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A note on VETIVER GRASS, identification and determination

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SUMMARY

Vetiver grass represents a low-cost soil conservation method. For its determination in the field, relevant parts of botanic literature are gathered and introduced.
Also non botanic characteristics like local names are given in order to facilitate determination throughout West Africa.

1. Introduction.

In de Jager 1989a I recommended the use of Vetiver grass as a hedge and silttrap for soil conservation purpose. A major advantage of Vetiver is its availability in nature. However among the 400.000 plant species we have to identify this particular grass.
Therefore I wrote this note, it should help as a start for fieldworkers willing to find the grass in the humid and semi-arid tropics.

2. Vetiver grass (Vetiveria).

There are 12 Vetiver grass types described in literature. In Ghana we will search for Vetiver Nigritana or Zizanioides. The latter has an important advantage due to its sterility. V. Zizanioidis does not spread seeds thus it is easy to control on the farmers field.
The Vetiver grass has an economic value. The roots provide a strong scent. The perfume industry used to be interested in the oil from the roots. If the Vetiver grass is used in this way it does not provide any soil conservation.
The roots of the Vetiver grass are especially interesting for soil conservation purpose. They have a tendency to grow downward only, sometimes till 2 metres deep.
Thus the grass restores a nutrient cycle between the deeper soil layers, usually not rooted by crops, and holds the soil together like a vertical straw wall in the ground.
While applying Vetiver Zizanioides as a soil conservation method we have to be aware of the possibility that farmers dug out the roots for selling them to the perfume industry. This potential danger seems to be the main problem which could arise for our purpose. The advantages of the grass are widely treated in Grimshaw and Greenfield (1988).
In brief the advantages are the summarized below;

1. V. survives drought
2. V. is easy to control due to its low quantity of seedlings
3. V. can be used as mulch or thatch
4. V. roots do not compete with important crops
5. Within three years a stable hedge can be established
6. V. is no host for any plant pest
7. V. is fire resistent
8. V. conserves as well soil as moisture
9. V. needs almost no maintenance ones estabished.

3. Use of Vetiveria.

According to Dalziel (1936) Vetiveria Nigritana is very useful, for matting material. Remark in the following copy from Dalziel the Dagomba name for Vetiver Nigritana; it is Kulikarili.
If used for matting Vetiver Nigritana functions as well as soil conservator if the roots remain unaffected (copie Dalziel 1936).

VETIVERIA Thouars (2 : 582)

V. nigritana *Stapf*—Holl. 4 : 806.

Fr. Sud. (A. Chev.) : Bamb. *babin, ngôngôn, ngoko ba* ; Songhai *diri* ; Ful. *kidli, dimi pallol* ; Sarakolé *kamaré* ; Mossi *roudoum* ; Gourma *kulkaddré* ; others—R.B.A. 1933 : 858). **Senegal** : Wol. *sep*, also *tiep* (but properly for *Oryza*), also (Sébire) : Falor *toul* ; Tuk. *semban*. **S. Leone** (N. W. Thomas) : Me. *pindi* ; Susu *barewali* ; Ti. *an-wunga ro-gban* (Deighton). **Gold Coast** : N. Terr. Dag. *kulikarili* (Lloyd Williams). **N. Nigeria** : Hausa *jemo* (including *Urelytrum*) ; Ful. *so'dornde, s. mayo*, pl. *cho'dor'de, ngôngômers* (from Bamb.), *zemako*.

Used for coarse matting and for plaiting armlets and rings (Hausa *darambuwa*), toy hoops, hats, baskets, etc. ; the split stems are twisted into head-bands, used by youths at marriage ; also used for thatch.

The roots are often not distinctly aromatic, but probably vary according to habitat, etc. ; they are eaten by wart-hogs. After soaking in water they are twisted to make small bracelets used by children in play, or tied up as charms in leather armlets (Hausa *kambu*) worn by hunters to prevent injury in fight, etc. Women use them like lavender in sachets, or as a body perfume, or made into necklaces. The fibrous roots sold in Salaga, Kumasi, etc., under the name *sansan*, and used like a loofah scrubber, are said to be of this grass (see also *Parkia filicoidea*).

At the end of the dry season it produces fresh leaves which are valued by Fulani herdsmen as a fodder.

An infusion of the roots is taken as a beverage. In Gold Coast it is an ingredient in the treatment for the cattle sickness *garli* (see *Ipomoea repens*).

V. zizanioides *Nash*—Holl. 4 : 806. Vetiver or khus-khus (India). Chiendent odorant.

Cultivated in the tropics for the fragrant roots, in West Africa as a border for roads, gardens, cultivated fields, etc., to prevent extension of dub grass. Samples from Gold Coast yield a high percentage (2·25) of volatile oil. The leaves are odourless and can be used in the young state as a cattle fodder.

Ref.—Holl. 4 : 808, up to 1920. Camus, "Les Andropogonées odorantes," R.B.A. 1921 : 303. Georgi, "Vetiver oil," Malay. Agr. Journ. 1924 : 197–199. "Vetiver roots from Gold Coast," B.I.I. 1924 : 265–267 ; *ibid* 1926 : 46 (Java), 1934 : 264 (E. Africa).

4. Where to find Vetiver grasses.

The search for a plant is facilitated if we know the natural environment in which it is growing. This location is called the habitat. Biologists found that for Vetiver species the habitat consists of embankments of lakes and larger rivers in tropical countries. Examples are lake Chad, and black Volta embankments.

5. The family of Gramineae.

The easiest way for determination is to use the information provided in section three during interviews with villagers.
To ensure that they provide the right species or in case nobody provides usefull information we can determine ourselves. The latter should in preference carried out by a botanist.
In Ghana the University of Kumasi is able to provide these.
As an introduction in determination techniques I will also provide in this note some copies concerning the determination of grasses and the Vetiveria species in particular.
Botanist devide the plants in several families and subfamilies to facilitate determination. In this hierarchial system while looking for Vetiveria we meet the following names

a. the family of grasses or the GRAMINEAE
b. the tribe of ANDROPOGONEAE
c. the genera of Vetiveria
d. the species of Vetiveria Nigritana (=actual plant)

the hierarchal system functions as the drawning from figure 1.

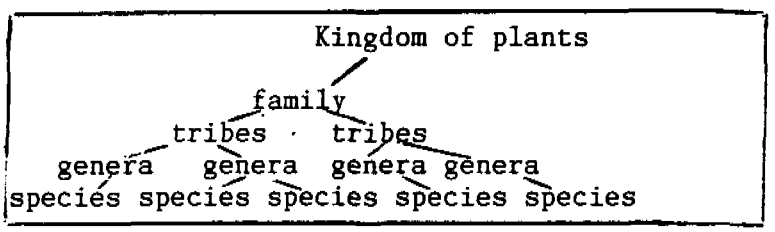

Figure 1. The hierarchal system of the botanist.

General information about grasses is copied from Purseglove (1985).
He also outlines in this publication the use of Vetiveria Zizanioides as an anti-erosion measure in India.
In summary we can conclude that Vetiver Nigritana has a history of a matting crop and Vetiver Zizanioides is used as both perfume oil privider and soil conservation crop.

GRAMINEAE

The grasses, with about 620 genera and 10 000 spp., constitute a natural and homogeneous family, widely dispersed in all parts of the world where plants can survive. It is one of the largest families of flowering plants, the number of spp. only being exceeded by the Orchidaceae, Compositae and Leguminosae. If judged by the number of individuals, the area which they cover, and the great variety of habitats they frequent, the grasses are among the most successful of all angiosperms. They occur from the Equator to near the Poles, often dominating the vegetation in savannas, prairies, steppes and meadows; they extend from sea level to the limit of permanent snow on mountains; they grow in wet and dry places, from brackish and fresh water to deserts, with all situations between the two extremes. Open situations are preferred, and they are least numerous in forests.

Grasses differ markedly from the rest of the plant kingdom. They resemble the sedges (Cyperaceae) superficially, but grasses can be distinguished by their usually round (terete) stems, with conspicuous nodes and usually with hollow internodes, their alternate, 2-ranked distichous leaves, and the structure of the spikelets with flowers borne within two bracts. In the Cyperaceae the stems are usually triangular and solid, with leaves borne in three ranks, and flowers borne in the axil of a single bract.

With the exception of the woody bamboos, which may reach a height of 30 m, grasses are herbaceous, ranging in height from 2 cm–10 m, and include ephemerals, annuals, biennials and short- or long-lived perennials. They may form loose or dense tufts or tussocks, or may have basal sympodial creeping stolons at the surface of the soil, or subterranean rhizomes, to give dense mats or sods.

Seminal roots are produced from the embryo, followed by adventitious roots from the basal nodes of the stems; stolons and rhizomes produce roots at the nodes and bear scales. Stems erect, ascending or creeping, usually branched at base; in perennials, with sterile shoots and flowering stems or culms; in annuals, the latter only usually present; stems usually cylindrical, with solid nodes, and internodes which are usually hollow, but may be filled with soft tissue. Buds in leaf axils; those at or below the soil surface may burst through the leaf sheath to produce stolons or rhizomes; those near base of stem may grow up within the developing sheath to give tillers. Leaves solitary at nodes, alternate in two opposite vertical rows (distichous), sometimes crowded near base of stem. Leaf consists of: (1) basal sheath, encircling shoot or culm and protecting the young growth, with margins free or overlapping, or more or less connate, frequently swollen at base to give a sheath node; (2) ligule, a membranous outgrowth at junction of sheath and blade, sometimes reduced to a hairy fringe; (3) blade or lamina usually long and narrow (linear-lanceolate), parallel-veined, often with strong midrib, without petiole, flat, conduplicate (folded), convolute or involute; ear or teethlike appendages (auricles) at base of blade well or poorly developed, and may be rounded, linear, clawlike or absent.

Inflorescence usually terminal on culm, consisting of spikelets arranged in dense to loose panicles, or in spikes, or racemes which may be solitary, digitate or scattered along primary axis. Spikelets composed of a series of alternating bracts borne distichously along a slender axis or rachilla; 2 lower empty sterile bracts comprise outer and inner glumes, which vary in size and texture, and may be longer or shorter than the rest of the spikelet, or may be reduced; above the glumes are one to many pairs of scales, the outer scale of each pair being the lemma, flowering glume or valve, which may or may not be awned, and the inner scale being the palea or valvule enclosing the flower; the lemma, palea and flower constitute the floret. This basic pattern of spikelet structure is consistent throughout the family, but may be modified by reduction, suppression or elaboration.

The flowers are usually hermaphrodite, but are sometimes unisexual or reduced, and are small and inconspicuous, consisting of: (1) lodicules, usually two in number, minute hyaline or fleshy scales, which represent the inner of 2 perianth whorls; (2) stamens, usually three in number, hypogamous, with delicate filaments and 2-celled versatile anthers, which usually dehisce by longitudinal slits; (3) unilocular ovary, superior, with one anatropous ovule often adnate to adaxial side of carpel, and usually two styles with plumose stigmas. Fruit 1-seeded, mostly a caryopsis with thin pericarp adnate to the seed; commonly combined with various parts of the spikelet. Seed with starchy endosperm and embryo at base of abaxial face.

Most grasses are chasmogamous. The opening of the floret is due to the swelling of the lodicules permitting the exsertion of the anthers and stigmas.

Pollination is by wind. Some spp. are self-fertile and are mainly self-pollinated. Others are self-sterile, so that cross-pollination is obligatory. Others, such as maize, are mainly cross-pollinated. Cleistogamy and apomixis occur in the family.

The classification of the grasses has been based in the past largely on the structure and arrangement of the spikelets. Other aspects of plant structure are now receiving increasing attention in classification; these include: (1) relative size and basic number of chromosomes; (2) anatomy of the leaf; (3) structure of the epidermis; (4) structure of the embryo; (5) the form of the first green leaf of the seedling; (6) the structure of the flower, especially the lodicules; (7) form of the starch granules; (8) physiological nature of the plant. Between 50–60 tribes have been recognized. These may be grouped into a varying number of subfamilies, ranging from 2–12, depending upon the system of classification. In this account two subfamilies are recognized, namely, Pooideae and Panicoideae.

USEFUL PRODUCTS

Gramineae is economically the most important family of flowering plants. The grasses provide the staple or basis of diet of most of the world's population in the form of cereals (q.v.), which may also be used for feeding livestock. The grains of most cereals are also used for the production of beverages, including beer and liquors. They are used industrially for the production of starch, alcohol and many other products. The green herbage and dried fodder from grasses provide the basic food for most domestic and many wild animals. They are often planted as temporary pastures or leys, permanent pastures, or for cutting for fodder; a brief account of the species used for this purpose in the tropics is given below. Large areas of the world's surface are covered by natural grasslands which are used for grazing by domestic stock; they are not dealt with in this work.

Saccharum cvs (q.v.) are the world's most important source of cane sugar and one of its most valuable crops. Essential oils are obtained from *Cymbopogon* spp. (q.v.) and *Vetiveria zizanioides* (q.v.). Bamboos (q.v.) have innumerable uses in most eastern countries, and to a lesser extent elsewhere. The grasses also provide packing, thatching and building materials, fibres and paper. They are widely used in soil conservation to prevent erosion. They contribute much to the landscape of the earth, including the lawns which man plants near his habitations and on his sports fields. A number are planted for ornamental purposes, and grasses are becoming increasingly popular with modern flower arrangers. One of the best known ornamental grasses is pampas grass, *Cortaderia selloana* (Schult.) Aschers & Graebn., from Argentina. The family also contains some very troublesome weeds and grass pollen is the chief cause of hay fever.

By comparison, the Cyperaceae contains no important food plants. Only *Cyperus esculentus* L., the tiger nut, is cultivated occasionally for its small edible tubers.

About 10 spp. of coarse perennial grasses in the tropics of the Old World, belonging to the tribe Andropogoneae. *V. zizanioides*, yields an essential oil.

Vetiveria zizanioides (L.) Nash (2n = 20) KHUSKHUS, VETIVER

A densely tufted, wiry, glabrous, perennial grass, native in India and Ceylon, but now widely introduced throughout the tropics, where it has become naturalized in some areas. The aromatic roots have been used since ancient times in India. They are now cleaned and dried and used for making mats, fans, screens, awnings, pillows and sachet bags. They are often put with clothes because of their scent and in the belief that they keep out insects. The leaves are odourless. A viscous essential oil, vetiver oil, is distilled from the roots, which is used in perfumery in Western countries, but this use was not developed until late in the nineteenth century. Arctander (1960) describes the odour as 'sweet and very heavy woody-earthy, reminiscent of roots and wet soil, with a rich undertone of "precious wood" notes.' Vetiver oil is often used as a fixative for more volatile constituents, for scenting soaps, and in the preparation of cosmetics. It is also used for the extraction of vetiverol and vetiverone. The grass is widely used throughout the tropics for planting on the contour as an anti-erosion measure, for protective partitions in terraced fields, and as a border for roads and gardens.

In its natural environment in India, vetiver often grows on riverbanks up to an altitude of 600 m. It requires a hot and humid climate, It will grow on most soils, but for commercial production should be grown on rather sandy soils, as heavy soils make harvesting of the roots difficult, with a loss of the finer roots which contain most of the oil. Prior to the Second World War Java was the principal producer of vetiver oil, but Haiti, Réunion and India are now the main producers, with subsidiary production in the Congo, Angola, Brazil and Guatemala. Annual world production is 100–150 tons. Roots are sometimes imported for oil extraction in Europe.

V. zizanioides grows in large clumps from a much-branched spongy root-stock with erect culms 0·5–1·5 m high. Leaf blade stiffish, long, narrow, up to 75 cm long, 8 mm or less in width, glabrous, but rough on the edges. Panicles 15–30 cm long, very narrow; branches 2·5–5·0 cm long, whorled; spikelets in pairs, narrow, acute, appressed, awnless; one sessile and hermaphrodite, somewhat flattened laterally, with short sharp spines, 3 stamens and 2 plumose stigmas; the other spikelet pedicelled and staminate. Some cultivated forms seldom flower.

Vetiver grass is propagated by root divisions, which are planted at a distance of about 40 cm. The roots are usually harvested 15–24 months after planting. Harvesting may be done at a year or even earlier, but, although the young roots give a better yield of oil, this will be of low specific gravity and lacking the valuable high-boiling constituents. If the roots stay in the ground for over two years, the yield of oil diminishes considerably, and the oil becomes very viscous with a dark colour, but of a high quality. The roots are usually dried in the shade. They are crushed or powdered before distillation, which presents special problems, as the most valuable constituents are contained in the high-boiling fractions, and the roots must be distilled for many hours, usually 24–36. The oil content of the dried roots varies from 0·5–3·0 per cent. In Réunion, Gailleton (1968) gives the average yield of dried roots as 5 ton/ha per annum, the oil content as 0·7–2·3 per cent with an average of 1·5 per cent, and the yield of oil per hectare per annum as 40–100 kg with an average of 80 kg.

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BROWN, E. and MATTHEWS, W. S. A. (1951). Notes on the Aromatic Grasses of Commercial Importance. *Col. Plant and Animal Products*, 2, 174–87.

GAILLETON, J. M. (1968). L'Evolution de la Production des Huiles Essentielles à la Réunion. *Tropical Products Institute Conference*, May 1967, 41–61.

GUENTHER, E. (1952). Recent Developments in Essential Oil Production. *Econ. Bot.*, 6, 355–78.

6. Determination of the genera.

When we are searching for Vetiveria genera we might confuse them with other Gramineae genera. I copied (page 10-14) the gramineae determination tables as developped by Clayton (1982) as an aid for proper seperation.
On page three we have to check the remarks. If they are correct we continue with the remark number as given behind the checked remark.
For Vetiveria the sequence is as follows 1 30 31b
In chapter XXX we then continue the procedure finally arriving at remark 156 if we are dealing with Vetiveria grasses.

7. The three main Vetiveria types.

Among the Vetiver grasses we will meet in Ghana dominantly Vetiver Nigritana. Prain (1934) distinguished the three main Vetiver types as follows; (see copies on page 15 and 16).

note sessile means; attached directly by the base without stalk or peduncle.

A practical drawning is presented in the flora of tropical East Africa (1970), see copy page 17.

About 620 genera and 10,000 species, in 50–60 tribes; throughout the world.

The grasses form a natural and homogeneous family, remarkable both for the constancy of its basic theme, and for the number of variations that have been derived from it. The division of the family into tribes was formerly based upon spikelet morphology, but now relies heavily upon cryptic characters, whose significance is discussed by Bor, The grasses of Burma, Ceylon, India and Pakistan (1960) and Jacques-Félix, Les Graminées d'Afrique tropicale (1962). Among the most important of these are characters derived from the anatomy of the plant, briefly summarized here in the tribal descriptions, but described in detail by Metcalfe, Anatomy of the Monocotyledons I, Gramineae (1960). The only recent overall account of the family is that of Pilger in E.J. 76: 281–384 (1954), who provides keys to the genera, but his classification has its faults and should not be adopted uncritically. Jacques-Félix (*op. cit.*) provides keys and descriptions for all the tropical African genera.

It is not always easy to separate annuals from perennials, though the character is sometimes unavoidable in keys. The following characters should be looked for in perennials: sterile shoots mixed with the flowering culms; charred remnants of the previous year's growth; dormant buds on the rootstock; perennating rhizomes.

The embryo characters have been discussed by Reeder in Amer. Journ. Bot. 44: 756–768 (1957) & 49: 639–641 (1962). For convenience they are here referred to one of six types according to Table 1.

TABLE 1. Types of embryo found in East African grasses, showing component characters

	Vascular internode	Epiblast	Scutellum cleft	First leaf Rolled or Folded
Bambusoid	−	±	±	R
Poöid	−	+	−	F
Arundinoid	+	−	+	F
Centothecoid	+	+	+	R
Eragrostoid	+	+	+	F
Panicoid	+	−	+	R

Grasses are strongly influenced by local, and often transient, environmental factors, and their distribution is often only loosely correlated with that of the associated woody synusia. Vegetation types are therefore mentioned only in general terms in the habitat notes.

Tribes 1–21 are published in this part, the Eragrostoid tribes, 22–28, will comprise part 2 and the Panicoid tribes, 29–31, part 3.

The following bibliographic abbreviations have been used in addition to those listed in the Preface: viii (1952):

Ann. list grasses Ug.	= W. J. Eggeling, *An annotated list of the grasses of the Uganda Protectorate* (Entebbe, 1947)
Ann. list Nyasaland grasses	= G. Jackson, *An annotated check-list of Nyasaland grasses* (Zomba, 1958)
E.A. Pasture Plants	= C. E. Hubbard & W. E. Trevithick, *East African Pasture Plants* (London, 1926–27)
Fl. Agrost. Congo Belge	= W. Robyns, *Flore Agrostologique du Congo Belge* (Bruxelles, 1929, 1934)
G.T.	= D. M. Napper, *Grasses of Tanganyika* (Dar es Salaam, 1965)
I.G.U.	= K. W. Harker & D. M. Napper, *An illustrated guide to the grasses of Uganda* (Entebbe, 1960)
Imp. grassl. pl. Kenya	= D. C. Edwards & A. V. Bogdan, *Important grassland plants of Kenya* (Nairobi, 1951)
R.K.G.	= A. V. Bogdan, *A revised list of Kenya grasses* (Nairobi, 1955)

NOTE. References to the literature do not in every case make mention of the associated figures, but details of the inflorescences and spikelets of many species figured in G.T. and I.G.U. may be found a useful complement to the illustrations given here.

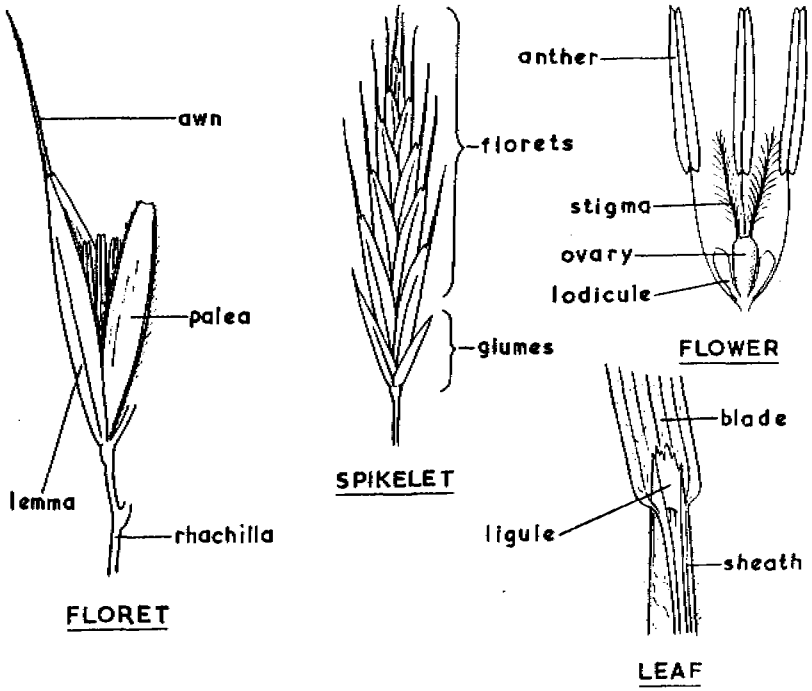

FIG. 1. Schematic diagram showing parts of leaf, spikelet, floret and flower.

KEY TO THE TRIBES

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

   Spikelets 2-flowered, falling entire at maturity, with the upper floret ♀ and the lower ♂ or barren and in the latter case often much reduced; spikelets usually dorsally compressed 30

2. Spikelets unisexual, dissimilar, the sexes mixed or in different parts of the same inflorescence 3

   Spikelets bisexual, similar 4

3. Leaf-blades with the lateral nerves parallel to the midrib; ♀ lemma indurated, shorter than the glumes . II. OLYREAE, p. 17

   Leaf-blades with slanting lateral nerves running obliquely from the midrib to the margin; ♀ lemma papery, much longer than the glumes . . III. PHAREAE, p. 19

4. Tall woody bamboos, rarely perennial herbs; leaf-blades flat, lanceolate to ovate, many-nerved, with transverse veins, usually with a petiole-like base and articulated with the sheath; lemmas several, 5–many-nerved, awnless, lodicules usually 3 . . . . . I. BAMBUSEAE, p. 7

Perennial or annual herbs with herbaceous culms; leaf-blades usually sessile and not articulated with the sheath, or if with a petiole-like base then not with the other characters given above 5

5. Spikelets borne on opposite sides of the rhachis of solitary spikes or racemes, the spikelets placed broadside on to the rhachis. 6

Spikelets in panicles or 1-sided spikes or racemes, very rarely on opposite sides of the rhachis of solitary spikes, but then edgeways on with the back of the lemmas pressing against the rhachis 7

6. Spikelets borne upon a pedicel 1·5 mm. long, several-flowered. . . . X. BRACHYPODIEAE, p. 70

Spikelets quite sessile, or 1-flowered . XI. TRITICEAE, p. 73

7. Lemmas deeply cleft into 9 lobes or awns . . . . . XXI. PAPPOPHOREAE, p. 163

Lemmas entire or bilobed, rarely 3-awned 8

8. Spikelets containing 2 or more fertile florets (except *Leptochloa uniflora*) 9

Spikelets containing 1 fertile floret (except *Tetrapogon*), with or without 1 or 2 ♂ or barren florets below it and 1 or more above 20

9. Leaf-blades transversely veined between the main nerves, narrowly lanceolate to ovate; lemmas 7- or more nerved, entire 10

Leaf-blades without transverse veins, linear 11

10. Inflorescence a 1-sided raceme . . . IV. STREPTOGYNEAE, p. 21

Inflorescence a panicle (if lemmas 3–5-nerved and awned see 19, *Pseudobromus*) . . . . . XX. CENTOTHECEAE, p. 159

11. Rhachilla-internodes bearing long silky hairs which envelop the lemmas (the latter glabrous in only East African genus); tall grasses with large plume-like panicles . . XVII. ARUNDINEAE, p. 115

Rhachilla-internodes glabrous or shortly hairy, in the latter case with the hairs not enveloping the [illegible]as 12

12. Spikelets 2-flowered, one or both of the lemmas hardened or leathery (membranous in *Coelachne*); spikelets awnless . . . . . XXVIII. ISACHNEAE

Spikelets nearly always 3- or more flowered; lemmas membranous or awned 13

13. Inflorescence made up of racemes, either solitary, digitate or scattered along an axis . . . . . XXII. ERAGROSTIDEAE

Inflorescence either an open to contracted panicle or of globose clusters 14

14. Glumes shorter than the lowest lemma, with the upper florets distinctly exserted; lemmas awnless or with straight awns from the entire or lobed tips 15

Glumes longer than the lowest lemma, usually as long as the spikelet and enclosing the florets, rarely shorter but then the lemmas with geniculate or dorsal awns; lemmas 5- to many-nerved 19

15. Lemmas 1–3-nerved 16

Lemmas 5- to many-nerved (sometimes 3-nerved in *Bromus leptoclados*, see p. 68) 17

16. Spikelets awnless . . . . . XXII. ERAGROSTIDEAE

Spikelets awned (but if palea 2-awned see *Apochiton*) . . . . . XVIII. DANTHONIEAE, p. 120

17. Lemmas bearing long slender awns, closely coiled and entangled towards the tips (in only East African genus) . . . . . XII. MELICEAE, p. 74

Lemmas awnless or with stiff straight awns 18

18. Ovary glabrous or hairy, the styles arising from its tip; lemmas awnless or awned from the tip (some exceptions in *Festuca* and *Pseudobromus* which have glabrous leaf-sheaths and scabrid palea-keels) . VIII. POEAE, p. 40

Ovary crowned by a fleshy hairy cap, the styles arising from beneath the latter; lemmas awned from just below the tip; leaf-sheaths usually hairy; palea-keels ciliate or ciliolate in African species . . . IX. BROMEAE, p. 66

19. Lemmas awned from the back, rarely awnless (and then with pubescent inflorescence-axis, otherwise see 20, *Festuca*); ligule membranous. XIII. AVENEAE, p. 76

Lemmas awned from the sinus of the prominently 2-lobed tip; ligule a ciliate fringe . . . . . XVIII. DANTHONIEAE, p. 120

20. Glumes very minute or suppressed (in *Oryza* and *Maltebrunia* 2 sterile lemmas at the base of the floret simulate glumes, the true glumes being barely discernible as minute collars at the tip of the pedicel); palea 3-nerved, similar to the lemma in texture; stamens often 6; spikelets laterally compressed. . V. ORYZEAE, p. 23

Glumes usually well-developed, or at least the upper; palea usually 2-nerved and hyaline; stamens 3 or less 21

21. Spikelets falling entire at maturity, either singly or in clusters, from the persistent axis of spike-like panicles or racemes; lemma delicate, 1–3-nerved . . . XXVI. ZOYSIEAE

Spikelets breaking up at maturity above the persistent glumes, or embedded in a segment of the fragile rhachis and falling with it (rarely shed entire, and then with the lemmas firmly membranous to coriaceous and 5-nerved) 22

22. Inflorescence of racemes or spikes, these solitary, digitate or scattered along an axis 23

Inflorescence a panicle, either open or contracted and spiciform 24

23. Spikelets arranged in 1-sided spikes or racemes (rarely 2-sided, but then the rhachis tough or fracturing irregularly—*Oropetium*) . . XXIII. CHLORIDEAE

Spikelets embedded in alternate sides of a fragile cylindrical spike . XXV. LEPTUREAE

24. Spikelets 1-flowered 25
Spikelets 2–3-flowered 28

25. Lemmas bearing a 3-branched awn (except *Aristida diminuta*, see p. 146); ligule ciliolate . . . XIX. ARISTIDEAE, p. 137

Lemmas with an unbranched awn or awnless 26

26. Lemmas indurated at maturity, terete, awned; ligule membranous . . XVI. STIPEAE, p. 114

Lemmas hyaline or membranous at maturity 27

27. Lemmas usually awned; glumes longer and firmer than the hyaline lemma (if shorter see 19, *Pseudobromus*) . XV. AGROSTIDEAE, p. 98

Lemmas awnless; glumes and lemmas similar in texture, the former often shorter (see also 17, *Colpodium*) . XXIV. SPOROBOLEAE

28. Florets 2 per spikelet, the lower ♂ or barren, the upper ♀ . . . XXVII. ARUNDINELLEAE

Florets 3 per spikelet, the 2 lower florets represented by barren lemmas (sometimes one of them much reduced or suppressed in *Phalarideae*) 29

29. Sterile lemmas as long as or longer than the fertile floret (if with a geniculate dorsal awn see 25, *Anthoxanthum*) . . . . . VII. EHRHARTEAE, p. 36

Sterile lemmas much shorter than the fertile floret . . . . XIV. PHALARIDEAE, p. 94

30. Spikelets all ♀, or each ♀ spikelet paired with a ♂ or barren one 31

Spikelets unisexual, the sexes in separate inflorescences or in different parts of the same inflorescence 32

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

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

32. Main axis of inflorescence leaf-like, the margins folding over short racemes borne along its midrib . . VI. PHYLLORHACHIDEAE, p. 33

Main axis of inflorescence terete, triquetrous or cylindrical, but not leaf-like . . . . . XXXI. MAYDEAE

XXX. ANDROPOGONEAE

Dumort., Obs. Gram. Belg.: 84, 141 (1823); Clayton in K.B. 27: 457 (1972) & 28: 49 (1973)

Annual or perennial herbs. Leaf-blades usually flat and linear; ligule scarious or membranous, a line of hairs, or absent. Inflorescence composed of fragile (very rarely tough) racemes, these sometimes in a large panicle, but usually solitary, paired or digitate, terminating the culm or axillary and numerous, in the latter case each true inflorescence subtended by a modified leaf-sheath (spatheole) and often aggregated into a leafy false panicle. Racemes bearing the spikelets in pairs (rarely singly or in threes, but usually terminating in a triad), nearly always with one sessile and the other pedicelled, these sometimes alike but usually dissimilar, the sessile being hermaphrodite and the pedicelled ♂ or barren (very rarely the sexes reversed); occasionally with 1 or more of the lowermost pairs in a raceme (homogamous pairs) alike, infertile and persistent for some time after the other spikelets have fallen. Sessile spikelet 2-flowered, falling entire at maturity with adjacent internode and pedicel (the pedicelled spikelet usually falling separately); glumes usually as long as the spikelet and ± hardened, the lower very variable in shape and ornamentation, the upper usually boat-shaped and fitting between the internode and pedicel; lower floret ♂ or barren, the lemma membranous or hyaline and awnless, the palea usually suppressed if floret barren; upper floret hermaphrodite, with or without a spirally twisted and geniculate awn from the membranous or hyaline lemma; palea shorter than the lemma, frequently absent; lodicules 2; stamens mostly 3; stigmas 2. Pedicelled spikelet sometimes similar to the sessile, but commonly ♂ or barren, awnless, and smaller or even vestigial (though occasionally large and colourful); rarely the pedicel absent or fused to the internode. Grain with large embryo and punctiform hilum; starch grains simple, angular.

Leaf anatomy: chlorenchyma radiate; bundle sheaths single; silica-bodies commonly cross- or dumb-bell-shaped; 2-celled hairs slender; stomatal subsidiary cells triangular or low dome-shaped. Embryo panicoid. Chromosomes small, basic number 5, 6 or 9.

Genera ± 87; throughout the tropics, extending into warm temperate regions.

The most characteristic feature of the tribe is the occurrence of paired spikelets on fragile racemes, so that the basic floral unit is a segment comprising internode, sessile spikelet, pedicel and pedicelled spikelet. In the least modified genera the spikelets are alike, but there is a progressive loss of function in the pedicelled spikelet, coupled with a tendency for the pedicel to take part in the investment of the sessile spikelet; in extreme cases the pedicel becomes flattened and fused to the internode. Investment of the sessile spikelet is augmented in certain genera by the modification of the lowermost spikelets in the raceme to form involucral scales. Note that *Cleistachne*, *Oxyrhachis* and some species of *Arthraxon* have no pedicel or pedicelled spikelet; their inclusion in the tribe depends upon their obvious similarity to adjacent genera.

A second characteristic of the tribe is a progressive reduction in size of the inflorescence, accompanied by axillary branching and modification of the subtending leaves. Thus the large terminal panicle of the least modified genera gives way to a profusion of short racemes or raceme-pairs, each partially enclosed by an inflated bladeless sheath, and all crowded towards the top of the culm to form a complex leafy branch system which imitates a true panicle.

Internodes of rhachis and pedicels slender, filiform or linear, rarely thickened upwards and then with the upper lemma awned:
- Spikelets of each pair alike, at least one of them pedicelled:
  - Racemes borne upon a long central axis or its branches:
    - Callus not bearded; spikelets solitary (if paired see 153, *Sorghastrum*) . . . . . 154. **Cleistachne**
    - Callus conspicuously bearded, the hairs forming an involucre around the spikelet:
      - Panicle spike-like, silvery, apparently not composed of racemes . . . . . 140. **Imperata**
      - Panicle open or contracted, the component racemes distinct:
        - Rhachis of racemes tough; both spikelets of the pair pedicelled . . . . . 141. **Miscanthus**
        - Rhachis of raceme fragile; one spikelet of each pair sessile:
          - Callus-hairs silvery (in E. African species):
            - Hairs of callus much longer than spikelet . 142. **Saccharum**
            - Hairs of callus shorter than spikelet . . 153. **Sorghastrum**
          - Callus-hairs rufous or tawny; racemes short, dense . . . . . 143. **Eriochrysis**
  - Racemes subdigitate:
    - Callus acutely conical to pungent; rhachis fragile (if tough see 144, *Trachypogon*) . . . . . 145. **Homozeugos**
    - Callus acutely rounded to truncate:
      - Lower glume convex or concave, often villous . 146. **Eulalia**
      - Lower glume medianly grooved, glabrous or ciliate only at the tip (in E. African species) . . 147. **Microstegium**
- Spikelets of each pair different, sometimes the pedicelled much reduced, or rarely suppressed but then the spikelets all sessile:
  - Racemes arranged in a panicle with its common axis longer than the lowest raceme, not supported by spathes:
    - Sessile spikelets dorsally compressed:
      - Pedicels all bearing awnless spikelets:
        - Rhachis-internodes and pedicels with translucent or balsamiferous median line; racemes of 1–2 sessile spikelets (if 10 or more see *Bothriochloa bladhii*) . . . . . 148. **Capillipedium**
        - Rhachis-internodes and pedicels solid . . 152. **Sorghum**
      - Pedicels barren, or some of them bearing awned spikelets similar to the sessile . . . . 153. **Sorghastrum**
    - Sessile spikelets laterally compressed or terete:
      - Racemes reduced to 1 sessile and 2 pedicelled spikelets . . . . . 155. **Chrysopogon**
      - Racemes composed of many pairs of spikelets . 156. **Vetiveria**
  - Racemes solitary, paired or subdigitate, often supported by spathes:
    - Fertile lemma awned from low down on the back . 157. **Arthraxon**
    - Fertile lemma awned from the tip, or the sinus of the 2-toothed tip, rarely awnless:
      - Awn from the tip of the narrow fertile lemma (or with racemes solitary and sessile spikelet pitted—*Dichanthium foveolatum*):
        - Racemes composed of many pairs of spikelets:
          - Callus obtuse (but if inflorescence a dense spatheate head, see *Cymbopogon densiflorus*):
            - Pedicels and internodes with a translucent median line:
              - Racemes erect or divergent, without homogamous pairs . . . . 149. **Bothriochloa**
              - Racemes nodding, with 1–3 homogamous pairs at base. . . . . 150. **Euclasta**
            - Pedicels and internodes solid . . . 151. **Dichanthium**
          - Callus pungent:
            - Upper spikelet of the pair awned; with or

without the lowermost pair homogamous; rhachis tough . . . . . 144. **Trachypogon**
Upper spikelet of the pair awnless; lower 1–10 pairs homogamous, the rhachis fragile above them . . . . . 171. **Heteropogon**
Racemes composed of a single awned spikelet (rarely more) and 2 pedicelled spikelets, enclosed by an involucre of 4 sterile spikelets 172. **Themeda**
Awn from the sinus of the 2-toothed fertile lemma, or rarely awnless:
Lower glume of sessile spikelet transversely rugose; pedicelled spikelet represented only by a narrow curved pedicel . . . . 158. **Thelepogon**
Lower glume of sessile spikelet smooth, rarely rugose and then the pedicelled spikelet well developed:
Callus of sessile spikelet inserted into the crateriform or cupuliform tip of the internode, at least the rim of the internode lapping over and concealing the tip of the callus; lower glume of sessile spikelet 2-keeled or with the margins sharply inflexed, and usually depressed between the keels, rarely the keels rounded but then deeply grooved between them:
Lower floret of sessile spikelet ♂, with a well-developed palea:
Racemes paired or digitate (rarely solitary but then the upper glume neither awned nor crested) . . . . 159. **Ischaemum**
Racemes solitary:
Glumes inconspicuously winged, the upper awned . . . . . 160. **Sehima**
Glumes with a prominent wing-like crest, muticous . . . . . 161. **Andropterum**
Lower floret of sessile spikelet barren and reduced to a lemma:
Callus of sessile spikelet obtuse, usually very short:
Racemes solitary; lower glume of sessile spikelet convex on the back, the keels lateral or frontal with several intercarinal nerves . . . . 162. **Schizachyrium**
Racemes paired or digitate, rarely solitary and then with the lower glume of the sessile spikelet concave and nerveless between the keels:
Racemes deflexed at maturity, borne upon subequal flattened raceme-bases, seldom exceeding the spatheole in length; internodes of the rhachis and pedicels linear; leaves aromatic; panicle dense, decompound . . . . 163. **Cymbopogon**
Racemes not deflexed, borne upon unequal ± terete raceme-bases; leaves not aromatic. . . 164. **Andropogon**

Callus of sessile spikelet acute to pungent, 1–5 mm. long . . . . . 165. **Diheteropogon**
Callus of sessile spikelet applied obliquely to apex of the internode with its tip free, usually acute to pungent; lower glume of sessile spikelet convexly rounded on the back without keels (rarely with a median groove); internodes and pedicels linear:
Racemes paired:
Lower glume of sessile spikelet with a median groove . . . . 166. **Hyperthelia**
Lower glume of sessile spikelet convex on the back:
Upper glume of sessile spikelet awnless:
Upper raceme-base up to 10 mm. long, but usually much shorter . 167. **Hyparrhenia**
Upper raceme-base 15–25 mm. long; homogamous pairs 2 at the base of each raceme, forming an involucre . . . . 168. **Exotheca**
Upper glume of sessile spikelet awned . 169. **Elymandra**
Racemes solitary . . . . . 170. **Monocymbium**
Internodes of rhachis and pedicels stout, 3-angled, rounded or flattened and thickening upwards; upper lemma awnless:
Pedicels distinct:
Lower glume of sessile spikelet produced into a long flattened tail; spikelets similar . . . . 173. **Vossia**
Lower glume of sessile spikelet without a herbaceous tail:
Pedicelled spikelet long-awned (1–12 cm.) from the lower glume; racemes obliquely jointed . . 174. **Urelytrum**
Pedicelled spikelet awnless or with an awnlet up to 5 mm.:
Racemes single:
Jointing of racemes oblique:
Callus not inserted in the internode; lower glume of sessile spikelet not ridged, often bifid . . . . . 175. **Elionurus**
Callus inserted in the crateriform internode, the node fringed with a ring of hairs; lower glume of sessile spikelet usually longitudinally ridged, entire . . . 176. **Loxodera**
Jointing of racemes transverse:
Lower glume of sessile spikelet winged . . 177. **Coelorachis**
Lower glume of sessile spikelet not winged . 178. **Rhytachne**
Racemes numerous on a short common axis (if joints oblique see *Urelytrum giganteum*). . 179. **Phacelurus**
Pedicels fused to the internode, rarely wanting:
Lower glume of sessile spikelet rough:
Sessile spikelet globose . . . . . 180. **Hackelochloa**
Sessile spikelet broadly elliptic . . . . 181. **Heteropholis**
Lower glume of sessile spikelet smooth:
Raceme dorsally compressed, tough . . . 182. **Hemarthria**
Raceme cylindrical, fragile:
Pedicelled spikelet present . . . . . 183. **Rottboellia**
Pedicelled spikelet and pedicel absent . . . 184. **Oxyrhachis**

30. **VETIVERIA**, Thouars ex Virey in Journ. de Pharm. 1re sér. xiii. 499.

Spikelets 2-nate, of each pair subsimilar, differing in sex, one sessile, the other pedicelled, on the articulate fragile rhachis of copiously whorled (rarely panicled) peduncled 3- to many-jointed racemes, the sessile spikelets falling with the contiguous joint and the accompanying pedicelled spikelet or at least the accompanying pedicel; joints and pedicels slender, slightly and gradually thickened upwards. Florets 2, lower reduced to an empty valve, upper ♀ in the sessile, ♂ in the pedicelled spikelets. Sessile spikelet laterally slightly compressed, awned or awnless. Glumes equal; lower more or less coriaceous or chartaceous with a broad rounded back and subinflexed margins, usually muticous, upper boat-shaped, keeled upwards, with broad hyaline ciliate margins, muticous, mucronate or aristulate. Valves hyaline, of lower floret 2-nerved, of upper minutely 2-dentate, muticous or mucronulate or with a perfect or imperfect awn from the sinus. Valvule minute, hyaline, nerveless. Lodicules 2, glabrous. Stamens 3. Stigmas laterally exserted; styles subterminal. Grain oblong, top slightly oblique. Pedicelled spikelet dorsally compressed; glumes much thinner than in the sessile spikelet, like the valves usually awnless:—Coarse perennial glabrous grasses with stout rhizomes. Culms stout, more or less compressed below. Lower leaf-sheaths much compressed, flabellate-imbricate; blades firm to hard, conduplicate in bud, then flattening out at least upwards, gradually passing into the sheath. Panicles erect, long, of many-rayed whorls of slender simple or rarely compound racemes, glabrous except for the frequently minutely bearded calli.

Species about 7, in the tropics of the Old World, 1 introduced into the New World.

Spikelets 2–2½ lin. long, quite awnless; callus glabrous, very short, obtuse	1. *V. zizanioides.*
Spikelets 2½–3½ lin. long, more or less awned; callus bearded, beard exceeding the callus.	
Sessile spikelets spinulously muricate more or less all over; callus short, almost square; awn a bristle, enclosed or more or less exserted ...	2. *V. nigritana.*
Sessile spikelets smooth on the back to beyond the middle, aculeolate on the sides, spinulously scabrid at the tips, callus up to ½ lin. long, acute; awn perfect with the column exserted	3. *V. fulvibarbis.*

1. **V. zizanioides**, *Stapf in Kew Bulletin*, 1906, 346–349, 362. Rhizome aromatic. Culms stout, up to over 6 ft. high, usually sheathed all along. Leaf-sheaths compressed, particularly the lower which are sharply keeled and fan-like imbricate, very smooth, firm; ligules reduced to a scarious rim; blades linear, acute, 1–3 ft. long, 2–5 lin. wide, erect, rigid, firm or somewhat spongy, usually glabrous, rarely more or less hairy downwards on the face, pale-green, midrib slender, lateral nerves close, 6 or more on each side, rather stout, slightly prominent, margin spinulously rough. Panicle oblong, up to over 1 ft. long, usually contracted; rhachis stout, smooth; whorls 6–10 with up to 20 rays; branches oblique to suberect, naked for up to 2 in., filiform, slightly rough. Racemes up to 2 (rarely 3) in. long, very slender; joints about as long as the sessile spikelets or sometimes distinctly exceeding them, smooth or more or less rough, minutely and unequally ciliolate at the slightly oblique tips; pedicels similar but shorter. Sessile spikelet linear-lanceolate to almost linear, acute or subacute, 2–2½ lin. long, yellowish, olive- or violet-brown or purplish to almost black; callus obtuse, under ½ lin. long, glabrous. Glumes acute, coriaceous; lower muriculate all over the back, 5-nerved, lateral nerves close, very fine; upper glume spinulously muricate on the keel. Valve of lower floret as long as the glumes, acute, reversedly ciliolate, upper floret up to 1½ lin. long, narrow, oblong-lanceolate, mucronulate, eciliate. Anthers 1–1½ lin. long. Pedicelled spikelet sparingly aculeolate or almost smooth; valve of upper floret entire, acute.—*V. odorata*, Virey in Journ. de Pharm. 1re sér. xiii. 499. *V. arundinacea* and *V. muricata*, Griseb. Fl. Brit. W. Ind. 559, 560. *Phalaris zizanioides*, Linn. Mant. Alt. 183. *Andropogon muricatus*, Retz. Obs. iii. 43. *A. festucoides*, J. S. Presl in C. B. Presl, Reliq. Hœnk. i. 340. *A. squarrosus*, Hack. in DC. Monogr. Phan. vi. 542 (var. *genuinus*), not of Linn. f. *Agrostis verticillata*, Lam. Ill. Gen. i. 162. *Anatherum muricatum*, Beauv. Agrost. Expl. Planch. 15.

Lower Guinea. French Congo: Brazzaville, *Chevalier*, 11225! Belgian Congo: Boma, *Gillet*, *Wilwerth*; Stanley Pool Distr.; between Leopoldville and Mombasi, *Gillet*.

So far found in the wild state only in tropical Asia; cultivated on account of the aromatic roots in many parts of the tropics and therefore possibly also in the Congo region. It is the *Khas-Khas* of Anglo-Indians and the source of Vetiver oil (oleum Andropogonis muricati).

2. V. nigritana, *Stapf.* Culms and leaves as in *V. zizanioides*. Panicle oblong, up to over 1 ft. long, rigid and contracted or often somewhat nodding and more or less open; rhachis moderately stout, smooth; whorls 8–10 with up to 15 rays; branches obliquely erect, often flexuous or curving, naked for up to over 2 in., finely filiform, smooth or nearly so. Racemes up to 6 in. long, very slender; joints filiform, as long as to twice as long as the sessile spikelets, smooth, tips somewhat oblique, very minutely ciliolate; pedicels similar, but shorter. Sessile spikelet very narrowly linear lanceolate to linear, acuminate, 3–3½ lin. long, dull-green or somewhat purplish; callus short, almost square seen from the back, shortly bearded laterally. Glumes and valves as in the preceding species, but less coriaceous, the lower glume often mucronate and the upper valve with a bristle-like awn, 1–6 lin. long. Pedicelled spikelet 3 lin. long, otherwise as in *V. zizanioides*.—*Andropogon nigritanus*, Benth. in Hook. Niger Fl. 573. *A. squarrosus*, var. *nigritanus*, Hack. in DC. Monogr. Phan. vi. 544; Durand & Schinz, Consp. Fl. Afr. v. 727, and Étud. Fl. Congo, 319; Franch., Contr. Fl. Congo Franç. 20; K. Schum. in Engl. Pfl. Ost-Afr. C. 98; De Wild. & Durand, Reliq. Dewevr. 255. T. & Hél. Durand, Syll. Fl. Congol. 627. *Anatherum muricatum*, Rendle in Cat. Afr. Pl. Welw. ii. 153, not of Beauv. *Mandelorna insignis*, Steud. Syn. Pl. Glum. i. 359.

Upper Guinea. Senegal, *Roger*! Senegambia: Richard Toll, *Perrottet*, 929! Mbidjem, *Thierry*, 34! and without precise locality, *Heudelot*, 294! French Guinea: Farana, on the Upper Niger, *Scott Elliot*, 5359! Baffing Valley, *Poëguin*, 1739! Kabarah, *Chevalier*, 1353! Gold Coast: Accra, *Vogel*! Togo: Koukomba Steppe, *Kersting*, A, 661! Dahomey: Cotonou, *Chevalier*, 4455! Northern Nigeria: Nupe, *Barter*, 1387! Katagum Distr.; *Dalziel*, 273! Southern Nigeria: Nun River, *Vogel*, 18! Oyan River, *Holland*, 9! Illah, *Macleod*, 15! Yola, *Macleod*! Cameroons: Lere, *Macleod* 113!

Nileland. White Nile: Meshera, *Schweinfurth*, 1270! Jur: Ghattas' Seriba, *Schweinfurth*, 2132! Bongo: Addai, *Schweinfurth*, 2201!

Lower Guinea. Lower Congo: Lukolela, *Hens, C*, 173! Bolobo, *Dewèvre*; Buffing, savannas, *Lecard*, 123! Angola: Massuca, River Lueloi, *Gossweiler*, 2695! Pungo Andongo, marshes, *Welwitsch*, 2780! 2867*b*! 2817! country of the Ganguellas and Benguellas, *Gossweiler*, 4118!

South Central. Rhodesia: Victoria Falls, *Allen*!

Mozambique Distr. "Zanzibar" (according to K. Schum., l.c.). Portuguese East Africa: Lower Zambesi; Shupanga and Mazzaro, covering large tracts, *Kirk*! Lower Buzi River, *Swynnerton*, 956!

There is no evidence that the rhizome of this species is aromatic like that of the preceding species.

3. V. fulvibarbis, *Stapf.* Culms moderately stout, sparingly branched, up to 6 ft. high, most of the middle and upper nodes exserted. Leaves very similar to those of the two preceding species, but rather smaller or at least narrower. Panicle oblong, 4–8 in. by 1½–2 in., slightly contracted, erect or more often slightly nodding and secund; rhachis slender, smooth; whorls 6–8 with up to over 12 rays; branches obliquely erect, usually slightly curved, naked for up to 1½ in., finely filiform, smooth or slightly rough. Racemes up to 2 in. long, very slender; joints 3–4 lin. long, tips very oblique, very minutely ciliolate, smooth; pedicels similar but shorter. Sessile spikelet subulate-linear (seen from the back), acuminate, 3–4 lin. long, pale; callus up to ¾ lin. long, acute, fulvously bearded on the sides and at the base of the upper glume, hairs up to 1 lin. long. Glumes subcoriaceous; lower rigidly ciliate or ciliolate on the sides, smooth on the back except sometimes towards the rough tips, finely 3–5-nerved; upper glume similarly ciliate from the keel, aristulate from the minutely 2-dentate tip, reversedly ciliate along the margins, faintly 3-nerved. Valve of lower floret almost as long as the glumes, oblong, subacute, reversedly ciliate, 2-nerved; of upper floret somewhat shorter, sublinear in profile, 2-dentate, eciliate, 1-nerved, awned; awn slender, up to 10 lin. long, column chestnut brown, not twisted, scabrid, bristle shorter than the column, very pale, flexuous. Valvule linear, glabrous, up to almost 1 lin. long. Anthers 1¾ lin. long. Grain oblong with an obliquely rounded off top, over 1½ lin. long. Pedicelled spikelet linear-lanceolate, pale or livid-purplish, about as long as the sessile. Glumes membranous; lower acutely acuminate, smooth or almost so, finely 7–8-nerved, frequently terminating with a short bristle; upper 3-nerved, reversedly ciliate. Valves of both florets narrowly oblong, acute, reversedly ciliate, that of the lower 2-, of the upper 3-nerved. Valvule ciliolate, otherwise as in the sessile spikelets.—*Andropogon fulvibarbis*, Trin. in Mém. Acad. Pétersb. 6me sér. ii. 287; Hack. in DC. Monogr. Phan. vi. 544. *A. verticillatus*, Schumach. in Schumach. & Thonn. Beskr. Guin. Pl. 50, not of Roxb.

Upper Guinea. French Sudan: San, *Chevalier*, 2340! 2342! Gold Coast: Christianborg, *Johnson*, 1027! Accra, *Vogel*! Ashanti; banks of the Black Volta at Bjury, *Chipp*, 507!

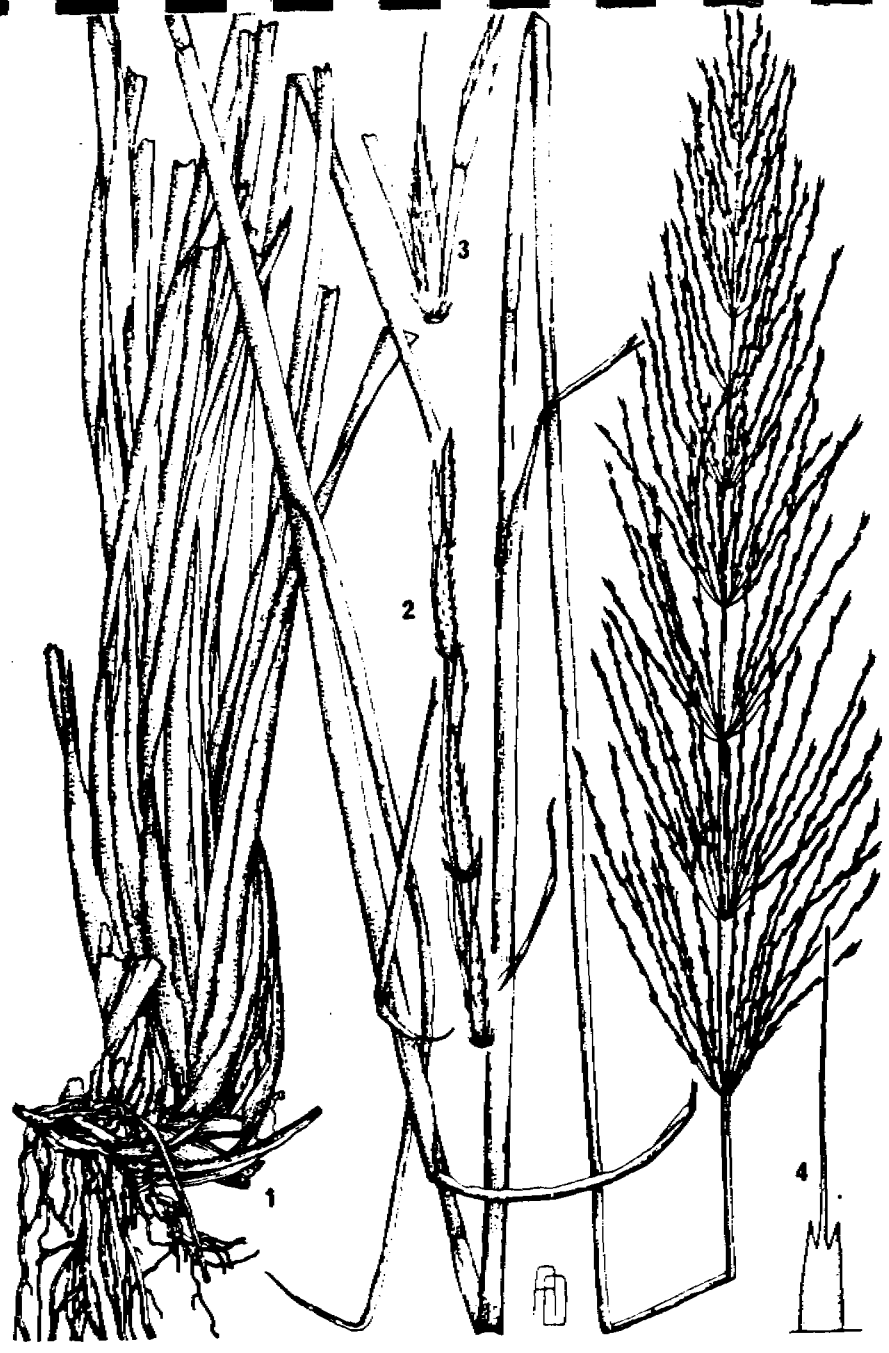

FIG. 172. *VETIVERIA NIGRITANA*—1, habit, × ½; 2, raceme, × 3; 3, spikelet pair, × 4; 4, tip of upper lemma, × 7. All from *Robinson* 414. Drawn by Ann Davies.

156. VETIVERIA

Lem.-Lisanc. in Bull. Soc. Philom. 1822: 43 (1822)

Coarse perennials forming large clumps from stout rhizomes. Leaf-blades linear, firm to hard, the basal sheaths laterally compressed and keeled; ligule a short membrane or a line of hairs. Inflorescence a terminal panicle with whorls of numerous slender racemes; racemes fragile, composed of several to many spikelets, the internodes and pedicels linear. Sessile spikelet laterally compressed, linear to lanceolate; callus rounded and ± truncate or oblique and pungent; lower glume coriaceous to chartaceous, rounded on the back, spinulose; upper glume with or without an awn; lower floret reduced to a hyaline lemma; upper lemma hyaline, bidentate, with a glabrous geniculate awn from the sinus, the awn sometimes reduced or absent. Caryopsis oblong. Pedicelled spikelet ♂, similar to the sessile but smaller.

Species 10; Old World tropics.

V. nigritana (*Benth.*) *Stapf* in F.T.A. 9: 157 (1917); Fl. Agrost. Congo Belge 1: 100 (1929); F.P.S. 3: 557 (1956); Ann. list Nyasaland grasses: 65 (1958); G.T.: 99 (1965); Clayton in F.W.T.A., ed. 2, 3: 470 (1972). Type: Nigeria, Nun R., *Vogel* (K, holo.!)

Tufted perennial; culms 1.5–3 m. high. Leaf-blades narrow, up to 90 cm. long and 7 mm. wide. Panicle lanceolate, 15–40 cm. long, its longest raceme 5–15 cm. Sessile spikelet 4.5–7 mm. long, including the bearded (hairs 0.5–1 mm.) callus which is rounded to fit the slightly hollowed tip of the internode; lower glume spinulose; upper glume awnless; upper lemma with a straight or curved awn 1–4(–9) mm. long, usually protruding from the glumes but sometimes enclosed by them. Fig. 172.

TANZANIA. Rufiji District: Kiwawe, 3 Sept. 1937, *Greenway* 5220!; Ulanga District: Kilombero, 22 Nov. 1959, *Anderson* 1283! & 9 Mar. 1965, *Nicholson* 35!

DISTR. T4, 6, 8; tropical Africa, Sri Lanka and Thailand, with sporadic records from Malaysia and the Philippines

HAB. Flood plains and other seasonally flooded places; 0–1100 m.

SYN. *Andropogon nigritanus* Benth. in Hook., Niger Fl.: 573 (1849)
Mandelorna insignis Steud., Syn. Pl. Glum. 1: 359 (1854). Type: Senegambia (whereabouts uncertain, not P)
Andropogon squarrosus L. f. var. *nigritanus* (Benth.) Hack. in DC., Monogr. Phan. 6: 544 (1889)
Vetiveria zizanioides (L.) Nash var. *nigritana* (Benth.) A. Camus in Bull. Mus. Nat. Hist. Nat. Paris 25: 674 (1919)

NOTE. *V. nigritana* is difficult to separate from *V. zizanioides* (L.) Nash, an Asiatic species which is sometimes cultivated for the aromatic oil obtainable from its roots. The latter is typically awnless, though very rarely there may be a mucro up to 1 mm. long, supporting characters are the shorter spikelets (3.5–5 mm.), and the callus which is commonly glabrous and generally rather shorter than in *V. nigritana*.

8. Consulted literature.

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