THE UNIVERSITY
of EDINBURGH

This thesis has been submitted in fulfilment of the requirements for a postgraduate degree (e.g. PhD, MPhil, DClinPsychol) at the University of Edinburgh. Please note the following terms and conditions of use:

- This work is protected by copyright and other intellectual property rights, which are retained by the thesis author, unless otherwise stated.
- A copy can be downloaded for personal non-commercial research or study, without prior permission or charge.
- This thesis cannot be reproduced or quoted extensively from without first obtaining permission in writing from the author.
- The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the author.
- When referring to this work, full bibliographic details including the author, title, awarding institution and date of the thesis must be given.

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

EX BIBL. UNIV. EDINB. GEN.

ABSTRACT OF THESIS

Name of Candidate Alfred Apau Oteng-Yeboah

Address University Department of Botany, Taxonomy Section, Royal Botanic Garden, EDINBURGH.

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 Cyperoideae (excluding the tribe Rhynchosporeae) on a world-wide basis. It involves a broad survey of comparative exomorphic and endomorphic 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 Cyperoideae, have been employed to form the basis of the supra-specific classification presented here.

The two large Linnaean genera, viz: Scirpus and Cyperus, have been split into a number of small, natural genera. Four distinct taxa, previously included in Scirpus s.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 monotypic 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 Cypereae and Scirpeae 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 Cyperoideae 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.

Use other side if necessary.

DEDICATION

I wish to dedicate this thesis to my parents

Afua and Kofi of Ghana

LIST OF CONTENTS

LIST OF FIGURES

LIST OF MAPS

ACKNOWLEDGEMENTS

I wish to express my gratitude to my supervisors viz: Dr P.H. Davis and Dr P.M. Smith for the keen interest they have taken in the research, and for their constructive criticisms of my draft manuscript.

I also wish to thank the general staff at the Botany Department, University of Edinburgh and at the Royal Botanic Garden, Edinburgh, for their invaluable help and assistance in many ways.

Thanks are due to the Directors of the following herbaria: the British Museum, Natural History (BM); Edinburgh (E); Geneva (G); Kew (K); the Linnean Society of London (LINN); Lund (LD); Mexico (MEXU); Sao Paolo (SP) and Tokyo (TNS) who made their specimens available to me for study. I am especially indebted to the authorities at the British Museum, Edinburgh and Kew for kindly providing facilities for me to work in their herbaria.

To the following persons who helped me in various ways, I wish to express my thanks. They are Messrs B.L. Burtt (Edinburgh), A.C. Jermy (BM), F. Richardson (Jodrell Laboratory) and Misses S.S. Hooper (Kew) and Carol Milne (Edinburgh).

To Mrs G.H. Millar, many thanks are due for her patience in typing out the manuscript.

This research was financed through an award of a Post-Graduate Scholarship by the University of Cape Coast, Ghana, to whom I am very grateful.

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 Cypereae 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), Holttum (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 submerged 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 *Caricoideae*, 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 Caricoideae.

Rays: refer to the lateral branches from the main inflorescence axis. Depending on their position, they may be primary when they are direct offshoots 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. vii). 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, scarious, 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 ~~Polygonaceae~~ 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 Metcalfe and Gregory 1964, Metcalfe 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 Acetic Acid Alcohol (F.A.A.) 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 Metcalfe 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. treatment 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. H.Cl 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 cellosolve 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 urigated 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 carbolic 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 gum 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.

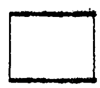
i Contractions used in Figures and Plates

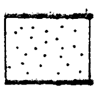
AC	air cavity	B	Bulliform cells
Bar.	Barbs	Br.	Bracts
C	Culm	Chl.	chlorenchyma
Cu P.	Cuticular papillae	Ep.	Epidermis
Endo.	Endocarp	Exo.	Exocarp

Fr.	Fruit	Gl.	Glume
G.C.	Guard cell	G.T.	Ground tissue
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.	Substomatal cavity	TC	Translucent cell
VB	Vascular bundle		

ii <u>Key to the shadings in Anatomical Line drawing</u> (after Metcalfe 1971)

 Sclerenchyma

 Parenchyma

 Phloem

 Xylem

 Chlorenchyma

PART I

CHAPTER I

INTRODUCTION

A broad morphological survey of Ascolepis, 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 Ascolepis, 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 Scirpeae and Cypereae 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 Rhynchosporeae 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 he 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 *Fimbristylis* (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), *Ficinia* (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), *Blysmus* (Panzer 1824), *Eleogiton* (Link 1827), *Holoschoenus* (Link 1827), *Nemum*

(Desv. 1825), Schoenoplectus (Palla 1888), Bolboschoenus (Palla 1905), Websteria (Wright 1887), Desmoschoenus (Hook.f. 1853), Hellmuthia (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, Eleogiton, Eu-Isolepis, Holoschoenus, Desmoschoenus and Androcoma, while subgenus Eu-Scirpus had 4 sections, viz: Baeothryon, Schoenoplectus, Blysmus 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, Monostachya, Isolepis, Eu-Scirpus, Blysmus, Seidlia, Michelianae, 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, Oxycaryum, Holoschoenus, Isolepis, 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 Aphylloides having erect non-foliaceous, culm-like involucral bracts and greatly reduced cauline leaves. Under the subgenus Eu-Scirpus, he recognised 6 sections, viz: Oxycaryum, Monocephales, Reigera, Nemocharis, Androcoma, Trichophorum and under the subgenus Aphylloides 7 sections, viz: Baeothryon, Eleogiton, Isolepis, Actaeogeton, 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 bristles 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. Eleogiton, Actaeogeton, Isolepis, Holoschoenus)

Group II Fuirena (sect. Vaginaria)

Group III Blysmus (sect. Blysmus)

Group IV Bolboschoenus (sect. Bolboschoenus, Actinoscirpus)

Group V Scirpus (sect. Desmoschoenus, Micranthi, Oxycaryum, Trichophorum 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. juncoides and in other Fuirena species, e.g. F. stricta to petal-like plates as in Fuirena s.s., e.g. F. squarrosa, 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) bristles to a fruit, through 6 filiform and antrorsely scabrous bristles 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 Blysmus, Desmoschoenus, Oxycaryum, 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 Mariscus (especially the one-flowered species) and Koyama (op. cit.) accordingly sank it in Cyperus s.l. as a section of his subgenus Mariscus. Previously, Remirea had been considered a member of the tribe Rhynchosporeae (cf. Pax 1887, Kukenthal 1935). Classification of Cyperus s.l., in which such groups as Dichostylis, Lipocarpha, Remirea etc. had been included, was made more complex by Koyama and McVaugh (1963) who further transferred the Mexican Scirpus orbicephalus 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 ± 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.

Metcalfe'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 attemps to classify Scirpus s.l. and Cyperus s.l. Though Metcalfe took a relatively broad concept of Scirpus (excluding Fuirena, 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, Mariscus, 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 Mariscus spp. and one species of Juncellus (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 develoment 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 uninvestigated taxa, especially in Scirpus s.l., and especially for those from the tropics and subtropics. Some of the uninvestigated species in Scirpus included S. junghuhnii, S. submersus (confervoides), S. nevadensis, S. membranaceus, S. inanis, S. frondosus, S. oxyjulos etc. Some of these taxa have fairly recently been circumscribed, (e.g. S. junghuhnii, 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. analecti and S. coahuilensis (from Mexico), S. paniculato-corymbosus, S. petalotii and S. rosthornii (from Indo-China & China), S. ficinioides 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. ficinioides 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 Kukenthal (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-schoenus was a section in Clarke's (1908) classification of Scirpus and is based on Scirpus inanis.

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 Pycnostachys (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 comfirm 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).

Erioscirpus has been adopted to accommodate E. comosum and E. microstachyum, as well as the relatively recently described E. scabriculme (Scirpus scabriculmis) and E. transiens, all from Indo-China (Raymond 1957, 1960). The South African Scirpus falsus has also been transferred to Erioscirpus 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 atacamensis 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. hystrix 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. schomburgkii (cf. Friedland 1941). In the absence of this adaxial hyaline scale, there is no difference between these two species of Hemicarpha 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. serotinus has been taken out to form Duval-Jouvea.

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 ined. combinations have been made with their Latin descriptions deferred, due to lack of time. These new combinations are found in the Appendix.

TABLE 1 HISTORY OF CLASSIFICATIONS OF GENERA ADOPTED

GENERA ACCEPTED AND ADOPTED IN PRESENT WORK	PAX 1887	CLARKE 1908	KUKENTHAL 1936	BEETLE 1940, 1941, 1944, 1947	KOYAMA 1958, 1961
ANDROTRICHUM Brongn. ex Kunth (1837)	+	Scirpus L. sect. Isolepis series Holoschoeneae p.p.	-	-	-
ASCOLEPIS Nees ex Steud. (1855)	+	+	-	-	-
BLYSMUS Panzer (1824)	Scirpus L. subgen. Euscirpus sect. Blysmus	Scirpus sect Blysmus	-	Nomochloa p.p.	Scirpus Group Blysmus sect. Blysmus
BOLBOSCHOENUS (Aschers.) Palla (1905)	-	Scirpus sect. Eu-Scirpus series Lacustres	-	Scirpus subgen. Eu-Scirpus sect. Reigera	Scirpus Group Bolboschoenus sect. Bolboschoenus series Bolboschoenus
COURTOISIA Nees (1834)	+	+	Cyperus subgen. Mariscus sect. Aristati p.p.	-	-
CYPERUS L. (1753)	+	+	+	-	+
DESMOSCHOENUS Hook. f. (1853)	Scirpus subgen Isolepis sect. Desmoschoenus	Scirpus sect. Desmoschoenus	-	-	Scirpus Group Scirpus sect. Desmoschoenus p.p.
ELEOGITON Link (1827)	Scirpus subgen. Isolepis sect. Eleogiton	Scirpus sect. Monostachyae p.p.	-	Scirpus subgen. Aphylloides sect. Eleogiton	Scirpus Group Isolepis sect. Eleogiton
DUVAL-JOUVEA Palla (1905)	Cyperus sect. Juncellus	Juncellus p.p.	Cyperus subgen. Juncellus sect. Serotini		Cyperus subgen. Cyperus sect. Juncellus
ERIOPHORUM L. (1753)	Eriophorum subgen. Eueriophorum p.p.	Eriophorum sect. Eriophorum	-	-	Scirpus Group Eriophorum sect. Japonici, Vaginati
ERIOSCIRPUS Palla (1896)	Eriophorum subgen. Eueriophorum p.p.	Eriophorum sect. Lachnophorum	-	-	Scirpus Group Baeothryon sect. Lachnophorum
FICINIA Schrad. (1832)	+	+	-	-	-
FUIRENA Rottb. (1773)	+	+	-	-	Scirpus Group Fuirena sect Vaginaria
GALILEA Parl. (1845)	Cyperus sect. Eu-Cyperus p.p.	Cyperus sect. Conglomeratae	Cyperus subgen. Eu-Cyperus sect. Bobartia p.p.	-	Cyperus subgen. Cyperus p.p.
HELLMUTHIA Steud. (1855)	Scirpus subgen. Eu-Scirpus sect. Schoenoplectus p.p.	Scirpus sect. Isolepis series Holoschoeneae	-	-	-
HEMICARPHA Nees (1834) emend.	+	Scirpus sect. Microstylae	-	-	-
HOLOSCHOENUS Link (1827)	Scirpus subgen. Isolepis sect. Holoschoenus	Scirpus sect. Isolepis Series Holoschoeneae	-	Scirpus subgen. Aphylloides sect. Holoschoenus	Scirpus Group Isolepis sect. Holoschoenus
HYMENOCHAETA Beauv. (1819)	Scirpus subgen. Eu-Scirpus sect. Schoenoplectus p.p.	Scirpus sect. Eu-Scirpus series Lacustres p.p.	-	-	Scirpus Group Bolboschoenus sect. Actinoscirpus
ISOLEPIS R. Br. (1810) emend.	Scirpus subgen. Isolepis sect. Eu-Isolepis	Scirpus sect. Isolepis	-	Scirpus subgen. Aphylloides sect. Isolepis	Scirpus Group Isolepis Sect. Isolepis
JUNCELLUS Clarke (1893) emend.	Cyperus sect. Juncellus p.p.	+	Cyperus subgen. Juncellus sect. Laevigati	-	Cyperus subgen. Cyperus sect. Juncellus p.p.

TABLE 1 HISTORY OF CLASSIFICATIONS OF GENERA ADOPTED (contd.)

GENERA ACCEPTED AND ADOPTED IN PRESENT WORK	PAX 1887	CLARKE 1908	KUKENTHAL 1936	BEETLE 1940, 1941, 1944, 1947	KOYAMA 1958, 1961
KYLLINGA Rottb. (1773)	+	+	Cyperus subgen. Kyllinga	-	Cyperus subgen. Kyllinga
LIPOCARPHA R. Br. (1818)	+	+	-	-	Cyperus subgen. Lipocarpha
MARISCUS Gaertn. (1788)	Cyperus sect. Mariscus	+	Cyperus subgen. Mariscus	-	Cyperus subgen. Mariscus
NELMESIA Van der Veken (1955)	-	-	-	-	-
NEMUM Desv. ex Hamilton (1825)	Scirpus subgen. Isolepis sect. Nemum	Scirpus sect. Nemum	-	-	-
OXYCARYUM Nees (1842)	Scirpus subgen. Isolepis sect. Androcoma p.p.	Scirpus sect. Isolepis series Holoschoeneae p.p.	-	Scirpus subgen. Eu-Scirpus sect. Oxycaryum p.p.	Scirpus Group Scirpus sect. Oxycaryum p.p.
PHYLLOSCIRPUS Clarke (1908)	-	Scirpus sect. Michelianae p.p.	-	Scirpus subgen. Eu-Scirpus sect. Monocephales	Scirpus Group Scirpus sect. Micranthi p.p.
PSEUDO-SCHOENUS (Clarke)	-	Scirpus sect. Pseudo-schoenus	-	-	Scirpus Group Scirpus sect. Desmoschoenus p.p.
PYCREUS Beauv. (1807)	Cyperus sect. Pycreus	+	Cyperus subgen. Pycreus	-	Cyperus subgen. Pycreus
QUEENSLANDIELLA Domin (1915)	-	-	Cyperus subgen. Mariscus sect. Aristati p.p.	-	
REMIREA Auld. (1775)	+	+	-	-	Cyperus subgen. Mariscus sect. Remirea
SCHOENOPLECTUS (Reichb.) Palla (1889)	Scirpus subgen. Eu-Scirpus sect. Schoenoplectus p.p.	Scirpus sect. Eu-Scirpus series Mucronatae, Lacustres, Littorales	-	Scirpus subgen. Aphylloides sect. Actaeogeton, Schoenoplectus, Pterolepis	Scirpus Group Isolepis sect. Actaeogeton Scirpus Group Bolboschoenus series Malacogeton
SCIRPUS L. (1753) emend.	Scirpus subgen. Eu-Scirpus p.p.	Scirpus sect. Seedlia, Eu-Scirpus p.p.	-	Scirpus subgen. Eu-Scirpus sect. Nemocaris, Androcoma, Trichophorum p.p.	Scirpus Group Scirpus sect. Scirpus, Trichophorum p.p.
TORULINIUM Desv. ex Hamilton (1825)	Cyperus sect. Diclidium	+	Cyperus subgen. Torulinium	-	Cyperus subgen. Mariscus sect. Diclidium
TRICHOPHORUM Persoon (1805) emend.	Eriophorum subgen. Trichophorum p.p.; Scirpus subgen. Eu-Scirpus sect. Baeothryon	Eriophorum sect. Trichophorum Scirpus sect. Monostachyae p.p. sect. Blysmus p.p. sect. Michelianae p.p.	-	Scirpus subgen. Aphylloides sect. Baeothryon	Scirpus Group Baeothryon sect. Baeothryon
WEBSTERIA Wright (1887)		Scirpus sect. Monostachyae series Fluitantes p.p.	-	-	Scirpus Group Isolepis sect. Eleogiton p.p.
GENUS A	-	-	-	-	-
GENUS B	Scirpus subgen. Eu-Scirpus sect. Blysmus p.p.	Scirpus sect. Blysmus p.p.	-	Nomochloa p.p.	Scirpus Group Blysmus sect. Blysmus p.p.
GENUS C		Scirpus sect. Eu-Scirpus series Mucronatae p.p.	-	Scirpus subgen. Aphylloides sect. Schoenoplectus p.p.	-

Key:
subgen. = subgenus
sect. = section
series = series
p.p. = pro parte (in part)
+ = status of taxon unchanged
- = not considered

CHAPTER II

COMPARATIVE 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 Isolepis, 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 Veken 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. Phylloscirpus, Genus C, Remirea and Galilea. In Phylloscirpus, 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 Genus 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, a bud 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, Rendle 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 Palmae (Arecaceae) and Liliaceae and differs from that of Gramineae (Rendle 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 cotyledon alone grows, the sheath elongates, breaks through the testa, and bends upwards. A circlet 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*, *Blysmus* 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 *Websteria* 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*, *Isolepis*, *Erioscirpus*, *Nelmesia*, *Nemum*, *Hemicarpha*, *Cyperus*, *Kyllinga*, *Lipocarpha*, *Desmoschoenus*, *Hymenochaeta*, *Ficinia*, *Holoschoenus*, *Hellmuthia*, *Oxycaryum*, *Mariscus*, *Juncellus*, *Duval-Jouvea*, *Galilea*, *Androtrichium*, *Genus C* etc. In *Remirea* and *Phylloscirpus*, 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 either slender or robust shoots, measuring 2.0 mm to 5.0 mm diameter, while others, especially Isolepis, Eleogiton, Trichophorum, Websteria, Nelmesia, Nemum, Juncellus, most Erioscirpus 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 sheathe the bases of the axillary non-leafy part of the shoot. The normal phyllotaxy is tristichous, but in Remirea, Phylloscirpus 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, Oxycaryum, Lipocarpha, Phylloscirpus, 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.

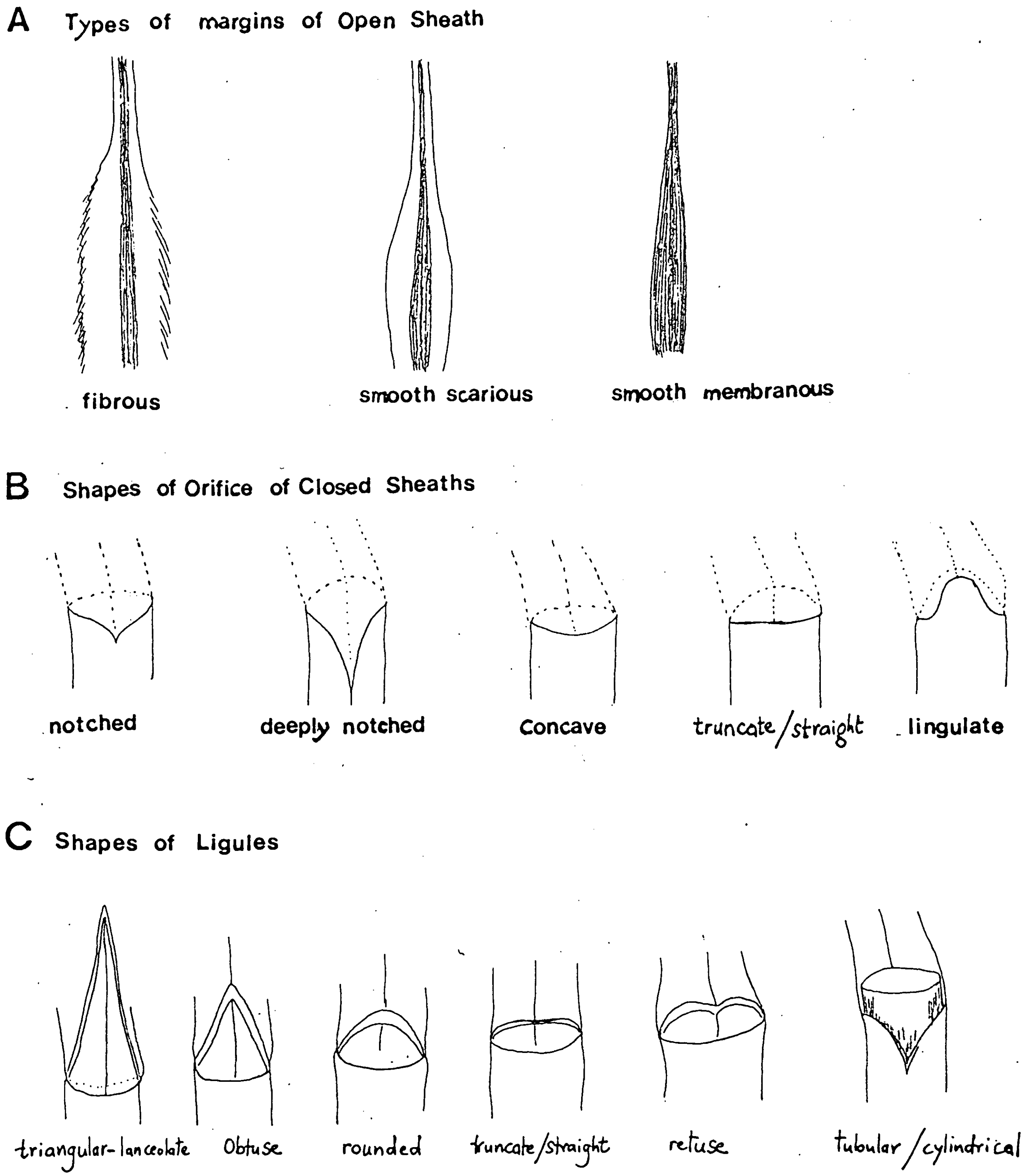


Fig 1 Leaf Sheath and Ligule

(B, 3-5 & C 2-4, 6 after Jermy & Tutin 1968)

Ligule: Ligules have been found in only Scirpus, Trichophorum, Genus A, Fuirena, Eriophorum, Blysmus, 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 Actaeogeton, Pseudo-schoenus, Fuirena subgenus Vaginaria, Ficinia especially F. aphylla and Holoschoenus especially H. dioecus, H. nodosus and H. thunbergianus, which often have no leaf bladès, or only a short mucro: 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 Scirpus, Cyperus, Bolboschoenus, Eriophorum, Genus A, Fuirena, Hymenochaeta, Blysmus, Oxycaryum, Pycreus, Duval-Jouvea, Mariscus, Kyllinga, Remirea etc. The channelled or canaliculate 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, Phylloscirpus, Lipocarpha, Ascolepis, Erioscirpus spp., Ficinia spp., Galilea, Juncellus etc.

The _setaceous_ 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_, _Nelmesia_, _Hemicarpha_, _Erioscirpus_ spp.

INTERNAL MORPHOLOGY

THE ROOT

Roots in different genera and species vary in length, thickness and fleshiness (i.e. the extent to which they are fleshy). 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 & Douliot 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 schizo-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 (periclinal) and radial walls more strongly thickened than the outer tangential (periclinal) 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, amprphous substance which usually gives the reaction for tannins (Metcalfe 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, Matcalfe 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

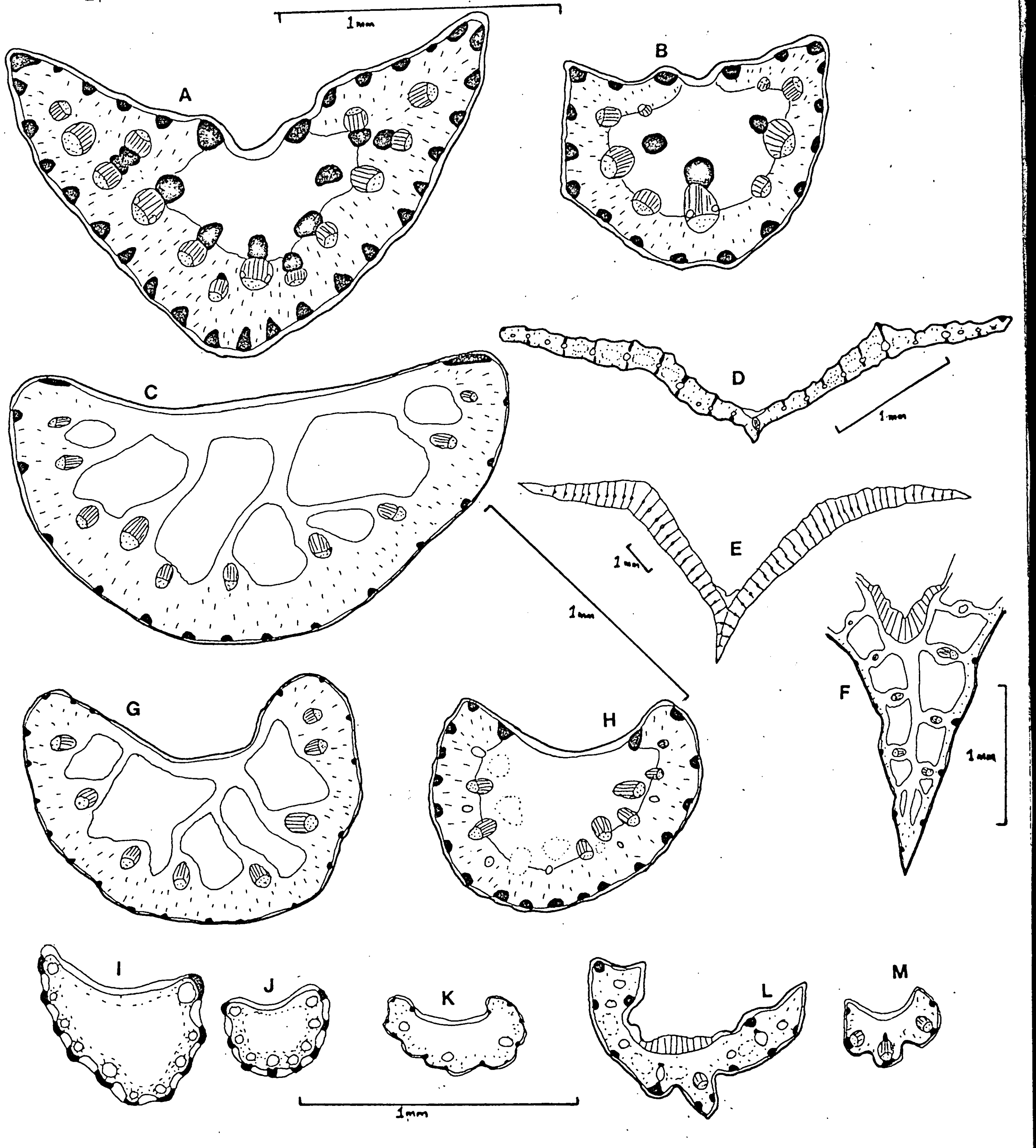


Fig. 2 T.S. of Leaf

A, B. Desmoschoenus spiralis (A. Middle region; B. Distal ×50); C. Genus B (Blysmus rufus) ×50
D. Blysmus compressus ×25; E, F. Hymenochaeta grossa (E. Whole Leaf t.s. ×6; F. Keel region ×25)
G. Schoenoplectus sp. ×50; H. Genus C (Scirpus nevadensis) ×50; I, J Nemum (I. N. angolensum; J. N. spadiceum) ×50
K. Hemicarpha micrantha ×50; L, M Trichophorum ×50 (L: T. atacamensis; M. T. clementis)

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 hemisphaerical, 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 vascualr bundles - simulating a V or an arc, and in the presence or absence of a keel in the abaxial surface respectively. Variously 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), Oxycaryum etc. The flanged V-shaped outline may sometimes appear as inversely W-shaped, as in Blysmus (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 canaliculate leaves, and most other genera with setaceous leaves, show various crescentiform shapes: such as thickly crescentiform shapes, e.g. Desmoschoenus (see Fig. 2.A.B), Nemum (see Fig. 2.I.J) etc. truncately-circular e.g. Lipocarpha spp; hemisphaerical, e.g. Juncellus, 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, Mariscus, *Cyperus*, *Pycreus*, *Eriosoirpus* (see Fig. 3.C) 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*, *Websteria*, 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 theleaf. 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 Bulliform 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,

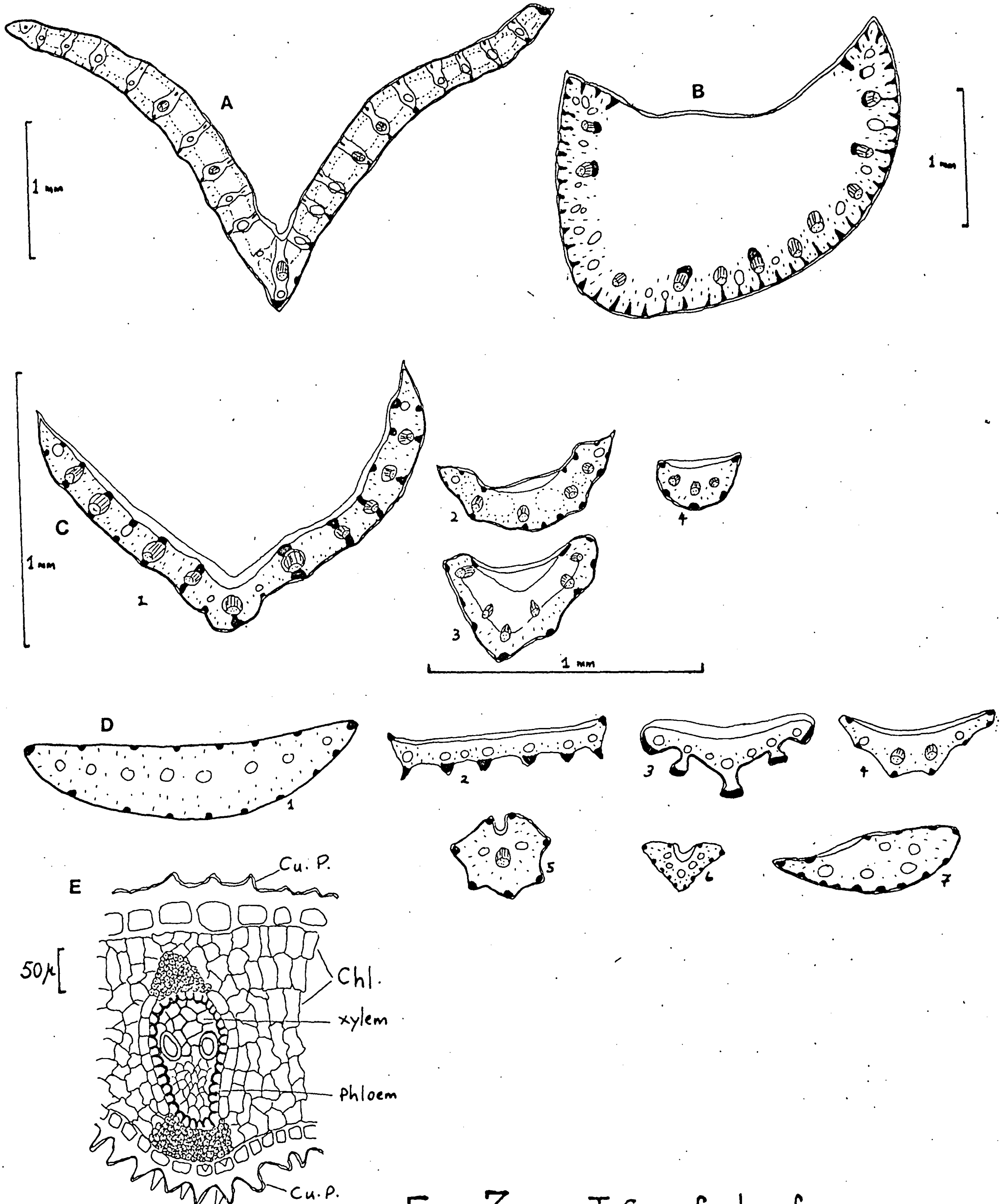


Fig. 3 T.S. of Leaf

A. *Bolboschoenus planiculmis* X25 ; B. *Holoschoenus vulgaris* x25
C1-4 *Erioscirpus* spp. X50 (1, *E. comosus* ; 2, 3; *E. falsus* 4, *E. microstachyus*) ; D1-7 *Ficinia* spp. diagrammatic
(D1 *F. praemorsa* : 2 *F. angustifolia* ; 3, *F. longifolia* ; 4 *F. trichoides* ; 5 *F. paradoxa* ; 6 *F. secunda* ; 7 *F. brevifolia*)
E. Genus A (*Scirpus junghuhnii*) X160

as in Hellmuthia, those over the sclerenchymatous 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 Fuirena.

Frequently variously shaped silica bodies project into the lumina from the inner tangential (periclinal) walls of the epidermal cells overlying the hypodermal sclerenchyma. These salica bodies measure between 3-6 μ x 6-15 μ 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 Oxycaryum. 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, Juncellus, Duval-Jouvea, Remirea, Courtoisia, Torulinium, Cyperus spp., Nelmesia, Nemum, Queenslandiella 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.G.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 "Diaphragms"; 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 Trichophorum (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.

Sclerenchyma: The distribution of the sclerenchymatous 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, Hymenochaeta, 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, Trichophorum, Fuirena and Erioscirpus contain species which show large or small variously shaped sclerenchyma which may also be strands, girders or partial girders.

In most genera, especially those with variously V-shaped leaves, the sclerenchymatous 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 shaped crescentiform leaves e.g. Holoschoenus, Hellmuthia etc. (see Fig. 3.B) the sclerenchyma 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 sclerenchymatous caps associated with the vascular bundles are often found around larger bundles. Genera in which they were not observed include Nemum, Isolepis, Hemicarpha, Phylloscirpus, Eleogiton, Ascolepis, Ficinia, Lipocarpha, Nelmesia, 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

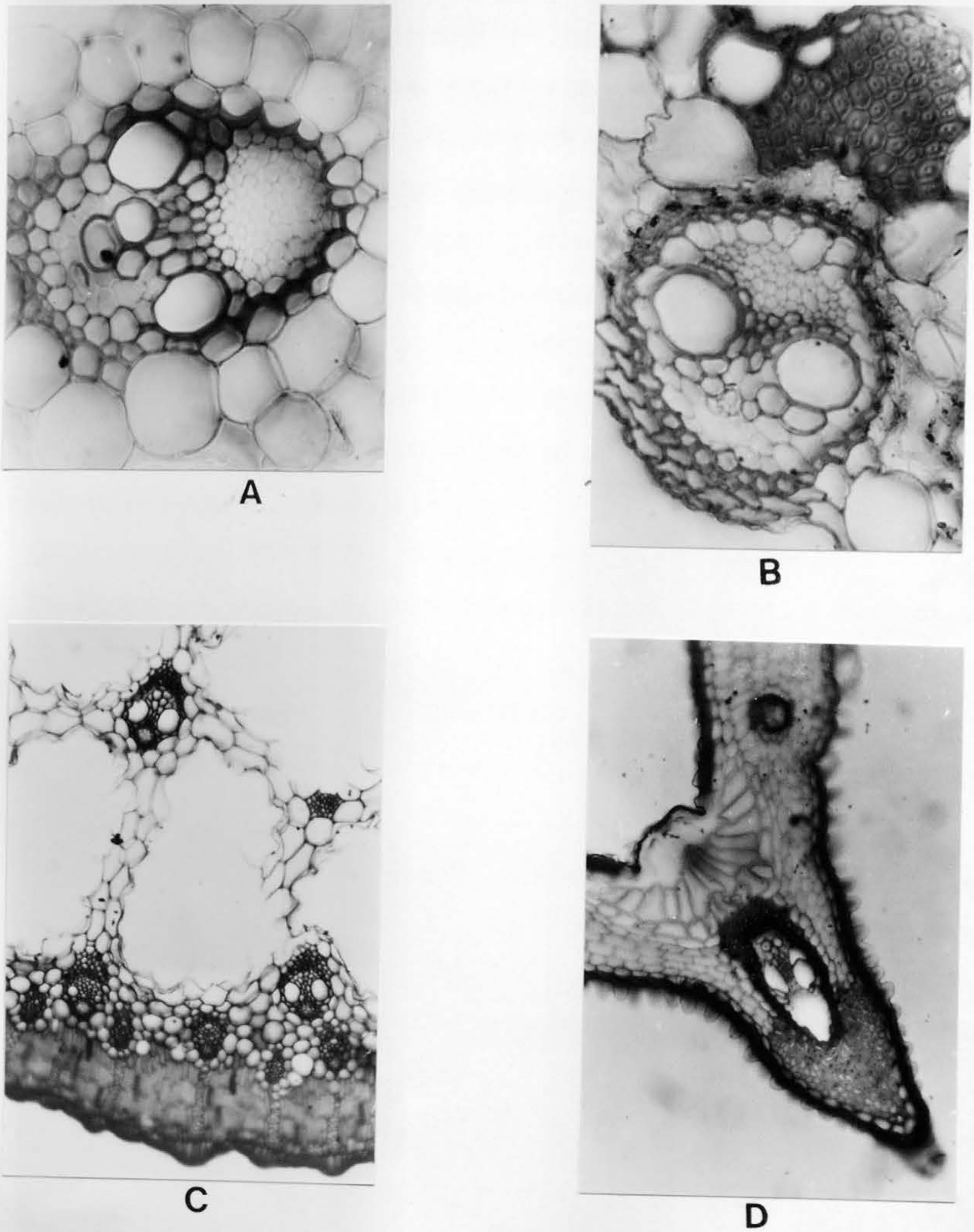
Distribution and arrangement: As already noted, the distinction made between the four leaf types observed from t.s., was based among others largely on the relative distribution and arrangement of the vascular bundles. Since all the genera considered here have the dorsiventral type of leaf, one might 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 Juncellus, Remirea, Mariscus, Pycreus, Lipocarpha etc., has the vascular bundles arranged in an arc, as in the second type above. Another group of genera, e.g. Mariscus, 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. Metcalfe (op. cit) has rightly suggested developmental anatomical investigations



A B C D

Pl. 2

A. Vascular Bundle from Leaf of Genus B (Blysmus 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 junghuhnii × 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 Metcalfe (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, Oxycaryum, Ficinia etc. (see Fig. 4.F), or uniformly and completely U-shaped as in Genus A, Hellmuthia, Eleogiton etc. (see Fig. 4.A-C), or partially U-shaped at the xylem pole, as in some Trichophorum spp. (see Fig. 4.D.) or at

Fig. 4 Types of Vascular Bundle sheaths x660

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

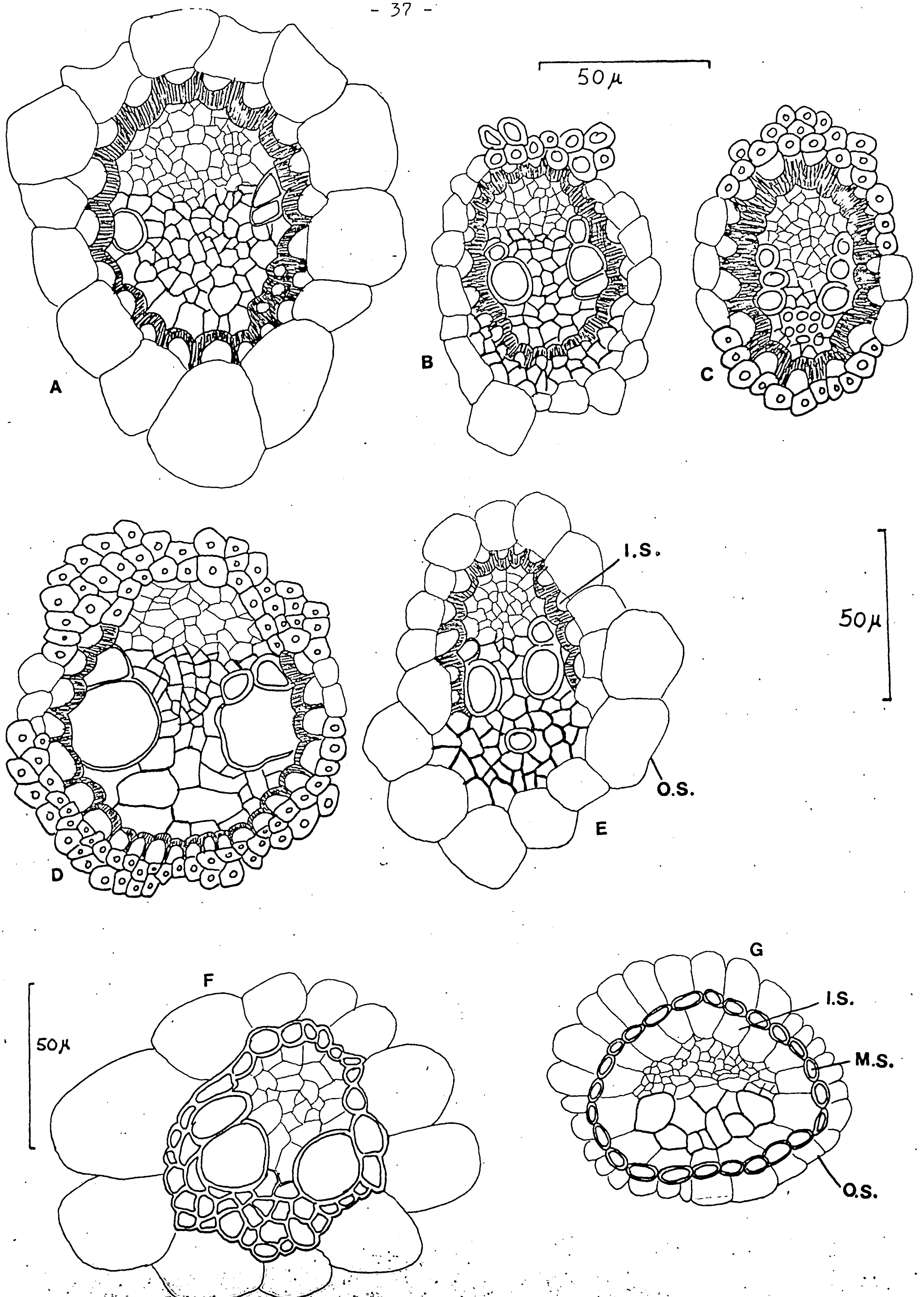


Fig. 4

the phloem pole, as in Blysmus, Genus B, 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, Mariscus, Pycreus, Juncellus, Duval-Jouvea, Remirea, Torulinium, Galilea, 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 SHOOT OR CULM

Internodal structure: 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, Monoyer 1934, Metcalfe 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, Hellmuthia, Websteria, Genus A, Genus C, Phylloscirpus, Remirea and Desmoschoenus.

Outlines/shapes in transverse section: The outlines generally shown in the culms are variations from circular and triangular shapes (see Metcalfe 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 cicular 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

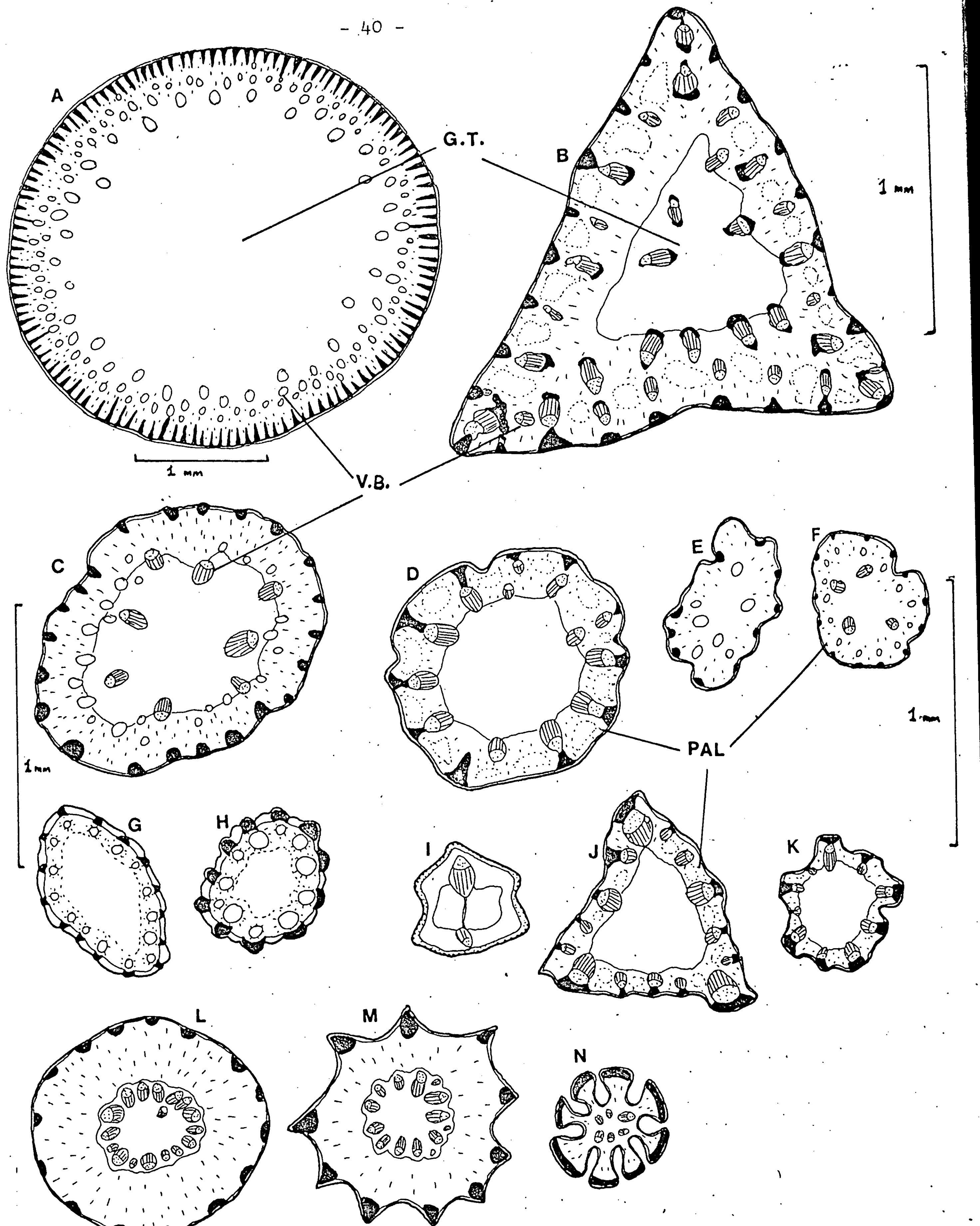


Fig. 5 T.S. of Culm

A. *Holoschoenus vulgaris* x25 ; B. *Bolboschoenus planifolius* x50 ; C. Genus C (*Scirpus nevadensis*) x 50
D. *Phylloscirpus* sp. (*Scirpus acaulis*) x 50 ; E.F. *Hemicarpha* spp. x50 (E. (*Scirpus*) *brevicaulis*, F, *Hemicarpha micrantha*)
G.H. *Nemum* spp. x 50 (G. *N. angolensum* ; H, *N. spadiceum*) ; I. *Websteria* sp. x50 (*W. confervoida*) ; J.K. *Trichophorum* spp. x50
(J, *T. wattfeldianum* ; K, *T. clementis*) ; L,M,N, *Ficinia* spp. diagrammatic (L, *F. scariosa* ; M *F. paradoxa* N, *F. longifolia*)

triangular shapes, corresponds to the external surface structure of the culm as observed with a handlens 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, Erioscirpus, Cyperus. Among the genera showing only circular variations in culm shapes are Nemum, Androtrichium, Phylloscirpus, Hemicarpha, Lipocarpha, Ascolepis, Genus C, Genus B, Holoschoenus, Hellmuthia, Pseudo-schoenus, Ficinia, Nelmesia, Genus A, Juncellus, Galilea, Isolepis, Eleogiton etc. Among those showing only triangular variations are Bolboschoenus, Blysmus, Courtoisia, Eriophorum, Duval-Jouvea, Kyllinga, Mariscus, Hymenochaeta 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, sclerenchyma, 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 sclerenchymatous tissues are generally smaller and shorter than, or sometimes of the same size as those over the chlorenchymatous tissues; except in Pseudo-schoenus (Pl. 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,

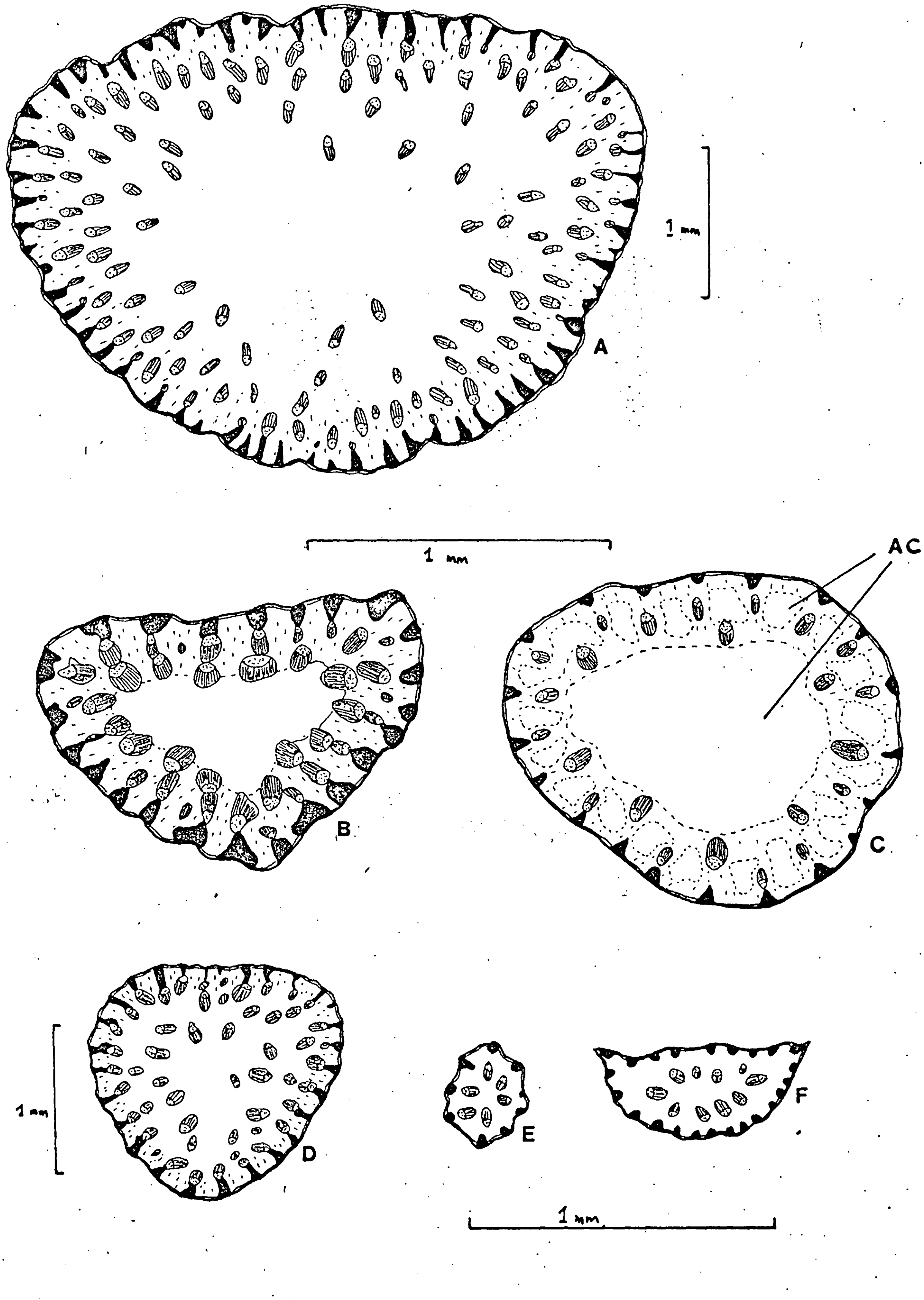


Fig. 6 T. S. of Culm

A. *Scirpus sylvaticus* ×25 B.C. *Eriophorum* spp. ×50 (B, *E. japonicum* ; C, *E. callitrix*)

D.E.F. *Erioscirpus* spp. (D, *E. comosus* ×25 ; E, *E. microstachyus* ×50 ; F, *E. falsus* ×50) or are completely absent but in some species of *Trichophorum* and *Erioscirpus* prickles are found on the culm. 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 *Desmoschoenus*. The cells may be slightly or strongly lobed. Radiate chlorenchyma is found in the same examples mentioned under the leaf (see p. 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 sclerenchomatous tissues, the distinction between them is as in the leaf. Genera with predominantly small sclerenchymatous strands include *Hymenochaeta*, *Schoenoplectus*, *Isolepis*, *Genus B*, *Hemicarpha*, *Eleogiton*, *Websteria*, *Oxycaryum*, *Lipocarpha*, *Ascolepis*, *Kyllinga*, *Juncellus*, *Duval-Jouvea*, *Mariscus*, *Pycreus*, *Galilae*, *Ficinia* etc. Those with predominantly tall and narrow or large sclerenchymatous girders or partial girders include *Scirpus*, *Genus A*, *Pseudo-schoenus* (Pl.2. C), *Desmoschoenus*, *Bolboschoenus*, *Trichophorum*, *Holoschoenus*, *Androtrichium*, *Hellmuthia*, *Fuirena*, *Eriophorum* etc.

In *Erioscirpus* (Fig. 6.D-E) and *Cyperus* different species show either strands or girders. The thickly crescentiform hypodermal sclerenchyma in *Nelmesia* and

and Nemum (Fig. 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, Nelmesia, Eleogiton, Websteria. Sclerenchymatous tissues occurring irregularly in the chlorenchyma or ground tissue or both have been seen in Hymenochaeta, Pseudo-schoenus, Desmoschoenus, Schoenoplectus and Oxycaryum.

Vascular bundles

Number: With the exception of Isolepis, Eleogiton, Websteria, Trichophorum, Schoenoplectus sect. Actaeogeton, Phylloscirpus, Hemicarpha, Ficinia (except in F. radiata), Nelmesia 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, Blysmus, Hellmuthia, Trichophorum, Eriophorum, Phylloscirpus, Nelmesia, some Erioscirpus 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, Androtrichum, Genus C, some Scirpus spp. Often in Desmoschoenus, some Scirpus spp., Bolboschoenus, Genus A, Fuirena, Oxycaryum, some Cyperus spp., Erioscirpus (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, Ascolepis etc., or forming more than one often irregular ring in the ground tissue as in some Cyperus spp., Juncellus, Kyllinga, Mariscus, Galalea, Torulinium, Remirea, Pycreus, Duval-Jouvea. In Ficinia, 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 Genus B 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, Fig. 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.

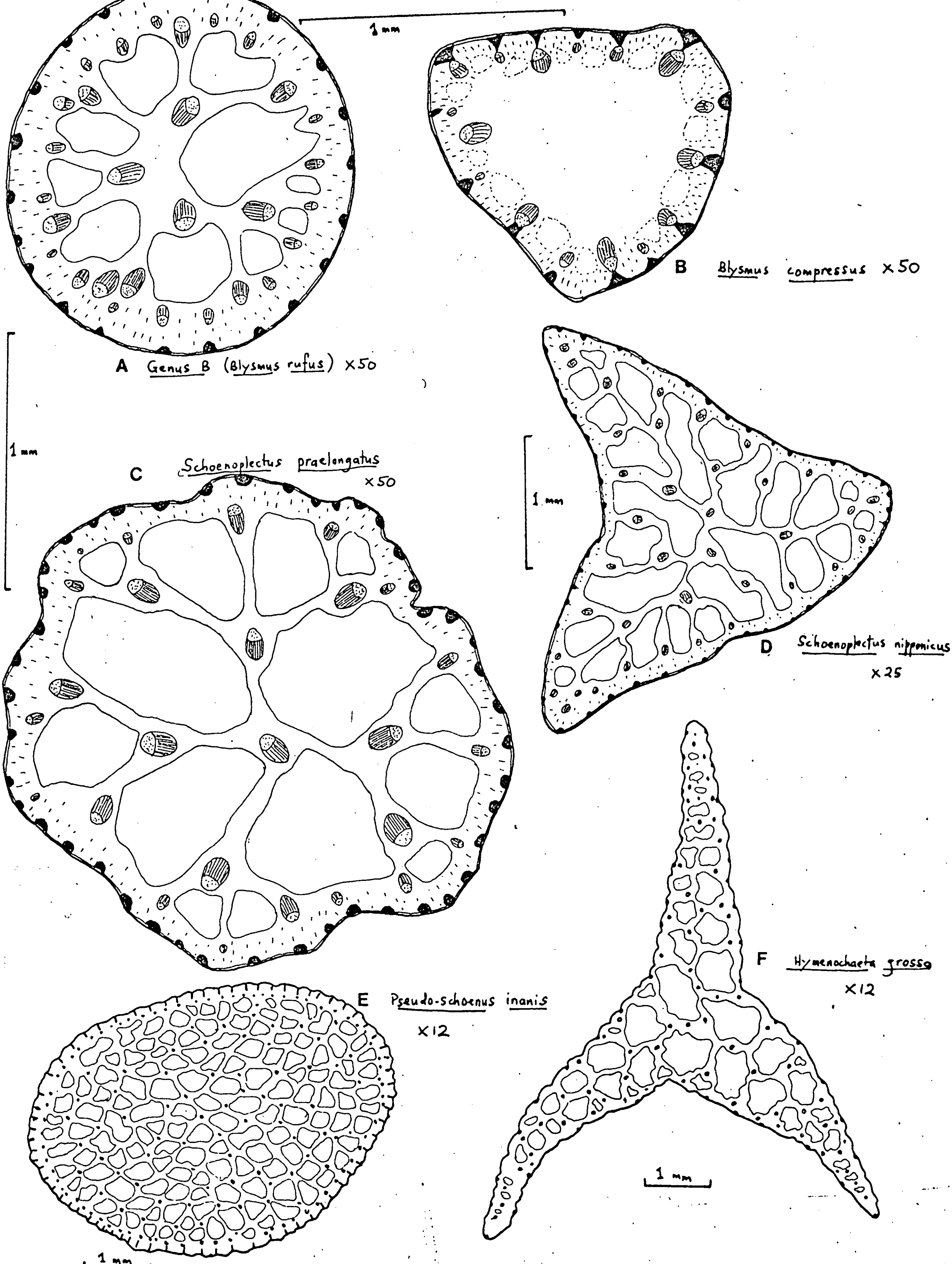


Fig. 7 t.s. of Culm

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, Oxycaryum etc., and (2) those in which the cells are intact, as in Erioscirpus, Ficinia, Phylloscirpus, Genus C, Hellmuthia. 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-schoenus 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 lysigenously by the breakdown of the chlorenchyma; and they normally contain the broken ends of cells. Genera in which this type of air cavaties 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 air-cavities in the ground tissue are of two types according to their suspected mode of development and also the cells or material included in them. The air-cavities in the net-like ground tissues are believed to have developed schisogenously and very often contain stellate or lobed translucent cells with transverse veins, often referred to as "Diaphragms" (after Duval-Jouve 1873). The large central air cavities, in such genera as Nemum, Eriophorum etc. are

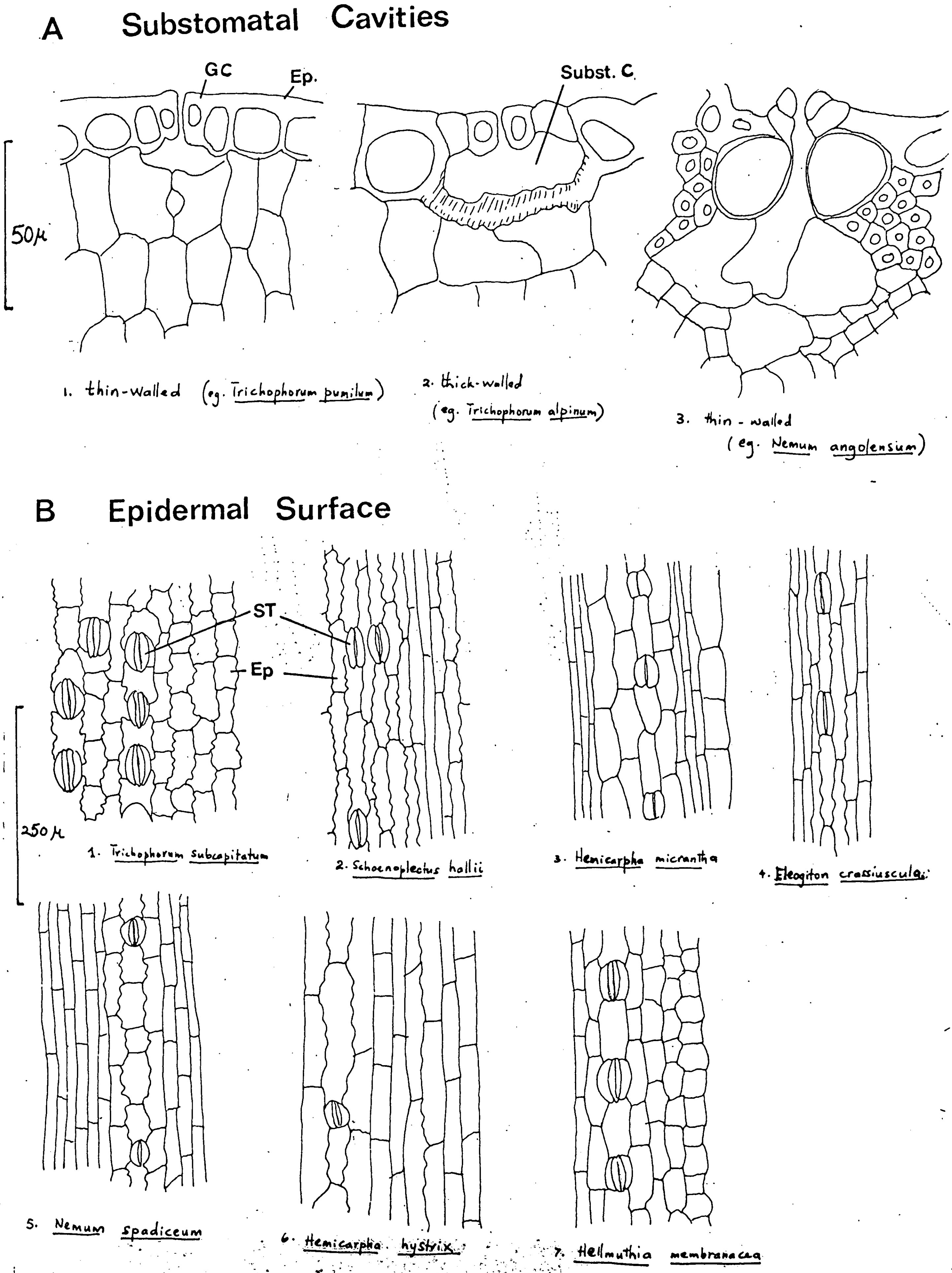

A Substomatal Cavities
GC
Ep.
Subst. C
50μ
1. thin-walled (eg. Trichophorum pumilum)
2. thick-walled (eg. Trichophorum alpinum)
3. thin-walled (eg. Nemum angolensum)
B Epidermal Surface
ST
Ep
250μ
1. Trichophorum subcapitatum
2. Schoenoplectus hallii
3. Hemicarpha micrantha
4. Eleogiton crassiuscula
5. Nemum spadiceum
6. Hemicarpha hystrix
7. Hellmuthia membranacea

Fig. 8

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 *Fuirena*. 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.

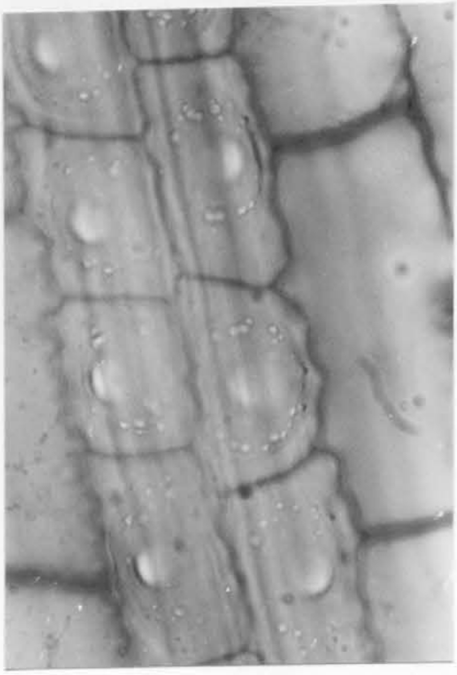
The course of vascular bundles in the shoot/culm: This has been followed by Plowman (op. cit.) and Monoyer (1928-9, 1934) in a number of species belonging to Scirpus, Trichophorum, Bolboschoenus, Schoenoplectus, Eleogiton, Blysmus, Isolepis, Holoschoenus, Oxycaryum, Nemum etc.

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, Fuirena etc. In the genera with long naked distal shoots e.g. Schoenoplectus, Trichophorum etc. the bundles of the involucral bracts 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 sclerenchyma strands may be vestigial indications of the cortical system of bundles (Plowman op. cit.).

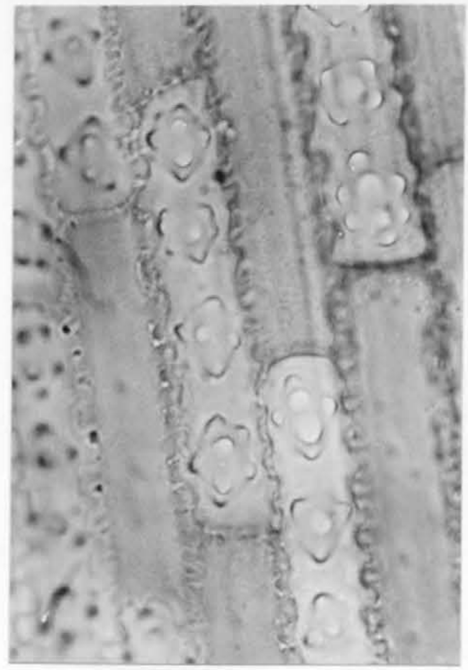
Axillary buds have been observed to have collateral bundles, which may be traced downward to their insertion upon the cauline bundles below the nodal plexus. They have no direct connection with the leaf trace (Plowman op. cit.)

EPIDERMAL SURFACE STUDIES

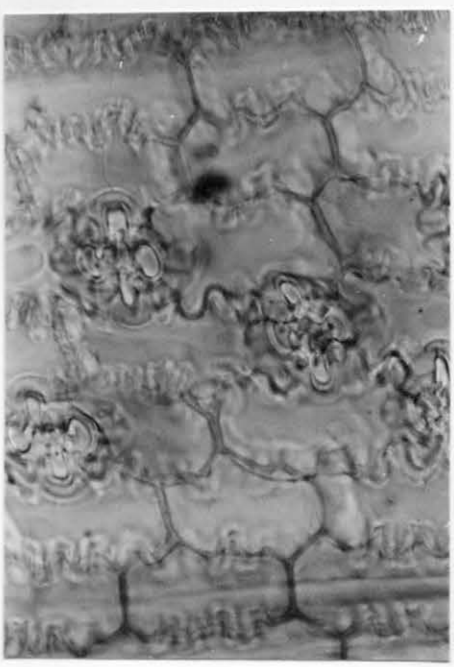
The characteristics of the epidermal cells in the leaf and culm are better observed by removing this layer and mounting it separately. The characteristics observed include stomata, cuticular papillae, prickles, crystals and silica bodies. My observations cover Pseudo-schoenus, Hellmuthia, Websteria, Genus A, Genus B, Genus C, Desmoschoenus, Phylloscirpus and Nemum.
Most species belonging to the other genera investigated by Metcalfe (1971) were also re-examined, and most of the observations are confirmed.



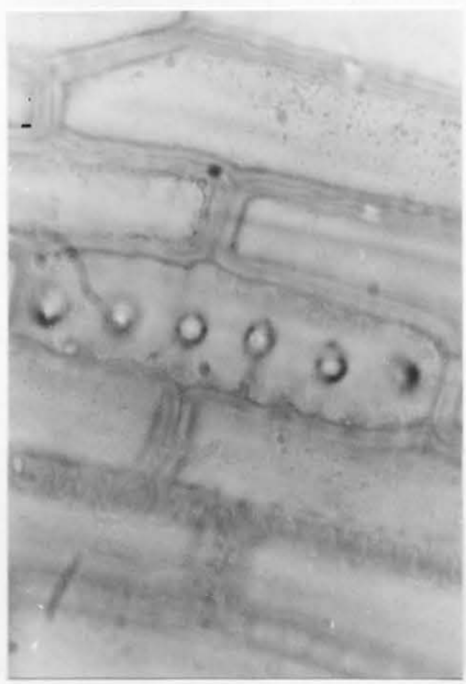
A



B



C



D

Pl. 3 Epidermal Surface view

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

B. *Scirpus wichurai* : " Nodular Silica Bodies × 1250

C. *Fuirena pachyrrhiza* : showing Stomata overarched by cuticular papillae × 600

D. *Desmoschoenus spiralis* : " Conical-without-satellite Silica Bodies × 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, Hemicarpha, 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 over-arching 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, Ficinia and Erioscirpus, prickles occur along the greater part of the culm.

CRYSTALS: in the form of echinate druses are of very rare occurrence; observes in a few species of Bolboschoenus (e.g. B. paludosus) where they are often found deposited towards the transverse anticlinal walls in both leaf and culm;

EX BIBL. UNIV. EDINBURGEN

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 Fuirena etc., (see Pl. 6. C), occasionally against the outer periclinal walls, or in some of the intercostal zones as in Erioscirpus (e.g. E. 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, Phylloscirpus, Desmoschoenus, Pseudoschoenus, Genus C, Hymenochaeta, Eleogiton, Blysmus, Erioscirpus, Hemicarpha, Isolepis, Holoschoenus, Hellmuthia, Ficinia. Examples of genera with conical-with-satellites sometimes tending to be nodular include Bolboschoenus, Genus B, Juncellus, Androtrichum, Duval-Jouvea, Kyllinga, Mariscus, Courtoisia, Remirea, Galilea, Oxycaryum. Examples of genera with distinctly nodular (though sometimes some of the peaks appear as satellites) include Scirpus, Eriophorum, Genus A, Websteria.

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

Arrangement in cell: Usually the silica bodies are arranged in only one row, parallel to the longitudinal axis of the cell; however, in some sections of specimens or species of Erioscirpus, Ascolepis, Cyperus, Ficinia and Desmoschoenus, 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. Actaeogeton), Isolepis, Websteria, Desmoschoenus, Eleogiton and Hemicarpha, most or all their species have more than 5 bodies per cell.

Explanation to Table 2 contd.

3. Sclerenchymatous 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 sinuosities; (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

Explanation to TABLE 2 COMPARATIVE VEGETATIVE ANATOMY

LEAF ('no comparison' implies no leaf blade present)

1. Outline

(a) variously V-shaped; (b) variously crescentiform; (o) no comparison

2. Bulliform cells

(a) present; (b) absent; (o) no comparison

3. Cuticular papillae on epidermal surface

(a) present; (b) absent; (o) no comparison

4. Unicellular hairs on adaxial and abaxial surfaces

(a) present; (b) absent; (o) no comparison

5. Hypodermis

(a) differentiated; (b) not differentiated; (o) no comparison

6. Arrangement of vascular bundles

(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; (o) no comparison

7. Number of bundles in keel region when prominent

(a) keel prominent, one median VB; (b) keel prominent, 2 superimposed VBs; (c) keel not prominent; (o) no comparison

CULM

1. Outline

(a) circular and variants of it; (b) triangular and variants of it

2. Epidermal cells

(a) taller and larger over hypodermal sclerenchyma; (b) smaller over hypodermalsclerenchyma; (c) of relatively equal sizes

3. Number of vascular bundles

(a) up to 20; (b) more than 20

TABLE 2 COMPARATIVE VEGETATIVE ANATOMY

CHARACTERS / TAXA	LEAF							CULM						BUNDLE SHEATH		CHLORENCHYMA & SCLERENCHYMA			EPIDERMAL TISSUE				
	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2	1	2	3	1	2	3	4	5
ANDROTRICHUM	o	o	o	o	o	o	o	a	c	b	b	a	b	a	a	b	c	a	a	b	b	a	a
ASCOLEPIS	b	b	b	b	a	c	c	a	b	b	c	a	b	a	e	a	a	a	b	b	a–c	a	a
BLYSMUS	a	a	b	b	b	a	a	b	b	b	a	a	b	a	c	b	d	a	b	b	a	a	a
BOLBOSCHOENUS	a	a	b	b	b	a	ab	b	b	b	b	a	b	a	a	b	d	a	b	b	b	a	a
COURTOISIA	a	a	b	b	b	a	a	b	b	b	b	a	b	a	a	a	a	a	b	b	b	a	a
CYPERUS	a	a	b	b	ab	a	a	ab	b	b	bc	a	b	a	ae	ab	a(d)	a	b	b	a–c	a	a
DESMOSCHOENUS	b	b	b	b	±a	e	c	a	c	b	b	a	b	a	a	b	d	a	b	b	a	a	b
DUVAL–JOUVEA	a	a	b	b	a	d	b	b	b	b	c	a	b	a	e	a	a	a	b	b	b	a	a
ELEOGITON	±b	b	b	b	±b	b	c	a	b	a	d	a	b	a	b	b	a	b	a	b	a	a	b
ERIOPHORUM	a	a	b	b	b	a	a	b	b	b	a	b	a(b)	a	a	b	d	a	b	b	c	a	a
ERIOSCIRPUS	(a)b	b	b	b	a(b)	b	c	ab	b	a(b)	ab	a	b	a	a	b	a(d)	(a)b	a(b)	b	a	a(c)	a
FICINIA	b	b	b	b	a	b	c	a	c	a(b)	d	a	b	a	a	b	a	±b	(a)b	b	a	a	a
FUIRENA	ab	±a	b	a	±b	ab	ac	ab	b	b	b	a	b	a	a	b	d	a	b	ab	a–c	ab	a
GALILEA	b	b	b	b	a	c	c	a	b	b	c	a	b	a	e	b	a	a	b	b	b	a	a
HELLMUTHIA	b	b	b	b	a	b	c	a	a	b	a	a	b	a	b	b	c	a	b	b	a	a	a
HEMICARPHA	b	b	b	b	a	b	c	a	b	a	c	a	b	ab	e	b	a	b	a	b	a	a	b
HOLOSCHOENUS	b	b	b	b	a	b	c	a	ac	b	b	a	b	a	c	b	c	a	b	b	a	a	a
HYMENOCHAETA	a	a	b	b	b	a	c	b	b	b	d	c	b	a	a	b	a	a	b	b	a	a	a
ISOLEPIS	b	b	b	b	±b	b	c	a	b	a	±d	a	b	ab	ac	b	a	b	a	b	a	a	a
JUNCELLUS	b	b	b	b	a	c	c	a	±b	b	c	a	b	a	e	a	a	a	b	b	b	a	a
KYLLINGA	a	a	b	b	a	a	(a)b	b	b	b	c	a	b	a	e	a	a	a	b	b	b	a	a
LIPOCARPHA	b	b	b	b	a	c	c	a	b	b	c	a	b	a	e	a	a	a	b	b	a–c	a	a
MARISCUS	a	a	b	b	a	ad	ab	b	b	b	c	a	b	a	e	a(b)	a	a	b	b	b	a	a(b)
NELMESIA	b	b	b	b	a	b	c	a	b	a	a	a	b	b	e	±a	b	b	a	b	±a	a	a
NEMUM	b	b	b	b	a	b	c	a	b	a	a	b	b	b	e	a	b	b	a	b	a	a	a
OXYCARYUM	a	±b	b	b	a	a	a	b	b	b	b	ab	b	a	a	b	a	a	b	b	b	a	a
PHYLLOSCIRPUS	b	b	b	b	a	b	c	a	b	a	a	a	b	a	a	b	d	a	b	b	a	a	a
PSEUDO–SCHOENUS	o	o	o	o	o	o	o	a	a	b	d	c	b	a	a	b	c	a	b	b	a	a	ab
PYCREUS	ab	b	b	b	a	ab(c)	ac	±a	b	b	c	a	b	a	e	a	a	a	b	b	a–c	a	a
QUEENSLANDIELLA	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
REMIREA	b	b	b	b	a	c	c	±a	b	b	c	a	b	a	e	a	a	a	b	b	b	a	a
SCHOENOPLECTUS	ab	ab	b	b	ab	ab	abc	ab	b	ab	d	c	b	a	a	b	a	a	ab	b	a–c	a	a
SCIRPUS	a	a	b	b	b	a	a	ab	b	b	b	ab	b	a	a	b	d	a	b	b	c	a	a
TORULINIUM	a	a	b	b	±b	±a	a	b	b	b	c	a	b	a	e	a	a	a	b	b	b	a	a
TRICHOPHORUM	ab	ab	b	b	±b	ab	ac	ab	b	a	a	a	ab	a	acd	b	d	a	(a)b	b	a	a	a
WEBSTERIA	b	b	b	b	a	b	c	±a	b	a	d	±b	b	a	a	b	a	b	?	b	c	a	b
GENUS A	a	a	a	b	b	a	a	a	±b	b	b	a	b	a	b	b	d	a	b	b	c	a	a
GENUS B	b	b	b	b	a	b	c	a	±b	b	d	c	b	a	bc	b	a	a	b	b	b	a	a
GENUS C	b	b	b	b	a	b	c	a	±c	b	b	a	b	a	e	b	a	a	b	b	a	a	a

Note:

? = No information

( ) = rarely

± = more or less

a–c = abc

ac = 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 Ell.) or on the number of spikelets and the ultimate number of fruit set (especially S. lineatus 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

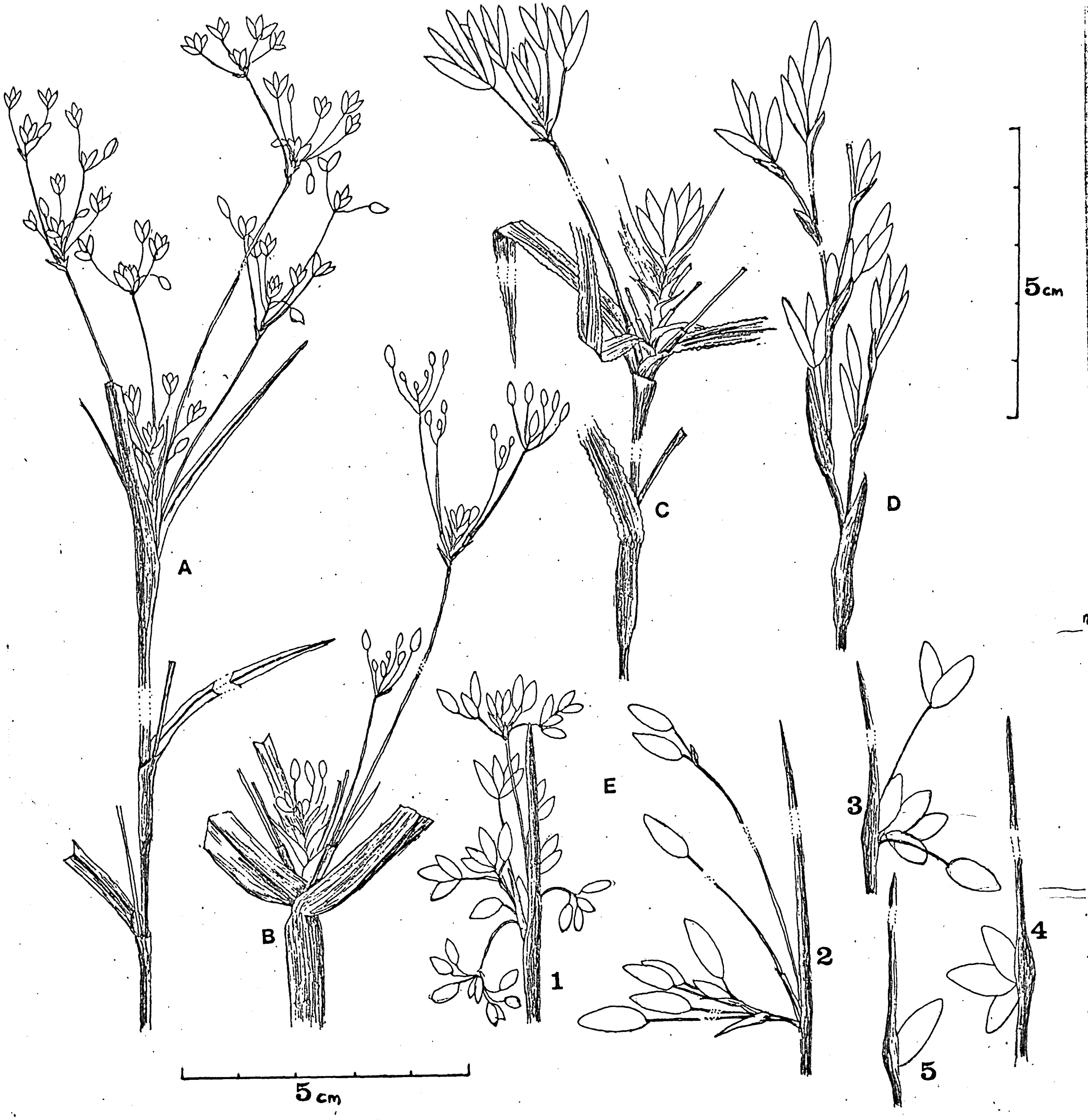


Fig. 9 General Inflorescence

A, Scirpus spp. ×1 ; B, Hymenochaeta grossa ×1

C, Genus A (Scirpus junghuhnii) ×1 ; D, Pseudo-Schoenus inanis ×1

E, Schoenoplectus spp. ×1 (1. S. lacustris ; 2. S. etuberculatus

3, S. americanus ; 4. S. erectus ; 5. S. torreyi)

Fig. 10 Gen. Inflores. contd.

A, *Bolboschoenus* spp. × 1 (1. *B. laeteflorens* ; 2. *B. maritimus* ; 3-5. *B. paludosus*)
B, *Desmoschoenus spiralis* × 1 ; C, *Holoschoenus* spp. (1, *H. vulgaris* subsp. *globiferus* × 1 ; 2. *H. thunbergius* ; 3.4 *H. nodosus* × 1 ; 5. *H. dioecus* × 1)
D, *Oxycaryum cuben* × 1 ; E, *Androtrichum trigynum* × 1

always broader, taller and bears a compound corymb. In Bolboscheonus (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 spathula-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. scirpoides (Fig.12 j), the inflorescence is a head of one to few spikelets, with very reduced involucral bracts. F. squarrosa has been observed to show transitional forms from the typical panicle to the compact head.

Inflorescences in Cyperus, Kyllinga, Torulinium, Courtoisia, Mariscus, Duval-Jouvea, Oxycaryum 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. pygmaeus (Fig.15.A.7), C. orbicephalus (Fig.11.A) etc. A similar situation appears in Kyllinga (e.g. in K. brevifolia Fig.15.B.2), Mariscus (e.g. M. dregreanus 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,

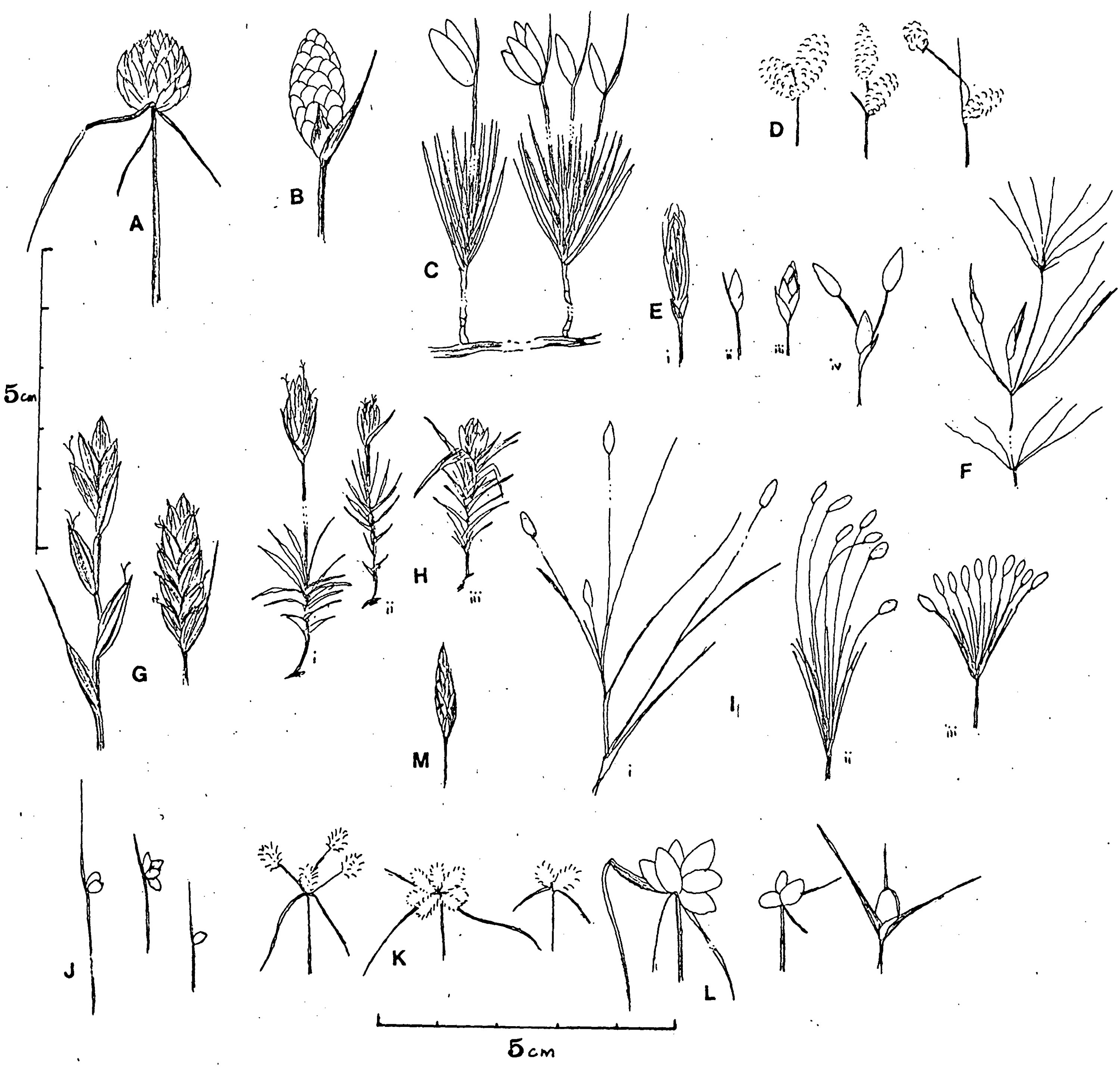


Fig. 11 Gen. Inflores.

A *Cyperus orbicephalus* ×1 B *Hellmuthia* sp. ×1

C *Genus* C ×1 (*Scirpus nevadensis*) D *Nemum* spp. ×1

E *Trichophorum* spp. ×1 (i T. *alpinum* ii T. *verecundum* iii T. *atacomensis* iv T. *subcapitatum*)

F *Websteria confervoides* ×1 G *Blysmus compressus* ×1

H *Phylloscirpus* spp. ×1 (i *P. acaulis* ii & iii P. *semisubterraneus*) I Eleogiton spp. ×1 (i E. crassiuscula ii E. ludwigii iii E. *fascicularis*) J *Isolepis* spp. ×1

K *Hemicarpha* spp. ×1 L *Lipocarpha* spp. ×1 M *Nelmesia melanostachya* ×1

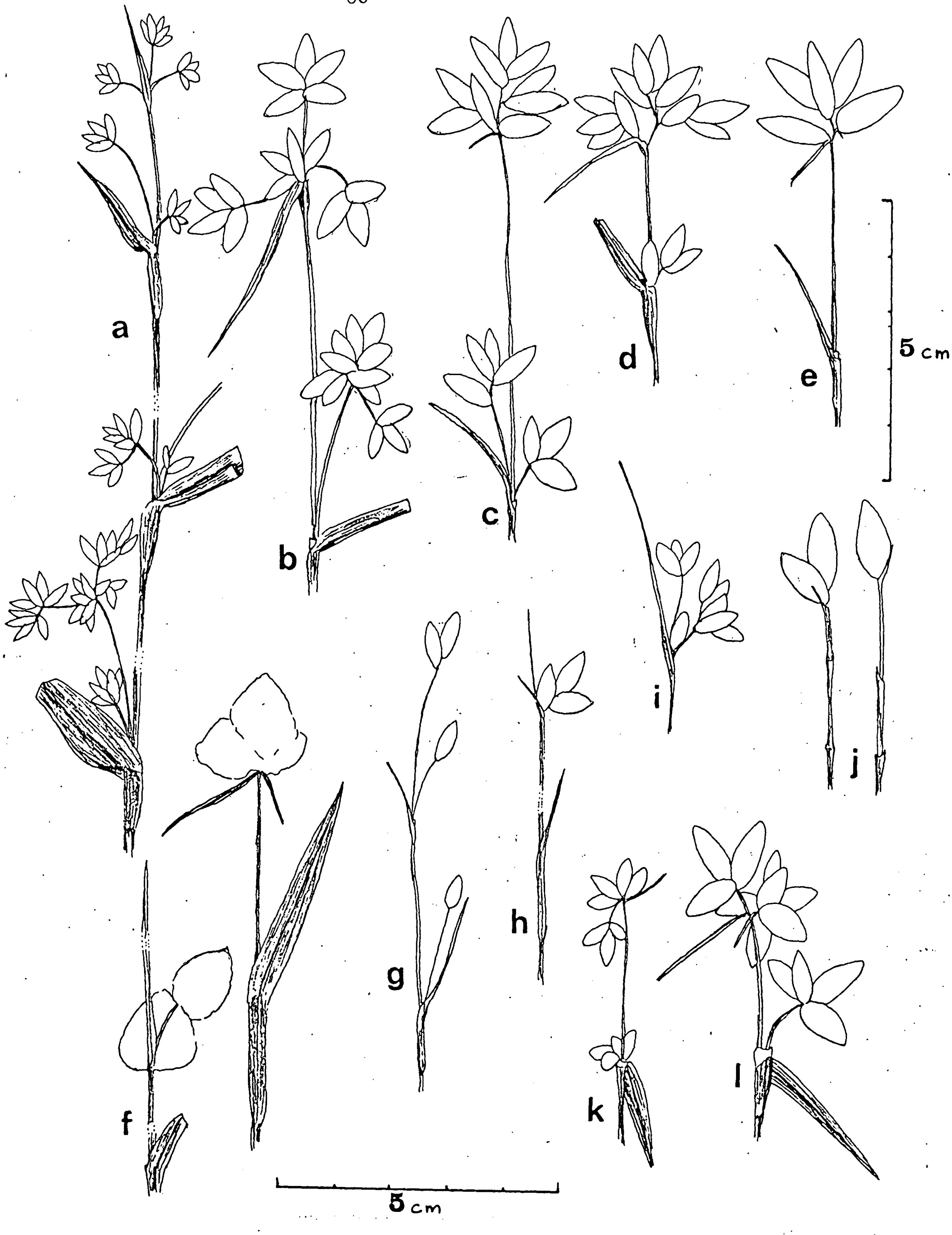


Fig. 12 Inflorescence Forms in Fuirena

a, F. umbellata b, F. squarrosa c, F. incompleta d, F. welwitchiana
e, F. ecklonii f. F. hirta g. F. stricta h. F. pachyrrhiza
i. F. wallichiana j. F. scirpoidea k, l, F. ciliaris
(a-l ×1)

as in Oxycaryum (Fig. 10.D), Kyllinga, Courtoisia, Mariscus 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.).

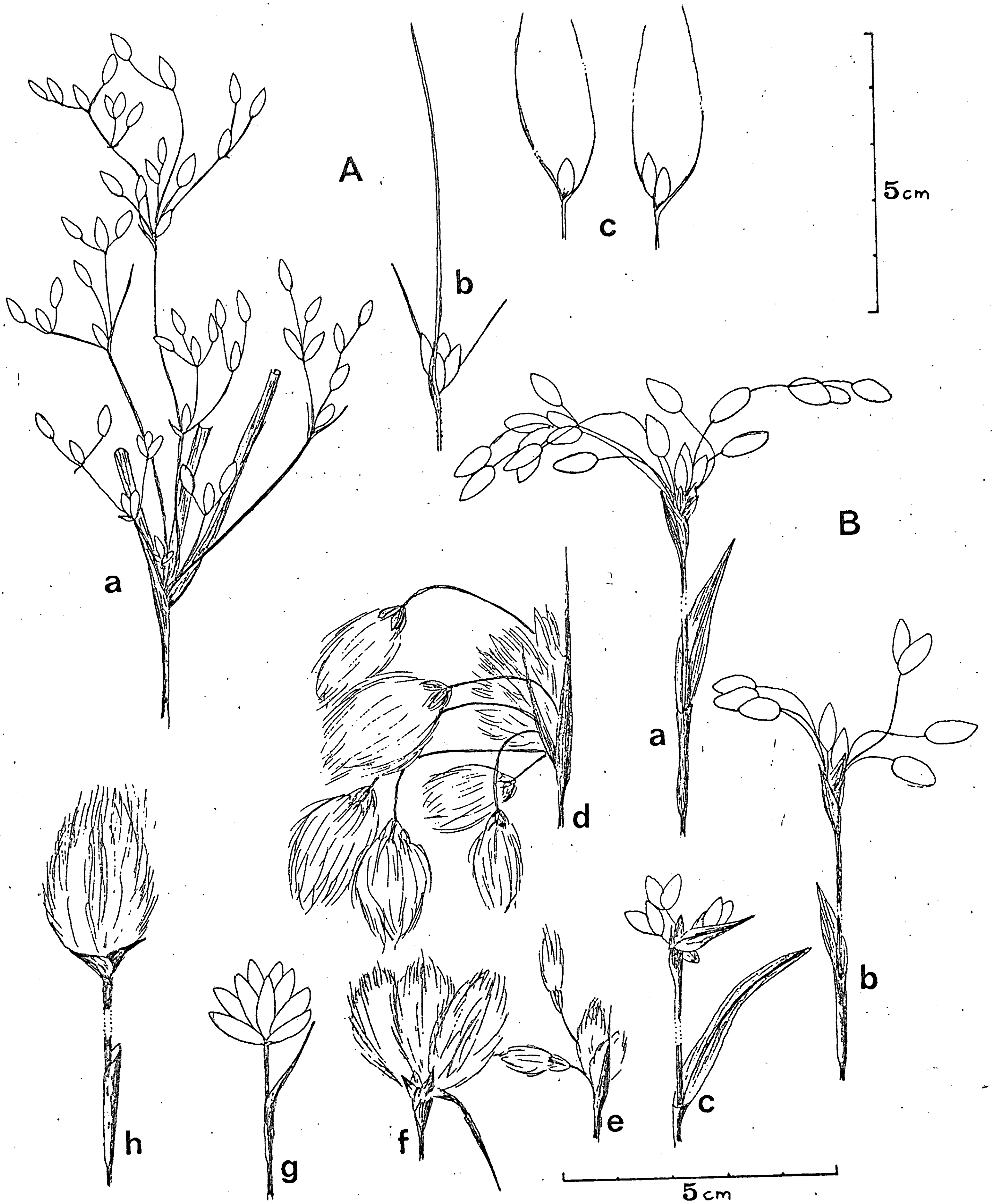


Fig 13 Gen. Inflorescence in Erioscirpus and Eriophorum

A Erioscirpus spp. × 1 a E. comosus b E. falsus c E. microstachyus

B Eriophorum spp. × 1 abc E. japonicum de E. latifolium f E. virginicum g E. crinigerum h E. vaginatum

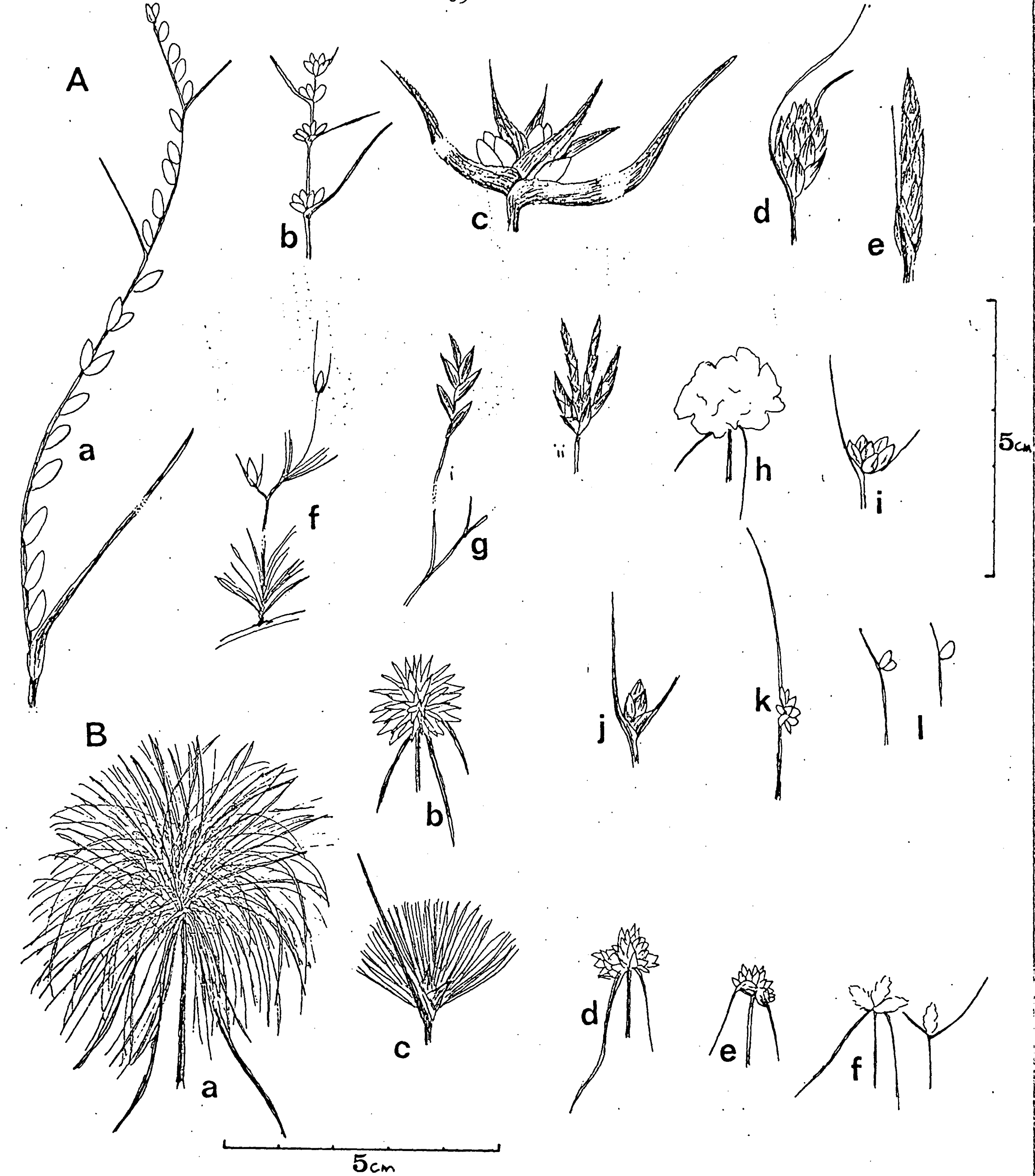


Fig. 14 Gen. Inflorescence in Ficinia and Ascolepis

A Ficinia spp. x1 a. F. secunda b. F. bulbosa c. F. radiata d. F. bracteata
e F scariosa f F. ramossisima g i F. longifolia ii F. angustifolia
h. F. ecklonii i. F. brevifolia j. F. paradoxa k. F. aphylla l. F. filiformis

B Ascolepis spp. x1 a. A. pinguis b. A. protea c. A. elata d. A. brasiliensis
e. A. capensis f. A. dipsacoides

Lipocarpha 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 *Hemicarpha*, 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 *Trichophorum*, *Eleogiton*, *Websteria*, *Nelmesia* and *Eriophorum*. In *Trichophorum* subgenus *Anthelophorum*, 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 *Phyllanthelum*, together with the subgenera *Japonici* and *Eriophoropsis*, show transitional forms from a simple umbel to a head-like cluster of spikelets (Fig. 13.B.a-g) and subtended by leaf-like involucral bracts which sometimes tend to be glume-like.

Erioscirpus exhibits two forms of inflorescences. In the subgenus *Erioscirpus* (Fig. 13.A.bc) the inflorescence is a contracted head of one to few spikelets, while in the subgenus *Lachnophorum* (Fig. 13.A.a) 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.

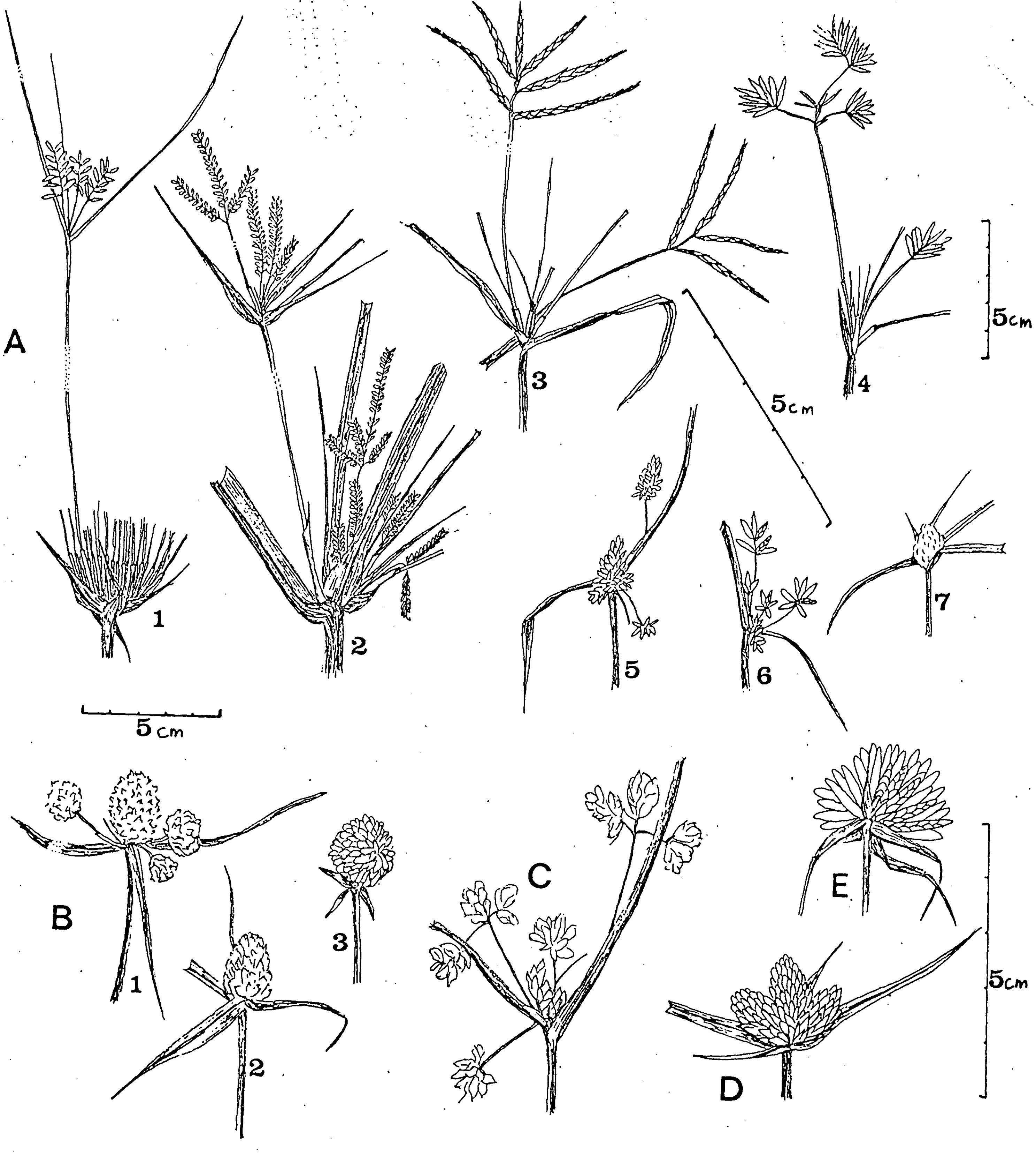


Fig. 15 Gen. Inflorascanca in Cyperus etc.

A Cyperus spp. 1 C. papyrus x0.5 2. C. dives x0.5 3. C. rotundus x1
4. C. articulatus x0.5 5. C. difformis x1 6. C. fuscus x1
7. C. pygmaeus x1

B Kyllinga spp. x1

C Courtoisia sp. x1 D Remirea maritima x1 E. Galilea mucronata x1

Typical of this group is Schoenoplectus whose subgenera Schoenoplectus and Malacogeton 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 Actaeogeton, 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, Juncellus and Isolepis have similar pseudo-lateral head-like inflorescences as in Schoenoplectus subgen. Actaeogeton, 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 Juncellus 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 Holoschoenus, 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. thunbergianus 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

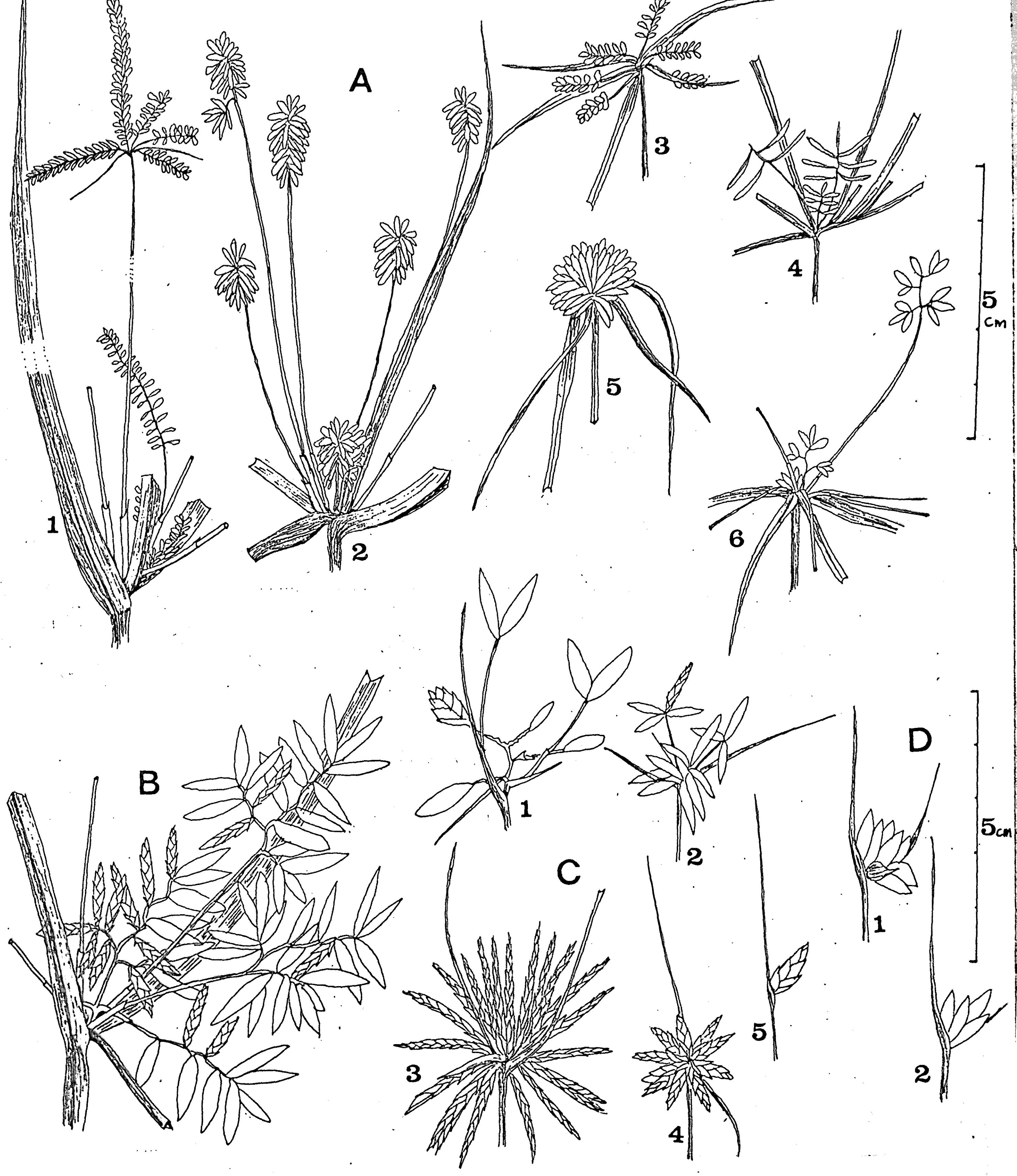


Fig. 16 Gen. Inflorescence in Mariscus etc.

A. Mariscus spp. ×1 (1. M. mutisii, 2. M. ovularis; 3. M. pseudo-flavus 4. M. flabelliformis 5. M. dregeanus 6. M. falsus):
B. Duval-Jouvea serotina ×1 ; C. Pycreus spp. ×1 (1. P. blastophorus 2. P. flavescens 3. P. pervillei 4. P. globosus 5. P. fontinalis)
D. Juncellus spp. ×1 (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. sulcinux, P. diander etc. (Fig. 16. C. 2), while terminal head-like forms are observed in other species, especially P. pumilus, P. pervillei etc. (Fig. 16.C.3) Pseudo-lateral heads are also found in some species, especially P. megapotamicus, 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 secund-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-verticillasters. Terminal 1-spicate and head-like inflorescences are of frequent occurrence, as well as pseudo-lateral heads like the type found in Isolepis and Hellmuthia. In the same way as the inflorescences are varied, the subtending involucral bracts also vary, ranging from leaf-like in the secund-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 (amphicarpic) axillary spikelets are found at the base of the culm (cf. Haines 1971b). Amphicarpy 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 amphicarpy has been observed have tufted habits, and I would not be surprised if many more amphicarpous or amphibasal spikelets are found in other unrelated genera.

Of the aerial spikelets, those forming capitate or secund inflorescence forms are normally sessile, while those on corymbose, umbellate 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.

Spicular prophylls are of common occurrence in Cyperus, Kyllinga, Torulinium, Remirea, Mariscus, Juncellus, Duval-Jouvea, Galilea 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. Fuirena Haines 1966), the prophylls are actually of ray origin, but due to the reduction of the ray axis appear spicular.

Relative to the arrangement of the glumes, there are two very distinct forms of spikelets, viz: distichous form (Fig.17.e-j) 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 C. michelianus, C. orbicephalus etc.), Mariscus, Kyllinga, Androtrichum

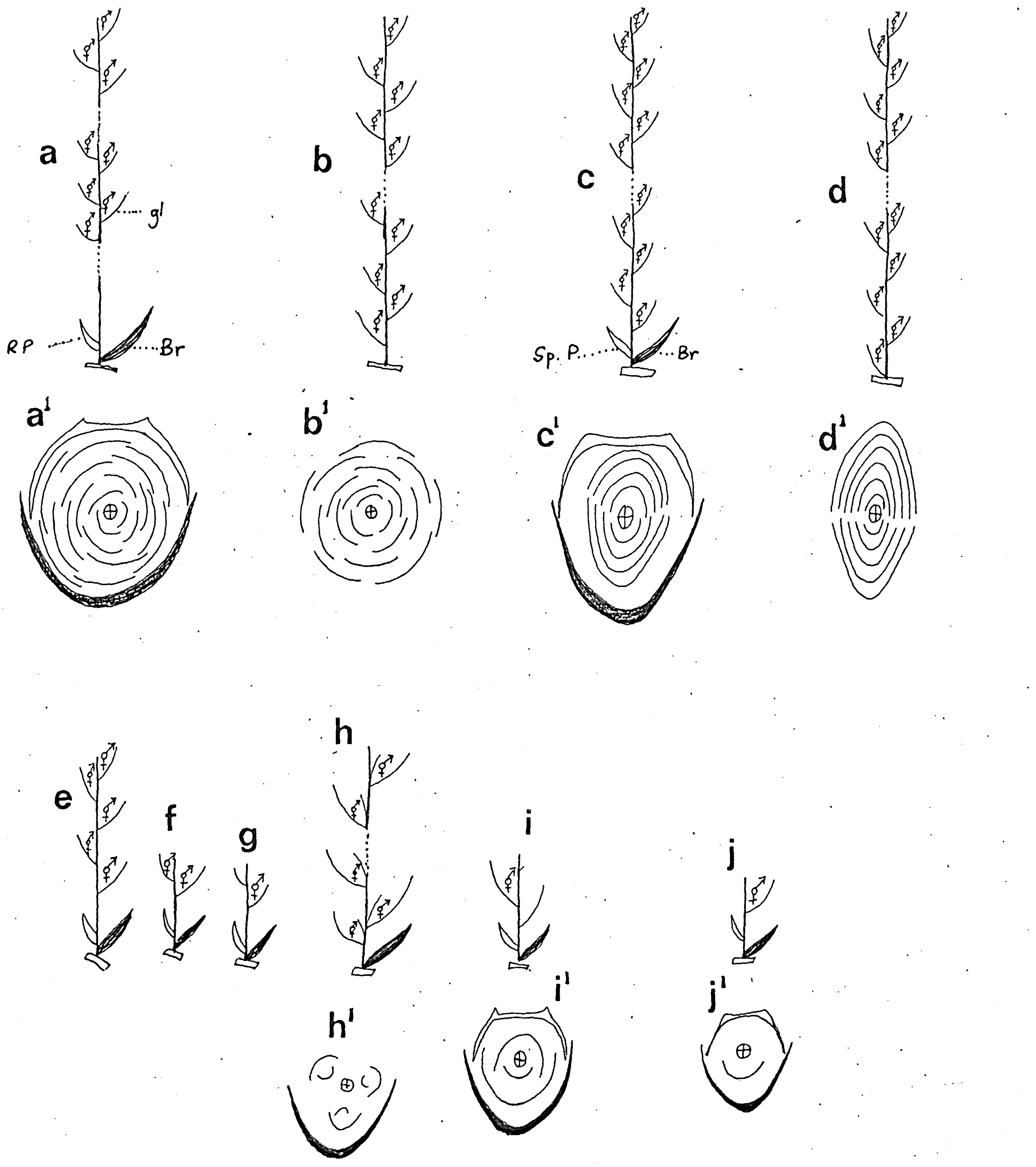


Fig. 17 Schematic Spikelet Diagram

a a stalked spikelet as in Scirpus spp. a' spikelet diagram of 'a'
b a sessile or terminal spikelet as in Scirpus spp. b' spikelet diagram of 'b'
c a sessile spikelet as in Cyperus spp. c' spikelet diagram of 'c'
d a terminal spikelet as in Cyperus spp. d' spikelet diagram of 'd'
e.f. 2-few flowered spikelet as in Mariscus spp. g 1-flowered spikelet as in Kyllinga spp.
h spikelet with anterior 'scale' as in Nelmesia h' spikelet diagram of 'h'
i a spikelet of Remirea maritima i' spikelet diagram of 'i' (after Kern 1958)
j a reduced spikelet of Lipocarpha spp. j' spikelet diagram of 'j'

Pycreus, Juncellus, Duval-Jouvea, 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, Erioscirpus, 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, 1 a-e) Trichophorum, Isolepis, Eleogiton (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 Rhyncchospora 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 Lipocarpha whose individual flowers are interpreted as forming reduced spikelets /cf. R. Brown, 1810, Rikli 1895, Holm 1899, Palla 1905, Koyama 1961, Raynal 1968, Haines 1971a/ 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 1961/ 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 Hemicarpha and Nelmesia only the anterior scale is present and may sometimes be absent altogether as in some Hemicarpha /cf. 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. fuiremoides, f. S. atrovirens/

2. Genus A x 6 (Scirpus junghuhnii)

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. verecundum)

7. Isolepis setacea x 6

8. Eleogiton fluitans x 6

9. Websteria confervoides x 6

10. Oxycaryum cubense

11. Cyperus spp. (a. C. uncinatus x 12, b. C. difformis x 12, c. C. aristatus x 12, d. C. iria x 12, e. C. orbicephalus x 6)

12. Kyllinga spp. x 12 (a. K. squarrosa, b. K. peruviana)

13. Androtrichum trigynum x 12

14. Courtoisia cyperoides x 12

15. Torulinium eggersii x 12

16. Mariscus spp. x 12 (a. M. cyperinus, b. M. flabelliformis)

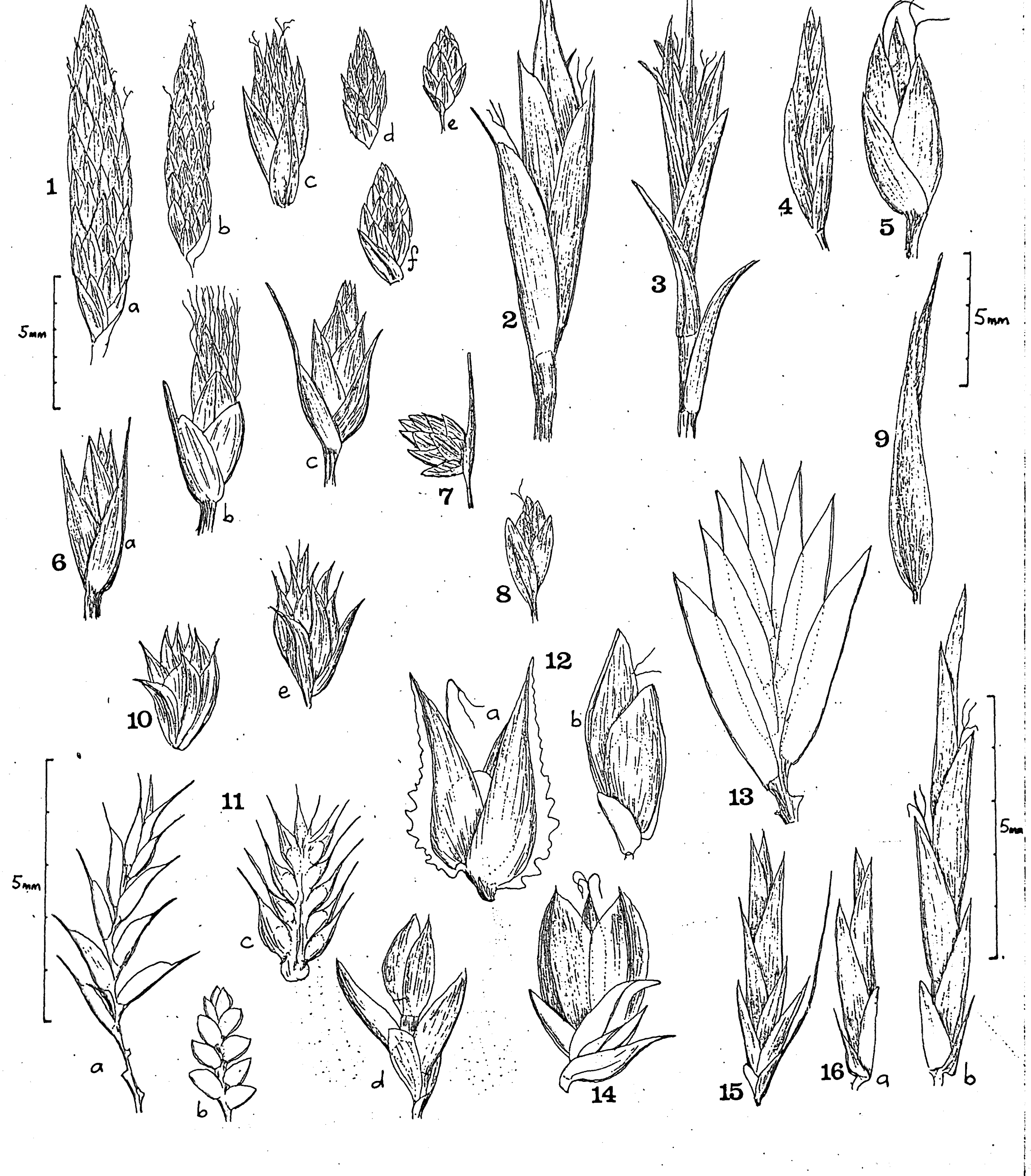


Fig. 18 Spikelet Forms

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, Websteria. Often in Mariscus, especially in the groups Umbellati Clarke, Ochrocephali Kukenthal and Bulbocaules 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 Websteria, Remirea, Ascolepis, Kyllinga, Courtoisia, Lipocarpha and in some Mariscus 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 (1868), Bentham (1883), Clarke (1883-1884), Kukenthal (1935), Ohwi (1944), Chermezon (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 Chermezon, 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 [x 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 [x 44]

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

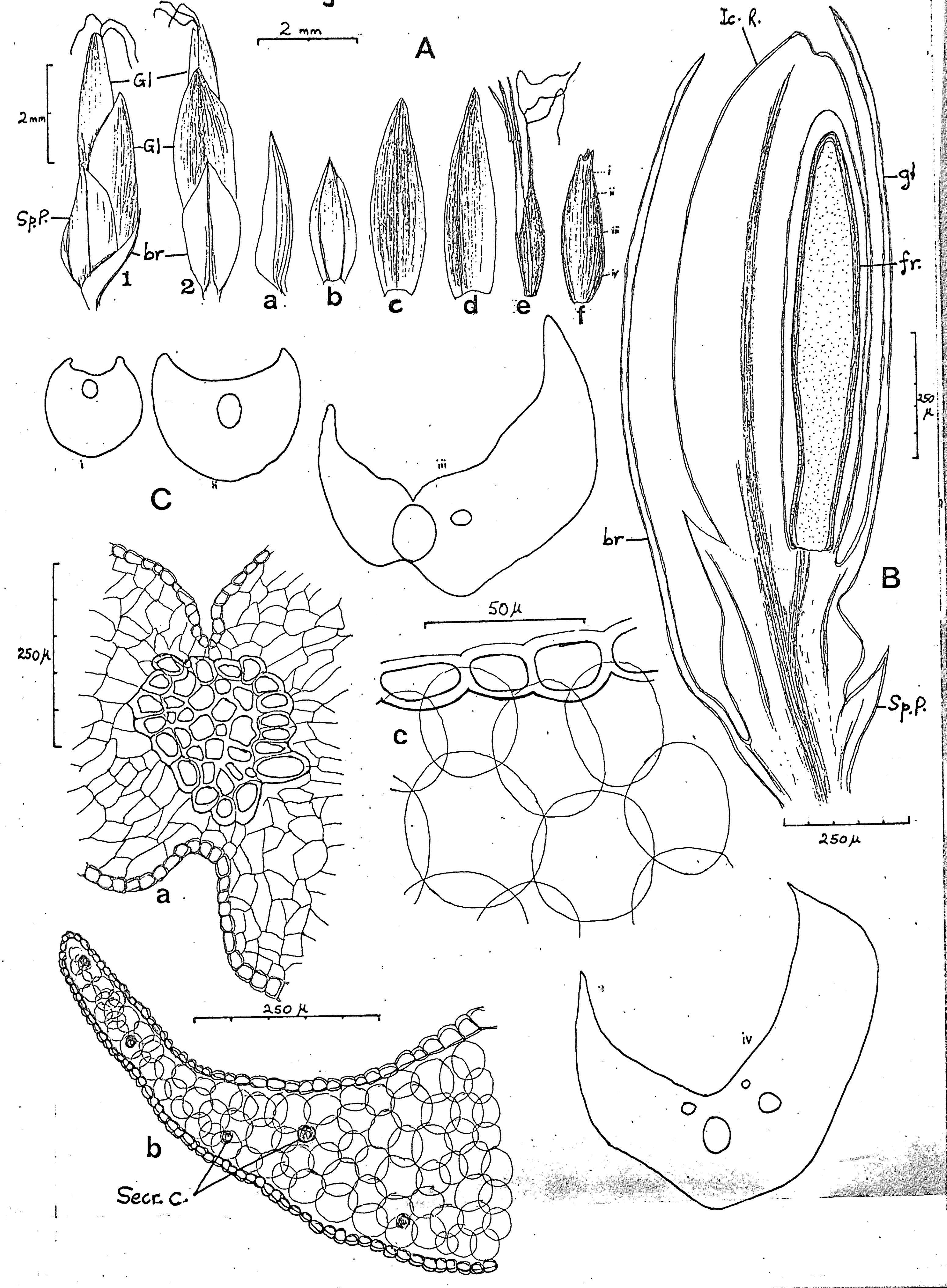
i-iv outlines of sections through various regions in the rachilla (see A. 'f')

a. mid-nerve region x 160

b. winged lateral region x 160

c. epidermal and cortical tissues x 660

Fig. 19 Remirea



the anatomy of this corky organ are illustrated in Fig.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 cucullate 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 vasculation 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.Ci.iv the corky organ is shown to predominantly have one distinct nerve which may or may not subdivide from the base upwards. These vasculations 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 vasculations 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*, *Mariscus*, *Courtoisia* etc. the rachilla is articulate and caducous. The same can be said of the indistinct rachilla in *Ascolepis* and *Lipocarpha*; whose spikelets can be easily pulled out. The number of articulations in these articulate rachillas vary; for example in *Kyllinga*, *Queenslandiella*, *Remirea*, *Courtoisia*, *Mariscus* and possibly *Ascolepis* and *Lipocarpha*, 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*, *Juncellus*, *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*, *Juncellus* 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*, *Mariscus* and *Courtoisia*. In *Cyperus* some species show well developed wings, e.g. *C. odoratus* L., *C. eleusinoides* 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 *Genusia* 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.

GLUMES: 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, set above the spicular prophyll when present, one or two in number, and often smaller and distinct from the fertile ones, rarely indistinct as in Remirea, Kyllinga, Websteria 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 incrassate, 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 anticous 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 then 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. leucocephala (Ascolepis subgen. Platylepis) x 60 [after Palla 1905 t. 14]

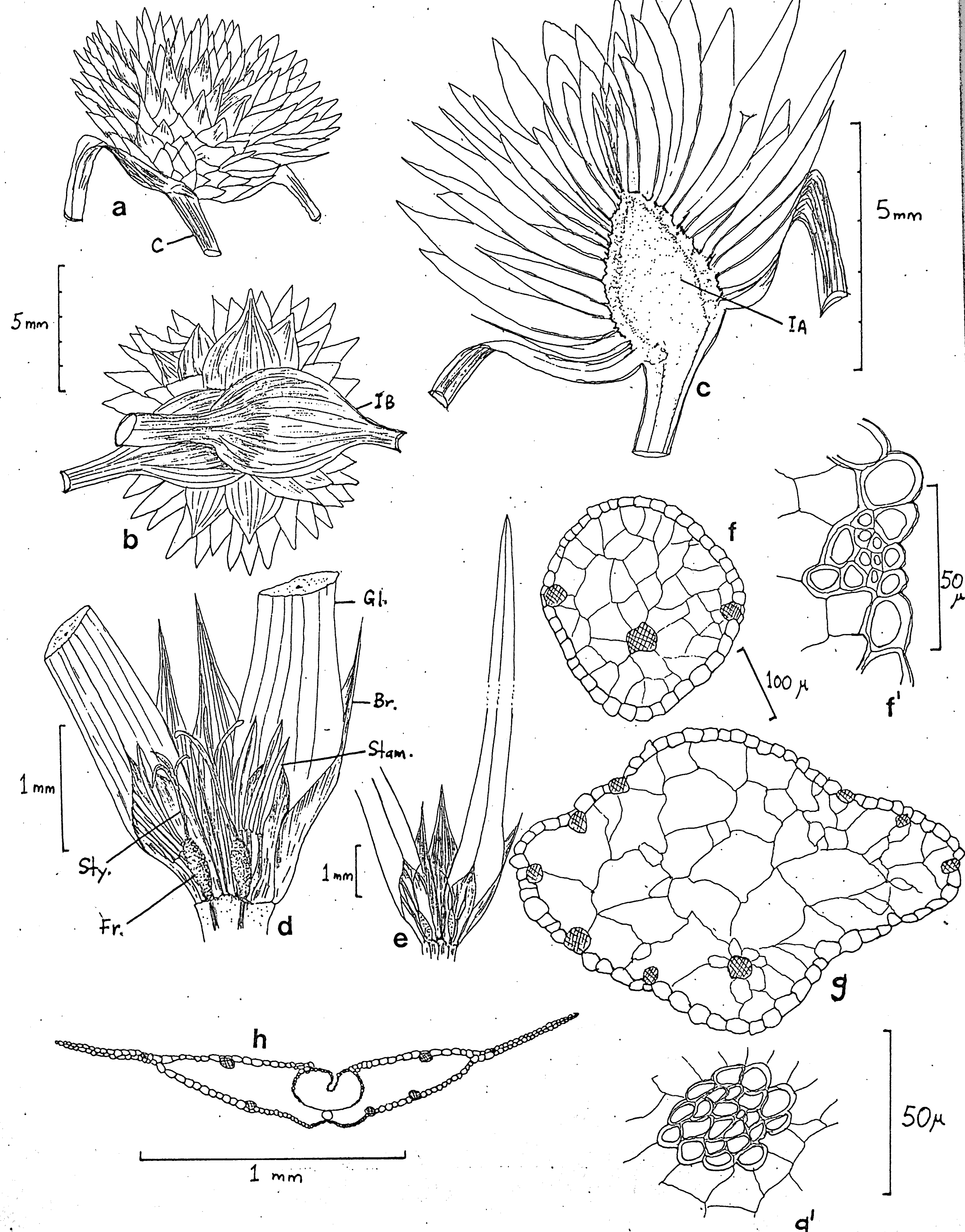

a
c
5 mm
b
IB
c
IA
5mm
Gl.
Br.
Stam.
1 mm
Sty.
Fr.
d
1mm
e
f
100 μ
50 μ
f'
g
h
1 mm
50μ
g'

Fig. 20

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 stand-point, 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.fg 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-nerve or vasculation 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 Ascolepis pusilla; the base of the organ shows a tendency for the two free margins to unite. In A. eriocauloides, A. elata, A. protea 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 vasculation. These nervules give a sulcate appearance to the external surface of this organ. From these observations, I follow Palla (1905) in regarding the 'squamella' or 'scale' in Ascolepis 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. dipsacoides]. The tip of the glume is projected into a strongly or less flattened conic beak, which may be well elongated as in subgenus Ascolepis or less elongated as in subgenus Platylepis, but in every case the glumes develop centripetally and thus always give the inflorescence a rayed appearance, as in Compositae.

The nature of the glumes in the other genera, apart from Ascolepis, 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 [x 12]

A. *Scirpus* spp. [1. *S. sylvaticus*, 2. *S. radicans*, 3. *S. pallidus*,
4. *S. fontinalis*, 5. *S. mitsukurianus*, 6. *S. divaricatus*,
7. *S. polyphyllus*, 8. *S. atrocinctus*, 9. *S. peckii*,
10. *S. microcarpus*]

B. *Isolepis* spp. (1. *I. thoursiana*, 2. *I. cyperoides*, 3. *I. prolifer*,
4. *I. keilolepis*, 5. *I. antartica*, 6. *I. cernua*, 7. *I. macer*,
8. *I. merrillii*, 9. *I. minute*, 10. *I. setacea*)

C. *Eleogiton* spp. (1. *E. striatus*, 2. *E. pseudo-fluitans*, 3. *E. crassiuscula*
4. *E. fluitans*, 5. *E. brizoides*)

D. *Oxycaryum cubense*,

E. *Cyperus orbicephalus*

F. *Trichophorum* spp. (1. *T. subcapitatum*, 2. *T. alpinum*, 3. *T. caespitosum*
4. *T. clintonii*, 5. *T. verecundum*, 6. *T. pumilum*, 7. *T. mattfeldianum*
8. *T. clementis*)

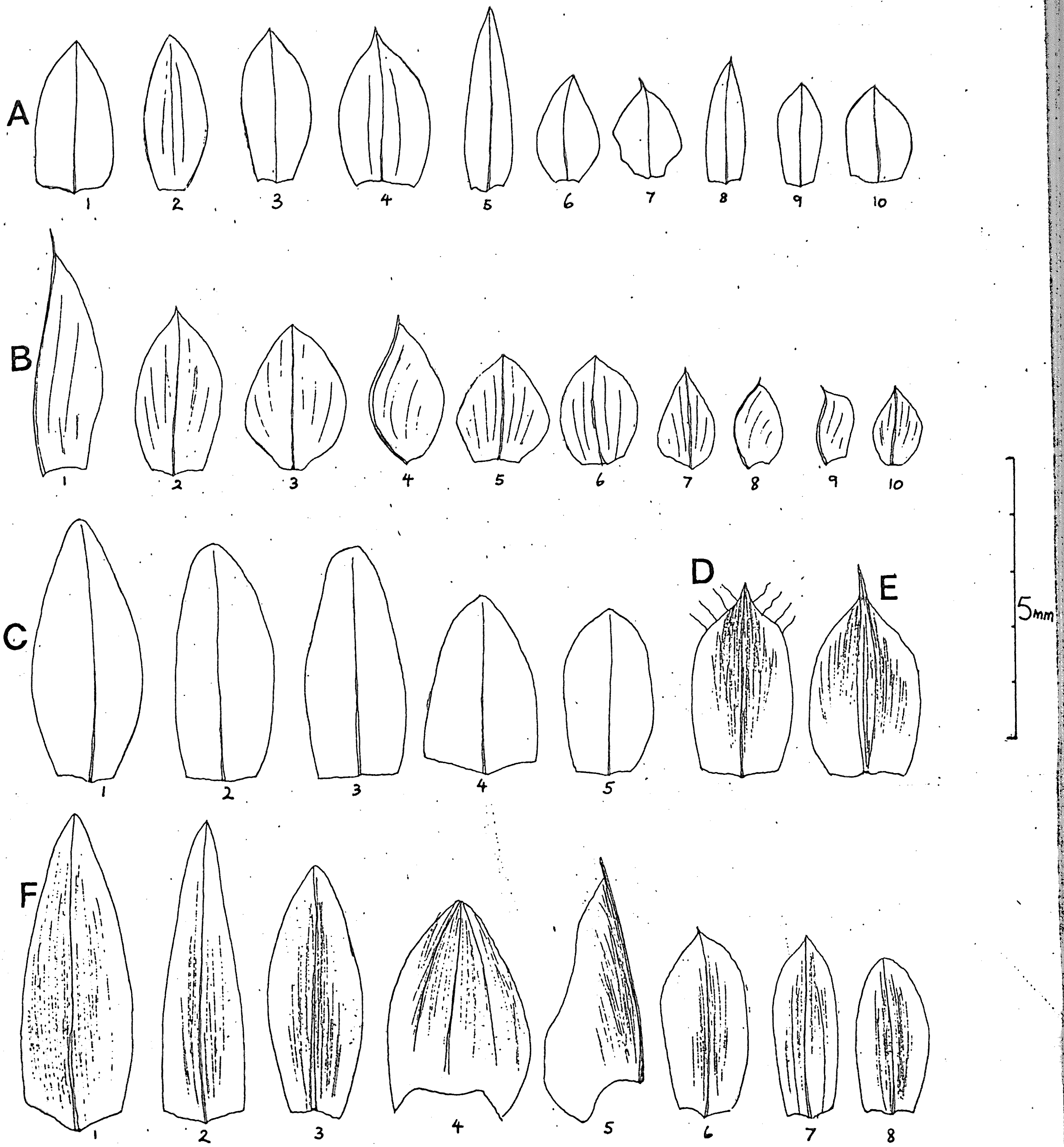


Fig. 21 Glume Outlines

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 subgenera 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 ovate, 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 obovoid 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. ecklonea and F. pinguior. In Hellmuthia and F. pinguior the notched apex is smooth and of hyaline nature, while in F. paradoxa and F. ecklonea the margins are several times dissected and appear hairy (cf. Fig. 24.B.1) The rest of the genera are ovate, lanceolate or elliptic glumes have obtuse to acute apices, very rarely nearly rotund as in Eleogeton, Ficinia, Juncellus, Mariscus and Eriophorum subgenus Japonici.

Fig. 22. Glume Outlines [x 12]

A. *Schoenoplectus* spp. (1. *S. torreyi*, 2. *S. mucronatus*, 3. *S. etuberculatus*, 4. *S. lineolatus*, 5. *S. juncoides*, 6. *S. wallichii*, 7. *S. lacustris*, 8. *S. littoralis*, 9. *S. validus*, 10. *S. tatora*)

B. *Holoschoenus* spp. (1. *H. nodosus*, 2. *H. thunbergianus*, 3. *H. dioecus* 4. *H. vulgaris*)

C. *Bolboschoenus* spp. (1. *B. planiculmis*, 2. *B. maritimus*, 3. *B. tuberosus*)

D. *Phylloscirpus acaulis*

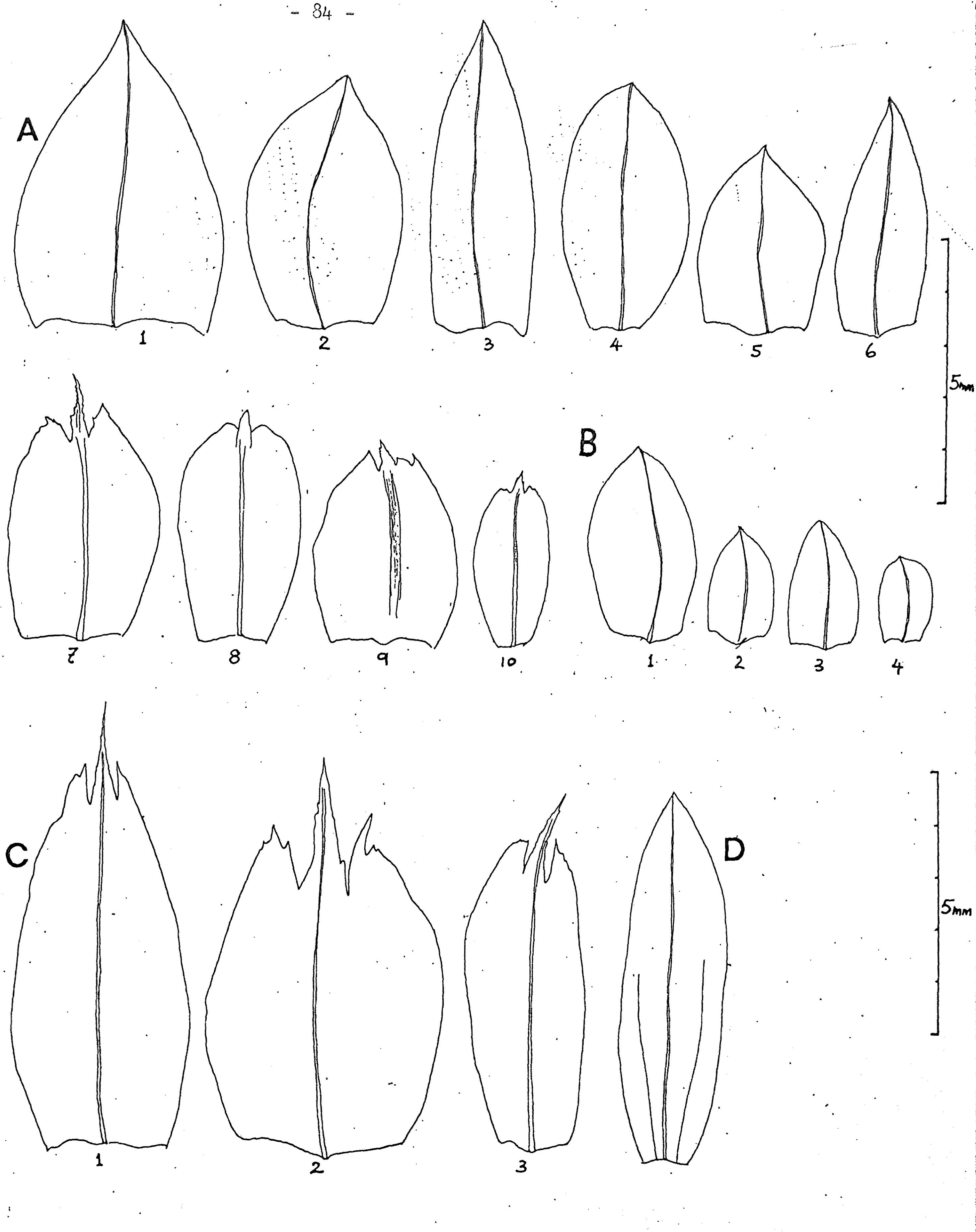


Fig. 22 Glume Outlines

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 Mariscus and Torulinium, the rachilla has several articulating nodes and the bases of the glumes are decurrent 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 Torulinium, that part of the glume decurrent with the internodal rachilla is conspicuously swollen (Fig. 24.K)

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. Eleogiton, Nemum and Eriophorum subgenera Eriophorum and Japonici 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.H). Typical aristate glumes are found in Fuirena, Bolboschoenus, Lipocarpha etc. and mucronate glumes are found in Scirpus, Pseudo-schoenus etc. Fig. 25. 6 show the outline of some of

Fig. 23. Glume Outlines [x 12]

A. Websteria confervoides

B. Genus A (Scirpus junghuhnii)

C. Desmoschoenus spiralis

D. Pseudo-schoenus inanis

E. Nemum spp. (1. N. angolensum, 2. N. spadiceum)

F. Hymenochaeta grossa

G. Lipocarpha spp. (1. L. argentea, 2. L. senegalense, 3. L. sphacelata 4. L. microcephala, 5. L. atropurpurea, 6. L. maculata)

H. Hemicarpha spp. (1 & 2. H. hytrix, 3. H. kernii, 4. H. squarrosa 5. H. micrantha)

I. Genus B (Blysmus rufus)

J. Blysmus compressus

K. Fuirena spp. (1. F. simplex, 2. F. glomerata)

L. Eriophorum spp. (1. E. angustifolium, 2. E. japonicum)

M. Erioscirpus spp. (1. E. comosus, 2. E. microstachyus)

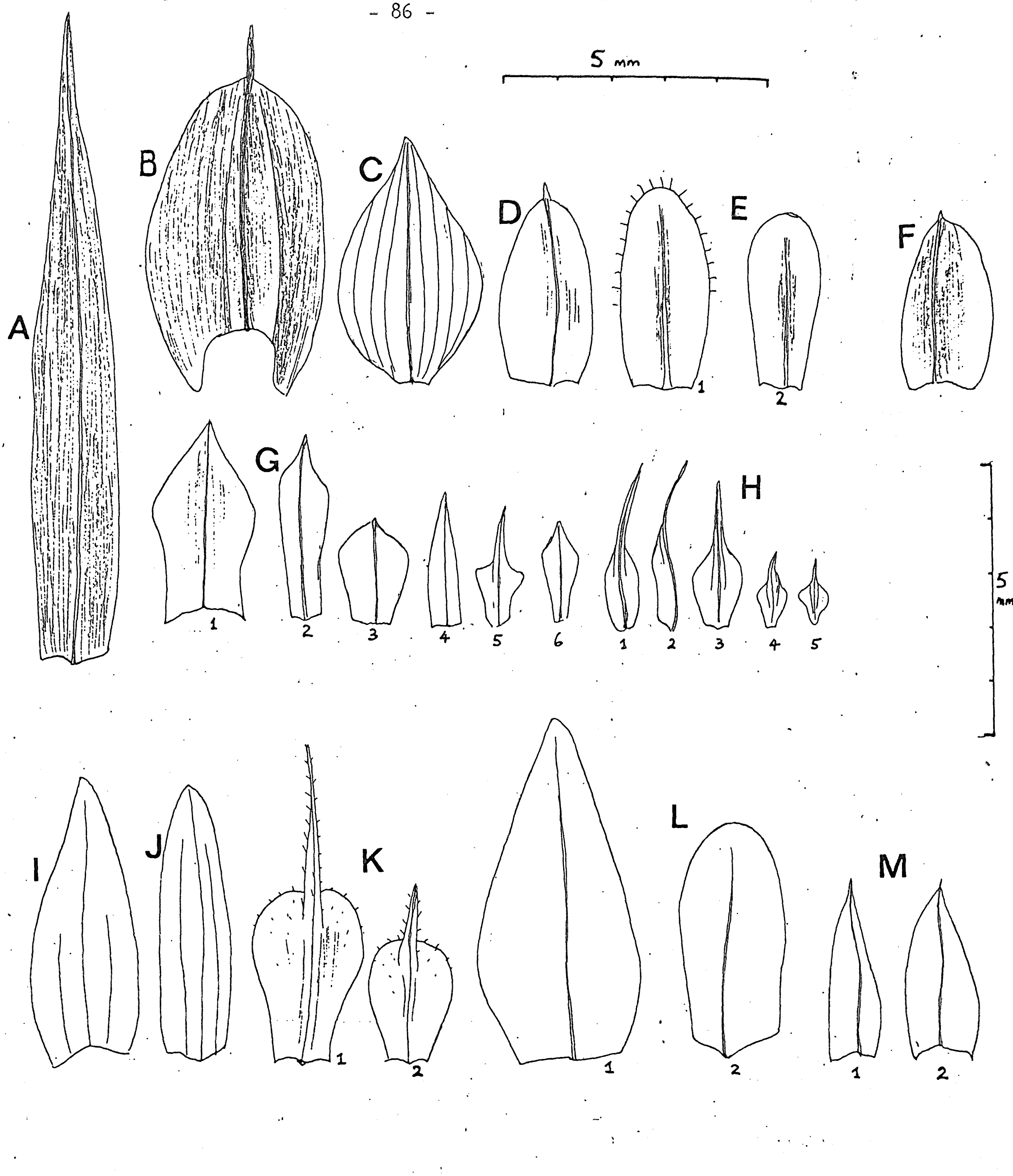


Fig. 23 Glume Outlines

these awns. Commonly prickles are found along the whole length, as in Bolboschoenus, Hymenochaeta etc., or at the tip only as in Oxycaryum or completely glabrous as in Galilea etc. Occasionally the indumentum tends to be of prickle hairs as in Fuirena.

Keel: Very often in glumes with an excurrent midnerve, 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 Actaeogeton, 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 midnerve area, but also along the lateral parts of the glume (the margins excepted).

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

Fig. 24. Glume Outlines

A. Ascolepis spp. x 6 [1. A. pinguior, 2. A. protea, 3. A. brasiliensis 4. A. capensis]

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

C. Galilea mucronata x 12

D. Cyperus spp. [1. C. glomeratus, 2. C. rotundus, 3. C. noeanus 4. C. pygmaeus, 5. C. uncinatus, 6. C. iria, 7. C. difformis]

E. Androtrichum trigynum x 12

F. Pycreus sanguinolentus x 12

G. Juncellus laevigatus x 12

H. Kyllinga squarrosa x 12

I. Courtoisia 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]

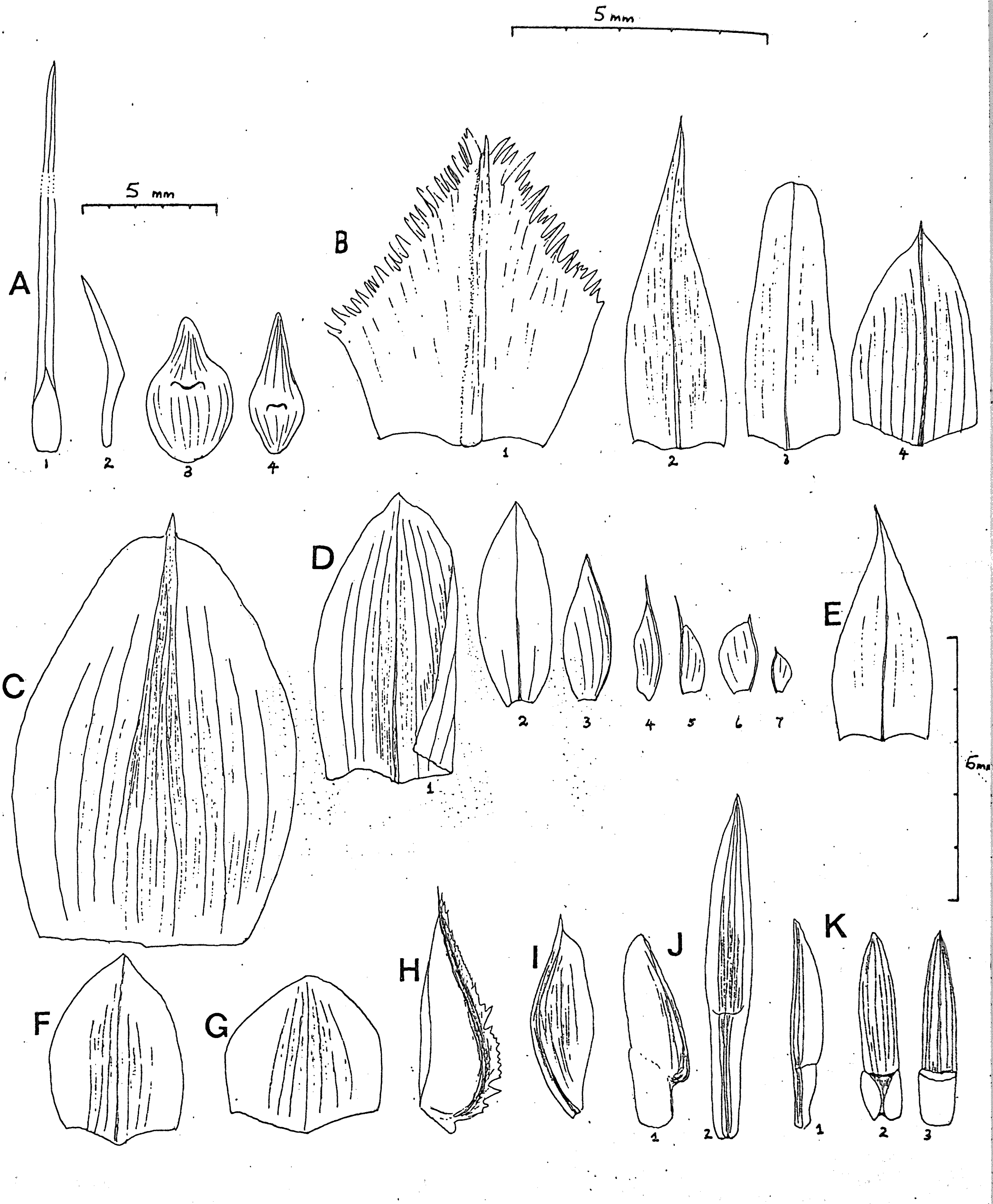


Fig. 24 Glume Outlines

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 angolensum* these prickle-hairs are present in the same position as in *Oxycaryum*, while absent in the other species *Nemum spadiceum*.

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*, *Holoschoenus* 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 *Isolepis*, *Eleogiton*, *Schoenoplectus* subgenera *Actaeogeton* and *Malacogeton*, *Nelmesia*, *Cyperus*, *Kyllinga* *Torulinium*, *Androtrichum*, *Pycreus*, *Juncellus*, *Mariscus*, *Websteria*, *Desmoschoenus*, *Lipocarpha*, *Blysmus*, *Genus B*, *Eriophorum* subgenus *Eriophorum* and *Japonici*.

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 oxyjulos

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 mattfeldianum

C. Awns of glume x 160

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

3. e.g. Schoenoplectus corymbosus

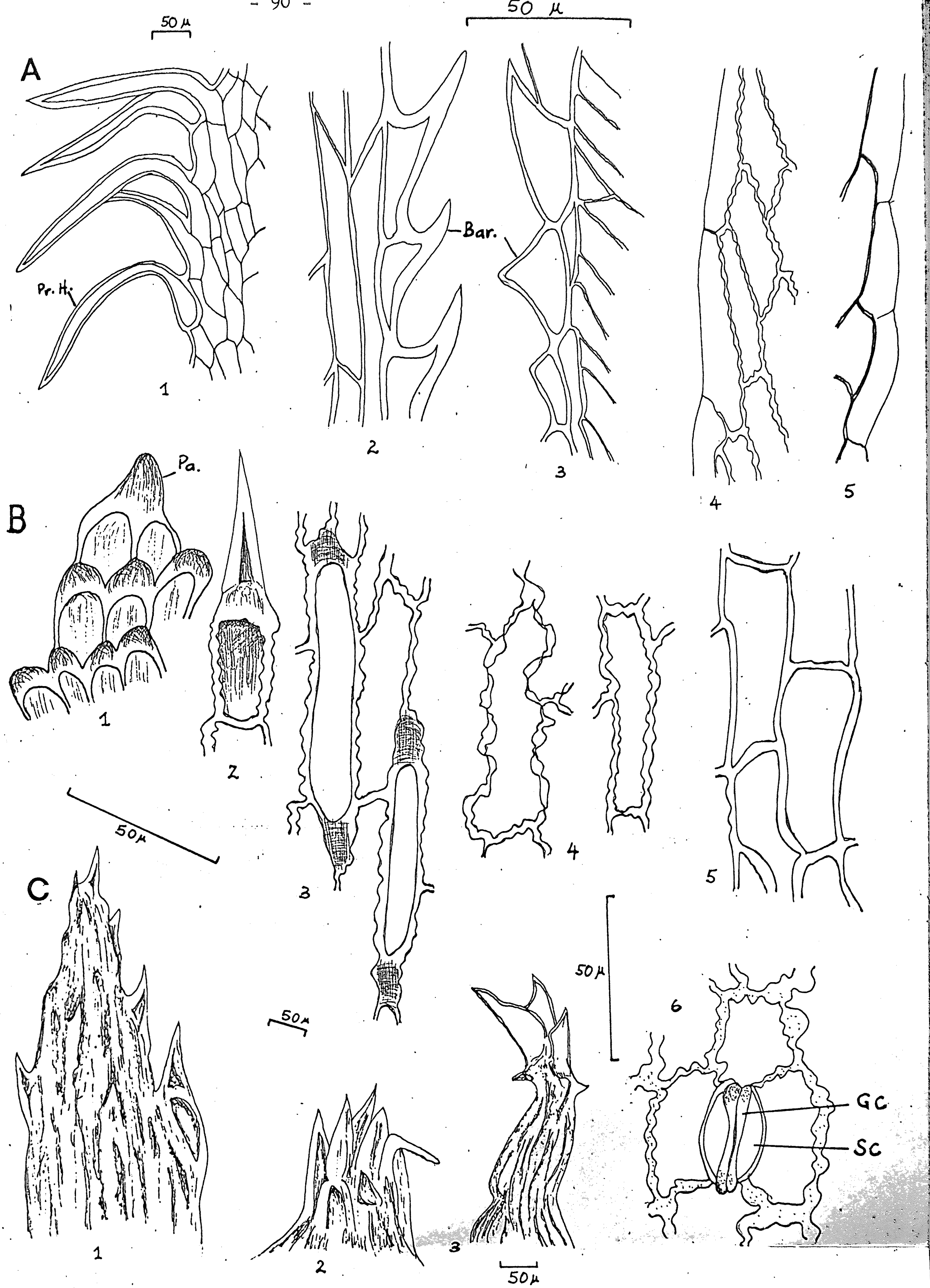


Fig. 25 Microscopic structures of Glume

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 angolensum the epidermal cells on the top lateral half of the glumes have papillose projections on their transverse anticlinal walls (Fig.225.B.1); while in Schoenoplectus oxyjulos 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.

Explanation to Table 3 contd.

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 contd.

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

Explanation 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/canaliculate; (c) setaceous; (O) 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 3 COMPARATIVE VEGETATIVE AND INFLORESCENCE MORPHOLOGY

CHARACTERS / TAXA	SHOOT		LEAF				GENERAL INFLORESCENCE			SPIKELET			RACHILLA			GLUMES							
	1	2	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3	4	5	6	7	8
ANDROTRICHIUM	b	a	b	c	b	0	±b	ab	b	a	a	b	b	0	c	a	b	c	b	b	b	d	c
ASCOLEPIS	b	ab	b	c	a	b	a	f	a	a	±a	a	±a	a	c	b	a	ad	bc	±b	c	d	c
BLYSMUS	±b	a	±b	b	a	a	a	e	±c	a	b	b	b	0	c	c	b	ac	c	b	c	d	c
BOLBOSCHOENUS	a(b)	a	(a)b	b	a	a	a	ad	a	ab	b	b	b	0	c	c	b	a	d	b	a	±a	b
COURTOISIA	b	a	b	c	a	a	a	b	a	a	a	ab	a	a	b	a	b	d	b	b	±b	d	c
CYPERUS	b	ab	b	c	a	a	a(b)	bd	a	a	a	b	b	0	bc	a(c)	b	acd	bc	b	(a)b	d	c
DESMOSCHOENUS	b	a	b	c	a	±b	a	c	a	a	b	b	b	0	c	c	b	a	c	b	c	d	c
DUVAL-JOUVEA	b	a	b	c	a	a	a	b	a	a	a	b	b	0	c	a	b	a	c	b	c	d	c
ELEOGITON	b	b	b	c	a	c	a	i	c	a	b	b	b	0	c	c	b	ad	ac	a	c	d	c
ERIOPHORUM	a	a	ab	b	a(b)	a	a	bdi	±c	a(b)	b	b	b	0	c	c	b	a(b)	ac	a(b)	c	d	(b)c
ERIOSCIRPUS	b	(a)b	b	c	a	bc	a	bd	a	ab	b	b	b	0	c	c	b	d	b	b	b	d	b
FICINIA	b	ab	b	b	a(b)	bc	c	dg-i	a-c	a	±b	b	b	0	c	(a)c	b	ac	a-ce	b	(b)c	d	bc
FUIRENA	a	a	a	a	a(b)	a	±a	cd	a	a	b	b	b	0	c	c	b	b	a	b	a	a	ab
GALILEA	b	a	b	c	a	b	a	d	±b	a	a	b	b	0	c	a	b	a	±a	b	b	d	c
HELLMUTHIA	b	a	b	c	a	b	b	d	b	a	b	b	b	0	c	c	b	a	±d	b	b	d	c
HEMICARPHA	b	b	b	c	a	c	±c	d	a	a	b	b	b	0	c	c	b	±d	b	b	a	d	c
HOLOSCHOENUS	b	a	b	c	a(b)	b	b	bd	b	a	±b	b	b	0	c	c	b	a	c	b	b	±a	±b
HYMENOCHAETA	b	a	b	c	a	a	a	a	a	ab	b	b	b	0	c	c	b	d	c	b	b	±d	b
ISOLEPIS	b	b	b	c	a	c	b	d	b	a	b	b	b	0	c	c	b	a	c	b	bc	d	c
JUNCELLUS	b	±b	b	c	a	b	b	d	b	a	a	b	b	0	c	a	b	a	±a	b	c	d	c
KYLLINGA	b	ab	b	c	a	a	a	bd	a	a	a	a	a	a	b	a	b	cd	b	b	b	ad	c
LIPOCARPHA	b	ab	b	c	a	b	a	d	a	a	±a	a	±a	a	c	b	b	b	bc	b	a-c	d	c
MARISCUS	b	a	b	c	a	a	a	bd	a	a	a	ab	a	a	b	a	b	d	c	b	c	d	c
NELMESIA	b	b	b	c	a	c	a	i	c	a	b	b	b	0	c	c	b	a	c	b	c	d	c
NEMUM	b	b	b	c	a	c	±b	(b)d	b	ab	b	b	b	0	c	c	b	b	a	±a	c	cd	ac
OXYCARYUM	b	a	b	c	a	a	a	b	a	a	±a	b	b	0	c	c	b	a	c	b	b	d	a
PHYLLOSCIRPUS	±b	±b	±b	c	a	b	a	d	c	a	b	b	b	0	c	c	b	a	c	b	c	d	c
PSEUDO-SCHOENUS	b	a	b	c	b	0	a	c	b	(a)b	b	b	b	0	c	c	b	a	c	b	b	d	±b
PYCREUS	b	a(b)	b	c	a	a	c	(a)bd	ab	a	a	b	b	0	c	a	b	a	c	b	(b)c	d	c
QUEENSLANDIELLA	b	a	b	c	a	a	a	b	a	a	a	b	a	a	a	a	b	d	c	b	c	d	c
REMIREA	±b	a	±b	c	a	±b	a	d	a	a	a	a	a	a	±a	a	b	d	c	b	c	d	c
SCHOENOPLECTUS	b	a(b)	b	c	(a)b	ab	b	ad	b	ab	b	b	b	0	c	c	b	a	cd	b	ac	bd	bc
SCIRPUS	a	a	a	b	a	a	a	a	a	(a)b	b	b	b	0	c	c	b	a(d)	c	b	bc	d	bc
TOROLINIUM	b	a	b	c	a	a	a	b	a	a	a	b	a	b	a	a	b	d	b	b	c	d	c
WEBSTERIA	b	b	b	c	a	c	a	i	c	a	b	a	b	0	c	b	b	d	b	b	±c	d	c
GENUS A	a	a	a	b	a	a	a	a	a	a	b	b	b	0	±b	c	b	a	±a	b	a	a	c
GENUS B	±b	a	b	b	a	b	a	e	±c	a	b	b	b	0	c	c	b	a	c	b	c	d	c
GENUS C	±b	±a	±b	b	a	b	b	d	b	a	b	b	b	0	c	c	b	a	c	b	c	d	±b

Note:

± = more or less

( ) = rarely

a–c = abc

ac = a and c

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 exserting 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, viz: 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 appears 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, Malacogeton and Actaeogeton, Fuirena subgen. Pentasticha sect. Pentasticha, Genus A, Genus C, Trichophorum, Websteria, 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 Vaginaria [cf. Clarke 1909, Blaser 1941, Koyama 1958]

Fig. 26 <u>Schematic Floral Diagrams</u>

Type	I	a-e	after Clarke 1909, Koyama 1958
Type	II	f	cf. Blaser 1941
Type	III	g	after Clarke 1909
Type	IV	h-k	
Type	V	l	after Van der Veken 1955
Type	VI	m-o	'o' after Palla 1908
Type	VII	p	after Clarke 1909

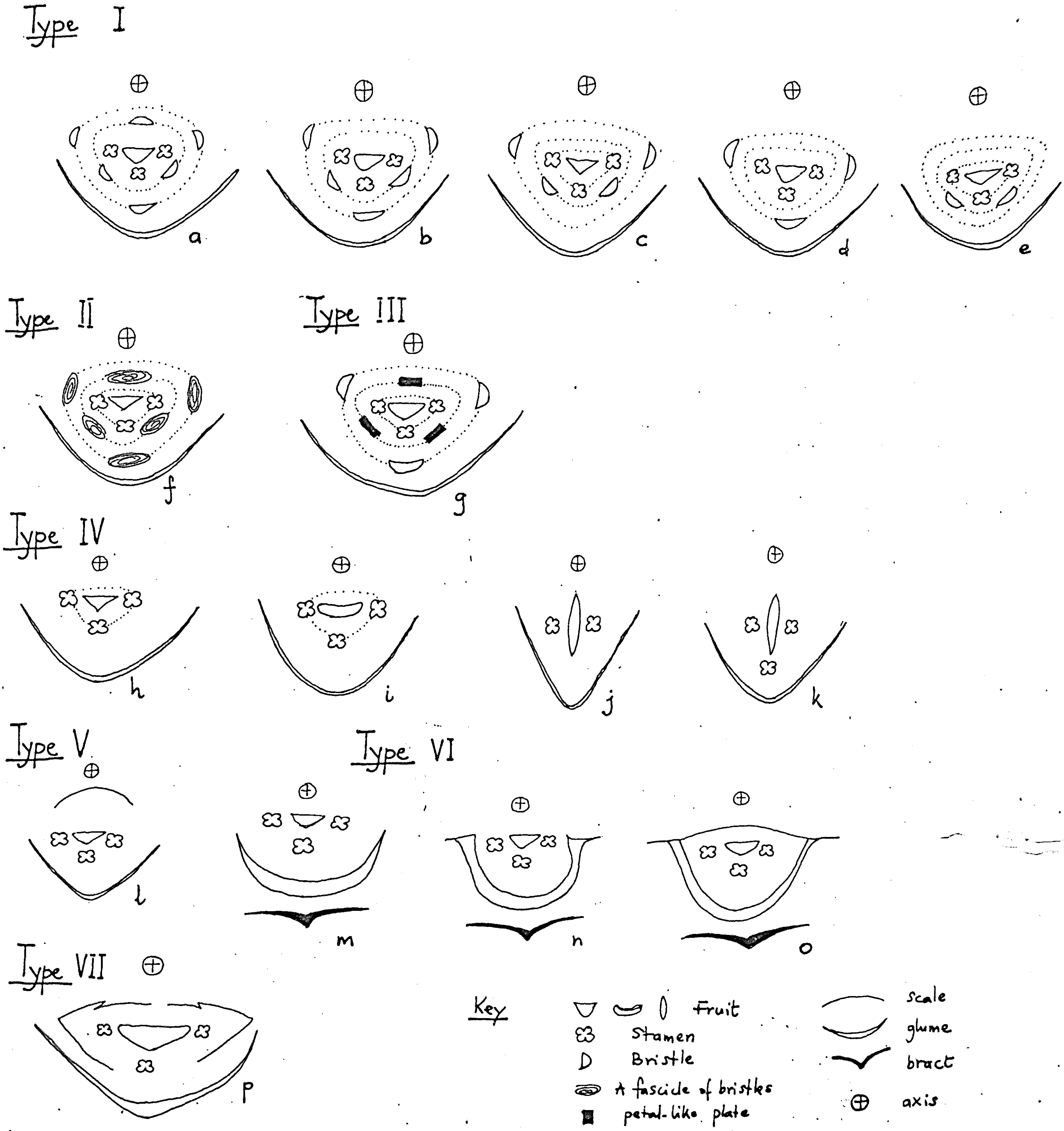


Fig. 26 Schematic Floral Diagrams

a–e *Scirpus*, *Schoenoplectus* etc f. *Eriophorum* & *Erioscirpus*
g. *Fuirena* subgen. *Fuirena* & *Vaginaria* h–i *Cyperus* etc j. *Kyllinga*
k. *Pycreus* l *Nelmesia* m–o *Ascolepis* p. *Hellmuthia*

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, Mariscus, Torulinium, Galilea, Courtoisia, Lipocarpha [Volkiella], Oxycaryum, Haloschoenus, 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 Pycreus. The other group in which the ovary is adaxially compressed or adaxially and abaxially compressed includes Juncellus, Duval-Jouvea, Nemum etc. Isolepis and Schoenoplectus subgen. Actaeogeton 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 Nelmesia [cf. Van der Veken 1955] Hemicarpha.

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 "glumellae" [cf. Steudel 1855, Clarke 1897] are sometimes present, e.g. Hellmuthia.

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. *Blysmus compressus* 2. *Websteris confervoides*

3. *Bolboschoenus maritimus*

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

4. *Trichophorum alpinum*, 5. *Erioscirpus falsus*

6 & 7. *Trichophorum caespitosum*, 8. *Scirpus fontinalis*

9 9. *Erioscirpus comosus*

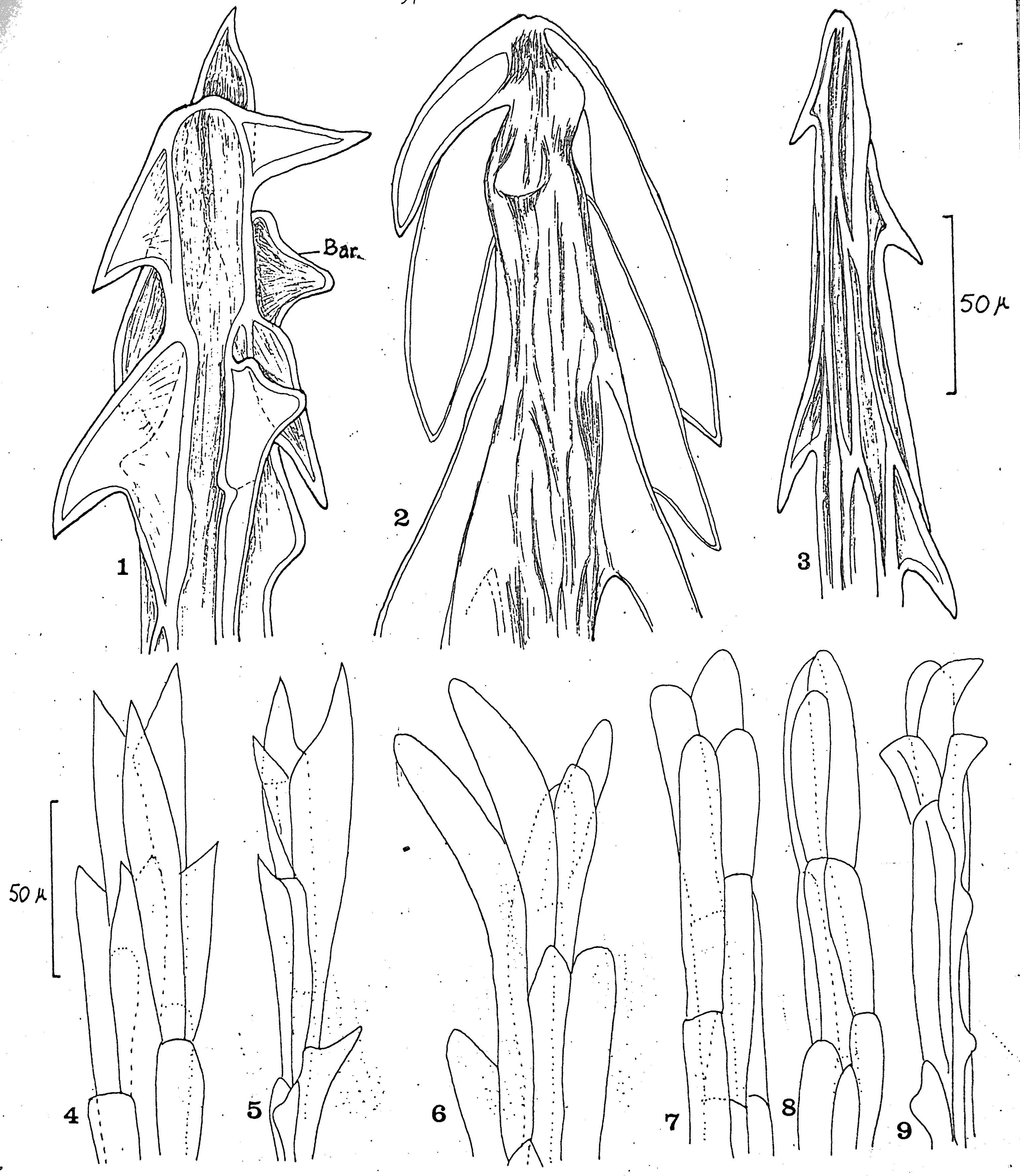


Fig. 27 Hypogynous Perianth Bristles

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. 28.8 the scale is papery hyaline to palely 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 vasculation. In Hemicarpha Fig. 28.7 it is scarious, hyaline and obovate, entire or bilobed, with or without vasculation, often vestigial or absent [cf. Friedland 1941].

The two lateral scarious "squamellae" found in Hellmuthia [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 1909].

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. coerulescens, 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, Genus A, Genus C, Trichophorum,

Fig. 28. <u>Hypogynous Perianth Segments</u> (Bristle and scale)

1 & 2. Needle-like, irregularly scabrous bristle x 660

1. *Scirpus polyphyllus*, 2. *Scirpus radicans*

3 & 4. Plumosely fimbriate bristle

3. *Schoenoplectus littoralis* (diagrammatic), 3' multi-celled setulose

4. *Schoenoplectus riparius* (diagrammatic) 4' uni-celled setulose

5 & 6. Reduced bristles

5. *Trichophorum clementis* x 160, 6. *Trichophorum pumilum* x 660

7 & 8. Scales

7. *Hemicarpha occidentalis* x 160, 8. *Nelmesia melanostachya*

(after Van der Veken 1955)

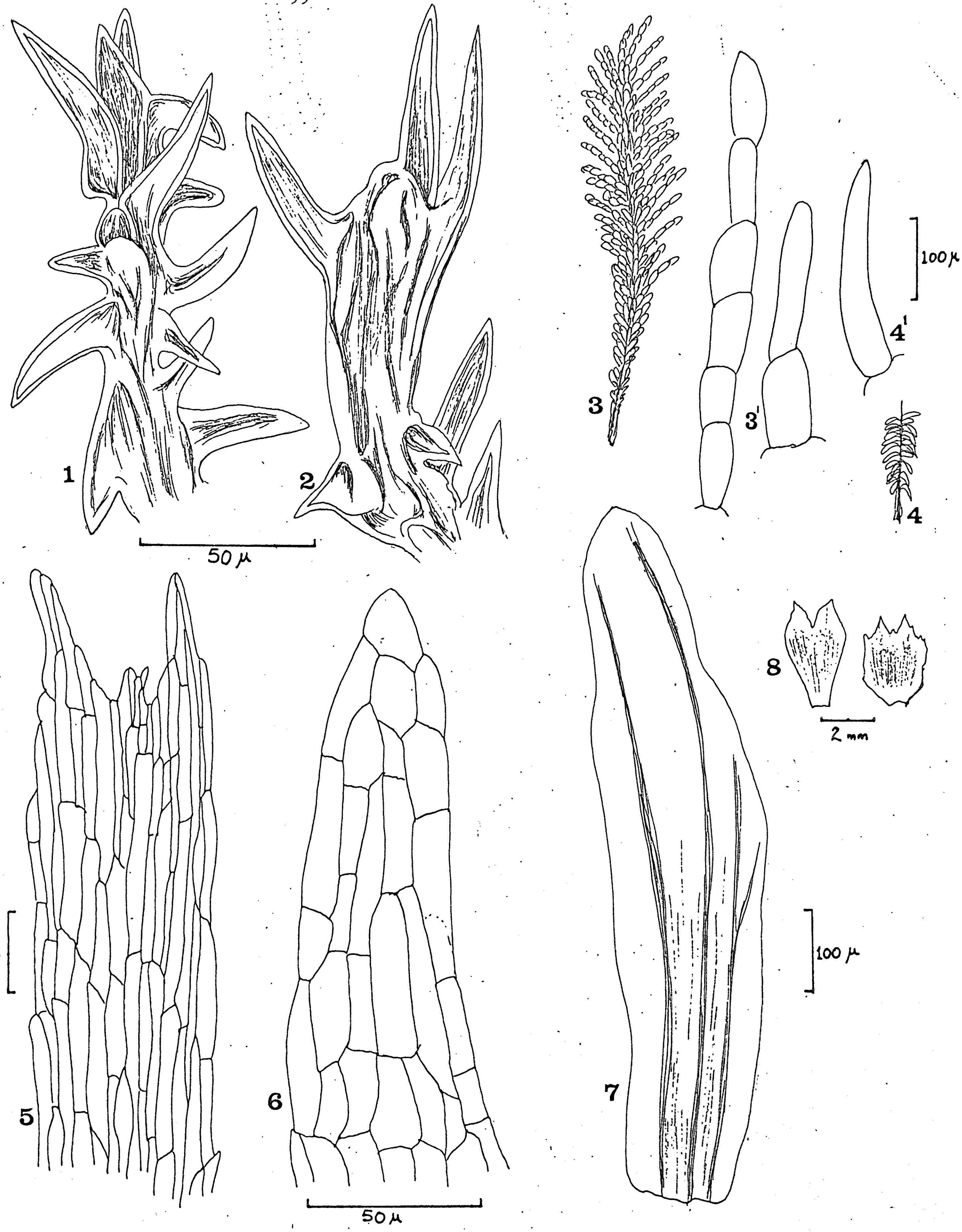


Fig. 28 Hypogynous perianth segments

Websteria, *Phylloscirpus*, *Blysmus*, *Genus B*, *Erioscirpus* p.p., *Eriophorum* p.p. In *Erioscirpus* 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 been 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, plumosely-fimbriate and filiform or silky; the former (first) is very common, occurring in *Hymenochaeta*, *Pseudo-schoenus*, *Fuirena*, *Bolboschoenus*, *Genus A*, *Genus C*, *Websteria*, *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 plumosely-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 *Scheonoplectus* proper which is a typical needle-like bristle [cf. Koyama 1963].

The filiform or silky bristles occur in *Eriophorum*, *Erioscirpus*, *Scirpus* and *Trichophorum*. Typically, as in most species of *Eriophorum* and *Erioscirpus*, 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

4. _F. cinerascens_ x 20, 5. _F. umbellata_ x 25, 6. _F. simplex_ x 25

7. _F. glomerata_ x 25, 8. _F. scirpoidea_ x 25, 9. _F. squarrosa_ x 25

10. _F. pumila_ x 25, 11. _F. hirta_ x 25, 12. _F. robusta_ x 20

13. _F. wallichiana_ var. _evoluta_ x 20, 14. _F. ecklonii_ x 20

15. _F. coerulescens_ x 20, 16. _F. quercina_ x 20, 17. _F. enodis_ x 20

18. _F. microlepis_ x 20, 19. _F. gracilis_ x 20, 20. _F. claviseta_ x 20

21. _F. ciliaris_ x 25, 22. _F. leptostachya_ x 25, 23. _F. leptostachya_ x 30

24. _F. trilobites_ x 30

1 & 16 after Chermezon 1936

2, 20-22 after Napper 1963

3, 4, 9-15, 17-19, 23, 24 after Clarke 1909

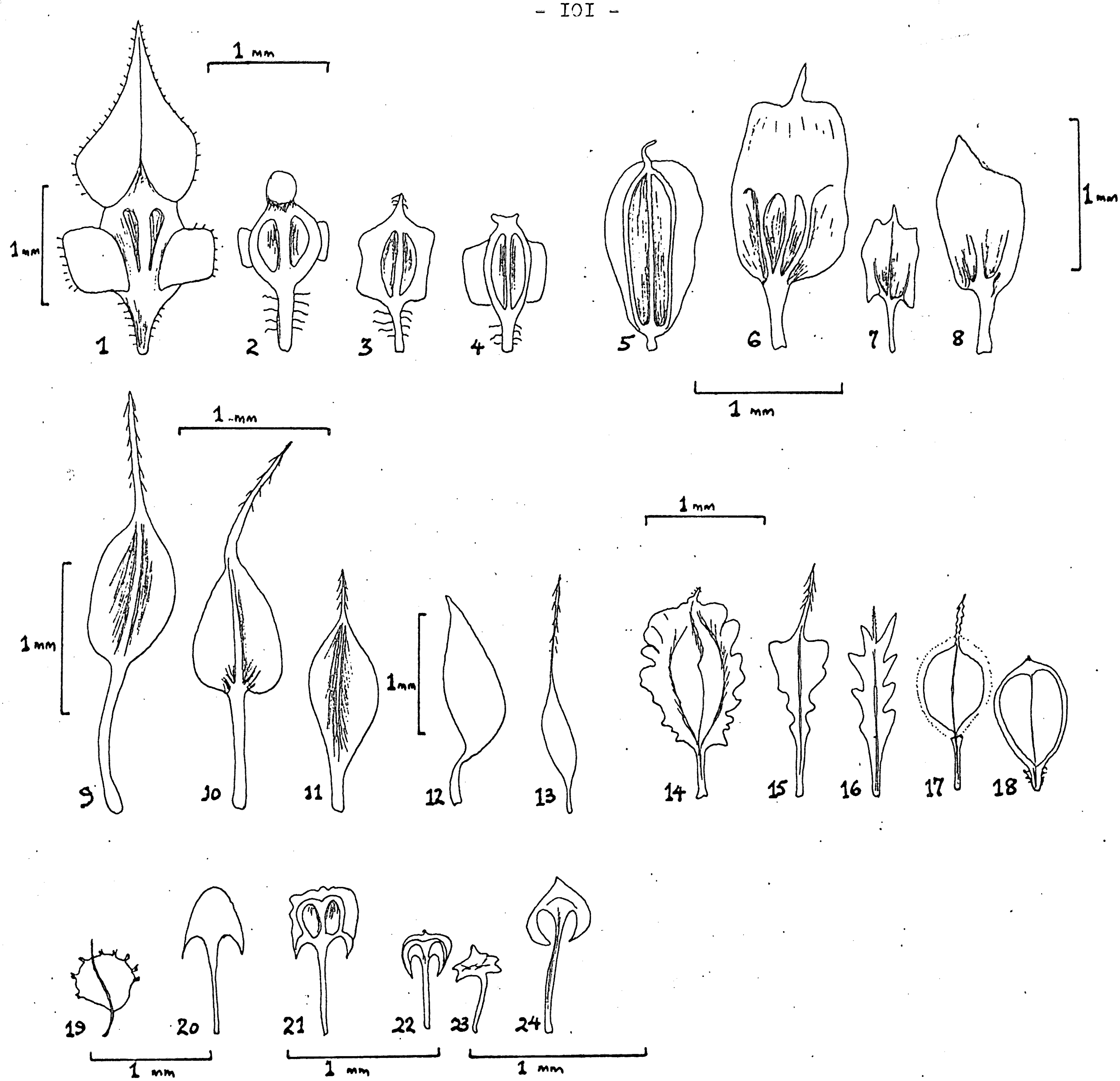


Fig. 29 Petal-like Plates in Fuirena

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 Lineati and one species in Trichophorum (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) [cf Beetle 1942, Schuyler 1967 p. 296] and in subgenus Japonici (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 Trichophorum, 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 Erioscirpus, 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) Retrorsely 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 (periclinal) 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 μ long, with acute tip (Fig.27.1,3). This is generally found in Bolboschoenus, Schoenoplectus p.p., Hymenochaeta, Pseudo-schoenus, Fuirena, Phylloscirpus, Blysmus, some Scirpus spp. especially S. sylvaticus, S. asper, S. atrovirens etc.

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

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

(b) Antrorsely 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 Erioscirpus 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 Erioscirpus species (especially E. falsus, E. macrostachyus), few Eriophorum species (especially E. japonicum, E. crinigerum) and some species in Scirpus (especially S. cyperinus, S. fuirenoides, 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. polyphyllus, S. congdonii, S. peckii, S. divaricatus, S. radicans etc. and also in Schoenoplectus subgenus Malacogeton 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 varies from one to three, often the whole variation is observed in a single genus, as in Cyperus, Ascolepis, Pycreus etc. A frequent number of three is found in Scirpus, Schoenoplectus, Fuirena, Bulboschoenus, Holoschoenus, Websteria, Remirea, Nelmesia etc.

Filaments: The filaments characteristically elongate at maturity, often exserting 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 Androtrichum.

Fig. 30. Staminal Crests x 160

A. 1. Eleogiton crassiuscula, 2. Schoenoplectus mucronatus

3. Genus C (Scirpus nevadensis), 4. Schoenoplectus erectus

B. Papillose & Prickled Crests

1. Desmoschoenus spiralis, 2. Erioscirpus falsus

3. Holoschoenus thunbergianus, 4. Websteria confervoides

5. Oxycaryum cubense, 6. Bolboschoenus maritimus

7. Schoenoplectus subulatus

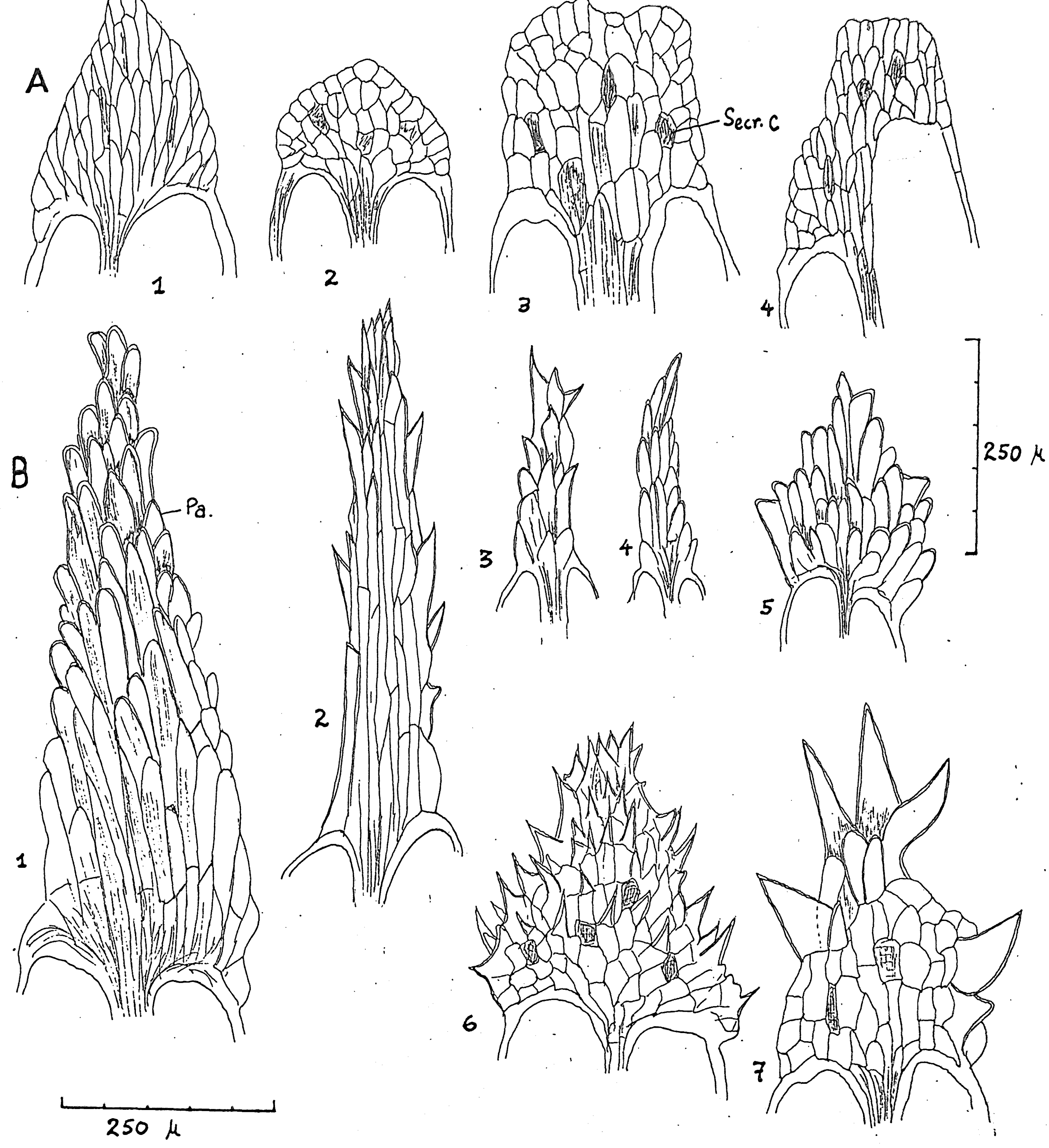


Fig. 30 Staminal Crests

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 *Androtrichum*.

Anthers: The anthers are generally basifixed, linear with introrse longitudinal dehiscence. In some genera the anthers are conspicuously large, as in *Blysmus*, *Phylloscirpus*, *Bolboschoenus*, *Nelmesia*, *Websteria* etc., while in other genera they are relatively smaller, as in *Scirpus*, *Nemum*, *Remirea* etc. The genera with conspicuously large anthers tend to have large glumes and large fruits, as in *Blysmus*, *Genus 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 retuse (Fig. 30.A.3) Conspicuously long acuminate crested anthers are found in *Desmoschoenus*, though in *Websteria*, *Erioscirpus*, *Bolboschoenus* spp., *Schoenoplectus* spp., *Holoschoenus* spp., *Ficinia* spp. there are intermediates from long to shortly acuminate crested anthers. Obtuse crested anthers are rather common, being found in most *Bolboschoenus* spp., most *Schoenoplectus* spp., *Pseudo-schoenus*, *Nemum*, *Ascolepis*, *Fuirena*, *Genus A*, some *Holoschoenus* spp., *Oxycaryum*, *Hellmuthia*, *Isolepis*, *Phylloscirpus*, *Blysmus*, *Genus B*, some *Ficinia* spp., *Nelmesia* etc. Intermediate states from obtuse to rotund crested anthers occur in *Scirpus*, *Trichophorum*, *Eriophorum*, *Lipocarpha*, *Androtrichum*, *Cyperus*, *Galilae*, *Pycreus*, *Juncellus*, *Duval-Jouvea*, *Courtoisia*, *Kyllinga*, *Mariscus*, *Torulinium*, *Remirea* etc. Retuse crested anthers occur occasionally, being observed in *Genus C*, *Eleogiton* and [*Volkiella* cf. Merxm. & Czech. 1953] 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 Actaeogeton [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, Hellmuthia and Blysmus. Desmoschoenus and Oxycaryum have a papillose profile, while Pseudo-schoenus, Holoschoenus and Eriocirpus 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 Malacogeton and Actaeogeton, 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. ramossisima etc.) while a few show smooth profiles (cf. F. praemorsa). In Websteria and Genus B there are tendencies towards papillose profiles, but the papillea are not clearly defined. Predominantly smooth profiles are characteristic in Scirpus, Hymenochaeta, Nemum, Ascolepis, Fuirena, Genus C, Trichophorum, Eleogiton, Isolepis, Phylloscirpus, Eriophorum, Lipocarpha, Androtrichium, Cyperus, Galilea, Pycreus, Juncellus, Duval-Jouvea, Courtoisia, Kyllinga, Mariscus, Torulinium, Nelmesia [Volkiella], Hemicarpha and Queenslandiella.

Pollen grains

Structure: There is a long sequence of references to the pollen structure dating back to 1830 [ref. Erdtman 1952, Cranwell 1953, Davis 1966 etc.]. The grains are either subglobose, ovoid, elongated ovoid, wedge or gourd-shaped or spheroidal, and measures from c. 16-76 μ x 20-46 μ [Erdtman op. cit., Cranwell op. cit., Bakker 1953]. These shapes and sizes are not absolute to any particular genera.

Aperturate and rarely inaperturate grains have been observed by most of these workers. Kyllinga is noted to have aperturate or panto-aperturate grains which show a zonal distribution of 4-6 aperturates [Padhye 1966-67, 1971b]; a more or less similar kind of grain has been observed in Lepironia [Erdtman op. cit. p. 141] and Cladium [Erdtman op. cit., Koyama 1956]; while most genera (especially those considered in this part) have aperturate, rarely inaperturate, largely monoporate or monocolpate grains [Woodehouse 1935, Bakker op. cit., Cranwell op. cit., Padhye 1967, Sharma 1967 etc.].

The exine structure has been observed as thin, varying in thickness from 1.0-2.5 μ, sculpturing being minutely granulate, scrobiculate or reticulate [Bakker op. cit.], or lectate, smooth, but rough over exits, rod layer distinctive [Cranwell op. cit.], or simply as having stratification which is apparently more or less the same as in other plants [Erdtman op. cit.]. Woodehouse [op. cit. p. 351] noted adaptive likenesses between the grains of Cyperaceae and those of ash and poplars; an observation which was later confirmed from peat studies [cf. Iversen 1946]. 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.]. 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.]

preferred the term "Cryptotetrads" though suggested that this question of terminology be open to await future cytological investigations, especially of Maparia and its allies. Skottsberg [1940 p. 654] 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 relationship between the Cyperaceae and the Juncaceae where also the outer wall of the tetrad is derived from the microspore mother cell but in the Juncaceae the inner walls dividing the microspore nuclei are not reabsorbed as in the Cyperaceae to form "pseudomonads" or "Cryptotetrads" [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. Täckholm 1920] or dysploid [cf. Jeffrey 1925] series in the chromosome numbers [Hakansson 1928, 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 irregularities in the whole family Cyperaceae, viz: Defective conjugation in meiosis (non-conjunction) leading to polysomy, [Heilborn 1939]; bastardizing [Hakansson op. cit., Hicks op. cit.]; structural changes of the chromosomes [Sharma & Bal op. cit., Schuyler 1967, Strandhede 1965]; hybridization [Hicks op. cit., Strandhede op. cit. etc.]; polyploidy - allo - or auto-polyploidy [Heilborn 1932, 1934, 1939, Meurman 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 consequence 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 Oxycaryum, Schoenoplectus subgenera Schoenoplectus and Malacogeton, Bolboschoenus, Websteria, Genus A, Blysmus, Genus B, Fuirena etc. Often in Scirpus, Phylloscirpus, 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 1971] and disposed divaricately or erect.

Papillae: The surface of most stigmas show papillae which may be densely (as in Holoschoenus etc.) or minutely (as in Blysmus etc.) distributed. Often a number of genera, viz: Cyperus, Remirea, Duval-Jouvea, Kyllinga, Pycreus, Androtrichium, Hemicarpha, Mariscus, Juncellus, Galilea, Torulinium,

TABLE 4 HAPLOID CHROMOSOME NUMBERS AVAILABLE

GENERA	Total No. of species investigated	Haploid number of chromosomes	References and Citations
CYPERUS	12	9, 12, 13, 15, 16, 17, 18, 31, 32, 36, 51, 54	Hicks 1929, cited by Federov 1969
JUNCELLUS	3	40, 42, 43, 76-87	Federov op. cit.
PYCREUS	5	21, 24, 25, 40, 47	Federov op. cit.
MARISCUS	2	41, 73	Federov op. cit.
KYLLINGA	3	54, 56, 60	Federov op. cit.
LIPOCARPHA	1	23	Federov op. cit.
BOLBO-SCHOENUS	8	40, 43, 52, 55, 57	Hakansson 1928, Hicks 1929, Clapham et al 1962, Federov 1969
SCHOENO-PLECTUS	9	14, 18, 19, 20, 21, 22, 38, 39, 60, 64	Hakansson op. cit.; Hicks op. cit., Tanaka 1937, 1940, 1942, 1948, Bakker D. 1954; Otzen 1962; Clapham et al op. cit.; Smith 1969; Federov 1969
SCIRPUS	18	14, 18, 20, 25, 26, 27, 28, 29, 32, 33, 34	Hakansson op. cit.; Hicks op. cit.; Heilborn 1939; Clapham et al op. cit.; Schuyler 1964, 1967; Dennis 1965; Federov op. cit.
BLYSMUS	1	22, 39, 40	Clapham et al op. cit.; Federov op. cit.
GENUS B [as Blysmus]	1	20	Clapham et al op. cit.; Federov op. cit.
ISOLEPIS	3	13, 14, 21. 24	Hakansson op. cit.; Moore & Edgar 1970; Clapham et al op. cit.; Federov op cit.
ELEOGITON	1	30	Clapham et al op. cit.
TRICHO-PHORUM	2	29, 52	Clapham et al op. cit.; Federov op. cit.
ERIOPHORUM	13	27, 29, 30, 38	Hakansson op. cit., Hicks 1929; Clapham et al op. cit.; Federov op. cit.

and Pseudo-schoenus have completely smooth stigmata, occasionally showing tnedencies to developing these papillae. Predominantly smooth (non-papillose) stigmas occur in Bolboschoenus, Oxycaryum, Websteria, Ascolepis, Lipocarpha etc. In Schoenoplectus 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 stigmata, 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 Blysmus, Genus B, Eleogiton, Genus C, Nemum, Websteria, Juncellus, Kyllinga, Torulinium, Duval-Jouvea and Pycreus. Those with predominantly 3 stigmas include Phylloscirpus, Holoschoenus, Pseudo-schoenus, Desmoschoenus, Hymenochaeta, Cyperus, Galilea, Mariscus, Remirea, Lipocarpha, Courtoisia, Fuirena, Eriophorum, Erioscirpus, Trichophorum, Nelmesia and Androtrichium. In Scirpus, Isolepis, Hemicarpha, Schoenoplectus, 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 Schoenoplectus [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, bitegmic and crassinuclear with micropyle formed by the inner integument [cf. Davis 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 micropyle, and frequently degenerate after fertilization - has been found to organise at the mature embryo sac stage [Padhye 1960, Padhye et al 1970, Padhye and Kasture 1970, Tiwari 1969, Padhye 1971a] or become fully developed at the tetrad stage of the megaspores [Padhye 1971b].

Embryogeny: The development of the zygote is summarised in Fig.33 adapted from Padhye 1971b. The process conforms to the Onagrad Type [cf. Davis op. cit.] whereby instead of the quadrant 'q' organising into octants as is normally the case, they divide periclinally to cut off the Dermatogen initials and four central cells which form the periblem 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 1971a, 1971b] and in certain taxa of the Juncaceae [Souèges 1923, 1933; Shah 1963] 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] mucronatus. In Kyllinga, Padhye 1971b, has observed a well marked tendency towards precocious differentiation of the plerome and periblem, 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 periblem 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 periblem and plerome are laid down later.

This condition in Kyllinga had earlier been reported in Bulbostylis barbata [Shah 1965] and in Juncus bufonicus [Shah 1963].

Mature embryo: Following the earlier works of Didrichsen [1894, 1897], Schneider [1932], 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 A. The following table summarises the basic distinction mentioned by him:

TABLE 5 TYPES OF MATURE EMBRYOS

TYPE	General form	Coleoptile	Root cap [Coiffe radiculaire]
BULBOSTYLIS Type	Largely centrifugal or turbinate	basal	basal
CAREX Type	centrifugal or turbinate	lateral	basal
SCHOENUS Type	centrifugal or turbinate	sub-lateral	sub-lateral
FIMBRISTYLIS Type	centrifugal or turbinate	basal	lateral
CYPERUS Type	ellioso idal	basal	lateral
SCIRPUS Type	fungiform	basal	lateral

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

Bulbostylis type (Fig.34.A1) found in Nemum, Nelmesia, [Bulbostylis]

Carex type (Fig.34.A2) found in Trichophorum, Blysmus, Genus B, [Dulichium]

Schoenus type (Fig.34.A3) in Phylloscirpus, Genus C

Fimbristylis type (Fig.34.A4) in Scirpus, Eriophorum, Erioscirpus, Websteria, [Eleocharis], [Egleria], [Fimbristylis]

Cyperus type (Fig.34.A5) in Eleogiton, Isolepis, Holoschoenus, Oxycaryum, Desmoschoenus, Hemicarpha, Androtrichium, Hellmuthia, Lipocarpha, Ascolepis, [Volkeilla], Ficinia, Cyperus, Kyllinga, Torulinium, Juncellus, Pycreus, Courtoisia, Duval-Jouvea, Mariscus, Remirea, Queenslandiella

Scirpus Type (Fig.34.A6) 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 [Davis op. cit.; Padhye 1971b] 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 [1960, 1967, 1971a, 1971b] 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 Caricoideae. 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 susceptable 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 31-32 represent typical fruit sizes in the genera investigated.

Explanation to Table 6 contd.

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. Mature embryo shape and form (ref. Fig.

(a) "Bulbostylis" type; (b) "Schrenus" type; (c) "Fimbristylis" type;
(d) "Cyperus" type; (e) "Carex" type; (f) "Scirpus" type.

Explanation to Table 6 Comparative Floral Morphology

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) papillose; (c) smooth

5. Pollen grains

(a) monoporate or monocolpate; (b) with zonal distribution of 4-6 apertures

TABLE 6 COMPARATIVE FLORAL MORPHOLOGY

	FLORAL DIAGRAM	HYPOGYNOUS PERIANTH SEGMENT				ANDROECIUM					GYNOECIUM							
		1	2	3	4	1	2	3	4	5	1	2	3	4	5	6	7	8
ANDROTRICHIUM	d	o	o	o	o	b	a	b	c	?	a	b	b	a	b	b	b	d
ASCOLEPIS	f	o	o	o	o	c	b	b	c	?	b	b	ab	a	b	b	b	d
BLYSMUS	a	b	o	a	a	b	b	b	a	?	b	a	a	b	b	a	a	e
BOLBOSCHOENUS	a	b	o	a	a	b	b	ab	a	?	b	b	ab	b	b	(a)b	a	f
COURTOISIA	d	o	o	o	o	b	b	b	c	?	a	b	b	±b	b	b	b	d
CYPERUS	d	o	o	o	o	c	b	b	c	a	a	b	b	a	b	b	b	d
DESMOSCHOENUS	d	o	o	o	o	b	b	a	b	a	a	a	b	a	b	b	b	d
DUVAL-JOUVEA	d	o	o	o	o	b	b	b	c	?	a	b	a	a	b	b	±a	d
ELEOGITON	d	o	o	o	o	b	b	b(c)	c	a	a	a	a	a	b	b	b	d
ERIOPHORUM	(a)b	b	o	b(a)	bd	b	b	b	c	?	a	a	b	ab	b	b	a	c
ERIOSCIRPUS	(a)b	b	o	b	b	b	b	a	ab	?	a	a	b	a	b	b	a	c
FICINIA	d	o	o	o	o	b	b	ab	a-c	?	a	a	(a)b	ab	a	bc	a	d
FUIRENA	ac(d)	bc	o	a	a	b	b	b	c	?	a	a	b	a	b	a(b)	±a	±f
GALILEA	d	o	o	o	o	b	b	b	c	?	a	b	b	b	b	b	a	d
HELLMUTHIA	d(g)	(a)o	(b)o	o	o	b	b	b	a	a	a	a	b	?	?	?	?	d
HEMICARPHA	de	ao	ao	o	o	c	b	b	c	?	a	b	ab	a	b	b	bd	d
HOLOSCHOENUS	d	o	o	o	o	b	b	ab	ab	a	a	a	b	a	b	b	b	d
HYMENOCHAETA	a	b	o	a	a	b	b	b	c	?	a	a	b	a	b	b	a	f
ISOLEPIS	d	o	o	o	o	b	b	b	c	a	a	a	ab	a	b	b	bd	d
JUNCELLUS	d	o	o	o	o	b	b	b	c	?	a	b	a	a	b	(b)c	b	d
KYLLINGA	d	o	o	o	o	c	b	b	c	(a)b	a	b	a	a	b	b	b	d
LIPOCARPHA	d	o	o	o	o	a	b	b	c	?	a	b	b	a	b	b	b	d
MARISCUS	d	o	o	o	o	b	b	b	c	a	a	b	b	a	b	b	b	d
NELMESIA	e	a	a	o	o	b	b	b	c	?	a	a	b	b	b	b	a	a
NEMUM	d	o	o	o	o	b	b	b	c	?	a	a	a	a	b	c	a	a
OXYCARYUM	d	o	o	o	o	b	b	b	b	?	a	b	a	b	b	a	a	d
PHYLLOSCIRPUS	a	b	o	a	a	b	b	b	c	?	a	a	b	a	b	±a	±a	b
PSEUDO-SCHOENUS	a	b	o	a	ac	b	b	b	ab	?	a	b	b	±a	b	b	a	f
PYCREUS	d	o	o	o	o	c	b	b	c	a	a	b	a	a	b	b	b	d
QUEENSLANDIELLA	d	o	o	o	o	a	b	b	c	?	a	b		?	b	?	?	d
REMIREA	d	o	o	o	o	b	b	b	c	?	a	b	b	b	b	b	a	d
SCHOENOPLECTUS	ad	b(o)	o	a	a	b	b	ab	a-c	?	a	ab	ab	ab	b	ab	ac	f
SCIRPUS	a	b	o	ab	a-d	b	b	b	c	?	a	a	ab	a	b	b	b	c
TORULINIUM	d	o	o	o	o	b	b	b	c	?	a	b	b	a	b	b	b	d
TRICHOPHORUM	a(d)	b(o)	o	ab	b	b	b	b	c	?	a	a	b	ab	b	b(c)	a	e
WEBSTERIA	a	b	o	a	a	b	b	a	bc	?	a	a	a	b	b	a	±a	c
GENUS A	a	b	o	a	b	b	b	b	a	?	a	a	ab	b	b	a	a	?
GENUS B	a	b	o	a	b	b	b	b	bc	?	b	a	a	b	b	a	a	e
GENUS C	d	b	o	a	a	b	b	bc	c	?	a	a	a	±a	b	c	a	b

Note:

? = no information

( ) = rarely

± = more or less

a-d = a b c d

ac = 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, Erioscirpus, Nelmesia etc. There appears to be relative uniformity in the fruit sizes of many genera, as in Scirpus, Isolepis, Eleogiton, Phylloscirpus, Nemum, Eriophorum, Fuirena, Lipocarpha etc.; however, in some other genera the fruit sizes are often variable, as in Cyperus, Ficinia, 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), Erioscirpus (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 Ficinia (Fig. 32.J), or may be relatively long attenuate as in Schoenoplectus subgenera Schoenoplectus and Malacogeton (Fig. 31F 1-5) Bolboschoenus (Fig. 31.G), Phylloscirpus (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), Erioscirpus (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. Malacogeton) and Blysmus. Small and shorter beaks occur in other genera, except in Nemum, Genus C, Juncellus and some species of Trichophorum (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, Juncellus 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 Isolepis (especially in I. setacea) and Hemicarpha (especially H. brevicaulis).

Fig. 31. Fruit shapes x 12

A. *Scirpus* spp. (1. *S. fuirenoides*, 2. *S. sylvaticus*, 3. *S. pallidus* 4. *S. fontinalis*, 5. *S. mitsukurianus*, 6. *S. divaricatus*, 7. *S. peckii*)

B. *Isolepis* spp. (1. *I. thouarsiana*, 2. *I. cyperoides*, 3. *I. koilolepis* 4. *I. costata*, 5. *I. cernua*, 6. *I. prolifer*, 7. *I. inundata* 8. *I. setacea*, 9. *I. antartica*)

C. *Eleogiton* spp. (1. *E. crassiuscula*, 2. *E. pseudo-fluitans* 3. *E. brizoides*, 4. *E. fluitans*, 5. *E. lenticularis*)

D. *Oxycaryum cubense*

E. *Trichophorum* spp. (1. *T. pumilum*, 2. *T. verecundum*, 3. *T. clintonii* 4. *T. mattfeldianum*, 5. *T. clementis*, 6. *T. subcapitatum*)

F. *Schoenoplectus* spp. (1. *S. torreyi*, 2. *S. americanus*, 3. *S. nipponicus* 4. *S. mucronatus*, 5. *S. erectus*, 6. *S. oxyjulos*, 7. *S. hallii* 8. *S. supinus*, 9. *S. dissachantus*)

G. *Bolboschoenus* spp. (1. *B. fluviatilis*, 2. *B. tuberosus*, 3. *B. maritimus* 4. *B. robustus*, 5. *B. paludosus*, 6. *B. planiculmis*, 7. *B. strobilinus*)

H. *Phylloscirpus* spp. (1. *P. acaulis*, 2. *P. semisubterraneus*)

I. *Holoschoenus* spp. (1. *H. nodosus*, 2. *H. vulgaris*, 3. *H. dioecus* 4. *H. thunbergianus*)

J. *Websteria confervoides*

K. *Genus* A (*Scirpus junghuhnii*)

L. *Pseudo-schoenus inanis*

M. *Hymenochaeta grossa*

N. Nemum spp. (1. *N. angolensum*, 2. *N. spadiceum*)

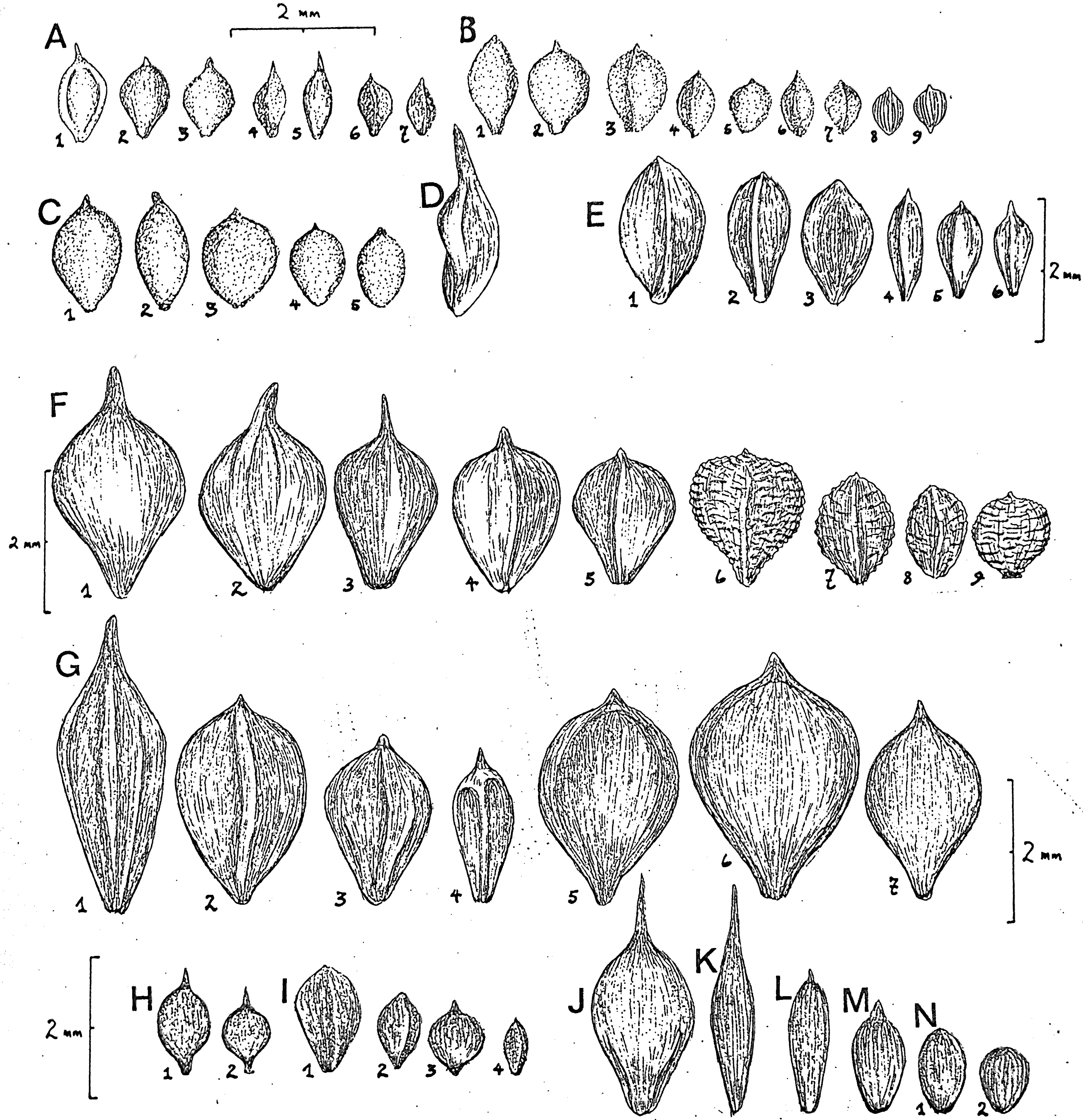


Fig. 31 Fruit Shapes

Fig. 32. Fruit shapes x 12

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

C. *Desmoschoenus spiralis*

D. *Eriophorum* spp. (1. *E. vaginatum*, 2. *E. latifolium*, 3. *E. brachyantherum*, 4. *E. russeolum*, 5. *E. japonicum*)

E. *Erioscirpus* spp. (1. *E. comosus*, 2. *E. falsus*)

F. *Fuirena* spp. (1. *F. scirpoides*, 2. *F. incompleta*, 3. *F. simplex* 4. *F. ciliaris*)

G. *Lipocarpha* spp. (1. *L. sphacelata*, 2. *L. chinensis*, 3. *L. argentea*)

H. *Hemicarpha* spp. (1. *H. occidentalis*, 2. *H. micrantha*, 3. *H. hytrix* 4. *H. kernii*, 5. *H. squarrosa*, 6. *H. brevicaulis*)

I. *Ascolepis* spp. (1. *A. protea*, 2. *A. capensis*, 3. *A. brasiliensis* 4. *A. pinguior*)

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

K. Genus C (*Scirpus nevadensis*) L. *Nelmesia melanostachya*

M. *Androtrichum trigynum* N. *Courtoisia cyperoides*

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

P. *Duval-Jouvea serotina* Q. *Torulinium ferax*

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

S. *Pycreus* 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. *badius*, 6. *C. nocamus*, 7. *C. iria*, 8. *C. fuscus* 9. *C. uncinatus*, 10. *C. difformis*)

U. *Galilea mucronata* V. *Remirea maritima*

W. *Mariscus* spp. (1. *M. latebracteata*, 2. *M. congestus*)

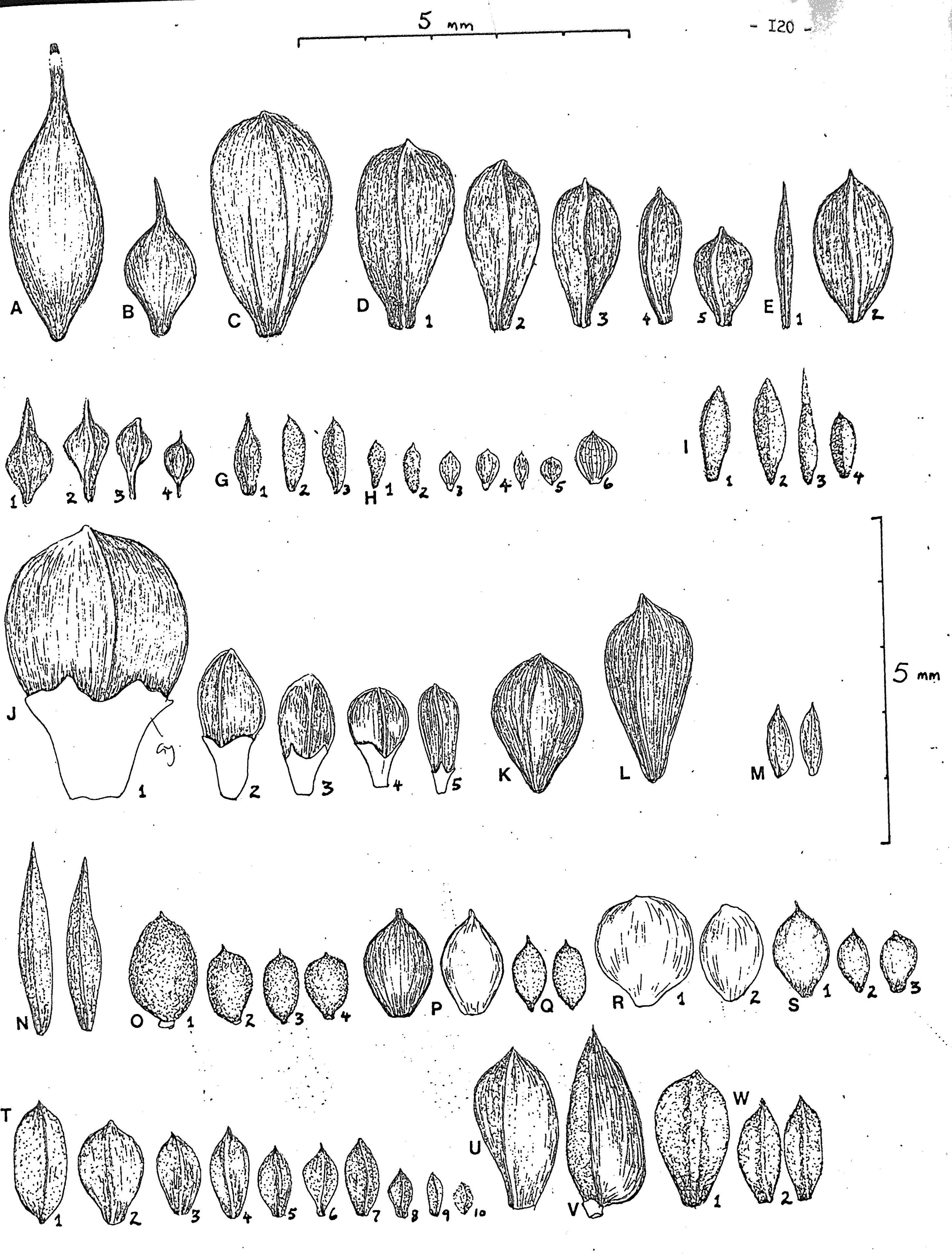


Fig. 32 Fruit Shapes

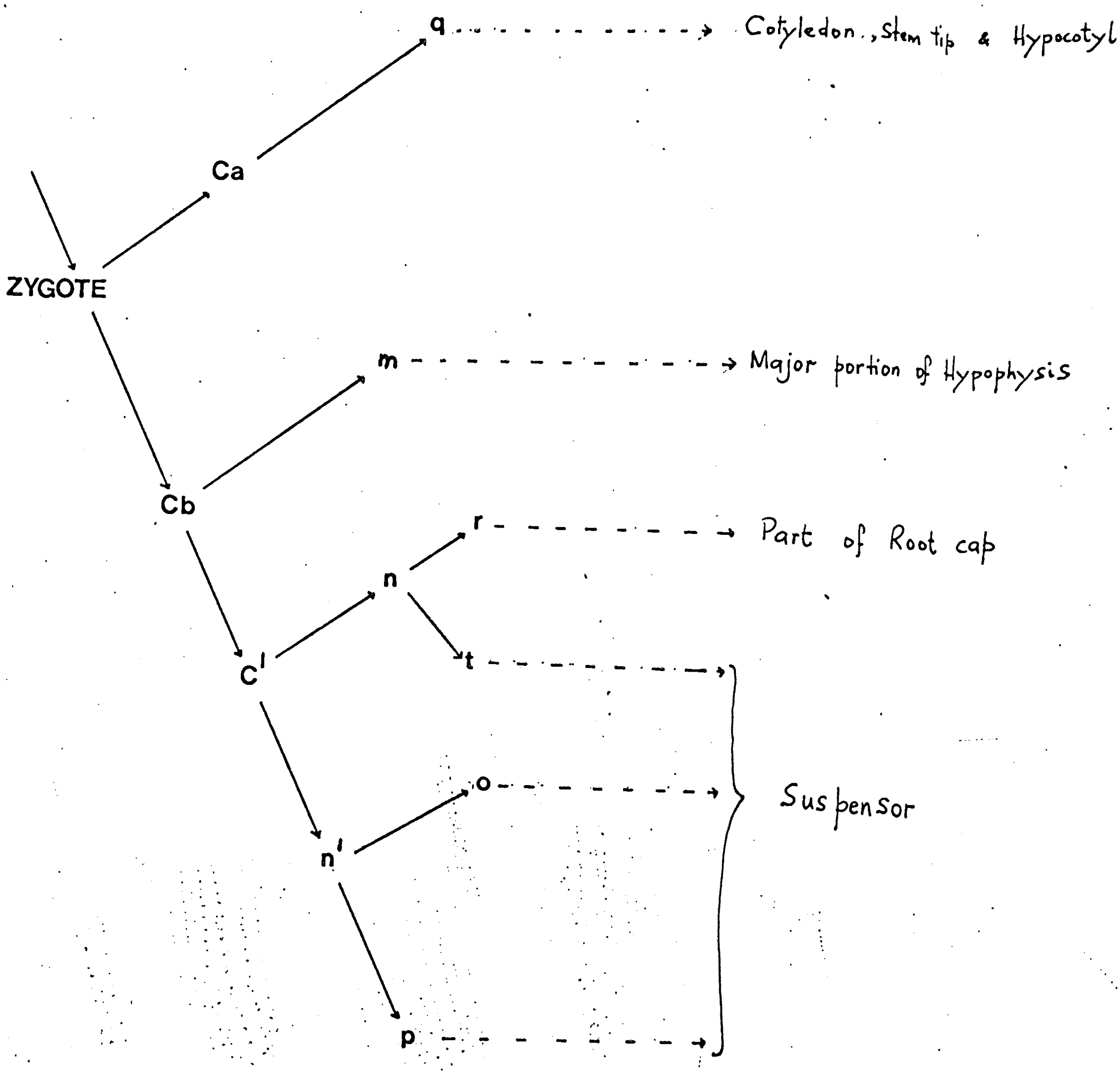


Fig. 33 Schematic representation of Embryogenesis in Cyperaceae
(After Padhye 1971 b p. 175)

Ca, Cb first transverse division of Zygote
q a quadrant of 4 cells giving rise to precocious Dermatogen and Prelome & Periblem

C', m from vertical division of Cb
n, n' from transverse division of C'
r, t " " " " n
o, p " " " " n'

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 Eleogiton, 'h' to Bolboschoenus, 'j' to Genera C, 'k' to Genus B and 'l' to Hemicarpha; the other outlines are of wide occurrence in various other genera, including some of the above, especially Eleogiton 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 concavity 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 Pycreus 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

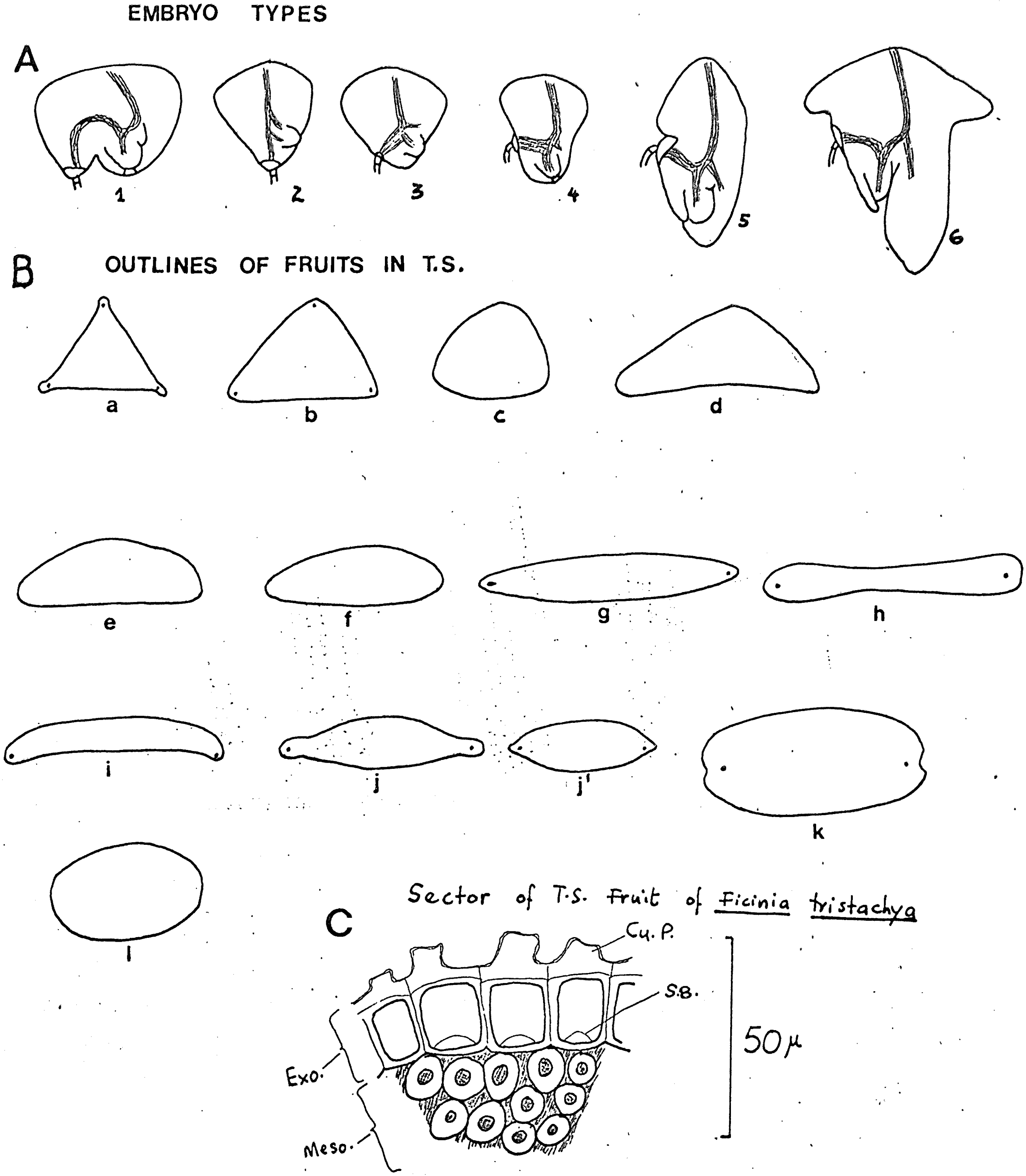


Fig. 34

A Embryo Types (After Van der Veken 1965)
1, 'Bulbostylis' type 2, 'Carex' type 3, 'Schoenus' type 4, 'Fimbristylis' type
5, 'Cyperus' type 6, 'Scirpus' type.

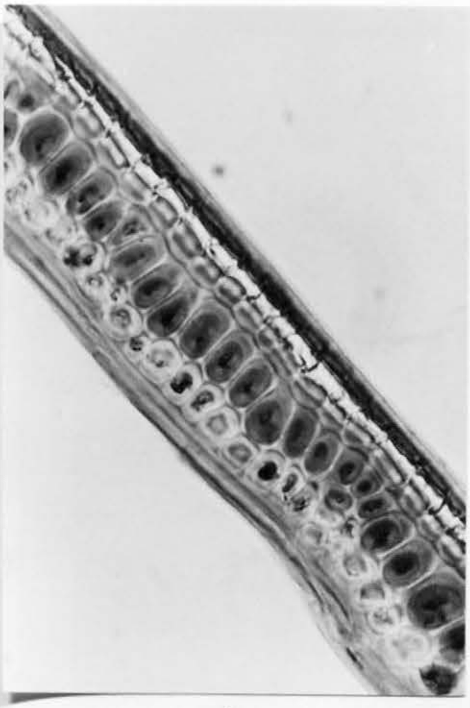
B Outlines of Fruits in T.S.

C T.S. fruit of *Ficinia tristachya* showing cuticular papillae on outer tangential walls of exocarp [x 660] have been some kind of orientation of the fruit with the abaxial and adaxial surfaces orientated to the [illegible] 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.

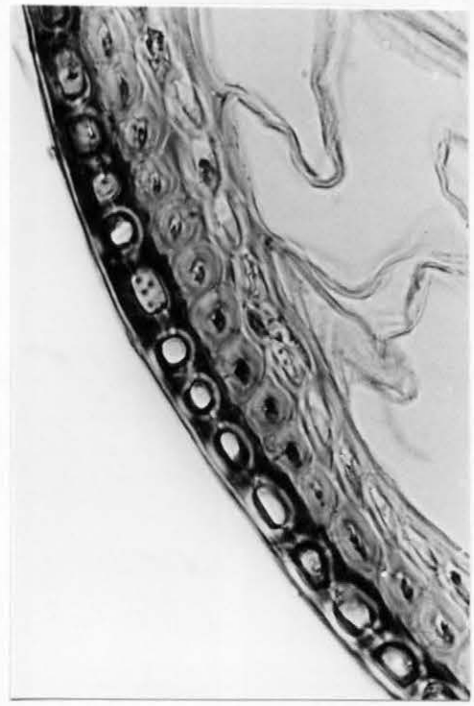
As for the adaxial nature of the fruit, the abaxial surface appears to form in direct relationship with the angle of the concavity in the adaxial surface of the subtending glume. When the glume is strongly keeled, that surface of the fruit lying against it is sharply pointed as in outlines 'a' and 'b'. 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 preceeding 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 Hemicarpha appears to have resulted because of the unusual shape and form of the glumes having long alternate bases and a strongly exserted aristate apex and also the occurrence of the posterior hyaline 'scale' which tightly surrounds the fruit on its adaxial surface in most species.

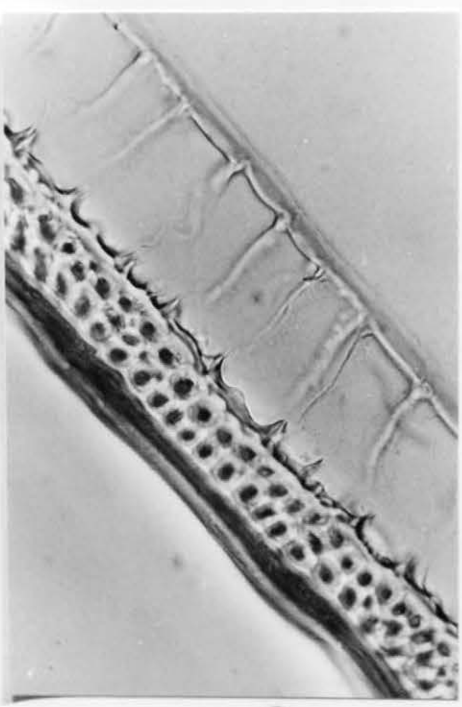
(b) Pericarp: As mentioned under the ovary, the ovary wall differentiates at maturity to become the pericarp of the fruit. There is very scanty information on the process of differentiation of the ovary wall into conspicuously



A



B



C

D

Pl. 4 T. S. of Fruit Pericarp

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

C. Phylloscirpus acaulis × 600 D. Schoenoplectus dissachanthus × 600 lignified and unlignified 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, Eleogiton, Cyperus, Juncellus, Duval-Jouvea, 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 Artjuszenko 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.

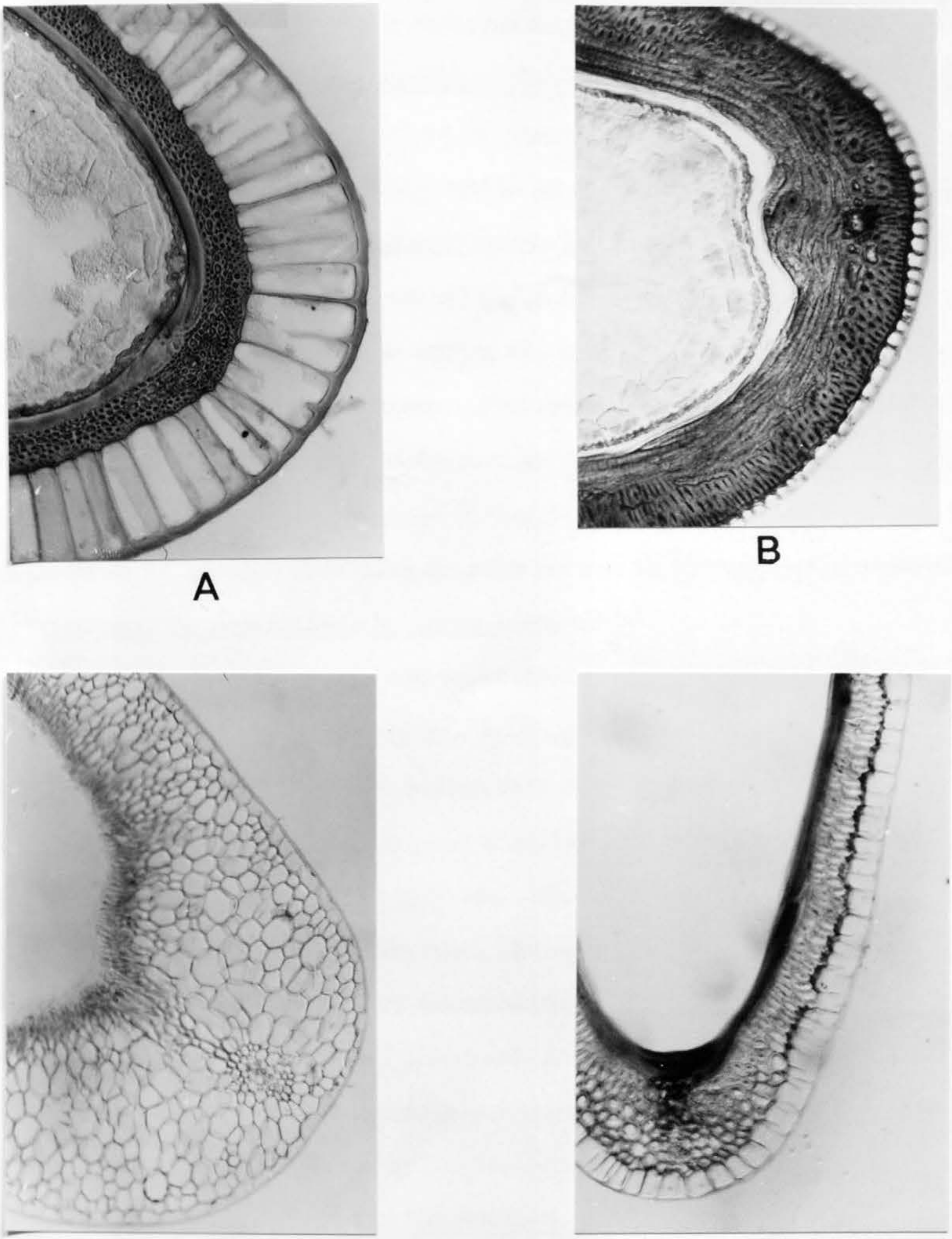
As can be seen from under "revised morphological terminologies (cf. p ix) I have avoided entering into this controveray, and have merely used the term "fruit". This was necessary because I had not investigated any developmental sequences to ascertain the right application of what term of fruit to use ..... 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 μ, while those areas between the nervations ranged from 18-198 μ. Genera whose average pericarp height did not exceed 60 μ included Scirpus, Nemum, Kyllinga, Torulinium, Pycreus, Mariscus, Ascolepis, Hemicarpha, Lipocarpha, Fuirena, Eriophorum, Erioscirpus, Pseudoschoenus. Those between 60 and 100 μ included Phylloscirpus, Blysmus, Isolepis, Eleogiton, Genus A, Trichophorus, Holoschoenus, Websteria, Desmoschoenus, Hymenochaeta, Cyperus, Galilea, Courtoisia, Remirea, Nelmesia etc. and those over 100 μ included Genus B, Genus C, Schoenoplectus, Bolboschoenus, Duval-Jouvea, 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 μ high), thick (i.e. < 100 μ high) or very thick (> 100 μ 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 [cf. Marek op. cit.] in which the cells are widest in the middle of the fruit - from 30-100 μ - 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 (periclinal) walls are thin, and these features appear to give the characteristic longitudinal and transverse striations observable on the surface view of the fruit [cf. Fig. 31B.8,9 & p. 118].



Pl. 5 T. S. of Fruit Pericarp

A. Bolboschoenus paludosus × 150 B. Schoenoplectus limensis × 210

C. Genus B (Blysmus rufus) × 150 D. Blysmus compressus × 225

Radially elongated cells are restricted to Juncellus, Bolboschoenus and Schoenoplectus subgenus Actaeogeton. In Juncellus and Bobloschoenus /especially the bicarpellate group/ the height of these cells is more or less uniform, measuring between 66-174 μ tall; while in Schoenoplectus subgenus Actaeogeton /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.6-9/ 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, Phylloscirpus, 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, Juncellus, Bolboschoenus, Ficinia 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 Ficinia tristachya /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, Rhynchospora longisetis and R. exserta; Schoenus curvifolius and S. cruentus; Cladium, Baumea 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. Rikli 1895, Hryniewiecki & 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 /1971b/ has mentioned that conical silica bodies with nodular peaks occur in one species of Isolepis /I. koilolepis/ 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 mucronatus by Marek (op. cit.).

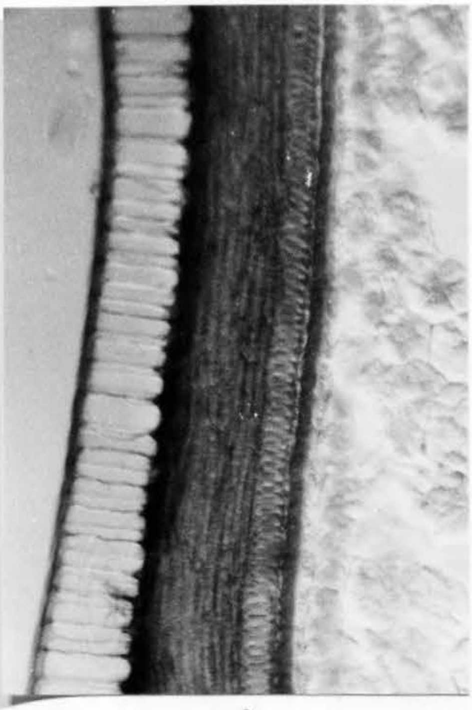
Apart from these siliceous cones, which when present are slightly transparent, there is a continuous band of finger-like ornamentations between the inner tangential walls of the exocarp and the outermost layer of the mesocarp, which has a wavy outline and often projects into the lumen of the exocarp 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, Eleogiton, Hemicarpha, Pycreus, Galilea, Duval-Jouvea, Juncellus, Courtoisia, Kyllinga, Torulinium, Mariscus, Remirea, Ascolepis, Lipocarpha, Isolepis 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.

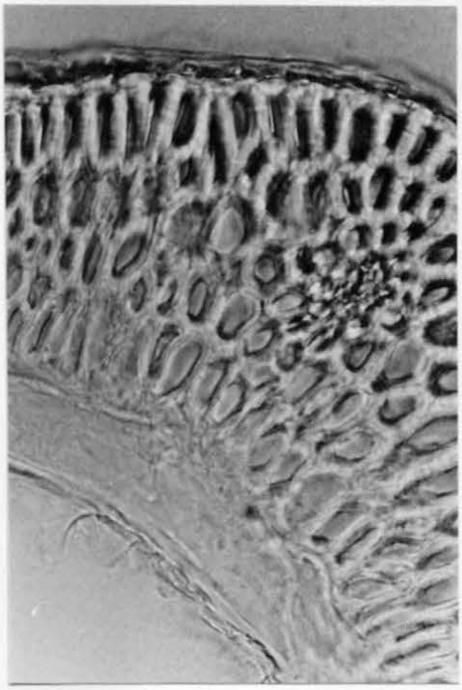
Schuyler /1971a/ has used the Scanning Electron Microscope (SEM) to study the structure of the exocarp cells of 58 species belonging to Scirpus, Trichophorum, Isolepis, Schoenoplectus, Eriophorum, Erioscirpus and Hymenochaeta. The above discussion on the exocarp based on light microscopic studies, correlates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

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

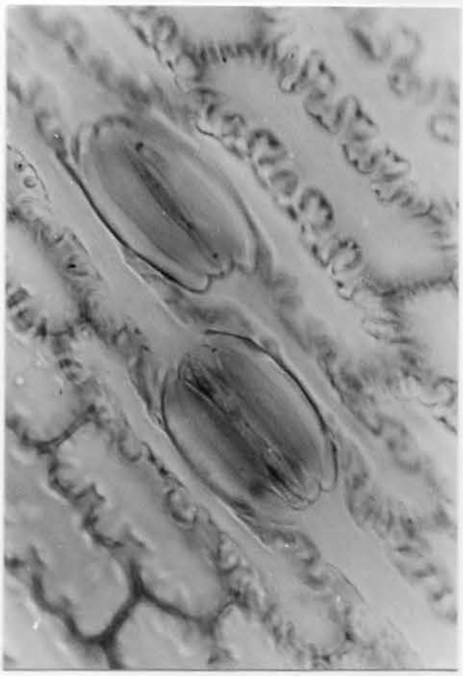
The mesocarp consists of cells which are radially (or longitudinally) elongated, rarely isodiametrical, as seen from both L.S. and T.S. preparations. With the exception of Genus B /and Neesenbechia, Tricostularia, Lepidosperma, Mesomelaena, Macrochaetium, Cladium, Galuria/ in which the outer most layers 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 1969/, while



A



B



C

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. $< 6\ \mu$), large (i.e. 6–$15\ \mu$) or very large (i.e. $> 20\ \mu$), often corresponding to the size of their lumen which may also be referred to as small (i.e. $< 2\ \mu$), wide (i.e. 3–$8\ \mu$) or very wide (i.e. $> 15\ \mu$) 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 *Websteria*, *Schoenoplectus*, *Bolboschoenus*, *Galilea*, *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. fluviatilis*] 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 [cf. 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. mucronatus] 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-Jouvea, 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) isodiametrical

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 ($< 2\mu$); (b) lumen wide ($3-8\mu$); (c) lumen very wide ($>15\mu$)

5. Cell walls

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

E. Number of VASCULATIONS in fruit

F. ENDOCARP

1. Height of layer

2. Number of cell layers

TABLE 7 FRUIT ANATOMY

	OUTLINE	PERICARP		EXOCARP						MESOCARP					VASCU-LATION	ENDOCARP	
		1	2	1	2	3	4	5	6	1	2	3	4	5		1	2
ANDROTRICHIUM	e	?	?	?	c	?	?	a	?	9	1	a	a	c	3	9	1
ASCOLEPIS	j[1]	18-36	30-51	15-18	c	a	b	a	ac	9-12	2	a	a	c	2-3	3-9	1
BLYSMUS	e	69	120	24	c	a	b	b	c	36-45	2-3	a	b	b	2	18	1
BOLBOSCHOENUS	bdgh	90-198	180-390	(15)-66-174	ac	a	a	b	ac	45-150	5-8(-15)	a	b	b	2-3	15-45	1-3
COURTOISIA	a	60	90	21	c	b	b	a	a	15	2	a	a	c	2	9	1
CYPERUS	b	24-81	54-138	18-27	c	±b	ab	a	ac	15-36	2-4	a	a	c	3	6-18	1(-2)
DESMOSCHOENUS	d	60	165	18	c	a	a	b	c	24	2	a	b	b	3	24-30	1
DUVAL-JOUVEA	e	105	183	15	c	a	a	a	a	90	6	a	c	b	3	15	1-2
ELEOGITON	gi	42-45	90-114	18-21	c	b	±b	a	ac	15-21	2(-3)	a	a	c	2	4-6	1
ERIOPHORUM	cf	21-39	39-75	6-9	c	b	b	b	a	9-21	2(-3)	a	a	c	3	6-21	1
ERIOSCIRPUS	cd	30-51	45-90	9-15	c	a	a	b	a	12-18	2	a	a	c	3	6-18	1
FICINIA	bf	90-180	105-240	27-30	c	a	ac	b	a	60-159	7-13	a	b	b	3	6-45	1
FUIRENA	ac	33-36	75	9-15	c	b	b	b	c	15-24	2-3	a	b	b	3	3-6	1
GALILEA	b	69	120	18	c	±a	b	a	a	36	5	a	b	b	3	15	1-2
HELLMUTHIA	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
HEMICARPHA	l	21-45	-	12-30	c	b	±b	a	c	9-18	2-3	a	a	b	?	±4	1
HOLOSCHOENUA	b	24-42(-60)	36-90	9-21	c	a	a	±a	ac	(9)-30-36	2(-4)	a	a	c	3	3-9	1
HYMENOCHAETA	b	75	132	6	c	a	b	b	c	60	3-4	a	b	b	3	9	±3
ISOLEPIS	bdg	30-60	60-90	9-30	bc	b	b	ab	ac	15-24	2-3	a	a	c	2-3	3-6	1
JUNCELLUS	f	99	150	84	a	a	a	a	a	18	2	a	b	b	2	6	1
KYLLINGA	g	42	48	9-13	c	±b	b	a	a	18-24	2-3	a	a	c	2	12	1
LIPOCARPHA	bc	24-26	36-45	9-15	c	b	b	a	a	12	2	a	a	c	3	3	1
MARISCUS	d	45	75	15	c	b	b	a	a	21	2-3	a	a	c	3	12	1
NELMESIA	?	?	?	?	c	?	?	?	?	9	2	a	?	?	3	12	1
NEMUM	g	30	42	4-6	c	a	a	±a	a	15-18	2	a	a	c	2	3	1
OXYCARYUM	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
PHYLLOSCIRPUS	b	39-51	60-81	15-30	c	a	b	a	a	15-18	2	a	a	c	3 3	3-5	1
PSEUDO-SCHOENUS	b	39	75	6	c	a	a	b	a	21	2	a	b	b	3	9	1
PYCREUS	egj[1]	30-72	33-75	9-24	c	±b	b	a	a	12-51	2-4	a	b	b	2	6-9	1
QUEENSLANDIELLA	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
REMIREA	f	63	84	15	c	b	b	a	a	21	2	a	a	c	3	15	1
SCHOENOPLECTUS	bcefg	45-190	60-425	5-45	ac	a	a	b	ac	24-150	3-9	a	ab	b	2-3	3-66	1-4
SCIRPUS	abfg	18-45	42-60	3-15	c	±b	b	±a	ac	10-21	2-3	a	a	bc	2-3	3-8	1
TORULINIUM	f	36	-	12	c	b	b	a	a	15	2	a	a	c	2	9	1
TRICHOPHORUM	bde	24-84	45-165	9-21	c	a	ab	b	ab	(6)-21-60	1-3-5	a	b	b	3	4-24	1
WEBSTERIA	g	75	108	6	c	a	b	b	c	60	5-6	a	b	b	2	9	1
GENUS A	b	45	75	15	c	±a	b	b	c	15	2	a	a	b	2-3	?	?
GENUS B	h	144-174	252-270	24-30	c	a	a	b	c	105-120	±10	b	c	a	2	15	1
GENUS C	j	99	279	60	a	a	a	b	a	69	3-4	a	a	c	2	6	1

? = Not investigated or detail not known; ± = more or less or about; ( ) = rarely

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 *Cyperöideae* 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 Caricopsis 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 ar 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, Egleria, 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, Lipocarpha, 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-Jouvea, Eriophorum, Erioscirpus, Fuirena, Galilea, Hellmuthia, Hemicarpha, Hymenochaeta, Nelmesia, Nemum, Oxycaryum, Phylloscirpus, Pseudo-Schoenus, Queenslandiella, Scirpus, Trichophorum, Websteria and Genus A, B and C. The distributions of [Volkiella, 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.

The following floristic works covering the various geographical regions were consulted. They include M. Barros (1960), Beetle (1941, 1947), Blake (1969), Chermezon (1936), Clapham et al (1962 Ed. 2), Fitzgerald (1917), Friedland (1941), Gleason (1952), Hegi (1908), J.D. Hooker ed. (1894), Komarov ed. (Engl. transl. 1964), Koyama (1958, 1961), Maire (1957), Moore & Edgar (1970), Napper (1963-65, 1971), Raymond (1957, 1960), Raynal (1968), Schuyler (1967), Täckholm & Drar (1950), Thiselton-Dyer ed. (1898, 1901-1902) etc.

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 Pentasticha 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 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 Chlorosoirpus 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).

Blysmus (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 distributions in the Western United States and Canada, and in Argentina.

Hymenochaeta (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, Nelmesia in the Belgian Congo, and Pseudo-Schoenus, and Hellmuthia in South Africa. Other genera with endemic ranges include /Egleria/ in Brazil (Eiten 1964), /Volkiella/ in South West Africa (Merxmüller & Czech 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 Rhynchosporeae). 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.

	Area	No. of Genera
A.	NEW WORLD	
1.	North America (including Canada and United States)	21
2.	Central America (Mexico-Panama, including the West Indies)	17
3.	South America	25
B	OLD WORLD	
4.	Europe (excluding the Mediterranean Europe and Soviet Union)	16
5.	Mediterranean Area	14
6.	Soviet Union (including Caucasia)	18
7.	South-West Asia (excluding Caucasia)	17
8.	Tropical & Subtropical Africa (including Egypt and Madagascar)	26
9.	Southern Africa	23
10.	"British India" (including Pakistan, Himalaya, Ceylon)	28

11. The Far East (including Indo-China, China, Malaysia, Melanesia, Japan) 20

12. Australia (including Tasmania) and New Zealand 13

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 alphabeticaly) have their highest species concentration in the following areas:

1. /Abildgaardia/ containing c. 30 species, with largest concentration in Indo-Malaya
2. Ascolepis containing c. 15 species, with highest concentration in Tropical Africa
3. Bolboschoenus 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. Eleogiton out of c. 11 species, 4 in South Africa, 3 in Australia
9. Eriophorum with 11 species (out of c. 18) in Eurasia
10. /Fimbristylis/ containing c. 220 species, the highest concentration in the tropics and subtropics of both Old and New Worlds
11. Fuirena 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. Isolepis 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. Pycreus 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

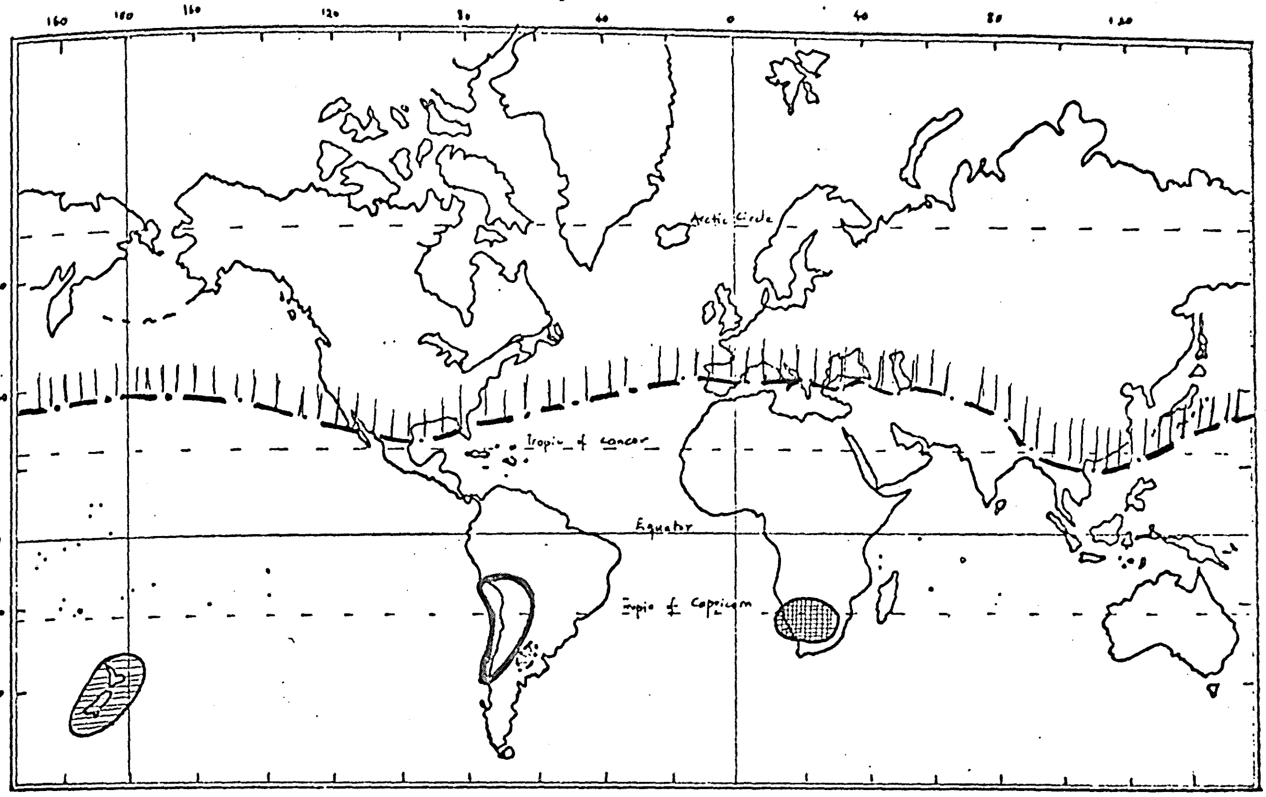
21. Scirpus s.s. with 18 species (out of c. 32) in North America

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

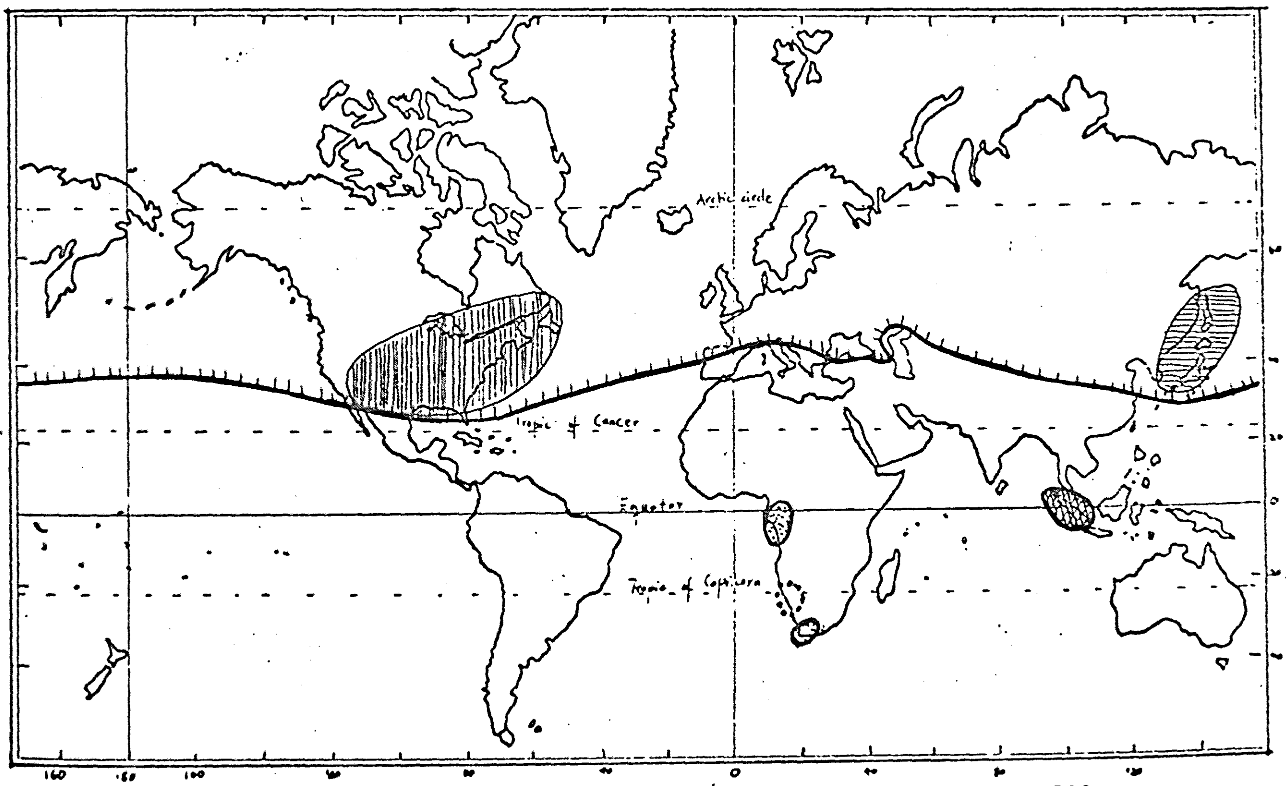
It appears from the above results that the centres of diversity of the majority of genera are apparently in the tropics. This is very interesting, especially when one recalls that the Floras in most tropical regions are still in the 'pioneer' phase of investigation, as compared with those in Europe and 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.

Map 1



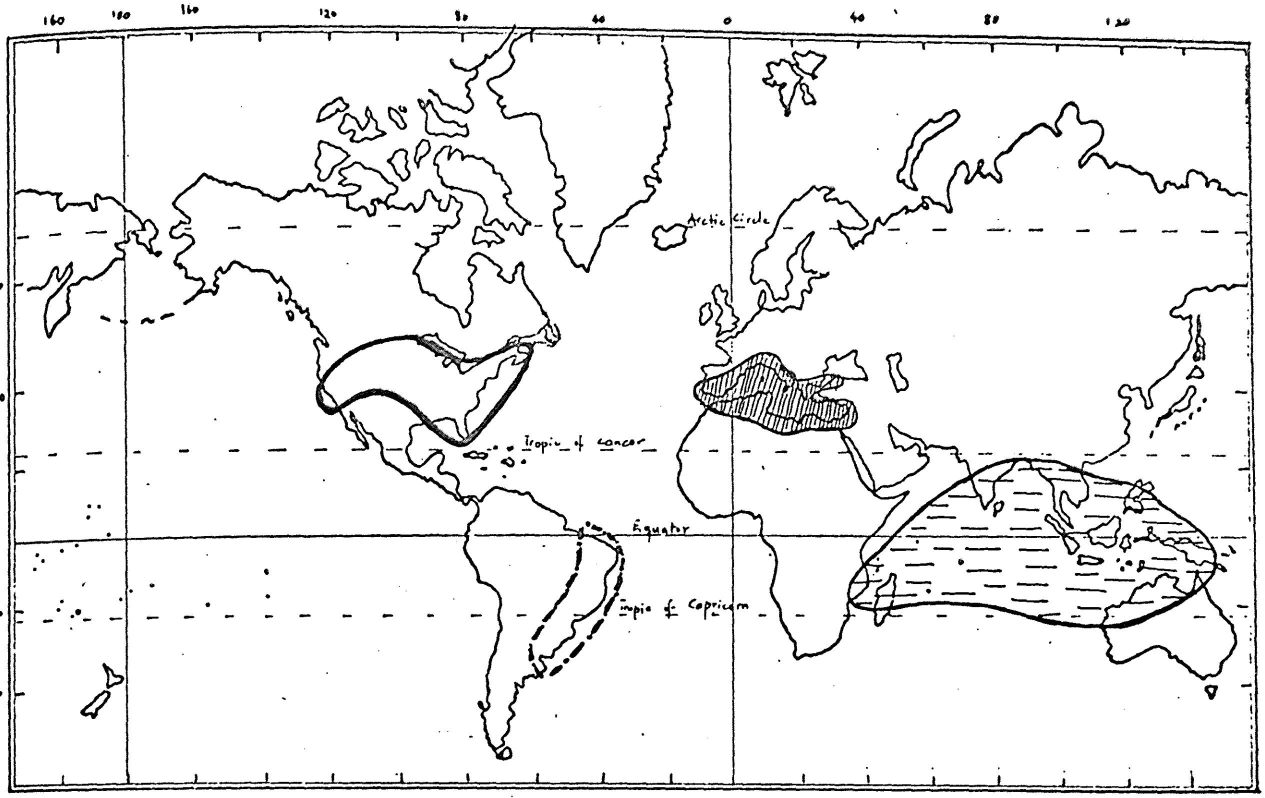
Desmoschoenus
Pseudo-schoenus
Phylloscirpus
Scirpus

Map 2



ERIOPHORUM
subgen. Eriophorum
" Eriophoropsis
" Japonici
NELMESIA
GENUS A.
VOLKIELLA

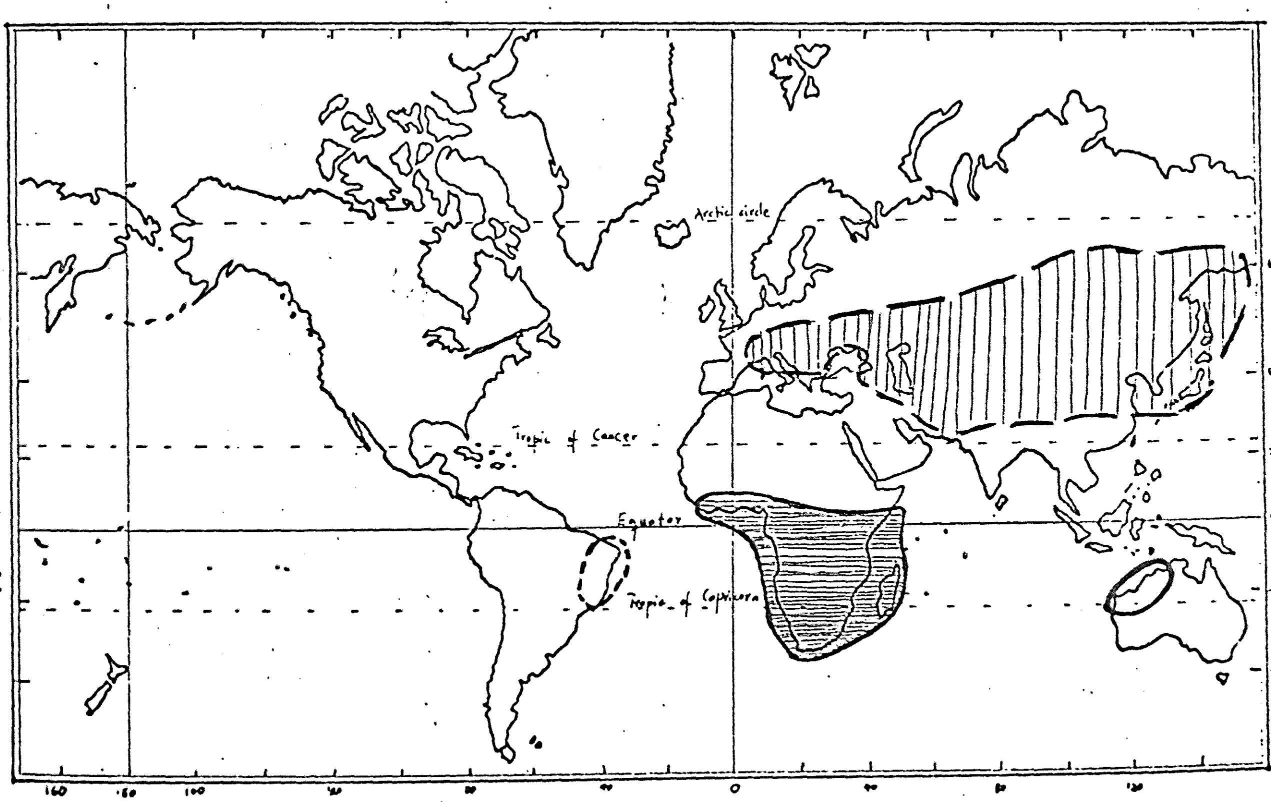
Map 3



Androtrichum — Dulichium

Galilea — Queenslandiella

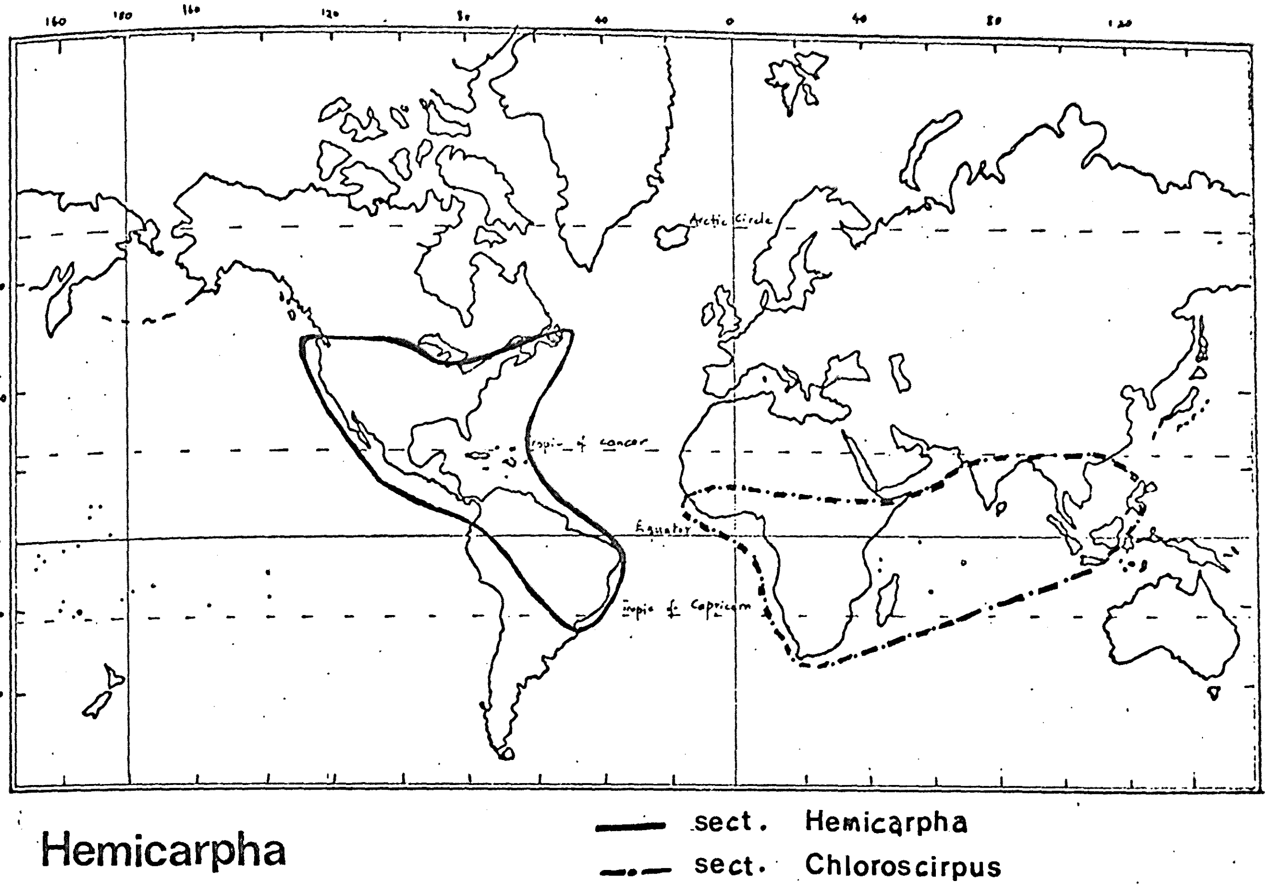
Map 4



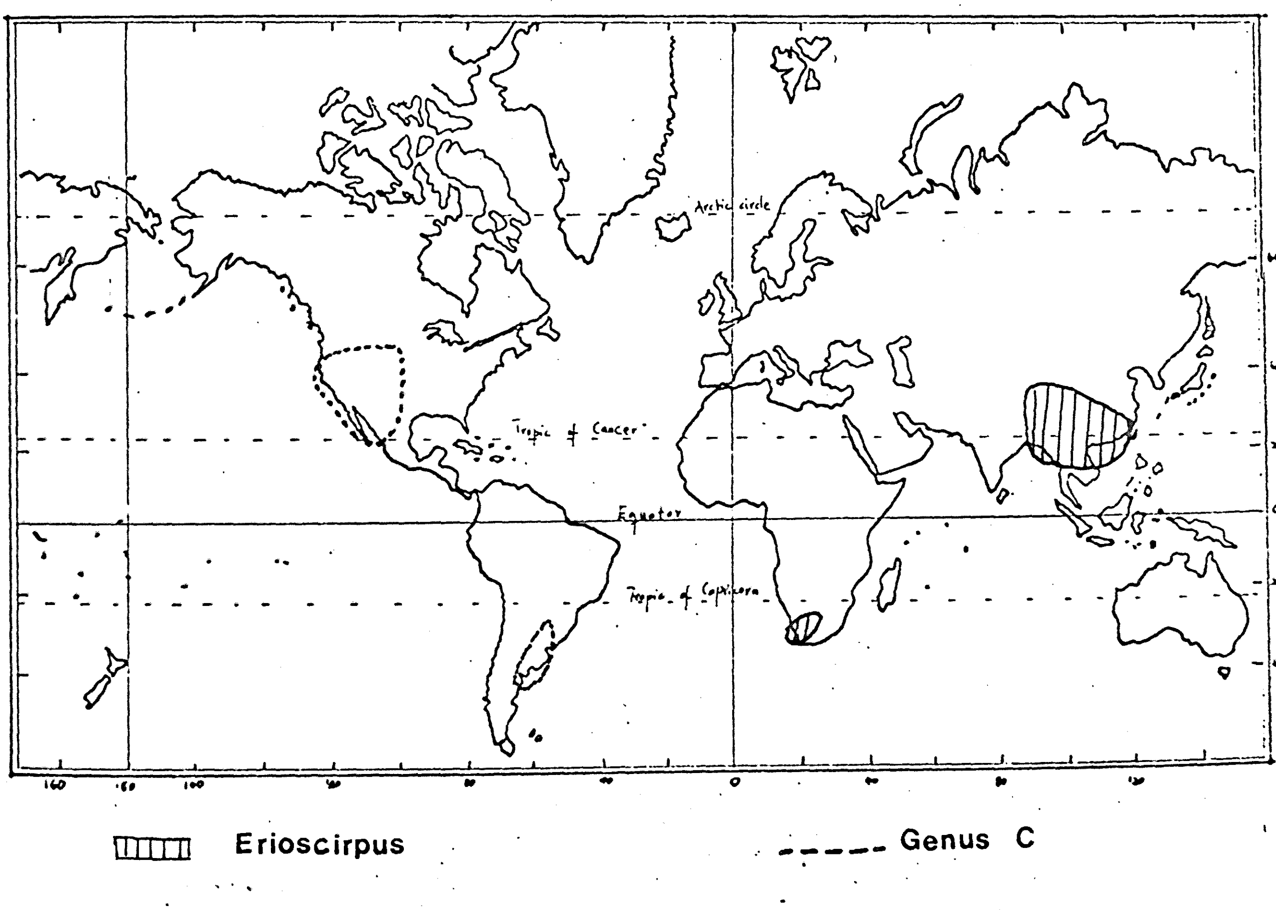
Crosslandia — Duval-Juvea

Egleria — Ficinia

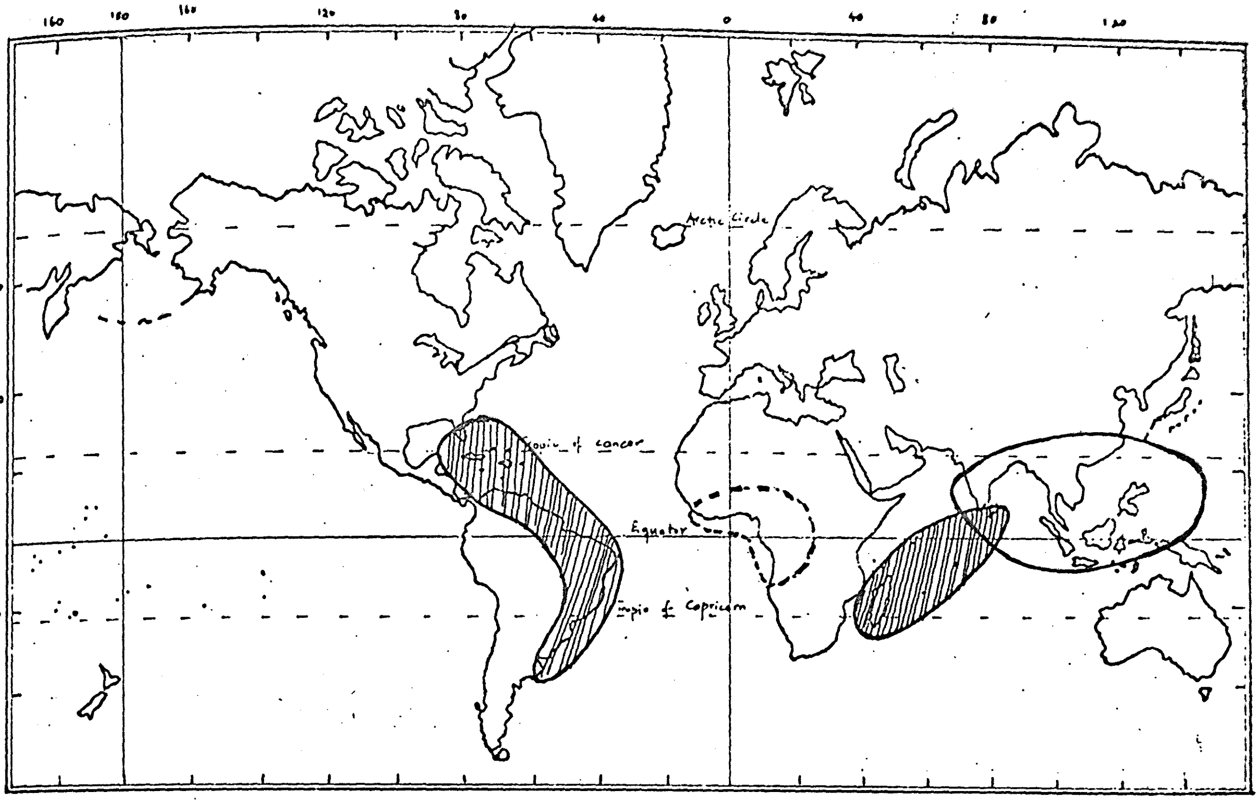
Map 5


Arctic Circle
Tropic of cancer
Equator
Tropic of Capricorn
Hemicarpha
sect. Hemicarpha
sect. Chloroscirpus

Map 6

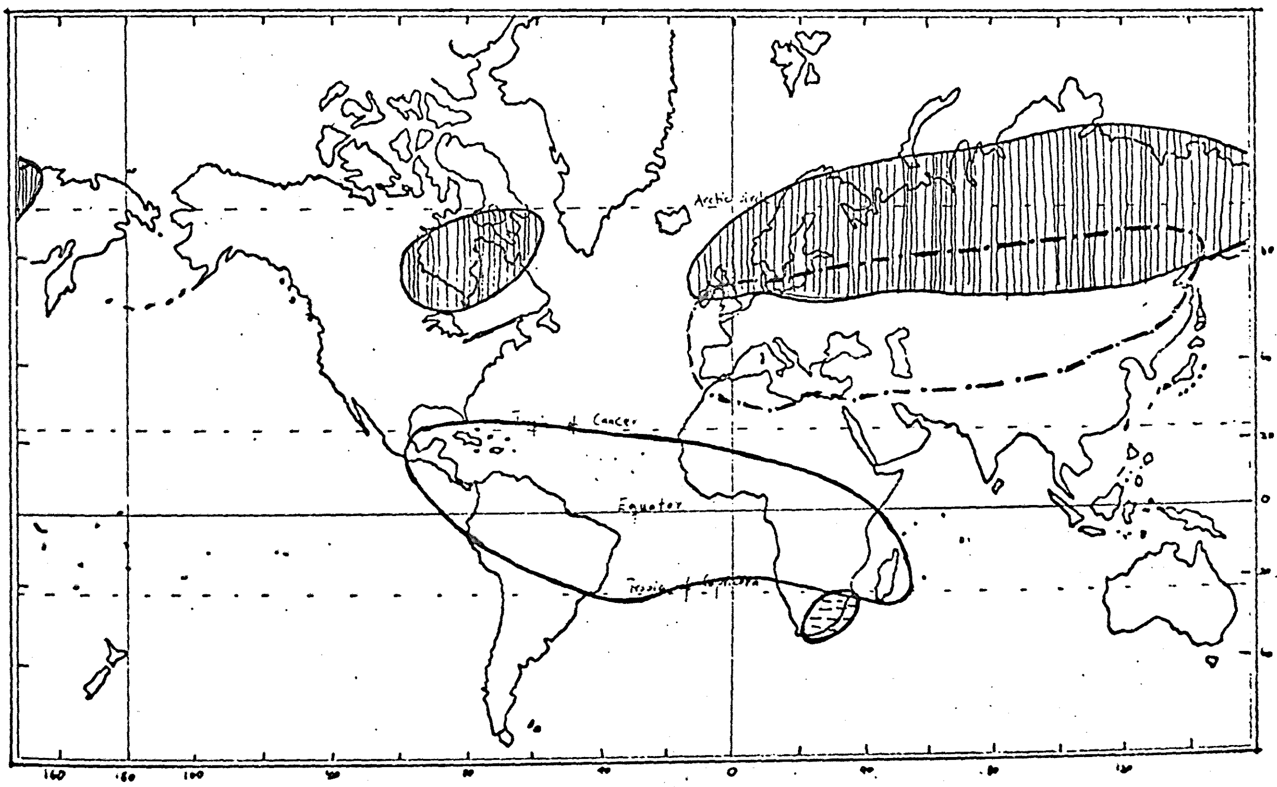

Arctic circle
Tropic of Cancer
Equator
Tropic of Capricorn
Erioscirpus
Genus C

Map 7



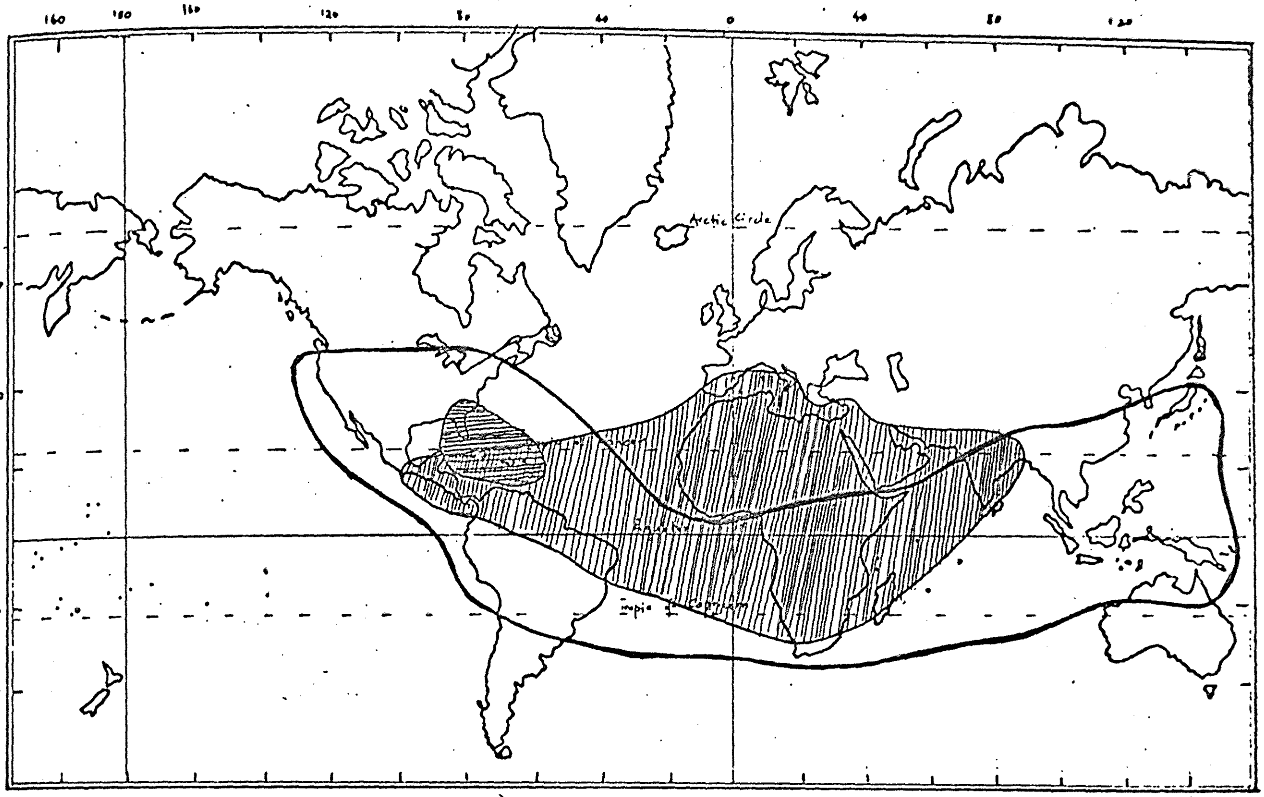
Hymenochaeta — Nemum — Websteria

Map 8



Blysmus — Genus B — Hellmuthia — Oxycaryum

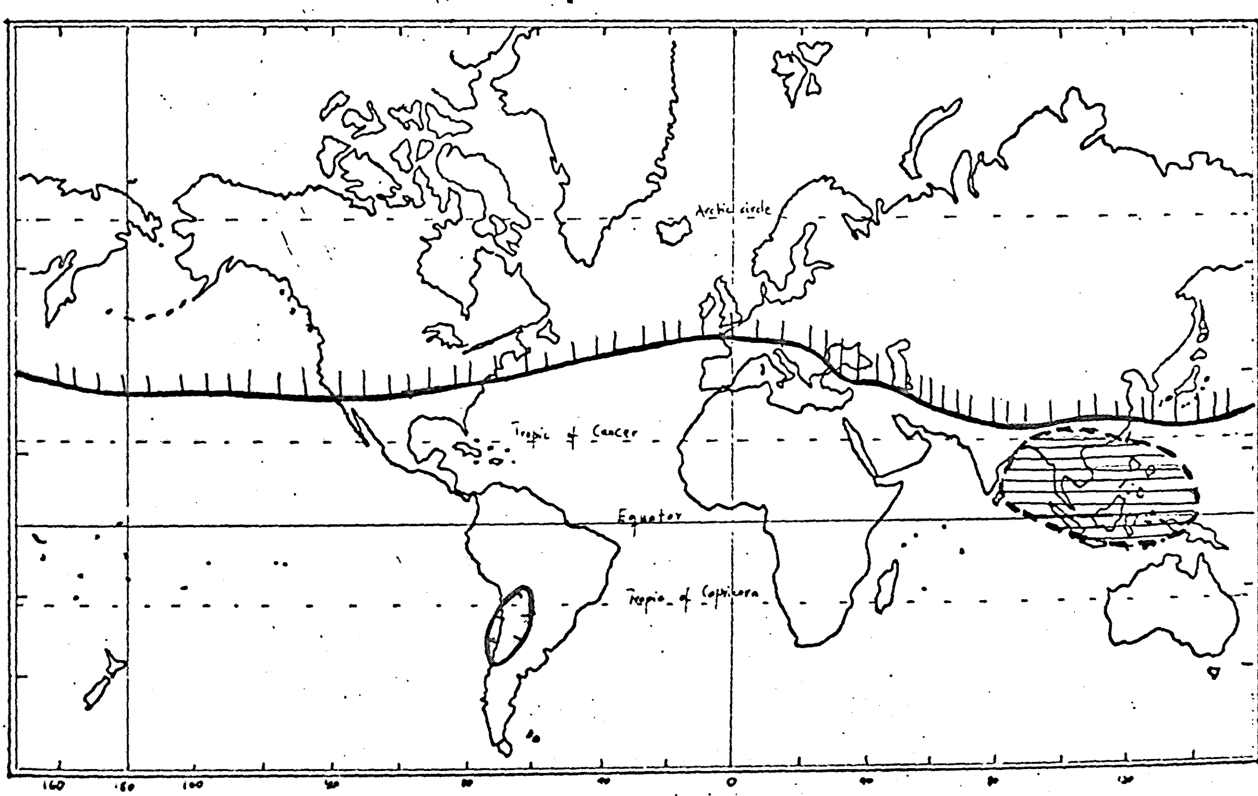
Map 9



Fuirena

subgen. Fuirena
" Pentasticha
" Vaginaria

Map 10



Trichophorum

subgen. Trichophorum
" Anthelophorum

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 Rhynchosporeae and Dulichieae), 47 distinct natural genera are recognised, keyed out and anotated 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 Rhynchosporeae)

Note: The genera in square brackets were not personally investigated in Part I. To facilitate rapid identification, anatomical characters have been subordinated to exomorphic 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 [DULICHIUM]

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. naumanii]

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 rhizome conspicuous, bearing at its apex solitary or tufted culms

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

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 [EGLERIA]

9b. All culms bearing spikelets; only the basal part of plants occasionally submerged

10a. Fruit generally with conspicuously thickened persistent articulate 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; antrorsely scabrous or smooth; shoot/culm setaceous to wiry

13a. Anthers with long acuminate, papillose 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 plumosely fimbriate

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

15a. General inflorescence paniculate; hypodermal sclerenchymatous tissue in culm as tall and narrow girders with the overlying epidermal cells taller than the adjacent ones .... 8 PSEUDO-SCHOENUS

15b. General inflorescence a pseudo-lateral head or corymb; hypodermal sclerenchymatous tissue in culm as small rounded to angular strands with the overlying epidermal cells smaller than the adjacent ones .... 6 SCHOENOPLECTUS

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 overtopping the spikelet, rarely shorter, (6)-12-24 or more to the fruit .... 2 ERIOPHORUM

17b. Upper cauline leaves longer than or equal to the lower ones; bristles often needle-like, rarely filiform or silky, occasionally 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(-8) 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 berbed .... 5 BOLBOSCHOENUS

20b. Glumes narrowly lanceolate, obtuse, dark crimson; spikelets angular subcompressed; bristles antrorsely 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 NELMESIA

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

25a. Scales laterally placed .... 28 HELLMUTHIA p.p.

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 [VOLKIELLA]

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 involucral 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/ canaliculate

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

34b. Leaves channelled/canaliculate; 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

33b. 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 biconcave; predominantly aquatic .... 47 ELEOGITON

37b. Plant densely tufted; style 3-fid; fruit trigonous or compressed trigonous; predominantly of bogs and moors on high mountains .... 9 TRICHOPHORUM p.p. (eg. *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. (eg. *S. supinus*)

38b. Surface of fruit minutely dotted or longitudinally and transversely striated; leaves present, rarely wanting .... 46 ISOLEPIS 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. (eg. *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 [FIMBRISTYLIS p.p., eg. *F. spadiceus*]

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

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

42a. Base of style confluent with the fruit, not thickened

43a. Fruit minutely apiculate; glumes ovate, keeled, stramineous to light brown, caducous .... 46 ISOLEPIS p.p. (eg. I. cernua)

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 /FIMBRISTYLIS/

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. (eg. 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 TORULINIUM

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 JUNCELLUS

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 PYCREUS

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. .... 31 CYPERUS p.p. (eg. 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 not been described here, and it is hoped that reference will be made to the table of comparative fruit anatomy (Table 7) and pp 115-131 for discussion on this topic.

1. SCIRPUS L., Sp. Pl. 47 (1753) et Gen Pl. ed. 5: 26 (1754) emend.; Reichb. Fl. Germ. Exc. 79 (1830); Beurl. in Bot. Notiser 52 (1853); Darlington Floral Cestr. ed. 3: 40 (1853); Aschers., Fl. Brand. 1: 751 (1864); Nyman, Conspect. Fl. Euro. 763 (1882); Palla in Engler, Jahrb. 10: 296 (1889); Clarke in Kew Bull. Add. ser. 8: 113 (1908); Ohwi in Mem. Coll. Sci. Kyoto Imper. Univ. ser. B, 18: 95 (1944); Beetle in Amer. Journ. Bot. 31: 263 (1944); Koyama in Journ. Fac. Sci. Univ. Tokyo, sect. 3 (Botany), 7(6): 290-293 (1958); Schuyler in Proc. Acad. Nat. Sc. Phila. 119: 295-323 (1967).

External morphology: see p. 220.

Internal morphology: culm: 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 sclerenchyma 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 sclerenchymatous 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.

Type species: S. sylvaticus L. (see Hitchcock in Nomencl. Prop. Brit. Bot. 110-199, 1930).

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, antrorsely 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).

2. ERIOPHORUM L., Sp. Pl. 52 (1753). Andersson, Cyper. Scand. 13 (1849); Bentham & Hook. f., Gen. Pl. 3: 1052 (1883); Norman in Christ., Vidensk.-Selk. Forh. 16: 45 (1893); Palla in Bot. Zeitschr. 54: 151 (1896); Fernald in Rhodora 7: 81-92, 129-136 (1905); Ibid. 27: 206 (1925); Raymond in Svensk Bot. Tidskr. 48(1): 77 (1954); Koyama in Journ. Fac. Sci. Univ. Tokyo, sect. 3, 7(6): 294-296 (1958).

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/serrated 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 antrorsely 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 involucral bract .... sect. Eriophorum

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

.... 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 [As Scirpus junghuhnii Miq., Fl. Ind. Bot. 3: 307 (1855); Kukenthal in Bull. Jard. Bot. Buitenzorg, ser. 3, 16: 301 (1940)].

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, antrorsely 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).

4. FUIRENA Rottb., Descr. et Icon. Pl. 70, t.19 (1773). Persoon, Synops. Pl. 1: 70 (1805); Turcz. in Bull. Soc. Nat. Moscou, 35: 330 (1862); Coville in Bull. Torr. Bot. Club 17: 1-8 (1890); Clarke in Kew Bull. Add. ser. 8: 115, 116 (1908); Chermezon in Humbert, Fl. Madagascar 29e Famille, 158 (1936); Koyama in Journ. Fac. Sci. Univ. Tokyo, sect. 3 (Botany), 7 (6): 286 (1858).

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 sclerenchyma as securiform to subtriangular girders or strands. Chlorenchyma not radiate, palisade-like to rounded, polygonal. Leaf: vascular bundles in a single V or arc 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 Rottb.

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. stricta Steud.)
.... subgen. Pentasticha (Turcz.) Oteng-Yeboah

2a. Bristles present .... sect. Pentasticha

2b. Bristles absent (Type sp. F. pubescens (Poir) Kunth)
.... sect. Pseudo-isolepis (Clarke) Chermezon

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 Pentasticha 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 Phylloscirpus, 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 Scirpeae 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 Scirpeae.

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

5. BOLBOSCHOENUS (Aschers.) Palla in Koch, Synops. Deutsch. Fl. ed. 3: 2531 (1904). Aschers., Fl. Brand 1: 753 (1864); Ohwi in Mem. Coll. Sci. Kyoto Imp. Univ. Ser B, 18: 95, 96 (1944); Beetle in Amer. Journ. Bot. 29: 82 (1942); 31: 263 (1944); Koyama in Journ. Fac. Sci. Univ. Tokyo, sect. 3, 7 (6): 288 (1958).

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: fungiform 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-concave; 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. strobilinus*, *B. planiculmis* etc. pending a proper sectional name.

Affinity: *Bolboschoenus* shares a number of characters with *Schoenoplectus* and *Hymenochaeta*. 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. SCHOENOPLECTUS (Reichenb.) Palla in Engler Bot. Jahrb. 10: 298 (1889) gen. conserv. Reichenb., Fl. Germ. Exc. 78 (1830) et Icon. Fl. Germ. 8: 40 (1846) Schrader, Gött. Gel. Anzeig. 3: 2071 (1821); Aschers. et Graebn., Synops. Mitteleur. Fl. 2(2): 318 (1903); Clarke in Kew Bull. Add. ser. 8: 112 (1908); Nees in Linnaea 9: 292 (1834); C.A. Mey. in Mem. Sav. Etrang. Petersb. 1: 200, t.2 (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 Mem. Coll. Sci. Kyoto Imp. Univ. ser. B, 18: 97 (1944); Koyama in Journ. Fac. Sci. Univ. Tokyo, 111, 7(6) 1958; Komarov, Fl. URSS (Engl. trans.) 3: 37 (1964).

External morphology: see p.235.

Internal morphology: Culm: outline circular to triangular, hypodermal sclerenchyma as small rounded to angular strands. Ground tissue net-like with numerous scattered vascular bundles and air cavities; the air cavities filled with diaphragmetic plates containing transverse veins and stellate and/or lobed translucent 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 coleoptile and lateral root cap.

Type species: Schoenoplectus lacustris (L.) Palla [Rickett & Stafleu in Taxon 8(7): 213-243 (1959)].

Key to infra-generic groups

1a. Culms generally tufted; fruit small, up to 1.5 mm x 2.5 mm, rounded or mucronulate, often transversely wrinkled/rugose (Type sp. S. mucronatus (L.) Palla) .... subgen. Actaeogeton (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. etuberculatus (Steud) Oteng-Yeboah .... subgen. Malacogeton (Ohwi) Oteng-Yeboah

Observation: The subgenus Malacogeton 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 Actaeogeton 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)
Ohwi in Mem. Coll. Sci. Kyoto Imper. Univ. Ser. B, 18: 98 (1944); Beetle in Amer. Journ. Bot. 33: 661 (1946).

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 humerous, 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 Hymenochaeta 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 (Hymenochaete Lev.) to its usage in the Cyperaceae.

Affinity: This genus differs from Schoenoplectus (q.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).

8. PSEUDO-SCHOENUS (Clarke) Oteng-Yeboah, stat. et gen. nov. ined.

Syn: Scirpus L. sect. Pseudo-schoenus Clarke in Kew Bull. Add. Ser. 8: 113 (1908), basionym. Clarke in Thiselton-Dyer, Fl. Capensis 7: 233 (1898).

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 flexuose rays, subtended by short, rigid, culm-like involucral bracts. Spikelets cylindircal, many-flowered, flowers often polyganus-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 oblanceolate, smooth apiculate.

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

Type species: Pseudo-schoenus inanis (Thunb.) 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 Desmoschoenus in Scirpus s.l. [cf. 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)

9. TRICHOPHORUM Persoon, Synops. Pl. 1: 69 (1805) emend., quoad T. alpinum. Dietrich, Sp. Pl. Ed. 6, 2: 89 (1833); Koch, Synops. ed. 2, 859 (1844); Aschers. et Graebn., Synops. Mitteleur. Fl. 2(2): 298 (1903); Ohwi in Mem. Coll. Sci. Kyoto Imper. Univ. ser. B, 18: 95 (1944); Beetle in Amer. Journ. Bot. 28: 469 (1941); 33: 664 (1946); Raymond in Mem. du Jard. Botan. de Montreal no 48: 146 (1957); Koyama in Journ. Fac. Sci. Univ. Tokyo, sect. 3 (Bot.) 7(6): 293 (1958).

External morphology: see p. 245.

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 sclerenchyma, 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. *Anthelophorum* (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. lineatus* 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 *Baeothryon* 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 *Erioscirpus*. But considering overall similarities particularly in vegetative and floral characters, it appears that *Trichophorum* spp. are more closely related to *Erioscirpus* than to either *Eriophorum* or *Scirpus*. The elongate silky bristles may have developed independently.

Distribution: see p.137 and Map 10.

10. ERIOSCIRPUS Palla in Bot. Zeitschr. 54: 151 (1896).

Nylander in Acta Soc. Sci. Fenn. 3: 22 (1846); Clarke in Kew Bull. Add. ser 8: 115 (1908); Raymond in Natur. 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, nodeless, 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 apiculate.

Internal structure: Culm, ground tissue solid. Vascular bundles in a single ring, sometimes penetrating into the ground tissue as in E. comosus. Hypodermal sclerenchyma 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: Erioscirpus 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. Erioscirpus

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 Erioscirpus 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 evolution. 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 Lachnophorum 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 Lachnophorum 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.

11. PHYLLOSCIRPUS Clarke in Kew Bull. Add. Ser 8: 44 (1908).

Syn: Scirpus sect. Michelianae Clarke in Kew Bull. Add. Ser. 8: 113 (1908) p.p.

Scirpus sect. Monocephales Beetle in Amer. Journ. Bot. 31: 263 (1944).

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, ± 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, andoften 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.

12. GENUS C [As Scirpus nevadensis Watson, Bot. King's Expl. 360 (1871); Beetle in North American Flora Ser. 1, 18(8): 499 (1947)].

External morphology: Perennial, rhizomatous. Culm tufted or solitary, terete, borne on an ascending rhizome. Leaves basal, rosette-like, channelled. Inflorescence a pseudo-lateral head, subtended by an erect culm-like involucral bract. Spikelet: cylindrical, many-flowered. Glumes spirally imbricate, ovate, shortly mucronate, margins ciliate. Hypogynous bristles needle-like, 1-3, retrorsely scabrous, with soft scabridity. Stamens 3, anthers linear, with smooth crests.

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 sublateral 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 which it differs in having no disc-like gynophore at the base of the fruit. Because of the indefinite 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.

13. ELEOCHARIS R. Br., Prodr. Fl. Nov. Holl. 224 (1810).

Svenson in Rhodora 31: 121-135; 152-163; 167-191; 199-219; 224-242 (1929); Svenson l.c. 34: 193-203; 215-277 (1932); Svenson l.c. 39: 210-231; 236-273 (1937); Zinserling in Komarov. Fl. URSS 3: 49-70 (Engl. Transl.) 1964.

External morphology: see p. 247

Internal morphology: see Metcalfe, Anat. of Monocot. 5: 237-248 (1971); Van der Veken in Bull. Jard. Bot. Bruxelles 35: 328-332, fig. 40 (1965).

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 Fimbristylis group (see Chermezon 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 Egleria (q.v.) and Websteria (q.v.).

Distribution: c. 200 spp. cosmopolitan.

14. EGLERIA Eiten in Phytologia 9(8): 481-483 fig. 1-10 (1964).

External morphology: see Eiten op. cit.

Type species: Egleria fluctuans Eiten (isotype Ducke n. 34609 (SP)!) *

Note: Egleria appears to be intermediate between Eleocharis and Websteria, showing spikelet and fruit structures of the former, and habit and habitat (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.

15. WEBSTERIA Wright in Bull. Torrey Club 14: 135 (1887).

Syn: Scirpus L. sect. Monostachyae series Fluitantes Clarke in Kew Bull. Add. ser. 8: 111 (1908) p.p.

Scirpus subgen. Eu-Scirpus sect. Confervoidei Chermezon in Humbert Fl. Madagascar, 29^{e} 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, ovoid-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-apiculate, finely striated or smooth, brown.

Internal morphology: Culm: ground tissue spongy with two air cavities separated by 1-3-celled thick parenchymatous strand which connect to the two vascular bundles. Hypodermal schlerenchyma 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 confervoides (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 epither "limnophila" which Britton 1888 considered as a later synonym of "submersus" Sauvalle (1873) and overlooked 'confervoides' Poir. In this account, the earliest specific epithet is adopted.

Affinity: The habit and habitat of Websteria is shared with Egleria, Eleogiton and some Eleocharis species. Egleria 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. Egleria and Eleocharis appear to be more related to Websteria than is Eleogiton whose affinity lies more with Isolepis.

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).

16. BLYSMUS Panz. in Schultes, Mant. 2: 41 (1824) emend.

Roshev. in Komarov, Fl. URSS 3: 45 (engl. Trans. 1964); Clapham et al, Fl. Brit. Isles, Ed. 2: 1066 (1962).

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 sclerenchyma 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: Blysmus compressus (L.) Panz.

Observation: The occurrence of a spike-like inflorescence with sessile distichous spikelets in various species of Carex subgenus Vignea, 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); Clapham et al, Fl. Br. Isles, Ed. 2: 1066 (1962)].

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, antrorsely 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 schlerenchyma 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).

18. DULICHIUM Persoon, Syn. Pl. 1: 65 (1805).

Mattfeld J. in Ber. Deutsch. Bot. Ges. 56: 86-116 (1938); Blaser H.W. in Amer. Journ. Bot. 28: 542-551 (1941); Schultze-Motel in Willdenowia 2: 170-175 (1959a); Koyama in Journ. Fac. Sci. Tokyo, 111, 8(3): 46 (1961).

External morphology: see Gleason H.A., New Britton & Brown Ill. Fl. 1: 258 (1952).

Internal morphology: see Metcalfe C.R., Anatomy of the Monocots. 5 (Cyperaceae): 234-237 (1971); Van der Veken in Bull. Jard. Bot. Bruxelles 35: 319 (1965).

Type species: Dulichium arundinaceum (L.) Britt.

Observation: The 2-fid styles, turbinate 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).

19. FIMBRISTYLIS Vahl, Enum Pl. 2: 285 (1806).

Clarke in Thiselton-Dyer, Fl. Trop. Afr. 8: 411-427 (1902); Koyama in Journ. Fac. Sci. Univ. Tokyo, 111, 8(3): 99-119 (1961); Shishkim in Komarov, Fl. URSS 3: 70-74 (Engl. Transl. 1964); Gordon?Gray in Mitt. Bot. Staatssamml. Munchen 10: 549-574 (1971).

External morphology: see p. 260.

Internal morphology: see Metcalfe, Anatomy of the Monocots 5: 271-279 (1971); Gordon-Gray op. cit.; Van der Veken in Bull. Jard. Bot. Bruxelles 35: 323-328, f. 39 (1965).

Type species: Fimbristylis 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.

20. CROSSLANDIA W.V. Fitzgerald in Journ. Proc. Roy. Soc. West. Australia 3: 122 (1917).

External morphology: see Fitzgerald op. cit.

Internal morphology: see Metcalfe, Anat. of Monocots 5: 181-182 (1971).

Type species: Crosslandia setifolia W.V. Fitzgerald.

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

Distribution: A monotypic genus endemic to Western Australia.

21. BULBOSTYLIS Kunth ex Clarke in Hook. f., Fl. Brit. Ind. 6: 651 (1894) gen. conserv. Clarke in Thiselton-Dyer, Fl. Trop. Africa 8: 427-446 (1902); Koyama in Journ. Fac. Sci. Univ. Tokyo, 111, 8(3): 99-119 (1961); Napper in J.E. Afr. Nat. Hist. Soc. 25(1), 110: 2-6 (1965); K. Lye in Mitt. Staatssamml. München 10: 539-547 (1971); Gordon-Gray in Mitt. Bot. Staatssamml. München 10: 549-574 (1971).

Internal morphology: see Metcalfe, Anatomy of Monocots. 5: 94-102 (1971); Gordon-Gray op. cit.; Van der Veken in Bull. Jard. Bot. Bruxelles 35: 333-336 fig. 41 (1936).

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.

22. ABILDGAARDIA Vahl, Enum. Pl. 2: 296 (1806).

Clarke in Thiselton-Dyer, Fl. Trop. Africa 8: 424-425 (1902); Koyama in Journ. Fac. Sci. Univ. Tokyo, 111, 8(3): 99-119 (1961); Napper in J.E. Afr. Nat. Hist. Soc. 25(1), 110: 6-8 (1965); Lye in Mitt. Bot. Staatssamml. München 10: 539-547 (1971).

Internal morphology: see Metcalfe, Anat. Monocots. 5: 65 (1971); Van der Veken in Bull. Jard. Bot. Bruxelles 35: 323- 328, fig. 39 (1965).

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.

23. NELMESIA Van der Veken in Bull. Jard. Bot. Bruxelles 25: 143 (1955).

External morphology: see Van der Veken op. cit.

Internal morphology: see Metcalfe, Anatomy of Monocots. 5: 394 (1971); Van der Veken in Bull. Jard. Bot. Bruxelles 35: 337 (1965).

Type species: Nelmesia melanostachya Van der Veken.

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 Fimbristylis 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).

24. NEMUM Desv. ex Hamilton, Prodr. Pl. Ind. Occ. 13 (1825)

Pax in Engler & Prantl, Die Naturl. Pflanzenf. 2, 2: 111 (1887); Clarke in Kew Bull. Add. ser. 8: 111 (1908).

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.

Internal morphology: Culm: ground tissue spongy, breaking down to form a large central cavity. Vascular bundles few, in a single ring of ± unequal sizes in the chlorenchyma. Hypodermal sclerenchyma as crescentiform partial strands. Chlorenchyma radiate or semi-radiate. Leaf: outline thickly crescentiform. Hypodermis differentiated. Vascular bundles c. 8 in a single arc series. Bundle sheath: inner layer parenchymatous. Silica bodies: conical without satellites; 1-4 bodies per cell. Embryo structure: turbinate with basal coleoptile and root cap.

Type species: Nemum spadiceum (Lam.) Desv. ex Hamilt.

Affinity: with Nelmesia (q.v.)

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

25. DESMOSCHOENUS Hook. fil., Fl. New Zeal. 1: 271 (1853)

Moore & Edgar, Fl. New Zeal. 2: 170 (1970).

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 sclerenchyma 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 subtending/involucral 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)

26. FICINIA Schrader in Comm. Soc. Reg. Sci. Gotting, ser 3, 7: 143 (1832) gen. conserv.

Clarke in Thiselton-Dyer, Fl. Capensis 7: 235-260 (1898); Levyns M.R. in Journ. South African Bot. 13: 65-71 (1947); Levyns in Fl. Cape Peninsula 117 (1950).

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 secund 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 obovoid, 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).

27. HOLOSCHOENUS Link, Hort. Berol. Descr. 1: 293 (1827).

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); Rozhevits in Komarov, Fl. URSS 3: 31 (Engl. Transl. 1964).

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 penetrating into the periphery of the ground tissue. Hypodermal sclerenchyma tall and narrow girders or subgirders. Chlorenchyma not radiate, palisade-like, often breaking down between the sclerenchyma girders to form peripheral air cavities. Epidermal cells often uniformly sized, sometimes those over the sclerenchyma 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 Steud., Syn. Pl. Glum. 2: 90 (1855)

Syn: *Scirpus* sect. *Isolepis* ser. *Holoschoenae* Clarke in Kew Bull. Add. Ser. 8: 112 (1908) p.p. [Clarke in Thiselt-Dyer, Fl. Cap. 7: 225 (1898) Clarke Ill. 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 psuedo-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: Hellmuthia restioides Steud.

Observation: With some specimens of this taxon showing the 2 large lateral scales (e.g. Drege 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. restioides 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 Drege 3943 it is proper to cite the type species as Hellmuthia restioides Steud. Thunberg's Scirpus membranaceous (see Thunb., 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, Hellmuthia 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 Hypolytreae, 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)

Beetle in Amer. Journ. Bot. 31: 263 (1944); K. Lye in Bot. Notiser 124 (2): 280-284 (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 which 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)

Brongn. in Duperr. Voy. Coq. Bot. 177 + 32 (1829); M. Barros in Sellowia 12: 256 (1960).

External morphology: Perennial, with robust rhizomes. Culm inserted in series, nodeless, solitary, terete, with basal bladeless sanguineous sheaths. Inflorescence compound umbel, with several rays, each terminating in a hemisphaerical 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 exserted 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 Brazil to Argentina (see Map 3).

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

Kukenthal in Engler, Das Pflanzen. 4, 20: 42-315 (1936).

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. esculentus or partly to obscurely to not radiate, e.g. C. diffusus, C. orbicephalus. Hypodermal sclerenchyma 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. esculentus 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 esculentus 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. esculentus, 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.

32. DUVAL-JOUVEA Palla in Koch, Synops. Deutsch. u. Schweiz. Fl. ed. 3, 2: 2555 (1905), emend.

External morphology see p. 304.

Internal morphology: Culm: outline triangular. Vascular bundles in more than one ring; minor ones peripheral. Hypodermal Sclerenchyma 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 Vahl, C. procerus Rottb., Mariscus compactus (Retz.) Druce etc. (see Kukenthal 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).

33. JUNCELLUS (Griseb.) Clarke in Hook. fil., Fl. Brit. Ind. 6: 594 (1893) emend. Griseb., Fl. Brit. West-Ind. Isl. 562 (1864); Kukenthal in Engler, Das Pflanzenr. 4, 20: 315-326 (1936).

External morphology: see p. 307.

Internal morphology: Culm: outline oval. Vascular bundles in slightly sinuous circle in chlorenchyma. Minor bundles numerous, more peripheral. Hypodermal sclerenchyma 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: Juncellus laevigatus (L.) Clarke.

Observation: Clarke's circumscription of the genus was based on Grisebach's (1864) Cyperus sect. Juncellus which contained only one species Cyperus mucronatus Rottb. (= J. laevigatus (L.) Clarke; Cyperus laevigatus L.). Clarke included in Juncellus, Cyperus serotinus Rottb. (= Juncellus 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 Juncellus is now homogenous, including 2 species, viz: J. laevigatus and J. pannonicus (Jacq.) Clarke.

Affinity: Juncellus 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

Kukenthal in Engler, Das Pflanzen. 4, 20: 326-402 (1936).

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*, *Juncellus* etc. By its persistent rachilla and spikelets, *Pycreus* appears to be more closely related to *Duval-Jouvea* and *Juncellus*.

Distribution: c. 100 spp. widely distributed in tropical and warm temperate regions.

35. GALILEA Parl., Fl. Palerm. 1: 297 (1845)

Clarke in Journ. Linn. Soc. 21: 110 (1884); Hayek, Pr. Fl. Pen. Balcanicae 3: 148 (1933).

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 Maps 3 & 27).

36. KYLLINGA Rottb., Descr. et Icon. Nov. Pl. 12 (1773) gen. conserv.
Kukenthal in Engler, Das Pflanzenr. 4, 20: 566-614 (1936).

External morphology: Annual or perennial. Culm trigonous or triquetrous, nodeless. Leaves basal, linear, graminaceous, sometimes reduced. Inflorescence terminal, umbellate or capitate with numerous spikelets aggregated in the head. Involucral bracts leaf-like. Spikelets sessile, compressed, 1(-few) flowered, 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 apiculate, 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 monocephala Rottb.

Affinity: Kyllinga has affinities with Pycreus and Mariscus. It is related to Pycreus through the group Pseudo-Pycreus of Kyllinga which has 2-5 flowers per spikelet, differing only in the inflorescence and articulate rachilla in Pycreus. Its affinity to Mariscus (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 Pycreus and Mariscus.

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)

Chermezon in Humbert, Fl. Mad. 29^{e} Fam. 16 (1936); Napper in J.E. Afr. Nat. Hist. Soc. 28 (124): 7 (1971).

Syn: Mariscopsis Cherm. in Bull. Mus. 25: 60 (1919).

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 obovoid or suborbicular, lenticular, not apiculate, minutely dotted, reddish-brown to black.

Internal morphology: as in Mariscus.

Type species: Queenslandiella hyalina (Vahl) Ballerd

Affinity: On external morphology this genus approaches Mariscus, Kyllinga, Duval-Jouvea and Pycreus. It differs from Mariscus in having 2-fid styles and lecticular fruits; from Kyllinga in having umbel with distinct elongated rays; and from Duval-Jouvea and Pycreus in ahving 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)

Clarke in Thiselton-Dyer, Fl. Trop. Afr. 8: 377-402 (1902); Kukenthal in Engler, Das Pflanzen. 4, 20: 402-566 (1936); Chermezon in Humbert, Fl. Madagascar 29e Famille: 19-42 (1936); Napper in J.E. Afr. Nat. Host. Soc. 28 (124): 7-17 (1971).

External morphology: see p. 311.

Internal morphology: Culm: outline obtusely triangular. Hypodermal sclerenchyma 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

Duval-Jouvea where some minor bundles encircle the air cavities; other species, e.g. M. purpurascens 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 sub-tropical regions of the world.

39. TORULINIUM Desv. in Hamilton, Prodr. Ind. Occid. 15 (1825)

Kukenthal in Engler, Das Pflanzen. 4, 20: 614-626 (1936).

External morphology: Perennial. Culm nodeless, trigonous. Leaves basal, linear, graminaceous. Inflorescence terminal, umbellate with numerous rays terminated by several aggregated spikelets. Involucral bracts leaf-like. Spikelets slightly compressed, many-flowered, deciduous. Rachilla thick, winged, disarticulating several times at each node. Glumes distichous, decurrent into swollen bases sheathing the internode of the rachilla, boat-shaped. Hypogynous perianth absent. 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: Torulinium confertum Hamilton.

Affinity: Closely related to Mariscus from which it differs in having several articulate rachillae 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 Linnaea 9: 286 (1834)

Kukenthal in Engler, Das Pflanzen. 4, 20: 499-502 (1936); Chermezon in Humbert, Fl. Mad. 29e Famille 41 (1936).

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 spicular 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.

41. REMIREA Aubl., Pl. Guian. 1: 44 (1775).

Syn: Cyperus subgen. Mariscus sect. Remirea (Aubl.) Koyama in Journ. Fac. Sci. Univ. Tokyo, III, 8(3): 120 (1961).

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 incrassate at its uppermost internode and clasping the flower, often disarticulating above the bract and the spicular prophyll. 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 sclerenchyma 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 Mariscus, from which it differs in its more dwarfed habit, head-like inflorescence, and the presence of an incrassate uppermost internode of the rachilla.

Distribution: A monotypic genus widely distributed in the tropics.

42. ASCOLEPIS Nees ex Steud., Syn. Pl. Glum. 2: 105 (1855) gen. conserv.

Kunth, Enum. Pl. 2: 26a (1835); Welw., Apont. Phyto-Geograph. 578 (1858); Clarke in Thiselton-Dyer, Pl. Trops. Afr. 8: 473-478 (1902); Clarke in Kew Bull. Add. ser. 8: 116 (1908); Chermezon in Humbert, Fl. Mad. 29e Famille 169-170 (1936); Napper in J.E. Afr. Nat. Hist. Soc. 24, 5 (109): 36 (1964).

External morphology: Annual or perennial, often tufted. Culm nodeless, filiform to robust, terete. Leaves setaceous, 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. Hypogenous 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 crescentiform, 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. Ascolepis brasiliensis (Kunth) Clarke) .... subgen. Platylepis (Kunth) Oteng-Yeboah

Observation: Kunth op. cit. circumscribed the genus Platylepis as distinct from Ascolepis 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 Ascolepis, 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 Scirpeae, but from the present observation they are closely related to the tribe Cypereae, especially to Kyllinga.

Distribution: with c. 15 spp., widely distributed in the tropics of Old and New Worlds, especially in tropical Africa.

43. LIPOCARPHA R. Br. in Tuckey, Narr. Exped. Congo Append. 459 (1818), gen conserv. Holm in Amer. J. Sci. 7: 171-183 (1899); Clarke in Thiselton-Dyer, Fl. Trop. Afr. 8: 468-473 (1902); Raynal in Adansonia Ser. 2, 7(1): 81-87 (1967).

Syn: Hypaelyptum Vahl, Enum. Pl. 2: 283 (1806)

Cyperus L. subgen. Lipocarpha (R. Br.) Koyama in Journ. Fac. Sci. Univ. Tokyo 111, 8(3): 120 (1961).

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, oblanceolate, with smooth margins. Hypogynous perianth absent (unless the 2 scales are considered so).

Stamens 1-2, anthers linear-oblong, with obtuse crests and smooth profile. Style 3-fid 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 sclerenchyma 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.

44. VOLKIELLA Merxmüller & Czech in Mitt. Bot. Staatssamml. München. 1(8): 317-323 fig. 1-2 (1953).

External morphology: see Merxm. & Czech, op. cit.

Internal morphology: Embryo - see Van der Veken in Bull. Jard. Bot. Bruxelles 35: 342 (1965).

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).

45. HEMICARPHA Nees in Edinb. New Philos. Journ. 17: 263 (1834) proposed gen. conserv. (Haines & Lye in Bot. Notiser 124(4): 477 (1971); Chermezon in Humbert Fl. Madagascar 29e Famille 141 (1936); Friedland in Amer. Journ. Bot. 28: 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, oblanceolate to suborbicular. 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 crescentiform, 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. squarrosa (L.) Oteng-Yeboah) .... sect. Chloroscirpus (Chermezon) 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 Chloroscirpus 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. Chloroscirpus 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).

46. ISOLEPIS R. Br., Prodr. Fl. Nov. Holl. 1: 34 (1810) emend.

Griseb., Spicil. Fl. Rumel. Bith. 2: 417 (1845); Pax in Engler & Prantl, Nat. Pflansenf. 2(2): 111 (1887); Koyama in Journ. Fac. Sci. Univ. Tokyo 111, 7(6): 283 (1958); Clapham et al, Fl. Brit. Isles Ed. 2: 1068 (1962).

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. Descr. 1: 293 (1827)

Reichenb., Icon. Fl. Germ. 8: 38 (1846); Fries in Andersson, Cyper. Scand. 8 (1849); Aschers., Fl. Brand. 1: 749 (1866); Clarke in Hook. f., Fl. Brit. Ind. 6: 635 (1894); Clarke in Kew Bull. Add. ser. 8: 111 (1908); Chermezon in Humbert, Fl. Madag. 29^{e} Fam. 142 (1936); Koyama in Journ. Fac. Sci. Univ. Tokyo 111, 7(6): 293 (1958); Clapham et al, Fl. Brit. Isles Ed. 2: 1069 (1962).

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 seatceous. 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 biconcave, 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 surface 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.

C. 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 Rhynchosporeae) 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 antrorsely 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 internode ± 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.

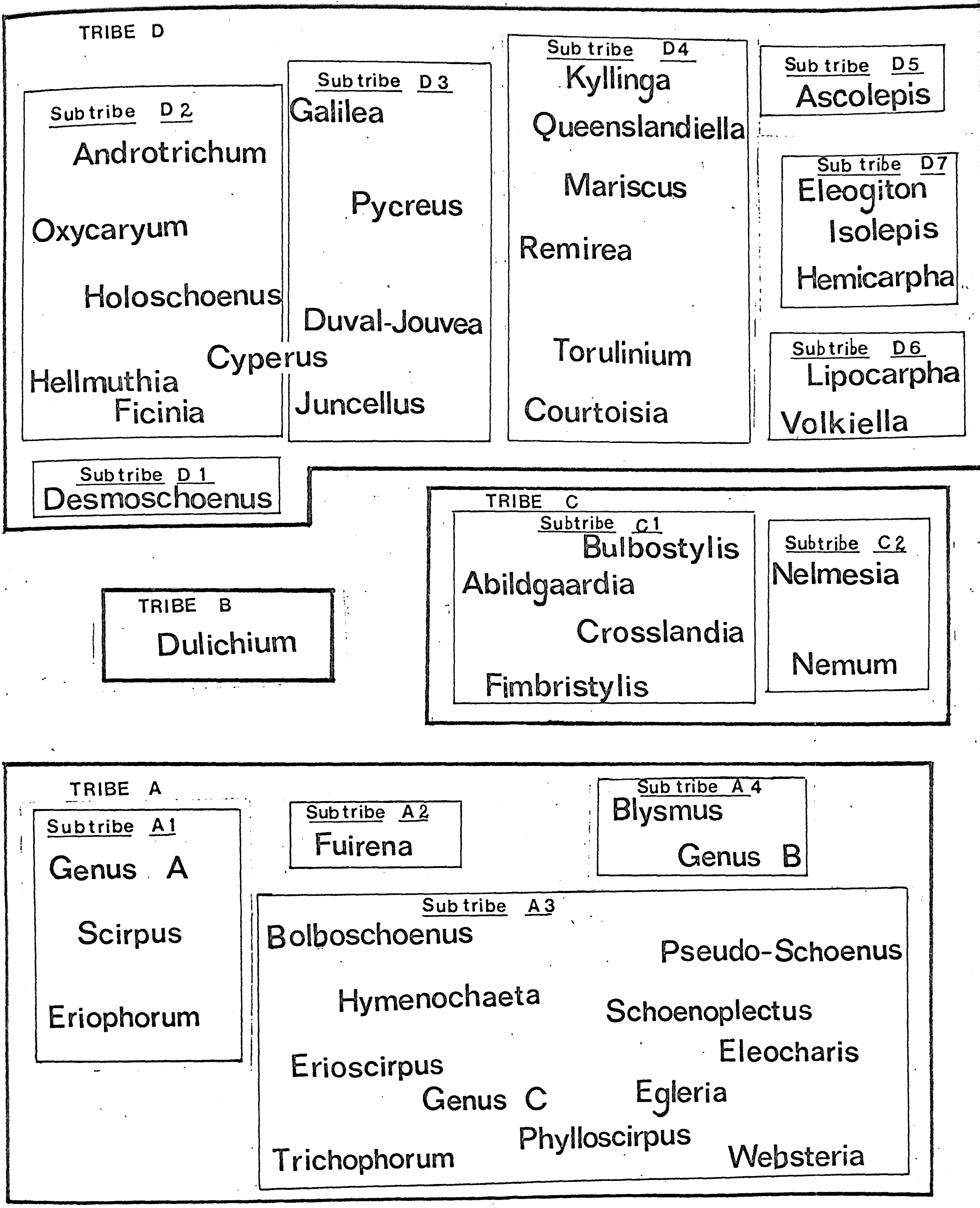


Fig. 35 DIAGRAMMATIC REPRESENTATION OF PROPOSED TRIBAL & SUBTRIBAL GROUPS

——— 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 paniculate with spikelets in terminal and axillary clusters, rarely solitary; hypogynous bristles needle-like, often occuring with hypogynous petal-like plates, very rarely both wanting.

Fuirena

Subtribe A3 (tribus Scirpeae p.p. excluding type and tribus Fimbristyleae p.p. [Eleocharis]).

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 paniculate but without axillary clusters with spikelets in terminal or pseudo-lateral clusters, sometimes solitary; hypogynous bristles variable from plumosely fimbriate to needle-like to filiform to silky.

Bolboschoenus, Schoenoplectus, Hymenochaeta, Pseudo-schoenus, Erioscirpus, Trichophorum, Phylloscirpus, Genus C, Eleocharis, Egleria, Websteria.

Subtribe A4 (tribus Scirpeae p.p. exclusing 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;

hypogynous bristles present, retrorsely scabrous; bundle sheath of the vascular bundle 2-layered, inner layer fibrous; embryo structure of the "Carex" type.

Dulichium

TRIBE C (tribus Fimbristyleae p.p. including type)

General inflorescence terminal, rarely pseudo-lateral; spikelets many-flowered; glumes spirally imbricate, rarely distichous; hypogynous bristles absent; bundle sheath of vascular bundles 3-layered, inner layer parenchymatous; embryo structure of the "Bulbostylis" or "Fimbristylis" types.

Subtribe C1 (tribus Fimbristyleae p.p. including type)

Style base thickened, articulate with the apex of fruit.

Fimbristylis, Crosslandia, Bulbostylis, Abildgaardia

Subtribe C2 (tribus Scirpeae p.p. excluding type)

Style base confluent with the body of fruit, not thickened.

Nelmesia, Nemum

TRIBE D (tribus Cypereae expanded, including part of tribus Scirpeae)

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; hypogynous 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 Scirpeae 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 Scirpeae 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.

Ficinia, Holoschoenus, Hellmuthia, Oxycaryum, Cyperus p.p., Androtrichum.

Subtribe D3 (tribus Cypereae 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.

Cyperus p.p., Juncellus, Duval-Jouvea, Pycreus, Galilea.

Subtribe D4 (tribus Kyllingeae)

Culm robust, rarely setaceous; general inflorescence umbellate or head-like; spikelets one to few flowered; rachilla conspicuous, articulate, deciduous; glumes distichous; chlorenchyma radiate.

Kyllinga, Queenslandiella, Mariscus, Torulinium, 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 Lipocarpheae)

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, Volkiella

<u>Subtribe D7</u> (tribus <u>Scirpeae</u> p.p. excluding type)

<u>Culm filiform to setaceous</u>; general inflorescence terminal or pseudo-lateral, head-like or solitary; spikelets many-flowered; <u>glumes spirally imbricate, occasionally enclosing one anterior hyaline scale</u>; <u>rachilla conspicuous, not articulate, persistent</u>; chlorenchyma radiate or not radiate.

<u>Hemicarpha</u>, <u>Isolepis</u>, <u>Eleogiton</u>.

PART II

A REVISION OF THE SUBFAMILY CYPEROIDEAE 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 Cyperoideae 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, Bornmüller, 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 Cyperoideae 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 Cyperoideae 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 & Heywood 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, Fimbristylis, Eleocharis, Schoenoplectus, Bolboschoenus, Cyperus s.s., Pycreus and Isolepis. 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 noeanus, 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. Schoenoplectus 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 Azerbaidshan, 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 mariscus, 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 Kavkaza ed. 2 (1940) which recorded the genus Bulbostylis with 2 species and 5 other species belonging to Eleocharis (2), Pycreus (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 Amanus [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 Lazistan) and such species are therefore largely confined to these areas (cf. distribution of Sphagnum, Henderson 1961).

Family CYPERACEAE St. Hil., Expos. Fam. 1: 62 (1805)

Annual or perennial, generally herbaceous, and often rhizomatous. Culms trigonous, triquetrous or terete, rarely compressed; noded 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 papillose. Ovary sessile or stipate, sometimes carried on a dilated disc or gynophore, unilocular with a single basal anatropous ovule. Fruit indehiscent, monospermous, endospermous, trigonous, lenticular or globose with a dry or vary 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(-3) empty basal glumes (cf. p. 219)

2a. Lowest empty glume not consistantly 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 blade; 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 subterete 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. Juncellus

13b. Axis of spikelets articulate and broadly winged; glumes persistent, falling with the rachilla; rachilla deciduous .... 17. Mariscus

1b. 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 spikelets

18a. Fruit-bearing flower(s) borne above staminate/imperfect flower(s); fruit drupe-like; leaves pseudo-dorsiventral in T.S. ... 18. Cladium

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

1. SCIRPUS L. spec. Pl.: 47 (1753) and Gen. Pl. ed. 5: 26 (1754) Emend.

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 fid. Fruits usually not longer than 1.5 mm long, small, lenticular or trigonous.

1. S. sylvaticus L.

1. Scirpus sylvaticus L. Sp. Pl.: 51 (1753)

Syn: Scirpus gramineus Nech., Delic. Gallo-Belg. 27 (1768)

Scirpus latifolius Gilib., Exerc. Phyt. 2: 515 (1792)

Seidlia sylvatica (L.) Opiz, Natur-Tausch. 340 (1826)

Nemocharis 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 bracts to 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, equalling 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 Aznavour!

A2(A) Istanbul: Çatal dağ (15 km E.N.E. of Usküdar and Erenköy) June 1892, Aznavour!

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, Kuhne 3210!

A9 Çoruh (Artvin): Ardanuç-Kordevan 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: Linagrostis 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 antrorsely 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. β 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 (Honck) Koyama subsp. latifolius (Hoppe)Koyama, Journ. fac. Sci. Univ. Tokyo 3 vol. 7 (6): 356 (1958)

Perennial with an abbreviated rhizome. Culms (12)-16-31 cm tall, trigonous. Basal leaves 3-8 mm wide, terminating in a short triquetrous 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 [B.M. (Nat. Hist.)!].

Widely scattered in NE and C. Anatolia, rare.

A8 Çoruh: Şavval 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 Söğüt 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., Sp. Pl. 52 (1753)

Syn: Linagrostis vaginata (L.) Scop., Fl. Carn. ed 2, 1: 47 (1772)

Scirpus vaginatus (L.) Salisb., Prodr. 31 (1796), non Thunb. (1794)

Eriophorum caespitosum Host., Gram. austr. 1: 30 (1801)

Scirpus fauriei (Camus) Koyama subsp. vaginatus (L.) Koyama, Journ. fac. Sc. Univ. Tokyo 3 vol. 7 (6): 358 (1958)

Perennial, forming large tussocks. Culms 14-44 cm tall, smooth, erect, terete below, trigonous above. Basal leaves 1 mm wide, ± setaceous, triquetrous, smooth or scabrous. Spikelets solitary, 2.5-3.5 cm long, oblong (in flower), sub-globose to broadly obovoid, 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 Gümüsane: 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., Descr. 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, paniculate-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, attenuate at base, and often prolonged into a slender beak.

1. F. pubescens (Poiret) Kunth

1. F. pubescens (Poiret) Kunth, Enum. 2: 182 (1837)

Syn: Carex pubescens Poiret, Voy. Barb. 2: 254 (1789)

Scirpus pubescens (Poiret) Lam., Illust. 1: 139 (1791)

Carex poiretii Gmelin, Syst. 1: 140 (1796)

Isolepis 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), Gönük, Davis 15029!

Is: Rodhos, Salakos, Fiori 77, Dimilia, Fiori 78.

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.

4. BOLBOSCHOENUS (Ascherson) Palla in Koch, Syn. Deutsch. Fl. ed. 3: 2531 (1904)

Syn: Scirpus L. sect. Bolboschoenus Ascherson, Fl. Brand. 1: 753 (1864), basionym

Scirpus L. sect. Phyllantheli Nyman, Consp. Fl. Eur. 763 (1882) p.p.

Scirpus L. sub-gen. Bolboschoenus (Ascherson) Ohwi in Mem. Coll. Sci. Kyoto Imp. Univ. ser. B, 18: 95,96 (1944)

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 sesile 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, apiculate 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

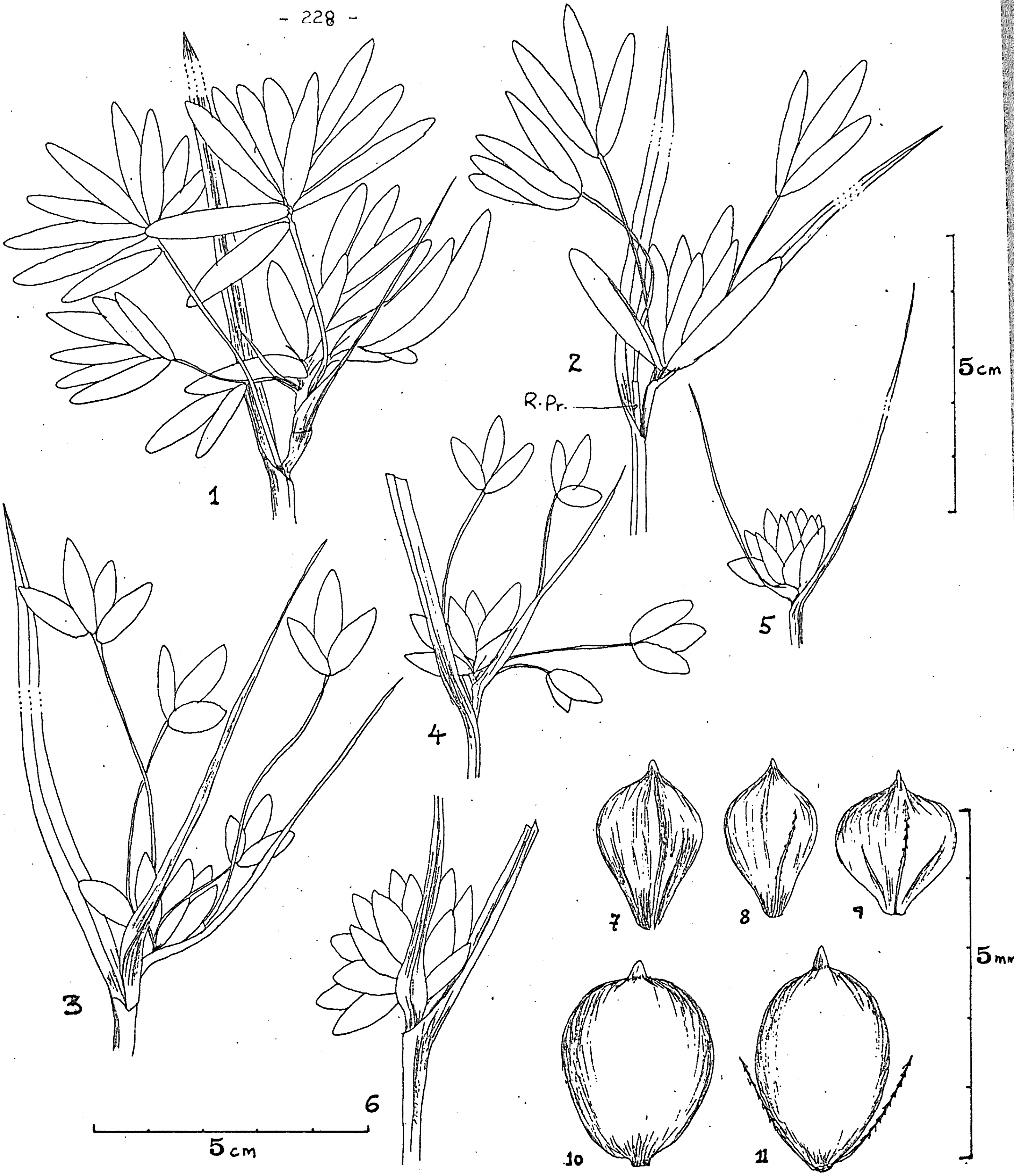


Fig. 36 Bolboschoenus spp. in Turkey

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

1. B. maritimus (L.) Palla in Koch, Synops. Deutsch. Fl. ed. 3: 2532 (1904)

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. cymosus

1. var. maritimus

Syn: Scirpus maritimus L. Sp. Pl. 52 (1753), basionym

S. macrostachyus Lam., Illustr. 1: 142 (1791)

S. macrostachys Willd., Enum. Hort. Berol. 1: 78 (1809)

S. maritimus L. var. macrostachys (Willd.) Koch, Synops. Pl. Germ. ed. 2: 858 (1844)

Scattered.

A1(E) Edirne: Enez, sea level, Coode, Jones & Dönmez 2913!

A2(E) Istanbul: Belgrad forest, 28 August 1982, Aznavour!

A2(A) Kocaeli: Pendik-Tuzla, 24 June 1898, Aznavour!

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.32757!

C3 Antalya: Finike, Schultz 136!

C4 Içel: sea shore east of Tosluça, Alava & 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 auct. plur., non L. (1753)

S. maritimus L. var. maritimus f. cymosus (Reichb.) Koyama in Can. J. Bot. 40: 936 (1962)

Scattered.

A2(E) Istanbul: Kücük Çekmeçe, 30 August 1937, Post!

A2(A) Istanbul: Kartal, 8 June 1899, Aznavour!

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!

C5 Adana: Adana to Karatas, 5 miles S. of Adana, near sea level, Coode & Jones 256!

C6 Hatay: Iskenderun-Antakya, west of Amik Göl, 150 m, Davis & Hedge D.27270!

C8 Mardin: Mardin-Savur, on N. side of watershed, 11-12 miles from Mardin, 1100 m, Davis & Hedge D.28534!

C9 Van: Başkale-Hakkari (Çolemerik) c. 50 km from Başkale, 1800 m, McNeill 699!

Islands: Gallipoli (Sirj.); Troas (Schmidt); Mytilene (Cand., Rechinger 5676b, Rechinger 5457); Rodhos (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. cymosus.

A2(E) Istanbul: Küçük Çekmeçe, 19 May 1939, B. Post!

A2(A) Istanbul: Kartal, 14 July 1894, Aznavour!

A2(A) Kocaeli: Pendik-Tuzla, 24 July 1898, Aznavour!

B4 Konya: Cihanbeyli, Boluk Gölu, 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. cymosus (Reich.) Oteng-Yeboah, which is the Scirpus maritimus of several authors, is differentiated by having shorter spikelets 0.8-1.9 cm long.

2. B. paludosus (Nelson) Oteng-Yeboah, comb. nov.

ssp. paludosus

Syn: Scirpus campestris Britt., in Britt. & Brown, Ill. Fl. 1: 267 (1896), non Rottb. (1795)

S. paludosus A. Nelson, Bull. Torr. Club 26: 5 (1899), basionym

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)

S. campestris Britt. var. longi-spicatus Bates, Univ. Nebr. Stud. 14: 155 (1914)

S. maritimus L. var. paludosus (Nelson) Kukenth., Feddes Repert. Sp. Nov. 23: 200 (1926)

S. paludosus Nelson var. atlanticus Fern., Rhodora 45: 291 (1943)

S. paludosus Nelson var. digynus (Hillebr.) Beetle in Leafl. 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.

ssp. hakkiaricus Oteng-Yeboah, ssp. nov.

Perennial, culms to 150 cm tall, sharply triquetrous, 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 nodose, 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 scabrous 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 scabrous, 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, concave-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: Yüksekova, 1900 m, 7 Sept. 1967, Duncan & Tait 203!

Additional material: C10 Hakkari: Gevar Ovasi between Yüksekova 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 ssp. paludosus and the Turkish ssp. hakkiaricus are as follows:

	ssp. paludosus	ssp. hakkiaricus
spikelet:	10-20 mm x 6-10 mm	14 mm x 5.0-5.3 mm
style:	6-10 mm long, 2-fid	5.5 mm long, 2(-3)-fid
Fruit:	3.0-4.0 mm x 2.0 mm	3.0-3.3 mm x 2.3 mm

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: Heleophylax Beauv. ex Lestib., Ess. Cyp. 41 (1819)

Scirpus L. sect. Actaeogeton Reichb., Fl. Germ. Excurs. 78 (1830)

Elytrospermum Meyer in Mem. Sav. Etr. Petersb. 1: 200 (1831)

Scirpus L. subgen. Schoensplectus 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. triqueter

4. Culms terete, or obscurely trigonous .... 5. S. lacustris

1. S. supinus (L.) Palla in Sitzb. Zool-bot. Gesel. Wien 38: 49 (1888)

Syn: Scirpus supinus L., Sp. Pl. 49 (1753)

Scirpus halleri Vitm., Summa Pl. 1: 150 (1789), non Vill. (1787)

Isolepis supina (L.) R.Br., Prodr. Fl. Nov. Holl. 1: 77 (1810)

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-(18.5) cm long. Inflorescence a head containong 1-7 spikelets. Involucral 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)-8-9.

Habitat: wet places, near sea level.

Described from France: habitat in Parisiis.

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.

2. S. mucronatus (L.) Palla in Engler, Bot. Jahrb. 10: 299 (1889)

Syn: Scirpus mucronatus L., Sp. Pl. 50 (1753)

S. glomeratus Scopoli, Fl. Carn. ed. 2, 1: 47 (1772), non Linn. (1753)

S. tricarinatus Pers., Synops. 1: 68 (1805)

Perennial with an abbreviated rhizome. Culms 49-87 cm tall, densely tufted, triquetrous. Sheaths 2-3, bladeless; lowest membraneous, 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. 71.31!].

N. Turkey, local.

A2(E) Istanbul: Bakirköy, 6 Oct. 1929, B.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.

3. S. littoralis (Schrader) Palla in Engler. Bot. Jahrb. 10: 299 (1889)

Syn: Scirpus littoralis Schrader, Fl. Germ. 1: 142 (1806)

Heleogiton littorale (Schrader) Reichb., Pl. Germ. Excus. 1: 78 (1830)

Malacochaete 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. desprauxii 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.

4. S. triqueter (L.) Palla in Engler, Bot. Jahrb. 10: 299 (1889)

Syn: Scirpus triqueter L., Mant. 1: 29 (1767)

S. mucronatus Host, Gram. Austr. 3: 44 (1801-9) non L. (1753)

S. trigonus Roth, Neue Beytr. 1: 90 (1802)

S. lejeunei Weihe in Flora 11: 116 (1828)

S. hoppii 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 oblong-ovoid, obtuse, reddish brown. Glumes 3.5 mm x 2.2 mm, oblong-elliptic, retuse, 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, 30!].

N.E. 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.

5. S. lacustris (L.) Palla in Engler, Bot. Jahrb. 10: 299 (1889)

ssp. lacustris

Syn: Scirpus lacustris L., Sp. Pl. 48 (1753)

S. macrophyllus 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, obovoid, 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. 71.15!/.

N. Turkey and adjacent Inner Anatolia, Islands.

A1(A) Balikesir: Bandirma-Manya gölu, Kayacik & Yaltirik 3741!

A2(E) Istanbul: Belgrad forest, 8 July 1920, Aznavour!

A3 Sakarya: Sapanca Gölu, 50 m, Davis & Coode D.36223!

A5 Çorum: Köse Dag, north of Çorum, 1500 m, Coode & Jones with Tobey 1910!

B7 Erzincan (Armenia Turcica): Sipikor dag in Sipikor-Goel, 26 July 1890, Sintenis 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, Svansk. Og Norsk Exc. Fl. 10 (1846)

S. lacustris L. var. digynus Gren. & Godr., Fl. France 3: 372 (1855)

S. lacustris L. ssp. tabernaemontani (Gmelin) Boswell 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: utringue in stagnis et paludibus praesertim sylvaticis Rheno vicinis frequens.

Widespread but local in Turkey, Islands.

A1(E) Edirne: distr. Keşan, 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!

B2 Kütahya: Simav-Dagardi road, 8 Aug. 1968, E. Anglia Exped. D14!

B5 Kayseri: Kayseri-Incesu, 1200 m, Davis & Hedge D.32753!

B7 Malatya: Gürün-Malatya, c. 10 km E. of Darende, 90 m, McNeill 430!

B9 Van: Van, Davis & Polunin D.24540!

B10 Kars: Aralik (Aras valley), 810 m, Davis 43649!

C2 Antalya: Kara göl near Yura, Davis 13907!

C6 Hatay: Iskenderun-Antalya, west of Amik Göl, 150 m, Davis & Hedge D.27269!

C9-10 Van: Zab gorge, south of Başkale, Davis & Polunin D.23794!

C10 Hakkari: Gevar Ovasi 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.

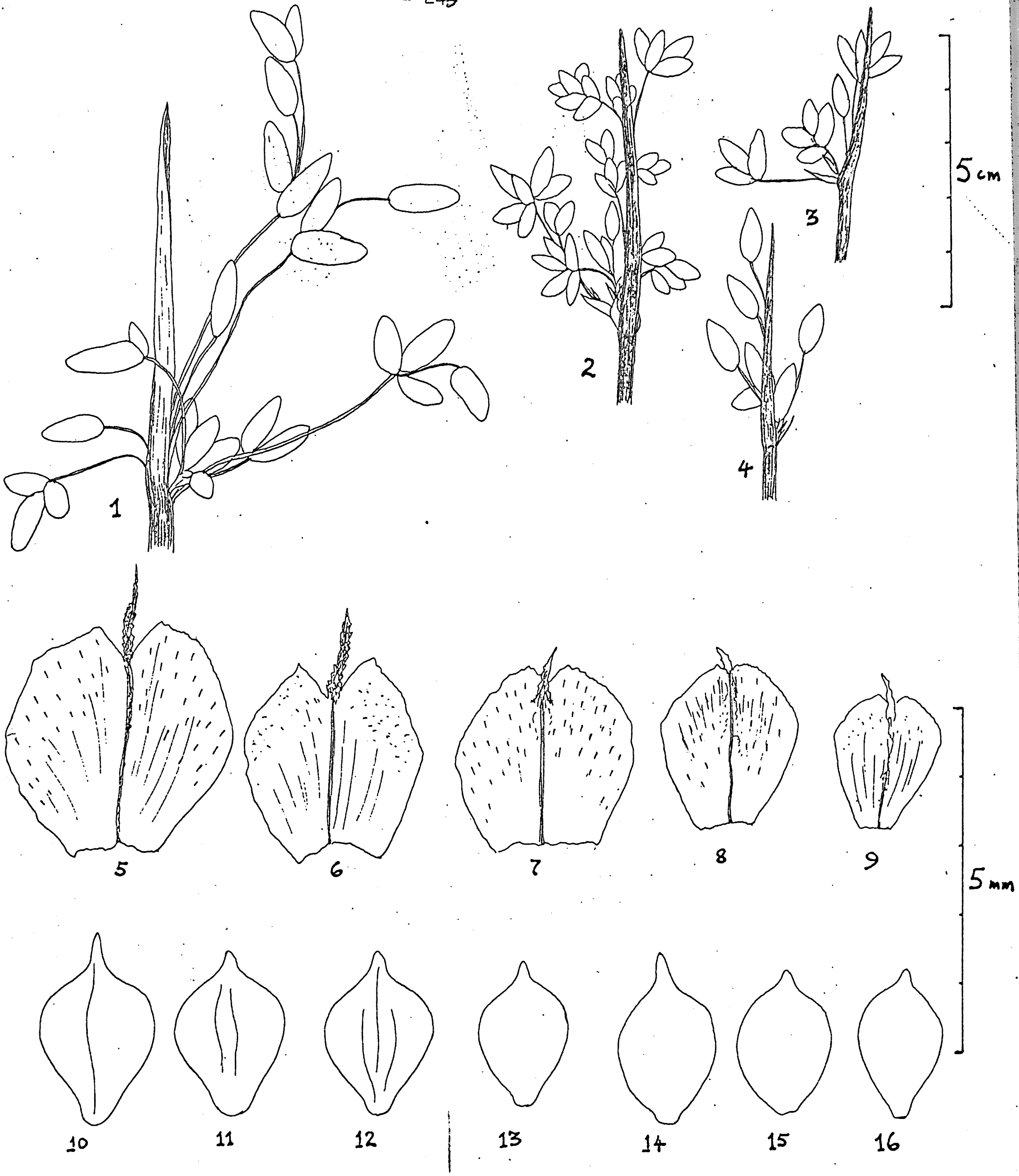


Fig. 37 Variations in Schoenoplectus lacustris in Turkey

1-4 Inflorescence forms in S. lacustris & subsp. glaucus × 1.

5-9 Glume forms × 12 ; 10-16 Fruit shapes × 12

(10-12 ... subsp. lacustris ; 13-16 ... subsp. glaucus)

<u>Observation</u>: 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 (<u>S. lacustris</u>) 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 (1964), 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 <u>S. lacustris</u> 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 together (Danser 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 .

6. TRICHOPHORUM Persoon, Synops. Pl. I: 69 (1805) emend.

Syn: Baeothryon Ehrh. ex. Dietr. Sp. Pl. 2: 89 (1833) p.p.

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.

11. T. pumilum (Vahl) Schinz & Thell., in Viert. Nat. Ges. Zurich 66: 265 (1921)

Syn: Scirpus pumilus Vahl, Enum. 2: 243 (1805)

Isolepis pumila (Vahl) Roem & Schult., Syst. Veg. 2: 106 (1817)

Scirpus alpinus Schleich., in Gaudin. 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. Elr. 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.

7. ELEOCHARIS R.Br., Prodr. Fl. Nov. Holl. 224 (1810)

Syn: Limnochloa Nees in Wight, Contr. Bot. Ind. 71 (1834)

Scirpidium Nees in Linnaea 9: 293 (1834)

Eleogenus 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) Schultes

1. E. pauciflora (Lightf.) Link, Hort. Berol. Descr. 1: 284 (1827)

Syn: Scirpus pauciflorus Lightf., Fl. Scot. 2: 1078 (1777)

S. baeothryon L. fil., Suppl. 103 (1781)

S. halleri 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 Gümüşane: Szandschak, 5 June 1894, Sintenis 5772!

B2 Kütahya: Murat dağ above Gediz at Kesik Söğüt, 1200 m, Davis & Coode D.36721!

B3 Konya: (Phrygia vil. Konia): in subalpine region of Sultan Dağ near Akscheher, 1500 m, 25 June 1899, Bornmuller 5613!

B6 Kayseri: 5 km N. of Sariz, 1900 m, Coode & Jones 1407!

B9 Van: 4 km W. of Erçiş, 1720 m, Davis 43447!

C9 Hakkari: Kara Dağ, 3292 m, Davis & Polunin D.24442!

External distribution: Wide spread in Europe, Siberia, Caucasus, Himalaya, Morocco and North America.

2. E. acicularis (L.) R. Br., Prodr. Fl. Nov. Holl. 224 (1810)

Syn: Scirpus acicularis L., Sp. Pl. 48 (1753)

Mariscus acicularis (L.) Moench, Meth. 350 (1794)

Cyperus acicularis (L.) With., Arr. Brit. Fl. ed. 3, 2: 78 (1796)

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)

Chaetocyperus acicularis (L.) Nees in Martius, Fl. Brasil. 2: 95 (1842) p.p.

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 spathula-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 traberculae. Fl. 6-8.

Habitat: in wet sandy or muddy places near pools.

Described from Europe: habitat in Europa sub aquis purioribus [Hb. Linn. 71.13!].

Bosphorus, rare.

A2(E) Istanbul: Grand Bend, Belgrad Forest, 28 August 1892, Aznavour!

External distribution: Europe (except the extreme North and South), Northern Asia, Transcaucasus, 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.

3. E. palustris (L.) R.Br., Prodr. Fl. Nov. Holl. 224 (1810)

Syn: Scirpus palustris L. Sp. Pl. 47 (1753)

Heleocharis eupalustris Lindb. fil. in Acta Soc. Pro. Fauna Fl. Fennica 23 (7): 5 (1902)

Scirpus palustris, a typicus Aschers. & Graebn., Syn. Mitteleur. Fl. 2 (2): 290 (1903)

Trichophyllum palustre (L.) Farwell, Rep. Mich. Acad. Sci. 15: 166 (1913)

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 mmlong, 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 tubercle 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 [Hb. Linn. 71-5!]

Widespread.

A1(E) Edirne: 4 km W. of Edirne, alt. 50 m, Davis 41906!

A1(E) Tekirdağ: between Muratli and Tekirdağ, A. Baytop 10994!

A2(E) Istanbul: Yedikoule (near Makriköy) 7 June 1898, Aznavour!

A2(A) Kocaeli: Tuzla (S.E. of Pendik) 26 April 1894, Aznavour!

A3 Bolu: Abant göl, alt. 1400 m, Davis & Coode D.37158!

A4 Ankara: Karagöl, 40 km N. of Ankara, 1600 m, Coode & Jones 2206!

A5 Çorum: 12 mls. Alaca to Sungurlu, 1200 m, Coode & Jones 1654

A6 Samsun: marsh east of Samsun, 5 m, Tobey 790!

A6-7 Ordu: Cambaşi at Semen, 2200 m, Tobey 1437!

A7 Gümüşane: Gümüşane, 28 June 1894, Sintenis 6024!

A9 Kars: 4 km from Sarikamiş to Karaurgan, 2200 m, Davis 46606!

B1 Balikesir: mt. Ida, 15 July 1883, Sintenis 1217!

B2 Kütahya: Simav, Kiçir to Akdag, 1100 m, Coode & Jones 2685!

B2 Uşak: 11 mls. from Dumlupinar to Banaz, 100 m, Coode & Jones 2350!

B2 Bursa: Tahtaköprü between Inegöl and Domaniç, Davis & Coode D.36413!

B5 Yozgat: 20 km N. of Himmetdede, 1200 m, Coode & Jones 1472!

B6 Yozgat: Akdagmadeni to Büyük Nalbant dag at Yukari Culhali, 2100 m, Coode & Jones 1409!

B9 Agri: d. Suluçem (Musum), S. end of Balik G., 2300 m, Davis 47065!

B9 Bitlis: Kotum, Davis & Polunin D.22422!

B10 Kars: Aralik, 850 m, Davis 43879!

C2 Muğla: Girdev Gölu, 75 km E. of Fethiye, Lycian Taurus, 2350 m, Lambert & Thorp 599!

C5 Adana: Adana to Karataş, 5 mls. S. of Adana, near sea level, Coode & Jones 257!

C6 Hatay: Iskenderun, R. Alava 66[illegible]!

C10 Hakkari: 19 km from Yüksekova to Şemdinli, 1950 m, Davis 42128!

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 lenght; 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. ssp. 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 [B3] 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 specmiens, viz. Coode & Jones 604 and Alava 6601 from C6 Hatay, Davis & Polunin D.21929 from Kayseri, Tobey 776 from A6 Samsun, also have flat or depressed culms. It is believed that the flatness of these specimens was caused by pressing.

44 E. uniglumis (Link) Schultes, Mant 2: 88 (1824)

Syn: Scirpus uniglumis Link in Jahrb. der. Gew 1, 3: 77 (1818)

Heleocharis eu-uniglumis Zinserl. in Fl. Yugo-Vost 3, 278 (1929)

Differs from E. palustris (L.) R.Br. in having: culms 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, spathiform 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: Çubuk Su (Ankara-Ravli), Davis 21431!

A5 Corum: Köse Dag north of Corum, 1500 m, Coode & Jones 1909!

B5 Kirşehir: Sifegöl nr. Mucur, Davis 21789

B6 Kayseri: Bünyan to Pinarbaşi, 1500 m, Coode & Jones 1327!

B6 Maraş: Göksun-Çardak, near Findik, 1300 m, Davis & Hedge D.27617!

B9 Bitlis: crater of Nemrut Dağ, c. 2400 m, by lake Nemrut Gölu, McNeill 544!

C3 Isparta: Sütçüler, Dedegöl dağ in Dedegöl tarn, 2300 m, Davis 16033!

C10 Hakkari: Yüksekova, 1900 m, Duncan & Tait 203A!

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.

8. BLYSMUS Panz. in Schult. Mant. 2: 41 (1824)

Syn: Nomochloa Beauv. in Lestib., Ess. Famil. Cyperac. 37 (1819)

Scirpus L. Sect. Blysmus (Panz.) Koch, Synops. Pl. ed. 2: 858 (1844)

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 membraneous, 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

11. 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. caricis Retz., Pl. Scand. Prodr. 11 (1779)

S. compressus (L.) Pers., Syn. 1: 66 (1805), non Moench (1794)

Nomochloa compressa (L.) Beetle in Amer. J. Bor. 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 Europa: habitat in Anglia, Helvetia, Italia.

Widespread in Anatolia.

A4 Kastamonu: North side of Ilgaz Dağ flush, 2100 m. Davis, Coode & Yaltirik D.38359!

A5 Kastamonu: Tosya, 29 May 1892, Sintenis 4015!

A7 Giresun: Balaban-Dağlari (Kilinç Tepe) above Tamdere, 2600 m, Davis, Dodds & Çetik D.20611A!

A8 Çoruh (Artvin): Yalnizçam Dağlari, on west side of pass between Ardahan and Artvin, 2350 m, Davis & Hedge D.32529!

A9 Kars: Susuz, 1750 m, Davis & Hedge D. 30629!

B1 Balikesir: Mt. Ida, 15 July 1883, Sintenis 1216!

B3 Konya (Phrygia): Sultan dag near Akschehr, 25 June 1899, Bornmüller 5612!

B4 Ankara: Beynam, 1000 m Davis 13059!

B5 Kayseri (Cappadocia): Argaeus (Erciyas Da), 20 July 1898, Siehe 200!

B6 Maraş: Göksun, Binboga dag, on Işik dag above Karliyayla, 2200 m, Davis, Dodds & Cetik D.20014!

B7 Erzincan: Keşiş dag above Cimin, 2450 m, Davis & Hedge D.31652!

B9 Van: Satak, Kavusşahap Dag, 3100 m, Davis & Polunin 23213!

C2 Mugla: Girdev Dagh in Belyaila, 2000 m, Davis 13966!

C5 Nigde: alpine region of Taurus, 26 Aug. 1855, Balansa 825!

C9 Hakkari: Cilo Dag above Dizderesi, 2338 m, Davis & Polunin 23982!

C10 Hakkari: Koçanis, 2286 m, Davis & Polunin 24339!

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 *Blysmus* in the herbarium

9. FIMBRISTYLIS Vahl, Enum. Pl. 2: 285 (1806)

Annual, very rarely perennial. Culms tufted, 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. diphylla (Retz.) Vahl var. floribunda Miq. in Ann. Mus. Bot. Ludg.-Batav. 2: 144 (1865)

F. polymorpha Böckr. in Linnaea 37: 15 (1871)

F. novae-brittaniae Böckr. in Engler, Bot. Jahrb. 5: 93 (1884)

F. tikushiensis Hayata, Icon. Pl. Formos. 6: 113 (1916)

F. annua R. & S. var. pseudo-ferruginea Kukenth. in Engler, Bot. Jahrb. 59: 5 (1924)

F. annua R. & S. var. diphylla (Retz.) Kukenth. in Engler, Bot. Jahrb. 59: 47 (1924) nomen, and in Act. Hort. Gotob. 5 (1929)

Annual with slender fibrous roots. Culms 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 ligule. 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. 71.34!].

Scattered in Outer Anatolia, Turkey-in-Europe, Islands.

A1(A) Çanakkale: near Bayramiç 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: Rodhos, Asphandos, Fiori 82.

Widely distributed throughout the tropical-subtropical and warm temperate regions of the Old World, and Northern Australia.

2. F. ferruginea (L.) Vahl, Enum. Pl. 2: 291 (1806)

Syn: Scirpus ferrugineus L. Sp. Pl. 50 (1753)

Isolepis turkestanica Regel, in Act. Hort. Petrop. 7: 561 (1881)

Scirpus turkestanica Meinsh. in Act. Hort. Petrop. 18, 3: 247 (1901)

Fimbristylis vitiata C.B. Clarke, in Kew Bull. ser. 8: 24 (1908)

F. turkestanica B. Fedtsch., in Act. Hort. Petrop. 37, 1: 181 (1924)

F. ciliata Drobov, in Opred. rast. okr. Tashkenta 1: 49 (1927)

Differing from F. dichotoma (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 Jamaicae paludibus maritimis [Hb. Linn. 71. 37, 38!]

Rare in S. Anatolia, Islands.

C6 Gaziantep: Islahiye, Kasapligil 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. Holochoenus (Link) Koch, Synops. ed. 2: 293 (1844)

Scirpus sect. Isolepis holoschoeneae Clarke in Kew Bull. ser. 8: 112 (1908)

Perennial, with thick, lignose, long-creeping or abbreviated rhizomes. Culms densely cespitose, nodeless, leaved at base. Leaves subterete or reduced. Inflorescence a pseudo-lateral hemisphaerical heads of densely aggregated, numerous spikelets. Lower involucral bracts appearing as a continuation of the culm, erect, sub-terete. Spikelets small, sessile, with spirally arranged glumes. Hypogynous bristles absent. Stamens 3, anthers linear, connective ciliate. Style with 3 villous stigmas. Fruit small, trigonous.

1. H. vulgaris Link

1. 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, subterete, 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 5–48(–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 0.6–1.8 mm, obovate, 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 [Hb. Linn. 71.17, 18, 19].

Widespread in Turkey, Islands.

A1(E) Edirne: Enez, sea level, Coode & Jones 2892!

A2(E) Istanbul: Kiathane-Bosphore, 25 June 1917, B. Post!

A2(A) Istanbul: Koru-Pendik, 19 May 1939, B. Post!

A3 Adapazari: Karasu to Söğütlü, 10 m, Davis & Coode D.39089!

B1 Izmir: Kemalpaşa, near Byzantine fortress, Alava & 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 Tunceli: above Pülümür, 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!

C3 Isparta: Eğirdir, Foot hills, Barla Dag, 1200 m, Khan et al 413!

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!

Is: Khios, Rechinger obs; Kos, Rechinger obs; Tilos, Ade.

var. australis (L.) Hayek, Prodr. Fl. Pen. Bal. 3: 156 (1933)

Syn: Scirpus australis L., Syst. Veg. ed. 13: 85 (1774)
Holoschoenus australis (L.) Reichb. Fl. Germ. exc. 76 (1830)
Scirpus holoschoenus var. australis (L.) Koch, Syn. ed. 2: 85 (1845)

Widespread in Turkey.

A2(E) Istanbul: Kilios, 5 May 1890, Aznavour!

A2(A) Istanbul: Kartal, Aydos-Dagi, Aytug & Yaltirik 3328!

A4 Ankara: Çubuk Su (Ankara-Ravli), Davis 21429!

A5 Çorum: Iskilip, 26 km from Çorum to Iskilip, Kizilirmah valley, 600 m, Coode & Jones 1723!

A6 Samsun: beach area near Oyumca, 2 m, Tobey 792!

B4 Ankara: Ankara, Ortadogu Universites; Çayiri (meadow), Alinoglu 170!

B6 Adana: Karakilisse to Gujuk Sou, 10 June 1906, B. Post 160!

B8 Erzurum: 10 km North of Hinis, 1630 m, Davis 46241!

B9 Bitlis: crater of Nemrut Dagh, by lake (Nemrut Gölü), 2400 m, McNeill 543!

C2 Denizli: near ruins of Pamukkale (former Hierapolis), Alava & Bocquet 5288!

C3 Antalya: Duden Basli near Antalya, Palmer T/49!

C4 Antalya: Alanya, A. Baytop 1-228!

C7 Urfa: Hilvan-Siverek, 700 m, Davis & Hedge D.28257!

C9 Van: Başkale-Hakkari (Çolemerik), 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 vary 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 infloresecence 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 Findlay 268
3 & 4 Khan et al 413 ; 5 Aznavour 2063 [x 0.5] ; 6 Aznavour 2067 ; 7 McNeill 223
8 Aznavour 2112 ; 9 Aznavour 2059)

10–12 Holoschoenus vulgaris Link var. australis
(10 Davis 28257 ; 11 Coode & Jones 1723 ; 12 Alava 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.

---

*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)

8. ISOLEPIS R. Br., Prodr. Fl. Nov. Holl. 1: 34 (1810), emend.

Syn: Scirpus L. Sect. Isolepis (R.Br.) Griseb., Spicil. Fl. Rumel. Bith. 2: 417 (1845)

Scirpus L. subgen. Isolepis (R.Br.) Pax in Engler et Prantl, 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, ligule-less, 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. Involucral 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.

1. Involucral 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.

1. I. cernua (Vahl) Roem & Schultes., Syst. Veg. 2: 106 (1817)

Syn: Scirpus cernuus 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 ligule. 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. Stamens 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, obovoid, 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: Zekeriekoy, 23 May 1899, Aznavour!

A2(A) Istanbul: Nem Dağ, Alt. 350 m, 6 June 1892, Aznavour!

A5 Sinop: Ince Burun, 40–50 m, Tobey 1097!

C1 Muğla: Marmaris, Datça port, sea level, Davis 41365!

C4 Antalya: Alanya bay, 2 m, Davis & Polunin D.25909!

C5 Içel: 15 mls. from Silifke towards Mersin, sea level, Coode & Jones 1091

Islands: Lesvos; 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 Sebestiani & Mauri mentioned the number of stamens in the description of their species.

2. I. setacea (L.) R. Br. Prodr. Fl. Nov. Holl. 1: 78 (1810)

Syn: Scirpus setaceus L., Sp. Pl. 49 (1753)

Schoenoplectus setaceus (L.) Palla in Koch, Synops. ed. 3: 2538 (1907)

Differs from I. cernua (Vahl) Roem. & Schultes in having: culms 0.5-15 cm tall; involucral bract 2.0-15 mm long, always longer than the inflorescence; stamens always 2; fruits smaller, 0.5-0.9 mm x 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(A) 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 setaceus L., were found to be near Isolepis cernua (Vahl) R. & S. because of the minutely dotted fruits. The typification of I. 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)

Syn: Cyperus L. sect. Eucyperus Griseb., Spicil. Fl. Rumel. 2: 420 (1844)

Cyperus L. subgen. Eucyperus (Griseb.) Clarke in Journ. Linn. Soc. 21: 33 (1884)

Eucyperus Rikli in Pringsheims 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 decompound umbel, sometimes contracted into a head. Involucral bracts leaf-like, few to many, unequal. Spikelets compressed, many-flowered; rachilla 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 .... [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-obovate, chestnut-brown, hyaline at margins, 0.5 mm long .... 7. C. difformis 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. noeanus 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.

1. 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 decompound 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 0.6-2.3 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 Italiae, 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. badius

1. 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. heldreichianus

2. Inflorescence a compound to decompound umbel, up to 30 cm tall

3. Spikelets acute, 0.6-2.0 mm broad .... var. longus

3. Spikelets obtuse, 2.0-2.3 mm broad .... var. anatolicus

ssp. longus

var. longus

Syn: Cyperus procerus M-Bieb. ex Georgi, Beschr. russ. Reich. 3: 674 (1800)

C. hybridus Hausskn. in Mitt. Thur. Bot. Ver. N.F. 13-14: 34 (1899)

Chlorocyperus longus Palla in Allg. Bot. Zeitschr. 6: 201 (1900)

NW. Turkey, Outer and E. Anatolia, Islands.

A1(E) Tekirdag: Yenice (south of Inecik), 610 m, 13 Aug. 1968, E. Anglia Exp. F.18!

A2(E) Istanbul: Tatli Su (near Kilyos), 22 July 1900, Aznavour!

A2(A) Istanbul: Scutari (Üsküdar), 10 Aug. 1893, Aznavour!

A3 Zonguldak: Kozlu, Khan, Prance & Ratcliffe 812!

B1 Balikesir: Zeitunli (Seitinly), 26 June 1883, Sintenis 837!

B8 Muş/Bingöl: Mus-Sulhan, 135 m, Davis & Polunin D.24784!

B8 Muş: Warto, 1560 m, Davis 46300!

C3 Isparta: Eğirdir, Barla Dağ, 1200 m, Khan et al 408!

C4 Içel: E. of Tasuçu, Alava & Kukkonen 6730!

C5 Içel: 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 Boeck. (Linnaea 36: 280, 1870), but I have withheld 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: Büyük Gök Su, 11 July 1906, B. Post 823!

A2(A) Kocaeli: Koru-Pendik, 17 May 1939, B. Post!

A3 Sakarya: Sapanca Gölü, 50 m, Davis & Coode D.36224!

A6 Samsun: Kirazlik beach area, 1 m, Tobey 800!

A6 Ordu: Fatsa-Aybasti, 700 m, Tobey 1368!

C2 Antalya: Kara göl, 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. anatolica Oteng-Yeboah, var. nov. in ed. (see diagnosis in key).

Inner Anatolia

B5 Kayseri: Kayseri-Incesu, 1200 m, Davis & Hedge D.32755!

B8 Diyarbakir: Diyarbakir-Bitlis, c. 65 km from Diyarbakir, 750 m, McNeill 492!

C3 Konya: Beyşehir, Davis 16106 (holotypus E)!

C4 Konya: Kashanan, 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. Atl. 1: 45 (1798) t. 7, f. 2

C. longus Brotero, Fl. Lusit. 1: 57 (1804), non L. (1753)

C. brachystachys Presl, Gram. et Cyp. Sicul. 15 (1820)

C. thermalis Dumort, Fl. Belg. 145 (1827)

C. longus var. badius (Desf.) Cambess. in Mem. Mus. Hist. Nat. Paris 14: 323 (1827)

C. preslii Parl., Fl. Ital. 2: 40 (1852)

Chlorocyperus badius (Desf.) Palla in Allg. Bot. Zeitschr. 6: 20 (1900)

N.W. Turkey, Islands.

A2(E) Istanbul: Kagathane, 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 (1964), Hayek (1933) 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)

Perennial with long stolons, tuber-bearing (tubers not found in our specimens!). Culms 8-30-(60) cm tall, triquetrous, 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 Rottb., Descr. et Icon. 28 (1773) t. 14 f. 2

C. ferrugineus Forskal, Fl. Aeg.-arab. 14 (1775) p.p.

Cyperus tetrastachyos Desf., Fl. Atl. 1: 45 (1798) t. 8

C. esculentus Savi, Fl. Pisan 1: 140 (1798), non L. (1753)

C. hydra Michx., Fl. Bor.-amer. 1: 27 (1803)

C. olivaris Targ.-Tozz. in Mem. Soc. Ital. Sc. 13, 2: 338 (1807)

C. radicosus Sibth. et Smith, Fl. Graec. Prodr. 1: 30 (1806) t. 45

C. patulus M. Bieb., Fl. Taurc.-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. purpureo-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!/

Turkey-in-Europe, Outer Anatolia, Islands.

Armenia: /probably/ between Erzurum and Trabzon, Calvert & Zohrab 840! 871!

A1(A) Çanakkale (Mysia): Bunarbaschi, 12 Sept. 1883, Sintenis 1214!

A2(E) Istanbul: Makriköy- San Stefano (Yesilköy), 5 Oct. 1893, Aznavour!

A2(A) Istanbul: Maltepe, 22 Aug. 1897, Aznavour!

A6 Samsun: Çarşamba, Yesilirmak, Kayacik & Elicin 1866!

B1 Manisa: Manisa, Ünal 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 Içel: Silifke, Alava 6639!

C5 Içel: Mersin, Aug. 1896, Siehe 663!

C8 Mardin: Zikiltepe, Davis & Hedge D.28664!

Is: Lesvos, Ikonomopulos; 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, Pl. 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 Presl., Fl. Sic. 1: 43 (1826)

C. tenorianus Roem. & Schultes, Mant. 3: 544 (1827)

C. esculentus β aureus Richter, Pl. Europ. 1: 135 (1890)

Chlorocyperus aureus (Ten.) Palla in Allg. Bot. Zeitschr 9: 69 (1903)

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 c.2.0 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 Monspelli, ingue Italia, Oriente [Hb. Linn. 70.4!].

N.E. Anatolia

Armenia: [probably between Erzurun and Trabzon], Calvert & Zohrab 841!

A7-8 Trabzon, 24 Aug. 1889, Sintenis 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. C. glaber L., Mant. 2: 179 (1771)

Syn: Cyperus patulus Kit. in Host, Gram. Austr. 3: 49 (1805) t. 74

C. erubescens Link, Enum. Hort. Berol. 1: 44 (1821)

C. pictus Ten., Fl. Napol. 3: 47 (1824-29)

C. banaticus Kit. ex. Nym., Consp. Fl. Eur. 759 (1882)

Chlorocyperus glaber (L.) Palla in Allg. Bot. Zeitschr. 6: 201 (1900)

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 Kastamonu (Paphlagonia): Tosya, 4 Aug. 1892, Sintenis 4927!

B1 Balikesir: Seitinly, 25 June 1883, Sintenis 538!

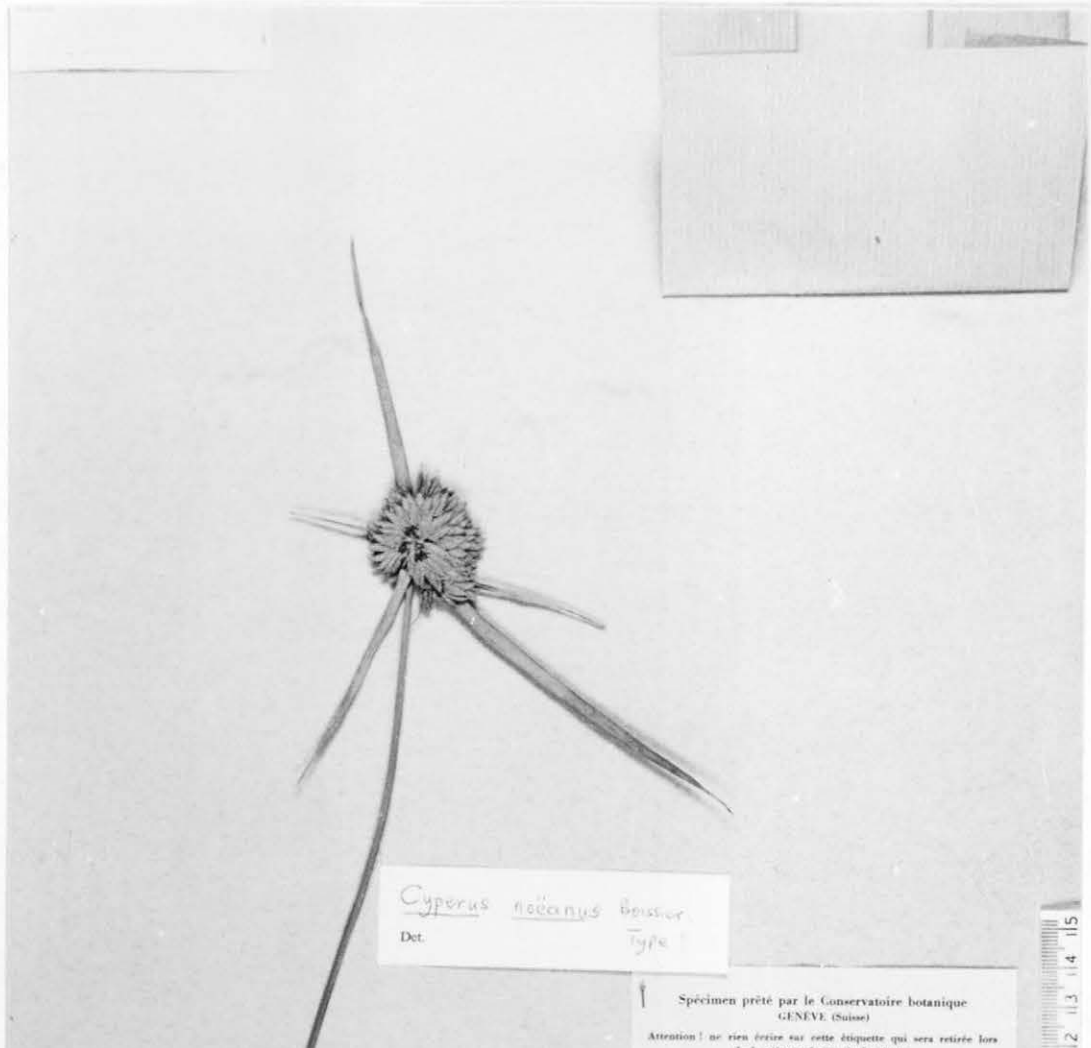
C6 Maraş: Süleymanli, Llywelyn-Williams S.R.8!

C6 Adana: near Hasanbeyli river valley, 914-1219 m, Darrah 687! 660!

C9-10 Hakkari: Cilo Dağ, in Diz deresi, 1644 m, Davis & Polunin D.23895!

Is: Lesvos, Cand.; Rodhos, Fiori 71.

External distribution: all over Europe, Asia and tropical Africa.



Pl. 7 Holotype specimen of _Cyperus_ _noeanus_ Boiss. (G!)

5. *C. noëanus* Boiss., Fl. Orient. 5: 371 (1884)

Annual with fibrous roots. Culm solitary, 20 cm x 2.0 mm, triquetrous, 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 salsis Anatoliae interioris loco non indicato, Noë (G!) (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:

	C. glaber L.	*C. noeanus* Boiss.
Leaves	2.0-2.8 mm wide	4.5 mm wide
Number of Involucral bracts	3	6
Spikelet length	7-14 mm long	7 mm long
Glume	rufous, many-nerved	palely stramineous, one-nerved
Fruit	1.1-1.3 mm x 0.7-0.8 mm, ash-grey	1.0-1.2 mm x 0.5 mm, greyish-brown to brown

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. Pl. 2: 730 (1821)

C. forskalii Dietr., Spec. 2: 251 (1833)

Eucyperus 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 Inecik), 610 m, E. Anglia Exped. F.27

A1(A) Çanakkale: Bunarbaschi, 12 Sept. 1883, Sintenis 1027!

A2(E) Istanbul: Domusdere (Belgrad forest), 30 Aug. 1893, Aznavour!

A2(A) Kocaeli: Pendik-Tuzla, 1 Oct. 1893, Aznavour!

A4 Ankara: Kizilcahaman, Kurumcuköyü, 1500 m, Khan et al 752!

A5 Kastamonu: Tosya, 4 Aug. 1892, Sintenis 4928!

B4 Ankara: Ankara-Kayseri, c. 30 km W. of Bala, c. 1200 m, McNeill 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 Içel: Geuksóu (Gok Sü), Aug. 1872, Péronin 208!

C6 Adana: near Hasanbeyli, 914-1219 m, Darrah 649!

Is: Lesvos, Cand.

External distribution: in Southern Europe, North Africa, Asia and the Atlantic North America.

7. C. difformis 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 Delite

C. oryzetorum Steudel, Syn. Cyp. 24 (1855)

C. lateriflorus Torrey in Bot. Mex. Bound. 226 (1859)

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 [Hb. Linn. 70. 12!].

N. Turkey, rare.

A2(E) Istanbul: between Hisarbeyli 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. mulen-pullu Roem. & Schultes, Syst. Veg. Mart. 2: 99 (1824)

C. squarrosus Roxb., Fl. Ind. 1: 190 (1832), non L. (1756)

C. pugioniformis Dietr., Sp. Pl. 1: 210 (1839)

C. michelianus (L.) Link var. pygmaeus (Rottb.) O. Ktze., Rev. Gen. 2: 750 (1891)

Pycreus 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. Mitteleurop. 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 2.0-2.3 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 (now 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.

Perennial, with a short or creeping woody rhizome. Culms rigid, trigonous or terete, solitary, thickened at base, nodeless. Leaves narrowly linear, channelled, glaucous, eligulate. Inflorescence contracted capitate. Involucral bracts patent, unequal. Spikelets many flowered, oblong-lanceolate, acute, compressed-turgid, densely fascicled. Glumes densely imbricate, ovoid or oblong-ovoid, keeled, mucronate, nerves only towards the apex. Hypogynous perianth segments absent. Stamens 3, anthers linear, obtuse. Style 3-fid. Fruit obovate, adaxially concave, abaxially convex-angular, minutely dotted.

1. G. mucronata (L.) Parl.

1. G. mucronata (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) t. 11 f. 5

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)

C. kalli Murbeck, Contrib. Fl. Nord-Ouest de l'Afr. 3: 24 (1899)

Chlorocyperus aegyptiacus Rikli in Pringsheims Jahrb. 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, canaliculate, 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 hemisphaerical 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, Narbonae, Tyrrheni, Smyrnae maritimis [Hb. Linn. 68.7!].

Turkey-in-Europe, Outer Anatolia, Islands.

A1(E) Tekirdag: Marmara-ereglisi 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 Kizilay Kampi, 5 m, Tobey 261!

B1 Balikesir: Troas, Webb, Virch.

C3 Antalya: Antalya, Truman 78!

C4 Içel (Cilicie): May 1872, Péronin 96!

C5 Içel: Mersin, Balls 702!

C5 Adana: near Tuzla, Coode & Jones 341!

Is: Lesvos, Cand.; Samos Rechinger 4008; Rodhos, 7 May 1870, Bourgeau 149!

External distribution: round the whole Mediterranean coasts.

14. PYCREUS P. Beauv., Fl. Oware 2: 48 (1807) t. 86

Syn: <u>Torreya</u> Raf. in Journ. Phys. 89: 105 (1819)

<u>Distimus</u> Raf. in Journ. Phys. 89: 105 (1819)

<u>Picreus</u> Juss., Dict. 40: 194 (1826)

<u>Cyperus</u> L. sect. Picreus (Juss.) Griseb., Spicil. Fl. Rumel. 2: 419 (1844)

<u>Cyperus</u> L. subgen. <u>Pycreus</u> (Beauv.) Clarke in Journ. Linn. Soc. 21: 33 (1884)

<u>Chlorocyperus</u> Rikli in Pringsheim Jahrb. 27: 563 (1895)

<u>Annual</u> or <u>perennial</u>, generally with fibrous roots. <u>Culms</u> caespitose, trigonous, smooth, nodeless. <u>Leaves</u> linear, keeled, often scabrous on margins and keel, eligulate. <u>Inflorescence</u> a simple or compound umbel, sometimes contracted or reduced, rays unequal. <u>Involucral bracts</u> leaf-like, unequal. <u>Spikelets</u> many-flowered, compressed; rachilla persistent, not winged, generally straight often flexuous. <u>Glumes</u> densely imbricate, distichous, often obtuse, keeled, with or without lateral nerves. Hypogynous perianth segment absent. Stamens 1-3, anthers linear, obtuse. <u>Style</u> 2-fid. <u>Fruit</u> 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-oblong; glumes 3-nerved, often mucronate ....1. <u>P. flavescens</u> (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. <u>P. sanguinolentus</u> (Vahl) Nees

  2. Glumes not sulcate, (palely) white hyaline on the margins; stamens always 2 .... 3. <u>P. globosus</u> (All.) Reichb.

Cyperus

1. P. flavescens (L.) Reichb., Fl. Germ. Excurs. 72 (1830)

Syn: Cyperus flavescens L., Sp. Pl. 46 (1753)

C. flavens Pall., Tabl. Taur. 45 (1795)

C. poaeformis 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. abyssinicus Schweinf., Beitr. Fl. Aethiop. 214 (1867), non Hochst. (1855)

C. durandii Boeckl. in Allg. Bot. Zeitschr. 1: 165 (1895)

Chlorocyperus flavescens (L.) Rikli in Pringsheim's Jahrb. Wiss. Bot. 27: 563 (1895)

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, sub-acute, 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 paludosis. [Hb. Linn. 70.30!].

Turkey-in-Europe, Outer Anatolia, Islands.

A1(A) Çanakkale: Bunarbaschi (Pinarbaşi), 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. Hemşin, 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.

2. P. sanguinolentus (Vahl) Nees in Linnaea 9: 283 (1835)

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. eragrostis Vahl, Enum. Pl. 2: 322 (1806), non Lam. (1791)

C. sanguinolentus Vahl, Enum. Pl. 2: 351 (1806)

C. erythraeus Schrader ex Roem. & Schultes, Syst. Mant. 2: 477 (1824)

C. concolor Steudel, Synops. 6 (1855)

C. rehmanni Boiss., Fl. Orient. 5: 364 (1884)

Chlorocyperus eragrostis (Vahl) Rikli in Pringsheims Jahrb. Wiss. Bot. 27: 563 (1895)

Pycreus eragrostis (Vahl) Palla in Ann. Naturh. Hofmus 23: 204 (1909)

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. Involucral 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; at c. sea level to c. 900 m.

Described from India: habitat in India.

N.E. Anatolia

A7 Trabzon: Trabzon, sea level, David & Hedge D.32025!

A8 Rize: d. Hemşin, Meydan Kobaca-Mollaveysa, 900 m, Davis & Dodds D.21370, sheet 1B!

External distribution: Caucasia to China; East Africa, St. Helena and Australia.

3. P. globosus (All.) Reichb., Fl. Germ. Excurs. 140 (1830)

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. fascicularis Lam. & D.C., Fl. Franç, ed 3, 3: 722 (1805)

C. conglomeratus Vahl, Enum. Pl. 2: 339 (1806), non Rottb. (1773)

C. humifusus Roxas Clemente, Ensayo 234 (1807)

C. lamarckianus Roem. & Schultes, Syst. Mant 2: 108 (1824)

C. capillaris Koenig ex Roxb., Fl. Ind. 1: 194 (1832)

C. trachyrhachis Steudel, Synops. Cyper. 3 (1855)

C. flavescens Thwaites, Enum. Pl. Zeyl. 342 (1864), non L. (1753)

Pycreus capillaris Nees in Linnaea 9: 283 (1834)

Chlorocyperus globosus (All.) Palla in Allg. Bot. Zietschr. 6: 61 (1900)

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 dağ, above Priene, 400 m, Davis 18358!

C3 Antalya: near Kemer, Davis 14063! 15036!

C5 Seyhan: south end of Ulukişla 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.

15. DUVAL-JOUVEA Palla in Koch, Synops. Deutsch. U. Schweiz. Fl. ed. 3, 2: 2555 (1905), emend.

Syn: Cyperus L. sect. Pycreus B. Pseudopycreus Boeck in Linnaea 35: 485 (1868) p.p.

Cyperus L. subgen. Juncellus (Griseb.) Clarke in Journ. Linn. Soc. 21: 33 (1884) p.p.

Juncellus (Griseb.) Clarke in Hook. fil., Fl. Brit. Ind. 6: 594 (1893) p.p.

Chlorocyperus Rikli in Pringsheims Jahrb. 27: 563 (1895) p.p.

Perennial, rhizomes sometimes with stolons. Culm smooth, solitary, triquetrous or acutely trigonous, nodeless. Leaves linear, keeled, eligulate. Inflorescence a compound umbel, lax, with long unequal rays. Involucral bracts leaf-like, 3-5 unequal. Spikelets many-flowered, linear, oblong, compressed; rachilla persistent, not winged. Glumes loosely imbricate, distichous, with conspicuous lateral nerves. Hypogynous perianth segments absent. Stamens 3, anthers linear, obtuse. Style 2-fid. Fruit obovoid, plano-convex, shortly apiculate, densely dotted.

1. D. serotina (Rottb.) Palla

1. D. serotina (Rottb.) Palla in Koch, Synops. Deutsch. u. Schweiz. Fl. ed 3, 2: 2556 (1905)

Syn: Cyperus serotinus Rottb., Progr. 18 (1772) and Descr. et Icon. 31 (1773)

C. monti L. fil., Suppl. 102 (1781)

C. glaber Vill., Hist. Pl. Dauph. 2: 182 (1787), non L. (1753)

Pycreus monti (L. fil.) Beauv. ex Reichb., Fl. Germ. Excurs. 72 (1830)

Cyperus japonicus Miq. in Ann. Mus. Lugd. Bot. 2: 140 (1865)

C. puncticulatus Aitch. in Journ. Linn. Soc. 19: 189 (1882), non Vahl (1806)

C. krebsii Boeck., Cyper. Nov. 2: 2 (1890)

Juncellus serotinus (Rottb.) Clarke in Hook. fil., Fl. Brit. India 6: 594 (1893)

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 Içel (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 Caucasia 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.

16. JUNCELLUS (Griseb.) Clarke in Hook. fil., Fl. Brit. India 6: 594 (1893), emend.

Syn: Cyperus L. sect. Juncellus Griseb., Fl. Brit. West-Ind. Isl. 562 (1864)

Cyperus L. sect. Pycreus B. Pseudopycreus Boech. in Linnaea 35: 485 (1868)

Cyperus L. subgen. Juncellus Clarke in Journ. Linn. Soc. 21: 33 (1884) p.p.

Acorellus Palla in Koch, Synops. Deutsch. U. Schweiz. Fl. ed. 3, 2: 2557 (1905)

Chlorocyperus Rikli in Pringsheims Jahrb. 27: 563 (1895) p.p.

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

1. J. laevigatus (L.) Clarke in Hook. fil, Fl. Brit. Ind. 6: 596 (1893) subsp. laevigatus

Syn: Cyperus laevigatus L., Mant. Pl. 2: 179 (1771)

C. mucronatus Rottb., Descr. et Icon. 19 (1773) t. 8 f. 4

C. lateralis Forskal, Fl. Aeg.-Arab. 13 (1775)

C. monostachyus Link in Buck, Ins. Canar. 138 (1805), non Rottb.

C. leucostachys Willd. in Link, Jahrb. 1 (3): 81 (1820)

C. roxburghii A. Dietr., spec. Pl. 2: 214 (1833)

C. pleuranthus Nees in Wight, Contrib. 73 (1834)

C. cossyrensis Tineo 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. juncellus Dinter, Deutsch-Südwest Afric. 41 (1909)

Pycreus mucronatus (Rottb.) Nees in Linnaea 9: 283 (1835)

P. lateralis Nees in Linnaea 9: 283 (1835)

P. laevigatus (L.) Nees in Linnaea 10: 130 (1836)

Chlorocyperus laevigatus (L.) Palla in Allg. Bot. Zeitschr. 6: 221 (1900)

Acorellus laevigatus (L.) Palla in Koch, Synops. Deutsch. U. Schweiz. Fl. ed. 3, 11: 2558 (1905)

Perennial with woody creeping rhizome, abbreviated (in ours) bearing tufted culms, or long with solitary culms, their bases ensheathed by imbricate, chestnut sheaths. Culms 5-9 cm tall (in ours), triangular, sulcate, smooth. Leaves narrowly linear, convolute, upper part terete-trigonous, with a blunt tip. Involucral bracts 2, the lower several times longer than inflorescence, slightly dilated at base, and seemingly continuing the culm, the upper equalling 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-orbicular ovate, obtuse, rarely mucronate with nerves especially towards the apex, none laterally, stramineous. Rachilla tetragonous, thick. Stamens 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, obovoid, plano- or concave-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. Spei. 1. G. Koenig [Hb. Linn. 70.13!].

E. Anatolia, Islands, rare.

B7 Erzincan: plain east of Erzincan, 1250 m, Davis & Hedge 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 greennerves 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., Auctaur. Fl. pedem. ad 48 (1789) t. 2, f.5.

C. junciformis Cav. Icon. et Descr. 3: 2 (1794) t. 204, f. 1

C. laevigatus var. distachyos (All.) Coss. et Durieu, Fl. Alger. 2: 251 (1854-56)

Cyperus laevigatus var. junciformis (Cav.) Clarke in Journ. Linn. Soc. 21: 79 (1884)

Juncellus laevigatus var. junciformis (Cav.) Clarke in Hook. fil. Fl. Brit. India 6: 597 (1893)

Chlorocyperus junciformis Rikli in Jahrb. Wiss. Bot. 27: 563 (1895)

Acorellus distachyus (All.) Palla in Allg. bot. Zeitschr. 9: 68 (1903)

Juncellus distachyos (All.) Turrill 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

Adupla Bosc in Jaume St. Hilaire, Expos. fam. 1: 65 (1805)

Cyperus L. sect. Mariscus (Gaertner) Endl. Gen. 119 (1836)

Cyperus L. subgen. Mariscus (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)

Sphaeromariscus 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. Hypogynous perianth segment absent. Stamens 3, anthers linear, obtuse. Style 3-fid. Fruit obovate, trigonous, shortly apiculate, minutely dotted.

1. M. congestus (Vahl) Clarke

1. M. congestus (Vahl) Clarke in Durand & Schinz, Consp. Fl. 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. paramatla Mart., Hort. Erlang 24 (1814)

C. bulbosus Lag., Gen. et Spec. Pl. Nov. 2(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 R. Br. (1810)

Chlorocyperus congestus (Vahl) Palla in Allg. Bot. Zeitschr. 8: 66 (1902)

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 capitate, 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-fid. 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, Caucasia, 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)

Perennial, often robust, with lignous rhizomes, sometimes stoloniferous. Culms terete or nearly so, leafy. Leaves linear, keeled, pseudo-dorsiventral. Inflorescence consisting of a terminal compound panicle. Glumes imbricate, lower sterile. Hypogynous bristles absent. Stamens 2, rarely 3. Style filiform, enlarged at base, with 3(-2) villous stigmas. Fruit drupe-like, trigonous or nearly globular.

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 serratius Gilib, Exerc. Phyt. 2: 512 (1792)

Cladium germanicum Schrad., Fl. Germ. I: 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, noded, hollow. Leaves 6-10 mm wide, linear, keeled, with a long triquetrous point, serrate-scabrous on margins and midrib, 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 Sögütlii, 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!

C6 Hatay: 1-2 mls. N. of Iskenderun, sea level, Davis & Hedge D.26956!

Islands: Lesvos, Candargy.

A cosmopolitan species, scattered through nearly all warm and warm-temperate regions of both hemispheres.

19. SCHOENUS L. Sp. Pl. 43 (1753)

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. Spikelets 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) fid, 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, antrorsely-barbed, yellowish brown. Stamens 3, anthers c. 3.5 mm long, with long-acuminate tip. Style 5 mm long, caducous, 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, exsiccatis [Hb. Linn. 68. 5!]

Widespread but scattered.

A1(A) Çanakkale: Erenköy, 12 May 1881, Sintenis 1216!

A2(E) Istanbul: Menekşche, hear Halkali, 24 May 1903, Aznavour!

B2 Kütahya: Murat Dağ above Banaz, 2000 m, Coode & Jones 2489!

B3 Konya: Sultan Dağ above Akşehir, 1500 m, 25 June 1899, Bornmüller 5615!

B6 Maraş: Göksun-Çardak, 1300 m, Davis & Hedge D.27637!

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: Kayajik, Davis 14746!

C5 Hatay: Samandağ to Antakya, Coode & Jones 679!

C6 Hatay: Dörtyol, Kuzuculu to Bülke, Coode & Jones 437!

Islands: Lesvos, Malea, Cand.; Tilios, Ade; 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

1. R. alba (L.) Vahl, Enum. Pl. 2: 236 (1806)

Syn: Schoenus alba L. Sp. Pl. 44 (1753)

Mariscus albus (L.) Gilib., Exerc. 2: 512 (1792)

Triodon album (L.) Farwell, in Rep. Mich. Acad. Sc. 19: 253 (1917)

Phaeocephalum album (L.) House, in Amer. Mid. Natur. 6: 201 (1920)

Dichromena alba (L.) Macbride, in Public. Field Mus. Nat. Hist. Chicago Bot. ser., 4: 166 (1929)

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. Involucral 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, ~~equalling~~ 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.

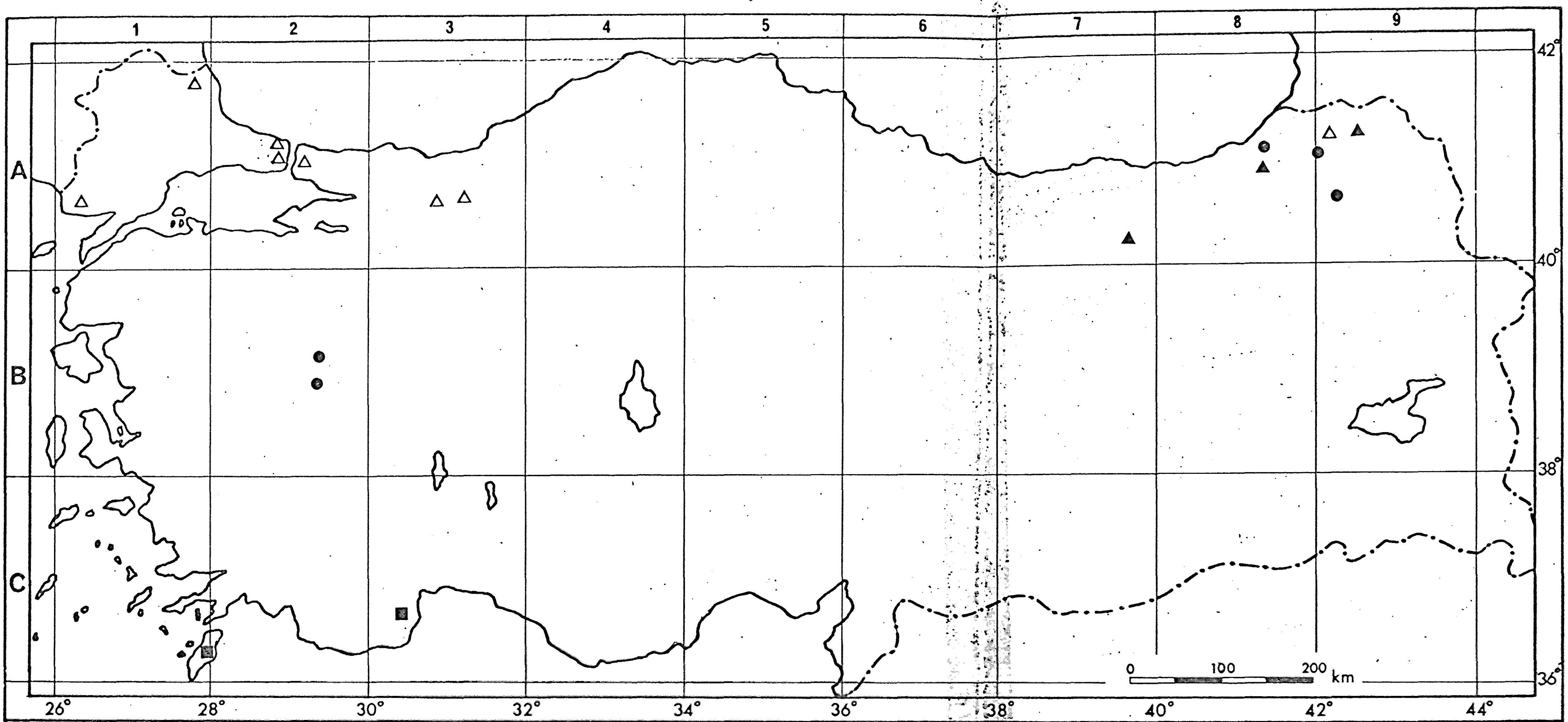
Described from Europe: habitat in Europae borealis paludibus siccatis [Hb. Linn. 68. 17, 18!]

N.E. Anatolia, rare.

A8 Çoruh (Artvin): Şavval 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



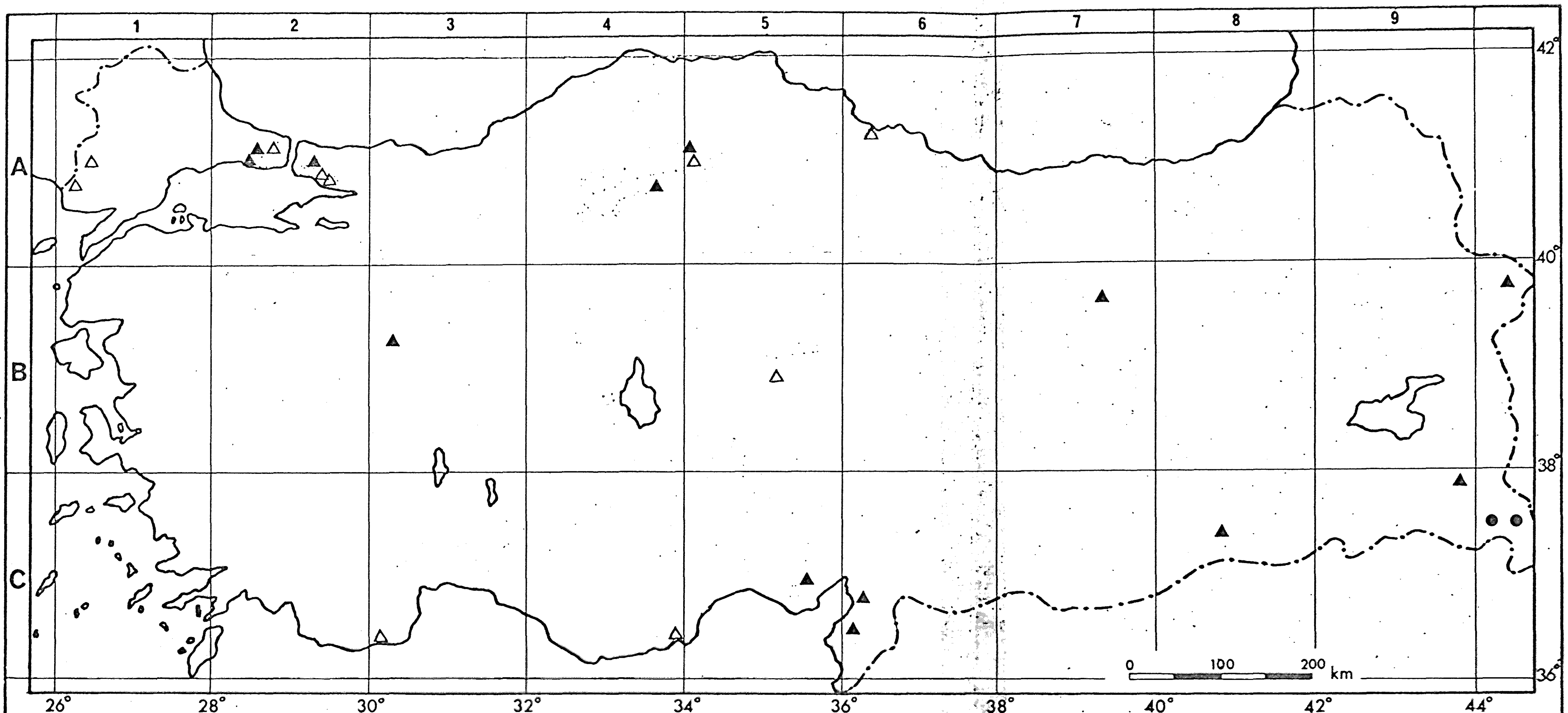
▲ Eriophorum vaginatum L.

● Eriophorum latifolium Hoppe

■ Fuirena pubescens (Poiret) Kunth

△ Scirpus sylvaticus L.

Map 12

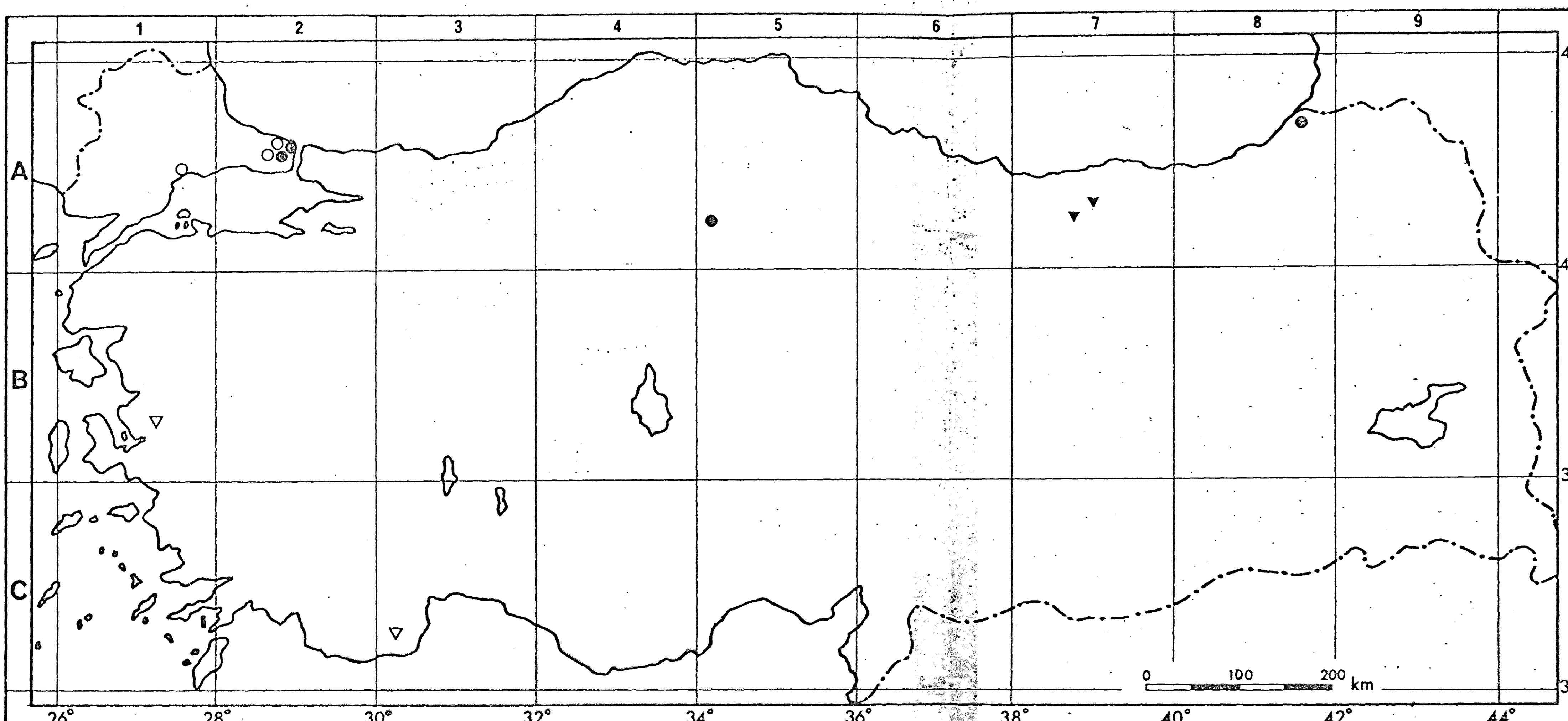


△ Bolboschoenus maritimus (L.) Palla

▲ B. maritimus var. cymosus (Reichenb.) Oteng-Yeboah

● Bolboschoenus paludosus (A. Nelson) Oteng-Yeboah subsp. hakkiaricus Oteng-Yeboah

Map 13



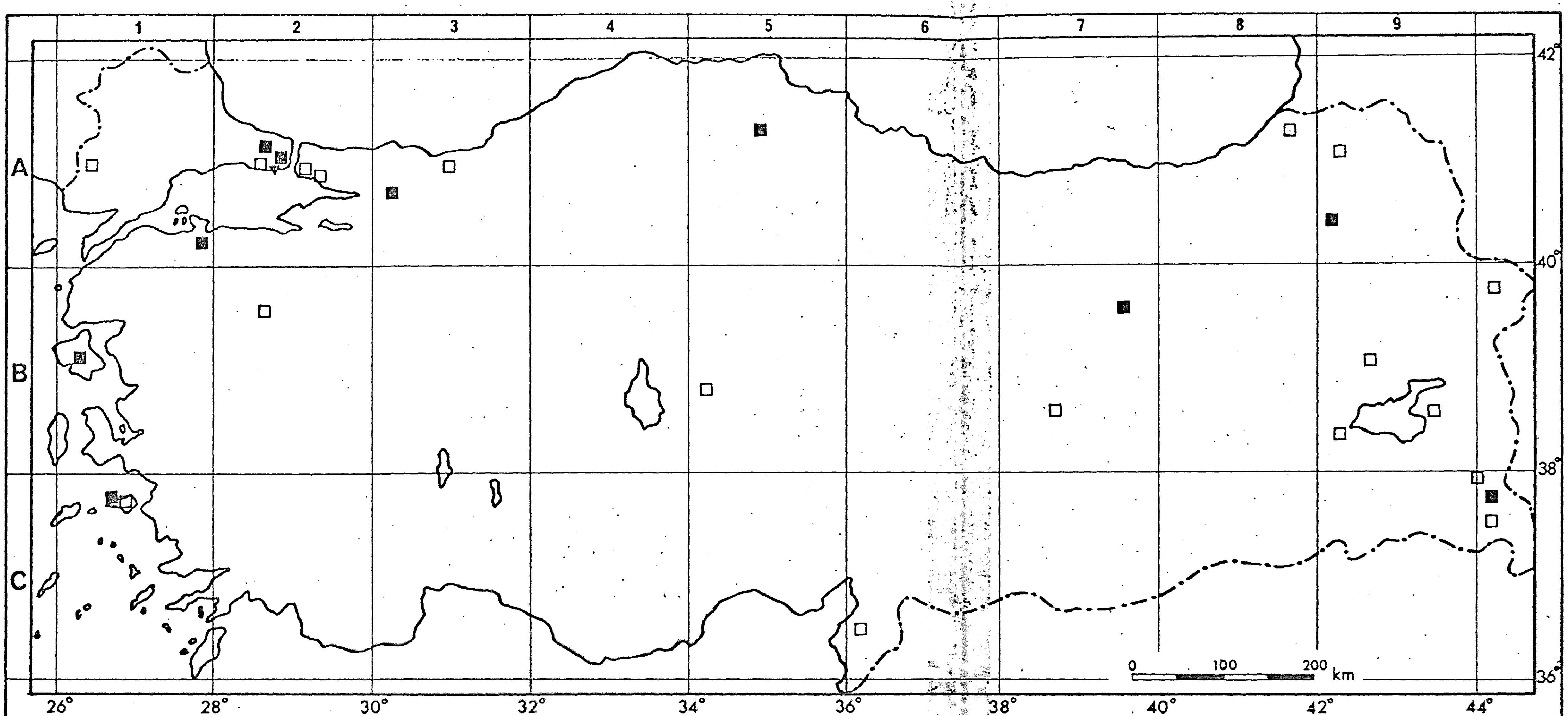
▼ *Schoenoplectus triqueter* (L.) Palla

● *S. mucronatus* (L.) Palla

▽ *S. littoralis* (Schrader) Palla

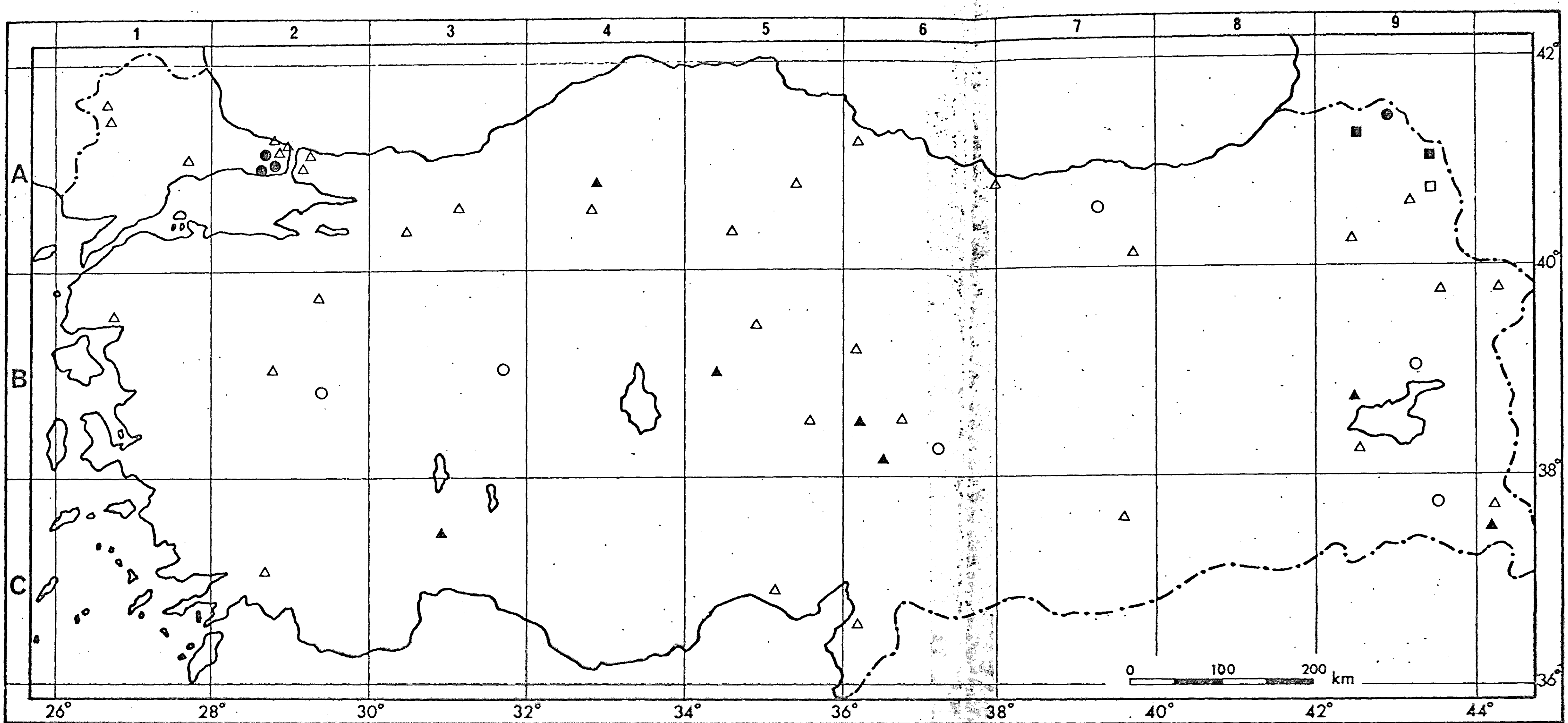
○ *S. supinus* (L.) Palla

Map 14



■ *Schoenoplectus lacustris* (L.) Palla □ *S. lacustris* subsp. *glaucus* (Hartman) Oteng-Yeboah ▼ *S. lacustris* × *glaucus*

Map 15



● *Eleocharis acicularis* (L.) R. Br.

○ E. *pauciflora* (Lightf.) Link

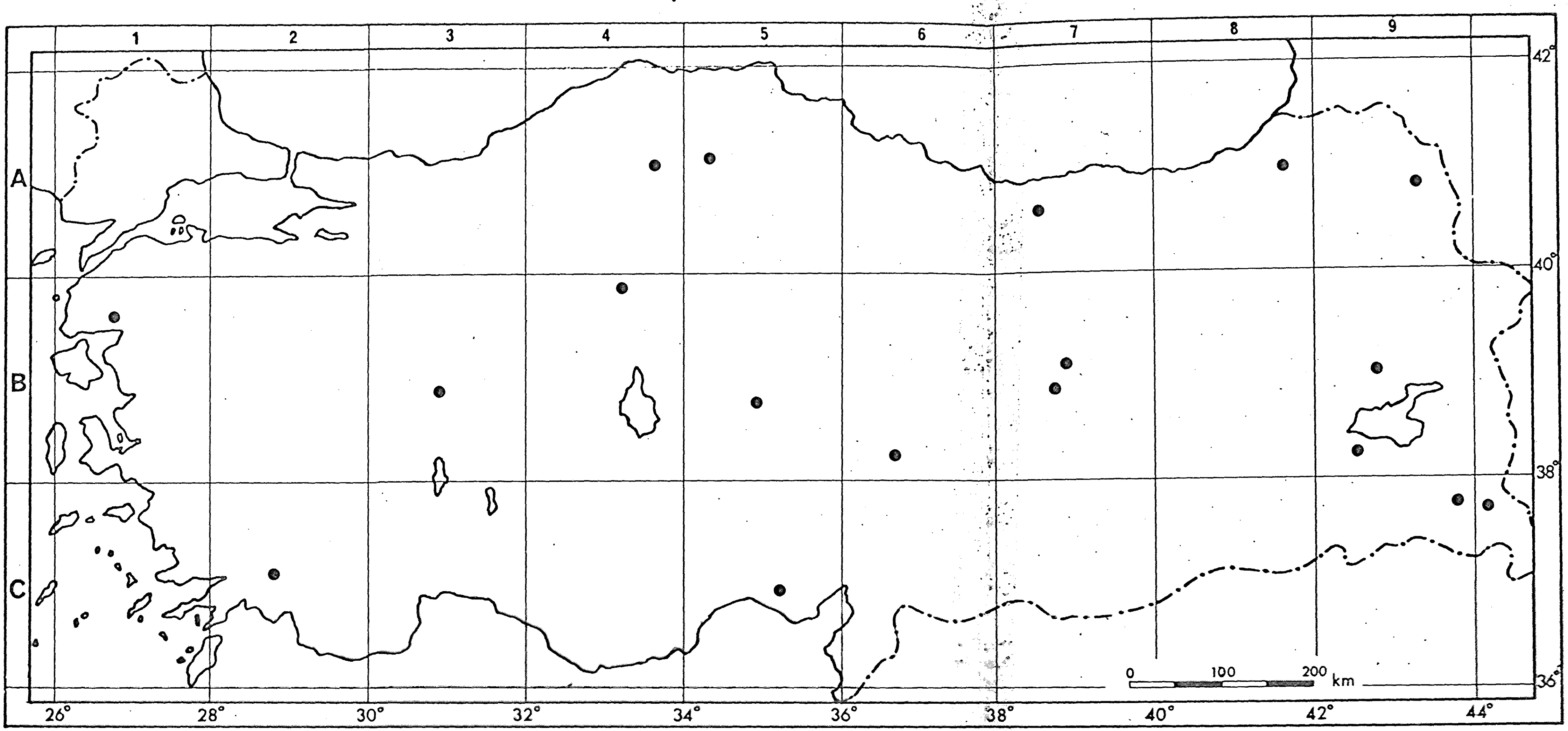
△ E. *palustris* (L.) R. Br.

▲ E. *uniglumis* (Link) Schultes

■ E. *meridionalis* Zinserling

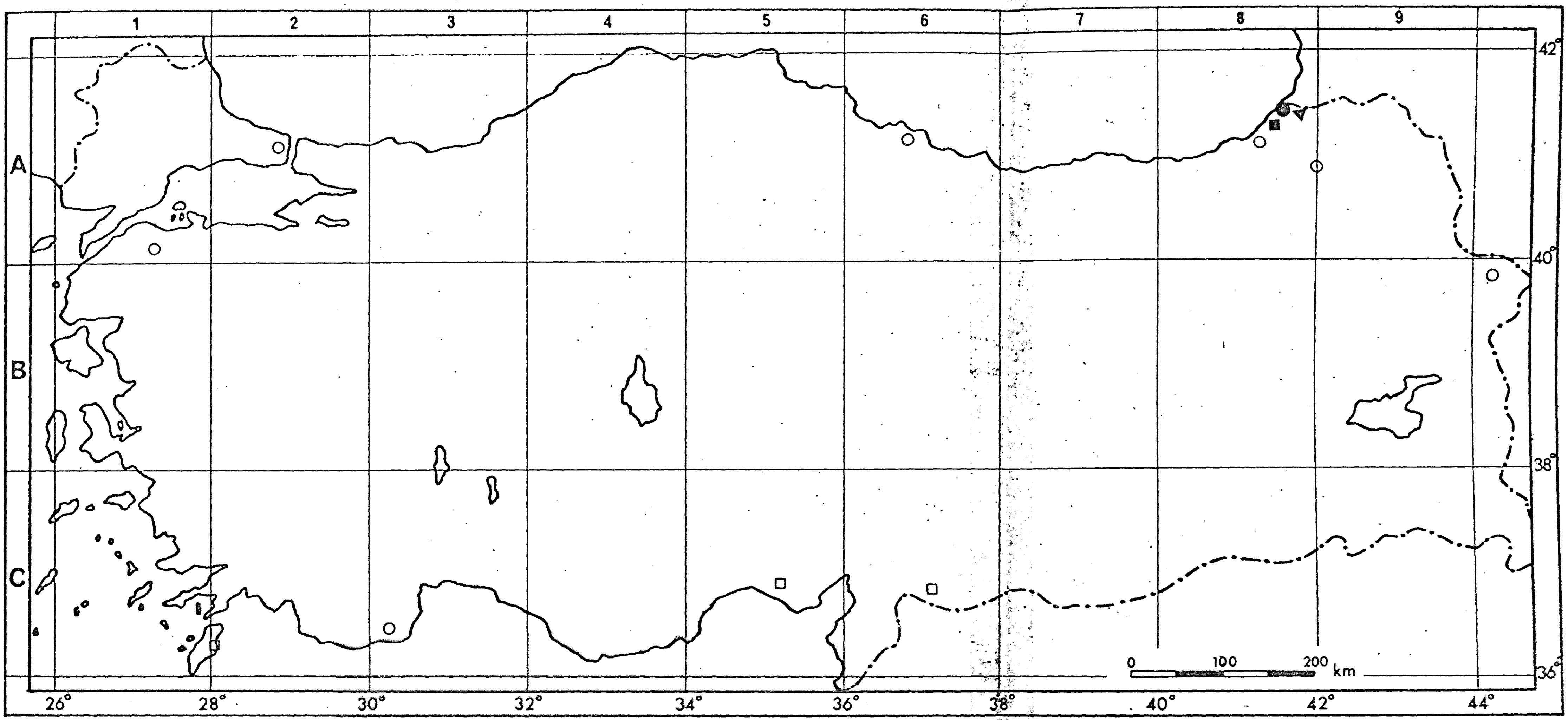
□ E. *transcaucasica* Zinserling

Map 16



● *Blysmus compressus* (L.) Panz.

Map 17



○ *Fimbristylis dichotoma* (L.) Vahl

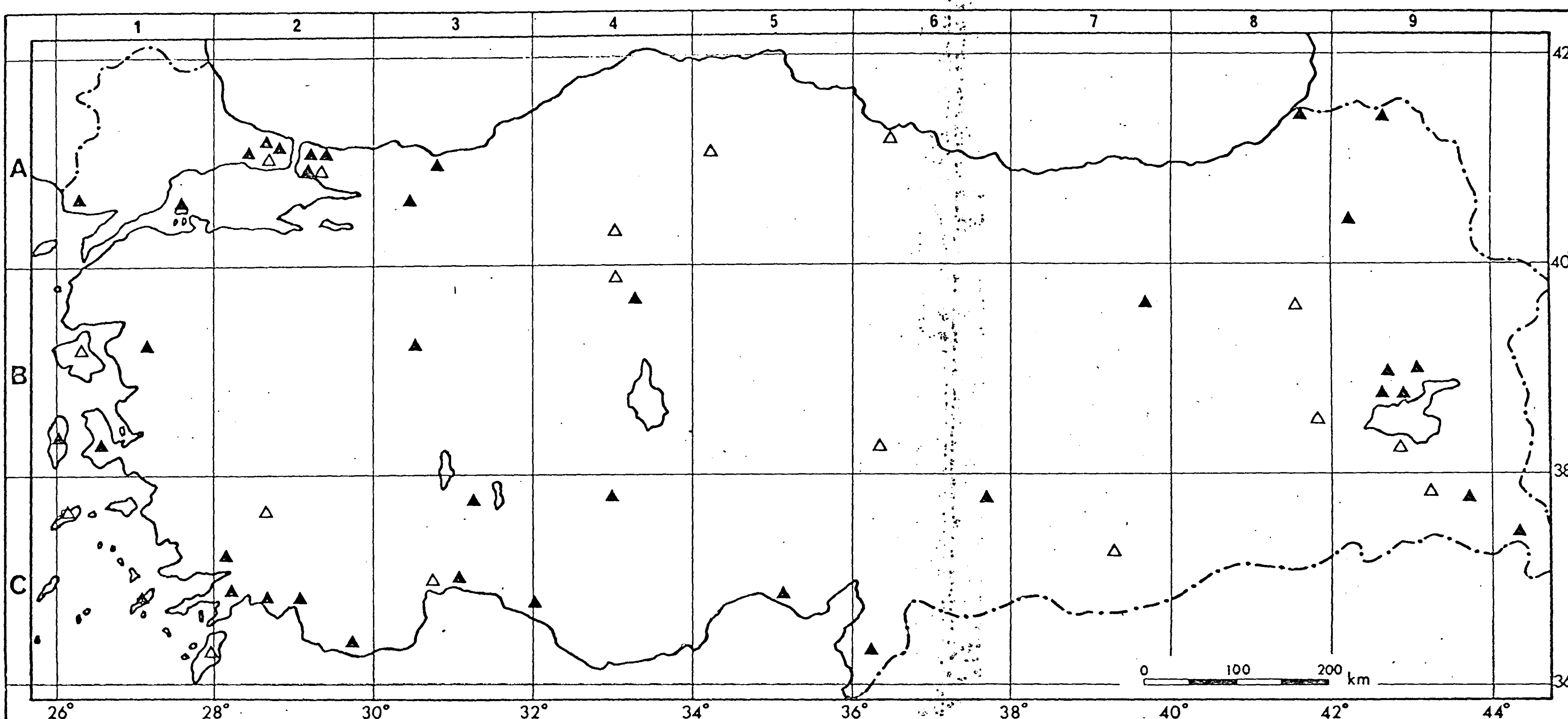
▫ F. *ferruginea* (L.) Vahl

■ F. *annua* (All.) R. & S.

● *Bulbostylis tenerrima* (F. & M.) Palla

▼ B. *woronowi* Palla

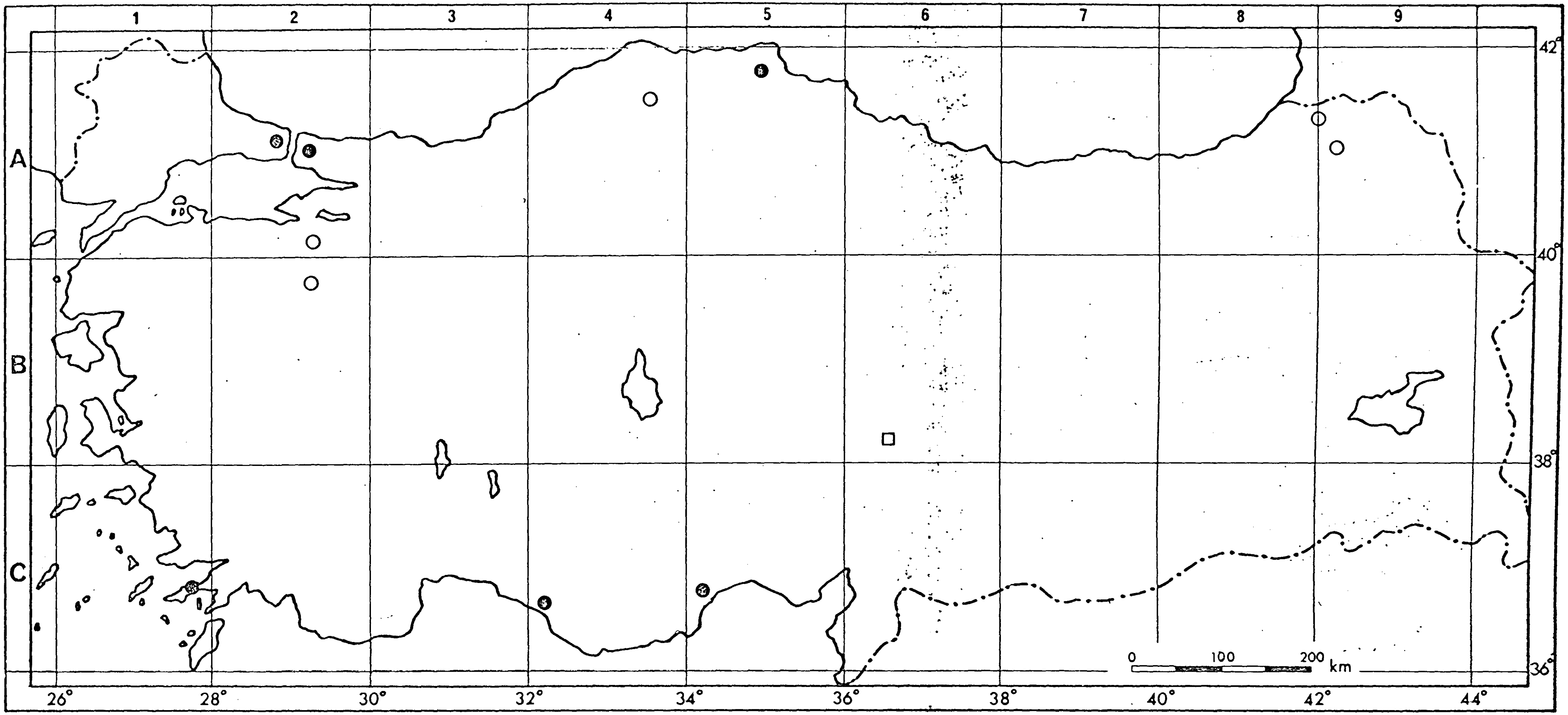
Map 18



▲ Holoschoenus vulgaris Link

△ Holoschoenus vulgaris var. australis (L.) Hayek

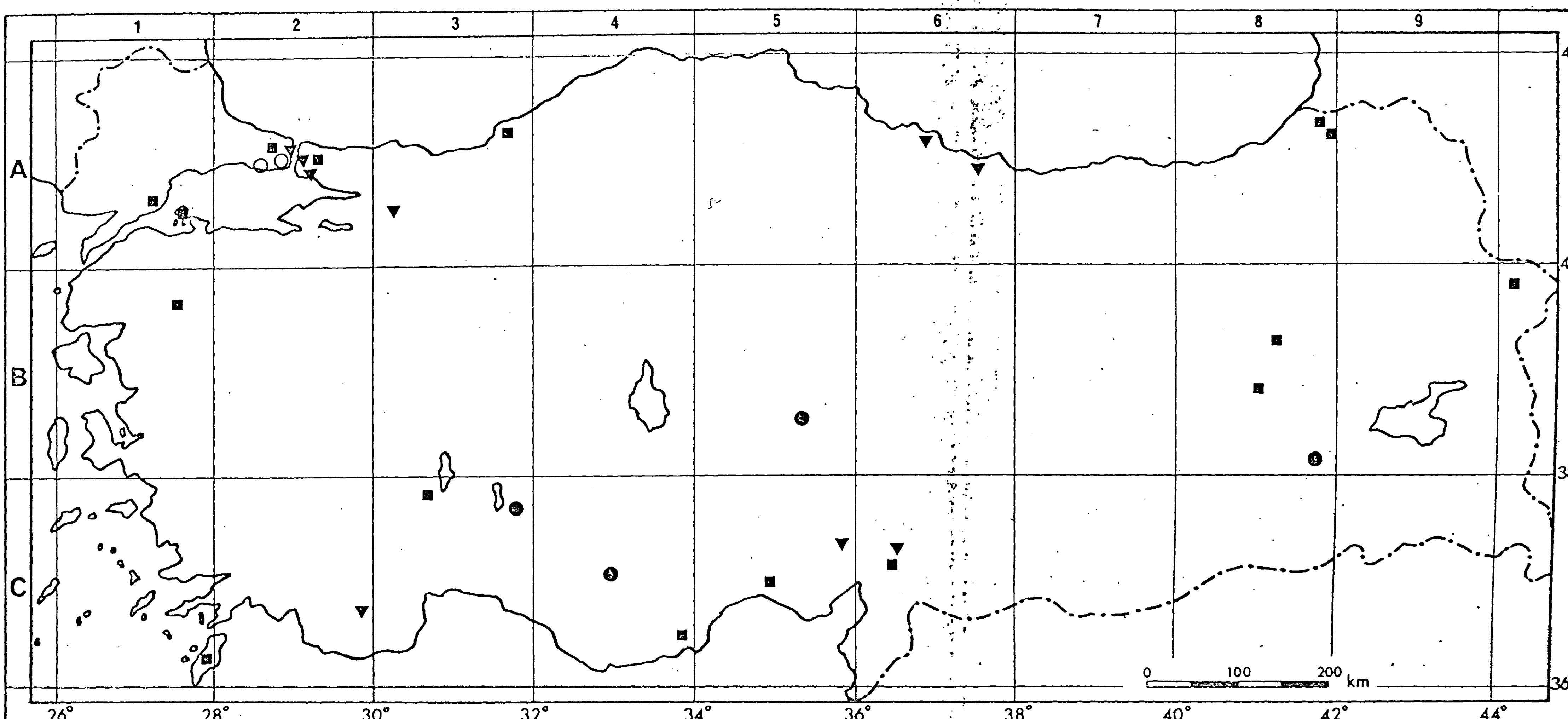
Map 19



● *Isolepis cernua* (Vahl) R. & S. □ *Trichophorum pumilum* (Vahl) Schinz & Thell.

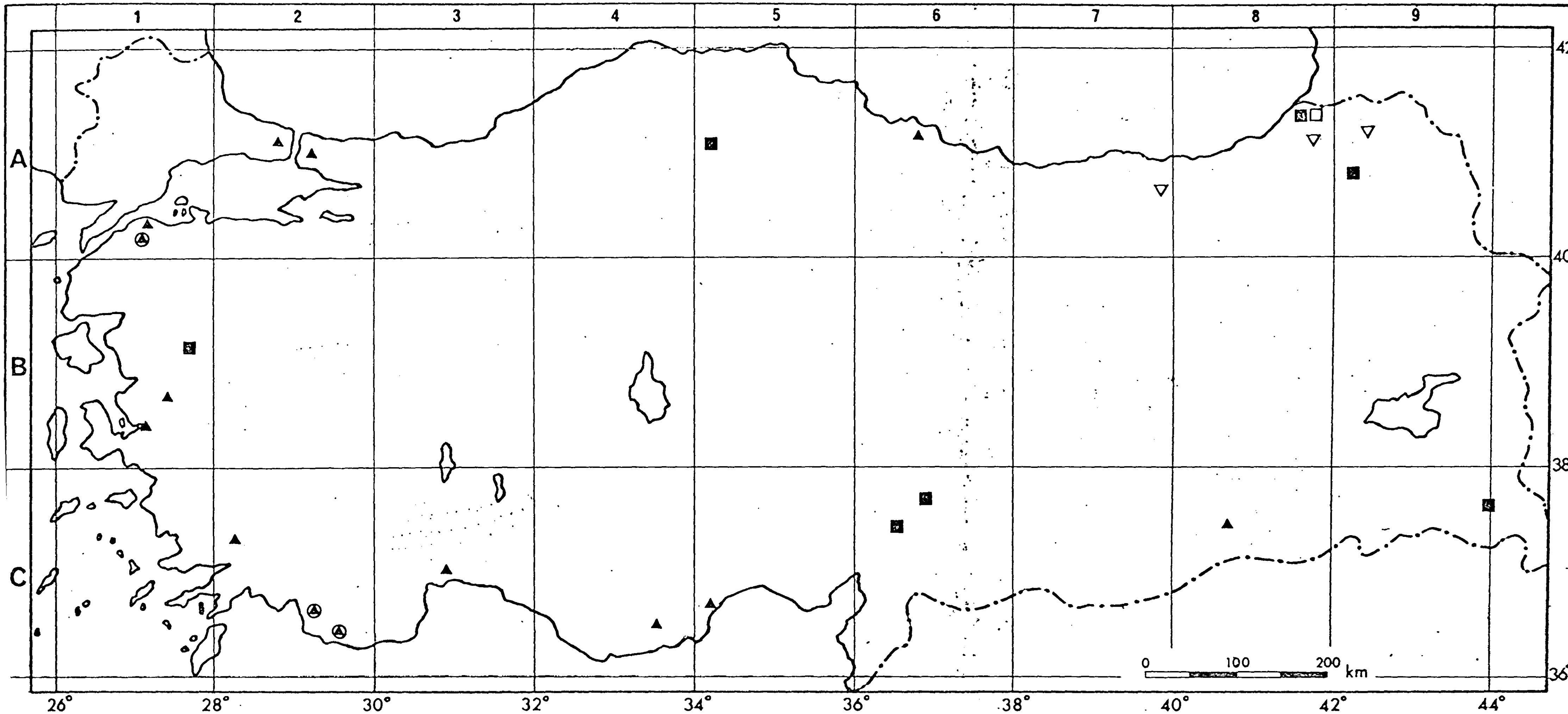
○ *I. setacea* (L.) R. Br.

Map 20



■ *Cyperus longus* L.
▼ C. *longus* var. *heldreichianus* (Boiss.) Boiss.
● C. *longus* var. *anatolicus* Oteng-Yeboah
○ C. *longus* subsp. *badius* (Desf.) Aschers. & Graebn.

Map 21



Cyperus glaber L.

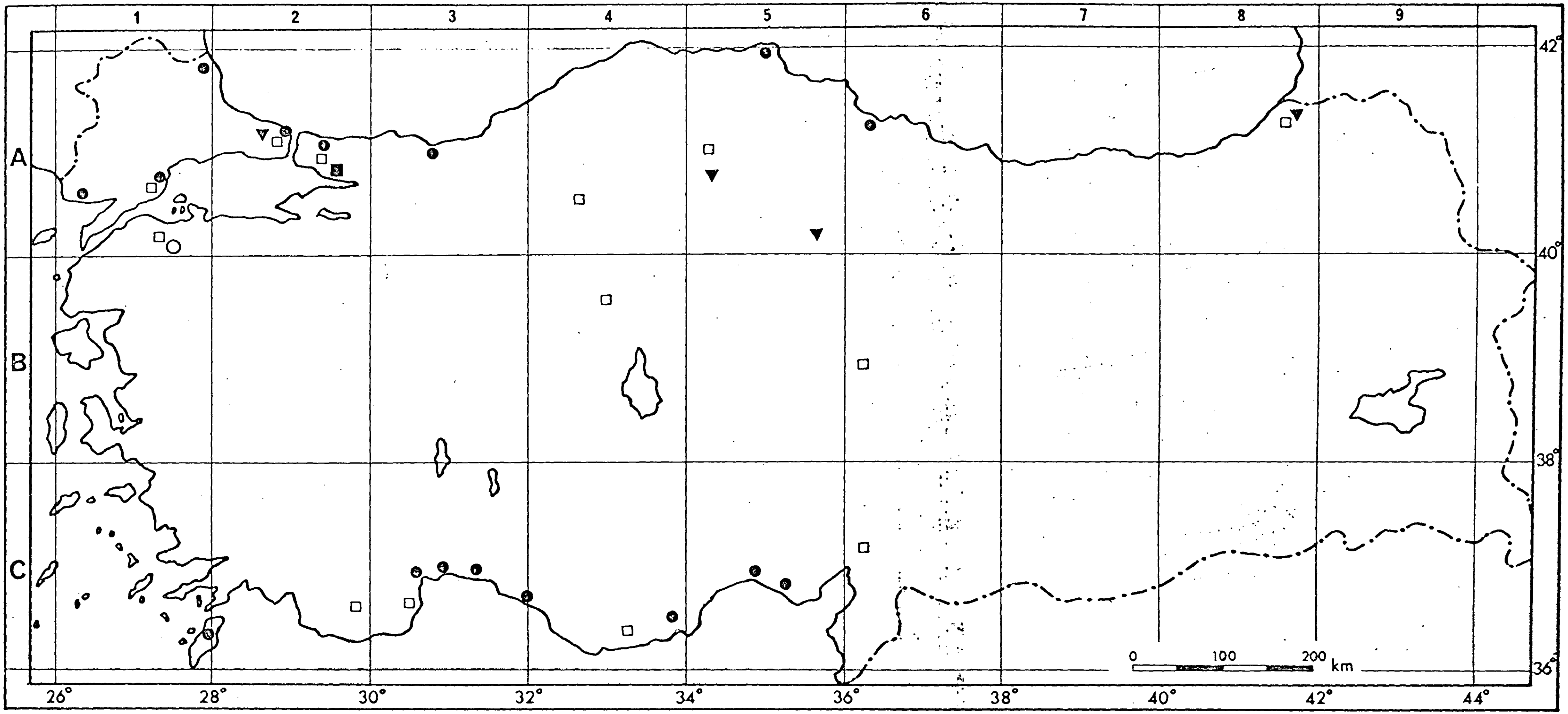
C. esculentus L.

C glomeratus L.

C. rotundus L

C. rotundus var major Parl.

Map 22



▼ Cyperus difformis L

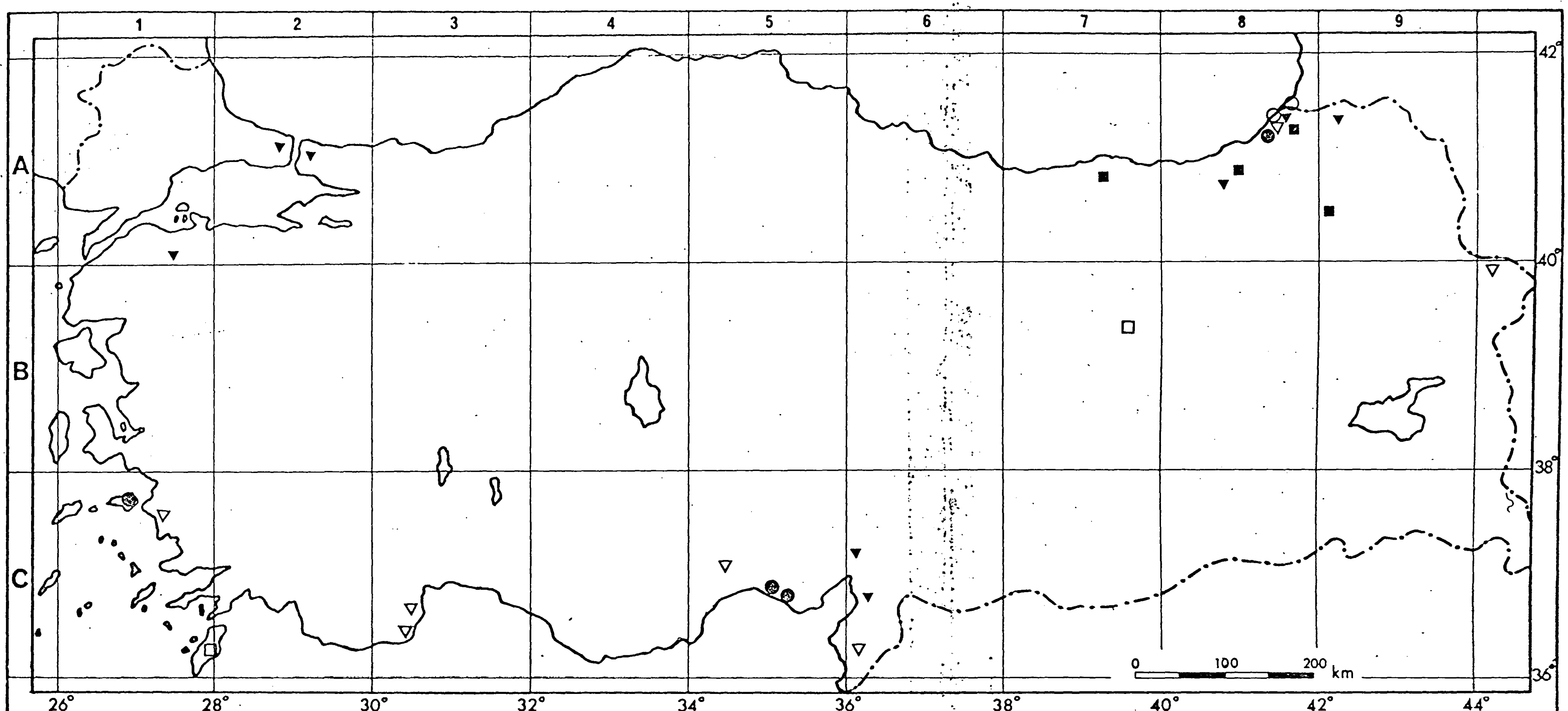
□ C. fuscus L

● Galilea mucronata (L.) Parl.

○ Cyperus pygmaeus Rottb.

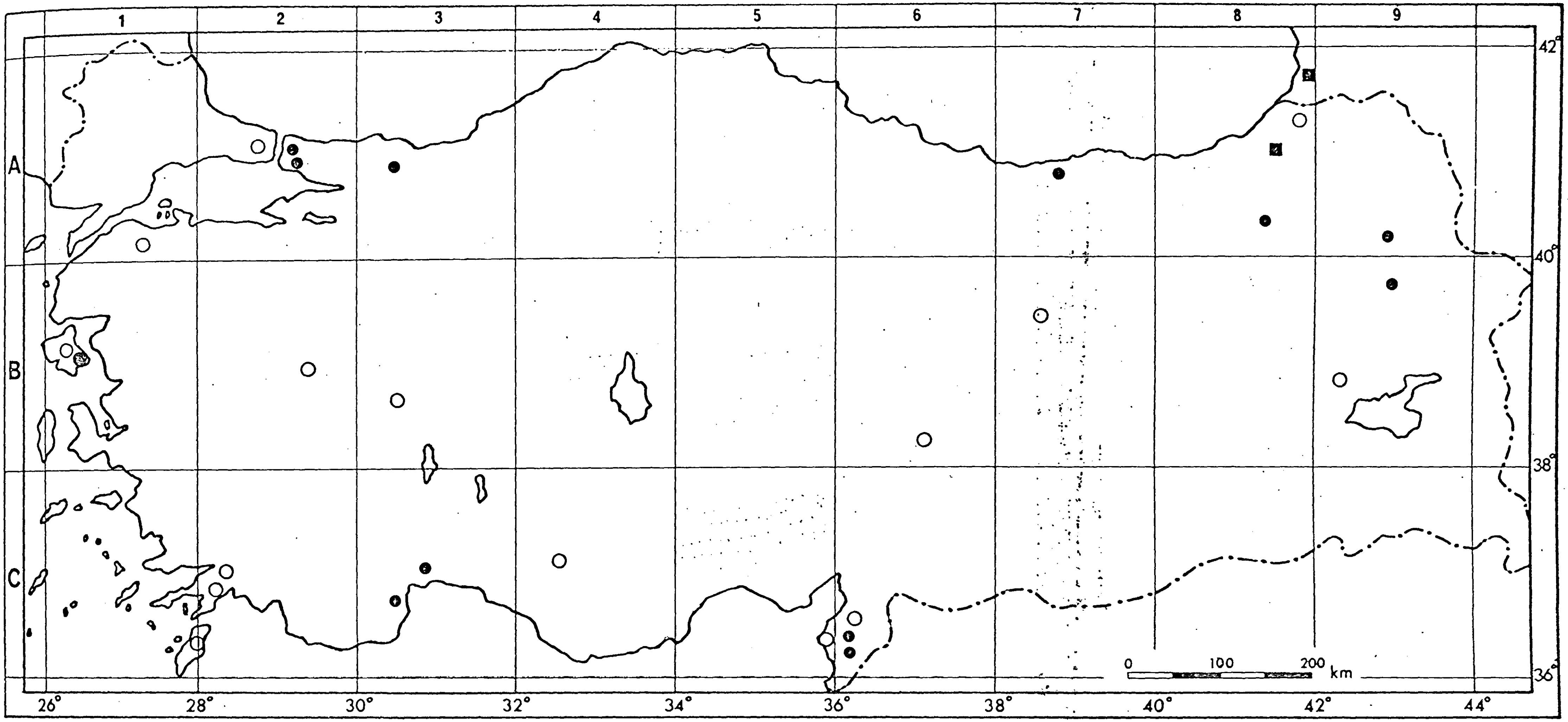
■ Mariscus congestus (Vahl) Clarke

Map 23



● Duval-Jouvea serotina (Rottb.) Palla
□ Juncellus laevigatus (L.) Clarke
■ Pycreus sanguinolentus (Vahl) Nees
▽ P. globosus (All.) Reichb.
▼ P. flavescens (L.) Reichb.
○ P. colchicus (C. Koch) B. Schinschk.

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 nepanus 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 1884 (Flora Orientalis vol. 5), Grossheim 1940 (Caucasia) Komarov 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), Køie & Rechinger 1965 (Afghanistan), J.D. Hooker ed. 1894 (British India vol. 6). North African Floras includ[e] those of Täckholm & Drar 1950 (Egypt) and Maire 1957 (the whole of North Africa excluding Egypt).

				ASIA													CAUCASIA				MEDITERRANEAN																				C. EUR.								
		N. AMER.	E. ASIA	ARABIA	SINAI	KHORAS	C. IRAN	W. IRAN	N.W. IRAN	N. IRAN	SYR. DES.	N. IRAQ	TRANSCAS.	TURKEST.	AFGHAN.	W. PAK.	SIBERIA	CAUCASUS	GEORGIA	AZERB.	ARMENIA	EGYPT	CYRENAICA	N.W. AFR.	PORTUGAL	SPAIN	S. FRANCE	CORSICA SARDINIA	SICILY	ITALY	JUGOSL.	BULGARIA	DOBRUDJA	ALBANIA	GREECE	AEGEAN	LATAKIA	LEBANON	ANTI-LEB.	PALESTINE	CYPRUS	ROMANIA	GE,CZ,PO,SW	HE, AU	CRIMEA	S. U.S.S.R.	C. U.S.S.R.	N. EUR.	W. EUR.	TURKEY
Scirpus sylvaticus			+														+	+	+	+	+										+	+		+	+							+	+	+	+	+	+		+	+
Bolboschoenus maritimus		+	+				+	+	+	+	+	+			+	?	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+
Fuirena pubescens															+							+		+	+			+								+		+	+											+
Eriophorum latifolium		+	+														+	+	+		+										+	+		+								+	+	+		+	+		+	+
E. vaginatum		+															+	+	+	+	+											+										+	+	+		+	+	+	+	+
Fimbristylis dichotoma				?			+	+	+	+	?	+			+				+	+	+	+		+								+		+	+	+				+		+				+	+			+
F. ferruginea		+	+								+	+										+		+												+		+	+	+	+						+			+
F. annua																			+					+	+	+	+					+		+	+								+	+						+
Bulbostylis tenerrima																			+																															+
B. woronowii																			+																															+
Schoenoplectus supinus																	+	+						+																+			+	+		+	+			+
S. mucronatus																			+	+	+	+						+				+		+	+		+	+	+	+		+	+	+		+	+			+
S. littoralis							+	+	+	+	+	+			+			+	+	+		+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+				+		+			+
S. triqueter		+	+				+	+	+	+	?				+			+	+	+		+										+		+	+					+			+	+		+	+		+	+
S. lacustris		+	+				+	+	+	+	+	+						+	+	+	+		+	+	+	+	+	+	+	+	+	+			+	+	+	+	+	+		+	+	+	+	+	+		+	+
S. lacustris subsp. glaucus			+								?				+			+	+	+	+			+				+		?	?	+					?	?	?			+	+	+	+	+	+		+	+
Holoschoenus vulgaris					+						+				+							+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+
Isolepis cernua																							+	+	+	+	+	+	+	+	+	+		+	+	+		+	+	+	+								+	+
I. setacea							+	+	+	+	+				+		+	+	+	+	+			+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+		+	+	+	+	+	+		+	+
Eleocharis pauciflora		+																+	+	+				+							+	+		+	+								+	+		+	+			+
E. meridionalis																			+		+																													+
E. acicularis		+	+															+	+		+			+				+				+		+	+							+	+	+	+				+	+
E. palustris		+					+	+	+	+	+				+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
E. uniglumis									+	+								+		+	+			+																								+	+	+
E. transcaucasica															+					+	+																													+
Trichophorum pumilum		+					+								+		+	+	+																							+					+			+
Blysmus compressus							+	+	+	+		+			+		+	+	+	+	+			+	+	+	+		+	+	+	+			+	+		+				+	+	+	+	+	+		+	+
Cyperus longus							+	+	+	+	+	+			+				+	+	+	+		+			+	+		+		+		+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+
C. longus subsp. badius							+	+	+	+		+						+	+	+		+		+	+	+	+	+	+	+					+	+				+	+	+			+					+
C. rotundus		+					+	+	+	+	+	+			+				+	+	+	+	+	+	+	+	+	+	+	+					+	+	+	+	+	+	+						+			+
C. esculentus		+					+	+	+	+					+			+	+	+		+		+				+	+	+					+	+		+		+										+

Table 8. External Distribution of Turkish species

Group	Region	Cyperus glaber	C. [illegible]	C. fuscus	C. difformis	C. pygmaeus	C. glomeratus	Galilea mucronata	Pycreus flavescens	P. sanguinolentus	P. globosus	P. colchicus	Duval-Jouvea serotina	Juncellus laevigatus	Mariscus congestus	Cladium mariscus	Schoenus nigricans	Rhynchospora alba
	TURKEY	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	W. EUR.			+												+	+	+
	N. EUR.																+	?
	C. U.S.S.R.	+		+	+		+		+	+	+		+	+		?	+	
	S. U.S.S.R.	+		+			+		+				+			+	+	+
	CRIMEA	+					+		+							+	+	
C. EUR.	HE, AU			+			+		+							+	+	+
C. EUR.	GE, CZ, PO, SU			+			+		+							+	+	+
C. EUR.	ROMANIA	+			+								+			+	+	+
MEDITERRANEAN	CYPRUS	+		+				+			+					+	+	
MEDITERRANEAN	PALESTINE	+		+		+		+	+		+			+		+	+	
MEDITERRANEAN	ANTI-LEB.	+		+		+		+	+		+			+		+	+	
MEDITERRANEAN	LEBANON	+		+	+	+		+	+		+			+		+	+	
MEDITERRANEAN	LATAKIA	+		+	+	+		+	+					+		+	+	
MEDITERRANEAN	AEGEAN	+			+			+	+							+	+	
MEDITERRANEAN	GREECE	+		+	+			+	+		+					+	+	
MEDITERRANEAN	ALBANIA	+		+				+	+		+					+	+	+
MEDITERRANEAN	DOBRUDJA							?										
MEDITERRANEAN	BULGARIA	+						+	+		+		+		+	+	+	
MEDITERRANEAN	JUGOSL.	+						+	+		+							
MEDITERRANEAN	ITALY	+		+	+			+	+		+				+			
MEDITERRANEAN	SICILY				+			+	+		+		+					
MEDITERRANEAN	CORSICA SARDINIA			+				+	+				+			+	+	
MEDITERRANEAN	S. FRANCE			+	+			+	+		+		+					
MEDITERRANEAN	SPAIN			+	+			+	+		+							
MEDITERRANEAN	PORTUGAL							+	+		+							
MEDITERRANEAN	N.W. AFR.			+		+		+	+		+			+		+	+	
MEDITERRANEAN	CYRENAICA							+						+				
MEDITERRANEAN	EGYPT			+	+			+	+					+		+	+	
CAUCASIA	ARMENIA	+		+	+	?	+		+		+		+				+	
CAUCASIA	AZERB.	+		+	+	+	+		+	+	+		+			+	+	
CAUCASIA	GEORGIA	+		+	+	+	+		+	+	+	+	+			+		+
CAUCASIA	CAUCASUS	+		+			+		+	+			+			+	+	+
ASIA	SIBERIA			+														+
ASIA	W. PAK.																	
ASIA	AFGHAN.	+		+	+	+			+	+	+		+	+			+	
ASIA	TURKEST.																	
ASIA	TRANSCAS.																	
ASIA	N. IRAQ	+		+		+					+			+			+	
ASIA	SYR. DES.	+		+	+	+			+					+		+	+	
ASIA	N. IRAN	+		+		+			+		+			+		+	+	
ASIA	N.W. IRAN	+		+		+			+		+			+		+	+	
ASIA	W. IRAN	+		+		+			+		+			+		+	+	
ASIA	C. IRAN	+		+		+			+		+			+		+	+	
ASIA	KHORAS																	
ASIA	SINAI							?						+				
ASIA	ARABIA																+	
	E. ASIA			+	+						+		+					+
	N. AMER.			+					+					+				+

+ = present ? = doubtful

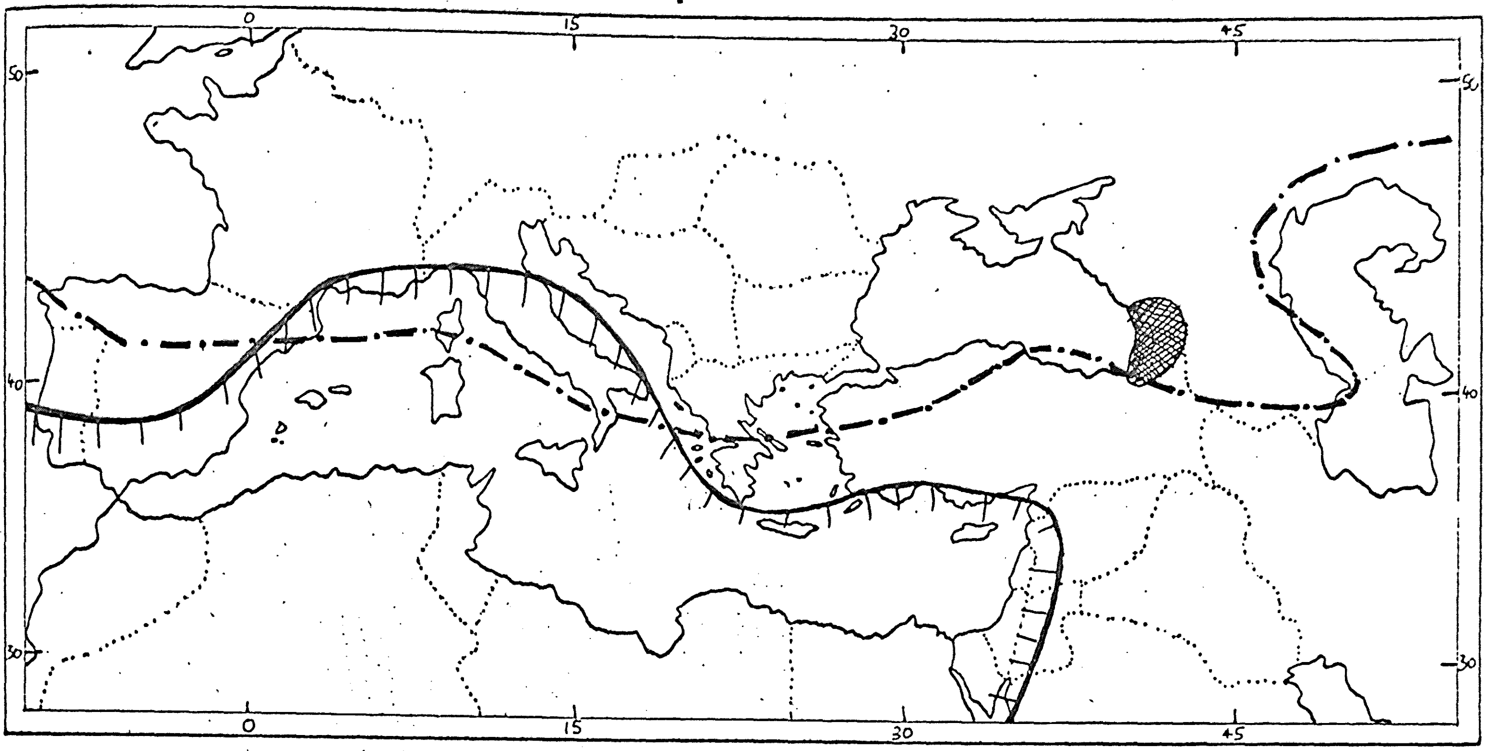
Kukenthal's (1936) Monograph of Cyperus L. s.l. was also used. Specimens from most of the areas in the table were seen in the herberia at Kew, British Museum or Edinburgh.

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. Bulbostylis worononi, Eleocharis mesidionalis, E. 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 it has isolated disjunct stations in Central Europe, Afghanistan to the temperate Far East, and East Africa. Scirpus sylvaticus, Eriophorum vaginatum, E. latifolium and Rhynchospora 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).

Galilae mucronata 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.

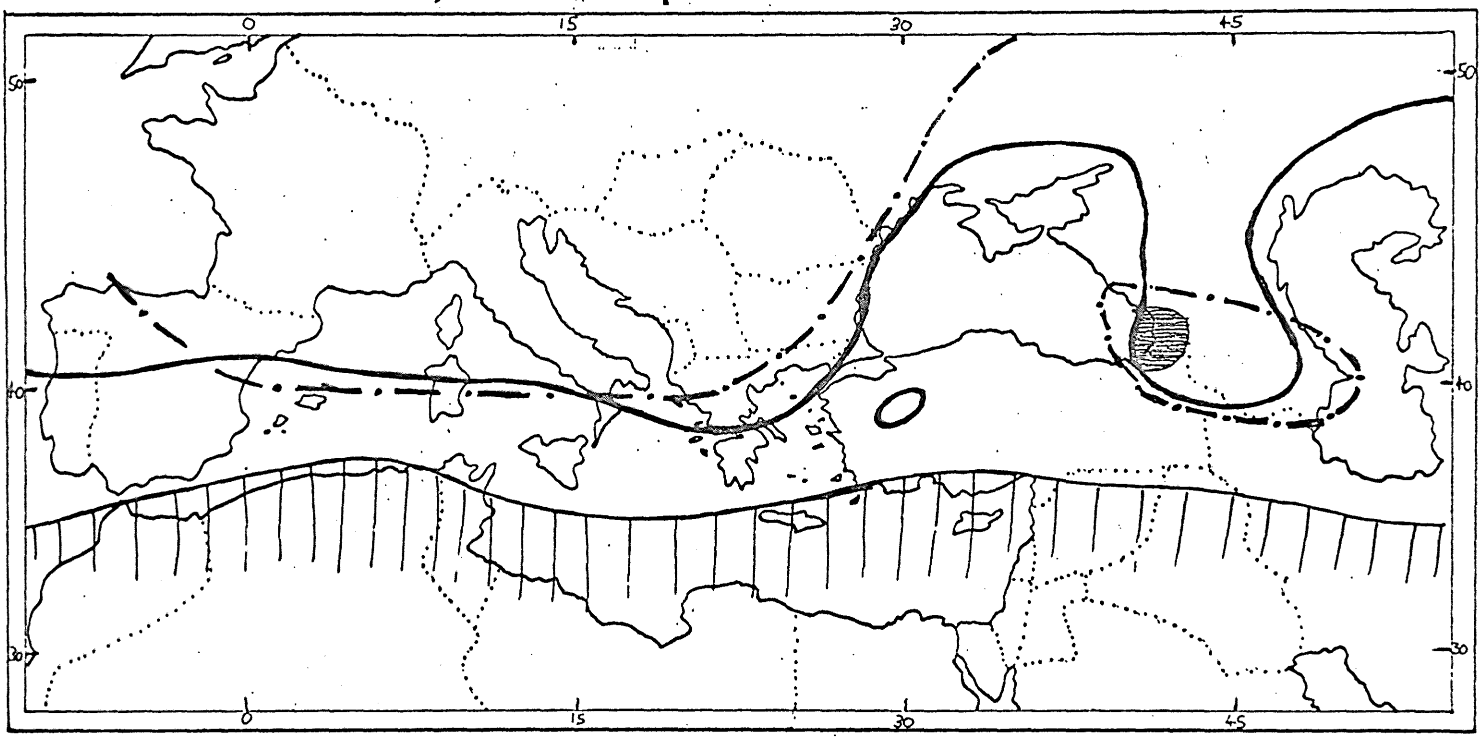
The distributional map of Fuirena pubescens shows its northernmost range (and in fact that of the entire genus Fuirena) reaching Portugal, Spain, France and Italy, missing the Balkans and just touching the Lycian Taurus in South

Map 25



Fuirena pubescens — Pycreus sanguinolentus — Scirpus sylvaticus

Map 26



Eriophorum latifolium — Eriophorum vaginatum — Fimbristylis ferruginea

Pycreus colchicus

Anatolia (see Map 25). Elsewhere, especially in Africa and India, its range is fairly continuous.

Fimbristylis 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).

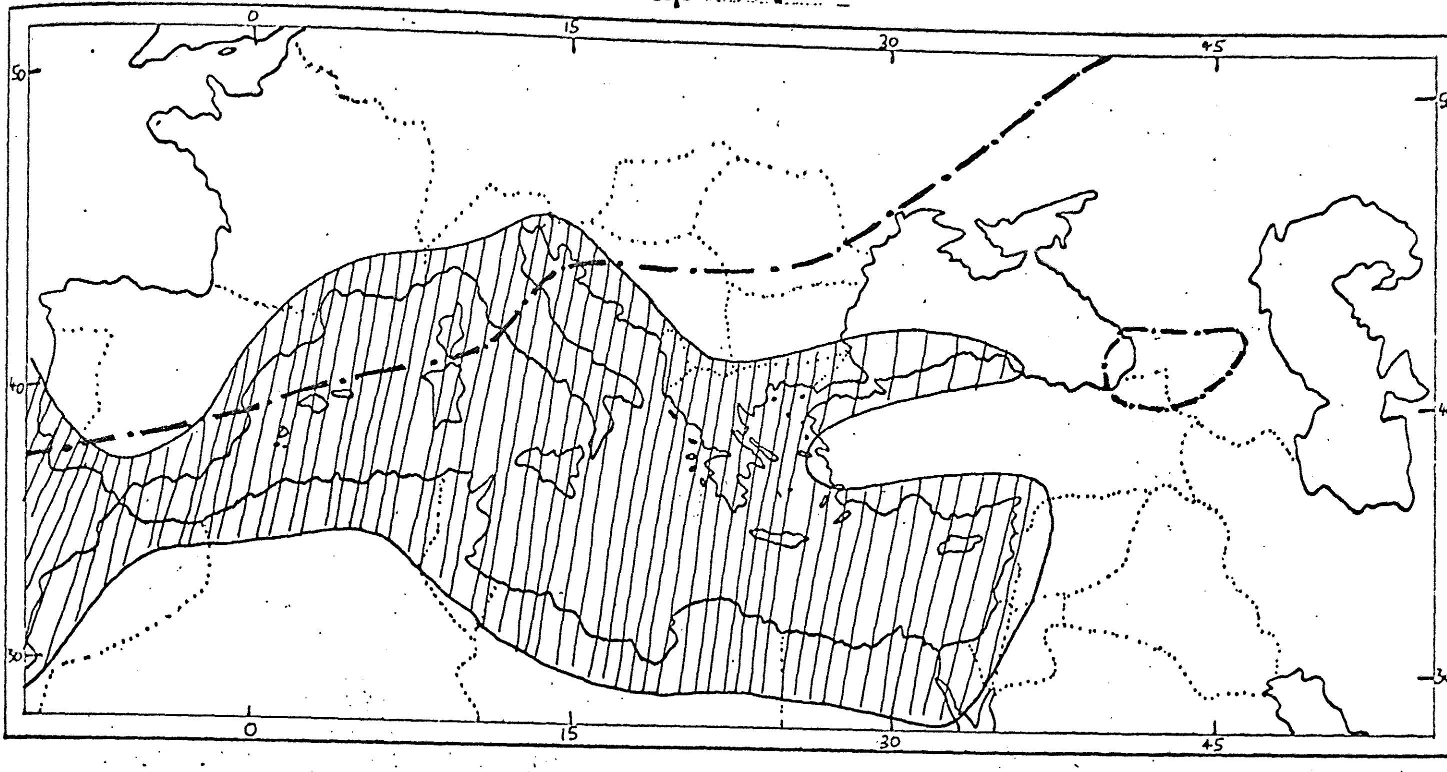
The subtropical species that extend into Egypt and enter Palestine (e.g. Cyperus papyrus, C. conglomeratus, C. alopecuroides, Juncellus laevigatus subsp. distachyos etc.) are absent from Turkey for climatic reasons.

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.

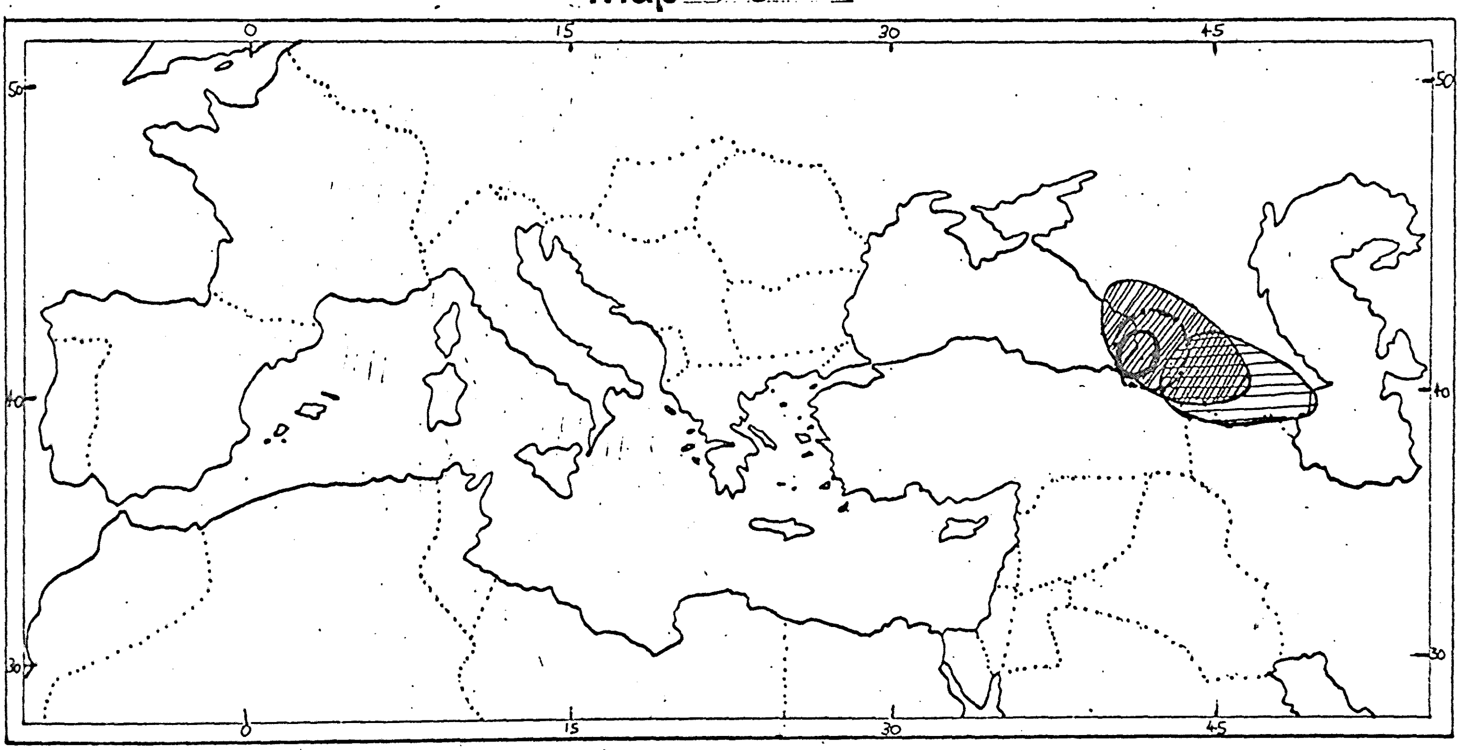
Our knowledge of the effects of the climatic changes of Pleistocene in Turkey on the distribution of the Cyperaceae can only be referred - I could trace no fossil evidence except that of Cladium mariscus from Kodor river in West Caucasia (Kolakovsky 1964). However, considering the drying effects of the 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 Euxine 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 woronowii, B. tenerrima, Eleocharis meridionalis, E. transcaucasica, Pycreus 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:

Map 27



Galilea mucronata — Rhynchospora alba

Map 28



Bulbostylis tenerrima — Bulbostylis woronowii

Eleocharis meridionalis — Eleocharis transcaucasica 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.E. and N.W. Turkey and may therefore have reached Turkey by a "pincer" 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.E. Turkey combined (i.e. to the Colchic 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)

Isolepis R. Br. sect. Bulbostylis Kunth, Enum. Pl. 2: 205 (1837)

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

1. B. tenerrima (Fisch. & Mey.) Palla in Monit. Jard. Bot. Tiflis 21: 21 (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 29]

Described from the Caucasus

Related to B. capillaris (L.) Nees from which it differs in having glabrous glumes and smooth fruit.

2. B. woronowii Palla in Monit. Jard. Bot. Tiflis 21: 22 (1912)

Recorded from A8 Çoruh [see Grossheim op. cit. map 33] and Komarov op. cit. p. 76

Described from Western Transcaucasia: In paludosis prope p. Gonieh.

Related to B. tenerrima and B. capillaris from which it differs in having larger spikelets (see key) and a caducous swollen style base.

Note: The persistence of the style base is one of the characters that distinguish the genus Bulbostylis from Fimbristylis. With B. woronowii having a caducous 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)

syn: E. pauciflora Grossg. Fl. Kavk. 1: 147 (1928) p.p., non Link (1827)

Recorded from A9 Çoruh [see Grossheim op. cit. map 28]

Described from Kirgiziya: habitat ad ripas, in paludibus pratisque humidis et apud nives alpinas Transcaucasiae et in regionibus montanis territoriisque adjacentibus Asiae Mediae soveticae 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 Kars [see Grossheim map 29]

Described from Soviet Armenia: habitat ad ripas et in pratis Transcaucasiae (et Turciae regionum adjacentium) et ad ostia Borysthени atque Tanaitis.

Closely related to E. uniglumis from which it differs in having a narrowly conical tubercle, about half as long as the fruit.

PYCREUS (see p. 297).

P. colchicus (C. Koch) B. Schinschk. in Grossh., Fl. Kavk. 1: 152 (1928)

syn: Cyperus colchicus C. Koch in Linnaea 21: 623 (1848)

Pycreus woronowii Palla in Monit. Jard. Bot. Tiflis 21: 22 (1912)

Cyperus tremulus Poir var. colchicus (C. Koch) Kukenthal in Engler, Das Pflanzenreich 4, 20: 362 (1936)

Recorded from A8 Çoruh [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 Çoruh [see Grossheim op. cit. map 8]

Described from Italy: [Hb. Linn. 70. 23, 24 photo!]

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 A8 Çoruh [see Grossheim map 31]

Described from Italy; loc: circa lacus et locis humidis agri Canapiciensis frequens est. copiose circa lacum di Vivronne et in pratis paludosis di Bolengo et Azeglio

Related to F. dichotóma (L.) Vahl, from which it differs in having a simple umbel, subtended by 2-3 involucral bracts; fruit 1.0 mm long.

BIBLIOGRAPHY

The following is a list of references on taxonomic and general botanical literature consulted. References to nomenclatural authorities are excluded unless such references contain other taxonomic information mentioned in the thesis.

Al-Rawi, A. (1964). Wild Plants of Iraq with their distribution. Min. Agric. Bull. No. 4 (Baghdad)

Andersson, N.J. (1849). Plantae Scandinaviae, Pt. I. Cyperaceae Scandinaviae 6.

Arber, A. (1925). Monocotyledons. A morphological study C.U.P.

Artjuszenko, Z.T. and KonoWalow I.N. (1951). Trudy Bot. Inst. im. Komarowa ser. VII Morf. i Anat. Rast. 2: 170-191

Ascherson, P. and Graebner, P. (1904). Synopsis der Mitteleuropäischen Flora 2: 264-339

Bakker, D. (1954). Miscellaneous notes on Scirpus lacustris L. sensu lat. in the Netherlands Acta. Bot. Neerl. 3: 426-445

Bakker, E.M. van Zinderen (1953). South African Pollen Grains and Spores Part I: 26-30 (A.A. Balkema, Amsterdam)

Barros, M. (1960). Las Ciperaceas del estado de Santa Catalina. Sellowia 12: 181-433

Beetle, A.A. (1940). Studies in the genus Scirpus L. I. Delimitation of the Subgenera Eu-Scirpus and Aphylloides. Amer. Journ. Bot. 27: 63

——— (1941). Certain North and South American Distributions in Scirpus. Madroño 6: 45-49

——— (1942). Scirpus criniger Gray transferred to Eriophorum. Leaflets Western Bot. 3(7): 164-166

——— (1943). A key to the North American species of the genus Scirpus based on achene characters. Amer. Midl. Nat. 29: 533-538

——— (1944). Studies in the genus Scirpus L. VII. Conspectus of Sections represented in the Americas. Amer. Journ. Bot. 31: 261-

Beetle, A.A. (1946). Studies in the genus Scirpus L. VIII. Notes on its taxonomy. phylogeny and distribution. Amer. Journ. Bot. 33: 661-

——— (1947). in H.K. Svenson. North American Flora. Tribe 2 Scirpeae 18(8): 481-504

Bentham, G. (1883). In Benth. & Hook. fil. Genera Plantarum 1037-1073

Blake, S.T. (1969). Studies in Cyperaceae. Contrib. Queensland Herb. No. 8

Blaser, H.W. (1941) Studies in the morphology of the Cyperaceae I. Morphology of the flowers. A. Scirpoid genera. Amer. Bourn. Bot. 28: 542-551

——— (1944) Studies in the morphology of the Cyperaceae II. The Prophyll. Amer. Journ. Bot. 31: 53-64

Boeckeler, O. (1868) Cyperaceae. Linnaea 35: 435-436

——— (1870) Ibid. 36: 712-714

Boissier, E. (1884) Flora Orientalis 5: 362-393

Braun-Blanquet, J. (1932) Plant Sociology Ed. 1. McGraw-Hill, London & N.Y.

Briquet, J. (1910) Prodr. Fl. Corse Tome I

Britton, N.L. (1888) New or Noteworthy North American Phanerogams I. Bull. Torr. Botan. Club 15: 99

Brown, R. (1810) Prodr. Fl. Novae Hollandiae et Insulae Van-Diemen 236, Londres

Chermeson, H. (1922) In Bull. Soc. Bot. Fran. 69: 809-814

——— (1936) In Humbert, Fl. Madagascar 29[e] Fam. - Cyperacees

Clapham, A.R., Tutin, T.G. & Warburg E.F. (1962) Flora of the British Isles Ed. 2. C.U.P.

Clarke, C.B. (1883) In Journ. Linn. Soc. Bot. 20: 374-403

——— (1897-1900) In Thiselton-Dyer, Flora Capensis vol. 7: 149-267

——— (1898) Ibid. p. 225

——— (1901-02) In Thiselton-Dyer, Fl. Trop. Afr. 8: 266-524

——— (1908) New Gemera and Species of Cyperaceae. Kew Bull. Add. ser. 8 1-196

Clarke, C.B. (1909) Illustrations of Cyperaceae, 144 tab. Williams & Norgate, London.

Cranwell, L.M. (1953) New Zealand, pollen studies: the Monocotyledons. Bull. Auckland Inst. & Museum No. 3, 91 pp. Harvard Univ. Press, Cambridge, Mass.

Croizat, L. (1943) The concept of Inflorescence. Bull. Torr. Bot. Club 70: 496-509.

Custor, C. (1830) In Gaud., Flora Helvetica 6: 337-339.

Danser, B.H. (1950) Bibl. Bioth. 4: 117-180.

Davis, G.L. (1966) Systematic Embryology of the Angiosperms, 102-103 John Wiley & Son Inc., N.Y.

Davis, P.D. (1965) Flora of Turkey vol. I: 1-26, Edinburgh Univ. Press.

——— (1971) in Plant Life of South West Asia, 15-27, (Davis, P.D., Harper, P.C. & Hedge, I.C. Ed.) Botanical Society of Edinburgh.

——— & Heywood, V.H. (1963) Principles of Angiosperm Taxonomy, Oliver & Boyd, Edinburgh & London.

De Bary, H.A. (1884) Comparative anatomy of Phanerogams and Ferns. English translation & annotation by Bower, F.O. & Scott, D.H., Oxford, Clarendon Press.

Dennis, L.J. (1965) A species of Scirpus new to Oregon. Leafl. Western Bot. 10: 179-180.

Didrichsen, A. (1894) Om Cyperaceernes Kim. Bot. Tidsskr., Kjøbenh. 19: 1-6, 4 fig.

——— (1897) Ibid 21: 1-10, 8 fig.

Döll, J.C. (1843) Rheinische Flora 164-165.

Duval-Jouve, J. (1873) Diaphragmes vasculiferes des Monocotyledons aquatiques <u>Mem. Acad. Sci. Montpellier</u> 8: 157-176.

——— (1873) Bot. Z. 31: 198-200.

Erdtman, G. (1952) <u>Pollen Morphology and Plant Taxonomy</u>: <u>Angiosperms</u>. Almquist & Wiksells, Stockholm.

Esau, K. (1965) <u>Plant Anatomy</u> Ed. 2. John Wiley & Sons, Incl. New York, London, Sydney.

Federov, A. (1969) Ed. <u>Chromosome Numbers of Flowering Plants</u>. Acad. Sci. USSR, V.L. Komarov Bot. Inst.

Fernald, M.L. (1901) <u>Scirpus supinus</u> and its North American allies. <u>Rhodora</u> 3: 249-252.

Fitzgerald, W.V. (1917) The Botany of the Kimberleys, North-West Australia. <u>Journ. Rroc. Roy. Soc. W. Australia</u> 3: 122.

Friedland, S. (1941) The American species of <u>Hemicarpha Amer. Journ. Bot.</u> 28: 855-861.

Fries, E. (1828) <u>Novitiae Florae Suecicae</u> 6.

Gleason, H.A. (1952) The New Britton & Brown <u>Illustrated Flora of the North-Eastern United States and adjacent Canada</u> vol. I. New York Bot. Gdn.

Gordon-Gray, K.D. (1971) <u>Fimbristylis</u> and <u>Bulbostylis</u>: Generic limits as seen by a student of Southern African species. <u>Mitt. Bot. Staatssamml. Munchen</u> 10: 549-574.

Grossheim, A.A. (1940) <u>Flora Kavkaza</u> Ed. 2.

Guignard, J.L. (1961) Embryogenie vegetale - <u>Cyperacees</u>. Developpement de l'embryon chez le <u>Cyperus vegetus</u> Willd. <u>Acad. Sci. (Paris) Compt. rend.</u> 252: 2125-2127.

Haines, R.W. (1966) Prophylls and branching in Cyperaceae. Journ. E. Afr. Nat. Hist. Soc. 26(1): 51-70.

——— (1971a) see Haines & Lye 1971.

——— (1971b) Amphicarpy in East African Cyperaceae. Mitt. Bot. Staatssamml. München 10: 534-538.

——— & Lye, K.A. (1971) Studies in African Cyperaceae IV, Lipocarpha R.Br., Hemicarpha Nees and Isolepis R.Br. Bot. Notiser 124(4): 473-482.

Hakansson, A. (1928) Die chromosomen einiger Scirpoideen. Hereditas 10: 277-291.

Hartman, C.J. (1849) Handbok i Skandinaviens Flora.

Hegi, G. (1908) Flora von Mittel-europa, Band 2: 5-49.

Heilborn, O. (1922) Die chromosomenzahlen der Gattung Carex. Svensk. Bot. Tidskr 16: 271-274.

——— (1924) Chromosome numbers and dimensions, species formation and phylogeny in the genus Carex. Hereditas 5: 129-216.

——— (1928) Chromosome studies in Cyperaceae. Hereditas 11: 182-192.

——— (1932) Aneuploidy and polyploidy in Carex. Svensk Bot. Tidskr 26: 137-146.

——— (1934) On the origin and presentation of polyploidy. Hereditas 19: 233-242.

——— (1936) The mechanics of so-called secondary association between chromosomes. Hereditas 22: 167-188.

——— (1937) Notes on chromosome associations. Cytologia, Fujii Jubilee volume.

——— (1939) Chromosome studies in Cyperaceae III-IV. Hereditas 25: 224-240.

Henderson, D.M. (1961) Contribution to the Bryophyte Flora of Turkey V: Summary of Present Knowledge. Notes from the R.B.G. Edinburgh 23(3): 279-300.

Heywood, V.H. (1958) The presentation of Taxonomic Information (A short Guide for Contributors to Flora Europaea). Leicester Univ. Press.

Hicks, G.C. (1928) Chromosome studies in the Cyperaceae with special reference to Scirpus. Botan. Gaz. 86: 295-317.

——— (1929) Cytological studies in Cyperus, Eleocharis, Dulichium and Eriophorum. Botan. Gaz. 88: 132-149.

Holttum, R.E. (1948) The spikelets in Cyperaceae. Bot. Rev. 14: 525-541.

Holm, T. (1899) Studies in the Cyperaceae IX: The genus Lipocarpha R. Br. Amer. Journ. Sci. 7(4): 171-183.

——— (1929) The application of the term "Rhizome". Rhodora 31: 6-17.

Holmboe, J. (1914) Studies in the vegetation of Cyprus.

Hooker, J.D. (1853) The Botany of the Antarctic Voyage II. Flora Novae-zelandiae I: 271.

——— Ed. (1894) Fl. Brit. Ind. 6: 585-677.

Hryniewiecki, B. & Kurtz, W. (1936) La repartition des cones siliceux dans les cellules des Cyperacees et leur correlation. Bull. Intern. Acad. Pol. Sci. Math. Nat. S.B.1 1/2, 33.

Husnot, T. (1906) Cyperacees: Descr. et Fig. des Cyperacees fe France, Suisse et Belgique.

Inversen, J. (1946) Geologisk datering af en senglacial Boplads vel Bromme. Aarb. f. Nordisk Oldk. Og. Hist., 198.

Jardine, N & Sibson, R. (1971) Mathematical Taxonomy, John Wiley, London.

Jeffrey, E.C. (1925) Polyploidy and the origin of species. Amer. Nat. 59: 209-217.

Jermy, A.C. & Tutin, T.G. (1968) British Sedges. Bot. Soc. British Isles, London.

Johansen, D.A. (1944) Plant microtechnique. McGraw-Hill, N.Y.

——— (1950) Plant Embryology. Chronica Botanica Co. Waltham. Mass.

Kern, J.H. (1958) Notes on Malaysian and some S.E. Asian Cyperaceae VII. Acta Bot. Neerl. 7: 795-798.

——— (1962) New look at some Cyperaceae mainly from the tropical standpoint. Advan. Sci. 19(78): 141-148.

Khanna, P. (1965) A contribution to the embryology of Cyperus rotundus L., Scirpus mucronatus L. and Kyllinga melanospora Nees. Can. Journ. Bot. 43: 1539-1547.

Klebs, G. (1885) Beiträge zur Morphologie und Biologie der Keimung. Bot. Inst. Z. Tübingen 1: 571.

Klinge, J. (1879) Vergleichende histiologische Untersuchung der Gramineen - und Cyperaceen - wurzeln, insbesondere der Wurzel-leitbündel. Zap. imp. Akad. Nauk [Mem. Acad. imp. Sci. St-Petersbourg] ser. 7, 26(12), 70 pp.

Koch, G.D.J. (1837) Synopsis Florae Germanicae et Helveticae ed 1: 741.

——— (1843) Ibid. ed. 2: 855-856.

Køie, M. & Rechinger K.H. (1965) Symbolae Afghanicae VI. Biol. Skr. Dan. Vid. Selsk. 14(4) 94 pp.

Kolakovski, A.A. (1964) A Pliocene Flora of the Kodor River. 198 (summary) Sukhumi Bot. Saad, Monogr. 1.

Komarov, V.L. ed. (1964) Flora U.R.S.S. vol. III. Israel Program for Scientific Translations Ltd., Jerusalem

Koyama, T. (1956) Taxonomic study of Cyperaceae V. Bot. Mag. Tokyo 69(812): 59-67.

——— (1958) Taxonomic study of the genus Scirpus Linne Journ. Fac. Sci. Univ. Tokyo, sect. III (Botany) 7(6): 271-366.

Koyama, T. (1961) Classification of the family Cyperaceae I. Journ. Fac. Sci. Univ. Tokyo, sect. III (Botany) 8: 37-148.

——— (1962) The genus Scirpus Linne. Some North American aphylloid species. Can. Journ. Bot. 40: 913-937.

——— (1963) The genus Scirpus Linne. Critical aspects of the section Pterolepis. Can. Journ. Bot. 41: 1107-1131.

——— & McVaugh, R. (1963) Cyperus orbicephalus, new generic status of Scirpus orbicephalus Beetle. Bull. Torrey Bot. Club 90(4): 229-232.

Kukenthal, G. (1935) In Engler, Das Pflanzenreich 4, 20: 30

——— (1936) Ibid. 671 pp.

——— (1944) Vorarbeitsen zu einer Monographie der Rhynchosporoideae XV. Fedde, Rep. 53: 200-209.

Kunth, C.S. (1837) Enum. Plantarum 2: 138.

Levyns, M.R. (1943) A Revision of Trianoptiles Frenzl. Journ. South Afr. Bot. 9: 21-26.

——— (1944) Notes on Scirpus and Descriptions of three New species. Journ. South Afr. Bot. 10: 29-32.

Lindberg, H. (1902) Die nordeuropäischen formen von Scirpus (Heleocharis) paluster L. Acta Societatis pro Fauna et Flora Fennica 23(7): 1-16.

Lye, K.A. (1971a) Studies in African Cyperaceae II. The genus Oxycaryum Nees Bot. Notiser 124(2): 280-286.

——— (1971b) The Generic concept of Bulbostylis Kunth ex C.B. Clarke. Mitt. Bot. Staatssamml. München 10: 539-547.

Maire, R. (1957) Flore de l'Afrique Du Nord (Maroc, Algerie, Tunisie Tripolitaine, Cyrenaique et Sahara) vol. 4: 5-97.

Marek, S. (1958) A study of the anatomy of fruits of European genera in the sub-families Scirpoideae Pax, Rhynchosporoideae Aschers. & Graebn. and some genera of Caricoideae Pax. Monogr. Botan. 6: 151-177.

Mattfeld, J. (1938) Das Morphologische wesen und die phylogenetische Bedeutung der Blumenblätter. Ber. Deut. Botan. Ges. 56: 86-116.

Mertens, F.C. & Koch, G.D.J. (1823) Deutsh. Fl. 1: 434

Merxmüller, H. & Czech, G. (1953) Eine Neue gattung der Cyperaceen. Mitt. Bot. Staatssamml. München 8: 317-323.

Metcalfe, C.R. (1969) Anatomy as an aid to classifying the Cyperaceae. Amer. Journ. Bot. 56(7): 782-790.

——— (1971) Anatomy of the Monocotyledons V. Cyperaceae, Oxford, Clarendon Press 597 pp.

——— & Gregory, M. (1964) Some new descriptive terms for Cyperaceae with a discussion of variations in leaf noted in the family. Notes Jodrill Lab. 1: 1-11.

Meurman, O. (1929) Prunus laurocerasus L., a species showing high polyploidy. Journ. Gen. 21: 85-94.

Meyer, G.F.W. (1849) Fl. Hann. Exc., 613-614.

Monoyer, A. (1928-29) Morphologie comparee du Scirpus sylvaticus L. et du Scirpus lacustris L. Son importance au point de vue lamarckiens. Bull. Soc. Bot. Belg. 61: 171-181.

——— (1934) Contribution a l'anatomie du genre 'Scirpus' Arch. Inst. Bot. Univ. Liege 11: 185 pp.

Moore, L.B. & Edgar, E. (1970) Fl. New Zealand vol. 2: 167-215.

Mouterde, P. (1966) Nouvelle Flore Du Liban et de la Syrie, Tome premiere.

Muntzing, A. (1936) The evolutionary significance of autopolyploidy. Hereditas 21: 263-378.

Napper, D.M. (1963) Cyperaceae of East Africa I. J.E. Afr. Nat. Hist. Soc. 24 No. 2(106) 1-18.

——— (1964) Cyperaceae of East Africa II. Ibid. 24, No. 5(109); 39.

Napper, D.M. (1965) Cyperaceae of East Africa III. Ibid. 25 No.1(110): 1-27.

——— (1965) Cyperaceae of East Africa IV. Ibid. 26 No.1(113): 1-17.

——— (1971) Cyperaceae of East Africa V. Ibid. 28 No. 124: 1-24.

Nees von Essenbeck, C.G. (1835) in Linnaea 9: 273-306.

——— (1854) in Hooker's Journ. Bot. and Kew Miscellany 6: 29.

Ohwi, J. (1944) Cyperaceae-Japonicae II. Mem. Coll. Sc. Kyoto Imp. Univ. Ser. B, 18: 1-182.

Otzen, D. (1962) Chromosome studies in the genus Scirpus L. sect. Schoenoplectus Benth. et Hook. in the Netherlands. Acta. Botan. Neerl. 11: 37-46.

Padhye, M.D. (1960) A contribution to the life history of Kyllinga triceps Rottb. Bot. Soc. Coll. Sci., Nagpur, Bull. 1: 1-15.

——— (1966-67) The pollen grains of Kyllinga Rottb. Palyno. Bull. 2 & 3: 101-103.

——— (1967) Ph.D. thesis. Nagpur Univ. Nagpur (A.V.)

——— (1971a) studies in Cyperaceae I. Embryology of Cyperus iria L. Indian Nat. Sci. Ass. Proc. 37: 1-10.

——— (1971b) Life History of Kyllinga brevifolia Rottb. Bot. Gaz. 132(3): 172-179.

Palla, E. (1888-9) Zur Kenntnis der Gattung Scirpus. Bot. Jb. 10: 293-301.

——— (1896) Zur systematik der Gattung Eriophorum. Bot. Zeitung 8: 141-158.

——— (1905) Über den Morphologischen Wert. der Blüte der Gattungen Lipocarpha und Platylepis. Ber. Deutsch. Bot. Ges. 23: 316-323.

——— (1908) Über Hemicarpha. Österr. Bot. Zeitschr. 58: 417-422.

Parlatore, F. (1852) Flora Italiana 2: 5-114.

Parsa, A. (1950) Flore de l'Iran vol. 5. Min. Educ. Museum D'histoire (Teheran).

Patel, C.M. & Shah, C.K. (1962) Life History of Cyperus niveus Retz. J. Gujrath Univ. 5: 148-159.

Pax, F. (1887) in Engler & Prantl. Die Natur. Pflanzenf. 2, 2: 98-126.

Pfeiffer, H. (1927) Untersuchungen zur vergleichenden Anatomie der Cyperaceen I. Die Anatomie der Blatter. Beih. Bot. Zbl. 44(1): 90-176.

Phillips, M.E. (1954) Eriophorum angustifolium Roth (E. polystachion L.) Biological Flora of the British Isles. J. Ecol. 42: 612-622.

Plowman, A.B. (1906) The comparative anatomy and phylogeny of the Cyperaceae. Ann. Bot. (London) 20: 1-34.

Pobedimova, E. (1950) in Not. Syst. (Leningrad) Tom 12: 13-24.

Post, G.E. (1933) Flora of Syria, Palestine and Sinai (Ed. Dinsmore, J.E.) Ed. 2 vol. 2.

Raymond, M. (1957) Some new or critical Scirpus from Indo-China. Natur. Canad. 84: 111-150.

——— (1960) Additional Notes on some S.E. Asiatic Scirpus. Mem. Jard. Bot. Montreal No. 54: 225-242 (Extract from Natur. Canad. 86: 225-242 (1959).

Raynal, J. (1967) Notes Cyperologiques: VII. Sur quelques Lipocarpha Africains Adansonia, ser. 2, 7(1): 81-87.

——— (1968) Notes Cyperologiques: XI. Sur quelques Scirpus et Ascolepis de L'ancien Monde. Adansonia, ser. 2, 8(1): 85-104.

Rechinger, K.H. (1943) Flora Aegaea.

——— (1964) Flora of Lowland Iraq.

Reichenbach, L. (1846) Icones Florae Germanicae et Helveticae 8: 33.

Rendle, A.R. (1904) The Classification of Flowering Plants vol. I. Gymnosperms and Monocotyledons. C.U.P. 385 pp.

Rickett, H.W. (1944) The classification of Inflorescences. Bot. Rev. 10: 187-231.

Ridley, H.N. (1930) Dispersal of Plants throughout the World, L. Green & Co., Ltd., Kent.

Rikli, M. (1895) Beiträge zur vergleichenden Anatomie der Cyperaceen mit besonderer Berücksichtigung der inneren Parenchymcheide. Jb. Wiss. Bot. 27: 485-580.

Schneider, M. (1932) Untersuchungen über die Embryoblidung und - entwicklung der Cyperaceen Beih. Bot. Centralbl. 49: 649-674.

Schultze-Motel, W. (1959) Entwicklungsgeschichtliche und vergleichend - morphologische Untersuchungen im Blütenbereich der Cyperaceae. Engler. Bot. Jahrb. 78: 129-170.

——— (1959a) Dulichieae, eine neue Tribus der Cyperaceae - Scirpoideae. Willdenowia 2: 170-175.

Schuyler, A.E. (1967) A taxonomic revision of North American Leafy species of Scirpus. Proc. Acad. Nat. Sci. Phila. 119: 295-323.

——— (1969) Research challenges in the Cyperaceae. Current Topics in Plant Science (J.E. Gunckel ed.) 167-175, Academic Press, London & New York.

——— (1971a) SEM of Achene Epidermis in species of Scirpus (Cyperaceae) and related Genera. Proc. Acad. Nat. Sci. Phila. 123(2): 29-52.

——— (1971b) Some relationships in Scirpeae bearing on the delineation of Genera. Mitt. Bot. Staatssamml. München. 10: 577-585.

Selling, O. (1947) Studies in Hawaiian Pollen Statistics 2. The pollen of the Hawaiian Phanerogams. Spec. Publ. Bishop Mus. 38.

Shah, C.K. (1962) Pollen development in some members of the Cyperaceae p. 81-93 in Plant Embryology - a symposium, C.S.I.R., New Delhi.

——— (1963) The life history of Juncus bufonicus L. J. Indian Bot. Soc. 42: 238-251.

Shah, C.K. (1964) Embryo development in Eleocharis palustris L. Nat. Canad. 111: 40-49.

——— (1965) Embryogeny in some Cyperaceae. Phytomorphology, 15: 1-9.

Sharma, M. (1967) Pollen morphology of Indian monocotyledons. Journ. Palynology. Special volume.

Sharma, A.K. & Bal, A.K. (1956) A Cytological investigation of some members of the family Cyperaceae. Phyton, Buenos Aires 6: 7-22.

Skottsberg, C. (1940) Översikt av växtrikot. "Vaxternas Liv", 5: 137-735.

Smith, S.G. (1969) Natural Hybridization in the Scirpus lacustris complex in the North Central United States. Current Topics in Plant Science (J.E. Gunckel ed.) 175-200, Acad. Press.

Soueges, R. (1923) Embryogenie des Joncacees. Development de l'embryon chez le Luzula forsteri D.C. Acad. Sci. (Paris) Compt. rend.117: 705-708.

——— (1933) Recherches sur l'embryogenie des Joncacees. Soc. Bot. France Bull. 80: 51-69.

Sparkling, J.H. (1968) Schoenus nigricans L. (Chaetospora nigricans Kunth). Biological Flora. J. Ecol. 56: 883-889.

Strandhede, S.O. (1960) A note on Scirpus lacustris L. Bot. Notiser, 113(2): 161-171.

——— (1961) Eleocharis Palustres in Scandinavia and Finland. Taxonomical units within the area. Bot. Notiser, 114: 417-434.

——— (1965) Chromosome studies in Eleocharis subser. Palustres III. Observations on WesternEuropean Taxa. Opera Botanica 9(2): 1-86.

Täckholm, G. (1920) On the cytology of the genus Rosa Svensk Bot. Tidskr. 14: 300-311.

Täckholm, V & Drar, M. (1950) Flora of Egypt vol. 2. Bull. Fac. Sc. No. 28, Cairo.

Takhtajan, A. (1963) Principles of Paleontology 623-626 (Moscow).

Tanaka, N. (1937) Chromosome studies in Cyperaceae I. Cytologia, Fujii Jub. vol. 814-821.

——— (1938) Chromosome studies in the Cyperaceae II. Scirpus lacustris L. Cytologia 8: 515-520.

——— (1939) Chromosome studies in Cyperaceae III. The maturation division in Scirpus lacustris L. with special reference to heteromorphic pairing. Cytologia (Tokyo) 9: 533-556.

——— (1940) Chromosome studies in Cyperaceae VI. Pollen development and additional evidence for the compound chromosome in Scirpus lacustris L. Cytologia 10, 3: 348-362.

——— (1942) Chromosome studies in Cyperaceae XVI. Chromosome numbers in the genus Scirpus. Med. and Biol. 2: 91-95.

——— (1942) Chromosome studies in Cyperaceae XVII. Chromosome numbers in the genus Heleocharis and allied genera. Med. and Biol. 2: 96-100.

——— (1948) The problem of aneuploidy - chromosome studies in Cyperaceae with special reference to the problem of aneuploidy - Biol. Contr. Japan 4: 1-327.

Tiwari, D.K. (1968) Embryological studies in Cyperaceae II. Endosperm and embryo development in Fimbristylis quinquangularis Kunth. J. Indian Bot. Soc. 47: 264-271.

——— (1969) Embryological studies in the Cyperaceae. A contribution to the embryology of Pycreus sanguinolentus Nees. J. Biol. Sci. 12: 21-30.

Van der Veken, P. (1955) Trois taxa nouveaux de Cyperacees du Congo belge. Bull. Jard. Bot. Etat. Bruxelles 25: 143-147.

Van der Veken, P. (1965) Contribution a l'embryographie systematique des Cyperaceae-Cyperoideae. Bull. Jard. Bot. Bruxelles 35: 285-354.

Van Tieghem, P. & Douliot, H. (1888) Recherches comparatives sur l'arigine des membres endogenes dane les plantes vasculaires. Ann. Sci. Nat. Bot. ser. 7, 8: 1-656.

Walters, S.M. (1949) Eleocharis R. Br. Biological Flora of the British Isles. J. Ecol. 37: 192-206.

——— (1961) The shaping of Angiosperm Taxonomy. New Phytol. 60: 74-84.

Wille, N. (1882) Om pollenkornenes udvikling hos Juncaceer og Cyperaceer. Forhand. i Vidensk. - Selsk. i Christiania No. 16: 1-4.

Woodehouse, R.P. (1935) Pollen grains: their structure, identification and significance in science and medicine. Ed. 1 McGraw-Hill, New York.

Wright, S.H. (1887) A new Genus in Cyperaceae. Bull. Torrey Bot. Club 14: 135

Wulff, E.W. (1929) Flora Taurica (Ukranian, Crimea) vol. I. Fasc. 2.

Wulff, H.D. (1939) Die Pollenentwicklung der Junceceen nebst einer Auswertung der embryologischen Befunde hinsichtlich einer Verwandtschaft zwischen den Junceceen und Cyperaceen. Jahrb. f. wiss. Bot. 137(4): 533-556.

Zander, E. (1935) Pollengestaltung und Herkunftsbestimmung bei Blütenhonig (Beiträge zur Herkunftsbestimmung bei Honig), Berlin.

INDEX

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).

Only the more important page references are given. Underlined page references indicate a description or diagnoses.

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

Ascolepis Nees ex Stued. subgen. Platylepis (Clarke) Oteng-Yeboah, comb. et stat. nov.

Platylepis Kunth, Enum. Pl. 2: 269 (1837), non L.C. Richard (1828)
Ascolepis sect. Platylepis Clarke in Kew Bull. Add. ser. 8: 116 (1908), basionym

Eriophorum L. subgen. Japonici (Koyama) Oteng-Yeboah, comb. et stat. nov.

Scirpus L. sect. Japonici Koyama in Journ. Fac. Sci. Univ. Tokyo, Sect. 3 (Botany) 7(6): 295 (1958), basionym

Erioscirpus Palla subgen. Lachnophorum (Nylander) Oteng-Yeboah, comb. et stat. nov.

Eriophorum L. sect. Lachnophorum Nylander in Acta Soc. Fenn. 3: 22 (1846), basionym
Scirpus L. sect. Lachnophorum series Lachnophorum (Nylander) T. Koyama in Journ. Fac. Sci. Univ. Tokyo, sect. 3 (Botany), 7(6): 294 (1958)

Fuirena Rottb. subgen. Pentasticha (Turcz.)Oteng-Yeboah, comb. et stat. nov.

Pentasticha Turcz. in Bull. Soc. Nat. Moscou 2: 330 (1862), basionym

Fuirena Rottb. subgen. Vaginaria (persoon) Oteng-Yeboah, comb. et stat. nov.

Vaginaria Persoon, Synops. Pl. 1: 70(1805), basionym
Fuirena sect. Vaginaria (Persoon) C.B. Clarke in Kew Bull. Add. ser. 8: 115 (1908)
Scirpus sect. Vaginaria (Persoon) Koyama in Journ. Fac. Sci. Univ. Tokyo, sect. 3 (Botany), 7(6): 286 (1958)

Hemicarpha Nees sect. Chloroscirpus (Chermezon) Oteng-Yeboah comb. et stat. nov.

Scirpus L. subgen. Chloroscirpus Chermezon in Humbert Flore Madagascar 29^{e} Famille, 141 (1936) basionym

Schoenoplectus (Reichenb.) Palla subgen. Actaeogeton (Reichenb.) Oteng-Yeboah, comb. et stat. nov.

Scirpus L. sect. Actaeogeton Reichenb., Pl. Germ. Excurs. 78 (1830), basionym
Scirpus L. sect. Eu-Scirpus series Mucronarae C.B. Clarke in Kew Bull. Add. Ser. 8: 112 (1908)

Schoenoplectus (Reichenb.) Palla subgen. Malacogeton (Ohwi) Oteng-Yeboah, comb. et stat. nov.

Scirpus L. subgen. Schoenoplectus (Reichenb.) Ohwi sect. Malacogeton Ohwi in Mem. Coll. Sci. Kyoto Imper. Univ. Ser. B, 18: 97 (1944), basionym

Scirpus L. sect. Bolboschoenus Aschers. series Malacogeton (Ohwi) T. Koyama in Journ. Fac. Sci. Univ. Tokyo sect. 3 (Botany), 7(6): 288 (1958)

Scirpus L. sect. Lineati (Beetle) Oteng-Yeboah, comb. et stat. nov.

Scirpus L. sect. Androcoma (Nees) Benth. et Hook. f. series Lineatae Beetle in Amer. Journ. Bot. 31: 263 (1944), basionym

Trichophorum Persoon subgen. Anthelophorum (Ohwi) Oteng-Yeboah, comb. et stat. nov.

Scirpus L. subgen. Trichophorum (Persoon) Ohwi sect. Anthelophorum Ohwi in Mem. Coll. Sci. Kyoto Imper. Univ. ser. b, 18: 95 (1944), basionym

Scirpus L. sect. Baeothryon (Ehrh. ex A. Dietr.) Benth. et Hook. f. series Anthelophorum (Ohwi) T. Koyama in Journ. Fac. Sci. Univ. Tokyo sect. 3 (Botany), 7(6): 293 (1958)

II. New Species combinations

Bolboschoenus fluviatilis (Torr.) Oteng-Yeboah, comb. et stat. nov.

Scirpus maritimus L. var. fluviatilis Torr. in Ann. Lyceum Nat. Hist. New York 3: 324 (1836), basionym

S. fluviatilis (Torr.) Gray, Man. Bot. Ed. 1, 527 (1848)

Bolboschoenus laeteflorens (Clarke) Oteng-Yeboah, comb. nov.

Scirpus laeteflorens Clarke in Th. Dur. & Schinz., Consp. Fl. Afr. 5: 625 (1894-95), basionym

Bolboschoenus planiculmis (Fr. Schmidt) Oteng-Yeboah, comb. nov.

Scirpus planiculmis Fr. Schmidt, Reisen Amurl. u. Ins. Sachal 190, t. 8 f. 1-7 (1868), 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: 86, t. 143A (1858), basionym
Scirpus crassiusculus (Hook. f.) Benth., Fl. Austr. 7: 326 (1878)

Eleogiton lenticularis (Poir.) Oteng-Yeboah, comb. nov.

Scirpus lenticularis Poir. in Lam., Encycl. Meth. Suppl. 5: 103 (1804)
Isolepis lenticularis R. Br., Prodr. 222 (1810)

Eleogiton ludwigii (Steud.) Oteng-Yeboah, comb. nov.

Fimbristylis ludwigii Steud. in Flora 1P 139 (1829) basionym
Isolepis ludwigii (Steud.) Kunth, Enum. Pl. 2: 189 (1837)
Scirpus ludwigii (Steud.) Böech 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 Candd. 86: 240 (1959) basionym

Hemicarpha brevicaulis (Levyns) Oteng-Yeboah, comb. nov.

Scirpus brevicaulis Levyns in Journ. S. Afr. Bot. 10: 31 (1944) basionym

Hemicarpha hystrix (Thunb.) Oteng-Yeboah, comb. nov.

Scirpus hystrix Thunb., Prodr. Pl. Cap. 17 (1794), basionym

Hemicarpha kernii (Raymond) Oteng-Yeboah, comb. nov.

Scirpus kernii Raymond in Naturaliste Canad. 136: 230 (1959), basionym

Hemicarpha squarrosa (L.) Oteng-Yeboah, comb. nov.

Scirpus squarrosus L., Mantissa Pl. 2: 181 (1771), basionym

Hemicarpha rehmanii (Ridley) Oteng-Yeboah, comb. nov.

Scirpus rehmanii Ridley in Trans. Linn. Soc. (London) ser. 2, 2: 159 (1884), basionym

Holoschoenus dioecus (Kunth) Oteng-Yeboah, comb. nov.

Isolepis dioeca Kunth, Enum. Pl. 2: 199 (1837), basionym
Scirpus dioecus (Kunth) Boeck in Linnaea 36: 719 (1869-70)

Holoschoenus thunbergianus (Nees) Oteng-Yeboah, comb. nov.

Isolepis thunbergiana Nees in Linnaea 7: 508 (1832), basionym
Scirpus thunbergianus (Nees) Levyns in Journ. S. Afr. Bot. 10: 28 (1944)

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.

Scirpus inconspicuus Levyns in Journ. S. Afr. Bot. 10: 30 (1944) basionym

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.

Schoenoplectus merrillii Palla in Allg. Bot. Zeitschr. Beil. 3: 17 (1911), basionym
Scirpus merrillii (Palla) Kükenthal ex Merrill. Enum. Philipp. Fl. Pl. 1: 117 (1923)

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.

Scirpus angolensis Clarke in Dur. & Schinz. Consp. Fl. Afr. 5: 617 (1894-5), basionym

Phylloscirpus acaulis (Phil.) Oteng-Yeboah, comb. nov.

Scirpus acaulis Phil. in Linnaea 29: 78 (1857-58), basionym

Phylloscirpus semisubterraneus (Böeck) Oteng-Yeboah, comb. nov.

Scirpus semisubterraneus Böeck. in Linnaea 36: 495 (1869-70) basionym

Phyllosoirpus deserticola (Phil.) Oteng-Yeboah, comb. nov.

Isolepis deserticola Phil. Fl. Atacam. 53 (1860), basionym

Pseudo-schoenus inanis (Thunb.) Oteng-Yeboah, comb. nov.

Schoenus inanis Thunb., Prodr. Pl. Cap. 16 (1794), basionym
Scirpus spathaceus Hochst in Flora 759 (1845)
S. inanis (Thunb.) Steud., Syn. Pl. Glum 2: 86 (1855)

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.

Scirpus chilensis Nees & Meyer in Nova Acta. Acad. Leop.-Carol. Nat. Curr. 19 Suppl. 1: 93 (1843), basionym

Schoenoplectus etuberculatus (Steud.) Oteng-Yeboah, comb.nov.

Scirpus maritimus var. cylindricus Torr. in Ann. Lyc. N.Y. 3: 325 (1836)
Rhynchospora etuberculata Steud., Syn. Pl. Glum. 2: 142 (1855), basionym
Scirpus macranthus Böeck., Flora 41: 412 (1858)
S. etuberculatus (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.

Elytrospermum californicum C. Meyer, Mem. Acad. St. Petersb. Sav. Etr. 1: 201 (1831), basionym
Scirpus californicus (C. Meyer) Steud., Nom. Bot. ed. 2. 2: 538 (1841)

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 8: 29 (1908), basionym

Schoenoplectus muricinux (Clarke) Oteng-Yeboah, comb. nov.

Scirpus muricinux 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 (Steud.) Oteng-Yeboah, comb. nov.

Cyperus ranko Steud., Syn. Pl. Glum. 2: 315 (1855) basionym
Scirpus perpusillus Böeck. in Linnaea 36: 496 (1869-70)
S. ranko (Steud.) Günckel in Rev. Univ., Chile 33(1): 24 (1948)

Schoenoplectus corymbosus (Heyne ex Roth) Oteng-Yeboah, comb. nov.

Scirpus corymbosus Heyne ex Roth, Nov. Pl. Sp. 28 (1821), basionym

Schoenoplectus pterolepis (Kunth) Oteng-Yeboah, comb. nov.

Scirpus pterolepis Kunth, Enum. Pl. 2: 166 (1837), basionym

Schoenoplectus rhodesicus (Podlech) Oteng-Yeboah, comb. nov.

Scirpus rhodesicus Podlech in Mitt. Bot. Staatsamml. München 4: 117 (1961), basionym

Schoenoplectus saximontanus (Fern.) Oteng-Yeboah, comb. nov.

Scirpus saximontanus Fern. in Rhódora 3: 351 (1901), basionym

Schoenoplectus smithii (Gray) Oteng-Yeboah, comb. nov.

Scirpus smithii A. Gray, Man. Bot. ed 5: 563 (1867), basionym

Schoenoplectus smithii var. williamsii (Fernald) Oteng-Yeboah, comb. nov.

Scirpus debilis Pursh, Fl. Ann. Sept. 1: 55 (1814), non Lam. (1791)
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.

Scirpus subterminalis Torr., Fl. U.S. 47 (1823), basionym

Schoenoplectus hallii (Gray) Oteng-Yeboah, comb. nov.

Scirpus hallii A. Gray, Man. Bot. Ed. 3: 97 (1862), basionym

Schoenoplectus rubiginosus (Beetle) Oteng-Yeboah, comb. nov.

Scirpus rubiginosus Beetle in Amer. Journ. Bot. 28: 697 (1941) basionym

Schoenoplectus triangulatus (Roxb.) Oteng-Yeboah, comb. nov.

Scirpus triangulatus Roxb., Fl. Indica 1: 219 (1820) basionym

Schoenoplectus uninodis (Delile) Oteng-Yeboah, comb. nov.

Isolepis uninodis Delile Fl. Egypt 2: 152 (1812), basionym
Scirpus uninodis (Delile) Coss. & Durien, Fl. Alger., pt. 2 Phanerog.: 310 (1867)

Schoenoplectus riparius (Presl) Oteng-Yeboah, comb. nov.

Scirpus riparius Presl, Rel. Haenk. 1: 193 (1830), basionym

Trichophorum atacamensis (Phil.) Oteng-Yeboah, comb. nov.

Isolepis atacamensis Phil. Fl. Atacem. 53 (1860), basionym
Scirpus atacamensis (Phil.) Böeck. in Linnaea 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 planifolius Muhl. var. brevifolius Torr., Ann. Lyc. N.Y. 3: 442 (1836)
Scirpus clintonii A. Gray, Amer. Journ. Sci. II 38: 290 (1864), basionym

Trichophorum mattfeldianum (Kükenthal) Oteng-Yeboah, comb. nov.

Scirpus mattfeldianus Kükenthal in Fedde, Repert 27: 108 (1929), basionym

Trichophorum rigidum (Steud. ex Böeck.) Oteng-Yeboah, comb. nov.

Scirpus rigidus Steud. ex Böeck. in Linnaea 36: 492 (1869-70), basionym

Trichophorum verecundum (Fern.) Oteng-Yeboah, comb. nov.

Scirpus planifolius Muhl., Descr. Gram. 32 (1817) non Grimm. (1767)
S. 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 (MEXU), 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.

Species	Voucher specimen	Country of origin	Date
Androtrichum trigynum (Spreng.) Pfeiff.	A. Glazion 20066 (K)	Brazil	1892
Ascolepis brasiliensis (Kunth) Benth. ex Clarke	E. Hassler (E) J. Steinbach 6727 (E)	Paraguay Santa Cruz	1913
capensis Ridl.	Irvine 2473 (E) Baum 209 (E) Cooper T.911 (E)	Ghana S. Africa	1934 1899 1862
elata Welw.	Hilliard & Burtt 4364 (E)	Malawi	1967
pinguis Clarke	Hassner Expd. 2550 (E)	Congo	1908
protea Wele.	Baum 627 (E)	-	1900
Blysmus compressus (L.) Panz.	Seth (E)	Sweden	1872
Bolboschoenus affinis (Roth) Drobov	Drummond 24933 (E)	India-Punjab	-
fluviatilis (Torr.) Oteng-Yeboah	E.S. Steele (E)	U.S. (Washington DC)	1897
maritimus (L.) Palla	-	-	-

Bolboschoenus laeteflorens (Clarke) Oteng-Yeboah	Story 5873 (K)	-	1956
	Strey R.G. 2172 (K)	S.W. Africa	1947
paludosus (Nels.) Oteng-Yeboah	E.P. Walker 399 (E)	Utah (U.S.)	1912
	Nelson A. & E. 6878 (K)	Wyoming (U.S.)	1899
planiculmis (Fr. Schmidt) Oteng-Yeboah	Kawakami 74088 (TNS)	Manchuria (Japan)	1895
	Hatanaka 122555 (TNS)	Kyushu (Japan)	1955
robustus (Pursh) Oteng-Yeboah	Leo. Koch 1004a (E)	Calif. (U.S.)	1940
strobilinus (Roxb.) Krecz	Hb. Ind. Or. Hook. f. (E) Thomson	India	-
Courtoisia cyperoides Nees	Hb. Wight 1255 (E)	India	-
Cyperus aristatus Rottb.	E. Hassler 12626 (E)	Paraguay	1913
conglomeratus Rottb.	R.W. Haines 1011 (E)	Iraq	1957
	J. Lamond 89 (E)	Iran	1965
difformis L.	-	-	-
fuscus L.	-	-	-
glaber L.	-	-	-
longus L.	-	-	-
iria L.	R.W. Haines 1827, 5040 (E)	Iraq	1960
margaritaceus Vahl	F.R. Irvine 5018 (E)	Ghana	1961
pustulatus Vahl	F.R. Irvine 4702 (E)	Ghana	1961
flabelliformis Rottb.	R.E.S. Tanner 1728 (E)	Tanganyika	1953
*uncinatus Poir.	J.T. Swarbrick 2714 (E)	Nigeria	1962
*pygmaeus Rottb.	-	-	-
orbicephalus (Beetle) Koyama	C.G. Pringle 3173 (E)	Mexico	1890
	C.C. Parry & Ed. Palmer 905 (K)	Mexico	1878
	J.G. Schaffner 566 (K)	San Luis Potosi (Mexico)	1877
	R. McVaugh 13021 (MEXU)	Jalisco (Mexico)	1952
micheliamus (L.) Link	Hb. Wight 2307 (E)	India	-
Desmoschoenus spiralis (A. Rich.) Hook. f.	Ex Hb. Lauder Lindsay (E)	New Zealand	1861
	J.K. Heyes 7/48 (E)	New Zealand	-
Duval-Jouvea serotina (Rottb.) Palla	N. Pastukhovch (E)	Caucasus	1916
	R.R. Stewart 28729 (E)	Pakistan	1959
Eleogiton fluitans (L.) Link	Westfeldt (E)	Sweden	1950
	Reverchon (E)	France	1882
pseudo-fluitans (Makino) Ohwi	Ohwi & Okamota 739 (E)	Hondo (Japan)	1953
crassiuscula (Hook. f.) Oteng-Yeboah	R. Schoddle 1757 (E)	New Guinea	1961

Eleogiton brizoides (Benth.) Oteng-Yeboah	Drummond 919 (E)	W. Australia	-
striatus Nees (= Scirpus capillifolius Parl.)	R. Dümmeri 2034 (E)	S. Africa	1908
fascicularis Nees	Ex Hb. Harvey 374 (E)	S. Africa	-
ludwigii (Steud.) Oteng-Yeboah	Hb. John Ball (E)	S. Africa	-
lenticularis (Poir.) Oteng-Yeboah	W.M. Curtis (K)	Tasmania	195
	Cheeseman T.F. 801 (K)	North Island N.Z.	
Eriophorum angustifolium Honck	J. Brudler (E)	-	1865
	N. Vyhodcevski 794 (E)	Bulgaria	1953
gracile Koch	Ex. Hb. Chas. Hornell (E)	-	1872
	St. Petrov. 414 (E)	Bulgaria	1956
intercedens Lindb.	I. Montell (E)	-	1910
latifolium Hoppe	Giti (E)	-	1861
	Stungn. (E)	Austria	1888
opacum Fern.	Harry Smith	Sweden	1926
russeolum Fries	Paavo S. Jokela (E)	Finland	1964
	Santesson (E)	-	1894
scheuchzeri Hoppe	Ex Hb. Balfour 835 (E)	-	-
	Emil Warodell (E)	Sweden	1913
vaginatum L.	Paavo S. Jokela (E)	Finland	1963
	Ex Hb. Böeck (E)	-	1888
fauriei E.G. Camus	Hiroko Morimune 16201 (E)	Honshu (Japan)	1961
brachyantherum Trantv.	Walton & Hyde (E)	Canada	1949
callitrix Cham.	Spreadborough 16387 (E)	Canada	1896
	K. Holmen & S. Laegaard (E)	Greenland	1958
spissum Fern.	Gillet & Findlay 4904 (E)	Canada	1950
tenellum Nutt.	Hamilton 80809 (E)	Canada	1890
	Knowlton 527, Ex Hb. Grayanae (E)	Maine (U.S.)	1932
triste (Hadac) Løve & Løve	I. Waterston W. 149 (E)	Scoreby Land	1968
crinigerum (Gray) Beetle	E.A. McGregor 100 (E)	Calif. (U.S)	1909
	Copeland 3902 (K)	Calif. (U.S.)	1903
virginicum L.	Gillet & Findlay 5657 (E)	Canada	1950
	Ex Hb. Watson (E)	Philad. (U.S.)	1861
viridi-carinatum (Engelm.) Fern.	J. Macoun 16389 (E)	Canada	1896
	Maire-Victorin et al. 56939 (E)	Canada	1943
japonicum Maxim.	Ex Hb. P. Maximowicz (K)	Japan	1865
	Ohwi 224864 (TNS)	Hokkaido (Japan)	1928
	Nakashima 14 (NSM 171795 TNS)	Honshu (Japan)	1967
Erioscirpus comosus (Wall.) Palla	J. Cavalerie 2073 (E)	China	1904
	George Forrest (E)	-	1904

Erioscirpus microstachyus (Böeck.) Palla	J.F. Duthie 19763 (E)	Himalaya	-
falsus (Clarke) Oteng-Yeboah	Hilliard & Burtt 5680 (E)	S. Africa	1968
	E.E. Gulpin 6874 (K)	S. Africa	1904
Ficinia aphylla Nees	R.J. Rodin 3173 (E)	S. Africa	1948
argyropa Nees	R. Dümmeri 1246 (E)	S. Africa	1908
secunda Kunth	R. Dümmeri 1989 (E)	S. Africa	1908
	Hb. Walker Arnott 1701 (E)	S. Africa	1903
bracteata Böeck.	R. Dümmeri 1704 (E)	S. Africa	1908
brevifolia Nees	R. Dümmeri 1982 (E)	S. Africa	1908
bulbosa Nees	R.J. Rodin 3112 (E)	S. Africa	1948
	Nees ab Essenb. 85 (E)	S. Africa	-
contexta Nees	Nees ab Ess. 10.9 (E)	S. Africa	-
ecklonea Nees	R. Dümmeri 1808 (E)	S. Africa	1908
elongata Böeck	R. Wilms 3827 (E)	S. Africa	1883
filiformis Schrad.	R. Dümmeri 51D (E)	S. Africa	1908
	Hb. Dümmeri 1426 (E)	S. Africa	1908
gracilis Schrad.	R. Dümmeri 1036 (E)	S. Africa	1908
lateralis Kunth	R. Dümmeri 1942 (E)	S. Africa	1908
pinguior Calrke	R. Dümmeri 1536 (E)	S. Africa	1908
praemorsa Nees	Nees ab Essen. 44.6 (E)	S. Africa	-
ramossisima Kunth	Burtt-Warg 7879 (E)	S. Africa	1908
scariosa Nees	Hb. MacOwanianum (E)	S. Africa	-
	R. Dümmeri 1852 (E)	S. Africa	1908
paradoxa Nees	Hb. Dümmeri 1439 (E)	S. Africa	1898
	R. Dümmeri 1945 (E)	S. Africa	1908
	G.F. Scott Elliot 217 (E)	S. Africa	1888
seliformis Schrad.	Hb. John Ball	S. Africa	-
steudeli Nees	Drege 10.10	S. Africa	-
trichodes Benth.	Pl. Schlech. Austro.-Afric. 7551 (E)		1896
tristachya Nees	Ex Hb. Harvey 385 (E)	S. Africa	-
angustifolia (Schrad.) Clarke	Pl. Schlech. Austro.-Afric. 7966 (E)		1897
longifolia Clarke	W. Keddie 132 (E)	S. Africa	-
radiata Kunth	Nees ab Ess. 84 (E)	S. Africa	-
	Hb. Dümmeri 347 (E)	S. Africa	1908
Fuirena pubescens (Poir.) Kunth	A. Beguinot 223 (E)	Italy	1905
	Davis 50653 (E)	Morocco	1970
	Hedge et al. W.7467 (E)	Afghanistan	1969
ciliaris (L.) Roxb.	M. Togasi T.N.S. 1457 (E)	Japan	1956
	H.Y. Liang 66132 (E)	-	1933
glomerata Lam.	J.H. Lace 2528 (E)	India	1902
	A. Henry 1084 (E)	China	-
umbellata Rottb.	S.K. Lau 404 (E)	China	1932
	M.S. Clemens 10708A (E)	New Guinea	1939
wallichiana Kunth	J. Sinclair 4354 (E)	India	1945
scirpoidea Michx.	R. M. Harper 1490 (E)	Georgia (U.S.)	1902
	Forster & Smith 1329 (E)	-	1946
	Tracy 8623 (E)	Florida (U.S.)	1903

Fuirena simplex Vahl	Arsene (E)	Mexico	1911
	Albert Ruth 522 (E)	Texas (U.S.)	1914
	H. Curtiss 237 (E)	West Indies	1903
squarrosa Michx.	Smith & Hodgon 921 (E) (Pl. Exsicc. Grayanae)	-	1939
	Fernald 331 (E)	-	1918
incompleta Nees	Reineoh & Czermak 439 (E)	Brazil	1899
welwitchiana Ridl.	G. Adamson 106 (E)	Zambesica	-
pachyrriza Ridl.	H. Baum 145 (E)	Zambesica	1899
ecklonii Nees	Clarke (E)	S. Africa	-
hirta Vahl	R. Dümmeri 1801, 1065 (E)	S. Africa	1908
Galitea mucronata (L.) Parl.	M. Zohary 31 (E)	Israel	1928
	E.K. Balls 702 (E)	Turkey	1934
Hellmuthia sp. (= Scirpus membranaceus Thunb.)	Zeyher 1775 (K)	S. Africa	-
	Burchell (K)	S. Africa	-
	H. Bolus 7187 (K)	S. Africa	1892
	R.N. Parker 4792, 3706(K)	S. Africa	1952
	Acocks 21214 (K)	S. Africa	-
Hemicarpha occidentalis Gray	H.N. Bolander 6223 (K)	Calif. (U.S.)	1866
micrantha (Vahl) Britt.	Earl E. Sherff. 1793 (E)	Illinois (U.S.)	1912
squarrosa (L.) Oteng-Yeboah	J.W. Helfer 144 (E)	India	-
hystrix (Thunb.) Oteng-Yeboah	F. Wilms 1594 (E)	S. Africa	1894
brevicaulis (Levyns) Oteng-Yeboah	R.N. Parker 4364 (K)	S. Africa	1948
Holoschoenus vulgaris Link	-	-	-
vulgaris subsp. globiferus (L.f.) Oteng-Yeboah	Hunting Techn. Services Ltd. Ref. No. 36(P2) (E)	Hoggar Mts. (Morocco)	1955
nodosus (Rottb.) Dietr.	J. Staer (E)	W. Australia	1905
thunbergianus (Nees) Oteng-Yeboah	Pl. Schlecht. Austro.-Afric. 9929 (E)		1897
	Burchell 685 (K)	S. Africa	1811
dioecus (Böeck.) Oteng-Yeboah	Werdermann & Oberdiech 614 (K)	S. Africa	-
	H.H.W. Pearson 6082 (K)	S. Africa	1910
Hymenochaeta grossa (L. fil.) Nees	H.Y. Liang 62943 (E)	China	1933
	Hb. Francis Hamilton (E)	India	-
	Ihwaites 847 (E)	Ceylon	1870
Isolepis sulcata (Thouars.) Carm.	R.N.R. Brown (E)	Gongh Is.	-
	N.M. Wace T.101 (K)	Tristan Is.	1968
cartilaginea R. Br.	Max Koch 1965 (E)	S.W. Australis	1910
psammophila (Blake) Oteng-Yeboah (= Scirpus arenarius Benth.)	Drummond 360 (E)	W. Australia	-

Isolepis cyperoides R.Br.	J. Staer (E)	W. Australia	1905
inundata R.Br.	R. Brown 5975 (E)	Australia	1802-5
	A. Kneucker Exsicc. (E)	-	-
prolifer (Rottb.) R.Br.	R. Brown 5971 (E)	Australia	1802-5
	R.N. Parker 3637 (K)	S. Africa	1942
costata Hochst. ex A. Rich	Schimper 1464 (E)	Ethiopia	1863-68
antartica (L.) R. & S.	F. Wilms 3826 (E)	Australia	1883
	Hb. A. Morrison (E)	-	1906
	M.J.A. Werger E. &W 164 (K)	-	-
aucklandica Hook. f.	Moseley; Challenger Expd. 3 (E)	-	1873
	Ex Hb. Mus. Paris (K)	-	1875
macer (Böeck.) Oteng-Yeboah	F. Wilms 1615 (E)	S. Africa	1884
venustula (Böeck) Kunth	F. Wilms 1617 (E)	S. Africa	1884
koilolepis Steud.	C.G. Pringle (E)	Arkansan (U.S.)	1883
(= Scirpus carinatus Gray)	A.A. Heller 6771 (E)	Calif. (U.S.)	1903
bicolor Carm.	N.M. Wace T.116 (K)	Tristan Is.	1968
delicatula (Levyns) Oteng-Yeboah	M.R. Levyns 837 (K.)	S. Africa	1924
inconspicua (Levyns) Oteng-Yeboah	R.N. Parker 4363 (K)	S. Africa	1948
minuta (Turrill) Oteng-Yeboah	E.L. Stephens 3530 (K)	S. Africa	1908
merrillii (Palla) Oteng-Yeboah	L. Craven 546 (K)	Australia	1965
producta (Clarke) Oteng-Yeboah	Cleland J.B. (K)	S. Australia	1929
cernua (Vahl) R. & S.	-	-	-
*setacea (L.) R.Br.	-	-	-
*Juncellus laevigatus (L.) Clarke	-	-	-
laevigatus subsp. distachyos (All.) Oteng-Yeboah	R.W. Haines 57 (E)	Iraq	1954
Kyllinga monocephala Rottb.	To Kang Peng et al. 12083 (E)	Kwantung (China)	1924
brevifolia Rottb.	M. Togasi 626 (E)	Japan	1952
squamulata Thonn. ex Vahl	R.R. Stewart 23437a (E)	India	1959
triceps Rottb.	J.H. Lace (E)	Burma	1912
	J.J. Swarbrick 2682 (E)	W. Nigeria	1962
aurata Nees	G. Volkono 2102 (E)	Kilimanjaro	1897
elatior Kunth	George Adamson (E)	Zambesica	-
erecta Schum.	Irvine 1629 (E)	Ghana	1931
peruviana Lam.	Irvine 2154 (E)	Ghana	1934
pumila Michx.	A.J.M. Leeuwenberg 1879(E)	Ivory Coast	1958
rigidula Steud.	G.L. Bates 199 (E)	Cameroon	1895
cylindrica Nees	H.H. Johnston (E)	Mauritius	1889
polyphylla Kunth	H.H. Johnston (E)	Mauritius	1887
caespitosa Nees	M. Bourgeau 662 (E)	Mexico	1865-66

Kyllinga odorata Vahl	M. Bourgeau (E)	Mexico	1865-66
pungens Link	P. Dusen 13616 (E)	Brazil	1912
Lipocarpha maculata (Michx.) Torr.	Bradley & Sears 3605 (E)	North Carolina (U.S.)	1966
argentea R. Br.	H.H. Johnston (E)	Mauritius	1888
	G. Schweinfurth 1461 (E)	Central Africa	1869
	Rev. N. Michael 1434 (E)	Queensland Australia	-
atropurpurea Böeck. (= L. pulcherrima Ridl.)	J. Buchanan	Zambesica	1885
senegalensis (Lam.) Th. & H. Durand	W.T. Tsang 29322 (E)	Tonkin (China)	1939
	Drummond & Cookson 6475 (E)	N. Rhodesia	1959
microcephala Kunth	J. Staer (E)	Kimberly (W. Australia)	1905
chinensis (Osb.) Kern	van Bueseken & Phengkhlai (E)	Thailand	1968
laevigata Nees	Hb. Wight 3162 (E)	India	-
sphacelata Kunth	Macbold 9982 (E)	China	1908
Mariscus flabelliformis H.B.K.	J.M. Dalziel 1300 (E)	Nigeria	-
rufus H.B.K	J.M. Dalziel 1305 (E)	Nigeria	-
ligularis (L.) Urb.	John Rattray (E)	Sao Tome	-
congestus (Vahl) Clarke	F. Wilms 1621 (E)	S. Africa	1895
latebracteatus Palla	Arsene (E)	Mexico	1909
cayennensis (Lam.) Urb.	P. Dusen 11373 (E)	Brazil	1911
umbellatus Vahl (= Cyperus subumbellatus Kükenthal)	Irvine 4971 (E)	Ghana	1961
cyperinus (Retz.) Vahl	G. Zenker 898 (E)	Cameroon	1896
flavus Vahl (= Duval-Jouvea buchtienii Palla)	Otto Buchtien 1222 (E)	Bolivia	1907
Nelmesia melanostachya Van der Veken	Gerard 57 (K)	Belgian Congo	1951
Nemum angolensum (Clarke) Oteng-Yeboah	E.A. Robinson 5166 (K)	N. Rhodesia	1962
spadiceum Desv. ex Hamilton	E.A. Robinson 4676 (K)	N. Rhodesia	1961
(= Scirpus briziformis Hutch.)	J.T. Swarbrick 2838(E)	S. Cameroon	1962
Oxycaryum cubense (Kunth) Lye	Nil & Schweinfurth 1109(E)	Central Africa	-
	C. Wright 3380 (K)	Cuba	1865
	G.S. Jenman 7063 (K)	Br. Guina	1896
Phylloscirpus acaulis (Phil.) Oteng-Yeboah	H.F. Comber 69 (E)	Andes	1925
	J.H. Hunziker 2191B (K)	Argentina	1947
	Eyerdam, Beetle & Grondona 24303 (K)	Argentina	1939
semisubterraneus (Böeck.) Oteng-Yeboah	G. Mandon 1417 (K)	Peru	1868
	Lloyd & Marshall 113 (K)	Peru	1961

Pseudo-schoenus inanis (Thunb.) Oteng-Yeboah	L. MacOwan 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 maritima Aubl.	J. Sinclair 39042, 38907(E)	Singapore	1950
	Tenasserim & Andamana 6239 (E)	India	1862-63
*Schoenoplectus triqueter (L.) Palla	-	-	-
*lacustris (L.) Palla	-	-	-
*lacustris subsp. glaucus (Hartm.) Oteng-Yeboah	-	-	-
*littoralis (Schrad.) Palla	-	-	-
*mucronatus (L.) Palla	-	-	-
*supinus (L.) Palla	-	-	-
tatora (N. & M.) Palla	J. Soukup 487 (K)	Peru	1936
limensis (Clarke) Oteng-Yeboah	Clarke 1059 (K)	Peru	1887
ranko (Steud.) Oteng-Yeboah	Hohenacker 786 (K)	Chile	-
rubiginosus Beetle Oteng-Yeboah	M. H. Sachet 318 (K)	Mexico	1958
heterochaetus (Chase) Oteng-Yeboah	Fernald et al. 14192	N.Y. (U.S.)	1922
subterminalis (Torr.) Oteng-Yeboah	C.K. Dodge (E)	Mich. (U.S.)	1906
	Ex Hb. Gray (K)	N.Y. (U.S.)	1865
muricinus (Clarke) Oteng-Yeboah	A.O.D. Mogg (K)	S. Africa	1934
rhodesicus (Podlech) Oteng-Yeboah	E.A. Robinson 3758 (K)	N. Rhodesia	1960
	Greenway & Brenan 8200 (K)	Chalubi Is.	1947
	H.M. Richards 18081 (K)		1963
	Corby 482 (K)		1949
oxyjulos (Hooper) Oteng-Yeboah	K.A. Kershaw 900420 (K)	N. Nigeria	1964
uninodis (Del.) Oteng-Yeboah	M. de Wailly 5006 (K)	-	1936
dissachanthus (Blake) Oteng-Yeboah	F.J. Hicks 114 (K)	Australia	1958
erectus (Poir.) Palla	Canton Chr. Coll. 12918 (E)	China	1924
juncoides (Roxb.) Krecz	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
	M. Mizushima 384 (E)	Hondo (Japan)	1950
lineolatus (Franch. et Sav.) Ohwi	Ohwi & Koyama T.S.M. 983(E)	Hondo (Japan)	1953

Schoenoplectus nipponicus (Makino) Ohwi	Kunio Sata T.S.M. 1100 (E)	Honshu (Japan)	1954
preslii (Dietr.) Ohwi	Pl. Jap. Exsic. 306 E. Kitagawa (E)	Honshu (Japan)	1964
wallichii (Nees) Ohwi	Wall. Cat. 3468 (E)	-	-
articulatus (L.) Oteng-Yeboah	R. Ritche 780 (E)	-	-
corymbosus (Heyne ex Roth) Oteng-Yeboah	F. Wilms 1608 (E)	S. Africa	1883
	Hb. F. Hamilton 191 (E)	-	-
jacobi (Fischer) K. Lye	Hb. Wight 3148 (E)	India	-
lateriflorus (Gmelin) K.Lye	Hb. Wight (E)	India	1889
roylei (Nees) Ovczinn & Czukar	J. Chatterjee (E)	India	1958
	Sinclair & bin Salleh 40383 (E)	-	-
	Hb. Royle (K)	India	1886
subulatus (Vahl) Ohwi	B.L. Burtt B.1002 (E)	-	1958
	Ex Hb. Campbell 27 (E)	-	-
brachyceras (Hochst ex A. Rich.) K. Lye	Drümmond & Cookson 6574 (E)	N. Rhodesia	
paludicola (Kunth) Palla	L. MacOwan 1743 (K)	-	1871
	F. Wilms 1610 (E)	S. Africa	1895
pterolepis (Kunth) Oteng-Yeboah	Pl. Schlecht. Austro-Afr. 10473 (E)		1895
californicus (Mey.) Oteng-Yeboah	E.K. Balls 11837 (E)	Calif. (U.S.)	1958
americanus (Pers.) Volkart	Radford 44863 (E)	N. Carol. (U.S.)	1966
	W.N. Suksdorf 62 (E)	Washington DC (U.S.)	1912
	R.M. Harper 370 (E)	-	1900
hallii (Gray) - Oteng-Yeboah	M.L. Fernald & C.A.Weatherby 143 (E)	Mass. (U.S.)	1908
	Pl. Exsicc. Grayaea		
etuberculatus (Steud.) Oteng-Yeboah	S.M. Tracy 8627 (E)	Alabama (U.S.)	1903
(= Scirpus cylindricus (Torr.) Britt)	R.M. Harper 1095 (E)	Georgia (U.S.)	1901
	Ex Hb. Gray (K)	-	1866
	Sullivan (K)	Alabama (U.S.)	1845
	Drummond 268 (K)	Alabama (U.S.)	-
acutus (Muhl.) A. & D. Løve	A.A. Heller 9472 (E)	Nevada (U.D.)	1908
olneyi (Gray) Palla	J. Macoun 16408 (E)	Saskatch. (Canada)	1896
	R.M. Harper 2181 (E)	Georgia (U.S.)	1904
	E.L. Ekman H.47 (K)	-	1917
torreyi (Olney) Palla	Weatherby et al. 526 (E)	Mass. (U.S.)	1932
validus (Vahl) A.& D. Løve	W.T. Cody & R.L.Gutteridge 7835 (E)	Cañada	1953
riparius (Presl.) Palla	K. Fiebrig 2311 (E)	Bolivia	1903
	M. Glazion 9044 (K)	Brazil	1877
	E. Hassler 12255 (K)	Paraguay	1913
chilensis (Nees & Meyer) Oteng-Yeboah	Werdermann 428 (E)	Chile	1924

Schoenoplectus saximontanus (Fern.) Oteng-Yeboah	H.M. Pollard (E)	Calif. (U.S.)	1952
smithii (Gray) Oteng-Yeboah	A. Kneucker 190 (E)	-	1909
smithii var. williamsii (Fernald) Oteng-Yeboah	Dr. Henry 4212 (E)	Central China	-
triangulatus (Roxb.) Oteng-Yeboah	B.L. Burtt B.1521, B.675 (E)	W. Pakistan	1958
	J. Sinclair 4333 (E)	India	1945
praelongatus (Poir.) Oteng-Yeboah	F.R. Irvine 4753 (E)	Ghana	1961
Schoenoplectus spp.			
/Scirpus schlecten Schöul/	C.J. Ward 4025 (K)	S. Africa	1962
/Scirpus tuberculatus Schöul/	J.P.H. Acocks 2104 (K)	S. Africa	1937
/Scirpus fusco-rubens Koyama/	J. Cavalerie 4088 (K)	China	1918
	J. Cavalerie 8050 (K)	China	1918
*Scirpus sylvaticus L.	-	-	-
radicans Schkuhr.	A. Kneucker 153 (E)		1947
	K. Harz 5353 (E)		1907
ternatanus Reinw.	A. Henry 1400 (E)	China	1885-88
(= S. chinensis Munro)	K.L. Chu 2940 (E)	China	1936
	Handel-Mazzetti (E)	S.E. China	1936
	J. Cavalerie 1177 (E)	China	1900-20
	H.C. Cheo 371 (E)	China	1932
cyperinus (L.) Kunth	Handel-Mazzetti 7919 (E)	Yunnan	1915
	Handel-Mazzetti 12613	Hunan (China	1914
eriophorum Michx.	G. Forrest F.933 (E)	S.W. China	1903
	J.F. Rock 6400 (E)	China	1922
	G. Forrest 28018 (E)	China	1929
fuirenoides Maxim.	Handel-Mazzetti 12614 (E)	Hunan (China)	1914
	Rev. Pere Faurie (E)	Japan	1886
mitsukurianus Makino	Makoto Togasi N.S.M.T. 373 (E)	Japan	1951
	Hb. Yokohama Nursery Co. Ltd. (E)	Japan	1909
wichurai Boeck.	Ohwi & Koyama N.S.M. 320 (E)	Japan	1951
	M. Togasi T.N.S. 1260 (E)	Japan	1955
	K. Iwatsuki & H. Koyama 795 (E)	Japan	1966
atrovirens Willd.	A.A. Heller (E)	Pennsylvania (U.S.)	1901
	A. Kneucker 65 (E)	-	1902
	O.W. Knight (E)	Maine (U.S.)	1905
pallidus (Britt. Fern.	J.C. Blumer 1552 (E)	Arizona (U.S.)	1907
atrocinctus Fern.	M. Victorin et al. 7398 (E)	Quebec (Canada)	1944
	P.S. Green 3508 (E)	N.Y. (U.S.)	1959
microcarpus Presl.	C.C. Loan 208 (E)	Canada	1950
congdoni Britt.	E.B. Copeland 343 (E)	Calif. (U.S.)	1929
divaricatus Ell.	R.M. Harper 799, 1142 (E)	Georgia (U.S.)	1901
expansus Fern.	A.E. Radford 44890 (E)	North Carolina (U.S.)	1966
fontinalis Harper	R.M. Harper 2130 (E)	Georgia (U.S.)	1904
lineatus Michx.	W.C. Cusick 2900 (E)	Oregon (U.S.)	1902

Scirpus longii Fern.	F.F. Forbes 144 (E) (Pl. Exsicc. Grayanaea)	Mass. (U.S.)	1911
rubrotinctus Fern.	C.E. Gaston 9790 (E)	Ontario (Canada)	1963
peckii Britt.	W.W. Eggleston 251 (E)	Vermont (U.S.)	1901
polyphyllus Vahl	A. Ruth 218 (E)	Tenn. (U.S.)	1960
	J.R. Bozeman et al. 7780(E)	N. Carol. (U.S.)	1966
Asper Presl	E. Wendermann 82 (E)	Chile	1923
	Hugo Gunckel 18839 (E)	Chile	1950
sylvaticus L. var. bissellii Fern.	E.H. Eames 1022 (11963)(E)	Conn. (U.S.)	1939
Torulinium ferax Urb.	R.W. Haines 1811a (E)	Iraq	1960
eggersii (Boeck) Clarke	O. Buchtien 1225 (E)	Bolivia	1907
Trichophorum atacamensis (Boeck.) Oteng-Yeboah	Angel L. Cabrera 3557A (K)	Chile	1936
clementis (Jones) Oteng-Yeboah	F.W. Peirson 11300 (K)	Calif. (U.S.)	1934
clintonii (Gray) Oteng-Yeboah	F.J. Herman 7491 (K)	N.Y. (U.S.)	1936
	G.W. Clinton (K)	N.Y. (U.S.)	1865
mattfeldianum (Kükenthal) Oteng-Yeboah	W.T. Tsang 20501 (K)	Kwantung (China)	1932
alpinum (L.) Pers.	Makoto Togasi T.S.M. 947(E)	Hokkaido (Japan)	1953
(=S. hudsonianus (Michx.) Fern.	Gillet & Findlay 5476 (K)	Canada	1950
	Hb. John Ball (E)	Switzerland	1845
subcapitatum (Thw.) Ohwi	Huwaitti c.v. 306 (E)	Ceylon	1870
caespitosum (L.) Hartm.	E.P. Walker 627 (E)	Alaska (U.S.)	1915
	E.P. Walker 845 (E)	Alaska (U.S.)	1915
verecundum (Fern.) Oteng-Yeboah (= Scirpus planifolius Muhl.)	K.K. MacKenzie 670	New Jersey (U.S.)	1904
pumilum (Vahl) Shinz & Thell	D.G. Lowndes 973 (E)	Nepal	1950
filipes (Clarke) Oteng-Yeboah	R.C. Ching 1332 (E)	China	1924
	Dunn 3606 (K)	Fokien (China)	1905
rigidum (Steud. ex Boeck) Oteng-Yeboah	A.W. Hill 477 (K)	Peru	1903
	G. Mandon 1412 (K)	Bolivia	1859
Websteria confervoides (Poir.) Hooper	C. Wright (K) (Pl. Cubenses wightianea)	Cuba	1869
	B. Balansa 2550 (K)	Paraguay	1876
Genus A (= Scirpus junghuhnii Miq.	C.G.G.J. van Steenis 8484 (K)	Archipel India (Indonesia)	1937
	" " 8397(K)	"	1937
Genus B	G. Palusch (E)	Russia	1875
(= Blysmus 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