A JOURNAL ON TAXONOMIC BOTANY, PLANT SOCIOLOGY AND ECOLOGY

REINWARDTIA

Published by
HERBARIUM BOGORIENSE
LEMBAGA BIOLOGI NASIONAL — LIPI
BOGOR, INDONESIA

Reinwardtia Vol. 9, Part 3, 225—375 17 May 1977

10 ISSN 0034—365X

KEINWARDTIA
Published by Herbarium Bogoriense — LBN, Bogor
Vol. 9, Part 3, pp. 225 — 375 (1977)

THE GENUS CYMBOPOGON SPRENGEL (GRAMINEAE)

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ABSTRACT

Morphological, anatomical, geographical and ecological data were utilized in a systematic study of the grass- genus *Cymbopogon.* The genus is largely confined to the Old World tropics and subtropics; *C. densiflorus* has become naturalized in the New World (Brazil) and *C. refractus* in the Pacific Islands. A taxonomic account is presented in which 55 species are recognized and placed in 5 series which have definite geographical distribution: ser. *Cymbopogon* (from West Africa to India), ser. *Rusae* (from Africa to Indo-China), ser. *Citrati* (Africa, Asia and Australia), ser. *Proceri* (Australia) and ser. *Refracti* (Australia). Ser. *Proceri* and ser. *Refracti* are described for the first time, as is *C. goeringii* var. *hongkongensis.* In this study three new combinations are proposed, one species is excluded from *Cymbopogon,* while two species and four varieties are considered of uncertain status because type material was not available. One natural hybrid between *C. bombycinus* and *C. ambiguus* is recognized. Full descriptions of species and key to the series and species are given. Two new chromosome counts of *C. procerus* and *C. bombycinus* were reported so that data are now available for 22 species, which are all on the polyploid series 2n = 20, 40, 60.

ABSTRAK

Marga *Cymbopogon* yang tersebar di daerah tropika dan subtropika kawasan dunia lama mencakup 55 jenis. Di antara jenis-jenis tersebut dua jenis bernaturalisasi di luar kawasannya, yaitu *C. densiflorus* (asli dari Afrika Tengah) di Brasilia dan *C. refractus* (asli dari Australia bagian Timur) di kepulauan Pasifik, sedang lima jenis ditanam orang di daerah-daerah tropika. Data-data morfologi, anatomi daun, daerah penyebaran dan daerah tempat tumbuh telah digunakan dalam merevisi marga ini. Berdasarkan sifat-sifat morfologinya 55 jenis tersebut digolong-golongkan menjadi 5 deret; yaitu ser. *Cymbopogon,* ser. *Rusae,* ser. *Citrati,* ser. *Proceri* dan ser. *Refracti.* Kedua nama yang terakhir merupakan takson baru. Selain itu satu varietas baru, tiga kombinasi baru, dan satu hibrid alami diusulkan. Pertelaan lengkap, daftar sinonim masing-masing jenis, kunci determinasi jenis-jenis serta beberapa gambar telah disajikan pula. Dua data baru jumlah kromosom telah ditambahkan kepada data-data 20 jenis yang sudah diketahui jumlah kromosomnya.

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ACKNOWLEDGEMENTS

This paper is based on a Ph.D. thesis prepared at Reading University under the supervision of Prof. V.H. Heywood and Dr. W.D. Clayton, to whom I am greatly indebted for their continuous advice, much needed help and encouragement. I would like to express my deep gratitude to Prof. V.H. Heywood (Chairman of the Department of Botany, University of Reading) and to Prof. J. Heslop-Harrison (Director of the Royal Botanic Gardens, Kew) for the use of research facilities in their respective institutions, where this work was executed during the period of October 1972 to June 1975. I am grateful to the Director of Rijksherbarium, Leiden, and the Director of Museum National d'Histoire Naturelle, Laboratoire de Phanerogamie, Paris, for sending the herbarium specimens and to various institutions and persons for sending fresh material and seeds. I wish to extend my thanks to Prof. D.M. Moore, Dr. E.V. Watson and Mrs. Margaret Doggett for their valuable discussion and advice during the preparation of the thesis. Thanks are also due to Messr. Moh. Anwar, Damhuri and Eko B. Walujo of Herbarium Bogoriense for the drawings, and Miss Pratini for typing the manuscript.

This study was undertaken during the tenure of scholarship from the British Council to which a grateful acknowledgement is made.

INTRODUCTION

Sprengel (1815) established the genus *Cymbopogon* by trasferring four species of *Andropogon,* and at the same time unnecessarily renamed three of them. The species are *C. elegans (A. cymbaria* L.), *C. glandulosa* (A. *prostata* (Willd.) L.), *C. humboldtii (A. bracteatus* Humb. & Bonpl.), and *C. schoenanthus (A. schoenanthus).* The genus was diagnosed as "involucarum monophyllum, hermaphroditos masculis mixtos. Cal. utrisque, bivalvis, muticus, basi pilosus, etc.", thus separating it from *Andropogon* L., *Apluda* L. and *Anthistiria* L. (= *Themeda* Forssk.).

Andersson (1856) in his "Monographiae Andropogonearum" mentioned 3 new names of excluded genera *(Exotheca, Hyparrhenia* and *Cymbanthelia)* in discussing the diagnostic characters of Anthistireae. The list of excluded species included *"Anthistiria tortilis* Presl = videtur *Cymbanthelium* species", suggesting that he intended to publish the the genus *Cymbanthelia* later. In fact the name *Cymbanthelia* has never been published or has never received any attention. In the same paper he transferred *Anthistiria prostata* (= *C. glandulosa* Spreng.) to his new genus *Iseilema, I. prostata* (Willd.) Anderss. Schweinfurth (1867) published a list of Ethiopian plants, in which he cited several combinations in the new genus *Gymnanthelia,* which he attributed to Andersson, i.e. *G. proxima* based on *Andropogon proximus* Hochst. and *G. lanigera* based on *Andropogon laniger* Desf. At the same time Schweinfurth added 2 further combinations under this genus, *G. nervata* based on *Andropogon nervatus* Hochst. and *G. sennarensis* based on *A. sennarensis* Hochst. It seems that both *Cymbanthelia* and *Gymnanthelia* refer to the same genus and it is not clear why different names were employed. Since neither name was validly published, the problem is of no practical significance.

Bentham & Hooker (1883) reduced the genus *Cymbopogon* to a section of *Andropogon,* and included *Hyparrhenia* and *Gymnanthelia* as synonyms under this section. Hackel (1889) put *Cymbopogon* as a subgenus of *Andropogon,* and divided the subgenus into two sections, sect. *Gymnanthelia* and sect. *Hyparrhenia,* and placed *A. bracteata (C. humboldtii* Spreng.) and *A. cymbaria (C. elegans* Spreng.) under sect. *Hyparrhenia.* His description of sect. *Gymnanthelia* was cited by Stapf (1906, 1919) in taking *Cymbopogon* up as a genus again, and he did the same thing with that of sect. *Hyparrhenia* in recognizing the genus *Hyparrhenia* in 1919. Since *C. schoenanthus* is the only one of Sprengel's original species left in *Cymbopogon,* this species is accepted as the lectotype, although it may have been *C. cymbaria* that was foremost in Sprengel's mind when he first proposed the genus *Cymbopogon.*

Cymbopogon belongs to the tribe Andropogoneae by having a pair of spikelets, one sessile and one pedicellate. The majority of the species in *Cymbopogon* can be clearly distinguished from the related genera in the tribe by the aromatic smell. Stapf (1906) divided the genus into three series: ser. *Schoenanthi (=* ser. *Cymbopogon),* ser. *Citrati* and ser. *Rusae.* Gupta (1969b), whose works are based mainly on the Indian species, supported this division by studying the oil content. The taxonomy of *Cymbopogon* as a whole is in the work of Mile Camus (1929) and she recognized 40 species, but she did not cite Stapf's division. Most of the recent works on this genus are based on Stapf's work in relation to the local or regional flora, such as that of Bor (1953 & 1954) for species in India, Burma and Ceylon, that of Blake (1969, 1974) on the Australian species, and Chiovenda (1909) on the Ethiopian species. The essential oils of some *Cymbopogon* species, mainly the cultivated ones, have been recorded in Guenther's work (1950). The work also includes the cultivation, propagation and extraction of the oils.

The present work concerned with the genus as a whole classified mainly on the basis of morphology and anatomy, but considering other evidences such as geographical distribution, ecology and cytology, where it is helpful in drawing the relationship within the genus. This work was mainly based on herbarium specimens deposited with the Herbarium of the Royal Botanic Gardens, Kew. The location of other specimens consulted from some important herbaria are clearly indicated.

MORPHOLOGY

Habit

The species of *Cyrnbopogon* are either densely or loosely tufted, ranging in the height from 20 cm (C. *mekongensis)* to 3 m *(C. tvinteranus, C. giganteus, C. densiflorus).* They are perennial, except some of *C. nervatus*, which are annual. It is not always possible to distinguish annuals from perennials. Annuals, however, usually have solitary culms or 2 - 3 culms in loose tuft, the cataphyll or the basal scale is absent, the rhizomes are usually absent, and the base of the culm is without the old basal sheaths. Perennials, on the other hand, usually have several culms in loose or dense tufts, coated by old basal sheaths, the cataphylls, rhizomes and perennating buds are present.

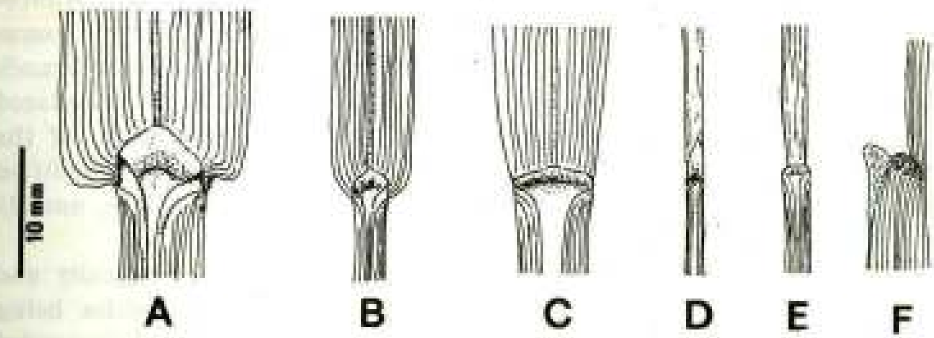
In the perennial plants the young basal shoots, or the innovation are either intravaginal, when the branches grow closely appressed to the main axis and remain enclosed within the basal sheaths, extravaginal, when the branches grow obliquely, breaking the basal sheaths, or combination of the two. Intravaginal innovations are found in ser. *Cymbopogon*, extravaginal innovations occur in ser. *Rusae*, whilst in ser. *Citrati*, ser. *Proceri* and ser. *Refracti* they are extra- and intravaginal.

Culms of most species of *Cymbopogon* are erect and unbranched, but in ser. *Rusae* they may be slightly geniculate and branched. The internodes are usually yellowish and smooth, but sometimes tinged with purple, as in *C. nardus.* The internodes and nodes are commonly glabrous, except in ser. *Proceri* in which tha nodes and the upper part of the internodes are tomentose to woolly.

Leaf

The leaf-sheaths of the culm enclose the internodes and are normally cylindrical and glabrous. In *C. flexuosus* the leaf-sheaths are often provided with auricles on the margins where the sheath joins the leaf-

blade (fig. IF). The basal-sheaths are rarely present in ser. *Rusae*, but they are persistent in the other series, and form a dense tuft as in ser. *Cymbopogon.* They are usually glabrous, but in *C. parkeri, C. plurinodis* and all species of ser. *Proceri* they are tomentose.



PIG. 1. Leaf-bases and ligules in *Cymbopogon: A. C. martinii*, B. *C. caecius*, C. *C. ivinteranus*, D. *C. jwarancusa* subsp. *jwarancusa*, E. *C. bombycinus* P. *C. flexuosus.*

There are 3 types of leaf-blades in *Cymbopogon*, they are (fig. 1): i) linear-lanceolate, smooth, cordate to rounded at the base; this is characteristic of ser. *Rusae*, except *C. mekongensis* whose leaves are linear but smooth; ii) broadly linear, rough on both surfaces and along the margins, narrow at the base; this type is found in most species of ser. *Citrati* and two species of ser. *Proceri* (e.g. *C. procerus* and *C. globosus);* iii) filiform to narrowly linear, rough on both surfaces and along the margins,narrow at the base; filiform type is found in the desert plants of ser. *Cymbopogon* and of ser. *Proceri*, whilst narrowly linear one occurs in savanna plants of both series, *C. refractus* and two species of ser. *Citrati* (e.g. *C. dieterlenii* and *C. distans).*

The leaf-blades are commonly glabrous. In *C. flexuosus* and all species of ser. *Proceri*, however, long silvery hairs occur at the base on the upper surface. At the base of the blade where the sheath joins the blade there is a triangular patch (fig. IF), which is either glabrous, as in ser. *Rusae* and ser. *Cymbopogon*, or often tomentose, as in the other series.

The ligules may be rounded or truncate and vary in length. They can often be used to differentiate related species, such as *C. martinii* and *C. giganteus*, the former having the ligule 4.5 mm long and the latter less than 1.5 mm long.

Inflorescence

The inflorescence of *Cymbopogon*, and also that of other related genera, e.g. *Andropogon*, *Hyparrkenia*, is very complex in structure. All the members of the genus *Cymbopogon* posses a so-called false panicle or spathate panicle. The structure of the spathate panicle of *Andropogon* has been described by Stapf (1918 :209) and that of the genus *Hyparrhenia* by Clayton (1969 :10). In this type of panicle each branch is supported by a spathe. The spathes are at first sheath-like with reduced leaf-blades. They gradually become modified by non-development of the leaf-blades and inflation of the leaf-sheath (spathe). The most modified spathe is called spatheole, which supports the true inflorescence, namely a pair of raceme (fig. 2).

The primary branches of the panicle are arranged spirally and sometimes distichously on the main axis. Each branch, besides being supported by a subtending spathe, also has a prophyll, which is regarded as the first leaf of the lateral branch. The prophyll is a 2-keeled membranous structure, concave on the back.

The basic structure of the spathate panicle can be summarised as follows; the first axis produces one lateral branch; the second axis produces one lateral branch etc. Thus the whole forms a cincinnus or helicoid cyme, or drepanoid cyme. This drepanoid branch is termed "tier" by Stapf (1918) and its members as "rays". The "tier" can be simple, having one "ray", which is equivalent to the true inflorescence; or it can be compound with more than one "ray" (fig. 2A). The "tier" is always supported by a spathe and each "ray" has always a prophyll. In a compound panicle the first axis of the primary "tier" may start with elongated internode and beyond that behaves like the primary axis, producing either a simple or compound secondary "tier". In the more compound panicle this structure is repeated in the second axis, producing a tertiary "tier", and so on (fig. 2).

In the simple panicle, such as that occurs in most specimens of *C. distans*, there are one or three "rays" in each "tier" and very rarely does the primary "tier" produce any further internodes (fig. 2B). In the simple "tier" with only one "ray", the other "rays" remain undeveloped, although one or more prophylls can be seen. In the more compound and large panicle, such as in *C. winteranus*, the rays are zig-zag formation. This can be explained as follows: the primary branches are compound "tiers", in which each ray produces an elongated internode and behaves like the main axis. The upper "tiers" are usually simple,

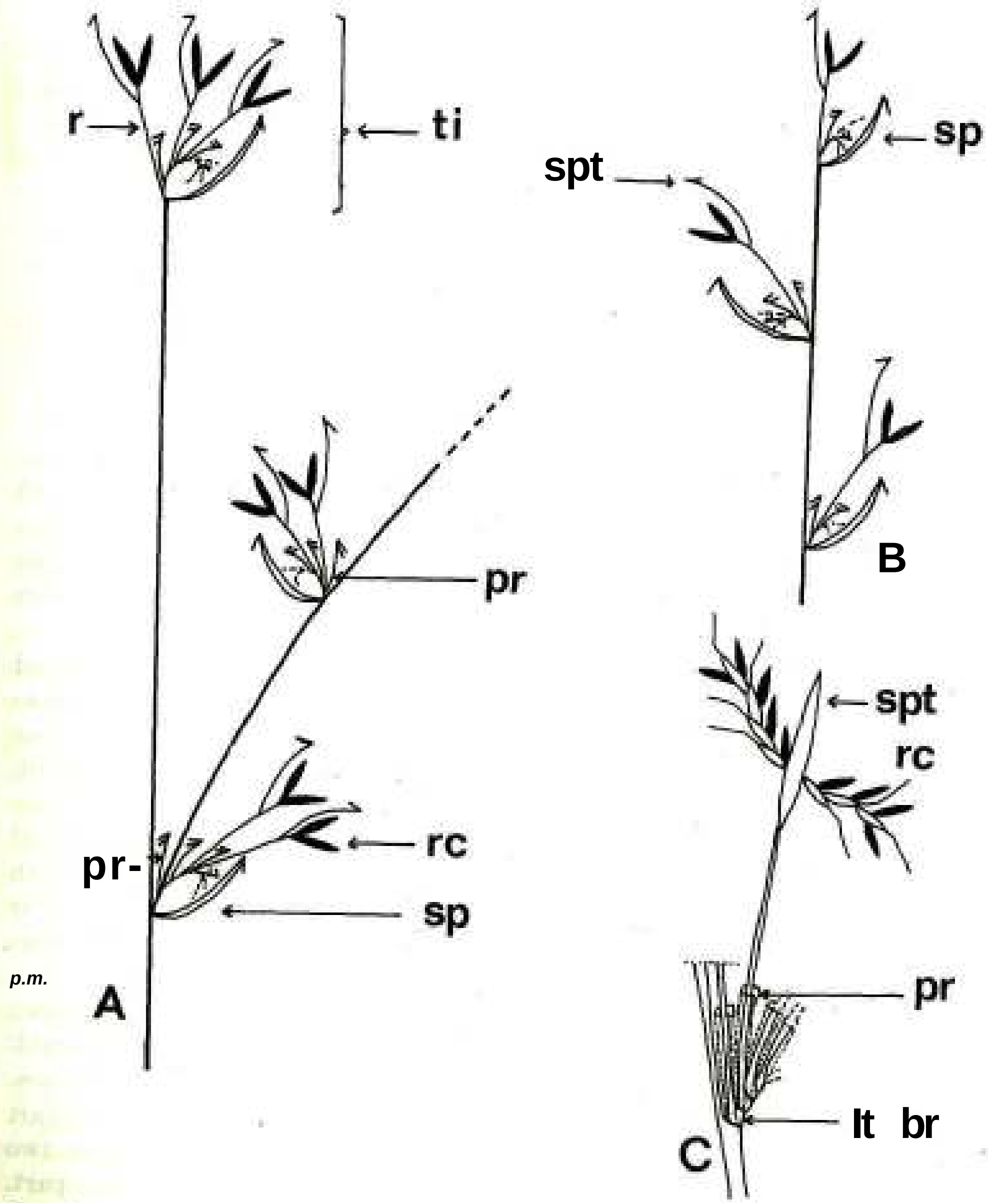


FIG. 2. Diagram of spathate panicle in *Cymbopogon*: lt br = lateral branch, pr = prophyllum, r = ray, rc = raceme, ti = tier, sp = spathe, spt = spatheole.

producing a well developed branch or ray (in this case ray is equivalent to the true inflorescence). These well developed rays are arranged alternately along the zig-zag axis.

Spatheole and peduncle

The spatheole varies in length with the species, but its structure is more or less similar throughout the genus, being narrowly boat shaped, chartaceous, hyaline along the margins and usually glabrous. In *C. bombycinus,* however, the spatheole is herbaceous, often sparsely pilose along the edge of the herbaceous parts, with glabrous hyaline margins.

The peduncle is filiform and usually shorter than the spatheole. It is glabrous, but often tomentose in the upper part. The peduncle seldom has features of any taxonomic value.

Raceme bases

The try9 inflorescence, or the ultimate unit of the spathate panicle, is a pair of racemes, each supported by a stalk called a raceme-base. The two bases are fused together above the point where they are articulated with the common peduncle. They are usually shorter than the rachis internode though the difference in length may not be very great. The raceme-bases can be considered as parts of a modified rachis internodes (Clayton 1969).

The raceme-bases in *Cymbopogon* are generally unequal and deflexed at maturity. The lower raceme-base is usually shorter and more variable than the upper one. The structure of the lower raceme-base is of great taxonomic importance in recognition of, and in differentiating between, certain species. It is either short and flat, or swollen and sometimes fused with the swollen lowermost pedicel (fig. 3). On the other hand the two bases in ser. *Proceri* are nearly similar to one another in length and shape. The two bases in this series can be filiform and erect or slightly swollen, and sometimes deflexed (fig. 3A, B). The equal, non-deflexed raceme-bases also occur in *Andropogon* (fig. 3E-H), a genus closely related to *Cymbopogon.* It seems that some species of ser. *Proceri,* notably *C. ambiguus, C. globosus* and *C. procerus,* retain what is considered to be a primitive character, i.e. equal, non-deflexed raceme-bases.

The tip of the raceme-base is always cupuliform. The lower part of the raceme-base is commonly dark brown and pubescent. The two bases are sparsely pilose or glabrous and polished at the upper part. In ser. *Proceri* the raceme-bases are densely woolly.

Racemes

As noted above the racemes commonly occur in pairs, but in abnormal cases three racemes are found, borne on a common peduncle and enclosed

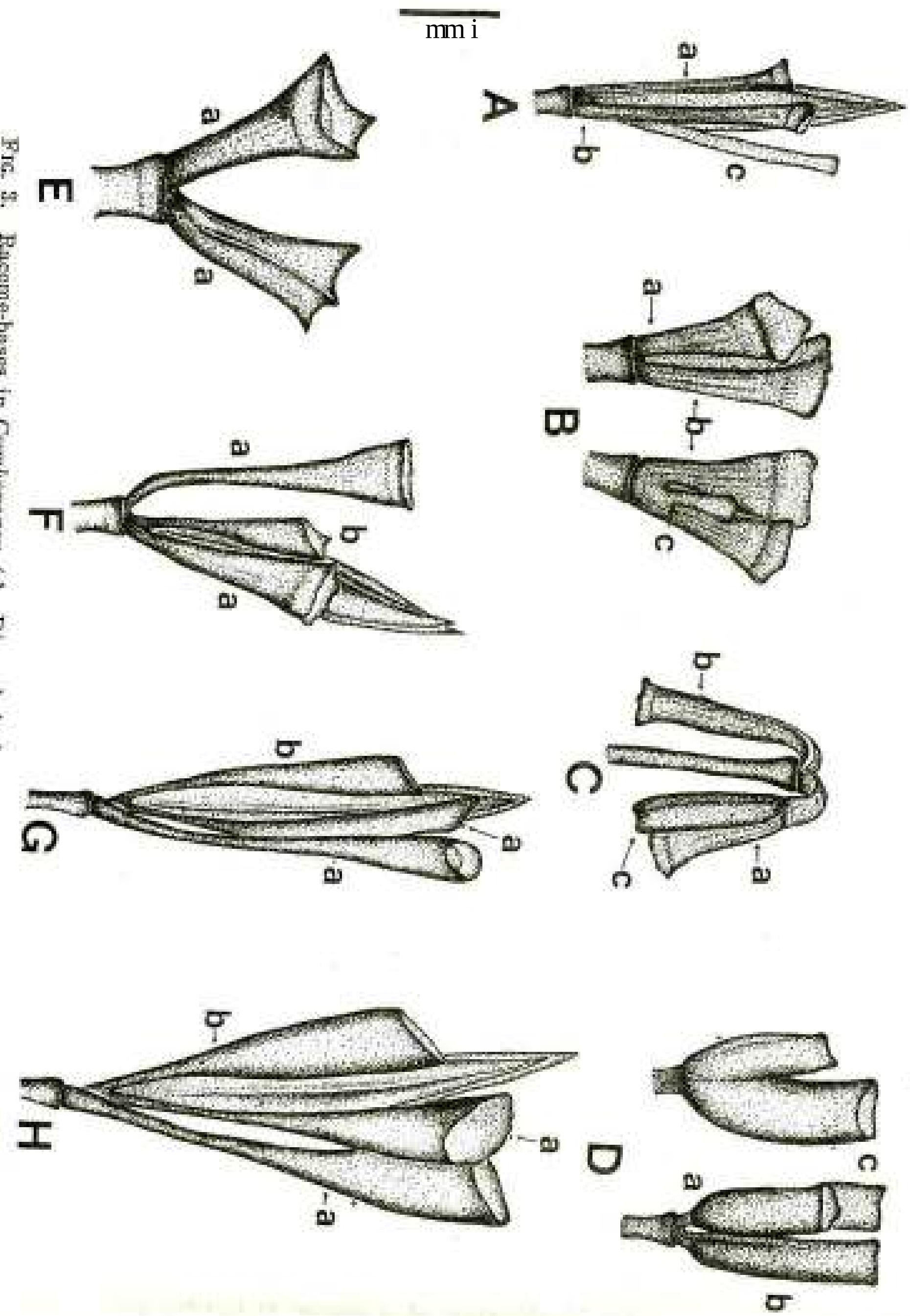
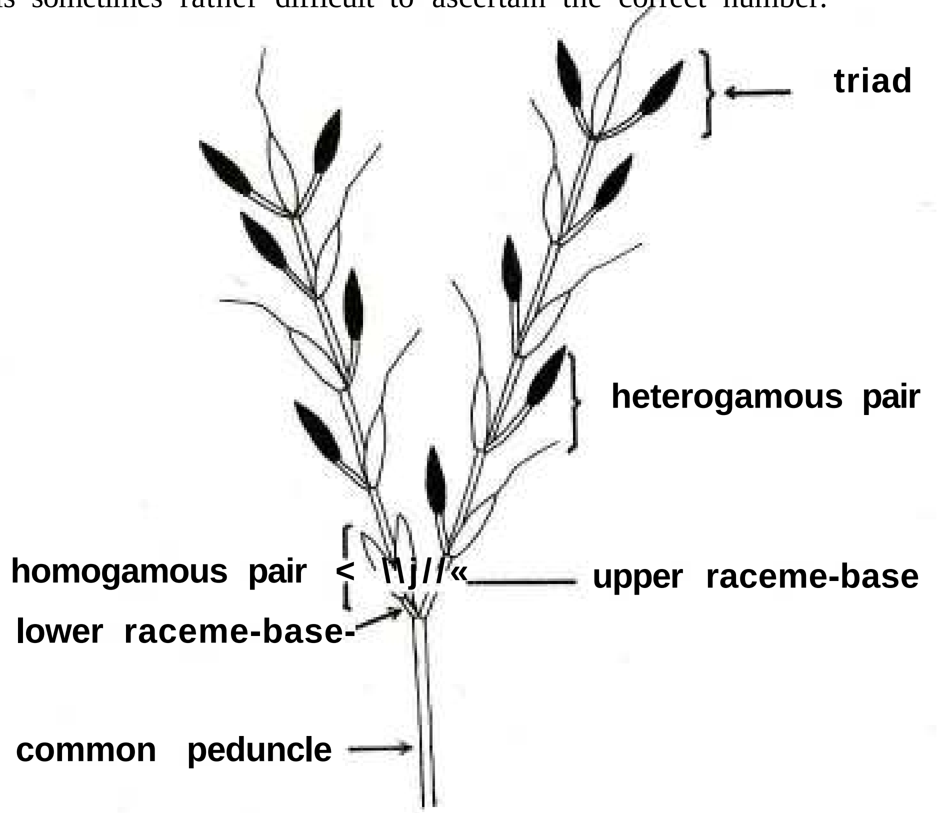


FIG. 3. Raceme-bases in *Cymbopogon* (A-D) and *Andropogon* (E-H): A. *C. ambiguus,* B. *C. bombycinus,* C. *C. plurinodis,* D. *C. giganteus,* E. *A. pumilus,* F. *A. tristis,* G. *A. ascinodis,* H. *A. pseudapricus;* a. lower raceme-base, b. upper raceme-base, c. lowermost pedicel.

by a spatheole. The upper raceme-base gives rise to two equal raceme-bases and on each of them there is one raceme. A very reduced spatheole is often found between the two lower raceme-bases, as if it supports the following two racemes which are borne on the upper raceme base.

Each raceme consists of several pairs of spikelets, in each pair one is sessile and one is pedicellate. Such pairs are known as heterogamous pairs. The sessile spikelet is hermaphrodite and the pedicellate spikelet male. A triad, which consists of one sessile and two pedicellate spikelets, terminates each racemes. At the base of the subsessile lower raceme there is one pair of spikelets, which are alike and male or barren. This lowermost pair is termed a "homogamous pair" (fig. 4). There are usually 4-5 pairs of spikelet in the upper raceme and fewer pairs in the lower one, but up to 7 pairs in the upper raceme are found in *C. pospischilii* and *C. commutatus.* Since the rachis internodes break easily, it is sometimes rather difficult to ascertain the correct number.



PIG. 4. Diagram of a raceme in *Cymbopogon.*

The length of the raceme depends very much on the length of the spikelet and on the number of spikelet pairs. In some cases the length is useful for differentiating between two closely related species.

Rachis internodes and pedicels

The rachis internodes and pedicel are similar to one another; they are usually cupuliform at the tip, flattened on one side and slightly rounded on the other. The margins are usually pilose, and they are glabrous, or sparsely or densely pilose on the back. In ser. *Proceri* the rachis internodes and pedicels are woolly, concealing the sessile spikelet. On the other hand in *C. refractus* they are usually glabrous, rather stout and often wider above (fig. 5).

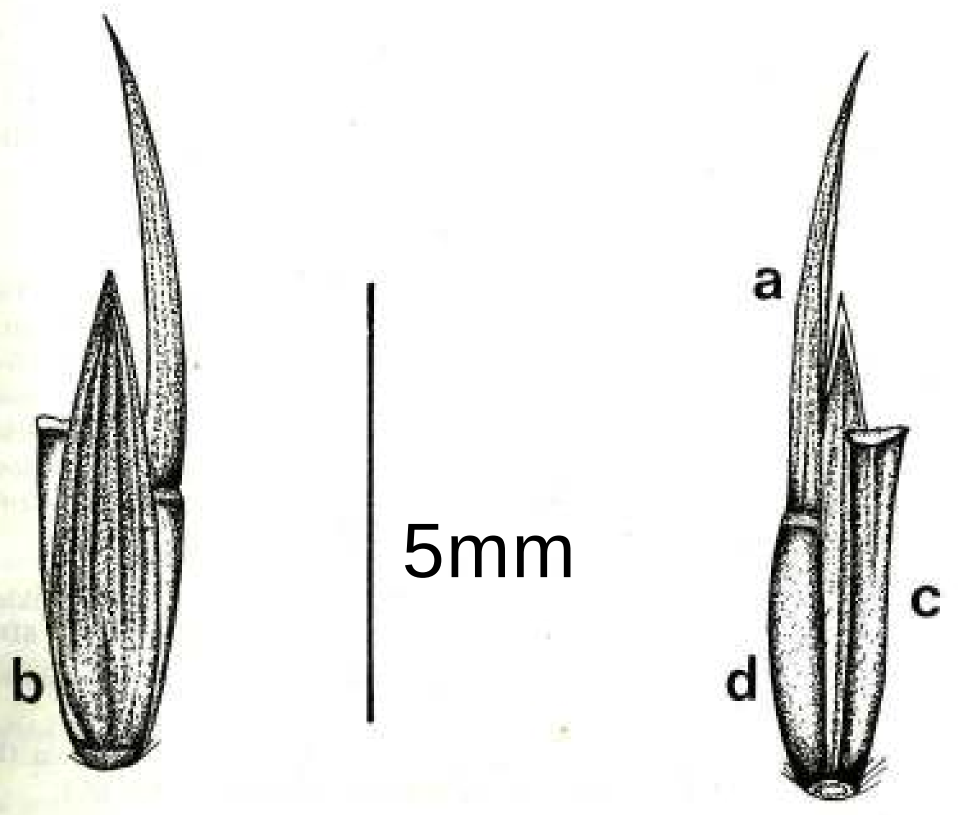


FIG. 5. Dispersal organ of *C. refractus:* a. pedicellate spikelet, b. sessile spikelet, c. rachis internode, d. pedicel.

Homogamous pair

The homogamous pair is found at the base of the subsessile (lower) raceme. One of the pair is situated in the lower part of the raceme-base and appressed to it; the other is side by side with the raceme-base, borne usually on a short stalk, the lowermost pedicel. The structure of the lowermost pedicel is of great importance taxonomically, whether it is swollen or flat. In most of ser. *Proceri* (except *C. bombycinus* and *C. obtectus)* the lowermost pedicel is well-developed and is as long as the two equal raceme-bases.

Both spikelet of the homogamous pair are usually similar being male or sterile and awnless, each consists of two glumes, either one or two lemmas, the upper usually containing a male floret. In ser. *Proceri,* however^ each spikelet of the homogamous pair consists of either one or two glumes only, except in *C. ambiguus* in which the homogamous pair is absent. The lower most pair in this species comprises one sessile spikelet, which is awned and hermaphrodite, and one pedicellate spikelet, which is awnless, male or sterile. This situation suggests that *C. ambigmis* resembles *Andropogon* in having equal raceme-bases and in the absence of a homogamous pair.

Sessile spikelet

Sessile spikelets contain two florets enclosed in two glumes. The lower floret is reduced to an empty lemma, the other is hermaphrodite.

The lower glume is 2-keeled, usually glabrous, except in *C. clandestinus,* in which the glume is sparsely tomentose. Probably the most important character in *Cymbopogon* for the differentiation of the series and the species is the structure of the lower glume, as used by previous authors (Stapf 1906, 1918; Bor 1953/4). There are four main structures (fig. 6) :

(1) the glume is flat or with slightly concave lower portion, wrinkled on the back and winged along the keels, as in ser. *Citrati* (fig. 6D).

(2) the glume is concave, often with inflexed margins and is wingless, as in ser. *Proceri* and ser. *Cymbopogon* (fig. 6A, B).

(3) the glume has a longitudinal (median) groove running from the middle downwards and is winged as in ser. *Rusae* (fig. 6C).

(4) the glume is more or less rounded on the back and is wingless, as in *C. refractus* (fig. 5).

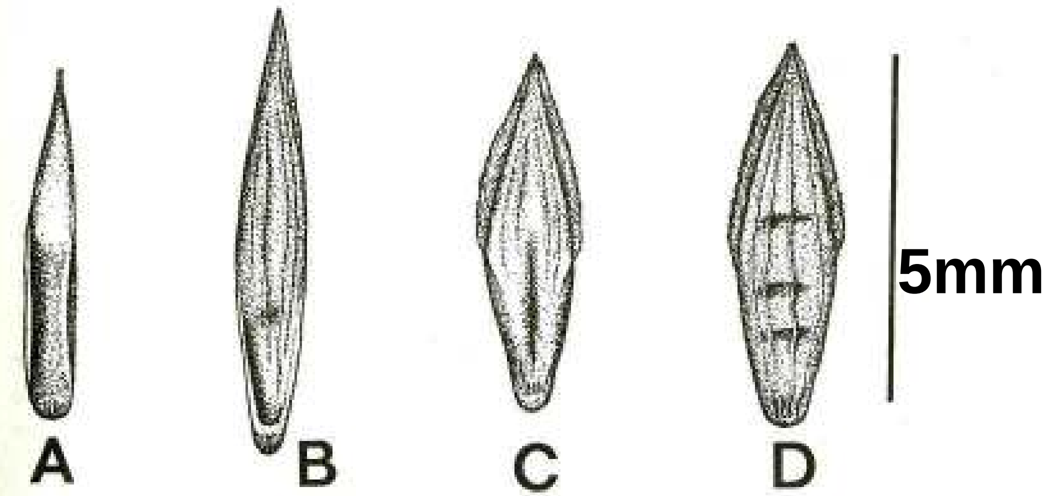


FIG. 6. Lower glumes of the sessile spikelets in *Cymbopogon:* A. *C. floccosus,* B. *C. ambiguus,* C. *C. elandestiniis,* D. *C. goeringii.*

The upper glume is boat-shaped, one-keeled along the upper J/3 which is winged. The margins are hyaline, folded and ciliate. The lemma of the lower floret is hyaline, narrow and ciliate along the margins. That of the fertile floret is more or less 3-toothed, the median nerve is prolonged into the middle tooth which becomes an awn. The other teeth (lobes) form either short or long hyaline scales. The lobes are absent in the lemma of the awnless spikelet of *C. refractus.* In some cultivated species, *C. citratus, C. nardus* and *C. winter anus,* the 3-toothed lemmas do not have the median nerve developed into a long awn.

The awn consists of a column, which is twisted, and a filiform limb. The awn is usually geniculate; the column is glabrous, brown to dark brown. In reduced awns the column is short, not twisted and the awn is not geniculate, as in *C. globosus.*

The two lodicules are cuneate, at one side of the ovary. There are three stamens, each with linear anthers. The ovary is glabrous, the stigmas plumose.

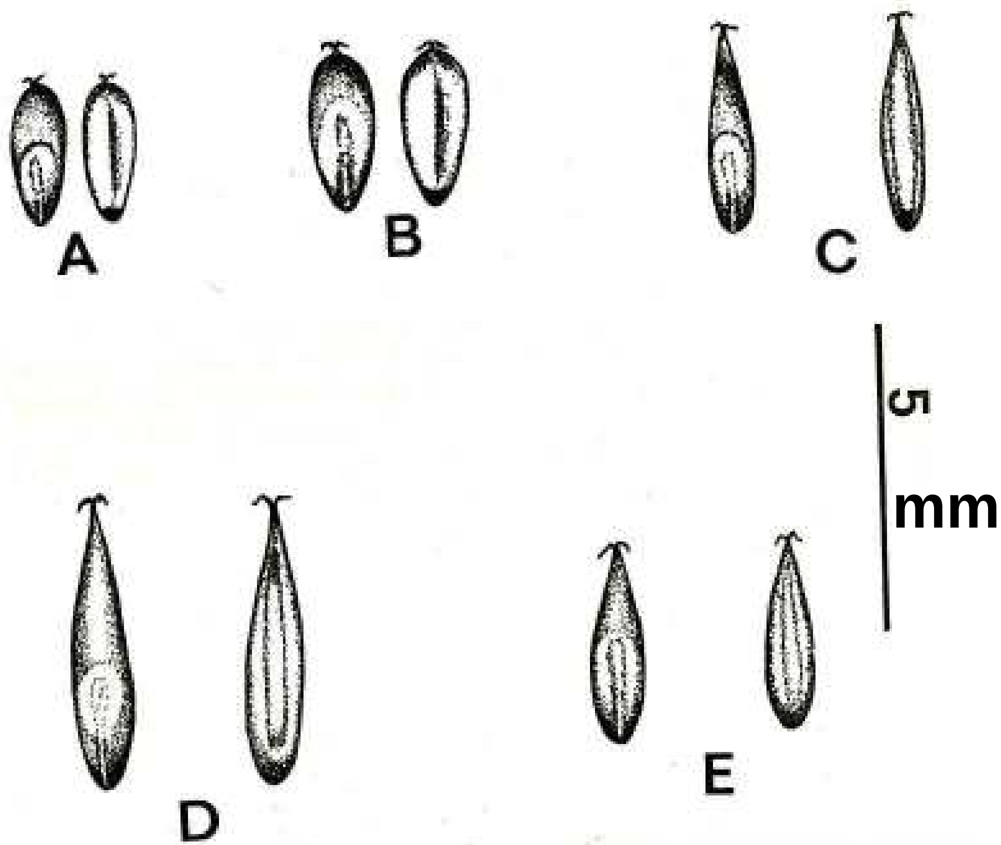
Pedicellate spikelet

The pedicellate spikelet differs from the sessile one in being shorter and awnless. It usually contains a single floret which is male or sterile. Normally the pedicellate spikelet is of no taxonomic value. In *Cymbo-Pogon,* however, ser. *Proceri* can be distinguished from the other series in having one or two empty glumes in the pedicellate spikelet. In ser. *Refracti* the pedicellate spikelet consists of one empty, sharply pointed glume which functions as a dispersal organ, together with the sessile spikelet which usually contains mature seed (fig. 5).

The number of the nerves of the lower glume can occasionally be used to differentiate species. The upper surface of the lower glume may be smooth, rough or tomentose (as in *C. clandestinus)*; usually it is ciliate along the margins.

Caryopses

It is not common to find *Cymbopogon* species with grain or caryopses, since the rachis internodes break easily and fall with the spikelet before the grains are mature. However, the Australian species



PIG. 7. Caryopses in *Cymbopogon:* A. *C. proeerus,* B. *C. bombycinns,* C. ***C. ambiguus,*** **D.** *C. refractus,* E. *C. nervatus.*

retain plenty of mature grains; in annual specimens of *C. nervatus,* from Africa, some grains are also found in the mature spikelets. The grain is enclosed within the spikelet, together they form a disseminule. The grains may be globose, as in *C. proeerus, C. globosus* and *C. bombycinus,* or elliptical, as in *G. ambiguus, C. refractus* and *C. nervatus* (fig. 7).

The embryo occupies half the grain, the dark brown hilum is on the opposite side and is more or less concave.

ANATOMY

LEAF ANATOMY AND EPIDERMIS

It has been known since the end of the 19th century that anatomical features of the grass leaf have provided a valuable source of information for taxonomic work on the Gramineae. Avdulov (1931) recognized two types of grass leaf structure based on the distribution of the chlorophyllous tissue in the leaf. By investigating the microscopic structure of the leaf epidermis Prat (1932, 1960) found that the epidermal structure was useful systematically and supported the division of the Gramineae in the new classification proposed by previous authors (Hubbard 1934; Tateoka 1957). Working on the basis of the leaf anatomy Brown (1958) proposed six groups in the Gramineae: festucoid, bambusoid, arundinoid, panicoid, aristidoid and chloridoid. Although Metcalfe (1960) did not propose any new classification of the Gramineae, his work on grass anatomy provides valuable information for diagnostic purpose; for instance, he employed features of the epidermal structure, which appears in some respect to be unique in the Gramineae.

Various investigators have studied the epidermal structure of the grass leaf in relation to systematics. Tateoka *et al.* (1959) investigated the systematic significance of bicellular microhairs and suggested that the hair characters and the systematic grouping in the Gramineae are correlated. Stewart (1965) pointed out that the epidermal structure can be useful for identifying leaf-fragments from animal droppings.

The anatomical structure of some *Cymbopogon* species, namely *C. dtratus, C. giganteus, C. martinii, C. nardus* and *C. validus* has been recorded by Metcalfe (1960); the important anatomical features are: a) the arrangement of the short cells in the costal band, whether they are in pairs, solitary, or in short or long rows, b) the structure of the silica bodies, either cross, dumbbell-shaped or nodular. In the present study the leaf anatomy and epidermis of about 24 species of *Cymbopogon* were studied. The main purpose of this study is to investigate the anatomical structures of 5 series in *Cymbopogon*, and to discover whether the five series differ from or resemble one another and whether the grouping of the species into series is confirmed as natural on anatomical evidence.

All material used for the anatomical study was taken from herbarium specimens at Kew (see specimens with asterisks in 'Specimens examined' under the species). Mid portions were cut from leaf-blades which were still more or less green. Each leaf portion was placed in boiling water with a few drops of bleaching liquid for 5 - 10 minutes, and then placed in a mixture of formalin, acetic acid and alcohol for about 24 hours. For the preparation of the leaf epidermis standard techniques were used (Metcalfe 1960). The epidermis was stained with Safranin and Fast Green. The leaf portion was cut by hand and mounted in glycerine without staining. Scanning electron micrographs of the epidermal surface were made.

Epidermis

Prickle hairs and hooks: In ser. *Cymbopogon* and two species of ser. *Proceri* (e.g. *C. ambiguus* and *C. obtectus*) prickle hairs are abundant, often overlying stomata in the furrows. Prickle hairs and hooks are common in ser. *Citrati*, ser. *Refracti* and some of ser. *Proceri*. In ser. *Rusae* prickle hairs are absent and hooks are occasionally present (fig. 9). Fahn (1967) pointed out that plants growing in arid habitats tend to possess plenty of trichomes on their leaf-surfaces, and the trichomes are, in general, denser in xerophytes than in mesophytes (Coulter *et al.* 1931). The free occurrence of prickle hairs in ser. *Cymbopogon*, whose species occur in dry areas and adapt to arid condition, is quite possibly related to the dry habitats favoured by species in this series. Similarly in *C. ambiguus* and *C. obtectus*, growing in the semi-deserts, prickle hairs are more densely massed than in *C. procerus*, which occurs in the relatively wet tropical savannas.

Microhairs: The term microhair refers to a smaller hair, which normally consists of two cells. The basal is usually longer than the distal cell, which is very thin walled and easily damaged during preparation. However, in ser. *Rusae* the distal cell is often as long as, or sometimes slightly longer than, the basal one (fig. 10; table 1).

Macrohairs: Macrohairs vary in length, but are longer than the microhairs, and often form an indumentum. Macrohairs can be seen on

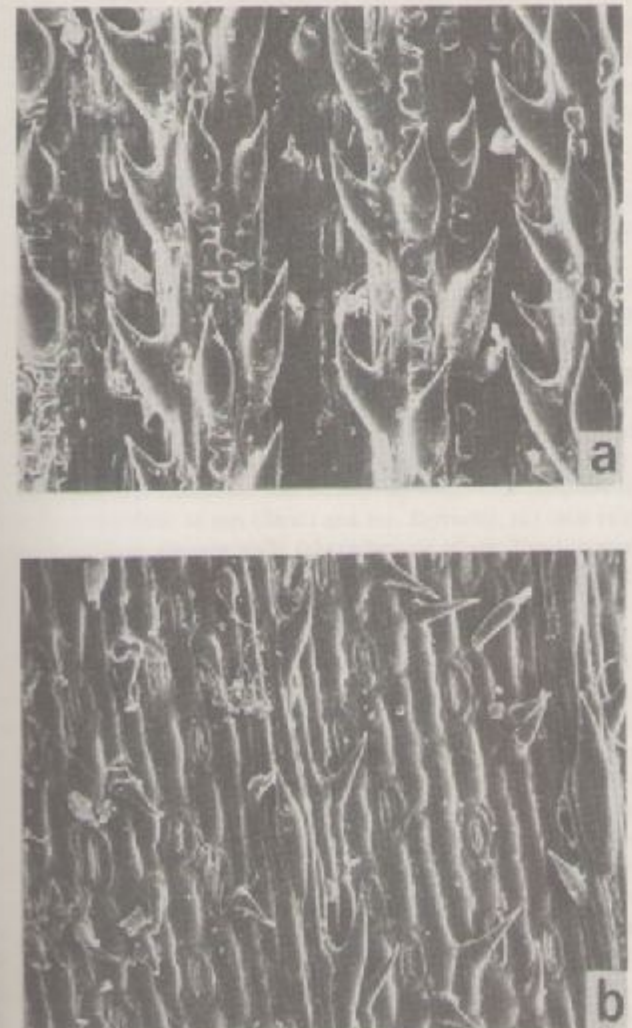


Fig. 8. Lower surface of leaf-blades of *C. schoenanthus* subsp. *proximus* (A), and *C. procerus* (B); SEM. 380x.

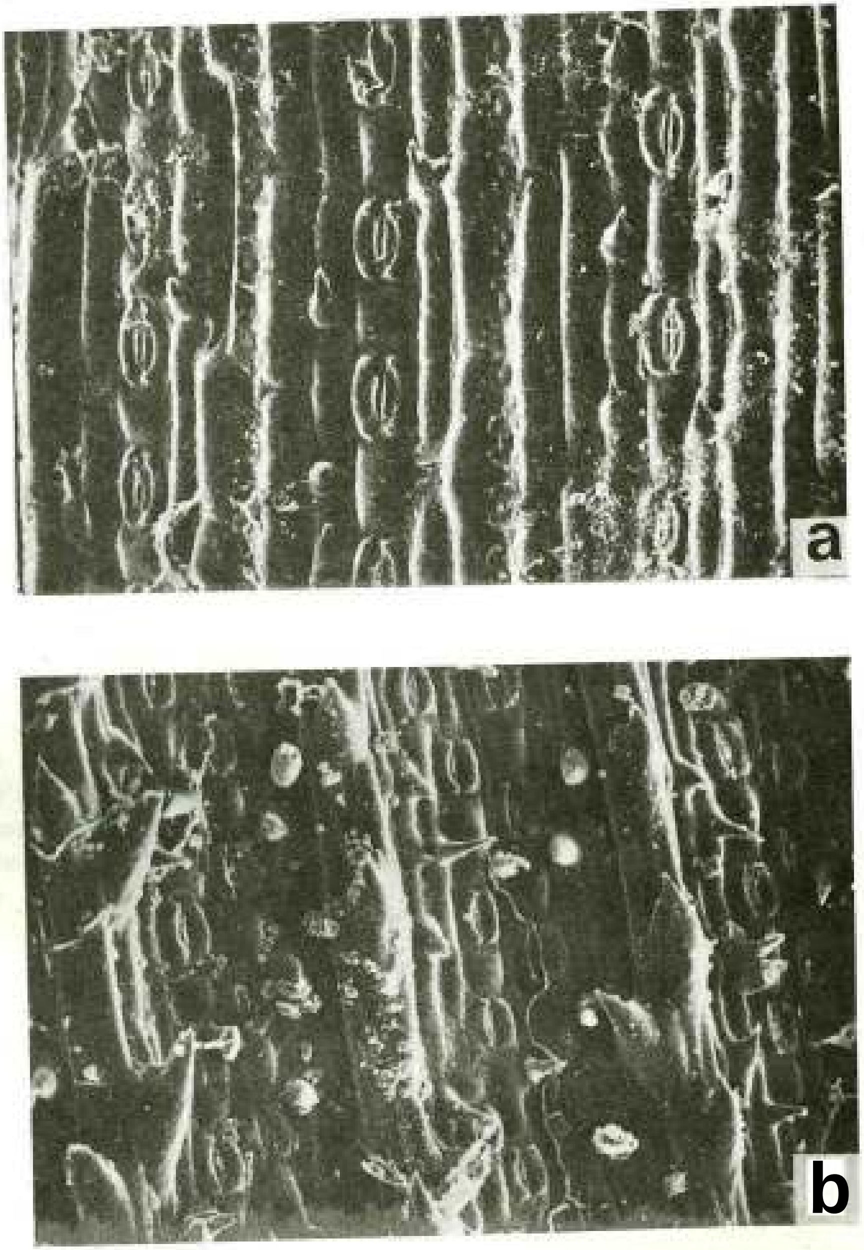


FIG. 9. Lower surface of leaf-blades of *C. caesius* (A), and *C. nardus* (B) ; SEM, 380x.

the abaxial surface in some species of ser. *Citrati* (namely *C. nardus, C. winteranus* and *C. queenslandicus)* and some species of ser. *Proceri* (namely *C. globosus* and *C. ambiguus)* (table 1). They are absent in ser. *Cymbopogon,* ser. *Rusae* and ser. *Refracti.* It is interesting to note that the length of these hairs in the above species varies from 22 μm to 56 μm. The short ones are about the same length as the hooks, but are more slender. It is rather difficult to decide whether the short macrohairs are merely slender hooks. In the species mentioned above the swollen-based hooks are absent or very rare and are replaced by the macrohairs. Quite possibly there is a gradual transition from a swollen-based hook to a long slender macrohair.

Long cells: Long cells in the costal bands are usually thick walled and narrower than those in the intercostal bands and of no taxonomic value. Those in the intercostal bands vary in shape and length. Metcalfe (1960) stated that the detailed structure of the long cells has proved to be of diagnostic value. It is truly so in *Cymbopogon,* since the walls of these cells differ from series to series. There are three types of cells (fig. 10): i) cells relatively long, with thin, markedly sinuous walls (characteristic of ser. *Rusae),* ii) cells relatively long, with thin, not sinuous walls (characteristic of ser. *Citrati* and ser. *Refracti),* iii) cells relatively short, with thick, sinuous walls (characteristic of ser. *Cymbopogon).* In ser. *Proceri* the walls of long cells are thin and slightly sinuous, but more or less resemble those of ser. *Citrati.*

Short cells: They can be classified either as silica cells, when silica body is present, or as cork cells, when the cell wall is thick and gives the microchemical reaction of cork. In the intercostal bands they are usually in pairs, one silica cell and one cork cell. The silica cells and cork cells in the costal bands can be arranged alternately in long, uninterrupted rows, as in ser. *Rusae* (fig. 10A). In ser. *Cymbopogon,* ser. *Refracti* and ser. *Proceri* the long rows of short cells are interrupted by the prickle hairs (fig. 10B, D & E). In ser. *Citrati* cork cells are very rare, and the silica cells and short cells are arranged irregularly, being in pairs or in rows of 3-5 cells (table 2; fig. 10C). The structure of the silica bodies in the silica cells of the mature leaves is of taxonomic importance. In *Cymbopogon* they can be cross-shaped, dumbbell-shaped or nodular (Metcalfe 1960) (table 2). Dumbbell silica bodies are found in all species of *Cymbopogon;* cross-shaped ones are common in ser. *Cymbopogon* and very rarely occur in ser. *Rusae,* whilst the nodular silica bodies occur in ser. *Citrati* and ser. *Refracti.* Metcalfe (1960) Pointed out that the arrangement of short cells in the costal band in

Cymbopogon varies with the species. In this study the arrangement of the short cells agrees with Metcalfe's statement on the genus, but it is useful only to differentiate the series one from another.

Stomata: In *Cymbopogon* the stomata can be classified according to the shape of the subsidiary cells, i.e. triangular low dome-shaped and tall dome-shaped (fig. 8). The structure of the subsidiary cells has little value taxonomically. Nevertheless low dome-shaped subsidiary cells are common in ser. *Rusae,* whereas triangular ones occur commonly in ser. *Citrati,* ser. *Cymbopogon,* ser. *Proceri* and ser. *Refracti.*

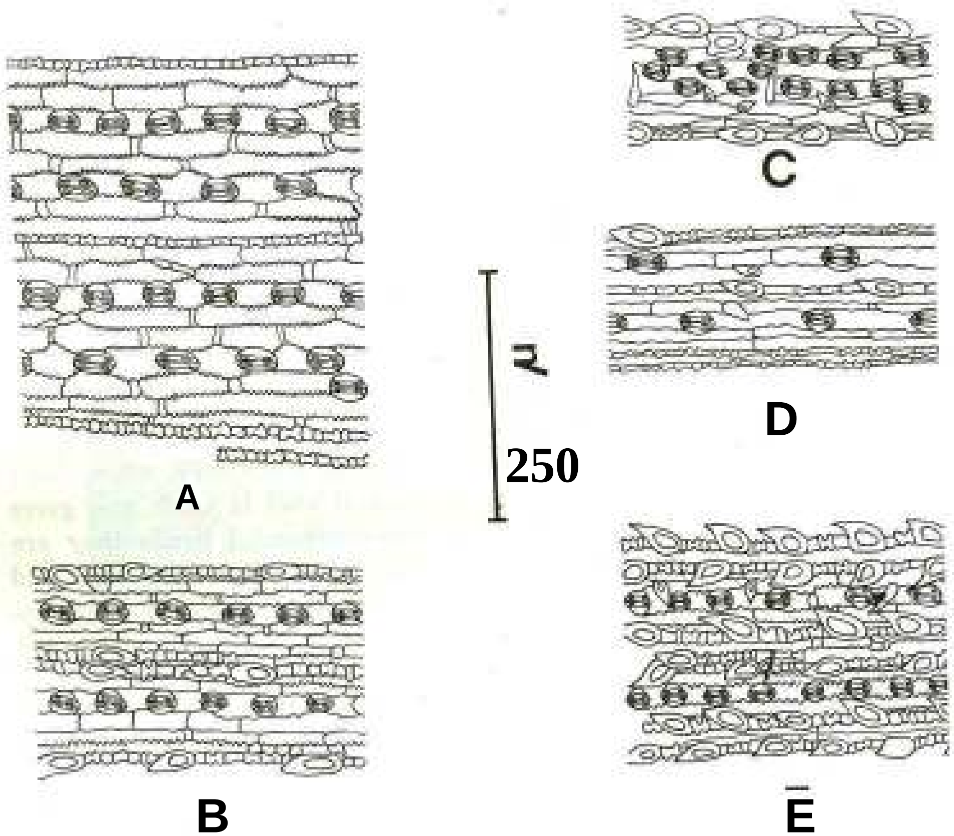


FIG. 10. Leaf epidermis (abaxial surface) in *Cymbopogon:* A. *C. martinii,* B. *C. obteetus,* C, *C. nardus,* D. *C. refractus,* E. *C. schoenanthus* subsp. *proximus.*

Transverse section

Chlorenchyma: Two distinct types of chlorenchyma are recognized according to the arrangement of the cells around the vascular bundles

and are commonly referred to as festucoid and panicoid. In *Cymbopogon* the chlorenchyma is of a panicoid type.

Colourless cells and bulliform cells: Among the mesophyll cells are found colourless cells, so named because they do not contain chloroplasts. They form the ground tissue in the midrib and gradually disappear towards the leaf-margin. There are also bulliform cells, large cells found in groups on part of the adaxial surface (fig. lie). They are often described as motor cells, as it is thought that they have some functions in rolling or folding the leaf. It is interesting to note that in *C. parkeri* from Iraq *(Gillett and Rawi 6105)* the bulliform cells are absent and are replaced by relatively thick-walled epidermal cells (fig. 12). The leaf-blades of this species are variable, plants from N.W. Pakistan possess more or less flat leaf-blades, whilst from Iraq and Northern Arabia have filiform leaf-blades. In fact there is a gradual change of the leaf-shape, from flat to filiform, and of the presence or absence of the bulliform cells. This transition can be observed in the plants from Bahrain Islands and from Afghanistan. This situation is possibly connected with the difference between the habitats, i.e. dry grassland in N.W. Pakistan by contrast with desert areas in Iraq and Northern Arabia.

Vascular bundles: There are three types of vascular bundles, which are commonly present in *Cymbopogon.* The basic type (or large vascular bundle, Metcalfe 1960), which also occur in all grass species, is characterized by having two conspicuous metaxylem vessels and distinguishable phloem and xylem (fig. lla). In the relatively small vascular bundle the phloem and xylem are easily distinguished from one another, but the large metaxylem vessels are absent (fig. lie). In the small vascular bundle the phloem is not easily distinguished from the xylem on account of the extremely small size of the cells, and again the metaxylem vessels are absent (fig. lib). The proportion of these three types of vascular bundles differs from series to series. In ser. *Proceri* and ser. *Cymbopogon* the relatively small vascular bundles are rarely present, such as in *C. jwarancusa* subsp. *jwarancusa.* The three types of vascular bundles are present in the other series of *Cymbopogon.*

Bundle sheaths: In *Cymbopogon* the bundle sheath usually consists of a single layer of cells, the type which is generally found in panicoid grasses.

Sclerenchyma: The grass leaf generally has mechanical support from thick-walled cells, the sclerenchyma. They form subepidermal longitudinal fibres, which follow the course of the vascular bundles.

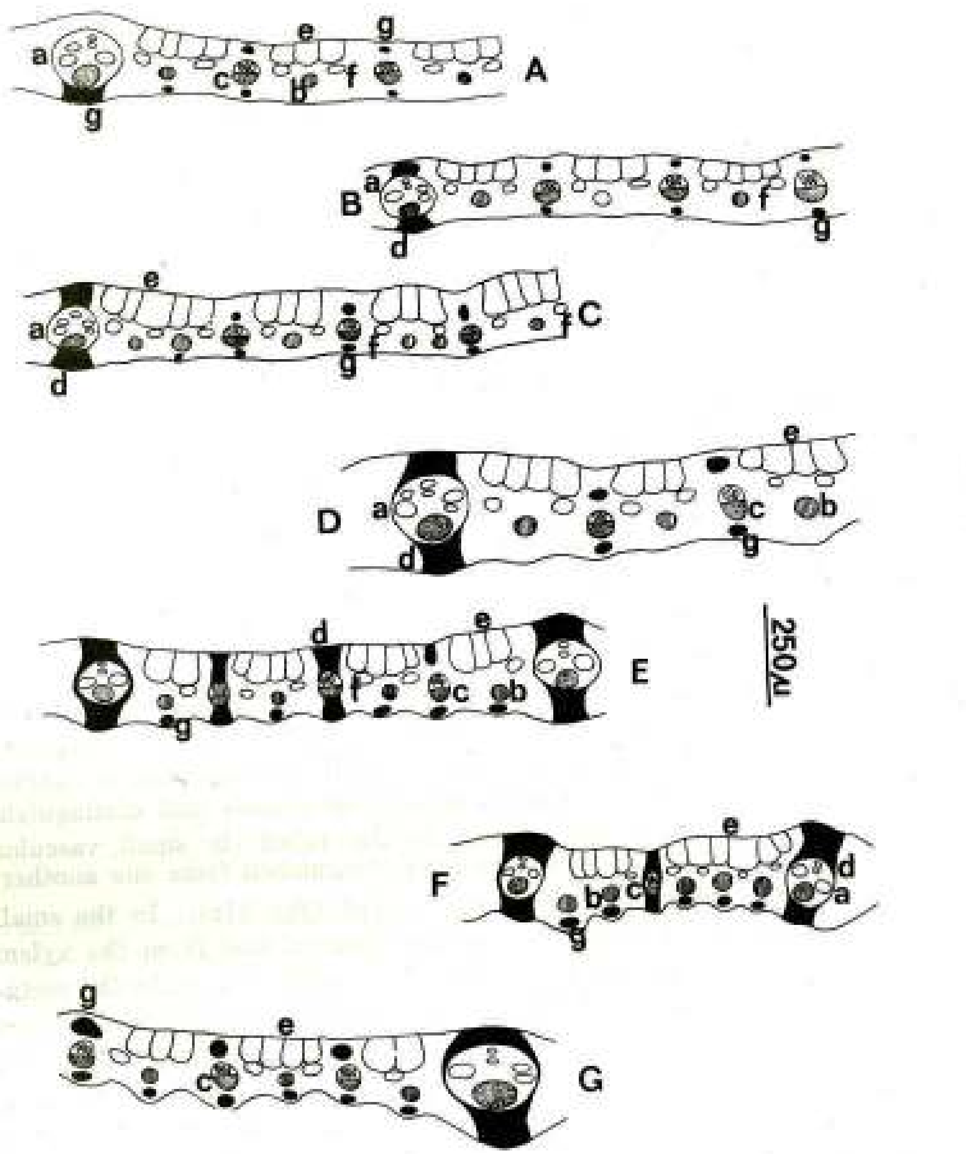


FIG. 11. Transverse section of leaf-blades in *Cymbopogon*, showing sclerenchyma strands and girders: A. *C. caesius*, B. C. *martinii*, C. C. *polyneuros*, D. C. *mandalaiaensis*, E. C. *calciphilus*, F. C. *distans*, G. C. *winteranus*; a. large vascular bundle, b. small v.b., c. relatively small v.b., d. sclerenchyma girder, e. bulliform cell, f. oil cell, g. sclerenchyma strand.

Strands are formed when the sclerenchyma extends from the epidermis to the vascular bundle; if the sclerenchyma envelope the vascular bundle

it is termed as girder (Metcalfe 1960) (fig. lid). The large vascular bundle are often enclosed by the girders and the sclerenchyma interrupt the bundle sheath either abaxially only or both abaxially and adaxially. The small vascular bundles are normally accompanied by sclerenchyma strands abaxially, and the relatively small vascular bundles are accompanied by abaxial and adaxial strands. In ser. *Rusae*, however, the small vascular bundles are very rarely accompanied by the sclerenchyma strands (fig. 11A-D). In ser. *Citrati* and ser. *Proceri* sclerenchyma girders are commonly present, enveloping large vascular bundles and the bundle sheaths are often interrupted by the sclerenchyma abaxially and rarely adaxially (fig. 11E-G). These sclerenchyma girders are often prominent, as for example in three species of ser. *Citrati (C. flexuosus-, C. nardus* and *C. winteranus),* forming massive ground tissue around the vascular bundles. Thus these three species, besides providing essential oils, also furnish fibres that are useful for making paper (Heyne 1927). In ser. *Cymbopogon* and ser. *Refracti* sclerenchyma girders are rarely present and they are absent in ser. *Rusae* (fig. 11A-D).

Adaxial and abaxial surfaces: In all species of *Cymbopogon* the adaxial surface is commonly flat. In ser. *Rusae* the abaxial surface is flat, whereas that of other series is undulating. In desert plants of ser. *Cymbopogon* furrows and ribs are found in the abaxial surface (fig. 11; table 3).

Midrib: In *Cymbopogon* the midrib is prominent on the lower surface and can usually be easily differentiated from the other longitudinal nerves. In the filiform leaf-blades, such as in *C. parkeri* from Iraq and in *C. schoenanthus* subsp. *schoenanthus*, it is difficult to recognize the midrib. In most species of *Cymbopogon* the number of the large vascular bundles in the midrib is limited to one, except in *C. flexuosus, C. afronardus* and *C. coloratus*, in which there are three (occasionally five in *C. flexuosus)* large vascular bundles (fig. 13).

Secretory cells (fig. 14): In grasses internal secretory cells have never been recorded. It is probably because most grasses do not produce any secretion, such as oil or tannine, except for the genus *Cymbopogon*. In this anatomical study it can be observed that the oil is stored in solitary cells in the leaf-blades. In cross section the oil cell more or less resembles the colourless cell, but it often has a thicker wall. It occurs in the ground tissue and is associated with the mesophyll and the vascular bundle. The aromatic smell is one of the diagnostic characters of the genus, on the other hand, the presence of oil cells in the tissue is less important than the Slhell• itself ' '^>1-^«^7 cost* su-.«r'.uiv;n ..--.) A.ihi ^,:vmn:

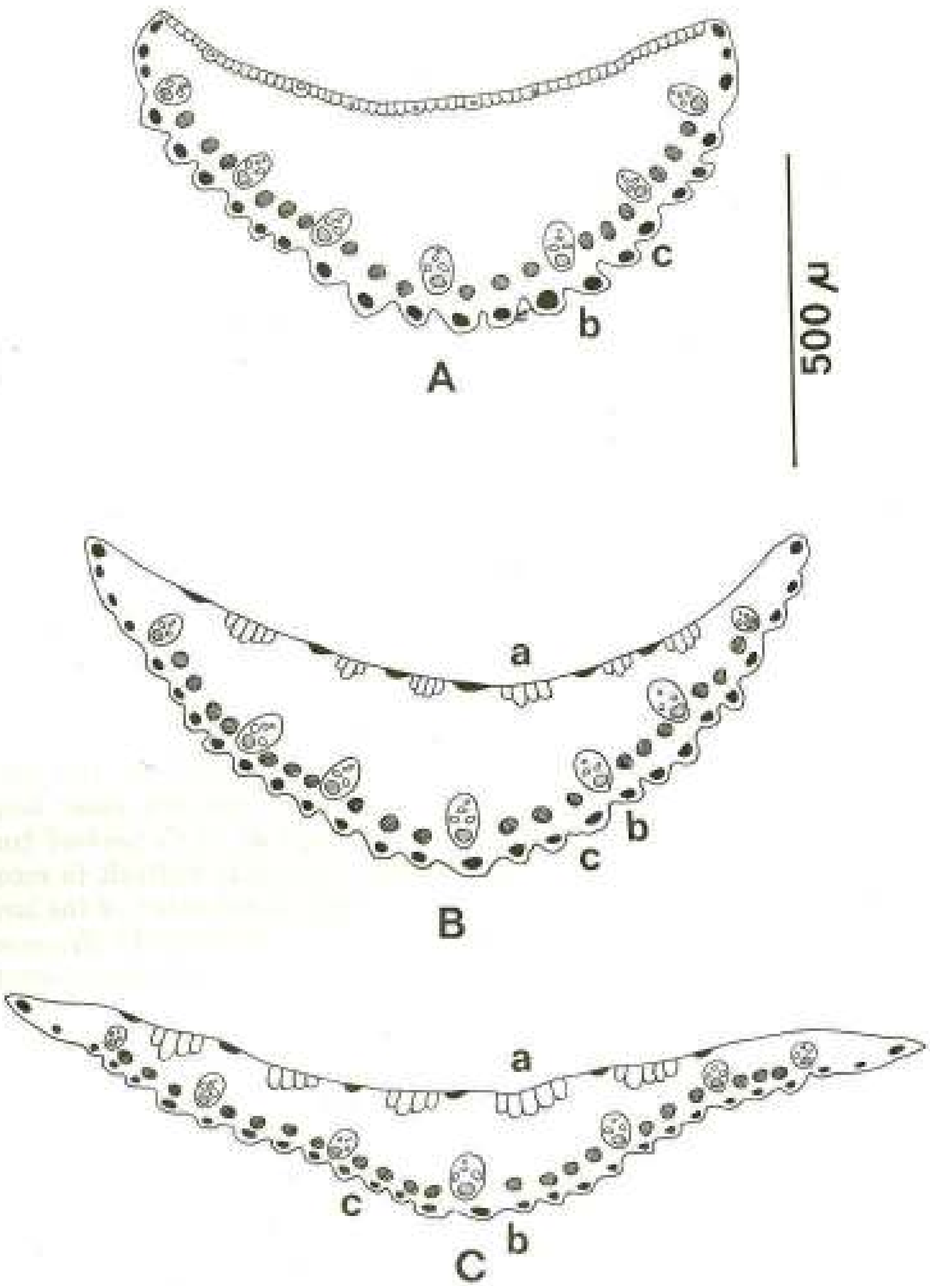


FIG. 12. Transverse section of leaf-blades in *C. parkeri*. A. *Gillett & Rawi 6105* (Iraq), B. *Good 849* (Bahrain Isl.), C. *Rachman 25655* (Pakistan); a. bulliform cell, b. large vascular bundle, c. small vascular bundle.

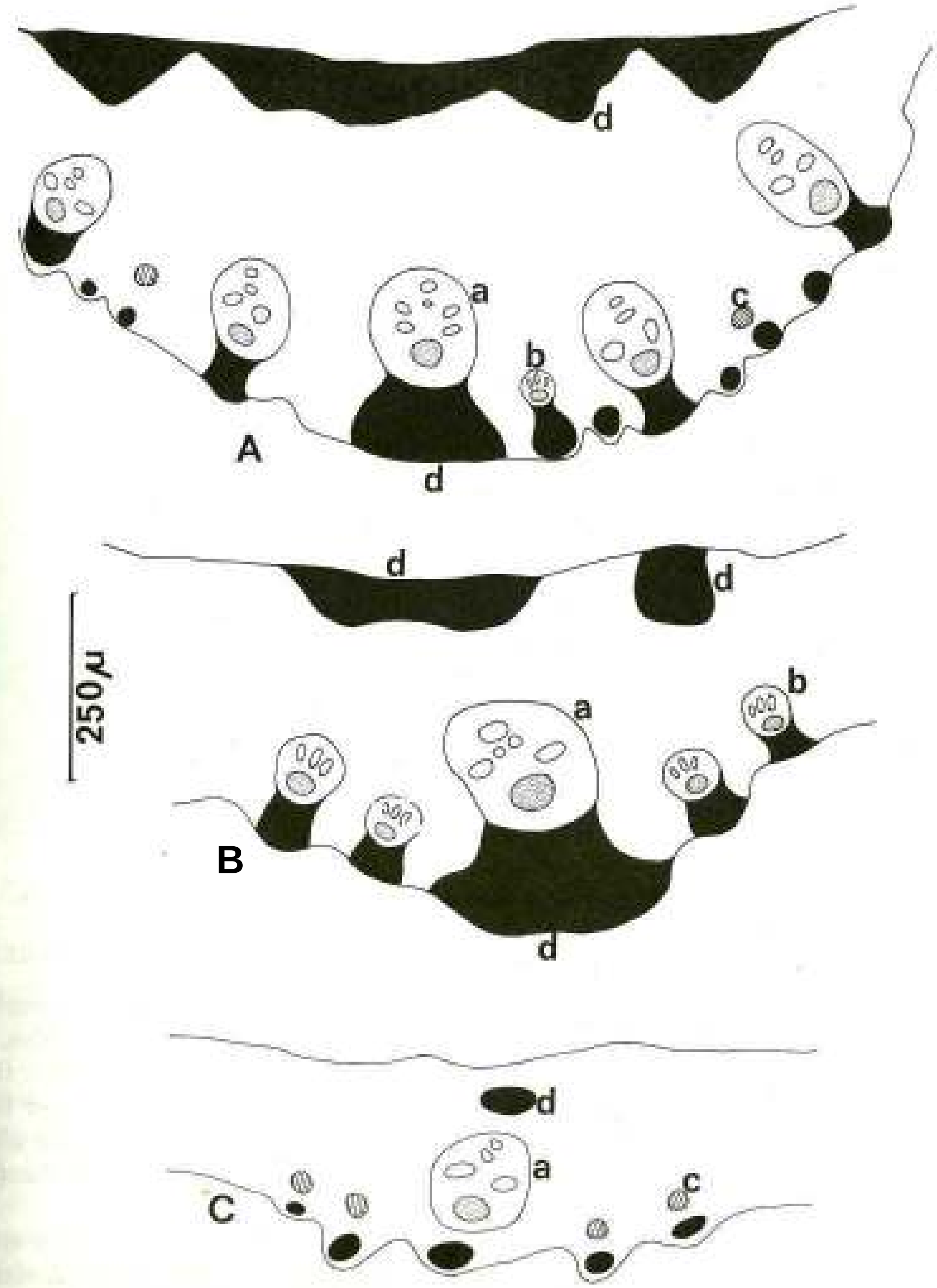


FIG. 13. Transverse section of leaf-blade midrib: A. *C. flexuosus*, B. *C. calciphilus*, C. *C. bombycinus;* a. large vascular bundle, b. relatively small v.b., c. small v.b., d. sclerenchyma strand.

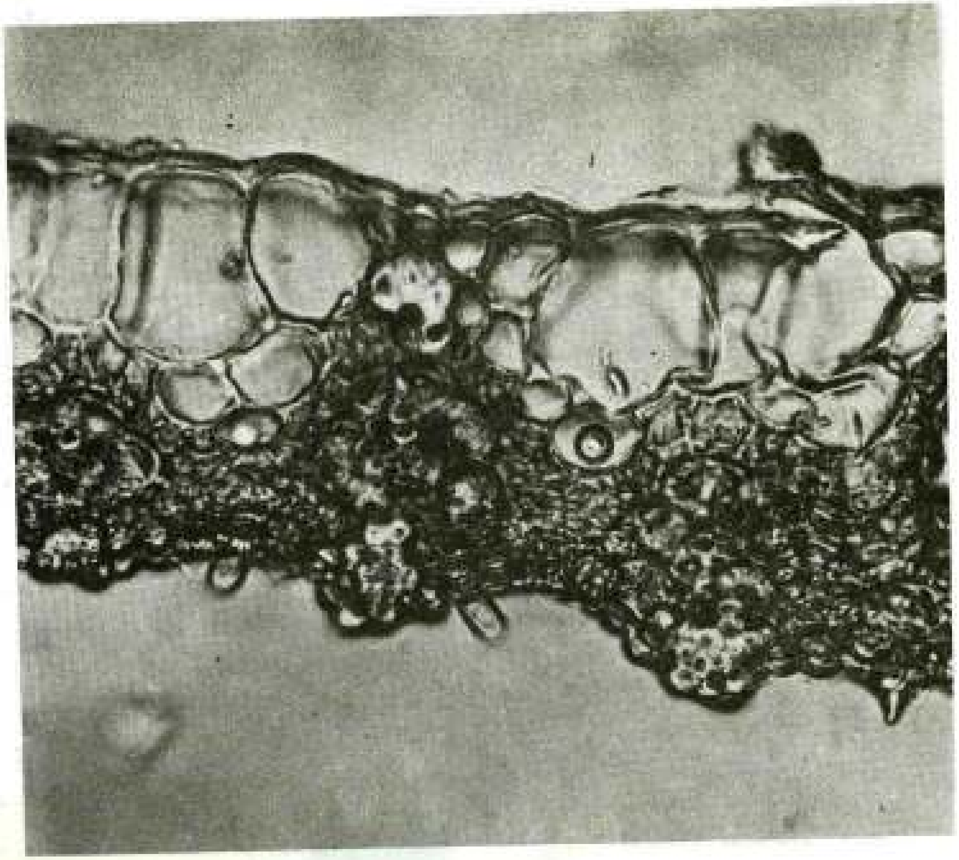


FIG. 14. Transverse section of leaf-blades of *C. calciphilus*, showing oil cells,

EPIDERMIS OF THE LOWER GLUME OF THE PEDICELLATE SPIKELET

The lower glume of the pedicellate spikelet is similar throughout the genus, but the number of nerves is variable. In *C. afronardus*, for example, there are 5 nerves, whilst in its related species, *C. validus*, there are 7 nerves. The object of the present study is to discover whether there is any taxonomic significance in the epidermal structure of the lower glume of the pedicellate spikelet. For the preparation of the epidermis standard techniques were used (Metcalfe 1960).

Since the glumes and the lemmas in grass spikelet are foliar in origin (Arber 1934; Barnard 1957, 1964; Gould 1968) one may expect a similar anatomical structure in the glumes and in leaf-blades, such as the presence of short cells, silica cells, stomata, microhairs, prickle hairs

and the hooks on the epidermis. Even so there is a difference in the arrangement of the cells in the two organs.

In the glume the costal bands are not clearly distinguishable from the intercostal bands in the lower half, they gradually become prominent towards the apex. Nevertheless the intercostal bands can be recognized by the presence of stomata.

It seems that the epidermal structure of the lower glume is more or less similar throughout the genus. Prickle hairs are found along the margins toward the apex in all species examined. Short cells are always in pairs with silica cells and are situated below the silica cells (fig. 15).

Prickle hairs in the costal bands are common in some species of ser. *Cymbopogon,* i.e. *C. floccosus, C. divaricatus, C. plurinodis* and *C. j'warancura* subsp. *jwarancusa.* In the other series they are found only in the upper part towards the apex. Hooks cannot usually be distinguished from short prickle hairs, since they usually have long tips. Nevertheless recognizable hooks are found in the intercostal bands in the upper part of the glume.

As mentioned elsewhere macrohairs often form an indumentum. In the lower glume macrohairs are absent, except in that of *C. clandestinus,* in which the hairs are visible with a hand lense (x 10) (fig. 15D).

Microhairs usually occur in the middle towards the apex and near the margins. These hairs are very rare in *C. floccosus, C. marginatus* and *C. ambiguus.*

Silica bodies are commonly saddle-shaped and rarely dumbbell-shaped; they are often fitting into the cavity of cork cells.

Walls of the long cells in *C. martinn, C. mandalaiaensis* and *C. excavatus* are thin and sinuous, whereas in the other species examined they are usually thick to moderately thick and sinuous.

It seems that the shape of the subsidiary cell in the glume is more constant in each species than are characters derived from leaf-blades. They are either dome-shaped or triangular in outline as seen in surface view (table 5; fig. 15).

As a result of the discussions above it is suggested that the epidermal characters have more taxonomic value than do those other characters revealed in the transverse section. The anatomical features of the leaf-blade appear to be relevant to the grouping of apecies in *Cymbopogon* into series based on morphological structure and it is suggested that this

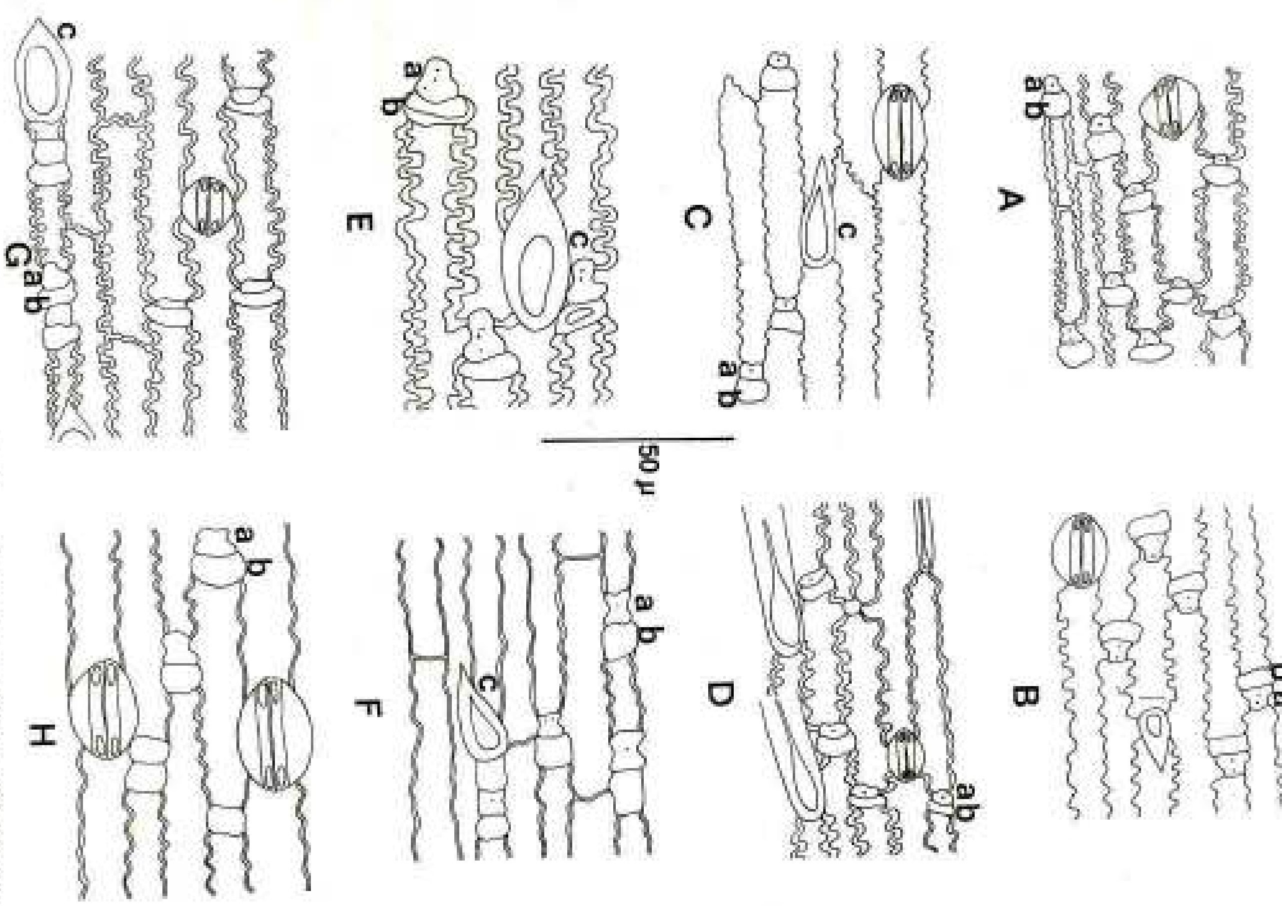


Fig. 15. Epidermis of lower glume of the pedicellate spikelet in *Cymbopogon*: A. *C. goeringii*, B. *C. flexuosus*, C. *C. martinii*, D. *C. clandestinus*, E. *C. divaricatus*, F. *C. bombycinus*, G. *C. floccosus*, H. *C. ambiguus*; a. silica cell, b. cork cell, c. prickle hair.

Table 1. **DERMAL APPENDAGES ON ABAXIAL** SURFACE **OF CYMBOPOGON** SPECIES
(+ present; — absent)

Species	Prickle hairs	Hooks	Macrohairs	Microhairs (length) Basal cells	Distal cells (µm)
Ser. *Proceri*					
C. ambiguus	+, not common	+, rare	+, rare	29.1 — 32.1	19.4 — 24.3
C. bombycinus	+, " "	+, not common	—	26.2 — 31.5	15.7 — 21
C. globosus	+, " "	+, rare	+, rare	21 — 26.3	12.6 — 15.7
C. procerus	+, " "	—	+, rare	26.4 — 27.5	11 — 16.5
C. obtectus	+, " "	+, common	—	25.2 — 37.8	14.7 — 16.8
Ser. *Rusae*					
C. martinii	—	+, rare	—	16.5 — 22	27 — 27.5
C. giganteus	—	—	—	22 — 26.3	21 — 26.3
C. caesius	—	+, rare	—	18.7 — 22	18.7 — 25.5
C. excavatus	—	+, rare	—	—	—
C. polyneuros	—	—	—	14.3 — 16.5	14.3 — 16.5
Ser. *Cymbopogon*					
C. parkeri	+, abundant	+	—	23.5 — 33	16.5 — 20.9
C. jwarancusa subsp. *jwarancusa*	+, abundant	+, rare	—	16.5 — 24.2	11 — 14.3
C. schoenanthus subsp. *schoenanthus*	+, abundant	+	—	27.5 — 30.5	16.5 — 22
C. schoenanthus subsp. *proximus*	+, abundant	+	—	22 — 27.5	13.2 — 16.5
Ser. *Citrati*					
C. nardus	+, common	+, very rare	+	22 — 25.3	11 — 14.3
C. winteranus	+, "	+, " "	+, rare	16.5 — 17.6	11 — 12.1
C. flexuosus	+, "	+, " "	+	16.5 — 22	8.8 — 11
C. distans	+, "	+, " "	—	18.9 — 26.3	15.7 — 18.9
C. afronardus	+, "	+, " "	—	27.3 — 31.5	15.7 — 18.9
C. queenslandicus	+, "	+, " "	+	26.3 — 33.6	missing
C. coloratus	+, "	+, common	—	30.1 — 36.4	11.5 — 16.8
C. calciphilus	+, "	+, common	+, rare	16.8 — 20.1	10.5
Ser. *Refracti*					
C. refractus	+, common	+, not common	—	21.1 — 26.3	14.7 — 18.9

Table 2. EPIDERMAL CELLS ON ABAXIAL SURFACE OF CYMBOPOGON SPECIES

Species	Walls of the long cells	Short cells & silica cells on the costal bands	Silica bodies
Ser. *Proceri*			
C. ambiguus	thin, slightly sinuous	in long interrupted rows	dumbbell-shaped
C. bombycinus	"	"	"
C. globosus	"	"	"
C. procerus	"	"	dumbbell-shaped & cross
C. obtectus	"	"	dumbbell-shaped
Ser. *Rusae*			
C. martinii	thin, sinuous	in long interrupted rows	dumbbell-shaped
C. giganteus	"	"	dumbbell-shaped & cross
C. caesius	"	"	dumbbell-shaped
C. excavatus	"	"	"
C. polyneuros	"	"	"
Ser. *Cymbopogon*			
C. parkeri	thick, sinuous	in long interrupted rows	cross-shaped
C. jwarancusa subsp. *jwarancusa*	"	"	dumbbell-shaped & cross
C. schoenanthus subsp. *schoenanthus*	"	"	cross-shaped
C. schoenanthus subsp. *proximus*	"	"	"
Ser. *Citrati*			
C. nardus	thin, non-sinuous	in short rows or in pairs	dumbbell-shaped & nodular
C. winteranus	"	"	"
C. flexuosus	"	"	"
C. distans	"	"	"
C. afronardus	"	"	"
C. queenslandicus	"	"	"
C. coloratus	"	"	dumbbell-shaped
C. calciphilus	"	in long interrupted rows	dumbbell-shaped & nodular
Ser. *Refracti*			
C. refractus	thin, non-sinuous	in long interrupted rows	dumbbell-shaped & nodular

Table 3. TRANSVERSE SECTION OF LEAF BLADES OF CYMBOPOGON SPECIES
(+: present; —: absent)

Species	Small vascular bundles	Relatively small vascular bundles	Large vascular bundles	Large v.b. in midrib	Bulliform cells	Abaxial surface	Adaxial surface
Ser. *Proceri*							
C. ambiguus	+	+	+	1	+	undulate	flat
C. bombycinus	+	+, very rare	+	1	+	"	"
C. globosus	+	+	+	1	+	"	"
C. procerus	+	+, rare	+	1	+	"	"
C. obtectus	+	+, rare	+	1	+	"	"
Ser. *Rusae*							
C. martinii	+	+	+	1	+	flat	flat
C. giganteus	+	+	+	1	+	"	"
C. caesius	+	+	+	1	+	"	"
C. excavatus	+	+	+	1	+	"	"
C. polyneuros	+	+	+	1	+	"	"
Ser. *Cymbopogon*							
C. parkeri	+	+, very rare	+	1	+ or —	undulate	flat
C. jwarancusa subsp. *jwarancusa*	+	—	+	1	+	"	"
C. schoenanthus subsp. *schoenanthus*	+	+, very rare	+	1	+	"	"
C. schoenanthus subsp. *proximus*	+	+, very rare	+	1	+	"	"
Ser. *Citrati*							
C. nardus	+	+	+	1	+	undulate	flat
C. winteranus	+	+	+	1	+	"	"
C. flexuosus	+	+	+	3(5)	+	"	"
C. distans	+	+	+	1	+	"	"
C. afronardus	+	+	+	1	+	"	"
C. queenslandicus	+	+	+	1	+	"	"
C. calciphilus	+	+	+	3	+	"	"
C. coloratus	+	+	+	3	+	"	"
Ser. *Refracti*							
C. refractus	+	+	+	1	+	undulate	flat

Table 4. IMPOETANT ANATOMICAL FEATUEES OF THE SEEIES IN CYMBOPOGON

	Cymbopogon	*Rusae*	*Refracti*	*Proceri*	*Citrati*
Abaxial surface	undulate, prikle hairs and hooks abundant	not undulate, very rarely with hooks	undulate, prikle hairs common	undulate, prikle hairs and hooks common	undulate prikle hairs and macro-hairs present
Cell wall of long cell	thick, sinuous	thin, sinuous	thin, non-sinuous	thin or thick, non-sinuous	thin or thick, non-sinuous
Short cells and silica cells in the costal bands	in long interrupted rows	in long un-interrupted rows	in long, often interrupted rows or in short rows	in long often interrupted rows	in pairs or short rows
Cork cells	present	often present	absent	rarely present	rarely present
Vascular bundles	commonly 2 types (small and large)	3 types	2 types (small and large)	commonly 2 types (small and large)	3 types
Bulliform cells	usually very distinct rarely absent	distinct	distinct	distinct	distinct
Bundle sheath of large vascular bundle	interrupted by sclerenchyma girdes abaxially	rarely interrupted	often interrupted abaxially	rarely interrupted	interrupted abaxially often adaxially

Table 5. EPIDERMAL STRUCTURE OF THE LOWER GLUMES OF THE SESSILE SPIKELETS OF SOME CYMBOPOGON SPECIES

Species	Prickle hairs *)	Hooks *)	Wall of long cell	Silica hairs	Microhairs basal & distal (nm)	Subsidiary cells of stomata	Macrohairs
C. bombycinus	common to-wards the apex	rare	moderately thick, slightly sinuous	saddle-shaped or oblong	not common 20.1-25.2 25.2	rare, low to tall dome-shaped	absent
C. ambiguus	rare	very rare	moderately thick, slightly sinuous	saddle-shaped	very rare, 27.3-36.7 21-26.2	common, low dome-shaped	absent
C. martinii	very common towards the apex	not common	thin, sinuous	saddle-shaped	not common 28.3-36.7 33.6-36.7	not common, low dome-shaped	absent
C. mandalaiaensis	very rare	rare	thin, sinuous	short, fitting into cavity of cork cell	very common 17.8-20.1 20.1-26.2	common, low dome-shaped	absent
C. clandestinus	very common	rarely present	thick, sinuous	saddle-shaped	not common 21-24.1 21-24.1	not common, low dome-shaped	present
C. excavatus	very rare	very rare	thin, sinuous	saddle-shaped	common 21-26.2 26.2-27.3	common, low high dome-shaped	absent
C. refractus	very rare	very rare	moderately thick, sinuous	dumbbell-shaped	very rare 22-26.2 15.7	not common, low-high dome-shaped	absent
C. flexuosus	not common	common in the apex	moderately thick, sinuous	saddle-shaped to dumbbell-shaped	common in the apex 30.4-36.7 15.7-19.8	not common, low -tall dome-shaped	absent

(Continued)

Species	Prickle hairs *)	Hooks *)	Wall of long cell	Silica bodies	[illegible] hairs [illegible] & [illegible] (μm)	Subsidiary cells of stomata	Macrohairs
C. mar[illegible]tus	very rare	[illegible]	[illegible]tely thick, [illegible]	[illegible] 1 to [illegible] -shaped	very rare [illegible] 0.1 0.1	[illegible], trian- tall [illegible]ped	absent
C. goeringii	very rare	rare	thick, [illegible]	[illegible]	[illegible]	common, tall dome-shaped	absent
C. queenslandicus	common towards the apex	rare	thick, sinuous	[illegible] or [illegible]ell-	[illegible] common [illegible]5-36.7 [illegible]7-21	[illegible], tall [illegible]aped [illegible]gular	absent
C. floccosus	common	not common	thick, sinuous	[illegible] to [illegible]ll-	very rare [illegible]5 15.7-21	co[illegible] tal[illegible]	absent
C. divaricatus	common	[illegible]	thick, sinuous	du[illegible] [illegible]ped	[illegible]	[illegible]mmon, tall [illegible] gul[illegible]	absent
C. plurinodis	[illegible]	rare	thick, sinuous	saddle- to dumbbell-shaped	[illegible]	[illegible]	absent
C. jwarancusa subsp. jwarancusa	common toward the apex	[illegible]	thick, [illegible]	[illegible]bbell- [illegible]ddle- [illegible]ed	[illegible]	not common, tall dome-shaped or triangular	absent

*) Prickle hairs and hooks are observed only [illegible] le [illegible] the a[illegible]x.

grouping is, as it is stands at present, a more or less natural one. The anatomical features of each of the 5 series in the genus are summarized in table 4 and in the key below.

KEY TO THE SERIES OF CYMBOPOGON BASED ON ANATOMICAL DATA

1. Short cells in the costal bands solitary, in pairs or in short rows of 3 - 5 cells, silica cells not common, cork cells rarely present ..... *Citrati*

1. Short cells and silica cells in the costal bands alternating in long rows, uninterrupted or interrupted by prickle hairs, cork cells present among them

   2. Walls of the epidermal cells non-sinuous to slightly sinuous

      3. Silica cells commonly nodular ..... *Refracti*

      3. Silica cells dumbbell-shaped, often cross-shaped ..... *Proceri*

   2. Walls of the epidermal cells sinuous

      4. Prickle hairs abundant in the costal bands; hooks common in the intercostal bands; short cells and silica cells in the costal bands in long, interrupted rows; abaxial surface undulate ..... *Cymbopogon*

      4. Prickle hairs absent; hooks not common in the intercostal bands; short cells and silica cells in the costal bands in long uninterrupted rows; abaxial surface flat ..... *Rusae*

GEOGRAPHICAL DISTRIBUTION

With the exception of the cultivated and introduced species, *Cymbopogon* occurs only in the Old World tropics and subtropics. The distribution of the species is shown in table 6, 7 & 8 and fig. 16 & 17.

As indicated by Hartley (1958), the tribe Andropogoneae is adapted to hot moist conditions. From maps it can be seen that *Cymbopogon* is well-established in the area where the tribe Andropogoneae is successful. The species are more or less evenly distributed throughout the area, but several rather diffuse centres of diversity, such as Indo-China, India, East Africa and Queensland, can be recognized. They are readily seen on the map of superimposed distribution and suggest that *Cymbopogon* is a relatively old and successful genus. As mentioned earlier the genus is divided into 5 series and it is proposed to consider the distribution of each in turn.

Ser. *Cymbopogon.* This series occurs mainly in the Saharo-Sindian Region (fig. 16), the only exception being the two species, *C. microthcca* which is found in Nepal, and *C. gidarba* which occurs from Orissa to Madras. The occurrence of *C. plurinodis* in South Africa agrees with the disjunct distribution of the Saharo-Sindian elements in South Africa, which is discussed by Clayton and Hepper (1974). This species has a vicarious species which is found in Western Himalaya (fig. 18). These

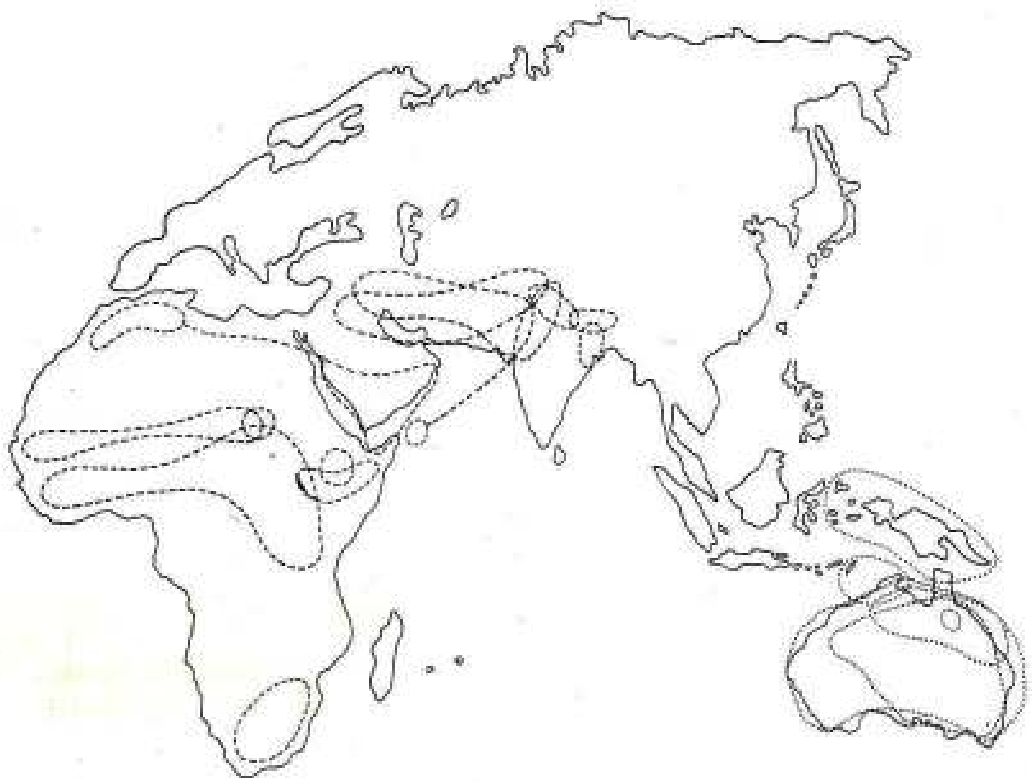


FIG. 16. Superimposed distribution for species of *Cyinbopogon,* ——— ser. *Cymbopogon,* . . . . ser. *Proceri.*

two species show apparently independent evolution from the common ancestor in response to the aridity in South Africa and Western Himalaya.

Ser. *Proceri.* Ser. *Proceri*, which is limited to Australia and neighbouring islands such as New Guinea and the Moluccas, has its centre of diversity in Queensland (fig. 16). The peculiar flora of the Australia

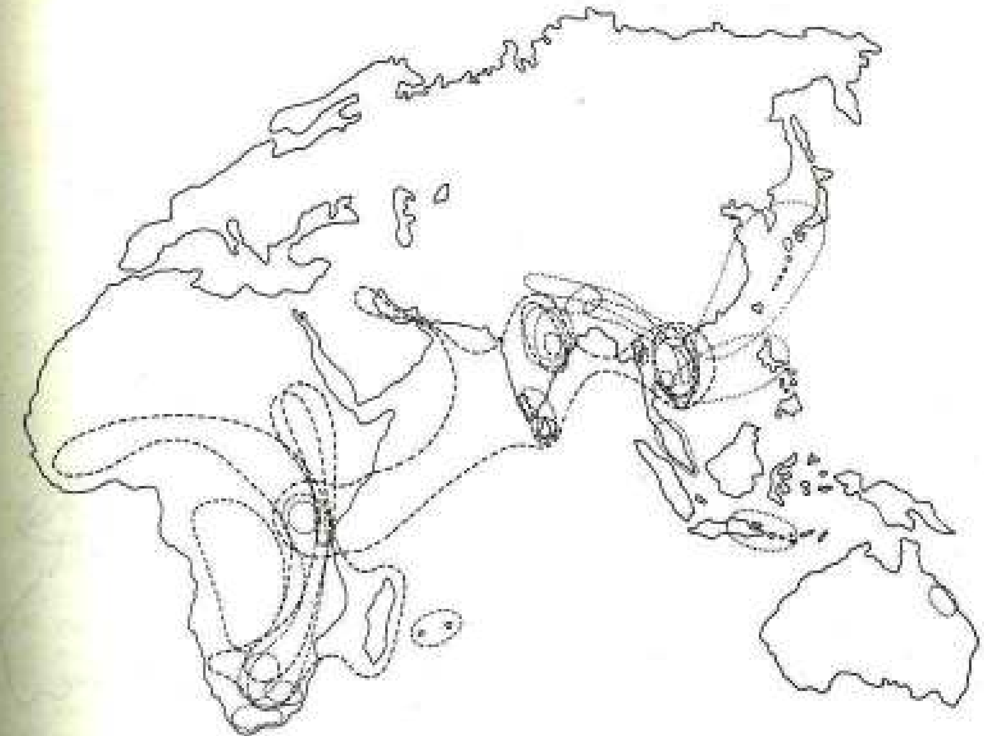


FIG. 17. Superimposed distribution for species of *Cyinbopogon,* ——— ser. *Rusae,* . . . . ser. *Citrati.*

continent is generally thought to result from long geographical isolation. Therefore ser. *Proceri*, which is well distributed in Australia, is possibly one of the products of this long isolation. The two closely related species, *C. procerus* and *C. globosus,* both occurring in tropical savannas, have different distribution patterns (fig. 18), which may be related to the appearance of the Torres Strait. However, *C. globosus* also occurs in the Cape York Penninsula in Queensland, but whether this is a result of introduction or dispersal across the Torres Strait subsequent to its appearance is not clear.

Ser. *Refracti.* *C. refractus,* the only species in this series, is native to the eastern part of Australia. It is also found in the Pacific Islands (New Caledonia, Tahiti, Hawaii Isl.). Carlquist (1967) has discussed that some factors, such as birds and oceanic drift, have been involved

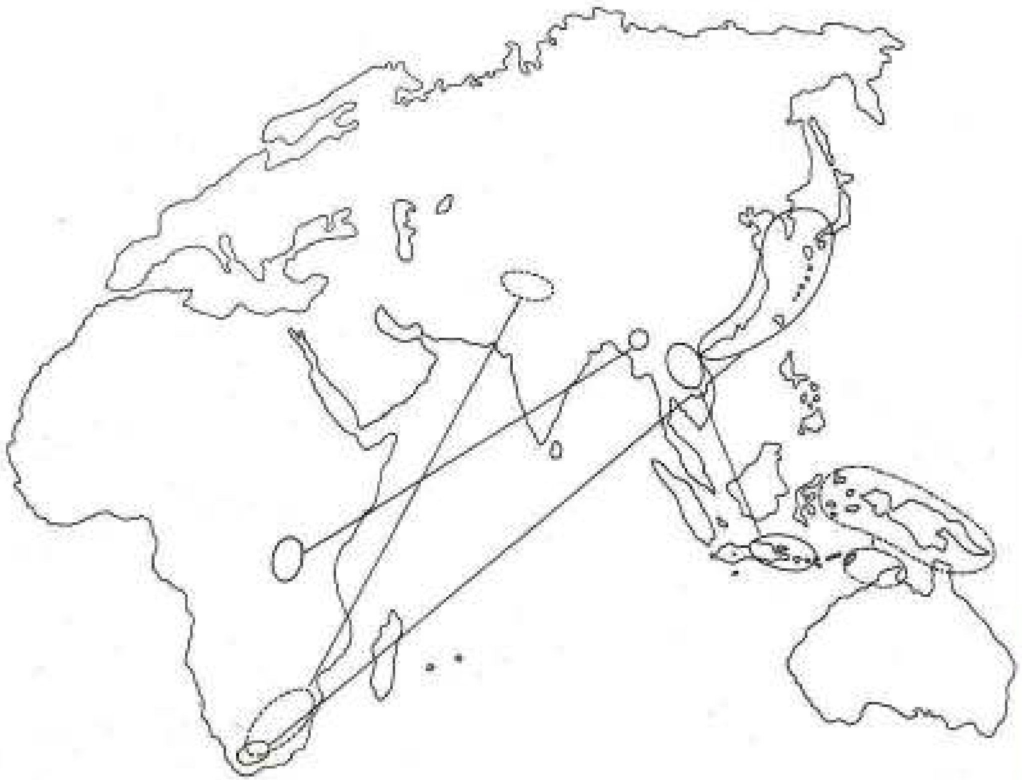


FIG. 18. Vicarious species of *Cymbopogon,*————ser. *Cymbopogon,* ————ser. *Citrati,* —.—.— ser. *Proceri.*

in long-distance dispersal to the Pacific Islands. He pointed out that in the Hawaiian flora most grasses appear to have arrived through transportation by birds; usually grass seeds are attached to bird's feathers mechanically by means of barbs, bristles, awn etc. *C. refractus* possesses an advanced dispersal organ, which is easily attached to clothes or bird's feathers. Its occurrence in the Pacific Islands, therefore, is probably the result of long-distance dispersal by birds.

Ser. *Rusae.* In Africa ser. *Rusae* occurs mainly in the Sudano-Zambezi an Region, and in Asia it is found from India to Indo-China. The distribution of this series is partly disjunct, as one of the species, *C. caesius* is widely distributed from South China, India, Ceylon to East Africa. The wide distribution of *C. caesius* can be explained, since

Table 6. OCCURRENCE OF THE SPECIES OF CYMBOPOGON IN THE DOMAINS AND SUBREGIONS IN AFRICA*)
(-j- = present; o = endemic)

Species	Western Saharo-indian Subregion	Mid Saharo-indian Subregion	Sahelian Domain	Sudanian Domain	Afro-oriental Domain	Congo Domain	Zambezian Domain	Guinean Domain	Cape Region	Karroo-Namib Region	South Arabian Domain	Mauritius
C. schoenanthus subsp. *proximus*			+	+								
C. schoenanthus subsp. *schoenanthus*	+	+			+						+	
C. commutatus			+		+							
C. floccosus					o							
C. plurinodis							+			+		
C. pospischilii					+		+					
C. sennarensia				o								
C. divaricatus					4-							
C. nervatus			+		+							
C. excavatus			+		+		+					
C. giganteus				+	+			+				
C. pruinosus												o
C. densiflorus						+						
C. validus					+	+	+					
C. afronardus					+	+						
C. dieterlenii							+					
C. marginatus									+			
C. prolixus							+		+			

*) Area designation after Clayton & Ileppcr (1974).

there is a phytogeographical relationship between Africa and India-Ceylon, which has been discussed by Wild (1965). Two possible connections between Asia and Africa have baen pointed out: 1). along the North Eastern desert in Africa, in which the xsrophytic elements follow this pattern, 2), through Madagascar and the Seychelles to Ceylon and India, which appears to have been followed by the more tropical and mesophytic, or forest elements only. *C. caesius* seems to occur in the relatively wet savannas and its distribution in both continents, therefore, tends to follow the second pattern of distribution. The rare occurrence of *C. caesius* in Iraq (fig. 17) is probably due to introduction expained *via* trade

Table 7. OCCURRENCE OP THE SPECIES OF CYMBOPOGON IN ASIA *)
(+ = present; o = endemic)

Species	Oman & N. Arabia	Afghanistan & W. Pakistan	West Himalaya	Nepal & Sikkim	India	Ceylon (Sri Lanka)	Burma	Naga & Khasi Hills	Indo China	Yunnan and South China	Formosa	Korea & Japan	Philippines
C. jwarancusa subsp. *jivarancusa*		+	+										
C. jwarancusa subsp. *olivieri*	+	+	+										
C. parkeri	+	+											
C. stracheyi			+	+									
C. gidarba					+								
C. microtheca				o									
C. polyneuros					+	+							
C. cambogiensis									+	+			
C. annamensis									+	+			
C. mekongensis									+	+			
C. clandestinus							o						
C. mandalaiaensis							o						
C. osmastonii					o								
C. goeringii										-1-	+	+	
C. tortilis									+	+	+		+
C. khasianus								+		+			
C. coloratus					+								
C. virgatus							o						
C. pendulus					+								
C. distans			+	+						+			
C. calciphilus									+	+			
C. traninnensis								+	+	+			
C. flexuasus					+								
C. nardus					+	+							

*) Area designation after Meusel *et al.* (1965), Good (1964), and Clayton & Panigrahi (1974).

Table 8. OCCURRENCE OP THE CYMBOPOGON SPECIES IN INDONESIA AND AUSTRALIA *)
(+ = present; o = endemic)

Species	Java	West Lesser Sunda Islands	East Lesser Sunda Islands	The Moluccas	New Guinea	North Australia	East Australia (Queensland)	South-East Australia	Central Australia	S.W. Australia	Bismarck Archip.	New Caledonia
C. rectus	+	+										
C. queenslandicus							o					
C. globosus				+	+		+				+	
C. procerus			+			+						
C. bombycinus						+	+					
C. gratus							o					
C. ambiguus			+			+	+	+	+	+		
C. obtectus							+	+	+	+		
C. refractus							+	+				+

*) Area designation after van Steenis (1961) and Burbidge (1960).

route from India. The distribution of two closely related species, *C. pruinosus* in Mauritius and *C. polyneuros*, supports the distribution pattern of ser. *Rusae*.

Ser. *Citrati*. This series has a wider distribution than the other series and shows an interesting disjunction between Africa and Asia (fig. 17). Nevertheless the existence of several vicarious species-pairs (fig. 18) indicates that the disjunction is not complete. *C. afronardus*, which is confined to the area around lake Victoria in East Africa, has a vicarious species, *C. virgatus*, endemic to Burma. *C. marginatus* from South Africa and *C. goeringii* from South Japan and South Korea are also closely related, as are *C. rectus* from Java and the Lesser Sunda Islands and *C. traninhensis* from Indo-China. This widely disjunct distribution is somewhat difficult to explain. However, Hartley's (1958) statement that there was a strong correlation between climatic factors and the distribution of the Andropogoneae permits some explanation. it is generally accepted that the African and Asian (notably India and

Indo-China) continents were once united. In the absent of the grass fossils it is difficult to explain whether the disjunct distribution of *C- afronardus* and *C. virgatus* is a result of continental drift. Nevertheless the disjunct areas between Indo-China and Africa have been discussed by Schnell (1962), who pointed out that the dry areas in continental S.E. Asia appeared to be a natural extension of the African distribution. The distribution of *C. afronardus,* therefore, presents quite strong evidence of Schnell's statement. The central part of Malesia, including the Philippines, Sulawesi, the Moluccas, Central and East Java, the Lesser Sunda Islands, forms a more or less single area characterized by a relatively dry climate (van Steenis 1961). This dry area extends to Indo-China across the South-China sea. Thus this more or less continous area explains the disjunct distributions of *C. rectus* and *C. traninhensis. C. queenslandicus,* endemic in Queensland, is the only species of ser. *Citrati* found in Australia, and is related to *C. rectus.* Their distributions support the close relationship between Australia and the Lesser Sunda Islands (van Steenis 1961).

From the above discussions it seems that ser. *Cymbopogon* has evolved towards an adaptation to dry regions. Ser. *Proceri* and ser. *Refracti* have evolved independently during long isolation. The distribution pattern of ser. *Rusae* and ser. *Citrati* shows a more or less parallel evolution.

ECOLOGY

Although *Cymbopogon* is rarely dominant in native grasslands, there is evidence that *Cymbopogon* species become dominant in grazed grasslands in, for example, Australia (Turner 1895), Africa, e.g. Ghana (Rose-Innes, pers. comm.), and in India (Whyte 1957). This may be due to their unpalatability to grazing animals, since the essential oils possessed by most species often produce an unpleasant taste.

Apart from cultivated species (notably *C. winter anus* and *C. citratus) Cymbopogon* species occur in tropical, subtropical and mountain grasslands and in arid regions, supporting semi-desert and desert vegetation, and can roughly be divided into two major groups depending on the environment in which they occur. The groups are: 1) species in desert and semi-desert areas, and 2) species in savannas, including lowland and mountain grasslands.

Desert and semi-desert regions. There are eight species of *Cymbopogon* found in the semi-desert areas as well as in the dry savannas, *C. schoenanthus* subsp. *schoenanthus* occurs only in the semi-desert areas, and *C. parkeri,* which is found in dry savannas and semi-desert regions, often forms a community in the desert areas in Northern Arabia and Iraq. *C. obtectus* and *C. ambiguus* grow among the spinifex grasses in the semi-desert areas in Australia (Moore 1964; Lazarides 1970). These two species are also found in the dry savannas. Since in desert the humidity is low and the water supply is limited, the desert plants may respond to drought by reduction in physiological activity, such as shedding or reducing their transpiring organs or shortening their life. *Cymbopogon* species growing in desert areas commonly posses filiform, rigid leaf-blades. The basal sheaths are also rigid, persistent and form dense tufts. It is generally assumed that increase in xeromorphy has meant increased specialization and relative evolutionary advance. The reduction of the leaf surface in xeromorphy plants is to be considered derivative (Bews 1925, 1929). However, it is not clear whether this applies to the reduction of the leaf surface in *Cymbopogon* of arid regions.

Savannas. Savanna usually refers to a disclimax plant community, in which grass species are dominant but with scattered shrubs and trees. Extensive savannas occur in the continental area of Africa, Asia and Australia, where the dry season is definite and the rainfall is sufficient to keep the soil moist during the vegetative period. In some areas, as in Africa and Australia, the savannas are climatically controlled. Other factors are also involved in maintaining the grasslands or savannas, such as fire and grazing. The fire may be produced by such factors as volcanism, lightning and man (Bews 1929; Loogen 1942; van Steenis 1972). Various types of savanna, such as scattered tree savanna, semi-desert savanna etc., are found in Africa. *Cymbopogon* species occur in all type of these savannas and together with *Hyparrhenia* spp., *Themeda triandra,Chloris gayana* etc., often form high grass community (Edwards and Bogdan 1957; Clayton 1969). In Australia the grass vegetation varies from tropical savanna, tussock grassland to woodland and sclerophyll forest. *C. procerus* is confined to the tropical savannas in northern part of Australia, whereas the other five species of *Cymbopogon* in Australia occur in the drier savannas and woodlands. Extensive grassland occur in Asia, where there is a pronounced monsoon climate (Whyte 1957), and *Cymbopogon* species are commonly found and often occupy large areas of open lowland grasslands and the low hills of the plateau.

In New Guinea the savannas are found in the area where the rainfall in markedly seasonal (Henty 1969). Compared with the areas discussed above the annual rainfall in New Guinea is relatively high for grassland. The most extensive savannas in New Guinea occur in the areas with the lowest rainfall, both in the lowlands and in the highlands (Robbins 1960), and the only *Cymbopogon* species in New Guinea, *C. globosus,* grows in the lowland savannas.

It is interesting to note that *C. rectus,* the species endemic to Java and West Lesser Sunda Isl., is found in the mountain grasslands. The mountain grasslands in East Java (especially) is maintained by regular fires paused by the long dry season together with frequent volcanic eruptions and the common release of hot air from the craters. This species grows either in the open grasslands, along the mountains tracts, or in the *Casuarina* parklands. Mountain grassland also occurs in Ceylon. Compared with Java, Ceylon has been geologically stable for a very long period (Fernando 1968). The dominant grass is the tall, tufted *C. nardus* var. *confertiflorus.*

Since both environment are different, it is interesting to see whether the species present in each show any characteristic feature in their habits. The select feature of the habits, the habitat and the number of the species occurring in each habitat are given in table 9.

Table 9. NUMBERS OF CYMBOPOGON SPECIES, THE HABITS AND FEATURES IN TWO DIFFERENT HABITATS

	Semi-desert	*Savanna*
Number of species	one (restricted) 8 (partly)	44 8 (partly)
Culm	relatively short, usually less than 20 cm **high**	relatively tall, usually more than 20 cm high
Old basal leaves	persistent	absent or often persistent
Leaf-blades	filiform, rigid	flat, often very brtfad (more than 8 mm wide)
Racemes	densely hairy	sparcely, rarely densely hairy
Abaxial ribs of leaf-blades	deep and narrow	absent or shallow
Prickle-hairs on the abaxial surface of leaf-blades	abundant	absent or not common

It has been recorded (Verboom, dicussed by Clayton 1969) that the basal sheaths in *Hyparrhenia smithiana* and *H. nyasae* are often soaked with dew in the morning, and may be concerned with conserving water from this source. It is possible that this situation applies to some *Cymbopogon* found in the desert areas. Moreover they may serve as additional protection for the dormant buds during the dry season.

The degree of hairiness on the rachis internodes and pedicels of the raceme is interesting. In ser. *Cymbopogon* (except *C. mierotheca* and *C. gidarba)* which is found mainly in arid regions, the racemes are usually densely pilose or more or less pilose, whereas in ser. *Rusae* and ser. *Citrati,* which are found in savannas, the racemes are sparcely hairy. Densely hairy racemes of ser. *Cymbopogon* is probably an adaptation of arid condition. Nevertheless this situation does not apply to ser. *Proceri,* since both savanna and desert plants or species have pilose even woolly racemes.

The prominent ribs on the abaxial surface of the leaf-blades in the desert plants are probably also an adaptation to dry conditions; the furrows, in which the stomata occur, are deep and narrow between the ribs and seem to protect stomata in such a way as to reduce physiological activity.

From the discussion above it is clear that there is a correlation between the habit and habitats in *Cymbopogon,* and the reduction of leaf surface is merely an adaptation to arid conditions. Increasing hairiness, on the other hand, shows increasing xeromorphism in ser. *Cymbopogon,* but it is not so in ser. *Proceri.*

CHROMOSOMES

Chromosome number

Number, size and meiotic behaviour of chromosomes have been widely studied in the Gramineae and many recent taxonomic treatments have utilized cytological data, as well as morphological and anatomical information (e.g. Stebbins & Crampton 1961). The first application of cytological data to the taxonomy of grasses was that of Avdulov (1931), who showed that the number and size of the chromosomes was useful in helping to delimit the tribe.

Chromosome data, in general only referring to the number, were previously available for about 20 species of *Cymbopogon* (table 10). Two new counts reported here were obtained from the mitotic karyotypes in root tip meristems of the plants growing in the greenhouse at Reading. Root tips were collected between 11.30 and 12.00 a.m. and pretreated in saturated paradichlorobenzene for 2V2 — 3 hrs. They were thep transferred to freshly made fixative of acetic acid and absolute alcohol (1 :2) for 2 hrs. and then put in 70% alcohol, prior to staining with propionic orcein. The author would like to thank to Mr. S. Jacobs of Sydney (Australia) for providing the seeds of *C. procenm* and *C. bombycinus,* and the Department of Botany, University of Groningen (Holland), for supplying living plants of *C. citratus.*

De Wet (1954b) deduced that the basic number of *Cymbopogon* was x = 10, as in the other member of the Andropogoneae, although the basic number for the tribe may be 5 (Celarier 1956). Gupta (1969a) showed that the series in *Cymbopogon* seemed to adapt different polyploid levels. The species in ser. *Cymbopogon* and ser. *Rusae* are either diploid or tetraploid, whereas those of ser. *Citrati* are either tetraploid or hexaploid. It is interesting to note that three species of ser. *Cymbopogon,* occurring in the arid regions, have the chromosome number 2n = 40; it seems that polyploidy in this series is more likely to have reduced their adaptation to arid conditions. Ser. *Citrati* which has a wide distribution pattern, is in fact a polyploid complex and it seems that this complex is a mature one (Stebbins 1971); each of the diploid species (table 10) is often confined to a small area (tables 6 & 7). Polyploid complex is useful for analising problem of plant geography and phylogeny, since trends of polyploidy are from lower to higher level (Stebbins 1971). However, it is premature to suggest any phylogenetic relationship within the genus *Cymbopogon,* since the cytological data is not complete.

There seems to be some correlation between the polyploid level of the plants and the essential oil they contain, as reported by Jannaki Ammal & Gupta (1966) who showed that the species with high chromosome number, hexaploids, yield more oil than its diploid relatives.

Hybridization

There is no information on experimental hybridization in *Cymbopogon.* There have, however, been various reports of natural hybridization, but some are certainly open to question. Bor (1953) discussed possible hybridization among species which are closely related to one another, such as *C. flexuosus* and *C. nardus* var. *confertiflotus, C. distans* and *C. gidarba* whose distributions overlap in India. He recognized intermediate plants between the two species, but the evidence he gave is very weak, since *C. flexuosus* is a very variable species. Quite possibly the intermediate plant is one of the extreme variants in *C. flexuosus.*

Table 10. CHROMOSOME NUMBERS OF CYMBOPOGON SPECIES

Species	Origin	2n	Authors
Ser. *Citrati*			
C. afronardus	Africa	20	Tateoka (1965)
C. citratus	Culta	40, 60	Bor (1953)
	Culta, Holand	60	this study
C. coloratus	India	40	Gupta (1969a)
C. distans	India	20, 40	Gupta (1969a)
C. flexuosus	India	20	Ragh. & Arora (1958)
	India	40, 20 -h 2b	Gupta (1969a)
C. khasianus	India	60	Gupta (1969a)
C. nardus			
var. *nardus*	India	40	Ragh. & Arora (1958)
C *wnvfJiii*			
var. *confertiflorus*	India	60	Ragh. & Arora (1958)
C. pendulus	India	30, 60	Gupta (1969a)
C. prolixus	Transvaal	40	de Wet & Anderson (lyoo)
C. tortilis	South China	20	Chen & Hsu (1962)
C. validus	South Africa	20	de Wet (1954a)
Ser. *Rusae*			
C. martinii	Culta	20, 40	Ragh. & Arora (1958) Mehra *et al.* (1962) Gupta (1969a)
C. caesius	India	20	Gupta (1969a)
C. excavatus	South Africa	20	de Wet (1954)
C. polyneuros	India	20	Gupta (1969a)
Ser. *Cymbopogon*			
C. jivarancusa			
subsp. *jivarancusa*	India	20	Ragh. & Arora (1958) Mehra *et al.* (1962) Gupta (1969a)
C. jivarancusa			
subsp. *olivieri*	Iraq	20	Gould (1956)
	India	20	Gupta (1969a)
C. parkeri	India	20, 40	Gupta (1969a)
C. stracheyi	India	20, 40	Gupta (1969a), Mehra & Sharma (1972)
C. plurinodis	South Africa	40	de Wet (1954) Mehra & Sharma (1972)
C. microtheca	India	20	
Ser. *Proceri*			
C. bombycinus	Australia	20	Celarier (unpubl.)
		20	this study
C. procerus	Australia	20	this study

Blake (1974) recognized some natural hybrids in Australia. A good example of a hybrid is that of *C. refractus* and other species of *Cymbopogon,* i.p. *C. queenslandicus* and *C. bombycinus. C. refractus* has glabrous rachis internodes and pedicels, and awnless sessile spikelets (very rarely with awn) ; some specimens with pilose rachis internodes and pedicels are also found. It does not seem right to put such plants in *C. refractus,* and Blake (1974) recognized such plants as hybrid between *C. refractus* and *C. queenslandicus.* The other example, which is discussed later under the species concerned, is that of hybrids between *C. bombycinus* and *C. ambiguus* in Queensland.

DISPERSAL

The fruits or caryopses of grasses usually do not fall off themselves. They are surrounded either by lemma and palea or by glumes, lemma and palea. These surrounding structures often assist in wind dispersal. Hairs and awns also help in wind dispersal but they may assist the grass fruits for dispersal by animals.

In the Andropogoneae the caryopsis is protected by the hard, large glume of the sessile spikelet. The spikelets in this tribe fall entire below the callus where the rachis disarticulate. Thus the disseminule consists of a rachis internodes, a sessile spikelet and a pedicellate spikelet with its pedicel. The dispersal mechanism is usually performed by the awns and callus which are entangled to one's clothing or animal's body, e.g. pointed callus in *Heteropogon contortus* (L.) P. Beauv. In *C. refractus* the spikelets are usually awnless, the callus, rachis internodes and pedicels are nearly always glabrous. Thus the dispersal mechanism in this species is performed by the sharply pointed pedicellate spikelet (p. 235).

ECONOMIC USES

Oil grass, lemon grass and serai of Indonesia and Malay are common names for the *Cymbopogon* species. It is almost impossible for the South Asian people to cook without using serai, namely *C. citratus.*

The aromatic smell is characteristic of all *Cymbopogon* species and it seems that any part of the plant smells pleasantly. Even so among 55 species there are only 5 species cultivated commercially for the oils. They are *C. nardus, C. winteranus, C. flexuostis, C. citratus* and *C. martinii.* The oil can be obtained by steam distillation from leaves dried for 3 - 4 hrs. in bright sunlight. *C. flexuosus* and *C. citratus* contain

0.2 - 0.4% oil, depending on the season and the condition of the plant. *C. nardus* contains 0.5% oil and *C. winteranus* 0.7% oil, whereas *C. martinii* contains 0.6%. Lemon grass oil, which can be obtained from *C. flexuosus* and *C. citratus,* has a strong odour of lemon and is used as a perfume for soap and in medicine, since the oil contains high percentage of citral, which is the source of B-ionone used in the synthesis of vitamine A (Burkill 1935; Guenther 1950). Citronella oil, which is produced in large quantities in Ceylon, Java and West Indies is used in perfumery and is also used as a perfume for soap and in insect repellent.

Most of the wild species are used locally by native people for making tea or in medicine. *C. jwarancusa* is used to suppress fevers in India (Blane 1790; Stapf 1906; Bor 1960). *C. dieterlenii,* together with *Elionorus argenteus,* is used as a poultice for wound in South Africa; the dried root of *C. marginatus* are used as an enema for stomachache (Watt & Breyer-Brandwijk 1932).

Usually animals do not eat *Cymbopogon* species, because of unpleasant taste. However, the young plants of some species (e.g. *C. schoenanthus, C. bombycinus, C. refractus)* are the most important grazing plants for all livestocks, since they grow quickly after the rain (Turner 1895; Bor 1968). Only when the grass becomes old, it is unpalatable and then is used for thatching (Turner 1895; Uphof 1968).

In the areas of low rainfall *C. jwarancusa,* together with other species, such as *Panicum antidotale, P. turgidum, Lasiurus hirsutus,* is recommended for the fixation and reclamation of sand dunes in Rajasthan, India (Prakash & Chowdhary 1957).

TAXONOMY

CYMBOPOGON Spreng.

Cymbopogon Spreng., PI. Pugill. 2: 14. 1815; Stapf *in* Kew Bull. 1906: 297-363. 1906; *in* Prain, Fl. Trop. Afr. 9: 265. 1919; Chiovenda, Gram. Ess. 1909; Domin *in* Bibl. Bot. 85: 273. 1915; A. Camus *in* Rev. Bot. Appl. Colon. 1: 270. 1921; Pilger *in* Engl. & Prantl, Pfl. Fam., ed. 2, 14e: 162. 1940; Bor *in* J. Bomb. Nat. Hist. Soc. 51: 890, 897. 1953; Blake *in* Proc. Roy. Soc. Queensl. 80: 69. 1969; *in* Contr. Queensl. Herb. 17: 29. 1974. — *Andropogon* sect. *Cymbopogon* (Spreng.) Steud., Syn. PI. Glum. 1: 383. 1854. — Type species: *C. schoenanthus* (L.) Spreng. *(Andropogon 8choenanthus* L.).

Gymnanthelia Schweinf., Beitr. Fl. Aethiop. 1: 299. 1867, *nom. nud.* (ut *Gymnanthelia* Anderss.). — *Andropogon* subgen. *Cymbopogon* sect, *Gymnanthelia* Hackel *in* DC, Monogr. Phan. 6: 594. 1889.

Perennials or rarely annuals, tufted, aromatic, very rarely not so. Flowering culms 30 cm to 3 m high, glabrous or pubescent below or on the occasionally swollen nodes. Leaf-blades filiform, linear to broadly linear with long filiform tips, narrow, rounded or cordate (often amplexicaul) at the base, glabrous or hairy to the base, margins often scabrid, smooth or rough on both surfaces. Leaf-sheaths tightly embracing the culm, the basal sheaths becoming loose and slipping, glabrous or densely tomentose. Ligule chartaceous or membrano-chartaceous, glabrous or ciliate on the back. Spathate panicle compound or decompound; the ultimate unit, a pair of racemes, borne upon a common peduncle, supported by a spatheole; peduncle filiform, terete or concave on one side, glabrous or pubescent at the apex; spatheole herbaceous or not so, usually glabrous, margin hyaline. Racemes consisting 4 to 7 pairs of spikelets, one of each pair sessile and the other pedicellate, terminated by one sessile and two pedicellate spikelets; raceme-bases usually deflexed at maturity, usually the lower one shorter and of different structure to the upper, or both equal, deflexed or hardly deflexed at maturity; pedicels and rachis internodes slender, almost flat on one side, pilose along the margins, glabrous or pubescent on the back, often woolly all over, rarely glabrous; homogamous pairs only one, sometimes absent, at the base of the lower raceme-base, male or barren. Sessile spikelet containing two florets, lower sterile reduced to an empty lemma; upper hermaphrodite, usually awned, very rarely awnless; lower glume as long as the spikelet, 2-keeled, with narrow to broad wings along the keels, or wingless, membrano-chartaceous, nerved or nerveless, flat or deeply concave on the back, or with median groove below the middle, usually glabrous, rarely pubescent; upper glume boat-shaped, 1-keeled on the back, membrano-chartaceous; lemma of the lower floret hyaline, glabrous, often ciliate along the margins; upper floret hermaphrodite; lemma hyaline, 2-lobed, rarely entire, usually with a short or long perfect awn, ciliate along the margins; palea usually absent, if present then as a minute hyaline scale, obovate, as long as the lodicules; lodicules 2, cuneate or truncate; stamens 3; stigmas 2, plumose, emerging laterally; caryopses oblong, subglobose, rarely obovate, with basal hilum, embryo half as long as the grain. Pedicellate spikelet male or reduced to one or two empty glumes; lower glume as long as the spikelet, many nerved, often rounded on the back, membrano-chartaceous to chartaceous; upper glume membrano-chartaceous to hyaline, nerveless; palea absent; stamens 3.

HABITAT: In savannas; lowland and mountain grasslands; in semi-desert, rarely in desert areas; rarely in sandy coasts.

DISTRIBUTION: Old World tropics and subtropics to Australia; one is naturalized in the Pacific Islands; one is introduced and has become naturalized in Brazil; five species are cultivated elsewhere in the tropics.

MORPHOLOGICAL AFFINITY OF THE SPECIES OF CYMBOPOGON: From the previous discussions it can be seen that each series in *Cymbopogon* forms a natural group, and that the species in each series are closely

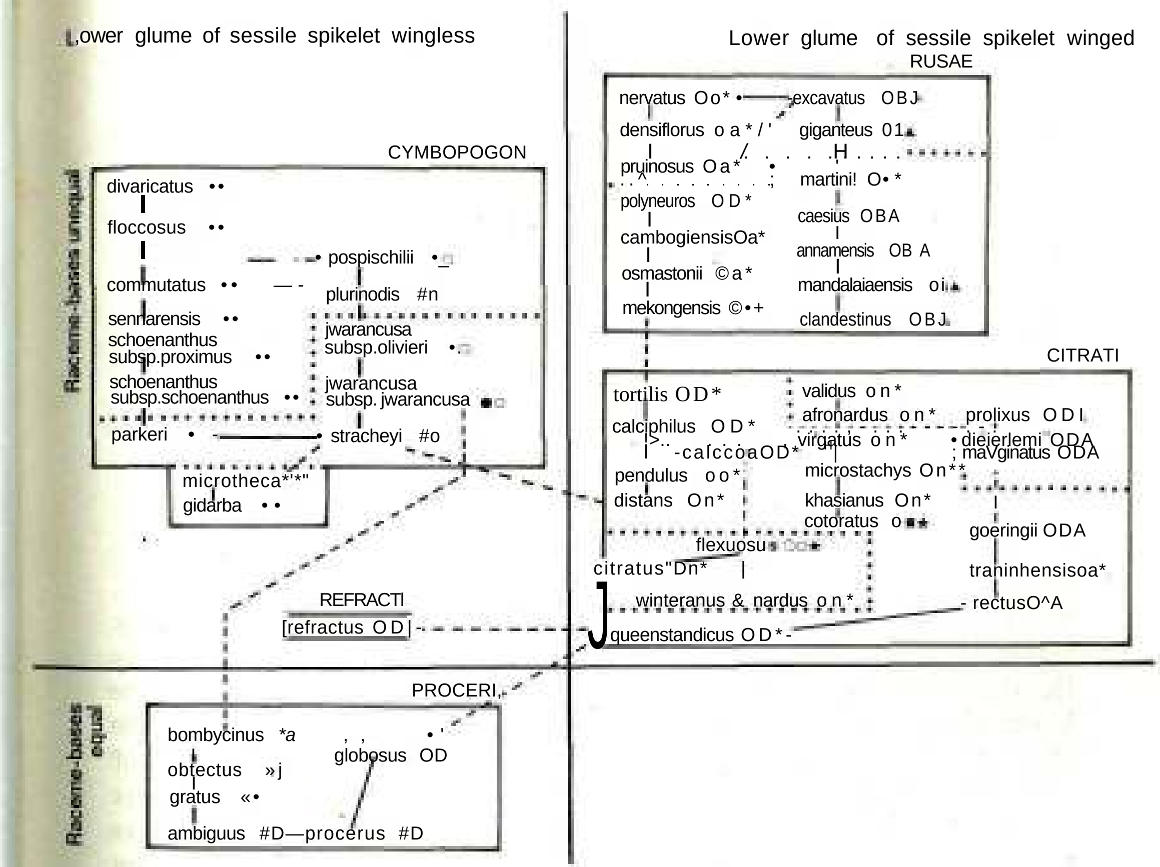


FIG. 19. Morphological affinity of the species in *Cymbopogon:*
• lower glume of sessile spikelet concave on the back;
o lower glume of sessile spikelet flat ;
© lower glume of sessile spikelet flat with median groove on the back;
a lower raceme-base and/or lowermost pedicel swollen;
n lower raceme-base and/or lowermost pedicel not swollen;
A wing broad;
* wing narrow.

related. On the other hand it is rather difficult to indicate the relationship between the series. A diagram showing (the relationships within and between the series in the genus using Sealy's (1958) method is presanted in fig. 19.

Ser. *Proceri.* Owing to the equal raceme-bases which are often not deflexed at maturity this series seems io approach the genus *Andropogon.* Moreover in *C. qmbigum* the homogamous pair is absent as is the situation in *Andropogon.* Each species in this series is well-defined, with very little variation. *C. procerus* and *C. globosus* are related and the former is considered near to *C. ambiguus* as it has equal, not deflexed raceme-bases. *C. grains* is a rare species in which the homogamous pair is absent, and seems to connect the line between *C. ambiguus* in one side and *C. obtectus* and *C. bombycinus* in the other.

Ser. *Cymbopogon. C. microtkeca* and *C. gidarba)* which are found in the eastern part of India are not aromatic and do not possess oil cells in their tissues, their rachis internodes and pedicels are wider above with hollow tips. However, the lower glumes of the sessile spikelet in these two species are concave on the back and wingless, which puts these two species near to *C. straeheyi.* Ser. *Cymbopogon* and ser. *Proceri* possess wingless lower glumes of the sessile spikelet and densely hairy rachis and pedicels. Their relation is rather weak, for they occur in different areas (fig. 16).

Ser. *Citrati.* Although ser. *Citrati* is well-defined by the flat, often wrinkled lower glume of the sessile spikelet, this series is heterogeneous. The relation of this series with ser. *Cymbopogon* is through *C. distans.* Gupta (1969b) put this species in ser. *Cymbopogon,* because it possesses the characteristics of ser. *Cymbopogon;* the leaf-blades are filiform, the lower glumes of the sessile spikelet are often wingless; moreover the oil in *C. distans* contains piperitone, which is the main constituent of the oil in ser. *Cymbopogon,* as well as citral. However, the structure of the leaf-epidermis and the flat lower glume of the sessile spikelet leave no doubt that *C. distans* belongs to ser. *Citrati. C. queenslandicus,* an endemic species in Eastern Australia, possesses some undeflexed raceme-bases. Through this species ser. *Citrati* is related to ser. *Proceri.*

Ser. *Rusae.* This series is more or less homogeneous. The relationships among the species, therefore; are very close. On the other hand the relation with the other series is not clear. The structure of the leaf epidermis shows a slight similarity with ser. *Cymbopogon.* Ser. *Rusae* is also related to ser. *Citrati* through *C. mekongensis,* which' has narrow leaf-blades with narrow base, and a shallow median groove showing similarity to ser. *Citrati.*

Ser. *Refracti.* It is rather difficult to place this series. Nevertheless ser. *Refracti* resembles ser. *Proceri* by the reduced pedicellate spikelet, and *C. refractus,* the only species in this series, is related to *C. queenslandicus* of ser. *Citrati* by having a flat glume of the sessile spikelet.

It seems that *C. refractus* crosses freely with the other species, i.e. *C. bombycinus* (ser. *Proceri)* and *C. queenslandicus* (ser. *Citrati),* producing natural hybrids in the areas where their distributions overlap (Blake 1974). Therefore ser. *Refracti* lies between ser. *Proceri* and ser. *Citrati.*

KEY TO THE SERIES AND SPECIES OP CYMBOPOGON

1. Lower glume of sessile spikelet with deep median groove from the middle downwards, often corresponding to a keel inside; leaf-blades rounded to cordate at the base; perennials, rarely annuals ser. *Rusae*
1. Lower glume of sessile spikelet flat or concave on the back; leaf-blades narrow or attenuate at the base; perennials
    2. Pedicellate spikelet of two or more glumes, lower glume acuminate, narrowly lanceolate or ovate-lanceolate; rachis internodes pilose or woolly
        3. Lower glume of sessile spikelet flat, often wrinkled on the back, with narrow to broad wings along the keels ser. *Citrati*
        3. Lower glume of sessile spikelet shallowly or deeply concave on the back, wingless to very narrowly winged
            4. Raceme-bases unequal, the lower shorter, often swollen, deflexed at maturity; pedicellate spikelet with one male floret; innovation intravaginal ser. *Cymbopogon*
            4. Raceme-bases equal, rarely deflexed at maturity; pedicellate spikelet barren, consisting of 2 glumes only; innovation extravaginal or a combination between extravaginal and intravaginal ser. *Proceri*
    2. Pedicellate spikelet of one glume only, linear, sharply pointed, oblique; rachis internodes usually glabrous ser. *Refracti*

I. SER. REFRACTI

There is only one species 1. *C. refractus*

II. SER. PROCERI

1. Spatheole chartaceous, rachis internodes densely pilose
    2. Lower glume of sessile spikelet 5.5—7 mm long; homogamous spikelets absent; sessile spikelet of lowermost pair of lower raceme hermaphrodite and awned 7. *C. ambiguus*
    2. Lower glume of sessile spikelet not more than 4.5 mm long; homogamous spikelets present
        3. Lower glume of sessile spikelet obtuse; spatheole not more than 22 mm long (rarely 25 mm long); raceme-bases rarely deflexed at maturity; spathate panicle often globose 3. *C. globosus*

3. Lower glume of sessile spikelet acuminate; spatheole usually over 22 mm long; raceme-bases never deflexed; spathate panicle elongated 2. *C. procerus*

1. Spatheole herbaceous; rachis internodes and pedicels densely woolly
4. Sessile spikelet awned
5. Lower glume of sessile spikelet narrowly lanceolate, deeply concave on the back, nerveless, 5 mm long, 1 mm wide 4. *C. bombycinus*
5. Lower glume of sessile spikelet ovate-lanceolate, concave at the base, 2(4)-nerved, 5-6 mm long, 1.5 mm wide 5. *C.obtectus*
4. Sessile spikelet awnless 6. *C. gratus*

III. SER. CYMBOPOGON

1. Rachis internodes and pedicels pilose or woolly; plants aromatic
2. Lower glume of sessile spikelet narrowly lanceolate, subchartaceous; rachis internodes and pedicels densely pilose or woolly
3. Spathate panicle narrow, simple; leaf-blades geniculate
4. Lowermost pedicel of lower raceme not swollen
5. Ligule less than 1 mm long; basal sheath and leaf-blades often curled 9a. *C. jwarancusa* subsp. *jwarancusa*
5. Ligule usually more than 1 mm long; basal sheath and leaf-blades rarely curled 9b. *C. jwarancusa* subsp. *olivieri*
4. Lowermost pedicel swollen
6. Lower glume of sessile spikelet glabrous on the back; raceme more than 20 mm long; spatheole 23 — 30 mm long 8a. *C. schoenanthus* subsp. *schoenanthus*
6. Lower glume of sessile spikelet pubescent on the back; raceme less than 20 mm long; spatheole 13 — 20 mm long 8b. *C. schoenanthus* subsp. *proximus*
3. Spathate panicle more or less compound, elongated; leaf-blades erect 10. *C. sennarensis*
2. Lower glume of sessile spikelet lanceolate, chartaceous; rachis internodes and pedicels densely pilose along the margins, often sparsely pilose, sometimes glabrous, on the bade
7. Lowermost pedicel swollen
8. Basal sheath pubescent; lower glume of sessile spikelet 2 — 3 nerved 14. *C. parkeri*
8. Basal sheaths glabrous; lower glume of sessile spikelet nerveless
9. Leaf-blade flat
10. Lower raceme-base slender not fused with the swollen lowermost pedicel; lower glume of sessile spikelet with little bump at the base 13. *C. commutatus*

10. Lower raceme-bases swollen and fused with the swollen lowermost pedicel; lower glume without bump at the base 12. *C. floccosus*
9. Leaf-blades filiform 11. *C. divaricatus*
1. Lowermost pedicel swollen
11. Upper racemes with 5 pairs of spikelets; peduncle less than 8 mm long, stift
12. Basal sheaths, glabrous; leaf-sheaths glabrous 16. *C. stracheyi*
12. Basal sheaths tomentose, leaf-sheaths often densely tomentose 15. *C. plurinodis*
11. Upper racemes with 7 pairs of spikelets; peduncles more than 15 mm long, flexuous 17. *C. pospischilii*
1. Rachis internodes and pedicels more or less glabrous; plants not aromatic
13. Raceme 23 mm long; lower glume of sessile spikelet with little bump at the base, shallowly concave on the back; awn 16 mm long, leaf-blades pubescent on the upper surface; basal sheaths rounded on the back 18. *C. gidarba*
13, Raceme 12 —15 long; lower glume of sessile spikelet without little bump, deeply concave on the back; awn 10 mm long; leaf-blades glabrous, except the lower part with spreading white hairs; basal sheaths more or less 1-keeled on the back 19. *C. microtheca*

IV. SER. RUSAE

1. Culm with stilt roots at the lower nodes, often solitary, rarely loosely tufted; sometimes annuals
2. Lower glume of sessile spikelet with oil marks on each side of median groove; spikelet glabrous
3. Lower glume narrowly winged, with shallow median groove; awn 14 — 15 mm long; leaf-blades thin and soft in texture, cordate at the base 20. *C. nervatus*
3. Lower glume broadly winged, with deep median groove; awn 25 mm long, leaf-blades moderately hard in texture, rounded at base 22. *C. mandalaiaensis*
2. Lower glume of sessile spikelet without oil marks; spikelet pubescent 21. *C. clandestinus*
1. Culm tufted, without stilt roots at the lower nodes; perennials
4. Leaf-blades cordate at the base
5. Lower glume of sessile spikelet deeply grooved; awn more than 10 mm long
6. Ligule not more than 1.5 mm long; lower glume of sessile spikelet narrowly winged 23. *C. giganteus*
6. Ligule 4.5 mm long; lower glume broadly winged 26. *C. martinii*
5. Lower glume of sessile spikelet shallowly grooved; awn less than 7 mm long 25. *C. densiflorus*

4. Leaf-blades rounded to attenuate at the base
   7. Lowermost pedicel swollen
      8. Ligule more than 4 mm long; sessile spikelet less than 4 mm long
         9. Lower glume of sessile spikelet broadly winged, more or less obtuse; leaf-blades rounded at the base 27. *C. caesius*
         9. Lower glume narrowly winged, wider at the middle, more or less acuminate; leaf-blades attenuate at the base 24. *C. excavatus*
      8. Ligule less than 1 mm long; sessile spikelet more than 4.5 mm long 31. *C. annamensis*
   7. Lowermost pedicel not swollen
      10. Sessile spikelet awned; leaf-blades up to 13 mm wide
         11. Lower glume of sessile spikelet more or less 3-toothed, plants not more than 45 cm high 28. *C. pruinosus*
         11. Lower glume of sessile spikelet entire or rarely 2-toothed, plants more than 50 cm high
            12. Ligule about 1 mm long; lower glume more than 4 mm long
               13. Leaf-blades 6 — 7 mm wide 30. *C. polyneuros*
               13, Leaf-blades 3.5 mm wide 33. *C. mekongensis*
            12. Ligule more or less 5 mm long; lower glume of sessile spikelet 3 — 3.2 *mm* long 29. *C. cambogiensis*
      10. Sessile spikelet awnless; leaf-blades 17 mm wide 32. *C. osmastonii*

V. SER. CITRATI

1. Leaf-blades 2 mm wide, often filiform
   2. Lower glume of sessile spikelet 7 mm long, narrowly lanceolate, sometimes oblique, cliartaceous, narrowly winged; racemes often with 7 pairs of spikelets, 22 — 35 mm long 46. *C. distans*
   2. Lower glume of sessile spikelet less than 6.5 mm long, ovate-lanceolate to broadly lanceolate, subchartaceous, broadly winged; racemes usually with 5 pairs of spikelet, 22 mm long 35. *C. dieterlenii*
1. Leaf-blades more than 3.5 mm wide, flat, linear
   3. Lowermost pedicel not swollen; rachis internodes and pedicels pilose along the margins (except in *C. marginatus)*
      4. Lower glume of sessile spikelet broadly winged, 5 — 7 mm long (except in *C. goeringii* var. *hongkongensis,* 4.5 mm long)
         5. Leaf-blades 3.5 mm wide
            6. Rachis internodes and pedicels densely pilose along "the margins and on the back 34. *C. marginatus*
            6. Rachis internodes and pedicels pilose along the margins, glabrous on the back
               7. Lower glume of sessile spikelet chartaceous, flat on the back, 3-nerved 36. *C. prolixus*
               7, Lower glume of sessile spikelet subchartaceous, slightly rounded on the back, (3)5 — 6-nerved 38. *C. goeringii*

                  8. Lower glume of sessile spikelet 6 mm, 5 — 6-nerved 38a. var. *goeringii*
                  8. Lower glume of sessile spikelet 4.5 mm long, 3 — 4 nerved 38b. var. *hongkongensis*
         5. Leaf-blades more than 5 mm wide
            9. Awn more than 14 mm long; lower glume of sessile spikelet lanceolate to broadly lanceolate; nodes usually bearded
               10. Lower glume of sessile spikelet 4 — 5-nerved, glabrous 37. *C. rectus*
               10. Lower glume of sessile spikelet 2-nerved or nerveless, often tomentose on the back 40. *C. traninhensis*
            9. Awn less than 12 mm long; lower glume of sessile spikelet oblong-lanceolate; nodes glabrous; racemes slender 39. *C. khasianus*
      4. Lower glume of sessile spikelet narrowly winged, 3.5 — 5 mm long
         11. Leaf-blades 5 — 10 mm wide
            12. Lower glume of sessile spikelet concave at the base
               13. Racemes 17 — 20 mm long, often deflexed; awn 10 —12 mm long; lower glume of sessile spikelet deeply concave in the lower part 55. *C. queenslandicus*
               13. Racemes 10 —12 mm long, nearly deflexed, awn 5 — 8 mm long; lower glume of sessile spikelet shallowly concave in the lower part 52. *C. microstachys*
            12. Lower glume of sessile spikelet flat and often wrinkled on the back
               13. Culm more than 150 cm high
                  14. Raceme slender, 20 mm long 54. *C. calcicola*
                  14. Raceme not more than 17 mm long
                     15. Panicle contracted; rachis internodes and pedicels rigid; lower glume of pedicellate spikelet 7(9)-nerved 47. *C. validus*
                     15. Panicle interrupted, all parts rather loose; lower glume of pedicellate spikelet 5-nerved
                        16. Ligule 12 mm long; sessile spikelet 4.5 — 5 mm long, 1 — 1.2 mm wide 48. *C. afronardus*
                        16. Ligule 3 mm long; sessile spikelet 3.5 mm long, 0.8 mm wide 49. *C. virgatus*
               13. Culm less than 120 cm high
                  17. Nodes glabrous; basal sheath glabrous
                     18. Racemes in fascicle of 4 pairs; leaf-blades 10 mm wide; sessile spikelet 5 — 6 mm long 45. *C. pendulus*

18. Raceme not in fascicle; leaf-blades 5 mm wide; sessile spikelet 4 mm long 50. *C. tortilis*
17. Nodes bearded; basal sheath pubescent; lower glume of sessile spikelet membrano-chartaceous, nerveless or 2-nerved 51. *C. calciphilus*
11. Leaf-blades more than 15 mm wide
19. Sessile spikelet awnless; basal sheaths remain attached at the base, whitish green 43. *C. citratus*
19. Sessile spikelet awned; basal sheaths loose often slip from the culm, green to purplish green
20. Lower glume of sessile spikelet often nerveless narrowly lanceolate; leaf-blades with long spreading hairs at the base on the upper surface 44. *C. flexuosus*
20. Lower glume of sessile spikelet often 2 — 3-nerved, lanceolate; leaf-blades glabrous
21. Panicle congested, interrupted
22. Lower glume of sessile spikelet narrowly winged, usually nerveless and awnless 42a. *C. nardus* var. *nardus*
22. Lower glume of sessile spikelet broadly winged, usually 2 — 3 nerved and awned, 6 mm long 42b. C. *nardus* var. *confertiflotus*
21. Panicle not interrupted, spreading, branches arranged in zig-zag axis; awn up to 5 mm long 41. *C, tvinteranus*

N

Ser. Refracti S. Soenarko, *set. nov.*

Racemis deflexis, rhachidis internodiis et pedicellis glabris, callo spiculae sessile plerumque glabro et spiculis pedicellatis neutra, gluma unica instructa, destinguenda.

TYPUS: *C. refractus* (R.Br.) A. Camus.

Rachis internodes and pedicels nearly always glabrous; callus usually glabrous. Sessile spikelet awnless; lower glume wingless, conspicuously 3-nerved. Pedicelate spikelet barren, consisting of one glume; lower glume sharply pointed, oblique.

TYPE SPECIES: *C. refractus* (R.Br.) A. Camus.

1. CYMBOPOGON REFRACTUS (R. Br.) A. Camus

Andropogon refractus R.Br., Prod. Fl. Nov. Holl. 202. 1810. — *Cymbopogon refractus* (R.Br.) A. Camus MI Rev. Bot. Appl. Colon. **1:** 270. 1921; **Blake in Contr.**

Queensl. Herb 17: 57. 1974. — Type: Port Jackson, New South Wales, Australia, *R. Brown 6177* (K, iso!).

Andropogon tahitensis Hook. & Arn., Bot. Beechey's Voy. 72. 1832. — Type: Society Isl., *Beechey s.n.* (K, holo!).

Perennial often tufted; culm erect, 75 — 90 cm high, smooth and glabrous, almost bare of the sheath at the base. Leaf-blades linear, 30 cm long, 3 mm wide, flat, narrow at the base, tapering, glabrous. Leaf-sheaths smooth to slightly rough, glabrous. Ligule less than 1 mm long (rarely 2 mm long), glabrous, serrulate. Spathate panicle narrow, erect, interrupted, rarely with tertiary tiers; peduncle 9 —14 mm long, rarely 25 mm long (then as long as or longer than the spatheole), glabrous; soatheole 20 — 26 mm long, glabrous. Racemes 22 — 24 mm long, deflexed; raceme-bases flat, the upper about 1—5 mm long, the lower slightly shorter; rachis internodes 3 mm long, pedicels slightly shorter, both stout and firm, rounded in the back, glabrous, very rarely with a few scattered hairs along the margins; homogamous spikelets reduced to one glume each, narrowly lanceolate, acuminate. Sessile spikelet awnless; callus conspicuous, usually glabrous; lower glume 5 mm long, 1 mm wide, ovate-lanceolate, wider towards the base, glabrous, chartaceous, wingless, acuminte, 3-nerved. Caryopsis subterete, narrowly ovate-lanceolate, up to 4.5 mm long. Pedicellate spikelet barren, reduced to one empty glume, 4 — 5 mm long, 0.6 mm wide, narrowly lanceolate with sharply pointed tip, oblique, glabrous.

HABITAT: From coastal sands to *Eucalyptus* forests on dark grey sandy loam at up to 900 m altitude.

DISTRIBUTION: Native in Eastern Australia; naturalised in the Pacific Islands (Tahiti, New Caledonia and Hawaii).

MINOR VARIATIONS: The sessile spikelet is generally awnless but awned spikelets are also found *(Hubbard 5679; Wikes; McKee 10051,* rachis internodes hairy; *Franc 2163; Balansa 889).* In *Cymbopogon refractus* the culm is erect, in the specimen from Fraser Isl. *(Hubbard H50)* the culm is prostrate, it grows on sand near the sea.

It is rather difficult to place this species in any of the recognized series in *Cymbopogon. Cymbopogon refractus* is characterized by having deflexed racemes, almost glabrous rachis internodes and pedicels, a glabrous callus, and a sharply pointed lower glume of the sessile spikelet. The last three characters mentioned are not found in the other series in *Cymbopogon.* Because of the dissimilarities, this species, therefore, should be placed in a separate series.

AUSTRALIA. Queensland. Cape York Peninsula, April, *Nat. Herb. N.S. Wales;* between Inglewood and Milnerran, Jan., *C.T. White 9751;* Dalby, April, *R. Beier 65;* Mt. Edwards, April, *S.L. Everist 60S;* Parada near Lumbullah, April, alt. 400 m, *H.S. McKee 9S62* Wondai, Burnett Distr., *C.T. White 7221;* Jandowae, March, *R. Moore* a.m.; S.W. of Mt. Garnet, Township, Febr., *M. Lazarides 4209;* Biloela, *W. Cowdry 28;* Petri, Dec, *S.T. Blake 88;* Burke Distr., near Poison Creek, April, alt. 900 m, *S.T. Blake 8489A;* Chinchilla, Dec, *R.C. Beasley 8;* Moreton Distr., Coolangatta, Febr., *C.S. Clydesdale 46;* Mt. Tambouri, March, *K. Domin;* Chillagoe Distr., Febr., *K. Domin;* Blackdown Tableland, Leichhardt, alt. 600-900 m, April, *R.J. Henderson et al 701;* Munduberra, H.S. *Bloxsome 62;* near Rockhampton, March, *S.T. Blake 12718;* north of Pentland near Cape River, April, *S.T. Blake 8411;* Wallangara, Jan., alt. 1000 m, *S.T. Blake 4424;* Wallumbilla, April, *G.C. Blunden 19;* Dogwood Creek, E. of Gurulmundi, *Belson*);* Nanango, Burnett Distr., March, *R.W. Williams B78;* Lockerbie, April, alt. 30 m, *L.J. Brass 18393;* S. Kennedy Distr., May, *Adams 965;* Moreton Distr., Coolangatta, Jan., *Winders 12;* Mt. Coolum, March, *M.S. Clemens;* Moreton Isl., May, *S.-T. Blake 13065;* Roma, Maranoa Distr., March, alt. 300 m, *S,T: Blake 10841;* Chesterton, April, alt. 630 m, *S.T. Blake 11136;* N.W. of Beerwah, May, *H.S. Tutt A;* near Barcaldine, March, *K. Domin;* S.E. of Mackey, April, *M. Lazarides 5637;* Sidney, June, *J. Vickery 2;* S. Percy Isl., March, *H. Tyron;* Bribie Isl., April, *C.T. White;* Happy Valley on eastern side of Fraser Isl., May, P.Baxter 918; Frasser Isl, Oct C.E.Hubbard 4450._--Newsouth Wales. Gungal, Nov., *J.L. Boorman NSW128272;* Liverpool Plains, *Cunningham;* Kelso, NW of Guyra, April, *E.N. McKee 699;* E. of Mt. Tennet, Febr., alt. 700 m, *R. Pullen S058;* NW of Scone, Hunter Valley, Nov., *R. Story 6935;* Mambah Pool, Murnumbidgee Riv., Jan., *F.A. Rodway 2137;* Hurstville, Dec, *J.H. Camfield NSW-121579;* Lapstone Hill, Febr., *D.L.W. Henderson 303.* — Victoria. Mita Mitta, *F.V. Muller.*

NEW ZEALAND. Rorotong, Cook Isl., June, *T.F. Cheesman 722; Cunningham.*

NEW HOLLAND. *Banks & Solander* (BM); *Sieber 54* (BM).

NEW HEBRIDES. Aneiteum, Nov., *J.M. Gillivry 919.*

FIJI ISL. *Seemar, 685* (BM).

TAHITI. Society Isl., *Wilkes; Ribout; Gumming 1405; Bank & Solander* (BM); *Lay & Collie* (BM).

NEW CALEDONIA. Voh, foot of Mt. Katipahie, Jan., alt. 50 m, *H.S. McKee 10051; I. Franc 2163;* Mt. Mou, March, *Compton 525* (BM); *Deplanche; Bernier;* March, *Balansa 889; Germain* (BM).

HAWAII. Parker Ranch, Puu Hinai, Jan., alt. 900 m, *C.R. Ewart 111;* S. Kohala, Keanoku, *Shipman* (BM).

Ser. Proceri S. Soenarko, *ser. nov.*

Ser. Cymbopogon affinis, sed basibus racemi equalibus, raro deflexis, et spicula pedicellata neutra glumis duis instructa, differt.

TYPUS: *C. procerus* (R.Br.) Domin.

Perennials; leaf-blades filiform to linear glabrous, narrow at the base; leaf-sheath usually glabrous, basal sheaths tomentose; ligule glabrous, rounded. Spathate panicle compound to decompound. Racemes hardly deflexed to rarely deflexed maturity; raceme-bases equal, slender to slightly swollen; rachis internodes and pedicels densely pilose to woolly. Sessile spikelet awned, rarely awnless, hermaphrodite; lower glume concave, wingless to very narrowly winged. Pedicellate spikelet consisting of two empty glumes. Caryopses usually obovoid to elliptic.

TYPE SPECIES: *Cymbopogon procerus* (R.Br.) Domin.

DISTRIBUTION: The Moluccas, Timor, New Guinea and Australia. — fig. 20.

Six species in this group share similar structure, i.e. equal raceme-bases, slender or slightly swollen to filiform, rarely deflexed at maturity, and the pedicellate spikelets barren, comprising 2 glumes. Hackel (1889) recognized *Andropogon procerus* R.Br., *A. exaltatus* R.Br. and its varieties (var. *lanatus* and var. *ambiguus)* as a distinct group of the genus *Andropogon* sect. *Gymnanthelia* (now recognized as *Cymbopogon* Spreng.) and distinguished this group by the erect racemes. Blake (1974) pointed out that the Australian species, excluding *C. refractus* and *C. queenslandicus*, differ from their relatives from Asia by the usually erect (rarely deflexed) racemes and by its lowermost pedicel not adnate to the others. The characters mentioned above are not found in the other series. Therefore, these six species should be placed in a separate series.

Its relationship with the other series is not entirely clear, for the leaf-blades are almost similar to those of ser. *Citrati* being commonly linear (rarely filiform), and narrow at the base; the concave lower glume of the sessile spikelet puts this series near to ser. *Cymbopogon.*

Each species in this series is easily recognized by several small characters, and three groups of species are recognized. They are:

(1). Culm tall with large, broad leaf-blades, decompound spathate panicle, slender, equal raceme-bases, and much reduced homogamous spikelets; two species, *C. procerus* and *C. globosus,* are included in this group.

(2). Culm relatively short, with filiform to narrowly linear leaf-blades, narrow spathate panicle, slender, equal raceme-bases, without homogamous spikelets; there is one species in this group, *C. ambiguus.*

(3). Culm relatively short, with filiform to narrowly linear leaf-blades, narrow spathate panicle slightly swollen raceme-bases, and much reduced homogamous spikelet; *C. bombycinus* and *C. obtectus* belong to this group.

Cymbopogon gratus seems to be a link species of these groups, for it has slender, equal raceme-bases as in *C. ambiguus,* the homogamous

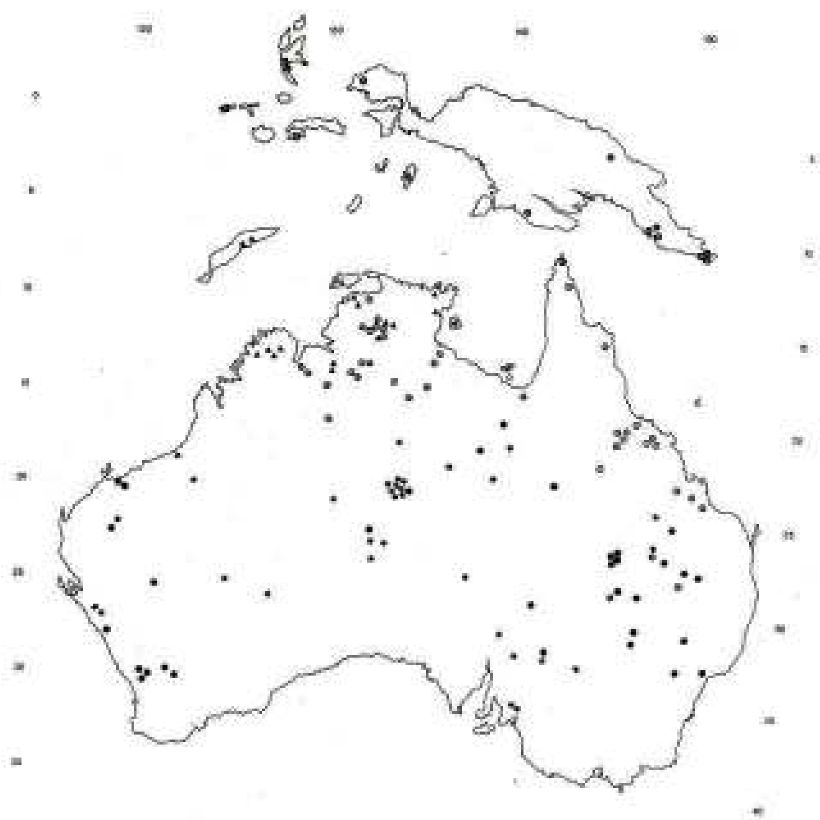


FIG. 20. Distribution of *C. obtectua* • , *C. bombycinus* • , *C. ambiguus* * *C. procerus* * , and *C. globosus* o

spikelets are absent, and the lower glume of the sessile spikelet resembles *C. obtectus,* but is narrower.

2. CYMBOPOGON PROCERUS (R.Br.) Domin

Andropogon procerus R.Br., Prod. Fl. Nov. Holl. 202. 1810. — *Cymbopogon procerus* (R.Br.) Domin *in* Bibl. Bot. 85: 273. 1915; Blake *in* Contr. Queensl. Herb, no. 17: 35. 1974. — Type: Australia, Groote Eylandt, *R. Brown 6172* (BM holo!-K, iso!).

Andropogon exaltatus R.Br., l.e. 202. — *Cymbopogon exaltatus* (R.Br.) Domin *in* Bibl. Bot. 85: 273. 1915. — Type: Australia, Mallinson's Isl., *R. Brown 6173* (BM holo!; K, iso!).

Culm erect, 100 — 200 cm high, glabrous, nodes shortly bearded. Leaf-blades up to 50 cm long, 8 —15 mm wide, smooth to slightly rough on both surfaces, narrow at the base. Leaf-sheaths usually glabrous, basal sheaths pubescent on the back. Ligule 3 mm long, chartaceous, rounded. Spathate panicle decompound, 60 — 75 cm long, elongated, interrupted, internodes of main axis and branches pilose in the upper part; spatheole 23 — 30 mm long (rarely 22 mm), narrowly elliptic with very fine tip, reddish, chartaceous, margins inflexed inside at maturity; peduncle 4.5 mm long, hniry in the upper part. Racemes 17 — 20 mm long, hardly deflexed; rachis internodes and pedicels 2.5 mm long, slender, densely pilose, hairs up to 6 mm long, concealing the spikelets; homogamous spikelets comprising one or two empty glumes, glabrous, narrowly lanceolate. Sessile spikelet 4.5 mm long; lower glume lanceolate, as long as the spikelet, glabrous 0.6 mm wide, membrano-chartaceous, concave on the back,acuminate, 2-nerved, usually wingless, rarely winged; awn 17 — 22 mm long. Caryopses 2 mm long, elliptic, subterete. Pedicellate spikelet 4 mm long; lower glume narrowly lanceolate, 0.2 mm wide, 3-nerved, glabrous.

CHROMOSOME NUMBER: Australia, $2n = 20$ *(S. Jacobs 1137).*

HABITAT: Locally dominant in sandy ironstone soil; frequent in *Eucalyptus* forest on lateritic podsol or occasional in low, dense monsoon scrub.

DISTRIBUTION: Northern part of N. Territory, Australia; very rare in east coast of Timor Isl.

The elongated and loose panicle with silvery long hairs in the racemes is a remarkable feature of this northern Australian species.

Blake (1969) included the type specimen of *Andropogon exaltatus* R.Br. *{Cymbopogon exaltatus)* in this species, as the two-nerved lower glume of the sessile spikelet, which was used by Brown (1810) to distinguish *Andropogon exaltatus* from *Andropogon procerus,* is also found in *Cymbopogon procerus;* moreover, the culm of *Cymbopogon procerus* is not always scaberulous.

TIMOR. S. of Locke, south east coast near Be Turac, 3. IV. 1970, *Joachim Metzner 12U; R. Cinatti 11,5.*

AUSTRALIA. Northern Territory. Near Lee Point, NE of Darwin, 20.111.1965, *M. Lazarides & Adams 281;* E. of Darwin, 29.111.1946, *W. Hartley 11772;* Port Darwin, Oct. 1869, JR. *Schomburgh 2U;* Nightcliff, *R.L. Specht S9;* Yirrkala, *R.L. Specht 1000;* Edith Falls, N. of Katherine, 9.VI.1967, *D.E. Symon 5130;* W. of Victoria River, Down St., 9.VI.1949, *R. A. Perry 2107;* Upper Victoria, *Muller;* Groote Eylandt, *R. Brown 6172* (Type); Hemple Bay, 5.V.1948, *R.L. Specht 369.* — Western Australia. Prince Regent River, July 1921, *C.A. Gardner;* Balmaningarra, April 1916, *H. Basedow 12;* near Aligator Spring, 27.VII.1949, *R. A. Perry 2618;* NW of Elgie, 17.IV.1955, *M. Lazarides 5098*);* SW of Bedford Down, 17.IV.1955, *M. Lazarides 5078*).*

3. CYMBOPOGON GLOBOSUS Henr. — Fig. 21.

Cymbopogon globosus Henr. *in* Fedde Reptr. 22: 106. 1925; Blake *in* Proc. Roy. Soc. Queensl. 80(6): 71. 1969. — Type: The Moluccas, Taliabu Isl., *Atjeh 61* (L, holo!).

Andropogon moluccanus Backer ex Henr. l.c., pro syn.

Culm erect 100 — 200 cm high, glabrous. Leaf-blades up to 60 cm long, 7 mm wide, glabrous or sometimes ciliate towards the base. Leaf-sheaths redd'sh and polished inside, glabrous, basal-sheaths tomentose. Ligule up to 5 mm long, glabrous. Spathate panicle comprising one or more globose to elongated branches, often interrupted, up to 20 cm long, 9 cm wide; internodes of main axis glabrous or pilose in the upper part; spatheole 17 — 23 (25) mm long, 2.5 mm wide, the margins remaining flat at maturity, acuminate; peduncle pilose in the upper part. Racemes 15 — 20 mm long, erect, rarely deflexed; homogamous spikelets much reduced; rachis internodes and pedicels flat, 2.5 mm long, densely pilose, hairs up to 5 mm long. Sessile spikelet 4 mm long; lower glume narrowly ovate-lanceolate, 1 mm wide obtuse, membrano-chartaceous, flat on the back, concave at the base, often narrowly winged, 3 — 4-nerved; awn 12 — 19 mm long. Caryopses obovoid, subterete, 1.5 mm long, 0.5 mm in diameter. Pedicellate spikelets 4 mm long; lower glume linear, glabrous.

HABITAT: Common in lime stone savannas at an altitude of 30 m or occasional in secondary grasslands at an altitude of 100 m.

DISTRIBUTION: The Moluccas (Halmahera, Ambon, Sula Isl.) and New Guinea; the Cape York Peninsula, Australia.

MINOR VARIATIONS: Reinwardt's specimen from the Moluccas is very much like *Cymbopogon procerus*. It has almost acuminate lower glume of the sessile spikelet with very faint nerves. The panicle is too incomplete to tell whether it is globose or elongated. However, the lower glume of the sessile spikelet is narrowly ovate lanceolate, showing that the specimen belongs to *Cymbopogon globosus*.

This species is closely related to *Cymbopogon procerus* in having equal raceme-bases, a barren pedicellate spikelet, densely pilose rachis-internodes and pedicels, and a tall culm.

Cymbopogon globosus can usually be recognized by the globose panicle as is seen in the type specimen and others from the Moluccas. It is more difficult with some of the specimens from New Guinea, which have a slightly globose to elongated panicle as in *Cymbopogon procerus*. However, the obtuse lower glume of the sessile spikelet of *Cymbopogon globosus* with 3 — 4 distinct nerves can be used to differentiate this

FIG. 21. *Cymbopogon globosus;* after *Atjeh 61*, isotype.

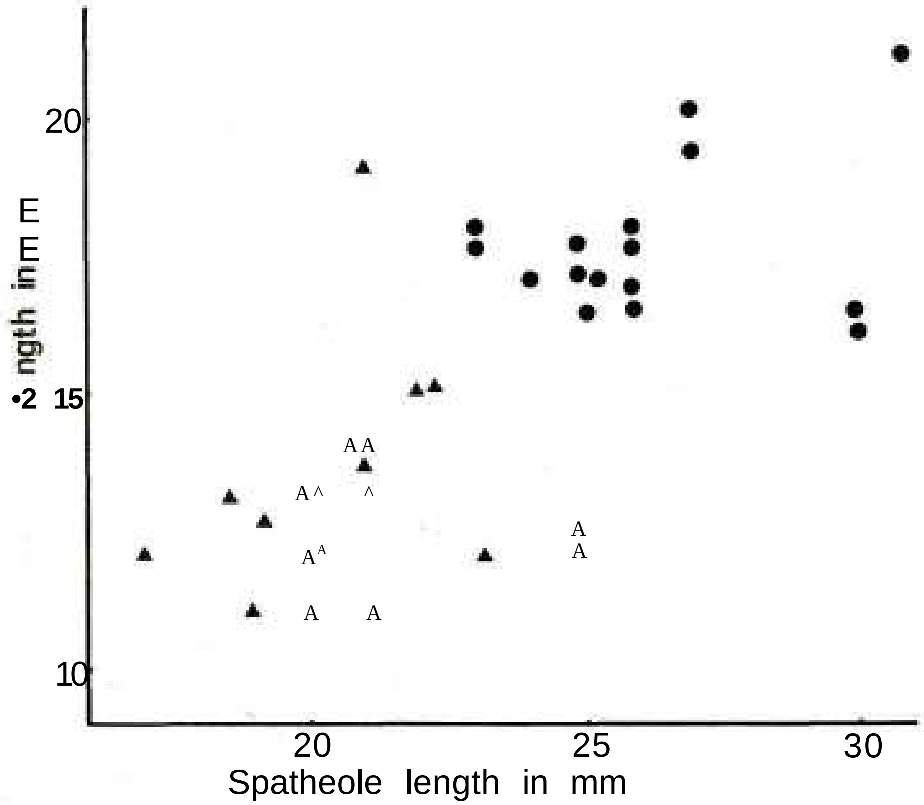


FIG. 22. Scatter diagram of *C. procerus* « and C. *globosus* ▲

species from *Cymbopogon procerus.* Moreover, the length of the peduncle and the awn can also be used to separate these two species, as is shown in the scatter diagram (fig. 22).

MOLUCCAS. Amboina, alt. 125 m, *Robinson 46;* ibid., *Reinwardt* (L); Taliabu Isl., *Atjeh 61* (L, holo!; BO, iso!); Halmahera Isl., Galela, 29.IX.1921, alt. 1 m, *Beguin 1800* (K, L, BO); ibid., *Beguin 123;* ibid., *Teijsman* (L.); Buru Isl., Mt. Trawesi, Djikumerasa, 29.VII.1936, alt. 100 m, *Oersipuny 33.*

NEW GUINEA. Merauke, S. Bivak, 23.111.1908, *Branderhorst 313;* Misool Isl., 10.X.1948, *Pleyte 1156*);* Lower Fly River, Nov. 1936, *L.J. Brass 837;* Baroka, April 1933, *L.J. Brass 3713;* Wuroi, Oriomo River, 1934, *L.J. Brass 5725;* Daru Isl., March 1936, *L.J. Brass 6364.;* Cape Vogel Peninsula, Milne Bay Distr., 3.IV.1953, alt. 30 m, *L.J. Brass 21874;* North Sagarai Valley, Milne Bay Distr., 30.V.1964, alt. 85 m, *E.E. Henty NGF 16833;* Port Moresby, 18.IV.1967, alt. 40 m, *R. Pullen 6767;* Central Distr,, S. of Sogeri, 5.IX.1962, alt. 500 m, *R. Schodde 2906;* Port

Moresby, 1918, *C.T. White 3;* Menapi, Cape Vogel Peninsula, 28.IV.1958, alt. 100 m, *R.D. Hoogland 22093;* Moi Biri Bay, Milne Distr., 7-10.V.1953, alt. 30 m, *L.J. Brass 22129;* Gogol Valley, Madang Distr., 24.VI.1955, alt. 60 m, *R.D. Hoogland 4955;* Rogers Airstrip, Central Distr., 12.VII.1962, alt. 10 m, *P. J. Darbyshire 642;* Taskal Isl., *Dwyer BG 504;* S. of Binigiein Village, N. Distr., *J.S. Womersley & P. Katik NGF 43995.*

AUSTRALIA. Cape York Peninsula, Lockerbie, SW of Somerset, 1.V.1948, alt. 50 m, *L.J. Brass 18590;* Mt. Molley, *L.J. Brass 2545.*

4. CYMBOPOGON BOMBYCINUS (R.Br.) Domin

Andropogon bombycinus R. Br., Prod. Fl. Nov. Hoi. 202. 1810; Hackel *in* DC, Monogr. Phan. 6: 597. 1889. — *Cymbopogon bombycinus* (R. Br.) Domin *in* Bibl. Bot. 85: 274. 1915; Blake in Proc. Roy. Soc. Queensl. 80(6): 70. 1969; *in* Contr. Queensl. Herb. no. 17: 44. 1974. — Type: Australia, *R. Brown 6175* (BM, holo!; K, iso!).

Andropogon lanatus R. Br., Prod. Fl. Nov. Holl. 202. 1810. — *Andropogon exaltatus* var. *lanatus* (R. Br.) Hack, *in* DC, Monogr. Phan. 6: 596. 1889. — Type: Australia, *R. Brown 6174* (BM, holo!; K, iso!).

Andropogon procerus var. *schultzii* Hack, *in* DC, Monogr. Phan. 6: 595. 1889. — Type: Australia, Port Darwin, *Schultz 60* (K, iso!).

Tufted grass; culm 30—100 cm high, usually glabrous, nodes shortly bearded. Leaf-blades 15—25 cm long, 2—4.5 mm wide, glabrous, slightly rough below. Leaf-sheaths tinged with red, glabrous, basal sheaths pubescent, often curled, as are the leaf-blades. Ligule 3—5.5 mm long, membranous, glabrous. Spathate panicle erect, narrow, 25 cm long; spatheole 20—34 mm long, herbaceous, margin hyaline glabrous, glabrous except a little silky pubescence along the margins of the herbaceous part; peduncle 6 mm long, pubescent upwards. Raceme 17—22 mm long, rarely deflexed at maturity, woolly, fragile, raceme-bases stout, slightly swollen, woolly, wider above at maturity, lowermost pedicel shorter than the raceme-bases; homogamous spikelet very much reduced; rachis internodes and pedicels stout, densely woolly. Sessile spikelet concealed by the hairs; lower glume deeply concave, usually lanceolate, 5 mm long, 1 mm wide, acuminate, membrano-chartaceous nerveless, glabrous; awn 9—18 mm long. Caryopses obovoid to sub-globose, 2—5 mm long, 1 mm in diameter. Pedicellate spikelet narrowly lanceolate, acuminate; lower glume glabrous, 7-nerved.

CHROMOSOME NUMBER: Australia, 2n = 20 (Celarier, unpubl.) 2n = 20 *(S. Jacobs).*

HABITAT: Hillsides in *Eucalyptus* forest, grasslands or in savannas.

DISTRIBUTION: Northern part of Australia.

Cymbopogon bombycinus is perhaps the most distinct of the species in ser. *Proceri;* it can be recognized by the herbaceous spatheole with spreading hairs along the margins of the herbaceous part. The racemes are usually not deflexed and the raceme-bases are equal, more or less cylindrical, and wider above. Some deflexed racemes are also found, and the raceme-bases are slightly swollen with conspicuously cupuliform tips. The deflexed and woolly racemes might seem to place this species near to ser. *Cymbopogon*, but it can be distinguished from ser. *Cymbopogon by having* extravaginal or mixed innovations, and a barren pedicellate spikelet consisting of two glumes.

AUSTRALIA. Northern Territory. E. of Darwin, 26.111.1964, *Adam 905;* N. of Katherine, 13.V.1952, *M. Lazarides 2772;* SW of Katherine, 3..VI.1949, *R. A. Perry 2003;* Katherine, 17.11.1961, *H. S. McKee 8524;* ibid., *l.B. Wilson 195;* ibid., *H.J. Tyack Bake 10;* ibid., 21.111.1946, *W. Hartley 11771;* SW of Innerway, 5.VII.1948, *R. A. Perry 2353;* SE of Wavehill, 18.VII.1952, *M. Lazarides 2900;* N. of Tennant Creek, 26.IV.1948, *R. A. Perry 632;* E. of Borroloola, 31.VII.1948, *R. A. Perry 1843;* McAthur Riv., May, alt. 137 m, *S.T. Blake 17770*);* S.W. of Dorrisvale St., Flora Riv., 21.V.1952, *M. Lazarides 2817;* N. of Brunette Down St., 6.VII.1948, *P. A. Perry 1607;* E of Limbunga St., 28.VI.1949, *R. A. Perry 2299;* SW of Birrimbah, 22.V.1948, *R. A. Perry 2059.* — Western Australia. Near Powells Creek, July 1922, *C. E. F. Allen 665;* Balmaningarra, N. Kimberley, April 1916, *H. Basedow 4, 106;* E. of Denham Riv., 19.VII.1949, *R. A. Perry 2530;* Springvale, 16.IV.1955, *M. Lazarides 5064;* Karunjie, 30.VII.1952, *M. Lazarides 8148.* —. Queensland. Cape York Peninsula, Aug., alt. 170 m, *L.J. Brass 19989;* Townsville, 7.VI.1934, *S.T. Blake 5943;* S. Kennedy Distr., 21.V.1964, *Adams;* Emu Park, Curtis Distr., 3.III.1935, S. *T. Blake 7877;* Winton, April 1932, *W. Davies;* ibid., June, alt. 410 m, *S. T. Blake 6079;* Gladstone, March, alt. 5 m, *S. T. Blake 12800;* Emu Park, Curtis Distr., 3.III.19835, *S. T. Blake 7877;* Winton, April 1932, *W. Davies;* SW of Nebotownship, 20.VI.1962, *Story & Yapp 38;* Gurulmundi, *E. Belson; S.* of Tangool, 17.V.1956, *S.T. Blake 19989;* Mt. Molley, April, alt. 400 *m, L.J. Brass 2463, 2545;* Castle Hill, Townsville, *C.E. Hubbard & M.W. Winders 66196;* W. of Maroeba. May, *H.S. McKee 9470;* Mt. Isa, April, alt. 415 m. *S.T. Blake 8796;* Normanton, 18.V.1935, *S.T. Blake 8947;* Gilbert Riv., March 1931, *L.J. Brass 1835;* Minerva, N. of Springsure, July, alt. 400—450 m, *S.T. Blake 6973;* Peak Down, *F. v. Mueller;* Ne of Conjuboy, 27.11.1954, *M. Lazarides 4189;* between Roekampton and Westward, 25.11.1927, *C. T. White 8391;* Hughenden, June 1919, *H.C. Hawthorn;* W. of Westmoreland, 5.VI.1948, *R.A. Perry 1315;* E. of Blackwater, 29.IV.1971, *R.J. Henderson et al 899;* Munduberne, April 1931, *H.S. Bloxsome 12;* Mornington Isl., Aug. 1966, *J.P. Woolston;* Middle Percy Isl., 26.IV.1956, *M. Lazarides 5633;* South Percy Isl., *H. Tyron; R. Brown 6174, 6175;* near Gurulmundi, Nev., *C.E. Hubbard 5148;* Bowen, N. Kennedy, Jan., *C.E. Hubbard 6550;* Warrigal, Febr., *C.E. Hubbard 7118.* — New South Wales. Originally collected in the vicinity of Canberra, *R.E. Celarier {2n* = 20).

5. CYMBOPOGON OBTECTUS S. T. Blake

Cymbopogon obtectus S. T. Blake *in* Univ. Queensl. Pap. Dept. Biol. 2(3): 55. 1944; *in Contr.* Queensl. Herb. no. 17: 49. 1974. — Type: Australia, Queensland, *Blake 6517* (BRI, holo; K, iso!).

Densely tufted grass; culm erect, 45 — 60 cm high, glabrous, nodes shortly bearded. Leaf-blades up to 25 cm long, 2 mm wide, more or less flat, glabrous except for silky pubescence at the base behind the ligule, rough on the lower surface. Leaf-sheath glabrous, basal sheaths pubescent. Ligule membrano-chartaceous, up to 6 mm long, glabrous, rounded to obtuse. Spathate panicle up to 14 cm long, erect, rarely with tertiary tiers; spatheole herbaceous, margins hyaline, glabrous peduncle woolly in the upper part. Racemes deflexed, woolly, 19 — 23 mm long; raceme-bases stout, slightly swollen; lowermost pedicel very short, shorter than the raceme-bases; homogamous spikelet of 2 empty glumes; rachis internodes and pedicels woolly. Sessile spikelet 5 — 6 mm long; lower glume lanceolate to ovate-lanceolate, concave in the lower part, 1 —1.5 mm wide, chartaceous, acuminate, wingless, with 2(4) conspicuous nerves; awn 7 —14 mm long, pale brown. Caryopses subglobose. Pedicellate spikelet 4.5 mm long; lower glume chartaceous, 7-nerved, glabrous.

HABITAT: In savannas and semi-desert areas.

DISTRIBUTION: In Australia except the northern part.

In appearance this species resembles *Cymbopogon bombycinus* in that it has woolly racemes and a herbaceous spatheole. It differs from the latter in haying a broader lower glume of the sessile spikelet, as shown in histogram (fig. 23) and nearly always deflexed raceme-bases.

AUSTRALIA. Western Australia. Roebourne, Malyie Station, 1899, *Herb. A. Morrison;* Swan River, Darling Range, *C.A. Gardner;* ibid., *Herb. A. Morrison;* Kellerberring, between Northam and Merredin, Sept. 1897, *R.B. Leaky;* near Northampton, 1909, *A. Morrison;* Murchisson, *Herb. Oldfield;* Bruce Rock, *F. Howard 185;* between Ashburton and De Gray River, *E. Clement;* Swan River, *Herb. Drummond.* — Northern Territory. Mt. Olga, 22.VI.1926, *H. Basedow 100;* E. of Alice Spring, 5.III.1953, *R.A. Perry 3215;* about 20! m Glen Edith, 25. VI.1959, *G. Chippendale 6278.* — Queensland. Between Bolland and Cunnamulla, Jan., *C. W. Winder;* Near Cunnamulla, April, *C. T. White 11580;* near Dirranbandi, 9.III.1936, *S.T. Blake 10742;* Jericho, 27.XI.1935, *S.T. Blake 10264;* Charleville, 19.X.1945, *M.S. Clemens;* between Charleville and Westgate, 20.IV.1934, *S.T. Blake 5416;* ibid., *S.T. Blake 5399;* Chincilla, 1931, *R.S. Beusley 118;* Miles,. *E. Belson;* Mt Isa Township, 15.111.1954, *M. Lazarides 4370;* between Inglewood and Milmerran, 20.1.1934, *C.T. White 9778;* Munduberra, *H.S. Bloxsome 92;* top of Dividing Range, Wandoan, *E. Belson;* Wyberda, 19.1.1933, S. *T. Blake 4557;* ibid.,

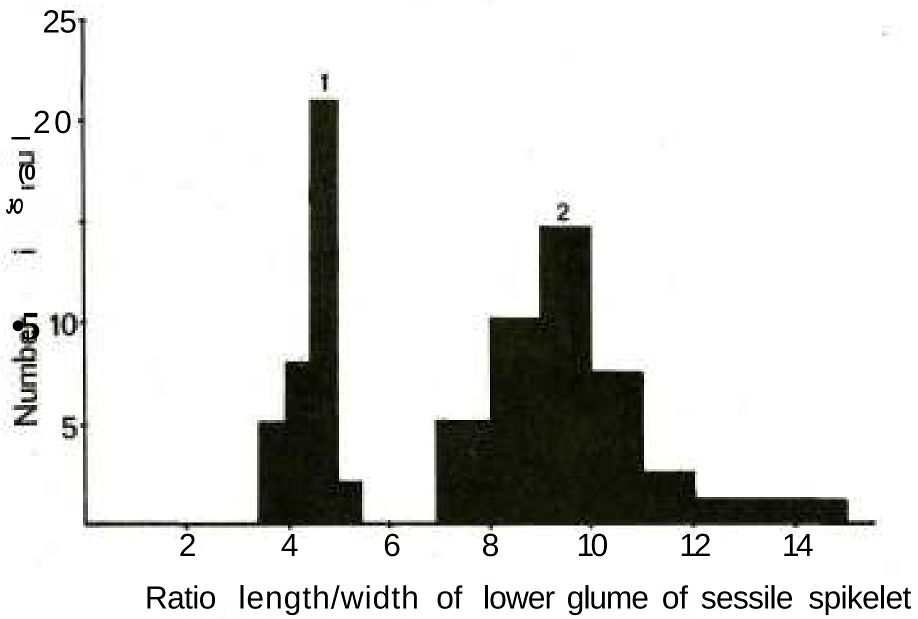


FIG. 23. Histogram of *C. obtectus* (1) and *C. bombycinus* (2).

S.T. Blake 6UU Woodstock, West of Winton, 29.VI.1934, *S.T. Blake 6517.* — New South Wales. Broken Hill, 22.XI.1919, *A. Morris;* Wellington Valley, *Cunningham;* Tiboobura, 16.X.1949, *E.F. Constable 11157;* Mt. Harris-, N. of Warren, 29.IV.1952, *E.F. Constable 20360*);* Castlercagh River, *Ch. Moore 122;* W. of Singleton, 11.V.1960, *R. Story 7392;* SE of Ulinda, 17.111.1968, *J.C. Morron 16;* Baurke Byrack, 22.XII.1934, *G. Vickery 12950; Herb. Morrison.* — South Australia. W. of Everard Range, 19.VI.1891, *R. Helms;* Armandillo, Barton, *Herb. Midler; Bilwill H5.*

6. CYMBOPOGON GRATUS Domin

Cymbopogon gratus Domin *in* Bibl. Bot. 85: 274. 1915. — Type: Australia, N. Queensland, *Domin II. 1910* (PR, holo.).

Culm 35 cm high, erect. Leaf-blades up to 20 cm long, glabrous, slightly rough, 2 — 4 mm wide. Leaf-sheaths glabrous, basal sheaths densely tomentose. Ligule not more than 1 mm long. Spathate panicle not more than 20 cm long; spatheole herbaceous, 20 — 21 mm long, margins hyaline, glabrous except for the lower part with silky long hairs; peduncle 6 mm long. Racemes woolly, rarely deflexed at maturity; rachis internodes and pedicels slender, woolly, the longest hair being 7 mm long; raceme-bases slender, lowermost pedicel more or less as long as the raceme-bases; homogamous spikelets absent. Sessile spikelet awnless, 4.5 mm)ong, concealed by the hairs; lower glume lanceolate, subchartaceous 0.8 mm wide, flat to shallowly concave, 3-nerved. Caryopses narrowly obovate 2 mm long. Pedicellate spikelet 3 mm long; lower glume narrowly lanceolate, glabrous.

HABITAT : Savannas; on hill slopes on black soil.

DISTRIBUTION: Northern Queensland, Australia.

When *Cymbopogon gratus* was first described by Domin (1915) it was based only on one single specimen collected by himself in Chillagoe, Australia. Blake (1969) considered this species as a hybrid between *Cymbopogon bombycinus* and *Cymbopogon refractus'*, it resembles *Cymbopogon refractus* in foliage, short ligule and reduced awn. Since the morphological similarities with *Cymbopogon refractus* are insufficient and *Cymbopogon gratus* posseses slender, equal raceme-bases, a herbaceous spatheole and heterogamous spikelet at the base of the lower raceme, this species is therefore accepted as distinct.

AUSTRALIA. Queensland. North of Hughenden, Mt. Emu, Febr., *Hubbard 7S59.* i

7. CYMBOPOGON AMBIGUUS (Steud.) A. Camus — Fig. 24.

Cymbopogon ambiguus Steud., Syn. PI. Glum. 1: 385. 1845. — *Andropogon exaltatus* var. *ambiguus* (Steud.) Hack, *in* DC, Monogr. Phan. 6: 596. 1889. — *Cymbopogon exaltatus* var. *ambiguus* (Steud.) Domin *in* Bibl. Bot. 85: 273. 1915. — *Cymbopogon ambiguus* (Steud.) A. Camus *in* Rev. Bot. Appl. Colon. 1: 290. 1921; Blake *in* Proc. Roy. Soc. Queensl. 80(6): 70. 1969; *in* Contr. Queensl. Herb. no. 17: 39. 1974. — Type: Western Australia, *Baudin's Exp.* (P, holo!).

Tufted grass; culm erect, 55 — 60 cm high, terete, usually glabrous, pubescent in the upper part of the internodes. Leaf-blades very narrow, filiform to flat with very long tips, up to 2 mm wide, less than 35 cm long, often rigid, glabrous, very rough. Leaf-sheaths glabrous sometimes with auricles; basal sheaths tomentose. Ligule 1.9 — 9 mm long, glabrous, membranous. Spathate panicle up to 20 cm long with very few to many racemes; rarely with secondary tiers; spatheole 49 mm long, glabrous, chartaceous. Racemes 15 — 20 mm long, hardly deflexed; raceme-bases and lowermost pedicel almost equal, more or less filiform, homogamous spikelets absent, the lowermost sessile spikelet hermaphrodite and awned; rachis internodes and pedicels more or less flat, woolly. Sessile 5.5 — 6.5 mm long, awned; lower glume ovate-lanceolate, acuminate, 0.9 mm wide, chartaceous, very narrowly winged, flat, slightly, concave in the lower part, 3 — 4-nerved (clearly, seen in the upper part) ;

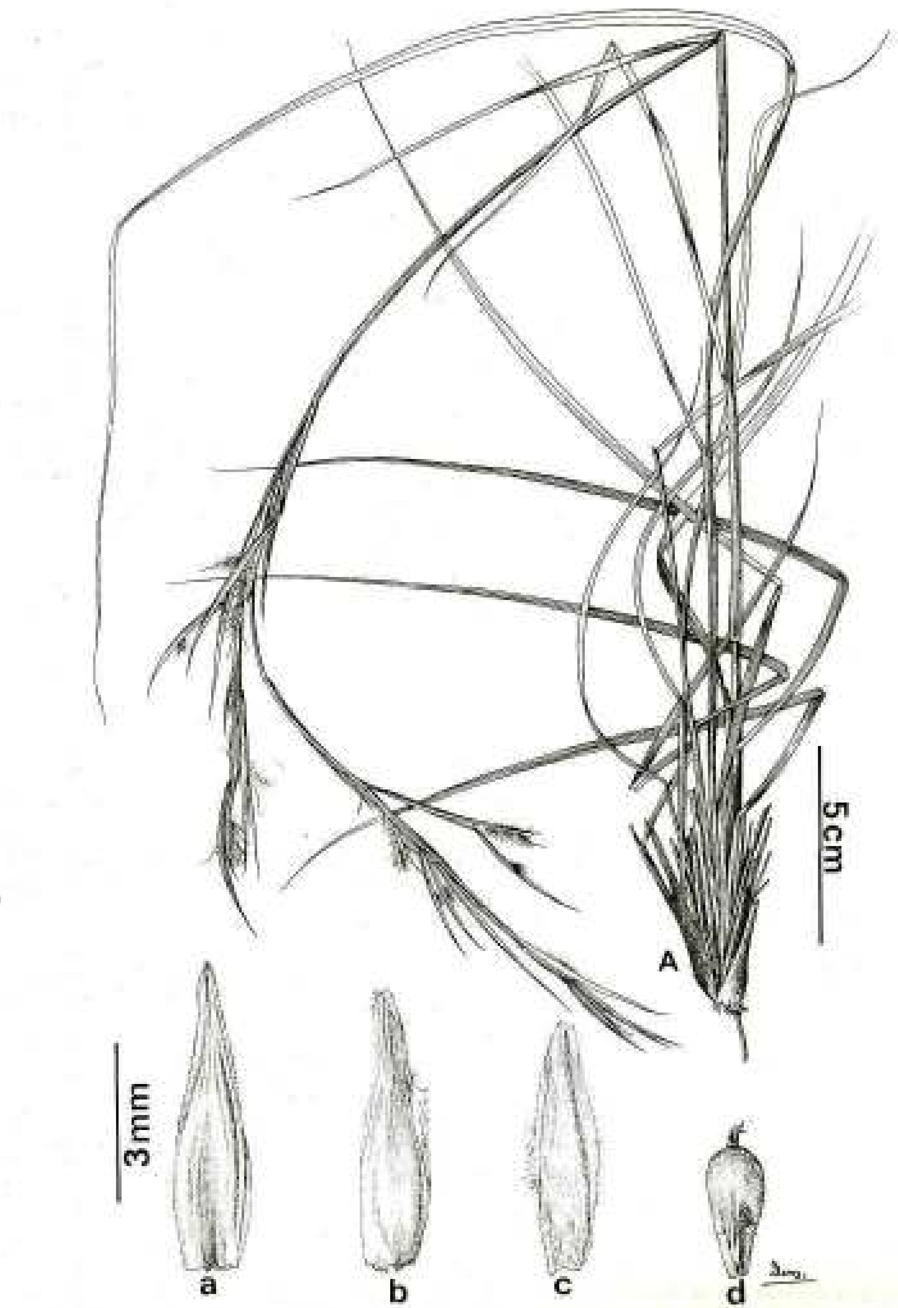


FIG. 24. *Cymbopogon ambiguus:* lower glume (a), upper glume (b) and lemma of the lower floret (c) of the sessile spikelet, and grain (d); after *van Steenis 18577.*

awn 15 mm long. Caryopses oblanceolate, subterete, 2 mm long, 1 mm in diameter. Pedicellate spikelet 3 — 4 mm long; lower glume linear, 0.6 — 0.7 mm wide, glabrous, 7-nerved.

HABITAT : In rock crevices in shallow sands of the semi-desert areas; common in *Eucalyptus* forest and in damp places.

DISTRIBUTION: Widespread in Australia; very rarely in Timor Isl.

Cymbopogon ambiguus is easily recognized by the woolly racemes with similar raceme-bases, and by the heterogamous spikelet at the base of the subsessile raceme. It is unusual for the genus as all the other members have a pair of homogamous spikelet. There is no doubt, however, that this species belongs to the genus *Cymbopogon,* since it has an obtuse callus and a 2-keeled lower glume of the sessile spikelet; moreover, the plant is aromatic.

Cymbopogon ambiguus is often confused with *Cymbopogon bombycinus* and *Cymbopogon obtectus* as three of them have woolly racemes, but the absence of the homogamous spikelet in the former clearly distinguishes *Cymbopogon ambiguus* from *Cymbopogon bombycinus* and *Cymbopogon obtectus.* Intermediate specimens between *Cymbopogon ambiguus* and *Cymbopogon bombycinus* are found and are considered as hybrids, which are discussed in the following section.

AUSTRALIA. Western Australia. Port Hedland, 1905, *W.H. Fitzgerald 79;* Barr Smith Range, 26.VII.1931, *C. A. Gardner 2417;* Murchison Distr., *F. Howard 184a;* Mt. Barrel Well, Murchison River, *Oldfied 235;* Yandonooka, *Maddox;* Laverton,, 5.IV.1903, *J.H. Rowe;* E. of Meekathasa, 26.111.1959, *N.H. Speck 757;* Marble Bar, 1938, *Stewart 287;* prob. Perth, *A. Morrison 841;* N.W. coast, Pebr. 1818, *Cunningham* (Capt. King's 1st voyages); *Drummond;* Dampier Arch., 1877, *F. van Mueller.* — Northern Territory. N.W. of Tennant Creek, 25.IV.1948, *R. A. Perry 581;* Alice Spring, 1922, *C. E. F. Allen 551; J. B. Cleland 21;* W. of Alice Springs, 23.VIII.1932, *J.B. Cleland 13;* Nappesby Creek, 22.XI.1961, *H.S. McKee 8569;* S.W. of Alice Springs, 22.V.1953, *R. A. Perry 3514;* ibid., 4.IX. 1955, *R. A. Perry 5373;* Ayers Rock, 7.X.1956, *M. Lazarides 6145;* S.W. of Lucy Creek St., 8.V.1955, *M. Lazarides 5228;* near Hermansburg, 17.VIII.1929, *J.B. Cleland H106;* ibid., *R.T. Patton 5;* Mt. Lietz, 16.VIII.1932, *J.B. Cleland L2;* Mt. Ultin, 1.IX.1930, *J.B. Cleland H87.* — Queensland. Duchess, Gregory North Distr., May, alt. 400 m, *S. T. Blake 111530;* Mt. Brandon, 8.IV.1936, alt. 700 m, *S.T. Blake 11156;* Mt. Alpin, N.E. of Dajarra, 6.IX.1956, *M. Lazarides 4067*).* — New South Wales. S. of Corona, 14.IV.1970, *J.C. de Nardi 445;* N.W. of Wicannia, 20.V.1969, *J. C. de Nardi 268.* — South Australia. Nepabuna, Flinders River, 26.V.1937, *J.B. Cleland SA 3137;* Southern Flinders Range, 31.11.1966, *B. Copley 1031;* South Para, Jan. 1903, *Max Koch 59;* Lake River, near Adelaide, 10.XI.1884, *J. G. O. Tepper;* Porcupina Hill, S. of Musgrave

Eyre, Nov. 1875, *Andrews 172;* Mt. Lyndhurst, Nov. 1898, *Max Koch;* Litle Para Park St., 29.X.1966, *J. Z. Weber 186.*

TIMOR. Plateau of Baucau, 16.XII.1953, alt. c. 350 m, *C. G. G. J. van Steenis 18577.*

CYMBOPOGON BOMBYCINUS X CYMBOPOGON AMBIGUUS

Cymbopogon ambiguus differs from *Cymbopogon bombycimis* by the absence of the homogamous spikelets together with the 3—4 nerved lower glume of the sessile spikelet. Morphological differences between the two species are seen in the table 11.

In Australia, *C. bonbycimts* is found in the northern part, whereas *C. ambiguus* is widespread (fig. 20). The hybrids between the two species are found in the northern part of Queensland.

The Hybrid Index was used to analyze the hybrids (Anderson 1949). The characters and the scoring are given below.

Table 11. MORPHOLOGICAL STRUCTURE OF C. BOMBYCINUS, C. AMBIGUUS AND THEIR HYBRIDS

	C. bombycinus	*C. ambiguus*	*Hybrids*
Homogamous spikelets	present	absent	absent, very rarely present
Lower glume of the sessile spikelets	nerveless	3-4 nerved	nerveless to 2-nerved
	narrowly lanceolate	lanceolate	narrowly lanceolate
	membrano-chartaceous	chartaceous	membrano-chartaceous to chartaceous
Raceme-bases	more or less swollen	slender	slender

1. Homogamous spikelets : present: 0
   absent: 2
2. Lower glume of the sessile spikelet : nerveless: 0
   2-nerved: 1
   3-4nerved: 2
3. Lower glume of the sessile spikelet : narrowly lanceolate: 0
   lanceolate: 2
4. Lower glume of the sessile spikelet : membrano-chartaceous: 0
   > chartaceous : 2

5. Raceme-bases : swollen: 0
   slender: 2
6. Length of the awn (mm) : 9—13: 0
   14—16: 1
   17—20: 2
7. Ratio length/width of the lower glume of the sessile spikelet : 8 and over: 0
   7.1 — 7.9 : 1
   7 and less : 2

The results are given in the diagram presented in fig. 25.

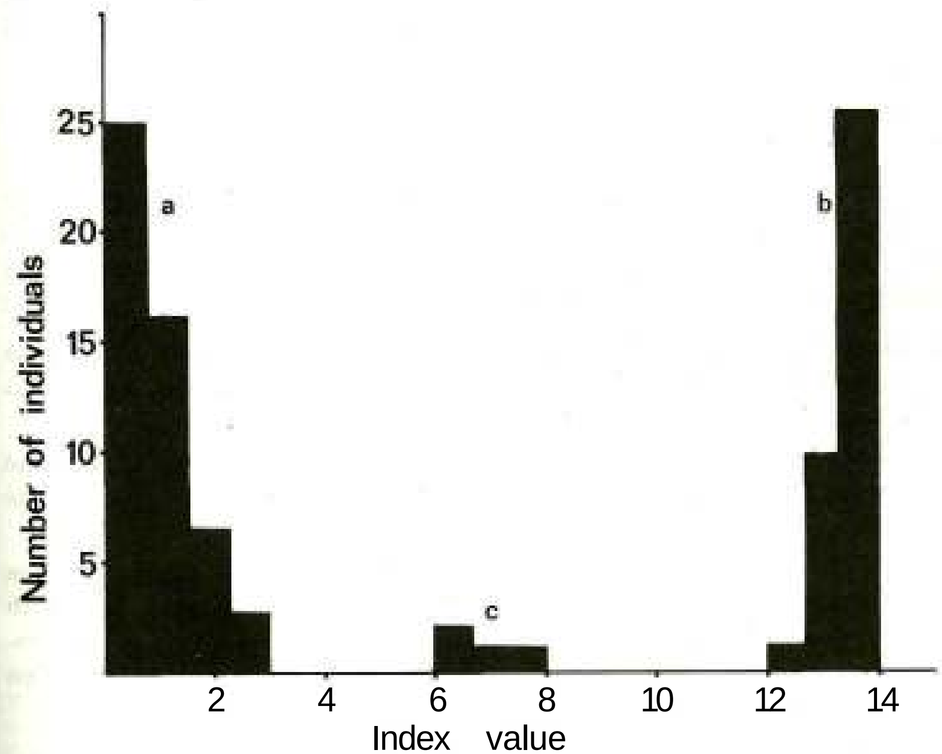


FIG. 25. Hybrid index of *C. bombycinus* (a), *C. ambiguus* (b), and the hybrid (c).

AUSTRALIA. Queensland. Poison Creek, 90 miles north of Hughenden, April 1935, *S.T. Blake 8U90;* Pentland, North Kennedy Distr., *S.T. Blake 8381;* Port Curtis Distr., Coominglah Range, May 1956, *S.T. Blake 19998.*

Ser. CYMBOPOGON

Cymbopogon ser. *Schoenanthi* Stapf *in* Kew Bull. 1906: 350. 1906.

Perennial, tufted grasses, with innovations intravaginal; culm erect. Leaf-blades filiform to narrowly linear and flat, narrow at the base, both surfaces very rough, glabrous; leaf-sheaths glabrous, basal sheaths glabrous or pubescent; ligule rounded or truncate. Spathate panicle narrow, usually with very few (occasionally numerous) racemes, rarely compound. Racemes usually deflexed at maturity; raceme-bases unequal, the lower one often swollen and fused with the swollen lowermost pedicel, not swollen; rachis internodes and pedicels densely pilose along the margins, glabrous or minutely puberulous to densely pilose on the back. Sessile spikelet awned; lower glume wingless, concave on the back. Pedicellate spikelet compound of two glumes, one or two lemmas, and one male flower.

TYPE SPECIES: *Cymbopogon schoenanthus* (L.) Spreng.

DISTRIBUTION: Africa to Himalaya, but mainly in the Saharo-Sindian Region (fig. 26).

This series can be recognized by the narrow, wingless, concave lower glume of the sessile spikelet, pilose racemes, and filiform to narrow leaf-blades with a narrow base. The series can be divided into two groups which differ only slightly and a third more distinct group. The groups are:

(1) rachis internodes and pedicels pilose along the margins and on the back, lower glume of the sessile spikelet sharply 2-keeled, subchartaceous *(Schoenanthus* group)

(2) rachis internodes and pedicels pilose along the margins and in the upper part, often glabrous on the back, lower glume chartaceous with rounded keels at the base *(Floccosus* group)

(3) rachis internodes and pedicels slightly swollen more or less glabrous, lower glume of the sessile spikelet chartaceous, with rounded keels *(Microtheca* group). Note: the plants are not aromatic and the rachis internodes have more or less V-shaped tips which do not occur in the other members of *Cymbopogon.*

In groups (1) and (2) the species are very closely related to one another. In the first group the chief character used to differentiate the species is whether the lowermost pedicel of the sessile raceme is swollen or not. In the second group there are more characters, such as the structure of the lower glume of the sessile spikelet and the number of heterogamous pairs in the upper racemes, used to distinguish between the species.

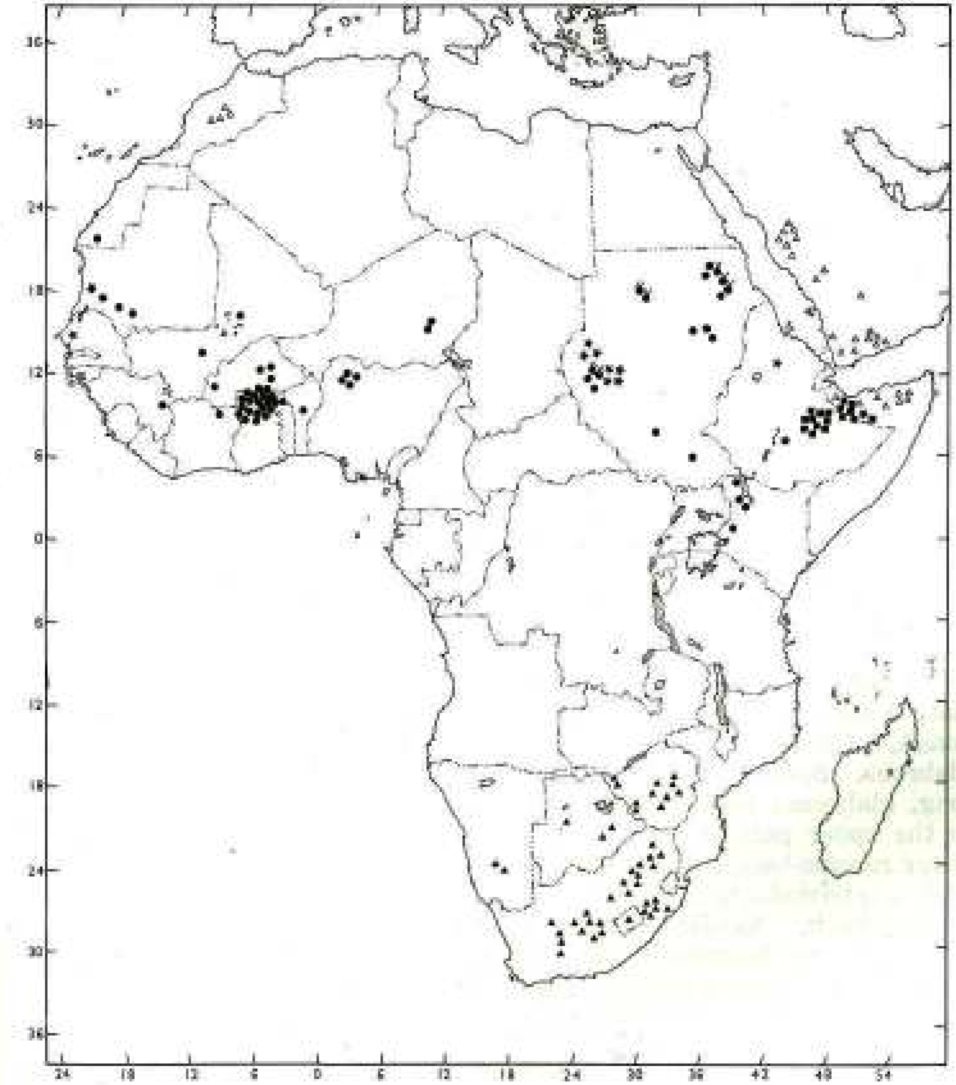


FIG. 26. Distribution of C. *schoenanthus* subsp. *proximus* • (lower glume of sessile spikelet hairy) T$ (lower glume of sessile spikelet glabrous), *C. schoenanthus* subsp. *schoenanthtis* *• /\, *C. floccosus* • , *C. plurinodis* » , C. *commutatus.* * .

It is interesting to note that in all species of this series the racemes are coated with a thick layer of wax. The wax often covers the sessile spikelet, and makes white deposits on the concave surface of the lower glume. The leaf-blades are also coated with a thin layer of wax.

In the third group, which includes *C. gidarba* and *C. microtheca,* it seems that the wax is absent. These two species are not aromatic although Hackel (1889) did mention "mild terebinthine". These two species are not easily accommodated in this series, although the structure of the lower glume of the sessile spikelet suggests that they could belong here. On the other hand there is no obvious genus to which they could be transferred, and they seem insufficiently distinct to justify setting up a new genus.

8. CYMBOPOGON SCHOENANTHUS (L.) Spreng.

Andropogon schoenanthus L., Sp. PI., ed. 1, 1046. 1753. —• *Cymbopogon schoenanthus* (L.) Spreng., PI. Pugill. 2: 14. 1815; Stapf *in* Kew Bull. 1906: 303 & 352. 1906; *in* Prain, PI. Trop. Afr. 9: 268. 1919; Chiovenda, Gram. Ess. 15. 1919; Maire & Weiller, Fl. Afr. Nord 1: 286. 1952. — Type-.*Plukenet's specimen* (BM, holo!).

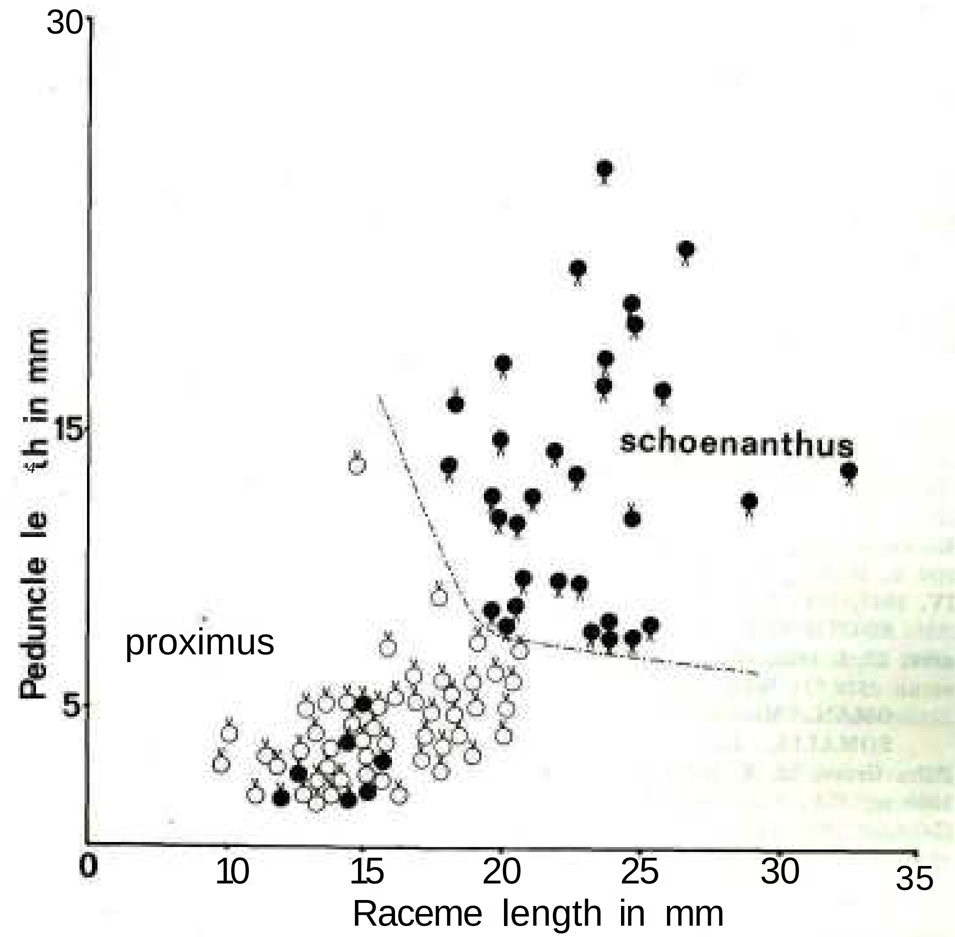
Andropogon lanigerum Desf., Fl. Atl. 2: 379. 1800; Hackel *in* DC., Monogr. Phan. 6: 598. 1889.

Andropogon circinatus Hochst. ex Steud., Syn. PI. Glum. 1: 387. 1854. — Type: Arabia, *W. Schimper 789* (K, iso!).

Culm erect, 20—130 cm high, glabrous. Leaf-blades filiform to flat, 1.5—4 mm wide, rough below. Leaf-sheaths glabrous, slightly rough, often auricled. Ligule 1.4—5 mm long, truncate or rounded, glabrous. Spathate panicle erect, 10—30 cm long; spatheole 15—36 mm long, glabrous; peduncle 3.5—25 mm long, slender, sparsely tomentose in the upper part or sometimes glabrous. Racemes 13—29 mm long; lower raceme-base not swollen, fused with the swollen lowermost pedicel; rachis internodes and pedicels densely pilose along the margins and on the back. Sessile spikelet 4—7 mm long; lower glume narrowly lanceolate, subchartaceous, 0.8—0.9 mm wide, acuminate, concave on the back, glabrous or minutely tomentose; awn 6—9 mm long. Pedicellate spikelet 5—7 mm long; lower glume lanceolate, glabrous, (3)7-nerved.

C. schoenanthus is characterized by having densely pilose racemes, a subchartaceous, concave lower glume of the sessile spikelet and a swollen lower pedicel.

The two subspecies have different distribution pattern; subsp. *schoenanthus* occurs in northern Sahara whereas subsp. *proximus* in southern Sahara. Subsp. *proximus* differs from subsp. *schoenanthus* by having shorter racemes, awns and peduncles, and the lower glume of the sessile spikelet minutely tomentose on the back. (See scatter diagram fig. 27.)



FKS. 27. Scatter diagram of *C. schoenanthus* subsp. *schoenanthus* **and subsp.** ***proximiu;***
• lower glume of sessile spikelet glabrous;
O lower glume of sessile spikelet **pubescent;**
• awn > 8% mm long;
tf aWn < 81/2 mm long.

Subsp. SCHOENANTHUS

Tufted grass. Leaf-blades usually filiform. Peduncle 8—25 mm long, sparsely tomentose in the upper part. Raceme 20—29 mm long. Lower glume of the sessile spikelet glabrous on the back; awn more than 8 mm long.

HABITAT: In semi-desert areas; low limestone hills or open stony grounds.

DISTRIBUTION: Morocco, Algeria, South of Saudi Arabia, Yemen and North of Somalia (fig. 26).

USES: This plant was much esteemed by the ancient Greeks and Romans and is used for medicinal purposes and sometimes employed in perfumery.

MOROCCO. Road between Taroundant and Marrakech, 7.V.1961, 1300 m, *de Wilde & Dorgelo 2208;* Gebel Erbib, near Marrakech, 20.IV.1936, *N.D. Simpson S62U;* Erford, 27.IV.1939, *P. Davis 592;* El Defilia, April 1913, *C.J. Pitard 3786.*

ALGERIA. No definite locality, *E. Cosson (Kralik 95).*

SAUDI ARABIA. Jidda, Febr., *Tiphin 132;* ibid., *W. Schimper 789* (type of *Andropogon circinatus* Hoclist. ex Steud.); NE of Jidda, 1. IV. 1949, alt. 150 m, *A.C. Pratt 1236;* along SAMS Re, N. of Jidda, 6. I. 1953, alt. 150 *m, H. Schwan 30;* Jidda-Mecca Rd., Febr., alt. 130 m, *A.C. Pratt 1584;* Jidda-Mohd Rd., Feb. 1940, alt. 65 m, *A.C. Pratt 246;* El Birka, *Meinertzhagen;* no definite locality, *Plukenet;* Buraiman, 16. I. 1947, alt. 65 m, *D.V. FitzGerald 16720;* Huraichla, 20. I. 1938, alt. 900 m, *Wake field exp. 21;* Wadi Arika, 12. II. 1946, *W. Thesiger;* Jebel Dhalm, 19. IV. 1947, *D.V. FitzGerald 1695011;* Wadi Saylet, 4. I. 1890, *M. Deflers Ul.*

SOUTH YEMEN. Wadi Idin, E. of Aden, April 1961, *O. Kerfoot 3005;* Saihut area, 27. I. 1952, alt. 650 m, *Gilliland 1,109;* Aqabet Halhal, 30. IV. 1919, *H.V. Wissmann 2579* *); Wadi Djari, 4. V. 1939, *H.V. Wissmann 2673.*

OMAN. Muskat, 28. I. 1893, *J. Borrmuller 701,.*

SOMALIA. Duwi, 19. X. 1932, alt. 1200 m, *J.B. Gillett 4371;* Dikhil Date Palm Grove, 12. X. 1968, alt. 450 m, *H. Lavranes 685813;* Erigave, 7. X. 1941, alt. 1300 m, *E.F. Pock 260;* Wagga Mt., *Philips K239;* Hudin, 25. X. 1944, *Glover & Gilliland 169;* Buran, *C. Collenette 89;* Harme, 23. X. 1929, alt. 750 m, *C. Collenette 172.*

subsp. PROXIMUS (Hochts. ex A. Rich.) Maire & Weiller

Andropogon proximus Hochtst. ex A. Rich., Tent. Fl. Abyss. 2: 464. 1851. — *Andropogon jwarancusa* subsp. *proximus* (Hochtst. ex A. Rich.) Hack, *in* DC, Monogr. Phan. 6: 601. 1889. — *Cymbopogon proximus* (Hochtst. ex A. Rich.) Stapf *in* Prain, Fl. Trop. Afric. 9: 271. 1919. — *Cymbopogon schoenanthus* subsp. *proximus* (Hochtst. ex A. Rich.) Maire & Weiller, Fl. Afr. Nord 1: 287. 1952; Clayton *in* Hutch. & Dalziel, Fl. West Trop. Afr. 3(2): 482. 1972. — Type: Ethiopia, *Schimper 1792 (K,* iso!).

Leaf-blades filiform to flat. Peduncle 3.5—6 mm long, glabrous. Racemes 13—20 mm long. Lower glume of the sessile spikelet minutely tomentose, very rarely glabrous; awn 6.7 mm long.

HABITAT: Open woodlands; savannas; semi-deserts.

DISTRIBUTION: West Africa to Sudan and Kenya.

USES: Used by native in Ghana as antidote for snake bite; used also for thatching.

MAURITANIA. Trarza, 19.IX.1958, *D. Sadio 251;* El Hagner Plateau, 28. VIII.1934, *T. Monod 2102;* Tioulit, 10.IV.1959, *Bonetti 59/24.*

MALI. Kare near Dioura, Nov. 1954, *J.J. Davey 143;* Gaoto Ansongo, 15.1. 1932, *A. Chevalier 43042;* Ansongo, Sept. 1927, *O. Hogerup 330; J.F. Rogeon 466; A. heelercq 42695.*

GUINEA. Falama, 24.111.1949, *D.H. Winkoun;* SW of Ouaggadougon, 4.X. 1968, alt. 304 m, *Scholz la;* W. of Banfora 4.VI.1962, alt. 300 m, *A.J.M. Leeuwenberg 4299.*

IVORY COAST. Bouna Nat. Park. Jehini, 24.VII.1963, *R.A.A. Oldeman 328.*

GHANA. NE of Nakpanburi, 26.X.1958, *R. Rose-Innes 30742;* Tong Hills, 3.VII.1930, *T.L. Williams 520;* S. of Bolgatonga, *R. Rose-Innes 30238;* Saboba, Dogomba Distr., 20.111.1958, *F.H. Hepper & J.K. Morton A3115;* Tuma Town, 29.VI.1963, *R. Rose-Innes 31710;* near Bawku, *F.R. Irivine 4605;* Kaleo Hill, Wa, 2.IV.1956, *CD. Adams 4008;* Birifu near Lawra, Aug. 1948, *C. A. Thorold 218;* near Lawra, *CD. Adams 4015;* Zuarungu, 30.XI.1935, *G.K. Akpabla 399;* ibid., June 1938, alt. 3C0 m, *C Vigne 4548.*

TOGO. Kande Village, 3.X.1960, *R. Rose-Innes 31405.*

DAHOMEY. Atacora, 16.VI.1910, alt. 450—550 m, *A. Chevallier 24075.*

NIGERIA. Between Mongonu and Kukawa, *F. Golding 4* Sokoto, 19.IX.1968, *P.N. de Leauw 2032;* ibid., July 1919, *J.M. Dalziel 486;* N. of Sokoto, Sept. 1930, *J.H. Palmer 10;* Kukana, 25.111.1962, *G. Jackson 2597.*

NIGER. Agades, 20.11.1970, alt. c. 500 m, *P.N. Bradley 16;* Mt. Tarraouaji, Sept. 1942, alt. 900 m, *L. Chopard & A. Villiers.*

SUDAN. Semeth, 23.X.1962, *G.E. Wickens 718;* Sugura, Gedaref Distr., 23. IX.1951, alt. 18 m, *B. Beshir 134;* El Fasher Darfur Prov., 9.X.1947, *M.N. Harrison 86;* Wady O Mareg,-G. *Schweinfurth 561;* Lokomoringang, 9.VI.1953, alt. c. 650 m, *S.H. Padwa 266;* near Khartum, *A. F. Braun 687;* Nuba Mts., Tolodi, 11.V.1930, *D. Simpson 7725*);* Soturba area, 8.III.1964, *G. Schweinfurth 1041;* Haiban Distr., 1971, *Osman Alatif B9/71;* Zalingei, 1971, *Osman Alatif B16/71;* Jebel Marra, 30. X.1964, alt. c. 1100 m, *G.E. Wickens 2800; R.E. Massey.*

ETHIOPIA. Ailet near hot spring, 18.11.1892, *G. Schweinfurth & D. Piva 462;* Mt. Jelajeranne, 20.X.1940, *Schipmer 1792.*

KENYA. Near Karpendo, VI.1957, *D.J. Pratt 5722;* Akoret, Baringo, 4.VI. 1957, alt. c. 1200 m, *D.J. Pratt MS 22;* S of Tarkama, 6.1.1970, alt. c. 850 m, *B. Mathew 6670;* Larda Gash, near Lake Rudolf, 2.IX.1944, alt. c. 650 m, *Joy Adamson B 3589.*

9. CYMBOPOGON JWARANCUSA (Jones) Schult.

Andropogon jwarancusa Jones *in* Asiat. Res. 4: 109. 1795; Roxburgh, Fl. Ind. 1: 279. 1820; Hackel *in* DC, Monogr. Phan. 6: 599. 1889. — *Cymbopogon jwarancusa* (Jones) Schult., Mant. 2: 458. 1824; Stapf *in* Kew Bull. 1906: 313, 354. 1906; Bor *in* J. Bomb. Nat. Hist. Soc. 52: 178. 1955. — Type: India, Lmcknow.

Culm erect, rarely geniculate, 105 cm high, nodes often swollen. Leaf-blades whitish, smooth glabrous, basal-sheaths glabrous, flat or curled. Ligule 0.5—3 mm long , membranous. Spathate panicle erect, 15—40 cm long. Racemes 13—22 mm long; lowermost pedicel and lower raceme-base not swollen and not fused; rachis internodes and pedicels densely pilose along the margins and on the back. Sessile spikelet 4.5—5.5 mm long, lower glume lanceolate, 0.8 mm wide, subchartaceous, shallowly concave on the back, glabrous, nerveless or 1—2-nerved; awn 7—10 mm long. Pedicellate spikelet 6 mm long; lower glume lanceolate, 0.8—1 mm wide, 3—7-nerved.

C. jwwrancusa belongs to the group which has a sharply keeled lower glume of the sessile spikelet. It differs from its relatives by having flat raceme-base and lowermost pedicel.

The two subspecies are very close to one another. Previous authors (Stapf 1906, Bor 1954) distinguished *jwarancusa* from *olivieri* by its curled basal sheaths. In fact, it is not as clear cut, for in subsp. *jwarancusa* the basal sheaths are often not curled. The differences between the two subspecies are shown in the scatter diagram (fig. 28). There seems to be an ecological difference, but only partial geographical segregation.

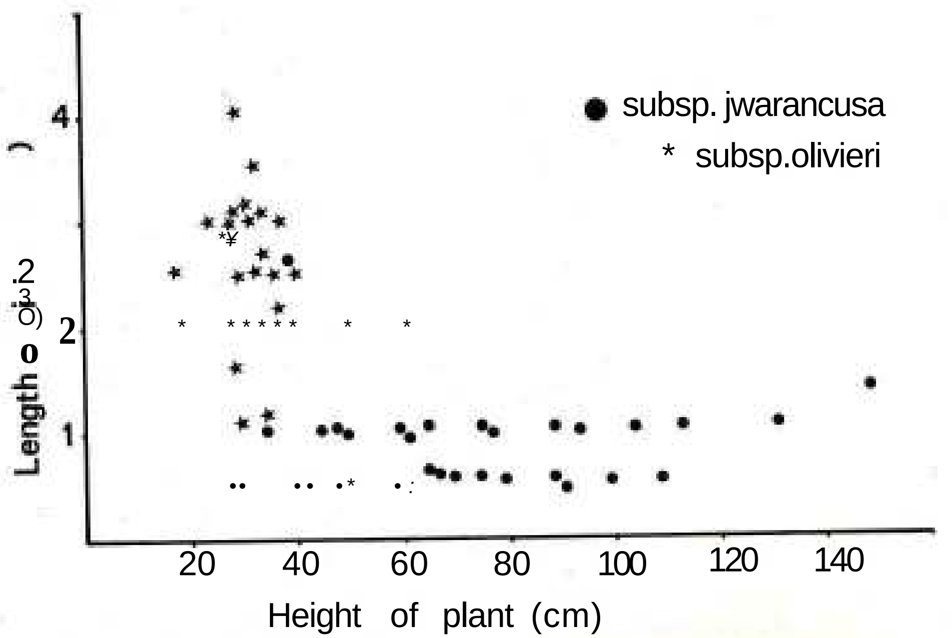


FIG 28. Scatter diagram of *C. jwarancusa* subsp. *jwarancusa* and subsp. *olivieri*

SUbsp. JWARANCUSA

Basal sheaths more or less curled; ligule less than 1 mm long.

CHROMOSOME NUMBER: India, 2n = 20 (Ragh. & Arora 1958; Mehra *et al.* 1962; Gupta 1969a).

HABITAT: Wet grasslands.

DISTRIBUTION: Western India (Punjab) and Pakistan.

USES: Used to restrain any kind of fever in India, to purify the blood; also used for cough, chronic rheumatism etc. The essential oil contains piperitone and carene (Guenther 1954; Gupta 1969).

INDIA- W. Himalaya, Gorakpur Distr., 26.111.1898, *J.F. Duthie 22892;* Lachnipur, 15.IV.1898, *J.F. Duthie 22981;* Tihri Garhwal, 1871, alt. 800—900 m, *Falconer 404*; 17.V.1893, alt. 1000—13C0 m, J.S. *Gamble 12922;* Tons Valley, May 1895, alt. c. 100 m, *J.S. Gamble 25444; J.F. Duthie 15579; V. Jackquemant 278;* Kandia, 12.IX.1943, alt. 2500 m, *W.N. Kolz 21719;* Bijrani, 9.VI.1902, *J.F. Duthie 26012;* Gilgit, 1885, *Gilles 237;* Kumaon, *Royle; R. Strachey & J.E. Winterbottom 5;* Rania, Hissar Distr., 17.1.1886, *J.R. Drummond 21106;* Punjab, *Hooker & Thomson;* Khelam, 8.X.1962, alt. 1000 *m, J.R. Drummond 15102;* Shahpur Distr., 15.IX.1902, *J.R- Drummond 14587;* Chantata, 24.1.1886, *J.R. Drummond 21101;* Kulu, 19.IV. 1931, *W.N. Koelz 1882;* Assam, Lohit Valley, 19.V.1950, alt. c. 1400 m, *F.K. Ward 19480;* Goulpara, 1.XII.1912, *R.S. Hole;* Menoka, 16.11.1952, *W.N. Koelz 29277;* Forest North Oudh, 1870, *R. Thompson 375;* C.B.L. Allahabad, 1964, *E.K. Janaki Ammal 1001; Wallich 879S.*

PAKISTAN. Kahot-Hangu, N.W. Frontier, April 1957, *R.R. Stewart 28247;* near Karachi, 6.V.1969, *Sultan-al-Abedin 2749*);* Nagarparker, 16.IX.1968, *S.I. Ali 1517;* between Samtsar to Gnadar, 29.11.1971, *Sultan-al-Abedin & A. Husain 6320.*

NEPAL. N. of Sallyon, 30.111.1952, alt c. 1200 m, *O. Polunin et al. 3753.*

subsp. olivieri (Boiss.) S. Soenarko, *comb. nov.*

Andropogon olivieri Boiss., Diagn. PI. Or., ser. 1, no. 5: 76. 1844. — *Cymbopogon olivieri* (Boiss.) Bor *in* Notes Roy. Bot. Card. Edinb. 25: 63. 1963. — *Cymbopogon jivaraneusa* subsp. *olivieri* (Boiss.) S. Soenarko, *comb. nov.* — Type: Iraq, Mesopotamia, *Aucher 2955* (K, iso!).

Cymbopogon laddakensis B.K. Gupta *in* Proc- Ind. Nat. Acad. Sc, sect. B, 71: 9. 1970. — Type: India, *B.K. Gupta 37* (Dehra Dun, holo; K, fr.!).

Basal sheaths hardly curled; ligule more than 1 mm long.

CHROMOSOME NUMBER: Iraq, 2n = 20 (Gould 1956); India, 2n = 20 (Gupta 1969).

HABITAT: Dry grasslands; alt. up to 900 m. (often more than 2500 m).

DISTRIBUTION: West Pakistan, Punjab to Iraq.

IRAQ. Mesopotamia, *Aucher 2955; Kotschy 386;* Mosul, 15.V.1939, *B.E. Baylies 128;* S. of Mosul, 27.V.1948, alt. c. 300 m, *J.B. Gillet 11170;* Ain Sifin, 10.VI.1932, *Salim Effendi 2565;* Jarmo, 19.V.1955, *H. Helback 1821;* Altun Kufir on Zab River, 8.VII.1933, *E. Guest 4024;* Qara Tafu, 15.IV.1932, *E. Guest 1977* NW of Paluja, 4.V.1957, *A. Rawi 20249;* Tanurah, 1958, *M.E.D. Poore 567;* Kharazin, 10.X.1929, *F. A. Rogers 412;* N. of Amarah, 2.VI.1961, *Hazim & Nuri 30638A;* Kirkuk, 30.IV.1933, *E. Guest 4375;* N.E. of Kirkuk, 6.V.1959, *Rawi et al. 27884;* Jebel Hamrin, 3.V.1956, *E. Guest 15553;* Diana, 20.IX.1956, alt. 650 m, *E. Guest & Husham 15875.*

IRAN. Rotal Bartak, 1.III.1940, *A. Parsa 569;* Khouzertan, 20.IV.1959, *Pahat 101 HE;* near Mandali, 2.VI.1957, *A. Rawi 20653;* Kurkuz, 1867, *C. Haussknecht 1070a,,*

SOCOTRA. *Schweinfurth 405; Balfour et al. 275, 379; Smith & Lawranos 596.*

PAKISTAN. Sind. between Karachi and Dadu, 5.V.1965, *J. Lamond 843;* near Surab, 5.VI.1970, *M. Qaiser 1214.*

AFGHANISTAN. Ziarah, 15.VI.1962, alt. 2530 m, *R.R. Stewart 562;* near Kandahar, 21.V.1948, alt. 900 m, *M. Koie 20916;* between Girishk and Kandahar, 25.IV.1964, alt. c. 800 m, *P. Furse 5581;* 11.V.1884, *J.E.T. Aitchison 59;* 4.VIII.1885, *J.E. T. Aitchison 762.*

INDIA. Kashmir, Nitar Valley, 3.VIII.1892, alt. c. 1800 m, *J.F. Duthie 12335.*

BALUCHISTAN. 3.IV.1949, G. Charif 1210, 12.IV.1956, *J.J. Norris 176.*

10. CYMBOPOGON SENNARENSIS (Hochst.) Chiov.

Andropogon sennarensis Hochst. *in* Flora 27: 243. 1844. — *Andropogon jwarancusa* var. *sennarensis* (Hochst.) Hackel *in* DC, Monogr. Phan. 6: 600. 1889. — *Cymbopogon sennarensis* (Hochst.) Chiov., Gram. Ess. 16. 1909; Stapf *in* Prain, Fl. Trop. 9: 270. 1919. — Type: Sudan, Sennar, *Kotschy 187* (K, iso!).

Culm up to 70 cm high, smooth, glabrous. Leaf-blades linear, erect, up to 40 cm long, 2 mm wide, glabrous, rough below. Leaf-sheath slightly rough, glabrous, basal sheaths glabrous. Spathate panicle 40 cm long, branched, branches elongated, lowermost nodes barren; spatheole 16 mm long, glabrous; peduncle 3—4 mm long. Raceme 15 mm long, pilose; lower raceme-base very short, not swollen and not fused with the swollen lowermost pedicel; rachis internodes and pedicel densely pilose along the margins and on the back. Sessile spikelet 6.5 mm long; lower glume lanceolate, subchartaceous, 0.8 mm wide deeply concave on the back, glabrous; awn 7 mm long. Pedicellate spikelet 5.5—7 mm long; lower glume lanceolate, 1 mm wide, 7(ll)-nerved.

HABITAT: Savannas.

DISTRIBUTION: Sudan.

This species is related to *C. schoenanthus* subsp. *proximus* by its short racemes and peduncle, and its swollen lowermost pedicel.

SUDAN. Sennar, Oct. 1837, *Kotschy 187;* Cordofan, April 1837, *Kotschy 119;* Jebel Marra, Wadi Taro, 12. VIII. 1963, alt. c. 1200 m, *Blair 143.*

11. CYMBOPOGON DIVARICATUS Stapf

Cymbopogon divaricatus Stapf *in* Prain, Fl. Trop. Afr. 9: 278. 1919. — Type: Somalia, *Drake Brockman 411* (K, iso!).

Culm 65 cm high, wiry, glabrous. Leaf-blades filiform, up to 30 cm long, usually glabrous, rough below. Leaf-sheath glabrous, basal sheath often minutely pubescent. Ligule rounded, 3 mm long. Spathate panicle 20 cm long, narrow, very rarely with secondary tiers; spatheole 24—24 mm long; peduncle 15 mm long. Raceme 20—30 mm long, 5—6 pair of spikelets; lower raceme-base not swollen and not fused with the swollen lowermost pedicel; rachis internodes and pedicels pilose along the margins, more or less pubescent on the back. Sessile spikelet 5—7 mm long; lower glume 0.7—0.8 mm wide, shallowly concave in the lower part, nerveless, very rarely 3-nerved; awn 21 mm long. Pedicellate spikelet 6.5 mm long; lower glume 1.4 mm wide, glabrous, 7—9-nerved.

HABITAT: Savannas at the altitude 1500—2500 m.

DISTRIBUTION: Somalia; endemic.

This species can be recognized by the filiform leaf-blades and the nerveless, shallowly concave lower glume of the sessile spikelet.

SOMALIA. Erigays, 1938, alt. 1500—2000 m, *A. S. McKinon S222;* Rhyolite Plateau, 25.VII.1957, *A. T. Grove 12; Drake Brockman 411 *).*

12. CYMBOPOGON FLOCCOSUS (Schweinf.) Stapf

Andropogon floccosus Schweinf. *in* Bull. Herb. Boiss. 11: 14. 1894. — *Cymbopogon floccosus* (Schweinf.) Stapf *in* Prain, Fl. Trop. Afr. 9: 276. 1919. — Type: Ethiopia, *Schiveinfurth* (B).

Tussock grass, culm up to 120 cm high, often branched, glabrous. Leaf-blades linear, tapering, up to 20 cm long, 3 mm wide, dull-green, glabrous except for scanty long spreading hairs on the upper surface behind the ligule. Leaf-sheaths glabrous, basal-sheaths glabrous. Ligule 3 mm long, rounded. Spathate panicle 5—30 cm long, with 2 to numerous racemes, rarely with tertiary tiers; spatheole 25—43 mm long; peduncle 20 mm long. Raceme 20—35 mm long, consisting 5—6 pairs of spikelets; lower raceme-basa swollen, fused with swollen lowermost pedicel, stout and erect, 3 mm long, upper raceme-base slightly longer, flat, deflexed at maturity and often turned back upright; rachis internodes and pedicels 5 mm long, pilose along the margins, puberulous on the back. Sessile spikelet 6 mm long; lower glume deeply concave below the middle, flat in the upper part, 0-5—1 mm wide, glabrous ,nerveless, awn (9)10—15 mm long. Pedicellate spikelet 6—6.5 mm long; lower glume more or less dull-green, 1—1.2 mm wide, glabrous.

HABITAT: Open scrub on mountain slopes; stony grounds; alt. 900—1600 m.

DISTRIBUTION: Ethiopia, Somalia.

At maturity the lower raceme-base in this species is shorter than the upper raceme-base, which is flat and deflexed and almost immediately turns upright again forming a loop at the base of the upper raceme. This structure is characteristic of *C. floccosus.*

ETHIOPIA. Awash Nat. Park, Oct. 1962, *Beauchere & Mooney 1004-0;* ibid., 14.IV.1969, *M. G. & S. B. Gilbert 1222* *); ibid., road to hot spring, 16.IV.1969, *M.G. & S.B. Gilbert 1256;* ibid., W. of Metahara, 18.VIII.1968, *P.M. Headley 213* (S. 36); Robi Bailey, Sera-Magbia, 31.VIII.1969, *H.F. Mooney 8136;* near Yerer-Gota, 6.VIII.1960, *IECAMA I. 16;* Ever River, W. of Dire Dawa, 7.X.1962, *W. Burger 2184;* ibid., 1961, *W. Burger 626, 611, 464.*

SOMALIA. Golis Range, 26.11.1906, *Drake Brockman 121, 126;* Borama Goljeit, 1.IX.1938, *A.S. McKinnon S53;* Upper Sheikh & Burao, July 1903, *Appleton;* near Ghor, 25.IX.1956, *Bally B108S6;* Marabe Hills, Durkahomanya, 22.11.1945, *P.E. Glover & Gilliland 841;* Burmado (10°31' N, 43°50' E), 2.XI.1932, *J.B. Gillett 4543;* Ohob Pass, 4.II.1933, *J.B. Gillitt 4944;* Hargeisa, 23.VII.1929, *R. A. Farquharson 12;* ibid., northern region, Oct. 1961, *C.F. Hemming 2251;* (9°48' N 43°17' E), May 1933, *H. C. Godding 12, 46.*

13. CYMBOPOGON COMMUTATUS (Steud.) Stapf

Andropopon commutatus Steud., Syn. PI. Glum. 1: 387. 1854; Hackel *in* DC, Monogr. Phan. 6: 612. 1889. — *Cymbopogon commutatus* (Steud.) Stapf. *in* Kew **Bull. 1907:** 211. 1907; *in* Prain, Fl. Trop. Afr., 9: 275. 1919. — Type: Ethiopia, *Schimper 685* (P, holo; K, iso!).

Culm erect, 60—150 cm high, smooth, glabrous, or pubescent in the upper part of the internodes. Leaf-blades flat or folded, 50 cm long, 3.5 mm wide, dull-green, rigid and rough, glabrous or with fine spreading hairs, behind the ligule. Ligule truncate to rounded, glabrous, membranous. Spathate panicle 35 cm long erect, narrow, with 6 to numerous racemes, rarely with secondary tiers; spatheole (21)27—43 mm long; peduncle 15 mm long. Raceme with 7—8 pairs of spikelets, 23 mm long; lower raceme-base slender, not swollen, and not fused with the swollen lowermost pedicel, upper raceme-base slender, deflexed, rachis internodes and pedicels pilose along the margins, glabrous or minutely puberulous on the back. Sessile spikelet 6 mm long; lower glume deeply concave below the middle with a little bump at the base, 1 mm wide, chartaceous to subchartaceous, minutely puberulous on the back; awn 19 mm long. Pedicellate spikelet deflexed laterally, 7 mm long; lower glume ovate-lanceolate, 1.5 mm wide, dull green, glabrous, 7-nerved.

HABITAT: Open bush; woodlands; upland grasslands; alt. 1500—2500 m.

DISTRIBUTION: Sudan, Ethiopia, Mauritania, Somalia.

This species is easily recognized by the presence of a little bump at the base of the lower glume of the sessile spikelet together with the swollen lowermost pedicel not fused with the short, not swollen lower raceme-base.

C. commutatus closely resembles *C. floccosus* in having a swollen lowermost pedicel and it can be easily confused when the bump is very small or inconspicuous. However, the unusual deflexed upper raceme-base in *C. floccosus* does not occur in *C. commutatus.*

MAURITANIA- 10.XII.1927, *H. Jumella, 2201.*

SENEGAL. Bakel, 29.XII.1953, *R.P. Berhaut 1311.*

SUDAN. Jebel Marra, Golol, 26.VI.1963, alt. 2100 m, *I.J. Blair 40;* ibid., June 1963, alt. c. 1800 m, *I.J. Blair 58;* ibid., near Zalingei, 1.XI.1964, alt. c. 1150 m, *G.E. Wickens 2317* ibid., 4.IX.1964, alt. c. 1100 m, *G.E. Wickens* 2351; Gur Lambang, 17.IX.1964, alt. c. 1800 m, *G. E. Wickens 2581;* Jebel Sirni, 1.X.1964, *G.E. Wiekens 2763;* Kelling, 14.X.1964, alt. 2100 *m,G.E. Wickens 2781;* Darfur Prov., Sept. 1921, *H. Lynes 528.*

ETHIOPIA, By the Mesiam, 13.V.1894, alt. c. 1500 m, *G. Schweinfurth 45;* 10.XII.1909, *Dhiovenda 1243; Schimper 1801.*

SOMALIA. Hargeisa, *R. A. Farquharson 5.*

14. CYMBOPOGON PARKERI Stapf

Cymbopogon parkeri Stapf *in* Kew Bull. 1929: 10. 1929; Bor *in* J. Bomb. Nat. Hist. Soc. 52: 182. 1954. — Type: India, *R.S. Person* (K, holo!).

Culm 50—90 cm high, erect to slightly geniculate, smooth, glabrous. Leaf-blades dull green to reddish, 50 cm long, 1.5—5 mm wide, filiform to flat, scabrid. Leaf-sheaths smooth, glabrous, basal sheaths tomentose. Ligule membrano-chartaceous, glabrous, 1—3 mm long. Spathate panicle compound or often with a very few racemes, erect; spatheole 20—26 (43) mm long, glabrous; peduncle (7) 16—26 mm long, glabrous. Raceme 22 (40) mm long, waxy; lower raceme-base not swollen, fused &t the base with the swollen lowermost pedicel; rachis internodes and pedicels rigid, more or less rounded on the back, pilose along the margins, glabrous or minutely puberulous on the back. Sessile spikelet 5.5—7.7 mm long, lower glume broadly lanceolate to lanceolate, chartaceous, 1 mm Wide, slightly flat to deeply concave on the back, glabrous to minutely puberulous on the back, often ciliate along the keels, 3-nerved; awn 14 mm long. Pedicellate spikelet 6(9) mm long, deflexed laterally; lower glume narrowly ovate-lanceolate to lanceolate, 1—1.2 mm wide, ciliate along the margins, 7-nerved.

CHROMOSOME NUMBER: India, 2n = 20, 40 (Gupta 1969).

HABITAT: Open grasslands; semi-desert, rarely in desert areas.

DISTRIBUTION: From Punjab, India to Iraq and Northern Arabia.

C. parkeri is related to the African species, *C. floccosus* and its allies. It differs from *C. floccosus* in having tomentose basal sheaths.

C. parkeri is variable in leaf-shape. Nearly all the plants from the Punjab and Pakistan have flattened leaf-blades, whilst those from Arabia, Iraq and Persia have filiform, often curled leaf-blades. The Arabian plants are often confused with *C. schoenanthus* subsp. *schoenantlms* which also has filiform leaf-blades. However, the rounded keels at the base of the lower glume of the sessile spikelet make this species quite distinct from *C. schoenanthus* subsp. *schoenanthus;* moreover the glume in *C. parkeri* is chartaceous and 3-nerved.

ARABIA. Azaiza, 28.111.1946, *D.V. Fitzgerald 15648;* Afif, Jebel Nir, 3*.VI. 1946, *D.V. Fitzgerald 15926;* Qatar, 6.II.1971, *C. Wilcox 70;* Wady Ibn Hashabil, 23.VI.1946, *D.V. Fitzgerald 15998;* Jilh at 'Ashar', 29.111.1964, *J. P. Mandaville 1U;* north side of the Jebel, III.1965, *T. Carpenter 113 & 150.*

IRAQ. Near Safwan, 21.IV.1967, *Alizzi &\ Sabah Omar 34963;* S. of Zubair, 23.111.1957, *E.R. Guest et al. 16940 & 16943;* N.W. of Zubair, 19.IV.1964, *F.A. Barkley 6495;* W. of Al Barsah, 7.V.1960, *Bharucha et al. 2931;* between Al Basrah pnd Safwan, 2.IV.1965, *Alizzi & Khatib 33306*);* S. of Zubair, 17.11.1947, *Gillett & Rawi 6105*);* W. of Zubair, 8.IV.1933, *E. Guest 5036;* S.W. of Zubair, 16.IV.1955, alt. c. 15 m, *E. Guest & Al Raivi 14343;* Abu Ghrar, 30.111.1936, alt. c. 80 *m, E. Guest & Mahallal 15301;* near Um Qass, 2.IV.1965, *Alizzi & Khatib 3308;* Ruhba near Neger, 13.IV.1961, *Agnew et al. W1935.*

IRAN. E. of Lar, 1.III.1939, *Morton 3638.*

BAHRAIN ISL. Jebel Dukhan, 17.11.1936, *J. Fernandes 231;* 19.111.1950, *R. Good 348;* 16.111.1950, *R. Good 349*);* S.E. of Awali, 22.111.1950, *R. Good 351;* 25.111.1950, *R. Good 352;* S.E. of Ali, 28.111.1950, *R. Good 353.*

AFGHANISTAN. Kumar Valley near Chanki, 26.V.1969, alt. 750 m, *Carter 311* *).

PAKISTAN. Karachi, 4.IX.1953, *A. Rahman 25665*);* 2.IX.1952, *R.R. Stewart 24777;* Baluchistan, 1956, *M. Sharet 7a;* Merhail near Quetta, 10.V.1956, *J. J. Morris 183;* Fort Sandeman, 8.V.18.V.1897, *Harsukh 2066*);* Rawalpindi, April 1948, *R.R. Stewart 23357;* ibid., Sept. 1948, *R.R. Stewart 23358;* ibid., VII.1870, ***J.E.T.** Aitchison 97;* Chitral, 28.VI.1953, *M. Siddigi 25639;* ibid., 1908, *Troppin 177;* Nort West Frontier, 24825, IV.1957, *R.R. Stewart 28248;* ibid., 22.IV.1954, *A. Rahman 25794;* Nagar Parker, 24.X.1970, *M. Qaieer & A. Ghafoor 3988.*

INDIA. Punjab, Hissar, 3.IX.1886, *J.R. Drummond 21097;* ibid., 28.11.1886, I *J. R. Drummond 21098 & 21099;* Khelam 26.IV.1904, *J.R. Drummond 21125;* **Shahpur,** 13.X.1902, alt. c. 750 m, *Mulchand 14753;* Etawah, VIII.1923, *R. S. Pearson;* Ajmera, 12.X.1887, *J.F. Duthie 6760;* Waziristan, 26.IV.1895, *J.F. Duthie 15721; J.F. Duthie \s0705; J.R. Drummond 21102*).*

15. CYMBOPOGON PLURINODIS (Stapf) Stapf ex Burtt-Davy.

Andropogon plurinodis Stapf *in* Dyer, Fl. Gap. 7: 353. 1898. — *Cymbopogon plurinodis* (Stapf) Stapf ex Burtt-Davy *in* Ann. Transv. Mus. 3: 121. 1912; Stapf *in* Prain, Fl. Trop. Afr. 9: 273. 1919. — Type: Natal, *Wood 4318* (K, lecto!).

Culm erect, 40—90 cm high, usually glabrous. Leaf-blades linear, flat, 2—4 mm wide, up to 25 cm long, rigid, rough on both surface. Leaf-sheath usually glabrous, basal sheaths tomentose. Ligule rounded, 1—3 mm long. Spathate panicle 25 cm long, with a very few to numerous racemes, rarely with tertiary tiers; spatheole 20—26 mm long, glabrous; peduncle 5—8 mm long. Racemes 18—22 mm long; lower raceme-baso and lowermost pedicel not swollen and not fused; rachis internodes and pedicels densely pilose along the margins and in the upper part. Sessile ppikelet 5.5—7 mm long; lower glume 0.9 mm wide, glabrous, concave on the back, 2—4-nerved; awn 14 mm long. Pedicellate spikelet 6.5 mm long; lower glume narrowly ovate-lanceolate, 1.4 mm wide, often pubescent on the back.

CHROMOSOME NUMBER: South Africa, 2n = 40 (de Wet 1954a).

HABITAT: Grassvelds; open veld between bushes; on the hill between 900—2000 m alt.

DISTRIBUTION: South Africa, Natal, Transvaal and South West Africa.

MINOR VARIATIONS: Leaf-sheaths are usually glabrous, but in *E.B. Schoeuj'elder 67* the sheaths are densely tomentose.

SOUTHERN RHODESIA. Bulawayo, 18.11.1912, alt. c. 1480 m, *F.A. Rogers 5918;* Matopo Res. St., 4.II.1954, alt. 1500 m, *J.M. Rattnay 1572;* Gwelo, 3.II.1967, alt. c. 1500 m, *H.M. Biegel 1859;* Salisbury, Dec. 1908, *A. E. Nobbs 634;* Ft. Victoria Commonage, 30.XII.1947, *D. A. Robinson 163;* Plumtree Commonage, March 1949, **alt.** c. 1500 m, *R. M. Davies D298.*

SOUTH WEST AFRTCA. Namaqualand, Schakalskuppe, 18.11.1909, alt. c. J 860 m, *H. H. W. Pearson 4252.*

SOUTH AFRICA. Bechuanaland. Rakops, Dec. 1962, *A.M. Yalala 369;* S.E. of Nata River, 24.IV.1957, alt. 900 m, *S. C. Seagrief 2459* *); W. of Luthle, 17.XII.1960, *B. de Winter 7332;* Rochudi, Feb. 1914, *F.A. Rogers 6572.* — Transvaal. Burttholm, 5.III.1917, *J. Burrtt-Davy 17201;* Amersfoort, 15.111.1917, alt. c. 1830 m, *J. Burtt-Davy 17365;* Lydenburg, 1873/4, *W.C. Atherstone;* Pretoria, 1931, alt. 1500 m, *Trapnell 655;* Kruger Nat. Park, E. of Skukuza, 5.II.1949, alt. 300 m, *B. de Winter & L.E. Codd 532;* Bloemhof, 6.IV.1955, alt. 1300 m, *O. A.*

Leister 123; near Pieterburg,, 1.V.1945, *J. Gerstner 5353;* Doomkloof, Irene, 2.1. 1929, *J. Hutchinson 2405;* N. of Kroostad, 4.II.1967, alt. c. 1500 m, *J.C. Scheepers 1281;* Koopmansfontein, 4.1.1968, alt. 1500 *m, P.D. Hattingh H21;* Fauresmith, 9. V.1929, alt. 1500 m, *C. A. Smith 4091;* Bloemfontein, Jan. 1963, *van Rensburg 2564;* Hobhouse (Orar.ge Free State), Dec. 1962, *M. Grobber 2539;* Bergplaas, 30.IV.1934, *I.C. Verdom 1346;* Barkley West Div., 18.11.1945, *A. Brueckner 164.* — Natal. Mooi River, 26.IV.1890, *J. M. Wood 4318* (lectotype); Pasture Res. St. (eastcoast), 4.II.1940, lat. c. 1300 m, *O. West 1777;* Umfolozi Game Res. Madlozi Valley, 20. XII.1969, *N.O. Smith 103;* Tugela River, 1875-80, *A. Rehmann 7158;* Biggarsberg, 1875-80, *A. Rehmann 7112.* — Cape Province. Albert, 1861, *T. Cooper 1363 & 3369;* Kaffraria, Kal River, Aug. 1885, *R. Baur;* Modderrivier, 20.1.1955, *D. P. Annecke 414;* Schmidtsdrift, Herb?r, 5.II.1963, *W.R.F. Nursey 31;* Bergkwagga, Cradock, 18.XII.1969, alt. c. 1800 m, *B.L. Penzhorn 5813;* W. of Harz River, N. of Kimberley, 11.11.1948, *R.J. Rodin 3631;* Crodock, 20.111.1969, alt. 1600 m, *P. Muller 568;* Queenstown, 28.111.1898, alt. c. 1150 m, *Galpin 2359;* no definite locality, *R. Baur 78.* — Lesotho. *A. Dieterlen 1083.*

16. CYMBOPOGON STRACHEYI (Hook, f.) Raiz. & Jain

Andropogon nardus var. *stracheyi* Hook.f., Fl. Brit. India. 7: 207. 1896. — *Cymbopogon stracheyi* (Hook.f) Raiz. & Jain *in* Ind. For. 80: 44. 1954; Bor *in* J. Bomb. Nat. Hist. Soc. 52: 160. 1954. — Type: India, NW Himalaya, *Stoliczka* (K, iso!).

Culm up to 60 cm high, slender, wiry, glabrous, slightly geniculate. Leaf-blades 17 cm long, 2 mm wide, bluish green, flat or folded, scabrid on the lower surface. Leaf-sheath glabrous smooth, basal sheaths glabrous. Ligule 1.5 mm long, membranous, glabrous. Spathate panicle about 15 cm long, with a very few racemes, rarely with secondary tiers, erect or nodding; spatheole up to 31 mm long, glabrous, peduncle 11 mm long. Raceme 24 mm long; lower raceme-base and lowermost not swollen and not fused; rachis internodes and pedicels 3 mm long, pilose along the margins, glabrous on the back, often tomentose. Sessile spikelet 5—5.5 mm long; lower glume chartaceous, oblong-lanceolate, glabrous, 0.8 mm wide, concave below the middle downwards or often flat, 4-nerved; awn 18 mm long. Pedicellate spikelet 6 mm long; lower glume narrowly ovate-lanceolate, 1 mm wide, glabrous to minutely scabrid on the back, 7—9-nerved. —

CHROMOSOME NUMBER: India, 2n = 40 (Gupta 1969a).
HABITAT: Dry open mountain slopes; alt. c. 2700 m.
DISTRIBUTION: Western Himalaya and Nepal.

C. stracheyi resembles *C. plurinodis* from South Africa, but the basal sheaths in *C. stracheyi* are glabrous.

INDIA. W. Himalaya, Bashahr, 6.X.1890, *J.H. Lace 633;* Pangi, *Stoliczka;* Kagan, Malkandi, 1.VIII.1897, *J.E. Duthie 22655;* Kumaon, *Strachey & J.E. Winterbottom 4;* Garhwal, Bhyundar Valley, 19.X.1962, alt. 2400—2700 m, *U.C. Bhattachary a 24544;* Satley Valley, near Rampere, Aug. 1847, *Hooker and Thomson;* Simla, *Falconer;* Kulu Valley, Nov. 1876, *Brandis;* Kashmir, Aster Valley, 28.VII. 1892, *J.F. Duthie 12301;* Gilgit. Nittar Valley, 3.VIII.1892, *J.F. Duthie 12328;* Gilgit, Jutial NulkTi, 31.VII.1954, *R.R. Stewart 26647;* Nagar, 16.VIII.1954, alt. 2000—2300 m, *R.R. Stewart 26648.*

NEPAL. Between Narku & Ila, Bheri River, 6.IX.1952, *O. Polumin et al. 3211.*

17. CYMBOPOGON POSPISCHILII (K. Schum.) C. E. Hubbard

Andropogon pospischilii K. Schum. *in* Engl. Bot. Jahrb. 24: 328. 1897; Stapf *in* Prain, Fl. Trop. Afr. 9: 265. 1919. — *Cymbopogon pospischilii* (K. Schum.) C.E. Hubbard *in* Kew Bull. 1949: 175. 1949. — Type: Mozambique, Muani, *Pospischil* (B, holo; K, frag.!).

Culm 75—95 cm high, glabrous, lowermost internodes often tomentose, nodes shortly bearded or glabrous. Leaf-blades up to 2.5 mm wide, flat or folded, upper surface with spreading long hairs at the base. Leaf-sheaths glabrous, basal sheaths glabrous or tomentose, often with spreading long hairs. Ligule truncate, 1 mm long. Spathate panicle 15—20 cm long with flexuous branches and racemes, rarely with secondary tiers; spatheole 27—40 mm long, peduncle up to 21 mm long, slender, flexuous, often slipped out of spatheole. Raceme 30—40 mm long, upper raceme usually with 7 pairs of spikelets; lower raceme-base and lowermost pedicel not swollen, deflexed, 2 mm long; rachis internodes and pedicels 2 mm long, pilose along the margins, pubescent on the back. Sessile spikelet 6 mm long; lower glume chartaceous, 0.8 mm wide, concave on the back, glabrous to puberulous, 2-nerved, narrowly lanceolate; awn 19—20 mm long. Pedicellate spikelet 6 mm long; lower glume 1.1 mm wide, glabrous, 9-nerved.

HABITAT: Grassland with scattered bush; alt. 1000—1500 m.
DISTRIBUTION: Ethiopia, Uganda, Kenya, Rhodesia, Mozambique.

C. pospischilii belongs to the Floccosus group characterized by a chartaceous lower glume of the sessile spikelet. This species can be recognized by its flexuous branches and racemes together with 7 pairs of spikelets in the upper racemes.

The raceme-bases place this species near to *C. plurinodis* from South Africa. It is almost impossible to differentiate between them at glance. However, *C. plurinodis* can be differentiated from *C. pospischilii* as it has 5 (occasionally 6) pairs of spikelets in the upper raceme. *C. pospischilii* also resembles *C. commutatus* which also has 7 pairs of spikelets, but it differs from the latter by its flat raceme-bases.

ETHIOPIA. Shoa Prov., 10.VIII.19C1, alt. 1500 *m, T. Ouren 20522.*

KENYA. E. of Nairobi, 19.VI.1951, alt. c. 1730 m, *A. Bogdan 3062;* N. oi' Nairobi, 15.VII.1962, alt. c. 1830 m, *P.E. Glover & Samuel 3159;* National Park, Nairobi, 6.VIII.1948, *A. Bogdan 1856;* S. Kavirondo, 1.V.1925, alt. c. 1200 m, *N.D. Spranger S29;* N. of Peckover, Ngai, 7.VI.1967, alt. c. 1300 m, *A. H.I. T.I. 12;* Kaekeliba, 9.X.1964, *//. Leippert 5085;* Esageri, Aug. 1957, alt. 1930 m, *C.G. Trapnell 2357;* Esagerist, 11.X.1948, alt. c. 2000 m, *A. Bogdan 2019;* Elmenteita, 17.1.1950, *A. Bogdan 2807.*

UGANDA. Karamoja, 22.V.1940, *A. S. Thomas 3503;* Moroto, Aug. 1954, *J. Wilson 7;* ibid., *O. Kerfoot 1194.*

MOZAMBIQUE. *Pospischil.*

18. CYMBOPOGON GIDARBA (Ham. ex Steud.) Haines

Andropogon gidarba Ham. ex Steud., Syn. PI. Glum. 1: 387. 1854; Hook, f., Fl. Br. India 7: 208. 1896; Hackel *in* DC, Monogr. Phan. 6: 613. 1889. — *Cymbo*-pogon gidarba* (Ham. ex Steud.) Haines, Bot. Bihar & Orissa 1048. 1924; Bor *in* J. Bomb. Nat. Hist. Soc. 52: 156. 1955. — Type: India, *Wallich 8797* (K, holo!).

Culm 32—90 cm high, glabrous. Leaf-blades 17—35 cm long, flat, 2—5 mm wide, glabrous below, pubescent above. Leaf-sheaths glabrous, basal sheaths glabrous. Ligule 1 mm long, truncate. Spathate panicle 6—30 cm long, commonly with primary tiers only, rarely with tertiary tiers; spatheole 22 mm long; peduncle 10 cm long. Racemes 23 mm long, with 4—5 pairs of spikelets; lower raceme-base swollen, not fused with the swollen lowermost pedicel; rachis internodes and pedicels stout, glabrous and polished on the back, pilose along the margins, more or less widened upwards. Sessile spikelet 4.5 mm long; lower glume chartaceous, 0.6 mm wide, glabrous, narrowly lanceolate, deeply concave on the back with a little bump at the base, nerveless; awn 16 mm long. Pedicellate spikelet 5 mm long; lower glume broadly lanceolate, 1 mm wide, glabrous, 7-nerved.

HABITAT: Grassy hills; alt. up to 2000 m.

DISTRIBUTION : India.

USES: Nothing is known, but Hackel (1889) mentioned that it smelled of terebenthine.

This species and the following one differ from all the other species in *Cymbopogon,* in that it has the rachis internodes and pedicels wider above. This feature occurs in *Andropogon.* However, the swollen raceme-base and deeply concave lower glume of the sessile spikelet place *C gidarba* in ser. *Cymbopogon.*

INDIA. Himalaya, W. of Simla, 24.VIII.1889, *J.F. Duthie 10098;* Madya Pradesh, Koderma forest, 12.X.1916, *II. H. Haines 5324;* Orissa, W. of Sambalpur,

8.IX.1949, *H.F. Mooney 3681; Herb. Wallich 8797;* Bengal, Giya, Oct. 1894, *Makim iS3"2;* Madras, Chingleput, 16.V.1901, *Bourne 2453;* Mysore, 5.X.1903, *Barber 6135*).*

19. CYMBOPOGON MICROTHECA (Hook, f.) A. Camus

Andropogon microtheca Hook, f., Fl. Brit. Ind. 7: 208. 1896. — *Cymbopogon microtheca* (Hook, f.) A. Camus *in* Rev. Bot. Appl. Colon. 1: 284. 1921; Bor *in* J. Bomb. Nat. Hist. Soc. 52: 157. 1954. — Type: Nepal, *Hooker f.* (K, holo!).

Culm 20 cm high and glabrous. Leaf-blades about 40 cm long, 3 mm wide, glabrous except for the scattered white hairs at the base on the upper surface, erect (not ascending), very narrow at the base. Leaf-sheaths glabrous, whitish, more or less 1-keeled on the back, basal sheaths about 10 cm long, glabrous. Ligule 1 mm long. Spathate panicle compound; spatheole 15—20 mm long; peduncle 3—4 mm long. Raceme 12—15 mm long, more or less deflexed; lower raceme-base slightly swollen, and not fused with the swollen lowermost pedicel, rachis internodes and pedicels widened upwards, more or less curved at the tip, sparsely pilose along the margins, glabrous and often pilose on the back, stout. Sessile spikelet 3 mm long; lower glume deeply concave on the back, glabrous, nerveless, acuminate; awn 10 mm long. Pedicellate spikelet 4 mm long; lower glume 0.5 mm wide 5—7-nerved.

HABITAT: Open slopes; at edges of fields; alt. 750—500 m.

DISTRIBUTION: Nepal, Sikkim.

As in the case of *C. gidarba, C. microtheca* also possesses unusual rachis internodes, which are wider above; moreover the plant does not smell. It is rather difficult to place this species in the genus, but its swollen lower raceme-base places this species near to *C. gidarba* and the other species in ser. *Cymbopogon.* This species can be recognized by its keeled basal sheath and the compound loose spathate panicle with yellowish racemes.

According to Burkill (1909) the plant does not smell.

NEPAL. Arun Valley, Sept. 1954, *J.D.A. Stainton 1510 & 1779;* Mayangdi Khola, 5.IX.1954, *Stainton, Sykes & Williams 4207;* Andi Kholo, 2.X.1954, *Stainton, Sukes & Williams 8713;* 12.XI.1848, *Hooker 1;* Sikkim, Tista Valley, *J.S. Gamble H05 A & B;* Darjeeling, 2.XI.1909, *I.H. Burkill 34034*).*

INDIA. Orissa, Ramnagar, Nov. 1916, *H.H. Haines 5325.*

Ser. RUSAE Stapf

Ser. *Rusae* Stapf *in* Kew Bull. **1906:** 351. 1906.

Perennial, rarely annual, tufted grasses; culm geniculate, with [innovations mixed between intrayagjnal and extravaginal, almost naked at the base. Leaf-blades soft to hard in texture, broadly linear to linear-lanceolate, rounded to cordate at the base, smooth on both surfaces; leaf-sheath glabrous, basal sheaths very few or almost absent at the base of the culm. Spathate panicle compound to decompound, erect, usually narrow. Racemes deflexed at maturity; raceme-bases unequal, lower

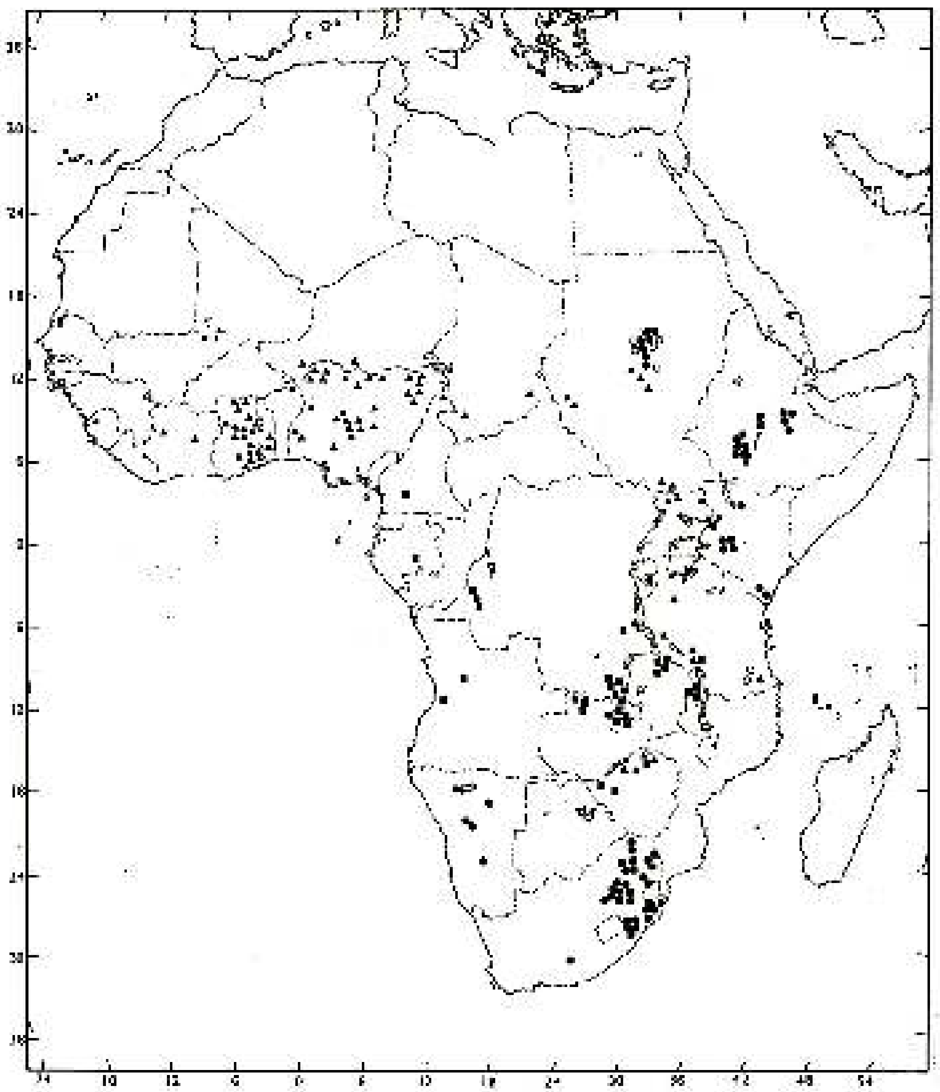


FIG 29. Distribution of some species in ser. *Rusae* in Africa: *C. excavatus* ● *C. giganteus* ▲ , *C. nervatus* O , *C. densiflorus* ■

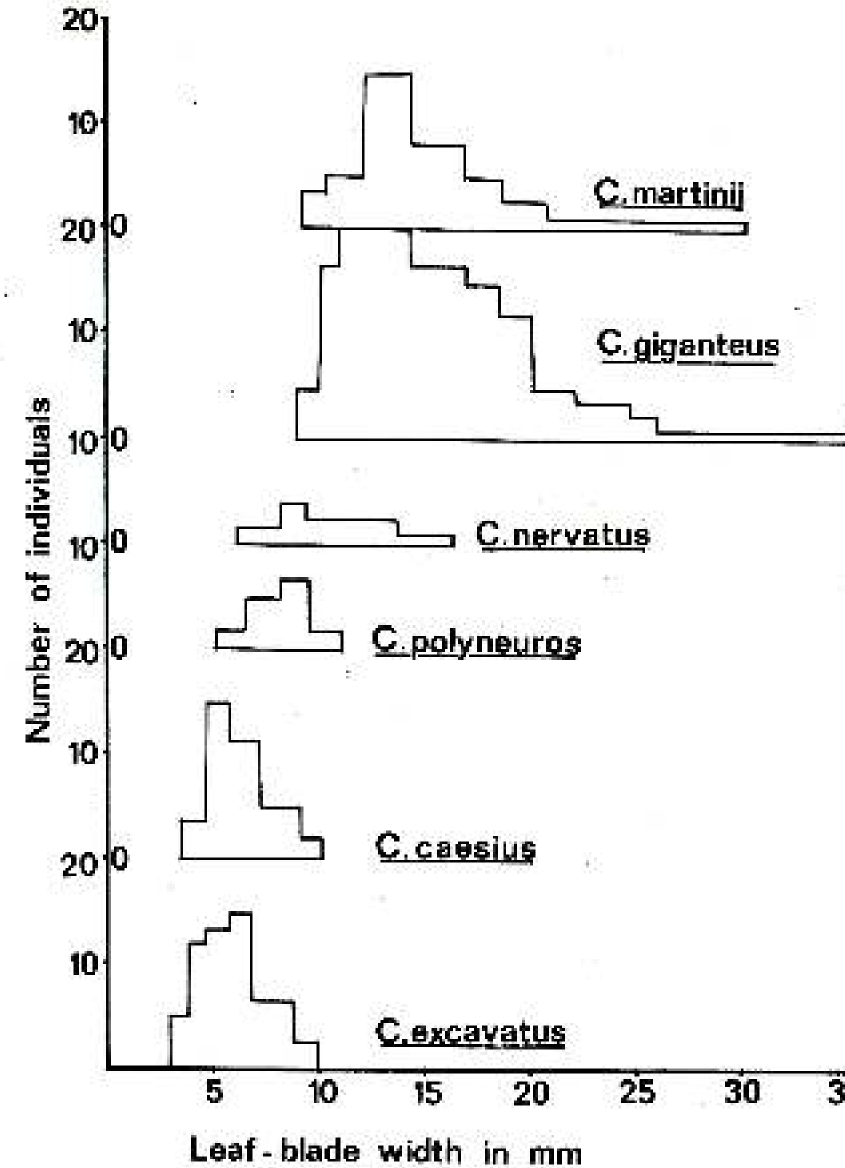


FIG. 30. Histogram of leaf-blade width of some species of ser. *Rusae*.

one shorter, sometimes swollen and usually fused with the lowermost pedicel; rachis internodes and pedicels pilose along the margins, glabrous to pilose on the back. Sessile spikelet awnless to awned; lower glume with median groove from the middle downwards, winged. Pedicellate spikelet consisting of 2 glumes, one or two lemmas and one male flower.

TYPE SPECIES: *Cymbopogon martinii* (Roxb.) Stapf.

DISTRIBUTION: Africa to Indo-China (fig. 17 & 29).

This series is readily recognized by the presence of the median groove (from the middle downwards) on the back of the lower glume of the sessile spikelet and smooth leaf-blades rounded to cordate at the base. These two characters are sufficient to recognize ser. *Rusae.* Besides this most of the species in this series have extravaginal or mixed innovation, so that the culms are tufted and are usually without basal sheaths. The culm is often branched at the lower nodes.

It seems that there is continuous variation throughout the species in ser. *Rusae.* It is sometimes rather difficult to define the species, since they are very close to each other. The width of the leaf-blades, for example, is continuously variable from 35 mm, as in *C. giganteus*, to 3.5 mm, as in *C. mekongensis* (see histogram, fig. 30). The depth of the median groove also varies from species to species. In *C. martinii* the groove is deep corresponding to a keel inside, whilst in *C. cambogiensis* and *C. densiflorus* the groove is shallow. The transition from deep to shallow is gradual throughout the species. Nevertheless the species can be grouped into two very close groups:

(1) the culms usually have stilt roots at the lower nodes and are often solitary, but are sometimes loosely tufted.

(2) the stilt roots are absent and the culms are usually tufted.

20. CYMBOPOGON NERVATUS (Hochst.) Chiov.

Andropogon nervatus Hochst. *in* Flora 27: 243, 1844; Steud., Syn. PL Glum. 1: 387. 1854. — *Andropogon schoenanthus* var. *nervatus* (Hochst.) Hack, *in* DC, Monogr. Phan. 6: 611. 1889. — *Cymbopogon nervatus* (Hochst.) Chiov., Gram. Ess. 10. 1909; Stapf *in* Prain, Fl. Trop. Afr. 9: 283. 1919. — Type: Sudan, *Kotschy 37 U* (K, iso!).

Cymbopogon nervatus var. *aerythraeum* Chiov. Gram. Ess. 11. 1909. — Type: Ethiopia, *A. Pappi 7207* (L, iso!).

Annual or perennial; culms up to 105 (180) cm high, 1.5—5 mm in diam., solitary or loosely tufted, erect or geniculate, sometimes branched, with stilt roots at the lower nodes, glabrous. Leaf-blades linear-lanceolate, up to 10 mm wide, cordate at the base, thin and soft, smooth, glabrous. Leaf-sheaths glabrous. Ligule hyaline to membranous, glabrous, 3 mm long. Racemes 15 mm long; lower raceme-base and lowermost pedicel slightly swollen; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 4—5 mm long; lower glume 1 mm wide, lanceolate, flat on the back with shallow median groove, bordered by intracarinal nerves and brown oil-mark on each side, broadly winged; awn 14—15 mm long. Caryopsis cylindrical, elongated. Pedicellate spikelet glabrous; lower glume 4.5—5 mm long,'], mm wide, more or less membranous, 7-nerved.

HABITAT: In savannas; alt. 450 m (in Sudan) and 1000 m (in Ethiopia and Tanzania).

DISTRIBUTION: Sudan, Ethiopia and Tanzania.

The culm in this species is variable in height, from 25 cm *(Benedicts 162)* to 180 cm *(Greemvay & Kanuri 14-463).* Some specimens *(Pappi 7563, 7670* and *Greenway & Kanuri 14106, 14-370, 14463)* show annual nature indicated by the absence of dormant buds at the base of the culms and of the cataphylls. Clayton (1965) pointed out that it was probable that the annual habit was merely a facultative adaptation in this species.

C. nervatus is easily distinguished from the other species in ser. *Rusae* by soft, thin leaf-blades and a conspicuous oil mark on the lower glume of the sessile spikelet; the culm is usually solitary, although a branched culm is often found. The stilt roots are remarkably long in tall plants.

This species has occasionally been confused with *C. giganteus* and *C. excavatus. C. nervatus* differs from the latter two species by the characters mentioned above; moreover the lower glume of the sessile spikelet and pedicellate spikelet are submembranous and thinner than those of *C. giganteus* and *C. excavatus.*

The brown oil mark on the lower glume of the sessile spikelet is often invisible, as in some specimens from Iringa, Tanzania *(P.J. Greenway & Kanuri 14106, 14370, 14463).*

SUDAN. Khartoum — Abu Duleig Rd., Sept. 1957, *R. Halwagy;* Khashum, El Gerba, Dec. 1971, *Gasim B8/71;* Omdourman, Nov. 1920, *R.E. Massey;* cult, in Bot. Gard. Cairo (originated from Sudan), Nov. 1863, *Figari;* Meshra Jeraof, June 1910, *A.F. Brown 41;* near the Jobat River, Jan. 1930, *D. Simpson 7US;* Soba Blue Nile, *A.F. Brown 687;* Tozi, Blue Nile Province, Nov. 1952, *T.O. Lea 81;* Gezina, Blue Nile Province, Jan. 1936, *F.W. Andrews A161; Kotschy 374.*

CENTRAL AFRICA. Diuka, Jan. 1909, *G. Schweinfurth 1069.*

ETHIOPIA. Beni Amir, Mt. Civeu, Sept. 1907, *A. Pappi 7690;* ibid., *A. Pappi 7207;* ibid., *A. Pappi 7563;* greenhouse in Okhahoma (originally from Tessenei) March 1954, *R.P. Celarier AS708-II;* Tessenei, Oct. 1949, *Dept. Agric. & For.;* Messenei, Barca, Nov. 1931, *A. de Benedictis 162.*

KENYA; N. Front Prov., Huri Hills, Febr. 1963, *Bally B12537.*

TANZANIA. Iringa, May, 1970, *P. J. Greenway & Kanuri 14463, 14106, 143730.*

21. CYMBOPOGON CLANDESTINUS (Steud.) Stapf

Andropogon clandestinus Steud., Syn. PI. Glum. 1: 388. 1854. — *Cymbopogon clandestinus* (Steud.) Stapf *in* Bull. Imp. Inst. London 27: 458. 1929; Bor *in* J. Bomb. Nat. Hist. Soc. 52: 149. 1954. — Type: Burma, *Wallich 8794.K* (K, iso!).

Perennial or annual; culm up to 200 cm high, 4 mm in diam., erect, sometimes geniculate, solitary, greenish to purplish, with stilt roots on the lower nodes. Leaf-blades up to 45 cm long, 9 mm wide, hard in texture, glabrous, slightly rounded at the base. Leaf-sheath glabrous. Ligule 3 mm long, membranous. Spathate panicle erect, with loose branches, 15—60 cm long, greenish to purplish: peduncle 25—31 mm long, subchartaceous. Raceme 17.5—23 mm long; pedicels and rachis internodes pilose along the margin and on the back. Sessile spikelet 5 mm long, tomentose; lower glume tomentose on the back, 1.4 mm wide, narrowly ovate, 2-toothed, broadly winged, 2-nerved; awn 20—24 mm long. Pedicellate spikelet 5 mm long, tomentose; lower glume 1 mm wide, densely tomentose on the back, ciliate along the margins.

DISTRIBUTION: Burma (endemic).

C. clandestinus can be readily recognized by having hairy spikelets, a long narrow panicle and stilt roots supporting the culm.

The deep median groove and broadly winged lower glume in *C. clandestinus* place this species near to *C. marUnii. C. clandestinus is* also similar to *C. nervatus* from Africa as the former has single culms with the stilt roots at the lower nodes. However, *C. clandestinus* differs from *C. nervatus* by the narrow leaf-blades and the absense of oil marks in the lower glume of the sessile spikelet.

BURMA. Mt. Segain, *Wallich 879AK*);* Mandalay, 5.XI.1928, *D. Rhind;* ibid., Jan., *D. Rhind;* 9.XI.1913, *C.G. Rogers;* 27.XII.1906, *K.S. Troupe 5859;* Upper Burma, Dec. 1890, *Abdul Huk.*

22. CYMBOPOGON MANDALAIAENSIS S. Soenarko

Cymbopogcv. mandalaiaensis S. Soenarko *in* Reinwardtia 9(2): 183. 1975.

Perennial or annual; culm erect or geniculate, up to 120 cm high, often solitary, glabrous, nodes swollen, with stilt roots at the lower nodes. Leaf-blades hard in texture, 9 mm wide, smooth, rounded at the base. Leaf-sheaths glabrous. Ligule subchartaceous, 5 mm long. Spathate panicle erect, narrow and often interrupted, about 50 cm long, with loose branches; spatheole 27 mm long, subchartaceous, glabrous; peduncle slender, stout. Racemes 22 mm long; lower raceme-base and lowermost pedicel more or less swollen, almost glabrous; rachis internodes and

pedicels pilose along the margins, glabrous on the back. Sessile spikelet 4.5 mm long, lower glume lanceolate, 0.8 mm wide, subchartaceous, with deep median groove, nerveless to 2-nerved, with brown oil-marks along the nerves, broadly winged, glabrous; upper glume glabrous, membrano-chartaceous, rounded on the back; awn 22 mm long. Pedicellate spikelet 4.5 mm long, glabrous; lower glume narrowly ovate-lanceolate, 1.2 mm wide, acuminate, 2-nerved, glabrous; upper glume membrano-chartaceous, glabrous.

HABITAT: Grasslands in dry places.

DISTRIBUTION: Endemic to Mandalay, Burma.

BURMA. Mandalay. Tatkon, 7.XI.1928, *D. Rhind 928*);* ibid., 28.XI.1927, [7 *Ba Thein I;* ibid., *U Thei Lwin 94;* Mimbu Steamer Ghat, Dec. 1908, *J. MacKenna & I.H. Burkill 31551;* Maklaing, 17.XI.1928, *E.B. Minus.*

23. CYMBOPOGON GIGANTEUS (Hochst.) Chiov.

Andropogon giganteus Hochst. *in* Flora 27: 242. 1844. non Tenore 1811. — Trop. Afr. 9: 288. 1919. — Type: Sudan, *Kotschy 250* (K, iso!).
Cymbopogon giganteus (Hochst.) Chiov., Gram. Ess. 12. 1909; Stapf *in* Prain, Fl.

Culm 120—300 cm high, 7—8 mm in diam., erect, glabrous. Leaf-blades up to 60 cm long, 10—35 mm wide, tapering, smooth, slightly rough along the margins, cordate at the base, often amplexicaul- Leaf-sheath glabrous. Ligule 0.5—1.5 mm long, membrano-chartaceous to chartaceous. Spathate panicle erect, narrow, compound, spatheole 15—• 20 mm long. Racemes 15—17 mm long; lower raceme-base swollen and fused in the lower part with the swollen lowermost pedicel, upper raceme-base often swollen; rachis internodes and pedicels along the margins and in the upper part, glabrous on the back. Sessile spikelet 3.5—4.5 mm long; lower glume 0.8—1 mm wide, with deep median groove, 2-nerved, broadly winged, wings often ciliolate; awn 6 mm to 17 mm long. Pedicellate spikelet 3.5—5 mm long; lower glume 1.2 mm wide, glabrous, 7-nerved.

HABITAT: Savannas; woodlands or river banks.

DISTRIBUTION: West Africa, Sudan to Rhodesia. *C. giganteus* can usually be icaul leaf-blades, and broadly winged, deeply grooved lower glume of the sessile spikelet. This species closely resembles *C. martinii* but it has a shorter ligule.

var. GIGANTEUS

Awn of the sessile spikelet 14—17 mm long with column and limb.

PORTUGUESE GUINEA. Mansoa, 26. XI. 1961, *J. Alves Pereira & M. Carreira 197S.*

SIERRA LEONE. *Vogel.*

IVORY COAST. 27.X.1962, *Assanon 6847.*

GHANA. N. of Tamale, 3.X.1956, *R. Rose-Innbs 393;* Accra Plains, 7.VIII. 1900, *N.H. Johnson 756;* Mole Reserve, 6.XI.1966, *Hall & Enti CG35760;* Afram, 22.1.1930, *A. S. Thomas D95;* Tog'oland, Atakpame-Sckode Rd., 1.X.1960, *R. Rose. Innes 1904;* S. of Asukawkaw River at Akroso, 22.IX.1957, *R. Rose-Innes 635 (CG30412);* Kwahu Tafo on Markrong Rd., 11.IV.1954, *J.K. Morton A690;* Bawku-Bolgatonga Rd., 6.X.1960, *R. Rose-Innes CG31U8;* NE of Wapuli, 8.X.1959, *R. Rose-Innes GC30969;* Ashanti, 1928, *J.R. Proine 367;* S. of Tanfiano, 17.X.1958, *R. Rose-Innes GC30619.*

DAHOMEY. Kpinnou, *D. Froment 1149;* Tanguita, 14.XI.1963, *S.A. Risopoulos 1274-*

NIGERIA. Jos Plateau, 21.X.1957, alt. 1070 m, *F.N. Hepper 1087;* Kaiama, 28.X.1948, alt. c. 300 m, *J.F. Ward 37;* Bodeggi, 1.X.1955, alt. c. 115 m, *W.D. Clayton 367;* Sokoto, 1910, *J.M. Dalziel 485;* Naraguta, 1930, *H. V. Lely 424;* Dikwa, Bornu Prov., 27.X.1950, *H.B. Johnston N49;* Tula SE of Gombe, 19.XI.1968, *J. Lowe 1645;* Maiduguri, 28.XII.1960, *M.E. Gambes 2;* Zaira Distr., 1930, *C.B. Taylor 31;* Lagos, 1902, *W. MacGregor 164;* Ibadan, 18.XII.1951, *M.F. Fahunle & T. Russell 14967.*

NIGER. Dogondoutchi, 1963, *L.P. White 54;* Ziela, 2.III.1969, alt. 215 m, *K.J. Virgo 11.*

TEHAD. Dar Banda Ndeli, 20.XII.1902, *A. Chevalier 6832;* Bousso, *A. Chevalier 10467.*

SUDAN. Zalingei, 4.XI.1957, alt. 100 m, *V.R. Robertson 8;* Mazrub, 21.VIII. 1962, *G.E. Wickens 2446;* N. of Wapoeta, 28.VIxI.1953, *A. W. Peers 28;* Upper Nile, 27.111.1948, *M.N. Harrison 254;* Katire, 8.II.1950, *J.J. Jackson 1139;* Wadi Bulbul, Darfur Prov., *M. N. Harrison 199;* Cordofan, 8.XI.1839, *Kotschy 250;* Djur, *G. Schweinfurth 4276.*

UGANDA. Mt. Elgon, Semir Valley, 12.XII.1927, alt. 1400 m, *J.D. Snowden 1246;* Paranga, alt. 1000 m, *A. S. Thomas 4326;* Imatong Mt., 16.XII.1935, alt. 950 m, *A.S. Thomas 1594;* Karamoja, 27.V.1940, alt. c. 1300 m, *A. S. Thomas 3559;* ibid., 1930, alt. 1400 m, *L.C.C. Liebenberg 1741;* Ghua, 12.XI.1945, alt. c. 1300 m, *A.S. Thomas 4352;* Gulu, 8.XI.1941, alt. 1200 m, *A.S. Thomas 4000;* Tororo, 1926, *T.D. Maitland 1179.*

KENYA. N.E. of Kapenguriti, alt. c. 2300 m, *A. Bogdan 3854.*

TANZANIA. Knogere, 24.IX.1968, alt. 500 m, *H. Fauckner 4138;* Katisunga, 1949, *C. Petre 17;* Mbeya-Itigi Rd., 5.III.1963, alt. c. 1400 m, *S.B. Boaler 869;* Iringa Distr., near Magangwe, 19.V.1968, S.A. *Renvoize 2270;* Dar-es-Salaam, 28. III.1968, alt. 30 m, *D.C. Robertson 624;* N.E. of Morogoro, 19.IV.1966, alt. 500 m, *J.R. Walch 608;* Bohoboho Game Res., 4.IV.1965, alt. c. 300 m, *B. D. Nicholson 57;* Kabungu, 28.VIII.1948, S.A. *Semsei F.H. 2610;* Tanga Prov., Pangani, 13.VI.1957, sea level, *R. Tonner 3557;* Kiwangwa, 1964, alt. 275 ra, *J. Procter 2569;* Amani, 30.VIII.1929, *A.S. Hitchcock 24518.*

MALAWI. Nono Hil!, *P.O. White 153;* Lilongive, *Sclubeni 447.*

MOZAMBIQUE. Manica-Sofala Rd., *H. Horrocks 205770;* Mutuali, 28.IV.1961, A. *Balsinhas & L. Marrime 467;* Niassa, A. *R. Torre & J. Paiva 10553.*

ZAMBIA. Mpika Distr., Luangwa Game Res., 22.IV.1965, *B. L. Mitchell 2633.*

RHODESIA. Mapanza, 14.IIL1954, alt. c. 1150 m, *E. A. Robinson 608;* Salisbury. Bolvedere, 4.III.1965, alt. 1600 m, A. *O. Crook 701*; Myazura, 1920, alt. c. 1200 m, *M.L. Lloyd 23994;* Mumbwa-Nangoima Rd., 20.III.1963, *H.J. van Rensburg 1709;* M e, 24.111.1963, *W.C. Verboom 932;* Mazoc, 1920, alt. c. 1200 m, *J. Winter 2308.*

var. INERMIS W.D. Clayton

Cymbopogon giganteus var. *inermis* W.D. Clayton *in* Kew Bull. 19: 454. 1965. — Type: Mauritania, *Rosseti 61/282* (K, holo!).

Awn of the sessile spikelet not more than 6 mm long, without column.

24. CYMBOPOGON EXCAVATUS (Hochst.) Stapf

Andropogon excavatus Hochst. *in* Flora 29: 116. 1846; Steud., Syn. PI. Glum. 1: 388. 1854. — *Cymbopogon excavatus* (Hochst.) Stapf *in* Prain, Fl. Trop. Afr. 9: 285. 1919; *in* Bull. Imp. Inst. London 27: 458. 1929; A. Camus *in* Rev. Bot. Appl. Colon. 1: 295. 1921. — Type: Natal, *Kraus 26* (K, iso!).

Andropogon connatus Hochst. ex A. Rich., Tent. Fl. Abyss. 2: 464. 1852. — Type: Ethiopia, *Schimper 411* (K, iso!).

Cymbopogon plicatus Stapf *in* Kew Bull. 1914: 83. 1914; Bosser, Gram. Madag. 260. 1969. — Type: Madagascar, *Parker 12* (K, holo!).

Perennial; culm erect or geniculate, wiry, up to 100 cm high, often branched, sometimes tinged with dark purple. Leaf-blades up to 30 cm long, 3—10 mm wide, rounded at the base, smooth, hard in texture, tapering. Leaf-sheaths glabrous, whitish to purplish. Ligule membranous, 5(7) mm long. Spathate panicle 35 cm long, often tinged with dark purple, sometimes reddish, erect and narrow; spatheole 16—19 mm long; peduncle 4—6 mm long. Racemes 10 mm long; lower raceme-base and lowermost pedicel swolllen and fused at the base, upper raceme-base often swollen, pedicels and rachis internodes pilose along the margins, glabrous to puberulous on the back. Sessile spikelet glabrous, 3—4 mm long, 0.8—1 mm wide, lanceolate, widened in the middle, narrowly winged, 2-nerved; awn 14 mm long. Pedicellate spikelet 3—5 mm long; lower glume 1—13 mm wide, 3—7-nerved.

CHROMOSOME NUMBER: S. Africa, 2n = 20 (de Wet 1954a).

HABITAT: Grasslands and swampy grounds at 1000—1500 m alt.

DISTRIBUTION: Sudan to South Africa.

USES: Used by the native for thatching (Uphof 1968); the roots are given internally for the prevention of malaria and horse-sickness (Watt and Breyer - Brandwijk 1932); the essential oil contains geraniol & phellandrane (Guenther 1950).

C. excavatus is very much like depauperate specimens of *C. giganteus*. In general *C. giganteus* differs from *C. excavatus* by having tall culms, wider leaf-blades and a more compound spathate panicle. A diagram of culm height and leaf width shows continuous variation (fig. 31). Nevertheless the structure of the lower glume of the sessile spikelet and the base of the leaf-blade can be used to differentiate between them.

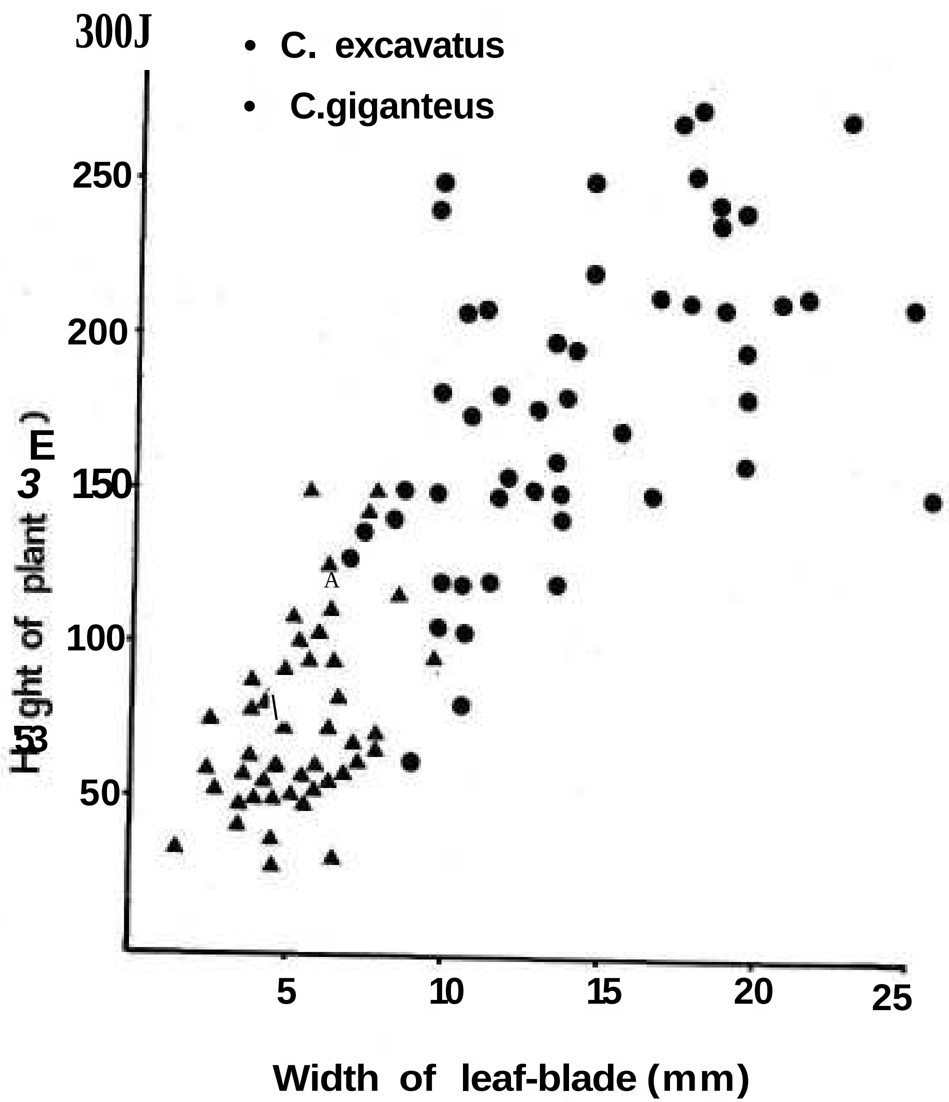


FIG. 31. Scatter diagram of *C. excavatus* and *C. giganteus.*

In *C. excavatus* the lower glume is widened in the middle with narrow wings along the keels, the leaf-blade is rounded at the base. In *C. giganteus* the glume is wider above with broad wings and the median groove is very deep in comparison with that of *C. excavatus*, which is rather shallow, the leaf-blade is cordate or even amplexicaul.

C. excavatus is also similar to *C. caesius*, as both have wiry, branched culms and a narrow panicle. *C. caesius* also occurs in Eastern Africa, where the distribution of the two species overlaps, *C. caesius* differs from *C. excavatus* in that it has a broadly winged lower glume of the sessile spikelet, and more densely pilose rachis internodes.

SUDAN. Gebel Marra, near Golol, *G.E. Wickens 1932;* Gur Lumbung, *G.E. Wickens 2821;* N.E. of Coolier, */.,/. Blair 293;* Toru Tonga, *J. Blair 2S7;* near Shambe, *M.N. Harrison 667;* near Mosu, Yapipi, *J.B. Myers 1402;* Bahr El Ghazal, *M.N. Harrison 913;* Jebel Idaib, *F.W. Andrews 3607.*

ETHIOPIA. Mega, *J.B. Gillett H372;* N. W. of Ghinir, *R. Sandford 22;* Yavello, Sidamo, *H.F. Mooney 5529;* S.W. of Harar, *M.G. & S.B. Gilbert 1416;* Chilalo near Assa, 20.X.1971, *Mats Thulin 1577.*

KENYA. Mt. Kulal, *Vercourt 2261;* Nakuru, *H.J. Taylor 1293;* Shimba Hills, Kwale, *F. Magogo 1253;* Naivasha, *M.M. Webster K139;* Thika, *R. B. Faden 67417.*

S.W. AFRICA. Etosha Nat. Park, N. of Duikerdrink, 16.111.1971, *he Roux & Steyn 336;* SW of Windhoek, 2.III.1955, alt. 18C0—2100 m, *B. de Winter 2557;* Otjiwarango, May 1949, *L.C.C. Liebenberg 1,807;* Avis Mt., 17.11.1959, alt. 1600 m, *R. Seydel 1699;* Simkue, E. of Grootfontein, 19.1.1958, *R. Story 6185.*

S. AFRICA. Natal. Inanda, 14.IX.1965, alt. c. 100 m, *E.J. Moll 20tf;* Zululand, 29.11.1944, *J. Gerstner U40U;* Eastcourt, 4.II.1940, alt. c. 1300 m, O. *West 1776;* slope of Ezuntunzuni, Nkandla, 17.111.1970, *N.O. Smith 132;* Camperdown, 7.V.1966, alt. 500 m, *J.W. Morris 97U;* Ubombo, 22.XI.1969, alt. c. 600 m, *E.J. Moll 4703;* S. of Johannesburg, March 1937, *J. Lintner 43;* 17.VIII.1893, *R. Schlechter 3099.* — Transvaal. Kruger Nat. Park, 4.II.1949, alt. c. 600 m, *B. de Winter & L.E. Codd 467;* Lynwood, 12.HI.1965, *B. de Winter 8326;* Mooihoek, 4.III.1961, alt. 1300—1500 m, *N.J. Devenish 615;* Krugersdorp Distr., 16.1.1967, *A.O.D. Mogg SS221;* Rooikop, 28.XI.1922, *I.B. Pole Evans 576;* near Lydenburg, Nov. 1884, *F. Wilms 1688;* Groonkloof, 27.111.1920, *J. Burtt-Davy 18450;* Dongola area, 30. IV.1948, *B, de Winter & L.F. Codd 330;* Blaunbergh, April 1947, *H.G. Schweickertd 1991;* Zebediela, 22.11.1968, *B.J. Huntley 1524;* Ventersdrop, 2.IV.1945, *W.J. Louw 1383;* Apies Riv., *A. Rahmann 5682;* Belfast, 19.111.1934, *I.B. Pole Evans 3681.*

25. CYMBOPOGON DENSIFLORUS (Steud.) Stapf

Andropogon densiflorus Steud., Syn. PI. Glum. 1: 386. 1854; Hack, *in* Mart. & Eichl., PI. Bras. 2: (3): 281. 1878. — *Cymbopogon densiflorus* (Steud.) Stapf in Prain, Fl. Trop. Afr. 9: 289. 1919. — Type: Gabon, *Jardin* (P, holo.).

Andropogon stypticus Welw., Syn. Explic. 27. 1862. — *Cymbopogon stypticus* (Welw.) Fritsch in Bull. Herb. Boiss., ser. II, 1: 1099. 1901. — Type: Huilla, *Welwitsch* (K, iso!).

Perennial; culm up to 180 cm high, 8—9 mm in diam., erect, glabrous. Leaf-blades broadly linear to narrowly linear-lanceolate, 30—45 cm long, up to 30 mm wide, smooth on both surfaces, rounded to cordate at the base, slightly rough along the margins. Leaf-sheaths glabrous. Ligule membranous, 2 mm long, glabrous. Spathate panicle globose to obovate, often elongated, very dense; spatheole 15—20 mm long. Racemes 12 mm long, very slender, deflexed at maturity; lower raceme-base and lowermost pedicels not swollen; rachis internodes and pedicels sparsely pilose along the margins, glabrous on the back. Sessile spikelet 3(4) mm long; lower glume lanceolate, with shallow median groove, nerveless or occasionally 2-nerved, narrowly winged; awn 3.5—8 mm long, column very short. Pedicellate spikelet 2—3 mm long; lower glume 0.7 mm wide.

HABITAT: Grasslands.

DISTRIBUTION: Zaire, Zambia, Rhodesia, Gabon, introduced and naturalized in Brazil.

USES: Used as a tonic and styptic by the natives in Africa (Welwitsch).

C. densiflorus can be easily recognized by the globose to subglobose (rarely elongated), dense spathate panicle terminating the tall plant, a comparatively small sessile spikelet with reduced awn, and a shallow median groove on the back of the lower glume of the sessile spikelet.

This species resembles *C. giganteus* and can be easily confused with it, as both species are tall plants with wide leaf-blades. It differs from *C. giganteus* by the flat raceme-base and a smaller sessile spikelet with a shallow median groove.

C. densiflorus is native in tropical Africa. It is probably introduced in Brazil and became naturalized there. The awn of the sessile spikelet in the specimens from Brazil is longer than in specimens from Africa, otherwise there is no difference between them (see histogram, fig. 32).

CAMEROON. Yaounde, 1890-94, alt. 800 m, *Zenker & Staudt 569*.

GABON. Sibange Farm, Munda, 30.IV.1882, *H. Soyaux 422*.

ZAIRE. Kinshasa, Plateau de Kando, 26.VI.1971, *S. Lisowski 612*; Kalemie (Albertville), 12.II.1920, *H.L. Shoute 660*; between Kalemie and Kambare, 8.VII.1932, *Yuyen 145*; Katanga, Karavie, June 1929, *Quarrie 1816*; Tschinsenda, May 1914, *F.A. Rogers 10785*; Kisantu, 16.II.1950, *J.T. Baldwin Jr. 14125*; Madimba, Sept. 1956, alt. 600 m, *Carlier 115*; Lubumbashi (Elisabthville), 18.III.1957, alt. 1230 m, *J.J. Symoens 3425*; between Sona & Batie, 1913, *H. Vanderyst 250*; Kitobota, 1911, *Flamigni 324*; Kumbuwa, 1914, *H. Vanderyst 4919*; Balati, 1912, *A. Chevalier 27589*; Yanongie, 1948, *R. Germain*; Standleyville, 20.I.1926, *H. Robyns 1355*.

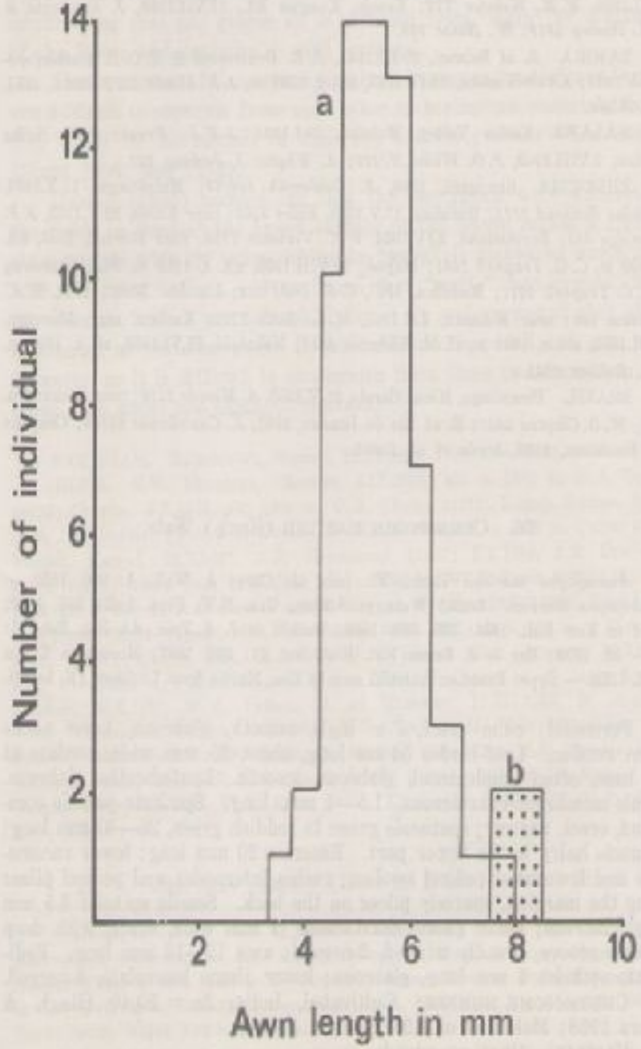


FIG. 32. Histogram of *C. densiflorus* in Africa (a) and in Brazil (b).

ANGOLA. Country of Ganguella and Ambuellas, 1910, *J. Gossweiler 2571,;* Mossamedes, 1923, *N. M. Alemanni 132; Welwitsch 7526.*

TANZANIA. N. of Lake Nyasa, 1926, *A. Stolz 1084;* Ufipa Distr., Ruhwa, 12.111.1959, *M.M. Webster T73;* Kasoje, Kungwe Mt., 15.VII.1959, *J. Newbould & R.M. Harley 4319; W. Busce 738.*

ZAMBIA. S. of Solwesi, 20.111.1961, *R.B. Drummond & R.O.B. Rutherford-Smith 7089;* Kitwe-Nindota, 28.IV.1953, alt. c. 1300 m, *J.H. Hinds 132;* Ndota, 1951, *J. A. Allan.*

MALAWI. Kositu Valley, Mzimba, 29.1.19£S, *J.E.L. Fenner 267;* Nyika Plateau, 9.VIII.1949, *P.O. Wiche N/179; A. Whyte; J. Jackson 541.*

RHODESIA. Shangani, 1956, *B. Goldsmith 136/56;* Muinilunga, 11.X.1937, *E. Milne Redhead 2714;* Unfuliza, 17.V.1934, *Eyles 8401;* near Kitwe, 29.V.1963, *J. P. Loveridge 683;* Barotseland, 2.IV.1964, *W.C. Verboom 1359;* near Bowood, 1933, alt. c. 1300 m, *C.G. Trapnell 1668; Magodi,* 17.VIII.1938, alt. c. 1250 m, *P.J. Greenway & C.G. Trapnell 5617;* Mufulira, 1937, *C.E. Duff 228;* Lemdazi Distr., 1962, *W.C. Verboom 580;* near Muskota, 2.II.1962, *W.L. Astle 137U;* Kasama near Abercorn, 29.111.1952, alt. c. 1600 m, *H.M. Richards 1356;* Nakataki, 27.VI.1950, alt c. 1900 m, *A. A. Bullock 2952.*

BRAZIL. Piraptinga, Minas Gerals, 21.V.1950, *A. Macedo 2410;* near Alexandra, 1965, *W.D.Clayton 4827;* E. of Rio de Janeiro, 1961, *A. Castellanos 23159;* Chapada dos Veadeiros, 1966, *Irwin et al. 12892.*

26. CYMBOPOGON MARTINII (Roxb.) Wats.

Andropogon martinii Roxb., Fl. Ind., ed. Carey & Wall., 1: 280. 1820. — *Cymbopogon martinii* (Roxb.) Wats, *in* Atkins., Gaz. N.W.. Prov. India 382. 1882; Stapf *in* Kew Bull. 1906: 335, 359. 1906; Burkdll *in* J. & Proc. As. Soc. Beng 5: 89 — 93. 1909; Bor *in* J. Bomb. Nat. Hist. Soc. 51: 908. 1953; Morton *in* Taxon 8: 13. 1959. — Type: Based on material sent by Gen. Martin from Lucknow (K, holo!).

Perennial; culm erect, 2 m high, smooth, glabrous, lower nodes often swollen. Leaf-blades 50 cm long, about 25 mm wide, cordate at the base, often amplexicaul, glabrous, smooth. Leaf-sheaths glabrous. Ligule membrano-chartaceous, 1.5—4 mm long. Spathate panicle compound, erect, narrow; spatheole green to reddish green, 20—40 mm long; peduncle hairy in the upper part. Racemes 20 mm long; lower raceme-base and lowermost pedicel swollen; rachis internodes and pedicel pilose along the margins, sparsely pilose on the back. Sessile spikelet 3.5 mm long, glabrous; lower glume chartaceous, 1 mm wide, ovate, with deep median groove, broadly winged, 2-nerved; awn 12—18 mm long. Pedicellate spikelet 4 mm long, glabrous; lower glume lanceolate, 8-nerved.

CHROMOSOME NUMBER: Cultivated, India, 2n = 20,40 (Ragh. & Arora 1958; Mehra *et al.* 1962; Gupta 1969a).

HABITAT: Open grasslands.

DISTRIBUTION: Native in India; cultivated in the tropics.

USES: TWO kinds of oils can be obtained from the two forms, ("motia" and "sofia") of *C. martinii;* palmarosa oil, which is distilled from the leaves of "motia", contains 80—90% geraniol and is used for adulterating rosa oil; ginger oil is obtained from "sofia" by distillation of the leaves and contains ± 40% geraniol.

The two forms of *C. martinii* popularly known as "motia" and "sofia", are difficult to separate from each other in herbarium materials though they differ by the content of their oils and their odour when crushed (Stapf 1906; Bor 1953).

Burkill (1909) pointed out that the two forms were different in the field; in "motia" the upper surface of the leaves makes a right or obtuse angle with the culm, whilst in "sofia" it makes an acute angle with the culm. Gupta (1970) found that "motia" was diploid, 2n = 20, whereas "sofia" was tetraploid, 2n = 40, and suggested they should be treated as varieties under *C. martinii*, var. *martinii* and var. *sofia.* However, as it is difficult to distinguish them these two forms are combined here under one name, *C. martinii.*

PAKISTAN. Baluchistan, Sarmal, 11.XI.1888, *J.H. Lace 3967.*

INDIA. N.W. Himalaya, Chamba, 4.IX.1896, alt. c. 1300 m, *G.A. G.ammie 18475;* Chamba, 3.X.1874, alt. 1000 m, *C.B. Clarke 24295;* Kagan Hazara, 9.VIII. 1899, *J.F. Duthie;* Tirah, *J.F. Duthie 153;* Simla, 1877, alt. c. 1600 m, *Collett 5388A.* Punjab, Karnal, 12.X.1887, *J.R. Drummond 21107;* 5.X.1886, *J.R. Drummond 21110, 21111;* Dehra Dun, 14.IX.1948, alt. c. 1300 m, *W.N. Koelz 21778;* Mt. Abu, 1888, alt. c. 300 m, *J. S. Gamble 21010;* Nagpur Wardha, 19.XII.1902, *Herb. Econ. Ind. 17923;* Chota Nagpur, 1880, *J.S. Gamble 8625;* 1881, alt. c. 600 m, *J.S. Gamble 9121;* Sylari, Khajin For., 29.X.1909, *H.H. Haines 2404;* Amraoti, 30.XI.1902, *E.G. Fernandes 1, 2 & 3;* Nagar, Paskar Hills, *M. Qaiser et al. 4050;* Bombay, Singhur, P.0.X.1907, *W. A. Talbot;* N. of Dharwar, 11.XII.1953, *H. Santapau 16529;* Coimbatore, Hanore, 10.11.1924, *K.G. Jacob 17312;* Satzymangallam, 1902, *Bourne;* 1900, *Bourne 2548;* Cuddapah, Sinepoy Hills, 1882, *J.S. Gamble 10843;* Madras, Solem, 2.III.1927, *K.G. Jacob 18068;* Indore, 1928, *H.H. Haines 2865;* Surgaja State, 7.X.1947, *W.N. Koelz 19235;* Kondapalli, 31.VII.1907, *C.A. Barber 7989; Wight 1702.*

27. CYMBOPOGON CAESIUS (Nees ex Hook. & Arn.) Stapf

Andropogon caesius Nees ex Hook. & Arn., Bot. Beech. Voy. 244. 1838. — *Andropogon schoenanthus* var. *caesius* (Nees ex Hook. & Arn.) Hack, *in* DC, Monogr. Phan. 6: 610. 1889. — *Cymbopogon caesius* (Nees ex Hook. & Arn.) Stapf *in* Kew Bull. 1906: 341. 1906; Bor. *in* J. Bomb. Nat. Hist. Soc. 51: 912. 1953. — Type: India, *Wight 1700b* (K, holo!).

Andropogon schoenanthus var. *gracillimus* Hook, f., Fl. Brit. Ind. 7: 205. 1896. — Type: India, *C.A. Barber 3346* (K, holo!).

Perennial; culm up to 175 cm high, wiry, erect or geniculate, glabrous, often branched. Leaf-blades up to 30 cm long, 10 mm wide, rounded at the base, smooth, hard in texture, slightly rough along the margins. Leaf-sheaths glabrous. Ligule membranous, 5 mm long. Spathate panicle 30 cm long; spatheole 18—20 mm long. Racemes 12 mm long; lower raceme-base swollen, fused in the lower part with the swollen lowermost pedicel; rachis internodes and pedicels pilose along the margins and on the back. Sessile spikelet glabrous, 3—4 mm long; lower glume ovate-lanceolate, 1 mm wide, membrano-chartaceous, nerveless or 2-nerved, more or less obtuse, broadly winged; awn up to 16 mm long. Pedicellate spikelet glabrous, 3—4 mm long; lower glume 1—1.2 mm wide, 7-nerved.

CHROMOSOME NUMBER: India, 2n = 20 (Gupta 1969a).

HABITAT: Open dry grasslands; hedges; alt. 1000—1500 m.

DISTRIBUTION: Common in India to Indo-China, rarely in East Africa and Arabia.

USES: Used locally as an occasional domestic remedy. The essential oil is recorded to contain geraniol and limonene..

C. caesius is closely related to *C. martinii* by the structure of the sessile spikelet. Both species have the lower glume of the sessile spikelet with a deep median groove and broad wings and the lower raceme-base and lowermost pedicel swollen. *C. caesius* differs from *C. martinii* by having wiry, geniculate culms, narrower and shorter leaf-blades, rounded at the base, and an obtuse lower glume of the sessile spikelet.

PAKISTAN. Nazar Parker Hills, 25.X.1970, *M. Qaiser & A. Ghafoor 4028;* Lower Sind 25. XI. 1956, *JJ. Noris 151.*

INDIA. Travancore, 8.IX.1913, *C. C. Colder & M. S. Ramaswami 721*; Mysore, Gandagere, 7.VII.1970, *T. P. Rammamoorthy HFP262;* Hassan, 22.1.1970, *C.J. Saldanha 16097;* Coimbatore, Burgur Hills, 1902, *Bourne 6429;* Sanganallur, 10.VIII.1902, *C. A. Barber U55;* N. Coimbatore, 1902, *Bourne;* ibid., 7.XI.1900, *C. A. Barber 2558;* Nilgiris, *Madras Herb. 16;* Bangalore, 31.X.1923, *J.J. Sudborough;* Maruthuamalai (Kerala Univ.), 19.IV.1959. */. Christopher GS68;* Madras, 19.X.1901, *C.A. Barber 248;* ibid., 1908, *Bourne;* Chingleput, 1886, *J.S. Gamble 17627;* Madras, Hulalu, *E.K. Janaki Ammal 1749* *); Cuddakah, 1915, *Bourne;* Kaliandrug, 1915, *Bourne;* Lilicut, *E.K. Janaki Ammal 1867;* Kollogal, 8.1.1930, alt. c. 700 m, *J.R. Naganathan 194.01;* Tiranelveli, 30.VI.1904, *C.A. Barber SS46;* Tinevelly, 29.VI.1901, *C. Barber ,1,115; Herb. Wight 1700, 1806 & 3091; E. Blatter 2522.*

CEYLON. N. Province, Jaffna Distr., 14.1.1970, alt. 2 m, *W.D. Clayton 3239;* Bandarawella, 1903, *Jowitt;* ibid., 17.VI.1908, alt. 1500 m, *Jowitt;* Ruhuna Nat. Park, Kataragama, 23.V.1968, *R.G. Cooray 685S01R;* Pallugaturai, 30.XII.1968, *F. R. Fosberg et al. 50911;* Prov. of Uva, 13.111.1969, *R.D. Hoogland 111559;* SE of Nuwara Eliya, 9.IV.1970, alt. 1000 m, *F. W. Gould 13358.*

S. CHINA. Yunnan, *Delaway 1797* (P).

ARABIA. Wolledge, 1889, *G. Schweinfurth 629.*

AFGHANISTAN. *Aitchison US.*

SOMALIA. Gollis Range 1908, *Drake Brockman 463;* no definite locality, 16. VIIL1923, *Imp. Inst. 3505/23.*

KENYA. Danyo Sabuk, 1.VII.1933, alt. 1600 m, *V. A. Beckley 2076;* Nairobi, 14. II. 1933, *E.R. Napier 2497.*

28. CYMBOPOGON PRUINOSUS (Nees ex Steud.) Chiov.

Andropogon pruinosus Nees ex Steud., Syn. PI. Glum. 1: 388. 1854. — *Cymbopogon pruinosus* (Nees ex Steud.) Chiov., Gram. Ess. 13. 1909. — Type: Mauritius, *Her. Sieb. 45* (K, iso!).

Perennial; tufted culm 20—60 cm high, glabrous, erect or geniculate, coated with old basal sheaths. Leaf-blades smooth, glabrous, 30 cm long, 5—13 mm wide, rounded to cordate at the base, often amplexicaul, tapering. Leaf-sheath glabrous, smooth. Ligule 2 mm long, rounded, membrano-chartaceous. Spathate panicle 7—20 cm long, erect, narrow to broad (up to 10 cm wide); spatheole 17—25 mm long. Eacemes 15—17 mm long; lower raceme-base and lowermost pedicel not swollen; rachis internodes and pedicels densely pilose along the margins and in the upper part. Sessile spikelet 4 mm long, glabrous; lower glume 0.8—1.2 mm wide, more or less oblong, with shallow to deep median groove, broadly winged, 2-nerved, usually 3-toothed; awn 11 mm long. Pedicellate spikelet lanceolate, 7-nerved.

HABITAT: Rocky escarpments; savannas.

DISTRIBUTION: Mauritius (Rodriques, He Bourbon, Le Reunion).

In ser. *Rusae* the culm is usually bare of old basal sheaths. In *C. pruinosus* the culm is coated with the basal sheaths, probably because the lower internodes are shorter than the upper ones and the sheaths remain on the culm.

The leaf-blades vary in width. The plants from Bourbon Isl. have wide and cordate leaf-blades as in *C. martinii.* The plants from the other islands (Le Reunion and Rodriques) have narrower leaf-blades, rounded at the base.

In appearance *C. pruinosus* resembles *C. excavatus*, but the former can be differentiated from the latter by its flat lowermost pedicel and lower raceme-base and 3-toothed lower glume of the sessile spikelet.

MAURITIUS ISLANDS. Le Reuinion, 11.IV.1968, *P. Home, 9;* 1890, *P. Home 48; 1871, P. Home 113.* Rodriques, *P. Rival; M. Boivin,* He Bourbon, *M. Richards; Herb. Sieber 45.*

29. CYMBOPOGON CAMBOGIENSIS (Balansa) E. G. & A. Camus

Andropogon cambogiensis Balansa *in* J. de Bot. 4: 114. 1890. — *Cymbopogon cambogiensis* (Balansa) E.G. & A. Camus *in* Lecomte, Fl. Gen. Indo-China 7: 351. 1922, as "cambodgiensis". — Type: Cambodia, *Godefray 292* (K, iso!).

Cymbopogon siamensis Bor *in* Dansk Bot. Arkiv 23: 158. 1965. — Type: Thailand, *Kai Larsen 8989* (K, holo!).

Perennial; culm up to 175 cm high, 4 mm in diam., geniculate, wiry, often branched, nodes swollen. Leaf-blades up to 9 mm wide, glabrous, smooth, hard in texture, rounded at the base. Leaf-sheath glabrous. Spathate panicle with very few to numerous racemes, narrow, 12—20 cm long; spatheole up to 19 mm long. Racemes 15 mm long, deflexed; lower raceme-base and lowermost pedicels not swollen, glabrous; rachis internodes and pedicels glabrous or sparsely pilose along the margins. Sessile spikelet 3—3.2 mm long, with reduced awn; lower glume narrowly ovate-lanceolate to elliptic, 0-8 mm wide, with shallow median groove, narrowly winged, nerveless or 2-nerved; awn up to 7 mm long. Pedicellate spikelet glabrous, 3 mm long; lower glume 0.8 mm wide, narrowly ovate to ovate-lanceolate, 5 (7)-nerved.

HABITAT: Open grassy grounds; savannas.

DISTRIBUTION: Cambodia, Thailand and Indo-China.

C. cambogiensis is characterized by having almost ovate sessile spikelets and pedicellate spikelets in short racemes, together with a flat lower raceme-base and lowermost pedicel, and a shallow median groove in the lower glume.

This species is in fact variable in its habit and panicle. In the type specimen the plant is tall with a narrow, long, dense panicle. In some specimens it is found that the plant is much smaller, a few cm high with shorter leaf-blades and shorter panicle.

C. cambogiensis is easily confused with *C. caesius*, the spikelets of both species being similar. *C. cambogiensis* differs from *C. caesius* by having a flat raceme-base and a shallow median groove of the lower glume.

THAILAND. Chumpaan, 12. I. 1927, alt. 20 m, *A.F.G. Kerr 11391;* Chainat, 19. IX. 1930, *A.F.G. Kerr 19677;* Aren Pratet, 9. VIII. 1930, alt. 50 m, *A.F.G. Kerr 19586;* Supan, 22. IX. 1930, *A.F.G. Kerr;* Chantaburi, 13. VI. 1963, alt. 50 m, *Kai Larsen 10027.*

INDO-CHINA. Annam, 1930, *Colani 3958* (P); *Ebernardt 2180* (P); 29. IX. 1921, *Hitchcock 19373* (P).

CAMBODIA. 1878, *M. Godefray 292.*

30. CYMBOPOGON POLYNEUROS (Steud.) Stapf

Andropogon polyneuros Steud., Syn. PI. Glum. 1: 385. 1854. — *Cymbopogon polyneuros* (Steud.) Stapf *in* Kew Bull. 1906: 345, 361. 1906; Bor *in* J. Bomb. Nat. Hist. Soc. 51: 913. 1953. — Type: India, *Hohenacker 933* (P, holo!; K, iso!).

Perennial; culm erect or geniculate, up to 100 cm high, 2—2.5 mm in diam., glabrous, often branched. Leaf-blades 17 cm long, 6—7 mm wide, rounded at the base, smooth, hard in texture, slightly rough along the margins. Leaf-sheaths glabrous. Ligule membranous, 3 mm long. Spathate panicle with few racemes, purplish; spatheole 15—17 cm long; peduncle 10 mm long. Racemes 15 mm long; lower raceme-base and lowermost pedicel not swollen; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 4 mm long; lower glume 1.2 mm wide, with deep median groove, chartaceous, widened upwards, broadly winged, nerveless or 2-nerved; awn 16 mm long. Pedicellate spikelet 4.5—5 mm long; lower glume 1 mm wide, 7-nerved.

CHROMOSOME NUMBER: India, 2n = 20 (Gupta 1969a).

HABITAT: Grassy hills.

DISTRIBUTION: Nilgiris (India), Ceylon.

USES: The oil is not yet produced commercially, it contains limonene (Guenther 1950).

This species is often confused with *C. caesius*, but it has the lower raceme-base and the lowermost pedicel not swollen, the hairs of the rachis internodes and pedicels are less dense, and the raceme longer than in *C. caesius.*

The non swollen raceme-base and lowermost pedicel place *C. polyneuros* near to *C. pruinosus* from Mauritius, but *C. pruinosus* differs from the former in having a 3-toothed lower glume of the sessile spikelet.

INDIA. Nilgiris, 1964, *E. K. Janaki Ammal 10983*);* ibid., 1884, J.S. *Gamble 15326;* ibid., 1885, *J.S. Gamble 16648; Bot. Gard. 101; Bourne;* Burligar, 1889, *J-S. Gamble 22555; Pykara; J.S. Gamble 11834; Schmidt; R.F. Hohenacker 933;* 1834, *Perrotet 1269;* Doodabetta, 1889, *Bourne 78; Wight 1705; Griffith 6769.*

CEYLON. *C.P. 3135.*

31. CYMBOPOGON ANNAMENSIS (A. Camus) A. Camus — Fig. 33.

Cymbopogon martinii. var. *annamensis* A. Camus *in* Bull. Mus. Hist. Nat. Paris 25: 670. 1919. — *Cymbopogon annamensis* (A. Camus) A. Camus *in* Bull. Mus. Hist. Nat. Paris 26: 563. 1920; E.G. & A. Camus *in* Lecomte, Fl. Gen. Indo-China 7: 344. 1922. — Type: Indo-China, *Chevalier* (P, holo!).

Cymbopogon bassacensis A. Camus *in* Bull. Mus. Hist. Nat. Paris 26: 564. 1920. — Type: Mekong, *Thorel* (P, holo!).

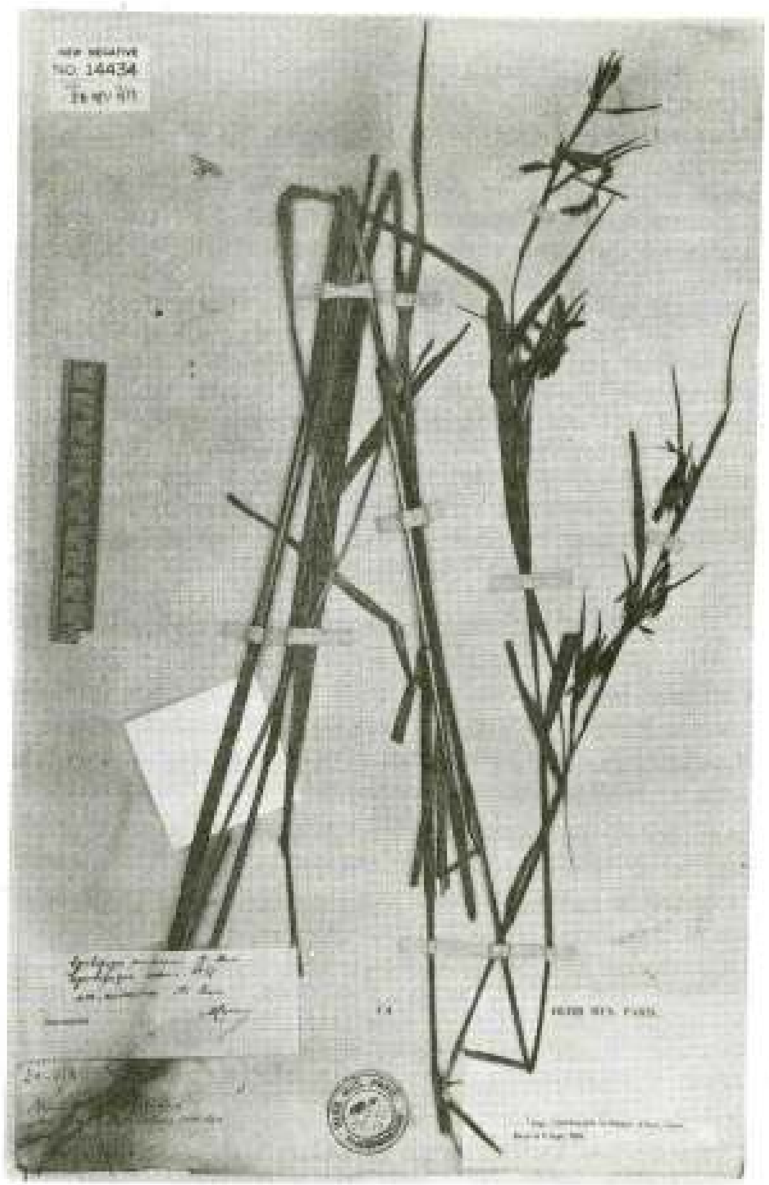


FIG. 33. Type specimen of *C. annamensis.*

Culm 65—100 cm high, wiry, glabrous, slightly geniculate, with the innovations extravaginal. **Leaf-blades 30—40 cm long, 3—9 mm wide,** smooth, tapering, **more** or less **rounded at the base, very rarely attenuate.**

Leaf-sheaths glabrous. Ligule 0.5—1.5 mm long, rounded. Spathate panicle erect, 20 cm long, narrow; spatheole 25 mm long. Raceme 18—20 mm long, reddish to purplish; lower raceme-base and lowermost pedicel swollen, fused in the lower part, almost glabrous; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 4.5 mm long; lower glume 0.8—1 mm wide, nerveless to 2-nerved ; awn 16 mm long. Pedicellate spikelet 3.8 mm long; lower glume 0.8—1 mm wide, broadly lanceolate, 7-nerved.

HABITAT: Open grasslands; alt. 1000—1400 m.
DISTRIBUTION : Indo-China.

A. Camus (1920) distinguished 2 species from Indo-China, *C. bassacensis* and *C. annamensis.* The latter differs from the former by the purplish racemes and internodes, also the spikelets are persistent in *C. annamensis,* whilst in *C. bassacensis* they break easily. In fact there is not much difference between the two species. In both forms the lower raceme-base and the lowermost pedicel are swollen and fused in the lower part, and are glabrous; and the lower glume of the sessile spikelet is broadly winged with a deep median groove. Therefore, they should be put in the same species, *C. annamensis.*

This species is more or less variable in habit. In the type specimen the culm is tall and slender, erect, with a diameter of about 3 mm. In the specimens from Korat, Thailand *(Kerr 8130* and *Put 4245)* the culm **is** smaller, with a diameter of about 1 mm.

This species resembles *C. polyneuros* by its long purplish racemes and deeply grooved, broadly winged lower glume, but it differs from the later by the swollen lower raceme-base and lowermost pedicel.

THAILAND. Korat, Pak Tong Chai, *A.F.G. Kerr 8130;* Bua Yai, 1.X.1931, *Put 4245;* 23.XL1923, *A.F.G. Kerr 7948;* Mekong, *Thorel* (P).
INDO-CHINA. *Chevalier* (P).

32. CYMBOPOGON OSMASTONII R. N. Parker

Cymbopogon osmastonii R.N. Parker *in* Feddes Repert. 31: 126. 1932: Bor *in* J. Bomb. Nat. Hist. Soc. 51: 915. 1953. — Type: India, *Osmaston 1430* (Dehra Dun, hole).

Perennial; culm 120 m high, glabrous. Leaf-blades 19 mm wide, hard in exture, smooth, rounded to cordate at the base, sometimes amplixicaul. Leaf-sheaths glabrous. Ligule less than 1 mm long. Spathate panicle with few to numerous racemes. Racemes 12 mm long; lower raceme-base and lowermost pedicel flat; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet awnless, 3 mm long; lower glume ovate, 1 mm wide, glabrous, narrowly to broadly winged, 2-nerved. Pedicellate spikelet glabrous, 2 mm long; lower glume broadly ovate, 1 mm wide, 7-nerved (rarely 5-nerved).

HABITAT: Grasslands.

DISTRIBUTION: India (endemic).

This species resembles the awnless *C. cambogiensis*, but it differs from the latter by the ovate lower glume of the sessile spikelet and the cordate of the leaf-blade.

INDIA. Uttar Pradesh, *Osmaston 1430;* 1931, *For. Ranger; Bullock 758;* N.W. of India, *Royle.*

33. CYMBOPOGON MEKONGENSIS A. Camus

Cyvibopogon mekongensis A. Camus *in* Bull. Mus. Hist. Nat. Paris **62: 563. 1920; E.G.** & **A.** Camus *in* Lecomte, Fl. Gen. Indo-China .7: 344. 1922. — Type: Mekong, *Thorel 2481* (P, holo!).

Perennial; culm 55 cm high, with innovation extravaginal, geniculate, wiry. Leaf-blades 10—20 cm long, 1.5—3.5 mm wide, hard in texture, smooth, tapering, narrow at the base. Leaf-sheaths glabrous, basal-sheaths persistent. Ligule 1.5—2 mm long, membrano-chartaceous, glabrous, rounded. Spathate panicle erect, usually with few racemes; spatheole 23 mm long, glabrous, more or less reddish brown; peduncle slender. Racemes 15 mm long; lower raceme-base and lowermost pedicel not swollen; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 4 mm long; lower glume lanceolate, 0.8 mm wide, chartaceous, glabrous, with fairly deep median groove, narrowly winged, nerveless; awn 14 mm long. Pedicellate spikelet 4.2 mm long; lower glume narrowly lanceolate, 0.8 mm wide, glabrous 5-nerved.

HABITAT: Grasslands.

DISTRIBUTION: Indo-China to South China.

C. mekongensis is distinct from the rest of the species in ser. *Rusae.* It possesses narrow leaf-blades with a narrow base, which is unusual in ser. *Rusae.* Besides this the base of the culm is covered by persistent sheaths. However, the median groove of the lower glume of the sessile spikelet resembles that found in other members of ser. *Rusae*, and for that reason this species is placed together with them.

INDO-CHINA. Mekong, *Thorel 2481* (P); Annam, 1927, *J. & M. S. Clemens 4357;* 16.VIII.1911, *H. Lecomte & A. Finet 2092.*

HONG KONG. 5.VIII.1854, *Wight;* 21.X.1969, *Shin Ying Hu 8S09;* 7X1972, *Shin Ying Hu 12236;* 14.1.1936, *N.L. Bor HK84.*

S CHINA. Canton, 1921, *F. A. McClure 10S02;* Kwangtung, 1923, *To Rang P. a 11350* (P); Lo Fan Shan, 1883, *Hort. Bot. Hong Kong 127;* Tonkin, 6. **IX. 1881** ***R-P.*** *Bon* (P); Macau, 6. IX. 1961, *F.A. Soars Sil;* ibid., 7. IX. 1961, *FA. Soar's 413;* ibid., *F.A. Soars 432;* Hainan, 1889, *A. Henry 8287.*

Ser. CITRATI Stapf

Ser. *Citrati* Stapf *in* Kew Bull. 1906: 351. 1906.

Perennial; tufted grasses with innovations mixed between intravaginal and extravaginal. Leaf-blades broadly linear to narrowly linear, often filiform, tapering, narrow at the base, slightly rough on the lower surface. Leaf-sheaths often persistent, basal-sheaths usually glabrous, often persistent Spathate panicle simple, rarely with secondary tiers, to decompound, large, from 15 cm to 100 cm long. Racemes often deflexed at maturity; lower raceme-base flat, shorter than the upper one, lowermost pedicel flat, never fused with the lower raceme-base; rachis internodes and pedicels pilose along the margins, usually glabrous on the back. Sessile spikelet awned, sometimes the awn reduced to a short bristle (C. *winteranus)* ; lower glume flat, usually with 2—3 wrinkles on the back, narrowly winged to broadly winged. Pedicellate spikelet consisting of 2 glumes, two lemmas and one male flower.

TYPE SPECIES: *Cymbopogon citratus* (DC.) Stapf.

DISTRIBUTION: From South and East Africa, India to S.E. Asia, Malesia and Eastern Australia.

This series is characterized by its flat, winged lower glume of the sessile spikelet together with linear leaf-blades with a narrow base, and often a large compound panicle; the lower glume often has 1—3 wrinkles on the back.

It seems that this series is more variable and complex than the other series and it is divided into two groups, which differ only slightly:

(1) lower glume of the sessile spikelet broadly winged *(Marginatus* group) and

(2) lower glume of the sessile spikelet narrowly winged *(Flexuosus* group).

There is a species intermediate between the two groups e.g. *C. Ithasianus*, because the terms "broad" and "narrow" are very relative. The *Flexuosus* group can be divided into two:

(1) large tufted grass, culm tall with a large decompound panicle terminating the culm and broadly linear leaf-blades; the four cultivated species (i.e. *C. winteranus, C. nardus, C. citratus* and *C. flexuosus)* and some wild species (e.g. *C. afronardus)* belong to this group.

(2) tufted grass, culm relatively short with a narrow compound panicle and narrowly linear leaf-blades; most of the wild species (e.g. *C. calciphilus)* belong to this group.

This division is also artificial, since some intermediate forms are found (e.g some specimens of *C. citratus)* and the size of the plant often depends on the place where it grows (e.g. in *C. flexuosus).*

Some characters which can be used to differentiate the species are the size and structure of the lower glume of the sessile spikelet, the structure of the spathate panicle, size of the leaf-blade, the length of the awn, and the colour of the basal-sheath. Often the smells of the living plants of the cultivated species is enough to recognize *C. citratus,* which smells of a strong lemon when the leaf is crushed.

34- CYMBOPOGON MARGINATUS (Steud.) Burtt-Davy

Andropogon marginatus Steud. *in* Flora 12 (2) : 472. 1892. — *Andropogon nirdus* var. *marginatus* (Steud.) Stapf *in* Thiselton-Dyer, Fl. Cap. 7: 351. 1892. — *Cymbopogon marginatus* (Steud.) Burtt-Davy *in* Ann. Trans. Mus. 3: 121. 1912; A. Camus *in* Rev. Bot. Appl. Colon. 1: 286. 1921. — Type: South Africa, Cape, *Ecklon 920* (P, holo!).

Densely tufted grass; culm erect, about 65 cm high, coated with the old basal sheaths. Leaf-blades 35 mm long, 2—5 mm wide, linear, flat and rigid. Leaf-sheaths glabrous, often auricled, basal-sheaths tomentose. Ligule membrano-chartaceous, 2 mm long. Spathate panicle narrow, interrupted, often with secondary tiers; spatheole (19—)49 mm long, chartaceous, very rarely herbaceous with reduced leaf-blades; peduncle 6—21 mm long, stout. Racemes rather stout, deflexed, 28 mm long, with 5—7 pairs of spikelets; rachis internodes and pedicels 3 mm long, pilose along the margins and sparsely pilose on the back. Sessile spikelet 6 mm long; lower glume chartaceous, flat in the upper part, narrow and shallowly concave in the lower part, broadly winged, 2(3)-nerved with the nerves visible in the upper part; awn 15 mm long. Pedicellate spikelet 5.5 mm long; lower glume 1.5 mm wide, broadly lanceolate, acuminate, 7-nerved.

HABITAT: Sand dunes; velds; alt. up to 80 m.
DISTRIBUTION: Cape (South Africa); endemic.

USES: Used by the natives as an enema for pains in the infant's stomachache and in the treatment of chest diseases (Watt & Breyer - Brandwijk 1932).

C. marginatus may usually be recognized by the broadly winged lower glume of the sessile spikelet and by the dense hairs along the margins of the rachis internodes and pedicels.

SOUTH AFRICA. Cape Prov. Hangklip Point, 6.1.1948, *R. J. Rodin S1Z5-* Tonkerhoek, 19.V.1950, *R.N. Parker 4475;* Great Klinkhoek, 1916, *E.R. Phillips lino;* Betty's Bay, 4.IV.1961, *M. Vogts 51;* Klaver Valley, 21.1.1923, *C.E. Moss 7581;* 'capland, Mowbry, 10.1.1894, *O. Kuntze;* Pooles' Bay, 18.1.1920, *J. Burtt-Davy 18789;* Kirtenbosch Bot. Gard., 24.VII.1929, *Hitchcock 24078;* Caledon Div., Nieuw Kloof, 1815, *Burchell 805;* Simon's Bay, *C. Wright;* Witteberg, 21.V.1925, *R.H. Compton 2977;* Jonkerhoek, Stellenbosch, 14.111.1962, *H.B. Taylor 3197;* ibid., 1912, *S. Gainde 1206;* between Blousteen and Kegelbaas, 10.IX.1969, *C. Baucher 552;* Paardenberg, 21.XI.1962, *P.J. Grobter 29300;* 20.11.1922, *Bolus 796.*

35. CYMBOPOGON DIETERLENII Stapf ex Schweickerdt

Andropogon dieterlenii (Stapf) Phillips *in* Ann. S. Afr. Mus. 16: 336. 1919, *nom. nud.; Cymbopogon dieterlenii* Stapf, I.e., in syn. — *Cymbopogon dieterlenii* Stapf ex Schweickerdt *in* Kew Bull. 1938: 52. 1939. — Type: South Africa, Basutoland, *Dieterlen 390* (K, holo!).

Culm erect, up to 70 cm high, glabrous, coated with old basal sheaths. Leaf-blades more or less filiform, 45 cm long, glabrous, slightly rough. Leaf-sheath narrow in the upper part, glabrous, basal-sheaths pubescent. Ligules 7—15.5 mm long, chartaceous, glabrous, Spathate panicle narrow, compound with few racemes; spatheole 27 mm long. Racemes 22 mm long with 5—6 pairs of spikelets; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 6—6.2 mm long; lower glume broadly lanceolate, 1.5—1.8 wide, wider above, broadly winged, chartaceous to subchartaceous, flat on the back, shallowly concave in the lower part, nerveless or 2-nerved; awn 11 mm long. Pedicellate spikelet 5.5 mm long; lower glume 1 mm wide, elliptic oblong, shortly and narrowly winged in the upper part, 7-nerved.

HABITAT: Velds.
DISTRIBUTION: South Africa; endemic.

The name "dieterlenii" was given by Stapf in the material at Kew without publishing it. Phillips (1919) published the name *Cymbopogon dieterlenii* Stapf as a synonym of *Andropogon dieterlenii* (Stapf) Phillips without giving a description. Schweickerdt (1939) published *C. dieterlenii* together with a latin description.

In this species there are occasionally 3 racemes instead of the usual 2- In this case the upper raceme-base behaves like a peduncle and gives rise to two racemes, borne on equal raceme-bases.

C. dieterlenii can be recognized by the broadly winged lower glume of the sessile spikelet and filiform (very rarely flat) leaf-blades. This species resembles *C. marginatus* in having a broadly winged lower glume, but differs in its filiform leaf-blades and sparsely hairy rachis internodes and pedicels.

SOUTH AFRICA. Seneral, 1.XII.1931, alt. c. 1750 m, *A.. P. Pooseons 663;* ibid., 17.XII.1931, *A. P. Pooseons 961;* Nieuwport, 14.111.1942, *P. J. Boltu 10;* Fieksburg! 1949, *H. A. Mathysen 5;* Bethlehem, 1941, *A. J. Richardson;* ibid., 1.1.1969, *L.C.C. Liebenberg 6853;* between Ladybrand and Moseru, 24.XII.1958, alt. 1600 m, *E. Wedermann & H.D. Oberdick 1522.* Lesotho. Above Buffalo River, 12.III.1904,'alt. c. 2500 m, *E.E. Golpin 6897; Dieterlen 390.*

36. CYMBOPOGON PROLIXUS (Stapf) Phillips

Andropogon nardus var. *prolixus* Stapf *in* Thiselton-Dyer, Fl. Cap. 7: 352. 1898. — *Cymbopogon prolixus* (Stapf) Phillips, S. Afr. Grasses 218. 1931. — Type: South Africa, Cape, *Burchell 3845* (K, lecto!).

Culm 90—145 cm high, glabrous, erect. Leaf-blades 30—35 cm long, 4—5 mm wide, tapering, glabrous. Leaf-sheath smooth and glabrous, basal sheaths tomentose. Ligule 4—7 mm long, subchartaceous, rounded, glabrous. Spathate panicle erect, narrow, 40—75 cm, interrupted, spatheole 26—31 mm long, peduncle 9—11 mm long, glabrous. Eaceme 19—23 mm long; rachis internodes and pedicels densely pilose along the margins, usually glabrous on the back. Sessile spikelet 6—6.5 mm long; lower glume chartaceous, 1.2 mm wide, broadly winged, 3-nerved; awn 17—18 mm long. Pedicellate spikelet 5.5—7 mm long; lower glume 1—1.3 mm wide, often with wings in the upper part, 7-nerved.

CHROMOSOME NUMBER: Transvaal, 2n = 40 (de Wet & Anderson 1956).

HABITAT: Grasslands; alt. 2000—3000 m.

DISTRIBUTION: South Africa, Tanzania.

C. prolixus can be recognized by the yellowish racemes arranged in a very interrupted spathate panicle with a broadly winged lower glume of the sessile spikelet. It resembles *C. marginatus* by the broadly winged glume of the sessile spikelet, but it differs from the latter by the longer ligule, longer awn, and the rachis internodes and pedicels glabrous on the back.

TANZANIA. Iringa, May, *H.E. Emson 452;* Signal Hill, Feb., *Thompson 471.*
RHODESIA. Southern part, June, *H.B. Gilliland 409.*
SWAZIELAND. Mbabano, Dec, *H. Bolus 12426.*
TRANSVAAL. Pretoria, *A.F. Appleton 56.*
SOUTH AFRICA. Johannesburg-, Linkfield, Jan., *Prosse 1857.*
CAPE PROVINCE. Between Port Alferd and Kaffir Drift, *Burchell S845;* Port Elizabeth, *ESC A 118;* Mossel Bay, Mouth of Gauritz River, *Mund and Maire.*

37. CYMBOPOGON RECTUS (Steud.) A. Camus — Fig. 34

Andropogon rectus Steud., Syn. PL Glum. 1: 388. 1854. — *Cymbopogon rectus* (Steud.) A. Camus *in* Rev. Bot. Appl. Colon. 1: 286. 1921; Monod de Froideville *in* Backer & Bakh. v.d. Brink Jr., Fl. Java 3: 611. 1968; Blake *in* Proc. Roy. Soc. Queensl. 80(6): 72. 1969. — Type: Java, *Zollinger 2562* (P, holo!; L, iso!).

Cymbopogon javensis Hofman, B\jdr. Kennis Ind. Grassol. 11. 1919.

Culm 100 cm high, glabrous, purplish in the upper part. Leaf-blades 50 cm long, 5 mm wide, glabrous. Leaf-sheath glabrous, yellowish to purplish, often auricled. Ligule chartaceous, 3 mm long. Spathate panicle erect, branches nodding, 50 cm long, interrupted; spatheole 10—34 mm long; peduncle glabrous, 7—9 mm long. Racemes 15—20 mm long; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 5.5—7 mm long; lower glume broadly lanceolate, 1 mm wide, glabrous, 4—5-nerved, broadly winged, flat on the back or with 3 wrinkles; awn 14 mm long. Pedicellate spikelet 6 mm long; lower glume lanceolate, often winged above, 7(9)-nerved.

HABITAT: Grasslands; *Casuarina* parklands; alt. 1200—2200 m.

DISTRIBUTION: Java (Central and East), Bali, Lombok, Sumbawa.

The panicle of *C. rectus* is variable. The panicles of the plant known from the type locality (Mt. Tengger) have few branches, but those found in Mt. Dieng and its surroundings (Central Java) have longer and denser panicles. Both forms are similar in having the lower glumes of the sessile spikelet with 4—5 nerves, 2 wrinkles on the back, broad wings along the keels, and narrow leaves.

JAVA. Mt. Merapi, 27.IV.1920, alt. c. 2500 m, *Coert 101* (L); Dieng Plateau, 1917, alt. 1200 m, *C.A. Backer 22050* (BO); Tawangmangu, 31.V.1941, alt. 1550 m, *van Slooten 2706* (BO); Mt. Sumbing-, 14.V.1912, alt. 1550 m, *Lorzing 418* (BO); Mt. Kelut, 23.111.192.9, salt. 2500 m, *Coert 706* (L); Mt. Kawi, 19.IV.1929, alt. 2400 m, *Docters van Leeuwen 12434* (BO); Mt. Arjuno, 1940, alt. 1500—2400 m, *van Steenis 11854* (BO, L); Batu, 9.VI.1970, alt. c. 1000 *m, S. Soenarko 157* (BO); Mt. Wilis, 1898, *Koorders 23337* (BO); Mt. Tengger, 26.111.1968, alt. 2200 m, S. *Soenarko 64* (BO); ibid., *Zollinger 2562;* ibid., 22.IV.1940, alt. 2000 m, *van Steenis 11896* (BO); top of Mt. Widodaren, 24.X.1899, alt. 2500 m, *Koorders 37575* (BO); Ijen Plateau, 28.111.1968, alt. 1600 m, *S. Soenarko 83* (BO); Mt. Pendil, 3.V.1940, alt. 1690 *m, van Steenis 12127* (BO, L); between Sempol and Mt. Merapi, 23.VI. 1918, alt. 1200—1500 m, *C. A. Backer 25S15* (BO); Iyang Plateau, 29.IV.1914, alt. 2150 m, *C.A. Backer 13390* (L); ibid., 25.X.1913, alt. 2100 m, alt. 2150 m, *C.A. Backer 13390* (L) ; ibid., 25.X.1913, alt. 2100 m, *C.A. Backer 9756* (BO).

BALI. Kintamani, 20.111.1964, alt. 1200 m, *A. Dilmy 972;* S. of Mt. Agung, 6.IV.1936, alt. 1500 m, *van Steenis 7818* (L); Mt. Batur, 6.VI.1970, alt. 1200 m, S. *Soenarko 137* (BO); ibid., 25.V.1935, alt. 1300 *m, de Voogd 2032;* Tegagula,

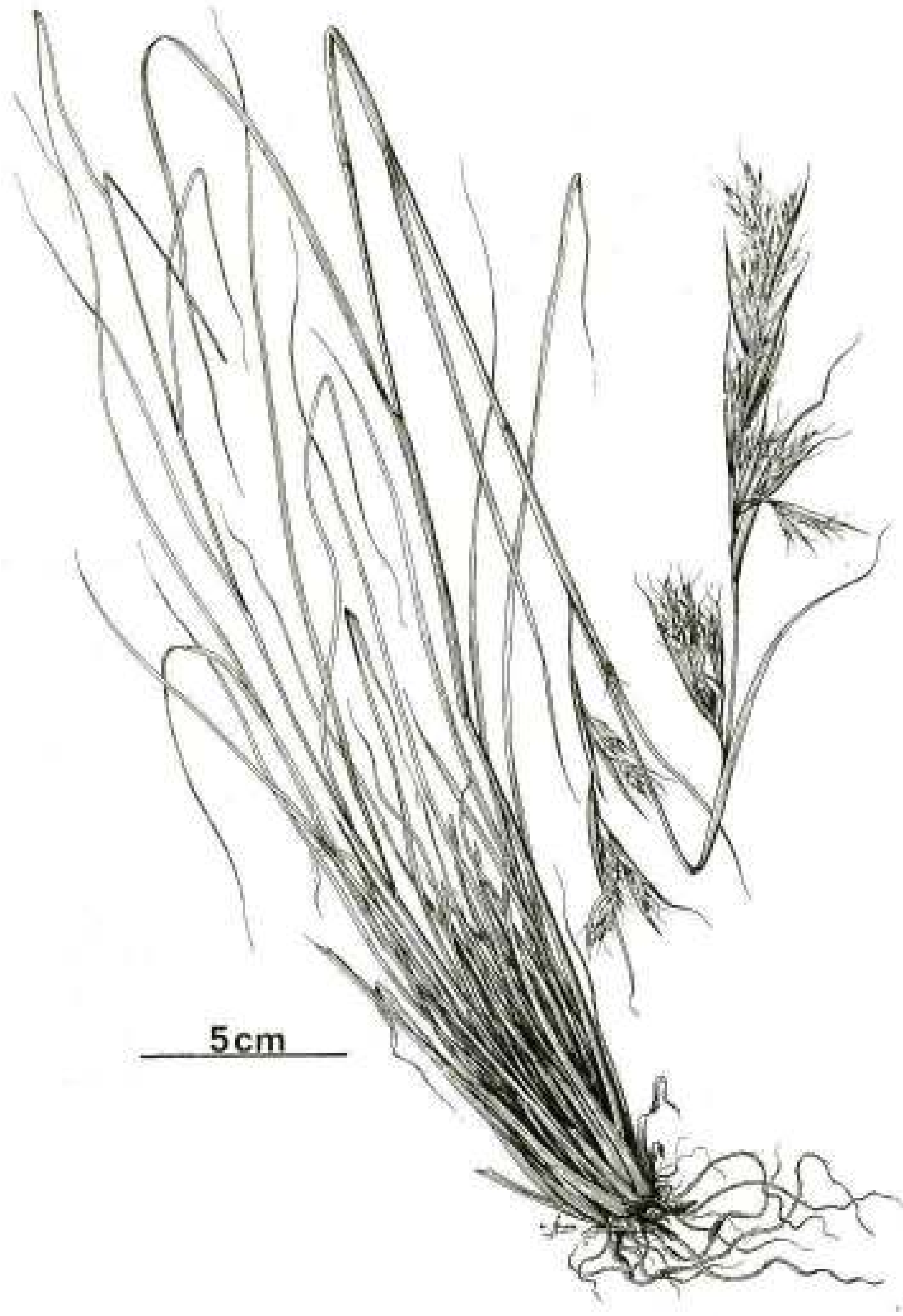


FIG. 34. *Cymbopogon rectus;* after *S. Soenarko 83.*

4.IV.1936, alt. 150 m, *van Steenis 7761* (BO) ; Mt. Abang, 9.IV.193G, *van Steenis S025* (BO, L).

LOMBOK. Mt. Rinjanz, 26.VI.1936, alt. 2000 m, *de Voogd 2632* (BO); Plawang, alt. 2400 m, *de Voogd 2591* (BO); Simbalun, alt. 1600 m, *de Voogd 2605* **(BO); ibid.,** alt. 2500—2843 m, *Elbert 2339* (L).

SUMBAWA. Semongkat atas, 13.V.1961, alt. 700 *m, K. Kartawinata 167.*

38. CYMBOPOGON GOERINGII (Steud.) A. Camus

Andropogon goeringii Steud. *in* Flora 24: 22. 1846. — *Andropogon nardus* var. *goeringii* (Steud.) Hack, *in* DC, Monogr. Phan. 6: 607. 1889. — *Cymbopogon goeringii* **(Steud.) A.** Camus *in* Rev. Bot. Appl. Colon. 1: 286. 1921. — *Cymbopogon tortilis* **var.** *goeringii* (Steud.) Hand. Mzt., Symb. Sin 7: 1314. 1936. — Type: Japan, *Goering S* (P, holo!).

Culm up to 90 cm high, glabrous. Leaf-blades flat, 30 cm long, 4.5 mm wide, glabrous. Leaf-sheaths smooth, glabrous, basal sheath glabrous. Ligule 3.5 mm long, membranous. Spathate panicle interrupted, more or less loose, rarely with tertiary tiers, purplish to yellowish; spatheole 23 mm long; peduncle glabrous, 13 mm long. Racemes up to 23 mm long; rachis internodes and pedicels pilose along the margins, glabrescent on the back, pedicel slightly swollen above. Sessile spikelet 4.5—6 mm long; lower glume 1—1.6 mm wide, subchartaceous, flat on the back, ovate-lanceolate or lanceolate, narrowly to broadly winged, 3—• 6-nerved, the middle nerve often narrowly winged in the upper part; awn 17 mm long. Pedicellate spikelet 5.5 mm long; lower glume broadly lanceolate, J—1.2 mm wide, slightly rounded on the back, often winged in the upper part.

C. goeringii is related to the South African species, *C. marginatus* and *C. dieterlenii* in having broadly winged lower glume of the sessile spikelet. It differs from both species by having broadly lanceolate subchartaceous lower glume, broader leaf-blades and a longer awn.

This species consists of two varieties. Var. *goeringii* can easily be recognized by the conspicuous nerves on the lower glume of the sessile spikelet together with the swollen tip of the pedicel, and the purplish spathate panicle. Var. *hongkongensis* differs from var. *goeringii,* because it possesses a yellowish spathate panicle and a shorter lower glume °f the sessile spikelet. However, it is not feasible to make it separate species, since the shape of the lower glume of the sessile spikelet is similar to that of var. *goeringii.* It is therefore regarded as a local variety of this species.

var. GOERINGII

Lower glume of sessile spikelet 6 mm long, broadly winged, conspicuously 5(6)-nerved; pedicel usually swollen above.

HABITAT: In grassy pastures; grassy hills, alt. 20—50 m.

DISTRIBUTION: South Japan & South Korea.

JAPAN. Yokohama, 1877, *Dickins;* Okoyama, 9.XI.1893, *Faurie 114.51;* Fujiyama, 20.VIII.1890, *Faurie 6649; Fauri 6522;* Yokoska, *Savatier 2559, 1506;* Kyushu, Wakamatsu, 4.IX.1894, *Faurie 1724;* Hokozaki, 30.X.1928, *K. Ichikawa 50;* Matmuyama, 14.XI.1893, *Faurie 11694; Goering 3*);* Choshabaru, 1929, *M. JaJcenouchi;* Ryukyu, 16.VI.1900, *Faurie; N. Noguchi 3371;* W. of Nakazone, 20.VIII.1956, *F.R. Fosberg 38304;* SW of Ozato, 22.V.1956, *F.li. Fosberg 37056; F. R. Fosberg S7722, S7816.*

KOREA. Chuiramko, 1906, *Faurie 1215; Faurie 820.*

var. hemgkongensis S. Soenarko, *var. nov.*

A varietate typica gluma inferiore spiculae sessilis 4.5 mm longa, anguste alato, differt.

TYPUS: Hongkong, *Shiu Ying Hu 12182* (K(holo!).

HABITAT: Grassy Hills; alt. 50—900 m.

DISTRIBUTION: Hong Kong, Formosa.

HONG KONG. Wah San Kuek, 23.VIII.1970, *Paul But 110;* Fan Fan Valley, 21.X.1972, *S.Y. Hu 12302;* Ma On Shan, 22.IX.1968, *S.Y. Hu 5695; Paul But 240;* Victoria Peak, 10.X.1970, *Paul But 156;* Tai O, 18.VIII.1929, *W.Y. Chun 3158;* Central Isl, *S.Y. Hu 12182;* Cheung Chau, 8.VII.1970, *Paul But 39.*

FORMOSA, Apes Hills, *G.W. Play fair 237;* South Cape, *A. Henry 1309.*

39. CYMBOPOGON KHASIANUS (Munro ex Hack.) Bor

Andropogon nardus var. *khasianus* Munro ex Hack, *in* DC, Monogr. Phan. 6: 603. 1889; Hooker f., Fl. Br. India 7: 206. 1896. — *Cymbopogon khasianus* (Munro ex Hack.) Bor *in* Ind. For. Rec. (Bot.) 1 (13): 92. 1938; *in* J. Bomb. Nat. Hist. Soc. 52: 168. 1954. — Type: India, Khasi Hills, *Griffith 6764* **(K,** syn!).

Culm about 170 cm high, glabrous and smooth, nodes glabrous or bearded. Leaf-blades 50 cm long, 9.5 mm wide, slightly rough, glabrous except woolly triangular patches at the base. Leaf-sheaths glabrous, basal sheath often tomentose. Ligule membrano-chartaceous, 4 mm long. Spathate panicle compound, lax, interrupted; spatheole 21 mm long; peduncle 9 mm long, slender, with scattered hairs in the upper part. Raceme 20 mm long, slender, rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 4.5—5 mm long;

lower glume chartaceous or often subchartaceous, flat on the back, often with 3 wrinkles, broadly winged, 4(5)-nerved; awn 12 mm long- Pedicellate spikelet 4.5 mm long; lower glume broadly lanceolate, 1 mm wide, 7-nerved.

CHROMOSOME NUMBER: India, 2n = 60 (Gupta 1969a).

HABITAT: Grasslands; pine forests; alt. 1300—2000 m.

DISTRIBUTION: Khasi Hills (Assam), Thailand.

Hackel (1889) cited 3 specimens, *Griffith 6764, 6765* and *Wallich 8794-H.* Hooker f. (1896) ascribed the third specimen to a form of *Andropogon nardus* var. *khasianus*, since the lower glume of the sessile spikelet is nerveless and wingless. *Wallich 8794H* is, in fact, *C. flexuosus,* which is a very variable species.

C. khasianus can be recognized by the slender racemes and broadly winged, 4 (5)-nerved, lanceolate lower glume of the sessile spikelet.

INDIA. Khasi Hills, Iserra, 8.X.1867, alt. 1300 m, *C.B. Clarke 6432;* Mawryungkneng, 4.IX.1951, *W.N. Koelz 28343;* ibid., 24.IX.1951, *Thakur Rup Chand 4802;* Mawphlang, 10.IX.1949, *Thakur Rap Chand 2185;* ibid., 29.VI.1953, *W.N. Koelz S3230; I.H. Burkill & S..C. Benerjee 329;* 1830, *Herb. Hooker 1381;* Shillong, *C.B. Clarke 38513;* ibid., 22.X.1942, *N.L. Bor 17153;* Sataka, 8.IX.1942, alt. 2000 m, *N.L. Bor 163320;* Ridima, 2.IX.1935, *N.L. Bor 6255;* Naga Hills, Kohima, 16.IX.1950, *Chand 3472; N.L. Bor 2379; Griffith 6764;* Manipur, Mythi Phuni, 13.XI.1885, *C.B. Clarke 41959A;* Bishenpur, 20.XI.1943, *N.L. Bor 18099;* Karong, 1950, *Thakur Rup Chand 3699.*

THAILAND. Dai Sutch, 12.XI.1911, *A.F.G. Kerr 1554B.*

S. CHINA. Yunnan, *J. Cavalerie 8016.*

40. **Cymbopogon traninhensis** (A. Camus) S. Soenarko, *comb. nov.*

Cymbopogon confertiflorus var. *traninhensis* A. Camus *in* Bull. Mus. Hist. Nat. **Paris 26:** 565. 1920; E.G. & A. Camus *in* Lecomte, Fl. Gen. Indo-China 7: 341. 1922. — Type: Laos, Traninh, *Mieville* (P, holo!).

Cymbopogon khasianus var. *nagensis* Bor *in* Bomb. Nat. Hist. Soc. 52: 169. 1954. Type: Assam, Naga Hills, *N.L. Bor 10* (K, holo!).

Tufted grass; culm 135 cm high, whitish to purplish, glabrous. Leaf-Wade? up to 75 cm long, 1.3 cm wide, glabrous except the bearded lower part at the junction with the sheaths, narrow at the base, smooth on the upper surface, slightly rough beneath and along the margins. Leaf-sheath glabrous. Ligule chartaceous, 5 mm long, glabrous. Spathate panicle compound, narrow, erect or lax, nodes often bearded; spatheole 25—30 mm long, glabrous, peduncle slender, not stout. Racemes fragile, 19—29 mm long; lower raceme-base and lowermost pedicel not swollen; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 7 mm long; lower glume glabrous to pubescent on the back, lanceolate, 1 mm wide, 1—2-wrinkled on the back, broadly winged, nerveless to 2-nerved; awn up to 20 mm long. Pedicellate spikelet 5—5.5 mm long; lower glume 1 mm wide, 7-nerved.

HABITAT: Open savannas in the hills; in plateau; alt. 900—1900 m.

DISTRIBUTION: Naga Hills (Assam), Northern part of Indo-China, South China and Burma.

USES: Little known but oil extracted from the plant by the natives (A. Camus 1920).

This species was originally described by Mlle Camus based on a plant growing on the plateau Traninh (Laos). It has a narrow, dense, purplish panicle, and the lower glume of the spikelet is 5 mm long with broad wings, with or without wrinkles on the back. I cannot find any differences between this species and *C. khasianus* var. *nagensis* Bor, a plant from the Naga Hills (Assam).

C. traninhensis is variable. In the type specimen the lower glume of the sessile spikelet is usually glabrous, occasionally pubescent on the back. In the plant from the Naga Hills, the lower glume is usually pubescent on the back. The plants from Yunnan have a yellowish panicle with loose branches. However, all specimens share a similar structure of the lower glume, which is 5—7 mm long, broadly winged, narrow at the base and wrinkled on the back.

The broadly winged lower glume in this species suggests an affinity with *C. prolixus* from South Africa- The latter is distinguished by the narrower and shorter leaf-blades and the pubescent basal sheaths.

INDIA. Manipur State, Thonbal, 19.XII.1942, alt. c. 1000 m, *N.L. Bor 16955;* Naga Hills, Shiloi Jopi, 16.XI.1935, alt. 2500 *m, N.L. Bor 10.*

BURMA. Mandalay. Popa, 12.IX.1938, alt. 1500 m, *D. Rhind 2619.*

THAILAND. Chiangmai, 7.XII.1959, alt. 900 m, *T. Smitinand & E.G. Abbe 6263;* ibid., 2.XII.1961, alt. 1600—1900 m, *T. Smitinand & J.A.R. Anderson 7258;* ibid., 11.XI.1962, alt. 1600—1850 *m, T. Smitinand 27722.*

LAOS. Traninh, *Mievile* (P).

YUNAN. *G. Forest 11694;* 1885, *Delaway 1789, 1797* (P); Kochan, 2.X.1889, *Delaway 4772* (P).

41. CYMBOPOGON WINTERANUS Jowitt

Cymbopogon winteranus Jowitt *in* Ann. Roy. Bot. Gard. Perad. 4: 188. 1908; Bor *in* J. Bomb. Nat. Hist. Soc. 51: 906. 1953; Monod de Froideville *in* Backer & Bakh. v.d. Brink Jr., Fl. Jav. 3: 611. 1968. Type: Ceylon, *A.W. Winter* (K, holo!).

Large tufted grass; culm 2—2.5 m high, smooth, glabrous. Leaf-blades up to 1 m long, 1.5 cm wide, usually light green, glabrous, smooth on the upper surface, slightly rough below and along the margins. Leaf-sheath glabrous, yellowish green, basal sheath glabrous, green to reddish. Ligule chartaceous, about 1 mm long. Spathate panicle decompound, large, about 1 m long, with many racemes arranged along a zig-zag axis; spahteole 20 mm long, glabrous. Racemes 20 mm long; rachis inter-nodes and pedicels pilose along the margins, glabrous or puberulous on the back. Sessile spikelet 5 mm long; lower glume oblong-lanceolate, usually flat, narrowly winged, 3-nerved; awn 5 mm long when present. Pedicellate spikelet 5 mm long; lower glume lanceolate, 7-nerved.

DISTRIBUTION: Cultivated only; its origin is unknown.

USES: The oil distilled from the leaves of this species is known as citronella oil; it contains 25—54 per cent geraniol and about 35 per cent citronellal (Burkill 1935; Guenther 1950). The oil which contains a high citronellal is used for isolation of citronellal and for convertion of the latter into citronellol, citronellol ester, hydroxycitronellol and synthetic menthol; oil with low percentage of citronellal is used for isolation of geraniol for scenting soaps (Guenther 1950).

VERNACULAR NAMES: mahapengiri; old citronella grass; serai wangi.

JAVA. Bogor, cult., 1968, *S. Soenarko 85* (BO); Ciburial, 23.IV.1922, *Bakhuizen v.d. Brink 5461* (BO); Jakarta, cult., 1903, *C.A. Backer S361S* (BO); Cianjur, **cult.,** 1968, *S. Soenarko 87* (BO); Garut, 1969, *S. Soenarko 111* (BO).

SUMATRA. Habinsaran, 1929, *Lorzing 15510* (BO).

BORNEO. Sandakan, 1962, *D.I. Nicholson SFN2749;* Sungai Kayu, 1933, *N. Mendosa 4029;* Kabili-Sepilok, 1937, Angian 7052, *Kadir A 2699;* Paku River, 17, **XI.1936,** *Noorudin 6770;* Sarawak, Upper Rejang River, 1929, *Clemens 21882.*

CEYLON: *A.W. Winter; Jowitt 4*).*

42. CYMBOPOGON NARDUS (Linn.) Rendle

Andropogon nardus Linn., Pl., ed. 1, 1046. 1753; Hook, f., Pl. Br. Ind. **7:** 205. **1896.** — *Cymbopogon nardus* (Linn.) Rendle *in* Cat. Welw. Afr. Pl. 2: 155. 1899; **Stapf** ***in*** Kew Bull. **1906:** 314, 354. 1906; Bor *in* J. Bomb. Nat. Hist. Soc. 51: 903. **1953.** — Type: Ceylon, *Hermann's specimen.*

Tufted grass; culm up to 2.5 m high, erect and finally nodding, 9 mm in diam., smooth, whitish sometimes tinged with purplish red, nodes often swollen. Leaf-blades about 1 m long, 15 mm wide, tapering, glabrous, tomentose at the triangular patches, rough on the lower surface and along the margins, often smooth above, dark green or dark brown when dry, Leaf-sheaths glabrous, smooth, often auricled, basal sheaths Purplish red outside, reddish inside. Ligule chartaceous, glabrous.

Spathate panicle decompound, interrupted, up to 1 m long; spatheole brown, 12—15 mm long; peduncle glabrous. Racemes 15—17 mm long; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 4—4.5 mm long, awned or awnless; lower glume 0.9 mm long, ovate-lanceolate, flat on the back, reddish brown or purplish in the upper part, narrowly winged, nerveless or 3(4)-nerved; awn 7.5 mm lanceolate, 7-nerved.

According to Guenther (1950) there is no record of the introduction of var *confertiflorus* from Ceylon to Java, but it seems that some cultivations of citronella grass in Java are of *C. nardus* var. *confertiflorus.*

var. NARDUS

Sessile spikelet usually awnless; lower glume usually nerveless.
CHROMOSOME NUMBER: India, 2n = 40 (Ragh. & Arora 1958).
HABITAT: Patanas; alt. 2800 m.
DISTRIBUTION: Native in Ceylon; introduced elsewhere in the tropics.

USES: The oil is known as citronella oil and is used chiefly for scenting of soap, disinfectants and sprays (Guenther 1950).
VERNACULAR NAMES: lenabatu; new citronella grass.

CEYLON. Bandarawella, 2.XII.1904, *C. A. Barber 2383, 2385, 2388 & 2389;* 16.XI.1903, *D.N. Silva 4;* Peradenya, 8.III.1970, *F. Gould 13030;* Pussellawa, 26.1.1970, *W.D. Clayton 5434;* Hakgala, 1950, *F. Bollard 1163;* N. E. of Galle, 16.IV.1970, *F. Gould 13415;* S. E. of Nuware Eliya, 7.IV.1970, *F. Gould 13290;* many specimen sent by *J. F. Jowitt.*

var. CONFERTIFLORUS (Steud.) Bor. — Fig. 35

Andropogon confertiflorus Steud., Syn. PL Glum. 1: 385. 1854. —• *Cymbopogon confertiflorus* (Steud.) Stapf *in* Kew Bull. 1906: 318, 355. 1906; A. Camus *in* Rev. Bot. Appl. Colon. 1: 282. 1921. —• *Cymbopogon nardus* var. *confertiflorus* (Steud.) Bor *in* J. Bomb. Nat. Hist. Soc. 51: 905. 1953. — Type: India, *Hohenacker 932* (K, iso!).

Andropogon thivaitcsii Hook. f. *in* Trimen, Fl. Ceyl. 243. 1900. —• *Cymbopogon thwaitesii* (Hook, f.) Bor *in* J. Bomb. Nat. Hist. Soc. 52: 172. 1954. — Type: Ceylon, *Thwaites C.P. 378A* (K, holo!).

Sessile spikelet awned; lower glume 3(4)-nerved; awn about 7.5 mm long.
CHROMOSOME NUMBER: India, 2n = 60 (Ragh. & Arora 1958); 2n = 20 (Janaki Ammal, unpublished).
HABITAT: Grasslands; alt. up to 1500 m.

DISTRIBUTION: India and Ceylon; introduced into cultivation in Java.

USFS: The oil contains 39.1—64.2% of geraniol.

INDIA. Nilgiris, 1889. *J.S. Gamble 21423;* 1910, *Meebold 11998; Hohenacker 932;* Pulney, 1905, *C. A. Barber 2643;* Sirumalai, *Santapau 879;* Salem, 2.III.1927, *K. Jacob 18067K;* Poonachi, 10.X.1901, *C.A. Barber 3725;* Sambalpur, 20.XII.1949, *H.F. Mooney 3188;* Orissa, S. Kalahandri, *Mali;* 1964, *Janaki Ammal 11* (2n = 20).

CEYLON: Agrapatana, 24.IV.1970, *F. Gould 13585;* S. of Palugama, 3.1.1970, *W.D. Clayton 5003;* Badulla Distr., 27.1.1970, *W.D. Clayton 5457, 5512;* Newara **Eliya.** 1862, *Thwaites C.P. 3784.*

JAVA: Bogor, 17.VII.1970, S. *Soenarko 174-* (BO); Sukabumi, 1968, *S. Soenarko 88* (BO).

43. CYMBOPOGON CITRATUS (DC.) Stapf

Andropogon citratus DC., Cat. Hort. Monsp. 78. 1813; Nees *in* Allg. Gartenzeit 3: 266. 1835. — *Cymbopogon citratus* (DC.) Stapf *in* Kew Bull. 1906: 322, 357. 1906; Bor *in* J. Bomb. Nat. Hist. Soc. 51: 907. 1953; Monod de Froideville *in* Backer & Bakh. v.d. Brink Jr., Fl. Java 3: 611. 1968.

Andropogon schoenanthus Roxb., Fl. Ind., ed. 2 (Carey) 1: 278. 1820, non Linne **(1753).**

Andropogon roxburghii Nees ex Steud., Syn. PI. Glum. 1: 395. 1854.

Andropogon cerifereus Hack., *in* Mart., Fl. Bras. 2(3) : 281. 1883. — Type: Brazil, *Glaziau 1496.*

Culm up to 200 cm high, smooth, glabrous. Leaf-blades linear, tapering, up to 90 cm long, 5 mm wide, smooth on both surfaces, glabrous, glaucous'green, base narrow. Leaf-sheath terete, glabrous, smooth, basal sheath persistent, glabrous, smooth. Ligule chartaceous, less than 1 mm long, glabrous. Spathate panicle decompound, 30 cm long, spatheole reddish brown, 15—25 mm long; peduncle glabrous. Raceme 15—17 mm long; rachis internodes and pedicels pilose along the margins and on the back. Sessile spikelet 6 mm long; lower glume 0.7 mm wide, lanceolate, narrowly winged, flat on the back, slightly concave in the lower part, glabrous, nerveless- Pedicellate spikelet 4.5 mm long; lower glume 0.7 mm wide, glabrous.
CHROMOSOME NUMBER: Cultivated, 2n = 40, 60 (Bor 1953; p. 271).
DISTRIBUTION: Found in cultivation only, widely cultivated in the tropics; the origin is unknown.

USES: In S.E. Asia the hearts of young shoots are used as a spice, for flavouring curries; for medicinal purpose it is reputedly good for the digestion. The oil contains a high percentage of citral, more than

FIG. 35. *Cymbopogon nardus* var. *confertiflorus*; after *S. Soenarko 174.*

50% and nine compounds have been recorded present in its oil including citronelol, citronellal, citral, geraniol and myrcene (Guenther 1950).

VERNACULAR NAMES: serai dapur (Indonesia, Malay); lemon grass.

This species hardly ever flowers, but *C. citratus* can be recognized by the glabrous, more or less smooth leaf-blades and leaf-sheaths, and the strong smell of lemon when the leaf is crushed.

BORNEO. Sandakan, 1920, *Ramos 1668* (BO, L).

SUMATRA. Palembang, 1915, *Grashoff 559* (BO).

PHILIPPINES. Luzon, Prov. of Rizal, 1914, *Ramos 1932* (L, BO); Antipolo, 1913, *Herb. Elmacoanse 267.*

SULAWESI. Batu Angin, 1954, *Alston 16091.*

NEW GUINEA. Lae, 1953, *Womersley*; Morobe Distr., Andarora Village, *Blackwood 172*; Tarawai Isl., 30.V.1969, *Millar & Vandenberg NGF40568.*

44. CYMBOPOGON FLEXUOSUS (Nees ex Steud.) Wats. — Fig. 39B

Andropogon flexuosus Nees ex Steud., Syn. Pl. Glum. 1: 388. 1854. — *Cymbopogon flexuosus* (Nees ex Steud.) Wats. *in* Atkins., Gaz. N.W. Prov. India 392. 1882; Stapf in Kew Bull. 1906: 319, 356. 1906; Bor *in* J. Bomb. Nat. Hist. Soc. 52: 16. 1954; Blake *in* Proc. Roy. Soc. Queensl. 80(6): 73. 1969. — *Andropogon nardus* var. *flexuosus* (Nees ex Steud.) Hack. *in* DC., Monogr. Phan 6: 603. 1889. — Type: India, *Wight 1704* (K, iso!).

Andropogon ampliflorus Steud., Syn. Pl. Glum. 1: 388. 1889. — Type: Java, *Zollinger 549* (P, holo!).

Cymbopogon travancorensis Bor *in* J. Bomb. Nat. Hist. Soc. 52: 170. 1954. — Type: India, *Bourne 5509* (K, holo!).

Tufted grass; culm about 250 cm high, terete, smooth, glabrous, nodes often shortly bearded. Leaf-blades linear, 100 cm long 15 mm wide, tapering, scabrid and rough on both surfaces, very rough along the margins with spreading long hairs on the upper surface at the base, or usually glabrous, triangular patches at the base densely tomentose. Leaf-sheath glabrous, often auricled. Ligule 5 mm long, chartaceous. Spathate panicle decompound, branches flexuosus or drooping, internodes of the main axis often tomentose in the upper part, nodes shortly bearded, rays often arranged on a zig-zag axis; spatheole 10—20 mm long, glabrous; peduncle very slender, ciliate in the upper part. Racemes 15—17 mm long, slender, often deflexed; rachis internodes and pedicels more or less flat, pilose along the margins, glabrous on the back. Sessile spikelet 4.5 mm long; lower glume subchartaceous, lanceolate, 0.8 mm wide, acuminate, narrowly winged, flat, often with (2)3 wrinkles on the back, 3-nerved; awn 10—11 mm long. Pedicellate spikelet 4 mm long; lower glume narrowly lanceolate, acuminate.

CHROMOSOME NUMBER: India, 2n = 20 (Ragh. & Arora 1958); 2n = 40, 20 + 2B (Gupta 1969a).

HABITAT: Grassfields; in teak forests on lime stone; alt. 100—1500 m.

DISTRIBUTION: Native in India, naturalized in Indonesia (Java, Bali and Sumbawa), cultivated in the tropics.

USES: The oil contains 70—85% citral, and is used for scenting soaps and detergents. The isolated citral is used in cosmetics and perfumes. Nine compounds have been recorded present in its oil including citronellal, citral, geraniol and myrcene (Guenther 1950).

VERNACULAR NAMES: malabar grass, lemon grass.

C. flexiiosus usually is easily recognized by its narrowly winged lower glume of the sessile spikelet with 2 or 3 wrinkles and 3 nerves on the back. In its native country (India), this species is variable; the wrinkles are often absent; the glumes may be nerveless; and the wings are often broader *(Barber 6718).* The plants from Java commonly have a broadly winged lower glume, and can be recognized by the presence of long spreading hairs on the upper surface at the base of the leaf-blades, which are rarely present in the Indian plants. It seems that in Java this species is more homogeneous than that in India. However, this species from both areas possesses the same characters, i.e. a large spathate panicle with flexuous or drooping, slender branches, a slender racemes, a densely tomentose triangular patches at the base of the leaf-blades (fig. IF), and a narrowly lanceolate lower glume of the sessile spikelet, rounded on the back.

C. flexuosus is similar to *C. winteranus*, but the latter can be distinguished by the glabrous leaf-blades.

INDIA. Dehra Dun, 1891, *J.F. Duthie;* Chandpur 1891, alt. c. 600 m, J.S. *Gamble 23294;* Odakkali, 1964, *E.K. Janaki Ammal 10981;* Kerala State, 1962, Lemon Grass Res. no. 2; *E.K. Janaki Ammel 11030;* Gorakhpur, 17.IV.1898, *Herb. Gamble 22895;* Munnar, 2.XII.1959, alt. 1500 m, */. Christopher 400;* Travancore, 19.X.1904, *C. A. Barber 6718;* ibid., 26.XI.1914, *K. Venkoba Row;* Mangalore, 1902, *C. A. Barber 4825;* Poonaehi, 10.X.1901, alt. c.1500 m, *C. A. Barber 3752;* Coonoor, *D. Hooper;* Pulney, 11.VII.1898, *A. G. Bourne 1347;* Gundar Valley, 10.VI.1901, *A. G. Bourne 1U6;* Nilgiris, 1889, *J.S. Gamble 21398;* Ketty Valley, 1964, *E.K. Janaki Ammal 11032;* Berliar, 2.II.1901, *A.G. Bourne 2547;* Madras, Wynad, 25.XI.1940, *N.L. Bor H6S9;* ibid., 1940, *N.S. Kaikini;* Rampa, 1.X.1920, alt. c. 800 m, *V. Narayanaswami 379;* Naduvattam, 18.XI.1905, *C.A. Barber 2695; C.A. Barber 2934;* Herb. *Wight 1704-*

JAVA. Mt. Cikepuh, 2.VII.1939, *v. Steenis 11407* (BO); Jakarta, 1922, *C.A. Backer;* Padalarang, 1932, alt. 700 m, *Fiji 489* (BO); Bogor, cultivated, *Herb. Bog;* Mt. Merbabu, 29.111.1920, alt. 1200—1500 *m, C.A. Backer 3029* (BO); Boyolali, 1918,

alt. 1200—1500 m, *Beguin 10* (BO); Mt. Lawu, 3.II.1913, alt. 600—900 m, *C. A. Backer 6701* (BO); Ponorogo, 1917, alt. 150 *m, Noltee 1272* (BO); S.W. of Tulungagung, 1922, alt. 100—150 m, *Kramer 56* (BO); N. of Kediri, 4.V.1918, alt. 200 m, *Gouterink SOU* (BO).

BALI. Gilimanuk, 17.IV.1934, *de Voogd 1756* (BO); *van Steenis 7599* (BO).

SUMBAWA. 1930, alt. 400—800 m, *Gouv. Veeart.* (BO).

45. CYMBOPOGON PENDULUS (Steud.) Wats.

Andropogon pendulus Steud., Syn. PL Glum. 1: 388. 1854. — *Cymbopogon pendvlus* (Steud.) Wats, *in* Atkins., Gaz. N.W. Prov. India 392. 1882; A. Camus *in* Rev. Bot. Appl. Colon. 1: 280. 1921; Bor *in* Bomb. Nat. Hist. Soc. 52: 163. 1954. — Type: Nepal, *Wallich 8794G* (K, iso!).

Culm erect, 120—150 cm high, glabrous. Leaf-blades up to 80 cm long, 11 mm wide, slightly rough on the lower surface, glabrous. Leaf-sheaths glabrous and smooth, basal sheaths tomentose below. Ligule chartaceous, 1.5 mm long. Spathate panicle 60 cm long, more or less interrupted, each tier composed of 3—4 rays in a cluster; spatheole 15—26 mm long; rachis internodes and pedicels pilose along the margins and on the upper part. Sessile spikelet 5—6 mm long; lower glume yellowish, lanceolate to ovate-lanceolate, 1—1.2 mm wide, chartaceous, nerveless or 2-nerved, narrowly winged; awn 11 mm long. Pedicellate spikelet 3.8 mm long; lower glume 0..8 mm wide, more or less rounded on the back.

CHROMOSOME NUMBER: India, 2n = 30, 60 (Gupta 1969a).

HABITAT: Grassfields on the slopes of the hills; alt. 600—1500 m.

DISTRIBUTION: Nepal, North-Eastern India.

INDIA. Purnea, Paksiri near Kalyaganj, 29.1.1911, *I.H. Burkill 34144;* Jalpaiguri, 22.VIJI.1908, *I.H. Burkill 30753;* Howrah, 1908, *Kalka Parshad 30638;* between Sivok and Satiguri, 6.XI.1909, *I.H. Burkill 33425;* Banarhat, 24.VIII.1908, *I.H. Burkill 30772;* Sikkim, Dulkajahr, 15.X.1884, *C.B. Clarke 36873;* ibid., 1867, *Hooker;* Darjeeling, between Matigera and Naxalbari, 25.1.1911, *I.H. Burkill 34104;* Bengala, *Griffith 6763;* Khasi Hills, *Griffith 6759;* Manipur, Bishinpur, 5.X.1943, alt. 1000 m, *N.L. Bor 18051.*

NEPAL. Punkabang, 1873, alt. 600 m, *J.S. Gamble 3329A; Wallich 8794G.*

46. CYMBOPOGON DISTANS (Steud.) Wats. — Fig. 36

Andropogon distans Steud., Syn. PL Glum. 1: 387. 1854. — *Cymbopogon distans* (Steud.) Wats, *in* Atkins., Gaz. N.W. Prov. India 392. 1882; Bor *in* J. Bomb. Nat. Hist. Soc. 52: 169. 1954; Keng, Fl. III. PL Prim. Sin. 833. 1959. — *Andropogon nardus* SUbsp. *marginatus* var. *distans* (Steud.) Hack, *in* DC, Monogr. Phan. 6: 608. 1889. — Type: Nepal, *Royle 236* (LIV, lecto!).

Culm about 90 high, glabrous. Leaf-blades narrowly linear to filiform, flat or folded, up to 33 mm long, light green to dark green, tapering, with scattered short stiff hairs on the upper surface. Leaf-sheath glabrous, basal sheaths glabrous to minutely puberulous. Spathate panicle simple, interrupted, rarely with secondary tiers, often with a single ray in the primary tier; peduncle 7—20 mm long, glabrous; spatheole 25—35 mm long. Racemes with 5—8 pairs of spikelets, 22—35 mm long; rachis internodes and pedicels pilose along the margins and on the upper part. Sessile spikelet 7 mm long; lower glume narrowly lanceolate, 1.2 mm wide, chartaceous (rarely coriaceous-chartaceous), shallowly concave in the lower part, narrowly winged, acuminate, 2-toothed, faintly 4-nerved; awn 16—21 mm long. Pedicellate spikelet 7 mm long; lower glume narrowly ovate-lanceolate, 1 mm wide.

HABITAT: On open grassy slopes; alt. 2000—3000 m.

DISTRIBUTION: N. West and Central Himalaya, Nepal, Yunnan (S. China).

Steudel (1854) in describing this species cited two numbers, *Royle 236* and *2A7.* In the Royle specimen in Liverpool there are two numbers on one sheet 187/236 and 187/245, and it is possible that Steudel cited the digit 7 (from 187?) instead of 5 (from 245). There is a difference between specimens 236 and 245. In *Royle 236* the panicle is simple and interrupted, with very few pairs of racemes, which are deflexed- I have accepted this specimen as the type of *Andropogon distans* Steud. In the second specimen the raceme pairs are more numerous and the racemes are not deflexed. This second specimen is probably an extreme variant of *C. distans.*

Unlike the other species in ser. *Citrati, C. distans* possesses narrow to filiform leaf-blades, as in *C. dieterlenii.* It can easily be recognized by the simple interrupted panicle with primary (rarely secondary) tiers, a long, lanceolate narrowly winged, chartaceous lower glume of the sessile spikelet, and filiform leaf-blades.

PAKISTAN. Nasan, 1.X.1970, *S. A. Farouqi & M. Qaiser 3250;* Murree Hills, Hazara, 19.VIII.1949, *R.R. Stewart 23360.*

INDIA. Kumaon, *R. Strachey & J.E. Winterbottom 2;* Tihri Rd., 1881, *J.F. Duthie 2154;* ibid., 25.IX.1895, *J.F. Duthie 17839;* Jumna Valley, above Bari, l.IX. 1883, *J.F. Duthie 304;* Kashmir, 1874, *W.S. Atkinson 24181;* Pahlgam, 23.VIII.1945, *R.R. Stewart 21768;* Simla, 8.VII.1918, *H.H. Rich 858;* Glysium Hills, 9.IX.1877, *J.S. Gamble 4959B;* Tara Devi, 1839, *J.F. Duthie 10098;* Jakko, 1877, alt. 2800 m, *J.S. Gamble 1891; J.S. Gamble 25006;* Chakrata, 1894, *J.F. Duthie 15147;* Pangi, J.F. *Duthie;* near Bhina Tal, 1885, *J.F. Duthie 5059; G. Wingate;* Musoorie, 3.IX. 1930, *R.R. Stewart 11406;* ibid., 1944, *R.R. Stewart 21218;* ibid., 1898, *J.S. Gamble 27222;* ibid., 9.IX.1948, *Thakur Rup Chand 971;* Dehra Dun 1891, *J.S. Gamble 23262;*

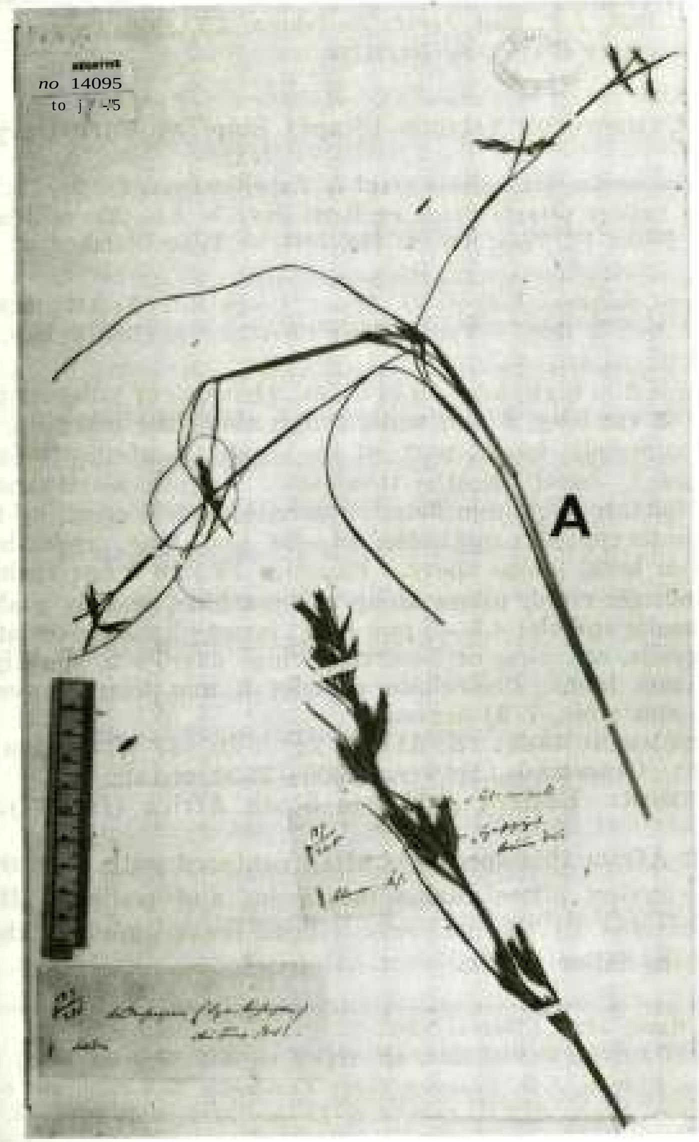


FIG. 36. Type specimen of *C. distans (Andropogon distans), Royle 236* (A).

Punjab, Cheena Slopes, 1970, *M.L. Shanna 254;* Kasauli, 5.IX.1933, *R.N. Parker s%77;* Mattiana. 1885, *J.R. Drummond 21103.*

NEPAL. Micha near Jumla, 9.VII.1952, *O. Polunin et al 4485;* near Maikot, 8.X.1954, *Stainton et al 4733*); Royle 236.*

S. CHINA. Yunnan. Szechuan, 10.VIII.1942, *Y.L. Keng 3713;* between Tseku and Tsehchung, 1923, *J.F. Rock 11602;* Su-Tchuen, 2.XI.1908, *Legendre 550* (P); 6.II.1906, *Ducloux 4215* (P); *G. Forest 14748.*

47. CYMBOPOGON VALIDUS (Stapf) Stapf ex Burtt-Davy

Andropogon nardus var. *validus* Stapf *in* Thiselton-Dyer, Fl. Cap. 7: 352. 1892. — *Cymbopogon validus* (Stapf) Stapf ex Burtt-Davy *in* Ann. Trans. Mus. 3: 129. 1912; Stapf *in* Prain, Fl. Trop. Afr. 9: 280. 1919. — Type: Natal, *J.W. Wood 162* (K, lecto!).

Cymbopogon classensii Robyns, Fl. Agrost. Congo Belg. 1: 145. 1929; *in* Bull. Jard. Bot. Brux. 8: 229. 1930. — Type: Congo, *Classens 1503* (BRUX, hole; K, iso!).

Culm about 2 m high, 5.5—10 in diam., glabrous or pubescent. Leaf-blades up to 42 cm long, 6 mm wide, rough along the margins, glabrous except for the woolly lower part at the base. Leaf-sheaths glabrous, rarely pubescent, basal sheaths tomentose. Ligule membrano-chartaceous to subchartaceous, 5 mm long. Spathate panicle erect, up to 60 cm long, often interrupted; spatheole 14—20 mm long, reddish brown; peduncle 6 mm long, pilose above. Racemes 14 mm long; rachis internodes and pedicels rigid, pilose along the margins, usually glabrous on the back. Sessile spikelet 4.5—5 mm long; lower glume lanceolate, 1 mm wide, chartaceous, nerveless or 3-nerved, wings narrow to slightly broad; awns 8—10 mm long. Pedicellate spikelet 5 mm long; lower glume lanceolate, 1 mm wide, 7(9)-nerved.

CHROMOSOME NUMBER: S. Africa, 2n = 20 (de Wet 1954a).

HABITAT: Grasslands, between 2000—2500 m. alt.

DISTRIBUTION: Eastern Africa to South Africa (fig. 37).

In South Africa this species is often confused with *C. marginatus*, both species having pilose rachis internodes and pedicels. It differs from *C. marginatus* by the narrowly winged lower glume of the sessile spikelet and the taller culms.

ZAIRE. Garu, 1921, *Classens 1503.*

UGANDA. Ankole, 30.VIII.1938, alt. c.1800 m, *A.S. Thomas 2510;* Bushengi, 22.1.1929, alt. c. 1600 m, *J.D. Snowden 1282;* Karamoja, 30.V.1939, alt. c. 2800 m, *A.S. Thomas 290;* Kigezi, 21.VIII.1938, *A.S. Thomas 2398;* ibid., 1949, alt. c.2300 m, *J.W. Purseglove P2838;* Kashenji, 28.XI.1935. alt. c.2800 m, *H.B. Johnston 1375.*

KENYA. Nairobi, 16.111.1928, *W. Lyve Watt 3;* ibid., 1925, alt. c. 1800 m, *J. McDonald 901;* Thika, 1925, alt. c. 1800 m, *./. McDonald 886;* NW of Ford Hall, 15.XI.1956, alt. 1600 m, *A. Bogdan 4352;* Meru, 14.XII.1949, alt. c. 1700 m, *A. Bogdan 2735;* Embu, 8.V.1920; *H.L. Shantz 984;* ibid., 28.111.1948, *A. Bogdan 1554.*

TANZANIA. Lushoto, 2.XII.1966, *Semsei 4150.*

MOZAMBIQUE. Maputo, Uampochane, 16.11.1952, *Barbosa & Balsinhas 4700;* E. of Lourenco Marques, 23.IX.1957, alt. 200 m, *Mogg 32085.*

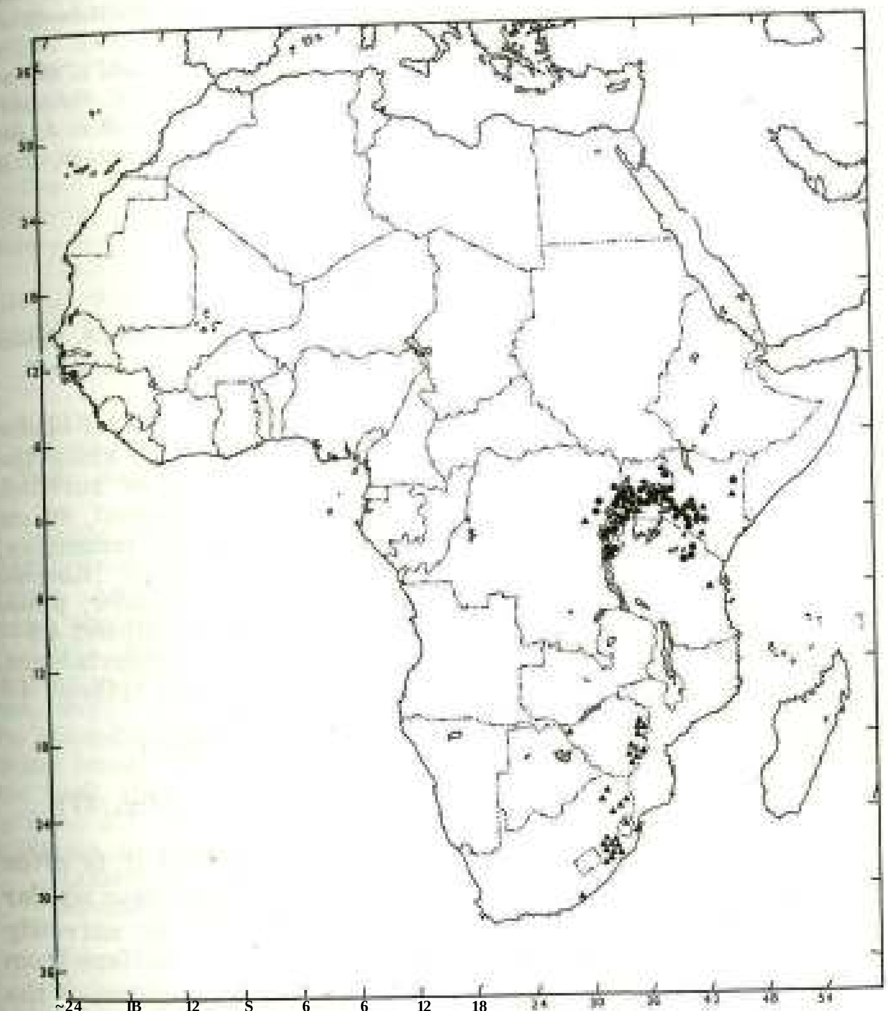


FIG. 37. Distribution of *C. validus* k and *C. afronardus* •

SWAZILAND. Mbababe, 21.1.1961, alt. c.1160 m, *R.H. Compton 30435.*

RHODESIA. Inyanga, 17.IV.1966, *H.M. Biegel 1110;* Lower Mare Valley, 28.IV.1966, *O. West 7299;* W. of Melsetter, 19.VI.1953, *A. O. Crook 475;* Melsetter, 19.11.1964, *O. West 47U;* ibid., 13.111.1949, alt. c.1500 m, *F. R. Williams 4;* Mt. Hut, 5.II.1965,alt. c.1800 m, *B.K. Simon 116;* Chipinga, 1964, alt. c.HOO *m, B. Goldsmith 22/63;* S. Bank of Zambesi, 9.II.1912, alt. 1000 m, *F.A. Rogers 5672.*

SOUTH AFRICA. Natal. Mapumolo, 10.11.1965, alt. c.800 m, *E.J. Moll 1622;* Clairmont 10.111.1894, *C. Kuntze;* Mpendle, 2.III.1964, alt. c.1500 m, *E.J. Moll 711;* Umvoti 11.II.1965, alt. c. 800 m, *E.J. Moll 1665;* Utrecht Distr., 16.1.1963, alt.

2000 m, *N.J. Bevenish 988;* Alexandra Distr., 14.111.1910, *H. Rudatis 882;* Nottingham, 1874, *Buchanan 134;* Inanda, 1882, *J.W. Wood 1622;* Pieter Maritzburg, *A. Rehmann 7600;* Port Natal, *Williamson 52; Kroup 87.* — Transvaal. W. of Krugerdorp, 28.11.1948, *R.J. Rodin 3920;* Kruger Nat. Park, 8.II.1949, alt. c. 400 m, *Boeldinter&L.C. Codd 596;* E. of Steilkop, 21.IV.1971, *P. J. Muller & J.C. Scheepers 52;* Pieterburg, 20.IV.1935, *R. A. Dyer 3170;* Soutpansburg, 28.111.1964, *D.R.J. van Vurren 1682;* Lhnoubu River, 1880, *W. Nelson;* Port St. John's, 10.11.1919, *C.E. Moss 5502; Zeyher 1800.*

48. CYMBOPOGON AFRONAEDUS Stapf

Cymbopogon afronardus Stapf *in* Prain, Fl. Trop. Afr. 7: 279. 1919; A. Camus *in* Rev. Bot. Appl. Colon. 1: 283. 1921. Type: Uganda, *Bummer 445* (K, holo!).

Tufted; culm erect, 150—225 cm high, glabrous smooth. Leaf-blades linear, 60 cm long, 4—10 mm wide, tapering, glabrous, rough along the margins. Leaf-sheath glabrous, basal-sheath pubescent, often auricled. Ligule subchartaceous, 12 mm long. Spathate panicle compound, 60 cm long, interrupted, loose, narrow; spathes glabrescent to tomentose; spatheole 17 mm long, glabrous, ciliolate along the margins. Raceme rather loose, 17 mm long; rachis internodes and pedicels slender, pilose along the margins, minutely tomentose on the back. Sessile spikelet 4.5— 5 mm long; lower glume lanceolate, 1—1.2 mm wide, subchartaceous, narrowly winged, 2—3-nerved; awn 8 mm long. Pedicellate spikelet 4-5 mm long; lower glume lanceolate, 1 mm wide, 5-nerved.

CHROMOSOME NUMBER: Africa, 2n = 20' (Tateoka 1965).

HABITAT : Hill grasslands.

DISTRIBUTION: East Africa, around Lake Victoria (fig. 37).

C. afronardus is closely related to *C. validus.* Indeed it is often difficult to distinguished between the two species, since they have similar characters, such as the tall culm, broad leaf-blades and the narrowly winged lower glume of the sessile spikelet. *C. afronardus* differs from *C. validus* by having a longer ligule, a subchartaceous lower glume of the sessile spikelet, a loose panicle and a 5-nerved lower glume of the pedicellate spikelet.

ZAIRE. Biumba, 22.IX.1959, alt. 1400 m, *G. Troupin 4127;* Kigali, 17.XI.1958, alt. 1450 m, *G. Troupin 9080;* Gabira, *R. Germain 1130;* Tshambe, 1937, alt. 1000 m, *J. Lebrun 8086.*

BURUNDI. Kirundo, 26.X.1965, alt. 1500 *m, L. Lewalle 131.*

UGANDA. Kampala, 17.XI.1929, *A. S. Hitchcock 24925;* Kwala, alt. 2000 m, *Scott Elliot 7581;* Tororo, 1.III.1936, *A. P. Michelmore 1196;* Ruizi River, 12.XII.1950, alt. c.1400 m, *1\ Jarette 268;* Masaka, 25.VII.1946, alt. c.1300 m, *A. S. Thomas 4509;* Mubende, 5.X.1933, *H.B. Johnston 324;* Kigezi, 1951, alt. 1400 m, *J.W. Purseglove S587;* Karamoja, 27.V.1940, alt. c.1300 m, *A. .S. Thomas 3580;* Kipayo, 913, alt. c 1300 m, *R. Bummer 445;* Entebbe, 19.VI.1922, *T.D. Maitland 25;* Kavirondo, alt. 1500 m, *Scott Elliot 7021.*

KENYA. Embu Distr., 4.VIII.1958, alt. 1500 m, *C.G. Trapnell 24H;* Nakuru, 9.VIII.1967, alt. 2400 m, *O.M. Mwangangi 183;* Narok, Olulunga, 7.VI.1961, alt. 2400 m, *Glover et al 1753;* Kitale, 30.VIII.1961, alt. c.2200 m, *A. Bogdan 5188;* Orengitok, 17.V.1961, alt. 2500 m, *Glover et al 1424;* Broderick Falls Rd., 22.1.1964, *M. Brunt 139*);* Chyulu-North, 1938, alt. c.1700 m, *Bally 8108;* SE of Aberdares, 28.IV.1919, *D.K.S. Grant 1042; E. James;* Gdlgil, 8.VI.1933, alt. c. 2500 m, *V. A. Beckley 2074;* Mt. Longonot, alt. 2000 m, *Ahiti 258; Pawell 21.*

TANZANIA. Nasishi, 1930, alt. c.1500 m, *R. Sanders 63;* Arusha, 1937, *G. Milne 6;* Bunazi, 1935, *H. Gillman 514;* Mtagata hot spring, 1958, *J. Procter 1015;* Arusha, 15.1.1970, *A. Bjernstad AB 335.*

49. CYMBOPOGON VIRGATUS Stapf ex Bor

Cymbopogon virgatus Stapf ex Bor *in* J. Bomb. Nat. Hist. Soc. 52: 169. 1954. — Type: Burma, Mandalay, *B. Rhind 926* (K, holo!).

Culm erect, about 180 cm high, glabrous, smooth, nodes often shortly bearded. Leaf-blades bluish green, 8 mm wide, glabrous, slightly rough. Leaf-sheath smooth, glabrous, often pubescent in the lower part, basal sheaths tomentose. Ligule 3 mm long, membrano-chartaceous. Spathate panicle erect, interrupted, narrow, 4.5 cm long, flexuous; spatheole 15 mm long, glabrous, peduncle 5 mm long. Raceme 13—15 mm long; rachis internodes and pedicels more or less flat, pilose along the margins, glabrous on the back. Sessile spikelet 3.5 mm long; lower glume broadly lanceolate, 0.8 mm wide, subchartaceous, 2—3-wrinkled on the back, narrowly winged, 1—3-nerved; awn 8 mm long. Pedicellate spikelet 3.5 mm long; lower glume broadly lanceolate, 0.6 mm wide, glabrous, 5-nerved.

HABITAT: In rocky parts; alt. 100 m.

DISTRIBUTION- Endemic in Mandalay, Upper Burma.

USES: The oil is not likely to be commercially valuable (Bor 1954).

This species resembles *C. afronardus* from East Africa, but it differs from the latter in having a shorter spikelet and shorter ligule, and a very much interrupted spathate panicle.

BURMA. Mahlaing, 17.XI.1928, *E.B. Minus;* Mandalay, Thaphangaing, 12.XI. 1928, *B. Rhind;* ibid., 15.11.1929, *B. Rhind 926.*

50. CYMBOPOGON TORTILIS (Presl) Hitchc. — Fig. 38

Anthistiria tortilis 3. S. Presl *in* C. B. Presl, Rel. Haenk. 1: 347. 1830. — *Cymbopogon tortilis* (Presl) Hitchc. *in* Lingn. Sc. J. 7: 246. 1931. — Type: Philippines, Luzon, *Herb. Haenk.* (PH, holo).

Andropogon hamatulus Nees ex Hook. & Arn., Bot. Beehey Voy. 244. 1841; Steudel, Syn. PL Glum. 1: 388. 1854 (ut *hamulatus*, sphalm.). — *Cymbopogon hamatulus* (Nees ex Hook. & Arn.) A. Camus *in* Rev. Bot. Appl. Colon. 1: 284. 1921. — Type: China, Macau, *Vachel* (K, iso!).

Culm erect, 75—110 cm high, smooth, glabrous, whitish to reddish. Leaf-blades dark green, up to 60 cm long, 4—5 mm wide, glabrous, sparsely tomentose in the lower part. Leaf-sheaths glabrous, reddish inside. Ligule membranous. Spathate panicle 35 cm long, with few to numerous racemes; spatheole 14 mm long, reddish brown. Racemes 13 mm long; rachis internodes and pedicels pilose along the margins. Sessile spikelet 4 mm long; lower glume 0.9 mm wide, lanceolate, subchartaceous, flat or slightly rounded on the back, often wingless, 3—4-nerved; awn 8 mm long. Pedicellate spikelet 3 mm long; lower glume ovate-lanceolate, 7-nerved.

HABITAT: In the meadows; alt. 200—600 m.

DISTRIBUTION: The Philippines, South China, Formosa, Indo-China, very rarely in the Moluccas.

This species is variable in its habit, the plants from the Philippines have narrow, not dense spathate panicles, whereas those from Indo-China have large, spreading panicles.

C. tortilis can easily be confused with *C. goeringii*, but it differs from *C. goeringii* by the narrowly winged lower glume of the sessile spikelet.

FORMOSA, Qui tze-cha, 2.IX.1949, *H. Keng 1339*.

HAINAN. Kiung-shaw, 1932, *H. Fung 20287*.

HONG KONG. 1885, *Furet 272* (P).

INDO-CHINA. Tongking, N. of Quang-Yen, 10.IX.1885, *B. Balansa 415;* near Quang-Yen, 11.VI.1886, *B. Balansa;* Mt. Bani, 1888, *B. Balansa 1732, 1733;* Tu-Phap, 14.VII.1886, *B. Balansa;* Phu-Lo, 26.XII.1902, *D. Bois 517;* Ho Yang San, 1940, *W.T. Tsang; H. Lecomte & A. Finet 131* (P.).

PHILIPPINES. Sulu Isl., Cagajan, 15.X.1906, *Merrill 5307;* 1.VI.1909, *Ramos 7793;* Luzon, Pampanga Prov., Mt. Penatuba, 1927, *Merrill 22352;* Alaminos, Pangasinan Prov., 1928, *Clemens 17934;* near Dupax, 1912, *B.C. McGregor 801;* Mt. Darna, 1953, *G.E. Edano 18H2; A.D.E. Elmer 22353; H. Cuming 1000.*

MOLUCCAS. Ternate, 1900, *Smith 614*.

51. CYMBOPOGON CALCIPHILUS Bor

Cymbopogon calciphilus Bor *in* Dansk Bot. Arkiv 23: 157. 1965. — Type: Thailand, *Kai Larsen 8335* (K, holo!).

Loosely tufted; culm 70—120 cm high, smooth, glabrous, nodes often bearded. Leaf-blades 0.6—10 mm wide, light green, tapering, densely

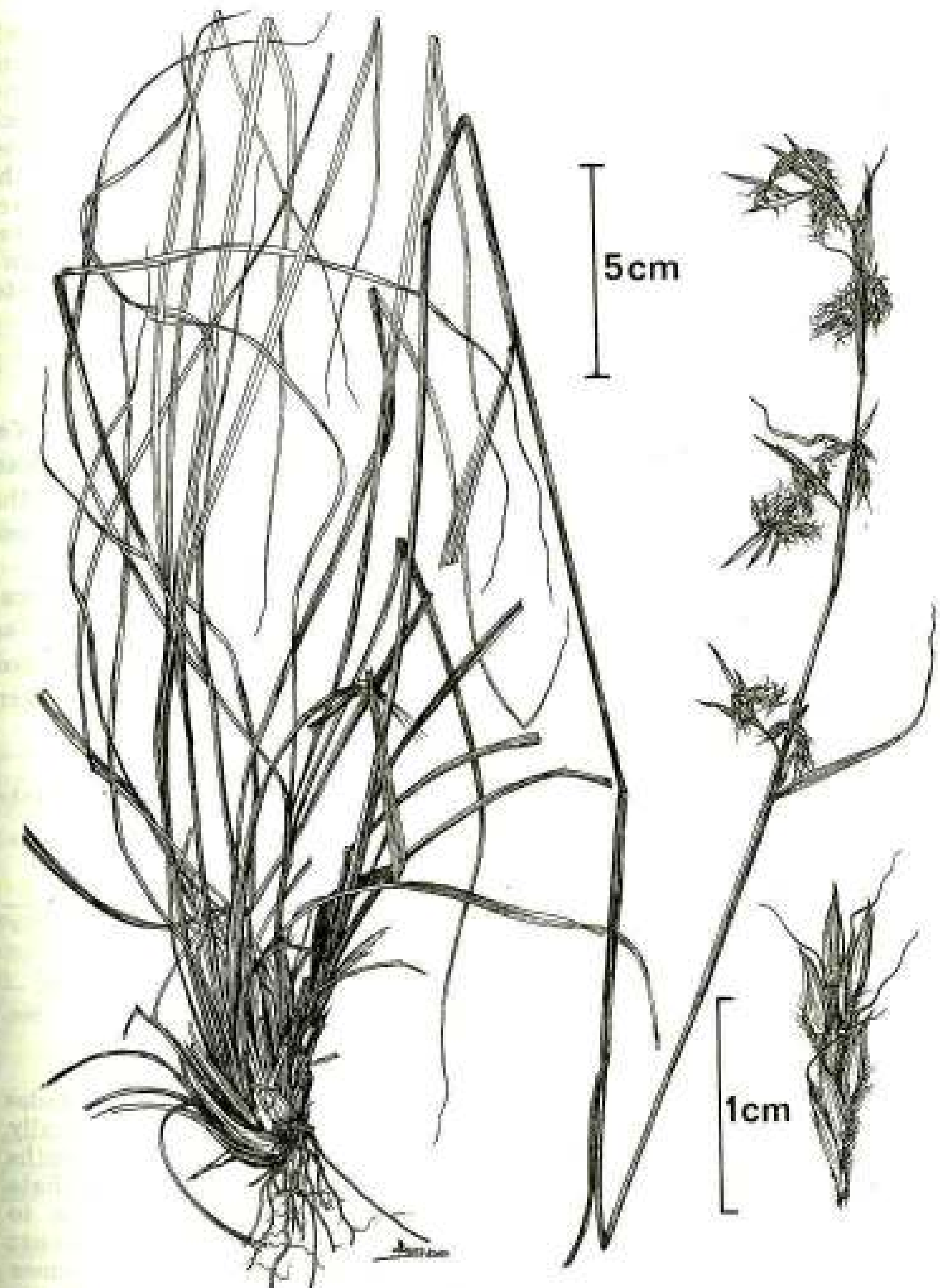


FIG. 38. *Cymbopogon tortilis;* alter *Elmer 22S5S.*

tomentose at the base on the triangular patches. Leaf-sheaths smooth, whitish, basal sheaths densely tomentose. Ligule not more than 1.5 mm long, glabrous. Spathate panicle 15—20 cm long, narrow, compound, often interrupted; spatheole 15 mm long, membrano-chartaceous; peduncle 6—10 mm long. Racemes 15 mm long; lower raceme-base and lowermost pedicels not swollen; rachis internodes and pedicels pilose along the margins, glabrescent on the back. Sessile spikelet 4—4.5 mm long; lower glume membrano-chartaceous, lanceolate, slightly concave on the lower part, often with 1—2 wrinkles on the back, nerveless to 2-nerved; awn 11 mm long. Pedicellate spikelet 4.5 mm long; lower glume lanceolate, 7-nerved.

HABITAT: Common in limestone hills at lower altitudes.

DISTRIBUTION: Thailand.

C. calciphilus was described by Bor (1963) based on specimen *Kai Larsen 8335,* in which the lower glume of the sessile spikelet is nerveless. In some specimens from Thailand the nerves are often present in the lower glume although nerveless lower glume are not uncommon. It seems that this character must be accepted as variable within the species.

This species is characterized by its narrow panicle, hairy, comparatively long basal sheaths, and bearded triangular patches. *C. calciphilus* resembles *C. flexuosus* in that it has narrow wrinkled, narrowly winged lower glume, but differs in its smaller stature with shorter and narrower leaf-blades, and hairy basal sheaths.

THAILAND. Between Thoen and Lee, 21.XI.1959, *T. Smitinand & B.C. Abbe 6168;* Tung Quang, 8.XI.1931, *A.F.G. Kerr; Kai Larsen 8335*).*

52. Cymbopogon microstachys (Hook, f.) S. Soenarko, *comb. nov.* — Fig. 39

Andropogon nardus var. *microstachys* Hook, f., PI. Br. India 7: 207. 1896. — *Cymbopogon flexuosus* var. *microstachys* (Hook, f.) Bor *in* J. Bomb. Nat. Hist. Soc. 52: 16. 1954 — Type: India, *Mann 5* (K, lecto!).

Culm erect, about 165 cm high, glabrous, yellowish. Leaf-blades 40—75 cm long, 10—12 mm wide, rough on both surfaces, usually glabrous. Leaf-sheaths smooth, glabrous, yellowish, basal sheaths glabrous. Ligule 5—6 mm long, rounded, subchartaceous. Spathate panicle 60—90 cm long, decompound, interrupted narrow, with few to numerous racemes and dense, yellowish or purplish, nodes glabrous; spatheole 11—12 mm long; peduncle 5—6 mm long, glabrous. Racemes nearly always epinastically deflexed, 10—12 mm long, slender; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 3-5—4.5 mm long; lower glume lanceolate, 0.8 mm long, nerveless or 2-nerved, flat on the back, slightly concave in the lower part, narrowly winged; awn 5—8 mm long. Pedicellate spikelet 4 mm long; lower glume glabrous, 7-nerved.

HABITAT: Open rocky grounds or open forests; alt. 10—1000 m.

DISTRIBUTION: India to Thailand.

Hooker f. (1896) described this variety based on two specimens, *Thompson* and *Mann 5.* Bor (1954) cited *Thompson* as the type of *Andropogon nardus* var. *microstachys* Hook, f. and did not mention Mann's specimen. Since Thompson's specimen is mixed with other grasses, Mann's specimen has been chosen as the lectotype.

C. microstachys can be separated from *C. flexuosus* as it nearly always has deflexed racemes, a narrow spathate panicle, and the lower glume of the sessile spikelet is slightly concave at the base. This species is more or less intermediate between *C. flexuosus* and *C. khasianus* (fig. 39). *C. microstachys* differs from *C. khasianus* by having a shorter raceme, shorter sessile spikelet, and a narrowly winged lower glume of the sessile spikelet. *C. microstachys* can easily be confused with *C. calciphilus,* but the latter usually has bearded nodes, tomentose basal sheaths and bearded triangular patches.

INDIA. Dehra Dun, *J.S. Gamble 23994;* Ambari, 1891, alt. c. 600 m, *J.S. Gamble 2SS80;* Khajanchibagh, 9.XI.1928, *Umarao Singh 404;* Siwaliks, *J.S. Gamble 25580;* Khajnair Pass, 1890, *J.S. Gamble 22392;* Ramnager State, 1916, *H.H. Haines 5S26;* Chilawalla, 1898, *J.S. Gamble 26436;* Forest North Ayodha, *R. Thompson 381;* Garo Hills, 1886, *Mann 5;* Darjeeling, *I.H. Burkill 34012.*

BURMA. Katha Distr., Bilamayo Reserve, *J. H. Lace 5534.*

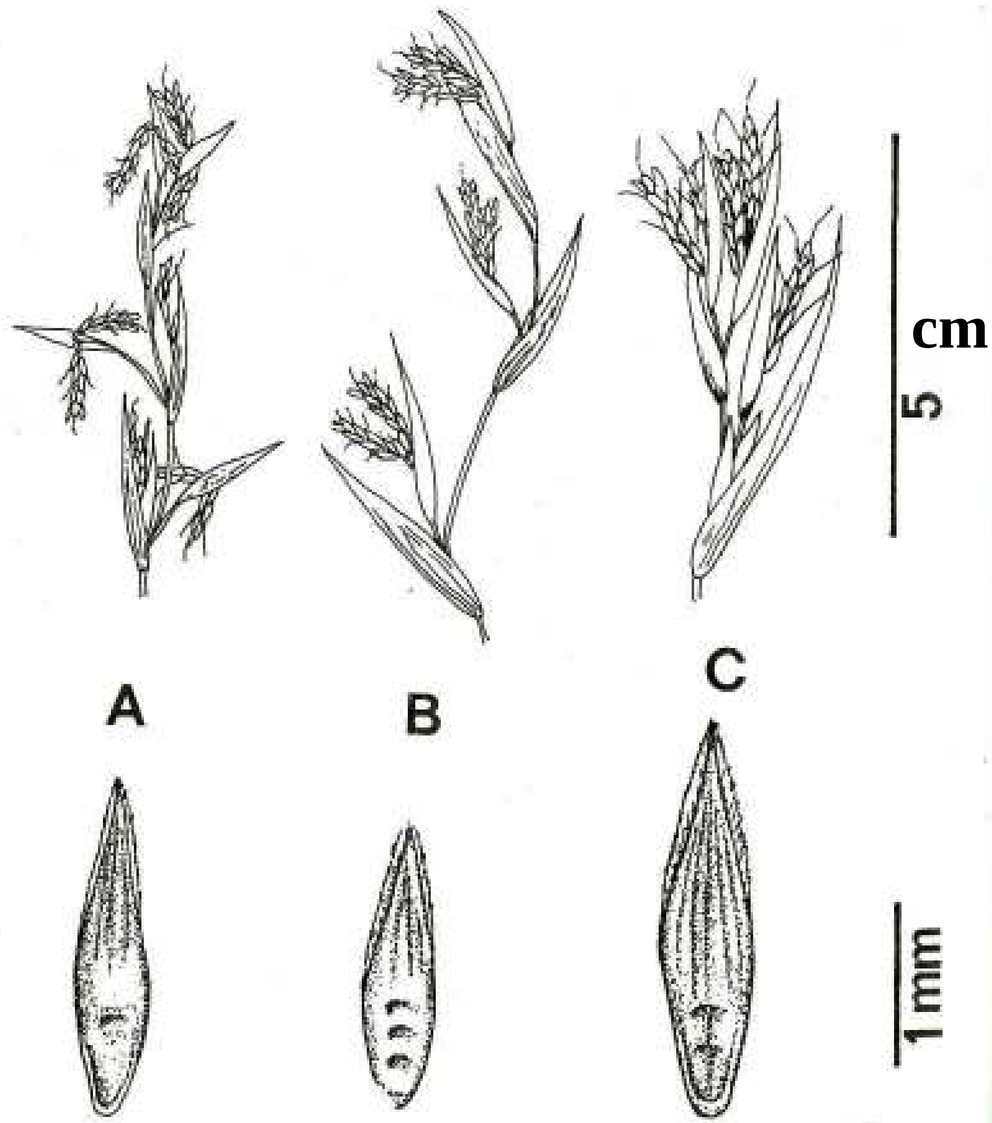
THAILAND. Kaw Tao, 23.IX.1928, alt. 310 *m, A.F.G. Kerr 16074;* Hard Palom (near the border with Burma), 25.XII.1961, alt. 400 m, *Kai Larsen 8939;* Chaibadan, Dong Pya Yen, 16.XII.1923, *A.F.G. Kerr 8013;* Ko Lanta Yai, 12.11.1966. *B. Hansen & T. Smitinand 12252.*

53. CYMBOPOGON COLORATUS (Hook, f.) Stapf

Andropogon coloratus Nees *in* Wight Cat. no. 1703. 1833, *nom. nud.* — *Andropogon nardus* var. *coloratus* Nees ex Hook, f., Fl. Br. Ind. 7: 206. 1896. — *Cymbopogon coloratus* (Hook, f.) Stapf *in* Kew Bull. 1906: 321, 356. 1906; A. Camus *in* Rev. Bot. Appl. Colon. 1: 281. 1921; Bor. *in* J. Bomb. Nat. Hist. Soc. 52: 172. 1954.

Andropogon nardus subsp. *glomeratus* Hack, *in* DC, Monogr. Phan. 6: 604. 1889. — Type: India, *Wight 3087* (K, holo!).

Culm 60—140 cm high, erect, nodes bearded. Leaf-blades 30—40 cm long, 4—6 mm wide, dull green turning to brownish green, glabrous, rough on both surfaces. Leaf-sheaths glabrous and smooth, often minute-



PIG. 39. Part of spathate panicle and lower glume of sessile spikelet: A. *C. microstachys* (type), B. *C. flexuosus* (cult, from India), C. *C. khasianus (Bor 2379).*

ly tomentose in the lower part, basal sheaths sparsely to densely tomentose in the lower part, basal sheaths sparsely to densely tomentose. Ligule membrano-chartaceous 2 mm long, rounded. Spathate panicle 65

cm long, erect, interrupted, compound; spatheole 20 mm long, glabrous; peduncle glabrous. Raceme 18 mm long; lower raceme-base not swollen and not fused with the swollen lowermost pedicel; rachis internodes and pedicels 3 mm long, woolly. Sessile spikelet 5.5—6 mm long; lower glume narrowly lanceolate, 1 mm wide, flat, chartaceous, with 2—3 wrinkles in th3 lower part, 2-toothed, reddish in the upper part, nerveless or 2-nerved; awn 15 mm long. Pedicellate spikelet 5 mm long; lower glume glabrous, 0.8 mm wide, lanceolate, 7-nerved.

CHROMOSOME NUMBER: India, 2n = 40 (Gupta 1969a).

HABITAT: Rocky hills; open gravelly places in dry deciduous secondary forests; alt. 200 m.

DISTRIBUTION: India.

USES: Little known; four compounds, i.e. geraniol, camphene, phellandrene and borneol, are recorded present in the oil (Guenther 1950).

Unlike the other species in ser. *Citrati, C. coloratus* possesses woolly rachis internodes and pedicels, and a swolen lowermost pedicel.

INDIA. Madras, Cudappah, 1883, *J.S. Gamble 11195;* Bellary 1889, J.S. *Gamble;* Malpangudi, 1889, *J.S. Gamble;* Chandragiri, 23.11.1914, *Madras Herb. 10000;* Devarbetta, 25.11.1927, *K. Cherian Jacob 18052; R.S. Hole;* Bothageddi, 1886, *J.S. Gamble;* Kalyandrug, *A. G. Bourne.*

54. CYMBOPOGON CALCICOLA C. E. Hubbard

Cymbopogon calcicola C. E, Hubbard *in* Kew Bull. Misc. Inf. 1941: 24. 1941; Gilliland, Fl. Mai. 3: 297. 1971. — Type: Malay Peninsula, *SFN 36256* (K, holo!).

Culm 150 cm high, glabrous. Leaf-blades 8—11 mm wide, glabrous, about 70 cm long, usually smooth, often slightly rough below, minutely puberulous on the triangular patches. Leaf-sheaths glabrous, smooth, yellowish. Ligule 1—3 mm long, subchartaceous, glabrous. Spathate panicle up to 90 cm long, narrow, interrupted, branches slender, drooping; spatheole 21 mm long; peduncle glabrous, 6—10 mm long. Racemes slender, 20 mm long; rachis internodes and pedicels pilose along the margins, glabrous on the back. Sessile spikelet 4 mm long; lower glume 0.8 mm wide, lanceolate, narrowly winged, rarely wrinkled, 3-nerved; awn 8—11 mm long. Pedicellate spikelet 3.5 mm long; lower glume 0.8 mm wide, 7-nerved.

HABITAT: Open slopes among the crevices; limestone hills; alt. **1200** m.

DISTRIBUTION: Malay Peninsula and Thailand.

C. calcicola resembles *C. flexuosus*, but the former can be distinguished by its slender racemes together with the lanceolate sessile spikelets.

MALAY PENINSULA. Gn. Baling, Kedah, *SFN 36250;* ibid., 5.VIII.1941, *J.C. Mauen SFN 38031;* Pahang, Bukit Chintamani, 11.XII.1970, *Chin See Chung 559.*

THAILAND. P. Panji, 16.XII.1918, *Md. Haniff & M. Nur U07U-*

55. CYMBOPOGON QUEENSLANDICUS S. T. Blake

Cymbopogon queenslandicus S.T. Blake *in* Contr. Queensl. Herb. 17: 53. 1974. — Type: Australia, Queensland, *S.T. Blake 8353* (K, iso!).

Culm erect, about 1 m high, glabrous or sometimes pubescent in the upper part of the internodes. Leaf-blades flat, 3—10 mm wide, slightly rough on both surfaces. Leaf-sheath glabrous and smooth, basal sheath often sparsely pubescent. Ligule 2—5 mm long, glabrous. Spathate panicle narrow, with few racemes, about 40 cm long, rarely with tertiary tiers; spatheole 20—22 mm long, peduncle glabrous. Racemes 16—20 mm long; rachis internodes and pedicels densely pilose along the margins, sparsely villous on the back. Sessile spikelet 5 mm long; lower glume 1 mm wide, narrowly lanceolate to oblong-lanceolate, narrow at the base, 2—4-nerved, narrowly winged, usually flat on the back; awn 10—12 mm long. Pedicellate spikelet 5—6 mm long; lower glume lanceolate, 7(9)-nerved.

HABITAT: Woodlands; savannas; among rocks; alt. 20—300 m.

DISTRIBUTION: Queensland (Australia), endemic.

This species resembles *C. rectus*, but it differs from the latter by the flat lower glume of the sessile spikelet, a narrower panicle and a shorter sessile spikelet.

AUSTRALIA. Queensland. Cape York, Iron Range, 17.VI.1948, *L.J. Brass 192S0;* SW of Somerset, 20.IV.1948, *L.J. Brass 18^65;* Cook Distr., 1970, *D. Nicholson;* near Townsville, 1910, *K. Domin;* ibid., 30.111.1935, *S.T. Blake 8353*);* S. Kennedy Distr., 16.VII.1964, *Adam 1096;* Lexington, 24.VII.1934, *S.T. Blake 7008;* Rockhampton, 1877, *F.V. Mueller;* ibid., 6.III.1937, *S.T. Blake 12720;* Rocky Isl., 1910, *K. Domin.*

DOUBTFUL AND EXCLUDED TAXA

1. *C. hookeri* (Munro ex Hack.) Stapf ex Bor *in* Ind. For. Rec. (Bot.) 1: 92. 1938. Based on *Andropogon hookeri* Munro ex Hack, *in* DC., Monogr. Phan. 6: 614. 1889. — Type: India, *Griffith 6767* (K, holo!). This is *Andropogon munroi* C. B. Clarke *(in* J. Linn. Soc. (Bot.) 25: 87. 1889).

2. *C. motia* B- K. Gupta *in* Proc. Ind. Nat. Sci. Acad., Sect. B 71: 90. 1970. — Type: *B. K. Gupta 25* (Dehra Dun, hole). I have not seen the types of this species.

3. *C. ramnagarensis* B. K. Gupta *in* Proc. Ind. Nat. Sci. Acad., sect. B 71: 86. 1970. — Type: India, *B.K. Gupta 30* (Dehra Dun, holo). This species is considered related to *C. parkeri* Stapf (Gupta 1970). I did not see the type and I have not come across any specimens at Kew which resembles this species. It seems to me that this species is identical with *C. stracheyi* (Hook, f.) Raiz. & Jain.

4. The type specimens of the following varieties have also not been available for examination:

a. *C. distans* var. *mundensis* B. K. Gupta, I.e.: 97. 1970. — Type: India, *B.K. Gupta 23* (Dehra Dun, holo).

b. *C. flexuosus* var. *coimbatore* B. K. Gupta, I.e.: 94. 1970 — Type: India, *B.K. Gupta 32* (Dehra Dun, holo.).

c- *C. jwarancusa* var. *assamensis* B.K. Gupta, I.e.: 95. 1970. — Type: India, *B.K. Gupta 17* (Dehra Dun, holo.).

d. *C. parkeri* var. *jammuensis* B. K. Gupta, I.e.: 96. 1970. — Type: India, *B.K. Gupta U2* (Dehra Dun, holo.).

REFERENCES

ANDERSON, E. (1949). *Introgressive hybridization.* New York.

ANDERSSON, N. J. (1856). Monographiae Andropogonearum I. Anthistiriae. *In* Nova Acta Soc. Sci. Upsal. Ill, 2: 229-255.

ARBER, A. (1934). *The Gramineae. A study of cereal, bamboo and grass.* Cambridge.

AVDULOV, N. (1931).. Karyosystematische Untersuchung der Familie Gramineen. *In* Bull. Appl. Bot. PL-Breed., Suppl. 44: 1-428.

BARNARD, C. (1957). Floral histogenesis in the Monocotyledons. I. The Gramineae. *In* Austr. J. Bot. 5: 1-20.

BARNARD, C. (1964). *Grasses and grasslands.* London.

BENTHAM, G. & HOOKER, J. D. (1883). *Genera Plantarwm S.* London.

BEWS, J. W. (1925). *Plant form, and their evolution in South Africa.* London.

BEWS, J. W. (1929). *The world's grasses.* London.

BLAKE, S.T. (1969). Taxonomic and nomenclatural studies in the Gramineae. — 1. *In* Proc. Roy. Soc. Queensl. 80(6): 55-84.

BLAKE, S.T. (1974). Revision of the genera *Cymbopogon* and *Schizachyrium. In* Contr. Queensl. Herb. 17: 1-70.

BLANE, G. (1790). *Nardus indica* or spikenard. *In* Phil. Trans. 80: 284.

BOR, N. L. (1953). The genus *Cymbopogon* in Burma, Ceylon and India. *In* J. Bombay Nat. Hist. Soc. 51: 890-916.

BOR, N. L. (1954). The genus *Cymbopogon* in Burma, Ceylon and India (Cont.). *In* .1. Bombay Nat. Hist. Soc. 52: 149-183.
BOR, N. L. (1960). *Grasses of Burma, Ceylon and India.* London.
BOR, N. L. (1963). A new name in *Cymbopogon* Spreng. *In* Notes Roy. Bot. Gard. Edinburg 25: 63.
BOK, N. L. (1968). Gramineae. *In* C. C. TOWNSEND *et al., Flora of Iraq 9.* Baghdad.
BOSSER. J. (1969). *Graminées des paturages et des cultures á Madagascar.* Paris.
BROWN, R. (1810). *Prodromus florae Novae Hollandiae.* London.
BROWN, W. N. (1958). Leaf-anatomy in grass systematics. *In* Bot. Gaz. 119: 170-179.
BURBIDGE, N. T. (1960). The phytogeography of the Australian region. *In* Austr. J. Bot. 8(2) : 75-211.
BURKILL, I. H. (1909). First notes on *Cymbopogon martinii* Stapf. *In* J. Asiat. Soc. Beng. 5: 89-93.
BURKILL, I. H. (1935). *A dictionary of the economic products of the Malay Peninsula.* London.
BtiRTT-DAVY, J. & POTT-LEENDERT, R. (1912). A first check-list of the flowering plants and ferns of the Transvaal and Swaziland. *In* Ann. Transv. Mus. 3(3) : 119-122.
CAMUS, A. (1920). Notes sur quelques *Cymbopogon* odor ants (Gramineae). *In* Bull. Mus. Hist. Nat., Paris 26: 562-566.
CAMUS, A. (1921). Ies Andropogonées odorantes des régions tropicales. *In* Rev. Bot. Appl. Colon. 1: 270-306. .
CAMUS, E.G. & A. (1922). Graminées. *In* LECOMTE, *Flore Génerate de I'lndo-Chine 7.* Paris.
CARLQUIST, S. (1967). The biota of long distance dispersal. V. Plant dispersal to Pacific Islands. *In* Bull. Torrey Bot. Club 94: 129-162.
CELARIER, R. P. (1956). Additional evidence for five as the basic chromosome number on the Andropogoneae. *In* Rhodora 58: 135-143.
CHEN, C. C. & Hsu, C. C. (1962). Cytological studies on Taiwan grasses. 2. Chromosome numbers of some miscellaneous tribes. *In* J. Jap. Bot. 37(10) : 300-313.
CHIOVENDA, E. (1909). *Intorno ad alcune Graminaceae da essenze ed a quelle de la colonia Eritrea.* Roma.
CLAYTON, W. D. (1964). Studies in the Gramineae V. *In* Kew Bull. 17: 465-285.
CLAYTON, W. D. (1965). Studies in the Gramineae VII. *In* Kew Bull. 19: 454-455.
CLAYTON, W. D. (1969). A revision of the genus *Hyparrhenia. In* Kew Bull., Add. ser. 2.
CLAYTON, W. D. & HEPPER, F. N. (1974). Computer-aided chorology of West African grasses. *In* Kew Bull. 29: 213-234.
CLAYTON, W. D. & PANIGRAHI, G. (1974). Computer-aided chorology of Indian grasses. *In* Kew Bull. 29: 669-689.
COULTER, J. M., BARNES, C. R. & CLOWES, H. C. (1931). *A. textbook of botany 3. Ecology.* New York.
EDWARDS,. D. C. & BOGDAN, A. V. (1951). *Important grassland plants of Kenya.* Nairobi.
FAHN, A. (1967). *Plant anatomy.* Oxford.
FERNANDO. S. N. O. (1968). *The natural vegetation of Ceylon.* Colombo.
GILLILAND, H. B. (1971). *Flora of Malaya 5: Gramineae.* Singapore.

GOOD, R. (1964). *The geography of the flowering plants.* London.
GOULD, F. W. (1956). Chromosome counts and cytotaxonomic note on grasses of the tribe Andropogoneae. *In* Amer. J. Bot. 43: 395-404.
GOULD, F. W. (1968). *Grass systematics.* New York.
GUENTHEE, E. (1950). *The essential oils S.* New York.
GUPTA, B. K. (1969a). Studies in the genus *Cymbopogon* Spreng. II. Chemocytotaxon- in Indian *Cymbopogon. In* Proc. Indian Acad. Sci. sect. B 70: 80-87.
GUPTA, B. K. (1969b). Studies in the genus *Cymbopogon* Spreng. I. Chromosome studies omic studies in Indian *Cymbopogon. In* Proc. Indian Acad. Sci. sect. B70: 241-247.
HACKEL, E. (1878). Gramineae II. Andropogoneae, Tristegineae. *In* C. F. P. MARTIUS & A.. G. EICHLER, *Flora Brasiliensis II, 3.* München.
HACKEL, E. (1889). Andropogoneae. *In* A. P. DE CANDOLLE, *Monographiae Phanerogamarum 6.* Paris.
HANDEL-MANZZETI, H. (1936). *Symbolae Sinicae 7.* Wien.
HARTLEY, W. (1958). Studies on the origin, evolution, and distribution of the Gramineae I. The tribe Andropogoneae. *In* Austr. J. Bot. 6: 116-128.
HENTY, E. E. (1969). *A manual of the grasses of New Guinea.* Lae.
HEYNE, K. (1927). *De nuttige planten van Nederlandsch Indie.* Buitenzorg.
HOLMES, C. H. (1951). *The grass and savanna lands of Ceylon, their nature and ecological significance.* Oxford.
HUBBARD, C. E. (1934). Monocotyledons. *In* J. HUTCHINSON, *Families of flowering plants.* Oxford.
JANAKI AMMAL, E.K. & GUPTA, B. K. (1966). Oil content in relation to polyploidy in *Cymbopogon. In* Proc. Indian Acad. Sci. ser. B 64: 334-335.
JONES, W. (1795). Additional remarks on the spikenard of the ancients. *In* Asiat. Res. 4: 109-118.
JOWITT, J. E. (1908). Notes on the Dr. Otto Stapf's nomenclature of *Cymbopogon nardus* Rendle and *C. confertiflorus* Stapf. *In* Ann. Roy. Bot. Gard. Perad. 4: 185-192.
LAZARIDES, M. (1970). *The grasses of Central Australia.* Canberra.
LOOGEN, J (1942). De zuidhelling van de Smeroe. *In* Trop. Natuur 31: 14-17.
MEHRA, K. L., SUBRAMANYAM, K. N. & SAMINATAN, M.S. (1962). Cytogenetical studies in some members on Andropogoneae. *In* J. Indian Bot. Soc. 41: 491-502.
MEHRA, P. N. & SHARMA, M. L. (1972). *In* A. Löve, IOPB chromosome number reports 36. *In* Taxon 21(2/3) : 340-341.
METCALPE, C. R. (1960). *Anatomy of monocotyledons. I. Gramineae.* Oxford.
MEUSEL, H.,JAGER, E. & WEINERT, E. (1965). *Vergleichende Chorologie der zentraleuropischen Flora.* Jena.
MONOD DE FROIDEVILLE, CH. (1968). Poaceae. *In* C. A. BACKER & R. C. BAKHUIZBN VAN DEIN BRINK JR., *Flora of Java, 3.* Groningen.
MOORE, C. W. E. (1964). Distribution of grasslands. *In* C. BARNARD, *Grasses and grasslands.* London.
MORTON, C. V. (1957). Nomenclature proposals for the Montreal Congress. *In* Taxon 8: 11-16.
PILGER, R. (1940). Gramineae III. Panicoideae. *In* A. ENGLER & K. PRANTL, *Die naturlichen Pflanzenfamilien He.* Leipzig.

PRAKASH, M. & CHOWDHARY, M. (1957). Reclamation of sand dunes in Rajasthan. *In* Indian For. 83: 492-496.

PRAT, H. (1932). L'Epidermie de Gramineae etude anatomique et systématique. *In* Ann. Sri. Nat., Bot. X, 10: 117-234.

PRAT, H. (1960). Vers une classification naturelle des Gramineae. *In* Bull. Soc. Bot. Pr. 109: 32-79.

RAGHAVAN, R. S. & ARORA, CM. (1958). Chromosome numbers in Indian medicinal plants III. *In* Proc. Indian Acad. Sci. ser. B 47: 352-358.

RENDLE, A. B. (1899). *Catalogue of the African plants collected by Dr. Friedrich Wblwitsch.* London.

ROBBINS, R. G. (1960). The anthropogenic grasslands of Papua and New Guinea. *In* Proc. UNESCO Symposium on the impact of man on humid tropic vegetation, Goroka: 313-329.

SCHNELL, R. (1962). Remarques préliminaires sur quelques problèmes phytogeographique du Sud-Est Asiatique. *In* Rev. Gén. Bot. 69: 301-366.

SCHWEINPURTH, G. (1867). *Beitrag zur Flora Aethiopiens.* Berlin.

SEALEY, R. (1958). *A revision of the genus Camellia.* London.

SMITH, A. C. (1967). The presence of primitive angiosperms in the Amazon basin and its significance in indicating migrational routes. *In* At. Simp. Biota Amaz. 4 (Bot.) : 37-59.

SPRENGEL, C. (1815). *Plantarum minus pugillus 2.* Halae.

STAPF, O. (1906). The oil grasses of India and Ceylon. *In* Kew Bull. 1906: 298-363.

STAPF, O. (1918-1919). Gramineae. *In* D. PRAIN, *Flora of Tropical Africa 9.* Ashford.

STEBBINS, G. L. (1956). Cytogenetics and the evolution of the grass family. *In* Amer. J. Bot. 43: 890-905.

STEBBINS, G. L. (1971). *Chromosomal evolution in higher plants.* London.

STEBBINS, G. L. & CRAMPTON, B. (1961). A suggested revision of the grass genera of temperate North America. *In* Recent Advanc. Bot. 133-145.

STEENIS, C. G. G. J. VAN (1961). Malaysian Papilionaceae I. Introduction. *In* Reinwardtia 5: 420-429.

STEENIS, C. G. G. J. VAN (1965). Concise plant geography of Java. *In* A. C. BACKER & R. C. BAKHUIZEN VAN DEN BRINK JR., *Flora of Java 2.* Groningen.

STEENIS, C. G. G. J. VAN (1972). *Mountain flora of Java.* Leiden.

STEWART, D. R. M. (1965). The epidermal characters of grasses with special reference to East African species. *In* Bot. Jahrb. 84: 63-174.

TATEOKA, T. (1957). Proposition of a new phylogenetic system of Poaceae. *In* J. Jap. Bot. 32: 275-287.

TATEOKA, T. (1965). Chromosome numbers of some East African grasses. *In* Amer. J. Bot. 52: 864-869.

TATEOKA, T., INOUE, S. & KAWANO, S. (1959). Notes on some grasses XIX. Systematic significance of bicellular microhairs of leaf epidermis. *In* Bot. Gaz. 121: 80-91.

TURNER, P. (1895). *Australian grasses 1.* Sydney.

UPHOF, J. C. TH. (1968). *Dictionary of economic plants.* New York.

WATT, J. M. & BREYER-BRANDWIJK, M. G. (1932). *The medicinal and poison plants of Southern Africa.* Edinburgh.

WET, J. M. J. DE (1954a). Chromosome number of a few Southern African grasses. *In* Cytologia IS: 97-103.

WET, J. M. J. DE (1954b). Stomatal size as a cytological criterion in *Danthonia.* *In* Cytologia 19: 176-181.

WET, J. M. J. DE & ANDERSON, L. J. (1956). Chromosome numbers in Transvaal grasses. *In* Cytologia 21: 1-10.

WHYTE, R. O. (1957). *The grasslands and fodder resources of India.* New Delhi.

WILD, H. (1965). Additional evidence for the African-Madagascar-India-Ceylon land-bridge, with special reference to the genera *Anisopappus* and *Commiphora.* *In* Webbia 19:'497-505.

ZOHARY, M. (1973). *Geobotanical foundation of the Middle East 2.* Stuttgart.

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Printed by ARCHIPEL, Bogor, Java