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A key to the grasses (Poaceae) of Egypt

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Abstract. A key for identifying 284 native and naturalized Egyptian grass species belonging to 103 genera in 22 tribes and 7 subfamilies is presented. The key is principally based on floral characters of the inflorescence and spikelet. A list and classification of all known species of Egyptian grasses is provided.

Keywords: classification, Gramineae, grasses, Egypt, identification key.

INTRODUCTION

The Poaceae (Gramineae) is a large cosmopolitan family with 768 genera and 11,506 species (Soreng et al. 2017). The family includes cereal grasses, bamboos, and species occurring in natural grasslands, cultivated lawns, and pastures. The family has been divided into subfamilies ranging from two (Tzvelev 1989) to six (Clayton and Renvoize 1986), and more recently the family has been divided into 12 subfamilies (Takhtajan 2009; Reveal 2012; Soreng et al. 2017, 2019; Stevens 2017).

In Egypt the grasses are the largest family of flowering plants with 284 species belonging to 103 genera and 22 tribes (Ibrahim et al. 2016). The most comprehensive account of the family in Egypt was done by Täckholm et al. (1941). Other treatments of the grasses of Egypt include Täckholm (1974), Cope and Hosni (1991), Cope (2005), Boulos (2009), and Ibrahim et al. (2016).

The identification of grasses is usually based on the structure of the inflorescence and floral characteristics. However, in some cases it is necessary to identify grasses by its vegetative character if the flowers are not available. In such cases the vegetative characters can be used until a flowering specimen is obtained (Hosni and Ibrahim 2004; Ibrahim et al. 2016).

Phylogenetic studies using results from DNA sequences have changed the classification of the grasses and this paper follows the current use of a name as proposed in these papers. With the publication of the grasses of Egypt using a vegetative key (Ibrahim et al. 2016), the need for an updated floral key is apparent. Earlier traditional treatments of the grasses of Egypt,

i.e., Cope and Hosni (1991) and Cope (2005) are outdated and it is often difficult to determine the current use name. Our paper presents a new key for the identification of grasses native and adventive in Egypt and is written for use by both trained botanists and interested amateurs. Therefore, we have included an introduction defining many terms used in the key. The key is designed to facilitate the identification and is simplified as much as possible using characters based on the inflorescence and spikelet. Our key refers only to Egyptian specimens and, in addition, we include a updated classification of all grasses found in Egypt.

The accepted names follow the Catalogue of New World Grasses (Soreng et al. 2015, 2017) using terminology found in Kellogg (2015), Clayton et al. (2016), Ibrahim et al. (2016, 2018), and Herrera Arrieta and Peterson (2018). Because the inflorescence of grasses takes a variety of shapes, it is convenient to group them into categories based on their morphology. Accordingly, the identification key is divided into two parts, a key of major groups based mainly on inflorescence characters followed by keys to the species within each group. Brief descriptions, synonyms, and illustrations of the species was provided in Ibrahim et al. (2016). The classification of each species in Table 1 follows Soreng et al. (2017, 2019).

GENERAL MORPHOLOGY

Grasses are annual, biennial or perennial herbs and the root systems are fibrous, rhizomatous or stoloniferous. Flowering stems (culms) are usually unbranched, composed of several internodes and are mostly hollow, rarely solid throughout, and the solid nodes can sometimes be hairy. Leaves are borne solitary at the node and can be crowded at the base of the culm. Each leaf consists of a sheath, ligule and lamina. Leaf blades may be hairy or glabrous. The base of the leaf sheath is attached to the nodes and clasping the stems firmly with overlapping free or connate margins, sometimes with two small falcate or erect outgrowths at the mouth (auricles). At the junction of a sheath and blade is a ligule that can be membranous or hairy (often a line of hairs) but occasionally a ligule can be absent. Leaf sheaths are mostly linear, flat, and sometimes folded or rolled in various ways.

Flowers (Fig. 1) are usually hermaphrodite, sometimes unisexual (male and female), anemophilous (sometimes autogamous, apomictic or entomophilous) small and inconspicuous. The perianth is usually represented by two or three, minute but up to six, inconspicuous hyaline scales (lodicules) which correspond to the inner perianth whorl of other monocots. Stamens are hypogenous, 1–6 in number but usually 3 with delicate filaments and two anthers that dehisce through terminal pores or longitudinal slits. The ovary is unilocular with a single ovule. There are usually two or three (rarely 1) styles, generally with plumose stigmas. In grasses the fruit or caryopsis is single-seeded with an adherent pericarp, although there are numerous species with free pericarps and these would technically be termed akenes.

The floral parts are placed between two bracts, the lower (lemma) and upper (palea). These two structures are collectively referred to as a floret. The floret is usually subtended by two glumes. Lemmas vary in size and texture like the glumes and differ in the number of veins (usually with an odd number of veins), their overall shape, and the nature of their attachment to the rachilla. Lemmas are often awned or mucronate near the apex, or the awn is borne somewhere along the dorsal back. Awns can be straight, keeled or twisted. The paleas are usually membranous, tightly enclosing the pistil and stamens. Paleas (sometimes reduced) usually have two major veins and are therefore 2-keeled. The lemma, palea, and reproductive structures are called florets. The characteristic floral structure in grasses (spikelets) consist of one to many florets distichously inserted on either side of a slender, jointed rachilla (Fig. 1). Spikelets vary in size from minute (1 mm or less) to relatively large (1 or 2 cm). Each spikelet is usually subtended by two lower empty scales or glumes. Glumes are variously veined and sometimes bear one or more awns. The base of a spikelet or floret is sometimes enlarged and hardened into a small knob or stalk (often sharp) called a callus. Glumes may be shorter than the adjoining lemma or longer and sometimes can be long enough to enclose the entire spikelet, or one or both glumes may be reduced or absent. Spikelets may be dorsiventrally compressed, laterally compressed, or terete.

Table 1. The following list is a synopsis of the classification of the genera into subfamilies and tribes for the grasses of Egypt.

I. Subfamily: ARISTIDOIDEAE Caro

1. TRIBE: ARISTIDEAE C.E.Hubb.
Aristida adscensionis L.
Aristida funiculata Trin. & Rupr.
Aristida mutabilis Trin. & Rupr.
Stipagrostis acutiflora (Trin. & Rupr.) De Winter
Stipagrostis ciliata (Desf.) De Winter
Stipagrostis drarii (Täckh.) De Winter
Stipagrostis hirtigluma (Steud. ex Trin. & Rupr.) De Winter

Stipagrostis lanata (Forssk.) De Winter
Stipagrostis multinerva H. Scholz
Stipagrostis obtusa (Delile) Nees
Stipagrostis paradisea (Edgew.) De Winter
Stipagrostis plumosa (L.) Munro ex T. Anderson
Stipagrostis raddiana (Savi) De Winter
Stipagrostis scoparia (Trin. & Rupr.) De Winter
Stipagrostis shawii (H.Scholz) H.Scholz
Stipagrostis uniplumis (Licht.) De Winter
Stipagrostis vulnerans (Trin. & Rupr.) De Winter

II. Subfamily ARUNDINOIDEAE Kunth ex Beilschm.

2. TRIBE: ARUNDINEAE Dumort.
Arundo donax L.
3. TRIBE: MOLINIEAE Jirásek
Phragmites australis (Cav.) Trin. ex Steud.
Phragmites karka (Retz.) Steud. [syn *Phragmites mauritianus* Kunth]

III. Subfamily CHLORIDOIDEAE Kunth ex Beilschm.

4. TRIBE: CENTROPODIEAE P.M. Peterson, N.P. Barker & H.P. Linder
Centropodia forskalii (Vahl) Cope
Centropodia fragilis (Guinet & Sauvage) Cope

5. TRIBE: CYNODONTEAE Dumort.
Aeluropus lagopoides (L.) Trin. ex Thwaites
Aeluropus littoralis (Gouan) Parl.
Chloris flagellifera (Nees) P.M. Peterson [syn. *Ochthochloa compressa* (Forssk.) Hilu]
Chloris gayana Kunth
Chloris prieurii Kunth [syn *Enteropogon prieurii* (Kunth) Clayton]
Chloris pycnothrix Trin.
Chloris virgata Sw.
Coelachyrum brevifolium Hochst. & Nees
Cynodon dactylon (L.) Pers.
Cynodon transvaalensis Burtt Davy
Dactyloctenium aegyptium (L.) Willd.
Dactyloctenium aristatum Link
Dactyloctenium scindicum Boiss.
Desmostachya bipinnata (L.) Stapf
Dinebra retroflexa (Vahl) Panz.
Dinebra panicea (Retz.) P.M.Peterson & N.Snow [syn. *Leptochloa panicea* (Retz.) Ohwi]
Diplachne fusca (L.) P.Beauv. [syn. *Leptochloa fusca* (L.) Kunth]
Eleusine africana Kenn.- O'Byrne
Eleusine coracana (L.) Gaertn.
Eleusine floccifolia (Forssk.) Spreng.
Eleusine indica (L.) Gaetn.
Halopyrum mucronatum (L.) Stapf
Leptothrium senegalense (Kunth) Clayton
Melanocenchris abyssinica (R.Br. ex Fresen.) Hochst.
Schoenefeldia gracilis Kunth
Tetrapogon cenchriformis (A.Rich.) Clayton
Tetrapogon villosus Desf.
Tragus berteronianus Schult.
Tragus racemosus (L.) All.
Trichoneura mollis (Kunth) E.Ekman

6. TRIBE ERAGROSTIDEAE Stapf
Enneapogon desvauxii P.Beauv.
Enneapogon lophotrichus Chiov. ex H.Scholz & P.Koinig
Enneapogon persicus Boiss.
Enneapogon scaber Lehm.
Eragrostis aegyptiaca (Willd.) Delile
Eragrostis aspera (Jacq.) Nees
Eragrostis barrelieri Daveau
Eragrostis cilianensis (All.) Vign. ex Janch.
Eragrostis ciliaris (L.) R. Br.
Eragrostis japonica (Thunb.) Trin.
Eragrostis lepida (A.Rich.) Hochst. ex Steud.
Eragrostis minor Host
Eragrostis pilosa (L.) P.Beauv.
Eragrostis sarmentosa (Thunb.) Trin.
Eragrostis tef (Zucc.) Trotter
Eragrostis tenuifolia (A.Rich.) Hochst. ex Steud.
Eragrostis tremula Hochst. ex Steud.
Schmidtia pappophoroides Steud.

7. TRIBE TRIRAPHIDEAE P.M. Peterson
Triraphis pumilio R.Br.

8.TRIBE ZOYSIEAE Benth.
Sporobolus alopecuroides (Piller & Mitterp.) P.M.Peterson [syn. *Crypsis alopecuroides* (Piller & Mitterp.) Schrad.]
Sporobolus aculeatus (L.) P.M.Peterson [syn. *Crypsis aculeata* (L.) Aiton]
Sporobolus ioclados (Nees ex Trin.) Nees
Sporobolus natalensis (Steud.) T. Durand & Schinz
Sporobolus niliacus (Bornm.) P.M.Peterson [syn. *Crypsis vaginiflora* (Forssk.) Opiz]
Sporobolus spicatus (Vahl) Kunth
Sporobolus pungens (Schreb.) Kunth
Sporobolus schoenoides (L.) P.M.Peterson [syn. *Crypsis schoenoides* (L.) Lam.]
Sporobolus wrightii Munro ex Scribn.

IV. Subfamily DANTHONIOIDEAE H.P. Linder & N.P. Barker

9. TRIBE: DANTHONIEAE Zotov.
Cortaderia selloana (Schult. & Schult. f.) Asch. & Graebn.
Schismus arabicus Nees
Schismus barbatus (L.) Thell.

V. Subfamily: ORYZOIDEAE Kunth ex Beilschm.

10. TRIBE: EHRHARTEAE Nevski
Ehrharta calycina Sm.

11. TRIBE: ORYZEAE Dumort.
Leersia hexandra Sw.
Oryza sativa L.

VI. Subfamily PANICOIDEAE Link

12. TRIBE: ANDROPOGONEAE Dumort.
Andropogon distachyos L.
Chrysopogon plumulosus Hochst.
Chrysopogon zizanioides (L.) Roberty
Coix lacryma-jobi L.
Cymbopogon citratus (DC.) Stapf
Cymbopogon flexuosus (Nees ex Steud.) Watson
Cymbopogon jwarancusa (Jones) Schult.
Cymbopogon martinii (Roxb.) Watson
Cymbopogon nardus (L.) Rendle
Cymbopogon schoenanthus (L.) Spreng. subsp. *schoenanthus*
Cymbopogon schoenanthus subsp. *proximus*
Dichanthium annulatum (Forssk.) Stapf
Dichanthium foveolatum (Delile) Roberty
Elionurus royleanus Nees ex A. Rich
Hemarthria altissima (Poir.) Stapf & C.E.Hubb.
Hyparrhenia hirta (L.) Stapf
Imperata cylindrica (L.) Raeusch.
Lasiurus scindicus Henrard
Miscanthus sinensis Andersson
Pogonatherum paniceum (Lam.) Hack.
Saccharum officinarum L.
Saccharum spontaneum L.
Sorghum arundinaceum (Desv.) Stapf
Sorghum bicolor (L.) Moench
Sorghum x drummondii (Nees ex Steud.) Millsp. & Chase
Sorghum halepense (L.) Pers.
Sorghum virgatum (Hack.) Stapf
Themeda triandra Forssk.
Themeda villosa (Poir.) A.Camus
Vossia cuspidata (Roxb.) Griff.
Zea mays L. subsp. *mays*
Zea mays subsp. *mexicana* (Schrad.) Iltis

13. TRIBE: PANICEAE R.Br.
Cenchrus americanus (L.) Morrone [syn. *Pennisetum glaucum* (L.) R.Br.]
Cenchrus biflorus Roxb.
Cenchrus ciliaris L. [syn. *Pennisetum ciliare* (L.) Link]
Cenchrus clandestinus (Hochst. ex Chiov.) Morrone (syn. *Pennisetum cladestinum* Hochst. ex Chiov.)
Cenchrus echinatus L.
Cenchrus longisetus M.C.Johnst. (syn. *Pennisetum villosum* R. Br. ex Fresen.)
Cenchrus orientalis (Rich.) Morrone (syn. *Pennisetum orientale* Rich.)
Cenchrus pennisetiformis Hochst. & Steud.
Cenchrus ramosissimus Poir. (syn. *Pennisetum ramosissimus* Poir.)
Cenchrus setaceus (Forssk.) Morrone [syn. *Pennisetum setaceum* (Forssk.) Chiov.]
Cenchrus setiger Vahl
Cenchrus sieberianus (Schltdl.) Verloove [syn. *Pennisetum sieberianum* (Schltdl.) Verloove]
Cenchrus violaceus (Lam.) Morrone
Digitaria ciliaris (Retz.) Koeler
Digitaria nodosa Parl.
Digitaria sanguinalis (L.) Scop.
Digitaria velutina (Forssk.) P.Beauv.
Digitaria violascens Link
Echinochloa colona (L.) Link
Echinochloa crusgalli (L.) P.Beauv.
Echinochloa pyramidalis (Lam.) Hitchc. & Chase
Echinochloa stagnina (Retz.) P.Beauv.
Megathyrsus maximus (Jacq.) B.K.Simon & S.W.L.Jacobs (syn. *Panicum maximum* Jacq.)
Melinis minutiflora P.Beauv.
Melinis repens (Willd.) Zizka
Moorochloa eruciformis (Sm.) Veldkamp [syn. *Brachiaria eruciformis* (Sm.) Griseb.]
Panicum antidotale Retz.
Panicum coloratum L.
Panicum hygrochris Steud.
Panicum miliaceum L.
Panicum repens L.
Panicum turgidum Forssk.
Setaria geminata [syn. *Paspalidium geminatum* (Forssk.) Stapf]
Setaria italica (L.) P.Beauv.
Setaria megaphylla (Steud.) T.Durand & Schinz
Setaria obtusifolia (Delile) Morrone [syn. *Paspalidium obtusifolium* (Delile) D.Simpson]

Setaria pumila (Poir.) Roem. & Schult.
Setaria verticillata (L.) P.Beauv.
Setaria viridis (L.) P. Beauv.
Stenotaphrum secundatum (Walter) Kuntze
Tricholaena teneriffae (L.f.) Link
Urochloa deflexa (Schumach.) H.Scholz [syn. *Brachiaria deflexa* (Schumach.) C.E.Hubb. ex Robyns.]
Urochloa leersioides (Hochst.) H.Scholz & Valdés [syn. *Brachiaria leersioides* (Hochst.) Stapf]
Urochloa mutica (Forssk.) T.Q.Nguyen [syn. *Brachiaria mutica* (Forssk.) Stapf]
Urochloa panicoides P. Beauv.
Urochloa ramose (L.) T.Q.Nguyen [syn. *Brachiaria ramosa* (L.) Stapf]
Urochloa reptans (L.) Stapf [syn. *Brachiaria reptans* (L.) C.A. Gardner]

14. TRIBE: PASPALEAE J.Presl
Paspalum dilatatum Poiret
Paspalum distichum L.
Paspalum racemosum Lam.

15. TRIBE: TRISTACHYIDEAE Sánchez-Ken & L.G. Clark
Danthoniopsis barbata (Nees) C.E.Hubb.

VII. Subfamily: POOIDEAE Benth.

16. TRIBE*:* BRACHYPODIEAE Harz
Brachypodium distachyon (L.) P.Beauv.

17. TRIBE: BROMEAE Dumort.
Bromus aegyptiacus Tausch
Bromus alopecuros Poir.
Bromus catharticus Vahl
Bromus danthoniae Trin. ex C.A.Mey.
Bromus diandrus Roth var. *diandrus*
Bromus diandrus var. *rigidus* (Roth) Sales
Bromus fasciculatus C.Presl
Bromus hordeaceus L.
Bromus inermis Leyss.
Bromus japonicus Thunb.
Bromus lanceolatus Roth
Bromus lepidus Holmb.
Bromus madritensis L.
Bromus pectinatus Thunb.
Bromus pulchellus Fig. & De Not.
Bromus pumilio (Trin.) P.M. Sm. [syn *Boissiera squarrosa* (Banks & Sol.) Nevski]
Bromus rubens L.
Bromus scoparius L.
Bromus sterilis L.
Bromus tectorum L. subsp. *tectorum*
Bromus tectorum subsp. *lucidus* Sales

18. TRIBE: LYGEEAE J.Presl
Lygeum spartum Loefl. ex L.

19. TRIBE: MELICEAE Rchb.
Melica persica Kunth

20. TRIBE: POEAE R.Br.
Agrostis stolonifera L.
Alopecurus myosuroides Huds.
Ammochloa palaestina Boiss.
Avena barbata Pott ex Link subsp. *barbata*
Avena barbata subsp. *wiestii* (Steud.) Mansf.
Avena fatua L.
Avena longiglumis Durieu
Avena sativa L.
Avena sterilis L.subsp. *sterilis*
Avena sterilis subsp. *ludoviciana* (Durieu) J.M.Gillet & Magne
Briza maxima L.
Briza minor L.
Calamagrostis arenaria (L.) Roth [syn. *Ammophila arenaria* (L.) Link
Catapodium rigidum (L.) C.E.Hubb..
Corynephorus divaricatus (Pourr.) Breistr.
Cutandia dichotoma (Forssk.) Batt. & Trab.
Cutandia maritima (L.) Barbey
Cutandia memphitica (Spreng.) Benth.
Cynosurus echinatus L.
Dactylis glomerata L.
Desmazeria philistaea subsp. *rohlfsiana* (Coss.) H.Scholz
Festuca brevis (Boiss. & Kotschy) Asch., Schweinf. & Muschl. (syn. *Vulpia brevis* Boiss. & Kotschy)
Festuca fasciculata Forssk. [syn. *Vulpia fasciculata* (Forssk.) Samp.]
Festuca bromoides L. [syn. *Vulpia bromoides* (L.) Gray]
Festuca myuros L. [syn. *Vulpia myuros* (L.) C.C.Gmel.]
Festuca pectinella Delile [syn. *Vulpia pectinella* (Delile) Boiss.]
Gastridium phleoides (Nees & Meyen) C.E.Hubb.
Holcus annuus Salzm.
Lagurus ovatus L.
Lamarckia aurea (L.) Moench
Lolium arundinaceum (Schreb.) Darbysh. (syn *Festuca arundinacea* Schreb.)
Lolium multiflorum Lam.
Lolium perenne L.
Lolium rigidum Gaudin
Lolium temulentum L.

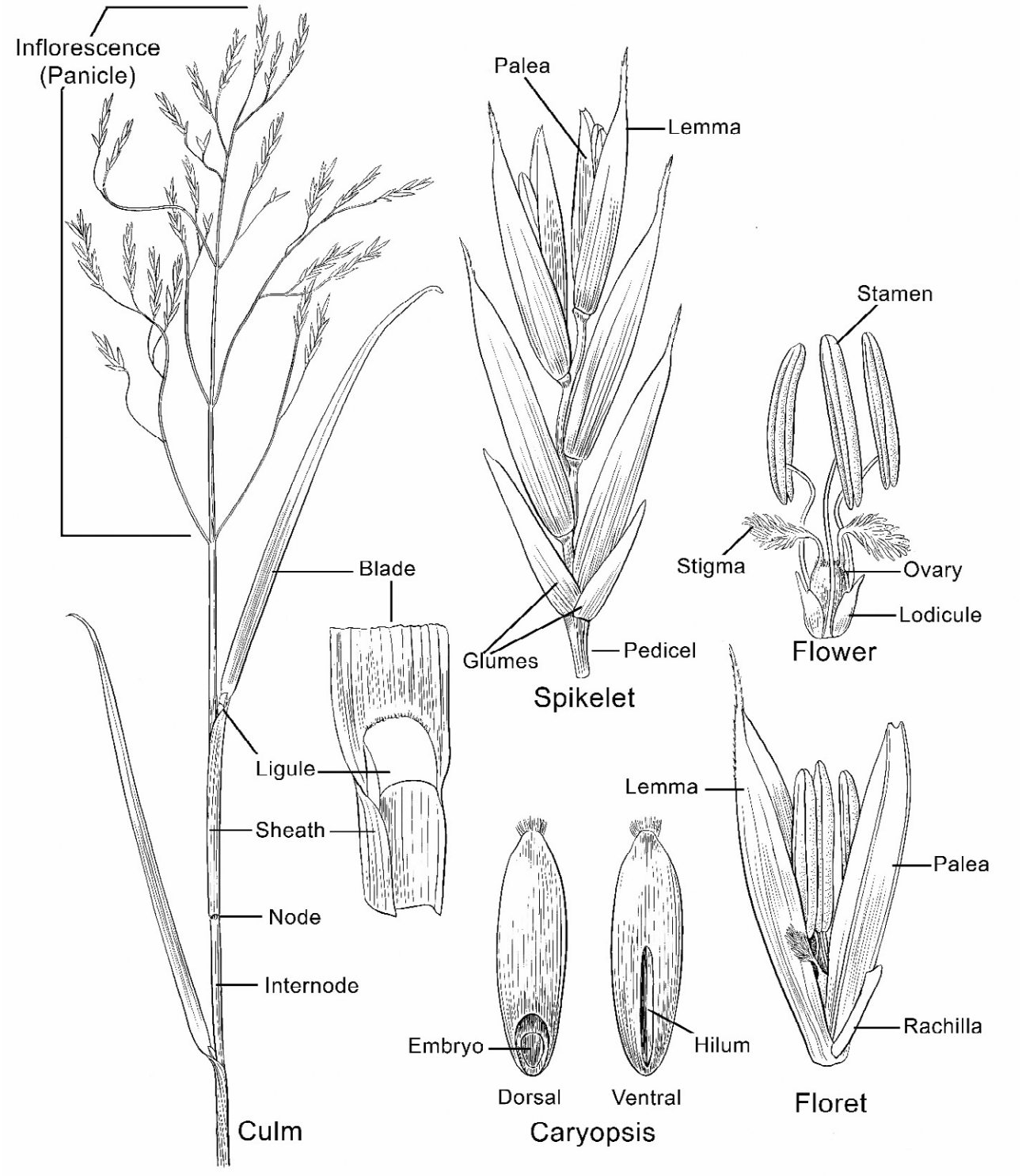

Figure 1. General morphology of a grass, illustrating the culm, blade, panicle, spikelet, floret, flower, and caryopsis.

Parapholis filiformis (Roth) C.E.Hubb.
Parapholis incurva (L.) C.E.Hubb.
Parapholis marginata Runem.
Phalaris aquatica L.
Phalaris arundinacea L.
Phalaris canariensis L.

Figure 2. Inflorescence types used to determine groups in the key. A Open panicle (*Avena sativa*) B Headlike panicle (*Bromus rubens*) C Dichotomously branched panicle (*Cutandia dichotoma*) D Digitately arranged spikes (*Dactyloctenium aegyptium*) E Spikes along central axis (*Dinebra retroflexa*) F Simple spike (*Lolium rigidum*) G Panicles subtended by spatheole (*Lygeum spartum*) H Plumose panicle (*Saccharum spontaneum*) I Spiciform panicle (*Trisetaria linearis*).

Phalaris coerulescens Desf.
Phalaris minor Retz.
Phalaris paradoxa L.
Phleum pratense L.
Phleum subulatum (Savi) Asch. & Graebn.
Poa annua L
Poa diaphora Trin. [syn. *Eremopoa altaica* (Trin.) Roshev.]
Poa infirma Kunth
Poa persica Trin. [syn. *Eremopoa persica* (Trin.) Roshev.]
Poa sinaica Steudel
Polypogon maritimus Willd.
Polypogon monspeliensis (L.) Desf.
Polypogon viridis (Gouan) Breistr.
Rostraria cristata (L.) Tzvelev
Rostraria hispida (Savi) M.Dogan
Rostraria obtusiflora (Boiss.) Holub subsp. *obtusiflora*
Rostraria pumila (Desf.) Tzvelev
Rostraria rohlfsii (Asch.) Holub
Sphenopus divaricatus (Gouan) Rchb.
Triplachne nitens (Guss.) Link
Trisetaria glumacea (Boiss.) Maire
Trisetaria koelerioides (Bornm. & Hack.) Melderis
Trisetaria linearis Forssk.
Trisetaria macrochaeta (Boiss.) Maire

21. TRIBE: STIPEAE Dumort.
Oloptum miliaceum (L.) Röser & H.R.Hamasha [syn. *Oryzopsis miliacea* (L.) Asch. & Schweinf.]
Piptatherum holciforme (M.Bieb.) Roem. & Schult. [syn. *Oryzopsis holciformis* (M.Bieb.) Hack.]
Stipa arabica Trin & Rupr.
Stipa lagascae Roem. & Schult.
Stipellula capensis (Thunb.) Röser & H.R.Hamasha (syn. *Stipa capensis* Thunb.)
Stipellula parviflora (Desf.) Röser & H.R.Hamasha (syn. *Stipa parviflora* Desf.)

22. TRIBE: TRITICEAE Dumort.
Aegilops bicornis (Forssk.) Jaub. & Spach
Aegilops geniculata Roth
Aegilops kotschyi Boiss.
Aegilops longissima Schweinf. & Muschl.
Aegilops peregrina (Hack.) Eig
Aegilops ventricosa Tausch
Agropyron cristatum (L.) Gaertn.
Crithopsis delileana (Schult.) Roshev.
Elymus elongatus (Host) Runem.
Elymus farctus (Viv.) Runemark ex Melderis
Elymus repens (L.) Gould
Eremopyrum bonaepartis (Spreng.) Nevski
Eremopyrum distans (K.Koch) Nevski
Hordeum marinum Huds. subsp. *marinum*
Hordeum marinum subsp. *gussoneanum*
Hordeum murinum L. subsp. *leporinum* (Link) Arcang.
Hordeum murinum L. subsp. *glaucum* (Steud.) Tzvelev
Hordeum spontaneum K. Koch
Hordeum vulgare L.
Taeniatherum caput-medusae (L.) Nevski
Triticum aestivum L.
Triticum dicoccum (Schrank) Schubl.
Triticum durum Desf.
Triticum pyramidale (Delile ex Schult.) Percival
Triticum turgidum L.

The inflorescence (synflorescence) is usually compound, composed of simple or complex aggregation of primary inflorescences (spikelets) often produced on a central axis (rachis) which may be terminal, rarely axillary, or compound and rebranched (Fig. 2). Spikelets may be arranged in spikes, racemes or panicles (open or contracted). In spikes, the spikelets are attached directly (sessile) to the unbranched main axis without pedicels. Racemes are unbranched inflorescences with each spikelet borne on a single pedicel directly on a branch axis. Multiple racemes can be arranged digitally or scattered along the rachis. Open or contracted panicles are inflorescences in which the main axis has several lateral, whorled or individual indeterminate branches with each branch terminating in a pedicellate spikelet. Spiciform panicles is where contraction has proceeded to the point where individual branches are closely appressed or adherent to the central axis. Inflorescences can sometimes be subtended by a bladeless sheath known as spatheole.

IDENTIFICATION KEY

The identification key is composed of two parts: a key to major groups and a key to each group.

Key to major groups

1a. Inflorescence ovoid, cylindrical or a headlike panicle ..... **group 1**

1b. Inflorescence open and not ovoid or a headlike panicle .. 2

2a. Inflorescence branches or spikes digitate or subdigitately inserted, terminal..... **group 2**

2b. Inflorescence branches branched and rebranched (paniculate) and not digitately or subdigitately inserted 3

3a. Inflorescence with racemes or spikelike panicles terminal; spikelets with an involucre of numerous bristles or hairs at the base ..... **group 3**

3b. Inflorescence with racemes appressed along a central axis or a panicle; spikelets without an involucre of numerous bristles or hairs at base 4

4a. Spikes or racemes appressed along central axes .... **group 4**

4b. Spikes or racemes not appressed along central axes 5

5a. Spikelets 3–9-awned or lemma awns 3-branched; inflorescence a contracted or open panicle ..... **group 5**

5b. Spikelets 1-awned or unawned; inflorescence a raceme or panicle 6

6a. Spikelets prickly; inflorescence a simple raceme or spikelike panicle ..... **group 6**

6b. Spikelets not prickly; inflorescence a raceme or panicle .. 7

7a. Inflorescence tri- or dichotomously branched ..... **group 7**

7b. Inflorescence not tri- or dichotomously branched 8

8a. Inflorescence subtended by spatheoles..... **group 8**

8b. Inflorescence not subtended by spatheoles..... 9

9a. Inflorescence plumose, large 20–60 cm long, open; culms 4–8 m tall ..... **group 9**

9b. Inflorescence not plumose, generally ≤ 20 (–60 cm) long, if longer, never plumose, open or contracted; culms ≤ 2 m tall 10

10a. Inflorescence a simple spike, raceme or spikelike panicle ... . **group 10**

10b. Inflorescence an open or contracted panicle..... 11

11a. Panicles spiciform, narrow usually < 1 cm wide . **group 11**

11b. Panicles open usually 0.5–30 cm wide..... 12

12a. Panicles contracted, 0.5–3 (–4) cm wide ..... **group 12**

12b. Panicles open, not contracted, usually (2–) 4–30 cm wide. 13

13a. Spikelets awned ..... **group 13**

13b. Spikelets unawned..... **group 14**

Group 1: Inflorescence ovoid, cylindrical or a headlike panicle

1a. Heads woolly with plumose hairs or bristles 2

1b. Heads not wooly 3

2a. Spikelets not subtended by bristles, 1-flowered with a single perfect floret; glumes (5.5–) 7–10 mm long, awned, the awns 1.5–3 mm long..... *Lagurus ovatus*

2b. Spikelets subtended by an involucre of bristles, 2-flowered, the lower floret sterile; glumes 0.3–5.2 mm long, unawned .....*Cenchrus longisetus*

3a. Spikelets subtended by an involucre of bristles, bristles plumose, 4–7 cm long .....*Cenchrus longisetus*

3b. Spikelets not subtended by an involucre of bristles 4

4a. Panicle bilateral, pyramidal; cultivated .... *Triticum pyramidale*

4b. Panicle not pyramidal; native..... 5

5a. Stoloniferous perennials; with stringlike culms, richly branched at the nodes .....*Aeluropus lagopoides*

5b. Plants not stoloniferous; culms erect..... 6

6a. Glumes shiny with attenuate apices; lemmas shiny, surface villous, hairy below, hairs 4–8 mm long, apex setaceous or attenuate .....*Cortaderia selloana*

6b. Glumes and lemmas green and not shiny, with acute and/or mucronate apices..... 7

7a. Panicles subtended by an inflated sheath,or spatheole; spikelets 1-flowered 8

7b. Panicles not subtended by an inflated leaf sheath or spatheole; spikelets 2-many-flowered..... 10

8a. Panicles ellipsoid; lower glume with glabrous margins ....*Sporobolus schoenoides*

8b. Panicles ovoid or ellipsoid, lower glumes with hairy margins..... 9

9a. Panicles 0.5–1 cm long; uppermost leaf continuous with its sheath; paleas 0–1-veined .....*Sporobolus aculeatus*

9b. Panicles 0.3–1.5 cm long; uppermost leaf clearly demarcated from its sheath; paleas 2-veined ..*Sporobolus niliacus*

10a. Lemmas unawned..... 11

10b. Lemmas awned..... 12

11a. Spikelets 4–14-flowered; panicles exserted ....*Ammochloa palaestina*

11b. Spikelets 3-flowered with only one fertile floret; panicles partially included in the sheath .....*Phalaris minor*

12a. Glumes dissimilar; lemmas mucronate or short-awned, the awns ≤ 1.5 mm long ..... *Dactylis glomerata*

12b. Glumes similar; lemmas all awned, awns ≥ 2 mm long . 13

13a. Most florets perfect; sheaths pubescent to pilose 14

13b. Florets both sterile and perfect; sheaths glabrous 15

14a. Spikelets 15–30 mm long; lemmas 10–15 mm long, awns 7–23 mm long ..... *Bromus rubens*

14b. Spikelets 4–5 mm long; lemmas 3–4. 5 mm long, awns 3–5 mm long ..... *Rostraria hispida*

15a. Awns of sterile spikelets 15–20 mm long; spikelets 6–7 mm long; lemmas 3.4–4 mm long..... *Cynosurus coloratus*

15b. Awns of sterile spikelets 6–15 mm long; spikelets 8–14 mm long; lemmas 4–6.5 mm long..... *Cynosurus echinatus*

Group 2: Inflorescence branches or spikes digitate or sub-digitately inserted, terminal

1a. Racemes 1–2 (3) digitate 2

1b. Racemes usually 2 or more 8

2a. Lemmas awned 3

2b. Lemmas unawned 4

3a. Racemes subtended by reddish spatheole; rachis with white hairs; lemma awns 10–35 mm long, geniculate with twisted column ..... *Hyparrhenia hirta*

3b. Racemes not subtended by spatheole; rachis glabrous; lemma awns 7–10 mm long, straight..... ..... *Brachypodium distachyon*

4a. Culms spongy; racemes 10–30 cm long; rachis angular; glumes with long caudate apex ..... *Vossia cuspidata*

4b. Culms not spongy; racemes ≤ 15.5 cm long; rachis winged or flattened; glumes without a caudate apex..... 5

5a. Spikelets 4–7-flowered, 3.3–7.8 mm long..... 6

5b. Spikelets 1 or 2-flowered, when 2-flowered the lower floret sterile, 2–3.2 mm long..... 7

6a. Leaf blades with tufts of short white hairs scattered along the margins; upper glumes 1veined; grain rugulose .... *Eleusine floccifolia*

6b. Leaf blades without tufts of hairs scattered along the margins; upper glumes 2–3-veined; grains striate .... *Eleusine indica*

7a. Racemes 2–8 cm long; rachis narrowly winged; spikelets dorsally compressed..... *Paspalum distichum*

7b. Racemes 0.7–1.5 cm long; rachis flattened; spikelets laterally compressed ..... *Cynodon transvaalensis*

8a. Lemmas awned..... 9

8b. Lemmas unawned or short aristate 16

9a. Lemmas with geniculate awns and twisted columns..... 10

9b. Lemmas with straight or flexuous awns..... 12

10a. Upper glume awned, the awn 4–10 mm long; fertile spikelets 8–16 mm long ..... *Andropogon distachyos*

10b. Upper glume unawned; fertile spikelets 2–7 mm long... 11

11a. Racemes 3–7 cm long; lemma apex entire, awns 8–25 mm long, adventive ..... *Dichanthium annulatum*

11b. Racemes 10–30 cm long; lemmas apex bifid, awns 6–12 mm long, cultivated..... *Miscanthus sinensis*

12a. Lemmatal awns flexuous,10–30 (–40) mm long; glumes 1-awned, awns 0.5–1 mm long ..... *Schoenefeldia gracilis*

12b. Lemmatal awns straight, less than 10 mm long..... 13

13a. Lemmatal awns 0.5–5 mm long, as long as lemma .... *Chloris gayana*

13b. Lemmatal awns more than 5 mm long, more than twice as long as lemma 14

14a. Leaf blade with an obtuse apex; glume apex acute .... *Chloris pycnothrix*

14b. Leaf blade with an acute apex; glume apex acuminate... 15

15a. Lowest lemma without a crown of spreading hairs; spikelets 4–6-flowered..... *Chloris prieurii*

15b. Lowest lemma with a crown of long spreading hairs, the hairs 1.5–4 mm long; spikelets 3 flowered .. *Chloris virgata*

16a. Flowers unisexual, plants monoecious, female inflorescences subtended by leafy spatheoles, rachis enlarged into a woody cob..... 17

16b. Flowers perfect, plants hermaphroditic, inflorescences not subtended by spatheoles and rachis not enlarged into a cob 18

17a. Female inflorescences 2–5 (–10) cm thick with 8–24 rows of spikelet pairs forming a thick woody cob, all tightly enclosed by several leafy spatheoles .... *Zea mays* subsp. *mays*

17b. Female inflorescences less than 1 cm thick with 2 rows of spikelet pairs formang a hardened rachis, all enclosed by a single leafy spatheole..... *Zea mays* subsp. *mexicana*

18a. Racemes 1–2 mm broad..... 19

18b. Racemes 2–5 mm broad 23

19a. Glumes equal; racemes 3–5..... *Chloris flagellifera*

19b. Glumes unequal or absent; racemes 2–16..... 20

20a. Spikelets 1-flowered; racemes 2 or more closely placed or whorled with a flat rachis, unwinged; ligule a ciliate membrane ..... *Cynodon dactylon*

20b. Spikelets 2-flowered; racemes mostly in pairs or whorled or alternate, he rachis flat or triquetrous, winged; ligule membranous 21

21a. Glumes two, dissimilar..... *Digitaria ciliaris*

21b. Glume one, the lower absent or obscure 22

22a. Spikelets 2.5–3.3 mm long; fertile spikelets paired along a narrowly winged rachis..... *Digitaria sanguinalis*

22b. Spikelets 1.2–2 mm long; fertile spikelets ternate along a broadly winged rachis ..... *Digitaria violascens*

23a. Racemes terminated by the naked tips of the rachis, bristle like 24

23b. Racemes terminated by a spikelet..... 26

24a. Racemes 1.2–6.5 cm long, inflorescence open .... *Dactyloctenium aegyptium*

24b. Racemes 0.8–2 cm long, inflorescence compact 25

25a. Stoloniferous perennials; anthers 1.1–2 mm long .... *Dactyloctenium scindicum*

25b. Tufted annuals often rooting at the lower nodes; anthers 0.3–0.5 mm long..... *Dactyloctenium aristatum*

26a. Racemes in terminal pairs (rarely 3) with scattered one or two below; spikelets 8–20-flowered..... *Acrachne racemosa*

26b. Racemes not in terminal pairs, digitate or subdigitately arranged; spikelets 3–9-flowered 27

27a. Upper glume apex obtuse; lemma apex obtuse …… ... . *Coelachyrum brevifolium*

27b. Upper glume apex acute; lemma apex acute 28

28a. Racemes 9–15 mm wide; spikelets ovate; grains subglobose, brown, exposed between gaping lemmas and paleas at maturity, cultivated ..... *Eleusine coracana*

28b. Racemes 3–8 mm wide; spikelets elliptic; grains ellipsoid, blackish, not exposed or concealed by the florets, native and/or weedy 29

29a. Leaf blades with tufts of short white hairs scattered along the margins; upper glumes 1veined; grain rugulose .... *Eleusine floccifolia*

29b. Leaf blades without tufts of hairs scattered along the margins; upper glumes 2–3-veined; grains striate or granular 30

30a. Lemmas 2.1–3.6 mm long; racemes 3–3.5 mm wide; grains 1–1.3 mm long, striate..... *Eleusine indica*

30b. Lemmas 3.7–5 mm long; racemes 4–8 mm wide; grains 1.2–1.6 mm long, granular ..... *Eleusine africana*

Group 3: Inflorescence with racemes or spikelike panicles terminal; spikelet with an involucre of numerous bristles or hairs at the base

1a. Inflorescence 1 or 2 digitate racemes; spikelets surrounded by hairs; lemmatal awns 2–4 mm long, straight .... *Tetrapogon villosus*

1b. Inflorescence a panicle; spikelets surrounded by free or connate bristles; lemmas unawned 2

2a. Plants robust 2–3 m tall 3

2b. Plants 90 cm or less tall 4

3a. Annuals; culms glabrous below the panicle; bristles shorter than the spikelets, persistent; cultivated..... ..... *Cenchrus americanus*

3b. Perennials; culms villous below the panicle; bristles much longer than the spikelets, deciduous; indigenous .... *Cenchrus orientalis*

4a. Bristles connate, deciduous with the spikelets, inner bristles longer than outer with one long bristle, flat 5

4b. Bristles free, not deciduous with the spikelet..... 9

5a. Bristles of the involucre retrorsely barbellate, tenaciously clinging to clothing, longest bristles scarcely emergent ... 6

5b. Bristles of the involucre antrorsely scaberulous not clinging; sometimes with one conspicuous longer bristle 7

6a. Inner bristles connate only at the bases to form a shallow disc, 2–4 mm long; inner bristle 2.9–7 mm long; ciliate .... *Cenchrus biflorus*

6b. Inner bristles fused for about half their length to form a cup, 5–10 mm long; longest bristle 2–5 mm long, pubescent spinose ..... *Cenchrus echinatus*

7a. Inner bristles rigid, flattened, 2–3 mm long, connate for ½–2/3 their length forming a cup, inner bristles with longest bristle scarcely emergent; 2–4 mm long..... ..... *Cenchrus setiger*

7b. Inner bristles flexuous, filiform above, 6–12 mm long, inner bristles with one conspicuously longer bristle 8–16 mm long; ciliate 8

8a. Inner bristles united only at the bases to form shallow disc 0.5–1.5 mm diam., occasionally connate for up to 0.5 mm above its rim..... *Cenchrus ciliaris*

8b. Inner bristles connate for 1–2.5 mm above the rim of the basal disc forming a cup ..... *Cenchrus pennisetiformis*

9a. Bristles persistent 10

9b. Bristles deciduous with the spikelets 14

10a. Inflorescences open panicles, bristles 2–2.5 cm long ..... *Setaria megaphylla*

10b. Inflorescences a spiciform panicles 11

11a. Bristles retrosely barbed clinging to clothes, 4–7 mm long ..... *Setaria verticillata*

11b. Bristles antrorsely barbed 12

12a. Upper glumes as long as the spikelets; each spikelet subtended by 1–3 bristles, 5–10 times as long as the spikelets. *Setaria viridis*

12b. Upper glumes shorter than the spikelets 13

13a. Lemmas strongly rugose; each spikelets subtended by 4–12 bristles, 3–8 mm long ..... *Setaria pumila*

13b. Lemmas rugulose or unwrinkled; each spikelet subtended by 1–3 bristles, 4–16 mm long ..... *Setaria italica*

14a. Inflorescences comprising only a few spikelets; comprising 2–4(–6) fertile spikelets; shorter than basal leaves; subtended by an inflated leaf-sheaths; enclosed; bristles shorter than the spikelets (cult.) .... *Cenchrus clandestinum*

14b. Inflorescences spike-like panicles, exserted 15

15a. Panicles ovoid to subspherical very dense;bristles plumose, 40–70 mm long; lemmas acute, 7–9-veined ..... *Cenchrus longisetus*

15b. Panicles elongate; lemmas 16

16a. Involucre sessile ..... *Cenchrus violaceum*

16b. Involucre stipitate (stalked 17

17a. Plants glaucous, pinkish; spikes purple or pink; involucral base stipitate, the stipe 1–3 mm long .... *Cenchrus setaceus*

17b. Plants not glaucous, not pinkish; involucral base stipitate, the stipe 0.5–1 mm long 18

18a. Panicles axes glabrous; involucral bristles 7–20 mm long .. *Cenchrus ramosissimus*

18b. Panicles axes pubescent; involucral bristles 6–9 mm long with a conspicuous longer bristle, 10–25 mm long ..... *Cenchrus sieberianus*

Group 4: Spikes or racemes appressed along central axes

1a. Spikelets headlike, several, small, nodding along an unbranched axes; glumes long villous and soft ..... *Melanocenchris abyssinica*

1b. Spikelets not headlike, erect or reflexed along the central axis but not nodding; glumes not long villous 2

2a. Glumes as long as or longer than the spikelets, persistent, similar, exceeding apex of florets; lower glume apex caudate ..... *Dinebra retroflexa*

2b. Glumes much shorter than the spikelets; lower glume apex not caudate 3

3a. Racemes 0.5–1 cm long; spikelets embedded in a corky rachis; leaf blade apex obtuse .... *Stenotaphrum secundatum*

3b. Racemes more than 1 cm long, not embedded in rachis; leaf blades apex acute 4

4a. Lemmas and/or glumes acuminate or awned 5

4b. Lemmas or glumes unawned 9

5a. Racemes 15–35 cm long; spikelets 8–15 mm long; lemma apex mucronate or with a short awn ≤ 1.5 mm long; fertile spikelets pedicelled, pedicels filiform, 0.5–1.5 mm long; glumes unequal ..... *Diplachne fusca*

5b. Racemes 2–10 cm long; spikelets 3–6 mm long; lemma apex awned; fertile spikelets sessile or with pedicels <0.5 mm long; glumes equal or subequel 6

6a. Lemmas apex mucronate or short awned, the awns 0.3–3 mm long 7

6b. Lemmas awned, the awn 20–50 mm long 8

7a. Racemes 2–7(–10); spikelets comprising 1 fertile floret; spikelets 3–4.5 mm long; lemmas rugulose, mucronate, the mucro 0.3–1 mm long ..... *Urochloa panicoides*

7b. Racemes 10–40; spikelets comprising 5–9 fertile florets; spikelets 6–8 mm long; lemmas sparingly hairy, mucronate or short awned up to 2 mm long ... *Trichoneura mollis*

8a. Caespitose annuals; racemes straight; spikelets pedicelled, 1–2 mm long; lemmas hispid, awns up to 50 mm long; upper glumes apex cuspidate ..... *Echinochloa crusgalli*

8b. Rhizomatous perennials; racemes flexuous; spikelets sessile to subsessile; lemmas pubescent, awns 20 mm long, upper glumes entire or awned, the awns 0–4 mm long ..... *Echinochloa stagnina*

9a. Rachis winged 10

9b. Rachis unwinged 15

10a. Racemes compact, appressed to the long slightly hollowed common axis; leaf blade apex obtuse ..... *Setaria obtusifolia*

10b. Racemes not compact, and not as above; leaf apex acute 11

11a. Spikelets 6–9 mm long; lemma margin and midvein pubescent; glume apex caudate ..... *Dinebra panicea*

11b. Spikelets 1.5–4 mm long; lemmas glabrous; glume apex acute to obtuse 12

12a. Spikelets 2.5–3.5 mm long; rachis broadly winged, the wing 0.5–2 mm wide; lemmas apex obtuse 13

12b. Spikelets 1.5–2.5 mm long; rachis narrowly winged, the wing < 0.5 mm wide; lemma apex acute 15

13a. Lower glumes absent or obscure..... *Paspalum racemosum*

13b. Both glumes present, dissimilar 14

14a. Racemes 5–20 cm long; spikelets 2.5–3.5 mm long; lemma surfaces rugulose, stramineous ..... *Urochloa mutica*

14b. Racemes 0.5–4 cm long; spikelets 1.5–2.5 mm long; lemma surface smooth, shiny, dark brown..... ..... *Setaria geminata*

15a. Glume one, the lower absent or obscure 16

15b. Glumes 2, the lower present 17

16a. Glumes apex obtuse; lemmas 3-veined ....*Paspalum dilatatum*

16b. Glumes apex acute; lemmas 7-veined ..... *Digitaria velutina*

17a. Inflorescences up to 60 cm long, racemes numerous 20–50 or more .....*Desmostachya bipinnata*

17b. Inflorescences <60 cm long, racemes few, up to 10..... 18

18a. Lemma and glume apices obtuse ... *Moorochloa eruciformis*

18b. Lemma and glume apices acute or cuspidate..... 19

19a. Spikelets with 8–25 florets..... 20

19b. Spikelets with 1fertile and 1 sterile floret 21

20a. Rachilla villous; callus bearded .... *Halopyrum mucronatum*

20b. Rachilla glabrous; callus not bearded .... *Catapodium rigidum*

21a. Lower glume apex obtuse; lemmas pilose or villous, bearing white hairs .....*Digitaria nodosa*

21b. Lower glume apex acute; lemmas not pilose or villous .. 22

22a. Spikelets packing adaxial, distant, irregular..... .....*Urochloa deflexa*

22b. Spikelets packing regular, 2- or 4–6-rowed 23

23a. Spikelets packing regular, 2-rowed 24

23b. Spikelets packing regular, 4–6-rowed 27

24a. Spikelets packing broadside to rachis; glume apex obtuse and erose, lemma apex apiculate ..... *Aeluropus littoralis*

24b. Spikelets not packing broadside to rachis; glume apex acute, not erose; lemmas apex acute, often mucronate 25

25a. Spikelets 1.5–2 mm long with hirsute pedicels; lower glumes 0.15–0.25 as long as the spikelets without veins, apex truncate ..... *Urochloa reptans*

25b. Spikelets 2–3.5 mm long with glabrous or scabrous pedicels; lower glumes 1/3–½ as long as the spikelets with 3–7 veins, apex acute or obtuse 26

26a. Lemmas dark brown; upper glumes not separated from lower glumes by an internode..... *Urochloa ramosa*

26b. Lemmas green; the upper glumes separated from the lower glumes by a distinct internode 0.2–0.5 mm long..... .....*Urochloa leersioides*

27a. Plants annual, caespitose; upper glumes pubescent, apex cuspidate .....*Echinochloa colona*

27b. Plants perennial with rhizomes; upper glumes glabrous or hispidulous, apex acute .....*Echinochloa pyramidalis*

Group 5: Spikelets 3–9-awned or lemma awns 3-branched; inflorescence a contracted or open panicle

1a. Lemmas 5–9-awned 2

1b. Lemmas awns 3, or awns 3-branched 7

2a. Panicles open or contracted; lemmas hairy below the middle, 5-awned, the awns 4–8 mm long..... .....*Schmidtia pappophoroides*

2b. Panicles compact or spiciform; lemmas not hairy; lemmas 5–9-awned 3

3a. Small villous grasses; panicles densely ovoid; lemmas with 5–9 scabrid awns ..... *Bromus pumilio*

3b. Tall, glabrous grasses, panicles spiciform, oblong-linear; lemma awns 9, feathery..... 4

4a. Lemmas awns scaberulous throughout ....*Enneapogon scaber*

4b. Lemmas awns ciliate below, scaberulous only towards tip.. 5

5a. Fertile lemmas with 3 dense patches of hairs on the backs, one along midrib and one along each margin; nodes glabrous ..... *Enneapogon lophotrichus*

5b. Lemmas with hairs on the back evenly distributed; nodes bearded..... 6

6a. Basal leaf sheaths persistent, forming a bulbous swelling near base; spikelets 2.8–5.5 mm long..... ..... *Enneapogon desvauxii*

7a. Basal leaf sheaths persistent, not forming a bulbous swelling near base; spikelets 5.5–12 mm long..... *Enneapogon persicus*

7a. Lemma awns glabrous to scabrous, column not twisted .. 8

7b. Lemma awns feathery, at least the principal or central awn with atwisted column 14

8a. Lemma 3-awned, central awn arising from sinus and the lateral awns arising dorsally or marginally, persistent, central awn not more than 10 mm long, lateral awns not more than 5 mm long 9

8b. Lemma with a single 3-branched awn, deciduous, central awn more than 10 mm long, lateral awns usually more than 5 mm long..... 15

9a. Central lemma awns geniculate with twisted column, apex of awn smooth..... 10

9b. Central lemma awn straight, apex of awn scabrous..... 13

10a. Central lemma awns inserted below the middle, scarcely exserted from the spikelet, the awns 2.5–3 mm long, lateral lemma awns 1–1.5 mm long..... *Trisetaria glumacea*

10b. Central lemma awns inserted near the middle or upper ¼, exserted from the spikelet, the awns 3–10 mm long, lateral lemma awns 1–5 mm long 11

11a. Lemmas glabrous, central awns 5–7 mm long; lateral awns 1.5–5 mm long 12

11b. Lemmas villous, central awns 3–4 mm long, lateral awns 1–1.5 mm long..... *Triplachne nitens*

12a. Panicles loosely contracted, 0.5–3.5 cm wide, oblong-ovate; central lemma awn 5–8 mm long, lateral awns 1.5 mm long ..... *Trisetaria macrochaeta*

12b. Panicles densely contracted, 0.5–1 cm wide, linear; central lemma awn 8–15 mm long, lateral awns 3–5 mm long ..... *Trisetaria linearis*

13a. Spikelets elliptic, 10–40 mm long; lemmas with minutely bifid apex, awns curved, spreading, 5–15 mm long, lateral lemma awns arising dorsally, shorter than the central ..... *Bromus danthoniae*

13b. Spikelets lanceolate, 4–6 mm long; lemmas central awns 1.5–3 mm long, lateral lemma awns arising from the margins 0.5–1 mm long 25

14a. Spikelets 5–11-flowered; glumes 1.5–3 mm long, shorter than the spikelet; lemmas pilose, margins ciliate, central awn inserted in the sinus, the awn 1.5–2.5 mm long, not geniculate or twisted ..... *Triraphis pumilio*

14b. Spikelets 2-flowered; glumes 4–5 mm long, longer than the spikelet; lemmas entirely glabrous, shiny, central awn inserted dorsally on upper ½, the awn 2.5–3 mm long, geniculate and twisted ..... *Trisetaria glumacea*

15a. All three awns glabrous, lateral awns as long as the central awn; glumes unequal..... 16

15b. Central and sometimes lateral awns plumose, lateral awns shorter than the central; glumes subequal..... 18

16a. Awns without a column, not articulating at the summit; ligule a ciliolate membrane..... *Aristida adscensionis*

16b. Awns with a column, articulating at the summit; ligule a fringe of hairs 17

17a. Spikelets 6–7 mm long; lemma awns 10–30 mm mm long ..... *Aristida mutabilis*

17b. Spikelets 20–30 mm long; lemma awns 35–45 mm long .... *Aristida funiculata*

18a. All three lemma awns plumose, lateral awns about as long as the central awn with or without a twisted column 19

18b. Only the central lemma awn plumose, lateral awns much shorter than the central awn with a twisted column 21

19a. Internodes densely woolly; panicles 5–10 cm long; central lemma awns 20–35 mm long, the column 3–5 mm long, twisted ..... *Stipagrostis lanata*

19b. Internodes glabrous; panicles 10–40 cm long; central lemmas awns 7–10 mm long, the column 0–1 mm long, straight or slightly twisted 20

20a. Lower glumes longer than the upper; panicles 20–40 cm long; awns not or scarcely exserted from spikelets..... ..... *Stipagrostis scoparia*

20b. Lower glumes shorter than the upper; panicles 10–20 cm long; awns exserted from the spikelets..... ..... *Stipagrostis vulnerans*

21a. Nodes bearded; lemmas articulating near the middle (across the body) ..... *Stipagrostis ciliata*

21b. Nodes not bearded; lemmas articulating near apex..... 22

22a. Central lemma awns plumose throughout 23

22b. Central lemma awns glabrous in the lower and/or upper portions..... 25

23a. Callus glabrous; column straight or slightly twisted .... *Stipagrostis raddiana*

23b. Callus bearded; column twisted..... 24

24a. Callus with 2 collars of hairs; column 7–13 mm long, hairy on the upper portion; central lemma awns 35–70 mm long, lateral lemma awns 10–25 mm long..... ..... *Stipagrostis hirtigluma*

24b. Callus with a single collar of hairs; column 5–10 mm long, glabrous; central lemma awns 20–35 mm long, lateral lemma awns 10–12 mm long .... *Stipagrostis uniplumis*

25a. Central lemma awns glabrous in the lower or upper portion.....26

25b. Central lemma awns glabrous in the lower and upper portion.....29

26a. Central lemma glabrescent toward tip.....27

26b. Central lemma awns glabrescent toward base 28

27a. Callus glabrous; column 1.5–2 mm long; central lemma awns 13–25 mm long, lateral lemma awns 7–17 mm long .....*Stipagrostis drarii*

27b. Callus bearded; column 11–14 mm long; central lemma awns 60–70 mm long, lateral lemma awns 17–25 mm long .....*Stipagrostis paradisea*

28a. Lower glume apex obtuse; lemmas 2–2.5 mm long, central lemma awns 20–30 mm long, ...*Stipagrostis obtusa*

28b. Lower glume apex acute; lemmas 3–4 mm long, central lemma awns 45–47 mm long .....*Stipagrostis shawii*

29a. Column straight or slightly twisted, 1 mm long, central lemma awns 13–18 mm long.....*Stipagrostia acutiflora*

29b. Column twisted, 3–9 mm long, central lemma awns 25–60 mm long 30

30a. Glumes 3-veined, lower glumes glabrous .....*Stipagrostis plumosa*

30b. Glumes 5–7-veined, lower glumes pilose.....*Stipagrostis multinerva*

Group 6: Spikelets prickly; inflorescence a simple raceme or panicle

1a. Lower glumes well developed, modified into a long flat recurved tail, upper glumes usually smaller, enfolding the lemmas, tuberculate .....*Leptothrium senegalense*

1b. Lower glumes very small or suppressed, upper glumes and lemmas about equal with raised veins bearing hooked bristles.....2

2a. Apical spikelets sterile; upper glumes 7-veined .....*Tragus racemosus*

2b. All spikelets fertile; upper glumes 5-veined .....*Tragus berteronianus*

Group 7: Inflorescence tri- or dichotomously branched

1a. Panicles trichotomously branched and rebranched; spikelets 2 mm long; pedicels terete, club-shaped, slender .....*Sphenopus divaricatus*

1b. Panicles dichotomously branched; spikelets 6–8 mm long; pedicels 3-angled.....2

2a. Spikelets 5–9 (–12)-flowered; glumes 3–5-veined .....*Cutandia maritima*

2b. Spikelets 2–4-flowered; glumes 1-veined.....3

3a. Panicles partially enclosed in the sheath below; panicle internodes longer in length than the spikelets; lemmas 7.5– 8.5 mm long, apex awned, the awns 10–11 mm long .....*Cutandia memphetica*

3b. Panicles exserted not enclosed in the sheath; panicle internodes shorter in length than the spikelets; lemmas 4.5–5.5 mm long, apex acute or bidentate .....*Cutandia dichotoma*

Group 8: Inflorescence subtended by spatheoles

1a. Inflorescence a single terminal spikelet, one-sided enclosed by spatheole; lemmas villous.....*Lygeum spartum*

1b. Inflorescence composed of many spikelets; lemmas not villous.....2

2a. Inflorescence composed of male and female racemes.....3

2b. Inflorescence composed of bisexual florets 5

3a. Female racemes sessile subtended by bony utricles; male racemes pedunculate projecting from the utricles .....*Coix lacryma-jobi*

3b. Female racemes subtended by 1 or more herbaceous spatheoles.....4

4a. Female inflorescences 2–5 cm broad; rachises thick woody, enclosed by several leafy spatheoles.....*Zea mays* subsp. *mays*

4b. Female inflorescences less than 1 cm broad; rachises tough not woody, enclosed by single spatheole .....*Zea mays* subsp.*mexicana*

5a. Rachis with white hairs.....*Hyparrhenia hirta*

5b. Rachis pubescent or glabrous but not with white haris....6

6a. Spatheoles colored red or brown 7

6b. Spatheoles green.....9

7a. Plants not aromatic; spikelets 6–14 mm long surrounded by hairs; callus bearded, the hairs red; lemma awns 20–70 mm long, straight, hispidulous ..... *Themeda triandra*

7b. Plants aromatic; spikelets 4–5.5 mm long; callus not bearded; lemma awns 7–18 mm long, geniculate with a twisted column.....8

8a. Lower glume of sessile spikelet veins distinct, winged; lemma awns 12–18 mm long..... *Cymbopogon martini*

8b. Lower glume of sessile spikelet veins absent or obscure and not winged; lemma awns 7–10 mm long..... *Cymbopogon jwarancusa*

9a. Rachis villous; spikelet pedicels villous; lemmas unawned. ..... *Cymbopogon citratus*

9b. Rachis ciliate; spikelet pedicels ciliate; lemmas awned ... 10

10a. Awns geniculate with a twisted column..... 11

10b. Awns straight..... 14

11a. Plants aromatic; racemes 2 12

11b. Plants not aromatic; racemes 1 13

12a. Lower glume of sessile spikelet elliptic lanceolate, usually 2- or 3-veined between the keels ..... *Cymbopogon nardus*

12b. Lower glume of sessile spikelet narrowly lanceolate, usually veinless between the keels ..... *Cymbopogon flexuosus*

13a. Lower glume of sessile spikelet pubescent with reddish hairs and not pitted, apex obtuse; lemma awns absent or to 10 mm long..... *Themeda villosa*

13b. Lower glumes of sessile spikelet glabrous, shining, pitted, apex acute; lemma awns 12–18 mm long..... *Dichanthium foveolatum*

14a. Racemes 2–3 cm long; spatheoles 2–3 cm long; lower glume of sessile spikelet glabrous ..... *Cymbopogon schoenanthus* subsp. *schoenanthus*

14b. Racemes 1–2 cm long; spatheoles 1–2 cm long; lower glume of sessile spikelet pubescent..... *Cymbopogon schoenanthus* subsp. *proximus*

Group 9: Inflorescence plumose, large 20–60 cm long, open; culms 4–8 m tall

1a. Culms solid; callus bearded with white silky hairs..... 2

1b. Culms not solid; callus not bearded..... 3

2a. Callus hairs white; panicles 25–40 cm long..... *Saccharum spontaneum*

2b. Callus hairs off-white; panicles up to 1 m long..... *Saccharum officinarum*

3a. Lemmas pilose, the hairs 4–9 mm long; rachilla glabrous; glumes longer than the florets..... *Arundo donax*

3b. Lemmas glabrous, rachilla hairy; glumes shorter than the florets..... 4

4a. Rachilla hairs 4–7 mm long; upper glumes 3–5(–6) mm long; leaf blades scabrid below..... *Phragmites karka*

4b. Rachilla hairs 8–15 mm long; upper glumes 6–9 mm long; leaf blades smooth below..... *Phragmites australis*

Group 10: Inflorescence a simple spike, raceme or spikelike panicle

1a. Inflorescence a fragile cylindrical bilateral raceme with spikelets sunken in hollow of axes, glumes placed side by side covering the hollow 2

1b. Inflorescence not as above and without any sunken spikelets along the axis..... 4

2a. Keel of glume wingless; culms and racemes strongly curved..... *Parapholis incurva*

2b. Keel of glume winged; culms and racemes usually straight 3

3a. Racemes bearing 5–10 spikelets; upper glume apices acute; lemma apices acute..... *Parapholis marginata*

3b. Racemes bearing 10–20 spikelets; upper glume apices acuminate; lemmas apices obtuse ..... *Parapholis filiformis*

4a. Spikes 1-sided..... 5

4b. Spikes 2- or more sided..... 6

5a. Raceme not subtended by inflated leaf sheath; spikelets pectinate, solitary..... *Festuca pectinella*

5b. Raceme subtended by an inflated leaf sheath; spikelets surrounding the rachis, not pectinately arranged..... *Tetrapogon cenchriformis*

6a. Spikelets white-silky villous..... *Lasiurus scindicus*

6b. Spikelets green..... 7

7a. Raceme subtended by an inflated leaf sheath..... *Elionurus royleanus*

7b. Racemes not subtended by an inflated leaf sheath 8

8a. Racemes partially enclosed in the sheath ..... *Dichanthium foveolatum*

8b. Racemes exserted, not enclosed in the sheath 9

9a. Inflorescence open, lax with remote spikelets..... 10

9b. Inflorescence dense, narrow with approximate spikelets. 16

10a. Lower glumes absent; spikelets rotated 90° edgewise from the culm axis and packed adaxially..... 11

10b. Lower glumes present; spikelets not rotated 90° edgewise from culm axis and packed laterally 14

11a. Glumes much longer than the spikelets; lemmas elliptic-ovate, rigid ..... *Lolium temulentum*

11b. Glumes shorter than the spikelets; lemmas oblong-lanceolate, not rigid 12

12a. Spikelets 11–22-flowered; lemmas awned, at least the upper ones ..... *Lolium multiflorum*

12b. Spikelets 3–10-flowered; lemmas unawned, rarely awned 13

13a. Perennials; spikelets 2–10-flowered; lemma, if awned, up to 8 mm long; glumes 1/3 to as long as the spikelets ..... *Lolium perenne*

13b. Annuals; spikelets 5–8-flowered; lemma, if awned, the awns 3–10 mm long; glumes as long or longer than the spikelets ..... *Lolium rigidum*

14a. Rachis fragile, disarticulating at the base of each internode, spikelets falling with attached rachis ..... *Elymus farctus*

14b. Rachis not disarticulating at maturity; florets falling separately, the glumes persistent 15

15a. Glumes unawned, apex obtuse or mucronate; lemmas unawned; rhizomes absent ..... *Elymus elongatus*

15b. Glumes mucronate or short-awned, apex acute; lemmas unawned or short-awned if awned, the awns up to 6 mm long; rhizomes present ..... *Elymus repens*

16a. Inflorescence short, rarely over 10 cm long; internodes clavate; spikelets in pairs at each node of thick rachis, pedicelled spikelet sterile and sessile spikelet fertile, deeply sunken in excavated rachis ..... *Hemarthria altissima*

16b. Inflorescence long, over 10 cm; internodes not clavate; one to many spikelets borne at a node, not as above and not sunken in an excavated rachis 17

17a. Glumes narrowly-linear throughout their length appearing awnlike 18

17b. Glumes lanceolate to ovate, wider near the base and not appearing awnlike throughout. 19

18a. Inflorescence rachis glabrous throughout; lemmas 8–12 mm long, scabrous ..... *Taeniatherum caput–medusae*

18b. Inflorescence rachis ciliate along the margins; lemmas 5–7 mm long, villous ..... *Crithopsis delileana*

19a. Spikelets in pairs or in groups of 3 at a node 20

19b. Spikelets solitary at each node 26

20a. Spikelets in pairs, comprising 1 sessile and 1 pedicelled spikelet without rhachilla extension; glumes dissimilar; central lemma awned from a sinus; flexuous; 8–22 mm long ..... *Pogonatherum paniceum*

20b. Spikelets in group of 3 at each node, lateral spikelets staminate or sterile, central spikelets 1-flowered with bristlelike rachilla extension; glumes similar; central lemma awned from apex, not within a sinus 21

21a. Inflorescence rachis tough, not disarticulating at maturity. ..... *Hordeum vulgare*

21b. Inflorescence rachis fragile, disarticulating at maturity 22

22a. Awns of fertile lemma stout, 4–15 cm long; 2 lateral florets sessile; glumes silky hairy ..... *Hordeum spontaneum*

22b. Awns of fertile lemma slender, not more than 3 cm long; 2 lateral florets pedicelled; glumes not silky hairy 23

23a. Margin of glumes eciliate; lemma awns 10–24 mm long 24

23b. Margin of glumes long ciliate; lemma awns 18– 50 mm long 25

24a. One glume of the lateral spikelets expanded below into a broad or narrow wing ..... *Hordeum marinum* subsp.*marinum*

24b. Both glumes of the lateral spikelets not expanded below into a broad or narrow wing ..... *Hordeum marinum* subsp. *gussoneanum*

25a. Leaf blades green; anthers of central spikelets 0.7–1.4 mm long; prolongation of rachilla of lateral spikelets 3–4 mm long, slender ..... *Hordeum murinum* subsp. *leporinum*

25b. Leaf blades glaucous; anthers of central spikelets 0.2–0.5 mm long; prolongation of rachilla of lateral spikelets 1–2 mm, stout ..... *Hordeum murinum* subsp. *glaucum*

26a. Glumes rounded over the midveins, lateral veins distinct 27

26b. Glumes keeled over the midveins, lateral veins not always distinct 32

27a. Spikes moniliform (resembling a string of beads), swollen at base; disarticulating at the base of the spikelet ..... *Aegilops ventricosa*

27b. Spikes not moniliform or swollen at base; disarticulating at the base of the internode 28

28a. Spikes 10–20 cm long; glumes unawned; only the terminal spikelets with 2 long stout awns ..... *Aegilops longissima*

28b. Spikes 1–8 cm long; glumes awned or unawned; terminal spikelet with awns no different than those below. 29

29a. Spikes 4–8 cm long; glume apex bidentate; principal lemma awns 30–60 mm long ..... *Aegilops bicornis*

29b. Spikes 0.5–5 cm long; glumes apex not bidentate; principal lemma awns ≤30 mm long 30

30a. Glumes with veins unequal in width, unequally spaces and sunk into the surface of the glume ..... *Aegilops geniculata*

30b. Glumes with veins equal in width, equally spaced, riblike and protruding from the surface of the glume 31

31a. Awns of lower glumes of equal width below and about equal in length; glumes of lowest fertile spikelet always with 3 awns ..... *Aegilops kotschyi*

31b. Awns of lower glumes of unequal width below and unequal in length; glumes of lowest fertile spikelet with 2 or 3 awns ..... *Aegilops peregrina*

32a. Lemma awns up to 15 cm long (cultivated wheat) 33

32b. Lemma awns 0–7 mm long (wild plants)..... 36

33a. Inflorescense rachis fragile, disarticulating at maturity; upper glumes apex emarginate; lemma awns 10–15 cm long ..... *Triticum dicoccum*

33b. Inflorescence rachis tough, not diararticulating at maturity; upper glumes apex with a unilateral teeth, truncate or 1-awned 34

34a. Glumes keeled above; winged on keeled; , rounded below; upper glumes apex with a unilateral teeth; truncate or 1-awned, awns 0–40 mm long; lemma awns 0–15 cm long *Triticum aestivum*

34b. Glumes keeled from the bases to the apex; upper glumes apex with unilateral teeth, truncate; lemma awns 8–15 cm long..... 35

35a. Spikelets with 2–3 fertile florets..... *Triticum durum*

35b. Spikelets with 3–5 fertile florets..... *Triticum turgidum*

36a. Perennials; racemes tough; anthers 3–5 mm long ..... *Agropyron cristatum*

36b. Annuals; racemes fragile; anthers < 1.5 mm long 37

37a. Palea at least as long as the body of the lemma; lemma awned, the awns 5–7 mm long; upper glumes awned, the awns 5–7 mm long..... *Eremopyrum distans*

37b. Palea shorter than the body of the lemma; lemma unawned or with a short awn, the awns up to 3 mm longupper glumes unawned..... *Eremopyrum bonaepartis*

Group 11: Panicles spiciform, narrow usually < 1 cm wide

1a. Panicles silky with the spikelets enveloped in long silky white hairs originating from the callus..... *Imperata cylindrica*

1b. Panicles not silky and callus not long hairy..... 2

2a. Base of glumes dilated forming a bulblike swelling ..... *Gastridium phleoides*

2b. Base of glumes not dilated..... 3

3a. Panicle branches consisting of clusters each with 3 sterile spikelets ± covering 2 smaller spikelets, one of which is fertile ..... *Lamarckia aurea*

3b. Panicle branches not as above..... 4

4a. Spikelets awned (lemma and/or glumes) 5

4b. Spikelets unawned..... 13

5a. Glumes awned 6

5b. Glumes unawned; lemmas awned or mucronate..... 9

6a. Lemmas awned..... 7

6b. Lemmas unawned 8

7a. Lower glume mucronate, the mucro 0.5–1 mm long; upper glume awns 1.5–6 mm long; fertile lemma apex entire; sterile lemma awn hooked..... *Holcus annuus*

7b. Lower glume awns 3–7 mm long; upper glume awns 4–7 mm long; lemma apex dentate, 4-fid; lemma awns not hooked..... *Polypogon monspeliensis*

8a. Lower and upper glumes awns 1–2 mm long ..... *Phleum pratense*

8b. Lower and upper glumes awns 3–7 mm long..... *Polypogon maritimus*

9a. Lemma apex entire, mucronate or awned, the awns up to 2 mm long..... *Trisetaria koeleroides*

9b. Lemmas usually awned, the awns 1–16 mm long..... 10

10a. Lemma awns 8–16 mm long, the geniculate awn arising dorsally near the base of the lemma..... *Alopecurus myosuroides*

10b. Lemma awns 1–5 mm long; the straight awn arising near or just below the apex of the lemma 11

11a. Glumes subequal, the lower minutely longer than the upper and often densely wooly ..... *Rostraria pumila*

11b. Glumes unequal, the lower shorter and narrower than the upper, the lower never densely wooly, usually glabrous or with a few scattered hairs 12

12a. Panicles oval in outline, bristly; lemma surface setose, the hairs 0.5 mm long; lemma awns 3–5 mm long ..... *Rostraria hispida*

12b. Panicles linear or oblong in outline, not bristly; lemma surface not setose; lemma awns 1–3 mm long..... 13

13a. Panicles branches pubescent; lower glumes pubescent; lemma awns subterminal, scabrous. ..... *Rostraria rohlfsii*

13b. Panicles branches glabrous; lower glumes glabrous or pubescent; lemma awns terminal, glabrous ..... *Rostraria cristata*

14a. Glume keel winged 15

14b. Glume keel not winged 20

15a. Glume with 2 teethlike projections just above the middle .. *Phalaris paradoxa*

15b. Glume without 2 teethlike projections just above the middle 16

16a. Wings broad, margins erose or denticulate. 17

16b. Wings narrow, margins entire 18

17a. Perennials; culms with a swollen base or pseudocorm; sterile spikelets surrounding the fertile spikelet; lemmas glabrous or with a few hairs near apex ..... *Phalaris coerulescens*

17b. Annuals; culms without a swollen base; sterile spikelets not surrounding the fertile spikelet; lemmas pubescent ..... *Phalaris minor*

18a. Inflorescence capitate, wider near base; caespitose annuals ..... *Phalaris canariensis*

18b. Inflorescence oblong, not wider near base; rhizomatous perennials 19

19a. Panicles interrupted below; rhizomes long and creeping; ligules 6–10 mm long ..... *Phalaris arundinacea*

19b. Panicles not interrupted below; rhizomes short and knotty; ligules 2–4 mm long ..... *Phalaris aquatica*

20a. Lemmas pilose with tubercle-based hairs, the hairs 4–5 mm long ..... *Melica persica*

20b. Lemmas not long pilose or with tubercle based. 21

21a. Glumes deciduous 22

21b. Glumes persistent 23

22a. Spikelets with 6–12 florets; palea keels pectinate-ciliate, the hairs nearly 1 mm long; ligule a ciliate membrane; lemma apex obtuse ..... *Eragrostis ciliaris*

22b. Spikelets with 1 floret; palea keels not pectinate-ciliate; ligule a line of hairs; lemma apex acute ..... *Sporobolus spicatus*

23a. Lemma surface pubescent with clavate hairs; lemma apex truncate ..... *Phleum subulatum*

23b. Lemma surface glabrous or pubescent but without clavate hairs; lemma apex acute or obtuse 24

24a. Culms 60–150 cm tall, erect and reedlike; spikelets 10–16 mm long; panicles 7–22 cm long .... *Calamagrostis arenaria*

24b. Culms 5–50 cm tall, decumbent, geniculate or mat-forming; spikelets 2–7 mm long; panicles 1–7.5 cm long 25

25a. Spikelets 1-flowered, 2–2.5 mm long; lemmas 1-veined, 2–2.5 mm long; glumes shorter than the florets ..... *Sporobolus alopecuroides*

25b. Spikelets 3–5-flowered, 3–77 mm long; lemmas 5-veined, about 4 mm long; glumes slightly longer than the florets .. *Rostraria obtusiflora*

Group 12: Panicles contracted, 0.5–3 (–4) cm wide

1a. Upper and/or lower glumes awned 2

1b. All glumes unawned 3

2a. Lower glume awned, the awns 3–5 mm long; upper glume awns 7–8 mm long; lemmas 6–7 mm long; spikelets 7–10 mm long ..... *Festuca brevis*

2b. Lower glume unawned; upper glume awns 4–6 mm long; lemmas 8–18 mm long; spikelets 12–16 mm long ..... *Festuca fasciculata*

3a. Principal lemmas awned 4

3b. Principal lemmas unawned 9

4a. Lemmas hairy between the veins with 2–8 transverse rows of hair tufts; lemma awns 3–5 mm long 5

4b. Lemmas not hairy between veins or with transverse rows of hair tufts; awns 5–15 mm long 6

5a. Culms 50–120 cm tall, robust; panicles 17–35 cm long; anthers 1.6–2.7 mm long ..... *Centropodia fragilis*

5b. Culms 10–50 cm tall, smaller; panicles 2–15 (–20) cm long; anthers 0.7–1.3 mm long ..... *Centropodia forskalii*

6a. Lemma apex bidentate ..... *Bromus fasciculatus*

6b. Lemmas apex entire 7

7a. Panicles curved or nodding ..... *Festuca myuros*

7b. Panicles straight, not curved or nodding 8

8a. Lemmas awns 5–12 mm long; callus rounded, about 0.2 mm long; glumes similar ..... *Festuca bromoides*

8b. Lemma awns 15–25 mm long; callus pointed, 0.5–0.8 mm long; glumes dissimilar ..... *Festuca fasciculata*

9a. Spikelets 1-flowered 10

9b. Spikelets 3–10-flowered 13

10a. Lemmas 1-veined; ligule a line of hairs; glumes as long or shorter than the floret 11

10.b. Lemmas 3 or 5-veined; ligule membranous; glumes longer than the floret 12

11a. Leaf blades stiff and pungent, conspicuously distichous; glumes ½ to as long as the floret; lower glume apex acute. ..... *Sporobolus pungens*

11b. Leaf blades not stiff, pungent or distichous; glumes <1/2 as long as the floret; lower glume apex obtuse..... ..... *Sporobolus natalensis*

12a. Glumes shiny and glabrous, scaberulous only along the keel; lemmas 1.5–2.3 mm long, apex obtuse; anthers 1–1.5 mm long..... *Agrostis stolonifera*

12b. Glumes scabrous throughout, roughened and not shiny; lemmas 1–1.5 mm long, apex truncate; anthers 0.5–0.8 mm long..... *Polypogon viridis*

13a. Lemmas 3-veined, 1.4–1.5 mm long, membranous, apex acute; glumes deciduous ..... *Eragrostis sarmentosa*

13b. Lemmas 5–7-veined, 2–7.5 mm long, coriaceous, apex obtuse or truncate; glumes persistent..... 14

14a. Spikelets with 3–10 fertile florets, if sterile florets present these located above the fertile ones; lemmas 2–2.5 mm long, apex obtuse; stamens 3; anthers about 0.3 mm long. ..... *Catapodium rigidum*

14b. Spikelets with a single upper fertile floret and two basal sterile florets; lemmas 3.5–7.5 mm long, apex truncate; stamens 6; anthers 3–4 mml long ..... *Ehrharta calycina*

Group 13: Spikelets awned; panicles open

1a. Lemma awns (8–)10–30 cm long, feathery 2

1b. Lemma awns much shorter, usually < 5 cm long, glabrous or scabrous..... 5

2a. Awns conspicuously twisted together with adjacent spikelet awns forming a tail; annuals ..... *Stipellula capensis*

2b. Awns not conspicuously twisted together with others and not forming a tail; perennials 3

3a. Awns plumose for their whole length, the hairs 0.5–1.3 mm long..... *Stipa arabica*

3b. Awns scabrid or pubescent, the hairs < 0.3 mm long..... 4

4a. Awns 20–25 cm long, pubescent ..... *Stipa lagascae*

4b. Awns 6–13 cm long, scabrous..... *Stipellula parviflora*

5a. Spikelets usually flushed with purple; awns of lemmas inserted from the base, the column with a clavate upper limb, brownish, with a ring of hairs at the junction .... *Corynophorus divaricatus*

5b. Spikelets green; awns of lemmas subapical or inserted near the middle, the column never clavate or with a ring of hairs at the junction..... 6

6a. Spikelets all solitary. 7

6b. Spikelets in pairs usually with a sessile and pedicellate or in triplets with two pedicellate and one sessile. 30

7a. Spikelets (10–) 15–60 mm long 8

7b. Spikelets 1.5–12 mm long 36

8a. Glumes longer than the spikelet; lemma awns geniculate with a strongly twisted column; ovaries pubescent all over 9

8b. Glumes much shorter than the spikelet; lemma awns usually straight and not geniculate; ovaries pubescent only near the apex 15

9a. Tips of lemmas bidentate with awned teeth, the teeth awns usually 1–1.5 cm long. 10

9b. Tips of lemmas bidentate with unawned teeth or with the awns of the teeth much shorter than 0.8 mm long 12

10a. Spikelets erect; callus elongated, 4.2–6 mm long; lower glumes 25–40 mm long..... *Avena longiglumis*

10b. Spikelets pendulous; callus obtuse, < 2 mm long; lower glumes 16–26 mm long..... 11

11a. Spikelets (1.8–) 2–3 cm long; lower lemma 1.6–2 cm long. ..... *Avena barbata* subsp. *barbata*

11b. Spikelets 1.4–1.8 cm long; lower lemma 1.2–1.4 cm long... ..... *Avena barbata* subsp. *wiestii*

12a. Floret callus glabrous; lemmas glabrous. ..... *Avena sativa*

12b. Floret callus hairy; lemmas hairy on the lower 1/3..... 13

13a. Lemmas dark brown; rachilla not disarticulating at maturity..... *Avena fatua*

13b. Lemmas green; rachilla disarticulating between the florets at maturity 14

14a. Glumes 30–50 mm long; lowest lemmas 25–40 mm long.... ..... *Avena sterilis* subsp. *sterilis*

14b. Glumes 25–30 mm long; lowest lemmas 20–25 mm long.... ..... *Avena sterilis* subsp. *ludoviciana*

15a. Spikelets 45–60 mm long; lemmas awns 45–60 mm long.... 16

15b. Spikelets less than 45 mm long; lemmas awns 4–40 mm long..... 17

16a. Panicles lax, spreading, broadly ovate, the branches longer than spikelets; base of lemmas in profile, contracted just above the callus; callus blunt with an oval scar .... *Bromus diandrus* var. *diandrus*

16b. Panicles contracted, stiffly erect, narrowly ovate, the branches usually shorter than the spikelets; base of lemmas in profile, continuous with callus; callus pointed with an elliptic scar .....*Bromus diandrus* var. *rigidus*

17a. Lower glumes 1-veined; upper glumes 3-veined; lemma awns not more than 20 mm long.....18

17b. Lower glumes 3–9-veined; upper glumes 5–13-veined; awns usually 15–40 mm long 21

18a. Panicles branches compound bearing (3–) 5–8 fertile spikelets..... *Bromus tectorum* var. *tectorum*

18b. Panicles branches simple bearing 1–3 fertile spikelets....19

19a. Panicles branches bearing 1–3 fertile spikelets; spikelet pedicels ≤ 1 cm long; lemmas 10–20 mm long.....20

19b. Panicles branches bearing a single fertile spikelet; spikelet pedicels usually > 3 cm long; lemmas 15–40 mm long..... ..... *Bromus sterilis*

20a. Plants perennial and rhizomatous; lemmas awnless, mucronate or short-awned, the awns up to 1.5 mm long .. .. *Bromus inermis*

20b. Plants annuals, caespitose; lemmas awned, the awns 12–20 mm long..... *Bromus madritensis*

21a. Lemma awns curved and reflexed-spreading.....22

21b. Lemma awns straight 23

22a. Lemmas coriaceous with inconspicuous veins; margins of lemma not involute but overlapping the back of the adjacent lemma; ligules 1–3 mm long.....*Bromus japonicus*

22b. Lemmas membranous with conspicuous veins; margins of lemma somewhat involute at maturity, not overlapping the back of the adjacent lemma but wrapped around the caryopsis; ligules 3–6 mm long ..... *Bromus pulchellus*

23a. Lemma awns briefly coiled at the base 24

23b. Lemmas awns not coiled at the base.....26

24a. Spikelets 10–15 mm long, 2–3 mm wide; lemmas 6–11 mm long..... *Bromus scoparius*

24b. Spikelets (12–) 25–50 mm long, 3–16 mm wide, lemmas 11–18 mm long.....25

25a. Leaf blades 3–5 mm wide; lemma awns awns 11–20 mm long; spikelets 3–7 mm wide..... *Bromus alopecuros*

25b. Leaf blades 1–2.5 mm wide; lemma awns 6–12 mm long; spikelets 6–16 mm wide ..... *Bromus lanceolatus*

26a. Lemmas strongly keeled; spikelets strongly laterally compressed..... *Bromus catharticus*

26b. Lemmas rounded on the back; spikelets terete to moderately laterally compressed 27

27a. Glumes with ciliolate margins; culms nodes swollen..... ..... *Bromus aegyptiacus*

27b. Glumes without ciliolate margins; culm nodes not swollen 28

28a. Lemmas 5.5–6.5 mm long; lemma awns 3–7 mm long, terete near base, straight; caryopsis longer than the palea, often visible beyond the tip of the lemma.. *Bromus lepidus*

28b. Lemmas 8–17 mm long; lemma awns 5–17 mm long, flattened near base, straight or slightly divergent; caryopsis shorter than the palea, concealed within the floret.....29

29a. Lemmas 5–7-veined, 2–4 mm wide, glabrous or pubescent, narrowly lanceolate in profile; lemma awn arising 2–3 mm below the tip; anthers 1 mm long; lower glumes usually 3-veined .....*Bromus pectinatus*

29b. Lemmas 7–9 (–11)-veined, 4.5–5.5 mm wide, hirsute, narrowly oblanceolate in profile; lemma awn arising 0.7–1.9 mm below the tip; anthers 2–2.5 mm long; lower glumes 3–7-veined..... *Bromus hordeaceus*

30a. Spikelets in triplets with two pedicellate and one sessile31

30b. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled 32

31a. Panicles branches villous with white or dark brown hairs; fertile lemmas glabrous without transverse tufts of hairs; leaf blade apices not stiff and pungent, margins not white cartilaginous; upper glume of fertile lemma plumose ....*Chrysopogon plumulosus*

31b. Panicle branches scaberulous without white or dark brown hairs; fertile lemmas with transverse tufts of hairs, the hairs 4–5 mm long; leaf blade apices stiff and pungent with conspicuous white cartilaginous margins; upper glume of fertile lemma unawned .....*Danthoniopsis barbata*

32a. Column of the lemma awns pubescent, hairy on the spiral; paleas present 33

32b. Column of the lemma awns glabrous, not hairy on the spiral; paleas absent or minute.....34

33a. Apex of lower glume dentate, 3-fid; awns of upper lemma 10–16 mm long; plants perennial, rhizomatous ....*Sorghum halepense*

33b. Apex of lower glume entire; awns of upper lemma up to 10 mm long; plants annual or short-lived perennials, not rhizomatous..... *Sorghum bicolor*

34a. Lower glumes pubescent with white or yellow hairs..... ..... *Sorghum arundinaceum*

34b. Lower glumes glabrous....35

35a. Panicle branches tough; spikelet callus pilose.... *Sorghum x drummondii*

35b. Panicle branches fragile at node; spikelet callus not pilose. *Sorghum virgatum*

36a. Glumes and lemmas villous with white or purplish-red hairs....37

36b. Glumes and lemmas glabrous....37

37a. Spikelets 1.5–2 (–2.4) mm long; upper glumes not gibbous.... *Melinis minutiflora*

37b. Spikelets 5–12 mm long; upper glumes gibbous.... *Melinis repens*

32a. Lemmas 1.5–2 mm long, the awns 3–5 mm long; apex of lemma obtuse.... *Oloptum miliaceum*

32b. Lemmas 6–7.5 mm long, the awns 8–13 mm long, apex of lemma acute.... *Piptatherum holciforme*

Group 14: Spikelets unawned; panicles open

1a. Both glumes absent or obscure....2

1b. Both glumes or at least the upper present....3

2a. Spikelets 8–11 mm long, 2.5–3.5 mm wide, persistent; lemma apex mucronate or awned, the awns up to 160 (cult.).... *Oryza sativa*

2b. Spikelets 3.4–4.8 (–5.2) mm long, 1.2–1.4 (–1.7) mm wide, disarticulating entire; lemma apex entire, not mucronate or awned.... *Leersia hexandra*

3a. Primary panicles branches whorled, at least on the lower nodes....4

3b. Primary panicles branches not whorled at most nodes..10

4a. Lemmas pubescent, hairy below and along the veins....5

4b. Lemmas glabrous throughout....6

5a. Lemma apex apiculate; anthers 1.4–2.6 mm long.... *Poa diaphora*

5b. Lemma apex not apiculate; anthers 0.3–0.7 (–1) mm long.. *Poa persica*

6a. Glumes longer than the florets, persistent....7

6b. Glumes ≤ the florets, deciduous or persistent....8

7a. Roots aromatic; lower glumes surface spinose, glumes dissimilar; spikelets 3.5–5 mm long.... *Chrysopogon zizanioides*

7b. Roots not aromatic; lower glumes surface not spinose, glumes similar; spikelets 1.8–3 mm long.... *Agrostis stolonifera*

8a. Spikelets dorsally compressed with a 5-veined sterile lemma just below the fertile lemma; leaf blades usually 12–35 mm wide.... *Megathyrsus maximus*

8b. Spikelets laterally compressed without a sterile lemma below the fertile lemma, the fertile lemma 1-veined; leaf blades 1–10 mm wide....9

9a. Panicles 3–20 cm long; apex of lower glumes obtuse; anthers 0.7–1 mm long.... *Sporobolus ioclados*

9b. Panicles 20–60 cm long; apex of lower glumes acute; anther 1.1–1.3 mm long.... *Sporobolus wrightii*

10a. Spikelets pendulous; lemmas orbicular, gibbous, and auriculate near base....11

10b. Spikelets not pendulous; lemmas not orbicular. gibbous or auriculate near base....12

11a. Spikelets 3–5 mm long, 3–5 mm wide; apex of lemma not cuspidate.... *Briza minor*

11b. Spikelets 14–25 mm long, 8–15 mm wide; apex of lemma cuspidate.... *Briza maxima*

12a. Spikelets in pairs with a fertile sessile and sterile pedicelled.... *Sorghum bicolor*

12b. Spikelets not in pairs....13

13a. Lemmas with white capitate hairs near base, the hairs 0.2 mm long.... *Desmazeria philistaea*

13b. Lemmas without white capitate hairs....14

14a. Glumes and lemmas pilose with white tubercle-based hairs.... *Tricholaena teneriffae*

14b. Glumes and lemmas not pilose or, if hairy, the hairs not white and tubercle-based....15

15a. Lemma apex bifid and dentate....16

15b. Lemmas apex not bifid or dentate....19

16a. Spikelets 15–25 mm long; lemmas 10–13 mm long; ovary pubescent on the apex; rhizomatous perennials.... *Bromus inermis*

16b. Spikelets ≤ 7 mm long; lemmas 1.2–3.3 mm long; ovary glabrous throughout; caespitose annuals or perennials..17

17a. Spikelets 1.5–2.4 mm long, persistent; lower glumes without veins.... *Melinis minutiflora*

17b. Spikelets 4–7 mm long, deciduous with the pedicels; lower glumes 5–7-veined....18

18a. Lemmas 2–3.5 mm long, apical lobes narrowly triangular,

0.6–1.3 mm long; palea shorter than the lemma. .... *Schismus arabicus*

18b. Lemmas 1.5–2 mm long, apical lobes broadly triangular, 0.3–0.4 mm long; palea ≥ the lemma in length ....*Schismus barbatus*

19a. Spikelets all 1-flowered with no additional florets .... *Sporobolus wrightii*

19b. Spikelets with more than a single floret.....20

20a. Spikelets with one fertile floret and 1 or 2 sterile florets..... 21

20b. Spikelets with 3–10 fertile florets 28

21a. Spikelets laterally compressed, each spikelet with 2 basal sterile florets; fertile florets with 6 stamens ....*Ehrharta calycina*

21b. Spikelets dorsally compressed, each spikelet with 1 basal sterile floret; fertile florets with 3 stamens 22

22a. Upper fertile lemma faintly to strongly rugose..... .....*Megathyrsus maximus*

22b. Upper fertile lemma smooth 23

23a. Spikelets 3.5–5.5 mm long 24

23b. Spikelets 2–3.2 (–3.5) mm long 25

24a. Plants annual without woody culms or resembling bushes; leaf blade apices not pungent ..... *Panicum miliaceum*

24b. Plants perennial with woody culms resembling bushes; leaf blade apices pungent ..... *Panicum turgidum*

25a. Lower glumes ½–2/3 the length of the spikelet; lemmas apex acute .....*Panicum antidotale*

25b. Lower glumes up to ⅓ the length of the spikelet 26

26a. Plants with a knotty rootstock; lower glume membranous, 1–3 (–7)-veined.....*Panicum coloratum*

26b. Plants without a knotty rootstock but with slender rhizomes or stolons; lower glumes hyaline, usually unveined, rarely 3-veined.....27

27a. Plants erect with spreading rhizomes; leaf sheaths tough, wooly on the margins when young; leaf blade apices pungent; ligules 0.3–0.5 mm long..... *Panicum repens*

27b. Plants with stolons; leaf sheaths loose, papery, glabrous on the margins; leaf blade apices not pungent; ligules 0.8–2 mm long.....*Panicum hygrocharis*

28a. Lemmas 5-veined.....29

28b. Lemmas 3-veined.....32

29a. Spikelets 10–18 mm long; lemmas 6–9 mm long; culms 50–150 cm tall; leaf blades 4–10 mm wide .... *Lolium arundinaceum*

29b. Spikelets 2–10 mm long; lemmas 2–5 mm long; culms ≤ 65 cm tall; leaf blades 1–5 mm wide 30

30a. Plants perennial forming a bulbous base composed of old leaf sheaths; anthers 1.5–2.5 mm long; apex of ligule acute .....*Poa sinaica*

30b. Plants annual or short-lived perennials, not forming a bulbous base of old leaf sheaths; anthers ≤ 1.1 mm long; apex of ligule obtuse.....31

31a. Anthers 0.6–1 (–1.1) mm long; spikelets crowded or sparsely arranged on the branches.....*Poa infirma*

31b. Anthers 0.1–0.5 mm long; spikelets always crowded on the branches.....*Poa annua*

32a. Plants perennial, forming innovations at the basal nodes; caryopses narrowly triangular in cross section, strongly laterally flattened with a deep ventral groove .... *Eragrostis tenuifolia*

32b. Plants annual, usually tufted, without innovations at the basal nodes; caryopses not narrowly triangular in cross section or strongly laterally flattened, without a deep ventral groove.....33

33a. Palea keels prominently ciliate, the cilia 0.2–1 mm long 34

33b. Palea keels smooth or scabrous the scabridities < 0.2 mm long. 35

34a. Spikelets 2.2–3 mm long; lemmas and culms without glands; lemmas (0.8–) 1–1.2 mm long, oblong; anthers 2... .....*Eragrostis lepida*

34b. Spikelets 6–20 mm long; lemmas with crateriform glands on the keels, similar glands also often present below the nodes; lemmas 2–2.8 mm long, broadly ovate; anthers 3 ... .*Eragrostis cilianensis*

35a. Ligules membranous, neither ciliolate or ciliate..... .....*Eragrostis japonica*

35b. Ligules membranous and ciliolate to ciliate, the cilia often longer than the basal membrane 36

36a. Plants with glandular pits or bands somewhere, the locations various, including any or all of the following: below the cauline nodes, on the sheaths, blades, rachises, panicle branches or pedicels, or on the keels of the lemmas and paleas.....37

36b. Plants without glandular pits or bands 40

37a. Spikelets 1–1.4 mm wide; pedicels 1–10 mm long, lax appressed or divergent.....*Eragrostis pilosa*

37b. Spikelets 1.1–4 mm wide; pedicels 0.2–4 mm long, stiff, straight, usually divergent.....38

38a. Lemmas 2–2.8 mm long with 1–3 crateriform glands along the keels; spikelets 6–20 mm long, 2–4 mm wide, with 10–40 florets; disarticulation below the florets, the rachillas persistent; anthers yellow ..... *Eragrostis cilianensis*

38a. Lemmas 1.4–1.8 mm long, rarely with 1 or 2 crateriform glands along the keels; spikelets 4–7 (–11) mm long, 1.1–2.2 mm wide, with 7–12 (–20) florets; disarticulation below the lemmas , both the paleas and rachillas usually persistent; anthers reddish-brown 39

39a. Panicles with glandular regions below the nodes, the glandular tissue forming a ring or band, often shiny or yellowish; blade margins without crateriform glands; pedicels without glandular bands ..... *Eragrostis barrelieri*

39b. Panicles sometimes with glandular areas, but rarely rings of glandular spots or crateriform pits below the nodes, the glands usually dull greenish-gray to straminious; blade margins sometimes with crateriform glands; pedicels usually with glandular bands..... *Eragrostis minor*

40a. Lemmas 1.6–3 mm long; florets persistent and the grain retained within; caryopses 0.3–1.3 mm long obovoid, smooth, light brown to white; plants cultivated, occasionally escaping..... *Eragrostis tef*

40b. Lemmas 1.2–1.7 mm long; florets deciduous, the grains not retained within; caryopses 0.4–0.9 mm long, ovoid, orbicular to prism-shaped or isodiametric, smooth or striate, brownish; plants native or established introductions 41

41a. Spikelets 5–25 mm long, 10–60-flowered; anthers 2..... ..... *Eragrostis tremula*

41b. Spikelets 3–15 mm long, 4–20 flowered; anthers 3 42

42a. Lower glumes 1–1.5 mm long, about as long as the upper glume, 1-veined; panicle branches not whorled at the lower nodes; lemma apex truncate or obtuse; caryopses orbicular, isodiametric ..... *Eragrostis aspera*

42b. Lower glumes 0.5–0.7 mm long, ½ to 2/3 as long as the upper glume, unveined; panicle branches whorled at the lower nodes; lemma apex acute or obtuse caryopses ellipsoid 43

43a. Panicle branches partially included below in the subtending leaf; spikelets 5–15 cm long; caryopses 0.5–0.7 mm long..... *Eragrostis aegyptiaca*

43b. Panicle branches exserted and not included below in the subtending leaf; spikelets 3–6 mm long; caryopses 0.7–1 mm long..... *Eragrostis pilosa*

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REFERENCES

Boulos L. 2009. Flora of Egypt checklist - Revised annotated edition. Cairo: Al Hadara Publishing.

Clayton W, Renvoize S. 1986. Genera graminum. Grasses of the world. Kew Bulletin, Additional Series 13: 1–389.

Clayton WD, Vorontsova MS, Harman KT, Williamson H. 2016 onwards. GrassBase - The online World grass flora. The Board of Trustees, Royal Botanic Gardens http://www.kew.org/data/grasses-db.html (accessed 9 April 2019).

Cope TA. 2005. Gramineae. In: Boulos L (Ed) Flora of Egypt, vol 4: Monocotyledons (Alismataceae-Orchidaceae). Cairo: Al Hadara Publishing; p. 124–349.

Cope TA, Hosni A (1991) A key to Egyptian Grasses. Royal Botanic Gardens, Kew.

Herrera Arrieta YH, Peterson PM. 2018. Grasses of Chihuahua, Mexico. Smithsonian Contributions to Botany. 107: 1–380.

Hosni HA, Ibrahim KM. 2004. The identification of grasses of the northwestern coastal region of Egypt by their vegetative characters. Taeckholmia. 24: 79–89.

Ibrahim KM, Dube S, Peterson PM, Hosni HA. 2018. Grasses of Mali. Smithsonian Contributions to Botany. 108: 1–146.

Ibrahim KM, Hosnii HA, Peterson PM. 2016. Grasses of Egypt. Smithsonian Contributions to Botany. 103: 1–201.

Kellogg EA (2015) Xlll. Flowering Plants, Monocots, Poaceae. In: Kubitski K (Ed) The Families and Genera of Vascular Plants. Switzerland: Springer International; p. 1–416.

Reveal JL. 2012. An outline of a classification scheme for extant flowering plants. Phytoneuron. 2012-37: 1–221.

Soreng RJ, Davidse G, Peterson PM, Zuloaga FO, Judziewicz EJ, Filgueiras TS, Morrone O. 2019. Catalogue of New World Grasses (Poaceae). http://wwwtropicosorg/project/cnwg (accessed 4 April 2019).

Soreng RJ, Peterson PM, Romaschenko K, Davidse G, Teisher JK, Clark LG, Barberá P, Gillespie LJ, Zuloaga FO. 2017. A worldwide phylogenetic classification of the Poaceae (Gramineae) II: An update and a comparison of two 2015 classifications. Journal of Systematics and Evolution. 55: 259–290.

Soreng RJ, Peterson PM, Romaschenko K, Davidse G, Zuloaga FO, Judziewicz EJ, Filgueiras TS, Davis JI, Morrone O. 2015. A worldwide phylogenetic classification of the Poaceae (Gramineae). Journal of Systematics and Evolution. 53: 117–137.

Stevens PF. 2001 onwards. Angiosperm Phylogeny Website, Version 14, July 2017. http://wwwmobotorg/MOBOT/research/APweb/ (accessed 4 April 2019).

Täckholm V. 1974. Students' Flora of Egypt, 2nd edition. Cairo: Cairo University.

Täckholm V, Täckholm G, Drar M. 1941. Flora of Egypt vol. I. Pteridophyta, Gymnospermae and Angiospermae, Part Monocotyledones: Typhaceae- Gramineae. Bulletin of the Faculty of Science. 17: 1–557.

Takhtajan A. 2009. Flowering plants, ed. 2. Netherlands: Springer.

Tzvelev N. 1989. The system of grasses (Poaceae) and their evolution. The Botanical Review. 55: 141–204.