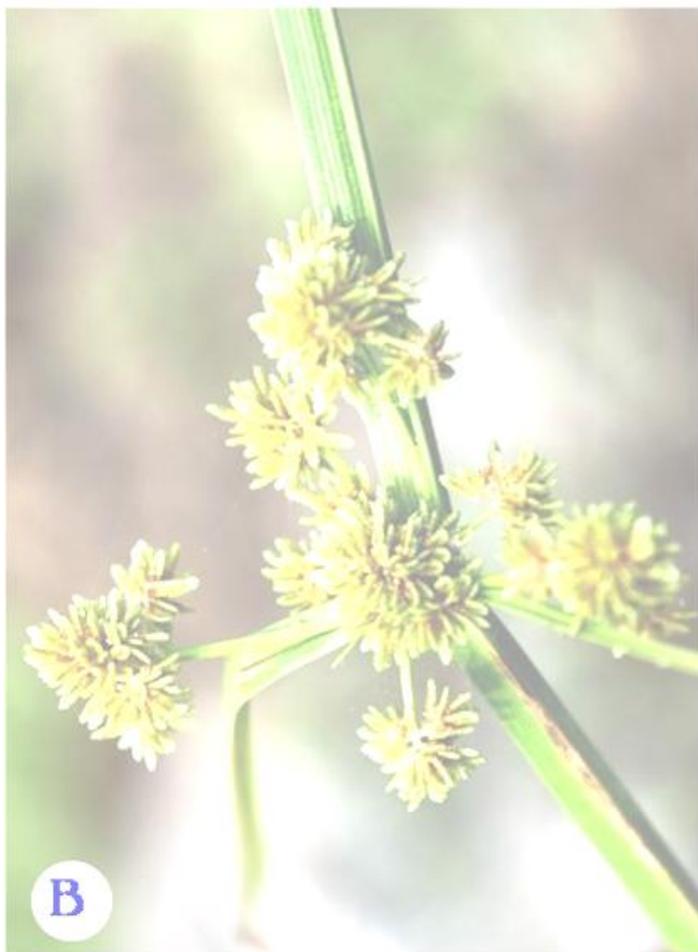


Pistil & Stamen Nut

A:Plant Habit; B: Close-up of Inflorescence; C : Line drawing



Spikelet

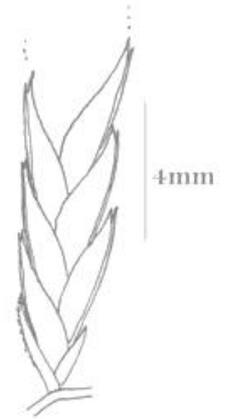


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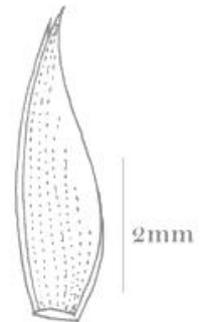


C Pistil & Stamens

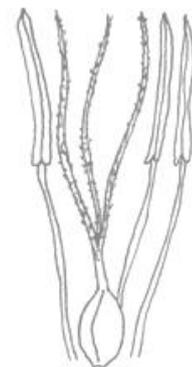
A: Plant Habit; B: Close-up of Inflorescence; C : Line drawing



Spikelet

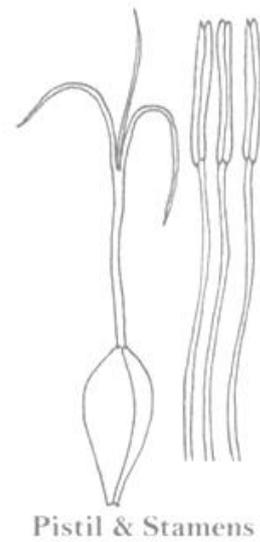
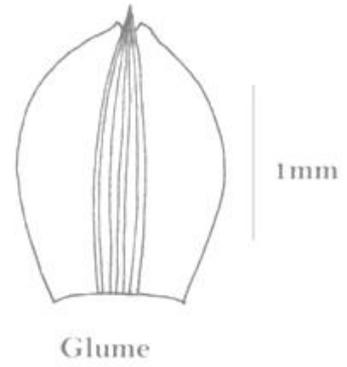
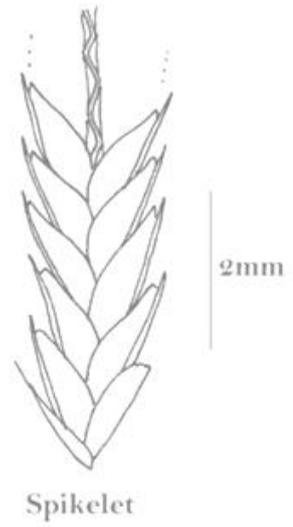


Glume



Pistil & Stamens

A: Plant Habit; B: Close-up of Inflorescence; C : Line drawing



D

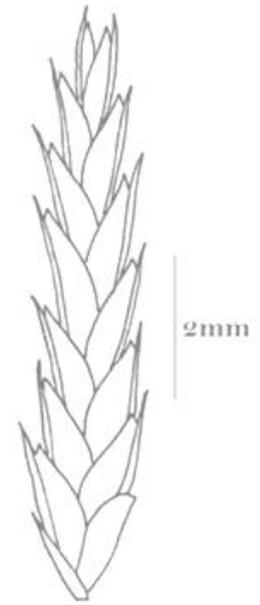
A: Plant Habit; B: Close-up of Inflorescence; C : Spikelet; D: Line drawing



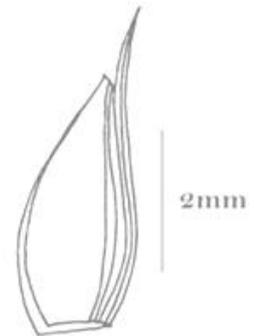
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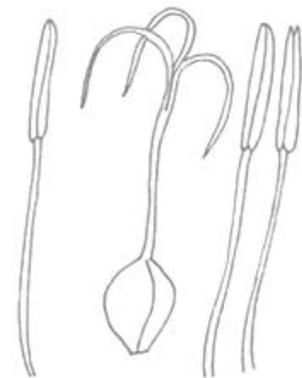
B



Spikelet



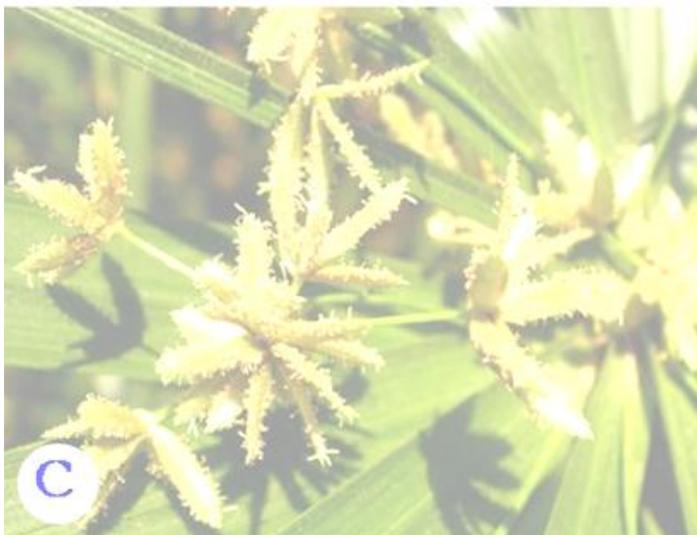
Glume



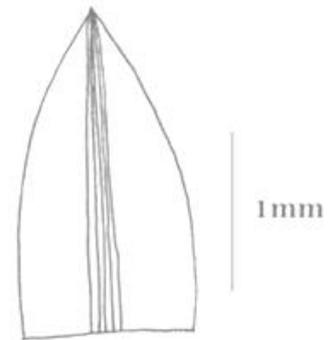
Stamens & Pistil

C

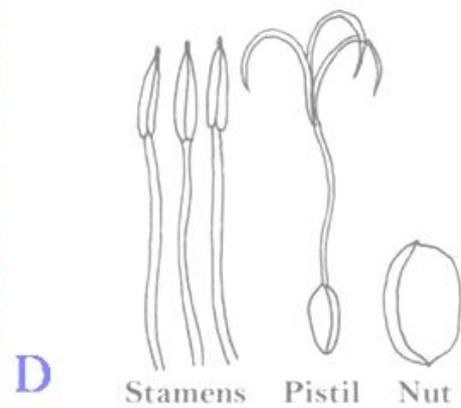
A: Plant Habit; B: Close-up of Inflorescence; C: Line drawing



Spikelet



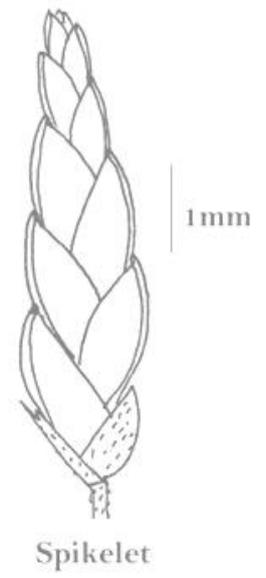
Glume



A:Plant Habit; B:Inflorescence; C: Close-up of Inflorescence ; D: Line drawing



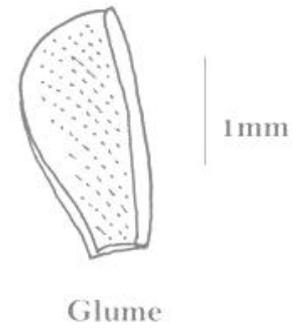
A



Spikelet

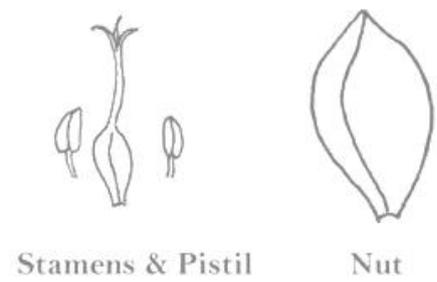


B



Glume

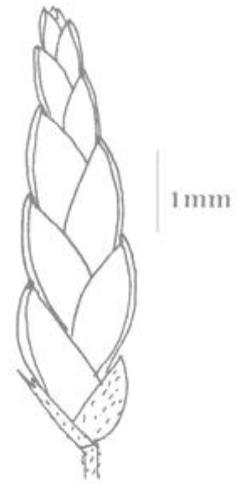
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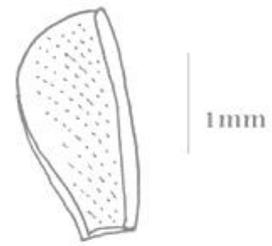
Stamens & Pistil

Nut

A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing



Spikelet



Glume

C

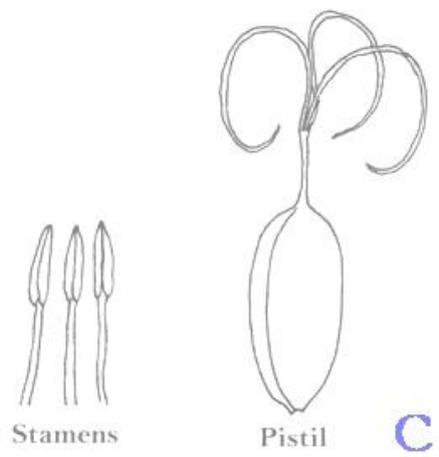
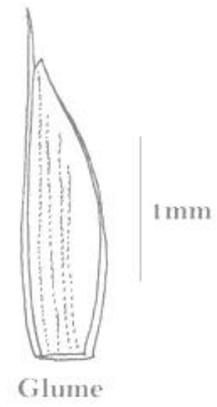
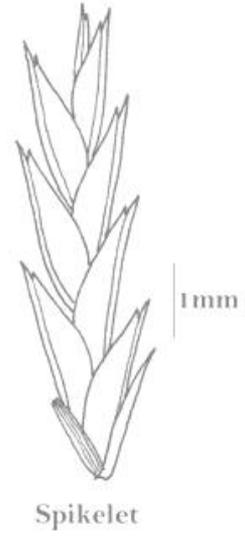


Stamens & Pistil



Nut

A: Inflorescence; B: Close-up of Inflorescence; C: Line drawing



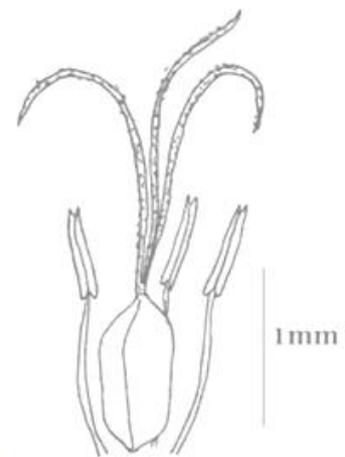
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Spikelet



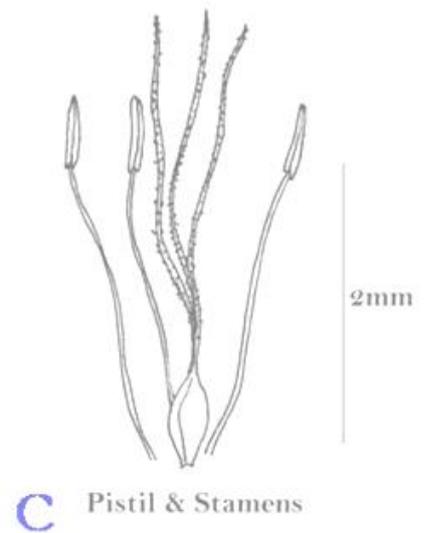
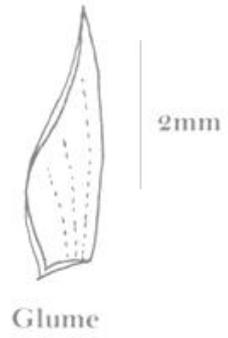
Glume



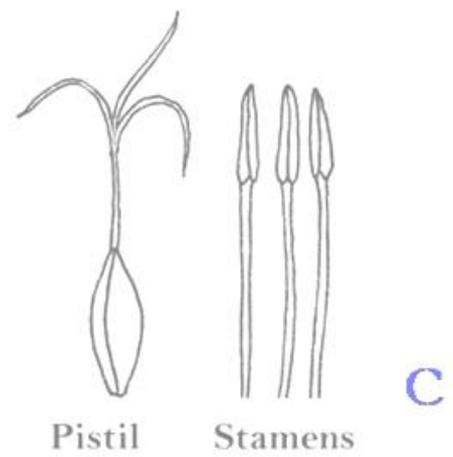
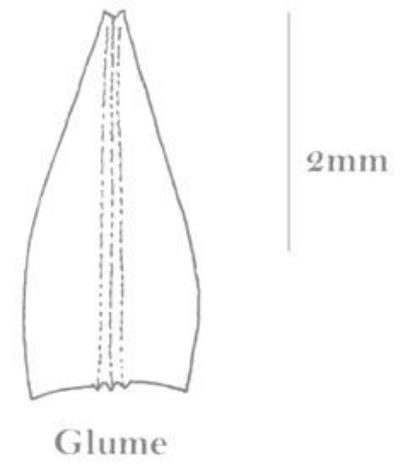
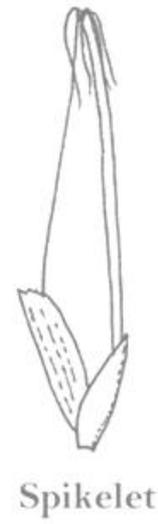
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Pistil & Stamens

A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



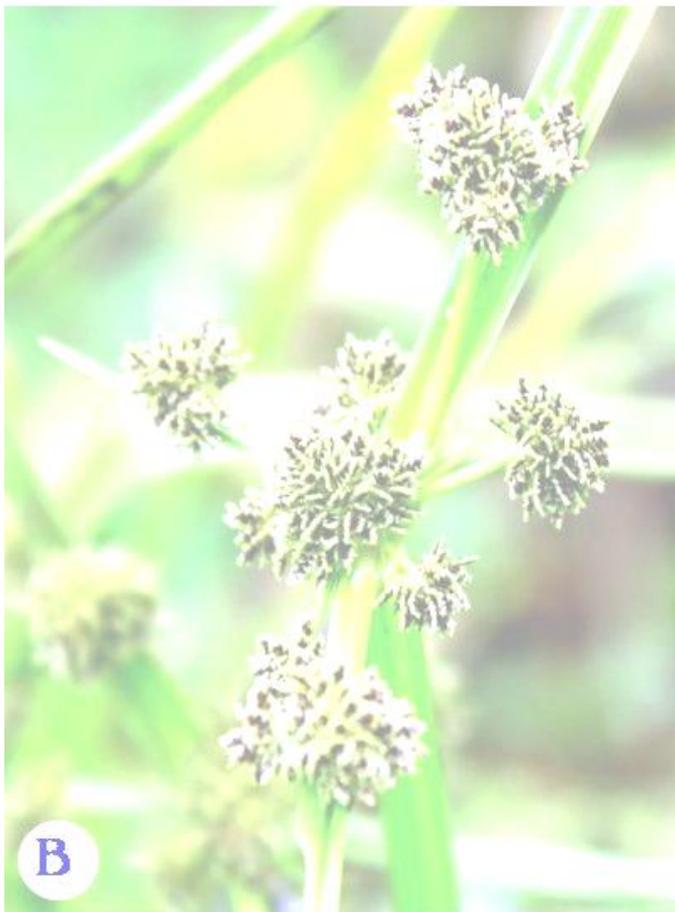
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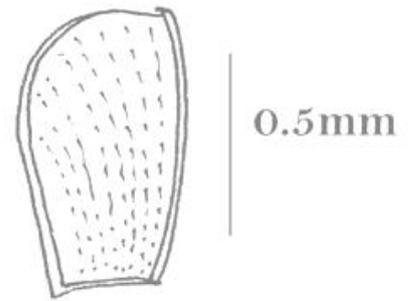
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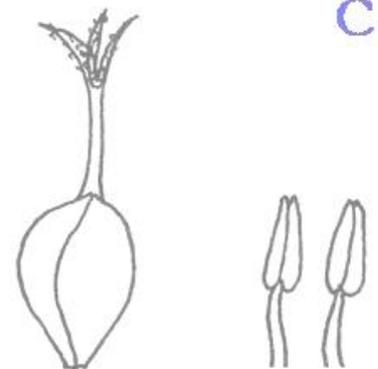
Spikelet



B



Glume



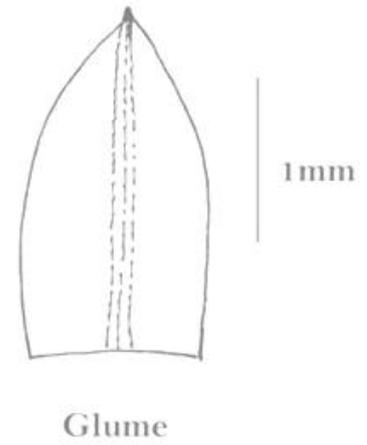
Pistil

Stamens

A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



Spikelet



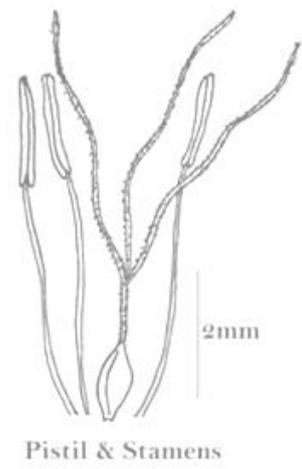
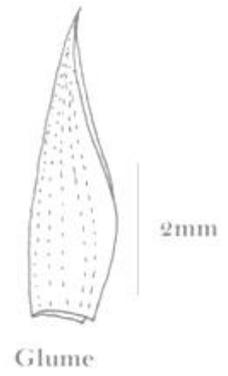
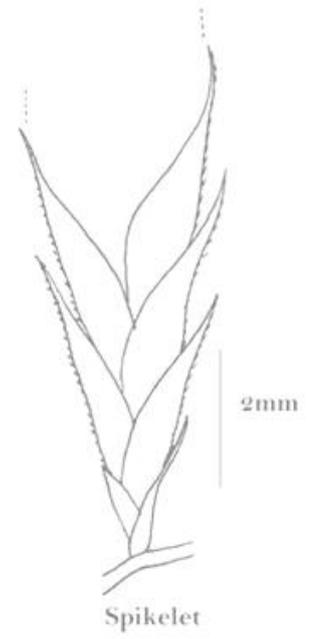
Glume



Pistil & Stamen

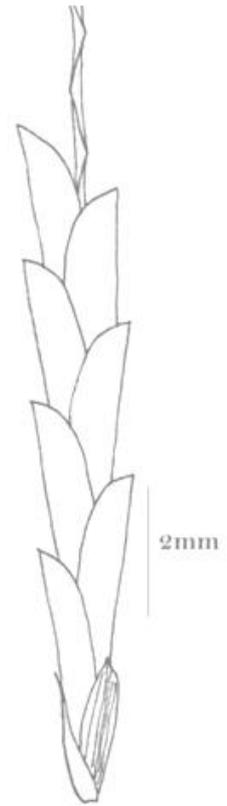
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A & B: Plant Habit ; C: Close-up of Inflorescence; D: Line drawing

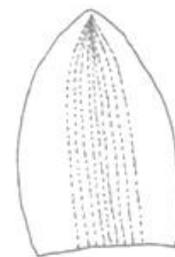


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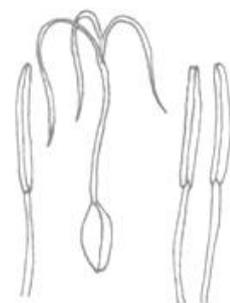
A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



Spikelet

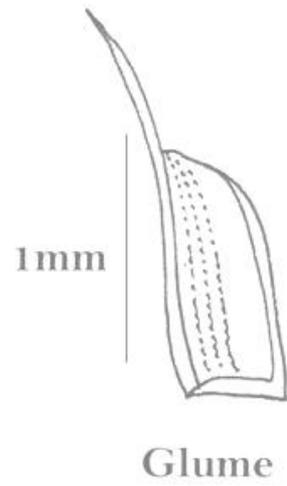
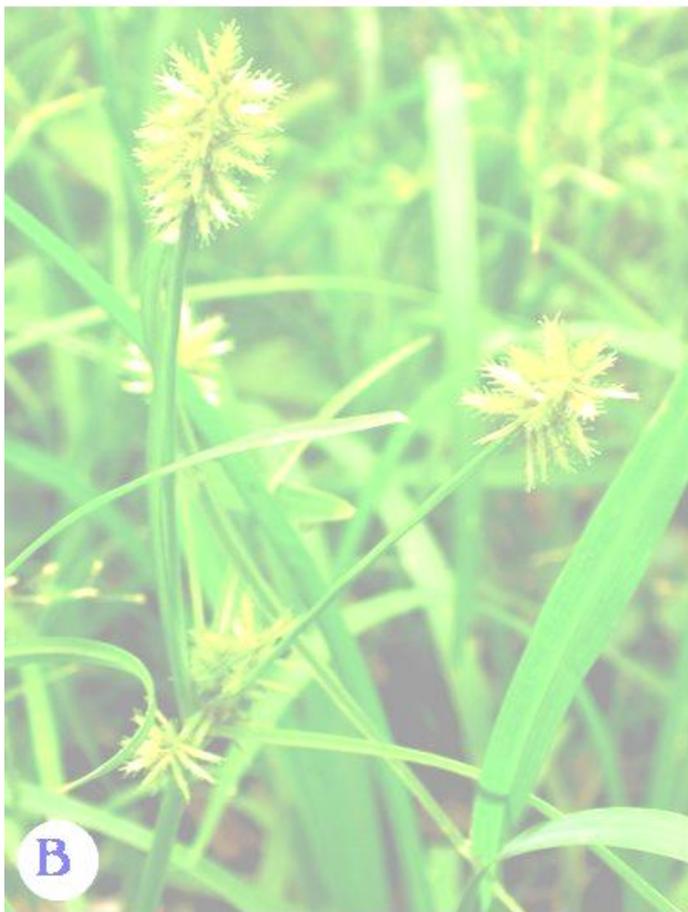


Glume

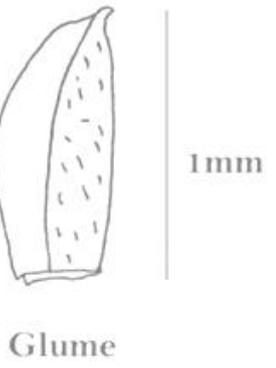
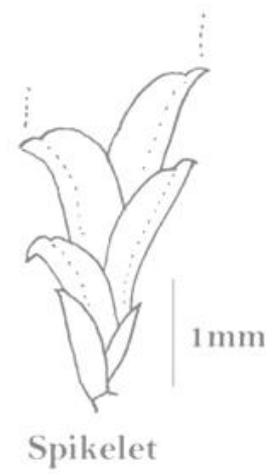


Pistil & Stamens

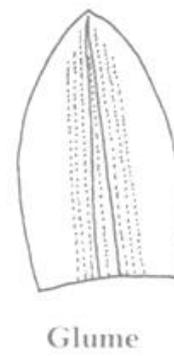
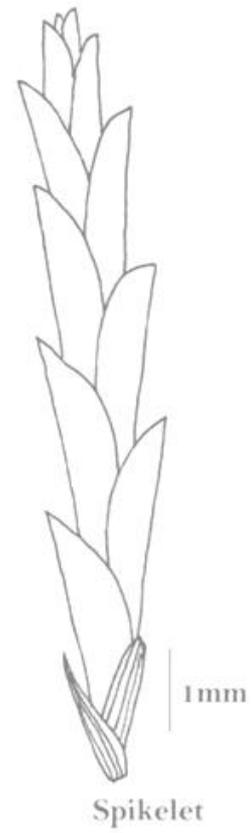
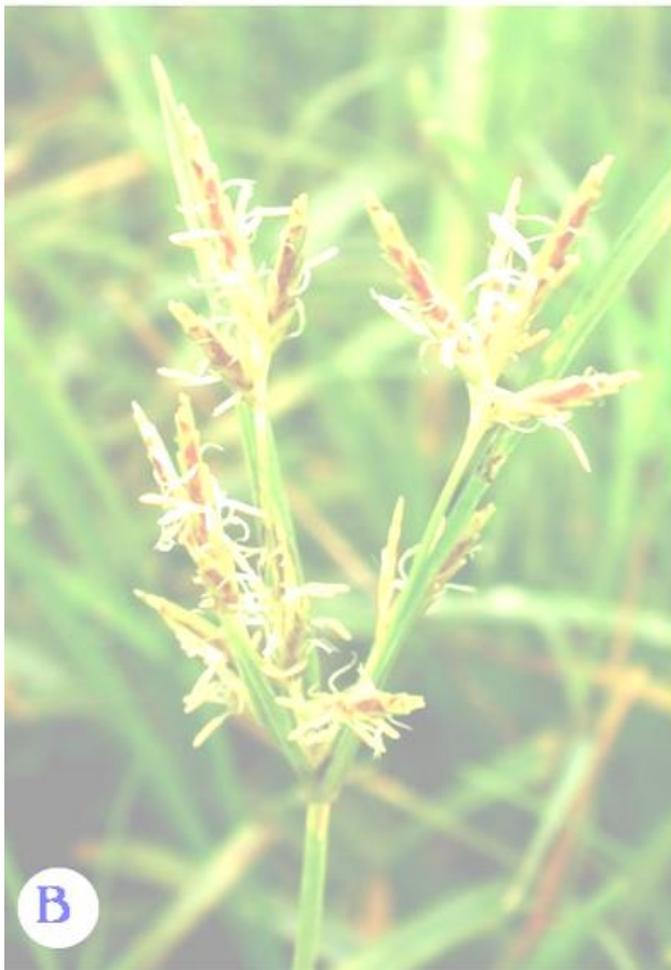
A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



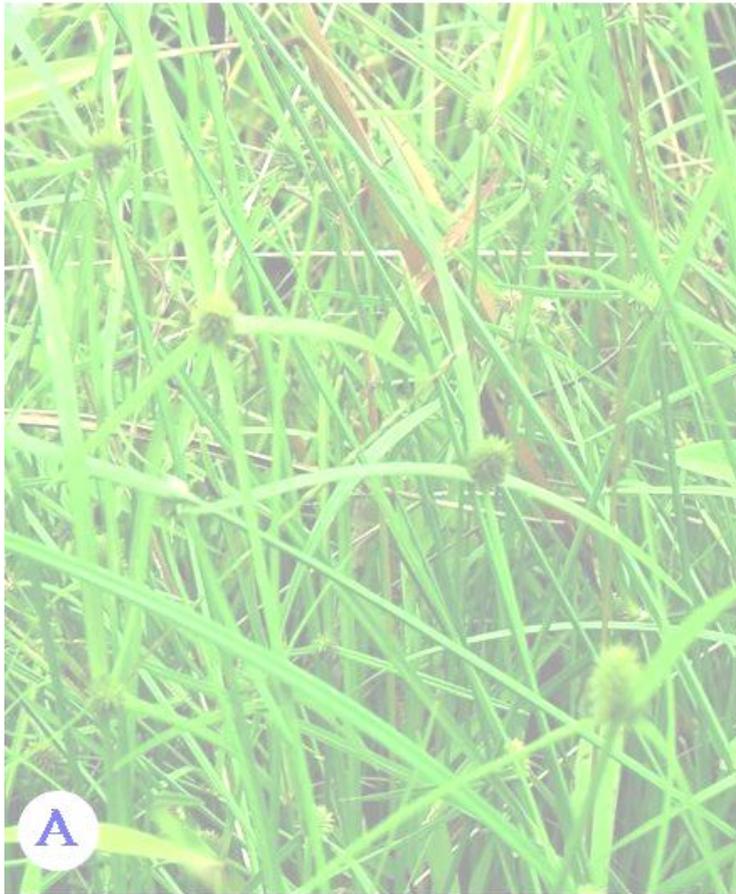
A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



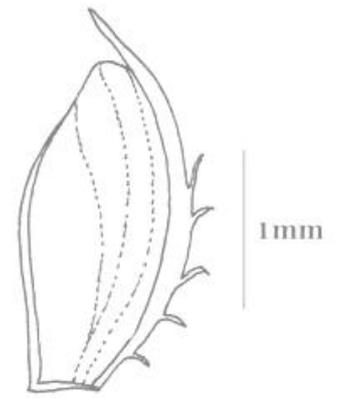
A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



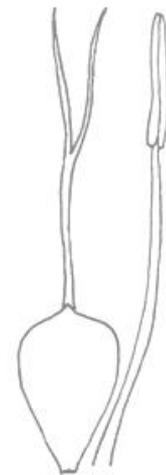
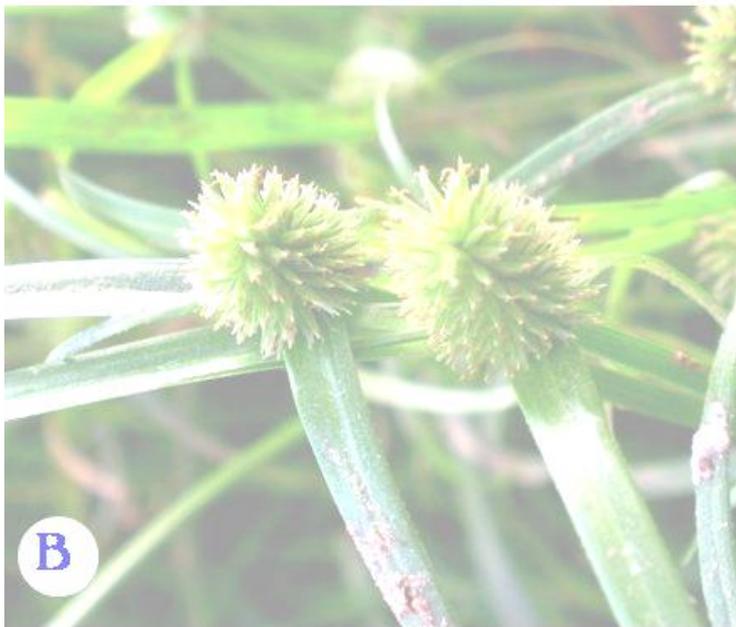
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Spikelet

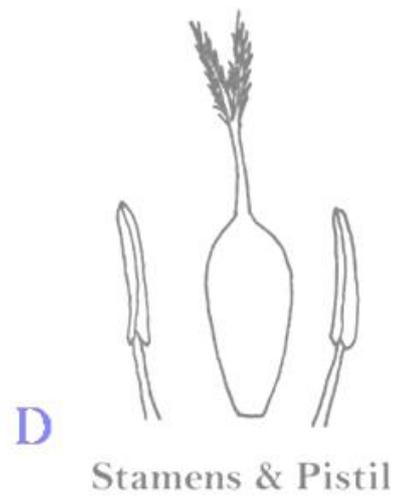
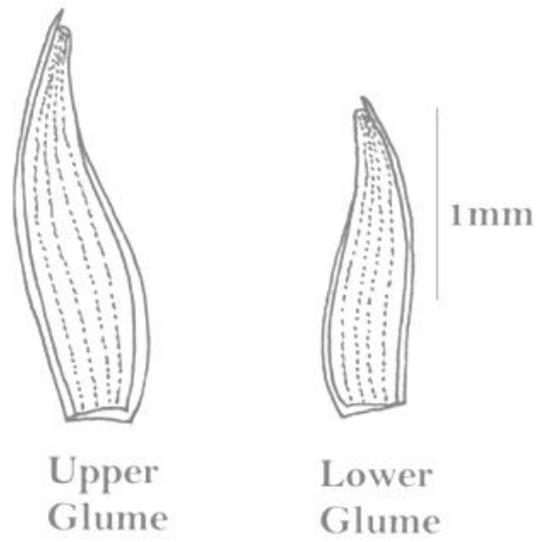
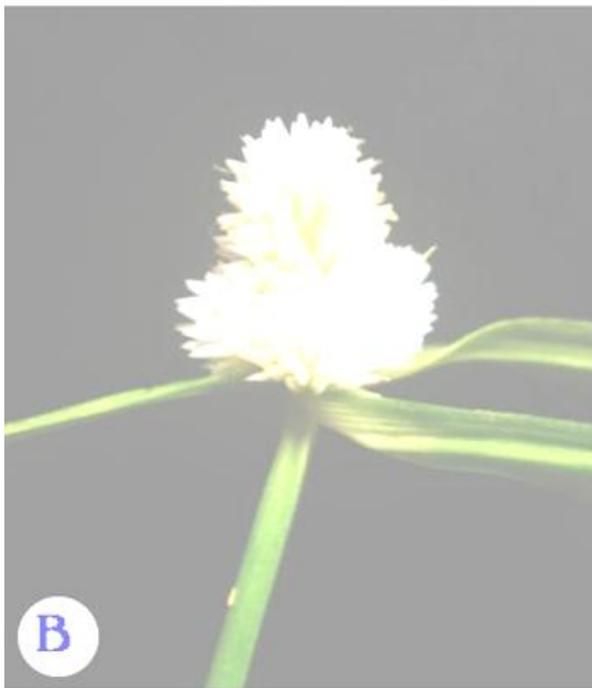


Glume



Pistil & Stamen

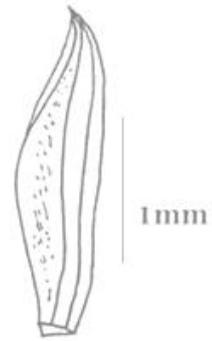
A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



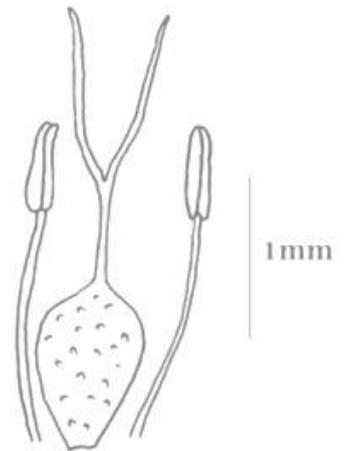
A: Plant Habit ; B: Close-up of Inflorescence; C: Achene; D: Line drawing



Spikelet



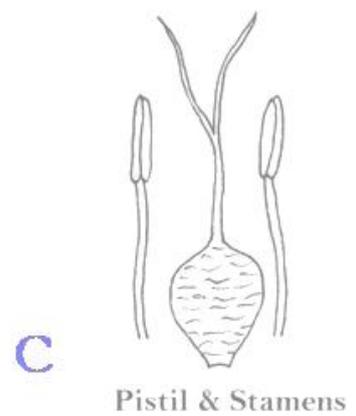
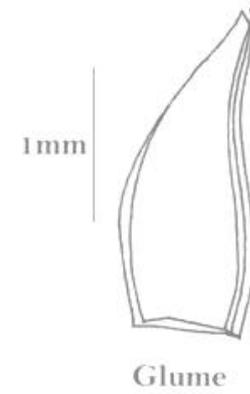
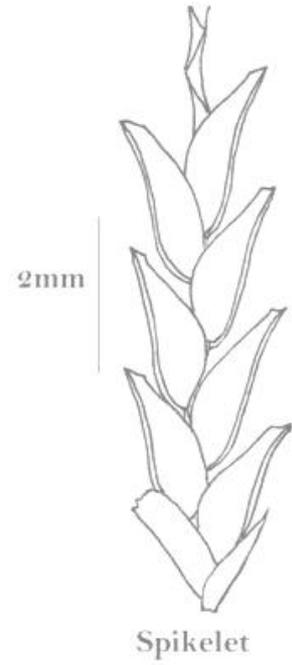
Glume



C

Stamens & Pistil

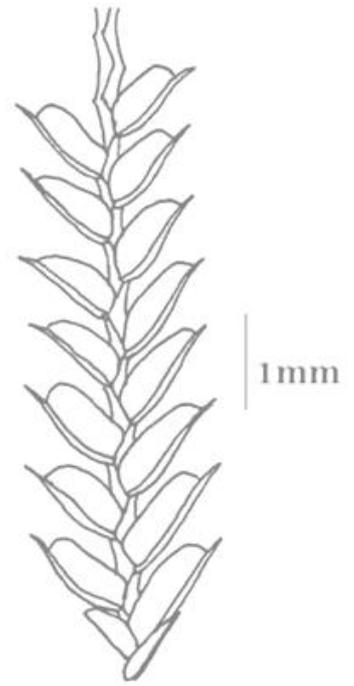
A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



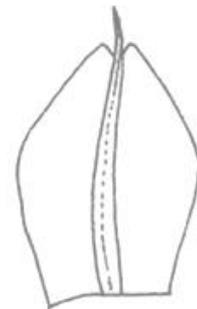
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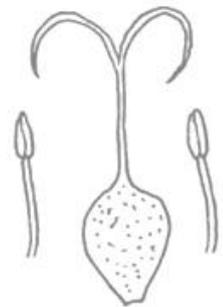
Spikelet



B



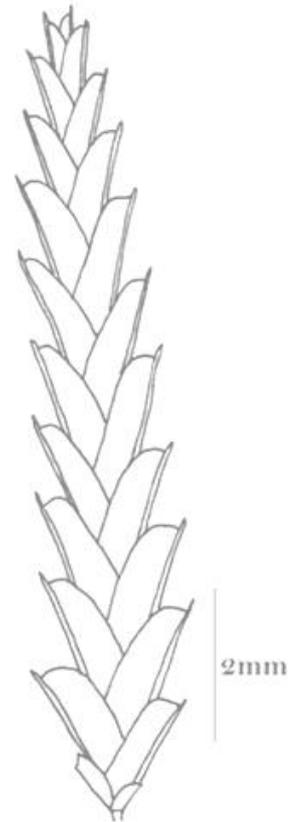
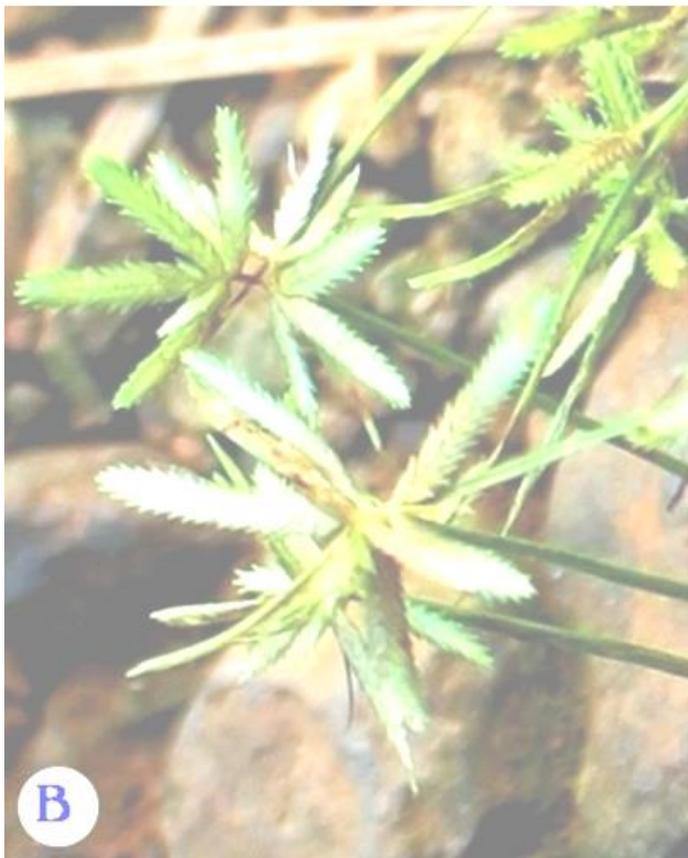
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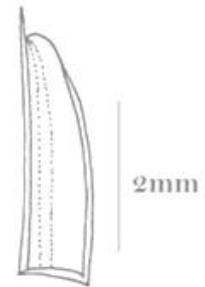
Stamens & Pistil

C

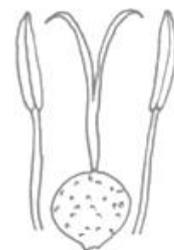
A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



Spikelet



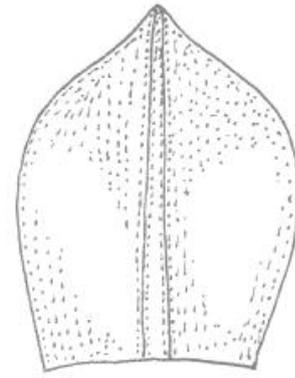
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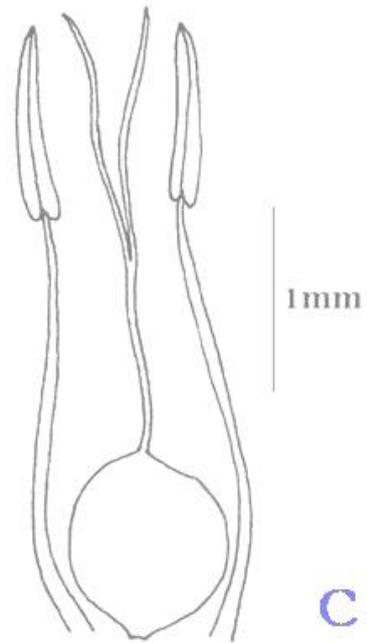
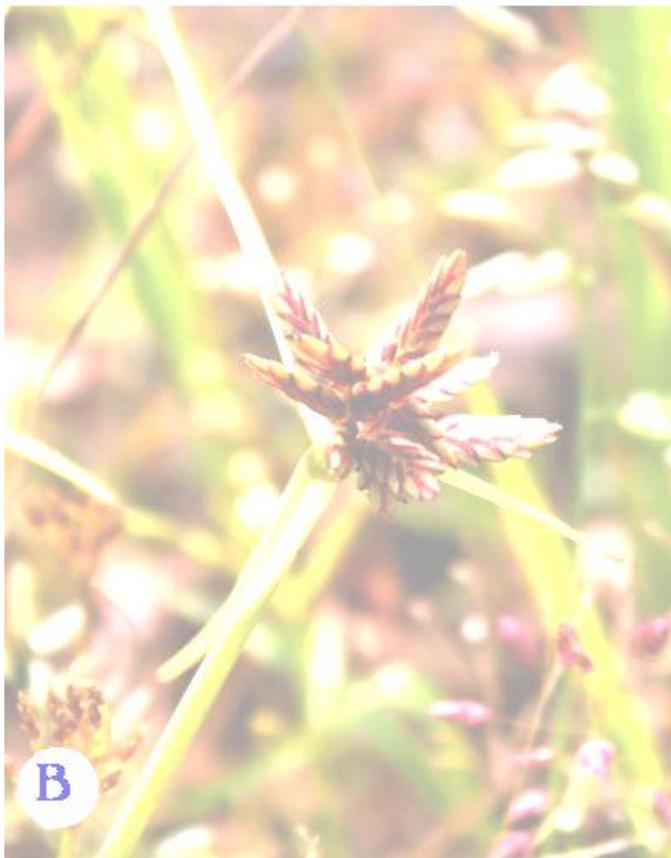
Pistil & Stamens

C

A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing

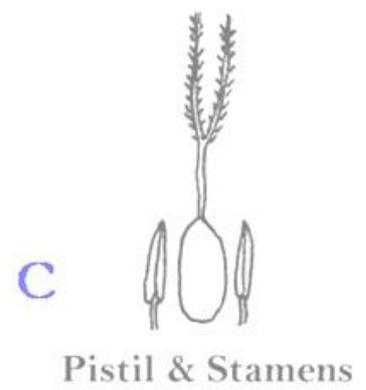
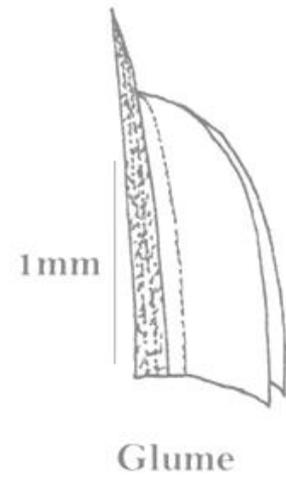
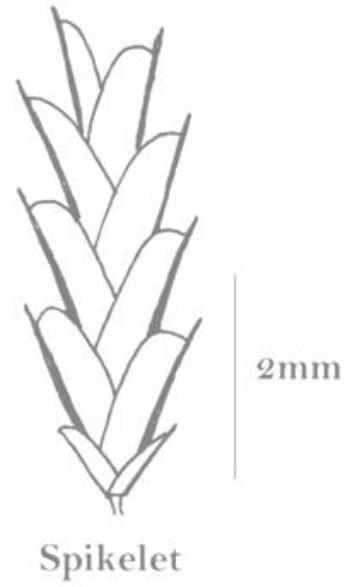


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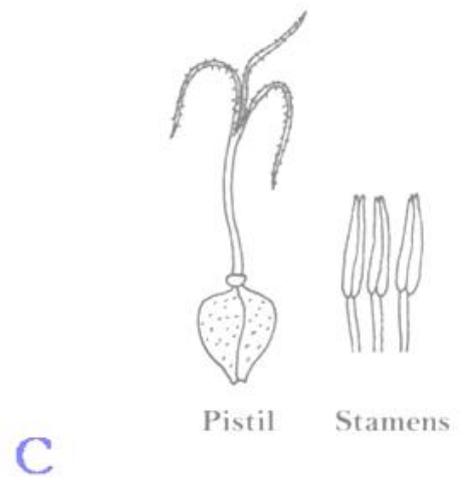
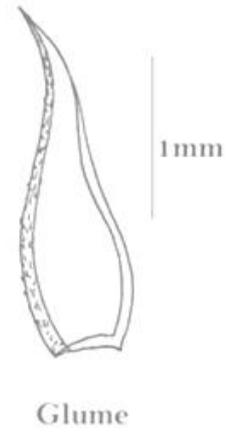
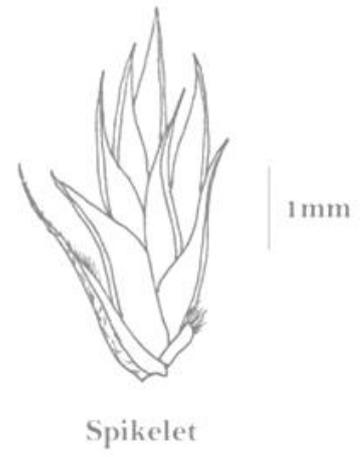


Pistil & Stamens

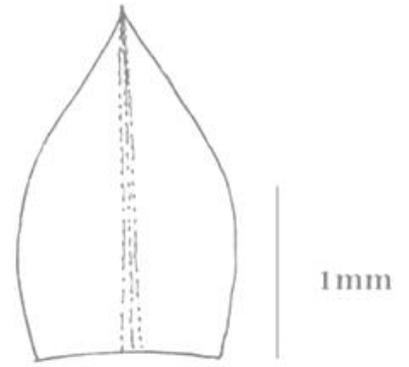
A & B: Close-up of Inflorescence; C: Line drawing



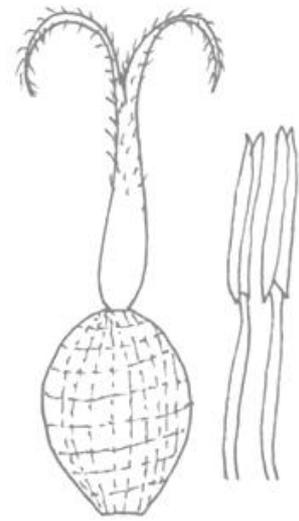
A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



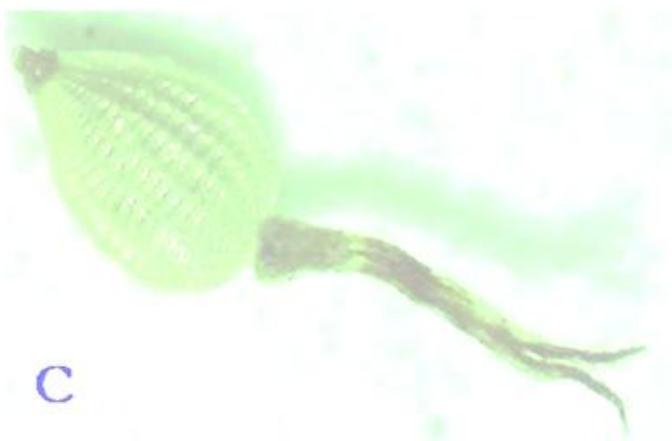
A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing



Glume



Pistil & Stamens

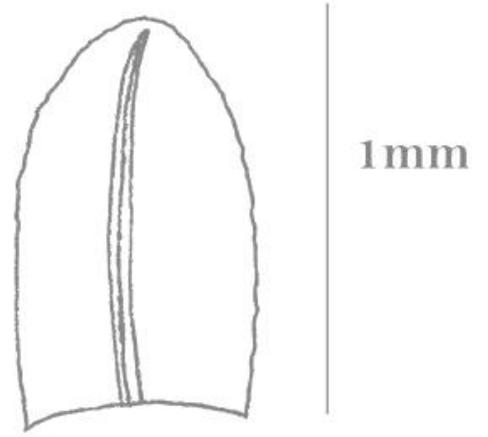


D

A: Plant Habit ; B: Close-up of Inflorescence; C: Achene with Style and Stigma; D:Line drawing



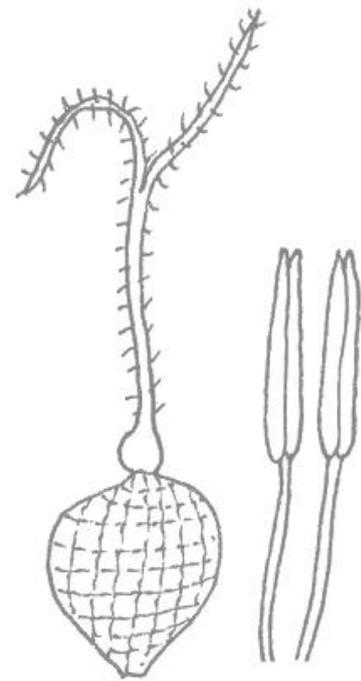
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Glume



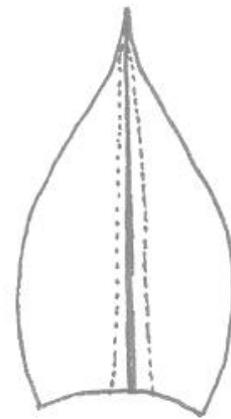
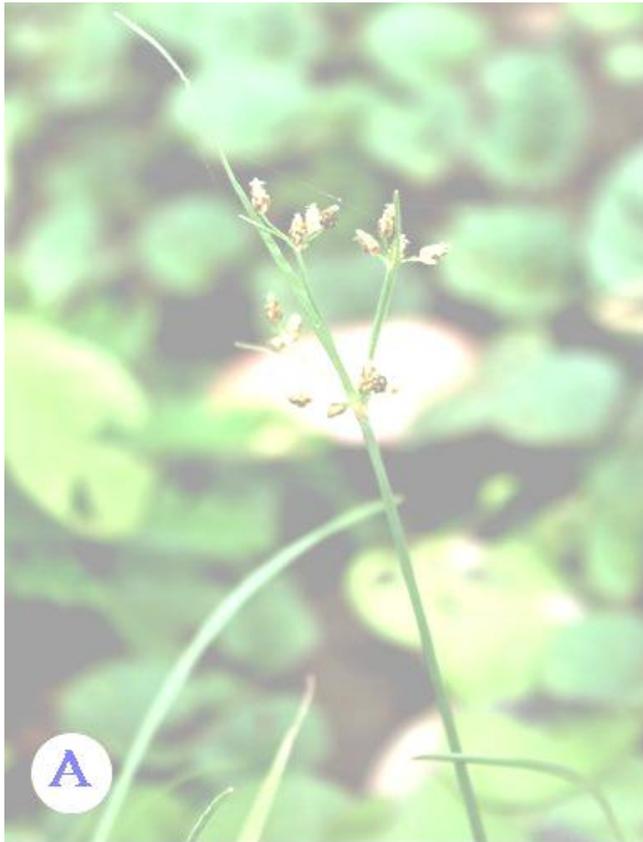
B



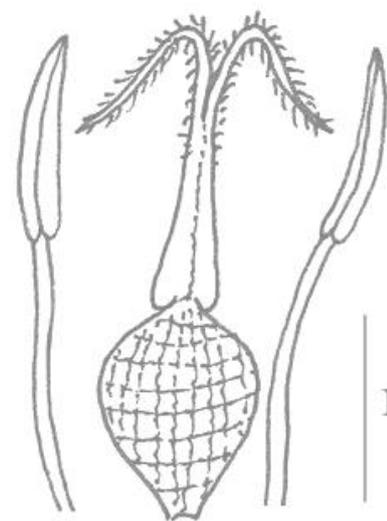
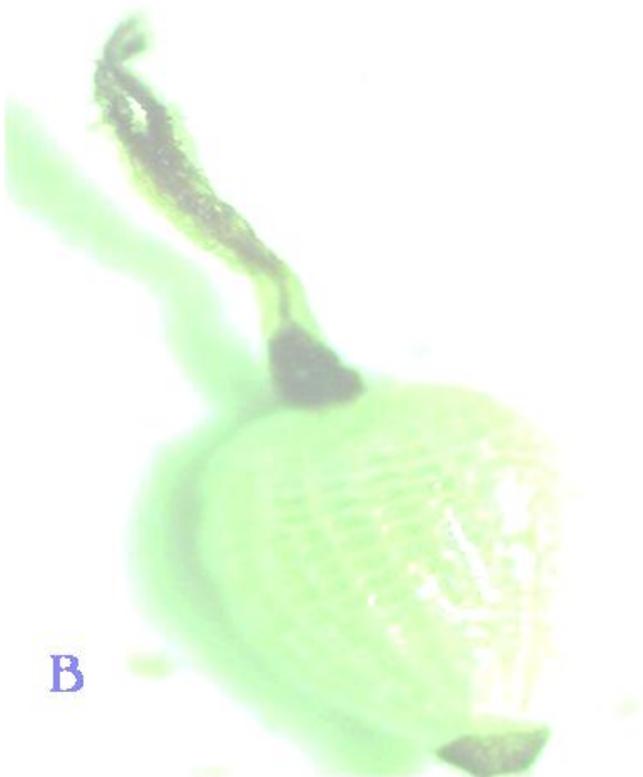
C

Pistil & Stamens

A: Plant Habit ; B: Close-up of Inflorescence; C: Line drawing

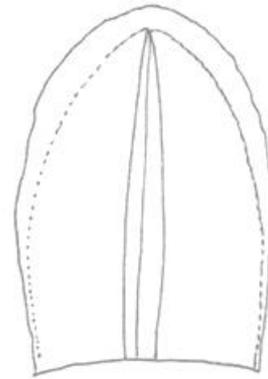
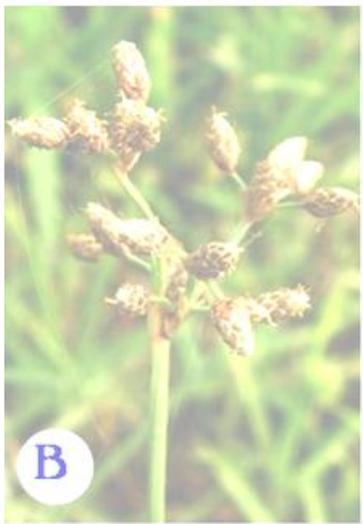


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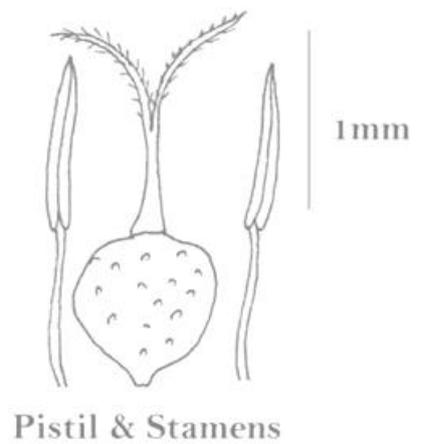
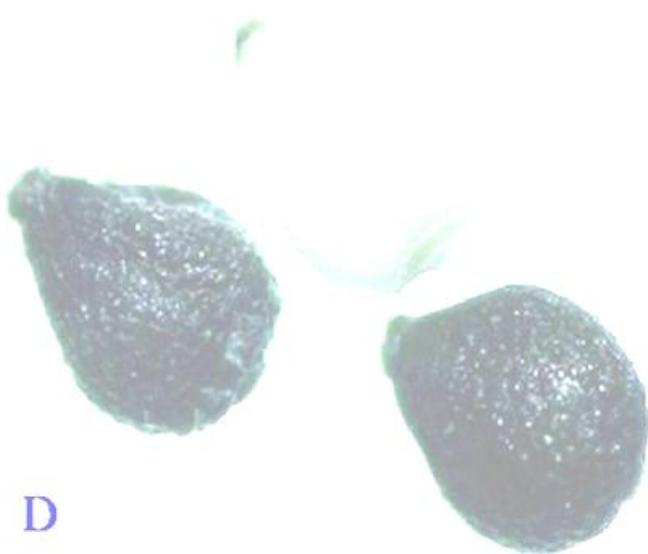


Stamens & Pistil

A: Inflorescence; B: Achene with Style and Stigma; C: Line drawing

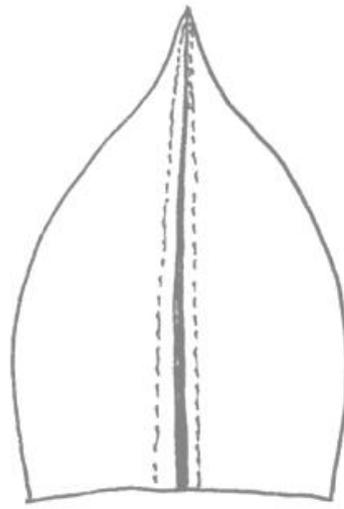


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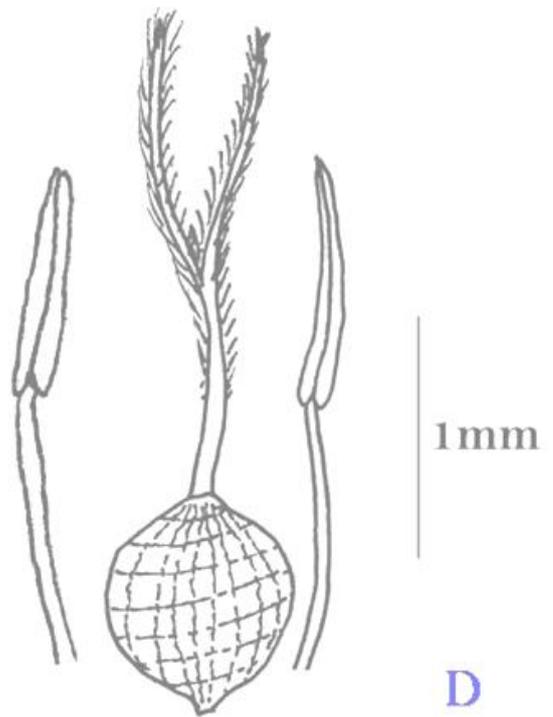
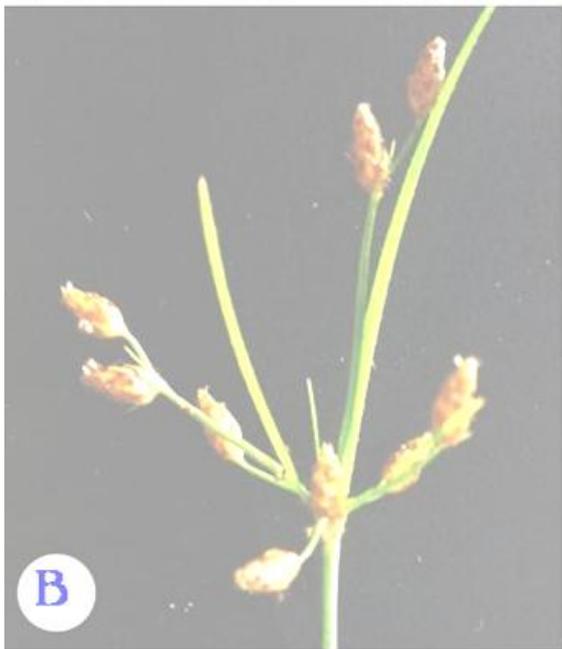


Pistil & Stamens

A: Plant Habit; B & C: Close up of Inflorescence; C: Achene; D:Line drawing



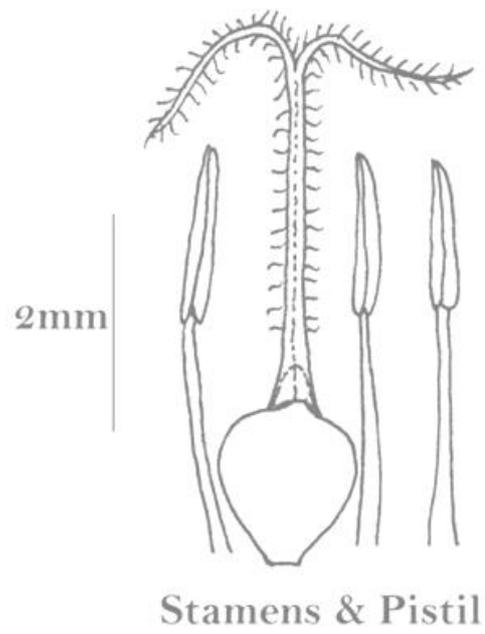
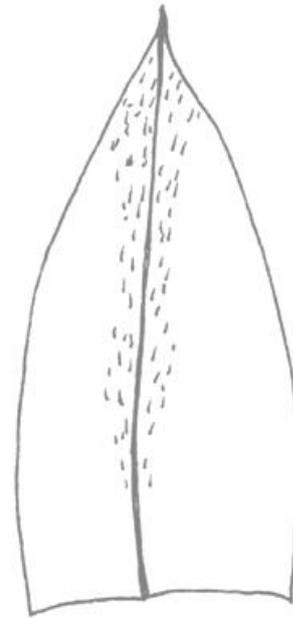
Glume



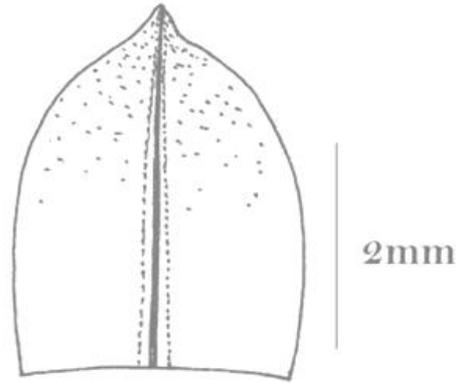
Pistil & Stamens



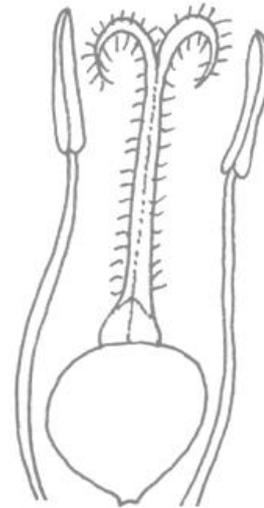
A: Plant Habit; B : Close up of Inflorescence; C: Pistil; D:Line drawing



A: Plant Habit; B : Close up of Inflorescence; C: Achene with stigma and style; D:Line drawing



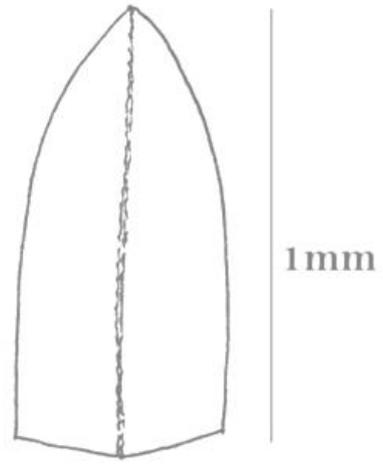
Glume



Pistil & Stamens

D

A: Plant Habit; B : Close up of Inflorescence; C: Achene with stigma and style; D:Line drawing

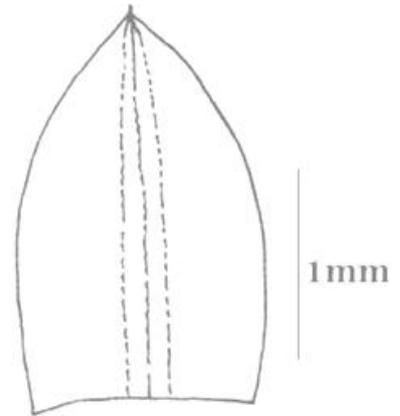
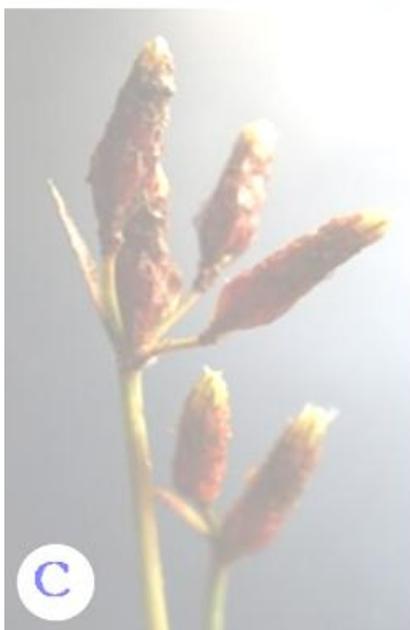


Glume

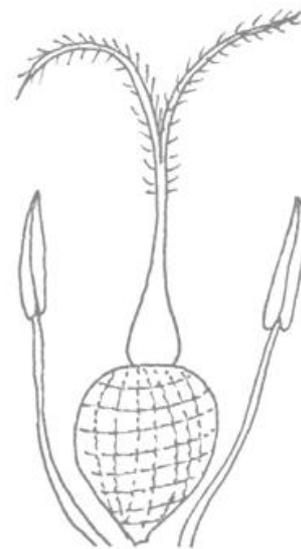


D

A: Plant Habit; B : Close up of Inflorescence; C: Achene with stigma and style; D:Line drawing



Glume



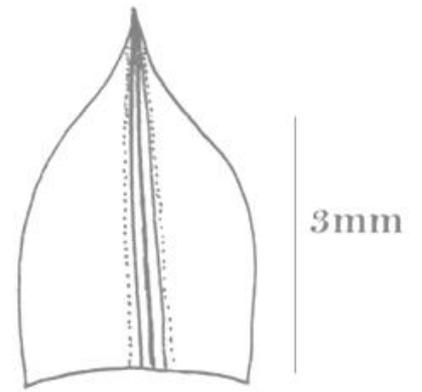
Pistil & Stamens

E

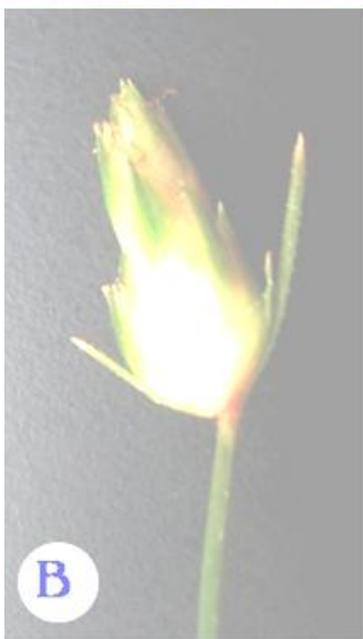
A & B: Plant Habit; C: Close up of Inflorescence; D: Achene; E: Line drawing



A



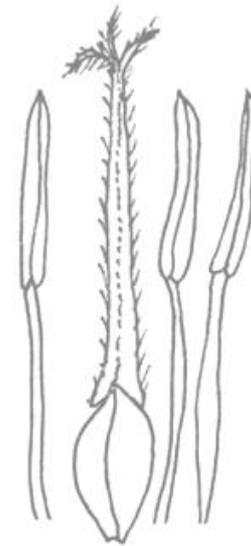
Glume



B



C



Stamens & Pistil



D



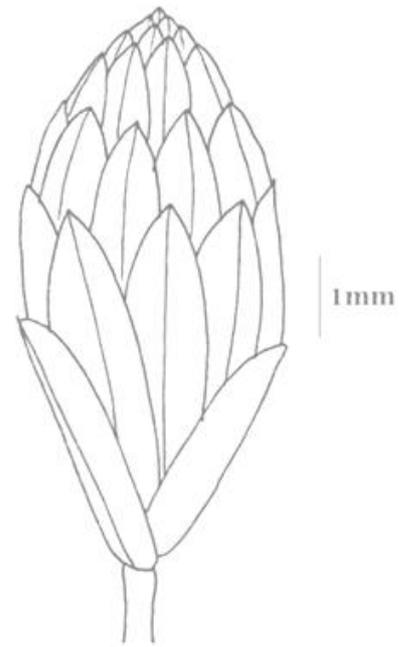
Nut

E

A: Plant Habit; B & C : Close up of Inflorescence; D: Achene with stigma and style; E:Line drawing



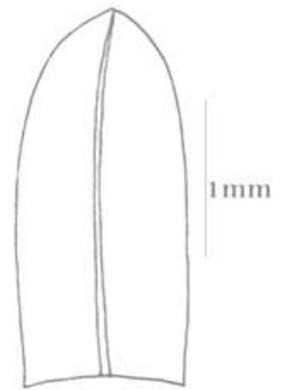
A



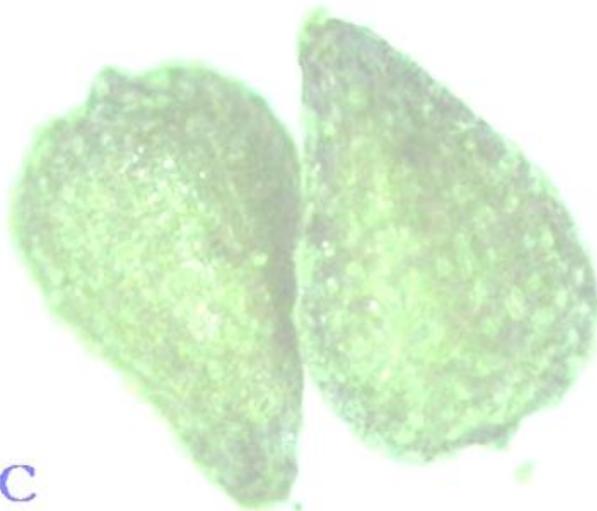
Spikelet



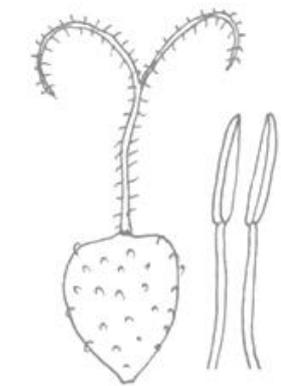
B



Glume



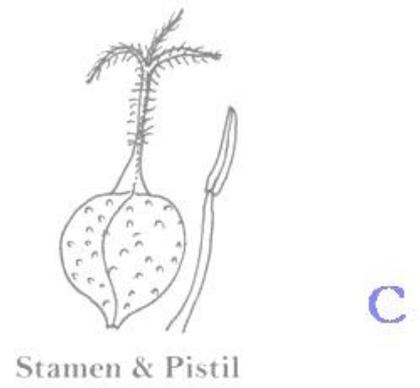
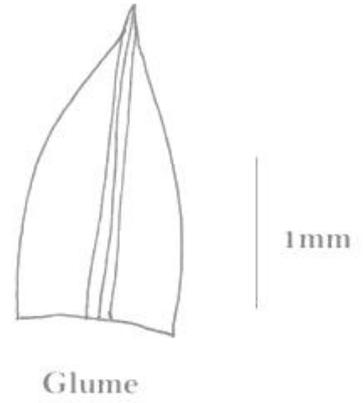
C



D

Pistil & Stamens

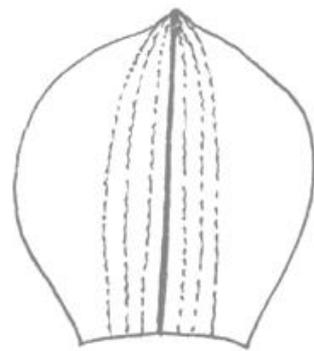
A: Plant Habit; B : Close up of Inflorescence; C: Achene ; D:Line drawing



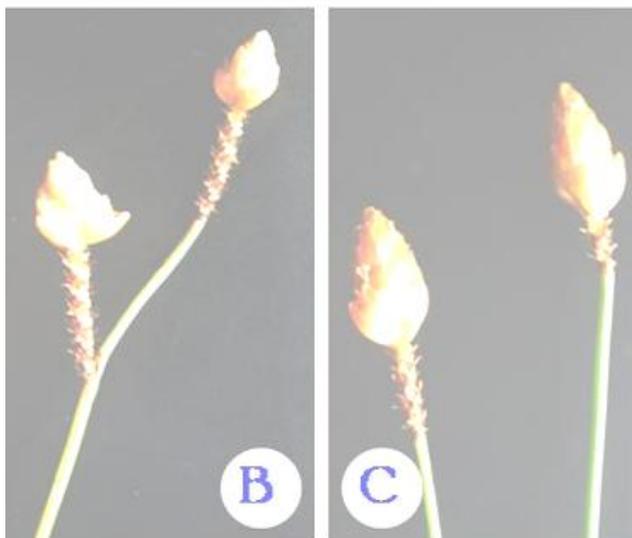
A: Plant Habit; B : Close up of Inflorescence; C: Line drawing



A

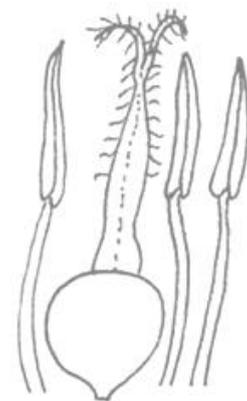


Glume



B

C



2mm

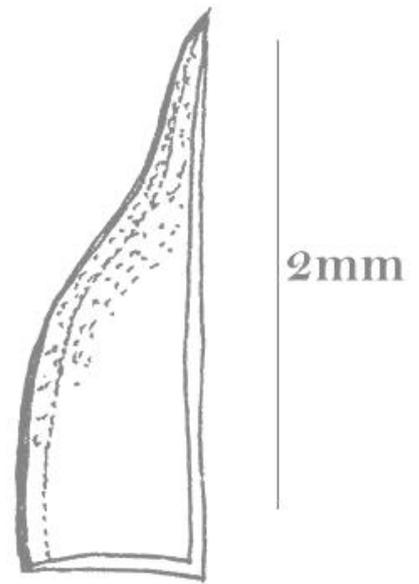
Pistil & Stamens



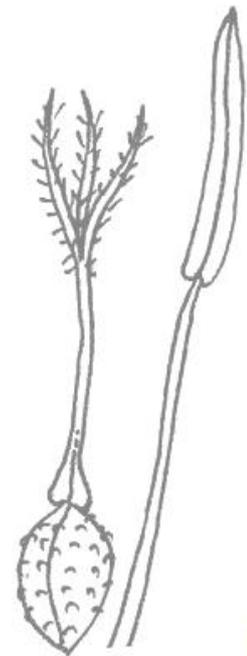
D

E

A: Plant Habit; B&C : Close up of Inflorescence; D: Achene ; E:Line drawing

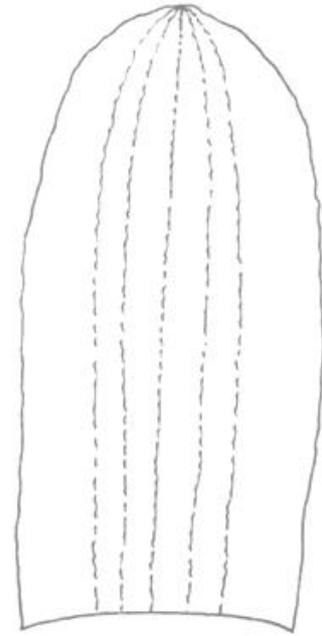
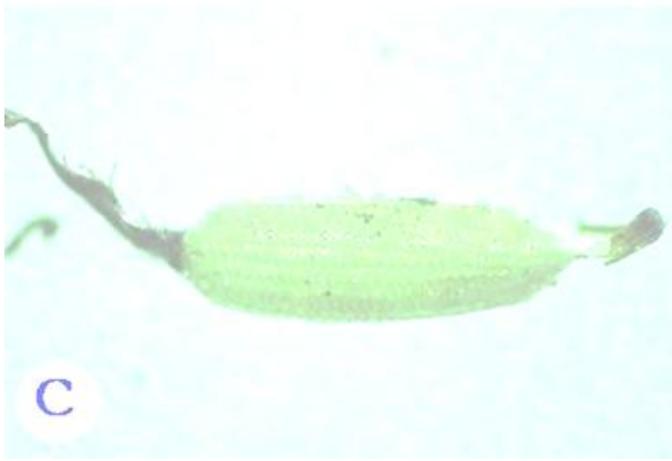
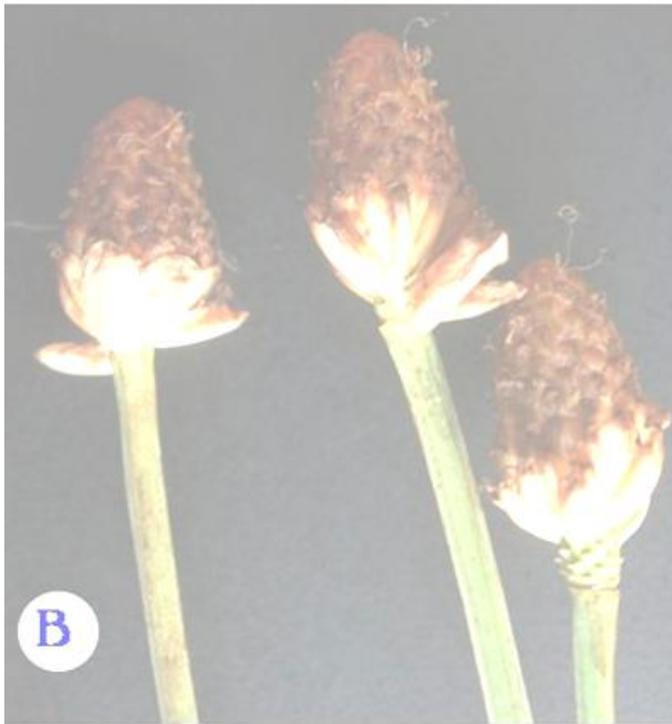


Glume

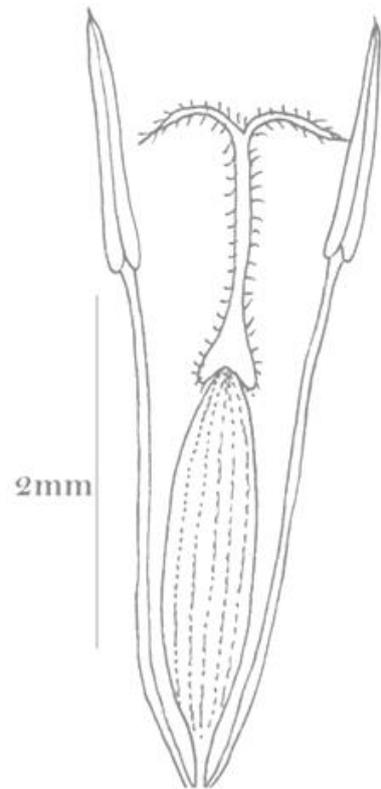


Pistil & Stamen

A: Plant Habit; B : Close up of Inflorescence; C: Line drawing



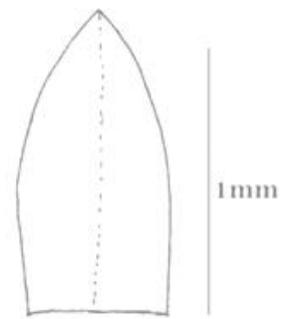
Glume



Pistil & Stamens

D

A: Plant Habit; B : Close up of Inflorescence; C: Achene; D: Line drawing



Glume



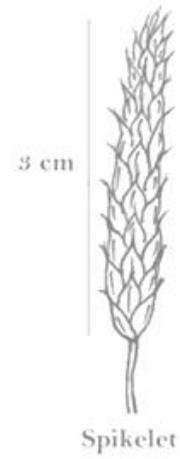
Pistil



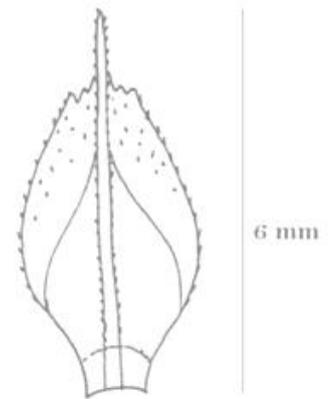
Stamens

C

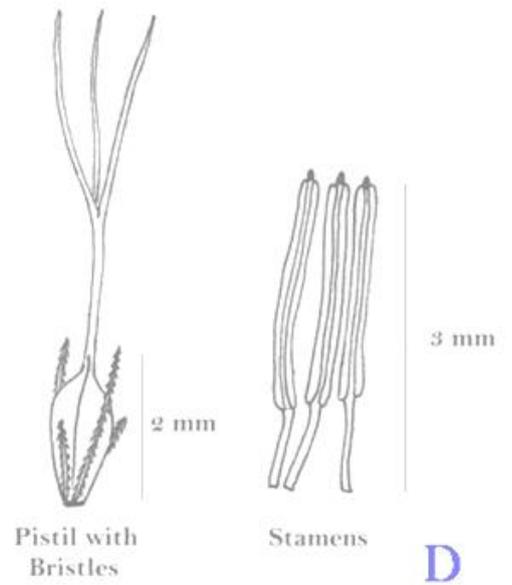
A: Plant Habit; B : Close up of Inflorescence; C: Line drawing



Spikelet



Glume

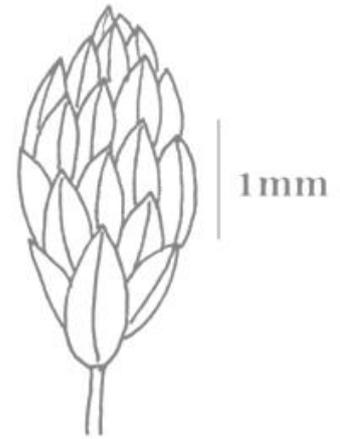
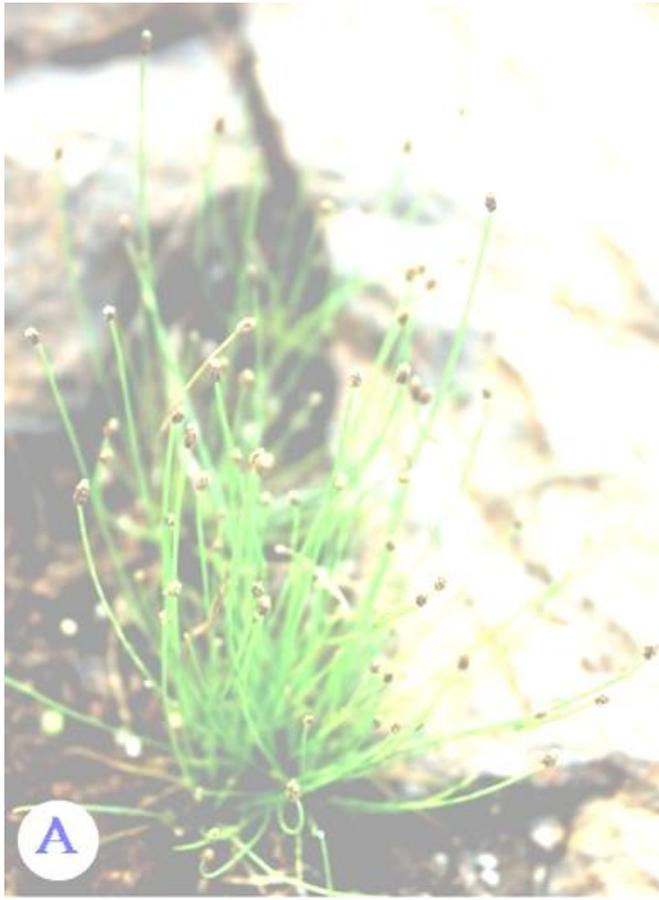


Pistil with Bristles

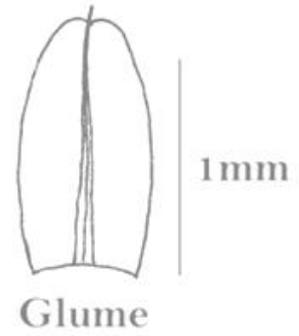
Stamens

D

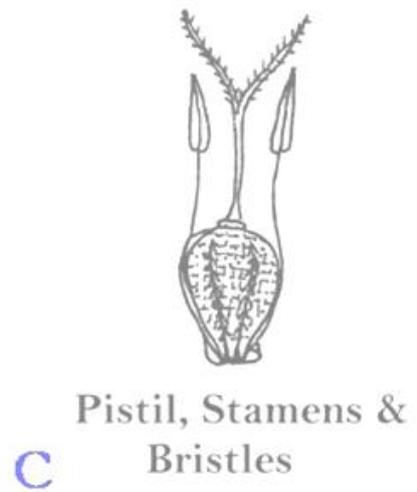
A: Plant Habit; B : Inflorescence; C: Close up of Inflorescence; D: Line drawing



Spikelet

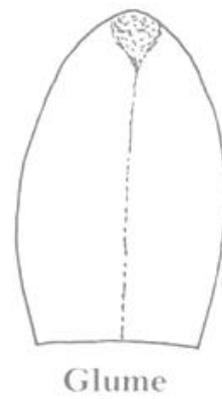
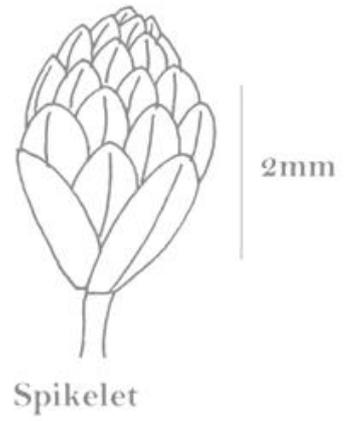


Glume



Pistil, Stamens & Bristles

A: Plant Habit; B : Close up of Inflorescence; C: Line drawing



D

A & B: Plant Habit; C: Close up of Inflorescence; D: Line drawing



A

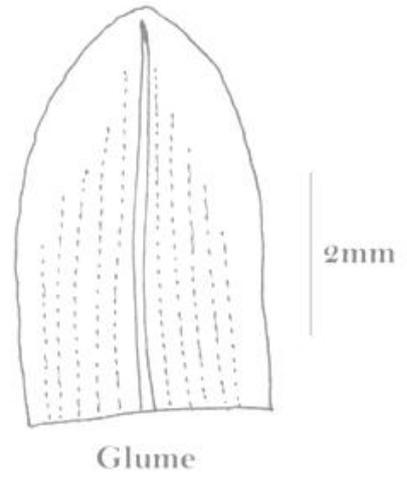


B

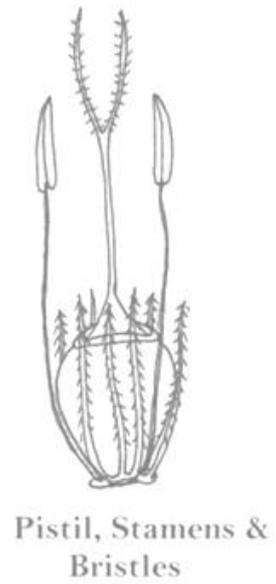
C



D



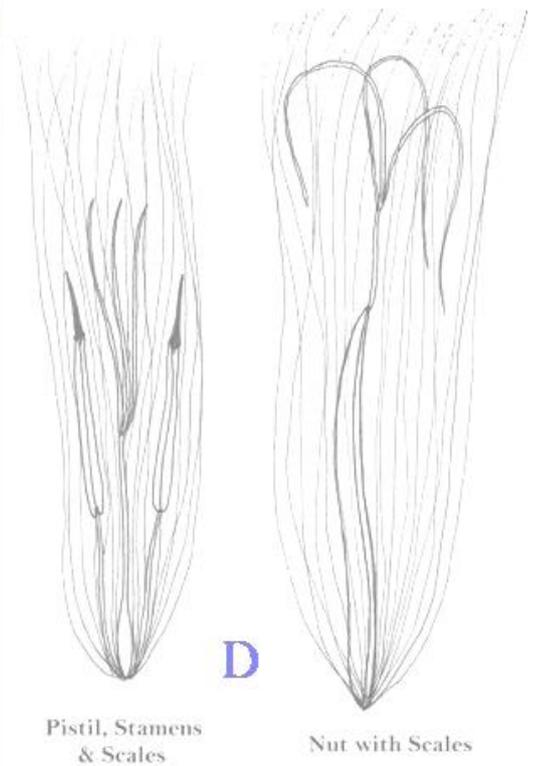
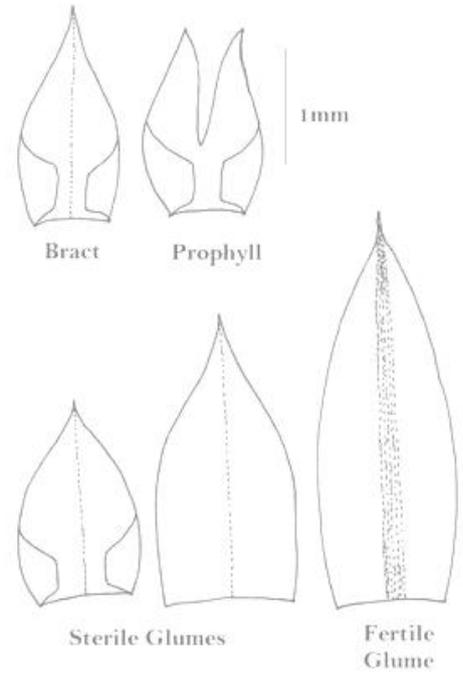
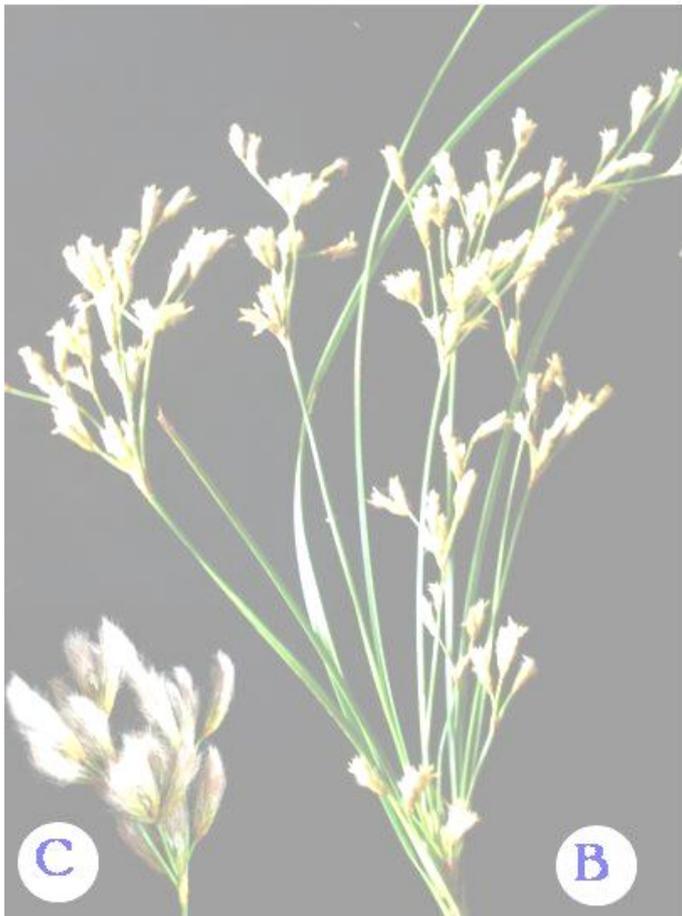
Glume



Pistil, Stamens & Bristles

E

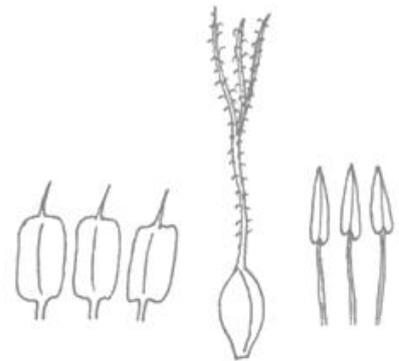
A: Plant Habit; B : Close up of Inflorescence; C: Kulm with septa; C: Achene with style, stigma and perianth scale; E: Line drawing



A: Plant Habit; B : Close up of Inflorescence; C: Line drawing



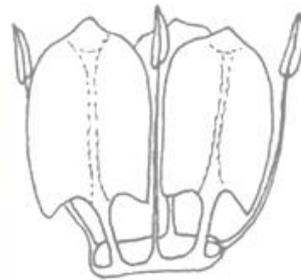
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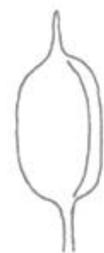
Scales

Pistil

Stamens



Mature Stamens
with Scales

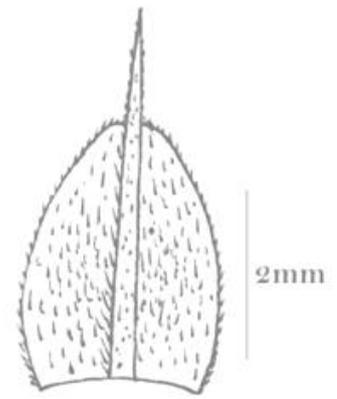
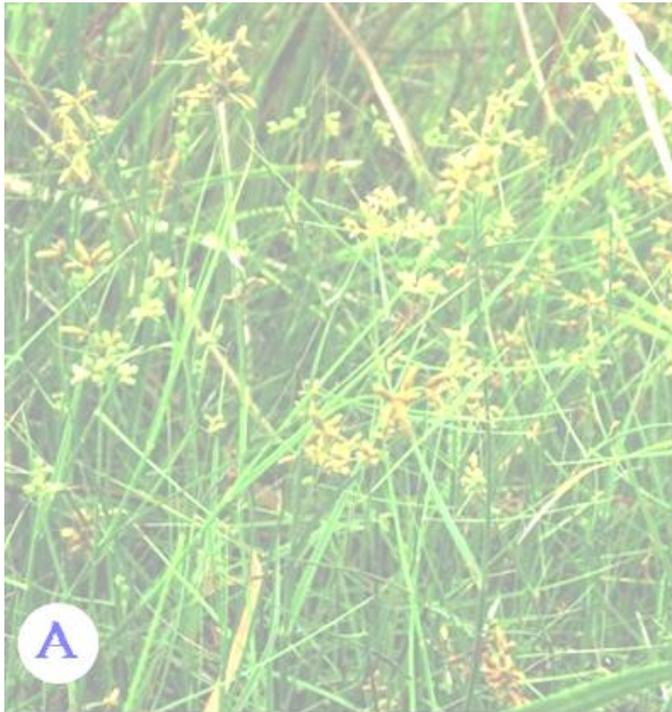


Nut

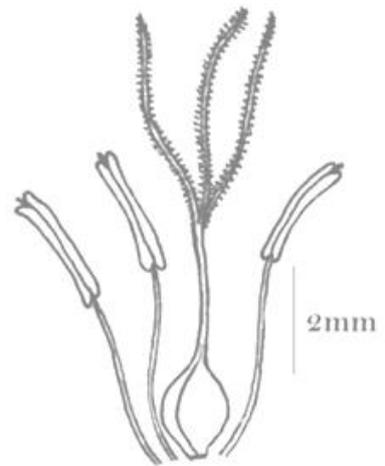
1mm

C

A: Plant Habit; B : Close up of Inflorescence; C: Line drawing



Glume



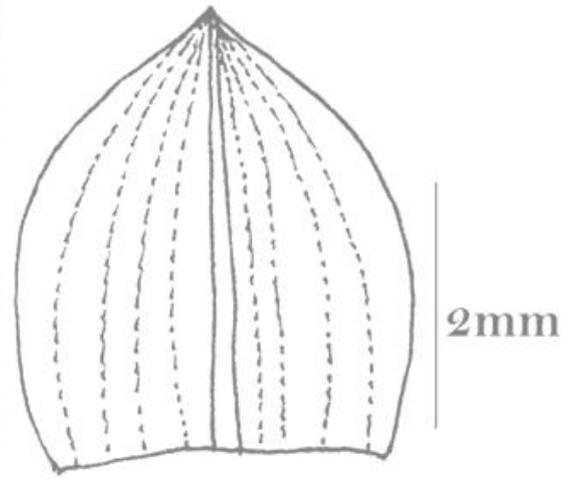
Pistil & Stamens



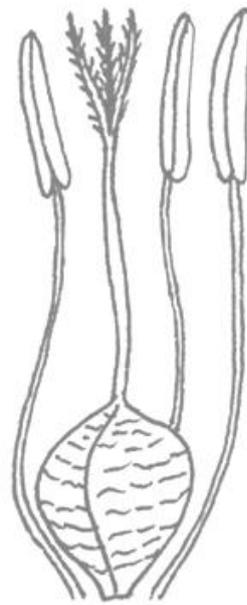
Nut

C

A: Plant Habit; B : Close up of Inflorescence; C: Line drawing



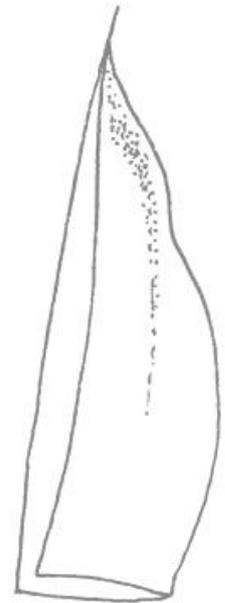
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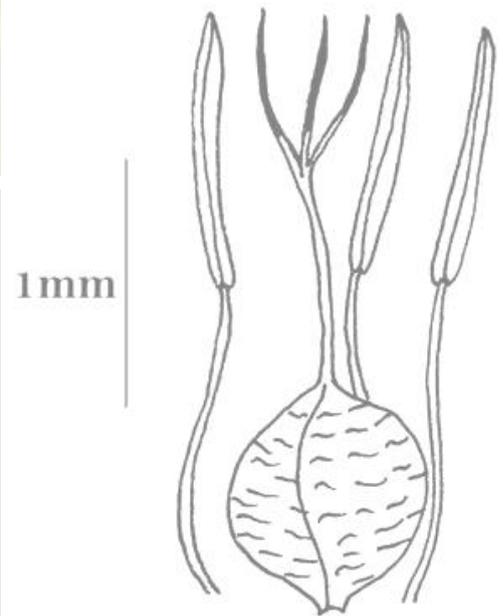
Stamens & Pistil

D

A: Plant Habit; B :Different Stages of Inflorescence Development; C: Open kulm showing septa; D: Line drawing

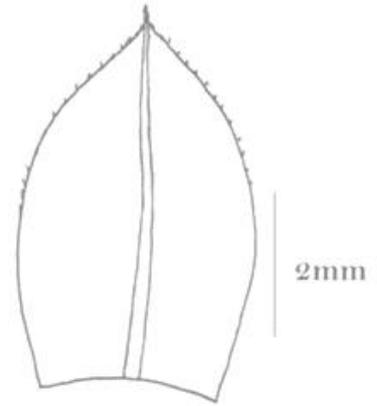


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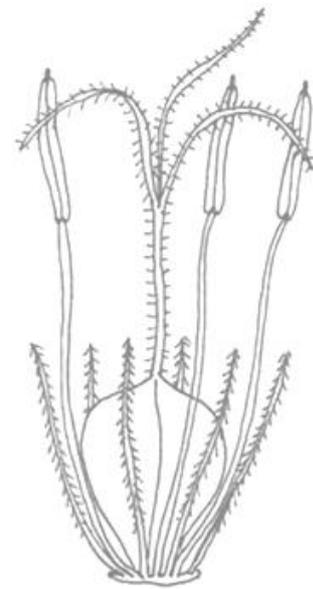


Pistil & Stamens

A: Close up of Inflorescence; B :Different Stages of Inflorescence Development; C: Line drawing



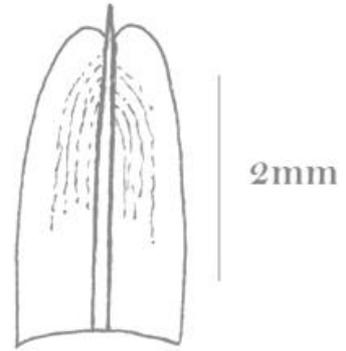
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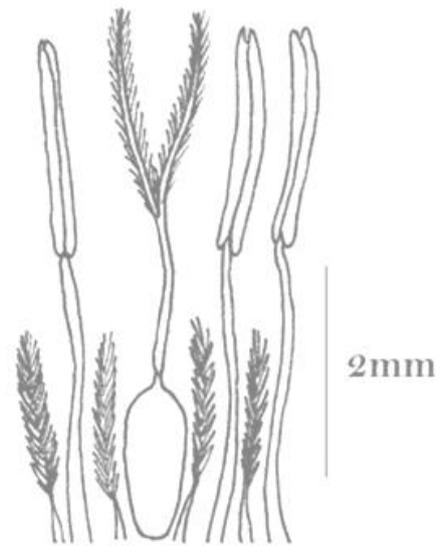
Pistil, Stamens & Bristles

D

A: Plant Habit; B :Different Stages of Inflorescence Development; C: Close up of Inflorescence; D: Line drawing



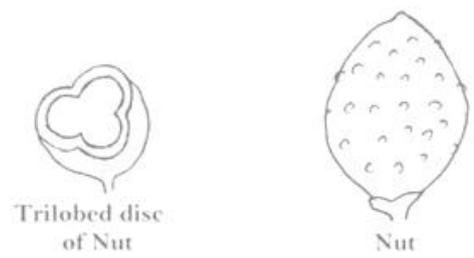
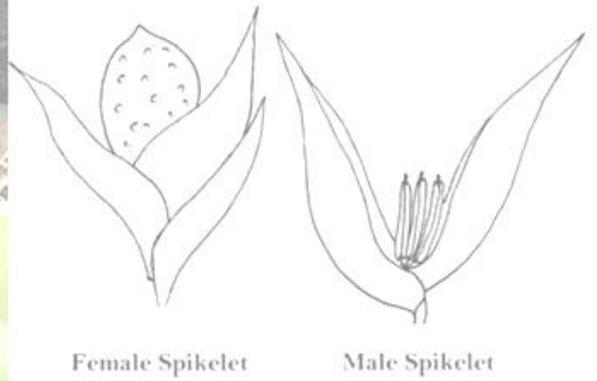
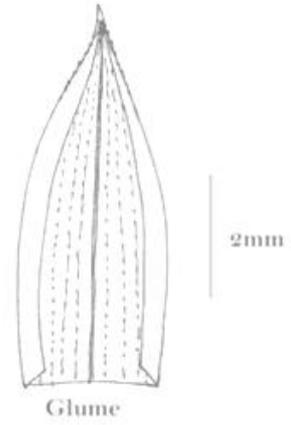
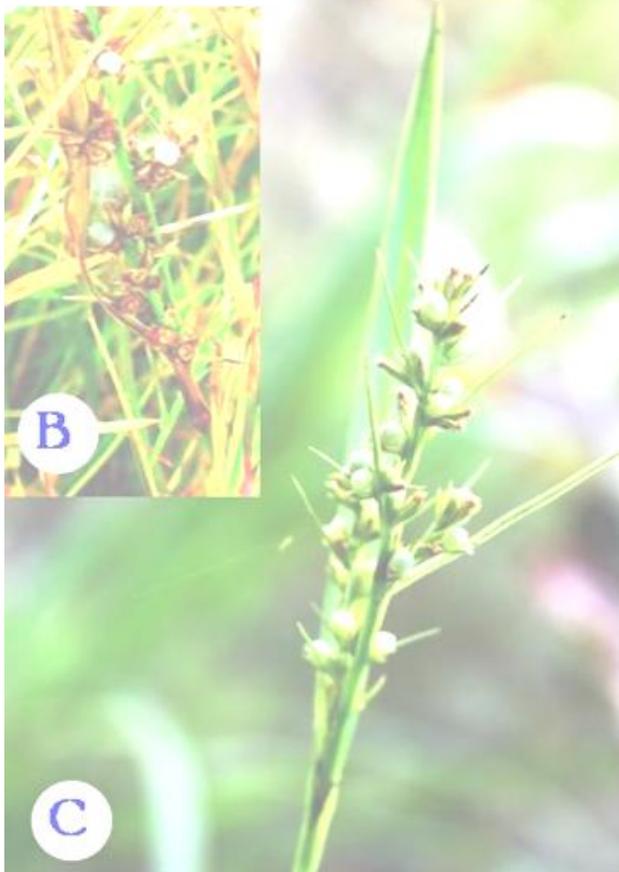
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Pistil, Stamens & Bristles

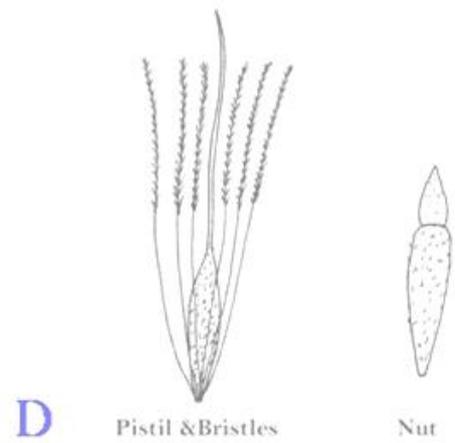
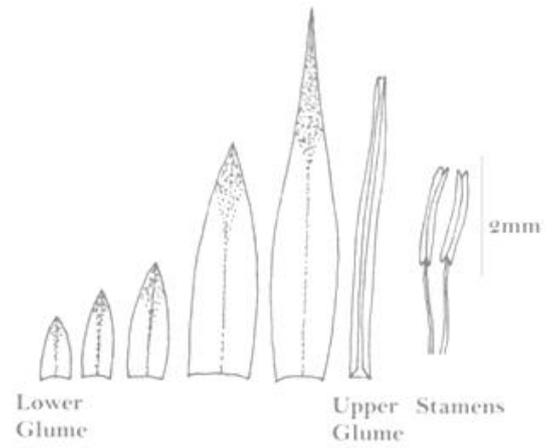
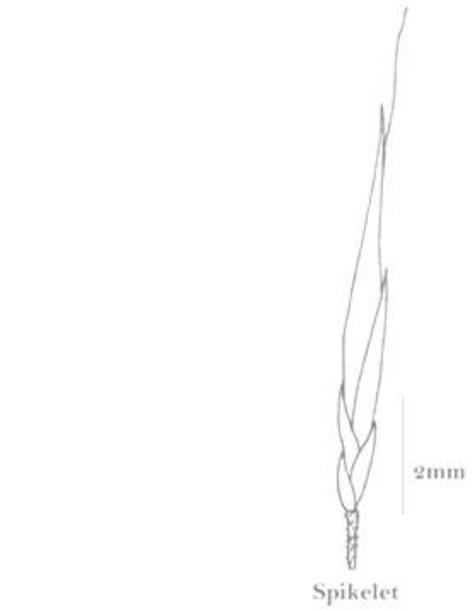
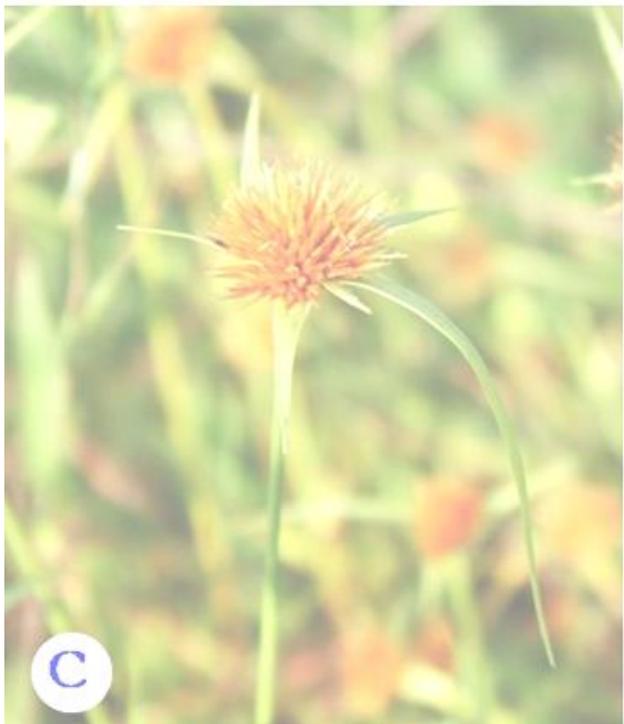
E

A & B: Plant Habit; C&D : Close up of Inflorescence; E: Line drawing

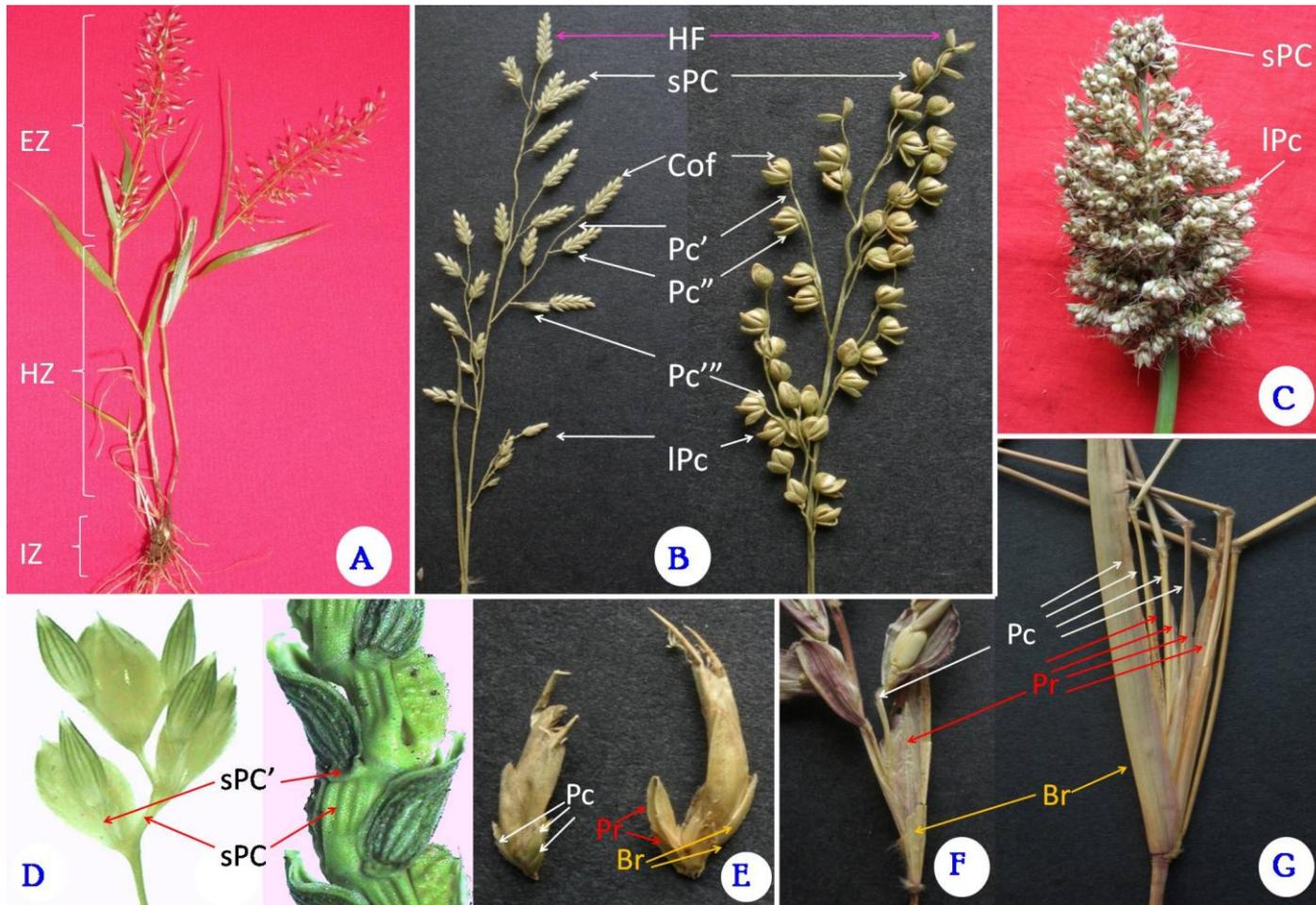


D

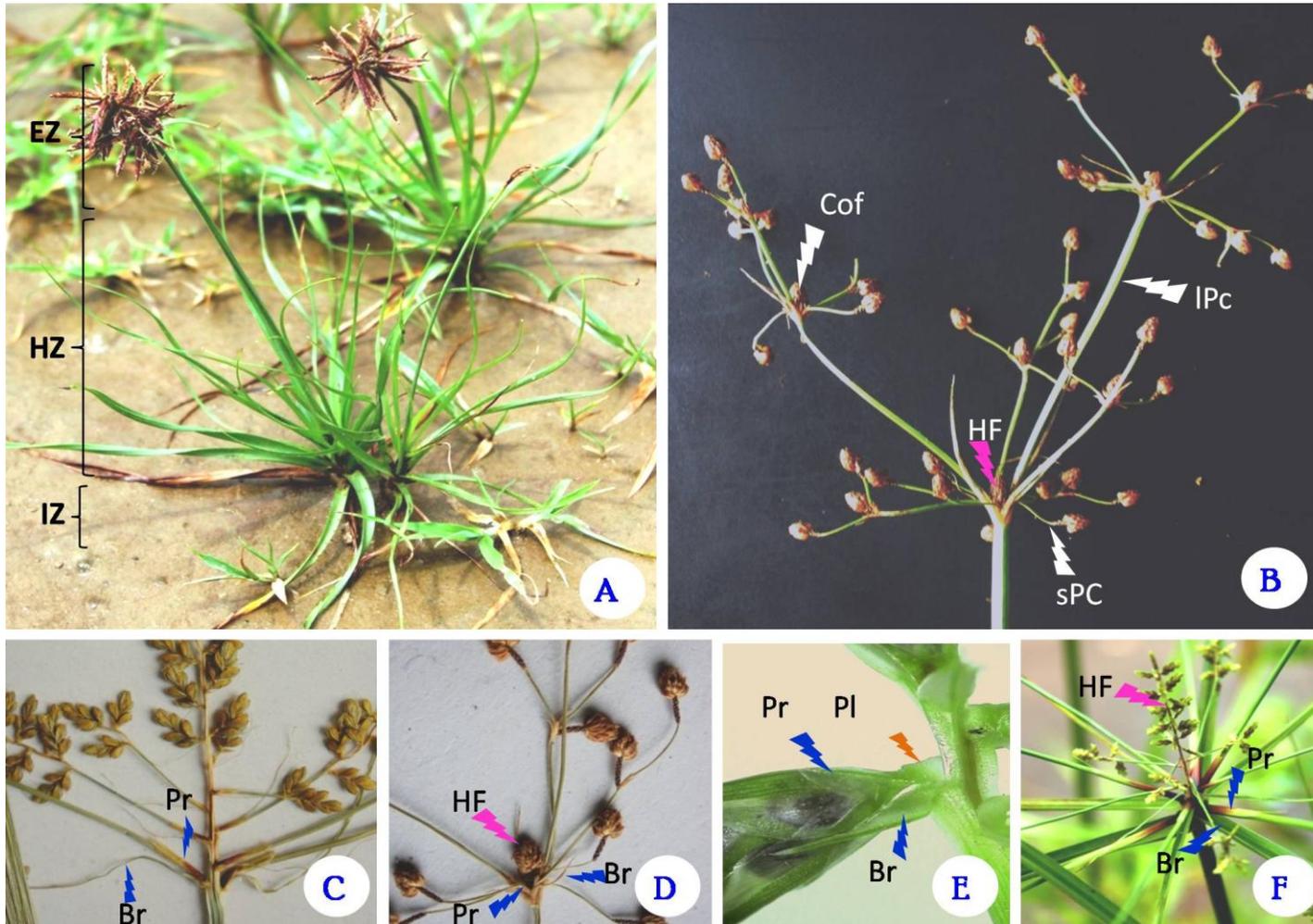
A : Plant Habit; B & C: Close up of Inflorescence; D: Line drawing



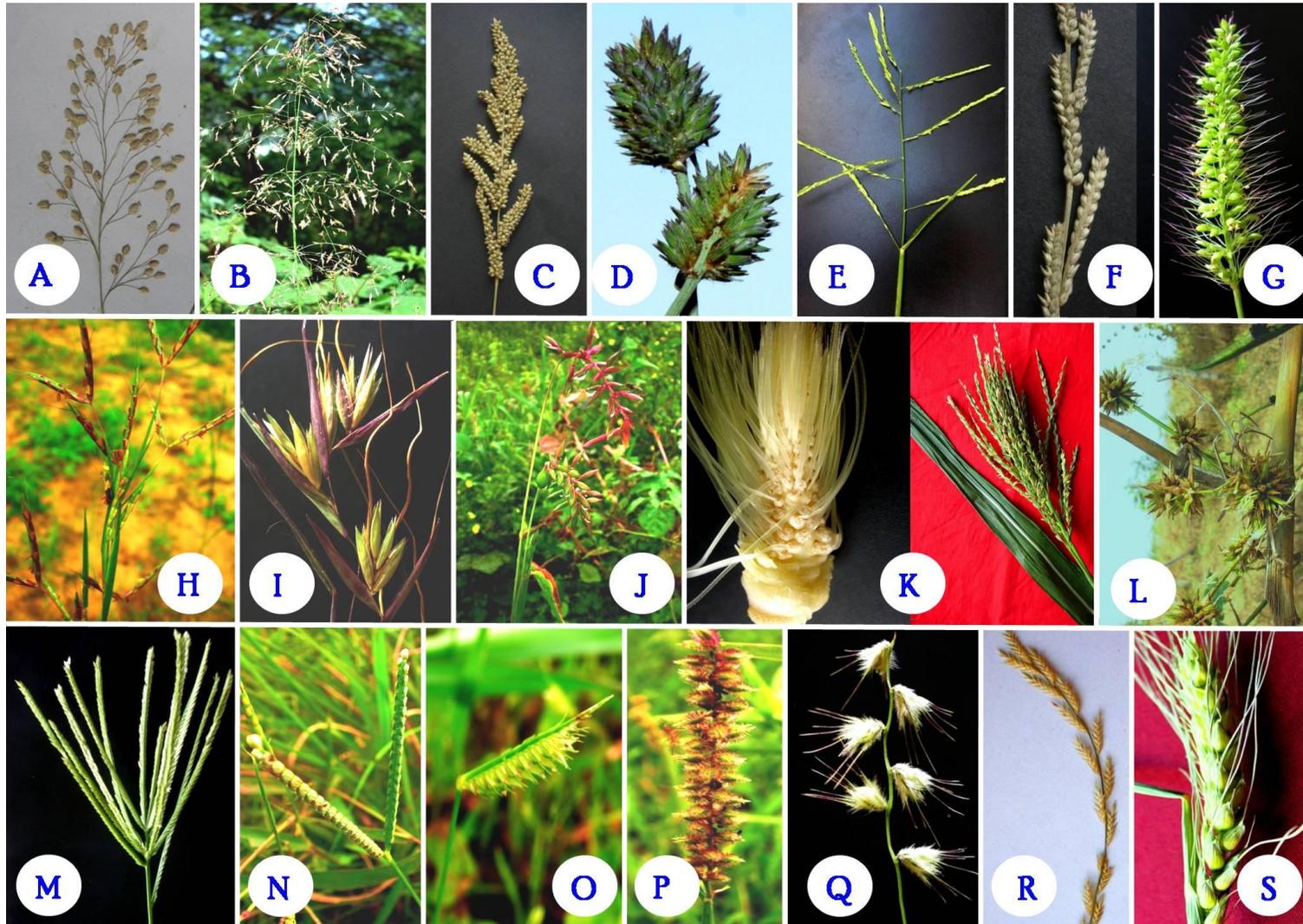
A : Plant Habit; B & C: Close up of Inflorescence; D: Line drawing



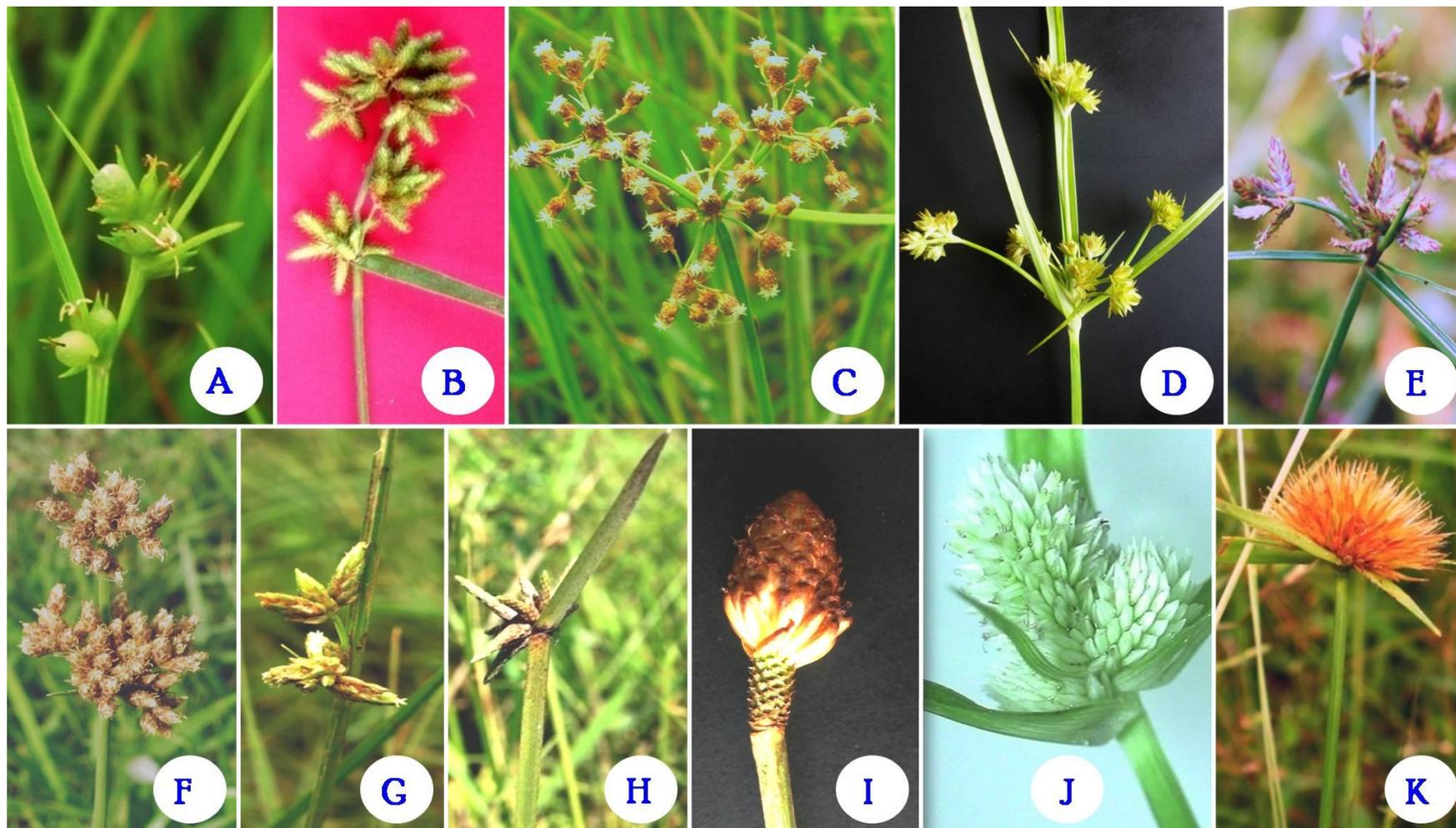
A: Zonation in Synflorescence; B & C: Elements of Inflorescence; D: Part of Raceme of Andropogoneae showing 2° grade Paracladia (sPc'); Pseudospikelet of *Dendrocalamus*; F & G Prophyllar branching of *Chionachne gigantea* & *Ischaemum santapui* (Pc: Paracladia, Br: Bract, Pr: Prophyll, Cof: Coflorescence, sPC: Short paracladia, IPc: Long paracladia, HF: Mainflorescence, IZ: Innovation Zone, HZ: Inhibition Zone, EZ: Enrichment Zone.)



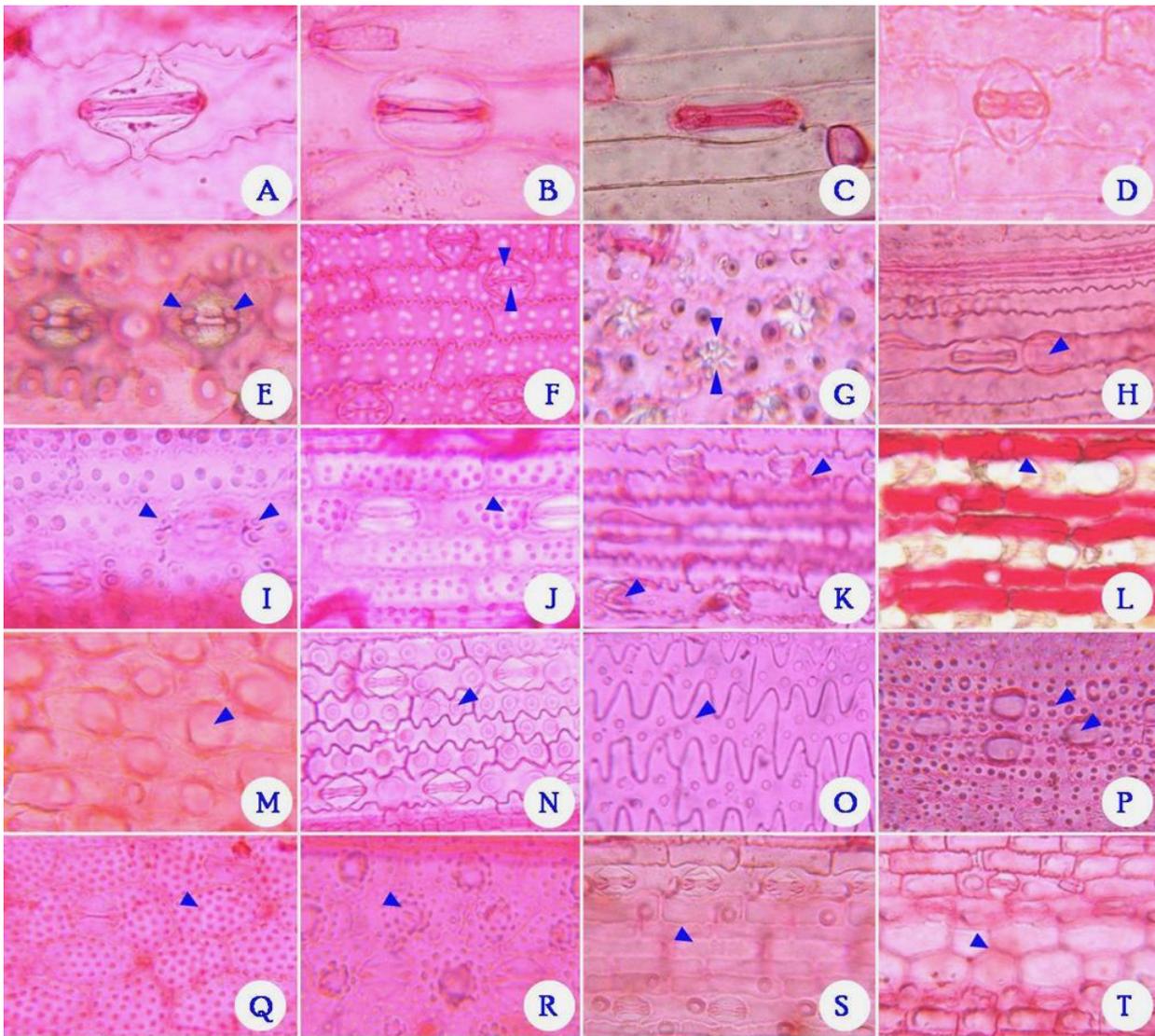
A: Zonation in Synflorescence; B: Elements of Inflorescence; C, D & F: Normal branching of *Cyperus* & *Fimbristylis*; E: Orange arrow indicate Pulvinus near the Prophyll (Pc: Paracladia, Br: Bract, Pr: Prophyll, Cof: Coflorescence, sPC: Short paracladia, IPC: Long paracladia, HF: Mainflorescence, IZ: Innovation Zone, HZ: Inhibition Zone, EZ: Enrichment Zone.)



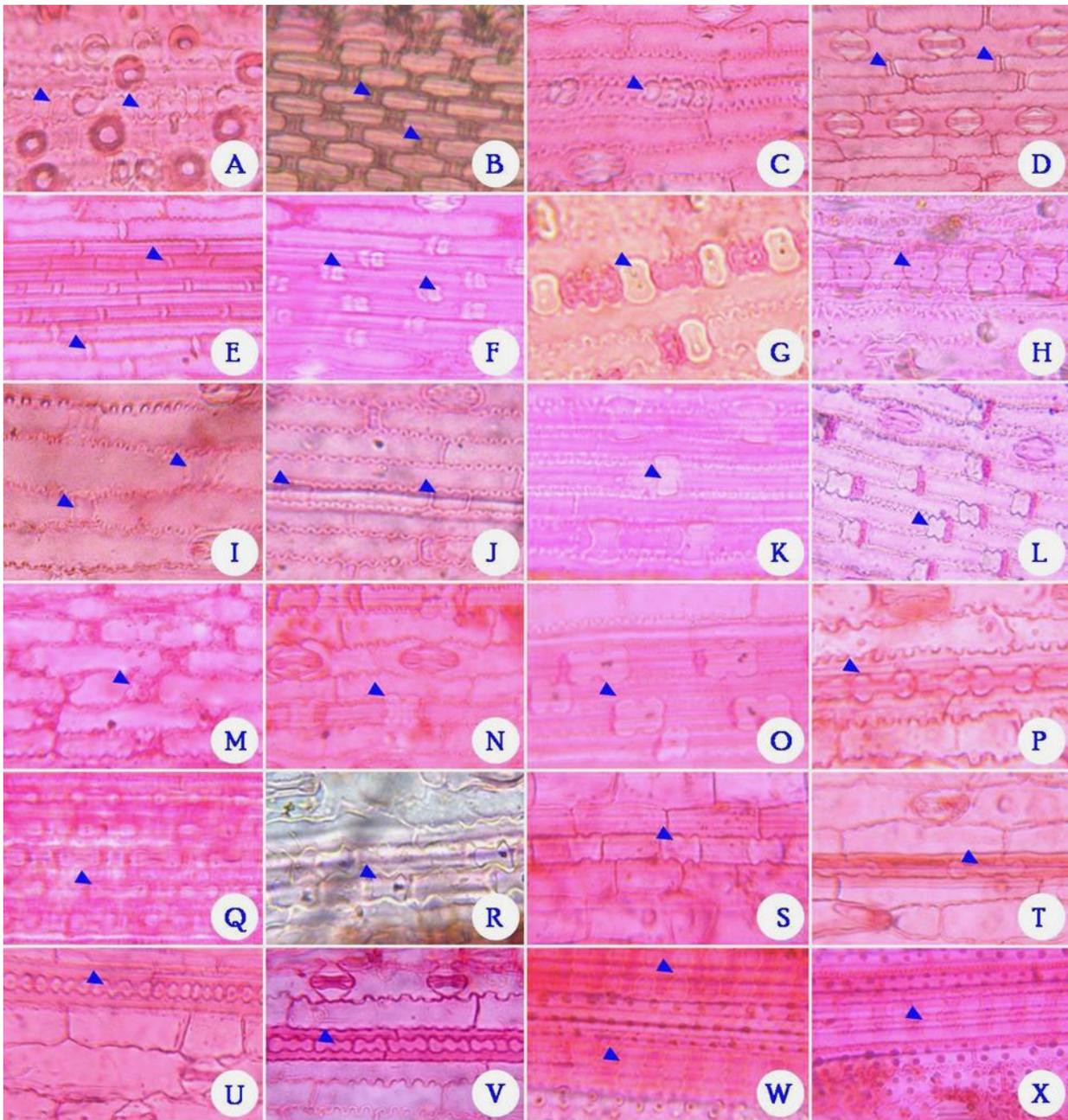
Synflorescence Types in Poaceae: Explanation in Text



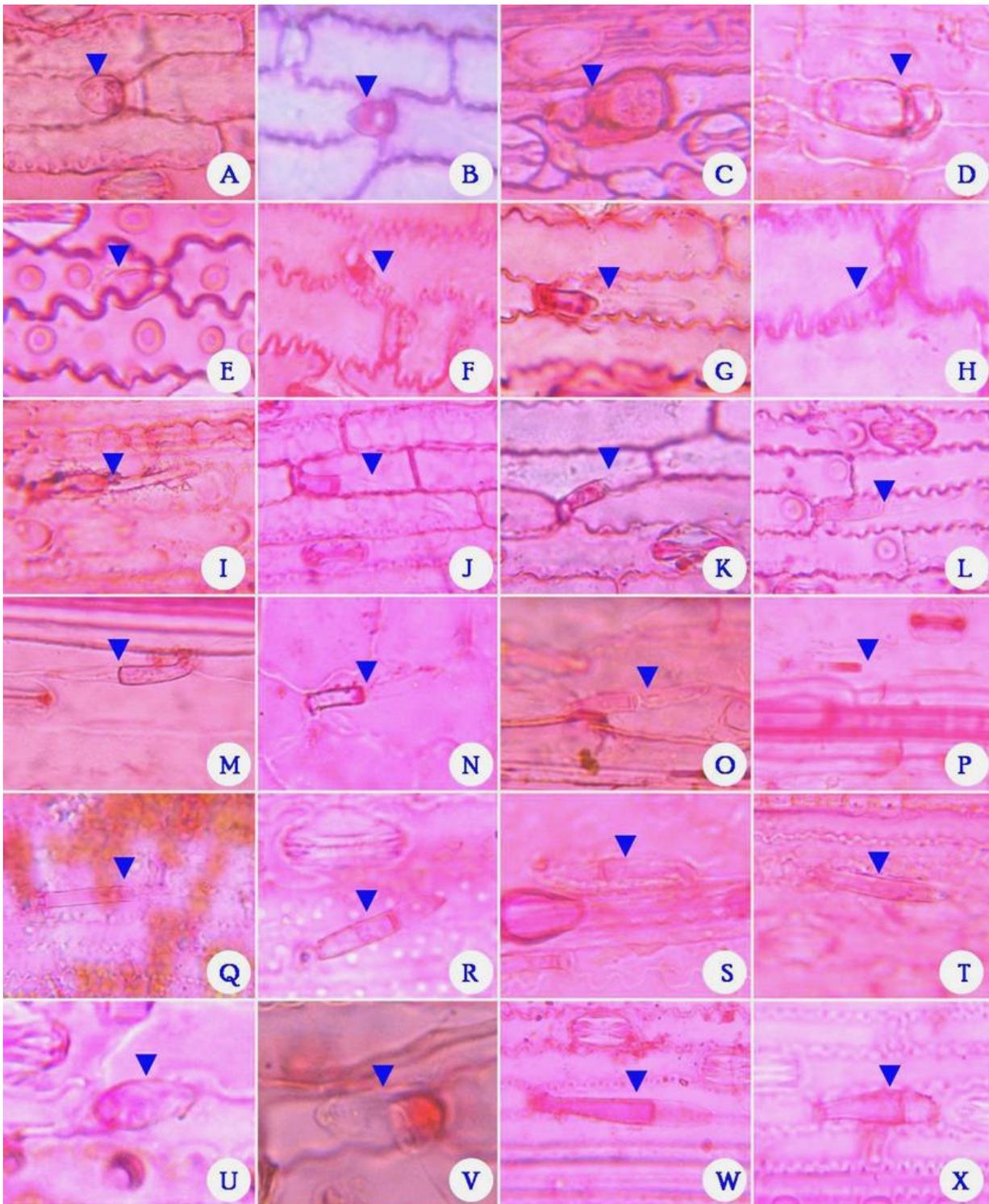
Synflorescence Types in Cyperaceae: Explanation in Text



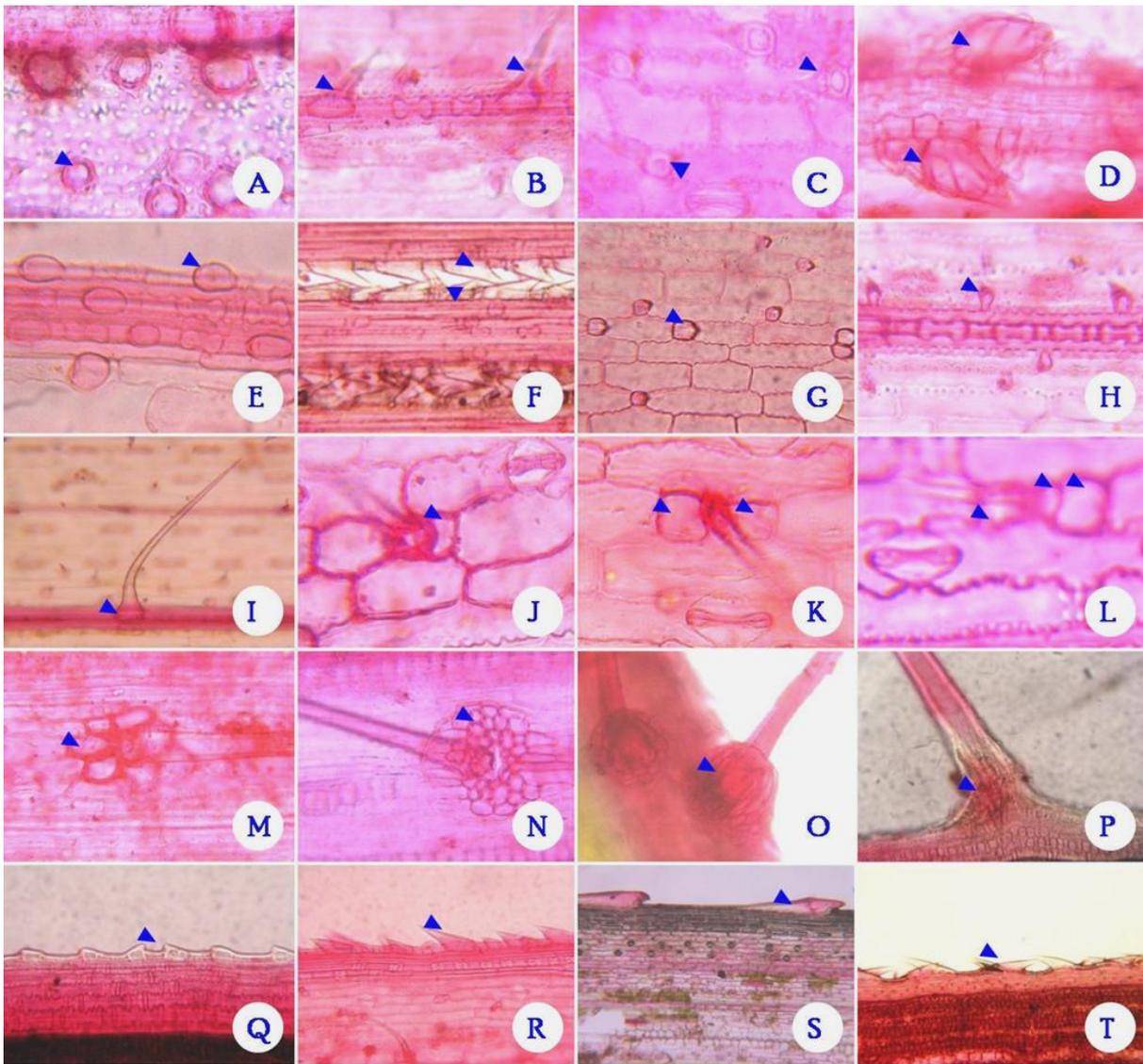
A-D: Subsidiary cell shape of stomata, A: Triangular, B: Parallel-sided, C: Low-domed, D: Tall-domed; **E-L: Stomata and adjacent long cell relationship**, E: 4-papillate, F: 6-papillate, G: 6-papillate, H: one papillae touched the stomata from one side, I: 2 papillae touched the stomata from both sides, J: numerous small papillae aggregate near one side of stomata, K: one papillae partially covers the stomata, L: one large papillae covers entire stomata; **M-S: Variation in number of papillae per cell**, M: single large papillae, N: 2-5 papillae in one row, O: numerous small papillae in 2-rows, P: numerous papillae of different sizes, Q: evenly scattered numerous small papillae, R: numerous small papillae aggregates in the centre of the cell, S: only one papillae; **M-P: Long cell shape**: M: Hexagonal, smooth-slightly sinuous walled, N: Rectangular sinuous walled, O: Rectangular deeply sinuous walled, P: Rectangular moderately sinuous walled; **S-T: Straight walled Bulliform cells**, S: Rectangular shaped, T: Cubical-hexagonal shaped.



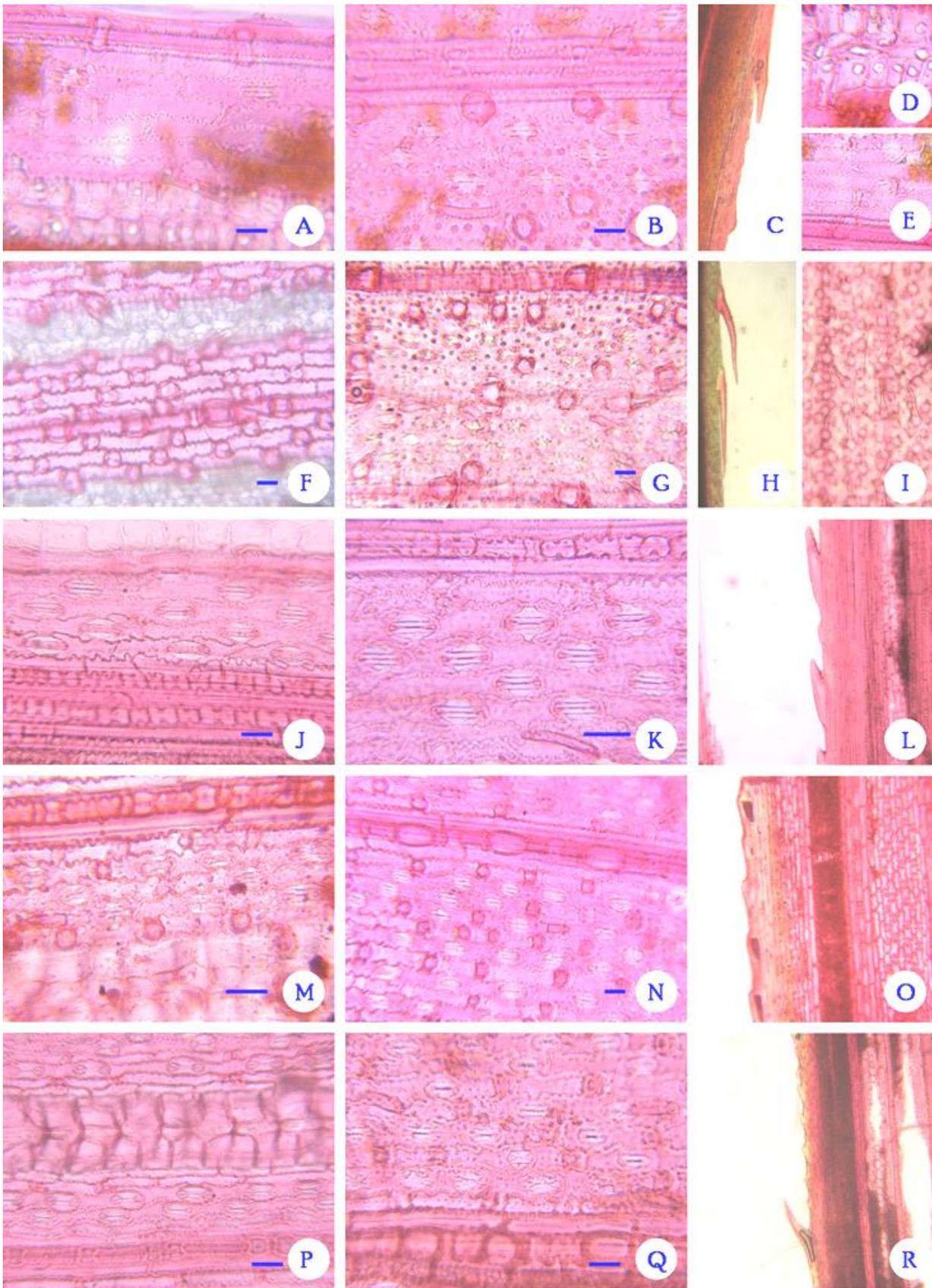
Types of Silica bodies: **A:** Tall narrow; **B:** Cubical; **C:** Round fitting into concavity of cork cell (Silica-cork pair); **D:** Elliptical; **E:** Crescent; **F:** Saddle fitting into concavity of cork cell (Silica-cork pair); **G-K:** Saddle; **H:** Crescentric saddle; **I:** Acutely angled; **J:** Elongate sinuous; **L-N:** Cross-shaped; **O:** Intermediate between cross & dumbbell; **P-Q:** Elongate dumbbell; **R:** Shortly dumbbell; **S:** Shortly nodular; **T-V:** Nodular; **W-X:** Oryza type, **W:** Vertical nodular, **X:** Vertical dumbbell.

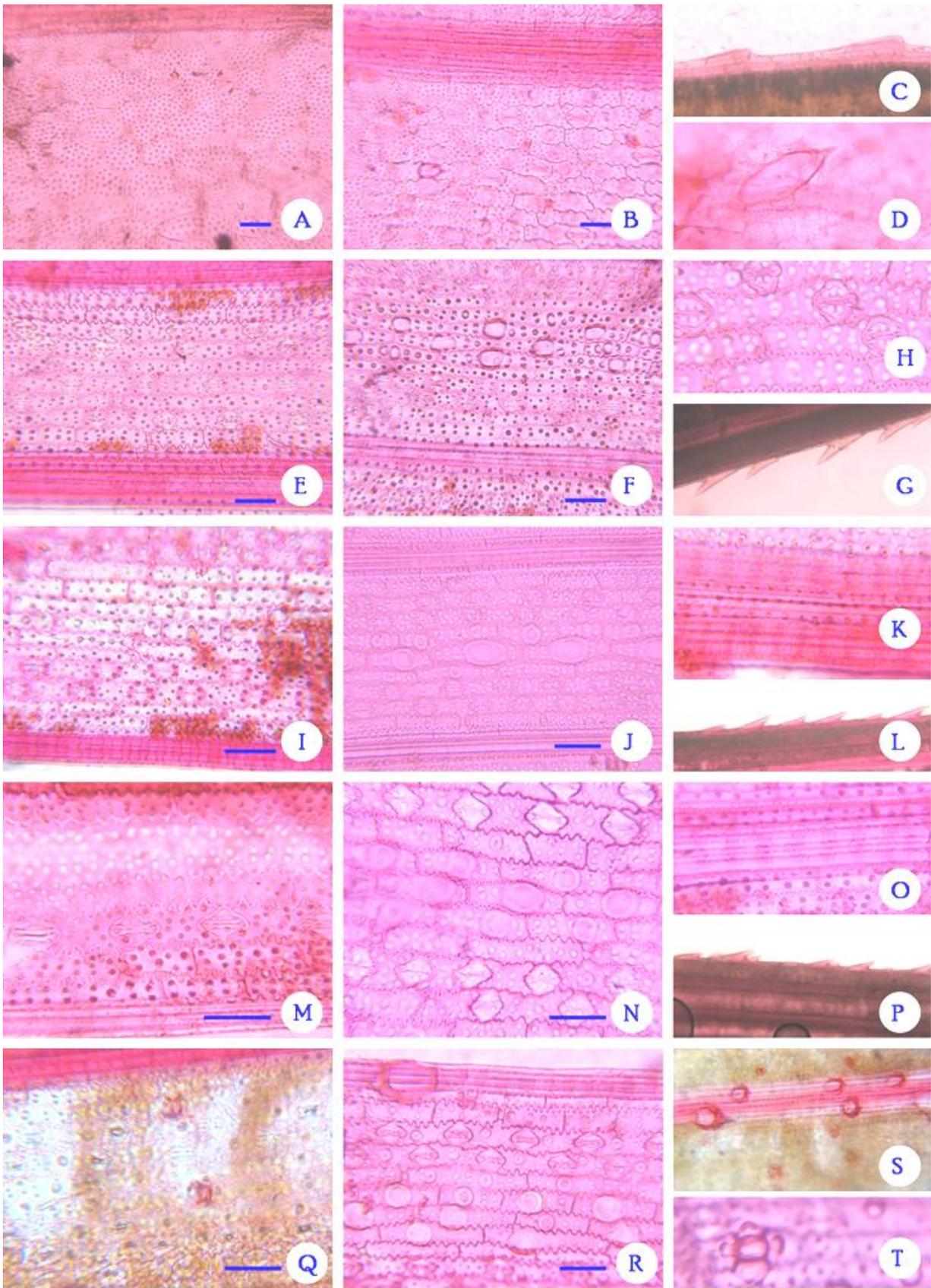


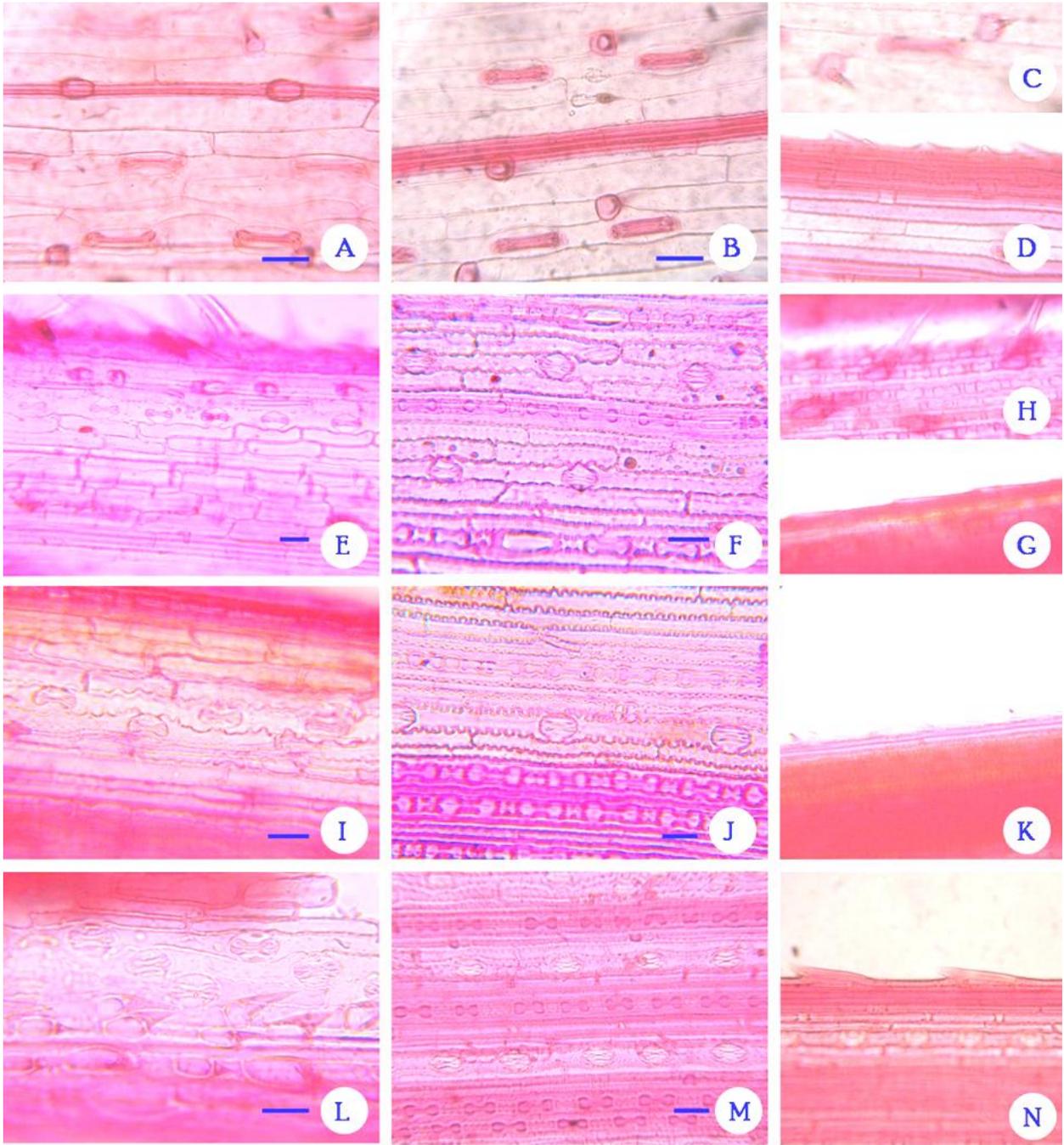
Types of Micro-hairs: **A-B:** Unicellular Sporobolus- dome shaped; **C-X:** Bicellular, **C-E:** Chloris- dome shaped apical cell, **F-H:** Zea- short basal and rounded long apical cell, **I-L:** Panicoid- short basal and tapering long apical cell, **M-O:** Echinochloa- apical & basal cells equal in length, **P:** Loudetia- very long with equal diameter, **Q:** Bambusoid- long variable, **R-T:** Arundo- longer basal & short tapered apical cell, **U-V:** Zizania- both cell equal and shorter in size, **W-X:** Eragrostis- long basal and shorter domed apical cell

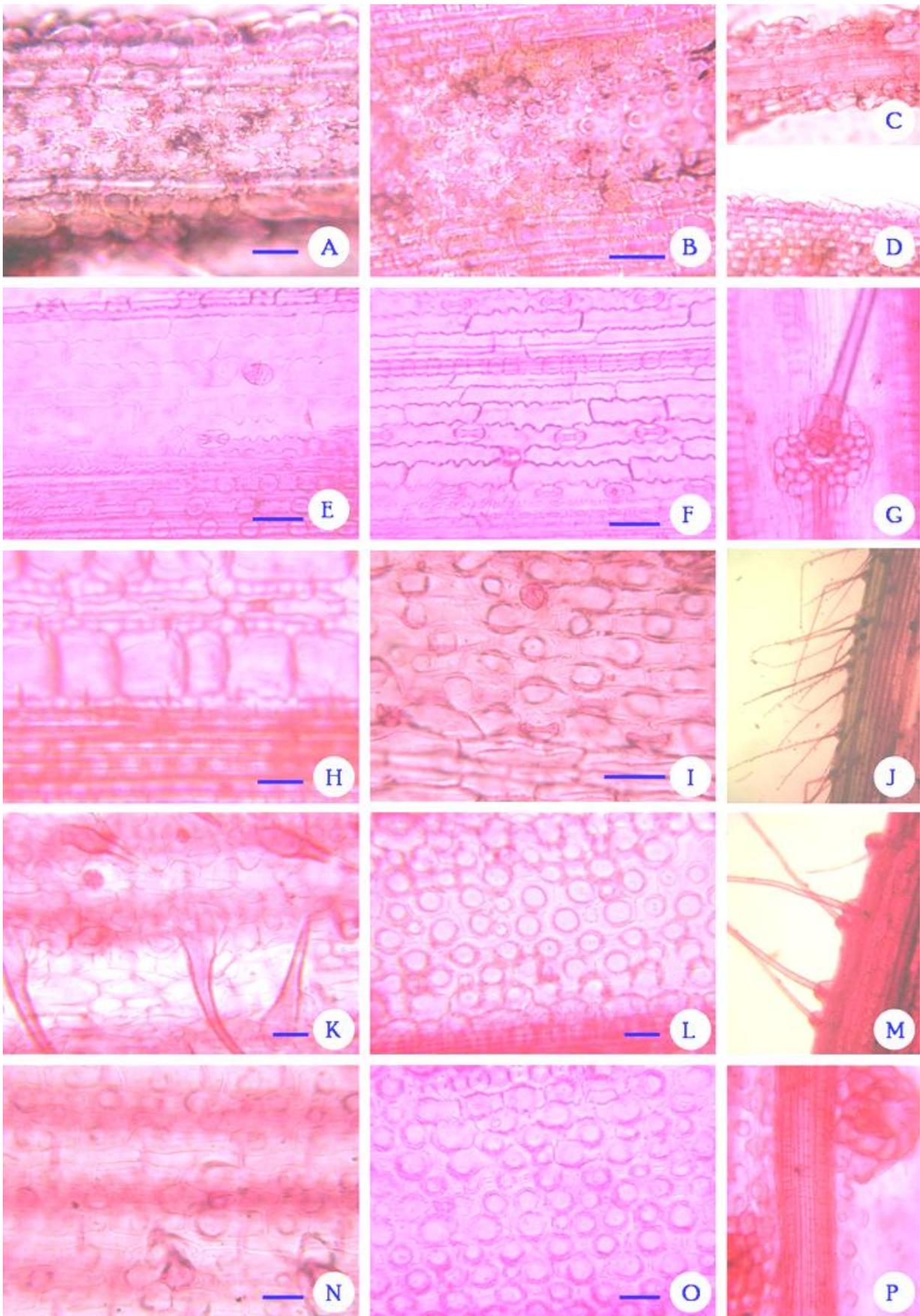


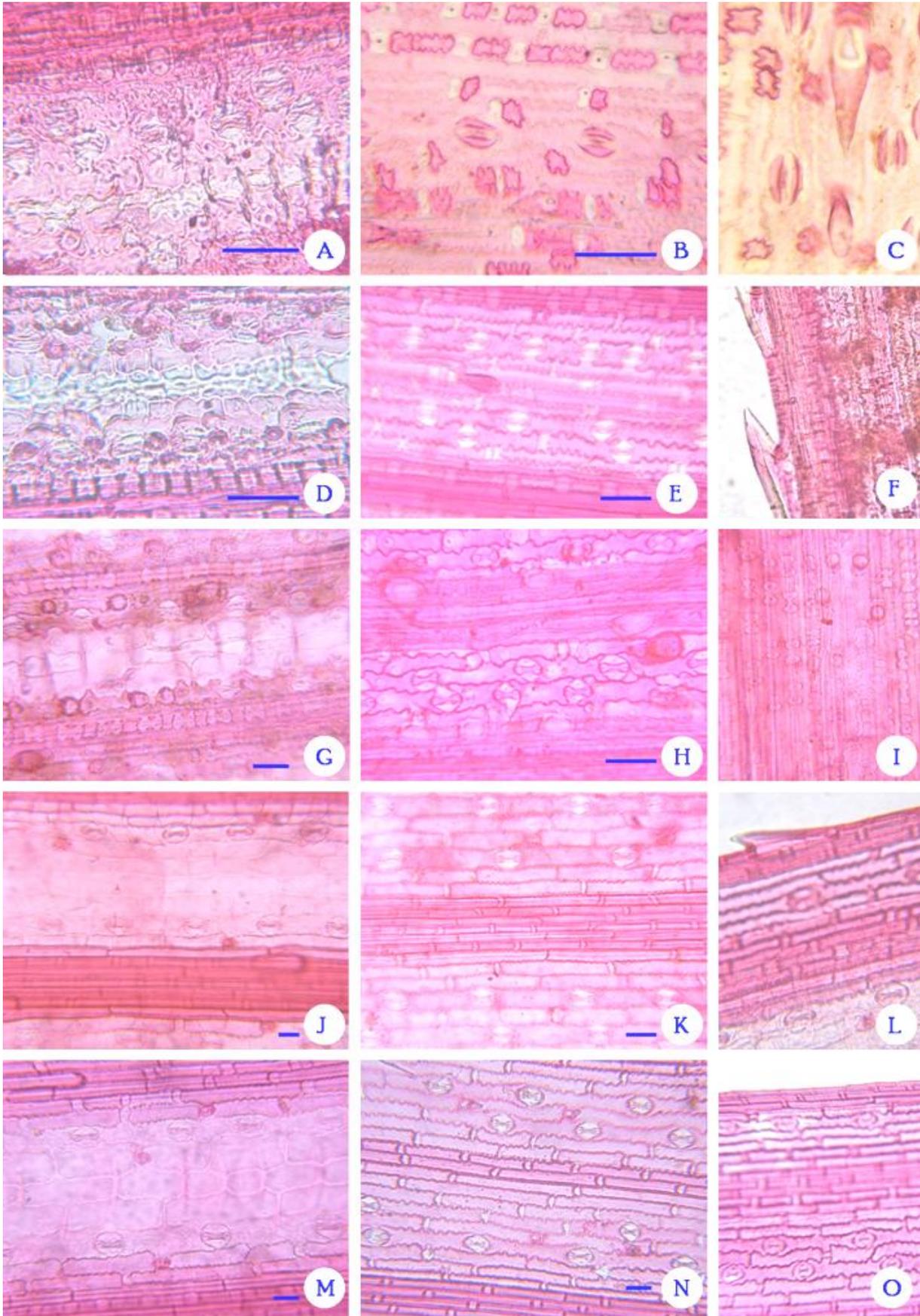
A-F: Prickle hairs, A: Small pointed, B: Large pointed, C: Small & large pointed, D: Covered with epidermal cells, E: Un-pointed apex (blunt), F: Interlocking; **G-H: Hooks**; **I-O: Macrohairs** with variable basal cells, I: Unicellular hair with no basal cells, J: with 1-basal cell, K: with 2-basal cells, L: with 3-basal cells, M: with 6-8-basal cells, N & O: Tubercled hairs; **P-T: Variation along margin**, P: With tubercled hairs, Q: Cris-cross arranged small pointed angular prickles, R: Angular prickled, S: large angular prickles, T: Cris-cross arranged large angular prickles.

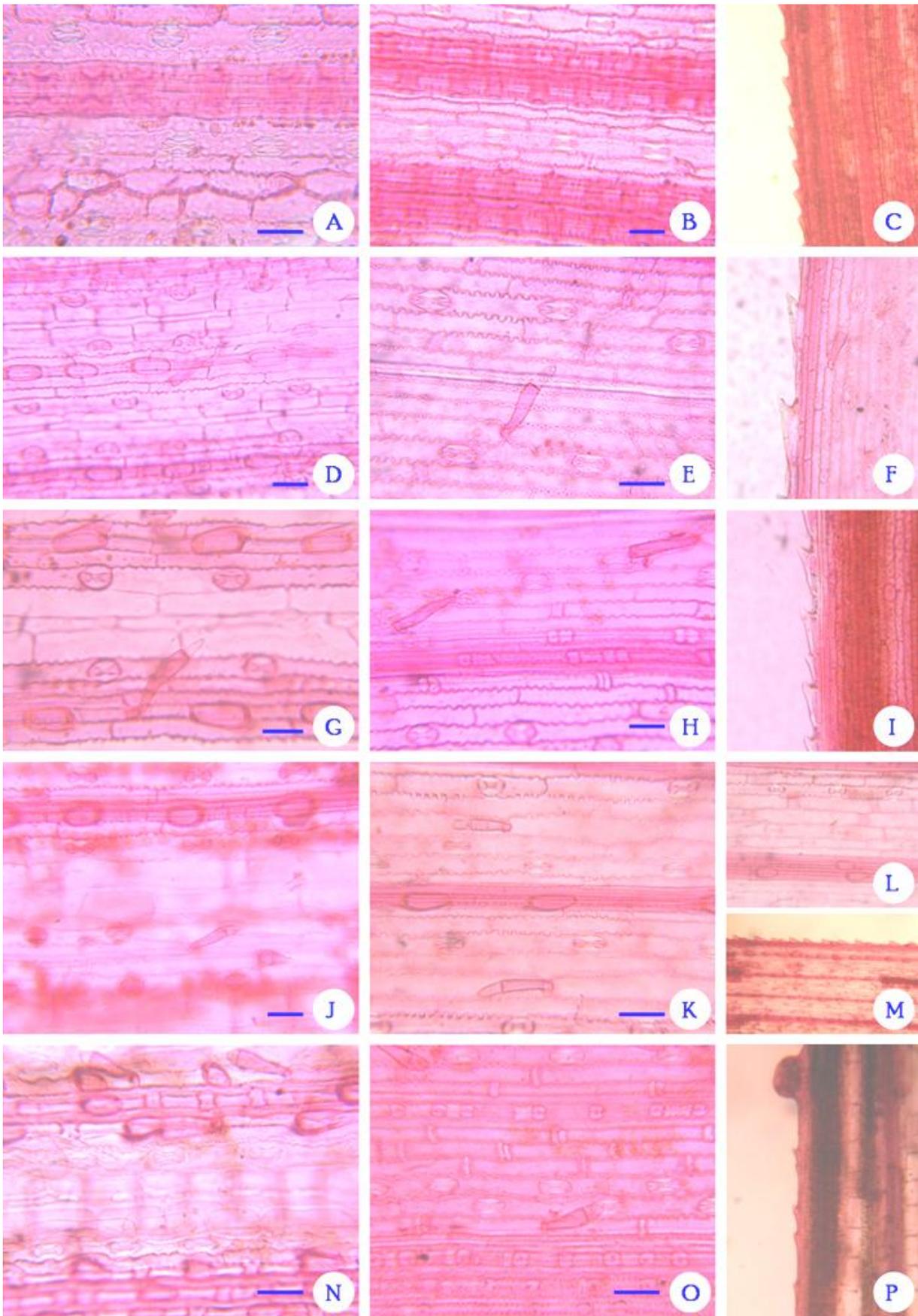


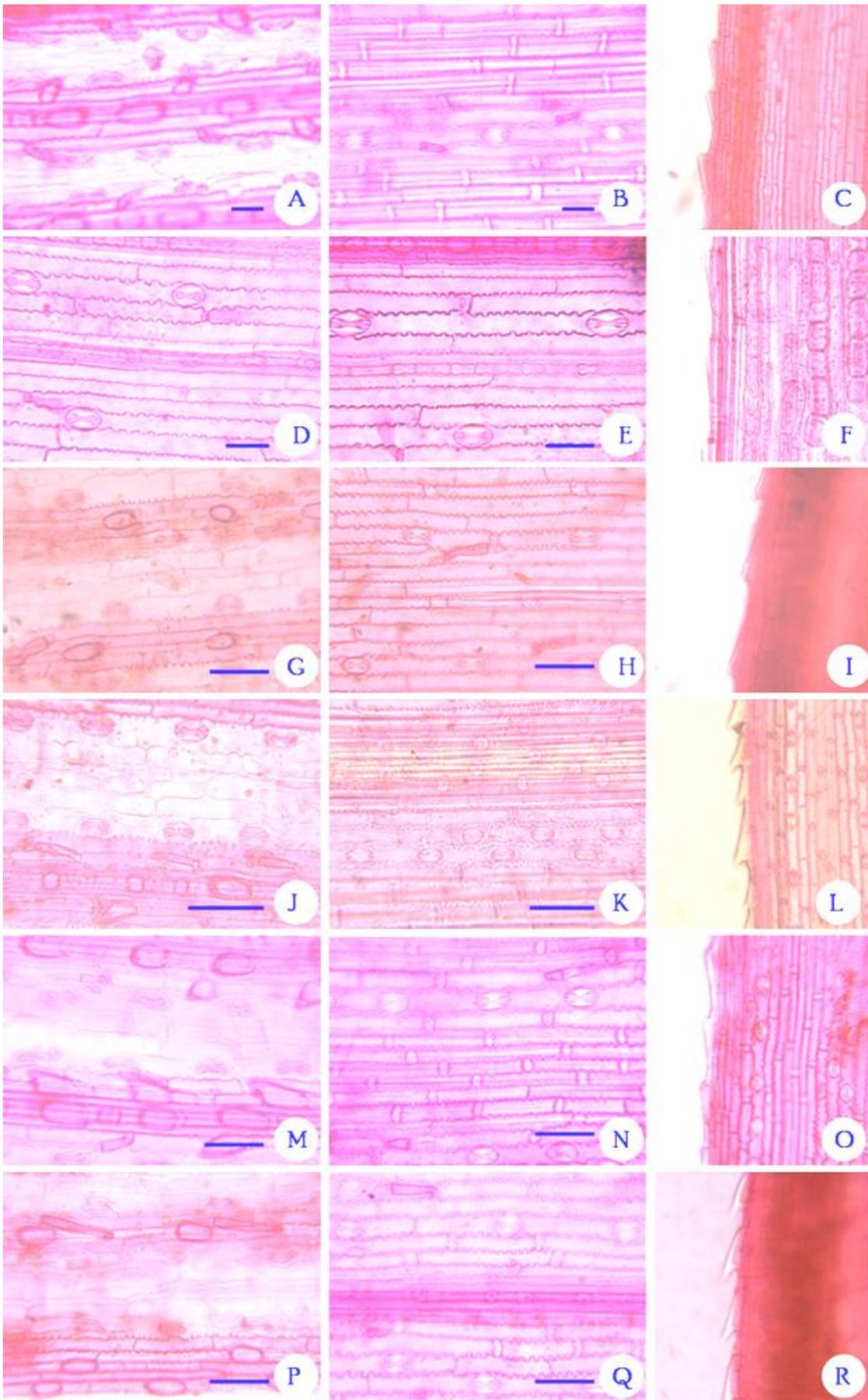


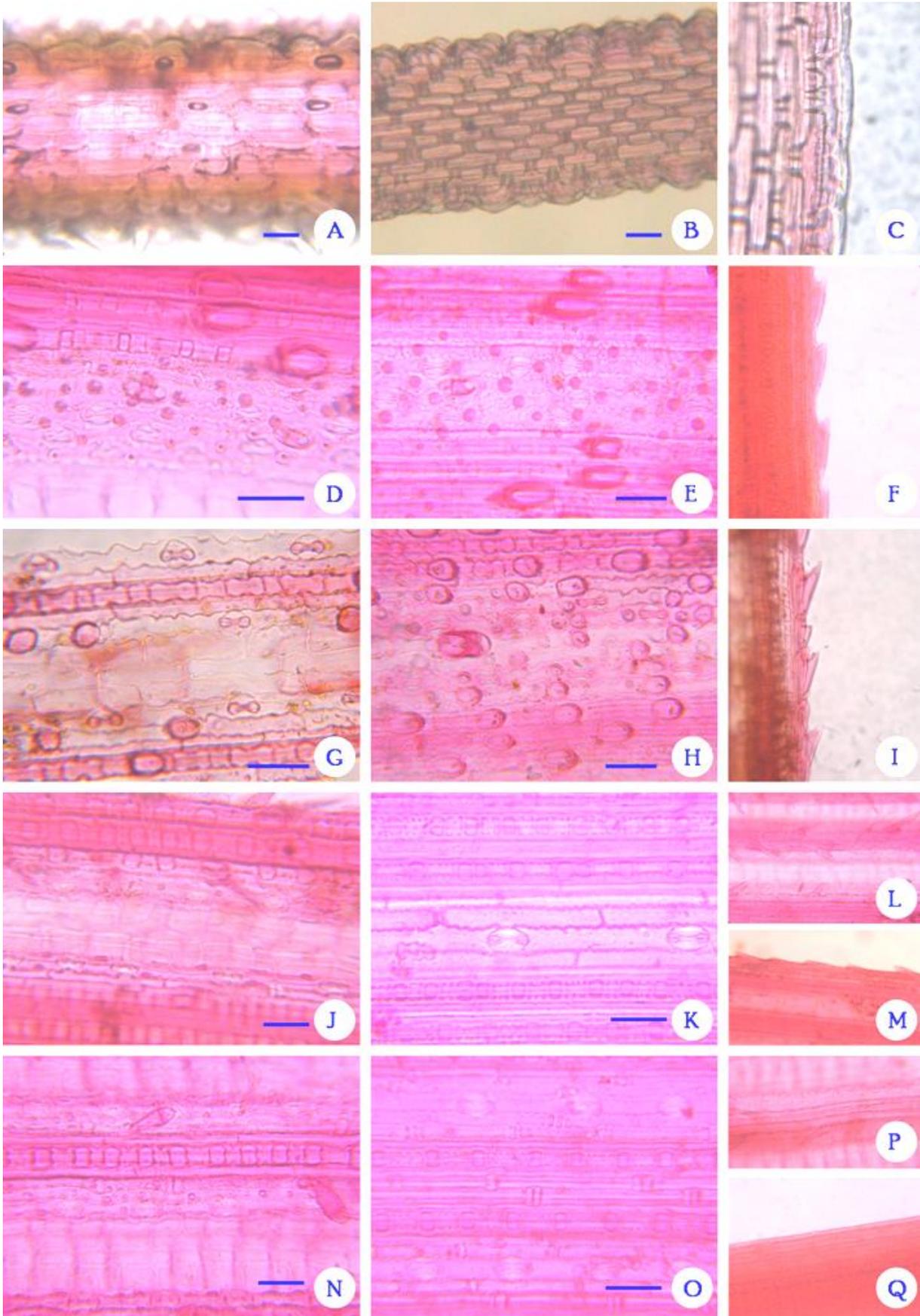


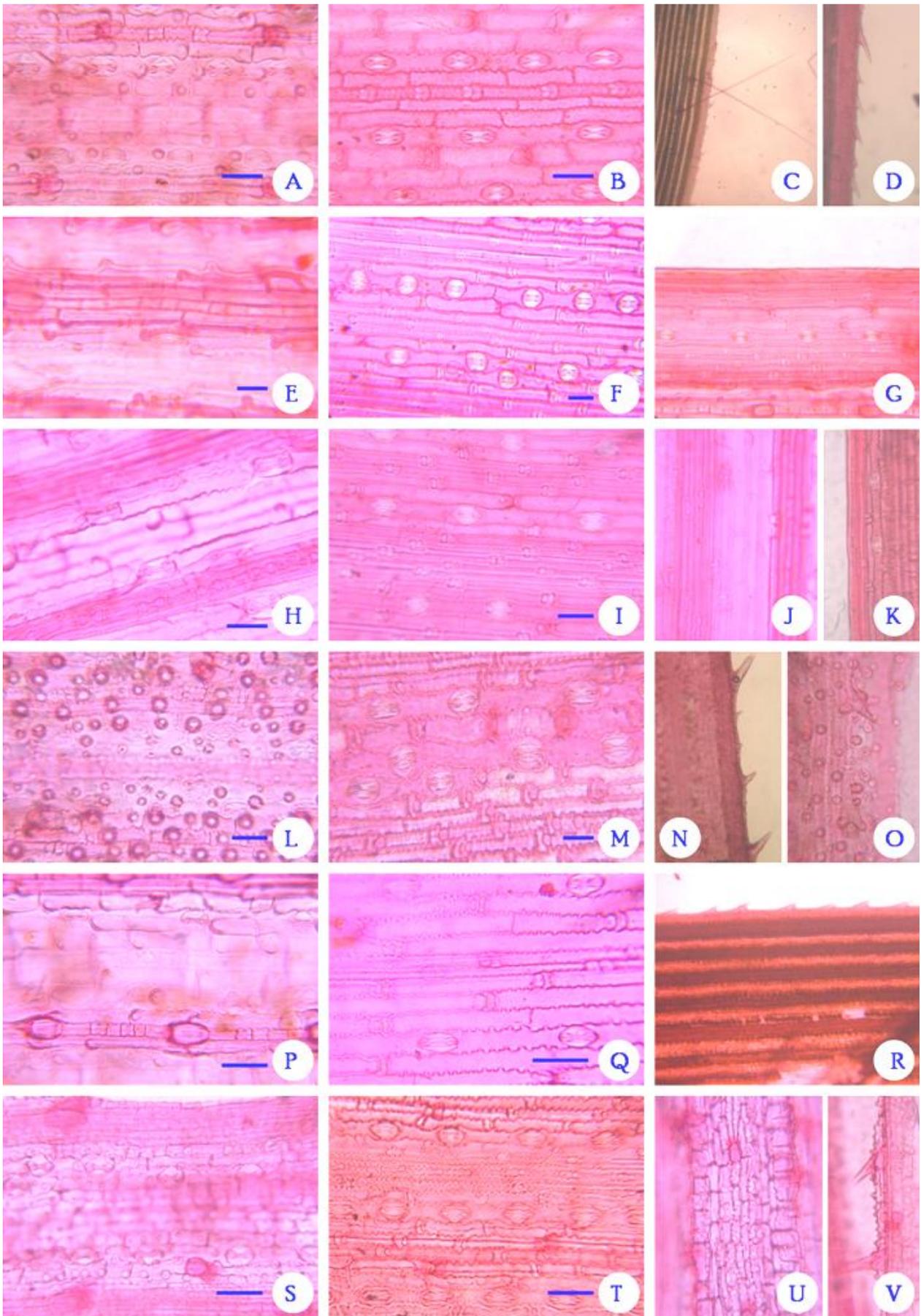


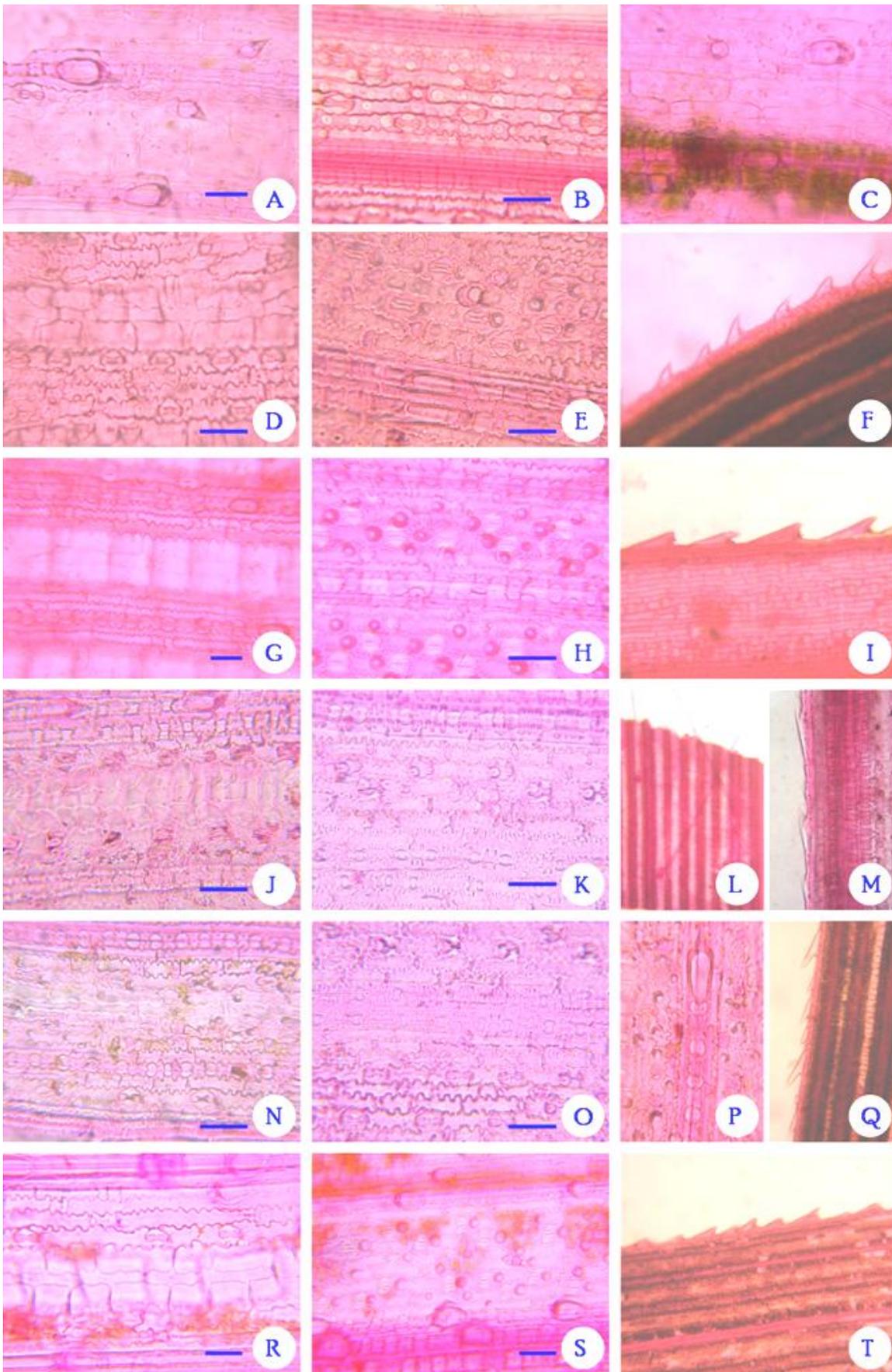


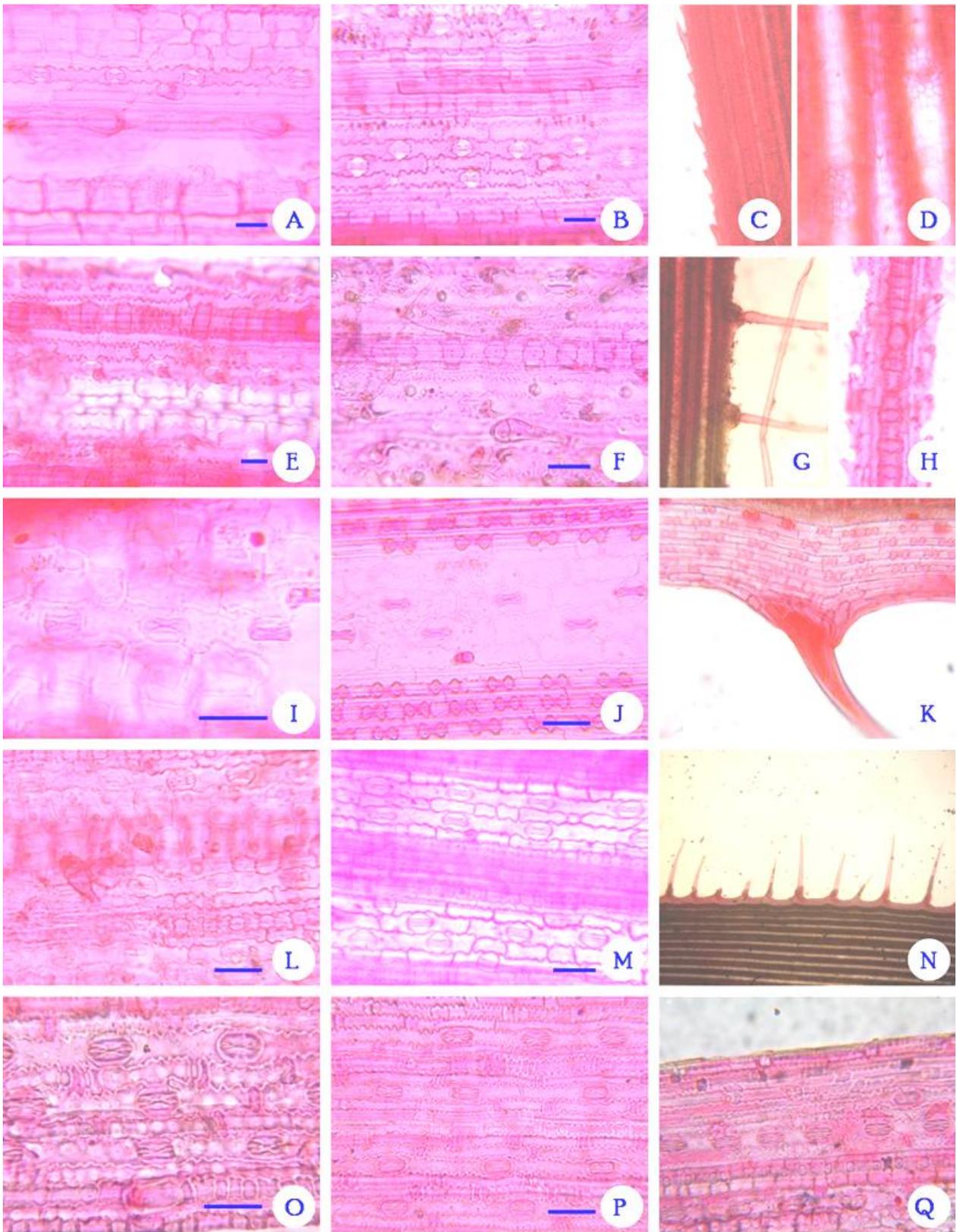


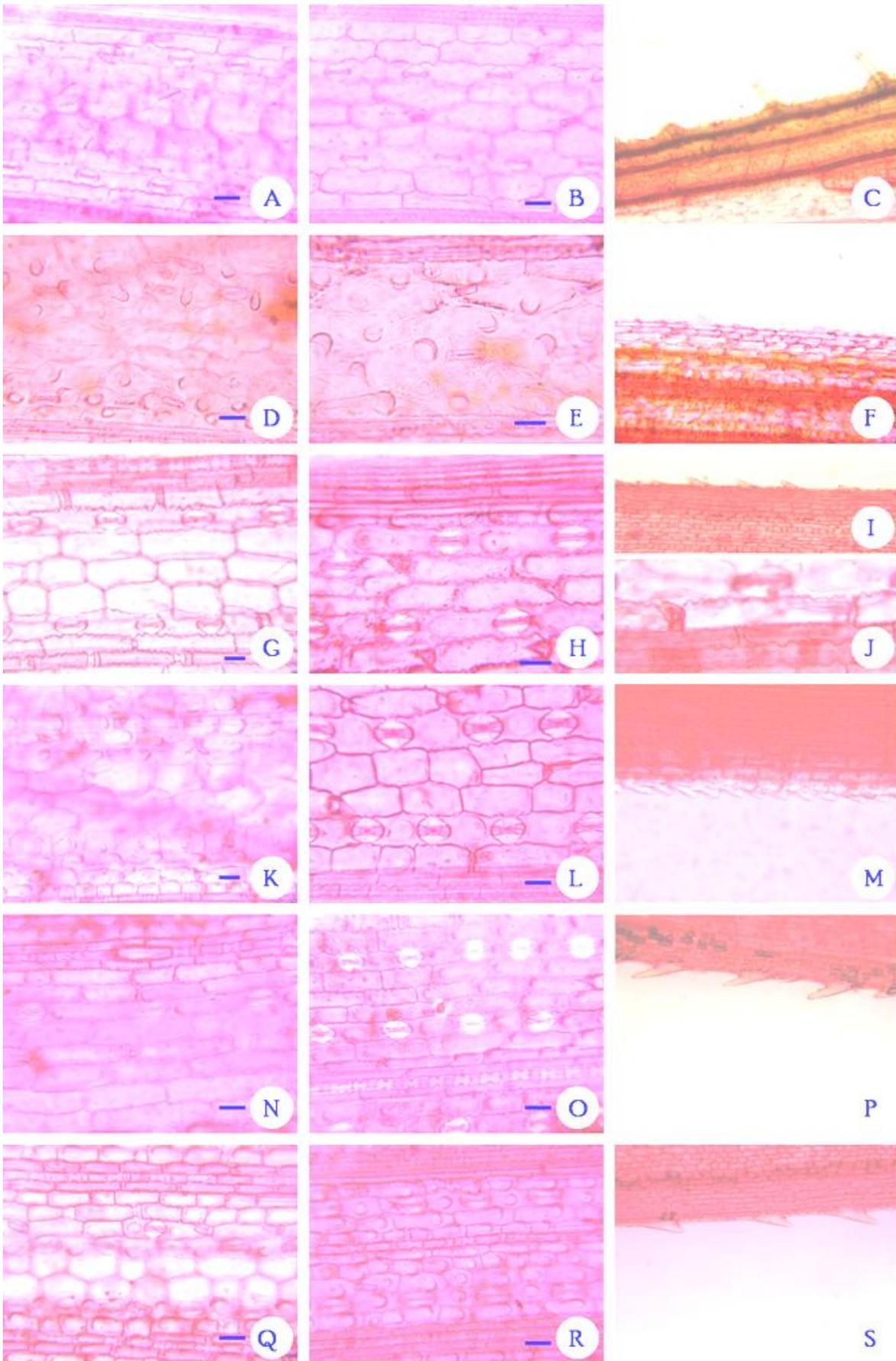


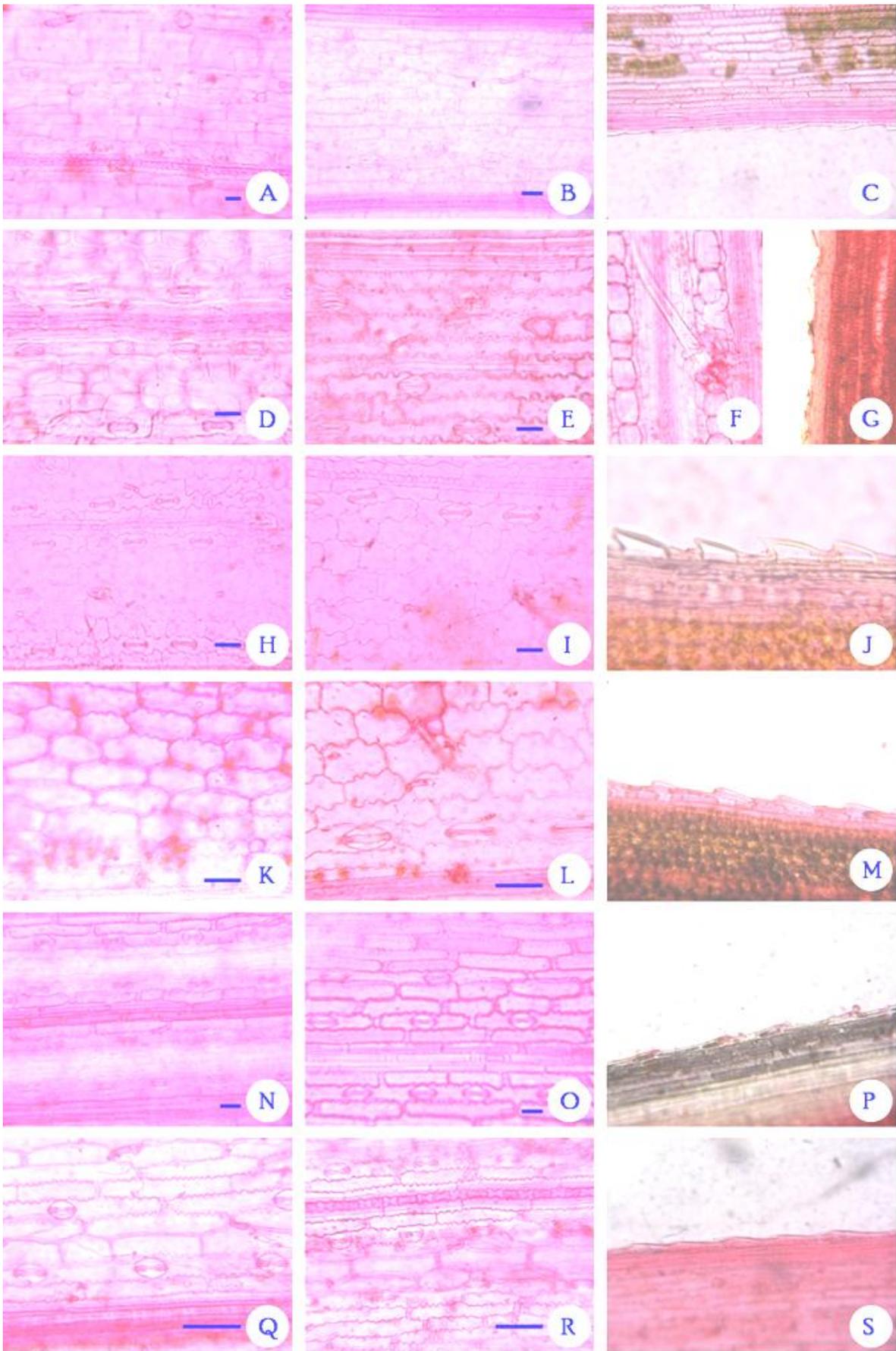


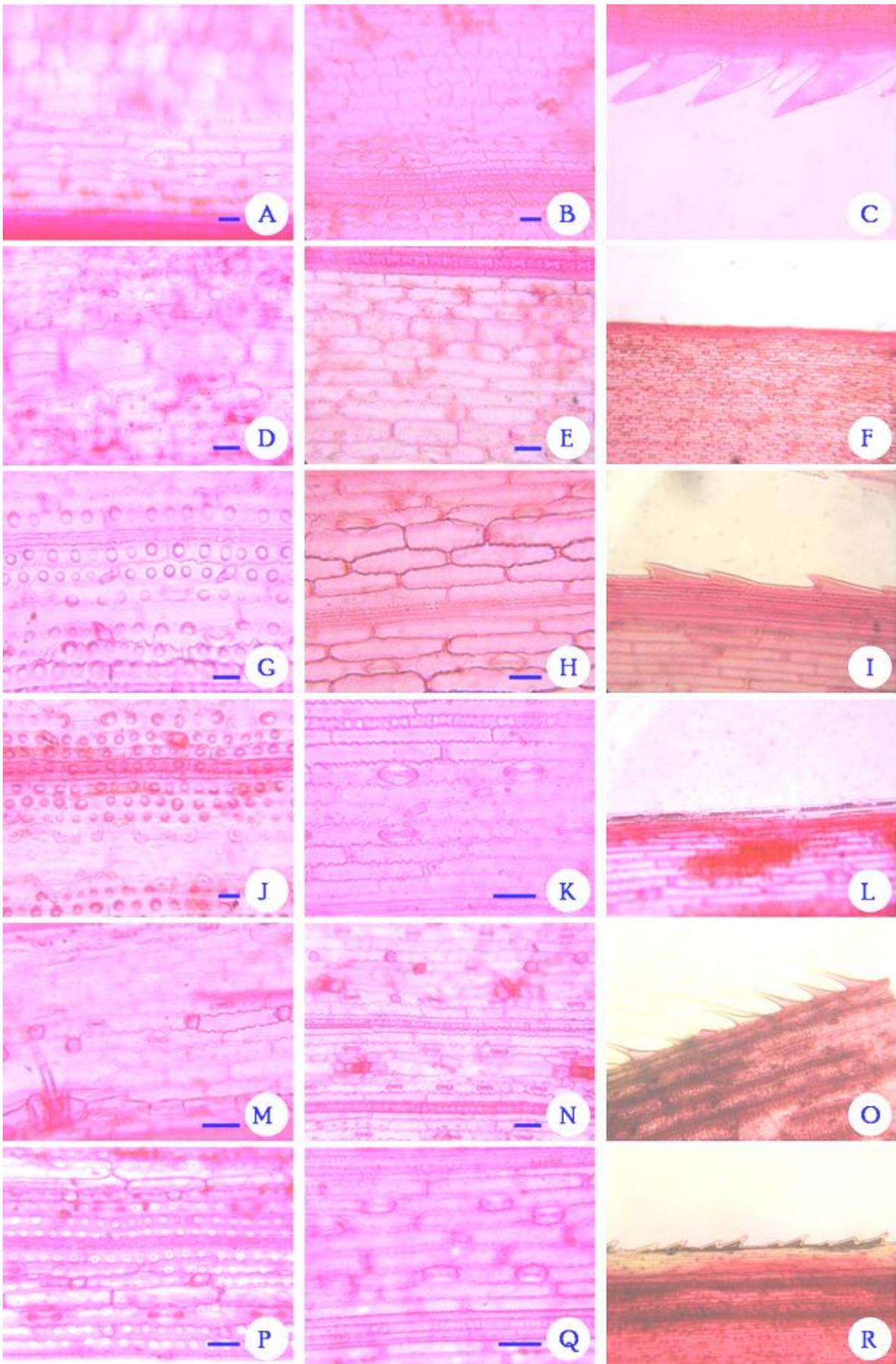


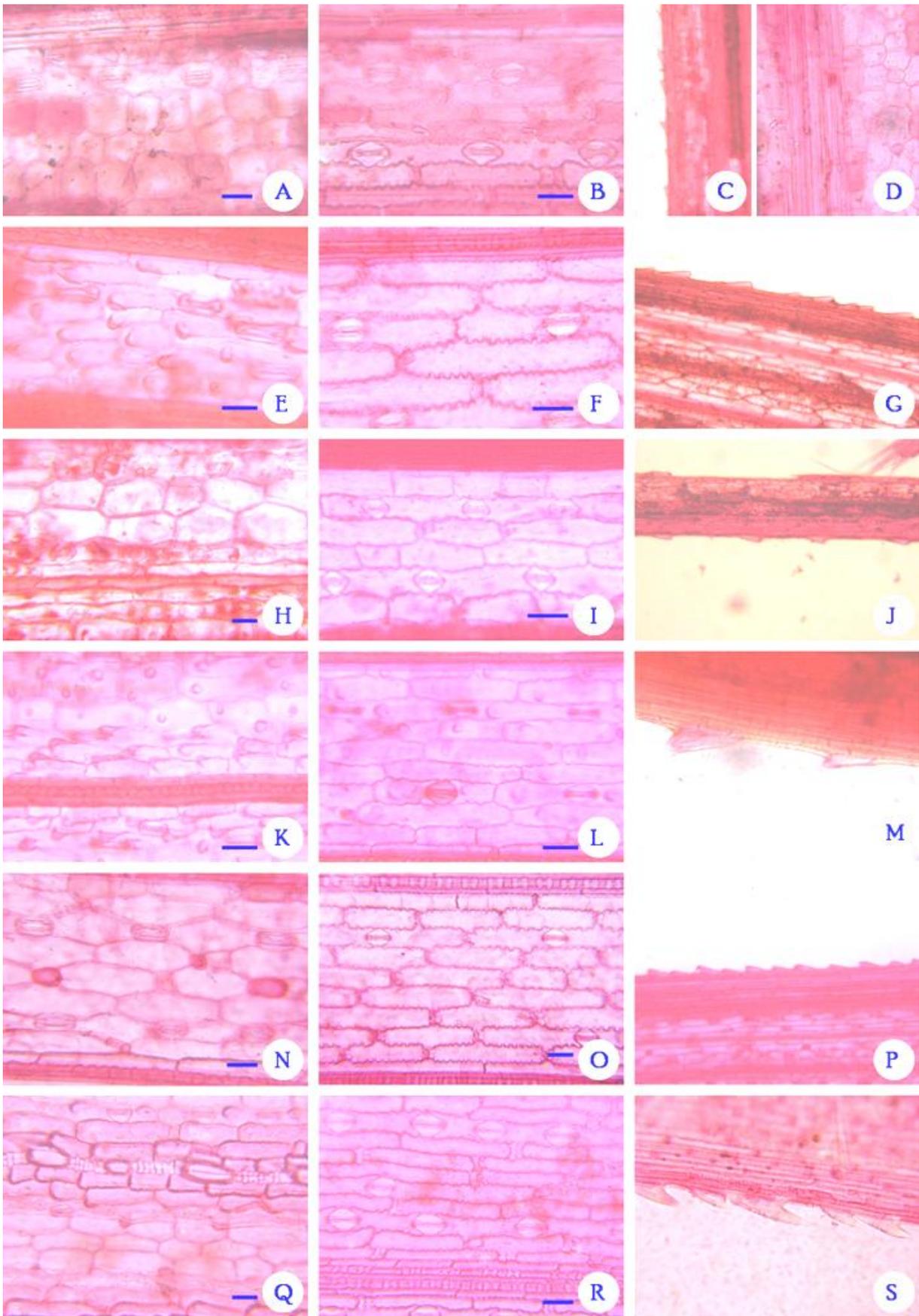


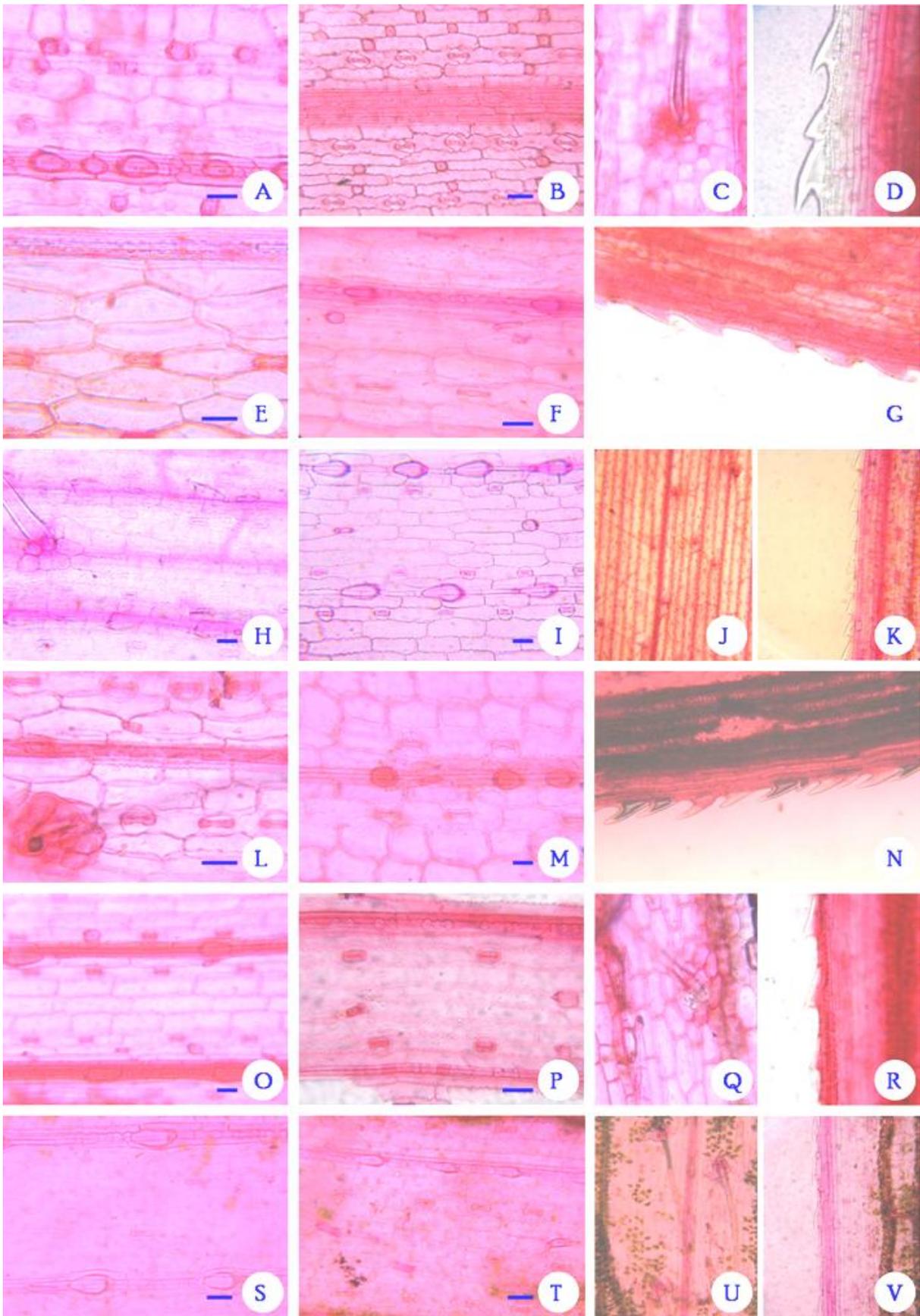


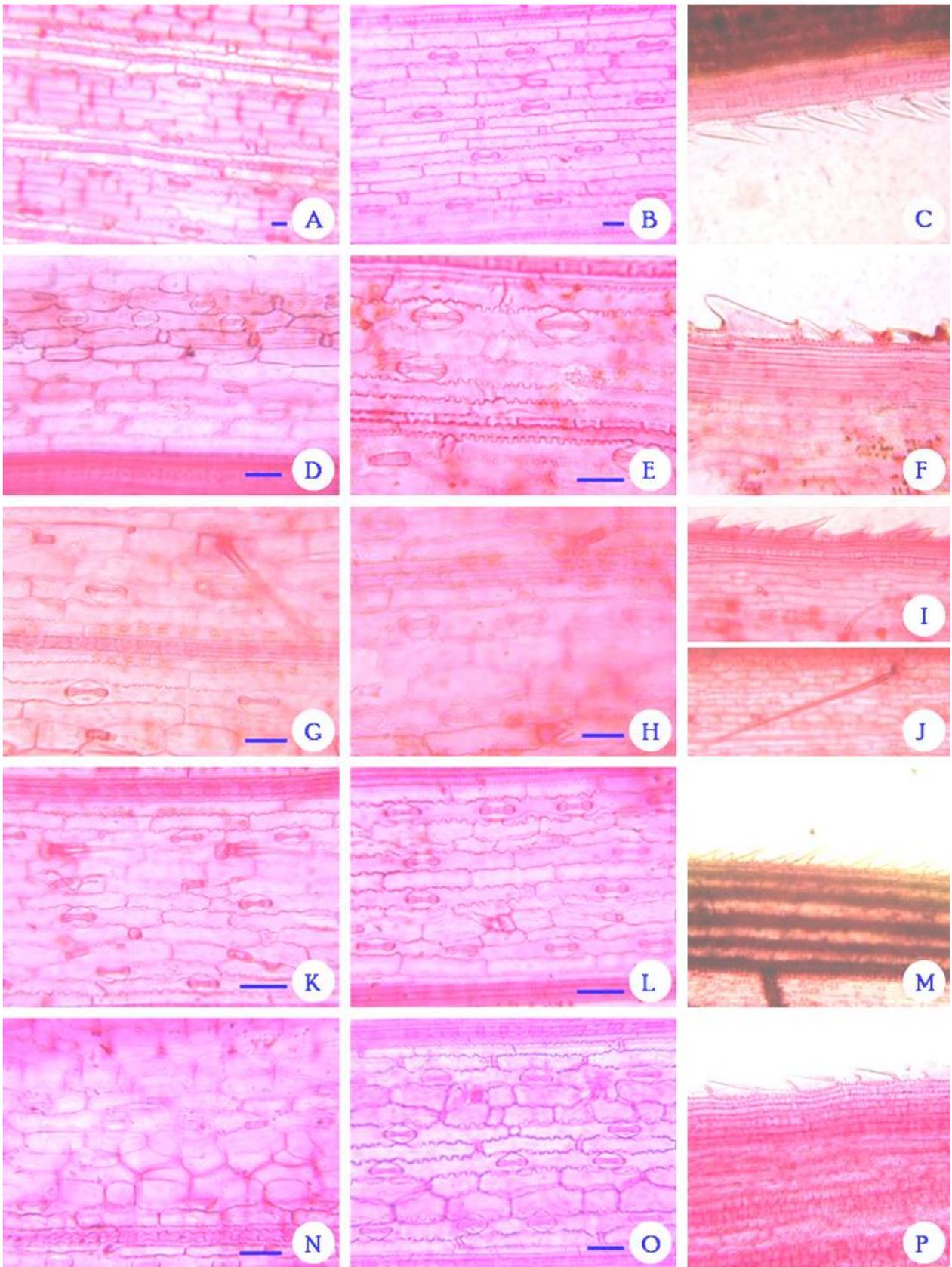


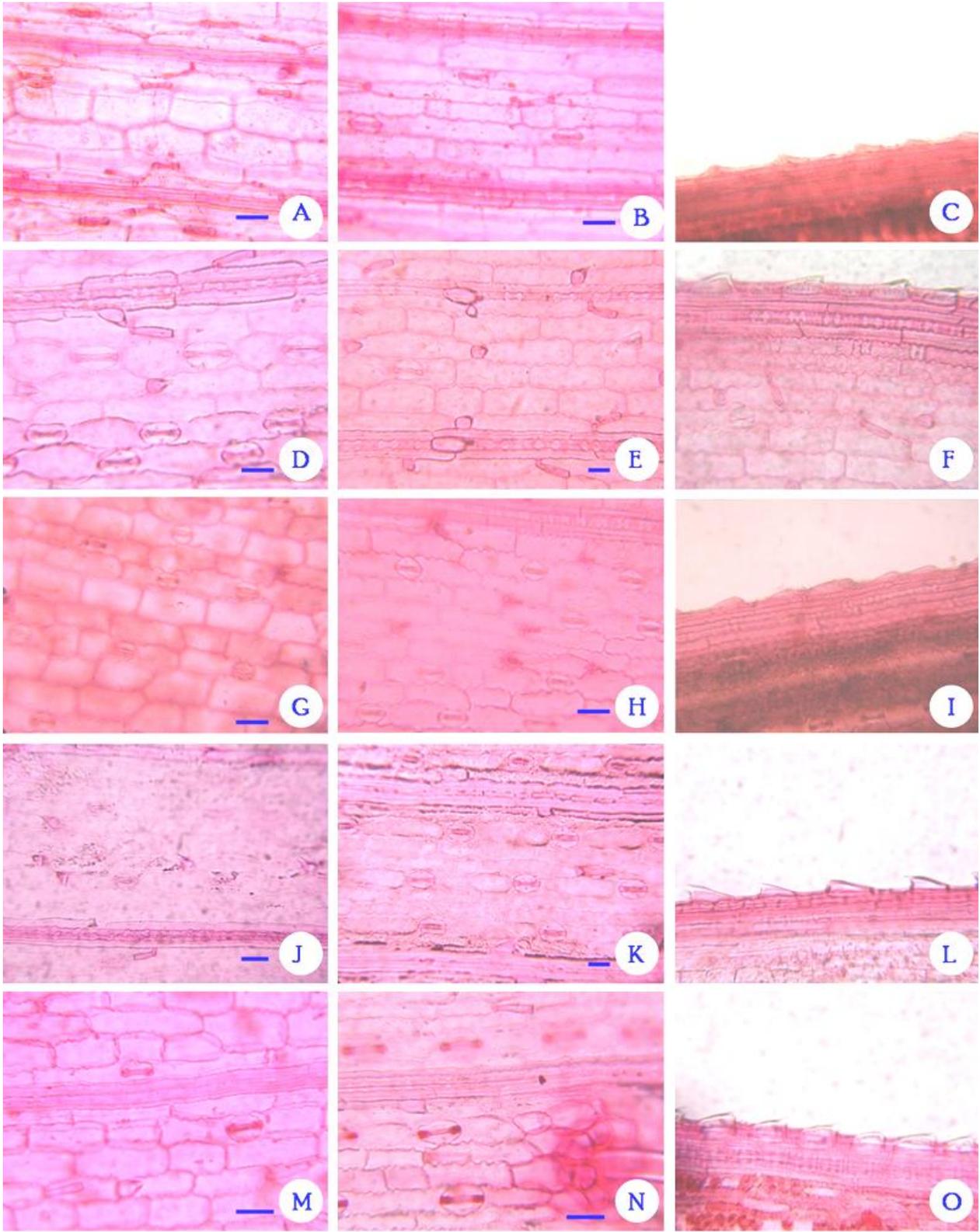


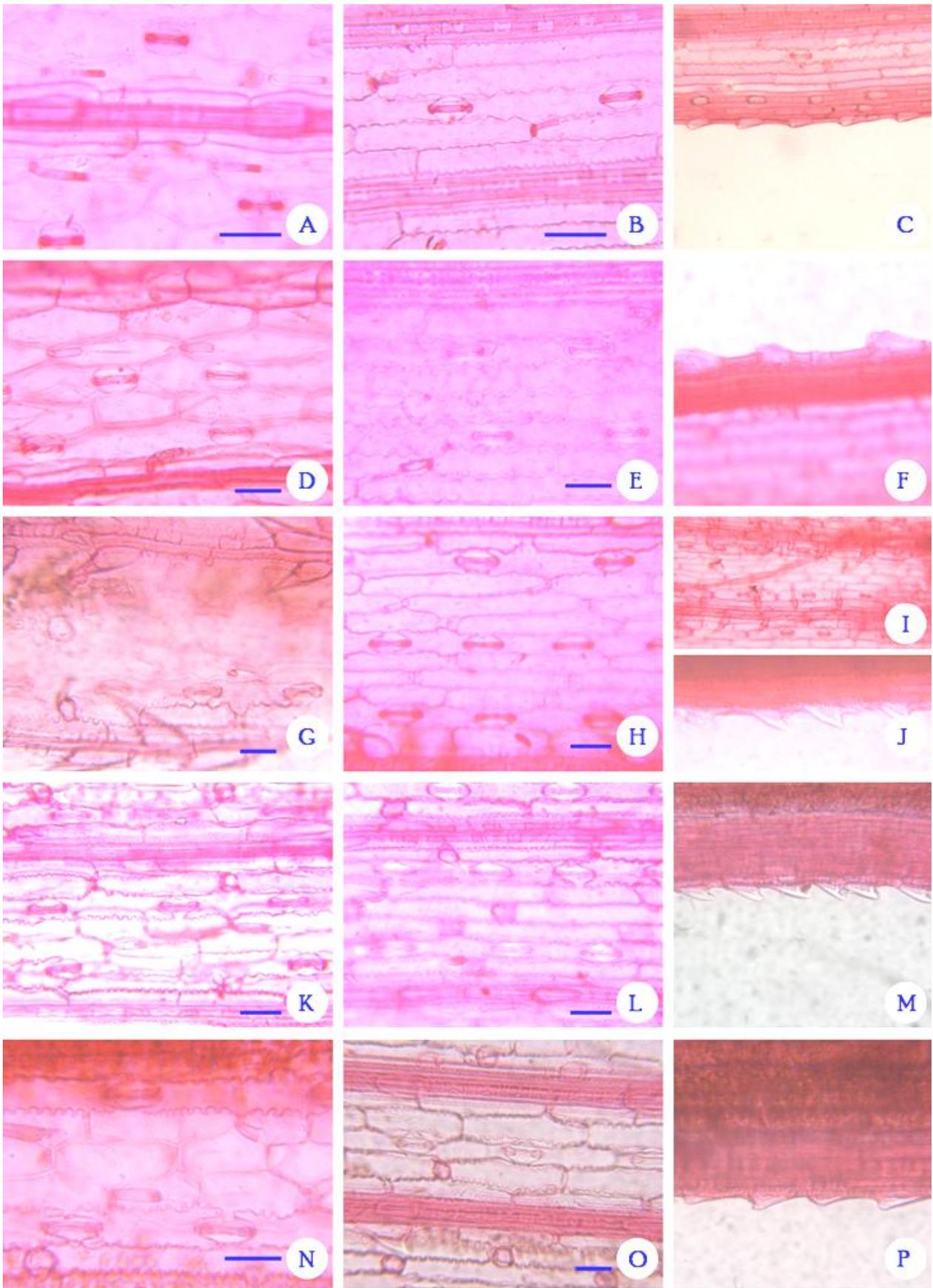


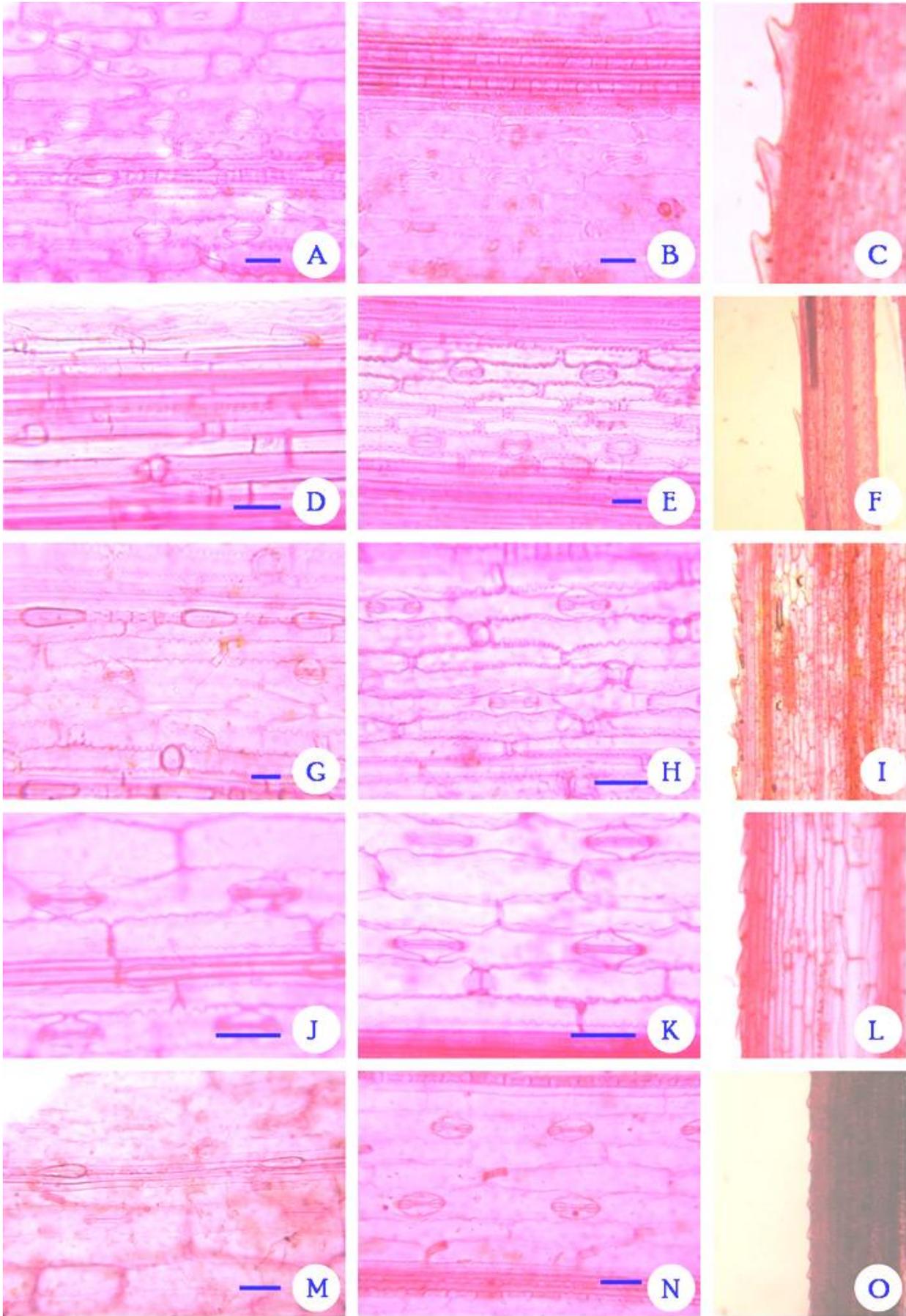


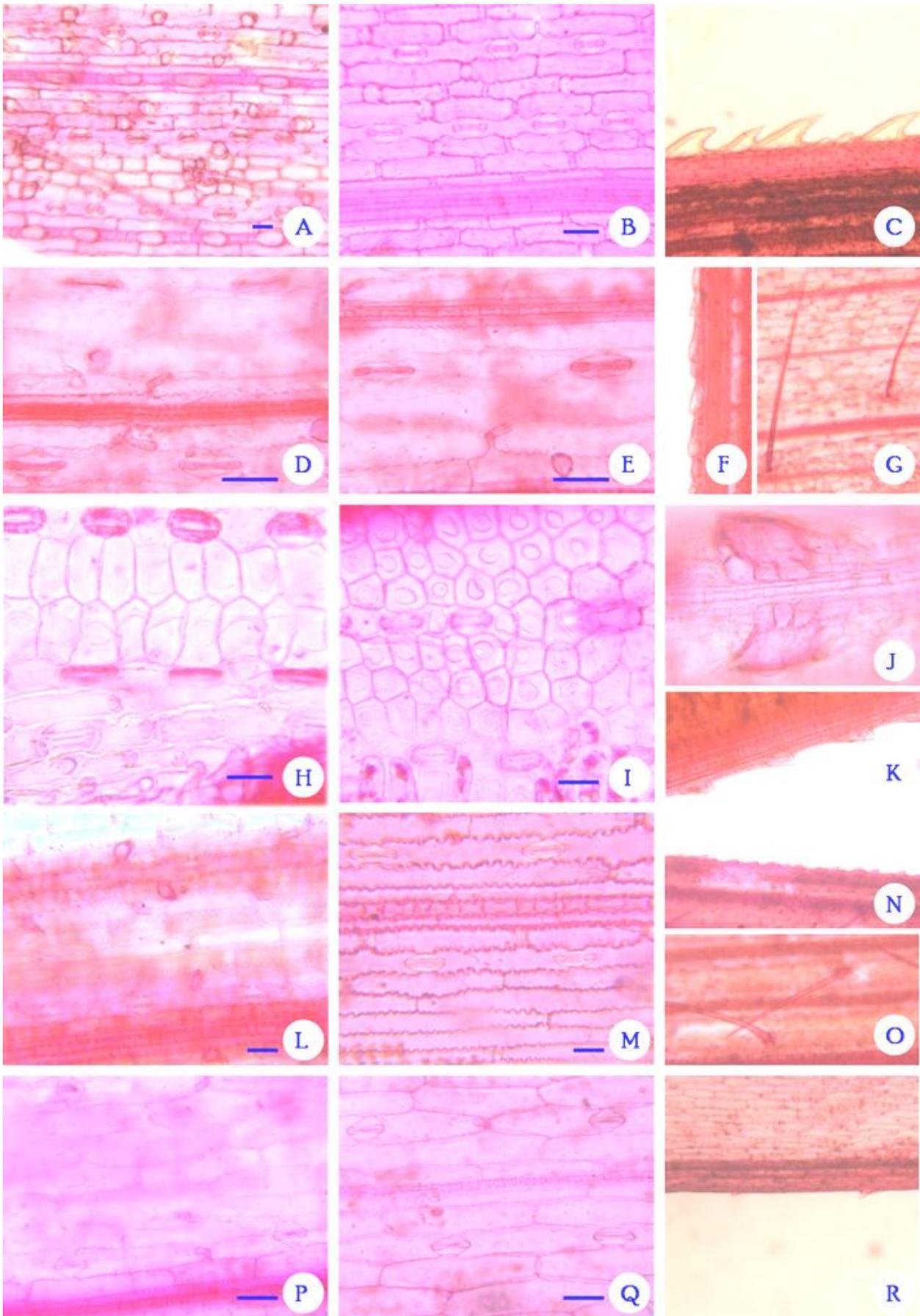


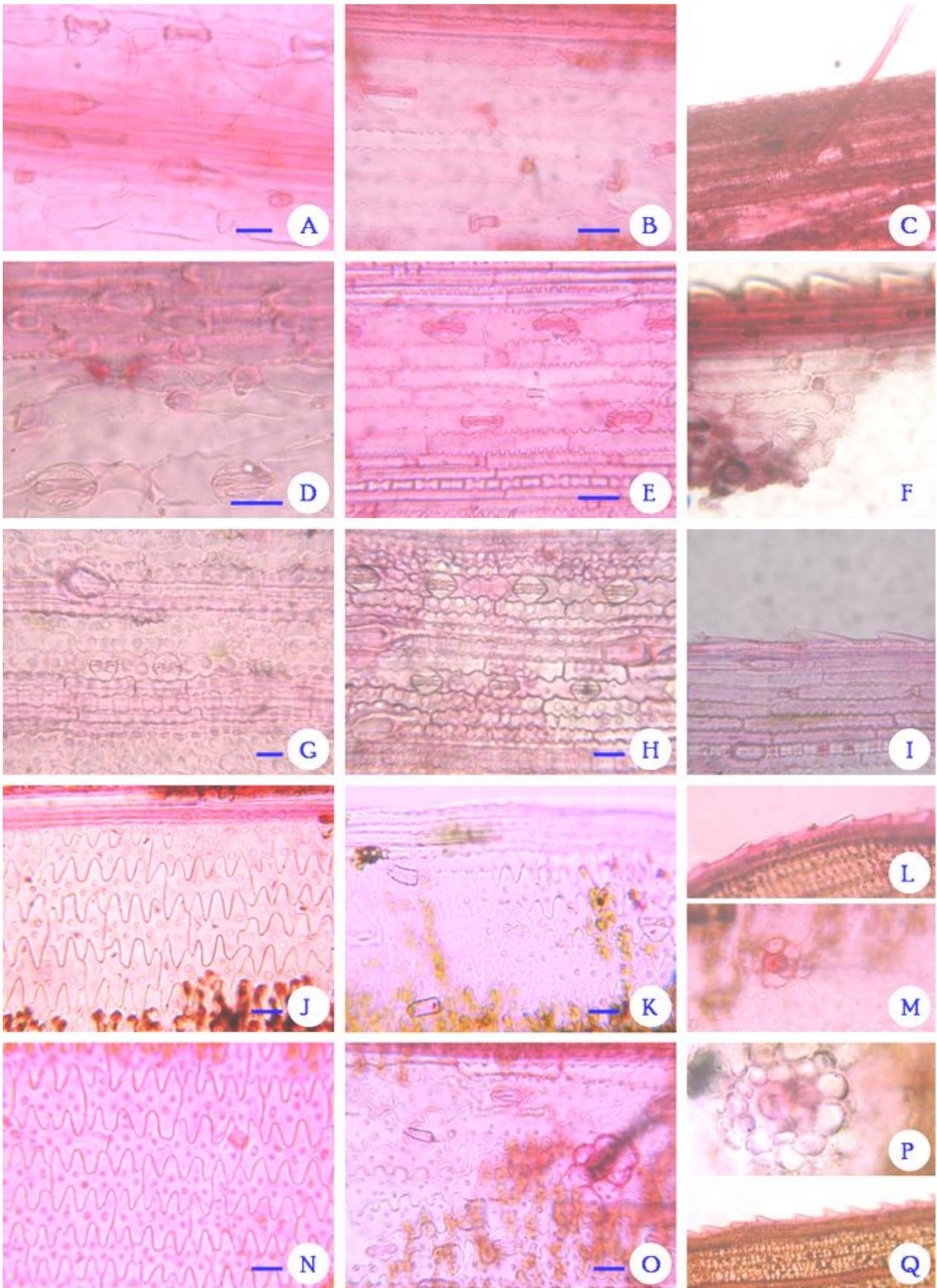


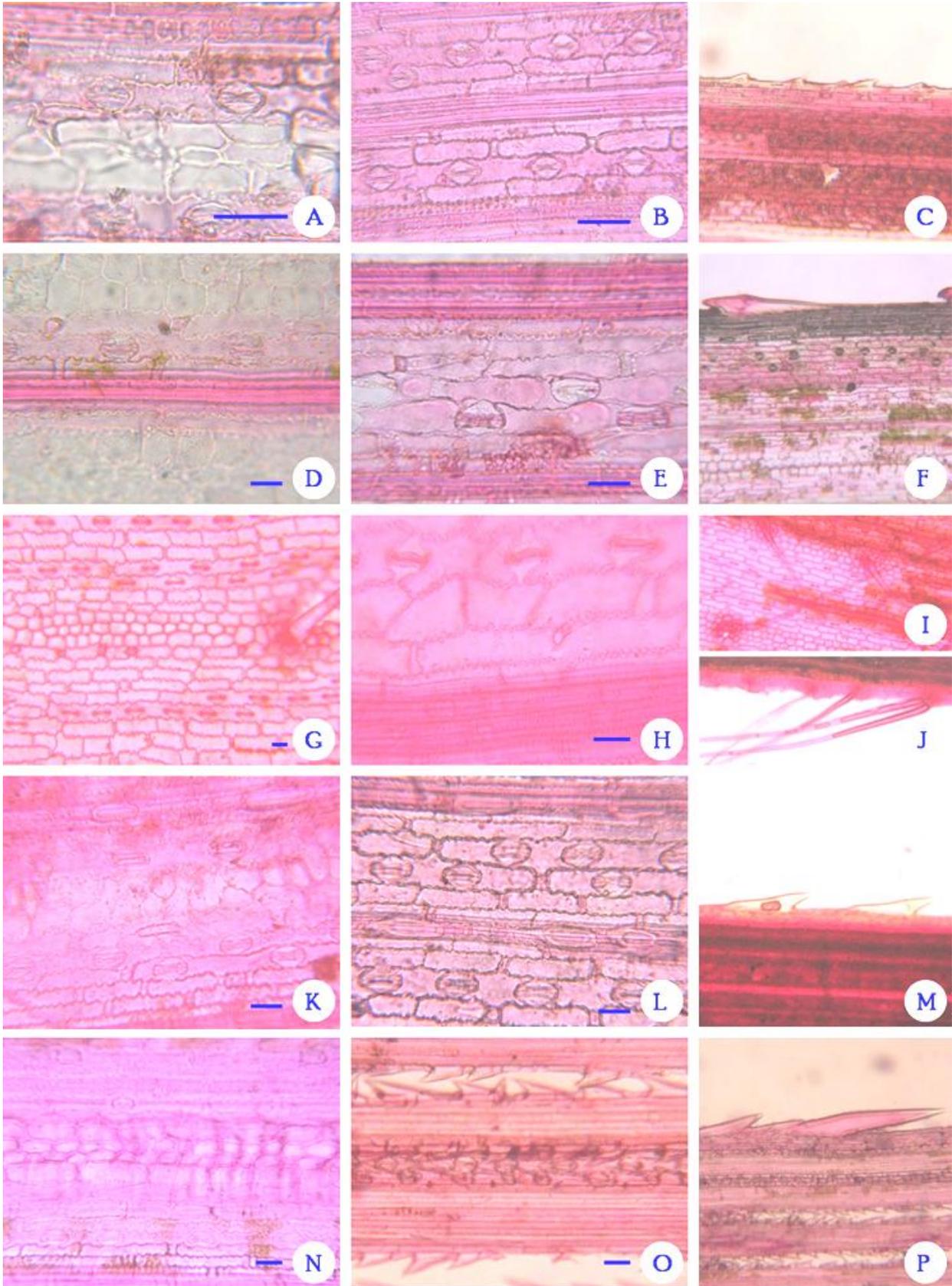


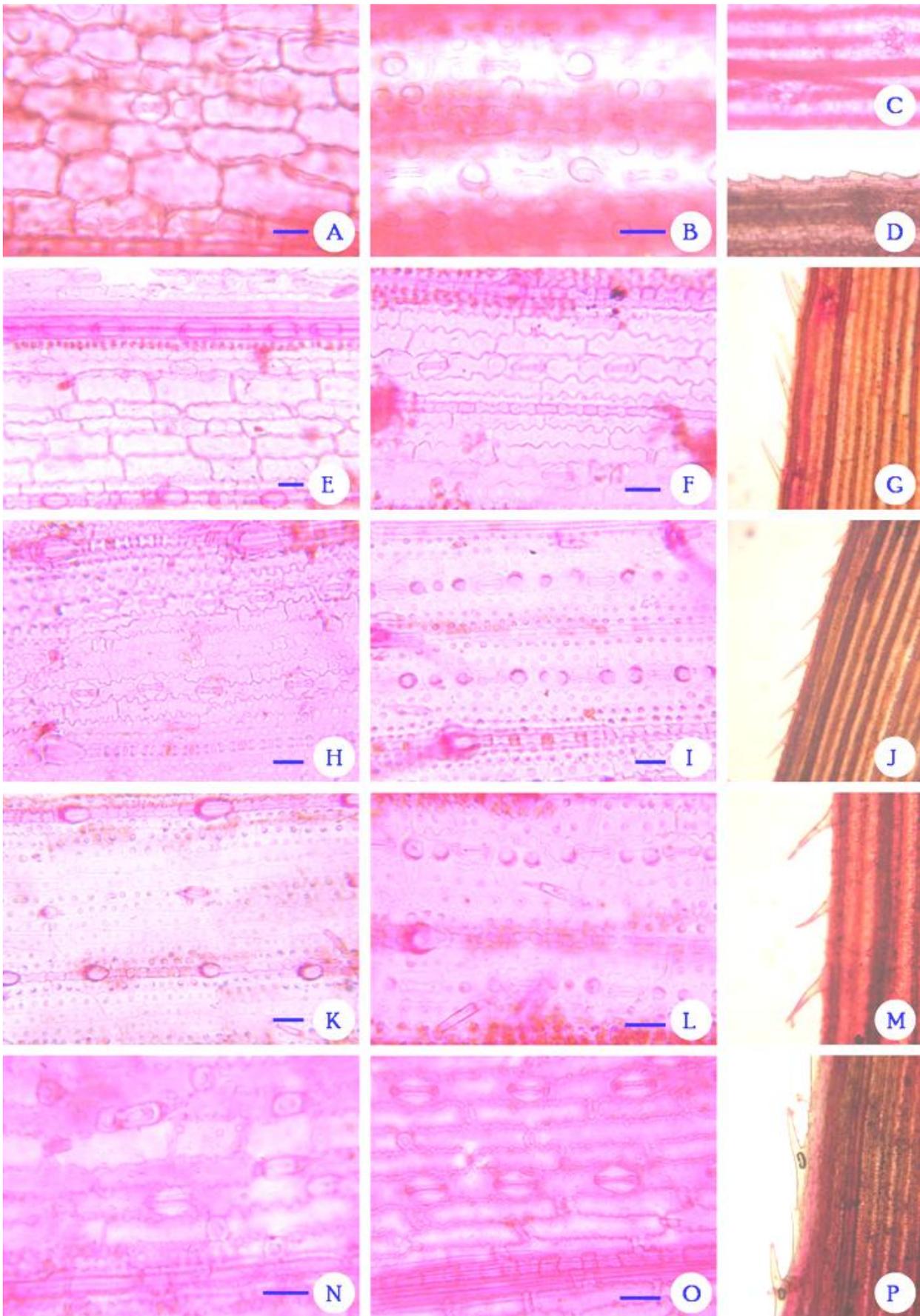


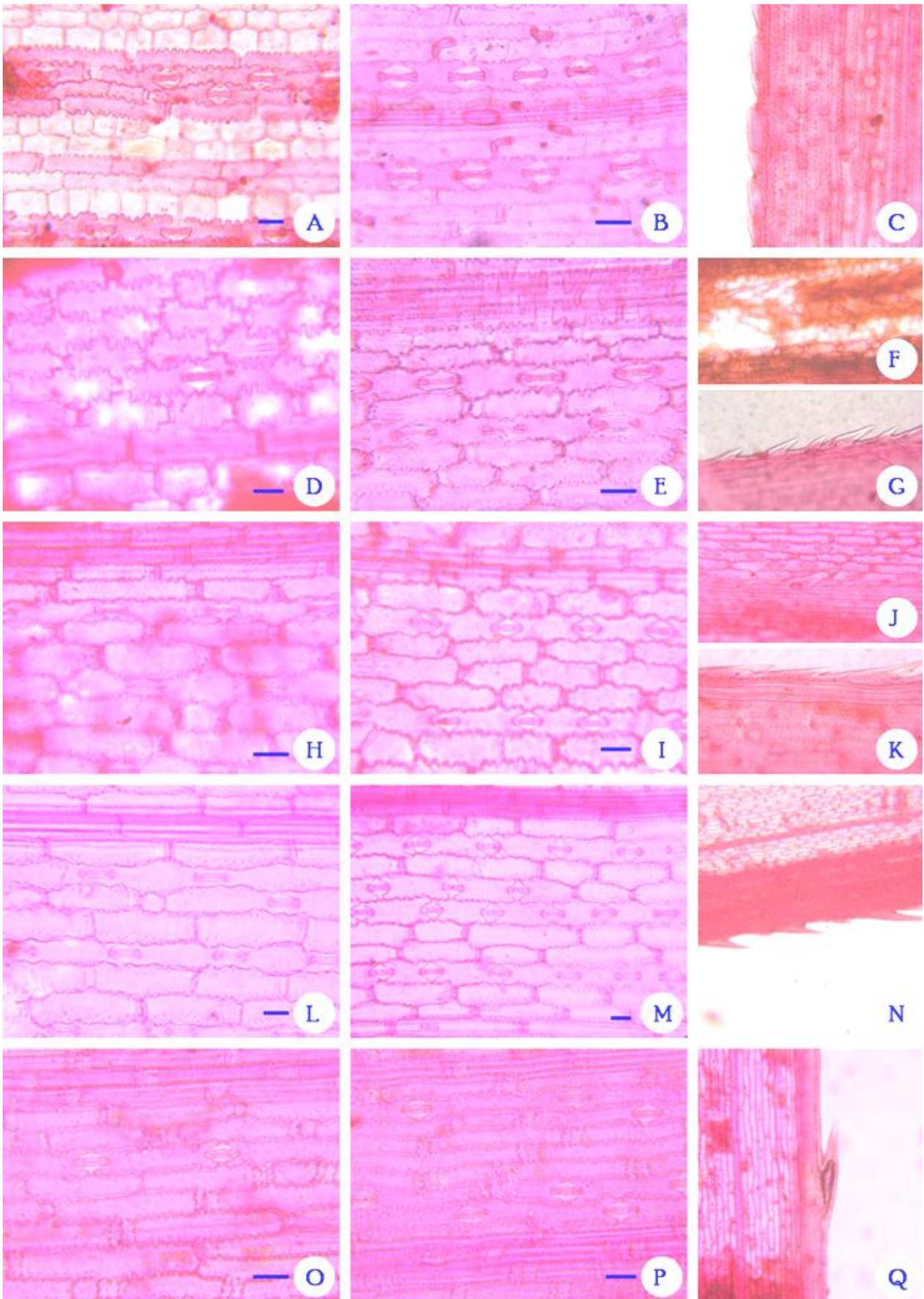


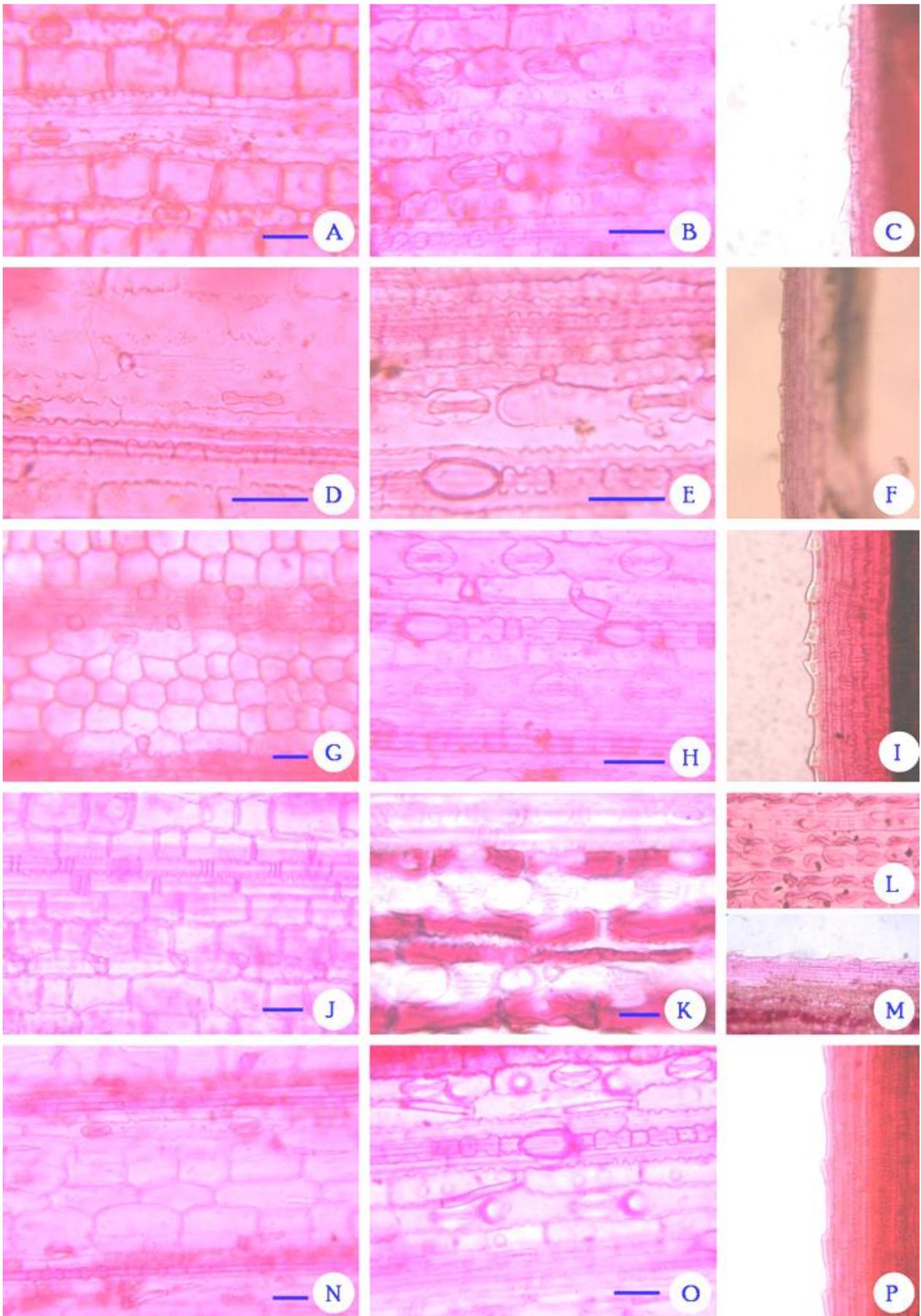


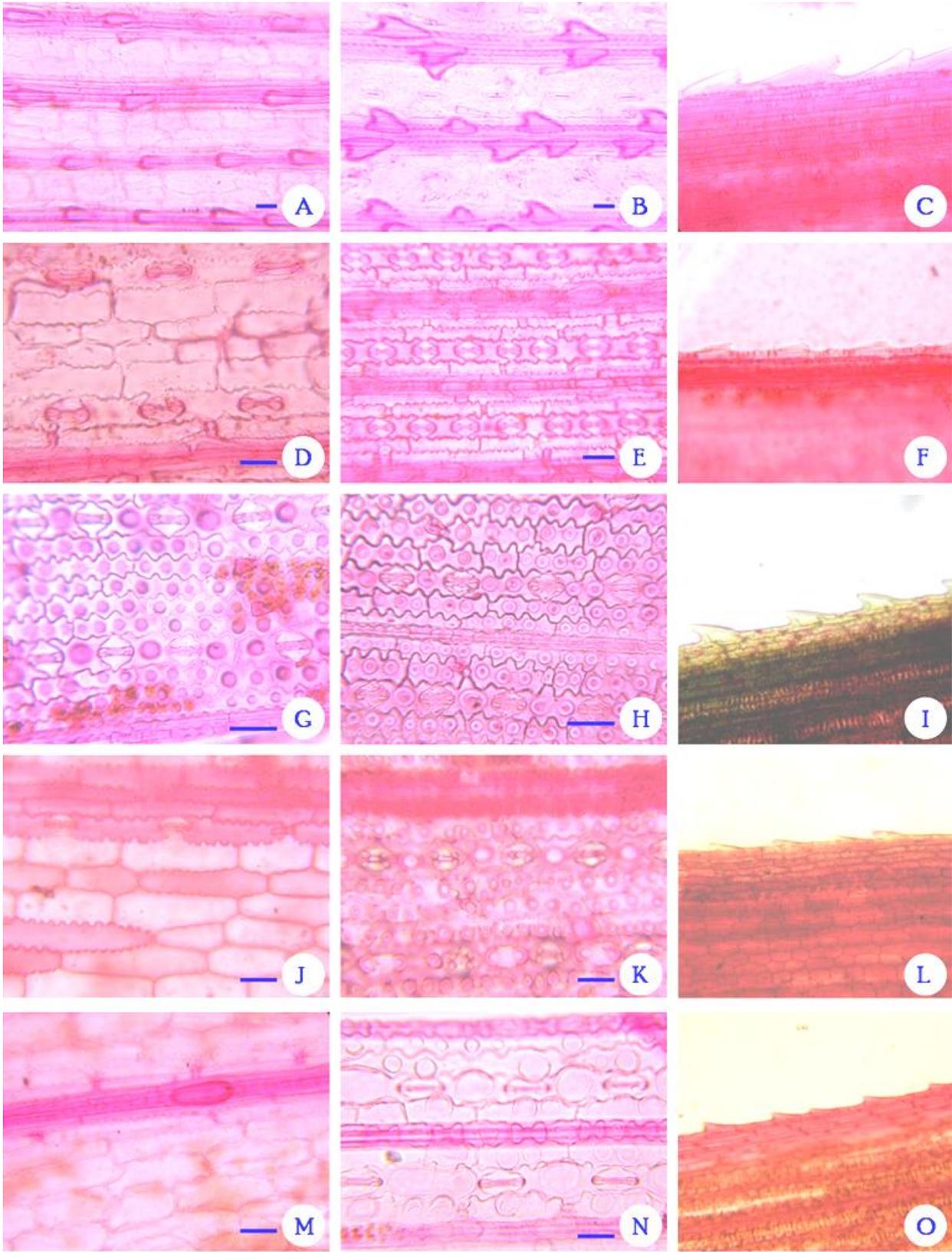


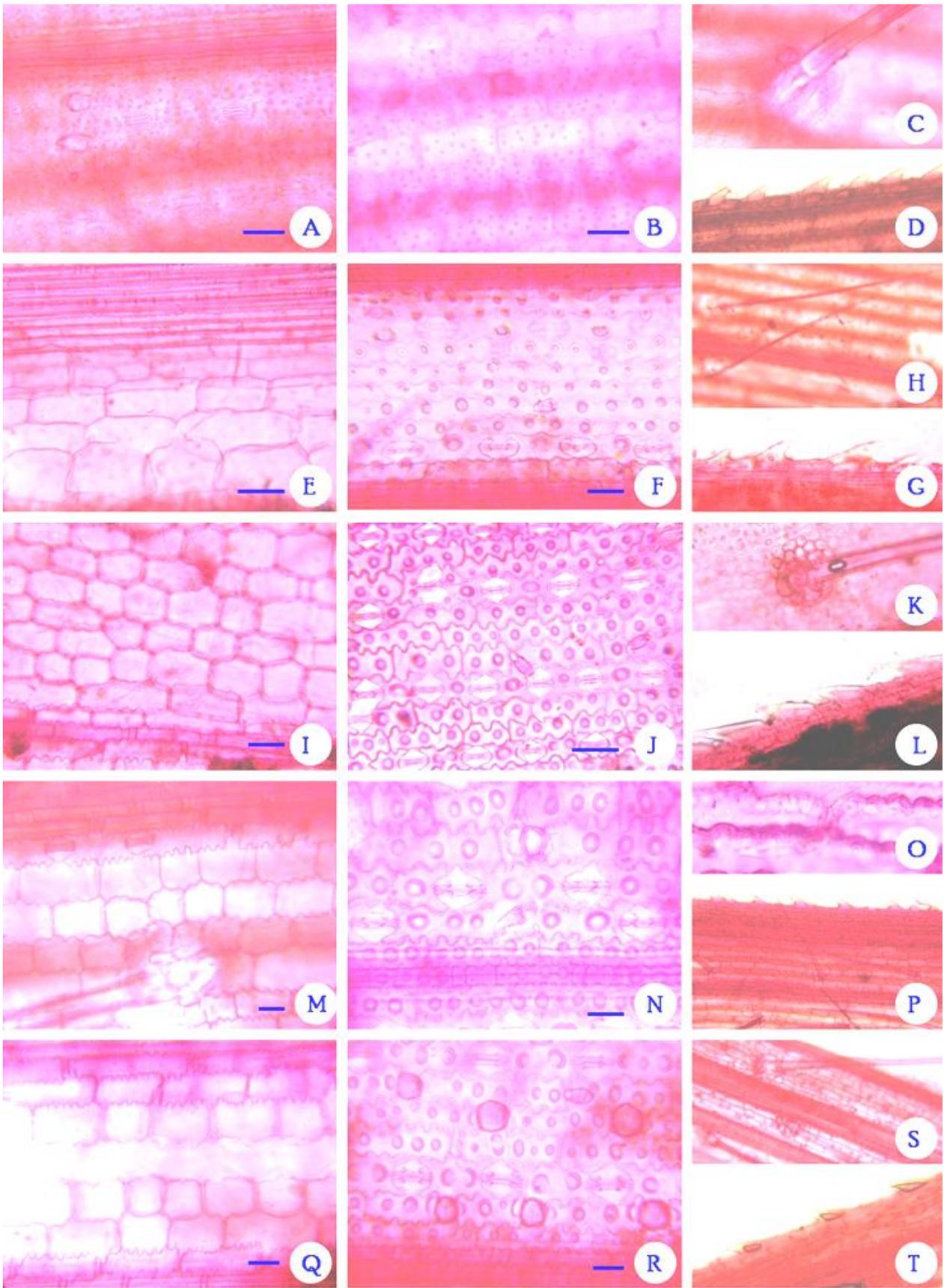


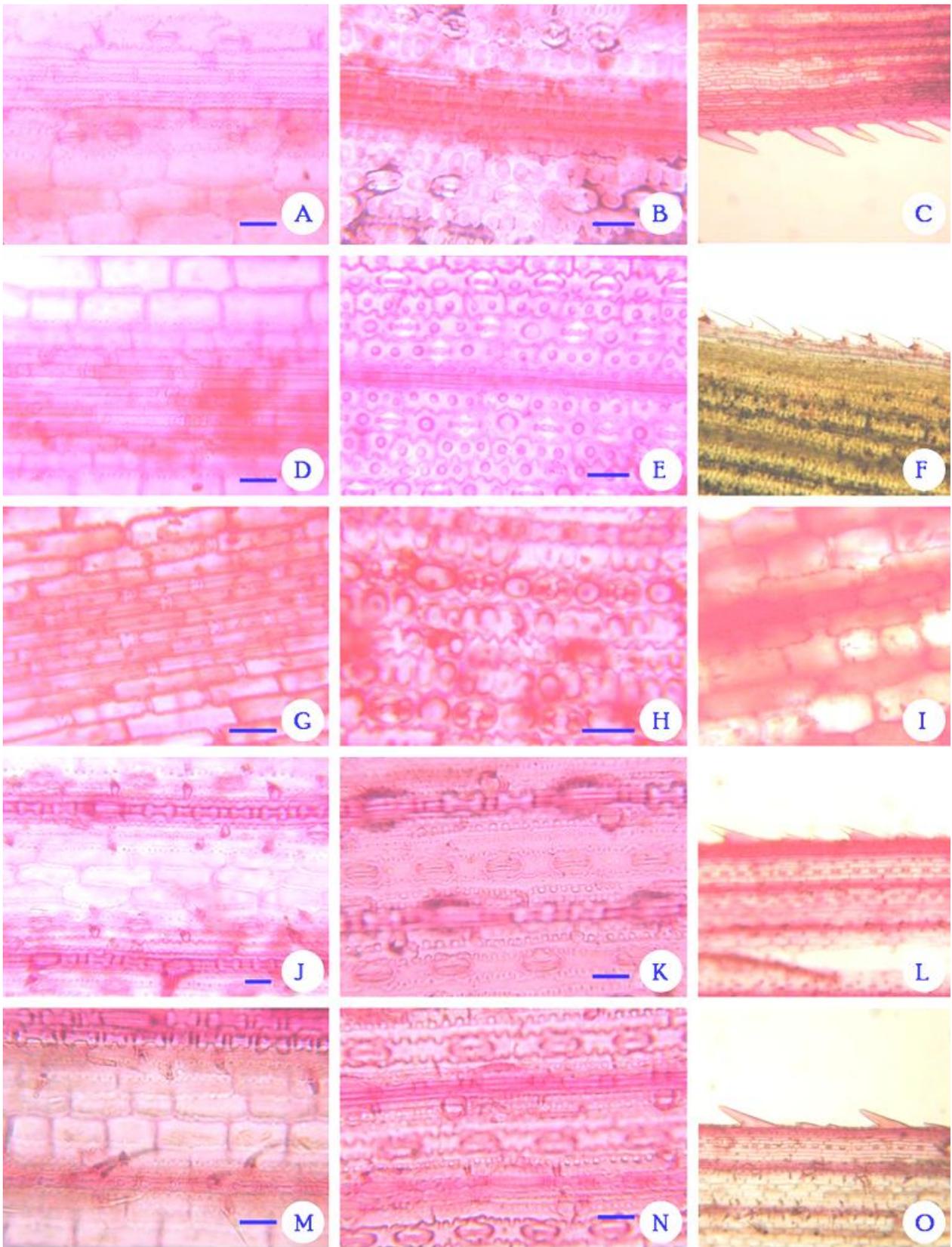


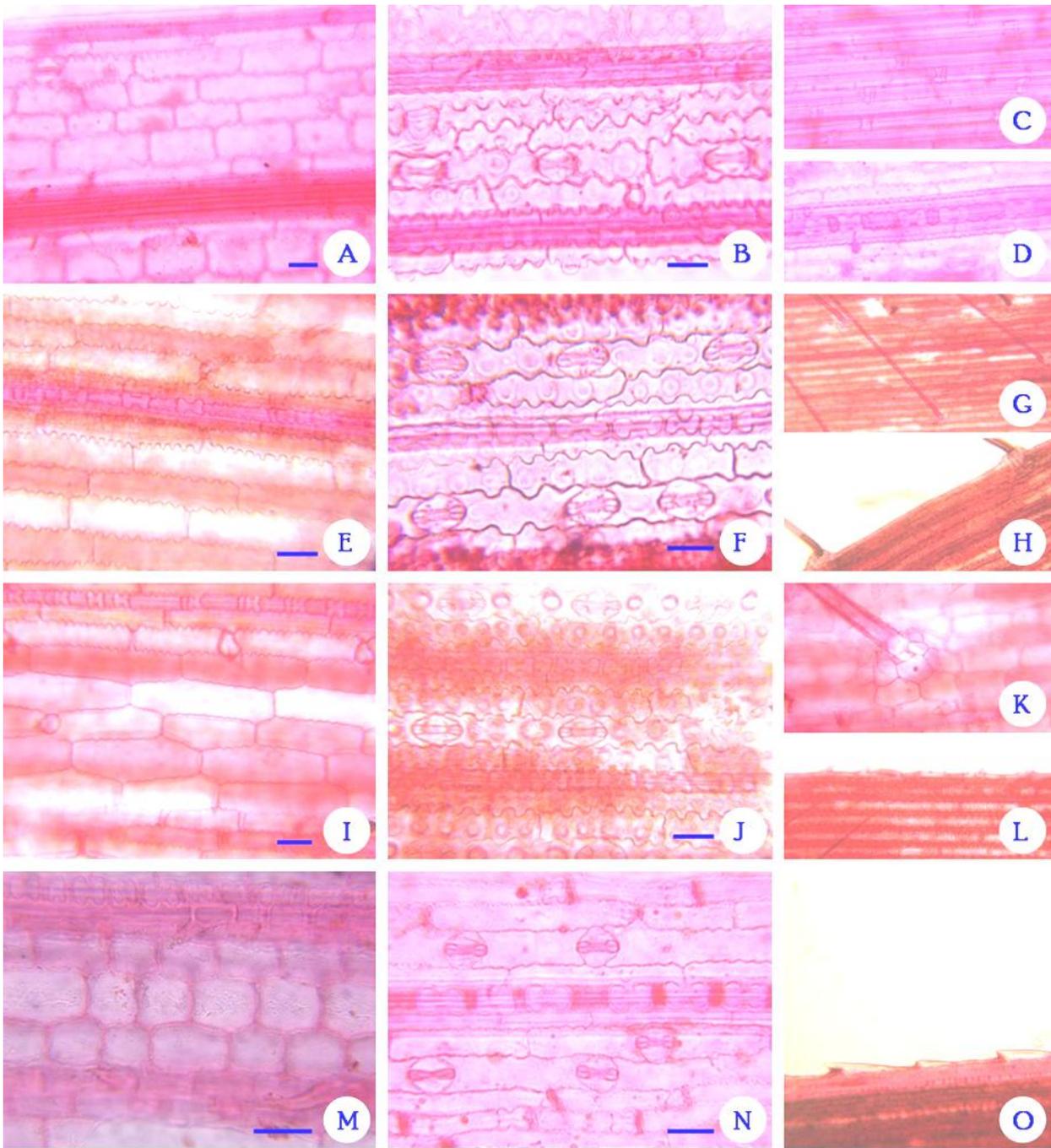


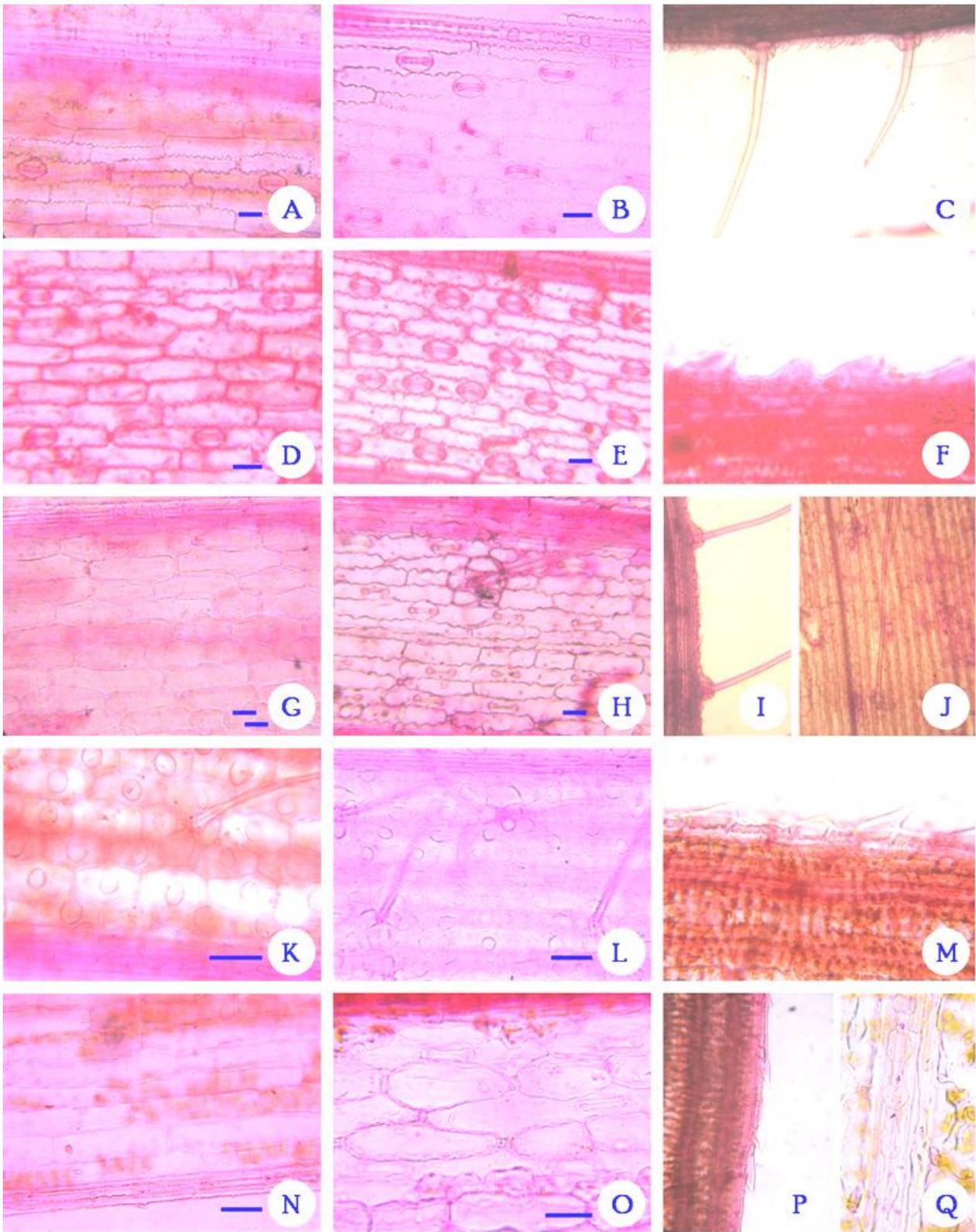


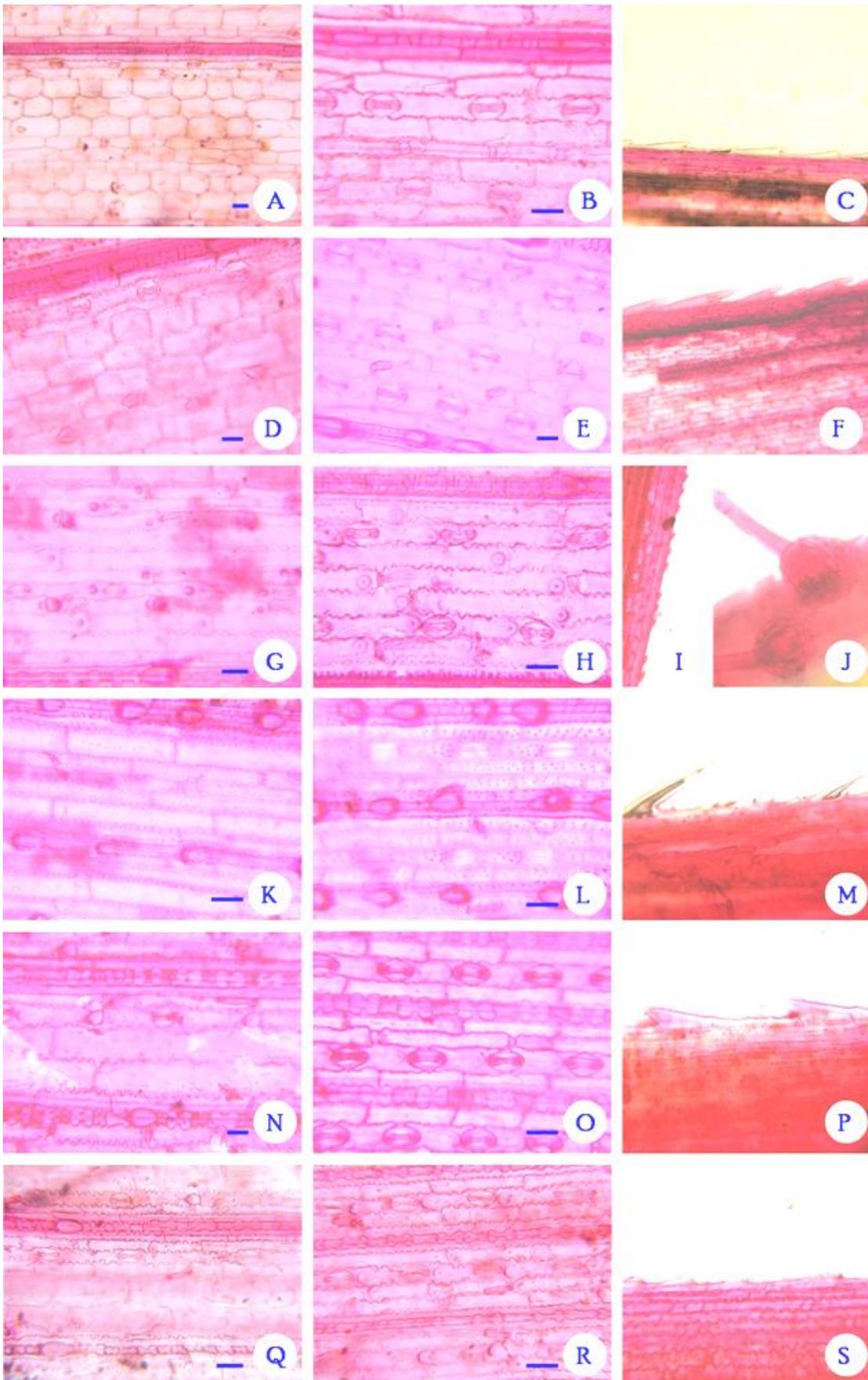


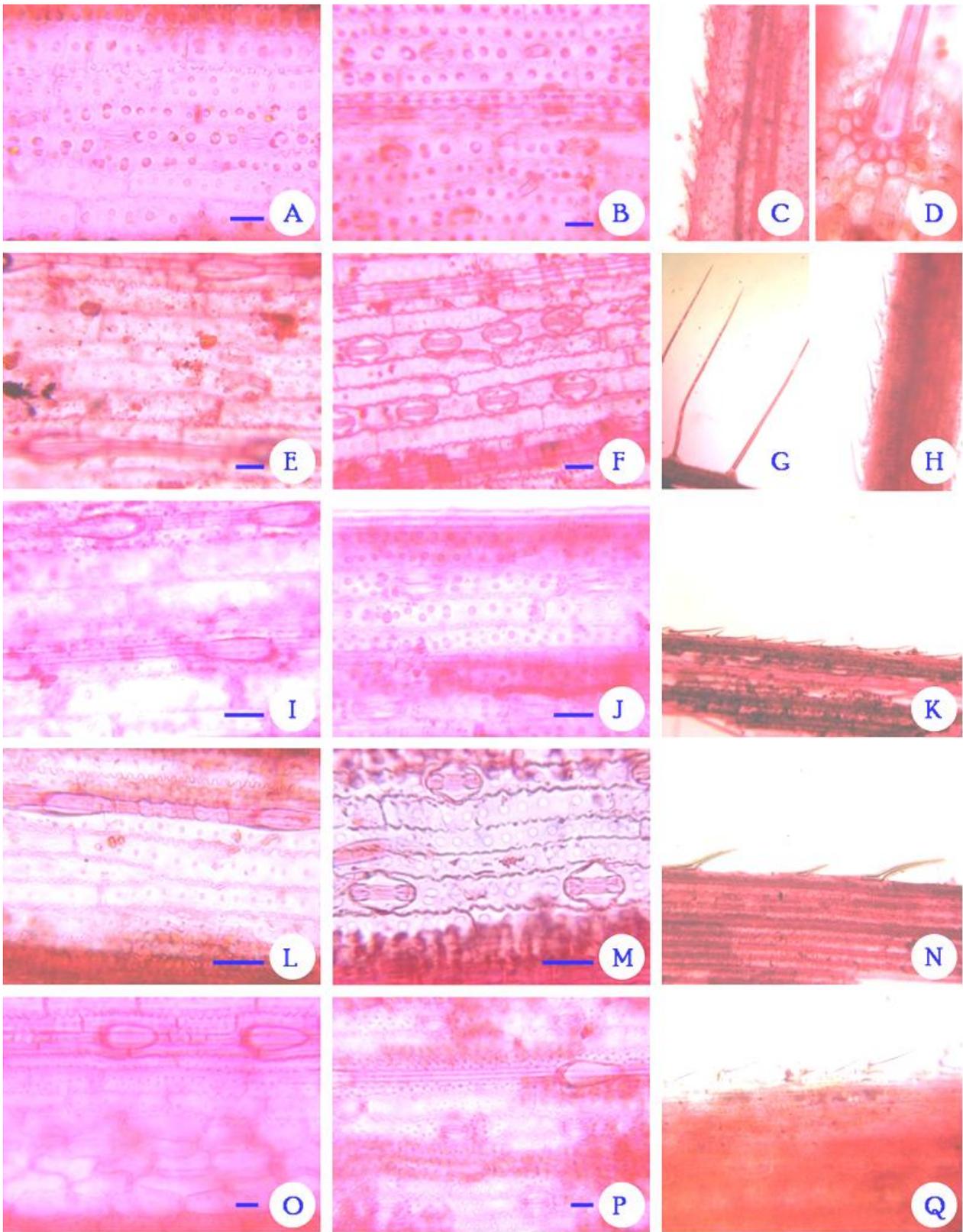


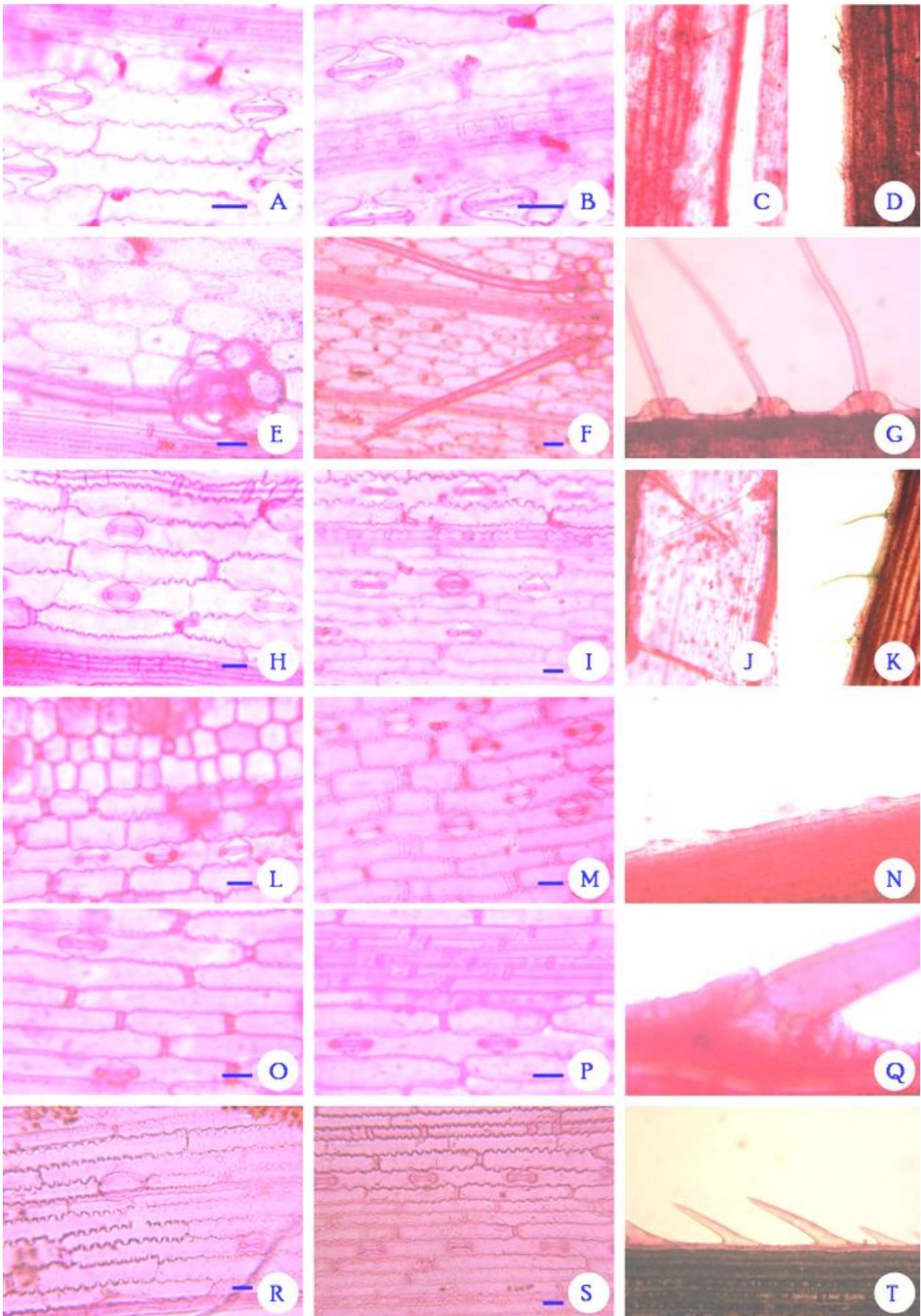


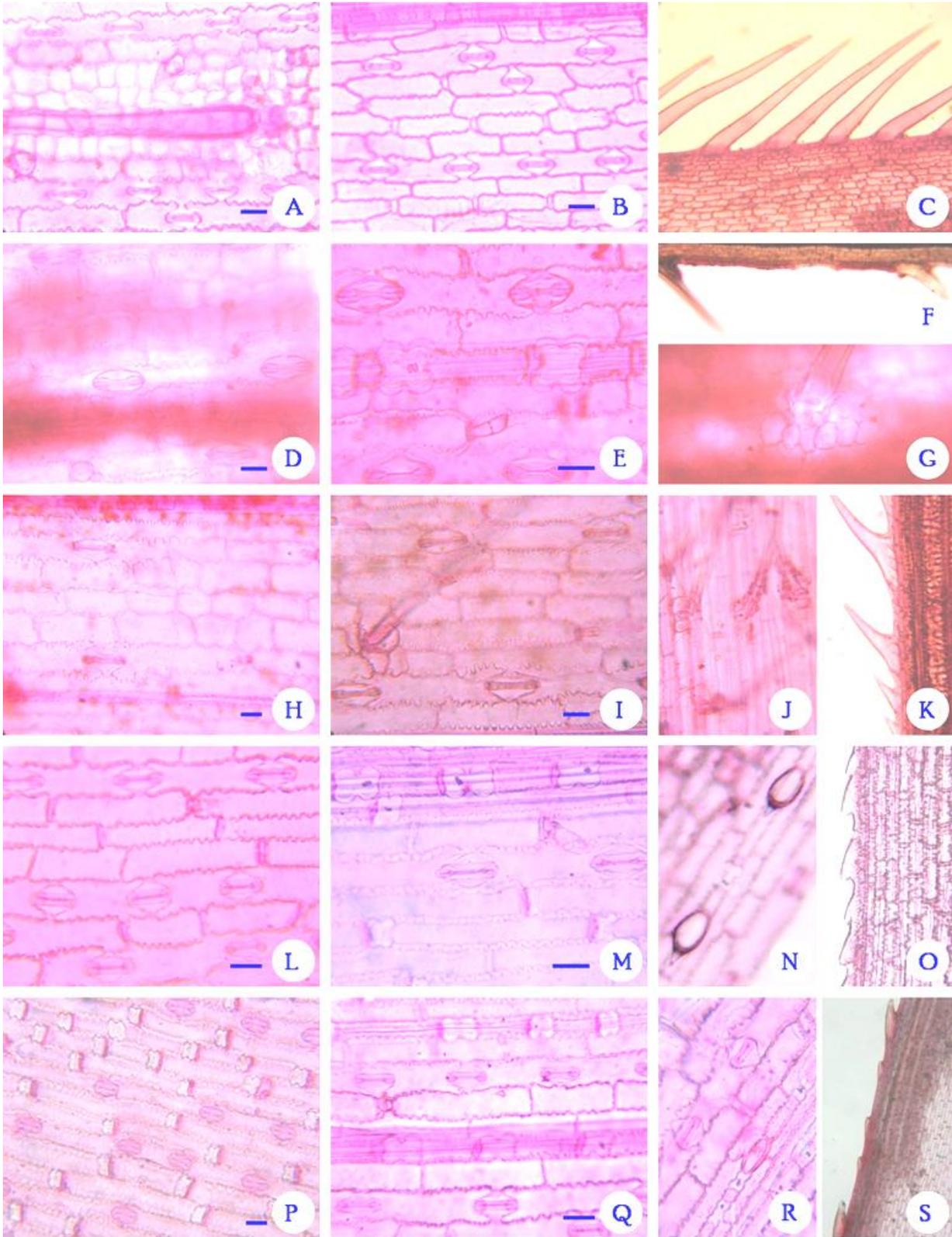


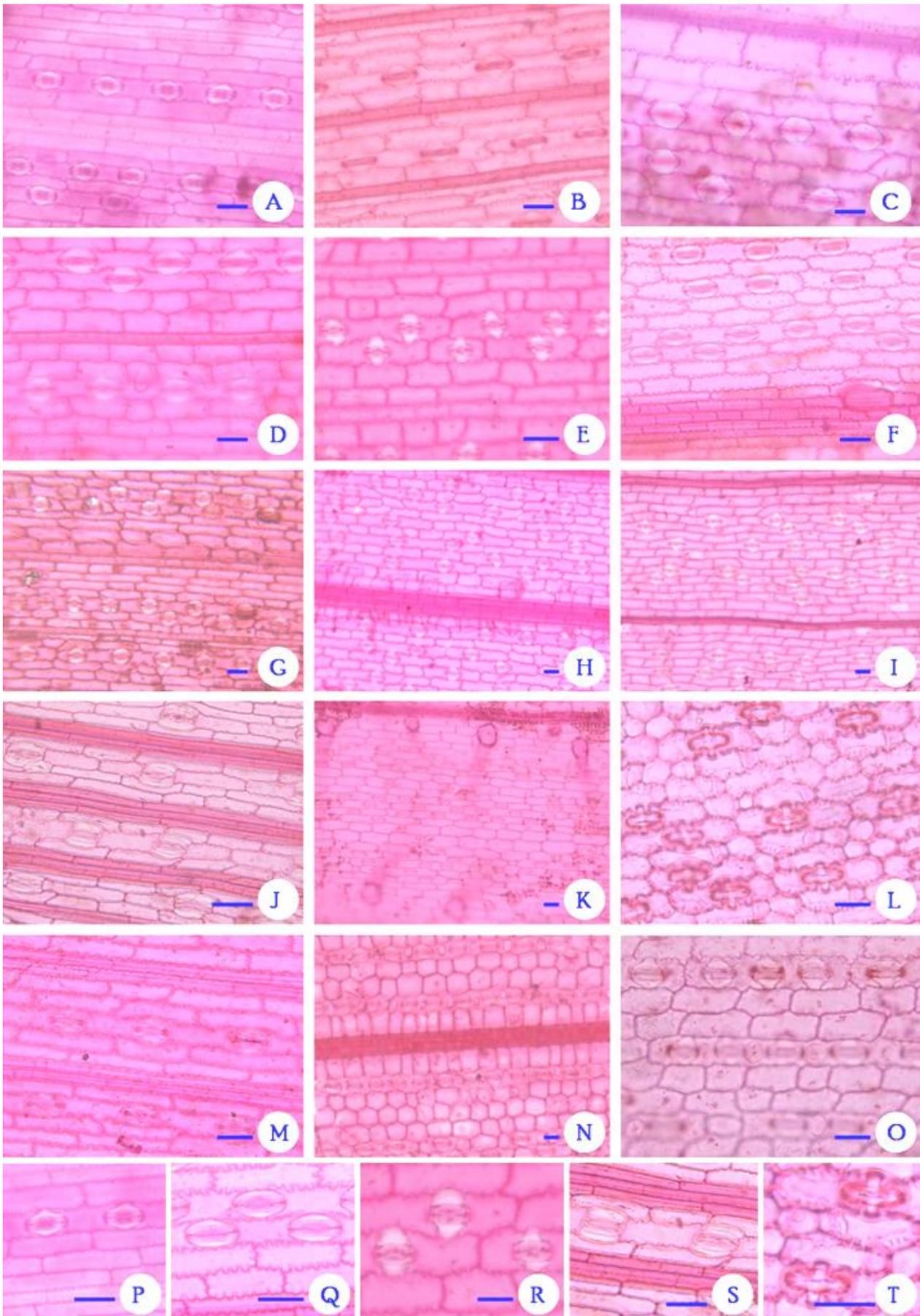


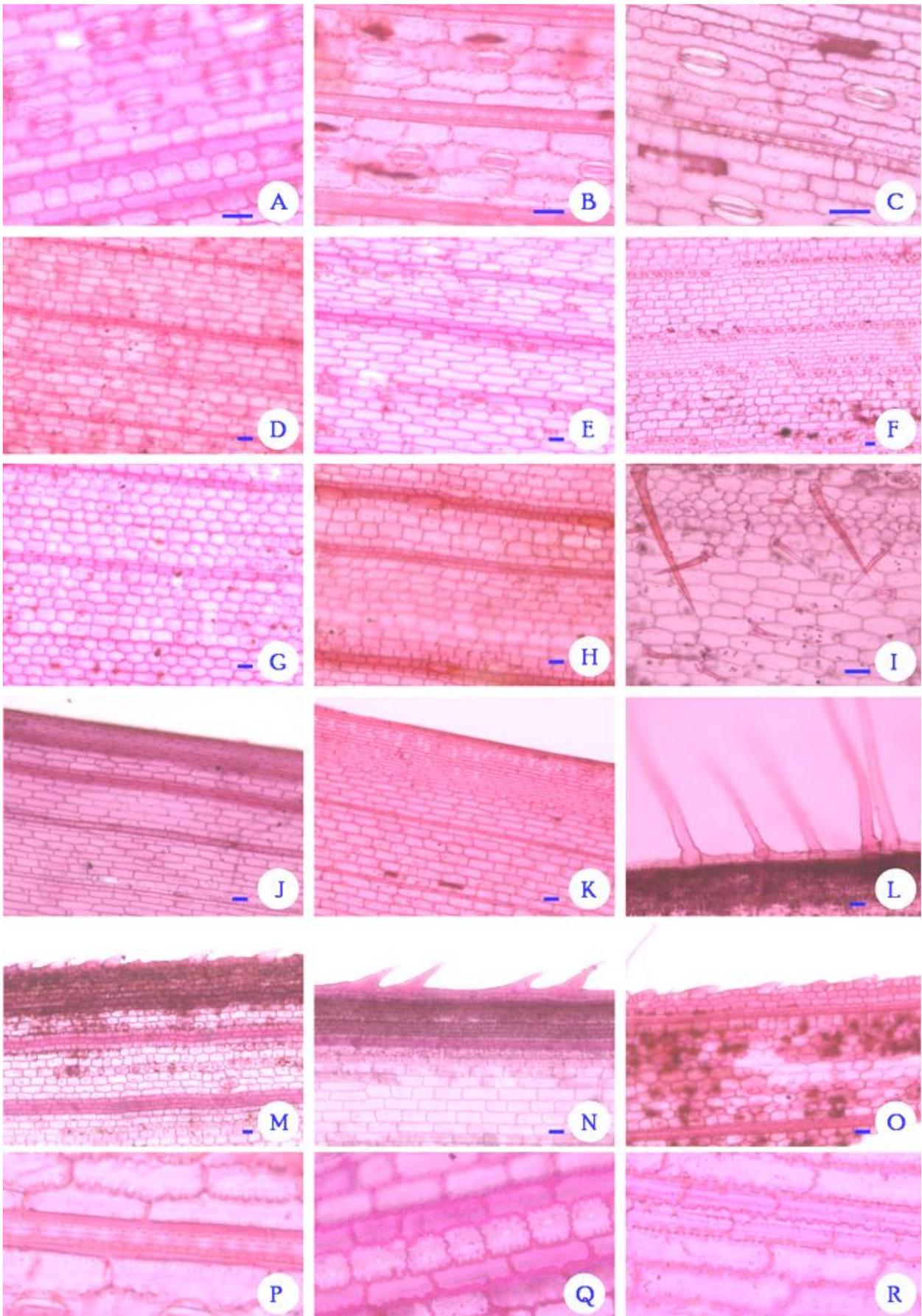


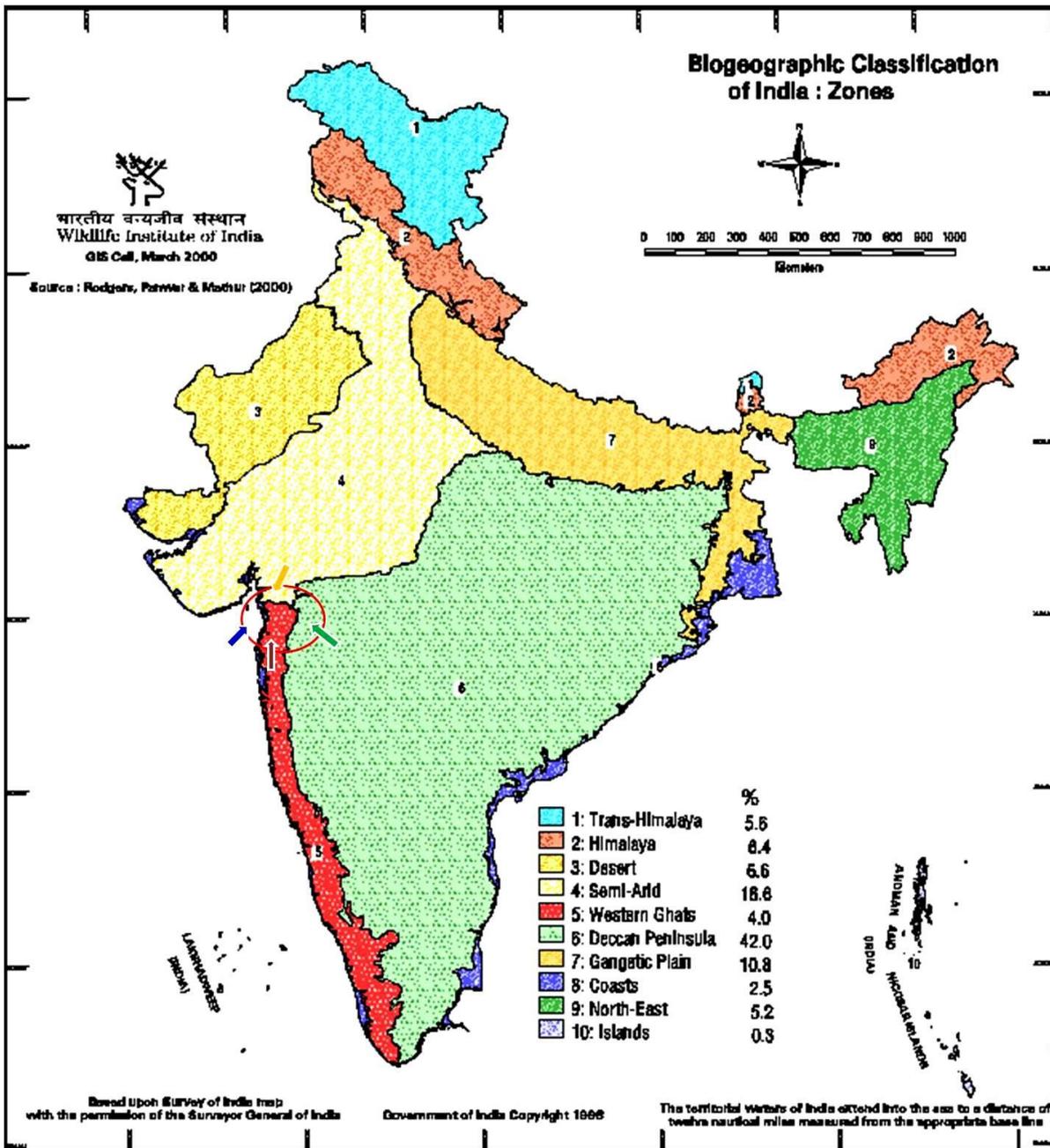






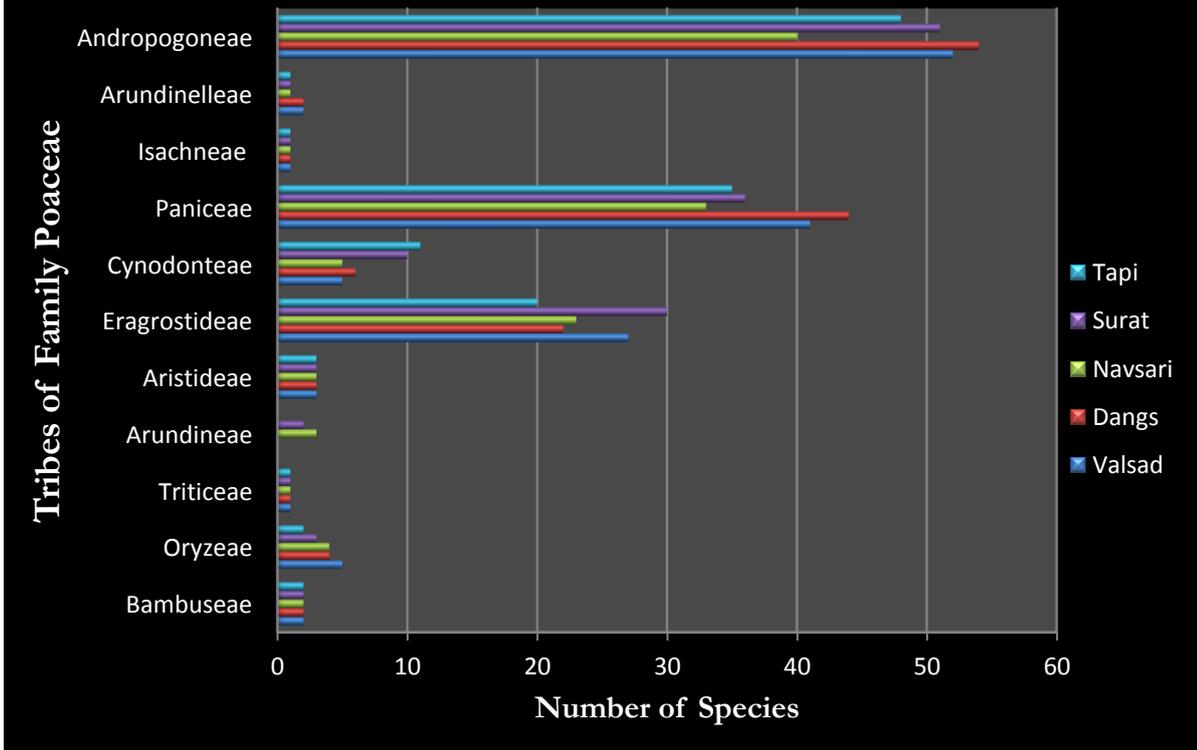




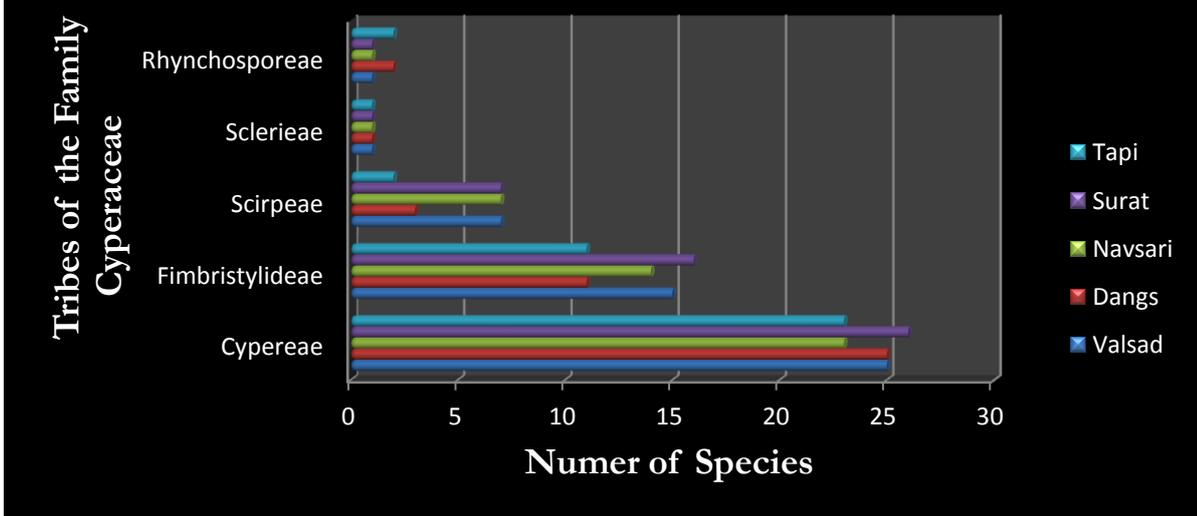


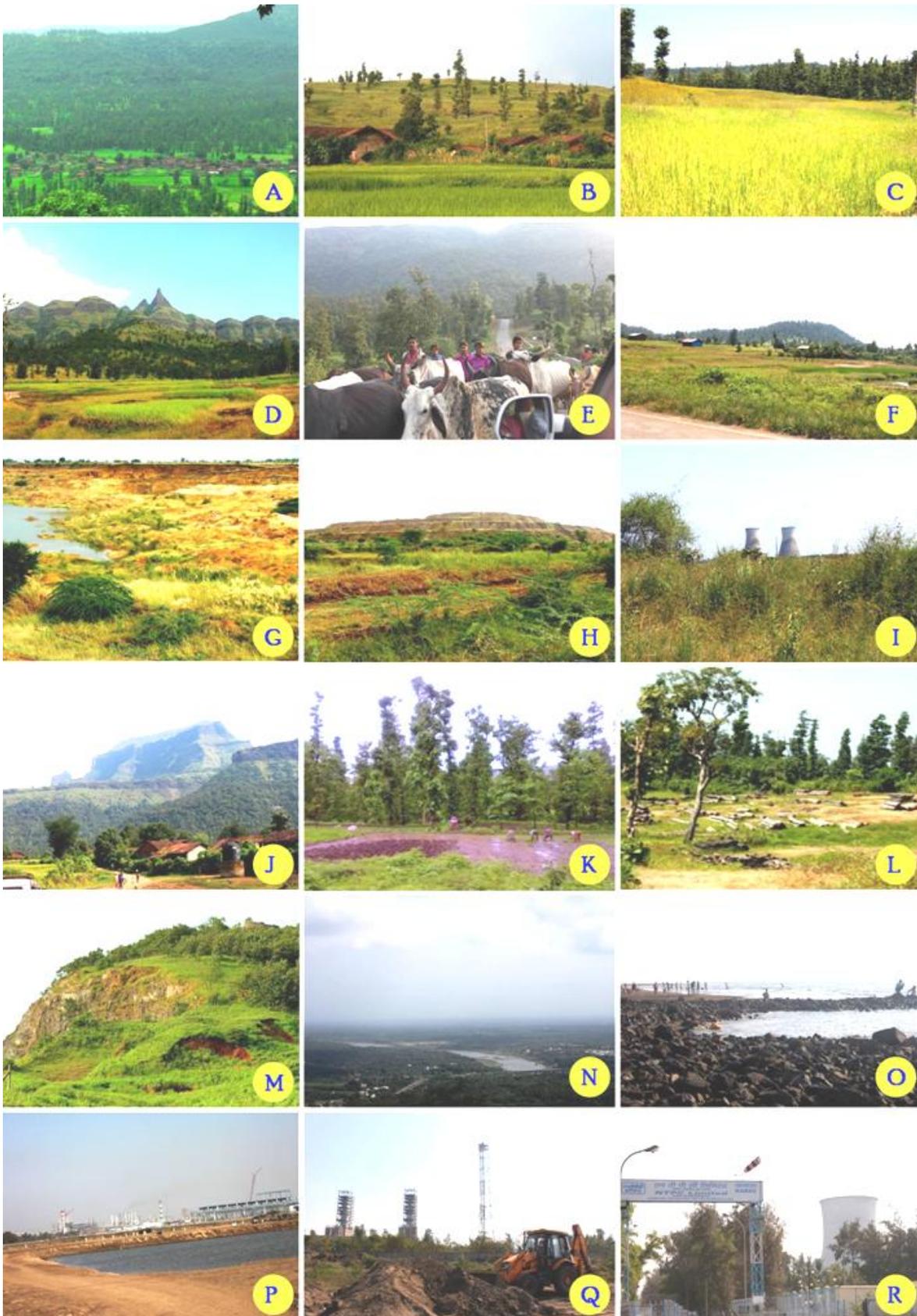
Biogeographical Map of India (After Rodger, Panwar & Mathur, 2000),
 Showing position of South Gujarat (in Red Circle)
 Arrows indicating influence of 4 different regions on study area

Distribution of Tribe members of Poaceae across the Districts



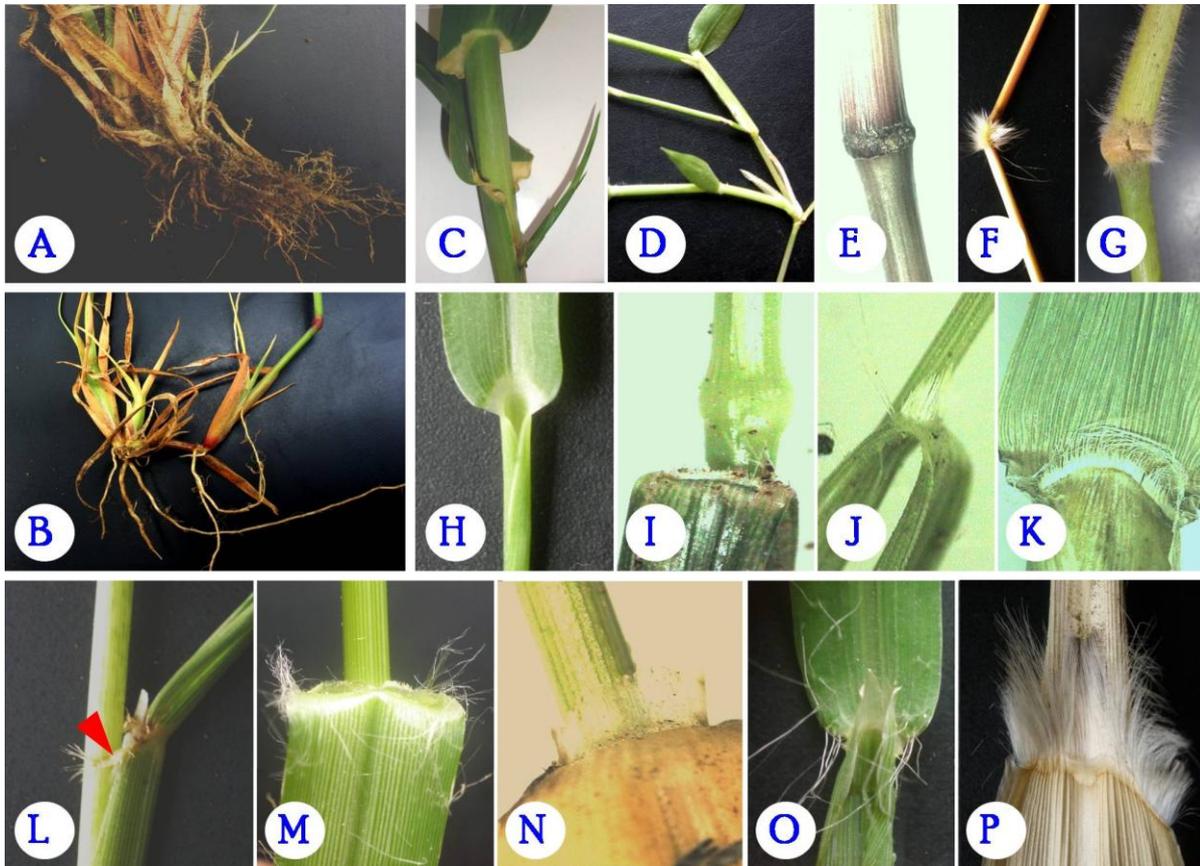
Distribution of Tribe members of Cyperaceae across the Districts



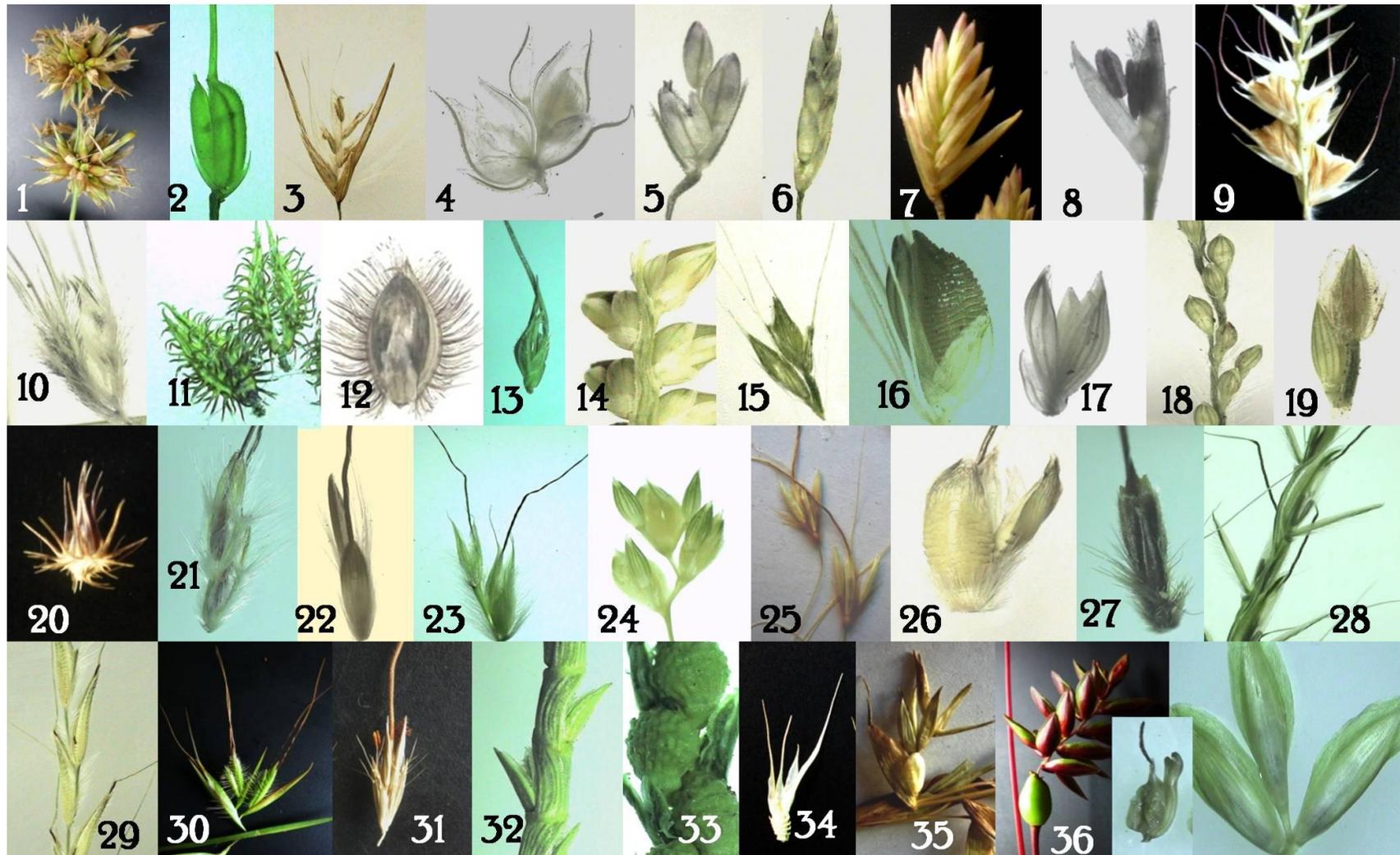


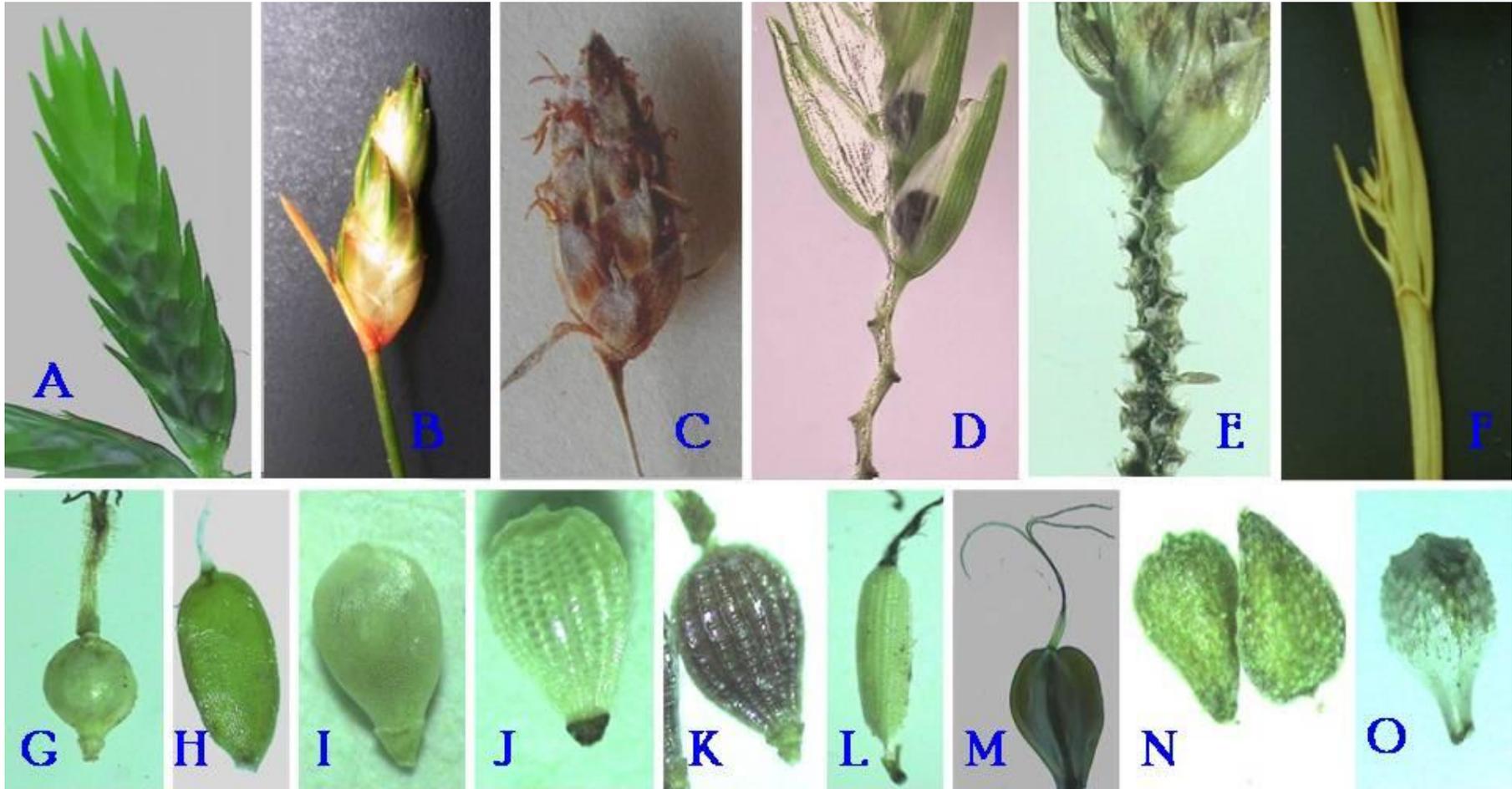
A-F: Deforestation and Expansion of Human habitation in Dangs; G-H: Mining sites at Mangrol, Surat; I : Atomic Power Station at Kakrapar, Surat; J-K: Habitat destruction & Raab Cultivation in Dangs; L: Deforestation in Tapi district; M: Cutting of Hillocks in

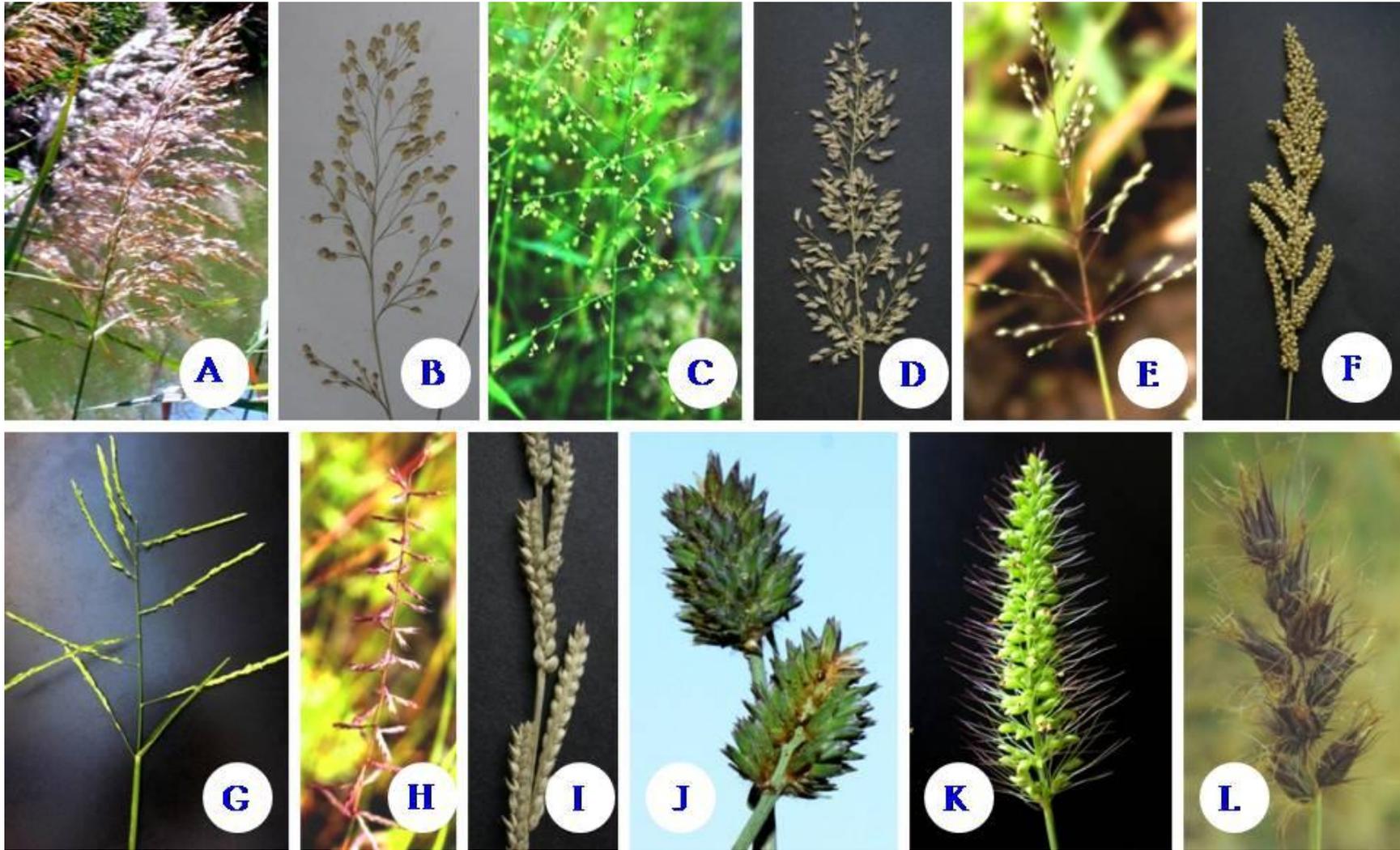
Valsad; N: Human habitation in Valsad; O-R: Habitat destruction at Hajira & Duman due to Industrialization and Anthropogenic activities.



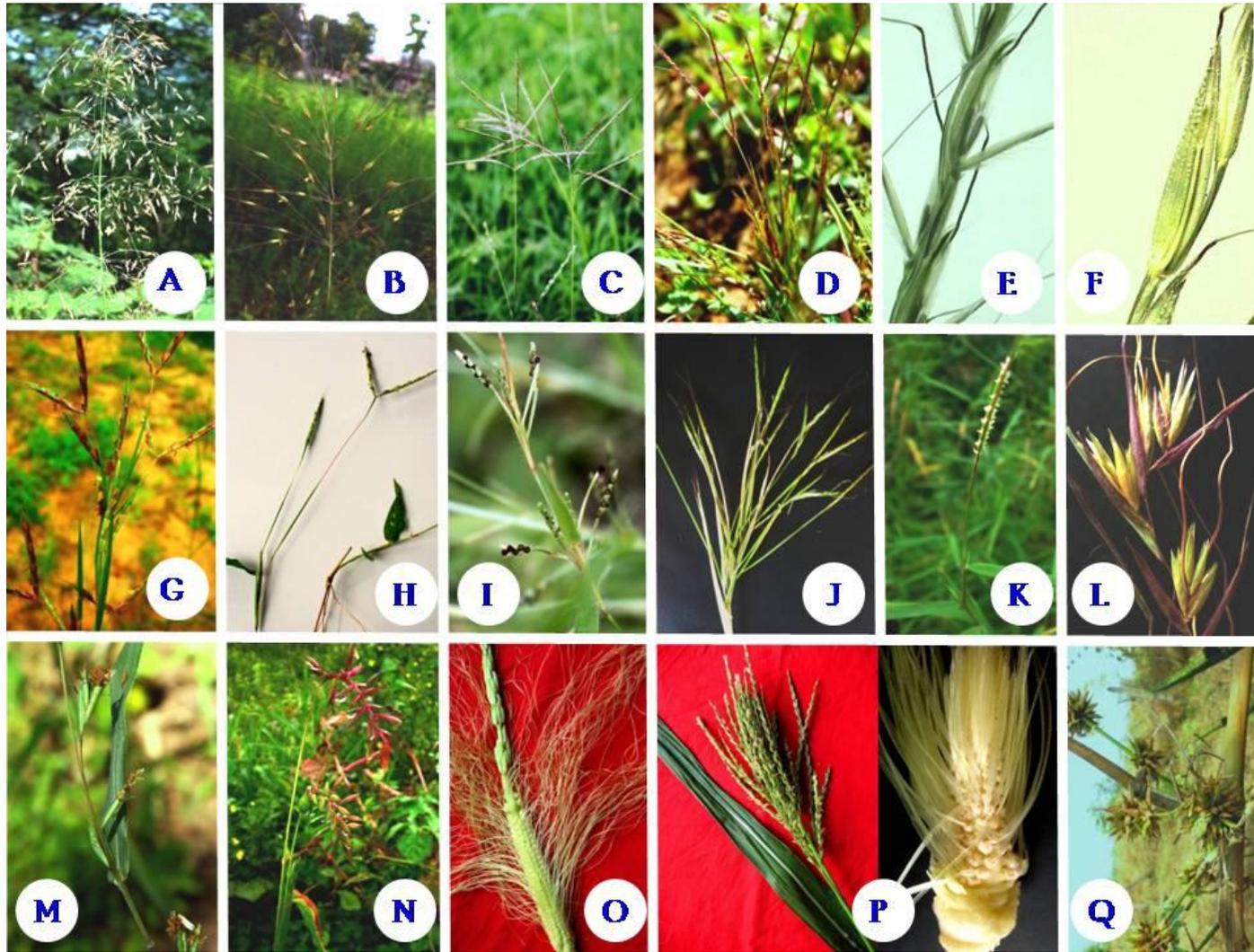
A. Tufted culm,
 B. Rhizomatous culm,
 C. Extravaginal shoot,
 D. Intravaginal shoot,
 E. Glabrous node,
 F. Villose node,
 G. Pilose node and leaf sheath;
H-P. Variations in Ligule, H. Ligule Absent, I:Rim of cilia, J. Pilose/Hairy, K. Long hairs,
 L. Membranous & arrow indicate auricles, M. Rim of small membrane, N. Truncate membrane, O. Long membrane, P: Small membrane with long hair



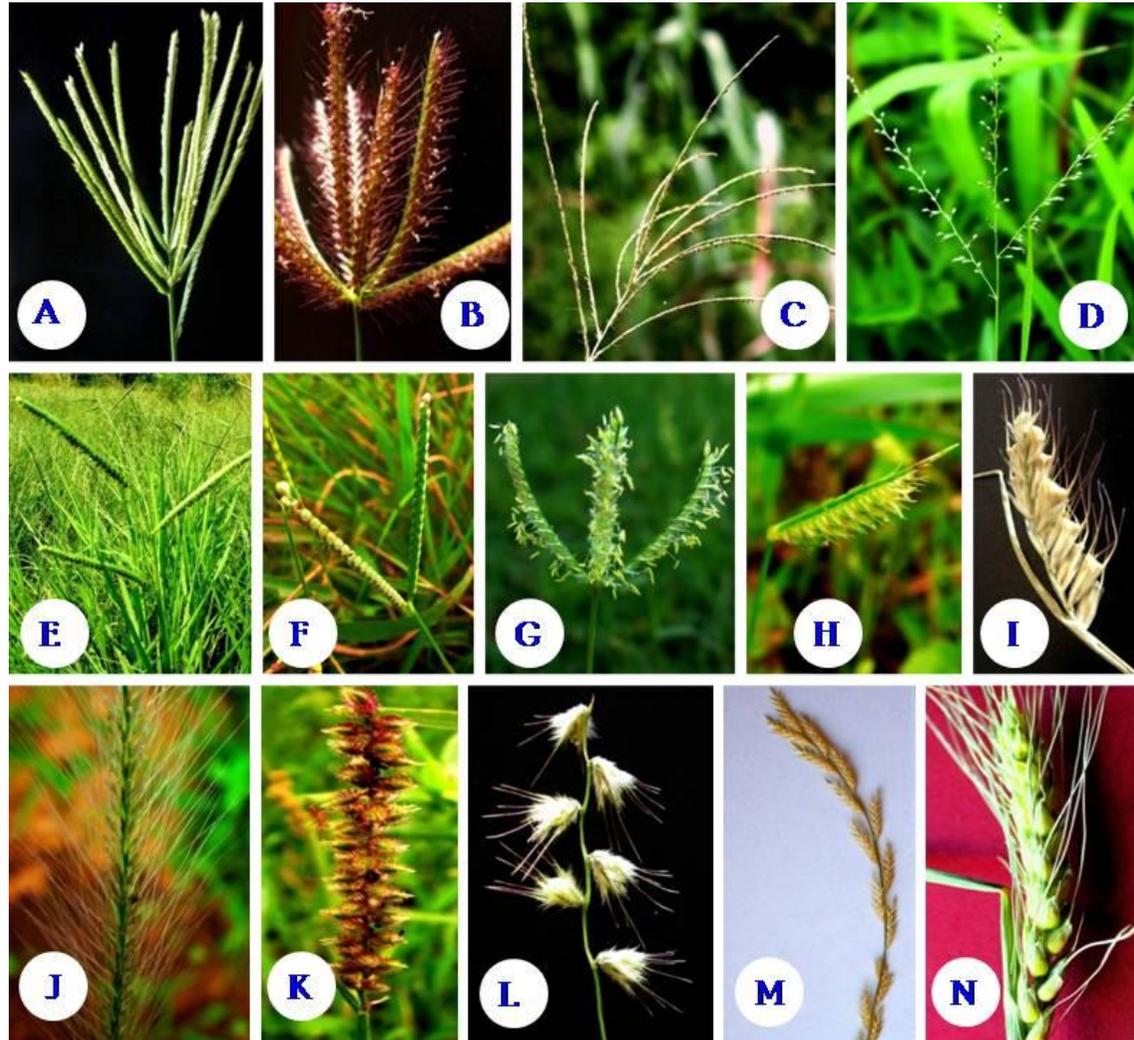




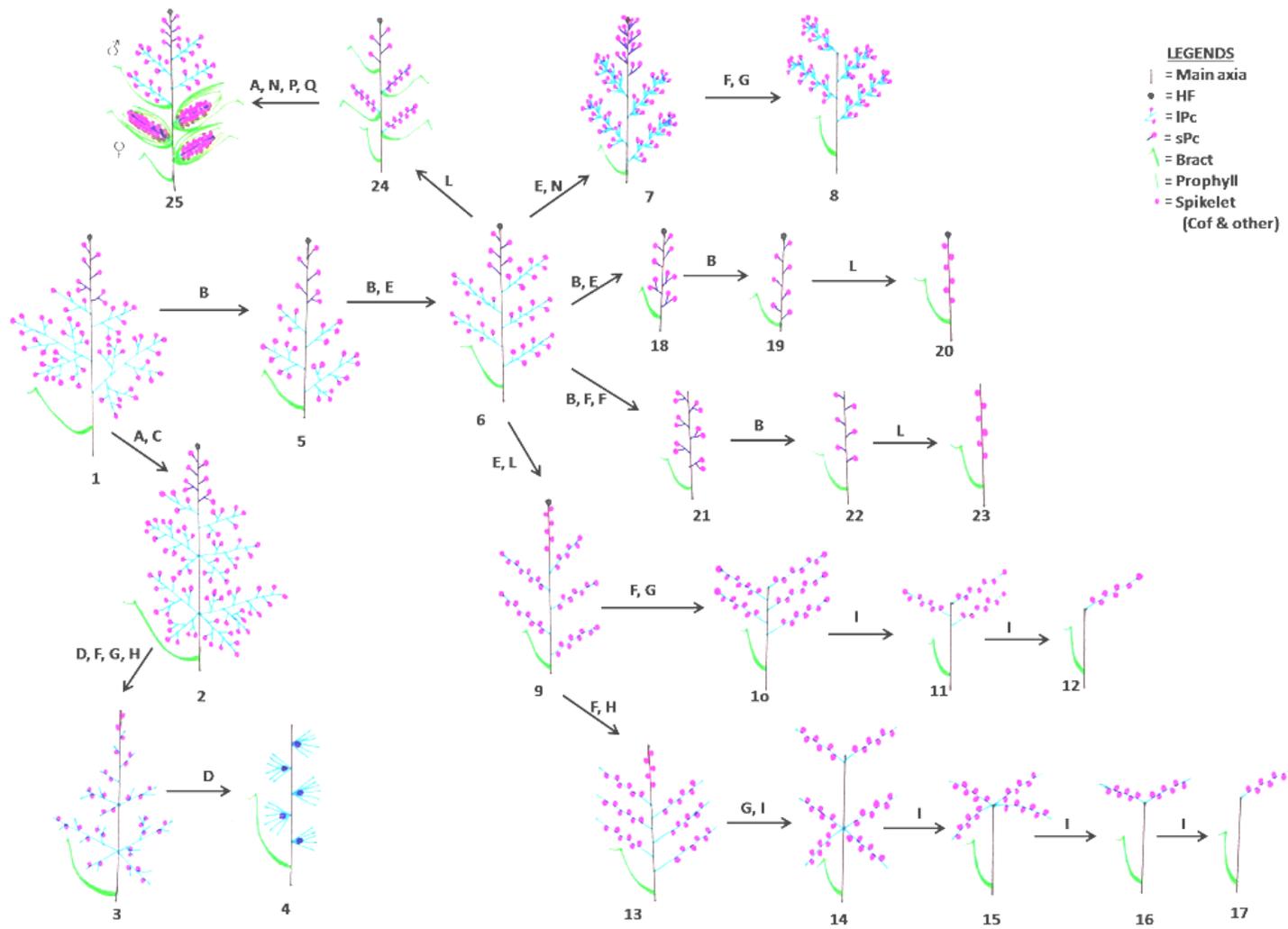
Synflorescence Types in Poaceae: Explanation in Text



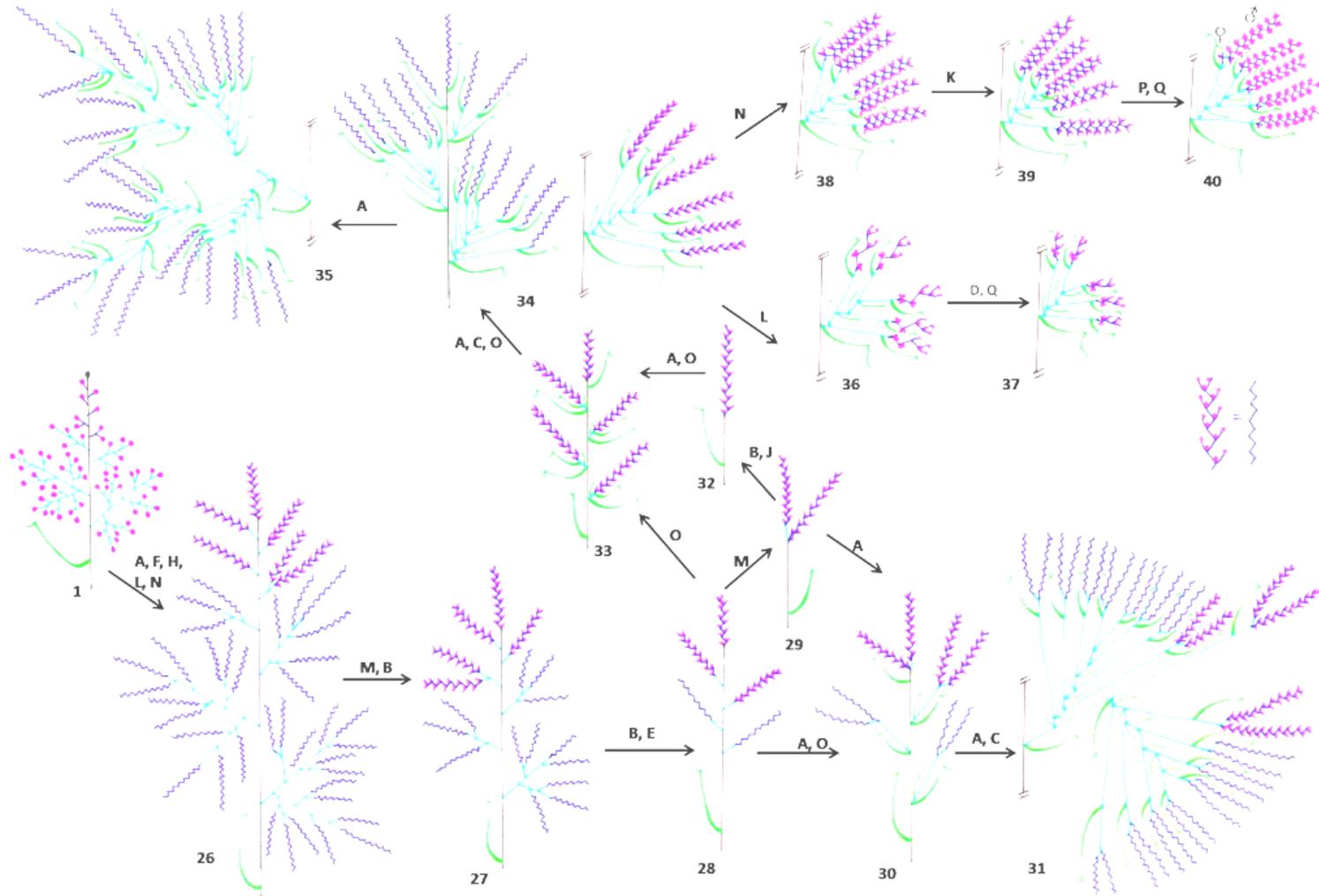
Synflorescence Types in Poaceae: Explanation in Text



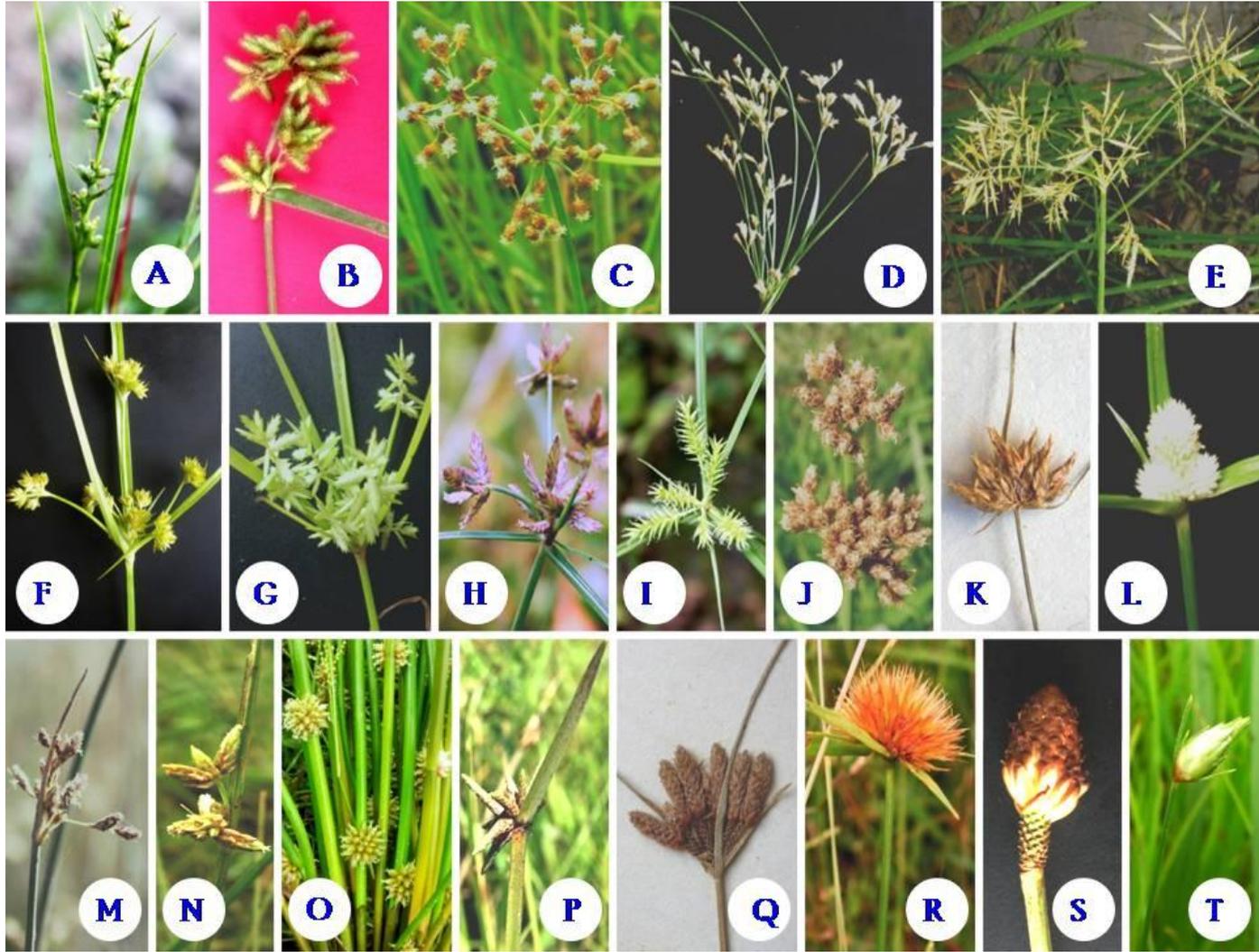
Synflorescence Types in Poaceae: Explanation in Text



Hypothetical Process responsible for Transition in Synflorescence structure in Poaceae: Explanation in Text



Hypothetical Process responsible for Transition in Synflorescence structure in Poaceae: Explanation in Text



Synflorescence Types in Cyperaceae: Explanation in Text

