# SYSTEMATICS OF THE SOUTHERN AFRICAN SPECIES OF *CAREX* L. (CYPERACEAE)

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Graduated with distinction 30 April 1991.

A Dissertation Submitted to the Faculty of Science
University of the Witwatersrand, Johannesburg
for the Degree of Master of Science

Johannesburg 1991

## ABSTRACT

The southern African species of Carex L. are revised. Characters and character states are analyzed for habitat, macro- and micromorphology and cytology. The results of this study are presented in eleven tables, twelve photographic plates and three figures. Keys to the taxa and descriptions for each are generated from the character list, utilizing DELTA. A schematic classification of the genus is included. Sixteen species are recognized, including a new species, C. acocksii C. Reid, from the Hantamsberg, Calvinia district. An adventive species, C. sylvatica Huds., is here newly recorded. A putative hybrid, C. spicato-paniculata C.B. Cl. X C. zuluensis C.B. Cl., is discussed. Five names, C. merxmuelleri Podlech, C. schlechteri Nelmes, C. leribensis Nelmes, C. cognata Kunth var. drakensbergensis (C.B. Cl.) Kuekenth. and C. aethiopica Schkuhr var. latispica C.B. Cl., are here newly placed into synonymy. Nomenclature and typification for each taxon is discussed and distribution maps for each are provided. A distribution map indicating the number of species occurring per geographical degree square in southern Africa is included.

## DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Lisbe Reid

Eleventh day of January, 1991.

## ACKNOWLEDGEMENTS

My employers, National Botanical Institute, are thanked for allowing me to work part-time on this project. All colleagues who gave advice and instruction in techniques are thanked, in particular Mrs S.M. Perold and Dr. H.F. Glen (SEM), Mrs A. Botha (wax-embedding and microtoming) and Dr. G.E. Gibbs Russell (DELTA). Mrs A. Romanowski is thanked for all the printing of photographs, rephotographing of plates and for the photographs for Plate 1. Dr. M.L. Frean (University of the Witwatersrand) is thanked for the instruction in resin-embedding and for cutting sections on the ultramicrotome. Finally my friend and supervisor, Dr. K. Balkwill, is thanked for his enthusiastic interest in the project and for painstaking checking at every stage of text production.

## LIST OF CONTENTS

## APPENDICES

## LIST OF TABLES, PLATES, FIGURES AND DISTRIBUTION MAPS

# CHAPTER 1. INTRODUCTION

## 1. *Carex* in southern Africa - the problems

Since Linnaean times caricologists have concentrated on the production of inventories or monographs of the taxa of *Carex*, e.g. Schkuhr (1801 & 1806), Steudel (1840), Boott (1858--67), Boeckeler (1875--77) and many others. The most recent of these is Kuekenthal's 1909 monographic treatment of Caricoideae (in German), in which nearly 800 *Carex* species and many more varieties and forms (as well as hybrids) are recognized. Although this type of treatment is extremely valuable for many purposes, it is difficult to identify the species of a defined geographical area (due to very lengthy keys!) or to extract information about local characters and their variation - hence the necessity for regional treatments.

For the major part, regional African floras in which *Carex* is treated have not yet been published. Clarke, working overseas with limited material, provided a basic treatment of the southern African species in Flora Capensis (1898). Subsequent authors such as Nelmes (1940--55b) attempted to clarify the names and delimititations of these taxa, but the work was only partially completed. It is obvious that there is a need for a modern systematic treatment of the genus in the southern African region.

One of the major problems in the nomenclature of *Carex* is the absence of typification of names, compounded by the

absence of critical characters in the original descriptions. This has led to the misapplication of names to southern African taxa and proliferation of synonymy. In addition specimens that lack information (e.g. very young material) have been misidentified throughout history. A lack of understanding of the significance of exact locality and habitat has also caused misidentification or confusion of taxa. Recently, improved tools and techniques and more adequate amounts of good herbarium material have become available, enabling better taxonomic judgements to be made.

There is a large amount of recent "beta"-taxonomic literature relating to the northern hemisphere representatives of the genus Carex (e.g. Bruederle et al., 1989). Apart from the basic principles involved, which are applicable to both "alpha"- and "beta"-taxonomy, this literature has little relevance to the present study, which is of necessity "alpha"-taxonomic in nature.

The aim of this study, therefore, is to provide a modern taxonomic revision of the southern African representatives of the genus Carex, utilizing many modern tools and techniques (i.e. use of the Scanning Electron Microscope, and computer-generated keys and descriptions). Other tools and techniques, e.g. cladistic analysis, palynology and cytology were not utilized.

## 2. Classification of Carex

Cyperaceae is a large family, comprising about 70 genera and 3 700 species (Schultze-Motel, 1980). Characters of the family are discussed in detail by Kern (pp. 435--452, 1974) and summarized in Dahlgren, Clifford & Yeo (1985); the family is usually divided into two sub-families, Cyperoideae and Caricoideae (Kern, 1974), mainly on the basis of reproductive characters. Sub-family Cyperoideae contains the tribes Hypolytreae, Cypereae (including Scirpeae), and Rhynchosporeae, while Sub-family Caricoideae contains the tribes Sclerieae and Cariceae. (There are in reality almost as many different classifications as there are researchers in Cyperaceae, e.g. frequently Sclerieae is placed in its own Sub-family, Sclerioideae (Reznicek, 1990).) Carex is placed in Tribe Cariceae, together with Schoenoxiphium Nees, Kobresia Willd. and Uncinia Pers., as well as a few monotypic genera which are not always recognized (Nelmes, 1952; Kern, 1974). Fig. 1 is a schematic representation of this classification. The subgenera as recognized by Kuekenthal (1909) are also indicated in Fig. 1. These subgenera are also controversial and frequently authors (e.g. Reznicek, 1990) recognize only three, with the species of Subgenus Primocarex being placed within Subgenus Carex.

### 2.1. The Tribe Cariceae

This tribe is chiefly characterized by extremely reduced, unisexual flowers lacking a perianth, and by the

occurrence of the perigynium (utriculus).

The pistillate flower is represented by a solitary, naked gynoecium, subtended by two structures, a perigynium and a glume-like bract (Fig. 2b and c). The perigynium, which is of extreme taxonomic importance, was shown by Kunth (1835) to be a single modified prophyll rather than a perianth, and is therefore extrafloral. (He also suggested that the perigynium is derived from two fused bracts, but this theory has since been discarded (Smith & Faulkner, 1976).) The prophyllar theory is upheld by many recent authors (e.g. Snell, 1936; Blaser, 1944; Smith & Faulkner, 1976; Haines & Lye, 1983), mainly on anatomical and teratological evidence. In Cyperaceae the first "leaf" of every lateral inflorescence branch is generally a bicarinate (two-keeled) prophyll (Kern, 1974). The size, texture and nervation may vary, depending on the order and position of the branch and whether the prophyll is exposed, or concealed by the sheath of the opposing bract. It has been fairly conclusively shown (Snell, 1936) that the individual pistillate and staminate spikelets are themselves reduced branches, thus confirming Kunth's original conclusion. This theory of the nature of the perigynium is upheld in the present study. Hereafter the prophyll, except where it is modified as a perigynium, is referred to as a bracteole, because it is adaxial to a bract.

The perigynium may be open and bract-like in some Kobresia species, partially closed in some Schoenoxiphium

species, or completely closed (thus enclosing the pistillate flower, with an orifice through which the stigmas are exserted) in Carex and Uncinia and in the presumably more advanced members of the former two genera. In these taxa the fruit and perigynium together comprise the disseminule.

The staminate flowers throughout the tribe have large exserted anthers (typical of anemophilous plants); each is subtended by a glume-like bract (Fig. 2d and e).

Bisexual spikelets occur frequently in Schoenoxiphium and Kobresia, but are rare in Carex and Uncinia, and in Carex are interpreted as teratological in origin (Smith & Faulkner, 1976). Thus, the two genera represented in Africa, namely Carex and Schoenoxiphium, are usually fairly easily distinguishable on sight. There are, however, a few species of Schoenoxiphium that bear unisexual single-flowered spikelets and are otherwise similar in facies to species of Carex in the Subgenus Indocarex. In these species of Schoenoxiphium there is a large flattened structure, which represents the rudimentary rhachilla of the staminate spikelet (Levyns, 1945), present within the perigynium. This structure is absent in Carex, apart from some easily identifiable species of Subgenus Primocarex, or sometimes in basal spikelets in the other two subgenera (Vignea and Carex), in which it is always a reduced filiform structure. Primocarex as construed by Kuekenthal is thought to be polyphyletic in origin (Nelmes, 1952; Reznicek, 1990), and many authors do not recognize it as a subgenus. Furthermore,

it is probable that at least some of the recently described southern African species that bear rhachillae should be transferred to Schoenoxiphium (Nelmes, 1952; Kukkonen, pers. comm.).

To summarize the above discussion, distinguishing characters of Carex are the unisexual, single-flowered spikelets, of which the individual pistillate spikelets comprise a gynoecium lacking a perigynium, and are usually unaccompanied by a rhachilla except in Subgenus Primocarex; each is subtended by two extrafloral structures, adaxially by a closed perigynium and abaxially by an open, glume-like bract; the individual staminate spikelets comprise an androecium, subtended by one extrafloral structure, an abaxially inserted glume-like bract.

Although Carex has been recognized as a taxon since antiquity (Robertson, 1979), generic delimitation in Cariceae has always been problematical. Since 1753 about 33 generic synonyms have been recorded within Carex itself (Hooker & Jackson, 1895; Kuekenthal, 1909). Fortunately they have never been applied to the southern African taxa with the exception of C. divisa. so they are not discussed, but are merely listed in the Systematic Section (Chapter 5). A number of southern African species that were placed in Carex by Clarke (1894, 1898), were subsequently transferred to Schoenoxiphium by Kuekenthal (1909). Although there is as yet no entirely satisfactory resolution of genera, Kuekenthal's decisions are upheld by Kukkonen (1983), who is

currently engaged in a systematic revision of the southern African species of Schoenoxiphium. For the purposes of this study it has been possible to reach agreement with Kukkonen on the problematical issue of generic limits between Carex and its apparent sister genus, Schoenoxiphium, applying the strict definition of Carex as discussed above. Future monographic studies of Cariceae may very well lead to a different circumscription of genera, but for the purposes of the present investigation the currently accepted generic concepts are upheld.

Authors prior to Kuekenthal (e.g. Boeckeler, 1875--77), formally or informally recognized a number of natural groupings within the genus. Kuekenthal (1909) formally divided Carex into four subgenera, 69 sections and many subsections. Unfortunately he did not designate types, and the names applied to these subdivisions, being subject to the rules of the International Code of Botanical Nomenclature (Jermy & Tutin, 1968), still require typification. This is not attempted in the present study. Recent taxonomic literature has either ignored these subdivisions, and employed a different classification, or has concentrated on refining them (e.g. Crins & Ball, 1988), but the subdivisions remain controversial (Schultze-Motel, p. 98, 1980, and references therein) and are frequently retained as a matter of convenience rather than as a reflection of phylogeny. These subdivisions are listed in the Systematic Section (Chapter 5). The four subgenera

recognized by Kuekenthal are discussed in some detail in Chapter 2 because they directly reflect the four types of inflorescence structure that occur in Carex.

### 3. Important collectors of the genus in southern Africa

Only two categories of people have collected Carex in southern African, namely:

(1) professional botanists, collectors and interested amateurs who methodically sampled the flora of particular areas, and

(2) travellers who collected and pressed whatever scraps they could, in the short time available to them.

The third category of botanical collectors in southern Africa comprises people who were sent, usually by wealthy patrons, to search for species of horticultural interest. At that time Cyperaceae were considered to have no horticultural value (this is a possible reason for the existence of relatively few synonyms) and were generally avoided by these collectors. It is interesting to note that in recent years, with the increasing interest in "landscape gardening", a number of cultivars of Carex have become available in the nursery trade.

All the collectors of Carex are listed alphabetically in Appendix 1.1; they are discussed in detail in Gunn & Codd (1981) and Codd & Gunn (1985), so some of the first category only, are briefly mentioned here.

The earliest known southern African Carex collections

were made around 1772 in the winter rainfall area, by two Swedes who arrived independently at the Cape, A. Sparrman and the "Father of Cape Botany", C.P. Thunberg. Thunberg published the results of his Cape expeditions (1794, 1811, 1823), describing two Carex species, C. clavata and C. glomerata (a synonym of C. glomerabilis Krecz.) in 1794. A third species he described is now placed in Schoenoxiphium and a fourth species he described, C. vesicaria, is now regarded as a synonym of C. clavata. A fifth species, C. aethiopica, was published by Schkuhr in 1801. The Thunberg specimens, many of which are types, are mostly at UPS, but are singularly uninformative regarding locality or habitat; they are also unavailable for loan purposes.

Between 1810 and 1815 the British naturalist, W. Burchell, travelled extensively in southern Africa, and recorded many well-documented localities for Carex, also collecting specimens of C. burchellii, published by Boeckeler in 1877. The specimens were donated to K in 1865.

J.F. Drège worked as a professional collector at the Cape, undertaking numerous expeditions between 1826 and 1834. With his numbers he collected many duplicates which were eventually sold to European herbaria; an alphabetical list of species, cross-referenced to the collecting localities, was published (Drège, 1843). Drège's numbering is somewhat confusing, as in his published account (Drège, 1843) the specimens are indexed by a very complicated system. Additionally the specimens were only numbered after

Drège's return to Germany, and some numbers appear to have been duplicated. Several of his Carex specimens were described as new species (Kunth, 1837), but have subsequently been found to be synonymous with previously described taxa, or to be recent adventives. The sheets in K have collecting numbers added in what appears to be Clarke's handwriting.

C.F. Ecklon and C.L.P. Zeyher, botanical collectors, undertook several joint expeditions between 1829 and 1832, mainly to the south-western, southern and eastern Cape. During this time each also collected independently, and Zeyher collected independently prior to, and subsequent to, this period. Details of their itineraries are provided in Gunn & Codd (1981, appendix).

The German botanist F.R.R. Schlechter, while living at the Cape made several trips into the interior, between 1891 and 1898. His collection is one of the first major contributions to the study of the summer rainfall taxa.

In the latter part of the nineteenth century P. MacOwan, H. Bolus and J. Medley Wood, among others, were engaged in collecting activities in the eastern Cape, south-western Cape and Natal respectively. Much of their material was pooled in an exchange club known as the Herbarium Normale Austro-Africanum, and sets of specimens were sold to overseas herbaria.

At about the same time, and continuing into the early twentieth century, E.E. Galpin was collecting extensively,

mainly in the summer rainfall region; he also encouraged relatives and acquaintances to collect specimens in other parts of the country. Important collections were made in the Witteberg near Barkly East and in the mountains near Barberton, which yielded many new species in several plant families, and included Carex subinflata Nelmes. Galpin's original specimens were donated to the National Herbarium, Pretoria (PRE) in 1916.

J.P.H. Acocks, who between 1940 and 1953 was engaged in surveying and mapping the vegetation of southern Africa, travelled the length and breadth of the country, discovering many new taxa and new records. He is to be commemorated in a new species described in the present study. Acocks' original specimens are housed in the National Herbarium, Pretoria.

O.M. Hilliard (while based at Natal University, Pietermaritzburg) and B.L. Burtt (Royal Botanic Gardens, Edinburgh) have in recent years jointly collected extensively in the southern Drakensberg in Natal, Lesotho and eastern Cape Province, making large population samples of the high-altitude summer rainfall taxa available for the present investigation.

## 4. General Phytogeography and Habitat of Carex

Cyperaceae are thought to have originated as lowland, forest-floor plants in the late Cretaceous or early Tertiary period and to have rapidly diversified into open, upland and subpolar regions (Ball, 1990). Carex is by far the largest

and most diverse genus of the family, containing about half the species (Reznicek, 1990). It is cosmopolitan, comprising 1 500--2 000 species worldwide (Willis, 1973). In a recent paper Ball (1990) discusses some aspects of the phytogeography and origins of Carex and of the three subgenera he recognizes. Such a study, as he clearly states, cannot be conclusive while the taxonomy remains largely unresolved. Available phytogeographical evidence, however, indicates an early Tertiary origin (i.e. 65 million years ago (Raven & Axelrod, fig. 5, 1974)) for the genus, with the major groups being well-established and widely dispersed by the mid-Tertiary.

While its value as a natural part of wetland ecosystems is inestimable, the genus has known economic importance as pasturage (Catling, Reznicek & Crins, 1990), and the fruits as wildfowl feed, in the northern hemisphere, where there is a high concentration of species (119 recorded in Illustrierte Flora von Mitteleuropa: Schultze-Motel, 1980; 180 recorded in Flora Europaea: Chater, 1980; 214 in northeastern United States: Gleason & Cronquist, 1963). The species occupy a wide range of wet or moist habitats, and form a counterpart to the Poaceae of south temperate regions (Good, 1974). In the south temperate areas, species diversity and habitat range of the genus Carex is much restricted, so that during the present study only sixteen species have been recorded from southern Africa. The majority of these species are widely distributed within the

summer rainfall area, and some are cosmopolitan or vicariant taxa. A number are apparently endemic to the region. Although there is some overlap of taxa, the winter rainfall species are generally quite different and much fewer in number (Map 1).

All of the southern African species occur on forest margins or in permanently marshy or moist areas. These ecologically vulnerable habitats are disappearing due to marginal farming practices and urbanisation. According to herbarium records and to observations made in the field during the present investigation, individual plants are infrequent or even rare in populations of some species. Many former southern African Carex localities no longer exist (pers. obs.). It is therefore possible that some of the southern African species (i.e. those with very particular habitat requirements) are threatened with extinction.

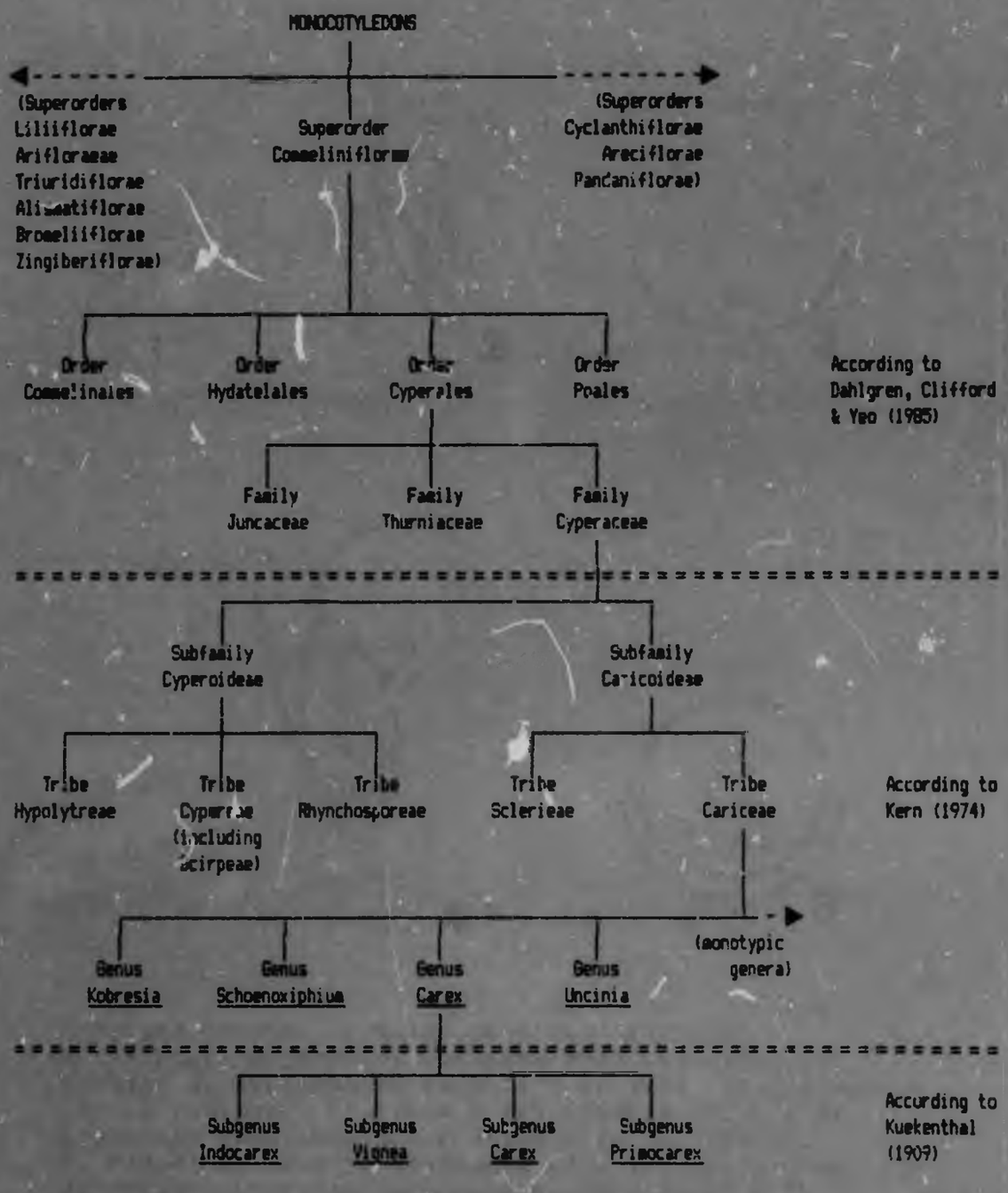



Fig. 1. Classification of Carex L. (schematic).

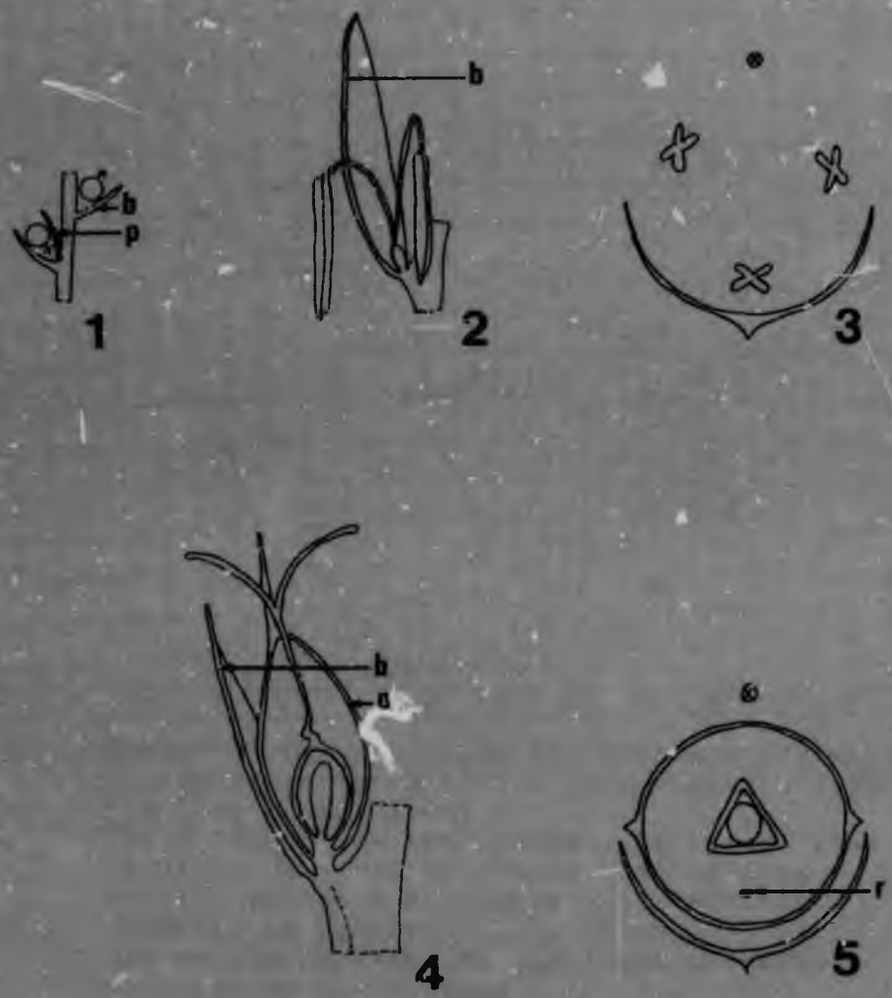
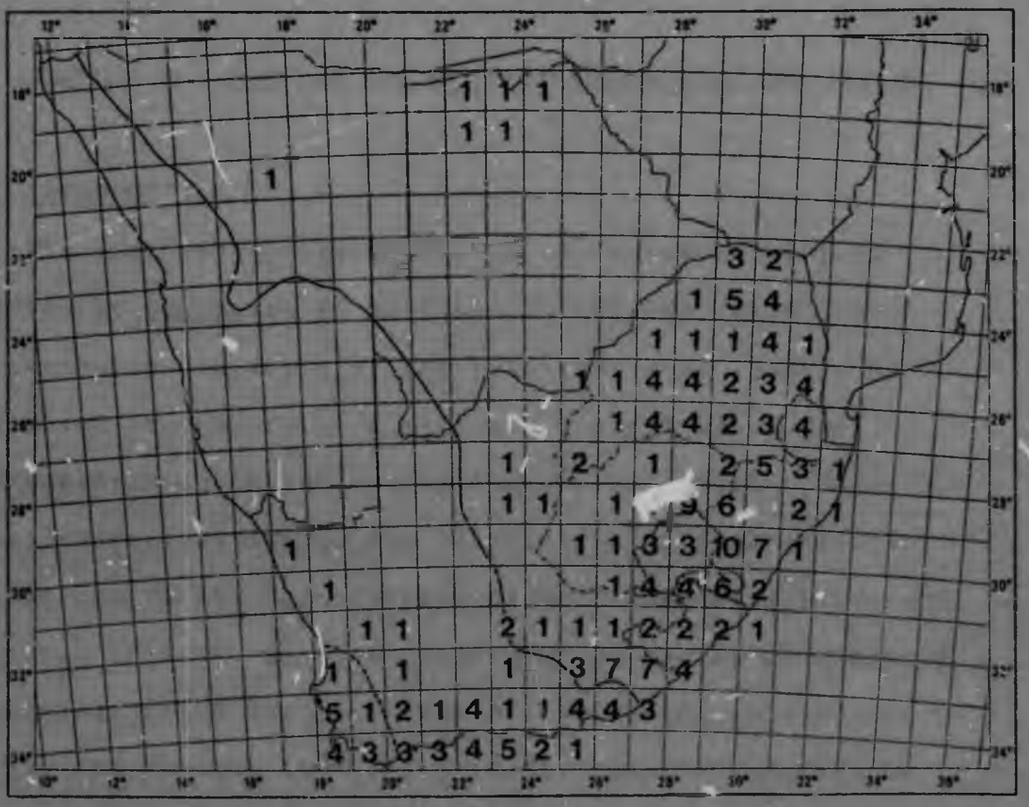



Fig. 2. Diagrams to show spikelet structure in Carex L. 1. Bisexual segment of ultimate inflorescence unit showing arrangement of spikelets on axis (diagrammatic) (after Dahlgren, Clifford & Yeo (1985)). 2. L/s of staminate spikelet (after Jermy & Tutin (1968)). 3. Floral diagram of staminate spikelet. 4. L/s of pistillate spikelet (C. cognata. Reid 1210) X 10. 5. Floral diagram of pistillate spikelet. b = bract of spikelet; p = perigynium; r = position of rhachilla.



Map 1. Number of Carex species per geographical degree square in southern Africa (see Appendix 1.2. for list of species).
Solid line = eastern boundary of region that receives rainfall in winter. Dashed line = western boundary of region that receives rainfall in summer.
The region between the two lines receives rainfall in all seasons.

# CHAPTER 2. HABITAT AND MACROMORPHOLOGICAL CHARACTERS

## A. INTRODUCTION

The most recent treatments of the southern African species of *Carex* are Flora Capensis (Clarke, 1898), and Kuekenthal's monograph of the tribe Cariceae (1909). As discussed in Chapter 1, a relatively small amount of inadequately collected material was available to these researchers, leading to the utilization of problematical characters in the construction of keys and delimitation of species. This statement is borne out by the large quantity of misidentified material encountered during this study.

In the present study, previously constructed keys to taxa and descriptions of taxa have been replaced by entirely new ones, based on a more extensive character set. It was necessary to verify the identity of taxa by consulting type material.

## B. MATERIALS AND METHODS

In order to obtain computer-generated identification keys and descriptions, a large number of qualitative and quantitative characters were recorded for habitat and macromorphological features. Characters that are normally recorded on labels, or are observable with the unaided eye or under an ordinary dissecting microscope were included.

The importance of characters for taxon delimitation was assessed in two ways. Firstly by a study of both old and

recent literature, in order to record all the characters that had been utilized in Carex by previous researchers. Literature references were verified in Stafleu & Cowan (1976--88). Secondly, a wide range of herbarium and live material was studied in order to establish how effectively these "traditional" characters delimited taxa, and also to search for additional useful characters.

Material, including type specimens, was borrowed from the following herbaria: B, BM, BOL, BUDW, GRA, K, MO, NBG, NH, NU, P, S, SAM, STE, TCD, Z: acronyms are according to Holmgren, Keuken & Schofield (1981). Material in J and PRE was examined in situ. Microfiche reproductions of the Thunberg herbarium, UPS, were examined at PRE.

Gunn & Codd (1981), Stafleu & Cowan (1976--88) and Holmgren, Keuken and Schofield (1981) were used to determine locations of holotypes and potential lectotypes. Unfortunately all types of names in Carex that may have been housed in B have been destroyed. A photograph of the holotype of C. aethiopica Schkuhr was supplied by HAL. About ten years ago the types of the southern African species were removed from the main herbarium at K for photography (T.H. Arnold, pers. comm.). They have evidently not all been reincorporated as they were not all sent on loan during the present study, initially causing a different interpretation of typification. Fortunately the photographs (which include several of Carex) were recently examined at PRE, enabling the typification to be corrected.

Greuter et al. (1988) was used as a guide when determining nomenclature of the taxa. Author abbreviations are according to an unpublished list at PRE, which is based on Stafleu & Cowan (1976--88).

Measurements were made with the aid of a Nikon SMZ-2B stereo microscope and a fine steel rule, and were recorded for each specimen on a prepared "specdata" sheet. To obtain a reasonable assessment of taxonomic variability, wherever possible one specimen was measured for each geographical quarter-degree square from which the taxon was recorded. For each taxon the "specdata" were summarized on a prepared "taxdata" sheet corresponding to the list of characters presented in Appendix 2.

In addition field observations were made, to supply information which, as explained in Chapter 1, is usually inadequately recorded or absent from existing herbarium specimens. These included: a systematic study of habitat, habit, and morphological variability within populations of as many taxa as possible, plus the collection and preparation of herbarium specimens comprising whole plants, including the rootstock. Up to 10 duplicates were prepared, ensuring that these represented a population sample. Two long trips of several thousand kilometres were undertaken to the summer rainfall area (eastern Transvaal, Natal, eastern Cape Province) and to the winter rainfall area (south-western and southern Cape Province) respectively. Short trips were made to some summer rainfall localities and an

additional trip was made to the Calvinia district, Cape Province, to collect a suspected new species. Pressed material and material preserved in FAA, of one taxon endemic to Lesotho (C. monotropa Nelmes) was collected by Dr. D.J.B. Killick. Material of three taxa was cultivated under mist-spray at Pretoria National Botanic Gardens.

Taxon distribution maps were plotted, using Leistner & Morris (1976) and 1 : 250 000 topocadastral maps of southern Africa in order to determine geographical grid references for specimen localities.

## C. GENERAL STUDY OF CHARACTERS

All of the characters that were studied are listed in Appendix 2 and in Tables 1 to 11; they are mostly self-explanatory, but some required a more intensive investigation: these are listed and discussed below (Sections D, F and H).

## D. CHARACTERS STUDIED IN DETAIL

### 1. Habitat

Kuekenthal (pp. 10--21, 1909) presented a detailed analysis of the phytogeographical affinities of the 69 sections that he recognized. However, when a small number of individual species from a limited geographical area are analyzed, it appears to be more meaningful to compare types of habitat rather than phytogeographical regions. Referring to Map 1, it can be easily demonstrated that the

geographical degree square containing the greatest species diversity (i.e. 29°S 29°E), also contains the largest range of habitats suitable for Carex, ranging from alpine bog, through montane forests to montane marshland. This degree square receives rainfall in summer.

For the relatively well-studied British species of Carex, Jermy & Tutin (1968) list fourteen different types of habitat, ranging from "Sea-spray zone, brackish ditches, estuarine flats" to "Wet corries and ledges above 2 000 ft altitude". Each has a characteristic assemblage of species with very little overlap. Habitats of the southern African taxa were examined in a similar fashion, although in less detail, as chemical analyses of water and soils were not easily obtainable.

2. Vegetative

Kuekenthal (1909) and Jermy & Tutin (1968) summarize the vegetative characters of Carex. A similar character list was constructed for the southern African species.

In his key to the southern African species Clarke (1898) utilizes a number of vegetative characters, e.g. rhizome length is used to distinguish C. divisa Huds. from C. glomerabilis Krecz. This character was studied to determine its usefulness in distinguishing these two species, particularly because much of the material appeared to be misidentified.

For the British species Jermy & Tutin attach some

importance to rhizome growth type, distinguishing monopodial and sympodial systems. An explanation of these growth types is required here: In monopodial systems negatively geotropic shoots are produced, usually singly and abaxially, from nodes on the (ageotropic) rhizome, while in sympodial systems it is the apex of the (ageotropic) rhizome that becomes negatively geotropic, turning upwards and producing a shoot. At the base of this shoot one or a few buds are produced adventitiously; these develop into new (ageotropic) rhizomes, with their apices becoming negatively geotropic and producing shoots ... etc. The length of the rhizome in the sympodial growth type determines whether the plant will be caespitose or long-rhizomatous. These growth types are frequently recognizable on herbarium material: Monopodial types usually have straight rhizomes and sympodial types usually have "looping" rhizomes. These are illustrated in Fig. 3. The southern African species were examined to determine the usefulness of this character.

### 3. Inflorescence Structure

It has already been noted that inflorescence structure is the basis for subgeneric classification of *Carex*.

Some inflorescence characters previously utilized in keys included total size, number of branches and degree of branching. Recently (Haines & Lye, 1972; Kukkonen, 1984, 1986) inflorescence structure of a small number of species has been analyzed and discussed in detail, utilizing a very

complex terminology, which is specific to the particular subgenus and species studied, and is not flexible enough to accomodate slight variation due to ecological factors, also rendering very difficult a general comparison between species of different subgenera.

In the present study inflorescence structure was examined in detail: Firstly at subgeneric level, to ensure that the southern African taxa were correctly placed in their respective subgenera and that the subgenera were, at least for the present purposes, correctly delimited. Phylogenetic trends within the genus were also studied. Secondly inflorescence structure was studied at species level, to gain an impression of morphological variability within and between taxa. Comparative inflorescence structure was also studied in order to devise relatively simple descriptive terms which would be useful in constructing keys to and descriptions of the southern African taxa.

The distribution of staminate and pistillate spikelets within the inflorescence was examined in detail, because although this character has been widely used in keys (e.g. Clarke, 1898), it appeared to be rather variable and unreliable as a diagnostic character.

### 3.1. Glossary of Descriptive Terms for Inflorescence, Spikelets and Flowers

Accessory spike = small spike occurring at base of (usually basal) pistillate spike.

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### 3.1. Glossary of Descriptive Terms for Inflorescence, Spikelets and Flowers

Accessory spike = small spike occurring at base of (usually basal) pistillate spike.

**Androecious** = male (alternative term for staminate).

**Androgynecandrous** = spikelets of a single sex grouped together in a particular order from apex, viz. staminate-pistillate-staminate. Refers to ultimate unit of inflorescence.

**Androgynous** = spikelets of a single sex grouped together in a particular order from apex, viz. staminate-pistillate. Refers to ultimate unit of inflorescence.

**Cladoprophyll** = bracteole that is adaxial to bract that subtends primary units of inflorescence. Used by Kuekenthal (1909).

**Clustered** = descriptive of appearance of primary inflorescence units when internodes are very short.

**Coflorescence** = alternative term for primary inflorescence unit.

**Diclinous** = flowers unisexual i.e. stamens and pistils occur in separate flowers on the same plant.

**Dimorphic** = of two different forms. Refers especially to the bracts that subtend the spikelets in C. acutiformis. in which those of the staminate spikelets differ markedly from those of the pistillate spikelets.

**Glomerule** = descriptive of ultimate inflorescence units of Subg. Vignea in which the ultimate axis is vertically compressed and thus the spikelets are very crowded.

**Gynecandrous** = spikelets of a single sex grouped together in a particular order from apex, viz. pistillate-staminate. Refers to ultimate unit of inflorescence.

Gynoecious = female (alternative term for pistillate).

Perigynium = modified bracteole that subtends and encloses pistillate flower.

Pistillate = female. Refers to flower, spikelet, or to ultimate unit of inflorescence (when unisexual).

Primary inflorescence unit = first major division of inflorescence, arising on main inflorescence axis. Includes an entire system of branches in paniculate inflorescences and = a spike in inflorescence types that comprise a raceme of spikes.

Protandrous = stamens ripen before pistils (in Carex, staminate flowers mature before pistillate flowers in inflorescence).

Rostrum = distal, usually drawn-out portion of perigynium.

Staminate = male. Refers to flower, spikelet, or to ultimate unit of inflorescence (when unisexual).

Synflorescence = alternative term for compound inflorescence.

Ultimate inflorescence unit = final division of inflorescence, that is subtended by a bract and bracteole. Refers to branch, glomerule or spike.

Utricle = alternative term for perigynium.

## E. RESULTS OF GENERAL STUDY OF CHARACTERS

Characters that are common to all the southern African species of Carex are listed in the generic description (Chapter 5). Characters with their component character

states, that distinguish the southern African taxa are listed in Appendix 2 and in Tables 1, 2 and 4 to 7. These were utilized in the DELTA (DEscriptive Language for TAxonomy) computer programme to generate keys to the species and descriptions thereof, presented in Chapter 5.

## F. RESULTS OF CHARACTERS STUDIED IN DETAIL

### 1. Habitat

During fieldwork in some marshland areas, potential Carex sites could be recognized from a distance by the presence of large aquatic emergents e.g. Typha and Phragmites species in the summer rainfall area, and Prionium and Carpha species in the winter rainfall area, all of which signify the occurrence of perennial water.

Descriptions of habitat for each species are summarized in Table 1.

### 2. Vegetative

Vegetative characters that distinguish the southern African species are listed in Table 2. Diagnostic features are underlined.

With respect to rhizome length, population studies of C. glomerabilis showed that this species frequently produced rhizomes as long as those of C. divisa, therefore this character did not effectively distinguish these two species.

Rhizome growth (i.e. monopodial or sympodial) was not easily determinable in the majority of specimens due to

their being poorly collected. The specimens could, however, be categorized by the rather vague "caespitose" and "long-rhizomatous", which are descriptive terms employed by most collectors when completing labels.

### 3. Inflorescence Structure

Inflorescence characters of the four subgenera are summarized in Table 3. Representatives of the four inflorescence types are depicted on Pl. 1.

Some previously utilized inflorescence characters included total size and number and degree of branching. In the field it was observed that plants growing in optimal conditions were robust, with correspondingly large, much-branched inflorescences, while plants growing in less ideal conditions (e.g. the outer, drier margin of marshes) were depauperate, with small, few-branched inflorescences. After a relatively short period under mist-spray cultivation these depauperate plants were indistinguishable from herbarium specimens of robust plants of the same species (see discussion of C. zuluensis, Chapter 5).

It was also observed that in the larger species (e.g. C. clavata and C. aethiopica), robust plants produced inflorescences over a period of time during the flowering season. Early in the flowering season, inflorescences were produced on central shoots that had apparently developed towards the end of the previous growing season. A little later during the flowering season, further inflorescences

were produced on side shoots that were apparently developed during the current growing season. The first inflorescences produced were much larger and more complexly branched than those that were produced later, on these side shoots. This latter type of inflorescence therefore resembled those that were produced on depauperate plants. In herbarium material there is no means of distinguishing these inflorescence types. Total size of inflorescence, plus number and degree of branching were therefore found to be rather variable within certain limits, and were clearly influenced by edaphic factors; this was confirmed by the results of the above population and cultivation studies.

Other previously utilized key and descriptive characters were found to be fairly constant within certain limits, even in depauperate specimens. These included the width of the ultimate inflorescence units (branches or spikes).

Although distribution of staminate and pistillate spikelets had been widely used in keys, this character was also found to be rather variable. The amount of variability was to some extent dependent on the taxon under consideration.

Characters of the inflorescence and spikelets that distinguish the southern African species, are listed in Tables 4 and 5. Diagnostic features are underlined.

## G. GENERAL DISCUSSION

The arrangement of taxa in Chapter 5 does not reflect a new classification scheme, being based upon that of Kuekenthal (1909), with some adjustments to the order of subgenera. In order to achieve a sound classification of the southern African species, some form of cladistic analysis should be attempted. Although intuitive determination of polarities of some characters could be made, a much broader study (including as many foreign species as possible) would have been required to be certain of these polarities. There are also high levels of homoplasy within the genus, between different sections (Standley, 1990). Determination of the outgroup at any level is also problematical. Crins (1990) recommends the use of character compatibility analysis of sections in which the taxonomy is fairly stable, in order to overcome these difficulties.

## H. DISCUSSION OF CHARACTERS STUDIED IN DETAIL

### 1. Habitat

Like their British counterparts, the southern African species were found to occupy very distinctive habitats. While not always diagnostic, it is clearly a very useful key and descriptive character.

If the results are compared with characters which function in dispersal, for example inflorescence structure and amount of inflation of the perigynium, it can be shown that the taxa are specifically adapted to particular

habitats. The forest-margin species, C. spicato-paniculata (Subgenus Indocarex) and C. mossii (Subgenus Carex), both have uninflated perigynia. The former species has a paniculate inflorescence; the perigynia are equipped with a basal callus which appears to be glandular and may contain elaiosomes, suggesting dispersal of the fallen fruits by ants (see Kern p. 444, 1974). C. mossii has a very large pendulous inflorescence which produces vast numbers of small, light fruits; wind-action would cause dispersal by a censer-type mechanism. Both these dispersal strategies ensure that at least some of the fruits would be dispersed at some distance from the parent plant. Open-marshland species of Subgenus Carex (e.g. C. clavata) have much-inflated perigynia, and species of Subgenus Vignea (e.g. C. glomerabilis) have corky material present at the base of the perigynia. Both these character states are undoubtedly adaptations to water-dispersal.

2. Vegetative

Although providing many valuable characters for delimitation of taxa, for the present purposes vegetative characters were generally avoided in keys, except where used selectively as confirmatory characters. This decision was partly due to the extreme variability of quantitative characters e.g. leaf width. Many suitable (and more stable) inflorescence characters are available and very effectively distinguish the few southern African species. The decision

was also partly due to the abundance of poorly collected material in herbaria. In these specimens the inflorescence, at least, is usually present, therefore a key that utilizes mainly inflorescence characters is more satisfactory when identifying these plants.

Although rhizome length was found to be a potentially useful descriptive character, its use in keys was avoided due to the general incompleteness of herbarium material. This problem undoubtedly led to Clarke incorrectly distinguishing C. divisa and C. glomerabilis on rhizome length. Rhizome length in these two species is in fact very similar, providing evidence of their close relationship.

Rhizome growth type, another potentially useful character, has been omitted from this study, although preliminary investigations indicated that, in the southern African species at least, growth was monopodial in Subgenus Vignea and sympodial in the remaining subgenera. It should be noted that, while species with short rhizomes are usually sympodial, species with long rhizomes are either monopodial or sympodial. Thus the terms adopted in this study ("caespitose" and "long-rhizomatous") cut across those used by Jermy and Tutin (1968).

Vegetative characters of the southern African taxa are undoubtedly neglected. Bernard (1990) and Reznicek and Catling (1986), who studied North American species, discuss various vegetative characters, mainly with reference to the life histories of the individual plants. With similar

intensive field studies of the southern African taxa it would be possible to produce a key to the species employing only vegetative characters. This would be especially useful for ecological surveys, which are frequently carried out when plants are in the vegetative phase.

### 3. Inflorescence Structure

The southern African taxa were found to be correctly placed in their respective subgenera as recognized by Kuekenthal. In Kuekenthal's classification Subgenus Primocarex, with its unispicate inflorescences, is regarded as the most primitive, followed by Subgenus Vignea, Subgenus Indocarex and finally Subgenus Carex. Recent authors (Smith & Faulkner, 1976, and references therein) differ from Kuekenthal, generally agreeing that Subgenus Indocarex has the most primitive inflorescence form, and that Subgenus Vignea and Subgenus Carex are derived (probably independently) from it. The position of Subgenus Primocarex remains problematical, and it is frequently not recognized as a subgenus, but the species it contains are certainly not the most primitive. In the Taxonomic Section (Chapter 5) the southern African species are arranged more-or-less according to Kuekenthal, but with the order of subgenera re-arranged to reflect these recent views.

Smith & Faulkner (Fig. 5, 1976) showed that many of the differences in inflorescence structure between the subgenera "arise by variation in the relative degree of development of

the bract primordium and the two axes at female flower nodes; these axes are the main axis and the female flower primordium respectively".

It should be emphasised that for practical reasons modern treatments of Carex require comparison of structures which are almost certainly homologous (Snell, 1936). In the present study, the term "ultimate inflorescence unit" in fact refers to inflorescence units of different orders, for example in Subgenus Indocarex to a(n apparent) branch and in Subgenus Carex to a(n apparent) spike. Each individual spikelet has been shown (Chapter 1) to comprise a much-reduced branch, so that the spike in Subgenus Carex should more correctly be referred to as a pseudo-spike. Additionally, because the trend in specialized Cyperaceae appears to be towards reduction and simplification of the inflorescence (Kern, 1974), it seems likely, although not proven conclusively, that the spikelet in Subgenus Carex and the ultimate branch in Subgenus Indocarex are equivalent.

In an important recent paper Reznicek (1990) discusses the evolutionary development of the inflorescence with respect to the subgenera, in some detail. Interestingly, and for the same reason as stated above (i.e. to facilitate comparison of inflorescences between subgenera) he resorts to the use of terminology very similar to that which has been developed for the present study.

Results of the population and cultivation study of inflorescences clearly showed that total size, plus number

of branches and degree of branching could not be employed as key characters or for taxon delimitation. Results of the study also influenced the decision to reduce a number of species to synonymy (see discussions of C. zuluensis, C. glomerabilis and C. cognata in Chapter 5).

In a study that supports the above discussion and is also relevant to the study of distribution of staminate and pistillate spikelets, Smith (1967) found experimentally that manipulation of complementary levels of auxin and kinetin could lead to development of either a lateral spike, or a staminate or pistillate spikelet, depending on the relative levels of each hormone. In nature these levels of hormone are undoubtedly influenced by edaphic conditions, leading to variation in size of inflorescence, degree of branching, and various abnormalities in sexual expression. Use of characters describing distribution of staminate and pistillate spikelets was therefore avoided in keys. On the other hand, width of the ultimate inflorescence units proved to be a reliable key character.

Stigma number shows an interesting trend. The tristigmatic condition is clearly primitive, as it occurs throughout Subgenus Indocarex, in which a number of other primitive character states are evident. This condition also occurs in most members of Subgenus Carex and Subgenus Primocarex. Although it is unclear how the distigmatic condition could be selectively advantageous, it has arisen in one section of Subgenus Carex, in some members of

Subgenus Primocarex, and occurs throughout Subgenus Vignea. Inflorescence structure in Subgenus Vignea is apparently a specialization of the panicle of Subgenus Indocarex, although it is not clear at which stage the distigmatic condition, and the basal culm nodes arose. Similarly the inflorescence of Subgenus Primocarex is somewhat anomalous, as the single spike appears to be a reduction from the multiple spikes of Subgenus Carex, but the presence of the rhachilla is interpreted as a primitive feature.

## I. CONCLUSIONS

The study of a large amount of herbarium material and population samples showed that many macromorphological characters, which had previously been utilized in keys, were for various reasons not suitable for the purpose. There were numerous other characters, particularly those of the inflorescence and perigynium, which could be better utilized.

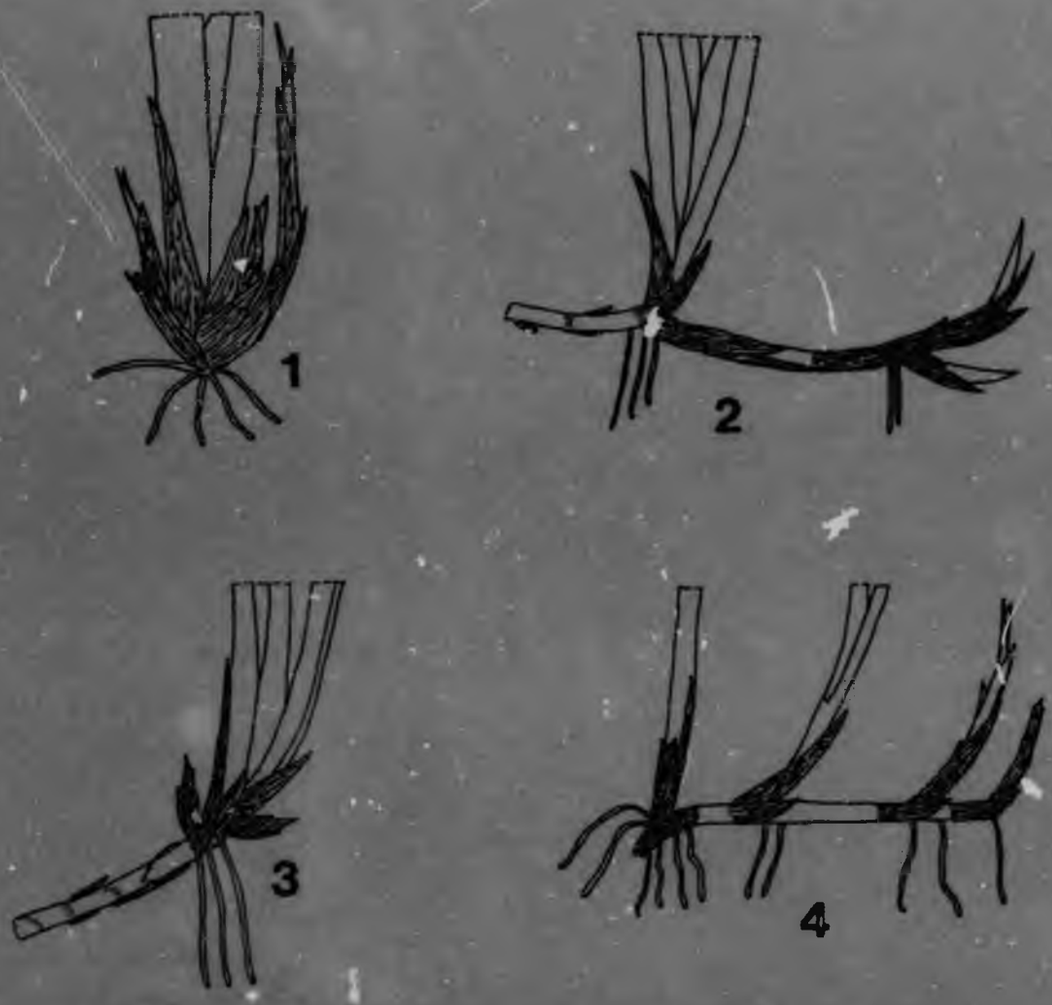


Fig. 3. Southern African species of Carex L.: Illustrations of rhizome types. Shoot scales and rhizome scales shaded.
1. Rhizomes very short; sympodial growth system; plant caespitose (C. clavata. Reid 1129) X 0,67.
2. Rhizomes very long; sympodial growth system; plant not caespitose (C. cognata. Reid 1187) X 0,4.
3. Rhizomes very short and very long in the same plant; sympodial growth system; plant forms a "tiller clump" (C. acutiformis. Reid 1367) X 0,5.
4. Rhizomes very long; monopodial growth system; plant not caespitose (C. glomerabilis. Reid 1148) X 1.5.

Table 1. Habitats of the southern African species of Carex L.

| Features | Taxa | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subgenus Indocarex | | Subgenus Vignea | | Subgenus Carex | | | | | | | | | | | Subg. Primocarex |
| | C. spicato-paniculata | C. cukomensis | C. divisa | C. oligocephala | C. austro-africana | C. exilis | C. aethiopica | C. sylvatica | C. burchelliana | C. acklonii | C. monotropa | C. cognata | C. acutiformis | C. clavata | C. subrubiginosa | C. sp. nov. |
| Physiographic distribution: | Midlands to montane | Near coast to montane | Near coast to midlands | Near coast to alpine | Midlands to montane | Midlands to montane | Near coast to midlands | Midlands | Midlands | Coastal | Alpine | Coastal to alpine | Midlands to alpine | Coastal | Midlands to alpine | Midlands |
| Vegetation type: | Forest margin | Forest margin | Marshland | Marshland | Marshland and riparian situations | Riparian situations on forest margin or in interior | Forest margin | Riparian situations in forest interior | Marshland | Marshland on sea shore | Marshland | Marshland, wet flush or riparian situations | Marshland | Marshland | Wet flush or riparian situations | Beneath sclerophyllous shrubs |
| Light conditions: | Partial shade | Partial shade (full sun) | Full sun | Full sun (partial shade) | Full sun (partial shade) | Partial or full shade | Partial or full shade | Full shade | Full sun | Full sun | Full sun | Full sun or partial shade | Full sun | Full sun | Full sun | Partial shade |
| Moisture regime: | Moist (wet) | Moist (wet) | Perennially waterlogged | Perennially waterlogged | Perennially waterlogged | Perennially waterlogged | Wet (moist) | Wet (moist) | Perennially waterlogged | Perennially waterlogged | Seasonally waterlogged | Perennially waterlogged | Perennially waterlogged | Perennially waterlogged | Seasonally waterlogged | Seasonally waterlogged |
| Substratum type: | Loam (clay) | Loam (clay) | Sand | Clay (loam) | Clay (loam) | Clay or loam | Clay or loam | Loam (clay) | Dolomite-derived | Sand | Basaltic | Clay or loam | Dolomite-derived, or clay or loam | Clay (loam) | Basaltic | Dolerite-derived |
| Rainfall regime: | Summer | Summer (all seasons) | Summer and winter | Winter, summer or all seasons | Summer | Summer | Winter (all seasons) | Summer | Summer | Winter (all seasons) | Summer | Summer, winter or all seasons | Summer (all seasons) | Winter (all seasons) | Summer | Winter |

**Table 2.** Macromorphological characters of the vegetative organs that distinguish the southern African species of *Carex* L.

| Features | Taxa | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subgenus *Indocarex* | | Subgenus *Vignea* | | | Subgenus *Carex* | | | | | | | | | | | Subg. *Primocarex* |
| | *C. spicato-paniculata* | *C. zuluensis* | *C. divisa* | *C. planorabilis* | *C. austro-africana* | *C. acossii* | *C. aethiopica* | *C. sylvatica* | *C. burchelliana* | *C. ecklonii* | *C. exotropa* | *C. cognata* | *C. cautiformis* | *C. clavata* | *C. subinflata* | *C. sp. nov.* |
| VEGETATIVE - | | | | | | | | | | | | | | | | | |
| Plants - height: | 1 000—1 400 mm | 1 000—1 150 mm | 100—415 mm | (100)—670 mm | 250—605 mm | 1 400 mm | 470—1 200 mm | 470 mm | 340—440 mm | 170—710 mm | 20—60 mm | 340—765 mm | 450—800 mm | 410—1 100 mm | 285—900 mm | 460 mm |
| Habit: | Caespitose | Caespitose | Long-rhizomatous | Long-rhizomatous | Caespitose or long-rhizomatous | Caespitose | Caespitose | Caespitose | Caespitose | Caespitose | Caespitose or long-rhizomatous | Caespitose or long-rhizomatous | Caespitose and long-rhizomatous | Caespitose | Caespitose | Caespitose |
| Rhizome diameter: | 4 mm | 2,5—3(—5) mm | 1,5—3,0 mm | 1,5—3,5 mm | 3 mm | 5 mm | 3—6 mm | 1,5—3,0 mm | 1,5—2,5 mm | 1,5 mm | 1,0—1,5 mm | 2,5—4,0 mm | 5 mm | 3—5 mm | 2,5—3,0 mm | 2,5—3,0 mm |
| Anthocyanin colouration in sheath scales and basal leaves: | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) | Intensively developed | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) | Absent (or present as small patches) |
| Leaves - glaucous: | No | No | No | No | Yes | Yes | Yes | No | No | No | No | No | Yes | Yes | Yes | No |
| Leaves - colour: | Dark green | Yellow-green or dark green | Yellow-green | Yellow-green or mid-green | Mid-green | Dark green | Dark green | Dark green | Mid-green | Yellow-green | Mid-green | Yellow-green | Mid-green | Yellow-green | Mid green | Mid-green |
| Transverse venation: | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous | Very conspicuous | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous | Usually not conspicuous |
| Basal leaf sheath - shape: | Folded | Folded | Tubular | Tubular | Folded | Folded | Folded | Folded | Folded | Tubular | Folded | Folded | Folded | Folded | Folded | Tubular |
| Old basal leaf sheaths becoming spongy: | No | No | No | No | No | No | No | No | No | No | No | No | Yes | No | No | No |
| Adaxial face of basal sheaths - mode of splitting: | Splitting simply | Splitting simply | Splitting simply | Splitting simply | Tearing into membranous strips | Splitting simply | Tearing into membranous strips | Splitting simply | Splitting simply | Tearing into membranous strips | Tearing into membranous strips | Tearing into membranous strips or splitting simply | Splitting into connected fibrillae | Splitting simply | Tearing into membranous strips | Tearing into membranous strips |
| Largest basal leaf blade - dimensions: | 600 × 8,5—14,0 mm | 500—650 × 7—12 mm | (140)—150 × 2,0—2,5 mm | 130—300 × 2,5—5,0(—9,0) mm | 300—480 × —7 mm | 485 × 12—15 mm | 800—1,50 × 7—12 mm | 450 × 7—9 mm | 200—250 × 4—5 mm | 20—340 × 2,5—4,0 mm | 65—100 × 2,2—3,0 mm | 230—[illegible] × 6—8 | 550 × 5—10 mm | 300—500 × 6—11 mm | 220 × 6—10 mm | 220 × 0,75 mm |
| Blade - shape in cross-section: | Flat or plicate | Flat | Channelled | Flat or channelled | Flat or plicate | Flat or plicate | Flat, keeled or plicate | Flat | Flat | Channelled or plicate | Flat or keeled | Flat | Flat or plicate | Plicate | Flat or plicate | Channelled |
| Adaxial surface - indumentum: | Scabrid in vicinity of veins | Scabrid in vicinity of veins | Papillate | Papillate | Glabrous | Glabrous | Glabrous | Glabrous | Glabrous | Glabrous | Glabrous | Scabrid in vicinity of veins | Glabrous | Glabrous | Glabrous | Glabrous |
| Abaxial surface - indumentum: | Glabrous | Glabrous | Glabrous | Glabrous | Papillate | Papillate | Papillate | Glabrous | Glabrous | Glabrous | Glabrous | Scabrid | Papillate | Papillate | Papillate | Glabrous |
| Margins - indumentum (low mag.): | Proximal: glabrous Distal: minutely scabrid | Proximal: glabrous Distal: minutely scabrid | Proximal: glabrous Distal: minutely scabrid | Proximal: papillate Distal: scabrid | Proximal: glabrous Distal: minutely scabrid | Proximal: papillate Distal: scabrid | Proximal: glabrous to papillate Distal: minutely scabrid to scabrid | Proximal: papillate Distal: scabrid | Proximal: papillate Distal: scabrid | Proximal: glabrous Distal: minutely scabrid | Proximal: papillate Distal: scabrid | Proximal: glabrous Distal: minutely scabrid | Proximal: glabrous Distal: minutely scabrid | Proximal: papillate Distal: scabrid | Proximal: papillate Distal: scabrid | Proximal: glabrous Distal: minutely scabrid |
| Lowest cula leaf - shape of sheath mouth: | Truncate or concave | Concave | Truncate | Truncate | Concave | Convex | Truncate | Concave | Convex | Concave | Concave | Truncate, or usually concave | Concave | Concave | Concave | Concave |
| Sheath mouth - texture: | Membranous | Herbaceous | Membranous | Membranous | Membranous | Membranous | Membranous | Membranous | Membranous | Membranous | Membranous | Membranous | Herbaceous | Membranous | Membranous | Membranous |
| Ligule - texture and colour: | Membranous Stramineous or fuscous | Membranous Fuscous | Membranous Fuscous | Membranous Whitish or stramineous | Membranous Fuscous | Membranous Fuscous | Membranous Stramineous | Membranous Stramineous or fuscous | Membranous Fuscous | Membranous Fuscous | Membranous Whitish | Membranous Stramineous | Membranous. Whitish, stramineous or fuscous | Membranous. Whitish with ferruginous spots | Membranous. Whitish with ferruginous spots | Membranous Fuscous |
| Ligule - height: | 3 mm | 4 mm | 1,5 mm | 1,5—2,0 mm | 7—11 mm | 20 mm | 1,3—2,5 mm | 5 mm | 2—4 mm | 1 mm | 2 mm | 4 mm | 14 mm | 35 mm | 35(—45) mm | 1 mm |
| Ligule - apex: | Acute to obtuse | Acute or obtuse | Obtuse | Obtuse | Acute | Acute or emarginate | Acute | Emarginate | Acute | Obtuse (to emarginate) | Obtuse | Acute or obtuse | Acute | Acute | Acute | Obtuse |

Table 3. Description of the inflorescence in the four subgenera of *Carex* L.

| Feature | Subgenus | | | |
|---|---|---|---|---|
| | Indocarex | Vignea | Carex | Primocarex |
| Inflorescence - description | Panicle | Spike or panicle of glomerules | Raceme of spikes | Single spike |
| Primary branches - description | Primary units of inflorescence sometimes paired, all pedunculate | Branches sessile, vertically compressed | Spikes pedunculate | N/ap |
| Bracts and bractelets - description | Primary bracts leaf-like, sheathing basally. Opposing bracteoles (cladoprophylls) tubular, concealed by bract sheaths. Higher order bracts setaceous. Opposing bracteoles exposed, frequently inflated and perigynium-like | Primary bracts setaceous, not sheathing. Opposing bracteoles neither sheathing nor inflated | Primary bracts leaf-like, sheathing basally. Opposing bracteoles (cladoprophylls) tubular, concealed by bract sheaths | Basal bract glume-like (to setaceous) |
| Staminate and pistillate flowers - distribution | Ultimate units of inflorescence bisexual, androgynous | Ultimate units of inflorescence bisexual, androgynous | Ultimate units of inflorescence unisexual or bisexual, usually apical units staminate, basal units pistillate and median units androgynous, frequently all units androgynous or mixed | Inflorescence bisexual, androgynous (in the southern African species) |
| Stigmas - number | 3 | 2 | 3 (2) | 3 (in the southern African species) |

N/ap = not applicable

Table 4. Macromorphological characters of the inflorescence that distinguish the southern African species of Carex L

| Features | Taxa | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subgenus Indocarex | | Subgenus Vignea | | | Subgenus Carex | | | | | | | | | | | Subg. Pricorarex |
| | C. spicato-paniculata | C. zuluensis | C. divisa | C. glomerabilis | C. austro-africana | C. aossii | C. aethiopica | C. sylvatica | C. burchelliana | C. acklonii | C. monostroma | C. cognata | C. acutiformis | C. clavata | C. subinflata | C. sp. nov. |
| INFLORESCENCE - | | | | | | | | | | | | | | | | | |
| Culm cross-section: | Triangular | Triangular | Triangular | Triangular | Sharply triangular | Triangular | Triangular | Triangular | Triangular | Triangular | Triangular | Sharply triangular | Sharply triangular | Triangular | Triangular | Terete |
| Culm diameter: | 2—3 mm | 1,5—2,7 mm | 1 mm | 1—3 mm | 2 mm | 2,5—4,0 mm | 1,5—3,0 mm | 1,5—2,0 mm | 1,2—1,7 mm | 1—2 mm | 0,5—1,0 mm | 2—3 mm | 2—3 mm | 1,5—3,0 mm | 1,5—2,0 mm | 0,8—1,2 mm |
| Culm nodes and internodes - description: | Internodes all of about equal length, exposed | Internodes all of about equal length, exposed | Uppermost internode very long, lower all basal, very short, concealed by leaf sheaths | Uppermost internode very long, lower all basal, very short, concealed by leaf sheaths | Uppermost internode very long, lower all basal, very short, concealed by leaf sheaths | Internodes all of about equal length, exposed | Internodes all of about equal length, exposed | Internodes all of about equal length, exposed | Internodes all of about equal length, exposed | Internodes all of about equal length, exposed | Culm very short, concealed by leaf sheaths | Internodes all of about equal length, exposed | Uppermost internode very long, lower all basal, very short, concealed by leaf sheaths | Internodes all of about equal length, exposed | Internodes all of about equal length, exposed | Uppermost internode very long, lower all basal, very short, concealed by leaf sheaths |
| Nodes exposed: | (1—)2—3 | 2—3 | 0 | 0 | 0 | 2 | 1—2 | 1—2 | 1 | 0—1 | 0 | 1—2 | 0 | (0—)2 | 2—3 | 0 |
| Inflorescence - description: | Panicle | Panicle | Spike of glomerules | Spike or panicle of glomerules | Raceme of spikes | Raceme of spikes | Raceme of spikes | Raceme of spikes | Raceme of spikes | Raceme of spikes | Raceme of spikes | Raceme of spikes | Raceme of spikes | Raceme of spikes | Raceme of spikes | Raceme of spikes | Single spike |
| Inflorescence dimensions: | 270—335 x 35—40 mm | 240—505 x 20—60 mm | 12—17 x 7—8 mm | 15—60 x 8—15 mm | 50—310 mm long (width n/av) | 280—560 mm long (width n/av) | 165—445 mm long (width n/av) | 200—330 mm long (width n/av) | 80—440 mm long (width n/av) | 20—50 mm long (width n/av) | 12—20 mm long (width n/av) | 115—195 mm long (width n/av) | 130—400 mm long (width n/av) | 115—650 mm long (width n/av) | 65—110 mm long (width n/av) | 14—28 x 7 mm |
| Basal bract - description: | Leaf-like, not reflexed near base | Leaf-like, not reflexed near base | Bristle-like | Bristle-like | Leaf-like, not reflexed near base | Leaf-like, not reflexed near base | Leaf-like, not reflexed near base | Leaf-like, not reflexed near base | Leaf-like, not reflexed near base | Leaf-like, reflexed near base at maturity | Leaf-like, not reflexed near base | Leaf-like, not reflexed near base | Leaf-like, not reflexed near base | Leaf-like, not reflexed near base | Leaf-like, not reflexed near base | Glume-like |
| Bract sheath - length: | 25—50 mm | 20—60 mm | 0 mm | 0 mm | 0 mm | 50—225 mm | 35—90 mm | 25—50 mm | 15—55 mm | 0—25 mm | 2—4 mm | 0—20 mm | 0 mm | 25—90 mm | 15—25 mm | 0 mm |
| Blade - length: | 290 mm | 170—340 mm | 10—17 mm | 10—45(—140) mm | 150—380 mm | 185—600 mm | 190—580 mm | 300 mm | 220 mm | 50—190 mm | 15—45 mm | 300—500 mm | 140—570 mm | 110—350 mm | 60—165 mm | 5—25 mm |
| No. branches/ spikes - number: | Branches, 4—5 | Branches, 5—6 | Branches, 5—7 | Branches, 7—10 | Spikes, 4—6 | Spikes, 7—9 | Spikes, 4—6 | Spikes, 7—8 | Spikes, 3—5 | Spikes, 4—5 | Spikes, 3—4 | Spikes, 5—6 | Spikes, 6—7 | Spikes, (3)—4 | Spikes, 4—6 | Spike, 1 |
| Orientation: | Spreading | Erect or suberect | Erect or suberect | Spreading | Pendulous | Pendulous | Erect, suberect or pendulous | Erect or suberect | Erect or suberect | Spreading | Spreading | Erect, suberect or pendulous | Erect or suberect | Erect or suberect | Erect or suberect | N/ap |
| Clustering of 1° branches/ spikes: | No | No | Yes | Yes | No (except 2—3 apical) | No (except 2—3 apical) | No (except 2—3 apical) | No (except 2—3 apical) | No (except 2—3 apical) | Yes (basal spike sometimes remote) | Yes | Yes in one form No in another | No (except 2—3 apical) | No (except 2—3 apical) | No (except 2—3 apical) | N/ap |
| Largest 1° unit - dimensions: | 40—60 x 25—35 mm | 30—95 x 8—20 mm | 5 x 2 mm | 5—15 x 5—10 mm | 25—70 x 7—11 mm | 120—185 x 5—8 mm | 30—75 x 7—8 mm | 35—65 x 6—7 mm | 10—25 x 3—4 mm | 15—22 x 7—10 mm | 7—9 x 7—9 mm | 20—70 x 7—11 mm | 300—800 x 4—8 mm | 30—100 x 10—15 mm | 20—40 x 9—11 mm | N/ap |
| Longest peduncle exserted length: | 50—60 mm | 125—185 mm | N/ap | N/ap | 125—150 mm | 15—100 mm | (17)—130 mm | 35—70 mm | 8—22 mm | 0 mm | 0 mm | 0—65 mm | 0—50 mm | 0—45 mm | 0—23 mm | N/ap |
| Peduncle indumentum: | Hairy | Hairy | N/ap | N/ap | Scabrid | Scabrid | Scabrid on angles or glabrous | Scabrid on angles | Glabrous | Glabrous | Glabrous | Scabrid on angles | Scabrid on angles | Scabrid on angles | Scabrid on angles | N/ap |
| Bractoles subtending higher order branches: | Inflated | Not inflated | Not inflated | Not inflated | N/ap | N/ap | N/ap | N/ap | N/ap | N/ap | N/ap | N/ap | N/ap | N/ap | N/ap | N/ap |
| Apical spike - sex: | N/ap | N/ap | N/ap | N/ap | Usually staminate, occasionally androgynecandrous | Usually staminate, frequently androgynous, occasionally androgynecandrous, gynecandrous or mixed | Usually staminate | Usually staminate | Usually staminate | Usually staminate | Usually staminate | Usually staminate, occasionally androgynecandrous | Usually staminate | Usually staminate | Usually staminate | Androgynous |
| Spikes - sex and number: | N/ap | N/ap | N/ap | N/ap | Staminate 0—1 Pistillate 3—9 Bisexual 0—1 | Staminate 0—1 Pistillate 0 Bisexual 6—8 | Staminate 1—2 Pistillate 3—5 Bisexual 0 | Staminate 1 Pistillate 6—7 Bisexual 0 | Staminate 1—2 Pistillate 1—3 Bisexual 0—3 | Staminate 1 Pistillate 3—4 Bisexual 0—3 | Staminate 0—1 Pistillate 2—3 Bisexual 0—1 | Staminate 0—2 Pistillate 2—6 Bisexual 0—1 | Staminate 1—2 Pistillate 1—4 Bisexual 0—2 | Staminate 1—3 Pistillate 1—4 Bisexual 0—3 | Staminate 1—2 Pistillate 3—5 Bisexual 0—2 | Bisexual 1 |
| Accessory spikes: | N/ap | N/ap | N/ap | N/ap | Absent | Absent | Absent | Absent | Absent | Occasionally present | Absent | Absent | Absent | Occasionally present | Occasionally present | N/ap |

N/ap = not applicable
N/av = not available

Table 5. Macromorphological characters of the spikelet bracts and staminate spikelets that distinguish the southern African species of Carex L.

| Features | Taxa | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subgenus Indocarex | | Subgenus Vignea | | Subgenus Carex | | | | | | | | | | | Subg. Primocarex |
| | C. micro-pomicola[1] | C. zuluensis | C. divisa | C. glomerabilis | C. austro-africana | C. acuta | C. acuticarpa | C. sulcatica | C. spicatiformis | C. acklonii | C. appressa | C. cognata | C. exilinervis | C. clavata | C. subinflata | C. sp. nov. |
| SPIKELET BRACTS & STAMINATE SPIKELETS - | | | | | | | | | | | | | | | | |
| Staminate spikelets - bracts: | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Extremely dimorphic | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) | Not dimorphic (or only slightly) |
| Anther length: | 1,5—2,2 mm | 2,8—3,5 mm | 2,8—3,2 mm | 1,7—2,6 mm | 2,5 mm | 3,5—4,0 mm | 2,2—4,0 mm | 2,2 mm | 2,0—2,2 mm | 2,5 mm | 1—2 mm | 2,3—2,5 mm | 2,5—4,0 mm | 3,0—5,5 mm | 2,5—3,2 mm | N/av |
| Pistillate spikelets - bract dimensions: | 3—4 X 1,5—1,8 mm | 3,5—4,5 X 2 mm | 4,5—5,0 X ?,5 mm | 3,0—5,5 X 1,3—2,0 mm | 4,5—4,5 X 0,8—1,2 mm | 4,0—5,5 X 1,0—1,5 mm | 4—6 X 1,5—3,0 mm | 4—5 X 1,5 mm | 2,5—3,0 X 2,0—2,2 mm | 4,2—5,0 X 1,8—2,2 mm | 2,5—3,0 X 1,2 mm | 5—6 X 1,2—1,8 mm | 3,0—5,5 mm 0,6—1,2 mm | 5—6 X 1,9—4,0 mm | 3,5—5,0 X 1,5—2,5 mm | 6 X 3,2 mm |
| Bract dimensions relative to perigynium: | Shorter and of equal width | Shorter and narrower | Longer and wider | Shorter and narrower | Longer and narrower | Longer and narrower | Equal length and narrower | Equal length and narrower | Shorter and narrower | Shorter and narrower | Shorter and narrower | Equal length and narrower | Longer and narrower | Shorter and narrower | Shorter and narrower | Longer and wider |
| Bract - body colour: | Straminous, or straminous with ferruginous striae and hyaline margins | Straminous with ferruginous striae and hyaline margins | Golden-brown, with wide hyaline margins | Golden-brown or ferruginous | Straminous | Golden-brown, with wide hyaline margins | Straminous with ferruginous striae and hyaline margins, or ferruginous | Hyaline with ferruginous striae | Straminous | Ferruginous | Yellow and ferruginous | Ferruginous | Ferruginous | Straminous with ferruginous striae and hyaline margins | Ferruginous | Golden-brown, with wide hyaline margins |
| Bract - body indumentum: | Scabrid mainly on distal half, rarely glabrous with distal margins ciliate | Glabrous with distal margins ciliate | Glabrous | Scabrid mainly on distal half or glabrous with distal margins ciliate | Glabrous, sometimes with distal margins ciliate | Glabrous | Glabrous with distal margins ciliate | Glabrous | Glabrous with distal margins ciliate | Glabrous | Glabrous | Glabrous | Glabrous with distal margins ciliate | Glabrous with distal margins ciliate | Glabrous | Glabrous |
| Bract - body shape: | Ovate | Ovate | Ovate | Ovate | Ovate | Lanceolate | Obovate | Lanceolate | Broadly ovate | Ovate | Lanceolate | Ovate-lanceolate | Lanceolate | Ovate-lanceolate | Broadly ovate | Obovate |
| Coring of bract: | Narrow, 1-nerved | Narrow, 1-nerved | Broad, 3-nerved | Narrow, 1-nerved | Broad, 3-nerved | Narrow, 1-nerved | Broad, 3-nerved | Broad, 3-nerved | Broad, 3-nerved | Broad, 3-nerved | Broad, 3-nerved | Broad,3-nerved | Broad, 3-nerved | Broad, 3-nerved | Broad, 3-nerved | Narrow, 1-nerved |
| Apex of bract: | Acute or obtuse | Obtuse (usually) or emarginate | Acute | Acute, rarely obtuse | Obtuse or emarginate | Acute | Acute or emarginate | Acute | Obtuse or emarginate | Obtuse or emarginate | Obtuse or emarginate | Obtuse, sometimes emarginate | Acuminate or emarginate | Acuminate or emarginate | Emarginate, sometimes acute | Cuspidate |
| Carina terminations: | Shortly awned | Shortly awned | Awned to mutic-ous | Awned or mutic-ous | Awned | Awned, usually mucronate | Awned | Awned | Shortly awned | Shortly awned | Awned, mucronate or sub-apical | Awned | Awned | Awned | Shortly awned | Awned or mutic-ous |
| Awn length: | 0,3—0,7 mm | (0)—1 mm | 0—0,3 mm | 0—2 mm | 2,0—4,2 mm | 0—0,3 mm | 0,5—1,8 mm | 0,5—1,0 mm | 0,2—0,4 mm | 0,8—2,0 mm | 0—0,2 mm | 1,2—3,0 mm | 1,3—3,0 mm | 0,7—2,0 mm | 0,5—1,0 mm | 0—0,5 mm |
| Awn margin: | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Scabrid | Sparsely scabrid |

N/av = not available

Table 6. Macromorphological characters of the perigynium that distinguish the southern African species of Carex L.

| Features | Taxa | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subgenus Indocarex | | Subgenus Vignea | | | Subgenus Carex | | | | | | | | | | | Subg. Primocarex |
| | C. spicato-paniculata | C. zuluensis | C. divisa | C. glomerabilis | C. austro-africana | C. acossii | C. aethiopica | C. sylvatica | C. burchelliana | C. ecklonii | C. agnotropa | C. cognata | C. acutiformis | C. clavata | C. subinflata | C. sp. nov. |
| PERIGYNIUM - | | | | | | | | | | | | | | | | | |
| Perigynium base: | Not stipitate, with a callus | Not stipitate, with a callus | Not stipitate, without a callus | Stipitate or not, without a callus | Stipitate, without a callus | Stipitate, without a callus | Not stipitate, without a callus | Stipitate, without a callus | Not stipitate, without a callus | Stipitate, without a callus | Not stipitate, without a callus | Stipitate, without a callus | Stipitate, without a callus | Not stipitate, without a callus | Stipitate, without a callus | Not stipitate, without a callus |
| Perigynium base: | Not corky | Not corky | Not corky | Corky | Not corky | Not corky | Not corky | Not corky | Not corky | Not corky | Not corky | Not corky | Not corky | Not corky | Not corky | Not corky |
| Perigynium apex: | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Rostrate | Erostrate |
| Mature perigynium - orientation: | Suberect | Suberect | Suberect | Spreading | Suberect | Suberect | Suberect | Suberect | Suberect | Suberect | Suberect to spreading | Spreading | Suberect | Spreading | Spreading, sometimes reflexed | Suberect |
| Perigynium - degree of inflation: | Not inflated | Slightly inflated | Not inflated | Not inflated | Slightly inflated | Not or slightly inflated | Slightly to much inflated | Not inflated | Much inflated | Slightly to much inflated | Much inflated | Much inflated | Not inflated | Much inflated | Much inflated | Not inflated |
| Shape in cross-section: | Triangular | Triangular with winged base | Elliptic | Elliptic with flat base | Narrowly elliptic | Triangular | Narrowly elliptic | Triangular with rounded base | Triangular | Triangular with rounded base | Rotund | Rotund | Triangular | Shallowly triangular | Rotund | Narrowly elliptic |
| Perigynium - dimensions: | 3,0—3,5 x 1,2 mm | 4,5—6,0 x 1,5—2,0 mm | 4,2 x 1,8 mm | (3,0—)3,5 x (1,1—)2,2 mm | 3—4 x 1,5—1,8 mm | 2,5—3,5 x 1,0—1,5 mm | 5,5—6,5 x 1,2—1,0 mm | 4,5—4,7 x 1,3 mm | 3,0—3,5 x 1,6—2,0 mm | 4,5—5,5 x 1,8—2,5 mm | 4,0—4,5 x 1,2—1,5 mm | 4,0—5,2 x 1,5—2,0 mm | 3—4 x 1,6—2,0 mm | 6—7 x 2,5—3,0 mm | 4—5 x 1,2—2,5 mm | 4 x 2 mm |
| Colour: | Green to golden-brown | Green | Golden-brown | Straminous to ferruginous | Mid-brown to ferruginous, rostrum whitish | Green to straminous, rostrum whitish | Green to straminous, ferruginous spotted | Green or golden-brown | Green to straminous, ferruginous spotted | Green to straminous, ferruginous spotted | Bright yellow | Straminous and ferruginous | Green, rostrum whitish | Green or straminous, ferruginous spotted | Green or straminous with or without ferruginous spots | Hyaline and golden-brown |
| Texture: | Herbaceous | Herbaceous | Cartilaginous | Cartilaginous | Cartilaginous | Membranous | Cartilaginous | Membranous | Cartilaginous | Cartilaginous | Herbaceous | Cartilaginous | Cartilaginous | Cartilaginous | Cartilaginous | Membranous |
| Nervation: | 4—6 curved, on abaxial surface | 2 submarginal on abaxial surface | Many-nerved | Many-nerved | Few- or inconspicuously nerved | Few- or inconspicuously nerved | Many-nerved | Few- or inconspicuously nerved | Many-nerved | Many-nerved | Many-nerved | Many-nerved | Many-nerved | Many-nerved | Many-nerved | Few- or inconspicuously nerved |
| Indumentum (including rostrum): | Scabrid in distal half | Scabrid in distal half | Glabrous | Glabrous | Papillate, with solid papillae | Glabrous | Glabrous | Glabrous | Glabrous | Glabrous | Glabrous | Glabrous | Papillate, with hollow papillae | Glabrous | Glabrous | Mainly glabrous, with a few short conical hairs at distal end |
| Rostrum shape: | Abrupt Straight | Tapered Bent upwards | Tapered Straight | Tapered Straight | Abrupt Straight | Abrupt Straight | Tapered Straight | Abrupt Straight | Abrupt Straight | Abrupt Straight | Tapered Straight | Abrupt Straight | Abrupt Straight | Abrupt, sometimes tapered Straight | Abrupt Straight | N/ap |
| Rostrum length: | 2 mm | 1,2—2,0 mm | 1,5 mm | 0,8—2,0 mm | 0,3—0,5 mm | 0,5—0,6 mm | 1,2—1,6 mm | 2 mm | 0,5 mm | 0,7—1,2 mm | 1,2—1,8 mm | 1,1—2,0 mm | 0,8—1,0 mm | 1,0—1,5 mm | 1,0—1,2 mm | N/ap |
| Rostrum margin: | Not winged, scabrid | Not winged, scabrid | Not winged, scabrid | Winged, scabrid | Not winged, glabrous | Not winged, glabrous | Not winged, scabrid | Not winged, scabrid | Not winged, scabrid | Not winged, glabrous | Not winged, glabrous | Not winged, glabrous | Not winged, glabrous | Not winged, scabrid | Not winged, glabrous | N/ap |
| Rostrum apex: | Deeply bidentate | Shallowly bidentate | Shallowly bidentate | Shallowly bidentate | Truncate | Shallowly bidentate | Deeply bidentate | Shallowly bidentate | Shallowly bidentate | Shallowly bidentate | Shallowly bidentate | Deeply bidentate | Shallowly bidentate | Deeply bidentate | Shallowly bidentate | N/ap |
| Tooth length: | 0,6—1,0 mm | 0,4—0,7 mm | 0,8 mm | 0,3—0,7 mm | 0,25 mm | 0 mm | 0,6—1,0 mm | 0,2 mm | 0,2 mm | 0,3—0,5 mm | (0,2)—0,7 mm | 0,5—1,0 mm | 0,3 mm | 0,5—1,0 mm | 0,3—0,6 mm | N/ap |
| Rhachilla: | Absent | Absent | Absent | Sometimes present in basal spikelets | Absent | Absent | Sometimes present in basal spikelets | Absent | Absent | Present | Absent | Absent | Absent | Absent | Absent | Present |

N/ap = not applicable

Table 7. Macromorphological characters of the gynoecium and fruits that distinguish the southern African species of Carex L.

| Features | Taxa | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subgenus Indocarex | | Subgenus Vignea | | Subgenus Carex | | | | | | | | | | | | Subg. Primocarex |
| | C. spicato-paniculata | C. zuluensis | C. divisa | C. glareosilla | C. austro-africana | C. capensis | C. cathiensis | C. sylvatica | C. burchelliana | C. eckloni | C. monostroma | C. cognata | C. acutiformis | C. clavata | C. subinflata | C. sp. nov. | |
| GYNOECIUM & FRUITS - | | | | | | | | | | | | | | | | | |
| Style base: | Straight | Straight | Straight | Straight | Straight | Slightly bent to straight | Twisted | Straight | Slightly bent or straight | Twisted, bent or straight | Straight | Twisted | Straight | Slightly bent or straight | Slightly bent or straight | Straight | |
| Stigmas: | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| Utricle cross/transection - shape: | Triangular | Triangular | Narrowly elliptic | Narrowly elliptic | Narrowly elliptic | Triangular | Triangular | Triangular | Triangular | Triangular | Triangular | Triangular | Triangular | Triangular | Triangular | Shallowly triangular | |
| Utricle shape: | Elliptic | Elliptic | Ovate | Square | Obovate | Obovate to elliptic | Obovate | Elliptic | Obovate | Obovate | Obovate | Obovate or elliptic | Obovate | Obovate | Obovate | Elliptic | |
| Utricle claw: | Narrow | Narrow | Broad | Broad | Absent | Narrow | Absent | Absent | Narrow | Narrow with a foot-like base | Absent | Absent | Absent | Narrow | Absent | Absent | |
| Utricle - dimensions: | 2,4—3,0 X 1,0—1,2 mm | 2,5—3,5 X 1,2—1,8 mm | 2 X 1,4 mm | 1,7—2,2 X 1,0—1,7 mm | 1,9—2,2 X 1,0—1,7 mm | 1,8—2,0 X 1,0—1,2 mm | 2,5—2,8 X 1,2—1,8 mm | 2,3—2,4 X 1,3—1,4 mm | 2,0—2,4 X 1,0—1,4 mm | 2,5—3,2 X 1,5—2,0 mm | 1,5—1,8 X 1 mm | 1,7—2,8 X 1,2—1,5 mm | 1,7—2,0 X 1,2—1,5 mm | 2,0—3,5 X 1,7—2,5 mm | 2,2—2,8 X 1,2—1,8 mm | 4 X 2 mm | |
| Utricle epidermis (low mag.): | Glabrous | Minutely papillose | Glabrous | Glabrous | Minutely papillose | Glabrous | Minutely papillose | Glabrous | Minutely papillose | Minutely papillose | Minutely papillose | Minutely papillose | Glabrous | Minutely papillose | Minutely papillose | Glabrous | |
| Utricle colour: | Fuscous with lighter angles | Fuscous with lighter angles | Yellowish-brown | Yellowish-brown | Fuscous with lighter angles | Blackish, or fuscous with lighter angles | Fuscous with lighter angles | Fuscous with lighter angles | Fuscous with lighter angles | Fuscous with lighter angles | Fuscous | Fuscous with lighter angles | Yellowish-brown | Fuscous with lighter angles | Fuscous with lighter angles | Yellowish-brown | |

No. of facing pg.: 44

## Plate 1.

Southern African species of Carex L.: Inflorescence morphology of representatives of the subgenera.

Plate 1.1: Subgenus Indocarex: Inflorescence a panicle; primary units pedunculate; bracts subtending primary units leaf-like, sheathing basally; opposing bracteoles (cladopropylls) tubular, concealed by bract sheaths; higher order bracts setaceous; opposing bracteoles exposed, frequently inflated and perigynium-like; ultimate units of inflorescence bisexual, androgynous (C. spicato-paniculata, Reid 1191) X 0,7.

Plate 1.2: Subgenus Vignea: Inflorescence a spike or panicle of glomerules (i.e. axes of ultimate units vertically compressed); primary units sessile; bracts subtending primary units setaceous, not sheathing; opposing bracteoles neither sheathing nor inflated; ultimate units of inflorescence bisexual, androgynous (C. glomerabilis, Reid 1137). Life size.

Plate 1.3: Subgenus Carex: Inflorescence a raceme of spikes; spikes pedunculate; bracts subtending spikes leaf-like, sheathing basally; opposing bracteoles (cladopropylls) tubular, concealed by bract sheaths; spikes unisexual or bisexual, usually apical spikes staminate, basal spikes pistillate and median units androgynous, but frequently all spikes androgynous or mixed (C. cognata, Reid 1210). Life size.

Plate 1.4: Subgenus Primocarex: Inflorescence a single spike; basal bract glume-like (to setaceous); spike bisexual, androgynous (in the southern African species) (C. sp. nov., Reid 1337). Life size.


1
2
3
4

# CHAPTER 3. MICROMORPHOLOGICAL CHARACTERS

## A. INTRODUCTION

This section includes all characters studied with the aid of a Scanning Electron Microscope (SEM). There is a slight overlap with Macromorphological Characters (Chapter 2), as perigynium and fruit shape and size were measured under the dissecting microscope.

Although Metcalfe (1971) and Ellis (1979) discussed lamina surfaces that had been prepared from epidermal scrapes and were mostly examined under the compound microscope, the same principles are applicable to the present study. The terminology of Metcalfe and Ellis has been utilized wherever appropriate.

## B. MATERIALS AND METHODS

For studies of the lamina surface, pieces of fresh material were placed into FAA in the field. (FAA = 40% formalin, 95% alcohol, acetic acid, and water, in the proportion 1:10:1:8.) A voucher specimen was prepared for each collection; duplicates are to be lodged in [illegible] and PRE. Vouchers are marked with a plus symbol (+) in Appendix 1.1. In the laboratory small pieces of entire leaf were critical-point dried; the procedure is explained in Appendix 3. This was done for all taxa except one (C. divisa), where fresh-preserved material was not available. In this case dried herbarium material was first rehydrated by boiling, placed

in FAA for 24 hours, and critical-point dried.

The pieces were mounted on aluminium stubs with the aid of double-sided adhesive tape, ensuring that both abaxial and adaxial surfaces were exposed. Drops of silver DAG were placed between and in contact with the specimen and the mounting tape, to achieve better contact and prevent charging. Gold sputter-coating was performed automatically in an Emscope SC 500 for two minutes at 20 mA. Using an ISI-SX-25 SEM, the specimens were examined and photographed at 25 kV. For ease of comparison it was ensured that the distal end of the leaf was always on the left side in the photograph.

For studies of the perigynium and fruit surfaces, both mature and immature samples were removed from herbarium specimens. The immature samples were required for examination of the morphology of the style and of the rostrum teeth, which are frequently lost or damaged on mature specimens. Vouchers are marked in Appendix 1.1 with a dollar symbol ($). From one mature sample the perigynium was removed by hand to expose the fruit (and the rhachilla, when present). A further sample, after removal of the perigynium, was subjected to acetolysis (the procedure is listed in Appendix 3). The procedure was carried out for all taxa. Vouchers are marked in Appendix 1.1 with a numero symbol (№). These samples were mounted on aluminium stubs, as explained above, coated, and examined under SEM. For ease of

comparison it was ensured that the distal end of the specimen was always on the left side of the photograph.

## C. RESULTS

### 1. Leaf lamina surface

#### 1.1. General description of the southern African species

Margins: Papillae, when present, occurring singly at distal end of cell (Pl. 2.3 & 3.1). Prickles, when present, with barbs orientated towards lamina apex (Pl. 2.1). Epicuticular wax: When present on both surfaces, thicker on abaxial (Pl. 2.4) than adaxial surface (Pl. 2.5). When present frequently interrupted, absent from outer surface of stomatal guard cells and apices of papillae (Pl. 2.4 & 3.2), usually also from lamina margin. Leaf surface papillae: When present, very conspicuous under SEM, appearing much brighter than adjacent epidermal features due to charging. Generally epidermal cells longitudinally elongated with papillae single, eccentrically situated, at distal end of cell (Pl. 2.4 & 3.2). Prickles. When associated with costal zones, occurring in one or few longitudinal files on either side of, or occasionally within, chains of silica cells (Pl. 4.3). Stomata: Paracytic, subsidiary cells "kidney"-shaped (Pl. 3.1 & 3.2). Lamina zonation and cell shape: Lamina longitudinally divided into distinct costal and intercostal zones, characterized by differences in cell shape and size, noticeable even at relatively low magnification (Pl. 2.1 &

3.5); cells of intercostal zone longer and wider than those of costal zone (Pl. 4.1); stomata always located in intercostal zones (Pl. 3.5); costal zones conspicuous due to occurrence of one to several rows of silica cells (Pl. 4.1). Generally cells of intercostal zone large and rectangular (Pl. 2.5), but varying to almost square when occurring in stomatal rows between two vertically adjacent stomata. In all species cell walls markedly sinuous (Pl. 2.5 & 4.1); sini of sinuosities known to contain minute silica bodies (Pl. 4.5). (In C. sp. nov. cut edge of sample revealed sinuosities to be peg-like structures not extending full depth of cell. In this same specimen epidermal cells were seen to be longitudinally greatly elongated, being about four to five times longer than subjacent mesophyll cells.) Silica cells: Rows known to mark position of larger veins; unlike Poaceae, cells not accompanied by cork cells. Cell walls not always visible under SEM, but silica bodies within visible as bright spots of light due to charging (Pl. 4.1). (Structure of silica bodies was examined in two taxa in which sample was obliquely cut: C. acutiformis and C. spicato-paniculata X C. zuluensis. These consist of a large plate resting on and filling base of cell, with a large central cone almost touching outer cell wall, and a ring of smaller satellite cones near margin of plate - Pl. 4.2.)

1.2. Characters that distinguish the species

Margins: Smooth to papillate in most species (Pl. 2.3 & 3.3), usually with a few prickles at lamina apex, but well-developed prickles along most of lamina length in some species (Pl. 2.2). Barbs of prickles generally raised at about 30° from surface (Pl. 2.2), but in some species almost appressed (Pl. 2.1). Epicuticular wax: Vestigial or absent in some species, present only on abaxial surface in some species, and present on both surfaces in others. Leaf surface papillae: These were absent in many species, abaxial in most of the remaining species (Pl. 2.1, 2.4, 3.2, 3.5 & 3.6), and adaxial in one species. Prickles: Absent in most species; in some species present on adaxial and abaxial surfaces, in two of these associated with costal zones (Pl. 4.3). Stomata: Abaxial in most species, but in one species with one submarginal row on adaxial surface (Pl. 3.1) and in another species with six submarginal rows on adaxial surface (Pl. 3.3). Stomatal complex normal in most species but overarched by four papillae in two species: in one species papillae long and narrow (Pl. 3.2), in the other broad and triangular (Pl. 3.6). Surface of subsidiary cells flush with surrounding cells in most species, but markedly domed in one species (Pl. 3.2). Lamina zonation and cell shape: Cells of intercostal zone of adaxial epidermis were rectangular to square in most species (Pl. 2.5 & 4.4), but in two species were distinctly narrower at proximal end, broadening to distal end with the surface becoming domed (Pl. 2.6).

These distinguishing characters are also summarized in Table 8. Diagnostic features are underlined.

2. Perigynium morphology

For illustrative purposes perigynium morphology was resolved by means of SEM, but most of the qualitative and quantitative characters were measured with the aid of a dissecting microscope: the measurements are presented in Table 6 and in the species treatments in Chapter 5.

In surface view (as viewed under SEM) the perigynium was of the same basic ovate shape in all the southern African species, differing mainly in size, details of surface ornamentation and rostrum morphology. The latter two are discussed under separate headings below. In some species (C. mossii, C. cognata, C. spicato-paniculata and C. zuluensis) the perigynium was notably long-stipitate (Pl. 5.3 & 6.5). In the remaining species it was either short or undeveloped (Pl. 5.1 & 6.3) and seemed to be rather variable. In C. spicato-paniculata and C. zuluensis the stipe was developed into a conspicuous callus-like structure with a round base (Pl. 5.2).

Shape in cross-section was not easily resolved under SEM. The distigmatic species (C. divisa, C. glomerabilis and C. austro-africana) were basically biconvex or with one surface (adaxial) flattened; the remaining (tristigmatic) species had a basic trigonous shape, which was however frequently obscured due to the degree of inflation of the

perigynium. For example, the extremely inflated perigynium of C. cognata appeared almost rotund (Pl. 6.5), and that of C. clavata appeared biconvex.

3. Perigynium surface

In most species the perigynium surface comprised mainly rectangular cells, which were similar to the intercostal epidermal cells of the leaf lamina, and which also had sinuous walls (Pl. 5.6). At least two longitudinal ribs (costae) occurred in all of the species excepting C. austro-africana (Pl. 6.3) and C. sp. nov., but were numerous and conspicuous in C. cognata (Pl. 6.5). The surface structure of the ribs (costal zones) was difficult to resolve under SEM, probably due to the cells being indurated, thus obliterating surface features.

In C. austro-africana (Pl. 6.3) and C. acutiformis the entire surface was papillate, but the shape of the papillae differed markedly: in C. austro-africana they remained swollen and globular even in very mature perigynia (Pl. 6.4). In C. acutiformis the papillae appeared collapsed and scale-like even in very young perigynia, and in mature perigynia they appeared hollow (Pl. 6.6). In both these species the perigynium surface bore epicuticular wax, which was absent from all the other species. In C. sp. nov. there was a distinct narrow zone of uniquely-shaped papillae near the distal end of the perigynium. They were short and borne singly near the distal end of each cell, rising abruptly

from the cell surface (Pl. 5.4 & 5.6).

Scabrid hairs occurred especially towards the distal end of the perigynium surface in C. spicato-paniculata, C. zuluensis, and the suspected hybrid of C. zuluensis (Pl. 6.1). In these species the hair morphology differed from that of the leaf lamina hairs: the bases consistently bore a longitudinal impression (Pl. 6.2), which was absent from the leaf lamina hairs.

4. Rostrum and style morphology

The term "rostrum" is applied to the distal part of the perigynium when it has become elongated, ensheathing the style base. For illustrative purposes the shape and ornamentation of the rostrum was more easily resolved with SEM than with LM. Measurements of the above-mentioned characters were made with the aid of a dissecting microscope, however. These are presented in Table 5 and in the taxonomic description of each species in Chapter 5.

The rostrum was developed in all species except C. sp. nov. (Pl. 5.4), being very short in C. austro-africana (Pl. 6.3) and extremely long in C. sylvatica and C. monotropa. The apex was bidentate in most species with the teeth exceptionally long and narrow in C. cognata (Pl. 6.5). The apex was truncate in C. austro-africana (Pl. 6.3) and very shortly bidentate in C. mossii. C. monotropa and C. burchelliana (Pl. 5.1 & 5.3).

The inner margins of the rostrum teeth were usually

ciliate (Pl. 5.1), but were glabrous in C. austro-africana (Pl. 6.3), C. cognata (Pl. 6.5) and C. subinflata. The outer margins were usually scabrid (Pl. 5.1, 5.5 & 6.1), hairy or papillate to a greater or lesser degree, but were glabrous in C. mossii (Pl. 5.3), C. aethiopica, C. sylvatica, C. monotropa, C. cognata (Pl. 5.5) and C. subinflata. The outer margins were very sparsely papillate in C. ecklonii.

Style morphology for all the species was fairly constant. All of the species had fairly thick, markedly papillate stigmas (Pl. 5.1). It was difficult to measure stigma length due to their being curled at maturity and breaking readily. The most notable difference between groups of species was in the number of stigmas: C. divisa, C. glomerabilis and C. austro-africana had two stigmas, and the remaining species had three, but a suspected hybrid between C. zuluensis and an unknown species varied between two and three stigmas in the same inflorescence.

5. Nutlet morphology

For illustrative purposes nutlet morphology was recorded with a SEM, but quantitative characters were measured by means of a dissecting microscope. These measurements are presented in Table 7 (with diagnostic features underlined) and in the species treatments in Chapter 5.

In surface view the nutlet had a basic ovate to obovate shape in all the southern African species, but was rather elongate in C. spicato-paniculata and C. zuluensis (Pl.

7.3). It was markedly clawed (stipitate) in the following species: narrowly so in C. zuluensis (Pl. 7.3) and C. mossii. broadly so in C. glomerabilis (Pl. 7.4). In C. ecklonii the claw was expanded basally into a foot-like structure (Pl. 7.6). In the remaining species the claw was short or absent (Pl. 7.5).

In all the species the nutlet was surmounted by a short to long beak which passed abruptly into the style base. This transition was visible under the dissecting microscope due to a change in colour and surface ornamentation. The beak and style base were usually straight (Pl. 7.4) to slightly bent (Pl. 7.6) but were markedly twisted in C. aethiopica (Pl. 7.2) and C. cognata.

The shape in cross-section was a direct reflection of stigma number, with the distigmatic species having biconvex nutlets (or with one surface flat) and the tristigmatic species having trigonous nutlets. In C. sp. nov. the nutlets were very shallowly trigonous.

6. Nutlet surface

Nutlet surface appeared very similar in all the species. It was glabrous throughout, and usually the outlines of cells were visible, due to the contents being shrunken, exposing the shape and structure of the anticlinal walls. In all the species the cells were arranged in longitudinal files and were irregular in shape and size, but had straight-sided to slightly curved anticlinal walls, forming

five- to seven-sided polygons (Pl. 8.1). Additionally in the centre of each cell a cone-shaped structure was visible (the nature of this structure is investigated below, point 7), which was variable in size, depending on the species. In C. zuluensis and C. burchelliana the cone apices stood above the anticlinal cell walls (Pl. 8.3), while in C. sylvatica and C. sp. nov. they were hardly visible (Pl. 9.5), being immersed in the cell contents.

7. Acetolyzed nutlet surface

Acetolysis removed cell debris and outer periclinal and anticlinal cell walls of the pericarp epidermis, revealing the underlying silica bodies. Overall position of the cell was found to influence the shape and size of the silica body, thus it was important to compare them in a constant position (median, on an abaxial facet of nutlet) for all the samples (Pl. 10.2 - 10.6).

7.1. General description of the southern African species

Basic shape of silica body: Five- to seven-sided polygonal flat plate. At distal and proximal ends of fruit, silica bodies become rectangular (Pl. 10.5 & 10.2). Shape of plate somewhat variable and depending to some extent on relative position of silica body on fruit (Pl. 10.2 - 10.6). When plates not in close contact, intervening middle lamellae (of anticlinal walls) evidently also silicified,

and connected to main silica body by numerous small rods (Pl. 9.2). In all species plates more widely separated near distal end of fruit. Generally towards distal end amount of silica per cell gradually reduced, disappearing altogether at style base (Pl. 10.5).

Ornamentation: Present except on angles of trigonous nutlets (Pl. 10.3). Usually a single more-or-less central cone (Pl. 8.2), but sometimes, and more frequently in proximal cells, silica bodies bearing two or three large cones (Pl. 10.2). Shape and height of cones depending to some extent on relative position of the silica body on fruit. In biconvex fruits where cones tending to be low and rounded over most of fruit surface (Pl. 8.6), cones increasing in height towards edges of fruit. Satellite cones: When present, small, occurring at margins of plates (Pl. 9.2).

### 7.2. Characters that distinguish the species

Basic shape of silica body: Basal plates flat in most species, but domed in some species (Pl. 9.4), and in some species thickened (or possibly upturned) at margins (Pl. 8.2). In a median position plates in close contact in most species (Pl. 8.4), but widely separated in others (Pl. 8.6). Ornamentation: Central cone ranging from tall and slender in one species (Pl. 8.4), to conical in several species (Pl. 8.1), to low and rounded in other species (Pl. 8.6 & 9.6). Satellite cones: Absent in most species, present in two

species (Pl. 9.2).

These characters are also summarized in Table 9. Diagnostic features are underlined.

## D. DISCUSSION

### 1. Leaf lamina surface

Some characters of the lamina surface proved to be diagnostic, or were at least useful in recognizing the taxonomic groups, for example, the unusual shape of the intercostal cells in C. spicato-paniculata, C. zuluensis and the putative hybrid of C. zuluensis. Unfortunately no data exist for the remaining species of Subgenus Indocarex; it would be necessary to obtain preserved material of all the species to determine whether this character state is constant throughout the subgenus.

Although the morphology of the stomatal complexes in C. mossii was unique among the southern African species, Metcalfe (1971) reports a similar morphology in C. pendula Huds., a European representative of Section Maximae, to which C. mossii also belongs. Once again, it would be necessary to obtain preserved material of all the species of the section in order to confirm that this character state is constant throughout.

Similarly, in C. austro-africana the morphology of the abaxial lamina surface, particularly of the stomatal complexes, was unique among the southern African species. It is likely that this morphology is common to the remaining

species of the section, because papillae are visible on the abaxial lamina surface in specimens in PRE of C. papillosissima Nelmes, a Tropical African representative, even at 20x magnification.

Under SEM, stomatal frequency and distribution was difficult to estimate due to the limited field of view and limited size of the sample. Standley (1986), in her light microscope study of these characters in Carex aquatilis, utilized epidermal replicas. This rapid, simple and inexpensive technique would be worthwhile pursuing for the southern African species.

2. Perigynium morphology

Perigynium characters were very important indeed for diagnosis, permitting the construction of a key to the species based almost solely on these characters. Many of them, however, were qualitative (e.g. perigynium texture), and these, plus the quantitative characters were assessed mainly by means of the dissecting microscope.

3. Perigynium surface

Some of the characters of the perigynium surface proved to be diagnostic for the southern African species. When extended to the species of a wider geographical area they ceased to be diagnostic, but indicated relationships between species. For example, the shape of the surface papillae was very different in C. acutiformis and C. austro-africana. The

latter, however, appeared very similar to those illustrated in Haines & Lye (1983, p. 379) for C. papillosissima Nelmes. C. austro-africana and C. papillosissima are indeed very closely related and it will be necessary to re-examine this relationship when undertaking a revision of all the African species.

The morphology and locality of the papillae in C. sp. nov. was different from those of specimens of any other related species available in PRE, thus providing further proof that this species has developed in isolation and is not closely related to any other species within Subgenus Primocarex.

It is likely that the distinctive morphology of the scabrid hairs in C. spicato-paniculata, C. zuluensis and the putative hybrid of C. zuluensis will also be present in other members of Subgenus Indocarex.

4. Rostrum and style morphology

Without exception, characters of the rostrum were diagnostic when used in combination with other confirmatory characters, but were of little use in indicating phylogenetic relationships. From the literature (e.g. Kukenthal, 1909) it is apparent that this is also true of the remainder of the genus.

The function of the rostrum is clearly protective, as it ensheaths the style base, protecting it from mechanical damage. Additionally many marshland species have

cartilaginous rostrum teeth which may protect the undispersed fruits from grazing mammals: the fruits are spirally arranged within the infructescence and the sharp teeth point in all directions. Equally, the rostrum teeth and their associated scabrid hairs could have an important function in ectozoochory, leading to long-range dispersal by birds and short-range dispersal by mammals.

The selective advantage of the distigmatic versus the tristigmatic condition is unclear. It has certainly arisen several times in the evolutionary history of the genus, occurring throughout Subgenus Vignea and in one section of Subgenus Carex, as well as in Subgenus Primocarex. The fact that a suspected hybrid between two tristigmatic species of Subgenus Indocarex has both conditions in one inflorescence, demonstrates that it is genetically a relatively unstable character. In this respect, for example, species of Subgenus Vignea could quite easily be derived from species of Subgenus Indocarex, as hypothesized by Nelmes (1952).

5. Nutlet morphology

Some nutlet characters were important for diagnostic purposes. For example, the twisted beak and style base were very useful in distinguishing poorly collected specimens of C. aethiopica and C. clavata.

It would probably have been possible to construct a key to the southern African species based solely on nutlet characters, provided that a larger sample had been measured.

This was done for the South Scandinavian species by Nilsson & Hjelmqvist (1967). They found that shape, colour and surface t- cture were very stable characters, but that nutlet size and beak length were very variable, especially in species which have a wide ecological and geographical range. A similar result was obtained in the present study, but much more fieldwork is required to confirm this.

6. Nutlet surface

On its own, nutlet surface morphology was not very useful diagnostically. This is evidently because the nutlet surface is protected throughout its maturation period by the perigynium, and is therefore not subject to environmentally induced evolutionary changes.

One useful character was the relative height of the anticlinal walls of the epidermal cells, as seen in C. sylvatica, and of the height of the cone on the silica body, as seen in C. zuluensis. It would be important to use a larger sample and to measure parameters accurately under SEM to obtain a better indication of disjunctions in these characters.

7. Acetolyzed nutlet surface

Toivonen & Timonen (1976) studied fruits of species of Subgenus Vignea which had been cleaned ultrasonically to expose the silica bodies. Although in the present study slightly different methods were employed, similar results

were obtained.

For some taxa the shape and size of the silica bodies appeared to be diagnostic, or to provide indications of phylogenetic relationships. An example of the former is the unique domed shape of the basal plate in C. acklonii, and of the latter is the very similar shape of the silica bodies in C. burchelliana and C. monotropa, indicating that the two species are fairly closely related. It would be desirable to extrapolate these observations, but unfortunately very few of the total number of species of Carex have been studied in this manner.

Ragonese et al. (1984), discussed and illustrated the origin and development of silica bodies in the pericarp of Rhynchospora Vahl. (This genus is placed in Tribe Rhynchosporeae, which is usually considered to be fairly closely related to Cariceae.) According to these authors, the silica body arises in the epidermal cells as a thickening on the inner periclinal cell wall. It grows centripetally into the cell, later becoming isolated from the protoplast by a transverse septum comprising cellulose, lignin, cutin and silica. The epidermis (exocarp) thus becomes bistratified, with the outer layer containing tannin compounds and the inner layer containing silica bodies.

## E. CONCLUSIONS

Some micromorphological characters were useful for diagnosing the southern African species or groups of

species. While they were not practical "key" characters, they could be used in conjunction with macromorphological and anatomical characters to make taxonomic decisions at the species level. They could also be used very effectively both to indicate phylogenetic groupings of the southern African species and their relationships with species outside southern Africa.

Table 8. Micromorphological characters of the leaf lamina that distinguish the southern African species of Carex L.

| Features | Taxa | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subgenus Indocarex | | Subgenus Vignea | | | Subgenus Carex | | | | | | | | | | | Subg. Primocarex |
| | C. spicato-paniculata | C. sulcanensis | C. divisa | C. glaucabilis | C. austro-africana | C. acuta | C. aethiopica | C. sylvatica | C. burchelliana | C. acutiformis | C. monostachya | C. cognata | C. acutiformis | C. clavata | C. subinflata | C. sp. nov. |
| LEAF LAMINA SURFACE - | | | | | | | | | | | | | | | | | |
| Papillae - occurrence of papillae and prickles: | Well-developed prickles along most of length | Well-developed prickles along most of length | Smooth to papillate, with a few prickles at leaf apex | Smooth to papillate, with a few prickles at leaf apex | Well-developed prickles along most of length | Smooth to papillate, with a few prickles at leaf apex | Smooth to papillate, with a few prickles at leaf apex | Smooth to papillate, with a few prickles at leaf apex | Smooth to papillate, with a few prickles at leaf apex | Smooth to papillate, with a few prickles at leaf apex | Smooth to papillate, with a few prickles at leaf apex | Well-developed prickles along most of length | Smooth to papillate, with a few prickles at leaf apex | Smooth to papillate, with a few prickles at leaf apex | Smooth to papillate, with a few prickles at leaf apex | Smooth to papillate, with a few prickles at leaf apex |
| Mark of prickle - angle to surface: | About 30° | About 30° | About 30° | About 30° | Almost appressed | About 30° | About 30° | About 30° | About 30° | Almost appressed | About 30° | About 30° | About 30° | About 30° | About 30° | About 30° | About 30° |
| Epicuticular wax: | Vestigial or absent | Vestigial or absent | Vestigial or absent | Vestigial or absent | Present on adaxial and abaxial surfaces | Present on abaxial surface | Present on adaxial and abaxial surfaces | Vestigial or absent | Vestigial or absent | Vestigial or absent | Vestigial or absent | Vestigial or absent | Present on adaxial and abaxial surfaces | Present on adaxial and abaxial surfaces | Present on adaxial and abaxial surfaces | Vestigial or absent |
| Surface - occurrence of prickles: | Present on adaxial and abaxial surfaces, associated with costal zones | Present on adaxial and abaxial surfaces, associated with costal zones | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Present, scattered over adaxial and abaxial surfaces, more common on adaxial | Absent | Absent | Absent | Absent |
| Surface - occurrence of papillae: | Absent | Absent | Adaxial | Absent | Abaxial | Mainly abaxial (adaxial: a few associated with stomatal complexes) | Abaxial | Absent | Absent | Absent | Absent | Absent | Abaxial | Abaxial | Abaxial | Absent |
| Stomata - distribution: | Abaxial | Abaxial | Abaxial | Abaxial | Abaxial | Abaxial, plus about six submarginal rows on adaxial surface | Abaxial | Abaxial | Abaxial | Abaxial | Abaxial, with one submarginal row on adaxial surface | Abaxial | Abaxial | Abaxial | Abaxial | Abaxial | Abaxial |
| Stomatal complex - description: | Normal | Normal | Normal | Normal | Overarched by one to four long narrow papillae | Overarched by four triangular papillae (these larger on abaxial surface) | Normal | Normal | Normal | Normal | Normal | Normal | Normal | Normal | Normal | Normal | Normal |
| Subsidiary cells - outer surface: | Flush with surrounding cells | Flush with surrounding cells | Flush with surrounding cells | Flush with surrounding cells | Markedly domed, frequently with a papilla at distal end of each cell | Stoma slightly sunken | Flush with surrounding cells | Flush with surrounding cells | Flush with surrounding cells | Flush with surrounding cells | Flush with surrounding cells | Flush with surrounding cells | Flush with surrounding cells | Flush with surrounding cells | Flush with surrounding cells | Flush with surrounding cells |
| Cells of intercostal zone of adaxial epidermis - shape: | Narrow at proximal end, broadening to distal end, where surface domed | Narrow at proximal end, broadening to distal end, where surface domed | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square | Rectangular to square |

Table 9. Micromorphological characters of acetolyzed fruits that distinguish the southern African species of Carex L.

| Features | Taxa | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subgenus Indicae | | Subgenus Vignea | | Subgenus Carex | | | | | | | | | | | Subg. Primocarex |
| | C. microglochin subsulata | C. cuspidata | C. divisa | C. pinguicula | C. austro-africana | C. acutiformis | C. aethiopica | C. silvatica | C. burchelliana | C. ecklonii | C. acrophrys | C. cognata | C. gaudichaudiana | C. clavata | C. subinflata | C. sp. nov. |
| Acetolyzed outlet surface region portions | | | | | | | | | | | | | | | | |
| Silica body - basal plate shape | Flat with up-turned margin | Flat | Flat | Flat | Flat | Flat with up-turned margin | Flat | Flat with narrow upturned margin | Flat | Domed | Domed | Flat | Flat | Flat | Flat | Flat |
| Cortex with adjacent plates | Close | Close | Close | Close | Not close | Close | Close | Close | Not close | Close | Not close | Close | Close | Close | Close | Close |
| Central cone - shape | Conical | Markedly tall and slender | Low and rounded | Low and rounded | Low and rounded | Low and rounded | Conical | Conical | Conical | Conical | Low and rounded | Conical | Conical | Low and rounded | Conical | Low and rounded |
| Satellite cones | Absent | Absent | Absent | Absent | Absent | Present | Absent | Absent | Present | Absent | Present | Absent | Absent | Absent | Absent | Absent |

No. of facing pg.: 66

## Plate 2.

Southern African species of *Carex* L.: Scanning Electron Micrographs of leaf lamina epidermides. Distal end of lamina on left.

Plate 2.1: Abaxial surface: Margin with prickles present, prickles almost appressed; surface papillate (*C. austro-africana*, Reid 1368, J, PRE). Scale bar = 278 µm.

Plate 2.2: Adaxial surface: Margin with prickles present. barb of prickle at 30°; surface with prickles present (*C. cognata*, Reid 1210, J, PRE). Scale bar = 270 µm.

Plate 2.3: Abaxial surface: Margin papillate (*C. glomerabilis*, Reid 1137, J, PRE). Scale bar = 278 µm.

Plate 2.4: Abaxial surface: Epicuticular wax present, copious; papillae present; stomatal complex without overarching papillae (*C. aethiopica*, Reid 1144, J, PRE). Scale bar = 20 µm.

Plate 2.5: Adaxial surface: Epicuticular wax present; cells of intercostal zone rectangular; cell walls sinuous (*C. austro-africana*, Reid 1368, J, PRE). Scale bar = 22 µm.

Plate 2.6: Adaxial surface: Epicuticular wax absent; cells of intercostal zone narrow at proximal end, widened and with surface domed at distal end (*C. spicato-paniculata*, Reid 1188, J, PRE). Scale bar = 38 µm.


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## Plate 3.

Southern African species of Carex L.: Scanning Electron Micrographs of leaf lamina epidermides. Distal end of lamina on left.

Plate 3.1: Adaxial surface: Single submarginal row of stomata present (C. monotropa. Killick 4593. PRE, ROML). Scale bar = 20 µm.

Plate 3.2: Abaxial surface: Stomatal complex overarched by four long narrow papillae; subsidiary cells with domed outer surface (C. austro-africana. Reid 1368. J, PRE). Scale bar = 20 µm.

Plate 3.3 & 4: Adaxial surface: Six submarginal rows of stomata present; stomatal complexes (one is arrowed in No. 3) overarched by four triangular papillae (No. 3 damaged, No. 4 with a fungal hypha) (C. mossii. Reid 1204. J, PRE). Scale bars: 3 = 278 µm; 4 = 20 µm.

Plate 3.5 & 6: Abaxial surface: Stomata more frequent with larger papillae than on adaxial surface; one stomatal complex arrowed in No. 5 (C. mossii. Reid 1204. J, PRE). Scale bars: 5 = 278 µm; 6 = 20 µm.


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No. of facing pg.: 68

**Plate 4.**

Southern African species of *Carex* L.: Scanning Electron Micrographs of leaf lamina epidermides. Distal end of lamina on left.

Plate 4.1: Abaxial surface: Morphology of costal zone (arrowed) with silica cells (*C.* sp. nov.. Reid 1337. J, PRE). Scale bar = 38 µm.

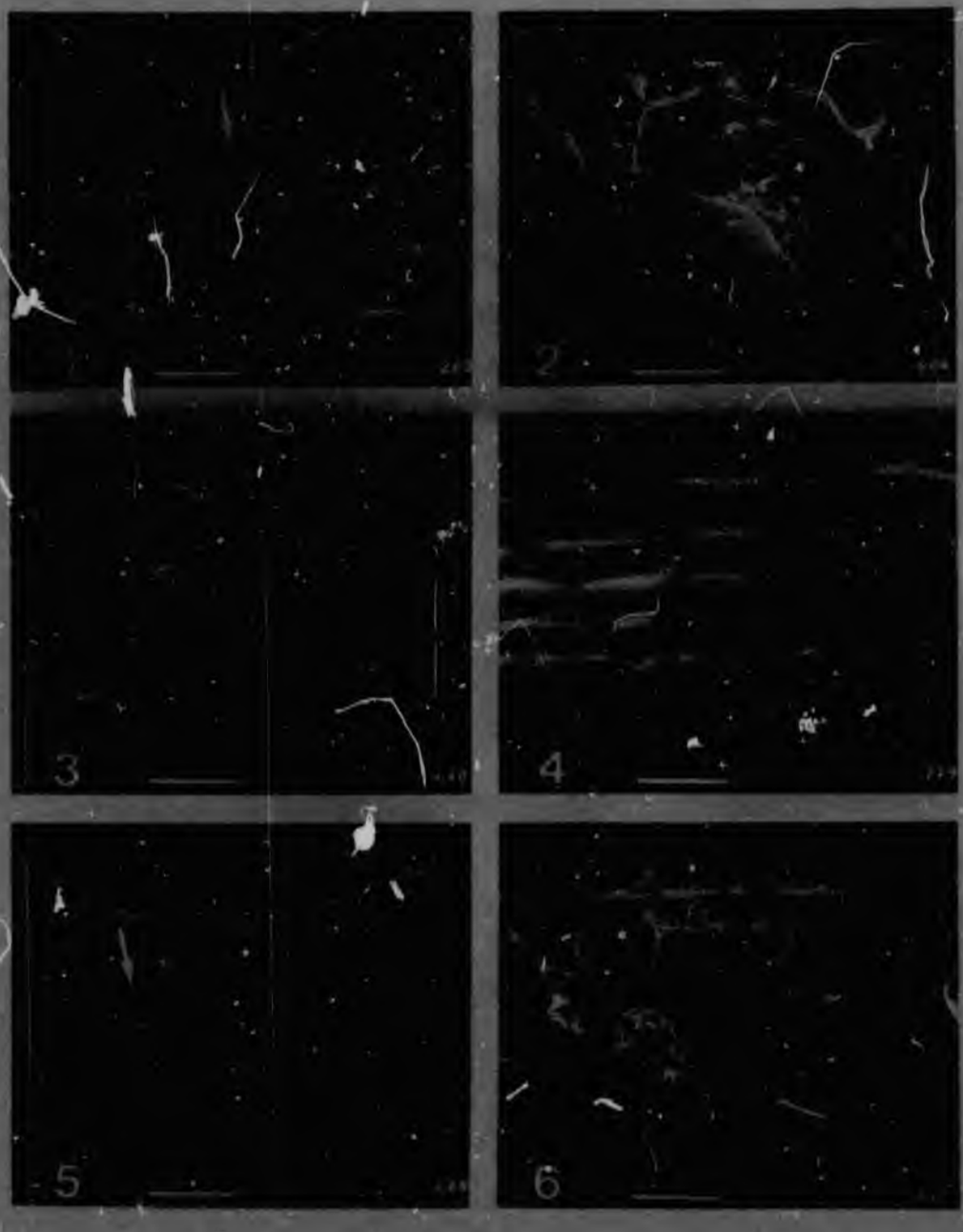
Plate 4.2: Abaxial surface: Morphology of silica body (*C. acutiformis*. Reid 1367. J, PRE). Scale bar = 6 µm.

Plate 4.3: Adaxial surface: Costal zone with associated prickles (*C. zuluensis*. Reid 1192. J, PRE). Scale bar = 38 µm.

Plate 4.4: Adaxial surface: Cells of intercostal zone square to rectangular (*C. aethiopica*. Reid 1144. J, PRE). Scale bar = 63 µm.

Plate 4.5: Adaxial surface, oblique view: Internal morphology of sinuous cell walls; position of one of the minute silica bodies arrowed (*C.* sp. nov.. Reid 1337. J, PRE). Scale bar = 20 µm.

Plate 4.6: Adaxial surface, oblique view: Internal morphology of leaf lamina (*C. burchelliana*. Reid 1115. J, PRE). Scale bar = 38 µm.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## Plate 5.

Southern African species of Carex L.: Scanning Electron Micrographs of perigynia. Distal end of perigynium on left.

Plate 5.1: Perigynium base not stipitate, without a callus; rostrum abrupt, short, margin scabrid, apex shallowly bidentate (C. burchelliana, Reid 1121, J, PRE). Scale bar = 952 µm.

Plate 5.2: Perigynium base bearing a callus (arrowed) (C. zuluensis, Reid 1192, J, PRE). Scale bar = 377 µm.

Plate 5.3: Perigynium base stipitate (C. mossii, Lowrey s.n. sub PRE 60417, PRE). Scale bar = 870 µm.

Plate 5.4 & 6: Perigynium erostrate; surface mainly glabrous with a zone of short conical hairs near distal end (No. 6: central cells have domed surfaces due to 2° electron image) (C. sp. nov., Reid 1337, J, PRE). Scale bars: 4 = 370 µm; 6 = 19 µm.

Plate 5.5: Rostrum margin winged, scabrid (C. glomerabilis, Reid 1137, J, PRE). Scale bar = 364 µm.


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## Plate 6.

Southern African species of *Carex* L.: Scanning Electron Micrographs of perigynia. Distal end of perigynium on left.

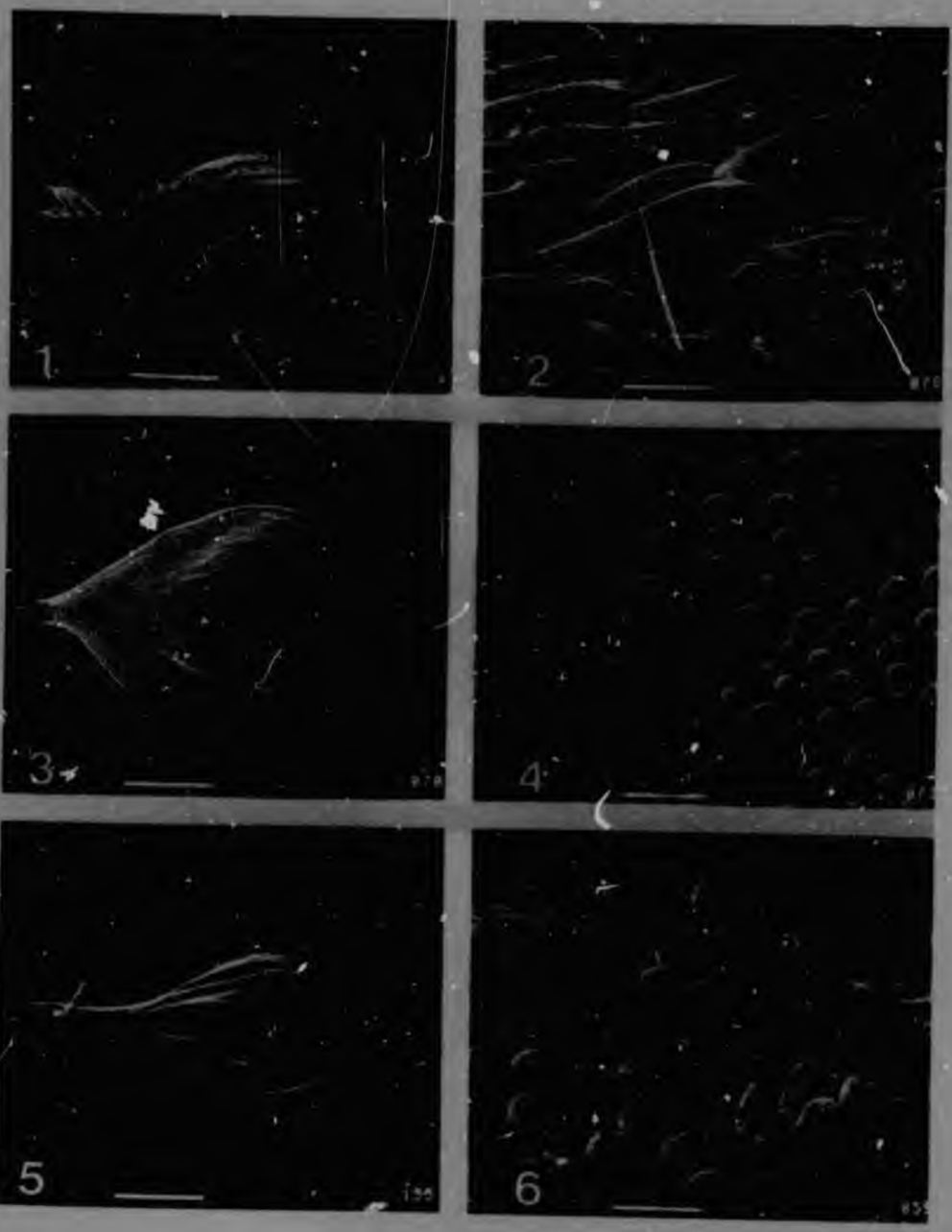
Plate 6.1: Perigynium surface scabrid in distal half; nerves 4--6, submarginal (*C. spicato-paniculata*, *Hilliard & Burtt 14221*. PRE). Scale bar = 909 µm.

Plate 6.2: Scabrid hairs impressed near base (Putative hybrid: *C. spicato-paniculata* X *C. zulvensis*. *Reid 1186*. J, PRE). Scale bar = 38 µm.

Plate 6.3 & 4: Perigynium inconspicuously nerved, papillate, with solid papillae (*C. austro-africana*, *Deall 2578*. PRE). Scale bars: 3 = 625 µm; 4 = 38 µm.

Plate 6.5: Rostrum deeply bidentate (*C. cognata*, *Reid 1210*. J, PRE). Scale bar = 1000 µm.

Plate 6.6: Perigynium papillate, with hollow papillae (*C. acutiformis*, *Reid 1367*. J, PRE). Scale bar = 38 µm.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## Plate 7.

Southern African species of *Carex* L.: Scanning Electron Micrographs of perigynia and fruits. Distal end of perigynium and fruit on left.

Plate 7.1: Morphology of rhachilla (arrowed) in species of Subgenus *Primocarex* (*C.* sp. nov., Reid 1337, J, PRE). Scale bar = 571 µm.

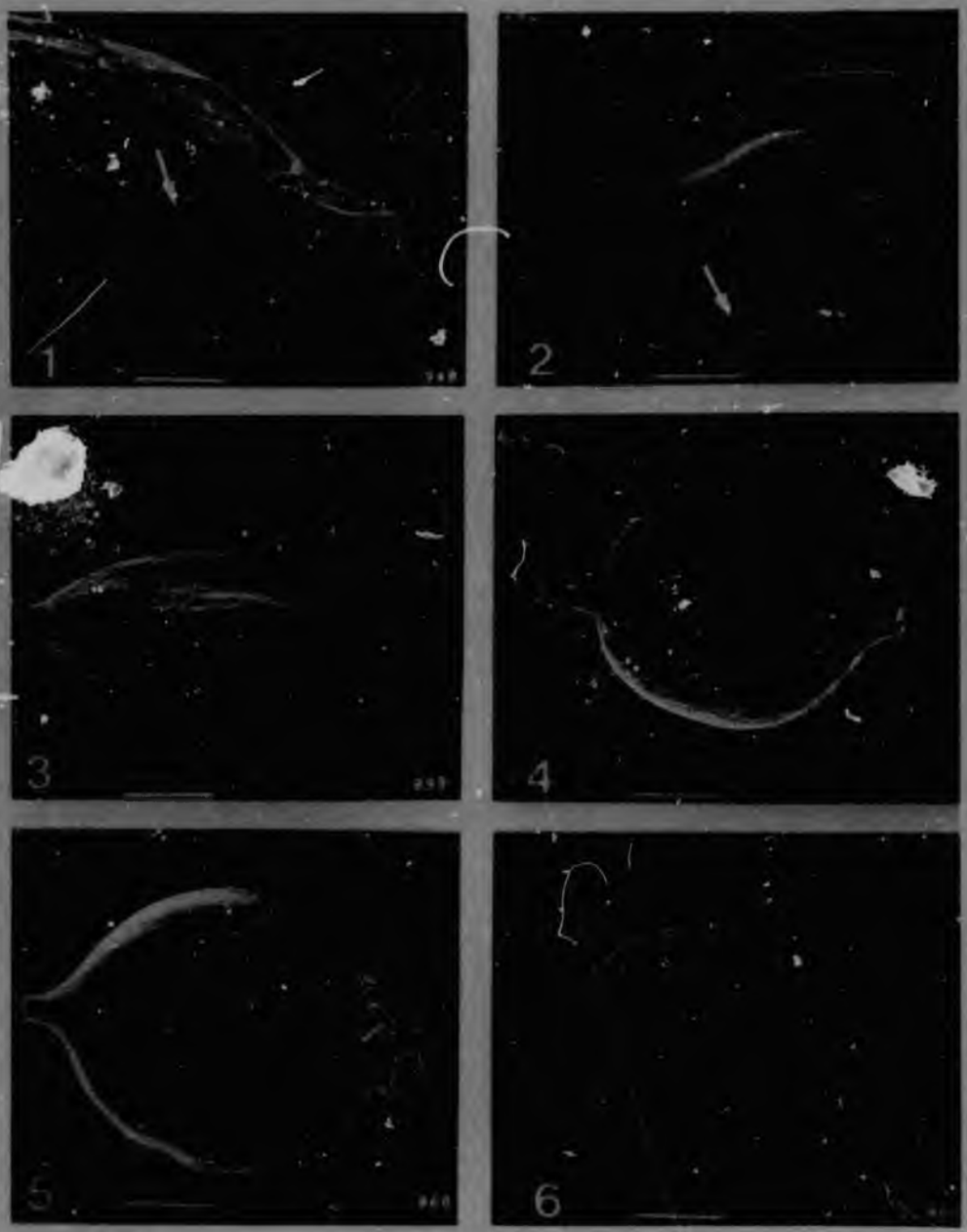
Plate 7.2: Basal spikelet: Morphology of rhachilla (arrowed); nutlet obovate, not clawed, style base twisted (*C. aethiopica*, Fourcade 4135, BOL, PRE, STE). Scale bar = 870 µm.

Plate 7.3: Nutlet elliptic, narrowly clawed (*C. zuluensis*, Reid 1192, J, PRE). Scale bar = 667 µm.

Plate 7.4: Nutlet square, broadly clawed; style base straight (*C. glomerabilis*, Coleman 707, PRE). Scale bar = 526 µm.

Plate 7.5: Nutlet obovate, not clawed (*C. austro-africana*, Deall 2578, PRE). Scale bar = 465 µm.

Plate 7.6: Nutlet obovate, clawed, claw with a foot-like base; style base slightly bent (*C. ecklonii*, Reid 1128, J, PRE). Scale bar = 571 µm.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## Plate 8.

Southern African species of *Carex* L.: Scanning Electron Micrographs of fruits and acetolyzed fruits. Distal end of fruit on left.

Plate 8.1: Cell outlines comprising 5--7-sided polygons; central cones lower than anticlinal walls, conical (*C. spicato-paniculata*. Hilliard & Burtt 14221, NU, PRE). Scale bar = 38 µm.

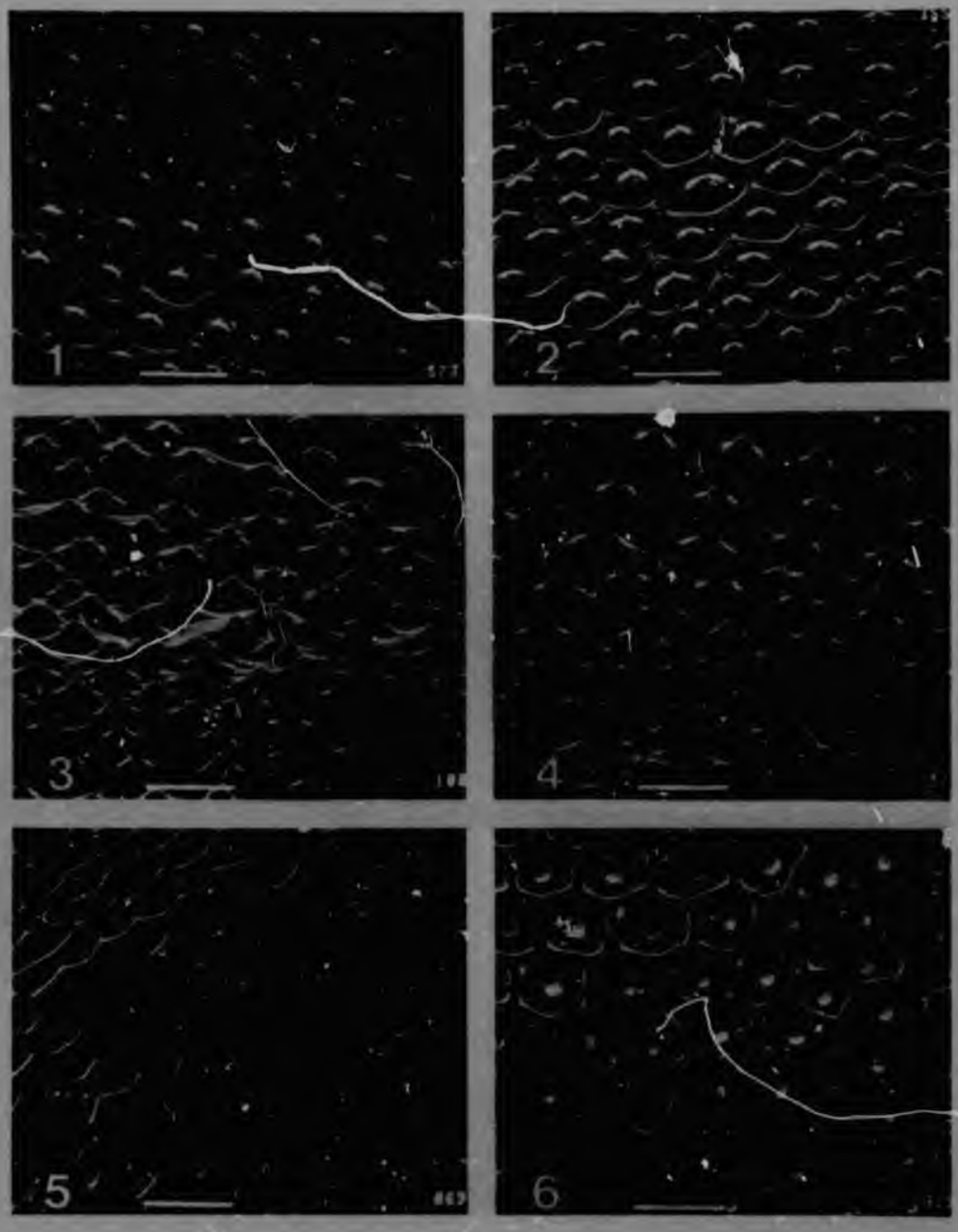
Plate 8.2: Acetolyzed: Basal plates in close contact with adjacent plates; margins of plates thickened (or upturned); central cones conical (*C. spicato-paniculata*. Hilliard & Burtt 14221, NU, PRE). Scale bar = 38 µm.

Plate 8.3: Central cones higher than anticlinal walls (*C. zuluensis*. Reid 1192. J, PRE). Scale bar = 38 µm.

Plate 8.4: Acetolyzed: Basal plates flat; central cones markedly tall and slender (*C. zuluensis*. Reid 1192, J, PRE). Scale bar = 38 µm.

Plate 8.5: (*C. austro-africana*, Deall 2578, PRE). Scale bar = 38 µm.

Plate 8.6: Acetolyzed: Adjacent basal plates not in close contact; central cone low and rounded (*C. austro-africana*. Deall 2578, PRE). Scale bar = 38 µm.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## Plate 9.

Southern African species of *Carex* L.: Scanning Electron Micrographs of fruits and acetolyzed fruits. Distal end of fruit on left.

Plate 9.1: (*C. burchelliana*, Reid 1121, J, PRE). Scale bar = 38 µm.

Plate 9.2: Acetolyzed: Small satellite cones on margin of basal plate (*C. burchelliana*, Reid 1121, J, PRE). Scale bar = 38 µm.

Plate 9.3: (*C. ecklonii*, Reid 1128, J, PRE). Scale bar = 38 µm.

Plate 9.4: Acetolyzed: Basal plate domed (*C. ecklonii*, Reid 1128, J, PRE). Scale bar = 38 µm.

Plate 9.5: Central cone not visible (*C. sp. nov.*, Reid 1337, J, PRE). Scale bar = 38 µm.

Plate 9.6: Acetolyzed. (*C. sp. nov.* Acocks 18659, PRE). Scale bar = 38 µm.

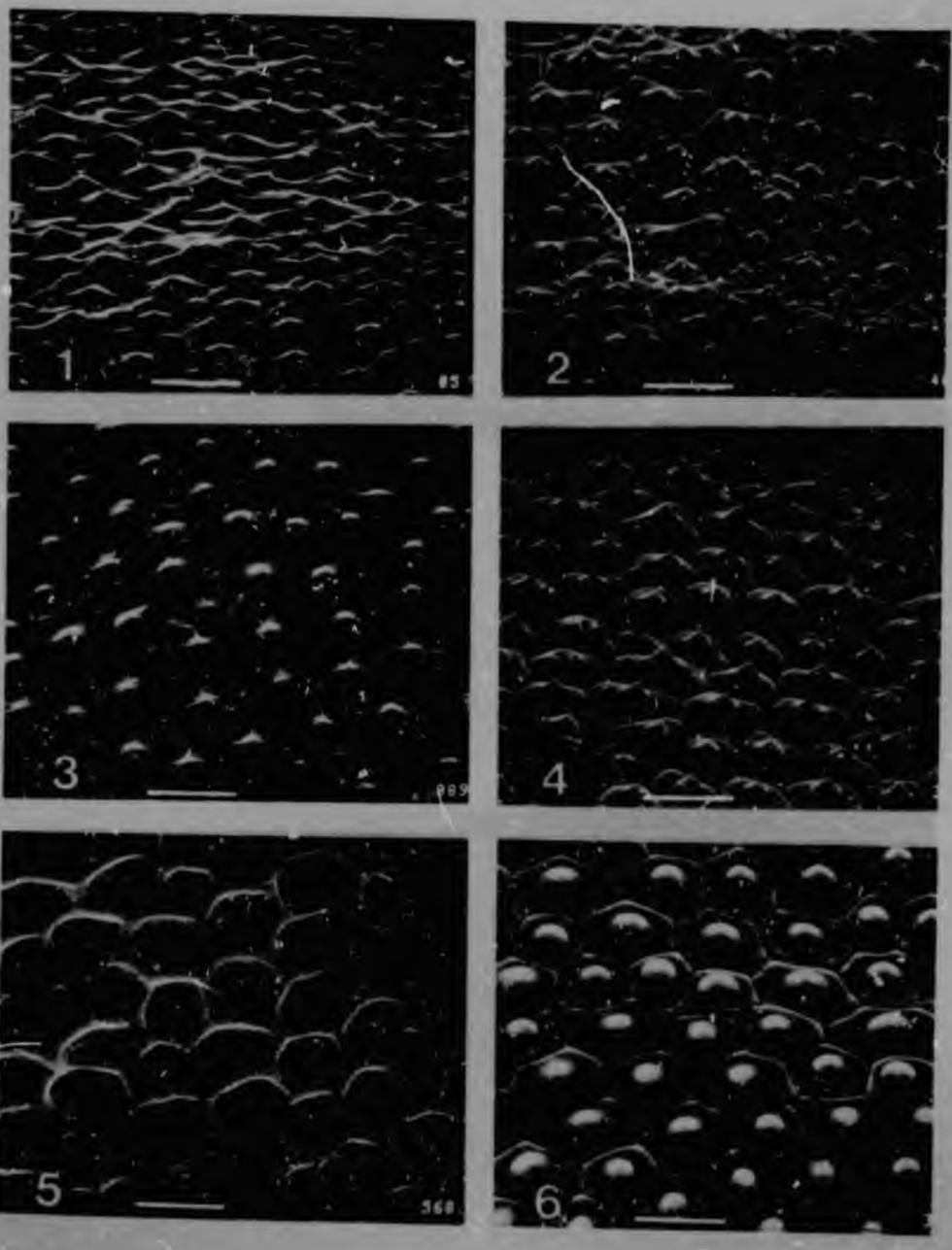
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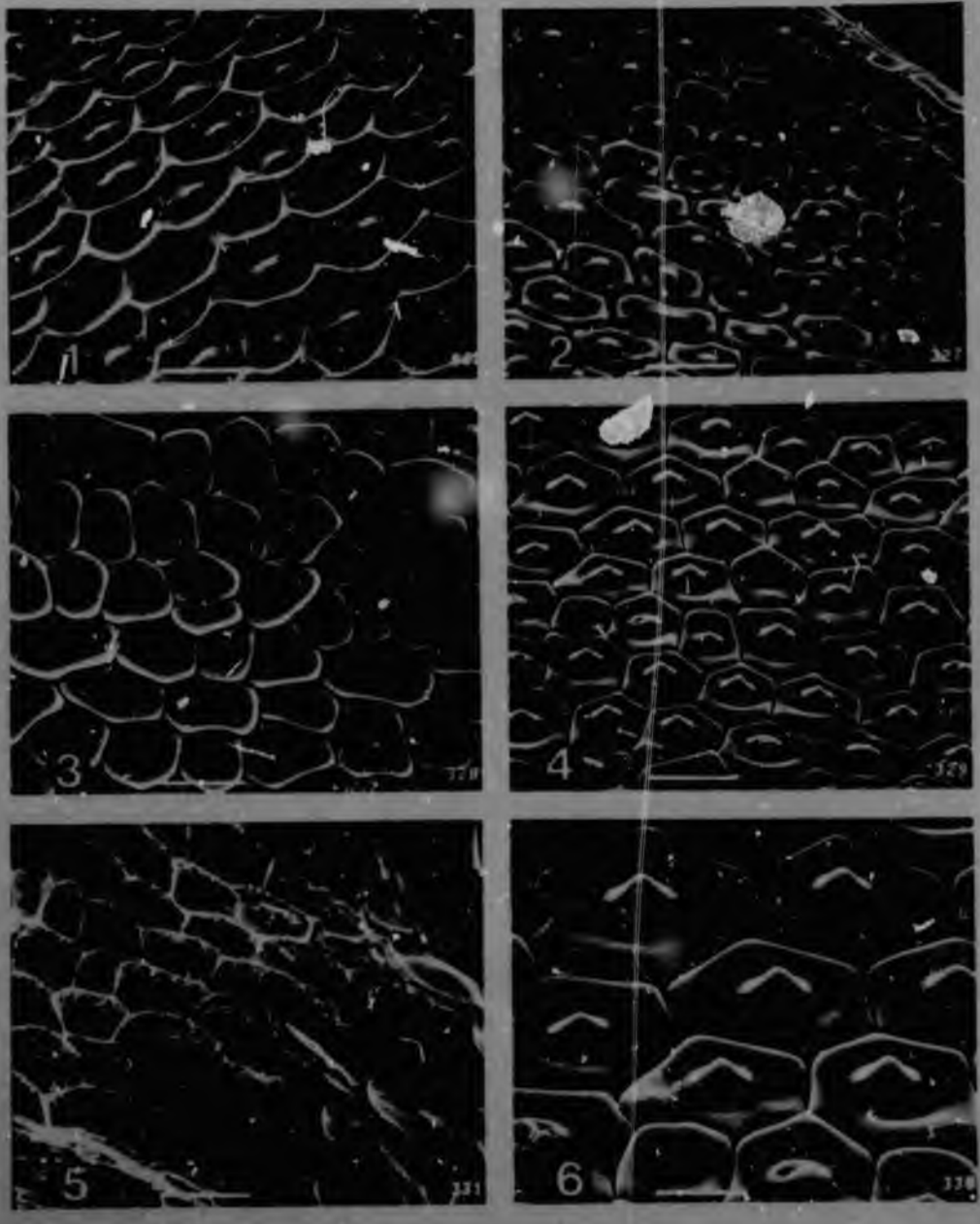
Plate 10.

Southern African species of C[illegible] L.: Scanning Electron Micrographs of fruits and acetolyzed fruits. Distal end of fruit on left.

Plate 10.1: (C. aethiopica. Reid 1144. J, PRE). Scale bar = 38 µm.

Plate 10.2 - 6: Acetolyzed: Series to show variation in shape of silica body, depending on position on fruit. 2: Basal region. 3: On angle of trigonous fruit. 4 and 6: Median position, abaxial face. 5: Stylar region. (C. aethiopica. Fourcade 4135. BOL, PRE, STE). Scale bars: 2 - 4 = 38 µm; 5 = 13 µm; 6 = 19 µm.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# CHAPTER 4. ANATOMICAL CHARACTERS

## A. INTRODUCTION

A limited investigation of the anatomy of leaves and culms of the southern African species of *Carex* was carried out, in order to test taxonomic decisions that were mainly based on morphological characters. Anatomical characters were not utilized in the generation of keys and descriptions, because they are not practical characters to use for routine identifications.

Kuekenthal (1909) referred only briefly to the anatomy of *Carex* in his monograph of the genus. Jermy & Tutin (1968) in their handbook on the British species of *Carex*, included plan diagrams of transverse sections of leaves and culms. *Carex* anatomy was reviewed in some detail by Metcalfe (1971), who also listed all the available literature on *Carex* anatomy (pp. 140--149) but no southern African species was fully discussed, although the two introduced species, *C. acutiformis* Ehrh. and *C. sylvatica* Huds., and the culm of *C. spicato-paniculata* were included. For the European species, Schultze-Motel (1980) included plan diagrams of transverse sections of culms and some transverse sections of leaves.

To ensure standardization, Metcalfe's terminology (pp. 2--29, 107--149; 1971) and order of discussion is utilized in the present study.

## B. MATERIALS AND METHODS

Leaves were sampled at about mid-point and culms at mid-point of an internode mid-way along their length. All of the southern African taxa except C. divisa Huds. were sampled. Material was placed into FAA in the field. In the laboratory the material was dehydrated, embedded in paraffin wax (melting point 56°C), sectioned on a rotary microtome, stained and mounted. The procedure is outlined in Appendix 3. Voucher specimens are marked in Appendix 1.1 with an asterisk (*).

Material of one critical taxon, which did not provide good results by the above method, was fixed in osmium tetroxide, embedded in Spurr's resin (see Appendix 3), and sections were cut by Dr. M.L. Frean on a Reichert ultramicrotome. The sections were stained with toluidine blue, coverslipped and mounted with XPD.

Photomicrographs were taken on an Olympus VANOX-S using Ilford PANF film and white filters, excepting the sections cut on the ultramicrotome, for which an additional blue filter was used.

Due to the unusual anatomy of these plants (i.e. heavily sclerified tissue alternating with air cavities) the sections obtained were far from perfect. Had this difficulty been anticipated, time would have been allowed for treatment of the material with Mollifex to soften the strengthening tissue: the material must be soaked for a minimum of three

months.

## C. RESULTS

### 1. Lemma Transverse Section

#### 1.1. General description of the southern African species

Plan: (From adaxial to abaxial surface) Cuticle; adaxial epidermis; ground tissue comprising vascular bundles associated with sclerenchyma, alternating with mesophyll containing chlorenchyma surrounding large air cavities; abaxial epidermis; cuticle. Cuticle: Thick; generally of equal thickness on adaxial and abaxial surfaces, but very thin on small cells overlying sclerenchyma strands (Pl. 11.4). Epidermis: Cell shape round to square, smaller where overlying sclerenchyma strands, adaxial cells diminishing in size towards the margins. Papillae: When present, one per epidermal cell. Bulliform cells: Situated in median adaxial groove, well-developed, replacing normal epidermal cells (Pl. 11.2 & 11.6). In tranverse section appearing greatly enlarged longitudinally and less enlarged laterally. Uppermost 1-few layers (depending on the species) continuous, lowermost generally discontinuous, interrupted by sclerenchyma. Stomata: Fairly uniform in size and shape; guard cells, subsidiary cells and substomatal cavities small (Pl. 11.8). Sclerenchyma: Associated with vascular tissue, with an additional strand occurring adaxially near lamina

margin, subjacent to epidermis (Pl. 11.4). Primary (or median) vascular bundle situated in keel accompanied abaxially by a very large descending-crescentiform sclerenchyma girder, and adaxially by a smaller cap of sclerenchyma (Pl. 11.2). Secondary vascular bundles always accompanied abaxially by sclerenchyma girders (Pl. 11.5), but shape and size of adaxial sclerenchyma depending on species. Minor vascular bundles with varying amounts of associated sclerenchyma, depending on size of bundle. Interconnected pits in walls of fibres clearly visible at 50x magnification. Mesophyll: Several types: (1) Parenchyma sometimes present, associated with adaxial sclerenchyma strands (Pl. 11.5). (2) Chlorenchyma: not radiate, confined to two to four cell layers surrounding each air cavity (Pl. 11.5). Cells rounded to polygonal and slightly lobed. (3) Mesophyll parenchyma cells (that ultimately give rise to air cavities) very large and thin-walled and apparently lacking chloroplasts. (4) Mesophyll cells surrounding commissural vascular bundles (Pl. 11.7) intermediate in size between types (2) and (3) and apparently containing some chloroplasts; lobate. Air cavities (lysigenous spaces): Large, well-developed, occurring in mesophyll between consecutive vascular bundles; decreasing in size towards lamina margin (Pl. 11.3). Vascular bundles: Collateral, occurring in single row parallel to long axis of lamina, alternating major (large) and minor (small) bundles. Major bundles tending to be elongate, minor bundles tending to be

round. Protoxylem, metaxylem and phloem easily distinguished (Pl. 11.5). In each bundle two laterally situated metaxylem vessels occur, sometimes appearing to be more than two due to the overlapping ends of two cells being visible. Major bundles, especially median ones, with large cavity apically in protoxylem. Commissural bundles occur at right angles to long axis of lamina, linking parallel bundles; spiral thickening of elements clearly visible (Pl. 11.7). Bundle sheath: Double, with fibrous inner sheath and parenchymatous outer sheath (Pl. 11.5). In major bundles outer sheath interrupted by sclerenchyma both abaxially and adaxially, in minor bundles sheath almost continuous (Pl. 11.8). In transverse section thickening on outer walls of inner sheath cells much thinner or absent, appearing U-shaped. Secretory cells: When present, occur in the mesophyll, usually lining air cavities but sometimes dispersed through chlorenchyma (Pl. 11.5).

1.2. Characters that distinguish the species

Profile: Crescentiform in one species (Pl. 11.3), keeled and flat to V-shaped in two species, keeled and flat to broadly flanged in the remaining species (Pl. 11.1). In larger species lamina can be described as flat to plicate. Keel: Present and prominent abaxially in all species except one in which it is absent (Pl. 11.3). Keel acute in most species (Pl. 11.2), round in one species. Median adaxial groove: Prominent in most species (Pl. 11.2 & 11.6), barely

discernable in one species (Pl. 11.3). Thickness: Usually thickest at middle and tapered to margins, but in species with flanged or plicate laminae, also thickened at angle of flange (Pl. 11.1). In one species lamina grooved above vascular bundles, especially abaxially (Pl. 11.4). Epidermis: Adaxial cells usually more than twice as large as abaxial cells (Pl. 11.8) but only slightly larger in one species (Pl. 11.4). Papillae: Absent in most species; very prominent villiform papillae occur abaxially in three species (Pl. 11.5); less prominent papillae, formed by doming of cell outer surface, occur abaxially in three species. Adaxial papillae occur in one species. Bulliform cells: Comprise a single continuous layer in some species (Pl. 11.2 & 11.3), a single continuous layer plus a discontinuous subjacent layer in most species, two continuous layers in two species, and three continuous layers plus one discontinuous layer in one species (Pl. 11.6). Stomata: Usually flush with surrounding epidermal cells (Pl. 11.8); sunken in one species, where also overarched by papillae (Pl. 11.5). Sclerenchyma: Secondary vascular bundles accompanied adaxially by baculiform girders in seven species (Pl. 11.6), and by V-shaped strands in the remaining species (Pl. 11.5). In species with flanged laminae, adaxial sclerenchyma strand in angle of flange much larger than in remaining groups of sclerenchyma. Mesophyll: (Type (4)) Commissural bundles sectioned in three species: Associated mesophyll cells with narrow villiform lobes in

two species and with wide lobes in one species (Pl. 11.7). Air cavities: Round to square in transverse section in most species (Pl. 11.4 & 11.5); in three species width about twice the height (i.e elliptic) (Pl. 11.8). Vascular bundles: Usually occurring about midway between the two epidermides (Pl. 11.4), but in three species minor bundles especially, closer to abaxial epidermis (Pl. 11.5). Metaxylem elements much larger than protoxylem elements in all species (Pl. 11.5) except two (Pl. 11.4). Bundle sheath: In minor vascular bundles, outer sheath with cells conspicuously large in three species (Pl. 11.8); not conspicuously large in the remaining species (Pl. 11.7). Secretory cells: Absent in three species (Pl. 11.7), fairly common in most species (Pl. 11.2, 11.4, 11.5 & 11.8), and very frequent in one species.

These characters are also summarized in Table 8, where diagnostic characters are underlined.

## 2. Culm Transverse Section

### 2.1. General description of the southern African species

Plan: (In a centripetal direction) Cuticle; epidermis; sclerenchyma girders, numerous peripheral major and minor vascular bundles and sclerenchyma caps alternating with chlorenchyma and air cavities; central parenchymatous ground tissue with or without minor vascular bundles. Cuticle: About same thickness as in leaf lamina, also usually thinner

on small epidermal cells overlying sclerenchyma girders. Epidermis: Cells about same size and shape as abaxial epidermal cells of lamina. Stomata: In transverse section about same shape and size as stomata in lamina. Sclerenchyma: Large strands generally present at angles of culm, either independently or associated with vascular bundles (Pl. 12.3). Large triangular girders generally associated with peripheral major vascular bundles (Pl. 12.6). In most species, girders occasionally interrupted by parenchyma (Pl. 12.8). Sclerenchyma caps present at xylem poles of peripheral major bundles and at xylem and phloem poles of peripheral minor and inner minor bundles (Pl. 12.2). Assimilatory tissue: Chlorenchyma confined to two to four cell layers subjacent to epidermis, on outer edges of air cavities (Pl. 12.3 & 12.6). Secretory cells: When present, more common in tissue surrounding air cavities, also occurring in central ground tissue. Vascular bundles: Very similar to those in lamina. Commissural bundles also occur (Pl. 12.7). In shape major bundles generally slightly elongate (Pl. 12.1), minor bundles round (Pl. 12.4). Major bundles, especially in larger species, with conspicuously large cavities in protoxylem (Pl. 12.8). Ground tissue: Either undifferentiated with central parenchyma not differing markedly in shape and size from peripheral parenchyma (Pl. 12.1 & 12.2), or differentiated with central parenchyma comprising very large cells with large air-cavities (Pl. 12.5).

## 2.2. Characters that distinguish the species

Profile: Triangular with round angles in most species (Pl. 12.1), but with angles acute in three species; sides straight to convex in most species, but in three species at least one side concave. Profile circular and ribbed in one species (Pl. 12.5). Stomata: Usually flush with surrounding epidermal cells; sunken in one species (Pl. 12.6). Sclerenchyma: Large strands usually present at angles of culm (Pl. 12.3); absent in one species (Pl. 12.1). Large triangular girders usually associated with peripheral major vascular bundles(Pl. 12.2), but in one species (in which the culm is supported by a leaf sheath) girders only present opposite thin-tissued adaxial portion of leaf sheath (Pl. 12.1). Air cavities: Usually round to square in shape (Pl. 12.1); vertically elongated in two species (Pl. 12.8). Very large in most species (Pl. 12.1), of medium size in four species (Pl. 12.2) and very small in three species (Pl. 12.6). Secretory cells: Present in seven species (Pl. 12.8), absent in the remaining species (Pl. 12.2). Vascular bundles: Major ones usually slightly elongated (Pl. 12.1); markedly elongated in two species (Pl. 12.8). Ground tissue: Undifferentiated with many minor vascular bundles scattered throughout in two species (Pl. 12.2 & 12.4); undifferentiated with minor vascular bundles confined to a few rows on outer edge in six species (Pl. 12.1); differentiated with a few rows of minor vascular bundles confined to outer, smaller-celled tissue in five species;

differentiated, without minor vascular bundles in two species (Pl. 12.5).

These characters are also summarized in Table 11, where diagnostic features are underlined.

## D. DISCUSSION

The interaction between structure, morphology and function is very complex, meriting a much more intensive investigation than the present study afforded. However the results that were obtained, especially the general description, correlated well with Metcalfe's results. They are useful for general comparative purposes, as shown by the great number of distinguishing characters listed in Tables 10 and 11. They also aided in the interpretation of surface morphological features, especially of characters such as stomatal complexes and papillae, and elucidated the nature of the supporting tissue in such prominent features as the keel of the lamina. It was borne in mind that, like morphology, anatomy is under genetic control, and that to provide conclusive evidence of discontinuities, a large range of material of each taxon should have been studied. All the southern African species have a $C_3$ leaf lamina anatomy which suggests that they all may have a $C_3$ photosynthetic pathway.

As well as lamina anatomy having diagnostic value in some cases, culm anatomy (but not lamina anatomy) provided important indications of relationships especially at

subgeneric level, within the southern African taxa. Lamina profile was immediately diagnostic in one species, C. sp. nov., as it was the only species with a crescentiform lamina, the remaining species having variously flat, keeled or plicate laminae. Two or more characters in combination could also be diagnostic, e.g. in the laminae of C. mossii and C. sylvatica sclerenchyma strands rather than girders were associated with the secondary vascular bundles. In addition C. mossii had large epidermal papillae on the abaxial surface, thus even small lamina fragments of C. mossii would be identifiable.

In a recent paper Standley (1990) stressed that while foliar (leaf lamina) anatomical characters were valuable in distinguishing species within a section, these characters alone could not be used as a basis for determining relationships among species or sections, due to a high level of homoplasy, i.e. evolutionary trends within all sections of the group are similar, resulting in the evolution of similar anatomical phenotypes in many apparently unrelated groups.

Culm anatomy supported hypotheses of relationships based on morphological characters. In C. ecklonii, C. burchelliana and C. monotropa, all members of Subgenus Carex, culm anatomy was almost identical. In the culm of the dwarf species C. monotropa, the occurrence of only a few sclerenchyma girders, confined to a particular area, could be explained by the fact that the culm was protected and

supported by leaf sheaths, and the sclerenchyma girders occurred only opposite the adaxial, thin-tissued portion of the leaf sheath. In the culms of C. sp. nov. and C. glomerabilis the differentiated ground tissue and single peripheral ring of vascular tissue showed that these species were not closely related to the remaining species, and that their placement in separate subgenera from the remaining species on morphological evidence was justified. Similarly, the culms of C. spicato-paniculata and C. zuluensis were distinctive. The undifferentiated ground tissue with vascular bundles scattered throughout, was unlike any of the other species and justified their being placed in a separate subgenus and showed that they were quite closely related.

## E. CONCLUSIONS

This brief study showed that lamina and culm anatomy provided many very valuable characters, which could be utilized both diagnostically and in support of theories about relationships made on morphological grounds. It would be worthwhile pursuing this study species by species and assessing the intraspecific variation that undoubtedly exists.

Table 10. Anatomical characters of the leaf lamina that distinguish the southern African species of Carex L.

| Feature | Taxa | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subgenus Indocar. | | Subgenus Vignea | | Subgenus Carex | | | | | | | | | | | Subg. Primocarex |
| | C. spicato-paniculata | C. zuluensis | C. divisa | C. glareosilis | C. austro-africana | C. exilis | C. aethiopica | C. sylvatica | C. burchelliana | C. echinata | C. monotrera | C. cognata | C. acutiformis | C. clavata | C. subinflata | C. sp. nov. |
| LAMINA TRANSVERSE SECTION - | | | | | | | | | | | | | | | | |
| Profile: | Keeled, flat to broadly flanged | Keeled, flat to broadly flanged | N/av | Keeled, flat to V-shaped | Keeled, flat to broadly flanged | Keeled, flat to plicate | Keeled, flat to broadly flanged | Keeled, flat to broadly flanged | Keeled, flat to broadly flanged | Keeled, flat to broadly flanged | Keeled, flat to broadly flanged | Keeled, flat to broadly flanged | Keeled, flat to broadly flanged | Keeled, flat to plicate | Keeled, flat to broadly flanged | Crescentiform |
| Keel: | Prominent, acute | Prominent, acute | N/av | Prominent, acute | Prominent, acute | Prominent, acute | Prominent, acute | Prominent, acute | Prominent, acute | Prominent, acute | Prominent, acute | Prominent, acute | Prominent, rounded | Prominent, acute | Prominent, acute | Absent |
| Median adaxial vascular bundle: | Prominent | Prominent | N/av | Prominent | Prominent | Prominent | Prominent | Prominent | Prominent | Prominent | Prominent | Prominent | Prominent | Prominent | Prominent | Barely discernible |
| Thickness: | Thickest next to keel and at angle of flange, tapered between and to margins | Thickest next to keel and at angle of flange, tapered between and to margins | N/av | Thickest next to keel, tapered to margins | Thickest next to keel and at angle of flange, tapered between and to margins | Thickest next to keel and at angles of folds, tapered between and to margins | Thickest next to keel and at angle of flange, tapered between and to margins | Thickest next to keel and at angle of flange, tapered between and to margins | Thickest next to keel and at angle of flange, tapered between and to margins | Thickest next to keel and at angle of flange, tapered between and to margins | Thickest next to keel and at angle of flange, tapered between and to margins | Thickest next to keel and at angle of flange, tapered between and to margins | Thickest next to keel and at angle of flange, tapered between and to margins | Thickest next to keel and at angles of folds, tapered between and to margins | Thickest next to keel and at angle of flange, tapered between and to margins | Thickest at middle, tapered to margins, prominent (especially abaxially) above vascular bundles |
| Epidermal cells - relative size: | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | N/av | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial more than 2x size of abaxial | Adaxial slightly larger than abaxial |
| Papillae: | Absent | Absent | N/av | Absent | Prominent, villiform | Prominent, villiform | Present, formed by domed outer surface of cells | Absent | Absent | Absent | Absent | Absent | Prominent, villiform | Present, formed by domed outer surface of cells | Present, formed by domed outer surface of cells | Absent |
| Bulliform cells - number of layers: | 1 continuous 1 discontinuous | 1 continuous 1 discontinuous | N/av | 1 continuous 1 discontinuous | 1 continuous 1 discontinuous | 3 continuous 1 discontinuous | 1 continuous | 1 continuous 1 discontinuous | 1 continuous | 1 continuous 1 discontinuous | 1 continuous | 1 continuous 1 discontinuous | 1 continuous | 2 continuous | 2 continuous | 1 continuous |
| Stomata: | Not sunken, not associated with papillae | Not sunken, not associated with papillae | N/av | Not sunken, not associated with papillae | Not sunken, associated with papillae | Sunken, overarched by papillae | Not sunken, not associated with papillae | Not sunken, not associated with papillae | Not sunken, not associated with papillae | Not sunken, not associated with papillae | Not sunken, not associated with papillae | Not sunken, not associated with papillae | Not sunken, not associated with papillae | Not sunken, not associated with papillae | Not sunken, not associated with papillae | Not sunken, not associated with papillae |
| Sclerenchyma adaxial to 2° vasc. bundles: | Bauliflora girder | Bauliflora girder | N/av | V-shaped strand | V-shaped strand | V-shaped strand | V-shaped strand | V-shaped strand | Bauliflora girder | Bauliflora girder | Bauliflora girder | V-shaped strand | Bauliflora girder | V-shaped strand | V-shaped strand | Bauliflora girder |
| Mesophyll parenchyma: | Absent | Absent | N/av | Present | Present | Present | Present | Present | Absent | Absent | Absent | Present | Absent | Present | Present | Absent |
| Air cavities - shape: | Width 2x height | Width 2x height | N/av | Width = height | Width = height | Width = height | Width = height | Width = height | Width = height | Width = height | Width = height | Width = height | Width = height | Width = height | Width = height | Width = height |
| Vascular bundles - relative position: | Equidistant from adaxial and abaxial epidermis | Equidistant from adaxial and abaxial epidermis | N/av | Closer to abaxial epidermis | Equidistant from adaxial and abaxial epidermis | Closer to abaxial epidermis | Equidistant from adaxial and abaxial epidermis | Closer to abaxial epidermis | Equidistant from adaxial and abaxial epidermis | Equidistant from adaxial and abaxial epidermis | Equidistant from adaxial and abaxial epidermis | Equidistant from adaxial and abaxial epidermis | Equidistant from adaxial and abaxial epidermis | Equidistant from adaxial and abaxial epidermis | Equidistant from adaxial and abaxial epidermis | Equidistant from adaxial and abaxial epidermis |
| Metaxylem elements - relative size: | Markedly larger than protoxylem elements | Markedly larger than protoxylem elements | N/av | Markedly larger than protoxylem elements | Markedly larger than protoxylem elements | Markedly larger than protoxylem elements | Markedly larger than protoxylem elements | Markedly larger than protoxylem elements | Markedly larger than protoxylem elements | Markedly larger than protoxylem elements | Not markedly larger than protoxylem elements | Markedly larger than protoxylem elements | Markedly larger than protoxylem elements | Markedly larger than protoxylem elements | Markedly larger than protoxylem elements | Not markedly larger than protoxylem elements |
| Outer sheath of minor vascular bundles - cell size: | Conspicuously large | Conspicuously large | N/av | Not conspicuously large | Not conspicuously large | Not conspicuously large | Conspicuously large | Not conspicuously large | Not conspicuously large | Not conspicuously large | Not conspicuously large | Not conspicuously large | Not conspicuously large | Not conspicuously large | Not conspicuously large | Not conspicuously large |
| Accessory cells: | Fairly common | Fairly common | N/av | Absent | Fairly common | Fairly common | Fairly common | Absent | Fairly common | Fairly common | Very frequent | Absent | Fairly common | Fairly common | Fairly common | Fairly common |

N/av = not available

Table 11. Anatomical characters of the culm that distinguish the southern African species of Carex L.

| Features | Taxa | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Subgenus Indocarex | | Subgenus Vignea | | Subgenus C. [illegible] | | | | | | | | | | | | Subg. Uncertain |
| | C. micro-pericalata | C. rubrensis | C. divisa | C. elsmorabilis | C. subsp. africana | C. acrasii | C. bathiopica | C. sylvatica | C. burchelliana | C. eylesii | C. spanogona | C. cognata | C. scottiorsis | C. elevata | C. subinflata | C. sp. nov. | |
| CULM TRANSVERSE SECTION - | | | | | | | | | | | | | | | | | |
| Profile: | Triangular, angles round, sides straight to convex | Triangular, angles round, sides straight to convex | N/av | Triangular, angles round, sides straight to convex | Triangular, angles acute, sides straight to convex | Triangular, angles round, sides straight to convex | Triangular, angles round, sides straight to convex | Triangular, angles round, sides straight to convex | Triangular, angles round, sides straight to convex | Triangular, angles round, sides straight to convex | Triangular, angles round, sides straight to convex | Triangular, angles acute, at least one side concave | Triangular, angles round, at least one side concave | Triangular, angles round, sides straight to convex | Triangular, angles acute, at least one side concave | Circular, ribbed | |
| Stomata: | Not sunken | Not sunken | N/av | Not sunken | Not sunken | Not sunken | Not sunken | Not sunken | Not sunken | Not sunken | Not sunken | Not sunken | Not sunken | Not sunken | Not sunken | Sunken | |
| Sclerenchyma strands at culm angles: | Present | Present | N/av | Present | Present | Present | Present | Present | Present | Present | Absent | Present | Present | Present | Present | Present | |
| Sclerenchyma girders associated with major vascular bundles: | Always | Always | N/av | Always | Always | Always | Always | Always | Always | Always | Only opposite thin-flanged adaxial portion of leaf sheath | Always | Always | Always | Always | Always | |
| Air cavities - shape and size: | Round to square, medium size | Round to square, medium size | N/av | Round to square, very large | Round to square, very large | Vertically elongate, medium size | Round to square, very large | Round to square, very large | Round to square, very small | Round to square, very small | Round to square, very large | Round to square, very large | Round to square, very large | Vertically elongate, medium size | Round to square, very large | Round to square, very small | |
| Parenchyma cells: | Absent | Absent | N/av | Absent | Present | Present | Absent | Absent | Present | Absent | Absent | Absent | Present | Present | Present | Present | |
| Major vascular bundles - shape: | Slightly elongate | Slightly elongate | N/av | Slightly elongate | Slightly elongate | Markedly elongate | Slightly elongate | Slightly elongate | Slightly elongate | Slightly elongate | Slightly elongate | Slightly elongate | Slightly elongate | Markedly elongate | Slightly elongate | Slightly elongate | |
| Ground tissue: | Undifferentiated | Undifferentiated | N/av | Differentiated | Undifferentiated | Differentiated | Undifferentiated | Undifferentiated | Undifferentiated | Undifferentiated | Undifferentiated | Differentiated | Differentiated | Differentiated | Differentiated | Differentiated | |
| Distribution of minor vascular bundles: | Scattered throughout | Scattered throughout | N/av | None | Confined to a few rows on outer edge | Confined to a few rows in outer smaller-celled tissue | Confined to a few rows on outer edge | Confined to a few rows on outer edge | Confined to a few rows on outer edge | Confined to a few rows on outer edge | Confined to a few rows on outer edge | Confined to a few rows in outer smaller-celled tissue | Confined to a few rows in outer smaller-celled tissue | Confined to a few rows in outer smaller-celled tissue | Confined to a few rows in outer smaller-celled tissue | None | |

N/av = not available.

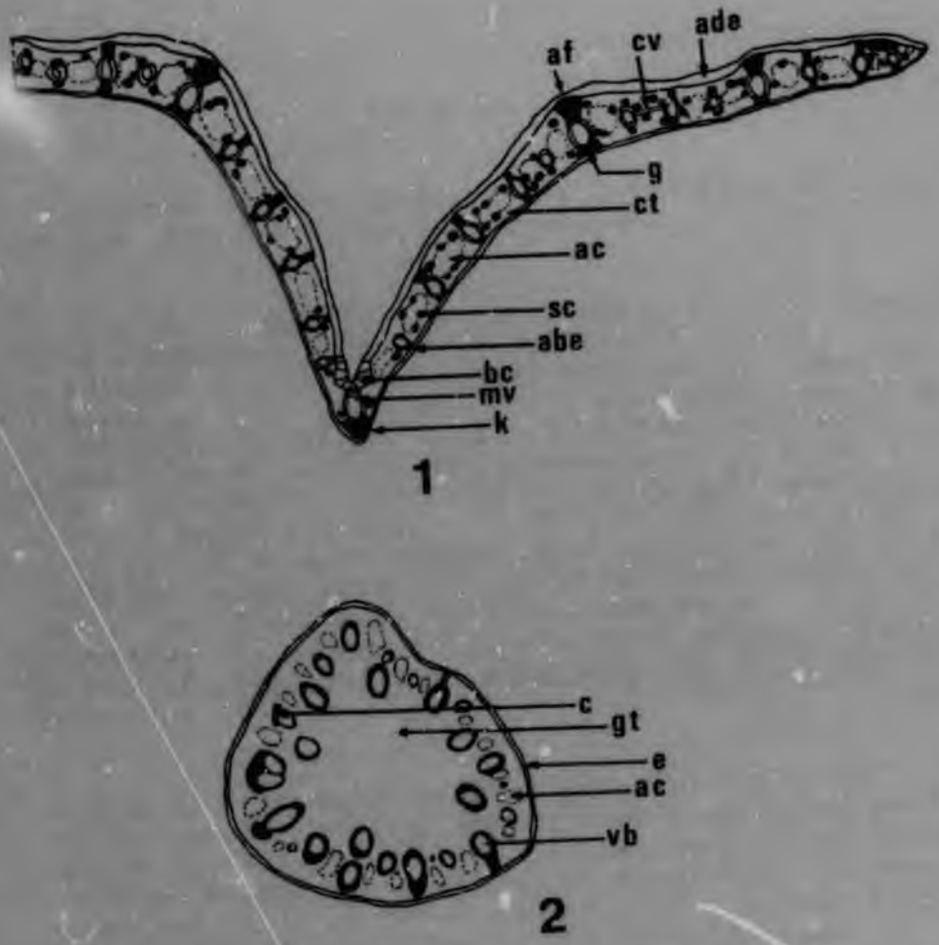



Fig. 4. Plan diagrams of anatomical structure in Carex L. Sclerenchyma shaded black, secretory cells stippled. 1. Leaf lamina (C. burchelliana, Reid 1115) X 20. 2. Culm (C. monotropa, Killick 4593) X 20. ac = air cavity; abe = abaxial epidermis; ade = adaxial epidermis; af = angle of flange; bc = bulliform cells; c = sclerenchyma cap; ct = chlorenchyma tissue; cv = commissural vascular bundle; e = epidermis; g = sclerenchyma girder; gt = ground tissue; k = keel; mv = median vascular bundle; sc = secretory cell; vb = vascular bundle.

No. of facing pg.: 90

## Plate 11.

Southern African species of Carex L.: Transverse sections of leaf laminae. Adaxial epidermis uppermost.

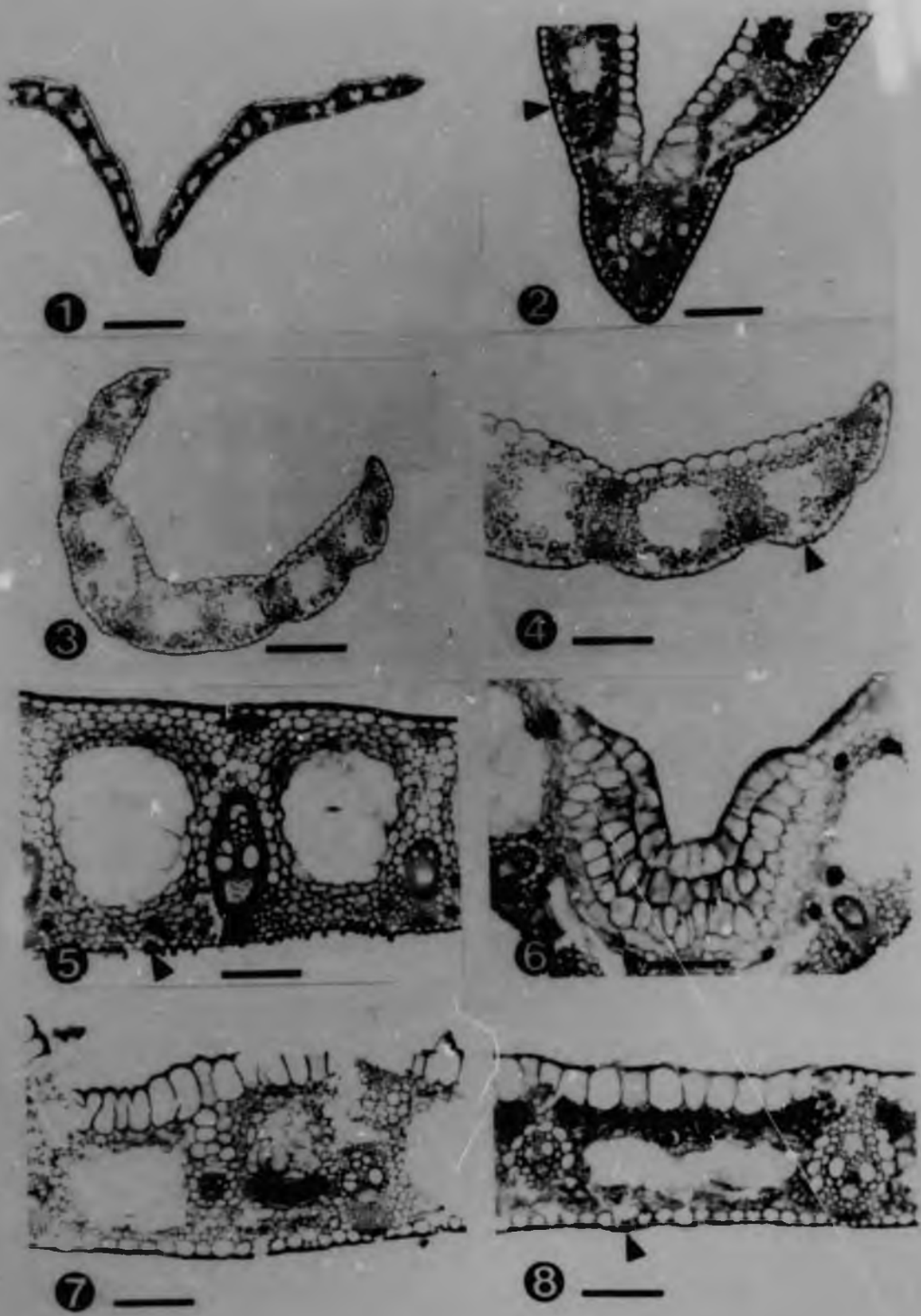
Plate 11.1 & 2: Transverse section keeled, flanged V-shaped; keel prominent, acute, median adaxial groove prominent; lamina thickest at keel and at angle of flange; adaxial epidermal cells more than twice size of abaxial; bulliform cells: 1 continuous layer; stoma arrowed; sclerenchyma associated with 2° vascular bundles: baculiform girder; air cavities: width = height; vascular bundles equidistant from adaxial and abaxial epidermides; metaxylem elements markedly larger than protoxylem elements; cells of outer sheath of minor vascular bundles not conspicuously large; secretory cells present, fairly common (C. burchelliana. Reid 1115. J, PRE). Scale bars: 1 = 1166 µm; 2 = 241 µm.

Plate 11.3 & 4: Transverse section crescentiform, not keeled, median adaxial groove barely discernable; lamina thickest at middle, tapered to margins, grooved where sclerenchyma subjacent to epidermis; adaxial epidermal cells slightly larger than abaxial; stoma arrowed; metaxylem elements not markedly larger than protoxylem elements (C. sp. nov.. Reid 1337. J, PRE). Scale bars: 3 = 444 µm; 4 = 241 µm.

Plate 11.5 & 6: Bulliform cells: 3 continuous layers, 1 discontinuous layer; abaxial epidermis papillate, papillae villiform; stomata (one is arrowed in No. 5) overarched by papillae; mesophyll parenchyma present; sclerenchyma associated with 2° vascular bundles: V-shaped strand; vascular bundles closer to abaxial epidermis (C. mossii. Reid 1204. J, PRE). Scale bars: 5 = 254 µm; 6 = 260 µm.

Plate 11.7: Presence of commissural vascular bundle; surrounding chlorenchyma with small angular air-spaces (C. glomerabilis. Reid 1137. J, PRE). Scale bar = 325 µm.

Plate 11.8: Air cavity: width at least twice the height; stoma arrowed (C. zulensis. Reid 1192. J, PRE). Scale bar = 203 µm.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## Plate 12.

Southern African species of *Carex* L.: Transverse sections of culms.

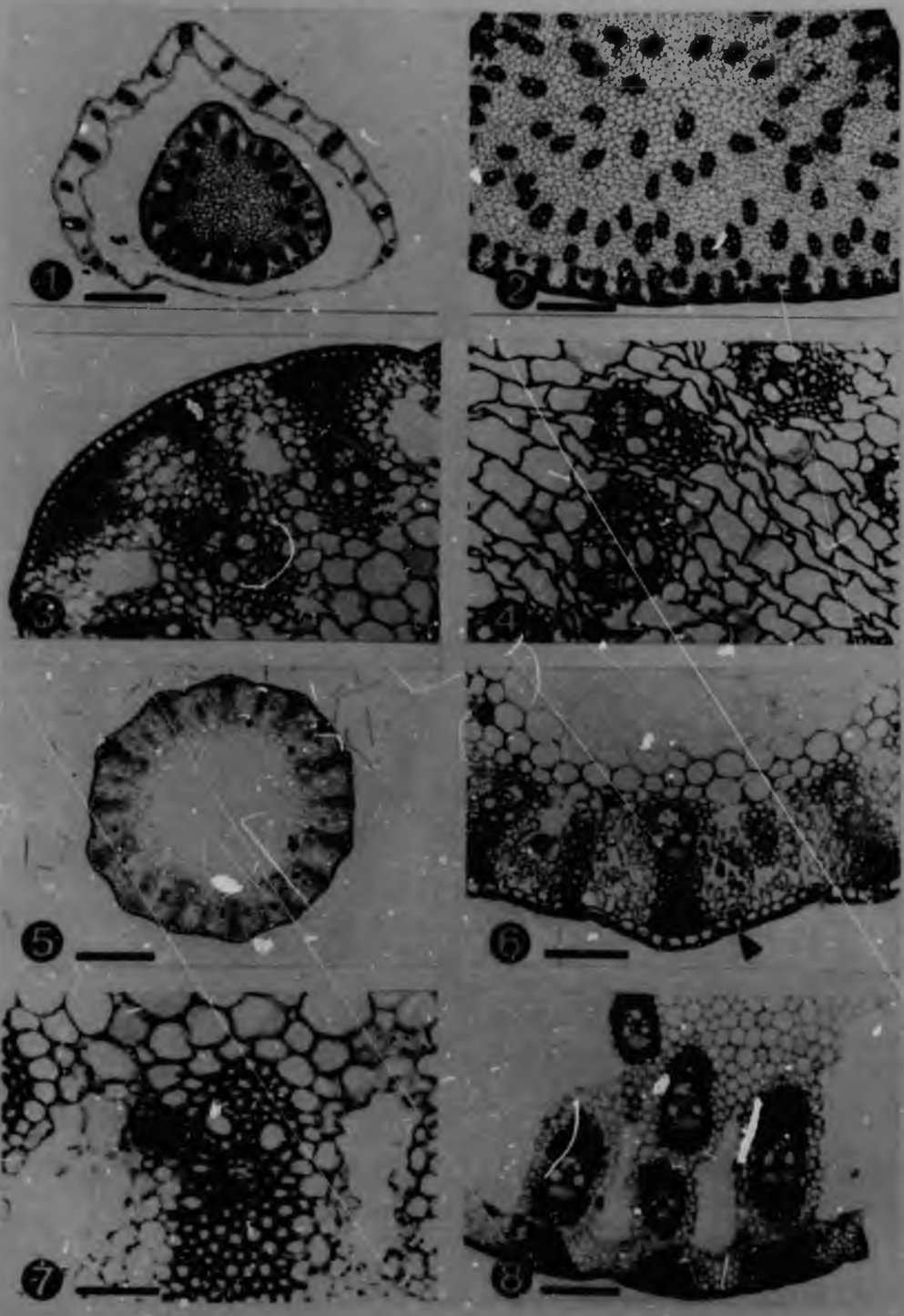
Plate 12.1: Culm enclosed by leaf sheath; culm profile triangular, angles rounded, sides straight to convex; air cavities round to square, very large; sclerenchyma strands absent from culm angles; sclerenchyma girders associated with major vascular bundles only opposite thin-tissued (adaxial) portion of leaf sheath; major vascular bundles slightly elongated; ground tissue undifferentiated, with minor vascular bundles confined to a few rows on outer edge (*C. monotropa*. Killick 4593, PRE, ROML). Scale bar = 922 µm.

Plate 12.2 - 4: Sclerenchyma girders associated with all major vascular bundles; ground tissue undifferentiated, with minor vascular bundles scattered throughout (*C. spicato-paniculata*. Reid 1188, J, PRE). Scale bars: 2 = 1155 µm; 3 = 260 µm; 4 = 260 µm.

Plate 12.5 & 6: Culm profile circular, ribbed; stomata sunken (one is arrowed); ground tissue differentiated; no minor vascular bundles; secretory cells present (*C. sp. nov.*, Reid 1207, J, PRE). Scale bars: 5 = 620 µm; 6 = 204 µm.

Plate 12.7: Major vascular bundle (part of sclerenchyma girder has been cut off) showing small commissural bundle (*C. zuluensis*. Reid 1192, J, PRE). Scale bar = 135 µm.

Plate 12.8: Air cavities vertically elongated, of medium size; major vascular bundles markedly elongated (*C. mossii*. Reid 1204, J, PRE). Scale bar = 355 µm.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# CHAPTER 5. TAXONOMIC TREATMENT

## A. GENERIC DESCRIPTION

### CAREX

Carex L., Species plantarum edn 1: 972 (1753); Thunb.: 14 (1794); Schkuhr: 1 (1801); Willd.: 207 (1805); Thunb.: 341 (1811); Thunb. 90 (1823); Nees: 534 (1832); Nees: 203 (1836); Steud. 285 (1840); Kunth: 368 (1837); Boeck.: 14 (1875); Boeck.: 327 (1876); Boeck.: 145 (1877); Pax: 122 (1887); C.B. Cl.: 678 (1894); C.B. Cl.: 299 (1898); Bolus & Wolley-Dod: 356 (1904); Kuekenth.: 67 (1909); Levyns: 130 (1950); Dyer: 890 (1976); Bond & Goldblatt: 38 (1984). Lectotype (fide Stafleu, 1979): C. pulicaris L.

Perennial, caespitose or rhizomatous herbs; diclinous, or occasionally dioecious (the European species C. dioica L.). Rhizome: scales triangular, nervose, usually decaying into fibres later. Leaves many, tristichous, basal and cauline ("culm leaves"), sheathing basally, thin tissue on adaxial face of sheath usually splitting later; blades linear, not articulated, outer very short (cataphylls), increasing in length in centripetal direction, erect to recurved, flat, plicate or channelled; veins parallel; apex acute to acuminate. Ligule present, convex, partially fused to leaf sheath, free part usually membranous. Culms triangular or terete in cross-section, usually nervose;

nodes leaf-bearing ("culm leaves"); internodes either more-or-less equal, or basal internodes short with nodes concealed by leaf sheaths and upper internode extended. Inflorescence (synflorescence) terminal; occasionally spicate, glomerate-spicate to glomerate-paniculate, paniculate or usually a raceme of spikes; usually 1 primary unit (glomerule, branch, "spike" or coflorescence) or sometimes 2 primary units (in paniculate inflorescences) borne in axils of a spirally arranged series of bracts; bracts leaf-like (in paniculate and racemose-spicate inflorescences), glume-like or setaceous (in spicate, glomerate-spicate and glomerate-paniculate inflorescences); primary units and bracts diminishing in size and complexity of branching towards apex; when bract leaf-like, opposing adaxially inserted bracteole (cladoprophyll) tubular, membranous, concealed by bract sheath; when bract glume-like or setaceous, opposing bracteole also glume-like, exposed; in higher order branches of paniculate inflorescences bracteole usually exposed, nervose, sometimes markedly inflated. Flowering usually protandrous, in southern African taxa the lower inflorescence mostly pistillate, the upper mostly staminate or bisexual. Spikelets 1-flowered, solitary in axils of spirally arranged, carinate, cymbiform, glume-like bracts. Flowers unisexual, solitary. Perianth wanting. Staminate flower: stamens usually 3, anthers basifixed, apiculate. Pistillate flower enclosed by ovate, usually bicarinate, apically rostrate, modified bracteole

("perigynium" or "utricle"), sometimes together with adaxially inserted, rudimentary rhachilla; style exserted through apical, entire or 2-toothed orifice in rostrum; spikelet axis usually aborted beyond attachment of flower, sometimes evolute, exserted (in 1 European species, C. microglochin Wahlenb., not in southern Africa). Style 2--3(--4)-stigmatic, stigmas papillate. Ovary 2--3(--4)-carpellate, 1-locular. Ovule 1, basal, anatropous. Fruit a beaked, flattened or 3(--4)-angled nutlet; pericarp sclerified, epidermis siliicified; still enclosed by perigynium at dispersal; perigynium frequently inflated at dispersal, sometimes with a basal corky layer or sometimes fleshy (C. baccans Nees, not southern African) or bearing elaiosomes. Chromosome number 2n = 16--112.

A large genus of 1 500--2 000 species, distributed mainly in northern hemisphere temperate wetlands, also in woodlands, grasslands, heath, sea shore, alpine and tundra vegetation.

Species of Carex have previously been placed under a wide diversity of generic names, which are now considered to be synonymous with Carex. Two of these names, Vignea P. Beauv. emend Reichenb. and Caricina St.-Lag. have been applied to a southern African taxon, C. divisa Huds., in 1830 and 1887 respectively. Each combination was reduced to synonymy under C. divisa less than ten years after its

publication, by Kunth (1837) and Kuekenthal (1909) respectively. The following generic names have not been applied to the southern African taxa: Agastachys Ehrh., Baecchortus Ehrh., Callistachys Heuff., Caricella Ehrh., Caricinella St.-Lag., Chordorrhiza Ehrh., Cryptoglochin Heuff., Pectinax Rafin. ex Steud., Dornera Heuff. ex Schur, Drymeia Ehrh., Genersichia Heuff., Heleonastes Ehrh., Leptostachys Ehrh., Leucoglochin Heuff., Limonaetes Ehrh., Maukschia Heuff., Mondo Adans., Neilreichia Kotule, Phyllostachys Torr., Physiglochis [illegible]., Polyglochin Ehrh., Pseudocarex Mic., Psyllophora Ehrh., Ptacoseia Ehrh., Schelhammeria Moench., Scuria Rafin., Trasus S.F. Gray, Triodus Rafin., Triplima Rafin., Ulva Hall, Uva Steud., Vignantha Schur.

Carex is a classical name, used in Virgil's Georgics 3: 231, published in 30 B.C. (Kuekenthal, 1909; Robertson, 1979). Here it was used in its singular ablative form, Carice, which is derived from the ancient Greek charaktos, meaning "notched or toothed", karcharos, meaning "jagged" in reference to the sharp teeth along the edges and veins of the leaves, and keirin, meaning "to cut" (Robertson, 1979).

The sixteen southern African species may be placed in the following Subgenera and Sections:

Subg. Ignocarex Baill.; Kuekenth.: 251 (1909).

Sect. Indicae Tuckerm.; Kuekenth.: 260 (1909).

1. C. spicato-paniculata C.B. Cl.

2. C. zuluensis C.B. Cl.

Subg. Vignea (P. Beauv. emend Reichenb.) Kuekenth.: 111 (1909).

Vignea P. Beauv. emend Reichenb.: 55 (1830). Caricina St.-Lag.: 854 (1889).

Sect. Divisae Christ.; Kuekenth.: 119 (1909).

3. C. divisa Huds.

Sect. Stenorhynchae Holm; Kuekenth.: 165 (1909).

4. C. glomerabilis Krecz.

Subg. Carex (= Eucarex Coss & Germ.): Kuekenth.: 293 (1909).

Sect. Acutae Fries; Kuekenth.: 296 (1909).

5. C. austro-africana (Kukenth.) Raymond

Sect. Maximae Aschers.; Kuekenth.: 423 (1909).

6. C. mossii Nelmes

Sect. Hymenochlaenae Drejer; Kuekenth.: 576 (1909).

7. C. sylvatica Huds.

Sect. Elatae Kuekenth.: 645 (1909).

8. C. aethiopica Schkuhr

Sect. Spirostachyae Drejer; Kuekenth.: 657 (1909).

9. C. burchelliana Boeck.

10. C. ecklonii Nees

11. C. monotropa Nelmes

Sect. Pseudo-cyperaeae Tuckerm.; Kuekenth.: 683 (1909).

12. C. cognata Kunth

Sect. Paludosae Fries; Kuekenth.: 730 (1909).

13. C. acutiformis Ehrh.

14. C. clavata Thunb.

15. C. subinflata Nelmes

Subg. Primocarex Kuekenth.: 68 (1909).

Sect. Petraeae Lang; Kuekenth.: 85 (1909).

16. C. sp. nov.

## B. KEYS TO THE SPECIES

### 1. Key utilizing macromorphological characters ("DELTA"-derived)

For complete character list, items list and tabular version of this key, see Appendix 2.
For interactive version of this key, see diskette in pocket on back endpapers.

1(0). Inflorescence unispicate; stigmas 3 (Subg. Primocarex)..... C. sp. nov.
Inflorescence glomerate-spicate to glomerate-paniculate; stigmas 2 (Subg. Vignea)..... 2
Inflorescence paniculate; stigmas 3 (Subg. Indocarex)..... 3
Inflorescence comprising a raceme of spikes; stigmas 3 or rarely 2 (Subg. Carex)..... 4

2(1). Bracts of pistillate spikelets (including awn) longer and wider than perigynia; mature perigynia suberect..... C. divisa
Bracts of pistillate spikelets (including awn) shorter and narrower than perigynia: mature perigynia spreading..... C. glomerabilis

3(1). Bracteoles subtending higher order inflorescence branches inflated, mature perigynia not inflated,

with 4--6 conspicuous nerves on abaxial surface..... C. spicato-paniculata

Bracteoles subtending higher order inflorescence branches not inflated; mature perigynia slightly inflated, with 2 conspicuous curved submarginal nerves on abaxial surface ..... C. zuluensis

4(1). Spikes erect or suberect..... 5

Spikes spreading..... 11

Spikes pendulous..... 12

5(4). Apex of perigynium rostrum deeply bidentate; teeth 0,5--1,0 mm long..... 6

Apex of perigynium rostrum shallowly bidentate; teeth 0,2--0,5 mm long..... 8

6(5). Shoot scales and basal leaves developing extensive anthocyanin colouration; leaves dark green..... ..... C. aethiopica

Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches); leaves yellow-green..... 7

7(6). Plants very tall, 1,4--1,7 m tall or more; leaves usually without conspicuous transverse venation..... C. clavata

Plants of medium height, 0,1--1,4 m tall; leaves with conspicuous transverse venation, especially in dry material..... C. cognata

8(5). Perigynia much inflated at maturity; bracts of pistillate spikelets broadly ovate..... 9
Perigynia not inflated at maturity; bracts of pistillate spikelets lanceolate..... 10

9(8). Margins of perigynium rostrum scabrid; bracts of pistillate spikelets glabrous, but ciliate distally on margin..... C. burchelliana
Margins of perigynium rostrum glabrous; bracts of pistillate spikelets wholly glabrous ..... C. subinflata

10(8). Mature perigynia glabrous, membranous, few- (2- or 3-) or inconspicuously nerved ..... C. sylvatica
Mature perigynia papillate, with hollow papillae, cartilaginous, conspicuously many- (more than 10-) nerved..... C. acutiformis

11(4). Plants of medium height, 0,1--1,4 m tall; basal inflorescence bract sharply reflexed near base of blade at maturity..... C. ecklonii
Plants very short, less than 0,06 m tall; basal inflorescence bract not reflexed near base of

blade at maturity..... C. monotropa

12(4). Stigmas 3; mature perigynia glabrous..... 13
Stigmas 2; mature perigynia papillate, with solid papillae..... C. austro-africana

13(12). Shoot scales and basal leaves developing extensive anthocyanin colouration; bracts of pistillate spikelets glabrous, but ciliate distally on margin..... C. aethiopica
Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches); bracts of pistillate spikelets wholly glabrous..... 14

14(13). Plants very tall, 1,4--1,7 m tall or more; leaves usually without conspicuous transverse venation..... C. mossii
Plants of medium height, 0,1--1,4 m tall; leaves with conspicuous transverse venation, especially in dry material..... C. cognata

2. Key utilizing mainly perigynium characters (handwritten)

Characters utilized 68-69, 71-74, 77-79, 81, 83-90

1(0). Perigynium papillate over entire surface..... 2
Perigynium surface scabrid or glabrous, or if papillae present, these confined to a small area near the distal end..... 3

2(1). Surface papillae solid; perigynium narrowly elliptic in cross-section..... C. austro-africana
Surface papillae hollow; perigynium triangular in cross-section..... C. acutiformis

3(1). Perigynium scabrid in distal half, including margins; bearing a conspicuous triangular basal callus..... 4
Perigynium glabrous, or scabrid only on margins; not bearing a basal callus..... 5

4(3). Perigynium not inflated, with 4--6 conspicuous curved nerves on abaxial surface; margins not winged..... C. spicato-paniculata
Perigynium slightly inflated, with 2 conspicuous curved submarginal nerves on abaxial surface; margins winged, the wings curving towards the abaxial surface..... C. zuluensis

5(3). Perigynium erostrate; enclosing a large, flattened rhachilla adaxial to the nutlet; nutlet very shallowly triangular in cross-section ..... C. sp. nov.

Perigynium rostrate; rhachilla absent, or when present, extremely reduced, filiform; nutlet triangular or narrowly elliptic in cross -section..... 6

6(5). Perigynium not inflated; nutlet narrowly elliptic in cross-section..... 7

Perigynium slightly to much (rarely not) inflated; nutlet triangular in cross-section..... 8

7(6). Perigynium base with a layer of corky material; margin winged; nutlet square..... C. glomerabilis

Perigynium base not corky; margin not winged; nutlet ovate..... C. divisa

8(6). Perigynium few- (2- or 3-) or inconspicuously-nerved; texture membranous..... 9

Perigynium conspicuously many- (more than 10-) nerved; texture cartilaginous or rarely herbaceous..... 10

9(8). Rostrum short, c. 0,5--0,6 mm long..... C. mossii

Rostrum very long, c. 2 mm long..... C. sylvatica

10(8). Perigynium bright yellow, 2-layered; texture herbaceous..... C. monotropa

Perigynium stramineous, ferruginous or green, 1-layered; texture cartilaginous..... 11

11(10). Rostrum short, c. 0,5 mm long; apex shallowly bidentate. teeth c. 0,2 mm long; perigynium triangular with adaxial side flat in cross-section..... C. burchelliana

Rostrum 0,7--2,0 mm long; apex shallowly to deeply bidentate, teeth 0,3--1,0 mm; perigynium various shapes in cross-section, if triangular then adaxial side rounded..... 12

12(11). Perigynium rotund in cross-section..... 13

Perigynium narrowly elliptic, shallowly triangular, or triangular with adaxial side rounded in cross-section.....14

13(12). Perigynium evenly inflated; rostrum 1,1--2,0 mm long; apex deeply bidentate, teeth 0,5--1,0 mm long..... C. cognata

Perigynium adaxial surface more inflated than abaxial surface, appearing "humpbacked"; rostrum short, 1,0--1,2 mm long; apex shallowly

bidentate, teeth 0,3--0,6 mm long
..... C. subinflata

14(12). Rostrum margin scabrid..... C. clavata
Rostrum margin glabrous..... 15

15(14). Rostrum abrupt; perigynium 3,0--3,5 mm long
..... C. ecklonii
Rostrum tapered; perigynium 5,5--6,5 mm long
..... C. aethiopica

## C. ENUMERATION OF TAXA

1. Carex spicato-paniculata C.B. Cl. in Durand & Schinz (eds), Conspectus Florae Africae 5: 690 (1894); C.B. Cl.: 304 (1898); Kuekenth.: 269, t. 41 (1909); Schoenl.: 69 (1922); Nelmes: 160 (1941b); Haines & Lye: 374 (1983). Type: Natal, Inanda, Medley Wood 1190 (K, lecto., designated by Nelmes: 160 (1941b), --PRE, photo.!; BM!, BOL!, NH!, SAM!). Syntypes: Transvaal, Pietersburg district, Houtbosch, Rehmann 5627 (K!, Z!) [actually C. zuluensis C.B. Cl.]; Natal, Buchanan 350 (K!); Natal, Buchanan 355 (K!); Orange Free State, Buchanan 98 (K, --PRE, photo.!); Orange Free State, on the Drakensberg, Cooper 1066 (BM!, K!, TCD!, Z!).

Plants 1,0--1,4 m tall, caespitose. Rhizomes very short, 4 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves not glaucous, dark green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face splitting simply. Largest basal leaf blades 600 X 8,5--14,0 mm, flat or plicate in cross-section; adaxial surface scabrid; abaxial surface glabrous; margins proximally glabrous, distally minutely scabrid. Lowest culm leaf: sheath mouth truncate or concave, membranous; ligule 3 mm high, stramineous, or fuscous, membranous, apex acute to obtuse. Culms triangular in cross-section, 2--3 mm in

diameter; internodes all of about equal length, exposed; (1--)2--3 nodes exposed. Inflorescence paniculate, 270--335 X 35--40 mm. Basal inflorescence bracts leaf-like; sheaths 25--50 mm long; blades 290 mm long. Primary inflorescence units 4--6; all androgynous; usually 1, or sometimes 2 branches from basal nodes, spreading, pyramidal, the largest 40--60 X 25--35 mm. Longest peduncle exserted by 50--60 mm, hairy. Bracts subtending higher order branches with a long setaceous cusp; opposing bracteoles inflated. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 1,5--2,2 mm long. Bracts of pistillate spikelets ovate, 3--4 X 1,5--1,8 mm, shorter than and the same width as the perigynium, stramineous, with or without light to heavy ferruginous striae and hyaline margins, scabrid (mainly on distal half), or (rarely) glabrous, but ciliate distally on margin; carina narrow, 1-nerved; apex acute or obtuse, shortly awned; awn 0,5--0,7 mm long, margin scabrid. Mature perigynium suberect, not stipitate, with a conspicuous basal callus, rostrate, 5,0--5,5 X 1,2 mm, triangular in cross-section, not inflated, green or golden brown, base without a layer of corky material, herbaceous, with four to six conspicuous curved nerves on abaxial surface, scabrid in distal half; rostrum abrupt, 2 mm long, straight, margin not winged, scabrid; rostrum apex deeply bidentate, apical teeth 0,6--1,0 mm long. Rhachilla absent from perigynia. Style base straight; stigmas 3. Mature nutlet elliptic, narrowly clawed, 2,4--3,0 X 1,0--1,2 mm, triangular in cross-section,

fuscous with lighter angles, glabrous.

This species flowers and fruits from August to July (i.e. all year round). The plants grow in light shade, on wet or moist forest margins, on clay or loam substratum. The species occurs in areas receiving rainfall in summer, in the midlands and in montane areas of northern, eastern and central Transvaal, Swaziland, and Natal. Map 2. It is also recorded from East Africa, in southern Tanzania, Kenya, Zambia and Zimbabwe, where it is common in the Eastern Highlands.

The specific epithet refers to the inflorescence morphology, which is paniculate with the ultimate branches spike-like.

Cufodontis (1971) stated the type to be Rehmann 5627; he was obviously unaware of Nelmes's lectotypification, or that lectotypification was required. Interestingly, Rehmann 5627 is not C. spicato-paniculata, but C. zuluensis C.B. Cl. Because it is the only specimen of C. zuluensis to be included amongst the syntypes, it is obvious that Clarke intended the circumscription of C. spicato-paniculata to be as described here.

C. spicato-paniculata is easily recognized due to its paniculate inflorescence, in which each ultimate unit (branch) is usually androgynous. It is distinguished from its nearest southern African relative, C. zuluensis C.B.

Cl., by the inflation of the bracteoles subtending the higher order branches, which causes the inflorescence to assume a pyramidal, rather than a linear shape as in C. zuluensis; this is noticeable even at a very young stage of development. The other differences between the two taxa are not always easily determined, especially in young inflorescences. These include the number of nerves on the abaxial surface of the perigynium and the degree of inflation of the perigynium.

There is a small group of Tropical African species of Subgenus Indocarex, in which the bracteoles subtending the higher order branches are inflated. Although clearly related to these, and perhaps especially to C. chlorosaccus C.B. Cl., C. spicato-paniculata has inflorescence and spikelet characters differing in most respects, including differently coloured spikelet bracts and mature perigynia (greenish in C. chlorosaccus, brown in C. spicato-paniculata). Upon drying the rostrum of the perigynium in C. chlorosaccus becomes sharply bent upwards; this is not the case in C. spicato-paniculata.

In its forest margin habitat, C. spicato-paniculata is very common and grows in large dense populations. It appears able to colonize artificially created forest margins, such as road cuttings through forests, but only in the absence of aggressive competitors. Examination of plants in the field showed that the fruits were subject to insect attack; this would have the effect of limiting population increase. It is

thought (see Chapter 2) that the triangular callus on the proximal end of the perigynium is an elaiosome. This would probably serve as an attractant to ants, which are known to store such elaiosome-bearing fruits underground. Thus the presence of the elaiosome indicates a high degree of adaptation to a habitat where fruit dispersal by water is not guaranteed.

**SELECTED CITATIONS**

TRANSVAAL.---2229 (Waterpoort): Soutpansberg district, Budworth Farm (-DD), Mogg 28176 (J).

---2230 (Messina): Soutpansberg district, Entabeni Forest Reserve (-CC), Getliffe 1018 (J, PRE).

---2328 (Baltimore): Bochum district, Blaauwberg (-BB), Codd & Dyer 9082 (BM, PRE).

---2329 (Pietersburg): Pietersburg district, Houtbosch (-DD), Schlechter 4759 (BOL, GRA, Z).

---2330 (Tzaneen): Letaba district, 8 km from Tzaneen, Westfalia Estates (-CA), Arnold 382 (PRE); Letaba district, near Tzaneen, New Agatha (-CC), Rogers 18837 (BM, Z).

---2427 (Thabazimbi): Thabazimbi district, Kransberg, below confluence of Fern Kloof (-BC), Westfall 1019 (PRE); Thabazimbi district, Kransberg, Groothoek Farm (-DA), Westfall 758 (PRE).

---2429 (Zebediela): Pietersburg district, near Potgietersrus, Makapansgat (-AA), Maguire 2729A (J).

---2430 (Pilgrim's Rest): Pilgrim's Rest district,

Mariepskop, Col. Reitz's grave (-DB), Meeuse 9939 (PRE); Lydenburg district, Ohrigstad Dam Nature Reserve (-DC), Jacobsen 2361 (PRE); Pilgrim's Rest district, 8,8 miles from Pilgrim's Rest, God's Window (-DD), Davidson & Mogg 33329 (K, PRE).

---2431 (Acornhoek): Pilgrim's Rest district, about 5 miles west of Acornhoek, near road bridge (-CA), Bruyns-Haylett 143 (NU).

---2526 (Zeerust): Marico district, Enzelsberg (-AC), Louw 1874 (PRE).

---2527 (Rustenburg): Rustenburg Kloof (-CA), Steyn 889 (NBG); Rustenburg district, about 14 km south-east of Rustenburg near Crystal Waters (Sparkling Waters Hotel) (-CB), Forbes 399 (J); Rustenburg district, Tierkloof (-CC), Venter 1057 (PRE); Brits district, Magaliesberg, Jacksonsruin (-DA), Van Vuuren 424 (PRE); Krugersdorp district, Magaliesberg, Nooitgedacht (-DC), Van Rensburg s.n. sub J37011 (J).

---2529 (Witbank): Middelburg district, Loskop Dam, first stream after Scheepersloop (-AD), Du Plessis 1733 (PRE); Middelburg district, Loskop Dam Nature Reserve, Donkerhoek (-CB), Reid 1113 (J, PRE).

---2530 (Lydenburg): Lydenburg district, Spitskop (-AB), Wilms 1592 (BM); Lydenburg district, Coromandel Farm, above nature reserve (-AD), Reid 849 (J, PRE); Pilgrim's Rest district, Sabie (-BB), Rogers 18683 (Z); Nelspruit district, Houtbosloop on road between Sudwala Caves turnoff and

Rosehaugh (-BC), Hilliard & Burtt 14221 (NU, PRE); Nelspruit, Lowveld Botanical Garden, Hall & Sons side near fountain (-BD), Buitendag 531 (PRE, STE); Waterval Boven (-CB), M. Moss s.n. sub C.E. Moss 17498 (BM, J).

---2531 (Komatipoort): White River district, 5 km from turnoff to Sabie on White River/Hazyview road, about 25 km from White River, private farm (-AA), Jordaan 220 (NH); Barberton district, Agnes Gold Mine (-CC), Balsinhas 3138 (MO, PRE).

VENDA.---2230 (Messina): Thohoyandou district, Thathe Vondo Forest Reserve (-CD), Hemm 181 (J, PRE); Tshidsini (Tshamutshedsi), western side of mountain (-DB), Van Wyk 3664 (PRE).

LEBOWA.---2430 (Pilgrim's Rest): Letaba district, The Downs (-AA), Moss & Rogers 253 (S); Shilouvane (-AB), Junod 2249 (PRE, Z).

SWAZILAND.---2531 (Komatipoort): Piggs Peak district, Havelock (-CC), Compton 31309 (NBG, PRE).

---2630 (Carolina): Usutu Forest (-BD), Haines 7025 (PRE).

---2631 (Mbabane): Piggs Peak district, Komati Bridge (-AA), Compton 26846 (NBG, NU, PRE); Mbabane district, near Mbabane, caves above Black Mbuluzi Valley (-AC), Gordon-Gray 6076 (BUDW, NU, PRE).

NATAL.---2729 (Volksrust): Newcastle district, northern Drakensberg, Ncandu State Forest (-DC), Nicholas & Briggs 1963 (NH, PRE).

---2730 (Vryheid): Utrecht district, Donkerhoek Farm (-AD),

Devenish 1806 (PRE); Vryheid Nature Reserve (-DC), Youthed 141 (PRE).

---2731 (Louwsburg): Ngotshe district, Ngotshe Krans (-CB), Bayer s.n. (NU); Ngotshe district, Ngome State Forest, along road from staff houses to start of Wilderness Trail (-CD), Reid 1188 (J, PRE).

---2828 (Bethlehem): Bergville district, Royal Natal National Park, Tiger Falls (-DB), Hilliard & Burtt 15405 (NU).

---2829 (Harrismith): Bergville district, Little Switzerland (-CA), Anderson 201 (PRE); Bergville district, Cathedral Peak, Umlambonja Forest (-CC), Schelpe 247 (NU); Estcourt district, eastern end of Draycott Hill (-DC), Acocks 11508 (BM, PRE).

---2831 (Nkandla): 21 km from Nkandla to Eshowe, Nkandla Forest (-CA), Reid 1191 (J, PRE).

---2929 (Underberg): Estcourt district, Drakensberg, Cathkin Park, Ndedema Forest (-AB), Galpin 11889 (BOL, PRE).

---2930 (Pietermaritzburg): Lions River district, near Howick, Shafton Farm (-AD), Hutton 112 (GRA); New Hanover district, Little Noodsberg, Laager Farm (-BD), Hilliard & Burtt 14497 (NU, PRE); Pietermaritzburg, Town Bush Valley (-CB), Moll 1788 (MO, NU, PRE); Pietermaritzburg district, Table Mountain (-DA), Killick 303 (NU); Ndwedwe district, Inanda Game Park (-DB), Ward 8739 (NU, PRE).

**Putative hybrid:** *C. spicato-paniculata* C.B. Cl. X *C. zuluensis* C.B. Cl.

A putative hybrid between this species and *C. zuluensis* C.B. Cl. has been noted. In appearance it is similar to *C. zuluensis*. with a linear inflorescence (i.e. the bracteoles subtending the higher order branches are not inflated). The nervation of the perigynia is similar to that of *C. zuluensis* (i.e. with 2 submarginal nerves on the abaxial surface). The perigynia are however, not inflated (as in *C. spicato-paniculata*). The stigma number is unstable, being two or three within the same inflorescence. The undivided portion of the style is much longer than in either of the putative parent species, and is exserted from the rostrum, remaining attached to the nutlet after the stigmas have been shed. The nutlet, although basically elliptic in shape as in the putative parents, tends to be somewhat irregular. In addition the nutlet is only very shortly stipitate, as in *C. spicato-paniculata* (in *C. zuluensis* it is long-stipitate). The foliage tends to be yellow-green, as in *C. zuluensis*, but this is assumed to be habitat-related, as one specimen (*Reid 1018*) was growing in an open sunny habitat, between rocks on the steep side of a small waterfall.

The possibility exists that a distigmatic species is one of the putative parents: *C. austro-africana* is recorded from Oshoek Farm and *C. glomerabilis* is known to occur in the Wakkerstroom district (see specimen citations for that species). Isozyme studies could be employed to test this

possibility.

This putative hybrid has been recorded from two localities in the 2730AD geographical quarter-degree square, which straddles the Transvaal-Natal border. Included on Map 3.

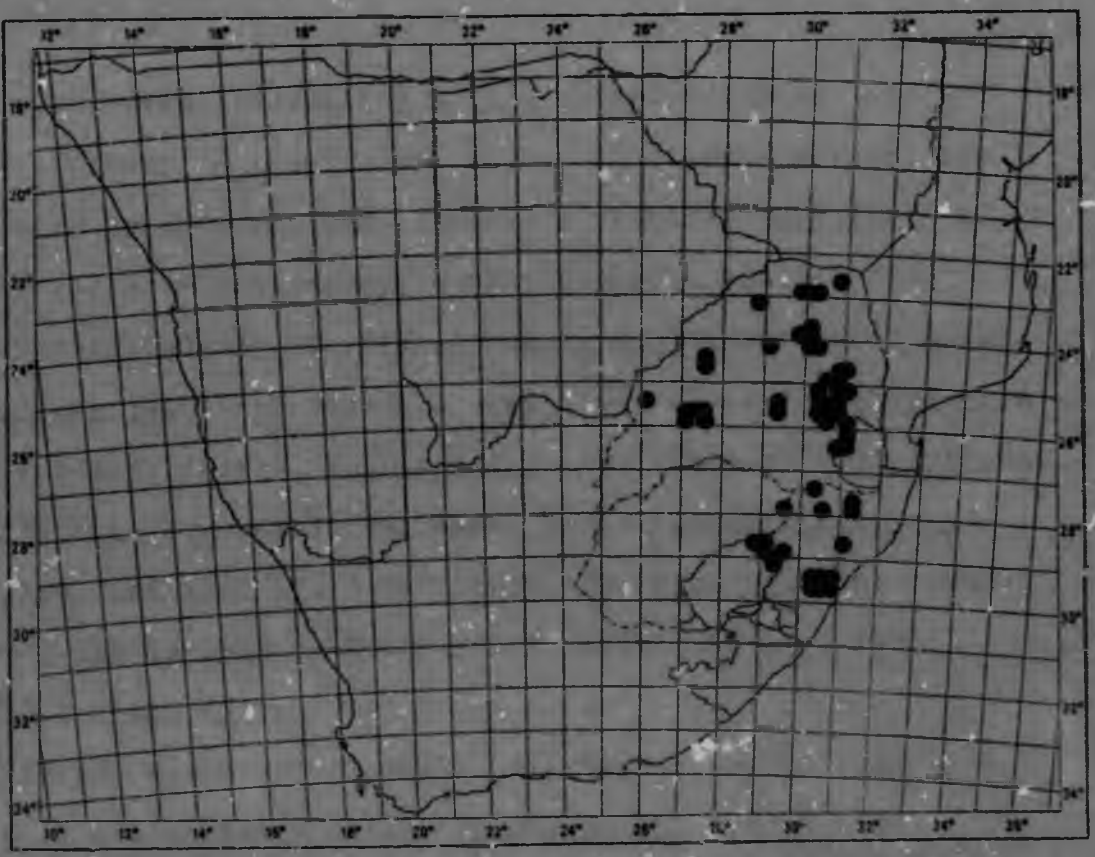
**SPECIMEN CITATION**

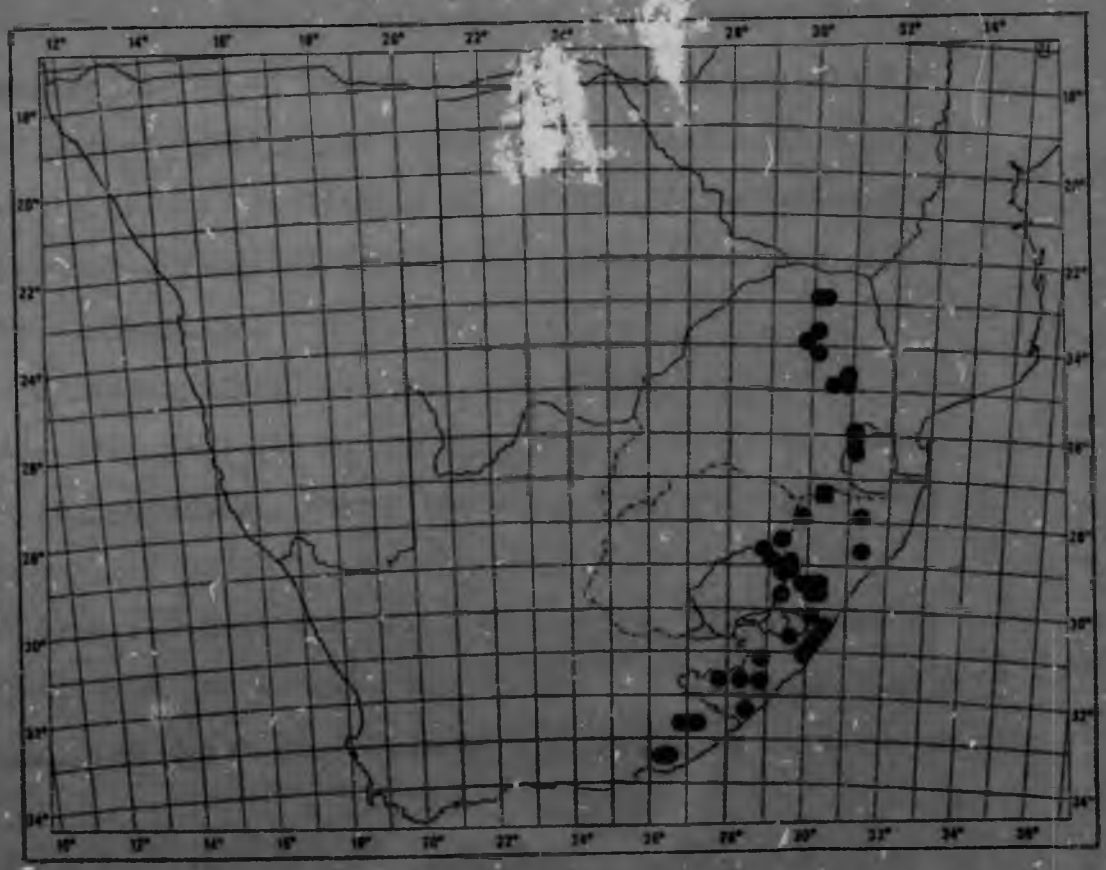
TRANSVAAL.---2730 (Vryheid): Wakkerstroom district, Oshoek Farm (-AD), Reid 1018 (J, PRE).

NATAL.---2730 (Vryheid): Utrecht district, Retirement Farm (-AD), Devenish 1512 (MO, PRE).

Map 2. (Opposite above): Distribution of Carex spicato-paniculata C.B. Cl. in southern Africa.

Map 3. (Opposite below): Distribution of Carex zuluensis C.B. Cl. (dots) in southern Africa and of putative hybrid: C. spicato-paniculata C.B. Cl. X C. zuluensis C.B. Cl. (square).





2. Carex zuluensis C.B. Cl. in Kew Bulletin Add. Ser. 8: 74 (1908); Schoenl.: 69, 70, t. 79 (1922); Nelmes: 100 (1954). Type: Tembuland (Transkei), Baziya, Baur 1156 (K, lecto.!, here designated, --PRE, photo.!; BOL!).
Syntypes: Malawi, Mt. Mlanje, Whyte s.n. (not seen); Natal, Buchanan 149 (not found); Orange River Colony, Buchanan 150 (not found); Natal, Buchanan 353 (NH!) [actually C. spicato-paniculata C.B. Cl.]; Zululand, Komo, Haygarth s.n. sub Medley Wood 7540 (K, --PRE, photo.!); Baur 444 (not found).

C. huttoniana Kuekenth.: 271 (1909); Cufod.: 1493 (1971), nom. illeg.
Syntypes: Nyasaland (Malawi), Mt. Mlanje, Whyte s.n. (not seen); Orange River Colony, Buchanan 150 (not found); Zululand, Komo, Haygarth s.n. sub Medley Wood 7540 (K, --PRE, photo.!); Natal, Buchanan 149 (not found); Natal, Buchanan 353 (NH!) [actually C. spicato-paniculata C.B. Cl.]; Natal, Hutton 344 (not found); Natal, Sim 923 (not found); Umtata, Schlechter 6341 (GRA!, Z!); Tembuland (Transkei), Baur 444 (not found); Tembuland (Transkei), Baziya, Baur 1156 (BOL!, K!).

C. merxmuelleri Podlech: 121 (1961), syn. nov. Type: Transvaal, Mariepskop, Merxmuller 553 (M, holo.; PRE!).

[C. condensata auct. non Nees: C.B. Cl.: 305 (1898).]

Plants 1,0--1,2 m tall, caespitose. Rhizomes very short, 2,5--3,0(--5,0) mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or

sometimes small patches). Leaves not glaucous, yellow- or dark green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face simply splitting. Largest basal leaf blade 500--650 X 7--12 mm, flat in cross-section; adaxial surface scabrid; abaxial surface glabrous; margins proximally glabrous, distally minutely scabrid. Lowest culm leaf: sheath mouth concave, herbaceous; ligule 4 mm high, fuscous, membranous, apex acute or obtuse. Culms triangular in cross-section, 1,5--2,7 mm in diameter; internodes all of about equal length, exposed; 2 or 3 nodes exposed. Inflorescence paniculate, 240--505 X 20--50 mm. Basal inflorescence bracts leaf-like; sheaths 20--60 mm long; blades 170--360 mm long. Primary inflorescence units 5--6; linear; all androgynous; usually 1, or sometimes 2 branches from basal nodes, erect, or suberect; the largest 50--95 X 8--20 mm. Longest peduncles exserted by 25--85 mm, hairy. Bracts subtending higher order branches with a long setaceous cusp; opposing bracteoles not inflated. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 2,8--3,5 mm long. Bracts of pistillate spikelets ovate, 3,5--4,5 X 2 mm, shorter and narrower than perigynium, stramineous with light to heavy ferruginous striae and hyaline margins, glabrous, but ciliate distally on margin; carina narrow, single-nerved; apex obtuse, sometimes emarginate, shortly awned; awn (0--)1 mm long, margin scabrid. Mature perigynium suberect, not stipitate, with a conspicuous basal callus, rostrate, 4,5--

6,0 X 1,5--2,0 mm, triangular with adaxial side winged in cross-section, slightly inflated, green, base without a layer of corky material, herbaceous, with 2 conspicuous curved submarginal nerves on abaxial surface, scabrid in distal half; rostrum tapered 1,2--2,0 mm long, bent sharply upwards, margin not winged, scabrid; rostrum apex shallowly bidentate, apical teeth 0,4--0,7 mm long. Rhachilla absent from perigynia. Style base straight; stigmas 3. Mature nutlet obovate, narrowly clawed, 2,5--3,5 X 1,2--1,8 mm, triangular in cross-section, fuscous with lighter angles, minutely papillose.

This species flowers and fruits from September to May. The plants grow in full sun, or light shade, on wet or moist forest margins, on clay or loam substratum. The species occurs in areas receiving rainfall in summer or at all seasons, from near the coast to montane areas, in northern and eastern Transvaal, Swaziland, Natal, eastern Cape Province, and Transkei. Map 3. It is also recorded from East Africa, in Malawi and Zimbabwe, where it is fairly common in the Eastern Highlands.

The specific epithet refers to the distribution of this species (in KwaZulu, then known as Zululand), but is not particularly appropriate as the species is fairly widely distributed in the summer rainfall regions of southern and eastern Africa.

C. zuluensis is not obviously closely related to any other Tropical African species of subgenus Indocarex, apart from C. spicato-paniculata C.B. Cl.; however the latter is readily distinguishable even at a very early stage of development of the inflorescence, due to the bracteoles which subtend the higher order branches being inflated, causing the inflorescence to assume a pyramidal, not linear shape.

C. merxmuelleri Podlech appears to be a more slender form of C. zuluensis. Material (Reid 1173) collected near Tzaneen, northern Transvaal, in a habitat with low light intensity, was initially identified as C. merxmuelleri (by comparison with the isotype in PRE) due to its slender vegetative habit, dark green leaves, and slender, less branched inflorescence form. While cultivated at Pretoria National Botanic Gardens the plants were exposed to brighter light, and became indistinguishable from C. zuluensis s. str., being vegetatively far more robust with yellow-green leaves, and with a more robust, more complexly branched inflorescence. It appears that the differences between C. merxmuelleri and C. zuluensis are merely habitat-related and not genetically based, as shown by field and cultivation studies. Thus it is appropriate that C. merxmuelleri be regarded as a synonym of C. zuluensis.

Clarke's C. zuluensis was published posthumously (1908) and shortly thereafter Kuekenthal's C. huttoniana was published (1909). The syntypes cited for C. huttoniana

include all of the syntypes of C. zuluensis, so there is no doubt that C. huttoniana is illegitimate (Greuter et al., 1988, International Code of Botanical Nomenclature, Art. 63.1). When Podlech described C. merxmuelleri (1961) he noted its similarity to C. huttoniana; he was clearly unaware that the latter is illegitimate. Likewise Cufodontis (1971) was apparently unaware of this fact, as he lectotypified C. huttoniana, designating Hutton 344 as the lectotype.

Like C. spicato-paniculata, C. zuluensis bears a basal callus on the perigynium; as the two species grow in similar habitats, where water is not freely available for dispersal of fruits, this feature is thought to be an adaptation for dispersal of the fruits by ants.

A putative hybrid between this species and C. spicato-paniculata C.B. Cl. is discussed above.

Members of the Subgenus are numerous in the forested parts of Malaysia, and it is possible that the Subgenus originated there (Smith and Faulkner, 1976, and references therein).

SELECTED CITATIONS

TRANSVAAL.---2230 (Messina): Soutpansberg district, Entabeni (-CC), Obermeyer 914 (PRE).
---2329 (Pietersburg): Pietersburg district, Woodbush, Mountain Home Farm (-DD), Mogg s.n. sub PRE 39284 (PRE).
---2330 (Tzaneen): Letaba district, Duiwelskloof, Westfalia

Estate, Grootbosch Mt. (-CA), Bos 1171 (PRE).

---2430 (Pilgrim's Rest): Pilgrim's Rest district, Drakensberg, Mariepskop (-DB), Merxmuller 553 (PRE); Pilgrim's Rest district, Mount Sheba Nature Reserve (-DC), Kerfoot, Goover & Eastman 247 (J); Pilgrim's Rest district, Fairyland just outside Graskop (-DD), Kluge 1520 (PRE).

---2531 (Komatipoort): Barberton (-CC), Pott 5571 (PRE).

VENDA.-- 2230 (Messina): Thohoyandou district, Thathe Vondo Forest Resrve, on road between Tshidzivhe and Tshilungwi (-CD), Hemm 416 (J, PRE).

LEBOWA.---2430 (Pilgrim's Rest): Letaba district, The Downs (-AA), Junod 4107 (PRE).

SWAZILAND.---2631 (Mbabane): Mbabane district, Hawane Falls (-AA), Compton 27400 (NBG, PRE); Mbabane district, Gobolo (-AC), Compton 30357 (NBG, PRE).

NATAL.---2729 (Volksrust): Newcastle district, Buffelshoek (-DD), Smit 1157 (PRE, PRU).

---2731 (Louwsburg): Ngotshe district, Ngome State Forest, start of wilderness trail (-CD), Reid 1189 (J, PRE).

---2828 (Bethlehem): Bergville district, Royal Natal National Park, Tiger Falls (-DB), Hilliard & Burtt 15408 (NU).

---2829 (Harrismith): Klip River district, Van Reenen (-AD), Bews 472 (NU); Bergville district, Cathedral Peak, close to hotel on path to Umlambonja (-CC), Goetghebeur 4534 (PRE); Estcourt district, Draycott Hill (-DC), Acocks 11443 (BM, PRE).

---2831 (Nkandla): Mtonjaneni district, Imfulazane Farm (-CB), Mogg 6219 (GRA, PRE).

---2929 (Underberg): Estcourt district, Drakensberg, Cathkin Park, on the way to the Grotto (-AB), Howlett & Howlett 14 (PRE); Estcourt district, Thabamhlope, 0,5 km from police post on road to Draycott (-BA), Reid 1192 (J, PRE); Lions River district, Umgeni Poort Farm (-BD), Moll 1397 (PRE); Underberg district, Cobham Forest Station, valley of "Troutbeck" draining from Ndlovini Mt. (-CB), Hilliard & Burtt 9721 (NU).

---2930 (Pietermaritzburg): Lions River district, Lidgetton (-AC), Mogg 6737 (GRA); Lions River district, Karkloof, Ehlatini Farm (-AD), Rycroft 52 (NH, NU); Lions River district, Dargle State Forest (-CA), Willan s.n. (NU); Pietermaritzburg, Town Bush Valley (-CB), Ward 637 (NU).

---2931 (Stanger): Durban, Stella Bush (-CC), Fries & Fries 3231 (S).

---3029 (Kokstad): Alfred district, Weza Forest Reserve (-DA), Schrire 771 (NH).

---3030 (Port Shepstone): Ixopo district, 1 km east of Ixopo (-AA), Strey 6122 (PRE); Umzinto district, Mgayi (-BC), Ward 5044 (BUDW, NH, PRE); Port Shepstone district, The Valleys Farm (-CB), Mogg 13950 (PRE); Port Shepstone district, Etheldale Farm, adjacent to Mtamvuna Nature Reserve (-CC), Ward 7198 (BUDW, NH, PRE); Umzinto district, Allerton (-DA), Mogg 6619 (GRA).

---3130 (Port Edward): Port Edward (-AA), Taylor 5410 (NBG).

CAPE.---3226 (Fort Beaufort): Cathcart district, Hogsback, Auckland Forest Reserve, picnic site (-DB), Reid 1203 (J, PRE).

---3227 (Stutterheim): Stutterheim district, Dohne Mt., near summit (-CB), Galpin 2454 (K, PRE).

---3326 (Grahamstown): Albany district, Goldspring near Grahamstown (-AD), Hilner 396 (GRA); Grahamstown (-BC), Gane s.n. sub TRV 17151 (PRE).

TRANSKEI.---3127 (Lady Frere): Engcobo district, Satanna's Nek (-DB), Hilliard & Burtt 14546 (NU).

---3128 (Umtata): Mountain between Qumbu and Shawbury Mission (-BB), Schoenland 4123A (GRA); Baziya Mt. (-CB), Hilliard & Burtt 13878 (NU, PRE); Umtata (-DB), Schlechter 6341 (GRA, Z).

---3228 (Butterworth): Centani district, Manubi Forest (-BC), Compton 17726 (NBG).

CISKEI.---3227 (Stutterheim): Keiskammahoek district, ridge above Evelyn Valley (-CA), Acocks 15730 (PRE); King William's Town district, Maden Dam (-CB), Acocks 9291 (BM, PRE).

3. Carex divisa Huds. in Flora Anglica edn 1: 348 (1762); Boeck.: 55 (1875); C.B. Cl.: 682 (1894); C.B. Cl.: 301 (1898); Kuekenth.: 125 (1909); Schoenl.: 68 (1922). Vignea divisa (Huds.) Reichb.: 58 (1830). Caricina divisa (Huds.) St.-Lag.: 874 (1889). Type fide Nelmes (1942): Europe, probably lost.

C. consanguinea Kunth: 374 (1837); Steud.: 288 (1840). Type: Cape, Namaqualand, between Pedroskloof and Leliefontein, Drège 2450 (B, holo.†; P, lecto.!, here designated; BM!, K!, S!, SAM!, TCD!).

Plants 100--415 mm tall. Rhizomes long, 1,5--5,0 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves not glaucous, yellow-green, usually without conspicuous transverse venation. Basal leaf sheaths tubular, old sheaths not becoming spongy; inner face simply splitting. Largest basal leaf blade (140)--150 X 2,0--2,5 mm, channelled in cross-section; adaxial surface papillate; abaxial surface glabrous; margins proximally glabrous, distally minutely scabrid. Lowest culm leaf: sheath mouth truncate, membranous: ligule 1,5 mm high, fuscous, membranous, apex obtuse. Culms triangular in cross-section, 1 mm in diameter; uppermost internode very long, the lower all more-or-less basal, very short, concealed by leaf sheaths. Inflorescence glomerate-spicate to glomerate-paniculate, 12--17 X 7--8 mm. Basal inflorescence bract

bristle-like, not sheathing; blade 10--17 mm long; opposing bracteole exposed, not sheathing. Primary inflorescence units 5--7; all androgynous; the largest 5 X 2 mm. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 2,8--3,2 mm long. Bracts of pistillate spikelets ovate, 4,5 --5,0 X 2,5 mm, longer and wider than perigynium, golden-brown, with wide hyaline margins, glabrous; carina broad, 3-nerved; apex acute, awned to muticous; awn 0--0,3 mm long, margin scabrid. Mature perigynium suberect, not stipitate, without a basal callus, rostrate, 4,2 X 1,8 mm, elliptic in cross-section, not inflated, golden brown, without a layer of corky material, cartilaginous, glabrous, nerves conspicuous, many (more than 10); rostrum tapered, 1,5 mm long, straight, margin not winged, scabrid; apex shallowly bidentate, apical teeth 0,8 mm long. Rhachilla absent from perigynia. Style base straight; stigmas 2. Mature nutlet ovate, broadly clawed, 2 X 1,6 mm, narrowly elliptic in cross-section, yellowish-brown, glabrous.

In southern Africa this species flowers and fruits from September to June. The plants grow in full sun, in perennially waterlogged marshland, on sandy substratum. The species occurs in areas receiving rainfall in summer and winter, from near the coast to the interior, in Orange Free State and north-west and central Cape Province. Map 4. It is fairly common and widespread in Europe and Asia, and in North Africa (Morocco, Algeria, Egypt and Libya); also

recorded from New Zealand.

In Europe the common name for this species is "Divided Sedge"; both this name and the specific epithet are descriptive of the inflorescence morphology, in which the main branches of the inflorescence are frequently remote from each other.

As noted in the nomenclature section above, the type of C. divisa has probably been lost. According to Stafleu and Cowan (p. 3[illegible], 1979) Hudson's house and much of his herbarium was destroyed by fire in 1783. The name therefore requires neotypification, but it is felt that the problem is one for European systematists to solve.

When Kunth (1837) described C. consanguinea, based on specimens collected by Drège in Namaqualand, he noted its similarity to C. divisa. In 1875 Boeckeler placed C. consanguinea in formal synonymy under C. divisa; Boeckeler's decision has been upheld by all authors since then and is confirmed by the present study. It is probable that the holotype was housed in B and has been destroyed (Stafleu & Cowan p. 693, 1979), thus the specimen in P should be designated as the lectotype.

C. divisa is easily distinguished from other southern African species of Subgenus Vignea, by the broadly ovate, membranous bracts of the pistillate spikelets, which are much larger than the perigynia they subtend. The perigynia, which remain erect, not spreading at maturity as in C.

glomerabilis Krecz., and which do not have a corky layer at the base as in that species, are also distinctive. C. divisa is distinguished from other members of Section Divisae by the following combination of characters: very thick, horizontal rhizomes, narrow (2 mm wide) leaves, the large bracts subtending the pistillate spikelets, perigynium conspicuously nervose on both upper and lower surfaces, and short rostrum.

In southern Africa C. divisa is apparently a very occasional adventive, dispersed by birds migrating between Europe and southern Africa; very few herbarium records exist, possibly due to very specific habitat requirements of the species. Previous collection sites (such as Sandwerf Farm, Calvinia district) were revisited during the course of the present study; in the intervening period the existing sandflats had been irreversibly altered by the planting of Arundo species, with the result that no Carex plants were in evidence.

SELECTED CITATIONS

O.F.S.---2725 (Bloemhof): Hoopstad district, Swartsrus Farm (-DA), Zietsman 199 (PRE).

CAPE.---2917 (Springbok): Namaqualand, 8,5 miles south of Springbok (-DB), Acocks 19564 (PRE).

---3018 (Kamiesberg): Namaqualand, Draaiklip (-AA), Pearson 6789 (BOL, K).

---3120 (Williston): Calvinia district, Sandwerf Farm (-AC),

Acocks 18588 (PRE).

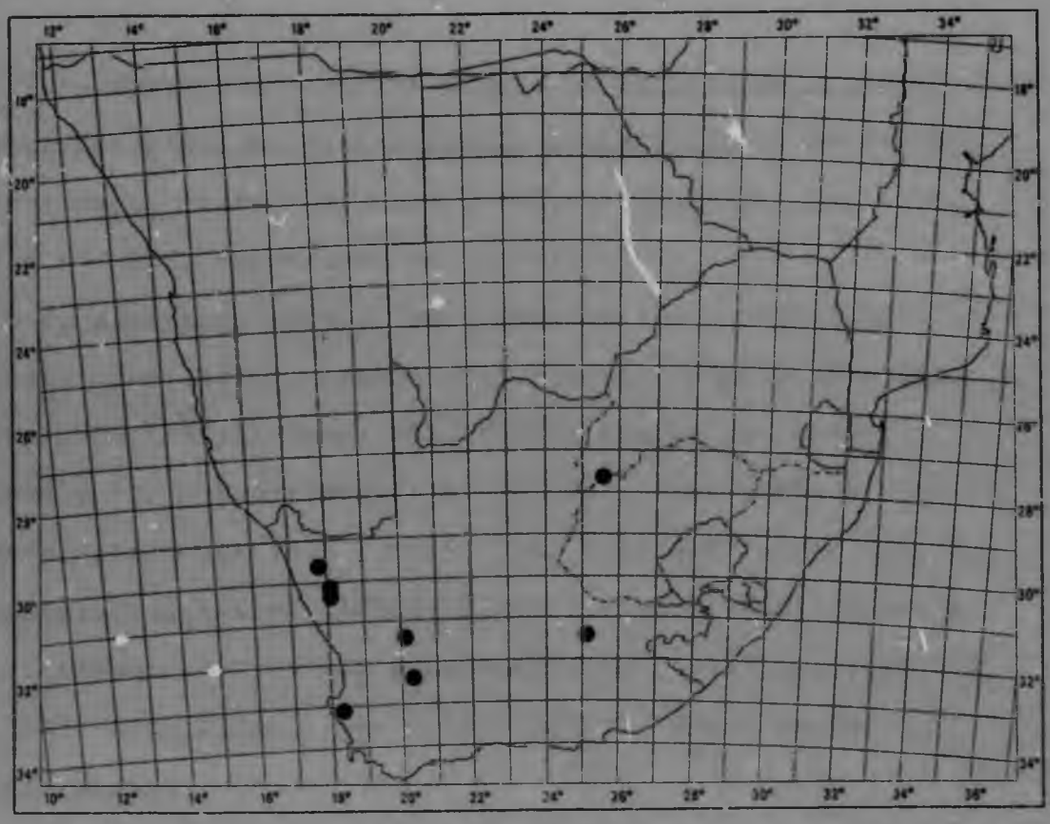
---3125 (Steynsburg): Middelburg district, Grootfontein (-AC), Acocks 15896 (BM, PRE).

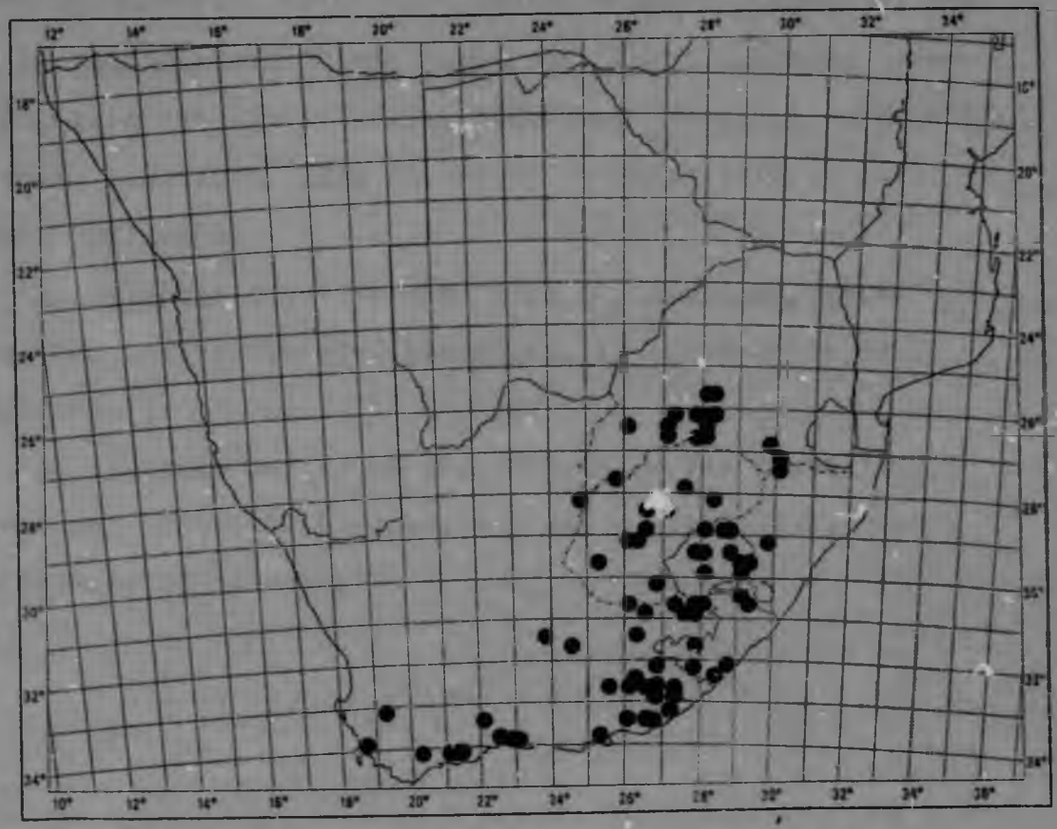
---3220 (Sutherland): Sutherland district, Uitkyk Farm (-AD), Marloth 9696 (PRE).

---3318 (Cape Town): Hopefield district, on the way to Coenraadenburg Farm (-AB), Bachmann 2159 (Z).

Map 4. (Opposite above): Distribution of Carex divisa Huds. in southern Africa.

Map 5. (Opposite below): Distribution of Carex glomerabilis Krecz. in southern Africa.





4. Carex glomerabilis Krecz. in Botaniceskij zurnal Sovuz Sovietskikh Sotsialistkikh Republikikh 7: 34 (1937). Type: Cape, without precise locality, Thunberg s.n. (UPS, holo., --PRE, microfiche No. 21837!).

C. glomerata Thunb.: 14 (1794); Willd.: 232 (1805); Thunb.: 344 (1811); Schkuhr: 13 (1806); Thunb.: 90 (1823); Nees: 534 (1832); Nees: 203 (1836); Kunth: 384 (1837); Steud.: 290 (1840); Boott: 81, t. 222 (1860); Boeck.: 59 (excl. spec. americ.) (1875); C.B. Cl.: 685 (excl. syn. C. bronsniartii Kunth) (1894); C.B. Cl.: 301 (1898); Bolus & Wolley-Dod: 356 (1904); Kuekenth.: 168 (1909); Levyns: 131 (1950), nom. illeg., non Gilib. (1792). Type: As for C. glomerabilis.

C. vulpina L. var. glomerata (Thunb.) Wahlenb.: 144 (1803); Schoenl.: 69 (1922). Type: As for C. glomerabilis.

C. schlechteri Nelmes (nom. nov. for C. vulpina sensu C.B. Cl.): 269 (1941c), syn. nov. Type: Transkei, near Bashee, Schlechter 6286 (K, holo., --PRE, photo.!; BM!, GRA!, NBG!, PRE!).

C. leribensis Nelmes: 269 (1941c), syn. nov. Type: Lesotho, Leribe Plateau, Dieterlen 758 (K, holo.!; NH!, PRE!, SAM!).

[C. vulpina auctt. non L.: C.B. Cl.: 301 (1898); Kuekenth.: 168 (1909); Schoenl.: 69, t. 78 (1922); Bond & Goldblatt: 38 (1984).]

Plants (100)--675 mm tall. Rhizomes long, 1,5--3,5 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves not glaucous, yellow-green, usually without conspicuous transverse venation. Basal leaf sheaths tubular, old sheaths not becoming spongy; inner face simply splitting. Largest basal leaf blade 130--300 X 2,5--5(--9) mm, flat or channelled in cross-section; adaxial surface papillate; abaxial surface glabrous; margins proximally papillate, distally scabrid. Lowest culm leaf: sheath mouth truncate, membranous; ligule 1,5--2,0 mm high, whitish, or stramineous, membranous, apex obtuse. Culms triangular in cross-section, 1--3 mm in diameter; uppermost internode very long, the lower all more-or-less basal, very short, concealed by leaf sheaths. Inflorescence glomerate-spicate to glomerate-paniculate, 15--60 X 8--15 mm. Basal inflorescence bract bristle-like, not sheathing; blade 10--45(--140) mm long; opposing bracteole exposed, not sheathing. Primary inflorescence units 7--10, the largest 5--15 X 5--10 mm. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 1,7--2,6 mm long. Bracts of pistillate spikelets ovate, 3,0--5,5 X 1,3--2,0 mm, shorter and narrower than perigynium, golden-brown, or ferruginous, scabrid (mainly on distal half), or glabrous, but ciliate distally on margin; carina narrow, 1-nerved; apex acute or rarely obtuse, awned, or muticous; awn 0--2 mm long, margin scabrid. Mature perigynium spreading, sometimes stipitate,

without a basal callus, rostrate, (3,0--)3,5--5,5 X (1,1--)1,8--2,2 mm, ellipti[illegible]ch flat base in cross-section, not inflated, straminеous, or ferruginous, base with a layer of corky materi[illegible] cartilaginous, conspicuously many- (more than 10-) nerved, glabrous; rostrum tapered, 0,8--2,0 mm long, straight; rostrum margin winged, scabrid; apex shallowly bidentate; apical teeth 0,3--0,7 mm long. Rhachilla sometimes present [illegible] perigynia of basal spikelets. Style base straight; stigmas 2. Mature nutlet square, broadly clawed, 1,7--2,2 X 1,0--1,7 mm, narrowly elliptic in cross-section, yellowish-brown, glabrous.

This species flowers and fruits from September to May. The plants grow in full sun, or light shade, in perennially waterlogged marshland, on clay or loam substratum. The species occurs in areas receiving rainfall in summer, winter, or in all seasons, from near the coast to the alpine plateau, in southern Transvaal, Natal, Lesotho, central, south-western, southern and eastern Cape Province, and Transkei. Apparently endemic to southern Africa. Map 5.

The common name for this species is "Foxtail Sedge" in reference to the distinctive inflorescence morphology. The specific epithet refers to the closely packed inflorescence branches which are thus difficult to distinguish.

C. glomerabilis as recognized here has quite a complicated synonymy. Kuekenthal (1909), without attempting

to rectify the problem, noted that Thunberg's C. glomerata (1794) was pre-empted by C. glomerata Gilibert (1792). Kreczetowicz published C. glomerabilis in 1937 as an avowed substitute for C. glomerata Thun[illegible] Clarke (1893) and Kuekenthal (1909) recognized two different closely related species, the small, indigenous C. glomerat[illegible] and the larger, European C. vulpina L. Schoenland (1922) interpreted the two taxa differently, citing most of the large specimens under C. vulpina var. glomerata. The present delimitation of C. glomerabilis includes C. schlechteri Nelmes (nom. nov. for C. vulpina sensu C.B. Cl.) and C. leribensis Nelmes. Nelmes separated these two taxa from C. glomerabilis on size differences of vegetative organs, C. schlechteri being more robust, with broader leaves, and C. leribensis being more slender, with narrower leaves than C. glomerabilis. Additionally, during the present study specimens which could be placed in C. schlechteri on account of their broad leaves, appeared to have larger, more complexly branched inflorescences (termed here "glomerate-paniculate"). Examination of plants in the field and of a wide range of herbarium material of C. glomerabilis s. lat. showed that these characters could not be used to distinguish these three taxa; even the complexity of branching of the inflorescence appeared to be influenced by the availability of nutrients in the substratum, and in many specimens of C. glomerabilis s. str. the lower branches were rebranched, thus approaching the morphology of C. schlechteri. Other

distinctions which had been utilized by Clarke and Nelmes (differing colour and nervation of perigynia, presence of wings on rostrum), were found upon examination of the type material, to have been incorrectly observed, and the types of C. schlechteri and C. leribensis could be placed within the range of variation of C. glomerabilis. In contrast to C. glomerabilis s. str., C. leribensis does appear to have consistently smaller perigynia and slightly ovate, rather than square fruits. More fieldwork is required to determine whether these characters are sufficient to uphold C. leribensis as a separate species; in the list of selected citations, specimens which would fall into this taxon are marked with an asterisk (*).

The group of species of Subgenus Vignea to which C. glomerabilis belongs are rather difficult to distinguish; certainly the Tropical African species require revision. Of the species which occur in Tropical Africa, C. conferta A. Rich. and C. leptosaccus C.B. Cl. are possibly most closely related to C. glomerabilis. however the descriptions of these two species provided in Haines & Lye: 372 (1983) definitely do not describe C. glomerabilis.

SELECTED CITATIONS

TRANSVAAL.---2528 (Pretoria): Pretoria district, Aapies River (-CA), Leendertz s.n. sub TRV 6038 (PRE); Wonderboom district, Marks Farm 13 miles east of Pretoria (-CB), Lubke 174 (PRE, S).

---2626 (Klerksdorp): Coligny district, Hakboslaagte (-AA), Kinges 1635 (PRE).

---2627 (Potchefstroom): Rustenburg district, Cyferbult Farm (-AB), Sutton 724 (PRE); Potchefstroom district, Die Oog van Gerrardminnebron Farm (-AC), Reid 1154 (J, PRE); Carletonville, A. Bailey Nature Reserve (-AD), Van Wyk 458 (PRE); Florida, edge of Florida Lake (-BB), Moss 13949 (BM, J); Potchefstroom, western approach from Viljoenskroon (-CA), Reid 1153 (J, PRE); Vereeniging district, Leeuwkuil Research Station (-DB), Acocks 16190 (PRE).

---2628 (Johannesburg): Modderfontein (-AA), Haagner s.n. sub PRE 57253 (PRE); Brakpan, Geduld Dam (-AB), Murray s.n. sub PRE 39127 (PRE); Alberton district, south of Alberton on road to Heidelberg (-AC), Forbes 412 (J); Vereeniging district, Henley on Klip (-CA), Moss 17294 (J, K).

---2629 (Bethal): Amersfoort district, Brakfontein Farm (-DD), Turner 439 (PRE).

---2730 (Vryheid): Amersfoort district, 16 km south-east of Amersfoort on road to Wakkerstroom (-AA), Reid [illegible]34 (J, PRE); Wakkerstroom, Martin's Dam (-AC), Hilliard & Burtt 18518 (PRE).

O.F.S.---2725 (Bloemhof): Hoopstad district, Sandveld Nature Reserve (-DB), Viljoen 21 (PRE).

---2727 (Kroonstad): Lindley district, 12,9 km north-east of Steynsrus on Vyfspruit road at Heuningspruit crossing (-DC), Smook 6654 (PRE).

---2826 (Brandfort): Theunissen district, 4 km west of

Theunissen, Abrahamshof Farm (-BC), Smook 6511 (PRE); Brandfort district, 5 km south of Verkeerde Vlei (-DC), Du Preez 1712 (PRE).

---2827 (Senekal): Winburg district, Willem Pretorius Game Reserve (-AC), Muller 1962 (PRE).

---2828 (Bethlehem): Bethlehem district, Arran Farm (-AB), Werger E&W114 (PRE).

---2925 (Jagersfontein): Fauresmith district, Wolwas Drift (-CB), Smith 5173 (PRE).

---2926 (Bloemfontein): Bloemfontein, Wintervalley (-AA), Muller 163 (PRE); Bloemfontein, Dewetsdorp road (-AB), Potts s.n. sub BLFU 1094 (BOL, NU).

---3026 (Aliwal North): Zastron district, 14 km north-west of Zastron (-BB), Smook 5908 (PRE); Bethulie district, Tussen-die-Rivieren Game Farm (-CA), Vorster 170 (PRE).

NATAL.---2929 (Underberg): Estcourt, Bushmans River (-BB), Acocks 9915 (NH, PRE); Underberg district, Sani Pass (-CB), Hilliard, Burtt & Manning 17240 (NU, PRE, S).

---3029 (Kokstad): East Griqualand, near Cedarville, Greenfield Farm (-AC), Hilliard & Burtt 19026 (NU, PRE, S); East Griqualand, near Kokstad, Thornham Farm (-CB), Coleman 707 (PRE).

LESOTHO.---2828 (Bethlehem): Leribe (-CC), Dieterlen 890* (NBG, PRE); Oxbow Agricultural Camp (-DC), Williamson 407 (K); Butha Buthe district, Namahali A Camp (-DD), Lubke 294 (NH, PRE).

---2927 (Maseru): Mountain Road, Bushman's Pass (-BD),

Schmitz 8466 (PRE).

---2928 (Marakabei): Mamalapi (-AC), Compton 21262 (NBG); Above St. Martin's Mission, west of Matsoku River (-BD), Coetzee 546 (PRE); Semonkong (-CC), Jacot Guillarmod 1733 (PRE).

---2929 (Underberg): Sani River Valley (-CA), Killick 4448 (PRE); Sani River Valley towards Hodgson's Peaks (-CB), Hilliard & Burtt 9674 (NU, PRE); Sehlabathebe National Park, Oribi Hill (-CC), Hoener 1910* (PRE); Sehlabathebe National Park, near cutline on pass (-CC), Schmitz 7004 (PRE).

CAPE.---2824 (Kimberley): Warrenton (-BB), Wilman s.n. sub KMG 2983 (BOL).

---3026 (Aliwal North): Aliwal North district, Flandshoek Farm (-DC), F. Bolus 163 (BOL, PRE).

---3027 (Lady Grey): Barkly East district, Ben MacDhui (-DB), Hilliard & Burtt 16364 (NU); Barkly East district, Three Drifts Stream below Pitlochrie (-DC), Hilliard & Burtt 14735* (NU, PRE); Barkly East district, along road south of Lundean's Nek, 1 km south of Fetcani Glen Farm track (-DD), Phillipson 623 (MO, PRE).

---3028 (Matatiele): Barkly East district, near Naude's Nek, 2 km east of Cairntoul (-CA), Phillipson 690 (PRE).

---3123 (Victoria West): Richmond district, vicinity of Styl Kloof (-BD), Drège s.n. (K).

---3124 (Hanover): Middelburg district, Compassberg Farm (-DA), Acocks 18659 (PRE).

---3126 (Queenstown): Molteno (-AD), Theron 929 (B, BM,

PRE).

---3225 (Somerset East): Somerset East district, Bonchberg, Glen Avon Farm (-DA), Hilliard & Burtt 13211* (NU, PR[illegible]; Somerset East district, Glen Avon Farm (-DA), Reid 1202 (J, PRE).

---3226 (Fort Beaufort): Great Winterberg (-AD), Galpin 5602 (PRE); Bedford district, Turpin Dam (-CA), Acocks 16303 (PRE); Cathcart district, Hogsback, lower margin of Zingcuka Forest, south of Hogsback Peaks (-DB), Phillipson 788 (PRE).

---3227 (Stutterheim): Stutterheim district, Dohne Hill (-CB), Sim 2832 (GRA); King William's Town district, Orange Grove Farm (-CD), Hilner 136 (GRA, PRE).

---3318 (Cape Town): Bellville district, Sarepta (-DC), Acocks 776 (S).

---3319 (Worcester): Koue Bokkeveld, Wagedrift (Wadrif) (-AB), Schlechter 10070 (B, BM, BOL, PRE).

---3322 (Oudtshoorn): Oudtshoorn district, Cango Valley, Boomplaas Farm (-AC), Moffett 439 (PRE, STE); George district, Wilderness (-DC), Compton 14292 (NBG); George district, eastern arm of Swartvlei (-DD), REID 1148 (J, PRE).

---3325 (Port Elizabeth): Swartkopsrivier (-CD), Ecklon & Zeyher 118 (BOL, PRE).

---3326 (Grahamstown): Albany district, Alicedale, New Year's River Dam (-AC), Jacot Guillarmod 7461 (GRA, PRE); Albany district, Curries Kloof near Grahamstown (-BC), MacOwan 115 (BOL, TCD); Bathurst district, Kowie River,

about 7 miles up (-DB), Britten 2659 (GRA, PRE).

---3420 (Bredasdorp): Swellendam (-AB), Mund s.n. (S).

---3421 (Riversdale): Riversdale district, Glen Leith (-AA), Muir 3029 (GRA, PRE); Riversdale district, Kruispad road on western side of Kafferkuils River (-AB), Reid 1137 (J, PRE); Riversdale district, Great Vals River (-BA), Burchell 6554 (K).

---3422 (Mossel Bay): George district, Skaapkop River mouth (-AB), O'Callaghan, Van Wyk & Fellingham 737 (PRE, STE).

---3423 (Knysna): Knysna district, Brenton (-AA), Duthie 709 (GRA, STE).

TRANSKEI.---3027 (Lady Grey): Herschel district, Sterkspruit Farm (-CB), Hepburn 293 (GRA).

---3127 (Lady Frere): Engcobo (-DB), Flanagan 2795 (PRE).

---3227 (Stutterheim): Savages house near Nqamakwe (-BB), H. Bolus 10361 (BOL).

---3228 (Butterworth): Xhora district, The Haven (-BB), Gordon-Gray 1052 (MU); Centani district, Mazeppa Bay, Qora River mouth (-BC), Hilner 451 (GRA, PRE).

CISKEI.---3226 (Fort Beaufort): Hewu district, Shiloh (-BB), Baur 1136 (K); Katberg (-DA), Drège s.n. (C. glomerata "d") (S); Victoria East district, Tyrme river near road bridge to King William's Town (-BD), Phillipson 227 (MO, PRE).

---3327 (Peddie): Peddie district, 2,2 km from Hamburg (-AD), Arnold 576 (PRE).

5. Carex austro-africana (Kuekenth.) Raymond in Le Naturaliste Canadien 91: 126 (1964). Type: Mooi River, MacOwan 1690 [actually Medley Wood s.n. sub HNAA 1690] (BM, lecto.!, designated here).

Syntypes: Biggarsberg, Wilms 1852 (not found); Pretoria, Rehmann 4039 (BM!); Orange River Colony, Cooper 909 (K, -- PRE, photo.!; BOL!); Weenen County, Medley Wood 4981 (BM!, PRE!); Without locality, Hutton 144 (BM!, PRE!); Without locality, Hutton 354 [actually 357] (GRA!).

C. cernua Boott var. austro-africana Kuekenth.: 354 (1909); Schoenl.: 69, 70, t. 80 (1922). Type: as for C. austro-africana.

[C. phacota auct. non Spreng.: C.B. Cl.: 689 (1894); C.B. Cl.: 302 (1898).]

Plants 250--605 mm tall, usually but not always caespitose. Rhizomes usually very short, sometimes long, 3 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves glaucous, yellow- or mid-green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face tearing into membranous strips. Largest basal leaf blade 300--480 X 3--7 mm, flat or plicate in cross-section; adaxial surface glabrous; abaxial surface glabrous; margins proximally glabrous, distally minutely scabrid. Lowest culm leaf: sheath mouth concave, membranous; ligule 7--11 mm high,

fuscous, membranous, apex acute. Culms sharply triangular in cross-section, 2 mm in diameter; uppermost internode very long, the lower all more-or-less basal, very short, concealed by leaf sheaths. Inflorescence a raceme of spikes, 50--310 mm long. Basal inflorescence bract leaf-like, not reflexed near base of blade at maturity; sheath 3 mm long; blade 150--380 mm long; opposing bracteole tubular, membranous, usually concealed by bract sheath. Primary inflorescence units 1 from each node. Spikes 4--6, pendulous, not clustered, excepting frequently apical 2--3 (usually staminate) spikes; the largest 25--70 X 7--11 mm. Longest peduncle exserted by 20--150 mm, scabrid on angles. Apical spikes usually staminate, occasionally androgynecandrous. Staminate spikes 0--1. Pistillate spikes 3--5. Bisexual spikes 0--1. Small accessory spikes not present. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 2,5 mm long. Bracts of pistillate spikelets ovate, 4,5--6,5 X 0,8--1,2 mm, longer and narrower than perigynium, stramineous, wholly glabrous or ciliate distally on margin; carina broad, 3-nerved; apex obtuse or emarginate, awned; awn 2,0--4,2 mm long, margin scabrid. Mature perigynium suberect, stipitate, without a basal callus, rostrate, 3--4 mm X 1,5--1,8 mm, narrowly elliptic in cross-section, slightly inflated, mid-brown, or ferruginous with rostrum whitish, base without a layer of corky material, cartilaginous, papillate, with solid papillae, inconspicuously nerved; rostrum abrupt, 0,3--0,5

mm long, straight, margin not winged, glabrous; rostrum apex truncate. Rhachilla absent from perigynia. Style base straight; stigmas 2. Mature nutlet obovate, not clawed, 1,9--2,2 X 1,0--1,7 mm, narrowly elliptic in cross-section, fuscous with lighter angles, minutely papillose.

This species flowers and fruits from September to May. The plants grow in full sun, or light shade, in perennially waterlogged marshland, or riparian situations, on clay or loam substratum. The species occurs in areas receiving rainfall in summer, in the midlands and in montane areas, in northern, eastern and southern Transvaal, Orange Free State, Swaziland, Natal, eastern Cape Province, and Transkei. Map 6. The species is apparently endemic to southern Africa and it is to this that the specific epithet refers.

In his monograph (1909) Kuekenthal indicates that he saw all of the syntypes listed above. Although none of the BM specimens are annotated by him, it seems that he must have either borrowed the specimens from BM, or visited the herbarium. It seems appropriate therefore to designate the most complete specimen of the various syntypes in BM, as the lectotype. This is Medley Wood s.n. sub HNAA 1690.

C. austro-africana belongs to a large, widely distributed Section (Acutae Fries), which is anomalous within Subgenus Carex, as the species are all bistigmatic, with fruits narrowly elliptic in cross-section, whereas the

remainder of the Subgenus is usually tristigmatic with fruits triangular in cross-section. It is not easy to estimate the selective advantage of the distigmatic condition. The perigynia in Section Acutae are generally only slightly inflated; however most species grow in marshland and the fruits are presumably dispersed by water. It is conceivable that the biconvex fruits float more efficiently than the triangular fruits of the remainder of the Subgenus, which generally require highly inflated perigynia to achieve short-range dispersal.

The very long, scabrid awns on the bracts of the pistillate spikelets distinguish C. austro-africana from all the Tropical African species of Section Acutae, especially C. rhodesiaca Nelmes (the isotype was examined in PRE). Interestingly, when Raymond (1964) raised C. austro-africana to species level he cited Robinson 3340, which is actually C. rhodesiaca according to Podlech (p. 122, 1961).

SELECTED CITATIONS

TRANSVAAL.---2229 (Waterpoort): Soutpansberg district, Soutpansberg, Wyllies Poort (-DD) Hafstrom & Acocks 102 (S).

---2329 (Pietersburg): Pietersburg district, Broederstroom, Woodbush Forest Reserve above Dap Naude Dam, near forester's office (-DD), Crawford 313 (PRE).

---2330 (Tzaneen): Soutpansberg district, Tshakoma (-AB), Obermeyer 1116 (PRE).

---2430 (Pilgrim's Rest): Letaba district, 10 km from Ofcolaco on road to The Downs (-AB), Ellis 2362 (PRE); Pilgrim's Rest district, Swadini Nature Reserve, above Blyderivierspoort Dam, along Ohrigstad River (-DB), Retief, Reyneke, Coetzer & Reid 1135 (PRE); Pilgrim's Rest (-DD), Rogers 14933 (BM).

---2527 (Rustenburg): Brits district, Magaliesberg, Jacksonstuin Farm (-DA), Van Vuuren 294 (PRE); Rustenburg district, Uitkomst 499 JQ Farm (-DD), Coetzee 841 (PRE).

---2528 (Pretoria): Pretoria district, Aapies Poort (-CA), Rehmann 4039 (BM).

---2530 (Lydenburg): Belfast district, Dullstroom, near dam (-AC), Strey 3430 (PRE); Lydenburg district, Lisabon State Forest (-BA), Reid 825 (J, PRE); Nelspruit district, Wonderkloof Nature Reserve (-BC), Kluge 2011 (PRE); KaNgwane, Songimvelo Nature Reserve, Uitval (-DD), Heymans 115 (PRE).

---2531 (Komatipoort): Barberton (-CC), Thorncroft s.n. sub PRE 15183 (PRE).

---2627 (Potchefstroom): Krugersdorp district, Witpoortjie Kloof (-BB), Moss 15816 (K).

---2628 (Johannesburg): Heidelberg district, Suikerbosrand Nature Reserve, Boschfontein (-CA), Bredenkamp 354 (PRE).

---2629 (Bethal): Ermelo, Spitskop (-BD), Pott 5227 (PRE).

---2630 (Carolina): Ermelo district, Athole Pasture Research Station (-CB), Norval 22 (PRE).

---2730 (Vryheid): Wakkerstroom, Martin's Dam (-AC),

Hilliard & Burtt 18517 (NU, PRE); Wakkerstroom district, Oshoek Farm (-AD), Devenish 197 (PRE).

O.F.S.---2828 (Bethlehem): Witzieshoek district, Bestersvlei (-BD), Flanagan 2005 (PRE).

---2829 (Harrismith): Harrismith district, Nelson's Kop (-AB), Cooper 909 (BOL); Harrismith district, Sterkfontein Dam (-CA), Blom 44 (PRE).

SWAZILAND.---2631 (Mbabane): Mbabane district, Malolotja Nature Reserve (-AA), Braun 421 (PRE); Mbabane district, Poliniane River (-AC), Dlamini s.n. sub NBG 11134 (NBG, PRE).

NATAL.---2828 (Bethlehem): Bergville district, Royal Natal National Park, Rugged Glen, near dam (-DB), Browning 255 (NU, PRE).

---2829 (Harrismith): Klip River district, Van Reenen (-AD), Medley Wood 6157 (BM, BOL, PRE); Bergville district, Oliviershoek Pass (-CA), Thode s.n. sub STE 3541 (STE); Bergville district, Cathedral area, Umlambonja River (-CC), Schelpe 884 (NU).

---2929 (Underberg): Estcourt district, 37 km west of Mooi River at intersection with Kamberg road, at Hlatikulu River (-BA), Reid 1368 (J, PRE), Mooi River (-BB), Medley Wood 4038 (BOL, GRA); Mpendle district, Mulungane Ridge above Carter's Nek (-BC), Hilliard & Burtt 17036 (NU, PRE); Lions River district, Nottingham Road (-BD), Moll & Mauve 2444 (NU, PRE); Underberg district, Sani Pass (-CB), Hilliard & Burtt 17885 (NU); Underberg district, Upper Umzimouti River

Valley (-CC), Hilliard & Burtt 9367 (NU, PRE); Mpendle district, Tillietudlem Farm (-DB), Huntley 383 (BM, NU); Polela district, Bulwer north, Deepvale Farm, Long Dam (-DD), Musil 541 (NH, PRE).

---2930 (Pietermaritzburg): Lions River district, St. Ives Farm (-AC), Mogg 6427 (GRA); Lions River district, near Howick, Shafton Farm (-AD), Hutton 144 (BM, PRE); Pietermaritzburg, Town Bush Valley (-CB), Ward 698 (NU, PRE).

---3029 (Kokstad): East Griqualand, near Kokstad, Thornham Farm (-CB), Coleman 919 (PRE).

LESOTHO.---2828 (Bethlehem): Leribe district, Khanyane (-CC), Dieterlen 860 (BM, PRE).

CAPE.---3226 (Fort Beaufort): Cathcart district, Amatole Mts., below Gaikas Kop (-DB), Furness & Phillipson 128 (MO).

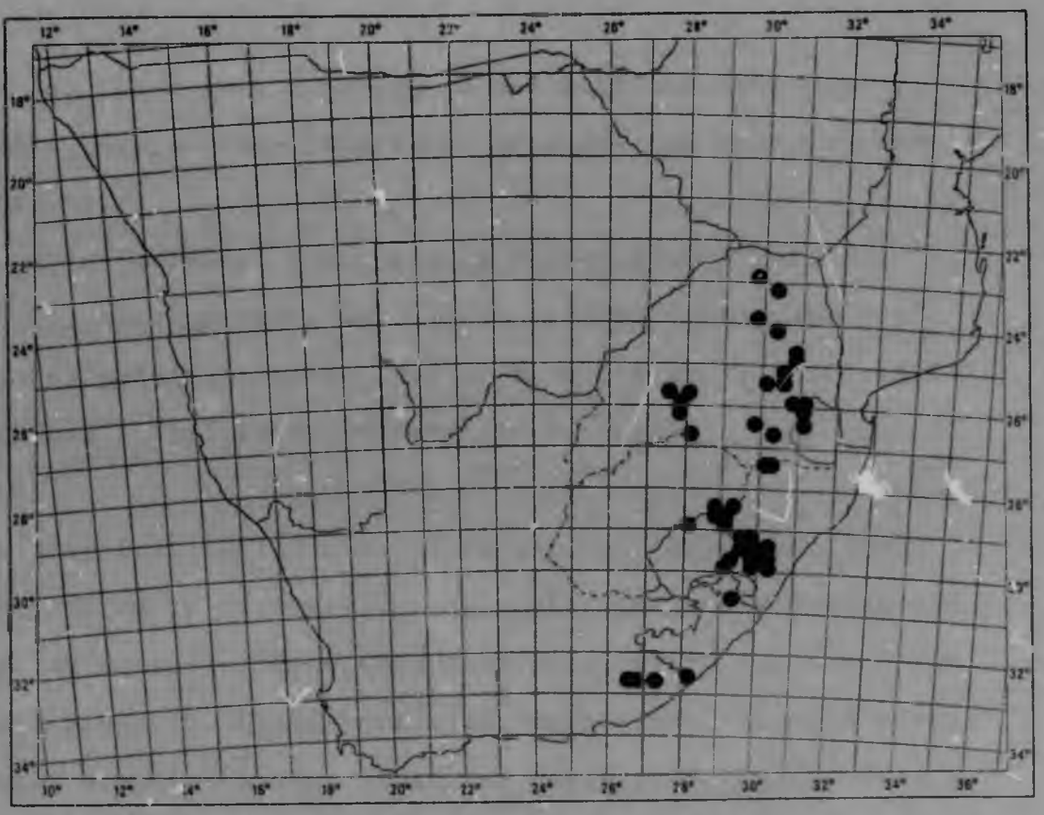
TRANSKEI.---3228 (Butterworth): Centani (-CB), Pegler 1150 (BM, BOL, K).

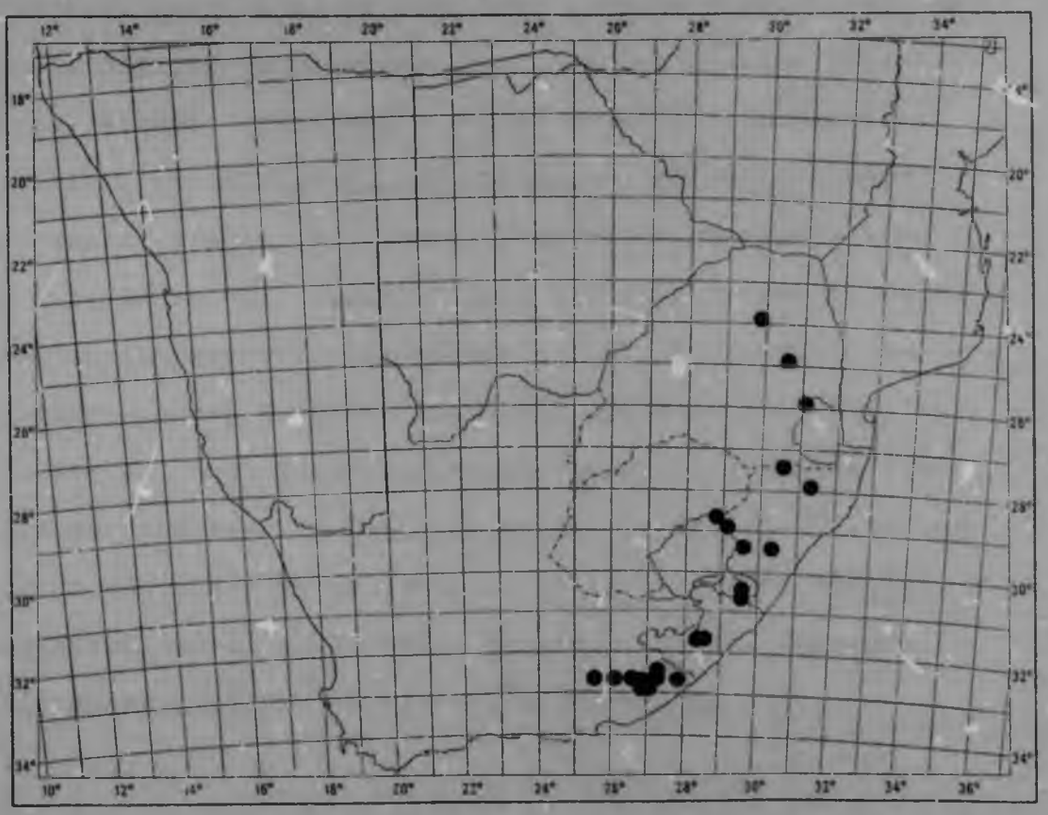
CISKEI.---3226 (Fort Beaufort): Katberg (-DA), Hutton s.n. (TCD).

---3227 (Stutterheim): King William's Town district, Maden Dam (-CB), Acocks 9281 (BM, PRE).

Map 6. (Opposite above): Distribution of *Carex austro-africana* (Kuekenth.) Raymond in southern Africa.

Map 7. (Opposite below): Distribution of *Carex mossii* Nelmes in southern Africa.





6. Carex mossii Nelmes in Kew Bulletin 1940: 137 (1941a). Type: Cape, Hogsback, Moss 999 (K, holo., --PRE, photo.!).

Probable isotypes: Young s.n. sub Moss 15336 (BM!, J!).

[C. pendula auct. non Huds.: C.B. Cl.: 688 (1894).]

[C. petitiana auctt. non A. Rich.: C.B. Cl.: 306 (1898); Kuekenth.: 424 (1909); Schoenl.: 69 (1922).]

Plants up to 1,4 m tall, caespitose. Rhizomes very short, 5 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves glaucous, dark green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face simply splitting. Largest basal leaf blades about 485 X 12--16 mm, flat or plicate in cross-section; adaxial surface glabrous; abaxial surface papillate; margins proximally papillate, distally scabrid. Lowest culm leaf: sheath mouth convex, membranous; ligule 20 mm high, fuscous, membranous, apex acute or emarginate. Culms triangular in cross-section, 2,5 --4,0 mm in diameter; internodes all of about equal length, exposed; 2 nodes exposed. Inflorescence a raceme of spikes, 280--560 mm long. Basal inflorescence bract leaf-like, not reflexed near base of blade at maturity; sheath 50--225 mm long; blade 185--600 mm long; opposing bracteole tubular, membranous, usually concealed by bract sheath. Primary inflorescence units 1 from each node. Spikes 7--3,

pendulous, not clustered, excepting frequently apical 2--3 (usually staminate) spikes; the largest 120--185 X 5--8 mm. Longest peduncle exserted by 15--100 mm, scabrid on angles. Apical spikes usually staminate, frequently androgynous, occasionally androgynecandrous or gynecandrous or with staminate and pistillate spikelets mixed. Staminate spikes 0--1. Pistillate spikes 0. Bisexual spikes 6--8. Small accessory spikes not present. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 3,5--4,0 mm long. Bracts of pistillate spikelets lanceolate, 4,0--5,5 X 1,0--1,5 mm, longer and narrower than perigynium, golden-brown, with wide hyaline margins, glabrous; carina narrow, 1-nerved; apex acute, very shortly awned or muticous; awn 0--0,3 mm long, margin scabrid, or glabrous. Mature perigynium suberect, stipitate, without a basal callus, rostrate, 2,5--3,5 X 1,0--1,5 mm, triangular in cross-section, slightly or not inflated, green or stramineous with rostrum whitish, without a layer of corky material, membranous, glabrous, nerves few (2 or 3) or inconspicuous; rostrum abrupt, 0,5--0,6 mm long, straight, margin not winged, glabrous; rostrum apex shallowly bidentate, apical teeth 0,25 mm long. Rhachilla absent from perigynia. Style base slightly bent, or straight; stigmas 3. Mature nutlet obovate or elliptic, narrowly clawed, 1,8--2,0 mm X 1,0--1,2 mm, triangular in cross-section, blackish, or fuscous with lighter angles, glabrous.

This species flowers and fruits from August to May. The plants grow in light or full shade, in perennially waterlogged riparian situations in forest interiors, on clay or loam substratum. The species occurs in areas receiving rainfall in summer, in the midlands and in montane areas, in northern and eastern Transvaal, Natal, eastern Cape Province, and Transkei. Map 7. Apparently endemic to southern Africa.

The Section to which C. mossii belongs, Maximae Aschers., comprises about eight to ten similar large, robust species with large, pendulous inflorescences. They appear to share similar habitat requirements. The exact relationship between C. mossii and the evidently closely related Tropical African species C. bequaertii De Wild. requires investigation. One important difference noted in specimens in K and PRE identified as the latter species is that the bracts of the pistillate spikelets are conspicuously awned, while in C. mossii the bracts are muticous or very shortly awned.

When Nelmes described C. mossii he reported that Transvaal specimens examined had fruits of a different shape to the Cape Province specimens; upon examination of the material in K, the particular Transvaal specimen seen by Nelmes was found to have galled fruits.

Some confusion exists regarding the collector of the holotype. In the original description Nelmes cited it as

Moss 999. collected at Hogsback on 1st January 1927. The holotype (photo. in PRE!) bears a label in the lower right-hand corner with this information. In the lower left-hand corner of the sheet, however, is an envelope that evidently contains scraps from this or another sheet. It is labelled, possibly in Nelmes's hand, with "C.E. Moss 15336. Hogsback, 1 Jan. 1927, Leg. Miss E.M. Young". This is the other specimen cited by Nelmes, of which complete specimens are housed in BM and J. Interestingly, according to Moss's register in J, Moss collected his first 2 000 numbers with F.A. Rogers and no Moss 999 exists. Moss & Rogers 999 is Equisetum ramosissimum Desf., and was collected at "Zookmakaar" on 16th November 1917. The register shows that Moss never collected at Hogsback. It is therefore probable that the two specimens cited by Nelmes are part of the same collection.

SELECTED CITATIONS

TRANSVAAL.---2329 (Pietersburg): Pietersburg district, Woodbush Mts (-DD). Moss 15577 (K, NU, PRE).
---2430 (Pilgrim's Rest): Pilgrim's Rest district, Mount Sheba Nature Reserve, from hotel to owner's house at first stream (-DC), Kluge 2474 (NBG, PRE).
---2531 (Komatipoort): Barberton district, Moodies Estate (-CC), Thorncroft s.n. sub PRE 15184 (PRE).

NATAL.---2730 (Vryheid): Paulpietersburg district, Pongola Bush Nature Reserve, Stinkwood Falls (-BC), Glen

2432 (PRE).

---2731 (Louwsburg): Ngotshe district, Ngome State Forest, Ntendeka Wilderness Area (-CD), Van Wyk 6990 (PRE).

---2828 (Bethlehem): Bergville district, Royal Natal National Park, Mont aux Sources, Fairy Glen (-DB), Schelpe 1495 (NU).

---2829 (Harrismith): Bergville district, Cathedral area, Mlambonja Forest (-CC), Schelpe 205 (NU).

---2929 (Underberg): Estcourt district, Giant's Castle Game Reserve, Forest Walk (-BC), Reid 983 (J, PRE).

---2930 (Pietermaritzburg): Lions River district, 32 km north of Howick on Karkloof - Rietvlei road (-AD), Reid 1198 (J, PRE).

---3029 (Kokstad): Alfred district, Weza, Ingeli Forest about 4 km from Weza (-DA), Arnold 328 (PRE).

CAPE.---3225 (Somerset East): Somerset East district, Boschberg (-DA), MacOwan 1608 (BOL, S, Z).

---3226 (Fort Beaufort): Bedford district, Turpin Dam (-CA), Arnold 764 (NH, PRE); Cathcart district, Hogsback, Auckland Forest Reserve, near Arboretum (-DB), Reid 1204 (J, PRE).

---3227 (Stutterheim): Stutterheim district, Fort Cunynghame (-AD), Galpin 2475 (GRA, K, PRE); Komga (-)B), Flanagan 919 (GRA, PRE, Z).

TRANSKEI.---3029 (Kokstad): Sneezewood Plantation (-BC), Strey 9179 (PRE).

---3128 (Umtata): Baziya Mt. (-CB), Baur 443 (K); Nquadu, north of Umtata (-DA), Hilliard & Burtt 16320 (NU).

CISKEI.---3226 (Fort Beaufort): Katberg (-DA), Galpin 1741 (GRA, PRE); Victoria East district, Fort Beaufort, University of Fort Hare (-DD), Giffen 703 (PRE).
---3227 (Stutterheim): Keiskammahoek district, Dontsa Forest 10 miles north-east of Keiskammahoek (-CA), Story 3687 (PRE); King William's Town district, Maden Dam (-CB), Acocks 9282 (BM, PRE); Pirie (-CC), Sim 929 (NU).

**7. Carex aethiopica** Schkuhr in Beschreibung und Abbildung der theils bekannten, theils noch nicht beschrieben Arten von Riedgrasern nach eigenen Beobachtungen und vergrosserter Darstellung der kleinsten Theile, Wittenberg 1: 107, t. z fig. 83 (1801); Boott 3: 110, t. 341--343 (1862); Steud.: 285 (1840); Boeck.: 285 (1877); C.B.Cl.: 679 (1894); C.B. Cl.: 308 (1898); Bolus & Wolley-Dod: 356 (1904); Kuekenth.: 654 (1909); Schoenl.: 69 (1922); Levyns: 131 (1950); Bond & Goldblatt: 38 (1984). Type: Cape, without precise locality, Thunberg s.n. (HAL, holo., --PRE, photo.!).

C. iridifolia Kunth: 492 (1837). C. aethiopica Schkuhr var. iridifolia (Kunth) C.B. Cl.: 679 (1894). Type: Cape, Ruigte Vallei, Drège 7398 (B, holo.†; P, lecto.!, designated here; K!).

Plants 470--1190 mm tall, caespitose. Rhizomes very short, 3--6 mm in diameter. Shoot scales and basal leaves developing extensive anthocyanin colouration. Leaves glaucous, dark green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face tearing into membranous strips. Largest basal leaf blades 800--1150 X 7--12 mm, flat, keeled, or plicate in cross-section; adaxial surface glabrous; abaxial surface papillate; margins proximally glabrous to papillate and distally minutely scabrid to scabrid. Lowest culm leaf: sheath mouth truncate,

membranous; ligule stramineous, 1,3--2,5 mm high, membranous, apex acute. Culms triangular in cross-section, 1,5--3,0 mm in diameter; internodes all of about equal length, exposed; 1--2 nodes exposed. Inflorescence a raceme of spikes, 165--445 mm long. Basal inflorescence bracts leaf-like, not reflexed near base of blade at maturity; sheaths 35--90 mm long; blades 190--580 mm long; opposing bracteole tubular, membranous, usually concealed by bract sheath. Primary inflorescence units 1 from each node. Spikes 4--6, erect, suberect, or pendulous, not clustered, excepting frequently apical 2--3 (usually staminate) spikes; the largest 30--75 X 7--8 mm. Longest peduncle exserted by (17)--130 mm, scabrid on angles, or glabrous. Apical spikes usually staminate. Staminate spikes 1--2. Pistillate spikes 3--5. Bisexual spikes 0. Small accessory spikes not present. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 2,2--6,0 mm long. Bracts of pistillate spikelets ovate, 4--6 X 1,5--3,0 mm, the same length as and narrower than the perigynium, stramineous with light to heavy ferruginous striae and hyaline margins, or wholly ferruginous, glabrous, but ciliate distally on margin; carina broad, 3-nerved; apex acute or emarginate, awned; awn 0,5--1,8 mm long, margin scabrid. Mature perigynium suberect, not stipitate, without a basal callus, rostrate, 5,5--6,5 X 1,2--4,0 mm, narrowly elliptic in cross-section, slightly to much inflated, green, or stramineous with ferruginous spots, base without a layer of corky material,

cartilaginous, glabrous, nerves conspicuous, many (more than 10); rostrum tapered, 1,2--1,6 mm long, straight; rostrum margin not winged, glabrous; apex deeply bidentate; apical teeth 0,6--1,0 mm long. Rhachilla sometimes present in perigynia of basal spikelets. Style base twisted; stigmas 3. Mature nutlet obovate, not clawed, 2,5--2,8 X 1,2--1,8 mm, triangular in cross-section, fuscous with lighter angles, minutely papillose.

This species flowers and fruits from September to June. The plants grow in light or full shade on wet or moist forest margins, on clay or loam substratum. The species occurs in areas receiving rainfall in winter and in all seasons, near the coast and in the midlands, in south-western and southern Cape Province. Map 8. Endemic to the Cape Province.

The specific epithet refers to the distribution of the taxon, which was mistakenly thought to be Ethiopian. This confusion regarding locality is doubtless why Clarke initially (1894) reduced C. iridifolia to a variety of C. aethiopica, rather than placing it into direct synonymy, as he did in 1898. An annotation by Clarke dated 26th August 1896 of a sheet of Drège 7398 in BM, points out that Boott proves (1862) "that the Aethiopica of Schkuhr was founded on this Cape plant. C. simensis Hochst. from Abyssinia has the terminal spike female at top and other differences".

It seems likely that an isotype of C. aethiopica exists in the Thunberg herbarium, because microfiche 21960 (seen at PRE), although not annotated, very clearly depicts this species. The holotype of C. iridifolia was probably housed in B (Stafleu & Cowan p. 693, 1979) and has been destroyed, thus the specimen in P is chosen as the lectotype.

One of the characteristics of Section Elatae Kuekenth., to which C. aethiopica belongs, is the cinnamon to reddish anthocyanin colouration on the shoot scales and sheaths of the basal leaves. In addition to C. aethiopica there are a number of Tropical African species in this section, which, however have very different inflorescence, spikelet and perigynium morphology (Kuekenthal, 1909) and are obviously not very closely related to C. aethiopica.

C. aethiopica has been treated by some authors (e.g. Nees (1832)) as synonymous with C. clavata Thunb., but the two taxa are distinguished by many characters, including habitat (forest margin in C. aethiopica, open marsh and in C. clavata), inflorescence morphology (spikes 7 to 8 mm wide and spreading to pendulous in C. aethiopica, spikes 10 to 15 mm wide and erect in C. clavata), and the colour of the basal leaf sheaths (red in C. aethiopica, stramineous in C. clavata). In addition the style base in C. aethiopica is markedly twisted, whereas it is straight to slightly bent in C. clavata. There are several differences in perigynium characters, including a tapered rostrum in C. aethiopica (abrupt in C. clavata), and a fibrous rostrum margin in C.

aethiopica (scabrid in C. clavata). These characters are not easily observed in immature inflorescences, or material in which the bases are not represented; thus misinterpretation of descriptions and keys could easily have occurred.

SELECTED CITATIONS

CAPE.---3318 (Cape Town): Cape Town, Kirstenbosch Botanic Gardens, Skeleton Gorge path, a short distance above Contour Path (-CD), Reid 1127 (J, PRE).

---3320 (Montagu): Heidelberg district, Grootvadersbosch State Forest (-DD), Taylor 1047 (NBG).

---3321 (Ladismith): Ladismith district, Waterkloof north of Ladismith (-AD), Geldenhuys 381 (PRE).

---3322 (Oudtshoorn): George district, Outeniqua Mts., Montagu Pass (-CD), Rehmann 68 (BM); George district, George - Knysna old main road at Kaaimans River bridge (-DC), Reid 1144 (J, PRE); Knysna district, Homtini Pass, near bridge (-DD), Fourcade 4135 (BOL, PRE, STE).

---3323 (Willowmore): Knysna district, Deepwalls Forest Station north of Knysna, about 3,5 km below first "big tree" (-CC), Reid 1149 (J, PRE); Knysna district, Keurbooms River above bridge at mouth (-CD), Gillett 323 (STE); Humansdorp district, Storms River Forest Reserve, off the National Road (-DD), Dahlstrand 512 (J, PRE).

---3325 (Port Elizabeth): Alexandria district, Zuurberg Forest (-BC), Wylev s.n. (TCD); Port Elizabeth district, Van Staden's Nature Reserve (-CC), Wells 3375 (GRA).

---3418 (Simon's Town): Wynberg district, Cape Peninsula, Karbonkelberg (-AB), Compton 17859 (NBG, NU).

---3419 (Caledon): Hermanus district, Vogelgat Nature Reserve (-AD), Reid 1130 (J, PRE); Bredasdorp district, Groot Hagelkraal (-DA), Taylor 10403 (PRE, STE).

---3420 (Bredasdorp): Heidelberg district, Grootvadersbos Farm (-BB), Reid 1132 (J, PRE).

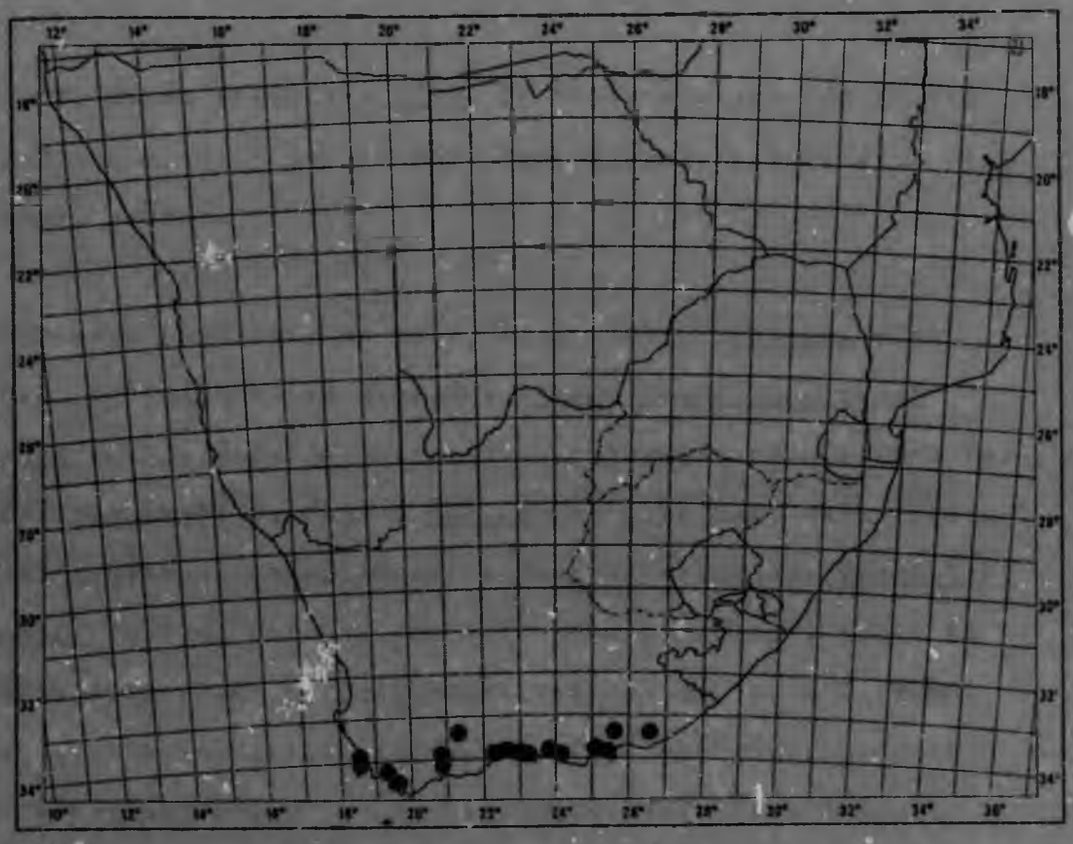
---3422 (Mossel Bay): Knysna district, Groenvlei fen (-BB), Martin 4500 (K).

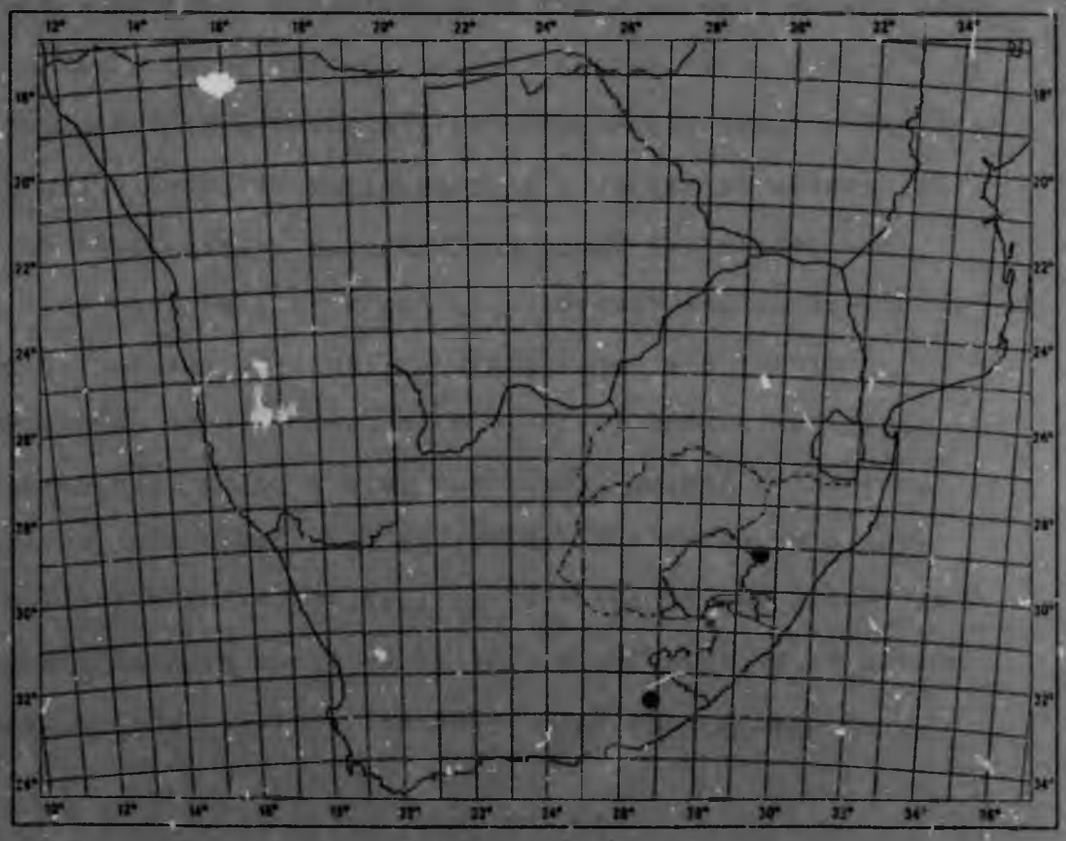
---3423 (Knysna): Knysna district, Harkerville Forest east of Knysna (-AA), Hugo 2059 (PRE, STE); Knysna district, Plettenberg Bay (-AB), Smart s.n. sub Rogers 26751 (PRE); Humansdorp district, Tsitsikamma National Park, at Storms River Mouth (-BB), Liebenberg 7847 (PRE).

---3424 (Humansdorp): Humansdorp district, Witelsbos State Forest, Kwaaibrandbos (-AA), Geldenhuys 962 (PRE).

Map 8. (Opposite above): Distribution of Carex aethiopica Schkuhr in southern Africa.

Map 9. (Opposite below): Distribution of Carex sylvatica Huds. in southern Africa.





8. Carex sylvatica Huds. in Flora Anglica edn 1: 353 (1762); C.B. Cl.: 690 (1894). Type fide N. lmes (1942): From Europe, probably lost.

Plants about 470 mm tall, caespitose. Rhizomes very short, 1,5--3,0 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves not glaucous, dark green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face simply splitting. Largest basal leaf blade 450 X 7--9 mm, flat in cross-section; adaxial surface glabrous; abaxial surface glabrous; margins proximally papillate, distally scabrid. Lowest culm leaf: sheath mouth concave, membranous; ligule 5 mm high, stramineous or fuscous, membranous, apex emarginate. Culms triangular in cross-section, 1,5--2,0 mm in diameter; internodes all of about equal length, exposed; 1--2 nodes exposed. Inflorescence a raceme of spikes, 200--330 mm long. Basal inflorescence bract leaf-like, not reflexed near base of blade at maturity; sheath 25--50 mm long; blade 300 mm long; opposing bracteole tubular, membranous, usually concealed by bract sheath. Primary inflorescence units 1 from each node. Spikes 7--8, erect or suberect, not clustered, excepting frequently apical 2--3 (usually staminate) spikes; the largest 35--45 X 6--7 mm. Longest peduncle exserted by 35--70 mm, scabrid on angles. Apical spikes usually staminate. Staminate spikes 1.

Pistillate spikes 6--7. Bisexual spikes 0. Small accessory spikes not present. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 2,2 mm long. Bracts of pistillate spikelets lanceolate, 4--5 X 1,5 mm, the same length as and narrower than the perigynium, hyaline with ferruginous striae, glabrous; carina broad, 3-nerved; apex acute, awned; awn 0,5--1,0 mm long; awn margin scabrid. Mature perigynium suberect, stipitate, without a basal callus, rostrate, 4,5--4,7 X 1,3 mm, triangular with rounded base in cross-section, not inflated, green or golden brown, base without a layer of corky material, membranous, glabrous, nerves few (2 or 3) or inconspicuous; rostrum abrupt, 2 mm long, straight, margin not winged, scabrid; rostrum apex shallowly bidentate, apical teeth 0,2 mm long. Rhachilla absent from perigynia. Style base straight; stigmas 3. Mature nutlet elliptic, not clawed, 2,3--2,4 X 1,3--1,4 mm, triangular in cross-section, fuscous with lighter angles, glabrous.

In southern Africa this species flowers and fruits from November to May. The plants grow in full shade, in wet or moist riparian situations in forest interiors, on clay or loam substratum. The species occurs in areas receiving rainfall in summer, in the midlands, in Natal and eastern Cape Province. Map 9. It is apparently fairly recently adventive in southern Africa; it is common and widespread in Europe and Asia Minor, also in North Africa (Algeria), and

is also recorded from North America.

In Britain the common name for this species is "Wood Sedge"; this name and the specific epithet are descriptive of the habitat. The unusual habitat of C. sylvatica. together with the membranous perigynium with a very long rostrum, make the species very distinctive and unlikely to be confused with any other southern African species.

As noted in the nomenclature section above, the type has probably been lost. According to Stafleu and Cowan (p. 354, 1979), Hudson's house and much of his herbarium was destroyed by fire in 1783. The name therefore requires neotypification, but it is felt that the problem is one for European systematists to solve.

SELECTED CITATIONS

NATAL.---2929 (Underberg): Estcourt district, Thabamhlope, about 2 km from White Mountain Resort on Kamberg road (-BA), Reid 1370 (J, PRE).

CAPE.---3226 (Fort Beaufort): Cathcart district, Hogsback, Auckland Forest (-DB), Giffen 1586 (PRE).

9. **Carex burchelliana** Boeck. in Linnaea 41: 234 (1877); C.B. Cl.: 680 (1894); C.B. Cl.: 306 (1898); Kuekenth.: 660 (1909); Schoenl.: 69 (1922). Type: Cape, Hay Division, Griquatown, Burchell 1911 (B, holo.†; K, lecto.!, designated here, --PRE, photo.!).

C. flavescens Burch.: 467 (1822), nom. nud.; C.B. Cl.: 693 (1894) (as species dubium).

Plants 340--440 mm tall, caespitose. Rhizomes very short, 1,5--2,5 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves not glaucous, mid-green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face simply splitting. Largest basal leaf blade 200--210 X 4--5 mm, flat in cross-section; adaxial surface glabrous; abaxial surface scabrid; margins proximally papillate, distally scabrid. Lowest culm leaf: sheath mouth convex, membranous; ligule 2--4 mm high, fuscous, membranous, apex acute. Culms triangular in cross-section, 1,2--1,7 mm in diameter; internodes all of about equal length, exposed; 1 node exposed. Inflorescence a raceme of spikes, 80--440 mm long. Basal inflorescence bract leaf-like, not reflexed near base of blade at maturity; sheaths 15-55 mm long; blades 220 mm long; opposing bracteole tubular, membranous, usually concealed by bract sheath. Primary inflorescence units 1 from each node. Spikes 3--5, erect or suberect, not

clustered, excepting frequently apical 2--3 (usually staminate) spikes; the largest 10--25 X 3--8 mm. Longest peduncle exserted by 8--22 mm, glabrous. Apical spikes usually staminate. Staminate spikes 1--2. Pistillate spikes 1--3. Bisexual spikes 0--3. Small accessory spikes not present. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 2,0--2,2 mm long. Bracts of pistillate spikelets broadly ovate, 2,5--3,0 X 2,0--2,2 mm, shorter and narrower than perigynium, stramineous, glabrous, but ciliate distally on margin; carina broad, 3-nerved; apex obtuse or emarginate, awned (shortly); awn 0,2--0,4 mm long, margin scabrid. Mature perigynium suberect, not stipitate, without a basal callus, rostrate, 3,0--3,5 X 1,6--2,0 mm, triangular in cross-section, much inflated, green, or stramineous with ferruginous spots, without a layer of corky material, cartilaginous, glabrous, nerves conspicuous, many (more than 10); rostrum abrupt, 0,5 mm long, straight; rostrum margin not winged, scabrid; apex shallowly bidentate, apical teeth 0,2 mm long. Rhachilla absent from perigynia. Style base slightly bent, or straight; stigmas 3. Mature nutlet obovate, narrowly clawed, 2,0--2,4 X 1,0--1,4 mm, triangular in cross-section, fuscous with lighter angles, minutely papillose.

This species flowers and fruits from October to December. The plants grow in full sun, in perennially waterlogged marshland, on dolomite-derived substratum. The

species occurs in areas receiving rainfall in summer, in the interior, in western Transvaal and central Cape Province. Map 10. Endemic to southern Africa.

The specific epithet commemorates William Burchell, the first collector of this taxon. C. burchellii was only published in 1877, about 12 years after Burchell's specimens were donated to K, suggesting that Boeckeler's attention was drawn to the new species only after their incorporation in that herbarium. Burchell's duplicates may have been widely distributed, also going to Boeckeler at B (and therefore the holotype has been destroyed). The specimen in K is here designated as the lectotype.

C. burchelliana is unlike any Tropical African species. Clarke (1898) pointed out that it is similar to the European species C. diluta Marsch.-Bieb., but both he and Kuekenthal (p. 660, 1909) list a number of significant differences. These include characters of the perigynium (ovate in C. diluta and ellipsoid in C. burchelliana) and of the nutlet (hardly stipitate in C. diluta. strongly stipitate in C. burchelliana).

SELECTED CITATIONS

TRANSVAAL.---2626 (Klerksdorp): Ventersdorp district, Die Oog Van Schoonspruit Farm (-BD), Reid 1115 (J, PRE).

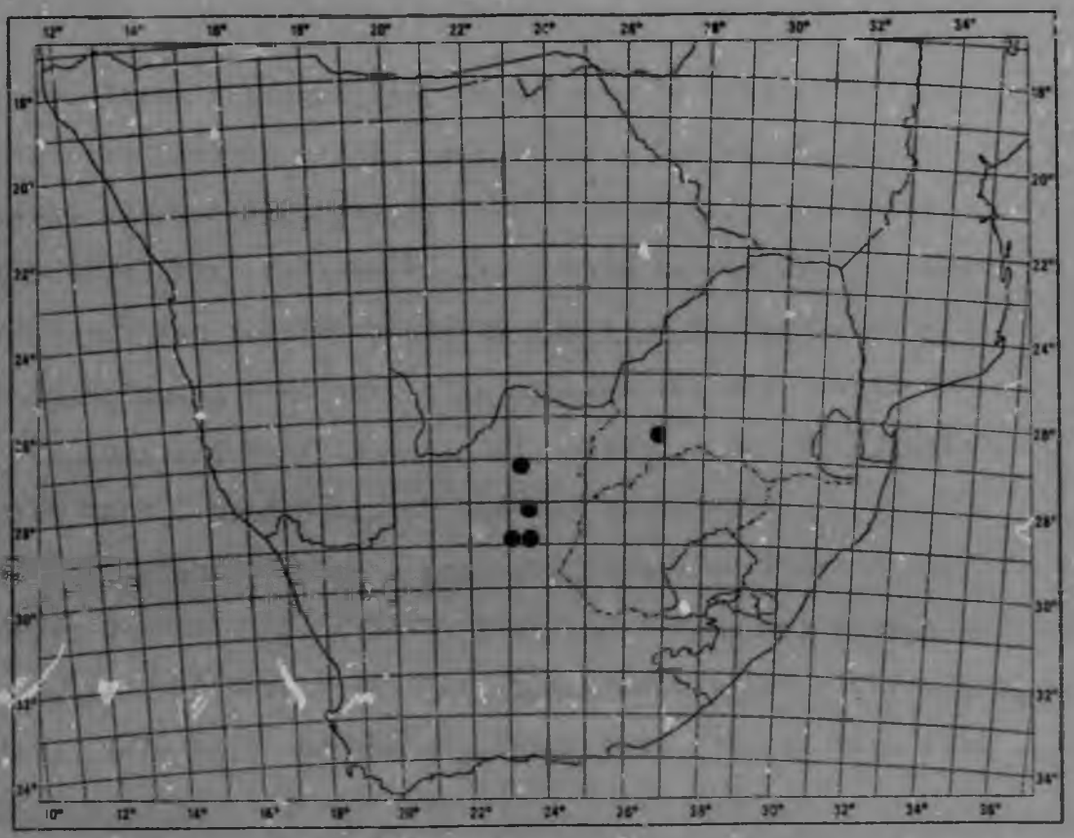
CAPE.---2823 (Douglas): Postmasburg district, Danielskuil, southern outskirts on road to Campbell (-BA),

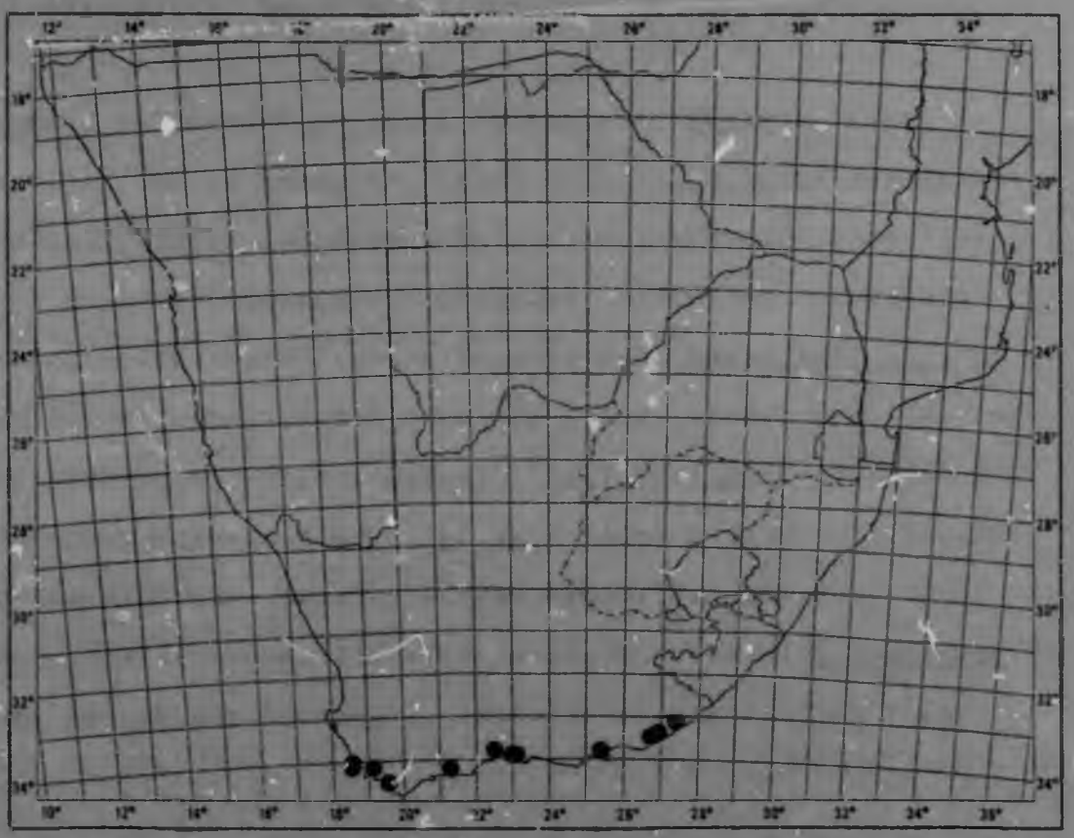
Reid 1121 (J, PRE); Hay district, Griquatown (-CC), Burchell 1911 (K); Herbert district, Upper Campbell (Campbell) (-DC), Burchell 1831 (K).

BOPHUTATSWANA.---2723 (Kuruman): Kuruman district, Cotton End Farm, banks of Matlhwaring River (-AB), Acocks 2503 (PRE).

Map 10. (Opposite above): Distribution of Carex burchelliana Boeck. in southern Africa.

Map 11. (Opposite below): Distribution of Carex ecklonii Nees in southern Africa.





10. Carex ecklonii Nees in Linnaea 10: 203 (1836); Kunth: 517 (1837); Steud.: 289 (1840); Kunze: 25, t. 5 (1840); Levyns: 151 (1950); Bond & Goldblatt: 38 (1984). Type: Cape, Port Elizabeth dist., Cape Receif nr. Seaview (collector not stated, probably Ecklon & Zeyher).

C. ecklonii Nees var. α in Linnaea 10: 203 (1836).

C. ecklonii Nees var. β: 203 (1836). Type: Swellendam & George dist., Mund s.n. (B, holo.†; S!).

C. extensa Good. var. ecklonii (Nees) Kuekenth.: 667 (1909); Schoenl.: 69 (1922). Type: As for C. ecklonii.

C. extensa Good. var. latifolia Boeck.: 289 (1877), nom. illeg.; C.B. Cl.: 684 (1894). Type: Cape, "Prom. bon. spei", Ecklon & Zeyher 119 (B, holo.†).

[C. extensa auctt. non Good.: Boeck.: 289 (1877); C.B. Cl.: 684 (1894); Bolus & Wolley-Dod: 356 (1904).]

Plants 170--710 mm tall, caespitose. Rhizomes very short, 1,5 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves not glaucous, yellow-green, usually without conspicuous transverse venation. Basal leaf sheaths tubular, old sheaths not becoming spongy; inner face tearing into membranous strips. Largest basal leaf blade 80--340 X 2,5--4,0 mm, channelled or plicate in cross-section; adaxial surface glabrous; abaxial surface glabrous; margins proximally glabrous, distally minutely scabrid. Lowest culm leaf: sheath mouth concave, membranous; ligule 1 mm high,

fuscous, membranous, apex obtuse or occasionally emarginate. Culms triangular in cross-section, 1--2 mm in diameter; internodes all of about equal length, exposed; 0--1 nodes exposed. Inflorescence a raceme of spikes, 20--50 mm long. Basal inflorescence bract leaf-like, sharply reflexed near base of blade at maturity; sheath 0--25 mm long; blade 60--190 mm long; opposing bracteole tubular, membranous, usually concealed by bract sheath. Primary inflorescence units 1 from each node. Spikes 4--5, spreading, clustered; the largest 15--22 X 7--10 mm. Peduncles not exserted, glabrous. Apical spikes usually staminate. Staminate spikes 1. Pistillate spikes (0--)3--4. Bisexual spikes 0--3. Small accessory spikes occasionally present at base of basal pistillate spikes, usually absent. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 2,5 mm long. Bracts of pistillate spikelets ovate, 4,2--5,0 X 1,8--2,2 mm, shorter and narrower than perigynium, ferruginous, glabrous; carina broad, 3-nerved; apex obtuse or emarginate, shortly awned; awn 0,8--2,0 mm long, margin scabrid. Mature perigynium suberect, stipitate, without a basal callus, rostrate, 4,5--5,5 X 1,8--2,5 mm, triangular with rounded base in cross-section, much or slightly inflated, green or stramineous with ferruginous spots, base without a layer of corky material, cartilaginous, glabrous, nerves conspicuous, many (more than 10); rostrum abrupt, 0,7--1,2 mm long, straight, margin not winged, glabrous; apex shallowly bidentate, apical teeth 0,3--0,5 mm long. Rhachilla absent

from perigynia. Style base twisted, slightly bent, or straight; stigmas 3. Mature nutlet obovate, narrowly clawed, 2,5--3,2 X 1,5--2,0 mm, triangular in cross-section, fuscous with lighter angles, minutely papillose.

This species flowers and fruits from October to April. The plants grow in full sun, in perennially waterlogged marshland, on sandy substratum. The species occurs in areas receiving rainfall in winter and in all seasons, at sea level, in south-western, southern, and eastern Cape Province. Map 11. Endemic to the Cape Province (?); possibly also from Scotland (Kuekenthal, 1909).

The specific epithet commemorates C.F. Ecklon, who probably, with Zeyher, collected the type specimen. Cape Receif, the type locality, is certainly one of their collecting localities (Gunn & Codd, 1981). Unfortunately no specimen of theirs from this locality has been traced. There is no doubt as to the identity of Nees's species, as his descriptive phrase "spicis femineis subternis cylindricis approximatis fastigiatis [illegible] subaequantibus subsessilis, ..." (p. 203, 1836, is entirely diagnostic. If the specimen was housed in B it has been lost (Stafleu & Cowan p. 706, 1981). Isotypes could be at CGE, but this has not been checked because loan requests were unable to be fulfilled. If no isotype exists, a neotype must be designated.

C. ecklonii is evidently closely related to the common European species C. extensa Good., with which it also shares a preference for sea shore habitats. Major differences, as noted by Kuekenthal (1909) are the 3 mm long perigynia and spikes not clustered in C. extensa. The latter species has been reported to occur in southern Africa (Kuekenthal, 1909), but during the present study no specimens of this species have been seen.

**SELECTED CITATIONS**

CAPE.---3318 (Cape Town): Cape Town, Clifton, Moses' Beach (-CD), Acocks 3726 (S).

---3322 (Oudtshoorn): George district, Bo-Langvlei, northern shore (-DC), Reid 1146 (J, PRE).

---3325 (Port Elizabeth): Port Elizabeth (-DC), E.S.C.A. Herbarium 177 (Z).

---3326 (Grahamstown): Bathurst district, Kowie (-DB), Simon s.n. (NH).

---3327 (Peddie): East London district, Kidd's Beach (-BA), Hilliard & Burtt 18987 (PRE); Bathurst district, Riet River Estuary (-CA), Ward 9285 (BUDW, PRE).

---3418 (Simon's Town): Simon's Town district, Cape Peninsula, Noordhoek Vlei (-AB), Reid 1128 (J, PRE); Simon's Town district, Smitswinkel Bay (-AD), Whellan 1750 (PRE).

---3419 (Caledon): Hermanus (-AC), Whellan 1483 (K, PRE); Hermanus district, Uilkraals River north bank, 100 m below bridge (-CB), O'Callaghan 1534 (STE); Bredasdorp district,

Ratelvlei (-DA), Reid 1131 (J, PRE).

---3421 (Riversdale): Riversdale district, Still Bay strand (-AD), Levyns 9513 (BOL).

---3422 (Mossel Bay): Knysna district, Groenvlei fen (-BB), Martin 4548 (K).

---3423 (Knysna): Knysna district, Noetzie (-AA), Phillips 5 (GRA).

11. Carex monotropa Nelmes in Kew Bull. 11: 86 (1955a). Type: Lesotho, between Indumeni Dome and Castle Buttress, Killick 1847 (K, holo.!; BM!, CPF, PRE!, NU!).

C. oederi Retz. var. cataractae (R. Br.) Kuekenth.: 673 (1909), p.p.; Schoenl.: 69 (1922).

[C. flava auct. non L.: C.B. Cl.: 307 (1898).]

Plants 20--60 mm tall, caespitose (sometimes very loosely caespitose). Rhizomes very short to long, 1,0--1,5 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves not glaucous, mid-green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face tearing into membranous strips. Largest basal leaf blade 65--100 X 2,2--3,0 mm, flat or keeled in cross-section; adaxial and abaxial surfaces glabrous; margins proximally papillate, distally scabrid. Lowest culm leaf: sheath mouth concave, membranous; ligule 2 mm high, whitish, membranous, apex obtuse. Culms triangular in cross-section, 0,5--1,0 mm in diameter, very short, concealed by leaf sheaths; nodes not exposed. Inflorescence a raceme of spikes, 12--20 mm long. Basal inflorescence bracts leaf-like, not reflexed near base of blade at maturity; sheaths 2--4 mm long; blades 15--45 mm long; opposing bracteole tubular, membranous, usually concealed by bract sheath. Primary inflorescence units 1 from each node. Spikes 3--4, spreading, clustered; the

largest 7--9 X 7--5 mm. Peduncles not exserted, glabrous. Apical spikes usually staminate. Staminate spikes 0--1. Pistillate spikes 2--3. Bisexual spikes 0--1. Small accessory spikes not present. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 1--2 mm long. Bracts of pistillate spikelets lanceolate, 2,5--3,0 X 1,2 mm, shorter and narrower than the perigynium, yellow and ferruginous, glabrous; carina broad, 3-nerved; apex obtuse or emarginate, awned or muticous, or carina terminating subapically; awn 0--0,2 mm long, margin scabrid. Mature perigynium suberect to spreading, not stipitate, without a basal callus, rostrate, 4,0--4,5 mm X 1,2--1,5 mm, elliptic or rotund in cross-section, much inflated, bright yellow, 2-layered, without a layer of corky material, herbaceous, glabrous, nerves conspicuous, many (more than 10); rostrum tapered, 1,2--1,8 mm long, straight; margin not winged, glabrous; apex shallowly bidentate, apical teeth (0,2--)0,5--0,7 mm long. Rhachilla absent from perigynia. Style base straight; stigmas 3. Mature nutlet obovate, not clawed, 1,5--1,8 X 1 mm, triangular in cross-section, fuscous, minutely papillose.

This species flowers and fruits from December to February. The plants grow in full sun, in seasonally waterlogged marshland, on basaltic substratum. The species occurs in an area receiving rainfall in summer, on the alpine plateau in Lesotho, to which it is endemic. Map 12.

The specific epithet refers to the isolation of this taxon from other members of the Carex flava "group" (Nelmes, 1955a). In his monograph Kuekenthal (1909) cited a specimen of the southern African taxon (i.e. C. monotropa), along with specimens of taxa from Tasmania, New Zealand and South America, as C. oederi var. cataractae. When Nelmes (1955a) discussed the Southern Hemisphere members of this widespread "group", he showed that C. monotropa is clearly related to, although easily distinguished from, the remaining members. They all occupy similar, specialised habitats on high-altitude mountain plateaux.

During summer, shallow temporary pools form in the habitat of C. monotropa (i.e. in the poorly drained basaltic soils). In late summer the plants produce inflorescences just above water level. The inflated fruits float and are dispersed by water, being "pl[illegible]d" when the water recedes.

**SELECTED CITATIONS**

LESOTHO.---2828 (Bethlehem): Butha Buthe, Valley No. 1 (-CC), Coetzee 397 (NBG); Pela Ts'oeu River (-CD), Jacot Guillarmod 2055 (PRE); Mont aux Sources, summit of mt. (-DD), Flanagan 2013 (BOL, K, PRE).

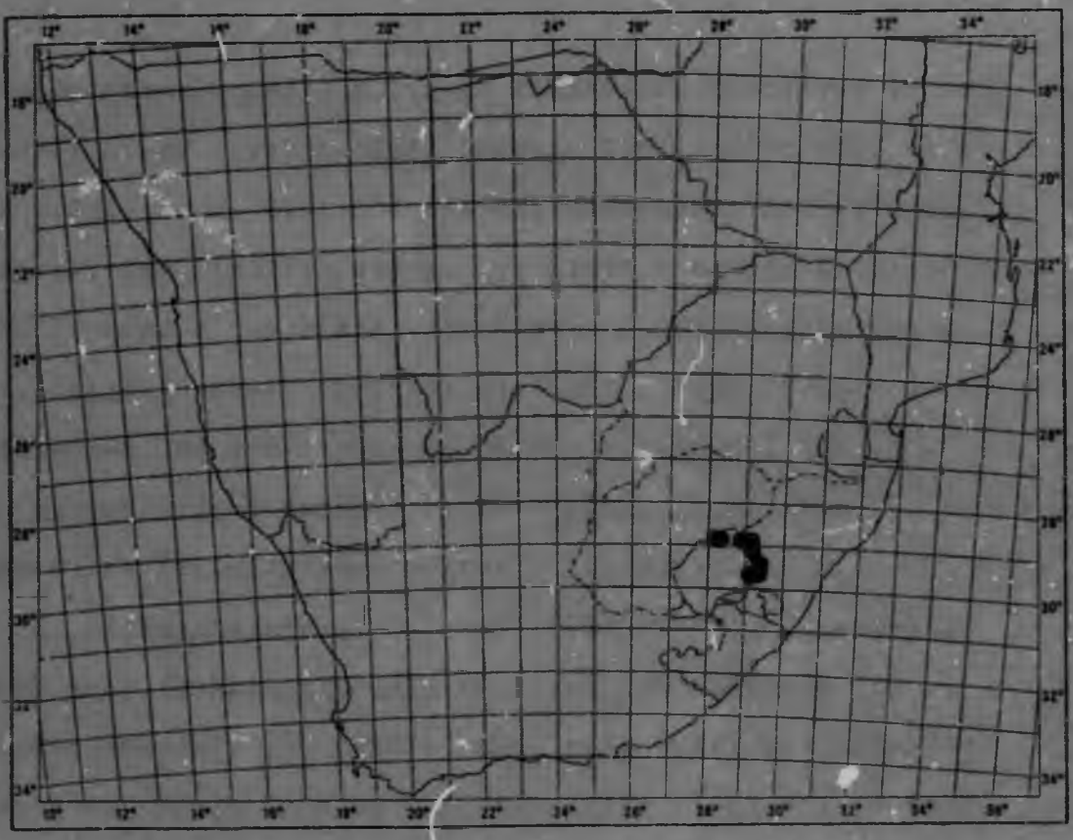
---2829 (Harrismith): Cathedral Peak, top of Organ Pipes Pass (-CC), Smook 1075 (PRE).

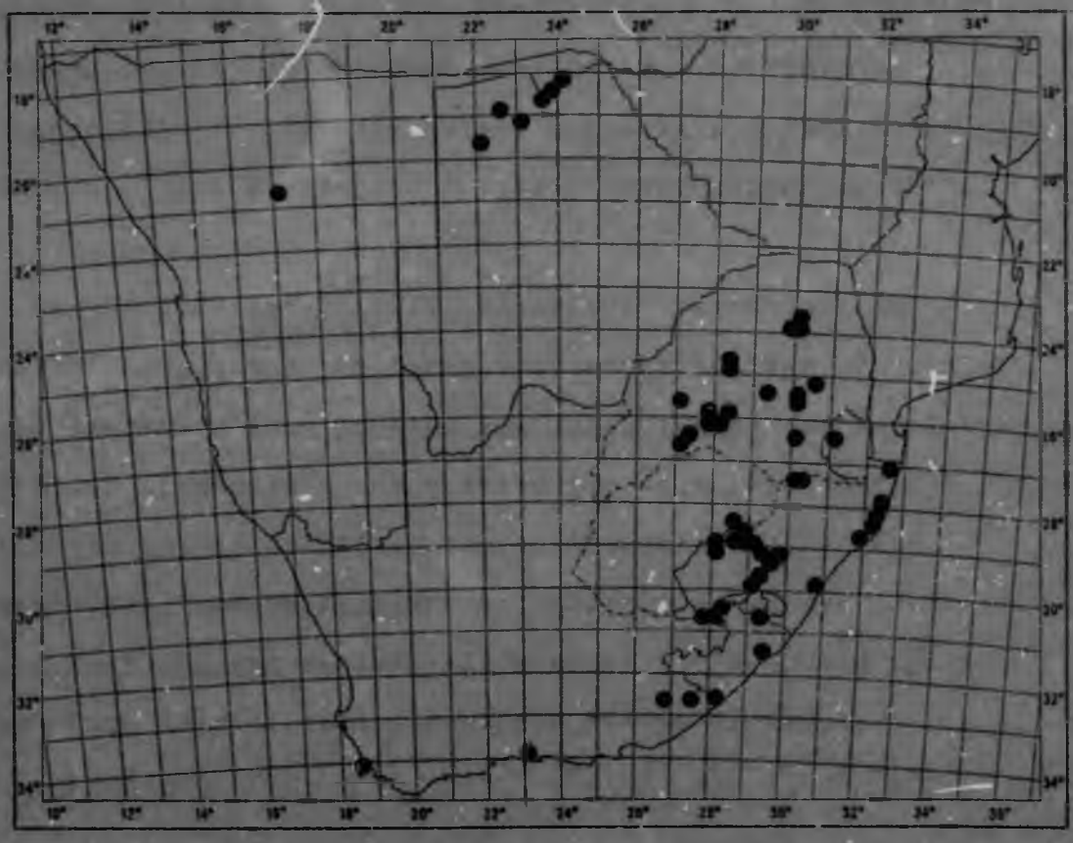
---2929 (Underberg): Between Indumeni Dome and Castle Buttress (-AA), Killick 1847 (BM, CPF, K, NU, PRE); Mokhotlong district, near Thabana Ntlenyana (-AD), Coetzee

573 (PRE); On road to Sani Top, 5 km from Kotisephola Pass summit (-CA), Killick 4593 (PRE, ROML); Sani Pass, valley towards Hodgson's Peaks (-CB), Hilliard & Burtt 9669 (PRE).

Map 12. (Opposite above): Distribution of Carex monotropa Nelmes in southern Africa.

Map 13. (Opposite below): Distribution of Carex cognata Kunth in southern Africa.





12. Carex cognata Kunth in Enumeratio Plantarum 2: 502 (1837); Steud.: 287 (1840); Boeck.: 299 (1877): C.B. Cl.: 681 (1894); C.B. Cl.: 308 (1898); Kuekenth.: 697 (1909); Schoenl.: 69 (1922); Levyns: 131 (1950); Haines & Lye: 383 (1983); Bond & Goldblatt: 38 (1984). C. pseudo-cyperus L. var. cognata (Kunth) Boott: 141 (1867). Type: Cape, Swellendam and George dist., Mund s.n. (B, holo.†).

C. retrorsa Nees: 204 (1836), nom. illeg., non Schweinitz (1824). Type: As for C. cognata.

C. drakensbergensis C.B. Cl.: 309 (1898). C. cognata Kunth var. drakensbergensis (C.B. Cl.) Kuekenth.: 699 (1909); Schoenl.: 69 (1922), syn. nov. Type: Kokstad, Vaal Bank Farm, Haygarth s.n. sub Medley Wood 4201 (K, lecto.!, designated here; BOL!, NH!).

Syntypes: Orange Free State, Drakensberg, near Harrismith, Buchanan 112 (K, --PRE, photo.!); Natal, Harrismith, Buchanan 136 (not found); Natal, Buchanan 137 (not found); Transvaal, Mooi River near Potchefstroom, Nelson 72 (K!).

Plants 340--765 mm tall, caespitose (sometimes very loosely caespitose). Rhizomes very short to long, 2,5--4,0 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves not glaucous, yellow-green, with conspicuous transverse venation, especially in dry material. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face tearing into membranous strips or simply

splitting. Largest basal leaf blade 230--680 X 6--8 mm, flat in cross-section; adaxial and abaxial surfaces scabrid; margins proximally glabrous, distally minutely scabrid. Lowest culm leaf: sheath mouth truncate, or usually concave, membranous; ligule 4 mm high, stramineous, membranous, apex acute or obtuse. Culms sharply triangular in cross-section, 2--3 mm in diameter; internodes all of about equal length, exposed; 1--2 nodes exposed. Inflorescence a raceme of spikes, 115--195 mm long. Basal inflorescence bract leaf-like, not reflexed near base of blade at maturity; sheath 0--20 mm long; blade 300--500 mm long; opposing bracteole tubular, membranous, usually concealed by bract sheath. Primary inflorescence units 1 from each node. Spikes 3--6, erect, suberect, or pendulous, all clustered, or only apical 2--3 (usually staminate) spikes; the largest 20--70 X 7--11 mm. Longest peduncle exserted by 0--65 mm, scabrid on angles. Apical spikes staminate, occasionally androgynecandrous. Staminate spikes 0--2. Pistillate spikes 2--6. Bisexual spikes 0--1. Small accessory spikes not present. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 2,3--2,5 mm long. Bracts of pistillate spikelets ovate-lanceolate, 5-6 mm X 1,2--1,8 mm, the same length as and narrower than the perigynium, ferruginous, glabrous; carina broad, 3-nerved; apex obtuse or sometimes emarginate, awned; awns 1,2--3,0 mm long, margins scabrid. Mature perigynium spreading, stipitate, without a basal callus, rostrate, 4,0--5,2 X 1,5--2,0 mm, elliptic or rotund

in cross-section, much inflated, stramineous and ferruginous, base without a layer of corky material, cartilaginous, glabrous, nerves conspicuous, many (more than 10); rostrum abrupt, 1,1--2,0 mm long, straight, margin not winged, glabrous; apex deeply bidentate, apical teeth 0,5--1,0 mm long. Rhachilla absent from perigynia. Style base twisted; stigmas 3. Mature nutlet obovate or elliptic, not clawed, 1,7--2,8 X 1,2--1,5 mm, triangular in cross-section, fuscous with lighter angles, minutely papillose.

This species flowers and fruits from October to July. The plants grow in full sun, or light shade, in perennially waterlogged marshland or wet flushes, or in riparian situations, on clay or loam substratum. The species occurs in areas receiving rainfall in summer, winter, or in all seasons, from sea level to the alpine plateau, in Namibia, Botswana, northern, eastern and central Transvaal, Orange Free State, Swaziland, Natal, Lesotho, south-western and eastern Cape Province, and Transkei. **Map 13.** It is also fairly widespread in East Africa, in Tanzania, Kenya, Zimbabwe and Mozambique.

C. retrorsa Nees (1836) is illegitimate because it is predated by the North American species C. retrorsa Schweinitz (1824). Kunth (1837) published C. cognata as an avowed substitute for C. retrorsa Nees. The specific epithet cognata means "related" but it is uncertain why it was

applied to this particular taxon. The holotype has not been traced; it seems likely that it has been destroyed as, according to Stafleu and Cowan (p. 706, 1981) Nees's types of "Glumaceae" were acquired by B in 1855. The designation of a neotype is therefore required.

C. cognata belongs to the very distinctive, widespread Section Pseudo-cypereae Tuckerm., which is characterized by the leaves having conspicuous transverse venation, the long, scabrid-awned bracts of the pistillate spikelets, and the inflated, sharp-toothed perigynia. The relationship of C. cognata to the Tropical African species of this Section requires investigation, especially C. congolensis Turrill and C. pseudo-sphaerogyna Nelmes; the former species was reduced to a variety of C. cognata by Haines and Lye (1983), with C. pseudo-sphaerogyna included as a synonym of the variety.

When population studies were undertaken at Hogsback in the eastern Cape Province, individuals conforming to the popular concept of C. drakensbergensis C.B. Cl., that is, with long rhizomes and ferruginous coloured, more-or-less distant, pendulous, secund spikes, were observed growing in open grassland on a streambank. A very short distance downstream individuals of what is evidently the same population were lightly shaded by planted Pinus species. These conformed to the popular concept of C. cognata, that is, with short rhizomes, and greenish, clustered, suberect, distichously arranged spikes. The conclusion is that the

differences between these two taxa are entirely habitat-related, and that C. drakensbergensis cannot be upheld, even as a variety of C. cognata, as was published by Kuekenthal (1909). Additionally, studies of herbarium material have shown that the characters listed above intergrade completely.

The Waterberg, Namibia record (see specimen citation) is surprisingly not mentioned by Podlech in the Prodromus: Einer Flora von Südwestafrika (1967). It is certainly an isolated locality, but easily explained considering that the long-range dispersal of this species is most probably by means of migrant avian fauna. This locality represents probably the only water source for many kilometres and is likely to be visited by many migrant birds.

SELECTED CITATIONS

NAMIBIA.---2017 (Waterberg): Waterberg, Okozongomuinja (-CA), Dinter 1770 (SAM).

BOTSWANA.---1822 (Kangara): Northern district, Okavango River, Duba (Xesabe) Island (-DC), Smith 1066 (MO, PRE).
---1823 (Siambisso): Chobe (-BD), Morwe 72 (PRE); Northern district, island in Zibadianja Lagoon (-DA), Gibbs Russell 3148 (MO, PRE).
---1824 (Kackikau): Botswana - Caprivi border, Linyanti River swamp, Shaile (-AA), Edwards 4391 (PRE).
---1922 (Nokoneng): Northern district, Quanqua, Thaoge River bed (-CA), Smith 1531 (MO, PRE).

---1923 (Maun): Okavango, Godikwe Island (-AA), Ellery 275 (J, PRE).

TRANSVAAL.---2329 (Pietersburg): Pietersburg district, Woodbush (-DD), Wager s.n. sub TRV 23137 (PRE).

---2330 (Tzaneen): Letaba district, Duiwelskloof, Westfalia Estate, below Merensky Dam (-CA), Scheepers 763 (B, PRE); Letaba district, New Agatha (-CC), MacCallum 625 & 626 (GRA, PRE).

---2428 (Nylstroom): W[illegible]berg district, 3 km west of Nylstroom - Vaalwater road, on road to Loubad (-CB), Reid 463 (PRE); Warmbaths (-CD), Leendertz s.n. sub TRV 6022 (PRE).

---2527 (Rustenburg): Rustenburg district, Rainhill Farm, portion of Donkerhoek, kloof no. 46 (-CA), Rose-Innes 232 (J, PRE); Krugersdorp district, Gladysvale Farm (-DD), Rodin 3923 (PRE).

---2528 (Pretoria): Pretoria, Waterkloof, Ravenal Stream (-CD), Mogg 15902 (PRE).

---2529 (Witbank): Witbank district, Koskop Dam, Renosterhoek (-AD), Theron 1931 (PRE).

---2530 (Lydenburg): Belfast district, Dullstroom, near dam (-AC), Strey 3430 (BM); Pilgrim's Rest district, Ceylon Forest Reserve, Hartebeestvlakte (-BA), Deall 2443 (PRE); Belfast district, near Tol (-CA), Stent s.n. sub PRE 5613 (PRE).

---2627 (Potchefstroom): Carletonville, A. Bailey Nature Reserve (-AD), Van Wyk 229 (PRE); Krugersdorp district,

W tpoortjie Kloof (-BB), Heatley & Moss sub Moss 2772 (J, K); Potchefstroom, Mooi River (-CA), Nelson 72 (K).

---2628 (Johannesburg): Johannesburg, Houghton Estate (-AA), Moss 5235 (J).

---2630 (Carolina): Ermelo district, Chrissiemeer (-AC), Theron 2403 (PRE).

---2730 (Vryheid): Wakkerstroom (-AC), Beeton 54 (PRE); Wakkerstroom district, Oshoek Farm (-AD), Reid 1187 (J, PRE).

O.F.S.---2828 (Bethlehem): Bethlehem district, Golden Gate Highlands National Park, at Golden Gate (-BC), Liebenberg 7008 (PRE).

SWAZILAND.---2631 (Mbabane): Mbabane district, Forbes Reef road (-AC), Compton 30266 (NBG, PRE).

NATAL.---2732 (Ubombo): Ngwavuma district, Kosi system, Sihadla (-BB), Ward 10050 (BUDW); Ubombo district, north-eastern St. Lucia Sytem, Pukwini (-DC), Ward 8094 (BUDW, NU, PRE).

---2828 (Bethlehem): Bergville district, Royal Natal National Park, Rugged Glen (-DB), Browning 256 (NU, PRE).

---2829 (Harrismith): Bergville district, Cathedral Peak Forest Reserve (-CC), Killick 991 (NH, NU, PRE).

---2832 (Mtubatuba): Hlabisa district, St. Lucia eastern shores south of Tewate (-AB), Taylor 422 (NH); Hlabisa district, Dukuduku East (-AD), Ward 5080 (BUDW, PRE); Lower Umfolozi district, Richards Bay (-CC), Ward 716 (BUDW, NU).

---2929 (Underberg): Estcourt district, Champagne Castle

(-AB), Mecbold 14386 (B); Estcourt district, Thabamhlope Research Station (-BA), Gordon-Gray 5013 (NU); Estcourt district, Broadmoor Farm (-BB), Downing 228 (NU); Mooi River district, Highmoor Forest Station, south of Giant's Castle (-BC), Smook 1057 (MO, PRE); Underberg district, Cobham Forest Reserve, Sipongweni (-CB), Hilliard & Burtt 13976 (NU, PRE); Underberg district, Drakensberg Garden Hotel, path to Rhino Peak (-CC), Goetghebeur 4505 (PRE).

---2930 (Pietermaritzburg): Durban district, Isipingo Beach (-DD), Ward 1221 (BUDW, NU).

---3029 (Kokstad): East Griqualand, Vaal Bank Farm (-CB), Haygarth s.n. sub Medley Wood 4201 (BOL, K, NH).

LESOTHO.---2828 (Bethlehem): Butha Buthe district, Tsehlanyane, Oxbow (-CC), Roberts 5310 (PRE); Oxbow, Agricultural Camp (-DC), Williamson 390 (K); Butha Buthe district, Namahali Camp B (-DD), Lubke 298 (NH, PRE).

---2928 (Marakabei): Little Bokong (-AA), Jacot Guillarmod 128 (PRE).

---2929 (Underberg): Sehlabathebe National Park, east of administration and research centre (-CC), Hoener 1464 (PRE).

CAPE.---3027 (Lady Grey): Barkly East district, Wittebergen, Ben MacDhui (-DB), Galpin 6881 (BOL, PRE).

---3028 (Matatiele): Barkly East district, Naudes Nek Pass, 28 km east of Rhodes near top of pass (-CA), Reid 1210 (J, PRE).

---3226 (Fort Beaufort): Cathcart district, Hogsback, Auckland Forest Reserve, near forestry offices (-DB), Reid

1205 (J, PRE).

---3227 (Stutterheim): Cathcart district, Toise River (-AD), Hilner 521 (GRA, PRE).

---3418 (Simon's Town): Simon's Town district, Cape Peninsula, Lakeside (-AB), Levyns 7120 (B, BOL).

---3423 (Knysna): Knysna (-AA), Martin 4232 (K).

TRANSKEI.---3028 (Matatiele): Ongeluks Nek (-AD), Hilliard & Burtt 18689 (NU).

---3129 (Port St. Johns): Port St. Johns (-DA), Wager s.n. sub PRE 39183 (PRE).

---3228 (Butterworth): Centani (-CB), Pegler 151 (PRE).

13. Carex acutiformis Ehrh. in Beitrage zur Naturkunde 4: 43 (1789); Boeck.: 289 (1877); C.B.Cl.: 679 (1894); C.B.Cl.: 307 (1898); Kuekenth.: 733 (1909); Schoenl.: 69 (1922). Type fide Cufod.: 1490 (1971): Europe, "in paludosis Brunvico-Lunebergensis", Ehrhart s.n. (not seen).

[C. paludosa auct. non Good.: Kunth: 487 (1837).]

Plants 450--800 mm tall, caespitose, with tufts connected by long rhizomes. Rhizomes very short within tufts, long between tufts, 5 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves glaucous, mid-green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths becoming spongy; inner face splitting into connected fibrillae. Largest basal leaf blade 550 X 5--10 mm, flat or plicate in cross-section; adaxial surface glabrous; abaxial surface papillate; margins proximally glabrous, distally minutely scabrid. Lowest culm leaf: sheath mouth concave, herbaceous; ligule 14 mm high, whitish, stramineous, or fuscous, membranous, apex acute. Culms sharply triangular in cross-section, 2--3 mm in diameter; uppermost internode very long, the lower all more-or-less basal, very short, concealed by leaf sheaths. Inflorescence a raceme of spikes, 130--400 mm long. Basal inflorescence bract leaf-like, not reflexed near base of blade at maturity, not sheathing; blades 140--570 mm long; opposing bracteole tubular, membranous, usually concealed by

bract sheath. Primary inflorescence units 1 from each node. Spikes 5--7, erect or suberect, not clustered, excepting frequently apical 2--3 (usually staminate) spikes; the largest 300--800 X 4--8 mm. Longest peduncle exserted by 0--50 mm, scabrid on angles. Apical spikes usually staminate. Staminate spikes 1--3. Pistillate spikes (1--)3(--4). Bisexual spikes 0--2. Small accessory spikes not present. Bracts of staminate spikelets extremely dimorphic. Anthers 2,5--4,0 mm long. Bracts of pistillate spikelets lanceolate, 3,0--5,5 mm X 0,6--1,2 mm, longer and narrower than perigynium, ferruginous, glabrous, but ciliate distally on margin; carina broad, 3-nerved; apex acuminate or emarginate, awned; awn 1,3--3,0 mm long, margin scabrid. Mature perigynium suberect, stipitate, without a basal callus, rostrate, 3--4 X 1,6--2,0 mm, triangular in cross-section, not inflated, greyish green with rostrum whitish, base without a layer of corky material, cartilaginous, papillate, with hollow papillae; nerves conspicuous, many (more than 10); rostrum abrupt, 0,8--1,0 mm long, straight, margin not winged, glabrous; apex shallowly bidentate, apical teeth 0,3 mm long. Rhachilla absent from perigynia. Style base straight; stigmas 3. Mature nutlet obovate, not clawed, 1,7--2,0 X 1,2--1,5 mm, triangular in cross-section, yellowish-brown, glabrous.

In southern Africa this species flowers and fruits from August to April. The plants grow in full sun, in perennially

waterlogged marshland, on dolomite-derived, or clay or loam substratum. The species occurs in areas receiving rainfall in summer or in all seasons, in the midlands, in montane areas, on the alpine plateau, and in the interior, in southern Transvaal, Orange Free State, Natal, Lesotho, southern and eastern Cape Province, and Transkei. Map 14. It is common and widespread in Europe and Asia, also in North Africa (Algeria) and East Africa (Tanzania); it is also recorded from North America.

In Britain the common name for this species is "Lesser Pond Sedge". The specific epithet probably refers to the shape of the rostrum, although it is not particularly acute when compared with other species. No attempt was made to trace type material because it is felt that the problem is better left to European systematists, but according to Stafleu and Cowan (p. 731, 1976) the holotype is very likely to be in MW, or possibly LE, LINN or UPS.

C. acutiformis is a very distinctive marshland species, with its dark, erect inflorescences, the sessile individual spikes and the sheathless bracts. Other distinctive features are the extremely dimorphic bracts of the staminate spikelets, and the old basal leaf sheaths being markedly spongy due to large air cavities. At a young stage of inflorescence development the species is especially distinctive as the staminate apical spikes are very much shorter and thicker than the immature pistillate spikes. The

species is related to the common European species C. riparia Curt. (which is also recorded from Algeria in North Africa), an altogether stouter species in which the bracts of the staminate spikelets are homomorphic, being scarcely distinguishable from those of the pistillate spikelets (Jermy & Tutin, 1968).

The growth habit of C. acutiformis, although unusual among the southern African species, is in fact fairly common in large marshland species (Bernard, 1990). This growth habit, in which the plants produce both long and short rhizomes, results in a so-called tiller clump.

On one specimen (Devenish 682) the collector reports that the species is unpalatable to livestock, except possibly when the foliage is very young. On the farm the plants are cut for bedding and for waterproofing for the tops of haystacks.

**SELECTED CITATIONS**

TRANSVAAL.---2525 (Mafeking): Marico district, banks of the Matebe River (-BD), Holub 1558 (K).

---2527 (Rustenburg): Rustenburg district, Uitkomst 499 JQ Farm (-DD), Coetzee 275 (PRE).

---2528 (Pretoria): Near Pretoria (-CA), Moss 2322 (J, K); Pretoria, Fountains Valley (-CC), Repton 1102 (PRE); Pretoria district, Rietvlei Dam 12 miles south-east of Pretoria (-CD), Codd 3189 (BM, PRE).

---2627 (Potchefstroom): Potchefstroom district,

Gerrardminnebronoog Farm (-AC), Reid 1367 (J, PRE); Krugersdorp district, Witpoortjie Kloof (-BB), Moss 2325 (J); Potchefstroom, University Botanical Garden (natural) (-CA), Ubbink 698 (PRE).

---2628 (Johannesburg): Germiston district, Elsburg (-AA), Schlechter 3541 (Z).

---2730 (Vryheid): Wakkerstroom district, Oshoek Farm (-AD), Devenish 682 (BM, K, PRE).

O.F.S.---2828 (Bethlehem): Bethlehem district, Golden Gate Highland National Park, near Glen Reenen House (-BC), Liebenberg 7319 (K, PRE).

NATAL.---2828 (Bethlehem): Bergville district, Royal Natal National Park, Rugged Glen, below dam (-DB), Browning 245 (NU, PRE).

---2829 (Harrismith): Bergville district, Drakensberg, Cathedral area, Baboon slopes (-CC), Schelpe 871 (NH, NU).

---2929 (Underberg): Estcourt district, Champagne Castle (-AB), Meebold 14387 (B); Estcourt district, Giant's Castle Game Reserve (-AD), Ward 6965 (BUDW, NU, PRE); Estcourt district, Thabamhlope Research Station (-BA), West 827 (PRE); Estcourt district, foot of Griffins Hill (-BB), Acocks 10691 (PRE); Lions River district, Umgeni Poort Farm (-BD), Moll 1381 (NU, PRE); Underberg district, Drakensberg, Umzimkulu River Valley (-CA), Small 8 (PRE); Polela district, Glengariff Farm (-DC), Rennie 1347 (NU).

---2930 (Pietermaritzburg): Lions River district, near Howick, Shafton Farm (-AD), Hutton 145 (BM, GRA); Umvoti

district, Greytown (-B[illegible]), Meebold 14391 (B).

---3029 (Kokstad): East [illegible]qualand, Kokstad (-CB), Tyson 1837 (BOL, PRE, SAM).

---3030 (Port Shepstone): Umzinto district, Dumisa Station, Campbellton Farm (-AD), Rudatis s.n. sub STEU 2142 (STE).

LESOTHO.---2828 (Bethlehem): Leribe (-CC), Dieterlen 601 (SAM).

---2927 (Maseru): Bushman's Pass (-BD), Schmitz 7911 (PRE); Likhoele, Ntsana-Talana (-CD), Dieterlen 1158 (PRE); Maseru district, Makhaleng - Nyakasoba road, on top of pass (-DB), Jacot Guillarmod 5701 (PRE).

---2929 (Underberg): Sehlabathebe National Park, northern edge of Maal Cof (-CC), Hoener 1627 (K, MO, NU, PRE).

CAPE.---3027 (Lady Grey): Barkly East district, Witteberg, Bedgelert Farm (-DA), Hilliard & Burtt 14641 (NU, PRE); Barkly East district, near New England, Abo Farm (-DC), Joubert s.n. sub PRE 19181 (PRE).

---3123 (Victoria West): Murraysburg (-DD), Tyson 580 (GRA).

---3223 (Rietbron): Murraysburg district, Sneeuwberg, Koudeveld Mt. (-BB), Tyson 242 (BOL).

---3225 (Somerset East): Somerset East district, Boschberg Mt. (-DA), MacOwan 1963 (K, SAM).

---3226 (Fort Beaufort): Cathcart district, Fairford Farm (-BD), Cotterrell 1 (GRA); Cathcart district, Amatole Mts., below Gaika's Kop (-DB), Furness & Phillipson 86 (MO).

---3320 (Montagu): Montagu district, Baden (-CA), Levyns 7936 (BOL).

---3422 (Mossel Bay): Knysna district, Groenvlei (-BB), Van [illegible] Merwe 2377 (PRE).

TRANSKEI.---3027 (Lady Grey): Herschel district, [illegible]terkspruit Farm (-CB), He[illegible]n 163 (GRA).

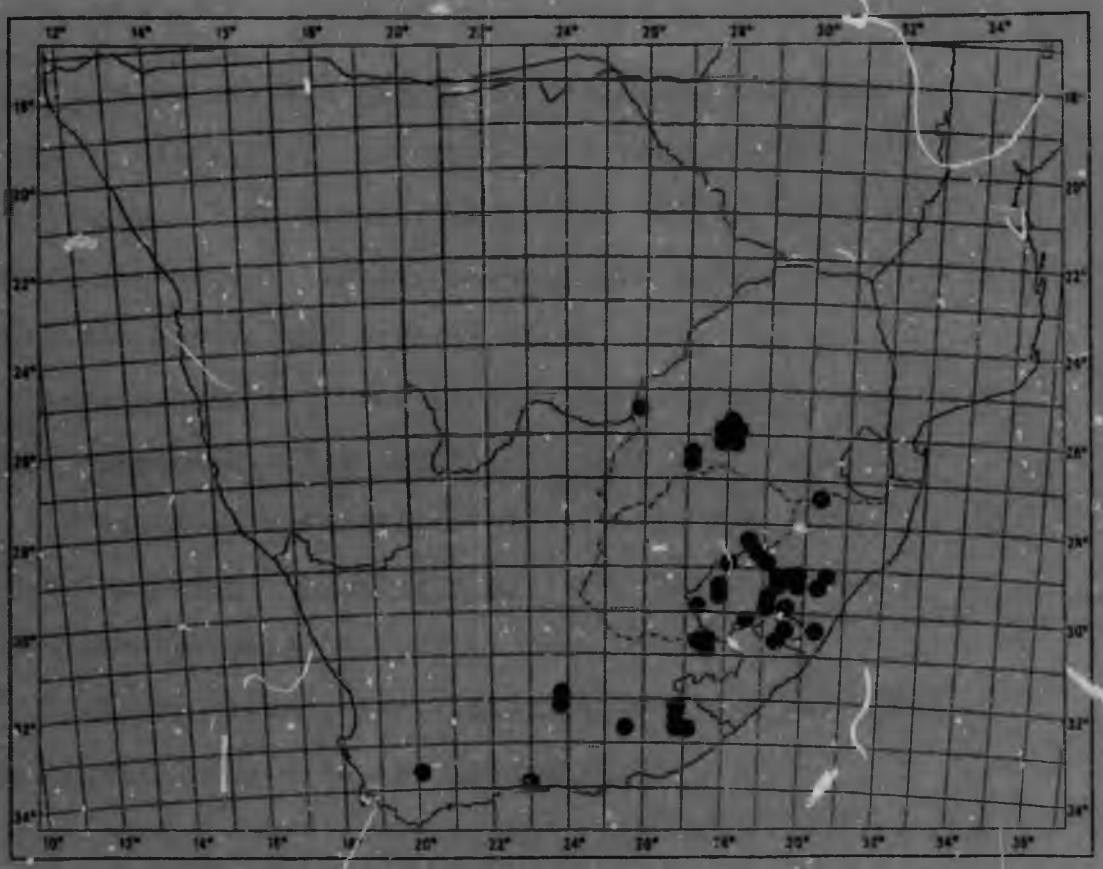
---3028 (Matatiele): Belfort (-BA), Jacottet & Jacottet 422-3515 (Z).

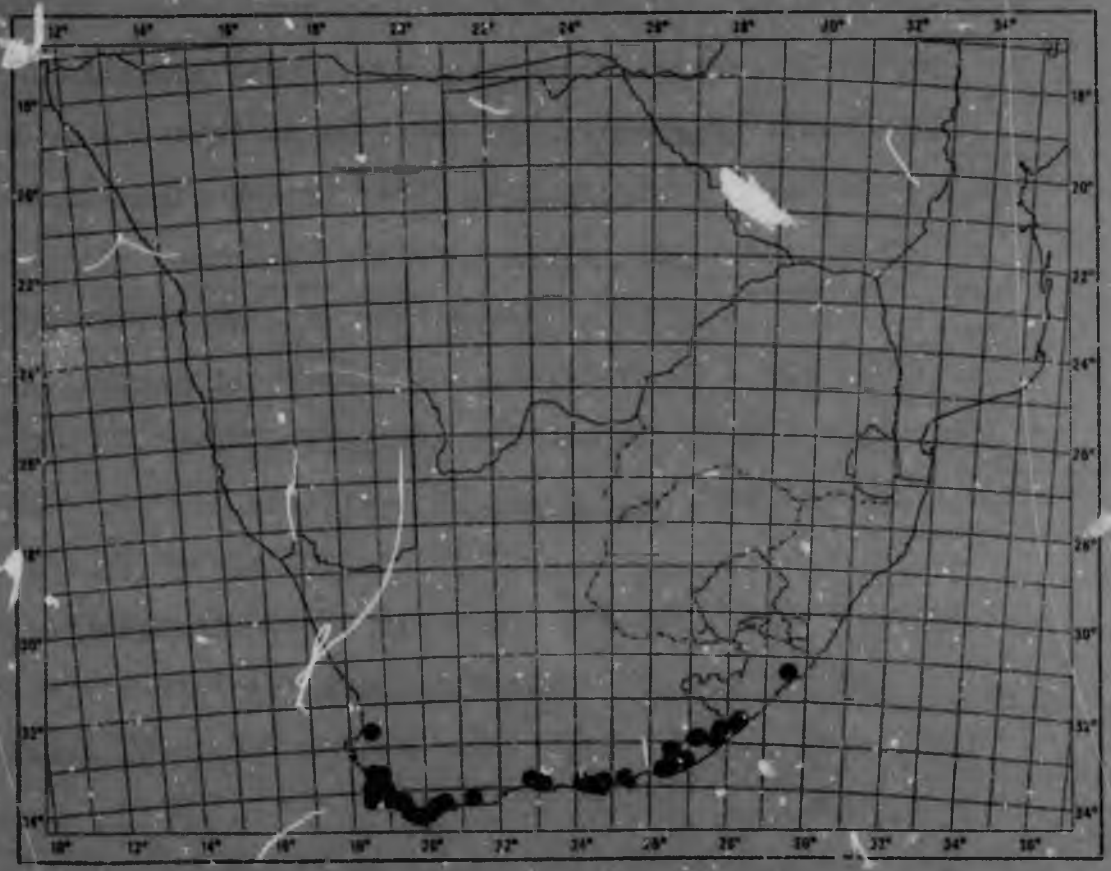
---3029 (Kokstad): La[illegible]gewacht (-BC), Strey 10552 (BUDW, NH, [illegible]U, PRE).

CISKEI.---3227 (Stutterheim): Keiskammahoek district, Keiskamma River banks (-CA), Acocks 9099 (PRE).

Map 14. (Opposite above): Distribution of Carex [illegible]ormis Ehrh. in southern Africa.

Map 15. (Opposite below): Distribution of Carex clavata Thunb. in southern Africa.





14. Carex clavata Thunb. in Prodromus Plantarum Capensium: 14 (1794); Schkuhr: 55 (1806); Thunb.: 341 (1811); Thunb.: 90 (1823); Nees: 535 (1832); Nees: 204 (1836); Kunth: 495 (1837); Steud.: 287 (1840); Kunze: 67 t. 17 (1840); Boott: 183 (1867); Boeck.: 298 (1877); C.B. Cl.: 681 (1894); C.B. Cl.: 309 (1898); Bolus & Wolley-Dod: 356 (1904); Kuekenth.: 736 (1909); Schoenl.: 69 (1922); Levyns: 131 (1950); Bond & Goldblatt: 38 (1984). Type: Cape, without precise locality, Thunberg s.n. (UPS, holo., --PRE, microfiche No. 21788!).

C. clavata Thunb. var. latifolia Willd.: 267 (1805), nom. superfl. Type: As for C. clavata.

C. clavata Thunb. var. cylindracea Wahlenb.: 151 (1803). Type: Cape, without precise locality, Thunberg s.n. (not seen).

C. clavata Thunb. var. triticea Wahlenb.: 151 (1803). Type: Cultivated in Belgium, Kallstrom s.n. (not seen).

C. clavata Thunb. var. campylostachya Nees: 204 (1836). Type: Cape, Seaview, Ecklon & Zeyher 121 (NBG!, PRE!; specimens in BOL!, S! excluded).

C. vesicaria Thunb.: 14 (1794); Thunb.: 342 (1811); Thunb.: 90 (1823), nom. illeg., non L. (1753). Type: Cape, without precise locality, Thunberg s.n. (UPS, holo., --PRE, microfiche No. 21950!).

C. lutensis Kunth: 487 (1837); Steud.: 292 (1840); C.B. Cl.: 692 (1894) (as species dubium). C. clavata Thunb. forma lutensis (Kurth) Kuekenth.: 737 (1909). Type: Cape, near

Paarl Mt., Drège 1563 (B, holo.†; P, lecto.!, designated here, --PRE, photo.!; BM!, K!, S!, TCD!).

C. macrocystis Boeck.: 50 (1888); C.B. Cl.: 687 (1894) (tentatively as syn. of C. clavata). Type: Prmont. bon. Spei, Ecklon & Zeyher s.n. (B, holo.†).

C. aethiopica Schkuhr v.r. latispica C.B. Cl.: 308 (1898), syn. nov. (tentative). Syntypes: Cape, Kaffir Drift, Burchell 3869 (not found); Cape, Bothas Hill, MacOwan 1013 (K, --PRE, photo.!; BOL! GRA!, S!, Z!).

[C. aethiopica auct. non Schkuhr: Nees: 536 (1832).]

Plants (410)--1700 mm tall, caespitose. Rhizomes very short, 3--5 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves glaucous, yellow-green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face simply splitting. Largest basal leaf blade 300--500 X 6--11 mm, plicate in cross-section; adaxial surface glabrous; abaxial surface papillate; margins proximally papillate, distally scabrid. Lowest culm leaf: sheath mouth concave, membranous; ligule 35 mm high, whitish with ferruginous spots, membranous, apex acute. Culms triangular in cross-section, 1,5--3,0 mm in diameter; internodes all of about equal length, exposed; (0)--2 nodes exposed. Inflorescence comprising a raceme of spikes, 115--650 mm long. Basal inflorescence bract leaf-like, not reflexed near base of

blade at maturity; sheaths 23--90 mm long; blades 110--350 mm long; opposing bracteole tubular, membranous, usually concealed by bract sheath. Primary inflorescence units 1 from each node. Spikes (3)--6, erect or suberect, not clustered, excepting frequently apical 2--3 (usually staminate) spikes; the largest 30--100 X 10--15 mm. Longest peduncle exserted by 0--45 mm, scabrid on angles. Apical spikes usually staminate. Staminate spikes 1--3. Pistillate spikes 1--4. Bisexual spikes 0--3. Small accessory spikes occasionally present at base of basal pistillate spikes. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 3,0--5,5 mm long. Bracts of pistillate spikelets ovate-lanceolate, 5--6 mm long, 1,9--4,0 mm wide, shorter and narrower than perigynium, stramineous with light to heavy ferruginous striae and hyaline margins, glabrous, but ciliate distally on margin; carina broad, 3-nerved; apex acuminate, or emarginate, awned; awn 0,7-2,0 mm long, margin scabrid. Mature perigynium spreading, not stipitate, without a basal callus, rostrate, 6--7 X 2,5--3,0 mm, shallowly triangular in cross-section, much inflated, green, or stramineous with ferruginous spots, base without a layer of corky material, cartilaginous, glabrous; nerves conspicuous, many (more than 10); rostrum abrupt, or sometimes tapered, 1,0--1,5 mm long, straight; rostrum margin not winged, scabrid; rostrum apex deeply bidentate, apical teeth 0,5--1,0 mm long. Rhachilla absent from perigynia. Style base slightly bent, or straight; stigmas 3. Mature nutlet

obovate, narrowly clawed, 2,8--3,5 X 1,7--2,5 mm, triangular in cross-section, fuscous with lighter angles, minutely papillose.

This species flowers and fruits from August to January. The plants grow in full sun, in perennially waterlogged marshland, on clay or loam substratum. The species occurs in areas receiving rainfall in winter and in all seasons, at sea level and near the coast, in south-western, southern and eastern Cape Province and Transkei. Map 15. Endemic to the southern coast.

The specific epithet describes the shape of the spikes at a particular stage of development. There is a Thunberg specimen in S that is possibly an isotype of C. clavata, but some uncertainty exists due to the characteristic lack of information on the specimen. Many holotypes of the synonyms listed above viz. those described by Boeckeler, Kunth and Nees may have been housed in B according to Stafleu and Cowan (p. 246, 1976, p. 693, 1979 & p. 706, 1981 respectively) and thus have been destroyed. There is definite evidence relating to the type of C. macrocystis, which was previously housed in BREM, according to Boeckeler (1888). The herbarium was donated to B in 1915 (Stafleu & Cowan, p. 444, 1981) and has been destroyed. Wahlenberg's holotypes are likely to be in SBT, according to Stafleu and Cowan (p. 17, 1988).

Typification of C. clavata var. campylostachya Nees presents an interesting problem, as labels and specimens of two collections appear to have been mixed. These are Ecklon and Zeyher 121 from Sea View near Cape Recife, the type of C. clavata var. campylostachya, and Zeyher 4443 From Van Stadensberg, which is undoubtedly C. aethiopica. In some herbaria these labels are definitely attached to the wrong specimens; an indication that this has occurred is provided by a sheet in NBG, which has both specimens mounted on the same sheet, with the original labels attached to the plants so that there is no doubt about their identity. With other duplicates these labels could have become separated from specimens during transit.

C. aethiopica var. latispica C.B. Cl. is tentatively placed as a synonym of C. clavata. Unfortunately all of the material seen of MacOwan 1013 is very young and mostly incomplete. The spikes are however, short, thick and erect as in C. clavata. but the specimen in S (which has the basal parts present) has quite a large tinge of anthocyanin colouration. This taxon has not been recollected during the present investigation. The possibility exists that it is a hybrid between C. clavata and C. aethiopica.
Lectotypification of this name has not been attempted, because it is necessary to locate and examine the Burchell specimen, primarily to ensure that the name is not based upon two different taxa.

C. clavata is probably not closely related to C. aethiopica Schkuhr, but Nees (1832) considered the two species to be synonymous. More recently Clarke's key (1898) utilized inadequate characters to separate the two species and has caused confusion, although the habitats differ (C. clavata prefers open marshland and C. aethiopica forest margins) and C. clavata does not develop anthocyanin colouration of the leaf sheath bases. Other important differences in inflorescence and perigynium characters (see discussion under C. aethiopica) serve to distinguish the two species.

SELECTED CITATIONS

CAPE.---3218 (Clanwilliam): Clanwilliam district, Bergvalley (-DA), Ecklon & Zeyher 120 (MO, PRE).
---3227 (Stutterheim): King William's Town district, 4 miles west of King William's Town, Orange Grove Farm (-CD), Hilner 131 (GRA, PRE); Komga district, near Komga (-DB), Flanagan 1007 (BOL, GRA, PRE).
---3228 (Butterworth): Komga district, Kei Mouth (-CB), Arnold 554 (PRE).
---3318 (Cape Town): Malmesbury district, foot of Mamre Hills (-AD), Henderson 1857 (NBG); Malmesbury district, Groene Kloof (Mamre) (-CB), Drège 1583 (K, P, S); Cape Town, Bishopscourt (-CD), Pillans 10880 (MO); Paarl district, Paarl Mts. (-DB) Drège 1563 (BM, K, P, S, TCD); Bellville district, Sarepta (-DC), Acocks 1051 (PRE); Stellenbosch

district, Idas Valley (-DD), Parker 4355 (BOL, MO, NBG).

---3322 (Oudtshoorn): George district, above eastern arm of Swartvlei (-DD), Reid 1147 (J, PRE).

---3324 (Steytlerville): Humansdorp district, station 9 miles from Humansdorp on Hankey road (-DD), Fourcade 4902 (BOL, STE).

---3325 (Port Elizabeth): Port Elizabeth district, Kraggakamma Farm (-CD), Ecklon s.n. (S); Port Elizabeth, on road to Walmer at robot (-DC), Arnold 641 (PRE).

---3326 (Grahamstown): Albany district, Brakkloof Farm (-BA), White 127 (GRA); Albany district, Blaauwkrantz (-BC), Hilner 73 (GRA); Bathurst district, Martindale (-BD), Salisbury s.n. (GRA); Alexandria district, De Kol, Longvale (-CB), Gant & Gant 38 (GRA); Bathurst district, at the source of the Kasuga River (-DA), Burchell 3904 (K).

---3327 (Peddie): East London district, 11 miles west of East London, Overton Farm (-BB), Hilner 172 (GRA, PRE); Bathurst district, coast between Kleinemonde and Fish Rivers (-CA), MacOwan 1343 (BOL).

---3418 (Simon's Town): Simon's Town district, Cape Peninsula, Noordhoek Vlei in vicinity of new shopping complex (-AB), Reid 1129 (J, PRE); Simon's Town district, Cape of Good Hope Nature Reserve, near Brightwater (-AD), Sniiman 389 (NBG, PRE); Hottentot's Holland Mts. (-BB), Hafstrom & Lindeberg s.n. (S); Caledon district, Rooi Els (-BD), Compton 17517 (NBG).

---3419 (Caledon): Hermanus district, Rietfontein, Westcliff

(-AC), Williams 753 (MO); Caledon district, Mossel River shore (-AD), Compton 23626 (NBG); Hermanus district, Gansbaai, Baviaansfontein Farm (-CB), Stokoe 8101 (BOL, PRE); Bredasdorp district, Elim (-DB), Schlechter 9665 (BM, MO, PRE, S, Z).

---3420 (Bredasdorp): Swellendam district, below Hamerkop on road to Cape Infanta (-BC), Levyns 8390 (BOL); Bredasdorp district, The Poort (-CA), Acocks 2528 (S).

---3421 (Riversdale): Riversdale district, Stil Bay, Riethuiskraal Farm (-AD), Bohnen 4853 (PRE, STE).

---3423 (Knysna): Knysna Heads West (-AA), Schoenland 3380 (GRA, PRE).

---3424 (Humansdorp): Humansdorp district, Witte Els Bosch, sea shore (-AA), Fourcade 4895 (BOL); Humansdorp district, Slang River (-BA), Fourcade 1832 (BOL); Humansdorp (-BB), Galpin 4843 (GRA, PRE).

---3425 (Port Elizabeth): Port Elizabeth district, near Sea View at Cape Receif (-BA), Ecklon & Zeyher 912 (S).

TRANSKEI.---3129 (Port St. Johns): Port St. Johns (-DA), Moss 5525 (J).

---3228 (Butterworth): Centani district, Qolora Mouth (-CB), Wager s.n. (NH); Centani district, Kobongaba (-DA), Taylor 3566 (NBG).

CISKEI.---3227 (Stutterheim): King William's Town district, Pirie (-CC), Sim 928 (NU).

**15. Carex subinflata** Nelmes in Kew Bull. 1940: 270 (1941c). Type: Cape, Barkly East, Doodman's Krans, Gaipin 6882 (K, holo., --PRE, photo.!; BOL!, GRA!, NH!, PRE!).

C. clavata auctt. non Thunb.: C.B. Cl.: 681 (1894); C.B. Cl.: 309 (1898); Kuekenth.: 736 (1909), p.p.

Plants 285--900 mm tall, caespitose. Rhizomes very short, 2,5--3,0 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves glaucous, mid-green, usually without conspicuous transverse venation. Basal leaf sheaths folded, old sheaths not becoming spongy; inner face tearing into membranous strips. Largest basal leaf blade 220 X 6--10 mm, flat or plicate in cross-section; adaxial surface glabrous; abaxial surface papillate; margins proximally papillate, distally scabrid. Lowest culm leaf: sheath mouth concave, membranous; ligule 35(--45) mm high, whitish with ferruginous spots, membranous, apex acute. Culms triangular in cross-section, 1,5--2,0 mm in diameter; internodes all of about equal length, exposed; 2--3 nodes exposed. Inflorescence a raceme of spikes, 65--110 mm long. Basal inflorescence bract leaf-like, not reflexed near base of blade at maturity; sheaths 15--25 mm long; blades 60--165 mm long; opposing bracteole tubular, membranous, usually concealed by bract sheath. Primary inflorescence units 1 from each node. Spikes 4--6, erect or suberect, not clustered, excepting frequently apical 2--3 (usually

staminate) spikes; the largest 20--40 X 9--11 mm. Longest peduncle exserted by 0--23 mm, scabrid on angles. Apical spikes usually staminate. Staminate spikes 1--2. Pistillate spikes 3--5. Bisexual spikes 0--2. Small accessory spikes occasionally present at base of basal pistillate spikes. Bracts of staminate spikelets not or only slightly dimorphic. Anthers 2,5--3,2 mm long. Bracts of pistillate spikelets broadly ovate, 3,5--5,0 X 1,5--2,5 mm, shorter and narrower than mature perigynium, ferruginous, glabrous; carina broad, 3-nerved; apex usually emarginate, shortly awned; awn 0,5--1,0 mm long, margin scabrid. Mature perigynium spreading (usually), or reflexed, stipitate, without a basal callus, rostrate, 4--6 X 1,2--2,5 mm, elliptic or rotund in cross-section, much inflated ("hump-backed"), green, or stramineous, with or without ferruginous spots, base without a layer of corky material, cartilaginous, glabrous, nerves conspicuous, many (more than 10); rostrum abrupt, 1,0--1,2 mm long, straight, margin not winged, glabrous; rostrum apex shallowly bidentate, apical teeth 0,3--0,6 mm long. Rhachilla absent from perigynia. Style base slightly bent, or straight; stigmas 3. Mature nutlet obovate, not clawed, 2,2--2,8 X 1,2--1,8 mm, triangular in cross-section, fuscous with lighter angles, minutely papillose.

This species flowers and fruits from November to January. The plants grow in full sun, in seasonally waterlogged wet flushes, or riparian situations, on basaltic

substratum. The species occurs in areas receiving rainfall in summer, in the midlands, montane areas and on the alpine plateau, in Natal, Lesotho, and eastern Cape Province. Map 16. Endemic to this region.

The specific epithet describes the inflated condition of the perigynia. (The epithet "inflata" was pre-empted by C. inflata Huds. (1762) (= C. vesicaria L.).)

C. subinflata is a very distinctive species, with its short, suberect spikes and short, ferruginous bracts subtending the pistillate spikelets, which contrast with the greenish, inflated ("hump-backed") perigynia. It is possibly related, although not closely, to C. clavata Thunb., with which it shares the character states of glaucous, papillate leaves, and small accessory spikes sometimes being present at the base of the basal pistillate spikes. It is however, a smaller species in all respects and has a very different habitat from that of C. clavata. The shape and texture of the perigynia are also markedly different.

SELECTED CITATIONS

NATAL.---2929 (Underberg): Estcourt district, Bushmans River Valley near Estcourt (-BB), Acocks 9976 (NH, PRE). ---2930 (Pietermaritzburg): Umvoti district, near Greytown (-BA), Buchanan 167 (K).

LESOTHO.---2828 (Bethlehem): Leribe district, Malaoaneng (-CC), Dieterlen 1234 (NBG, PRE); Near Oxbow Lodge, 1 km

past on Mokhotlong road (-DC), Roux 1321 (NBG, PRE); Butha Buthe district. Namahali Camp B (-DD), Lubke 299 (PRE).

---2927 (Maseru): Maseru district, Bushman's Pass (-BD), Hilliard & Burtt 12125 (NU).

---2928 (Marakabei): Orange River Valley, 26 km from Taung, between Mashai and Sehonghong (-DB), Killick 4299 (PRE).

---2929 (Underberg): Mokhotlong (-AC), Compton 21549 (NBG); Bushmans Nek Pass near Underberg (-CC), Werdermann & Oberdieck 1543 (B, PRE).

CAPE.---3027 (Lady Grey): Barkly East district, Ben MacDhui (-DB), Hilliard & Burtt 16512 (NU).

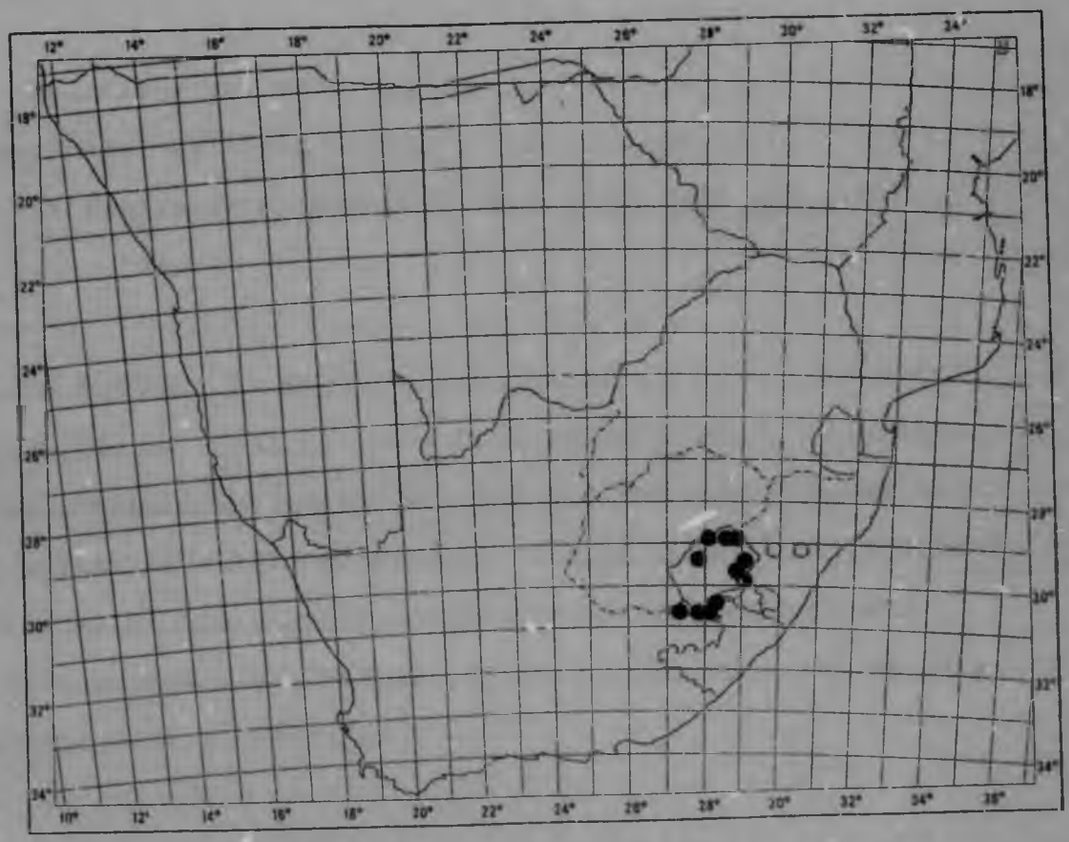
---3028 (Matatiele): Barkly East district, 8 km from Naudes Nek Pass on track to police post and Ben MacDhui (-CA), Reid 1212 (J, PRE).

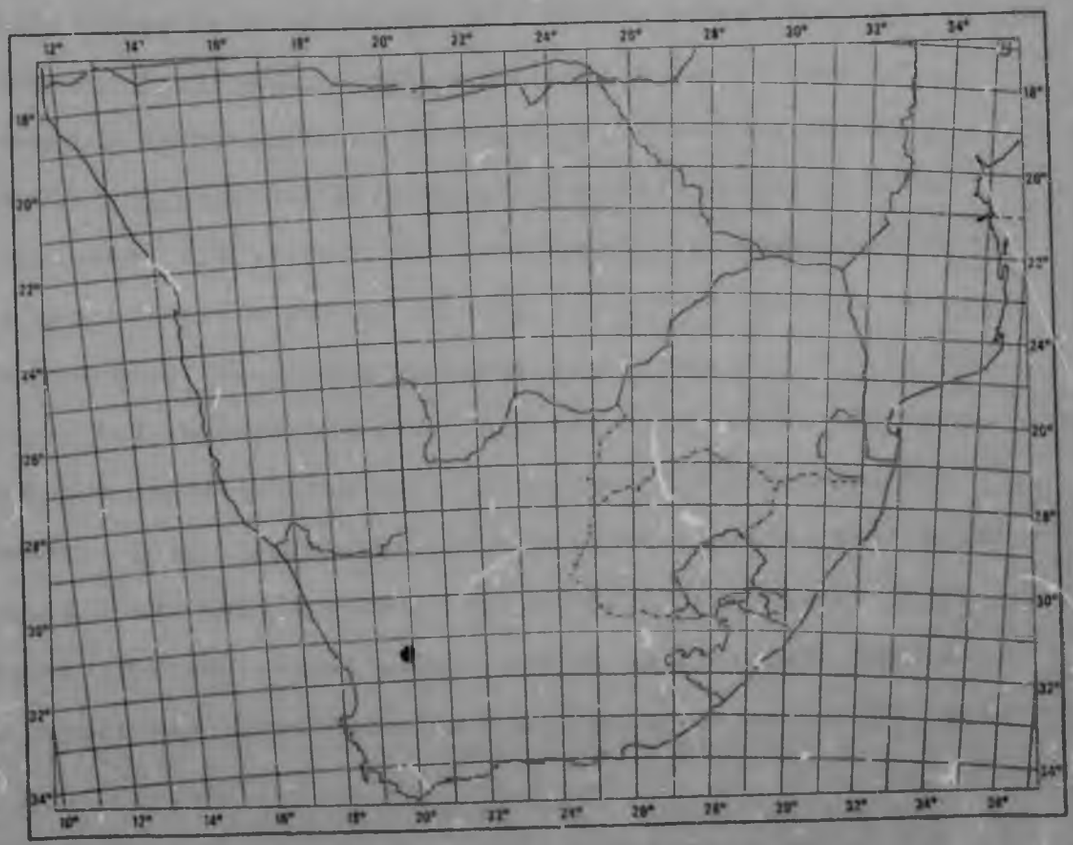
TRANSKEI.---3027 (Lady Grey): Herschel district, Sterkspruit Farm (-CB), Hepburn 292 (GRA).

---3028 (Matatiele): Ongeluks Nek (-AD), Hilliard & Burtt 18688 (PRE, S).

Map 16. (Opposite above): Distribution of Carex subinflata Nelmes in southern Africa (dots). The open circles represent possible incorrect localities.

Map 17. (Opposite below): Distribution of Carex sp. nov. in southern Africa.





16. Carex sp. nov.

Type: Cape, Calvinia district, in vicinity of FM tower on top of Hantamsberg, Van Rhynshoek farm, Reid 1337 (PRE, holo.; J, iso.).

Carex acocksii C. Reid sp. nov. ad subgeneris Primocaricis Kuekenth. sectioni Petraeae Lang pertinentes C. filifolio Nutt. similis sed culmis ca. 460 mm (non 100--300 mm) altis et perigynio erostrato complanato 4 mm longo 2 mm lato haud inflato, glabro praeter trichomata pauca brevia conica versus apicem (non rostrato trigono 3 mm longo 1,6 mm lato inflato scabro) differt.

Plants about 460 mm tall (at flowering and fruiting time), caespitose. Rhizomes very short, 2,5--3,0 mm in diameter. Shoot scales and basal leaves not developing extensive anthocyanin colouration (or sometimes small patches). Leaves not glaucous, mid-green, usually without conspicuous transverse venation. Basal leaf sheaths tubular, old sheaths not becoming spongy; inner face tearing into membranous strips. Largest basal leaf blade 220 X 0,75 mm, channelled in cross-section; adaxial and abaxial surfaces glabrous; margins proximally glabrous, distally minutely scabrid. Lowest culm leaf: sheath mouth concave, membranous; ligule 1 mm high, fuscous, membranous, apex obtuse. Culms terete in cross-section, 0,8--1,2 mm in diameter; uppermost internode very long, the lower all more-or-less basal, very

short, concealed by leaf sheaths. Inflorescence unispicate, androgynous, 14--28 mm long; staminate part 2 mm in diameter, pistillate part 7 mm in diameter Basal inflorescence bract glume-like, not sheathing; blade 6--25 mm long. Bracts of staminate spikelets not or only slightly dimorphic. Bracts of pistillate spikelets obovate, 6 X 3,2 mm, longer and wider than the perigynium, golden-brown, with wide hyaline margins, glabrous; carina narrow, 1-nerved; apex cuspidate, awned or muticous; awn 0--0,5 mm long, margin sparsely scabrid. Mature perigynium suberect, not stipitate, without a basal callus, erostrate, 4 X 2 mm, narrowly elliptic in cross-section, not inflated, hyaline and golden brown, base without a layer of corky material, membranous, mainly glabrous, with a few short conical hairs near the distal end, nerves few (2 or 3) or inconspicuous. Rhachilla always present, adaxial to nutlet; rhachilla a large, flattened structure, with scabrid margins and obtuse apex. Style base straight; stigmas 3. Mature nutlet elliptic, not clawed, 4 X 2 mm, shallowly triangular in cross-section, yellowish-brown, glabrous.

This species flowers and fruits from October to November. The plants grow in light shade, in seasonally waterlogged situations, under sclerophyllous shrubs, on dolerite-derived substratum. The species occurs in areas receiving rainfall in winter, in the interior, in north-western Cape Province. Map 17. Endemic to this region.

This new species is apparently the sole representative of Subgenus Primocarex in southern Africa. It is currently known from only one locality (the Hantamsberg plateau near Calvinia), but should be searched for in similar habitats on nearby mountains. The culms appear to elongate subsequent to flowering, pushing up through the sclerophyllious shrubs under which they grow, presumably to aid dispersal of the fruits. These are possibly not water-dispersed, as the perigynia are not inflated.

This species is possibly most closely related to the American species C. filifolia Nutt., differing mainly in characters of the perigynium (in C. filifolia it is shortly rostrate, trigonous, 3 X 1,6 mm, somewhat inflated and scabrid; in the new species it is erostrate, flattened, 4 X 2 mm, not inflated and glabrous except for a few short conical hairs towards the apex). The relationship between these two species is difficult to explain as no other species of Section Petraeae is known to occur in Africa. Two members of the same Subgenus with similar overall morphology occur in Tropical Africa, C. monostachya A. Rich. in Ethiopia, Tanzania and Kenya, and C. runssoroensis K. Schum. in Uganda, Kenya and Zaire. They grow in alpine bogs and are very large plants, the latter especially producing very large "stilted" tussocks. It is proposed to name the species in honour of J.P.H. Acocks, the first collector of the taxon.

**SPECIMEN CITATION**

CAPE.---3119 (Calvinia): Calvinia district, Hantam Mts., flat dolerite top, in watercourse (-BD), Acocks 18638 (PRE).

## D. EXCLUDED TAXA

Carex bisexualis C.B. Cl.: 302 (1898) = Schoenoxiphium ecklonii Nees var. unisexuale Kuekenth.: 33 (1909).

Carex bolusii C.B. Cl.: 304 (1898) = Schoenoxiphium sparteum (Wahlenb.) C.B. Cl., according to Kukkonen: 823 (1983).

Carex buchananii (C.B. Cl.) C.B. Cl.: 305 (1898) = Schoenoxiphium rufum Nees, according to Kukkonen: 822 (1983).

Carex capensis Thunb.: 14 (1794) = Schoenoxiphium rufum Nees, according to C.B. Cl.: 298 (1898).

Carex capensis Schkuhr: 39 t. Bbbb fig. 183 (1806) = Schoenoxiphium ecklonii Nees var. unisexuale Kuekenth.: 33 (1909).

Carex dregeana Kunth: 511 (1837) = Schoenoxiphium sparteum (Wahlenb.) C.B. Cl.: Kuekenthal placed it in synonymy under Schoenoxiphium kunthianum Kuekenth.: 31 (1909) and Kukkonen: 823 (1983) reduced the latter to a synonym of S. sparteum.

Carex dregeana Kunth var. major C.B. Cl.: 303 (1898) = Schoenoxiphium sparteum (Wahlenb.) C.B. Cl. (same reason as for C. dregeana).

Carex esenbeckiana Boeck.: 103 (1876) = Schoenoxiphium lehmannii (Nees) Steud.: Kuckenthal placed it in synonymy under Schoenoxiphium sparteum (Wahlenb.) C.B. Cl. var. lehmannii (Nees) Kuekenth.: 32 (1909) and Kukkonen treated the latter at specific level: 823 (1983).

Carex esenbeckiana Boeck. var. elongata Boeck.: 371 (1876) = Schoenoxiphium sparteum (Wahlenb.) C.B. Cl., according to Kuekenth.: 31 (1909).

Carex indica Schkuhr: 37 (1801), non L. (1771) = Schoenoxiphium sparteum (Wahlenb.) C.B. Cl., according to Kuekenth.: 31 (1909).

Carex killickii Nelmes: 89 (1955b). Type: Lesotho, between Indumeni Dome and Castle Buttress, Killick 1848 (K, holo.!; CPF, NU!, PRE!). This = a Schoenoxiphium species, fide Kukkonen (pers. comm.).

Carex lanceus (Thunb.) Baill.: 341 (1893) = Schoenoxiphium lanceum (Thunb.) Kuekenth.: 30 (1909).

Carex poiretii Gmel.: 140 (1791) = Fuirena pubescens (Poir.) Kunth, according to Kuekenth.: 765 (1909).

Carex pubescens Poir.: 254 (1789) = Fuirena pubescens (Poir.) Kunth, according to Kuekenth.: 765 (1909).

Carex ramosa Schkuhr ms., noted by Nees: 533 (1832) and recorded in Kuekenthal as C. ramosa Eckl. ex Nees = Schoenoxiphium lanceum (Thunb.) Kuekenth.: 30 (1909).

Carex reflexa Dietr. ms., noted on some Ecklon and Zeyher sheets, and recorded in Index Kewensis as C. reflexa Dietr. ex Kunth = C. glomerabilis Krecz.

Carex rufa (Nees) Baill.: 340 (1893) = Schoenoxiphium rufum Nees, according to Kuekenth.: 30 (1909).

Carex schimperiana Boeck.: 373 (1876) = Schoenoxiphium sparteum (Wahlenb.) C.B. Cl., according to Kukkonen: 822 (1983).

Carex spartea Wahlenb.: 149 (1803) = Schoenoxiphium sparteum (Wahlenb.) C.B. Cl., according to Kuekenth.: 31 (1909).

Carex sprengelii (Nees) Boeck.: 371 (1876) = Schoenoxiphium sparteum (Wahlenb.) C.B. Cl., according to Kuekenth.: 31 (1909).

Carex uhligii K. Schum. ex C.B. Cl.: 73 (1908) = Schoenoxiphium lehmannii (Nees) Steud. according to Kukkonen: 823 (1983).

Carex zeyheri C.B. Cl.: 303 (1898) = Schoenoxiphium ecklonii Nees, according to Kuekenth.: 32 (1909).