— 1890 —

Bambusa arundinacea Retz, 23 m. high, in Dehra Dun Valley (Northwestern Himalayas, 6070 m. above sea-level). In the background at the right are the outposts of the Himalayas, at the left those of the Sivalik range. In the valley are groves of *Mangifera indica* L., and on the hills forests of *Shorea robusta* Gaertn. (After nature by Katharina Brandis.)

THE

TRUE GRASSES

BY

EDUARD HACKEL

TRANSLATED FROM

DIE NATÜRLICHEN PFLANZENFAMILIEN

BY

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AND

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PREFACE TO THE TRANSLATION.

A work embracing the grass family as a whole, in all its aspects, enumerating the best known economic species and the uses which they serve, discussing their structure and morphology and their arrangement into tribes and genera with the characters of these pointed out in a manner enabling one to classify any grass which may come to his hand, is a desideratum in our literature and one which has long been felt by many. Such a work is the contribution made by Prof. Eduard Hackel, of St. Poelten, Austria, to that great German publication on the Natural Families of Plants (*Die natürlichen Pflanzenfamilien*) edited by Drs. Engler and Prantl. Prof. Hackel stands without a peer among agrostologists; his contribution, therefore, has an especial value and may be accepted as expressing the latest views of the highest authority.

The work here referred to contains so much of practical as well as of scientific importance and interest that its presentation in a form available to English readers seemed highly desirable. A further incentive to the preparation of an English translation was the fact that at this time particular interest in the investigation of grasses is being taken by the United States Government, and on all sides eager demands are being made for information relative to these plants. That this is so is not remarkable when we consider the unrivalled economic importance of grasses, furnishing as they do daily food to man and the animals upon which he is most dependent, as well as supplying a great variety of articles used in manufacture, the arts, and medicine. While the present work may not add to the interest in the subject already existing, it cannot fail to afford information much desired.

With a view to increasing the value of the work and rendering it more serviceable to private students and

general readers, an introduction wherein is illustrated the manner of using the keys of analysis in determining genera is given, and a full glossary and index are added. It is hoped also that the translation will thus be made more suitable for use as a text-book in our Agricultural Colleges, for which purpose the treatment of the structure, morphology, and physiology of grasses, given in detail and fully illustrated in Part I, renders the work especially well adapted.

Those familiar with the German will notice that in translation occasional liberties have been taken with the original by the omission of unimportant matter, insertion of head-lines, etc. Except in the account of the Bambuseæ, all matter enclosed in brackets has been added by myself. A number of notes and observations have been added by Prof. Hackel, to whom the manuscript was submitted for revision and approval before being sent to the printers.

Following the number of each genus there has been inserted, in parenthesis, its number in Bentham and Hooker's *Genera Plantarum*, facilitating reference to that work and at the same time showing the diversity between the systems of classification adopted.

With few exceptions the illustrations are from electrotypes of the original woodcuts obtained from the German publisher, Wilhelm Engelmann, of Leipzig. The figures illustrating the spikes of the cereals were redrawn from the imprints in the original and reduced nearly one half by photo-engraving. Figures 3*a* and 91*a* are additions, while figures 45*a*, 75*a*, and 78 were drawn especially for the translation and appear here for the first time.

Thanks are due Mr. Charles E. Smith, of Philadelphia, for his kind assistance with the proofs, and Dr. W. J. Beal, of Lansing, Michigan, and Mr. C. M. McClung, of Knoxville, Tennessee, for their interest in the progress of the work and material aid in its publication.

F. Lamson-Scribner.

University of Tennessee,
Knoxville, Feb. 1. 1890.

INTRODUCTION.

No introduction appears to be necessary further than to give for the benefit of those unfamiliar with botanical keys, an illustration of their use. For this purpose let us suppose that we have in hand a specimen of Orchard-grass. After examining it carefully and noting the characters presented by the inflorescence, spikelets, glumes, etc., we turn to the key to the tribes on page 34, and read the characters under "A. Spikelets one- rarely two-flowered," etc. In our specimen the spikelets are 3–5-flowered, so we pass to "B," on the next page. The characters here—"spikelets 1–∞ (many) flowered, . . . rachilla articulated above the empty glumes, . . . with distinct internodes between the flowers" (flowering glumes)—are those of our plant, and we continue by reading the characters following "a," all of which apply, and then go on reading the characters following "α." As those of our specimen are here included, the spikelets being upon distinct pedicels and disposed in a panicle, we proceed to the next section of the key; viz., "I. Spikelets one-flowered." As those in our specimen are 3–5-flowered, we pass on to "II. Spikelets 2–∞ flowered." Our Orchard-grass falls under this section, and as it possesses characters (flowering glumes longer than the empty ones, and with a short straight awn from the point) which exclude it from the next division, "1," we try "2," which leads us to tribe XI, **Festuceæ**, further described on page 135. Carefully comparing our plant with the more extended characters here given, we note their agreement (or disagreement, as would be the case if we had proceeded wrongly to this point).

Being satisfied that our plant must belong to the

Festuceæ, we now try to determine its genus by the key which follows. The flowering glumes are not "divided into three-to-many awn-like lobes," so we pass from "A" to "B" on the next page, where it says "Flowering glumes entire or two-toothed," etc. As those of Orchard-grass are entire, we continue with the next division of the key, "a. Rachilla or flowering glumes with long hairs which envelop the latter." There are no such hairs in our specimen, so we pass at once to "b. Rachilla and flowering glume naked or hairy, hairs much shorter than the glumes." These characters apply to our plant, and as it has plumose stigmas projecting from the sides of the flowering glumes, we pass from "α" directly to "β," the division having stigmas of this character.

In order to avoid repetition, we will simply quote from the succeeding divisions of the key that which it is necessary to read to complete the determination, placing in italics the characters *excluding* from any one of them the grass we are analyzing. All reference to the subdivisions under these last are of course omitted.

"I. Spikelets of *two* forms," etc.

"II. Spikelets all alike."

"1°. Flowering glumes *three-toothed*," etc.

"2°. Flowering glumes of some other structure."

"* Flowering glumes *one to three*-nerved," etc.

"** Flowering glumes 3–5- to many-nerved, with *two or more* of the upper glumes *empty*," etc.

"*** Flowering glumes five- to many-nerved; each containing a ☿ flower or the upper with only a ♂ flower, or empty." (Exceptions noted.)

"† Leaves *broad, lanceolate or ovate, with fine transverse veins between the longitudinal nerves.*"

"†† Leaves linear or lanceolate, no distinct transverse veins."

"○ Keel of palea *winged*," etc.

"○○ Keel of palea not appendaged."

"△ Empty glumes *three to six* at the base of each spikelet."
"△△ Empty glumes two."
"X Plants strictly *diœcious*," etc.
"XX Plants hermaphrodite," etc.
"□ Flowering glumes *cordate* at the base."
"□□ Flowering glumes not cordate at the base. . . . AA. etc." (referring to the next series of divisions in the key).

"AA. Spikelets closely imbricate, arranged in a *linear, dense false spike.*"
"BB. Spikelets densely imbricate, *crowded in short spikes*," etc.
"CC. Spikelets in small fascicles which are united in a glomerate or interrupted panicle."
"aa. Panicles one-sided. . . **252. Dactylis.**"

Our analysis by the key has thus brought us to the genus *Dactylis*, No. 252, and on page 161 we find given further characters belonging to it. We learn here also that the genus contains but one species, *Dactylis glomerata* L. or Orchard-grass, its geographical distribution, that it is "a first-class fodder-grass, especially for heavy, wet soils," that it is very productive, growing rapidly after cutting, and endures shade. There is also a figure, illustrating the inflorescence and a single spikelet, on page 102.

Orchard-grass was selected to illustrate the use of the keys not only because it is widely distributed, either naturally or in cultivation for hay, and therefore readily obtainable, but also because its analysis required such an extended use of the key. There are very many genera requiring much less reading in their analysis and possible of determination far more quickly. The manner of procedure is practically the same in every case. While the keys are in the majority of cases a certain guide in determining the genus, the statement made on

page 33 must be kept in mind when using them; for in the tribes as well as in the larger genera the characters given are of necessity subject to many exceptions.

Under each genus will be found its distinguishing characters not already mentioned in the keys, the number of species it embraces and their geographical distribution, also the names and uses of those species of marked economic value. The somewhat extended account given of the Cereals and Bamboos, due to their special importance, contains much of general interest.

THE TRUE GRASSES.

(GRAMINEÆ.*)

PART I.

STRUCTURE, MORPHOLOGY, AND PHYSIOLOGY.

Special Characters of the Order.—Flowers hermaphrodite, rarely unisexual, perianth none, in the axils of enveloping chaff-like scales or bracts (flowering glumes), solitary or united into many-flowered spikelets ; one bract (palea) usually two-keeled and opposite the flowering glume ; one very small scale (anterior lodicule) split to the base and usually herbaceous, above the flowering glume; rarely with another entire scale (posterior lodicule) above the palea; occasionally with the palea only, or even without that ; very rarely truly terminal.

Stamens usually in a whorl of three (rarely two) members, sometimes in two alternating whorls ; the number of stamens in a whorl is very rarely either much increased, or reduced by abortion to one. Carpel single, standing opposite the palea. Ovary one-celled, usually with two lateral, rarely with three or one, styles. Ovule solitary, slightly campylotropous, without a funiculus and with the micropyle turned downwards. Fruit usually a caryopsis rich in amylaceous matter. The embryo, covered only by the pericarp, lies outside of the albumen at the front and base of it. Embryo usually small and straight with a shield-shaped cotyledon, in the anterior cavity or furrow of which lies the plumule, having several rudimentary leaves, and the radicle with its surrounding tissues.

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* Important Literature :—R. Brown, *General Remarks*, etc., in *Vermischte Schriften*, I. p. 107.—Palisot de Beauvois, *Essai d'une Nouvelle Agrostographie*, Paris, 1812.—Kunth, *Révision des Graminées*, Paris, 1829, and *Agrostographia sive Enum. Graminum*, Stuttgart, 1833.—Röper, *Beiträge z. Flora Mecklenburgs*, 2 parts, Rostock, 1844.—Payer, *Traité d'Organogénie de la Fleur*, p. 701, Paris, 1857.—Döll, *Flora d. Grossherz. Baden*, and in Martius et Eichler, *Flora Brasiliensis*, vol. II. parts II. and III.—Eichler, *Blüthendiagramme*, I. 199.—Hackel, *Untersuchungen über die Lodiculæ der Gräser*, in Engler's Bot. Jahrb., I. 336.—Bentham in Journ. Linn. Society, XIX. p. 14, and in Bentham and Hooker's *Genera Plantarum*, III. p. 1074.

Herbs, rarely shrubs or trees, with closed-jointed stems (culms) and alternate, sheathing leaves. Spikelets or solitary flowers usually with empty chaff-like bracts (empty glumes) at the base, arranged in panicles or spikes.

Organs of Vegetation.—THE CULM.—Grasses are either monocarpic or, more commonly, perennial by means of a rhizome which is formed by the catenulate lowest internodes of the consecutive flowering culms and their leafy basal branches. Aerial, woody, perennial stems occur only among the *Bambuseæ*. Perennial grasses may usually be recognized by the presence of sterile shoots which grow from the lowest joint of the culm or proceed from that of other similar shoots; they often break through the sheath of the subtending leaf while yet buds (extravaginal shoots) or, more rarely, develop within the sheath (intravaginal). In the latter case the grass forms dense and sometimes large but always isolated tufts. For the formation of close *turf* (Grasnarbe), such as the meadows of wooded regions present, only grasses with extravaginal shoots are adapted, since these shoots, before they grow upwards, creep for a longer or shorter distance below the surface, and the runners thus formed quickly fill up all the available interstices of the soil by their ramifications. All grass culms branch at least from the lowest nodes, and these also have the power of sending out secondary roots. Even aside from the richly branched *Bambuseæ*, branches from the upper or from all nodes occur in many tropical grasses, but in those of the temperate zone of the Old World this habit is rare. The culm is rarely filled with pith (e.g., almost all *Andropogoneæ*, many *Paniceæ*, etc.); it is usually hollow, the central cavity resulting from the separation of the original pith cells which have ceased to grow, and the remains of these cells line the walls of the cavity.

The Nodes.—The pith cavity is always closed at the nodes which are the larger or smaller swellings at the limits of the internodes. The difference between culm-nodes and sheath-nodes is constantly overlooked, but ought to be carefully noted. The swellings that are visible externally do not belong to the culm,

but to the base of the leaf-sheath; they are to be found in all grasses (*Molinia* excepted), at least so long as the internode above has not completed its growth; but when the base of the internode, the portion which remains longest capable of growth, is transformed into permanent tissue, one of two things may happen: the tissue of the sheath-node may remain turgescent and capable of growth, then no swelling is formed at the base of the culm-joint; or a true culm-node may be developed from one to three millimeters above the sheath-node, assuming all the properties of the sheath-node (see below), and at the same time the latter shrivels up. This last is the case with all *Andropogoneæ* and *Paniceæ*, and many *Bambuseæ*, as well as with many single genera of other tribes (for example, *Stipa*, *Eragrostis*, *Pappophorum*, *Arundo*, etc.). The majority of *Agrostideæ*, *Aveneæ*, *Festuceæ*, and *Triticeæ* have only sheath-nodes; and, finally, there are grasses without any distinct nodes, such as have their branches very thickly leaved, from the fact that in these the sheaths of several internodes overlap each other, as in many *Bambuseæ*.

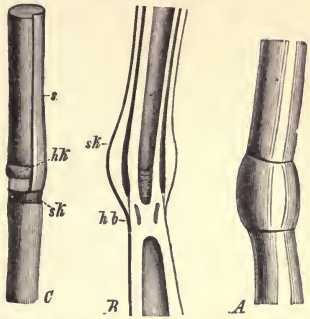

FIG. 1.—*A*, Fragment of culm of wheat with sheath-node, somewhat bent. *B*, Longitudinal section of the same: *sk*, sheath-node; *hb*, point of insertion of the sheath. *C*, *Andropogon;* the sheath *s* removed on the left side in order to show the culm-node, *hk*; *sk*, sheath-node.

The nodes are not, as is often supposed, to give strength to the culm; they are composed of a somewhat thin-walled parenchyma whose cells are strongly turgescent and through which run delicate fibro-vascular bundles with well-developed bundles of collenchyma on the outside. Their function consists solely in the erection of culms that have become bent down. The parenchyma of the node is geotropically sensitive, and as

soon as the culm is placed in a horizontal or oblique position the cells of the node on the side turned towards the earth begin to elongate, and consequently the lower side becomes longer, while the upper side is shortened and often wrinkled from the pressure of the opposite side; this continues until the upper internodes have resumed the vertical position. Several nodes, however, may share in this process at the same time.

Minute Structure.—In the tissues of the culm a larger or smaller ring of sclerenchyma is especially prominent; it lies close under the epidermis, to which it is often joined by rib-like sclerenchyma bundles. Similar bundles accompany the fibro-vascular bundles both without and within, or even form a ring about them; the great firmness of the culms is due to the mass of strongly developed sclerenchyma. In pithless culms the fibro-vascular bundles are usually arranged in two circles, one of which is on the inside and the other on the outside of the sclerenchyma ring; in culms containing pith other bundles are present, either scattered through the pith or arranged in indistinct circles. Each bundle contains two or three large, pitted vessels between which and towards the centre is an air-passage resulting from the rupture of an old, ringed vessel, as is shown by the presence, here and there, of isolated rings. For other portions of the bundle, see explanation of Fig. 2.

The fibro-vascular bundles run parallel in the internodes; the superficial ones join those of the lower internodes directly, the others take the form of a shallow arch bending towards the centre (in culms with pith), where they pass through several internodes, and finally bend outwards to join the superficial ones. In the nodes the bundles cross and interlace by means of small and short cross-bundles, which pass from the axillary shoots or buds towards the centre. In this way arise the diaphragms or plates of tissue which separate the pith cavities of the internodes.

THE LEAF.—The leaves of grasses usually alternate in two ranks 180° apart, and those near the ground often form tufts or even fan-shaped bunches through the non-

development of the internodes. Such tufts are also found upon the upper nodes and runners of some grasses, for example *Sporobolus*, *Cynodon*, *Æluropus*, and *Chloris*, whenever a well-developed internode is followed by 2–4,

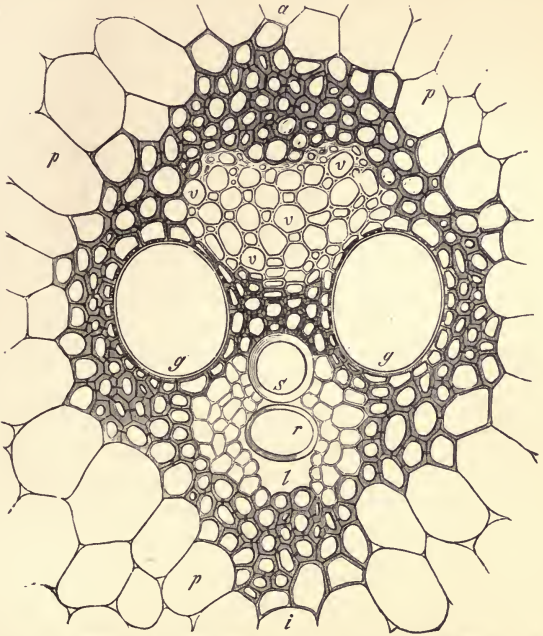

FIG. 2.—Cross-section of a fibro-vascular bundle from the culm of Maize (× 550). *p p*, Surrounding parenchyma (*a*, outer side; *i*, inner side). *g g*, Pitted vessels; *l*, air-passage with isolated ring, *r*, from a former ring-vessel; *v v*, sieve-tubes. The shaded cells in the circumference are those of the sclerenchyma threads; those between *g* and *g* are very narrow pitted vessels; *s*, a spiral vessel. (After Sachs.)

shortened, nodeless ones. Every branch begins with a two-keeled, rarely (*Cynodon*) two-cleft, membranous prophyllum with its back towards the main axis, and is followed by the other leaves in such a manner that their median plane crosses with that of the prophyllum and the leaf in whose axil the branch originates. The suc-

cessive shoots are antidrom [a technical term of German morphologists],—that is, if the first leaf of one falls to the left of the subtending or supporting leaf, that of the next falls to the right, etc.,—so that the first leaves of all branches fall on the same side of the main axis. The same holds true, of course, in case of secondary branches rising from the axils of these leaves even when the subtending leaves are undeveloped, as is usually the case in the inflorescence.

Every foliage leaf consists of at least two parts, the *sheath* and the *blade*. A true petiole is inserted between these only in a few broad-leaved, tropical grasses (*Pharus*, *Phyllorachis*, some *Ischæma*, many *Bambuseæ*, etc.). The blade is always absent in hypophyllia and prophylla, and in the floral leaves (called glumes or bracts) it is either absent or transformed into a narrow bristle-shaped appendage, the awn, which is sometimes twisted or bent. The sheath surrounds the culm like a tube, and the two edges usually overlap in front, the covering edge being somewhat raised. In the successive internodes the raised edge is alternately on the right and left. The sheaths of numerous grasses (all *Sesleriеæ*, many *Poæ* [*pratensis L.*, *trivialis L.*, *alpina L.*], *Bromus* [*inermis* Leyss., *erectus* Huds.], *Briza*, *Melica*, *Dactylis*, *Glyceria fluitans* Brown, etc.) are, on the contrary, perfectly closed, but the young and still included inflorescences, by forcing their way upward through these narrow channels, usually cause them to split. The sheath matures earlier than the internode above its insertion, and consequently its stiffening tissues, viz., the sclerenchyma bundles, are perfectly formed at the time when the enclosed internode in its basal portion is yet tender and without firmness. The sheath is, in consequence, a very important protection for the young internodes, and this function is performed even by the bladeless first leaf in breaking through the ground with its hard point; if the latter be cut away, the enclosed shoot is not able to stand upright and reach the surface.

The Ligule.—At the point of union between the blade and sheath there is at the inside an erect prolongation

of the latter (ligule) which is usually membranous, but may be herbaceous at the sides. It originates from an additional growth of the sheath upwards at the insertion of the blade. If the blade is narrower than the sheath, then at least the side portions of the ligule are of the same character as the sheath, and are furnished with fibro-vascular bundles, while the centre, upon which the blade rests while in the bud, remains membranous (see Fig. 3, *B*). If the blade is the same breadth as the sheath, then the entire ligule is membranous (Fig. 3, *A*).

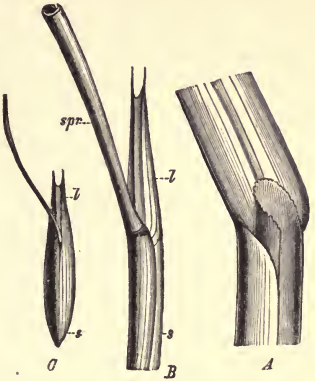

FIG. 3.—Point of separation of the sheath (*s*) and blade (*spr*). *A*, in *Dactylis glomerata* L. *B*, in *Ammophila arundinacea* Host. *l*, Ligule. *C*, Flowering glume of *Bromus Alopecurus* Poir.

In the flowering glumes of many grasses—*Avena* and *Bromus*, for example—whose blade has developed into an awn (Fig. 3, *C*), the ligular portion is much developed, and the awn is then said to be on the back or dorsal (see above). Flowering glumes with terminal awns have no ligular portion; there are also analogous cases in ordinary leaves, for example in *Panicum Crus-galli* L. In many grasses, especially in many of the *Chlorideæ*, the ligule is transformed into a fine hairy fringe. The ligule always embraces the culm very closely, and Schlechtendahl thought that its office was to keep rain or water from getting between the sheath and culm.

The Leaf-blade.—The blade is usually elongated, narrow linear or linear-lanceolate, rarely, and only in tropical species, ovate-lanceolate, elliptical, cordate or sagittate (*Phyllorachis*, etc.). In the bud the leaf is simply folded (rarely plicate folded, as in *Panicum plicatum* and related species) or rolled up from one side, the other half being somewhat broader, and the sides by which

the rolling up commences alternating from right to left in the successive leaves.

Leaf Torsion.—The adult blade often exhibits torsions; all the broader leaves of *Festuca, Holcus, Calamagrostis,* etc., are twisted to the left, at least in the upper portions, those of *Secale, Triticum,* etc., to the right, and of many *Avenece* in both directions, being twisted in one direction above and the other below. The leaves of many woodland grasses (*Milium effusum* L., *Brachypodium silvaticum* R. & Sch., *Festuca silv.* Vill., *Melica altissima* L., *Pharus latifolius* L.), also of some narrow-leaved species (*Gynerium argenteum* Nees., *Ammophila arundinacea* Host.), are turned 180° at the base, so that the upper and under sides are reversed. In this case the stomata are only upon the original upper side. This phenomenon is probably due to the influence of light (heliotropism); and this is more certainly true in regard to the remarkable sleep-movements exhibited by the leaves of *Olyra Guyanensis* (*Strephium Guyan.* Brongn.). In the day-time the leaves of this grass stand out from the culm, and the upper surfaces are turned upwards, but at night they lie close to the culm and their surfaces are at an angle of 90° from the position during light. This torsion is effected by means of a very short petiole.

Nervation.—The fibro-vascular bundles (nerves) of the blade either enter it separately and then run parallel, or a number at first unite with colorless parenchyma to form a strong midrib at their entrance to the blade, later the single bundles separate one at a time and pass towards the edge of the leaf. This arrangement gives an especial firmness to the base of the leaf, which has to bear the weight of the entire blade. Maize, Sorghum, etc., are examples of this arrangement, which is especially frequent in tropical grasses. The fibro-vascular bundles, at least the primary ones, are accompanied on the lower or on both sides by bundles of sclerenchyma which are frequently united into rings; this happens especially in those species with rush-like leaves, and gives them their very stiff blades. The epidermis contains very irregular cells whose walls in many cases

contain much silica. The bands of upper epidermis that lie between the nerves often present wedge-shaped cells ("bulliform" cells), arranged in the form of a fan, whose growth and expansion causes the blade to open out; in those leaves which are folded in the bud these cells are only to be found on each side of the midrib. In grasses that do not have such fan-shaped cell-groups the blades remain always folded or rolled up, or at most open but a little, and consequently appear thread- or rush-like (many species of *Stipa*, *Festuca*, and *Nardus*). In others, especially in many of the Steppe grasses, the

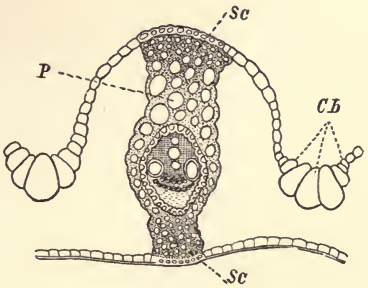

FIG. 3*a*.—Transverse section of the primary vein of *Festuca elatior*, var. *arundinacea*. *Sc*, sclerenchyma; *P*, colorless parenchyma; *Cb*, bulliform cells. (After Hackel, Monog. Festuc. Europ., Tab. II. Fig. 6.)

blades roll up whenever these cells lose their turgescence by excessive evaporation, but become flat again, or at least half open, as soon as the air becomes moist. This rolling up of the blade acts as a protection against excessive evaporation; for the lower side, which is then alone exposed to the air, has especial protective arrangements against transpiration in its strong cuticle, sclerenchyma masses, etc.

The stomata of grass leaves usually stand in longitudinal rows and are surrounded by four cells; two large secondary cells project beyond and cover two long and narrow guard-cells, which are usually much narrower than the first.

Inflorescence.—Distinction must be made between the special inflorescence, the spikelets—which will be referred to farther on—and the entire inflorescence. The latter arises by monopodial division of the upper portion of the culm, and the branching may be in different degrees: when the primary branches form single spikelets and the lowest glumes of these are apparently sessile upon the main axis, the inflorescence is a *spike* (which is really compound); if the bases of these primary branches are naked, forming a pedicel, it is a *raceme;* and if the spikelets are only upon secondary or farther divided branches, a *panicle.* The inflorescence is yet more complicated in many *Andropogoneæ*, *Paniceæ*, and in Maize, where the branches of the panicle bear racemes, whose spikelets, however, are borne partly on primary and partly on secondary branchlets of these racemes. The primary branches of the whole inflorescence are most frequently alternately two-ranked, and more rarely (as in many *Andropogoneæ*, *Paniceæ*, *Sporobolus*, *Eragrostis*, etc.) spirally arranged; in the latter case they are often in whorls of from 2 to 4 members. The two-ranked arrangement is often altered by the more rapid growth of one side of the main axis (the side which is turned more away from the earth in the bud); the spikelets accordingly move toward one side and the inflorescence becomes one-sided, as is especially noticeable with the panicles of *Dactylis* and *Cynosurus*, and the spikes of the *Chlorideæ*.

This appearance is intensified by the relations of the secondary branches. According to the laws of antidromy (see page 6), the first secondary branches all fall upon the same side of the culm; since these mostly arise near the base and are again branched, this side of the main axis appears to be much richer in spikelets. Where the secondary branches also arise near the base and are as strongly developed as the primary ones, the inflorescence regains a symmetrical appearance (*Poa pratensis*, *P. trivialis*). If the branches are short and lie close to the main axis and all the internodes of the branches remain short, the result is a cylindrical, false

spike or spike-like panicle (*Phleum*, *Alopecurus*, etc.). In this case the primary branches are frequently grown to the main axis, and consequently the secondary branches appear to be arranged spirally on this (*Phleum pratense* L.), while *Ph. Bœhmeri* Wib. has free primary branches.

The supporting bracts of the branches of the inflorescence are usually entirely aborted, but on the lowest branches they often occur as rudiments, rarely as well-formed glume-like scales (*Sesleria*), and still more rarely (*Anomochloa*, *Phyllostachys*) they are well developed on all the primary branches. Frequently the leaf of the culm or branch which stands next to the inflorescence is in the form of a sheath enclosing the spikelets (*Zea* ♀, *Coix*, *Lygeum*, etc.). The false panicles of some *Andropogoneæ* (*Andropogon*, *Nardus*, Fig. 19) are interspersed with leaves, and arise from branches supported by the upper leaves of the culm, these branches in turn bearing leaves and branching again.

THE SPIKELET.—The spikelets consist of an axis composed of short articulations, two-ranked chaffy leaves (glumes) (spiral in *Streptochæta* only), the first 1 to 6 of which (usually 2) are sterile and known as empty glumes or glumes only, while the following one to many glumes (flowering glumes or lower paleæ) bear in their axils a very short branch which begins with a bractlet called palea (or superior palea) with its back turned towards the axis, and ends with a flower.* The end of the axis of the spikelet is either visible beyond the upper flower (Fig. 84) or its growth is arrested early; in many one-flowered spikelets it is not at all visible even in the earliest stage of them, and consequently the flower is situated upon the end of the axis. In this case there is no longer a true distinction between empty and flowering glumes and paleas, for the entire spikelet represents a single flower with many

* In the figures the entire inflorescence is always designated by *A*, the spikelets by *B*, the empty glumes by *C*, the flowering glumes by *D*, the palea by *E*. Compare Fig. 90.

bracts (*Anthoxanthum, Oryza, Andropogoneæ*). However, it is possible to demonstrate a perfect series of stages by which one-flowered spikelets with a distinctly lateral flower pass over into those with terminal flowers; consequently a palea and flowering glume can be distinguished in the latter by analogy.

The uppermost glumes of a spikelet are not infrequently empty, and in this case they are usually dwarfed

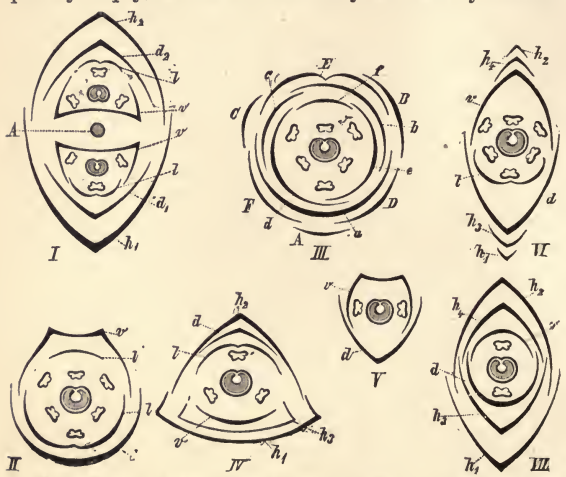

FIG. 4.—I, Diagram of a many-flowered spikelet of *Avena, Poa, Triticum; A*, axis (rachilla). II, Diagram of a flower of *Bambusa* with flowering glume and palea; l_1, posterior lodicule. III–VII, Diagrams of an entire spikelet; h, h_1, etc., empty glumes; *d*, flowering glumes; *v*, palea; *l*, anterior lodicules. III, *Streptochæta; A, B–F*, small outer bracts; *a–f*, large inner bracts, the latter distinctly in two whorls. IV, *Andropogon;* V, *Coleanthus;* VI, *Oryza;* VII, *Anthoxanthum.*

or anomalous (*Melica*, Fig. 80). The empty glumes are lacking (*Coleanthus*), or scarcely visible as rudiments (*Leersia*), in only a few genera; there is rarely but one, most frequently there are two, and more rarely more than two, present. In the latter case those following the second are described by most authors as sterile flowers (e.g., in *Panicum, Andropogoneæ*, and many *Bambuseæ*), a plan which we shall not adopt in our descriptions. It is true that in closely related species (of *Panicum*, for

example) the third glume of some is empty and therefore a sterile glume, while in others it bears a ♂ flower or merely a sterile branch with the palea, in which case it becomes a flowering glume; but this by no means makes all Panicums two-flowered, any more than we would call *Leucojum vernum* a three-flowered plant because both of its empty bracts bear flowers in other species of the same genus. In most and the best works (e.g., Kunth's, but not Bentham's) this third glume is called a neuter flower ("flos neuter"), a term whose meaning should be always present to those desiring to use these works. The empty glumes are often very like the flowering, but are seldom awned. The flowering glumes assume many forms and are frequently awned; they almost always have a middle nerve. At their point of insertion they frequently extend downwards a little on the axis of the spikelet; this portion which is grown to the axis is separated from the free portion by a more or less distinct furrow and is called the callus; it occurs also upon many empty glumes (*Heteropogon contortus* R. & Sch.), is frequently hairy, and in the fruiting glumes serves to fasten them to other objects. (Compare *Stipa*, Fig. 44, *cal.*) The palea, which with its enclosed flower stands opposite to the flowering glume, does not belong to the main axis of the spikelet, but to the branch which bears the flower. That this relation of parts may be gradually obliterated in the one-flowered grasses, and that the palea may be moved back upon the main axis, has been explained above. As long as an axis or a rudiment of one, at least in its earliest stage, is visible beyond the palea, this latter possesses (like the prophylla of the culm-branches) two keels, or at least two lateral nerves, without a midrib; only when all trace of the axis is absent does the palea become from one- to many-nerved (with a midrib) or nerveless. It is almost always of a more delicate texture than the flowering glume, its edges are usually turned in, and it has a furrow instead of a midrib. The prophyllum of the culm-branches has no blade, and the palea resembles it in being almost always (excepting *Amphipogon*) awnless; and as the former

is sometimes split in two parts (*Cynodon*), so the palea is often split at the time the fruit is mature (many *Sporobolus* and *Triticum monococcum L*). This state has been understood by some authors as originally bifoliate, and false genera have been established upon it by some (*Diachyrium* Griseb, etc.). The palea is completely aborted in many *Andropogoneæ* and species of *Agrostis*.

Opposite the palea, and therefore above the flowering glume, are, in most grasses, visible two small delicate scales (lodicules); they stand close together, their front edges touching, their bases somewhat grown together and swollen with sap at the time of flowering (cf. Fig. 28, *F*; Fig. 63, *G*). They are usually considered the two anterior members of a rudimentary perianth, whose posterior member (the posterior lodicule) is developed in *Stipa* and many *Bambuseæ*. The author has endeavored to prove that the anterior scales represent the halves of a leaf which sometimes (*Melica*, Fig. 80, *F*) remains undivided, and can be regarded as a second, and the posterior scale as a third, palea.* The anomalous condition of these paleas (in respect to the ordinary palea) is explained by their biological properties. The rapid swelling of the bases at least, causes the separation of the flowering glume and palea, and consequently the opening of the flower. In grasses where they swell only a little the spikelets open but slightly, and where the lodicules are membranous or entirely lacking the spikelets remain entirely closed at the sides, and the reproductive organs protrude only at the apex (compare *Anthoxanthum*, *Alopecurus*, etc.). The absence of the lodicules is not necessarily a case of abortion; for if they are bractlets, a decrease in their number (as in the Juncaceæ) is not very remarkable. Their large number (8 or more) and apparent spiral arrangement is striking in *Ochlandra;* here their relations have, however, still to be studied in living material.

All the leaf forms that have so far been mentioned in the spikelet do not really belong to the flower;

* For details see Engler's bot. Jahrbücher, I. Bd., S. 33*a*.

they all lie (*Streptochæta* and perhaps *Ochlandra* excepted) with their median lines in one and the same plane, and, as in the branches of the culm, this crosses that of the subtending bract, which in this case must be supposed. Where the entire inflorescence ends in an apical spikelet its glumes are naturally arranged like the supposed subtending bract, and therefore cross those of the lateral spikelets (e.g., *Triticum sativum* Lam.). Several genera related to *Lolium* form an exception to this; in these genera the median plane of all the glumes coincides with that of the subtending bract. *Hordeum* and *Elymus* form another, but only an apparent exception; in these not only do the empty glumes of the 2–3 lateral spikelets converge in front, but their median plane crosses that of the flowering glume at different angles (30°–90°). All these variations depend upon mechanical causes, and are only to allow the glumes of the double or triple spikelets to fit into a given space, since the normal arrangement is present in the solitary terminal spikelets of some species of *Hordeum* (*H. crinitum* Desf., etc.) and all species of *Elymus*.

The succession of the flowering of the spikelets should be especially noticed, since in panicles it usually occurs about in that order in which the spikelets emerge from the sheath of the upper leaf; therefore the terminal spikelets of the panicle and its branches flower first, and from there downwards. In spikes the spikelets situated just above the middle usually precede the others, as they are best developed. In single spikelets, flowering passes from below upwards; in *Panicece* and *Andropogonece* only, if a terminal ♂ stands below the apparently terminal ☿ one, it blooms later than the latter.

Organs of Reproduction.—The Stamens.—The androecium consists of from one to two whorls, each composed of from two to three members; the stamens are rarely (*Pariana, Luziola, Ochlandra*) more than six (to forty), and in this case apparently spirally arranged. The first stamen of the outer, and usually the only, whorl always stands above the flowering glume; this is distinguished by the fact that it is earlier and

more strongly developed than the other two, which stand in front of the keels of the paleæ. On the other hand, this very stamen may be aborted and only the two posterior ones remain (*Diarrhena*, *Orthoclada*); where the entire whorl is reduced to a single stamen (*Uniola*, *Cinna*, many species of *Festuca* and *Andropogon*, etc.) this is generally the anterior one, but in *Elytrophorus* it is posterior. We find a typical two-membered whorl in *Anthoxanthum*, *Hierochloa* ☿, and *Crypsis;* here the stamens lie in the mid-line of the glumes, but in *Coleanthus* they alternate with the glumes. Two alternating whorls occur in the majority of the *Bambuseæ* and in many *Oryzeæ*. Generally both whorls have three members, but in *Tetrarrhena* and *Microlæna* they have but two. Since the following (single) carpel always stands above the flowering glume no matter whether the stamens are in one whorl or two, when only one is present the inner must be supposed.

The stamens always have slender, distinct, rarely (*Streptochæta*, *Gigantochloa*, *Oxytenanthera*) monadelphous filaments that are composed of thin-walled cells. In the closed flower they are very short, but at the time of flowering they elongate by the very rapid extension of the cells. They remain straight for a time (*Phleum*), or suddenly become tipped over in such a way (*Triticum*) that the main mass of the pollen is emptied.

The elongated, usually narrow-linear anthers have a very fine connective and are versatile; that is, the filament is attached below the middle ($\frac{1}{4}$ or $\frac{1}{3}$) by a tapering end. This circumstance assists in the scattering of the pollen by the wind. Rarely the filaments are attached at the base of the anthers (*Coleanthus*). The pollen-sac usually opens by a longitudinal split which proceeds from above downwards, more rarely (*Andropogoneæ*) by a hole at the apex, which is often continued into a split. The pollen is very finely granular, spherical, and perfectly smooth. It is discharged in very abundant masses, and scattered by the wind (except in the cleistogamic species).

THE PISTIL.—The pistil arises from a single carpel

which always stands in the median plane of the spikelet towards the front. It is composed of an ovary with one ovule and 1–3 styles, each with one stigma; the stigmas may also arise from a single style or directly from the ovary. If but one style with one stigma is present, it corresponds to the midrib of the carpel, and is to be regarded as the blade, and the ovary as the sheath (*Nardus*). Many times an apparently simple style arises from the union of two (*Zea*, *Euchlæna*, and many species of *Pennisetum*). If there are, as is by far the most frequent, two styles or two sessile stigmas, they are lateral, never posterior, being either on the sides or the front of the carpel. Both may be regarded as the developed side portions of one lamina (or blade), the central part of which is at the same time suppressed; they are therefore analogous to the anterior lodicules. If the middle portion is developed, we have the three (free or partly grown together) styles of many *Bambuseæ* and *Streptochæta*, where the third style consequently lies in front. In many pistils (*Briza media*) there is frequently a rudiment of a posterior style (often provided with a stigma) which may be explained as a commissural form like the ligule of *Melica uniflora* Retz., which is opposite the blade and rises from the united edges of the sheath. The stigmas, easily recognizable by their papillate cells, are rarely simple (barbellate) (Figs. 73, 74), but are usually spirally branched; in the latter case the branches either come off in all directions—aspergilliform (Figs. 15, 18),—or only from two sides—plumose (Figs. 80, 89, 95). From these branches rise smaller papillæ. The entire system of branches has of course a large surface, and is especially arranged to catch pollen carried by the wind.

Pollination.—As has been stated, grasses are fertilized by the wind. Monœcious and dicœcious species are not numerous; but not a few are polygamous (many *Andropogoneæ* and *Paniceæ*), and in these the ♂ flower of a spikelet always blooms later than the hermaphrodite, so that its pollen effects cross-fertilization upon the stigmas of other spikelets or other individuals. There are also many arrangements for cross-fertilization

among the entirely hermaphrodite species. Many genera (*Alopecurus*, *Anthoxanthum*, *Pennisetum*, *Spartina*) are strongly proterogynous; in most cases, however, the anthers protrude earlier and discharge the greater part of their pollen, especially by turning over suddenly, before the stigmas are visible. When these emerge at the sides of dependent or nodding spikelets they are directed upwards, and consequently only the pollen from flowers situated higher up can come in contact with them. More rarely the stigmas project from the apex of the spikelet, and then mainly in the proterogynous and monœcious species. In some hermaphrodite flowers cross-fertilization is so much the rule that they have lost the power of effectual self-fertilization, as in Rye. In the majority of cases, however, both kinds of fertilization seem at least to be possible; for example, the species of Wheat are usually self-fertilized, but may also be adapted to cross-fertilization, since their glumes are open above, the stigmas project laterally, and the anthers empty only about $\frac{1}{3}$ of their pollen in their own flower and the rest into the air. Cross-fertilization is much more rare and difficult in Barley, and in certain races like the six-ranked, the short-spiked two-ranked, and the peacock Barley, the flowers, especially in our climate, never open, and consequently cross-fertilization is made impossible. Again, *Leersia oryzoides* Swz. and *Amphicarpum Purshii* Kunth, are strongly cleistogamic; in both there are two kinds of inflorescence; the conspicuous terminal panicle of the culm is perfectly sterile, but the lateral inflorescence of *Leersia*, which remains covered by the sheath, is abundantly fertile; in *Amphicarpum* the fertile spikes are upon short scapes close to the ground, and seem to be fertilized and mature under ground. *Diplachne serotina* Link., *Danthonia spicata* Beauv., *Stipa juncea* L., etc., are also cleistogamic species.

The Ovule.—The ovule is grown to the ventral suture of the carpel without a funiculus. The point of union may be confined to a narrow place at the base, or may vary so far as to reach to the other end of the ovule (Fig. 6, *A*). The ovule itself is hemitropous (slightly campylotropous),

with its micropyle turned downward and outward. It possesses two integuments (Fig. 6, *A*, i_1, i_2), the outer one of which has very delicate walls and forms a conductive tissue for the pollen-tube upon the anterior side. It disintegrates soon after fertilization.

The embryo-sac (Fig. 6, *A*, *es*) grows rapidly after fertilization at the expense of the tissues of the endosperm, so as to leave only 1–2 layers. At the same time it becomes filled with considerable albumen in whose cells, the outer layer excepted, is deposited an abundant supply of starch. The ovule meantime grows rapidly in length and later also in breadth, and finally fills the cavity of the ovary so completely that any further growth causes it to grow to the walls, and this fails to happen only in a few cases. The embryo is at first a many-celled club-shaped body whose vegetative point is situated in a lateral depression; the portion of the embryo above this depression becomes the cotyledon, which farther expands, becoming shield-shaped. Then the borders of the depression in which the vegetative point is situated rise up in the form of a collar,—the beginning of the first sheath-like leaf, hypophyllum, and opposite to it, later on, is developed the first foliage leaf. The initials of the main root lie deep within the lower half of the young embryo, so that the surrounding tissue grows with the root for some time until the latter separates itself from the tissue around it by forming a cleft. But the entire radicle is still imbedded in it, and not earlier than the seed germinates the root first breaks through this tissue, called the *coleorhiza* or root-sheath (compare *c* in Fig. 6, *L*, *N*). Upon the sides of the main radicle 2–4 secondary radicles are occasionally situated (w_1, w_2 in Fig. 6, *F*), and on the other end of the axis the beginnings of the foliage leaves increase in the bud to 3 or 4, so that the germ of the grass at the maturity of the seed has reached a high degree of development.

Fruit and Seed.—The fruit of most grasses is a caryopsis the thin pericarp of which is grown fast to the seed. The pericarp here answers the purpose of the testa, which is only very feebly developed; it gener-

ally consists merely of a few cell layers; one, a very thick-walled epidermis, and several of tolerably thin-walled parenchyma with delicate fibro-vascular bundles, and an inner epidermis that is frequently indistinct. It contains no amylaceous material, and when the grain is ground it, together with the adjacent layer of albumen, is removed as bran. In many grasses the pericarp unites more or less with the bracts, growing especially to the palea, seldom to the flowering glume. Those caryopses adherent to the bracts (e.g., most barleys) must not be confused with those in which the bracts are close around the fruit but not grown to it (for example, in Spelt, *Triticum spelta* L., whose fruit is often spoken of as adherent). After long soaking in water the bract may with care be removed even from the adherent fruit.

The following fruit forms are more rare in grasses: *Utricle*—the pericarp thin, dehiscent, free from and surrounding the seed; for example, *Sporobolus* (Fig. 51, k_1, k_2), *Eleusine* (Fig. 71, *k*), *Crypsis*, and *Heleochloa; Nut-fruits* in some *Bambuseæ* (*Dendrocalamus, Pseudostachyum, Schizostachyum*, etc.) and in *Zizaniopsis; Berries*, often as large as apples, as in the *Bambuseæ, Melocalamus, Melocanna*, and *Ochlandra*. The berries of *Melocanna bambusoides* are often from 8 to 13 centimeters in diameter and are edible.

Upon the caryopsis is a place where the embryo lies covered only by the pericarp and plainly visible on the outside (Fig. 6, *B*). This place is upon the front side (that is, the side facing the floral glume) of the base of the fruit. Opposite to it, or on the posterior side, the fruit bears a more or less clear, sometimes punctiform and sometimes elongated or linear mark, the hilum, the place where the seed was fastened to the wall of the ovary (Fig. 5).

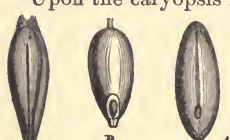

FIG. 5.—*A*, Fruit of *Agrostis sesquiflora*, Desv., with punctiform hilum; *B*, of *Pennisetum Chilense*, with an oval-bordered one; *C*, of *Bromus Mango* Desv., with a linear hilum. (After Desvaux Gram. and Cyp. Chil.)

Since the form of the hilum is constant in every genus, and also sometimes in whole tribes, it is very im-

portant in identification, and enables us to recognize the kind of attachment of the ovulum to the carpel even in the fruit. A punctiform or only short oblong hilum at the base of the fruit indicates a narrow, and an elongated linear hilum an extended, attachment. If there is a furrow in the fruit, then the hilum is always to be looked for in this, and moreover invariably on the side of the palea, which must first be shaved off in those fruits where the pericarp is adherent to the bracts.

The embryo is usually small, seldom more than half as long as the fruit, straight, rarely slightly bent (*Oryza*), with the radicle turned downwards. Its most striking portion is the scutellum (*Sc* in Fig. 6), which is regarded (although not undisputedly) as the cotyledon. It is a flat but somewhat thick body, roundish to elongated-oval in circumference, lying close on its inner side to the albumen, with the plumule and radicle surrounded by the coleorhiza situated in its somewhat shallow exterior. The plumule lies free upon the scutellum, but below the plumule the axis of the embryo is united with it; this is the point of insertion of the scutellum beyond which it projects downwards and outwards as far as the point of the coleorhiza (Fig. 6, *E*, *H*). This descending portion of the scutellum is grown for a longer (Wheat) or shorter (Maize) distance to the posterior part of the coleorhiza, and its edges are either free at both sides (*Triticum*, etc.), or they turn forward and grow so completely over the coleorhiza that they entirely unite in front or leave only a small cleft (Maize, *L* in Fig. 6, *M*, Sorghum). If this is the case, it is only in germination that the side portions are pushed back (Fig. 6, *N*) and the entire embryo becomes visible. The inside of the scutellum shows a peculiar kind of epidermis, the so-called cylinder epithelium, of palisade-formed, cylindrical cells with delicate walls. They are for the purpose of absorbing the dissolved amylaceous material of the albumen. The scutellum also contains a fibro-vascular bundle, and this often has short branches. In germination it remains within the pericarp.

In many grasses there is in front of the embryo and

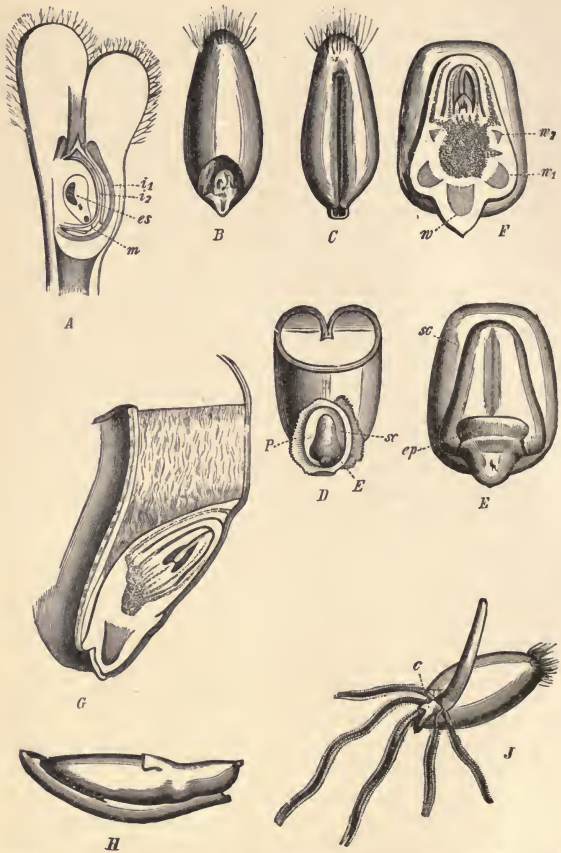

FIG 6.—*A*, Longitudinal section through the ovary of Barley (after Johannsen, "Das Endosperm der Gerste"); *m*, micropyle; i_1, i_2, outer and inner integuments; *es*, embryo-sac. *B*, Fruit of Wheat from in front. *C*, The same from behind. *D*, The same with the embryo uncovered; *P*, the pericarp thrown back; *sc*, scutellum; *E*, embryonic bud and rootlet. *E*, The embryo by itself, highly magnified; *sc*, scutellum; *ep*, epicotyl. *F*, The same in radial section. *H*, The same seen from the side. *J*, Germinating wheat; *c*, the coleorhiza after being broken through.

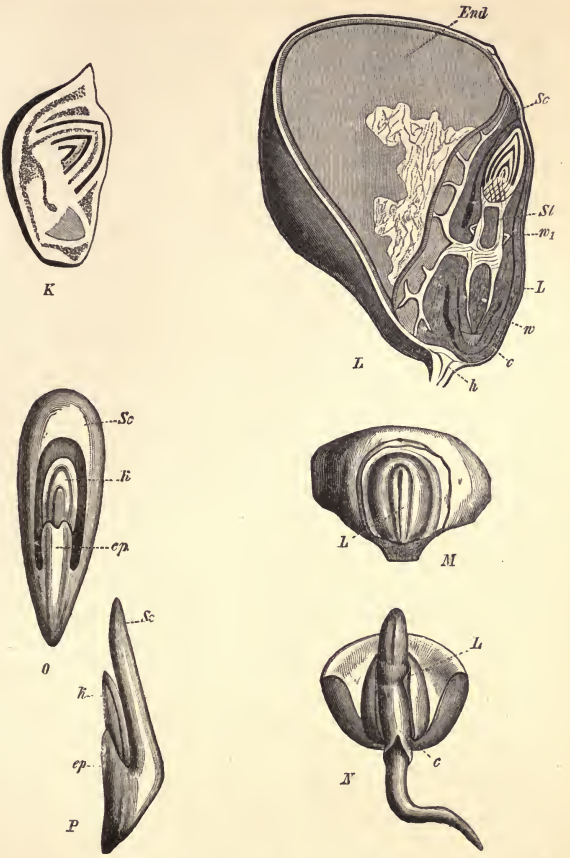

FIG. 6, *Continued.*—*K*, embryo of Rice, radial longitudinal section (Figs. B–K after L. Richard, Analyse des embryons et endorhizes). *L*, Fruit of maize, longitudinal section after Sachs, Lehrb. der Bot.); *End*, albumen; *Sc*, scutellum; *St*, epicotyl joint of stem; w_1, the beginnings of roots rising from the epicotyl; *w*, main root; *c*, coleorhiza; *L*, anterior edges of the scutellum; *h*, hilum. *M*, embryo of Maize; *L*, anterior edges of the scutellum covering the plumule (after Richard, *a*, *a*, *O*). *N*, The same germinating, consequently *L* are pushed to one side; *c*, coleorhiza (after *Mirbel*, Ann. Mus. Nat., XIII. pl. 13). *O*, embryo of *Stipa chrysophylla* Desv.: *Sc*, scutellum; *K*, plumule; *ep*, epicotyl. *P*, The same seen from the side (after E. Desvaux, Gram. et Cyp. chil., tab. 76).

opposite the scutellum a small scale-like appendage, the *epiblast* (*ep* in Fig. 6, *E*, *O*, *P*). It is especially clear in *Stipa* (Fig. 6, *O*, *P*), and yet better developed in *Zizania* (where it is as long as the plumule), but is entirely lacking in many grasses (Rye, Maize, and Barley); generally it is merely a delicate formation consisting of parenchyma without fibro-vascular bundles, and its morphological nature is still doubtful. Yet the view that it is a rudimentary second cotyledon is the most reasonable, for among other things this makes comprehensible the surprising position of the first leaf of the plumule just above (not opposite to) the scutellum. The plumule of the embryo consists of a very short, often indistinct internode of the axis (epicotyl) and of two to four leaves, and according to the development of the former the plumule is sessile or petioled. The first leaf, the germ-sheath, surrounds the others like a closed tube, which breaks through the ground with its hard point at the time of germination, and opens at its apex after a time in order to allow the exit of the second leaf. It is colorless or pale green or frequently reddish. Many authors consider it a part of the cotyledon, a view which is certainly incorrect, for in many grasses (all *Paniceæ*, *Andropogoneæ*, *Maydeæ*, many *Festuceæ* and *Hordeæ*) it is clearly separated from the scutellum at the time of germination by a distinct internode (epicotyl) which is often much elongated (compare Fig. 6, *L*, *st*). In others (*Triticum*, etc.) this epicotyl is very short or entirely lacking, so that the back of the sheath may even be grown to the scutellum.

The majority of grasses have only one radicle, and grow therefore with a primary root; in addition to which, especially from the epicotyl, new roots soon arise which finally exceed the main root in growth. In several grasses, especially in the cereals, and also in *Coix lachryma* and others, the foundation of these secondary roots is already laid before germination, usually in the hypocotyl (the axis below the insertion of the scutellum); seldom, and only to a rudimentary degree, in the epicotyl (*Zea*, Fig. 6, *L*, w_1). The plane of these secondary roots

is parallel to that of the scutellum; they can therefore be seen only in tangential (Fig. 6, *F*) and not in radial section (Fig. 6, *G*) of the seed. In germination, each rootlet independently breaks through the coleorhiza, which surrounds each with a small sheath. Before the roots break through, the elongating coleorhiza ruptures the

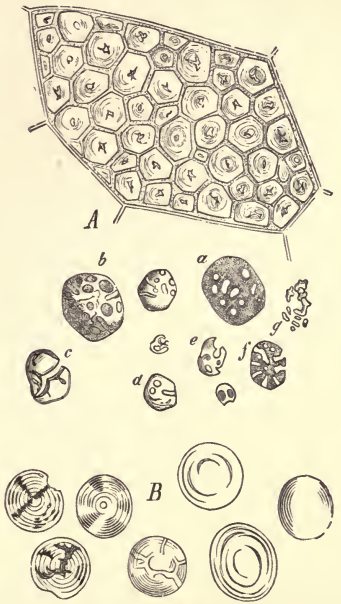

FIG. 7.—*A*, A cell in the albumen of *Zea Mays* filled with polyhedral starch-grains, between which are thin plates of dried, finely-grained protoplasm. *a–g*, Starch-grains from the amylaceous tissue of germinating maize seed. *B*, Starch-grains (lenticular) from the amylaceous tissue of a germinating seed of *Triticum vulgare*; the first action of the dissolving ferment shows itself in the distinct lamination (× 800). (After Sachs.)

pericarp and sends numerous hairs from its epidermis, thus fastening the somewhat superficially placed seed to the ground. The embryo is rich in oils and proteids and even sugar, but contains no starch. The albumen consists of large, polygonal, parenchymatic cells which, with the exception of the outer layer, are rich in starch-

grains. Between these, which often fill nearly the entire space, finely granular albuminous bodies are irregularly distributed or formed into a network of delicate plates, especially distinct in the peripheral layers. The inner cells show them but little, and are still richer in starch-grains. If the albuminoids so fill up the intervals between the starch-grains that the latter seem to be imbedded in cement, the albumen appears translucent and the fruit is called corneous; but if the union is less intimate, there remain numerous small air cavities, and the albumen is opaque and the fruit is mealy. Both conditions may occur in the same species or variety (Wheat), and they seem to be occasioned by differences in climate and soil. Corneous fruits are usually richer in albuminoids than mealy ones of the same species.

Starch.—As to the form of the starch-grains, we must distinguish between simple and compound. The latter (Fig. 8, 6) are large and composed of many angular granules, into which they often separate. Simple grains are generally present with them. The simple grains have central cavities and are either isodiametric and polygonal (Fig. 7, *A*), or more rarely lens-shaped with rounded edges, in the latter case often distinctly lamellated and without central cavity. These lens-shaped bodies are always mingled with many smaller ones, while the isodiametric grains are of tolerably uniform size. These characters are constant within most genera, and even within entire tribes; they are therefore important from a systematic view, although they are not without exception. At the time of germination the starch-grains become eaten through by the action of a kind of ferment, so as to be full of holes before they fall apart (Fig. 7. *a–g*). The starch-grains of certain kinds of Rice (gluten rice), *Sorghum* (gluten sorghum), and of Millet, *Panicum miliaceum*, do not turn blue upon the addition of iodine, but red or reddish brown, and swell up very quickly. According to A. Meyer this is caused by their containing amylodextrin and dextrin. The outermost layer and sometimes two or three layers of the albumen (Fig. 8, 5) contain no starch but small oil-

drops, and still finer proteid granules are imbedded in the very delicate protoplasmic net. They are often called, but not properly, gluten cells : true gluten is not to be found in a dry kernel ; it is first formed from one of the albuminoids (Myosin) by the addition of water.

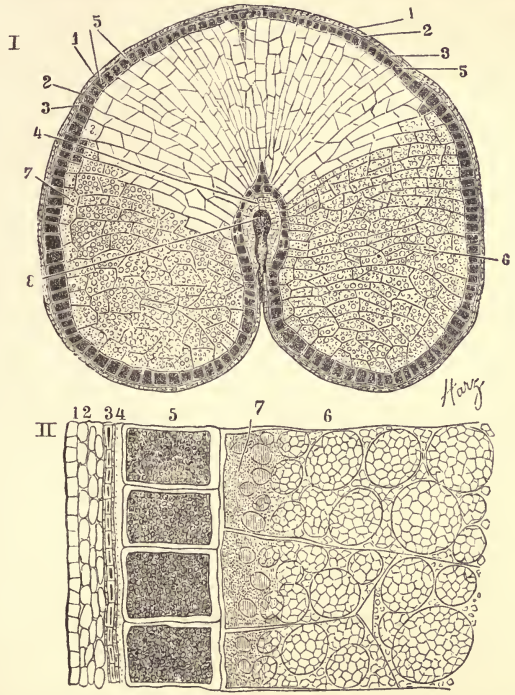

FIG. 8.—*Avena sativa* L. I, Cross-section of the entire fruit. II, A small piece of the peripheral portion, 1; 2, Pericarp; 3, Testa; 4, Remains of the *nucellus;* 5-7, Amylaceous tissue; 5, Gluten cells; 6 and 7, Cells of albumen containing compound starch-grains—at 7 they are richer in albumen and poor in starch; 8, Fibro-vascular bundle of the seed-coat. (From Harz, "*Landwirtsch. Samenkunde.*")

Frequently we understand by gluten the whole of the albuminoids, but these, as already shown, are not found in the glutinous cells only. It has been often asserted that bran and bran-bread (in which the glutinous layer

is not removed) are very nourishing, but through later investigations this assertion has been brought into question.

The so-called gluten layer is the outermost one formed in the embryo-sac; outside of it is to be seen a generally indistinct, rarely very clear (*Brachypodium* and *Bromus*) layer of cells, the remainder of the nucleus of the seed; outside of this is the testa, which has arisen from the inner integument, the outer one having disappeared. Then follows the pericarp. (See above.)

Means of Distribution.—In all wild grasses certain parts of the spikelet or of the entire inflorescence fall off with the fruit. If the spikelet is many-flowered and every flower ripens its fruit, then its axis breaks into as many pieces as there are fruits, and every piece carries a floral glume and palea. If the spikelet is one-flowered, the axis of the spikelet may separate above the empty glume, so that the floral glume and the palea fall off with the fruit (*Agrosteæ*); or it may divide below the empty glume, and the spikelet fall off as a whole (*Paniceæ*, *Andropogoneæ*, etc.). If the spikelets form a spike or a raceme, it frequently happens that the axis of the latter divides, so that one spikelet falls off with each joint (many *Andropogoneæ* and *Hordeæ*); short spikes (*Triticum ovatum* Godr.) fall from the culm as a whole. All these arrangements are necessary for the distribution of the seed; they are lacking (with two exceptions) in all cultivated cereals, but are present, on the contrary, in all native races of the same species, so far as these are known. Since these arrangements are very disadvantageous for the complete gathering of the fruit, varieties whose axes are less or not at all articulated will be preferred in culture, and will be finally fixed by natural selection.

The bracts surrounding the fruit act as a more strongly developed pericarp; they protect the embryo, which is near the surface, from too rapid wetting, and keep the soluble contents from being soaked out; and when it is once soaked through, they also protect it from drying up again. But they are especially important as means for distributing the fruit. They decrease the

specific gravity, and consequently the seed is better adapted for transportation by the wind (very small fruits, like those of *Agrostis* and *Eragrostis*, which are light enough in themselves, usually fall entirely out of the bracts), especially if the empty glumes accompany it and have a considerable surface (*Holcus*), or generally the fruit-bracts are large in comparison with the fruit (*Briza*), the whole having the effect of a winged seed. A still greater effect is produced when a large number of sterile glumes, or whole groups of sterile spikelets (*Phalaris cœrulescens* Desf.), fall off with the fruit. The glumes or parts of the axis, if they bear long hairs, form a peculiar winged apparatus (*Phragmites*, *Arundo*, *Calamagrostis*, very many *Andropogoneæ*, especially those related to *Saccharum*; *Melica ciliata* L., and *Stipa pennata* L. (by its feathery awns), as well as many *Aristida* species). Many grasses are also adapted to distribution by the fur of animals, for either the bracts themselves (*Tragus*) or the awns (*Hordeum*, *Echinaria*) are very rough or have hooked bristles. In *Streptochæta* the ripe fruit hangs from delicate spiral threads (the awns), which are fastened together at the end of the spike; they are free below, and their stiff pointed bracts, bent outward, act like fish-hooks by catching into the fur of any animal that touches them in passing. The fleshy berries of many *Bambuseæ* are evidently fitted for distribution by animals, which neither destroy nor digest the seeds. Not a few grass-fruits possess a powerful instrument in the surrounding bracts for fastening themselves into the ground. First we find the base of such bracts prolonged into a pointed often prickly callus, which makes its penetration easy, and above the point are stiff hairs pointing upwards which make it difficult to draw out a bract that has once penetrated the soil (Fig. 44, *cal*). A very strong bent awn, twisted like a rope below the bend, often acts as a motor. This awn is very hygroscopic; the coils unroll or unwind when damp, and when dry they return to their former condition; and every time this happens the point of the bract is rotated with lateral variations, especially when the upper half of the awn

has a support (a neighboring culm or merely an unevenness in the soil). This rotation and nutation, together with the action of the bristles, soon causes the bract surrounding the fruit to bore deeply into the ground (observed in several *Stipa* species, *Heteropogon contortus* R. & Sch., *Avena fatua* L. and *A. barbata* Brot., several *Aristida* species from Brazil and New Holland). If such boring fruits get into the wool of sheep, many kinds will in a short time bore through the skin into the intestines, where they cause fatal inflammation (observed in *Stipa capillata* L. in Russia, *St. spartea* Trin. in N. America, *Aristida hygrometrica* Br. in Queensland, *Heteropogon contortus* R. & Sch. in New Caledonia). Fruit may also bury itself without the help of twisted awns; in *Triticum ovatum* Godr. the spike falls off entire, and since it possesses a very pointed base and numerous outward-pointing rough awns, wherever these find a hold they exert, by every movement of the wind, etc., a pressure upon the point, and this drives it into the ground. (Herbarium specimens loose between papers, creep backwards of themselves.) The entire inflorescence of *Cornucopiæ* (Fig. 46) falls off at the time of fruit, and the stem then becomes curved and very pointed at the end. Whether this serves to bury it or to attach it to animals is uncertain.

The awns of *Avena sterilis* L. have a peculiar use. Two strongly awned fruit-bracts fall off fastened together; in moist surroundings the twisted awns begin to rotate their diverging upper halves, consequently they cross and press against each other until the bracts are forcibly separated, thus giving the fruit an impetus which throws it for some distance.

Finally, we will mention a peculiar method of distribution, viz., distribution by means of leafy spikelets. In many grasses, especially in high latitudes (south as well as north) and upon high mountains where the ripening of the fruit is often uncertain, it is not rare that entire spikelets or single flowers with floral glume and palea transform themselves into small-leaved shoots which are provided at the base with the beginnings of

roots. When these fall off from their axes they take root in the ground. In some grasses (*Poa stricta* Lindb.) we know only this apogamic condition; others are very seldom sexual (*Deschampsia alpina* R. & Sch., *Festuca Fuegiana* Hook.), or the sexual stage is lacking in certain regions (*Poa bulbosa* L.). *Poa alpina* L. and *Festuca ovina* L. are always sexual in lower countries, but in high mountains in the north are frequently asexual. Such leafy panicles have a very curled appearance.

Geographical Distribution.—Grasses are found in all parts of the globe, and belong to the outposts of phænogamous vegetation in the polar regions, as well as to the limits of perpetual snow of high mountains. The greatest number of species is found in the tropical zone, but the number of individuals is greater in the temperate zones, where they are closely united to form extended areas of turf that cover large meadows. The formation of meadows is dependent upon a uniform rainfall or continuous irrigation. Grasses also predominate in steppes and savannas, but here they grow in scattered sods or tufts and do not entirely cover the ground. The savanna grasses are characterized by the fact that they often reach above a man's head and are reed-like. The *Bambuseæ* of the lowlands form an important part of tropical forests, especially in regions of the Monsoon. Upon South American mountains the bushy *Bambuseæ* form an entirely closed cover. Aside from the weed-grasses that have been generally distributed by commercial intercourse and colonization, there are several species that are cosmopolitan (for example, *Heteropogon contortus* R. & Sch., and *Phragmites communis* Trin.), and still others that are native to both hemispheres (also to both tropics). Several species from the northern wooded regions (*Deschampsia flexuosa* Trin., *discolor* R., *atropurpurea* Scheele, *Festuca ovina* L., *rubra* L., *elatior* L., *Poa nemoralis* L. and *pratensis* L.) are absent in the tropics, and appear again unchanged in the antarctic regions; others appear in isolated places between on high mountains of the tropics (*Phleum alpinum* L.); still others (*Alopecurus alpinus* L., *Trisetum subspicatum* Beauv.) ap-

pear in varieties that may even be regarded as corresponding species. Not less than 90 genera are common to both continents; among these are many that are exclusively tropical, and besides ten are single types. No one tribe is confined to one hemisphere, and no genus of numerous species to any one floral region. All this goes to prove that grasses are a family distributed very uniformly, and that the separation of their tribes goes back to very ancient times. To be sure, the single tribes have varied under the influence of the later divisions into zones; while the *Paniceæ* and *Andropogoneæ* preponderate in the tropics, they are put in the background by the *Festuceæ*, *Aveneæ*, and *Hordeæ* in the temperate and frigid zones. The eastern North American forest region has preserved many more of them (and in general of tropic types) than has the Old World.

Fossil Grasses.—It cannot be doubted that during the past geological ages, and especially in the tertiary period, grasses must have been widespread and abundantly developed. The numerous remains of grass-like leaves are a proof of this, but any botanist who has made the matter a study will regard as a complete failure the efforts of some phyto-palæontologists to fix upon relations to living species from the crushed and compressed spikes and spikelets. The fragments described as *Poacites* Brongn., *Arundinites* Sap., *Pseudophragmites* Sap., *Paleopyrum* Schmalh., may be entirely passed over; but even others, whose forms point towards the living genera *Oryza*, *Panicum*, *Uniola*, and consequently may lead to conclusions as to the reasons of the existing geographical distribution, are not sufficiently characterized for the determination of genera. There are still others which with good reasons may be referred to *Arundo*, *Phragmites*, and perhaps to the *Bambuseæ*. (Engler.)

Relations.—The grasses form a very isolated family, showing close relationship only to the Cyperaceæ, but markedly differing in the structure of the fruit and embryo (outside position, shield-shaped cotyledon, etc.). The number of species is uncertain, since our knowledge of them is made obscure by a mass of synonyms. There

are probably about 3500 well-defined species. As in most isolated families, the subdivision of the grasses is very difficult and nowhere consists in single characters, but in a combination of them. No single tribe, no large genus numbering over 50 species, can be definitely characterized. The keys of analysis in Part II, especially the first, are therefore subject to many exceptions.

PART II.

KEYS OF ANALYSIS AND DESCRIPTIONS OF TRIBES AND GENERA.

NOTE.—The numbers in parenthesis preceding the names of the genera refer to the corresponding genus numbers in *Bentham & Hooker, Genera Plantarum.*

KEY TO THE TRIBES.

A. *Spikelets one-, rarely two-flowered, lower flower when present imperfect; falling from the pedicel entire or together with certain joints of the rachis at maturity. Rachilla not produced beyond the flowers. Internodes between the different glumes or flowers not measurable.*

a. Hilum punctiform. Spikelets not flattened laterally, but usually somewhat dorsally compressed or else perfectly round.

α. Flowering glumes and palea (the latter often wanting) hyaline. Empty glumes thick membranaceous to coriaceous or cartilaginous, the lowest the largest, with its edges embracing the others. Spikelets generally in racemes or spikes whose articulate axes break up at maturity.

I. ♂ and ♀ spikelets in separate inflorescences or on different parts of the same inflorescence. . . . . **I. Maydeæ.**

II. Spikelets either all ☿, or ♂ and ☿, and so arranged in the same inflorescence that a ♂ stands near a ☿. . . **II. Andropogoneæ.**

β. Flowering glume and palea membranaceous; empty glumes herbaceous, chartaceous or coriaceous, the first generally the largest; spikelets falling off singly or in groups from the continuous rachis. . . . . **III. Zoysieæ.**

γ. Flowering glume and palea membranaceous, empty glumes, herbaceous or chartaceous; the first empty glume smaller or narrower than the following ones. Spikelets falling off singly from the ultimate branches of the panicle.
IV. Tristegineæ.

δ. Flowering glume and palea cartilaginous, coriaceous, or chartaceous. Empty glume more delicate, usually herbaceous, the first usually smaller. Spikelets falling off singly from the ultimate branches of the panicle or continuous (rarely articulate) rachis of a spike.
V. Paniceæ.

b. Hilum linear, spikelets laterally compressed.
VI. Oryzeæ.

B. *Spikelets 1–∞ flowered, the 1-flowered frequently with the rachilla produced beyond the flowers, rachilla generally articulated above the empty glumes, so that these remain after the fall of the fruiting glumes. When from two- to many-flowered there always are distinct internodes between the flowers.*

a. Culm herbaceous, annual; leaf-blade sessile, not articulated with the sheath.

α. Spikelets upon distinct (sometimes very short) pedicels, in panicles, spike-like panicles, or racemes (without notches in the main axis).

I. Spikelets one-flowered:

1. Empty glumes four, palea one-nerved.
VII. Phalarideæ.

2. Empty glumes two (rarely none), palea two-nerved. . . . **VIII. Agrostideæ.**

II. Spikelets 2–∞ flowered:

1. Flowering glume generally shorter than the empty ones; usually with a bent awn on the back, rarely awned from the point or awnless. When not awned there are two nearly opposite florets, and the rachilla is not produced beyond them. . . . . **IX. Aveneæ.**

2. Floral glume generally longer than the

empty ones, unawned or with a straight awn from the point (seldom below).
XI. Festuceæ.

β. Spikelets crowded in two close rows, forming a one-sided spike or raceme with a continuous axis. . . . . **X. Chlorideæ.**

γ. Spikelets in two (rarely more) opposite rows forming an equilateral spike (very rarely unilateral). . . . . **XII. Hordeæ.**

b. Culm (at least at the base) woody, leaf-blade often with a short, slender petiole articulated with the sheath from which it finally separates.
XIII. Bambuseæ.

Tribe I.—Maydeæ.

The ♂ spikelets occupying the upper portion of the inflorescence or of its divisions, the ♀ below. Grain ellipsoidal or roundish, unfurrowed, with large embryo, and enclosed in a hard capsule formed by the glumes or part of the articulate rachis (*Zea* excepted), separating finally as a false fruit. Starch-grains simple, polyhedral. Culm tall, with pith; leaves broad, flat.

Remarks.—Only the ♀ spikelets are arranged in true spikes; the ♂ spikes, so called, of Maize, etc., are, like the spikes of *Andropogoneæ*, really racemes, since the spikelets corresponding to the primary branches of the axis of the spike are distinctly pedicellate. But since these pedicels bear secondary, sessile spikelets at their bases, and these apparently are borne on the main axis, the whole has the appearance of a spike. In *Maydeæ* the term "spike" has been kept up also for the ♂ racemes in order to avoid two different terms.

A. ♂ *spikes numerous in terminal panicles*, ♀ *spikes in the axils of leaves subtended by large membranaceous bracts at the base.*

a. ♀ spikes of each leaf-axil free, articulated.
1. Euchlæna.

b. ♀ spikes of each leaf-axil grown together into a continuous, compound and much thickened axis (the "ear"). . . . . **2. Zea.**

B. ♂ *spikes solitary at the ends of the branchlets*, ♀ *below*, 1–2, *each of them reduced to a single spikelet which is*

entirely enclosed by the ovate or spherical, ivory-like sheath of the subtending bract. . . . . . **7. Coix.**

C. ♂ *and* ♀ *spikelets in the same spike (at least in the lateral spikes), the lowest empty glume of the* ♀ *spikelets indurated.*

a. The covering of the false fruit chiefly formed by the rachis, its opening in front closed by the narrow empty glume. . . . . **3. Tripsacum.**

b. The covering of the false fruit chiefly formed by the first empty glume, which is appressed to the narrow joint of the axis to which it is attached on the inner side.

α. The terminal spikes ♂, the lateral ones androgynous or ♀. . . . . **4. Polytoca.**

β. Spikes all monœcious.

I. Several ♂ spikelets above the ♀, the latter without membranaceous appendages. **5. Chionachne.**

II. One ♂ spikelet above every ♀, each of the latter provided with an open membranaceous appendage (the hardened outer glume). . . . . **6. Sclerachne.**

NOTE.—In the explanations of all the following figures the letters are used as follows: A, entire inflorescence or part of the same; B, spikelet; C, empty glumes (in order C_1, C_2, C_3, C_4); D, flowering glume; E, palea; F, flower; G, lodicules; J, pistil; K, fruit or grain. Special letters are explained in the descriptions.

1. (37) **Euchlæna** Schrad. (*Reana* Brign.). Two ♂ spikelets to each joint of the rachis (one sessile, the other pedicellate), both two-flowered with membranaceous glumes; ♀ in two-ranked spikes (apparently one-ranked). These spikes are fasciculate in the leaf-axils; the joints of the axis to which they belong are trapezoids, so that as they fall off, the obliquity of the upper surface of one alternates in direction with that above or below it. The edges of the cavity embrace the first cartilaginous empty glume, forming with it at maturity a smooth cartilaginous capsule or false fruit. Styles prolonged far beyond the leaf at the base of the spikelet, and two-cleft at the end. Tall annuals with very broad leaves.

Only one species (*E. Mexicana* Schrad.) (Fig. 9) with varieties (e.g., *E. luxurians* in Mexico, "Teosinte"). Stems 2–7 m. high, very leafy, and valuable for fodder in warm countries; rarely blossoms in Europe, even in the south. [Teosinte is cultivated in the Southern States for green fodder. It rarely blooms, and matures its seeds only in southern Florida.]

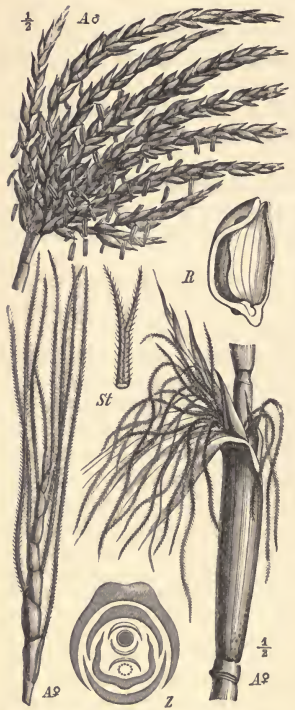

FIG. 9.—*Euchlæna Mexicana* Schrad. *R*, Joint of the rachis. *St*, Stigma. *Z*, Diagram. *A* ♀, Single spike at the left; at the right, a tuft of the same surrounded by the sheath. (After *Bot. Mag.*, plate 6414.)

2. (38) **Zea** L. (*Mays* Gärtn.). Habit, foliage, ♂ inflorescence, arrangement of the ♀ spikes in the leaf-axils with membranaceous basal bracts and the long projecting styles, as in the preceding genus, but the ♀ spikes (originally by monstrous or teratological development?) are grown together into a spongy, continuous, club-shaped body (the "cob") upon which the 4–11 double rows (each sessile upon a low longitudinal elevation that is limited by a long shallow furrow on each side) correspond to a single spike of *Euchlæna*. Grain developed at the expense of the other parts, projecting beyond the thin bracts, which rarely become coriaceous and enclose it.

One species (*Zea Mays* L.), Maize (Fig. 10), known only in its cultivated state, but originating at all events in tropical America, apparently greatly changed by cul-

FIG. 10.—*Zea Mays* L. (Grosser parts after Maout and Decaisne, details after Nees, Gen. I., 3. 4.)

ture. "Husk Maize" (see below) may approach the native form in its glumes, the occasional division into more or less separated spikes, and an indication of articulations in the inflorescence.

The present condition, perhaps an anomaly obtained by culture, is lacking in every means of distribution, and is therefore scarcely typical. The cultivation of Maize has not only extended into nearly all tropical and sub-tropical countries, but has also penetrated into temperate regions (in Europe and North America, as a cereal, as far as 48°, and as a fodder plant still farther north), and around Lake Titicaca at 3900 meters above sea level. Culm 1–5 m. high, 1–6 cm. thick; leaves broad with undulating margins and gently drooping ends.

About sixty varieties are known, differing from one another in form, color, and size of fruit. The following are the most important:

a) *Common Maize.* Ear 8–24 cm. long; kernel medium size, compressed from the back, rounded at the point, generally yellow; rarely white, red, violet, black, blue, or variegated in the same ear.

b) *Pearl Maize,* very small, slender; kernels scarcely 6 mm. long, round above, vitreous, very shiny like glassy beads.

c) *Horse-tooth Maize.* Kernels large, strongly compressed from the back, sides flat, base dimple dented or creased. A very tall variety found especially in North America.

d) *Sugar Maize.* Kernels much wrinkled, vitreous, appearing like gum arabic when broken, containing, instead of starch-grains, a soluble modification of starch, together with a little finely granular starch. Cultivated in North America.

e) *Cuzco Maize.* Kernels 2.5 cm. in length and 1.8 cm. in breadth, much compressed, tapering toward the base.

f) *Husk Maize,* with herbaceous, ovate, pointed empty glumes entirely covering the kernels. If the ovary of yellow maize be fertilized with the pollen of a black

fruited variety, the resulting grain will be yellow with grayish-black flecks.

Uses.—The very nourishing meal is sometimes made into mush ("Polenta") by boiling, but its exclusive use gives rise to a skin disease; it is also made into cakes ("Tortillas"), and sometimes mixed with wheat flour, or wheat and rye, to make bread ("Brown bread" of New England). The unripe ears are roasted or pickled in vinegar as a vegetable; from the fruit the natives of South America prepare an alcoholic drink ("Chica"), another ("Pulque de Mahiz") is made in Mexico by the fermentation of the very sweet sap that is pressed out of the stem. In North America efforts have been made to make sugar from this juice. The boiled fruit makes an excellent food for swine and poultry, and the entire plant, even the straw, is an excellent fodder for cattle. The husks are used for making paper as well as for hats, matting, and for filling beds, etc. The large variety horse-tooth maize) as well as that with striped leaves is used for lawn decorations in ornamental gardening.

Maize was imported into Europe soon after the discovery of America, at about the same time that Northern Europe received Buckwheat from Central Asia and Russia. In view of the wide distribution it had attained when America was discovered, and the manner of its cultivation, its culture in this country must be very ancient, though older discoveries are wanting, since the finding of maize-kernels in the renowned graveyard of Ankon in Lima is not reliable, for determining its antiquity, for those graves were evidently used after as well as before the discovery of America.

3. (36) **Tripsacum** L. One to several upright terminal spikes, besides those in the leaf axils. The ♂ spikelets in pairs at each joint of the axis, two-flowered; the ♀ single, one-flowered; styles connate near the base, stigmas long. Capsule or false fruit as in *Euchlæna*, but separating less obliquely; at each side of the base of the empty glumes (as in *Euchlæna*) there is a cavity for

the protruding radicle in germination. Tall perennial grasses with rather broad leaves.

Species two or three, in sub-tropical America north of the Equator. *Tr. dactyloides* L. ("Gama grass") extends

FIG. 11.—*Tripsacum dactyloides* L. R. Joint of the rachis. (After Asa Gray, "Man.," plate 14.)

FIG. 12.—*Coix Lacryma* L. (After Mart. and Eichl., "Fl. bras.," II. II. plate 10.)

as far north as Illinois and Connecticut, growing in wet places, and is used for fodder and also as an ornamental plant. (Fig. 11.)

4. (33) **Polytoca** Brown. (*Cyathorachis* Nees.) Terminal panicle consisting of from three to many ♂ spikes. Fas-

cicles of spikes in the axils of the leaves composed of ♂ spikelets above and ♀ below; the latter with rather long sterile glumes that are cartilaginous below and chartaceous above, completely enclosing the narrow joints of the rachis.

Species three, in the East Indies, one (*P. macrophylla* Benth.) in Louisiade Archipelago.

5. (34) **Chionachne** Brown. Culm much branched, branches terminated by spikes that are subtended by a sheathing leaf. Spikes with 1–5 ♀ and many (usually in pairs) ♂ spikelets. Similar to *Coix* (see below), but the fruit capsule is formed by the first empty glume.

Species three, in the East Indies, Malayan Archipelago to Australia.

6. (35) **Sclerachne** Brown. Like the preceding, but the spikes, which are half enclosed in the leaf-sheath, have only one ♂ spikelet, and the ♀ spikelet has an appendage upon the first empty glume. Species one (*S. punctata* Brown) in Java.

7. (32) **Coix** L. (*Lithagrostis* Gärtn.). Culm branched repeatedly, branches ending in one or two short, ivory-like, nearly globose capsules with an orifice at the top, and surrounding the ♀ inflorescences, each of which contains one fertile and 1–2 sterile (often reduced to a pedicel) spikelets; the ♂ inflorescence projects out of the orifices of the capsules, and is composed of spikelets in pairs. The capsule is formed by the sheath of the leaf at the base of the ♀ inflorescence, and often shows a rudimentary blade. Glumes of the ♀ spikelets delicate; style long, stigma short, hairy.

Species 3–4, in India and China, and from there (*C. Lacryma* L., Tear-grass ["Job's Tears"], Fig. 12) spread throughout the tropical zone; cultivated in China because the fruit is believed valuable as a diuretic and antiphthisis. In Catholic countries the fruit capsule is used for rosaries.

Tribe II.—Andropogoneæ.

Spikelets in spike-like racemes (cf. remarks on *Maydeæ*), two (rarely only one) at each joint of the usually

articulate rachis, one sessile and one pedicellate, often apparently three at the terminal joint. Raceme sometimes reduced to the terminal joint. Spikelets generally one-flowered with three empty glumes, rarely a flowering glume with a ♂ flower instead of the third empty glume; first empty glume always more indurated than the flowering glume, the latter often hyaline, usually bearing a bent or twisted awn. Palea usually shorter than its glume, sometimes 0. Stamens three, rarely two or one. Style free, stigma plumose. Grain unfurrowed, embryo nearly half as large as the fruit. Starch-grains simple, polyhedral to roundish. Mainly natives of elevated plains within the tropics, forming an important part of the grasses of the savannas.

A. *Spikelets homogamous,* ☿ ; *joints of the rachis not much thickened, nor excavated for the reception of the spikelet.* (*Saccharew.*)

a. Axis of racemes continuous.

α. Spikelets solitary.

I. Spikelets on very short pedicels, disposed in one to several slender unilateral racemes. **8. Dimeria.**

II. Spikelets pedicellate, forming a narrow, symmetrical, and much-branched panicle. **36. Cleistachne.**

β. Spikelets in pairs, rarely in threes, upon each joint of the rachis.

I. Racemes in a narrow spike-like panicle, spikelets awnless. . . . . **9. Imperata.**

II. Racemes in broad often fan-shaped panicles, spikelets usually awned. **10. Miscanthus.**

b. Axis of racemes articulate.

α. Racemes solitary, terminal.

I. Spikelets in pairs at each joint of the rachis. **16. Pogonatherum.**

II. Spikelets in threes at each joint of the axis. **15. Polytrias.**

β. Racemes two to many, digitate or approximate on a shortened main axis.

I. Spikelets one-, rarely two-flowered; when

two-flowered the first empty glume has a median longitudinal furrow. . **13. Pollinia.**

II. Spikelets two-flowered, first empty glume without a longitudinal furrow.

25. Ischæmum (in part).

γ. Racemes in a much-branched panicle upon an elongated main axis, the lateral racemes sessile.

I. Spikelets awned. . . . . **12. Erianthus.**

II. Spikelets unawned. . . . **11. Saccharum.**

δ. Racemes (usually short) in branched panicles with elongated main axis, the lateral racemes pedicellate. . . . . **14. Spodiopogon.**

B. *Spikelets heterogamous or rarely homogamous, the joints of the axis of the raceme (false spike) appressed or grown to the pedicels of the primary spikelets, forming together with the pedicels a hollow or excavation for the reception of the secondary spikelets; fertile glumes always awnless.* (*Rottbœlliecæ.*)

a. Joints of the rachis and pedicels complanate, not pressing against each other, but opposite; the ♀ spikelets sessile upon each joint of the axis and their posterior sides pressed against each other, embracing only by the edges. . **17. Ratzeburgia.**

b. Joints of rachis and pedicels thick, appressed or grown together, the ♀ spikelets single upon each joint (very rarely in twos), entirely enclosed in front.

α. First empty glume naked, awnless (at most only the terminal spikelet caudate).

I. The first empty glume flat or simply convex. . . . . **18. Rottbœllia.**

II. First empty glume globose, with an opening upon the inner side which is closed by the joint of the rachis. . . **19. Manisuris.**

β. The first sterile glume of all or of only the pedicelled spikelets awned or caudate.

I. Racemes simple or again disposed in racemes (compound).

1. Spikelets, both sessile and pedicellate (the latter sometimes apparently re-

duced to a pedicel) with 1–2 short awns. . . . . **20. Rhytachne.**

2. Sessile spikelets awnless, the pedicellate with long awns. . . . **21. Urelytrum.**

II. Racemes digitate; the first glumes of all the spikelets long caudate-pointed. **22. Vossia.**

C. *Spikelets heterogamous, the sessile* ☿ (*rarely* ♀), *the pedicellate* ♂, *empty or wanting, very rarely all* ☿ *or all pedicellate. Joints of raceme not strongly thickened, nor with excavations for the reception of the spikelets.* (*Thelepogon excepted.*)

a. Sessile spikelets two-flowered (*Ischæmeæ*).

α. Racemes reduced to the terminal joint with three spikelets, and enclosed by a sheathing leaf or bract. . . . . **28. Apluda.**

β. Racemes with many joints.

I. Pedicellate spikelets developed, flower-bearing.

1°. Sessile spikelets awnless, pedicellate awned; first empty glume three-toothed. . . . . **27. Lophopogon.**

2°. Sessile spikelets awned or with the flowering glume at least mucronate-pointed; empty glumes not three-toothed. . . . . **24. Ischæmum.**

II. Pedicellate spikelets, very rudimentary, or reduced to the pedicel.

1°. First sterile glume pectinate-fringed at least at the base; racemes solitary, spikelets awnless. . . **25. Eremochloa.**

2°. First empty glume not fringed; racemes two, closely appressed to each other; spikelets usually awned. **26. Apocopis.**

3°. First empty glume not fringed, transversely wrinkled and tuberculate; racemes digitate; spikelets awned. **23. Thelepogon.**

b. Sessile spikelets, one-flowered (*Euandropogoneæ*). Flowering glume of the pedicellate spikelets awnless.

α. Axis of racemes indistinctly articulate, not brittle; spikelets all pedicellate.

29. Trachypogon.

β. Axis of racemes distinctly articulate; spikelets both sessile and pedicellate.

I. First empty glume with a balsam-bearing line within the side keels. Racemes solitary; spikelets awnless. **30. Elionurus.**

II. First empty glume without balsam lines. Racemes when solitary almost always awned.

1. A false whorl of four or more staminate or empty spikelets at the base of each raceme. Racemes solitary, short, usually subtended by a sheathing leaf.

* False whorl composed of four ♂, one-flowered or empty spikelets.

† ☿ spikelets with a pointed callus, readily separating from the false whorl. . . . **33. Themeda.**

†† ☿ spikelets without a callus, falling off together with the false whorl. **35. Iseilema.**

** False whorl composed of 6–9 ♂ two-flowered spikelets. **34. Germainia.**

2. No distinct false whorl of ♂ spikelets at the base of the racemes, or where an imperfect one occurs, the racemes in pairs, subtended by a leaf-sheath.

* Fertile glume awned from the back or base; leaves cordate at base. **31. Arthraxon.**

** Fertile glumes awned from the point or from a more or less deep cleft, or awnless; leaves not cordate at the base. . . . . **32. Andropogon.**

1. Sub-tribe **Dimerieæ.**

8. (82) **Dimeria** R. Brown. (*Haplachne* Presl., *Didactylon* Zoll., *Psilostachys* Steud., *Pterygostachyum* Nees). Spike-

FIG. 13.—*Saccharum officinarum* L. (After Bentley et Trimen, "Medicinal Plants.")

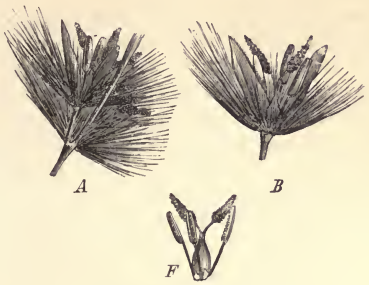

FIG. 13.—*Continued.*

lets one-flowered, linear, laterally compressed; first empty glume keeled, flowering glumes awned. Stamens two.

Species twelve, in East Indies, S. China, N. Australia.

2. SUB-TRIBE **Saccharеæ.**

9. (73) **Imperata** Cyr. Spikelets one-flowered, densely clothed with long silky hairs. Empty glumes membranaceous, narrow, the two outer with long hairs. Flowering glume small. Stamens 1–2. Stigmas long, exserted from the point of the spikelet.

Species five, throughout the tropical and sub-tropical zones, also in warm temperate countries. *I. arundinacea* Cyr. is cosmopolitan in its several varieties. It forms the principal grass of the Alang Alang fields in the Malay Archipelago, and furnishes material for thatching roofs.

10. (74) **Miscanthus** Andersson. Distinguished from the preceding by the broad panicle, three stamens, and the flowering glumes more or less bifid and usually awned between the teeth or lobes. Tall, the ample panicles terminal and usually silky hairy, rarely naked.

Species six, in Southern and Eastern Asia to Amur. *M. Sinensis* Anders. (*Eulalia Japonica* Trin.) with awned spikelets, is a favorite ornamental grass, as also is the more rare *M. sacchariflorus* Hack. (*Imperata sacchariflora* Maxim.) with awnless spikelets, from Amur.

11. (75) **Saccharum** L. Panicles usually expanded, the branches (racemes) many-jointed. Spikelets slender, the

somewhat hardened first and second empty glumes with long hairs (especially on the callus). Third empty glume (often 0) as well as the flowering glume and short palea hyaline. Anthers three. Tall grasses, usually with narrow leaves; the small spikelets surrounded by long silky hairs.

Species twelve, mostly in the tropics of the Old World, only three (forming Sec. II) in America.

Sec. I. Spikelets all ☿. Panicles expanded, axis of racemes articulate. To this section belongs *S. officinarum* L. (Sugar-cane) (Fig. 13), which has a culm 2–4 m. high, 2–5 cm. thick, with very juicy pith; leaves long, 2–4 cm. broad; panicles 40–80 cm. long, pyramidal, and the third empty glume wanting. Native country not known, probably from tropical East Asia, but now cultivated in all tropical countries, especially in South America, and also in South Spain. In many countries, especially in the islands of the Pacific Ocean, it readily becomes spontaneous, and when this is the case it blossoms. For culture varieties are chosen which have been reproduced for centuries by cuttings, and consequently have become nearly incapable of blooming. To propagate sugar-cane it is sufficient to place a piece of the culm possessing buds at its nodes, in a hole or furrow in the ground, where it will root rapidly if sufficiently moist.

The different cultivated varieties are distinguished almost entirely by the color and height of the culm. The expressed juice or sap yields 17 to 18 per cent saccharose (crystallizable sugar), and the uncrystallizable molasses that remains is used for the manufacture of rum. In many countries the fresh culms are sold for chewing. At present the colonial sugar industry is somewhat on the decline, a condition to which the manufacture of beet-sugar and the attacks of certain insects (*Tortrix saccharipha*ga, *Coccus sacchari*) have contributed. *S. spontaneum* L. with narrower leaves and a developed third empty glume is found from Sicily (where it is also cultivated as a hedge plant) through the tropics of the Old World, and is a component of the Alang Alang fields of Sunda Islands (Malayan Archipelago), and of the grassbars of the Upper Nile.

Sec. II. **Sclerostachya.** Like Sec. I., but the axis of the raceme is continuous. Spikelets all pedicellate. Species one, in Asia.

Sec. III. **Eriochrysis** (Beauv. as a genus). Pedicellate spikelets ♀, smaller; panicle compact, interrupted; axis articulate. Species four, in South America and Cape of Good Hope.

Sec. IV. **Leptosaccharum.** Spikelets single along the axis of the raceme. Rachis not articulate. Species one, in South America.

12. (76) **Erianthus** Michx. (*Ripidium* Trin.). Differs from *Saccharum* only by the awned spikelets. Reed-like, narrow-leaved grasses with the usually expanded panicles clothed with silky hairs.

Species seventeen, in the warmer countries of both hemispheres. One species (*E. Ravennæ* Beauv.) extends as far north as upper Italy. Also cultivated for ornament. (Fig. 14.)

FIG. 14.—*Erianthus Ravennæ* Beauv. (After Nees, Gen. Germ. I. 90. *A*, Branch of the panicle.)

13. (78) **Pollinia** Trin. Racemes usually digitate, seldom arranged in panicles. First and second empty glumes chartaceous or membranaceous, the third hyaline. Flowering glumes awned from the point or from a notch. Awns twisted or geniculate, very rarely 0.

Species thirty-two, in the tropical and sub-tropical regions of the Old World.

Sec. I. **Eulalia** (Kunth as a genus). Spikelets clothed with silky hairs. Leaves narrow-linear.

Sec. II. **Leptatherum** (Nees as a genus, *Nemastachys*

Steud., *Microstegium* Nees). Spikelets slightly hairy, usually only upon the callus, rarely upon the keel. Leaves lanceolate, much narrowed at the base.

14. (77) **Spodiopogon** Trin. Racemes with long pedicels, usually with only two to three pairs of spikelets; first empty glume keelless, strongly 5–9-nerved. Spikelets somewhat laterally compressed, awned from a deep notch in the flowering glume.

Species five, in Asia Minor, Hindostan, China, Amur, and Japan.

15. (77*a*) **Polytrias** Hack. A low, prostrate grass with shining, red-brown, hairy racemes, each joint of the rachis bearing two sessile and one pedicellate spikelet. Flowering glumes with a terminal awn.

Species one (*P. præmorsa* Hack.), in Java.

16. (79) **Pogonatherum** Beauv. (*Homoplitis* Trin.). Spikelets very small, the second empty glume and the flowering glume with long delicate awns. Anthers two. Delicate grasses.

Species two, in the East Indies; one (*P. saccharoideum* Beauv.) extends to Japan.

3. Sub-tribe Rottbœllieæ.

Joints of the rachis and the spikelets usually naked.

17. (86) **Ratzeburgia** Kunth. Racemes (false spikes) linear, flattened. Joints of the rachis curved above; first empty glume reticulately ribbed.

Species one (*R. pulcherrima* Kunth), on the river Irawaddi.

18. (84) **Rottbœllia** L. False spikes cylindrical or slightly compressed; first empty glume coriaceous, covering the excavation in the rachis-joint; spikelets awnless.

A polymorphous genus with the following sub-genera:

Sub-genus I. *Cœlorhachis* (Brongn. as a genus, *Stegosia* Lour.). Racemes solitary and terminal upon the culm and its branches, articulate and joints readily separating; joints of the rachis hollow at the apex,

free, rarely grown to the pedicels of the lateral spikelets; spikelets usually one-flowered, the pedicellate and sessile ones alike, the former rarely rudimentary.

Species twenty, in the tropics of both hemispheres.

Sub-genus II. *Ophiurus* (Gärtn. as a genus). Resembling Sub-genus I, but the lateral spikelets are absent or rudimentary, and their pedicels grown to the rachis; sessile spikelets one-flowered.

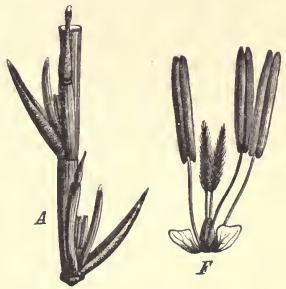

FIG. 15.—*Rottbœllia loricata* Trin. (After Mart. et Eichl., "Flora Bras," II, III.)

Species four, in the tropics of the Old World. In *O. lævis* Benth. (*Mnesithea* Kunth, *Thyridostachyum* Nees) there are frequently sessile spikelets, in pairs, upon the lower portion of the false spike. *Ophiurus* may be correctly considered as an independent genus.

Sub-genus III. *Hemarthria* (Brown as a genus). Resembling Sub-genus I, but the false spikes are more compressed, not imperfectly articulate, and joints of the rachis hollow at the apex. Lateral spikelets formed like the one-flowered sessile spikelets, their pedicels usually grown to the rachis-joints so that the spikelets appear to be in pairs.

Species three, in warm countries extending beyond the tropics as far as South Europe and Tasmania.

Sub-genus IV. *Peltophorus* Desv. (*Manisuris* L., not Sw.). Like Sub-genus III, but the two contiguous sessile spikelets are very unlike, the first sterile glume of one having a broad margin ("bordered on each side at the apex by a membranous wing"—Bentham); joints of the axis easily separable, with two appressed cavities at the apex.

Species three, in India.

Sub-genus V. *Thyrsostachys.* False spikes in a bushy panicle. First empty glume of the sessile, one

flowered spikelets almost membranaceous, coriaceous only upon the edges.

Species one, in Khasya Mountains.

Sub-genus VI. *Phaclurus* (Griseb. as a genus). False spikes in simple racemes, sessile, rarely solitary. All spikelets alike, two-flowered.

Species three, in the Orient, Himalaya, and East Asia.

19. (87) **Manisuris** Sw. Sessile spikelets one-flowered, hollow-globose, pitted externally; pedicellate spikelets flat, ♂, or empty, their pedicels grown to the rachis.

Species one (*M. granularis* Sw.), with leaves cordate at the base. A weed in all tropical countries.

20. **Rhytachne** Desv. Axis of the false spike articulate, easily separable at the joints whose ends are at right angles to the axis and without appendages. First empty glume of the sessile spikelets rugose and with one or two terminal points or tails. Pedicellate spikelets rudimentary, awned.

Sub-genus I. *Eurytachne.* False spikes terminal and solitary.

Species two, in tropical Africa; one of them said to occur upon the Antilles.

Sub-genus II. *Jardinea* (Steud. as a genus). False spikes, several, in a simple raceme, pedicellate.

Species two, in tropical Africa.

21. **Urelytrum** Hack. Axis of the false spike articulate, easily breaking into joints whose ends are oblique and provided with an appendage at the upper end. First empty glume of the sessile spikelets smooth, awnless.

Species two, in tropical Africa to Natal.

22. (89) **Vossia** Wall. & Griff. False spikes digitate, stout, compressed. Rachis-joints curved, notched, not excavated. First empty glume of the sessile spikelets smooth, and like the pedicellate produced into a long straight point or awn 1.5 to 2 cm. long.

Species one (*V. procera* Wall. & Griff.), a tall, aquatic grass, frequently floating. In western India, and in tropical Africa, where it occurs in the swampy lands of the Upper Nile, forming, in company with *Saccharum spon-*

taneum L., the vast floating grass-bars which frequently make navigation impossible.

4. Sub-tribe **Ischæmeæ.**

23. (90) **Thelepogon** Roth (*Rhiniachne* Hochst.). Racemes digitate. Rachis flexuose, joints notched. First empty glume tuberculate. Flowering glume strongly awned from the notch.

Species one (*Th. elegans* Roth), in India and Abyssinia.

24. (91) **Ischæmum** L. (Fig. 16). Racemes two to many, digitate, rarely solitary. Spikelets broad, the pedicellate like the sessile, but frequently unawned,

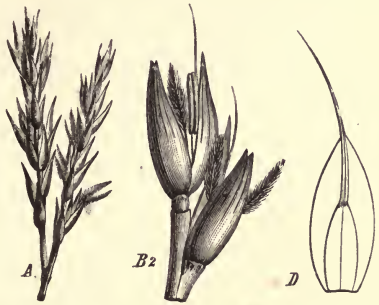

Fig. 16.—*Ischæmum Urvilleanum* Kunth. (After Mart. et Eichl., "Flora Bras." II, III, 72.)

rarely ♂ or empty. First empty glume coriaceous or membranaceous, obtuse, often two-toothed. Flowering glume awned from the apex or a notch. Mostly low grasses with rather broad leaves.

Species thirty-four, chiefly in Southern Asia and Australia, very few in America and Africa.

Sec. I. *Meoschium* (Beauv. as a genus, *Colladoa* Cav., *Ischæmopogon* Griseb.). Racemes two to many.

Sec. II. *Sehima* (Forsk. as a genus) (*Hologamium* Nees). Racemes solitary.

25. (89) **Eremochloa Büse** non Watson (*Pectinaria* Benth. as a section). Racemes solitary, densely flowered, unilateral. Spikelets broad, awnless. Delicate, ornamental grasses.

Species six, in East Indies.

26. (80) **Apocopis** Nees (*Amblyachyrum* Hochst.). Racemes in pairs (often having the appearance of being single). Spikelets crowded, the lowest sessile, ♂, awnless, the upper ☿, awned. Stamens two. Delicate, low grasses.

Species three or four, in East India, China, and the islands of the Malayan Archipelago.

27. **Lophopogon** Hack. Spikes in pairs, appressed together, clothed with shining, rusty-brown hairs; spikelets crowded. (Characters in the key.) A low, delicate grass with narrow leaves.

Species one (*L. tridentatus* Hack.), in western India.

28. (98) **Apluda** L. Racemes minute, enclosed in the sheaths, fascicled; fascicles in false panicles interspersed with numerous leaves. Callus of the sessile spikelets spherical, both the other spikelets (one ♂ and one rudimentary) upon broad, flat pedicels.

Species one (*A. varia* Hack.), with many varieties (spikelets awned or awnless), in East Indies, China, and Australia.

5 Sub-tribe **Euandropogoneæ.**

29. (92) **Trachypogon** Nees. The long, pedicellate spikelet of every pair ☿, with a long stout awn; the ♂ spikelet subsessile, awnless. Racemes solitary or two or three together, often clothed with silky hairs.

Species one (*T. polymorphus* Hack.), in tropical and subtropical America, Southern Africa, and Madagascar.

30. (83) **Elionurus** Humb. & Bonpl. Axis of the solitary raceme obliquely articulate, densely hairy. First empty glume bifid or two-lobed, fringed; spikelets with a strong balsam-like odor when fresh or after soaking in water, and burning the tongue when chewed. [Two species within the limits of the United States, viz., *E. tripsacoides* H.B.K. (*Rottbœllia ciliata* Nutt.) and *E. barbiculmis* Hack. (Wright, No. 2106).]

Species fifteen, mostly in tropical and subtropical America, some in Africa, western India, and Australia. Savanna grasses, rejected by cattle. (The

strong balsamic products in these grasses may protect them from being exterminated by grass-eating animals.)

31. (82) **Arthraxon** Beauv. (*Pleuroplitis* Trin., *Bathratherum* Nees, *Lucœa* Kunth, *Alectoridia* Rich., *Psilopogon* Hochst., *Lasiolytrum* Steud.). Racemes usually digitate, delicate, often becoming true spikes by the abortion of the ♂ spikelet together with its pedicel. Spikelets awned, very rarely awnless. Delicate grasses.

Species nine, in the tropics of the Old World; one extends to Japan, China, and Asia Minor.

32. (94) **Andropogon** L. Racemes solitary or in pairs, digitate or panicled, occasionally reduced to a few joints or to the terminal joint with three spikelets. Rachis and callus of the first empty glume usually hairy. Spikelets usually narrow, the pedicellate ♂, empty, or reduced to the pedicel, its flowering glume awnless, but the first empty glume occasionally awned. Palea frequently small or 0.

A polymorphous genus, spread over all parts of the world in the tropical and temperate zones; the species prefer dry places, especially savannas. The numerous sub-genera form two distinct series.

Series A. *Isozygi.* The sessile spikelets of the lowest pairs in each raceme like those above as regards sex, form, and awns.

Sub-genus I. *Schizachyrium* (Nees as a genus). Racemes slender, solitary, usually smooth, terminal upon the culm or its branches, the thickened joints of the rachis with a cup- or tooth-like appendage at the apex. Flowering glume often cleft nearly to the base, awned from between the divisions; second empty glume awnless.

Species twenty-seven, in the tropics, especially of America, and as far north as New England (e.g., *A. scoparius* Mich.).

Sub-genus II. *Diectomis* (Humb. & Bonpl. as a genus). Like Sub-genus I, but the spikelets laterally compressed, the second empty glume awned, the flowering glume slightly notched at the point.

Species one, in tropical countries.

Sub-genus III. *Hypogynium* (Nees as a genus). Ra-

cemes solitary, terminal upon the branches and culm, subtended by sheathing leaves. Rachis slender, without appendages; flowering glume awned from the point or from a narrow slit, or awnless.

Species five, scattered through the tropics (*A. spathiflorus* Kunth from Paraguay to Cuba).

Sub-genus IV. *Anadelphia* (Hack. as a genus). Like the preceding, but only a part or none of the sessile, ☿ spikelets are accompanied by ♂ ones.

Species one, in tropical Western Africa.

Sub-genus V. *Arthrolophis* (*Euklastaxon* Steud. as a genus). Racemes mostly in pairs, rarely digitate or panicled, the lateral ones sessile; joints of the rachis somewhat thickened, not translucent. Flowering glume usually bifid or two-toothed.

FIG. 17.—*Andropogon Ischæmum* L. (After Nees, Gen. Germ. I. 92.) *B*, a pair of spikelets.

Species fifty, the majority American (*A. Virginicus* L. ["Broom Sedge"] and its allies, *A. provincialis* Lam., etc.).

Sub-genus VI. *Amphilophis*. Racemes digitate or panicled, all pedicellate. Rachis-joints and pedicels with a median, longitudinal, translucent line. Flowering glume pedicel-like, tapering into an awn.

Species fifteen, mostly of the Old World. *A. Ischæmum* L. (Fig. 17) of Central Europe and Asia, and *A. saccharoides* Sw. of America, belong here.

Sub-genus VII. *Sorghum* (Pers. as a genus, *Blumenbachia* Köl.). Racemes in panicles, frequently with few (sometimes only one) fertile spikelets. Rachis-joints without a translucent line, empty glume usually broad-lanceolate, finally indurated and shining.

Species thirteen, *A. arundinaceus* Scop. (*A. Halapensis* Sibth.) (Fig. 18) with a compound panicle, 2–5 spikelets in each raceme, and fringed lodicules. Scattered in many varieties over the torrid and warm temperate countries. This is probably the original form of the cultivated Sorghum or Black Millet races (*A. Sorghum* Brot.). In these the fruit and spikelets are usually larger and rounder, and the rachis is not articulate. The most important are variety *saccharatus* (*Sorghum saccharatum* Pers.), Sugar Sorghum, panicles looser with drooping branches and red-brown spikelets; var. *technicus*, like the preceding, but the branches very long, exceeding the shortened main axis; var. *vulgaris* (*S. vulgare* Pers.), with more compact panicles and light-colored obovate spikelets; var. *niger*, like the preceding, but with black spikelets; var. *cernuus* (*S. cernuum* Host.), like *vulgaris*, but the culm is bent or recurved just below the panicle; var. *Durra*, with more condensed panicles and deltoid spikelets, etc. The culture of Sorghum probably had its origin in Africa, where "Durra," as it is called there, is now cultivated over the entire continent, and has become the most important cereal. The natives also chew the stem, which contains sugar. It is also considerably cultivated in India and China. In Europe it is raised less for bread than for mechanical purposes (especially the variety *technicus*); the panicles are made into the so-called "rice brooms," and into brushes, etc. Italy, South France, and North America furnish the raw material in great quantity. In Germany, Sorghum, like Maize, is only occasionally raised for green fodder. In North America sugar is also made from the culms, and for this purpose the variety called Sugar Sorghum (*S. saccharatum*) is used less than certain kinds of the variety *vulgaris*. In South Europe these industries may develop in the future. From the fruit the Caffirs make "*Tialva*," and the negroes "*Merisa*," alcoholic drinks. The fruiting glumes contain useful coloring matters.

Sub-genus VIII. *Vetiveria* (Virey as a genus). Ra-

FIG. 18.—*Andropogon Sorghum* Brot. *A*, the original form (*A. Halapensis* Sibth.). *B*, a cultivated form (var. *vulgaris*); after Reichenb., Ic. 1503. *D*, *G*, and *K*, var. *vulgaris*, after Reichenb., VII. 465.

cemes very many, in whorls upon slender pedicels; these are arranged above one another, forming a panicle.

Species two. *A. squarrosus* L., fil. (*A. muricatus* Retz., *Anatherum muricatum* Beauv.). Spikelets small, narrow; empty glumes cartilaginous, beset with small spines. Swamp plants, called in India "Khushus" or "Bena," in the French colonies "Vetives." [Introduced in Louisiana, where it has become spontaneous.] The rhizome is very aromatic. In India the whole plant is used in making the "Vessaries," or broad fan-screens, which when kept wet and placed in a current of air, cool and at the same time perfume the heated atmosphere of a room. When laid among clothing the rhizome keeps it free from insects. In European drug stores it is known as *Radix Anatheri* or *R. Vetiveriæ*, a stimulant or antiseptic. It is also used in perfumery (Vitivert).

Sub-genus IX. *Chrysopogon* (Trin. as a genus; *Rhaphis* Lour.). Racemes whorled, pedicellate, usually reduced to one or two terminal joints. Spikelets somewhat laterally compressed.

Species twelve (*A. Gryllus* in S. Europe and Asia, etc.), with one exception (*A. pauciflorus* = *Sorghum pauciflorum* Chapm.) from the Old World.

Series B. *Heterozygi*. Sessile spikelet of the lowest pair or of several of the lower pairs (at least in one or two racemes) differs from the upper pairs in sex and awns, or is empty.

Sub-genus X. *Dichanthium* (Willemet as a genus, *Lepeocercis* Trin.). Racemes usually three to many, digitate, all pedicellate or all sessile, not subtended by a leaf-sheath. Flowering glume usually stalk-like.

Species ten, in the tropics of the Old World, two of them (*A. piptatherus* Hack., *A. Neesii* Kunth) also in America.

Sub-genus XI. *Cymbopogon* (Spreng. as a genus). Racemes in pairs, terminal upon the culm or its branches, one sessile, always with 1–2 basal homogamous pairs (of 2 ♂ spikelets), the other short pedicelled with or without homogamous pairs, both together subtended by a sheathing leaf, frequently arranged in a false panicle

interrupted by leaves. Flowering glume usually two-toothed, strongly awned. About forty species in the tropics of the Old World (very few in America). Predominating grasses of the savannas of tropical Africa. *A. Nardus* L. (Fig. 19), in Ceylon and Hindostan, also

FIG. 19.—*Andropogon Nardus* L. (After Bentley et Trimen, "Medicinal Plants.")

cultivated, has very large panicles, and is in all parts, especially the spikelets, rich in a volatile oil, which when distilled is known in commerce as Citronella oil; the closely related *A. Schœnanthus* L., distinguished by a longitudinal furrow in the lower third of the first empty glume, is the source of Lemon-grass oil. Both are used as stimulants and anti-spasmodics for neuralgia and rheumatism, and are also employed in the adulteration of oil of roses. One variety of *A. Schœnanthus* is highly valued by the negroes for stopping hemorrhages. *A. laniger* Desf., from North Africa to India, furnishes *Herba Schœnanthi* or *Junci odorati*, and *A. Iwarancusa*

Blane, is in use in India as a medicine for cholera. From the related *A. refractus* Brown, the Tahiti ilsanders prepare a cosmetic oil (" monoi "). *Exotheca* Andersson also belongs to this sub-genus.

Sub-genus XII. *Heteropogon* (Persoon as a genus). Racemes solitary and terminal upon the culm or its branches ; spikelets imbricated, the first to fifth pairs homogamous ; awns large, and those of all the spikelets often entangled together ; ☿ or ♀ spikelets with a pointed callus.

Species five, in the tropics, one of which (*A. contortus* L.) is cosmopolitan as far north as South Europe and North America. The fruiting glumes of these species easily bore into the skin and flesh of sheep by means of their pointed callus, and are thus a source of injury, especially in Australia. The awns may serve as hygrometers.

33. (97) **Themeda** Forsk. (*Anthistiria* L. fil., *Androscepia* Brongn., *Heterelytrum* Jungh., *Perobachne* Presl). The racemes are united into false panicles ; they appear like a fascicle of 7–11 spikelets. Occupying the middle of the racemes are 1–3, long-awned, ☿ spikelets ; near these and in a false whorl at the base are the unawned ♂ spikelets ; the whole included in a foliaceous bract.

Species nine, in the warmer countries of the Old World. *Th. Forskalii* Hack. (*Anthistiria ciliata* of authors, not of L. fil.) (Fig. 20) from Syria and Algeria to Cape of Good Hope and Tasmania. This is the " Kangaroo grass" of the Australian farmer, often almost exclusively

FIG. 20.—*Themeda Forskalii* Hack. (After Andersson, Monogr., Androp. pl. 3.)

covering wide-extending plains and mountain slopes in Australia and South Africa.

34. (97 §) **Germainea** Balansa & Poitrass. Inflorescence terminal, clustered, consisting of three central ♀, long-awned, one-flowered spikelets, and of 6–9 ♂, awnless, two-flowered ones.

Species one (*G. capitata* Bal. & Poitr.), from Saigon to South China and the Khasiya Mts.

35. (97 §) **Iseilema** Anderss. Like *Themeda*, but more delicate. (For characters, see Key.)

Species three, in India, one in Australia. (*I. Wrightii* Anderss. has a scent like bedbugs.)

36. (59) **Cleistachne** Benth. Resembling Sorghum in its habit and the hard empty glume, but without lateral ♂ spikelets or their pedicels. Awns of the fertile glume terminal, stout.

Species two, one in the East Indies, one in tropical Africa.

Tribe III.—Zoysieæ.

Spikelets solitary or in groups, usually one-flowered, the flowering glume always awnless, membranaceous; the empty glumes of firmer texture and frequently awned. Rachis continuous. Otherwise as in *Andropogoneæ*.

A. *Spikelets in groups of from three to several at each joint of the main axis; each group falling off entire.*

a. Spikes in pairs, articulate; spikelets 7–8 together. **37. Trachys.**

b. Spikes or racemes solitary, continuous, terminating the culm or its branches.

α. Spikelets 3–4 together, each group surrounded by an indurated, pitcher-shaped pseudo-involucre formed by the first empty glume of each spikelet. . . . . **38. Anthephora.**

β. Groups of spikelets without an involucre.

I. Uppermost spikelet of each group sterile. Second empty glume coriaceous, with hooked spines on the back. . **41. Tragus.**

II. Lowest spikelet of each group sterile, terminal one fertile, one-flowered with delicate glumes. . . . . **40. Ægopogon.**

III. Two outer spikelets ♂, two-flowered; one inner ☿, one-flowered. . . . **39. Hilaria.**

B. *Spikelets solitary, very rarely two upon each internode of the rachis.*

a. Empty glumes three, the third often having the function of the flowering glume of a ♂ flower. **44. Neurachne.**

b. Empty glumes two, these much longer than the flowering glume.

α. Both empty glumes with hooked spines upon the back, awnless. . . . . **42. Latipes.**

β. Both empty glumes with a fringed crest upon the back, awnless. . . . . **43. Lopholepis.**

γ. Both empty glumes smooth.

I. Empty glumes with long awns. **45. Perotis.**

II. Empty glumes subulate, awnless. **46. Leptothrium.**

c. Empty glume one.

α. Empty glume coriaceous, acute, awnless. **47. Zoysia.**

β. Empty glume with 3–5 awns. . **48. Schaffnera.**

37. (64) **Trachys** Pers. (*Trachyozus* Reichb., *Trachystachys* Dietr.). The outer spikelets of the clusters ♂, the inner 1–3 ☿; the third glume very large, coriaceous, all the others much smaller.

Species one (*T. mucronata* Pers.), on the sea shores of western India.

38. (63) **Anthephora** Schreb. (Fig. 21). Rachis strongly flexuose, spikelets fitting exactly into the curves in the joints. Pseudo-involucre below with 3–5 deep incisions; all spikelets ☿, awnless.

Species five; one in tropical America, the others in tropical and southern Africa.

39. (60) **Hilaria** Kunth (*Hexarrhena* Presl, *Pleuraphis* Torr.). Empty glumes of the ☿ spikelets two-cleft, with one to several awns, those of the ♂ spikelets very obtuse, short awned or awnless. Flowering glume awnless or mucronate-pointed.

Species five, from Central America to California and Texas.

40. (61) **Ægopogon.** Humb. & Bonpl. (*Hymenothecium* Lag., *Schellingia* Steud.). Fascicles of spikelets secund along a delicate axis, finally pendent. Spikelets small, usually awned.

Species two, from Brazil to California.

41. (65) **Tragus** (Fig. 22). The 3–5 spikelets of each fascicle somewhat divergent. First empty glume minute, sometimes wanting; the second large, beset with hook-

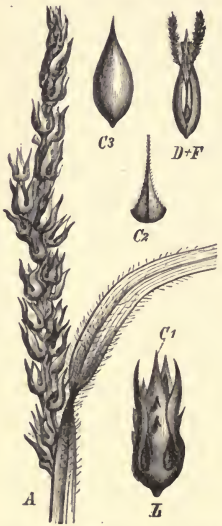

FIG. 21.—*Anthephora elegans* Schreb. *L.* Involucre. (After Mart. et Eichl., Fl. br. II. III. pl. 44.)

FIG. 22.—*Tragus racemosus* Hall. (After Nees, Gen. Germ., I. 23.)

like spines. Flowering glume and palea smaller and smooth.

Species (or varieties) two. Low, branching weeds, in all warm countries. [Introduced about Philadelphia, Mobile, etc.] The fruiting glume readily adheres to the wool and hair of animals.

42. (66) **Latipes** Kunth. Spikelets curved, very spiny, solitary or in pairs upon a very broad and flat pedicel,

finally bent downwards, and together with the pedicel they easily fall off.

Species one (*L. Senegalensis* Kunth), from Senegambia to the East Indies (Scinde).

43. (67) **Lopholepis** Decne. (*Hollbœllia* Wall. in Hook. Misc.). Spikelets very small, resembling a bird's head. First empty glume with a basal, knob-like protuberance (the head), then suddenly bending outward and like the second, assuming the form of a beak. Delicate, annual grasses.

Species one (*L. ornithocephala* Decne.), in Hindostan.

44. (68) **Neurachne** Brown. Spikes elongated or short and thick. Second empty glume largest and fringed within the edge. Perennials with narrow and hard leaves.

Species three, in Australia.

45. (69) **Perotis** Ait. (*Xystidium* Trin.). Spikelets narrow, delicate, very long-awned, standing at right angles to the axis of the long, linear spikes. Leaves short and broad.

Species three, in the tropics of the Old World.

46. (70) **Leptothrium** Kunth. Empty glumes two, otherwise like the next.

Species one (*L. rigidum* Kunth), in the warmer portions of America.

47. (71) **Zoysia** Willd. (*Matrella* Pers., *Osterdamia* Neck.). Spikes slender. Spikelets closely appressed. Empty glume one, compressed, keeled, coriaceous, surrounding the flowering glume and palea. Creeping, maritime grasses with rigid and frequently sharp-pointed leaves.

Species 2–3, in Southern and Eastern Asia, on the Mascarene Isles, Australia, and New Zealand.

48. (72) **Schaffnera** Benth. Spikelets not in spikes, but disposed in clusters in the axils of the upper leaf-sheaths. Flowering glume with a single awn. A low, anomalous grass of very doubtful position.

Species one (*Sch. Mexicana* Benth.), in Mexico.

Tribe IV.—Tristegineæ.

Spikelets all ☿, 1–2-flowered, in panicled racemes; axis continuous. Empty glumes three, the third sometimes having the function of a flowering glume of a ♂ flower. Like the preceding tribe, this forms a transition between the *Andropogoneæ* and *Paniceæ*. All tropical.

A. *Flowering glumes of the ☿ spikelets awned; awns usually geniculate and twisted below.* . . . **49. Arundinella.**

B. *Flowering glume awnless (frequently, however, the* 1–3 *empty glumes are awned).*

a. First empty glume very small, appressed to the one above. . . . . **50. Melinis.**

b. First and second empty glumes very small, resembling minute scales; spikelets in spikes. **55. Beckera.**

c. First empty glume half as large as the second and third, all awnless.

α. The long racemes of spikelets in distant whorls along a common axis. . . . **51. Phænosperma.**

β. The short racemes of spikelets solitary along the main axis. . . . . **52. Triscenia.**

d. First and second empty glume equal in length, half as long as the third and the flowering glume, all awnless; spikelets minute. . **54. Thysanolæna.**

e. First empty glume subulate, awn-like, projecting beyond the others. . . . . **53. Arthropogon.**

Note.—Compare *Tricholæna* (*Paniceæ*).

49. (51) **Arundinella** Raddi (*Goldbachia* Trin., *Acratherum* Link, *Thysanachne* Presl, *Brandtia* Kunth). (Fig. 23.) Spikelets pedicellate, usually in pairs upon the branches of the panicle, pedicels of unequal length. First empty glume shorter than the others, the second frequently awned, the third awnless, usually inclosing a ♂ flower.

Species twenty-four, mostly in the tropical regions of the Old World, a few in South America [one in Mexico].

50. (53) **Melinis** Beauv. (*Tristegis* Nees, *Suardia*

Schrk.). Spikelets very small, elliptical, naked; third glume usually awned; disposed in somewhat compact panicles.

Species one (*M. minutiflora* Beauv.), in Brazil, Ascension, Natal, Madagascar. In Brazil it is called "Capimmellado" on account of its glutinous properties. It is prized for fodder and is even cultivated.

51. (52) **Phænosperma** Munro. Panicles large, branches in whorls; caryopsis projecting from the glumes half its length.

Species one (*Ph. globosa*), in China.

52. (54) **Triscenia** Griseb. A grass of doubtful relationship, on account of the small embryo, having nearly the same habit as *Festuca ovina*. Panicles few-flowered. Spikelets one-flowered.

Species one (*T. ovina* Griseb.), in Cuba.

FIG. 23.—*Arundinella Nepalensis* Trin. (After Trin., Spec. Gr. pl. 268.)

53. (55) **Arthropogon** Nees. Panicles loose. Empty glumes coriaceous, the second largest. One ♂ flower in the axil of the third glume.

Species two; one in Brazil, the other in Cuba.

54. (58) **Thysanolæna** Nees (*Myriachæta* Zoll.). Panicles very large, with innumerable minute spikelets in short racemes. Spikelets as in *Panicum*, but the flowering glume is delicate and fringed with hairs.

Species one (*Th. acarifera* Nees), "Tiger Grass," in tropical Asia—a troublesome weed among cultivated plants; 2–4 m. in height.

55. (47) **Beckera** Fresen. Spikelets in numerous spikes in the axils of the leaves. Third empty glume with a long straight awn, flowering glume awnless or

mucronate-pointed, three-nerved; palea narrow, hyaline, nerveless, two-toothed.

Species three, in Abyssinia. Position of the genus doubtful.

Tribe V.—Paniceæ.

Spikelets one- (or occasionally two-) flowered, the second flower ♂ (very rarely ☿), in the axil of the third glume; arranged in spikes, racemes, or panicles; axis usually continuous. Flowering glume and palea of the ☿ flower always firmer in texture than the empty glumes, unawned (empty glumes rarely awned). Fruit as in *Andropogoneæ*.

A. *Spikelets all hermaphrodite.*

a. Spikelets neither sunken in an excavation in the rachis nor subtended by a large leaf-sheath.

α. Spikelets without any special covering consisting of bristles or spines (sterile branches).

I. Empty glume one. . . . . **56. Reimaria.**

II. Empty glumes two, ☿ flower single.

1°. Lower empty glume with a swollen ring-like callus. . . . **60. Eriochloa.**

2°. Lower empty glume without a ring-like and swollen callus.

* Spikelets in one-sided racemes or spikes, these frequently in pairs or in panicles. . . . **57. Paspalum.**

** Spikelets in panicles.

○ All the spikelets alike, fertile, in terminal panicles. **58. Anthænantia.**

○○ Spikelets of two kinds: first, the sterile, borne on a terminal panicle; second, the fertile, borne on short subterranean branches. . **59. Amphicarpum.**

III. Empty glumes two, and ☿ flowers two. **61. Isachne.**

IV. Empty glumes three, and ☿ flower one, or a flowering glume with ♂ flower instead of the third empty glume.

1°. First and second empty glumes without a distinct callus, awnless.

* Flowering glumes without lateral appendages or pits at the base. **62. Panicum.**

** Flowering glume with membranaceous appendages or pits at the base. . . . . **63. Ichnanthus.**

2°. First empty glume very small, awnless, the second apparently distant from the first on account of a conical or pedicel-like callus, and like the third (flowering glume of the ♂ floret) more or less awned between the cleft apex. **64. Tricholæna.**

3°. First and second empty glumes awned.

* First empty glume without any distinct callus. . . . **65. Oplismenus.**

** First empty glume with a pointed, pedicel-like callus. **66. Chætium.**

β. Spikelets single or in pairs, subtended by an involucre consisting of from one to many bristles or spines (sterile branches) which are sometimes grown together.

I. Spikelets falling at maturity, bristles persistent. . . . . **67. Setaria.**

II. Involucral bristles falling off with the spikelets at maturity (cultivated forms excepted).

1°. Bristles numerous, rigid, thickened at the base, frequently grown together. **68. Cenchrus.**

2°. Bristles usually numerous, apparently whorled, delicate, not thickened at the base, often plumose. **69. Pennisetum.**

3°. Involucral bristles numerous, forming a paniculate, one-sided system of branchlets. . . . . **70. Plagiosetum.**

4°. Only one bristle below each spikelet.
71. Chamæraphis.

NOTE.—Compare *Pennisetum*, Sec. D.

b. Spikelets in small spikes, these surrounded by large subtending bracts and united into a raceme.
72. Xerochloa.

c. Spikelets forming very short spikes which are sunken into cavities of the one-sided, broad axis. . . . . **73. Stenotaphrum.**

B. *Plants monœcious, diœcious, or dichogamous, or the spikelets partly neuter.*

a. Spikes very short, consisting of one ☿ and two to three upper, neutral spikelets crowded and united into a one-sided spike with a leaf-like axis.
74. Phyllorachis.

b. One terminal, simple spike, consisting of one to two lower ☿ and four to six upper ♂ spikelets upon a broad (not leaf-like) axis. . . . **75. Thuarea.**

c. Diœcious; ♀ spikelets in heads with spiny subtending bracts, ♂ in spikes which are united into dense, globular heads. . . . . **76. Spinifex.**

d. Monœcious, spikelets scattered in panicles.
77. Olyra.

56. (1) **Reimaria** Flügge. Spikelets one-flowered, acuminate-pointed, in loose two-ranked, digitate spikes. Flowering glume and palea slightly indurated. Stamens two.

Species four, in tropical and sub-tropical America. [One species, *R. oligostachya* Munro, in Florida.]

57. (2) **Paspalum** L. Spikelets one-flowered, usually obtuse, in two- to four-ranked racemes or spikes, these two to many, digitate or disposed in panicles, seldom solitary. Flowering glume and palea cartilaginous. Stamens three.

Species one hundred and sixty, in the tropics of both hemispheres, but most abundant in America, forming an important component of the pampas and campos.

Sec. I. *Eupaspalum.* The lower empty glume and the flowering glume turned towards the rachis of the spike or raceme. *P. dilatatum* (Fig. 24), with remote racemes, is a good forage plant, like many other species of

the genus. *P. exile* Kippist, with digitate spikes, and spikelets 2 mm. long, is found in Sierra Leone, where it is cultivated ("Fundi" or "Fundungi"), the fruit being used for food; *P. scrobiculatum* L. (with racemes in pairs, and roundish spikelets having small pits at their bases) is used in India ("Koda") for food; the rhizome of *P. distichum* L. (with racemes in pairs, and oblong, pointed spikelets) is used in India as a medicine for inflammation of the gums and against conjunctivitis, and in the Argentine Republic for liver complaint; and *P. notatum* Flügge for gonorrhœa. The few species with only one empty glume form the sub-section *Anachyris* (Nees as a genus); those with the axis of the spikes leaf-like, form the sub-section *Ceresia* (Pers. as a genus).

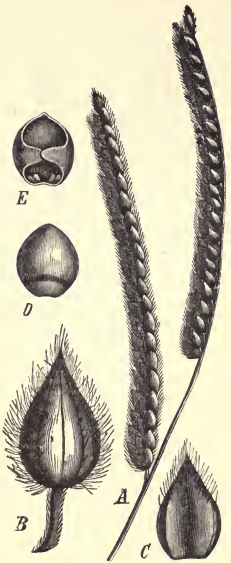

FIG. 24. — *Paspalum dilatatum* Poir. (After Trin., Spec. Gram. pl. 139.)

Sec. II. *Cabrera* (Lag. as a genus). Like Sec. I, but the spikelets sunken in the notches of the axis.

Sec. III. *Anastrophus* (Schlechtend. as a genus). Lower empty glume and flowering glume turned away from the axis. [*P. platycaule* Poir., a forage plant in the warmer parts of America.] The genus *Lappagrostis* Steud. belongs here.

58. (3) **Anthænantia** Beauv. (*Aulaxanthus* Ell., *Aulaxia* Nutt., *Leptocoryphium* Nees). Spikelets as in *Paspalum*; hairy, arranged in panicles; flowering glume and palea slightly indurated.

Species three, in the Southern United States and in South America.

59. (4) **Amphicarpum** Kunth. Fertile spikelets cleistogamous, upon filiform runners at the base of the culm;

runners with scale-like leaves. The open-flowered spikelets of the terminal panicle sterile.

Species two, in the Southeastern United States.

60. (5) **Eriochloa** Kunth. (*Helopus* Trin., *Œdipachne* Link) (Fig. 25). Spikelets in racemes and these arranged again in simple or compound racemes. Spikelets, aside from the annular callus, as in *Paspalum*. Flowering glume mucronate-pointed or very short-awned.

Species five, in the tropical and subtropical zones of both hemispheres.

61. (7) **Isachne** Brown. Spikelets in panicles, two-flowered, the fruiting glumes with the grain falling out of the persistent empty ones.

Species about twenty, in the warmer countries of both hemispheres, especially of the Old World.

FIG. 25. — *Eriochloa grandiflora* (Trin.) Hack. (*Helopus grandiflorus* Trin.) (After Trin., Spec. Gram. pl. 278.)

62. (8) **Panicum** L. Spikelets in spikes, racemes, or panicles, one- to two-flowered. First empty glume usually smaller than the second, and this as large as the third, which has the same structure but often encloses a ♂ flower. Flowering glume and palea indurated, awnless or very short-awned. Stamens three.

Species about three hundred, in all warm and a few in temperate countries. They form, with species of *Paspalum*, excellent forage in the savannas and campos of South America.

Sec. I. *Digitaria* (Pers. as a genus, *Syntherisma* Walt.). Racemes (false spikes) simple, one-sided, digitate, rarely scattered. *P. sanguinale* L. (Fig. 26), "*Blutfennich*," is

a weed in gardens, but is cultivated in Bohemia upon sandy soils, where the fruit is used for mush and porridge; in the Southern United States, where it is known as Crab-grass, it is valued for fodder.

Sec. II. *Trichachne* (Nees as a genus, *Acicarpa* Raddi, *Urochloa* Kunth, *Alloteropsis* Presl, *Holosetum* Steud.,

FIG. 26.—*Panicum sanguinale* L. A_1, Part of a spike enlarged. A ½ nat. size. (After Nees, Gen. Germ. I. 18.)

FIG. 27.—*Panicum spectabile* Nees. A ½ nat. size. (After Mart. and Eichler, Fl. bras. II. II. pl. 22.)

Coridochloa Nees, *Bluffia* Nees). Racemes or panicles simple, usually with long silky hairs.

Sec. III. *Thrasya* (Kunth as a genus, *Tylothrasya* Döll.). Spikes with a broad axis, solitary. Flowering glume of the ♂ flower frequently two-cleft.

Sec. IV. *Echinolæna* (Desv. as a genus). Spikes single, divergent (Genus No. 17 of B. & H., Gen. Pl. III. p. 1107).

Sec. V. *Brachiaria*. Inflorescence as in *Paspalum*, glumes awnless.

Sec. VI. *Echinochloa* (Beauv. as a genus). Spikelets in three- to four-ranked racemes, and these again in racemes or panicles; second and third glumes more or less awned. *P. Crus-galli* L., without ligules and with naked nodes, is cosmopolitan, also cultivated for fodder; one variety (*P. frumentaceum* Roxb.) is cultivated in India for its fruit. *P. spectabile* Nees (Fig. 27), with a more distinct ligule and bristly-hairy nodes, is an extremely productive fodder-grass for tropical countries, and largely cultivated in Brazil.

Sec. VII. *Hymenachne* (Beauv. as a genus). Spikelets small, in spike-like panicles. Flowering glume but slightly indurated.

Sec. VIII. *Ptychophyllum.* Spikelets in false spikes which are arranged in panicles; axis projecting beyond the spikelets. Leaves plicate, elegant in appearance. *P. plicatum* Lam., from the tropics of the Old World, is a favorite ornamental grass in greenhouses.

Sec. IX. *Eupanicum.* Spikelets all pedicellate, in panicles, naked or with short hairs. *P. Miliaceum* L. (Millet) (Fig. 28) has loose drooping panicles and ovate spikelets; first empty glume half as long as the second, flowering glume smooth and shining. Cultivated from prehistoric times. Native country unknown, but probably the East Indies, where, and in China and Japan as well, it is yet much cultivated. It is raised to a considerable extent in South Russia and Roumania, but only here and there in other parts of Europe. Several varieties are distinguished by the color of the fruit and the habit of the panicles. The fruit is mostly used for porridge ("Brei"). *P. altissimum* Jacq. (*P. jumentorum* Pers.), "Guinea grass," is 2–3 m. high, spikes loose, upright, spikelets, lanceolate, fruiting glumes with fine transverse wrinkles. Native of tropical Africa. Cultivated as a fodder-grass, especially in America, on account of its vigorous and rapid growth. The rhizome of *P. junceum* Nees is used in the Argentine Republic as a substitute for soap for washing woollen goods. To this section belong *Coleatœnia* Griseb., *Otachyrium* Nees, *Streptostachys* Desv., all more or less anomalous species.

63. (9) **Ichnanthus** Beauv. (*Navicularia* Raddi). Spikelets ovate or acute, short pedicellate on the branches of the panicle, with one ☿ and one ♂ flower. Leaves broad-lanceolate to ovate.

Species twenty, all in tropical America, one of them also in India.

64. (8 §) **Tricholæna** Schrad. (*Rhynchelytrum* Nees, Hochst., *Monachyron* Parl.). Spikelets in loose panicles,

FIG. 28.—*Panicum miliaceum* L. (After Nees, Gen. Germ., I. 19.)

broad, somewhat laterally compressed, very hairy, especially on the callus of the second empty glume. The latter and the flowering glume of the ♂ flower often thick-membranaceous; flowering glume and palea much shorter, chartaceous, shining.

Species ten, in all parts of Africa: one of them extends to Sicily and western India, one of which is endemic, two in Madagascar. *Tr. rosea* Nees, with reddish, silky hairs on the spikelets, awns short or wanting, from the Cape

of Good Hope, is an elegant ornamental grass, especially for dry bouquets.

65. (10) **Oplismenus** Beauv. (*Orthopogon* Brown, *Hekaterosachne* Steud.). Spikelets one-flowered, in small groups or clusters along the branches of the panicle, turned to one side; first and second empty glumes always, and the third frequently, awned. Broad-leaved, delicate grasses.

Species four, in the tropical and sub-tropical zone (one species in South Europe).

66. (11) **Chætium** Nees (*Berchtoldia* Presl). Spikelets lance-awl-shaped, pedicellate, in close panicles, one-flowered, all three empty glumes awned.

Species two; one in Mexico, one in Cuba and Brazil.

67. (12) **Setaria** Beauv. (Fig. 29). Spikelets 1–2 flowered, ovate, in a close, cylindrical or bushy panicle. Glumes awnless, first empty glume short. Flowering glume and palea obtuse, finally hard and shining or transversely wrinkled. Involucral bristles usually projecting beyond the spikelets, rough.

Fig. 29.—*Setaria glauca* Beauv. *B* + *L*, Sp. with involucre of bristles. (After Nees, Gen. Germ., I. 22.)

About ten species, in all the warmer countries of the world; some as weeds in the temperate regions. *S. glauca* Beauv. (Fig. 29), with numerous bristles under each spikelet, and flowering glume with strong transverse wrinkles, is cosmopolitan. *S. viridis* Beauv., with 2–3 bristles under each spikelet, and flowering glume indistinctly transverse-wrinkled, is widespread, and is probably the original form of *S. Italica* Beauv., Hungarian grass, which is distinguished only by its larger panicles and thicker and larger spikelets which

do not fall off at maturity. The fruiting glume has, at its base, a smooth place enclosed by two slight longitudinal swellings and is not shining, a character which makes it easy to distinguish this species from the common Millets. Hungarian grass is extensively raised in Japan, China, some parts of the East Indies and Trans-Caucasia, where it forms an important article of food; in Europe its culture is less important, and it is mostly used for food for fowls.

The sixteen varieties may be divided into two main groups: large Millet, with long, usually irregular, nodding false spikes, and "Mohar" (Hungarian), with short, regular, upright spikes. The culture of *Setaria Italica* Beauv. has its origin in prehistoric times. As early as 2700 B.C., Hungarian grass formed one of the main cereals of the Chinese; it was sown in early spring by the princes of the royal house themselves, just as the emperor sowed rice with his own hand. Its culture extends back to an early date also in Egypt, and in the Lake Dwellings of the stone age it is found in such quantities that it must be regarded as the main bread-supply of the prehistoric peoples. Traces of its very ancient culture are also found in other places (Hungary, Upper Italy, etc.). *Ixophorus* Schlechtd. is a *Setaria* with only one bristle.

68. (13) **Cenchrus** L. (Fig. 30). Spikelets narrow, each one, or as many as two to three together, enclosed by an involucre. The involucres in a spike or raceme. First empty glume small, all awnless; stamens three; styles mostly united below.

Species twelve, in the tropical and sub-tropical zones of both hemispheres, and in America also in the temperate zone. *C. tribuloides* L., bristles grown together into a coriaceous and very spiny capsule. A troublesome weed in North America. The involucre adheres very strongly to the wool of sheep, from which it can scarcely be removed, and in consequence materially injures its value. It ought to be carefully rooted out in sheep districts. It is also very troublesome to workmen who are

barefooted, like *C. myosuroides* Humb. & Kunth, in South America.

69. (14) **Pennisetum** Pers. Spikelets in racemes, spikes or false spikes, narrow or ovate, single or in groups of twos or threes, usually surrounded with many (rarely with only one) dissimilar bristles. First empty glume very

FIG. 30.—*A. Cenchrus echinatus* L. (After Mart. and Eichler, Fl. bras., II. II. pl. 43.) *L*, Involucre of *C. tribuloides* L. *L'*, Cross-section of the same. *B*, Sp. of latter. (After A. Gray, Man. pl. 14.)

FIG. 31.—*Penniselum Prieurii* Kunth. (After Kunth, Revis. pl. 119.)

small, flowering glume shorter than the second empty glume. Styles often united, projecting from the apex of the spikelet.

Species forty, mostly in tropical and sub-tropical Africa; one in Southern Europe, and a few in America and Asia.

Sec. I. *Pennisetum* (*Eriochæta* Figari & De Notar. as a genus). Bristles numerous, all, or only the middle ones, bearded. *P. villosum* Brown, from Abyssinia, with broad spikes, is a favorite ornamental grass under the false name of *P. longistylum* (which belongs to Section III).

Sec. II. *Penicillaria* Willd. (as a genus). Distinguished from the preceding section only by the artificial character (probably due to cultivation) of the permanent involucre. *P. typhoideum* Rich. (*Penicill. spicata* Willd.) "Pearl Millet" (Fig. 32), the original form and native country of which are unknown, has a culm 1–2 m. high, and fruiting panicles 8–20 cm. long, 2–4 cm. thick, and bearded. This is an important agricultural grass in Central Africa. The fruit is used for Mush ("Kuskus"). It is also grown in Arabia Felix and the East Indies. [Cultivated in the Southern United States for fodder.]

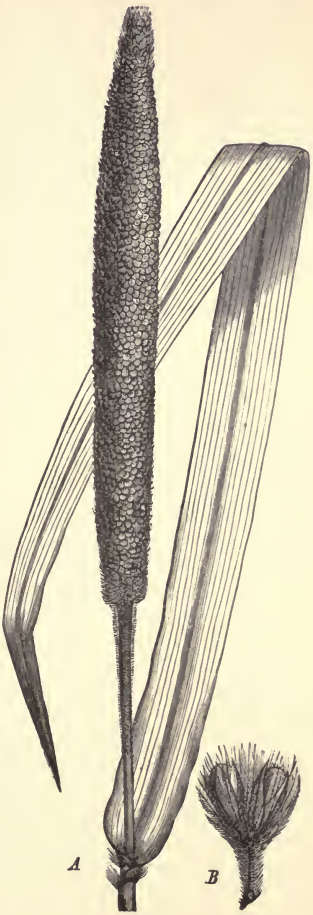

FIG. 32.—*Pennisetum typhoideum* Rich.

Sec. III. *Gymnothrix* Beauv. (*Oxyanthe* Steud.). All involucral bristles naked. *P. latifolium* Spr. (*Gym-*

nothrix latifolia Schult.), with culms 1–1.5 m. high, leaves broad-lanceolate, is an ornamental grass used for covering roofs of houses in the Argentine Republic, where it is native; *P. Japonicum* Trin. (*Gymnoth. Japonica*), a low-growing species with linear leaves, is also an ornamental grass. *Amphochæta* Anderss. includes a species with spikes in panicles; *Sericura* Hasskarl, is a Malayan species with very long bristles.

Sec. IV. *Beckeropsis* (Fig. & De Notar, as a genus) has only one involucral bristle to each spikelet; spikes in panicles. Distinguished from *Chamæraphis* by the persistent pedicels of the spikelets.

70. (15) **Plagiosetum** Benth. One to two, narrow, acute spikelets within each involucrum.

Species one (*P. refractum* Benth.), in Australia.

71. (18) **Chamæraphis** Brown (*Paratheria* Griseb.). Spikelets lanceolate, in simple or slightly branched racemes, on short pedicels which fall off with the spikelets. First empty glume very short.

Species five; four in tropical Asia and Australia, one in the West Indies and Brazil.

72. (20) **Xerochloa** Brown. Subtending bracts of the spikes husk-like, distichous; axis of the spike short, with a chaff-like continuation beyond the spikelets. Spikelets two-flowered; flowering glume of ♀ flower very narrow.

Species three, in Australia.

73. (21) **Stenotaphrum** Trin. (*Diastemanthe* Steud.). Spikelets 2–4, forming a short, partial spike, embedded in the alternate notches of the broad rachis of a spike-like panicle; axis of the spike with a chaff-like prolongation. Spikelets two-flowered, first empty glume small. Creeping grasses with compressed culms and flat, divergent leaves.

Species three or four, one of which, *St. Americanum* Schrank (Fig. 33), is widespread in the tropics and subtropical regions, and is useful for holding the sand on the banks of rivers. The rhizome is used in South America as a diuretic. The other species occur on the islands of the Indian and Pacific oceans.

74. (22) **Phyllorachis** Trimen. Each partial spike with one fertile spikelet, and 2–3 sterile ones reduced to single glumes; axis prolonged. First empty glume minute, bristle-like, the third glume largest, with a palea in its axil. Besides the terminal leaf-like spikes there are solitary, long-pedicelled spikelets in the axils of the leaves.

Species one (*Ph. sagittata* Trim.), with sagittate leaves, found at Coanza in Angola. Relationship doubtful.

75. (23) **Thuarea** Pers. (*Microthuareia* Thouars, *Orinthocephalochloa* Kurz). Spikes surrounded by a sheathing leaf; at maturity the dilated base of the axis envelops the 1–2 ♀ spikelets, and the rest of the axis, stripped of its spikelets, forms a beak which bores into the ground. A creeping maritime grass.

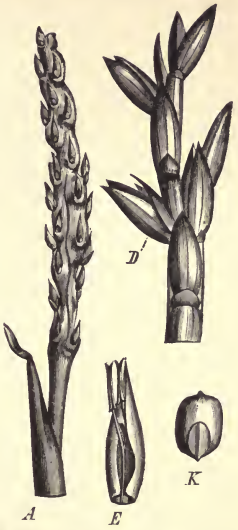

FIG. 33.—*Stenotaphrum Americanum* Schrank. (After Mart. and Eichler, Fl. bras., II. part II. pl. 39.)

Species one (*Th. sarmentosa* Pers.), from Ceylon to New Caledonia.

76. (24) **Spinifex** L. (Fig. 34). The ♂ spikes with projecting rachis, in dense heads with subtending bracts at the base; spikelets two-flowered; ♀ spikelets one-flowered, with the pungent-pointed, subtending bracts projecting far beyond them.

Species four; three in Australia, the fourth from there to Ceylon and Japan. At maturity the entire ♀ head falls off and is carried away by the winds or floats on the sea, and finally presses itself into the sand by means of its bristles and falls in pieces. The species are an important agent in binding the drifting sands of the coasts. Leaves usually with hard, rigid points. This

genus should not be confused with the "*Spinifex*" of Australian travellers (see *Triodia*).

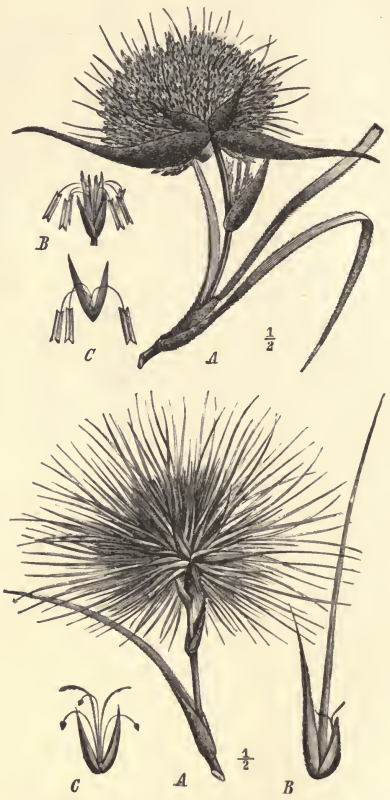

FIG. 34.—*Spinifex hirsutus* Labillard. ♂ plant above, ♀ below. (After Labill., Sert. Pl. N. Holl. pl. 230, 231.)

77. (25) **Olyra** L. (*Lithachne* Beauv., *Strephium* Schrad., *Raddia* Bertol.) (Fig. 35). All the spikelets one-flowered,

the ♂ upon the lower portion of the panicle or in separate panicles, without empty glumes; flowering glume narrow and acuminate-pointed; ♀ spikelets ovate; empty glumes two, herbaceous, pointed or awned; flowering glume much shorter, cartilaginous. Lodicules three. Leaves broad, netted-veined, often with short petioles.

Species twenty, all, with the exception of one in Africa, from tropical America.

FIG. 35.—*Olyra micrantha* Humb. and Kunth. *A* ½ natural size. (After Kunth, Revis. Gram. pl. 12.)

TRIBE VI.—ORYZEÆ.

Spikelets ☿ or unisexual, one-flowered; flowers apparently terminal and enclosed by a flowering glume and a palea which is usually one-nerved. Empty glumes two or none, very seldom numerous. Stamens frequently six. Stigmas more or less elongated, fruit usually with a small embryo and long, linear hilum. Starch-grains compound.

A. *Spikelets unisexual; plants monœcious; anthers six or more.*

a. Spikelets in short, solitary spikes, terminal and axillary. . . . . **78. Hydrochloa.**

b. Spikelets in panicles, or spikes arranged in panicles.

α. Spikelets in pairs at each node of the panicle-branches; one large, ♀, sessile, the other small, ♂, long-pedicelled.

I. Flowering glume linear-oblong.

79. Pharus.

II. Flowering glume inflated, globose, closed excepting a hole at the point.

80. Leptaspis.

β. Spikelets not in pairs at the nodes of the branches.

I. Spikelets without empty glumes.

1°. Spikelets linear. Embryo as long as the fruit. . . . . **83. Zizania.**

2°. ♀ spikelets ovate or elliptical. Embryo many times smaller than the fruit.

* ♂ and ♀ spikelets in different panicles, rarely in the same, and then the ♂ spikelets terminal on each branch. **81. Luziola.**

** ♂ and ♀ spikelets in the same panicle, the ♀ terminal, the ♂ at the base of each branch. **82. Zizaniopsis.**

II. Spikelets with two very small or bristle-like empty glumes. . . **84. Potamophila.**

B. *Spikelets all* ☿.

a. Spikelets arranged in panicles.

α. Empty glumes two, short but distinct, awnless (two additional rudimentary empty glumes in *Oryza*).

I. Flowering glume and palea roundish in section (but slightly compressed). **85. Maltebrunia.**

II. Flowering glume and palea much compressed laterally. . . . . **86. Oryza.**

β. Empty glumes two, awned, exceeding or slightly shorter than the flowering glume.

* Empty glumes gradually tapering into awns. **58. Achlæna.**

** Empty glumes awned from a notch in the apex. . . . . **89. Reynaudia.**

γ. Empty glumes wanting or present only as minute rudiments.

I. Flowering glume awnless. . **87. Leersia.**

II. Flowering glume awned. . **90. Hygroryza.**

b. Spikelets in a terminal, naked spike at whose apex the ends of the awns of all the spikelets are fastened together. . . . . **93. Streptochæta.**

c. Spikelets in twos or threes in the axils of sheath-like subtending bracts.

α. Only one subtending bract with 2–3 united spikelets terminating the culm. . **92. Lygeum.**

β. Subtending bracts in two series with 2–3 free spikelets in the axil of each. **91. Anomochloa.**

78. (39) **Hydrochloa** Beauv. An aquatic grass with flat leaves, 3–5 ♂ spikelets in a terminal spike, a few ♀ in each axillary spike, which scarcely exceeds its subtending sheath. Stigmas long.

Species one (*H. Carolinensis* Beauv.), in the Southern United States.

79. (26) **Pharus** L. ♀ spikelets linear; empty glumes two, short; flowering glume long, coriaceous, involute. Palea two-nerved. Spikes paniculate. Leaves broad, pedicellate; blade reversed. (See page 8.)

Species five, in tropical America.

80. (27) **Leptaspis** Brown. ♂ spikelets small, terminal on the short branchlets; ♀ spikelets 1–2, sessile on the lower portions of same, large, globose, with two short empty glumes. Leaves as in *Pharus*.

Species five, in the tropics of the Old World.

81. (41) **Luziola** Juss. (Fig. 36). Spikelets awnless, ovate; flowering glume with many prominent nerves. Caryopsis with a thick, hard pericarp. Creeping, narrow-leaved, marsh or aquatic grasses.

FIG. 36.—*Luziola Peruviana* Juss. A ♂ spikelet.

Species six, from Brazil to Alabama.

Sec. I. *Euluziola*. ♂ and ♀ spikelets in separate panicles. Stamens usually more than six (6–18).

Sec. II. *Caryochloa* (Trin. as a genus). *Arrozia* Schrad. ♂ and ♀ spikelets in the same panicle. Stamens six.

82. (40) **Zizaniopsis** Döll & Ascherson. Habit of *Zizania*. ♀ spikelets terminating the branches of the panicle. Fruit a globose nut with a hard, shining, easily

separable pericarp. Embryo and hilum not visible on the outside. Stigmas united.

Species one, with two varieties—*Z. miliacea* Döll & Asch. [(*Zizania miliacea* Mx.)] in Brazil and the Southern United States.

83. (40) **Zizania** L. (*Hydropyrum* Link, *Melinum* Link). A reed-like grass with broad leaves and large panicles which are ♀ and narrow, with the branches somewhat appressed above, and ♂ and expanded below. ♀ spikelets almost subulate, awned, supported on thick pedicels. ♂ awnless, lanceolate. Fruit a caryopsis 2 cm. long and 1 mm. thick, pericarp thin; embryo very long, concealed in a furrow, with large epiblast, plumule pedicellate.

Species one, *Z. aquatica* L. (*Z. palustris* Link and *Hydropyrum esculentum* Link), "Tuscarora rice" or "Indian rice," which grows upon the banks of streams and lakes in North America and Northeastern Asia. The Indians annually collect the fruit in quantities for food; they also sow the seed in order to provide for farther extension of the plants. Lately it has been sown in fish-ponds, for the fruit, when it falls, is eagerly eaten by the fish.* The Asiatic form (*Z. latifolia* Turcz.) is only a variety.

84. (42) **Potamophila** Brown. Spikelets lanceolate, awnless, in long panicles whose lower branches bear the ♀ (with distinct staminodia in the flowers) and the upper the ♂ or ☿ spikelets. Fruit spherical.

Species one (*P. parviflora* Brown), in Australia.

85. (42) **Maltebrunia** Kunth. Like the preceding, but with all the spikelets ☿. Leaves broader, almost petiolate.

Species two, in Madagascar and Cape Colony.

86. (44) **Oryza** L. (*Padia* Zolling & Mor.). Spikelets elongated; empty glumes of two small scales or bristles, and underneath these two more minute rudimentary empty glumes. Flowering glume complicate and keeled, usually awned; palea narrow, one-nerved.

* The stems are used by coopers for making the joints of barrels intended to hold whiskey or petroleum perfectly tight. The tidal mud along the Delaware River for fifty miles bears a heavy growth of *Z. aquatica* (locally called "The Reeds"), and the fruit furnishes the food of the Reed-bird, giving it the flavor for which it is so much esteemed.

Stamens six; fruit long, obtuse, closely enveloped by the fruiting glume, and compressed laterally with two lateral furrows; embryo short, curved.

About six species, in the tropics of both hemispheres. *O. sativa* L., Rice, has contracted panicles and rough, prominently five-nerved flowering glumes. Wild in wet places in India and tropical Australia; one variety in Africa; naturalized in Brazil. Rice has been cultivated in China from the most ancient times (for over 2800 years B.C.), in South Europe, where it was introduced by the Arabs, and in Egypt, since the middle ages (in Central Africa earlier?), in North America since 1700 A.D., and besides in Mexico, Brazil, and Paraguay. It needs stagnant water which readily breeds swamp-fever, and in Europe its culture in the vicinity of villages or hamlets is forbidden. Mountain- or Upland-rice, which requires only to be irrigated, is much less prized for economic uses. Rice is used for food by more people than any other one grain. It is generally used in the form of soup or boiled rice. "Arak" is made from it by fermentation; in Japan a light alcoholic drink, "Sake," is made from rice by means of an organic ferment. Gluten rice ("Klebreis"), whose grains stick fast together when cooked, forming a firmly united mass, and whose starch turns reddish brown (see p. 26) instead of blue with iodine, is used in Japan for paste and for making an elastic dough from which cakes are baked. In China a kind of sugar and a sweet drink are prepared from it. Rice-starch has lately become an article of trade, especially in England. Rice-brooms, rice-paper,

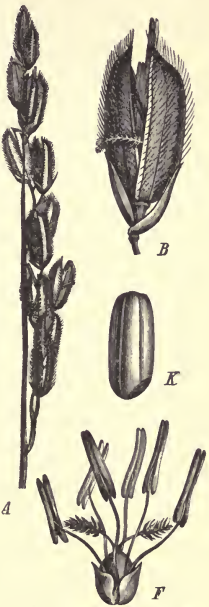

FIG. 37.—*Oryza sativa* L. (After Nees, Gen. Germ., I. pl. 2.)

are not made from rice; the first comes from Sorghum, the second from Broussonetia or Bambusa. About forty varieties are founded upon the color and size of the fruit and the absence or presence of awns.

87. (45) **Leersia** Swartz (*Homalocenchrus* Mieg, *Ehrhartia* Wigg., *Blepharochloa* Endl.). Distinguished from *Oryza* only by the aborted (indicated by minute rudiments) empty glumes, awnless flowering glume, three, two, or one stamen (six only in *L. hexandra*), and the relatively smaller fruit.

Species five; swamp-grasses, one of which, *L. oryzoides* Sw., is found in the north temperate zone of both the Old World and New World; another, *L. hexandra*, throughout the entire tropical zone, and three in America only.

88. (46) **Achlæna** Griseb. Panicle widely expanded. Spikelets large, linear-lanceolate, awned. First empty glume aristiform; flowering glume convolute. Stamen one. Caryopsis linear, with a very small embryo.

Species one (*A. piptostachya* Gr.), in Cuba.

89. (56) **Reynaudia** Kunth. Spikelets long. Empty glumes subequal, two-lobed at the apex; flowering glume short-awned below the point, slightly exceeding the empty glumes. Lodicules two; stamens two; embryo small.

Species one (*R. filiformis* Kunth), in Cuba. Leaves narrow; branches of the panicle erect; spikelets small.

90. (43) **Hygroryza** Nees (*Potamochloa* Griffith). Floating, aquatic grasses with broad, short leaves; the sheaths of the lower ones much inflated. Panicles umbellate, few-flowered.

Species one (*H. aristata* Nees), in the East Indies.

91. (30) **Anomochloa** Brongniart. An anomalous grass with long-petiolate leaves; the solitary apical spike with many large, sheathing bracts. Flowering glume membranaceous, palea harder, closed and tubular below with a filiform appendage. A membranaceous fringed ring in place of the lodicules. Stamens four.

Species one (*A. marantoidea* Brongn.), in Brazil.

92. (28) **Lygeum** L. The united, very hairy flowering

glumes of the 2–3 spikelets finally form a hard capsule or false fruit. Palea linear, two-nerved, much exceeding the flowering glume. Styles elongated, stigmas short, feathery; stamens three; common subtending or sheathing bract of the spikelets lanceolate.

Species one, *L. Spartum* L. (Fig. 38), has a creeping rhizome and stiff, rush-like, convolute leaves. In rocky soil on the high plains of the countries bordering the Mediterranean, especially of Spain and Algeria. A part of the "Esparto" (see *Stipa tenacissima*) is furnished by this plant.

FIG. 38.—*Lygeum Spartum* L. *S*, sheathing leaf. (After Schreber, Beschr. d. Gräs. pl. 52, 53.)

93. (29) **Streptochæta** Schrad. (*Lepideilema* Trin.). Distinguished from all other grasses by the spiral arrangement of its numerous (12) glumes, one of which bears a delicate, tendril-like, twisted awn.

Spikelets elongated, terete, acuminate. Stamens six, monadelphous. Style one, stigmas three; leaves broad.

Species one (*S. spicata* Schrad.), in Brazil. A genus of very doubtful relationship, placed with the *Oryzeæ* on account of the character of its fruit. (For manner of dispersing its seed, see page 29.)

TRIBE VII.—PHALARIDEÆ.

All the spikelets fertile, one-flowered or with 1–2 ♂ flowers inserted below the apparently terminal one. Empty glumes four (the two inner ones rarely acting as flowering glumes for ♂ flowers), unequal, the third and fourth occasionally very small, or one of them rudimentary. Flowering glume and palea alike, laterally compressed, nerves one or none, awnless. Styles distinct; stigmas usually projecting from the point of the spike-

let; caryopsis unfurrowed; embryo small; starch-grains compound.

A. *The third and fourth (or only the fourth) empty glumes larger than the first and second.*
   a. Stamens six, rarely three. . . . **94. Ehrharta.**
   b. Stamens four or two.
      α. Panicles loose, third and fourth empty glumes equal, awned. . . . . **95. Microlæna.**
      β. Inflorescence a spike or spike-like panicle. Fourth glume longer than the third, awnless. **96. Tetrarrhena.**

B. *Third and fourth empty glumes smaller than or barely equalling the first and second.*
   a. Third and fourth glumes empty, reduced to small scales, awnless. . . . . **97. Phalaris.**
   b. Third and fourth glumes empty, small, awned upon the back. . . . . **98. Anthoxanthum.**
   c. Third and fourth glumes, or at least the third, with a ♂ flower, almost equalling the first and second, awnless or short-awned. . . . **99. Hierochloë.**

94. (99) **Ehrharta** Thunb. (*Trochera* Rich.) (Fig. 39). Spikelets arranged in panicles or simple racemes. First and second empty glumes short, the third and fourth frequently awned; flowering glume slightly shorter, keeled, with a callus or tuft of hairs at the base.

Species twenty-four; twenty in South Africa, two on Mascarene Isles, two in New Zealand. Two have become naturalized in New Holland.

95. (100) **Microlæna** Brown (*Diplax* Hook.). First and second empty glumes very short, third and fourth longer than the flowering glume, all keeled; lodicules quite large; stamens two or four. Inflorescence paniculate.

Species five, in Australia to New Zealand.

96. (101) **Tetrarrhena** Brown. Like the preceding, but the spikelets in a more simple, scarcely branched spike. Fourth glume largest, indurated; stamens four.

Species four, in Australia.

97. (102) **Phalaris** L. Inflorescence usually a close spike-like, rarely interrupted panicle; spikelets laterally compressed. First and second glumes boat-shaped,

usually with a membranaceous wing upon the keel. Flowering glume and palea hard, shining; lodicules distinct; stamens three.

Species ten, mostly in Southern Europe; a few in Northern Europe and in America. *Ph. canariensis*, "Canary grass" (Fig. 40), with strongly-winged keels on

FIG. 39. — *Ehrharta Urvilleana* Kunth. (After Kunth, Revis. Gram. pl. 6.)

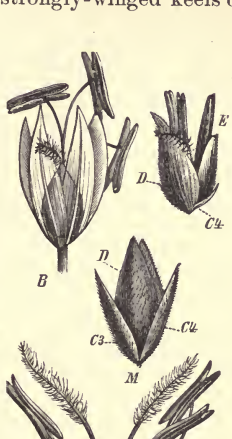

FIG. 40.—*Phalaris minor* L. *M*, *Ph. canariensis* L. (After Nees, Gen. Germ., I. 12.)

the empty glumes and the third and fourth empty glumes half as long as the flowering glume, is cultivated in Southern Europe and in Germany. The grain is used for bird-food, and sometimes, in Southern Europe, as a cereal. From the flour, weaver's glue is prepared. *Ph. arundinacea* L., "reed-grass," with more open, interrupted panicles and wingless empty glumes, forming a distinct section—*Digraphis* (Trin. as a genus, *Baldingera* Mey. & Schreb.)—grows upon river-banks and is of some value for hay; a variety with leaves striped with white ("ribbon-grass") is cultivated for ornament.

98. (103) **Anthoxanthum** L. Spikelets in short, spike-like panicles, narrow; first and second empty glumes unequal, herbaceous; third and fourth clothed with brown hairs. Flowering glume and palea short, membranaceous; lodicules none; stamens two.

FIG. 41. — *Anthoxanthum odoratum* L. (After Nees, Gen. Germ. pl. 16.)

Species four, in Europe, one of them in Northern Asia, North America, and Australia. *A. odoratum* L. (Sweet Vernal-grass) (Fig. 41) is fragrant on account of its containing *cumarin*, and is often wrongly considered a valuable forage-plant; it forms a low turf which can scarcely be mowed, and its taste is unpleasant to cattle.

99. (104) **Hierochloë** Gmelin (*Savastana* Schrad., *Disarrenum* Labill., *Torresia* Ruiz & Pav.). Inflorescence an open or close panicle. Spikelets shining, having one apparently terminal ☿ flower with two stamens, and 1–2 ♂ flowers below, each with three stamens. Flowering glume of the male flower frequently awned. Glumes all membranaceous, those surrounding the fruit indurated. All contain cumarin.

Species thirteen, throughout the temperate and frigid zones, rarely in high mountains of the tropics. *H. odorata* Wahlb., Vanilla grass (Fig. 42), is very fragrant, but useless for forage, as it is disliked by most animals. [The long leaves of the sterile shoots are woven into mats and small boxes by the North American Indians.]

FIG. 42.—*Hierochloë odorata* Wahlb. (After Nees, Gen. Germ.)

The five species with only one ♂ flower form the section *Ataxia* (Brown as a genus).

Tribe VIII.—Agrostideæ.

Spikelets usually all ☿, one-flowered, rachilla sometimes prolonged beyond the palea. Empty glumes often somewhat unequal, usually as long as or longer than the flowering glume, very rarely none; palea usually two-nerved; grain not sulcate; embryo usually small; starch-grains compound.

A. *Flowering glume indurated at maturity (at least firmer in texture than the empty glumes) and very closely enveloping the fruit.* (Sub-tribe *Stipeæ*.)

a. Spikelets all ☿, fertile.

α. Rachilla not prolonged beyond the palea.

I. Flowering glume deeply three-cleft, each segment awned; palea two-awned. **100. Amphipogon.**

II. Flowering glume entire, awned; awn trifid or three-branched (lateral divisions often very short). . . . . **101. Aristida.**

III. Flowering glume entire [two-toothed or bifid]; awn simple.

1°. Lodicules usually three, flowering glume and palea finally very hard.

* Flowering glume narrow. Awn twisted, stout, persistent. **102. Stipa.**

** Flowering glume broad, awn slender, falling off after flowering.

† Flowering glume elliptical or ovate, not gibbous at top; awn terminal or but slightly eccentric; embryo small. **103. Oryzopsis.**

†† Flowering glume obliquely obovate, gibbous at top; awn decidedly eccentric; embryo small.

○ Palea membranaceous, without nerves or keel. **104. Nassella.**

○○ Palea coriaceous, two-keeled, with a deep furrow between the keels. **105. Piptochætium.**

2°. Lodicules two (anterior); awns slender, sometimes reduced to a mere point. Palea simply membranaceous, spikelets small. . . . **108. Muhlenbergia.**

(N.B. Compare *Limnas.*)

IV. Flowering glume awnless. . **106. Milium.**

β. Rachilla with a pedicel-like prolongation beyond the palea.

I. Both empty glumes much shorter than the flowering glume, the latter with a straight, terminal awn. . . . **109. Brachyelytrum.**

II. Second empty glume one fourth shorter than flowering glume, the latter with a terminal, recurved awn. . . . **110. Podophorus.**

b. One ☿ and one ♂ (or sterile spikelet) in pairs on each branchlet of a spike-like panicle, these branchlets deciduous at the time of fruiting. **111. Lycurus.**

c. ☿ spikelets surrounded at the base with numerous sterile (and a few ♂) spikelets which are either reduced to bristles or delicate bracts. **112. Perieilema.**

d. Spikelets dicœcious, the ♀ solitary upon long pedicels. . . . . **107. Aciachne.**

B. *Flowering glume usually hyaline or membranaceous at maturity, at least more delicate than the empty glumes; grain loosely or not at all enclosed.*

a. Stigmas sub-plumose (their very short hairs springing from all sides), projecting from the apex of the nearly closed glumes.

α. Spikelets in a head which is surrounded by a bell-shaped involucre formed by the uppermost leaves. . . . . **113. Cornucopiæ.**

β. Spikelets in a flattened (broader than long) head which is enclosed between two opposite inflated sheaths with thorn-like blades. . **114. Crypsis.**

γ. Spikelets in a close, often shortened false spike, the upper leaf not forming an involucre.

I. Spikelets readily falling off at maturity.
119. Alopecurus.

II. Empty glumes persistent; flowering glumes usually deciduous.

1°. Flowering glume awned from below the bifid apex. . . . **118. Echinopogon.**

2°. Flowering glumes awnless.

* Flowering glume somewhat longer than the empty ones. . . **115. Heleochloa.**

** Flowering glume somewhat shorter than the empty ones, the latter with winged keels. . . . . **116. Maillea.**

*** Flowering glume much shorter than the wingless empty ones. **117. Phleum.**

δ. Spikelets in a delicate, simple spike.
120. Mibora.

ε. Spikelets in a panicle consisting of small umbel-like clusters; empty glumes none.
121. Coleanthus.

ζ. Spikelets in a short, narrow panicle; empty glumes short. . . . . **122. Phippsia.**

η. Spikelets in a loose, broad panicle, empty glumes as long as the flowering glumes and falling off with them. . . . . **129. Limnas.**

b. Stigmas distinctly plumose (branchlets distichous), projecting from the sides of the spikelets, rarely remaining enclosed within them.

α. Grain not covered by the flowering glume and palea, usually with a loosely attached pericarp which opens readily at maturity. . **123. Sporobolus.**

β. Grain covered by the flowering glume and palea, pericarp adherent.

1°. The entire spikelets deciduous (together with the whole or a part of the pedicel) at maturity. The pedicel of the spikelet often being distinctly articulated even at the time of flowering.

* First empty glume long-awned.
125. Chæturus.

** First and second empty glumes awned.
126. Polypogon.

*** Empty glumes awnless or only the second very short-awned.

† Flowering glumes awned from the very point or not at all. **127. Garnotia.**

†† Flowering glume awned below the toothed point. . . **128. Thurberia.**

[*Cinna*, No. 131, may be looked for here.]

2°. Empty glumes persistent upon the unarticulate pedicel of the spikelet.

* Palea one-nerved, with one keel; stamen one. . . . . **131. Cinna.**

** Palea two-nerved, rarely wanting; stamens three.

† Empty glumes covered with long plumose hairs. . . **144. Lagurus.**

†† Empty glumes saccate at the base, many times longer than the flowering glumes. . . . **134. Gastridium.**

††† Empty glumes neither plumose-hairy, nor saccate at the base.

○ Flowering glume four-cleft, each division terminated by a fine straight awn besides a strong twisted awn upon the back. **143. Pentapogon.**

○○ Flowering glumes two-cleft, the divisions awn-pointed, and between these an awn that is tortuous below. **142. Diplopogon.**

○○○ Flowering glumes with two fine lateral awns exceeding the length of the glume, and a delicate dorsal awn. **141. Trisetaria.**

○○○○ Flowering glume with a delicate awn, inserted below the point and many times longer than the glume.

◁ Second empty glume larger than the first. . **139. Apera.**

◁◁ Empty glumes equal. **140. Dichelachne.**

○○○○○ Flowering glumes different from those under ○ to ○○○○.

◁ Callus, or prolongation of the rachilla, having a tuft of hairs at least one third as long as the flowering glume.

X Spikelets all ☿.

□ Flowering glume and palea thin-membranaceous.

136. Calamagrostis.

□ □ Flowering glume and palea chartaceous, panicle spike-like.

138. Ammophila.

□ □ □ Flowering glume and palea chartaceous, panicles expanded.

138a. Calamovilfa.

XX Spikelets unisexual.

137. Cinnagrostis.

◁ ◁ Callus naked or with a few very short hairs.

X Spikelets in a long, narrow, many-flowered panicle.

124. Epicampes.

XX Panicles pyramidal, oval, or short and spike-like.

□ Empty glumes somewhat shorter than the flowering glumes, spikelets large.

130. Arctagrostis.

□ □ Empty glumes longer than the flowering glumes.

§ Without a distinct prolongation of the rachilla beyond the palea. **132. Agrostis.**

§§ With a distinct, bristle-like, naked prolongation of the rachilla.
133. Chætotropis.

§§§ With a distinct prolongation of the rachilla in the form of a pencil of hairs.
135. Triplachne.

SUB-TRIBE 1.—**Stipeæ.**

Fruiting glume more or less indurated, closely embracing the grain.

100. (119) **Amphipogon** Brown (*Gamelytrum* Nees). Inflorescence capitate, or a dense spike-like panicle with numerous awns, even the palea having two long awns.

FIG. 43.—*Aristida cærulescens* Desf. (Trin., Spec. Gram. pl. 313.)

Species five, in Australia. *Pentacraspedon* Steud. belongs here.

101. (108) **Aristida** L. Panicles usually expanded. Empty glumes usually longer than the flowering ones, the latter with a pointed callus; palea shorter; lodicules two.

Species about one hundred, in the warmer portions of both hemispheres, very few in the temperate parts of Europe and Asia, but numerous in North America.

Sec. I. *Chætaria* (Beauv. as a genus). Awns naked, not deciduous. *A. cærulescens* Desf. (Fig. 43), in South Europe and North Africa. *A. hygrometrica* in Queensland, is dangerous to sheep (see page 30). *Streptachne* Kunth (*Ortachne* Nees) has either no lateral awns or only very short ones.

Sec. II. *Arthratherum* (Beauv. as a genus). Awns naked, deciduous.

Sec. III. *Stipagrostis* (Nees as a genus. *Schistachne*, Fig. & De Notar.). Awns plumose, deciduous. Grasses of the high plains and deserts of Africa and Western Asia.

102. (109) **Stipa** L. Panicles usually expanded, empty glumes narrow, often awned, longer than the flowering glumes, the latter usually with a hairy callus; awns geniculate, usually twisted below the geniculation, finally deciduous.

Species about one hundred, distributed throughout the temperate and tropical zones, growing especially on elevated plateaus and savannas, and upon rocky soil. Leaves frequently filiform or stiff and rush-like.

St. pennata L., with long plumose awns, together with *St. tirsa* Stev. and the following species (viz., *St. capillata*), form the principal grasses of the Russian Steppes. *St. pennata* is also an ornamental grass for dry bouquets.

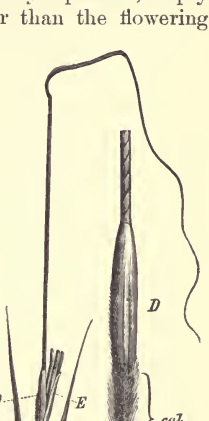

FIG. 44.—*Stipa capillata* L., *cal*, Callus.

St. capillata L. (Fig. 44) has naked awns that are curved irregularly back and forth towards the end. The fruiting glume with its pointed callus easily bores through the skin of sheep, reaches the intestines and causes death (especially in Russia), as does the "Porcupine grass" (*St. spartea* Trin.) of North America. Upon the prairies and especially upon the elevated plains of the West the numerous species of *Stipa* form a considerable portion of the "bunch" grasses, and furnish much but rather coarse grazing for stock. *St. tenacissima* L. (*Macróchloa tenacissima* Kunth) is called "Esparto" in Spain and *Halfa* or *Alfa* in North Africa; it has contracted panicles, two-cleft flowering glumes awned from

between the teeth, and very long, stiff, cylindrical leaves; it yields material from which shoes, mats, ropes, etc., are woven, and from which paper is manufactured; it is exported in bulk from Spain, Algiers, and Morocco, especially to England. It is worthy of note that certain species of *Stipa* act upon cows, and more especially upon horses, as narcotics. This fact is established in regard to *St. inebrians* Hance, *St. viridula* Trin., and a species growing in Cashmere, probably *St. Sibirica* Lam.

To the genus *Stipa* belong a large number of groups of species which may be regarded as poorly defined sections, which have been distinguished by some as genera; viz., *Macrochloa* Kunth, *Aristella* Bertol., *Streptachne* Brown (*Orthoraphium* Nees), *Jarava* Ruiz & Pavon, *Lasiagrostis* Link (*Achnatherum* Beauv.), and *Ptilagrostis* Griseb.

103. (110) **Oryzopsis** Michaux (*Piptatherum* Beauv., *Urachne*. Trin. (in part), *Dilepyrum* Rafin.). Distinguished from *Stipa* by its broader flowering glumes with their shorter, more slender and deciduous awns; lodicules often only two; epiblast of the embryo short.

Species fifteen, in the northern temperate zones of both hemispheres. *Eriocoma* Nutt. (*Fendleria* Steud.) forms a section with two species, in western N. America, distinguished by the long and densely haired flowering glume.

104. (110 §) **Nassella** Desv. Palea short, membranaceous, nerveless; epiblast projecting beyond the plumule.

Species eight, in Peru, Chili, and the Argentine Republic.

105. (110 §) **Piptochætium** Presl. Palea coriaceous, its apex projecting beyond the flowering glume; epiblast large.

Species five, in extra-tropical South America.

106. (111) **Milium** L. (*Miliarium* Mœnch). Fruiting glumes strongly indurated, shining as in *Panicum;* panicles diffuse.

Species 5–6, in Europe and the temperate portions of Asia, one also in North America (*M. effusum* L.), a forest

grass with drooping leaves, the blades of which are reversed (see page 8).

107. (112) **Aciachne** Benth. A dwarf grass with closely two-ranked, short leaves and a single ♀ spikelet terminating the culm. Fruiting glume with a long subulate point. ♂ spikelets unknown.

Species one (*A. pulvinata*), in the Andes of the tropics.

108. (113) **Muhlenbergia** Schreb. (Fig. 45). Panicles

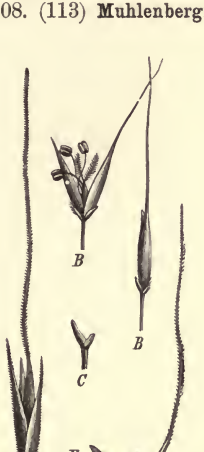

FIG. 45.—*Muhlenbergia diffusa* Schreb., above; *M. sylvatica* Torr., below. (After A. Gray, Man. pl. 8.)

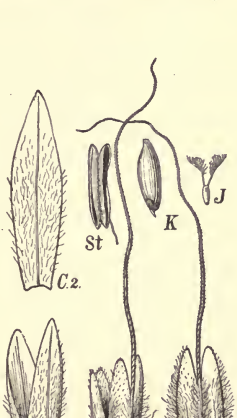

FIG. 45a.—*Bealia Mexicana*, Scribner (provisional); *C*, Empty glumes; *C.* 2., Dorsal view of expanded empty glume; *D* and *E*, Flowering glume and palea; *D*, Dorsal view of flowering glume; *St*, stamen; *J*, Pistil; *K*, Fruit. (Original.)

contracted or diffuse; spikelets small, awns often bent or flexuose but rarely twisted. Very varying in habit.

Species about sixty, mostly American, a few in Japan and in the mountains of Asia. *Vaseya* Thurber, *Podosæmum* Desv., *Tosagris* Beauv., *Trichochloa* Beauv.,

Clomena Beauv., and *Calycodon* Nutt. are all founded upon one or several species of this genus. *Clomena* Beauv., to which *Bealia* Scrib. belongs, found in Mexico and Peru, forms a sub-genus characterized by the two-toothed flowering glume which is awned between the teeth.*

109. (114) **Brachyelytrum** Beauv. Panicles with few spikelets; spikelets long and narrow; empty glumes minute; flowering glume with a long straight awn.

Species one (*B. aristatum* Beauv.), in North America.

110. **Podophorus** Philippi. Panicles open; flowering glumes longer than the empty ones, narrow, involute, with a pointed and short-bearded callus; awn geniculate near the base, but not twisted. Rachilla prolonged, frequently bearing an awned, rudimentary glume.

Species one (*P. bromoides* Ph.), upon the island of Juan Fernandez.

111. (116) **Lycurus** Kunth (*Pleopogon* Nutt.). Spikelets small, narrow, the upper one of each pair ☿, the lower ♂ or sterile. Lower empty glumes with 2–3 awns, the upper one and the flowering glume with only one.

Species two, in Mexico and New Mexico.

112. (115) **Perieilema** Presl. Panicles spike-like or interrupted, covered with the numberless awns (especially of the sterile spikelets). Palea and all the glumes awned.

Species three, in Mexico and tropical America.

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* I cannot agree with Prof. Hackel in this disposition of *Bealia* (Fig. 45*a*). There are several species of *Muhlenbergia* which have the flowering glume two-toothed, the awn arising from between the teeth, which certainly do not belong to the sub-genus or section *Clomena*. This sub-genus is best characterized by the broad, three-nerved and three-toothed second empty glume. The flowering glume closely envelops the conical or ovoid grain. In *Bealia* the empty glumes are entire, subequal, nerveless (or very faintly many-nerved), and the elongated grain *is only loosely enclosed* by the broad and deeply two-toothed flowering glume. The habit of *Bealia* somewhat resembles that of the typical *Clomena*, and I at first named it *Muhlenbergia Clomenoides*, but the characters presented by the empty glumes, flowering glumes, and grain are so unlike the true Muhlenbergias that I can but consider it generically distinct.—F. L. S.

SUB-TRIBE 2.—**Phleoideæ.**

Fruiting glumes delicate. Stigmas with short branches, projecting from the apex of the spikelets.

113. (106) **Cornucopiæ** L. A small, branched grass with minute spikelets in small heads; the pedicels be-

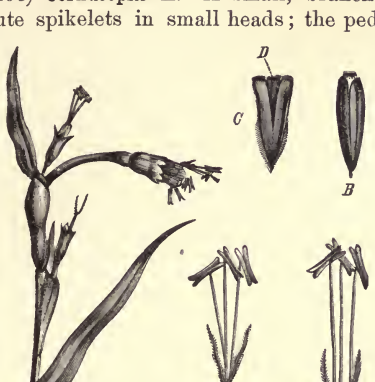


FIG. 46.—*Cornucopiæ cucullatum* L. (After Schreber, *Beschreib.*, pl. 41.)

come curved at maturity, when they separate at the jointed base and bore into the ground.

Species one (*C. cucullatum* L.), in the Orient (Fig. 46).

114. (105) **Crypsis** Ait. (*Antitragus* Gärtn.). Spikelets small, awnless; palea one-nerved; stamens two; fruit a utricle, the seed adhering to the spikelet for some time after it is expelled.

Species one (*C. aculeata* Ait.), in the Mediterranean region and upon the saline soils of the interior.

115. (120) **Heleochloa** Host. (*Pechea* Pourret). Like the preceding, except that the palea is two-nerved and the stamens three. The false spikes are subtended by a single leaf.

Species eight, in the Mediterranean region and in the temperate parts of Asia. *Rhizocephalus* Boiss. belongs

here. [*H. schœnoides* (*Crypsis schœnoides* Lam.) has been introduced into N. America, and become established about Philadelphia.]

FIG. 47. — *Phleum pratense* L. *B.r.*, Spikelet with ripe fruit. (After Nees, Gen. Germ. pl. 10.)

116. (121) **Maillea** Parl. A dwarf grass with short, false spikes and much compressed, awnless spikelets. Stamens two; palea one-nerved.

Species one (*M. Urvillei* Parl.), upon the Cyclades, Sporades, and also in Sardinia.

117. (122) **Phleum** L. Inflorescence usually in cylindrical, exserted, false spikes. Keel of the empty glumes extending into a point or short awn; flowering glumes awnless. Stamens three; palea two-nerved.

Species ten, in the temperate zones (except in Australia). *Ph. pratense* L., "Timothy" (Fig. 47), has its empty glumes truncate, with a long fringe upon the keel. Common in Europe. A very valuable grass for hay in heavy soils.

The section *Chilochloa* (Beauv. as a genus, *Achnodon* Link) has the rachilla prolonged beyond the palea. *Ph. Bœhmeri*, of central Europe, also belongs here.

118. (117) **Echinopogon** Beauv. (*Hystericina* Steud.). False spike bristling with the long, straight awns of the flowering glumes. Empty glumes awnless.

Species one (*E. ovatus* P. B.), in Australia and New Zealand.

119. (107) **Alopecurus** L. False spike cylindrical or ovate. Empty glumes awnless, usually fringed on the keels; flowering glume usually with a bent, dorsal awn; lodicules none, and palea often wanting. Flowers decidedly proterogynous.

Species twenty, in temperate Europe and Asia, a few also in North and South America and Australia.

A. pratensis L., "Meadow Foxtail," has acute, hairy, empty glumes connate below the middle; root-stock creeping; culms leafy. An excellent fodder-grass, especially for wet meadows. [*A. occidentalis* Scribn. is a valuable hay grass in the Rocky Mountain region.] The species having a distinct palea are *Colobachne* Beauv. (as a genus); *Tozettia* Savi is *A. utriculatus* L.

120. (123) **Mibora** Adans. (*Chamagrostis* Borkh.,

FIG. 48.—*Alopecurus pratensis.* (After Nees, Gen. Germ., I. 7.)

FIG. 49.—*Mibora verna* Adans. (After Nees, Gen. Germ., I. 6.)

Knappia Sm., *Sturmia* Hoppe). A delicate, dwarf grass with short setaceous leaves, slender spikes, and awnless glumes.

Species one (*M. verna* Adans.), in Western Europe (Fig. 49).

121. (124) **Coleanthus** Seid. (*Schmidtia* Trattin). A

dwarf, prostrate grass with the base of the panicle enclosed in the inflated upper leaf-sheath. Stamens two, alternating with the flowering glumes and palea. Grain projecting beyond the flower.

Species one (*C. subtilis* Seid.) (Fig. 50), on the muddy banks of rivers, lakes, and ponds. Distribution remark-

FIG. 50. — *Coleanthus subtilis* Seid. (After Nees, Gen. Germ., I. 27.)

FIG. 51.—*Sporobolus pungens* Kunth. *Br.*, Mature spikelet; K_1, K_2, Fruit, opened and discharging the seed. (After Nees.)

able: Bohemia, Moravia, Lower Austria, Tyrol, France, Norway, Amur, Oregon, and Washington.

122. (125) **Phippsia** Brown. Dwarf; panicle mostly enclosed in the leaf-sheath; spikelets minute; stamen one.

Species one (*P. algida* Br.), in the arctic polar regions, also on the higher Fjelden.

SUB-TRIBE 3.—**Euagrosteæ.**

Fruiting glume delicate; stigmas pectinately branched, usually projecting from the sides of the spikelets.

123. (126) **Sporobolus** Brown (*Vilfa* Beauv. non Adans., *Agrosticula* Raddi, *Cryptostachys* Steud.) (Fig. 51). Panicles variable. Spikelets small, awnless, naked; flowering glume and palea usually exceeding the empty glumes. Palea bifid. Fruit a utricle; the expelled seed usually remains adherent for a time to the spikelet.

Species eighty, chiefly in temperate and tropical America, but also in the warmer parts of Africa and Asia. One species (*S. pungens* Kunth) in Europe. Perennial, meadow grasses of the American prairies. [*S. cryptandrus* Gray, a valuable forage-grass.] *Diachyrium* Griseb. and *Triachyrium* Hochst. are founded upon the erroneous conception of two separate paleæ; the division or splitting of the palea arises mechanically during the ripening of the fruit.

124. (127) **Epicampes** Presl. Flowering glume with a delicate, often deciduous, or rudimentary awn on the point; fruit apparently a true caryopsis.

Species twelve, from California to the Andes, in the Argentine Republic. *Crypsinna* and *Bauchea* Fourn. belong here.

125. (130) **Chæturus** Link. Panicle contracted, short. Spikelets very narrow, in twos or threes upon each branchlet; flowering glumes somewhat shorter than the empty ones, awnless. Low, annual grasses.

Species two, *Ch. fasciculatus* Link and *Ch. prostratus* Hack. and Lange, upon the Iberian Peninsula.

126. (131) **Polypogon** Desf. (*Santia* Savi, *Raspalia* and *Nowodworskya* Presl) (Fig. 52). Panicles contracted or spike-like, often interrupted. Empty glumes frequently bifid, their awns usually long and slender; flowering glumes awned. The numerous awns impart a bristly appearance to the inflorescence.

Species ten, in the warm temperate zones of both hemispheres. Two in the tropics. *P. Monspeliensis*

Desf. and *P. maritimus* Willd. in the Mediterranean region. [Introduced into North America.]

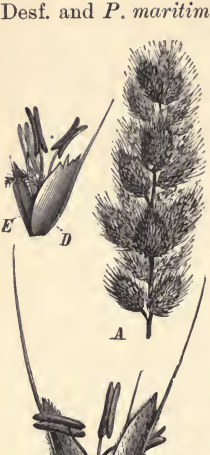


FIG. 52.—*Polypogon Monspeliensis* Desf. (After Nees, Gen. Germ., I. 32.)

127. (50) **Garnotia** Brongn. (*Miquelia* Nees, *Berghausia* Endlich). Spikelets small, in pairs along the branches of the usually expanded panicles. Flowering glumes with slender, slightly bent awns, or awnless.

Species eight, from Eastern India to Japan.

128. (48) **Thurberia** Benth. (*Greenia* Nutt. non Walk. et Arn., *Sclerachne* Torr. non Brown). Spikelets narrow, solitary along the branches of the panicle. Empty glumes rather hard. Awn of the flowering glume geniculate, twisted below.

Species two (*T. Arkansana* and *T. pilosa*), Arkansas and Texas.

129. (49) **Limnas** Trin. Panicles loose, few-flowered; all the glumes firm in texture; empty glumes with three prominent nerves; awns dorsal near the base, bent and twisted; styles connate below.

Species one (*L. Stelleri* Trin.), in Eastern Siberia.

130. (132) **Arctagrostis** Griseb. Panicles contracted, narrow, few-flowered. Spikelets large (for the tribe), awnless. Flowering glume herbaceo-membranaceous.

Species one (*A. latifolia* Griseb.), arctic-circumpolar.

131. **Cinna** L. (134) (*Abola* Adans., *Blyttia* Fries). Panicles elongated, many-flowered, spikelets small; flowering glumes with a very short awn just below the point. [Rachilla usually prolonged, naked.]

Species two, *C. pendula* Trin. and *C. arundinacea* L., in Northern Europe and North America.

132. (129) **Agrostis** L. Panicles variable, usually diffuse and many-flowered; spikelets small, flowering

glumes thin-membranaceous, or hyaline, awnless, or often with a bent awn inserted below the middle of the back; two lateral nerves sometimes also projecting into very short awns; palea usually short, often minute or none.

Species about one hundred, distributed over the entire globe, especially in the north temperate zone, where they constitute the more important meadow grasses, though the foliage is too low and too delicate to produce a great quantity of forage. *A. alba* L., "Fiorin grass" (Fig. 53), has a long ligule, pyramidal panicles which are contracted after flowering, and usually awnless spikelets. It is a valuable fodder-grass, especially for moist lands, moors, etc.; the same is true of the related *A. vulgaris* With. ("Red Top"), which has a shorter ligule and panicles more open after flowering. *A. nebulosa* Boiss. & Reut., a native of Spain, has extremely delicate panicles and very small spikelets; it is commonly cultivated for dry bouquets. The genus *Trichodium* Schrad. comprises those species having the palea rudimentary or wanting. *Bromidium* has a spike-like panicle.

FIG. 53.—*Agrostis alba* L. (After Nees, Gen. Germ., I. 29.)

133. (136) **Chætotropis** Kunth. Distinguished from the preceding by its very compact panicle, fringed keel of the empty glumes, and distinct projection of the rachilla beyond the palea.

Species one (*Ch. Chilensis* Kunth), in Chili.

134. (135) **Gastridium** Beauv. Panicles dense, spike-like; spikelets narrow, shining; rachilla produced beyond the palea, flowering glumes one third as long as the empty ones, awnless or awned.

Species two, *G. australe* Beauv., *G. scabrum* Presl, in the Mediterranean region.

135. (137) **Triplachne** Link. Panicles short, spike-

like, shining, flowering glume downy; awns almost basal, geniculate.

Species one (*T. nitens* Link), in the western countries of the Mediterranean region.

136. (133) **Calamagrostis** Roth (Figs. 54 and 55). Panicles very variable; hairs on the callus of the flowering glume sometimes short and sometimes longer than the glume itself, which is usually thin-membranaceous and variously awned. Frequently reed-like in habit. The spikelets usually larger than those of *Agrostis*.

FIG. 54.—*Calamagrostis Halleriana* D.C. (After Nees, Gen. Germ., I. 34.)

Sec. I. *Epigeos* Koch. Rachilla not produced; hairs on the callus usually long.

Species ten, in the north temperate zone of the Old World, including *C. Epigeos* (L.) Roth, *C. litorea* DC., *C. lanceolata* Roth, and *C. Halleriana* DC.

Sec. II. *Deyeuxia* Beauv. (as a genus). Usually with a hairy prolongation of the rachilla; callus hairs shorter than in Sec. I, very rarely wanting.

Species over one hundred and twenty, distributed throughout all the temperate and arctic zones, also upon the high mountains of the tropics; about sixty species in the Andes alone. [*Calamagrostis Tweedyi*, *Suksdorfii*, *Montanensis*, and *ambigua* Scribn. are Rocky Mountain species.]

FIG. 55.—*Calamagrostis (Deyeuxia) sylvatica.* (After Nees, Gen. Germ., I. 34.)

Achæte Fourn., *Relchela* Steud., *Cinnastrum* Fourn. are more or less anomalous species of this section.

137. (139) **Cinnagrostis** Griseb. Like the preceding, but with unisexual spikelets; rachilla with a long and very hairy prolongation; callus short, bearded.

Species one (*C. polygama* Griseb.), in the Argentine Republic.

138. (141) **Ammophila** Host. (*Psamma* Beauv.) Panicles usually narrow and spike-like. Flowering glume

and palea chartaceous, somewhat indurated, awnless; spikelets comparatively large.

Species one, *A. arundinacea* Host. ("Sand reed"), has long, creeping rhizomes, and cylindrical, false spikes. On the sandy coasts of Europe and the Atlantic States of N. America, rarely in the interior. This grass is frequently planted for binding the dunes and loose sands, as it penetrates these by a thick network of rhizomes that withstands the strongest washing of the waves. A cross (*A. Baltica* Link) is sometimes formed with *Calamagrostis Epigeos* Roth.

Obs.—Very nearly related to *Ammophila* are two N. American species, *Calamagrostis brevipilis* Gray and *C. longifolia* Hook., with the loose panicle of *Calamagrostis*, but the chartaceous flowering glumes of *Ammophila*, distinct from both genera by the one-nerved flowering glumes; they may best be considered a separate genus, *Calamovilfa* (Gray as a sect. of *Calamagrostis*). (Hackel in MS.)

[138*a*. **Calamovilfa.** Empty glumes unequal; flowering glumes one-nerved; rachilla not prolonged.

Species two, in N. America (*C. brevipilis* of the Atlantic coast, and *C. longifolia* of the western interior). These species are referred to *Ammophila* in B. & H. Gen. Pl., vol. III, p. 1153.]

139. (138) **Apera** Adans. (*Anemagrostis* Trin.). Panicles loose, spikelets delicate; rachilla prolonged, naked. Awns four times as long as the flowering glumes, straight or somewhat geniculate.

Species two, in Europe and Western Asia. *A. Spica-Venti* Beauv. is often a troublesome weed in crops. [Introduced into United States about Philadelphia, etc.]

140. (142) **Dichelachne** Endl. Panicles dense, long and narrow, bristly on account of the numerous awns; rachilla very slightly produced; awns very long, somewhat flexuous, not bent.

Species two (*D. crinita* and *D. sciurea* Hook.), from Australia to New Zealand.

141. (143) **Trisetaria** Forsk. (*Anomalotis* Steud.). Panicles long and narrow; rachilla prolonged, pedicel-like; middle awn from the back of the flowering glume, geniculate, twisted below; lateral awns delicate, straight.

Species two (*T. linearis* Forsk. and *T. quinqueseta* Hochst.), in Egypt and Abyssinia.

142. (118) **Diplopogon** Brown (*Dipogonia* Beauv.). False spikes capitate; rachilla not prolonged; palea with two awns; middle awn of the flowering glumes tendril-like below, recurved above.

Species one (*D. setaceus* Brown), in Western Australia.

143. (144) **Pentapogon** Brown. Panicles narrow, dense; rachilla prolonged, pedicel-like; middle awn of the flowering glume dorsal, twisted below, at length geniculate, longer than the four lateral awns.

Species one (*P. Billardieri* Brown), in Tasmania and Victoria.

FIG. 56.—*Lagurus ovatus* L. (After Nees, Gen. Germ., I. 45.)

144. (145) **Lagurus** L. Panicles spike-like or capitate; spikelets thickly clothed in the fine, woolly hairs covering the empty glumes, from which project the long dorsal awns of flowering glumes; lateral awns short.

Species one (*L. ovatus* L.) (Fig. 56), in the Mediterranean region; frequently cultivated for dry bouquets.

TRIBE IX.—AVENEÆ.

Spikelets 2–∞-flowered (only one-flowered in *Anisopogon*); inflorescence in panicles, rarely in spikes; all flowers ☿ or one ♂; empty glumes often persistent or remaining after the fruiting glumes have fallen, usually longer than the flowering glumes, the latter usually awned on the back, sometimes near the point; awn geniculate, rarely nearly straight; palea two-keeled; style short or none. Stigmas feathery, protruding above the base or middle of the spikelet. Grain usually furrowed; embryo small; starch-grains compound.

A. *Spikelets readily deciduous as a whole.* .. **145. Holcus.**

B. *Fruiting glumes deciduous, empty glumes persistent.*

a. Spikelets strictly two-flowered, rachilla not prolonged.
   α. Empty glumes cartilaginous on the back; keel with pectinate teeth. . . . **146. Prionachne.**
   β. Empty glumes membranaceous.
      I. Flowering glumes long ciliate-fringed on the back or margins; palea naked; empty glumes broad, many-nerved. **147. Eriachne.**
      II. Flowering glumes and palea, especially the latter, with a long fringe on the keels. Empty glumes narrow, 1–3-nerved. **148. Zenkeria.**
      III. Flowering glumes and palea naked.
         1. Upper flower in each spikelet on a rather long pedicel, smaller than the lower one, ♀. . . . **150. Cœlachne.**
         2. Both flowers nearly sessile, of equal size, ☿.
            * Palea many-nerved. **149. Micraira.**
            ** Palea two-nerved.
               † Empty glumes semi-globose. Panicle spike-like. **151. Airopsis.**
               †† Empty glumes not semi-globose. Panicle expanded.
                  ○ Empty glumes evidently longer than the flowering glumes.
                     ◁ Flowering glume truncate, slightly three-toothed, awnless. **153. Antinoria.**
                     ◁◁ Flowering glumes two-toothed, awned. **152. Aira.**
                  ○○ Empty glume shorter than the flowering glume. **154. Molineria.**

NOTE.—Compare *Isachne*.

b. Spikelets 2–∞-flowered (except *Anisopogon*), rachilla prolonged beyond the upper flower.
   α. Flowering glume awnless or with a short terminal awn. Spikelets small. . **155. Achneria.**
   β. Awn of the flowering glume upon the back (i.e.,

rising from below the teeth of the point, not *between* them).

I. Spikelets in an open (rarely spike-like) panicle, not in a true spike.

1. Flowers all ☿ or the upper ones ♂, or sterile.

* Grain free, unfurrowed. Spikelets usually small (less than 1 cm. long).

○ Flowering glumes finely erose-dentate, or two-lobed, or with the edges entire.

◁ Awns not articulated, the point fine. . . **157. Deschampsia.**

◁◁ Awns articulated, the point club-shaped. **156. Corynephorus.**

○○ Flowering glume cleft or two-toothed with the teeth sometimes produced into awns.

◁ Lower flower awnless, spikelets narrowly oblong. **159. Ventenata.**

◁◁ Lower flower awned. Spikelets elliptical-lanceolate. **158. Trisetum.**

** Grain furrowed, usually adherent to the glumes; spikelets over 1 cm. long.

○ Only two nerves of the flowering glume reach the point; grain hairy at the apex. . . . **160. Avena.**

○○ Nerves five, prominent, all extending to the point; grain naked. **161. Amphibromus.**

2. Upper flower ☿, the lower ♂ and strongly awned. . . . . **162. Arrhenatherum.**

II. Spikelets in a true, two-ranked, simple spike. . . . . **163. Gaudinia.**

γ. Awns from between the lobes or teeth of the flowering glume; the teeth also frequently awned.

I. Spikelets two-flowered, upper flower ☿ or ♀, lower ♂.
  1. Spikelets in threes, terminal on the branches of the panicle. **164. Tristachya.**
  2. Spikelets solitary, terminal on the branches of the panicle. **165. Trichopteryx.**

II. All the flowers ☿, or the upper imperfect.
  1. Spikelets one-flowered, very large. **166. Anisopogon.**
  2. Spikelets 3–∞ -flowered. **167. Danthonia.**

NOTE.—Compare the *Festuceæ; Graphephorum, Schismus, Dupontia, Dissanthelium* (all awnless).

145. (157) **Holcus** L. (in part). Spikelets paniculate, two-flowered, upper flower ♂ (rarely ☿), awned; lower ☿, awnless, its flowering glumes finally indurated, shining; empty glumes keeled, the upper one often short-awned.

Species eight, in Europe and North Africa, especially the western part, one in Cape Colony. *H. lanatus* L. (Fig. 57), with woolly or downy leaves, is of some value for forage.

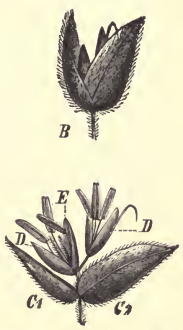


FIG. 57.—*Holcus lanatus* L. (After A. Gray, Man. pl. 12.)

146. (147) **Prionachne** Nees (*Chondrolæna* Nees [*Prionanthium* Desv.]). Panicle narrow, spike-like; spikelets awnless, somewhat like those of *Phalaris*.

Species one (*P. dentata* Nees), in South Africa.

Ktenosachne Steud. may also belong here.

147. (146) **Eriachne** Brown (Fig. 58). Panicle loose or dense. Empty glumes many-nerved; flowering glumes awnless or with fine terminal awns, finally somewhat indurated. Two flowers "apparently inserted at the same point, without any development of rachilla" (Benth. Notes, Gr. 92).

Species about twenty-two, all but two Asiatic and Australian.

Megalachne Thwaites, belongs here.

148. (148) **Zenkeria** Trin. (*Amphidonax* Nees (in part)). Panicle loose, empty glumes 1–3-nerved; flowering glumes awnless, the two flowers closely approximate.

FIG. 58.—*Eriachne glauca* R. Brown. (After Kunth, Rev. Gram. pl. 64.)

Species two, East Indian peninsula and Ceylon.

149. (149) **Micraira** F. Müll. A low, matted grass, with appressed, subulate leaves; spikelets very small, awnless, in loose panicles.

Species one (*M. subulifolia* Müll.) in Queensland.

150. (150) **Cœlachne** Brown. A very delicate, often prostrate grass with narrow panicles and small, round, awnless spikelets. Flowers divergent.

Species three, in East Indies, South China, and tropical Australia.

151. (151) **Airopsis** Desv. A delicate annual grass with nearly cylindrical panicles. Spikelets small, globose, shining, awnless; the two flowers very closely appressed to each other.

FIG. 59.—*Aira caryophyllea* L. (After Nees, Gen. Germ., I. 44.)

Species one (*A. globosa* Desv.), in Southwestern Europe and Northwestern Africa.

152. (152) **Aira** L. (in part) (*Fussia* Schur.). Spikelets small, usually in loose panicles. Empty glumes thin-membranaceous, the two flowers closely superposed. Flowering glumes usually awned on the back (awn rarely wanting), finally somewhat indurated. Delicate annual grasses with slender panicle-branches.

Species six, throughout Europe, especially in the South, and in North Africa, one species in all temperate countries. *A. elegans* Gaud. and *A. caryophyllea* L. (Fig. 59) are frequently cultivated for dry bouquets under the false name of *Agrostis elegans*. *Fiorinia* Parl. is an awnless species.

153. (152) **Antinoria** Parl. In general like the preceding, but the flowers are separated by a manifest internode of the rachilla, and the flowering glumes are different.

Species two, in Southwestern and Southern Europe.

154. (152) **Molineria** Parl. Like the preceding, but with the flowers projecting from the empty glumes. Flowering glumes truncate or slightly toothed, awnless or with short awns.

Species three, Western and Southern Europe to Asia Minor. *Periballia* Trin. is a species with a short, two-toothed flowering glume.

155. (155) **Achneria** Munro (non Beauv.). Spikelets small, in panicles; flowers separated by a short internode of the rachilla, somewhat shorter than the empty glumes, often hairy. Perennial grasses. Leaves frequently convolute.

Species eight, in Southern and tropical Africa (*Eriachne* of Nees, in Flora Afric. Austr.).

156. (153) **Corynephorus** Beauv. (*Weingærtneria* Bernhardi). Grasses with the habit of *Aira*, but with the rachilla prolonged, and club-shaped awns with a circle of short bristles at the point of articulation.

Species three, in Europe. *C. canescens* Beauv. (Fig. 60) grows in sand fields; it is a hardy but a poor pasture grass.

157. (154) **Deschampsia** Beauv. Spikelets rather small, two-flowered (rarely with an imperfect third flower); panicle loose or compact; florets separated by an internode; flowering glumes exceeding the empty ones; awns slender.

Species twenty, in all cold and temperate countries, a few in the high mountains of the tropics.

Sec. I. *Campella* Link (as a genus). Awns straight.

D. cæspitosa Beauv. (Fig. 61), with large, open panicles, narrow, rough, hard leaves, forms a thick turf, and is cosmopolitan. It is of little value for fodder.

FIG. 60.—*Corynephorus canescens* Bv. (After Nees, Gen. Germ., I. 42.)

FIG. 61.—*Deschampsia cæspitosa* Beauv. (After Nees, Gen. Germ., I. 43.)

FIG. 62.—*Trisetum pratense* Pers. (After Nees, Gen. Germ., I. 46.)

Sec. II. *Avenella* Parl. (as a genus) (*Lerchenfeldia* Schur.). Awns geniculate (*D. flexuosa* Trin. and others).

Sec. III. *Vahlodea* Fries (as a genus). Like Section II, but with entire flowering glumes (*Airidium* Steud., *Peyritschia* Four., and *Monandraëra* Desv. are more or less anomalous species).

158. (158) **Trisetum** Pers. Spikelets in an open or close panicle, two-flowered, rarely 3–6-flowered; empty glumes unequal, 1–3-nerved; flowering glumes keeled; callus and rachilla usually hairy; lateral teeth of the flowering glumes frequently produced into awns; middle awn geniculate.

Species about fifty, from the Arctic regions through

the north temperate zone, the high mountains of the tropics to the south temperate zone.

T. pratense Pers. (*Avena flavescens* L.), "Golden oats" (Fig. 62), has a loose panicle and yellow, shining spikelets, and is a valuable fodder-grass. *T. subspicatum* Beauv. is arctic, alpine, and antarctic. *Trichæta* Beauv. and *Acrospelion* Bess. are species of this genus.

159. (159) **Ventenata** Kölr. Like the preceding, but with the flowering glumes of the lower floret entire and awnless, and the spikelets longer and narrower; empty glumes 3–5-nerved.

Species three, Europe (*V. avenacea* Kölr.) and the Orient.

160. (160) **Avena** L. Spikelets 2–6-flowered (rarely one-flowered) in panicles. Empty glumes membranaceous, unequal; flowering glumes rounded on the back, 5–9-nerved, often two-toothed; awn dorsal, geniculate, twisted below (sometimes wanting or straight in cultivated forms). Callus of flowering glumes and the rachilla often hairy; ovary hairy all over or only at the point; caryopsis fusiform, deeply sulcate.

Species over fifty, in the temperate zones of the Old and a few in the New World.

Sec. I. *Crithe.* Annuals. Spikelets nodding; empty glumes many-nerved. *A. sativa* L., cultivated Oat (Fig. 63), with the awns of the persistent flowering glumes straight or none, has originated, perhaps, from the wild Oat (*A. fatua* L.), which has geniculate awns and deciduous flowering glumes; or from a similar species of which there are several in Southern Europe and Western Asia. Oats were cultivated in very ancient times in Europe, and extend as far as 69°.5 north latitude. It is the principal grain of Norway and Sweden, where it is used partly for mush, and partly for griddle-cakes ("Fladbrode"). Oatmeal is used in the same way in Scotland, Ireland, and on the Shetland and Orkney Islands. In the rest of Europe and in North America the plant is cultivated mainly as food for horses. In China there is a naked oat (see below) which is used in medicine; in Europe also water-gruel, made with oat-

meal, is used as a mildly stimulating drink (hence the officinal *Avenæ fructus excorticatus*). It is also raised for green fodder. There are two principal races: Panicled oats, with expanded, and "Banner oats" (*A. orientalis* Schreb.), with contracted, one-sided panicles. Each of these is divided into the chaffy and naked-fruited varieties, and the first, according to the color of the flowering glumes, into white, yellow, gray, brown, and black oats. In the naked oats (*A. nuda* L.) the rachilla is pro-

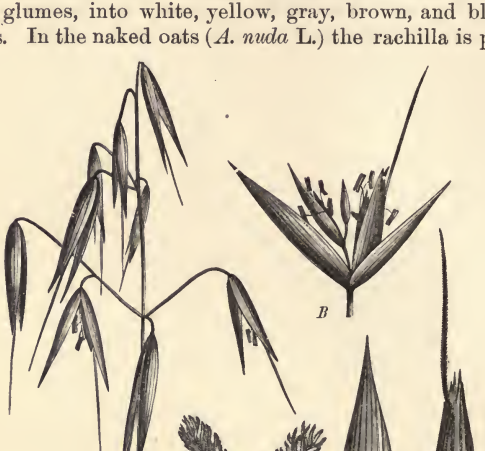


FIG. 63.—*Avena sativa* L. (After Nees, Gen. Germ., I. 48.)

longed and bears 4–6 flowers which project beyond the empty glumes; the flowering glumes are thin-membranaceous and allow the fruit to fall out. The "wild oat" (*A. fatua* L.) is often very troublesome as a field weed in crops, especially in Southern Europe. The "Hairy oats" (*A. strigosa* Schreb.) and the "Short oats" (*A. brevis* Roth.) are distinguished from *A. sativa* by the pedicellate lower flower and the usually two-awned spikelets; in the first the flowering glume is drawn out

into two fine, awn-like points; in the latter into two short, coarse teeth; the fruit is also shorter and broader. The culture of these two varieties has been given up in most countries on account of the small profits derived from them; they can be utilized advantageously only on very light, sandy soils. In Portugal, Spain, the Shetland and Orkney Islands, and in Mechlenburg, Holstein, etc., Hairy oats (*A. strigosa*) are here and there cultivated. Both species occur as weeds, however, especially among common oats.

Sec. II. *Avenastrum* (*Heuffelia* Schur., *Helicotrichum* Bess.). Perennials. Spikelets upright; empty glumes five-nerved. *A. pubescens*, "Downy oats," with downy lower leaves, is a good fodder-grass. [*Avena Hookeri* Scrib. (*A. versicola* Hook. non Vill.) with the habit of *A. pratensis* L. is common in the Rocky Mountain region of the Northwest.]

161. (162) **Amphibromus** Nees. Spikelets 8–10-flowered, loosely panicled; awns slender, geniculate.

Species one (*A. Neesii* Steud.), in Australia.

162. (163) **Arrhenatherum** Beauv. Habit of *Avena*, Sec. II; but the spikelets are somewhat smaller, and the two flowers in each are different (as to sex). The flowering glume of the lower floret is awned from the base, while that of the upper is awned from the point or awnless.

FIG. 64.—*Arrhenatherum avenaceum* Beauv. (After Nees, Gen. Germ., I. 49.)

Species six, in Europe, Northern Africa, Western Asia. *A. avenaceum* Beauv. (*Avena elatior* L.) (Fig. 64) with expanded panicles and naked, shining spikelets is the French "Ray grass." It is native in Central and Southern Europe, and much cultivated in North America ("Randall grass," "Evergreen grass"), a very good and productive grass for chalky soils.

163. (161) **Gaudinia** Beauv. (*Arthrostachya* Link) (Fig. 65). Annuals with the habit of *Lolium*, and spikelets as

in *Avena*, many-flowered, but singly sessile in notches of the articulate rachis ; awns slender.

Species two, one, *G. fragilis* Beauv., in the regions of the Mediterranean, the other (*G. geminiflora* J. Gay), on the Azores.

FIG. 65.—*Gaudinia fragilis* Beauv. (After Nees, Gen. Germ., I. 84.)

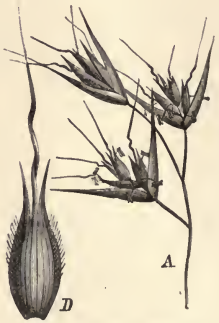


FIG. 66.—*Danthonia provincialis* DC. (After Nees, Gen. Germ., I. 50.)

164. (164) **Tristachya** Nees (*Monopogon* Presl). Panicles loose; flowering glumes of the ♂ flower awnless, that of the ♀ flower deeply cleft, and with a long, geniculate and twisted awn.

Species eight, in tropical America, the others in tropical Africa and Western Asia.

165. (165) **Trichopteryx** Nees (*Loudetia* Hochst.). Distinguished from the preceding only by the solitary spikelets. Flowering glume often hairy.

Species ten, in tropical and Southern Africa, one of them also in Brazil.

166. (166) **Anisopogon** Brown. Panicles loose, with solitary, very large (4 cm. exclusive of the awns) spikelets ; flowering glumes five-cleft, four lateral points finely awned, and the middle one with a strong geniculate awn.

Species one (*A. avenaceus* Brown), in Australia.

167. (167) **Danthonia** DC. Panicles loose or dense ; flowering glumes rounded on the back, 7–9 nerved, frequently fringed, two-cleft, the points sometimes two-

parted and ending in awns; middle awn flattened at the base, usually geniculate and twisted.

Species about one hundred, in the warm and temperate zones of both hemispheres, more than half of them in South Africa. [*D. compressa* Austin, on the mountains of North Carolina and Tennessee, is valuable for grazing.]

Sec. I. *Himantochœte.* The two teeth of the flowering glume undivided. *D. provincialis* DC. (Fig. 66), from South Europe to Vienna. *Crinipes* Hochst. and *Streblochœte* Hochst. are species of this section.

Sec. II. *Pentaschistis.* Teeth of the flowering glumes again two-toothed and often produced into awns. *Pentameris* Beauv. and *Chœtobromus* Nees belong here.

Tribe X.—Chlorideæ.

Spikelets one- to many-flowered, in two series upon the outer side of the continuous rachis of the spike or raceme; flowering glumes deciduous with the fruit; the usually two empty glumes rarely falling with them. Palea two-nerved; styles distinct; stigmas projecting from the sides, rarely from just below the apex, of the spikelets; grain free, unfurrowed; starch-grains usually compound, rarely simple.

A. *Flowers of all the spikelets hermaphrodite.*

a. One ☿ flower (very rarely two) in each spikelet.

α. No sterile glumes or ♂ flowers, and only rarely a short projection above the ☿ flower.

I. Spikelets awnless [sometimes short-awned in *Spartina*].

1°. Spikelets falling off from the rachis entire. **170. Spartina.**

2°. Empty glumes not deciduous.

* Spike terminal, slender. **168. Michrochloa.**

** Spikes 2–6, digitate. . **169. Cynodon.**

*** Spikes many along a common axis.

† The axis slender; flowering glume longer than the empty ones. **179. Schedonnardus.**

†† The axis bordered by a narrow membrane; flowering glumes many times shorter than the empty ones.

180. Craspedorhachis.

II. Spikelets distinctly awned.

1°. Spikes terminal, one to four in number.

171. Schœnefeldia.

2°. Spikes numerous, approximate at the end of the culm. . . . . **178. Monochæte.**

NOTE.—Compare *Nardus* with one spike, one pistil, one indistinct empty glume.

β. One to several empty glumes above the ☿ flower; these are often small or awn-like, rarely with a ♂ flower in their axils.

I. Empty glumes four, the two upper often having a palea in the axil but bearing no flower. . . . . **173. Ctenium.**

II. Empty glumes two.

1°. Spike one, terminal.

* Spikelets awnless. **172. Harpechloa.**

** Spikelets awned. **174. Enteropogon.**

2°. Spikes two to many (occasionally resembling short fascicles).

* Spikes in false whorls or at least closely approximate.

† Flowering glume of the ☿ flower with one awn, or awnless.

175. Chloris.

†† Flowering glume of ☿ flower with three awns. **176. Trichloris.**

** Spikes remote or the lowest only approximate.

† Spikelets scattered or remote.

177. Gymnopogon.

†† Spikelets crowded.

○ Flowering glume plumose-ciliate. **182. Melanocenchris.**

○○ Flowering glume not plumose. . . **181. Bouteloua.**

NOTE.—Compare the one-flowered *Leptochloa* species.

b. Each spikelet with 2–3 ☿ flowers.

α. Spikes terminal, solitary or 2–3 approximate and upright; spikelets awned.

I. Flowering glumes with three awns, the middle one from below the entire point, the lateral ones (often short) beginning lower down. . . . . **183. Tripogon.**

II. Flowering glumes with one awn below the entire point. . . . **184. Lepidopironia.**

III. Flowering glumes with one awn below the two obtuse lobes of the point. **185. Tetrapogon.**

IV. Flowering glume deeply three-cleft; lateral divisions pointed, the middle one prolonged into a strong awn. **186. Astrebla.**

β. Spikes 1–3, short, terminal, not digitate, spikelets awnless. . . . . **192. Cœlachyrum.**

γ. Spikes numerous, along a common axis or digitate at its apex; spikelets awnless.

I. Spikelets deciduous as a whole.

1°. Empty glumes four. . **187. Tetrachne.**

2°. Empty glumes two. **189. Beckmannia.**

NOTE.—Compare *Leptochloa bipinnata* Hochst.

II. Empty glumes two, persistent, flowering glumes deciduous.

* Empty glumes with a subulate awn, projecting beyond the flowering glumes. **188. Dinebra.**

** Empty glumes awnless or mucronate pointed, shorter than the flowering glume.

† Spikelets densely crowded, spikes usually digitate.

○ Spikes with terminal spikelets. **190. Eleusine.**

○○ Spikes without terminal spikelets; the rachis drawn out to a point and projecting beyond them. . **191. Dactyloctenium.**

†† Spikelets distinctly alternating; spikes remote. . **193. Leptochloa.**

NOTE.—Compare *Wangenheimia*, *Festuca*, also *Trichloris* with three awns.

B. *Plants diœcious, rarely monœcious, the two sexes very unlike.*

a. ♀ inflorescence capitate, ♂ spikelets 2–3-flowered. **194. Buchloë.**

b. ♀ inflorescence a loose, one-sided spike, ♂ spikelets one-flowered. . . . . **195. Opizia.**

168. (168) **Microchloa** Brown. Low, cæspitose, delicate-leaved grasses, with long, frequently curved spikes.

Species three, two African, the third (*M. setacea*) distributed throughout tropical zone.

169. (170) **Cynodon** Pers. (*Capriola* Adans., *Fibichia* Köl., *Dactylon* Vill. (in part)). Spikelets small; flowering glumes usually longer and broader than the narrow empty ones, ciliate on the keel; spikes slender, radially divergent.

FIG. 67.—*Cynodon Dactylon* Pers. (After Nees, Gen. Germ., I. 39.)

Species four, three in Australia, the fourth (*C. Dactylon* Pers. (Fig. 67) "Dog's tooth," with long creeping runners and 3–5 digitate spikes) cosmopolitan. This species covers the ground extensively in sandy soils, and although it has delicate leaves, it withstands protracted drouths. In the S. States ("Bermuda grass"), it is the most important grass for pasturage, and, as in Hindostan, it is prized for fodder, both for horses and cows. The Hindoos consider it sacred. In Bengal it is called "Durba," in N. India "Dub," and in the Deccan "Hariali." In Europe it has been little appreciated.

Its rhizome (*Rh. Graminis Italici*) is used in medicine like that of the *Paspalum distichum* (see p. 73).

170. (19) **Spartina** Schreb. (*Trachynotia* Michx., *Limnetis* Pers., *Solenachne* Steud.). Spikes two to several, usually upright, approximate, rarely remote; spikelets large, compressed; empty glumes unequal; as long or nearly as long as the flowering glume; embryo nearly as long as the fruit.

Species seven. Maritime grasses, three of which are common to the Atlantic coast and to the Mediterranean shores (*Sp. stricta* Roth); two in the Western prairies, one in Montevideo, one upon Tristan da Cunha, Amsterdam, St. Paul. Coarse grasses, of not much value as fodder.

171. (169) **Schœnefeldia** Kunth. Spikes 2–4, long. Spikelets densely crowded, sub-pectinate. Striking in appearance on account of the very long slender awns which impart to the spikes an elegant crinate aspect.

Species three, tropical Africa; one East Indian.

172. (171) **Harpechloa** Kunth. Spikelets crowded, pectinate; flowering glumes of ☿ flower broad, compressed, obtuse, long-fringed; above the ☿ flower are 1–3 small glumes that are either empty or with ♂ flowers; spikes dense, often falcate.

Species two (*H. capensis* Kunth), in South Africa.

173. (172) **Ctenium** Panzer (*Campulosus* Desv., *Monocera* Ell.) (Fig. 68). Spike one, rarely 2–3, usually curved; spikelets densely imbricated, pectinate; second empty glume awned on the back; awn stout, divergent; flowering glume of ☿ flower with a very slender awn below the point; one to two empty or ♂ bracts above the flowering glume.

Species seven, four in South and North America, three in Africa and the Mascarene Isles.

174. (173) **Enteropogon** Nees. Spikes long, often curved; spikelets imbricated; flowering glume of the ☿ flower with a slender awn below the point; 1–2 empty or ♂ bracts above.

Species four, in East India, tropical Africa or the Mascarene and Seychelles Islands.

175. (174) **Chloris** Sw. (Fig. 69). Empty glumes narrow, very acute; flowering glumes broader, usually two-

FIG. 68.—*Ctenium Americanum* Schrank. (After A. Gray, Man. pl. 9.)

FIG. 69.—*Chloris barbata* Sw. *O*, Sterile glume. (After Trin., Spec. Gram. pl. 306.)

cleft, frequently ciliate; one to several empty glumes above, which are usually broadly truncate and often awned.

Species about forty, in all warm countries, except Europe. Elegant grasses, some of which (*Ch. gracilis* Dur. for example) are cultivated as ornamental plants. The species with awnless flowering glumes compose the section *Eustachys* Desv. (as a genus), *Schultesia* Spreng.

176. (176) **Trichloris** Fournier. Spikes erect, rather slender, approximate, or in elongated panicles, clothed with the numerous delicate awns. Spikelets sometimes 2–3-flowered; sterile bracts reduced to awns.

Species two, in Mexico, Texas, Arizona; two in Chili and one in Argentine Republic. That in the latter country (*Tr. Blanchardiana* Hack.) is as yet undescribed, but has long been known to gardeners as *Chloropsis* or *Chloridopsis Blanchardiana*, and is prized as an ornamental grass; the one in Arizona is perhaps identical with it.

177. (177) **Gymnopogon** Beauv. (*Anthopogon* Nutt., *Dichætaria* Nees). Flowering glume a little broader than the empty glumes, awned below the two-cleft apex; sterile glumes often reduced to awns; spikes delicate, at first erect, finally divaricate-spreading or reflexed.

Species six, all, except one in Ceylon, American. Leaves short, rather broad and rigid.

178. (178) **Monochæte** Döll. Like the preceding, but the rachilla is not produced beyond the flowers; spikes many, densely flowered.

Species one (*M. fastigiata* Döll.), in Brazil.

179. (179) **Schedonnardus** Steud. Spikes loosely flowered, remote on a common rachis, spreading; flowering glume finally indurated, linear, acuminate-pointed.

Species one (*Sch. Texanus* Steud.), in N. America.

180. (180) **Craspedorhachis** Benth. Like the preceding, but the flowering glume and palea are very delicate, and so small as to appear like minute scales.

Species one (*C. Africana* Benth.), in tropical Africa.

181. (181) **Bouteloua** Lagasca (*Eutriana* Trin., *Actinochloa* Willd.) (Fig. 70). Spikes very variable, sometimes consisting of many and sometimes of 1–3 spikelets; in the latter case they resemble solitary spikelets, but are distinguished by the prolongation of the axis beyond the spikelets; flowering glumes with 3–5 teeth, of which 1–3 bear awns or mucros; upper sterile glumes usually reduced to awns.

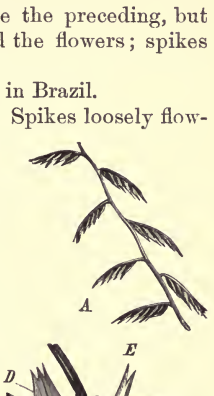


FIG. 70.—*Bouteloua racemosa* Lag. (After Asa Gray, Man. pl. 9.)

Species about thirty, especially abundant upon the plateaux of the southwestern United States, where they form a large part of the prairie-grass ("Mesquite" or "Grama grass") and furnish excellent grazing for stock.

Sec. I. *Chondrosium* Desv. (as a genus). Spikelets pectinate, numerous in each of the more or less falcate

spikes; upper sterile glumes usually three-awned.—*B. hirsuta* Lag., Illinois to Mexico.

Sec. II. *Atheropogon* Muhlenb. (as a genus) (*Heterostega* Desv.). Spikelets few (less than twelve) in many short spikes; upper sterile glumes variable (see Fig. 70).—*B. racemosa* Lag., New York to Peru.

Sec. III. *Triathera* Desv. (as a genus) (*Aristidium* Endl., *Tricena* Kunth). Spikelets either single or in twos or threes in each of the numerous spikes; upper sterile glume three-awned.—*B. aristidoides* Griseb., in Mexico, California, etc.

Sec. IV. *Polyodon* Kunth (as a genus) *Triplathera* Endl.). Like Sec. III, but with 2–3 sterile bracts above the ♀ flower; sterile bract with 3–5 awns united in a fascicle.—*B. multiseta* Benth. in S. America.—*B. Texana* Wats. in Texas.

182. (182) **Melanocenchris** Nees (*Ptiloneilema* Steud.). Spikes very short, sub-globose, very remote, finally deciduous. Low annuals.

Species three, in Hindostan and tropical Africa.

183. (183) **Tripogon** Roth. (*Plagiolytrum* Nees). Spikes terminal, elongated, solitary; spikelets sub-imbricated, many-flowered, the 1–2 upper flowers smaller, ♂, or sterile. Small, cæspitose grasses with very narrow leaves.

Species eight, in East India and tropical Africa.

184. (184) **Lepidopironia** Richard. May belong to the preceding; it differs only in the uni-aristate flowering glume, which is covered with long woolly hairs.

Species one, in Abyssinia.

185. (185) **Tetrapogon** Desf. (*Cryptochloris* Benth.). Spikes solitary or in twos or threes, usually clothed with silky hairs; spikelets crowded, 2–3-flowered, broad.

Species five, four in North Africa, Abyssinia, and Western Asia. One (*Cryptochloris*) of doubtful origin (in Patagonia?).

186. (186) **Astrebla** F. Müll. Spikes terminal, solitary or in pairs; spikelets large, thickened; empty glumes and flowering glumes many-nerved, the latter clothed with silky hairs.

Species two or three. *A. pectinata* and *A. triticoides* F. Müll. in Australia.

187. (189) **Tetrachne** Nees. Spikes remote, with densely crowded spikelets; leaves terete, convolute.

Species one (*T. Dregei* Nees), in South Africa.

188. (188) **Dinebra** Jacq. Spikes short, numerous, scattered along a common axis, finally reflexed.

Species one (*D. Arabica* Jacq.), a low annual in Northern and tropical Africa to Hindostan.

189. (6) **Beckmannia** Host. Spikelets broad, compressed, crowded, two-flowered. Empty glumes navicular, inflated on the back; flowering glumes narrower, keeled, pointed, but awnless.

Species one (*B. erucæformis* Host.). Eastern and Southern Europe, temperate portions of Asia and North America. [Specimens from America have one-flowered spikelets.]

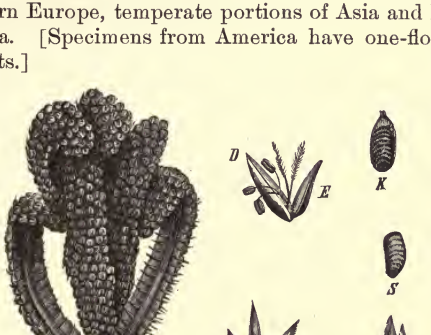


FIG. 71.—*A*, *Eleusine Coracana* Gärtn. (After Schreber, *Bschr.* pl. 35.) *B*, *S*, Spikelets of *E. Indica* Gärtn. (After A. Gray, Man. pl. 9.) *K*, Utricle. *S*, seed.

190. (191) **Eleusine** Gärtn. Spikes digitate or rarely scattered; spikelets many-flowered, crowded; glumes closely imbricate, diverging, compressed and keeled, obtuse or mucronate-pointed; pericarp very delicate.

Species six, mostly in the tropical and sub-tropical

zone of the Old World; one (*E. Indica* Gärtn.) is a weed in all warmer countries. *E. Coracana* Gärtn. ("Korakan" or "Dagussa;" "Mandua" in N. India, "Marua" in Bengal, "Ragi" in S. India) has thick spikes, and a seed which is marked with very fine comb-like lines. It is probably derived from *E. Indica* (see above), whose oblong seeds are marked with more distinct comb-like lines, and whose spikes are more slender. "Korakan" is cultivated in E. India, Sunda Islands, S. China, Japan, and especially through the whole of Africa. In many parts of Africa it forms the principal food in spite of the bitter taste of the flour. A kind of bread or unleavened cake is made from it. In Abyssinia and Niam Niam a tolerably good beer is brewed from it. In India it is much prized, as it yields good harvests from very poor soil.

191. (191) **Dactyloctenium** Willd. Empty glumes strongly mucronate-pointed. The pericarp is absorbed before the fruit is ripe.

Species one (*D. Ægyptiacum* Willd., with several varieties), which occurs as a weed throughout all warm countries. A decoction is prepared from the seeds, which is used in Africa for inflammation of the kidneys.

192. (230 §) **Cœlachyrum** Nees. Small, annual plants, with short spikes and no prolongation of the axis; fruit a utricle whose pericarp is easily loosened at an early period, leaving the shield-shaped seed marked with prominent radial lines.

Species two, *C. brevifolium* Nees in Arabia and *C. Indicum* Hack. (*Eragrostis brevifolia* Benth.) in India.

193. (192) **Leptochloa** Beauv. (*Oxydenia* Nutt., *Rabdochloa* Beauv.). Inflorescence a panicle formed of numerous slender spikes; spikelets small, two–∞-flowered, rarely one-flowered, compressed; glumes and palea keeled; flowering glume obtuse or acute, rarely awned.

Species twelve, in the warmer countries of both hemispheres. One, *L. mucronata* Kunth, in temperate North America.

194. (193) **Buchloë** Engelm. (*Bulbilis* Rafinesque). Male plant with 2–4 short unilateral spikes, spikelets obtuse,

2–3-flowered; inflorescence of the ♀ plant capitate, sessile (recalling *Cenchrus*), scarcely exserted from the sheath of the subtending leaf; empty glumes two, concave, indurated, three-lobed.

Species one (*B. dactyloides* Engelm.), the renowned "Buffalo grass" of the North American prairies. In Texas it remains green over winter, and if it completely dries up during the summer drouth it is still readily eaten by cattle, and a few hours' rain is sufficient to make it green again.

195. (195) **Opizia** Presl. ♂ spikelets in several alternating, slender spikes; second empty glume of the ♀ spikelet with three long awns surrounding the rest of the spikelet like an involucre; flowering glumes two-lobed, sterile bracts long-awned.

Species one (*O. stolonifera* Presl), in Mexico.

Tribe XI.—Festuceæ.

Inflorescence in panicles or racemes (apparently spikes on account of the very short pedicels of the spikelets); spikelets 2–∞-flowered, rarely one-flowered, usually ☿; empty glumes usually shorter than the nearest flowering glume; flowering glumes awnless or with from one to many awns which are usually terminal, rarely dorsal, and straight (very rarely geniculate); paleæ two-keeled; embryo usually small; starch-grains usually compound. The most important meadow-grasses of the temperate zones, as well as the predominating grasses of high mountains in the tropics.

A. *Flowering glumes divided into three-to-many awn-like lobes, or with the awns rising from between the lobes, or dorsal.*

a. Flowering glumes cleft above into 9–23 awn-like divisions. . . . . **196. Pappophorum.**

b. Flowering glumes with 9–11 irregular, membranaceous, awned lobes. . . . . **197. Cottea.**

c. Flowering glumes with 5–9 dorsal awns. **269. Boissiera.**

d. Flowering glumes with four membranaceous lobes, between and at the sides of which arise five awns. **198. Schmidtia.**

e. Flowering glumes with five sharp, subulate divisions, which are bent backwards. Spikelets two-flowered; inflorescence capitate. . **206. Echinaria.**

f. Flowering glumes with 3–5 lanceolate, pointed, rigid, and erect or straight lobes. Spikelets many-flowered, in racemes. . . . . **207. Orcuttia.**

g. Flowering glumes with five delicate awns.
210. Sesleria, Sec. *Psilathera.*

h. Flowering glumes five-cleft, divisions awl-shaped, the middle and two outer ones awned.
199. Calamochloa.
NOTE.—Compare *Triraphis.*

i. Flowering glumes deeply 3–4-cleft with a dorsal awn. . . . . **201. Pommereulla.**

k. Flowering glumes deeply four-cleft, usually awned between the hyaline divisions. **200. Cathestechum.**

l. Flowering glumes of the fertile flower three-cleft, three-awned.
α. Plant dicœcious, the two sexes very unlike.
202. Scleropogon.
β. Plant hermaphrodite. . . . **203. Triraphis.**

B. *Flowering glumes entire or two-toothed to two-cleft, awnless or with one awn* (3–5-*awned only in a variety of Bromus macrostachys*).

a. Rachilla or flowering glume (at least of the fertile flower) with long hairs which envelop the latter. Tall, reed-like grasses.
α. Plant dicœcious, ♀ spikelets hairy, ♂ spikelets naked. . . . . **214. Gynerium.**
β. Plant hermaphrodite (very rarely dicœcious), all the spikelets hairy.
I. Flowering glumes thick-membranaceous, five-nerved. . . . **215. Ampelodesmos.**
II. Flowering glumes thin-membranaceous or hyaline, three-nerved.
1°. Flowering glumes hairy, rachilla naked.
216. Arundo.
2°. Hairs on the rachilla only.
217. Phragmites.

b. Rachilla and flowering glume naked or hairy; hairs much shorter than the glumes.

α. Stigmas with short hairlets on all sides (barbellate), projecting from the point of the flowering glumes, upon elongated, free styles.

I. Spikelets dicœcious, solitary, terminal, concealed between the leaves.
204. Monanthochloë.

II. Spikelets usually in threes, terminal in the axils of stiff, spinescent leaves which project far beyond them. . . **205. Munroa.**

III. Spikelets in a capitate panicle which is enclosed within the sheath of a bract-like leaf and falls off with it. **209. Urochlæna.**

IV. Spikelets in a capitate or short cylindrical panicle which is neither surrounded by a leaf nor deciduous; the spikelets also (at least their empty glumes) persistent.

1°. Lowest spikelet with bracts at the base.

* Empty glumes winged upon the keel; spikelets very many-flowered.
208. Ammochloa.

** Empty glumes not winged, spikelets 2–6-flowered. . **210. Sesleria.**

2°. Lowest spikelet without bracts at the base. . . . . **211. Oreochloa.**

V. Spikelets in contracted, spike-like panicles, articulated below the empty glumes and falling off one by one.
212. Fingerhuthia.

VI. Spikelets minute in compact, very long, lobed panicles whose ultimate branches are subtended by subulate bracts; spikelets minute, not deciduous.
213. Elytrophorus.

NOTE.—Compare *Streptogyne*, *Zeugites*, *Schismus*.

β. Stigmas plumose, relatively short, sessile or raised on a short style, emerging from the sides of the flowering glume.

I. Spikelets of two forms, the fertile 1–3-flowered, surrounded by the sterile consisting of many glumes.

1°. Fertile spikelets one-flowered, sterile spikelet with obtuse glumes.
254. Lamarckia.

2°. Fertile spikelets 2–3-flowered, sterile spikelet with awned or pointed glumes.
253. Cynosurus.

II. Spikelets all alike.

1°. Flowering glumes three-toothed, three-pointed or two-toothed, usually three-nerved; lateral nerves and the callus usually hairy.

* Spikelets with only one fertile flower, four empty glumes and one upper, empty, three-awned rudiment. . . . **218. Blepharidachne.**

** Spikelets with three to many fertile flowers; empty glumes two.
219. Triodia.

*** Spikelets 1–3-flowered; flowering glumes keeled; branches of the diffuse panicle very long and capillary. . . . . **219a. Redfieldia.**

NOTE.—Compare *Diplachne* with its sharp-keeled flowering glumes.

2°. Flowering glumes of some other structure.

* Flowering glumes 1-3-nerved, all with ☿ flowers, or the uppermost only with a ♂ flower, or empty.

† Panicle-branches spirally arranged.

○ Panicle-branches in spike-like racemes either with short-pedicelled or sessile spikelets.

◁ Flowering glumes keeled.
220. Diplachne.

◁◁ Flowering glumes rounded on the back.
224. Ipnum.

○○ Branches of the panicle again with branchlets, these becoming shorter above.

◁ Spikelets loosely 2–4-flowered, conical; rachilla articulated. **222. Molinia.**

◁◁ Spikelets densely many-flowered; rachilla usually continuous: if articulated, the spikelet not conical. **223. Eragrostis.**

†† Primary panicle-branches distichous, usually branched again at the base.

○ Empty glumes much longer than the flowering glumes. **221. Dissanthelium.**

○○ Empty glumes not at all or only a little longer than the flowering glumes.

◁ Panicle spike-like or very much contracted, usually dense.

X Second empty glume much broader and somewhat longer than the flowering glumes.

□ Flowering glumes broadly obtuse, awnless. **225. Eatonia.**

□□ Flowering glumes awned. **226. Avellinia.**

XX Second empty glumes not broader nor longer than the flowering glumes. **227. Kœleria.**

◁◁ Panicle diffuse, with long slender branches.

Empty glumes slightly unequal.

228. Catabrosa.

XX Empty glumes very unequal, lower almost wanting.

229. Sphenopus.

◁◁◁ Panicles with very short but spreading and somewhat stout branches. Glumes indurated.

230. Cutandia.

** Flowering glumes 3–5- to many-nerved, with two or more of the upper glumes empty; appressed and frequently enclosing or enveloping each other.

† The sterile upper glumes forming together at their tips a tuft of awns.

○ Leaves narrow-linear.

231. Ectrosia.

○○ Leaves broad-lanceolate.

240. Lophatherum.

†† Sterile glumes not awned.

○ Flowering glumes flabelliform, white-membranaceous, and corolla-like.

234. Anthochloa.

○○ Flowering glumes of some other form.

◁ Spikelets laterally compressed; glumes sharply keeled.

X Empty glumes persistent; flowering glumes 5-nerved.

233. Heterachne.

XX Spikelets deciduous as a whole; flowering glumes three-nerved.

232. Harpachne.

◁◁ Spikelets not at all or only slightly compressed; glumes not keeled.

X Stamens three; lodicule one; upper sterile glumes usually club-shaped. . **235. Melica.**

XX Stamens 1–2; lodicules two; sterile glumes not club-shaped. **236. Diarrhena.**

NOTE.—Compare *Streptogyne.*

*** Flowering glumes five- to many-nerved; each containing a ☿ flower, or the upper with only a ♂ flower or empty (very rarely in many *Festuca* and *Bromus* species there are several empty glumes above the fertile; in *Zeugites* there are several ♂ flowers and only one ☿).

† Leaves broad, lanceolate or ovate, with fine transverse veins between the longitudinal nerves.

○ Spikelets one-, rarely two-flowered.

◁ Spikelets in a long unilateral raceme; stigmas very long and spiral. **242. Streptogyne.**

◁◁ Spikelets in several short spikes which are united in pairs along the axis of a panicle. **241. Pœcilostachys.**

◁◁◁ Spikelets paniculate. **239. Orthoclada.**

○○ Spikelets many-flowered.

◁ All the flowers ☿. **237. Cenototheca.**

◁ ◁ Only the lowest flower ☿, the others ♂, remote. **238. Zeugites.**

†† Leaves linear or lanceolate, no distinct transverse veins.

○ Keel of the palea winged or with a linear appendage. **243. Pleuropogon.**

○○ Keel of the palea not appendaged.

◁ Empty glumes 3–6 at the base of each spikelet.

X Spikelets one-flowered. **244. Brylkinia.**

XX Spikelets many-flowered. . . **245. Uniola.**

◁ ◁ Empty glumes two.

X Plants strictly dicœcious; spikelets almost sessile. **246. Distichlis.**

XX Plants hermaphrodite (very rarely dicœcious, and then loosely paniculate).

□ Flowering glumes cordate at the base. **247. Briza.**

□ □ Flowering glumes not cordate at the base. . . AA, etc.

AA. *Spikelets closely imbricate, arranged in a linear, dense, false spike.*

aa. Flowering glumes lanceolate, indistinctly five-nerved. . . . . **249. Wangenheimia.**

bb. Flowering glumes broadly ovate-lanceolate, seven-nerved with glandular hairs at the base. **248. Desmazeria.**

NOTE.—Compare *Festuca* and *Brachypodium*, whose spikelets stand farther apart and whose glumes are not keeled.

BB. *Spikelets densely imbricate, crowded in short spikes,*

several of which are united into a raceme or form a capitate inflorescence. . . . . . **250. Æluropus.**

CC. *Spikelets in small fascicles which are united into a glomerate or interrupted panicle.*

aa. Panicles one-sided. . . . . **252. Dactylis.**

bb. Panicles symmetrical. . . . **251. Lasiochloa.**

DD. *Spikelets in panicles or racemes, neither imbricated nor in fascicles.*

aa. Branches of the panicles in at least twelve-rayed false whorls, the lowest of which is sterile. . . . . **257. Nephelochloa.**

NOTE.—Compare *Poa*, Sec. A.

bb. Branches of the panicles in whorls of 1–5.

αα. Stigmas two, inserted at or near the apex of the ovary; empty glumes awnless.

* Empty glumes longer than all the flowering glumes.

† Flowering glumes two-cleft or two-lobed. . . . . **256. Schismus.**

†† Flowering glumes entire, or finely toothed. . . . . **260. Dupontia.**

** Flowering glumes, at least of the uppermost flowers, projecting from the empty glumes.

† Lateral nerves of the floral glumes nearly parallel, not converging.

○ Empty glumes but little or not at all shorter than the nearest flowering glumes.

◁ Flowering glumes with two very short, nearly obsolete, nerves on each side. **259. Colpodium.**

○○ Flowering glumes with 3–4 nerves on each side, at least one of which is prolonged beyond the point. **261. Scolochloa.**

◁◁ Empty glumes much shorter than the nearest flowering glume.

◁ Styles distinct, lodicules grown together.
263. Glyceria.

◁◁ Styles none, lodicules distinct. . . . **264. Atropis.**

†† Lateral nerves of the flowering glumes arched, converging above toward the mid-vein.

○ Rachilla with a fringe of stiff hairs. . . **262. Graphephorum.**

○○ Rachilla naked, downy, or with flexuose (or webby) hairs.

◁ Flowering glumes strongly keeled on the back; hilum punctiform.

X Flowering glumes cartilaginous at the base, upper half herbaceous.
255. Sclerochloa.

XX Flowering glumes membranaceous or herbaceous at the base. . . **258. Poa.**

◁◁ Flowering glumes rounded on the back, at least below.

X Palea rough or minutely fringed upon the keels.

□ Hilum linear.
265. Festuca.

□ Hilum punctiform.

§ Spikelets in a simple or branched raceme.
266. Catapodium.

§§ Spikelets in a short-branched panicle.
267. Scleropoa.

XX Palea pectinately fringed on the keels.
271. Brachypodium.

ββ. Stigmas two, plainly arising below the apex (lateral) on the anterior portion of the ovary; empty glumes awnless.
268. Bromus.

γγ. Stigmas three, inserted at the apex of the ovary (terminal); empty glumes extending into long awns. . . . **270. Megalachne.**

SUB-TRIBE A.—**Pappophoreæ.**

Flowering glumes with three to many awns or lobes.

196. (197) **Pappophorum** (Fig. 72). Panicles spike-like. Spikelets 1–3-flowered. At maturity the flowering glumes with their numerous awns resemble the fruit of a Composite with pappus.

Species about twenty, especially in the tropics of both hemispheres, one extending as far as Northern Asia, North America, and Australia.

Sec. I. *Polyraphis* Lindl. (as a genus). Flowering glumes with 13–23 naked awns.

Sec. II. *Enneapogon* Desv. (as a genus). Flowering glumes with nine, usually plumose, awns.

197. (198) **Cottea** Kunth. Panicles loose; spikelets 2–6-flowered, broad, short-awned, laterally compressed.

Species one (*C. pappophoroides* Kunth), in tropical America as far north as Arizona and New Mexico.

FIG. 72.—*Pappophorum pallidum* Brown. (After Kunth, Rev. Gram. pl. 51.)

198. (200) **Schmidtia** Steud. (*Antoschmidtia* Steud.). Panicles narrow, loose; spikelets resembling those of a small *Avena*; empty glumes long.

Species two, from tropical South Africa to Egypt.

199. (208) **Calamochloa** Fournier. Inflorescence an ovate panicle composed of short spikes. Spikelets 3–4 in each spike, two-flowered. Flowering glumes hairy on the callus.

Species one (*C. filifolia*), in Mexico.

200. (62) **Cathestechum** Presl. Spikelets in groups of threes, these in loose rows on a common axis and decidu-

ous as a whole; middle spikelet 2–4-flowered, the lateral 1–2-flowered.

Species two, one (*C. prostratum* Presl), in Mexico, and one (*C. erectum* Vasey & Hack.) in Texas and Sonora.

201. (196) **Pommereulla** L. fil. Spikelets sub-turbinate, in a dense spike, sheathed at the base. Flowering glumes finally indurated and with a pointed callus. A small, annual grass.

Species one (*P. Cornucopiæ* L. fil.), in the East Indian Peninsula.

202. (204) **Scleropogon** Philippi (*Lesourdia* Fourn.). Inflorescence an almost spike-like panicle at whose apex there is, in the ♀ plant, a tuft of sterile spikelets (each reduced to a single glume); ♂ plant with awnless or shortly three-toothed flowering glumes.

Species three (?), one in Chili which, together with one or two others, extends into Mexico and Texas.

203. (206) **Triraphis** Brown. Panicle narrow, elongated, with upright many-flowered spikelets; flowering glumes sometimes with membranaceous marginal lobes. Grasses with narrow or rush-like leaves.

Species five in Australia, one in South Africa.

SUB-TRIBE B.—**Sesleriеæ.**

Flowering glumes 1–5-awned, lobed, or awnless; style and stigma usually long, the latter narrow, protruding near the apex of the flowering glume.

204. (213) **Monanthochloë** Engelmann (*Halochloa* Griseb.). A creeping grass of the sea-coast and alkaline plains, with crowded, short, convolute leaves and nearly concealed spikelets.

Species one (*M. littoralis*), from Florida to California, and represented by a variety in the Argentine Republic.

205. (214) **Munroa** Torrey. Low grasses of the elevated plains. Branches much forked or fasciculate; leaves cuspidate-pointed, in clusters at the ends of the branches; spikelets nearly concealed by the upper leaves.

Species three, one (*M. squarrosa* Torr.) on the plateaux of the Western United States and the Argentine Republic, two in extra-tropical South America.

206. (215) **Echinaria** Desf. (*Panicastrella* Mönch.). A low annual. Spikelets in long-pedicellate, spiny, capitate clusters; 2–3-flowered.

Species one (*E. capitata* Desf.) (Fig. 73), in the Mediterranean regions.

207. **Orcuttia** Vasey. A low, prostrate annual, with long spikelets in racemes; empty glumes much like the flowering glumes, lobed.

Species one (*O. Californica* Vasey) (Fig. 73*a*), in Lower California (San Quentin Bay).

208. (216) **Ammochloa** Boiss. (*Cephalochloa* Cosson & Dur.). Spikelets small, in globose,

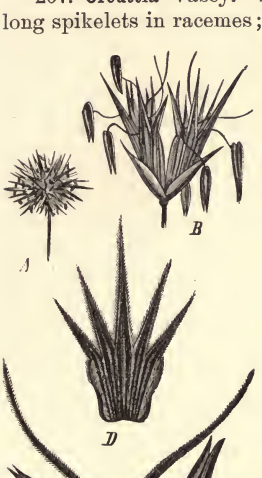
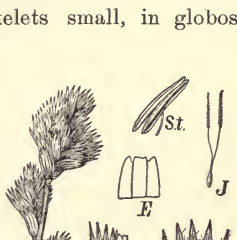


FIG. 73.—*Echinaria capitata* Desf. (After Nees, Gen. Germ., I. 38.)



[FIG. 73*a*.—*Orcuttia Californica* Vasey. *A*, Portion of inflorescence. *El*, Floret with a portion of the rachilla. *D*, Dorsal view of expanded flowering glume. *E*, Apex of palea. *St*, Stamen. *J*. Pistil. (Original.)]

capitate clusters, many-flowered; flowering glumes three-nerved with a rigid or cuspidate point.

Species two; low, annual, steppe and desert grasses: *A. pungens* Boiss. in Algiers; *A. subacaulis* from Algiers to Palestine and South Spain.

209. (217) **Urochlæna** Nees. Spikelets few-flowered; glumes 5–7-nerved and produced into long, divergent and curved awns.

Species one (*U. pusilla* Nees), in South Africa. A low, branched annual.

210. (218) **Sesleria** Scopoli (Fig. 74). Glumes keeled, membranaceous; flowering glumes with 3–5 small teeth that are frequently produced into short awns. Panicles very dense and spike-like or capitate. Perennial grasses.

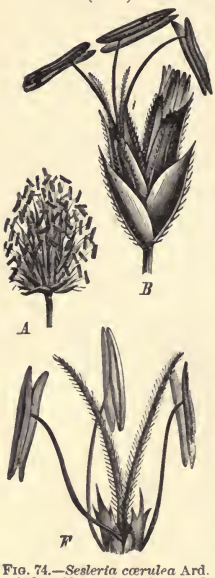


FIG. 74.—*Sesleria cærulea* Ard. (After Nees, Gen. Germ., I. 53.)

Species ten, in Europe and Western Asia, mostly alpine. *S. cærulea* Ard., with 3–5 short awns, extends all through Europe. *Psilathera* Link (as a genus) is a species (section?) with five distinct awns on the flowering glume and two short awns on the palea.

211. (223) **Oreochloa** Link. Habit of the preceding, but with no bracts at the base of the spike. Spikelets two-ranked, turned to one side.

Species two, *O. disticha* Lk. from the Carpathians to the Pyrenees, and *O. Pedemontana* Boiss. & Reut. in the W. Alps and Castile.

212. (220) **Fingerhuthia** Nees. Habit of *Sesleria*; the uppermost and lowest spikelet of the false spike aborted. A ♂ flower, or empty glume with a short awn, above the ☿ flower.

Species one (*F. Africana* Lehm.), in South Africa and Afghanistan.

213. (219) **Elytrophorus** Beauv. Spikelets minute, in small capitate clusters and these united into a long contracted panicle which appears like a small brush on account of the numerous, short awns. Spikelets many-flowered, with only one posterior stamen.

Species one (*E. articulatus* Beauv.), extending through the entire tropical zone of the Old World.

SUB-TRIBE C.—**Arundineæ.**

Flowering glumes awnless or short-awned; rachilla or flowering glume with long hairs.

214. (209) **Gynerium** Humb. & Bonpl. Spikelets loosely 2–∞-flowered, narrow; glumes membranaceous; flowering glume three-nerved, subulate, produced into a

FIG. 75.—*Gynerium argenteum* Nees. (From Müller's "Die Pflanzenwelt.")

fine awn. Tall reed-like grasses with long, rigid, narrow leaves that are much crowded at the base, and very large, thick, silvery-shining panicles.

Species three, in tropical and sub-tropical America. *G. argenteum* Nees, "Pampas-grass," from Southern Brazil and the Argentine Republic, has a culm 3–6 m. high; leaves 1–3 m. long; panicles 0.5–0.8 m. long; the ♂ panicle broad-pyramidal; the ♀ narrower, linear, elongated,

with a magnificent silvery-white or rose-red sheen. Showy, decorative plants for the garden. The panicles are used for dry bouquets. [Growing Pampas-plumes is an important industry in California. The plumes are cut when exposed only a few inches from the leaf-sheath.] In its native habitat the leaves are used for paper-making, and a decoction of the rhizome is employed as a diuretic.

215. (210) **Ampelodesmos** Beauv. Spikelets crowded, 2–∞-flowered; flowering glumes and the short joints of rachilla clothed with short, woolly hairs; flowering glumes with two short teeth between which is a cuspidate point; ovary hairy above.

Species one (*A. tenax* Link). A low, cane-like grass with nodding panicles and rush-like leaves, in the regions of the Mediterranean, and especially abundant in Algiers. The young leaves are used for fodder, and the very tough old ones are employed like Esparto; in Italy hats are woven from them, and in Sicily they are used to tie up grapes.

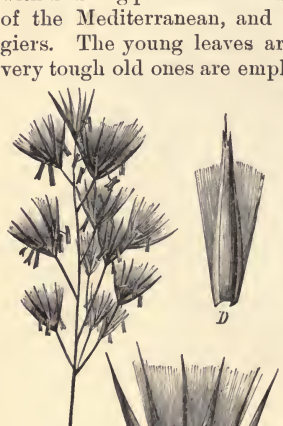


FIG. 76.—*Arundo Donax* L. (After Nees, Gen. Germ., t. 36.)

216. (211) **Arundo** L. (*Donax* Beauv., *Amphidonax* Nees, *Scolochloa* Mert. & Koch). Spikelets crowded with many flowers; rachilla naked; flowering glumes with long hairs, 2-toothed and a cuspidate point between the teeth; ovary naked. Tall reed-like grasses with almost woody stems and broad flat leaves.

Species six, distributed throughout the warmer countries of the world. *A. Donax* L. (Fig. 76) has a culm 2–4 m. high and fully 2 cm. thick below. Grows wild in wet places in the Mediterranean region, and is

generally cultivated in Spanish South America, forming living fences. The culms are used for laths, and, when split, for woven work. The leaves are used for roofing, and the rhizomes are employed as a diuretic. It is also grown as a decorative plant. [There is a cultivated variety which has its broad leaves striped with longitudinal white bands.]

Fossil Species.—Many rhizomes, culms, and leaves of *A. Goepperti* Heer are found in the tertiary of Europe and N. America which show points of agreement with the living species. *A. Groenlandica* Heer occurs in the upper chalk formation of Greenland.

217. (212) **Phragmites** Trin. (*Czernya* Presl). Spikelets loosely many-flowered, lowermost flower ♂, the others usually ☿; rarely the plants are dicœcious, but without any striking distinction between the sexes; flowering glumes naked, long-acuminate-pointed. Habit of *Arundo*, but with the culm usually not so stout.

Species three, one cosmopolitan, a second in tropical Asia, and a third (dicœcious) in the Argentine Republic. *P. communis* Trin. is a reed-like grass with culms 1–3 m. high and expanded, usually purple or violet colored panicles. It grows in standing or sluggish water and in swamps, is gregarious in habit, and is distributed throughout the world. The culms are used for roofing and as laths for covering walls about to be plastered, for matting, basket-work, mouth-pieces of musical instruments, weavers' spools, etc.; the young shoots are fed to horses, and an infusion of the root is used as a diuretic.

Fossil Species.—*Ph. Ungeri* Stur. Rhizomes in the lacustrine strata in Hungary. *Ph. œningensis* A. Br. is found in the tertiary of Europe, the polar regions and N. America. *Ph. cretaceus* Lesq. in the cretaceous formation of N. America.

SUB-TRIBE D.—**Triodieæ.**

Flowering glume usually 2–3-toothed; middle tooth often awned or awn-like.

218. (205) **Blepharidachne** Hack. in Monogr. Androp.,

p. 261 (*Eremochloë* S. Wats.). Low, branched grasses, with crowded, involute leaves; spikes few, in capitate panicles; flowering glumes very hairy.

Species two, upon the high western plateaux of North America.

219. (201) **Triodia** Brown. Panicle usually open; flowering glume rounded on the back (at least below), coriaceous or chartaceous, often hairy on the callus and margins. Perennial grasses with narrow rigid leaves and variable habit.

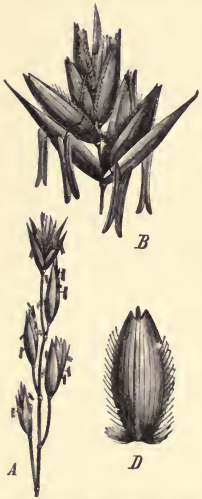


Fig. 77.—*Triodia decumbens* Beauv. (After Nees, Gen. Germ., I. 51.)

Species twenty-six, throughout the temperate zones, a few in tropical America.

Sec. I. *Isotria*. Flowering glume three-parted almost to the middle. *Tr. pungens* Brown, and the related *Tr. Mitchelli*, *Tr. Cunninghamii*, and *Tr. irritans* Brown, belonging to the following Sec., are characterized by their rigid, involute, finely-pointed, and often sticky leaves; they cover, often exclusively, large areas of the deserts and elevated plains of the interior of Australia, and are known to the colonists and to travellers as "Spinifex" (not to be confounded with No. 76), and are very troublesome.

Sec. II. *Sieglingia* Bernhardi (as a genus). Flowering glume with three short, rather obtuse teeth. *Triodia decumbens* Beauv. (Fig. 77) in Europe.

Sec. III. *Rhombolytrum* Link (as a genus). Flowering glume shortly two-toothed, sometimes entire. In North and South America. (*T. filiformis* Nees, *T. albescens* Munro, etc.)

Sec. IV. *Tricuspis* Beauv. (as a genus), (*Windsoria* Nutt., *Tridens* R. & S.). Flowering glume usually entire, but with the three nerves extending into three short awns

or sharp points. *T. cuprea* Jacq., a showy grass with open panicles [common in the Eastern United States].

Sec. V. *Triplasis* Beauv. (as a genus), (*Uralepis* Nutt., *Diplocea* Raf.). Flowering glumes three-cleft, the middle division recurved and awn-like. North America.

219*a*. **Redfieldia** Vasey. Florets crowded, the short joints of the rachilla smooth. Flowering glumes chartaceous, densely hairy on the callus only, 3-nerved, indistinctly 3-toothed or terminating in a short mucronate point. Styles long; stigmas short. Grain oblong, terete, free.

Species one (*R. flexuosa* Vasey, *Graphephorum* (?) *flexuosum* Thurber), (Fig. 78) in the Western United States.

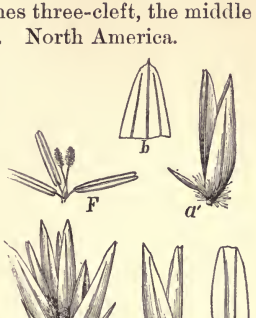


FIG. 78.—*Redfieldia flexuosa* Vasey. *B*, Spikelet. *a*, A single floret showing joint of rachilla, etc. *a'*, A single floret from a one-flowered spikelet, with a rudiment of a second floret above. *b*, Apex of flowering glume. *E*, Palea. *F*, Flower. (Original.)

220. (202) **Diplachne** Beauv. Spikelets narrow, many-flowered; flowering glumes 1-nerved, keeled, usually 2-toothed, the teeth mucronate or awn-pointed; fruit 3-angled, unfurrowed.

Species fifteen, in the warmer countries of both hemispheres. *Leptocarydion* Hochst. and *Trichoneura* Andersson include species that form a transition to *Triodia*.

SUB-TRIBE E.—**Eragrosteæ.**

Flowering glumes three nerved, awnless or short-awned.

221. (226) **Dissanthelium** Trin. (*Phalaridium* Nees, *Stenochloa* Nutt.). Panicle narrow; flowering glumes broad, obtuse, awnless, 3-nerved, the lateral nerves nearly marginal.

Species three, of low habit, one in California, the others upon the Andes of South America and coasts of Mexico.

222. (227) **Molinia** Schrank (*Enodium* Gaud.). Pani

cles diffuse or contracted; spikelets narrow, pointed, awnless. Perennial grasses with apparently nodeless culms.

Species one (*M. cærulea* Mönch), with violet-colored panicles and rigid leaves, grows in wet meadows in Central Europe and temperate Asia. A poor grass for fodder. [Sparingly introduced into North America.]

FIG 79.—*Eragrostis minor* Host. *R*, Rachilla with paleæ. (After Nees, Gen. Germ., I. 55, and Reichb., Ic. 164.)

223. (230) **Eragrostis** Host. (Fig. 79). Panicles various, generally open. Spikelets usually densely many-flowered; flowering glumes awnless, or at most mucronate-pointed, keeled; grain globose or ovate, unfurrowed.

Species about one hundred, distributed throughout all warm countries.

Sec. I. *Cataclastos.* Rachilla articulate; spikelets small; flowering glumes membranaceous. *E. ciliaris* Link in the Southern United States and throughout all tropical countries. *Macroblepharus* Philippi also belongs here.

Sec. II. *Petroëssa* (*Megastachya* Beauv.). Rachilla and usually also the paleæ remaining after the fruit and flowering glumes have fallen. Most of the species belong here. *E. Abyssinica* Link, is an important food-plant in Abyssinia. The various colored seeds have the appearance of grits, and the flour made from these is baked into bread. This grass is probably a cultivated form of *E. pilosa* Beauv. Many species (e.g., *E. Mexicana* Link) are cultivated for ornament. [*E. oxylepis* of the Southwestern United States, is a particularly showy species.]

Sec. III. *Myriostachya.* Like the preceding, but with long-awned empty glumes.

Species one.

Sec. IV. *Platystachya.* Rachilla articulate; spikelets large; flowering glumes coriaceous.

224. (231) **Ipnum** Philippi. Spikes short, standing

almost at right angles to the common axis; spikelets cylindrical; flowering glumes with a short mucronate point.

Species one (*I. Mendocinum* Phil.), in the Argentine Republic.

Obs.—This genus most probably belongs to *Diplachne*.

225. (225) **Eatonia** Raf. (*Reboulea* Kunth, *Colobanthus* Trin.). Spikelets two-flowered, small, shining, very numerous in contracted [expanded in flower] and often dense panicle. Habit of *Kœleria*.

Species two, *E. obtusa* and *E. Pennsylvanica* Gray, in North America [probably a third species is represented by *E. filiformis* Vasey].

226. (224) **Avellinia** Parl. A small, annual grass with a slender panicle, and very narrow spikelets; lower empty glumes short, very narrow, almost setiform, the second very large; flowering glumes awned below the point.

Species one (*A. Michelii* Parl.), in the regions of the Mediterranean.

227. (223) **Kœleria** Pers. (*Collinaria* Ehrh.). Spikelets 2–5-flowered, shining; empty glumes unequal; flowering glumes keeled, entire, awnless, or short-awned. Usually low, narrow-leaved grasses, with narrow, compact panicles.

Species fifteen, distributed throughout the temperate regions, mostly in Europe; isolated species in South Africa, Patagonia, and the Sandwich Islands.

Sec. I. *Airochloa* Link (as a genus). Flowering glumes awnless or with short mucronate points. *K. cristata* Pers., with silvery shining panicles; upon dry meadows in Europe and Western North America. A profitable fodder-grass for sandy soils.

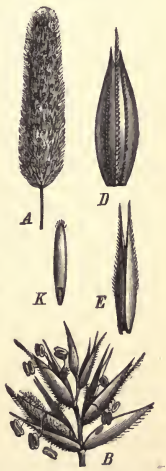


Fig. 80. — *Kœleria phleoides* Pers. (After Nees, Gen. Germ., I. 63.)

Sec. II. *Lophochloa* Reichen. (as a genus), (*Ægilitis* Trin., *Ægialina* Schult., *Wilhelmsia* C. Koch). Flowering glumes short-awned from or below the point. *K.*

phleoides Pers., in the regions of the Mediterranean (Fig. 80).

228. (229) **Catabrosa** Beauv. Spikelets small; two-flowered; empty glumes almost nerveless and very obtuse, much shorter than the awnless, indistinctly three-toothed flowering glume. Creeping, aquatic grasses with open pyramidal panicles.

Species one (*C. aquatica* Beauv.), in Europe, Northern Asia, and North America.

229. (228) **Sphenopus** Trin. Small, delicate, annual grasses with minute awnless spikelets upon somewhat thickened pedicels. Branches of the panicle in fascicles, finally spreading.

Species one (*Sph. Gouani* Trin.), along the shores of the Mediterranean to the Caspian Sea.

230. (232) **Cutandia** Willk. Panicles few-flowered, the short branchlets thickened at the point and finally strongly divaricate; spikelets narrow, loosely flowered, usually awnless. Annual, low, maritime grasses.

Species six, in the Mediterranean region. *C. maritima* Benth. on the seashore.

SUB-TRIBE E.—**Meliceæ.**

Uppermost glumes of the spikelets empty (rarely with flowers), overlapping or embracing each other.

231. (234) **Ectrosia** Brown. Panicles many-flowered, narrow, compound; spikelets with 1–2 fertile, short-awned flowers, followed by 1–2 ♂ flowers and several sterile glumes.

Species four, in Australia. *E. leporina* Brown, in North Australia and Queensland.

232. (230) **Harpachne** Hochst. Spikelets in a simple raceme with spirally arranged branches which finally fall off and bore into objects by means of their pointed, hairy bases; 3–4 fertile flowers and two sterile long-pointed glumes.

Species one (*H. Schimperi* Hochst.), in tropical Africa.

233. (235) **Heterachne** Benth. Spikelets very flat, in false spikes or heads, with one fertile flower and 6–14

empty glumes which form, as it were, an appendage to the fruiting glume; flowering glumes awnless.

Species two, *H. Brownii* and *H. Gulliveri* Benth., in North Australia.

234. (236) **Anthochloa** Nees. Panicles capitate, small; spikelets few-flowered, awnless; flowering glumes broad, flabellate, finely toothed, thin-membranaceous, silvery white.

Species two, in the Andes of Peru and Bolivia. The small heads of *A. lepida* recall those of *Helichrysum* or *Paronychia*.

235. (237) **Melica** L. Spikelets few-flowered, mostly in narrow or spike-like panicles; empty glumes membranaceous, 3–5-nerved; flowering glumes parchment-like, mostly 7–9-nerved, awnless or short-awned; anterior lodicules entire or slightly emarginate.

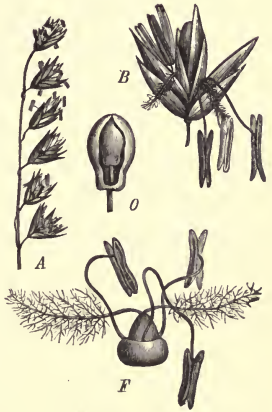


FIG. 81. — *Melica nutans* L. (After Nees, Gen. Germ., I. 60.)

Species over thirty, throughout temperate zones, excepting in Australia. *M. nutans* (Fig. 81), a forest grass in Europe, has narrow panicles and nodding, naked spikelets; *M. ciliata* L. has cylindrical false spikes, and long-fringed flowering glumes. It grows upon sunny hillsides in Europe, also cultivated for ornament.

236. (238) **Diarrhena** Rafin. (*Korycarpus* Zea, *Rœmeria* Zea, *Onoea* Franchet and Savatier). Spikelets in a loose panicle, 3–5-flowered, almost linear; flowering glumes coriaceous, shining, three-nerved, awnless; fruiting glumes somewhat remote, spreading, leaving the beaked caryopsis exposed.

Species two, one (*D. Japonica* Franch. and Sav.) in Japan and one (*D. Americana*, P. B.) in North America.

SUB-TRIBE F.—**Centotheceæ.**

Leaves broad, netted-veined.

237. (239) **Centotheca** Desv. Panicles expanded; spikelets small; flowering glumes rounded on the back, 5–7-nerved, awnless, but usually with hooked appendages or small protuberances on the keel.

Species three, in tropical Africa, Asia, and especially the South Sea Islands.

238. (243) **Zeugites** Schreb. (*Senites* Adans., *Despretzia* Kunth, *Krombholzia* Fourn.). Spikelets panicled, many-flowered, but only the lowest fertile, the very broad empty glumes approximate; the upper ♂, distant; leaves ovate.

Species five, in tropical America and Mexico.

239. (240) **Orthoclada** Beauv. Panicles diffuse; spikelets lanceolate, compressed, one-flowered, with a long prolongation of the rachilla (rarely two-flowered without this prolongation); fruit strongly compressed laterally.

Species one (*O. rariflora* Beauv.), with petiolate, broad lanceolate leaves; in tropical America.

240. (241) **Lophatherum** Brongn. (*Acroelytrum* Steud. and *Alletotheca* Steud.). Spikelets often two-ranked (rarely scattered), sessile on the branches of the panicle, linear, one-flowered, with a tuft of sterile glumes at the point. Empty glumes two; flowering glumes pointed or short-awned.

Species three, in the East Indies in the Sunda Archipelago to Japan.

241. **Pœcilostachys** Hackel. Spikelets in pairs on the spike-like branches of the panicle; empty glumes three, no sterile glumes at apex. A sterile flower is often found in the axil of the third glume.

Species two, *P. Hildebrandtii* and *P. geminata* Hack., in Madagascar.

242. (242) **Streptogyne** Beauv. Spikelets large, linear, almost sessile; first empty glume short, the second as well as the flowering glume involute, many-nerved, the latter short-awned, and with 1–3 empty falcate glumes above it.

Species one (*St. crinita* Link), in the tropics of both hemispheres. The detached fruiting glumes hang for a

long time by the spiral styles and stigmas which are interlaced above.

SUB-TRIBE G.—**Eufestuceæ.**

Without the special characteristics of the preceding sub-tribes. Flowering glumes five- to many-nerved.

243. (244) **Pleuropogon** Brown (*Lophochlœna* Nees). Spikelets rather large in a simple, loose raceme, 8–14-flowered; flowering glumes 7-nerved, mucronate-pointed or awned.

Species three, one (*P. Sabini* Brown) arctic-circumpolar, and two in California.

244. (245) **Brylkinia** F. Schmidt. Inflorescence like the preceding; spikelets pendent, one-flowered with four empty glumes; flowering glumes long-awned. A weak, broad-leaved grass.

Species one (*B. caudata* F. Schm.), in Japan and Saghalin.

245. (246) **Uniola** L. (*Trisiola* Rafin., *Chasmanthium* Link). Panicles usually loose, often showy; spikelets laterally compressed, broad, with 3–20 flowering glumes and 3–6 empty glumes. Flowering glumes chartaceous or coriaceous, with many delicate nerves.

Species five, mostly in North America; one in Central America; one in the Andes and extra-tropical South America. *U. latifolia* L. (Fig. 82), with broad leaves and elegant nodding spikelets, is a favorite ornamental grass.

246. (247) **Distichlis** Rafinesque. Spikelets 8–16-flowered; the ♂ with a continuous and the ♀ with an articulated rachis, oblong compressed; glumes and paleæ keeled, coriaceous; flowering glumes many-nerved, acute, awnless, closely two-ranked. Creeping grasses with rigid, densely two-ranked, involute leaves.

Species four, along the seacoast and on alkaline plains in the interior throughout America, one of which, *D. maritima*, occurs also in Australia.

247. (253) **Briza** L. (Fig. 83). Spikelets many-flowered, panicled, broad; glumes thin-membranaceous, very concave, densely crowded, five- to many-nerved; paleæ much

shorter than the flowering glumes. Fruit strongly dorsally compressed.

Species twelve, Europe, North Africa, and the temperate parts of Asia and South America.

Sec. I. *Eubriza.* Flowering glumes obtuse, without lateral projections, nerves separate their entire length. *B. media* L., "Quaking-grass," perennial; spikelets roundish. A valuable meadow-grass in Middle Europe. *B. maxima* L. has large ovate and *B. minor* L. small, three-

FIG. 82.—*Uniola latifolia* L. (After Gray, Man. pl. 11.)

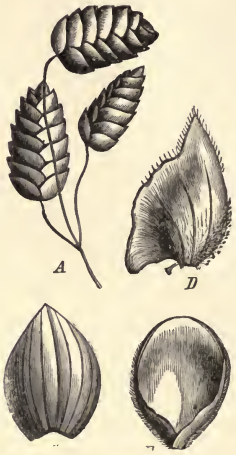


FIG. 83.—*Briza maxima* L. (After Trin., Spec. Gram. pl. 290.)

cornered, ovate spikelets; both are annuals, and frequently cultivated as ornamental grasses for dry bouquets.

Sec. II. *Chascolytrum* Desv. (as a genus). Flowering glumes awnless or mucronate-pointed, its nerves uniting at the apex. *B. erecta* Lam., an ornamental grass.

Sec. III. *Calotheca* Desv. (as a genus). Flowering glumes, with projecting lateral angles, awned.

Sec. II. & III. In South America; *B. elegans* Döll. in Uruguay.

248. (251) **Desmazeria** Dumort. (*Brizopyrum* Link).

Spikelets very many-flowered, strongly compressed, with crowded, two-ranked, coriaceous, sharply keeled glumes and paleæ. Flowering glumes pointed, awnless.

Species four, one in the regions of the Mediterranean, three in South Africa. *D. sicula* Dum. (*Brizopyrum siculum* Link) is an annual frequently cultivated as an ornamental grass.

249. (187) **Wangenheimia** Mönch. A small annual grass, with very short, compact, and one-sided spikes. Spikelets awnless, sharply keeled, downy.

Species one (*W. disticha* Mönch), in Spain and North Africa.

250. (248) **Æluropus** Trin. (*Chamædactylis* Nees). Creeping, rigid, much-branched grasses, with closely two-ranked, often stiff leaves. Spikelets densely crowded, many-flowered; flowering glumes 7–9-nerved, broad, somewhat mucronate-pointed.

Species four, mostly in the saline or alkaline soil in the regions of the Mediterranean, in Central Asia, Arabia, Hindostan.

251. (250) **Lasiochloa** Kunth. Spikelets 2–3-flowered in a crowded cylindrical or interrupted panicle. Empty glumes as long as the spikelet, 5–7-nerved, obtusely keeled, tuberculate-hispid; flowering glumes awnless.

Species 3–4, in South Africa. *L. hirta* and *L. adscendens* Kunth are the most frequent.

252. (249) **Dactylis** L. Spikelets 3–5-flowered, much compressed, somewhat concave on the inner side; arranged in dense fascicles; empty glumes 1–3-nerved, as well as the flowering glumes, sharply keeled; the flowering glumes fringed on the keel and short awn-pointed.

Species one, with several varieties, throughout Europe, in temperate Asia and North Africa. Naturalized in North America. *D. glomerata* L. (Fig. 84). Panicle made up of fascicles or dense glomerules. A first-class fodder-grass especially for heavy, wet soils. Very productive, rapidly growing, especially after cutting; endures shade, and on this account is called "Orchard-grass" in North America.

253. (222) **Cynosurus** L. Panicles spike-like or capitate, one-sided; the fertile spikelets not enclosed by the pectinate sterile ones; flowering glumes awned from or below the point, or simply mucronate; glumes of the sterile spikelets 2-ranked, spreading.

Species five, in the temperate zone of the Old World; one (*C. cristatus*) has also been introduced into America.

Sec. I. *Eucynosurus*. Flowering glumes and sterile glumes mucronate-pointed, not awned. *C. cristatus* L.

FIG. 84.—*Dactylis glomerata* L. (After Nees, Gen. Germ., I. 65.) (Panicle represented too loose.)

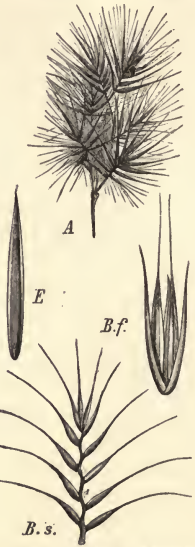


FIG. 85.—*Cynosurus echinatus* L. (After Mart. and Eichler, Fl. Bras, II, III, pl. 37.) *B.f.*, Fertile, *B.s.*, sterile spikelets.

with linear false spikes, in all Europe on meadows. A good, tender fodder-grass, also good for the foundation of grass-plots or lawns.

Sec. II. *Phalona* (*Falona*) Adans. (as a genus). Glumes awned. *C. echinatus* L. (Fig. 85) in South Europe, a field weed.

254. (221) **Lamarckia** Mönch. (*Chrysurus* Pers., *Pterium* Desv., *Tinæa* Garzia). A low annual grass, with an elegant, one-sided, crowded panicle whose branches are terminated by the fertile spikelets, which are entirely covered up by the long awns of the sterile ones.

Species one (*L. aurea* Mönch), in the regions of the Mediterranean to Afghanistan. Introduced in North America (California). A favorite ornamental grass ("*Chrysurus cynosuroides*").

255. (252) **Sclerochloa** Beauv. A prostrate, annual grass with short, one-sided, rigid panicles; joints of the rachilla much thickened; glumes narrow, very obtuse.

Species one (*S. dura* Beauv.), in southern and central Europe, western and central Asia.

256. (254) **Schismus** Beauv. (*Electra* Panzer, *Hemisacris* Steud.). Low, annual grasses with somewhat dense panicles. Large, somewhat acute, white, membranaceous-margined empty glumes; and small, membranaceous, 5–9-nerved flowering glumes.

Species four, two South African, two from the Mediterranean to Afghanistan.

257. (255) **Nephelochloa** Boiss. Panicles very delicate; spikelets very small; flowering glumes with a straight awn projecting from the two-toothed point.

Species one (*N. orientalis* Boiss.), in the Orient.

258. (256) **Poa** L. Spikelets 2–6-flowered, usually in open, rarely in spike-like panicles; rachilla and callus, as well as the marginal nerves of the flowering glumes, often clothed with tangled hairs; glumes herbaceous or membranaceous, awnless; flowering glumes often obtuse.

Species about one hundred, distributed throughout all temperate and cold countries; a few in the high mountains of the tropics; some cosmopolitan.

Sec. I. *Pseudopoa.* Habit of the preceding genus. Fruit grown to the glumes, slightly furrowed.

Species three, *P. Persica* Trin. in Asia Minor and Persia.

Sec. II. *Eupoa.* Fruit unfurrowed, mostly free. This section comprises some of the most important fodder-

grasses. *P. pratensis* L., "June grass," "Kentucky Blue grass" (Fig. 86), has underground runners, smooth sheaths, and a short ligule. *P. trivialis* L. has aerial runners, rough sheaths, and a long ligule. *P. alpina* L. has no runners, its leaves are obtuse and spikelets large; found in the high mountains of the northern hemisphere and in the Arctic region. The largest species of the genus is *P. flabellata* Hook. (*Dactylis cæspitosa* Forst.) the "Tussock grass" of the Falkland, Fire Islands, and Kerguelen Land. This grass forms great tufts which reach 2 m. in height, and its leaves are arranged like a fan. Its culture is remunerative only where the summers are very moist.

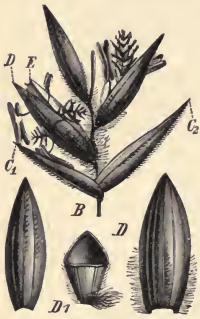


FIG. 86.—*Poa pratensis* L. D_1, Fruiting bract in cross-section. (After Nees, Gen. Germ., I. 56.)

Sec. III. *Dioicopoa.* Dicœcious, but without any other difference between the two sexes. Natives in America. *P. Chilensis* Trin., *P. lanuginosa* Poir. (*Poidium* Nees is a scantily-flowered *Poa*).

259. (257) **Colopodium** Trin. (*Arctophila* Rupr.). Spikelets 1–2-flowered, loosely panicled; rather small and bright-colored. Flowering glumes broad, very obtuse, membranaceous, awnless; ovary naked. Habit of *Poa.*

Species twelve, in the Orient and central Asia, especially on high mountains; two species (*C. fulvum* and *C. pendulinum* Gris.) are arctic, forming a peculiar section (*Arctophila*) with the callus of the flowering glume hairy.

260. (258 §) **Dupontia** Brown. Differs from the preceding genus only in the longer empty glumes. Callus of the flowering glumes distinctly hairy; panicles contracted.

Species two, *D. Fischeri* Brown and *D. psilosantha* Rupr., in the arctic zone.

261. (258 §) **Scolochloa** Link. Spikelets 3–4-flowered, lanceolate; panicles loose; flowering glumes rigid, not keeled, callus hairy; ovary hairy. Tall, reed-like grasses.

Species two, in the northern temperate zones of the

Old and New World. *S. festucacea* Link in both Old and New World; *S. spiculosa* Schmidt only upon Saghalin.

262. (258) **Graphephorum** Desv. Like the preceding, but lower and more delicate in habit, with more delicate almost membranaceous glumes and naked ovary.

Species one (*G. melicoides* Desv.), N. America.

263. (259) **Glyceria** Brown. Spikelets many-flowered in narrow or expanded panicles. Flowering glumes rounded on the back, obtuse, awnless, somewhat dry-membranaceous near the tip; 5–9-nerved. Fruit free, oval.

FIG. 87.—*Glyceria fluitans* R. Brown. (After Nees, Gen. Germ., I. 57.)

Species sixteen, mostly in N. America, some endemic in Australia, a few in Europe and Asia; one species, *G. fluitans* Brown, "Floating Manna-grass" (Fig. 87), which has linear, long-cylindrical spikelets, somewhat acute flowering glumes and narrow panicles, is cosmopolitan and aquatic. It is one of the best fodder-grasses for swampy meadows. The fruit is collected in Prussia, Silesia, and Poland by striking the panicles over a sieve. It forms an article of commerce, and is cooked for mush. *G. aquatica* Sm., which is cane-like, with expanded panicles, often occurs in quantities on the edges of ponds, and in a young state forms a useful food for cattle.

264. (259) **Atropis** Rupr. (*Puccinellia* Parl.). In general like the preceding, but distinguished by the lodicules and style (see key). Fruit usually grown to the palea.

Low, salt-loving grasses, often with rigid leaves.

Species fourteen, in all the temperate zones. *A. distans* Griseb. is very widely distributed.

265. (260) **Festuca** L. Spikelets usually lanceolate, paniculate or racemed, two- to many-flowered; flowering glumes rounded on the back below, often keeled

above, usually awned from the point, rarely below it, chartaceous to membranaceous, five-nerved; style almost wanting; fruit long, usually furrowed on the inner side, often grown to the palea.

FIG. 88.—*Festuca ovina* L. D1, Fruiting bract in cross-section. (After Nees, Gen. Germ., I. 72.)

Species about eighty, scattered over all countries, especially the temperate ones.

Sub-genus I. *Eufestuca*. Spikelets in panicles, rarely in racemes, distinctly pedicellate; anthers and stigmas projecting from the glumes at the time of flowering. Perennial species, separable into several sections. To this sub-genus belongs *F. ovina* L., "Sheep's Fescue," with involute, usually filiform leaves, the ligules of which are auriculate. It is distributed in numerous varieties over all the temperate countries of the northern hemisphere, preferring sandy soils and dry mountain slopes; a valuable pasture-grass, especially for sheep, in places where nothing better will thrive. *F. rubra* L., usually with runners, and ligule not auriculate, is also a good pasture-grass. *F. elatior* L. (*F. pratensis* Huds., *Schedonorus elatior* Beauv.), "Meadow Fescue," has flat leaves with two small, falcate auricles at the base. This is a very valuable meadow- and pasture-grass, especially for the moister places, and also for lawns. *Leucopoa* Griseb. is a species of the section *Variæ*. Whether *F. quadridentata* Kunth with four-toothed flowering glumes belongs here is doubtful. This tall (3–4 m.) species of the Ecuador Andes is deadly to all cattle, but serves for covering roofs.

Sub-genus II. *Vulpia* Gmelin (as a genus). Spikelets in panicles or racemes; pedicels often thickened above; stamens and stigmas usually remaining between the glumes during the time of flowering. Mostly annuals. *Ctenopsis* De Not. (*Fest. pectinella* Del.), with much crowded one-sided racemes, from North Africa, belongs here. It is sometimes cultivated as an ornamental grass.

Sub-genus III. *Nardurus* Reichenb. (as a genus) (*Micropyrum* and *Festucaria* Link, *Castellia* Tin.). Spike-

lets in simple or branched racemes with very short pedicels appressed to the rachis; stamens and stigmas protruding. *F. Lachenalii* Spenn. in Western Europe.

266. (260 §) **Catapodium** Link. Spikelets very short pedicelled, in simple racemes.

Species two, *C. loliaceum* Link and *C. Lolium* (Bal.) Hack., in the regions of the Mediterranean.

267. (260 §) **Scleropoa** Griseb. Panicles one-sided, slightly branched. Spikelets with thick pedicels.

Species two, in the Mediterranean region, one of which, *S. rigida* Griseb., is also in Western Europe as far as England. Like the preceding genus, it differs from *Festuca* only in the punctiform hilum, and perhaps should be considered as a sub-genus.

SUB-TRIBE H.—**Brachypodieæ.**

Spikelets like those of *Eufestuceæ*, but with simple, roundish starch-grains, and with the outermost cell-layer of the nucellus, which in most grasses disappears when the fruit is ripe, developed into a strong, thick-walled layer.

268. (263) **Bromus** L. (Fig. 89). Spikelets in panicles, rarely in racemes, usually large; flowering glumes 5–9-nerved, herbaceous, usually two-toothed, awned from the back below the point or from between the teeth, rarely awnless; awn sometimes straight, sometimes divergent, but never geniculate; ovary with a 2–3-lobed, hairy, cushion-like appendage at the summit, between the furrows of which arise the stigmas. Stigmas sessile on the anterior side; fruit linear or oblong, furrowed, adherent to the palea.

Species over forty, most abundant in the north temperate zone, some also in temperate South America, a few on the mountains of the tropics.

Sub-genus I. *Festucoides.* Mostly tall perennials; panicles loose; first empty glume one-, the second usually 3-nerved; flowering glumes short-awned; palea with a very short fringe on the keels. *Br. erectus* Huds., with upright spikelets, ciliate leaves and awns half the length of the flowering glume, grows in dry meadows in Europe. On dry chalky soils it yields considerable hay and is a

valuable forage-grass for such places. The related *B. inermis* Leyss., with awnless spikelets and creeping rhizomes, is an important pasture-grass for dry climates. The rhizome of *Br. catharticus* Vahl. of Chili is valued there as a purgative.

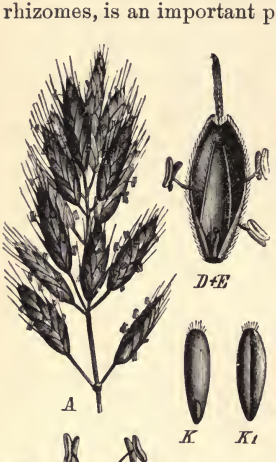


FIG. 89.—*Bromus mollis* L. (After Nees, Gen. Germ., I. 75.)

Sub-genus II. *Stenobromus*. Low annuals with narrow spikelets becoming broader above. Empty glumes as in Sub-genus I. Flowering glumes keeled, long-awned; palea with a stiff fringe. Weeds. *B. Tectorum* and *B. sterilis* L. in all Europe, and introduced in America. *Anisantha* C. Koch also belongs here.

Sub-genus III. *Zeobromus* (*Serrafalcus* Parl.). Annuals, with ovate or lanceolate spikelets, narrower above; first empty glume 3-5-nerved, second 5–7-nerved; flowering glumes 7–9-nerved, not keeled; awn often spreading, rarely wanting; palea with a stiff fringe of hairs. *B. secalinus* L. ("Chess"), panicles drooping after flowering, leaves smooth; a weed among crops, in wet years, sometimes very abundant in rye. If the fruit is not separated by a chess-sieve the rye is worthless, for the flour prepared from it will be dark-colored, remain moist, and is narcotic. *Br. arvensis* L., with similar panicles but hairy leaves, is less dangerous. *B. mollis*, with the branches of the panicle upright and hairy spikelets, growing in sandy places, furnishes a transient green fodder on light soils. *Triniusa* Steud. is a species usually having three awns.

Sub-genus IV. *Libertia* Lejeune (as a genus, *Michelaria* Dum.). Like *Zeobromus*, but the flowering glume

is three-cleft, three-awned, and has two lateral projections. *B. Arduennensis* Kunth is a species of this subgenus.

Sub-genus V. *Ceratochloa* Beauv. (as a genus). Spikelets lanceolate, compressed. Both empty and flowering glumes many-nerved, keeled. Ovary with three distinct elevations at the summit. *B. unioloides* Kunth (*B. Schraderi* Kunth, *Ceratochloa pendula* Schrad.). Spikelets 6–10-flowered, compressed, arranged in loose panicles, drooping at maturity; awns very short; from the Western United States to Chili and the Argentine Republic. A valuable fodder-grass for warmer countries, since it furnishes considerable foliage as early as January and February. In northern countries it freezes out. Sometimes grown for ornament. *B. Mango* Desv. was, before the introduction of the European grains, the most important cereal of the native Chilians.

269. (199) **Boissiera** Hochstetter. Related to the *Pappophoreæ* by the 5–9 dorsal awns, but is a *Bromus* as regards habit and anatomical characters of the fruit. A low annual with crowded panicles.

Species one (*B. bromoidès* Hochst.), on the elevated plains of the Orient.

270. (261) **Megalachne** Steud. (*Pantathera* Philippi). A *Zeobromus* as regards its habit of growth, but with long-awned empty glumes; flowering glumes awned from the point, faintly five-nerved; fruit unknown.

Species one (*M. Berteroniana* Steud.), upon Juan Fernandez. (Union with the *Brachypodieæ* doubtful.)

271. (264) **Brachypodium** Beauv. (*Hemibromus* Steud.). Spikelets many-flowered, narrow, almost cylindrical, in a simple raceme (false spikes) with very short pedicels; flowering glumes usually awned from the point, edge entire, 7–9-nerved; palea with stiff-fringed keels; fruit grown to the flowering glume and palea.

Species six, in Europe, temperate Asia and its tropical high mountains, in North and South Africa and their central high mountains, rarely in North America. Medium grade fodder grasses. *B. pinnatum* Beauv. with upright, and *B. sylvaticum* B. with nodding racemes,

are widespread. *Trachynia* Link is an annual species with few spikelets.

Tribe XII.—Hordeæ.

Spikelets one- to many-flowered (if many, the uppermost flower imperfect), sessile on teeth or notches of the rachis, forming a spike.

A. *Stigma one, spike unilateral.* . . . . . **272. Nardus.**

Note.—Compare *Streptogyne* with 2–3 stigmas.

B. *Stigmas two, spike symmetrical.*

a. Spikelets solitary at the notches of the rachis.

α. Spikelets in the median line of the rachis, that is, the glumes having their backs turned to the hollow surface of the rachis.

I. Spikelets many-flowered. . **273. Lolium.**

II. Spikelets two-flowered; flowering glumes three-cleft. . . . . **274. Kralikia.**

III. Spikelets with one lower ♂ flower, and one upper ☿ flower; flowering glumes awnless. . . . . **275. Kerinozoma.**

IV. Spikelets one-flowered.

1°. Dœcious. Empty glumes grown to the rachis for half their length. **277. Jouvea.**

2°. Hermaphrodite. Empty glumes free.

* Empty glumes two, the lower shorter. Callus of flowering glume hairy. . **276. Oropetium.**

** Empty glume one. Callus naked. **278. Monerma.**

*** Empty glume one. Joints of the rachilla with wing-like appendages. . . . . **278a. Ischnurus.**

β. Spikelets transverse, that is, the sides turned toward the hollowed surface of the rachis.

I. Spikelets 1–2-flowered in a slender, articulate spike, each joint of which separates with the adjoining spikelet at maturity.

1°. Empty glumes two, exceeding the flowering glumes.

* Flowering glumes awnless; callus naked. . . . . **279. Lepturus.**

** Flowering glumes awned; callus hairy. . . . . **280. Scribneria.**

2°. Empty glume one, very small. **281. Psilurus.**

II. Spikelets two- to many-flowered, usually in stout spikes whose joints either do not disarticulate at maturity, or which separate with the spikelet above (*Heteranthelium* excepted).

1°. All the spikelets fertile or the lowest only sterile.

* Flowering glumes with a distinct callus which is limited by a furrow at the base; falling off at maturity, each with a single grain which is grown to the palea. **282. Agropyrum.**

** Flowering glumes without a callus, persistent at maturity; grain free.

† Empty glumes subulate, one-nerved. . . . . **284. Secale.**

†† Empty glumes oblong, truncate, two-keeled. . **283. Haynaldia.**

††† Empty glumes ovate, three- to many-nerved. . **285. Triticum.**

2°. The one fertile spikelet alternating with three sterile ones which consist of numerous long-awned glumes. **286. Heteranthelium.**

b. Spikelets 2–6 at each joint of the rachis.

NOTE.—Compare the lower joints of the axis in *Scribneria*.

α. Stamens three in each flower.

I. Spikelets one-flowered or with a rudiment only of a second. . . . **287. Hordeum.**

II. Spikelets two- to many-flowered.

1°. Empty glumes a little smaller than the flowering glumes. . . . **288. Elymus.**

2°. Empty glumes very small or none.
289. Asprella.

β. Stamens 10–40 in each ♂ flower. **290. Pariana.**

SUB-TRIBE A.—**Nardeæ.**

Spikes unilateral; stigmas one; starch-grains compound.

272. (271) **Nardus** L. Both series of spikelets very close together, apparently united on the inner side of the continuous rachis. Spikelets one-flowered; empty glume one, very small, grown to the rachis, often indistinct; flowering glumes arranged in the median line of the rachis, awned. Spikelets not opening in flower. (The glumes remain almost embracing each other, only at the apex of the spikelet is a small opening for the stigma and anthers.)

FIG. 90.—*Nardus stricta* L. (After Nees, Gen. Germ., I. 86.) *N*, Apex of a stigma.

Species one (*N. stricta* L.) (Fig. 90). Leaves subulate, rigid. By the distichous arrangement of the short branches of the rhizome this grass forms a very thick and dense turf. It grows in moist calcareous soils throughout Europe and Northern Asia. It is a useless grass, crowding out better sorts.

SUB-TRIBE B.—**Lolieæ.**

Spikelets standing in the median line of the rachis; starch-grains usually compound.

273. (265) **Lolium** L. Rachis not articulate, terminal spikelets with two empty glumes; lateral spikelets with the upper (outer) one only, or at most a rudiment of the lower.

Species six, in Europe, North Africa and temperate Asia, often introduced into other countries. *L. perenne* L., English "Ray-grass" (Fig. 91), is a perennial, with leaves folded in the bud, and awnless spikelets. A valuable pasture-grass upon fresh, heavy soils, and much prized for lawns. *L. Italicum* A. Braun, Italian "Ray-grass," lasts 2–3 years; leaves rolled in the bud; spike-

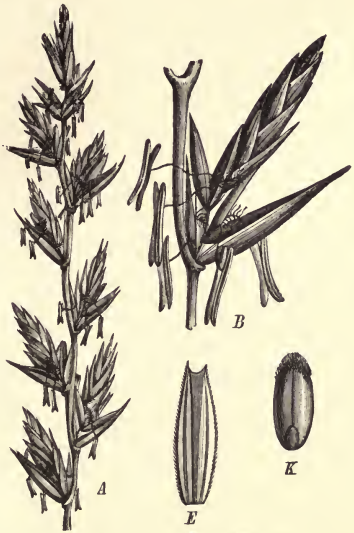


FIG. 91.—*Lolium perenne* L. (After Nees, Gen. Germ., I. 78.)

lets mostly awned. A tall-growing species, and can therefore be well recommended for mowing. Very profitable when irrigated. *L. temulentum* L. "Darnel" (*Crœpalia* Schrank. as a genus), annual, flowering glumes elliptical at maturity; empty glumes as long as or longer than the spikelets. A weed among grain crops, troublesome in wet years. The grain, as well as that of the related *L. remotum*, which is frequent in flax fields and distinguished by the shorter empty glumes, contains a narcotic principle (Loliin) soluble in ether, which

causes eruptions, trembling, and confusion of sight in man and in flesh-eating animals, and very strongly in rabbits, but it does not affect swine, horned cattle, or ducks. *Arthrochortus* Lowe belongs to this genus.

274. (272) **Kralikia** Cosson & Durieu. Spikes slender; spikelets very small; empty glumes two; callus of the flowering glumes bearded.

Species one (*K. Africana* C. & D.), in Algiers.

275. **Kerinozoma** Steud. A much-branched prostrate grass with only 3–5 spikelets in each spike, with a small cup-shaped, membranaceous, bracteate leaf enclosing the base. Terminal spikelet none. Upper leaf-sheath inflated, its blade short.

Species one (*K. littoralis* Zolling.), in Java.

276. (273) **Oropetium** Trin. A dwarf grass, the minute spikelets almost immersed in the notches of the flexuose rachis. Flowering glumes awnless.

Species one (*O. Thomæum* Trin.), in the East Indies.

277. (194) **Jouvea** Fournier. Only the ♀ plant known. First empty glume cartilaginous, and, like the second, grown fast to the rachis for half its length.

Species one (*J. straminea* Fourn.), on the sea-coasts of Mexico. A rush-like, thorny grass.

278. (270) **Monerma** Beauv. Spikes cylindrical, subulate, articulated. Spikelets deeply immersed in the rachis, awnless, terminal with two, others with one empty glume, these coriaceous; flowering glumes membranaceous.

Species three, one (*M. subulata* Röm. et Schult.) in the mediterranean regions, South Africa, and Australia; one from the Pacific Islands and Australia to Ceylon; the third in Madagascar.

278*a*. **Ischnurus** Balf. fil. Like *Monerma*, but the joints of the rachilla are provided in front with wing-like appendages which almost cover the deeply-immersed empty glumes. Spikelets not filling up the excavations in the rachis; the spike is therefore pitted.

Species one (*I. pulchellus* Balf. fil), a native of Socotra (an island east of Tropical Africa).

SUB-TRIBE C.—**Leptureæ.**

Spikelets transverse; starch-grains compound.

279. (269) **Lepturus** Brown. In habit like the genus *Monerma*, but with two nearly equal, approximate empty glumes opposite in the terminal spikelet. Low annuals.

Sec. I. *Eulepturus*. Spikelets one-flowered.

Species one, from the Baltic Sea to Egypt along the coast; the second in the Mediterranean regions and through the Orient and Hindostan to Australia; the third from Persia to Afghanistan.

Sec. II. *Pholiurus* Trin. (as genus). Spikelets two-flowered.

Species one, *L. Pannonicus* Kunth, from Hungary to Trans-Caucasia.

280. **Scribneria** Hackel. Rachis not articulate nor excavated; spikelets frequently in pairs (one pedicellate) on the lower joints [solitary above]. Empty glumes somewhat unequal, excentrically keeled, coriaceous; flowering glumes keeled, membranaceous, two-toothed, awned between the teeth. The rachilla prolonged beyond the flower and bearded at the point. Stamens not exserted at flowering time. Stigma short. Grain linear, laterally compressed, unfurrowed.

Species one (*S. Bolanderi* Hack., *Lepturus Bolanderi* Thurb.). A low, delicate annual in California and Oregon.

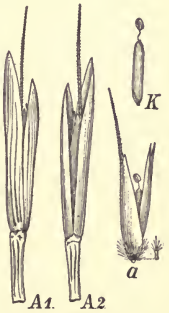


FIG. 91*a*.—*Scribneria Bolanderi* Hackel. *A* 1, Pedicellate spikelet viewed from the outside. *A* 2, Same seen from the inside. *a*, Floret with prolongation of rachilla detached. (After Hackel, Bot. Gazette, vol. xi. pl. 5.)

281. (270) **Psilurus** Trin. A delicate grass with very long, slender, curved spikes, the joints not hollowed out. Empty glumes many times shorter than the flowering glumes, the latter finely awned from the point; rachilla prolonged beyond the flower, often having a second flower; stamen one.

Species one (*P. nardoides* Trin.), South Europe to Afghanistan.

SUB-TRIBE D.—**Triticeæ.**

Spikelets transverse (side against the rachis); empty glumes opposite; starch-grains simple.

282. (266) **Agropyrum** Gärtn. (*Elytrigia* Desv.). Spikes with the rachis articulate or continuous; spikelets more or less compressed, 3–∞-flowered, all fertile; empty glumes not inflated, narrower than the flowering glumes, lanceolate or linear; flowering glumes coriaceous, rounded on the back or slightly keeled above, 5–7-nerved, awnless or awned, the uppermost often sterile; grain compressed on the back, hairy at the apex, slightly sulcate.

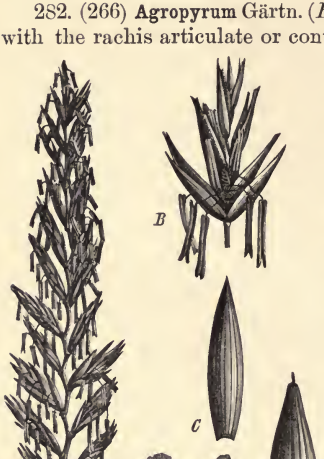


FIG. 92.—*Agropyrum repens* (L.) Beauv. (After Nees, Gen. Germ., I. 80.)

Species thirty-two, distributed throughout all temperate countries.

Sec. I. *Agropyrum.* Perennials. Spikes usually long and narrow with terminal spikelets; empty glumes not keeled, 3–5-nerved. *A. repens* Beauv. (*Triticum repens* L.). "Couch grass," "Witch grass" (Fig. 92), has creeping rhizomes, flat leaves, somewhat acute empty and flowering glumes. Common in Europe and Asia, also in North and South America. A troublesome weed in cultivated fields. The somewhat superficial, creeping runners may be removed by harrowing and raking them off, or killed by deep ploughing; and they may be smothered by thick planting of leafy plants, like the clover. For poor pastures it is, especially when young, valuable fodder-grass and is

useful to fasten the sand on river banks. The juicy rhizomes and runners are a nourishing food for cattle; they contain 3 % sugar and 6–8 % Triticin, a gummy carbohydrate, and are officinally known as "*radix graminis.*" The extract acts as a solvent upon collections of the mucous membranes and in affections of the intestinal canal. A syrup and even alcohol are also made from it. [*A. glaucum* R. & S. (?), "Blue Stem," is a valued hay-grass in Montana.] *A. junceum* Beauv. is distinguished by its involute leaves, obtuse spikelets, and articulate spikes. It serves to fasten down the dunes upon sandy coasts. *Roegneria* C. Koch is a species of this section.

Sec. II. *Eremopyrum* Jaub. & Spach. (as a genus). Spikes short, usually without terminal spikelets; empty glumes keeled, one- or indistinctly five-nerved.

Species seven, mostly oriental annuals. *T. cristatum* Schreb. extends as far west as Hungary and Vienna.

283. (266 §) **Haynaldia** Schur. Rachis of the very compact spike articulated; spikelets not inflated; two-flowered; empty glumes flat or channelled between the two keels, long-awned; flowering glumes keeled, awned below the point; grain free, laterally compressed, narrowly sulcate.

Species two, one (*H. villosa* Schur.) in the Mediterranean and steppe regions as far as Hungary; the other (*H. hordeacea* Hack.) in Algiers.

284. (267) **Secale** L. Spikes without terminal spikelets, somewhat loose, rachis articulate (cultivated forms excepted); spikelets not inflated, two-, rarely three-flowered, the lower flowers approximate; empty glumes subulate-pointed; flowering glumes long-awned from the point, sharply keeled to the base; keel fringed; grain slightly compressed laterally, deeply sulcate, hairy at the apex, free, without epiblast; embryonic rootlets four.

Species two, *S. fragile* Bieberst., with long awns to the empty glumes extending far beyond the flowering glumes, in the sandy plains of Hungary and Southern Russia, annual; and *S. cereale* L., Rye (Fig. 93), with subulate-pointed empty glumes which do not exceed the flowering glumes. The original species (called *S. mon-*

tanum Guss.) grows upon mountains of Spain and Morocco, through Silicia, Dalmatia, Servia, Greece, Asia Minor, Armenia, Kurdistan as far as Central Asia. It is perennial and has an articulate rachis, both of which characteristics are lost in culture. However, rye stubble, if it stands a long time in the field, will sprout again, a thing that never happens with wheat and barley because their original forms are annual. At present it is mainly cultivated in northern Europe (to 69½° north latitude), and also in North America. It is the chief cereal of the German and Slavonic nations. Its variations are unimportant. The fruit furnishes the well-known black flour used in making bread. In the green state rye forms a nourishing fodder. The straw is prized on account of its length; it is useful for making hats, and in the manufacture of paper. The bran is used for cattle-feed, for poultices, etc., and the grain for the distillery.* Its culture in Europe is not so old as that of the other cereals. It was unknown to the people of Western Europe

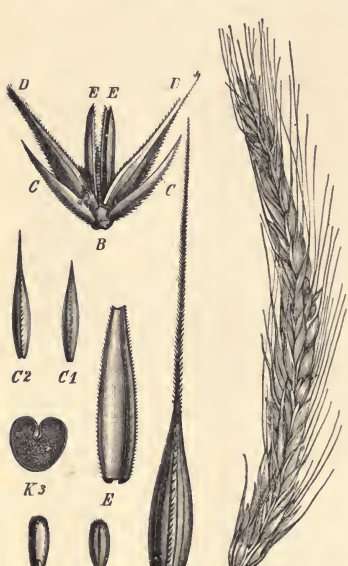


FIG. 93.—*Secale cereale* L. *A*, Spike (after Mull-Guyot). *K*1, Fruit from the front; *K*2, from the side; *K*3, in cross-section. (After Nees, Gen. Germ. 81.)

* For the details on cereals see Körnicke and Werner, "Handbuch des Getreidebaus" (Bonn, 1885), upon which are based many of the statements here given.

in the earliest prehistoric times, and appeared in Eastern Europe in the bronze age, as is proven especially by the remains found at Olmütz. The people of Eastern Europe probably received it from the natives of Southern Russia and Western Asia, who probably were the first to cultivate the plants which grew wild among them.

285. (268) **Triticum** L. Spikes with a (rarely aborted) terminal spikelet; rachis articulate (cultivated forms excepted); lowest 1–4 spikelets smaller than the others, awnless, sterile (occasionally fertile in the cultivated

FIG. 94.—*Triticum triunciale* Gren. and Godron. (After Nees, Gen. Germ., I. 85.)

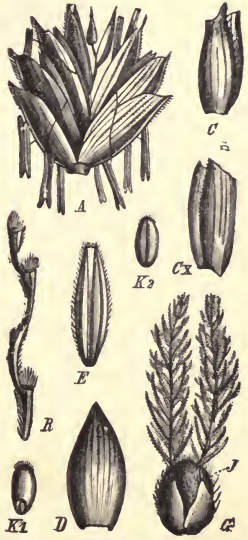


FIG. 95.—*Triticum sativum* Lam. *C*, Empty glume from the side; *CX*, from the back. *K* 1, Fruit from in front; *K* 2, from the back. *B*, Rachis. (After Nees, Gen. Germ., I. 79.)

forms). Fertile spikelets inflated or somewhat ventricose, 2–5-flowered, ripening only 1–3 fruits. Spikelets, especially the lowest, closely imbricated; empty glumes broad, always with one to many awns, or at least with a

blunt or toothed apex; flowering glumes rounded on the back, often navicular, many-nerved, ending in one to several teeth or awns; fruit very slightly compressed laterally, deeply sulcate, hairy at the apex, free. Embryo with epiblast and three rootlets. Always annual.

Two illy defined sections:

Sec. I. *Ægilops* L. (as a genus). Empty glumes flat or rounded on the back, not at all, or indistinctly, keeled.

Species twelve, in Southern Europe and the Orient to Afghanistan and Turkestan. *Æ. ovata* L. with 3–5 awns on the empty glumes, *Æ. triuncialis* (Fig. 94), three awns, etc., in Southern Europe; the former forms a cross with *T. sativum*. The spikes fall off as a whole, separating below the lowest fertile spikelet; the empty glumes of several Oriental species are one-awned or awnless and the spikelets fall off singly. These form transitions to the following section.

Sec. II. *Sitopyros*. Empty glumes sharply keeled. To this section belong the most important grains. They can be traced back to three species.

a. Terminal spikelet aborted, often scarcely visible. Palea falling into two parts at maturity. Lateral teeth of empty glumes acute. . 1. *Tr. monococcum*.

b. Terminal spikelets developed; palea remaining entire; lateral teeth of the empty glumes obtuse.

α. Empty glumes shorter than any of the flowering glumes, chartaceous; palea as long as flowering glumes. . . . . 2. *Tr. sativum*.

β. Empty glumes as long as or longer than any of the flowering glumes, chartaceous, lanceolate; palea of the lowest flower half as long as its glume. 3. *Tr. Polonicum*.

1. *Tr. monococcum* L. (Fig. 103). Spikes compact, articulate, joints readily separating (even in cultivated forms), every spikelet with one awn; usually only the lower, very rarely also the upper, flowers maturing their fruit. The wild plants (*Tr. Bœboticum* Boiss., *Crithodium ægilopoides* Link) scarcely distinguished from the

cultivated as varieties. They grow from Achaia through Thessaly (where they cover entire hills), Servia, Asia Minor, the Crimea, and Caucasian countries to Mesopotamia. This species is mostly cultivated in Spain, only rarely in France, Germany (especially in Würtemberg and Thuringia), and Switzerland, and upon poor and rough places that are not suited for other varieties of wheat. The finding of its fruit in the Lake dwellings belonging to the Stone age of Switzerland and Hungary, as well as at Hissarlik (Troy, according to Schliemann), proves its great antiquity. It is not so often used for bread as for mush and "cracked wheat," and as fodder for cattle. It varies but little.

2. *Tr. sativum* Lam. (in a wider sense), Wheat (Figs. 95–102), original form unknown. Many races and varieties produced by culture, of which those with the rachis articulate are probably most closely related to the original form. The brittleness of the rachis exists, however, in different degrees and is correlated with the more or less firm closing of the fruiting glumes. Three races:

   I. Rachis articulate at maturity; grain entirely enclosed by the glumes, not falling out when thrashed (however, it is not grown to the glumes).

      1°. Spikes loose, almost four-sided when seen from above; empty glumes broadly truncate in front, with a very short, obtuse middle tooth, obtusely keeled. . a. *Tr. sat. Spelta.*

      2°. Spikes very dense, laterally compressed; empty glumes tapering, with an acute middle tooth; sharply keeled. . . . b. *Tr. sat. dicoccum.*

   II. Rachis not articulated at maturity; grain visible between the somewhat open fruiting glumes, easily falling out. c. *Tr. sat. tenax.*

a. *Tr. sat. Spelta* (*Tr. Spelta* L.), Spelt* (Fig. 101). There are awned and awnless, hairy and smooth-spiked, white, gray-blue, and reddish varieties. One of the oldest grains. It was anciently the chief grain in Egypt and Greece, and was cultivated everywhere throughout the Roman Empire and distributed through its colonies. Its culture has continually decreased until, at present, it has disappeared from Egypt and Greece, and has become very rare in Italy and France; and even in S. Germany and Switzerland, where it is still the most cultivated, it is continually becoming rarer. It is yet important in N. Spain. The winter beardless Spelt, a white-spiked, awnless variety, is the most profitable. Spelt possesses undoubted advantage over the naked wheats only when grown upon poor soil, in small fields and with moderate culture; its demands are less, it is more certain, liable to fewer diseases, and not at all subject to the attacks of birds. Upon better soil and with reasonable cultivation the returns are better from common wheat.

b. *Tr. sat. dicoccum* (*Tr. dicoccum* Schrank) (Fig. 102). Always awned; spikes broader on the two-ranked side, narrower on the imbricated one. Cultivated from the most ancient times (Lake dwellings of Robenhausen), but always more sparingly than Spelt, and at present only in S. Germany, Switzerland, Spain, Servia, and Italy. It is a summer grain, and is used mainly as mush and for making starch. The best kind is the so-called Rice-spelt (*Reisdinkel*).

c. *Tr. sat. tenax.* This falls into four poorly characterized sub-races which in many characters overlap, and each of which, in turn, possesses numerous varieties, according to the awns, hairiness, and color of the spikes.

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* The illustrations of the spikes of the Cereals are taken from the works of Mull-Guyot in the "Encyclopédie d'Agriculture."

1°. Empty glumes distinctly keeled only in the upper half, rounded or only slightly keeled in the lower half.

* Spikes long, more or less loose, somewhat dorsally compressed.

α. Tr. sat. vulgare.

** Spike short, dense, distinctly four-sided. . . . *β. Tr. sat. compactum.*

2°. Empty glumes sharply keeled at the base.

* Fruit short, thick, not compressed, broadly truncate above.

γ. Tr. sat. turgidum.

** Fruit oblong, narrower, somewhat laterally compressed, and somewhat acuminate. . . . . *δ. Tr. sat. durum.*

α. Tr. sat. vulgare (*Tr. vulgare* Vill.), common wheat (Figs. 96, 97). The principal sub-varieties are awnless and bearded (awned) wheats, with naked or hairy, whitish, bluish, blackish, or reddish spikes. It has been known from most ancient times (grains found in Egyptian Pyramids); is generally cultivated as far north as its cultivation is possible (Norway, 69° N. Lat., Alps at 1400 metres altitude), and its culture is very import-

FIG. 96.—Common Bearded Winter Wheat. *Triticum sativum vulgare.*

FIG. 97.—*Tr. sativum vulgare muticum.*

ant in N. America; in Chili only in S. America. The most valuable German, American, and Hungarian kinds belong to this variety. It is cultivated either as a summer or winter grain.

β. *Tr. sat. compactum* (*Tr. compactum* Host.), "Dwarf Wheat," "Hedgehog Wheat." Spikes 3–4 times longer than broad, awned or awnless; culms and spikes very rigidly upright. A very old cultivated form (Lake dwellings of Robenhausen!) at present mainly cultivated in the Austrian Alps, Würtemberg, Alsace, Switzerland, Chili, and Turkestan. The awned kinds are called "Hedgehog Wheat." The Abyssinian "Dwarf Wheat" forms a special group. On account of their stiff culms the dwarf wheats are less liable to lodge. Certain kinds, like the yellow winter Hedgehogwheat, are peculiarly adapted to rough and stormy regions. The yellow summer Hedgehog wheat is also profitable on poor soils.

Fig. 98.—English Wheat. *Tr. sativum turgidum.*

Fig. 99.—Flint wheat. *Tr. sativum durum.*

γ. *Tr. sat. turgidum* (*Tr. turgidum* L.) (Fig. 98), English wheat. Culms tall, thickish, stiff and upright, with large,

thick, and dense four-sided spikes; leaves broader than in *T. vulgare*, and usually clothed with velvety hairs. It is especially cultivated in the Mediterranean countries, more rarely in England and Germany. The English wheat yields very good harvests, but its flour is poor in gluten and usually grayish; it is therefore less adapted to cooking, and prized less. In Germany most kinds are not sufficiently hardy to winter well.

The Miracle wheats ("Egyptian" wheats) (*Tr. compositum* L.) are formed by a special group of varieties, with branched spikes. Originally a sport, they have become strongly hereditary. Their culture is not profitable, for the grains are very unequally developed.

Fig. 100.—Polish Wheat. *Tr. Polonicum.*

Fig. 101.—Bearded Spelt. *Tr. sativum Spelta.*

δ. *Tr. sat. durum* (*Tr. durum* Desf.), Hard or Flint wheat (Fig. 99). Recognizable by its long, bristling awns. Culm often filled with pith or solid; fruit very hard, usually vitreous, rarely mealy. Cultivated in the Mediterranean countries, the most important grain in Spain, and also predominating in N. Africa. Of scarcely any importance in Germany. Several varieties have coal-black awns.

3. *Tr. Polonicum* L., Polish wheat (Fig. 100). A very striking species with large, compressed,

mostly blue-green spikes. Spikelets appearing as if cut off transversely because the third and fourth flowers scarcely reach to the point of the two lower ones; flowering glumes compressed, navicular, many-nerved, awned; fruit 8–12 mm. long. Original form unknown; perhaps not a true species; it may have originated by culture. It gives rise, but rarely, to a fertile cross with *Tr. sativum;* while the crossing of the *sativum* races among each other is perfectly fertile, that of the *monococcum* with the *sativum* races is entirely infertile. Poland is by no means its native country; more likely it originated in Spain, where it is now cultivated on a large scale in Leon, Old Castile, and the Balearic Isles. It is also still cultivated in Italy and Abyssinia, but in other places its culture, if it ever existed, has disappeared. The long and slender fruit resembles rye, but is on the whole larger, and under the name of "Giant Rye" it has sometimes been fraudulently sold to farmers. The returns are poor on account of its having few kernels.

FIG. 102.—"German" Wheat. *Tr. sativum dicoccum.*

FIG. 103.—One-grained Wheat. *Tr. monococcum* L.

Wheat flour furnishes the best and whitest bread, yet not all wheat is alike adapted for bread-making, since for this purpose a sufficient

amount of gluten, such as is found in the half hard and half soft kinds, is indispensable. Pronounced soft wheats, like the English, especially those grown in a moist climate, need the addition of flour of the hard-fruited races before baking. By themselves alone they are better adapted for starch-making. The especially hard wheats are over-rich in gluten, and the food baked from them is therefore too firm. They are accordingly used for macaroni and for making cracked wheat and mush. The straw is shorter than that of rye; an especially short and delicate-stalked kind is produced in Tuscany by thick sowing on poor soil, and used for making Florentine hats.

286. **Heteranthelium** Hochst. An annual grass, with spikes having many bristles. Empty glumes bristle-like, with hairs arranged like the barbs of a feather. Flowering glumes warty and with awl-shaped awns. Above the two fertile flowers is a pedicel with a tuft of sterile, subulate or awn-like glumes.

Species one (*H. piliferum* Hochst.), in the Orient.

SUB-TRIBE E.—**Elymeæ.**

Spikelets 2–6 on each notch of the rachis, forming a branching system in which one spikelet (the middle one) represents the primary, and the lateral spikelets the secondary and tertiary branches. Rarely the primary branch is aborted and the secondary ones only are present. The terminal spikelet when present has both empty glumes together with the flowering glumes in its median lines. In the lateral spikelets, on the contrary, they are thrown out of this line and occupy the place that is left to them from the crowding together of the spikelets; that is, they usually stand close together in twos in front of each spikelet, and therefore often apparently decussate with the median line of the spike. Stamens three.

287. (274) **Hordeum** L. Empty glumes narrow, usually subulate, all together forming a kind of involucre around the spikelet; flowering glumes in the median line of the rachis (as in *Lolium*) five-nerved, extending into a strong awn; grain usually adherent to the glume, hairy at the apex, usually sulcate, without epiblast.

Species about sixteen, in Europe, temperate Asia, North Africa, and North and South America.

Sub-genus I. *Zeocriton* Beauv. (as a genus). (*Critesion* Rafin.). Rachis (cultivated forms excepted) articulate, each joint falling off with the group of spikelets attached above it. The middle spikelet fertile, the lateral ones

FIG. 104. — Two-ranked barley. *Hordeum sativum distichon.*

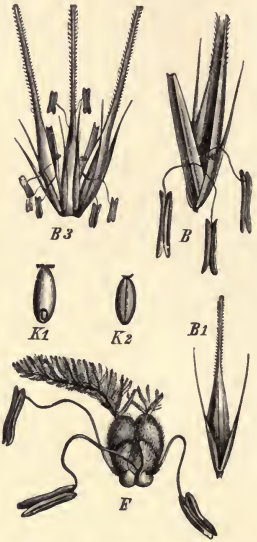

FIG. 105.—*Hordeum sativum hexastichon.* *B* 3, Group of three spikelets. *B*, a spikelet from behind; *B* 1, from in front. *K* 1, Fruit from in front; *K* 2, from behind. (After Nees, Gen. Germ., I. 83.)

FIG. 106.—Common 4-rowed barley. *Hordeum sativum vulgare.*

mostly short-pedicellate, rarely sessile, sterile (fertile only in cultivated forms); terminal spikelet aborted; fruiting glumes persistent on the pedicels.

Species twelve, among which are *H. murinum* L., with pedicellate lateral spikelets, a widespread weed; *H. sativum* Jessen, Cultivated Barley, with sessile lateral

spikelets, and empty glumes obtuse. This undoubtedly originated from *H. spontaneum* C. Koch, which grows wild from Asia Minor and Caucasian countries to Persia and Beloochistan, as well as in Syria, Palestine, and Arabia Petræa. The two-rowed, cultivated barley is distinguished from it only by the character due to cultivation—viz., the non-articulate axis and somewhat shorter awns.

Sub-species (Races):

a. All spikelets fertile, therefore six rows of fruit.
   α. The six rows distinctly separated. b. *H. sat. hexastichon.*
   β. Only the middle rows distinctly separated, the side rows overlapping. c. *H. sat. vulgare.*

b. Only the middle spikelet of each cluster of three fertile. . . . . a. *H. sat. distichon.*

a. *H. sat. distichon* (*H. distichon* L.), two-rowed Barley (Fig. 104). Spikes strongly compressed laterally, the sterile lateral spikelets appressed to the rachis, with or without stamens. Falls into numerous varieties, the most important of which are:

α. *nutans.* Lateral spikelets distinct, spikes usually uniform in width, awns appressed to the spike; spike loose, narrow, usually nodding.

β. *erectum.* Like α, but with broad, upright spikes.

γ. *Zeocriton,* "Peacock Barley," "Rice Barley." Like β, but the spikes tapering toward the end, and the awns diverging.

δ. *macrolepis,* with aborted lateral spikelets and broad, empty glumes in the middle spikelet.

ϵ. *deficiens.* Like δ, but the empty glumes narrow.

Besides these there is one variety with naked fruit (*H. nudum* L.), and several sub-varieties distinguished only by the pale yellow or black color of the spikes.

The two-rowed barley is cultivated especially in Central Europe (in Switzerland as far as 2000 metres above the sea) and England, and the varieties δ and ϵ in Abyssinia.

b. *H. sat. hexastichon* (*H. hexastichon* L.), six-rowed

barley (Fig. 105). Spikes roundish in circumference; all six rows diverging uniformly and forming a six-rayed star when viewed from above; joints of rachis very short, therefore the spikelets are closely imbricated. Very widespread, even in prehistoric times (Lake dwellings), but at present it is cultivated only in Southern Europe, rarely in Switzerland and in Germany.

c. *H. sat. vulgare* (*H. vulgare* L.), irregularly ranked or four-rowed barley (Fig. 106). Spikes dorsally compressed; the middle row more appressed to the rachis than the irregular rows of the lateral spikelets; spikes loose, often nodding. This race seems to be of later origin. Its variety *pallidum* (with pale yellow spikes) is the barley most frequently cultivated in Northern Europe (Norway to 78°) and Northern Asia. It is usually raised as a summer grain, and its period of vegetation may be limited to ninety days. In Central Europe, where its culture was earlier introduced, it is becoming gradually supplanted by the two-rowed, and especially by the Chevalier barley. The greater amount of gluten which it contains makes it less adapted for beer-brewing; besides, on good soil the produce of the two-rowed is greater than that of the four-rowed, while the latter surpasses it on poor land. The variety *cærulescens*, with the gray spikes, is more frequently cultivated in Southern Europe and Northern Africa. A special series of varieties is formed by the naked-fruited barleys (*H. cœleste* L.) as well as the Himalaya barleys, among which is the remarkable hereditary malformation (*H. trifurcatum*) with three-horned flowering glumes. Between the four-rowed, six-rowed, and two-rowed barleys are transition stages (e.g., var. *intermedium* Körn, and *H. Kaufmanni* Regel), in which all the spikelets are fertile but the lateral ones are awnless. These are spontaneous variations and not crosses, for the majority of barleys, especially the six-rowed, bear cleistogamic flowers, so that a cross in the open air is impossible.

How barley was used in ancient and in prehistoric times is uncertain. At present it forms the most important cereal of the far North. In Central Europe it is used only for brewing beer and for soup, and in South Europe mainly as food for horses. It is used for bread also in Asia, especially in Thibet, and in North China and Japan. North America produces considerable quantities of it; South America, on the contrary, very little. A mucilaginous tea, used as a medicine, is made from the naked barley (officinally known as "*Hordeum decorticatum*"). Malt and the extract of malt are also medicines.

Sub-genus II. *Crithopsis* Jaubert (as a genus). Rachis articulated; spikelets in twos, sessile, fertile; fruit persistent; apical spikelet with four decussating empty glumes, two of which are in the median line of the flowering glume.

Species one (*E. Delileanus* Schult.), in the Orient.

Sub-genus III. *Cuviera* Köl. (as a genus). Rachis continuous; spikelets in twos or threes, all fertile; fruiting glumes falling off from a distinct pedicel; apical spikelet with two opposite empty glumes in the median line of the flowering glume.

Species three (*H. sylvaticum, H. crinitum, H. Caput-Medusæ*), in Europe and the Orient.

288. (275) **Elymus** L. (Fig. 107). Rachis usually continuous; terminal spikelet with two empty glumes lying in the median line of the flowering glume, one of them frequently aborted; lateral spikelets in groups of from two to six, all fertile; fruiting glumes falling off with a joint of the rachilla; empty glumes narrow-linear, short-awned or awn-like; flowering glumes somewhat shorter, oblong or lanceolate, not keeled, five-nerved, awnless or awned; fruit adherent.

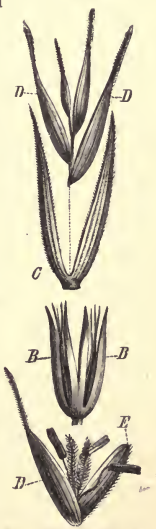

FIG. 107.—*Elymus Virginicus* L. (After Gray, Man. pl. 11.)

Species about thirty, throughout all temperate coun-

tries excepting Australia and South Africa. Tall, rigid, perennial grasses.

Sec. I. *Sitanion* Rafin. (as a genus) (*Polyantherix* Nees). Rachis articulate; empty glumes usually two- to many-cleft, long-awned.

Sec. II. *Clinelymus.* Rachis continuous; empty and flowering glumes awned.

Sec. III. *Psammelymus.* Like Sec. II, but the empty and flowering glumes awnless. To this section belongs *E. arenarius* L., which has long, creeping rhizomes, stiff leaves, elongated ligules, and more downy flowering glumes. On the banks of the North and Baltic Seas, rarely inland, thence extending through Russia and North Asia to North America. Very well adapted to binding drifting sands, and often planted for this purpose. In Iceland bread is made from the fruit.

289. (276) **Asprella** W. (*Hystrix* Mönch, *Gymnostichum* Schreb.). Like the preceding, but the spikelets are usually in pairs on short pedicels; empty glumes wanting or appearing as simple rudiments in the lowest spikelets of each spike.

Species four, two in N. America [(*A. Hystrix* Willd. and *A. Californica* Benth.)], one in Siberia, and one in New Zealand.

SUB-TRIBE F.—**Parianeæ.**

Spikelets usually in sixes at each joint of the rachis, forming a false whorl which consists of two opposite groups of three; in one the middle spikelet (primary branch) is ♀ and in the other ♂; all the lateral spikelets are ♂ on broad pedicels which are grown together; empty glumes (apparently) decussate with the flowering ones. The ♀ spikelet stands farther in. The terminal spikelet is solitary, large, ♀, with opposite empty glumes in the median line of the flowering glumes. All the spikelets are awnless. Stamens 10–40 in each ♂ flower. Fruit as in *Triticæ*.

290. (31) **Pariana** Aubl. Grasses with broad, somewhat petiolate leaves. The ♂ spikelets form an involucre around the ♀ and fall away with it.

Species ten, in tropical South America. *Eremitis* Döll. appears to be a species of this genus whose flowers are aborted, having only one stamen in each ♂ flower.

Tribe XII.—Bambuseæ.*

Spikelets 2–8-, rarely only one-flowered, in panicles or racemes, mostly arranged in tufts or false whorls at the nodes of the branches of the panicle. Empty glumes two to several, increasing in size upwards, shorter than the succeeding flowering glumes; buds developing into spikelets sometimes appear in axils of the lowest empty glumes; flowering glumes many-nerved, awnless, or rarely with short, straight, terminal awns; palea two- to many-nerved, rarely nerveless; scales or lodicules usually three, remarkably large, rarely fewer or wanting; stamens 3–6 to many; styles 2–3, often grown together at the base; fruit free; leaves usually articulated with the sheath.

[Large, often tree-like, perennial grasses with woody, rarely herbaceous, culms. The largest species are 30 cm. in diameter and 40 m. high. The rhizome lasts many years, and in most species consists of numerous short, entwined branches which send up numerous densely-crowded culms forming clumps. Bamboo forests of these species consist of such giant bushes intermingled with trees. Other species (*Bambusa villosula* Kurz., *Melocanna bambusoides* Trin., etc.) do not form clumps, but the culms, standing 30–60 cm. apart, often cover extended areas with a thick forest-like growth. In yet other species, for example those of *Phyllostachys*, the rhizome, which bears larger or smaller clumps, sends out long creeping branches that here and there produce solitary culms; these are upright, the outer ones in each clump bending or hanging over. Some species are climbers. Branches numerous, usually forming a crowded half-whorl at the nodes; sometimes all the nodes bear branches, sometimes the lower part of the culm is naked, in the upper portions the branches are often single, and in many species two-ranked; the culms and

* The portions here enclosed in brackets were written especially for the original by Dr. Brandis, author of "Forest-Flora of Northwest and Central India."

branches of some species are thorny on account of numerous hard and pointed twigs (aborted branches); a circle of secondary roots, which occasionally become thorn-like when they do not reach the ground, frequently occur on the lower culm-nodes below the insertion of the branches; the leaf-blade is often short, usually with a short petiole and jointed at the base, frequently deciduous; sheaths often fringed at the throat; the long nerves of the blade are bound together in many species by prominent cross-nerves.

After the ripening of the seed, the ground becomes covered with countless young plants with slender, pliant stems, and a thick foliage, resembling a meadow of waving grasses. This growth lasts many years, until the rhizomes have attained their full size, when the culms, some of which have been formed each preceding year, for the first time attain their full height and thickness. In the tropics a number of young culms in each clump shoot up during the rainy season, often attaining their full height (even to 40 m.) in from 40–60 days. The entire internodes of the growing culms, and the lower part only of those which are full grown, are surrounded by large, parchment-like sheaths which are frequently covered with long deciduous hairs, and which below bear small dry membranaceous blades that become larger and leaf-like above. In this condition the culms have no branches and are soft, but they become lignified towards the end of the first year, and branches and leaves are developed at the same time. In regard to flowering, we may distinguish between those that bloom frequently and those which rarely flower.

Many species (*Arundinaria Wightiana* Nees, upon the Neilgherries, species of *Guadua* and *Chusquea*) bloom annually, and the panicle is terminal on the leafy branches. In others (*Dendrocalamus strictus* Nees), single culms shed their leaves and become covered with panicles of flowers, while others again retain their foliage. Upon these species, which are of frequent occurrence in all the East Indies, blooming culms may consequently be found nearly every year. In other species, on the contrary,

not only all the culms of a clump become covered with flowers after they have shed their leaves, but also all the clumps of the same kind growing in the same country or province. Whole bamboo forests, so far as they consist of a single species, may be seen in bloom over an extended area. This is frequently observed in Asia as well as in America. In the East Indies the seeds, which are rich in flour, are then collected and cooked like rice, and are used for food by the poorer castes. But often, in Brazil as well as the Indies, misfortune follows the sudden production of such vast quantities of mealy seeds. It is the cause of an extraordinary increase of mice and rats, which, after having eaten up all the bamboo fruits, turn to the neighboring fields, devouring the crops of whole provinces. The German colonies in Rio Grande do Sul and Sta. Catarina are visited by these pests at intervals of about thirteen years.

On the west coast of the East Indian Peninsula the simultaneous blooming of *Bambusa arundinacea* Retz. has been observed at intervals of thirty-two years (1804, 1836, 1868). These and other facts seem to indicate that this and other similarly related species must reach a great age before they arrive at the stage of flowering. Small plants grown from runners and cuttings bloom in these cases at the same time as the larger growths from which the cuttings are taken. Simultaneous flowering has been observed in many species cultivated in France and Algiers. Nevertheless there are exceptions to this rule also. In many regions of the East Indies *Bambusa arundinacea* has bloomed several times in other than the above-named years, and in all cases in which the simultaneous flowering of one species has been observed over a large area, there were straggling blooming plants in the year following. The age of the bushes appears to be only one of the conditions of flowering; weather and other circumstances also exert their influences. In special years *Dendrocalamus strictus* blooms more profusely than at other times, and then it not infrequently happens that all or nearly all the culms of all the clumps in one region bloom simultaneously. The flowering, leafless

culms always die down after the ripening of the seed. When all the culms bear flowers, the rhizomes, whose reserve material is now exhausted, produce only weak and slender stems for a long time, and only gradually regain the power of producing culms of normal height and thickness. The rhizomes become weakened in a like manner if all or many of the culms of a bamboo clump are cut off. In this case, also, only slender culms are produced for a series of years until their strength is restored by the continued activity of the leaves. In greenhouses, species which would otherwise form high bushes may be checked in their development and kept small by cutting out many or all of the shorter shoots. In many cases not only the aërial portions die after flowering and ripening of seed, but the rhizomes also, and a renewal of the bamboo forests depends entirely upon seedlings. The preceding will explain why in many species the flowers and fruit have not yet been collected and described. In the forests it is not difficult to recognize the different species by the manner of growth, branching, sheaths and leaf-blades of the younger culms, and other characteristics; but without flowers it is only rarely possible to determine the genus. In many species, therefore, a reliable division into genera has not yet been possible.]

Geographical Distribution.—The Bambuseæ are distributed throughout the tropical zone, but very unevenly; a few species have penetrated into sub-tropical and even into the temperate zones. The Monsoon region in Asia is rich in species (over one hundred and fifty), but in Africa there are very few (five only known up to this time); several occur in Madagascar. America possesses about seventy species, the Pacific Islands a few, and North Australia two; eleven species grow in Japan, and but one on the Kurile Islands. In the Himalayas they extend to an altitude of 3400 m. above sea level, and still higher in the Andes. Here the species of *Chusquea* form impenetrable thickets, the "Carizales," covering wide areas within the tree limits; in Ecuador *Chusquea aristata* Munro reaches the snow-line. Many species

seem to have a very narrow range, and there are only two genera common to both hemispheres.

Uses.—The mere enumeration of the uses of the Bambuseæ would fill many pages. They are especially indispensable to the inhabitants of India and Eastern Asia. Their uses are more limited in South America. In building houses the thicker trunks are used as posts and beams, and the weaker ones, when split, for filling up the walls and for laying the floors. [For this purpose they are split longitudinally and then pressed out flat. In this condition they consist of narrow united strips, forming planks which may be 90 cm. broad.] The internodes cut in two longitudinally are used for tiles. Bamboo houses are durable, graceful, and, because they are airy, are especially healthful. In China all the theatres are built of bamboo. Huts for temporary residents are very rapidly constructed from them. Both hanging and floating bridges of bamboo are in common use, especially in the Malayan Archipelago. Water conductors are constructed either by cutting the stem in halves longitudinally, or by breaking through the cross-walls at the nodes. Floats made from bamboos are, on account of their containing air, capable of carrying an extraordinary load, and, for the same reason, the outrigging in the boats of the Zeylanese are made of bamboos. Slender culms serve for poles to support the betel-nut, beans and other climbing cultivated plants (they are even imported into Europe for the same purpose), and the stronger ones for palisades. From many species, especially the thorny ones, impenetrable, living hedges, and even works of defence, are constructed. Almost all the furniture of the Malays, Burmese, etc., is made from bamboos, and even in Europe bamboo is beginning to be imported for the manufacture of furniture. A single internode of a large species, in which both separating walls have been left and only one bored through, serves for a water-pail in which the water remains very pure. A dozen or more of these water-buckets stand in every Malayan house. While still full of sap these internodes are even used as cooking

utensils. Smaller internodes furnish pitchers, flasks, and cups; and wide internodes, bee-hives. They are in general use for carrying-poles, and for the masts of small and medium-sized ships. Some species supply walking-canes, especially the culms of the Japanese *Phyllostachys* and *Arundinaria*. The slender twigs furnish pipe-stems, purses, knife-handles, etc. Musical instruments (flutes) are easily made from the joints. The "Anklong" of the Malays consists of internodes of different thicknesses arranged according to their tones, and suspended near each other, and which are made to sound by striking. The living culms are made by the Malays into Æolian harps by piercing them at certain distances and thus allowing the air to pass through them. The finely split bamboos open a new category of uses. [The outer green rind of the young culms is split into narrow strips or ribbons, and made into baskets and fine braided work; for example, Chinese fans, large and small boxes, and even hats and jackets.] If the threads are boiled in lye and then rolled and scraped, they become soft enough for weaving and for ropes. Coarse mats and baskets are woven from split bamboos. Bamboo mats laid over each other like roofing-slate are a favorite roofing material in the Malayan Peninsula. The Shans and other inhabitants of the Malayan Peninsula prepare from the large parchment-like leaf-sheaths of the young culms broad-rimmed hats which are an excellent protection against the sun and rain. Bamboos are especially important for the manufacture of Chinese paper, of which it forms the chief ingredient. The well-known Chinese umbrella consists of bamboo paper with a bamboo handle and split bamboo for a skeleton. The leaves are used for packing, filling beds, etc. The young shoots of the larger species are a favorite vegetable with the Malays and Chinese, and are even preserved for exportation. Those of the smaller species are eaten in China like asparagus or lettuce. The importance which may be reached by the fruit of the bamboos has already been explained. The crops produced are enormous and form an important article of

commerce. Abundant and good drinking-water collects in the hollows of the internodes of many large species. In those of others (*Bambusa arundinacea* and *Melocanna bambusoides*) are formed those remarkable silicic-acid concretions, the "Tabasheer," that are still playing an important part in the superstitious system of medicine among the Orientals. Tabasheer is considered, not merely in India but in the whole Orient and in China, as a medicine of the highest value for bilious fever, dysentery, jaundice, leprosy, and lung diseases, as well as an aphrodisiac. As early as the times of the Roman Empire physicians ascribed medicinal properties to it, and it attained its world-wide fame through the Arabian physicians of the tenth and eleventh centuries. It occurs in commerce in two forms, the crude and the calcined. The first, in a fresh uninjured condition, is in the form of a more or less perfect cylinder with a rounded convex base, 1–3 cm. in diameter and 1–4.5 cm. long (Fig. 108, *B, C*), found in the hollows of the internodes upon one or both sides of the cross-wall, and as there are longitudinal furrows in the outer surface corresponding to the course of the fibro-vascular bundles, it represents an exact cast of the cavity of the internode. It is translucent, gray, yellowish, bluish, brownish, or blackish in color and greasy in appearance, and covered with a chalky coating. In warm, dry air it becomes opaque and finally falls into little pieces or fine grains like sand. When fresh it contains 58–62% of water and scarcely 1% of organic substance; the remainder is pure silicic acid, soluble in potassium hydrate. Calcined Tabasheer is formed by heating the crude substance red-hot, in consequence of which it is transformed into irregular, milk-white, opaque or bluish opalescent, concavo-convex pieces having an earthy taste. The origin of Tabasheer is not yet thoroughly explained; the most probable inference is that at the time of most rapid growth great quantities of water are conducted into the bamboo stems from the roots and collect in the hollow internodes. The silicic acid alkalies that are dissolved in it probably become decomposed by carbonic or organic

acids, the alkalies thus formed are re-absorbed together with the water, and a silicious jelly remains which hardens into Tabasheer. It is believed that the accounts of the ancients (Dioscorides, Plinius) which speak of σακχαρον and Saccharum do not refer to sugar, but to Tabasheer: perhaps the accounts of the two are confounded. The name comes from the Sanskrit (not Persian) word *Tavakkshíra*, meaning milk of the bark. [The present name in Bengal, Hindostan and in the Dekkan is Banslochan, Bans-kapúr.*]

Many species of bamboo are highly ornamental plants: the Chinese and Japanese have planted them for ages; and in Europe, especially in the South, where many can be kept in the open air, as well as in the greenhouses of the North, their use is becoming more general and frequent.

A. *Stamens three; palea two-keeled; fruit a true caryopsis* (*Arundinaricæ*).
  a. Spikelets two- to many-flowered (very rarely one-flowered—*Phyllostachys*).
    α. Spikelets with no subtending leaf.
      I. Empty glumes 1–2. . . **291. Arundinaria.**
      II. Empty glumes 3–4. **292. Arthrostylidium.**
    β. The 1–2 spikelets surrounded by a large leaf at their base. . . . . **293. Phyllostachys.**
  b. Spikelets one-flowered.
    α. In a compact globose head. **294. Athroostachys.**
    β. In a one-sided spike. . . **295. Merostachys.**
    γ. In panicles.
      I. Stem woody, leaves jointed at the base. **296. Chusquea.**
      II. Stem herbaceous, leaves not jointed. **297. Planotia.**

B. *Stamens six, fruit a true caryopsis with a delicate pericarp* (*Eubambuseæ*).
  a. Filaments free.
    α. Spikelets one-flowered, with many empty glumes. . . . . **298. Nastus.**

* For a more complete account of Tabasheer, see Cohn's "Beitr. z. Biologie d. Pfl.," vol. 4, part 3, and "Zeitschr. d. allg. öst. Apotheker-Ver.," 1887, No. 9, 10 (by Poleck).

β. Spikelets two- to many-flowered.

I. Palea of the uppermost flower two-keeled; style not thickened at the base at maturity, usually falling off. . . . **299. Bambusa.**

II. Palea of the uppermost flower and flowering glume one-keeled; style much thickened at the base at maturity; fitting over the caryopsis like a cap. **300. Atractocarpa.**

b. Filaments grown together, forming a tube.

α. Spikelets many-flowered, paleæ all two-keeled. **301. Gigantochloa.**

β. Spikelets one- to many-flowered, but only the uppermost flower fertile, and this with a one-keeled palea.

I. Spikelets elongated conical, round in cross-section. . . . . **302. Oxytenanthera.**

II. Spikelets ovate-lanceolate, compressed. **303. Puelia.**

C. *Stamens six (very rarely more); fruit a nut (with a thick, free paricarp) or berry.*

a. Paleæ two-keeled (*Dendrocalameæ*).

α. Spikelets two- to many-flowered.

I. Ovary hairy at the apex; fruit a small nut. **304. Dendrocalamus.**

II. Ovary naked; fruit large, fleshy (?). **305. Melocalamus.**

β. Spikelets one-flowered with a prolongation of the rachilla which often bears an upper empty glume; fruit a nut.

I. Spikelets in distant clusters or spikes on the branches of the panicle.

1°. Styles three, separate to the base. **308. Greslania.**

2°. Style one, very long, enclosed in a tubular beak of the ovary, with 2–3 stigmas.

* Nut almost globose, depressed, abruptly beaked. **306. Pseudostachyum.**

** Nut gradually tapering into the beak. . . . **307. Teinostachyum.**

II. Spikelets in one to several globose heads. **309. Cephalostachyum.**

b. Paleæ not keeled, resembling the flowering glumes (therefore considered wanting by many) (*Melocanneæ*).

α. Lodicules 0; spikelets very small. **311. Dinochloa.**

β. Lodicules 2–3.

I. Fruit a small nut; uppermost flower with a prolongation of the rachilla. **310. Schizostachyum.**

II. Fruit a large berry; uppermost flower without a prolongation of the rachilla. **312. Melocanna.**

γ. Lodicules very numerous (eight or more); anthers mostly more than six. . **313. Ochlandra.**

SUB-TRIBE A.—**Arundinarieæ.**

Stamens three.

291. (277) **Arundinaria** Michx. (*Miegia* Pers., *Ludolfia* Willd., *Triglossum* Fisch.). Spikelets loose, many-flowered, elongated, panicled or racemed; empty glumes small, unequal, the first occasionally wanting; flowering glumes not keeled, sometimes short-awned; styles 2–3, free; fruit rather long, furrowed. Suffruticose or tall shrubs.

Species about twenty-four, in America and Asia (as far east as Japan and on the Himalayas); several species in Europe as ornamental plants: *A. Japonica* Sieb. (*Bambusa Metake* and *B. mitis* of the garden), which has strong, transverse nerves in the leaves, withstands, unprotected, the winters of France and South England; *A. falcata* Nees, without transverse nerves, is from the Himalayas; *A. macrosperma* Michx. and *A. tecta* Muhl. occur in N. America as far north as Maryland and Illinois. The section *Thamnocalamus* Munro (as a genus) is distinguished by its large, deciduous, spathiform leaves enveloping the spikelets and branches of the panicle. *A.* (*Thamnocalamus*) *spathiflora* Ringall, a widespread species in N.W. Himalayas between 2500 to 3400 m. above sea level, furnishes pipe-stems which in Northern India form an important article of commerce.

292. (278) **Arthrostylidium** Rupr. Rachilla articulate and readily separating at the joints; spikelets in racemes or one-sided spikes, these arranged in tufts at the culm-nodes; leaves without distinct cross-veins. Tall shrubs and climbers.

Species twelve, in tropical America. The lowest culm-joint of *A. Schomburgkii* Munro, which may be 5 m. long, furnishes the dreaded "blow-gun" from which the natives of Guiana shoot their poisoned arrows. *A. excelsum* Griseb., of Trinidad and Dominica, attains the height of 25 m. and a diameter of 30 cm. *A. capillifolium* Griseb., of Cuba, has leaves as fine as horse-hair, 6 cm. long. *A. Quexo* (*Aulonemia* Goudot), of Colombia, is remarkable in its loose panicles.

293. (279) **Phyllostachys** Sieb. et Zuccar. Spikelets in short, loosely paniculate spikes which have a very peculiar appearance on account of the large imbricated leaves covering their bases, 1–4-flowered; empty glumes 2–3; style one with three feathery stigmas. Stems arborescent, semi-terete; nodes prominent and leaves netted-veined.

Species four, in Japan, China, and the Himalayas. The black-stemmed species cultivated in European gardens under the name of "*Bambusa nigra*" Lodd., whose flowers are unknown, probably belongs here. The graceful culms are used for walking-sticks ("pepper-canes").

294. (280) **Athroostachys** Benth. Spikelets one-flowered, in dense, globose heads, subtended by enveloping leaves; empty glumes two, short; styles two.

Species one (*A. capitata* Benth.), a suffrutescent climber of Brazil. Mouth of the sheath with long, stiff bristles.

295. (281) **Merostachys** Spreng. Spikelets with 3–4 empty glumes, the lowest of which is very small; flowering glumes chartaceous; palea many-nerved, with the rachilla prolonged beyond it and occasionally bearing a bract; styles two. Tall shrubs or climbing plants, with leaves indistinctly netted-veined. Spikes unilateral like those of the *Chlorideæ*.

Species nine, in Brazil, Paraguay, and Peru.

296. (282) **Chusquea** Kunth (*Rettbergia* Raddi, *Dendragrostis* Nees). Spikelets with four empty glumes, the lowest small and narrow, the upper like the flowering glume, the latter broad and awnless; rachilla not prolonged; styles two. Small-leaved, tall shrubby or climbing plants with terminal panicles.

Species thirty-five, all American; especially characteristic plants of the higher regions of the Andes and the Brazilian highlands from Mexico to South Chili, as far as Chiloë.

297. (283) **Planotia** Munro (*Platonia* Kunth non Mart.). Panicles very long and narrow, with small, very numerous spikelets having the same structure as those of *Chusquea*, but the habit of the plant is rather that of the *Festuceæ*, with herbaceous, almost leafless culms, and leaves crowded together close to the ground. The very long and often broad leaves are usually continuous (not articulate) with the sheaths.

Species five, in tropical South America, especially in Colombia. *P. nobilis* Munro has the largest leaves (1.5–4.5 m. long by 8–30 cm. broad) of any grass; panicles over 1 m. long. Characteristic species upon the Paramos of Riuz. ["Paramo" is the name applied to the elevated plains of Colombia, etc.]

SUB-TRIBE B.—**Eubambuseæ.**

Stamens six; caryopsis with a delicate pericarp.

298. (284) **Nastus** Juss. (*Stemmatospermum* Beauv.). Spikelets with 6–10 empty glumes which gradually increase in size and become above like the flowering glumes; rachilla prolonged beyond the flowers; flowering glumes coriaceous; ovary naked; styles 2–3, more or less grown together. Tall shrubs with branches apparently in whorls. Panicle short, upright, or contracted into a head and few-flowered.

Species two or three, upon the Mascarene Islands. *N. Borbonicus* Gmel. forms a sharply limited wooded zone on Reunion Island, between 950 and 1300 m. above

sea level, which is only here and there interrupted by lava streams.

299. (286) **Bambusa** Schreb. (*Bambos* Retz, *Ischurochloa* Büse). Spikelets with 2–6 empty glumes gradually increasing in size and becoming like the flowering glumes,

FIG. 108.—Leafy twig of *Bambusa arundinacea* Retz. *B*, *C*, pieces of Tabasheer.

which are coriaceo-chartaceous, awnless, or with short mucronate points. The two- to many-flowered spikelets are frequently polygamous, especially the upper ones, and the lowest is often ♂ or empty. Ovary hairy; styles 2–3, more or less grown together at the base; caryopsis elongated-linear, smooth or slightly furrowed on the inside.

Usually tall arborescent shrubs or climbers, with simple or compound, rarely capitate, panicles; spikelets in fascicles along the branches of the inflorescence. There are three geographically distinct sections:

Sec. I. *Eubambusa.* Palea with projecting keels, which, however, are not at all, or only indistinctly, winged.

FIG. 109.—*Bambusa vulgaris* Wendland. Habit ($\frac{1}{20}$). (After Maout and Dec., Traité de Bot.)

Species thirty (besides several which are known only by their leaves), all belonging to the Old World. *B. Balcooa* Roxb. and *B. Tulda* Roxb. are esteemed as the

species most useful in East India, especially the first, which becomes very durable after lying in water. Both are thornless. *B. arundinacea* Retz (Fig. 108, *A*, and Frontispiece) (*B. spinosa* Roxb.) is a thorny and also an Indian species. *B. vulgaris* Wendland (*B. Thouarsii* Kunth) (Figs. 109, 110), with prominently netted-veined leaves, compressed spikelets, and a long, hairy style, is frequently cultivated in the tropical zones of both hemispheres; its native country is uncertain; it is also found in European green-houses. *B. Fortunei* Van Houtte (*B. picta* and *B. variegata* Sieb.) is a somewhat dwarfed species, with broadly striped leaves and transparent cross-veins, and makes a beautiful ornamental plant. It is from Japan, and endures the winter in Western Europe. *B. nana* Roxb. (*B. glaucescens* Sieb.), from Japan and China, is 2 m. high and has leaves that are grayish blue on the underside. There are other species having horticultural names but which are not scientifically classified.

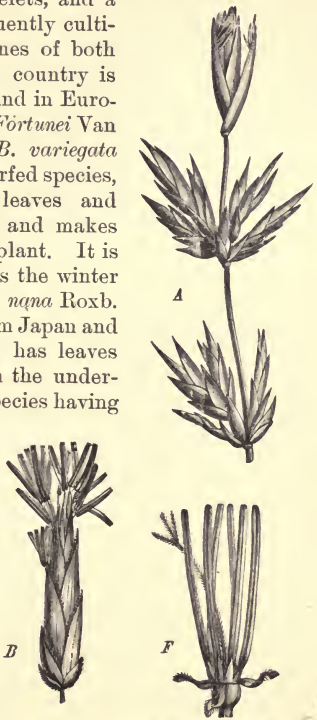

FIG. 110.—*Bambusa vulgaris* Wendland. (After Kunth, Revis. Gram. pl. 74.)

Sec. II. (285) *Guadua* Kunth (as a genus). Keel of palea more or less distinctly winged.

Species fifteen, all belonging to the New World, known in Brazil as "Taguara." The same name is, however, applied to the *Chusqueæ* and *Arthrostylidiæ*.

Sec. III. *Guaduella* Franch. (as a genus). Keel of the palea distinctly winged; spikelets strongly compressed.

According to Franchet the species included in this

section is only 60 cm. high, herbaceous, producing merely two large leaves on each culm.

Species one (*G. marantifolia* Franch.), grows at Gaboon in tropical West Africa.

Fossil Species.—A plant from the middle Pliocene of South France is placed in this genus as *B. lugdunensis* Sap., and perhaps correctly. On the contrary, the species described under *Bambusa* of different authors are, according to Schenk's critical remarks, partly remains of *Arundo* and partly fragments of other species which cannot be classified. (Engler.)

300. **Atractocarpa** Franchet. Spikelets in loose, terminal racemes, very much laterally compressed; two empty glumes, then several ♂ or sterile flowers, finally a ♀, terminal flower. Branches of the style conical at time of fruiting, broader than the caryopsis.

Species one (*A. olyræformis* Franch.), on the Congo at Brazzaville. According to Franchet this grass grows only 30 cm. high, is herbaceous, and has ovate-lanceolate leaves 18 cm. long by 7–8 cm. broad.

301. (287) **Gigantochloa** Kurz. Differing from *Bambusa* only by its monadelphous stamens. Tall arborescent species with numerous, dense fascicles of spikelets in branched panicles.

Species 4–5, in the Malayan Peninsula and Archipelago. *G. verticillata* Munro grows to the height of 40 m., with the branches beginning very high up on the stem.

302. (288) **Oxytenanthera** Munro. Spikelets long, conical, in compact fascicles, with ☿ terminal flowers, and 1–3 ♂ or sterile ones below; empty glumes 4–7, acute; lodicules none; anthers ending in a bristle or several hairs; fruit as in *Bambusa*. Tall shrubs. Five typical species in the East Indies and upon the Sunda Islands; a sixth, forming the section *Scirpobambos*, with large, spiny, capitate inflorescence (*O. Abyssinica* Munro), abounds everywhere in tropical Africa.

303. **Puelia** Franchet. Spikelets in short, terminal panicles, otherwise as in *Atractocarpa*, but with the

anthers grown together, and base of style persistent in fruit but not thickened.

Species one (*P. ciliata* Franch.), at Gaboon in tropical West Africa. According to Franchet this grass is only 30 cm. high; culms herbaceous, with long, narrow-lanceolate leaves.

SUB-TRIBE C.—**Dendrocalameæ.**

Stamens six; palea two-keeled; fruit fleshy or a nut.

304. (289) **Dendrocalamus** Nees. Spikelets in distant fascicles along the branches of the panicle; rachilla prolonged beyond the uppermost flower; empty glumes two to many, increasing gradually in size; lodicules none, or only 1–2 rudimentary ones; style long, with 2–3 short stigmas, enclosed below by a beak-shaped prolongation of the ovary; nut small, almost globose, beaked. Tall fruticose or somewhat arborescent, with habit of *Bambusa*.

Species nine, in East Indies, Sunda Archipelago, and China. *D. strictus* Nees, the "Male Bamboo" of the English, in India, is one of the most robust and useful species; it blooms almost annually and endures drought. The young shoots of *D. Hamiltoni* are a favorite vegetable.

305. (290) **Melocalamus** Benth. Spikelets two-flowered, small, in distant fascicles along the branches of the elongated panicle; rachilla prolonged and bearing a sterile glume. The lower flower only fertile; empty glumes two; lodicules three, large; styles three, united below; fruit globose, nearly as large as an apple, with a coriaceous, shining epicarp and "very large, fleshy seed." (Kurz.)

Species one (*M. compactiflorus* Benth.), a tall shrub in Martaban.

306. (291) **Pseudostachyum** Munro. Spikelets small, one-flowered, arranged in spikes along the branches of the panicle, each with a subtending leaf. Empty glumes one; flowering glumes acute, involute. Palea of the same length; above it there is a pedicellate globose or oblong

sterile glume. Lodicules three. Form of the fruit same as in *Anagallis*. Subarborescent.

Species one (*P. polymorphum* Munro), on the Himalaya Mountains.

307. (293) **Teinostachyum** Munro. Differing from the 306 in the fruit only; spikes in tufts, short, densely flowered, appearing like elongated spikelets and so understood by Munro. Shrubby or arborescent.

Species three, in East Indies.

308. (292) **Greslania** Balansa. Like the preceding, but differing in its styles and fruit. Fruit roundish-oblong, with a thick pericarp which is full of holes. Shrubs 2–3 m. high.

Species three, all in New Caledonia.

309. (294) **Cephalostachyum** Munro. Spikelets subtended by an enveloping leaf; rachilla prolonged beyond the fertile flower, bearing rudimentary bracts; empty glumes 1–2; lodicules 2–3; style elongated, 2–3-cleft; ovary and the elongated fruit beaked. Tall shrubs. Spikelets in dense heads, solitary, at the ends of the branches, or in many, remote glomerules; having the appearance of a hedgehog on account of the bristly projecting subtending leaves of the spikelets.

Species five, in the East Indies and Madagascar.

Sub-tribe D.—**Melocanneæ.**

Palea keelless, resembling the flowering glume.

310. (295) **Schizostachyum** Nees. Spikelets one-flowered, narrow-lanceolate, in remote fascicles along the branches of the panicle; rachilla prolonged, the projection bristle-like; empty glumes 4–6, gradually increasing in size, the uppermost one convolute like the flowering glume and palea, not keeled, many-nerved; lodicules 2–3, narrow; stamens free; style elongated, 2–3-cleft at the point; fruit a small ovate or globose, wrinkled nut, with a short beak. Tall shrubs with a slightly-branched or simple inflorescence.

Species seven, in Malayan Archipelago, China, and the South Sea Islands, as far as the Sandwich Islands.

According to Kurz, *Chloothamnus* Büse, with nodding spikelets, also belongs here.

311. (296) **Dinochloa** Büse. Spikelets very small, one-flowered, in distant fascicles along the branches of a very large panicle; rachilla not prolonged; empty glumes 2–3, obtuse; flowering glume one, similar to the empty ones; palea very broad, fringed; climbing, frutescent plants. Fruit not well known, probably fleshy.

Species one (*D. Tjankorreh* Büse), in the Malayan Archipelago.

312. (297) **Melocanna** Trin. Spikelets one-flowered, in crowded, one-sided spikes, 2–3 together in a tuft which is subtended by a leaf; rachilla not prolonged; empty glumes 4–8, mucronate-pointed, many-nerved; lodicules two, narrow; style elongated, 2–4-cleft; fruit shaped like an apple, fleshy. A tall tree.

Species one (*M. bambusoides* Trin.), in the East Indies, occasionally cultivated (on Mauritius, for example). The fruit, which is 8–12 cm. in diameter, is baked and eaten by the natives. The seed is the size of a betel-nut and of good flavor.

313. (298) **Ochlandra** Thwaites. Spikelets one-flowered, large, arranged in glomerules forming an interrupted spike, or in terminal heads; rachilla prolonged; empty glumes 3–7, coriaceous; flowering glume and palea involute, elongated. The numerous lodicules and the stamens somewhat connate at the base, the 6–30 filaments either in several bundles or grown together into a tube that elongates after flowering; ovary long-pointed, style elongated, slightly 4–6 cleft at the summit; fruit as in preceding genus, but somewhat smaller, acuminate-pointed or beaked. Tall shrubs.

Species three, in the East Indian Peninsula and Ceylon.

Doubtful genera: *Pentarrhaphis* Kunth and *Polyschistis* Presl (*Chlorideæ ?*); *Lepturopsis* Steud. (*Andropogoneæ*); *Chaboissæa* Fourn. (*Festucaceæ*); *Asthenochloa* Büse, *Lachnochloa*, *Kampmannia*, *Disakisperma* Steud., position undetermined.

INDEX AND GLOSSARY OF TERMS.

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