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UNITED STATES DEPARTMENT OF AGRICULTURE  
BUREAU OF PLANT INDUSTRY  
WASHINGTON, D. C.

DEPARTMENT OF AGRICULTURE.

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THE AGRICULTURAL GRASSES

OF THE

UNITED STATES,

BY

DR. GEORGE VASEY,

BOTANIST OF THE DEPARTMENT OF AGRICULTURE

ALSO

THE CHEMICAL COMPOSITION

OF

AMERICAN GRASSES,

BY

CLIFFORD RICHARDSON,

ASSISTANT CHEMIST.



WASHINGTON:  
GOVERNMENT PRINTING OFFICE.  
1884.





WASHINGTON, D. C., *July 1, 1884.*

SIR: I herewith submit a special report on the grasses of the United States which are either native or naturalized and which have more or less agricultural value.

Respectfully yours,

GEO. VASEY,  
*Botanist of the Department.*

Hon. GEORGE B. LORING,  
*Commissioner.*

1895

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## REPORT.

Every thoughtful farmer realizes the importance of the production on his land of a good supply of grass for pasturage and hay. He, who can produce the greatest yield on a given number of acres, will be the most successful man; yet this is a subject which has been, and still is, greatly neglected.

In the United States we have many climates, many kinds of soil, many geological formations, many degrees of aridity and moisture. It must be apparent that one species of grass cannot be equally well adapted to growth in all parts of this extensive territory; yet hardly a dozen species of grasses have been successfully introduced into our agriculture. True it is that this number answers with a tolerable degree of satisfaction the wants of quite an extensive portion of the country, chiefly the northern and cooler regions. But it is well known that in other localities the same kinds of grasses do not succeed equally well, and one of the most important questions for those regions is to obtain such kinds as shall be thoroughly adapted to their peculiarities of climate and soil. This is particularly the case in the Southern and Southwestern States, the arid districts of the West, and in California.

The solution of this question is largely a matter of experiment and observation.

The grasses which we have in cultivation were once wild grasses, and are still such in their native homes.

The question then arises, can we not select from our wild or native species some kinds which will be adapted to cultivation in those portions of the country which are not yet provided with suitable kinds? Many observations and some experiments in this direction have already been made, and if proper research is continued, and sufficiently thorough experiments are followed up, there is no reason to doubt that proper kinds will be found for successful cultivation in all parts of the country.

### GRASSES OF THE GREAT PLAINS.

The plains lying west of the one hundredth meridian, together with much broken and mountainous interior country, nearly treeless and arid, in New Mexico, Western Texas, and Arizona, are nearly useless for the purposes of ordinary agriculture, but are becoming more and more important as the great feeding ground for the multitudes of cattle which supply the wants of the settled regions of our country, as well as the constantly increasing foreign demand. The pasturage of this region consists essentially of native grasses, some of which have acquired a

wide reputation for their rich nutritious properties, for their ability to withstand the dry seasons, and for the quality of self-drying or curing, so as to be available for pasturage in the winter. This quality is due probably to the nature of the grasses themselves and to the effect of the arid climate. It is well known that in moist countries, at lower altitudes, the grasses have much succulence; they grow rapidly, and their tissues are soft; a severe frost checks or kills their growth, and chemical changes immediately occur which result in rapid decay; whereas in the arid climate of the plains the grasses have much less succulence, the foliage being more rigid and dry, and therefore when their growth is arrested by frost the tissues are not engorged with water, the desiccating influence of the climate prevents decay, and the grass is kept on the ground in good condition for winter forage. General Benjamin Alvord, of the United States Army, has recently published an article on the subject of these winter-cured grasses, and states that they only acquire this property on land which is 3,000 feet above the level of the sea. The region having such an altitude includes, he says, all, nearly up to the timber line, of Montana, Idaho, Wyoming, Utah, Nevada, Colorado, and New Mexico; five-sixths of Arizona, one-half of Dakota, one-fourth of Texas, one-fifth of Kansas, and one-sixth each of California, Oregon, and Washington Territory, embracing about one-fourth of the area of the whole United States.

Many of the grasses of this extensive region are popularly known as "bunch grass," from their habit of growth; others are known as "mesquite" and "gramma grass." These consist of many species of different genera, some of them more or less local and sparingly distributed, others having a wide range from Mexico to British America.

The most important of the "bunch grasses" may be briefly mentioned as follows: Of the genus *Stipa* there are several species; *Stipa comata* and *Stipa setigera* occur abundantly in New Mexico, Texas, Arizona, and California, reaching to Oregon. In Colorado, Kansas, and all the prairie region northward, stretching into British America, *Stipa juncea* is the principal one of the genus. On the higher plateaus and near the mountains the *Stipa viridula* is very common, extending from Arizona to Oregon and British America. Somewhat related botanically is *Eriocoma cuspidata*, a very rigid bunch grass, with a fine, handsome panicle of flowers. It is equally widespread with the preceding. Another widely diffused grass is *Aira cespitosa*, varying much in size and thriftiness according to the altitude and amount of moisture where it grows, but always having a light, elegant spreading panicle of silvery-gray flowers.

One of the most extensively diffused grasses is *Koeleria cristata*, varying in height from to 1 foot to 2½ feet, with a narrow and closely-flowered spike. Several species of fescue grass (*Festuca*) are intermixed with the vegetation in varying proportions; the most important of these, probably, are *Festuca ovina* in several varieties, and

*Festuca scabrella*, the latter especially in California, Oregon, and Washington.

The genus *Calamagrostis* (or *Deyeuxia*, as it is now called) furnishes several species which contribute largely to the vegetation of this region. They are mostly tall, stiff, and coarse grasses, but leafy and some of them very nutritious. Of these *Deyeuxia sylvatica* and *Deyeuxia stricta* are the least valuable. Perhaps the best of them is *Deyeuxia canadensis*, which is soft and leafy. Next in value, probably, is *Deyeuxia aleutica* of California and Oregon, extending into Alaska. *Calamagrostis* (*Ammophila*) *longifolia*, confined chiefly to the plains east of the Rocky Mountains, is tall and reed-like, growing in dense clumps, from 4 to 6 feet high.

Several species of *Andropogon* are diffused from Arizona to British America, but are not found on the western coast. The principal species are *Andropogon scoparius*, *A. furcatus* and *A. (Chrysopogon) nutans*. Some of them are known under the name of blue-joint.

Other grasses also widely spread, but in more sparing quantity are several species of *Poa* and *Glyceria*. Several varieties of *Triticum* (*Agropyrum*) *repens*, or Couch grass, occur abundantly in saline soils, and also *Agropyrum glaucum*, which is widely known as blue-stem and is considered among the most nutritious of grasses. *Brizopyrum spicatum* now called *Distichlis maritima*, and some species of *Sporobolus*, also form extensive patches or meadows in saline soils. Besides, there is a large number of grasses of low growth and of more spreading habit, which are known in the southwest and east of the Rocky Mountains under the names of mesquite and buffalo grasses. The former belong mostly to the genus *Bouteloua*, the most important species being *B. racemosa* or tall mesquite, and *B. oligostachya* or low mesquite. The true buffalo grass is botanically *Buchloë dactyloides*, which in many places forms extensive fields or areas. It is of a low and densely-tufted or matted habit. Another similar grass, spreading out in low, wide patches is *Munroa squorrosa*. The above-mentioned species form the larger proportion of the grassy vegetation of the great plains.

#### GRASSES OF MONTANA.

Prof. F. L. Scriber, of Girard College, Philadelphia, an accomplished botanist, spent the past summer in Montana in an investigation of the agricultural capabilities of the country, and he has furnished some valuable notes on the grasses of that region, from which we give the following selections:

“*Beckmannia erucaformis*.—Grows along the wet banks of streams, rivers, and irrigating ditches, never away from a constant and abundant supply of water. In favorable localities it attains the height of 3 feet, and yields an abundance of tender herbage. Well adapted for cultivation.

“*Hierochloa borealis*.—Common along the streams and rivers in the

mountainous districts, frequently occupying extensive areas to the exclusion of all other grasses.

"*Alopecurus glaucus*.—Very common along mountain streams and frequently covering acres of the so-called mountain meadows. Its slender but leafy culms grow to the height of 3 feet or more, and it is called in some localities 'native timothy,' which it resembles in habit. It yields to the acre a great bulk of fine, long, bright-colored hay, for which purpose it is often harvested and highly valued. It has little value for grazing. It grows most luxuriantly between the altitudes of 5,000 and 6,000 feet. Under cultivation I see no reason why this grass should not become as celebrated on the great western plateau as is its near relative, the meadow foxtail, in the moist climate of England.

"*Stipa comata*.—Common on the bench lands, growing in soil too gravelly and thin for *Poa tenuifolia*. In richer soil it grows tall and produces a great abundance of forage.

"*Stipa viridula*.—This is the most valuable of the *Stipas*, growing in light, sandy loam, frequently covering large areas to the exclusion of other species. In favorable localities it attains the height of 3 feet. The associated species are *Stipa comata*, *Poa tenuifolia*, and *Koeleria cristata*.

"*Eriocoma (Oryzopsis) cuspidata*, abundant on the lower sandy bench lands bordering the Missouri. It is one of the esteemed 'bunch grasses' and thrives on soil too sandy for other valuable species.

"*Phleum alpinum*, called 'native timothy,' it grows in mountainous regions near streams, ascending to the altitude of seven or eight thousand feet. At elevations between five and six thousand feet I have seen this grass growing in rich open woods along with common timothy (*Phleum pratense*), and it was the more luxuriant of the two—not so tall, perhaps, but growing to the height of 2 feet, with larger and more leafy culms. I see no reason why, in the region where this grass grows naturally in such luxuriance, it may not take the place in cultivation of the well-known and justly valued timothy of the East.

"*Agrostis exarata*.—Grows only along the rich, moist banks of streams in the mountain districts. Apparently a valuable grass to introduce into cultivation.

"*Deyeuxia Canadensis*.—Common along streams. There is a species allied to *Deyeuxia neglecta*, perhaps only a variety of it, that grows upon the dry bench lands along with *Poa tenuifolia* and *Koeleria cristata*, and so closely resembling the latter in habit that at a little distance it is difficult to distinguish the one from the other.

"*Deschampsia cespitosa* is common in moist meadows even when the soil is highly alkaline. It yields an abundant growth of stalks and leaves, and may have some value, but it is not recognized as a forage plant.

"*Bouteloua oligostachya*, the 'buffalo grass,' of Montana. Abundant on the lower benches at elevations of from 3,000 to 4,500 feet, and

regarded as one of the most valuable of the forage grasses. It stands tramping better than any other species, and comes in when other species have been tramped out. Its fine, curly leaves make a dense turf of highly nutritious herbage. The true buffalo grass (*Buchloë*) was not seen.

“*Kalearia cristata*, called ‘June grass,’ is very common on the bench lands, disputing possession with *Poa tenuifolia*. These two may be said to be the most common grasses of the low districts.

“*Distichlis maritima*, or ‘salt grass,’ is common in alkaline soil along the rivers. It is of little or no value for forage, and considered a great nuisance in agriculture, as its tough and matted roots form a sod that is almost impossible to be broken up.

“*Poa*.—All the *Poas*, wherever growing in abundance, yield much excellent food for stock. On the mountain tops we find *Poa alpina*, *Poa lava*, and *Poa casia*. *Poa Nevadaensis* is common along mountain streams, and on the slopes we find *Poa serotina* and *Poa nemoralis*. *Poa pratensis* is truly indigenous, and grows abundantly along the streams and rivers. *Poa tenuifolia*, in its various forms, may be called the grass of the country. It constitutes the chief forage upon the driest bench lands, where it is called ‘bunch grass,’ or, on account of its reddish color, ‘red-top.’ Another local name is ‘red-topped buffalo grass.’ In dry situations its culms are low and slender, and the foliage is confined to the dense radical tuft, the leaves of the stem being very short and of little account. When growing in rich soil, along streams or on land naturally irrigated, it makes a luxuriant growth of stems and foliage 2 to 6 feet high; and a field of *Poa tenuifolia* in bloom presents as fine an appearance as does a field of Kentucky blue grass in the East, and the produce per acre, I should think, nearly the same. This and *Kalearia cristata* are usually associated, and both bloom about the same time, June 15 to 30. As fine a field of natural grasses as I saw in Montana contained *Poa tenuifolia*, *Kalearia cristata*, *Stipa viridula*, and *Stipa comata* as the leading species, the *Poa* being the most abundant. In this field the *Stipas* were unusually fine, overtopping the other grasses.

“*Festuca scabrella*, the ‘great bunch grass’ and ‘buffalo bunch grass,’ is one of the principal grasses of the country. It is the prevailing species on the foot-hills and mountain slopes at from six to seven thousand feet. In respect to elevation above the sea, the following is the order of the most important grasses of the grazing lands of Montana: *Bouteloua oligostachya*, *Poa tenuifolia*, *Kalearia cristata*, and *Agropyrum glaucum* occupy the low lands and benches; then *Agropyrum divergens*; above this is *Festuca ovina*, var., and above all comes *Festuca scabrella*. In any of the mountain valleys the belts of altitude occupied by these grasses are well defined: First and lowest, *Poa tenuifolia* prevails; between this and *Festuca ovina* there is usually, though not always, a belt of *Agropyrum divergens*. Usually, at about 6,000 feet, *Festuca ovina* gives way to *Festuca scabrella*. The latter may be regarded as the more abundant

and valuable species of the two. It is rather too hard a grass for sheep, but there is no more valuable grass on the 'summer ranges' for cattle and horses. It makes excellent hay for horses, and is cut in large quantities for this purpose. It grows in large tussocks, making it rather a difficult grass to mow with a machine. *Festuca ovina*, var. prevails in the mountain regions on a line of altitude just below *Festuca scabrella*, growing in close bunches, and yields a large amount of forage for all kinds of stock.

"*Agropyrum glaucum*, 'blue-joint' and 'blue-stem,' is the most highly praised of the native grasses for hay. Wherever this grass occupies exclusively any large area of ground, as it frequently does in the lower districts, especially near Fort Benton, it is cut for hay. Naturally, it does not yield a great bulk, but its quality is unsurpassed. It has a tough, creeping root, like the 'couch grass' of the Eastern States, and by some is regarded as a variety of it. After two or three cuttings the yield of hay diminishes so much that it is scarcely worth the harvesting. An effectual way to increase the stand of grass after a succession of cuttings, as proved by actual experiment, is to drag over the sod a short-toothed harrow, which breaks up the roots or underground stems, and each fragment of root then makes a new plant.

"*Hordeum jubatum*, or 'fox-tail grass,' is common on the low lands, especially where there is moisture. It is looked upon as one of the worst of weeds. Its presence with other grasses destroys their value entirely for hay.

"*Elymus condensatus*, or 'wild-rye grass,' is the only species that is known popularly. It grows along the streams and rivers, often covering extensive areas. It is valued chiefly as a winter forage grass. It yields a great bulk of coarse hay, but is rarely harvested. When growing in fields of 'blue-joint' the blue-joint is cut and the rye grass is left standing. If cut before flowering it makes a good hay, but if left until it comes into flower, it is not only too hard for hay, but is too hard to cut, except with a bush-scythe."

In connection with this subject the question arises, what effect will continued pasturage have upon the perpetuity of the grasses composing these great pasture-fields? Probably in the course of time certain species will disappear, being unable to withstand the constant tramping and cropping by cattle and sheep, and it will be necessary to fill their place with more hardy species. If this is not done by self-propagation it will then become necessary for the proprietors of the land to make selection from the native species which prove hardy, or to seek out suitable species from other countries. It can hardly be doubted that among our very many native species there are those which will meet the requirements of the occasion, but much careful observation and many trials and experiments will need to be made before the question is satisfactorily determined. To an intelligent performance of this work a knowledge is first required of the characteristics, habits, and names of



the species now occupying the ground, and a very important aid to the acquisition of this knowledge will be found in the present work, with its descriptions and figures of a large number of the common grasses now prevailing in different parts of the country. A careful study of these and comparison with the living plants will enable an ordinary observer to identify the grasses which may come under his observation.

A chapter is also presented on the structure and characteristics of grasses in general, their various organs and parts, and the technical terms by which they are distinguished.

Where the species of a genus or order of plants are so numerous and so closely related as they are in the case of the grasses it is impossible, without an immense repetition of words, to describe accurately the differences between different kinds by the use of popular language. Any one, therefore, who may wish to obtain an accurate acquaintance with them will find it necessary to learn something of the botanical terms used in describing plants. We hope, therefore, that the reader will not be dismayed by the use of the technical descriptions, but will consult the glossary, where the terms are explained.

Among the younger readers, and especially, we may hope, among agricultural students, there are many who will be glad to have precise and scientific descriptions, for this is an age of progress, and an age when even the labor of the farm may be enlivened and beautified by mental improvement and by a scientific knowledge of the common objects of life.

For a close study of the flowers of grasses a small magnifier or lens, single or double, will be needed. One magnifying five to ten diameters will be sufficient, and such a one can generally be purchased at a jeweler's for a dollar or two.

Within the limits of the United States there are about six hundred species of grasses, mostly native, a few naturalized from other countries. Many of these species are either too small, too coarse, too sparse, or in some other way wanting in the character needed for a good agricultural grass. But it is certain that among this great number there are some which will be found suitable for cultivation at least in special districts. We have here selected from all parts of the country about one hundred and twenty species for description and illustration.

#### GENERAL REMARKS ON GRASSES.

The name grass in popular usage is by no means a definite term, as it is often applied to plants which have no botanical relationship. In a popular sense it includes the sedges, rushes, various plants with grass-like leaves, and sometimes such widely different plants as clover. On the other hand, many persons will be surprised on being informed that all the cereals, as wheat, barley, rye, oats, sugar-cane, sorghum, Indian corn, rice, and bamboo are true grasses. In this paper, however, we consider mainly such grasses as are used for pastures, meadows, or fodder purposes, or which have some importance in that direction.

## GENERAL DESCRIPTION OF GRASSES.

A grass possesses the following parts: (1) the root, (2) the culm, (3) the leaves, (4) the flowers.

(1.) The roots are the fibrous ramifications which extend downward into the ground and appropriate the water or other liquid nutriment to be conveyed into the stem and leaves.

(2.) The stem or *culm* is the ascending part which commonly rises above ground, either erect or reclining. Sometimes the culm is horizontal and subterranean, sending out erect branches and fibrous roots at the joints. These are called creeping stems, or, improperly, creeping roots. They are botanically called rhizomes, and sometimes are several feet long. In some grasses there is a kind of bulb at the base of the stem, in which is stored a concentration of nutriment for the support of the plant under peculiar circumstances, as in protracted drought. This bulbous formation is a part of the stem, and not of the root. The stem or culm of grasses is usually cylindrical and hollow; sometimes it is more or less compressed or flattened. It is divided at intervals by transverse thickened portions called joints or nodes, at which points leaves and sometimes branches are given off. These nodes tend also to strengthen the stem. Stems are usually simple and unbranched, except at the top, where they commonly divide into the more or less numerous branches of the panicle or flowering part. But some stems give rise from the side joints to leafy branches, which may, like the main stem, produce smaller panicles at the top.

(3.) The leaves take their origin at the nodes or joints in two ranks—that is, they are placed alternately on opposite sides of the stem at greater or less distances—thus, the first leaf will be on one side, the second on the opposite side a little higher up, the third still higher and directly over the first, the fourth over the second, and so on. The leaves consist of three parts: (1) the *sheath*, (2) the *ligule*, and (3) the *blade*. The *sheath* is that part which clasps the stem. It is generally open on one side, as will be readily observed in the leaves of a corn-stalk, but in some grasses the sheath is partly or even completely closed together by the adhesion of the opposite edges. The sheath is analogous to the stem or petiole of the leaves of many higher plants. The *ligule*: At the point where the blade of the leaf leaves the stem, at the top of the sheath and on the inner side, there is usually a small, thin, leaf-like organ, called the ligule or tongue. This is sometimes half an inch long, more commonly only two or three lines, and sometimes it is almost absent or reduced to a short ring, but its length and size is very constant in the same species. This ligule represents the stipules which occur at the base of the leaves in many of the higher plants. The *blade* or *lamina* of the leaf is the expanded part which is commonly called leaf. In the majority of grasses the leaf is long and narrow; that is, many times longer than wide. There is one central nerve, called

the *midnerve* or *midrib*, extending to the point of the leaf, and numerous fine lines or *nerves* on each side running parallel to each other, and not connected by transverse nerves and not giving off branches as in the higher plants. These leaves are in some species rough, in others smooth, hairy, or downy, &c. The agricultural value of a grass depends mainly upon the quantity, quality, size, and nutritive properties of the leaves.

(4.) The flowers: The flowers of the grasses are generally at the end of the stem or the side branches, sometimes very few in number, sometimes in great abundance, sometimes in a close *spike*, and sometimes in a *panicle*, with many spreading branches or *rays*. The flowers may be single on the branches or on the *pedicels*, or they may be variously clustered. In the common red-top (*Agrostis alba* or *A. vulgaris*), there is a single flower at the end of each of the small branchlets of the panicle. Each of these flowers is inclosed by a pair of small leaf-like scales or chaff, called the outer or empty *glumes*. The flower consists of (1) the essential organs and (2) the envelopes. The essential organs are the *stamens* and *pistils*, which may readily be seen when the grass is in bloom. The stamens, of which there are usually three in each flower, consist of the *anther* and *filament*, the anther being the small organ which contains the *pollen* or dust which fertilizes the pistil or female organ, and the filament being the thread-like stem on which the anthers are borne.

The *pistil* is the central organ of the flower, and consists of three parts, the *ovary*, the *style*, and the *stigmas*. In most of the grasses the styles are divided into two branches which have a handsome plumose appearance. The *stigmas* are the delicate parts at the extremity of these branches which receive the *pollen* for the fertilization of the flower, and the *ovary* is that part at the base which contains the future seed.

The envelopes of the flower are usually two leaf-like scales or husks inclosing between them the *stamens* and *pistil*; these scales face each other, one being a very little higher on the axis than the other, and also usually smaller and more delicate in texture. This smaller scale is called the *palet*; the other larger and usually coarser one is called the *flowering glume*; its edges generally overlap and partly inclose the palet.

The *flower* constituted as above described, together with the pair of outer or empty *glumes* at the base, form what is called a *spikelet*. In many cases, however, there are two three, or more flowers, sometimes even ten to twenty, in one spikelet, in which case they are arranged alternately on opposite sides of the axis, one above the other, with a pair of empty or outer glumes at the base of the cluster. Such may be seen in the blue grass (*Poa pratensis*), fescue grass (*Festuca*), and many others.

There are innumerable modifications of these floral organs, and upon the differences which exist in them the distinction of genera and species are based. In some cases the glumes are entire in outline, in some they

are toothed and lobed, and sometimes running out into a slender point called an awn, sometimes with a bristle or awn on the back, &c. They also vary in size from the twentieth part of an inch to an inch or more in length.

*Authorities consulted.*—In the preparation of this work reference has been had to many authorities, both scientific and practical. Among those who have written practically on the uses and the cultivation of grasses the following-named works have been consulted and frequently quoted. Flint on Grasses and Forage Plants; Grasses and their Culture, by Hon. J. Stanton Gould; Manual of Grasses at the South, by C. W. Howard; The Grasses of Tennessee, by J. R. Killebrew; The Farmer's Book of Grasses, by Prof. D. L. Phares, of Mississippi.

It is not thought necessary here to take up a systematic classification of the grasses farther than their arrangement in regular sequence, as the classification will be found fully described in the special report No. 63.

#### WINTER GRAZING IN THE ROCKY MOUNTAINS.

An article by General Benjamin Alvord, in a recent Bulletin of the American Geographical Society, with the above title, is deserving of extended publication and of careful study.

Our space will only allow us to give an abridgment of the article.

General Alvord says:

During the last fourteen years a revelation has dawned on the people of the United States, respecting the resources for winter grazing in the whole Rocky Mountain region. It is now known that all land over about 3,000 feet above the level of the sea has these qualities, viz, that without shelter, all the domestic animals can find ample food on the nutritious, summer-cured grasses of those plateaus, and that myriads of those animals are yearly raised by the great capitalists and others in our Western regions. The experiment has now for so many years been tried that it is not considered at all problematical, and although winters of great severity may occur, it is admitted that on an average the losses in the herds by the vicissitudes of the weather do not exceed 5 per cent. of the whole number.

General Alvord then proceeds to explain why this fact was so long unknown:

Surely it is extraordinary that so salient a fact as to the resources of this country should not have been fully known until the completion of the Union Pacific Railroad in 1869. My Army station from 1852 to 1865 was in Oregon or Washington Territory, and at Omaha from 1867 to 1871. Thus, I was thrown in the course of my official travels into regions giving me opportunities for observation, which I embraced. But I must confess that notwithstanding my knowledge of the benefits of the cured bunch-grasses in Oregon, east of the Cascade Mountains, and my large intercourse with emigrants yearly arriving on the Pacific slope, and with the officers and scientists of many exploring expeditions, it was not until during my residence in Omaha and my journeys over the Union Pacific Railroad that I knew of the immense resources for winter grazing on the Rocky Mountain plateaus which cover probably one-fourth of our whole territory. Our total area is 4,000,000 square miles, and we can safely add that the region for winter grazing is about a million of square miles, if not more—not including any portion of Alaska. The moment California, New Mexico, and the other

territories were acquired from Mexico in 1848, our Government turned its attention to the Pacific slope, and to the necessity of a Pacific railroad, and sundry exploring expeditions were organized in 1853 to examine the various routes—northern, southern, and central. These expeditions, and those preceding, of Lewis and Clarke, of Long, of Bonneville, and of Frémont, gave to the world a great mass of information of all kinds concerning those little known regions. Each of the Pacific railroad exploring parties had scientists of the greatest repute in various branches of investigation, as geology, botany, and natural history, and had with them experienced guides, hunters, woodsmen, mountaineers, and prairie-men; and all these were as ignorant as the rest of the winter resources of that vast domain. The reason was that all the explorations were made in summer, each party returning to winter in lower altitudes in the settlements without any attempt to discover and unveil the winter characteristics of the mountain regions.

We learned at Omaha that the discovery of the resources of the Rocky Mountain plateaus for winter grazing was really made during the war by the parties under that enterprising man, the late Edward Creighton (afterward president of the First National Bank of Omaha), who had taken the contract to build the telegraph line from Omaha to San Francisco. One winter their animals were left to graze in the elevated pastures of those regions, and were found in the spring in splendid order for the prosecution of their labors. This fact was utilized by Mr. Creighton, and it was the foundation of his large fortune, made in great part by stock-raising in Western Nebraska and Wyoming. These facts soon became known. By the time the Union Pacific Railroad was completed, in 1869, the enterprising capitalists and herdsmen of the West were aroused and ready to avail themselves of this new and promising mode of investment.

General Alvord proceeds further, as follows:

We will now undertake to explain the anomaly that the grasses of the arid plateaus are ready at all seasons for grazing, whereas in winter in all the lower altitudes they are not. Heat and moisture will cause the grasses in autumn and in winter to rot. With us they decay and, unless cut in season, cured and made into hay, are lost to use.

In the arid Rocky Mountain plateaus the grasses, as they stand on the soil, are cured in the sun during the summer, the action of heat retaining and concentrating in the stalks the sugar, gluten, and other constituents of which they are composed. This is true of the bunch grasses, the buffalo and grama, and many similar grasses which pervade those regions. It is so cold and so dry in those elevations that there are neither heat nor moisture to rot them. And the snows are so fine (save in some exceptional seasons) in that cold atmosphere, that they are so blown by the winds into drifts, that four-fifths of the soil is never covered by them. Thus, the grass is ever accessible to the domestic and other animals, while the snow is so fine that it falls from their backs; therefore they are not encumbered with a coating of frozen snow, which in the lower regions would go far toward killing the poor brutes. They find shelter in the hollows, bushes, and forests during very severe weather. In the natural abodes of the buffalo, antelope, and other wild animals, it is found that our valued domestic animals can in like manner survive the winter. Countless millions of buffaloes have ever subsisted on the buffalo grass. Although our domestic animals generally prefer the other grasses, the buffalo grass does not fail to be one of their resources.

The difficulties in lower altitudes than those I have described have been that after a warm spell and a thaw, the snow freezes to a crust and the grass is matted down by the ice, and kept from the stock. East of the Cascade Mountains, in the arid portion of Oregon, bunch grasses and cured grasses are found near the Dalles, where it is only 300 or 400 feet above the sea. In December, 1852, I witnessed such a thaw, followed by freezing, which kept the oxen from getting to the grasses, and consequently large numbers died of starvation. If they had been wintered near Fort Boise or any-

where 3,000 feet above the sea, they would have thriven on the rich bunch grasses ever accessible on those plains. Sheep should always have shelter from the cold winds, but no other stock requires it.

In Texas the grazing grounds are mostly at so low a level above the sea that the grasses rot in winter. Hence, in the latter part of winter, the animals there are often poor, and it is difficult to provide food for them. Thus it is that the vast herds started from Texas to be driven to market acquire flesh and improve every hundred miles of their journey north, as they reach new and well-advanced pastures.

But we must now allude to another element which prepares the elevated regions for winter grazing, viz, that the climate is much warmer than in the regions east of it in the same latitude. The isothermal lines all ascend in moving westward.

At Omaha cattle and horses must have shelter in winter, but none is needed at Fort Laramie. The extreme severity at Fort Buford, Dak., 1,900 feet above the sea is, in like manner, contrasted with the weather at Fort Phil Kearney or Powder River, 6,000 feet above the sea, or with the winter climate of Forts Custer and Keogh.

Scientists are not yet able to assign satisfactory reasons for these anomalies; perhaps they are inscrutable. Why in ascending the slopes of the Rocky Mountain plateaus a warmer climate should be encountered is a proper field for future consideration and investigation. It still remains a paradox.

We can make the following statement as to the region higher than 3,000 feet above the sea, fit for winter grazing. It includes all, nearly up to the timber line, of Montana, Idaho, Wyoming, Utah, Nevada, Colorado, and New Mexico, and five-sixths of Arizona, one-half of Dakota, one-third of Nebraska, one-fifth of Kansas, one-fourth of Texas, and one-sixth each of California, Oregon, and Washington Territory. This embraces, as we have already said, about one-fourth of the area of the whole United States.

Strange enough, all the best authorities who have had opportunities for comparison say that those regions farthest north are the best. Brisbin, page 90, says: "Montana has undoubtedly the best grazing grounds in America, and parts of Dakota stand next."

The writer thus engages in a consideration of the elevated plateaus of South America, Asia, and Africa, and a comparison with those of our own country, and thus proceeds as follows:

I shall now give some account of the various grasses which are found on the plateaus, and which are summer-cured. In Appendix C will be found a letter to me, of March 1, 1883, from Dr. George Vasey, botanist of the Department of Agriculture, who has complied with my request to give me a concise statement of the names of the principal grasses.

In general parlance it has been supposed that what are called "bunch" grasses are in the northern portions of the Rocky Mountain range, and that the "gama" or "grama" grasses were peculiar to the southern territories in New Mexico and Arizona. But I am satisfied, from personal inquiries of travelers (Marcy and Dutton among others), as well as from the statements of the botanists, that both the "bunch" grasses and others are found in each region. But it seems probable that the "gama" and "grama" grasses are found in the greatest abundance in the more southern portions. The "buffalo" grass or grasses (for the term is applied to more than one kind) are found throughout all the ranges of the buffalo from north to south. The term "bunch" grass was given because it grows in tufts or bunches a foot or more in height, sometimes two feet apart, so that the aspect from surrounding hills would often be that of a desert region. A green carpet is never or rarely seen. The buffalo grass grows as a low tuft, and it is summer-cured as it grows, like the other grasses under consideration.

By the courtesy of General F. A. Walker, Superintendent of the Census, I had the privilege of reading (before publication) a full and interesting paper by Prof. William

H. Brewer on "Pasture and Forage Plants." In the following statement I have often availed myself of some items from it.

The term "bunch grass" has been applied to several kinds, and we will name those prominently known:

The *Festuca scabrella* is the one best known on the Pacific slope, ranging from California to Oregon and Idaho.

The *Festuca occidentalis* is also found there.

The *Festuca ovina* (or sheep grass) in several varieties is found through the whole region of winter grazing, and seems the world over to be found wherever sheep graze.

*Eriocoma cuspidata* is one of the valuable bunch grasses generally prevalent.

Of the grasses termed "grama" *Eragrostis pectinacea* and *Eragrostis oxylepis* are called grama grasses. The former in Texas is sometimes called one of the buffalo grasses.

*Munroa squarrosa*, Mr. Brewer says, is a buffalo grass of the north, and one of the grama grasses of Texas. *Calamagrostis longifolia* has a wide range and is sometimes called "mesquit" and grama grass, and *Calamagrostis canadensis*, sometimes called "blue joint."

The terms "gama" and "grama" are not interchangeable. Mr. Brewer says that *Tripsacum dactyloides* is the "gama grass" of the South—a tall, coarse grass, from 3 to 7 feet high—and is found from Texas to Illinois and Connecticut.

Though much confusion of names is in popular use in reference to all the grasses it seems to be admitted that the term "buffalo grass" is applied most justly to *Buchloe dactyloides*. It is one of the most nutritious of grasses and pervades the whole range of the Rocky Mountain plateaus.

The following is the letter of Dr. Vasey, referred to in the preceding paper:

DEAR SIR: In reply to your request I offer the following remarks on the native grasses of the great plains and arid portions of the West. These grasses furnish the chief resource of the immense herds of buffaloes and the vast droves of domestic animals which feed upon the plains, and from the habit of growth are, for the most part, known by the name of bunch grasses. They are chiefly grasses of rigid aspect, at least as respects their culms and leaves, some of them, however, forming a diffuse and elegant panicle of flowers. The most important of the bunch grasses may be briefly mentioned as follows:

Of the genus *Stipa* there are several species. *Stipa comata* and *Stipa setigera* occur abundantly in New Mexico, Texas, Arizona, and the drier regions of California, reaching to Oregon. In Colorado, Kansas, and all the prairie region northward, stretching into British America, the *Stipa juncea* is the principal one of the genus. On the higher plateaus and near the mountains the *Stipa viridula* is very common, extending from Arizona to Oregon and British America. Somewhat related botanically is *Eriocoma cuspidata*, a very rigid bunch grass with a fine, handsome panicle of flowers. It is equally widespread with the preceding. Another widely-diffused grass is *Aira caespitosa*, varying much in size and thriftiness according to the altitude and amount of moisture where it grows, but always having a light, elegant, spreading panicle of silvery-gray flowers.

One of the most extensively-diffused grasses is *Koeleria cristata*, varying in height from one foot to two and a half feet, with a narrow and closely-flowered spike. Several species of fescue grass (*Festuca*) are intermixed with the vegetation in varying proportions; the most important of these are probably the *Festuca ovina*, in several varieties, and *Festuca scabrella*, the latter especially in California, Oregon, and Washington.

The genus *Calamagrostis* furnishes several species, which contribute largely to the vegetation of this region. They are mostly tall, stiff, and coarse grasses, but leafy, and some of them very nutritious. Of these *Calamagrostis sylvatica* and *C. stricta* are

least valuable. Perhaps the best of them is *Calamagrostis canadensis*, which is soft and leafy. Next, perhaps, in value is *Calamagrostis aleutica*, of California and Oregon, extending into Alaska. *Calamagrostis longifolia*, confined chiefly to the plains east of the Rocky Mountains, is tall and reed-like, growing in dense clumps, from four to six feet high. Several species of *Andropogon* are diffused from Arizona to British America on the plains, but are not found on the western coast. They are, however, not properly called bunch grass, as their habit of growth is more spreading. The principal species are *Andropogon scoparius*, *A. furcatus*, and *A. nutans*. Some of them are known through the plain region as blue-joint or blue-stem. Others, more sparingly spread, are several species of *Poa* and *Glyceria*. Several varieties of *Triticum repens* or couch grass occur abundantly in saline soils, and are among the most nutritious of grasses. *Brizopyrum spicatum* and species of *Vilfa* and *Sporobolus* also form extensive patches or meadows in saline soil. Besides the grasses already mentioned there are a large number of low growth and more diffused habit, which are known in the Southwest and east of the Rocky Mountains under the names of mesquit and buffalo grasses. The former belong mostly to the genus *Bouteloua*, the most important species being *B. curtipendula*, or tall mesquit, and *B. oligostachya* and *B. hirsuta*, or low mesquit. The true buffalo grass is botanically *Buchloe dactyloides*, which in some places forms extensive fields of its low and densely-tufted growth. Another similar grass spreading out in low patches is *Munroa squarrosa*. The above-mentioned species form the larger proportion of the grassy vegetation of the great plains.

Respectfully,

GEO. VASEY,  
Botanist.

General BENJAMIN ALVORD.

REPORTS ON GRASS AND GRASS CULTURE FROM ALL PARTS OF THE  
UNITED STATES.

In 1882 circulars were sent out by the Commissioner of Agriculture to agriculturists and farmers in all parts of the country asking information as to the natural pasture grasses of this district, what kind of natural and cultivated grasses were used for hay and pasture, and what grasses could be suggested for experiment. A large number of reports were received and compiled by the assistant botanist, W. P. Conant, and a summary of the results is herewith given. As a general thing the correspondents were not acquainted with the botanic or technical names of the grasses, and gave the common or local name where there was one. It frequently happens that the same grass will have different local names even in places not far remote from each other, and also that the same name will be applied to grasses very unlike. Many have no common name and are referred to as wild grass, woods grass, swamp grass, &c.

So, in examining the reports, a perplexing difficulty was often encountered in not being able to determine to what species a grass belonged from the name given. In some instances this difficulty was obviated by obtaining specimens of the plants referred to; in others they were not sent or failed to reach here.

The reports were sent in with commendable promptness, and all evinced a great interest in the subject, and expressed a strong desire to aid the undertaking by all means in their power.



## WASHINGTON TERRITORY AND OREGON.

From Washington Territory twelve reports were received, and from Oregon thirty-one. They are so much alike that we consider them together.

## NATIVE PASTURE GRASSES.

Bunch-grass is found in the drier places and on the hills; wild pea-vine and a few wild grasses in the timber; clover upon bottom-lands; wild rye-grass, a species of *elymus*, upon lowlands, and a variety of mixed grasses upon the prairies.

Several species of grass are called bunch-grass, the principal of which are *Poa tenuifolia* Nutt, *Festuca scabrella*, *Eriocoma cuspidata*, and some of the species of *Stipa*.

Bunch-grass, which formerly was the principal pasture grass upon the uplands, has become about extinct, partly from the land being taken for cultivation and partly from overfeeding. Its place has been taken by wild chess (*Bromus secalinus*) and other poor grasses.

But little native grass is cut for hay; some little wild red-top, wild-rye grass, salt-marsh grass upon tide-water, and, east of the Cascades, a little bunch-grass is cut.

## CULTIVATED GRASSES.

Timothy is found universally distributed throughout this section, and has become so well established that some consider it indigenous. It has so tenacious a hold upon the soil that it can scarcely be killed out. As a hay grass, timothy has no superior; for a pasture grass, it gives out too early in July.

Next in general diffusion come the clovers and orchard grass. Red-top, also, is quite common. Kentucky blue-grass, though not so extensively introduced, seems well adapted to some portions of this section.

The soil and climate of Oregon and Washington Territory are admirably adapted to the culture of grass, and any kind will do well if allowed a fair chance. There is a great diversity of soil; and often on the same farm all kinds may be found, from the black sandy loam to red clay.

From some, come inquiries for a grass that will do well upon lands worn out by constant wheat-cropping; others say that they are sowing clover on their exhausted lands to recuperate them, and no better advice can be given the former than to do likewise. By this means the tired lands can soon be restored to fertility.

A better way, and one which the intelligent farmers will soon learn to follow, is to avoid depleting the land at all, but by a suitable rotation of crops, among which the clovers and grasses should have a prominent place, the lands can be kept in a normal state of fertility, and, being naturally rich, will yield a generous reward to the husbandman's toil.

## CALIFORNIA.

From California thirty-seven reports were received. They give the following as the principal grasses:

## NATIVE PASTURE GRASSES.

Wild oats (*Avena fatua*), alfilaria (*Erodium cicutarium*), bur-clover (*Medicago denticulata*), wild clovers, of which there are several species, and bunch-grass, in the order named. In the northern part of the State a little wild rye-grass (*Elymus*), wild red-top, and wild pea-vine are found.

Accounts from the central and southern counties state that the native bunch-grass, which formerly furnished a nutritious feed for a large part of the Pacific slope, has of late years become about extinct, and in some sections the alfilaria, bur-clover, and other forage plants, which were found on the uncultivated lands during spring and early summer, are slowly but surely dying out, and their places are being taken by a worthless grass that nothing will eat green or dry.

Mr. C. O. Tucker, of Ballena, attributes this gradual disappearance of the native grasses to the constant and too close pasturage at and prior to the time for maturing their seeds, and to a too persistent pasturage with sheep at other times, causing the ground to become thoroughly trodden and compacted. This has been followed during the last few years by unusually hot and dry summers. He knows of no section where the need of useful forage plants is more severely felt than here.

Mr. Mart. Walker, of Saint Helena, says that there is an intense desire among farmers to obtain a grass capable of resisting the intense heat and drought of summer, and afford grazing for cattle during that period, and if possible one that will grow on poor soil. For the want of some such resource many districts are fast becoming worthless. He says that this results from the system of continuous cropping to which the land has been subjected for the last thirty years.

## NATIVE GRASSES CUT FOR HAY.

Except wild oats and bur-clover but little native grass is cut for hay. In the northern part of the State a little wild-rye grass, wild red top, and in some localities rushes are cut.

## CULTIVATED GRASSES.

The various grains, as wheat, rye, and barley, cut when in the milk, are principally relied upon for hay in many parts of California. They come as volunteers, or very often after the grain is taken off a "half cast" of seed is sown on the stubble at the first rain in the fall and harrowed in. Wild oats are cut extensively, and alfalfa (*Medicago sativa*), often called lucern, is cultivated largely for hay, especially in

the southern part of the State, where by irrigation large crops are made.

In the northern and central counties timothy and clover are cut to some extent, and are commented on favorably. Thus far but very little attention has been given to this subject. The general system of farming in vogue here is so different from that of other parts of the country, and so few experiments have been made, that no particular grasses or forage plants can be recommended at this time.

Further experiments and developments will have to determine the important question.

#### IDAHO AND MONTANA.

Bunch grass is common throughout the hill country. In the lowlands the wild rye grass and other coarse grasses are found. Timothy is found successfully cultivated everywhere. In Idaho clover is cultivated extensively, especially in the Boise Valley, where some very large crops are reported. Some farmers have put their whole places in it. The small red clover is preferred. Alfalfa succeeds well in Montana.

Timothy and clover are recommended for the bottoms, and alfalfa for the "bench lands." All the grasses would succeed well with attention. The soil and climate are well adapted to their growth, and all things seem favorable to their culture, both for pasture and hay. All the farmers have to do here is to avoid the mistake made in many new sections, that of overpasturing and continuous cropping, and for years to come they will have a never-ceasing source of wealth.

#### UTAH.

The principal native pasture grasses of Utah are the bunch grass, wire grass (*Juncus Balticus*), salt grass (*Vilfa depanperata*), and buffalo grass (*Buchloe dactyloides*). The wire grass and salt grass are cut for hay. Lucern, or alfalfa (*Medicago sativa*), is cultivated for forage and hay to a greater extent than anything else, and succeeds well. In some counties scarcely any other forage plant is cultivated.

Clover is reported successful in some places and timothy in others, though neither has been cultivated largely.

#### NEW MEXICO.

The gramma grass (*Bouteloua*) is common on the high ground throughout New Mexico. On the river bottoms there is a little blue grass. Alfalfa has been cultivated more than any other forage plant, and on the bottoms will thrive after the second year without irrigation. The millets have been raised some, and should receive more attention. No experiments worthy of note are reported.

The reports from Utah and New Mexico were so few in number, and the area so great and so diversified that no suggestions can be made as to what grasses will be best adapted to this section. Many experiments will have to be made to determine this.

## TEXAS.

## NATIVE GRASSES.

From Texas there were sixty-nine reports. The natural pasture grasses consist of the mixed grasses usually found on the prairies which occupy so large a part of the State. The sage or sedge grass holds a prominent place among them; but when overpastured it is run out, and the mesquite, both hardier and better, takes its place. The mesquite is found in the northern, central, and southern parts of the State, but not much in the northeastern part.

The term mesquite is used somewhat indefinitely, being applied to a number of grasses, but here it is probable that the buffalo grass of the plains (*Buchloe dactyloides*) is meant. It is found chiefly on the black lands. The gramma grass (*Bouteloua*), of which there are some patches, is rapidly disappearing, and is being replaced by the mesquite. Prairie grass thus far has been the chief reliance for hay as well as pasture.

Texas has always been a great stock-raising State, and while the range was uninterrupted no attention was given to cultivating grass or to improving pastures. But of late years portions of the State have been rapidly filling up, and the range consequently diminishing, so now the farmers are giving considerable attention to improving their pastures and to the hay crop. This, intelligent farmers write, should receive all the encouragement and assistance possible.

Mr. Talley says that the greatest difficulty in making the culture of Kentucky blue grass a success is in getting it to live the first year. The same remark is applicable to most of the grasses. The main reason of failure, he says, is not so much on account of the drought as on account of the nature of the soil. It is loose and porous, and dries up very quickly on the surface; hence they often find it difficult to get a "stand" of turnips in the fall or a "stand" of millet in the spring. The soil holds moisture well below the depth of 2 inches.

He further says:

I have taken great interest in investigating the subject of grasses, and my labors were awarded by finding a much greater variety on my place than I had ever suspected, and all I have to do is to cultivate and take care of what I already possess, and cut the weeds to prevent their shading and smothering out the grasses already in the ground.

Texas is naturally a great State, and only needs fair attention to succeed. Johnson grass and Bermuda are receiving considerable attention, and for the most part are spoken of favorably.

Bur, or California clover, does well in this State, and is highly esteemed in California for the feed it affords, though the burs or seed-pods stick to the wool of sheep and impair its value. Alfalfa is cultivated largely here, and does very well. Timothy, orchard grass, and clover are not reported on so favorably as could be wished.

The millets are cultivated quite extensively and do well. Mr. Clarke,

of Hempstead, Waller County, Texas, has recently sent to the Department samples of several kinds, among which were specimens of the so-called double-headed German millet  $4\frac{1}{2}$  feet high, and estimated to yield 3 tons to the acre.

Mr. W. H. D. Carrington, of Austin, says that there is but one native grass cultivated for hay, and that is what is called Colorado bottom grass; sometimes called goose grass, and in some places Green River grass (*Panicum Texanum*). The method of culture most commonly adopted is the same as that for crab grass. It comes voluntarily after corn is "laid by." A few farmers have found it so profitable that they plow and harrow their land in winter and cut the grass as soon as it matures. In this way they secure two crops annually. It is preferred by all kinds of stock to Hungarian grass or to oats in the sheaf. It seeds itself freely. The hay sells now (February, 1882), at \$25 per ton, while prairie hay sells at from \$10 to \$12 per ton. This might be introduced into the other Southern States without requiring any change in the method of culture generally pursued. It is figured and described in the report for 1879.

#### THE SOUTHERN STATES.

The returns from Georgia, Florida, Alabama, Mississippi, and Louisiana are so similar in general character that they are considered together, differences being noted as they occur.

#### NATIVE PASTURE GRASSES.

By an examination of the returns from this section, crab grass (*Panicum sanguinale*) is found to be the most extensively diffused pasture grass for summer and fall grazing, while crow-foot (*Eleusine Indica*) is quite common in Georgia and Florida.

The sedge grass also holds a prominent place as a pasture grass in Georgia, Alabama, and Louisiana, being reported from nearly one-half the counties. Several grasses are called sedge and broom sedge. They are for the most part some species of *Andropogon* or *Stipa*.

Bermuda grass (*Cynodon dactylon*) is reported in over one-third of the counties, and is probably growing in many more, and though an introduced grass it has become so well established that it is generally referred to as a native. The wild pea vine is also plentiful and in some places quite popular. In Florida it is said to do well on the poor sandy soil, and to endure the heat and drought of summer. Mexican clover (*Richardsonia scabra*) is spreading over the sandy uplands along the coast. Tick trifol, or tickseed, two species of *Desmodium*, is frequent in rich woods, and is esteemed as a milk-producing plant. Nimbwill (*Muhlenbergia Mexicana* and *diffusa*) are found in open woods in the northern and central counties.

In Alabama and Mississippi, Japan clover (*Lespedeza striata*) has spread extensively over the roadsides and uncultivated fields. It will

grow upon all soils, even the poorest, and withstands the heat and drought of summer remarkably well. It spreads rapidly, and some say it will root out the broom sedge and even Bermuda. It is rather a coarse plant, and should be tried only in places unsuitable for the better grasses. In Louisiana, crab grass, though still common, is gradually giving place as a pasture grass to Bermuda and white clover. Several species of clover seem to be spreading over this section; some of them are said to afford considerable seed.

The bur, or California clover (*Medicago denticulata*), is reported in two counties of Alabama, and has been successfully tried in Georgia. In California it is highly esteemed.

*Paspalum ovatum* is found in Texas and Louisiana. It is highly spoken of as a pasture grass by those who have examined it. (See report of the botanist for 1880.)

Numerous other grasses are found growing with the foregoing species, but generally are of no particular value, and having for the most part no common names, they are spoken of as wild grasses, &c.

In regard to native pasture grasses, Mr. Hawkins, of Hawkinsville, Ala., says:

There is but very little grass of any kind here, except the wild varieties which come spontaneously on all old fields with the broom sedge, and our very best pastures are on these old fields. Old fields when turned out usually grow weeds the first two years, and require about four years for them to become sodded with broom sedge. Burn this off in early spring, and with sufficient cattle it need never be burned again, as the cattle will keep it down. I have an excellent pasture of 150 acres of this kind, which will keep in good condition thirty head of cattle, half as many mules when not at work, and some hogs.

#### NATIVE HAY GRASSES.

In this section crab grass is cut very extensively, being reported from nearly every county where any attention at all is given to hay. Crow-foot, as a crop grass, is chiefly confined to Georgia. Some of the coarse swamp grasses are cut to a considerable extent in certain localities.

#### CULTIVATED GRASSES.

Over one-half of the reports from this section state that no attempts have been made to cultivate grass for hay. They rely entirely upon the volunteer grasses, the principal one being crab, which some consider to be superior to the so-called cultivated grasses.

The chief reasons given in favor of crab grass as a pasture grass and for hay are that it is indigenous, and therefore well adapted to withstand the effects of the climate; that the ground has only to be smoothed after the corn is "laid by," and it comes voluntarily; that it never fails, and does well on poor and sandy soil.

In the remaining counties more or less introduced grasses have been

cut for hay, consisting principally of herds grass (red top), the clovers, timothy, and orchard grass in the order named. Bermuda grass is reported to be cut for hay to a greater extent than any other, except the crab grass. The millets are cultivated for hay, and are deserving of more attention, for, being annuals, they can be grown successfully in all parts of the South. In Louisiana the cow-pea is considered one of the best forage crops, and its cultivation is extending. In the Red River district sorghum of various kinds is largely raised for food.

#### JOHNSON GRASS.

Johnson grass is steadily growing in favor and its cultivation extending. It is being introduced on the low, wet prairie lands of Texas, and the reports are quite favorable. It is essentially a hay grass, and may be cut three or four times a year. It should always be cut before the seed stalks run up, else it will be too coarse. It is even more difficult to exterminate when once well set than Bermuda, hence should not be allowed to seed. The best way to eradicate it is by frequent plowings in July and August, exposing the roots as much as possible to the sun. It will not bear tramping.

Both this grass and Bermuda are regarded as a great blessing, or as an unmitigated evil, according to the standpoint from which they are viewed. The exclusive cotton-planter is apt to look upon them with unabated hostility, while those who are beginning to diversify their crops look upon these and other grasses as a great boon.

In these States hay should be secured early enough in the season to allow the meadows to get a good start before the summer drought sets in, so that the roots may have a good protection during this trying period. Meadows should not be pastured until the fall rains set in, and then only lightly, and never when the ground is soft from much rain. Care should be taken not to pasture too late in the spring, thereby preventing the grass from growing tall enough to cut before the heat of summer. According to the reports, the farmers are accustomed very generally to pasture too closely, which causes great injury, if not destruction, to the grass.

#### PERMANENT PASTURE.

For a permanent pasture grass the Texas blue grass (*Poa arachnifera*) promises to be one of the very best grasses yet brought to the attention of the South. It is a strong, deep-rooted grass, with an abundance of foliage, and seems to possess all of the characteristics necessary for a grass to be successful in most parts of the South. It grows in woods or open prairie, and thrives upon a variety of soils, poor as well as rich, but has not, so far as reported, been tried upon a dry, sandy soil. This grass seems worthy of earnest consideration by

all interested. As it is figured and so fully described in another part of the report more need not be said here.

The Texas blue grass dies down during the heat of summer and springs up with the first fall rains and lasts till summer again. Bermuda comes in early spring and lasts till frost comes, thus being a summer pasture grass.

#### WINTER PASTURE.

From several places, especially in Georgia and Alabama, requests come for a grass that will make good winter pasture, and if possible one that will succeed upon weak, sandy soil. The cultivated grasses best adapted for winter pasture at the South are the tall meadow oat grass (*Arrhenatherum avenaceum*), which will thrive on more sandy soil than most of the cultivated grasses (though it prefers a rich upland), and will yield more green food in winter than any other grass.

Orchard grass (*Dactylis glomerata*) is next in value. It does well in orchards and thinned woods, and will do well on any rich, dry soil. After being cut or eaten down by stock it springs up again with great rapidity, thus rendering it of peculiar value as a pasture grass. Experiment demonstrates that these grasses will thrive and do well in the northern and central counties of the Gulf States, and ought to succeed in all sections, except, perhaps, on a very dry, sandy soil. These two grasses are thought to endure the heat and drought better than other cultivated grasses. Italian rye grass (*Lolium Italicum*) is one of the very best grasses for this section. By being sown and harrowed in at the first fall rains it will be ready for pasture by midwinter, and will afford a rich pasturage during the latter part of winter and spring, and can then be plowed under for the following crop, thus enriching the land as well as furnishing abundant winter feed. By only pasturing very lightly a crop of hay can be cut and the stubble turned under for a following wheat or other grain crop. The attention cannot be too strongly called to this useful grass. Wild rye grass (*Elymus*) and wild meadow barley (*Hordeum pratense*), also the common cultivated rye and barley, make excellent pasture.

#### BERMUDA GRASS.

Bermuda grass has of late attracted more than usual attention. It has been referred to and discussed by so many of the correspondents that an idea of the estimation in which it is held cannot be better given than by making a few extracts from their letters.

Mr. Hawkins, of Barbour County, Alabama, says that he is very certain now, and has been for years, that the great want of the South is a grass with which the tired lands may be seeded, and some return had while the land is being recuperated. Bermuda, he says, is the grass to do this if it seeded, and could be easily destroyed when the land is wanted for cultivation. These difficulties, he says, operate suf-



ficiently to almost exclude it from the tillable land. A correspondent from Mississippi says :

Bermuda is the grass for this country, resisting both the drought of summer and the frost of winter, and affording a richer pasturage than any other grass. With this for pasture and the Johnson grass (*Sorghum halapense*) for hay, stock-raising will be more profitable than cotton.

Georgia has taken the lead in introducing Bermuda grass. In the central part of the State it is found in every county, and is steadily growing in favor. The report of the State board of agriculture for 1881 says :

The hay crop of Georgia has been unusually fine in 1881. The clovers and cultivated grasses made heavy crops before the summer's drought commenced. Large harvests of Bermuda hay were realized in some of the counties of Middle Georgia, where this valuable grass is being more highly appreciated every year. It makes a hay inferior to none, with the advantage of being permanent when once well set. Quite a number of farmers now realize a better income from lands set in Bermuda than they did from the same when in cotton.

Another correspondent says :

Bermuda, beyond all doubt, is the best grass for pasture, but for hay we need other grasses, and I am satisfied that Johnson grass is the one for that purpose. These two grasses have the power to make this section a great stock country.

Such expressions as this frequently occur in the reports: "Bermuda is the best, but the farmers are afraid of it."

Mr. F. Seip, of Rapides Parish, Louisiana, says :

Of all the usual cultivated grasses none can compare in general usefulness to the Bermuda. It is invaluable as a pasture grass for all kinds of stock, furnishing, through nearly the entire year, and even in winter, under some circumstances, an extraordinary amount of food. For hay purposes it cannot be surpassed. Under favorable circumstances it will yield more to the acre than any other known grass, with the exception possibly of lucern (*Medicago sativa*) and Johnson grass, the latter being too coarse to make superior hay.

Again Mr. Seip says of Bermuda :

It can only be recommended for permanent pastures or meadows, as it is very difficult to eradicate, but still it is practicable to remove it. The best method, I think, is summer plowing repeated frequently, followed by oats in the fall and winter, and after the oat crop by a heavy crop of pease. If this is well done there will be no trouble in making a crop of corn or cotton the following year.

Colonel Lane, in "Forage Plants of the South," says, in reference to destroying Bermuda :

Upon ordinary upland I have found no difficulty in destroying it by close cultivation in cotton for two years. It requires a few extra plowings to get the sod thoroughly broken to pieces. The breaking should be done with a small plow first and a harrow run over it once or twice in winter or early spring. Take advantage of the dry hot months of summer to have the grass that may be found alive plowed and hoed, and exposed as much as possible to the sun. In ordinary seasons so much of the grass will be killed the first year that but little interference with the next crop need be apprehended.

Bermuda is essentially a Southern summer-pasture grass, and as such possesses superior qualities. It will thrive upon poor soil and stand the heat and drought of summer. It is nutritious, and is eaten by all kinds of stock. It is permanent when once well set, provided it is pastured; otherwise, the broom sedge and other grasses will run it out. It requires tramping to flourish. The objections it encountered during the first years of its introduction have gradually given way, as the farmers have seen more of it and have become better acquainted with its nature and habits. To make hay it requires a rich soil—a soil rich enough to produce good crops of timothy and the more valuable grasses. It is an ameliorating crop. A field kept in Bermuda a few years will become so enriched that should it be wanted for cultivation the increased crops will more than pay for the extra labor and expense required the first year on account of the sod.

Often in the reports a request is made for a grass that will do well on their exhausted lands and yield some return while they are being recuperated. Lands naturally fertile, but depleted by cropping, if not “turned out in commons,” can be recuperated by proper management through the agency of ameliorating crops, the particular ones to be used varying with the different conditions of location, nature of soil, &c., and cannot be entered into minutely here, but which the intelligent cultivator will soon learn to determine.

Immediate and constant returns, as some ask for, should not be expected from a soil already exhausted. But in a short time, by generous treatment, they can be brought to a condition to once more reward the toiler for his labor, and will prove in the end to be much more economical than to “turn the fields out” and wait thirty or forty years for the slow process of natural recuperation, expending meantime ones energies in clearing and bringing into cultivation new tracts, to be in turn abandoned and “turned out.”

Some ask for a grass that will do well upon a soil naturally poor or barren. Such a soil will not yield anything without fertilizing except a few worthless weeds or some of the coarser plants. Good grasses will not grow on land that will not produce medium crops of grain. By using fertilizers and turning under green crops the productiveness can be increased so as to give fair returns, and then by suitable rotation the land can be continuously improved.

#### EXPERIMENTS.

In nearly one-half of the counties, according to the reports, no experiments introducing new grasses have been made, while in many of the other counties they have been made only on a small scale, and were too often abandoned as failures before they had been fully tested. Failures frequently result from not fully understanding the nature and re-

quirements of the grasses, especially during the early stages of their growth.

Mr. J. J. Barclay, of Wheeler, Ala., says:

I have experimented on my place with most of the cultivated grasses, and find they do well if protected from the tramping and depredations of stock for one season. \* \* \* I am confident of their success and feel that their introduction into this portion of the South will be of incalculable benefit to the country and people, and especially attractive to the immigrant, whose first question is, "Do grasses grow in your State?"

Another says that orchard grass, tall meadow oat grass, and Johnson grass will do well if properly attended to and the ground suitably prepared. Mr. Hawkins says that his experiments show that any of the grasses will do well upon rich loam, or on moist, stiff land, or on moist, sandy land. Mr. D. P. Hurley, of Pike County says:

I would add, on the important subject of grasses, that their cultivation is sadly neglected, not because the climate is hostile or the soil unadapted, nor because they cannot be successfully cultivated, but for the reason that diversified agriculture is practically disfavored.

Mr. P. M. Morehouse sent from Texas a sample of Kentucky blue grass, grown on the open prairie, without shade or extra care after well set. It has withstood the heat and drought of summer for three years extremely well. Yet there are large tracts of country, often embracing counties, where a meadow of grass is not to be found. Mr. Hawkins says that he does not know of a meadow of cultivated grass in South-eastern Alabama. Similar statements come from Louisiana. This unfavorable condition has arisen from several influences which can only be referred to here. Among them may be mentioned the custom of exclusive cotton planting which has been so sedulously followed for so many years, leaving but little time for anything else; also the habit of "turning out" fields when depleted instead of recuperating them by ameliorating crops.

Another is the reluctance and hesitation which persons naturally feel about changing old-established ways for untried methods, without the encouragement and aid of example to guide them in their new enterprise. The want of seed has been quite an impediment to increased attention being given to the grass crops. The correspondents say that a liberal distribution of grass seed would relieve a deeply-felt need and do much toward determining the important question of extending grass culture.

Fifth inquiry. "Please suggest any grasses that might be useful in your section."

The replies to this request were somewhat limited, and often rather suggestive than definite. There are but few to be added to those already mentioned. But for convenience, all of the grasses recommended for trial will be given here, together with such suggestions as the gen-

eral tenor of the reports and correspondence, and information obtained elsewhere, would seem to warrant. They recommend as follows:

*For Washington Territory and Oregon.*—Italian rye grass, tall meadow oat grass, Kentucky blue grass, Texas mesquite, and Bermuda.

*For California.*—Timothy, large red clover, the millets, orchard grass, Italian rye grass, white clover, Guinea grass (*Panicum jumentorum*) Bermuda, alfalfa, and Johnson grass.

*For Idaho and Montana.*—All the grasses for bottom lands, and alfalfa for “bench lands.”

*For Texas.*—Alfalfa, Bermuda, timothy, the clovers, orchard grass, Johnson grass, and the millets in the order named.

*For Georgia.*—Kentucky blue grass, orchard grass, herds grass (called red top in New England), timothy, the clovers, and alfalfa, in the order named.

*For Florida.*—Bermuda, alfalfa, Guinea grass (*Panicum jumentorum*), orchard grass, Johnson grass, and clover.

*For Alabama.*—Orchard grass, Kentucky blue grass, timothy, herds grass (red top), Johnson grass, alfalfa, and California clover.

*For Mississippi.*—Orchard grass, herds grass (red top), the clovers, Kentucky blue grass, and the millets.

*For Louisiana.*—Kentucky blue grass, orchard grass, Bermuda, timothy, herds grass (red top), the clovers, and alfalfa.

The above are the principal forage plants enumerated for trial. It will be observed that in some instances instead of suggesting new grasses for trial those are named which have already been so fully tried that there is no question about their success.

It appears from the reports and correspondence that the principal need of Washington Territory and Oregon is a pasture grass for the dry hills in place of the nearly extinct bunch grass; some are desirous that Bermuda and Texas mesquite be tried. The latter has already been reported as successful in several counties. There is some uncertainty concerning what grass is referred to, as several go under the name of mesquite. It is probable that some mean the *Buchloe dactyloides*, the buffalo grass of the plains, a valuable pasture grass and similar in habit to Bermuda. In Texas it is called mesquite. The suggestion of these correspondents appear worthy of attention.

In Southern California some wish Bermuda to be tried for their pasture land which cannot be plowed, and where the bur-clover, &c., is being tramped out. They also think that the Guinea grass (*Panicum jumentorum*) might possibly succeed.

The suggestions from Florida were from only a few counties; the general impression seems to be that crab grass and other native grasses are superior to the so-called cultivated ones. Some think that a grass will have to be obtained from Cuba or the tropics to be suited to the climatic conditions existing there.

## DESCRIPTION OF GRASSES.

## PASPALUM, Linn.

Flowers in narrow, mostly linear, spikes, of which there may be one, or several crowded at the summit of the stem, or they may be more or less numerous, and arranged along the general peduncle. The spikelets are mostly obtuse and arranged in one or two rows on each side of the generally elevated crest or midrib of the flattened rhachis. The spikelets contain each one perfect flower inclosed within two outer membranaceous glumes; rarely one of the outer glumes much reduced or wanting. The glume of the perfect flower, called the flowering glume, is more or less convex or rounded on the back, usually thick and indurated, and incloses the shorter palet, which is of similar texture with the three stamens and two distinct plumose styles.

This genus has its range principally in the Southern States. They are mostly perennials, varying much in form and habit. Some are tall and erect, some decumbent or spreading, and others have the habit of sending out prostrate runners which take root at short intervals and thus spread and form dense patches. Several species may often be found in the same field. Professor Phares, of the Agricultural and Mechanical College of Mississippi, says:

They are all succulent, tender, nutritious, hardy, thrifty, and relished by all grass-eating animals. They fill the soil with a matting of roots and cover the surface densely with luxuriant foliage from early spring till autumnal frosts.

## PASPALUM LAEVE. (Smooth paspalum.)

This species grows from 2 to 4 feet high. The stem and leaves are smooth or smoothish, the lower leaves long and firm, the upper ones shorter and distant. Near the top of the culm are three to five slender spreading spikes, each from 2 to 3 inches long and 1 to 2 inches distant. There are a few longish hairs at the base of the spikes where they separate from the stem. The spikelets, or what becomes the seed, are oval, smooth, about one-tenth of an inch long, close together in two rows, which are wider than the narrow, slightly wavy rhachis.

Professor Phares (above quoted) says he has a neighbor who has been feeding this grass for twenty-five years: and for many years has had a meadow of it from which without ever having seeded, he annually mows about 2 tons of hay per acre. It should be cut before the seeds get ripe enough to fall off. (Plate 1.)

## PASPALUM DILITATUM. (Hairy-flowered paspalum.)

This species is quite similar to the preceding, but taller and stouter. The culms are from a thick perennial rootstock, erect, 3 to 5 feet high, smooth, and with three to five leaves from as many smooth, purplish joints. The leaves at the base of the culm are numerous, about a foot

long and one-third to one-half an inch wide. They are smooth on both sides and roughish on the margins. The raceme is from 5 to 8 inches long, composed of from five to ten somewhat spreading spikes, which are 3 inches or more in length, and 1 or 2 inches apart on the rather slender axis, the upper ones are gradually shorter, all with a few long hairs at the base. The spikelets are closely arranged in four rows, two on each side of the narrow and nearly straight axis, in alternate pairs. They are about one and a half lines long, ovate, acutely pointed, crowded and overlapping each other, compressed, and the margins clothed with silky hairs. The two outer or empty glumes are ovate, acute, five-nerved, nearly smooth, except the fringe of thin white hairs on the margin. The flowering glume is thick and firm, and very delicately punctate under a magnifier. The palea fits inside the margin of the flowering glume and inclosing the stamens and styles. This species has been found in Virginia, Alabama, Mississippi, Louisiana, and Texas. It is also a South American species. It has been called *Paspalum ovatum*, but the name first given is the proper one. It was described in the Agricultural Report for 1880, and has since then been noticed and experimented with by several persons. (Plate 2.)

Several other species of the same general appearance and habit occur in the Southern States, among which may be named *Paspalum lentiferum*, *P. Floridanum*, and *P. plicatulum*. Quite recently another species has been brought to our notice by Mr. H. B. Richards, of La Grange, Tex. It has been called *Paspalum remotum*, and Mr. Richards states that it roots at every joint and sends up shoots like a layered grapevine; it remains green all winter, and it is almost impossible to destroy it by cultivation. Plowing spreads it, as every stem broken off takes root again. It can only be killed by digging out every particle and exposing it to the hot sun. All soils seem to be equally acceptable to it; it grows as well in the shade as in the sunshine. Drought does not seem to affect it. Stock like it both in winter and summer. A single seed or joint has been known to spread over an area of five or six feet in diameter in a single season, with a perfect mat of grass firmly rooted all over. It evidently will bear close pasturage and hard tramping. The difficulty of eradicating it will be an objection to it in the opinion of some, but where it is desirable to make a permanent pasture this feature would seem to be an advantage. More extended observation and experiment with this grass is highly desirable.

Another species of *Paspalum*, having the same creeping habit, has been observed in several of the Southern States. It is the *Paspalum platycaule*. It is a grass of lower growth and smaller size than the preceding. It occurs in all the Gulf States, as well as in the West Indies and in South America. Mr. Benjamin Brodnax, of Morehouse Parish, Louisiana, has given a very full account of its habits in a Southern agricultural paper. He says the mode of growth is flat to the ground, taking root at every joint and spreading in every direction. It effectually kills

out every other grass or weed, as it forms a thick sod and is evergreen. It looks like Bermuda grass and is equally prolific, but it possesses one trait that Bermuda grass does not, that is, it is easily got rid of. It is only necessary to plow shallow, turn the sod over, and in a week harrow and your grass is gone. All grazing animals eat it in preference to any other except Bermuda grass. It grows on a great variety of soil, but thrives best in good soil. Some of the joints send up culms or stalks which are very fine and wiry, with a few slender seed-bearing spikes at the summit. The runners extend out several feet, taking root at all the joints, which are usually only 1 or 2 inches apart. It grows too close to the ground and is too short for a good grass for hay, but for grazing it has many good properties. Like the preceding species, it should receive attention from farmers, with careful experiments.

*Paspalum setaceum* is a species which is widely spread both in the Northern and Southern States. It grows usually  $1\frac{1}{2}$  to 2 feet high in dry, sandy, or gravelly soil, some forms having smooth and others very heavy leaves. It seems to have very little practical value. (Plate 3.)

#### DIGITARIA.

This genus is usually considered as a section of the genus *Panicum*, but it will be most convenient here to retain the old name. It serves to connect *Paspalum* and *Panicum*, and in the structure of the flowers differs from *Paspalum* very little except in commonly having an additional empty glume to the spikelets. This glume is sometimes very small and occasionally absent. The flowers or spikelets are arranged like those of *Paspalum* on one side of a narrow flattened axis or spike, and there are several spikes crowded together at or near the summit of the culm.

#### DIGITARIA SANGUINALE (*Panicum sanguinale*). Crab grass.

This is an annual grass, which, although a native of the Old World, has become spread over most parts of this country, and, indeed, over most tropical countries of the globe. It occurs in cultivated and waste grounds, and grows very rapidly during the hot summer months. The culms usually rise to the height of 2 or 3 feet, and at the summit have from three to six slender flower spikes, which are from 4 to 6 inches long. The culms are bent at the lower joints, where they frequently take root. This grass is well known to farmers and planters in the South under the name of crab grass. Professor Killebrew, Tennessee, says:

It is a fine pasture grass, although it has but few base leaves and forms no sward, yet it sends out numerous stems or branches at the base. It serves a most useful purpose in stock husbandry. It fills all our corn-fields, and many persons pull it out, which is a tedious process. It makes a sweet hay, and horses are exceedingly fond of it, leaving the best hay to eat it.

Professor Phares, Mississippi, says that the corn and cotton fields are often so overrun with it that the hay which might be secured would

be more valuable than the original crop. It is some times mowed from between the rows, some times cut across the ridges with the corn.

Any good piece of ground that has had this grass matured on it the preceding year may be plowed and harrowed smoothly and then rolled in May, and it will soon be covered with a rich growth. If the season is favorable two mowings should be made.

*Digitaria villosa* is a very similar species of the Southern States, with a perennial, creeping rootstock, the stem decumbent and bent below at the hairy joints. The leaves with their sheaths are very hairy. The external glume of the flower is scarcely one-fourth as large as the upper ones. It probably is frequently confounded with the preceding, and has the same qualities. (Plate 4.)

#### PANICUM. (Panic grass.)

The botanical character of this genus are as follows: Flowers in spikes, racemes, or panicles. The spikelets consist of one perfect flower (the upper or terminal one in the spikelet), and usually a second male or rudimentary one below it. Outer empty glumes two, one of which is smaller than the other, often very small, rarely absent. The glume of the perfect flower and its palet are usually of a coriaceous or leathery texture, and obtuse or obtusish. The grasses belonging to this genus are extremely numerous, and of widely different general appearance. We have about fifty native species, most of which have little practical value except as adding more or less to the wild forage of our woods and fields. But some species, both native and foreign, are of the highest agricultural value. We shall notice a few of those which seem best adapted to cultivation in this country.

#### PANICUM JUMENTORUM. (Guinea grass.)

A large, vigorous, perennial grass, attaining in good soil a height of from 6 to 10 feet, the leaves are 1 to 2 feet long, and frequently an inch or more wide, rough on the edges, and with a few scattered hairs on the surface; the sheath is long and nearly smooth, except near the joints, which are soft-hairy. The panicle is from 1 to 1½ feet long and diffusely branched, the upper branches single and 3 to 4 inches long, the lower ones two to five together and 6 to 10 inches long; the flowers are thinly scattered along the rather slender branches nearly the whole length on slender, rather short pedicels. The spikelets are about 1½ lines long, smooth and rather acutely pointed; the lowest glume is about one-third the length of the spikelet; the second glume is slightly longer than the perfect flower and five to seven nerves. The lower flower is staminate or male only, the glume and palet thin, the upper flower perfect, much thicker, and finely wrinkled transversely.

This grass is a native of Africa, but has been introduced into many tropical countries, and in the West Indies is extensively cultivated for pasturage. It has been introduced in Florida, but is yet very little



known in the Southern States. It has been confounded with the Johnson grass, which is very different, and is botanically *Sorghum halapense*. It (the *Panicum jumentorum*) seldom matures seed in this country and may be propagated by dividing the roots or by obtaining the seed from foreign countries. The best time to set out the roots is in March and April. If so treated it is said that they will be ready for the first mowing by the last of May, and that with favorable weather mowing may be repeated about every six weeks until frost occurs. The roots are tender and easily killed by frost, and should therefore be protected by mulching during the winter. It is too tender to be cultivated except in the very warmest portions of our country. An analysis made at the Department of Agriculture in 1878 shows it to be very rich in nutritive materials. (Plate 5.)

panicum BARBINODE. (Para grass *P. molle* Swz. in Annual Report, 1883.)

This is quite similar in general appearance to the preceding, but has smaller leaves, and a shorter, less spreading panicle, with shorter, more densely-flowered branches. The spikelets are closer together and very short-pedicelcd, the lowest glume is about one-fourth as long as the spikelet. It is said to be a native of Africa. It has been introduced into South America, and in Brazil is largely cultivated for pasturage, and is said to be unequalled for the quantity and quality of the feed which it produces. Dr. Charles Mohr, of Mobile, Ala., states that it has been some years introduced in that vicinity, and that it is extremely productive and valuable. It has also been introduced in Florida. (Plate 6.)

panicum MILIACEUM. (Millet grass.)

This annual species grows 2 to 3 feet high, with a large, open nodding panicle of flowers. The stem is thick and branching above, the nodes or joints swollen, the leaves, and especially the sheaths, are soft hairy. The leaves are numerous and about 6 inches long. The flowers and seeds are at the ends of the slender pedicils, and when ripe become yellow in color. It is a native of Asia, where it has been cultivated for ages, and in many parts is an important article in the food supply of the natives. It is also cultivated in Egypt, Turkey, and Southern Europe. It has been cultivated to a limited extent in this country for forage, and will thrive and ripen in the Northern as well as the Southern States.

Mr. Charles L. Flint says:

Millet is one of the best crops we have for cutting and feeding green for soiling purposes, since its yield is large, its luxuriant leaves juicy and tender, and much relished by milch cows and other stock. The seed is rich in nutritive qualities, but it is very seldom ground or used for flour, though it is said to exceed all other kinds of meal or flour in nutritive elements. An acre well cultivated will yield from 60 to 70 bushels of seed. Cut in the blossom, as it should be for feeding to cattle, the seed is comparatively valueless. If allowed to ripen its seed, the stalk is no more nutritious, probably, than oat straw.

Of the native species of *Panicum* we will notice a few :

PANICUM TEXANUM. (Texas millet.)

This grass is a native of Texas, and was first described and named by Prof. S. B. Buckley in 1866. It is an annual, growing from 2 to 4 feet high, at first erect, then becoming decumbent and widely spreading, sparingly branched, very leafy, the sheaths and leaves soft hairy, the margin of the leaves rough, the blade of the leaf 6 to 8 inches long, and one-half to 1 inch wide, the upper leaves reaching to the base of the panicle, or nearly so; the panicle is 6 to 8 inches long, strict or close, the branches alternate, erect, simple, 3 to 4 inches long, with somewhat scattered sessile spikelets. The branches of the panicle are rough, the pedicels with scattered hairs, especially near the flowers; the spikelets are oblong, somewhat pointed, 2 to 2½ lines long, sparsely hairy; the lower glume is half or two-thirds the length of the upper one, acute, five-nerved, the lateral nerves uniting with the mid-nerve below the apex, the upper empty glume prominently five to seven nerved, pointed; the flowering glume of the sterile flower is five to seven nerved, its palet thin and transparent, as long as the glume, the perfect flower ovate or oblong-ovate, acutish, transversely wrinkled with fine reticulated lines.

It is a grass of rapid, vigorous growth, many stalks proceeding from the same root, growing very close and thick at the base, succulent, and yielding a large amount of forage.

Mr. Pryor Lea, of Goliad, Tex., has had it in cultivation a number of years, and states as follows :

I consider it far superior to any grass that I ever saw for hay. It is a much more certain crop than millet, and cultivated with less labor, and all kinds of stock prefer it. In this region it is regarded, in the condition of well-cured hay, as more nutritious than any other grass. It grows only in cultivated ground; it prospers best in the warmest season of the year; its luxurious growth subdues other grasses and some weeds, with the result of leaving the ground in an ameliorated condition.

Mr. H. W. Ravenel, of Aiken, S. C., says he has been cultivating *Panicum Texanum* for several years. It is hardy and naturalized there, freely seeding and propagating itself, coming up in his grounds with other grasses, and much larger and better than any of them for hay and forage.

The experiments of Professor Phares and others, in Mississippi, substantially confirm the statements of Mr. Lea, although it is said that it will hardly hold its own against the common crab grass (*Digitaria sanguinalis*). It has been called concho grass in some parts; in others Colorado bottom grass. It is stated that on the Colorado bottoms, in Texas, many of the farmers have devoted their farms entirely to its production, finding it more profitable than corn or cotton. It is cut twice and sometimes three times in a year, yielding about one and a half tons per acre at each cutting. (Plate 7.)

## PANICUM PROLIFERUM.

This species has a wide range of growth, being found in the Northern and Western as well as the Southern States, growing late in the season, generally in low waste grounds. The stems are flattened, erectish, or decumbent, spreading and rooting at the lower joints. It is a useful grass as helping out the supply of wild fodder, but does not present particular promise for cultivation. But in the Southern States, from South Carolina westward, there occurs a variety of this grass, called *Panicum proliferum*, var. *geniculatum*, or sprouting crab grass.

It is an annual, growing in low moist ground. The stems are at first erect, then becoming decumbent and spreading, frequently attaining a length of 6 or 7 feet, bent and rooting at the lower joints. It has much the same habit as the *Panicum texanum*, but the stems are more flattened and smoother; the leaves are smoother and longer. The stems are sometimes nearly an inch thick at the base and very succulent. The leaves are sometimes 2 feet long and half to three-fourths of an inch wide. The lower joints give out numerous branches, which develop flowering panicles that are partly inclosed in the large leaf-sheaths. The main stem is also terminated by a diffuse panicle sometimes 2 feet long. Large specimens have a handsome appearance. The spikelets are pale green, rarely purplish, about one line long. The neutral flower is a little longer than the perfect one, the lower empty glume broad and short, the upper acute and strongly seven-nerved. Mr. Charles Mohr, of Mobile, says of it:

In damp grassy places it prefers rich ground throughout the coast region. It commences to vegetate vigorously in the hottest part of the summer, throwing out numerous shoots from the joints, forming large-branched bushes. The foliage is rich and tender, and the succulent, thick stems are sweet and juicy. After cutting, it throws out numerous sprouts from the lower joints, which grow rapidly, so as to allow repeated cuttings until frost. It is through all stages of its growth much relished by horses and cattle.

(Plate 8.)

## PANICUM AGROSTOIDES. (Red-top Panicum.)

This is a perennial grass, commonly growing in large clumps in wet meadows or on the muddy margins of lakes and rivers. It grows 4 to 6 feet high, is erect in habit, and develops its reddish panicles from several of the joints as well as at the apex. The stem is somewhat flattened and very smooth, as are the sheaths; the leaves are 1 to 2 feet long, about half an inch wide, and somewhat rough on the margins and midrib. The terminal panicle is 6 to 12 inches long, at first somewhat close, but becoming quite open and diffuse. The lateral panicles are shorter and partly inclosed by the sheath at the base. The branches of the panicle are mostly 1 or 2 inches long, and rather densely flowered nearly to the base. The spikelets are a little more than a line long, on very short pedicels, mostly racemose on one side of the branches, oblong, acute, the lower empty glume ovate, acute, half as long as the

upper one, which is rather long-pointed and five-nerved; the lower or sterile flower is a little shorter than the longer glume and a little shorter than the perfect flower, which is oblong, obtuse, and under a lens shows a few beards at the apex. This grass produces a large amount of foliage which makes fair hay if cut before flowering time; if left later it contains too many wiry stalks. It may be utilized as a hay crop in low grounds, but it is doubtful if it can be made productive on dry, tillable land. (Plate 9.)

**PANICUM ANCEPS.** (Two-edged Panic grass.)

A perennial grass, when well developed resembling the preceding, but of a smaller, lighter growth, generally found in moist clay soil. It has a flattish erect stem, 2 to 3 feet high, with smooth leaves a foot or more long, of a bluish-green color, and mostly near the base of the stem. The rhizoma, or root-stock, is thick, scaly, and creeping near the surface of the ground. The panicle is 6 to 12 inches long, with short branches near the top, the lateral branches 3 to 6 inches long, rather distant, erect or somewhat spreading. Usually there are also several smaller lateral panicles from the upper joints of the culm. The spikelets are about a line, and a half long, a little longer than those of *Panicum agrostoides*, oblong, lanceolate, a little curved, and sessile, or on very short pedicels. The lower empty glume is broadly ovate, and about half as long as the five to seven nerved upper one. The lower glume of the sterile flower is as long as the upper empty glume and much like it in texture, while the palet is thin, obtuse, and much shorter. The perfect flower is one-third shorter than the upper empty glume, oblong; the flowering glume and its palet, as in most species of *Panicum*, is thick and hard in texture. This cannot be considered a valuable grass, but it frequently occurs in neglected and poor land in sufficient quantity to afford considerable grazing for stock. It makes its growth late in the season, usually reaching the flowering stage in August. Dr. Mohr, of Mobile, remarks that it is not much relished by stock, being rather harsh and dry.

Professor Phares says it forms strongly-rooted spreading clumps, often completely carpeting the ground with very pretty, glossy, light-green foliage. (Plate 10.)

**PANICUM CRUS-GALLI.** (Barn-yard grass.)

This is an annual grass, with thick, stout, erect, or procumbent culms, usually 2 to 4 feet high, and branching at the base. The leaves are long, sometimes 1 to 1½ feet, and half an inch to an inch wide, rough on the margins, the sheaths sometimes hairy, sometimes smooth, and the lower ones much thickened at the base. The panicle, like the entire plant, is variable in size, sometimes 3 inches, sometimes a foot or more long, lanceolate in outline, and composed of a number of alternate, mostly simple, rough branches, or frequently the branches are glomerate and much

subdivided. The panicle is, in different varieties, narrow and with few short, simple branches, or large and dense with long and spreading branches. The glumes are also variable, being sometimes awnless and sometimes provided with long, rough awns or beards. These variable features have been indicated by special names, as variety *mutica*, the form without beards; var. *hispida*, a form with rough, hairy-leaf sheaths; variety *echinata*, a form with long, rough awns to the glumes. The spikelets are densely crowded on the spikes or branches of the panicle. The glumes are usually more or less rough, with oppressed, stiff hairs, the outer empty one very broad, with a very short point one-third as long as the pointed upper one, the glume of the sterile flower still longer and frequently having a long, strong awn sometimes an inch or more in length. The perfect flower is ovate, smooth, pointed, and contains a large flattened orbicular seed. This grass is found in almost all parts of the world. It is frequently found in barn-yards, and hence the common name.

In the Northern States it is esteemed as a rough, coarse weed; in the South it is often utilized and considered a very useful grass.

Dr. Charles Mohe, of Mobile, says of it :

An annual, 2 to 3 feet high, bearing its roughly-awned flowers in dense, one-sided panicles, composed of numerous crowded spikes: it grows luxuriantly, particularly in the lowlands of the coast; is greedily eaten by horses and cattle, and makes a hay of good quality. It is justly regarded as an excellent grass, particularly before it ripens its seed, as in the latter stages of its growth the long and stiff awns of its spikes tend to make it somewhat unpalatable.

Professor Phares, of Mississippi, says :

In Louisiana, Mississippi, and some other States it is mowed annually. Some farmers assure me that they harvest four or five tons of hay per acre. It may be cut twice each season by making the first mowing as soon as it begins to bloom. I know no one who plants it: but it annually reseeds the ground and requires no cultivation or other care, save protection from live stock and the labor of harvesting. Being a coarse grass, with long leaves and large succulent stems, it requires care to cure well. In one county in Mississippi hundreds of acres are annually mowed on single farms. Cows and horses are very fond of it, whether green or dry. Farmers who have tested it most thoroughly for many years prefer it to the best corn fodder.

(Plate 11.)

PANICUM VIRGATUM L. (Tall Panic grass; Switch grass.)

A tall perennial grass, 3 to 5 feet high, growing mostly in clumps in moist or even in dry sandy soil, very common on the sea-coast, and also in the interior to the base of the Rocky Mountains. The culms are erect, firm, and unbranched; leaves 1 to 2 feet long, flat, rough-margined, otherwise smooth, one-third to one-half inch wide. The panicle is large and diffuse, rather pyramidal, from 6 inches to 2 feet long, the branches angular, rather verticillate, the lower in fives or more, decreasing above, flowering mostly near the extremities. The lower branches are frequently half as long as the panicle and much subdivided. The

spikelets are usually short-stalked, variable in size, but usually about two lines long, ovate, sharp-pointed, commonly purplish. The lower empty glume is from half to two-thirds as long as the upper, both are pointed, sometimes long pointed; the lower glume is three nerved, the upper one five to seven-nerved; the lower flower is male, nearly as long as the upper glume, its glume five to seven-nerved and acute, its palea one-quarter shorter, thin, two-nerved. The perfect flower is shorter than the lower one, smooth, oblong, and obtuse. This is a good and prolific grass if cut when young; when ripe it becomes harsh and unpalatable. It forms a constituent of the native grasses of the prairies, particularly in moist localities. (Plate 12.)

**PANICUM DIVARICATUM.** (Cane-like Panicum.)

A tropical and subtropical species found in our country only in Florida and the Gulf States near the coast. It is a shrubby plant, the culms being woody and persistent, like the small kind of cane. Only the leaves and young shoots are eaten by cattle. The larger stems are of the size of a goose quill. It is smooth and decumbent, with short, spreading branches. The leaves are lanceolate, 2 to 3 inches long by four to five lines wide, gradually pointed. The panicles terminate the branches, are 2 to 4 inches long, with comparatively short divergent branches and few flowers. The spikelets are obovate, tumid, about two lines long, smooth. In the districts where it grows this grass may be utilized, as an analysis of its composition gives a very good result. (Plate 13.)

**PANICUM GIBBUM.**

A perennial species, growing in swamps and low wet ground in the Southern States, from North Carolina to Florida and to Texas. The stem is decumbent, branching, and rooting at the lower joints. The panicle is 3 to 5 inches long, and narrow from the erect, appressed branches. The spikelets are oblong or lance-oblong, rather obtuse, although narrowed above. The lower glume is small, about one-fourth as long as the upper one, which is strongly eleven-nerved, swollen at the base, and twice as long as the smooth, fertile flower. The leaves are smooth or rarely somewhat hairy, half an inch broad and 6 to 8 inches long. The whole plant is of a deep green color. The flowers drop off soon after flowering. This grass, if it occurs in abundance, would be of considerable value, as it furnishes a good deal of nutritious matter. (Plate 14.)

**PANICUM OBTUSUM.** (Obtuse-flowered Panicum.)

A perennial species of Texas, New Mexico, and Arizona. It has a strong, running root-stock, which at intervals sends up flowering culms, which are about  $1\frac{1}{2}$  to 2 feet high, very smooth, pale green, with numerous smooth, narrow, erect, stiff, long-pointed leaves, and a narrow linear panicle, 3 to 4 inches long, composed of about half a dozen

short, alternate, sessile branches, the lowest about an inch in length, the upper very short, and all densely crowded with the sessile flowers. The two outer glumes are of nearly equal length, or the lower one rather the longer, which is different from the ordinary rule of the genus. They are obtuse, five to seven-nerved, and fully as long as the male or sterile flower, which is also obtuse. The perfect flower is of equal length with the sterile one, very smooth, shining, delicately striate longitudinally, and obtusish. Leafy runners, 2 to 3 feet long, are sent out from the base, which at intervals form thickened woolly knots or nodes which eventually take root. This grass will evidently have great endurance of drought, and is deserving of trial with reference to its agricultural value.

**PANICUM CAPILLARE.** (Old Witch grass; Hair-stalked Panic grass.)

An annual grass varying in height from 6 inches to 2 feet, often branching at the base. It has a large terminal panicle, which, when mature, is very diffuse, with long capillary branches. The leaves and sheaths are usually covered with long spreading hairs. It is very common in cultivated grounds, making its growth late in the summer, and after maturity the tops break off and are blown about and accumulate in quantities in fence corners. There is a smoothish form growing in Texas and the Western Territories. The grass is generally rejected by cattle, especially the very hairy forms. It is one of the most worthless kinds. (Plate 15.)

There are many other species of *Panicum* which have some value as wild forage where they prevail, but they are generally scanty in foliage, thin in habit of growth, or otherwise unsuitable for cultivation.

**SETARIA.**

The structure of the flowers in this genus is the same as in *Panicum*, of which genus it is by some botanists considered only a section. It is characterized as follows. The spikelets collected into a cylindrical or elongated spike-like, or sometimes interrupted, panicle. Below the articulation of the spikelets are several (or one) bristles or stiff hairs, which are supposed to be abortive branchlets, and which are persistent after the fall of the spikelets.

**SETARIA ITALICA.** (Hungarian grass, Italian Millet, German Millet.)

This grass is supposed to be a native of the East Indies, but it has been extensively introduced into most civilized countries. It has long been cultivated as a fodder grass both in Europe and in this country. It is an annual grass of strong rank growth, the culms erect, 2 to 3 feet high, with numerous long and broad leaves, and a terminal, spike-like, nodding panicle, 4 to 6 inches long, and often an inch or more in diameter. The panicle is composed of a great number of small closely-crowded branches, each of which consists of a small group of several

clusters of spikelets, at the base of each of which there springs two or three bristles, sometimes short and sometimes so long as to give the head a very bristly appearance. The bristles are roughened or barbed by numerous teeth-like processes on the margin, pointing towards the apex. The spikelets are about 1 line long; the lower glume is about one-third as long as the upper one, which, with the glume of the sterile flower, is obtusish and about the length of the perfect flower. There is a great difference in the different varieties and forms of this grass, so much so that some of them have been considered different species, but the general opinion of botanists is that they are all varying forms of the same species, dependent upon the character of the soil, thickness of seeding, moisture or dryness, and time of sowing. It owes its value as a fodder plant to the abundance of its foliage and to the large quantity of seed produced. In some instances objection has been made to this grass on account of the bristles which surround the seed, and which have been said to penetrate the stomachs of cattle so as to cause inflammation and death. But it is plain that this opinion is not generally held, as the cultivation of the grass is widely extended and everywhere recommended.

For forage it should be cut as soon as it blooms, when of course, it is worth nothing for seed, but is most valuable for forage and exhausts the land much less. If left for the seed to mature they are very abundant and rich feed, but the stems are worthless while the soil is more damaged. The matured stems are very hard, indigestible and injurious, and the ripe seeds will founder more promptly than corn, and sometimes produce diabetes if mouldy and too freely used. If cut at the right stage the whole plant is a safe and very valuable forage. On good soil if the ground be moist it will be ready for mowing in sixty days from seeding and produce from two to four tons of hay per acre. It is folly to sow it on poor land.—Professor PHARES.

(Plate 16.)

SETARIA SETOSA. (Bristle grass, Fox tail.)

A native species growing in New Mexico, Texas, and southward into Mexico and South America. It grows about 2 feet high. The stem and leaves are smooth except a fine hairy ring at the joints. The leaves are 6 to 10 inches long, narrow, and gradually tapering to a long point. There is a tuft of short white hairs at the top of the leaf sheath. The panicle is 4 to 6 inches long, erect or slightly nodding at the top, narrowly cylindrical with very short sessile branches, usually somewhat interrupted below, sometimes the lower branches are longer and the panicle looser. It has much the appearance of the other species which we called Pigeon grass. The axis of the panicle is scabrous. The lower glume is broadly ovate, more than half as long as the upper, clasping the base of the spikelet, three-nerved, acute, the margins scarious and minutely pubescent; the upper glume is also broadly ovate, short-pointed, five-nerved, about as long as the perfect spikelet; the glumes of the sterile flower are much like the upper empty glumes and also five-nerved; its palea is about two-thirds as long as the glume, and much narrower;



the perfect flower is oblong, very finely striate and dotted. The bristles are variable in length, about one to each spikelet, usually three to four times as long as the spikelet.

We know little as to the agricultural value of this species; as it is found in the arid districts it is deserving the attention of farmers of that section. (Plate 17.)

*SETARIA GLANCA.* (Pigeon grass, Bottle grass.)

A native of most tropical and many temperate climates, and has been introduced into most cultivated fields, springing up or growing after the cutting of wheat and early grain, and making its growth in the latter part of the season. It is generally an annual, but southward it assumes a perennial form. It grows about 2 feet high, with leaves 6 to 9 inches long, one-fourth to one-third of an inch wide, and generally smooth. The panicle is terminal, cylindrical, 2 to 3 inches long, and about one-third of an inch wide, dense and spikelike from the numerous, approximated short branches or clusters of flowers. These clusters consist of from one to three spikelets, having at the base of each a cluster of from six to ten bristles, which are two to four lines long, and finely barbed upwardly. When mature they assume a tawny yellow color. The spikelets are a little over a line long, oblong; both the outer glumes are short and broad, the lower one third and the upper two-thirds as long as the flower; the glume of the male or lower flower is broadly ovate, obtusish and five-nerved, its palet is of equal length and two-nerved; the perfect flower is oblong, beautifully striated longitudinally, wrinkled and dotted transversely. This grass is often found with the next (*S. Viridis*), in stubble fields, and furnishes a considerable amount of fodder, which is as nutritious as Hungarian grass, but not as productive. The figure (Plate 18) does not represent a sufficient quantity of bristles.

*SETARIA VIRIDIS.* (Green Pigeon or Foxtail.)

This species has the general habit and appearance of the preceding; it differs in the commonly looser, longer, and more tapering, less erect spike, in the smaller spikelets, shorter lower glume, less distinctly transversely wrinkled seed, and in fewer bristles, which are of a greenish color. It grows in the same situations and commonly with the preceding. The seeds of both kinds are eagerly sought for by birds and poultry, especially among the stubble after harvesting wheat.

*PENICILLARIA SPICATA.* (African cane, Egyptian Millet, East India Millet, Cat-tail, and Pearl Millet.)

A tall, erect, thick-stemmed grass. It grows to the height of 6 feet or more, and the stock is terminated by a compact, dense, cylindrical spike resembling the common cat-tail, frequently a foot long and an inch in thickness, which is studded with the small obovate sessile grains, surrounded at the base by an abundance of short, coarse hairs or bristles.

This millet has been more or less cultivated, especially in the Southern States, for many years. In rich ground it is said to yield an immense amount of forage, for which purpose it should be cut before it has matured, and may be cut many times during the season. It is extensively cultivated in India and there forms an important article of food for the natives.

#### SPARTINA.

A genus of coarse, perennial grasses, growing mainly in marshy ground, from extensively-creeping, scaly root stocks. The leaves are long and tough and the sheaths smooth. The flowers are produced in racemed spikes, the spikes varying in size and arrangement in different species. The flowers are arranged in two ranks on one side of a triangular axis, being closely sessile and more or less imbricated. The spikelets are one-flowered, much flattened laterally. The outer glumes are strongly compressed and keeled, acute or bristle-pointed, the keel mostly rough-hispid, the upper one longer and larger than the obtusish flower. The flowering glume is strongly compressed and is shorter than the thin membranaceous palet. There are about five species in the United States.

#### SPARTINA CYNOSUROIDES. (Fresh-water Cord grass, Fall Marsh grass.)

This species has a wide range, from near the coast to the Missouri River. In the Western States it is very plentiful, often forming a large part of the grass of the sloughs and wet marshes of that region. It is coarse and stout, growing from 3 to 5 feet high, with leaves 2 to 3 feet long. The top of the culm for about 1 foot is occupied by from five to ten flower spikes, which are from  $1\frac{1}{2}$  to 3 inches long, and the spikelets are very closely imbricated. The outer glumes are unequal, the lower one linear-lanceolate, the upper one lanceolate, with a long, stiff point. The flowering glume is about as long as the lower glume, the upper half of the stout keel strongly hispid. The palet is thin membranaceous, two-nerved, and longer than its glume.

This grass is frequently cut for hay, but it is a very coarse, inferior article, unless cut when very young. It gives good feed very early in the spring, but becomes so coarse as soon to be rejected by the cattle when anything better is procurable. In the bottom lands of the Mississippi it is abundant, and has to some extent been manufactured into paper. (Plate 19.)

#### SPARTINA JUNCEA. (Marsh grass, Salt grass, Rush salt grass.)

A slender, rigid grass, usually 1 to 2 feet high, from a creeping, scaly rhizoma; leaves involute, rush-like, and rigid; panicle composed of three to five linear, alternate, shortly-peduncled, spreading spikes 1 to 2 inches long and an inch or more distant on the culm. The spikelets are crowded. The outer glumes are very unequal, acute, the upper one

linear-lanceolate, strongly compressed, and keeled, four or five lines long, the margins membranaceous, the middle thick, and the keel scabrous; the lower one is less than half as long as the upper, narrow and thin. The flowering glume is about four lines long, lanceolate, obtuse, membranaceous, compressed, and with a thick midrib which is roughish near the apex; the palet is thin, as broad and somewhat longer than its glume. This grass forms a large portion of the salt marshes near the sea-coast. It makes an inferior hay, called salt-hay, which is worth about half as much per ton as timothy and red-top. (Plate 20.)

TRIPSACUM DACTYLOIDES. (Gama-grass, sesame-grass.)

A tall, perennial grass, found both North and South, with solid culms from thick creeping rhizomes, broad and flat leaves, and with flower spikes 4 to 8 inches long produced from the side joints and from the top, either singly or two or three together. The upper portion of these spikes is staminate or male, and the lower portion pistillate and producing the seeds. The upper or male portion of the spikes drops off after flowering. The fertile portion is much thickened, somewhat flattened and angled, and the fertile flowers and seeds are deeply embedded in it. This part of the spike at maturity easily breaks up into short joints. The staminate flowers are three to four lines long, sessile, and in twos at each joint of the axis. Each spikelet is two flowered, the outer glumes are somewhat thick and coriaceous, oblong, the lower one obscurely many-nerved, the upper one of thinner texture, boat-shaped, five-nerved and scarious-margined; the flowering glumes and palets are equal in length to the outer glumes, very thin and membranaceous, awnless; the anthers open by two pores at the apex. The pistillate spikelets are single at each joint; also two-flowered; the outer empty glume is ovate, cartilaginous-thickened, the inner glume much thinner, and pointed. One of the flowers is neutral, the other fertile, the flowering glumes and palets very thin and scarious. The stigmas are long, purple, and feathered. Mr. Howard, in the Manual of Grasses for the South, says:

This is a native of the South, from the mountains to the coast. The seed stem was up to the height of 5 to 7 feet. The seeds break off from the stem as if from a joint, a single seed at a time. The leaves resemble those of corn. When cut before the seed stems shoot up they make a coarse but nutritious hay. It may be cut three or four times during the season. The quantity of forage which can be made from it is enormous. Both cattle and horses are fond of the hay. The roots are almost as large and strong as cane roots. It would require a team of four to six oxen to plow it up. It can, however, be easily killed by close grazing, and the mass of dead roots would certainly enrich the land. As the seeds of this grass vegetate with uncertainty, it is usually propagated by setting out slips of the roots about 2 feet apart each way. On rich land the tussocks will soon meet. In the absence of the finer hay grasses this will be found an abundant and excellent substitute. The hay made from it is very like corn fodder, is quite equal to it in value, and may be saved at a title of the expense.

This account is concurred in by other writers. (Plate 21.)

## EUCHLÆNA LUXURIANS. (Teosinte, Guatemala grass.)

This grass is a native of Mexico and Central America, but has been introduced into cultivation in various parts of the world, and recently in the Southern States. It is closely related to Indian corn (*zea mays*). It has the male flowers in a tassel at the top of the stalk. The fertile flowers are from the lateral joints, not like maize, on a thickened axis, but on a very slender stem, and inclosed in a loose external husk.

Prof. Asa Gray writes in the American Agriculturist for August, 1880, respecting this plant, as follows :

The director of the botanic garden and government plantations at Adelaide, South Australia, reports favorably of this strong-growing corn-like forage plant, that the prevailing dryness did not injure the plants, which preserved their healthy green, while the blades of other grasses suffered materially. The habit of throwing out young shoots is remarkable, sixty or eighty rising to a height of 5 or 6 feet. Further north, at Palmerston (nearer the equator), in the course of five or six months the plant reached the height of 12 to 14 feet, and the stems on one plant numbered fifty-six. The plants, after mowing down, grew again several feet in a few days. The cattle delight in it in a fresh state, also when dry. Undoubtedly there is not a more prolific forage plant known; but as it is essentially tropical in its habits, this luxuriant growth is found in tropical or subtropical climates. The chief drawback to its culture with us will be that the ripening of the seed crop will be problematical, as early frosts will kill the plant. To make the *Teosinte* a most useful plant in Texas and along our whole southwestern border, the one thing needful is to develop early-flowering varieties, so as to get seed before frost. And this could be done without doubt if some one in Texas or Florida would set about it. What it has taken ages to do in the case of Indian corn, in an unconscious way, might be mainly done in a human life-time by rightly-directed care and vigorous selection.

## ZEA MAYS. (Indian corn.)

This plant is too well known to need more than a botanical description. The staminate or male flowers are produced at the apex of the stalk in a large, branched panicle, a foot or more in length. The branches of the panicle are rather slender, 8 to 10 inches long, with a few shorter subbranches near the base. They are flower-bearing through their entire length. The flowers are in small clusters of two to four spikelets at each joint of the flattened axis, on very short, slender pedicels, or some of them almost sessile, the different clusters somewhat overlapping each other. The spikelets are each four to five lines long and two-flowered. The outer glumes are membranaceous, lanceolate, and acute or acuminate, sparsely hairy, five to nine nerved, and delicately purple striped. The flowering glumes and paleas are nearly as long as the outer glumes, lance oblong, alike in texture, very thin membranaceous, the glume three-nerved, the palea two-nerved, both delicately fringed on the margins near the apex with soft white hairs. Stamens, three in each flower.

The female or pistillate flowers are produced from lateral joints of the stem on a hard, thickened, cylindrical spike or axis, called the cob, in longitudinal rows (usually eight to sixteen). The spikelets are closely sessile and packed in the rows. The structure of the spikelets is some-

what obscure. The glumes and palets are reduced to a few scales at the base of the large grain, and are usually unnoticed. At the apex of each grain is produced a long thread-like style, varying from a few inches to a foot long. The entire axis, or ear of corn as it is called, is wrapped by a number of leaf-like bracts, commonly called the husks. The long thread-like styles extend beyond and protrude from the point of this envelope, where they may be fertilized by the pollen falling upon them from the male flowers in the terminal panicle. There is a variety of maize in which each kernel or grain of the corn is enveloped by a husk of three or four pieces three-fourths of an inch to 1 inch long. It is supposable that these are the normal envelopes, which in other varieties have become abortive.

ZIZANIA AQUATICA. (Wild rice, Indian rice, Water oats.)

This grass is botanically related to the common commercial rice (*Oryza sativa*), but is very different in general appearance. It is widely diffused over North America, and is found in Eastern Siberia and Japan. It grows on the muddy banks of rivers and lakes, both near the sea and far inland, sometimes in water 10 feet or more deep, forming patches or meadows covering many acres or extending for miles. Its ordinary growth is from 5 to 10 feet high, with a thick spongy stem and abundant long and broad leaves. The panicle is pyramidal in shape, 1 to 2 feet long, and widely branching below. The upper branches are rather appressed and contain the fertile flowers, and the lower branches contain only staminate ones. The spikelets are one-flowered, each with one pair of external husks or scales, which are by some botanists called glumes, and by others called palets. These husks or glumes in the fertile flower are nearly or quite an inch long, with an awn or beard as long or twice as long. The grain inclosed between them is half an inch long, slender, and cylindrical. The glumes of the staminate flowers are about half an inch long and without awns, each flower containing six stamens. These flowers fall off soon after they expand. The fertile flowers also drop very readily as soon as the grain is ripened. The grass abounds in the small lakes of Minnesota and the Northwest, and is there gathered by the Indians for food. The husk is removed by scorching with fire. It is a very palatable and nutritious grain. Some attempts have been made to cultivate the grass, but the readiness of the seed to drop must interfere with a successful result. Near the sea-coast multitudes of reed birds resort to the marshes where it grows and fatten upon the grain. The culms are sweet and nutritious, and cattle are said to be very fond of the grass. (Plate 22.)

LEERSIA.

A genus of rough-leaved grasses growing for the most part in marshy or moist ground throughout nearly all parts of the United States. There are about five species, two of which are confined to the Southern

States; the others, at least two of them, are very common, though rarely occurring in great quantity. They are sometimes cut for hay. They cannot be recommended for culture, but may be utilized wherever they grow spontaneously. The flowers grow in spreading panicles. The spikelets are sessile, on short one-sided branches or spikes. The spikelets are one-flowered, possessing but two scales, which may be called glumes or palets, which are strongly compressed, without awns, bristly ciliate on the keels, the lower one broader and inclosing the seed. Stamens, one to six; stigmas, two; grain flattened. The two common species are:

1. *LEERSIA ORYZOIDES*. (White grass, Cut grass, False rice.)

This is a handsome grass, the culms decumbent. It is commonly called rice grass, from its strong resemblance to common rice. The leaves are pale green, frequently a foot or more long, prominently veined below, very rough on the margins and on the sheaths. The panicle is about 1 foot long, diffusely branched, the branches mostly in twos, and an inch or two distant. The spikelets are very flat, about two lines long, nearly sessile, and mostly toward the ends of the long branches. The glumes are unequal, the lower one much the broader; the palets are wanting. The leaves are so rough on the margins as readily to cut the hand if roughly drawn through it.

2. *LEERSIA VIRGINICA*. (Small-flowered White grass.)

In this species the panicle is much smaller and narrower, and the branches appressed. The spikelets are smaller, the glumes narrower and smoother, and there are but two stamens. The leaves are narrower and smoother than in the first.

*HILARIA JAMESII*.

This grass was formerly called *Pleuraphis Jamesii*. It is a native of the arid regions extending from Mexico to Colorado, growing in clumps from strong, scaly runners or rhizomas. The base of the culm is usually covered with the dried leaves of the preceding year. The culms are from 1 to 1½ feet high, with a few short, rigid, light green, or bluish green leaves, which are more or less involute. Each culm is terminated by a simple, loose spike, 1 or 2 inches long, with alternate clusters of sessile spikelets. These clusters are quite complex in structure, each one containing three spikelets, one central and two lateral. The central spikelet consists of a single fertile flower, and the lateral spikelets each of two male flowers. The lower glume in each lateral spikelet is awned about the middle. The two outer glumes of the central spikelet are bifid or two lobed, strongly nerved, and with the nerves extended into awns reaching beyond the apex of the glume.

We do not know to what extent this grass prevails, nor what may be its agricultural value. (Plate 23.)

## ANDROPOGON.

There are numerous species of this genus. They are perennial grasses, mostly tall, and with tough, wiry stems. Some of them occur in nearly all parts of the country from New England to Florida and west to Arizona. They are most abundant, however, in the Southern States, where they have been employed for permanent pastures. When they occur in quantity they can be utilized, but to be of value they should be kept from sending up their strong stems as these are universally rejected by cattle and horses. They are not to be recommended for cultivation, but their place should as soon as possible be supplanted by more valuable grasses.

We will mention the more common kinds :

## 1. ANDROPOGON VIRGINICUS. (Broom grass, Broom sedge.)

This species has an extended range on the eastern part of this continent, growing in a great variety of soils and situations, but mostly on dry hills, abandoned fields, or stony woods and pastures. The culms are from 2 to 4 feet high, and very leafy; the leaves two-ranked at the base, smooth except a few long hairs on the margins and at the throat of the sheath. The panicle is long, narrow, and leafy, 1 to 2 feet long, composed of numerous lateral branches from the upper joints. These branches are several times subdivided and partly inclosed in the long-leaf sheath, each ultimate sheath or bract inclosing usually a pair of loose, slender flower spikes. These spikes are about 1 inch long, comprising ten or twelve joints, each joint giving rise to one sessile fertile spikelet, and a hairy pedicel longer than the fertile flower, at the summit of which there is the vestige of a flower, or a mere bristle-like point. The fertile spikelets are one-flowered and consist of two outer thickish glumes and two thin transparent inner ones, one of which has a slender awn three or four times its own length; the upper one is by some considered as a palet, and is not awned. (Plate 24.)

## 2. ANDROPOGON SCOPARIUS. (Wood grass, Broom grass.)

This grass usually grows from 2 to 3 feet high, the flowering spikes coming out in small clusters from many of the side joints on slender, graceful peduncles. The spikes have a small bract near the base, and consist of a slender axis, with from six to ten alternate joints. At each joint there is one sessile, fertile spikelet, and a flattened hairy pedicel or stalk nearly as long as the fertile spikelet, and at its apex a rudimentary flower, consisting of a single awned glume. The fertile spikelet has two outer, empty, narrowly lanceolate glumes, about four lines long. The flowering glume is very thin, and furnished with a twisted awn twice as long as the flower. The palet is also very thin and shorter than its glume.

Mr. Charles Mohr, of Mobile, says of this grass :

One of our most common grasses, covering old fields and fence-rows, and extensively growing in the dry sandy soil of the pine woods. Much despised as it is as a trouble-

some, unsightly weed, it has its good qualities, which entitle it to a more charitable consideration. In the dry pine woods it contributes, while green and tender, a large share to the sustenance of stock.

(Plate 25.)

3. *ANDROPOGON MACROURUS*. (Heavy topped Broom grass.)

This species is frequent on low sandy ground near the coast, from New Jersey to Florida and thence westward to Texas. It has a stout culm 2 to 3 or even 4 or 5 feet high, bushy branched at the summit, loaded with numerous flower-spikes, which form thick leafy clusters. The spikelets have the same general structure as the preceding. The fertile flower has a capillary awn three or four times as long as its glume, and the sterile flower, which is usually present in the genus, is reduced to a mere point at the apex of the slender plumose pedicel. (Plate 26.)

4. *ANDROPOGON FURCATUS*. (Finger-spiked Broom grass, Blue Stem.)

This is the tallest of our species. It grows erect to the height of 5 or 6 feet, in rocky or hilly ground, or at the West it is abundant on the native prairies, where it is frequently called blue stem. The leaves are long and frequently somewhat hairy on the sheaths and margins. The spikes are in small clusters of three to six, terminating the stalk, and also several clusters from the side branches. The spikes are usually 2 to 3 inches long, rather rigid, and contain ten to twenty points each. At each joint there is one sessile, perfect flower, and one stalked one, which is male only, otherwise it is nearly like the fertile one. The outer glumes are about 4 lines long, the upper ones tipped with a short stiff awn. The flowering glume of the perfect flower is twisted and about one-half inch long.

This species, as above stated, is abundant on the prairies of the West, where it is one of the principal hay grasses of the country, and is extensively cut and cured for winter use. (Plate 27.)

*CHRYSOPOGON NUTANS*. (Indian grass, Wood grass.)

This is a near relative of the *Andropogons*; is also related to the genus *Sorghum*, and is known in the botanical works as *Sorghum nutans*. It is a tall, perennial grass, having a wide range over all the country east of the Rocky Mountains. It grows rather sparsely and forms a thin bed of grass. The stalks are 3 to 4 feet high, smooth, hollow, straight, and having at the top a narrow panicle of handsome straw-colored or brownish flowers, 6 to 12 inches long, which is gracefully drooping at the top. The spikelets are at the ends of the slender branches of the loose panicle, generally of a yellowish color. At the base of each spikelet are two (one on each side) short, feathery pedicels, the flowers which they are supposed to have been made to support have entirely disappeared. The outer glumes are about three lines long, both alike lanceolate, obtusish, coriaceous five to seven nerved, the lower one sparsely hairy, and with hairs at the base and on the stalk below.



Within the outer glumes are two thin hyaline glumes, one nearly as long as the outer glumes, and a shorter one with a twisted and bent awn half an inch or more in length. The true palet is very minute or wanting.

This grass when it occurs in quantity is frequently utilized for hay making, for which purpose it should be cut early. There are three other species occurring in the Southern and Southwestern States not of much value in an economic view. (Plate 28.)

**SORGHUM HALAPENSE.** (Cuba grass, Johnson grass, Means grass, False Guinea grass, Evergreen millet, Arabian millet.)

A tall perennial grass, with strong, thick, undergrowing root-stocks, and an abundance of long and wide leaves. Its stems attain a height of 5 or 6 feet, with a large and spreading panicle. In botanical characters it does not differ much from the preceding genus, except in habit and in the flower glumes becoming more hardened after flowering. The panicle when well developed is a foot or more in length, with the lower branches 5 or 6 inches long, and whorled, the upper ones, fewer and gradually shorter, becoming widely spreading, subdivided and flower-bearing to below the middle. The spikelets on the short branchlets are in pairs at each joint and in threes at the extremity. Of the pairs, one is sessile and perfect, the other is stalked and male only. Of those at the extremity, one is sessile and perfect, and two stalked and male only. The spikelets are about two lines long, ovate-lanceolate. The outer glumes of the fertile spikelets are acute, coriaceous, smooth, and shining, or with a few sparse hairs; the veins, (5 to 9) are obscure externally, but internally are plain and sometimes beautifully cross-veined. Within these thick outer glumes are two thin delicate leaflets, by some called palets, by others considered to be inner glumes, the shorter of which occasionally bears a twisted awn or beard half an inch long. The male spikelets are on stems or pedicels one line long. They are as long as the perfect flowers, but the outer glumes are much thinner, and they contain only three stamens. The flowers and seeds are similar to those of broom-corn, which belongs to the same genus.

This grass has been often called Guinea grass, but that name properly belongs to a quite different plant, *Panicum jumentorum*, of which see an account elsewhere. The underground root-stocks are sometimes half an inch thick, very succulent, and are eagerly sought for and eaten by hogs. The grass spreads and is readily propagated from these root-stocks, every joint being capable of developing a new shoot. Mr. N. B. Moore, of Augusta, Ga., has cultivated this grass for over forty years, and prefers it to all others. He says it is perennial, as nutritious as any other, when once set is difficult to eradicate, will grow on ordinary land, and yields abundantly.

My meadow consists of 100 acres of alluvial land; the grass should be cut when from 2 to 4 feet high; on such land as mine it will afford three or four cuttings if the season is propitious.

Many farmers and planters especially object to this grass because of the difficulty of eradicating it. But Mr. Hubert Post says it is not as hard to get rid of as many suppose. He says that one of his neighbors, in 1878, broke up some 15 acres, which he has since successfully planted in cotton with no trouble from the grass. He also says that in this Johnson grass a kind Providence has given the South a mine of wealth, which could easily be made a foundation for wealth and prosperity such as the South has never seen. The history of the grass in this country is said to be as follows:

Governor Means, of South Carolina, obtained some of the seed from Turkey as early as 1835. He planted it on his plantation, where it is stilled called Means grass. In 1840 or 1845 William Johnson, of Alabama obtained some of the seed and sowed it upon his farm, whence it derived the name of Johnson grass. It is said to have been introduced into California from Australia, and has there been cultivated under the name of evergreen millet. It has been tried in Kansas with very promising results. A farmer there obtained some seed from his brother in California, who had cultivated it successfully on a very dry soil on an upland farm. This farmer finds it to be in Kansas perfectly hardy, rapid in growth, affording three cuttings in one season, and producing a heavy growth of after-math for fall grazing. Horses and cattle are fond of it both in its dry and green condition. Probably no grass gives better promise for the dry arid lands of the West. In Utah it has been cultivated under the name of *Arabian millet grass*. (Plate 29.)

SORGHUM VULGARE. (Sorghum sugar cane, Broom corn, Chinese sugar cane, Guinea corn, Doura corn, Indian millet, Chocolate corn, Pampas rice, African millet, &c.)

The above-named grasses are generally believed to be all varieties of *Sorghum vulgare*. Most of them are well known and cultivated for various purposes other than for hay or forage. The Doura corn has been extensively cultivated in some of the arid western counties of Kansas, where the grain is used for feed for hogs and cattle and also as human food. The seeds of the other varieties are probably also valuable for feed for stock.

The sugar corn has been extensively cultivated at the North and West, and has lately received an extraordinary impulse from the development of successful methods of manufacturing sugar from its juice. It is also frequently sown thickly for a forage crop, and in good seasons and with proper cultivation furnishes a very heavy yield.

The botanical character may be briefly given as follows: Flowers in an ample terminal panicle, loose and spreading, or close and compact, erect or nodding. The flowers are on the small branches near their extremities. If examined while young it will be observed that there are two kinds of flowers, one perfect and finally producing seeds, the others containing only stamens or empty. The male or sterile flowers are on

short stalks, one or two at the base of each perfect flower, which is sessile or without a stalk. At or near maturity the sterile flowers drop off, leaving still remaining the short stem or stems on which they were borne. The perfect spikelet has two outer glumes, which are tough and leathery, and two thin transparent inner ones, one of which is two-lobed at the apex, and between the lobes extended into a short, rigid, bent and twisted awn or beard. Stamens, three; stigmas, plumose. The sterile spikelets are narrower, the outer glumes without the leathery texture, nerved longitudinally, the two inner ones thin and delicate, destitute of the awn and containing three stamens or empty.

#### PHALARIS.

This genus is defined as having spikelets with one perfect flower and one or two rudimentary flowers, or mere sterile pedicels, within the outer glumes and below the proper flower.

The outer glumes are compressed and boat-shaped, acute, strongly keeled, becoming coriaceous or cartilaginous. The inner or true flower consists of two thin glumes, sometimes called palets, inclosing the stamens and pistils. No proper palet present.

#### PHALARIS ARUNDINACEA. (Reed canary grass.)

A perennial, grass with strong creeping rhizomas, growing from 2 to 5 feet high, usually in low or wet ground. It ranges from New England and New York westward to Oregon, and northward to Canada, also in the mountainous parts of Pennsylvania and Virginia. It is common, also, in the north of Europe. The culm is stout, smooth, and leafy; the leaves are mostly from 6 to 10 inches long, and about half an inch wide, the upper ones shorter. The ligule is about two lines long, rounded or obtuse. The panicle is from 2 to 4 inches long, narrow and spike-like; the branches short and crowded above, rather distant below, slightly spreading when in flower. The spikelets are three lines long; the outer glumes nearly equal, nearly smooth, boat-shaped, oblong-lanceolate, acute, three to five nerved, the keel scabrous and slightly thickened near the apex. The flowering glumes are one-third shorter, ovate, thick, somewhat hairy externally. The two sterile pedicels are about one-third as long as the flowering glumes and feathered.

The stout stems bear five or six leaves, which are 6 to 8 inches long, and a quarter to a half inch wide, smoothish except on the edge, striate and pointed. The ligule is conspicuous, thin, and rounded. This grass is said to be extensively used for fodder in Sweden, and is liked by cattle. Mr. J. S. Gould says of it:

In the province of Scania it is mown twice a year. The peasantry there use it as a thatch for their cottages and hay stacks and find it is more durable than straw. It is very certain that cattle in our country do not relish it either as pasture or hay, and they will not touch it as long as they can get anything better. When cut very young, say when about 1 foot high, and used for soiling, cattle eat it better than any other way.

The well-known ribbon grass of the garden is a variety of this grass, and will, it is said, easily revert to the normal type. In mountainous regions it may be worth trial for meadows. (Plate 30.)

*PHALARIS INTERMEDIA.* (Southern reed Canary grass, Gilbert's Relief grass, Stewart's Canary grass, California Timothy grass.)

This species resembles the foreign Canary grass (*Phalaris Canariensis*), which produces the seed commonly sold as food for Canary birds. It is, however, a taller and more robust species, growing 2 to 3 feet high, with a stout, erect culm and broad linear leaves, which are from 4 to 10 inches long. The spike is oblong and compact, 1 or 2 inches long. There is a variety called var. *angustata*, in which the spike is 3 or 4 inches long. The spikelets are much like those of the preceding species (*P. arundinacea*), having one perfect flower and two abortive ones. The outer glumes in *P. intermedia* are lanceolate and nearly alike and have a narrow wing extending down the keel. The glumes of the fertile flower are nearly like those of *P. arundinacea* already described.

This species grows in South Carolina and the Gulf States, extending to Texas, then stretching across to the Pacific coast and occurring through California and Oregon. It has frequently been sent to the Department from the Southern States as a valuable winter grass.

Mr. Thomas W. Beaty, of Conway, S. C., writes as follows:

The grass I send you was planted last September, and the specimens were cut on the 9th of March (following). You will notice that it is heading out and is just now in a right condition for mowing. It is wholly a winter grass, dying down in the latter part of April and first of May, and it seems to me should be a great thing for the South if properly introduced and cultivated, or rather the ground properly prepared and the seed sown at the right time. It would afford the best of green pasturage for sheep and cattle all winter. It is what we call Gilbert's relief grass.

Many years ago Dr. Lincecum, of Texas, experimented with this grass and recommended it very highly. In California it is called California timothy, and is said to have little or no agricultural value. It is an annual or biennial. Professor Phares says:

The variety *angustata* is much larger and more valuable. It grows 2 to 3 feet high, and in swamps 5 feet, with many leaves 4 to 10 inches long, the spike somewhat resembling the head of timothy; stock like it well, especially as hay. Mr. D. Stewart, of Louisiana, having tested other grasses, prefers this for quantity and quality for winter and spring grazing, and for soiling for milk cows. There is much testimony from many parts of the South of the same import, and this grass is doubtless worthy of extended, careful testing.

(Plate 31.)

*ANTHOXANTHUM ODORATUM.* (Sweet vernal grass.)

A perennial grass, native of Europe, much employed as a part of mixed lawn grasses, and also frequently found in meadows. It grows thinly on the ground, with slender culms, seldom more than 1 foot to 18 inches in height, and scanty in foliage. The panicle is 2 to 3 inches long, narrow and close, but expands considerably during flowering time.

The spikelets are clustered, three to four lines long, and with one perfect flower. There are two pairs of empty glumes; the outer pair is unequal; the lower are about half as long as the second; both are acute and keeled. Within these glumes is a second pair, about half as long as the first, thin, two-lobed, hairy, and with an awn or bristle on the back longer than the longest outer glume. These may be considered as abortive or defective flowers. Between these inner glumes is the fertile flower, consisting of another pair of glumes, inclosing the floral organs. These glumes are commonly called palets; they are less than a line long, thin and transparent, the lower one broad and three-nerved, the upper narrow and one-nerved. There are two stamens and two styles.

This grass is very fragrant and gives a pleasant odor to hay which contains it. Mr. J. Stanton Gould says:

It is nowhere considered a very valuable variety for hay, as the culms are wide apart, very thin, and bear but few leaves; hence it gives a light crop of hay.

(Plate 32.)

#### *HIEROCHLOA BOREALIS.* (Vanilla or Seneca grass. Holy grass.)

This is a perennial grass of northern latitudes, growing in moist meadows near the coast, also in low marshy ground in some parts of Illinois and other States bordering the Great Lakes, and in the mountains of Colorado and northward. The name *Hierochloa* means sacred grass, so called because it, with other sweet-scented grasses, was strewed before the church doors in the north of Europe. The culms grow from 1 to 2 feet high, with short lanceolate leaves, and an open pyramidal panicle from 2 to 5 inches long. The spikelets are three-flowered, the third or terminal one perfect, but with only two stamens; the two lower flowers of the spikelet are male only, each with three stamens. The two outer glumes are thin and scarious, acutely keeled; the glumes of the male flowers are thicker, slightly pubescent, and fringed on the margins with soft brownish hairs, sometimes with a very short awn from the apex, and inclosing a narrow, bifid, two-keeled palet; the upper or perfect flower has a one-nerved glume in place of the usual palet. This grass is very sweet-scented and is often used to perfume drawers, &c. It grows commonly in the northern parts of Europe, as Norway, Sweden, and Russia. In our country it does not appear to be adapted to general cultivation. There are two other species native to this country. (Plate 33.)

(1.) *Hierochloa alpina* growing on mountains at high altitudes, and  
(2.) *Hierochloa macrophylla*, a largeleaved, robust species, growing in California, whose value for agricultural purposes is undetermined.

#### *ALOPECURUS PRATENSIS.* (Meadow Fox tail.)

This is a perennial grass, native of Europe, but has been introduced and is frequently found in meadows in the Eastern States. It has considerable resemblance to timothy, but will be readily distinguished by

an examination. It ordinarily grows about 2 feet high but frequently in good soil reaches 3 feet or more. The culms are erect, with four or five leaves at pretty uniform distances. The sheaths are long and rather loose, particularly on the upper one. The blade of the leaf is 3 or 4 inches long, about one-quarter inch wide, at the base and tapering gradually to a point. The panicle terminates the stalk and is a cylindrical spike 2 or 3 inches long, dense, soft, and with the awns of the flowers conspicuously projecting. The spikelets are single-flowered, between two and three lines long. The outer glumes are strongly compressed, boat-shaped, keeled, nearly equal, sometimes slightly united together at the base, and have a line of soft, short hairs on the keels. These glumes closely inclose the flower, which is of nearly the same length, and consists of a flowering glume (formerly called the lower palet) and the floral organs, but without any true palet. This flowering glume is folded upon itself and incloses the stamens and styles. It gives rise on its back near the base to a fine awn, which extends two or three lines beyond the glumes.

Mr. J. S. Gould says :

It flourishes in May, nearly four weeks in advance of timothy, and is one of the earliest grasses to start in the spring. Pastures well covered with this grass will afford a full bite at least one week earlier than those which do not have it. It does not flourish in dry soils, but loves moist lands; no grass bears a hot sun better, and it is not injured by frequent mowings, on which account, as well as for its early verdure, it is valuable for lawns.

There is a variety of this grass called *A. alpestris*, growing in the Rocky Mountains, which may possibly be utilized there.

Mr. Charles L. Flint says :

It is a valuable pasture grass on account of its early and rapid growth, and of its being greatly relished by stock of all kinds. The stems and leaves are too few and light to make it so desirable as a field crop. It thrives best on a rich, moist, strong soil, and shoots up its flowering stalks so much earlier than timothy, that it need not be mistaken for that grass, though at first sight it considerably resembles it. It is superior to timothy as a permanent pasture grass, enduring the cropping of sheep and cattle better, and sending up a far more luxuriant aftermath. It is justly regarded, therefore, as one of the most valuable of the native pasture grasses of England forming there a very considerable portion of the sward and enduring a great amount of forcing and irrigation. Though forming a close and permanent sod when fully set, it does not acquire its full perfection and hold of the soil until three or four years after being sown.

(Plate 34.)

*ALOPECURUS GENICULATUS.* (Water Fox tail.)

This species, especially the variety *aristulatus*, is native to this country. It is commonly found on the muddy banks of streams and lakes, and sometimes is found in wet meadows and ditches. It seldom grows more than a foot in height; the stem is usually bent at the lower joints, and the sheaths of the leaves are more or less swollen, especially the upper one. It is of no value for cultivation, being only useful for the amount of grass it may contribute to the wild forage where it grows.

## ALOPECURUS ALPINUS.

A species resembling the *Alopecurus pratensis* grows in alpine meadows in the Rocky Mountains.

## • ARISTIDA.

This is a genus of grasses of which many species are found in the United States, Mexico, and South America. They are principally annual grasses and are of little value, unworthy of cultivation, but in some regions, particularly the arid Western plains, they furnish a portion of the wild forage.

## ARISTIDA PURPURASCENS. (Beard grass, Three-awned grass.)

This species grows in many of the States east of the Mississippi River, usually in poor, sandy, or clay soil, in thin woods or barren fields. It grows usually about 2 feet high, with a slender, smooth culm, narrow leaves, which are inclined to be involute when dry, and with a narrow, loose, spike-like panicle a foot or more long, which usually gracefully droops or bends. The branches are short, appressed, mostly single at the joints of the axis, and each having seldom more than two or three spikelets. The spikelets are single-flowered, the outer glumes are narrowly linear, four or five lines long, the lower one slightly the longer, both usually sharply pointed. These glumes inclose the flower, which consists of a slender, almost cylindrical flowering glume about three lines long, having a short-pointed, hairy base, and a long, three-bearded apex. This glume enrolls the narrow, thin palea and the floral organs. The awns or beards are widely spreading, the middle one about an inch long, the two lateral ones somewhat shorter. (Plate 35.)

## ARISTIDA PURPUREA. (Western Beard grass. Purple Three-awned grass.)

This species prevails extensively west of the Mississippi River, from British America to Mexico, and is abundant on the plains of Kansas, New Mexico, and Texas. It grows usually 1 to 1½ feet high, with slender culms, branching at the base, and with short, involute leaves. It is an exceedingly variable species, or there are several distinct varieties. The panicle is 6 to 8 inches long, rather narrow, erect, or flexuous. The spikelets are much like those of the preceding species, but usually larger and with longer awns or beards. In some varieties these awns are 2 or 3 inches long, widely diverging, and purplish colored, the whole panicle having a graceful and feathery appearance.

Like the other species, this is an inferior grass, but furnishes a considerable amount of wild forage. (Plate 36.)

## ARISTIDA BROMOIDES.

A small, apparently annual, grass, growing in New Mexico, Arizona, and Southern California. It grows in tufts, the culms from 6 to 12 inches high, slender, erect, and generally unbranched. The spikelets are seven to eight lines long, including the awn. (Plate 37.)

## STIPA. (Feather grass, Beard grass.)

A genus mostly of coarse, rigid grasses, chiefly Western, in structure and habit resembling the preceding genus. It differs in having the spikelets usually longer and the flowering glume having a single undivided awn or beard.

## STIPA VIRIDULA. (Bunch grass.)

A perennial grass, culms 2 to 4 feet high, leafy; the radical leaves 12 to 18 inches long, those of the stem 4 to 10 inches long, one to two lines wide, involute, and bristle-like at the point; sheaths long, smooth, the uppermost inclosing the base of the panicle; panicle very variable in size, from 6 inches to a foot or more, narrow and loose, variable in thickness, the branches mostly in twos or threes, erect and appressed, much subdivided; spikelets, one-flowered on short pedicels; outer glumes four to six lines long, bristle-pointed, nearly equal, lanceolate, three to five nerved, thin; flowering glume three to four lines long, cylindrical, covered with short, scattered hairs, which are longer at the minutely two-toothed apex, which is terminated by a slender awn 1 to 1½ inches long, once or twice bent, twisted and sparsely pubescent below, scabrous above. The palea is narrow and shorter than its glume, by which the floral organs and it are involved. Widely diffused over the Rocky Mountain region, extending to California, Oregon, and British America, furnishing a considerable part of the wild forage of the region. (Plate 38.)

## STIPA SETIGERA. (Bear-grass, Bunch grass.)

A perennial grass, growing in bunches on dry hills and plains from Oregon to Southern California and eastward to Arizona and Texas. The culms are 2 to 3 feet high, erect, somewhat pubescent at the joints, with about three leaves. The sheaths are long and somewhat scabrous, the upper one loose and inclosing the base of the panicle; the blade flat, two or three lines wide, 4 to 6 inches long, roughish and long-pointed; the upper one nearly as long as the panicle, which is about 6 inches long, loose, the rays mostly in pairs, rather distant, slender, bearing near the extremity the few spikelets on short pedicels. Spikelets one-flowered, the outer glumes one-half to two-thirds of an inch long, the upper one rather shorter, narrow, acute, purplish and three-nerved. The flowering glume is nearly cylindrical, four to five lines long, sparingly hairy above, with a short, stiff point at the base called a callus, and a hardened ring at the apex, to which is attached the slender, twisted awn, 2 to 3 inches long, the lower part of which is softly pubescent. Professor Brewer says this is the most common and most valuable "bunch grass" of the hills of California. (Plate 39.)

## STIPA EMINENS. (Feather grass, Beard grass.)

A very common species in California on dry hills, growing in rather small tufts with numerous short and narrow root-leaves. It is a per-



ennial, growing usually 2 to 3 feet high, with rather slender culms, and slightly hairy joints. The leaves are very narrow and convolute, rather rough and rigid, the lower ones about half the length of the culm. The panicle is rather narrow, but open and loose, usually about 6 inches long, at first sheathed by the upper leaf, but becoming exerted; the branches are slender, in pairs, and flower-bearing above the middle. The spikelets, as in the preceding, are single-flowered, the outer glumes about half an inch long, very narrow, three-nerved, and long, fine-pointed. The flowering glume is very similar to that of the preceding, rather shorter and smaller, with a ring of very short hairs at the apex, and with an awn about an inch long, which readily separates from its glume. (Plate 40.)

*Stipa spartea* and *Stipa comata* are two species, also called bunch grasses, which prevail from British America southward, on the plains and in the mountain region, very similar in general appearance to the preceding, but usually with longer awns, sometimes 6 inches long.

Mr. Robert Miller Christy, writes about these grasses in Manitoba, where they are common, that there is much complaint concerning them among stockmen on account of the injury they do to sheep by the penetration into their wool, and even into the flesh, of the sharp-pointed and barbed awns of the seeds.

*Stipa avenacea* is the only species prevailing in the Eastern and Southern States. It is more slender than those previously mentioned, and grows sparsely in open woods or on rocky hills. It is of no agricultural importance.

#### ERIOCOMA CUSPIDATA. (Bunch grass.)

This grass has a wide distribution, not only on the Sierras of California, but northward to British America, and eastward through all the interior region of Utah, Nevada, New Mexico, Texas, Colorado, and Nebraska to the Missouri River. It is a perennial, growing in dense tufts, whence its common name of bunch grass. The culms are 1 to 2 feet high, with about three narrow, convolute leaves, the upper one having a long, inflated sheath which incloses the base of the panicle. The radical leaves are narrow, rigid, and as long as or longer than the culm. The panicle is about 6 inches long, very loose, spreading, and flexuous. The branches are in pairs, slender, rather distant, and are subdivided mostly in pairs. The spikelets are at the ends of the capillary branches, each one-flowered. The outer glumes are three to four lines long, inflated and widened below, gradually drawn to a sharp-pointed apex, thin and colorless except the three or five green nerves, and slightly hairy. The glumes inclose an ovate flower, which is covered externally with a profusion of white, silky hairs, and tipped with a short awn, which falls off at maturity. This apparent flower is the flowering glume of a hard, coriaceous texture, and incloses a similar hard, but not hairy, and smaller palet. (Plate 41.)

## MILIUM EFFUSUM. (Wild millet.)

A perennial, rather slender, grass, 4 or 5 feet high, growing in damp woods in the northern portions of the United States and in Canada. It is also found in Northern Europe and in Russian Asia. There are four to five joints to the culm, each provided with a leaf which is broad and flat, 6 to 12 inches long, and half an inch wide, smooth above and roughish below. The sheaths are long and smooth. The panicle is loose and spreading, 6 to 10 inches long, the slender branches mostly in fives, of unequal length, the longer ones 2 to 3 inches, and flowering near the extremities. The whorls are from 1 to 2 inches apart. The spikelets are single-flowered, consisting of a pair of thin, concave, smoothish, empty glumes, one to one and one-half lines long, rather exceeding the flowering glume, which is thick and hard, very smooth and shining, and inclosing the palet which is of similar texture. The flowers are in structure similar to those of *Panicum*, to which this grass is closely related.

Hon. J. S. Gould, in the Report of the New York State Agricultural Society, says respecting this grass :

Mountain meadows and borders of streams and cold woods. It thrives when transplanted to open and exposed situations. It is one of the most beautiful of the grasses ; the panicle is often a foot long, and the branches are so exceedingly delicate that the small glossy spikelets seem to be suspended in the air. Birds are very fond of the seed. Mr. Colman says that he has raised 3 tons to the acre of as good nutritious hay as could be grown from it, when sown in May. The plants multiply by the roots as well as by the seed, sending out horizontal shoots of considerable length, which root at the joint as they extend.

(Plate 42.)

## MUHLENBERGIA. (Drop-seed grass.)

There are many species of this genus, mostly perennials. It is characterized as having small, one-flowered spikelets, generally in open panicles. The outer glumes are variable in size in different species, in some minute, in others nearly as large as the flowering glume, sometimes bristle-pointed, sometimes very blunt, and sometimes toothed at the apex. The flowering glume is longer than the outer glumes, with a short more or less hairy callus at the base, three to five nerved, thin-nish or rigid mucronate pointed, or commonly with a long capillary awn from the apex ; the palet as long as the flowering awn and of similar texture.

## MUHLENBERGIA DIFFUSA. (Nimble will, Drop seed, Wire grass.)

This species is perennial, low with much-branched, decumbent stems and slender panicles of flowers. The outer glumes are very minute, so small as to be scarcely visible to the naked eye, transparent and obtuse ; the flowering glume little more than a line long, tipped with a fine awn or beard once or twice its own length.

Professor Killebrew, of Tennessee, says :

It is hardly more than necessary to mention this grass, which forms in many sections the bulk of the pastures of the woods. It does not grow in fields, but in woods, where, after rains have set in, it carpets the earth with living green. Various opinions are entertained as to its nutritive qualities. Some farmers assert that their stock are fond of it, and that on sufficient range cattle, horses, and sheep will go into the winter sleek and fat from this vigorous grass. Others regard it as well nigh worthless.

According to the analysis of the chemist of this Department it has a very good amount of nutritive properties. It is considered by some that it is a good butter-producer and gives a good flavor to butter. In cultivation, no doubt, its place can be supplied with much more productive grasses. (Plate 43.)

#### MUHLENBERGIA MEXICANA. (Wood grass.)

A perennial grass of decumbent habit, 2 to 3 feet high, very much branched, from scaly creeping root-stocks. The culm has numerous short joints, which frequently are bent and rooting near the base, and sending out many long, slender, leafy lateral branches. From these branches and from the apex of the culm arise the flowering panicles, which are sometimes partially included in the leaf sheaths. The leaves are 3 to 4 inches long and two to three lines wide, gradually pointed. The panicles are narrow, usually 2 to 3 inches long, and composed of five to ten spike-like branches, closely approximated or distant and interrupted below. The spikelets are single-flowered; the outer glumes are abruptly sharp-pointed and nearly as long as the flowering glume, which is narrow, strongly three-nerved, and acute, with usually a few soft hairs at the base and on the nerves. The palea is of equal length with its glume, which is also acute, but not bristle-pointed.

This grass is frequently found in moist woods and low meadows or in prairie bogs. It probably would not endure upland culture, but in its native situations it fills an important part among indigenous grasses. (Plate 44.)

#### MUHLENBERGIA SYLVATICA. (Wood grass.)

This species in habit and appearance is very much like that of the preceding. The panicle is looser, the spikelets not so densely clustered, and the flowering glume bears an awn two or three times as long as itself. The outer glumes are generally bristle-pointed, but they vary much in this respect, in some forms being only acute. It inhabits drier situations than the *M. Mexicana*, being found in dry, open, or rocky woods and fence-corners. In agricultural value it corresponds with that species. (Plate 45.)

#### MUHLENBERGIA GLOMERATA. (Spiked Muhlenbergia.)

This grass grows in wet, swampy grounds, chiefly in the northern and western portions of the United States. It is found in Colorado,

Utah, Nevada, New Mexico, and Texas. It grows to the height of 2 or 3 feet, stiffly erect, and generally unbranched. The culm is hard, somewhat compressed, and very leafy. The panicle is narrow, 2 to 4 inches long, composed of numerous close clusters of flowers, becoming looser below, forming an interrupted glomerate spike. The spikelets are closely sessile in the clusters. The outer glumes are linear-lanceolate, gradually tapering into an awn or bristle of equal length. The flowering glume is one-third to one-half shorter than the outer glumes and very acute. The root-stock is hard and knotty and furnished with numerous short, firm shoots or stolons. In the Eastern States it is utilized as one of the native products of wet meadows in the making of what is called wild hay. Specimens have been sent from Colorado and Kansas and recommended as an excellent grass for hay. (Plate 46.)

*MUHLENBERGIA COMATA.* (Woolly-seeded Muhlenbergia.)

This species is closely related to the preceding. It grows throughout the Rocky Mountain region in Colorado, Utah, Wyoming, Idaho, Nevada, and California, usually on the sandy or alluvial banks of streams. It grows in tufts from firm, creeping root-stocks. There is reason to think it may be a valuable grass for arid regions. The culms are erect, simple, 2 to 3 feet high, leafy below, the leaves 3 to 6 inches long and roughish, the upper one at first inclosing the base of the panicle, the joint slightly pubescent. The panicle is 2 to 4 inches long, narrow, and close, sometimes interrupted below, generally of a purplish lead color and of soft texture. The spikelets are nearly sessile, the outer glumes very narrow, acute, nearly equal, one-nerved, one and one-half to two lines long. The flowering glume is rather shorter, and surrounded at the base by a copious tuft of long, silky hairs. It is also terminated by a slender awn three or four times as long as the flower. The palea is slightly shorter than its glume and acute. (Plate 47.)

*MUHLENBERGIA GRACILIS.* (Graceful Muhlenbergia.)

A perennial grass growing in tufts or loose patches from a creeping root-stock, much branched at the base. The culms are erect, much branched, slender, and wiry, 1 to 1½ feet high; the leaves mostly radical, involute, and bristle-like, 2 to 6 inches long, scabrous on the edges. The panicle is erect or somewhat nodding, 3 to 6 inches long, narrow, very loose, the branches erect, rather distant, and mostly single. The spikelets are on short pedicels; the outer glumes unequal, the lower one ending abruptly in a slender point, the upper one three-nerved and three-toothed, the teeth usually prolonged into short awns; the flowering glume is somewhat cylindrical, taper-pointed, and with a straight awn about half an inch long; palea as long as its glume without the awn.

This species, of which there are several varieties, inhabits the arid regions of Colorado, New Mexico, and Arizona. It is too small to be of much economic importance. (Plate 48.)

## PHELUM PRATENSE. (Timothy, Herd's grass.)

This is one of the commonest and best-known grasses. For a hay crop it is, perhaps, the most valuable, especially in the Northern States. The height of the grass depends on the soil and cultivation. In poor ground it may be reduced to 1 foot, while in good soil and with good culture it readily attains 3 feet, and occasionally has been found twice that height. It is a perennial grass with fibrous roots. The base of the culm is sometimes thickened and inclined to be bulbous. The culm is erect and firm, with four or five leaves, which are erect and usually from 4 to 6 inches long. The flower spike varies from 2 to 6 inches in length, is cylindrical and very densely flowered. The spikelets are sessile, single-flowered, and cylindrical or oblong in outline. The outer glumes are rather wedge-form, with a mucronate point or short bristle. The main nerve on the back is fringed with a few short hairs. The flowering glume is shorter than the outer ones and thinner, five-nerved, and toothed at the apex. The palea is thinner in texture and much narrower.

This grass, as known in cultivation, is supposed to have been introduced from Europe, but it is undoubtedly indigenous in the mountain regions of New England, New York, and the Rocky Mountains. It is said that about the year 1711 a Mr. Herd found this grass in a swamp in New Hampshire and cultivated it. From him it took the name of Herd's grass. About the year 1720 it was brought to Maryland by Timothy Hanson and received the name of Timothy grass. It is now the favorite and prevailing meadow grass over a large part of the country.

Mr. Charles L. Flint says :

As a crop to cut for hay it is probably unsurpassed by any other grass now cultivated. Though somewhat coarse and hard, especially if allowed to ripen its seed, yet if cut in the blossom or directly after, it is greatly relished by all kinds of stock and especially so by horses, while it possesses a large percentage of nutritive matter in comparison with other agricultural grasses. It is often sown with clover, but the best practical farmers are beginning to discontinue this custom on account of the different times of blossoming of the two crops. It grows very readily and yields very large crops on favorable soils. It yields a large quantity of seed to the acre, varying from 10 to 30 bushels on rich soils.

(Plate 49.)

## SPOROBOLUS INDICUS. (Smut grass.)

This grass is a native of India, but has spread over most tropical and warm climates. It occurs more or less abundantly in all the Southern States, and is called smut grass, from the fact that after flowering the heads become affected with a black smut. It grows in tufts or loose patches, is erect, from 1½ to 3 feet high, with an abundance of long, flat, fine pointed leaves near the base, and a narrow, terminal panicle frequently a foot in length, composed of short, erect, sessile branches, which are very closely flowered. The spikelets are narrow, less than a

line long; the outer glumes unequal, thin, and nerveless, the upper one about half as long as the flower, the lower one, still shorter, obtuse or truncate; the flowering glume and palet are of nearly equal length, membranaceous, lead-colored, smooth; the glume acute; the palet obtuse.

Professor Phares says:

It grows abundantly and luxuriously on many uncultivated fields and commons, and furnishes grazing from April till frost. It thrives under much grazing and many mowings, and grows promptly after each if the soil be moist enough. Cattle and horses are fond of it if frequently cut or grazed down, but if allowed to remain untouched long they will not eat it unless very hungry, as it becomes tough and unpalatable and probably difficult to digest.

Professor Killebrew also speaks favorably of it and recommends it for trial under cultivation. (Plate 50.)

#### SPOROBOLUS CRYPTANDRUS.

This species grows chiefly in sandy soil. It is stouter than the preceding, growing in loose tufts; the culms frequently bent at the lower joints, then rising erect to the height of 2 or 3 feet. The leaves are mostly near the base, where the joints of the culms are short; here the sheaths are short and the blades of the leaves 5 to 6 inches long; the upper sheaths become longer and the blades shorter; the leaves are flat, but become involute in dry weather. The top of the sheath is fringed with fine soft hairs. The long and narrow panicle is for a long time completely inclosed in the very long sheath of the upper leaf, but finally emerges except the base and becomes more or less spreading. The full panicle is from 6 to 12 inches long, the branches mostly alternate or scattered, the lower ones about 1 inch apart and 2 inches long, the upper ones much closer and shorter, all flowering nearly to their bases with the spikelets short stalked and appressed.

This species is very common in sandy fields in the Northern and Southern States, as well as over all the dry plains west of the Mississippi River, extending from British America to Mexico, where it furnishes a portion of the wild pasturage. It deserves observation and experiment as to its value. (Plate 51.)

#### SPOROBOLUS HETEROLEPIS.

This species grows in dense, firmly-rooted tufts, principally west of the Mississippi River, from British America to Texas. The culms are  $1\frac{1}{2}$  to 3 feet high, erect, smooth. The radical leaves are very long and narrow; those of the culm, 3 or 4, with long sheaths and blades, becoming involute when dry. The panicle is from 3 to 8 inches long, rather narrow and loose; the branches, two to three together, slender, and with few rather distant flowers. The spikelets are one-flowered, sessile or nearly sessile, on the slender branches; they are about two lines long, unequal, acutely long-pointed, the lower one a little shorter and the upper a little longer than the flower. The flowering glumes and palet

are of about equal length and texture; the seed is perfectly round, smooth and shining, thick and coriaceous.

A writer on the grasses of the Rocky Mountains and plains in the Agricultural Report for 1870 says:

This species may be identified from its long, slender leaves, growing abundantly from the base of the plant, gracefully curving and frequently resting their tips on the ground; from its tendency to grow branches or stools, and when in fruit, from its small panicle of sharp-pointed spikelets and its round seeds. These when bruised emit a strong, heavy odor, which has been compared to that of *Eragrostis megastachya* when crushed in the hands; but to most olfactories it is much less offensive, and to some not at all disagreeable. It attains to the average height of about 2½ feet in fruit, but in dry seasons large tracts almost exclusively composed of this species are without a single fruiting plant. It is sometimes cultivated for hay, in the absence of the more productive species, and makes an article of fine quality.

#### SPOROBOLUS AIROIDES. (Salt grass.)

Culms arising from strong perennial creeping root-stalks, 2 to 3 feet high, thickened at the base and clothed with numerous long, rigid, generally involute, long-pointed leaves, which are smooth and bearded in the throat of the sheath, panicle becoming exerted and diffuse, 6 to 12 inches long, 3 to 4 inches wide; the branches capillary, scattered, mostly single, or in whorls below, the branches subdivided above the middle and rather sparsely flowered.

The spikelets are one-flowered, purplish, on short slender pedicels. The outer glumes are unequal, thin, nerveless, or obscurely nerved, oblong, the lower half as long as the upper, the upper one rather shorter than the flowering glume, which is about one line long, oblong, obtusish or minutely dentate at the apex; palea about equal to its glume; bidentate.

A common grass throughout the arid regions of the West, sometimes called salt grass, and affording considerable pasturage in some places. (Plate 52.)

#### AGROSTIS. (Bent grass.)

This genus has many species all characterized by having one-flowered spikelets; the outer glumes acute, one-nerved, and awnless, nearly equal, or the lower rather longer, and longer than the flowering glume, which is very thin, three to five nerved, awnless or awned on the back; palea shorter than the flowering glume, frequently reduced to a small scale or absent.

#### AGROSTIS VULGARIS. (Red top, Fine top, Herd's grass of Pennsylvania Borden's grass, Bent grass.)

A perennial grass, growing 2 or 3 feet high from creeping root-stocks, which interlace so as to make a very firm sod; the culms are upright, or sometimes decumbent at the base, smooth, round, rather slender, and clothed with four or five leaves, which are flat, narrow, and roughish, from 3 to 6 inches long, with smooth sheaths, and generally truncate

ligules. The panicle is oblong in outline, 4 to 6 inches long, open, composed of eight or ten joints or whorls, the lower branches mostly in fives, slender, unequal, the longer ones much subdivided. The spikelets are about a line long, varying from greenish to purple. The outer glumes are lanceolate and pointed, nearly alike in size, smooth, except the more or less roughened keel. The flowering glume is but little shorter than the outer ones, thin and delicate, and occasionally with a minute awn on the keel. The palet is narrow, and from half to three fourths as long as its glume, and inclosing the floral organs. There are several varieties of this grass, which are by some botanists considered a distinct species.

*Agrostis alba*, the *Fiorin* grass of Ireland, and *Agrostis stolonifera* are usually considered synonymous, and are distinguished from *A. vulgaris* by having a closer, more verticillated panicle, and with longer and more acute ligules.

Mr. J. G. Gould says of *Agrostis vulgaris* :

This is a favorite grass in wet, swampy meadows, where its interlacing, thick roots consolidate the sward, making a firm matting which prevents the feet of cattle from poaching. It is generally considered a valuable grass in this country, though by no means the best one. Cattle eat hay made from it with a relish, especially when mixed with other grasses. As a pasture grass it is much valued by dairymen, and in their opinion the butter would suffer much by its removal.

Professor Phares, of Louisiana, says respecting this grass :

It grows well on hill tops and sides, in ditches, gullies, and marshes, but delights in moist bottom land. It is not injured by overflows, though somewhat prolonged. It furnishes considerable grazing during warm spells in winter, and in spring and summer an abundant supply of nutrition. Cut before maturing seed, it makes good hay and a large quantity. It seems to grow taller in the Southern States than it does farther north, and to make more and better hay and grazing.

Mr. Flint says :

It is a good permanent grass, standing our climate as well as any other, and consequently well suited to our pastures, in which it should be fed close ; for if allowed to grow up to seed the cattle refuse it ; and this seems to show that it is not so much relished by stock as some of the other pasture grasses.

(Plate 53.)

AGROSTIS EXARATA. (Northern Red top, Mountain Red top.)

This is chiefly a northern species, being found in Wisconsin and westward to the Rocky Mountains, also in British America, and California to Alaska. It is very variable in appearance, and presents several varieties. It is generally more slender in growth than the common red top. The panicle is usually longer, narrower, and looser. In all the forms the palet is wanting or is very minute. The form chiefly growing on the Pacific slope from California to Alaska is often more robust than the *A. vulgaris*, growing 2 to 3 feet high, with a stout, firm culm, clothed with three or four broadish leaves, 4 to 6 inches long. The panicle is 4 to 6 inches long, pale green, rather loose, but with erect branches.



The outer glumes are of about equal length, acuminate, rough on the keel. The flowering glume is one-third shorter than the outer ones, rather acute, four-nerved, the nerves extended into short points or teeth, and rarely with a very short awn on the back. The palet if present is very minute, scarcely as long as the ovary.

There is reason to believe that this grass can be made to supply the same valuable place on the Pacific coast that the *A. vulgaris* does at the East, but it requires investigation and experiment. (Plates 54 and 54a.)

#### AGROSTIS MICROPHYLLA.

This is a species belonging to the western coast and the adjacent mountains. It is apparently an annual or biennial, frequently with several culms springing from one root. The radical leaves are few and short. The culms are erect, stiff,  $1\frac{1}{2}$  to 3 feet high, with four or five rough and rather rigid leaves 3 to 6 inches long, two or three lines wide, and gradually pointed. The sheaths are long and roughish. The panicle is 3 to 5 inches long, erect, spikelike, narrow, and densely flowered, sometimes interrupted below. The spikelets are densely crowded on the short, almost sessile, branches. The outer glumes are slightly unequal, rather more than a line in length; awn pointed, narrowly lanceolate, scabrous or hispid on the keel. The flowering glume is about half as long as the outer glumes, thin, acute, two-toothed at the summit, and on the back, about one-third below the apex, furnished with a slender awn three times its own length, which is readily seen projecting beyond the outer glumes. There is no proper palet or only a microscopic one. This grass deserves the attention of those who live in its habitat. It may prove a useful species. (Plate 55.)

#### AGROSTIS CANINA. (Dog's Bent Grass, Mountain Red top.)

A grass usually of low size, 6 to 12 inches high, with slender culms, and a light, flexible, expanded panicle, growing in elevated regions or in high latitudes, and with a perplexing variety of forms. The radical leaves are numerous, but short and narrow. The culm has two or three fine short leaves, 1 or 2 inches long, the ligule acute, short but conspicuous. The panicle is pyramidal in form, 3 or 4 inches long, of few capillary branches, which are in pairs, horizontal in flower, more erect and close in fruit, dividing near the extremities into a few sparsely flowered branchlets. The spikelets are on short, fine pedicels; the outer glumes nearly equal, ovate and acute, one to one-half line long; the flowering glume is about a quarter shorter than the outer ones, thin, smooth, obtuse, and bearing on the back, about the middle, a fine, straight awn about two lines long; the palet is so minute as to be hardly visible to the naked eye.

There are several varieties of this grass growing in mountainous regions throughout the United States and in Europe. It forms a close sod, and affords considerable pasturage in those regions. (Plate 56.)

## POLYPOGON MONSPELIENSIS. (Beard grass.)

An annual grass frequent in California, Oregon, Arizona, Texas, and Utah, and sometimes found on the Atlantic coast. It is a native of Europe. The culms are from 6 inches to 2 feet high, rather stout, apt to be procumbent at the base, and often branching below. There are usually three or four leaves on the culm, which are broad, flat, 3 to 6 inches long, and somewhat rough; the sheaths are rather loose and striate, and the ligule long and obtuse. The panicle varies from 1 to 4 inches in length, contracted into a dense cylindrical spike, of a shining, yellowish-green color, the long awns or beards of the flowers being very conspicuous. The spikelets are one-flowered, about one line long. The outer glumes are nearly equal, one-nerved pubescent, notched at the apex, the midnerve extended into a slender awn or beard from two to four times as long as the glume. The flowering glume is about half as long as the outer ones, thin, toothed at the apex, and usually having a fine awn about one line long; the palet is smaller, thin, delicate, and without an awn. It is quite an ornamental grass, but of little agricultural value. (Plate 57.)

## CINNA ARUNDINACEA. (Wood Reed grass.)

A perennial grass, with erect, simple culms from 3 to 6 feet high, with a creeping rhizoma; growing in swamps and moist, shaded woods in the northern or mountainous districts. The leaves are broadly linear-lanceolate, about 1 foot long, four to six lines wide, and with a conspicuous elongated ligule. The panicle is from 6 to 12 inches long, rather loose and open in the flower, afterwards more close. The branches are four or five together below, about 2 inches long, above in twos or threes and shorter. The spikelets are one-flowered, much flattened, rather crowded on the branches, frequently purple colored. The glumes are linear-lanceolate, roughish, acute, and strongly keeled, mostly three-nerved, firm in texture, about two lines long, the lower rather the shorter. The flower is short-stalked within the glumes; the flowering glume is as long as the outer ones, and of the same texture, rather scabrous and three-nerved, and usually with a very short awn near the apex. The palet is rather shorter than its glume, thin and membranaceous, except on the green somewhat rough nerve. This is one of the very rare cases in which the true palet has only a simple nerve, probably, Mr. Bentham says, by the consolidation of two. There is but one stamen.

This leafy-stemmed grass furnishes a large quantity of fodder, but experiments are wanting to determine its availability under cultivation. (Plate 58.)

There is another species, *Cinna pendula*, which is more slender, with a looser drooping panicle and more capillary branches, and with thinner glumes. It occurs in the same situations as the preceding, and is more common in the Rocky Mountains and Oregon.

## DEYEUXIA (CALAMAGROSTIS.)

This genus is characterized by having one-flowered spikelets, with the addition at the base of the flowering glume of a small hairy appendage or pedicel, which is considered to be the rudiment of a second flower. In addition to this the flower is also generally surrounded at the base with a ring of soft hairs, and the flowering glume usually bears an awn on its back, which is generally bent and twisted. Our species have been until recently included in the genus *Calamagrostis*, which is principally a very similar European genus.

## DEYEUXIA (CALAMAGROSTIS) CANADENSIS. (Blue Joint, Small Reed grass.)

A stout, erect, tall perennial grass, growing chiefly in wet, boggy ground or in low, moist meadows. Its favorite situation is in cool, elevated regions. It prevails in all the northern portions of the United States, in the Rocky Mountains, and in British America. In those districts it is one of the best and most productive of the indigenous grasses. It varies much in luxuriance of foliage and size of panicle, according to the location. The culms are from 3 to 5 feet high, stout and hollow, hence in some places it is called the small reed-grass. The leaves are a foot or more long, flat, from a quarter to nearly half an inch wide, and roughish; the stem and sheaths smooth.

The panicle is oblong in outline, open, and somewhat spreading, especially during flowering; it is from 4 to 6 or even 8 inches in length, and 2 or 3 inches in diameter, of a purplish color; the branches are mostly in fives at intervals of an inch or less. These branches vary in length from 1 to 3 inches, the long ones flowering only toward the extremity. The spikelets are short-stalked, the outer glumes about one and one-half lines long, lanceolate and acute; the silky white hairs at the base of the flowering glume, are about as long as the glume; those on the sterile pedicel also nearly as long. The flowering glume is thin and delicate, about as long as the outer glumes, and somewhat finely toothed at the apex, three to five nerved, and bearing on the back, below the middle, a delicate awn, reaching about to the point of the glume, and not much stouter than the hairs. The proper palet is thin, oblong, and about two-thirds the length of its glume.

Mr. J. S. Gould says:

It constitutes about one-third of the natural grasses on the Beaver Dam Meadows of the Adirondacks. It is certain that cattle relish it very much, both in its green state and when made into hay, and it is equally certain that the farmers who have it on their farms believe it to be one of the best grasses of their meadows.

(Plate 59.)

## DEYEUXIA SYLVATICA. (Bunch grass.)

A coarse perennial grass, growing in large tufts, usually in sandy ground in the Rocky Mountains at various altitudes, also in California,

Oregon, and British America. It furnishes an abundant coarse forage in the regions where it is found. The culms are from 1 to 2 feet high, erect, rigid, and leafy; the radicle leaves are frequently as long as the culm, two or three lines wide, sometimes flat, but generally involute and rigid. The culm leaves are from 3 to 6 or 8 inches long, rigid and rough. The panicle is narrow and spike-like, 3 to 5 inches long, erect, rather dense, sometimes interrupted below, and varying from pale green to purple. The branches are mostly in fives, very short and rough. The spikelets are about a quarter of an inch long, on short, rough pedicels; the outer glumes are nearly equal, ovate-lanceolate, long and sharp pointed, the upper one three-nerved, the lower one-nerved. The flowering glume is about one-third shorter, of similar texture, three-nerved, four-toothed at the apex, and bearing on the back a twisted and bent awn longer than the glume. The hairs at the base are scanty and short, those of the rudiment about half as long as the flower. The palea is about half as long as its glume, thin, two-nerved, and two-toothed at the apex. (Plate 60.)

DEYEUXIA HOWELLII. (Howell's grass.)

Culms densely tufted, 1 to 2 feet high, erect or somewhat geniculate below, smooth; radical leaves numerous, as long as the culm, firm, but not rigid, inclined to be involute, the ligule conspicuous, about one and one-half lines long, scarious; culm with three or four leaves which are 4 to 6 inches long, the upper one nearly equaling the culm. Panicle pyramidal, loose and spreading, 3 to 4 inches long, the branches mostly in fives, the lower ones 1 to 1½ inches long, numerous flowered above the middle. Spikelets pale green or tinged with purple, outer glumes lanceolate, acute, two and one-half to three lines long, nearly equal, membranaceous, the upper three-nerved, the lower one-nerved; flowering glume slightly shorter than the outer ones, lanceolate, acute, three to five nerved, the apex bifid, usually with four mucronate points, a conspicuous strong awn one-half inch long, inserted on the back about the lower third, a tuft of short hairs, and a hairy pedicel about half as long as the floret; palea nearly as long as its glume, thin, acute, and two-toothed at the apex.

This grass has recently been discovered in Oregon by Mr. T. J. Howell, and also in Washington Territory by Mr. W. N. Suksdorf. From its habit of growth and the great abundance of foliage, it gives promise of being a valuable grass for cultivation. (Plate 61.)

AMMOPHILA.

This genus differs very little from *Deyeuxia*, but chiefly in the absence of the awn on the back of the flowering glume.

AMMOPHILA ARUNDINACEA. (Sea-sand reed, Beach grass, Mat grass.)

This is the *Calamagrostis arenaria* of the olden books. The entire plant is of a whitish or pale-green color. It grows on sandy beaches

of the Atlantic at least as far south as North Carolina, and on the shores of the Great Lakes, but has not so far been recorded from the Pacific coast. It also grows on the sea-coast of the British Isles and of Europe. It forms tufts of greater or less extent, "its long creeping roots extending sometimes to the extent of 40 feet. and bearing tubers the size of a pea, interlaced with death-like tenacity of grasp, and form a network beneath the sand which resists the most vehement assaults of the ocean waves." The culms are from 2 to 3 feet high, rigid and solid; the leaves long, involute, smooth, rigid, and slender-pointed; the panicle dense, 6 to 10 inches long, close and spike-like; the spikelets are about half an inch long, compressed, crowded on the very short branchlets. The outer glumes are nearly equal, five to six lines long, compressed, lanceolate, chartaceous, smooth except on the thin keel; the flowering glume is a little shorter, acute or slightly mucronate at the tip, obscurely five-nerved; the palea about as long as its glume, two-keeled. The hairs at the base are rather scanty, and about one-third as long as the flowering glume; the hairy pedicel is of about the same length. This grass has no agricultural value, but from time immemorial its utility in binding together the loose sands of the beach and restraining the inroads of the ocean has been recognized and provided for in some places by law. Mr. Flint, in his work on grasses, says that the town and harbor of Provincetown, once called Cape Cod, where the Pilgrims first landed, one of the largest and most important harbors in the United States, sufficient in depth for ships of largest size, and in extent to anchor three thousand vessels at once, owe their preservation to this grass. The usual way of propagating the grass is by transplanting the roots. The grass is pulled up by hand and placed in a hole about a foot deep and the sand pressed around it by the foot. There are undoubtedly many places on the sea-coast where this grass would be of inestimable value in restraining the encroachment of the ocean. It would also be useful in forming a dense turf for the protection of dikes and banks subject to water-washing.

#### AMMOPHILA LONGIFOLIA.

This grass, formerly called *Calamagrostis longifolia*, has recently been transferred by Mr. Bentham to genus *Ammophila*. It grows on the sandy plains of the interior from British America to Arizona, and on the borders of the Great Lakes. It has strong running root-stalks, like the preceding, but is much taller, the culms being 3 to 6 feet high, stout and reed-like; the leaves long, rigid, and becoming involute, with a long thread-like point. The panicle is quite variable, from 4 to 16 inches long, at first rather close, but becoming open and spreading, the branches in the smaller forms being 2 or 3 inches long, and in the larger ones often 10 or 12 inches and widely spreading. The outer glumes are lanceolate, unequal, smooth, and chartaceous, the upper one three to four lines long, the lower about one-fourth shorter.

The flowering glume and palet are of equal length and similar texture with the longest outer glume; the copious hairs at the base are more than half as long as the flower. There is no sterile pedicel or rudiment. This grass is too coarse to be of much agricultural value, but would be useful for the same purposes as the preceding.

DESCHAMPSIA. (*Aira* of the books.)

This genus has two-flowered spikelets, the upper flower usually smaller than the lower, generally in a loose panicle with slender branches. The axis or stem connecting the two flowers is hairy, and is extended into a hairy pedicel which rarely bears an empty glume or rudiment of another flower. The outer glumes are keeled, rather thin, and with scarious margins; the flowering glumes have a fine awn on the back below the middle.

DESCHAMPSIA CÆSPITOSA (*Aira cæspitosa*). (Hair grass.)

This is an exceedingly variable species, having a very wide distribution in this and other countries. It is somewhat rare east of the Mississippi, but on the elevated plains and in the Rocky Mountains, also in California and Oregon, it is one of the common bunch grasses which afford pasturage to cattle and horses. In the East it is found in the hilly regions of New England and the Alleghanies.

The culms form tussocks, are smooth, and grow from 2 to 4 feet high; the root leaves are very numerous, generally flat, narrow, and from 6 inches to a foot long; those of the culm about 2, and from 1 to 3 inches long; the ligule is conspicuous and pointed. The panicle is generally pyramidal, 4 to 6 or sometimes 10 inches long, the branches distant, 1 to 3 inches long; capillary and spreading, the lower ones in fives, those above two or three together, or single, and are flower-bearing mostly above the middle. The spikelets are smooth, on slender pedicels, and are about two lines long. The empty glumes are membranaceous, purple, or yellowish, nearly equal, the upper one a little the longer and about as long as the flowers; the flowering glumes are oblong, toothed at the obtuse apex, thin, scarious margined and delicately nerved; from the back near the base proceeds a slender awn about as long as the glume. The palets are similar in texture, narrow, two-nerved and two-toothed at the apex.

The panicle is very handsome, presenting a purple or glossy hue and a loose graceful appearance.

We know very little as to the value of this grass. It may be found worthy of cultivation in the arid interior districts. (Plate 62.)

DESCHAMPSIA FLEXUOSA. (Wood hair grass.)

A perennial grass, growing in tufts on rocky hills or in sandy woods. The culms are slender, 1½ to 2 feet high, and smooth. The leaves are mostly from the root, very numerous, very narrow, involute, and 6 to

12 inches long. The panicle is rather looser, and with longer, more naked branches, and fewer flowers than the preceding species. The branches are two to three together at the joints; the spikelets are of about the same size, on longer pedicels, the awn of the flowering glume about half longer, becoming bent and twisted. Sheep are fond of this grass, and where they have access to it, gnaw it close to the ground. It affords, however, but a small amount of feed, and is undeserving of cultivation.

DESCHAMPSIA DANTHONIOIDES. (*Aira danthonioides*.)

A slender annual grass, common in Oregon and California, growing in moist meadows, where, according to Mr. Bolander, it often forms a large portion of the herbage.

From its slender culms and small leaves it cannot furnish a large bulk of hay. The culms vary from 3 inches to a foot or 2 in height, sometimes bent and branching at the base. The leaves are 1 or 2 inches long and very narrow; the upper sheaths are very long. The panicle is loose, very slender, erect, usually 2 to 5 inches long, the lower branches in twos or threes, the upper ones in pairs or solitary, distant, appressed, branching from below the middle, and two-flowered. The spikelets are on slender pedicels. The outer glumes are about three lines long, lanceolate, gradually sharp-pointed, three-nerved, and slightly roughed on the keel. The two flowers are together, shorter than the outer glumes, being each about one line long, with a small tuft of silky white hairs at the base. The flowering glumes have a truncated apex with four small teeth, and the awn, which is inserted on the back about the middle, is three or four times as long as the glume, and usually more or less twisted and bent. (Plate 63.)

HOLCUS LANATUS. (Velvet grass, Meadow Soft grass, Velvet Mesquite grass.)

A foreign grass, which has been introduced and has become tolerably well established in many places. It is a perennial, with a stout, erect culm, 2 to 3 feet high, the leaves, and especially the sheaths, densely clothed with soft hairs feeling like velvet. The culm is leafy and the sheaths loose; the upper ones longer than the blade, which is three to six lines wide, 4 to 5 inches long, and rather abruptly pointed. The panicle is open and spreading, rather oblong in outline, and 4 to 6 inches long. The branches are mostly in twos or threes, much divided, and softly pubescent. The spikelets are two-flowered, the lower one being the larger and containing both stamens and pistils, the upper one small and staminate only. The outer glumes are about two lines long, membranaceous, boat-shaped, sparingly pubescent, and white, the upper one broader and three nerved, the lower one-nerved, both much longer than the flowers. The flowering glumes are smooth and shining, thicker

than the outer glumes, the lower flower awnless, the upper one with a short, stout, bent, or hooked awn at the apex.

This grass is not held in good repute as an agricultural grass in Europe. In this country, especially at the South, it has frequently been favorably spoken of. Professor Phares says :

It luxuriates in moist, peaty lands, but will grow on poor, sandy, or clay hill lands, and produce remunerative crops where few other plants will make anything. It has been cultivated in North Carolina on such land, and after cutting and allowed to grow again, plowed under with so much advantage that other crops were subsequently produced. Hon. H. W. L. Lewis, of Louisiana, has cultivated this grass many years with great satisfaction. It is by no means the best of our grasses, but best for some lands, and on such lands more profitable than other grasses. It seems to have been greatly improved by acclimating in Texas and other Southern States, and this is true of some of the other grasses and forage plants.

(Plate 64.)

#### TRISETUM.

This genus is characterized as having the spikelets two to three and, rarely, five flowered, the axis usually hairy, and at the base of the upper flower extended into a bristle; the outer glumes unequal, acute, keeled, membranaceous, with scarious margins; the flowering glumes of similar texture keeled, acute, the apex two-toothed, the teeth sometimes prolonged into bristle-like points, the central nerve furnished with an awn above the middle, which is usually twisted and bent in the middle; the palea hyaline, narrow, two-nerved, two-toothed.

#### TRISETUM PALUSTRE.

A slender grass, usually about 2 feet high, growing in low meadows or moist ground throughout the Eastern part of the United States. The culms are smooth, with long internodes and few linear leaves, 2 to 4 inches long; the panicle is oblong, 3 to 4 inches long, loose and gracefully drooping, the branches two to five together, rather capillary, 1 to 1½ inches long, and loosely flowered; the spikelets are two-flowered; the outer glumes are about two lines long, the lower one one-nerved, the upper rather obovate and three-nerved; the lower flower is commonly awnless or only tipped with a short awn; the second flower is rather shorter and with a slender, spreading awn longer than the flower.

This is a nutritious grass, but is seldom found in sufficient quantity to be of much value. (Plate 65.)

#### TRISETUM CERNUUM.

This grass grows to the height of 2 or 3 feet, with flat wide leaves, which are about 6 inches long, and with an open, spreading, and drooping panicle, 6 to 9 inches long; the branches are slender, solitary, or sometimes clustered below, and much subdivided above the middle. The spikelets vary from three to six lines in length and have two to three or, rarely, four flowers in each. The outer glumes are very unequal, the



lower one being very narrow and awl-shaped, the upper one broad, three-nerved, obtuse, and tipped with a fine point, and longer, sometimes twice as long as the lower.

The flowering glume has two slender pointed teeth, and on the back, near the apex, a slender awn twice its length.

Of this grass Mr. Bolander says that it deserves further attention. It grows on dry hill-sides near the Bay of San Francisco and the Oakland hills, and also extends northward to Oregon. (Plate 66.)

#### TRisetum SUBSPICATUM.

A perennial grass of the mountainous regions of Europe and North America. It is found sparingly in New England, on the shores of Lake Superior, in the Rocky Mountains of Colorado, Utah, California, Oregon, and northward to the Arctic circle. It varies in height according to the altitude at which it grows, being sometimes reduced to 3 or 4 inches, at other times running up to 2 feet high. The culms are erect and firm, smooth, or downy. The panicle is spike-like, dense, and cylindrical or elongated, and more or less interrupted, generally of a purplish color. The spikelets are two to three flowered. The flowers are slightly longer than the outer glumes, slightly scabrous, the flowering glumes acutely two toothed at the apex, and bearing a stout awn which is longer than its glume.

This undoubtedly furnishes a considerable portion of mountain pasturage. (Plate 67.)

#### AVENA. (Oats and Oat grass.)

This genus is closely related to *Trisetum*, the spikelets are larger and two to five flowered, the uppermost one generally imperfect; the axis is hairy below the flowers, the outer glumes nearly equal; the flowering glumes of firmer texture (in some species cartilaginous), shortly two-toothed at the apex, and with a long twisted awn below the point.

#### AVENA FATUA. (Wild oats.)

This species is very common in California. It is generally thought to have been introduced from Europe, where it is native, but it has become diffused over many other countries, including Australia and South America. It is thought by some to be the original of the cultivated oat, *Avena sativa*, that the common oat will degenerate into the wild oat, and that by careful cultivation and selection of seed the wild oat can be changed into the common cultivated oat. But on this question there is a conflict of opinions, and the alleged facts are not sufficiently established. The wild oat differs from the cultivated one chiefly in having more flowers in the spikelets, in the long brown hairs which cover the flowering glumes, in the constant presence of the long twisted awn, and in the smaller size and lighter weight of the grain. It is a great injury to any grain-field in which it may be introduced, but for

the purpose of fodder, of which it makes a good quality, it has been much employed in California.

It is stated above "that the common cultivated oat is believed sometimes to degenerate into the wild oat." The following case, described by Mr. J. G. Pickett, of Pickett's Station, Wis., certainly seems to afford evidence to that effect. The circumstance can only be otherwise accounted for by supposing the accidental introduction of the wild oat through seed obtained from some foreign source. It also shows how easily this pest is spread after once being introduced into a field. Mr. Pickett writes as follows :

Inclosed I send you specimens of a plant known in this section as wild oats. The history of the plant is as follows : In the year 1856 Mr. Lucius Hawley, of this town, threshed with a machine about 15 acres of common white oats from the stack, upon the ground where the crop grew. The straw was indifferently piled up, and so remained through the winter. In the following spring the straw was set on fire, but being wet was but partially burned, and what remained was scattered over about an acre of ground, and, with the balance of the field, was plowed under, and the field sown to spring wheat. At harvest time the threshing ground and the land upon which the partially burned straw had been drawn was found to be completely occupied by a crop of oats, and so thick upon the ground as to have completely smothered the wheat. Mr. Hawley, supposing the oats were from those of the former crop, did not examine the grain closely, but cut the wheat and oats with a reaper, at the same time keeping the grains separate as much as possible, and he did not discover until stacking the grain that the oats were not the common oats, but something different from any he had seen before. The oats ripening early, had shelled upon the reaper, and were carried more or less over the entire field, and a crop of spring wheat again following, the new oats were found scattered over the whole field. This was the first known of this pest here, and up to this time (March, 1882) it has continued to spread over the country by being mixed with seed wheat and oats, and transported from farm to farm by threshing-machines until the damage done can hardly be estimated. It will effectually run out any crop and take entire possession of the soil. Seeding down the land for three or four years will eradicate the grain, and this is the only remedy yet found. This oat is a winter grain and will not germinate and grow until it has laid in or upon the ground over winter and been frozen. I have known a field of 40 acres sown in the spring with clean wheat seed and nothing else, from which was threshed 600 bushels of these oats, and wheat about equaling the amount of seed sown. The oat, while growing, looks precisely like the common oat, but ripens early and shells easily. The kernel, when ripe, is nearly black, and has attached to it a spiral barbed tail, by which it attaches itself to clothing; grain-bags, and to every crevice about a threshing-machine, fanning-mill, or reaper, and will even penetrate the skins of animals. When cleaned the grain weighs from 12 to 18 pounds per bushel, and it is only used by finely grinding the grain for stock, or by cutting, before ripening, for hay, of which it makes a good quality. My own theory of its origin is that by the action of fire and the winter exposure the common oat on the farm of Mr. Hawley changed its variety and nature into this wild winter oat, which is now the worst pest this part of Wisconsin has yet known.

(Plate 68.)

*AVENA STRIATA.* (Wild oat grass.)

Grows on rocky hills in New England, New York, and north-westward. The culms are about 2 feet high, smooth and slender. The leaves are narrow and 4 to 6 inches long; the panicle is slender, 4 to 5

inches long, open and drooping; the upper branches are single and undivided, each with a single spikelet, the lower branches are in twos or threes, with longer pedicels, and sometimes having two or three spikelets. The spikelets are one-half to three-fourths inch long, and from three to six flowered. The outer glumes are much shorter than the spikelet, thin, scarious on the margins, acute, and purplish. Each of the flowers has a short tuft of hairs at the base. The lower palet is four lines long, seven nerved, sharply two toothed at the apex, just below which rises a slender bent awn. All the flowers of the spikelet are alike, except that the upper ones are smaller. This grass is related to the cultivated oats. Its range is to the northward, being addicted to a cool, elevated country. Its productiveness and value for agricultural purposes has not been tested. (Plate 69.)

*Avena pratensis* and *Avena flavescens* are two species of Europe, which have been cultivated to some extent in that country, but are little known here.

ARRHENATHERUM AVENACEUM. (Evergreen grass, Tall oat grass, Meadow oat grass.)

A perennial grass of strong, vigorous growth, introduced from Europe, and sparingly cultivated. Culms, 2 to 4 feet high, erect, rather stout, with four or five leaves each; the sheaths smooth, the leaves somewhat rough on the upper surface, 6 to 10 inches long, and about three lines wide, gradually pointed. The panicle is loose, rather contracted, from 6 to 10 inches long, and rather drooping; the branches very unequal, mostly in fives, the longer ones 1 to 3 inches, and subdivided from about the middle; the smaller branches very short, all rather full-flowered. The spikelets are mostly on short pedicels. The structure of the flowers is similar to that of common oats, but different in several particulars. The spikelets consist of two flowers, the lower of which is staminate only, the upper one both staminate and pistillate; the outer glumes are thin and transparent, the upper one about four lines long and three-nerved, the lower one nearly three lines long and one-nerved. The flowering glume is about four lines long, green, strongly seven-nerved, lanceolate, acute, hairy at base, roughish, and in the lower flower gives rise on the back below the middle to a long, twisted, and bent awn; in the upper flower the glume is merely bristle-pointed near the apex. The palet is thin and transparent, linear, and two-toothed. This grass is much valued on the continent of Europe. The herbage is very productive and its growth rapid. When growing with other grasses cattle and sheep eat it very well, but do not like to be confined to it exclusively.

Mr. Thomas Brigden, of South Lowell, Ala., says, respecting this grass:

We obtained seed from the Tennessee Valley under the name of evergreen grass, and it appears at the present time to be by far the most valuable kind that we have ex-

permented with; it remains green during the winter, and starts into growth very early in the spring, making a dense, heavy growth from 20 to 30 inches high, and, as far as at present tested, it stands the summer heat well.

Professor Phares, of Mississippi, says :

It is widely naturalized and well adapted to a great variety of soils. On sandy or gravelly soils it succeeds admirably, growing 2 to 3 feet high. On rich, dry upland it grows from 5 to 7 feet high. It has an abundance of perennial, long fibrous roots penetrating deeply in the soil, being therefore less affected by drought or cold, and enabled to yield a large quantity of foliage, winter and summer. These advantages render it one of the very best grasses for the South, both for grazing, being evergreen, and for hay, admitting of being cut twice a year. It is probably the best winter grass that can be obtained. It will make twice as much hay as timothy. To make good hay it must be cut as soon as it blooms, and after cut, must not be wet by dew or rain, which damages it greatly in quality and appearance. For green soiling it may be cut four or five times with favorable seasons. In from six to ten days after blooming the seeds begin to ripen and fall, the upper ones first. It is therefore a little troublesome to save the seed. As soon as those at the top of the panicle ripen sufficiently to begin to drop the seeds should be cut off and dried, when the seeds will all thresh out readily and be matured. After the seeds are ripe and taken off the long, abundant leaves and stems are still green, and being mowed make good hay. It may be sown in March or April and mowed the same season; but for heavier yield it is better to sow in September or October. Not less than 2 bushels (14 pounds, per acre should be sown. The average annual nutriment yielded by this grass in the southern belt is probably twice as great as in Pennsylvania and other Northern States.

Mr. Charles L. Flint says :

It produces an abundant supply of foliage, and is valuable for pastures on account of its early and luxuriant growth. It grows spontaneously on deep, sandy soils when once naturalized. It has been cultivated to some extent in New England, and was at one time highly esteemed, mainly for its early, rapid and late growth, making it well calculated as a permanent pasture grass. It will succeed on tenacious clover soils.

(Plate 70.)

#### DANTHONIA.

This genus is related to *Avena* and characterized as follows: Spikelets three to five or many-flowered, the axis hairy and produced beyond the flowers in a stipe or imperfect flower; outer glumes narrow, keeled, acute, usually as long as the spikelet; flowering glumes of firmer texture, convex on the back, seven to nine nerved, with two rigid or scarious terminal teeth or lobes, and with a flatish, twisted, and bent awn between the teeth. This awn is composed by the union of the middle and two of the lateral nerves.

#### DANTHONIA SPICATA. (Spiked Wild Oat grass.)

This species grows in small clumps on barren hills or in poor clay lands. The leaves are mostly in a tuft near the ground, short, narrow, and curled in dry weather. The culms are from 1½ to 2 feet high, erect and slender. The panicle is only an inch or two long, mostly simple, and of four to seven spikelets, with very short pedicels. The spikelets

are about five-flowered, the flowering glume loosely hairy, with the teeth about one-fourth its length and very acute.

It is a grass of very little value.

Hon. J. S. Gould says:

As it will grow on hard clay lands where nothing else will, it might be worth while to sow its seeds on such lands, as it is certainly better than nothing; but the better plan is to manure the soil so that it will produce the richer grasses.

(Plate 71.)

*DANTHONIA COMPRESSA.* (Mountain Oat grass.)

This species grows in Pennsylvania, New York, and New England. Mr. C. G. Pringle sends it from Vermont growing on dry hillocks along the Waterbury River. It also grows on the summit of the Roan Mountains, North Carolina, over large areas, and furnishes good summer pasturage. Probably it occurs on the other mountains of the Alleghany range. It differs from the preceding in forming a compact sod, by having more numerous and larger leaves, by a larger, longer, and spreading panicle, and by the longer, more slender awn-pointed teeth of the flowering glumes. (Plate 72.)

*DANTHONIA SERICEA.* (Silky-flowered, Oat grass.)

A perennial grass, 2 to 3 feet high, growing in open, sandy woods, with numerous long, slender, radical leaves, and three or four similar ones on the stem, the sheaths soft, hairy the ligule a mere hairy fringe; culms smooth, flexible; panicle loose and rather contracted, 3 to 4 inches long, and 1 or 2 inches wide; the branches single at the joints, and subdivided from the lower third into a few branchlets, each with one to three spikelets. The spikelets are about seven-flowered, the flowers closely packed and silky hairy; the outer glumes are smooth, half an inch or more in length, longer than all the flowers in the spikelet, linear-lanceolate, the lower one two-nerved and the upper one three-nerved. The flowering glumes are about three lines long, five to seven nerved, the awl-pointed teeth very slender and nearly as long as the rest of the glume, with the middle awn six or seven lines long, sparsely hairy on the back, and copiously white silky on the margins below. This species appears to be confined to the Atlantic States. Its value has not been tested. (Plate 73.)

*DANTHONIA CALIFORNICA.* (The California Oat grass.)

A perennial grass of California, Oregon, the Rocky Mountains, and Manitoba; not very common, variable in height, usually 1 to 2 feet, with narrow, convolute and long-pointed root-leaves, those of the culm somewhat wider, 3 or 4 inches long, the lower sheaths hairy, especially at the throat. The panicle usually consists of three to five spreading branches, each of which is terminated by a single spikelet. The spikelets are five to seven flowered, widening upwards. The outer glumes are about three-quarters of an inch long, linear-lanceolate, acute, five to seven

nerved, and purplish. The flowers are somewhat crowded on the axis. The flowering glumes are broad, obscurely nine-nerved, smooth on the back, the margins below fringed with long, silky hairs, the narrow, stiff, awned-teeth about half as long as the glumes (four or five lines). This is a somewhat ornamental grass, but probably not of much agricultural value. (Plate 74.)

CYNODON DACTYLON. (Bermuda grass.)

A low, creeping perennial grass, with abundant short leaves at the base, sending up slender, nearly leafless flower stalks or culms, which have three to five slender, diverging spikes at the summit. The spikelets are sessile in two rows on one side of the slender spikes; they each have one flower with a short pediceled, naked rudiment of a second flower; the outer glumes nearly equal, keeled; the flowering glume boat-shaped, broader and prominently keeled; the palea narrow and two-keeled. This grass is a native of Southern Europe and of all tropical countries. It is a common pasture grass in the West Indies. In the Southern States it has long been a chief reliance for pasture, has been extravagantly praised by some and cursed by others who find it difficult to eradicate when once established. Its properties have been very fully discussed in Southern journals. It rarely ripens any seed, and the usual methods of reproducing is to chop up the roots with a cutting knife, sow them broadcast, and plow under shallow.

Col. T. C. Howard, of Georgia, says :

The desideratum to the South is a grass that is perennial, nutritious, and adapted to the climate. While we have grasses and forage plants that do well when nursed, we have few that live and thrive here as in their native habitat. The Bermuda and crab grasses are at home in the South. They not only live, but live in spite of neglect, and when petted and encouraged they make such grateful returns as astonish the benefactor.

Professor Killebrew, of Tennessee, says :

In Louisiana, Texas, and the South generally it is and has been the chief reliance for pasture for a long time, and the immense herds of cattle on the southern prairies subsist principally on this food. It revels in sandy soils, and has been grown extensively on the sandy hills of Virginia and North and South Carolina. It is used extensively on the southern rivers to hold the levees and embankments of the roads. It will throw its runners over a rock 6 feet across and soon hide it from view, or it will run down the sides of the deepest gully and stop its washing. Hogs thrive upon its succulent roots, and horses and cattle upon its foliage. It has the capacity to withstand any amount of heat and drought, and months that are so dry as to check the growth of blue grass will only make the Bermuda green and the more thrifty.

Professor Phares, of Mississippi, says :

As a permanent pasture grass, I know of no other that I consider so valuable as this, after having transferred it from near the mouth of the Red River to my present residence thirty-five years ago, and having studied it on hundreds of other farms, commons, and levees for a longer period. To make good hay and the largest yield, this

grass must be mowed from three to five times every summer. Thus briars, broom grass, and other weeds are repressed and prevented from seeding, multiplying, and ruining the meadow.

Respecting the difficulty of eradicating this grass from ground wanted for other cultivation, Colonel Lane, of Georgia, says :

Upon our ordinary upland I have found no difficulty in destroying it by close cultivation in cotton for two years. It requires a few extra plowings to get the sod thoroughly broken to pieces.

(Plate 75.)

#### CHLORIS ALBA.

An annual grass, growing in tufts, 1 to 2 feet high, smooth, the culms frequently branched and bent at the lower joints, decumbent, becoming erect; leaves numerous, smooth, the sheaths mostly loose, the blade broad, the upper sheath dilated and at first inclosing the flower spikes, which are eight to fifteen in number, 2 to 3 inches long, and umbellate or fasciculate at the top of the culm or of the lateral branches. The spikelets are sessile and crowded in two rows on one side of the spikes; each spikelet contains one perfect and one or two imperfect or rudimentary flowers; the outer glumes are unequal, thin, keeled, the upper one mucronate-pointed, and about one and one-half lines long, the lower one one-third shorter; the flowering glume of the lower or perfect flower is thick and firm in texture, nearly one and one-half lines long, broad in the middle and narrowed above and below, much compressed, five nerved, with two short teeth at the apex, and a straight awn two or three lines long between the teeth, the margins toward the top strongly ciliate with long white hairs; the palea is of similar texture, narrow, and nearly as long as its glume; the neutral or upper flower is shorter, truncate above, of a club-like appearance, smooth, tipped with an awn. Sometimes there is another small imperfect flower or a pedicel above the second, and enwrapped by it.

This is a common grass in the arid regions of New Mexico, Arizona, and farther south and west. This grass furnishes a large quantity of foliage, but of its agricultural value we have no information. There are several other species growing in the same region. (Plate 76.)

#### BOUTELOUA. (Mesquite grass.)

This genus, of which there are many species, has generally numerous spikes in a racemose one-sided panicle. The spikes are generally densely flowered and from one-half to 1½ inches long. The spikelets are crowded in two rows on one side of the axis, each consisting of one perfect flower, and a stalked pedicel bearing empty glumes and one to three stiff awns; the outer glumes are unequal, acute, keeled, membranaceous; the flowering glume broader and usually thicker, with three to five lobes, teeth or awns at the apex; palea hyaline, narrow, entire or two-toothed, enfolded by its glume.

*BOUTELOUA OLIGOSTACHYA.* (Mesquite grass, Gramma grass, Buffalo grass.)

This is a perennial species growing on the great plains from Montana and Dakota southward to Texas. The culms are from one-half to 1½ feet high. Near the top there are usually two or three, sometimes more, curved flowering spikes, about 1½ inches long; the culm and leaves are smooth; the outer glumes and the flowering glumes are sparingly soft-hairy, the lobes awl pointed, the sterile flower or rudiment is copiously villous-tufted at the summit of the naked pedicel, its three awns equaling the perfect flower. (Plate 77.)

*BOUTELOUA HIRSUTA.* (Bristly mesquite or Gramma grass.)

This annual or biennial species has about the same range as the preceding, is of about the same size and general appearance. The upper empty glume is on the back hispid with bristly hairs proceeding from dark, warty glands; the flowering glume is pubescent, three-cleft into awl-pointed lobes; the sterile flower and its pedicel are glabrous, the three sterile awns longer than the fertile flower.

*BOUTELOUA POLYSTACHYA.* (Low Gramma grass.)

This species probably does not reach farther north than northern New Mexico. It is an annual from 6 to 10 inches high growing in clumps; the culms are slender, branching and bent at the lower joints. The culm terminates in a raceme-like panicle, 3 to 6 inches long, composed of five to seven alternate, narrow, one-sided spikes, which are about 1 inch long and one-half inch to 1 inch apart. The spikelets are generally close but not so dense as in the preceding, and much smaller; the outer glumes are thin, unequal, oblong, the upper one about one line long, bifid and mucronate pointed; the flowering glume of the perfect flower is oblong, obtuse, three-nerved, the nerves extended beyond the glumes into short awns, with two broad lobes, one on each side of the central awn, and two shall lateral lobes, one on the outer side of each lateral awn, the outer margins ciliate. The rudimentary flower is very short stalked, with three small glume-like scales and three short awns. There are several varieties or forms of this species, some smaller and some larger. It abounds near the banks of streams and furnishes excellent pasturage. (Plate 78.)

*BOUTELOUA RACEMOSA,* (*B. curtispindula*, GRAY). (Tall Gramma grass.)

This species ranges from Mexico to British America, and east of the Mississippi River in Wisconsin and Illinois. It is easily distinguished from the others by its taller growth, and by the long, slender raceme of twenty to fifty or more slender spikes. These are usually about half an inch long and reflexed. There are from six to ten spikelets on each spike. The outer glumes are lanceolate, acuminate; the upper about two lines long and scabrous; the flowering glume is oblong, between



two to three lines long, with three short awl-pointed teeth at the apex; the palet is nearly of equal length; the sterile flower is reduced to one or two minute scales with three short awns, or to a single small awn.

The most useful of the gramma grasses is, probably, the *Bouteloua oligostachya*, but the others aid in furnishing the supply of food for the thousands of animals which are fattened on the great plains. It is doubtful if these grasses would bear the effect of continued tramping and close cropping if the lands were inclosed and pastured.

ELEUSINE INDICA. (Yard grass, Crow-foot, Crab grass, Wire grass.)

An annual grass belonging to tropical countries, but now naturalized in most temperate climates. In the Southern States it is found in every door-yard and in all waste places. The culms are from 1 to 3 feet high, usually coarse and thick, and very leafy, especially below. The leaves are long and rather wide. At the top of the culm there are two to five or more thickish, densely-flowered spikes proceeding from a common point, with sometimes one or two scattering ones lower down on the culm. The spikelets are sessile and crowded along one side of the axis, each being from two to six flowered, the upper flower imperfect or rudimentary; the outer glumes are membranaceous, shorter than the flowers, the flowering glumes usually obtuse; the palet folded and two-keeled.

Professor Phares, of Mississippi, says:

The clumps have many long leaves and stems, rising 1 or 2 feet high, and many long, strong, deeply penetrating fibrous roots. It grows readily in door-yards, barn-yards, and rich cultivated grounds, and produces an immense quantity of seeds. It is a very nutritious grass, and good for grazing, soiling, and hay. The succulent lower part of the stems, covered with the sheaths of the leaves, renders it difficult to cure well, for which several days are required. It may be cut two or three times, and yields a large quantity of hay.

(Plate 79.)

LEPTOCHLOA MUCRONATA. (Feather grass, Slender grass.)

An annual grass, growing from 2 to 3 feet high, the flowers arranged in a long paniced, loose raceme. The branches or spikes are very slender, 1 to 5 inches long, and very numerous, thirty to fifty or more, with the spikelets sessile and continuous in two rows along one side of the spikes. The spikelets are about one line long, three-flowered, the uppermost flower imperfect. The outer glumes are lanceolate, acute keeled, and nearly as long as the spikelet; the flowering glumes are obtuse or sometimes slightly mucronate, one-half line long, keeled, and with strong, somewhat pubescent, lateral nerves.

This is a handsome grass when full grown, the panicles on thrifty specimens becoming 2 feet long, the slender branches arranged along the main stem in a feather-like manner, hence the name. It grows from Virginia, west and south, becoming quite common in the South-

ern States. It affords a small amount of grazing during the summer. Professor Phares says :

Its growth is very rapid, although it has little root and is easily uprooted. Although it contains a good percentage of nutritious matter, it is of little agricultural value. Its assurgent leaves and stems and immensely large panicles occupy so much space that a comparatively small number of plants would occupy an acre of ground, while it has so little weight that the product of several acres of the finest growth of it would be required to produce a single ton of hay.

(Plate 80.)

BUCHLOË DACTYLOIDES. (Buffalo grass, False Mesquite grass.)

This grass is extensively spread over all the region known as the great plains. It is very low, the bulk of leaves seldom rising more than 3 or 4 inches above the ground, growing in extensive tufts or patches, and spreading largely by means of stolons or offshoots similar to those of Bermuda grass, these stolons being sometimes 2 feet long, and with joints every 3 or 4 inches, frequently rooting and sending up flowering culms from the joints. The leaves of the radical tufts are 3 to 5 inches long, one or one-half line wide, smooth, or edged with a few scattering hairs. The flowering culms are chiefly diœcious, but sometimes both male and female flowers are found on the same plant but in separate parts. The flowering stems of the *male* plant are 4 to 8 inches high, bearing three or four slender leaves, and at the summit two to four short contiguous spikes, which are about half an inch long. These spikes consist usually of five to six sessile spikelets, alternate, in two rows, on the lower side of the flattened, scabrous axis. The spikelets are two to three lines long and mostly two-flowered. The outer glumes are unequal and one-nerved, the lower one half as long as the flower above it, the upper one shorter. The flowering glumes and palets are of equal length, membranaceous, the flowering glume three-nerved, the palet two-nerved. The flowering stalk of the *female* plant is shorter than the leaves, 1 to 2 or sometimes 3 or 4 inches high, sometimes almost concealed among the leaves at the joints of the stolons. The sheaths of the two or three uppermost leaves of the culm are dilated and inclose the spikes or clusters of flowers. Of these spikes there are two or three, each consisting of three to five spikelets. The spikelets are single-flowered and of a somewhat complex structure, the parts analagous to those of the male flowers, but thickened, indurated, and modified. All the upper glumes are indurated and united at their bases with the thickened axis, the lower glume of the lowest spikelet being lanceolate, with an herbaceous tip or two to three cleft, thickened and united to the upper glume, the lower glume of the other spikelets free, much smaller, ovate-lanceolate, acute, and one-nerved, the flowering glume shorter, three-nerved, and three-toothed at the summit.

It is hardly necessary to recapitulate the virtues of this widely celebrated grass. It plays an important part in the feeding and fattening of the vast herds of cattle, which have now mostly displaced the buffalo, whose favorite food it was supposed to be.

Prof. S. B. Buckley, of Austin, Tex., says :

This is one of the best grasses of Texas for pasturage, if not the very best; being perennial it affords food for stock both summer and winter. Even in midwinter it presents a green covering over many hills and prairies in this vicinity. It is also the best grass for lawns indigenous to Texas. It thrives on every variety of soil, growing on poor gravelly uplands, and also in rich river bottoms, but it mostly abounds on the prairies, among the mesquite trees scattered over their surface, throughout a large portion of our State, whence it is commonly called mesquite grass in Texas. This name, however, is given to two or three other species of grass which are associated with it. It is not difficult to eradicate, nor is it ever troublesome in cultivated fields, because it has so few seeds. All kinds of stock are extremely fond of it, from which we infer that it is very sweet and nutritious. In extreme droughts all the grasses seem dead, but a rain will make this grass green and growing in a few hours. Even when dry, weather-beaten, and seemingly dead it is still good food for stock.

Whether this grass can be successfully subjected to cultivation remains to be seen. (Plate 81.)

#### TRIODIA. (*Tricuspis*.)

This genus, which contains numerous species of very different size and aspect, is characterized as follows: Spikelets, several to many-flowered, some of the upper ones male or imperfect; the outer glumes keeled, acute, or acutish, awnless; the flowering glumes imbricated, rounded on the back, at least below, three-nerved, the marginal nerves usually hairy, mucronate, three-toothed or three-lobed at the apex, or obscurely erose, often hardened and nerveless in fruit; the palea broad, prominently two-keeled.

#### TRIODIA SESLERIOIDES. (*Tricuspis seslerioides*.) (Tall Red top.)

This grass grows from 3 to 5 feet high. The culms are very smooth; the leaves are long and flat, the lower sheaths hairy or smoothish. The panicle is large and loose, at first erect, but finally spreading widely. The branches are single or in twos or threes below, and frequently 6 inches long, divided, and flower-bearing above the middle. The spikelets are on short pedicels, three to four lines long, and five or six flowered. The outer glumes are shorter than the flowers, unequal and pointed; the flowering glumes are hairy toward the base, having three strong nerves, which are extended into short teeth at the summit. It is a large and showy grass when fully matured, the panicles being large, spreading, and of a purplish color. It grows in sandy fields, and on dry sterile banks, from New York to South Carolina, and westward. This is eaten by cattle when it is young, but the culms are rather harsh and wiry and not relished by them. It is, however, cut for hay where it naturally abounds. (Plate 82.)

#### TRIODIA TRINERVIGLUMIS. (*Tricuspis trinerviglumis*.)

Another perennial species of this genus, growing in Colorado, Arkansas, Texas, New Mexico, and southward. The culms are 2 to 3 feet high, and rather stont; the radical leaves are somewhat rigid, 6 to 12

inches long, narrow, acuminate-pointed, inclined to be involute, the sheaths more or less hairy. The smooth culm has three or four leaves, which are 4 to 8 inches long, and slender-pointed. The panicle is narrow and spike-like, 6 to 9 inches long, composed of five or six alternate, somewhat distant, and closely erect branches, the lower ones 1 to 2 inches long, and consisting of six to ten sessile, alternate spikelets, each of which are eight to ten flowered, and four to six lines long. The outer glumes are lanceolate, acute, smooth, nearly equal, somewhat faintly three-nerved, and three to five lines long; the flowering glumes are oblong, three-nerved, two to three lines long, entire or obscurely denticulate at the apex, acute or obtusish, the nerves and margins densely hairy for about two-thirds the length, also the base and axis hairy. The palet is one-third shorter, two-keeled, minutely toothed at the apex, hairy on the keels below.

Little is known of its abundance or agricultural value. (Plate 83.)

*Triodia stricta* is another species of Texas and the Southwest, much larger, stouter, and more rigid than the preceding.

TRIODIA ACUMINATA. (*Tricuspis acuminata*.)

A low species, growing in tufts, from 6 to 12 inches high, the leaves short and narrow, but abundant near the ground; the culms are erect, slender, with one or two short leaves, and terminated by an oblong, spike-like panicle about an inch long, composed of a few crowded sessile or nearly sessile branches, each with one to three spikelets. The spikelets each contain eight or ten crowded flowers. The outer glumes are nearly equal, lanceolate, acute, chartaceous, one-nerved, about three lines long; the flowering glumes are about three lines long, lanceolate or ovate-lanceolate, acute, three-nerved, the mid-nerve extended into a short stiff awn, the margins fringed with long white hairs, and the back below, with the axis, hairy. The palet is about one-third shorter than its glume, folded back on the two keels, sparingly hairy, and the keels scabrous pubescent. This is a native of the arid regions of Texas, New Mexico, and southwestward. (Plate 84.)

TRIPLASIS PURPUREA. (*Tricuspis purpurea*.) (Sand grass.)

An annual grass, growing in tufts in sandy soil along the Atlantic coast, and also in sandy districts in the interior. The culms are about 1 foot high, rather decumbent at the base, with eight to ten short joints, and an equal number of narrow, awl-shaped leaves, 2 to 3 inches long, which are bearded with hairs at the top of the sheaths. There are usually several lateral panicles of flowers as well as a terminal one. The lateral ones are inclosed within the sheaths; the terminal one usually exerted, but short and simple. The spikelets are two to five flowered; the glumes much shorter than the spikelet; the flowers rather distant from each other; the flowering glumes and palets strongly fringed on

the nerves; the flowering glumes two-lobed or two-cleft at the summit, with the mid-nerve extended into a short awn between the lobes. This grass has very little practical value.

DIPLACHNE. (*Leptochloa*.)

This genus is characterized as having the spikelets narrow, sessile, or nearly so, on the long slender branches of the panicle, usually in two rows, but not continuous as in *Leptochloa*, the outer glumes keeled, acute, but not awned; the flowering glumes one to three nerved, with a thin or hyaline, shortly two-toothed or two-lobed apex, the keel produced into a short point or awn between the lobes; palet thin and prominently two-nerved.

DIPLACHNE FASCICULARIS. (*Leptochloa fascicularis*.) (Spike grass.)

An annual grass of vigorous growth, 2 to 3 feet high, growing in brackish marshes or wet ground near the sea-coast, and, also, far inland in the Mississippi Valley, Texas, Arizona, &c., in alkaline soil. The radical leaves are narrow and half to two-thirds as long as the culms, rough on the margin; those of the culms similar, with long, smooth, loose sheaths, the upper one usually inclosing the base of the panicle. The culms are frequently branched at the lower joints. The panicle is large, 6 to 10 inches long, consisting of numerous (fifteen to thirty) spike-like branches, which are 2 to 4 inches long, mostly alternate, sometimes fascicled below, angular and rough, and flower-bearing throughout. The spikelets are nearly sessile and alternate, usually somewhat longer than the space between them; each contains five to seven flowers; the outer glumes are unequal, smooth, one-nerved, and mucronate-pointed; the flowering are ovate-lanceolate, about one and a half lines long, flattish on the back, three-nerved, pubescent on the nerves and margins below, shortly two-toothed at the apex, with a short rough awn between the teeth; the palet is somewhat shorter, lanceolate, two-nerved, and ciliate on the nerves. (Plate 85.)

DIPLACHNE DUBIA. (*Leptochloa dubia*.)

A grass of similar aspect to the preceding; the leaves somewhat longer and more rigid; the panicle rather shorter, and composed of six to twelve branches, which are stouter and more spreading. The outer glumes are lanceolate, nearly equal, acute, one-nerved, rough on the keel, about one and one-half lines long; the flowering glumes are oblong, very obtuse, two-lobed and somewhat fringe-toothed at the apex, three nerved, smooth except on the margins, awnless; the palet is as long as its glume, narrower, two-nerved, and ciliate on the nerves. The spikelets in age become spreading, and the axis zigzag. It is of more southern range than the preceding, occurring in the Gulf States and southwestward. (Plate 86.)

## PHRAGMITES COMMUNIS. (Reed grass.)

A tall, coarse, perennial grass, growing on the borders of ponds and streams, almost rivaling sorghum in luxuriance. It attains a height of 6 to 10 feet; the culms sometimes an inch in diameter, and leaves an inch or two in width. The panicle is from 9 to 15 inches long, loose but not much spreading, of an oblong or lanceolate form and slightly nodding. The branches are very numerous, irregularly whorled, 4 to 8 inches long, much subdivided, and profusely flowering. The larger panicles form very ornamental plumes, almost equal to those of *Arundo donax*, so much cultivated for ornamental purposes. The spikelets are three to seven flowered, all the flowers except the lowest surrounded by long silky hairs at the base; the lowest one is either empty or contains only stamens. The lower or empty glumes are thin, lanceolate, keeled, and unequal in size, the upper one being considerably the longer. The flowering glumes are membranaceous, narrowly awl shaped, and about as long as the silky hairs. The paleas are thin and only half to one-third as long as their glumes.

This grass is widely distributed in different parts of the globe, and in some countries is put to several uses, as for thatching, for which it is said to be valuable. It is also sometimes used for making light reed fences and screens. Its leaves are too coarse and innutritious for fodder except when very young.

Professor Scribner saw in Montana prostrate stems of this grass which were 28 feet long, and some of the upright culms were 10 to 14 feet high. (Plate 87.)

## KÆLERIA CRISTATA. (Crested Kæleria.)

This grass has a very wide diffusion both in this country and in Europe and Asia. It favors dry hills or sandy prairies, and on the great plains is one of the commonest species. It occurs throughout California and into Oregon. It varies much in appearance according to the location in which it grows, these variations being so striking that they have been considered different species, and perhaps two species ought to be admitted. It is perennial, with erect culms usually from 1 to 2 feet high, and a spike-like panicle varying from 3 to 6 inches in length and more or less interrupted or lobed at the lower part. When grown in very arid places the culms may be only a foot high, the radical leaves short, and the panicle only 2 inches long. When grown in more favored situations the radical leaves are 18 inches long, the stem 3 feet, and the panicle 6 inches long. The branches of the panicle are, in short, nearly sessile clusters, crowded above, looser and interrupted below. The spikelets are from two to four flowered. The outer glumes are a little shorter than the spikelets, lanceolate, acute, compressed. The flowering glumes are similar, membranaceous, acute, or mucronate. The palea is of nearly equal length, thinner and two-toothed at the apex. The flowers, panicle, culm, and leaves are usually more or less softly hairy. It is readily eaten by cattle. (Plate 88.)

## ERAGROSTIS.

Of this genus we have about twenty species in the United States. It is characterized as follows: Spikelets numerous, usually in a loose, sometimes spreading and diffuse, panicle; commonly many flowered (rarely two or three only), sessile or pediceled, usually glabrous; the outer glumes are unequal and rather shorter than the flowering ones, keeled and mostly one-nerved; the flowering glumes are membranaceous, acute or obtuse, unawned, but rarely mucronate pointed, three-nerved, the keel prominent, the lateral nerves sometimes very faint; the palea shorter than its glume, with two prominent nerves or keels, often persisting after the glume and grain have fallen away.

## ERAGROSTIS POLEOIDES var. MEGASTACHYA. (Pungent meadow grass.)

This is a foreign grass which has become extensively naturalized, not only in the older States but in many places in the western and southwestern Territories. It is found in waste and cultivated grounds and on roadsides, growing in thick tufts, which spread out over the ground by means of the geniculate and decumbent culms. The culms are from 1 to 2 feet long, the lower joints bent and giving rise to long branches. The sheaths are shorter than the internodes, the leaves from 3 to 6 inches long. The panicle is frequently 4 or 5 inches long, oblong or pyramidal, somewhat open, but full-flowered; the branches irregularly single or in pairs, branched and flowering nearly to the base. The spikelets are oblong or lanceolate one-fourth to one-half inch long, and ten to twenty flowered when well developed. The empty glumes are smaller than the flowering ones, rough on the keel, acutish. The flowering glumes are one line long, ovate, rather obtuse, and strongly three-nerved. The paleas are shorter than their glumes, narrow, the sides reflexed and the margin ciliate. This grass is said to have a disagreeable odor when fresh. It produces an abundance of foliage, and is apparently an annual, reaching maturity late in the season. We are not aware that its agricultural value has been tested. (Plate 89.)

## ERAGROSTIS PURSHII.

This is a native grass, very widely diffused over the United States, and extends into Mexico. In habit it is somewhat like the preceding species (*E. poaeoides*), growing in tufts, with the culms branching at the base and the lower joints bent. The culms are smooth, slender, 10 to 20 inches high, the leaves narrow and sparse, with a tendency to produce an abundance of flowering culms. The panicle is oblong, open and spreading, 3 to 4 inches long, with the branches irregularly single or in pairs, and much subdivided. The spikelets are oblong, lanceolate to linear, about two lines long, and usually from five to fifteen flowered. The empty glumes are small, only about half the length of the flowering glumes, ovate and acute. The flowering glumes are about half a line

long, acutish, and distinctly three-nerved. It has little or no agricultural value except in arid, sandy districts, where it seems to be most common. (Plate 90.)

#### MELICA.

Of this genus we have ten to twelve species. Its characters are as follows: Spikelets two to many flowered; the flowers usually convolute around each other, the upper one smaller and imperfect; the outer glumes membranaceous or hyaline, acute or obtuse, awnless, the lower one three to five and the upper sometimes seven to nine nerved, the lateral nerves not reaching to the margin. The flowering glumes are of thicker texture, becoming coriaceous, scarious at the apex, rounded or flattish on the back, five to nine nerved, the lateral nerves not reaching the apex, the central one sometimes ending in a point or an awn; the palets shorter than their glumes, two-keeled, ciliate on the keels.

#### MELICA MUTICA. (Melic grass.)

A perennial grass, growing sparingly in rich, rocky woods throughout most of the States east of the Rocky Mountains. It grows in loose tufts, the culms about 2 feet high, the lower leaves and sheathes soft hairy, the upper leaves narrow, 3 to 4 inches long, gradually pointed. The panicle is very simple or little branched. In the variety *diffusa* the panicle is larger, more branched and spreading; the spikelets are loosely arranged on the branches, almost sessile, and rather on one side of the branches. They are large and graceful in appearance, each one consisting of two perfect flowers and a small chaffy knob, called a rudiment. The outer glumes are thin, scarious-margined, five to seven nerved, purplish, and three to four lines long. The flowering glumes are thicker, strongly ribbed, scarious at the blunt apex, and minutely rough on the nerves. The two flowers are somewhat distant from each other. The palets are narrower and shorter than the flowering glumes, arched and ciliate on the keels. This grass is eaten and relished by cattle, but is probably not well adapted to cultivation. (Plate 91.)

#### MELICA BULBOSA. (Bulbous Melic grass.)

This species is distinguished by its large bulbous roots, or, more properly, by the bulb-like enlargement of the base of the culm. It grows to the height of 2 or 3 feet; the leaves narrow, scabrous, and mostly involute. The panicle is from 4 to 8 inches long, narrow, with short and distinct branches, which are mostly in pairs, erect and densely flowered. The spikelets are about half an inch long, with usually three or four flowers, the upper one sterile. The outer glumes are thin, broad, and obtuse, the lower one three to five nerved, the upper five to seven nerved. The flowering glume is about a quarter of an inch long, obtuse, roughish, and seven-nerved. The palet shorter than the flower-



ing glume and ciliate on the keels. This species grows in the mountain region of California and Oregon, also in Nevada, Utah, and Wyoming. (Plate 92.)

#### MELICA IMPERFECTA.

There are seven or eight species of *Melica* in California, some of them quite common, but they do not appear to have much agricultural value. The *Melica imperfecta* grows in tufts in shaded ground. There are several varieties, which differ considerably in size and general appearance. They may be described in general terms as growing from 1 to 3 feet high, with slender, rather wiry culms; the lower leaves are narrow, with long-tapering points, and about half as long as the culm, generally smooth or slightly scabrous. The roots are perennial, with strong fibers. The panicle varies in the different varieties from 6 to 12 inches in length, rather narrow, with distant rays, which are very unequal in length, and in clusters from three to five. The longer rays are 1 or 2, or sometimes 3 inches long, flower-bearing for half or two-thirds their length, while the shorter ones,  $\frac{1}{2}$  to 1 inch long, are flower-bearing to their base. The spikelets are one-quarter of an inch or less in length, and usually with two flowers, one of which is imperfect, sometimes, however, with three flowers, one or two of which are imperfect. The outer glumes are frequently purplish, with thin, whitish margins, slightly obtuse, and three to five nerved. The flowering glume is about seven-nerved, usually purplish, rather acute; the palet of about the same length and two-toothed. The imperfect flower has a short pedicel, and is about half as long as the perfect one. (Plate 93.)

#### UNIOLA.

This genus has closely, many-flowered spikelets, usually large, very flat, and two-edged, one or more of the lowest flowers neutral and consisting only of an empty glume; the glumes are closely folded together, keeled, rigid, or coriaceous; the flowering ones larger, many-nerved, usually acute or pointed, entire; palet rigid, two-keeled, the keels narrowly winged.

#### UNIOLA LATIFOLIA. (Broad-flowered Fescue grass.)

This is a handsome grass, growing 2 to 3 feet high, with very broad leaves and a spreading panicle; the drooping spikelets larger than those of any other grass we have, being an inch long or more, and nearly half as wide, consisting of ten to twelve flowers. It grows from Pennsylvania and Illinois southward. Mr. Charles Mohr, Mobile, Ala., says of this grass:

A fine vernal grass, with a rich foliage, blooming early in May; 2 to 3 feet high; frequent in damp, sandy loam, forming large tufts. This perennial grass is certainly valuable, affording an abundant range early in the season; if cultivated it would yield large crops ready for cutting from the 1st of May. It is called by some *wild*

*fescue* or *oat grass*. It is not found near the coast, consequently I had no chance to observe its growth during the latter part of the summer and in the winter season, and therefore am not able to judge of its value as a pasture grass.

(Plate 94.)

*DISTICHLIS MARITIMA*. (Salt grass, Marsh grass.)

This is described in most botanical works as *Brizopyrum spicatum*, but recently the name given by Rafinesque has been accepted and restored to it by Mr. Bentham. It is a perennial grass, growing in marshes near the sea-coast on both sides of the continent, and also abundantly in alkaline soil throughout the arid districts of the Rocky Mountains. It has strong, creeping root-stocks, covered with imbricated leaf-sheaths, sending up culms from 6 to 18 inches high, which are clothed nearly to the top with the numerous, sometimes crowded, two-ranked leaves. The leaves are generally rigid and involute, sharp-pointed, varying greatly in length on different specimens. The plants are diœcious, some being entirely male and some female. The panicle is generally short and spike-like, sometimes, especially in the males, rather loose, with longer, erect branches, and sometimes reduced to a few spikelets. The spikelets are from four to six lines long and five to ten flowered, the flowers being usually much compressed. The outer glumes are smooth, narrow, and keeled; the flowering ones are broader, keeled, acute, rather rigid, and faintly many-nerved. The paleas have an infolded margin, the keels prominent or narrowly winged. The pistillate spikelets are more condensed and more rigid than the staminate. Although this cannot be considered a first-rate grass for agricultural purposes, it is freely cut with other marsh grasses, and on the alkaline plains of the Rocky Mountains it affords an inferior pasturage. (Plate 95.)

*DACTYLIS GLOMERATA*. (Orchard grass, Cocksfoot grass.)

This is one of the most popular meadow grasses of Europe, and is well known to most farmers in the Northern and Eastern States. It is a perennial, of strong, rank growth, about 3 feet high, the culm and leaves roughish, the leaves broadly linear, light green, and five to six on the culm. The panicle is generally but 2 or 3 inches long, the upper part dense from the shortness of the branches; the lower branches are longer and spreading, but with the spikelets glomerated or closely tufted. The spikelets are usually three to four flowered, one-sided, and on short, rough pedicels. The glumes are pointed and somewhat unequal, the upper one being smaller and thinner than the lower. The flowering glumes are ovate-lanceolate, roughish, and ending in a sharp point or short awn, and are rather longer than the outer glumes.

Professor Phares, of Mississippi, says:

Of all grasses this is one of the most widely diffused, growing in Africa, Asia, every country of Europe, and all our States. It is more highly esteemed and commended than any other grass by a larger number of farmers in most countries, a most decided

proof of its great value and wonderful adaptation to many soils, climates, and treatments. Yet, strange to say, though growing in England for many centuries, it was not appreciated in that country till carried there from Virginia in 1764. But, as in the case of timothy grass, soon after its introduction from America, it came into high favor among farmers, and still retains its hold on their estimation as a grazing and hay crop. It will grow well on any soil containing sufficient clay and not holding too much water. If the land be too tenacious, drainage will remedy the soil; if worn out, a top dressing of stable manure will give it a good send-off, and it will furnish several mowings the first year. It grows well between 29° and 48° latitude. It may be mowed from two to four times a year, according to latitude, season, and treatment, yielding from 1 to 3 tons of excellent hay per acre on poor to medium land. It is easily cured and handled. It is readily seeded and catches with certainty. It grows well in open lands and in forests of large trees, the underbrush being all cleared off. I know but one objection to it. Like tall oat grass it is disposed to grow in clumps and leave much of the ground uncovered. This may be obviated by thick seeding, using 2½, or, better, 3 bushels of seed per acre. The gaps may be prevented by sowing with it a few pounds of red-top seed. But as the latter multiplies annually from seeds dropping, it would in a few years root out the orchard grass. In common with others I prefer red clover with orchard grass. It fills the gaps and matures at the same time with the orchard grass; the mixture makes good pasture and good hay; but if mowed more than twice a year, or grazed too soon after the second mowing, the clover will rapidly fail. One peck of red clover seed and six pecks of orchard grass seed is a good proportion per acre. \* \* \* After being cut it has been found to grow inches in less than three days. Sheep leave all other grasses if they can find this, and acre for acre it will sustain twice as many sheep or other stock as timothy. Cut at the proper stage it makes a much better hay than timothy, and is greatly preferred by animals, being easier to masticate, digest, and assimilate; in fact, more like green grass in flavor, tenderness, and solubility.

Mr. J. S. Gould, of New York, says :

The testimony that has been collected from all parts of the world for two centuries past establishes the place of this species among the very best of our forage grasses, and we have not the shadow of a doubt that the interests of our graziers and dairy-men would be greatly promoted by its more extended cultivation. It is always found in the rich old pastures of England, where an acre of land can be relied on to fatten a bullock and four sheep. It is admirably adapted for growing in the shade, no grass being equal to it in this respect, except the rough-stalked meadow grass (*Poa trivialis*). It receives the name of orchard grass from this circumstance. We have seen it growing in great luxuriance in dense old New England orchards, where no other grass except *Poa trivialis* would grow at all. It affords a good bite earlier in the spring than any other grass except the meadow fox-tail (*Alopecurus pratensis*). It affords a very great amount of aftermath, being exceeded in this respect by no other grass except Kentucky blue grass (*Poa pratensis*), and it continues to send out root leaves until very late in the autumn. When sown with other grasses its tendency to form tussocks is very much diminished; indeed, it is always unprofitable to sow it alone in meadows or pastures, as it stands too thin upon the ground to make a profitable use of the land, and the filling up of the interspaces with other varieties greatly improves the quality of the orchard grass by restraining its rankness and making it more delicate.

Mr. Sinclair states, and the statement has been abundantly verified in all countries, that the herbage when suffered to grow rank or old contains one-half less nutriment than that which is of recent growth. Cattle, sheep, and horses eat it with the greatest avidity when it is young, but will not touch it when old, hence the importance, when

pastures have been understocked, of going over them with a mowing machine; the orchard grass will then stool out, and the cattle will be found eating first on the very spots that they had previously rejected. (Plate 96.)

#### POA.

This is an extensive genus, there being about thirty-five species in the United States, and it contains some of the most valuable grasses for pasturage.

The chief characters of the genus are as follows: Spikelets somewhat compressed, usually two to five flowered; the axis between the flowers glabrous, or sometimes hairy; the flowers generally perfect, in a few species diœcious; the outer glumes commonly shorter than the flowers, membranaceous, keeled, obtuse or acute, one to three nerved, not awned; the flowering glumes membranaceous, five or rarely seven nerved; the lateral nerves frequently very faint and obscure, often scarious at the apex and margins; the back, especially toward the base, frequently pubescent on the nerves, often with a few or many loose or webby hairs at the base; palet about as long as its glume, prominently two-nerved or two-keeled.

#### POA PRATENSIS. (June grass, Kentucky blue grass, Spear grass.)

This grass is too well known to need an extended description. It is a perennial, growing usually  $1\frac{1}{2}$  to 2 feet high, with an abundance of long, soft, radical leaves. There are several well-marked varieties, which are much modified and improved by good cultivation. It is indigenous in the mountainous regions of this country as well as of Europe, and has been introduced into cultivation in many countries. The panicle is generally pyramidal in outline, 2 to 4 inches long, open and spreading, the branches fine, mostly in fives, the lower ones 1 to 2 inches long, subdivided and flowering above the middle. The spikelets are about two lines long, ovate, closely three to five flowered, mostly on very short pedicels. The outer glumes are acute; the flowering glumes acute or acutish, five-nerved, the lateral nerves prominent, the lower part of the keel and marginal nerves more or less hairy, and at the base more or less webby-hairy. From the unexampled success its cultivation has met with in Kentucky it has acquired the name of Kentucky blue grass, although in New England it is known by the name of June grass. In all the middle portions of the United States it forms the principal constituent of pastures, though its excellence is said to be rather depreciated in the Eastern States.

In some sections it has been used as a hay grass, but it is not a success as a meadow, its chief excellence being exhibited as a pasture grass. It endures the frosts of winter better than any other grass we have, and if allowed to grow rank during the fall months it will turn over and hide beneath its covering the most luxuriant of winter croppings.

Professor Killebrew, of Tennessee, says :

It would seem a work of supererogation to argue as to the advantages of cultivating this grass. All know its benefits, and all see around them the great increase in the value of the land covered by it. It grows readily in all parts of the United States north of 40°, and lower down on suitable soils. It flowers in the earliest summer, and gives rich pasturage, except in the driest months, all the year. It varies in size in different localities according to soil and climate.

Professor Phares, of Mississippi, says :

Kentucky blue grass, known also in the Eastern States as June grass, although esteemed in some parts of America as the best of all pasture grasses, seems not to be considered very valuable among English farmers except in mixtures. It is certainly a very desirable grass, however. Its very narrow leaves, 1, 2, or more feet long, are in such profusion and cover the ground to such depth with their luxuriant growth that a mere description could give no one an adequate idea of its beauty, quantity, or value; that is, on rich land. On poor, sandy land it degenerates sadly, as do other things uncongenially located. Perennial, and bearing cold and drought well, it furnishes grazing a large part of the year. It is specially valuable as a winter and spring grass for the South. In prolonged summer drought it dries completely, so that if fired it would burn off clean. But this occurs even in Kentucky, where, indeed, it has seemed, without fire, to disappear utterly; yet when rain came, the bright green spears promptly recarpeted the earth. Sown alone, 20 to 26 pounds, that is 2 bushels, should be used to the acre; in mixtures, 4 to 6 pounds.

Mr. Klippart, of Ohio, says that this grass is very much in favor in Southern Ohio, whilst in Northern and Northeastern Ohio it is considered a very unwelcome guest in the grass lands. This difference of estimation is probably due to varieties, or to alteration of soil and to treatment. (Plate 97).

POA TRIVIALIS. (Rough-stalked Meadow grass.)

This species very much resembles the *Poa pratensis*. It is distinguished chiefly by its having rough sheaths, by its long, pointed ligules, its fibrous roots, and the smooth marginal nerves of the flowering glumes; whereas, in *Poa pratensis*, the sheaths are smooth, the ligules obtuse, the root-stock running, and the marginal nerves of the flowering glumes are hairy. It has been little cultivated by itself in this country, but is sometimes found in low meadows or on the banks of shaded streams. It flourishes best in low or wet ground and in shaded situations, and is not so well adapted to general cultivation as the blue grass.

Professor Phares, of Mississippi, says :

It is specially adapted to wood pastures, as it delights in shade, banks of streams, and moist ground generally. It bears tramping and is an excellent pasture grass. It makes a good mixture with red top and orchard grass, or red top and tall oat grass, and with other pasture grasses.

POA SEROTINA. (Fowl Meadow grass.)

Culms erect, 2 to 3 feet high, without running root-stocks. The leaves are narrowly linear, 3 to 6 inches long and two to three lines wide, the sheaths long, smooth, and striate, the ligules long. The panicle varies

with the size of the plant from 5 to 10 or 12 inches long and 1 to 3 inches wide, and lax; the branches mostly in fives or more numerous, nearly erect, from 1 to 4 inches long, the longer ones subdivided and flowering above the middle. There are some mountain forms or varieties in which the culms are 1 foot or less in height and the panicle greatly reduced. The spikelets are one to two lines long, two to five flowered, on short pedicels. The outer glumes are about one line long and sharp-pointed. The flowering glumes are rather obtuse, the lateral nerves not prominent, slightly pubescent on the margins below, and somewhat webby at the base.

This species is most common in the Northern States, particularly in New England, New York, and westward to Wisconsin, and also in reduced forms in all mountainous districts.

Mr. J. S. Gould, of New York, says:

I have found it to grow on almost every kind of soil; but it attains the greatest perfection in a rich moist one. It is one of those grasses that thrive best when combined with others; it will not make a superior turf of itself, but it adds much to the value of a sward from its nutritive qualities and powers of early and late growth. As it perfects an abundance of seed it may be easily propagated.

Professor Phares, of Mississippi, says:

In portions of the Western States this grass has, for some years, been very highly recommended. In the Eastern States it has been cultivated for one hundred and fifty years or longer and valued highly. Jared Elliott, in 1749, spoke of it as growing tall and thick, making a more soft and pliable hay than timothy and better adapted for pressing and shipping for use of horses on shipboard. He says it makes a thick, abundant growth on land more moist than is adapted to common upland grasses, and may be mowed any time from June to October, as it never becomes so coarse and hard but the stalk is sweet and tender and eaten without waste. It has not been sufficiently cultivated in the Southern States, so far as I am aware, to know how long a meadow set with it may remain profitable. It is, however, worthy of extended trial.

Mr. Charles L. Flint says:

It grows abundantly in almost every part of New England, especially where it has been introduced and cultivated in suitable ground, such as the borders of rivers and intervals occasionally flooded. It never grows so coarse or hard but that the stalk is sweet and tender, and eaten without waste. It is easily made into hay, and is a nutritive and valuable grass.

(Plate 98.)

POA COMPRESSA. (Wire grass, Blue grass.)

This species has sometimes been confounded with the Kentucky blue grass, from which it differs in its flattened, decumbent, wiry stems, its shorter leaves and shorter, narrower, and more scanty panicle. It is found in many old pastures, on dry banks, and in open woods. The culms are hard and much flattened, 1 foot to 18 inches long, more or less decumbent, and frequently bent at the lower joints. The leaves are scanty, smooth, short, and of a dark bluish-green color. The pani-

cle is short and contracted, 1 to 3 inches long. The branches are in pairs or threes, short, rough, and frequently one sided. The spikelets are ovate-oblong, flat, short-stalked, and generally three to five flowered. The outer glumes are acute, the flowering ones obtuse, smooth, the nerves obscure, and the apex frequently purplish colored. It forms a very firm turf by means of its creeping rootstalks. Very contradictory accounts have been given as to its agricultural value, some denouncing it as worthless and others entertaining a good opinion of it. It thrives well on clay, or hard trodden and poor soils.

Hon. J. S. Gould says, respecting it :

It is certain that cows that feed upon it both in pasture and in hay give more milk and keep in better condition than when fed on any other grass. Horses fed on this hay will do as well as when fed on timothy hay and oats combined.

These discrepant opinions may be due in part to having mistaken the *Poa pratensis* for this grass. It is probably a nutritious grass, but from its spare yield can hardly obtain much favor for a hay crop. (Plate 99.)

#### POA ARACHNIFERA. (Texas Blue grass.)

This species was first described by Dr. John Torrey in the report of Captain Marcy's exploration of the Red River of Louisiana, as having been found on the headwaters of the Trinity, and named *Poa arachnifera* from the profuse webby hairs growing about the flowers, although it is found that this character is very variable, probably depending somewhat on the amount of shade or exposure to which the grass is subject.

Several years ago Mr. Hogan, of Texas, sent specimens of the grass to this Department, and as it was shown to be a relative of the Kentucky blue grass, Mr. Hogan adopted for the common name Texas blue grass. We give some extracts from his letters relating to the grass :

I find it is spreading rapidly over the country, and I claim for it all and more in Texas than is awarded to the *Poa pratensis* in Kentucky. It seems to be indigenous to all the prairie country between the Trinity River and the Brazos in our State. It blooms here about the last of March, and ripens its seeds by the 15th of April. Stock of all kinds, and even poultry, seem to prefer it to wheat, rye, or anything else grown in winter. It seems to have all the characteristics of *Poa pratensis*, only it is much larger, and therefore affords more grazing. I have known it to grow 10 inches in ten days during the winter. The coldest winters do not even nip it, and although it seems to die down during summer it springs up as soon as the first rains fall in September and grows all winter. I have known it in cultivation some five years, and have never been able to find a fault in it. It will be ready for pasture in three or four weeks after the first rains in the latter part of August or first of September. I have never cut it for hay. Why should a man want hay when he can have green grass to feed his stock on ?

Mr. James E. Webb, of Greensborough, Hale County, Alabama, writes to the Department December 26, 1883, and says :

Recent experiments show that the Texas blue grass (*Poa arachnifera*) flourishes and grows here in west Alabama as finely as could be wished, and is likely ere long to furnish us what we so much need, a fine winter grass. With Texas blue grass, Melilotus, and Bermuda grass, Alabama is a fine stock country.

Mr. S. C. Tally, of Ellis County, Texas, has sent specimens of this grass; he says it is abundant there, bears heavy pasturing, and makes a beautiful yard or lawn grass.

Similar favorable accounts have been received from others. It is likely to prove one of the most valuable grasses for the South and Southwest. By means of its strong stolons or offshoots it multiplies rapidly and makes a dense permanent sod. It produces an abundance of radical leaves, and those of the culm are long, smooth, and of good width, about 4 to 8 inches long and two lines wide. The culms are 2 to 3 feet high, each with two or three leaves, with long sheaths and blade, the upper leaf sometimes reaching nearly to the top of the panicle. The ligule is short and rounded, or lacerated when old. The panicle is from 3 to 8 inches in length, rather narrow, and with short, erect branches of unequal length, in clusters of from three to five, the longest seldom 2 inches, most of them short, some nearly sessile, and profusely flowering to the base. The spikelets usually contain about five flowers. The outer glumes are ovate-lanceolate, acute, with whitish scarious margins, and scabrous on the keel. The flowering glumes are longer, gradually sharp pointed, and smooth except on the margins and midnerve, which are usually pubescent, sometimes densely so. In many cases there is a remarkable development of long, silky hairs at the base of each flower, but sometimes these are quite absent. (Plate 100.)

POA TENUIFOLIA. (Oregon Blue grass.)

There is some uncertainty about the proper specific name of this grass. In the report for 1881-'82 it was published as *Poa Californica*, but it seems probable that that name belongs to a different species. It is common in California, Oregon, and Washington Territory, and is one of the numerous bunch grasses referred to in accounts of the wild pasturage of that country. The foliage of some forms of the grass seems to be too scanty, but of others the radical leaves are long and abundant. It furnishes an abundance of nutritious seeds, which are said to be gathered for food by Indians.

The culms are from 1½ to 3 feet high, erect, and scantily clothed with a few short, narrow leaves. The panicle is erect, 3 to 5 inches long, rather narrow and loose, the branches mostly in fives, unequal, from ½ to 1½ inches long, flowering above the middle. The spikelets are three to five flowered; the outer glumes are oblong-lanceolate, about two lines long, nearly as long as the flowers, three-nerved, rough on the keel, somewhat scabrous, and acutish. The flowering glumes are lanceolate, convex, or slightly compressed toward the apex, indistinctly five-nerved, two to three lines long, acutish, minutely scabrous, the apex and margins scarious and of a bronze or purplish color, sometimes slightly pubescent near the base. The palet is almost as long as its glume, narrower and bidentate at the apex.



It is probable that this species, by careful cultivation, may be made as valuable in agriculture for the region where it grows as the *Poa pratensis* is in the Eastern States. (Plate 101.)

POA ALSODES. (Tall Spear-grass, Woods grass, Wood Spear grass.)

A species of spear-grass of, probably, no great agricultural value, but found in mountainous districts in the northern parts of the United States, in woods and on hill sides in New England, New York, the mountainous parts of Pennsylvania, and westward to Wisconsin. The culms are 2 to 2½ feet high, slender, erect, and with about three narrowly-linear leaves, each 3 to 4 inches long. The panicle is about 6 inches long, very open, and composed of about four whorls of branches, chiefly in fours, the lower ones distant, very slender, 2 to 3 inches long, and with few flowers only toward the extremity of the branches. The species may most readily be distinguished by the acute flowers. The spikelets are about two lines long, chiefly three-flowered. All the glumes are acutely-pointed, the flowering ones obscurely nerved, and with a narrow tuft of long, webby hairs at the base.

Mr. J. S. Gould says :

It flourishes on mountain sides from 1,000 to 3,000 feet above the sea, but is very well adapted for lawns and for thick, shady places, where few other kinds will grow. The seeds weigh about 15 pounds to the bushel.

(Plate 102.)

POA ANDINA OF NUTTALL. (Mountain Spear grass.)

A perennial tufted grass, with short, narrow, rigid, and pungently pointed leaves, usually involute; the culms are 6 to 18 inches high, smooth, or nearly so, wiry and naked, except about two very short leaves, the blade an inch long, or almost wanting. The panicle is 2 to 4 inches long, narrow, erect, and rather loose, the branches mostly in pairs, which are erect, about an inch long, and flowering for the upper two-thirds, or nearly throughout. The spikelets are three to five flowered, and nearly sessile; the outer glumes are one and a half lines long, nearly equal, thin, ovate-lanceolate, acute or acutish, the margins scarios, the lower one-nerved, and the upper obscurely three-nerved, minutely scabrous; the flowering glumes are oblong, obtuse, or obtusish, slightly compressed, rounded on the back, at least below, obscurely nerved, softly and finely pubescent and below villous; the apex scarios and tinged with purple, sometimes denticulate or lacerated; the paleas are as long as their glumes, and pubescent on the nerves. The flowers separate very readily and drop off early.

This grass prevails widely throughout the region of the great plains and table lands from Arizona to British America. Little is known of its agricultural value. (Plate 103.)

## POA ANNUA. (Annual Spear grass, Goose grass.)

This grass is a native of Europe, but has become extensively naturalized in this and many other countries. It is an annual or biennial species of low growth, usually 3 or 4 to 6 or 10 inches high, with pale-green, tender leaves. It is commonly found in door-yards or neglected lots or on the roadside. It blooms very early in the spring, and also frequently in the fall. It is very nutritious, but so small that the yield is deficient in quantity. It appears to die at the approach of hot weather.

*Poa flexuosa*, *Poa brevifolia*, *Poa debilis*, and *Poa sylvestris*, are species growing in woods or shaded grounds in different parts of the country, South and East, but are not of much agricultural importance.

## GLYCERIA.

This genus is closely related to *Poa*, and is characterized as follows: Spikelets terete or flattish, several to many flowered, the axis of the flowers smooth, the outer glumes shorter than the flowers, unequal, membranaceous, one to three nerved, the flowering glumes membranaceous or subcoriaceous, obtuse, awnless, more or less hyaline, and finely-toothed or worn at the apex, rounded (not keeled) on the back, five to nine nerved, the nerves separate and all vanishing before reaching the apex; palea about as long as its glume, two-keeled, entire or bifid at the apex.

The species of this genus are not of much agricultural importance. They mostly grow in wet or swampy ground, and where found in abundance can be utilized for pasturage or hay-making.

## GLYCERIA AQUATICA. (Reed Meadow grass, White Spear grass.)

This species is widely diffused in the northern portions of the United States, Canada, the Rocky Mountains, and the Northwestern States and Territories. It has a stout, erect, leafy culm, 3 to 4 feet high. The leaves are a foot or two long, a quarter to half an inch wide, flat, and somewhat rough, especially on the edges. The panicle is large, 9 to 15 inches long, much branched; the branches arranged in half whorls alternately on the main axis, at first erect, but spreading with age. The spikelets are oblong, about three lines long, five to nine flowered, on capillary pedicels. The lower third of the branches is naked. The outer glumes are one-nerved, and unequal. The flowering glumes are obtuse, prominently seven nerved or ribbed, mostly entire at the apex. The palea is two-toothed, two-nerved, and about as long as its glume.

Hon. J. S. Gould says:

This grass is made into hay which is liked by cattle. It flowers in July. It is found in most parts of Europe, and is widely diffused in this country in wet meadows.

It is doubtful if the European grass of this name is identical with the American one, although much resembling it. (Plate 104.)

## GLYCERIA NERVATA. (Nerved Meadow grass, Nerved Manna grass.)

This is similar in appearance and habit to the preceding, but generally smaller. It has also much the same general range. The culms are 2 to 3 feet high, usually somewhat decumbent below, often branching and rooting at the lower joints. It varies greatly in size and in the magnitude of the panicle. It usually grows along the wet margins of streams and in swamps. The panicle is from 4 to 8 inches long, nodding when young, loose and spreading, with capillary branches. The leaves are 8 to 12 inches long, and two to three lines wide. The spikelets are small, about five-flowered, oblong, frequently becoming purplish with age. The outer glumes are unequal, obtuse, thin, and small, neither of them much more than half as long as the flowers. The flowering glumes are obtuse, oblong, prominently five to seven ribbed, and entire or minutely ciliate at the apex. The palea is as long as its glumes, two-nerved, two-toothed at the apex. Like the preceding this grows in wet meadows and swamps. It is nutritious and might be advantageously mixed with other grasses in wet or swampy grounds.

Mr. Charles L. Flint says:

It is a hardy grass, grows best on moist ground, but is said to succeed also on lightish upland soils. It is a very valuable native grass, retaining its nutritive qualities until the seed is ripe, and then sending up large fan-like shoots which are succulent and nutritious. It would be a valuable ingredient in a mixture for wet or moist pastures.

(Plate 105.)

## GLYCERIA CANADENSIS. (Rattlesnake grass, Tall quaking grass.)

A grass belonging to the northern portion of the United States, usually found in mountainous districts, in swamps, and river borders, growing in clumps. The culms are stout, about 3 feet high, smooth and leafy. The leaves are linear-lanceolate, 6 to 9 inches long, or the lower ones much longer, about four lines broad and rather rigid. The panicle is large and effuse, 6 to 9 inches long, oblong pyramidal, and at length drooping. The whorls are an inch or more distant, the branches semi-verticillate, mostly in threes, the largest 3 to 4 inches long, and subdivided from near the base. The spikelets are oblong to ovate, when mature nearly three lines long, rather turgid, but flattened at the sides, usually six to eight flowered. The empty glumes are shorter than the flowering glumes, ovate-lanceolate, acute, purplish, the upper one largest. The flowering glumes are broadly ovate, acute, five to seven nerved, one and one-half to two lines long. The paleas are shorter than their glumes and thicker in texture, roundish, and obtuse, with the sides strongly reflexed.

This is quite an ornamental grass, resembling the quaking grass (*Briza*). Cattle are fond of it, both green and when made into hay. It is well adapted to low meadows.

Hon. J. S. Gould says:

It is usually found on high elevations, in swampy lands, and by the margins of streams. It is very apt to grow in clumps. It is one of the most beautiful of grasses, and is exceedingly ornamental in grass bouquets. It is abundant on the Catskill and White Mountains and on the Raquette waters of the Adirondacks. Cattle eat it very well in pasture and when made into hay.

(Plate 106.)

GLYCERIA FLUITANS. (Floating Manna grass.)

This species grows in shallow water on the margins of lakes, ponds, and sluggish streams. Its culms are usually 3 to 4 feet high, rather thick and succulent and quite leafy. The leaves are 4 to 9 inches long and three to four lines wide. The panicle is often a foot long, very narrow, the short distant branches mostly in twos or threes, 1 or 2 inches long, erect and close, each having usually two to four spikelets. The spikelets are half an inch to three-quarters of an inch in length, rather cylindrical and nearly of the same thickness throughout, seven to thirteen flowered. The outer glumes are membranaceous and one-nerved. The flowering glumes are about two lines long, oblong, convex on the roughish back, rather thick, with a thin, scarious entire apex. The paleas are as long or sometimes longer than their glumes and minutely two-toothed.

Hon. J. S. Gould says:

This grass is found growing in shallow water, overflowed meadows and wet woods, but will bear cultivation on moderately dry grounds. Schreber says that it is cultivated in several parts of Germany for the sake of the seeds, which form the manna crop of the shops, and are considered a great delicacy in soups and gruels. When ground into meal they make bread very little inferior to that made from wheat. In Poland large quantities of the seeds are obtained for culinary purposes. All granivorous birds are exceedingly fond of these seeds. Trout and indeed most fish are very fond of them; wherever it grows over the banks of streams the trout are always found in great numbers waiting to catch every seed that falls. There is a great difference of opinion among agricultural writers with respect to the fondness of animals for the leaves and culms of this grass. We have often seen the ends of the leaves cropped by cattle, but have never seen the culms or root-leaves touched by them. On the other hand, reliable writers have asserted that cattle, horses, and swine were alike fond of it.

FESTUCA.

This is a large genus, of which we have some fifteen native and several introduced species. The genus is characterized as follows: Spikelets, three to many flowered, variously paniced, pedicellate; axis of the spikelets not hairy, outer glumes unequal, shorter than the flowers, the lower one-nerved and the upper three-nerved, narrow, keeled, acute; flowering glumes membranaceous, chartaceous, or subcoriaceous, narrow, rounded on the back (not keeled), more or less distinctly three to five nerved, acute, or commonly tapering into a straight awn, rarely obtusish; palea narrow, flat, prominently two-nerved or two-keeled.

FESTUCA ELATIOR. (Meadow Fescue grass, Tall Fescue, Randall grass, Evergreen grass.)

A perennial grass, growing from 2 to 4 feet high, with flat, broadish leaves about a foot long. The panicle is somewhat one-sided, loose, and spreading when in flower, contracted after flowering, from 6 to 10 inches long, the branches 1 to 2 inches long, erect, mostly in pairs below, single above, subdivided; the spikelets are lanceolate or linear, about half an inch long, five to ten flowered. The outer glumes are one and three nerved, shorter than the flowers; the flowering glumes are lanceolate, about three lines long, firm in texture, five-nerved, scarious at the margin, acute, and sometimes with a short but distinct awn at the apex. This is an introduced species, now frequently met with in meadows; it is one of the standard meadow grasses of Europe. Cattle are said to be very fond of it, both green and as hay. There is a smaller form or variety which is the variety *pratensis* or *Festuca pratensis*, Hudson.

Professor Killebrew, of Tennessee, writes of this grass as follows:

This grass has received some attention in different parts of the State, and has met with a warm reception from those testing it. It ripens its seed long before any other grass, and consequently affords a very early nip to cattle. It has been raised under various names, in Virginia as "Randall grass," and in North Carolina as "evergreen grass." Mr. James Taylor, writing from North Carolina, says: "The evergreen grass is very good for pasturing through the fall and winter. It will do best when sown on dry land, and is well adapted to sheep. It grows well on rocky soil to the height of 4 or 5 feet when ripe, continuing green in the spring, and affording fine herbage throughout the winter. It is best to sow in the spring with oats. A peck of well-cleaned seed is enough for an acre, or a bushel in the chaff. It ripens about the 1st of June. If sown in the spring this grass will not go to seed before the next year, but if sown in the fall it will bring seed the next spring." From the limited cultivation it has met with in Tennessee, it seems rather to be better adapted to moist, low lands, though I have seen it growing on some of the high ridges of East Tennessee, at least 1,500 feet above the sea. There it thrives luxuriantly and makes a very superior pasture.

Professor Phares, of Mississippi, says:

It grows well in nearly all situations, wet or dry, on hill or bottom land, even though subject to overflow, and matures an extraordinary quantity of seed. The seeds germinate readily, and it is easy to set a piece of land with this grass. Seeded alone, 28 pounds, or about 2 bushels, of seed should be sown broadcast in August, September, October, or from the middle of February to the 1st of April. From remaining green through the winter it is sometimes called "evergreen grass." Mowed and dried it makes a good hay, much relished by stock.

(Plate 107.)

FESTUCA OVINA. (Sheep's Fescue grass.)

A densely-tufted, perennial grass, with an abundance of rather narrow, sometimes involute, short radical leaves and slender culms, 1 to 1½ feet high. The panicle is 2 to 4 inches long, narrow, the branches mostly single and alternate, erect and few-flowered; the spikelets are

mostly three to five flowered, and about three lines long; the outer glumes are acute and narrow. The flowering glumes are lanceolate, two lines long, roughish, and with a short rough awn about half a line long.

This species has many varieties, both in this country and in Europe. It is indigenous in the mountainous parts of New England, in the Rocky Mountains, and in various Northern localities.

As found in cultivation it has been derived from Europe.

Hon. J. Gould, of New York, says:

It forms the great bulk of the sheep pastures of the highlands of Scotland, where it is the favorite food of the sheep, and where the shepherds believe it to be more nutritious for their flocks than any other. Gmelin says that the Tartars choose to encamp during the summer where this grass is most abundant, because they believe that it affords the most wholesome food for all cattle, but especially for sheep. Nature distributes it among dry, sandy, and rocky soils, where scarcely any other species would grow. It is without doubt the very best of the grasses growing on sandy soils. It roots deeply, and forms a dense, short turf, which adapts it admirably for lawns and pleasure-grounds where the soil is sandy. It is almost useless as a hay crop, as its leaves and culms are too fine to give a remunerative amount of hay; it is only as a pasture grass on sandy soils that it is valuable, and in these, when highly manured, it is driven out by the more succulent species. It is often found 4,000 feet above the level of the sea. Its seeds weigh about 14 pounds to the bushel.

(Plate 108.)

FESTUCA MICROSTACHYS. (Small Fescue grass, Western Fescue.)

A slender annual grass, which is very common in California and Oregon, considerably like the small fescue (*Festuca tenella*). The culms are slender, 6 to 18 inches high; the leaves are short and narrow. The panicle is from 2 to 5 inches long, with rather distant short branches, which are mostly single at the joints, and apt to be one-sided, sometimes with the lower branches spreading or reflexed. The spikelets are small, from two to five flowered, on short, thickened pedicels, varying from smooth to pubescent. The outer glumes are acute, about a line long. The flowering glumes are two or three lines long, with an awn nearly twice as long; the paleas have each two short, bristle-like teeth, which often project beyond the flowering glume. The grass is of little value, except as it helps to extend the pasturage of uncultivated ground.

(Plate 109.)

FESTUCA SCABRELLA. (Bunch grass.)

A perennial grass, growing in strong clumps or bunches, and hence called "bunch grass." It is a native of the Rocky Mountain region, from Colorado westward to California and Oregon. The culms are usually 2 to 3 feet high, erect, and smooth; the radical leaves are numerous, about half as long as the culm, generally rigid, involute, and scabrous on the margins; the blade is prone to separate when old, leaving an abundance of leafless sheaths at the base; the cauline leaves are about two, short and pointed, 2 to 4 inches long; the sheath scabrous, the ligule short or wanting; the panicle is usually 3 to 5 inches long; the

rays spreading, 1 to 3 inches long, distant, usually in pairs below, single above, subdivided to the middle; spikelets five to six lines long, three to five flowered, the flowers rather distant; outer glumes ovate-lanceolate, membranaceous, acute or acuteish, obscurely nerved, the upper one two lines long, the lower one-third shorter; flowering glumes lanceolate, acute, or short cuspidate, about five-nerved, minutely scabrous, of thicker texture than the outer glumes; palea as long as its glume, two-nerved, bifid at the apex.

This grass varies greatly in size and appearance in different localities, one form in Oregon and California growing 3 to 5 feet high, with panicle twice as large as the mountain form. Cattle are said to be fond of it, and it is considered one of the most valuable wild grasses of the region where it grows. (Plate 110.)

#### BROMUS.

Spikelets five to many flowered, subterete or compressed, the axis smooth; the outer glumes more or less unequal, shorter than the flowers, membranaceous, acute, one to nine nerved, awnless or short mucronate; flowering glumes, membranaceous to rigid-subcoriaceous, rounded on the back, or compressed or keeled, five to nine nerved, acute or awned from below the mostly two-cleft apex; palea commonly rather shorter than its glume, two keels, the keels rigid and ciliate.

#### BROMUS SECALINUS. (Chess or Cheat.)

We introduce this grass, not to recommend its cultivation, but to familiarize those interested with its appearance and character. Many farmers know it well, as it occurs in their wheat fields. It is an old tradition, which some farmers still cling to, that chess is a degenerated wheat; that the action of frost and other causes occasion the deterioration, whereas the truth undoubtedly is that chess seed was either in the land or in the seed sown, and being more hardy than wheat it survived the frost and took possession of the ground. Some years ago this grass had a temporary popularity under the name of Willard's Brome grass, but it was soon abandoned when brought into competition with better grasses.

It has a stout upright culm, 2 to 3 feet high, the panicle being from 4 to 6 inches long, rather spreading, and the large spikelets somewhat drooping when ripe. Usually there are three to five branches at each joint of the panicle; these branches are of different lengths, from  $\frac{1}{2}$  inch to 2 inches, and each with one to three spikelets. The spikelets are usually from five to ten flowered; the glumes unequal, nerved, shorter than the flowers; the flowering glume is convex or compressed, keeled on the back, with an awn variable in length from below the point.

In the South it would perhaps be a good winter grass, like its relative *Bromus unioloides*, but it is not as vigorous a grass as that species, and does not produce such an abundance of foliage. (Plate 111.)

BROMUS UNIOLOIDES. (Schrader's grass, Rescue grass.)

This is one of the so-called winter grasses; that is, it makes in the South a large share of its growth during the winter months. It belongs to the chess or cheat family. In its early growth it spreads and produces a large amount of leaves; early in the spring it sends up its flower stalks, which grow about 3 feet high, with a large, open, spreading panicle, the ends of the branchlets bearing the large flattened spikelets, which, when mature, hang gracefully upon their stems, giving them quite an ornamental appearance. These spikelets are from 1 inch to 1½ inches in length, and composed of two acute lanceolate glumes at the base, and from seven to ten flowers arranged in two rows alternate on each side of the axis. The flowers are lanceolate, or ovate-lanceolate, the flowering glume extending into a fine point or short awn.

During several years past this grass has been sent to this Department, chiefly from Louisiana and Texas, and has been much commended. Many years since the same grass was distributed and experimented with under the name of Australian oats, or *Bromus Schraderi*. It is not adapted to use in a country with severe winters, and hence did not give satisfaction in all places. Mr. C. Mohr, of Mobile, says of it:

Only of late years found spreading in different parts of this State; makes its appearance in February, grows in tufts, its numerous leafy stems growing from 2 to 3 feet high; it ripens the seed in May; affords in the earlier months of spring a much-relished nutritious food, as well as a good hay.

Under date of March 4, 1878, Mr. Williams writes from San Antonio, Tex., describing the introduction and spreading of a patch of this grass. He says:

Inasmuch as Western Texas is the great stock-producing section of the Southwest, and considering the fact that pasturage is scanty, particularly in February, stunting the growth of young cattle, this seems wonderfully adapted to supply just what is greatly wanted, both for milch cows, calves, colts, and ewes just dropping their lambs; and besides, this grass grows well on the thinnest soil and crowds out weeds, maturing in March and early April, while not interfering with the native *mesquite*. I therefore regard this grass as a wonderful and most important discovery.

This grass is said to have been introduced into Georgia by General Iverson, of Columbus, and by him called rescue grass. The favorable opinion which it at first received does not seem to have been well sustained in that State.

Professor Phares, of Mississippi, says:

This grass is also called *Bromus Schraderi*, *B. Willdenovii*, *Ceratochloa unioloides*, and *Festuca unioloides*. It is an annual winter grass. It varies in the time of starting growth. I have seen it ready for mowing the first of October, and furnish frequent cuttings till April. Again, it may not start before January, nor be ready to cut till February. This depends on the moisture and depression of temperature of the fall, the seeds germinating only at a low temperature. When once started, its growth after the successive cuttings or grazings is very rapid. It is tender, very sweet, and stock eat it greedily. It makes also a good hay. It produces an immense quantity of leaves. On loose soil some of it may be pulled up by animals grazing it.

(Plate 112.)



## BROMUS ERECTUS. (Erect Brome grass.)

This is a European species, which has become sparingly naturalized in some places. It is a perennial grass, growing about 2½ feet high, the culms erect, firm, and smooth. The leaves are narrowly-linear, mostly radical, or at the base of the stem. The panicle is somewhat oblong in outline, 5 or 6 inches long, the branches mostly in fives, 1 to 2 inches long, slender, erect, not much subdivided, and each terminated with the pretty large spikelet of seven to nine flowers. The spikelets are about 1 inch long. The empty glumes are lanceolate, thinnish, acute, rather shorter than the flowering glumes, which are about five lines long, linear-lanceolate, slightly rough, and pointed with an awn of half to three-quarters its own length.

This species is not so coarse as many of the brome grasses, and will be more useful for hay. It is of the same genus as chess or cheat, but is very different from and should not be confounded with broom grass, which is an *Andropogon* and much less valuable. (Plate 113.)

We have several other native species of this genus, and there are several species growing in California, Oregon, and the mountain region of the Pacific slope. The most important of these is the *Bromus grandiflorus*, which is in many respects like the *Bromus unioloides*, but of a larger growth and with larger spikelets. *Bromus mollis*, *Bromus racemosus*, *Bromus sterilis*, and some other European species are occasionally found introduced.

## LOLIUM PERENNE. (Rye grass and Italian Rye grass.)

A perennial grass, introduced from Europe. The culms are 2 to 3 feet high, very leafy, and terminating in a loose, spike-like panicle, 6 inches or more in length. The spikelets are arranged alternately on the axis, placed edgewise; that is, with one edge of the flat spikelet applied to the main stem at short distances, so that there may be twenty or more in the panicle. The spikelets are one-half to three-fourths of an inch long; generally seven to eleven flowered. The inner empty glume is generally wanting, so that, except on the terminal spikelet, only one glume is apparent, which is half or more than half the length of the spikelet, narrowly lanceolate, and acute. The general appearance of the panicle is like that of couch grass (*Triticum repens*). The flowering glumes are thickish, obscurely nerved, rather hispid, acutely pointed, or in the variety *Italicum*, with a longish awn. The proper palets are similar to the flowering glumes and of nearly equal length.

An intelligent writer, whom we have frequently quoted, says respecting this grass:

It occupies the same place in Great Britain that timothy does with us, and is there esteemed on the whole higher than any other species of grass, and is called rye grass or ray grass. Of all the varieties of *Lolium perenne* which are known that called *Italicum* is by far the most valuable. Its spikelets are conspicuously bearded, the flowers being all terminated by long, slender awns, which character distinguishes it very easily from *Lolium perenne*. Its name (Italian rye grass) is derived from the fact

that its native habitat is on the plains of Lombardy, where broad and extensive plains of pasture land are frequently inundated by the mountain streams which intersect them. It is mainly adapted to irrigated meadows, and in these it is undoubtedly superior to any other grass.

Professor Phares says :

This grass stands drought well and grows most luxuriantly in our Southern States. If not kept grazed or mowed, however, the leaves cover the ground so deeply and densely that an excess of rain in very hot weather in the extreme South causes it to rot suddenly, destroying even the roots. This I have never seen or heard mentioned by any other person, but it occurred on my own farm one season, where I was reserving a lot for seed.

Hon. J. S. Gould says :

The valuable qualities of this grass may be summed up as follows: Its habit of coming early to maturity; its rapid reproduction after cutting; its wonderful adaptation to all domestic animals, which is shown by the extreme partiality they manifest for it, either alone or when mixed with other grasses, whether when used as green food for soiling, as hay or as pasturage, in which latter stage its stems are never allowed to ripen and wither like those of other grasses. One of its greatest recommendations is its beneficial influence on the dairy, not only in augmenting the flow of milk, but in improving the flavor of the cheese and butter that are made from it.

(Plate 114.)

AGROPYRUM. (*Triticum*.)

This genus is by many botanists considered as a section of *Triticum*, and our species are best known under that name. The spikelets are usually from three to five flowered, compressed, alternately sessile on the continuous or slightly notched axis of the simple spike and with the side of the spikelets against the axis; the outer glumes are nearly equal membranaceous or herbaceous, one to three nerved, scarcely keeled, tapering to a point, or awned; flowering glumes similar to the outer ones, but generally broader, rounded on the back, three to seven nerved, pointed or awned from the apex; the palea nearly as long as its glume, the two prominent nerves almost marginal and ciliate.

AGROPYRUM REPENS. (*Triticum repens*.) (Couch grass, Quack grass, Quitch grass, Wheat grass, Twitch grass, Dog grass.)

There has been a good deal of discussion relative to this grass, some pronouncing it one of the vilest of weeds, and others claiming for it high nutritive qualities overweighing all the disadvantages of its growth. Whichever party may be right, it is proper that farmers should be acquainted with it in order to know how to treat it, and hence our figure and description. It forms a dense sod by means of its far-reaching rhizomas or root-stalks, which have short joints, and root tenaciously at every joint.

It has an abundance of foliage, and sends up a flowering culm, 2 to 3 feet high, which is terminated by a close, narrow spike of flowers from 3 to 6 inches long. This spike consists of a succession of closely-set spikelets, one at each joint of the axis, and placed flatwise with the side

against the stalk. Each spikelet contains several (three to eight) flowers, with a pair of nearly equal and opposite three to five nerved glumes at the base.

This grass as it occurs in the Eastern States is supposed to be introduced from Europe, but on the great Western plains and in the Rocky Mountains there are several varieties of it which are undoubtedly indigenous, as also several other species in the same region.

Hon. J. S. Gould says:

The farmers of the United States unite in one continuous howl of execration against this grass, and it seems strange, when every man's hand is against it, that it is not exterminated. Yet we could never really satisfy ourselves that its presence in meadows and pastures was such an unmitigated curse. In lands where alternate husbandry is practiced, it must be admitted to be an evil of great magnitude. Its hardiness is such, and its rapidity of growth is so great that it springs up much more rapidly than any other crop that can be planted, and chokes it. Still it has many virtues. It is perfectly cosmopolitan in its habits. It is found in all sorts of soils and climates. Its creeping roots are succulent, and very nutritive, and are greedily devoured by horses and cows.

Professor Phares, of Mississippi, says:

This is perennial, with stem 2 or 2½ feet high, so much like wheat as to be called also wheat grass. Cattle eat it heartily when green, and cut early it makes a good hay. But it fills the ground with roots, is as difficult to cultivate amongst and exterminate as coco or nut grass; and hogs are as fond of and root up the ground as industriously to obtain the roots. Cows and horses are also fond of them. It should be destroyed as soon as found in cultivated ground, but it is very valuable in permanent pastures.

(Plate 115.)

AGROPYRUM GLAUCUM. (Blue stem, Blue joint.)

This species, which has also been considered a variety of the preceding, prevails on the Western plains from Texas to Montana, and is well known to stockmen. It differs from the *A. repens* in having a stouter, more rigid stem and leaves; the leaves, indeed, often becoming involute and stiff. It is also of a light bluish-green color. The spike is generally shorter, denser, and with larger spikelets.

Mr. Richard Gaines, of Colorado Springs, Colo., says:

We think this is the best grass grown, superior to timothy or clover. We call it blue stem, or blue joint; no richer hay can be made from anything known.

HORDEUM NODOSUM. (Barley grass.)

An annual or biennial grass, growing principally in alkaline soils and on the borders of saline marshes, especially in the Western States and Territories. Although eaten by cattle when in a young state, it cannot be claimed as of anything more than temporary value. The culms are usually 1 to 1½ feet high, sometimes in moist places reaching 3 feet, and varying as to smoothness or pubescence. The leaves are usually flat, 2 to 4 inches long, and about two lines wide. The flowers are in a close, cylindrical spike, about 2 inches long, with three spikelets at each joint of the rachis. One (the central) spikelet is sessile and perfect; the two

lateral ones are short-stalked and imperfect or abortive. Each of the spikelets has a pair of empty glumes, which are narrowly lanceolate and awn-pointed, or the lateral ones may be reduced to rough bristles. The flowering glume of the perfect flower is lanceolate, indistinctly three-nerved, and terminated by an awn one-quarter to one-half inch long, equaling those of the empty glumes. The proper palet is inclosed in its glume, is of about the same length as that, excluding the awn, and of thinner texture. (Plate 116.)

**HORDEUM JUBATUM.** (Wild barley, Squirrel tail grass.)

This species has the same general characters as the preceding, but the flowers have awns 2 inches or more long, giving it a bushy and rather handsome appearance. It is frequently found in wet or marshy places, and is of no agricultural value.

**HORDIUM MURINUM.**

Professor Brewer states that this grass, unfortunately is extensively naturalized in California, and is a vile pest; it comes in when land is overstocked; is known there as "Squirrel grass," "Squirrel tail," "Fox tail," and "White oats." The heads break up and the barbed seeds work into the wool of sheep, and even into the flesh of lambs, killing them. It damages the eyes and throats of animals.

**ELYMUS.** (Wild rye.)

Of this genus we have several species. Its general characters are as follows: Spikelets in a simple, generally stout, spike, sessile, two to four at each joint of the axis, one to six flowered; outer glumes two for each spikelet, nearly side by side in front, forming a kind of involucre for the cluster, narrow, rigid, one to three nerved, acuminate or awned; flowering glumes herbaceous, thick and harsh, oblong or lanceolate, rounded on the back, not keeled, acute, or awned; palet shorter than its glume, acute, two-keeled.

**ELYMUS CANADENSIS.** (Wild rye, Lyme grass, Terrell grass.)

A perennial coarse grass, growing on river banks and in rich shaded woods. Culms, 2 to 4 feet high, leafy, terminated by a cylindrical loose spike, 4 to 8 inches long, with the spikelets placed at intervals of about half an inch on the axis. The spikelets are mostly in pairs at each joint, each composed of from three to five flowers. The glumes are narrow, strongly nerved, and tapering to an awn which is rather shorter than the awn of the flowers proper. The flowering glume of each flower is thick in texture, narrow, and extending into a long, somewhat curved, awn or beard, the palet with the awn being an inch or more in length. The palet is thinner in texture, obtuse, and not awned, fringed with short hairs on the margin. The spike is usually drooping at the top, and rather graceful in appearance. The leaves are broad and rough, the lower ones 9 to 12 inches long.

In some localities this is common in low meadows, and is cut with other native grasses for hay. If left until maturity it becomes too coarse to be of much value. In some portions of the Southern States this grass is known as Terrell grass from having been prominently brought to notice by Dr. Terrell, of Sparta, Ga. Mr. C. W. Howard writes concerning it, as follows:

This grass will live on thin land, but the soil, to make it valuable, must be rich—the richer the better. It lasts for years. I have known it to occupy and flourish on the same spot for twenty years. Horses, sheep, and cattle are very fond of it during the winter and spring; hogs reject it. Orchard, blue, or meadow-oat grass are either of them preferable to it where they thrive. Whatever doubt there may be of their thriving in a given locality, there can be no doubt of the thrift of the Terrell grass in any part of the South, however hot it may be, if the soil be made rich. The planter living in the flat and somewhat sandy portions of the South who says he cannot get a good winter pasture, has certainly never tried the Terrell grass on rich land.

(Plate 117.)

ELYMUS VIRGINICUS. (Wild Rye grass, Smooth Rye grass, Terrell grass.)

A coarse perennial grass, growing on alluvial river banks or in rich low grounds. The culm is rather stout, 2 to 3 feet high, leafy; the lower leaves are 10 to 15 inches long, broad and rough. The sheath of the upper leaf usually incloses the stock, and sometimes the base of the flower spike. This spike is erect, dense, and rigid, 2 to 4 or 5 inches long and one-half inch thick. The spikelets are two or three together at each joint, all alike and fertile, sessile, two to five flowered, and each with a pair of empty glumes. These glumes are very thick and coarse, strongly nerved, lanceolate, and bristle-pointed, about 1 inch long. The flowering glumes are of firm texture, lance-oblong, five-nerved, hairy on back, and terminating in a stiff, straight awn, half an inch to nearly an inch long. The lowest one in the spikelet having the longest awn, the others gradually shorter. The palea is oblong, obtuse, and as long as the flowering glume, excluding the awn.

This grass frequently forms a considerable portion of native meadow lands and makes a coarse hay. It starts growth early in the spring, and thus affords a good pasturage. Professor Killebrew, of Tennessee, says it is very valuable and ought to be tried in cultivation.

Professor Phares, of Mississippi, says:

This perennial grass is a native of the Southern States. As all farm stock except hogs are fond of it, and it is green through the winter and spring, it has been destroyed when grazing animals have access to it at all times. It is, however, found in many of our States along the banks of wooded streams, of ditches, and in fence-corners among briars and thickets. It will grow on thin clay, gravelly, or sandy soil, but much better on rich lands, dry or rather moist, and will thrive ten, twenty, or more years on the same land.

(Plate 118.)

*ELYMUS STRIATUS.* (Smaller Rye grass, Dennett grass).

This grass has a structure as to the flower-spike similar to the preceding, but it is a more slender grass in all its parts, varying from smooth to pubescent. The spike is 3 to 4 inches long, cylindrical, and inclined to droop. The glumes are more slender than in *E. Virginicus*, with longer awns. The spikelets are usually two-flowered, the empty glumes narrow, rigid, and about 1 inch long. The body or dilated part of the flowering glume is oblong, about four lines long, and tipped with a slender awn an inch or more in length.

This species grows in rocky woods and on river banks, growing more sparsely than the preceding, and it is said by some to furnish a good hay.

Professor Phares says of this species:

This, also, is a perennial and a native of the Southern States. Everything said of the preceding, *E. Virginicus*, applies with equal force to this, except the spikes of this are 3 to 7 inches long, and often slightly nodding. Also the spike of this species is raised by its long peduncle far above the sheath of the upper leaf, while the spike of the other is partly included in the upper sheath. They may be grazed or mown repeatedly during spring and early summer, and grow rapidly after each mowing. Many acres have been planted in the last few years. As hay it is rather hard unless cut when young. It should be cut as soon as the blooms appear or earlier. It would be preferable to have these grasses for grazing or soiling, and to sow better grasses for hay.

(Plate 119.)

*ELYMUS CONDENSATUS.* (Giant Rye grass, Western Rye grass.)

This is a perennial grass, ranging from San Diego throughout California, and into Oregon and Washington Territory, also in the Rocky Mountain region of the interior. It is very variable, but always a strong, heavy-rooted, coarse grass, from 3 to 5 or even to 12 feet high. Mr. Bolander states that it seems to do excellent service by fixing the soil on the banks of creeks and rivers. In the larger forms the culms are half an inch thick. The leaves are smooth, 2 feet long and an inch wide, or more, and the panicle 8 to 14 inches long and 1½ inches thick. As it usually occurs in arid grounds it is from 3 to 6 feet high, the leaves about a foot long and half an inch wide, and the spike-like panicle 4 to 8 inches. In the large form the branches of the panicle are subdivided and 1 or 2 inches long.

More commonly there are two to five sessile spikelets at each joint of the axis, the spikelets about three-flowered. The outer glumes are subulate or short, bristle-like. The flowering glumes are mostly coriaceous, five-nerved, rounded on the back, and acute or mucronate pointed.

There is a variety called *Triticoides*, which has a more slender, less crowded spike, the spikelets more distant, not more than two at a joint, and frequently single, the culm more slender, and the leaves narrow or involute. This variety seems to unite the genus to *Triticum*. (Plate 120.)

## GLOSSARY OF TERMS USED IN DESCRIBING GRASSES.

- Abrupt.* Terminating suddenly.
- Acuminate.* Extended into a tapering point.
- Acute.* Sharp-pointed.
- Alternate.* Situated regularly one above the other on opposite sides.
- Annual.* Living but one season.
- Anther.* The organ containing the pollen or flower dust.
- Apex.* The top or extreme end of any part.
- Appressed.* Pressed together, not spreading.
- Aristate.* Having an awn or beard.
- Articulated.* Connected by a joint or joints.
- Ascending.* Rising obliquely from the ground.
- Awl-shaped.* Gradually narrowed to a fine point like an awl.
- Awn.* A bristle-like hair proceeding from the glumes.
- Axis.* The central stem of a panicle, spike, or spikelet on which the flowers are disposed.
- Beard.* A long slender hair or awn.
- Biennial.* Living through two seasons.
- Bifid.* Divided into two portions at the apex.
- Bisexual.* Having both stamens and pistils.
- Blade.* The expanded portion of a leaf.
- Boat-shaped.* Folded together in the form of a boat, convex outwardly and concave on the inside.
- Branch.* A division of the stem or panicle.
- Branchlet.* A secondary division of the branch.
- Bristles.* Short, stiff hairs.
- Bulbous.* Thickened like a bulb.
- Cæspitose.* Growing in bunches or tufts.
- Capillary.* Hair-like, very slender.
- Cartilaginous.* Firm and tough like cartilage.
- Carinate.* Keeled, having a prominent ridge in the center.
- Cauline.* Belonging to the culm or stem.
- Chaff.* The dried glumes and paleas of grasses.
- Chartaceous.* The texture resembling paper or parchment in thickness.
- Ciliate.* Having the margin or nerves fringed with hairs.
- Compressed.* Flattened laterally.
- Contorted.* Twisted.
- Convolute.* Rolled together inward from the margins.
- Cornaceous.* Of a horn-like consistence.
- Coriaceous.* Of a leathery consistence.
- Culm.* The stalk or stem of grasses.
- Cuspidate.* Ending in a sharp, stiff point.
- Decumbent.* Reclining on the ground, but rising at the top.
- Dichotomous.* Branching in twos, forking by pairs.
- Digitate.* Dividing from a common point.
- Dioecious.* Having the stamens and pistils on separate plants, the staminate flowers on one and pistilate flowers on another.
- Diverging.* Widely spreading.
- Dorsal.* Belonging to or growing from the back.
- Emarginate.* Having a notch at the end.
- Entire.* Without notches or divisions.
- Equal.* Alike in length.
- Eserted.* Protruded, extended beyond, standing out.

- Fertile.* Having perfect pistils, producing fruit.
- Fibrous.* Having thread-like divisions.
- Filament.* The stalk or support of the anther.
- Filiform.* Thread-like.
- Flexuous.* Bending freely.
- Floret.* The flowers of grasses are sometimes called florets.
- Foliaceous.* Resembling a leaf.
- Fusiform.* Spindle-shaped, largest in the middle and tapering to both ends.
- Geniculate.* Bent abruptly at an angle, like a knee.
- Genus.* A group of species having a general agreement in structure.
- Glabrous.* Smooth, without hairs or roughness.
- Glaucous.* Having a light bluish-green color.
- Glomerate.* Clustered in small roundish heads.
- Glumes.* The chaff-like leaves forming a part of the flowers.
- Herbaceous.* Herb-like, not woody.
- Hirsute.* Pubescent, with rather stiff and coarse hairs.
- Hyaline.* Thin and transparent.
- Indigenous.* Growing naturally, not brought from some other country.
- Inferior.* Lower in position.
- Inserted.* Growing out of, or upon another.
- Internode.* The space between two nodes or joints.
- Involute.* Rolled together inwards.
- Imbricate.* Closely overlapping each other, as frequently the flowers of a spikelet.
- Joints.* Thickenings in the stem where the leaves originate; separable parts of an axis; point of issue of the branches of a panicle.
- Keel.* An elevated longitudinal ridge, in the middle of a leaf, glume, or palet; resembling the keel of a boat.
- Lamina.* The free or expanded portion of a leaf, as distinguished from the petiole or the sheath; the blade of a leaf.
- Lanceolate.* Tapering gradually to the apex, like a lancet.
- Lateral.* At or from the side.
- Ligule.* A tongue-like appendage at the upper part of the sheath of a leaf.
- Line.* The twelfth part of an inch.
- Linear.* Long and narrow, with parallel sides.
- Lobe.* Some division of a glume.
- Male flower.* A flower that has stamens, but without pistil.
- Membranaceous.* Thin like a membrane, generally somewhat translucent.
- Monœcious.* With stamens and pistils.
- Midrib.* The central and principal nerve of a leaf or glume.
- Mucronate.* Abruptly tipped with a short awn or bristle.
- Nerves.* The ribs or veins of a leaf, or leaf-like organ.
- Neutral.* Having neither stamens nor pistils.
- Nodes.* Knots or thickened portions in the culms.
- Oblong.* Longer than wide, with nearly parallel sides.
- Obovate.* Egg-shaped, with the wider end uppermost.
- Obtuse.* Blunt or rounded at the apex.
- Oval.* Broadly elliptical, approaching the round form.
- Ovary.* That part of the pistil which contains the seed.
- Ovate.* Egg-shaped.
- Palet or palea.* The inner scale or chaff of the proper flower, placed nearly opposite and a little higher on the axis than the flowering glume.
- Panicle.* A branched and subdivided stem bearing the flowers.
- Pedicel.* A small branchlet supporting a spikelet.
- Peduncle.* The main stem or stalk of a flower spike.
- Perennial.* Living more than two years, or indefinitely.



*Perfect.* Having both stamens and pistils.

*Petiole.* The stem of a leaf.

*Pistil.* The central or female organ of a fertile flower.

*Pistillate.* Having only pistils without stamens.

*Plumose.* Feather-like.

*Pollen.* The powder contained in the anthers.

*Pubescent.* Clothed with short and soft hairs.

*Radical leaves.* Those growing from the base of the culm.

*Revolute.* Rolling backwards or outwards.

*Rhachis.* The axis or stem on which the flowers of a spikelet are arranged ; also the common axis of a close spike or of a panicle.

*Rhizoma or rootstock.* A horizontal underground stem.

*Ribs.* Prominent nerves of the leaves or glumes.

*Rugose.* Wrinkled or furrowed.

*Scabrous.* Rough, with small points or hairs.

*Scarious.* Dry and thin, and generally transparent.

*Sericeous.* Covered with soft, silky hairs.

*Serrate.* Having teeth on the margin, pointed toward the apex.

*Serrulate.* Finely-toothed.

*Sessile.* Without a foot stalk or pedicel.

*Setaceous.* Like a bristle.

*Sheath.* That part of the leaf which embraces the culm or stalk.

*Spike.* A collection of sessile or nearly sessile flowers on a close, narrow axis.

*Spikelet.* A flower or cluster of flowers having one pair of outer glumes.

*Stamen.* The male organs of a flower, including the anther and filament.

*Staminate.* Having only stamens.

*Sterile.* Imperfect flowers not producing seed.

*Strict.* Erect and close.

*Stoloniferous.* Sending off offshoots or runners from the base.

*Strigose.* Having spreading, bristly hairs.

*Subulate.* Stiff and linear, shaped like an awl.

*Succulent.* Fleshy and juicy.

*Style.* That portion of the pistil bearing stigmas or a stigmatic surface ; in grasses often branching.

*Truncate.* Abruptly cut off at the apex.

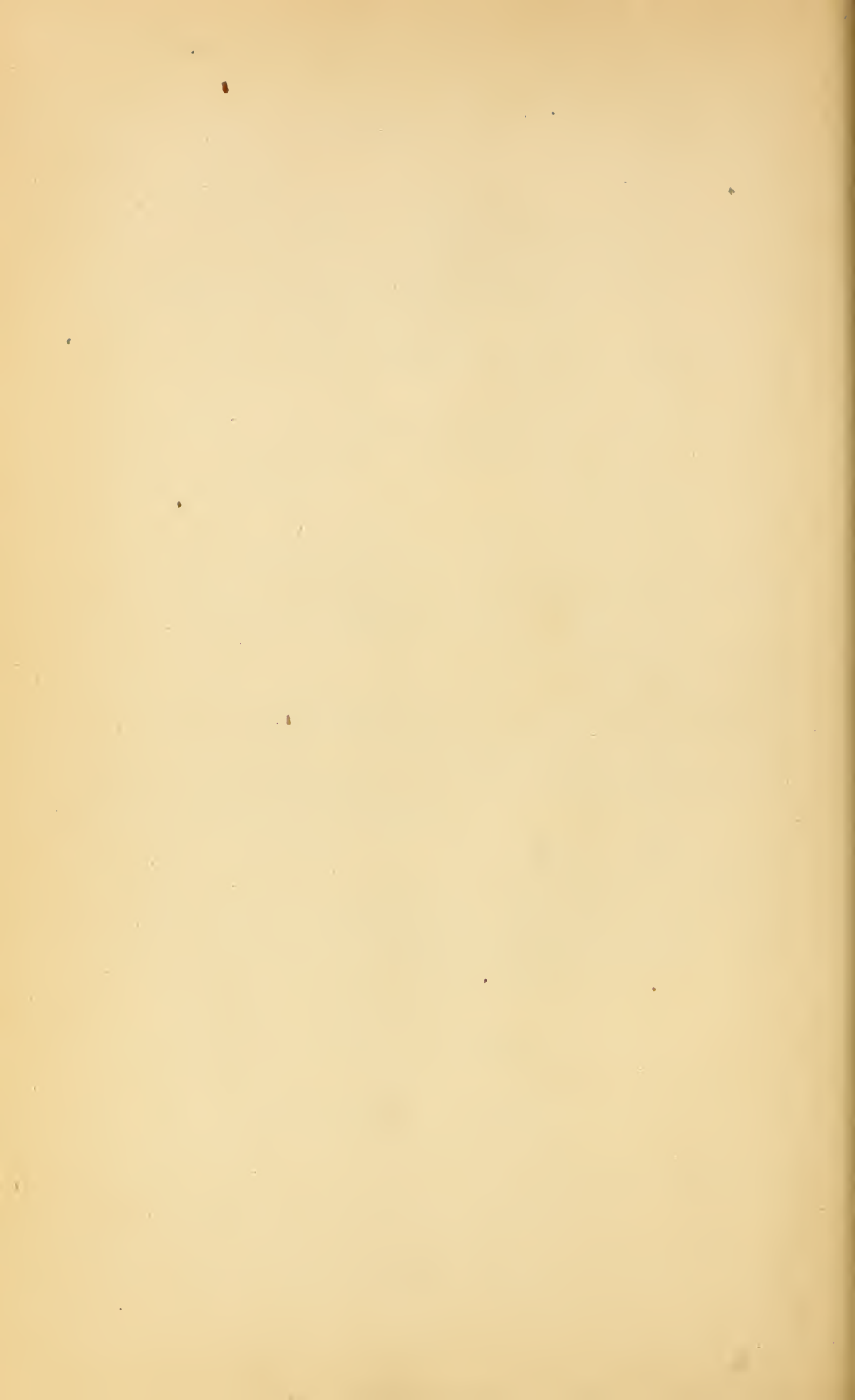
*Unequal.* Not of equal length.

*Verticillate.* Arranged in a whorl or whorls.

*Villous.* Velvety, clothed thickly with long, soft hairs.

*Whorl.* A number of leaves or branches arranged around a stem on the same plane.

*Wooly.* Clothed with long and matted hairs.



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THE CHEMICAL COMPOSITION

OF

AMERICAN GRASSES

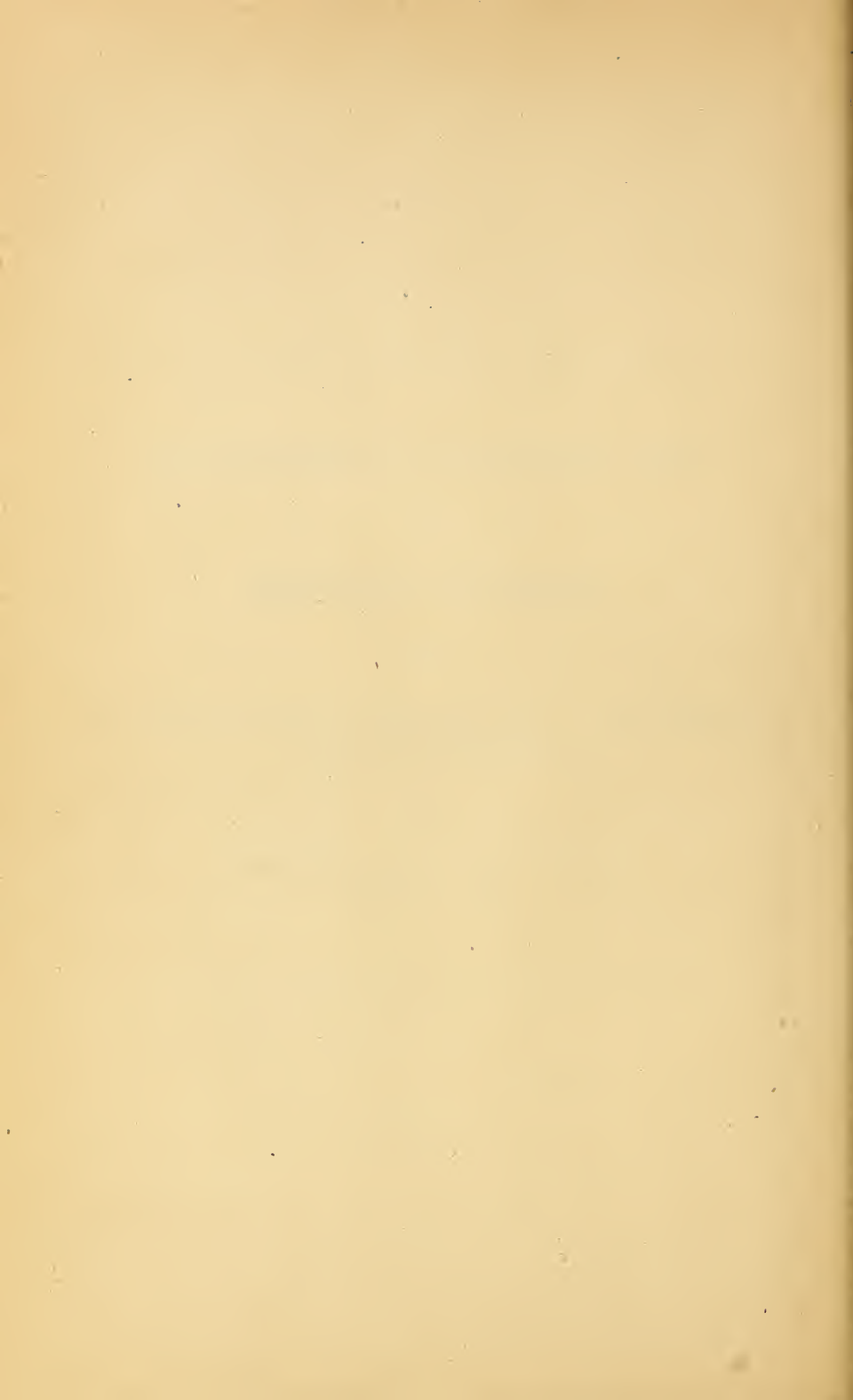
FROM

INVESTIGATIONS IN THE LABORATORY OF THE DEPARTMENT OF  
AGRICULTURE. 1878-1882.

BY

CLIFFORD RICHARDSON,  
ASSISTANT CHEMIST.

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## THE CHEMICAL COMPOSITION OF AMERICAN GRASSES.

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In submitting grasses to chemical analysis, with a view of judging of their nutritive value, it is usual to determine the amount present of water, ash, fat or oil, fiber and nitrogen. From the latter the amount of albuminoids to which it is equivalent is readily calculated by multiplying by a factor which represents the per cent. of nitrogen present in the average albuminoid, and by subtracting the sum of all these constituents from one hundred, the percentage of undetermined matter is obtained, and as it of course contains no nitrogen, and consists of the extractive principles of the plant, it is described as "Nitrogen free extract." It includes all the carbo-hydrates, such as sugar, starch, and gum, together with certain other allied substances, with which we are less intimately acquainted, but which have a certain nutritive value.

Although it has been customary to state as albuminoids the equivalent of the nitrogen found, this is rarely entirely correct, as a portion is generally present in a less highly elaborated form of a smaller nutritive value. This portion is described as non-albuminoid nitrogen, and in analyses of the present day the amount is always given as an additional source of information, although our knowledge of its exact value to the animal is rather uncertain.

The ultimate composition of the ash is also frequently determined, and examples of the results obtained are of interest, as showing the mineral matter that grasses withdraw from the soil.

Without entering into a discussion of the nutritive value of the several constituents of the grasses, for which reference can be made to Armsby's Manual of Cattle Feeding, it is sufficient to say that during the past few years the greater portion of the species described by Dr. Vasey in the preceding portion of this bulletin have been analyzed, and the results collected and rearranged, with some corrections, from the annual reports of the Department are presented in the following pages.

The first series consists of analyses made with specimens collected at or near the time of blooming. Their origin is as follows:

No. of anal.

1. *Paspalum laeve* (Water grass). From Prof. S. B. Buckley, Austin, Tex. 1878.
2. *Paspalum laeve* (Water grass). From the Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. 1880, August 23-29.
3. *Paspalum ovatum*. From S. L. Goodale, Saco, Me. 1880.
4. *Paspalum praecox*. From Charles Mohr, Mobile, Ala. 1879.
5. *Digitaria filiforme*. From Charles Mohr, Mobile, Ala. 1878.

## No. of anal.

6. *Digitaria sanguinalis* (Crab grass). From Charles Mohr, Mobile, Ala. 1878.
7. *Digitaria sanguinalis* (Crab grass). From the grounds of the Department. June 23, 1880.
8. *Digitaria sanguinalis* (Crab grass). From the Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. August 11, 1880.
9. *Panicum jumentorum*. From Charles Mohr, Mobile, Ala. 1878.
10. *Panicum Texanum* (Texas millet). From Prof. S. B. Buckley, Austin, Tex. 1879.
11. *Panicum proliferum* (Large Crab grass). "Very ripe and rank." From Charles Mohr, Mobile, Ala. 1879.
12. *Panicum agrostoides* (Marsh panic). From W. S. Robertson, Muscogee, Ind. T. 1879.
13. *Panicum anceps*. From Charles Mohr, Mobile, Ala. 1879.
14. *Panicum anceps*. From the Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. July 31, 1880.
15. *Panicum crus-galli* (Barn-yard grass). From Charles Mohr, Mobile, Ala. 1879.
16. *Panicum crus-galli* (Barn-yard grass). From Prof. S. B. Buckley, Austin, Tex.
17. *Panicum crus-galli* (Cock's foot). From the Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. August 25, 1880.
18. *Panicum virgatum* (Panic grass). From W. S. Robertson, Muscogee, Ind. T. 1879. Low growth.
19. *Panicum virgatum* (Tall panic or switch grass). From Prof. S. B. Buckley, Austin, Tex. 1878.
20. *Panicum virgatum* (Tall panic or switch grass). From Charles Mohr, Mobile, Ala. 1878.
21. *Panicum virgatum* (Tall panic or switch grass). From W. S. Robertson, Muscogee, Ind. T. 1879. Tall growth.
22. *Panicum divaricatum*. From Charles Mohr, Mobile, Ala. 1879.
23. *Panicum gibbum*. From Charles Mohr, Mobile, Ala. 1879.
24. *Panicum obtusum*. From Prof. S. B. Buckley, Austin, Tex. 1878.
25. *Panicum capillare* (Witch grass). From W. S. Robertson, Muscogee, Ind. T. 1879.
26. *Panicum dichotomum*. From Charles Mohr, Mobile, Ala. 1879.
27. *Setaria italica*. From the Eastern Experiment Farm, West Grove, Chester County Pennsylvania. July 24, 1880.
28. *Setaria glauca* (Foxtail). From the grounds of the Department. July 24, 1880.
29. *Setaria glauca* (Foxtail). From the Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. August 11, 1880.
30. *Setaria setosa* (Bristle grass). From Prof. S. B. Buckley, Austin, Tex. 1878.
31. *Tripsacum dactyloides* (Gama grass). From D. L. Phares, Woodville, Miss. 1878.
32. *Tripsacum dactyloides* (Gama grass). From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. 1880.
33. *Spartina cynosuroides* (Whip grass). From A. C. Lathrop, Glenwood, Pope County, Minnesota. 1879.
34. *Spartina cynosuroides* (Whip grass). From J. D. Waldo, Quincy, Ill. 1879.
35. *Spartina cynosuroides* (Whip grass). From W. S. Robertson, Muscogee, Ind. T. 1879.
36. *Andropogon Virginicus* (Brown sedge, Sedge grass). From Prof. S. B. Buckley, Austin, Tex. 1878.
37. *Andropogon scoparius*. From Charles Mohr, Mobile, Ala. 1879. Before bloom.
38. *Andropogon scoparius* (Broom grass). From Charles Mohr, Mobile, Ala. 1878.
39. *Andropogon scoparius*. From W. S. Robertson, Muscogee, Ind. T. 1879.
40. *Andropogon macrourus* (Broom grass). From Charles Mohr, Mobile, Ala.
41. *Andropogon furcatus* (Blue joint grass). From A. C. Lathrop, Glenwood, Pope County, Minnesota. 1879.

No. of anal.

42. *Andropogon furcatus* (Blue joint). From D. H. Wheeler, Nebraska. 1879.
43. *Andropogon furcatus* (Blue joint). From W. S. Robertson, Muscogee, Ind. T. 1879.
44. *Andropogon furcatus* (Blue joint grass). From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. September 2, 1880.
45. *Andropogon argenteus* (Silver Beard grass). From W. S. Robertson, Muscogee Ind. T. 1880.
46. *Sorghum halapense* (Johnson grass.) From Charles Mohr, Mobile, Ala. 1878.
47. *Sorghum nutans*. From W. S. Robertson, Muscogee, Ind. T. 1879.
48. *Sorghum nutans* (Wood grass). From Prof. S. B. Buckley, Austin, Tex. 1878.
49. *Phalaris intermedia*, var. *angusta* (American Canary grass). From South Carolina, 1879.
50. *Anthoxanthum odoratum*. (Sweet Vernal grass). From James O. Adams, Manchester, N. H. 1879.
51. *Anthoxanthum odoratum* (Sweet Vernal grass). From the Eastern Experimental Farm, West Grove, Chester County, Pennsylvania. May 11-24, 1880.
52. *Anthoxanthum odoratum* (Sweet Vernal grass). From the grounds of the Department. May 1, 1880.
53. *Hierochloa borealis* (Vanilla grass). From E. Hall, Athens, Ill. 1878.
54. *Alopecurus pratensis* (Meadow foxtail). From the grounds of the Department. May 1, 1880.
55. *Aristida perpurascens* (Purple Beard grass). From W. S. Robertson, Muscogee, Ind. T.
56. *Milium effusum*. From C. G. Pringle, Hazen's Notch, Vt. 1880.
57. *Muhlenbergia diffusa* (Drop-seed grass). From Prof. S. B. Buckley, Austin, Tex. 1878.
58. *Muhlenbergia diffusa* (Drop-seed grass). From Eastern Experimental Farm, West Grove, Chester County, Pennsylvania. Aug. 25, 1880.
59. *Muhlenbergia Mexicana*. From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. Aug. 22, 1880.
60. *Muhlenbergia glomerata* (Satin grass). From A. C. Lathrop, Glenwood, Pope County, Minnesota. 1879.
61. *Muhlenbergia* sp? (Knot grass). From James O. Adams, Manchester, N. H. 1879. 1879.
62. *Phleum pratense* (Timothy, Herd grass). From the grounds of the Department. June 18, 1880.
63. *Phleum pratense* (Timothy). From the grounds of the Department. Wayside growth. June 4, 1880.
64. *Phleum pratense* (Timothy). From the grounds of the Department. June 26, 1882. First year's growth from seed.
65. *Phleum pratense* (Timothy). From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. June 20, 1880.
66. *Phleum pratense* (Timothy, Herd grass). From J. W. Sanborn, Hanover, N. H. 1881.
67. *Phleum pratense* (Timothy). From W. H. Hackstaff, La Fayette, Ind. 1882.
68. *Phleum pratense* (Timothy). From J. M. Robinson, Queen Anne County, Maryland. July 4, 1882. Unmanured for years.
69. *Sporobolus Indicus* (Sweet grass). From D. L. Phares, Woodville, Miss. 1878.
70. *Agrostis vulgaris* (Red Top, Herd grass). From the grounds of the Department. June 23, 1880.
71. *Agrostis vulgaris* (Red Top). From the grounds of the Department. Wayside growth. June 18, 1880.
72. *Agrostis vulgaris* (Herd grass). From the Eastern Experimental Farm, West Grove Chester County, Pennsylvania.
73. *Agrostis vulgaris* (Red Top). From J. J. Rosa, Milford, Del.

No. of anal.

74. *Agrostis exarata* (Native Red Top). From Theo. Louis, Louisville, Wis. 1878.
75. *Cinna arundinacea* (Reed grass). From W. S. Robertson, Muscogee, Ind. T.
76. *Holcus lanatus* (Velvet grass). From the grounds of the Department. May 25, 1880.
77. *Avena striata* (Mountain Oat grass). From Cyrus G. Pringle, Charlotte, Vt. 1879.
78. *Arrhenatherum avenaceum* (Oat grass). From the grounds of the Department. May 25, 1880.
79. *Arrhenatherum avenaceum* (Oat grass). From Dr. W. C. Benbow, Greensboro', N. C. Late bloom. May 12, 1880.
80. *Danthonia spicata* (Wild Oat grass). From James O. Adams, Manchester, N. H. 1879.
81. *Danthonia compressa* (Wild Oat grass). From Cyrus G. Pringle, Charlotte, Vt. 1874.
82. *Cynodon dactylon* (Bermuda grass). From Charles Mohr, Mobile, Ala. 1878.
83. *Cynodon dactylon* (Bermuda grass). From D. L. Phares, Woodville, Miss. 1878.
84. *Bouteloua oligostachya* (Gamme grass). From A. C. Lathrop, Glenwood, Pope County, Minnesota. 1879.
85. *Eleusine Indica* (Yard grass, Crow-foot grass). From Prof. S. B. Buckley, Austin, Tex.
86. *Eleusine Indica* (Yard grass, &c.). From Dr. W. A. Creswell, Americus, Ga. 1878.
87. *Eleusine Indica* (Yard grass, &c.). From Charles Mohr, Mobile, Ala. 1878.
88. *Leptochloa mucronata* (Feather grass). From Prof. S. B. Buckley, Austin, Tex. 1878.
89. *Triodia purpurea* (Sand grass). From W. S. Robertson, Muscogee, Ind. T. 1879.
90. *Triodia seslerioides* (Tall Red Top). From Prof. S. B. Buckley, Austin, Tex. 1878.
91. *Uniola latifolia* (Fescue grass). From Charles Mohr, Mobile, Ala. 1879.
92. *Uniola latifolia* (Fescue grass). From M. S. Robertson, Muscogee, Ind. T. 1879.
93. *Dactylis glomerata* (Orchard grass). From James O. Adams, Manchester, N. H. 1879.
94. *Dactylis glomerata* (Orchard grass). From the grounds of the Department, May 13, 1880. First growth.
95. *Dactylis glomerata* (Orchard grass). From the grounds of the Department, June 18, 1880. Later growth.
96. *Dactylis glomerata* (Orchard grass). From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. 1880.
97. *Dactylis glomerata* (Orchard grass). From W. H. Cheek, Warren County, North Carolina. Early bloom. May 16, 1880.
98. *Dactylis glomerata* (Orchard grass). From Dr. W. C. Benbow, Greensboro', N. C. 1880. Early bloom, May 12.
99. *Dactylis glomerata* (Orchard grass). From S. L. Goodale, Saco, Me. 1880.
100. *Poa pratensis* (Blue grass, June grass). From Theo. Louis, Louisville, Wis. 1873.
101. *Poa pratensis* (Blue grass, &c.). From James O. Adams, Manchester, N. H. 1879.
102. *Poa pratensis* (Blue grass, &c.). From the grounds of the Department. May 28, 1880. Growth from best soil.
103. *Poa pratensis* (Blue grass, &c.). From the grounds of the Department. May 8, 1880. Growth from poorer soil.
104. *Poa pratensis* (Blue grass, &c.). From the grounds of the Department. May 19, 1880. Growth by wayside.
105. *Poa pratensis* (Blue grass, &c.). From J. D. Waldo, Quincy, Ill. May 17, 1880.
106. *Poa pratensis* (Blue grass, &c.). From W. B. Cheek, Warren County, North Carolina. 1880. Before bloom.



No. of anal.

107. *Poa pratensis* (Blue grass, &c.). From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. 1880.
108. *Poa compressa* (English Blue grass, Wire grass). From James O. Adams, Manchester, N. H. 1879.
109. *Poa compressa* (English Blue grass). From the grounds of the Department. June 17, 1880.
110. *Poa compressa* (English Blue grass). From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. June 10, 1880.
111. *Poa compressa* (English Blue grass). From J. J. Rosa, Milford, Del. June 6, 1880.
112. *Poa serotina* (Fowl-meadow grass, False red top). From Theo. Louis, Louisville, Wis. 1878.
113. *Poa arachnifera*. From Ellis County, Texas. 1882.
114. *Poa alsodes*. From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. June 2, 1880.
115. *Glyceria aquatica* (Reed Meadow grass). From Cyrus G. Pringle, Charlotte, Vt. 1879.
116. *Glyceria nervata* (Fowl Meadow grass). From Cyrus G. Pringle, Charlotte, Vt. 1879.
117. *Glyceria nervata* (Fowl Meadow grass). From James O. Adams, Manchester, N. H. 1879.
118. *Glyceria nervata* (Fowl Meadow grass). From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. June 2, 1880.
119. *Festuca orina* (Sheep's Fescue). From James O. Adams, Manchester, N. H. 1879.
120. *Festuca orina* (Sheep's Fescue). From the grounds of the Department. May 21, 1880.
121. *Festuca elatior* (Meadow Fescue). From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania. June 2, 1880.
122. *Festuca pratensis* (Meadow Fescue). From James O. Adams, Manchester, N. H. 1879.
123. *Festuca pratensis* (Field Fescue). From the grounds of the Department. June 1, 1880. After bloom.
124. *Bromus secalinus* (Cheat or Chess). From James O. Adams, Manchester, N. H. 1879.
125. *Bromus unioloides* (Schrader's grass). From the grounds of the Department. 1879.
126. *Bromus unioloides* (Schrader's grass). From the grounds of the Department. May 13, 1880.
127. *Bromus erectus* (Chess). From the grounds of the Department. May 19, 1880.
128. *Bromus carinatus* (California Brown grass). From E. Hall, Athens, Ill. 1878.
129. *Lolium perenne* (Common Darnel, Ray, or Rye grass). From the grounds of the Department. June 1, 1880.
130. *Lolium perenne* (Rye grass, &c.). From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania.
131. *Lolium italicum* (Italian Rye grass). From the grounds of the Department. May 26, 1882.
132. *Agropyrum repens* (Couch, Quitch, or Quick grass). From James O. Adams, Manchester, N. H. 1879.
133. *Agropyrum repens* (Couch grass, &c.). From Eastern Experiment Farm, West Grove, Chester County, Pennsylvania.
134. *Agropyrum repens* (Couch grass). From S. L. Goodale, Saco, Me. 1880.
135. *Agropyrum repens* (Couch grass, &c.). From the grounds of the Department. June 23, 1880. Early bloom.
136. *Elymus canadensis* (Wild Rye grass). From D. H. Wheeler, Nebraska. 1879.

The specimens, it will be seen, are from all parts of the country and grown under every condition of soil and environment. Those collected by Dr. Peter Collier in 1878 and 1879 were mostly from the poorer soils and were intended to represent the wild grasses of the country. Those collected in subsequent years by myself were chiefly cultivated varieties. The development in nearly every case was full bloom or shortly after, that being the period at which the grasses as a whole seem to be cut for hay.

The analyses have been calculated for "dry substance" and also for "fresh grass" where the amount of water in the fresh grass had been determined, otherwise for the average amount of water in hay as given by Wolff. This figure is probably too high for the United States owing to our drier climate, but, in the absence of exact data for the selection of a more accurate one, it has been provisionally accepted. It is very easily to calculate from the composition of the dry substance what effect the presence of any percentage of water would have on the absolute amount of any constituent present in a given weight of grass.

No. of analysis.	Sp.imen No.	Date cut.	Locality.	Height.	Dry substance.					Fresh substance or hay.					
					Crude fiber.	Nitrogen free extract.	Aluminoids.	Total nitrogen.	Non-aluminoid.	Per cent. of nitrogen as non-aluminoid.	Water.	Ash.	Fat.	Nitrogen free extract.	Crude fiber.
1	1	1878	Cal.	..	7.70	57.35	38.61	8.11	1.30	29.17	14.30	6.60	46.12	23.66	6.95
2	2	1880	Cal.	..	9.90	59.27	23.50	8.17	1.31	28.00	14.30	6.91	50.80	20.11	7.00
3	3	Aug. 23-9	Cal.	..	8.49	58.12	24.75	8.13	1.31	26.56	14.30	7.59	50.47	19.12	5.55
4	4	1878	Cal.	..	7.41	57.75	25.31	8.95	1.30	26.20	14.30	6.45	49.19	16.69	5.08
5	5	1878	Cal.	..	8.76	60.95	25.83	8.98	1.48	26.00	14.30	7.57	52.12	16.61	4.85
6	6	1878	Cal.	..	12.61	42.70	32.09	8.72	1.57	25.15	14.30	10.81	36.59	17.40	8.38
7	7	Aug. 23, 80	D. C.	55	13.01	37.99	33.63	13.13	3.70	32.6	76.30	3.33	33.8	1.47	5.14
8	8	Aug. 11, 80	Pa.	..	11.45	50.56	22.90	11.83	1.89	42.6	14.30	6.18	33.3	19.63	10.14
9	9	1878	Pa.	..	9.04	48.98	31.52	8.89	1.42	27.1	14.30	7.73	41.98	27.01	7.62
10	10	1878	Tex.	..	11.17	54.93	27.02	5.18	1.88	33.37	14.30	8.63	27.12	47.07	1.70
11	11	1879	Ala.	..	3.01	50.97	24.07	11.68	1.77	33.7	11.30	9.58	25.38	20.63	9.19
12	12		Ind. T.	..	6.69	50.87	30.86	5.89	1.94	39.11	11.30	7.73	43.52	26.43	5.05
13	13		Ala.	..	9.05	55.50	27.84	5.78	1.92	21.0	11.30	7.76	47.56	27.89	1.95
14	14	July 31	Pa.	..	5.68	62.59	20.88	9.03	1.11	44.30	11.30	8.71	53.61	17.80	7.71
15	15		Ala.	..	6.98	51.19	28.91	7.77	2.1	36.5	11.30	9.88	41.16	24.78	9.9
16	16		Tex.	..	16.07	46.77	31.13	3.99	1.61	15.23	14.30	13.77	40.08	26.68	3.42
17	17	Aug. 25	Pa.	..	11.82	2.49	47.77	25.32	12.60	2.02	14.30	10.13	40.45	21.69	10.80
18	18		Ind. T.	..	5.49	3.33	56.95	20.11	5.12	1.00	14.30	1.70	2.82	18.81	4.39
19	19		Tex.	..	7.21	1.66	49.39	36.78	4.93	7.8	14.30	6.21	14.2	33.53	4.23
20	20		Ala.	..	3.74	1.92	60.95	28.82	4.57	7.3	14.30	3.20	1.65	52.23	3.92
21	21		Ind. T.	..	1.57	98	57.40	32.25	2.80	1.15	14.30	3.92	5.5	49.19	2.40
22	22		Ala.	..	11.29	2.32	46.89	27.06	3.21	1.48	14.30	12.95	2.16	40.18	7.92
23	23	1878	Ala.	..	8.35	4.16	50.33	33.12	1.96	8.3	14.30	7.31	3.46	43.65	10.17
24	24		Tex.	..	3.25	46.44	33.12	7.24	1.16	65	14.30	9.38	1.93	39.80	6.21
25	25		Ind. T.	..	5.39	3.89	55.30	28.21	6.98	1.12	14.30	4.89	3.31	47.39	3.98
26	26		Ala.	..	10.13	3.55	50.07	29.48	6.77	1.68	14.30	6.68	3.01	42.91	5.80
27	27	July 24	Pa.	..	2.71	53.78	21.52	9.19	1.52	5.1	14.30	6.43	3.22	47.80	8.13
28	28	July 24	D. C.	..	7.27	2.66	55.28	25.75	9.04	1.41	68.40	2.30	8.1	17.47	8.76
29	29	Aug. 11	Pa.	..	7.94	3.06	58.54	21.94	8.52	1.36	28.7	6.80	2.62	50.18	7.30
30	30		do	..	9.08	1.49	48.64	32.30	8.49	1.41	14.30	7.78	1.28	41.68	2.68
31	31		Miss.	..	6.19	2.39	56.31	26.51	8.60	1.37	14.30	5.30	2.65	48.29	7.28
32	32	Aug. 11	Pa.	..	5.34	4.60	80	22.45	7.91	1.27	14.30	4.58	2.97	52.11	6.80
33	33		Min.	..	7.23	3.43	53.76	25.79	9.81	1.57	14.30	6.19	2.93	46.67	8.41
34	34		Ill.	..	6.55	2.96	61.12	22.89	6.18	1.01	11.30	6.5	2.54	52.98	5.55

No. of analysis.	Specimen No.	Date cut.	Locality.	Height.	Dry substance.							Fresh substance or hay.						
					Ash.	Fat.	Nitrogen free extract.	Crude fiber.	Albuminoids.	Total nitrogen.	Non-albuminoid.	Per cent of nitrogen non-albuminoid.	Water.	Ash.	Fat.	Nitrogen free extract.	Crude fiber.	Albuminoids.
35			Ind. T.	.....	5.20	3.40	59.32	27.20	4.88	.78	.45	57.5	14.30	4.46	2.91	50.84	23.31	4.18
36			Tex.	.....	7.11	1.67	55.92	33.08	3.00	.48	.12	24.4	14.30	8.00	1.43	43.35	28.35	5.57
37			Ala.	.....	9.33	1.85	52.92	29.07	6.45	1.04	.26	24.7	14.30	6.09	1.59	47.58	24.91	4.84
38			Ala.	.....	5.84	1.58	62.29	24.64	5.65	2.90	1.64	56.6	14.30	5.00	1.35	53.39	21.12	4.84
39			Ind. T.	.....	4.46	3.19	58.37	29.84	4.14	.66	.39	59.7	14.30	3.82	2.18	50.03	25.57	3.55
40			D. C.	.....	3.74	2.52	58.20	29.75	5.77	.92	.44	57.1	14.30	3.21	2.18	49.87	25.50	4.94
41			D. C.	.....	5.09	3.02	58.19	25.65	8.05	1.29	.63	33.9	14.30	4.36	2.18	49.87	21.98	6.90
42			Nebr.	.....	7.86	2.10	58.46	26.26	5.32	.85	.32	37.5	14.30	6.74	1.80	50.10	22.50	4.56
43			Ind. T.	.....	4.08	3.19	57.60	31.18	3.95	.63	.33	52.5	14.30	3.50	2.73	49.36	26.72	3.39
44			do.	.....	13.53	2.47	51.97	27.04	4.99	.80	.09	11.2	14.30	11.60	2.12	44.53	23.17	4.28
45			Ind. T.	.....	3.63	3.06	64.19	25.39	3.73	.60	.36	60.7	14.30	3.11	2.62	55.01	21.76	3.20
46			Ala.	.....	8.07	2.84	52.24	25.05	11.80	1.89	.76	40.0	14.30	6.92	2.43	44.77	21.47	10.11
47			Sorghum halapense.	.....	5.21	2.54	59.75	28.62	3.88	.62	.33	52.5	14.30	4.46	2.18	44.12	30.58	3.32
48			Ind. T.	.....	9.17	1.63	50.32	35.68	3.20	.51	.21	41.2	14.30	7.86	1.40	43.12	30.58	2.74
49			do.	.....	11.66	4.11	43.44	24.84	15.95	2.55	.52	38.1	14.30	9.99	3.52	37.23	21.29	13.67
50			Phalaris angusta	.....	8.43	3.41	53.81	25.79	8.56	1.37	.62	35.9	14.30	7.22	2.54	46.46	21.85	7.34
51			do.	.....	5.83	2.97	51.21	25.49	11.50	1.84	.66	38.1	14.30	5.00	2.54	46.46	21.85	9.85
52			Anthoxanthum odoratum	.....	7.00	3.36	59.45	26.63	9.47	1.52	.15	9.9	78.80	5.00	2.54	46.46	21.85	7.34
53			do.	.....	9.22	1.06	49.45	23.02	14.15	2.27	.86	37.7	14.30	7.99	3.48	42.38	19.73	12.12
54			Hierochloa borealis	.....	7.75	3.36	54.30	23.78	10.81	1.73	.00	0	69.00	3.10	1.34	21.72	9.51	4.33
55			Alopecurus pratensis	.....	6.85	2.39	61.36	24.88	4.32	.69	.20	29.7	14.30	5.81	2.22	52.50	21.32	3.70
56			Aristida purpurascens	.....	9.28	3.87	46.33	24.55	13.37	2.64	.70	28.8	14.30	7.95	1.52	39.69	21.05	13.69
57			Milium effusum	.....	9.28	1.81	55.35	23.56	10.00	1.60	.63	39.2	14.30	7.95	1.52	47.44	20.19	8.57
58			Muhlenbergia diffusa.	.....	16.40	3.43	47.35	21.94	10.88	1.74	.29	17.0	14.30	14.06	2.94	40.58	18.80	4.32
59			do.	.....	4.33	2.69	65.47	22.69	4.82	.77	.18	53.4	14.30	3.71	2.30	56.11	19.45	4.13
60			Muhlenbergia Mexicana	.....	15.02	5.77	41.21	17.68	20.32	3.25	.93	28.5	14.30	12.87	4.94	35.32	13.15	17.42
61			Muhlenbergia glomerata	.....	6.34	3.73	53.76	22.77	13.40	2.15	.88	34.0	14.30	5.86	3.20	46.07	19.52	11.48
62			Muhlenbergia sp. [?]	.....	5.66	3.58	58.93	21.93	9.90	1.58	.38	27.2	14.30	1.86	1.17	49.33	7.19	3.25
63			Phleum pratense.	.....	6.16	3.95	57.48	23.53	8.48	1.36	.30	22.0	63.40	2.40	1.45	21.04	8.61	3.10
64			do.	.....	7.16	4.47	50.03	27.35	10.99	1.75	.51	29.1	66.75	2.38	1.49	16.64	9.09	3.65
65			do.	.....	5.05	3.22	57.22	25.39	9.12	1.44	.41	28.5	14.30	3.32	2.77	48.96	21.72	4.96
66			do.	.....	4.57	4.20	57.16	28.28	5.79	.93	.10	10.8	14.30	3.92	3.60	48.99	24.23	4.73
67			do.	.....	7.05	2.18	52.99	32.26	5.52	.88	.00	0	14.30	6.04	1.87	45.41	27.65	4.73
68			do.	.....	4.93	4.92	52.73	30.43	7.69	1.23	.15	12.2	64.00	1.78	1.48	19.02	10.98	2.74
69			Sporobolus indicus	.....	7.04	3.27	51.67	25.67	12.35	1.98	.57	28.7	14.30	6.03	2.80	44.28	22.00	10.55

70	<i>Agrostis vulgaris</i> .....	70	June 23	D. C.	45	7.27	2.87	56.82	22.02	11.02	1.76	.53	30.1	61.40	2.81	1.11	21.93	8.50	4.29
71	do.....	71	June 18	D. C.	58.8	6.84	3.30	58.49	20.42	9.95	1.69	.32	50.7	58.8	2.90	2.84	24.10	8.41	4.11
72	do.....	72	July 1	Pa.	6.88	3.31	54.58	25.33	9.90	1.68	.80	.80	26.7	14.30	5.60	2.81	46.77	21.71	8.48
73	do.....	73	1882.	D. C.	6.53	3.54	56.80	21.68	11.25	1.70	.45	.45	25.3	14.30	5.60	1.97	48.53	18.75	9.64
74	<i>Agrostis exarata</i> .....	74	Wis.	D. C.	5.95	2.30	56.63	24.51	10.61	1.80	.40	.40	26.3	14.30	5.73	1.97	48.53	21.01	9.09
75	<i>Cinna arundinacea</i> .....	75	Ind. T.	D. C.	6.69	2.98	54.47	25.61	6.22	1.00	.60	.60	47.4	14.30	4.07	1.92	47.69	25.40	5.33
76	<i>Holcus lanatus</i> .....	76	May 25	D. C.	7.2	3.89	55.52	29.04	7.35	1.30	.60	.60	46.2	50.60	4.73	1.92	47.43	12.35	3.43
77	<i>Avena striata</i> .....	77	Vi.	D. C.	4.96	4.03	54.93	26.13	8.75	1.40	.15	.15	10.6	62.30	2.99	1.52	48.10	22.42	7.50
78	<i>Arrhenatherum avenaceum</i> .....	78	May 25	D. C.	8.5	4.03	54.93	26.13	8.78	1.41	.15	.15	10.6	62.30	2.99	1.52	48.10	19.17	3.31
79	<i>Dactylis spicata</i> .....	79	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
80	<i>Dactylis spicata</i> .....	80	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
81	<i>Dactylis spicata</i> .....	81	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
82	<i>Dactylis spicata</i> .....	82	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
83	<i>Cynodon dactylon</i> .....	83	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
84	<i>Bouteloua oligostachya</i> .....	84	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
85	<i>Elymus Indica</i> .....	85	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
86	do.....	86	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
87	do.....	87	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
88	<i>Leptochloa mucronata</i> .....	88	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
89	<i>Triodia purpurea</i> .....	89	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
90	<i>Triodia sesquoides</i> .....	90	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
91	<i>Urolophus latifolius</i> .....	91	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
92	do.....	92	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
93	<i>Dactylis glomerata</i> .....	93	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
94	do.....	94	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
95	do.....	95	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
96	do.....	96	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
97	do.....	97	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
98	do.....	98	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
99	do.....	99	May 12	N. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
100	<i>Poa pratensis</i> .....	100	June 13	D. C.	8.7	4.38	49.97	26.09	12.70	2.12	.09	.09	51.4	14.30	7.23	2.41	42.82	21.36	10.88
101	do.....	101	June 18	D. C.	8.0	6.33	2.66	54.94	27.51	8.56	1.37	.51	37.2	14.30	5.42	2.28	47.08	23.58	7.34
102	do.....	102	1880.	Pa.	7.42	3.56	56.63	23.08	9.91	1.68	.30	.30	19.0	14.30	6.36	3.05	48.02	19.78	8.49
103	do.....	103	1880.	N. C.	8.90	3.68	52.15	24.97	10.29	1.61	.62	.62	30.7	14.30	7.62	3.15	41.70	21.40	8.82
104	do.....	104	1880.	N. C.	8.90	3.68	52.15	24.97	10.29	1.61	.62	.62	30.7	14.30	7.62	3.15	41.70	21.40	8.82
105	do.....	105	1880.	N. C.	8.90	3.68	52.15	24.97	10.29	1.61	.62	.62	30.7	14.30	7.62	3.15	41.70	21.40	8.82
106	<i>Poa pratensis</i> .....	106	June 17	Pa.	4.20	2.86	52.46	27.94	11.54	1.89	.50	.50	26.8	14.30	4.46	2.05	44.96	23.91	7.49
107	do.....	107	June 17	Pa.	4.47	4.95	59.61	22.47	7.50	1.29	.06	.06	30.3	14.30	3.69	4.24	51.05	19.26	6.43
108	do.....	108	June 17	Pa.	7.02	2.85	56.85	25.46	7.82	1.28	.02	.02	71.90	14.30	2.33	1.10	47.48	4.68	3.54
109	do.....	109	June 17	Pa.	7.73	3.41	55.32	23.10	10.44	1.67	.10	.10	7.8	68.20	2.18	0.88	17.62	7.89	2.43
110	do.....	110	June 17	Pa.	9.01	4.35	47.95	24.13	14.56	2.33	.51	.51	21.1	14.30	6.70	1.15	18.70	7.81	3.53
111	do.....	111	June 17	Pa.	7.48	4.58	53.08	20.64	14.22	2.27	.47	.47	20.8	14.30	7.72	3.23	41.47	20.68	12.48
112	do.....	112	June 17	Pa.	5.21	3.44	57.18	25.35	8.82	1.41	.36	.36	25.2	14.30	4.46	4.95	49.00	17.69	12.19
113	do.....	113	June 17	Pa.	6.08	4.52	58.18	18.53	12.69	2.03	.48	.48	22.2	70.70	1.78	1.32	47.05	5.43	3.72
114	do.....	114	June 6	Pa.	7.85	3.81	58.47	20.90	8.94	1.43	.38	.38	26.9	14.30	6.60	3.64	47.66	17.27	7.66
115	do.....	115	June 6	Pa.	4.23	2.84	55.61	20.85	13.45	2.15	.53	.53	24.5	14.30	3.63	2.43	56.40	17.87	5.37
116	<i>Poa serotina</i> .....	116	June 2	Pa.	11.62	3.71	42.16	21.89	10.61	1.70	.33	.33	32.6	14.30	3.59	3.18	36.13	27.33	9.10
117	<i>Poa alsodes</i> .....	117	June 2	Pa.	9.41	4.09	51.11	21.25	13.84	2.21	.32	.32	14.5	14.30	8.06	3.59	41.06	18.21	11.86
118	<i>Glyceria aquatica</i> .....	118	June 2	Pa.	7.30	2.20	56.77	25.60	8.13	1.30	.30	.30	22.7	14.30	6.26	1.89	48.64	21.94	6.97
119	<i>Glyceria nervata</i> .....	119	June 2	Pa.	6.19	3.21	53.00	28.29	9.41	1.50	.33	.33	22.1	14.30	5.30	2.74	43.43	18.83	8.16
120	do.....	120	June 2	Pa.	6.80	2.91	60.01	21.97	8.31	1.31	.45	.45	34.1	14.30	3.83	2.49	51.43	18.83	7.12
121	do.....	121	June 2	Pa.	7.93	2.87	53.01	21.38	14.81	2.37	.58	.58	23.6	14.30	6.79	3.65	45.43	18.32	12.70
122	do.....	122	June 2	Pa.	5.03	4.26	84.18	23.79	6.53	1.04	.16	.16	10.5	14.30	4.31	3.65	72.14	18.32	5.60
123	do.....	123	June 2	Pa.	5.60	2.51	58.20	23.79	9.90	1.52	.16	.16	10.5	14.30	1.85	0.83	19.21	7.85	3.26



The great variation in composition of grasses becomes apparent on examining the one hundred and thirty-six analyses; and by selecting the highest and lowest determinations the following table of extremes has been prepared:

*Limits of composition of grasses.*

Dry substance.	Highest.	Lowest.
Ash .....	19.24	3.57
Fat .....	5.77	1.48
Nitrogen free extract .....	66.01	34.01
Crude fiber .....	37.72	17.68
Albuminoids .....	23.13	2.80
Nitrogen .....	3.70	.45
Non-albuminoid nitrogen .....	1.64	.00
Per cent. of nitrogen as non-albuminoid .....	60.7	.00
Water in fresh grass .....	76.50	60.00

The highest ash is undoubtedly owing to the presence of adherent soil, and the lowest carbo-hydrates are dependent relatively on the same cause. The wide variations in fiber and albuminoids must be regarded, however, as being entirely due to physiological causes, which are difficult to explain. *Digitaria sanguinalis*, for instance, which in one specimen contains the extreme amount of albuminoids and a small amount of fiber has in another only half as much albumen and one and three-quarter times as much fiber. We learn, then, that species are not in themselves at all fixed in their composition, there being as large variations among specimens of the same as between specimens of different species. Examples may be found in several portions of the preceding tables, and, for illustration, several analyses of *Phleum pratense* and of *Dactylis glomerata* from widely separated localities are given in the following tables:

*Analyses of Phleum pratense (timothy) from various localities.*

FULL BLOOM.

Locality.	Ash.	Fat.	Nitrogen free extract.	Crude fiber.	Albuminoids.	Total nitrogen.	Non-albuminoids nitrogen.	Per cent. of total nitrogen as non-albuminoids.
Department garden, 1881 .....	7.16	4.47	50.03	27.35	10.99	1.75	.51	29.1
Department garden, 1880 .....	5.66	3.58	58.93	21.93	9.90	1.58	.38	24.0
Maryland .....	4.93	4.22	52.83	30.43	7.69	1.23	.15	12.2
New Hampshire .....	4.57	4.20	57.16	28.28	5.79	.93	.10	10.8
Indiana .....	7.05	2.18	52.99	32.26	5.52	.88	.00	.0

*Analyses of Dactylis glomerata (orchard grass) from various localities.*

FULL BLOOM.

Locality.	Ash.	Fat.	Nitrogen free extract.	Crude fiber.	Albuminoids.	Total nitrogen.	Non-albuminoids nitrogen.	Per cent of total nitrogen as non-albuminoids.
North Carolina .....	7.42	3.56	56.03	23.08	9.91	1.58	.30	19.0
District of Columbia .....	8.07	3.24	53.76	25.40	9.53	1.53	.16	10.5
Maine .....	8.02	3.39	54.80	26.05	8.74	1.40	.36	25.7
District of Columbia .....	6.00	3.62	57.34	24.42	8.62	1.38	.42	30.4
Pennsylvania .....	6.33	2.66	54.99	27.51	8.56	1.37	.51	37.2
New Hampshire .....	8.44	3.49	54.75	24.91	8.41	1.35	.42	30.9

AVERAGE.

Five Localities.	7.38	3.33	55.17	25.19	8.91	1.43	.36	25.2
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The average composition of American grasses as derived from the preceding analyses of grasses in bloom and averages for different sections of the country, has been calculated. The results presented in the following table, with Wolff's averages for German grasses, are of interest:

*Average composition of grasses.*

	Number of analyses.	Ash.	Fat.	Nitrogen free extraction.	Crude fiber.	Albuminoids.	Total nitrogen.	Non-albuminoid nitrogen.	Per cent of total as non-albuminoids.
American:									
United States .....	135	7.97	3.14	53.97	25.71	9.21	1.47	.45	30.6
North of Potomac .....	70	7.64	3.44	55.01	23.70	10.21	1.63	.32	19.6
South .....	27	8.80	2.74	52.55	26.68	9.23	1.47	.56	38.1
Middle West .....	8	7.12	2.96	54.58	25.39	9.95	1.60	.41	25.6
West of Mississippi .....	30	8.23	2.86	52.67	29.60	6.64	1.06	.41	38.7
German (Wolff):									
Fair .....		6.30	2.34	46.53	34.09	10.74	1.72	.....	.....
Good .....		7.23	2.92	47.84	30.69	11.32	1.81	.....	.....
Very good .....		8.24	3.29	48.93	25.77	13.77	2.20	.....	.....

The different sections furnish very different qualities of grasses, and for the reason that those from the North were almost entirely from cultivated soil, while those from the other sections were many or most of them wild species from old sod. The improvement brought about by cultivation is marked and the difference between a ton of wild Western and Eastern cultivated hay is apparent.

In comparison with German grasses our best do not equal in amount of albuminoids those classed by Wolff as *fair*, but they are far superior in having a much smaller percentage of fiber and consequently a larger



amount of digestible carbo-hydrates. In the grasses of both countries the fiber increases with regularity as the nitrogenous constituents decrease, and of the latter the non-albuminoid portion is relatively greatly the poorer the quality of the grass.

## CHANGES IN COMPOSITION DURING GROWTH.

In addition to the single analysis previously tabulated, analyses have been made of series illustrating the changes in composition of several species from the appearance of the blade to the maturity of the seed.

The grasses examined comprise :

- I. *Agrostis vulgaris*. (Red top.)
  - A series from richer soil.
  - A series from poorer soil.
- II. *Phleum pratense*. (Timothy.)
  - A series from richer soil.
  - A series from poorer soil.
  - A series of first year's growth from seed sown in garden soil.
  - A series from La Fayette, Ind.
  - A series from Hanover, N. H., the two latter from rather poor soil.
- III. *Dactylis glomerata*. (Orchard grass.)
  - A series from the first growth.
  - A series from later growth.
- IV. *Alopecurus pratensis*. (Meadow fox-tail.)
  - A series from good sod.
- V. *Poa pratensis*. (Blue grass, Meadow grass.)
  - A series from good soil.
  - A series from poorer soil.
  - A series from the wayside.
  - A series from Quincy, Ill.
- VI. *Poa compressa*. (Wire grass.)
  - A series from poor soil.
- VII. *Bromus unioloides*. (Schrader's grass.)
  - A series from rich garden soil.
- VIII. *Bromus erectus*. (Broom grass.)
  - A series from poor soil.
- IX. *Holcus lanatus*. (Satin grass.)
  - A series from poor soil.
- X. *Arrhenatherum avenaceum*.
  - A series from medium soil.
- XI. *Setaria glauca*.
  - A series from medium soil.
- XII. *Anthoxanthum odoratum*. (Sweet vernal grass.)
  - A series from medium soil.
- XIII. *Festuca ovina*. (Sheep's fescue.)
  - A series from poor soil, growing in bunches.
- XIV. *Lolium Italicum*. (Italian Rye grass.)
  - A series from low moist soil.
  - A series of first year's growth from the seed in garden soil.
- XV. *Lolium perenne*. (Rye grass darnel.)
  - A series from medium soil.

With a few exceptions the specimens were personally collected in the grounds of the Department, and are to be so understood when nothing else is said in their description. They all grew in the summer of 1880 except the few series illustrative of the first year's growth of certain species. The character of the soils has been designated as rich or garden soil, good soil, poorer soil, and wayside soil. The first is that of the experimental garden of the Department, and is above the average richness of cultivated soils; the second is that of the lawns about the Department building, the third, a light gravelly soil, occurring in a portion of the grounds, and the last the gutters and paths.

The specimens were cut close to the roots, weighed and dried rapidly in a current of air at 60° C. The methods of analysis were such as have been described in previous reports.



	When cut.	Height in centimeters.	Ash.	Fat.	Nitrogen free extract.	Crude fiber.	Albuminoids.	Total nitrogen.	Non-albuminoid nitrogen.	Per cent. of nitrogen non-albuminoid.	Water.	Ash.	Fat.	Nitrogen free extract.	Crude fiber.	Albuminoids.
II.— <i>PHLEUM PRATENSE</i> —Continued.																
INDIANA.																
Head not out.....	June 8	.....	7.94	1.97	49.93	29.19	10.97	1.75	.18	10.3	70.00	2.38	.59	14.98	8.76	3.26
Before bloom.....	June 15	.....	7.64	2.27	52.64	29.65	7.80	1.25	.28	22.4	67.50	2.48	.74	17.11	9.64	2.53
In bloom.....	June 26	.....	7.05	2.18	52.99	32.26	5.52	.88	.00	.00	64.50	2.50	.78	18.81	11.45	1.96
After bloom.....	July 6	.....	6.63	2.55	53.93	31.32	5.57	.89	.03	3.3	56.30	2.90	1.11	23.57	13.69	2.43
Early seed.....	July 16	.....	5.95	3.74	60.77	24.70	4.84	.78	.00	.00	53.00	2.80	1.76	28.56	11.61	2.27
NEW HAMPSHIRE.																
Spike invisible.....	.....	.....	5.19	4.60	57.09	23.46	7.66	1.55	.30	19.4	.....	.....	.....	.....	.....	.....
Spike visible.....	.....	.....	4.73	4.22	56.10	25.34	9.61	1.54	.45	29.2	.....	.....	.....	.....	.....	.....
In bloom.....	.....	.....	4.57	4.50	57.16	28.28	5.79	.93	.10	10.8	.....	.....	.....	.....	.....	.....
After bloom.....	.....	.....	3.88	3.23	58.72	28.32	5.25	.84	.15	17.9	.....	.....	.....	.....	.....	.....
Early seed.....	.....	.....	3.2	2.7	62.5	26.03	3.41	.87	.18	20.7	.....	.....	.....	.....	.....	.....
III.— <i>DACTYLIS GLOMERATA</i> .																
DEPARTMENT GARDEN.																
Panicles not out.....	Apr. 23	35	10.29	4.12	50.86	18.76	15.97	2.49	1.01	40.6	78.8	2.18	.87	10.78	3.98	3.469
Panicles closed.....	May 4	55	8.26	3.13	55.04	23.18	10.39	1.63	*.00	0.0	79.3	1.71	.64	11.40	4.80	2.15
In full bloom.....	May 13	87	8.07	3.24	53.76	25.40	9.53	1.53	.16	10.5	77.3	1.83	.74	12.20	5.77	2.16
After bloom.....	June 1	125	9.01	2.83	52.65	27.26	8.25	1.32	.33	25.0	73.5	2.39	.75	13.95	7.22	2.19
Later growth:																
In bloom.....	June 18	80	8.64	3.98	50.20	24.67	12.51	1.99	.77	38.7	66.9	2.86	1.32	16.62	8.16	4.14
Late bloom.....	June 23	75	6.90	3.62	57.34	24.42	8.62	1.38	.42	30.4	60.2	2.39	1.44	22.82	9.72	3.43
Seed nearly ripe.....	July 1	75	6.73	3.34	57.54	25.09	7.30	1.16	.45	38.8	62.3	2.54	1.26	21.69	9.46	2.75
DEPARTMENT GARDEN.																
First year's growth:																
Head not out.....	June 12	28	11.50	6.89	48.06	20.63	12.92	2.07	.15	7.3	79.50	2.36	1.41	9.85	4.23	2.65
Green.....	July 15	.....	10.52	6.86	46.95	21.64	14.03	2.95	.39	17.3	72.30	2.91	1.90	13.00	6.00	3.89
Yellow.....	July 15	.....	10.14	5.95	52.37	22.44	9.10	1.46	.18	12.3	74.60	2.58	1.51	13.30	5.70	2.31
.....	Oct. 25	.....	10.95	6.50	47.98	21.24	13.33	2.14	.54	25.2	68.70	3.43	2.03	15.02	6.65	4.17

IV.—*ALOPECURUS PRATENSIS.*

Head just appearing	Apr. 19	9.21	4.69	52.16	18.21	15.73	2.52	.66	38.2	77.1	2.11	1.08	11.94	4.17	3.69
Before bloom	Apr. 19	7.90	4.46	51.63	23.40	13.58	2.17	.53	40.9	76.7	1.81	1.04	12.03	5.22	3.47
In bloom	May 1	7.75	3.36	54.30	23.78	10.81	1.73	.00	0.0	69.0	3.10	1.31	21.73	9.51	4.32
After bloom	May 12	8.17	3.50	54.35	25.36	8.62	1.38	.07	5.0	66.6	2.73	1.17	18.15	8.47	2.88

V.—*POA PRATENSIS.*

DEPARTMENT GARDEN.

Set No. 1 grown on good soil:															
Panicle just visible	Apr. 23	8.07	4.88	48.74	18.43	19.88	3.18	.48	15.1	76.70	1.88	1.14	11.34	4.30	4.64
Panicle spreading	May 1	5.51	4.07	51.32	23.83	16.21	2.68	.30	11.2	70.80	1.61	1.19	14.99	6.67	4.74
In full bloom	May 21	6.38	3.90	51.43	23.76	12.61	2.01	.02	1.0	71.90	2.33	1.10	14.45	6.68	3.54
In seed	June 5	6.38	4.25	52.54	24.34	12.49	2.00	.37	18.5	55.90	2.81	1.87	23.17	10.74	5.51
Set No. 2 grown on poor soil:															
Panicle closed	Apr. 27	6.61	3.92	55.23	21.92	12.23	1.96	.12	6.1	69.00	2.18	.88	17.62	7.90	2.42
In full bloom	May 8	7.02	2.85	56.85	25.46	7.82	1.28	.10	7.8						
Set No. 3 grown on poor soil; wey-side:															
After bloom; brown	June 1	7.23	3.92	56.12	23.85	8.88	1.62	.25	17.6	55.40	3.22	1.75	25.03	10.64	3.96
In full bloom	May 19	7.23	3.41	53.32	23.10	10.44	1.67	.14	8.4	66.20	2.62	1.15	18.69	7.81	3.53
In seed; brown	June 8	6.21	3.51	58.58	24.34	7.36	1.18	.15	12.7	51.60	2.81	1.59	26.61	11.65	3.31

QUINCY, ILL.

Set No. 4:															
Before bloom	May 10	8.42	4.99	45.34	21.87	19.38	3.10	.63	20.3						
In bloom	May 17	7.82	3.77	48.39	24.93	15.09	2.41	.51	21.1						
After bloom	May 27	9.07	3.30	52.51	22.75	12.37	1.97	.35	17.8						

VI.—*POA COMPRESSA.*

Poor soil:															
Panicle not out	June 1	7.75	5.29	58.08	18.19	10.69	1.71	*.10	5.8	67.90	2.19	1.70	18.61	5.84	3.43
Panicle well out	June 1	6.81	4.41	55.18	21.30	12.30	1.97	.52	26.4	68.70	2.13	1.38	17.27	6.67	3.85
In bloom	June 17	6.08	4.52	58.18	18.53	12.63	2.63	.45	22.2	70.70	1.78	1.32	17.05	5.43	3.72
After bloom	June 23	5.13	3.85	63.89	18.16	8.97	1.43	.35	24.5	51.80	2.47	1.86	30.79	8.75	4.33

VII.—*BROMUS UNOLADES.*

Panicle not out:															
Panicle closed	Apr. 23	10.65	5.03	48.73	18.51	17.05	2.73	1.06	38.8	80.60	2.07	.97	9.45	3.60	3.31
After bloom	May 4	8.95	3.44	51.03	22.22	14.36	2.31	.55	23.8	75.10	2.20	.85	12.55	5.47	3.53
In full bloom	May 13	9.26	3.96	51.46	22.69	12.63	2.02	.34	16.8	79.40	1.91	.82	10.60	4.67	2.60
After bloom	June 1	6.68	2.37	54.79	25.33	10.83	1.74	.35	20.1	67.50	2.17	.77	17.80	8.23	3.52
In seed; brown	June 1	8.55	2.10	59.71	19.85	9.79	1.57	.33	21.0	64.70	3.02	.74	21.08	7.01	3.45

VIII.—*BROMUS ERRECTUS.*

Very young:															
Before bloom	Apr. 27	8.63	3.67	45.27	26.65	15.78	2.52	.43	17.1	85.50	1.25	.53	6.57	3.87	2.28
Do	May 8	7.56	3.27	25.21	24.48	12.22	1.95	.24	12.3	74.30	1.86	.84	13.37	6.49	3.14
Do	May 12	7.40	3.72	53.35	24.48	11.02	1.76	.09	5.1	72.20	2.06	1.03	11.81	6.81	3.06



XIV.—*LOLIUM ITALICUM*—Continued.

Heads just out.....	May 21	75	11.39	3.81	48.74	21.75	14.31	2.29	.39	17.0	82.7	1.97	.66	8.43	3.76	2.48
In full bloom.....	May 26	90	11.02	2.32	51.73	20.44	14.49	2.32	.18	7.8	78.0	2.42	.51	11.39	4.49	3.19
After bloom.....	June 4	92	8.76	3.98	53.81	21.86	11.59	1.85	.43	23.2	71.5	2.50	1.13	15.34	6.23	3.30
First year's growth:																
Head not out.....	June 2	22	13.24	6.91	45.55	15.50	18.80	3.01	.60	19.9	84.00	2.12	1.10	7.29	2.48	3.01
Do.....	June 12	31	12.70	6.36	49.69	16.99	14.26	2.28	.45	19.7	82.70	2.20	1.10	8.59	2.94	2.47
Do.....	June 19	38	14.06	6.18	45.07	17.84	16.85	2.69	.66	24.6	82.30	2.49	1.09	7.98	3.16	2.98
Do.....	July 10	.....	13.87	6.53	41.50	20.65	14.45	2.31	.59	25.5	78.90	2.82	1.38	9.39	4.36	3.05
Do.....	Oct. 25	25	10.87	5.31	47.82	22.40	13.60	2.17	.49	22.6	71.60	3.09	1.51	13.58	6.36	3.86
XV.— <i>LOLIUM PERENNE</i> .																
Head invisible.....	May 1	35	8.66	3.58	57.70	18.39	11.67	1.87	.28	15.0	78.6	1.85	.76	12.35	3.94	2.50
Do.....	May 4	28	9.48	4.34	55.08	18.00	13.10	2.09	.39	18.7	82.4	1.67	.76	9.69	3.17	2.31
Head well out.....	May 4	30	7.96	3.64	56.75	20.55	11.10	1.78	.33	18.5	74.0	2.07	.94	14.71	5.24	2.89
Before bloom.....	May 12	55	8.40	3.75	54.33	23.93	8.99	1.43	.09	6.3	76.4	1.98	.89	12.96	5.65	2.12
After bloom.....	June 1	52	7.50	2.64	56.84	25.42	7.60	1.21	.....	.....	63.1	2.77	.97	20.97	9.38	2.81

The preceding analyses furnish the data from which is derived the general conclusion that as a grass grows older its content of water decreases, ash decreases, fat decreases, albuminoids decrease, carbohydrates increase, crude fiber increases, non-albuminoids decrease till bloom or slightly after, when it is at its lowest, and then increases again during the formation of the seed.

There are exceptions to these rules, but for the large majority of species under ordinary conditions of environment they hold good.

There are almost no exceptions to the fact that the water decreases in the maturer specimens; that is to say, the plant gradually dries up and becomes less succulent. The ash is very dependent on locality and surroundings, and as in the analyses which are here published it includes whatever soil there may be mechanically adherent to the blade or stalk as collected, it sometimes shows irregularities from one period to another.

The albuminoids decrease in amount with great regularity, the few cases where an increase appears being owing to the fact that the specimens were probably grown under varying conditions.

The fiber sometimes decreases, as in *Bromus erectus*, but the change in that direction is never large.

The non-albuminoid constituents, however, are often quite the reverse of constant in their manner of appearance and disappearance, and show themselves to be largely or more affected by environment than any other constituent. In *Agrostis vulgaris* they continue to decrease after bloom, and in *Anthoxanthum odoratum* and *Festuca ovina* they increase steadily from early growth to maturity. The relative amount present in the same species from different localities is extremely variable, as may be seen in the analyses of *Phleum pratense*, where specimens from Indiana contain almost no non-albuminoid nitrogen, while those from the District of Columbia and elsewhere are well supplied. The specimens from poorer soil having the smallest amount in some cases and the largest in others, the fact can hardly be due directly and entirely to the lack of cultivation, but as the averages show that the best grasses contain the least non-albuminoids it is plain that it is dependent on the sources of nitrogen and the supply furnished the plant. The usual changes in the non-albuminoids seem to point to the possibility that they increase at the time of the formation of the seed in the act of transferring to the seed, as amides, the nitrogen of the plant.

#### THE BEST PERIOD OF GROWTH AT WHICH TO CUT FOR HAY.

Although largely a matter of opinion, it would seem from the foregoing results that the time of bloom or very little later is the fittest for cutting grasses to be cured as hay. The amount of water has diminished relatively, and there is a proportionately larger amount of nutriment in the material cut, and the weight of the latter will be at its highest point economically considered. Later on, the amount of fiber becomes too prominent, the stalk grows hard, arid, indigestible, and the



albuminoids decrease, while the dry seeds are readily detached from their glumes and lost with their store of nitrogen.

For different species, however, different times are undoubtedly suitable, and experience must be added to our chemical knowledge to enable a rational decision to be arrived at.

THE COMPOSITION OF THE ASH.

The ash of many foreign varieties of grasses have been analyzed and the results collected and published by Wolff. Of American growth the ash of only a number of the wild grasses collected in 1878 have been examined. The results are here given:

Ash analyses—grasses.

Name.	Phosphoric acid, P <sub>2</sub> O <sub>5</sub> .	Sulphuric acid, SO <sub>3</sub> .	Silica, Si O <sub>2</sub> .	Chlorine, Cl.	Calcium oxide, Ca O.	Magnesium oxide, Mg O.	Pot. oxide, K <sub>2</sub> O.	Potassium, K.	Sod. oxide, Na <sub>2</sub> O.	Sodium, Na.
<i>Hierochloa borealis</i> (Vanilla grass).....	7.42	2.55	42.73	4.49	3.97	2.54	31.51	4.54	.....	.25
<i>Eleusine Indica</i> (wire grass).....	2.69	4.24	47.56	10.09	10.27	4.10	10.27	9.52	.....	1.26
<i>Eleusine India</i> (wire grass).....	9.63	5.79	24.61	6.71	13.65	7.98	24.79	7.39	.....	.....
<i>Eleusine India</i> (wire grass).....	9.84	8.55	16.25	9.61	11.10	5.57	30.98	4.55	.....	3.55
<i>Triola latifolia</i> (fescue grass).....	4.92	2.62	66.87	4.71	7.15	3.02	5.52	5.19	.....	.....
<i>Cynodon dactylon</i> (Bermuda grass).....	6.20	9.37	30.29	6.05	13.44	5.00	22.99	6.66	.....	.....
<i>Cynodon dactylon</i> (Bermuda grass).....	5.09	11.31	30.27	9.46	7.99	2.96	22.89	9.61	.....	.42
<i>Sporobolus Indicus</i> (smut grass).....	6.02	4.60	27.36	11.03	2.64	2.66	33.53	12.16	.....	.....
<i>Andropogon Virg.</i> (broom grass).....	2.97	2.80	58.33	6.37	6.76	1.83	13.93	7.01	.....	.....
<i>Andropogon scoparius</i> .....	1.33	trace	64.62	15.65	2.12	.58	.....	15.70	.....	.....
<i>Poa pratensis</i> (Kentucky blue grass).....	9.88	4.76	30.25	6.30	4.81	3.23	33.81	6.95	.....	.....
<i>Poa serotina</i> (fowl meadow grass).....	10.80	3.35	37.10	3.80	6.70	2.92	31.71	2.79	.....	.83
<i>Dactyloctenium Egypt</i> (Egyptian grass).....	3.37	4.42	34.17	6.76	20.67	6.91	21.20	7.50	.....	.....
<i>Panicum sanguinale</i> (Crab grass).....	6.40	4.02	30.93	6.04	4.40	7.98	33.56	6.67	.....	.....
<i>Panicum jumentorum</i> (true Guinea grass).....	4.37	2.51	16.51	7.77	10.18	14.16	35.93	8.57	.....	.....
<i>Panicum obtusum</i> .....	5.18	6.71	48.60	4.20	5.91	3.13	21.65	4.62	.....	.....
<i>Panicum virgatum</i> (tall panic grass).....	5.50	3.56	51.17	4.93	7.87	3.63	18.76	3.36	.....	1.22
<i>Panicum</i> .....	4.37	5.29	45.10	4.06	7.39	7.98	22.53	1.54	.....	1.74
<i>Panicum Texanum</i> (Texas millet).....	8.48	4.63	34.31	6.55	7.39	4.57	27.95	4.54	.....	1.58
<i>Panicum Crusgalli</i> (barn-yard grass).....	4.27	3.69	42.18	11.48	7.23	5.52	13.26	12.00	.....	.37
<i>Panicum filiforme</i> (slender crab grass).....	6.37	4.84	40.36	12.17	4.69	5.18	12.98	13.41	.....	.....
<i>Sorghum halapense</i> (Johnson grass).....	10.44	2.96	22.21	4.58	12.87	6.73	35.72	3.65	.....	.81
<i>Sorghum avenaceum</i> (Indian grass).....	2.35	2.13	61.56	6.11	2.92	1.36	16.84	6.74	.....	.....
<i>Muhlenbergia difusa</i> (drop seed).....	6.65	3.39	39.98	8.21	11.95	4.39	17.32	6.78	.....	1.33
<i>Bromus unioloides</i> (Schrader's grass).....	8.79	5.61	4.84	16.84	4.43	4.64	37.20	16.38	.....	1.27
<i>Bromus carinatus</i> (broome grass).....	9.29	3.94	38.33	3.30	6.19	2.19	31.61	.....	2.17	2.98
<i>Agrostis exarata</i> (brown top).....	8.01	1.93	34.63	3.60	5.61	3.84	38.41	3.97	.....	.....
<i>Paspalum lœve</i> (water grass).....	6.18	5.64	44.65	1.73	9.36	5.26	25.44	.....	.60	1.12
<i>Setaria setosa</i> (bristly foxtail).....	3.24	3.51	42.59	3.81	2.31	1.56	39.33	.....	1.18	2.47
<i>Leptochloa mucronata</i> (feather grass).....	6.46	3.31	55.92	2.89	5.94	2.66	20.21	1.81	.....	.80
<i>Tripsacum dactyloides</i> (gama grass).....	2.52	3.69	37.84	13.08	1.64	1.07	29.06	6.30	.....	4.77
<i>Tricuspis seslerioides</i> (tall red top).....	1.58	4.04	37.52	7.39	2.32	.53	38.49	8.13	.....	.....

CONCLUSION.

The work which has been collected in the previous pages extended over several years, from 1878 to 1883. It was inaugurated by Dr. Peter Collier, as chemist to this Department, and the laboratory work for the first year was in the hands of Mr. Henry B. Parsons, Mr. Charles Wellington, and myself. The remainder of the work has been under my own supervision, and has been almost entirely carried out by Mr. Miles Fuller and myself. It is hoped that the collection and rearrangement of the results will give them an increased value.



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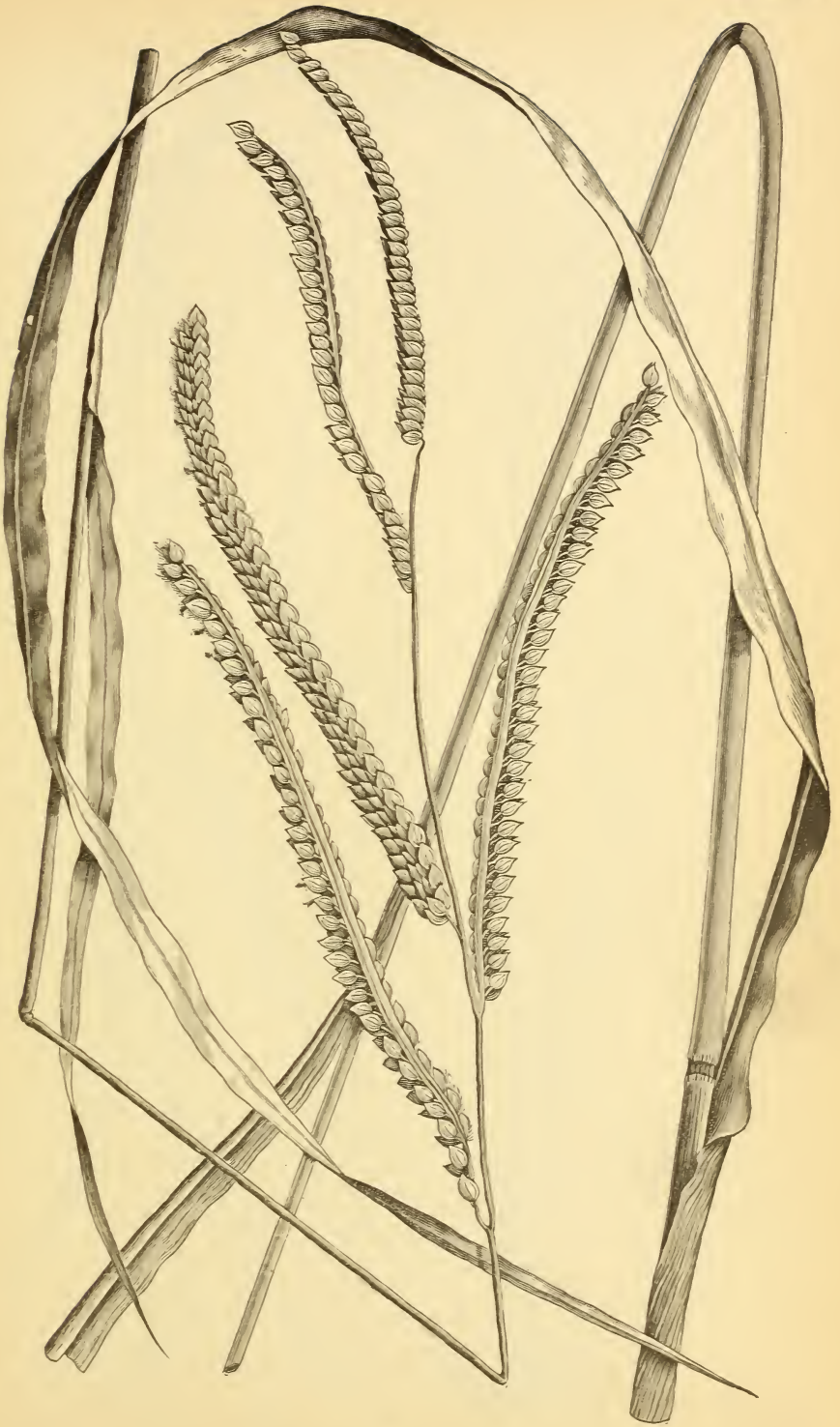


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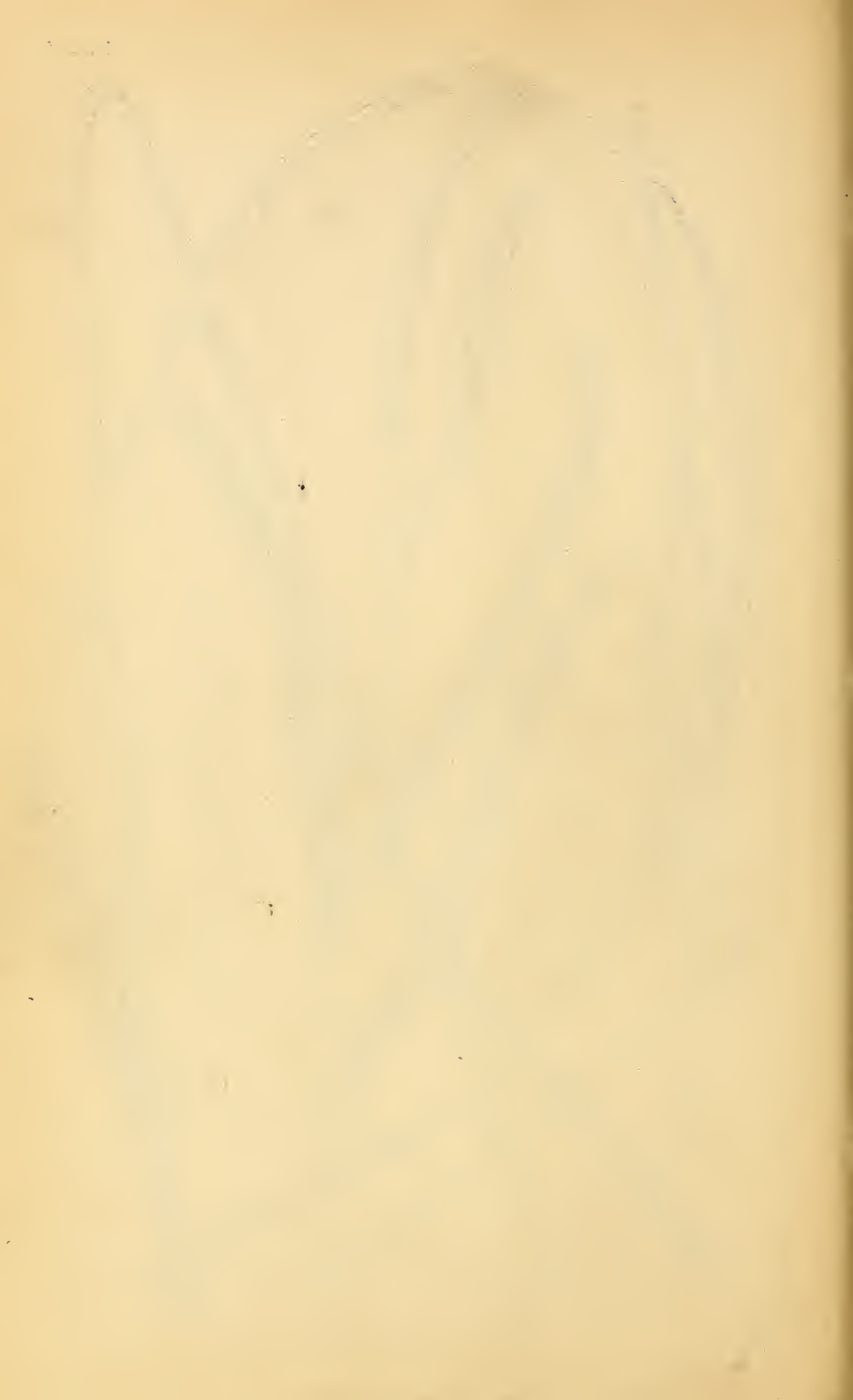
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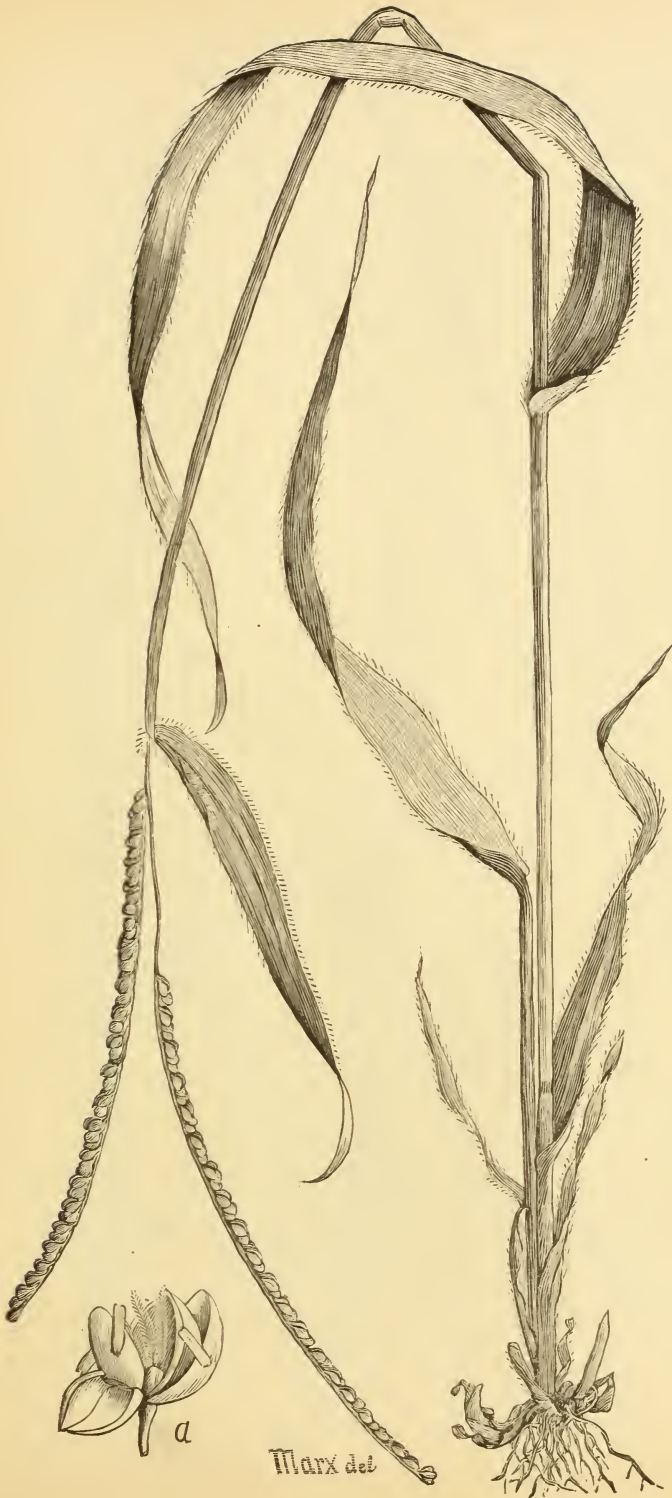






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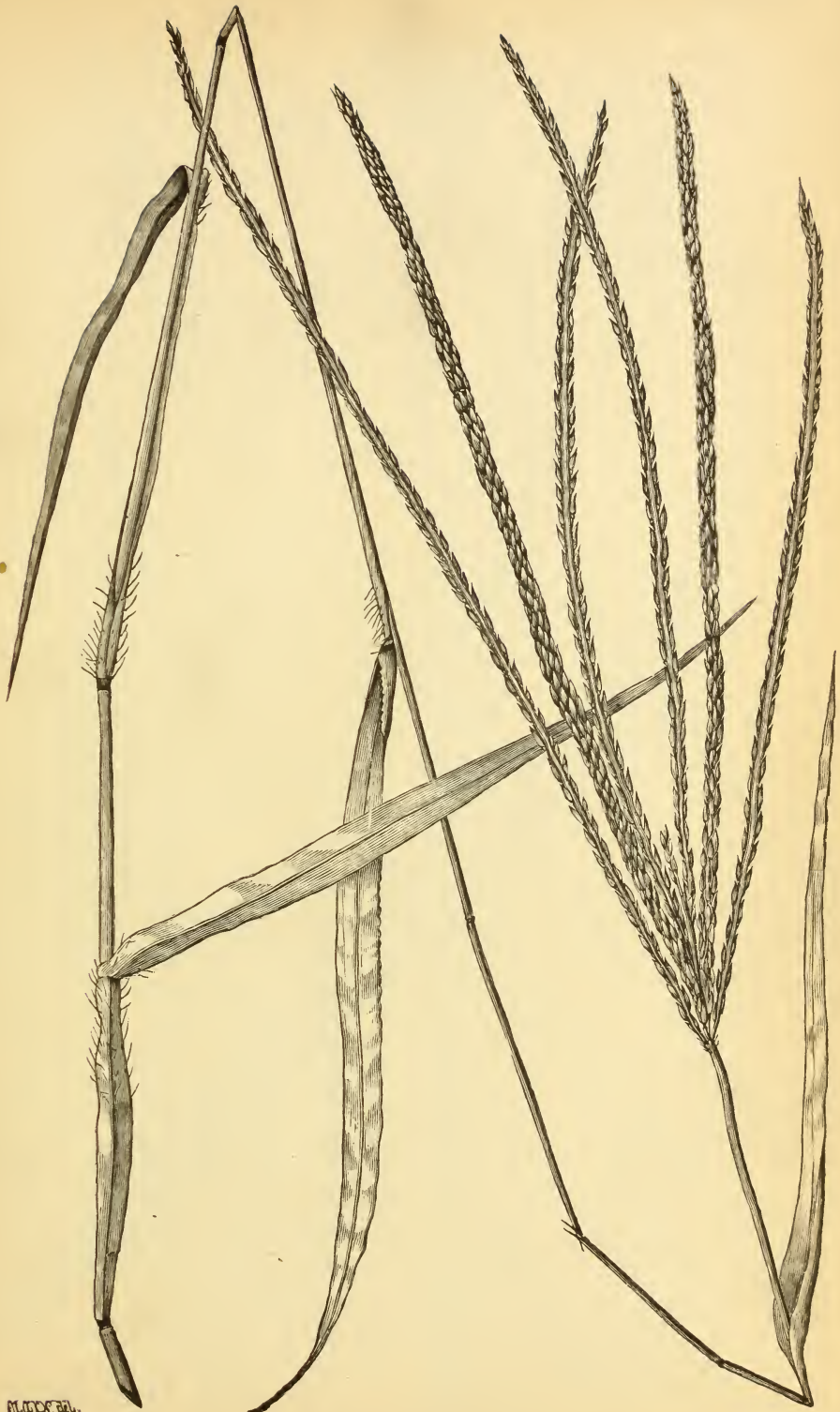




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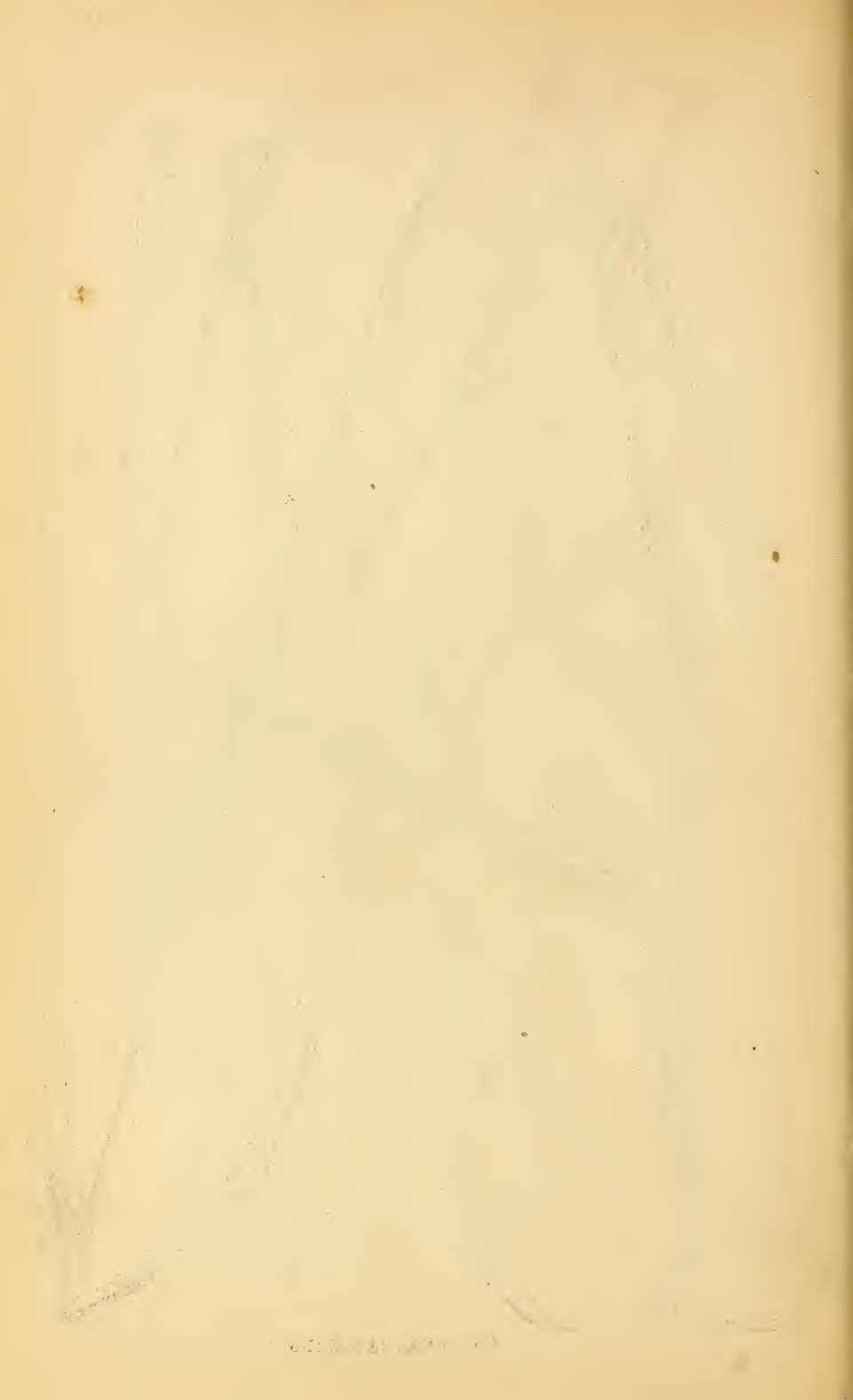
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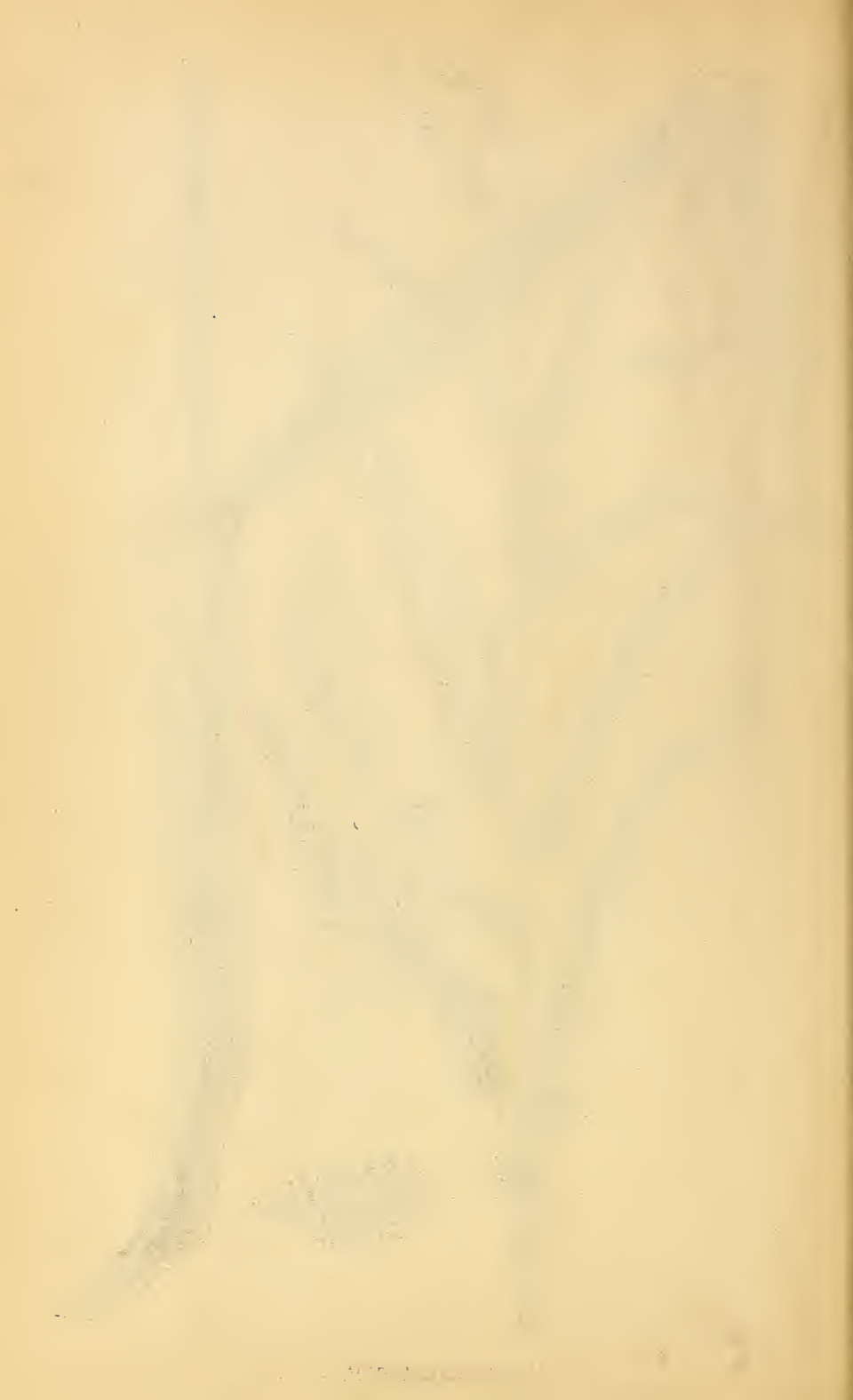
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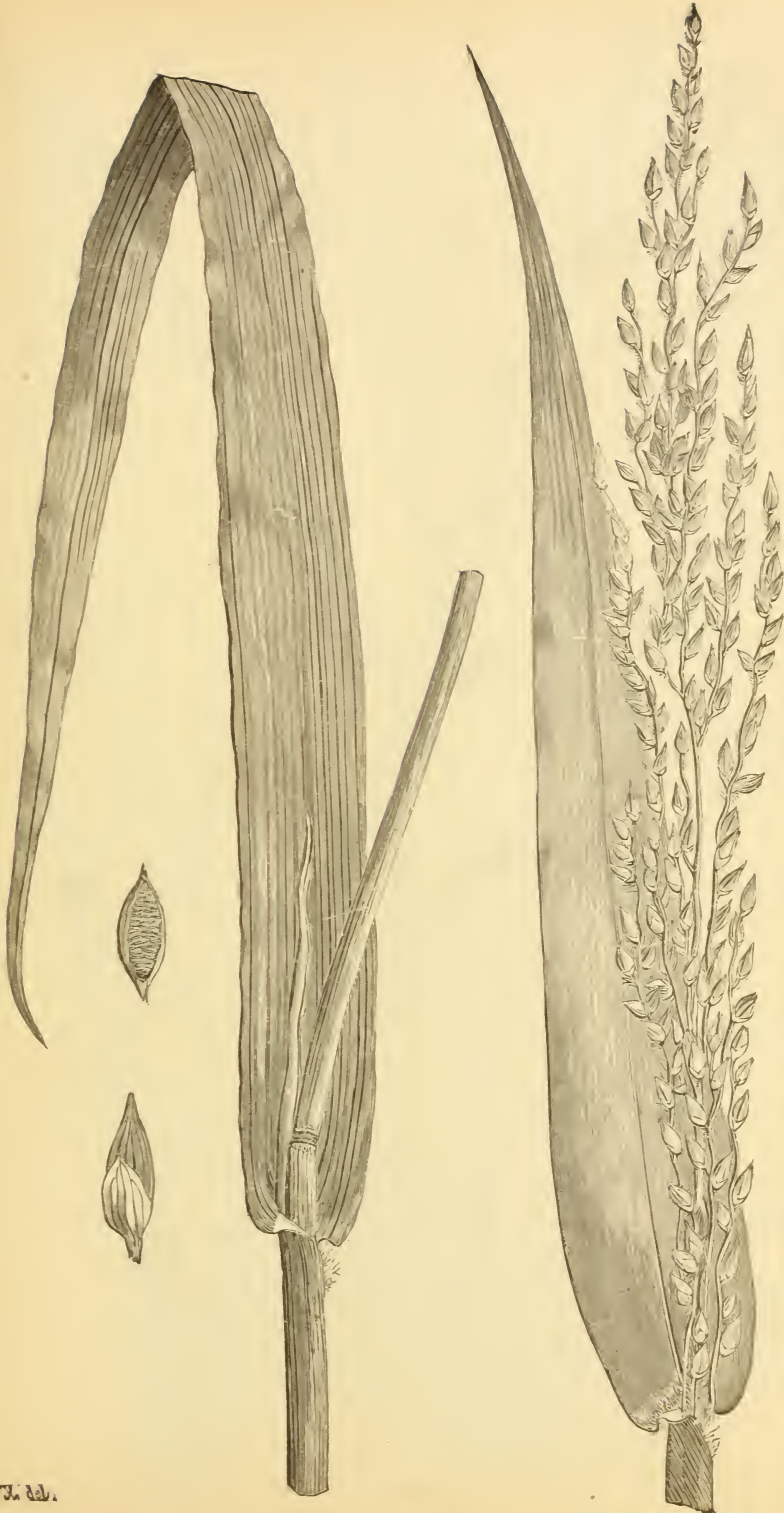






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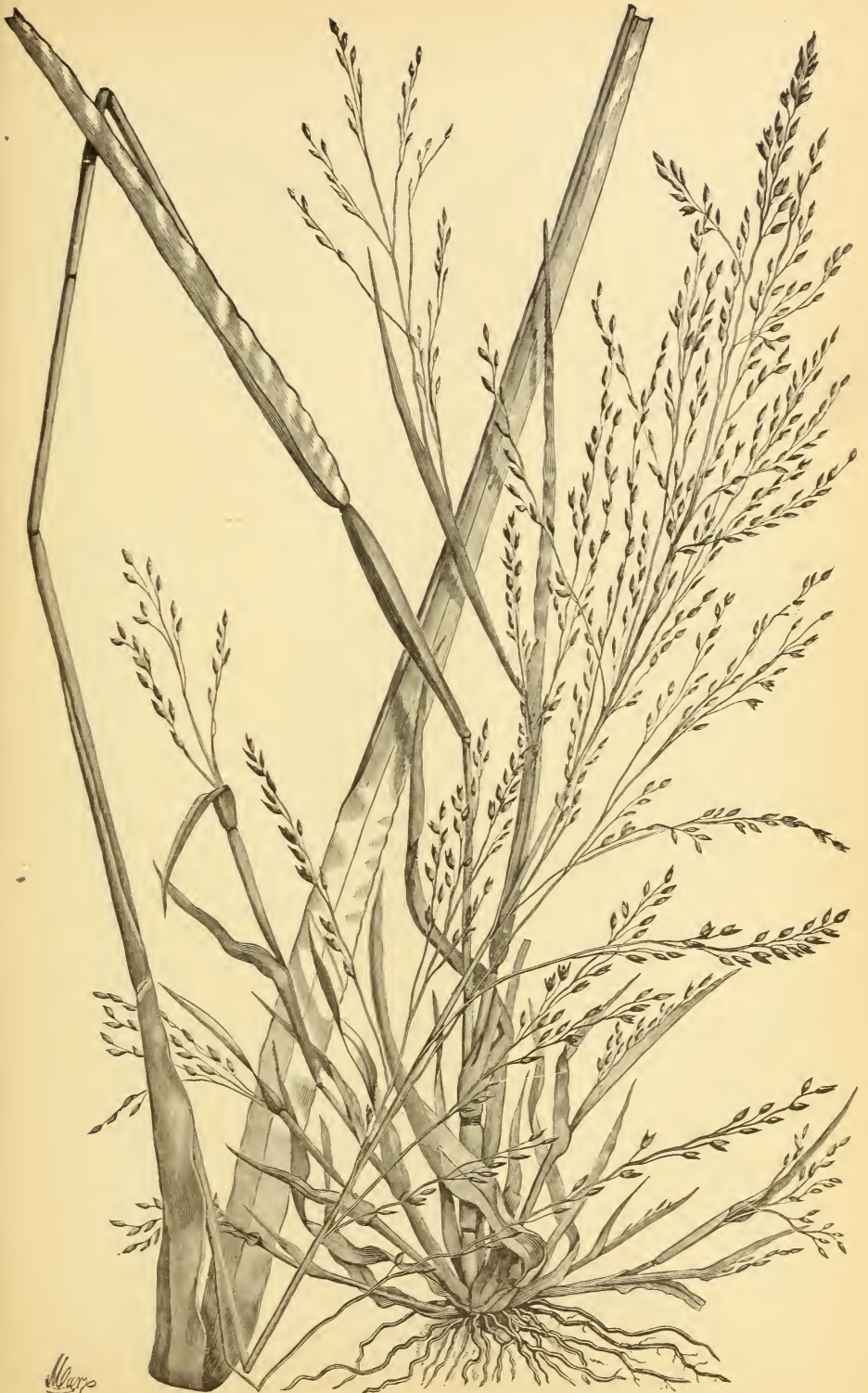




Mex. ab.

PANICUM TEXANUM.





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PANICUM PROLIFERUM.





PANICUM AGROSTOIDES.







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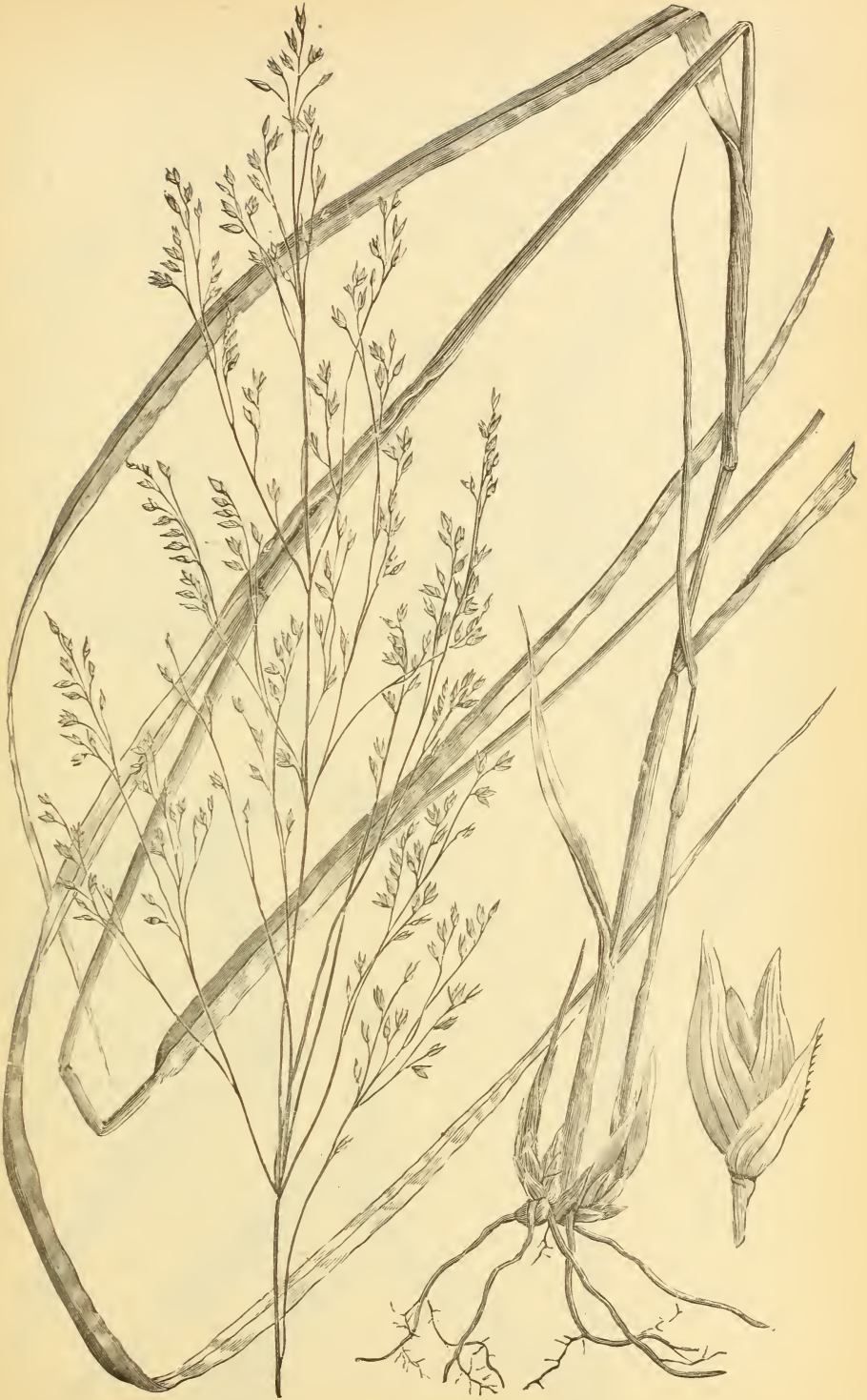




H. B. K. del.

PANICUM CRUSGALLI.





PANICUM VIRGATUM.





MARX DEL.

H.H.N.Sc.

PANICUM DIVARICATUM.







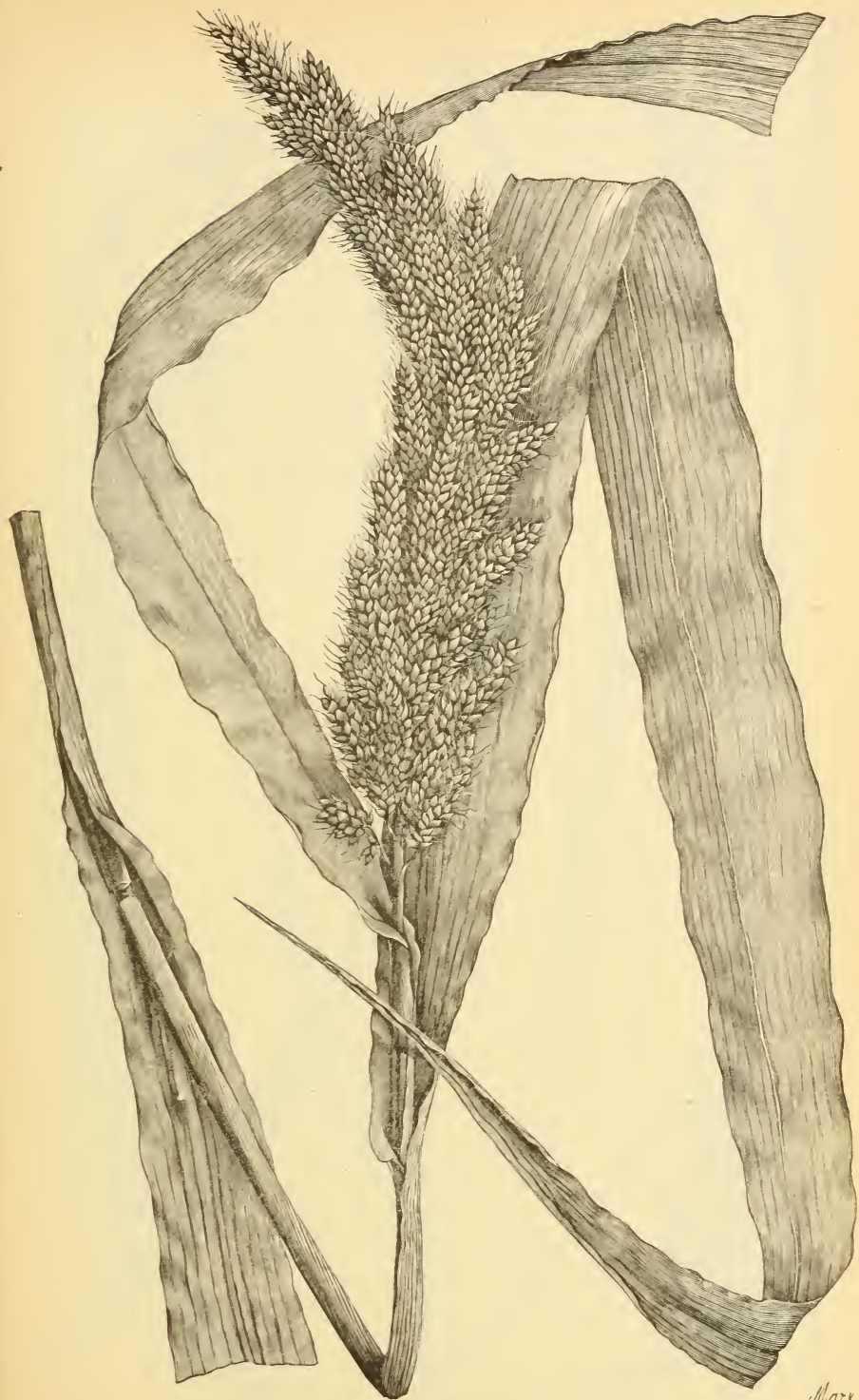
PANICUM GIBBUM.





PANICUM CAPILLARE.





*Marx del.*

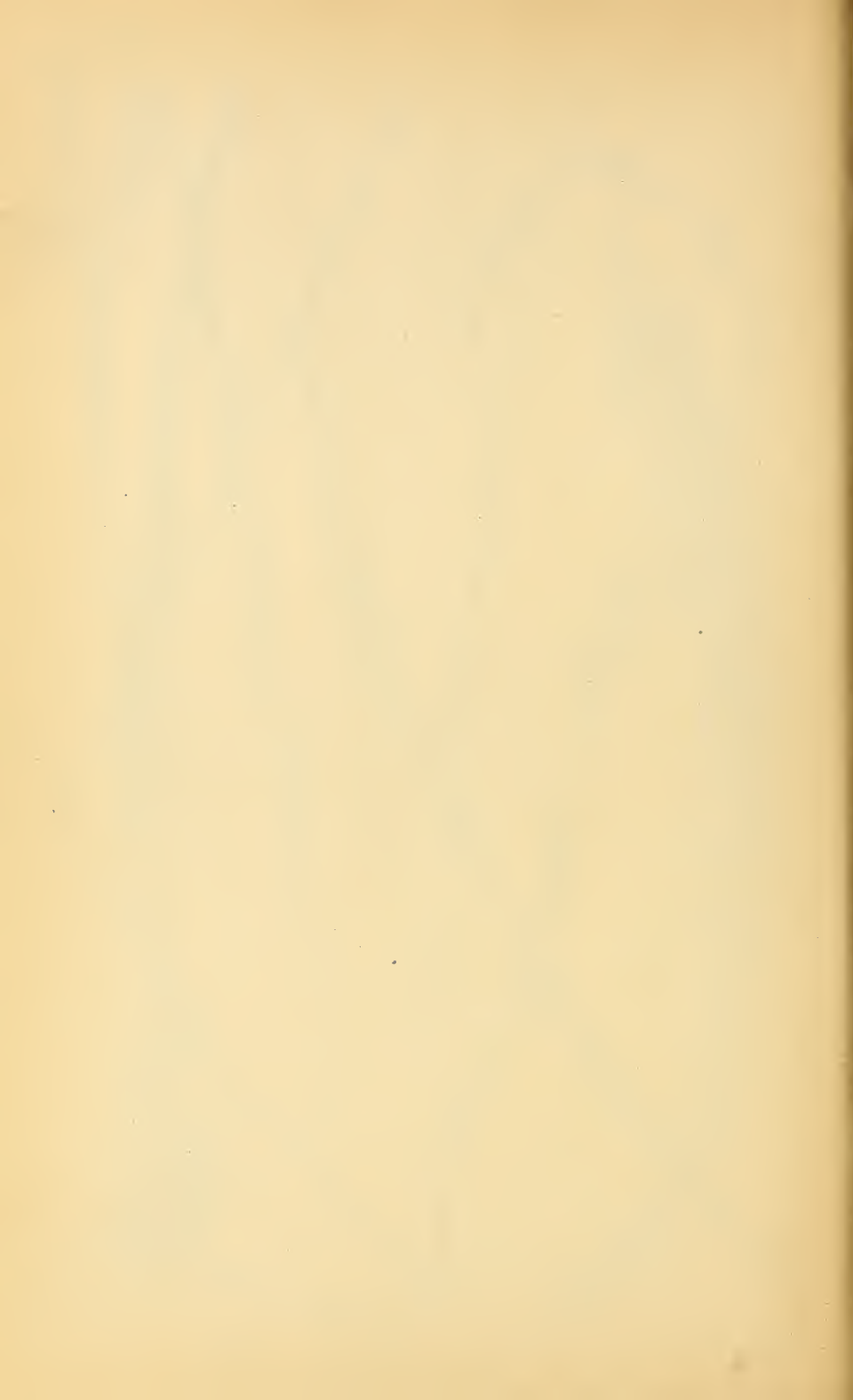
SETARIA ITALICA.





W. A. R. 20.

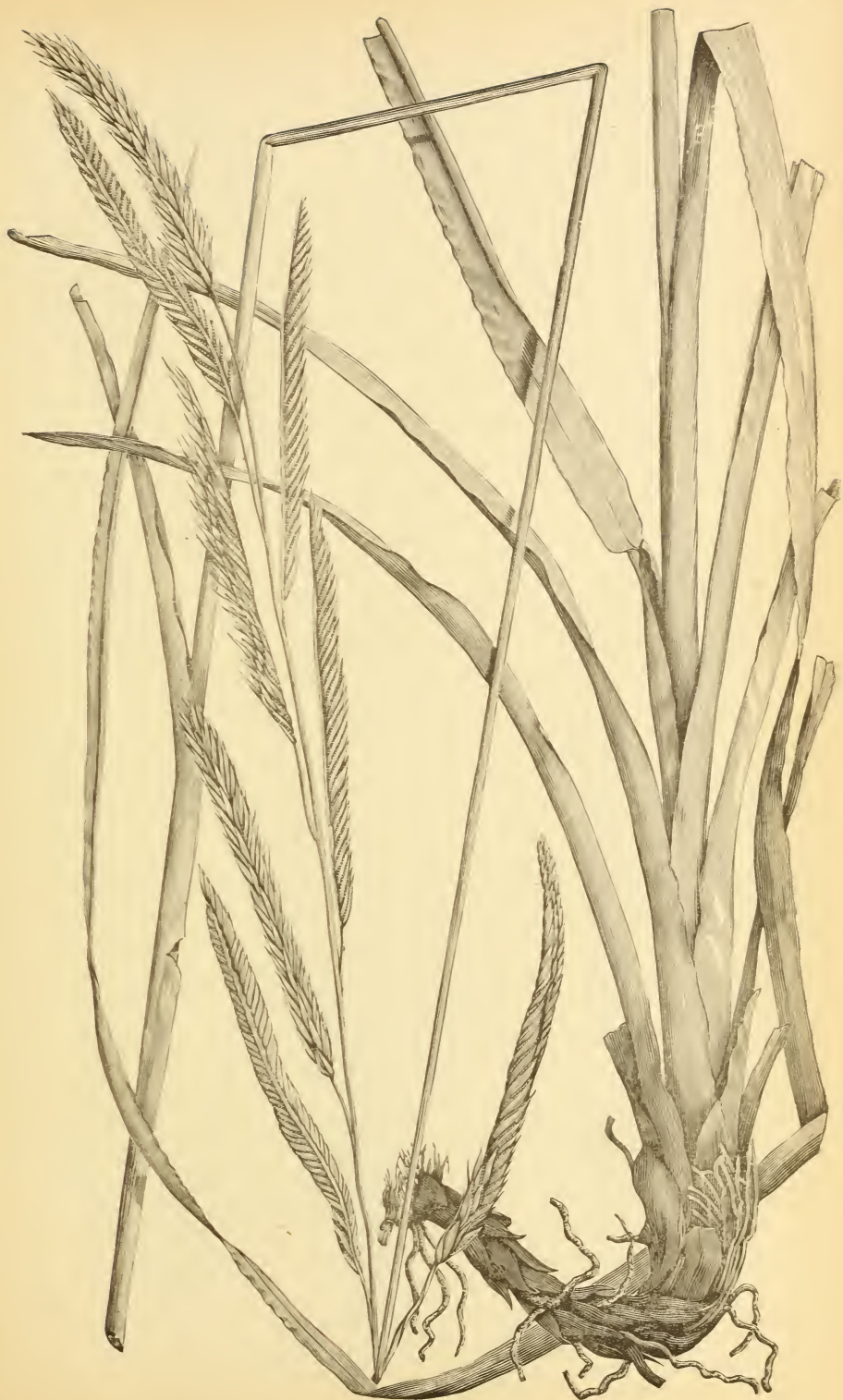
SETARIA SETOSA.











SPARTINA CYNOSUROIDES.





OPHEDEMANN. SC.

Marx del.

SPARTINA JUNCEA.

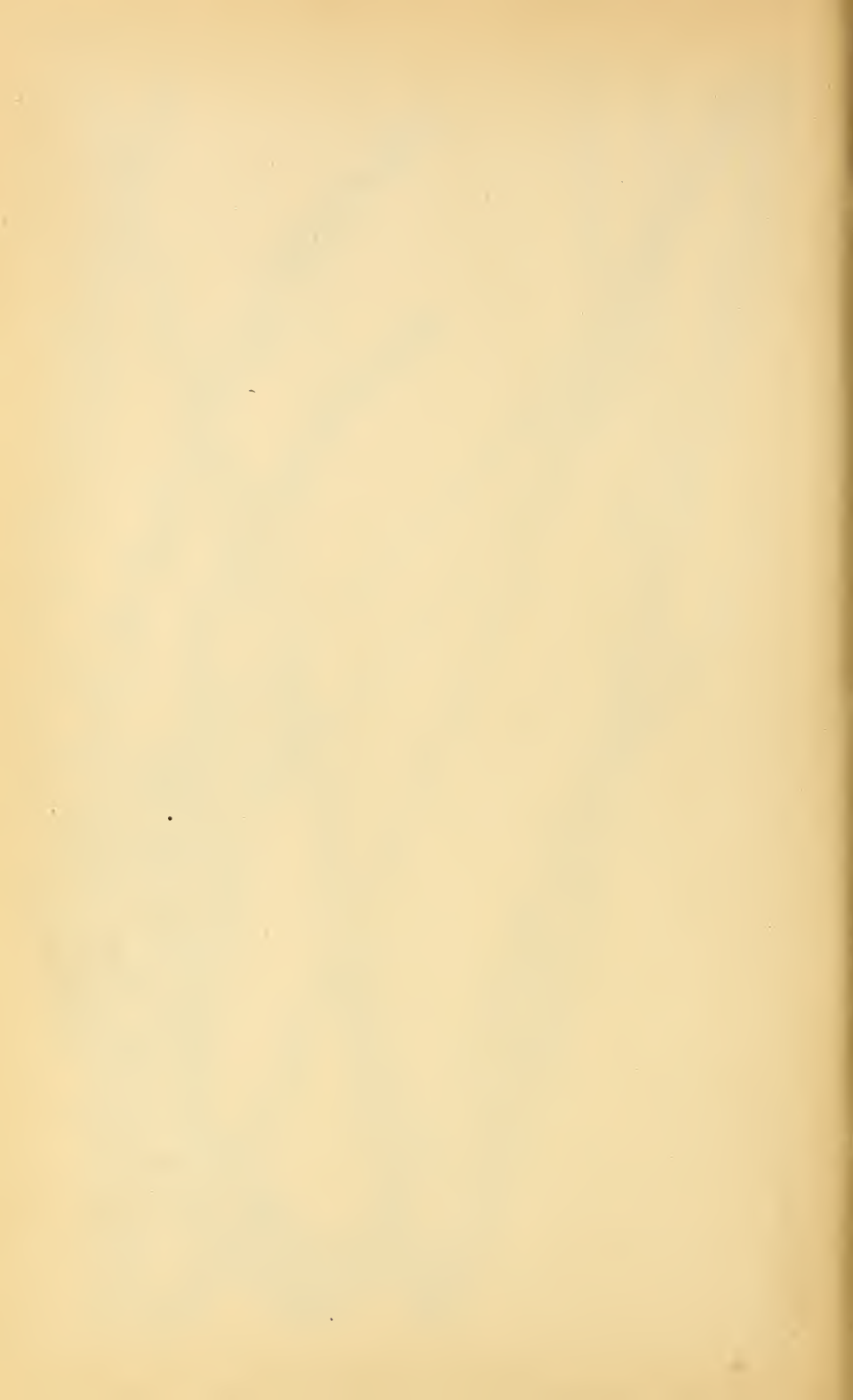




W. C. C. del.

H. H. M. Sc.

TRIPSACUM DACTYLOIDES.







ZIZANIA AQUATICA.





HILARIA JAMESII.



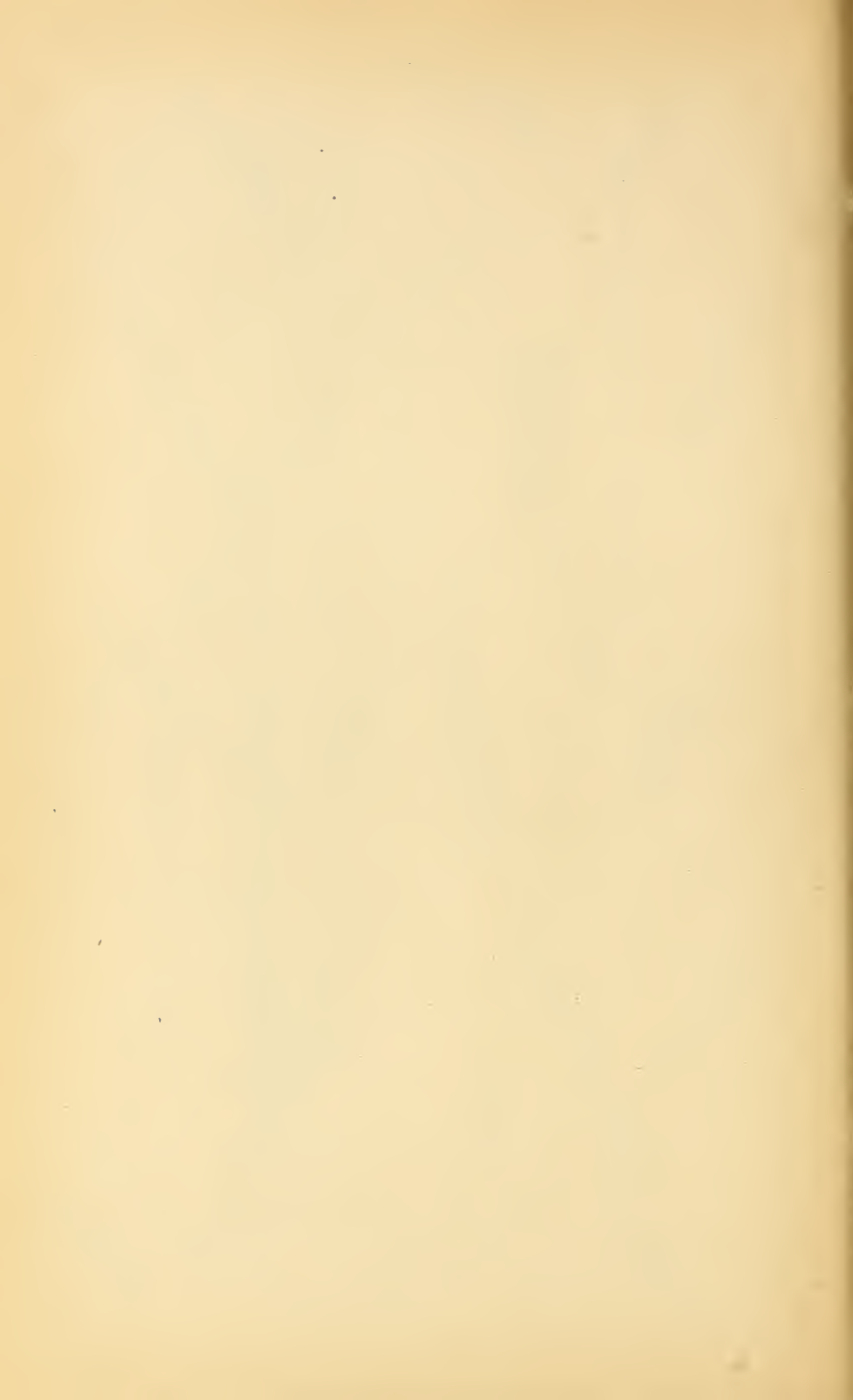


ANDROPOGON VIRGINICUS.





ANDROPOGON SCOPARIUS.





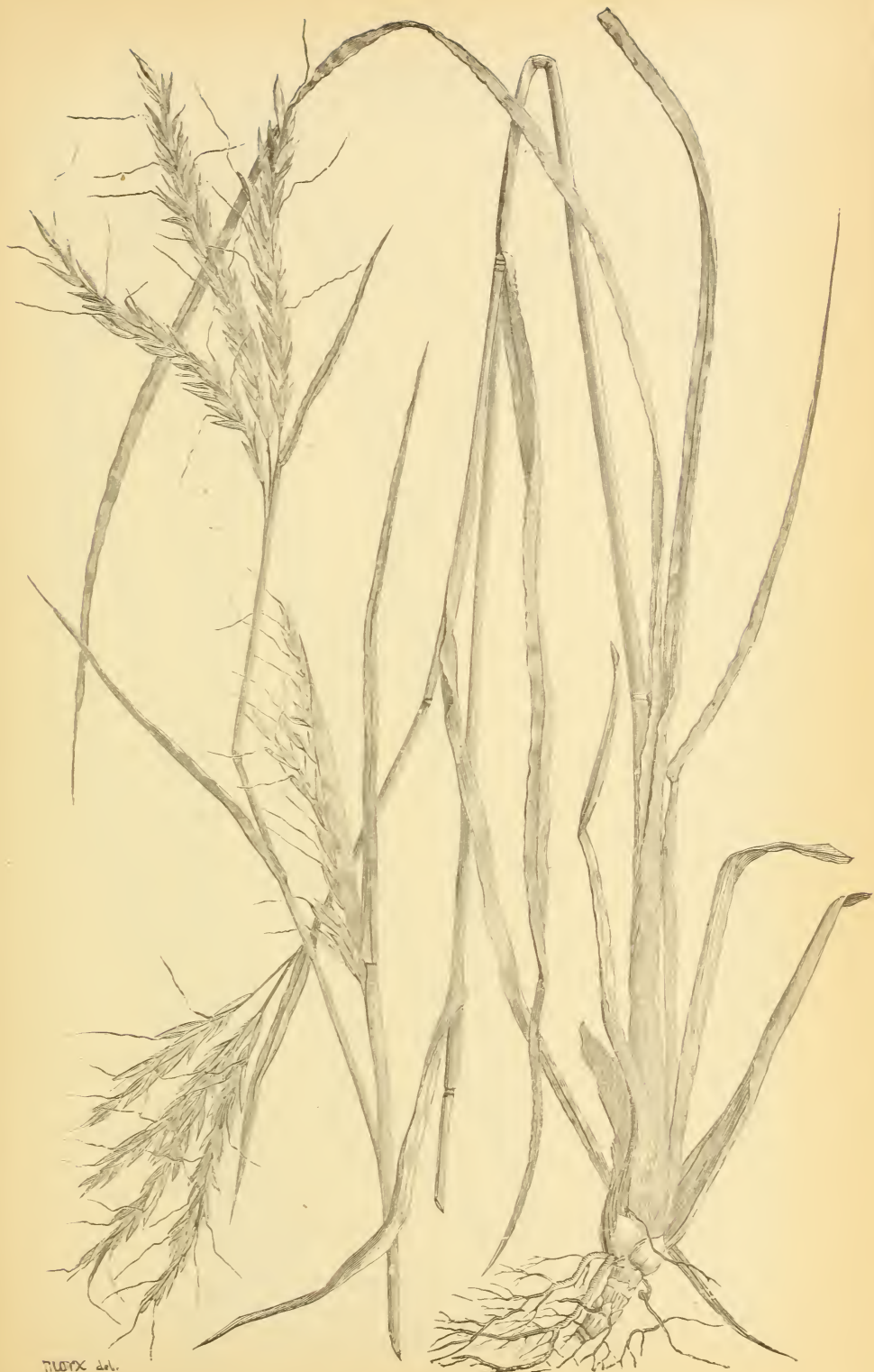


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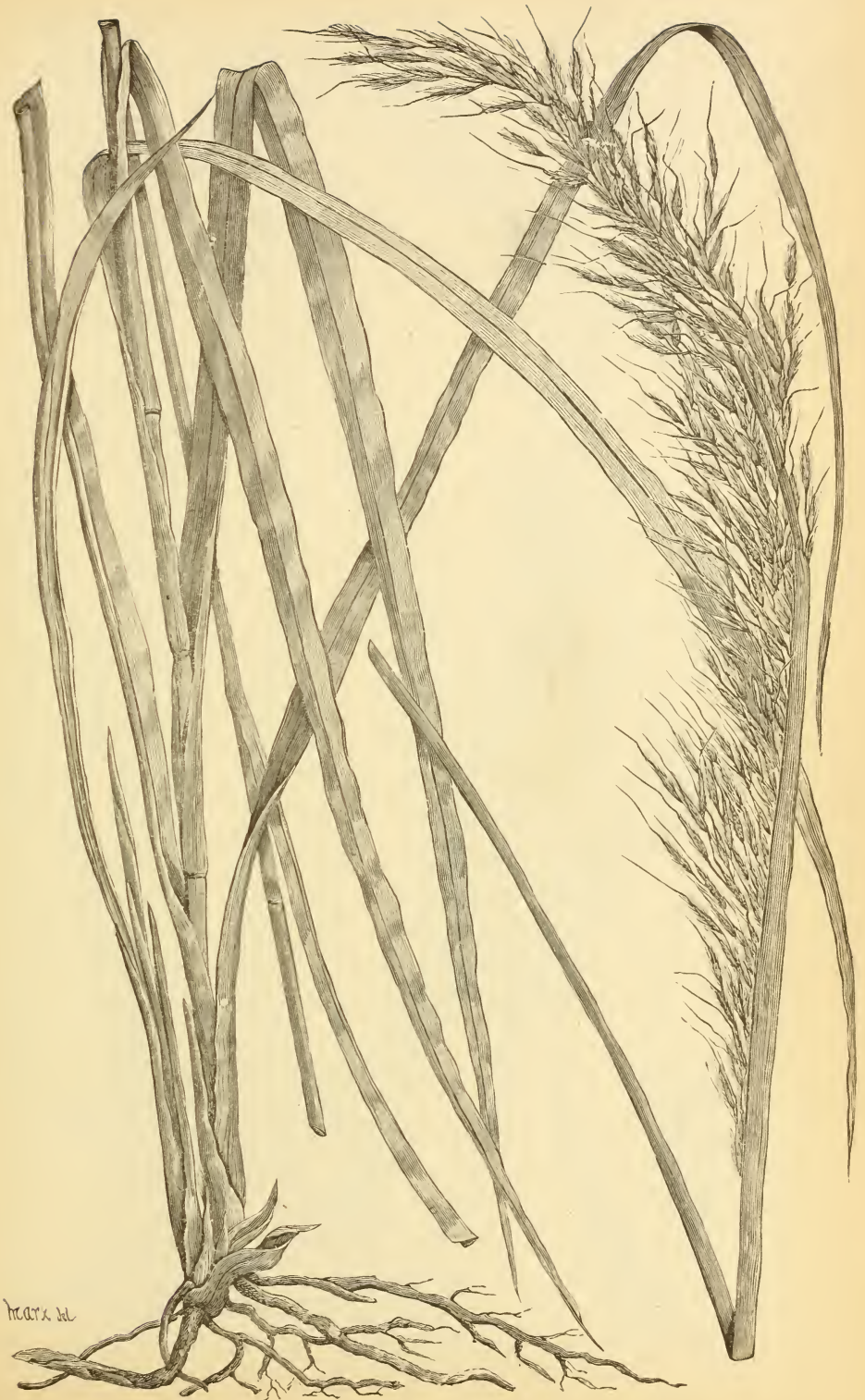




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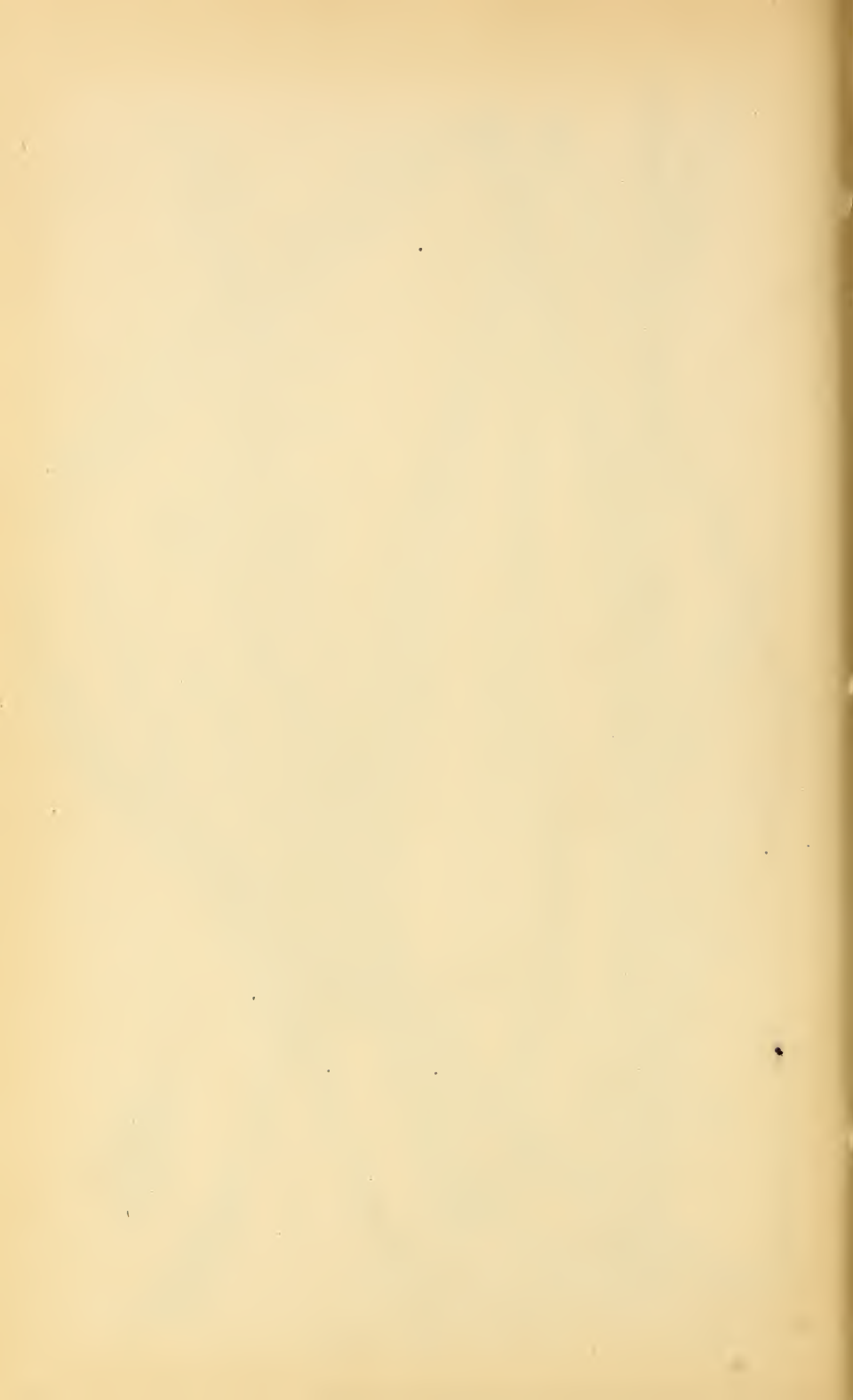


CHRYSOPOGON (SORGHUM) NUTANS.





SORGHUM HALAPENSE.







O. HEIDEMANN SC.

Marx del.

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H. NICHOLS. SC.

PHALARIS INTERMEDIA.

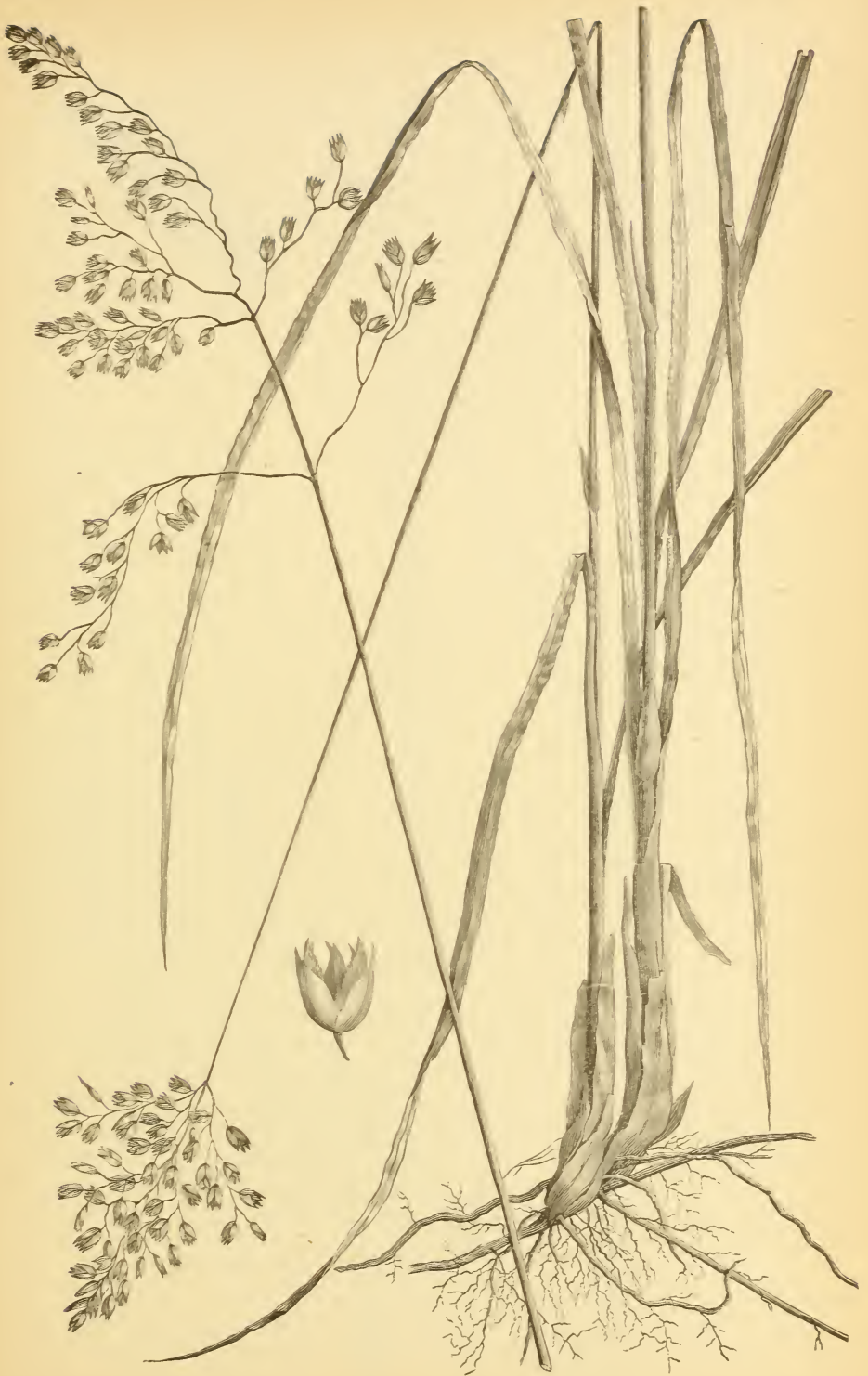




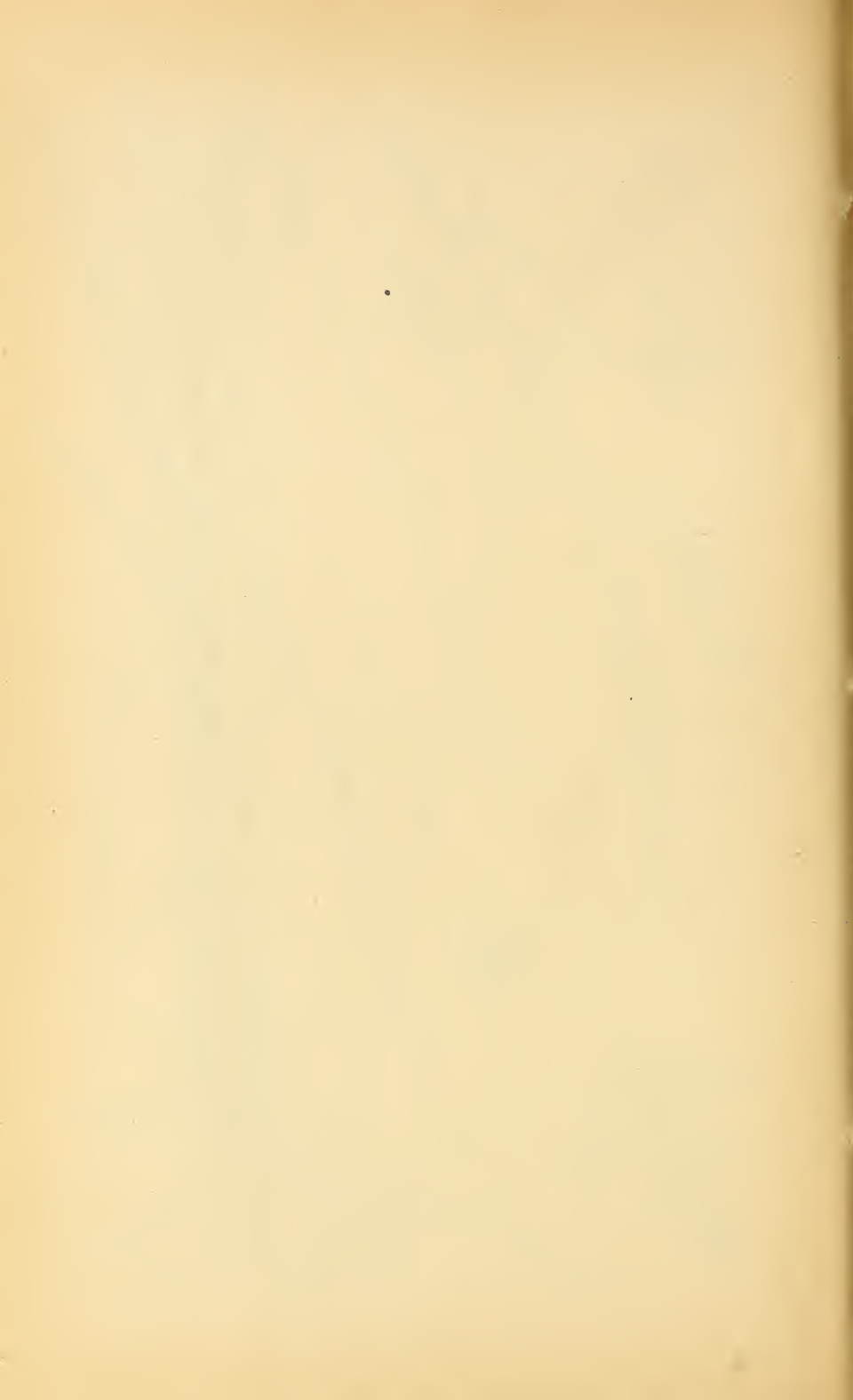
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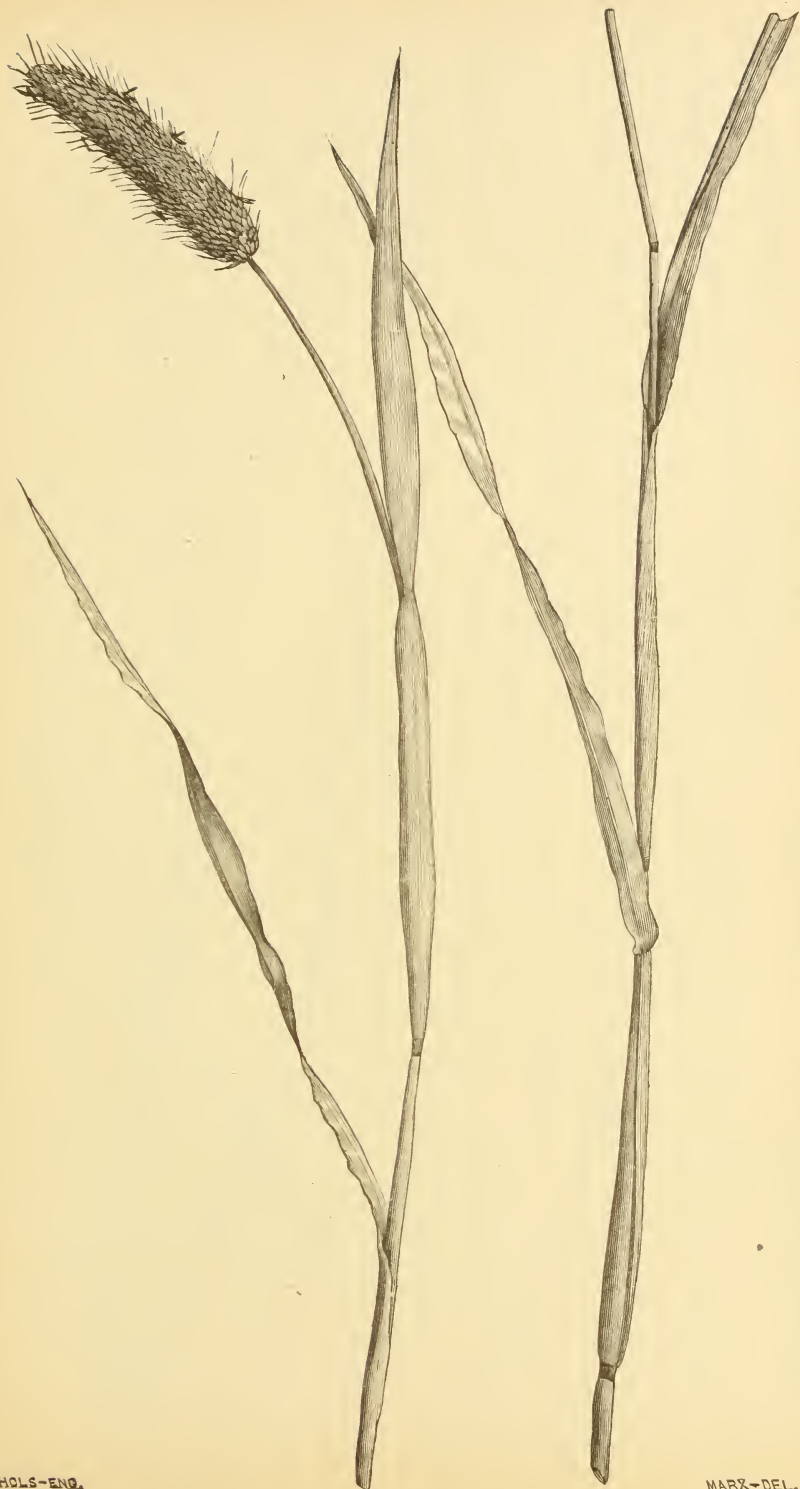




HIEROCHLOA BOREALIS.





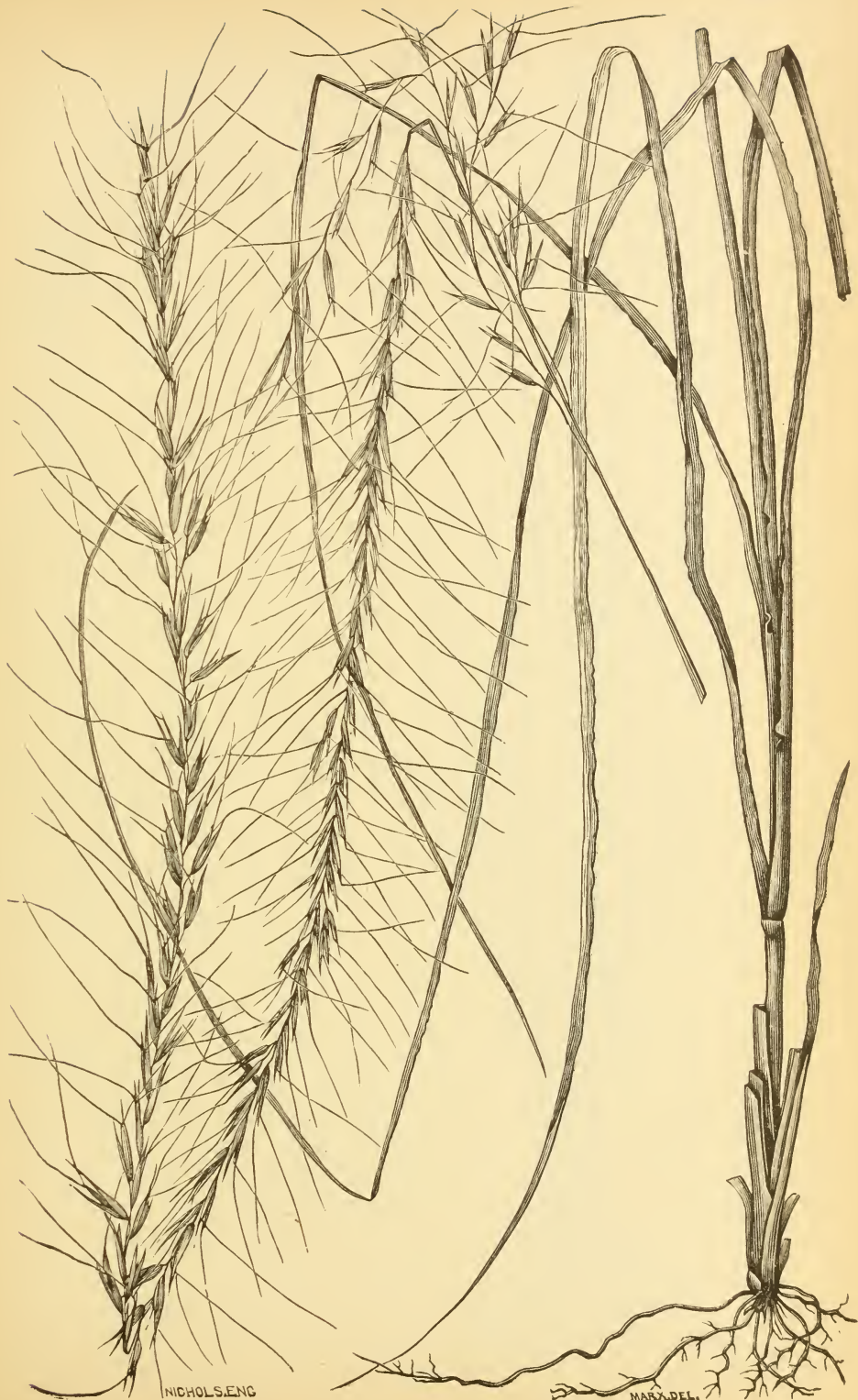


H.H.NICHOLS-ENG.

WARX-DEL.

ALOPECURUS PRATENSIS.





NICHOLS.ENG

MARX.DEL.

ARISTIDA PURPURASCENS.





H.H. NICHOLS-ENG.

MARX. DEL.

ARISTIDA PURPUREA.



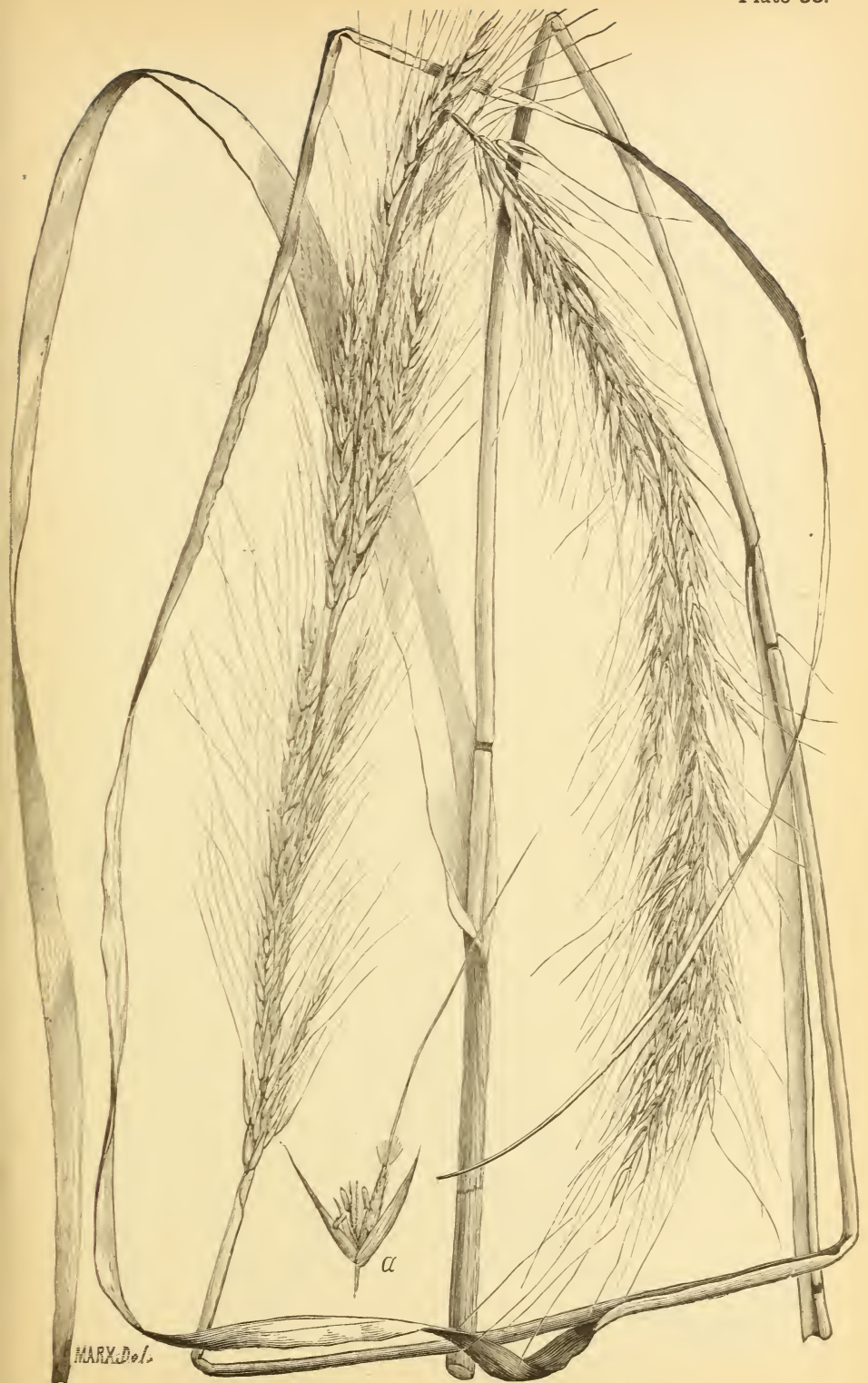


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ARISTIDA BROMOIDES.







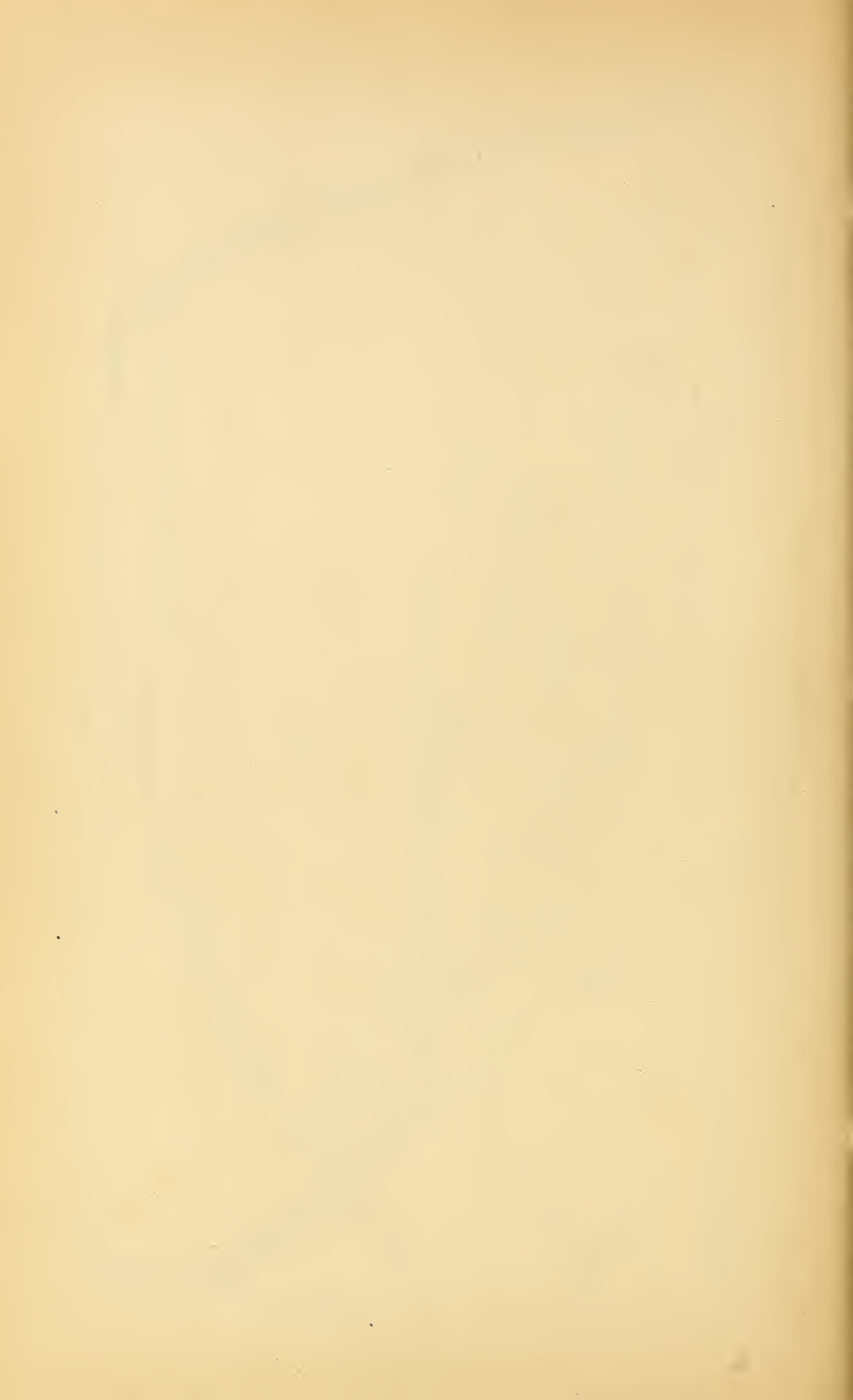
WARR. D. L.

STIPA VIRIDULA.





STIPA SETIGERA.





J. Taylor del

HHN

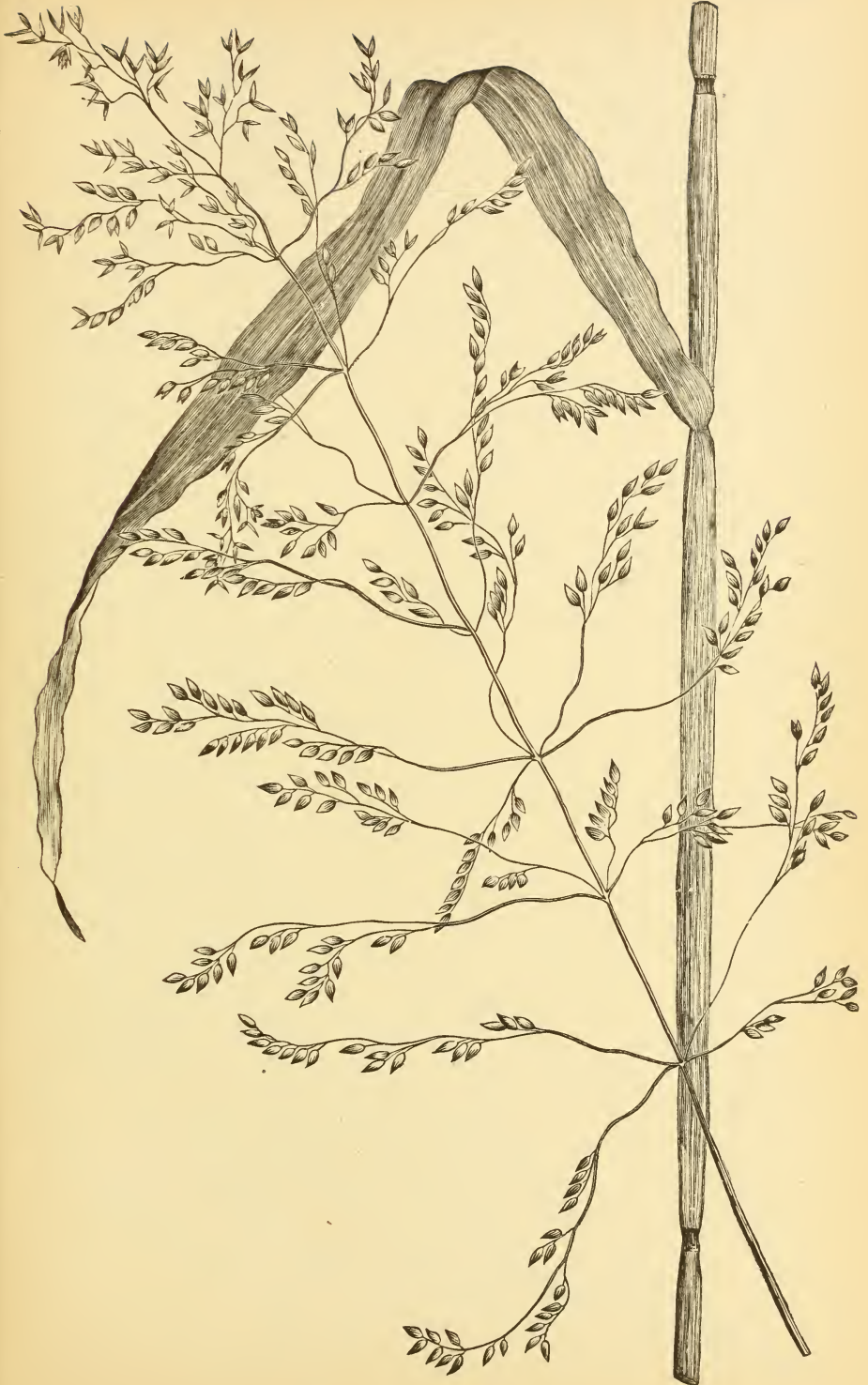
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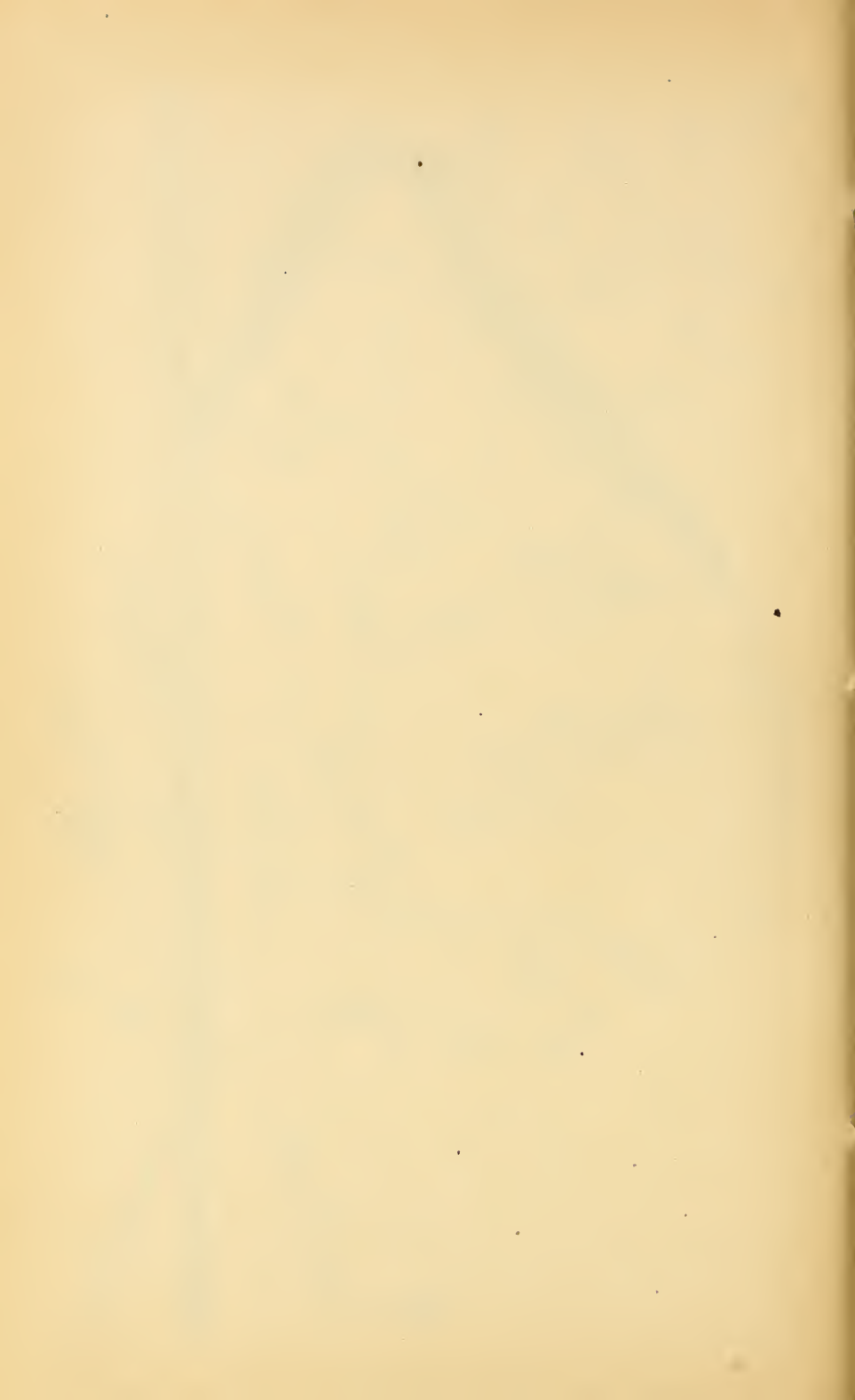


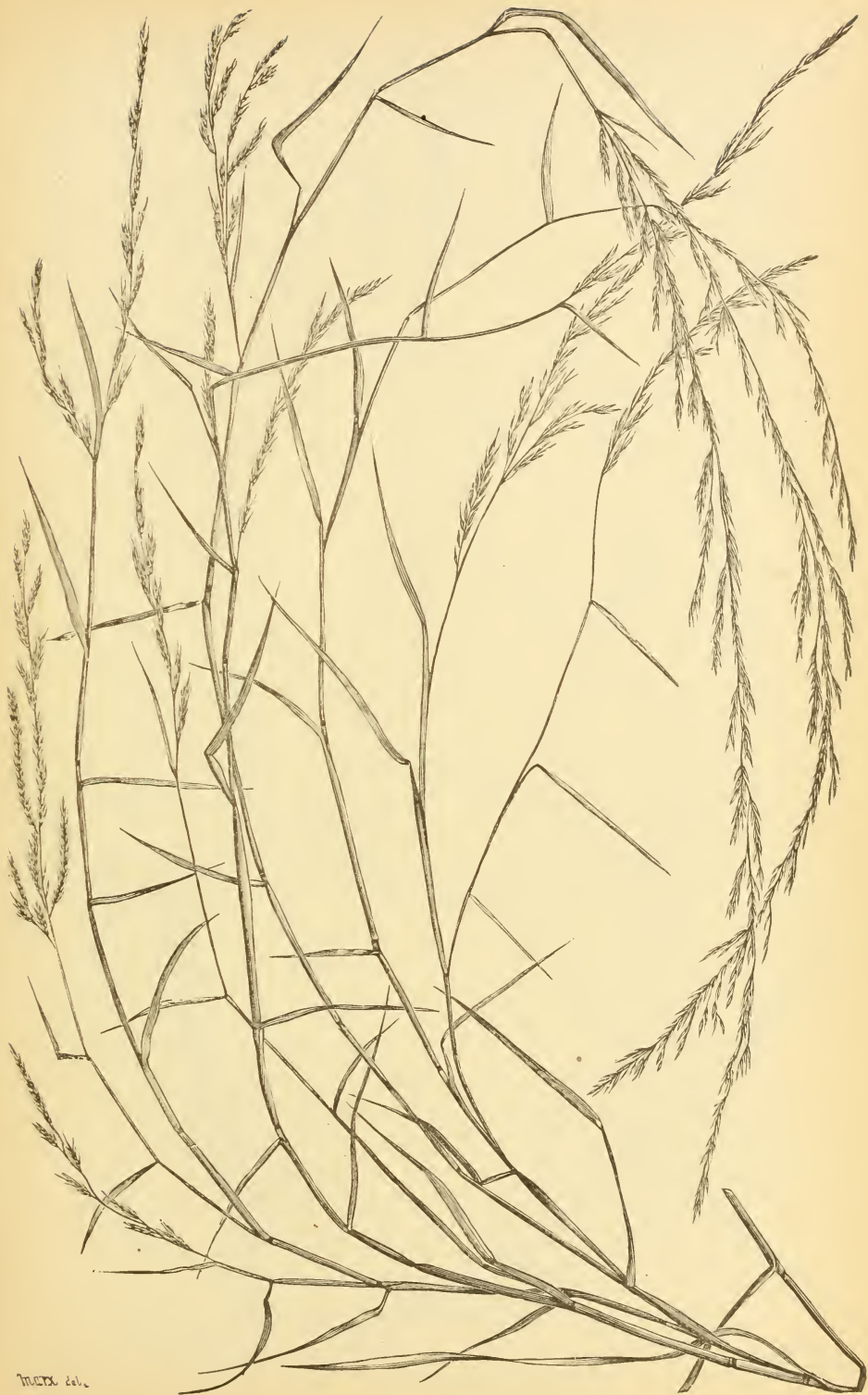






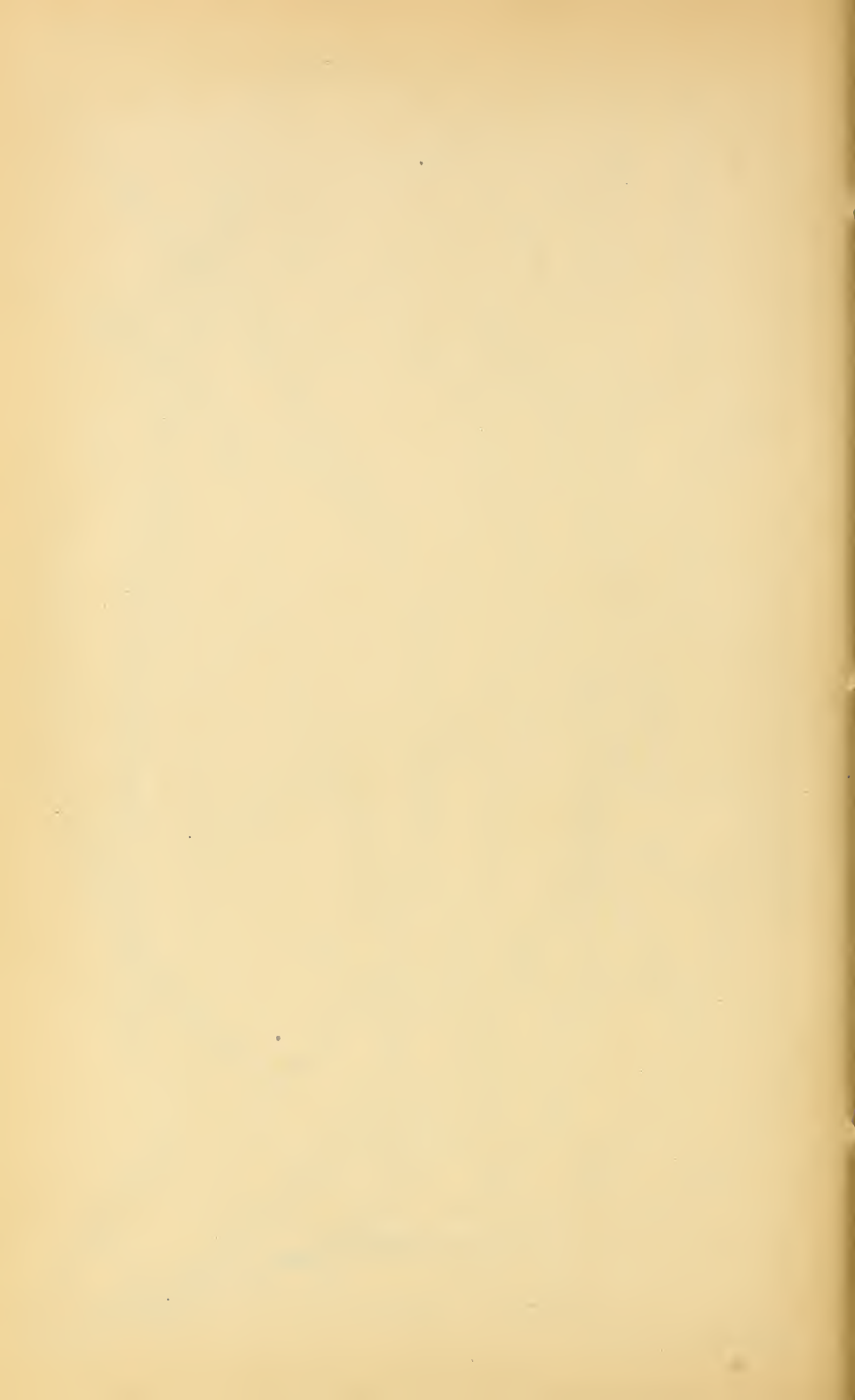
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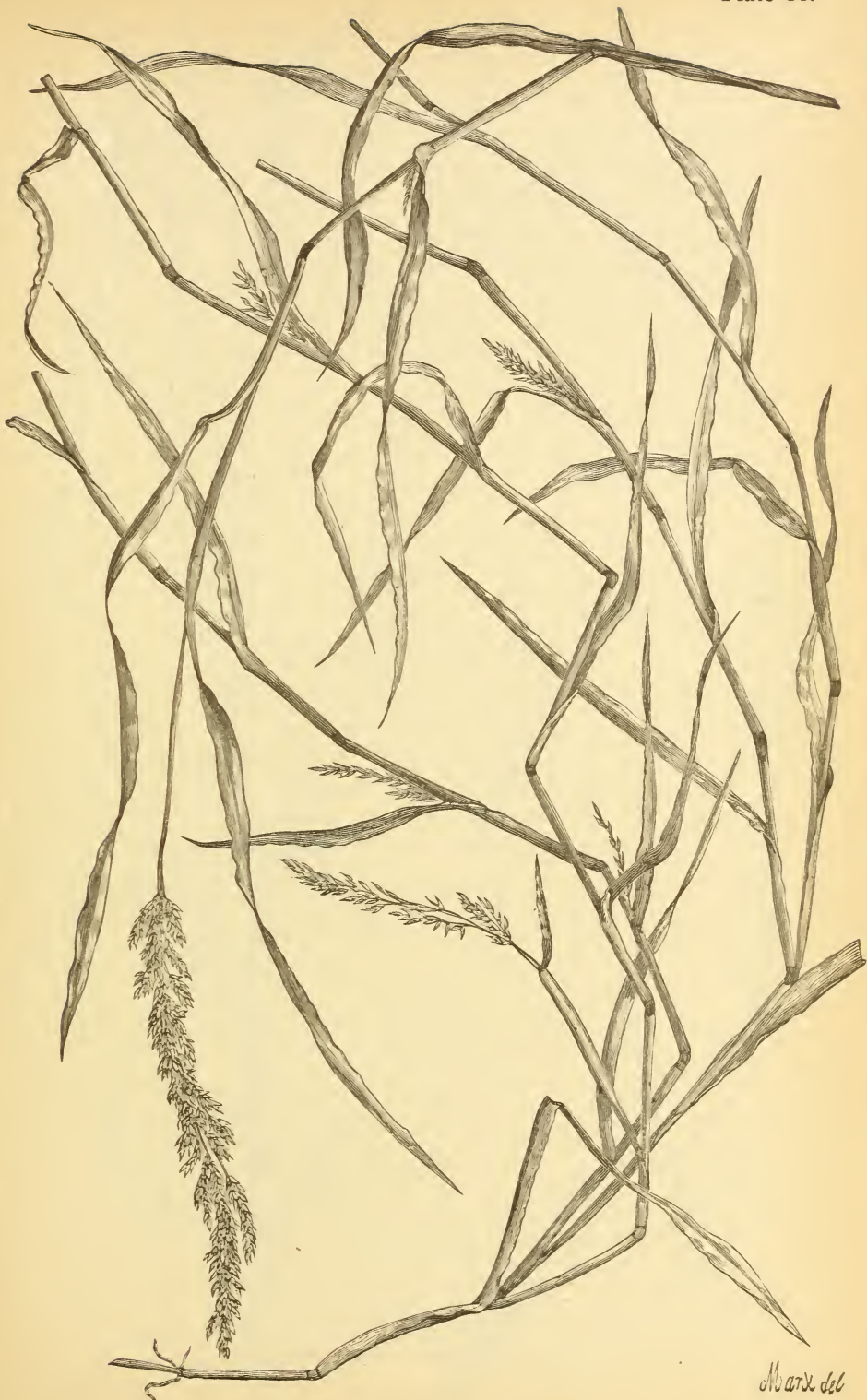




WATSON del.

MUHLENBERGIA DIFFUSA.

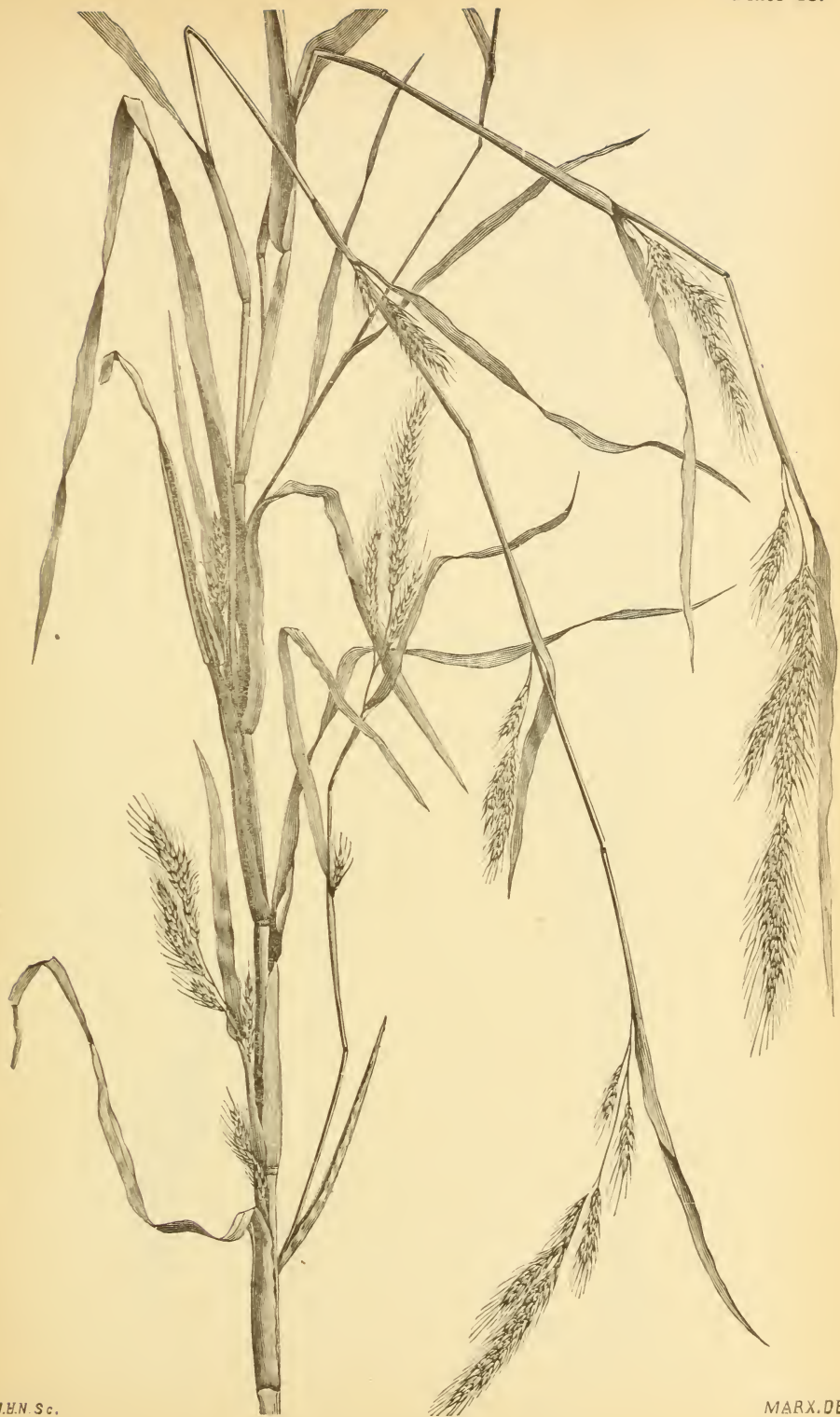




*M. A. del*

MUHLENBERGIA MEXICANA.





B.H.N. Sc.

MARX. DEL

MUHLENBERGIA SYLVATICA.







WASZ. DEL.

H.H. NICHOLS. E!

MUHLENBERGIA GLOMERATA.





MAX. DEL.

H. NICHOLS.

MUHLENBERGIA COMATA.





MUHLENBERGIA GRACILIS.





PHLEUM PRATENSE.

Mark. & C.







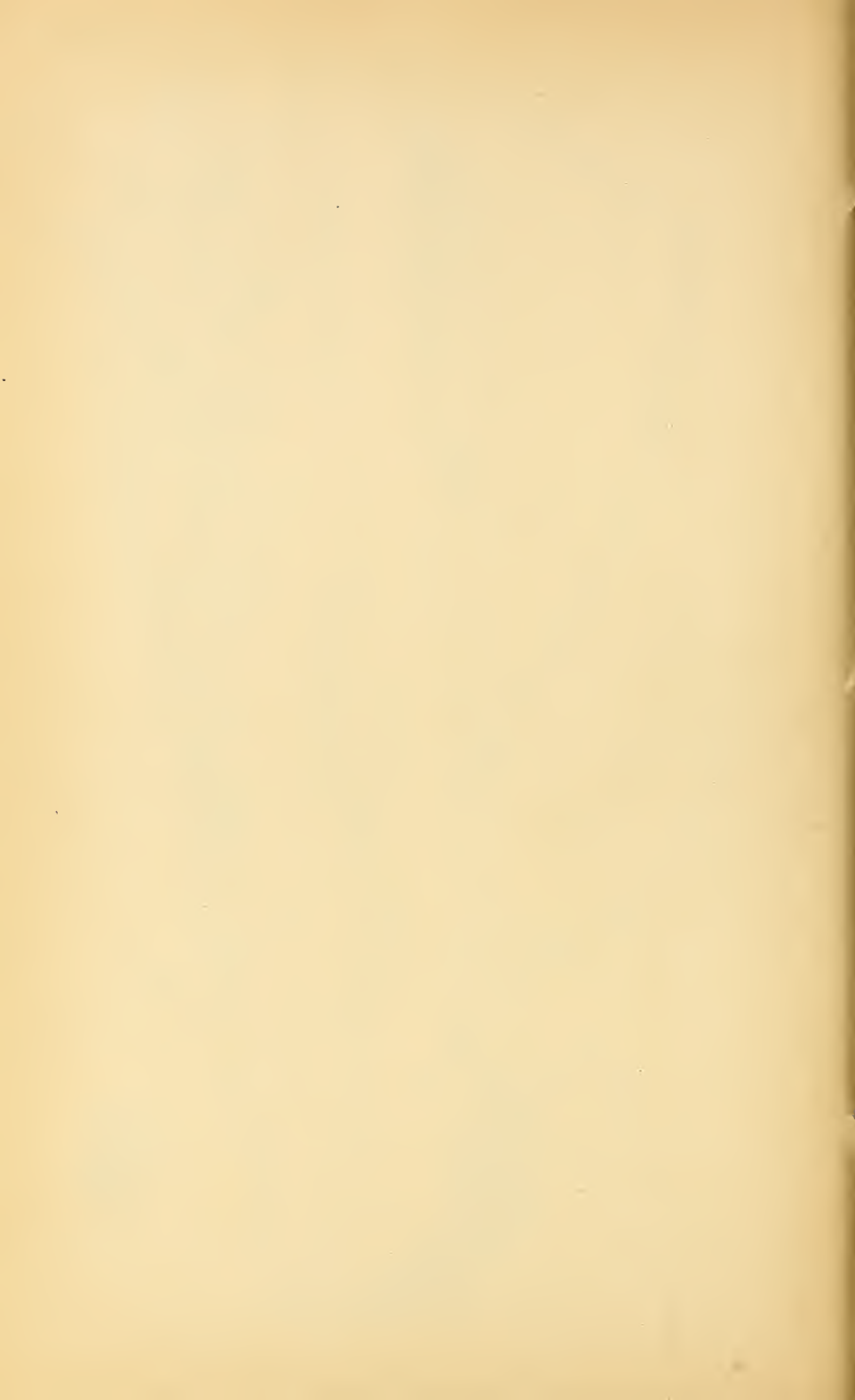
SPOROBOLUS INDICUS.





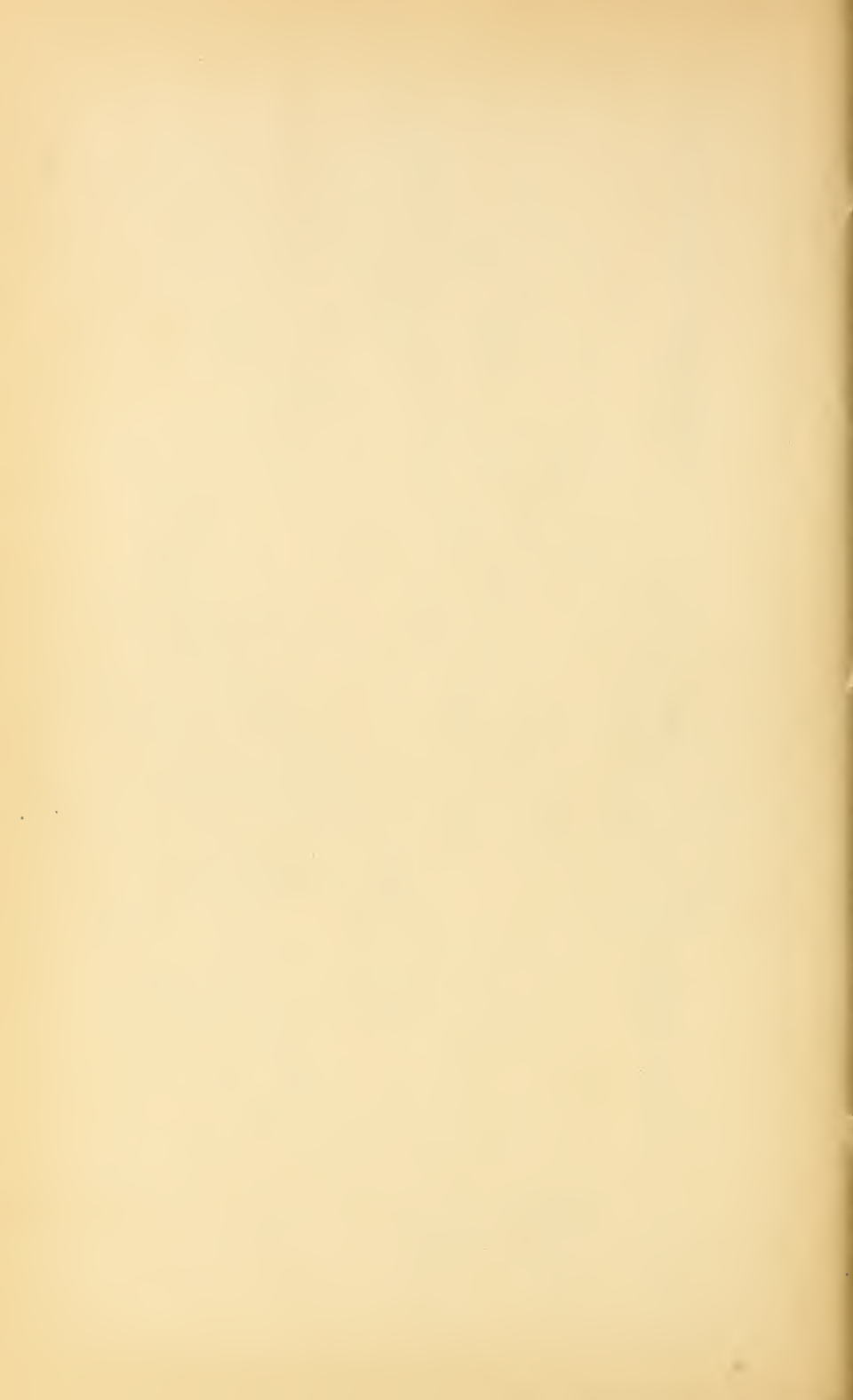
Murr det.

SPOROBOLUS CRYPTANDRUS.





SPOROBOLUS AIROIDES.





B.H.V.

MARX DEL.

AGROSTIS VULGARIS.







AGROSTIS EXARATA.





max del.

H.H.N.

AGROSTIS EXARATA (var.).





AGROSTIS MICROPHYLLA.

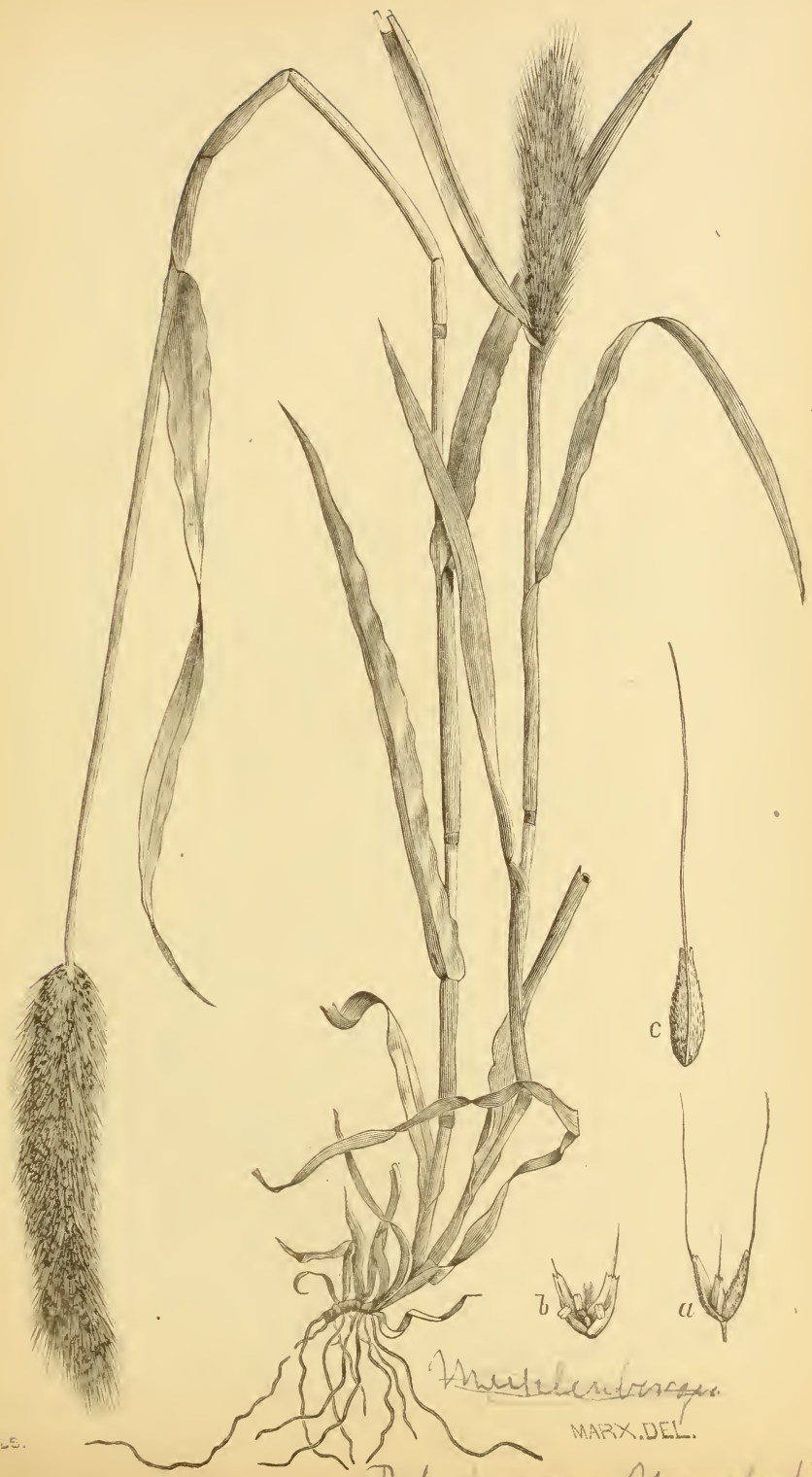




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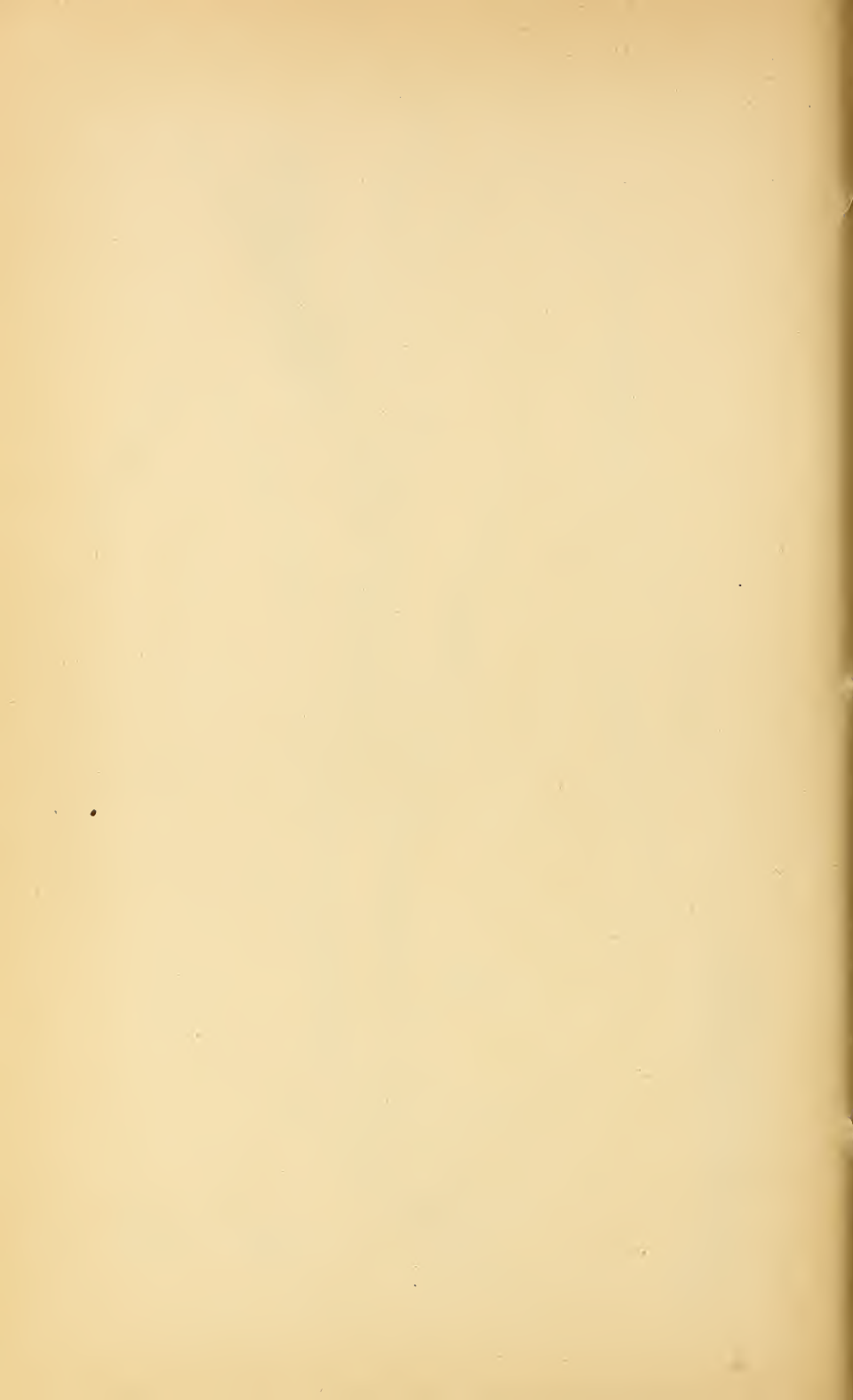


*Thurbergia*

MARX. DEL.

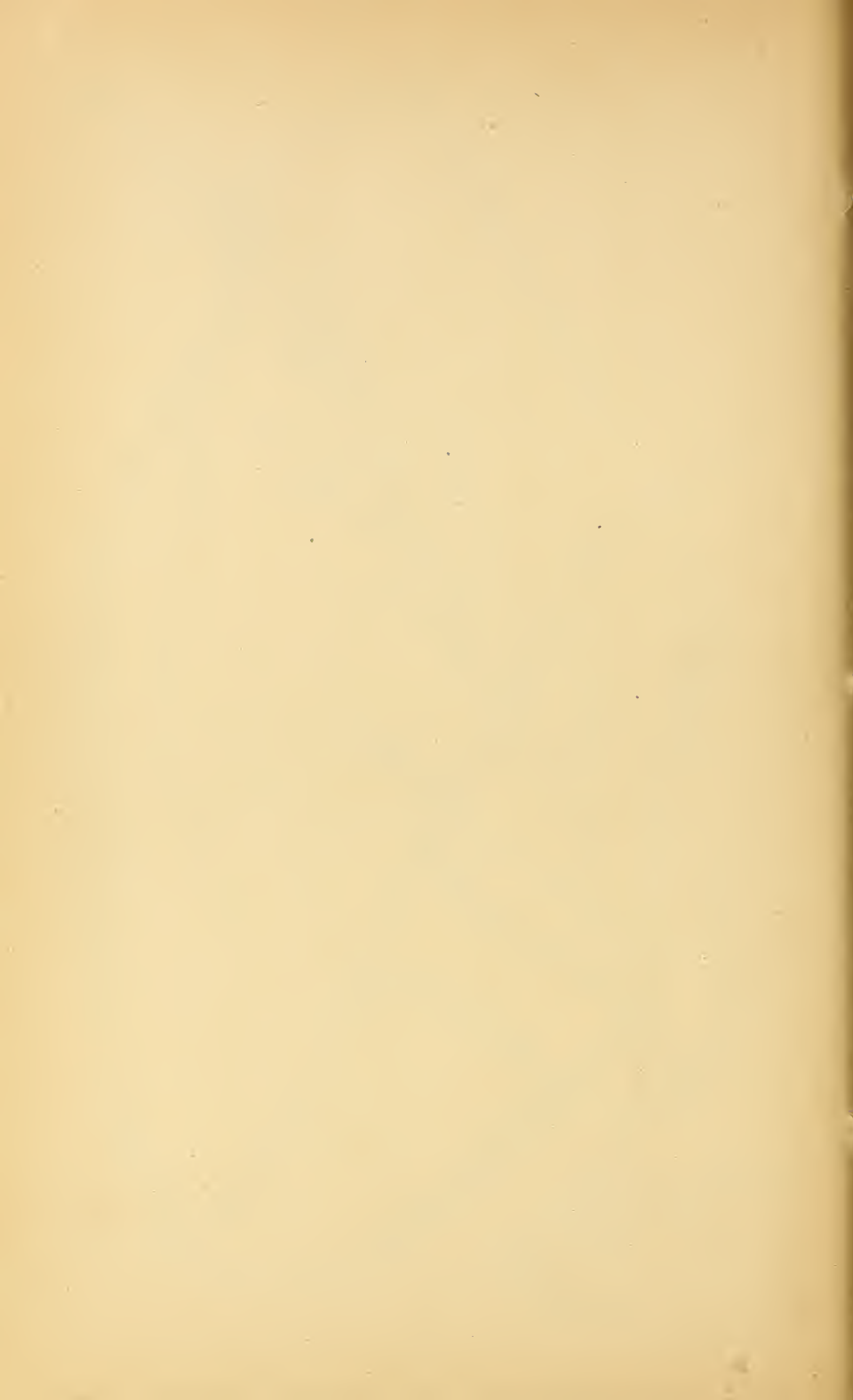
*Polygala Thurbergia*

PL. NICHOL. S.





CINNA ARUNDINACEA.

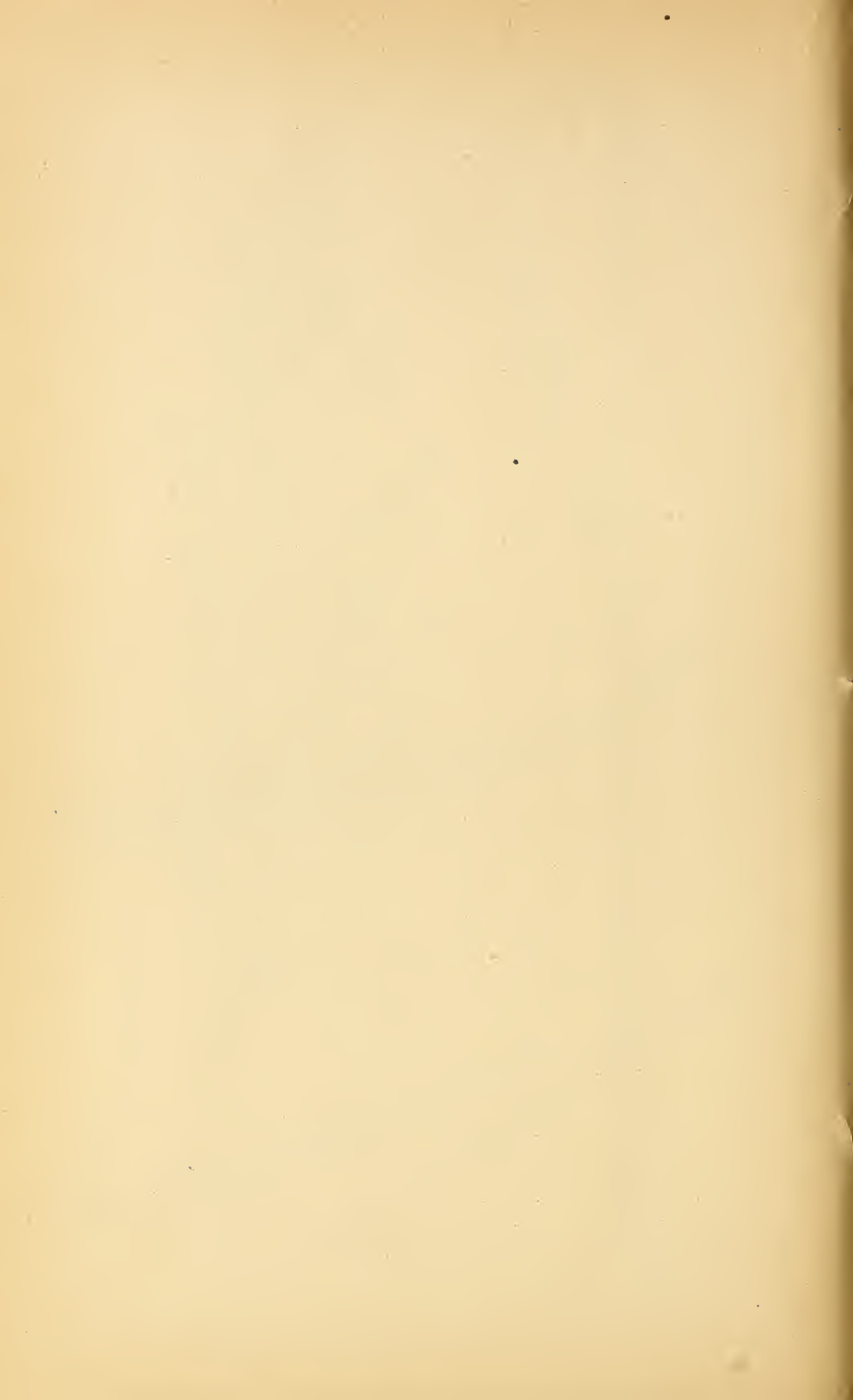




NICHOLS-ENG.

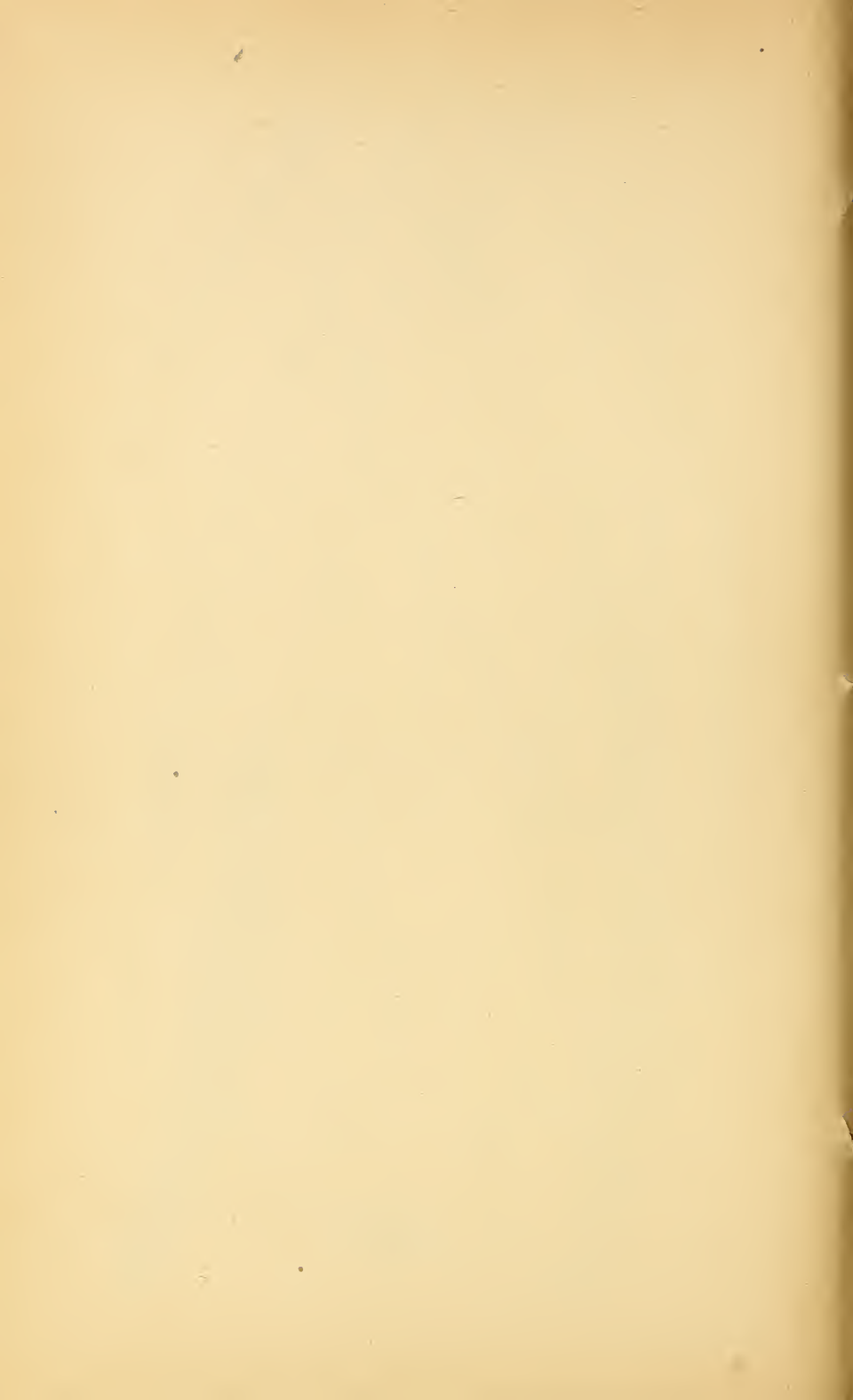
MARX-DEL.

DEYEUXIA (CALAMAGROSTIS) CANADENSIS.

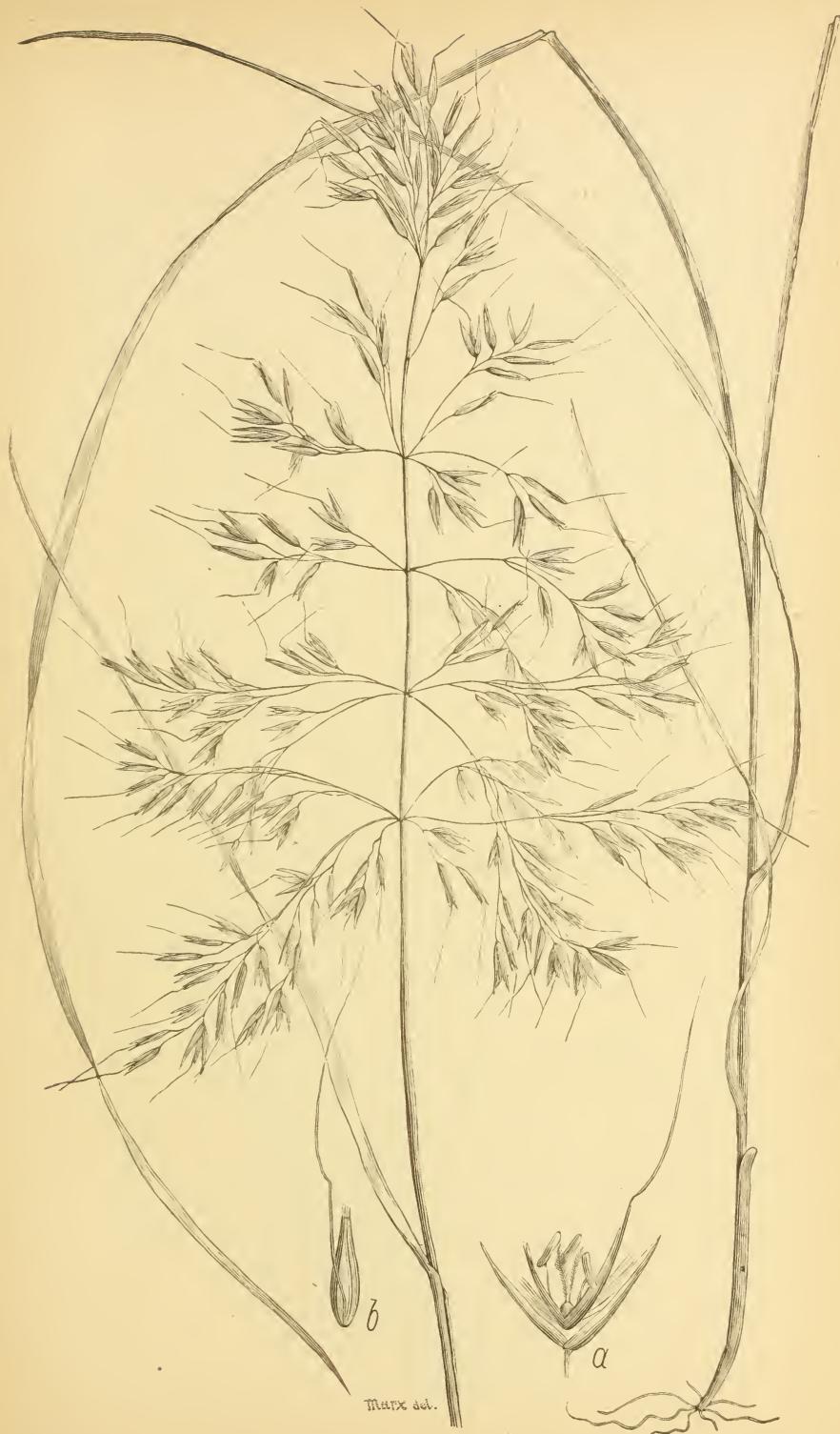




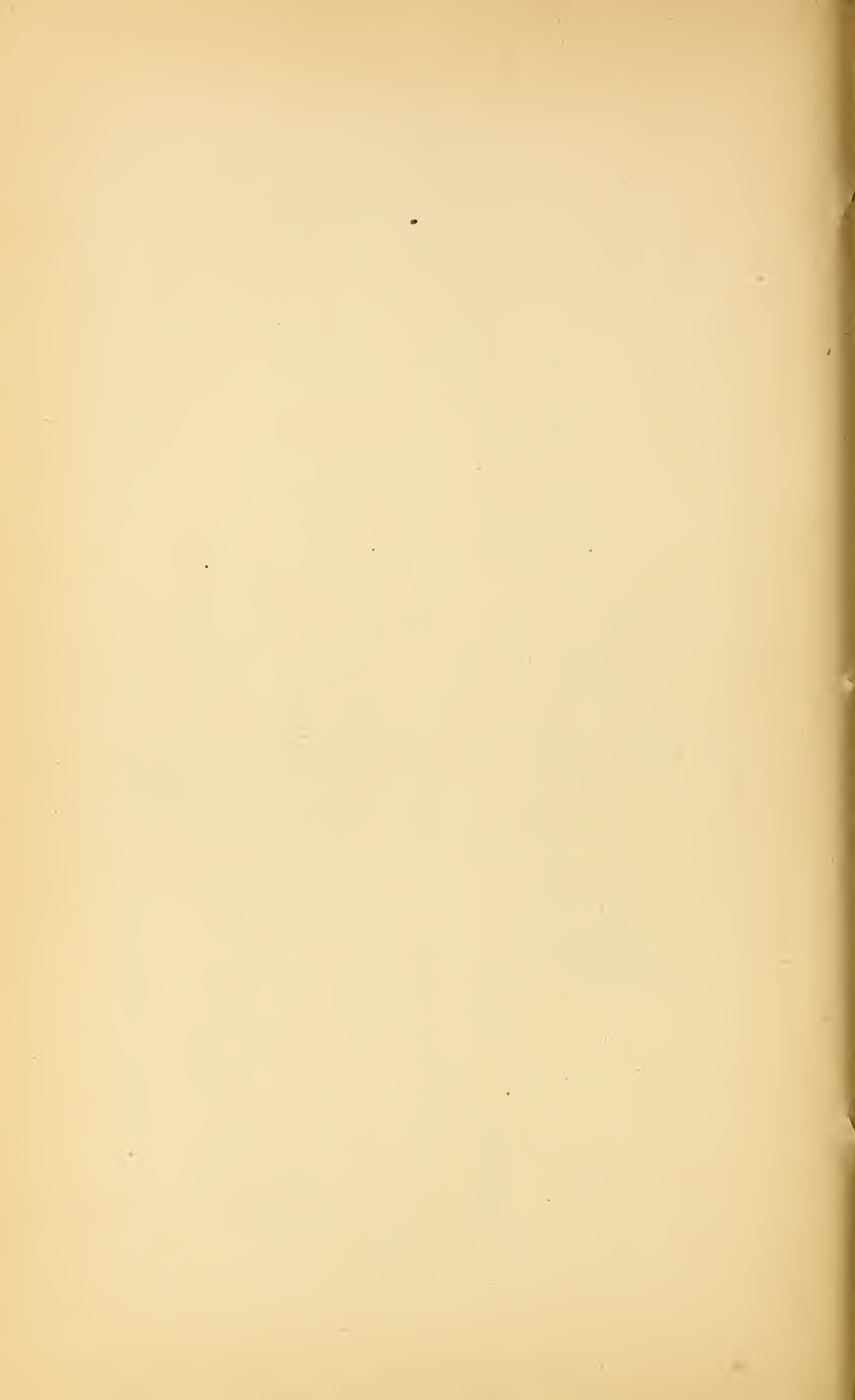
DEYEUXIA (CALAMAGROSTIS) SYLVATICA.







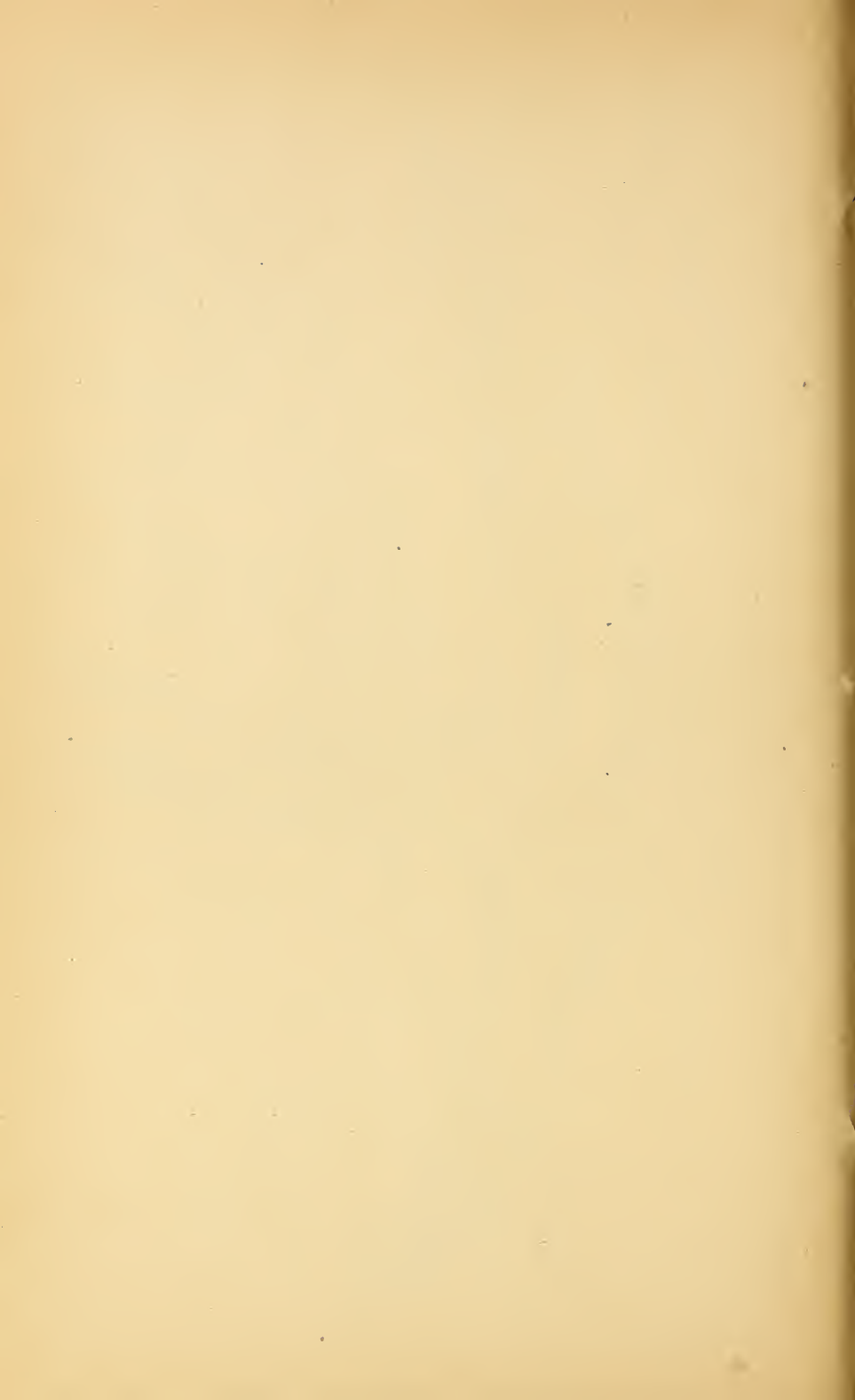
DEYEUXIA HOWELLII.





*Monard*

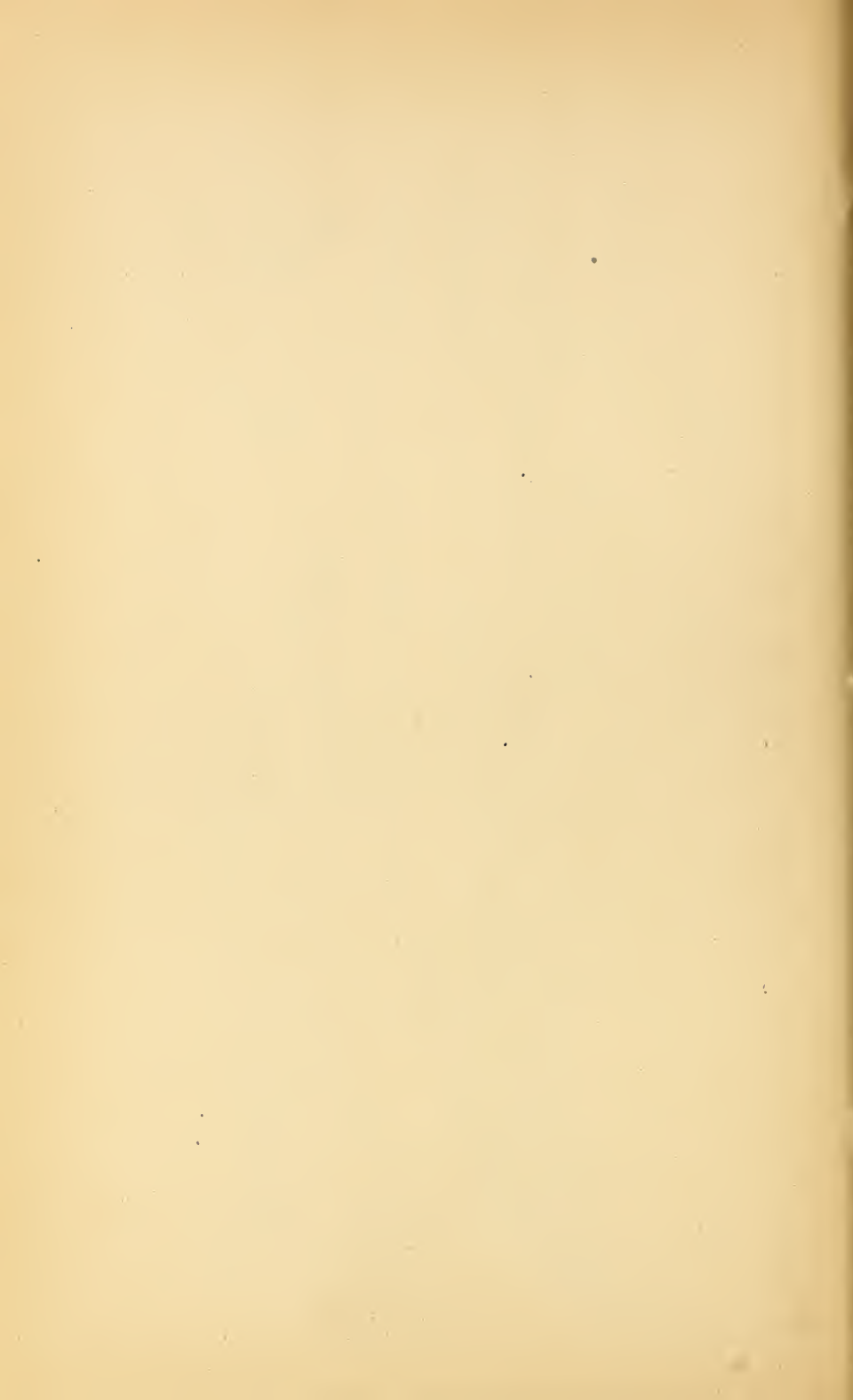
DESCHAMPSIA (AIRA) CAESPITOSA.





MAY del

DESCHAMPsia (AIRA) DANTHONIOIDES.





H. H. Nichols Sc

Worce del.

HOLCUS LANATUS.







Marx del.

TRISETUM PALUSTRE.





H.H. NICHOLS.

T. TAYLOR DEL.

TRISETUM CERNUUM.





W. M. C. D. S.

W. M. C. D. S.

TRISETUM SUBSPICATUM.





AVENA FATUA.

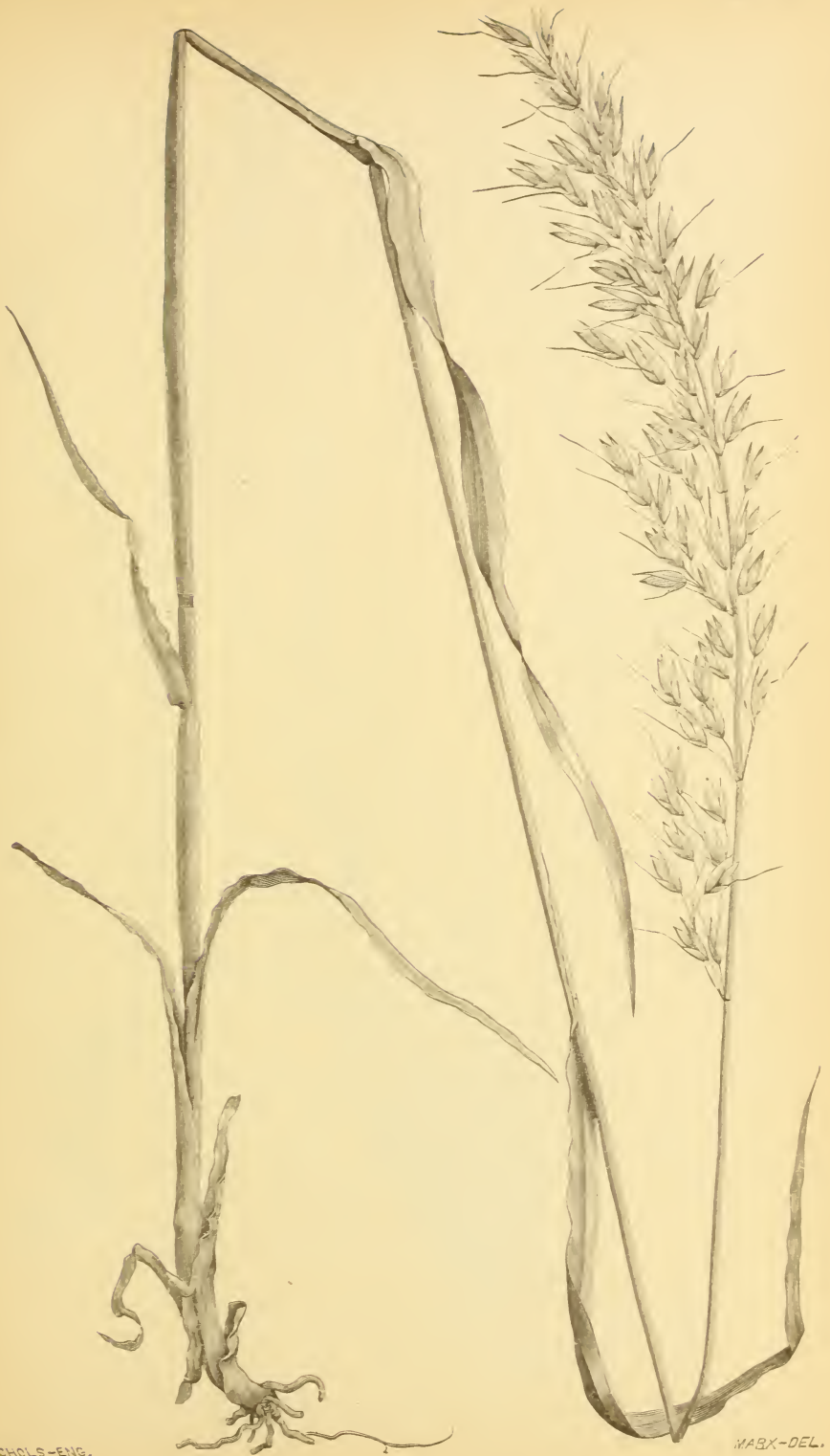






AVENA STRIATA.





WCHOLS-ENG.

MABX-DEL.

ARRHENATHERUM AVENACEUM.



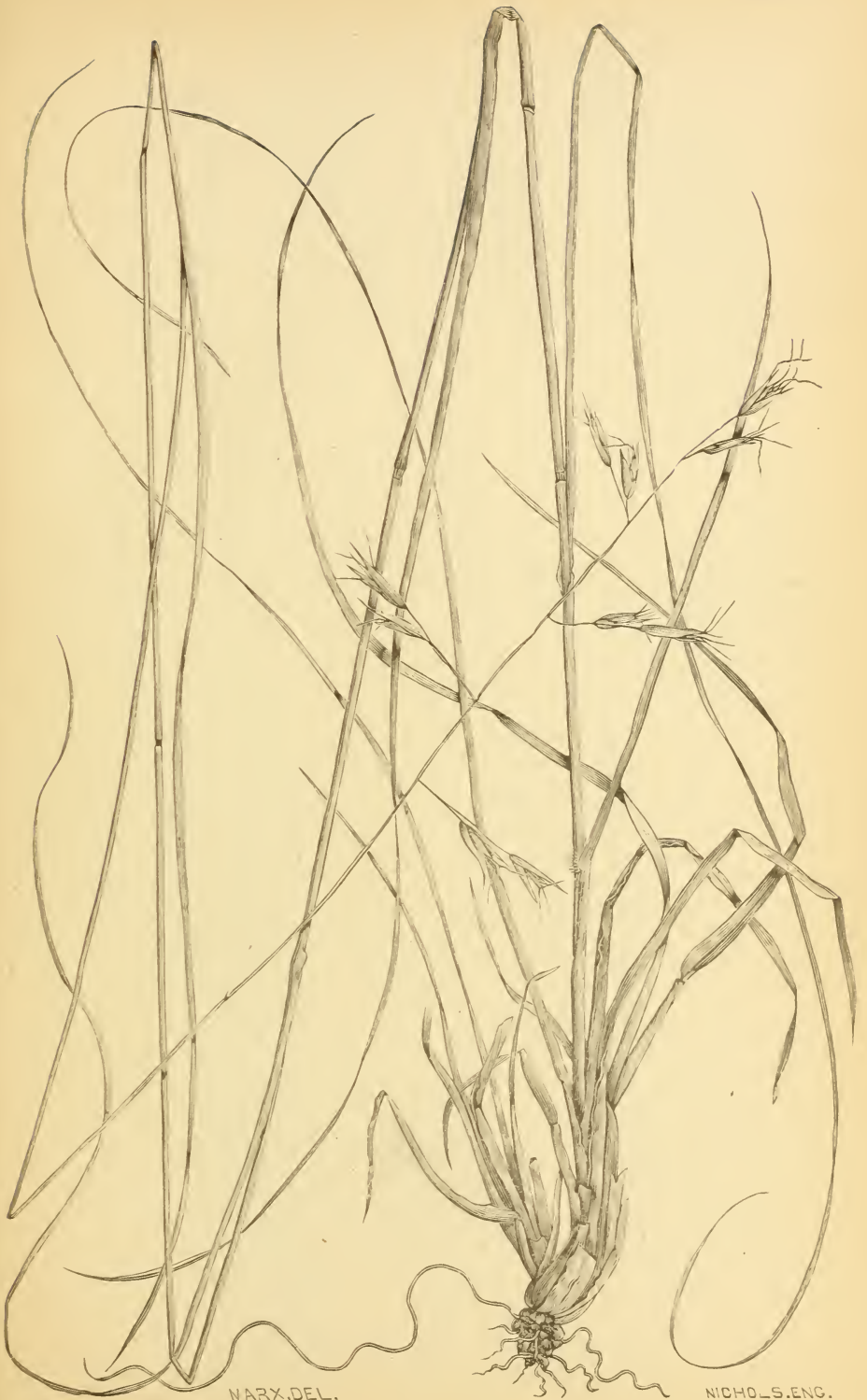


H. NICHOLS.

MARX DEL.

DANTHONIA SPICATA.





NARY.DEL.

NICHOLS.ENG.

DANTHONIA COMPRESSA.







DANTHONIA SERICEA.





MARX. DEL.

W. H. G.

DANTHONIA CALIFORNICA



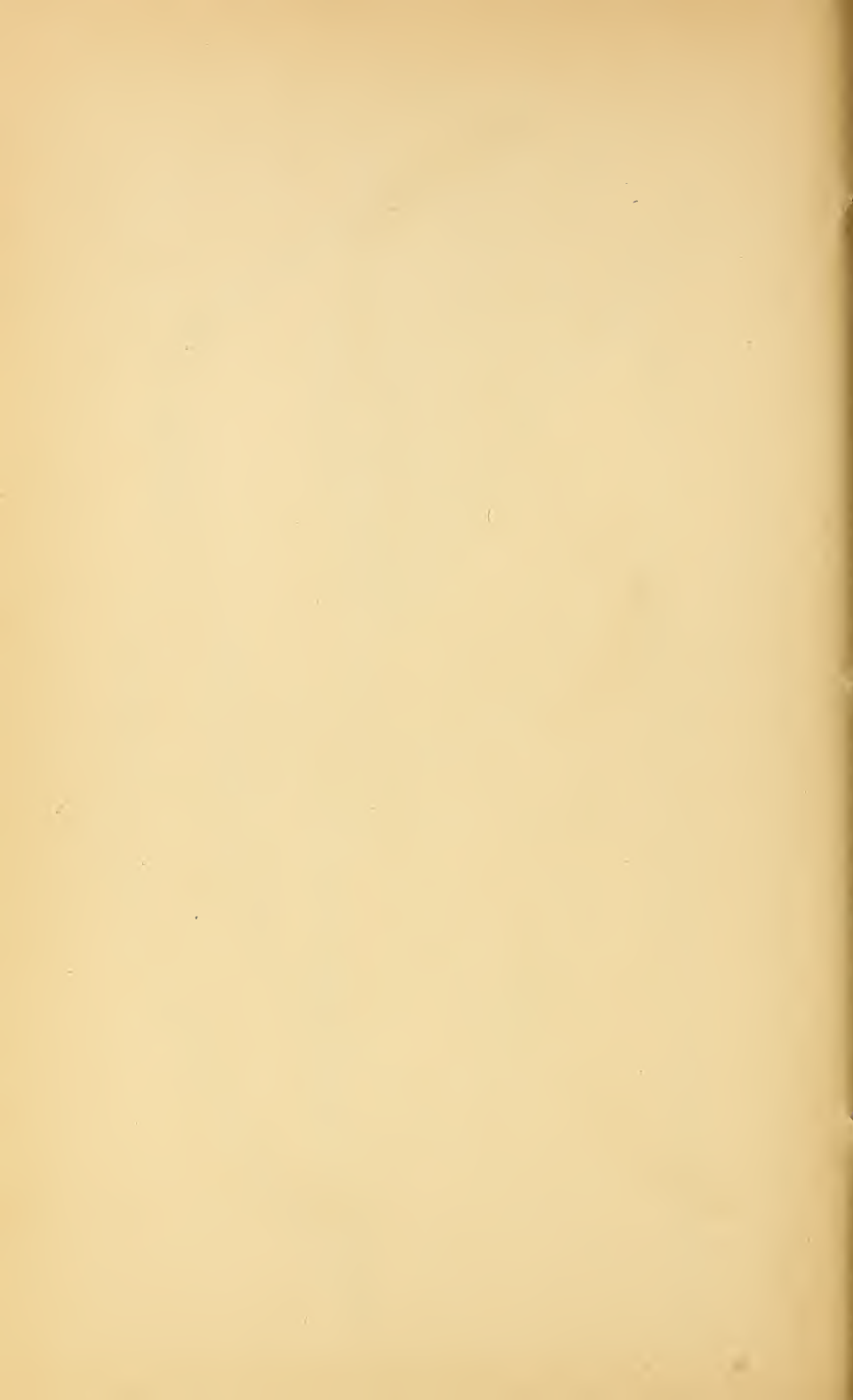


CYNODON DACTYLON.





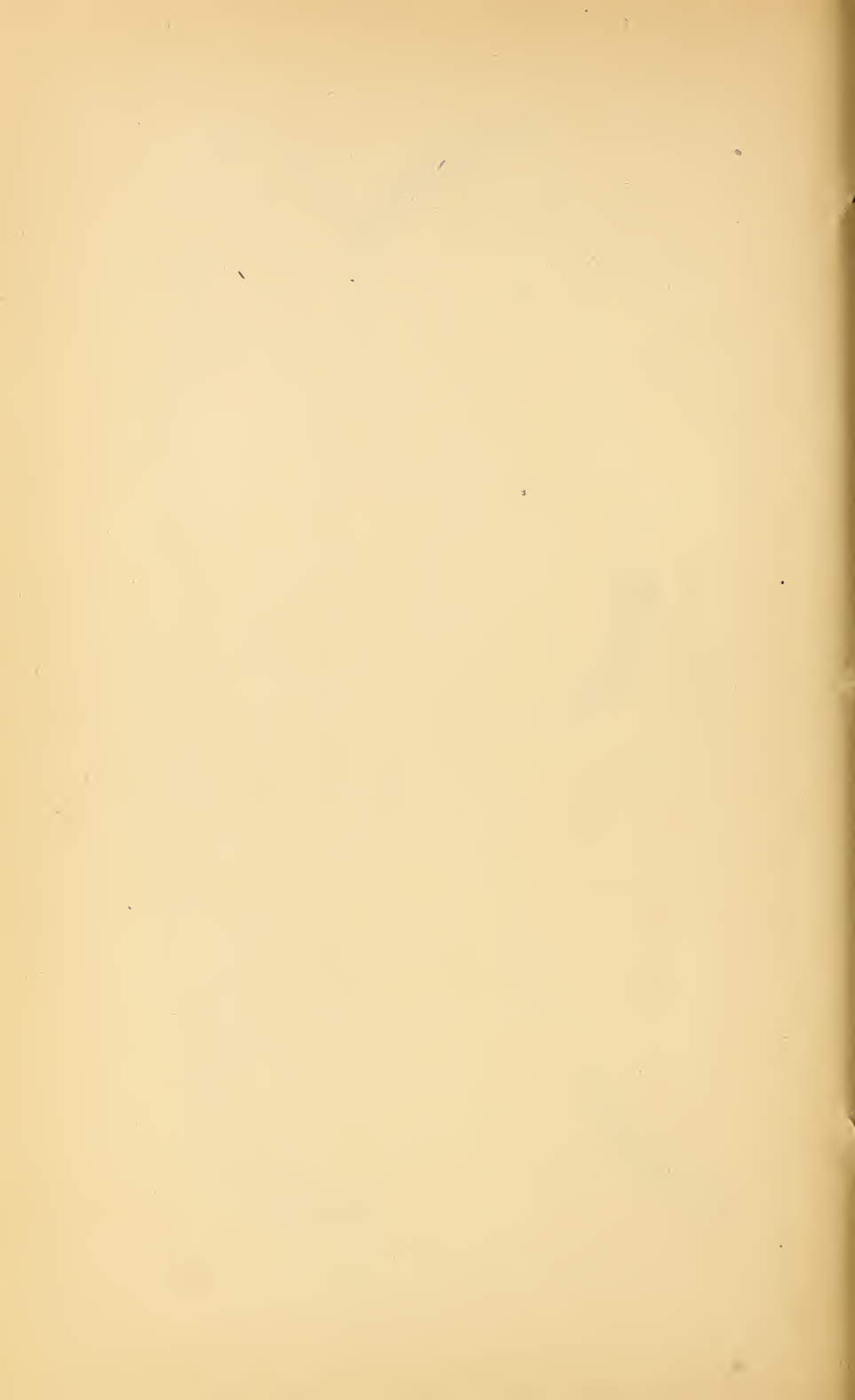
CHLORIS ALBA.







BOUTELOUÁ OLIGOSTACHYA.





BOUTELONA POLYSTACHYA.





M. B. R. 21.

ELEUSINE INDICA.

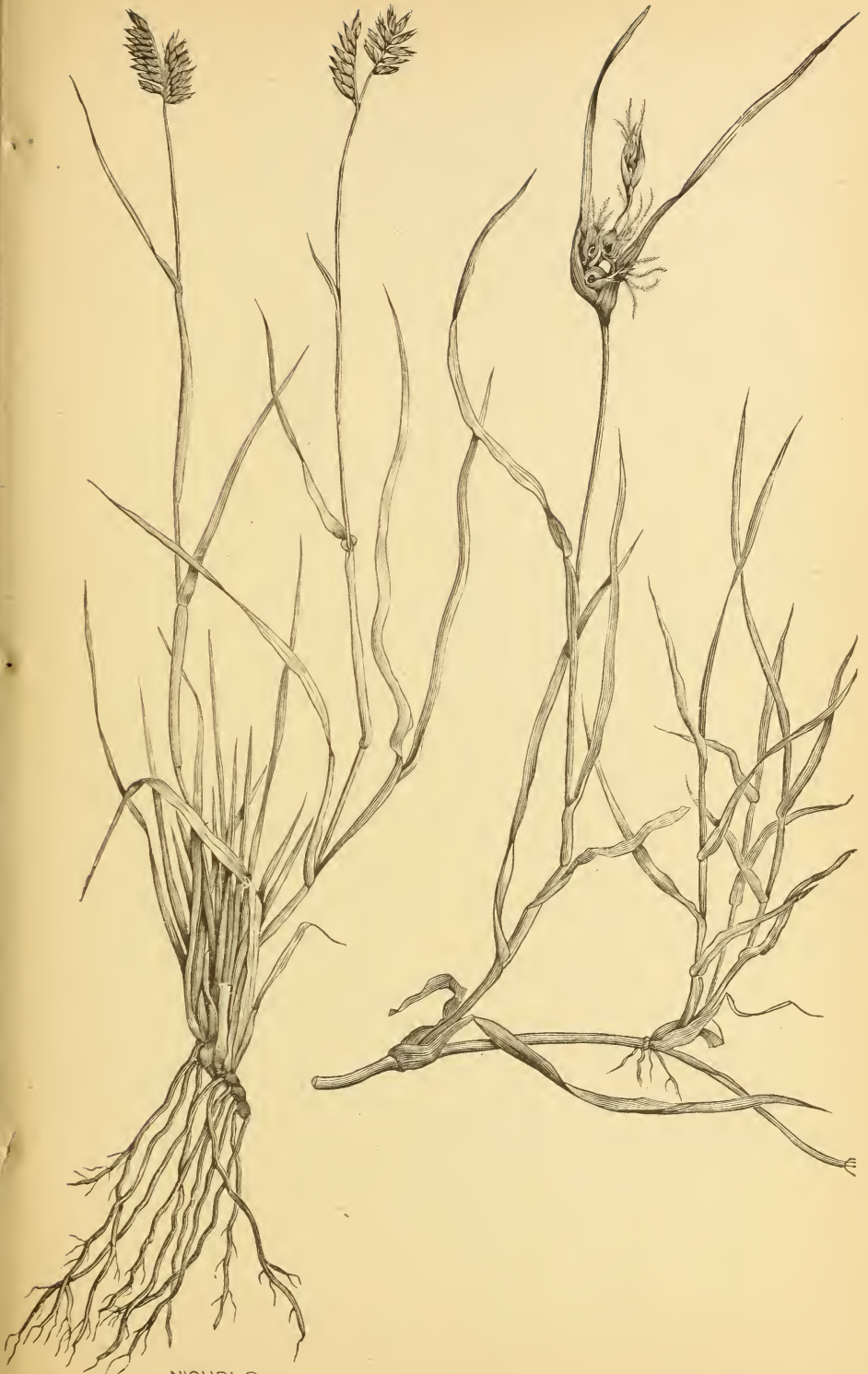




LEPTOCHLOA MUCRONATA.





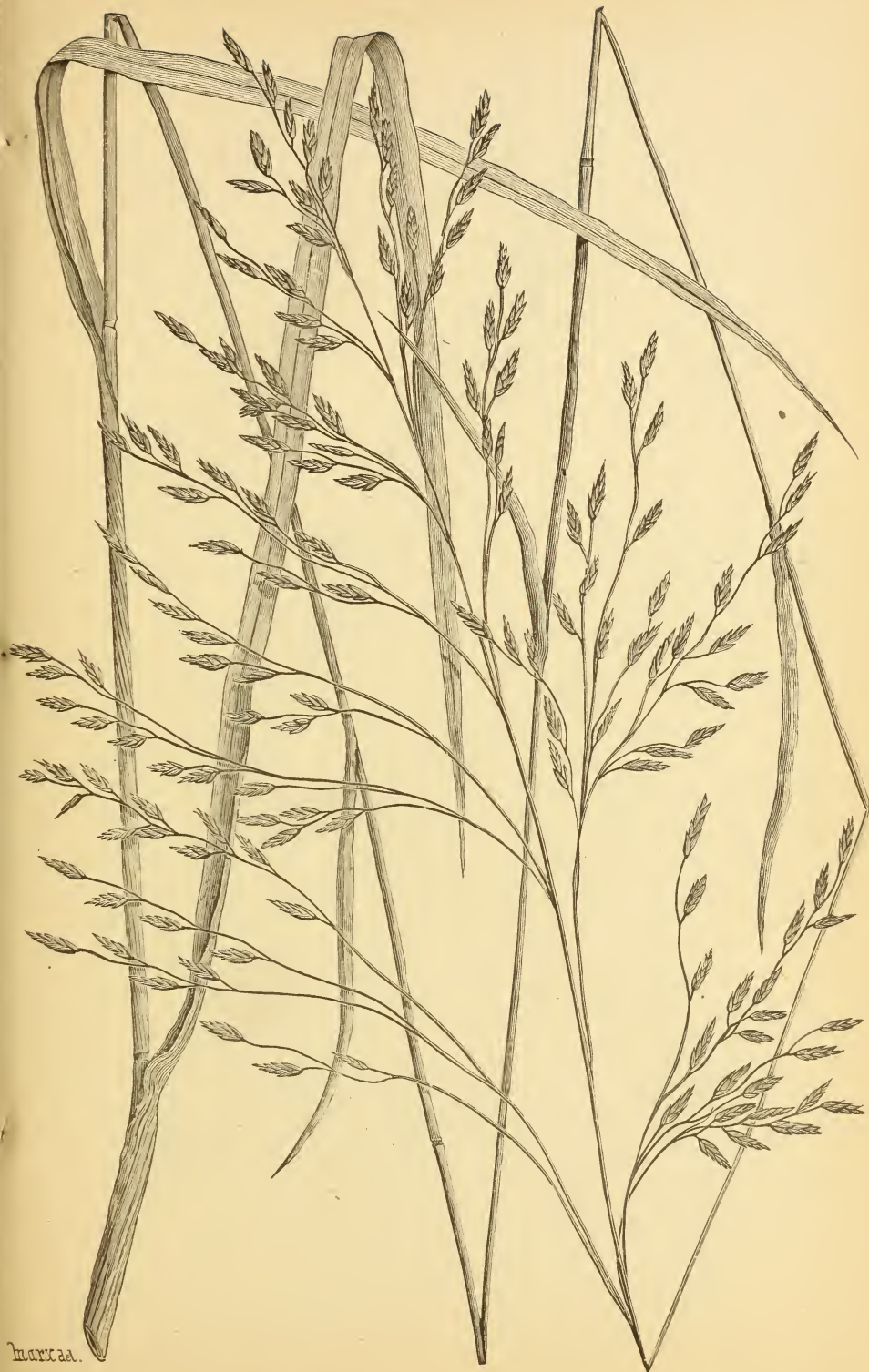


NICHOLS

MARX-DEL.

BUCHLOE DACTYLOIDES.

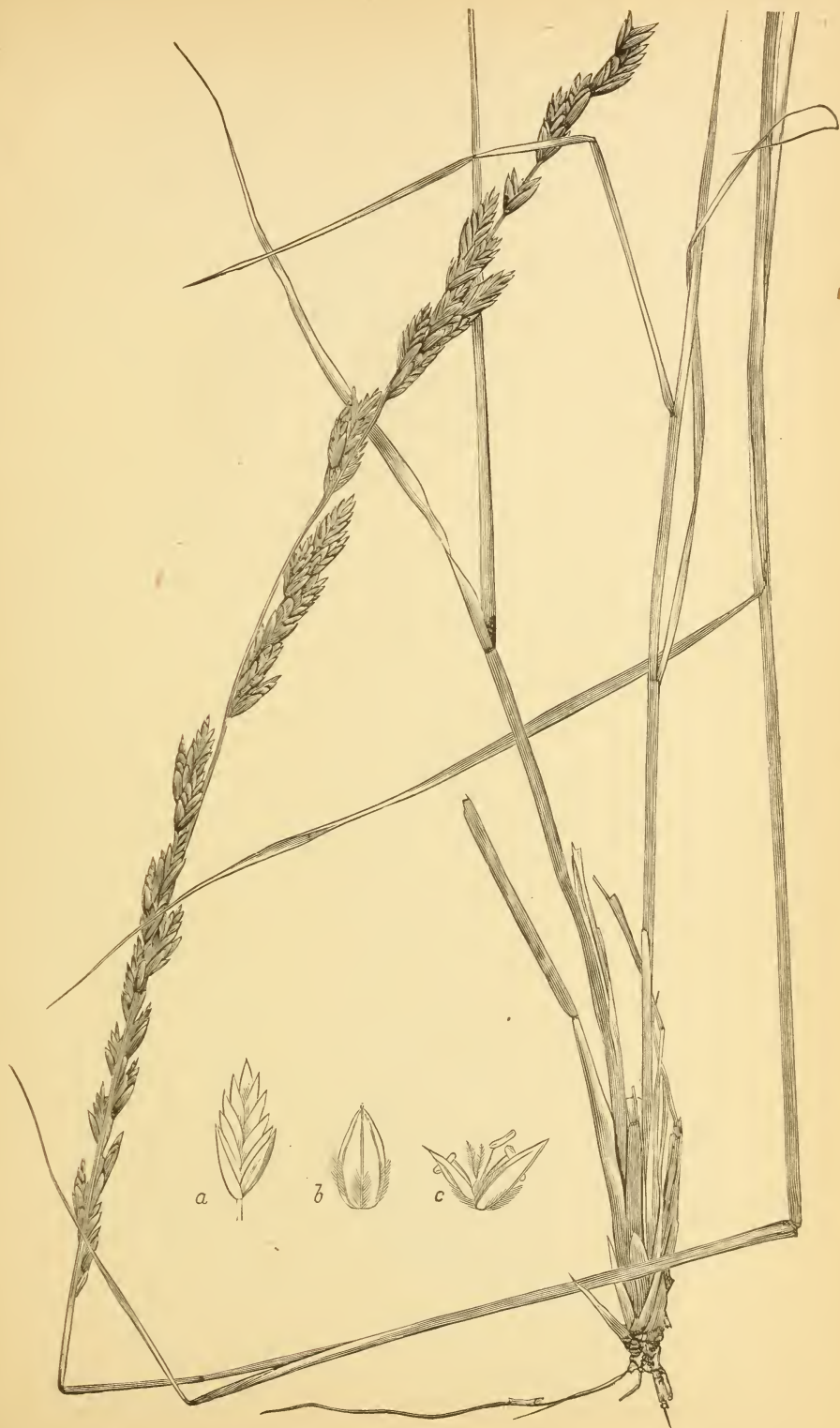




harca.

TRIODIA (TRICUSPIS) SESLERIOIDES.





TRIODIA TRINERVIGLUMIS.





TRIODIA ACUMINATA.

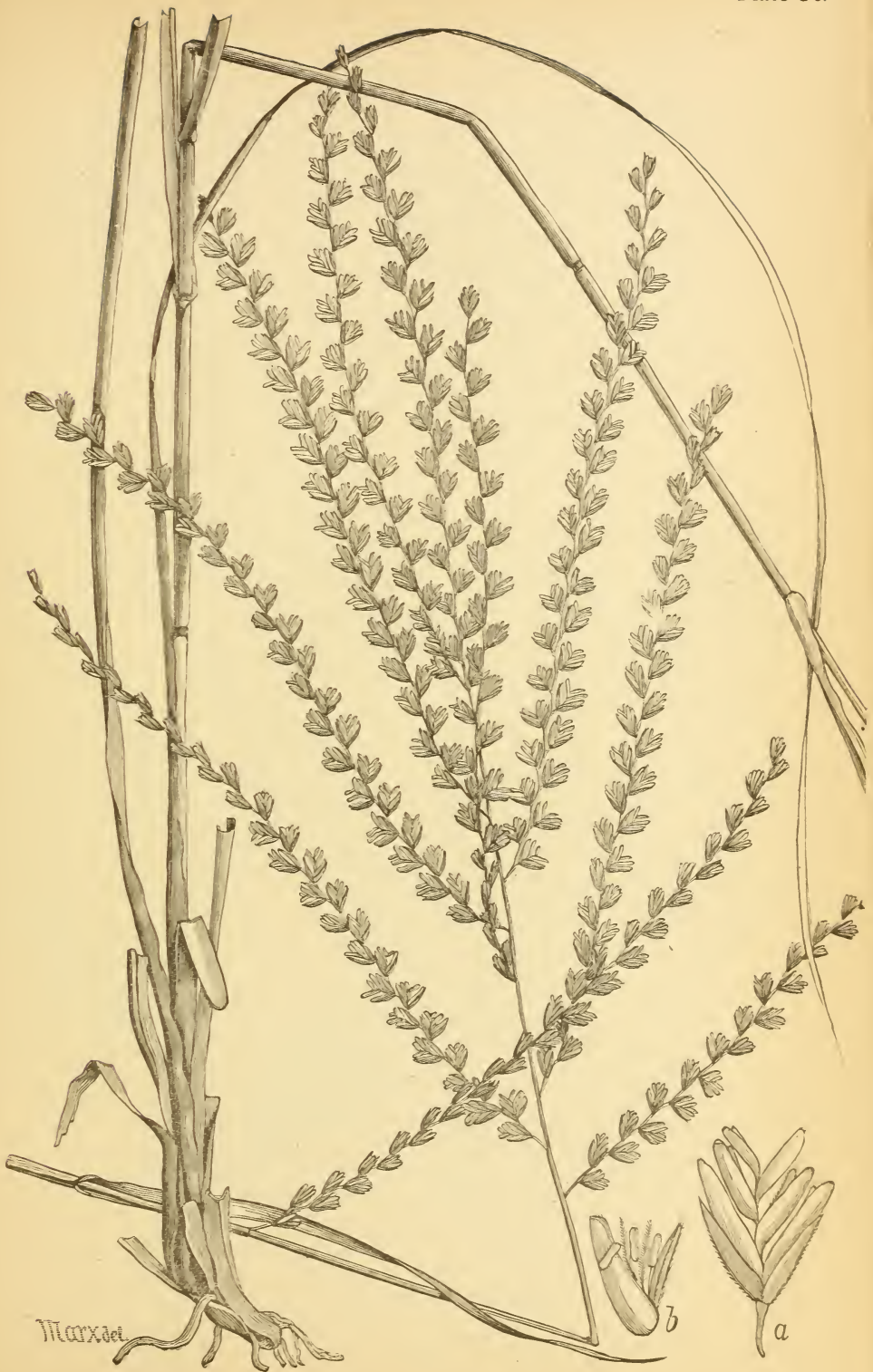






*DIPLACHNE FASCICULARIS.*





DIPLACHNE DUBIA.

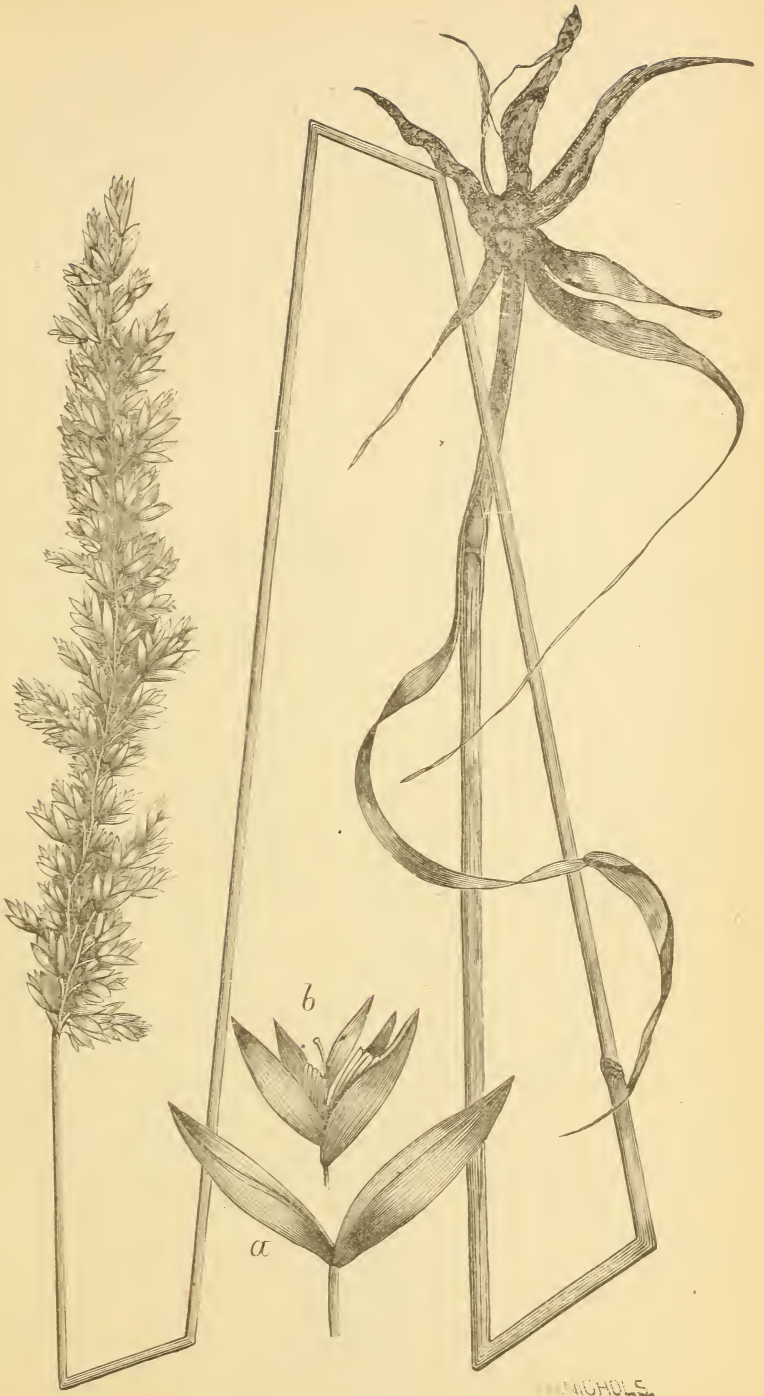




*Mart. del.*

PHRAGMITES COMMUNIS.





TAYLOR DEL.

W. MOORE

KOELERIA CRISTATA.







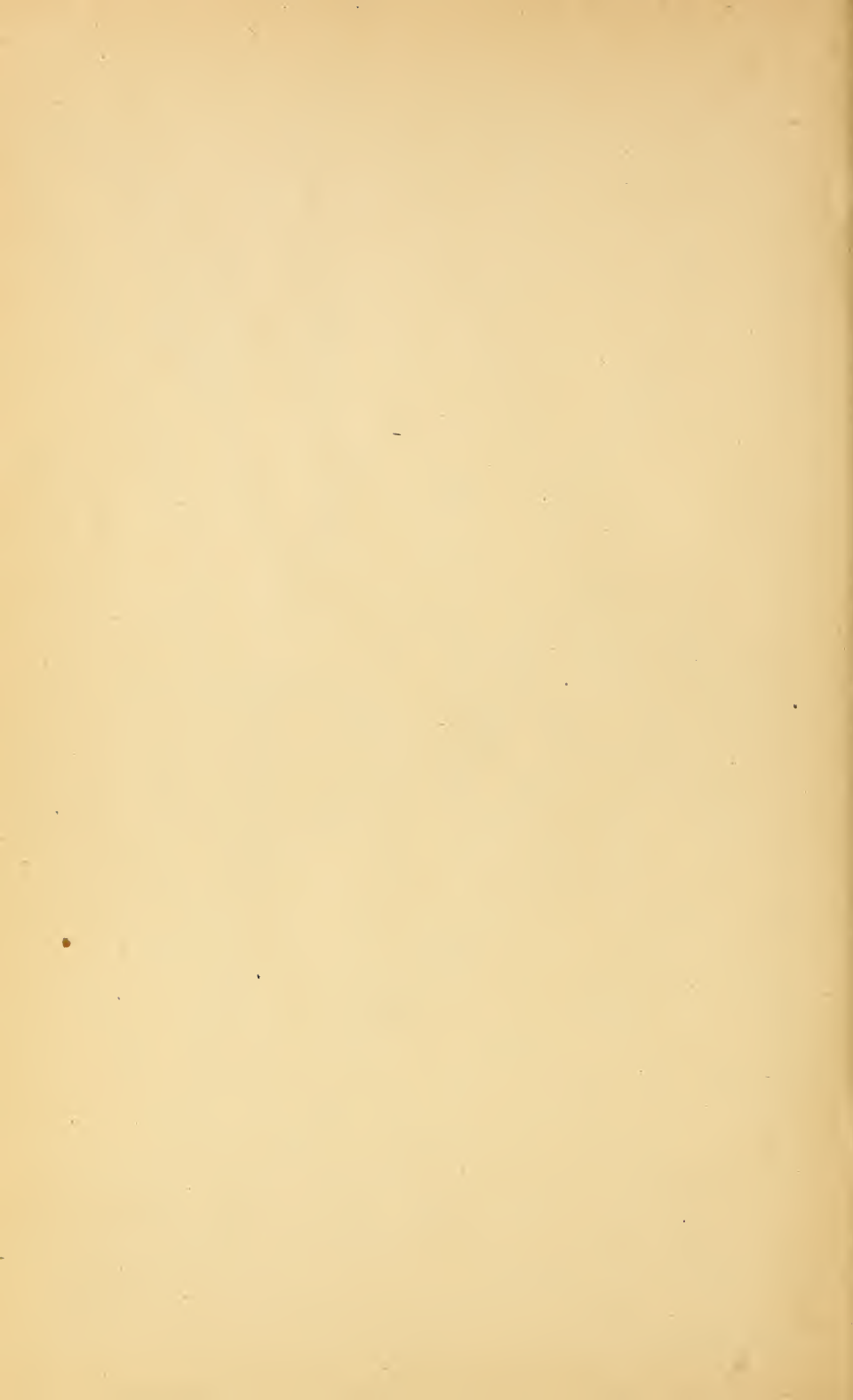
ERAGROSTIS POLEOIDES.

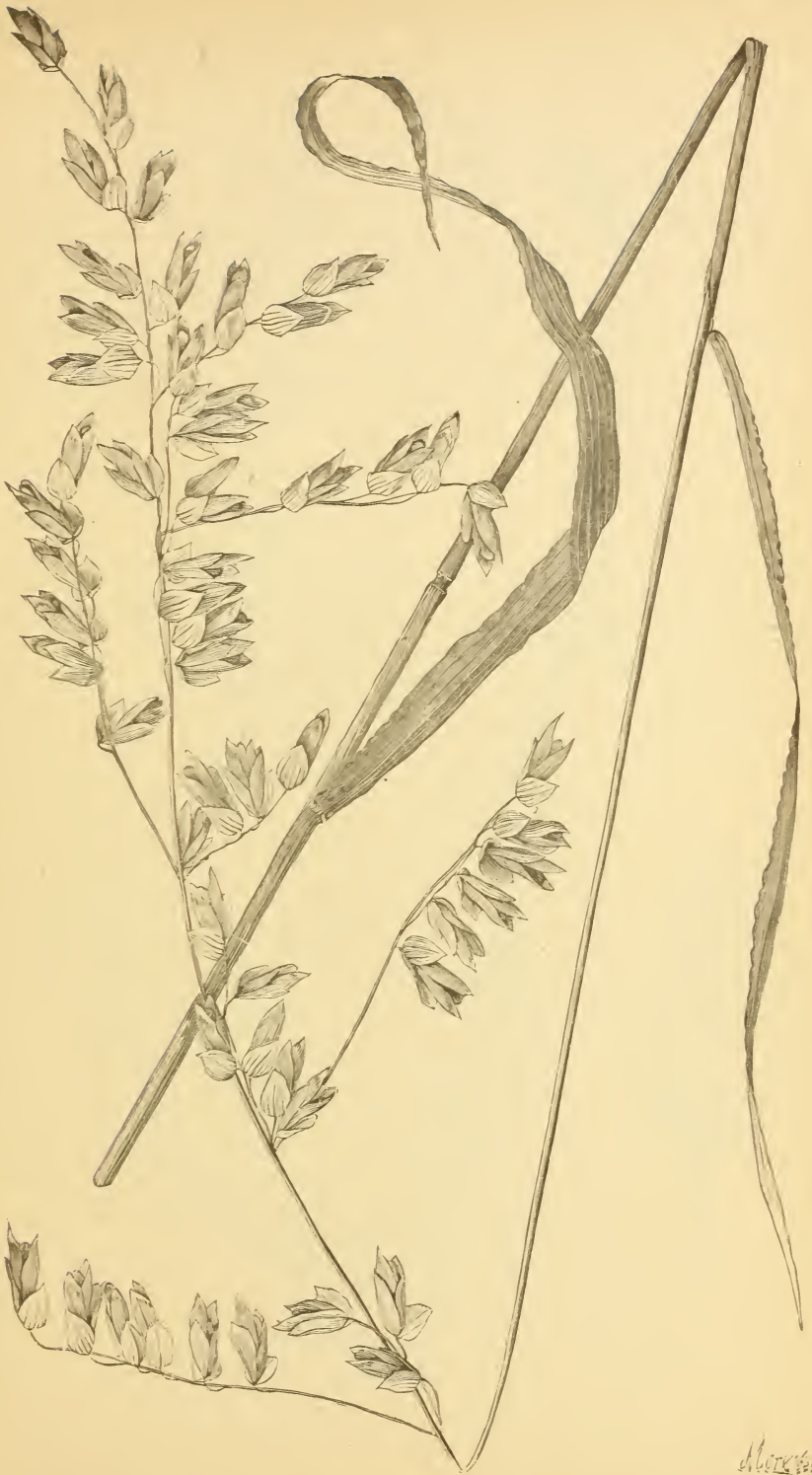




*Mox. del.*

ERAGROSTIS PURSILLI.





MELICA MUTICA, var. DIFFUSA.

*Handwritten signature*





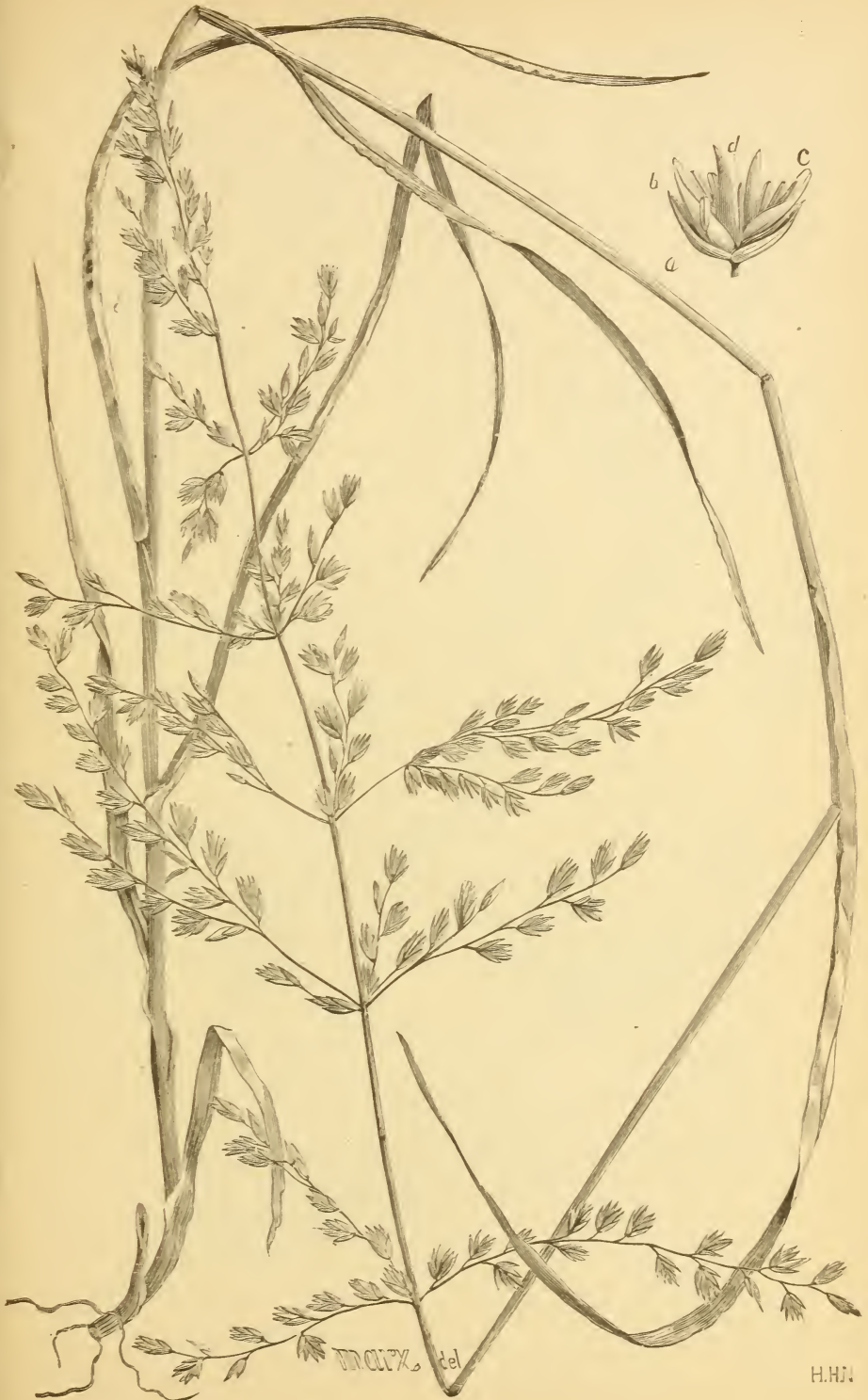
H. NICHOLS.

T. TAYLOR. DEL.

MELICA BULBOSA.







MELICA IMPERFECTA.





Marx del.

UNIOLA LATIFOLIA.





MAX del

HEIN

*DISTICHLIS MARITIMA.*





FRX.DEL.

*DACTYLIS GLOMERATA.*



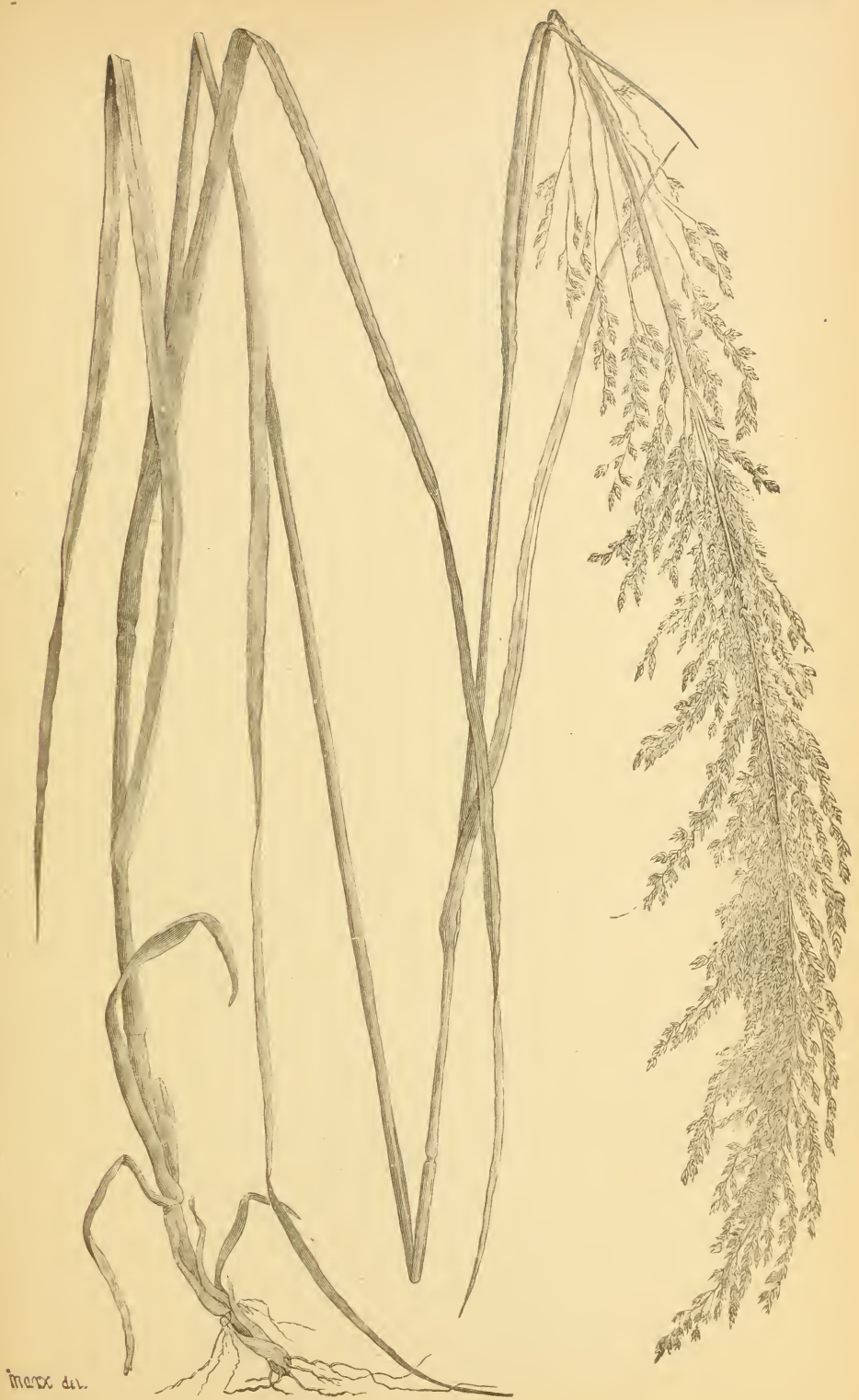




Marx del.

POA PRATENSIS.





maxx del.

POA SEROTINA.



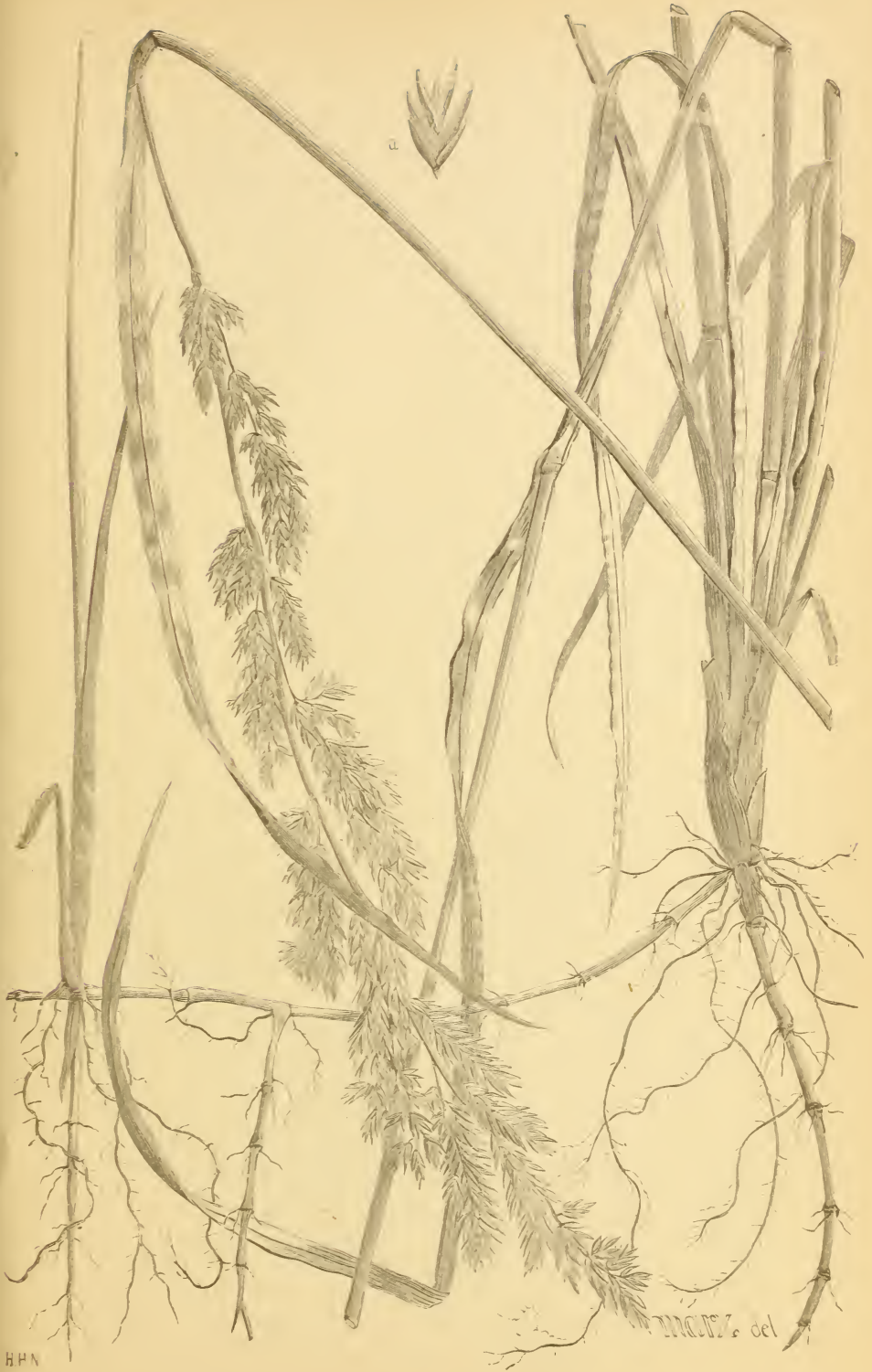


MARXDEL

W. BOLA

POA COMPRESSA.





HPN

W. G. S. del

POA ARACHNIFERA.



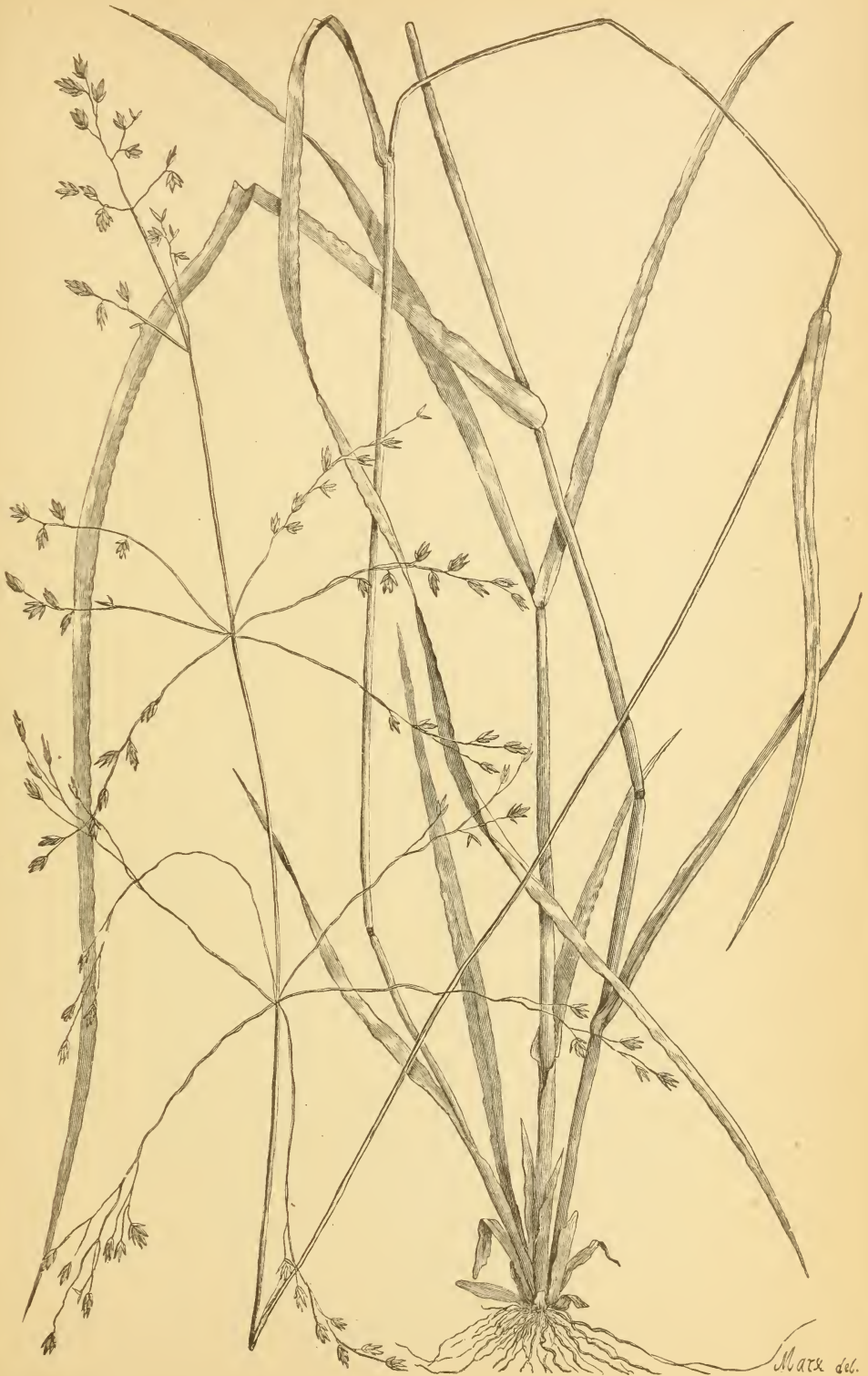




*POA TENUIFOLIA* (var.).

MERX.DEL.





*Marx del.*

POA ALSODES.





O HEIDEMANN.

Max del.

POA ANDINA (of Nuttall).



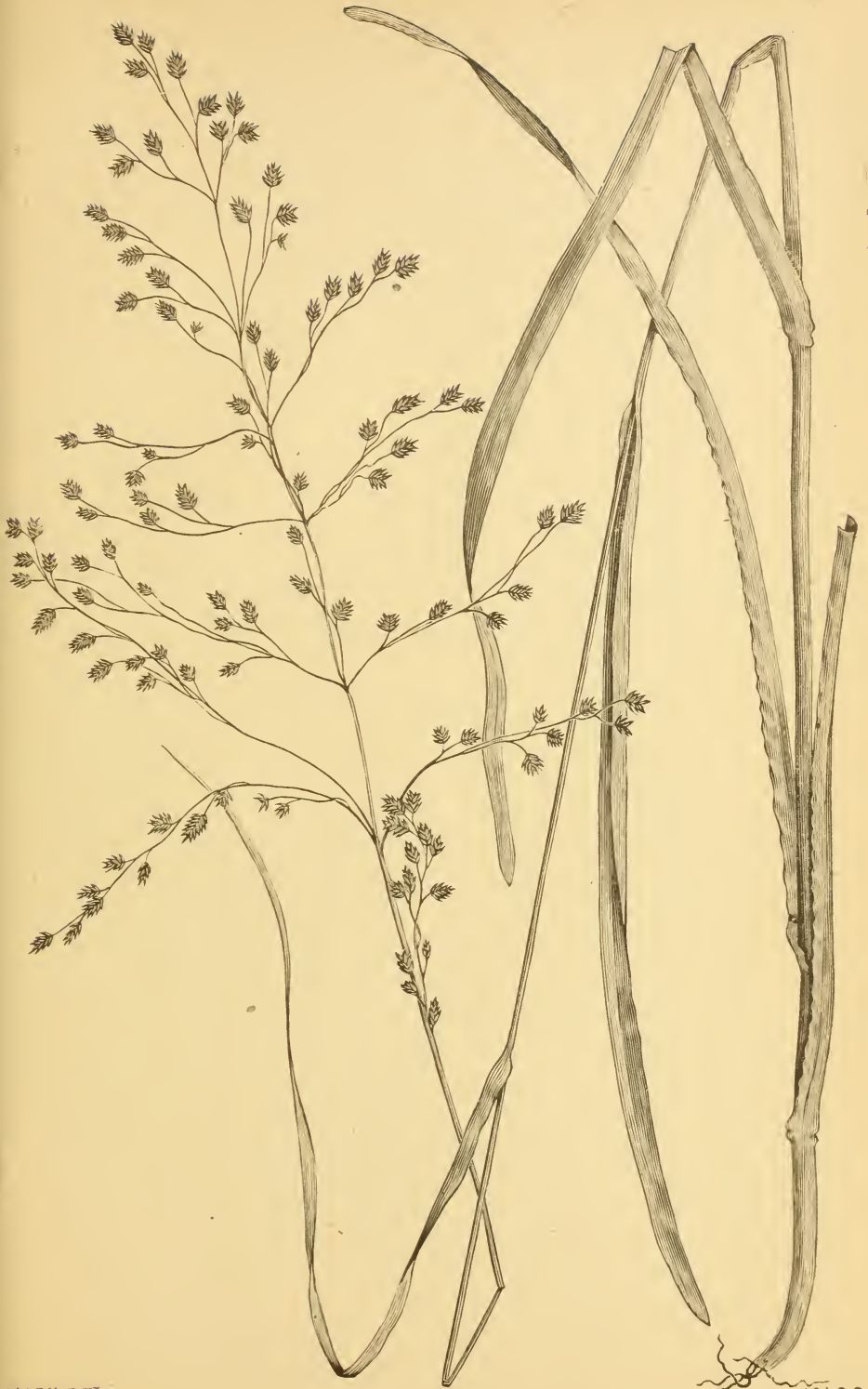


Wax

GLYCERIA AQUATICA.





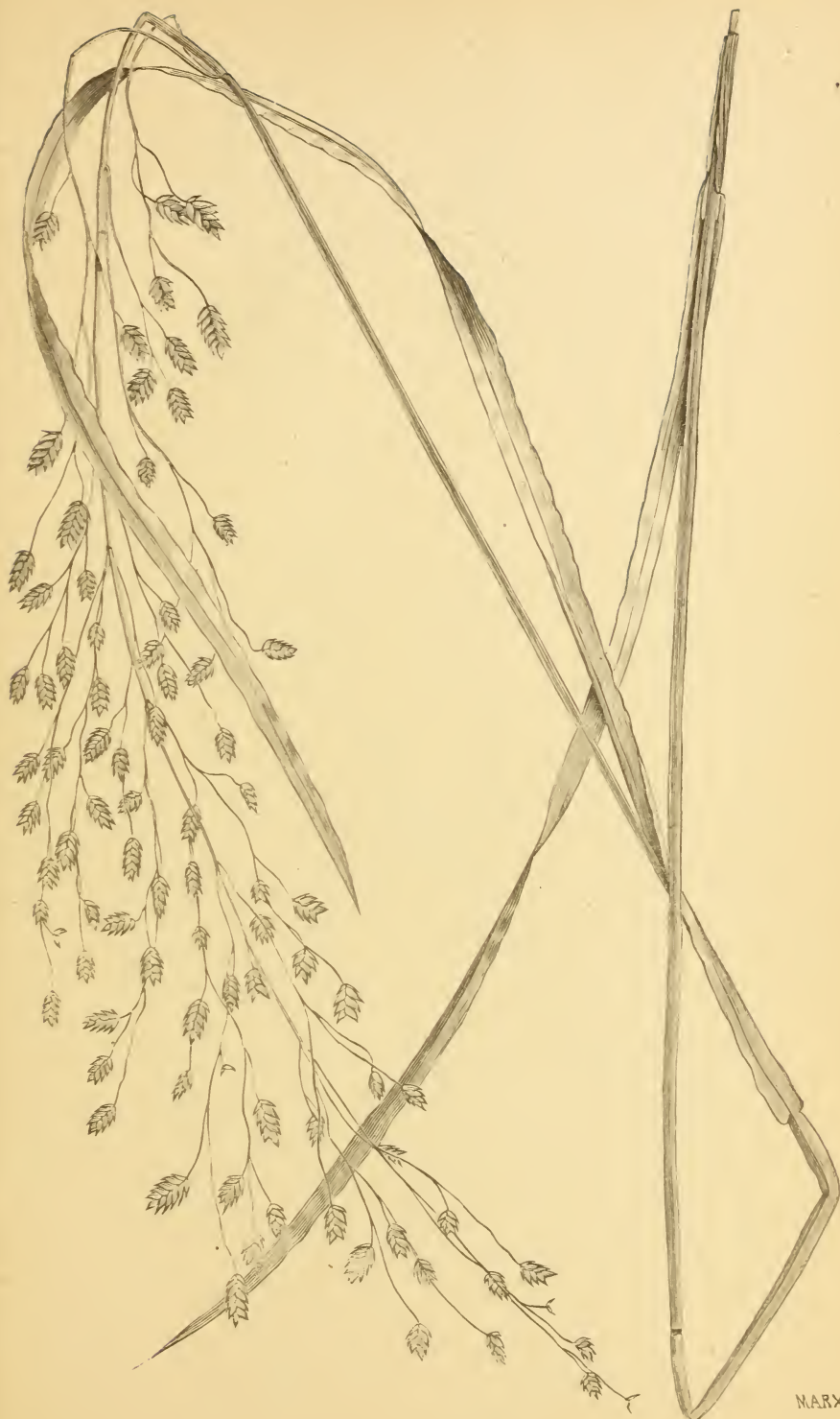


MARX, DEL.

NICHOLS, S.

GLYCERIA NERVATA.





MARX

GLYCERIA CANADENSIS.

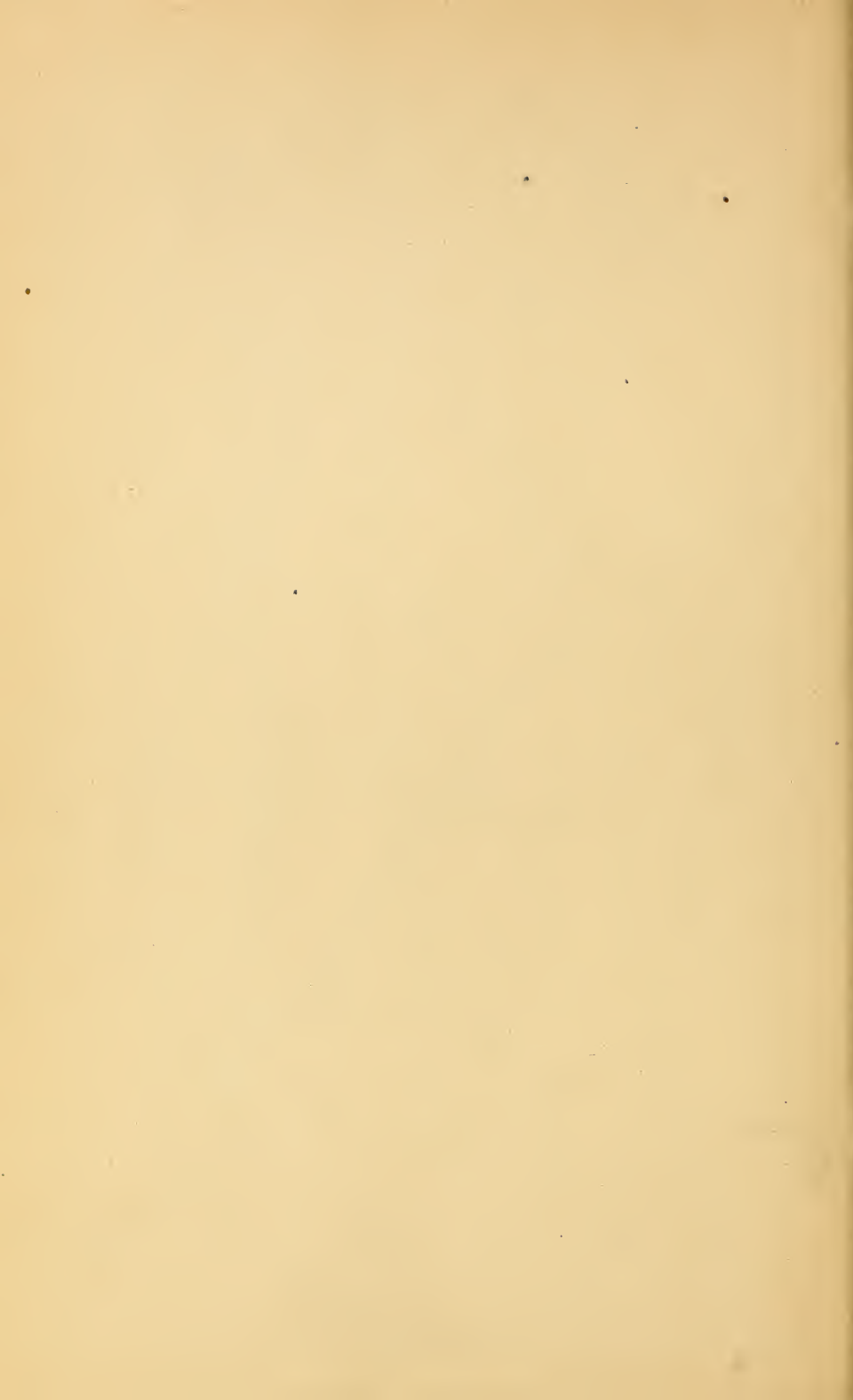




MARX, DEL.

NICHOLS

FESTUCA ELATIOR.





MARX DEL.

H.H. NICHOLS ENG.

FESTUCA OVINA.





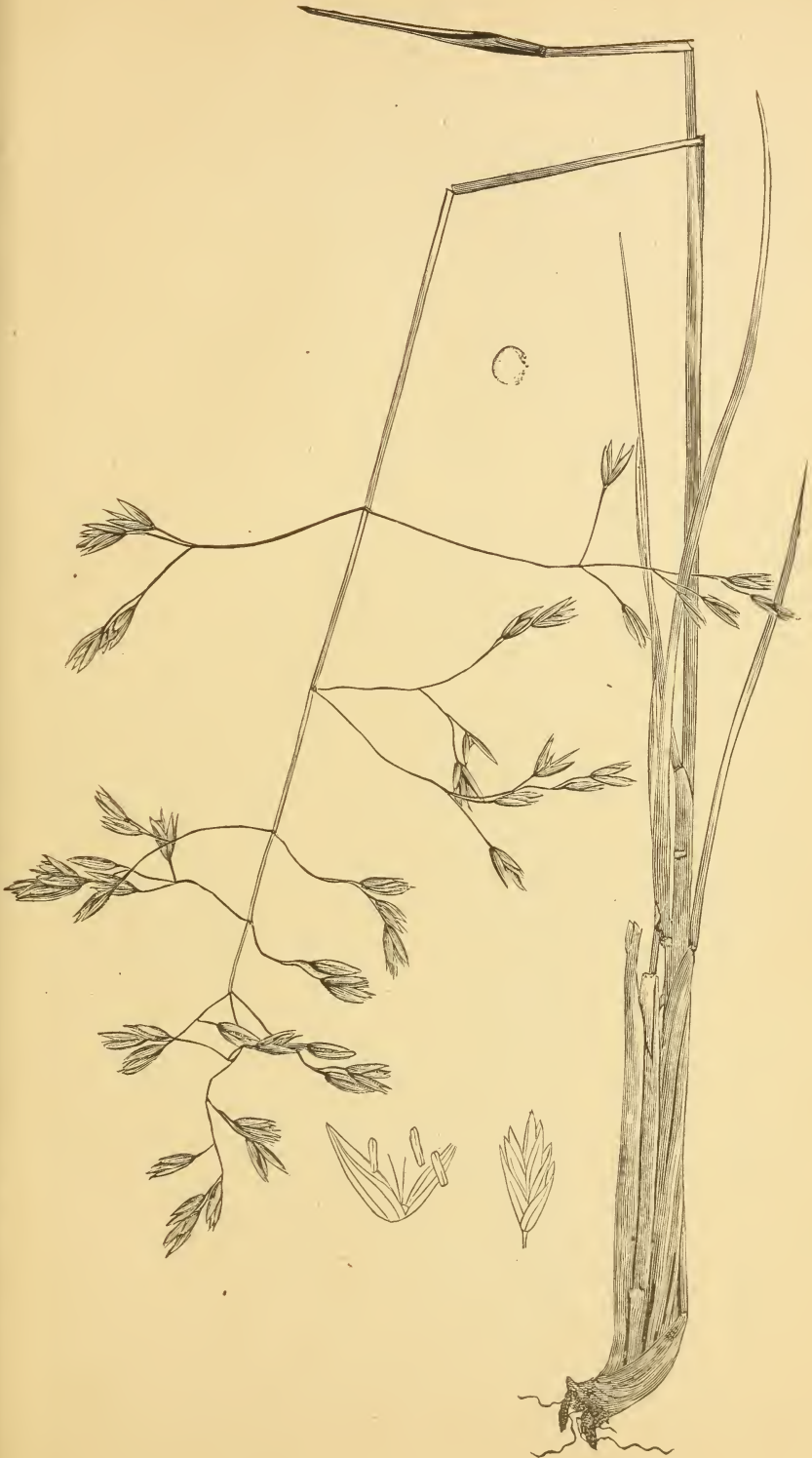


MARX.DEL.

NICHOLS.

FESTUCA MICROSTACHYS.





FESTUCA SCARBELLA





H. NICHOLS.

MARX. DEL.

BROMUS SECALINUS.





BROMUS UNIOLOIDES ( $\frac{1}{2}$  size).







BROMUS ERECTUS.





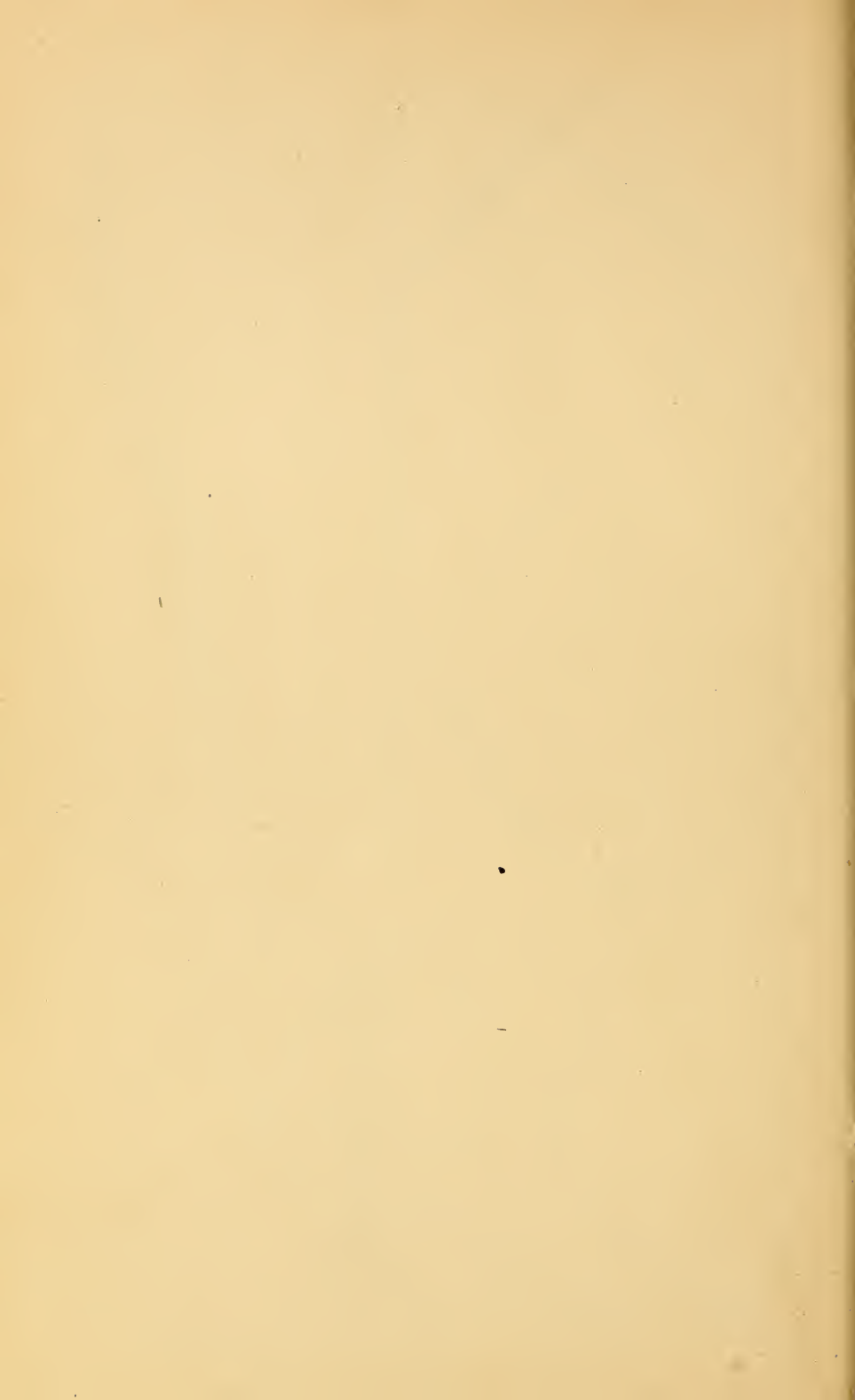
LOLIUM PERENNE.





MARX.DEL.

AGROPYRUM (TRITICUM) REPENS.





H. H. NICHOLS. Sc

MARX. Del.

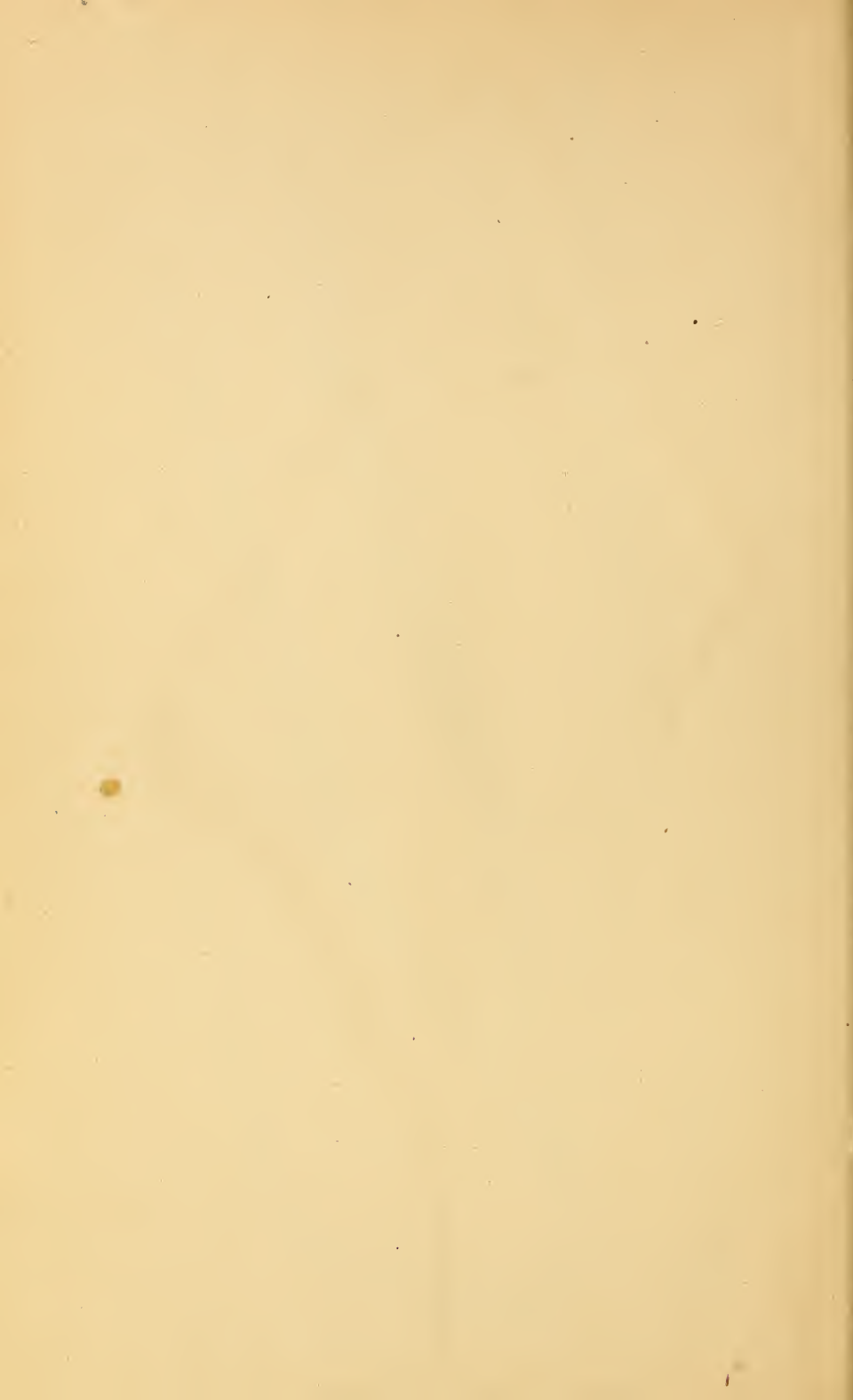
HORDEUM NODOSUM.







ELYMUS CANADENSIS.

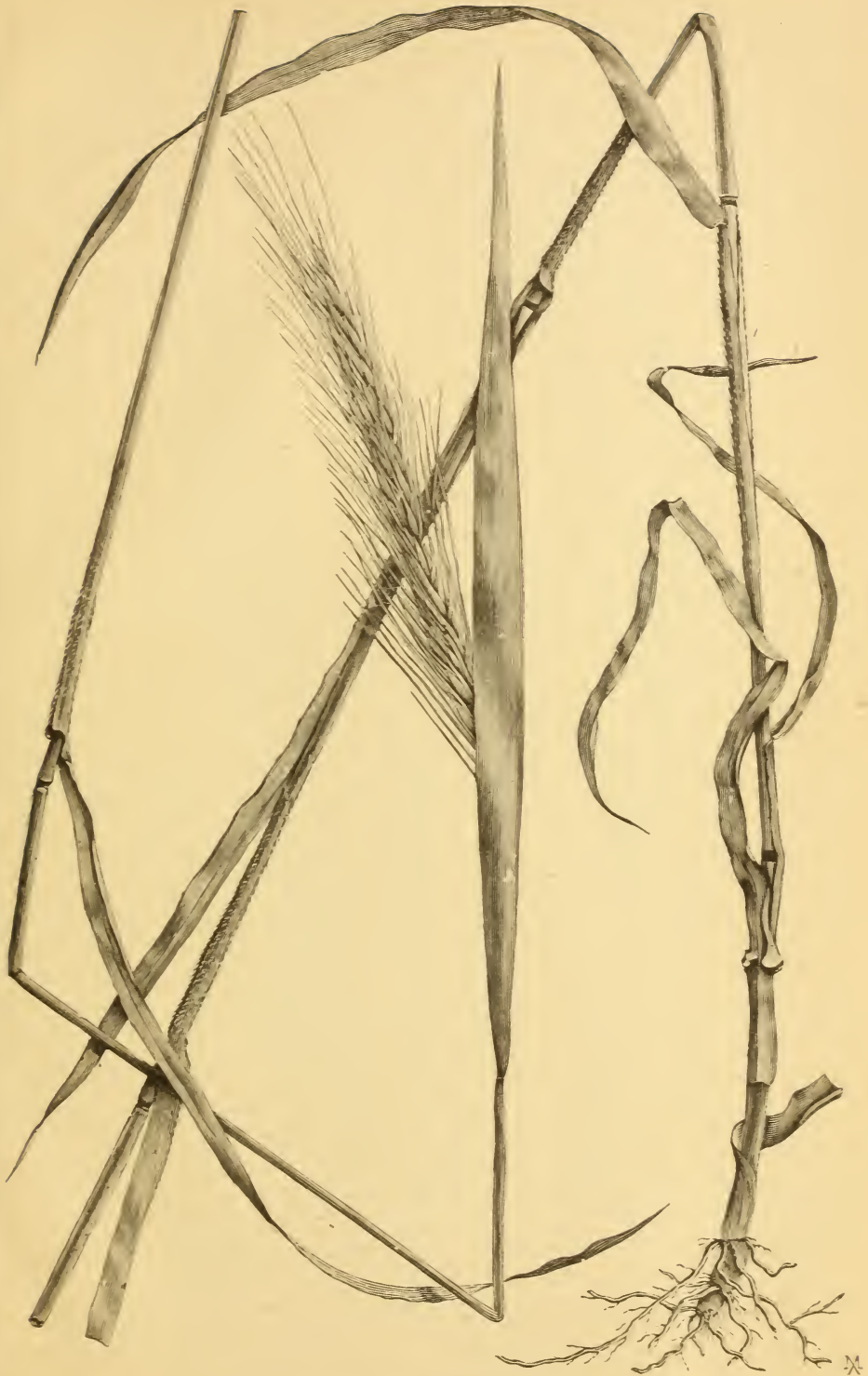




MARX. DEL.

ELYMUS VIRGINICUS.





ELYMUS STRIATUS.

M





ELYMUS CONDENSATUS.












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DEC. 65  
N. MANCHESTER,  
INDIANA

