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TAXONOMIC STUDIES IN CYPERACEAE

BY

ALFRED APAU OTENG-YEBOAH

THESIS PRESENTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

OF THE

UNIVERSITY OF EDINBURGH IN THE FACULTY OF SCIENCE

October 1972
ABSTRACT OF THESIS

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Degree: Ph.D. Date: October 1972

Title of Thesis: Taxonomic Studies in Cyperaceae

The thesis has been divided into 2 main parts.

Part I deals with the supra-specific classification of the subfamily Cyperoïdææ (excluding the tribe Rhynchosporaeæ) on a world-wide basis. It involves a broad survey of comparative exomorpho and endomorpho characters, with an analysis and synthesis of all available information from the literature. Many microscopic features of the leaf, culm, glume, hypogynous perianth bristle, stamen, style, stigma and fruit have been examined, many of them for the first time. Most of these features, together with the already known characters commonly used in the classification of genera in the subfamily Cyperoïdææ, have been employed to form the basis of the supra-specific classification presented here.

The two large Linnaean genera, viz: Soirpus and Cyperus, have been split into a number of small, natural genera. Four distinct taxa, previously included in Soirpus a.l., are for the first time accorded generic status, though formal generic names have not been given to 3 of these. These 3 unnamed genera have been temporarily called Genera A, B and C. Cyperus, in the restricted sense used here, is found still to be partly unnatural, but further studies are needed before attempting to change its circumscription.

Of the 47 genera adopted in this work, 25 are montypic and/or geographically restricted; the rest being widely distributed. The maximum concentration of species and genera is found to occur in the tropics.

Formal taxonomic treatments have been given to all the 47 genera in the conclusion, except for those genera which were not personally investigated; for the latter only keys for their identification and appropriate literature references have been given.

An informal tribal and subtribal grouping has been proposed to accommodate the narrower, more natural genera adopted, since the limits of the traditional tribes Cyperææ and Soirææ no longer stand.

New nomenclatural combinations made, as well as the list of species and citation of voucher specimens studied anatomically, have been given in Appendices.

Part II deals with the revision of the entire subfamily Cyperoïdææ as it is represented in the area covered by the Flora of Turkey (Davis 1965—). 47 species representing 21 genera are found in this area. This number includes taxa either seen by me or accepted from reliable records in the literature.

Descriptions, synonymy, habitats, specimen citations on a grid basis, notes on the variability of Turkish species, and a key for their identification have been included in this account.

Two new taxa have been discovered, for which English diagnoses have been given.

Finally, an attempt has been made to explain some of the apparent disjunctions in the distribution of certain species in Turkey.
DEDICATION

I wish to dedicate this thesis to my parents

Afua and Kofi of Ghana
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GENERAL INTRODUCTION

Preview to Parts I and II of thesis

The thesis has been divided into two Parts corresponding to the aims with the present taxonomic studies in the family Cyperaceae were undertaken.

Part I deals with the generic classifications in the tribes Scirpeae and Cyperaeae of the subfamily Cyperoideae, while Part II deals with the formal taxonomic revision of the entire subfamily Cyperoideae as represented in the Flora of Turkey area. It was in fact the generic problems arising in the revision of the Turkish Cyperaceae that led to the wide review of generic limits undertaken in Part I.

Revised morphological Terminology

Confusion over the usage of botanical terms has been a long standing problem for taxonomists. Reviews of terms used in the Cyperaceae by Holm (1929), Blaser (1944), Holitum (1948) etc. to mention only a few, show how subtle the problem is in the pursuit of taxonomic research.

The Cyperaceae is a family in which various terminologies have been applied to the same organs over the years. Except in very rare cases where the terms used have been given different meanings according to the interpretation attached to them, many different terms have been used by various authors to refer to organs which are apparently homologous throughout the family.

With this arbitrary usage of terms as a background, I felt it necessary to review some of these. A combined comparative morphological study and taxonomic revision, such as this one, could be intelligible only when there is a uniform application of terms. It was not possible to examine all the papers dealing with most of these terminologies; however, I have accepted or selected those terms of wide application. They are discussed below and their usage in this thesis made clear.
Rhizome: any horizontal or vertical subterranean stem bearing scale leaves and/or adventitious roots at its nodes.

Stolons, sometimes poorly delimited from rhizomes, refers to the lateral branches from the short, primary axis which are terminated (in Cyperaceae) by tubers, as in Cyperus esculentus.

Leaf sheath: the basal, often tubular part of the leaf, surrounding or partially surrounding the shoot/culm and attached to it at a node.

Orifice: the inner face apex of the frontal part of the leaf sheath resulting from the fused basal leaf margins (Fig. 1.B).

Ligule: the strap-shaped projection from the top of the leaf sheath, often overlying the base of the leaf blade (Fig. 1.C).

Leaf blade: the expanded or narrow external prolongation from the back of the sheath. The various types of leaf blade are discussed on p. 21.

Shoot/culm refers to the vertical or sometimes decumbent aerial or sometimes submersed stem which bears the leaves and crowned at the summit by the general inflorescence. The various forms are discussed in p. 18.

General inflorescence is used here to refer to the arrangement of the spikelets, the rays if present, and the involucral bracts. Adhering strictly to Rickett's (1944) review of the inflorescence, that "an inflorescence is a flower-bearing branch or system of branches", only the spikelets and rays in the Cyperaceae could be considered here without mention of the involucral bracts and the related tubular structures commonly called prophylls at the base of the rays. These last two structures are foliar morphologically and could find their place in the discussion of the whole plant under the vegetative organs, were it not for their relative positions. However, following Croizat (1943) whose conception of the inflorescence is rather wide, I regard these structures, together with the rays and spikelets, as composing the general inflorescence. This stand is taken in
order to elucidate the complexity of inflorescence forms in the Cyperaceae in a very strict morphological sense, thus avoiding phylogenetic speculation as much as possible.

Involucral bracts refer to the structures that subtend the inflorescence unit, be it in the primary, secondary or tertiary inflorescence axis. They are distinguished from the uppermost leaves in such genera as Fuirena and Scirpus whose axils often bear lateral inflorescences, in very rarely having sheathing bases. There are three distinct forms, viz: leaf-like, which appear like graminaceous leaves (e.g. in Scirpus s.s.); culm-like, appearing as a continuation of the culm (as in Schoenoplectus, Isolepis etc.); and glume-like, appearing as a glume at the base of the spikelet (as in Eleocharis etc.).

Prophyll is the term often indiscriminately used in the Cyperaceae to refer to (i) the sheath-like tubular organ surrounding the base of a shoot, and always placed dorsally, i.e. between the shoot and its parent axis, usually having two more or less equally developed main vascular bundles, each with its own keel (Wheeler Haines 1966); (ii) the sheath-like tubular organ surrounding the base of an inflorescence ray (Blaser 1944, Koyama 1961, W. Haines op. cit.); (iii) the glume-like empty organ following a reduced involucral bract in a sessile spikelet, especially in Cyperus (Blaser 1944, Koyama 1961, Kern 1962, W. Haines 1966); and (iv) the scaly more or less sack-like organs completely or partially surrounding the pistillate flowers of the subfamily Cariceoideae, commonly called utricles or perigynia (Koyama 1961). It has been shown from a morpho-anatomical study by Arber 1925, Blaser op. cit., Haines op. cit. that all these structures are homologous in that (i) they generally bear two very prominent vascular bundles, with or without lateral smaller bundles; (ii) each organ always encloses a bud which later develops either into a vegetative shoot, an inflorescence unit, a spikelet or a pistillate flower; which structure is produced depends upon its
relative position on the plant; (iii) they are always dorsally (adaxially) placed, i.e. between the parent axis and the organ they bear, the position being deduced from the two prominent vascular bundles which face towards the axis. The main differences between all these prophyllar structures therefore being, (i) their relative positions on the plant; (ii) the organs they surround and (iii) their ultimate external modifications.

In adopting the term prophyll in its general sense in the Cyperaceae, I have added some descriptive prefixes to it to qualify it further. Thus: (i) vegetative prophyll refers to the sheath-like tubular organs at the bases of vegetative shoots; (ii) ray prophyll refers to those surrounding the bases of rays; (iii) spicular prophyll refers to the glume-like organ following a reduced bract in the sessile spikelets of Cyperus s.l. and (iv) utricular prophyll in the sense of Koyama 1961, refers to scarious organs which completely or partially surrounds the pistillate flower in the subfamily Cariceoidae.

Rays: refer to the lateral branches from the main inflorescence axis. Depending on their position, they may be primary when they are direct off shoots from the primary axis; secondary when they branch off from the secondary inflorescence axis formed by the primary rays; tertiary when they branch from the tertiary inflorescence axis formed by the secondary rays etc. The primary ray may be confused with a lateral minor inflorescence axis which forms as a result of the division of the main inflorescence unit into major and minor units (cf. W. Haines 1966) and is commonly found in Scirpus, Fuirena etc. The distinction between a primary ray and a lateral inflorescence rests upon the basal subtending foliar structure, whether it has a long sheathing base or not (see under involucral bract p.vi.

Every ray is subtended at the base by an involucral bract, and their sizes and length are progressively reduced towards the summit.

Spikelet: refers to the ultimate cluster of flowers on a rachilla subtended by glumes.
Holttum (1948) and Koyama (1961) have reviewed the various forms of spikelets in the Cyperaceae.

Rachilla: refers to the main axis of the spikelet on which the flowers are borne.

Glumes: refer to the chaff-like, scarios, coriaceous or membranaceous structures that subtend single flowers in their axils, where they join the rachilla. The margins of the glume may be free as in most Cyperaceae, or united, thus completely or partially enclosing the flower as in Ascolepis.

Hypogynous perianth: refers to the reduced perianth of the Cyperaceae, often represented by bristles, hyaline, scales or petal-like plates. The various forms in each type are discussed in p. 98.

Fruit: is loosely used here to refer to the seed-bearing organ developed from the fertilized ovary. The fruit in the Cyperaceae is indehiscent and monospermous, with a dry or very rarely fleshy pericarp. It has often been referred to as an Achene, Nut, Nutlet or nucule. Unfortunately these names have had their widest application in certain families of the Dicotyledons, e.g. Achenes have been used for fruits in the Ranunculaceae and Compositae; Nut is universally applied to any indehiscent, 1-celled and 1-seeded hard and bony fruit, e.g. Corylus in Corylaceae; and nutlet or nucule have been used for the fruits of some members of Tubiflorae (Bicarpellatae) especially Boraginaceae and Labiatae. Nucule is also used in a very different sense in Characeae (Algae).

I considered it particularly dangerous to adopt the usage of any of these available fruit type names, for the fruit in the Cyperaceae, because there are some which are achene-like or nut-like, and others, especially in Cladium, Gahnia etc. which are drupaceous (cf. Marek 1958). I have therefore adopted the general term 'fruit' thereby avoiding misleading usages of a narrower term. The differences in external morphology and anatomy of the fruits in some members of Cyperaceae are discussed on p. 115 and it is hoped that on this basis more precise terminology would be considered in future work.
Internal structure: I have adopted the suggested terminology for the internal structure of the vegetative organs by Metcalf and Gregory 1964, Metcalf 1969, 1971. For the fruit wall (pericarp) anatomy, Marek (1958) and Esau (1965) have been followed as far as possible.

**GENERAL METHODS**

A. **External morphology:** The vegetative organs as well as the general inflorescence were studied by the use of a X10 hand lens. To study the structure of the spikelet, the spikelet was boiled in a crucible filled with water with a few drops of "Teepol" for about 10 minutes on an electric hot plate. It was then placed on a tile or a smooth surface, and using a binocular dissecting microscope and 2 fine needles, carefully dissected from bottom upwards. Having noted all important characters, such organs as glumes (usually one from the base and others from the middle part of the spikelet), young and matured flowers, matured hypogynous perianth segments etc. were picked up and mounted in 10% glycerine on a slide, covered with a cover slip, labelled and stored for further light microscopical details. Fruits were mounted on small cards, using an ordinary commercial "Gloy"; those to be investigated anatomically were stored in 70% ethyl alcohol or Formalin (F.A.A.) Acetic Acid Alcohol until they were needed.

B. **Internal morphology:**

Vegetative organs: The method used was contained in a handout from the Jodrell Laboratory, Kew, and is the same method described by Metcalf 1971. Specific areas of the organs were used, e.g. in culms the middle part of the internodes were taken; and in the leaves and involucral bracts the approximate middle regions were taken. The portions of material from herbarium specimens were boiled gently in water with 1-2 drops of Teepol until they had reverted to their natural shape and turgidity, and were placed in a beaker of cold water for a few minutes before being transferred to labelled bottles containing F.A.A. for a minimum
period of 48 hours. The portions of material from fresh specimens were thoroughly washed before being transferred into labelled bottles containing F.A. A. also for a minimum period of 48 hours to an indefinite time. After the F.A. A. the portions were washed in water for 6 hours and transferred to 70% alcohol.

Almost all the sections were cut free hand at 15-20 μ using 'Corrux' Ever-ready single-edged blades. The material to be sectioned was supported in pith which had been cut lengthwise with the material placed between the two halves. Some sections were also cut on a sledge microtome. The material, supported in pith or cork, was clamped very firmly lengthwise in the clamp of the microtome and orientated by the adjusting ratchets so that the material was correctly aligned for cutting the sections in the required plane. The material was now trimmed and after the clamp had been held just by adjusting the locking screw, sectioning started. The material was cut between 15 and 25 μ, and while the sectioning was in progress, the knife and material in the clamp were kept wet with 70% alcohol.

The sections were cleared in undiluted 'Parozone' (a commercial bleach) for 5-15 minutes before being transferred into water and washed in several changes of water to remove all traces of the 'Parozone'. The cleared and washed sections were then transferred to 50% alcohol for 5 minutes and finally placed in the staining mixture.

Two different staining procedures were used, viz: (i) over-night staining using a mixture of safranin and haematoxylin. This stain mixture was prepared by mixing 95 parts of 1% safranin in 50% alcohol with 5 parts of Delafield's haematoxylin. The mixture lasts for about a week (and fresh ones were prepared thereafter). The sections were put in watch glasses filled with the stain and left for about 10 hours or overnight. The following alcohol series were then used to destain and differentiate the tissues:

(a) 50% alcohol for a few minutes
(b) Acidified alcohol (made by adding a few drops of conc. HCl. in a solution of 50% alcohol) for a few minutes, depending on how fast the tissue differentiation takes place.

(c) 50% alcohol to remove the acid alcohol and stop its action

(d) 70% alcohol for 2-3 minutes

(e) 95% alcohol for 2-3 minutes

(f) Absolute alcohol for 5 minutes

After the alcohol series, the sections were then placed in xylene for 5 minutes and mounted in Canada Balsam or Clear mount.

(ii) **Safranin and Fast green stain after Johansen (1944):** The cleaned and washed sections from the 50% alcohol were placed in a 1% aqueous solution of Safranin for about 3 hours and then transferred to 50% alcohol, until differentiation occurred, and quickly dehydrated in 70%, 95% and Absolute alcohol series. The counter stain of Fast Green (prepared by making a nearly saturated solution in equal parts of methyl cellulose and absolute alcohol and adding enough of this solution to a mixture of 25 parts of Absolute alcohol and 75 parts clove oil) was then applied for up to 15 seconds. The sections were cleared quickly in a mixture of 50 parts clove oil, 25 parts absolute alcohol and 25 parts xylol. The sections were washed in xylol for a few seconds with 3-4 drops of absolute alcohol to remove moisture. Two more washes in pure xylol followed, and the sections were mounted in Canada Balsam.

C. **Surface view preparations of the Culm and Leaf epidermis:**

Portions of culm or leaf stored in F.A.A. were washed in water and transferred to 70% alcohol. They were then placed on a smooth hard surface, preferably a black-white tile, with the epidermis to be examined facing downwards. The material was then irrigated with undiluted commercial Parozone and the cells and tissues above the epidermis that were to be examined were gradually scraped away, using a
sharp blade. When most of the unwanted cells and tissues had been removed, the epidermis itself was cleared in Parozone and washed in water using a camel-hair brush to remove any cells that still adhered to the epidermis. The epidermis was then stained using the overnight staining schedule described above for permanent sections. For temporary mounts, fresh carboxylic acid solution was used, turning the silica bodies pink, and mounted in 10% glycerine.

D. Fruit: The following procedure was worked out by F. Richardson at the Jodrell Laboratory. The fruits already kept in F.A.A. or 70% alcohol for a minimum period of 16-24 hours, were now transferred into water for another 24 hours. From the water, the fruits were placed in polythene tubes filled with a 4% hydrofluoric acid (prepared by mixing 1 part of 40% hydrofluoric acid and 9 parts of water) and left for 16-48 hours, depending on the density or thickness of the fruit pericarp. The hydrofluoric acid was carefully decanted, and the fruits were rinsed in several changes of hot water to remove any traces of acid from the tissues or boiled gently for a few minutes. Sledge microtome sections were made in the same way as described above. The sections were cut at 15 μ and during the section cutting hot water, instead of 70% alcohol, was used to irrigate the knife and the material. The sections were mounted straight in 3% chloral without any staining procedures at all.

E. Diagrams and Plates: The outlines of most exomorphic and all endomorphic features were made using Wild and PZO, MNR-1 x10 camera lucidas.

1. Contractions used in Figures and Plates

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Fr. Fruit
G.C. Guard cell
G. T. Glume
Gyn. Gynophore
Hyp. Hypodermis
Hy.P.B. Hypogynous Perianth Bristle
I.A. Inflorescence axis
I.B. Involucral bract
I.R. Incrassate Rachilla
I.S. Inner Bundle Sheath
Meso. Mesocarp
M.S. Middle Bundle Sheath
O.S. Outer bundle sheath
PAL Palisade tissue
Pr. Prickle
Pr.H. Prickle hair
R.Pr. Ray Prophyll
S.B. Silica Body
SC Subsidiary cell
Secr.C. Secretory cell
Sp.Pr. Spicular prophyll
Spk. Spikelet
Sta. Stamen
St. Stoma
Sty. Style + Stigma
Subst.C. Sub stomatal cavity
TC Translucent cell
VB Vascular bundle

ii Key to the shadings in Anatomical Line drawing (after Metcalfe 1971)

Solenochyma
Parenchyma

Phloem
Xylem

Chlorenchyma
PART I
INTRODUCTION

A broad morphological survey of Asoolepis, Ficinia, Nelmesia and the taxa often included or associated with Scirpus s.l. (cf. Koyama 1958) and Cyperus s.l. (cf. Kukenthal 1936, Koyama 1961) has been undertaken, with the express aims of assessing their relationships and naturalness and establishing their limits and status.

The circumscriptions of Asoolepis, Ficinia and Nelmesia have never been particularly controversial, and so it was instructive to compare their overall characteristics with the disputed complex genera such as Scirpus s.l. and Cyperus s.l.

Since Linnaeus's time, classifications of Scirpus and Cyperus have varied over the years between numerous authors; and at present the exact limits and status of these two genera, which are the type genera of the tribes Scirpaceae and Cyperaceae respectively, are not sharply defined. Like other members of the family Cyperaceae, classifications of Scirpus and Cyperus have largely been based on the structure of the spikelet (including its associated organs such as glumes, hypogynous perianth segments etc.). The spikelet has been the basis of most controversy, because of its size and complexity of form, the parts having been interpreted in different ways by different authors. Such groups as Dichostylis, Anosporum, Androtrichum etc. have often been transferred between Scirpus s.l. and Cyperus s.l., while Remirea was considered to be in the tribe Rhynchospereae until lately (cf. Kern 1958).

History of the classifications in Scirpus s.l.

The controversy over the exact limits of Scirpus s.l. started from 1753 when Linnaeus circumscribed the genus, including in it 24 species grouped under 4 sections or subdivisions. His interpretation of the genus, separating it
from the other three genera which had delimited in the same work, viz: *Cyperus*, *Eriophorum* and *Schoenus*, was based on the spiral arrangement of glumes in the spikelet, each glume subtending a hermaphrodite flower, and the presence and absence of needle-like hypogynous bristles. Soon, some of the species were taken out to form the basis of such distinct genera as *Fimbriatula* (Vahl 1806) and *Eleocharis* (R. Brown 1810) mainly on the character of the swollen or thickened style base. As more and more material became available, especially from the tropics and subtropics, several distinct genera, such as *Fuirena* (Rottb. 1773), *Lipocarpha* (R. Brown 1818), *Ficiniea* (Schrader 1832), *Hemicarpha* (Nees 1834), *Ascolepis* (Steudel 1855) etc. were circumscribed as distinct from *Scirpus* though they were all believed to have spirally arranged glumes. *Fuirena* was circumscribed on the basis of the plate-like hypogynous perianth segments; *Lipocarpha* on the presence of two abaxial and adaxial hyaline scales surrounding the flower, *Ficinia* on the presence of a gynophore (in the form of a disc) at the base of the fruit, *Hemicarpha* on the presence of one adaxial hyaline scale surrounding the flower, and *Ascolepis* on the capitulum-like inflorescence and the incrassate glumes; all other taxa with spirally arranged glumes but lacking any of the above characteristics were subsequently assigned to *Scirpus*. *Scirpus* had by then become modified from Linnaeus's original concept though its exact limits were still difficult to establish, and it could not be keyed out without having first extracted the above distinct taxa. In other words it was a "dust-bin genus"!

Numerous authors such as Nees, Beauvois, Link, Palla, Persoon etc., soon observed the unnaturalness and complexity of the genus, and made several attempts to alter its concept by splitting from it various small genera. These included *Oxycaryum* (Nees 1842), *Trichophorum* (Persoon 1805), *Isolepis* (R. Br. 1810), *Blussiga* (Panzer 1824), *Elaeogiton* (Link 1827), *Holoschoenus* (Link 1827), *Nemum*
(Desv. 1825), Schoenoplectus (Palla 1888), Bolboschoenus (Palla 1905), Webasteria (Wright 1887), Desmoschoenus (Hook. f. 1853), Hallomithia (Steudel 1855), etc. on the basis of some vegetative characters combined with the floral characters. While some of these small genera have been accepted and adopted in various recent floristic works, especially in Europe and Russia, very many authors were still reluctant to accept them and continued to add many more new species to Scirpus s.l. The various classification systems proposed for Scirpus s.l. have largely come from this group of authors who still keep to a modified Linnean concept of Scirpus. These authors include Pax (1887), Clarke (1908), Beetle (1944) and Koyama (1958), and their treatments of Scirpus s.l. have been summarised in Table 1. It is evident from their works that they did recognise the distinctness of most of the small genera split from Scirpus, but because they were not willing to depart from the traditional original Linnean concept of the genus, they sunk them again in Scirpus, and assigned subgenus, sectional or series ranks to them.

Pax (op. cit.) made 2 subgenera and 10 sections. The subgenus Isolepis had 6 sections, viz: Nemum, Bleogiton, Eu-Isolepas, Holoschoenus, Desmoschoenus and Androcoma, while subgenus Eu-Scirpus had 4 sections, viz: Baeothryon, Schoenoplectus, Blysumus and Phylloscirpus. Pax's classification was based on the absence and presence of hypogynous bristles in subgenera Isolepis and Eu-Scirpus respectively, and it was not long before Fernald (1901) pointed out that this character in itself was insufficient even for the recognition of species.

Clarke (op. cit.) divided Scirpus into 10 sections, viz: Nemum, Monostechya, Isolepis, Eu-Scirpus, Blysumus, Seidlia, Micheliana, Microstylae, Desmoschoenus and Pseudo-schoenus. Clarke's classification was based on various characters such as the habit of the plants, the number of styles, the presence or absence of hypogynous perianth, the inflorescence, fruit and glumes. Though his sections were considered fairly reasonable, they included various unrelated species and
some of them have been transferred to other genera, while some of the species names were not valid.

Between 1908 and 1958, information from other fields of research became available, and some of it was incorporated into the subsequent classifications. Monoyer (1934) had discussed the investigations of various authors on vegetative anatomy and had himself studied the vascular system and leaf reduction in at least one species representing such taxa as Nemum, Eleogiton, Schoenoplectus, Oxyoaryum, Holoschoenus, Isoplepis, Trichophorum, Blysmus, Bolboschoenus etc. He made 4 groups in Scirpus s.l., based on the concept of gradual reduction in the vascular systems and leaves. He considered Scirpus sylvaticus as the least reduced and thus most near the ancestral stock, and from it derived the other three groups with reduced vascular system and leaves. Beetle (1940, 1944) considered this possible evolutionary trend in Scirpus, and considering the North American (and later South American) Scirpus, divided the genus into 2 subgenera, viz: Eu-Scirpus having foliaceous involucral bracts and well developed cauline leaves, and Aphyloides having erect non-foliaceous, culm-like involucral bracts and greatly reduced cauline leaves. Under the subgenus Eu-Scirpus, he recognised 6 sections, viz: Oxyoaryum, Monocephales, Reigera, Nemocharis, Androcoma, Trichophorum and under the subgenus Aphyloides 7 sections, viz: Baeothryon, Eleogiton, Isoplepis, Actaeogoton, Schoenoplectus, Pterolepis and Holoschoenus. He separated Blysmus from Scirpus s.l. and called it by its earliest name Nomochloa over which the name Blysmus is conserved (Int. Code of Botan. Nomen. 1966 p. 262). The classification systems of Monoyer and Beetle mark the beginning of evolutionary interpretation in the classification of Scirpus s.l.

Blaser's (1941) observations that the flowers of Fuirena and Dulichium do not fall in line with the synanthium theory, and also the fact that the incipient traces from the pedicel or flower stalk into the hypogynous bracts in Scirpus s.l.,
Fuirena, Eleocharis and Eriophorum are homologous, helped to consolidate the relationship between these four genera in the tribe Scirpeae, and a possible relationship to Dulichium in the tribe Dulichieae.

Blaser's revelations did not feature in any classification of *Scirpus* s.l. until Koyama (1958) made his historic classification. On the basis of the homology in the hypogynous bristles in Fuirena and Eriophorum to *Scirpus* s.l., these two distinct genera were for the first time sunk in *Scirpus* s.l.

To accommodate these distinct genera in *Scirpus*, Koyama divided the genus into 7 groups and 17 sections. The 7 groups and their sections were:

- **Group I** Isolepis (sect. Eleogeton, Actaeogoton, Isolepis, Holoschoenus)
- **Group II** Fuirena (sect. Vagnaria)
- **Group III** Blyamus (sect. Blyamus)
- **Group IV** Bolboschoenus (sect. Bolboschoenus, Actinoscirpus)
- **Group V** Scirpus (sect. Desmoschoenus, Micrahi, Oxyoaryum, Triophorum p.p., Scirpus)
- **Group VI** Baeothryon (sect. Baeothryon, Lachnophorum)
- **Group VII** Eriophorum (sect. Japonici, Vaginati).

Koyama argued his sinking of Eriophorum and Fuirena from the point of view of two species, viz: Eriophorum japonicum and Fuirena wallichiana respectively.

*E. japonicum* has 6 antrorsely scabrous filiform hypogynous bristles as in *Scirpus* s.s., e.g. *S. sylvaticus*, *S. lineatus*, but at the same time has a habit of *Eriophorum* s.s., e.g. *E. latifolium*, so that on the basis of the hypogynous bristles alone, this species draws all other members of Eriophorum into *Scirpus* s.l.

On the other hand, *Fuirena wallichiana* shows various states of transitional types from needle-like hypogynous bristles as in *Scirpus* s.l., e.g. *S. juncoidea* and in other *Fuirena* species, e.g. *F. striata* to petal-like plates as in *Fuirena* s.s., e.g. *F. squarrosea*, and therefore this species was considered a bridge between *Fuirena* and *Scirpus* s.l.
With his groups and sections established, Koyama began to speculate on the phylogeny of the hypogynous perianth segments and inflorescence types in his newly circumscribed *Scirpus*. Of the perianth segments, he considered 6 needle-like bristles to a fruit as the basic stock near a hypothetical 'Protoscirpus' and from it derived three tendencies: the first leading to silky, 6-8-(n)\_<b\> bristles to a fruit, through 6 filiform and antrorsely scabrous to a fruit; the second through less than 5 needle-like bristles to a fruit eventually to complete absence; and the third specially differentiating in shape into the petal-like plates. Of the inflorescence, he considered a panicle as the basic type, from which he derived three trends all leading to a single spikelet: the first trend passed through corymb and umbel; the second through corymb and head; and the third through a spike. Based on these tendencies, he produced a scheme to show the interrelationships among the groups and sections. His sections *Elymus*, *Desmochoeris*, *Oxyaeryx*, and *Micranthi* were doubtfully placed in his scheme because they did not wholly fall in line with the trends in the attributes he considered most important.

This classification of *Scirpus* s.l. is the most recent and it is no wonder that Kern (1962) made the following comment upon it, "the problem is not how to make Scirpus still more complex, but how to subdivide this already too heterogeneous group."

**History of the classification of Cyperus s.l.**

The basic concept of *Cyperus* has not changed much since it was circumscribed by Linnaeus in 1753. Of the 15 species originally assigned to *Cyperus*, only one (now called *Dulichium arundinaceum*) was found to be misplaced. The most common controversy in the classification of *Cyperus* s.l., until recently, was horizontal, i.e. to which ranks various authors wanted to assign the segregate groups. Some authors, e.g. Clarke (1908) preferred to separate out the segregate groups, such as *Kyllinga*, *Pycreus* etc. as distinct genera, while others, e.g. Kukenthal (1936), preferred a rather broader concept of the genus and kept the segregate groups at
subgeneric or sectional rank within it. Koyama's (1961) treatment of the genus was even broader than his predecessors like Kukenthal, sinking such distinct genera as *Lipocarpha* and *Remirea* in *Cyperus s.l.* for the first time. The relationship of *Lipocarpha* to *Cyperus s.l.* was assumed when the individual flowers enclosed by two hyaline scales at the interior and posterior positions were interpreted as forming a reduced spikelet. Koyama (op. cit.) thus derived the affinities of *Lipocarpha* through *Kyllinga* to *Cyperus s.l.* Similarly the relationship of *Remirea* to *Cyperus s.l.* was assumed when the incrassate organ enclosing the fruit at maturity was interpreted as representing the upper internode of the rachilla whose wings have become involute with an apex representing a vestigial uppermost glume whereas that of the two basal empty glumes the lower represented a spicular prophyll. As a result of this observation, the spikelet and inflorescence structure of *Remirea* were supposed to be similar to those of *Mariscous* (especially the one-flowered species) and Koyama (op. cit.) accordingly sank it in *Cyperus s.l.* as a section of his subgenus *Mariscous*. Previously, *Remirea* had been considered a member of the tribe *Rhynchosporae* (cf. Pax 1887, Kukenthal 1935). Classification of *Cyperus s.l.*, in which such groups as *Dichostyli*, *Lipocarpha*, *Remirea* etc. had been included, was made more complex by Koyama and McVaugh (1963) who further transferred the Mexican *Scirpus orbiculatus* into *Cyperus s.l.* This transfer was made on the basis of the occurrence of a strongly metamorphosed empty glume at the base of each spikelet, so that when a spikelet is removed from the short axis of the inflorescence, the empty scale is also removed together with the rachilla of the spikelet, but the bract of the spikelet which is setaceous and greenish remains on the axis of the inflorescence. This character had been Koyama's (1961) main point of differentiation between *Scirpus s.l.* and *Cyperus s.l.*
With these broad concepts of *Scirpus* s.l. and *Cyperus* s.l., the exact limits of the two genera became difficult to appreciate.

**Recent information from literature**

A fairly large amount of information has recently come to light since the various classifications of *Scirpus* s.l. and *Cyperus* s.l. were made.

Marek (1958), working on the fruit anatomy of some species of European genera in the family *Cyperaceae*, observed that the fruit anatomy of *Scirpus* s.l. was complex, and advocated the recognition of such groups as *Bolboschoenus*, *Schoenoplectus*, *Trichophorum* etc. as distinct genera. He also suggested the separation of *Blysmus rufus* from *Blysmus compressus*. His other conclusions were that the fruit of *Dichostylis* were similar to those of *Cyperus* s.l. and therefore the two should be classified together.

The embryological investigations by Van der Veken (1965) revealed that while every one of the genera whose species were investigated had only one type of embryo, *Scirpus* s.l. alone contained 6 different embryo types, with some of the segregate groups, such as *Desmoschoenus*, *Oxycaryum*, *Holoschoenus* etc., having variants from the type of embryo in *Cyperus* s.l. He therefore suggested that *Scirpus* s.l. be split - a conclusion which gives support to a narrower concept of *Scirpus* - and paved the way for more research into how *Scirpus* s.l. could be split into natural genera. Van der Veken's conclusion on *Cyperus* s.l. supported Kukenthal's and Koyama's broad concept of *Cyperus* because all the proposed segregate groups in *Cyperus* s.l. have the same embryo type. However, considering that such genera as *Ascolepis* and *Ficinia* as well as some of the segregate groups in *Scirpus* s.l. mentioned above have a similar embryo to those of *Cyperus* s.l., it certainly does not follow that our concept of *Cyperus* should be even wider to include these. So far as classification is concerned (as distinct from phylogenetic speculation) it seems best to treat the embryo types like any other character, and not to give them a priori weighting.
Metcalf’s (1971) comprehensive investigations into the vegetative anatomy, especially of Scirpus s.l. and Cyperus s.l., apart from reviewing the past and current results of various workers, has also provided us with more information and much food for thought about any future attempts to classify Scirpus s.l. and Cyperus s.l. Though Metcalf took a relatively broad concept of Scirpus (excluding Puirena, Eriophorum etc.) and made a narrow sampling of species, his results have a bearing on those observed on other fields of research such as those by Marek (op. cit.) and Van der Veken (op. cit.). With Cyperus s.l. he adopted the segregate groups such as Courtoisia, Marioua, Kyllinga, Pycreus etc. as distinct genera, and Cyperus s.s. was assigned to the species which have always been classified under the subgenus Cyperus proper (e.g. C. esculentus). Apart from observing that all the segregate groups, except some Cyperus spp. and Courtoisia, had inner parenchymatous bundle sheath, he also brought to light other complexities in the leaf sections, especially of some Marioua spp. and one species of Junoellus (J. serotinus) - the complexity in J. serotinus having been observed previously by Palla (1905) in the leaf sheaths, as the basis for his circumscription of the genus Duval-Jouvea. Other features such as the shape and structure of the leaf and culm in t.s., the nature of the chlorenchyma, the nature of the silica bodies on epidermal surfaces, the arrangement of the abaxial hypodermal sclerenchymatous tissues in the keel etc. were also very well investigated.

Observations of Schuyler (1967, 1971a, 1971b) on Scirpus s.l., Wheeler Haines (1966) on some African Cyperaceae, Wheeler Haines and K. Lye (1971) on Lipocarpha, Hemicarpha and Isolepis; K. Lye (1971) on Oxycaryum; Padhye (1966-67; 1971b) on pollen grains and embryo development in Kyllinga etc., have contributed immensely to our present knowledge of the two complex genera Cyperus s.l. and Scirpus s.l. as well as the other related genera.
Area of research

With this fairly rich background information coupled with the problems in the classification of *Scirpus* s.l. and *Cyperus* s.l., I have tried to find solutions for the deadlock. I have concentrated particularly on areas such as fruit and vegetative anatomy, as well as general inflorescences, external vegetative, floral and fruit morphology etc. for which the available information was more or less limited. This was to provide the links between the investigated and un-investigated taxa, especially in *Scirpus* s.l., and especially for those from the tropics and subtropics. Some of the uninvestigated species in *Scirpus* included *S. junghuhii*, *S. submersus* (*confleroides*), *S. nevadensis*, *S. membranae**s*, *S. inania*, *S. frondosus*, *S. oxyjulos* etc. Some of these taxa have fairly recently been circumscribed, (e.g. *S. junghuhii*, *S. oxyjulos*) and others are well known, but their real affinities have never been successfully established. Almost all available material on *Scirpus* s.l. as well as some of the other genera from all over the world, were investigated (see appendix for list). A few well known species of *Scirpus* s.l., viz: *S. giganteus* (from Argentina), *S. analo* and *S. coahuilensis* (from Mexico), *S. paniculato-corymbosus*, *S. petalotii* and *S. rosthornii* (from Indo-China & China), *S. ficinoides* and *S. burkei* (from South Africa) could not be investigated for lack of material and/or time. The isotype specimen of *S. paniculato-corymbosus* (see Pl. 1) was the only specimen seen. The South African *S. burkei* and *S. ficinoides* were seen, but too late to be included in the comparative accounts.

Genera in square brackets, e.g. [Volkiella], were not studied, but they were mentioned where necessary, and have also been keyed out in the conclusion.

Synopsis of the classification adopted in this work

The taxa that have been adopted as genera in this work have been tabulated alphabetically in Table 1. Their present status has been compared with the
Pl. 1 Isotype specimen of *Scirpus paniculato-corymbosus* Kükenthal (K!)
status assigned to them by the workers whose classification systems have largely been connected with the history of the classification of *Scirpus* s.l. and *Cyperus* s.l.

Four distinct taxa are for the first time accorded generic status, though formal generic names have not been given to 3 of these. The four monotypic genera proposed are as follows: Genus A is based on *Scirpus junghuhnii*, Genus B on *Blysmus rufus*, and Genus C on *Scirpus nevadensis*. *Pseudo-aquoenum* was a section in Clarke's (1908) classification of *Scirpus* and is based on *Scirpus imanis*.

The generic name *Websteria* has been wrongly treated by various authors such as Pfeiffer (1927), Koyama (1961) as a synonym of *Dulichium*, but here its original usage by Wright (1887) to refer to *Scirpus submersus* (correction later made by Britton 1888) has been adopted.

*Scirpus* s.s. now refers strictly to *Scirpus sylvaticus* and its allies. Species such as *S. giganteus*, *S. paniculato-corymbosus* etc. which were not considered in this study, have been recommended for further detailed study to establish their relationship with *Scirpus* s.s. Meanwhile, they have not been considered as members of *Scirpus* s.s.

The present status of *Cyperus* is restricted to the subgenus *Cyperus* proper (cf. Kukenthal 1936) excluding *Galilea* p.p. or subgenera *Pyrochrostachys* (excluding sect. *Conglomeratae* p.p.) and *Choristachys* (cf. Clarke 1908). In its present status, *Cyperus* s.s. is still complex, and it is recommended that a detailed study of all the groups, especially *Dichostylis* and *Anosporum*, be undertaken in future to confirm or disprove their supposed affinities. These are the groups which contain some species having spirally arranged glumes, and have at one time been regarded as members of *Scirpus* s.l.

The concept of *Eriophorum* is now restricted to the species having the same habit as *E. vaginatum*. This concept thus includes in *Eriophorum* such North American species as *Eriophorum virginicum* and *E. crinigerum*, and excludes
Eriophorum comosum, E. microstachyum and E. alpinum (species whose affinity with Eriophorum previously rested on the silky hypogynous bristles alone).

Eriocirpus has been adopted to accommodate E. comosum and E. microstachyum, as well as the relatively recently described E. scabriulus (Scirpus scabri-culmis) and E. transiens, all from Indo-China (Raymond 1957, 1960). The South African Scirpus falsus has also been transferred to Eriocirpus on the basis of over all similarities in habit, inflorescence and internal anatomy.

Trichophorum has strictly been assigned to E. alpinum and its closely related species like T. caespitosum etc. (excluding Scirpus cyperinus, and S. lineatus, all members of Scirpus s.s.). Included in Trichophorum are all the species from the Far East that belonged to the section Anthelophorum (Ohwi 1944), and also the two Andean species Scirpus atacamenais and Scirpus rigidus.

Isolepis has been restricted to the section Isolepis sensu Koyama, and includes all species closely related to Isolepis setacea and I. cernua.

Hymenochaeta refers only to Scirpus grossus, while Bolboschoenus strictly refers to species in Koyama's series Bolboschoenus of sect. Bolboschoenus. The species in Koyama's series Malacogeton are now regarded as members of Schoenoplectus.

Hemicarpha was left ill-defined and illegitimate following the transfer of type species H. isolepis to Lipocarpha (Haines 1971). However, Haines (op. cit.) has suggested the generic name Hemicarpha be conserved, with H. micrantha as the new type species. This suggestion has been taken up here, and the new genus Hemicarpha is now expanded to include 5 Old World species of Scirpus s.l., 4 of which having recently been studied by Raynal (1968), viz: Scirpus squarrosus, S. kernii, S. rehmanii, S. kystrix and S. brevicaulis. This consideration resulted from the occasional breakdown of the scale character that distinguishes Hemicarpha from Scirpus s.l. in Hemicarpha micrantha and its complete absence in H. sobomburgkii (cf. Friedland 1941). In the absence of this adaxial hyaline scale,
there is no difference between these two species of *Hemiarpha* and the above five Old World species of *Scirpus* s.l. on gross morphology.

*Juncellus* now refers strictly to the species in Kukenthal's *Cyperus* subgenus *Juncellus* sect. *Laevigati*, after *J. aerotinus* has been taken out to form Duval-Jouve.

With *Blysmus rufus* forming *Genus B, Blysmus* now contains only *Blysmus compressus*.

The remaining genera adopted remain unchanged or unaltered from their original circumscriptions. For the genera studied in this work, descriptions or diagnoses which embody, as far as possible, all available differential or diagnostic characters, have been given in the conclusion.

A small number of new index combinations have been made with their Latin descriptions deferred, due to lack of time. These new combinations are found in the Appendix.
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<th>GENERA ACCEPTED AND ADOPTED IN PRESENT WORK</th>
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<th>KUEHNERT 1936</th>
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<td>HELMUTHIA Steud. (1855)</td>
<td></td>
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<tr>
<td>HEMIGAERPA Nees (1834) emend.</td>
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<tr>
<td>HOLOTSCHONERUS Link (1827)</td>
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<tr>
<td>HYDOCHONERUS Beav. (1919)</td>
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<tr>
<td>ISOLEPIS R. Br. (1810) emend.</td>
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<tr>
<td>JUNCAELUS Clarke (1893) emend.</td>
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| - | - | - | - | - |

**TABLE 1** HISTORY OF CLASSIFICATIONS OF GENERA ADOPTED
### TABLE 1

<table>
<thead>
<tr>
<th>GENUS ACCEPTED AND ADOPTED IN PLEISANT WOOL</th>
<th>PAX 1887</th>
<th>CLARKE 1908</th>
<th>KUHNERTH 1956</th>
<th>KEYLE 1940, 1941, 1944, 1947</th>
<th>KOTYN 1958, 1961</th>
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<tr>
<td><strong>NATIOLIA</strong> Kothb. (1773)</td>
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<tr>
<td><strong>LIPOCARPA</strong> K. Br. (1816)</td>
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<tr>
<td><strong>MARISCUS</strong> Gaertn. (1788)</td>
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<tr>
<td><strong>NELISA</strong> Van der Veken (1955)</td>
<td>+</td>
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<tr>
<td>**NEWN Desv. ex Hamilton (1825) **</td>
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<tr>
<td><strong>CYPERUS</strong> Nees (1842)</td>
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<td><strong>QUEENSLANDIELLA</strong> Donin (1915)</td>
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<td><strong>REETERIA</strong> Auld. (1775)</td>
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<tr>
<td><strong>SCHONOPLECTUS</strong> (Riad.) Palla (1889)</td>
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<td><strong>SCIRPIUS</strong> L. (1753) emend.</td>
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<tr>
<td><strong>TORULINUM</strong> Beav. ex Hamilton (1925)</td>
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<tr>
<td><strong>TRICHOaoHORA</strong> Persoon (1905) emend.</td>
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<td><strong>GENUS B</strong></td>
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<td><strong>GENUS C</strong></td>
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**Key:**
- **subgen.** = subgenus
- **sect.** = section
- **series** = series
- **p.p.** = pro parte (in part)
- **+** = status of taxon unchanged
- **-** = not considered

### Notes:
- The table lists the genus names accepted and adopted in various works, along with the classification schemes used by different authors.
- The key at the bottom helps to distinguish between different taxonomic levels and changes in status.
CHAPTER II

CO'PARATIVE VEGETATIVE MORPHOLOGY

EXTERNAL MORPHOLOGY

GROWTH FORMS: Tufted or rhizomatous habits may be produced in different species and genera irrespective of the habitat in which they occur. In the most widely distributed genera such as *Isolania*, *Cyperus*, *Schoenoplectus* etc., it is very common to find both tufted and rhizomatous species. Tufted species normally have fibrous roots, and they may be predominantly annuals as in *Nelmesia* (Van der Venk 1955), *Hemicarpha* (Clarke 1901-2, Friedland 1941) etc.; or perennials as in *Trichophorum* (Clapham et al 1962, Komarov 1964) etc. The distinction between annuals and perennials on the basis of the habit alone is not sufficient, especially from herbarium sheets. Tufted annuals have no rhizomes, though tufted perennials are believed to have formed from horizontal rhizomes whose internodes are often suppressed (Rendle 1904, Jermy and Tutin 1968).

Most species and genera perennate through obvious rhizomes. There are two modes of branching systems, viz: *sympodial* in which the main axis is determinate, producing dense or loose tufts, tussocks or sometimes solitary shoots; and *monopodial* in which the main axis is indeterminate and often only solitary shoots are produced at regular intervals (Jermy and Tutin op. cit.). These two types of growth form are easily distinguished in the field but in the herbarium they must be cautiously scrutinised since the true nature of the branching is often obscured in mature rootstocks, and sometimes the rootstocks are not collected. Apart from these horizontal rhizomes which may be sympodial or monopodial, there are ascending rhizomes observed in a few genera, e.g. *Phyllosorus*, *Genus C.*, *Remirea* and *Galilea*. In *Phyllosorus*, *Remirea* and *Galilea* where a solitary shoot is produced with the leaves crowded at the base in a rosette fashion;
the ascending rhizome is sometimes very short and indistinct. In *Carna c.*, several shoots are produced in a loose tuft, and the ascending rhizome is often long and quite distinct.

**Habitat preferences and Life Form**

The majority of species and genera are water-loving, and occur in various habitats in which the water supply is relatively regular. However, there are a number of genera which contain some species adapted to survive in relatively dry conditions. *Cyperus* and especially *Carex* are examples. Any attempt to assign definite examples from genera to life forms initially classified by Raunkiaer and later adopted with slight modifications by Braun-Blanquet (1932) and Clapham et al (1962) has met with extreme difficulty. Dealing with herbarium specimens which often bear little or no information on the plant-soil relationships, it is often impossible to tell the position of the resting bud or the persistent stem apex relative to the soil level.

**Seedling development:** Apart from perennating to continue their life cycle, almost all genera reproduce by setting viable seeds. The percentage seedling germination has been found to be high enough, 60-90% (Walters 1949, Phillips 1954, Sparkling 1968) to contribute significantly to the propagation of most of the genera, especially of annuals. Whether the young shoot developed from a vegetative bud in the axil of a rhizome scale; from the axil of a leaf or from a seed, the first sheath that protects the bud during its development is the vegetative prophyll (cf. Arber 1925, Haines 1966, Randle 1904).

Seedling development from the seed has been followed by Klebs (1885) Walters (op. cit.), Phillips (op. cit.), Sparkling (op. cit.) etc., and it is found to be uniform in all the genera in *Cyperaceae*. The germination process resembles that of *Palm*ae (*Arecaceae*) and *Liliaceae* and differs from that of *Gramineae* (Randle op. cit.) The lower end of the embryo is occupied by the
radicle without any marked root-sheath, the upper end by the cotyledon, the
sheath of which is well-developed, enclosing the plumule. At first the cotyl-
edon alone grows, the sheath elongates, breaks through the testa, and bends
upwards. A circle of hairs is formed at the base of the sheath by which the
seedling becomes attached to the ground. The middle portion of the cotyledon
then grows rapidly and pulls the main root out of the seed. The primary
root elongates, and meanwhile the first leaf pushes through at the apex of the
sheath. The end of the cotyledon which remains in the seed swells and forms
a sucker, which after absorbing all the endosperm, almost fills the interior.

The SHOOT/CULM: The shoot is differentiated into two parts; viz: the
proximal leafy part with nodes and internodes, the internodes often elongated;
and distal non-leafy part which is nodeless and bears the inflorescence at its
summit. Genera in which the leafy part is relatively longer than the non-leafy
part, and the internodes conspicuous and very well elongated include Scirpus,
Fuirena, Eriophorum and Genus A. In Bolboschoenus, Eleagnus and Genus B,
the internodes are sometimes concealed in the leaf sheath, and very often the
non-leafy part is longer than the leafy part. In Eleogiton and Webateria
the leafy part is several times longer and is much branched. The length of
the internodes are often equal to the length of the axillary non-leafy part.
In some genera the leafy part is very short, with internodes compressed and
concealed in leaf sheaths, and the non-leafy part is several times longer.
Examples include Schoenoplectus, Isoelepis, Eriocirpus, Nalmasie, Namum,
Hemicarpha, Cyperus, Kyllinga, Lipocarpha, Desmoschoenus, Hymanoxbaeta, Ficinia,
Holoschoenus, Hallmuthia, Oxyocaryum, Mariscus, Juncellus, Duval-Jouvea, Helilea,
Androtrichium, Genus C etc. In Remirea and Phylloscorpus, the leafy part is
often well developed, though its internodes are compressed, while the non-leafy
part is often not well developed, very short, especially when the plant is
young and the inflorescence is not well developed.

Size: Most genera have slender or robust shoots, measuring 2.0 mm to 5.0 mm diameter, while others, especially *Isocoleia*, *Eleogiton*, *Trichophorum*, *Websteria*, *Nelmesia*, *Nemum*, *Juncellus*, most *Ericaerpus* spp., some *Schoenoplectus* spp., some *Lipocarpha* spp., some *Ascolepis* spp., some *Ficinia* spp., and some *Cyperus* spp. have setaceous, filiform or wiry shoots, which often measure less than 2.0 mm diameter.

The LEAF

Position and Phyllotaxy: Corresponding to the arrangement of the nodes and the nature of the internodes in the proximal leafy part of the shoot, the leaves may be cauline and sub-basal as in *Scirpus*, or sub-basal as in *Cyperus*, or basal as in *Holoschoenus*. In *Eleogiton* and *Websteria* the leaf distribution is quite peculiar in that they occur along the whole length of the much branched and floating shoot, and most of the terminal ones sheath the bases of the axillary non-leafy part of the shoot. The normal phyllotaxy is tristichous, but in *Remirea*, *Phylloscirus* and most other genera with tufted and basal leaves, the number forming a 'whorl' appears to have been multiplied, and the leaves produce a rosette-like appearance.

Leaf sheath: Often in genera with basal or sub-basal leaves, especially *Holoschoenus*, *Oxyoaryum*, *Lipocarpha*, *Phylloscirus*, *Cyperus*, *Desmoschoenus* etc. the sheaths split during the development of the shoot, so that they are open (Fig. 1.A); while in the genera with cauline leaves the sheaths are always closed (Fig. 1.B). The orifice or "inner face apex" of the closed sheaths may be in one of several as illustrated in Fig. 1.B. The distribution of all these different orifice types is widespread. Within a particular genus, especially *Scirpus*, all the various types may be found among specimens of a single species.
A  Types of margins of Open Sheath

fibrous  smooth scarious  smooth membranous

B  Shapes of Orifice of Closed Sheaths

notched  deeply notched  Concave  truncate/straight  lingulate

C  Shapes of Ligules

triangular-lanceolate  Obtuse  rounded  truncate/straight  reflex  tubular/cylindrical

Fig 1  Leaf Sheath and Ligule

(B 3-5  C 2-4,6  after Jermy & Tatin 1968)
Ligule: Ligules have been found in only *Soirpus, Trichophorum, Genus A*, *Fuirena, Eriophorum, Elymus, Genus B, Ficinia* and *Genus C*. The various shapes observed are illustrated in Fig. 1.C. *Fuirena* stands out from the rest in showing the tubular form. The other genera show variations from triangular-lanceolate, acute, triangular obtuse, rounded, truncate or retuse ligules in their various species.

Leaf blade: Apart from *Androtrichium, Schoenoplectus*, especially subgenera *Schoenoplectus* and *Actaeogoton, Pseudo-schoenus, Fuirena* subgenus *Vaginaria*, *Ficinia* especially *F. aphylla* and *Holoschoenus* especially *H. dioecus, H. nodosus* and *H. thumbergianus*, which often have no leaf blades, or only a short muco; the other genera have leaf blades which are often linear, tapering towards the tip. The leaf blades are of three different kinds depending on the relative size and shape, the occurrence of a conspicuous midrib region, and the structure of the adaxial surface. Most often, the kind of leaf blade correlates with the kind of involucral bract found in the same genus. The *graminaceous* kind of leaf blade resembles that found in the *Gramineae*, showing a distinct midrib with a well expanded lamina which may be flat, flanged, inversely W-shaped, plicate or inrolled. This kind of blade is found in *Soirpus, Cyperus, Bolboschoenus, Eriophorum, Genus A, Fuirena, Hymenochaeta, Elymus, Oxycaryum, Pyroes, Duval-Jouvea, Mariscaus, Kyllinga, Remira* etc. The channelled or canalicate kind has a distinct midrib, the abaxial surface is often rounded off, smooth or sulcate, and the adaxial surface is widely or narrowly concave, deeply or shallowly channelled and the lamina is often not well expanded as in the *graminaceous* type. Examples of genera with this kind of blade include *Desmoschoenus, Genus B, Genus C, Hellmuthia, Holoschoenus, Phylloscorpus, Lipocarpha, Ascolepis, Eriocirpus* spp., *Ficinia* spp., *Galilea, Juncellus* etc.
The acuteous kind of leaf blade is very narrow and wiry, and may or may not show a distinct midrib. The lamina is often very much reduced. Examples include Isolepis, Eleogiton, Websteria, Trichophorum, Ficinia spp., Nemum, Nelmosia, Hemicarpha, Eriocirpus spp.
INTERNAL MORPHOLOGY

THE ROOT

Roots in different genera and species vary in length, thickness and fleshiness (the extent to which they are flabby). The primary root is of short duration, and replaced by the secondary fibrous or spongy roots. These secondary roots may bear root hairs, especially when young, which are derived from the fibrous cells of the exodermis (Metcalfe 1971), or bear lateral roots which are derived from the rhizogenous pericambium situated just within the endodermal sheath (Van Tieghem & Douliet 1888, De Bary 1884, Klinge 1879, Plowman 1906).

The internal structure of the root in a number of species belonging to various genera has received the attention of numerous authors (see Plowman op. cit., Metcalfe op. cit.). The structure has been found to be of the same basic type occurring in various monocotyledons families, and consists of the exodermis, cortex, endodermis and stele.

The exodermis (sometimes called piliferous layer) is usually strengthened by a narrow hypodermal zone of fibrous cells. The layer varies in thickness and in the extent to which it is developed, even in the same species.

The cortex in young roots consists of many layers of parenchymatous cells arranged with great regularity in radial rows, in older roots it is differentiated into the concentric, parenchymatous zones that tend to merge into one another. The outer layer is usually compact, the middle layer is highly lacunose containing phloem-lysigenous air-cavities which vary in size and shape in different species, and the inner layer is somewhat compact with cells often arranged in conspicuously radiating rows, with their inner ends of the rows abutting on the endodermis.

The endodermis contains casparian thickenings in the young roots, but in older
roots the endodermal cells usually become thickened, the thickenings being uniform, or U-shaped with the inner tangential (periinal) and radial walls more strongly thickened than the outer tangential (periinal) walls. Depending on the occurrence or development of lateral roots, the endodermal layer may be interrupted or uninterrupted along its length.

The stele comprises a pericyclic region which is compact and relatively small followed by polyarch xylem and phloem. The xylem masses are radially disposed within the bundle sheath, alternating with the phloem masses. Differences in the number and distribution of the metaxylem elements may sometimes correlate with the diameter of the root. Each xylem mass consists of a few short, small thin-walled tracheids arranged in a radial plate terminated centrally in a single metaxylem element. The protoxylem elements are scalariform, reticulate or pitted. The phloem is less conspicuously developed, the masses being quite small and often but slightly differentiated. In mature roots, the elements of the phloem are either partially lignified or considerably crushed by growth pressure.

Secretory cells are of quite common occurrence in all parts of the root. These are cells filled with an opaque, amorphous substance which usually gives the reaction for tannins (Metcalf 1971 p. 21). The chemical nature of their secretion as well as function are not known.

**THE RHIZOME**

Like the root, the internal structure of the rhizome has also received the attention of numerous workers (see Plowman 1906, Metcalfe 1971). My investigations into the rhizomes of some species of Bolboschoenus, Cyperus, Trichophorum and Eleogiton confirm the already published details of the above workers.

Because of the diversity in the external morphological features of the rhizome, especially of the internodes, and also the occurrence of incipient
leaf traces, the exodermal-cortical regions are often obliterated and not as sharply defined as in the root. Typically the internal structure of the rhizome consists of an exodermis, cortex, endodermoid layer and stele. The exodermis, as in the root, is often fibrous. The cortex is usually parenchymatous, as in the young or old roots, but may become fibrous in whole or in part. The endodermoid layer somewhat resembling an endodermis in appearance except for the absence of casparian thickenings (which may be present in young rhizomes), consists of sinuous zone of cells often with U-shaped thickened walls. The stele lies within the cylinder bounded by the endodermoid layer. This is the region where vascular bundles are distributed. The vascular arrangement is very irregular, often congested and coalescent, especially at the periphery of the stele, but gradually becoming widely spaced out towards the centre. Often there is a pith region from which vascular bundles are absent.

Relative to the disposition of the xylem elements of the fibro-vascular bundles, two vascular bundle types are distinguished, viz: Amphivasal or concentric in which the xylem elements are distributed more or less uniformly around the phloem, as in most genera, e.g. Cyperus, Eriophorum, Holoschoenus, Trichophorum etc.; and collateral or centrivasal in which the xylem elements are distributed on the centripetal side of the bundle below the phloem, as in Eleogiton, Schoenoplectus, Bolboschoenus etc. In some species and genera intermediate forms may occur, and also both amphivasal and collateral vascular bundles may occur in the same rhizome or in different species e.g. Hymenochaeta, Blysmus, Scirpus etc. Secretory cells are of frequent occurrence, as in the roots.
THE LEAF

Types of leaves observed from transverse sections: Depending on whether the adaxial and abaxial surfaces are clearly distinguished; or depending on the distribution of the vascular bundles with the relative disposition of the xylem and phloem poles, Metcalfe 1971 distinguished four distinct leaf types; viz: dorsiventral, pseudo-dorsiventral, isobilateral and cylindrical. He also worked out three tentative evolutionary lines terminating into isobilateral, cylindrical and pseudo-dorsiventral leaf types from the typical dorsiventral leaf type through its various modifications.

The dorsiventral leaf type is the commonest, and it is the one featured by all the genera considered in this part of the thesis. In its typical form, the dorsiventral leaf usually has a single, rarely double series of vascular bundles arranged equidistantly from the adaxial and abaxial surfaces or nearer to the abaxial than the adaxial, or vice versa, with the phloem poles directed towards the abaxial surface and xylem pole towards the adaxial surface; the adaxial surface is almost always morphologically different from the abaxial surface. Desmoschoenus (see Fig. 2.A) shows a variation from this normal dorsiventral type in that its vascular bundles in the middle of each half of the lamina (viewed from a section of the middle portion of the leaf) are arranged in two series whose xylem poles are directed towards one another with the phloem poles respectively pointing towards the adaxial and abaxial surfaces. This variation in the vascular bundle arrangement could be considered as one of the intermediate types illustrated by Metcalfe as leading especially to the pseudo-dorsiventral type as in Cladium. In his interpretation for the possible development of the pseudo-dorsiventral leaf, Metcalfe had considered the possible gradual incurvation of the leaf margins and fusion of the two parts of the adaxial epidermis in the typical dorsiventral leaf, resulting in the inversion
Fig. 2  T.S. of Leaf

A, B. Desmoschoenus spiralis (A. Middle region; B. Distal x 50); C. Genus B (Blymus refractus) x 50
D. Blymus compressus x 25; E, F. Hynemochecta grossa (E. Whole leaf ts. x 6; F. Keel region x 25)
G. Schoenoplectus sp. x 50; H. Genus C (Scirpus nevadensis) x 50; I, J. Nenmu (I. N. angustatum; J. N. spadiceum) x 50
K. Hemicarpha microstigma x 50; L, M. Trichophorum x 50 (L. T. atacamensis; M. T. clementii)
of the vascular bundles. It is quite probable that the variant dorsiventral leaf in *Desmoschoenus* resulted from inversion of the marginal vascular bundles due to the incurvation of the leaf margins.

**Shapes of dorsiventral leaves in t.s.:** A number of shapes of dorsiventral leaves in t.s. have been illustrated and described by Metcalfe (op. cit. Fig. 1. a-i).

These include flanged V-shaped, V-shaped, V-shaped with median adaxial groove, thickly crescentiform, thinly crescentiform, inversely W-shaped, sub-triangular, adaxially concave etc. Other additional shapes observed include hemispherical, truncately-circular, thickly V-shaped, abaxially acute, and crescentiform with abaxial grooves etc. The various shapes may be conveniently grouped into variously V-shaped and variously crescentiform-shaped outlines. The distinction between the two lies in the arrangement of the vascular bundles - simulating a V or an arc, and in the presence or absence of a keel in the abaxial surface respectively. Various V-shaped outlines are widespread, being found in all the genera with graminaceous leaf forms, e.g. *Scirpus*, *Kyllinga*, *Bolboschoenus* (see Fig. 3.A), *Hymenochaeta* (see Fig. 2.E,F), *Oxy furryum* etc. The flanged V-shaped outline may sometimes appear as inversely W-shaped, as in *Elymus* (see Fig. 2.D) or Hymenochaeta. Some graminaceous leaf forms which do not show a distinct keel on the abaxial surface may sometimes be distinguished by having crescentiform shapes, as in *Remirea*.

All the genera with channelled or canalicate leaves, and most other genera with setaceous leaves, show various crescentiform shapes: such as thickly crescentiform shapes, e.g. *Desmoschoenus* (see Fig. 2.A.E), *Nemum* (see Fig. 2.I.J) etc. truncately-circular e.g. *Lipocarpha* spp; hemispherical, e.g. *Junceellus*, crescentiform with abaxial grooves, e.g. *Ficinia* (see Fig. 3.D)

Genera in which both variants of V-shaped and crescentiform-shaped outlines occur in different species include *Schoenoplectus*, *Trichophorum*, *Fuirena*, *Varicosus*,
Cyperus, Pycros, Eriocirpus (see Fig. 3.0) etc. Most of the other genera have species which show only one of the two distinct outlines.

**Internal structure:** The internal structure of some species belonging to most of the genera has been published in the works of various authors (see Metcalfe 1971). Most of the species, as well as some which have not been previously examined were investigated. The genera whose species have not been examined before, or for which information was not available, are Desmoschoenus, Nemum, Hellmuthia, Webateria, Genus A, B and C.

Like the leaf shapes, the internal anatomy of the leaf shows great variation. The variation arises from the presence or absence, development, modification and arrangement of the tissues that compose the leaf. The tissues commonly found composing the internal structure of the leaf include Epidermis, Hypodermis, Chlorenchyma (Assimilatory tissue) Sclerenchyma and Vascular bundles. Secretory cells and air cavities are also very frequent.

**Epidermis:** The adaxial epidermis, especially in the areas overlying the midrib in genera and species with variously V-shaped outlines, often differentiates into **bullaiform cells.** These cells are often much larger and more inflated than the neighbouring epidermal cells. Often in the variously crescentiform-shaped leaves, no distinct bulliform cells are found, since the entire adaxial epidermal cells are often equally inflated and of the same size.

Apart from the occurrence of the bulliform cells, it is very common to find the cells of the adaxial epidermis conspicuously larger than those of the abaxial epidermis. Occasionally they are almost of the same size, as in Desmoschoenus, Genus B etc. It is also very common to find that the abaxial epidermal cells overlying the hypodermal sclerenchymatous tissues are shorter and smaller than those over the chlorenchymatous tissues. Sometimes both groups of cells are uniform along the entire abaxial surface as in Desmoschoenus etc. Sometimes,
Fig. 3 T.S. of Leaf

A: *Juncus planiculmis* ×25; B: *Holoschoenus vulgaris* ×25

*Crew* *Eriocirpus* ×50 (1. *E. comatus*; 2. *E. falsus*; 4. *E. microstachyus*); *Dry* *Ficinia* spp. diagrammatic.


E: Genus A (*Scirpus junghuhnii*) ×160.
as in Helmluthia, those over the slerenchymatous tissues are taller and larger than those over the chlorenchyma.

The outer tangential (periclinal) walls of the epidermal cells in both abaxial and adaxial surfaces are very often smooth, slightly or strongly cutinised e.g. in the abaxial surface, or often thin-walled in the adaxial surface. In *Genus A* (see Pl. 2.D Fig. 3.E) cuticular papillae project from the outer tangential walls of the epidermal cells on both adaxial and abaxial surfaces, omitting only the bulliform cell area. Some genera, e.g. *Scirpus*, may show tendencies towards the development of these papillae in some species, but they are not as clearly defined and pronounced as in *Genus A*.

Unicellular hairs with moderately thick walls and relatively wide lumina, usually tapering from wide, slightly sunken bases to finely pointed apices, are present on either the abaxial or adaxial or both surfaces in most species of *Furniture*.

Frequently variously shaped silica bodies project into the lumina from the inner tangential (periclinal) walls of the epidermal cells overlying the hypodermal slerenchyma. These silica bodies measure between 3-6 \( \mu \times 6-15 \mu \). Occasionally they may project down from the outer tangential (periclinal) walls.

Prickles are frequent on the leaf margins, and sometimes on the keel, especially in the variously V-shaped leaves. Stomata (Fig. 8.B) are frequent in the abaxial surface, often absent from the adaxial surface except sometimes towards the margins.

**Hypodermis:** present in some of the genera as layer of translucent cells between the epidermis and the chlorenchyma, and found beneath the adaxial epidermis. This layer occurs widely in the species and genera showing variously crescentiform leaves, but is absent from the V-shaped leaves of most genera, except in *Oxyacryum*. It may be continuous along the whole sub-epidermal adaxial region
as in most genera, or confined to the middle portion as in Desmoschoenus
(see Fig. 2.A.B) etc.

Chlorenchyma (Assimilatory tissue): consists of a more or less homogenous
tissue composed of either palisade-like or spongy parenchymatous cells or both.
Very frequently the cells appear slightly or strongly lobed, with or without
minute intercellular spaces. It is believed that the development of palisade-
like or for that matter spongy tissues is modified by the environment in which
the plants are growing, e.g. as in some species of Schoenoplectus, Cyperus etc.

Often in some species or genera, solitary or groups of translucent cells
are found scattered irregularly in the chlorenchyma, especially between the
vascular bundles, e.g. Bolboschoenus. Radiate chlorenchyma is restricted to
such genera as Lipocarpha, Ascolepis, Kyllinga, Pycreus, Junoeullus, Duval-Jouvea,
Remirea, Courtoisie, Torulínium, Cyperus spp., Nelmesia, Nénup, Queenslandia etc.
In these genera, the chlorenchymatous cells surrounding each vascular bundle
radiate outwards from the circumference of the bundle. The radiate structure
may be conspicuous or inconspicuous, complete or incomplete.

Air-cavities: are found either in the chlorenchyma occurring between the
vascular bundles, especially in most genera with variously V-shaped leaves
(see Fig. 3.A) or outside the vascular bundles between the hypodermis and the
chlorenchyma, as in most genera with various crescentiform-shaped leaves, except
in the thinly crescentiform ones (see Fig.2.C.C.L) or in the sub-stomatal area
in the abaxial side. The development of the first two distributions of air
cavities may be schizogenous or lysigenous. In suspected schizogenously formed
air cavities, thin-walled translucent cells that are either lobed, stellate or
rounded may be found; and especially in those containing lobed or stellate
translucent cells transverse veins may occur ....... this is the structure often
referred to as "Diaphragma"; and it is very common in most species and genera.
In suspected lysigenously formed air cavities, the cavity is often empty save for the broken ends of the surrounding cells, e.g. *Nemum* (see Fig. 2.I.J.) The sub-stomatal cavities are of schizogenous origin. They may be conspicuous or inconspicuous. When conspicuous, the walls of the cells lining them are frequently thin-walled. In some species of *Triohophorum* (e.g. *T. alpinum* and *T. caespitosum*) the walls are conspicuously thickened (Fig. 8.A.2.)

The absence of air-cavities in any form is very rare; and genera which do not show them, e.g. *Hellmuthia* and *Genus A*, may show them in some other specimens.

Solerenochyma: The distribution of the solerenochymatous tissues is basically hypodermal, where they occur as strands or girders, but sometimes they may be distributed as caps at the xylem or phloem or both poles of the vascular bundles or irregularly in the chlorenchyma. The various shapes and the terms used to describe them have been illustrated by Metcalfe (op. cit. Fig. 7). The shapes may be rectangular, crescentiform, baculiform, turbiniform, securiform, bulbiform, T-shaped, Y-shaped, pulviniform and triangular. In the leaf the appropriate descriptions are given in relation to its position whether abaxial or adaxial and whether it is a strand or girder or cap to the actual shape of the tissue.

Because of the frequent occurrence of more than one shape in a single species, it is convenient to consider them here as strands, girders or caps with small or large variously shaped outlines. Genera with small strands only c. 20-60 μ tall and wide include *Scirpus*, *Hymanochaeta*, *Genus B*, *Schoenoplectus*, *Isolepis*, *Bolboschoenus*, *Phylloscirpus*, *Eleogiton* etc. Those with large strands only c. 40-80 μ x 20-40 μ include *Desmoschoenus*, *Genus C* and *Ficinia*. *Genus A* is the only one with girders or partial girders (see Pl. 2.D Fig. 3.E.). Such genera as *Blysmus*, *Hellmuthia*, *Holoschoenus*, *Triohophorum*, *Fuirena* and *Er eoscirpus* contain species which show large or small variously shaped solerenochyma which may also be strands, girders or partial girders.
In most genera, especially those with variously V-shaped leaves, the sclerenohymatous tissue is more or less equally distributed on both the abaxial and adaxial surfaces, often excepting the adaxial region near the bulliform cells. In most genera with the variously crescentiform leaves e.g. Holoschoenus, Hallmithia etc. (see Fig. 3.B) the sclerenohyma tissue is generally distributed in the abaxial region. The keel area of most V-shaped leaved genera and the margins of most species are normally strengthened by larger sclerenchyma tissue than anywhere else.

The sclerenohymatous caps associated with the vascular bundles are often found around larger bundles. Genera in which they were not observed include Nemum, Isolopis, Hemicarpha, Phylloscirpus, Eleogiton, Ascolepis, Picinia, Lipocarpha, Nalemesia, Pycreus, Mariscus, Juncellus, Courtoisia, Torulinium, Kyllinga, Galilea.

As mentioned under chlorenchyma, some of the irregularly distributed inflated translucent cells may be found lying beneath some sclerenchyma strands. Very often, as in Scirpus, Hymenochaeta, Bolboschoenus, Fuirena and Eriophorum, they connect these strands to the outer parenchymatous sheath of the vascular bundles abaxially and adaxially.

The developmental stages of the hypodermal sclerenchyma in relation to the deposition of the silica bodies may be useful for a further study.

Vascular bundles

Distribution and arrangement: As already noted, the distinction made between the four leaf types observed from t.s., was based among others largely on the relative distribution and arrangement of the vascular bundles. Since all the genera considered here have the dorsiventral type of leaf, one might have expected their vascular bundles to be arranged in the same fashion, but this is not so as noted under "shapes" (see p. 26).
Four very distinct patterns are observed:

The first pattern is the one in which the vascular bundles are in a single V-shaped series, generally distributed about mid-way between the adaxial and abaxial surfaces; with the largest bundle in the keel region and from the keel to the margins there is a sequence of relatively large and small bundles alternating. This pattern is very typical and common in all the genera with variously V-shaped outlines. Slight modifications occur especially when the shape of the leaf itself alters, thus generally it is observed that the vascular bundle arrangement corresponds to the shape of the leaf (see Figs. 2.D.E, 3.A.)

The second pattern has the vascular bundles in a single arc series and embedded in or outside the chlorenchyma which is restricted to the abaxial region because of the occurrence of a hypodermis. The arc series follows the outline of the abaxial surface of the leaf only. This pattern is very typical and common in all the genera with various crescentiform-shaped leaves. (see Figs. 2.C.G.H.I.J.)

The third pattern involves the occurrence of two, rarely more series of vascular bundles. One group of genera, including Junoellus, Remirea, Mariacous, Pycreus, Lipocarpha etc., has the vascular bundles arranged in an arc, as in the second type above. Another group of genera, e.g. Mariacous, Duval-Jouvea, has the principal vascular bundels embedded in girder-like partitions connecting the abaxial and adaxial regions, and separating the air-cavities; numerous minor vascular bundles almost completely encircle each air-cavity. At a glance, this arrangement simulates that in the pseudo-dorsiventral type of leaf typified in Cladium except that the opposite ones are not connected by parenchymatous strands or girders as in Cladium. At present, there is no evidence to show the correct interpretation of this curious arrangement, especially as to whether the air cavities formed first before the minor vascular bundles or vice versa.

Ketoalfe (op. cit) has rightly suggested developmental anatomical investigations
A. Vascular Bundle from Leaf of *Genus B* (*Bromus rufus*) × 600
B. " " " Nemum angolensum × 600
C. Sector of T.S. Culm of *Pseudo-schoenus inanis* × 150
D. T.S. Keel region of Leaf of *Genus A* (*Scirpus junghuhmi*) × 150
The fourth pattern applies in *Desmoschoenus* in which the vascular bundles near the margins are in two series, those towards the adaxial have their xylem poles directed abaxially and their phloem poles correspondingly pointing adaxially. The arrangement of the vascular bundles towards the abaxial are in an arc, as in the second pattern above. However, this arrangement changes in sections taken from the distal (apical) end of the leaf (see Fig. 2.A.B.)

Frequently there is only one median large vascular bundle occupying the mid-rib (keel) region; which is often accompanied to the right or to the left or both by large abaxial sclerenchymatous strand or girder. However, in *Kyllinga*, *Mariscus*, *Duval-Jouvea* and in some species of *Bolboschoenus* and *Schoenoplectus* there is the occurrence of a pair of superimposed vascular bundles, the distal one towards the adaxial region always larger, and the proximal one towards the abaxial smaller.

**Bundle sheath:** Three types of bundle sheaths have been distinguished by Kentale (1971). In the first kind there are two layers of sheath, the inner sheath consisting of relatively thick-walled, somewhat fibrous, axially elongated cells, and the outer sheath of parenchymatous cells which are of wider diameter, thin-walled and not greatly elongated in an axial direction. The outer sheath may be small or conspicuously inflated (see Fig. 4.A-F). This type of bundle sheath is the most common. Some differences occur in the extent to which the inner sheath is thickened, and also in the extent to which the outer sheath is interrupted by the sclerenchymatous caps, either at the xylem or phloem or both poles of the vascular bundle. The thickening of the inner sheath may be uniform, as in *Scirpus*, *Hymenochaeta*, *Desmoschoenus*, *Schoenoplectus*, *Bolboschoenus*, *Phylloscirpus*, *Oxyocorym*, *Ficinia* etc. (see Fig. 4.F), or uniformly and completely U-shaped as in *Genus A*, *Hallmuthia*, *Eleogiton* etc. (see Fig. 4.A-C), or partially U-shaped at the xylem pole, as in some *Trichophorum* app. (see Fig. 4.D.) or at
Fig. 4  Types of Vascular Bundle sheaths  ×660

A. 2-layered V.B.; outer sheath parenchymatous, inflated; inner sheath fibrous, uniformly U-shaped, e.g. Elsogiton pseudo-fluitans

B. 2-layered V.B.; O.S. parenchymatous, interrupted at phloem pole; I.S. fibrous, uniformly U-shaped, e.g. Trichophorum alpinum

C. 2-layered V.B.; O.S. parenchymatous, interrupted at phloem and xylem poles; I.S. fibrous, uniformly U-shaped, e.g. Trichophorum subcapitatum

D. 2-layered; O.S. parenchymatous, greatly interrupted at xylem and phloem poles; I.S. fibrous, partially U-shaped at xylem pole, uniformly thick-walled at phloem pole, e.g. Trichophorum mattfeldianum

E. 2-layered; O.S. parenchymatous, inflated; I.S. fibrous, partially U-shaped at phloem pole, uniformly thick-walled at xylem pole, e.g. Blysmus compressus

F. 2-layered; O.S. parenchymatous, inflated; I.S. fibrous, uniformly thick-walled, e.g. Schoenoplectus lacustris

G. 3-layered; O.S. and I.S. parenchymatous; M.S. fibrous, uniformly thick-walled, e.g. Nemum angolensum.
the phloem pole, as in *Blysmus*, Genus E, Genus C etc. (See Fig. 4.E) and partially uniformly thickened respectively. The outer sheath of most minor vascular bundles and sometimes major vascular bundles are often not interrupted (see genera mentioned in p. 34 as having no sclerenchyma caps). In most genera with interrupted outer sheaths, the interruption is often very minute, but in *Trichophorum* especially subgenus *Anthelophorum*, the outer sheaths are represented by only 2-3 parenchymatous cells on each side of the metaxylem; the rest are occupied by very thick-walled, fibrous cells with small lumina (see Fig. 4.B-D).

The second and third types of bundle sheaths are the structural converse of the first as far as the inner sheath is concerned. They have the inner sheath represented by parenchymatous cells. The distinction between the second and third types are largely on the number of sheath layers, viz: two in the second, and three in the third. In the second, the outer sheath is fibrous. Examples include *Ascolepis*, *Lipocarpha*, *Kyllinga*, *Marisoua*, *Pycnus*, *Juncoellus*, *Duval-Jouvea*, *Remirea*, *Torulinium*, *Galilae*, some *Cyperus* spp. In the third, the outermost sheath is parenchymatous radially elongated and the middle sheath is fibrous. Examples include *Nemum*, *Nelmesia* etc. (see Fig. 4.G.)

All examples under the second and third types have radiate chlorenchyma (see p.32). There is a difficulty in assigning any of these genera to either of the two types because of the incidence of the circumferential positions assumed by both the radial chlorenchymatous cells and the outermost parenchymatous cells of the bundle sheath. They could be one or the other, depending on whether chlorophyllous material is observed or not. Investigations from unstained fresh material may be very helpful.

Different species of *Isolepis* and of *Hemicarpha* show any one of the three types of bundle sheaths.
The internal structure of the long internodes of many species belonging to most of these genera has received the attention of numerous authors (see Palla 1888-9, Plowman 1906, Konoyer 1934, Metcalf 1971). Most of these species, including many others not seen by these authors, were examined and most of the reports are confirmed. Among genera whose species have not been examined before by any of the above authors or included in their publications are Pseudo-schoenus, Nellmuthia, Webasteria, Genus A, Genus C, Phyllosoirpus, Remirea and Desmoschoenus.

Outlines/shapes in transverse section: The outlines generally shown in the culms are variations from circular and triangular shapes (see Metcalf 1971, p. 26 Fig. 8). Variations from a strictly circular shape include circular with wavy outline (Fig. 7. C.), circular with grooves (Fig. 5. N.), truncated circular, oval (Fig. 5.G.), irregularly rectangular (Fig. 5. K.), tetragonal, pentagonal etc. Variations from triangular shapes may include obtusely triangular (Fig. 5. B.), triangular obovate (Fig. 7. B.), triangular with concave sides (Fig. 7.D.), acutely triangular to triangularly star-shaped (Fig. 7.F) etc. Shapes such as subcircular to obscurely triangular (Fig. 6. C.D.) etc. bridge the circular and triangular variations. Most of these variations are believed to result from the relative amount, arrangement and shapes of the strengthening hypodermal sclerenchymatous tissues, and also from the growth and life forms of individual species or genera. Pressing of specimens on herbarium sheets and sectioning of material may also contribute, but to a small extent, since the procedure of preparing sections for observation either from fresh or dried material involves the retention of the original form of the material as far as possible.

Frequently the resulting outline, whether a variation from circular or
Fig. 5  T.S. of Culm

A. Holoschoenus vulgaris  x 25; B. Bolboschoenus planifolius  x 50; C. Genus C (Scirpus nevadensis)  x 50
D. Phyllocladus sp. (Scirpus acruus)  x 50; E,F. Hemiacantha spp.  x 50 (S. Scirpus) brevicaulis, F, Hemiacantha micnula)
G,H. Nemum spp.  x 50 (G. N. angustatum; H. N. spadicéum); I. Wahlenbergia sp.  x 50 (W. confervoida); J,K. Trichophorum spp.  x 50
(L. T. aemulum; K. T. clementis); L,M,N. Sciria spp. diagrammatic (L, F. scariosa; M, P. paradoxa; N, P. longifolia)
triangular shapes, corresponds to the external surface structure of the culm as observed with a hand lens or binocular. Culms with smooth surfaces show smooth outlines, and those with grooved or sulcate surfaces show wavy or groovy outlines. Shapes such as circular, circular with wavy outlines, subcircular, triangular, obtusely triangular, and triangular with concave sides are widespread. Truncate circular shapes are common in Scirpus and Genus A and are believed to have resulted from the branching of lateral inflorescence axes.

Most genera show either a variation of circular or triangular shapes among the species examined. Those which show both shapes in different species include Fuirena, Scirpus, Schoenoplectus, Trichophorum, Eriocirpus, Cyperus. Among the genera showing only circular variations in culm shapes are Neorum, Androtrichium, Phylloscirpus, Hemicarpha, Lipocarpha, Ascolepis, Genus C, Genus B, Holoschoenus, Hellmuthia, Pseudo-schoenus, Picingia, Nelmesia, Genus A, Junecillus, Galilea, Isoplepis, Eleugoton etc. Among those showing only triangular variations are Bolboschoenus, Blymus, Courtoisia, Eriophorum, Duval-Jouvea, Kyllinga, Mariscus, Hymenochestea etc. Remirea has a shape which is sub-circular to obscurely triangular and could be placed in either of the above groups.

Internal structure: The tissues composing the internal structure include epidermis, chlorenchyma, solerenchyma, ground tissue, vascular bundles. Air cavities and secretory cells are of frequent occurrence. Almost all of these are structurally the same as in the leaf.

Epidermis: As in the leaf, the epidermal cells over hypodermal solerenchymatous tissues are generally smaller and shorter than, or sometimes of the same size as those over the chlorenchymatous tissues; except in Pseudo-schoenus (Bl. 2.C.), Hellmuthia and Holoschoenus where these cells are taller and longer than those over the chlorenchyma.

Unicellular hairs are absent. Prickles occur mostly below the inflorescence,
Fig. 6  T.S. of Culm

A. *Scirpus sylvaticus* x25  B.C. *Eriophorum* spp. x50 (B, *E. japonicum*; C, *E. callitrix*)
D, E, F. *Eriocirpus* spp. (D, *E. comosus* x25; E, *E. microstachyus* x50; F, *E. falsus* x50)
prickles are found on the culm. or are completely absent but in some species of *Trichophorum* and *Erioccirpus*, cuticular papillae may be present as just minute projections, but not as pronounced as that found in the leaf of *Genus A*. Silica bodies and stomatal apertures are just as frequent as in the abaxial surface of the leaf.

**Hypodermis:** The occurrence of this tissue has never been observed in the culm before, but it might be suspected in the predominantly aquatic genera *Websteria* and *Eleogiton* because of the translucent nature of the cells below the epidermis.

**Chlorenchyma** (Assimilatory tissue): as in the leaf, this is made up of few to several cell layers, and the cells may be distinctly palisade-like, as in *Pseudo-schoenus* (Pl. 2. C.) or palisade-like below the epidermis and gradually becoming rounded to polygonal towards the inside as in *Scirpus*, or wholly spongy rounded to polygonal as in *Desmo-schoenus*. The cells may be slightly or strongly lobed. Radiate chlorenchyma is found in the same examples mentioned under the leaf (see : .32 ) especially around minor peripheral vascular bundles.

**Sclerenchyma:** As in the leaf, the sclerenchymatous tissue is basically hypodermal occurring as strands or girders, but may also occur as caps to the vascular bundles or irregularly in the chlorenchyma and ground tissue of the hypodermal sclerenchymatous tissues, the distinction between them is as in the leaf.

Genera with predominantly small sclerenchymatous strands include *Hymanochacta*, *Sclero-npectus*, *Issolepis*, *Genus B*, *Hemicarpha*, *Eleogiton*, *Websteria*, *Oxyacaryum*, *Linocarpha*, *Ascolepis*, *Kyllinga*, *Juncellus*, *Duval-Jouvea*, *Murisous*, *Pyrena*, *Calilae*, *Ficinia* etc. Those with predominantly tall and narrow or large sclerenchymatous girders or partial girders include *Scirpus*, *Genus A*, *Pseudo-schoenus* (Pl.2. C.), *Desmo-schoenus*, *Bolboschoenus*, *Trichophorum*, *Holoschoenus*, *Androtrichium*, *Hallmuthia*, *Fuirena*, *Eriophorum* etc.

In *Erioccirpus* (Fig. 6.D-E) and *Cyperus* different species show either strands or girders. The thickly crescentiform hypodermal sclerenchyma in *Nolmesia* and
and Nemum (Pl. 5, G, Pl. 2, B.) may be considered as partial strands since their inner surface only just touch the parenchymatous sheath surrounding the vascular bundle without interrupting it.

The occurrence of caps to the vascular bundles is widespread, especially in the larger bundles occurring in the chlorenchyma and sometimes penetrating into the ground tissue. The absence of caps to the vascular bundles, has been observed in Nemum, Isolepis, Hemicarpha, Nalmesia, Eleogiton, Websteria. Sclerenchymatous tissues occurring irregularly in the chlorenchyma or ground tissue or both have been seen in Hymenochaeta, Pseudo-schoenus, Desmoschoenus, Schoenoplectus and Oxyccryum.

Vascular bundles

Number: With the exception of Isolepis, Eleogiton, Websteria, Trichophorum, Schoenoplectus sect. Actaeogeton, Phylloscirpus, Hemicarpha, Ficinia (except in F. radiata), Nalmesia and Nemum whose vascular bundles generally number between 2 and 16, rarely to 20, the other genera have many to several bundles, sometimes over 100 as in Scirpus, Holoschoenus.

Size and distribution: The vascular bundles may be distributed in a distinct ring or series, rarely two series, inside the chlorenchyma, and very often of uniform sizes as in Nemum, Elvmus, Hallmuthia, Trichophorum, Eriophorum, Phylloscirpus, Nalmesia, some Eriocirpus spp. Sometimes they are distributed in more than one ring or series in the chlorenchyma and along the peripheral part of the ground tissue with the larger bundles towards or rarely penetrating deeply into the ground tissue as in Holoschoenus, Androtrichim, Genus C, some Scirpus spp. Often in Desmoschoenus, some Scirpus spp., Bolboschoenus, Genus A, Fuirena, Oxyccryum, some Cyperus spp., Eriocirpus (e.g. E. comosus) the bundles are not arranged in any regular pattern and most larger vascular bundles penetrate deeply into the ground tissue but do not reach the centre of the culm.
In some genera the distribution of the bundles is relative to their sizes; normally the minor bundles are in a distinct ring or series at the periphery of the chlorenchyma, and the major ones either forming a ring in the ground tissue, as in *Hemicarpha*, *Lipocarpha*, *Asclepis* etc., or forming more than one often irregular ring in the ground tissue as in some *Cyperus* spp., *Juncellus*, *Kyllinga*, *Maricoua*, *Galalea*, *Torulinium*, *Remirea*, *Pyoreus*, *Duval-Jouve*. In *Plicinia*, *Isolepis*, *Eleogiton* and *Websteria*, the bundles are of uniform size in a ring at the boundary between the chlorenchyma and the ground tissue.

In *Schoenoplectus*, *Hymenochaeta*, *Pseudo-schoenus* and *Gerns 3* the bundles appear scattered. In the chlorenchyma, they seem to follow the outline of the culm and the chlorenchyma in one or two series, but in the ground tissue they follow no definite pattern except that they occur generally where the 1-4 celled parenchymatous strands separating the numerous air cavities meet (Pl. 2.C., 3.C., 7.A, C-F)

**Bundle sheath:** The three kinds of bundle sheaths whose descriptions and distributions in the various genera were dealt with in the leaf are the same in the culms of the same genera, though in the culms they are often not as clearly defined as in the leaf. The aphyllous genera, viz: *Pseudo-schoenus* and *Androtrichum* whose bundle sheaths could not be compared under the leaf, show the two layered type with the inner sheath fibrous (*cells uniformly thickened*) and outer sheath parenchymatous, often interrupted at the xylem and phloem poles by caps or girders.

**Ground tissue:** The ground tissue is generally made up of parenchymatous cells. Two very distinct types of tissue are apparent; viz: solid made up of spongy rounded to polygonal cells which may be slightly or strongly lobed, and often pitted; and net-like made up of a meshwork formed from 1-4 celled parenchymatous strands bordering many to several air cavities.
Fig. 7  t.s. of Culm
Of the solid ground tissues, there are two groups, viz: (1) those in which the cells have broken down, leaving a large cavity in the culm centre or are in the process of breaking down, as in *Scirpus, Genus A, Eriophorum, Oxyoaryum* etc., and (2) those in which the cells are intact, as in *Eriocirpus, Ficinia, Phylloscirpus, Genus C, Hallmuthia*. It is believed that the extent to which the ground tissue is hollow or in the process of becoming hollow or intact, often largely depends on the age, size, position and rigidity of the internode. The sectioning method may also contribute. The net-like ground tissues are widespread in *Schoenoplectus, Hymenochaeta, Pseudo-schoenusa* and *Genus B* (*Fig. 7,A,C-F, Pl. 2.C*).

Air-cavities are found in almost the same positions as in the leaf, viz: in the chlorenchyma either between the vascular bundles or below the stomata, or in the ground tissue. Those occurring between the vascular bundles are believed to have developed lysogenously by the breakdown of the chlorenchyma; and they normally contain the broken ends of cells. Genera in which this type of air cavities are developed are those whose major vascular bundles are distributed largely in the chlorenchyma, e.g. *Eriophorum*. The sub-stomatal cavities in most genera or species are either not distinct or distinct and lined by thin-walled cells. In most *Eriophorum* spp. and in two species of *Trichophorum* (e.g. *T. alpinum* and *T. caespitosum*) the outer tangential (periclinal) walls of the cells bordering the cavity are strongly thickened (*Fig. 8. A.2*).

The large central air cavities, in such genera as *Nemum, Eriophorum* etc. are
A  Substomatal Cavities

1. thin-walled (e.g. Trichophorum puniceum)
2. thick-walled (e.g. Trichophorum alpinum)
3. thin-walled (e.g. Nemum angolense)

B  Epidermal Surface

1. Trichophorum subcapitatum
2. Schoenopleura hollis
3. Hemicarpha micrantha
4. Elegion crassiuscula
5. Nemum spadiceum
6. Hemicarpha hystrix
7. Helminthia membranacea
believed to have developed lysigenously by the breakdown of the cells of the
ground tissue (see p. 32). These large central cavities are often empty or
contain the broken ends of cells lining it.

Secretory cells: are of very frequent occurrence, especially in the chlorenchyma.

Nodal structure: The internal structure of the node in some species of Scirpus
has been studied by Plowman (1906). The following are his observations,
described especially for Scirpus cyperinus which apply also to all species
of Scirpus which I have re-examined and to those of Eriophorum and Eriophora.

Immediately below the node, the xylem elements rapidly increase in number,
spreading around the phloem in a broad U-shaped mass. The arms of the U then
become involuted in such a manner as to include a portion of phloem on either
side of the original phloem, after which the small lateral amphivasal strands
separate off from the main central narrow V-shaped strand thus o V o

Passing to a slightly higher level, the small lateral amphivasal strands
are seen to pass divergently obliquely inward and upward, where they anastomose
with similar strands from adjacent cortical bundles, forming a dense circular
plexus of amphivasal strands to which are added strands from the peripheral
zone of proper cauline bundles, which here bend more or less sharply inward to
pass into the base of the next internode.

A little higher up we find the general anastomosis extending to the remainder
of the bundles, practically all of which assume the amphivasal character for
at least a short distance at some part of their course through the nodal complex.
The central strand from the original cortical bundle passes upward and sometimes
slightly outward into the leaf sheath. From the circular plexus are developed
new peripheral strands which pass upward as the cortical bundles of the next
internode.
The course of vascular bundles in the shoot/culm: This has been followed by Plowman (op. cit.) and Monoyer (1928-9, 1934) in a number of species belonging to Scirpus, Trichophorum, Bolboschoenus, Schoenoplectus, Eleocharis, Eleocharis, Isolepis, Holoschoenus, Oryzium, Nemum etc.

It is generally believed that the number of cortical bundles is constant in the several internodes of a given plant or species, but that of the cauline bundles usually decreases considerably from the base upward. Generally all bundles of the leaf-trace enter the cauline system at the same node, after passing as cortical bundles through one or more internodes below the insertion of the leaf. This is very typical of the genera with several elongated internodes as in Scirpus, Eriophorum, Pituereae etc. In the genera with long naked distal shoots e.g. Schoenoplectus, Trichophorum etc. the bundles of the involucral bases enter the culm in a broad curve and unite with the medullary bundles at the basal part of the nodal complex, and accordingly these forms show no cortical bundles, though the deep-seated cortical selerenchyma strands may be vestigial indications of the cortical system of bundles (Plowman op. cit.).

Axillary buds have been observed to have collateral bundles, which may be traced downward to their insertion upon the cauline bundles below the nodal plexus. They have no direct connection with the leaf trace (Plowman op. cit.)

EPIDERMAL SURFACE STUDIES

The characteristics of the epidermal cells in the leaf and culm are better observed by removing this layer and mounting it separately. The characteristics observed include stomata, cuticular papillae, prickles, crystals and silica bodies. My observations cover Pseudoschoenus, Hellmuthia, Websteria, Genus A, Genus B, Genus C, Desmochoenus, Phylloacrispus and Nemum.

Most species belonging to the other genera investigated by Metcalf's (1971) were also re-examined, and most of the observations are confirmed.
Pl. 3 Epidermal Surface View

A. Bolboschoenus paludosus: showing Conical-with-satellite Silica Bodies X 1250

B. Scirpus nichurii: " Nodular Silica Bodies X 1250

C. Fuirena pachyrhiza: showing Stomata overarched by cuticular papillae X 600

D. Desmoschoenus spiralis: " Conical-without-satellite Silica Bodies X 1250
STOMATA

Distributions: The stomata in the leaf (except in adaxial surface) and culm are distributed in the intercostal zones.

Arrangement: They are always arranged at intervals in longitudinal files of cells lying parallel to the long axis of the leaf or culm. The arrangement may be regularly in a single, rarely double file as in Isolepis, Hemiocephale, Nemum, Eleogiton etc., (Fig. 8. B) or irregularly in many files as in Scirpus, Bolboschoenus etc.

Type: They are paracytic, i.e. with a clearly defined subsidiary cell on either side lying parallel to the stomatal pore.

Size: The sizes range from 21-30-57 µ x 15-24-40 µ.

Shape: The shape is often determined by the relative shapes of the subsidiary cells. When the subsidiary cells are dome-shaped, or triangular, or compressed, the resulting shapes of the stomata are oval, fusiform or almost rotund or linear respectively (Fig. 8. B).

CUTICULAR PAPILLAE: are very conspicuous in the leaves of Genus A, even though they may be obscurely present in many other species belonging to various genera. In Fuirena subgen. Pentasticha the cuticular papillae are frequently found overarch ing the stomata (Pl. 3..C).

PRICKLES: are of very common occurrence, especially on the margins of the leaf. They may be distantly or densely distributed. In the culm, prickles are generally absent except below the insertion of the inflorescence. However, in some species of Trichophorum, Picinia and Eriocirpus, prickles occur along the greater part of the culm.

CRYSTALS: in the form of echinate druses are of very rare occurrence; observed in a few species of Bolboschoenus (e.g. 3. paludosus) where they are often found deposited towards the transverse anticlinal walls in both leaf and culm;
crystals of some form have been observed in some Cyperus and Lipocarpha species (metcalfe 1971 p. 545).

**SILICA BODIES:** are of wide occurrence, and the extent to which they form, and their distribution characterise certain genera and species.

**Distribution:** It is very common to find the silica bodies distributed in the costal zones of the epidermis. However, in certain genera and species, the silica bodies may be found deposited in the anticlinal sinuosities, as in Fuiirena etc., (see Pl. 6. C), occasionally against the outer periclinal walls, or in some of the intercostal zones as in Eriocirpus (e.g. F. falsus).

**Types:** The silica bodies in the costal zones may be one of several types distinguished according to their shapes from a t.s. or surface view. The three common types include conical-without-satellites (see Pl. 3.D); conical-with-satellites (see Pl. 3.A) and nodular (see Pl. 3.B). Intermediate forms often occur, especially between the last two types, which make the distinction between the two obscured. Such intermediate forms are often referred to as conical-with-satellites tending to be nodular. Examples of genera with the first type include Nemum, Trichophorum, Phyllocircus, Deamoschoenua, Pseudoschoenus, Gemua C, Hymenochaeta, Elegolion, Blymus, Eriocirpus, Hemicarpha, Isopleis, Holoschoenans, Hellmuthia, Ficinia. Examples of genera with conical-with-satellites sometimes tending to be nodular include Bolboschoenua, Gemua B, Junecullus, Androtrichum, Duval-Jouvea, Kyllinga, Maricaus, Courtoisia, Remirea, Galilea, Oxycaryum. Examples of genera with distinctly nodular (though sometimes some of the peaks appear as satellites) include Scirpus, Eriophorum, Gemua A, Webstera.

In Cyperus, Schoenoplectus, Ascolepis, Lipocarpha, Pycreus and Fuiirena, different species may show any of the three types.

**Arrangement in cell:** Usually the silica bodies are arranged in only one rot,
parallel to the longitudinal axis of the cell; however, in some sections of specimens or species of *Erioscirpus, Ascolepis, Cyperus, Ficinia* and *Desmo- schoenus*, they are arranged in two, rarely more, regular or irregular rows.

**Number per cell:** varies from 1 to 16 or more in different cells in different species and genera. It is very common to find variations between 1-5 bodies per cell in material of most genera. In such genera as *Schoenoplectus* (especially sect. *Actaeogoton*), *Isolepis, Webasteria, Desmoschoenus, Eleogiton* and *Nemicarpha*, most or all their species have more than 5 bodies per cell.
3. Scleranichmatous caps to vascular bundles
   (a) present; (b) absent

**EPIDERMAL TISSUE** (surface view)

1. Arrangement of stomata
   (a) frequently in a single file between costal cells; (b) in many,
      often irregular, files between costal cells

2. Cuticular papillae over-arching stomata
   (a) present; (b) absent

3. Type of major silica bodies
   (a) conical-without-satellites; (b) conical-with-satellites;
      (c) nodular

4. Distribution of silica bodies
   (a) in the costal zones; (b) in anticlinal simusities;
      (c) in intercostal zones

5. Number of silica bodies per cell in costal zones
   (a) 1-5 bodies per cell; (b) more than 5 bodies per cell
<table>
<thead>
<tr>
<th>LEAF</th>
<th>COMPARATIVE VEGETATIVE ANATOMY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>('no comparison' implies no leaf blade present)</td>
</tr>
<tr>
<td>1.</td>
<td>Outline</td>
</tr>
<tr>
<td></td>
<td>(a) variously V-shaped; (b) variously crescentiform; (c) no comparison</td>
</tr>
<tr>
<td>2.</td>
<td>Bulliform cells</td>
</tr>
<tr>
<td></td>
<td>(a) present; (b) absent; (c) no comparison</td>
</tr>
<tr>
<td>3.</td>
<td>Cuticular papillae on epidermal surface</td>
</tr>
<tr>
<td></td>
<td>(a) present; (b) absent; (c) no comparison</td>
</tr>
<tr>
<td>4.</td>
<td>Unicellular hairs on adaxial and abaxial surfaces</td>
</tr>
<tr>
<td></td>
<td>(a) present; (b) absent; (c) no comparison</td>
</tr>
<tr>
<td>5.</td>
<td>Hypodermis</td>
</tr>
<tr>
<td></td>
<td>(a) differentiated; (b) not differentiated; (c) no comparison</td>
</tr>
<tr>
<td>6.</td>
<td>Arrangement of vascular bundles</td>
</tr>
<tr>
<td></td>
<td>(a) single V-shaped series; (b) single arc series; (c) 2 series in an arc; (d) 2 series around air cavities; (e) inverted series near margins; (c) no comparison</td>
</tr>
<tr>
<td>7.</td>
<td>Number of bundles in keel region when prominent</td>
</tr>
<tr>
<td></td>
<td>(a) keel prominent, one median VB; (b) keel prominent, 2 superimposed VBs; (c) keel not prominent; (c) no comparison</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CULM</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Outline</td>
</tr>
<tr>
<td></td>
<td>(a) circular and variants of it; (b) triangular and variants of it</td>
</tr>
<tr>
<td>2.</td>
<td>Epidermal cells</td>
</tr>
<tr>
<td></td>
<td>(a) taller and larger over hypodermal sclerenchyma; (b) smaller over hypodermal sclerenchyma; (c) of relatively equal sizes</td>
</tr>
<tr>
<td>3.</td>
<td>Number of vascular bundles</td>
</tr>
<tr>
<td></td>
<td>(a) up to 20; (b) more than 20</td>
</tr>
<tr>
<td>TAXA</td>
<td>CHARACTERS</td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
</tr>
<tr>
<td>ANDROTRICHIA</td>
<td>o</td>
</tr>
<tr>
<td>ASCLEPIAS</td>
<td>b</td>
</tr>
<tr>
<td>BLYTHIA</td>
<td>a</td>
</tr>
<tr>
<td>BOLGOSCHERUS</td>
<td>a</td>
</tr>
<tr>
<td>CYPRES</td>
<td>a</td>
</tr>
<tr>
<td>DISMOSCHERUS</td>
<td>b</td>
</tr>
<tr>
<td>DUVAL-JOUVEA</td>
<td>c</td>
</tr>
<tr>
<td>ELE.GroupLayout</td>
<td>d</td>
</tr>
<tr>
<td>ERIOPHORUS</td>
<td>a</td>
</tr>
<tr>
<td>ERIOSPERMUS</td>
<td>(a)</td>
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<tr>
<td>FIGICHA</td>
<td>b</td>
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<tr>
<td>FUCIFERA</td>
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<tr>
<td>GALILEA</td>
<td>b</td>
</tr>
<tr>
<td>HELMOUTHIA</td>
<td>b</td>
</tr>
<tr>
<td>HEMICARPA</td>
<td>b</td>
</tr>
<tr>
<td>HOLGOSCHERUS</td>
<td>b</td>
</tr>
<tr>
<td>HYPNOCHIACIA</td>
<td>a</td>
</tr>
<tr>
<td>ISOLEPIS</td>
<td>b</td>
</tr>
<tr>
<td>JUNCARENSIS</td>
<td>b</td>
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<tr>
<td>KIILINGA</td>
<td>a</td>
</tr>
<tr>
<td>LIOCARPHA</td>
<td>b</td>
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<tr>
<td>MARIUSCUS</td>
<td>a</td>
</tr>
<tr>
<td>NELISIA</td>
<td>b</td>
</tr>
<tr>
<td>NICHEM</td>
<td>b</td>
</tr>
<tr>
<td>LYGPPHYLLUM</td>
<td>a</td>
</tr>
<tr>
<td>PHELIXCERIFER</td>
<td>b</td>
</tr>
<tr>
<td>PHLADOCHERUS</td>
<td>o</td>
</tr>
<tr>
<td>PICHUS</td>
<td>ab</td>
</tr>
<tr>
<td>RIMBRIA</td>
<td>b</td>
</tr>
<tr>
<td>SCHMIDTIA</td>
<td>ab</td>
</tr>
<tr>
<td>SCIPIALUS</td>
<td>a</td>
</tr>
<tr>
<td>TORILISIUM</td>
<td>a</td>
</tr>
<tr>
<td>TRICHOCERUS</td>
<td>ab</td>
</tr>
<tr>
<td>WEBSTERIA</td>
<td>b</td>
</tr>
<tr>
<td>GENES A</td>
<td>a</td>
</tr>
<tr>
<td>GENUS B</td>
<td>b</td>
</tr>
<tr>
<td>GENUS C</td>
<td>b</td>
</tr>
</tbody>
</table>

**Note:**
- ? = No information
- ( ) = rarely
- 1 = more or less
- a-c = abc
- ab = a and c
CHAPTER III

COMPARATIVE REPRODUCTIVE MORPHOLOGY

GENERAL INFLORESCENCE FORMS

Relative to the position of the lower involucral bract, two groups of inflorescence forms are observed, viz: terminal inflorescence in which the involucral bract is in a lateral position and leaf-like or glume-like; and pseudo-lateral inflorescence in which the involucral bract is terminal, erect and appears to be a continuation of the culm.

A Terminal inflorescence

Various forms of terminal inflorescences are observable and quite frequently some of these forms tend to be restricted to certain genera. Scirpus, Hymenochaeta, Genus A and Bolboschoenus show compound corymbose or paniculate-corymbose inflorescences. The main inflorescence axis is slightly shortened, terminated by a loose cluster of spikelets at its summit; the subsequent primary rays of unequal lengths overtop the main inflorescence axis. Scirpus (Fig. 9.A) and Genus A (Fig. 9.C) frequently bear minor lateral inflorescence axes in the axils of the sheathing bases of some upper cauline leaves, which tend to repeat the same arrangement as in the terminal inflorescence. The primary rays are frequently inserted acutely or obliquely on the main inflorescence axis, erect, but occasionally, as in Scirpus, tending to be divaricate and nodding, depending on the size of the rays (especially S. divaricatus E.11.) or on the number of spikelets and the ultimate number of fruit set (especially S. limosus Michx.). In Hymenochaeta (Fig. 9.B) the primary rays are of two distinct sizes arising from the axil of each involucral bract. Both rays are sheathed at the base by a ray prophyll, while the minor one tends to have another ray prophyll at its base. The minor primary ray is believed to have developed later, and is always smaller, shorter, and bears a simple corymb, while the major ray is
Fig. 9 General Inflorescence

A. *Scirpus* spp. x1; B. *Hymenochaeta grossa* x1
C. Genus A (*Scirpus junghuhnii*) x1; D. *Pseudo-Schoenus inanis* x1
E. *Schoenoplectus* spp. x1 (1. *S. lacustris*; 2. *S. etuberculatus*
Fig. 10  Gen. Inflores. contd.

A, Bolboschoenus spp. x 1 (4. B. laetifolens; 2. B. maritimus; 3-5. B. paludosus)
B, Desmoschoenus spiralis x 1; C, Holoschoenus spp. (1. H. vulgaris subsp. globiferus x 1; 2. H. hunbergius; 3. H. nodosus x 1; 5. H. dioecus x 1)
D, Oxyccaryum cuben x 1; E, Androtrichum trigynum x 1
always broader, taller and bears a compound corymb. In Bolboschoenus (Fig. 10.A.1-5) occasionally the main inflorescence axis, together with the primary rays, are completely reduced, and the inflorescence appears head-like, sometimes only one spikelet forming the head.

Paniculate inflorescences are exhibited by Desmoschoenus, Pseudo-schoenus, and Fuirena. In Desmoschoenus (Fig. 10.B) the panicle is contracted, containing several sessile spikelets in confluent clusters; the clusters alternate in the lower part of the inflorescence, but become spiral above, each cluster subtended by a rigid, prickly involucral bract with a spatula-shaped base. In Pseudo-schoenus (Fig. 9.D) the typical panicle as observed in Schoenus is found, with the involucral bracts appearing pseudo-terminal, reduced and culm-like. Fuirena (Fig. 12) generally has a paniculate inflorescence in which there are major and minor axes, each axis ending in a cluster of spikelets, with or without primary rays. In some species (e.g. F. hirta etc. Fig. 12 f) only the main axis is present, and the inflorescence is a compact head containing several spikelets, or occasionally, as in F. scirpoideus (Fig. 12 j), the inflorescence is a head of one to few spikelets, with very reduced involucral bracts. F. squarrose has been observed to show transitional forms from the typical panicle to the compact head.

Inflorescences in Cyperus, Kyllinga, Torulinium, Courtoisia, Mariscus, Duval-Jouvea, Orycoarym etc. appear to be umbellate. In Cyperus, the whole inflorescence may appear pseudo-lateral as in C. articulatus (Fig. 15.A.4) or may be contracted into single to few heads of several spikelets, as in C. pyramus (Fig. 15.A.7), C. orbicophalae (Fig. 11.A) etc. A similar situation appears in Kyllinga (e.g. in K. brevifolia Fig. 15.B.2), Mariscus (e.g. M. dregreamus Fig. 16.A.5) etc. Sometimes the primary rays are present, and their spikelets, as well as those on the main inflorescence axis, are in globose heads,
Fig. 11 Gen. Inflores.

A Cyperus orbicaphalus x 1  B Hellmuthia sp. x 1
C Genus C x 1 (Scirpus nevadensis)  D Nenun spp. x 1
E Trichophorum spp. x 1 (i. T. alpinum ii. T. verecundum iii. T. atacamenesis iv. T. subcapitatum)
F Websteria confervoides x 1  G Blyszus compressus x 1
H Phylloscirpus spp. x 1 (i. P. acaulis ii. P. semisubteraneus)  I Ekagiton spp. x 1
   (i. E. crassiuscula ii. E. luedwigi iii. E. fasciculata)  J Isolepis spp. x 1
K Hemiarpha spp. x 1  L Lipocarpus spp. x 1  M Nelmesia melanostachya x 1
Fig. 12 Inflorescence Forms in Fuirena


e. *F. ecklonii*  f. *F. hirta*  g. *F. stricta*  h. *F. bachyrrhiza*

i. *F. wallichiana*  j. *F. scirpoidea*  k, l. *F. ciliaris*

(a-l x1)
as in Oxyacrium (Fig. 10.D), Kyllinga, Courtoisia, Varicosus etc.

Blysmus and Genus B show a peculiar inflorescence form in which the spikelets are distichously arranged on the main inflorescence axis; the arrangement may be compact or distant (cf. Fig. 11.G). The involucral bracts appear glume-like, the lowest with a long barbed/prickled awn, progressively reduced in size towards the top.

An indeterminate head, appearing as a capitulum, is found in Ascolepis (Fig. 11.B) with the main inflorescence axis compressed and appearing as a false torus. A longitudinal section (Fig. 20.C) through the head reveals the indeterminate nature of the inflorescence, with the 1-flowered spikelets maturing acropetally (centripetally). The lower two to three subtending involucral bracts are large, unequal, leaf-like with dilated clasping bases. The bracts subtending the spikelets are smaller, equal, glume-like and often appearing hyaline. The latter have previously been referred to as "glumes" in the sense of subtending flowers in their axils, but (cf. p. 78, Fig. 20) the so-called flowers are indeed one-flowered spikelets, and therefore those glume-like organs are reduced bracts, often found in most compound inflorescences such as in Scirpus, Cyperus etc.

Other forms of head-like inflorescences are found in Galilea, Remirea and Phylloscirpus. In Galilea (Fig. 15.E) the head contains several sessile spikelets and is subtended by one to two involucral bracts, the lower with a dilated base and often appearing erect and culm-like. In Remirea, (Fig. 15.D) there are one to three heads clustered together, bearing numerous sessile spikelets on their reduced axes; and subtended by leaf-like involucral bracts. In Phylloscirpus (Fig. 11.H.) the head, containing few to several spikelets and subtended by glume-like involucral bracts, is often not easily distinguished, especially in specimens in which the inflorescence is young and the culm has not differentiated (cf. Fig. 11. H.3.).
Fig 13  Gen. Inflorescence in Eriocircus and Eriophorum

A  Eriocircus spp. x 1  a E. comosus  b E. falsus  c E. microstachyus

B  Eriophorum spp. x 1  abc E. japonicum  de E. latifolium
   f E. virginicum  g E. crinigerum  h E. vaginatum
Fig. 14  Gen. Inflorescence in Ficinia and Ascolepis

A  Ficinia spp. x1  
- F. secunda  b. F. bulbosa  c. F. radiata  d. F. bracteata  
- e. F. Scariosa  f. F. ramossicoma  g. F. Ingifolia  h. F. angustifolia  
- i. F. ecklonii  j. F. brevifolia  k. F. paradoxa  l. F. aphylla  m. F. filiformis

B  Ascolepis spp. x1  
- A. pinguis  b. A. protea  c. A. elongata  d. A. brasiliensis  
- e. A. capensis  f. A. dipsacoides
Lipocarpus generally shows one to several heads containing several spikelets (cf. p. 71) subtended by leaf-like involucral bracts (Fig. 11.L), but occasionally, as in Hemicarpus, short umbellate, 1-spicate primary rays may be present (Fig. 11.K) and the inflorescence is of a few spikelets (cf. p. 71). One-spicate inflorescences with glume-like involucral bracts occur generally in Triochophorum, Eleogiton, Websteria, Nelmesia and Eriophorum. In Triochophorum subgenus Anthalophorum, the inflorescence may contain one to few spikelets, occasionally with 1-spicate primary rays (Fig. 11.E). In Eleogiton and Websteria (cf. p. 18, Fig. 11.F, I) the position of the inflorescence is assumed in relation to the culm, and not with the widely branched, leafy aquatic stem as a whole. In Eriophorum the 1-spicate inflorescence is found only in subgen. Eriophorum, section Eriophorum (Fig. 13.B.h); the other section Phyllanthalum, together with the subgenera Japonici and Eriophoxopsis, show transitional forms from a simple umbel to a head-like cluster of spikelets (Fig. 13.B.a-e) and subtended by leaf-like involucral bracts which sometimes tend to be glume-like.

Eriocarpus exhibits two forms of inflorescences. In the subgenus Eriocarpus (Fig. 13.A.bc) the inflorescence is a contracted head of one to few spikelets, while in the subgenus Lechnophorum (Fig. 13.A.e) the inflorescence is a compound umbel-like corymb.

B. Pseudo-lateral inflorescences

This group exhibits a rather similar range of inflorescences to those in the Terminal inflorescence group, the only observable differences being the pseudo-lateral position of the main inflorescence axis, and the culm-like appearance of the lower involucral bract.
Fig. 15  Gen. Inflorascence in Cyperus etc.

A  Cyperus spp.  1  C. papyrus  x 0.5  2  C. dives  x 0.5  3  C. rotundus  x 1  
    4  C. articulatus  x 0.5  5  C. cliformis  x 1  6  C. fuscus  x 1  
    7  C. pygmaeus  x 1

B  Kyllinga spp.  x 1

C  Courtoisia sp.  x 1  D  Remirea maritima  x 1  E  Galilea nucronata  x 1
Typical of this group is Schoenoplectus whose subgenera Schoenoplectus and Malaconotum frequently show simple to compound paniculate-corymbose inflorescences, very rarely with primary rays becoming reduced or absent, as in S. torreyi, S. americanus etc. The lowest culm-like involucral bract is commonly equal to or slightly lower than the main inflorescence (Fig. 9.E). In subgenus Actaeogetum, the inflorescence is always in a pseudo-lateral head containing one to several spikelets with the involucral bract several times longer than the main inflorescence head (Fig. 9.E. 4, 5).

Genus C. Hellmuthia, Junecellus and Isolepis have similar pseudo-lateral head-like inflorescences as in Schoenoplectus subgen. Actaeogetum, but their lowest involucral bracts may be equal to or slightly longer than the head, as in Genus C (Fig. 11.C) and Hellmuthia (Fig. 11.B), or appear setaceous and filiform as in Isolepis (Fig. 11.J). In Junecellus the base of the lowest involucral bract is dilated, sometimes appearing leaf-like (Fig. 16.D).

Androtrichum exhibits a paniculate-corymb, or an obscured simple umbel with primary rays terminating in compact clusters of spikelets (Fig. 10.E).

In Holochoenusa, the pseudo-lateral inflorescence may be a compound sub-umbellate, with the primary rays often bearing secondary ones, and terminating in globose heads containing many to several small, sessile spikelets, as in H. vulgaris subsp. globiferus (Fig. 10.C.1); or a simple sub-umbel with primary rays bearing globose heads, as in H. vulgaris, H. thumbergianus and H. nodosus (Fig. 10.C.2-4); or a single globose head, without rays, as in H. dioecus etc. (Fig. 10. C.5). Frequently in H. vulgaris, transitional forms from the compound sub-umbellate, through simple sub-umbel to a single globose head, are observed (cf. Fig. 38).

Nemum appears to show the type of inflorescence in which there are one to few umbellate primary rays; sometimes the rays are absent and only a head-like
Fig. 16  Gen. Inflorascence in Mariscus etc.

B. Duval-Jouvea serotina x1
D. Juncellus spp. x1 (1. J. pannonicus 2. J. laevigatus)
cluster of spikelets, with the spikelets sometimes pseudo-terminal or pseudo-lateral, is found (Fig. 11.D).

C. Mixture of Terminal and Pseudo-lateral inflorescences

Occasionally in certain genera such as Pycreus and Ficinia both terminal and pseudo-lateral inflorescences occur.

In Pycreus terminal umbellate forms occur in certain species, especially P. subcintrix, P. diander etc. (Fig. 16. C. 2), while terminal head-like forms are observed in other species, especially P. pumilus, P. pervillai etc. (Fig. 16.C.3) Pseudo-lateral heads are also found in some species, especially P. magapotamicus, P. fontinalis etc. (Fig. 16.C.5), while pseudo-lateral paniculate corymbs are also found in others, especially P. blastophorus etc. (Fig. 16.C.1).

Ficinia shows a variety of inflorescences, some of which are never encountered in any of the other genera; for example in F. secunda the inflorescence is a terminal second-spike (Fig. 14.A.a), the spikelets appearing to be borne on only one side of the inflorescence axis, while in F. bulbosa the inflorescence (Fig. 14.A.b), gives an impression of interrupted pseudo-verticillaters. Terminal 1-spicate and head-like inflorescences are of frequent occurrence, as well as pseudo-lateral heads like the type found in Isolepis and Hellmathia. In the same way as the inflorescences are varied, the subtending involucral bracts also vary, ranging from leaf-like in the second-spike; the pseudo-verticillate and the terminal head-like inflorescences, through culm-like in the pseudo-lateral heads to glume-like in the 1-spicate forms.
SPIKELETS: As can be seen from the discussion under the general inflorescence forms, all spikelets are borne above, either on rays or directly on the culm, but occasionally in Schoenoplectus amphibasal (amplicarpic) axillary spikelets are found at the base of the culm (cf. Haines 1971b). Amplicarpy was previously not known in the Cyperaceae, but since 1943 when Levyns observed this feature in the South African Trianoptiles, more and more information is coming to light about their presence in other Cyperaceous genera, such as Bulbostylis (Haines 1971). Most of these genera in which amplicarpy has been observed have tufted habits, and I would not be surprised if many more amplicarpous or amphibasal spikelets are found in other unrelated genera.

Of the aerial spikelets, those forming capitate or seced inflorescence forms are normally sessile, while those on corymbose, umballate or paniculate inflorescences may be sessile and fascicled, sessile and spike-like, or stalked and divaricate, or stalked and congested, etc. Schemata of spikelet forms are illustrated in Fig. 17.

Spicilar prophylls are of common occurrence in Cyperus, Kyllinga, Toruliniunm, Remirea, Marisous, Juncellus, Duval-Jouves, Gaiilea etc. There is a tendency for their occasional occurrence in genera whose spikelets form globose heads, as in Holoschoenus, Oxycaryum and Ascolepis. It is suspected that in most other genera with head-like inflorescences (e.g. Puiroena Haines 1966), the prophylls are actually of ray origin, but due to the reduction of the ray axis appear spicicular.

Relative to the arrangement of the glumes, there are two very distinct forms of spikelets, viz: distichous form (Fig. 17.a-3) in which the glumes are distichously arranged, and the spikelet structure appears bilaterally compressed, rarely swollen and appearing slightly globose, as found in Cyperus (except G. michelianus, G. orbicephalus etc.), Marisous, Kyllinga, Androtrichum.
Fig. 17 Schematic Spikelet Diagram

a. a stalked spikelet as in Scirpus spp.
b. a sessile or terminal spikelet as in Scirpus spp.
c. a sessile spikelet as in Cyperus spp.
d. a terminal spikelet as in Cyperus spp.
e. 2-4 flowered spikelet as in Marisus spp.
f. spikelet with anterior scale as in Nelmesia
h. spikelet diagram of 'e' and 'f'
 i. a spikelet of Remirea macitans
j. a reduced spikelet of Lipocarpus spp.
Prerus, Juncellus, Duval-Jouve, Torulinium, Courtoisia, Galitea, Remirea
Fig. 17 i), Spiral form (Fig. 17 a-d) in which the glumes are spirally arranged
and the spikelet: structure appears terete or cylindrical, as found in Scirpus,
Eriophorum, Eriocirpus, Fuirena etc.

In both groups, the shapes of the spikelets are quite characteristic,
though some shapes, especially of the ones in the latter group appear in
several other unrelated genera, for example the shapes as exhibited in Scirpus
(Fig. 18, a-s) Trichophorum, Isolepis, Eleocharis (Fig. 18, 6-8), occur also in
Ficinia, Bulbostylis, Fimbristylis, Eleocharis, Hypolytrum etc. The spikelet
shape in Genus A (Fig. 18, 2) and /S. paniculato - corymbosus pl. 1, Fig. 18,3
are rather distinct, the former observed in some Schoenus spp. and the latter
in some Rhynchospora spp., though the number of sterile glumes at the base of
the spikelet differentiate these taxa from Schoenus and Rhynchospora respectively.

The three genera whose spikelets do not fall strictly into any of the two
forms of spikelets are Websteria whose spikelet is oblong with only two glumes
which appear to be subdistichously arranged (Fig. 18,9), Ascolepis whose spikelet
consists of only one glume which often encloses the flower (Fig. 20, d,e) and
Lipocarphe whose individual flowers are interpreted as forming reduced spikelets
Of. R. Brown, 1810, Rikli 1895, Holm 1899, Palla 1905, Koyama 1961, Raynal 1968,
Haines 1974 because of the enclosure of two hyaline scales at the anterior
(ventral or abaxial) and posterior (dorsal or adaxial) ends of the flowers;
the posterior having been interpreted as a spicular prophyll (Blaser 1944, Koyama
1964 and the anterior as the fertile glume with the stamens placed between it
and the fruit; the spikelet form is thus subdistichous or nearly so. In
Hemiparcph and Nelmisia only the anterior scale is present and may sometimes
be absent altogether as in some Hemiparcph Of. Clarke 1901, Palla 1908,
Friedland 1941 whether or not to consider the flower unit here as another
Fig. 18. Spikelet Forms

1. Scirpus spp. x 6 (a. S. lineatus, b. S. sylvaticus, c. S. asper,
   d. S. microcarpus, e. S. fuirescidae, f. S. atrovirens)
2. Genus A x 6 (Scirpus jungubnii)
3. Scirpus paniculato-corymbosus x 6
4. Blysmus compressus x 6
5. Genus B (Blysmus rufus) x 6
6. Trichophorum spp. x 6 (a. T. caespitosum, b. T. alpinum, c. T. verucundum)
7. Isolepis setacea x 6
8. Eleogiton fluitans x 6
9. Websteria confervoides x 6
10. Oxyoarym cubense
11. Cyperus spp. (a. C. uncinatus x 12, b. C. diformis x 12, c. C. aristatus x 12, d. C. iria x 12, e. C. orbiculatus x 6)
12. Kyllinga spp. x 12 (a. K. squarrosa, b. K. peruviana)
13. Androtrichum tricymum x 12
14. Courtoisia cypereoides x 12
15. Terulinium eggersii x 12
Fig. 18 Spikelet Forms
reduced spikelet is very debatable.

All the spikelets contain bisexual or hermaphrodite flowers. Unisexual flowers are of very rare occurrence, often occurring at the very top of the spikelet and showing signs of continuing to develop into a bisexual unit. The number of flowers borne in a spikelet varies from one genus to the other, though a majority of the genera produce many flowers corresponding to the number of glumes present. One-flowered, rarely two-flowered spikelets are found in Kyllinga, Courtoisia, Ascolepis, Remirea, Webstera. Often in Naricous, especially in the groups Umbellati Clarke, Ochrocephali Kukenthal and Bulbocaulus Clarke, one-flowered spikelets are common.

**RACHILLA:** Seemingly indeterminate rachillae are widespread, especially in the genera with many-flowered spikelets. The seemingly determinate type, which appears to have finished its growth after the production of the single flower laterally, is of restricted occurrence in Webstera, Remirea, Ascolepis, Kyllinga, Courtoisia, Lipocarphe and in some Naricous spp. especially those showing 1-flowered spikelets. In this latter type of rachilla, the apex may be indistinct, or distinct as a corky organ tightly clasping the fruit from the adaxial side; as in Remirea. The homology of this organ has been discussed by numerous authors, viz: R. Brown (1810), Nees (1835, 1854), Kunth (1837), Boeckeler (1856), Bentham (1883), Clarke (1883-1884), Kukenthal (1935), Ohwi (1944), Charmeson (1922), Kern (1958) and Koyama (1961). Up to the present, there is no unanimous agreement on its interpretation, though one group pioneered by R. Brown and including Nees, Boeckeler, Bentham, Clarke, Kukenthal and Ohwi agree that it is an incrassate flower-bearing glume; while another group pioneered by Kunth, including Charmeson, Kern, Koyama etc., agree that it is an incrassate upper internode of the rachilla. The morphology of the spikelet and
Fig. 19  Spikelet structure in Remirea

A. External structure of the spikelet \[ \times 12 \]  
1 & 2 whole spikelet of *Remirea maritima*  
(1. side view, 2. anterior view)

'a' bract, 'b' spicular prophyll, 'c' & 'd' glumes, 'e' flower,  
'f' incrassate upper internode of rachilla

B. L.S. through whole spikelet \[ \times 4 \frac{1}{2} \]

C. T.S. of incrassate upper internode of rachilla

i-iv outlines of sections through various regions in the rachilla  
(see A. 'f')

a. mid-nerve region  \( \times 160 \)

b. winged lateral region  \( \times 160 \)

c. epidermal and cortical tissues  \( \times 660 \)
the anatomy of this corky organ are illustrated in Figs 19.B.c. The spikelet is shown to consist of a basal bract 'a', a spicular prophyll 'b', two glumes 'c' and 'd', 'c' being empty and positioned at the back of the corky organ, and 'd' fertile facing and sheathing the corky organ, a flower 'e' whose three stamens are placed between 'd' and the fruit of the flower, and the corky organ 'f', which partially clasps the fruit, bearing a small cuculate appendage at its apex. Figs 19.B.c respectively show a longitudinal section through the entire spikelet and a transverse section through the corky organ.

In Fig. 19.B the spikelet is shown as having one main nerve or vasculature in the 'real' rachilla, with traces to the spicular prophyll and the glumes. Below the point of insertion of the corky organ, the main nerve appears bifurcating or branching, with one nerve leading straight into the corky organ, the other into the flower to give traces to the stamens and fruit. In Fig. 19.C.i.iv the corky organ is shown to predominantly have one distinct nerve which may or may not subdivide from the base upwards. These vasculatures have very distinct cells with thickened cell walls (Fig. 19.Ca), sometimes occupying the whole height of the centre of the organ, or positioned more towards the adaxial part. The winged lamina-like part of the organ and around the vasculatures are filled with rounded to polygonal or sometimes spongy, translucent more or less inflated aerenchymatous cells, with secretory cells irregularly distributed in them (Fig. 19.Cb) and bordered on the outside adaxially and abaxially by a slightly thickened epidermal layer.

These anatomical features explain why the name "corky" was applied to this organ, and from its clasping of the fruit it is very likely that it is a modified floating disseminule [cf. Kern 1958]. From the relatively terminal position of the nerve trace going into the corky organ, and the lateral position of the traces going into the spicular prophyll, glumes and the flower, it is quite in order to consider this organ as part of the rachilla. With these
observations, I follow the second group of authors in toto (Kunth etc.) in interpreting this organ as the upper internode of the rachilla whose wings have become involute, thus embracing the fruit, and with an apex representing a vestigial uppermost glume.

In some genera, viz: Kyllinga, Queenslandiella, Torulinium, Remirea, Marisca, Courtoisia etc., the rachilla is articulate and caducous. The same can be said of the indistinct rachilla in Ascolepis and Lipocarpa; whose spikelets can be easily pulled out. The number of articulations in these articulate rachillas vary; for example in Kyllinga, Queenslandiella, Remirea, Courtoisia, Marisca and possibly Ascolepis and Lipocarpa, there is only one point of articulation, usually below the insertion of the empty basal glume(s), thus leaving the spicular prophyll and the bract on the inflorescence. In Remirea Kern (1958) observed that the articulation may be at either of two places, i.e. above or below the spicular prophyll. In Torulinium the points of articulation are both below the two empty basal glumes and in the succeeding nodes along the length of the rachilla.

All the other remaining genera, viz: Scirpus, Bolboschoenus, Cyperus, Juncoellus, Galitea etc., have non-articulated and persistent rachillas. One very general feature on these persistent rachillas is that they are never smooth, constantly bearing the scars left by the deciduous glumes and flowers. In certain genera, especially Cyperus, Juncoellus etc., these scars are more pronounced because of the decurrent nature of the bases of their glumes.

Conspicuously winged rachillas are observed in Kyllinga, Queenslandiella, Torulinium, Remirea, Marisca and Courtoisia. In Cyperus some species show well developed wings, e.g. C. odoratus L., C. aestuincoides Kunth etc., while in other species wings are rudimentary or completely absent, as in C. difformis L., C. iria L. etc. Wings could be suspected in Gentria because of the
descending nature of the lateral bases of the glume (Fig. 23 B). The remaining genera do not show any wings on the rachilla.

As would be expected, genera with a distichous arrangement of glumes have a rachilla which appears bilaterally compressed, sub-rectangular, rarely sub-quadrangular, and may be erect or zig-zag, and firm or more or less flexible. Of the other groups with spirally arranged glumes, the rachilla is also spiral or sub-spiral and more or less cylindrical or terete, rarely quadrangular [as in Genus A] or sub-rectangular [as in Scirpus paniculato - corymbosus].

The 1-flowered spikelets, such as those of *Websteria, Ascolepis, Lipocarpha* etc., are not here accounted for, because their rachillas are so much reduced that their outlines cannot be easily made out. The rachilla in *Remirea*, at least from the discussion above on the homology of the "corky" organ, could be described as sub-erect and firm.
According to whether the glume subtends a flower in its axil or not, there are two types found in the spikelet, viz: sterile and fertile glumes respectively. The sterile glumes are always basal, not above the spicular prophyll when present, one or two in number, and often smaller and distinct from the fertile ones, rarely indistinct as in Ramirea, Kyllinga, Webstertia etc. Sterile glumes are often absent, as in Ascolepis etc. For purposes of comparison, fertile glumes are emphasised here, since they are constantly present in every spikelet.

**Structure:** Very frequently, fertile glumes are membranaceous, scarious or coriaceous, concave or carinate, with free margins which hardly clasp round the flower. The incassate, more or less membranaceous organ partially or completely clasping the flower is of restricted occurrence in Ascolepis (Fig. 24 A). This organ has often been called a "squamella", following Nees's initial idea of the limits of the genus Ascolepis. In trying to establish its homology, Clarke (1901-1902) describes it as made up of 2 lateral organs coalescent completely on the antioous side, imperfectly or not at all on the posticous side. They would be 2 lateral bracteoles (prophylla) not known in any other genus of Cyperaceae. Earlier he (Clarke 1897-1900) had referred to them as "scales at anterior position, parallel with the glume, longer than it, thickened, in the Cape species utricular enclosing the flower, perhaps representing two lateral partially connate bracteoles". Taking Clarke's interpretation as it is, one would infer that the 'glumes' in his sense are the reduced involucral bracts, as used in this text, subtending spikelets, and the 'scale' or 'squamella' in his sense as the spicular prophyll, normally found above the reduced glume-like involucral bract, and below the sterile (when present) and fertile glumes. A study of the general inflorescence in Ascolepis reveals the pseudo-capitulum as consisting of lower leaf-like involucral bracts with the
Fig. 20. Morphology of the inflorescence in Ascolepis

a. General inflorescence in Ascolepis capensis x 6 (lateral view)
b. General inflorescence in Ascolepis capensis x 6 (ventral view)
c. L.S. general inflorescence of A. capensis x 12
d. One-flowered spikelets in Ascolepis elata x 25
e. One-flowered spikelets in Ascolepis elata x 12
f. T.S. incrassate glume in A. elata (Ascolepis subgen. Ascolepis) distil region x 160
f' sector of 'f' showing lateral vascular tissue x 660
g. T.S. incrassate glume in A. elata middle region x 160
g' Magnification of mid vascular tissue in 'g' x 660
h. T.S. incrassate glume in A. leucoccephala (Ascolepis subgen. Platylepis) x 60 [after Palla 1905 t. 14]
whole inflorescence unit compressed into a torus-like organ, bearing flowers, each of which is enclosed by the 'scale' or 'squamella' and subtended abaxially by the 'glume'. Each flower consists of three stamens and a gynoecium.

In Clarke's interpretation, then, this genus is without a fertile glume, in the sense used in this text.

Palla (1905) was the first to trace the homology of the 'squamella' from an anatomical standpoint, working within the subgenus Platylepis. He referred to this organ as 'Deckblatt' or glume and as being homologous with the common ones found in Kyllinga etc., as opposed to 'Tragblatt' or involucral bract, and 'Vorblatt' or spicular prophyll. Fig. 20, f shows a transverse section through this organ in the areas above the insertion of the flower in the subgenus Ascolepis. Fig. 20, h was redrawn from Palla, cut through the middle part of the organ, i.e. through the area that normally encloses the flower in the subgenus Platylepis. From these sections, the supposition by Clarke that these organs are formed from two lateral coalescent bracteoles is probably wrong, since there is only one mid-nervous or vasculature which is median in position. The utricular-like structure formed in the subgenus Platylepis is illustrated by Palla to have formed from extensions of the adaxial epidermal cells in the adaxial concavity where the flower normally lies and meeting and fusing over the flower forming a single layer; and the lateral sides converging into acute, wing-like margins, and bordered at their extreme ends by two layers of epidermal cells from the adaxial and abaxial surfaces. The absence of this utricular-like structure from the subgenus Ascolepis is thus explained to have occurred through the inability of the adaxial epidermal cells in the concavity to extend over the flowers, probably during their initiation and differentiation. The subgenus Ascolepis shows various transitional stages towards this flattened, utricular-like structure in the subgenus Ascolepis;
for example in *Ascolapis pusilla*: the base of the organ shows a tendency for the two free margins to unite. In *A. criocauloides, A. alata, A. prota* etc. the margins meet only slightly over the top of the flower, though there is no evidence of fusion; the bases have free margins.

The ground tissue in this organ is made up of spongy, translucent cells, bordered abaxially and adaxially by equal epidermal cells. There are a number of peripheral nervules below some epidermal cells which are traces from the main nerve or vasculature. These nervules give a sulcate appearance to the external surface of this organ. From these observations, I follow Palla (1905) in regarding the 'aquarella' or 'scale' in *Ascolapis* as homologous to a glume, and thus refer to it as such. Since there is only one such glume, surrounding or partially embracing a single flower, subtended by a single reduced glume-like bract at the base, the whole unit is referred to as a spikelet. There is a tendency for the development of spicular prophylls in the spikelet, inserted between the glume and the reduced bract [cf. Raynal 1968 on *A. dipseccides*]. The tip of the glume is projected into a strongly or less flattened conic beak, which may be well elongated as in subgenus *Ascolapis* or less elongated as in subgenus *Platyylepis*, but in every case the glumes develop centripetally and thus always give the inflorescence a rayed appearance, as in *Composites*.

The nature of the glumes in the other genera, apart from *Ascolapis*, are nearly identical, save for details such as colour, outline, number and nature of nerves, keels, margins, cells composing the glume and the bases of the glumes. **Colour:** Under the microscope, most glumes appear variegated, and frequently the dominant colours appear on surface view as characterising glumes of particular genera and species. Various shades of light green to stramineous, light brown to dark-brown or yellowish brown, chestnut (reddish brown) to
Fig. 21. Glume Outlines \( \times 12 \)

10. *S. microcarpus*


D. *Crysantherum cubense*

E. *Cyperus orbicosetus*

8. *T. clematis*)
Fig. 21  Glume Outlines
sanguineous (dark reddish-brown) are of frequent occurrence in these genera, and often the whole range is found in a single genus, such as Cyperus.

In Scirpus and Eriophorum subgena Eriophorum and Japonici, blackish-gray to light brown colour is very common. In Eriophorum, the blackish-gray half is often uppermost, with the lower half hyaline transparent. Nemum and Nelmesia show dark purplish-brown to reddish-brown colours. In Nemum the proximal half of the glume is yellowish to light reddish-brown, while the distal half is conspicuously dark. In Nelmesia, the darkest part is median with the distal and proximal light reddish-brown to hyaline.

Outlines: Most frequently, the glumes are oval, lanceolate or elliptic in outline, very rarely obovate as in Nemum (Fig. 23.E), Lipocarpha (Fig. 23.G) and Fuirena (Fig. 23.K). Usually in the ovoid glumes the uppermost margins tend to be rounded off, except in Lipocarpha where the margins suddenly contract towards the midnerve into an obtuse/acute angle. Of the ovoid, lanceolate or elliptic glumes, it is in Bolboschoenus (Fig. 22.C) and Schoenoplectus subgen. Schoenoplectus (Fig. 22A 7-10) that the apex of the glume appears notched or emarginate, and the midnerve is excurrent into an awn. There is a tendency for this kind of glume to occur in Hellmuthia and Ficinia, characteristically in F. paradoxa, F. eckloniae and F. pinguior. In Hellmuthia and F. pinguior the notched apex is smooth and of hyaline nature, while in F. paradoxa and F. eckloniae the margins are several times dissected and appear hairy (cf. Fig. 24.B.1).

The rest of the genera are oval, lanceolate or elliptic glumes have obtuse to acute apices, very rarely nearly rotund as in Eleogeton, Ficinia, Juncellus, Narisous and Eriophorum subgenus Japonici.
Fig. 22. Glume Outlines $\times 12$


D. *Phyllosporbus asaulus*
Fig. 22  Glume Outlines
Base of glume: Commonly in genera with persistent rachilla, the bases of the glumes tend to be deciduous or caducous, falling with the fruit as the latter matures, except in Nemum in which the glumes are long-persistent even after the fruits have fallen. In genera with deciduous rachillas, the glumes fall together with the fruit and the disarticulated portion of the rachilla. In the multi-flowered species in Maricous and Toruliniurn, the rachilla has several articulating nodes and the bases of the glumes are deciduous with the internodes, so that the disarticulation of the rachilla involves the fertile glume as well, and the two units, viz: internoded rachilla and the fertile glumes, are shed together. In Torulinurn, that part of the glume deciduous with the internodal rachilla is conspicuously swollen (Fig. 24).

Nerves: The midnerve is always present in all glumes, and certain genera are distinguished on whether it reaches the very apex of the glume or stops short of the apex. Eleogon, Nemum and Eriophorum subgenus Eriophorum and Japoniic usually have midnerves of the latter type. The other genera show the former. The number of conspicuous lateral nerves, apart from the midnerve, varies considerably, even within species and genera, and three to several lateral nerves are of frequent occurrence; certain genera such as Bolboschoenus, Eriophorum subgenus Eriophorum, Schoenoplectus, Hymenochaeta etc. show us other nerves apart from the main nerve.

Awn: In some genera the midnerve, with or without two lateral nerves, becomes excurrent into a short or long awn, and in such cases, the glumes become mucronate or aristate respectively (Fig. 23). Typical arista glumes are found in Fuirene, Bolboschoenus, Lipocarpha etc. and mucronate glumes are found in Scorpus, Pseudo-schoenus etc. Fig. 25. 6 show the outline of some of
Fig. 23. Glume Outlines \(\times 12\)

A. *Websteria confervoides*

B. Genus A (*Scirpus junghuhnii*)

C. *Desmoschoenus spiralis*

D. *Pseudo-schoenus inanis*

E. *Nemus* spp. (1. *N. angolensum*, 2. *N. spadiceum*)

F. *Hymanochasta grossa*


I. Genus B (*Blymus rufus*)

J. *Blymus compressus*


M. *Eriogonum* spp. (1. *E. cernus*, 2. *E. microstachyus*)
Fig. 23 Glume Outlines
these awns. Commonly prickles are found along the whole length, as in Bolboschoenus, Hymenochaeta etc., or at the tip only as in Oxyacryum or completely glabrous as in Calithea etc. Occasionally the indumentum tends to be of prickles hairs as in Fuirena.

Keel: Very often in glumes with an excurrent mid-nerve, the keel is pronounced and very distinct along its whole length, and often tends to make the glumes appear V-shaped in a t.s., as in Kyllinga, Courtoisia etc.; However, sometimes it is only prominent towards the tip and the glume thus appears widely V-shaped or crescentiform, as in Bolboschoenus, Fuirena etc. Very rarely do we find a pronounced keel along the whole length of the glume but without the development of an awn, as in Schoenoplectus subgen Actaeogoton, Genus C etc. The back of the keel may be sharply angular, with or without prickles as in Kyllinga etc. or rounded as in most genera, occasionally bearing adpressed or not adpressed prickles, as in Holoschoenus, Bolboschoenus etc.; or firm papillae as in Genus A. Some gummy spots are often found irregularly distributed on the keel and the subadjacent lateral sides, as in Schoenoplectus subgen Schoenoplectus. Often in some genera, especially Eleogiton, some minute blackish spots in the back ground of light green or stramineous colour of the glumes are found, not only in the mid-nerve area, but also along the lateral parts of the glume (the margins excepted).

Margin of glumes: Three forms of glume margins are observed. The form with prickles hairs (Fig. 25A.1) tends to be restricted to certain genera and species. Oxyacryum and Fuirena show them in all their species, though in Fuirena typical prickles are sometimes present. In Oxyacryum the distribution of
Fig. 24. Glume Outlines

A. Aseolepis spp. x 6
1. A. pinguior, 2. A. protea, 3. A. brasiliensis
4. A. espensis

B. Ficinia spp. x 12
1. F. paradoxa, 2. F. bracteata, 3. F. trichoides
4. F. angustifolia

C. Galilea macronata x 12

D. Cyperus spp. x 12
1. C. glomeratus, 2. C. rotundus, 3. C. nosanus

E. Androtrichum trigynum x 12

F. Pyreaes sanguinolentus x 12

G. Juncellus laevigatus x 12

H. Kyllinga squarrosa x 12

I. Courtesia cyperoides x 12

J. Mariscus spp. x 12
1. M. rufus, 2. M. congestus

K. Torulinium spp. x 12
1. T. eggersii, 2 & 3. T. ferax
Fig. 24 Glume Outlines
prickle-hairs are borne only in the distal half of the glume margins, while the lower half are completely smooth. In 
Fuirena the distribution is over the whole abaxial surface. In Nemum angolenses these prickle-hairs are present in the same position as in 
Oxyarrhen, while absent in the other species Nemum spadicum.

The form with typical prickles (Fig. 25.A.2-3) is of frequent occurrence. Some have thickened walls while others have thin walls, but often the distinction between the two becomes obscured or diffused in the same specimen. In such genera as Bolboschoenus, Hymenochaeta, Schoenoplectus subgenus Schoenoplectus, all species have glumes whose entire margins and the whole abaxial surfaces are covered with these prickles. Frequently in certain genera such as 
Scirpus, Trichophorum, Ficinia, Holochoenus etc. some species show prickles on their margins while others have completely smooth margins. 
Pseudo-schoenus, Genus C etc. show three thin-walled prickles mostly at their uppermost margins; and in these genera it is believed that these thin-walled prickles developed as a result of the gradual dissolution of the middle lamellae in the peripheral cells from a glume with smooth margins.

The form with absolutely smooth margins (Fig. 25.A.4-5) is found in all species in Isolaepis, Eleogeton, Schoenoplectus subgenere Asthenogoton and 
Malnogoton, Nelmesia, Cyperus, Kylinga, Torulinum, Androtrichum, Pyrurus, 
Juncellus, Mariscus, Webstoria, Desmochoenus, Lipocarpha, Blysmus, Genus B, 
Eriophorum subgenus Eriophorum and Japonica.

Glume cells: Two types of epidermal cells are apparent on the surface of the glume; one with wavy or sinuous anticlinal walls, some obviously showing siliceous depositions (Fig. 25.B.3,4,6); and another with absolutely smooth
Fig. 25. Microscopic structures of glume

A. Glume margins

1. Prickle-haired margin x 160, e.g. *Oxycaryum cubense*

2 & 3. Prickled margins x 660

2. *Hymenochaeta grossa* 3. *Holoschoenus vulgaris*

4 & 5. Smooth margins x 660

4. *Trichophorum atacamensis* 5. *Eleogiton fluitans*

B. Glume surface x 660

1. Papillose surface towards distal lateral sides of glume
e.g. *Nemum angolensum*

2. Prickle cell e.g. *Hymenochaeta grossa*

3. Epidermal cells with differently coloured transverse anticlinal walls
e.g. *Schoenoplectus oxyjulus*

4. Sinuous anticlinal walls in epidermal cells, e.g. *Trichophorum clementis*

5. Smooth anticlinal walls in epidermal cells, e.g. *Holoschoenus thunbergianus*

6. Stomata in mid-nerve region, e.g. *Trichophorum mattleldianum*

C. Arms of glume x 160

1. e.g. *Holoschoenus vulgaris* 2. e.g. *Oxycaryum cubense*

3. e.g. *Schoenoplectus corymbosus*
Fig. 25 Microscopic structures of Glume
anticlinal walls (Fig. 25.B.5). Occasionally the two types are found in the same glume, the former towards the margins and the latter in the mid-nerve area, or vice versa.

Frequently in *Nemum angolense* the epidermal cells on the top lateral half of the glumes have papillosic projections on their transverse anticlinal walls (Fig. 25.B.1); while in *Schoenoplectus oxyjulus* the transverse anticlinal walls of some epidermal cells are differently coloured, being often deep yellow under the microscope (Fig. 25.B.3). These are believed to be incipient prickles, or possibly of a siliceous nature; I have no evidence to prove their exact nature. Frequently the midnerve area shows some evidence of photosynthetic activity in the glume, in having stomata (Fig. 25.B.6) distributed along the sides of the main nerve. The presence of the stomata appears sporadic; they are not found or easily distinguished in glumes with dark brown or reddish-brown colours in the midnerve area.
6. **Awn length relative to main body of glume**
   - (a) present, long; (b) present, short; (c) absent

7. **Back of keel**
   - (a) prickled; (b) with gummy spots; (c) papillose; (d) smooth

8. **Margin of glume (cf. Fig.)**
   - (a) with prickle hairs; (b) with typical prickles; (c) smooth
Explanation to Table 3 could.

Spikelet

1. (a) sessile; (b) stalked

2. Spicular prophyll
   (a) present; (b) absent

3. Number of flowers per spikelet
   (a) 1-2-flowered; (b) many-flowered

Rachilla

1. Articulation
   (a) present; (b) absent

2. Number of articulations
   (a) one; (b) more than one (0) absent

3. Nature of rachilla
   (a) conspicuously winged; (b) minutely winged; (c) not winged

Glumes

1. Arrangement in spikelet
   (a) distichous; (b) sub-distichous; (c) spiral

2. Number and nature
   (a) one to a spikelet, incrassate; (b) 2-many to a spikelet, scarious

3. Outline
   (a) ovate; (b) obovate; (c) lanceolate; (d) elliptic

4. Apex of glume (excluding awn when present)
   (a) rotund; (b) acute; (c) obtuse; (d) emarginate; (e) several
      times dissected

5. Midnerve
   (a) ending short of apex; (b) extending to apex, often excurrent
Explanations to Table 3

Comparative Vegetative and Inflorescence Morphology

The SHOOT

1. Occurrence of nodes
   (a) conspicuously noded above; (b) nodeless above

2. Size of shoot
   (a) slender to robust; c. 2.0-5.0 mm diam.; (b) setaceous, filiform or wiry 2.0 mm diam.

The LEAF

1. Position on culm
   (a) cauline and sub-basal; (b) basal or sub-basal

2. Ligule
   (a) present tubular; (b) present not tubular; (c) absent

3. Leaf blade
   (a) well-developed; (b) absent or reduced to a short mucro

4. Form of leaf blade
   (a) graminaceous; (b) channelled/paniculate; (c) setaceous;
   (c) not applicable

GENERAL INFLORESCENCE

1. Position on shoot
   (a) terminal; (b) pseudo-lateral; (c) mixed terminal and pseudo-lateral

2. Type of branching
   (a) corymbose; (b) umbellate; (c) paniculate; (d) capitate/head;
   (e) spike-like; (f) capitulum-like; (g) secund; (h) verticillate-like;
   (i) solitary

3. Involucral bract
   (a) leaf-like; (b) culm-like; (c) glume-like
### Table 5

**Distinguishing Characteristics and Taxonomic Relationships**

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<tr>
<th>TAXA</th>
<th>SUBC.</th>
<th>CHARACTERS</th>
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<td>ILEA</td>
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**Note:**

- ( ) = more or less
- ≥ = greater than
- < = less than
- ≥ = equal to

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<th>DATA</th>
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**Characters:**

- Rarely
- Less

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**Abbreviations:**

- REN: Rhenan
- RUB: Rubrastri
- S. = Striata
- T. = Tripartita
- V. = Verrucosa
CHAPTER IV

COMPARATIVE FLORAL MORPHOLOGY

THE FLOWER: The flower is hermaphrodite or bisexual consisting of a bicarpellate or tricarpellate gynoecium, androecium and often modified or reduced hypogynous perianth segments. It is always borne in the axil of a fertile glume, with the stamens lying towards or against the adaxial concavity of the fertile glume and away from the rachilla.

Protogynous flowers are frequent in the genera; the stamens elongating and exerting over and often above the fertile glumes at maturity, when the stigmas have already matured, but often stamens and stigmas at the same stage of maturity occur (cf. Smith 1969, p. 178 etc.). The general process of maturation of the flowers in the spikelet is progressively centrapetal (cf. Friedland 1941, Smith op. cit.).

The flowers are normally very small and the assessment of the relative positions of the parts of some of them has presented difficulties to many a cyperologist over decades and centuries. Very often theories and interpretations are propounded to try to explain most of the unusual forms of flowers, but by and by these theories largely become unacceptable in the light of new information and data. One such theory is the "synanthium" interpretation of the flowers in Fuirena and Dulichium. According to this theory, the flower is a synanthium when the hypogynous perianth segments are inserted inside the whorl of stamens; thus each separate stamen is considered as a lateral or axillary unisexual male flower and the pistil together with perianth segments as a terminal female flower - as opposed to a normal axillary hermaphrodite flower whose hypogynous perianth segments are outside the whorl of stamens.

Exponents for the "synanthium" interpretation of the flowers in Fuirena have included Nees (1835), Kern (1962) etc. and in Dulichium Mattfeld (1938), Schultze-Motel (1959) etc.
Floral anatomical investigations carried out by Blaser (1941) have revealed the true hermaphroditic nature of the flowers of these two genera, *Fuirena* and *Dulichium*, as well as *Cyperus*, *Pycreus*, *Kyllinga*, *Mariscus*, *Trichophorum*, *Eriophorum*, *Schoenoplectus*, *Bolboschoenus*, *Scirpus*, *Hemicarpha*, *Lipocarpha* etc., having traced the development of incipient traces from the 'pedicel' into the hypogynous perianth segments (when present), stamens and the bi- or tri-carpellate pistils. My consideration of the flower in the genera treated here as wholly bisexual or hermaphroditic, has largely been based on this work of Blaser.

**FLORAL DIAGRAMS**

As illustrated in Fig. 26, there appear to be seven very distinct types of floral diagrams.

Type I is shown by flowers consisting of 1–6 hypogynous perianth bristles, 3 stamens and bi- or tri-carpellate ovaries, as in *Scirpus*, *Bolboschoenus*, *Schoenoplectus* subgenera *Schoenoplectus*, *Malaogoton* and *Astaeogoton*, *Fuirena* subgen. *Pentaastica* sect. *Pentaastica*, *Genus A*, *Genus C*, *Trichophorum*, *Webateria*, *Phylloscirpus*, *Blysmus*, *Genus B*, *Erioscirpus p.p.*, *Eriophorum p.p.*, *Hymenochaeta*, *Pseudo-schoenus* etc.

Type II has more than 6 hypogynous perianth bristles, generally 3 stamens and tri-carpellate ovary, as in most *Eriophorum* and *Erioscirpus*.

This condition is believed to have resulted from the splitting of the 6-hypogynous bristles found in Type I (cf. Blaser 1941, Koyama 1958).

Type III is shown by flowers consisting of hypogynous perianth segments, the outer whorl of which is made up of 3 bristles and the inner of 3 petal-like plates; 3 stamens and a tri-carpellate ovary as found in *Fuirena* subgenera *Fuirena* and *Vignaria* (cf. Clarke 1909, Blaser 1941, Koyama 1958).
Fig. 26  **Schematic Floral Diagrams**

Type I
- a-e  after Clarke 1909, Koyama 1958

Type II
- f  cf. Blaser 1944

Type III
- g  after Clarke 1909

Type IV
- h-k

Type V
- l  after Van der Veken 1955

Type VI
- m-o  'o' after Falla 1908

Type VII
- p  after Clarke 1909
Fig. 26  Schematic Floral Diagrams

a-e  Scirpus, Schoenoplectus etc  f. Eriophorum & Erioscyrpus

j. Fuirena subgen. Fuirena & Vaginaria  h-i  Cyperus etc  j. Kyllinga

k. Poeceus  l  Nelmesia  m-o  Asclepis  p. Hellmuthia

Key:
- Fruit
- Stamen
- Bristle
- A fascicle of bristles
- Petal-like plate
- Scale
- Glume
- Bract
- Axis
Type IV is without hypogynous perianth segments, and consists of 1-3 stamens and a bi- or tri-carpellate ovary. Genera in which the pistil is tri-carpellate include Cyperus, Remirea, Haricosus, Torulinum, Galilea, Courtoisia, Lipocarpha \textit{Volckhiella}, Oxyoaryum, Heloschoenus, Androtrichum, Desmoschoenus, Ficinia etc.

In the bi-carpellate genera, there are two groups according to the orientation of the ovary. The group in which the ovary is bilaterally compressed (i.e. the margins of the fruit are in line with the axis of the spikelet) includes Kyllinga and Pyreus. The other group in which the ovary is adaxially compressed or adaxially and abaxially compressed includes Juncellus, Duval-Jouvea, Nemum etc. Isolepis and Schoenopleotus subgen. Actaegeton include both bi- and tri-carpellate species.

Type V is shown by flowers with a median adaxial (posterior) chartaceous (papery) or hyaline scale; 1-3 stamens and bi- or tri-carpellate ovary as shown in \textit{Nelmesia cf. Van der Veken 1955} Hemiarpha.

Type VI has flowers consisting of 1-3 stamens and a bi- or tri-carpellate ovary, and the fertile glume completely or partially enclosed the flower e.g. Ascolepis.

Type VII is similar to Type IV, except that two lateral scarious "glumellas" \textit{cf. Steudel 1855, Clarke 1897} are sometimes present, e.g. Helmmuthia.

**HYPOGYNOUS PERIANTH SEGMENTS**

In their present defined position as one or two, rarely more whorls of perianth segments, below the whorl of stamens, three different types are observed, excluding the disc-like gynophore often found in Ficinia and below which the stamens are inserted.
Fig. 27. **Hypogynous Perianth Segments (Bristle)** x 660

1-3 Needle-like, retrorsely, scabrous bristles

1. *Elymus compressus*  
2. *Websteris confleroides*

3. *Bolboschoenus maritimus*

4-9 Filiform to silky, anteriosely scabrous to smooth bristles

4. *Triehophorum alpinum*  
5. *Erioscirpus falsus*

6 & 7. *Triehophorum caespitosum*  
8. *Scirpus fontinalis*

9. *Erioscirpus comosus*
Fig. 27 Hypogynous Perianth Bristles
The three types include the papery or hyaline scales (Type V); petal-like plates (Type III) and bristles (Types I & II) [ref. floral diagrams].

All the taxa mentioned under Floral Diagrams Types IV and VI have no hypogynous perianth segments.

1. Scale-like: *Nelmesia* and *Hemicarpha* normally have one of such structures placed in the median adaxial (posterior) position of the flower towards the spikelet axis. In *Nelmesia* Fig. 28.3 the scale is papery hyaline to palaly rufous, suborbicular to obovate, irregularly bilobed and dentate at the apex, 3-4 mm long [Van der Veken, 1955]. There is no information on internal vasculature. In *Hemicarpha* Fig. 28.7 it is scarious, hyaline and obovate, entire or bilobed, with or without vasculature, often vestigial or absent [cf. Friedland 1947].

   The two lateral scarious "squamellae" found in *Hellmutida* [Floral diagram type VII] appear to occur in only one specimen, i.e. Drege 3943 [cf. Steudel 1855 p. 90, Bentham 1883 p. 1050, Clarke 1897 p. 225]; and have never been found in any other specimen. This lateral position assumed by the "squamellae" simulates the floral arrangement in *Hypolytrum* [cf. Bentham 1883, Clarke 1902].

2. Petal-like plates: Constantly three in number, are restricted to *Fuirena* subgenera *Fuirena* and *Vaginaria*. The various forms and shapes of these plates in the genus are illustrated in Fig. 29. It appears that each species has its own distinctive 'plate', though quite a few forms and shapes, such as those in *F.squarrosa*, *F.glabra*, *F.simplex*, *F.coeruleoens*, *F.claviseta* etc. appear in more than one species.

3. Bristles: Frequently the number of bristles is 6, but often series from one to six are found, as in *Scirpus*, *Hymenochaeta*, *Pseudo-schoenus*, *Fuirena*, *Bolboschoenus*, *Schoenoplectus*, *Glyceria*; *Glyceria*, *Triobophorum*,
Fig. 28. Hypogynous Perianth Segments (Bristle and scale)

1 & 2. Needle-like, irregularly scabrous bristle x 660
   1. *Scirpus polyphyllus*, 2. *Scirpus radicans*

3 & 4. Plumose fimbriate bristle
   3. *Schoenoplectus littoralis* (diagrammatic), 3' multi-celled setulose
   4. *Schoenoplectus riparius* (diagrammatic) 4' uni-celled setulose

5 & 6. Reduced bristles

7 & 8. Scales
   7. *Hemicarpha occidentalis* x 160, 8. *Nelmesia melanostachya*
   (after Van der Veken 1955)
Fig. 28 Hypogynous perianth segments
In *Eriocirpus* and *Eriophorum* there is often an increase in number of bristles per flower, from 6 through 9-12-18 to 24 or more. Blaser 1941 writes about this condition in the following words: "In older flowers no order or arrangement can be seen, but in young flowers there are five fascicles corresponding in position to five perianth segments. These fascicles are interpreted as split perianth members ....... the interpretation based only on analogy and position .......".

**Forms:** Of the three forms of bristles observed, viz: needle-like, plumose-fimbriate and filiform or silky; the former (first) is very common, occurring in *Hymenochaeta*, *Pseudo-schoenus*, *Fuirena*, *Bolboschoenus*, *Genus A*, *Genus C*, *Websterie*, *Phylloscirpus*, *Blysmus*, *Genus B* etc. This form of bristle normally appears yellowish-brown or reddish-brown, and is believed to contain vascular traces (Blaser 1941). In *Fuirena wallichiana* var. *evoluta* (Fig. 29.13) the middle of the bristle is swollen, showing a tendency towards the petal-like plates especially of those in *Fuirena squarrosa*, *F. pumila*, *F. hirta* and *F. robusta* (cf. Clarke 1909, Koyama 1958).

The plumose-fimbriate form is only found in *Schoenoplectus* subgenus *Schoenoplectus* section *Pterolepis*, and typically exhibited in *Schoenoplectus littoralis* (Fig. 28.3). From this typical form can be observed a reduction series in the nature of the papillae-like hairs or cells on the main axis of the bristle, through *Schoenoplectus riparius*, *S. tatora*, *S. californicus* whose hairs are one-to two-celled, to the form in *Schoenoplectus* subgenus *Schoenoplectus* proper which is a typical needle-like bristle (cf. Koyama 1962).

The filiform or silky bristles occur in *Eriophorum*, *Eriocirpus*, *Scirpus* and *Trichophorum*. Typically, as in most species of *Eriophorum* and *Eriocirpus*, they greatly elongate at maturity and extensively overtop the whole spikelet.
Fig. 29. Hypogynous Perianth Segments - Petal-like Plates in Fuirena

1. *F. bernieri* x 20,  2. *F. calolepis* x 20,  3. *F. glabra* x 20
7. *F. glomerata* x 25,  8. *F. scirpoidea* x 25,  9. *F. squarrosa* x 25
13. *F. wallachiana* var. *evoluta* x 20,  14. *F. ecklonii* x 20
15. *F. coerulescens* x 20,  16. *F. quercina* x 20,  17. *F. enodis* x 20
24. *F. trilobites* x 30

1 & 16. after Chermesov 1936
2, 20-22. after Napper 1963
3, 4, 9-15, 17-19, 23, 24. after Clarke 1909
Fig. 29  Petal-like Plates in Fuirena
including the fertile glumes, and are considered as organs adapted for wind disposal [Ridley 1930 p. 131, 150-151]. This typical form is found in a few species of Scirpus, especially those in section Linsei and one species in Triophorum (T. alpinum). The other form of filiform bristles normally shows very little elongation and is often tortuous, the bristles being enclosed in the fertile glume, occasionally over topping it. In Eriophorum it occurs in one species of subgenus Eriophoropsis (E. crinigerum) of Beetle 1942, Schuyler 1967 p. 296 and in subgenus Japonicum (E. japonicum) in both of which a hypogynous perianth number of six has frequently been observed, though in E. crinigerum Beetle [op. cit] has recorded a number ranging from six through nine to twelve. In Triophorum, most species show this form, e.g. in T. caespitosum; however some species do not show any bristles at all, as in T. atacamensis and T. pumilum, but occasionally in the latter species some rudimentary bristles in the form of membranaceous protuberances are found at the base of the fruit (Fig. 28.6). T. clementis shows 3-6 yellowish-green, broad, often bilobed, chartaceous 'bristles' (Fig. 28.5) In Scirpus filiform bristles are fairly well represented, as well as the typical needle-like forms. In Eriocirpus, only one species [E. falsus] shows this form of filiform bristles; they are always six in number as in Eriophorum japonicum.

Nature of scabridity: The nature of scabridity (or of cells on the periphery of the bristle) in all the above named forms of bristles, is variable, and often characterises certain genera. Four very distinct types are observed; viz. retrose, antrose, irregular or smooth.

(a) Retrussely scabrous bristles are those in which the tips of the barbs point downwards. Depending on the number of cells making the barb, the thickness of the external (periocinal) cell walls, the relative length of the barbs, and the angle formed at the tip of the barbs, three forms of
retrorsely scabrous bristles are observed, viz:

(i) one-celled, thick-walled, up to c. 100 \( \mu \) long, with acute tip (Fig. 27.1, 3). This is generally found in Bolboschoenus, Schoenoplectus p.p., Hymenocheta, Pseudo-schoenus, Fuirena, Phyllosorus, Sphagnum, some Scirpus spp. especially S. sylvaticus, S. asper, S. atrovirens etc.

(ii) one-celled, thin-walled, from 100-400 \( \mu \) long, with obtuse tip (Fig. 27.2), generally found in Websteria and Schoenoplectus subgen Schoenoplectus sect. Pterolepis (especially S. riparius Fig. 28.4).

(iii) two to many-celled, thin-walled, 450-900 \( \mu \), with obtuse tip (Fig. 28.3), generally found in Schoenoplectus subgenus Schoenoplectus sect. Pterolepis (especially S. littoralis Fig. 28.3).

(b) Antorsely scabrous bristles have the tips of the barbs pointing upwards. The barbs are usually one-celled and often thin-walled, rarely thick-walled as in Genus A and Genus B. Depending on the angle formed at the tip of the barb, the extent of distribution of the barbs along the length of the bristle, and the angle of insertion of the barbs on the main axis, two groups are observed, viz:

(i) barbs with rounded to obtuse tips, distributed along the whole length of the bristle, and inserted at obtuse to widely-obtuse angles on the axis (Fig. 27.6) ... is found in Genus B, most species of Trichophorum especially of the subgenus Anthelophorum, and in some Eriophorum spp.

(ii) barbs with acute tips, distributed mainly from about the middle upwards, rarely the whole length of the bristle, and inserted at an acute angle on the axis (Fig. 27.4, 5, 9) ... found in Genus A, some Trichophorum species (notably T. alpinum), some Eriophorum
species (especially E. falsus, E. macrostachyum), few Eriophorum species (especially E. japonicum, E. crinigerum) and some species in Scirpus (especially S. cyperinus, S. fuirenoideas, S. longii etc.). In some species of Eriophorum subgenus Eriophorum, notably E. callitrix, E. brachyantherum and E. vaginatum, the antrorse barbs are only at the tip of the bristle (Palla 1896 t. 5 f. 6-15).

(c) Irregularly scabrous bristles normally do not appear wholly retrorse or antrorse, showing a mixture of both arrangements, sometimes some barbs pointing horizontally or at right angles (Fig. 28.1, 2). This situation has been observed in some Scirpus species, especially S. polyphyllum, S. congonii, S. peckii, S. divaricatus, S. radioans etc. and also in Schoenoplectus subgenus Malacocoton in which the bristles are often smooth, but occasionally small barbs c. 35 µ long appear from the middle upwards towards the tip of the bristle.

(d) Smooth bristles normally have no barbs along their whole length (Fig. 28.7, 8) as found in most species of Eriophorum (Palla, op. cit.) and occasionally in Scirpus, especially S. fontinalis and S. lineatus.

**ANDROECIUM**

**Number of stamens:** As seen from the floral diagrams, the number of stamens is varies from one to three, often the whole variation/observed in a single genus, as in Cyperus, Ascolepis, Pycreus etc. A frequent number of three is found in Scirpus, Schoenoplectus, Fuirena, Bulboschoenus, Holoschoenus, Webstoria, Remirea, Nelmesia etc.

**Filaments:** The filaments characteristically elongate at maturity, often exerting the anthers above the fertile glumes. Occasionally, the remains of the filaments become persistent and tortuous, over topping the spikelets and simulating silky or filiform bristles, after the anthers have fallen off, as in Androtrichium.
Fig. 30. Staminal Crests x 160

A. 1. *Eleogiton crassiuscula*, 2. *Schoenoplectus mucronatus*

B. Papillose & Prickled Crests
    1. *Demoschoenus spiralis*, 2. *Eriocirpus falsus*
    5. *Oxyocaryum cubense*, 6. *Bolboschoenus maritimus*
    7. *Schoenoplectus subulatus*
Fig. 30 Staminal Crests
There is evidence of this kind of situation acting as an organ of disposal in *Gahnia* (Ridley op. cit. p. 117), but it is not yet known whether a similar function is carried out in *Androtrichium*.

**Anthers:** The anthers are generally basifixed, linear with introrse longitudinal dehiscence. In some genera the anthers are conspicuously large, as in *Elymus*, *Phylloscirpus*, *Bolboschoenus*, *Nelmesia*, *Webasteria* etc., while in other genera they are relatively smaller, as in *Scirpus*, *Nemum*, *Ramirea* etc. The genera with conspicuously large anthers tend to have large glumes and large fruits, as in *Elymus*, *Genua* B, *Bolboschoenus* etc.

**Crests:** The anthers are generally crested, the crests being formed from the sterile apical part of the connective. The crests assume a number of shapes; depending on the angle of the tip, the crest may be long or shortly acuminate (Fig. 30.B.2), obtuse (Fig. 30.A.1) rotund (Fig. 30.A.2) or rotate (Fig. 30.A.3). Conspicuously long acuminate crested anthers are found in *Deamoschoenus*, though in *Webasteria*, *Erioforpus*, *Bolboschoenus* spp., *Schoenoplectus* spp., *Holoschoenus* spp., *Ficinia* spp. there are intermediates from long to shortly acuminate crested anthers. Obetuse crested anthers are rather common, being found in most *Bolboschoenus* spp., most *Schoenoplectus* spp., *Pseudo-schoenus*, *Nemum*, *Ascolepis*, *Fuiuna*, *S. Setites* A, some *Holoschoenus* spp., *Oxyocarvum*, *Hallmuthia*, *Isolenis*, *Phylloscirpus*, *Elymus*, *Genua* B, some *Ficinia* spp., *Nelmesia* etc. Intermediate states from obtuse to rotund crested anthers occur in *Scirpus*, *Trichoporum*, *Eriophorum*, *Ligocarpha*, *Androtrichium*, *Cyperus*, *Galilae*, *Pyremum*, *Junclulls*, *Duval-Jouve*, *Courtoisia*, *Kyllinga*, *Mariscus*, *Torulinium*, *Ramirea* etc. Rotute crested anthers occur occasionally, being observed in *Genua* C, *Kleogiton* and *Volkiella* of *Nemum* & Czech. 1957 though in the two former genera, I have observed that variations from obtuse through
rotund to retuse or vice versa occur. There is a tendency for a similar variation to occur in Schoenoplectus, especially subgenus Actaeogoton <S. erectus. Fig. 30.A.4>.

Profile of crest: The profile of the crest from the adaxial surface may appear prickled (Fig. 30B2367) papillose (Fig. 30B4, 5) or smooth (Fig. 30.A.1-4). Genera frequently showing a prickled profile include Bolboschoenus, Genus A, Helimithia and Elymus. Desmoschoenus and Oxycaryum have a papillose profile, while Pseudo-schoenus, Holoschoenus and Eriocirrus show both prickled and papillose profiles in different species. In Schoenoplectus subgenus Schoenoplectus, both prickled and papillose profiles occur in different species, while in the subgenera Malacogoton and Actaeogoton, smooth profiles are observed. A similar condition to that in Schoenoplectus occur in Ficinia, though most species have prickles or papillose profiles (e.g. F. gracilis, F. remossissima etc.) while a few show smooth profiles (of. F. praemorse).

In Websteria and Genus B there are tendencies towards papillose profiles, but the papilla are not clearly defined. Predominantly smooth profiles are characteristic in Scirpus, Hymenocheta, Nemum, Ascolepis, Ruirena, Genus C, Trichophorum, Eleogiton, Isolepis, Phylloscirpus, Eriophorum, Lipocarpha, Androtrichium, Cyperus, Galilae, Pyrexus, Junellus, Duval-Jouvea, Curtoisie, Kyllina, Mariscous, Torulinium, Nelmia /Volkiella/, Hemicarpha and Queens-landiella.

Pollen grains

Structure: There is a long sequence of references to the pollen structure dating back to 1830 (ref. Erdtmann 1952, Cranwell 1953, Davis 1966 et al.).

The grains are either subglobose, ovoid, elongated ovoid, wedge or sord-shaped or spheroidal, and measured from c. 16-76 μ x 20-46 μ (Erdtmann op. cit.).
Aparturate this part). Kyllinga is noted to have aperturate or panto-aperturate grains which show a zonal distribution of 4-6 apertures (Padhye 1966-67, 1971); a more or less similar kind of grain has been observed in Lepironia (Erdtman op. cit. p. 1417 and Cladium (Erdtman op. cit., Kovama 1956); while most genera (especially those considered in this part) have aperturate, rarely inaperturate, largely monoporate or monocolpate grains (Woodhouse 1935, Bakker op. cit., Cranwell op. cit., Padhye 1967, Sharma 1967 etc.7).

The exine structure has been observed as thin, varying in thickness from 1.0-2.5 μ, sculpturing being minutely granulate, sorobiculate or reticulate (Bakker op. cit.7, or lectate, smooth, but rough over exits, rod layer distinctive (Cranwell op. cit.7, or simply as having stratification which is apparently more or less the same as in other plants (Erdtman op. cit.7. Woodhouse (op. cit. p. 3517 noted adaptive likenesses between the grains of Cyperaceae and those of ash and poplars; an observation which was later confirmed from peat studies (cf. Inversen 1945). Note that these groups are predominantly wind pollinated.

Development: The development of pollen grains of representative species of certain genera has been investigated by many workers, and it is generally accepted that the mode of development is completely different in that there is no formation of true tetrads as such, and the wall of the microspore mother cell becomes the wall of the functional microspore (Ref. Davis op. cit.7. Because of this abnormal condition in the family Cyperaceae, Selling (1947) suggested the term "Pseudomonads" for the pollen grains since they are not homologous with pollen grains in general usage, but Erdtman (op. cit.7
preferred the term "Cryptotetrad" though suggested that this question of
terminology be open to await future cytological investigations, especially
of *Neparia* and its allies. Skottsberg [1940, p. 65], Erdtman [op. cit.]
consider the condition in which the wall of the microspore mother cell becomes
the wall of the functional microspore as a form of support for a close relation-
ship between the *Cyperaceae* and the *Juncoaceae* where also the outer wall of the
tetrad is derived from the microspore mother cell but in the *Juncoaceae* the
inner walls dividing the microspore nuclei are not reabsorbed as in the
Cyperaceae to form "pseudomonada" or "Cryptotetrad" [Wille 1882, Zander 1935,
Selling op. cit., Cranwell op. cit. p. 39].

Chromosome counts: Chromosome counts of the Cyperaceae, and more especially
of the genera considered here, are very scanty. Almost all the counts were
made from the first meiotic metaphase stage of the microspore mother cell,
very few from root tips. Various cytological abnormalities have been reported;
viz: (a) occurrence of aneuploid [cf. Täkholm 1920] or dysploid [cf. Jeffrey
1925] series in the chromosome numbers [Hakansson 1922, Hicks 1928, Heilborn
1922, 1924, 1932, 1934, 1936, 1937, 1939, Tanaka 1939 etc.]
(b) cytomiXis [Hicks op. cit.]
(c) occurrence of chromatic extrusion into the cytoplasm [Hicks op. cit.]
(d) chromosomes with diffuse or polycentric centromeres [Sharma & Bal 1956], etc.
Most of these workers have offered explanations for these cytological irregulari-
ties in the whole family *Cyperaceae*, viz: Defective conjugation in meiosis
(----conjunction) leading to polysomy, [Heilborn 1932]; bastardizing [Hakansson
op. cit., Hicks op. cit.]; structural changes of the chromosomes [Sharma & Bal
op. cit., Schuchler 1967, Strandhede 1965]; hybridization [Hicks op. cit.,
Strandhede op. cit. etc.]; polyploidy - 1/10 - or auto-polyploidy [Heilborn 1932,
1934, 1939, Neurman 1929, Muntzing 1936, Hakansson op. cit., Wulff 1939,
Strandhede op. cit. though some of the explanations are highly hypothetical. However, there seems to be a general agreement over the consequences of these abnormalities or irregularities, i.e. the occurrence of highly fertile and viable hybrids which are predominant in most genera of Cyperaceae [cf. Schuyler 1969, Bakker D. 1954, Otzen 1962 etc.].

Chromosome counts available are summarised in table 4.

**THE GYNOECIUM:** consists of the style and stigmas and the ovary which mature to form the fruit.

**Style:** The styles generally have slender bases which are confluent with the apex of the ovary, and are deciduous, falling off as the ovary matures; often leaving behind their slender bases which appear as long or short beaks. Genera in which long beaks occur include *Oxyocaryum*, *Schoenoplectus* subgenera *Schoenoplectus* and *Malacogonon*, *Bolboschoenus*, *Websteria*, *Genus A*, *Blysmus*, *Genus B*, *Fuirena* etc. Often in *Scirpus*, *Phylloscopurus*, *Trichophorum* etc. short beaks occur. *Nemum* shows no trace of the deciduous styles on their matured fruit, save for the minute scar left by the style base; *Genus C* and some *Trichophorum* (e.g. *T. clintonii*, *T. pumilum* etc.) show similar features.

**Stigmas**

**Structure:** Most genera have weak or delicate stigmas, except in *Schoenoplectus*, *Bolboschoenus*, *Genus C*, *Blysmus*, *Genus B* and *Ascolepis* where the stigmas appear firm and often strap-like [cf. Schuyler 1974] and disposed divaricately or erect.

**Papillae:** The surface of most stigmas show papillae which may be densely (as in *Bolboschoenus* etc.) or minutely (as in *Blysmus* etc.) distributed. Often a number of genera, viz: *Cyperus*, *Ramirea*, *Duval-Jouvea*, *Kyllingae*, *Pycnium*, *Androtrichium*, *Hemicarpha*, *Marsous*, *Junoellus*, *Galilæ*, *Torulinium*.
<table>
<thead>
<tr>
<th>GENERA</th>
<th>Total No. of species investigated</th>
<th>Haploid number of chromosomes</th>
<th>References and Citations</th>
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<td>9, 12, 13, 15, 16, 17,</td>
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<td>PYCRAUS</td>
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<td>MARISCUS</td>
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<td>Federov op. cit.</td>
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<td></td>
<td>Smith 1969; Federov 1969</td>
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<td>28, 29, 32, 33, 34</td>
<td>Hicks op. cit.;</td>
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<td></td>
<td></td>
<td></td>
<td>Heilborn 1959; Clapham et al op. cit.;</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Schuyler 1964, 1967;</td>
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<td></td>
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<td>Dennis 1965; Federov op. cit.</td>
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<td>20</td>
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<tr>
<td>[as Blysms]</td>
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<td>ISOLEFTS</td>
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<td>13, 14, 21, 24</td>
<td>Hakanosson op. cit.;</td>
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<td>Moore &amp; Edgar 1970; Clapham et al op. cit.; Federov op cit.</td>
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<tr>
<td>ELYSITON</td>
<td>1</td>
<td>30</td>
<td>Clapham et al op. cit.</td>
</tr>
<tr>
<td>TRICIA-PHORUM</td>
<td>2</td>
<td>29, 52</td>
<td>Clapham et al op. cit.; Federov op. cit.</td>
</tr>
<tr>
<td>ERIOPHORUM</td>
<td>13</td>
<td>27, 29, 30, 38</td>
<td>Hakanosson op. cit.; Hicks 1929; Clapham et al op. cit.; Federov op. cit.</td>
</tr>
</tbody>
</table>
and Pseudo-schoenus have completely smooth stigmas, occasionally showing tendencies to developing these papillae. Predominantly smooth (non-papillose) stigmas occur in Bolboschoenus, Oxyoarum, Webstera, Ascolepis, Lipocarpa etc. In Schoenopectus the occurrence and non-occurrence of papillose stigmas is about even, some species showing it, others not. Often, in genera and species having these papillose stigmas, the upper half of the style tends to be papillose too.

Number per flower: The usual number of stigmas is 2 or 3. Genera with predominantly 2 stigmas include Alveus, genus B, Eleogiton, genus C, Nemum, Webstera, Junecellus, Kylinda, Toruliniun, Duval-Jouva and Procura. Those with predominantly 3 stigmas include Phyllospirus, Holoschoenus, Pseudo-schoenus, Desmoschoenus, Hymenochlata; Cyperus, Galilea, Mariscus, Remira, Lipocarpa, Courtoisia, Faurera, Eriophorum, Eriococpus, Trichophorum, Nalmenes and Androtrichium. In Scirtus, Isolenis, Hemiscara, Schoenopectus, Bolboschoenus and Ascolepis, the number of stigmas may be 2 or 3 in different species, occasionally 2 or 3 in the same species as in Schoenopectus.

Bakker D. 1954, Koyama 1958, Smith 1969 etc.

Ovary: The ovary is uni-locular, containing one basal ovule, which after fertilization forms the seed.

Ovule: The ovule is anatropous, bitgmic and crassimucilaginous with micropyle formed by the inner integument [of. Dais 1966]. The development of the ovule has been followed by a number of workers [ref. op. cit.; Padhye 1960 etc.]. The embryo sac formed is of the Polygonum type, i.e. consisting of a linear tetrad of megaspores; occasionally T-shaped tetrads are formed [Padhye 1971b]. The occurrence of an obturator - formed from a group of superficial cells at the base of the funiculus which become elongated and loosely cover the micropyyle, and frequently degenerate after fertilization - has been found to organise at

**Embryogenesis:** The development of the zygote is summarised in Fig. 35 adapted from Padhye 1974. The process conforms to the Onagrad Type of Davis op. cit., whereby instead of the quadrant 'q' organising into octants as is normally the case, they divide perinodally to cut off the Dermatogen initials and four central cells which form the periblum and plerome initials. Such a direct differentiation of Dermatogen has been frequently observed in the Cyperaceae Padhye 1960; Guignard 1961; Patel and Shah 1962; Shah 1962, 1965; Khanna 1965; Padhye 1967; Tiwari 1968; Padhye 1974 and in certain taxa of the Juncaceae Soubges 1923, 1933; Shah 1962 which correspond to the Juncus variation of the Onagrad type of Johansen (1950). This situation has only been reported absent once by Khanna 1965 in Schoenoplectus Scirpus maronatus. In Kylinga, Padhye 1974, has observed a well marked tendency towards precocious differentiation of the plerome and periblum, whereby the central cells divide vertically to form four inner cells X, and four outer cells Y to form the primordia of the plerome and periblum respectively; and these cells later divide transversely to form tiers; while in Cyperus, on the other hand, the tiers are formed first and the initials of periblum and plerome are laid down later.

This condition in Kylinga had earlier been reported in Bulboottis barbata Shah 1963 and in Juncus bufonius Shah 1963.

**Mature embryo:** Following the earlier works of Didriksen 1894, 1897, Schneider 1952, Shah 1964, 1965, on the shapes assumed by the mature embryos of the Cyperaceae, Van der Veken 1965 has distinguished six basic types of embryos from a study of 342 species. The six basic types are illustrated in Fig. 34. The following table summarises the basic distinction mentioned by him:
TABLE 5

<table>
<thead>
<tr>
<th>TYPE</th>
<th>General form</th>
<th>Coleoptile</th>
<th>Root cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>BULBOSTYLI S Type</td>
<td>Largely centrifugal or turbinate</td>
<td>basal</td>
<td>basal</td>
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<tr>
<td>CAREX Type</td>
<td>centrifugal or turbinate</td>
<td>lateral</td>
<td>basal</td>
</tr>
<tr>
<td>SCHOENUS Type</td>
<td>centrifugal or turbinate</td>
<td>sub-lateral</td>
<td>sub-lateral</td>
</tr>
<tr>
<td>FIMBRISTYLI S Type</td>
<td>centrifugal or turbinate</td>
<td>basal</td>
<td>lateral</td>
</tr>
<tr>
<td>CYPERUS Type</td>
<td>ellipsoidal</td>
<td>basal</td>
<td>lateral</td>
</tr>
<tr>
<td>SCIRPUS Type</td>
<td>fungiform</td>
<td>basal</td>
<td>lateral</td>
</tr>
</tbody>
</table>

The distribution of these six basic types of embryos are as follows:

Bulbostyli s type (Fig. 34 A) found in Namum, Nagmesia, B Bulbostyli s
Carex type (Fig. 34 A) found in Trichophorum, Elymus, Genus B, B Bulbostyli s
Schoenus type (Fig. 34 A) in Phyllosorus, Genus C
Fimbrystylis type (Fig. 34 A) in Scirpus, Eriophorum, Eriosorus, Websteria, B Elegorhesis, B Egeria, B Fimbrystylis
Cyperus type (Fig. 34 A) in Eleogiton, Isopleia, Holoschoenus, Oxyeuryum, Desmoschoenus, Hemicarpha, Androtrichium, Hellmuthia, Lipoarpha, Ascolepis, B Volkelia, Ficinia, Cyperus, Kyllinga, Torulinium, Junceus, Pyrenus, Curtelisia, Duval-Jouvea, Mariscus, Remirea, Queenslandiella
Scirpus Type (Fig. 34 A) in Hymenochaeta, Pseudo-schoenus, Schoenoplectus, Bolboschoenus, Fuirena
There is no information on the embryo type of *Genus A*, but I would not be surprised if it turned out to have a *Scirpus* type judging from the embryo's appearance in an untreated young fruit mounted in glycerine.

**Endosperm**: Nuclear endospermic formation has been reported for the family *Cyperaceae* by Padhye (1971) and the tissue later becomes cellular.

**Hypostase**: Which develops from some nucellar cells situated at the chalazal end of the ovule, has been reported as occurring in the family *Cyperaceae* by Padhye (1967, 1972), Khanna (1965) and Tiwari (1969).

**Seed coat**: Each integument of the ovule is two-layered which contribute to the development of the seed coat. The outer layer of the mature testa consists of flattened, tannin-filled cells derived from the outer epidermis of the outer integument. The inner layer consists of comparatively larger tannin-filled cells that show a wavy outline. This layer represents the inner epidermis of the inner integument. The other layers are crushed during development.

**FRUIT**: The fruits in these genera are normally referred to as 'naked' in that they are not enclosed in an utricular prophyll as found in the subfamily *Carioideae*. Morphologically they are dry, indehiscent, monospermous, endospermic fruits.

**I External features:**

(a) **size**: Beetle (1943) has considered size and shape (i.e., relative length and breadth measurements) as very important since they are the least susceptible to varying interpretations and are also least modified during dispersal. This has been confirmed in this study whereby variations in the mature fruit size of most cosmopolitan species did not exceed 0.2 mm.

**Illustrations in Figs.** Represent typical fruit sizes in the genera investigated.
GYNOECIUM

1. Nature of stigmas
   (a) weak and delicate; (b) firm and often strap-like

2. Surface of stigmas
   (a) papillose; (b) smooth

3. Number of stigmas to a fruit
   (a) 2; (b) 3

4. Fruit length including beak (when present)
   (a) 2.0 mm; (b) 2.0 mm

5. Base of fruit
   (a) with distinct disc-like gynophore; (b) without gynophore

6. Apex of fruit relative to main body of fruit
   (a) long apiculate; (b) minutely apiculate; (c) not apiculate

7. Surface of fruit
   (a) smooth and shiny; (b) dotted; (c) rugose; (d) striated longitudinally with transverse connections

8. Nature embryo shape and form (ref. Fig.)
   (a) "Bulbostylis" type; (b) "Schrenus" type; (c) "Fimbristylis" type;
   (d) "Cyperus" type; (e) "Carex" type; (f) "Scirpus" type.
FLORAL DIAGRAM

(a) Type I; (b) Type II; (c) Type III; (d) Type IV; (e) Type V;
(f) Type VI; (g) Type VII

HYPOGYNOUS PERIANTH SEGMENTS

1. Hypogynous perianth as
   (a) 'scale'; (b) bristle; (c) petal-like plate; (o) absent

2. Scale-like perianth
   (a) one median adaxial; (b) 2 lateral; (o) absent

3. Type of bristle
   (a) needle-like; (b) filiform/silky; (o) absent

4. Scabridity of bristle
   (a) retrorsely scabrous; (b) antrorsely scabrous; (c) irregularly
   scabrous; (d) smooth; (o) absent

ANDROECIUM

1. Usual number of stamens
   (a) 2; (b) 3; (c) 1-3

2. Filaments
   (a) simulating silky bristles; (b) not simulating silky bristles

3. Anther: apex of connective
   (a) with acute crests; (b) with obtuse crests; (c) with retuse crests

4. Profile of anther crest
   (a) prickly; (b) papilllose; (c) smooth

5. Pollen grains
   (a) monoporate or monooporate; (b) with zonal distribution of
   4-6 apertures
<table>
<thead>
<tr>
<th>FLORAL DIAGRAM</th>
<th>HYPOGYNOUS PERIANTH SEGMENT</th>
<th>ANDROECIUM</th>
<th>GYNOECIUM</th>
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<td>1</td>
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<td>4</td>
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<td>ANDROTRICHION</td>
<td>d</td>
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<td>o</td>
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<td>ASCOLEPIS</td>
<td>r</td>
<td>o</td>
<td>o</td>
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<td>ELYMUS</td>
<td>a</td>
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<td>BOLSOCHRENOUS</td>
<td>a</td>
<td>b</td>
<td>o</td>
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<td>COURTOISIA</td>
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<td>HELLEGLA</td>
<td>d(g)</td>
<td>(a)o</td>
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<tr>
<td>HEMICARPHA</td>
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<td>HOLSOCHRENOUS</td>
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<td>HYMNOSTACHA</td>
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<td>ISOPEPS</td>
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<td>PSEUDOSCHRENOUS</td>
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<td>QUEENSLANDIA</td>
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<td>REMIRA</td>
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<td>SCHERNOPEFLOCTUS</td>
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<tr>
<td>SCIRPUS</td>
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<tr>
<td>TANICRUS</td>
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<td>TRICOFERON</td>
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<tr>
<td>VERSTELLIA</td>
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<td>GENUS A</td>
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<td>GENUS B</td>
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<tr>
<td>GENUS C</td>
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Note:
- ? = no information
- ( ) = rarely
- ± = more or less
- a-d = a b c d
- a-c = a and c
The sizes range from 0.5–5.0 x 0.3–3.0 mm, the length including the beak when present. Conspicuously long fruits (over 2.0 mm long) are common in *Oxycaryum*, *Schoenoplectus*, *Bolboschoenus*, *Websteria*, *Genus A*, *Genus B*, *Desmoschoenus*, *Eriophorum*, *Eriocircus*, *Nelmesia* etc. There appears to be a relative uniformity in the fruit sizes of many genera, as in *Scirpus*, *Isolepis*, *Eleogoton*, *Phyllosciurus*, *Nemum*, *Eriophorum*, *Fuirena*, *Linocarpha* etc.; however, in some other genera the fruit sizes are often variable, as in *Cyperus*, *Fàcinia*, *Holoschoenus*, *Schoenoplectus*, *Bolboschoenus* etc.

(b) Shapes: According to whether the fruit is broader above or below the middle or equal, the fruit may be sub-orbicular, obovoid, ovoid, oblong-linear or linear-lanceolate. Except in *Genus A* (Fig. 31.K), *Eriocircus* (Fig. 32.E) *Ascolepis* (Fig. 32.I), *Courtoisia* (Fig. 32.N), where the fruits are oblong-linear to linear-lanceolate, the rest of the genera have sub-orbicular, obovoid, ovoid to elliptic fruits. The base of the fruit may show a distinct disc-like gynophore as in *Fàcinia* (Fig. 32.J), or may be relatively long attenuate as in *Schoenoplectus* subgenus *Schoenoplectus* and *Nelmesia* (Fig. 31.F, 175) *Bolboschoenus* (Fig. 31.G), *Phyllosciurus* (Fig. 31.H), *Websteria* (Fig. 31.J), *Genus A* (Fig. 31.K) *Genus B* (Fig. 32.A), *Blysmus* (Fig. 32.B), *Eriophorum* (Fig. 32.D), *Eriocircus* (Fig. 32.E), *Fuirena* (Fig. 32.F), *Nelmesia* (Fig. 32.L) and *Courtoisia* (Fig. 32.N).

As mentioned earlier under the style (p. 110), the mature fruit may bear at its apex the remains of the base of the confluent style, and thus make the fruit appear apiculate or beaked. Genera with very long beaks measuring > 1.0 mm long include *Genus B*, *Oxycaryum*, *Bolboschoenus* (especially *B. fluviatilis*), *Websteria*, *Genus A*, *Schoenoplectus* (especially subgen. *Nelmesia* and *Blysmus*. Small and shorter beaks occur in other genera, except in *Nemum*, *Genus C*, *Juncellus* and some species of *Triphophorum* (notably *T. pumilum*, *T. clintonii* and *T. verecundum*).
The angle at which the main body of the fruit gradually or suddenly contracts to form the apex of the fruit is quite characteristic, especially in those genera with apiculate fruits. In *Nemum* (Fig. 31.N) it is absolutely rotund, while in *Genus C, Junceellus* and the above species in *Trichophorum* one observes a sudden obtuse to near-retund contraction.

(c) **colour of the fruit:** Most immature fruits are white or cream-coloured, gradually changing to light brown, grey or various dark shades of brown or black. No particular genus has a distinctive fruit colour peculiar to it.

(d) **surface view:** The surface view of the fruit presents very interesting features. It may appear smooth and shiny, rough with minute or dense dots, longitudinally and transversely striated, or shallowly or deeply rugose. As will be fully discussed below, the internal structure of the exocarpic layer of the pericarp of the fruit invariably determines the surface expression of the fruit. If the cells of the exocarp are bound by a very thick cuticle, the surface view appears smooth and shiny as in *Bolboschoenus, Nemum, Trichophorum, Oxycaryum* etc., conversely if it has a thin-walled + transparent periclinal wall which easily collapses and depending on whether the cells contain silica bodies or not, the surface will appear dotted or punctulate, as in *Scirpus, Hemicarpha, Lipocarpha, Eleogiton, Cyperus* etc. However, if the exocarp cells are uneven in length, the surface view of the fruit appears shallowly or deeply rugose depending on the relative differences in length, as in *Schoenoplectus* subgenus *Actaeogeton*; on the other hand, if the exocarp has transversely elongated cells with more or less inflated periclinal walls and very firm anticlinal walls, the surface view appears longitudinally and transversely striated as in *Isoplepis* (especially in *I. setacea*) and *Hemicarpha* (especially *H. brvioculis*).
Fig. 31. Fruit shapes x 12

A. Scirpus spp. (1. S. fujireoide, 2. S. sylvaticus, 3. S. pallidus


B. Isolepis spp. (1. I. thurbersiana, 2. I. cyperoides, 3. I. koilolepis


8. I. setacea, 9. I. antartica)

C. Eleocharis spp. (1. E. orassiuscula, 2. E. pseudo-fluitans


D. Geocarpon cubense

E. Triphorum spp. (1. T. pusillum, 2. T. versundum, 3. T. clintonii


F. Schoenoplectus spp. (1. S. torreyi, 2. S. americanus, 3. S. nipponicus


8. S. supinus, 9. S. disaschansus)

G. Eleocharis spp. (1. E. fluvistilis, 2. E. tuberosus, 3. E. maritimus

4. E. robustus, 5. E. paludosus, 6. E. planiculmis,

7. E. strobilinus)

H. Phylloscirpus spp. (1. P. acusilis, 2. P. semisubterraneus)


4. H. thurnbergianus)

J. Websteria concoloroides

K. Genus A (Scirpus junghuhnii)

L. Pseudo-schoenus inaeus

M. Rymenocheata grossa

N. Namum spp. (1. N. angloplenus, 2. N. spadiceum)
Fig. 32. Fruit shapes x 12

A. Genus B (Blysmus rufus) B. Blysmus compressus

D. Desmoschoenus spiralis


F. Frigospirus spp. (1. E. comosus, 2. E. falsus)

W. Fuiresia spp. (1. F. scirroides, 2. F. incompleta, 3. F. simplex
4. F. ciliaria)

G. Lipocarphe spp. (1. L. sphagelata, 2. L. chinensis, 3. L. argentea)


I. Aescolenis spp. (1. A. protea, 2. A. capensis, 3. A. brasilensis
4. A. pinguicor)

J. Ficinia spp. (1. F. scariosa, 2. F. setiformis, 3. F. bracteata
4. F. tristachya, 5. F. angustifolia)

K. Genus C (Scirpus nevadensis) D. Nelmesia melanostachya

L. Androstrichum trigynum N. Courtoisia cyperoides

O. Kyllinga spp. (1. K. squarrosa, 2. K. polyphylla, 3. K. odorata
4. K. puniceus)

P. Duval-Jouvea adrotina Q. Torulinium ferax

R. Juncellus spp. (1. J. laevigatus, 2. J. laevigatus subsp. distachyos)

S. Pycnus spp. (1. P. sanguinolentus, 2. P. globosus, 3. P. flavescens)

T. Cyperus spp. (1. C. rotundus, 2. C. pustulatus, 3. C. glaber, 4. C. longus
5. C. longus subsp. bedius, 6. C. nesamus, 7. C. iria, 8. C. fuscus
9. C. uncinatus, 10. C. different)

U. Galilea mucrana V. Remirea maritima

W. Hariscaus spp. (1. M. latebracteata, 2. M. congestus)
Fig. 32 Fruit Shapes
Fig. 33  Schematic representation of Embryogenesis in Cyperaceae  
(After Padhye 1971 b p. 175)

Ca, Cb  first transverse division of Zygote
q  a quadrant of 4 cells giving rise to precocious Dermatogen and Pralome & Periblum
C', m  from vertical division of Cb
n, n'  from transverse division of C'
r, t  "  "  "  n
o, p  "  "  "  n'
122

II Internal structure

(a) outlines: The various outlines exhibited from cross sections through the widest part of the fruit, are illustrated in Fig. 34.B.

While some of these outlines appear to be restricted to certain genera, for example outline 'i' to Eleogitton, 'h' to Bolboschoenus, 'j' to Genera C, 'k' to Genus B and 'l' to Hamicarpha; the other outlines are of wide occurrence in various other genera, including some of the above, especially Eleogitton and Bolboschoenus.

It is believed that the outlines assumed by the fruit are determined wholly or partially by conditions existing in the spikelet, such as the nature of the rachilla, the angle formed in the adaxial convexity of the fertile glume, and the number of carpels. When the rachilla is generally cylindrical or its face towards the fruit is convex, and the fruit lies adpressed against this surface, that part of the fruit i.e. the adaxial surface becomes concave as observed in outlines 'd', 'h' and 'i'; conversely if the rachilla is rectangular or even triangular, showing its plane surface towards the fruit, and the fruit happens to lie against it, the adaxial surface also becomes plane, as in outlines 'a', 'b' and 'e'. Often the rachilla is shallowly concave at the area where the fruit lies on its adaxial surface, and thus the fruit is convex at its adaxial surface; as in outlines 'c', 'f', 'g', 'j', 'k' and 'l'. Sometimes, as in many-flowered spikelets with densely imbricated glumes, the fruits may lie against the back or abaxial side of the succeeding glume, and its adaxial surface is shaped according to the surface it laid on. Genera in which abaxial and adaxial surfaces of the fruit cannot be referred to in relation to the rachilla are Pyræus and Kyllinga because the margins of the fruit are in line with the axis of the spikelet which is formed by the rachilla, and it is one margin that lies against the rachilla, the other towards the keel of the glume. There must
Fig. 34

A  Embryo Types (After Van der Veken 1965)
5. Cyperus type  6. Scirpus type

B  Outlines of Fruits in T.S.

C  T.S. fruit of Ficinia tristachya showing cuticular papillae on outer tangential walls of exocarp [x 660]

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EMBRYO TYPES

OUTLINES OF FRUITS IN T.S.

Sector of T.S. fruit of Ficinia tristachya
have been some kind of orientation of the fruit with the abaxial and adaxial surfaces orientated to the interna side, so that the vertical plane of symmetry passing through the orientated abaxial and adaxial surfaces is periclinal or parallel to the rachilla (see floral diagram Fig. 26), all the other genera show a horizontal plane of symmetry to the rachilla.

As for the adaxial nature of the fruit, the abaxial surface appears to form in direct relationship with the angle of the concavity in the adaxial surface of the subtending glume. When the glume is strongly keeled, that surface of the fruit lying against it is sharply pointed as in outlines 'a' and 'b'. When the concavity is obtuse to rounded off, the abaxial surface of the fruit is convex, as in the remaining outlines, except in 'h' whose abaxial surface is concave and have resulted from direct pressure from the preceding glumes and fruits below.

The number of carpels also appears to contribute substantially to the outline exhibited. Outlines 'a'-'d' occur in tri-carpellate species; while outlines 'g'-'k' occur in bi-carpellate species. Outlines 'e' and 'f' appear to be the intermediate stages between the tri-carpellate and bi-carpellate groups, in that both outlines can be found in both groups. Outline 'l' appears unusual because it does not appear to have been influenced by the rachilla or the number of carpels. This outline which is restricted to *Hemibapha* appears to have resulted because of the unusual shape and form of the glumes having long alternate bases and a strongly exerted aristate apex and also the occurrence of the posterior hyaline 'scale' which tightly surrounds the fruit on its adaxial surface in most species.

(b) Pericarp: As mentioned under the ovary, the ovary wall differentiates at maturity to become the pericarp of the fruit. There is very scanty information on the process of differentiation of the ovary wall into conspicuously
Pl. 4  T. S. of Fruit Pericarp

A. Holoschoenus nodosus  x 600  B. Desmoschoenus spiralis  x 600

C. Phylloscirpus acaulis  x 600  D. Schoenoplectus disschanthus  x 600
lignified and unliignified zones of the pericarp in the Cyperaceae. Since 1892, when Wilczek made some developmental studies in the fruit and seed of Cladium, the only known recent work on this same problem has come from Marek (1958). According to Marek, two sclerenchymatization or lignification processes appear to occur independently in different groups of Cyperaceae leading to the pericarp formation; viz. (i) that sclerenchymatization takes place in the whole ovary with the exception of the outer epidermis and proceeds from the outside inwards; (ii) that sclerenchymatization takes place in the inner epidermis, plus part of the outer ovary which is adjacent to it, and proceeds from inside outwards. Examples cited under the first process included species of the following: Scirpus, Bolboschoenus, Schoenoplectus, Isolepis, Eleocharis, Cyperus, Juncellus, Duval-Jouve, Holoschoenus, Trichophorum, Eriophorum, Eleocharis, /Fimbristylis/, Blysmus etc. Examples under the second included Genus B (as Blysmus rufus), Cladium etc. He referred to the fruits of the first type as "nut" and of the second he introduced the term "pseudo-stone" as opposed to "stone" suggested by Artjuszhenko and Konowalow (1951) who worked on Cladium as well, because according to Marek a "stone" fruit originates from a single carpel while the type appearing in these groups of Cyperaceae originated from two or more carpels.

As can be seen from under "revised morphological terminologies (cf. p 16) I have avoided entering into this controversy, and have merely used the term "fruit". This was necessary because I had not investigated any developmental sequences to ascertain the right application of what term of fruit to use .... all my investigations having been conducted on mature fruits. The observations are summarised in Table 7.

Height of pericarp: In almost all the genera, the pericarp has an uneven height along its entire diameter. Frequently the heights at the position of
vasculations are comparatively higher, from 30-321 \( \mu \), while those areas between the nervations ranged from 16-198 \( \mu \). Genera whose average pericarp height did not exceed 60 \( \mu \) included Scirpus, Nennum, Kyllinga, Torulinium, Pycreus, Mariscus, Ascolepis, Hemicarpe, Lipocarpha, Fuirena, Eriophorum, Eriocirpus, Pseudoschoenus. Those between 60 and 100 \( \mu \) included Phylloscirpus, Blymus, Isolepis, Eleogiton, Genus A, Trichophorus, Holoschoenus, Websteria, Desmoschoenus, Hymanochaeta, Cyperus, Galilea, Courtoisia, Remirea, Nelsacia etc. and those over 100 \( \mu \) included Genus B, Genus C, Schoanoplectus, Bolboschoenus, Duval-Jouve, Juncellus and Ficinia.

The pericarp is differentiated into Exocarp (epicarp), Mesocarp and Endocarp, the latter frequently abutting on the seed coat. The exocarp and often the endocarp are made up of one-layer of cells, while the mesocarp may have one- to several-layers, and all of them together make the pericarp appear thin (i.e. \(< 60 \mu \) high), thick (i.e. \(< 100 \mu \) high) or very thick (\( > 100 \mu \) high). Some of the pericarps are featured in plates.

The Exocarp: (see pl. 4,5).

The cells of the exocarp may be isodiametrical or elongated, tangentially radially or axially. Isodiametrical and axially elongated cells are of very common occurrence in almost all the genera; and normally measure between 12-45 in both directions in T.S. Typical tangentially elongated cells have been observed in Isolepis setacea \( \varphi \). Marek op. cit.7 in which the cells are widest in the middle of the fruit - from 30-100 \( \mu \) - and gradually narrow down towards the distal and proximal ends of the fruit. The radial walls of these cells are distinctly thickened while the outer tangential (pericinal) walls are thin, and these features appear to give the characteristic longitudinal and transverse striations observable on the surface view of the fruit \( \varphi \). Fig. 31B, 8,9 & p. 1187.
Pl. 5  T.S. of Fruit  Pericarp

A. *Bolboschoenus paludosus*  x 150  
B. *Schoenoplectus limensis*  x 210

C. Genus B  (*Blysmus rufus*)  x 150  
D. *Blysmus compressus*  x 225
Radially elongated cells are restricted to Junellus, Bolboschoenus and Schoenoplectus subgenus Actaeogonon. In Junellus and Bolboschoenus (especially the bicarpellate group) the height of these cells is more or less uniform, measuring between 66-174 µ tall; while in Schoenoplectus subgenus Actaeogonon (especially in S. halii, S. lateriflorus, S. tuberculatus etc.) the cells are not of uniform height, one group of cells being about twice as tall as the other group (plate 4.D), thus making the outline of the exocarp appear characteristically undulate or rugulose. The shorter cells measure 5-15 µ tall and the taller 18-45 µ tall. This feature explains the occurrence of wrinkles on the surface of the fruit (cf. p. 118 Fig. 31F.6-2) and probably explains the occurrence of surface wrinkling in such genera as Rhynchospora (especially in R. albiceps, R. cyperoides, R. monostachya etc.).

The radial walls of the exocarp cells may be thin-walled, as in Scirpus, Phylloscirus, Isolepis, Eleogiton, Hemicarpha, Cyperus, Pycreus, Courtoisia, Mariscus etc., and thus could easily tear or make the whole layer collapse on to the surface of the mesocarp; or conspicuously thick-walled as in Schoenoplectus, Junellus, Bolboschoenus, Ficcinia etc. At the same time respectively, the tangential walls may be thin-walled and transparent with very little or no cuticle, or thick-walled opaque, rarely transparent, with obvious cuticular thickening. This explains why genera with thick-walled exocarps normally have glossy fruit surfaces. Occasionally in certain genera as Isolepis the radial walls may be slightly thickened and firm, while the tangential walls are thin; and the cells often appear inflated towards the outside, giving that characteristic surface appearance seen in I. setacea.

Occasionally there is a papillose cuticular projection from the middle of the outer tangential wall of the exocarp. This feature has only been seen in Ficcinia triestachya (Fig. 34.C) and it is conspicuously lobed at the apex.
A similar feature, but of stellate form and slightly thick-walled has been observed in Tricostularia neesii, Costularia paludosa, Rhyphospora longiseta and R. exserta; Schoenus curvifolius and S. oruantus; Cladium, Baumesia Oreobolus ......... and are conspicuously observable from surface view especially towards the apex of the fruit.

Conical silica bodies with either acute or obtuse tips are of rather sporadic occurrence in the genera. Because of their presence or absence in species of the same genera, they do not seem to be taxonomically important in the fruit studies. They may be diagnostic at specific rank (cf. Rippl 1895, Hryniecki & Kurtz 1936, Marek op. cit.), especially in those genera whose exocarp layer is absolutely thin-walled and thus appears to give the characteristic surface dotting or punctulation of the fruit. I may be wrong in my assumption that because silica bodies are absent in certain species of certain genera, they are not taxonomically important; and I think that their absence especially in the genera whose fruits appear dotted was largely due to the preparation of the fruit wall for sectioning which may have dissolved them. Schuyler (1971) has mentioned that conical silica bodies with nodular peaks occur in one species of Isolenis /I. koilelepis/ and are completely absent in I. setacea.

When they are present, the silica bodies are normally borne on the inner tangential walls of the exocarp with their peaks pointing outwards, as in most genera, but occasionally as in Trichophorum atacamensis and T. pumilum, the bases of the silica bodies are on the outer tangential walls with the peaks pointing inwards. This was also observed in Schoenoplectus muconatus by Marek (op. cit.).

Apart from these siliceous cones, which when present are slightly transparent, there is a continuous band of finger-like ornamentations between the inner tangential walls of the exocarp and the outermost layer of the mesocarp, which has a wavy outline and often projects into the lumen of the exocarp cells.
Marek (op. cit.) observed this feature in *Cyperus, Dichostylis* now sunk in *Cyperus* and *Scirpus*. I have observed them also in *Cyperus, Scirpus* spp., *Phylloscirpus, Eleogeton, Hemiscarpha, Pyreus, Galilea, Duval-Jouvea, Junceellus, Courtoisia, Kyllinga, Torulinium, Mariscus, Remirea, Ascolepis, Lipocarpha,* *Isolenis* spp., *Holoschoenus* and *Nemum*. Padhye [1971b] working in *Kyllinga*, describes the process leading to this feature ........ "outer epidermal cells which show deposits of silica, enlarge, and the cytoplasm recedes along their inner tangential walls. Later, lignified finger-like ingrowths develop along the inner tangential walls. In a section these look like blunt projections starting from the wall and converging toward the centre of the cell round a mound of siliceous matter." It is interesting to note that almost all these genera showing this feature tend to have a dotted fruit surface, and it seems reasonable to suppose that their presence as well as that of the silica bodies wholly or partially contributed towards the punctulation.

Schuyler [1971a] has used the Scanning Electron Microscope (SEM) to study the structure of the exocarp cells of 58 species belonging to *Scirpus, Trichophorum, Isolenis, Schoenoplectus, Eriophorum, Eriocirpus* and *Hymenochaeta*. The above discussion on the exocarp based on light microscopic studies, correlates and corroborates his conclusions.

The *Mesocarp*: (see pl. 4, 5).

The mesocarp consists of cells which are radially (or longitudinally) elongated, rarely isodiastmetrical, as seen from both L.S. and T.S. preparations. With the exception of *Genus B* [and *Nelesenbechis, Tricostularia, Lepidosperma, Mesomelaena, Macrochaetium, Cladium, Caluria*] in which the outer most layers are parenchymatous, spongy or diffused, showing some slight thickenings inwardly towards the endocarp (see pl. 5 C), occasionally there is no sign of lignification and the cells are all uniformly spongy [cf. Marek op. cit., Blake 1962], while
Pl. 6
A. L.S. Fruit pericarp of *Bolboschoenus planiculmis* × 72
B. T.S. " " *Hymenochaeta grossa* × 600
C. Epidermal surface view of *Fuirena umbellata* × 600
in all the other genera, the mesocarp layer is distinctly uniformly thickened, all cells showing lignification.

The individual cells of the mesocarp may be referred to as small (i.e. <6 µ), large (i.e. 6-15 µ) or very large (i.e. >20 µ), often corresponding to the size of their lumen which may also be referred to as small (i.e. <2 µ), wide (i.e. 3-8 µ) or very wide (i.e. >15 µ) and also the lignified cell walls which accordingly may also be referred to as very thick, thick or thin to slightly thickened. The shapes of the cells are generally rounded to polygonal, and compactly arranged regularly or irregularly to form the various layers of the mesocarp.

The height of the mesocarp ranges from 6 to 159 µ tall; often corresponding to the number of layers and the relative size of the individual cells. Genera in which one-layered mesocarp occur include Trichophorum (especially T. alpinum) and Androtrichium. The most frequent number of layers is 2-3, which is widely represented. In Webstertia, Schoenoplectus, Bolboschoenus, Galilee, Duval-Jouvea and Ficinia the frequent number of layers is 5-7.

In Genus B as well as those genera in which the mesocarp is not uniformly thickened the cell layers range from 10 to about 20. The only rare occasions in which cell layers in uniformly thickened mesocarp numbered over 10 were in Bolboschoenus B. fluvialis and in Ficinia F. scariosa.

The number of vascular traces was found to correlate with the outline of the fruit see p. 122 in T.S. and the number of carpels frequent in the genera. The only exception was found in Duval-Jouvea which had 3 traces, but is normally considered as bicarpellate. It is probable that the abaxial vasculature is a vestige of the reduced abaxial bundle from the three receptacular bundles whose incipient traces enter the flower as a whole to give subsequent traces to the stamens and the pistil of Blaser 1941 p. 54. It was not possible to observe
the number of traces in *Hemicarpha* because of the uniformly thickened pericarp, but I have every reason to assume that there are 2-3 traces, since the genus contains both bi- and tri-carpellate species.

The **Endocarp**: (see pl. 4, 5).

This layer consists of cells which are radially (or transversely) elongated, with thickened cell-walls, thickening not as much as in the mesocarp layer. Marek (1958) had observed that these radially (or transversely) elongated cells in *Schoenoplectus* /except in *S. macronatus*/ were part of the mesocarp. I have considered them as part of the endocarp because of their radial elongation, their cell walls in t.s., their cell lumen which appears tall and narrow, and their relative position in the pericarp. These characteristics are frequent for the endocarp layer in the taxa investigated, especially in *Bolboschoenus, Ficinia, Blysmus* etc.

The height of the endocarp ranges from 3-66 μ tall, with 3-15 μ as being very frequent, and here again, this height often corresponds to the number of layers of cells. One-layered endocarp is very frequent, while two- to four-layered are restricted to *Hymenochaeta, Schoenoplectus* and *Bolboschoenus*. Two-layered endocarps are observed in *Galilea* and *Duval-Jouve*, and occasionally in *Cyperus*. 
Explanation to Table 7  Detailed Fruit Anatomy

A. **OUTLINE** of fruit in T.S.  (Ref. p. 122 Fig. 34 B)

B. **PERICARP**

1. Whole height of pericarp between nervations
2. Whole height of pericarp at nervations

C. **EXOCARP**

1. Height of layer
2. Shape of cells
   (a) radially elongated; (b) tangentially elongated; (c) isodiadmetrical
3. Anticlinal walls
   (a) thickened; (b) thin
4. Outer tangential (periclinal) walls
   (a) thickened; (b) thin; (c) thick and conspicuously papillose
5. Inner tangential (periclinal) walls
   (a) with finger-like ornamentations; (b) without finger-like ornamentations
6. Silica bodies
   (a) present on inner tangential wall; (b) present on outer tangential wall; (c) absent

D. **MESOCARP**

1. Height of layer
2. Number of layers of cells forming the mesocarp
3. Cells of mesocarp
   (a) uniformly thickened; (b) irregularly thickened; spongy cells outer; thickened cells lower
4. Lumen of cells
   (a) lumen small (< 2 µ); (b) lumen wide (3-8 µ); (c) lumen very wide (>15 µ)
5. Cell walls

(a) thin to slightly thickened; (b) thick; (c) very thick

Σ. Number of VASCULATIONS in fruit

F. ENDOCARP

1. Height of layer

2. Number of cell layers
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? = Not investigated or detail not known; ± = more or less or about; ( ) = Possibly
CHAPTER V
DISCUSSION

General taxonomic aims and approaches with reference to the Cyperaceae

Considering the generally accepted purposes which classifications at the supra-specific levels are meant to achieve, and the various approaches that are employed to achieve these purposes (see Davis & Heywood 1963 Chapter I; Jardine & Sibson 1971), it is interesting to note how the approaches adopted by various Cyperologists differ. Whether a new system of classification is to be largely accepted or rejected has sometimes depended not so much on its world-wide applicability, as on its relatively strict adherence to long recognised groups, sometimes combined with some "credible" evolutionary considerations. This is the situation in the family Cyperaceae which I find rather disturbing. Though many Cyperologists want to see natural aggregation of species in the family, they still retain the limits of large traditional groups which contain numbers of unrelated taxa, and within them postulate hypothetical evolutionary trends. The result is that these classifications must be considered wholly or partly unnatural and they are no more acceptable than the previous ones they were trying to improve. There are a number of reasons why our attitude towards some of these relatively large traditional groups such as Scirpus s.l. have to change, and why our present approaches to the supra-specific classifications should be phenetic. By a phenetic classification I mean here one that demonstrates the relative similarities or dissimilarities of the groups, these being assessed on the basis of many attributes without a priori differential weighting of characters.

Some of the reasons for considering a phenetic approach to the classification of the family Cyperaceae as a whole, and the subfamily Cyperoideae in particular, are as follows:

a) With the advent of new up-to-date micro-techniques, which reveal the inherent
endomorphic characters of the species in the Cyperaceae, more natural affinities are gradually coming to light. This more insistently calls for a much closer look into generic limits and relationships. The obvious question that is raised is: do the genera currently in use in the Cyperaceae represent natural assemblages of species? If they do, they must be confirmed and extended if necessary; but if they do not, as has been revealed in the preceding chapters, it is our responsibility to make the genera more natural. We should no longer repeat those mistakes made by our predecessors owing to their lack of sophisticated equipment and research techniques.

b) Our knowledge of the family Cyperaceae is almost completely limited to present-day organisms, which are themselves the most recent products of the evolutionary history of the group. Since fossil records are almost lacking in the family (except for the isolated finds of Dulichium, Scirpus, Cladium and Carex, which are represented by their fruits, and such fossil genera as Cyperacites Schimper and Carioopsis Samylina (see Takhtajan 1963)), we have no evidence of the form and structure of the ancestral stock, as well as those of the ancestral connecting links that give rise to the present-day taxa.

c) It is true that the wide range of form and structure appearing in the present-day taxa are the results of evolution, but we have no proof whether they arose through parallelism, convergence or divergence. Features which we perhaps assume to be primitive or advanced may have arisen in the reverse order or from a median position, and they may be recent rather than ancient.

d) New distinct groups are being discovered, and new data are becoming available from various fields of research, all or most of which tend to destroy traditional concepts of the supra-specific groups.

e) It is believed that if our groups are constructed on the basis of many attributes, and those attributes that show the highest correlation are given a
posteriori weighting, then the groups have a greater chance of standing the test of time. New data which may be available later could be accommodated into the system without much change to the classification.

Following the reasons above, it is my conviction that we initially must settle for a natural grouping of species at the supra-specific level, based on overall similarities and dissimilarities, before venturing into phylogenetic speculation.

**Concept of supra-specific categories**

There is no agreed definition for any of the supra-specific categories like section, subgenus, genus, sub-tribe or tribe. The current usage of these categories appears to be subjective and very often relates to tradition. Subjective in the sense that what one botanist considers as a section or genus, may at the same time be considered as subgenus, sub-tribe or tribe by another; and traditional in the sense that the shape of the whole Angiosperm classification has been more or less predetermined by a particular historical and philosophical background from Pre-Linnean and immediate Post-Linnean era (cf. Walters 1961), so that later workers often find it difficult to deviate from it.

Looking back to the preceding chapters in which almost all the available data from various fields of research have been analysed, it is obvious that there are many useful characters other than the traditional floral and spikelet characters to be considered in the classification of *Cyperaceae*. This means that we are provided with a broadened perspective in which to consider our concept of genus, subgenus or tribe etc.

Most of the segregate groups in *Scirpus* s.l. (e.g. Bolboschoenus, Schoenoplectus, Holoschoenus etc.) and *Cyperus* s.l. (e.g. Kyllinga, Pycreus etc.) which I have accepted as distinct genera, have previously been regarded as such by a number of workers. The present investigations have confirmed how very distinctly
natural they are. Groups such as *Pseudo-schoenus*, which was thought to be related to *Desmoschoenus*, *Genus A* whose affinity was believed to be with *Bolboschoenus*, *Genus B* which has always been classified with *Blysmus*, and *Genus C* considered to be related to *Schoenoplectus*, have all been found to differ greatly in their anatomy and morphology from the genera they were previously referred to. Whether their new status will be generally accepted or not depends on individual opinions, tradition and on how useful the change proves to be. Changes in binomials are seldom welcome when first proposed.

Considering some of the recently circumscribed small genera such as *Nelmesia*, *Egeria*, *Volkiella*, *Crosslandia* in the subfamily *Cyperoideae* in comparison to such distinct groups as *Pseudo-Schoenus*, *Genera A*, *B* and *C* etc. as well as the relatively large genera such as *Ascolepis*, *Lipocarpa*, *Ficinia* etc. in the light of the present investigations, it is apparent that every one of these taxa is distinct in their own right. Each one has its own characteristics, at least as distinct as those which characterise other segregate genera in the *Cyperaceae*; it therefore seems logical that they should all be accorded equivalent (generic) rank.

In such genera as *Schoenoplectus*, *Fuirena*, *Bolboschoenus*, *Hemicarpha* etc. it has been necessary to consider infra-generic delimitations in the light of the present investigations, because of the discontinuities in certain morphological and anatomical attributes within each of these genera, some of these infra-generic categories such as subgenus or section, have sometimes coincided with distinctive geographical distributions.

**GEOGRAPHICAL DISTRIBUTIONS**

The world-wide distributions of the following genera are shown in Maps namely *Androtrichum*, *Blysmus*, *Desmoschoenus*, *Duval-Jouves*, *Eriophorum*, *Eriocirpus*, *Fuirena*, *Galilea*, *Helmuthia*, *Hemicarpha*, *Hymenochaeta*, *Nelmesia*, *Nemum*, *Oxyacanthum*,
Phylloscirpus, Pasudo-Schoenus, Queenslandiella, Scirpus, Trichophorum, Websteria and Genus A, B and C. The distributions of Volckella, Elgeria, Dulichium and Crosslandia are also shown.

The mapped genera are mostly those whose distributions are either restricted to certain hemispheres or endemic to certain geographical regions. The other genera, whose distributions have not been mapped, have very wide or sporadic distributions in both hemispheres or in many geographical regions.


From Maps 1 & 2 Scirpus and Eriophorum are seen to have more or less similar ranges in the northern hemispheres of both Old and New Worlds, with disjunct isolated stations in South America and South Africa respectively.

In Map 10 typical Trichophorum is seen to have a similar but sporadic range, with a disjunct distribution of two Andean endemics in South America. The subgenus Anthelophorum of Trichophorum is restricted to Indo-China, Indonesia and Malaysia.

Fuirena (Map. 9 ) is largely restricted to the southern hemisphere with some species extending northwards into the southern limits of the northern hemispheres. The subgenus Vaginaria of Fuirena is endemic to Florida and the West Indies, while the other subgenera Fuirena and Pentastichie have relatively wide distributions in the New and Old World tropics and subtropics. The restriction of sections Hemicarpha and Chloroscirpus of Hemicarpha (Map. 5 ) to the New and Old World tropics and subtropics respectively is of note worthy. While the section Hemicarpha is
found from the United States down to the Eastern part of South America, the
distribution of the section Chloroscrirpus extends from West Africa to Central,
East and South Africa, and thence to India, Indo-China, Indonesia and Malaysia.

Duval-Jouvea (Map. 4 ) belongs to the northern hemisphere of the Old World,
where it occurs from Southern France through Central Europe to the Far East, and
Galilea (Map. 3 ) is almost confined to the sea coasts of the Mediterranean.

Websteria (Map 7 ) has a disjunct distribution in the New World, from
Florida through the West Indies (but missing Central America) to Brasil in the
Eastern part of South America, and in the Old World from Madagascar north-
eastwards to Ceylon.

Erioscirpus (Map 6 ) is largely limited to the Far East, spreading from
Eastern Himalayas to Indo-China, with one disjunct distribution in South Africa.

Ficinia (Map 4 ) is concentrated in South Africa with a few species spreading
to Tropical Africa and Madagascar.

Oxycaryum (Map 8 ) is restricted to the tropics of East (including Madagascar),
Central and West Africa and Central and South America.

Queenslandiella (Map 3 ) spreads eastwards from East Africa to India, Indo-
China, Indonesia, Melanesia and Queensland (Australia).

Blysma (Map 8 ) is widely distributed in the Northern hemisphere of the
Old World, its southern most limit lying in Morocco and Algeria, while Genus B
(Map 8 ) is distributed in the northern hemispheres of both Old and New Worlds,
and occurring north of 53°N.

Genus C (Map 6 ) is restricted to the New World, where it has disjunct dis-
tributions in the Western United States and Canada, and in Argentina.

Hymenoechastea (Map 7 ) belongs to the Far East where it spreads from India
to Indo-China, China, Indonesia, Malaysia and Melanesia; while Nemum (Map 7 )
belongs to West Africa, extending from Sierra Leone to Angola.
The following genera have narrowly endemic ranges in the following areas (see Maps 1-4, 8), viz: Phylloscirpus in the Andes, Desmoschoenus in New Zealand, Androtrichum in Eastern South America, Nolmesia in the Belgian Congo, and Pseudoschoenus, and Hellmuthia in South Africa. Other genera with endemic ranges include Egleria in Brazil (Eiten 1964), Volkiella in South West Africa (Merxmüller & Czeck 1953), Dulichium in the United States, and Crosslandia in Western Australia (Fitzgerald (1917).

Summary of general distribution

Forty-seven genera represent the subfamily Cyperoideae (excluding the genera in tribe Rhynchosporae). Out of this number those distributed in the various geographical areas are summarised below. The geographical areas are arbitrarily defined, most of them not corresponding to the phytogeographical regions of the world.

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of Genera</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW WORLD</td>
<td></td>
</tr>
<tr>
<td>1. North America (including Canada and United States)</td>
<td>21</td>
</tr>
<tr>
<td>2. Central America (Mexico-Panama, including the West Indies)</td>
<td>17</td>
</tr>
<tr>
<td>3. South America</td>
<td>25</td>
</tr>
<tr>
<td>OLD WORLD</td>
<td></td>
</tr>
<tr>
<td>4. Europe (excluding the Mediterranean Europe and Soviet Union)</td>
<td>16</td>
</tr>
<tr>
<td>5. Mediterranean Area</td>
<td>14</td>
</tr>
<tr>
<td>6. Soviet Union (including Caucasus)</td>
<td>18</td>
</tr>
<tr>
<td>7. South-West Asia (excluding Caucasus)</td>
<td>17</td>
</tr>
<tr>
<td>8. Tropical &amp; Subtropical Africa (including Egypt and Madagascar)</td>
<td>26</td>
</tr>
<tr>
<td>9. Southern Africa</td>
<td>23</td>
</tr>
<tr>
<td>10. &quot;British India&quot; (including Pakistan, Himalaya, Ceylon)</td>
<td>28</td>
</tr>
</tbody>
</table>
11. The Far East (including Indo-China, China, Malaysia, Melanesia, Japan)

12. Australia (including Tasmania) and New Zealand

This table shows the maximum concentration of genera to be in 3 different continents, 'British India', Tropical-Subtropical Africa and South America.

Areas with highest concentration of species

Excepting the 25 monotypic and/or geographically restricted genera confined to some of the 12 areas above, the following widely distributed genera (arranged alphabetically) have their highest species concentration in the following areas:

1. **Abildgaardia** containing c. 30 species, with largest concentration in Indo-Malaya

2. **Ascoepis** containing c. 15 species, with highest concentration in Tropical Africa

3. **Bulboschoenus** with c. 5 species (out of c. 16) in Asia

4. **Bulbostylis** containing c. 100 species, largely in the warm regions of both Old and New Worlds

5. **Courtoisia** with 2 species, all represented in Tropical Africa

6. **Cyperus** s.s. containing c. 350 species, the highest concentration in the tropics and subtropics of both Old and New Worlds

7. **Eleocharis** with c. 200 species, the highest species concentration in Russia and United States

8. **Eleginton** out of c. 11 species, 4 in South Africa, 3 in Australia

9. **Eriophorum** with 11 species (out of c. 18) in Eurasia

10. **Eimbristylis** containing c. 220 species, the highest concentration in the tropics and subtropics of both Old and New Worlds

11. **Euirena** with c. 22 species (out of c. 35) in Tropical-Subtropical Africa

12. **Hemicarpha** with 5 species (out of 10) in Western United States
13. **Holoschoenus** out of c. 5 species, 4 in South Africa, 2 in North-West Africa

14. **Isolapis** out of c. 41 species, 24 in South Africa, 17 in New Zealand and 9 in Australia

15. **Juncellus** out of c. 3 species, all represented in the Mediterranean area

16. **Kyllinga** consisting of c. 60 species, most of which are in the tropics—subtropics of Africa and India

17. **Lipocarpha** with c. 12 species, most of which are in tropical Africa

18. **Mariscus** containing c. 200 species, majority of which are in the tropics of both Old and New Worlds

19. **Pyroserus** containing c. 100 species, largely in the tropics and subtropics of both Old and New Worlds

20. **Schoenoplectus** out of c. 50 species, c. 16 in North America, 12 in the Far East

21. **Scirpus s.s.** with 18 species (out of c. 32) in North America

22. **Torulinium** containing c. 11 species, largely concentrated in the New World

23. **Trichophorum** with 6 species in Northern United States and Canada, and 6 species in Indo-China

It appears from the above results that the centres of diversity of the majority of genera are apparently in the tropics. This is very interesting, especially when one recalls that the Floras in most tropical regions are still in the 'pioneer' phase of investigation, as compared with those in Europe and North America which are in the biosystematic or even encyclopaedic phases. It might be envisaged that by the time the Floras of the Tropics are better known, more genera and species of the *Cyperaceae* would have been discovered.
CHAPTER VI

FORMAL TAXONOMIC TREATMENT OF GENERA AND GENERAL CONCLUSIONS

On the basis of the overall similarities and dissimilarities observed during the above study into the generic delimitations of taxa belonging to the subfamily Cyperoideae (excluding the tribes Rhynchosporae and Dulichieae), 47 distinct natural genera are recognised, keyed out and annotated below.

In the following account reference has been made to Part II for descriptions of the external morphology of genera dealt with there. The references following the generic names contain useful additional information on these genera and their infra-generic divisions. New infra-generic combinations cited can be considered as provisional. References for information on the genera which appear in square brackets in the key have also been given. It is hoped that the character tables and contents in the preceding comparative accounts in chapters 2-4 as well as the keys to the genera will be consulted in conjunction with the descriptions below to give a more fuller picture of the variation among the genera and for comparative purposes.

The genera have been arranged and numbered in as natural a sequence as a linear arrangement allows.

A. Key to the genera of the subfamily Cyperoideae

(excluding the tribe Rhynchosporae)

Note: The genera in square brackets were not personally investigated in Part I. To facilitate rapid identification, anatomical characters have been subordinated to ecomorphic features in the key.

1a. Hypogynous perianth present as bristles

2a. Glumes distichously or sub-distichously arranged

3a. Spikelet many-flowered; glumes distichous with decurrent base to the wings of the rachilla; culm robust with well-developed graminaceous leaves

---

18 DULICHIU7
3b. Spikelet one-flowered; glumes subdistichous, not decurrent on the 
inconspicuous rachilla; culm filiform or wiry, leaves setaceous 
or absent

4a. Shoot much branched, wholly submerged; style base confluent with 
the body of fruit; bristles 6-10; leaves present ........... 15 WEBSTERIA

4b. Shoot not branched, rarely submerged; style base thickened, 
articulate with the apex of fruit; bristles up to 6; leaves 
absent ....................... 13 ELEOCHARIS p.p., eg. E. nanmannii

2b. Glumes spirally imbricate

5a. General inflorescence spike-like, with spikelets distichously arranged

6a. Bristles antrorsely barbed; leaves channelled; fruit up to 4 mm 
long, with irregularly thickened mesocarp layer ............. 17 GENUS B

6b. Bristles retrorsely barbed; leaves graminaceous; fruit up to 
2.0 mm long, with uniformly thickened mesocarp layer ...... 16 BLYSMUS

5b. General inflorescence not spike-like

7a. Ascending rhizomes conspicuous, bearing at its apex solitary 
or tufted culms

8a. Fruit apiculate, with long attenuate base; general inflorescence 
terminal ........................................... 11 PHYLLOSCHRIFUS

8b. Fruit not apiculate, with cuneate base; general inflorescence 
pseudo-lateral ...................................... 12 GENUS C

7b. Ascending rhizome absent or occasionally present, culms borne 
from horizontal rhizomes or from tufts

9a. Culms of two types, one type bearing a spikelet, the other 
sterile; aquatic with only the inflorescences emergent 14 ECLERIA

9b. All culms bearing spikelets; only the basal part of 
plants occasionally submerged
10a. Fruit generally with conspicuously thickened persistent articul
style base; leaves generally absent .......................... 13 **ELEOCHARIS**

10b. Fruit without articulate thickened style base; leaves
present or absent

11a. Uppermost internode of shoot/culm several times longer than the
lower ones which are short and obscured by the basal and/or
sub-basal leaves; nodes inconspicuous

12a. Bristles filiform to silky, often elongate; antroserly scabrous
or smooth; shoot/culm setaceous to wiry

13a. Anthers with long acuminate, papilloose to prickly crests;
sub-stomatal cavities often obscured, lined by thin-
walled cells .................................................. 10 **ERIOSCIRPUS**

13b. Anthers with obtuse, smooth crests; sub-stomatal cavities
conspicuous, often lined by thick-walled
cells ................... 9 **TRICHOPHORUM** p.p. (eg. **T. alpinum**)  

12b. Bristles needle-like, retrorsely scabrous or plumosey fimbriate

14a. Leaves reduced or absent; general inflorescence with an
erect culm-like involucral bract

15a. General inflorescence paniculate; hypodermal solerenohymatous
tissue in culm as tall and narrow girders with the overlying
epidermal cells taller than the adjacent ones

.................................................. 8 **PSUDOSCHOENUS**

15b. General inflorescence a pseudo-lateral head or corymb;
hypodermal solerenohymatous tissue in culm as small rounded
to angular strands with the overlying epidermal cells smaller
than the adjacent ones .......................... 6 **SCHOENOPLEKTUS**
14b. Leaves well-developed; general inflorescence with more than one
leaf-like involucral bracts, often diverging from the base

16a. Anthers with smooth crests; ground tissue of culm net-like
with numerous scattered vascular bundles and
air cavities ......................................................... 7 HYMENOCHAETA

16b. Anthers with prickly crests; ground tissue of culm solid,
not net-like ......................................................... 5 BOLBOSCHOENUS

11b. Uppermost internode of shoot/culm + of equal length to the
lower ones; nodes conspicuous along the whole length of shoot

17a. Upper cauline leaves shorter than the lower ones or reduced to
sheathing bases; bristles silky or filiform, generally over-
topping the spikelet, rarely shorter, (6)-12-24 or more
to the fruit ......................................................... 2 BRIOPHORUM

17b. Upper cauline leaves longer than or equal to the lower ones;
bristles often needle-like, rarely filiform or silky,
ocasionally overtopping the spikelet, up to 6 to a fruit

18a. Leaves generally pubescent, with tubular or cylindrical
ligules ............................................. 4 FUIRENA p.p. (eg. F. incompleta)

18b. Leaves glabrous, occasionally papillose, with variously
shaped, non-tubular ligules

19a. Spikelets small, 3-4(-6) mm long; fruits small, up to 1.75 mm
long; anthers with smooth crests ............................. 1 SCIRPUS

19b. Spikelets large, 8-25 mm long; fruits large, 2.0-4.0 mm
long; anthers with prickly crests

20a. Glumes ovate, emarginate or notched at apex, stramineous;
spikelets cylindrical; bristles retrorsely
barbed ......................................................... 5 BOLBOSCHOENUS
20b. Glumes narrowly lanceolate, obtuse, dark crimson; spikelets angular subcompressed; bristles antromaly barbed; cuticular papillae present on the abaxial and adaxial surfaces of leaves ....... 3 GENUS A

1a. Hypogynous perianth as scales or petal-like plates or absent

21a. 3 petal-like plates forming the inner whorl of the hypogynous perianth segments ........................................... 4 FUIRENA p.p.

21b. Petal-like plates absent

22a. Hypogynous scale(s) enclosing the hermaphrodite flower

23a. One scale present, anterior

24a. General inflorescence a solitary terminal spikelet, subtended by a glumaceous involucral bract ...................... 23 NELMIESIA

24b. General inflorescence a head-like containing one to few spikelets, subtended by setaceous involucral bracts with dilated bases ................ 45 HEMICARPHA p.p. (eg. H. micrantha)

23b. Two scales present


25b. Scales anteriorly and posteriorly placed

26a. Spikelets congested at the base of the small tufted plant; scales of different texture, one coriaceous, the other hyaline .............................................. 44 VOLKTELLA

26b. Spikelets borne aloft at the summit of the elongated culms; scales uniformly hyaline ...................... 43 LIPOCARPHA

22b. Hypogynous scales absent

27a. Cauline leaves present; stomata over-arched by cuticular papillae ........................................ 4 FUIRENA p.p. (eg. F. pubescens)

27b. Leaves all basal, sometimes sub-basal; stomata not over-arched by cuticular papillae
28a. Glumes spirally arranged

29a. Base of fruit with a distinct disc-like gynophore ......... 26 FICINIA

29b. Base of fruit without gynophore

30a. General inflorescence a terminal contracted panicle containing several sessile spikelets in confluent clusters, each cluster subtended by a rigid prickly involueral bract with a spathula-shaped base ........................................ 25 DESMOSCHOENUS

30b. General inflorescence not as above

31a. Fruit conspicuously beaked, beak c. 0.7 mm long ..... 29 OXYCARYUM

31b. Fruit not beaked

32a. Innermost bundle sheath of vascular bundles fibrous

33a. Shoot/culm robust; leaves graminaceous or channelled/canalicate

34a. Leaves graminaceous; general inflorescence terminal, subtended by leaf-like involucral bracts .............. 31 CYPERUS p.p. (eg. C. orbiculatus)

34b. Leaves channelled/canalicate; general inflorescence pseudo-lateral, subtended by an erect, culm-like involucral bract

35a. Spikelets numerous, up to 200, small, arranged in compact sub-hemispherical heads .......... 27 HOLOSCHOENUS

35b. Spikelets few, up to 7, very large, aggregated into one head ............................................ 28 HELLMUTHIA

36b. Shoot/culm filiform to wiry; leaves setaceous or wanting

36a. General inflorescence a solitary spikelet with a basal glumaceous bract
37a. Plant with elongated much branched basal leafy shoots; style 2-fid; fruit lenticular or biocconcave; predominantly aquatic ........................................ 47 ELEOCITON

37b. Plant densely tufted; style 3-fid; fruit trigonous or compressed trigonous; predominantly of bogs and moors on high mountains ............................... 9 TRICOPHRUM p.p. (e.g. T. pumilum)

36b. General inflorescence a pseudo-lateral head with culm-like, often setaceous involucral bracts

38a. Surface of fruit conspicuously wrinkled or rugulose; leaves absent or reduced to the sheathing base ........................................... 6 SCHOENOPLECTUS p.p. (e.g. S. supinus)

38b. Surface of fruit minutely dotted or longitudinally and transversely striated; leaves present, rarely wanting ........................................ 46 ISOLEPS p.p.

32b. Innermost bundle sheath parenchymatous

39a. Glumes aristate, awns very long

40a. General inflorescence a single terminal globose head containing numerous sessile spikelets ............... 31 CYPERUS p.p. (e.g. C. pygmaeus)

40b. General inflorescence head-like containing 1 to few, often stalked spikelets

41a. Fruit with lateral gelatinous glandular protrusions; spikelets stalked, central one sessile ............................................................ 19 TIMBRISTYLIS p.p., e.g. F. spadiceus

41b. Fruit without gelatinous glandular protrusions; spikelets sessile ......................................................................................... 45 HEMICARPHA p.p.

39b. Glumes not aristate, awns absent or as short micro

42a. Base of style confluent with the fruit, not thickened
43a. Fruit minutely apiculate; glumes ovate, keeled, stramineous
to light brown, caducous .......... 46 ASCOLEPIS p.p. (e.g. I. ceratia)
43b. Fruit not apiculate; glumes obovate, not keeled, dark
purplish brown to reddish brown, persistent .............. 24 NEMUM
42b. Base of style thickened, articulated with the fruit
44a. Spikelet monoecious; female spikelet solitary or in
clusters of 2 or 3 .................................. 20 CROSSLANDIA
44b. Spikelet bisexual
45a. Thickened style base caducous ..................... 19 PINHRISTYLIS
45b. Thickened style base persistent .................. 21 BULBOSTYLIS
28b. Glumes distichously arranged, at least in the basal half of
spikelet
46a. Style base thickened, articulated with the fruit .... 22 ABILDGAARDIA
46b. Style base not thickened, confluent with the fruit
47a. Base of fruit with a distinct disc-like
gynophore .................................. 26 FICINIA p.p. (e.g. F. angustifolia)
47b. Base of fruit without gynophore
48a. Glume incrassate wholly or partially enclosing the flower;
general inflorescence capitulum-like ...................... 42 ASCOLEPIS
48b. Glume not incrassate, only subtending the flower; general
inflorescence not capitulum-like
49a. Rachilla articulate, deciduous
50a. Style 2-fid, fruit lenticular bilaterally compressed
51a. General inflorescence capitate; spikelets few flowered,
often one-flowered .................................. 36 KYLLINGA
51b. General inflorescence not capitate, spikelets
many-flowered ................................... 37 QUEENSLANDIELLA
50b. Style 3-fid; fruit trigonous

52a. Upper internode of rachilla incrassate clasping the fruit .................................................. 41 REMIREA

52b. Rachilla uniform along its length, slender, not clasping the fruit

53a. Rachilla disarticulating several times, with a swelling at each internode formed from the decurrent swollen bases of the glumes .................................................. 39 TORULINUM

53b. Rachilla disarticulating only once, without any swelling

54a. Glumes keeled, with a subulate awn; rachilla minutely winged; inner bundle sheaths parenchymatous .................. 38 MARISCUS

54b. Glumes narrowly keeled, acuminate; rachilla conspicuously winged; inner bundle sheaths fibrous

.......................................................... 40 COURTOISIA

49b. Rachilla not articulate, persistent

55a. Filaments of stamens persistent, simulating filiform hypogynous bristles ........................................ 30 ANDROTRICHUM

55b. Filaments of stamens deciduous

56a. Air cavities in the leaf encircled by numerous minor vascular bundles ........................................ 32 DUVAL-JOUVEA

56b. Air cavities in leaf not encircled by minor vascular bundles

57a. Style 2-fid; fruit lenticular

58a. Fruit abaxially and adaxially compressed; exocarp cells of fruit in t.s. radially elongated; general inflorescence pseudo-lateral with an erect, culm-like involucral bract .......................................................... 33 JUNCCELLUS
58b. Fruit bilaterally compressed, i.e. with margins in line with spikelet axis; exocarp cells in t.s. isodiametrical; general inflorescence often terminal with leaf-like involucral bracts .................................................. 34 CYPERUS

57b. Style 3-fid; fruit trigonous

59a. Spikelet ± turgid; glumes only keeled towards the apex; fruits adaxially concave, abaxially convex-angular; involucral bracts sub-terete to thickly crescentiform in t.s. .......... 35 GALILEA

59b. Spikelet strongly compressed; glumes keeled; fruit not compressed; involucral bracts plane or sharply V-shaped in t.s. ................................. 3† CYPERUS p.p. (e.g. C. esculentus)
B. **Generic descriptions**

**Note:** The affinities given under each genus have been assessed phenetically and have not been based on phylogenetic speculation.

The internal morphology of the fruit has been described here, and it is hoped that reference will be made to the table of comparative fruit anatomy (Table 7) and pp / for discussion on this topic.


**External morphology:** see p. 220.

**Internal morphology:** *oulm:* outline circular to truncated circular or triangular to obtusely triangular. **Ground tissue** spongy, tending to break down to leave a large central air cavity. Hypodermal solerenchyma tall triangular to baculiform girders or partial girders, occasionally triangular to rectangular or pulviniform strands. Vascular bundles numerous, often in irregular rings in the chlorenchyma, sometimes penetrating into the periphery of the ground tissue. Chlorenchyma not radiate, locally breaking down between the solerenchymatous girders to form peripheral air cavities.

**Leaf:** outline generally broadly V-shaped, slightly flanged, with wide shallow median adaxial groove. Bulliform cells differentiated. Air cavities present between the vascular bundles which are arranged in a single V series.
Bundle sheath: inner layer fibrous, uniformly thick-walled. Silica bodies: nodular, 1-3(-8) bodies per cell. Embryo structure: centrifugal or turbinate with basal coleoptile and lateral root cap.


Key to infra-generic groups

1. Bristles needle-like, erect, often retrorsely scabrous; plant rhizomatous, generally solitary ............................................................... sect. Scirpus

1. Bristles filiform to silky, tortuous or greatly elongated, retrorsely scabrous, sometimes smooth; plant tufted (type sp. S. cyperinus (L.) Kunth) ....................................................... sect. Lineati (Beetle) Oteng-Yeboah

Observation: It would have been difficult to apply the generic name Scirpus to any one of the segregate groups whose species were described by Linnaeus among the original 24 species. However, Hitchcock's (op. cit.) recommendation to typify the genus by Scirpus sylvaticus has been welcomed and generally accepted. This in effect means that Scirpus s.s. refers to Scirpus sylvaticus and related species. A number of sections have been published in the Scirpus s.s., all of which are now synonymous with Scirpus proper. The section Trichophorum (in the sense of American authors), which has habitually been referred to the Scirpus spp. with silky bristles, is now referred to as section Lineati, since the name Trichophorum has been emended here from Persoon's original circumscription to refer in the restricted sense to species related to Trichophorum alpinum. This treatment has been adopted widely in Europe.

Affinity: The section Lineati brings Scirpus much closer to Eriophorum, especially on the character of the bristle. The assumed link between the two genera are discussed briefly under Eriophorum (p. 160).

Distribution: With c. 32 spp. widely distributed in the North Temperate regions, with one isolated endemic station in South America (see Map 1).

**External morphology:** see p. 222.

**Internal morphology:** Culm: Ground tissue almost broken down to form a large central cavity. Vascular bundles in 2-3 irregular rings, the peripheral ones connected by tall triangular to sub T-shaped hypodermal sclerenchyma girders. Chlorenchyma not radiate, palisade-like to spongy, often breaking down between adjacent vascular bundles to form small peripheral air cavities. Sub-stomatal cavities often lined by thick-walled cells. Leaf: Bulliform cells differentiated, 2-3 cell-layered, vascular bundles unequal in a single V series, separated by air cavities containing translucent lobed cells. Bundle sheath: inner layer fibrous, uniformly thick-walled, occasionally with U-shaped thickenings. Silica bodies: nodular, 1-3 bodies per cell. Embryo structure: centrifugal or turbinate with basal coleoptile and lateral root cap.

**Type species:** *E. vaginatum* L.

**Key to infra-generic groups**

1a. Uppermost sheath greenish, with relatively long leaf-blade, glumes brown, often prickly/serrate at margins (type sp. *E. virginicum* L.)

........................................... subgen. *Eriophoropsis* (Palla) Raymond

1b. Uppermost sheath blackish at least above the middle, often bladeless or with a mucronate tip; glumes blackish, margins smooth

2a. Hypogynous bristles more than 6, silky, smooth or antrrorselly scabrous near the tip, in fruit greatly elongating and overtopping the glumes ........................................... subgen. *Eriophorum*
3a. General inflorescence a solitary terminal spikelet, subtended by a glumaceous involuval bract ......................... sect. Eriophorum

3b. General inflorescence a terminal umbel containing few to several stalked spikelets, subtended by elongated leaf-like involuval bracts (type sp. E. angustifolium Honok.)

........................................ sect. Phyllanthela Anderss.

2b. Hypogynous, bristles 6, filiform, tortuous, antrorsely scabrous, remaining concealed in the glumes (type sp. E. japonicum Maxim.)

........................................ subgen. Japonici (Koyama) Oteng-Yeboah

Observation: The monotypic subgenus Japonici based on Eriophorum japonicum, has been established with the view to end a long-standing controversy. This species is somewhat intermediate between Eriophorum and Scirpus, though it shows more characters (particularly vegetative ones) of the former than the latter (cf. Key lead 17a). The decision to treat it as a subgenus was one of three possible alternatives to deal with taxa in conditions like this.

Affinity: With reference to the above observation, it is obvious that the closest taxon to Eriophorum is Scirpus, the links between them being the subgenera Japonici and Eriophoropsis of Eriophorum and the section Linaeti of Scirpus. The question of whether the two genera are congeneric as a result of these isolated intermediates needs further scrutiny. Both Eriophorum proper and Scirpus proper are well distinct genera, containing quite a large number of species. To sink one into the other just because of one or two not wholly intermediate species, as Koyama (1958) has done, would not be justified. The question therefore rests with what to do with the intermediates. I have assigned the intermediates to the genus they most resemble.

Distribution: With c. 18 spp. widely distributed in the North Temperate region, with one isolated station in South Africa (see Map 2).
3. **GENUS A**


**External morphology:** Perennial rhizomatous. Culm robust, trigonous, noded. Leaves sub-tended and cauline, linear, graminaceous. Inflorescence a terminal compound corymb, often lateral branches present, subtended by leaf-like involucral bracts. Spikelets sessile, clustered on rays, oblong-lanceolate, acute, sub-compressed-angular, many-flowered. Glumes spirally imbricate, narrowly lanceolate, mucronate, keeled, base appearing decurrent with smooth margins, dark crimson. Hypogynous bristles 6, flexuous, antrously scabrous, reddish brown. Stamens 3, anthers linear, with obtuse dark purple crests and prickly profile. Style 2- or 3-fid, long, papillose. Fruit ellipsoid, biconvex or trigonous, minutely striated, dotted, shortly apiculate.

**Internal morphology:** Leaf: outline V-shaped, bulliform cells differentiated. Cuticular papillae present on the abaxial and adaxial epidermal surfaces. Air cavities absent between vascular bundles. Bundle sheath: inner layer fibrous, uniformly U-shaped cells. Silica bodies: nodular, 1-2 bodies per cell Type species: *(Scirpus) junghuhnii* Miq.

**Observation:** On its habit and general inflorescence, this genus shows affinity with *Scirpus*, from which it differs in having oblong-lanceolate, angular-sub-compressed spikelets, narrowly lanceolate, decurrent crimson glumes, cuticular papillae on both surfaces of leaf, inner bundle sheath being uniformly U-shaped, and mesophyll of lobed spongy cells without air cavities forming between the vascular bundles. The differences between them are so large that it is necessary to treat *(Scirpus) junghuhnii* as a separate genus from *Scirpus*, if the latter is to remain a natural and coherent group.

**Distribution:** A monotypic genus with one variety endemic to Sumatra, Indonesia (see Map 2).

External morphology: see p. 225.

Internal morphology: Culm ground tissue spongy, often breaking down to form irregular air cavities. Vascular bundles largely in the chlorenchyma, very few in the ground tissue. Hypodermal solerenciyma as secundiform to subtriangular girders or strands. Chlorenchyma not radiate, palisade-like to rounded, polygonal.

Leaf: Vascular bundles in a single V or are series with the chlorenchyma breaking down between them to form air cavities. Unicellular hairs present on the abaxial and/or adaxial surfaces. Bundle sheath: inner layer fibrous, uniformly thick-walled. Silica bodies: of three types, conical with or without satellites, or as minute, variously shaped bodies associated with sinuations in anticlinal walls.

Embryo structure: turbinate to fungiform with basal coleoptile and lateral root cap.

Type species: *F. umbellata* Rotth.

Key to infra-generic groups

1a. Bristles 6, needle-like, or absent; culm trigonous, leaves V-shaped in
   T.s.; cuticular papillae present, overarching the
   stomata (Type sp.: *F. striata* Steud.)
   
   ............................ subgen. Pentaesthetic (Turoz.) Oteng-Yeboah

2a. Bristles present

2b. Bristles absent (Type sp. *F. pubescens* (Poir) Kunth)
   
   ............................ sect. Pseudo-isolepis (Clarkes) Chermes
1b. Bristles 6, inner 3 petal-like plates of various shapes, outer 3 needle-like; culm terete or nearly so; leaves thinly crescentiform in t.s.; cuticular papillae absent.

3a. Leaves with well developed blades; inflorescence generally paniculate ......................................................... subgen. Fuirena

3b. Leaf blades absent or greatly reduced to sheathing bases; inflorescence a single terminal cluster of few spikelets, sometimes solitary (Type sp. F. scirpoidea Michx.) ......................................................... subgen. Vaginaria (Pers.) Oteng-Yeboah

Observation: The recognition of the subgenera Pentaestichus and Vaginaria is justified because the differences between them and Fuirena proper are quite spectacular. Their previous status as distinct genera is not supported since their overall similarities out number their dissimilarities from Fuirena proper.

Affinity: Fuirena appears to be unique in such characters as tubular ligules, suborbicular aristate glumes, inner 3 petal-like plates, pubescent leaves etc. The fruit characters are shared with Phyllosciurus, and the internal anatomy of the vegetative organs is partly shared with Bolboschoenus, Scirpus s.s. etc. The characters that bring it nearer to the tribe Scirpae are the spirally imbricate glumes, and the presence of bristles; and it certainly is plausible to consider it as a distinct sub-group within the tribe Scirpae.

Distribution: c. 35 spp. widely distributed in the Tropical and subtropical regions (see Map 9).

External morphology: see p. 227

Internal morphology: Culm: ground tissue spongy, sometimes breaking down. Chlorenchyma not radiate, palisade-like, often breaking down between the vascular bundles to form peripheral cavities. Vascular bundles in more than one series, the inner ones often penetrating into the culm centre. Leaf: outline V-shaped, with a single series of vascular bundles connected by abaxial and adaxial inflated parenchymatous strands. Air cavities filled with stellate translucent cells. Bulliform cells well differentiated. Keel region often showing 2 superimposed vascular bundles. Bundle sheath: inner layer fibrous, uniformly thick-walled. Silica bodies conical with satellites, 1-4(-6) bodies per cell. Embryo structure: fimbriate with basal coleoptile and lateral root cap.

Type species: B. maritimus (L.) Palla

Key to infra-generic groups

1. Style 3-fid; fruit compressed trigonous to plano-convex; exocarp +
    isodiametrical in t.s. ........................................... sect. Bolboschoenus

1. Style 2(-3) fid; fruit lenticular to bi-convex; exocarp
    radially elongated in t.s. ........................................... Type sp. B. paludosus (Nelson) Oteng-Yeboah

................................................................. Sect. A

Observation: It is the first time infra-generic grouping has been introduced in this genus. The distinction between the two sections recognised above is based mainly on the fruit characters which are found to be constant and very reliable. The alphabetical 'name' Section A is accorded to the species related to B. paludosus, e.g. B. strobilimus, B. planiculmis etc. pending a proper sectional name.

Affinity: Bolboschoenus shares a number of characters with Schoenoplectus and Hymenochaetes. They therefore appear to be more closely related to each other than to any other genera.

Distribution: with c. 16 spp. widely distributed in all regions.
6. SCHOENOPECTUS (Reichenb.) Palla in Engler Bot. Jahrb. 10: 298 (1889)
gen. conserv. Reichenb., Fl. Germ. Em. 78 (1830) et Icon. Fl. Germ. 8: 40
Mitt. Fl. 2(2): 318 (1903); Clarke in Kew Bull. Add. ser. 8: 112 (1908);
Nees in Linn. Soc. 9: 292 (1834); C. A. Mey. in Mem. Sav. Etrang. Petersb. 1: 200,
t. 22 (1831); Steudel, Nom. Bot. ed. 2, 1: 552 (1840); Beetle in Amer. Journ.
Bot. 28: 691 (1941); 29: 653 (1942); 30: 395 (1943); 31: 264 (1944); Ohwi in

External morphology: see p. 235.

Internal morphology: Culm: outline circular to triangular, hypodermal scleren-
chyma as small rounded to angular strands. Ground tissue net-like with numerous
scattered vascular bundles and air cavities; the air cavities filled with dia-
phragmatic plates containing transverse veins and stellate and/or lobed trans-
luscent cells. Leaves when present, variable in outline. Bulliform cells
occasionally present; adaxial. Hypodermal layer frequent. Bundle sheath: inner
layer fibrous, uniformly thick-walled. Silica bodies: conical with or without
satellites, 1-10 bodies per cell. *Embryo morphology: fungiform with basal coleop-
tile and lateral root cap.

Type species: Schoenoplectus lacustris (L.) Palla / Rickett & Stafleu in Taxon

Key to infra-generic groups

1a. Culms generally tufted; fruit small, up to 1.5 mm x 2.5 mm, rounded or
mucoarilate, often transversely wrinkled/rugose (Type sp. S. mucronatus
(L.) Palla) .................... subgen. Actaeogiton (Reichenb.) Oteng-Yeboah

1b. Culm solitary from horizontal rhizome; fruit large up to 2 mm x 4 mm,
beaked, smooth or minutely dotted
2a. Glumes emarginate or notched at apex, broadly ovate, usually with
gummy spots at the back; anthers with prickly crests; leaves
reduced or absent .................................. subgen. Schoenoplectus

2b. Glumes not emarginate, often erose at apex, oblong-ovate or
narrowly elliptic, smooth at the back; anthers with smooth crests;
leaves well developed (Type sp. S. strobilulatus Steud.) Oteng-Yeboah

.................. subgen. Malagogeton (Ohwi) Oteng-Yeboah

Observation: The subgenus Malagogeton appears to be intermediate between
Schoenoplectus proper and Bolboschoenus, since it shares a number of characters
with both of them. However, in having a net-like ground tissue in addition to
other characters, such as the pseudo-lateral inflorescence and long-beaked fruits,
it is closer to Schoenoplectus than to Bolboschoenus. On account of its somewhat
intermediate position, subgeneric rank appears to be the best solution. It was
for the same consideration that the subgenus Actaeogoton is proposed, especially
because of its fruit characteristics which are also found in unrelated genera such
as Rhynchospora, and its tufted habit.

Affinity: The embryo structure, glume shapes and anther crests in the subgen.
Schoenoplectus, and the general habit of subgenus Malagogeton, bring the genus
Schoenoplectus closer to Bolboschoenus. Other genera in which Schoenoplectus
appears to show affinities include Hymenochaeta and Pseudo-schoenus, all of which
share net-like ground tissue in the culm.

Distribution: With c. 50 spp. widely distributed in all regions.

7. HYMENOCHAETA Beauv. in Lestib., Ess. Fam. Cyperac. 43 (1819)

External morphology: Perennial with long slender rhizomes. Culm nodeless,
solitary or tufted, triquetrous. Leaves basal, linear, graminaceous. Inflorescence a large terminal corymb, with numerous rays; two rays in distinct major and minor sizes sheathed by the ray prophyll from the axil of each bract. Involucral bracts numerous, large, leak-like. Spikelets solitary, sessile and/or stalked, ellipsoid, many-flowered. Glumes elliptic, spirally imbricate, mucronate, serrate on the margins. Hypogynous bristles 6, retrorsely scabrous. Stamens 3, anthers linear, with obtuse reddish-brown crests and smooth profile. Style 3-fid, papillose. Fruit broadly obovoid, trigonous or plano-convex, shortly apiculate, stramineous-brown, smooth.

Internal morphology: Culm: outline triangularly star-shaped. Ground tissue net-like with numerous scattered air cavities and vascular bundles. Hypodermal sclerenchyma as small rounded to angular strands. Leaf: outline V-shaped to flanged V-shaped, with a single V-series of vascular bundles. Vascular bundles supported by tall parenchymatous strands separating the adjacent air cavities. Bulliform cells well differentiated. Bundle sheath: inner layer fibrous, uniformly thick-walled. Silica bodies: conical without satellites, 2-4 bodies per cell.

Embryo structure: cf. Schoenoplectus.

Type species: H. grossa (L. fil.) Nees

Observation: The generic name Hymanochaeta has also been used in the Fungi (Hymenomycetes) and Donk, M.A. (The generic name proposed for Hymenomycetes 7: 73-74, 1966) has argued for the retention of the name in the Fungi though its usage there is later (Hymanochaeta Lev.) to its usage in the Cyperaceae.

Affinity: This genus differs from Schoenoplectus (g.v.) mainly on its general inflorescence and very well-developed leaves.

Distribution: A monotypic genus whose distribution is limited to the Far East (see Map 7).


**External morphology:** Culm robust, terete. Leaves wanting or reduced to sheathing bases, the uppermost slightly inflated, obtusely triangular on one side.

**Inflorescence:** A terminal panicle with flexuosely rays, subtended by short, rigid, culm-like involucral bracts. Spikelets cylindric, many-flowered, flowers often polygamous-chioecious. Glumes spirally imbricate, ovate, shortly mucronate, smooth.

**Hypogynous bristles:** Needle-like, 6, retrorsely scabrous. Stamens 3, anthers linear (in ♀ flowers reduced, empty), crest with prickly or papillose profile. **Style** 3-fid, papillose. **Fruit** oblancoelolate, smooth apiculate.

**Internal morphology:** Culm: ground tissue net-like, containing numerous air cavities filled with diaphragmatic plates and vascular bundles. Chlorenchyma not radiate, palisade-like. Epidermal cells over hypodermal solerenchyma taller and narrower than those over chlorenchyma. Peripheral vascular bundles often connected by narrow baculiform hypodermal solerenchyma gorders. **Bundle sheath:** inner layer fibrous, uniformly thick-walled. Siica bodies conical without satellites, 2-3 bodies per cell. **Embryo structure:** of *Schoenoplectus*.

**Type species:** Pseudo-schoenus *inanis* (Thum.) Oteng-Yeboah, *comb. nov., ined.*

**Observation:** It has been necessary to consider this taxon as a distinct genus because it shares different characters with *Schoenus*, *Cladium* and *Schoenoplectus*. The spikelet, fruit and bristle characters are as in *Schoenus*, the paniculate inflorescence is as in *Cladium*, and the leafless and internal structure of the culm, the number of flowers per spikelet and the embryo are as in *Schoenoplectus*. Its assumed relationship with Desmo-schoenus in *Scirpus* s.l. of Koyama in *Journ. Fac. Sci. Univ. Tokyo*, Sect 3, 7(6): 290 (1958) is found to be incorrect because of the number of differences in the external and internal features between
Desmoschoenus and Pseudo-schoenus. It seems that Koyama may not have compared
the species in the two genera before drawing his conclusion. In such circumstances,
where a small taxon does not fit into any allied genus, it appears justifiable to
assign it to a genus of its own.

The earliest specific epithet is 'inanis' given by Thunberg (Prodr. 16:
(1794) under Schoenus. The specific epithet 'spathaceus' Hochst. is treated as a
later synonym.

Affinity: Following the observation above, it is very difficult to establish the
affinity of this polygamo-dioecious genus confidently. However, the number of
features it has in common with Schoenoplectus, seem to indicate that the two
genera are related.

Distribution: A monotypic genus endemic to South Africa (see Map 1).


District, Sp. Pl. Ed. 6, 2: 89 (1833); Koeh, Synops. ed. 2, 859 (1844); Aschers.
(1944); 33: 664 (1946); Raymond in Mem. du Jard. Botan. de Montreal no 48: 146

External morphology: see p. 243.

Internal morphology: Culm outline triangular or circular to circular with grooves.
Ground tissue solid. Vascular bundles unequal, 6-18 in one conspicuous ring inside
chlorenchyma. Hypodermal chlorenchyma, often as crescentiform girders. Cells
bordering the substomatal cavity, sometimes thick-walled. Leaf: outline thinly
to thickly crescentiform, sometimes with a keel. Bulliform cells occasionally
present. Vascular bundles few, 3-6(-10) in a single arc, occasionally V series.

Bundle sheath: inner layer fibrous, uniformly thick-walled or partially U-shaped at
xylem or phloem poles. Silica bodies: conical without satellites, 1-4 bodies per cell. Embryo structure: + turbinate with lateral coleoptile and basal root cap. Type species: *T. alpinum* (L.) Pers.

Key to infra-generic groups

1. Inflorescence terminal; spikelet solitary; glumes persistent

........... subgen. *Trichophorum*

1. Inflorescence pseudo-terminal; spikelets (1 to) a few, the lower stalked; glumes deciduous (Type sp. *T. subcapitatum* (Thwaites) Ohwi

........... subgen. *Anthroslophorum* (Ohwi) Oteng-Yeboah

**Observation:** The generic name *Trichophorum* was originally applied to three species, two of which, *T*. *cyperinum* (= *S*. *cyperinus* (L.) Kunth) and *T*. *lineatum* (= *S*. *lineatum* Michx.), are treated as belonging to *Scirpus*. The other species, *T*. *alpinum* (= *Eriophorum alpinum* L., *Scirpus hudsonianus* (Michx.) Fern.), has been transferred between three different genera as can be seen from the synonymy cited. At present the generic name *Trichophorum* is widely used in Europe for the species related to *T*. *alpinum*, while in America it is used as a section of *Scirpus* to accommodate the above 2 named *Scirpus* spp. Since *Trichophorum* is accepted as a distinct genus from *Scirpus* s.s., it is reasonable to retain it for the *T*. *alpinum* group of species. The other available generic name *Basothryon* Ehrh. ex Dietr. (1833) was ill-defined, including species some of which do not even belong to the family *Cyperaceae*.

**Affinity:** On the basis of the elongate silky bristles in *T*. *alpinum*, one initially suspects affinities with *Eriophorum*, *Scirpus* p.p. and *Eriocirpus*. But considering overall similarities particularly in vegetative and floral characters, it appears that *Trichophorum* spp. are more closely related to *Eriocirpus* than to either *Eriophorum* or *Scirpus*. The elongate silky bristles may have developed independently.

**Distribution:** see p. 137 and Map 10.
Nylander in Acta Soc. Sci. Fenn. 3: 22 (1846); Clarke in Kew Bull. Add. ser 8:
115 (1908); Raymond in Nat. Canad. 84: 146 (1957); Koyama in Journ. Fac. Sci.
Univ. Tokyo, sect. 3 (Bot.) 7(6): 294 (1958).

External morphology: Perennial, tufted. Culm terete, sometimes compressed, node-
less, often prickly. Leaves basal, linear, often setaceous. Inflorescence a
terminal compound pseudo-umbel, sometimes capitate. Spikelets terete, many-
flowered, stalked and/or sessile. Glumes spirally imbricate, ovate, acuminate.
Hypogynous bristles filiform, frequently silky, 6 to many, frequently overlapping
the glume, antrorsely scabrous. Stamens 3, anthers small, linear, with acuminate
crests and prickly or papillose profile. Style 3-fid, papillose. Fruit lanceolate
to obovoid, trigonous, smooth, shortly spiculate.

Internal structure: Culm, ground tissue solid. Vascular bundles in a single ring,
sometimes penetrating into the ground tissue as in E. comosus. Hypodermal
solenenchyma rounded to angular strands, sometimes girders. Leaf: thinly to
thickly crescentiform. Vascular bundles in a single arc series. Adaxial hypodermis
often differentiated. Bundle sheath: inner layer fibrous, uniformly thick-walled.
Silica bodies: conical without satellites, 1-3 bodies per cell. Embryo structure:
turbinate with basal coleoptile and lateral root cap.

Type species: Eriocirpus microstachyus (Boeck.) Palla.

Key to infra-generic groups

1. Culm capillary or wiry, often prickly; spikelets few, crowded into a small
   head; vascular bundles in culm in a single ring; leaves thickly
crescentiform ........................................... subgen. Eriocirpus

1. Culm robust, smooth; spikelets numerous, arranged loosely on a
   compound pseudo-umbel; vascular bundles in culm scattered; leaves thinly
crescentiform to widely V-shaped (type sp. E. comosus (Wall.) Palla)

.................................... subgen. Lachnophorum (Nylander) Oteng-Yeboah
Observation: The species in this genus had always been classified in Eriophorum until Palla separated them out. The present observation further supports Palla's treatment in establishing Eriocirpus as a genus distinct from Eriophorum. The presence of silky bristles in both genera and also in Trichophorum alpinum and Scirpus may have arisen more than once through parallel or convergent evolutions.

Since there are no data on the origin of this form of bristle, it is worth treating all these genera as distinct on the basis of other characters. The inflorescence in the subgenus Lechnophorum typified by E. comosus recalls those in Scirpus s.s. and in correlation with other characters mentioned above, it was considered fitting to treat it as a subgenus. The only available infrageneric name was Lechnophorum given by Nylander in Acta Soc. Sci. Fenn. 3: 22 (1846) as a section of Eriophorum, and this has been used.

Affinity: The genus appears to show affinity with Trichophorum with which it shows a similar habit and a number of floral characters, such as fruit shape, bristles and number of style branches.

Distribution: Containing 5 species, 4 of which are endemic to Eastern Himalayas and Indo-China, and one endemic disjunct species in South Africa.


External morphology: Perennial, rhizomatous. Culm solitary, setaceous, short, nodeless, borne at the summit of an ascending rhizome. Leaves basal and/or sub-basal, rosette-like, setaceous. Inflorescence a terminal head containing few spikelets, subtended by glumaceous involucral bracts, often indistinguishable from the sub-basal rosette-like leaves. Spikelet terete, many-flowered. Glumes spirally imbricate, ovate, membranaceous, margins smooth. Hypogynous bristles 6,
needle-like, retrorsely scabrous. Stamens 3, anthers linear with smooth crest. Style 3-fid, deciduous. Fruit pyriform, attenuate at base and apex, trigonous, 1 long apiculate, smooth.

Internal morphology: Culm: ground tissue solid, often breaking down to form a large central cavity. Vascular bundles in one ring inside the chlorenchyma, and often connected by triangular hypodermal sclerenchyma girders. Chlorenchyma not radiate, palisade-like to spongy, often breaking down between the vascular bundles to form peripheral air cavities. Leaf: outline thinly crescentiform with the vascular bundles in an arc positioned towards the abaxial surface. Adaxial hypodermis differentiated. Bundle sheath: inner layer fibrous, uniformly thick-walled. Silica bodies: conical without satellites, 1 body per cell. Embryo structure: turbinate with sublateral coleoptile and root cap.

Type species: Phylloscirpus andesinus Clarke

Affinity: In habit and embryo structure this genus is very close to Genus C. The two genera differ in general inflorescence, fruit form and in the internal structure of the culm.

Distribution: Containing about 4 species, all of which are restricted to the Andes.


Style 3-fid, papillose. Fruit obovoid, plano-convex, smooth, not apiculate.
Internal morphology: Culm: Vascular bundles in a somewhat sinuous ring at the
inner boundary of the chlorenchyma. Ground tissue solid, occasionally breaking
down at its outermost boundary between the vascular bundles. Chlorenchyma not
radiate, palisade-like. Hypodermal sclerenchyma + large triangular to rounded
strands. Leaf: outline thickly crescentiform, with vascular bundles in a single
arc series. Adaxial hypodermis differentiated. Bundle sheath: inner layer
fibrous. Silica bodies: conical without satellites, 1 body per cell. Embryo
structure: turbinate with subapical coleoptile and root cap.
Type species: (Scirpus) nevadensis Watson
Observation: On the basis of the inflorescence alone, this taxon was associated
with Schoenoplectus (see Beetle in Amer. Journ. Bot. 31: 264 (1944). The genus
has been found not to belong to Schoenoplectus because of differences in a number
of characters, including the solid ground tissue. The presence of ascending
rhizomes and the structure of the embryo in Genus C recalls those of Phylloscirpus
from which it differs in such features as inflorescence form, shape of fruit and
its internal structures, and internal structure of the culm. The internal structure
of the culm in Genus C also recalls Ficinia, especially F. scariosa from it differs
in having no disc-like gynophore at the base of the fruit. Because of the in-
definite relationship of Genus C to any one of the above mentioned genera, it
seems reasonable to treat it as a monotypic genus.
See p.138 and Map 6 for distribution.

Svensen in Rhodora 31: 121-135; 152-163; 167-191; 199-219; 224-242 (1929);
Svensen l.c. 34: 193-203; 215-277 (1932); Svensen l.c. 39: 210-231; 236-273
(1957); Zinserling in Komarov. Fl. URSS 3: 49-70 (Engl. Transl.) 1964.
External morphology: see p. 247


Type species: Eleocharis palustris (L.) R. Br.

Affinity: Because of the occurrence of a thickened, articulate style base in Eleocharis, a number of workers have assumed that it had an affinity with the Eimbristylis group (see Chermesov 1936). Considering all features of the two genera, both floral and vegetative, it is clear to me that they are not related, the affinity of Eleocharis appears to lie more with Eglaria (q.v.) and Websteria (q.v.).

Distribution: c. 200 spp. cosmopolitan.


External morphology: see Eiten op. cit.

Type species: Eglaria fluviatilis Eiten (isotype Duke n. 34609 (SP))

Note: Eglaria appears to be intermediate between Eleocharis and Websteria, showing spikelet and fruit structures of the former, and habit and (cf. Key, lead 9a) characteristics of the latter. In this circumstance I lend support to Eiten in giving generic status to it.

*This specimen arrived after the present investigations had been completed, and there was no time to investigate the internal morphology. The external morphology, which I had time to study, confirms Eiten's description of the genus.


Madagascar, 29º Famille: 143 (1936).

**External morphology:** Submerged aquatic perennial with much branched flexuous shoots. Culms and leaves umbellate, setaceous to capillary, from the nodes of the much branched shoots. Inflorescence a solitary terminal spikelet.

Spikelet one-flowered, ovate-lanceolate; glumes 2 to a spikelet, subdistichous, elliptic, acute, with smooth reddish-brown margins. **Hypogynous bristles** 6-10, retrorsely barbed. **Stamens** 3, anthers long, linear, with acute, smooth or papillose crests. **Style** 2-fid, papillose. **Fruit** obovoid, biconvex, long-spiculate, finely striated or smooth, brown.

**Internal morphology:** Culm: ground tissue spongy with two air cavities separated by 1-3-celled/parenchymatous strand which connect to the two vascular bundles.

**Hypodermal sclerenchyma** numerous, very minute strands. **Bundle sheath:** inner layer fibrous, uniformly thick-walled. **Silica bodies:** nodular, 7-10 bodies per cell. **Embryo structure:** centrifugal or turbinate with basal coleoptile and lateral root cap.

**Type species:** Websteria confervoideae (Poir.) S. Hooper.

**Observation:** The earliest specific epithet was given by Poiret in Lamarck's Ency. 6: 755 (1804). When Wright circumscribed the genus, he gave the specific epithet "limnophila" which Britton 1888 considered as a later synonym of "submersus" Sauvelle (1873) and overlooked 'confervoideae' Poir. In this account, the earliest specific epithet is adopted.

**Affinity:** The habit and habitat of Websteria is shared with Egeria, Eleocharis and some Eleocharis species. Egeria is distinguished from Websteria on the
spikelet structure, number of flowers per spikelet, and number of bristles. *Eleogiton* is differentiated in the absence of bristles, many-flowered spikelets, and spirally imbricate glumes; and *Eleocharis* is differentiated in having thickened style bases, and very frequently many-flowered spikelets. *Egeria* and *Eleocharis* appear to be more related to *Websteria* than is *Eleogiton* whose affinity lies more with *Islepis*.

**Distribution:** This is a monotypic genus with a wide range of disjunct distributions in the Old and New Worlds (see p. 138 and Map 7).


**External morphology:** see p. 257.

**Internal morphology:** *Culm:* ground tissue solid, rarely breaking down. Chlorenchyma not radiate, palisade-like to spongy, often breaking down between the vascular bundles to form peripheral air cavities. Vascular bundles in a single ring, unequal, often connected by pulviniform to subtriangular girders. *Leaf:* outline inversely W- to flanged V-shaped. Vascular bundles in a single series, arranged according to the leaf outline; often connected to the adaxial and abaxial epidermis by tall and narrow chlorenchyma girders. Bulliform cells well-differentiated. Keel very prominent. *Bundle-sheath:* inner layer fibrous, uniformly thick-walled and/or partially U-shaped at phloem pole. *Silica bodies:* conical without satellites, 1-2 bodies per cell. *Embryo structure:* turbinate with lateral coleoptile and basal root cap.

**Type species:** *Elymus compressus* (L.) Panz.

**Observation:** The occurrence of a spike-like inflorescence with sessile distichous spikelets in various species of *Carex* subgenus *Vigmea*, which are often mixed up
with specimens of *Blysmus* s.l. in herbaria, may be considered as a clear example of convergent evolution in the *Cyperaceae*.

**Affinity:** with *Genus B* (q.v.).

**Distribution:** Widely distributed in Eurasia (see Map 8).

17. **GENUS B** *As Blysmus rufus* (Huds.) Link. Hort. Berol. Descr. 1: 278 (1827);

**External morphology:** Similar to *Blysmus* but differing in having channelled leaves with smooth margins, without keel; spikelets 5–8 in an inflorescence, dark brown; glumes 5 mm long; bristles white, antromesely scabrous; fruit 4 mm long, light brown.

**Internal morphology:** **Culm:** ground tissue net-like, with numerous air cavities. Vascular bundles regularly distributed in one ring between the chlorenchyma and ground tissue and irregularly in the ground tissue. Hypodermal sclerenchyma small rounded strands. **Leaf:** outline crescentiform; with vascular bundles arranged in an arc. Adaxial hypodermis differentiated; no bulliform cells present.

**Bundle sheath:** inner layer fibrous, partially U-shaped at phloem pole, sometimes uniformly U-shaped especially around the smaller bundles. **Silica bodies:** conical with satellites tending to be nodular, 2–4 bodies per cell. **Embryo structure:** as in *Blysmus*.

**Type species:** *(Blysmus) rufus* (Huds.) Link.

**Observation:** Comparing *Blysmus* (confined to *B. compressus*) and *Genus B* based on *(Blysmus) rufus*, I cannot help thinking that we are dealing with two basically distinct genera. From the present study, it is obvious that the characters common to these two taxa are mainly those of the inflorescence, style and embryo structure. It seems worth noting that in general facies including the inflorescence, *Blysmus compressus* is remarkably similar to some species of *Carex*, suggesting
that if convergence has occurred between these two genera (placed in different subfamilies), it could easily have done so between *Blysmus compressus* and *Genus B* (*Blysmus rufus*) which differs in so many microscopic features (cf. description above, Key 6a and Tables). I consider it justifiable to treat the two as distinct genera.

**Distribution:** Containing one species which is endemic to Northern Europe, and one variety which is restricted to the North Eastern North America (see Map 8).


**External morphology:** see Gleason H.A., New Britton & Brown Ill. Fl. 1: 258 (1932).


**Type species:** *Dulichium arundinaceum* (L.) Britt.

**Observation:** The 2-fid styles, terbinuate embryos with lateral coleoptile and basal root cap, and distichously arranged spikelets may suggest some affinity with *Blysmus* and *Genus B*. However, the combination of an axillary inflorescence, distichously arranged glumes, hypogynous bristles and several-noded leafy culm isolate *Dulichium* from all other genera. I think Schultze-Motel (op. cit.) was justified in assigning it to a tribe of its own.

**Distribution:** A monotypic genus endemic to North America (see Map 3).


External morphology: see p. 260.


Type species: Fimbrystylis dichotoma (L.) Vahl

Affinity: Closely allied to Crosslandia from which it differs in having bisexual spikelets.

Distribution: with c. 220 spp. widely distributed especially in the warm regions of the world.


External morphology: see Fitzgerald op. cit.


Type species: Crosslandia setifolia W.V. Fitzgerald.

Affinity: Closely allied to Fimbrystylis which it resembles in almost every character, except for its monoeccious spikelets.

Distribution: A monotypic genus endemic to Western Australia.


Type species: Bulbostylis capillaris (L.) Clarke
Affinity: Closely allied to *Abildgaardia*, but differing in the spirally imbricated glumes.

Distribution: with c. 100 spp. widely distributed in all warm regions of the world.


*Type species:* *Abildgaardia monostachyos* (L.) Vahl

Affinity: Closely allied to *Bulbostylis* (which it resembles among other features in its persistent thickened style base) but differing in the lower glumes of the spikelet being distichously arranged. Some authors (e.g., Koyama op. cit.) have preferred to put these two genera into *Fimbristylis*, as the characters separating these two genera and *Fimbristylis* have sometimes been considered unsound at the generic level. (See K. *Lye* op. cit., *Gordon-Gray* (1971) and *Van der Veken* op. cit. for arguments for and against the sinking of *Bulbostylis* and *Abildgaardia* into *Fimbristylis*).

Distribution: with c. 30 spp. widely distributed in the tropics and subtropics of both Old and New Worlds.


*External morphology:* see *Van der Veken* op. cit.

Type species: *Nelmesia melanostachya* Van der Vekan.

Affinity: *Nelmesia* is closely related to *Nemum* from which it differs in the presence of a hyaline anterior scale and general inflorescence, spikelets and fruit shapes. It also shows some affinity with the *Fimbriatula* group in the internal morphology of culm, through *Bulbostylis* especially, with which it shares the same embryo structure.

Distribution: The genus is monotypic, being endemic to the Belgian Congo (see Map 2).

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External morphology: Annual, tufted, Culm nodeless, filiform, terete, striate. Leaves basal, setaceous. Inflorescence pseudo-lateral, head containing one to few spikelets, subtended by an erect, short setaceous involucral bract. Spikelets sessile and/or stalked, cylindrical, many-flowered. Glumes spirally imbricate, obovate, reddish-brown, ciliate or smooth at the margins, persistent. Hypogynous perianth absent. Stamens 3, anthers linear, with obtuse crest and smooth profile. Style 2-fid, papillose. Fruit obovoid to orbicular, biconvex, not apiculate, smooth and shiny, dark brown.

Type species: *Nemum speciosum* (Lam.) Desv. ex Hamilt.

Affinity: with *Nelmesia* (q.v.)

Distribution: Both its 2 species are endemic to Tropical West Africa (see Map 7).


External morphology: see Moore & Edgar, op. cit.

Internal morphology: Culm: ground tissue spongy, tending to break down.
Vascular bundles in more than one irregular ring, often penetrating into the ground tissue. Hypodermal solerenenchyma largely rounded to securiform strands, very rarely girders. Chlorenchyma not radiate, lobed spongy cells. Leaf: outline thickly crescentiform. Vascular bundles seemingly in 2 rows towards each leaf margin (probably due to inversion of the margins). Adaxial hypodermis slightly differentiated. Bundle sheath: inner layer fibrous, uniformly thick-walled. Silica bodies: conical without satellites, sometimes in irregular 2 rows, 4-10 bodies per cell. Embryo structure: a variant from the form in *Cyperus*.

Type species: *Desmoschoenus spiralis* (A. Rich.) Hook. fil.

Observation: This genus has unique features especially in the inflorescence, the in subtending/volucral bracts, and the anatomy of the leaf. Its nearest relation may possibly be with *Holoschoenus*, based mainly on habit, (i.e. the external features of the culm and leaf) and the embryo structure.

Distribution: A monotypic genus endemic to New Zealand (see Map 1)


External morphology: Perennial, often tufted. Culm nodeless, robust to filiform. Leaves basal, channelled or setaceous, rarely absent. Inflorescence variable,
head-like or verticillate-like, or second or solitary; subtended by glumaceous or leaf-like or culm-like involucral bracts. Spikelets many-flowered. Glumes often spirally imbricate, rarely distichous. Perianth absent.

Stamens 3(-2), anthers linear, with or without prickly crests. Style (2)-3-fid, papillose. Fruit ovoid, trigonous or plano-convex, sitting on a minute disc-like or obpyramidal gynophore.

Internal morphology: Culm: vascular bundles in a single ring at the boundary of chlorenchyma and the ground tissue (except in F. radiata where they are scattered). Hypodermal sclerenchyma as small or large strands. Leaf: outline crescentiform; with adaxial hypodermis differentiating in the chlorenchyma. Vascular bundles arranged in a single arc series. Chlorenchyma not radiate, or obscurely so.

Bundle sheath: inner layer fibrous, uniformly very thick-walled. Silica bodies: conical without satellites, 1-5 bodies per cell. Embryo structure: a variant from the form in Cyperus.

Type species: Ficinia filiformis (Lam.) Schrader.

Observation: Though the external morphology including the habit, inflorescence and spikelets, vary widely among the species, there is a remarkable uniformity in the internal morphology, not to mention the gynophore. The only species which appears to be somewhat anomalous is Ficinia radiata which apart from having an undivided or microscopically notched style and bright yellow glumes, also has scattered vascular bundles in the culm. It has sometimes been classified as a distinct genus (Sickmannia Nees) and sometimes as a subgenus of Ficinia. Due to lack of time, it was not possible to take a proper decision on its status, except to consider it provisionally as a member of Ficinia.

Distribution: with c. 57 spp. endemic to the tropics and South Africa. (see Map 4).
Koch, Synops. ed. 2: 293 (1844); Clarke in Kew Bull. Add. Ser. 8: 112 (1908);
Clapham et al., Fl. Brit. Isles Ed. 2: 1065 (1962); Rozhavits in Komarov, Fl.

External morphology: see p. 264.

Internal morphology: Culm: ground tissue solid, occasionally breaking down.
Vascular bundles in distinct 1-2 rings in the chlorenchyma, occasionally penetrat-
ing into the periphery of the ground tissue. Hypodermal solerencyma tall and narrow girders or subgirders. Chlorenchyma not radiate, palisade-like, often breaking down between the solerencyma girders to form peripheral air cavities.
Epidermal cells often uniformly sized, sometimes those over the solerencyma are taller and bigger than those over the chlorenchyma. Leaf: outline thickly crescentiform, with several layers of adaxial hypodermal cells. Vascular bundles in a V-shaped series. Bundle sheath: inner layer fibrous, sometimes partially u-shaped at the phloem pole. Silica bodies: conical, without satellites, 1-2 bodies per cell. Embryo structure: a variant from the form in Cyperus.

Type species: Holoschoenus vulgaris Link

Affinity: with Androtrichum (q.v.) from which it differs in its spirally imbricate glumes; and also with Hellmuthia (q.v.) from which it differs in having small numerous congested spikelets and absence of lateral scales.

Distribution: c. 5 spp. widely distributed in all regions of the Old World and sporadically in the New World.

28. HELLMUTHIA Stend., Syn. Fl. Glum. 2: 90 (1855)
Syn: Scirpus sect. Isolepis ser. Holoschoenae Clarke in Kew Bull. Add. Ser. 8:
Cyper. t. 47 (1909); Levyns in Adamson & Slater, Fl. Cape Peninsula 107 (1950).

External morphology: As in Holoschoenus and Ficinia p.p., differing from both in
having a pseudo-lateral head containing 1-7 large spikelets, flowers sometimes
with 2 large lateral boat-shaped papery scales on each side of the flower within
the main subtending glume (note: a feature predominant in the Hypolytreae).

Internal morphology: as in Holoschoenus.

Type species: Hallmuthia resticoides Steud.

Observation: With some specimens of this taxon showing the 2 large lateral scales
(e.g. Druge 3943, Zeyher 1775 illustrated by Clarke 1909 op. cit.) while other
specimens (e.g. Bolus 7187!, Parker 4792! etc.) do not possess these scales, it
appears that 2 taxa may be involved here. Levyns op. cit. mentions that the 2
papery lateral scales are frequent which means therefore that H. resticoides Steud.
s.s. is not represented by one or two specimens as previously thought by earlier
authors (see Clarke 1898 p. 225). Since Steudel's genus was based on Druge 3943
it is proper to cite the type species as Hallmuthia resticoides Steud. Thunberg's
Scirpus membranaceus (see Thumb., Prodr. 17 (1794), which refers to specimens
lacking these 2 scales may turn out to be a distinct species from that of Steudel's,
but population studies are needed before a decision can be taken.

Affinity: Without doubt, Hallmuthia is very closely allied to Holoschoenus, and
probably would have been treated as congeneric with it, but for the size of the
spikelets forming the head-like inflorescence, and the 2 lateral scales (when
present). Lateral scales are very unusual in the Cyperaceae outside the Hypo-
lytreae, and for this taxon to show it while still maintaining its bisexuality
justifies its recognition as a distinct genus.

Distribution: endemic to South Africa (see Map 8).

29. OXYCARYUM Nees in Mart. Fl. Bras. 2(1): 90 (1842)

284 (1971).
External morphology: see K. Lye op. cit.

Internal morphology: Culm: vascular bundles numerous, scattered, penetrating deep into the spongy ground tissue, but not reaching the centre. Hypodermal sclerenchyma triangular to angular strands. Leaf: outline V-shaped with a prominent keel. Hypodermal layer differentiated, but Bulliform cells not well differentiated. Bundle sheath: inner layer fibrous, uniformly thick-walled. Silica-bodies: conical with satellites, 2-4 bodies per cell. Embryo structure: a variant from the form in Cyperus.

Type species: Oxycaryum cubense (Poepp. & Kunth) K. Lye.

Affinity: Oxycaryum is related to Cyperus s.s. (especially the groups Anosporum and Atomostylis) from it differs in its beaked fruit.

Distribution: A monotypic genus widely distributed in the tropics of Africa and America (see Map 8).

30. ANDROTRICHUM Brongn. ex Kunth, Enum. Pl. 2: 250 (1837)


External morphology: Perennial, with robust rhizomes. Culm nodeless, solitary, terete, with basal bladeless sanguineous sheaths. Inflorescence compound umbel, with several rays, each terminating in a hemispherical head of several fascicles of spikelets. Involucral bracts 1-4, the lowest erect, culm-like, Spikelets ellipsoid, compressed, many-flowered. Glumes distichous, boat-shaped, acute, mucronate. Hypogynous perianth absent. Stamens 3, anthers with obtuse crests and smooth profile, filaments flexuous, hyaline white, long exerted giving a cottony appearance to the inflorescence. Style 3-fid, smooth, with ± swollen base. Fruit ellipsoid, trigonous, smooth, brown.

Internal morphology: Culm and bundle sheath as in Holoschoenus. Silica bodies:
conical with satellites, 1-2 bodies per cell. Embryo structure: a variant from the form in Cyperus.

**Type species**: Androtrichum trigynum (Spreng.) Pfeiffer

**Affinity**: The genus is closely related to Cyperus s.s. especially C. nudicaulis, on the + swollen style base, and to Holoschoenus with which it shares the same habit, culm anatomy and embryo structures. The relationship with Cyperus and Holoschoenus is more plausible since they have more characters in common.

**Distribution**: A monotypic genus confined to Eastern South America, from Southern Brasil to Argentina (see Map 3).

### 31. CYPERUS L., Sp. Pl. 44 (1753) & Gen. Pl. ed. 5: 26 (1754)


**External morphology**: see p. 274.

**Internal morphology**: Culm: outline variants from triangular shape. Vascular bundles numerous, minor ones more peripheral. Chlorenchyma radiate, e.g. 

*C. esulentus* or partly to obscurely to not radiate, e.g. *C. diffusus, C. orbiculatus*. Hypodermal chlorenchyma mostly as strands, rarely girder-like. Leaf: outline crescentiform or variants of V-shape. Bulliform cells often well-developed. Adaxial hypodermis sometimes differentiated. Bundle sheath: inner layer parenchymatous as in *C. esulentus* or fibrous, uniformly thick-walled as in *C. diffusus*. Silica bodies: variable, conical with or without satellites or nodular. Embryo structure: ellipsoid with basal coleoptile and lateral root cap.

**Type species**: Cyperus esulentus L.

**Observation**: Even in its present restricted sense, Cyperus is still heterogenous. Apart from containing species which have spirally imbricate glumes, the anatomy of the leaves and glumes are variable: some species, including the type sp. *C. esulentus*, have radiate chlorenchyma and vascular bundles with inner
parenchymatous sheaths, and other species lack radiate chlorenchyma and inner parenchymatous sheaths. Due to lack of time and material, regrettably it was not possible to investigate all the species in this large genus to determine the extent of this variation. Further investigation is needed to settle the apparent heterogeneity in the genus.

**Distribution:** with c. 350 spp., widely distributed in all regions.

**Palla**


External morphology see p. 304.

Internal morphology: **Culm:** outline triangular. Vascular bundles in more than one ring; minor ones peripheral. Hypodermal Solerenohyma hemisphaerical to subtriangular or pulviniform strands, numerous. Chlorenchyma radiate especially around the minor bundles. **Leaf:** outline V-shaped; vascular bundles unequal, the minor ones encircling the air cavities. **Bundle sheath:** inner layer parenchymatous. **Silica bodies:** conical with satellites, 2-7 bodies per cell. **Embryo structure:** ellipsoid with basal coleoptile and lateral root cap.

Type species: **Duval-Jouvea serotina** (Rottb.) Palla.

Observation: It has been thought necessary to emend the circumscription of Duval-Jouvea to include only one species, i.e. D. serotina. Previously the genus included the following very different species. e.g. Cyperus babakensis Steud., C. pilosus Wahlenberg, C. procerus Rottb., Mariscus compactus (Retz.) Druce etc. (see Kükenthal p. 664, 1936).

Affinity: The affinity of Duval-Jouvea had previously been considered to be with Juncellus, based mainly on the nature of the spikelet, fruit and styles. However, considering the leaf anatomy which it shares with some Mariscus spp. (q.v.) and its inflorescence, it is probably closer to Mariscus than Juncellus.

Distribution: A monotypic genus widespread in Europe and Asia (see Map 4).

**External morphology:** see p. 307.

**Internal morphology:** Culm: outline oval. Vascular bundles in slightly sinuous circle in chlorenchyma. Minor bundles numerous, more peripheral. Hypodermal selerenchyma numerous, dome shaped strands. Chlorenchyma radiate. Leaf: outline hemisphaerical to thickly crescentiform. Adaxial hypodermis well developed. Vascular bundles in 2 arc series, the minor ones numerous, more abaxially distributed. Bundle sheath: inner layer parenchymatous. Silica bodies: conical with satellites, 1-3 bodies per cell. **Embryo structure:** ellipsoid with basal coleoptile and lateral root cap.

**Type species:** Junecellus laeavigatus (L.) Clarke.

**Observation:** Clarke's circumscription of the genus was based on Grisebach's (1864) Cyperus sect. Junecellus which contained only one species Cyperus microrhizus Rottb. (= J. laeavigatus (L.) Clarke; Cyperus laeavigatus L.). Clarke included in Junecellus, Cyperus serotinus Rottb. (= Junecellus serotinus (Rottb.) Clarke; Duval-Jouvea serotina (Rottb.) Palla) which is now the type species of Duval-Jouvea.

With Cyperus serotinus transferred to Duval-Jouvea, the genus Junecellus is now homogenous, including 2 species, vis: J. laeavigatus and J. pennonius (Jacq.) Clarke.

**Affinity:** Junecellus is closely related to Pycreus from which it differs in its adaxially compressed fruits and pseudo-lateral head-like inflorescence.

**Distribution:** widely distributed in warm and temperate regions.

34. PYCREUS P. Beauv., Fl. Oware 2: 48 (1807) t. 86


**External morphology:** see p. 297.
Internal morphology: Culm: outline subcircular to triangular. Minor vascular bundles in a peripheral ring in the chlorenchyma, around which the chlorenchyma radiate. Hypodermal sclerenchyma variable, strands. Leaf: outline V to crescentiform shapes; with adaxial hypodermis differentiated. Vascular bundles often in a single series, rarely in 2 arc series. Bundle sheath: inner layer parenchymatous. Silica bodies: variable, conical with or without satellites or nodular, often with more than 5 bodies per cell. Embryo: ellipsoid with basal coleoptile and lateral root cap.

Type species: Pycreus flavescens (L.) Reichb.

Affinity: The bilaterally compressed fruits recall those of Kyllinga. The internal morphology is shared with a number of genera including Kyllinga, Mariscus, Juncoellus etc. By its persistent rachilla and spikelets, Pycreus appears to be more closely related to Duval-Jouvea and Juncoellus.

Distribution: c. 100 spp. widely distributed in tropical and warm temperate regions.

35. GALILEA Parl., Fl. Palerm. 1: 297 (1845)

External morphology: see p. 294.

Internal morphology: Culm: vascular bundles in more than one ring, minor ones numerous, peripheral. Chlorenchyma radiate especially around the minor bundles. Hypodermal sclerenchyma small rounded to angular strands. Leaf: outline thickly crescentiform; vascular bundles in 1–2 arc series. Bundle sheath: inner layer parenchymatous. Silica bodies: conical with satellites, 1–3 bodies per cell. Embryo morphology: ellipsoid with basal coleoptile and lateral root cap.

Type species: Galilea mucronata (L.) Parl.

Observation: Because of its 3-fid styles, trigonous fruits and persistent spikelets,
Galilea has frequently been sunk in Cyperus s.s. However, considering the habit, habitat, the turgidity of the spikelets as well as the character of the glumes, fruits, the involucral bracts and leaves of Galilea, it has been found necessary to follow Parlatore (1845) in treating it as a genus distinct from Cyperus s.s. It has a habit, inflorescence and internal leaf structure similar to those of Remirea, from which it differs in having many-flowered persistent spikelet and a thick but not incrassate non-articulate rachilla.

Affinity: In its gross morphological characters, Galilea appears to provide a link between Cyperus s.s. (in part) and Remirea.

Distribution: monotypic, almost confined to the Mediterranean region. (see Kaps 3 & 27).


External morphology: Annual or perennial. Culm trigonous or triquetrose, nodeless. Leaves basal, linear, graminaceous, sometimes reduced. Inflorescence terminal, umbellate or capitulate with numerous spikelets aggregated in the head. Involucral bracts leaf-like. Spikelets sessile, compressed, 1 (-few) flowers, deciduous. Rachilla thin, minutely winged, disarticulating once above the bract and spicular prophyll. Glumes distichous, strongly keeled, the keel winged, with or without prickles, margins smooth. Hypogynous perianth absent. Stamens 1-3, anthers linear with obtuse crests and smooth profile. Style 2-fid, smooth. Fruit obovoid to sub-orbicular, lenticular, bilaterally compressed (i.e. with margins in line with axis of spikelet), shortly spiculate, densely or minutely dotted.

Internal morphology: Culm: vascular bundles in more than one ring, the peripheral ones smaller, numerous, surrounded by radiate chlorenchyma. Hypodermal sclerenchyma as small or large obtusely triangular strands. Leaf: outline
variant of V-shapes; Bulliform cells not easily differentiated from adjacent epidermal cells. Vascular bundles unequal, tending to be in 2 rows especially towards the margins; the keel region generally represented by 2 superimposed vascular bundles, the minor one abaxial. Bundle sheath: inner layer parenchymatous. Silica bodies: conical with satellites, 1-8 bodies per cell. Embryo structure: ellipsoid with basal coleoptile and lateral root cap.

Type species: Kyllinga monocaphala Rottb.

Affinity: Kyllinga has affinities with Pyreus and Marisous. It is related to Pyreus through the group Pseudo-Pyreus of Kyllinga which has 2-5 flowers per spikelet, differing only in the inflorescence and articulate rachilla in Pyreus. Its affinity to Marisous (especially groups Umbellati and Ochrocephali) is based on the deciduous one-flowered spikelets, but they differ in Kyllinga by having a winged keel to the glume, 2-fid styles, and lenticular bilaterally compressed fruits. The pollen grain with zonal distribution of 4-6 apertures, if found to be consistent in all Kyllinga spp., should serve to further differentiate the genus from Pyreus and Marisous.

Distribution: c. 60 spp. widely distributed in the tropic and sub-tropic region, especially in Africa.

37. QUEENSLANDIELLA Domin in Bibl. / Bot. 85: 415 (1915)

External morphology: Annual tufted. Culm nodeless, compressed trigonous. Leaves basal, linear graminaceous. Inflorescence terminal, simply umbellate, with unequal rays, subtended by leaf-like involucral bracts. Spikelets compressed, many-flowered, deciduous. Rachilla slender, flexuous, winged, disarticulating once above the
bract and spicular prophyll. Glumes distichous, decurrent, keeled, with smooth margins. Hypogynous perianth absent. Stamens 2, anthers minute, with obtuse crests and smooth profile. Style 2-fid, smooth. Fruit ovoid or suborbicular, lenticular, not apiculate, minutely dotted, reddish-brown to black.

Internal morphology: as in Mariscus.

Type species: Queenslandiella hyalina (Vahl) Ballard

Affinity: On external morphology this genus approaches Mariscus, Kyllinga, Duval-Jouvea and Pycreus. It differs from Mariscus in having 2-fid styles and lenticular fruits; from Kyllinga in having umbel with distinct elongated rays; and from Duval-Jouvea and Pycreus in having an articulate rachilla.

Distribution: A monotypic genus with a wide distribution in the tropics of Old World (see Map 3).

38. MARISCUS Gaertner, De Fruct. et Semin. Pl. 1: 12 (1788)


External morphology: see p. 311.

Internal morphology: Culm: outline obtusely triangular. Hypodermal solerecthyma numerous, angular strands. Vascular bundles in more than one ring, largely in chlorenchyma. Leaf: outline V-shaped. Minor vascular bundles sometimes encircling the air cavities. Chlorenchyma often conspicuously radiate, especially around the minor bundles. Bundle sheath: inner layer parenchymatous. Silica bodies: conical with satellites, sometimes tending to be nodular, 1-4-10 bodies per cell.

Embryo structure: ellipsoid with basal coleoptile and lateral root cap.

Type species: Mariscus capillaris (Swartz) Vahl, typ. conserv.

Observation: The leaf anatomy of some Mariscus spp (eg. M. rufus) recall that in
Duyval-Jouvee where some minor bundles encircle the air cavities; other species, e.g. M. purpureascens recall the leaf structure in Remirea, where the minor bundles are arranged in opposed pairs between the major bundles, but do not encircle air cavities.

Affinity: On the basis of overall similarities, Mariscus is closely related to Remirea (q.v.).

Distribution: with c. 200 spp., widely distributed in the tropical and subtropical regions of the world.

39. TORULINIUM Desv. in Hamilton, Prodr. Ind. Occid. 15 (1825)


Stamens 3, anthers linear, with obtuse crests and smooth profile. Style 3-fid, smooth. Fruit narrowly oblong, trigonous, minutely apiculate, densely dotted.

Internal morphology: Culm: minor peripheral vascular bundles in a conspicuous ring, the larger irregular, penetrating into the ground tissue. Leaf: outline V-shaped, with occasional adaxial hypodermis. Vascular bundles unequal, often nearer the adaxial surface than the abaxial. Bundle sheath: inner layer parenchymatous. Silica bodies: conical with satellites, 2-4 bodies per cell.

Embryo structure: ellipsoid with basal coleoptile and lateral root cap.

Type species: Toruliniuim coniferae Hamilton.

Affinity: Closely related to Mariscus from which it differs in having several
articulate racillae and swollen decurrent bases of glumes.

**Distribution:** with c. 11 spp. widely distributed in the tropics, especially in the New World.

40. **COURTOISIA** Nees in Linn. 9: 286 (1834)


**External morphology:** Annual. **Culm** nodeless, trigonous. **Leaves** basal, linear, graminaceous. **Inflorescence** terminal, umbellate, with rays terminating in globose heads, subtended by leaf-like involucral bracts. **Spikelets** compressed, few-flowered, deciduous. **Rachilla** minutely winged, disarticulating once above the bract and apical prophyll. **Glumes** distichous, elliptic, keel winged. **Hypogynous perianth** absent. **Stamens** 3, anthers linear, with obtuse crests and smooth profile. **Style** 3-fid, short, smooth. **Fruit** ellipsoid, trigonous, apiculate, minutely dotted.

**Internal morphology:** **Culm** vascular bundles numerous, scattered. Hypodermal sclerenchyma small triangular to rounded strands. **Leaf:** outline acutely V-shaped. Hypodermis not differentiated. Bulliform cells differentiated. Chlorenchyma radiate. **Bundle sheath:** inner layer fibrous. **Silica bodies:** conical, with satellites, 1-4 bodies per cell. **Embryo structure:** ellipsoid with basal coleoptile and lateral root cap.

**Type species:** *Courtoisia cyperoides* (Roxb.) Nees

**Affinity:** It is closely related to *Mariscus* especially on the inflorescence, spikelet and floral characters, but differs from it in having winged keels as in *Kyllinga*, and also in its vascular bundles which have fibrous inner sheaths, as in *Oxycaryum* and some species of *Cyperus*.

**Distribution:** 2 species widely distributed in tropical Africa and Madagascar, of which one species extends to India.


External morphology: Perennial with long, slender, branched rhizomes. Culms solitary, nodeless, trigonous, borne at the summit of an ascending rhizome often very short. Leaves sub-basal, ± channelled. Inflorescence terminal, with few contracted heads each containing numerous spikelets, subtended by channelled leaf-like involucral bracts. Spikelets sessile, one-flowered, deciduous. Rachilla inerassate at its uppermost internode and clasping the flower, often disarticulating above the bract and the spicular prophyl. Glumes distichous, ovate, smooth.

Hypogynous perianth absent. Stamens 3, anthers linear, with obtuse crests and smooth profile. Style 3-fid, smooth. Fruit oblong, trigonous, shortly apiculate, minutely dotted, reddish-brown.

Internal morphology: Culm: vascular bundles scattered with the minor ones situated at the periphery of the chlorenchyma, around which the chlorenchyma radiates. Hypodermal selenenchyma small triangular to rounded strands. Leaf: outline thinly crescentiform with conspicuous adaxial hypodermis. Vascular bundles in 2 arc series. Bundle sheath: inner layer parenchymatous. Silica bodies: conical with satellites, 1-2-5 bodies per cell. Embryo structure: ellipsoid with basal coleoptile and lateral root cap.

Type species: Remirea maritima Aubl.

Affinity: Without doubt this genus is closely related to Marisca, from which it differs in its more dwarfed habit, head-like inflorescence, and the presence of an inerassate uppermost internode of the rachilla.

Distribution: A monotypic genus widely distributed in the tropics.
Kunth, Enum. Pl. 2: 26a (1835); Wall., Apont. Phyto-Geograph. 578 (1858);
Add. ser. 8: 116 (1908); Charmezon in Humbert, Pl. Mad. 29th Famille 169-170

External morphology: Annual or perennial, often tufted. Culm nodeless, filiform
to robust, terete. Leaves sectaceous, basal. Inflorescence terminal, capitulum-
like, subtended by leaf-like involucral bracts. Spikelets one-flowered, each
subtended posteriorly by a glumaceous bract, densely arranged in spirals around
the swollen inflorescence axis. Glumes incrassate, completely or partially
surrounding the flower. Hypogonous perianth absent. Stamens 1-3, anthers linear,
oblong, with obtuse crests and smooth profile. Style 2-3-fid, smooth, deciduous.
Fruit small, narrowly ellipsoid, lenticular to trigonous, shortly apiculate, dotted.

Internal morphology: Culm: minor vascular bundles in a peripheral ring, with the
major ones also in a ring between the chlorenchyma and the ground tissue.
Chlorenchyma radiate especially around the minor bundles. Leaf: outline crescenti-
form, with well differentiated adaxial hypodermis. Vascular bundles in single arc
series embedded in the chlorenchyma. Bundle sheath: inner layer parenchymatous.
Silica bodies: variable, conical with or without satellites or nodular, 1-8 bodies
per cell. Embryo structure: a variant from the form in Cyperus.

Type species: Ascolepis eriocauloides (Steud.) Nees ex Steud.

Key to infra-generic groups
1a. Lower part of glume narrow, thin, hollowed slightly to hold the flower;
   upper part elongate, conical; style 3-fid; embryo shortly
   ellipsoid ......................................................... subgen. Ascolepis

1b. Glume obovate, strongly flattened, with acute scarious wings, with
   the flower held in a small pocket on the anterior side; style 2-fid;
embryo cylindrical-ellipsoid, (type sp. Ascolenis brasilienis (Kunth) Clarke) subgen. Platylepis (Kunth) Oteng-Yeboah

Observation: Kunth op. cit. circumscribed the genus Platylepis as distinct from Ascolenis mainly in the basis of the striking glume character. Having observed that the two taxa share similar characteristics except in the glume and style, it was decided to assign Platylepis to subgeneric rank.

Affinity: Apart from the capitulum-like inflorescence and the incrassate glumes, which diagnose Ascolenis, it shows an affinity to Lipocarpha on many other characters including the radiate chlorenchyma etc. Both of these genera have previously been regarded as members of the tribe Cyperaceae, but from the present observation they are closely related to the tribe Cyperaceae, especially to Kyllinoa.

Distribution: with c. 15 spp., widely distributed in the tropics of Old and New Worlds, especially in tropical Africa.


Syn: Hypaelyptum Vahl, Enum. Pl. 2: 283 (1806)


External morphology: Annual or perennial. Culm nodeless, filiform, terete, striate. Leaves basal, setaceous. Inflorescence terminal, rarely pseudo-lateral, head-like containing numerous reduced spikelets, subtended by leaf-like, setaceous involucral bracts. Spikelets spirally arranged on the reduced inflorescence axis, one-flowered, containing 2 anterior and posterior scales (which represent reduced spicular prophyll and glume). Glume subdistichous, oblong-ovate, with smooth margins. Hypogynous perianth absent (unless the 2 scales are considered so).
Stems 1-2, anthers linear-oblong, with obtuse crests and smooth profile.

Style 3-rid short, smooth. Fruit obovoid or oblong, trigonous, shortly apiculate, densely dotted.

Internal morphology: Culm: ground tissue solid, vascular bundles in 2 rings, minor peripheral ones numerous, larger few at the inner boundary of chlorenchyma with ground tissue. Hypodermal chlorenchyma small rounded to angular strands. Chlorenchyma radiate especially around the minor bundles. Leaf: outline thinly to thickly crescentiform with the lamina gradually increasing in thickness towards the margins. Adaxial hypodermis well differentiated. Vascular bundles in a single arc series, of unequal sizes. Bundle sheath: inner layer parenchymatous. Silica bodies: as in Ascolepis. Embryo structure: a variant from the form in Cyperus.

Type species: Lipocarpha argentea (Vahl) R. Br.

Affinity: On floral characters, Lipocarpha is closely allied to Volkiella in having anterior and posterior scales, but differs in habit, the arrangement of the spikelets, the reduced inflorescence axis, and the character of the posterior scale. It is also related to Ascolepis (q.v.).

Distribution: containing c. 12 spp., widely distributed in the tropics of both Old and New Worlds.

317-323 fig. 1-2 (1953).

External morphology: see Merxm. & Czech, op. cit.


Type species: Volkiella disticha Merxm. & Czech.

Affinity: This genus is closely allied to Lipocarpha (q.v.).

A monotypic genus restricted to South-West Africa (see Map 2).
conserv. (Haines & Lye in Bot. Notiser 124(4): 477 (1971); Chermesin in Humbert
Fl. Madagascar 296 Famille 141 (1936); Friedland in Amer. Journ. Bot. 26: 855-
861 (1941); Raynal in Adansonia ser 2, 8(1): 85 (1968).

External morphology: Annual, tufted with fibrous roots. Culms filiform, terete,
striate, nodeless. Leaves few, basal, setaceous. Inflorescence a terminal or
pseudo-lateral head containing 1 to few spikelets, subtended by 2-4 leaf-like
setaceous involucral bracts. Spikelets sessile, globose to narrowly ovoid, many-
flowered. Glumes spirally imbricate, often long-aristate, ob lanceolate to sub-
orbicular. Hypogynous perianth represented by a single anterior scale, often
notched, vestigial or wanting. Stamens 1 (or 3), anthers small, with obtuse
crests and smooth profile. Style 2(-3)-fid, papillose. Fruit oblong, + cylindrical,
obscurely subtrigonous, shortly apiculate, minutely dotted, rarely longitudinally
striate.

Internal morphology: Culm: vascular bundles few, in 2 rings, minor ones peripheral
and major ones at the inner boundary of the chlorenchyma. Leaf: outline crescenti-
form, with c. 5 vascular bundles in a single arc series. Bundle sheath: inner
layer parenchymatous. Silica bodies: conical without satellites. Exocarp of
fruit often with basal finger-like ornamentations. Embryo structure: ellipsoidal
with basal coleoptile and lateral root cap.

Type species: Hemicarpha micrantha (Vahl) Britt. (see Haines & Lye, op. cit. for
proposal for typifying the genus).

Key to infra-generic groups

1. Anterior hyaline scale present, rarely absent. style 2-fid; plants
   restricted to the New World ........................................ sect. Hemicarpha

1. Anterior scale absent; style 2-3-fid; plants restricted to the
   Old World tropics (type sp. H. squarrosum L.) Oteng-Yeboah
   ................................... sect. Chloroscirpus (Chermesin) Oteng-Yeboah
Observation: The reason for retaining the generic name *Hemicarpha* has been given in the introduction (see p. 12). The difference between *Hemicarpha* proper and the subgenus *Chlorocirrus* is very small, as can be seen above. However, taking into consideration the distinct geographical distributions of the two groups as well, sectional rank appears to be the most suitable rank to accord them.

**Affinity:** An affinity between *Hemicarpha* and *Isolepis* is established most strongly through *Hemicarpha* sect. *Chlorocirrus* which differs from *Isolepis* mainly in the form of its glumes.

**Distribution:** containing c. 10 species, one section (i.e. *Hemicarpha* proper) restricted to the New World, and another to the Old World (see Map 5).


**External morphology:** see p. 270.

**Internal morphology:** as in *Eleogiton* except **Leaf:** outline crescentiform.

**Bundle sheath:** inner layer parenchymatous or fibrous.

**Type species:** *Isolepis setacea* (L.) R. Br.

Observation: The original concept of *Isolepis* was too broad, including a number of species some of which are now in *Bulbostylis, Holoschoenus, Eleogiton* etc.

The present concept of *Isolepis* is homogeneous, and include species which are very closely related, some of which having been recently described, especially from Australia, New Zealand and South Africa.

**Affinity:** The genus is most closely related to *Eleogiton* (q.v.), from which it differs mainly in its pseudo-lateral head-like inflorescence and predominantly terrestrial habit. It also shows some affinity to *Hemicarpha* (q.v.).

**Distribution:** with c. 41 species; cosmopolitan.
47. **ELEOGITON** Link, Hort. Berol. Decr. 1: 293 (1827)


**External morphology:** Aquatic perennial, with much-branched, elongated, leafy shoots. Culm setaceous, nodeless arising from the axils of the uppermost leaves of the main shoot. **Leaves** setaceous. **Inflorescence** a solitary spikelet, subtended by a glumaceous involucral bract. **Spikelet** terete, many-flowered. **Glumes** spirally imbricate, ovate, thin membranous, contracted into rounded apex, mid-nerve often stopping short of apex. **Hypogynous perianth** absent. **Stamens** 3, anthers linear, with obtuse to retuse crests and smooth profile. **Style:** 2-fid, densely papillose. **Fruit:** ellipsoid obovoid or oblong obovoid, lenticular or biconeave, minutely apiculate, dotted.

**Internal morphology:** Culm: outline oval with c. 5 unequal vascular bundles in a ring between chlorenchyma and ground tissue, and connected by ground tissue parenchyma. Air cavities few in ground tissue. Hypodermal sclerenchyma as small rounded to slightly angular strands. **Leaf**: outline asymmetrical with adaxial surface half concave, half flat, and abaxial/convex. Vascular bundles 3 in one arc. **Bundle sheath**: inner layer fibrous, often U-shaped. **Silica bodies**: conical without satellites, 3-12 bodies per cell. **Embryo structure**: a variant of the form in *Cyperus*.

**Type species:** *Eleogiton fluitans* (L.) Link.

**Affinity:** closely related to *Isolepis* from which it differs in having a terminal solitary spikelet subtended by a glumaceous bract, and a constantly 2-fid style and in its floating aquatic habit.

**Distribution:** with c. 11 spp., widespread but with a sporadic distribution.
6. PROPOSED TRIBAL AND SUBTRIBAL GROUPINGS

Having adopted this relatively narrow but more natural generic concept, it follows that our tribal and/or subtribal limits have to change to accommodate them, since the tribes Cypereae and Scirpeae, as conventionally delimited, can no longer accommodate the variation covered by the genera keyed and described above.

A provisional and informal tribal and subtribal grouping for the subfamily Cyperoideae (excluding the tribe Rhynchosporaeae) is proposed below and presented diagrammatically in fig. 35. The arrangement of the groups and the placing of genera in them is not based on phylogenetic considerations. They are placed where they are according to their observed affinities, i.e. on the basis of their overall resemblances and differences. The size of the gap shown between the subtribal 'boxes' is roughly proportional to the degree of distinction between them.

**Cyperus** (as delimited at present) bridges subtribes D2 and D3.

**Synopsis**

**Note:** Tribal names already in use are given in the synonym of the lettered groups.

**TRIBE A** (tribus Scirpeae p.p.)

General inflorescence terminal or pseudo-lateral; very rarely axillary; spikelets many-flowered; glumes spirally imbricate, rarely subdistichous; hypogynous bristles present, retrorsely or antorsely scabrous or smooth; bundle sheath of vascular bundles 2-layered, inner layer fibrous; embryo structure variable but not of "Bulbostylis" or "Cyperus" types.

**Subtribe A1** (tribus Scirpeae p.p. including type).

Nodes conspicuous along the whole length of culm, with the uppermost inter-nodes equal in length to the lower ones; leaves not pubescent and without tubular ligules; general inflorescence terminal, variable, paniculate-corymb to umbellate to head-like to solitary; hypogynous bristles needle-like to filiform to silky.

**Scirpus s.s., Eriophorum, Genus A.**
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### TRIBE B

| Dulichium   |                |

### TRIBE A

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**Fig. 35** DIAGRAMMATIC REPRESENTATION OF PROPOSED TRIBAL & SUBTRIBAL GROUPS

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**TRIBAL LIMIT**  **SUBTRIBAL LIMIT**
Subtribe A2 (tribus Scirpeae p.p. excluding type)

Nodes conspicuous along the whole length of culm, with the uppermost internode equal in length to the lower ones; leaves pubescent with tubular ligules; general inflorescence panicle, with spikelets in terminal and axillary clusters, rarely solitary; hypogynous bristles needle-like, often occurring with hypogynous petal-like plates, very rarely both wanting.

Fuirena


Nodes on culm inconspicuous with uppermost internodes several times longer than the lower ones which are short and obscured by the basal and/or sub-basal leaves; leaves not pubescent and without tubular ligules; general inflorescence variable, not spike-like, occasionally panicle but without axillary clusters with spikelets in terminal or pseudo-lateral clusters, sometimes solitary; hypogynous bristles variable from plumose or fimbriate to needle-like to filiform to silky.


Subtribe A4 (tribus Scirpeae p.p. excluding type)

Nodes on culm inconspicuous, rarely conspicuous, with uppermost internode several times longer than the lower ones which are short and obscured by the basal and/or sub-basal leaves; leaves not pubescent and without tubular ligules; general inflorescence spike-like, with spikelets distichously arranged; hypogynous bristles needle-like.

Blysmus, Genus B.

TRIBE B (tribus Dulichieae)

General inflorescence axillary, from the cauline leaves; spikelets many-flowered; glumes distichous with hyaline margins decurrent on the rachilla;
hypoynous bristles present, retrorsely scabrous; bundle sheath of the vascular bundle 2-layered, inner layer fibrous; embryo structure of the "Cyperus" type.

Dulichium

TRIBE C (tribus Fimbristylaceae p.p. including type)

General inflorescence terminal, rarely pseudo-lateral; spikelets many-flowered; glumes spirally imbricate, rarely distichous; hypoynous bristles absent; bundle sheath of vascular bundles 3-layered, inner layer parenchymatous; embryo structure of the "Bulbostylis" or "Fimbristylis" types.

Subtribe C1 (tribus Fimbristylaceae p.p. including type)

Style base thickened, articulate with the apex of fruit.

Fimbristylis, Croslandia, Bulbostylis, Abildgaardia

Subtribe C2 (tribus Scirpaceae p.p. excluding type)

Style base confluent with the body of fruit, not thickened.

Nelmesia, Nemum

TRIBE D (tribus Cyperaceae expanded, including part of tribus Scirpaceae)

General inflorescence terminal, rarely pseudo-lateral, variable, often umbellate or head-like; spikelets few- to many-flowered; glumes often distichous decurrent on the rachilla, sometimes spirally imbricate; hypoynous bristles absent; bundle sheath of the vascular bundle 2-3 layered, inner layer parenchymatous or fibrous; embryo structure of the "Cyperus" type.

Subtribe D1 (tribus Scirpaceae p.p. excluding type)

Culm robust; general inflorescence a terminal contracted panicle containing several sessile spikelets in confluent clusters; spikelets many-flowered; rachilla conspicuous, not articulate, persistent; glumes spirally imbricate; chlorenchyma not radiate.

Desmoschoenus
Subtribe D2 (tribus Scirpaeae p.p. excluding type)

Culm robust, very rarely setaceous; general inflorescence not a contracted panicle, variable; spikelets many-flowered; rachilla conspicuous, not articulate, persistent; glumes often spirally imbricate, rarely distichous; chlorenchyma not radiate.


Subtribe D3 (tribus Cyperaeae p.p. including type)

Culm robust, rarely setaceous; general inflorescence umbellate or head-like; spikelets many-flowered; rachilla conspicuous, not articulate, persistent; glumes distichous; chlorenchyma radiate.


Subtribe D4 (tribus Kyllingae)

Culm robust, rarely setaceous; general inflorescence umbellate or head-like; spikelets one to few flowered; rachilla conspicuous, articulate, deciduous; glumes distichous; chlorenchyma radiate.

Kyllinga, Queenslandella, Mariscus, Torulimum, Courtoisia, Remirea.

Subtribe D5 (tribus Ascolepeae)

Culm slender, filiform to setaceous; general inflorescence capitulum-like; spikelets one-flowered; glumes subdistichous, incrassate, wholly or partially enclosing the flower; rachilla inconspicuous, ± determinate and ± deciduous; chlorenchyma radiate.

Ascolepis

Subtribe D6 (tribus Lipocarphaeae)

Culm filiform to setaceous; general inflorescence head-like; spikelets ± one flowered; glumes ± subdistichous enclosing 2 anterior and posterior scales; rachilla inconspicuous, ± determinate, ± deciduous; chlorenchyma radiate.

Lipocarpha, Volckella
Subtribe D7 (tribus Scirpae p.p. excluding type)

Culm filiform to setaceous; general inflorescence terminal or pseudo-lateral, head-like or solitary; spikelets many-flowered; glumes spirally imbricate, occasionally enclosing one anterior hyaline scale; rachilla conspicuous, not articulate, persistent; chlorenchyma radiate or not radiate.

Hemicarpha, Isolpis, Eleocharis.
A REVISION OF THE SUBFAMILY CYPEROIDRAE IN TURKEY

INTRODUCTION

This revision has been undertaken with the express aim of bringing up to date the generic and specific representation of the subfamily Cyperoidea in Turkey (including the E. Aegean Islands as adopted in Davis's Flora of Turkey), more especially at a time when the Flora of the area is being prepared. The fifth volume of the Flora Orientalis prepared by Boissier in 1884 treated the Cyperaceae, and to date is the only floristic account of the group to cover Turkey. Since this monumental piece of work was published, there has been an enormous accumulation of herbarium material from Turkey, particularly since the World War II, when road communications in Anatolia greatly improved. Collections forming the bulk of material from Turkey include those of Sintenis, Bornmiller, Siehe, B. & G. Post, Aznavour etc. during the pre-second war era; and Davis, Coode & Jones, Tobey, Huber-Morath, A. & T. Baytop etc. during the post second era. These large collections have largely provided the basis for this revision, and without doubt have greatly improved our knowledge of the group in Turkey.

Boissier's account of the subfamily Cyperoidea was a general one covering the "Orient", including Turkey, but it is obvious that he did not see very much Turkish material of the subfamily Cyperoidea compared with what is available today.

Apart from the wealth of herbarium material seen, there have been a considerable number of literature records of species from Turkey. The most useful of these covered areas from which few or no collections had been seen by me, e.g. some of the East Aegean Islands. Since all the records are scattered in numerous journals, it was necessary to bring them together to give a continuous and up to date representation of the taxa occurring within the political frontiers
of Turkey. There was no doubt about the authenticity of most of these records, because most of the authors are known to be relatively reliable, and most of the recorded species are not very variable throughout their entire distribution; the chance of misidentification is therefore small.

The generic concept adopted in this revision corresponds to the results of the investigations carried out in Part I of this thesis, in which the large and complex genera, viz: Scirpus and Cyperus have been split into their relative natural groups or genera. The number of genera in the subfamily Cyperoideae recognised in the Turkey area is now 21, showing an increase of 14 over the 7 recorded by Boissier in 1884. Apart from the segregate groups which have now been taken out of Scirpus s.l. and Cyperus s.l., new generic records for main land Turkey include Fuirena and Rhynchospora. Both of these genera were never mentioned even as occurring in the "Orient" by Boissier, though Rechinger (1943) recorded Fuirena pubescens from Rhodos.

The concept of species in this revision is primarily a morphological one (cf. Davis & Haywood 1963 p. 91), the same as that adopted by most Cyperologists or workers who have written taxonomic accounts of the Cyperaceae in most Floras. In the Turkey area, 47 species are represented, belonging to the 21 genera.

The majority of the genera are represented by only one species, most of which are found to be widely distributed. Very few genera are represented by more than one species; these include Eriophorum, Pimbristylis, Eleocharis, Schoenoplectus, Bolboschoenus, Cyperus s.s., Pycreus and Isoliris. New species records for the Flora of Turkey area include Trichophorum pumilum, and Rhynchospora alba. Almost all species occurring in Turkey are represented by at least half-a-dozen specimens, except in some cases where only one specimen was available. In such cases the literature records were very much relied upon for distribution in Turkey, and specimens from other areas near Turkey provided useful information
for the description of the species. In the case of *Cyperus nasanum*, only the
type specimen was available and studied. Where no specimens were available
and also the literature record of the species was doubtful, as in the case of
*Cyperus eragrostis* Lam., the species has been mentioned as doubtfully recorded.
In accordance with the tradition in the editing of the Flora of Turkey by
P.H. Davis, the infra-specific categories adopted are only at sub-specific
and varietal rank. Three subspecies have been observed, one of which is new
to science, i.e. *Bolboschoenus paludosus* subsp. *hakkiaricus*. Of the other
two, one is a new combination, i.e. *Poa lacustris* subsp. *glaucus*;
and the other is an old taxon though its status changes with different authors,
i.e. *Cyperus longus* subsp. *badius*. Varieties are recognised under only four
species, viz: *Cyperus longus*, *C. rotundus*, *Bolboschoenus maritimus* and
*Holoschoenus vulgaris*; most of these are already well-known taxa.
As a result of the breakdown of the morphological distributions between some
of these varieties, an appeal is made for a world wide investigation into the
species concerned to settle the infra-specific problems therein.

E. Pobedimova (1950) has added three new species to *Cladium*, *Schoenoplectus*
and *Fimbristylis*, the type localities of which are from Soviet Azerbaidzhan,
district Lenkoran. These new species are *Cladium grossheimii*, *Schoenoplectus*
grossheimii and *Fimbristylis schischkinii*. No material of these has been seen,
but from their descriptions and figures it seems very probable that they are
local variations of *Cladium marisca*, *Schoenoplectus lacustris* and *Fimbristylis*
ferruginea respectively, all species occurring in Turkey.

In the preparation of the floristic account of the Turkish genera and
species, I mistakenly overlooked Grossheim's Flora Kavkasa ed. 2 (1940) which
recorded the genus *Bulbochloa* with 2 species and 5 other species belonging to
*Eleocharis* (2), *Pyrolus* (1), *Cyperus* (1) and *Fimbristylis* (1) in North-Eastern
Turkey.
These records have been listed in the addendum, and have been considered together with the already treated taxa in the floristic account for the geographical distribution of taxa occurring within and outside Turkey.

Arrangement of taxa

No attempt has been made to arrange the taxa in any phylogenetic manner. The generic and specific arrangements are largely based on gross morphological resemblances. In this matter I have followed various European authors who have written taxonomic accounts of the Cyperaceae.

Geographical and climatic factors in Turkey

Turkey occupies a position which forms something like a bridge between South West Asia and the South Eastern part of Europe. It is bounded on the North-west by Bulgaria and Greece; on the North-East by the Caucasus; on the South-East by Iran, Iraq and Syria; and on the South and South West by the Mediterranean Sea. It is divided by Davis (1965) into 6 geographical areas, viz: Turkey-in-Europe; North Anatolia, West Anatolia, South Anatolia, Central Anatolia and East Anatolia. Its geographical position and the occurrence of different phytogeographical elements affords its recognition as the meeting ground of three phytogeographical regions (after Davis 1965, 1971) viz: Euro-Siberian (represented by the Euxine province); Mediterranean (represented by the East Mediterranean provinces of West Anatolia, Taurus and Amasus (i.e. West and South Anatolia respectively)); and Irano-Turanian (represented by Inner Anatolia (i.e. Central and Eastern Anatolia)). According to Davis (1965) though these regions in Turkey are recognised by their different vegetational aspects reflecting differences in climate, they are more fundamentally, if less obviously, based on floristic differences, including endemism. The limiting factors between the floras of the Euro-Siberian and Mediterranean regions are precipitation and temperature (mild wet winters and hot arid-summers in the Mediterranean...
region), and between Mediterranean and Irano-Turanian regions are the lower precipitation and especially very low summer humidity and extremely cold winters of the Irano-Turanian region. (These factors are, of course, much modified by altitude). Water supply is therefore often vital in controlling the distribution of Euro-Siberian, Mediterranean and Irano-Turanian elements. As most Cyperaceae in Turkey grow in wet places, they seldom suffer from water deficiency and therefore tend to have a wider distribution than xerophytic groups. But there are well marked edaphic requirements for certain species, especially of Eriophorum, e.g. E. vaginatum and Rhynchospora e.g. R. alba, which require acid soils. In Turkey, acid soils hardly occur outside the Euro-Siberian region (mainly in Lasistan) and such species are therefore largely confined to these areas (cf. distribution of Sphagnum, Henderson 1961).
Family CYPERACEAE St. Hill, Expos. Fam. 1: 62 (1805)

Annual or perennial, generally herbaceous, and often rhizomatous. Culms trigonous, triquetrous or terete, rarely compressed; node or nodeless. Leaves often tristichous, with well-developed blades, sometimes reduced to the sheath; blades linear or setaceous, plane, keeled or channelled, often scabrous on the margins; sheaths almost always closed, rarely open, with or without ligules. Inflorescence variable: spicate, capitate, umbellate, racemose, corymbose or paniculate, and often subtended by one to many leaf-like or glume-like involucral bracts. Spikelets solitary or clustered, one to many-flowered; rachilla articulate or not articulate, persistent or deciduous, winged or not-winged. Glumes distichous or spiral, concave, one to many nerved, mucronate or not. Flowers bisexual or unisexual, solitary in the axil of a glume, female flowers often enclosed in an utricular prophyll. Perianth absent or sometimes represented by hypogynous bristles, plates, scales, discs, etc. Stamens generally 3, rarely 1-2 or many; anthers basifixed, linear, with introrse longitudinal dehiscence, sometimes crowned by a papillose connective. Style terminal, base articulating or confluent with the fruit, stigmas often 2-3, rarely many, often papillous. Ovary sessile or stipitate, sometimes carried on a dilated disc or gynophore, unilocular with a single basal anatropous ovule. Fruit indehiscent, monosperous, endosperous, trigonous, lenticular or globose with a dry or very rarely fleshy pericarp.
KEY TO THE GENERA IN TURKEY

1a. Spikelets several- to many-flowered, all flowers bisexual, rarely imperfect, with only 1 or rarely 2 empty basal glumes (cf. p. 219)

2a. Lowest empty glume not consistently different from the upper fertile ones; glumes spirally arranged on the spikelet

3a. Culms few- to several-noded; leaves basal and cauline

4a. Uppermost leaf sheath with long blades; hypogynous bristles 6, various, rarely absent, always shorter than the glume, rarely elongating

5a. Leaf sheaths with straight or concave orifice, ligulate or eligulate; glumes obtuse to acute or bidentate, scabrous or smooth on the margins and abaxial surface; hypogynous bristles needle-like or filiform, one kind

6a. Spikelets small, 3-4(-8) mm long; fruits small, up to 1.75 mm long; glumes greyish-black to brown, often smooth on the surface .............................................. 1. Scirpus

6b. Spikelets large, 8-25 mm long; fruits large, up to 4 mm long; glumes chestnut to light brown, strongly scabrous on margins and abaxial surface, deeply notched at the tip with the midnerve excurrent into a long scabrous awn .............................................. 4. Bolboschoenus

5b. Leaf sheaths with tubular ligule/orifice; glumes with rotund apex and long awns, pubescent; hypogynous bristles absent or when present of two kinds, rarely of one kind .............................................. 3. Fuirena
4b. Uppermost leaf sheath with short blade or sometimes conspicuously reduced to a dark membranous, reticulately-veined sheath with an oblique, truncate tip; hypogynous bristles numerous, usually more than 6, silky and often elongating in maturity and greatly exceeding the glumes ........................................ 2. Eriophorum

3b. Culms node-less; leaves basal and sub-basal

7a. Inflorescence terminal; involucral bracts spreading from under the inflorescence or strongly clasping it laterally

8a. Inflorescence spicate, with spikelets distichously arranged ...................................................... 8. Blysmus

8b. Inflorescence a solitary spikelet, or simple to compound umbel

9a. Style-base not swollen ...................................... 6. Trichophorum

9b. Style-base swollen, confluent or conspicuously articulated with the fruit

10a. Inflorescence usually solitary; hypogynous bristles present, rarely absent ................................ 7. Eleocharis

10b. Inflorescence a simple to compound umbel, rarely solitary; hypogynous bristles always absent ...................................... 9. Fimbristylis

7b. Inflorescence seemingly lateral, the lower involucral bract erect, appearing as a continuation of the culm

11a. Hypogynous bristles present, rarely absent; spikelets large, 3-15(-25) mm long. Fruits large, 1.5-4.0 mm long ......................................................... 5. Schoenoplectus

11b. Hypogynous bristles always absent; spikelets small, 1.0-3.0(-5.6) mm long, fruits small, 0.5-1.5 mm long
12a. Plant very small, mostly annuals, rarely perennial; culms filiform, seldom exceeding 15 cm tall; inflorescence of 1-3 (-many) spikelets ........................................ 11. Isolepis

12b. Plant robust, mostly perennials; culms stout, seldom less than 20 cm tall; inflorescence of hemisphaerical heads, each head containing several aggregated spikelets ........................................ 10. Holoschoenus

2b. Lowest empty glume metamorphosed into a prophyll, and very different from the fertile upper ones; glumes usually distichously arranged on the spikelets, or rarely spirally arranged (Cyperus michelianus (L.) Link) ✓

13a. Axis of spikelets continuous; glumes deciduous, falling from the rachilla; rachilla persistent

14a. Fruits trigonous; style 3-fid

15a. Spikelets strongly compressed (except in C. michelianus (L.) Link where the glumes are spirally arranged and the spikelets thus ovoid); glumes keeled; fruits not compressed; involucral bracts plane or sharply V-shaped in T.S. ............ 12. Cyperus

15b. Spikelets turgid; glumes only keeled towards the apex; fruits adaxially concave, abaxially convex-angular; involucral bracts suberete to thickly crescentiform in T.S. ................................. 13. Galilea

14b. Fruits lenticular, compressed, or biconvex; style 2-fid

16a. Fruits bilaterally compressed, (i.e. the margins in line with axis of spikelet) .............................. 14. Pycreus

16b. Fruits adaxially compressed (i.e. the compressed surface facing the axis)
17a. Inflorescence terminal, lax with 5-7 long rays; glumes with conspicuous lateral nerves 15. Duval-Jouvea

17b. Inflorescence seemingly pseudo-lateral, without rays; glumes without lateral nerves 16. Junellus

13b. Axis of spikelets articulate and broadly winged; glumes persistent, falling with the rachilla; rachilla deciduous 17. Mariscus

18. Spikelets with very few flowers (1-3), at least one flower is bisexual, the rest imperfect; few to several basal glumes, empty and conspicuously smaller than those in the middle and upper parts of the spikelet:

18a. Fruit-bearing flower(s) borne above staminate/imperfect flower(s); fruit drupe-like; leaves pseudo-dorsiventral in T.S. 18. Gladium

18b. Fruit-bearing flower(s) borne below staminate/imperfect flower(s); fruit not drupe-like; leaves dorsiventral in T.S.

19a. Spikelets bilaterally compressed, with distichously arranged glumes; style 3-fid 19. Schoenus

19b. Spikelets less compressed, with spirally arranged glumes; style 2-fid 20. Rhynchospora

Perennial, rhizomatous. Culms solitary or tufted, several-noded, trigonous or terete. Leaves basal and cauline, broadly linear, scabrous on margins and midrib. Sheaths all with well developed elongate leaves, with thin, straight orifice and rounded to narrowly curved ligules. Inflorescence terminal, paniculate-corymbose or umbellate, with many rays and spikelets; and subtended by many leaf-like involucral bracts. Spikelets ovoid to ellipsoid, 3-10 mm long or shorter, solitary at the tips of pedicels or in glomerules at the tips of rays. Glumes spirally arranged. Hypogynous bristles 1-6, slenderly filiform, straight or tortuous, concealed in glume or elongating and exceeding the glume at maturity, retrorsely or antrorsely barbed or smooth. Stamens 3, rarely 2, anthers small, connective blunt. Style 2-3 fید. Fruits usually not longer than 1.5 mm long, small, lenticular or trigonous.

1. S. sylvaticus L.

Syn: *Scirpus gramineus* Neoch., Delic. Gallo-Belg. 27 (1768)

*Scirpus latifolius* Gilib., Exerc. Phyta. 2: 515 (1792)

*Seidelia sylvatica* (L.) Opiz, Natur-Tausch. 340 (1826)

*Nemoccharis sylvatica* (L.) Beurl., in Bot. Notiser 53 (1853)

**Rhizome creeping. Culms 25-35 cm tall, glabrous, obtusely 3-angled.**

Leaves 19-51 cm x 7.2-14 mm wide. **Inflorescence lax, 7-26 cm long, rays to 14 cm long. Lower involucral bract 32 cm long. Spikelets 3-4 mm x 1.4-2.5 mm, ovoid, subobtuse. Glumes 1.6-2.9 mm long, ovate, one-nerved, ciliate on margin and apex, smooth at the back, green when young, gradually turning black or greyish-black at maturity. Hypogynous bristles 6, 0.9-1.4 mm long, equaling or longer than fruit, retrorsely barbed, ± persistent. Stamens 3, anthers 0.4-1.2 mm long, oblong. Style 0.3-0.6 mm long, caducous, stigmas 3, papillose. Fruit c. 1 mm long, obovoid, plano-convex or compressed trigonous, yellowish, with a short mucro. Fl. 5-7. Fr. 7-8.**

**Habitat:** in marshes, or wet places in woods, meadows. 800-1450 m.

**Described from Europe:** habitat in Europae sylvis (Herb. Linn. 71.47!)

N.W. Turkey and N.E. Anatolia.

A2(E) Istanbul: Tchinar, July 1904, Asnavour!

A2(A) Istanbul: Çatal dağ (15 km E.N.E. of Uskudar and Erenköy) June 1892, Asnavour!

A3 Bolu: 40 km West of Bolu, 5 km N. of Elmalik, 1000 m, 11 June 1958, Kühne 2735!

40 km S. of Devrek, Yedigöller Lake, 850 m, 5 July 1958, Kühne 3210!

A9 Çoruh (Artvin): Ardanuc-Köredevan dag (Artvin-Ardahan) 1450 m, Davis & Hedge D.30123!

**External distribution:** Distributed all over Europe except the extreme North and South; Asia and Siberia.
2. **ERIOPHORUM** L., Sp.: Pl. 52 (1753)

Syn: **Ligustrois** Adanson, Fam. 2: 41 (1763).

Tufted or stoloniferous perennials. **Culms** slender, noded, with both cauline and basal leaves. Cauline leaves 2-3, short, sometimes the upper with blade reduced to conspicuously inflated, reticulate-veined sheath. Basal leaves many, linear and longer. **Inflorescence** solitary or umbellate, with or without conspicuous involucral bracts. **Glumes** greyish or dark grey above and silvery or hyaline below, usually one-nerved. **Hypogynous perianth** bristles numerous (rarely 6), white, silky, smooth or aptrorsely setulose at the upper part, often becoming greatly elongated in fruiting. **Stamens** 3, anthers linear. **Style** 3-fid. **Fruit** narrowly obovoid, trigonous.

1. Inflorescence umbellate, spikelets several (very rarely one) nodding, with one or more, conspicuously sheathing, involucral bracts ............................................ 1. *E. latifolium* Hoppe

1. Inflorescence solitary, spikelet one, erect, with glume-like involucral bracts

2. *E. vaginatum* L.
1. Eriophorum latifolium Hoppe Bot. Taschenb. 108 (1800)

Syn: Eriophorum polystachyon L. var. / Fl. Suec. ed. 2: 17 (1755)
Linagrostis paniculata Lam., Fl. France 3: 555 (1778) pro pte.
Eriophorum vulgare Pers. Synops. Fl. 1: 70 (1805)
Carex alopecurus Lap., Hist. Abr. Suppl. 141 (1818)
Eriophorum pubescens Smith, Engl. Fl. 68 (1824)
Scirpus angustifolius (Honek) Koyama subsp. latifolius (Hoppe)Koyama,

Perennial with an abbreviated rhizome. Culms (12)-16-31 cm tall, trigonous.
Basal leaves 3-8 mm wide, terminating in a short trigonous point; scabrous.
Inflorescence a simple umbel, subtended by 2-3 involucral bracts 1.0-2.5 cm long, leaf-like: Spikelets 3-12, 1.0-1.5 cm x 0.5-1.4 cm (in fruit), sessile or stalked, rays 1-3, nodding; densely hispid-scabrous. Glumes 3.7-4.5 mm x c. 1.7 mm, ovate-lanceolate. Hypogynous bristles numerous, antrorsely setulose towards the top. Anthers mostly less than 3 mm long. Fruit 2.5-2.8 mm x 1.3 mm, narrowly obovoid, reddish-brown. Fl. 5-6 Fr. 6-8.

Habitat: bogs and flushes, 1200-2100 m.

Described from Germany: Habitat in Germaniae pratis humidis /m. (Nat. Hist.)

Widely scattered in NE and C. Anatolia, rare.

A8 Çoruh: Savval Tepe above Murgul, 2100 m. Davis & Hedge, D.32319!

B2 Kütahya: Murat Dag above Banaz, S. slope, 2000 m, Coode & Jones 2490!
Murat Dag above Gediz, at Kesik Süküt Y., 1200 m, Davis & Coode, D.36720!

External distribution: Throughout most of Europe, Eastern Siberia, and on high mountains in Asia Minor and Caucasus; also in North America.

Observations: in the British Isles it is usually found in wet places on base-rich soils.
2. *E. vaginatum* L., *Spa*. Fl. 52 (1753)

Syn: *Linagrostis vaginata* (L.) Scop., Fl. Carn. ed 2, i: 47 (1772)

*S. vaginatus* (L.) Salisb., Prodr. 31 (1796), non Thumb. (1792)

*Eriophorum caespitosum* Host., Gram. austr. 1: 30 (1801)

*S. fauriei* (Camus) Koyama subsp. *vaginatus* (L.) Koyama, Jours.


Perennial, forming large tussocks. **Culms** 14-44 cm tall, smooth, erect, terete below, trigonous above. Basal leaves 1 mm wide, ± setaceous, triguoetsr,
smooth or scabrous. **Spikelets** solitary, 2.5-3.5 cm long, oblong (in flower), sub-globose to broadly ovoid, as long as broad (in fruit). **Glumes** ovate-
lanceolate, long-acuminate; the lower empty 10-20, 8 mm x 3 mm, reflexed after anthesis; the upper fertile, many, 6.0-7.5 mm x 2.0 mm. **Hypogynous** bristles numerous, c. 2 cm long. **Anthers** 2.5-3.0 mm long, linear. **Fruit** 2-3 mm x c. 1.8 mm, oblong-obovoid, yellowish brown. Fl. 4-5. Fr. 5-7.

Habitat: in damp peaty places, on high moors. c. 1750 m.

Described from Europe: in *Europa frigidis sterilibus* (Hb. Linn. 72.1!)

N.E. Anatolia, rare.

Armenia, Calvert and Zohrab (probably between Erzurum and Trabzon).

A7 Gümüşane: Karagoell dag, boggy alpine pastures, 22 July 1814, *Sintenis* 7406!

A8 Çoruh (Artvin): Tiryal dag, above Murgul, by lake, 1750 m, *Davis & Hedge* D.29909!

External distribution: all over Central and Northern Europe, Siberia, Caucasus and North America.
3. *Fuirena* Rottb., Desr. et Icon. Pl. 70, t. 19 (1773)

Annual or perennial, tufted, or sometimes with tuberous thickened rhizomes. Culms terete or triquetrous, nodose, with linear leaves, rarely bladeless, having tubular ligules. Inflorescence terminal and axillary, panicle-corymbose or paniculate (when fully developed) with remote lower branches, or often reduced to nearly a subterminal head. Spikelets terete, with spirally imbricated glumes, hairy on the back, and with long awns; the lower 1–2 often empty. Hypogynous bristles 6 to 0, usually 3 inner broad perianth-like, 3 outer needle-like retrorsely scabrous, or occasionally all 6 needle-like, or completely absent. Stamens 3, anthers linear. Style 3–fid. Fruit obovoid, sharply trigonous, alternate at base, and often prolonged into a slender beak.

1. *F. pubescens* (Poir.) Kunth
1. *F. pubescens* (Poiret) Kunth, Enum. 2: 182 (1837)

*Syn:*  *Carex pubescens* Poiret, Voy. Barb. 2: 254 (1789)

*Scirpus pubescens* (Poiret) Lam., Ill. 4: 139 (1791)

*Carex poiretii* Gmelin, Syst. 1: 140 (1796)

*Isolaepis pubescens* (Poiret) Roem. & Schultes, Syst. 2: 118 (1817)

Perennial with a long-creeping rhizome. **Culms** 18-44(-70) cm tall, erect, triquetrous, noded, sulcate, pubescent above. **Leaves** linear-lanceolate, keeled, 2-4 mm wide, middle ones much longer; sheaths triquetrous, hairy at the top, with tubular ligules. **Inflorescence** a panicle with remote rays, often reduced to a subterminal cluster. **Involucral bracts** many, lower leaf-like. Spikelets 1-5, 6.0-9.5 mm x 4.0-5.0 mm, ovate-oblong, obtuse, solitary or in glomerules, carried in pubescent rays from the axil of the lower sheath-forming involucral bract. **Glumes** 4.5-5.0 mm x 1.8-2.0 mm, ovate to oblong, keeled, pubescent, rounded at the tip where the 3 nerves converge and project into an awn 1.0-1.6 mm long. **Hypogynous bristles** absent, rarely rudimentary. **Anthers** 1.6-2.2 mm long. **Fruit** 1.2-1.5 mm x 0.7-0.8 mm, yellowish-brown. Fl. 5-7.

**Habitat:** By stream, near sea level.

**Described from North Africa [Poiret].**

S.W. Anatolia, Islands; rare.

C3 Antalya: distr. Kemer (Lycia), Gönlük, Davis 15029!


**External distribution:** this species has a sporadic distribution from Portugal and Corsica through North Africa to the Lebanon and South Africa, and also through Afghanistan to India.


Scirpus L. sect. Reigera (Opiz) Beetle in Amer. J. Bot. 31: 263 (1944)

Perennial, with thick rhizomes, often with long-creeping stolons ending in tubers. Culms solitary, acutely triquetrous, noded, nodes often not conspicuous due to the long sheathing bases of the leaves; culm base enlarged. Leaves broadly linear, scabrous on margins and midrib. Sheaths brown to pale green, ligule-less; upper triquetrous, tight, lower loose, often septate-nodose. Inflorescence a large terminal corymb, sometimes reduced to a head of sessile spikelets. Involucral bracts few to many, lower 1-3 large, leaf-like. Spikelets ovoid, sessile or stalked, chestnut to reddish brown. Glumes spirally arranged, thin membranous, notched or deeply dentate at the apex, with the mid-nerve excurrent into a long scabrous awn. Hypogynous bristles 1-6, strongly retrorsely barbed, caducous or persistent. Stamens 3, anthers linear, with subulate setulose connective. Style long, smooth, 2-3 fid, caducous, leaving a short beak on the fruit. Fruit large, 2.5-4.0 mm long, broadly obovoid, trigonous, plano-convex or almost lenticular, shiny, ajiulate with short conical to cylindrical style-base.

1. Fruit trigonous with short outer epidermal cells. Plant 11-100 cm tall,
   leaves 1.2-6.0 mm wide
   1. B. maritimus (L.) Palla

1. Fruit almost lenticular with tall outer epidermal cells. Plant robust,
   60-150 cm tall, leaves 8-10 mm wide
   2. B. paludosus (Nelson) Oteng-Yeboah
Fig. 36  Bolboschoenus spp. in Turkey

1-6 Inflorescence forms × 1  1, 2. B. maritimus; 3-5 B. maritimus var. cymosus
6. B. paludosus subsp. hakkiaricus

7-11 Fruit shapes × 12  7-9. B. maritimus races
10, 11. B. paludosus subsp. hakkiaricus

Perennial, stoloniferous, stolons usually ending in tubers. **Culms**
(11)-60-100 cm tall, triquetrous, noded, tough towards the top, and commonly thickened at the base. **Leaves** 10-48 cm x 1.2-6.0 mm, linear, keeled, scabrous on margins and keel, borne on triangular sheaths with straight orifice, liguleless, light brown to pale green, covering the nodes on the culm. **Inflorescence** a large terminal corymb with rays 0.9-5.0 cm long, each ending in 2-6 spikelets, or sometimes contracted into a head; subtended by several involucral bracts, lower 1-3 leaf-like to setaceous, 5-21 cm long. **Spikelets** 0.8-4.8 cm x 2.0-6.5 mm, ovoid, sessile or stalked, chestnut to reddish brown. **Glumes** 5.5-7.5 mm x 1.5-4.0 mm, ovate, deeply notched, with the midnerve excurrent into a scabrous awn 1.0-3.0 mm long. **Hypogynous bristles** 1-6, 1.2-4.0 mm long, needle-like, retrorsely barbed, brown, deciduous, rarely persistent. **Stamens** 3, anthers linear, 2.0-4.0 mm long, including the setulose connective. **Style** 2.0-5.0 mm long, stigmas 3, rarely 2. **Fruit** 0.9-3.0 mm x 0.5-2.3 mm, broadly obovate, trigonous or plano-convex, shining. Fl. 5-7. Fr. 7-9.

**Habitat:** in marshes, near sea level to 2000 m.

**Described from Europe:** in *Europae litoribus maritimus* [Hb. Linn. 71.43]/*

1. Spikelets very long, 2.0-4.8 cm long ........................... var. *maritimus*

1. Spikelets shorter, 0.8-1.9 cm long ............................ var. *campestris*

1. var. *maritimus*

**Syn:** *Scirpus maritimus* L. Sp. Pl. 52 (1753), basionym

*S. macrostachyus* Lam., *Illust. 1: 142* (1791)


**Germ. ed. 2: 858** (1844)
Scattered.

A2(E) Istanbul: Belgrad forest, 28 August 1982, Asanvour.
A2(A) Kocaeli: Pendik-Tuzla, 24 June 1898, Asanvour.
A5 Kastamonu: Tosya, Sabandja, 4 August 1892, Sintenis 4929.
A6 Samsun: Kirazlik beach area, Tobey 802.
B5 Kayseri: Kayseri-Incesu, 1200 m, Davis & Hedge D.3257.
C3 Antalya: Finike, Schwartz 136.
C4 Iğel: sea shore east of Toslua, Alaya & Kukkonen 6725.
Islands: Rodhos (Fiori 79).

2. var. cymosus (Reichenb.) Oteng-Yeboah, comb. nov.

Syn: S. maritimus L. var. cymosus Reichenb., Fl. Germ. Excur. 1: 79 (1830),
basionym

S. maritimus sensu aut. plur., non L. (1753)
S. maritimus L. var. maritimus f. cymosus (Reichb.) Koyama in Can.
J. Bot. 40: 936 (1962)

Scattered.

A2(E) Istanbul: Khotik Çekmece, 30 August 1937, Best.
A2(A) Istanbul: Kartal, 8 June 1899, Asanvour.
A4 Çankiri: Çankiri, 800 m, Davis 21500.
A5 Kastamonu: Tosya, 17 June 1892 Sintenis 4263.
B3 Kütahya: Eskişehir to Kutahya, 32 km from Kütahya, 800-900 m, Dudley
D.36081.
B7 Erzincan: plain east of Erzincan, 1250 m, Davis & Hedge D.31877.
B10 Kars: Aralik (Aras village), 810 m, Davis 43648.
65 Adana: Adana to Karatas, 5 miles S. of Adana, near sea level, Coode &
Jones 256!

66 Hatay: İskenderun-Antakya, west of Amik Göl, 150 m, Davis & Hedge D.27270!

68 Mardin: Mardin-Savur, on N. side of watershed, 11-12 miles from Mardin,
1100 m, Davis & Hedge D.28534!

69 Van: Başkale-Hakkari (Çolemerik) c. 50 km from Başkale, 1800 m, McNeill 699!
Islands: Gallipoli (Sirî); Troas (Schmidt); Mytilene (Cand., Rechinger 5676b,
Rechinger 5457); Rhodes (Fiori 80).

The following specimens have spikelets congested into a single head, and
could just be local variations, since most were collected from the same localities
as var. gynmosus.

A2(E) Istanbul: Kâğıtçık Çekmece, 19 May 1939, B. Post!

A2(A) Istanbul: Kartal, 14 July 1894, Asnavour!

A2(A) Kocaeli: Pendik-Tuzla, 24 July 1898, Asnavour!

B4 Konya: Cihanbeyli, Boluk Gölü, 1010 m, Khan, Prance & Ratcliffe 447!

C5 Adana: Adana to Karataş, 5 miles N. of Karataş, c. 10 m, Coode & Jones 296!

Observations: I have followed Koyama (1962) in selecting the Linnean specimen
71.43 as the lectotype of the species. This specimen has been regarded as the
type of the var. macrostachys (Willd.) Koch by several authors, but it is the
one that matches Linnaeus's original description of the species. The var.
gynmosus (Reich.) Oteng-Yeboah, which is the Scirpus maritimus of several authors,
is differentiated by having shorter spikelets 0.8-1.9 cm long.

ssp. *paludosus*

Syn: *Scirpus campestris* Britt., in Britt. & Brown, Ill. Fl. 1: 267 (1896), non Rottb. (1795)


*S. robustus* Pursh var. *campestris* (Britt.) Fern., Rhodora 2: 241 (1900)

*S. robustus* Pursh var. *paludosus* (Nelson) Fern., Rhodora 2: 241 (1900)

*S. robustus* Pursh var. *compactus* Davy ex Jepson, Fl. W. Middle Calif. 88 (1901)

*S. interior* Britt., Man. ed. 2: 178 (1905)

*S. pacificus* Britt. ex Parish, Bull. Soc. Calif. Acad. 4: 8 (1905)

*S. brittonianus* Piper, Contr. U.S. Nat. Herb. 11: 157 (1906)

*S. campestris* Britt. var. *paludosus* (Nelson) Fern., Rhodora 8: 162 (1906)


Feddes


*S. paludosus* Nelson var. *atlanticus* Fern., Rhodora 45: 291 (1943)

*S. paludosus* Nelson var. *digynus* (Hillebr.) Beetle in Leafâ. West Bot 4: 47 (1944)

Distributed in Temperate North America, throughout Southern Canada and Northern United States, and also in the Hawaiian Islands. Absent from the Old World.


Perennial, culms to 130 cm tall, sharply triquetrose, smooth to slightly scabrous beneath the inflorescence, 4-6 noded. Leaves 3-5, sub-basal, 8-10 mm wide, equal to or slightly longer than the culm, strongly keeled and very thick.
Sheaths: upper pale green, to 17 cm long, tightly surrounding the culm, ligule-less, with a straight or transversely truncate orifice; lower rust coloured conspicuously septate nodule, bladeless or sometimes bladed.

Inflorescence of 5-17 spikelets in a head and sometimes 1-rayed terminated by 2 spikelets. **Involucral bracts** 2, the lower larger and longer, sometimes appearing as a culm continuation. **Spikelets** ovoid, 1.4 cm x 5.0-5.3 mm, chestnut coloured to brown. **Glumes** 6.7-8.0 mm x 4.3 mm, oblong-ovate, notched at apex with a long seaboarous awn excurrent from the mid-nerve. **Hypogynous bristles** 2-6, 1.5-2.1 mm long, about \( \frac{1}{2}-\frac{2}{3} \) as long as the fruit, retrorsely seaboarous, caducous. **Stamens** 3, anther linear, 4.5 mm long including the long subulate, setulose connective. **Style** 5.5 mm long, stigmas 2, but occasionally obscurely 3. **Fruit** 3.0-3.3 mm x 2.3 mm, broadly obovate, orbiculate-convex to plano-convex or lenticular, apex contracted to a long mucro, brownish, shiny.

Fl. 5-7. Fr. 7-9.

**Habitat:** in marshes and swamps, 1900-1950 m.

**Type:** Turkey, C10 Hakkari: Yükselkova, 1900 m, 7 Sept. 1967, **Duncan & Tait** 203!

**Additional material:** C10 Hakkari: Gevar Ovasi between Yükselkova and Sat Dağ, (Nehil Çay), 1950 m, 30 June 1966, **Davis** 45791!

**Distribution:** known only from the province of Hakkari in Turkey.

**Observations:** The differences between the North American *B. paludosus* asp. *paludosus* and the Turkish asp. *hakkarious* are as follows:

<table>
<thead>
<tr>
<th></th>
<th>asp. <em>paludosus</em></th>
<th>asp. <em>hakkarious</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>spikelet</strong></td>
<td>10-20 mm x 6-10 mm</td>
<td>14 mm x 5.0-5.3 mm</td>
</tr>
<tr>
<td><strong>style</strong></td>
<td>6-10 mm long, 2-fid</td>
<td>5.5 mm long, 2(-3)-fid</td>
</tr>
<tr>
<td><strong>fruit</strong></td>
<td>3.0-4.0 mm x 2.0 mm</td>
<td>3.0-3.3 mm x 2.3 mm</td>
</tr>
</tbody>
</table>
Had it not been for the geographical isolation between these taxa which makes it possible to recognise the subspecies *hakkiaricus*, it would have been necessary to regard it as a variety. All the North American material of the ssp. *paludosus* in Edinburgh viz: McBride 886! A. Nelson 9593! 9661! and A. & E. Nelson 6878! was examined, and the differences between these and the Turkish specimens were very small indeed as shown in the table. It would be interesting to have cytological information.

The subspecies *hakkiaricus* differs from all known Turkish specimens of *B. maritimus* (L.) Palla, (the only other species of *Bolboschoenus* present in Turkey), in having large almost lenticular fruits which have tall outer epidermal cells; robust habit; and very long and wide leaves.
5. **Schoenoplectus (Reichb.)** Palla in Engler, Bot. Jahrb. 10: 298 (1889)

Gen. conserv.

**Syn:** Helophyllum Beauv. ex Lestib., Ess. Cyp. 41 (1819)
Elytrospermum Meyer in Mem. Sav. Etr. Petersb. 1: 200 (1831)
Scirpus L. subgen. Schoenoplectus Reichb., Icon. Fl. Germ. 8: 40 (1846)

Annuals or perennials. Culms nodeless, terete or trigonous, surrounded at base by few bladeless sheaths. Leaves not well-developed, or completely absent. Inflorescence a pseudo-lateral corymb or head; lower involucral bract erect, appearing as a continuation of the culm, beyond the inflorescence. Spikelets ovoid to oblong-ovoid, many-flowered. Glumes spirally arranged.

**Hypogynous bristles** 6, rarely fewer or absent, retrorsely scabrous or fimbriate, caducous or persistent. **Stamens** 3; **stigmas** 2 or 3.

1. Culms tufted, fibrous-rooted at base; glumes boat-shaped, suddenly contracted at upper margins into a mucronate tip; fruits mostly transversely wrinkled when mature.

2. Culms slender, 3.6-26 cm tall, hypogynous bristles absent ........................................ 1. **S. supinus**

2. Culms robust, 49-87 cm tall, constantly with hypogynous bristles ........................................ 2. **S. mucronatus**

1. Culms solitary from nodes of thick creeping rhizomes; glumes broadly ovate, bidentate or bilobed and notched at apex; fruit smooth, or minutely dotted.

3. Hypogynous bristles plumosely-fimbriate ..................... 3. **S. littoralis**

3. Hypogynous bristles needle-like, retrorsely barbed

4. Culms sharply triquetrous ..................................... 4. **S. triguster**

4. Culms terete, or obscurely trigonous .......................... 5. **S. lacustris**

Syn: *Scirpus supinus* L., Sp. Pl. 49 (1753)
*Scirpus halleri* Vitm., Summa Pl. 1: 150 (1789), non Vill. (1787)

Annual, tufted, culms 30-26 cm tall, erect, inconspicuously triangular; sheaths 2-3, lower bladeless, membraneous, upper with a setaceous subulate elongation 3.0-12.0-18.5 cm long. Inflorescence a head containing 1-7 spikelets.

Involucreal bract 3-15 cm long, sulcate, almost equal to the entire height of culm. Spikelets 3-12 mm x 2-3 mm, sessile, ovoid to oblong-ovoid, acute, stramineous to reddish-brown. Glumes 2.7-4.0 mm x 1.0-1.5 mm, elliptic or ovate-elliptic, with a green mid rib. Hypogynous bristles absent. Stamens 3, anthers 0.4-0.6 mm long, lanceolate, connective blunt. Stigmas 3 ± smooth.

Fruit 1.0-1.6 mm x 0.7-1.3 mm, obovate, trigonous, conspicuously transversely rugose, blackish-brown at maturity. Fl. (6) 6-9.

Habitat: wet places, near sea level.

Described from France: habitat in Parisis.

Turkey-in-Europe, rare.

A2(E) Istanbul: Belgradköy, 9 Sept. 1900, Aznavour:

External distribution: extending from Europe to Africa and Australia, it is abundant in the Mediterranean region and South-East Asia.

Syn: *Scirpus mucronatus* L., Sp. Pl. 50 (1753)

*S. glomeratus* Scopoli, Fl. Carn. ed. 2, 1: 47 (1772), non Linn. (1753)

*S. trigarinatus* Pers., Synops. 1: 68 (1805)

Perennial with an abbreviated rhizome. Culms 49-67 cm tall, densely tufted, triquetrous. **Sheaths** 2-3, bladeless; lowest membranaceous, brown to chestnut brown, upper stramineous-brown, with a short, acute or rounded mucronate blade, obliquely truncate orifice, ligule-less. **Inflorescence** a hemisphaerical head with 2-10 sessile spikelets. **Involucral bract** 3.0-8.5 cm long, triquetrous, exceeding the inflorescence. **Spikelets** 4-12 mm x 2-5 mm, ovoid to oblong-ovoid. **Glumes** 3.0-3.8 mm x 2.0-2.5 mm, obovate, one-nerved.

**Hypogynous bristles** 6, 2.1-2.5 mm long, retrorsely barbed. **Anthers** 0.7-0.9 mm long, connective blunt. **Style** slender, flat; **stigmas** 3, minutely papillose.

**Fruit** 2.0-2.5 mm x 1.2-1.7 mm, obovate, trigonous to plano-convex, obscurely transversely wrinkled, blackish-brown. Fl. 7-10

Habitat: in moist places, near sea level.

Described from Europe: habitat in Angliae, Italiae, Virginiae [sic]

stagnis maritimis [Hb. Linn. 71.317].

N. Turkey, local.

A2(E) Istanbul: Bakirköy, 6 Oct. 1929, E. Post!

A2(E) Istanbul: between Hisarbeyli and Ormanli, A. Baytop 14169!

A5 Kastamonu (Paphlagonia): Tosya, 4 Aug. 1892, Sintenis 4926!

External distribution: recorded as abundant in Europe, Western Asia to Japan, Australia and Polynesia. Also in Egypt (very rare along the Mediterranean coast); and Cameroon.

**Syn:** *Scirpus littoralis* Schrader, Fl. Germ. 1: 142 (1806)

*Haleogoton littorale* (Schrader) Reichb., Pl. Germ. Excurs. 1: 78 (1830)

*Melacocheta littoralis* Schrader) Nees in Linnaea 9: 292 (1834)

*Scirpus aegyptiacus* Decaisne in Ann. Sci. Nat. ser. 2, 4: 196 (1835),

non Poiret (1804)

*S. balearicus* Willd. ex Kunth, Enum. Pl. 2: 166 (1837)

*S. desprauchii* Steudel, Synops. Pl. Glumac 2: 86 (1855)

Stout perennial with slender creeping rhizomes. **Culms** 33-180 cm tall, glabrous, trigonous. **Sheaths**, lower shortly bladed or bladeless, upper usually bladed, with thin, concave, broadly hyaline, dotted orifice, ligule obtuse. **Inflorescence** a pseudo-lateral corymb, rays to 5.5 cm long. **Involucral bract** 1-10 cm long, equaling or exceeding the inflorescence. **Spikelets** 5-12 mm x 2-4 mm, oblong-ovoid or linear-ovoid, rufous or reddish-brown, solitary or in glomerules on rays. **Glumes** (2.8)-3.8-4.2 mm x 1.5-2.0 mm, notched with the excurrent mid-nerve forming a scabrous awn, margins scabrous. **Hypogynous bristles** 4(-5), 1.7-2.3 mm long, plumosely fimbriate. **Anthers** 1.3-1.7 mm long, connective strongly ciliate. **Style** flat, obviously 3-nerved, c. 1.5 mm long, stigmas 2, very broad, papillose. **Fruit** (0.8)-1.2-2.2 mm x 1.2-1.4 mm, obovoid, lenticular, yellowish-brown to dark brown. **Fl**. 5-10.

**Habitat:** in marshes near canals or sea.

Described from Germany.

W. & S.W. Anatolia, local.

B1 Izmir (Smyrne): border of the Papeterie canal, **Balansa** 148!

C3 Antalya: Antalya, on marsh, **Truman** 76!

External distribution: widespread throughout the Mediterranean region and S.W. Asia; common in South Africa, South-East Asia, Malaya and Northern Australia.

**Syn:** *Scirpus triqueter* L., Mant. 1: 29 (1767)

*S. mucronatus* Host, Gram. Austr. 3: 44 (1801–9) non L. (1753)

*S. trigonum* Roth, Neue Beytr. 1: 90 (1802)

*S. lejeunei* Weihe in Flora 11: 116 (1828)

*S. heppii* Weihe in Flora 11: 118 (1828)

*S. pollichii* Gren. & Godr., Fl. France 3: 374 (1855)

**Perennial** with purplish-red creeping rhizome. *Culms* 44–104 cm tall, *triquetrous*, *glabrous*, *stout*. *Sheaths* 2–3, reddish-brown or pale brown with red spots, lower bladeless, upper usually shortly bladed with straight orifice, and rounded to obtuse ligule. *Leaf blade* 2.0–2.8 cm x 4 mm, ribbed.

**Inflorescence** pseudo-lateral with crowded sessile spikelets, sometimes with rays bearing single or aggregated spikelets. *Involucral bract* 3–7 cm long, *triquetrous*, equaling or longer than inflorescence. *Spikelets* 5–10(-13) mm x 2–4 mm, *obovoid* or *oblung-ovoid*, obtuse, reddish brown. *Glumes* 3.5 mm x 2.2 mm, *oblung-elliptic*, *reutuse*, *mucronate*, scabrous on the margins. *Hypogynous bristles* 2–3, 2.1–3.0 mm long, retrorsely barbed. *Anthers* 1.2–2.0 mm long, connective strongly ciliate at the tip. *Style* 2(-3)-fid, third branch appearing as a rudiment. *Fruit* 2.7–3.0 mm x 1.4–1.6 mm, *obovoid*, *compressed trigonous* or *plano-convex*, *apiculate*, yellowish to reddish brown. *Fl.* 6–9(-12).

**Habitat:** wet places in various conditions; at sea level.

**Described from Europe:** *Habitat in Europa australi* (Hb. Linn. 71.29, 3057).

**N.A. Turkey:**

A7 Trabzon: sea level, *Davis & Hedge D.* 32036!

A7 Trabzon: Gilida Dere, c. 32 km West of Trabzon, near the sea, *Hennipman et al.* 1904!

**External distribution:** widespread in Europe and Asia, also in North America. **Recorded once from Egypt,** in the Suez Canal area.

ssp. *lacustris*

*Syn:* *Scirpus lacustris* L., Sp. Pl. 48 (1753)

*S. macrophyllum* Bess. ex Schult., Mant. 2: 535 (1827)

Stout glabrous perennial, with long creeping rhizomes. *Culms* 41-225 cm tall, terete, green; covered at the base by membranous sheaths, lower brownish, bladeless, upper pale green or brown, often with a short subulate or linear blade. *Inflorescence* a pseudo-lateral corymb, (1.5)-6.5-9.0 cm tall, the central aggregated spikelets on shorter rays, the lateral ones on longer rays. Ray prophyll constantly ensheathing 3 rays in the axil of the lower involucral bract. Lower *involucral bract* longer, channelled at base, (2.0)-5.6-13 cm long, equaling or slightly exceeding the inflorescence, upper small, setaceous. *Spikelets* 5.5-15 mm x 2-5 mm, oblong-ovoid, acute. *Glumes* 3.4-4.6 mm x 2.0-2.6 mm, ovate, emarginate, scabrous on margins, with the mid-nerve excurrent into an awn 0.3-1.5 mm long, scabrous, abaxial surface with or without gummy spots. *Hypogynous bristles* 6, needle-like, retrorsely barbed. *Anthers* linear, 1.1-2.0 mm long, with a subulate, setulose connective. *Style* (0.5)-1.3-3.0 mm long, with 3 papillose stigmas. *Fruit* (1.5)-2.1-3.0 mm x (0.5)-1.1-2.0 mm, obvoid, plano-convex or obscurely trigonous, greyish-brown.

Fl. 5-7. Fr. 7-9.

*Habitat:* marshes near lake and rivers; alt. 50-1950 m.

Described from Europe: *habitat in Europeae aquis stagnantibus et fluviatilibus* [Hb. Linn. 71.1517].

N. Turkey and adjacent Inner Anatolia, Islands.

A1(A) Balikesir: Bandirma-Manya gölu, Kayacik & Yaltırık 3741!

A2(E) Istanbul: Belgrad forest, 8 July 1920, Asnavour!

A3 Sakarya: Sapanca gölu, 50 m, Davis & Coode D.36223!
A5 Çorum: Köse Dag, north of Çorum, 1500 m, Coode & Jones with Tobey 1910!

Erzincan (Armenia Turcica): Sipikor dag in Sipikör-Goel, 26 July 1890, Sinentis 3556!

Is: Lesvos, Rechinger 5712; Samos, Colonna, Forsyth-Major 536.

External distribution: very widely distributed in Europe, Asia, Africa, North and South America, Polynesia and Australia.

ssp. glaucus (Hartman) Oteng-Yeboah, comb. nov.

Syn: Scirpus tabernaemontani Gmelin, Fl. Bad. 1: 101 (1805)

S. glaucus J.E. Smith in Sowerby, English Bot. ed. 1, 33: t. 2321 (1811), non. Lam. (1791)

S. lacustris L. var. tabernaemontani (Gmelin) Döll, Rhein. Fl. 165 (1843)

S. lacustris L. ssp. glaucus Hartman, Swansk. Og Norsk Exc. Fl. 10 (1846)

S. lacustris L. var. digynus Gren. & Godr., Fl. France 3: 372 (1855)

S. lacustris L. ssp. tabernaemontani (Gmelin) Bogwell Syme in English Bot. ed. 3, 10: 64 (1893)

Schoenoplectus tabernaemontani (Gmelin) Palla in Engler Bot. Jahrb. 10: 299 (1889)

Differs from ssp. lacustris in having ray prophyll constantly ensheathing 2 rays in the axil of the lower involucral bract; lower involucral bract shorter than the inflorescence; stigmas 2; glumes 3.0-4.1 mm long, constantly with red gummy spots at the abaxial surface; culms glaucous (in living specimens).

Fruits lenticular to plano-convex. Fl. 5-7. Fr. 7-9.

Habitat: in marshes near streams or lakes.

Described from Germany: utrinque in stagnis et paludibus praesertim sylvaticis Rheno vicinis frequens.
Widespread but local in Turkey, Islands.

A1(E) Edirne: distr. Kegan, Akhoca to Beylik Mera Köyü, Coode & Jones (with Dönmez) 2875!

A2(E) Istanbul: Yedikoule-Makriköy, 31 July 1898, Aznavour!

A2(A) Istanbul: Kartal, 14 Aug. 1898, Aznavour!

A3 Bolu: Abant göl, 1400 m, Davis & Coode D.37273!


B5 Kayseri: Kayseri-İncesu, 1200 m, Davis & Hedge D.32753!

B7 Malatya: Gürün-Malatya, c. 10 km E. of Darenge, 90 m, McNeill 430!

B9 Van: Van, Davis & Polunin D.24540!

B10 Kars: Aralik (Aras valley), 810 m, Davis 43649!

G2 Antalya: Kara göl near Yura, Davis 13907!

C6 Hatay: Iskenderun-Antalya, west of Amik Göl, 150 m, Davis & Hedge D.27259!

C9-10 Van: Zab gorge, south of Başkale, Davis & Polunin D.23794!

C10 Hakkari: Gevar Ovası between Yüksekova and Sat Dagi, 1900 m, Davis 45789!

Is: Samos, Forsyth-Major 536!

External distribution: widely distributed in Europe, the extreme North; Mediterranean region and temperate Asia.

*S. lacustris x glaucus*

This putative hybrid was collected by Aznavour on 25 July 1898 at A2(E) Istanbul: San Stefano (Yeşilköy) in the province of Istanbul, an area noted for large collections of the two subspecies. In almost all the characters used to distinguish between these two subspecies, this putative hybrid was found to be intermediate, though apparently highly fertile to judge by the large amount of fruit set.
Fig. 37 Variations in *Schoenoplectus lacustris* in Turkey

1-4 Inflorescence forms in *S. lacustris* a subsp. *glauces* × 1.

5-9 Glume forms × 12; 10-16 Fruit shapes × 12

(10-12 subsp. *lacustris*; 13-16 subsp. *glauces*)
Observation: Throughout the long taxonomic history of these two taxa in Europe, there have been differences of opinion as to the rank to accord them: whether to recognise just a single species (S. lacustris) and reduce the other to an infra-specific category; or to recognise both as separate species. These differences of opinion result from breakdown of characters which normally distinguish them. Such European workers as Mertens and Koch (1823), Custor (1830), Kunth (1837), Koch (1837, 1843), Komarov (1924), Clapham et al. (1962) etc., have considered them as separate species; while Fries (1828), Döll (1843), Anderson (1849), Hartman (1849), Meyer (1849), Parlatore (1852), Böckeler (1870) etc. recognise only S. lacustris and the other as a subspecies or variety.

Cytological evidence shows that the two taxa have the same chromosome number of \( n = 21 \) (Bakker 1954, Otzen 1962), and that the possibility of hybridization, with the production of fertile hybrids, can be assumed to be responsible for much of the taxonomic confusion, whenever these two taxa occur (Daneser 1950, Bakker 1954, Smith 1969).

The latest distinguishing character, i.e. the number of rays from the axil of the lower involucral bract, which I found to be constant in each of these taxa in relation with the other distinguishing characters (save for putative hybrids) in Turkey, has also been observed to be fairly constant in European specimens.

This character cannot be used when the inflorescence is immature or depauperate, and the rays have not fully extended. Having in mind the small differences between these two taxa, and the rather frequent hybridization known to occur between them, subspecific rank seems the most suitable status to accord them.


Perennial with slender ascending rhizome or densely tufted. Culms slender, wiry, nodeless, clothed at base with a few sheaths obliquely cut at apex, bladeless or with short, setaceous, erect blade. Inflorescence terminal, single to a few spikelets. Glumes spirally arranged. Hypogynous bristles 6, or wanting, slenderly filiform or silky elongating and exceeding glumes, or strongly curled and concealed in glumes, or broadly chartaceous and shorter than the fruit. Stamens 3, stigmas 3, fruits trigonous.

1. T. pumilum (Vahl) Schinz & Thell.

Syn: *Scirpus pumilus* Vahl, Enum. 2: 243 (1805)

*Isolepis pumila* (Vahl) Roem & Schult., Syst. Veg. 2: 106 (1817)

*Scirpus alpinus* Schleich., in Caudiv. Fl. Helv. 1: 108 (1828) non L (1753)

*Isolepis elongantha* C. Mey. in Ledeb. Fl. Alt. 1: 64 (1829)

*I. oligantha* C. Mey. in Mem. Acad. St. Petersb. Sav. Er. 1: 197 (1831)

*Trichophorum atrichum* Palla. in Bot. Jahrb. 10: 296 (1888)

Perennial, densely tufted. **Culms** 2.5-18 cm tall, slender. **Sheaths** 2-4, lower membranous, brown, bladeless, upper light green, with obtuse subulate blades 2-16 mm long, with concave, broadly hyaline inner face, and rounded or obtuse ligule. **Inflorescence** a solitary, terminal spikelet, subtended by a glume-like, caducous, involucral bract 2.5-4 mm long. **Spikelet** 2-4 mm x 1-2 mm broad, ovoid, 2-4 flowered. **Glumes** 2.5-3.5 mm x 0.7-2.0 mm, ovate, obtuse.

**Hypogynous bristles** absent or represented by 3-6 rudimentary chartaceous organs. **Anthers** 1.2-1.7 mm long; **style** 0.4-1.7 mm long. **Fruit** 1.7-2.1 mm x 0.7-1.0 mm, obovoid, smooth plano-convex to trigonous.

Described from Switzerland.

S. Anatolia (Taurus)

B6 Seyhan (Adana): Bulghar, Magara, 1896, Siehe 526!

**External distribution**: All over Eurasia and N. America in boreal and montane bogs.

**Syn.:**
- *Limnochloa* Nees in *Wight, Contr. Bot. Ind.* 71 (1834)
- *Scirpidium* Nees in *Linnaea* 9: 293 (1834)
- *Eleocharis* Nees in *Linnaea* 9: 294 (1834)
- *Chaetocyperus* Nees in *Linnaea* 9: 289 (1834)


*Perennial, rarely annual, with creeping rhizomes and tufted culms. Culms terete or 4-angular, nodeless, leafless, terminated by a solitary spikelet, the lowest glume(s) of which is usually sterile, and different in shape from the upper ones. Glumes spirally arranged. Hypogynous bristles present, retrorsely barbed, number variable, rarely wanting. Stamens 3. Stigmas 2-3 with the style-base dilated and/or articulated at the junction with the body of the fruit. Fruit trigonous or lenticular.*

1. **Style-base confluent with** (i.e. not differentiated from) **the apex of the fruit body**, but of a different colour and texture

   1. **E. pauciflora** (Lightf.) Link

1. **Style-base dilated and articulated with the fruit body**

2. **Style 3-fid; fruit with longitudinal ridges separated by numerous trabeculae, trigonous**

   2. **E. acicularis** (L.) R.Br.

2. **Style 2-fid; fruits smooth or minutely dotted, lenticular**

3. **Basal sterile glumes 2-3, at least each encircling half to a third of the base of the spikelet**

   3. **E. palustris** (L.) R.Br.

3. **Basal sterile glume solitary, spathiform, encircling the base of the spikelet**

   4. **E. uniglumis** (Link) Schultz
1. **E. pauciflora** (Lightf.) Link, Hort. Berol. Descr. 1: 284 (1827)

**Syn:**
- *Scirpus pauciflorus* Lightf., Fl. Scot. 2: 1078 (1777)
- *S. baehryron* L. fil., Suppl. 103 (1781)
- *S. baileri* Vill., Plant. Dauph. 2: 188 (1787)
- *S. quinqueflorus* Vitm., Summa Pl. 1: 150 (1789)

**Baeothryon pauciflorum** (Lightf.) A. Dietr., Sp. Pl. 2: 90 (1843)

Culm 3-17 cm tall, slender, erect or ascending, in small tufts. Sheaths (1)-2-3 cm long, lower reddish-brown, upper brown or stramineous, leafless, truncate. **Spikelets** 4-7(-8.5) mm long, 2-7 flowered, ovoid to globose. Lower glume brown to castaneous, larger, upper glumes smaller, ovate-lanceolate, acute, with hyaline margins. **Hypogynous bristles** 3-5, slender, profusely retrorsely barbed, equaling or slightly longer than fruit. **Anthers** 1.8-2.0 mm long. **Style** 3-fid, base confluent with the body of fruit. **Fruit** 1.8-2.0 mm long, obovoid or fusiform, trigonous or plano-convex, prominently reticulate with small rectangular cells. Fl. 5-8.

**Habitat:** beside streams and flushes on wet marshy ground; 1200-3292 m.

Described from Scotland.

**Inner Anatolia.**

A7 Gümüşhane: Sarıkent, 5 June 1894, Sintenis 5772.

B2 Kütahya: Murat Dağ above Gediz at Kesik Söğüt, 1200 m, Davis & Coode D.3672!

B3 Konya: (Phrygia vil. Konia): in subalpine region of Sultan Dağ near Akşehir, 1500 m, 25 June 1899, Bornmuller 5613!

B6 Kayseri: 5 km N. of Sarız, 1900 m, Coode & Jones 1407!

B9 Van: 4 km W. of Erçiş, 1720 m, Davis 43447!

C9 Hakkari: Kars Dağ, 3292 m, Davis & Polunin D.24442!

**External distribution:** Wide spread in Europe, Siberia, Caucasus, Himalaya, Morocco and North America.

Syn:  
- *Mariscus acicularis* (L.) Moench, *Meth.* 350 (1794)
- *Scirpus trichodes* Muhl., *Descr. Gram.* 30 (1817)
- *Eleocharis costata* Presl., *Fl.* Cech. 11 (1819)
- *Isolepis acicularis* (L.) Schlecht., *Fl. Berol* 1: 36 (1823)
- *Scirpus chaeta* Schultes, *Mant.* 2: 72 (1824)
- *Clavula acicularis* (L.) Dumort., *Fl.* Belg. 143 (1827)
- *Scirpidium aciculare* (L.) Nees in *Linnaea* 9: 293 (1834)

Culms 2-8.5 cm tall, filiform, erect or ascending, 4-angled, rarely terete or trigonous, sulcate. Sheaths to 12 mm long, 4-angled, scarious, loose at the top leaving a blunt spatulate-shaped projection. Spikelet 2-4.5 mm long, 5-8 flowered, ovoid to linear. Upper glumes ovate-lanceolate, obtuse to acutish, with a narrow to broad hyaline margin. Hypogynous bristle 0-3, very slender or weak retrorsely barbed, and as long as or longer than the fruit. Anthers c. 1.0 mm long. Style 3-fid, on a conical triangular or acicular tubercle. Fruit 0.9-1.0 mm long, obovoid-oblong, obscurely trigonous with many longitudinal ribs and close trabeculae. Fl. 6-8.

Habitat: in wet sandy or muddy places near pools.

Described from Europe: habitat in *Europa sub aquis purioribus* A. B. Linn.

71.1317.

Bosphorus, rare.

A2(E) Istanbul: Grand Bend, Belgrad Forest, 28 August 1892, *Aznavour!*
External distribution: Europe (except the extreme North and South),
Northern Asia, Transcaucasia, Morocco, Australia, North and South America.

Observations: The authorship of this species and also of *Eleocharis palustris*
has been attributed to Roemer & Schultes (1817) by many workers, but in reality,
one can assume the transfers to have been made by R. Brown (1810) when he
created the genus *Eleocharis* and cited these two species (among others)
under it.

Syn: Sirpus palustris L. Sp. Pl. 47 (1753)

Halesocharris eupalustris Lindb. fil. in Acta Soc. Pro. Fauna Fl.

Fennica 23 (7): 5 (1902)

Sirpus palustris, a typicus Aschers. & Graebn., Syn. Mitteleur.

Fl. 2 (2): 290 (1903)


Culms 6.5–51 cm tall, terete, sometimes compressed flat (in dried material), sulcate, solitary or tufted. Sheaths reddish-brown or dark-brown, lower loose, upper tightly surrounding the culm, truncate, 3–13 cm long. Spikelet (0.5)-0.9–2.9 cm x 2.5–5.0 mm, linear-cylindric to slenderly ovoid, many flowered. Basal glumes ovate to oblong, obtuse; upper glumes 3–4 mm long, oblong-ovate, obtuse to subacute, sometimes with two purple convergent bands, and hyaline margins. Hypogynous bristles 4, retrorsely barbed, as long as the fruit. Anthers 1.5–2.5 mm long, with obtuse tip. Style 2-fid, branches papillose, on a lanceolate to conic-ovoid or slenderly bulbiform, occasionally depressed-deltoid tuberole which is longer than broad, or sometimes equal. Fruit 1.2–1.5 mm x 1.0–1.3 mm, obovoid to pyriform, lenticular, yellowish to castaneous, inconspicuously reticulate or minutely dotted. Fl. 4–8.

Habitat: in marshes near lakes, rivers in meadows or mountain slopes; near sea level – 2350 m.

Described from Europe: habitat in Europae fossis & inundatis

/Ab. Linn. 71–517

Widespread.

A1(E) Edirne: 4 km W. of Edirne, alt. 50 m, Davis 41906!

A1(E) Tekirdağ: between Muratlı and Tekirdağ, A: Baytop 30994!
<table>
<thead>
<tr>
<th>No.</th>
<th>Destination</th>
<th>Distance</th>
<th>Elevation</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2(E)</td>
<td>Istanbul: Yedikoule (near Makriköy)</td>
<td>7 June 1898</td>
<td>Asnayour</td>
<td></td>
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<tr>
<td>A2(A)</td>
<td>Kocaeli: Tuzla (S.E. of Pendik)</td>
<td>26 April 1894</td>
<td>Asnayour</td>
<td></td>
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<tr>
<td>A3</td>
<td>Bolu: Abant göl, alt. 1400 m</td>
<td>Davis &amp; Coode</td>
<td>37158</td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>Ankara: Karagöl, 40 km N. of Ankara, 1600 m</td>
<td>Coode &amp; Jones</td>
<td>2206</td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>Çorum: 12 mls. Alaca to Sungurlu, 1200 m</td>
<td>Coode &amp; Jones</td>
<td>1654</td>
<td></td>
</tr>
<tr>
<td>A6</td>
<td>Samsun: marsh east of Samsun, 5 m</td>
<td>Tobev</td>
<td>790</td>
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<tr>
<td>A6-7</td>
<td>Ordu: Cambaşı at Semen, 2200 m</td>
<td>Tobev</td>
<td>1437</td>
<td></td>
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<tr>
<td>A7</td>
<td>Gümüşhane: Gümüşhane, 28 June 1894</td>
<td>Sintenis</td>
<td>6024</td>
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<tr>
<td>A9</td>
<td>Kars: 4 km from Sarikamış to Karaurgan, 2200 m</td>
<td>Davis</td>
<td>46606</td>
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<tr>
<td>B1</td>
<td>Balikesir: mt. Ida, 15 July 1883</td>
<td>Sintenis</td>
<td>1217</td>
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<tr>
<td>B2</td>
<td>Kütahya: Simav, Kişir to Akdag, 1100 m</td>
<td>Coode &amp; Jones</td>
<td>2685</td>
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<tr>
<td>B2</td>
<td>Uşak: 11 mls. from Dumlupinar to Banaz, 100 m</td>
<td>Coode &amp; Jones</td>
<td>2350</td>
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<tr>
<td>B2</td>
<td>Bursa: Tahtaköprü between İnegöl and Domaniç</td>
<td>Davis &amp; Coode</td>
<td>36413</td>
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<tr>
<td>B5</td>
<td>Yozgat: 20 km N. of Himmetdede, 1200 m</td>
<td>Coode &amp; Jones</td>
<td>1472</td>
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<tr>
<td>B6</td>
<td>Yozgat: Akdağmadeni to Büyük Nalbant dag at Yukari Culhari, 2100 m</td>
<td>Coode &amp; Jones</td>
<td>1409</td>
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<tr>
<td>B9</td>
<td>Agri: d. Suluçem (Musum), S. end of Balik G., 2300 m</td>
<td>Davis</td>
<td>47065</td>
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<td>B9</td>
<td>Bitlis: Kotum, Davis &amp; Polunin</td>
<td>D.22422</td>
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<tr>
<td>B10</td>
<td>Kars: Aralik, 850 m</td>
<td>Davis</td>
<td>43879</td>
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<tr>
<td>C2</td>
<td>Muşla: Girdev Gölü, 75 km E. of Fethiye, Lycian Taurus, 2350 m</td>
<td>Lambert &amp; Thorp</td>
<td>599</td>
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<tr>
<td>C5</td>
<td>Adana: Adana to Karataş, 5 mls. S. of Adana, near sea level</td>
<td>Coode &amp; Jones</td>
<td>257</td>
<td></td>
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<tr>
<td>C6</td>
<td>Hatay: Iskenderun, R. Alavya</td>
<td>6603</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10</td>
<td>Hakkari: 19 km from Yükselova to Şemdinli, 1950 m</td>
<td>Davis</td>
<td>42128</td>
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</tbody>
</table>

Islands: Lesvos, Cand.
Cosmopolitan; generally distributed in cold, temperate and subtropical regions throughout the globe, rare in the tropics.

**Observation:** The fact that this is a polymorphic or aggregate species Hakansson 1929, Walters 1949, Strandhede 1960, 1961 has been observed in the Turkish material; but some of the characters normally assigned to the taxa making up the aggregate, viz. chromosome number \(2n = 16, 38, 39\); stomatal length; glume margins; pollen length and width, fruit length and width; tubercle size, ecology (cf. Strandhede 1961), have been found to be not all constant in the material available. Apart from investigations into chromosome numbers and pollen sizes, which had hitherto been found to be consistent for the various cytodemes, and which were not conducted on the material available, the rest were found to be non-correlating. Altitudinal and habitat differences had no visible effect on the plants.

One is therefore left to assume that in Turkey, there is only one taxon within the *Eleocharis palustris* aggregate, which is equivalent to subsp. *palustris* sensu Strandhede 1960, with variations which are only local. This assumption gains ground from the two Sintenis specimens 1217 and 6024 cited above, which have been determined by Strandhede in 1967 as *E. palustris* (L.) R. & S. asp. *palustris*; and which do not differ from the rest of the specimens cited.

*Eleocharis mamillata* Lindb. f. is said to differ from this species mainly in the culms being flat with c. 12 vascular bundles in the t.s., fruit with a depressed-deltoid tubercle which is broader than high, and having 5-6-(8) hypogynous bristles (cf. Lindberg H. 1902)

Two specimens collected by Davis & Coode, D.37279 and D.37326 from Bolu, have flat culms and 12-16 vascular bundles. There are no mature fruits to
compare, but the hypogynous bristles were constantly 4 in number. Other specimens, viz. Coode & Jones 604 and Alava 6601 from G6 Hatay, Davis & Polunin D.21929 from Kayseri, Tobev 776 from A6 Samsun, also have flat or depressed culms. It is believed that the flatness of these specimens was caused by pressing.
E. uniglumis (Link.) Schultes, Mant 2: 88 (1824)

Syn: Scirpus uniglumis Link in Jahrb. d. Ges. 1, 3: 77 (1818)

Helechocharis eu-uniglumis Zinserl. in Fl. Yugo-Vost 3, 278 (1929)

Differs from E. palustris (L.) R.Br. in having: culm always terete, and not more than 1.0 mm diameter; spikelet 0.5–14.5 mm x 1.5–3.5 mm, lanceolate to slenderly ovoid to oblong-ovoid; spikelet completely clasped at the base by a single, rotund-ovate, spatheiform sterile glume, with broad hyaline margins; fruit 1.5–1.9 mm x 1.0–1.2 mm, obovoid, rarely oblong pyriform.

Fl. 5–9.

Habitat: in swamps usually near lakes, alt. 1300–2400 m.

Described from Germany.

Inner S. & S.E. Anatolia.

A4 Ankara: Şubuk Su (Ankara-Ravli), Davis 21431!
A5 Corum: Köse Dağ north of Corum, 1500 m, Coode & Jones 1909!
B5 Kirşehir: Sifegöl nr. Muşur, Davis 21789
B6 Kayseri: Bünyan to Pınarbaşı, 1500 m, Coode & Jones 1327!
B6 Maraş: Gökşun-Çardak, near Findik, 1300 m, Davis & Hedge D.27617!
B9 Bitlis: crater of Nemrut Dağ, c. 2400 m, by lake Nemrut Gölü, McNeill 544!
C3 Isparta: Stötzer, Dedegöl dağ in Dedegöl tarn, 2300 m, Davis 16033!
C10 Hakkari: Yuksekova, 1900 m, Duncan & Tait 2034!

External distribution: widely distributed in Europe, Western Asia and North Africa.

Observation: The distinction between this species and E. palustris (L.) R.Br. becomes difficult to detect when there is no spikelet or even when the spikelet is firmly stuck to the herbarium sheet. Comparing it with variable species such as E. palustris, the only reliable character to distinguish it is the one basal sterile glume which completely clasps the base of the spikelet.
The chromosome number $2n = 46$ is very constant in Europe, and could be used as a diagnostic character when available.

**Syn:** *Nomochloa* Beauv. in Lestib., Ess. Fam. Cyperac. 37 (1819)


Perennial with creeping rhizomes covered with brown scales. Culms solitary or tufted, nodeless, smooth. Leaves basal and sub-basal, linear. Inflorescence a terminal spike consisting of few to many sessile 2-ranked or distichously-arranged spikelets, subtended by a few to many involucral bracts. Glumes oblong-lanceolate, thin membranous, spirally arranged. Hypogynous bristles 3-6, retrorsely or antrorsely scabrous. Stamens 3, anthers with a subulate, setulose connective. Style long, persistent, stigmas 2, ciliate. Fruit lenticular or plano-convex, long apiculate.

1. *B. compressus* (L.) Panz
**B. compressus** (L.) Panz. in Link, Hort. Berol. Descr. 1: 278 (1827)

Syn:  *Schoenus compressus* L., Sp. Pl. 43 (1753)

*Scirpus planifolius* Grimm., in Nov. Act. Cur. iii App., 259 (1767)

*S. carici* Retz., Pl. Scand. Prodr. 11 (1779)

*S. compressus* (L.) Pers., Syn. 1: 66 (1805), non Moench (1794)

*Nomochloa compressa* (L.) Beetle, in Amer. J. Bot. 31: 262 (1944)

Culms 3.5-34 cm tall, obtusely 3-angled above, terete to subterete below. Sheaths 3-10, lower brown bladeless or shortly bladed, upper green with linear, ribbed, flat, keeled, scabrous margined blades, 5.5-17 cm x 1.4-3.3 mm. Inflorescence consisting of (3)-5-12(-15) spikelets, (1.5)-2-3.5 cm long. Spikelets 5-9 mm long, 6-12 flowered, ovoid lanceolate. Glumes 3-5 mm x 1.8-3.0 mm, 2-5 nerved, ovate or ovate lanceolate, acute, golden brown, rarely reddish brown. Hypogynous bristles 5, 3.0-3.8 mm long, about twice as long as fruit, yellowish brown on matured fruit, erect or bent, retrorsely barbed. Anthers (2.3)-3.0-3.6 mm long, including prolonged connective. Fruit (1.5)-2.0(-2.5) mm x 0.6-1.0 mm, ovate-elliptic, plano-convex, blackish-brown. Fl. (6)-7-8. Fr. 8-9.

Habitat in marshy places, near streams. Alt. 1000-3100 m.

Described from Europæ.: habitat in Anglia, Helvetia, Italia.

Widespread in Anatolia.

A4 Kastamonu: North side of Ilgaz Dağ flush, 2100 m. *Davis, Coode & Yaltırık* D.38559!

A5 Kastamonu: Tosya, 29 May 1892, *Sintenis* 4015!

A7 Giresun: Balaban-Dağlari (Kiling Tepe) above Tamdere, 2600 m, *Davis, Dodda & Çetik* D.20611A!

A8 Çoruh (Artvin): Yalnızçam Dağlari, on west side of pass between Ardahan and Artvin, 2350 m. *Davis & Hedge* D.32529!
External distribution: all over Europe and Temperate Asia.

Observation: The habit and young inflorescences of this species and that of B. rufus (Huds.) Link simulate various species of Carex subgenus Vignea, and more often specimens of these Carex spp. are found together with those of Elymus in the herbarium

Annual, very rarely perennial. Culms tifted, nodeless. Leaves narrowly linear, crowded at culm base. Inflorescence a simple or compound umbel with solitary or clustered spikelets crowning the rays, or contracted into a head, rarely solitary. Glumes spirally arranged enclosing axillary flowers. Stamens 3, rarely 2-1. Hypogynous bristles absent. Style 2-3-fid; villous in upper part below the stigmas or glabrous, the base dilated and articulated with the fruit, caducous. Fruit lenticular or trigonous in digynous and trigynous spp. respectively.

1. Glumes smooth at the upper part; fruit with longitudinal bands, transversely rugose ........................................ 1. dichotoma (L.) Vahl

1. Glumes copiously short-pubescent in upper part; fruit smooth ....................................................... 2. ferruginea (L.) Vahl
1. **F. dichotoma** (L.) Vahl, Enum. Pl. 2: 287 (1806)

**Syn:** *Scirpus dichotomus* L., Sp. Pl.: 50 (1753)

- *S. diphyllus* Retz., Observ. 5: 15 (1789)
- *Fimbristylis diphylla* (Retz.) Vahl, Enum. Pl. 2: 287 (1806)
- *F. tomentosa* Vahl, Enum. Pl. 2: 290 (1806)
- *F. communis* Kunth, Enum. Pl. 2: 234 (1837)
- *F. georingiana* Steudel, Synops. Pl. Glum. 2: 188 (1855)
- *F. diphylla* (Retz.) Vahl var. *tomentosa* (Vahl) Benth., Fl. Hongk. 392 (1861)
- *F. polymorpha* Böckr. in Linnæa 37: 15 (1871)
- *F. novae-bratianiae* Böckr. in Engler, Bot. Jahrb. 5: 93 (1884)

**Annual** with slender fibrous roots. **Culm** 3.5-14 cm tall, tufted, numerous, erect or ascending, obtusely triangular or subterete, covered at the base up to about a third by pubescent sheaths, lower brown, loose, upper light brown to stramineous, close, with concave inner face and rounded ligula. **Leaves** narrowly linear, 0.5-1.0 mm wide, flat or conduplicate, puberulent or glabrescent. **Inflorescence** umbellate, containing numerous spikelets distributed on 5-8 rays. Involucral bracts usually 5, leaf-like, the lowest longer than or equaling the inflorescence. **Spikelets** 2.5-10 mm x 1.5 mm, oblong-lanceolate to
lanceolate, pedicelled or sessile, many flowered. Glume 1.5-2.1 mm x 0.7-0.9 mm, broadly ovate, brownish, midnerve excurrent into a short micro. Stigmas 2, style 0.8-1.0 mm long, villous, base thickened into a conic-ovoid tubercle. Fruit 0.7 mm x 0.5-0.6 mm, obovoid, with 5-7 longitudinal bands, transversely rugose. Fl. (7)-8-9.

Habitat in boggy or swampy places near rivers, near sea level.

Described from India: habitat in India [Hb. Linn. 71.347].

Scattered in Outer Anatolia, Turkey-in-Europe, Islands.

A1(A) Çanakkale: near Bayramiq on "Scamander", 12 Sept. 1883, Sintenis 1029!

A2(E) Istanbul: Tatlisu, near Kilyos, 15 Aug. 1897, Aznavour!

A6 Samsun: Kirazlik, 1 m, Tobey 2823!

C3 Antalya: near Kemer, Davis 14062!

Is: Rodilos, Asphandos, Fiori 82.

Widely distributed throughout the tropical-subtropical and warm temperate regions of the Old World, and Northern Australia.

Syn: *Scirpus ferrugineus* L. Sp. Pl. 50 (1753)


*Fimbristylis vitiata* C.B. Clarke, in Kew Bull. ser. 8: 24 (1908)


*F. ciliata* Drobov, in Oprecl. rast. okr. Tashkenta 1: 48 (1927)

Differing from *F. distotoma* (L.) Vahl in having involucral bracts 2;

- glumes dark ferrugineous-brown, copiously short-pubescent in upper part; fruits
  - c. 1.0 mm long, smooth. Fl. 6–8

- Habitat: near river banks; at low altitudes.

- Described from Jamaica: habitat in Jamaicæ paludibus maritimis *Hb*. Linn. 71. 37, 38f

- Rare in S. Anatolia, Islands.

- 06 Gaziantep: Išlabiye, Kasağlıgil 430!

- Is: Rodhos, Salakos, *Fiori* 83; Dimilia *Fiori* 84

- Widely distributed in tropical and warm temperate regions throughout the world.
10. **HOLOSCHOENUS** Link, Hort. Berol. Descr. 1: 293 (1827)

Syn: **Scirpus** sect. *Holoschoenus* (Link) Koch, Synops. ed. 2: 293 (1844)

**Scirpus** sect. *Isolensis holoschoenae* Clarke in Kew Bull. ser. 8: 112 (1908)


1. *H. vulgaris* Link
H. vulgaris Link, Hort. Berol. Descr. 1: 293 (1827)

Rhizome creeping, bearing compactly arranged culms. Culms 28-130 cm tall, terete, smooth, sulcate. Leaves 10-64 cm long, filiform, rigid, sub-terete, channelled, scabrous on the margins, especially towards the tip. Sheaths splitting at maturity, their ends forming a fibrous mesh-work.

Inflorescence consisting of one sessile head, and a number of lateral heads on 0.5-6.0 cm long rays. Involucral bracts 1-2(-3), the lower 5-8(-66) cm long. Spikelets 2.5-3.5 mm long, sessile and compactly arranged in the heads.

Glumes (1.0)-1.6-2.5 mm x 0.6-1.3 mm, ovate, keeled, the mid-nerve excurrent into a short mucro, ciliate at the margins and keel. Anthers 0.9-1.8 mm long. Style very short. Fruit 0.6-1.2(-1.5) mm x 0.6-0.8 mm, obovoid, trigonous, smooth, brown. Fl. (5)-6-8.

Habitat: sand dune slacks near the sea, wet places near streams or waste ground under forest; sea level to 3048 m.

1. Plant robust, over 100 cm tall, culm green, erect. Heads in fully matured specimens 7-17 mm across .................................. var. vulgaris

1. Plant less robust, 14-60 cm tall, culm pale, often arcuate.

Heads 4-8 mm across .............................. var. australis (L.) Hayek

var. vulgaris

Syn: Scirpus holoschoenus L., Sp. Pl. 49 (1753)

Isolepis holoschoenus (L.) Roem. & Schultes, Syst. 2: 115 (1817)

Described from Europe: habitat in Europa australi Fl. Linn. 71.17, 18, 1917.

Widespread in Turkey, Islands.

A1(E) Edirne: Enez, sea level, Coode & Jones 2892!

A2(E) Istanbul: Kiythane-Bosphore, 25 June 1917, B. Post!

A2(A) Istanbul: Koru-Pendik, 19 May 1939, B. Post!
A3 Adapazari: Karasu to Söğütli, 10 m, Davis & Coode 139089!
B1 Izmir: Kamarapa, near Byzantine fortress, Alara & Bocquet 5004!
B3 Afyon: c. 10 miles from Çay to Afyon, c. 1000 m, Coode & Jones 2380!
B4 Ankara: Beynam woods, Davis 13047!
B6 Sivas: Gürün-Sivas, 20 km from Gürün, 1400 m, Stainton & Henderson 5737
B7 Tunçeli: above Ptilümbr, 1900 m, Davis & Hedge D.30988!
B9 Bitlis: Nemrut Dağ, volcanic ash, 3048 m, Tong 197A!
C2 Muğla: Marmaris-Muğla, 3 miles from Marmaris, Dudley D.35485!
C3 Antalya: Antalya, Atay 9!
C5 Seyhan: Karataş area, South of Adana, Findlay 268!
C6 Hatay: Mt. Cassius (Akra Dağ), 914-1214 m, Haradjian 3053!
C9 Hakkari: Zap gorge, 25 km from Hakkari to Van, 1300 m, Davis 44882!
C10 Hakkari: Sat Dağ, between Yüksekova and Varegöz, 2050 m, Davis 45745B!
Ia: Khios, Rechinger obs; Kos, Rechinger obs; Tilos, Ada.


Holoschoenus australis (L.) Reichb. Fl. Germ. eax. 76 (1830)

Sorirus holoschoenus var. australis (L.) Koch, Syn. ed. 2: 85 (1845)

Widespread in Turkey.

A2(B) Istanbul: Kilios, 5 May 1980, Azyavour!
A2(A) Istanbul: Kartal, Aydos-Dagı, Aytug & Yaltirik 3328!
A4 Ankara: Çubuk Su (Ankara-Ravli), Davis 21429!
A5 Çorum: Iskilib, 26 km from Çorum to Iskilib, Kızılirmah valley, 600 m, Coode & Jones 1723!
A6 Samsun: beach area near Öymocu, 2 m, Tobey 792!
B4 Ankara: Ankara, Ortedogu Universities; Çayiri (meadow), Alinoglu 170!
B6 Adana: Karakilisse to Gujuk Sou, 10 June 1906, E. Post 160!

B8 Erzurum: 10 km North of Hinis, 1630 m, Davis 4624!

B9 Bitlis: crater of Nemrut Dagh, by lake (Nemrut Göl), 2400 m, McNeill 543!

C2 Denizli: near ruins of Pamukkale (former Hierapolis), Alava & Bouquet 5288!

C3 Antalya: Duden Basli near Antalya, Palmer T/49!

C4 Antalya: Alanya, A. Baytop 1-228!

C7 Urfa: Hilvan-Siverek, 700 m, Davis & Hedges D.28257!

C9 Van: Başkale-Hakkari (Çelemrik), c. 50 km from Başkale, 1800 m, McNeill 695!

C9 Hakkari: Zab river, in gorge about 15 miles above Hakkari, 1370 m, Trelawny 1201!

External distribution: Both varieties are abundant along the Mediterranean part of North Africa, Atlantic and Mediterranean Europe, Central Europe eastwards to Siberia and South West Asia.

Observations: This species has been found to be very variable throughout its wide distribution, and it is no wonder that several infra-specific categories have been recognised by many workers. It is rather a pity to have to report the non-correlation of characters normally assigned to these infra-specific taxa in Turkey. Most of the distinguishing characters have been based on measurements of certain organs of the plant, and these I have found to be non-correlating. A typical example is the height of the culm and the diameter of the inflorescence head. The limits of var. australis (L.) Hayek, said to be distinguished from the var. vulgaris in having a comparatively low habit and heads not more than 8 mm across, were found to break down, especially in some specimens viz. Tong 197, Dudley D.35485, Coode & Jones 2380, which have a low habit and small heads, but appeared very different from the specimens identified as var. australis. The above mentioned specimens have erect and comparatively
Fig. 38  Inflorescence Forms in *Holoschoenus vulgaris* in Turkey

1-9  *Holoschoenus vulgaris* Link (1 Aznavour 2061; 2 Findley 268
3-4  Khan et al 413; 5 Aznavour 2063 [x 0.5]; 6 Aznavour 2067; 7 M. Neil 223
8 Aznavour 2112; 9 Aznavour 2059)

10-12  *Holoschoenus vulgaris* Link var. australis

(10 Davis 28257; 11 Coode & Jones 1723; 12 Aloya 5288)
strong or firm culms like those of var. vulgaris; thus separating them from
the var. australis specimens having rather weak (often compressed) and usually
arcuate culms. It was thought that habitat differences, altitudinal ranges,
and times of flowering might correlate with the forms of the head and culm,
but they were found not to do so.

The inflorescence branching has often been used to distinguish these two
taxa, but as can be observed from the illustrations in Fig. it is not uniform,
even within the same taxon.

I think that a more reliable infra-specific grouping can be recognised
in this highly variable species, only when the varying taxa are compared at
the same morphological stage of development. With the exception of the
Moroccan and Iranian ssp. globiferus (L. fil.) Oteng-Yeboah*, which has a
compound inflorescence with up to 200 small heads and very reduced leaves,
the whole ssp. vulgaris needs a world-wide revision to settle these infra-
specific problems.

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*Holoschoenus vulgaris Link subsp. globiferus (L. fil.) Oteng-Yeboah, comb. nov.

Syn: Scirpus globiferus L. fil., Suppl. 105 (1791)

Holoschoenus globiferus (L. fil.) Dietr., Spec. 1, 1, (2): 164 (1833)

Scirpus holoschoenus L. var. globifer (L. fil.) Boiss., Fl. Orient.
5: 382 (1884)

S. holoschoenus L. ssp. globiferus (L. fil.) Husnot, Cyper. 67 (1906)

S. holoschoenus L. var. hayekii Maire in M.C. 928 (1931)

2: 417 (1845)

Scirpus L. subgen. Isolepis (R.Br.) Pax in Engly & Fzantl, Nat.
Pflanzenf. 2 (2): 111 (1887)

Slender annual or rarely perennial, fibrous-rooted herbs. Culms tufted, filiform, nodeless, surrounded at base with bladeless sheaths. Leaves setaceous, liguleless, blunt tipped. Inflorescence a pseudo-lateral head of 1 to several spikelets; Glumes spirally arranged, involucral bracts 1, culm-like. Hypogynous bristles absent. Stamens 2-3, anthers very small, connective blunt. Style 2-3-fid. Fruit small, trigonous or lenticular, obovate.

1. Involutural bract shorter or slightly exceeding the inflorescence; fruit 0.8-1.1 mm x 0.5-0.9 mm, reddish brown, minutely dotted;
   stamens 2-3

   1. I. cernua (Vahl) Roem. & Schult.

2. Involutural bract always longer than the inflorescence; fruit
   0.5-0.9 mm x 0.2-0.6 mm, longitudinally ribbed with transverse bars between; stamens always 2

   2. I. setacea (L.) R. Br.
Syntarnum Vahl, Enum. 2: 245 (1806)

S. savii Seb. et Mauri, Prodr. Fl. Rom. 22 (1818)

Isolepis saviana Schultes, Mant., 2: 63 (1824)

Annual or perennial, in dense tufts or with a shortly branched ascending rhizome. Culms 0.5-16-(36) cm tall, filiform, angular. Sheaths purple or brownish gray, lower bladeless, upper bladed with straight inner face, and no ligules. Leaves 1.0-18.5 mm long, setaceous, subulate, blunt-tipped.

Involucral bract 1.7-9.0-(14.5) mm long, + deciduous. Spikelets (1.0)-2.0-5.6 mm x 1.0-2.0 mm, ovoid. Glumes 1.5-2.1 mm x 0.6-1.2 mm, ovate, green or reddish brown, smooth, mid-nerve excurrent into a short mucro. Stamine 2-3, anther 0.4 mm long; style 3-fid, 0.3 mm long. Fruit 0.8-1.1 mm x 0.5-0.9 mm, trigonous, ovoid, minutely dotted. Fl. 4-6.

Habitat: in wet places, especially in bare sandy or peaty places, near the sea. Alt. sea level to c.1100 m.

Described from Portugal: habitat in Lusitania.

Scattered in Turkey-in-Europe, Outer Anatolia, Islands.

A2(E) Istanbul: Zekeriskoy, 23 May 1899, Aznavour!

A2(A) Istanbul: Nem Dağ, Alt. 350 m, 6 June 1892, Aznavour!

A5 Sinop: Inoe Burun, 40-50 m, Topay 1097!

C1 Muğla: Marmaris, Datça port, sea level, Davis 41365!

C4 Antalya: Alanya bay, 2 m, Davis & Polumin D.25909!

C5 Iğal: 15 mls. from Silifke towards Mersin, sea level, Coode & Jones 1091

Islands: Samos, Rechinger; Ikaria, Rechinger 3472.

Distributed generally in Western and Southern Europe, North Africa, extra-tropical South Africa and New Zealand.
Observations: The variation in the number of stamens of this species in Turkey deserves comment. All the collections of Aznavour from Istanbul, and one by Davis and Polunin (D.25909) from Antalya, have 3 stamens, while those from other parts of Turkey and also from Lebanon and Israel have 2 stamens. Specimens seen from Portugal near the type locality of Vahl's *Scirpus cernuus*, and from Italy near the type locality of Sebastiani & Mauri's *Scirpus savii*, showed the same variation in the stamen number from 2 to 3. This may be the reason why neither Vahl nor Sebastiani & Mauri mentioned the number of stamens in the description of their species.

*Syn:* *Scirpus setacea* L., *Sp. Pl.* 49 (1753)

*Schoenoplectus setaceus* (L.) Palla in Koch, *Synops.* ed. 3: 2538 (1907)

Differs from *L. cernua* (Vahl) Roem. & Schultes in having: *culmi* 0.5–1.5 cm tall; involucrel bract 2.0–15 mm long, always longer than the inflorescence; *stamina* always 2; *fruits* smaller; 0.5–0.9 mm × 0.2–0.6 mm, longitudinally ribbed, with transverse bars between the ribs. *Fl.* 7–10.

*Habitat:* in damp places near streams; alt. c. 1100 m.

Described from Europe: habitat in Europae litoribus maritimis (see observation below).

N. and N.W. Anatolia.

A2(4) Bursa: Olympus Bith. (Ulu Da.), 9 August 1850, Clementi!

A4-5 Kastamonu (Paphlagonia): Ilgaz-dag, 11 August 1890, Bornmüller 2540!

B2 Bursa: Tahtaköprü, forest between Inegöl and Domaniç, 1100 m, Davis & Coode D.36383

External distribution: very frequent in Europe and Africa, and extending to Australia.

*Observations:* The Linnean specimens 71.21, 22, labelled as *Scirpus setacea* L., were found to be near *Isolepis cernua* (Vahl) R. & S. because of the minutely dotted fruits. The typification of *L. setacea* (L.) R. Br. thus needs further investigation if the name is to continue to be employed in the traditional sense.
12. CYPERUS L., Sp. Pl. 44 (1753) & Gen. Pl. ed. 5: 26 (1754)


Eucyperus Rikli in Fringsheim's Jahrb. 27: 568 (1895)

Annual or perennial, with or without rhizomes, sometimes stoloniferous.

Culms solitary from the rhizomes, or in tufts, trigonous or triquetrous, rarely terete, nodeless, smooth or scabrous at the upper part. Leaves linear, keeled, rarely reduced, scabrous on the margins and keel, eligulate.

Inflorescence simple or compound to decompose umbel, sometimes contracted into a head. Involucral bracts leaf-like, few to many, unequal. Spikelets compressed, many-flowered; racilla persistent, with or without wings. Glumes distichous, rarely spiral, often decurrent, 3-several nerved. Hypogynous perianth segment absent. Stamens 1-3, anthers linear, Style 3-fid. Fruit obovoid or ovoid, smooth or minutely dotted.

1. Spikelets borne in digitate clusters, heads or irregularly fascicled

2. Inflorescence a globose head, without rays (plant small, dwarf) ...................................................... 8. C. pygmaeus Rottb.

2. Inflorescence an umbel, generally with rays

3. Perennial with a short rhizome; culms robust, solitary, rarely tufted ........................................ 7. C. eragrostis Lam.

3. Annual with fibrous roots; culms usually tufted

4. Spikelets 5-15 in each cluster, loosely capitate, glumes ovate, blackish-brown, 1 mm long .................. 6. C. fuscus L.

4. Spikelets numerous, more than 15 in each cluster, densely capitate; glumes orbicular-ovate, chestnut-brown, hyaline at margins, 0.5 mm long ......................... 7. C. differmns L.
1. Spikelets borne on a rather long axis, spike-like

5. Rachilla not winged, often narrowly margined; glumes not
decurrent; style short

6. Leaves 2.0-2.8 mm wide, involucral bracts 3; spikelets 7-14 mm
long; glumes rufous, many-nerved ..................... 4. C. glaber L.

6. Leaves 4.5 mm wide; involucral bracts 6; spikelets up to
7 mm long; glumes palely stramineous, one-nerved

............................................................. 5. C. mosanus Boiss.

5. Rachilla conspicuously winged; glumes decurrent at base;
style long

7. Leaves well-spaced on the culm; plant rhizomatous, always
without stolons ............................................. 1. C. longus L.

7. Leaves sub-basal, rosette-like; plant rhizomatous or
without rhizomes, typically with subterranean stolons
ending in tubers

8. Glumes concave, scarcely keeled, conspicuously many-nerved,
stramineous to golden-yellow; spikelets arranged more
or less at right angles to the ray axis ....... 3. C. esculentus L.

8. Glumes V-shaped, obscurely few-nerved, rufous to
dark reddish-brown; spikelets arranged at an acute
angle to the ray axis ................................. 2. C. rotundus L.
C. longus L., Sp. Pl. 45 (1753)

Perennial with non-tuberous creeping rhizome. Culms 36-90(-124) cm tall, robust, sharply triquetrous, or sometimes compressed, smooth with a slightly swollen base. Leaves sub-basal or cauline, linear-acuminate, flat, 2-4-7 mm wide, scabrous on the margins and midrib; sheaths brown, long. Inflorescence usually a compound to decomposed umbel, rarely simple, with 2-17 rays up to 25 cm long. Involucral bracts 3-7, unequal, the lower much exceeding the inflorescence. Spikelets 4-25 mm x 0.6-2.5 mm, linear-lanceolate, acute or obtuse. Glumes (1.0)-2.0-2.5 mm x 1.3-1.7 mm, oblong-elliptic, obtuse, shortly mucronate, stramineous to brown or dark brown. Stamens 3, anthers linear. Style 3-fid, long. Fruit 1.0-1.5 mm long, obovate-oblong or elliptic or ovoid, trigonous, dark brown, densely dotted, apiculate. Fl. 5-8.

Habitat: wet places and sandy shores; alt. sea level to c. 1500 m.

Described from Italy: habitat in Italitae, Galliae paludibus.

Key to subspecies and varieties

1. Inflorescence a simple umbel 4-7 cm tall, with 2-4 rays 4.5-6.2 cm long; spikelets 7.0-15.5 mm x 1.5-2.0 mm, usually obtuse and inserted divaricately or at right angles to the ray axis; fruit ovoid ...................................................... ssp. haldreichianus

2. Inflorescence generally a compound umbel (rarely simple) up to 30 cm tall with 4-17 rays up to 25 cm long, spikelets 4-25 mm x 0.6-2.3 mm, acute or rarely obtuse, and inserted obliquely on the ray axis; fruit obovoid .................. ssp. longus

2. Inflorescence a simple umbel up to 10 cm tall ...... var. haldreichianus

3. Spikelets acute, 0.6-2.0 mm broad ........................................ var. longus

3. Spikelets obtuse, 2.0-2.3 mm broad ...................... var. anatolions
ssp. *longus*

var. *longus*

Syn:  
* Cyperus procerus* M-Bieb. ex Georgi, Besch. russ. Reich. 3: 674 (1800)  
* Chlorocyperus longus* Palla in Allg. Bot. Zeitschr. 6: 201 (1900)

NW. Turkey, Outer and E. Anatolia, Islands.

**A1(E)** Tekirdag: Yenice (south of Incik), 610 m, 13 Aug. 1968, *E. Anglia Exp. F.18!*

**A2(E)** Istanbul: Tatli Su (near Kilyos), 22 July 1900, *Aznavour!*

**A2(A)** Istanbul: Soutari (Uskudar), 10 Aug. 1893, *Aznavour!*

**A3** Zonguldak: Kozlu, *Khan, France & Ratcliffe* 812!

**B1** Balikesir: Zeitunli (Seitinly), 26 June 1883, *Sintenis* 837!

**B6** Mug/Bingöl: Mus-Sulhan, 135 m, *Davis & Polunin* D.24.784!

**B8** Mug: Warto, 1360 m, *Davis* 46300!

**C3** Isparta: Eğirdir, Barla Dag, 1200 m, *Khan et al 408!*

**C4** Iğdır: E. of Tasliju, *Alava & Kukkonen* 6730!

**C5** Iğdır: Tarsus, Karabucak, 26 May 1967, *Deaver T.188!*

**C6** Adana: near Hasanbeyli, 914-1219 m, *Darrah* 686!

**Is:** Rodhos, Salakos, *Bourgeau* 50! *Fiori* 74, 75; *Troas, Webb."

External distribution: almost cosmopolitan

Observation: Some of the specimens cited above have unusually pale spikelets, e.g. *Aznavour* (from A2(A)), *Khan et al. 408*, *Bourgeau* 50, and could be determined as var. *pallidus* Bosc. (*Linnaea* 36: 280, 1870), but withholding such a determination pending field observations, since most spikelets (especially immature ones) do change colour on pressing.

var. *heldreichianus* (Boiss.) *Boiss.*, *Fl. Orient.* 5: 375 (1884)

Syn:  
* Cyperus heldreichianus* *Boiss.*, *Diagn.* ser. 1, 13: 39 (1853)
Turkey-in-Europe, Outer Anatolia

A1(A) Balikesir: Marmara adasi, A. Baytop 13777!
A2(E) Istanbul: Baltaliman, N. of Rumelihisari, 17 May 1936, B. Post!
A2(A) Istanbul: Bıyık Gök Su, 11 July 1906, B. Post 823!
A2(A) Kocaeli: Koru-Pendik, 17 May 1939, B. Post!
A3 Sakarya: Sapanca Göl, 50 m, Davis & Coode 36224!
A6 Samsun: Kirazlik beach area, 1 m, Tobey 800!
A6 Ordu: Fatsa-Aybasti, 700 m, Tobey 1368!
C2 Antalya: Kara gül, near Yuva, Davis 13917!
C5 Adana: Pozanti, Aug. 1952, Ismail Akbas!
C6 Adana: near Hasanbeyli, 914-1219 m, Darrah 653!

External distribution: from the Balkans to the Middle East

Observation: The distinction between this variety and var. longus becomes obscured, especially when the latter is not fully mature; otherwise the var. heldreichianus can always be distinguished on spikelet length and inflorescence height. Kukenthal (1936) had previously cited Sintenis 837 (see under var. longus) under the var. heldreichianus, but from my observation of the specimen, on loan from Lund, I think it was a wrong identification - unless he saw a different specimen with the same number.

var. anatolicus Oteng-Yeboah, var. nov. in ed. (see diagnosis in key).

Inner Anatolia

B5 Kayseri: Kayseri-Incesu, 1200 m, Davis & Hedge 32755!
B8 Diyarbakir: Diyarbakir-Bitlis, c. 65 km from Diyarbakir, 750 m, MoNeill 492!
C3 Konya: Beyşehir, Davis 16106 (holotypus);
C4 Konya: Kashanah, Davis 14772!
Observation: This variety, only observed from the above cited localities, shows characters which are somewhat intermediate between the ssp. *longus* and ssp. *badius*. It is related to the ssp. *longus* on the general inflorescence form, and to ssp. *badius* on the size, form and colour of the spikelets.

subsp. *badius* (Desf.) Aschers. & Graebner, Synops. 2, 2: 283 (1904)

Syn:  
Cyperus *badius* Desf., Fl. Att. 1: 45 (1798) t. 7, f. 2
C. *longus* Brotero, Fl. Lusit. 1: 57 (1804), non L. (1753)
C. *brachystachyus* Presl, Gram. et Cyp. Sicul. 15 (1820)
C. *thermalis* Dumort, Fl. Belg. 145 (1827)
Paris 14: 323 (1827)
C. *preslii* Parl., Fl. Ital. 2: 40 (1852)


N.W. Turkey, Islands.

A2(E) Istanbul: Kâgapathane, 30 June 1906, Aznavour!
A2(E) Istanbul: Soghanlik, Bakirköy, 26 June 1898, Aznavour!
Is: Rodhos, Fiori 76; Lesvos, Cand.

External distribution: widely distributed in Mediterranean Europe from Portugal through the Balkans to Crimea, Cyprus and Syria; North Africa, extending west to the Canaries and south east to Ethiopia.

Observation: The rank to assign this taxon has not been generally agreed upon. Some authors, viz. Koch (1843), Reichenbach (1846), Boissier (1884), Husnot (1906), Komarov (1934), Hayek (1935) etc., regard it as a distinct species; while Ascherson & Graebner (1904), Briquet (1910) Kukenthal (1936), Täckholm & Drar (1950) etc., consider it as a subspecies of *Cyperus longus*. 
Having observed the intermediates between this taxon and *C. longus* proper in Turkey, (i.e. var. *anatolicus* and *heldreichianus*), I am convinced that only a subspecific rank is justified and have thus followed the latter authors.
2. *C. rotundus* L., Sp. Pl. 45 (1753)

Pentanoids with long stolons, tuber-bearing (tubers not found in our specimens!). Culms 8-30-(60) cm tall, triquetraceous, often compressed, smooth, tufted or solitary. Leaves 9-21 cm x 1.8-5.0-(6.5) mm, basal or sub-basal, linear, smooth. Inflorescence a simple to compound umbel with 1-5(-8) rays, longest 6-10 cm long. Involucral bracts few to many, shorter or longer than the inflorescence. Spikelets 5-16(-30) mm x 1.4-2.0-(2.5) mm, oblong linear to linear-lanceolate, compressed. Glumes 3.0-3.8 mm long, broadly ovate, sub-obtuse, often shortly mucronate, rufous to dark reddish brown. Stamens 3, anthers linear. Style 3-fid. Fruit 1.0-1.5 mm long, obovate-oblong or elliptical, trigonous, dark brown, minutely dotted and shortly apiculate.

Fl. 5-8. Fr. 7-9.

Habitat: sandy places on road sides or in damp cultivated fields; sea level to 660 m.

1. Culms 8-30 cm tall; leaves 1.8-3.8(-5.0) mm wide; inflorescence simple with 1-5 rays, longest rays to 6 cm long; spikelets straight 5-16 mm x 1.4-2.0 mm, lower involucral bract always longer than the inflorescence ................................ 1. var. rotundus

1. Culms 30-60 cm tall; leaves 5.0-6.5 mm wide; inflorescence large, simple to compound, with 6-8 rays, longest ray 7-10 cm long; spikelets often curved, 20-30 mm x 2.0-2.5 mm; lower involucral bract equaling or shorter than inflorescence .................................. 2. var. major Parl.

1. var. rotundus

Syn: *Cyperus hexastachyos* Rothb., Descri. et Icon. 28 (1773) t. 14 f. 2

Cypera tetrastachyos Desf., Fl. Atl., 1: 45 (1798) t. 8
C. esculentus Sawi, Fl. Pisan 1: 140 (1798), non L. (1753)
C. hydrea Michx., Fl. Bor.-amer. 1: 27 (1803)
C. oliveris Targ.-Tozz. in Mem. Soc. Ital. Sc. 13, 2: 338 (1807)
C. radiosus Sibth. et Smith, Fl. Graec. Prodr. 1: 30 (1806) t. 45
C. patulus M. Bieb., Fl. Tauro.-cauc. 3: 47 (1819)
C. agrestis Willd. ex Link, Jahrb. 1 (3): 86 (1820)
C. maritimus Bojer, Hort. Maurit. 378 (1837), non Poiret (1806)
C. leptostachyus Griff., Itin. Notes 321 (1848), non Nees (1835)
C. herbicavus Melliss, St. Helena 343 (1875)
C. longus Boeck., in Journ. Linn. Soc. 18: 104 (1881), non L. (1753)
C. purpurea-variegatus Boeck., Cyp. Nov. 2: 37 (1890)
Chlorocyperus rotundus (L.) Palla in Allg. Bot. Zeitschr. 6: 201 (1900)
Described from India: habitat in India /Hb. Linn. 70.6/7

Turkey-in-Europe, Outer Anatolia, Islands.

Armenia: Probably between Erzurum and Trabzon, Calvert & Zohrab 440! 871!
A1(A) Canakkale (Mysia): Bunarbaschi, 12 Sept. 1883, Sintenis 1214!
A2(B) Istanbul: Makriky- San Stefano (Yesilköy), 5 Oct. 1893, Asnavour!
A2(A) Istanbul: Maltepe, 22 Aug. 1897, Asnavour!
A6 Samsun: Çarşamba, Yesilirmak, Kayacik & Elicin 1866!
B1 Manisa: Manisa, Unal 39!
B1 Izmir: Izmir, Tanay!
C2 Muğla: 1 km west of Muğla, Lambert & Thorp 525!
C3 Antalya: in courtyard of Hotel Büyük, Antalya, Palmer T/23!
C4 İçel: Silifke, Alava 6639!
C5 İçel: Mersin, Aug. 1896, Siehe 663!
C8 Mardin: Zikiltepe, Davis & Hedge D.28664!
Is: Lesvos, Ikonomopoulos: Rodhos, Fiori, 72, 73.
External distribution: along the Mediterranean coasts of North Africa and Southern Europe, S.W. Asia, Central Asia to the Far East.

2. var. major Parl., Fl. Ital. 2: 37 (1852)

Syn: Cyperus comosus Sibth. et Smith, Fl. Graec. Prodr. 1: 30 (1806) t. 44
     C. rotundus var. elongatus Boeck. in Linnaea 36: 285 (1870)
     C. rotundus var. macrostachyus Boiss., Fl. Orient. 5: 377 (1884)
     C. rotundus var. centiflorus Clarke in Journ. Linn. Soc. 21: 171 (1884)
     C. rotundus f. comosus (Sibth. et Smith) K. Richter, Fl. Europ. 1: 135 (1890)

S.W. Anatolia

C2 Muğla: Fethiye, Schultz 93!

C2 Antalya: Kaş, Demre gorge, Khan et al 190!

External distribution: widely distributed along the Mediterranean coasts of North Africa and Southern Europe, S.W. Asia, India, Australia and Brazil.
3. *C. esculentus* L., Sp. Pl. 45 (1753)

Syn: *Cyperus aureus* Ten., Fl. Napol. Prodr. 1: 8 (1811)
* C. melanorrhizus* Del., Ill. Fl. Aeg. 50 (1813)
* C. nervosus* Roem. & Schultes, Mant. 2: 113 (1824)
* C. tenorii* Rresl., Fl. Sic. 1: 43 (1826)
* C. tenoritans* Roem. & Schultes, Mant. 3: 544 (1827)
* C. esculentus* β *aureus* Richter, Pl. Europ. 1: 135 (1890)


* C. esculentus* (L.) Palla in Koch, Synops. ed. 3, 3: 2553 (1907)

Perennial, stoloniferous; stolons normally ending in tubers (not found in our specimens). **Culm** 25-30 cm tall, triangular, often compressed, smooth, slightly swollen at the base. **Leaves** 3-7 mm wide, basal to sub-basal, plane; sheaths brown to reddish brown. **Inflorescence** an umbel with 6-8 rays, longest to 7 cm long, each bearing a loose cluster of spikelets disposed at right angles or divaricately from the ray axis. **Involucral bracts** 6, patent, the lower 2-3 longer than or equal to the inflorescence. **Spikelets** 6-12 mm x 1.5-2.0 mm, linear or oblong-obtuse, compressed, straminous to golden-yellow. **Glumes** 3.0-4.5 mm x 0.2-0.0 mm, ovate or ovate-elliptic with an obtuse truncate tip, 5-7 nerved, hyaline margined. **Stamens** 3, anthers linear. **Style** 3-fid, stigmas long. **Fruit** c. 1.0 mm long, obovate or oblong-obovate, trigonous, rufous.

Described from Italy: habitat in Monselli, ingue Italia, Oriente

**Ec.** Linn. 70.447.

N.E. Anatolia

Armenia: **probably between Erzurun and Trabzon** Calvert & Zohrab 641!

A7-8 Trabzon, 24 Aug. 1889, Sintenia 1417 (as *C. longus*)!
External distribution: occurring in Southern Europe, much of Africa, Madagascar, and North America, it is now known to be widely cultivated.

Observations: The distinction of this species from *C. longus* and *C. rotundus* is somewhat obscured in the herbarium, especially when the root system (including the tubers) is not present. However, the species is easily distinguished by its inflorescence; the arrangement of the spikelets on the ray axis, and the colour of the spikelets.
4. Cyperus glaber L., Mant. 2: 179 (1771)

Syn: Cyperus patulus Kit. in Host, Gram. Austr. 3: 49 (1805) t. 74
   C. erubescent Link, Enum. Hort. Berol. 1: 44 (1821)


   Annual, tufted, non-stoloniferous plant, with fibrous roots. Culms
   5–33 cm tall, trigonous, smooth. Leaves c. 13.5 cm x 2.0–2.8 mm, linear,
   plane, scabrous-serrated at apical margins and mid-rib; sheaths purplish
   brown. Inflorescence a simple or compound spike containing numerous spikelets
   aggregated in small or large fascicles. Involucral bracts 3, lower 2 larger,
   several times longer than inflorescence. Spikelets 7–14 mm x 2.5 mm, linear-
   lanceolate, slightly swollen. Glumes 2.0–2.6 mm long, keeled, rufous, rusty
   on the keels, rusty-white on the margins, many-nerved, largely decurrent on
   the rachis. Stamens 3, anthers linear. Style 3-fid. Fruit 1.1–1.3 mm x
   0.7–0.8 mm, obovate-oblong, trigonous, densely dotted, ash-grey. Fl. 6–8.

   Habitat: wet and muddy places on stream sides, ascending to 1890 m.
   Described from Italy: habitat in Veronae humentibus.

   Scattered.

A5 Kastamomu (Paphlogonia): Toya, 4 Aug. 1892, Sintenis 4927!
B1 Balikesir: Seitinly, 25 June 1883, Sintenis 338!
C6 Maras: Süleymanlı, Llywelyn-Williams S.R.S!
C6 Adana: near Hasanbeyli river valley, 914–1219 m, Darrah 687! 660!
C9-10 Hakkari: Cilo Dağ, in Diz järesi, 1644 m, Davis & Polunin D.23895!

   External distribution: all over Europe, Asia and tropical Africa.
Pl. 7 Holotype specimen of Cyperus noeanus Boiss. (G!)

**Cyperus noeanus Boiss.**

*Description:*

- Type specimen
- Specimen preserved by the Conservatoire botanique GENEVE, Switzerland
- Additional information on the conservation of the plant.
5. *C. noeanus* Boiss., *Fl. Orient.* 5: 371 (1884)

Annual with fibrous roots. Culm solitary, 20 cm x 2.0 mm, triglectous, smooth. Leaves 4.5 mm wide, basal, linear. Inflorescence contracted-capitate, 3 cm x 3 cm in size, with numerous congested spikelets. Involucral bracts 6, lower 3 longer, 7.0-11.0 cm x 3.0-4.5 mm, spreading from beneath the head. Spikelets 7.0 mm x 2.5 mm, compressed. Glumes 2.4 mm x 1.4 mm, ovate, keeled, acute, one-nerved, palely stramineous. Stamens 3. Style 3-fid. Fruit 1.0-1.2 mm x 0.5 mm, obovate, trigonous, attenuate at base, apiculate, densely dotted, greyish-brown to brown.

Holotype: Inner Anatolia in lacubus salis Anatoliae interioris leco non indicato, No 5 (C!) (see pl. 7).

Observation: The nearest relative to this species is *C. glaber* L. The above description is based on the type specimen, on loan from Geneva. The species has not been collected again. It is closely related to *C. glaber* from which it differs in the following characters:

<table>
<thead>
<tr>
<th>Character</th>
<th>C. noeanus Boiss.</th>
<th>C. glaber L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>4.5 mm wide</td>
<td>2.0-2.8 mm wide</td>
</tr>
<tr>
<td>Number of involucral bracts</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Spikelet length</td>
<td>7 mm long</td>
<td>7-14 mm long</td>
</tr>
<tr>
<td>Glume</td>
<td>palely stramineous, one-nerved</td>
<td>rufous, many-nerved</td>
</tr>
<tr>
<td>Fruit</td>
<td>1.0-1.2 mm x 0.5 mm, greyish-brown to brown</td>
<td>1.0-1.3 mm x 0.7-0.8 mm, ash-grey</td>
</tr>
</tbody>
</table>
6. *C. fuscus* L., Sp. Pl. 46 (1753)

**Syn:** *Cyperus ferrugineus* Forskal, Fl. Aegypt.-arab. 14 (1775) p.p.
* C. haworthii S.F. Gray, Nat. Arr. Brit. Fl. 2: 730 (1821)
* C. forskalii Distr., Spec. 2: 251 (1833)

**Eucyperis fuscus** (L.) Rikli in Jahrb. Wiss. Bot. 27: 568 (1895)

**Cyperus cyprius** Post in Mem. Herb. Boiss. 102 (1900)

Annual, non-stoloniferous, with fibrous roots. Culms 3-22 cm tall, tufted, triquetrous. Leaves 1.6-3.6 mm wide, linear, plane, scabrous-serrate at apical margins; sheaths purplish brown. Inflorescence simple or compound spike containing numerous spikelets aggregated in small or large fascicles. Involucral bracts 3, lower 2 larger and longer, over-topping the inflorescence. Spikelets 4.0-6.5 mm x 0.9-1.5 mm, linear-oblong, fascicled at the summit of unequal rays. Glumes 0.9-1.5 mm long, broadly ovate, blackish brown or dark red, obtuse with a small mucro. Stamens 2, anthers 0.4 mm long, linear. Style 3-fid. Fruit 0.8-1.1 mm x 0.4-0.5 mm, elliptical or oblong, trigonous, narrowly attenuate at both ends, minutely dotted, yellowish-brown. Fl. 7-10.

Habitat: wet places near streams, lakes, mountain slopes etc.; sea level - c. 1500 m.

Described from Europe: habitat in Galliae, Germaniae, Helvetiae pratis humidis /Hb. Linn. 70, 31, 32, 33/. Turkey-in-Europe, Outer and Central Anatolia, Islands.

A1(E) Tekirdag: Yenice (south of Ineck), 610 m, E. Anglia Exped. F. 27
A1(A) Çanakkale: Bunarbaschi, 12 Sept. 1883, Sintenis 1027!
A2(B) Istanbul: Domudere (Belgrad forest), 30 Aug. 1893, Aznavour!
A2(A) Kocaeli: Pendik-Tuzla, 1 Oct. 1893, Aznavour!
A4. Anadolu: Kisilikahan, Kursumuköyü, 1500 m, Khan et al 752!
A5 Kastamou: Tosya, 4 Aug. 1892, Sintenis 4928!

B4 Ankara: Ankara-Kayseri, c. 30 km W. of Bala, c. 1200 m, MoNeill 347!

B6 Sivas: Tuzla gol, between Gemerek & Kayseri, Davis & Hedge D.32734!

C2 Muğla: 1 km N. of Fethiye, sea level, Lambert & Thorp 540!

C3 Antalya: near Kemer, Davis 14061!

C4 Isp: Geuksou (Gok Sú), Aug. 1872, Peronin 208!

C6 Adana: near Hasanbeyli, 914–1219 m, Darrah 649!

Is: Lesvos, Cand.

Cyperus differens L., Centuria Pl. 2: 6 (1756)

Syn: Cyperus complanatus Forskal, Fl. Aegypt.-Arab 14 (1775)
C. holoschoenoides Jan ex Roem. & Schultes, Mant. 2: 111 (1824)
C. protractus Link, Hort. Berol. 1: 305 (1827), non Delile
C. oryzetorum Steudel, Syn. Cyp. 24 (1855)

Annual, tufted, non-stoloniferous, with fibrous roots. Culm 20-60 cm tall, densely caespitose, compressed-triquetrous. Leaves 2-4 mm wide, shorter than culm, linear, scabrous-serrate at upper margins; sheaths brownish-red.

Involucral bracts 2-3, unequal, the lower longer. Inflorescence simple, rarely compound umbel, frequently with 3-8 unequal rays, rarely contracted capitate.

Spikelets 4-8 mm x 0.75-1.25 mm, linear, obtuse, numerous sessile in globose clusters 6-12 mm across. Glumes c. 0.5 mm long, orbicular-obovate, rounded-tipped, keeled, reddish-brown or rufous, margins hyaline. Stamens 1-2. Style 3-fid. Fruit c. 0.5 mm long, obovate-elliptic, trigonous, shortly apiculate, minutely dotted, yellowish-green. Fl. 8.

Habitat: in wet places.

Described from India: habitat in India Λβ. Linn. 70. 12/7.

N. Turkey, rare.

A2(F) Istanbul: between Hisarbayli and Ormanli, A. Baytop 14171

A5 Kastamonu (Paphlagonia): Tosya, 4 Aug. 1892, Sintenis 4927; ibid.,

Bornmüller 2538

External distribution: Widely distributed in Southern Europe from Portugal and Spain to the Balkans, Caucasus, S.W. Asia (extending to Palestine) to the Far East and Australia, and from Egypt and Sudan throughout Tropical Africa, including Madagascar and the Mascarene Islands.
8. **C. pygmaeus** Rottb., Descr. et Icon. 20, t. 14, f. 4-5 (1773)

Syn: **Cyperus michelianus** Delile, Fl. Aegypt. Illustr. 50 (1813), non Link (1827)

*C. milen-pullu* Roem. & Schultes, Syst. Veg. Mart. 2: 99 (1824)

*C. squarrosus* Roxb., Fl. Ind. 1: 190 (1832), non L. (1756)

*C. pugioniformis* Distr., Sp. Fl. 1: 210 (1839)

*C. michelianus* (L.) Link var. *pygmaeus* (Rottb.) O. Ktze., Rev. Gen. 2: 750 (1891)

*Pyoreus pygmaeus* (Rottb.) Nees in Linnaea 9: 283 (1835)

*Dichostylis pygmaea* (Rottb.) Nees in Linnaea 9: 289 (1835)

*Juncellus pygmaeus* (Rottb.) Clarke in Hook. fil, Fl. Brit. Ind. 6: 596 (1893)

**Cyperus michelianus** (L.) Link ssp. *pygmaeus* (Rottb.) Aschers & Graebner, Synops. Mittteleurop. Fl. 2 (2): 273 (1903)

Annual with slender fibrous roots. **Culms** 3-15.5 cm tall, densely tufted, trigonous, sulcate, leafy at base. **Leaves** 1-2 mm wide, linear, plane; sheaths reddish-brown, membranaceous. **Involucral bracts** 3-8, spreading from below the inflorescence. **Inflorescence** a dense sphaerical head, 6-14 mm across. **Spikelets** 3-4 mm x 2.0-2.5 mm, oblong-lanceolate, sessile, congested. **Glumes** c. 2 mm long, linear-lanceolate, distichously arranged, 5-7 nerved, mid-nerve prolonged into a bent awn. **Stamens** 1-2. **Style** 2-3-fid. **Fruit** 0.8-1.0 mm long, oblong or oblong-elliptic, trigonous or plano-convex, densely dotted, castaneous. **Fl.** 7-9.

**Habitat:** wet sandy or muddy places, on river banks.

**No type locality cited.**
N.W. Turkey, rare.

A1(A) Çanakkale: Bunarbaschi (Pinarbasi), 12 Sept. 1883, Sintenis 1028!

External distribution: Sporadic in S.W. Asia, extending to the Far East; North, West and East Africa, extending to Madagascar and the Mascarene Is.

Observation: This species is closely related to Cyperus michelianus (L.) Link, under which it is sometimes placed as a subspecies. The differences between the two species are in the arrangement of the glumes in the spikelet (C. pygmaeus has a distichous arrangement of the glumes, while C. michelianus has a spiral arrangement), and in the outermost cells of the fruit which are conspicuously inflated and quadrate in C. michelianus, and not inflated and distinct in C. pygmaeus.
Species Doubtfully Recorded

C. eragrostis Lam., Tabl. Encycl. 1: 146 (1791)

Recorded from Constantinople (new Istanbul) by Kukenthal (1936).
The only specimen seen by me was collected by B. Post and contained no information about locality, year of collection, habitat, etc. I very much doubt if this species occurs in Turkey, as evidenced from the lack of specimens in Kew, Edinburgh and B.M. (Natural History) Herbaria.

One would have thought that an area, such as Istanbul, from which very extensive collections have been made by Aznavour and B. Post over the past 4-8 decades would have yielded at least a few specimens of this species, if it really does occur there. The species is very conspicuous and is unlikely to have been overlooked by these two pioneer botanists of the area and by subsequent collectors.

Kukenthal's citation might have been based on this specimen of B. Post, and, thinking that most of Post's specimens are from Istanbul, recorded it for that area. This is not the only unlocalised species collected by B. Post for which no other evidence for its occurrence in Turkey could be traced (P. Davis, in verbis).
13. GALILEA Parl., Fl. Palerm. 1: 297 (1845)

Syn: Bobartia L., Fl. Zeyl. 17 (1747)

_Cyperus_ sect. _Bobartia_ (L.) Clarke in Journ. Linn. Soc. 21: 110

(1884) p.p.


1. _G. mucronata_ (L.) Parl.
Cyperus mucronatus (L.) Parl., Fl. Palerm. 1: 299 (1845)

Syn: Schoenus mucronatus L., Sp. Pl. 42 (1753)
Cyperus capitatus Vandelli, Fasc. Pl. 5 (1771)
Schoenus maritimus Lam., Fl. France 3: 543 (1778)
Cyperus aegyptiacus Gloxin, Obs. Bot. 20 (1785) t. 3
Mariscus mucronatus (L.) Gaertner, De Fruct. et Semin. 1: 11 (1788)

Cyperus macrorrhizus Nees in Wight, Contrib. Fl. Ind. 73 (1834)
C. schoenoides Griseb., Spicil. Fl. Rumel. 2: 421 (1844)
C. mucronatus (L.) Mabille, Recherch. Cors. 1: 27 (1867), non Rottb (1773)
Fringsheims
Chlorocyperus aegyptiacus Rikli in/Jahr. Wiss. Bot. 27: 564 (1895)

Stout perennial, with long, thick, creeping rhizomes; covered with reddish-brown fibrous sheaths. Roots spongy, woolly covered towards the base. Culms 10-79 cm x 1.5-4.3 mm, robust, obtusely trigonous, sulcate, erect or arcuate. Leaves 3-6 mm wide, recurved, canalicate, semi-terete, acuminate towards tip, remotely denticulate on the margins; sheaths reddish-brown. Involucral bracts 3-4, unequal, dilated and sheathing at base, and spreading from beneath the inflorescence, sometimes erect. Inflorescence capitate, consisting of numerous sessile spikelets aggregated into a hemispherical head 1-3 cm x 1.5-4.8 cm. Spikelets 8-15 mm x 3-4 mm, oblong-lanceolate, acute, turgid. Glumes 6.5-7.5 mm long, broadly ovate or obovate, obtuse, rigid densely imbricate, keeled towards apex with the 3 central nerves converging at apex into a short mucro, dark brown to reddish-brown below, stramineous with narrow hyaline margins above. Stamens 3, anthers 2.8-3.2 mm long, linear, connective reddish-brown, shortly extended. Style flattened,
stigmas 3, revolute. Fruit 3.7 mm x 1.5-2.0 mm, obovate-oblong or elliptic, adaxially concave, abaxially convex-angular, minutely dotted. Fl. 5-7. Fr. 7-9.

Habitat: sand dunes, near the coast.

Described from S. France, Tyrrhenian Sea, and Turkey: habitat in Galliae, Narbones, Tyrrheni, Smyrnæ maritimis [Hb. Linn. 68.7].

Turkey-in-Europe, Outer Anatolia, Islands.

A1(E) Tekirdag: Marmara-erğlisi to Tekirdag, c. 25 km from Tekirdag, near sea level, Davis & Coode D.39249!

A1(E) Edirne: Enez, sea level, Coode & Jones 2905!

A1(E) Kirklareli: Kirklareli, A. Baytop 13981!

A2(E) Istanbul: Florya, 3 km N.W. of Yesilköy, 9 June 1917, B. Post!

A2(A) Istanbul: Kutchuk Schekwedji, 9 June 1917, B. Post!

A3 Sakarya: Karasu, near sea level, Davis & Coode D.39156!

A5 Sinop: Sinop, west beach, 1 m, Tobey 1006!

A6 Samsun: beach area after Kızilay Kampa, 5 m, Tobey 261!


C3 Antalya: Antalya, Truman 78!

C4 Iğel (Cilicia): May 1872, Péronin 96!

C5 Iğel: Mersin, Balls 702!

C5 Adana: near Tuzla, Coode & Jones 34.1!

I. Lesvos, Cahil; Samos Rechinger 4008; Rhodes, 7 May 1870, Bourgeau 14.9!

External distribution: round the whole Mediterranean coasts.
14. PYCREUS P. Beauv., Fl. Oware 2: 48 (1807) t. 86

Syn: Torreya Raf. in Journ. Phys. 89: 105 (1819)
Distimus Raf. in Journ. Phys. 89: 105 (1819)
Picros Juss., Dist. 40: 194 (1826)
Cyperus L. sect. Picros (Juss.) Griseb., Spicileg. Fl. Rumel. 2: 419 (1844)
Cyperus L. subgen. Picros (Beauv.) Clarke in Journ. Linn. Soc. 21: 33 (1864)
Chlorocyperus Rikli in Pringsheim Jahrb. 27: 563 (1895)

Annual or perennial, generally with fibrous roots. Culms cespitose, trigonous, smooth, nodeless. Leaves linear, keeled, often scabrous on margins and keel, eligulate. Inflorescence a simple or compound umbel, sometimes contracted or reduced, rays unequal. Involucre bracts leaf-like, unequal. Spikelets many-flowered, compressed; rachilla persistent, not winged, generally straight often flexuous. Glumes densely imbricate, distichous, often obtuse, keeled, with or without lateral nerves. Hypogynous perianth segment absent. Stamens 1-3, anthers linear, obtuse. Style 2-fid. Fruit obovoid, biconvex or lenticular, bilaterally compressed (i.e. the margins in line with the axis of the spikelet), shortly apiculate.

1. Surface of fruit undulate or muricate at base and towards apex, with outermost cells rectangular-oblung; glumes 3-nerved, often mucronate ............................................. 1. P. flavescens (L.) Reichb.

1. Surface of fruit reticulate or punctulate, with outermost cells hexagonal; glumes 3-5 nerved, without mucronate tip

2. Glumes conspicuously sulcate, dark-red or purplish-red on the margins; stamens 2-3 ............... 2. P. sanguinolentus (Vahl) Nees

2. Glumes not sulcate, (palely) white hyaline on the margins;
stamens always 2 .................. 3. P. globosus (All.) Reichb.

**Syn:**

- *C. flavescens* Pall., *Tabl. Taur.* 45 (1795)
- *C. paeiformis* Pursh, *Fl. Amer.* Sept. 1: 50 (1814)
- *Distimus flavescens* (L.) Raf. in *Journ. Phys.* 89: 105 (1819)
- *Cyperus xanthinus* Presl. in *Oken, Isis* 21: 271 (1828)
- *C. abyssintius* Schwein., *Beitr. Fl. Aethiop.* 214 (1867), non Hochst. (1855)
- *Chlorocyperus flavescens* (L.) Rikli in *Pringsheim's Jahrb. Wiss.* Bot. 27: 563 (1895)

**Description:** Annual, with fibrous roots. Culms 7-14 cm tall (in ours), tufted, trigonous, sulcate, smooth. Leaves c. 1 mm wide, linear, plane, acuminate, smooth; sheaths purplish-brown, ligule-less. **Involucral bracts** 2-3, unequal. **Inflorescence** a simple umbel with unequal rays, sometimes contracted into a head. **Spikelets** 6-12 mm x 2-3 mm, linear-lanceolate or linear-oblong, subacute, sub-sessile, compressed. **Glumes** 1.5-2.0 mm long, densely imbricate, ovate or broadly elliptic, obtuse, keeled with 3-5 nerves, yellowish to brown, sometimes with a short mucro. **Stamens** 3, anthers linear. **Style** slender, 2-fid. **Fruit** c. 1.0 mm x 0.5-0.8 mm, obovate, biconcave, shortly apiculate, undulate at base and towards apex. Fl. 8-10.

**Habitat:** damp sandy or marshy places, near rivers, lakes etc., alt. near sea level to 1500 m.

**Described from Europe:** habitat in Germaniae, Helvetiae, Galliae paludos. **Aeb. Linn. 70.3017.**

**Turkey-in-Europe, Outer Anatolia, Islands.**
A1(A) Çanakkale: Bunarbaschi (Pinarbaşı), 12 Sept. 1883, Sintenis 1030!
A2(E) Istanbul: Tatlisu (near Kilyos), 5 Sept. 1897, Aznavour!

A2(A) Istanbul: Beikos, 20 Oct. 1889, Aznavour!

A8 Rize: d. Hemsin, Meydan Kobaca-Mollaveysa, 900 m, Davis & Dodds D.21370 sheets IA & II!

C6 Adana: Osmaniye, Sorkum Yaylasi, 1500 m, Kayacik 359!

C6: Adana: Mt. Amanus, Kayacik

Is: Rodhos, Fiori 68, 69, 70

External distribution: in Europe except extreme North, S.W. Asia, (including Caucasia) North and Tropical Africa, North and South America.

Syn: *Cyperus pumilus* Rottb., *Descr. et Icon.* 29 (1773) t. 9, f. 4, non L. (1756)

*C. cruentus* Retz., *Obs.* 5: 13 (1789), non Rottb. (1773)


*C. erythraeus* Schrader ex Roem. & Schultes, *Syst. Mant.* 2: 477 (1824)

*C. concolor* Steudel, *Synops.* 6 (1855)

*C. rehmannii* Boiss., *Fl. Orient.* 5: 364 (1884)


Annual or perennial, with short rhizome, and fibrous roots. Culms 21-28 cm tall (in ours), solitary, slightly decumbent at base, trigonous, sulcate, smooth. Leaves c. 2 mm wide, sub-basal, linear, acuminate; sheaths light brown, membranaceous, ligule-less, with straight orifice. Involuval bracts 3, unequal, diverging from beneath the inflorescence, lower longer.

Inflorescence a compact or loose umbel, with or without conspicuous rays.

Spikelets 12-15 mm x 3-4 mm, oblong or oblong-lanceolate, sub-acute, 3-8 in a glomerule, divergent, subsessile, compressed. Glumes 2.5-3.1 mm long, loose, ovate, subobtuse, sulcate on keel with 3-5 nerves, margins dark red or sanguine. Stamens 3, anthers linear, connective with a short, red ovate tip. Style slender, 2-fid. Fruit c. 1.3 mm x 1.0 mm, broadly obovoid or subglobular, lenticular, brown or dark brown, densely dotted. Fl. 8.

Habitat: in swamps and marshes; alt. sea level to 6,500 m.

Described from India: habitat in India.
N.E. Anatolia

A7 Trabzon: Trabzon, sea level, David & Hedge D.32025!

A8 Rize: d. Hemsin, Maydan Kobaca-Mollaveysa, 900 m, Davis & Dodds D.21370, sheet 1B!

External distribution: Caucasus to China; East Africa, St. Helena and Australia.

*Syn:* *Cyperus globosus* All., *Auctuar. Fl. Pedem.* 49 (1789)

* C. *flavidus* Retz., *Observ.* 5: 13 (1789)

* C. *confertus* Lam., *Illustr.* 1: 145 (1791), non Swartz (1788)

* C. *divaricatus* Lam., *Illustr.* 1: 145 (1791)


* C. *humifusus* Roxas Álcolete, *Ensayo* 234 (1807)


* C. *capillaris* Koenig ex Roxb., *Fl. Ind.* 1: 194 (1832)

* C. *trachyrrhachis* Steudel, *Synops. Cyper.* 3 (1855)


*Pyoreus capillaris* Nees in *Linnaea* 9: 283 (1834)


Annual or perennial, with short rhizome, and fibrous roots. **Culms** 10-55 cm tall, tufted, rarely solitary, trigonous, sulcate, smooth. **Leaves** 0.5-2.5 mm wide, conduplicate, linear, acuminate, smooth; sheaths reddish-brown, ligule-less, with straight orifice. **Involucral bracts** 2-3, unequal, longer than the **inflorescence.** **Inflorescence** a simple umbel with 2-5 rays, rarely compact. **Spikelets** 7-25 mm x 1.5-2.0 mm, linear-lanceolate, subsessile, compressed. **Glumes** 1.7-2.4 mm long, densely imbricate, oblong-ovate, obtuse, brown or reddish-brown with 3-5 nerves on the keel and a white hyaline margin. **Stamens** 2, anthers c. 0.4 mm long, oblong, connective obtuse. **Style** 2-fid. **Fruit** 0.7 mm long, oblong-ovoid or obovate, lenticular or flattened on both sides, densely dotted. **Fl.** 6-8. **Fr.** 8-10.

**Habitat:** in marshes, swamps, ditches; alt. c. 400-1400 m.
Described from Italy: loc. in pratis spongiosis secus le var.

W. & S. Anatolia

C1 Aydin: Samsun dag, above Priene, 400 m, Davis 18358!

C3 Antalya: near Kemer, Davis 14063! 15036!

C5 Seyhan: south end of Ulukışla Pass, Findlay 244!

C5/6 Hatay/Adana: mt. Amanus, Sept. 1913, Haradjian 4638!

External distribution: along the Mediterranean sea coasts, S.W. Asia to the Far East, South Africa and Australia.


1. D. serotina (Rottb.) Palla

Syn: *Cyperus serotinus* Rottb., Progr. 18 (1772) and Descri. et Icon. 31 (1773)

*C. monti* L. fil., Suppl. 102 (1781)

*C. glaber* Vill., Hist. Pl. Dauph. 2: 182 (1787), non L. (1753)

*Cyperus monti* (L. fil.) Beauv. ex Reichb., Fl. Germ. Exp. 72 (1830)


*C. punaticulatus* Aitch. in Journ. Linn. Soc. 19: 189 (1882), non Wahl (1806)

*C. krebsii* Boeck., Cyper. Nov. 2: 2 (1890)


*Chlorocyperus serotinus* (Rottb.) Palla in Allg. Bot. Zeitschr. 6: 201 (1900)

Perennial, stoloniferous. Culms 30-120 cm tall, triquetrous, leafy at base. Inflorescence a loose compound umbel, with rather long unequal rays. Involucral bracts 3-5, unequal. Spikelets 6-15 mm x 2 mm, oblong to oblong-lanceolate. Glumes orbicular-ovate, obtuse, many-nerved, with narrow hyaline margins. Stamens 3. Style 2-fid. Fruit adaxially compressed, 1.8 mm x 1.5 mm.

No type locality cited.

S. Anatolia, Islands.

C5 Igel (Cilicia): Mersin, Balansa.

Is: Samos, Colonna, Forsyth-Major 535

External distribution: From Central Europe, it extends to Southern Europe and the Balkans, through European USSR to Caucasus and the Far East; growing in China, Formosa, Afghanistan etc.
Observation: As can be observed from the distribution in Turkey, no Turkish specimens have been seen by me, and so detailed measurements of organs, habitat and altitudinal range, as well as flowering and fruiting times are omitted from the description. The above description was based on the type description amplified by reference to specimens from outside Turkey.

**Syn:** *Cyperus* L. sect. **Juncellus** Griseb., Fl. Brit. West-Ind. Isl. 562 (1864)

*Cyperus* L. sect. **Pycereus** B. Pseudopycreus Bosch. in *Linnaea* 35: 485 (1868)


*Perennial* with short or creeping rhizome. **Culms** tufted or solitary, trigonous, sulcate, smooth, noseless. **Leaves** narrowly linear, convolute, semi-terete towards the apex or reduced, eligulate. **Inflorescence** a pseudo-lateral head containing 1-12 sessile, densely arranged spikelets. **Involucral bracts** 2-3, unequal, the lower sometimes dilated at base, seemingly terminal and continuing the culm. **Spikelets** many-flowered, oblong or oblong-lanceolate, turgid; rachilla persistent, not winged. **Glumes** densely imbricate, distichous, without nerves on the lateral sides. Hypogynous perianth segments absent. **Stamens** 3, anthers linear, obtuse. **Style** 2-fid. **Fruit** ovoid or obovoid, plano-convex, densely dotted.

1. **J. laevigatus** (L.) Clarke
subsp. *laevisatus*

**Syn:**  
*C. laevisatus* L., Mant. Pl. 2: 179 (1771)  
*C. muconatus* Rottb., Desr. et ICON. 19 (1773) t. 8 f. 4  
*C. lateralis* Forskal, Fl. Aeg.-Arab. 15 (1775)  
*C. monostachyus* Link in Buch, Ins. Canar. 138 (1805), non Pers.  
*C. leucoostachys* Willd. in Link, Jahrb. 1 (3): 81 (1820)  
*C. roxburghii* A. Dietr., spec. Pl. 2: 214 (1833)  
*C. pleuranthus* Nees in Wight, Contrib. 75 (1834)  
*C. cossyrensis* Tino in Guss., Syn. Fl. Sic. 2: 779 (1844)  
*C. teretifolius* A. Rich., Tent. Fl. Abyss. 2: 477 (1851)  
*C. submonostachyus* Steud. & Jard. in Bull. Soc. Linn. Normandie 2 (9): 272 (1875)  
*C. junceillus* Dinter, Deutsch-Südwest Afric. 41 (1909)

Pyoreus muconatus* (Rottb.) Nees in Linnaea 9: 283 (1835)  
P. *lateralis* Nees in Linnaea 9: 283 (1835)  
P. *laevisatus* (L.) Nees in Linnaea 10: 130 (1836)  


*Perennial* with woody creeping rhizome, abbreviat (in ours) bearing tufted culms, or long with solitary culms, their bases enshathed by imbricate, chestnut sheaths. Culms 5-9 cm tall (in ours), triangular, sulcate, smooth. Leaves narrowly linear, convolute, upper part terete-trigonal, with a blunt tip. Involucre bracts 2, the lower several times longer than inflorescence, slightly dilated at base, and seemingly continuing the culm, the upper equal/or slightly
exceeding the inflorescence, lateral. Inflorescence a pseudo-lateral head of few to many spikelets. Spikelets 4.5–7.0 mm x 2.5–3.2 mm, oblong-lanceolate, 1–3 in the pseudo-lateral axis, sessile, compact. Glumes 2.3–2.5 mm long, broadly ovate or sub-ornicular ovate, obtuse, rarely mucronate with nerves especially towards the apex, none laterally, stramineous. Rachilla tetragonous, thick. Stamina 3, anthers c. 0.9 mm long, linear, connective sub-acute. Style 2-fid. Fruit 1.8–1.9 mm x 1.2–1.4 mm, obvoid, plano- or consave-convex, obtuse, densely dotted. Fl. 7.

Habitat: by warm spring in saline marsh, alt. c. 1250 m.

Described from South Africa: habitat ad Cap b. Spel. 1. G. Koenig

[239] Linn. 70.13\%.

E. Anatolia, Islands, rare.

B7 Erzincan: plain east of Erzincan, 1250 m, Davis & Hodge D.31878!

Is: Rodhos, Post, Fiori 67.

External distribution of subspecies: widely distributed in sub-tropical and warm temperate regions of the world.

Observation: The subsp. distachyos (All.) Oteng-Yeboah of this species is differentiated in having spikelets up to 2 cm long; glumes ovate, acute with 3 green nerves at the abaxial side, often mucronate, dark-sanguine; fruits elliptical or oval.

*Juncellus laevigatus (L.) Clarke ssp. distachyos (All.) Oteng-Yeboah, comb. et stat. nov.

Syn: Cyperus distachyos All., Autour. Fl. sadoam. ad 48 (1789) t. 2, f.5.

C. juncoformis Cav. Icon. et Descr. 3: 2 (1794) t. 204, f. 1

C. laevigatus var. distachyos (All.) Coss. et Durieu, Fl. Alger.

2: 254 (1854-56)
Cyperus laevigatus var. junciiformis (Cav.) Clarke in Journ. Linn. Soc. 21: 79 (1884)

Juncellus laevigatus var. junciiformis (Cav.) Clarke in Hook. fil. Fl. Brit. India 6: 597 (1893)


Acorallus distachyus (All.) Pall in Allg. bot. Zeitschr. 9: 68 (1903)

Juncellus distachyus (All.) Farrill in Kew Bull. 375 (1926)
17. **MARISCUS** Gaertner, De Fruct. et Semin. Pl. 1: 12 (1788)

Syn:  
- Opetiola Gaertner, De Fruct. et Semin. Pl. 1: 14 (1788) t. 2, f. 8
- Adula Bosc in Jaume St. Hilaire, Expos. fam. 1: 65 (1805)
- Cyperus L. subgen. Mariscaus (Gaertner) Clarke in Journ. Linn. Soc. 21: 34 (1884)
- Cylindrolepis Boeck. in Bot. Centralbl. 39: 73 (1889)
- Chlorocyperus Rikli in Pringsheim Jahrb. 27: 563 (1895)
- Sphaeromarisca E. G. Camus in Lecomte, Fl. Indo-Chine 7: 79 (1912)

Perennial, with or without rhizomes. **Culms** trigonous, smooth, tufted or solitary, nodeless. **Leaves** linear, keeled, scabrous on the margins and keel, eligulate. **Inflorescence** a simple or compound umbel; sometimes contracted, rays unequal. **Involucral bracts** leaf-like, unequal. **Spikelets** sometimes 1-2 flowered, sometimes many-flowered, generally compressed; **rachilla** caducous, slender, flexuous with narrow wings, disarticulating above the two empty **basal glumes**. **Glumes** distichous, decurrent, many-nerved, keeled, the two basal empty ones often aristate. **Hydrogynous perianth segment** absent. **Stamens** 3, **anthers** linear, obtuse. **Style** 3-fid. **Fruit** obovate, trigonous, shortly spiculate, minutely dotted.

1. **M. congestus** (Vahl) Clarke
M. congestus (Vahl) Clarke in Durand & Schinz, Consp. Pl. Afr. 5: 553 (1895)

Syn: Cyperus congestus Vahl, Enum. Pl. 2: 358 (1806)
C. strigosus Willd., Enum. Horti Berol. 1: 74 (1809), non L. (1753)
C. parametra Mart., Hort. Erlang 2: 184 (1814)
C. bulbosus Lag., Gen. et Spec. Pl. Nov. 2: 186 (1816), non Vahl (1806)
C. subbulbosus Roem. & Schultes, Syst. Veg. 2: 186 (1817)
C. polycephalus Link, Enum. Hort. Berol 1: 46 (1821), non Lam. (1791)
C. martianus Roem. & Schultes, Mant. 2: 108 (1824)
C. linkianus Roem. & Schultes, Mant. 2: 118 (1824)
C. incarnatus Link, Hort. Berol 1: 306 (1827)
C. multiceps Link, Hort. Berol. 1: 311 (1827)
C. badius Steudel in Flora 12: 153 (1829), non Desf. (1798)
C. carinatus Nees in Pl. Preiss. 2: 72 (1847), non P. Br. (1810)

Perennial, rhizomatous. Culm robust, compressed-triquetrous, smooth. Leaves equaling to or shorter than culm in length, plane, acuminate, scabrous on the margins and keel; sheaths brownish-purple. Involucral bracts 3–6, patent, lower longer. Inflorescence a simple or compound umbel, rarely contracted capitulate, with 2–7 rays. Spikelets 8.0–20 mm x 1.5–2.0 mm, linear to linear-lanceolate, acute, compressed rectangular, radiate. Glumes oblong-elliptic, sub-acute, scarcely keeled, castaneous to sanguineous on the sides, many-nerved, scarious. Stamens 3; anthers linear, long. Style long, 3–6-sti. Fruit obovate-oblong, trigonous, black at maturity, apiculate, minutely dotted. 

Described from S. Africa: habitat in Cap. b. spei
Anatolia (sine loco), 1844, Noë (K!)

A2(A) Kocaeli: Bithynia, Noë 50, 503

External distribution: recorded as occurring sporadically in Central and Southern Europe, Caucasus, South Africa and Australia.

Observation: Noë's unnumbered specimen was the only seen for this species in Turkey, but unfortunately it contained no information on exact locality apart from the inscription 'Anatolia'. Kukenthal (1936) mentioned the species as occurring at Constantinople (now Istanbul) and Bithynia (now divided into Provinces Bursa, Kocaeli, Sakarya, Bolu etc.) and cited Noë 50. Earlier on Boissier (1884) had mentioned the species as occurring in Turkey at Byzantium and near Nicomedia (now Izmit), cited Noë 503. It is possible that Noë 50 and 503 refer to the same specimen, the error being typographical.
18. CLADIUM P. Br., Hist. Jamaica 114 (1756)


1. C. mariscus (L.) Pohl
1. **Cladium mariscus** (L.) Pohl, Tent. Fl. Bohem. 1: 32 (1809)

Syn: *Schoenus mariscus* L., Sp. pl. 42 (1753)

- *Mariscus serratus* Gilib, Exerc. Phyt. 2: 512 (1792)
- *Cladium germanicum* Schrad., Fl. Germ. 1: 75 (1806)
- *C. palustre* Poiret in Dict. Sc. Nat. 9: 344 (1817)
- *Mariscus cladium* O. Kuntze, Rev. gen. 2: 754 (1891)

A stout perennial, with creeping rhizome. **Culms** 1-2 m tall, terete, nodding, hollow. **Leaves** 6-10 mm wide, linear, keeled, with a long triquetrous point, serrate-scabrous on margins and middle, tough. **Sheaths** close, pale green to yellowish brown, very tough, inner face deeply concave (V-shaped) ligule-less. **Inflorescence** a compound panicle, consisting of 3-10 rays, bearing numerous aggregated spikelets. **Spikelets** 3-5 mm long, 1-2 flowered, ovoid-lanceolate, sessile or pedicelled. **Glumes** 2.8-4.6 mm long, lanceolate, acute, boat-shaped with a distinct mid-nerve, smooth. **Stamens** 2, anthers 1.8 mm long. **Stigmas** 3, villous, style-base thickened, caducous. **Fruit** 3.1-3.5 mm x 1.6-1.9 mm, ovoid, acuminate, dark brown, lustrous. Fl. (4)6-7. Fr. 7-8.

**Habitat:** on sandy and silty (neutral to alkaline) soil, in swamps near lakes, sea level to c. 1000 m.

Described from Europe: habitat in Europae paludibus (Hb. Linn. 68. 1, 2!).

Mainly Outer Anatolia, Islands.

**Armenia, Calvert & Zohrab:** Probably between Erzurum and Trabzon?

A2(A) **Kocaeli:** Pendik, Tuzla, 24 July 1898, Aznavour!

A3 **Sakarya (Adapazari):** Karasu to Söğütli, 10 m, Davis & Coode D.39121!

A7 **Giresun:** Tirebolu (c. 80 km W. of Trabzon), 5 m, Hennipman et al 1922!

A8 **Erzurum:** 5 km N. of Tortum Göl, 1000 m, Davis 47647!

C3 **Antalya:** Antalya, Truman 75!

C3 **Antalya:** Kirenithaneler, c. 12 km S.W. of Antalya, in lagoon, Hennipman et al 580!

A cosmopolitan species, scattered through nearly all warm and warm-temperate regions of both hemispheres.
Perennial, rarely annual, with or without creeping rhizomes. Culms terete or slightly compressed, erect, arcuate or drooping. Leaves basal or sub-basal, narrowly linear, rigid or flaccid, margins serrate, rarely reduced to sheathing bases with setaceous mucronate tips. Inflorescence paniculate, capitate or rarely solitary. Spikes 1-4 flowered, sessile or stalked, flowers hermaphrodite, the uppermost functionally male; glumes distichously arranged, keeled, usually nerveless except for a central mid-rib, several lower ones and some upper ones sterile or empty. Hypogynous bristles 3-5, plumose or ciliate, usually scabrid, rarely absent. Stamens 3, occasionally 2. Style 3(-2) fied, linear, deciduous. Fruits trigonous or nearly globular.

1. *S. nigricans* L.
1. Schoenus nigricans L. Sp. Pl. 43 (1753)

Syn: Chaetospora nigricans (L.) Kunth, Enum. Pl. 2: 323 (1837)

Perennial, densely tufted with a short rhizome. Culms 11-41 cm tall, obtuse-angular, sulcate, nodeless, leafy at base. Leaves half as long as culm, sub-terete, with more or less involute-margins, sulcate, scabrous or smooth towards tip. Sheaths tough, open; lower dark reddish-brown or blackish-brown, shiny; upper reddish or yellowish-brown. Inflorescence capitate, consisting of 5-10 spikelets. Involucral bracts 2, blackish cinnamon-brown; lower with a long narrow subulate-canaliculate blade, 2-5 times as long as inflorescence; upper shorter than or equaling the inflorescence. Spikelets 5-8 mm long, flattened, lanceolate-acuminate, 2-3 flowered. Glumes distichous, keeled, rough on the keel, ovate-lanceolate, blackish-brown, paler towards the upper and margins. Hypogynous bristles 3-5, antrosely-barbed, yellowish brown. Stamens 3, anthers c. 3.5 mm long, with long-acuminate tip. Style 5 mm long, ovoid, with 2-3 papillose stigmas. Fruit 1.5(-1.9) mm long, white, ovoid to oblong, trigonous to rotund, lustrous. Fl. 5-6. Fr. 7-8.

Habitat: in damp, often peaty boggy places, in meadows or near sea, sometimes in salt marshes, or open limestone heaths, sea level - 2000 m.

Described from Europe: habitat in Europae paludibus aestate, exsiccatas

Widespread but scattered.

A1(A) Çanakkale: Erenköy, 12 May 1881, Sintenis 1216!

A2(E) Istanbul: Menekse, near Halkali, 24 May 1903, Aznavour!

B2 Kütahya: Murat Dağ above Banaz, 2000 m, Coode & Jones 2489!

B3 Konya: Sultan Dağ above Alkeshir, 1500 m, 25 June 1899, Bornmüller 5615!

B6 Maras: Gökşun-Çardak, 1300 m, Davis & Hedge D27637!

B7 Erzincan: Avşin, 37 km NE of Kemaliye, 9 May 1890, Sintenis 2193!
B9 Bitlis: Baykan-Bitlis, 1300 m, Davis 22159!

C2 Muğla: Marmaris, Nimara Ada; Khan et al. 66A!

C4 Konya: Kayakik, Davis 14746!

C5 Hatay: Samandag to Antakya, Coode & Jones 679!

C6 Hatay: Dörtol, Kusuculu to Bülke, Coode & Jones 437!

Islands: Lesvos, Malea, Cand.; Tilios, Ada; Rodhos, R.8379, Fiori 85

External distribution: extending from Western Europe to North-West India; also in North and South Africa.
20. **RHYNCHOSPORA** Vahl, Enum. Pl. 2: 236 (1806)

Annual or perennial, often in tufts, rarely rhizomatous. **Culms** trigonous, leafy. **Leaves** setaceous or broadly linear, basal and cauline. Inflorescence varied, corymbose or sub-umbelliform or with one or more dense pherical heads. **Spikelets** white or brown with spirally imbricated glumes; the basal 2-4 glumes and few apical ones sterile or empty, the middle ones bearing 2-3 hermaphrodite, rarely female flowers. **Hypogynous bristles** present 5-13, antrorsely scabrous; rarely absent. **Stamens** 3 or 2. **Style** usually 2-fid, glabrous, with an enlarged persistent base, forming a beak to the nut, stigmas often very long. **Fruit** biconvex, oblong or narrowly oblong, smooth or transversely wrinkled.

1. **R. alba** (L.) Vahl

**Syn:** *Schoenus alba* L. Sp. Pl. 44 (1753)

*Maritimus albus* (L.) Gilib., Exerc. 2: 512 (1792)


*Phaeocephalum album* (L.) House, in Amer. Mid. Natur. 6: 201 (1920)


Perennial loosely tufted, with a short rhizome. **Culms** 11-25 (-50) cm tall, slender, trigonous noded. **Leaves** narrowly linear, subconduplicate or channelled below, gradually becoming triquetrous toward tip, margins scabrous. **Sheaths** trigonous, with straight orifice, ligule-less. **Inflorescence** a cluster 7-10 mm as long as broad, arranged terminally or sometimes also axillary on long rays from the axils of upper leaves. **Inflorescral bracts** many; the lower equaling or slightly exceeding the terminal head. **Spikelets** 4-5 mm long, linear-lanceolate, creamish or pale brown, usually 2-flowered. **Glumes** 5, ovate-elliptic, subulate-acuminate, 1-nerved with narrow hyaline margins; lower 2 small, empty, 2-3 mm long; upper 3 larger, 4-5 mm long, uppermost empty. **Hypogynous bristles** 9(-13), retrorsely barbed, ciliate at base, equaling the fruit. **Stamens** 3, **anthers** 0.9 mm long. **Style** 2-fid. **Fruit** 2 mm x 0.8 mm, narrowly obovoid, gradually tapering above into a long beak c. 1 mm long. **Fl.** 5-8, **Fr.** 8-9.

**Habitat:** in wet, usually peaty places, c. 1600 m.

Described from Europe: habitat in Europae borealis paludibus siccatis

**Hb. Linn. 68. 17, 1817**

N. E. Anatolia, rare.

Ağ Çoruh (Artvin): Savval Tepe above Murgul, 1600 m. *Davis & Hedge*, D. 32251!

**External distribution:** all over Europe, except extreme North and South, Caucasus, China-Japan, North America.
Map 11

- Eriophorum vaginatum L.
- Eriophorum latifolium Hoppe
- Scirpus sylvaticus L.
- Fuirena pubescens (Poiret) Kunth
Map 12

- 323 -

△ Bolboschoenus maritimus (L.) Pall
△ B. maritimus var. cymosus (Reichenb.) Oteng-Yeboah

• Bolboschoenus paludosus (A. Nelson) Oteng-Yeboah, subsp. hakkiaricus Oteng-Yeboah
Map 13

\[\begin{array}{c}
\text{Schoenoplectus triguter (L.) Palla} \\
\text{S. littoralis (Schrader) Palla} \\
\text{S. muenchel (L.) Palla} \\
\text{S. supinus (L.) Palla}
\end{array}\]
Map 14

- Schoenoplectus lacustris (L.) Palla
- S. lacustris subsp. glaucus
- S. lacustris x glaucus

(Hartman) Ohag. Yeboah
Map 15

- Eleocharis acicularis (L.) R. Br.
- Eleocharis palustris (L.) R. Br.
- Eleocharis uniglumis (Link) Schultes
- Eleocharis meridionalis Zinserling
- Eleocharis pauciflora (Lightf.) Link
- Eleocharis transcaucasica Zinserling
Map 16

- Blysmus compressus (L.) Panz.
Map 17

- Fimbristyis dichotoma (L.) Vahl
- F. annua (All.) R. e. S.
- Bulbostylys tenerrima (F. & M.) Palla
- F. ferruginea (L.) Vahl

\[ 26° 28° 30° 32° 34° 36° \]

\[ 0 100 200 \text{ km} \]

B. woronowii Palla
Map 18

A

B

C

\[ \text{\textcolor{red}{\text{\textbf{A}}}} \text{ Holoschoenus vulgaris Link} \quad \text{\textcolor{red}{\text{\textbf{A}}}} \text{ Holoschoenus Vulgaris var. australis (L.) Hayek} \]
Map 19

- Isolepis cernua (Vahl) R. & S.
- Trichophorum pumilum (Vahl) Schinz & Thell.
- I. setacea (L.) R. Br.
Map 20

- Cyperus longus L.
- C. longus var. heldreichianus (Boiss) Boiss.
- C. longus var. anatolicus Oteng-Yeboa
- C. longus subsp. badius (Desf.) Aschers. & Graebn.
Map 21

- Cyperus glaber L.
- C. esculentus L.
- C. glomeratus L.
- C. rotundus L.
- C. rotundus var. major Parl.
Map 23

- Duval-Jouvea serotina (Rotb.) Palla
- Juncellus laevigatus (L.) Clarke
- Pycreus sanguineolentus (Vahl) Nees
- P. globosus (All.) Reichb.
- P. flavescens (L.) Reichb.
- P. colchicus (C. Koch) B. Schinschi.
Map 24

- Rhynchospora alba (L.) Vahl
- Cladium mariscus (L.) Pohl
- Schoenus nigricans L.
DISTRIBUTION OF SPECIES

Distribution inside Turkey

The distribution of representative Turkish species are summarised in maps which are based on specimens seen and on what are believed to be reliable literature records. The provenance of *Cyperus napus* was too vague to be mapped. Grossheim's maps (in his Flora Kavkaza ed. 2 vol. 2 1940) were heavily relied upon for the distribution of many species in North-East Turkey.

As can be seen from the maps, the distributions of most of the species have fairly wide ranges, being at least in more than four adjacent grid squares, e.g. *Blysmus compressus*, *Eleocharis palustris* etc., and follow no conspicuous patterns. However, other species e.g. *Scirpus sylvaticus*, *Eriophorum latifolium* etc. have discontinuous ranges or very restricted distributions. The distribution of the latter group of species, and a few others of the former group has been followed outside Turkey as far as possible in order to see if explanations can be found for their present Turkish distribution.

Distributions outside Turkey

Table 8 summarises the external distribution of species occurring in Turkey. In preparing this table a number of Floras, notably from Europe, Asia and North Africa, were consulted. The works include most of the standard Floras listed from the Flora Europaea contributors by Heywood (1958 p.17-19).

Floristic works from South-West Asia included Boissier 1864 (Flora Orientalia vol. 5), Grossheim 1940 (Caucasia) Komerov ed. English translation 1964 (URSS), Wulff 1929 (Ukraine, Crimea), Mouterde 1966 (Lebanon & Syria), Post ed. Dinsmore 1933 (Syria, Palestine and Sinai), Al-Rawi 1964, Rechinger 1964 (Iraq), Parsa 1950 (Iran), Holmboe 1914 (Cyprus), Rechinger 1943 (Aegean Islands), Kôie & Rechinger 1965 (Afghanistan), J.D. Hooker ed. 1894 (British India vol. 6). North African Floras include those of Tackholm & Drar 1950 (Egypt) and Maire 1957 (the whole of North Africa excluding Egypt).
| Striga sylvatica | + |
| Bulbinella maritima | + |
| Fracula tuberosa | + |
| Enicrhaphe latifolia | + |
| E. vaginatum | + |
| E. strigosa | ? |
| F. ferruginea | + |
| F. tenuica | |
| Rudbecka leucantha | + |
| B. woolleyi | + |
| Scleropogon spinulosus | + |
| S. aurantiacus | + |
| S. littoralis | + |
| S. trigonota | + |
| S. lacustris | + |
| S. leucodendron glauces | + |
| Helenium vulgare | + |
| Toxicaphora cornua | + |
| F. segeta | + |
| Eriachis parviflora | + |
| E. maculata | + |
| E. aciculata | + |
| E. palustris | + |
| E. urticifolia | + |
| F. capecs | + |
| Prinophaea papillarum | + |
| Rhynchospora comosa | + |
| Capparon longus | + |
| T. longa subsp. deme | + |
| T. rufa | + |
| T. coerulea | + |
|--------|--------|--------|-------------|-------------|--------|--------|--------------|---------|--------|-------------|-----------|---------|--------|--------|--------|--------|--------|---------|--------|--------|-----------|-----------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|--------|--------|--------|--------|--------|--------|--------|--------|
| +      | +      | +      | +           | +           | +      | +      | +            | +       | +      | +           | +         | +      | +      | +      | +      | +      | +      | +      | +      | +         | +         | +      | +      | +      | +      | +      | +      | +      | +      | +       | +       | +      |

Table 8. External Distribution of Turkish Species

+ = present

Note: The table represents the distribution of Turkish species across different regions. Each '+' symbol indicates the presence of the species in that region.
Kukenthal's (1936) Monograph of *Cyperus* L. s.l. was also used. Specimens from most of the areas in the table were seen in the herbaria at Kew, British Museum or Edinburgh.

Most of the specimens were seen to have wide not markedly discontinuous distributions, whereas others have sporadic or narrow ranges. Those species whose distributions follow certain patterns into Turkey from adjacent countries have been mapped in Maps 25-28. These are largely species whose northernmost, westernmost or southernmost ranges pass through Turkey. *Bulboystis wrononi*, *Eleocharis mesidionalis*, *Z. transcaucasia* and *Pycreus colchicus* are confined to the Colchic sector of the Euxine province of N.E. Turkey and the Caucasus (see Maps 26, 28); they are therefore endemic to the Euxine province of the Euro-Siberian region. *Pycreus sanguinolentus* is also distributed in the same range, though has isolated disjunct stations in Central Europe, Afghanistan to the temperate Far East, and East Africa. *Scirpus sylvaticus*, *Eriophorum vaginatum*, *Z. latifolium* and *Rhyhochopora alba*, which are largely of northern hemispheric distribution with their southernmost range reaching much of continental southern Europe (including the Balkans), are mostly restricted to the Colchic sector in N.E. Turkey, where they extend into the Caucasus (see Maps 25-27). However, *Scirpus sylvaticus* is also distributed in the N.W. Turkey, apparently as an extension of its Balkan range; while *Eriophorum latifolium* has an isolated station on Murat dag (Central Anatolia).

*Galilaea muronata* spreads along the whole Mediterranean sea coasts of South Europe, South-West Asia (including South Anatolia) and North Africa. It also extends along the Black Sea coasts of N.W. Turkey and Bulgaria (see Map 27). The species belongs to the Mediterranean element.

The distributional map of *Fuirena pubescens* shows its northernmost range (and in fact that of the entire genus *Fuirena*) reaching Portugal, Spain, France and Italy, missing the Balkans and just touching the Lycian Taurus in South
Anatolia (see Map 25). Elsewhere, especially in Africa and India, its range is fairly continuous.

**Pimbristylis ferruginea**, which like *Fuirena pubescens* is largely of southern hemispheric distribution, has its northernmost range in South Anatolia, being absent from Southern Europe (see Map 26).

The subtropical species that extend into Egypt and enter Palestine (e.g. *Cyperus papyrus*, *C. conglomeratus*, *C. alopecuroides*, *Juncellus laevigatus* subsp. *distachyos* etc.) are absent from Turkey for climatic reasons.

Factors contributing to the present-day distributions in Turkey

A number of factors such as climatic history, under collecting, recent migration, dispersal by chance, etc. may be considered to be wholly or partly responsible for the disjunct or restricted distributions of some of these Turkish species.

Our knowledge of the effects of the climatic changes of Pleistocene in Turkey on the distribution of the *Cyperaceae* can only be referred — I could trace no fossil evidence except that of *Cladium mariscus* from Kodor river in West Caucasus (Kolakovsky 1964). However, considering the drying effects of the inter-pluvial periods in Turkey (more or less corresponding to the interglacial periods in North and Central Europe), it seems probable that many *Cyperaceae* were more widespread during the pluvial periods (believed to be wetter and cooler) and have contracted their range during interpluvial and/or recent times.

The colchic sector of the Buxine province is well known for its support of numerous relict mesophytes (cf. Davis 1971), and it is not surprising therefore, that such species as *Bulbostylis woronowi*, *B. tenerrima*, *Eleocharis meridionalis*, *E. transcaucasia*, *Pyreaus colchicus*, *P. sanguinolentus*, *Eriophorum vaginatum* and *Rhynchospora alba* are confined in Turkey to that region only. The disjunct distribution of *Eriophorum latifolium* may be explained in one of two ways:
either their disjunctions represent contractions of more continuous range, or they are recent migrants due to long distance dispersal. The disjunction of *Scirpus sylvaticus* is more apparent than real, since it is only present now in N. and N.W. Turkey and may therefore have reached Turkey by a "pioneer" migration via the Balkan and the Caucasus; its distribution north of the Black sea is almost continuous. Species in most genera of *Cyperaceae* (except *Carex*) have not been favoured by most collectors. They are not showy, often grow in inconveniently wet places and tend not to form those localised undescribed species that botanists like looking for. It is therefore probable that some of these disjunct or restricted distributions are exaggerated by under-representation in herbaria, as a result of under-collecting.

**ENDEMISM:** The following are the only known endemics in the flora of Turkey areas: *Cyperus noeanus*, *C. longus* var. *anatolica* and *Bolboschoenus paludosus* subsp. *hakkiaricus*.

The following species are endemic to the Caucasus and N.W. Turkey combined (i.e. to the Colchicus sector of the Euxine province): *Bulbostylis woronowi*, *B. tenerrima*, *Pycreus colchicus*, *Eleocharis meridionalis* and *Eleocharis transcaucasica*. *Pycreus colchicus* is closely related to *P. tremulus* in tropical and sub-tropical Africa; *Eleocharis meridionalis* is related to *E. pauciflora* and *Eleocharis transcaucasica* to *E. uniglumis*. 
ADDENDUM

The following is a list and diagnoses of taxa whose literature records for Turkey were overlooked, and therefore not included in the main floristic account of Turkish Cyperaceae. All are from floristic works of Russian authors, viz: Komarov ed. (1964, English translation) and Grossheim (1940).

BULBOSTYLIS Kunth ex. C.B. Clarke in Hook. f., Fl. Brit. Ind. 6: 651 (1894)

gen. conserv.

syn: Stenophyllus Rafin. in Neogenyt. 4 (1825)


Oncostylis Nees in Mart. Fl. Brazil 2(1): 80 (1842)

Closely related to Fimbristylis Vahl, in which it is often included; differing from it in having smooth styles whose basal swollen part is persistent at maturity on the apex of the fruit.

1. Spikelet 2-4 mm long; glumes 1.5-2 mm long, ferrugineous brown; stamens 2, rarely 1 or 3 ......................... 1. B. tenerrima

1. Spikelet 4-8 mm long; glume 2.5-3.0 mm long, dark purple-brown; stamens 3 ......................... 2. B. woronowii


(1912)

syn: Isolepis tenerrima Fisch. & Mey. ex Kunth, Enum. Pl. 2: 212 (1837)

I. capillaris Ldb., Fl. Ross. 4: 257 (1853), non R. & S. (1817)

Fimbristylis capillaris Boiss., Fl. Orient. 5: 390 (1884), non A. Gray (1878)

Recorded from A8 Coruh [see Grossheim, op. cit. map 27]

Described from the Caucasus

Related to B. capillaris (L.) Nees from which it differs in having glabrous glumes and smooth fruit.

Recorded from A8 Çoruh [see Grossheim op. cit. map 347 and Komarov op. cit. p. 76]

Described from Western Transcaucasia: In paludosis prope p. Gonish.

Related to *E. tenerrima* and *E. capillaris* from which it differs in having larger spikelets (see key) and a caduous swollen style base.

**Note:** The persistence of the style base is one of the characters that distinguish the genus *Bulbostylis* from *Fimbristylis*. With *E. woronowii* having a caduous style base, its affinity may lie more with *Fimbristylis* than with *Bulbostylis*. In the absence of material of this species I cannot settle this question here.

**ELEOCHARIS** (see p. 247)

1. Style base confluent with (i.e. not differentiated from) the apex of the fruit body, but of a different colour and texture

............................................................... 1. *E. meridionalis*

1. Style base not confluent, i.e. dilated and articulated with the fruit body ............................................. 2. *E. transcaucasica*

1. *E. meridionalis* Zinserl. in Komarov, Fl. URSS. vol. 3 Addenda 2:

580 (1935)


Recorded from A9 Çoruh [see Grossheim op. cit. map 287]

Described from Kirgiziya: habitat ad ripas, in paludibus pratisque humidis et apud nives alpinae Transcaucasiae et in regionibus montanis territoriisque adjacentibus Asiae Mediae sovieticae atque Turkestaniae chinensis.

Related to *E. pauciflora* from which it differs in having bristles always longer than the fruit and a tubercle which is usually much less than a quarter of the length of fruit.
2. E. transcaucasica Zinserl. in Komarov, Fl. URSS vol. 3, Addenda 2: 585 (1935)

Recorded from A9 Karas [see Grossheim map 29]  
Described from Soviet Armenia: habitat ad ripas et in pratis Transcaucasiae  
(et Turciae regionum adjacentium) et ad ostia Borystheni atque Tanaitis.  
Closely related to E. uniglumis from which it differs in having a narrowly conical  
tuberole, about half as long as the fruit.

PYCREUS (see p. 297).

P. colchicus (C. Koch) B. Schischk. in Grossh., Fl. Kavk. 1: 152 (1928)  
syn: Cyperus colchicus C. Koch in Linnaea 21: 623 (1848)  
Cyperus tremulus Poir var. colchicus (C. Koch) Kukenthal in Engler,  
Das Pflanzenreich 4, 20: 362 (1936)

Recorded from A8 Goruh [see Grossheim op. cit. map 27]  
Described from the vicinity of Poti (Georgia)  
Related to Pycreus tremulus (Poir) Clarke from which it differs in having more  
contracted inflorescences and shorter rays.

CYPERUS (see p. 274).

C. glomeratus L., Cent. Pl. 2: 5 (1756)  
syn: Cyperus cinnamomeus Retz., Obs. 4: 10 (1786)  
C. australis Schrad., Fl. germ. 1: 116 (1806)  
Chlorocyperus glomeratus (L.) Palla in Allg. Bot. Zeitschr. 6: 201 (1900)

Recorded from A8 Goruh [see Grossheim op. cit. map 37]  
Described from Italy: Hb. Linn. 70. 23, 24. photo 17  
Related to C. difformis L. from which it differs in having 3 stamens and  
oblong-linear fruits 1.0-1.4 mm long
FIMBRISTYLIS (see p. 260).

_**F. annua*** (All.) Roem. & Schult., Syst. 2: 95 (1817)

syn: *Scirpus annuus* All., Fl. Pedem. 2: 277 (1785)

Recorded from Aş Çoruh [see Grossheim map 31]

Described from Italy; loc: circa lacus et loois humidis agri Canapiciensis frequens est. copiose circa lacum di Vivronne et in pratis paludosis di Bolengo et Aseglio

Related to *F. dichotoma* (L.) Vahl, from which it differs in having a simple umbel, subtended by 2-3 involucral bracts; fruit 1.0 mm long.
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Accepted generic names are in capitals. Accepted subgeneric, sectional, specific, subspecific and varietal names are doubly underlined. All synonyms are singly underlined. Synonyms for accepted species refer only to Part II. Names not underlined refer to those mentioned in observations only.

An asterisk before an accepted specific and infraspecific name shows that it is included in Part II (although this need not imply exclusion from Part I).

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APPENDIX A

The following are a list of new combinations required as a result of the generic classification adopted in the thesis.

I. New Supra-specific combinations

Ascolepas Nees ex Stued. subgen. Platylepis (Clarke) Oteng-Yeboah, comb. et stat. nov.

Platylepis Kunth, Enum. Pl. 2: 269 (1837), non L. E. Richard (1828)
Ascolepas sect. Platylepis Clarke in Kew Bull. Add. ser. 8: 116 (1908), basionym


Eriophorium L. sect. Lechnophorum Nylander in Acta Soc. Fenn. 3: 22 (1846), basionym

Fuirena Rottb. subgen. Pentasticha (Turez.) Oteng-Yeboah, comb. et stat. nov.

Pentasticha Turez. in Bull. Soc. Nat. Moscou 2: 330 (1862), basionym


Vaginaria Persoon, Synops. Pl. 1: 70 (1805), basionym
Fuirena sect. Vaginaria (persoon) C.B. Clarke in Kew Bull. Add. ser. 8: 115 (1908)

Hemicarphe Nees sect. Chloroscirpus (Chermesone) Oteng-Yeboah comb. et stat. nov.

Scirpus L. subgen. Chloroscirpus Chermeson in Humbert Flore Madagascar 29 Famille, 141 (1936) basionym

Schoenoplectus (Reichenb.) Palla subgen. Actaeogoton (Reichenb.) Oteng-Yeboah, comb. et stat. nov.

Schoenoplectus (Reichenb.) Palla subgen. Malacogeton (Ohwi) Oteng-Yeboah, comb. et stat. nov.


Scirpus L. sect. Lineati (Beetle) Oteng-Yeboah, comb. et stat. nov.


II. New Species combinations

Bolboschoenus fluviatilis (Torr.) Oteng-Yeboah, comb. et stat. nov.


S. fluviatilis (Torr.) Gray, Man. Bot. Ed. 1, 527 (1848)

Bolboschoenus lasteflorens (Clarke) Oteng-Yeboah, comb. nov.


Bolboschoenus planiculmis (Fr. Schmidt) Oteng-Yeboah, comb. nov.

Scirpus planiculmis Fr. Schmidt, Reisen Amurl. u. Ins. Sachal 190, t. 8 f. 1-7 (1866), basionym

Bolboschoenus robustus (Pursh) Oteng-Yeboah, comb. nov.

Scirpus robustus Pursh, Fl. Am. Sept. 56 (1814), basionym

Eleogiton brizoides (Benth.) Oteng-Yeboah, comb. nov.

Scirpus brizoides Benth., Fl. Austr. 7: 326 (1878), basionym
Eleogiton crassiuscula (Hook. f.) Oteng-Yeboah, **comb. nov.**

*Isolepis crassiuscula* Hook. f., *Fl. Tasm.* 2: 36, t. 143A (1858), basionym

*Scirpus crassiusculus* (Hook. f.) Benth., *Fl. Austr.* 7: 326 (1876)

Eleogiton lenticularis (Poir.) Oteng-Yeboah, **comb. nov.**

*Scirpus lenticularis* Poir. in Lam., *Encycl. Math.* Suppl. 5: 103 (1804)

*Isolepis lenticularis* R. Br., *Prodr.* 222 (1810)

Eleogiton ludwigii (Steud.) Oteng-Yeboah, **comb. nov.**

*Fimbristylis ludwigii* Steud. in *Flora* 17: 139 (1829), basionym

*Isolepis ludwigii* (Steud.) Kunth, *Enum.* Pl. 2: 189 (1837)

*Scirpus ludwigii* (Steud.) Böehn in *Linnaea* 36: 486 (1869-70)

Erioscirpus falsus (Clarke) Oteng-Yeboah, **comb. nov.**

*Scirpus falsus* Clarke in *Thiselton-Dyer*, *Fl. Cap.* 7: 230 (1898), basionym

Erioscirpus transiens (Raymond) Oteng-Yeboah, **comb. nov.**

*Eriophorum transiens* Raymond in *Naturaliste Canad.* 86: 240 (1959), basionym

Hemiarpha brevicaulis (Levyns) Oteng-Yeboah, **comb. nov.**

*Scirpus brevicaulis* Levyns in *Journ. S. Afr.* Bot. 10: 31 (1944), basionym

Hemiarpha hystrix (Thunb.) Oteng-Yeboah, **comb. nov.**

*Scirpus hystrix* Thunb., *Prodr.* Pl. Cap. 17 (1784), basionym

Hemiarpha kernii (Raymond) Oteng-Yeboah, **comb. nov.**

*Scirpus kernii* Raymond in *Naturaliste Canad.* 136: 230 (1959), basionym

Hemiarpha squarrosa (*L.*), Oteng-Yeboah, **comb. nov.**

*Scirpus squarrosus* *L.*, *Mantissa* Pl. 2: 181 (1771), basionym

Hemiarpha rehmanii (Ridley) Oteng-Yeboah, **comb. nov.**

*Scirpus rehmanii* Ridley in *Trans. Linn. Soc.* (London) ser. 2, 2: 159 (1884), basionym

Holochoenus dioecus (Kunth) Oteng-Yeboah, **comb. nov.**

*Isolepis dioecia* Kunth, *Enum.* Pl. 2: 199 (1837), basionym

*Scirpus dioecus* (Kunth) Boeck in *Linnaea* 36: 719 (1869-70)
Holoschoenus thumbergianus (Nees) Oteng-Yeboah, comb. nov.

Isolepis thumbergiana Nees in Linnaea 7: 508 (1832), basionym

Isolepis delicatula (Levyns) Oteng-Yeboah, comb. nov.

Scirpus delicatulus Levyns in Journ. S. Afr. Bot. 10: 30 (1944), basionym

Isolepis inconspicua (Levyns) Oteng-Yeboah, comb. nov.


Isolepis macer (Boeck.) Oteng-Yeboah, comb. nov.

Scirpus macer Boeck in Engler, Bot. Jahrb. 5: 503 (1884), basionym

Isolepis merrillii (Palla) Oteng-Yeboah, comb. nov.


Isolepis minuta (Turrill) Oteng-Yeboah, comb. nov.

Scirpus minutus Turrill in Kew Bull. No. 2: 69 (1925), basionym

Isolepis producta (Clarke) Oteng-Yeboah, comb. nov.

Scirpus productus Clarke in Kew Bull. Add. Ser. 8: 28 (1908), basionym

Isolepis psammophila (Blake) Oteng-Yeboah, comb. nov.

Scirpus arenarius Benth., Fl. Austr. 7: 325 (1878), non Boeck (1870)
Scirpus psammophilus Blake in Proc. Roy. Soc. Qd. 51: 178 (1940), basionym

Nemum angolensum (Clarke) Oteng-Yeboah, comb. nov.


Phylloscirpus aculis (Phil.) Oteng-Yeboah, comb. nov.

Scirpus aculis Phil. in Linnaea 29: 78 (1857-58), basionym

Phylloscirpus semisubterraneus (Böek) Oteng-Yeboah, comb. nov.

Scirpus semisubterraneus Böek. in Linnaea 36: 495 (1869-70) basionym
Phyllosoirpus deserticola (Phil.) Oteng-Yeboah, comb. nov.

*Isoplepis deserticola* Phil. Fl. Atacama 53 (1860), basionym

**Pseudo-sochoenus inanis** (Thunb.) Oteng-Yeboah, comb. nov.

*Sochoenus inanis* Thunb., Prodr. Pl. Cap. 16 (1794), basionym
*Scirpus spathaceus* Hochst in Flora 759 (1845)

**Schoenoplectus articulatus** (L.) Oteng-Yeboah, comb. nov.

*Scirpus articulatus* L., Sp. Pl. 70 (1753), basionym

**Schoenoplectus dissachanthus** (Blake) Oteng-Yeboah, comb. nov.

*Scirpus dissachanthus* Blake in Vict. Nat. 63: 116 (1946), basionym

**Schoenoplectus chilensis** (Nees & Meyer) Oteng-Yeboah, comb. nov.


**Schoenoplectus etuberulatus** (Steud.) Oteng-Yeboah, comb. nov.

*Scirpus maritimus* var. *cylindricus* Torr. in Ann. Lyc. N.Y. 3: 325 (1836)
*Rhynchospora etuberulata* Steud., Syn. Pl. Glum. 2: 142 (1855), basionym
*Scirpus macranthus* Böeck., Flora 41: 412 (1856)
*S. etuberulatus* (Steud.) Kuntze, Rev. Gen. 2: 758 (1891)
*S. cylindricus* Britton in Trans. N.Y. Acad. 11: 79 (1892)

**Schoenoplectus californicus** (C. Meyer) Oteng-Yeboah, comb. nov.


**Schoenoplectus heterochaetus** (Chase) Oteng-Yeboah, comb. nov.

*Scirpus heterochaetus* Chase, in Rhodora 6: 70 (1904), basionym

**Schoenoplectus limensis** (Clarke) Oteng-Yeboah, comb. nov.

*Scirpus limensis* Clarke in Kew Bull. Add. Ser 3: 29 (1908), basionym

**Schoenoplectus muricinix** (Clarke) Oteng-Yeboah, comb. nov.

*Scirpus muricinix* Clarke in Engler, Bot. Jahrb. 38: 135 (1906), basionym

**Schoenoplectus oxyjulos** (S. Hooper) Oteng-Yeboah, comb. nov.

*Scirpus oxyjulos* S. Hooper in Kew Bull. 26(3): 581 (1972), basionym
Schoenoplectus ranko (Stud.) Oteng-Yeboah, comb. nov.

Cyperus ranko Stud., Syn. Pl. Glum. 2: 315 (1855) basionym

Schoenoplectus corymbosus (Heyne ex Roth) Oteng-Yeboah, comb. nov.

S. corymbosus Heyne ex Roth, Nov. Pl. Sp. 28 (1821), basionym

Schoenoplectus pterolepis (Kunth) Oteng-Yeboah, comb. nov.

S. pterolepis Kunth, Enum. Pl. 2: 166 (1837), basionym

Schoenoplectus rhodesicus (Podlech) Oteng-Yeboah, comb. nov.


Schoenoplectus saximontanus (Fern.) Oteng-Yeboah, comb. nov.

S. saximontanus Fern. in Rhodora 3: 351 (1901), basionym

Schoenoplectus smithii (Gray) Oteng-Yeboah, comb. nov.

S. smithii A. Gray, Man. Bot. ed 5: 563 (1867), basionym

Schoenoplectus smithii var. williamsii (Fernald) Oteng-Yeboah, comb. nov.

S. debilis var. williamsii Fernald in Rhodora 3: 252 (1901), basionym
S. smithii var. williamsii (Fernald) Beetle in Amer. Journ. Bot. 29: 655 (1942)

Schoenoplectus subterminalis (Torr.) Oteng-Yeboah, comb. nov.

S. subterminalis Torr., Fl. U.S. 47 (1823), basionym

Schoenoplectus hallii (Gray) Oteng-Yeboah, comb. nov.

S. hallii A. Gray, Man. Bot. Ed. 3: 97 (1862), basionym

Schoenoplectus rubiginosus (Beetle) Oteng-Yeboah, comb. nov.

S. rubiginosus Beetle in Amer. Journ. Bot. 28: 697 (1941) basionym

Schoenoplectus triangulatus (Roxb.) Oteng-Yeboah, comb. nov.

S. triangulatus Roxb., Fl. Indica 1: 219 (1820) basionym

Schoenoplectus uninodis (Delile) Oteng-Yeboah, comb. nov.

Isolepis uninodis Delile Fl. Egypt 2: 152 (1812), basionym
S. uninodis (Delile) Coss. & Durien, Fl. Alger., pt. 2 Phanerog., 310 (1867)
Schoenoplectus riparius (Prel.) Oteng-Yeboah, **comb. nov.**

Scirpus riparius Prel., Rel. Haenk. 1: 193 (1830), basionym

**Trichophorum atacamensis** (Phil.) Oteng-Yeboah, **comb. nov.**

Isolepis atacamensis Phil. Fl. Atacam. 53 (1860), basionym

Scirpus atacamensis (Phil.) Böeck. in Linnæa 36: 482 (1869-70)

**Trichophorum clementis** (M.E. Jones) Oteng-Yeboah, **comb. nov.**

Scirpus clementis M.E. Jones in Contrib. West Bot. 14: 21 (1912), basionym

**Trichophorum filipes** (Clarke) Oteng-Yeboah **comb. nov.**

Scirpus filipes Clarke in Journ. Linn. Soc. 36: 249 (1903), basionym

**Trichophorum clintonii** (A. Gray) Oteng-Yeboah, **comb. nov.**


Scirpus clintonii A. Gray, Amer. Journ. Sci. II 38: 290 (1864), basionym

**Trichophorum mattrfeldianum** (Kükenthal) Oteng-Yeboah, **comb. nov.**

Scirpus mattrfeldianus Kükenthal in Fedde, Repert 27: 108 (1929), basionym

**Trichophorum rigidum** (Staud. ex Böeck.) Oteng-Yeboah, **comb. nov.**

Scirpus rigidus Staud. ex Böeck. in Linnæa 36: 492 (1869-70), basionym

**Trichophorum verecundum** (Fern.) Oteng-Yeboah, **comb. nov.**

Scirpus planifolius Muhl., Descr. Gram. 32 (1817) non Grimm. (1767)

Scirpus verecundus Fern. in Rhodora 100: 284 (1948), basionym
APPENDIX B

List of species studied

The specimens cited below were investigated anatomically. This list therefore excludes numerous other specimens of which only the external morphology was observed in the herbaria at the British Museum (Nat. Hist.), Edinburgh and Kew; and also British material collected and pickled during my research. The bracketed letter(s) after the collector's name and numbers, indicate(s) the herbarium from which the specimen was made available to me. The contractions used in the Index Herbariorum have been adopted as ff. for Edinburgh (E), Kew (K), Mexico (MEKU), and Tokyo National Museum (TNS).

The species marked with an asterisk were studied from Turkish specimens, details of which have been given in Part II under each species.

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<td>A. Glazion 20066 (K)</td>
<td>Brasil</td>
<td>1892</td>
</tr>
<tr>
<td>Ascolepis brasiliensis (Kunth) Benth. ex Clarke</td>
<td>E. Hassler (E)</td>
<td>Paraguay</td>
<td>1913</td>
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<td>capensis Ridl.</td>
<td>Irvine 2473 (E)</td>
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</tr>
<tr>
<td></td>
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<td>1899</td>
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<td>pinguis Clarke</td>
<td>Hassmer Expd. 2550 (E)</td>
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<td>protea Welw.</td>
<td>Baum 627 (E)</td>
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<td>Elymus compressus (L.) Pans.</td>
<td>Seth (E)</td>
<td>Sweden</td>
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<td>Bolboschoenus affinis (Roth) Drob.</td>
<td>Drummond 24933 (E)</td>
<td>India-Punjab</td>
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<td>fluviatilis (Torr.) Oteng-Yeboah</td>
<td>E.S. Steele (E)</td>
<td>U.S. (Washington DC)</td>
<td>1897</td>
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<td>maritimus (L.) Palla</td>
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<td><em>Bolboschoenus lasteflorens</em> <em>(Clarke)</em></td>
<td>Story 5873 (K)</td>
<td>S.W. Africa</td>
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<td>Strey R.G. 2172 (K)</td>
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<td>1947</td>
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<td><em>paludosus</em> <em>(Nels.)</em></td>
<td>E.P. Walker 399 (E)</td>
<td>Utah (U.S.)</td>
<td>1912</td>
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<td><em>Oteng-Yeboah</em></td>
<td>Nelson A. &amp; E. 6878 (K)</td>
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<td>1899</td>
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<td><em>planiolmis</em> <em>(Fr. Schmidt)</em></td>
<td>Kawakami 74088 (TNS)</td>
<td>Manchuria (Japan)</td>
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<td><em>Oteng-Yeboah</em></td>
<td>Hatagaka 12255 (TNS)</td>
<td>Kyushu (Japan)</td>
<td>1955</td>
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<td><em>robustus</em> <em>(Pursh)</em></td>
<td>Leo. Koch 1004a (E)</td>
<td>Calif. (U.S.)</td>
<td>1940</td>
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<td><em>strobulinus</em> <em>(Roeb.)</em></td>
<td>Hb. Ind. Or. Hook. f. (E)</td>
<td>India</td>
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<td><em>Kreuz</em></td>
<td>Thomson</td>
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<td><em>Courtoisia cypoides</em> Nees</td>
<td>Hb. Wight 1255 (E)</td>
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<td><em>Cyperus aristatus</em> Rotb.*</td>
<td>E. Hassler 12626 (E)</td>
<td>Paraguay</td>
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<td><em>conglomeratus</em> Rotb.*</td>
<td>R.W. Haines 1011 (E)</td>
<td>Iraq</td>
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<td><em>fusus</em> L.</td>
<td>J. Lamond 89 (E)</td>
<td>Iran</td>
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<td><em>glaber</em> L.</td>
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<td><em>longus</em> L.</td>
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<td><em>ira</em> L.</td>
<td>R.W. Haines 1827, 5040 (E)</td>
<td>Iraq</td>
<td>1960</td>
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<td><em>margaritaeus</em> Vahl</td>
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<td>Ghana</td>
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<td>R.E.S. Tanner 1728 (E)</td>
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<td><em>uncinitus</em> Poir.</td>
<td>J.T. Swarbrick 2714 (E)</td>
<td>Nigeria</td>
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<td><em>pygmaeus</em> Rotb.*</td>
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<td><em>orbicophalus</em> <em>(Beetle)</em></td>
<td>C.C. Pringle 3173 (E)</td>
<td>Mexico</td>
<td>1890</td>
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<td><em>Koyama</em></td>
<td>C.C. Parry &amp; Ed. Palmer 905 (K)</td>
<td>Mexico</td>
<td>1875</td>
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<td><em>michelianus</em> <em>(L.)</em> Link</td>
<td>J.G. Schaffner 566 (K)</td>
<td>San Luis Potosi</td>
<td>1877</td>
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<td><em>Desmoschoenus spiralis</em> <em>(A. Rich.)</em> Hook. f.*</td>
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<td>1861</td>
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<td><em>(Rottb.)</em> Palla</td>
<td>J.K. Hayes 7/48 (E)</td>
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<td><em>Duval-Jouvea setotina</em></td>
<td>N. Pastukhov (E)</td>
<td>Caucasus</td>
<td>1916</td>
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<td><em>(Rottb.)</em> Palla</td>
<td>R.R. Stewart 28729 (E)</td>
<td>Pakistan</td>
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<td><em>Eleogiton fluitans</em> <em>(L.)</em> Link</td>
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<td><em>pseudo-fluitans</em> <em>(Maxim)</em></td>
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<td><em>Ohwi</em></td>
<td>Ohwi &amp; Okamoto 739 (E)</td>
<td>Hondo (Japan)</td>
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<td>R. Schodde 1757 (E)</td>
<td>New Guinea</td>
<td>1961</td>
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Eleginton brisoides (Benth.)
Oteng-Yeboah

strigatus Nees
(= Scirpus capillifolius
Parl.)

fascicularis Nees
ludwigii (Steu.)
Oteng-Yeboah

lenticularis (Poir.)
Oteng-Yeboah

W. M. Curtis (K)
Cheeseman T. F. 801 (K)

W. Australia
South Island N.Z.

Eriophorum angustifolium
Honok

precile Koch

intervened Lináb.
latifolium Hoppe

opacum Fern.
russeolum Fries

schaucheri Hoppe

vaginatum L.

fauriei E. G. Camus
brochyantherum Trantr.
callitrix Cham.

spissum Fern.
tenellum Nutt.

triste (Hadam) Léve &

aegilops (Gray) Beetle

E. A. McGregor 100 (E)
Copeland 3902 (E)
Gillett & Findlay 5697 (E)
Ex Hb. Watson (E)
J. Maoum 16389 (E)

Maire-Victorin et al. 56939 (E)

japonicum Maxim.

Ex Hb. P. Maximowicz (K)
Ohwi 224-864 (TNS)
Nakashima 14,
(NSM 171795 TNS)

Eriochirpus omeosus (Wall.)
Palla

J. Cavalarie 2073 (E)

George Forrest (E)

China

384

R. Dümmen 2034 (E)
Ex Hb. Harvey 374 (E)
Hb. John Ball (E)
W. M. Curtis (K)

Cheeseman T. F. 801 (K)

Bulgaria
Bulgaria
Austria
Sweden
Finland

Bulgaria

Holland (Japan)
Calif. (U.S.)
Calif. (U.S.)
Canada
Philad. (U.S.)

Canada

Canada

Canada

China

1908
1956
1910
1861
1888
1926
1964
1894
1913
1963
1888
1961
1949
1896
1958
1950
1890
1932
1968
1909
1903
1950
1861
1896
1943
1865
1928
1967
1904
1904
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<td>Ficinia aphylla Nees</td>
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<td>1903</td>
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<td>bulbosa Nees</td>
<td>R.J. Rodin 3112 (E)</td>
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<td>1948</td>
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<td>Nees ab Ess. 10.9 (E)</td>
<td>S. Africa</td>
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<td>cokloネa Nees</td>
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<td>preamorpha Nees</td>
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<td>trichodes Benth.</td>
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<td>tristachyua Nees</td>
<td>Hb. John Ball</td>
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<td>longifolia Clarke</td>
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<td>Fuirena pubescens (Poir.)</td>
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<td>umbellata Rotth.</td>
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<td>Italy</td>
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<td>Davis 50653 (E)</td>
<td>Morocco</td>
<td>1970</td>
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<td>1956</td>
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<td>soirpoidea Michx.</td>
<td>S.K. Leu 406 (E)</td>
<td>China</td>
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<td>M.S. Clemen 10708A (E)</td>
<td>New Guinea</td>
<td>1939</td>
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<td>glomerata Lam.</td>
<td>A. Sidney 6354 (E)</td>
<td>India</td>
<td>1945</td>
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<td>Georgia (U.S.)</td>
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<td>wallichiana Kunth</td>
<td>Forster &amp; Smith 1329 (E)</td>
<td>Florida (U.S.)</td>
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Fuirena simplex Vahl
Arsene (E) Mexico 1911
Albert Ruth 522 (E) Texas (U.S.) 1914
H. Curtiss 237 (E) West Indies 1903
Smith & Hodgson 921 (E) - 1939
(Pl. Exsicc. Grayanae)
Fernald 331 (E) - 1918

squarrosa Michx.

incomplete Nees
Reineck & Czermak 439 (E) Brasil 1899
welwitchiana Ridl.
G. Adamson 106 (E) Zambesia -
pechvryss Ridl.
H. Baum 145 (E) Zambesia 1899
ecklonii Nees
Clarke (E) -

birta Vahl
R. Dümmeri 1801, 1065 (E) S. Africa 1908

Galitea muoronata (L.)
M. Zohary 31 (E) Israel 1928
Parl.
E.K. Balls 702 (E) Turkey 1934

Hellmuthia sp.
Zeyher 1775 (K) S. Africa -
(= Scirpus membranaceus
Burchell (K) S. Africa -
(Thuem.)

Hemiarpha occidentalis
H.N. Bolander 6223 (K) Calif. (U.S.) 1866
Gray

mioreantha (Vahl) Britt.
Earl E. Sherff. 1793 (E) Illinois (U.S.) 1912
squamosa (L.)
J.W. Helfer 144 (E) India -
Oteng-Yeboah

hystric (Thuem.)
P. Wilms 1594 (E) S. Africa 1894
Oteng-Yeboah

crices (L.)
R.N. Parker 4364 (K) S. Africa 1948
levyns
Oteng-Yeboah

Holoschoenus vulgaris Link -
- Hunting Techn. Services Ltd. Hoggar Mts. 1955
vulgaris subsp. globiferus
- Ref. No. 36(P2) (E) (Morocco)
(L.f.)
Oteng-Yeboah

podogus (Roth.) Distr.
J. Staer (E) W. Australia 1905
thumbergianus (Nees)
Oteng-Yeboah

9929 (E)

dioecus (Böck.)
Burchell 685 (K) S. Africa 1811
Oteng-Yeboah
Werdermann & Oberdiech
614 (K) S. Africa -

Hymenochaeta grossa (L. fil.)
H.Y. Liang 62943 (E) China 1933
Nees

Hb. Francis Hamilton (E) India -
Ilwaiites 847 (E) Ceylon 1870

Isolapis sulcata (Thouars.)
R.N.K. Brown (E) Gough Is. -
Carm.

N.M. Wace T.1201 (K) Tristan Is. 1968
cartilaginea R. Br.
Max Koch 1965 (E) S.W. Australis 1910
paemophila (Blake)
Drummond 360 (E) W. Australia -
Oteng-Yeboah

(= Scirpus arenarius Benth.)
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<th>Year</th>
<th>Location</th>
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<td>R. Br.</td>
<td>J. Staer</td>
<td>1905</td>
<td>W. Australia</td>
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<td><em>inaudata</em> R. Br.</td>
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<td>R. Brown 5975</td>
<td>1802-5</td>
<td>Australia</td>
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<td><em>prolifer</em> (Rottb.) R. Br.</td>
<td>A. Knip]cker</td>
<td>Exsicc. E. (E)</td>
<td>1905</td>
<td>Australia</td>
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<td><em>costata</em> Hochst. ex A. Rich</td>
<td>R. N. Parker</td>
<td>3637 (K)</td>
<td>1802-5</td>
<td>S. Africa</td>
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<td><em>antarctica</em> (L.) R. &amp; S.</td>
<td>F. Wilms</td>
<td>3826 (E)</td>
<td>1942</td>
<td>Ethiopia</td>
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<td><em>moccasina</em> Hook. f.</td>
<td>Ex Hb. Mus. Paris</td>
<td>3 (K)</td>
<td>1863-68</td>
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<td><em>maer</em> (Böck.)</td>
<td>Oteng-Yeboah</td>
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<td><em>venustula</em> (Böck) Kunth</td>
<td>F. Wilms</td>
<td>1617 (E)</td>
<td>1883</td>
<td>S. Africa</td>
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<td><em>nolilepis</em> Steud. (= Scaurus carinatus Gray)</td>
<td>C.G. Pringle</td>
<td>6771 (E)</td>
<td>1906</td>
<td>Calif. (U.S.)</td>
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<td><em>bioceras</em> Carm.</td>
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<td>1923</td>
<td>Tristan Is.</td>
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<td><em>delicatula</em> (Levyns)</td>
<td>M.R. Levyns 837 (K)</td>
<td>1924</td>
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<td><em>inconsincua</em> (Levyns)</td>
<td>R. N. Parker 4363 (K)</td>
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<td><em>minute</em> (Turill)</td>
<td>E.L. Stephens 3530 (K)</td>
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<td><em>produca</em> (Clarke)</td>
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<td><em>satalica</em> (L.) R. Br.</td>
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*Juncellus laevisatus* (L.) Clarke

<table>
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<tr>
<th>Genus</th>
<th>Species</th>
<th>Author</th>
<th>Year</th>
<th>Location</th>
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<tr>
<td><em>laevisatus</em> subsp. digitaevosos* (All.) Oteng-Yeboah</td>
<td>R.W. Haines 57 (E)</td>
<td>1954</td>
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*Kyllinga monocophala* Rottb. To Kang Peng et al.

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<tr>
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<th>Year</th>
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<td><em>brevifolia</em> Rottb.</td>
<td>M. Togasi 626 (E)</td>
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<td>Kwartung (China)</td>
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<td><em>aquamulate</em> Thonn. ex Vahl R. R. Stewart 23437a (E)</td>
<td>1952</td>
<td>Japan</td>
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<td><em>triscapa</em> Rottb.</td>
<td>J.H. Lace (E)</td>
<td>1959</td>
<td>India</td>
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<td><em>auranta</em> Nees</td>
<td>G. Volkon 2102 (E)</td>
<td>1961</td>
<td>Burma</td>
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<td><em>elata</em> Kuntz</td>
<td>George Adamsen (E)</td>
<td>1961</td>
<td>W. Nigeria</td>
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<td><em>creasta</em> Schum.</td>
<td>Irvine 1629 (E)</td>
<td>1897</td>
<td>Kilimanjaro</td>
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<td><em>peruviana</em> Lam.</td>
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<td><em>rigidula</em> Steud.</td>
<td>G.L. Bates 199 (E)</td>
<td>1934</td>
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<td><em>cylinda</em> Neas</td>
<td>H.H. Johnston (E)</td>
<td>1958</td>
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<td><em>caespitosa</em> Neas</td>
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<td><em>Kyllinga odorata</em> Vahl</td>
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<td>13616</td>
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<td>1865-66</td>
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<td><em>Lipocerpa maculata</em> (Michx.) Bradley &amp; Sears</td>
<td>3605</td>
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<td><em>argentea</em> R. Br.</td>
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<td><em>atropurpurea</em> Boeck. (L. pulcherrima Ridl.)</td>
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<td>(E)</td>
<td>Central Africa</td>
<td>1869</td>
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<td><em>senegalensis</em> (Lam.) Th. &amp; H. Durand</td>
<td>J. Buchanan</td>
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<td><em>microcephala</em> Kunth</td>
<td>W.T. Tsang</td>
<td>29322</td>
<td>Zambesia</td>
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<td><em>chinensis</em> (Osb.) Kern</td>
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<td><em>spheletata</em> Kunth</td>
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<td><em>Mariscus flabelliformis</em> H.B.K.</td>
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<td>Nigeria</td>
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<td><em>rufus</em> H.B.K</td>
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<td>Nigeria</td>
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<td><em>ligularis</em> (L.) Urb.</td>
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<td><em>congestus</em> (Vahl) Clarke</td>
<td>P. Wilms</td>
<td>1621</td>
<td>S. Africa</td>
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<td><em>cayennensis</em> (Lam.) Urb.</td>
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<td>11373</td>
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<td><em>Nelmesia melanostachya</em> Van der Veken</td>
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<td>(K)</td>
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<td><em>Nemum angolense</em> (Clarke) Oteng-Yeboah</td>
<td>E.A. Robinson</td>
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<td><em>Oxyocaryum arbense</em> (Kunth) Lye</td>
<td>Nil &amp; Schweinfurth</td>
<td>1109</td>
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<td><em>Phylloceirpus sosulius</em> (Phil.) Oteng-Yeboah</td>
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<td>Cuba</td>
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<td><em>Phylloceirpus semisubterraneus</em> (Boeck) Oteng-Yeboah</td>
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<td>Peru</td>
<td>1868</td>
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<td><em>Phylloceirpus asulius</em> (Phil.) Oteng-Yeboah</td>
<td>H.F. Comber</td>
<td>69</td>
<td>Andes</td>
<td>1925</td>
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<td>*J.H. Hunsiker 2191B (K) Eyerdam, Beetle &amp; Grondona 24,303 (K)</td>
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<td><em>semisubterraneus</em> (Boeck) Oteng-Yeboah</td>
<td>G. Mandon</td>
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<td>*Lloyd &amp; Marshall 113 (K) Peru</td>
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Pseudo-schoenopus inanus (Thunb.) Oteng-Yeboah
L. MacGowan 1716 (K) S. Africa 1871
H.H.W. Pearson 3237 (K) S. Africa 1908

*Pycreus globosus (All.) Reichb.
* sanguinolentus (Vahl) Nees
* flavescens (L.) Reichb.

Remirea maritime Aubl. J. Sinclair 3904.2, 38907 (E) Singapore 1950
Tenasserim & Andamanas 6239 (E) India 1862-63

*Schoenoplectus triqueter (L.) Palla
" castratus (L.) Palla
" castratus subsp. glauces (Hartm.) Oteng-Yeboah

" littoralis (Schrad.) Palla
" muconatus (L.) Palla
" supinus (L.) Palla

tatora (N. & M.) Palla limensis (Clarke)
Oteng-Yeboah Clarke 1059 (K) Peru 1887

ranko (Steu.) Oteng-Yeboah
rubiginosus Beetle M. H. Sachet 318 (K) Mexico 1958
Oteng-Yeboah
heterochaetus (Chase) Fernald et al. 14192 N.Y. (U.S.) 1922
Oteng-Yeboah

" muricinus (Clarke) Ex Hb. Gray (K) N.Y. (U.S.) 1865
Oteng-Yeboah A.O.D. Mogg (K) S. Africa 1934

rhodiesious (Podlech) E.A. Robinson 3758 (K) N. Rhodesia 1960
Oteng-Yeboah

oxyjulus (Hooper) Greenway & Brenan 8200 (K) Chalubi Is. 1947
Oteng-Yeboah H.M. Richards 18081 (K) 1963
Corby 482 (K) Corby 482 (K) 1949
K.A. Kershaw 900420 (K) N. Nigeria 1964

uninodia (Del.) M. de Wailly 5006 (K) 1936
Oteng-Yeboah

dissechanthus (Blake) F.J. Hicks 114 (K) Australia 1958
Oteng-Yeboah

groctus (Poir.) Palla Canton Chr. Coll. 12918 (E) China 1924
junocides (Roxb.) Krens W.T. Tsang 26552 (E) China 1936
B.L. Burtt B.1385 (E) W. Pakistan 1958

hondoensis (Ohwi) Ohwi K. Okamoto T.S.M. 772 (E) Hondo (Japan) 1952

lineolatus (Franch. et Sav.) Ohwi M. Mizushima 384 (E) Hondo (Japan) 1950
Ohwi & Koyama T.S.M. 983 (E) Hondo (Japan) 1953
Schoenoplectus nipponicus
(Makino) Ohwi
pretii (Distr.) Ohwi
wallichii (Nees) Ohwi
articulatus (L.)
Oteng-Yeboah
gorybosus (Hayne ex Roth) Oteng-Yeboah
jacobi (Fischer) K. Lye
lateriflorus (Gmelin)
K. Lye
roylei (Nees) Ovzinn & Csukar
Hb. 191 (E).

K. Lye

Sinclair & bin Salleh
40583 (E)

subulatus (Vahl) Ohwi
Hb. Royle (K)

breachyceras (Hochst ex A. Rich.) K. Lye
6574 (E)

paludicola (Kunth) Palla
L. Macowan 1743 (K)

pterolepis (Kunth)
Oteng-Yeboah
10475 (E)

californicus (Ney.)
Oteng-Yeboah
E.K. Balls 11857 (E)
Calif. (U.S.)

americanus (Pers.)
Volkart
Radford 44863 (E)
N. Carol. (U.S.)

Hallii (Gray)
- Oteng-Yeboah

etuberculatus (Steud.)
Oteng-Yeboah
Pl. Exzisco. Grayaea
S.M. Tracy 8627 (E)

= Scirpus cylindricus
(Torr.) Britt
R.M. Harper 1095 (E)

acutus (Muhl.) A. & D. Löve

olneyi (Gray) Palla
J. Macoun 16408 (E)

torreyi (Olney) Palla
Weatherby et al. 526 (E)

validus (Vahl)
W.T. Cody & E.L. Gutteridge
A. & D. Löve
riparius (Presl.) Palla
K. Fiebrig 2311 (E)

chilensis (Nees & Meyer) Oteng-Yeboah
Werdermann 428 (E)

Kunio Sata T.S.M. 1100 (E) Honshu (Japan) 1954

Pl. Jap. Exsic. 306 Honshu (Japan) 1964

Wall. Cat. 3468 (E)

R. Ritche 780 (E)

P. Wilms 1608 (E) S. Africa 1883

Hb. F. Hamilton 191 (E)

Hb. Wight 3448 (E) India

Hb. Wight (E) India 1889

J. Chatterjee (E) India 1958

Hb. Royle (K) India 1886

B. L. Burtt B. 1002 (E) - 1958

Ex Hb. Campbell 27 (E) -

Drummond & Cookson N. Rhodesia

L. Macowan 1743 (K) - 1871

F. Wilms 1610 (E) S. Africa 1895


E.K. Balls 11857 (E) Calif. (U.S.) 1958

Radford 44863 (E) N. Carol. (U.S.) 1966

W.N. Suksdorf 62 (E) Washington DC (U.S.) 1912

R.M. Harper 370 (E) - 1900

M.J. Fernald & C.A. Weatherby Mass. (U.S.) 1908

Ex Hb. Gray (K)

Sullivan (K)

Drummond 268 (K)

A.A. Heller 9472 (E)

Ex Hb. Gray (K)

Sullivan (K)

Drummond 268 (K)

A.A. Heller 9472 (E)

Ex Hb. Gray (K)

Sullivan (K)

Drummond 268 (K)

A.A. Heller 9472 (E)

W.N. Suksdorf 62 (E) Washington DC (U.S.) 1912

R.M. Harper 370 (E) - 1900

M.J. Fernald & C.A. Weatherby Mass. (U.S.) 1908

R.M. Harper 1095 (E) Georgia (U.S.) 1901

J. Macoun 16408 (E) Saskatchewan. (Canada) 1896

R.M. Harper 2181 (E) Georgia (U.S.) 1904

E.L. Ekman H. 47 (K) - 1917

Weatherby et al. 526 (E) Mass. (U.S.) 1932

W.T. Cody & E.L. Gutteridge Canada 1953

7835 (E)

82311 (E) Bolivia 1903

M. Glazion 9044 (K) Brazil 1877

R. Hassler 12255 (K) Paraguay 1913

Chile 1924.
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<td><em>Schoenoplectus saximontanus</em></td>
<td>H.M. Pollard</td>
<td>Calif. (U.S.)</td>
<td>1952</td>
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<td>(Fern.) Oteng-Yeboah</td>
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<td><em>Schoenoplectus smithii</em> (Gray)</td>
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<td>Oteng-Yeboah</td>
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<td><em>Schoenoplectus smithii var. williamsii</em> (Fernald) Oteng-Yeboah</td>
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<td>Central China</td>
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<td><em>Schoenoplectus triangulatus</em> (Roxb.) Oteng-Yeboah</td>
<td>B. L. Burtt B. 1521, B. 675</td>
<td>W. Pakistan</td>
<td>1958</td>
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<td>praelongatus (Poir.) Oteng-Yeboah</td>
<td>J. Sinclair 4333</td>
<td>India</td>
<td>1945</td>
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<td><em>Schoenoplectus spp.</em></td>
<td>F.R. Irvine 4753</td>
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<td>/Scirpus tuberculatus Schoult.</td>
<td>J.P.H. Acocks 2104</td>
<td>S. Africa</td>
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<td>/Scirpus fusco-rubens Koyama.</td>
<td>J. Cavalarice 4088</td>
<td>China</td>
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<td>J. Cavalarice 8050</td>
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*Scirpus sylvaticus L. radicans* Schkuhr.

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<td>ternalinus Reinw.</td>
<td>A. Kneucker</td>
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<td>(= S. chinensis Munro)</td>
<td>A. Henry 1400</td>
<td>China</td>
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<td>K.L. Chu 2940</td>
<td>China</td>
<td>1936</td>
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<td>Handel-Mazzetti (E)</td>
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<td>J. Cavalarice 1177</td>
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<td>Yunnan</td>
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<td>S.W. China</td>
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<td>J.F. Rock 6400</td>
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<td>G. Forrest 28018</td>
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<td>Rev. Pere Faurie</td>
<td>Japan</td>
<td>1886</td>
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<td>Makoto Togasi N.S.M.T. 373</td>
<td>Japan</td>
<td>1951</td>
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<td>Ohwi &amp; Koyama N.S.M. 320</td>
<td>Japan</td>
<td>1951</td>
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<td>M. Togasi T.N.S. 1260</td>
<td>Japan</td>
<td>1955</td>
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<td>K. Iwatsuki &amp; H. Koyama</td>
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<td>1966</td>
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<td>atrovirens Willd.</td>
<td>A.A. Heller</td>
<td>Pennsylvanía (U.S.)</td>
<td>1901</td>
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<td>A. Kneucker 65</td>
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<td>1902</td>
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<td>O.W. Knight</td>
<td>Maine (U.S.)</td>
<td>1905</td>
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<td>J.C. Blumer 1552</td>
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<td>M. Victorin et al. 7398</td>
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<td>P.S. Green 3508</td>
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<td>-condonii Brit.</td>
<td>E.B. Copeland 343</td>
<td>Calif. (U.S.)</td>
<td>1929</td>
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<td>divericatus Ell.</td>
<td>R.M. Harper 799, 1142 (E)</td>
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<td>R.H. Harper 2130</td>
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Scirpus longii Fern.
rubrotritus Fern.
peckii Britt.
polyphylleus Vahl
Asper Prael
sylvatious L.
var. bissellii Fern.

Torulinini ferex Urb.
eggersii (Boecck) Clarke
Trichophorum atacamensis (Boecck.) Onteng-Yeboah
clementis (Jones) Onteng-Yeboah
clintonii (Gray) Onteng-Yeboah
mattfeldianum (Kükenthal) W.T. Tsang 20501 (K) Kwantung (China) 1932
alpinum (L.) Pers.
subcapitatum (Thw.) Olmi
caespitosum (L.) Hartm.
verecundum (Fern.)

Websteria confervoides (Poiret.) Hooper

Genus A
(=Scirpus junghumii Miq.)

Genus B
(=Blymus rufus (Huds.) Link Valentin Norlind (E) Sweden 1912
C.A. & Una F. Weatherby 1327 (E) Canada 1944

Genus C
(=Scirpus nevadensis Wats.) John Macoun 16413 (E) Saskatch. (Canada) 1896