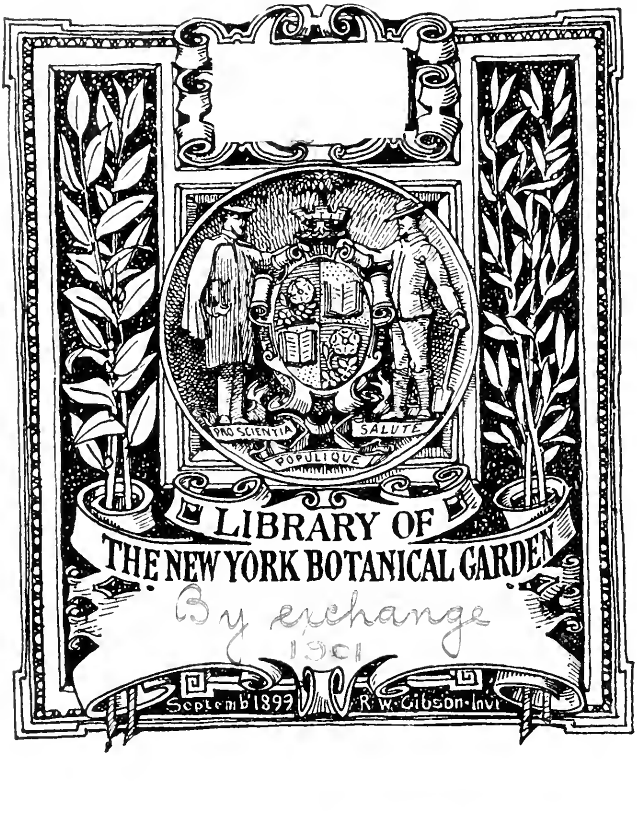
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CIRCULAR No. 1.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

A NOTE ON EXPERIMENTAL GRASS GARDENS.

There are some seven hundred distinct kinds of grass native to the United States. This is 20 per cent of the whole number known throughout the world. North America, from the southern boundary of Mexico to the Arctic Ocean, has about one-third the total number of known species. The grasses are the most important family of plants, since they provide food for man and forage for cattle. Wheat, corn, oats, rice, sugar cane, sorghum, and the bamboo which represents house and furniture to so many millions of people in oriental countries—these and many more are grasses. All of our grains the world over are grass products. Besides what we ourselves eat, most of the fodder and pasturage of our flocks and herds, and the pasturage for the wild game is provided by the many species of our prairies, valleys, and mountains.

Next in importance to the grass family is the bean family. All of our cultivated clovers and their relatives—red clover, alfalfa, cowpeas, and the multitude of less known forage plants—belong to the bean family. There are about eight hundred members of the bean family in the United States, not counting the trees. These seven hundred grasses and eight hundred legumes together form one of the richest legacies of our country.

The amount of money invested in the cattle industry is reckoned by the hundred million dollars, and every dollar of that value is absolutely dependent upon the question of forage. Strip our broad acres of their grasses and clovers, and instead of receiving millions of dollars for the meat products sent to foreign lands, we would have to pay out money for them. The cattle industry and the wool industry are dependent upon the question of grass.

Twenty years ago the whole prairie region west of the Missouri was given over to great herds of cattle. But the days of the cattle kings are past, and the lands that were then cattle ranges given up to the support of a few head to the square mile, are now divided up into farms. The native Western grasses are being rapidly driven out to make way for the worthless weeds that civilization and scanty cultivation bring with them. Already the buffalo grass and the mesquite have disappeared from a large section of Kansas and Nebraska. Acres that were once covered with these most nutritious species are now occupied by weedy kinds, and their value as pasture and hay lands is constantly diminishing Similar destruction of grasses has followed the cultivation of cotton in the South, and of tobacco and hoed crops generally in all sections of the country. The American has been a grass-killer everywhere.

Nearly all of our cultivated grasses and clovers are of foreign origin. This is true of red clover, cowpeas, alfalfa, and scarlet clover—the principal leguminous forage plants—and of orchard grass, red-top, timothy, and the rye grasses. Kentucky blue-grass was cultivated in Europe before it was in this country. Almost all of the grasses and clovers in common cultivation came from England or Germany or France or China, or from some place outside our borders. This is not because we do not have just as good or better sorts. The English or the German farmer has to earn a living from land that has been in cultivation for hundreds of years, and whatever he takes out of his soil must first be put into it. He is forced to adopt intensive rather than extensive farming. His farm is small. His soil is poor in plant food, though perhaps in the best physical condition; loose, friable, and well stirred by constant cultivation. This European farmer, with his exhausted soil, must compete with the American farmer whose acres are rich with plant food. To do this successfully, the European farmer is prone to try anything and everything that gives promise of producing the proverbial "two blades of grass where one grew before." He tries the native grasses and clovers that he sees his cattle pick from the hedge rows, to find out what effect cultivation will have upon them; whether they will, if planted in better soil, increase in size and add some value to the scant pastures and hay lands. Every weed of the fence corners that upon chemical analysis seems adaptable to cultivation for fodder is cultivated and perfected and improved until it is settled beyond doubt whether it is worthy or worthless. There is no European country whose natural resources, counted in the number of species of nutritious forage plants, equal ours. There are no finer natural meadows and pastures in the world than are to be found in all sections of our land. And yet these natural meadows, which form part of our most valuable resources, are being broken up and destroyed. Our native grasses and clovers are being driven out by foreign species, not through any superiority of digestibility or chemical composition, but because we have not found time to discover whether our own species are not far better suited for our own soil and climatic conditions. Enough money has been spent by American farmers for worthless fodder plants from foreign sources to more than pay the expenses of the whole Department of Agriculture for one year, with many useful lines of investigation.

All of the cultivated grasses and clovers of which we know the history have been cultivated in a small way at first. They are mostly species which have a large or conspicuous seed head. These were selected and cultivated mainly because their seeds were large enough to attract attention or because the seed could be easily shelled. Many of the grasses sown in foreign meadows have no value with us, and yet they are persistently advertised and offered for sale here because they are valuable in Germany or in England, on the principle that all things good in agriculture come from foreign lands. We have better species and more of them right here at home, that we will not have to plant ten or twenty years to get acclimated, or to learn whether they will grow in our soils. There are sixty native species of trifolium, the genus to which red clover belongs. There are sixty-five poas, all relatives of Kentucky blue-grass. There are twenty-five grasses closely related to the buffalo grass and the grama. There are ninety native lupins, thirty prairie clovers, forty-five vetches, forty relatives of the beggar weed of Florida, and brome grasses, meadow grasses, pasture grasses, and hay grasses almost numberless, suitable to every kind of soil and climate and rock formation which we possess. Of all this wealth of species not a dozen have been brought into cultivation.

The grasses and clovers and native forage plants of all descriptions should be thoroughly tried on the different soils and in the different sections of the United States. We want to know what plant will provide the greatest amount of the most nutritious forage in the shortest season at the least expense to the farmer. We want to know what forage plants remove the greatest amounts of mineral fertilizers from the soil and what improve the fields that they are planted upon. In short, we want the best, and we believe the best can be grown on American soil from native species.

There are no finer natural meadows and pastures anywhere in the world than in the Appalachian Mountains, and on the Western prairies from the Saskatchewan to the Gulf, and in the mountain valleys of the Western and Pacific States. Take, for an example, the State of Colorado as an illustration of the value of forage crops. The value of her herds and the products of the pastures and meadows which sustain them is equal to the output of her silver mines. Ten years ago, in 1885, there were nine thousand tons of alfalfa seed alone sown in Colorado, and the acreage and the value of the product has increased every year since. It is the same in the Western States and in the Southern States and throughout the length and breadth of our land. Every year more and more attention is being given to the raising of improved hay and forage plants. The raising of cattle is one of the most profitable industries in which the farmer and the man of small as well as large means can engage. There are larger returns for a farmer's labor if he feeds his crops on the farm and sells beef, pork, and mutton, than if he sells his hay and grain to the larger cattle feeders. Then, too, if all of the hay and all of the grain is fed on the farm, the soil is being constantly enriched by the return of the manurial portions of his crops to it. The cattle industry of the United States, instead of being on the wane, is becoming greater every year. The question of cultivating hay and pasture grasses to feed our growing herds and flocks is one of vital importance.

There are natural meadows and pastures in many of the newer portions of the country as good as the best grown in the older-settled Eastern States. The native grass and clover species which go to make up these meadows should be tested under the conditions of richer and better prepared soils.

Congress at its last session established a Division of Agrostology for the investigation of the native and foreign fodder plants. Two grass gardens have been started in connection with the work of the new division. The one on the grounds of the Department in Washington already contains four hundred species, native and foreign. This occupies the strip of ground between the Seed Building and the Agricultural Museum. It is about 300 by 60 feet. On account of the limited space in this garden, each variety can be represented by only a small number of plants. Special attention will be given to the cultivation of wild species which are known to be of some value, and which might be improved if planted on better tilled and richer soil. There are now some two hundred or more European, Australian, and American species. Experiments will be made in the old English method of propagating pasture grasses by inoculating land with pieces of turf; but the greatest dependence must be placed upon seed, on account of the expense of the former method. The method of inoculating land, as it is called, is probably the best one for establishing suburban and city lawns, for this is the surest way of obtaining pure cultures, and the value and beauty of the lawn depends as much upon the grasses of which it is composed as upon the care. The best lawns, and the most pleasing to the eye, are those composed of a single variety of grass. For establishing pastures or hay meadows inoculation is impracticable, because of the time and labor required.

Experiments on a larger scale have been begun at Knoxville, Tenn., where about 8½ acres have been secured on the grounds of the Agricultural Experiment Station. About two hundred grasses and clovers are growing there, mostly of those sorts which are sold by seedsmen, and such as are in general cultivation in various parts of the United States.

The plats in this garden vary in size from a yard square to half an acre. The land is rich, is in excellent condition, and may be taken as fairly representative of a large class of farming lands in the South. Special attention will be paid to the improvement of native forage plants. In this garden the most promising forage plants for the Southern and Southwestern States will be tried on a large scale, much as they would be if planted by a farmer or stockman. There are large silos on the farm, and the fodder will be tested as to its feeding value in the form of hay and as ensilage, and also for soiling. The question of grasses and clovers and other forage plants suitable to the Southern States will be investigated from as practical a standpoint as possible. Nearly all of the forage plants advertised or recommended by seedsmen as good for the Southern States have been in cultivation there the present summer, and the work will be continued through a series of years. This kind of work can not be done successfully by the farmer or by private means, because decisive results can not be obtained in less than a term of years, and the work can better be carried on by those who are trained for it and who have made this branch of agriculture a lifelong study.

In this connection it might be well to point out the advantages to be derived from such work. If one grass or one clover can be so improved that it will thrive on the arid lands of the West, and will grow as well as the sagebrush and creosote bush, and at the same time be of some value as forage, many times the cost of such experiments will be added each year to the material wealth of the nation. If a good forage plant can be found that can be substituted for a poor one on some sterile soil where it was thought good grasses would not grow, it means that two hundred head of cattle can be pastured on land where only one hundred were fattened before. There is no better or more profitable line of work open to the Department of Agriculture than the development of our resources as embodied in the richest grass flora of the world.

JARED G. SMITH,
Acting Agrostologist.

Approved:
J. STERLING MORTON,
Secretary.

WASHINGTON, D. C., *August 6, 1895.*

CIRCULAR NO. 2.

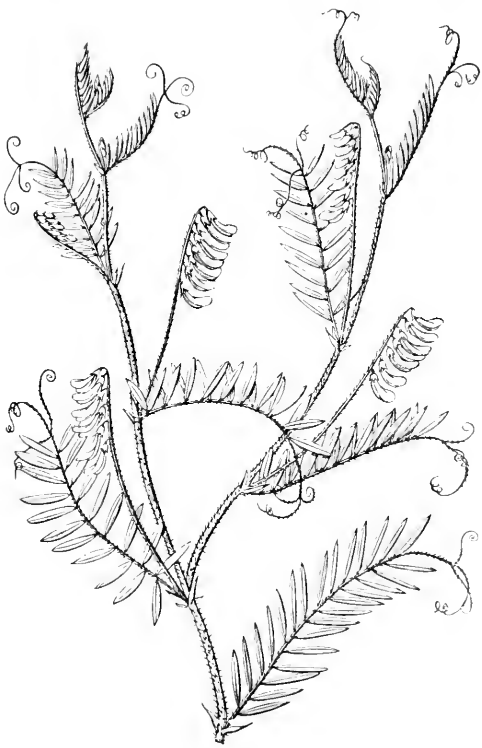
United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

HAIRY VETCH, SAND VETCH, OR RUSSIAN VETCH.

(*Vicia villosa.*)

This annual leguminous plant is a native of western Asia. It has been cultivated for about fifty years in some parts of Europe, especially southern Russia, Germany, and France, and was introduced into this country for the first time about 1847, under the name of Siberian vetch. But its cultivation was lost sight of, and no thought was given to it until reintroduced about ten years ago. It has been tried in various parts of the United States. Excellent reports as to its drought-resisting qualities and its adaptability to our climate have been received from Washington, Nebraska, and Pennsylvania. It has been grown in the past season on the experimental grounds of the Department of Agriculture at Washington, and has proved to be thoroughly adapted to, and valuable for, this region. The seed was planted about the 25th of April; the plant commenced to bloom the middle of July, and continued in bloom until the end of August. Hairy vetch withstands cold, heat, and drought, but it does not do well where there is an excess of water in the soil. It is one of the most promising fodder crops which has been brought into the United States in recent years.



Hairy vetch (*vicia villosa*).

Hairy vetches may be planted in autumn, from about the middle of August to the middle of September, or in spring, from the latter part of April to the middle of May. Sow broadcast at the rate of a bushel and a half of seed per acre, or plant in drills 2 to 4 feet apart. The latter method will require a less amount of seed. The seed is as yet very expensive in this country, about $6 per bushel of 60 pounds. When the seed is put in broadcast, a bushel of rye, oats, or wheat, should be sown at the same time, so as to furnish a support for the vetches, and keep the vines up off the ground. If it is sown in drills in the latter part of August, it should be cultivated several times between the rows. It will furnish some forage in autumn, and where the winter is not too severe, will start to grow again in the spring, thus producing forage in late autumn and early spring, at the two periods when it is most needed.

Prof. S. M. Tracy in "Forage Plants for the South" (Farmers' Bulletin No. 18 of this Department) states that the seed of hairy vetch was sown at the Mississippi Agricultural Experiment Station in October, 1888, and since that time has given heavy annual crops on the same ground, although it has received no attention and the ground has not been plowed since the first sowing. Its seeds germinate with the first autumn rains and in favorable seasons cover the ground by the first of January, and then furnish good grazing until April or May. If the stock is taken off the field in March, the plants will mature and reseed the ground freely for the next year.

The great desideratum in our American farming is some crop or crops, either clovers, grasses, or other forage plants, which may be sown after the grain crop of the year is harvested, to provide green forage and pasturage and to prevent the washing of the soils in winter and early spring. If the land is allowed to lie bare, large amounts of the soluble, and hence the most valuable, mineral fertilizers are washed into the creeks and rivers. The agricultural soils in the newly settled portions of the continent have been cultivated as though their riches were inexhaustible. Crop after crop of grain, cotton, corn, or tobacco is taken from the field, and no effort is made to replace the potash, phosphoric acid, and nitrogen which they contain. The result of this robbing of the soil is that in 15 or 20 years the yield has very materially diminished. The loss in fertility which these lands sustain each year is about equally divided between that portion sold from the farm in the form of grain or other raw material and that which leaches out of the soil through washing after the crop has been removed from the field and the surface is no longer protected from the elements. Now, if some crop can be planted which will cover the ground in autumn and winter and early spring, and which will be ready to take off the ground in time for spring planting, at least half of this loss of fertilizing material may be saved. Furthermore, if such a winter crop is planted, the land instead of losing organic and inorganic food elements is constantly acquiring them.

Analyses of hairy vetch made by Coudon in 1890 showed that this forage plant contains for every 100 parts of dry matter 22.78 per cent nitrogenous matter, or protein; 2.61 to 3 per cent of fats; 23.25 of cellulose, or crude fiber; and 39 per cent of nitrogen-free extract. Every ton of dry hay contains 45 pounds of nitrogen, 19 pounds of phosphoric acid, and 62 pounds of potash. The yield amounts to from 6 to 10, and sometimes on very rich soils 12 to 15, tons of green forage per acre. The nitrogen, potash, and phosphoric acid contained in a ton of vetch hay, if bought in the form of a commercial fertilizer at current prices would be worth about $11. The yield of dry hay taken on this basis would amount to from 1½ to 4 tons per acre, the yield depending much upon the fertility of the soil and the state of cultivation. These fertilizers, as produced by the vetch, are in the best form or combination to be used as food by the succeeding crop. A crop of hairy vetch plowed under about the first of May, would therefore place in the ground fertilizers that would cost from $16 to $45 per acre if purchased in the form of commercial fertilizers. The hairy vetch has as high a nutritive ratio as any forage plant, that has been analyzed, excepting the soja bean.

In proportion to its cellulose and nitrogen-free extract, which represent the contained starches, sugars, and like compounds, it has a very high per cent of protein and fat. To realize its fullest value as a soiling crop it should be fed mixed with corn fodder or timothy hay or roots, which are all rich in the carbohydrates but are deficient in protein. The two classes of foods need to be fed together to prevent loss of protein, which is that part of the food that becomes transformed into blood, bone, and muscle. The carbohydrates when digested go to produce heat and motion, and the surplus is stored up as animal fat.

Hairy vetch is eaten with relish by all kinds of farm animals. If properly cured it makes very fine hay, though on account of its habit of growth it is very difficult to cure. It has been tested in the silo in alternate layers with green corn and alone. The former method is the one to be used if the best ensilage is desired. It is a most excellent forage plant for soiling purposes. On account of the difficulty of curing it properly, it will give the most satisfactory results if fed green or ensilaged.

Hairy vetch, while it gives a fair crop on sterile soil, is most profitable as a forage plant on rich and well-tilled land. It needs considerable moisture during the first six weeks of its growth, but when once fairly established withstands drought and extremes of temperature.

SUMMARY.

Hairy vetch seed weighs 60 pounds per bushel. Spring prices, in New York, 1895, were $6 to $6.50 per bushel.

Sow broadcast or in drills, at the rate of $1\frac{1}{2}$ bushels to the acre from August 15 to September 15. Sow one-half bushel of winter wheat, winter rye, or winter oats with the vetches.

Hairy vetches sown in August may be fed in October or November. They will be ready to cut for soiling or hay from the 20th of April to the 1st of May.

For a summer crop, sow from the 20th of April to the middle of May. Cut when in full bloom.

Do not plant on land that is poorly drained.

To get the best results, feed with coarse fodder, hay, or root crops. Feed with corn fodder at the rate of four tons of corn fodder to one ton of hairy vetch.

Hairy vetch sown in autumn will cover the ground and prevent washing during the winter.

It is one of the best crops to turn under as green manure.

Do not commence to feed hairy vetches until they have begun to blossom. Like most of the bean and clover family they are somewhat diuretic if feed in large quantities before mature. Use caution in feeding until the animals have become accustomed to the change of food.

F. Lamson-Scribner,
Agrostologist.

Approved:
Chas. W. Dabney, Jr.,
Acting Secretary.

Washington, D. C., *October 1, 1895.*

CIRCULAR No. 3.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

SALTBUSHES.

AUSTRALIAN SALTBUSHES.

A considerable demand has arisen in the grazing regions of the West during the last decade for seeds of the various species of Australian saltbush. These saltbushes are nearly all plants of the salsolaceous, or pigweed, family, which botanists for purposes of exact knowledge call the *Chenopodiaceæ*. There are over one hundred species of this family in Australia, and the ones which have come into prominence as desirable forage plants grow wild upon the low plains and in the broad river valleys of the interior of that continent. They are plants which are specially adapted by nature for growth in arid and semiarid regions where the annual rainfall is small and torrential, and where there are long periods of months and perhaps years when no rain falls. Many of them grow on alkaline soil and along the margins of brackish or stagnant pools, and thrive where grasses and other more nutritious but less hardy forage plants will not grow. They are annuals, with small fleshy leaves and rigid harsh stems, and are protected by various

FIG. 1.—Australian saltbush (*Atriplex semibaccata*).

natural devices from the drying influence of the fierce summer heat. The leaves and stems are covered with a coating of hairs, or are mealy like the leaves of the common pigweed of cultivated lands, or the leaves and stems are mucilaginous like those of cactus. In common with all other plants native of alkaline or salty soils, they contain considerable quantities of salt and other soluble constituents of the soil. All of these characteristics tend to protect the foliage and prevent the evaporation from the leaves of the moisture which is necessary to the continued existence of the plant. Again in common with plants indigenous to semidesert regions, each individual produces an immense quantity of seed to insure reproduction of the species under the very unfavorable conditions which prevail.

FIG. 2.—Australian saltbush (*Atriplex leptocarpa*).

With the possible exception of portions of California and Arizona, the range of country in which the saltbushes grow wild is relatively much warmer than the grazing regions of the United States. There is never any snow and rarely frost, the summer heat is more intense, and the periods of drought longer.

AMERICAN SALTBUSHES.

The most valuable saltbushes are species of *Chenopodium* and *Atriplex*. They are not cultivated plants and are not any better adapted to the grazing regions of the United States than our own wild species of the same genera. There are over thirty different kinds of American saltbush, only they are not so designated, in the region extending from Montana, Colorado, and western Texas to the Pacific coast. Nearly all of these are recognized by herders and graziers as furnishing considerable forage for sheep and cattle, and many of them have acquired local importance under such names as sweet sage, white sage, or winter fat. In dry seasons and during severe winters they are supplementary to the native grasses. Their abundance adds value to the ranges.

NOT A CULTIVATED FORAGE PLANT.

These saltbushes are not cultivated plants. In many portions of Australia they have become well nigh extinct through the same causes that are leading to the extermination of our own native forage plants and grasses—the overpasturing of the ranges and the consequent destruction by too close feeding and by trampling. The introduction into foreign countries of saltbush seed has been accomplished mainly through the instrumentality of public-spirited scientists, notably through the efforts of Baron Ferdinand von Mueller of Melbourne. Some ten or more years ago, large quantities of seed were collected and sent by him to South Africa, and the world now beholds the anomalous state of affairs of Australian farmers buying Australian saltbush seed from South Africa.

GENERAL CONSIDERATIONS.

Many, if not all, of the American *Atriplex* and *Chenopodium* species, especially those that are natives of the great ranges, will become extinct along with some of our best pasture grasses, if an effort is not made to conserve and disseminate them. We know that they are valuable. We know that they are eaten by all kinds of stock. We know that they are thoroughly acclimated. They grow on the alkali plains, along the margins of brackish ponds, and on sterile lands. They are perfectly adapted to situations where better forage plants and grasses will not grow. They are natives of the vast arid and semiarid uplands, which through absence of water will never be used for anything but cattle and sheep ranges. They are better fitted to soil and climatic conditions as they now exist with us, and they are less liable to become weeds in cultivated lands. Saltbushes are valuable only as supplementary forage plants. They will not take the place of grasses for continuous pasturage. When mixed with native grasses of a range, they act as a bitter tonic to increase the appetite and improve the general condition of the grazing animals. But there is sufficient nourishment in them to sustain life when through drought or other causes there is no grass.

FIG. 3.—"Winter fat," or sweet sage. (*Eurotia lanata.*) Abundant from Montana to Arizona.

The preservation of our native forage plants is of first importance. The introduction of foreign ones should be secondary. There is abundant proof for the statement that the plants native to any soil or any climate are better suited and better adapted to that particular location than plants from another climate or that grew on another kind of soil. The American species of sweet sage and winter fat are thoroughly acclimated, and the seed can be readily and cheaply procured. We do not need to send to Australia or to South Africa or to Argentina to find forage plants that will grow on alkaline soil.

The indiscriminate introduction of new plants into any country is always fraught with danger, especially when such plants are of a known weedy character. The Russian thistle belongs to the same plant family as the Australian saltbush. This weed in its early stage furnishes good forage for sheep and cattle, and while it may be a blessing on a sheep ranch, it is an undisguised curse on the prairie hay lands and in cultivated fields. Considerable caution should therefore be exercised with these foreign saltbushes lest they spread to fields and places where they are not wanted.

JARED G. SMITH,
Assistant Agrostologist.

Approved:
J. STERLING MORTON,
Secretary.

WASHINGTON, D. C., *March 13, 1896.*

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CIRCULAR No. 1.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

THE RENEWING OF WORN OUT NATIVE PRAIRIE PASTURES.

Throughout the prairie regions of the West one frequently sees native pastures nearly devoid of grass and often grown up to weeds of various kinds. Plainly such pastures are of little value to the owners, so far as the forage obtained from them is concerned, and the weeds are a constant eyesore, often rendering the land even worse than worthless.

Such a condition of things is usually due to two causes, drought and overstocking. While the farmer may have no control over the drought itself, he can, by a little care and foresight, put the pasture in condition to withstand it in a great measure, and he certainly can prevent the pasture from being overstocked. Not infrequently the use of the pasture is almost entirely lost for one or two seasons, when a little rest by removing the stock for a time or by feeding green corn, sorghum, or other soiling crops would have kept it in good condition.

The native grasses are hardy and are adapted to the natural conditions which prevail on the prairies. Some species stand grazing much better than others, and after a pasture has been used for several years it will be found that the weaker grasses are giving way to the stronger ones.

As a rule the forage obtained from the average prairie pasture is furnished by a comparatively small number of species. In the more thickly settled portions of the great prairie States big blue-stem, bushy blue-stem, western wheat-grass, switch grass, prairie June-grass, wild rye, blue joint, and the various species of *Stipa* and *Bouteloua* furnish most of native pasturage.

FIG. 1.—Western wheat-grass (*Agropyron spicatum*).

WEEDS OF THE NATIVE PASTURES.

The most troublesome weeds are either annuals or perennials. The former, because of their vigorous and rapid growth, spring up and take possession of a pasture in a very short time. The latter spread more slowly, but are more difficult to eradicate. Left to themselves, the native grasses will hold their own against the weeds, but when they are pastured off and trampled upon by the stock they are less able to cope with the more aggressive species, and soon begin to die out. This is the time when the farmer should give the grasses some extra care. With very little trouble the pasture can be kept in condition for profitable grazing, while neglect or carelessness may result in the practical loss of the use of the pasture for one or more seasons.

Perennial weeds, such as golden-rod, iron-weed, and some of the sunflowers, can usually be kept in check by mowing when in early bloom. The mower should be run high so as to miss as much of the grass as possible. Occasionally it is necessary to grub out such plants as the rosinweeds.

Annual weeds, like marestail or fireweed, sunflower, and ragweed, may be destroyed in the same manner. The mowing should always be done before the seeds ripen. This not only gets rid of the weeds, but gives the grass a chance to take advantage of the fall rains. A thorough harrowing in the spring while the weeds are very young will destroy many of them and will also give new life to the grass. Very often weeds of both classes may be very effectually checked by burning over the pasture after they are well started in the spring.

EFFECT OF CULTIVATION ON NATIVE GRASSES.

The various native grasses are very differently affected by cultivation. Some do not do well at all and soon die out, others are but little affected either way, while still others respond very quickly and improve almost at once. This last class includes the most valuable of the native species, such as big blue-stem, western wheat-grass, wild-rye, and prairie June-grass.

Fig. 2.—Slender wheat-grass (*Agropyron tenerum*).

The effect of loosening up the soil is very apparent in a field which has "gone back" and seeded itself to wheat-grass or blue-stem. In many parts of Nebraska and the Dakotas three tons or more of hay is often cut from such fields. The fine growth which most grasses make along the edges of cultivated fields is a sight familiar to all who have traveled over the western prairies, and ought to be an object lesson to those to whom these same grasses are of so much importance.

The fact that cultivation improves the more desirable native grasses has been demonstrated by nearly every experiment station in the West and by a great many private parties as well.

An experiment made at the Kansas Station in 1892 shows what a thorough stirring up of the soil will do for an upland prairie pasture. The experiment was made on a pasture in which the grasses had been dying out for some time and the weeds were beginning to appear in abundance. It had been reduced to this condition by drought and overpasturing. The surface was thoroughly loosened up by driving a weighted disc harrow over the field in several directions. The pasture was sown to a mixture of orchard grass, meadow fescue, blue grass, timothy, red top, clover, and alfalfa, which was harrowed in and a roller was driven over the field to level the surface and firm the ground. The seed germinated quickly and the tame grasses made an excellent start, but by September the wild grasses had crowded them out and held complete possession of the field.

In this case the stirring of the soil and the season's rest not only enabled the prairie grasses to recover and to overcome the weeds, but to crowd out a good stand of tame grasses as well.

This has been the experience in Nebraska and South Dakota where like attempts have been made to renew worn out pastures. The tame grasses are undoubtedly valuable aids, since the hardier of them will retain at least partial possession of portions of the pasture and add considerably to the forage obtained. Many of them, though they do not as a rule stand drought so well as the native species, start earlier in the spring or make a better growth in the fall, and thus lengthen the season during which the pasture may be used.

The continual trampling of the stock can not help but pack the soil more or less, and consequently prevent its proper aeration. This packed condition also keeps the water from gaining ready entrance, and it runs off and is lost. This, too, when lack of moisture is perhaps the principal reason for the failure of the pasturage. The old grass roots become crowded and die out or are weakened through lack of available food and suitable soil in which to develope.

It is very readily seen then why the treatment which was given to the pasture at the Kansas Station produced such excellent results. The tearing up of the soil gave ready access to air and moisture, putting new life into the roots of the grasses which were cut up and separated by the disc harrow, so that thousands of new shoots sprang up immediately. The rest for one season gave these new plants time to get well established and form a new sod.

If this treatment is given before the pasture is too badly damaged, there is usually no need of sowing so much tame grass seed. There is little doubt that an occasional tearing up of this kind and a little care given to the time and manner of pasturing will get as much pasturage from the native grasses as can be obtained from tame varieties under the same conditions.

MANURING NATIVE PASTURES.

There is quite a diversity of opinion among farmers and stock raisers on the question of manuring native pasture lands. Some have obtained excellent results by manuring, while others seem to have had quite the opposite experience.

The soil of the western prairies is very rich and under ordinary circumstances will give fair returns without the application of fertilizers of any kind. Nevertheless, it is certain that better returns may be had if more *available* food is placed within reach of the grasses. Any one who has observed a piece of grass land so situated as to receive the wash from a barnyard, will have found that near the yard where the supply of fertilizer has been great the grasses have become thinned out to a few species, while where the supply has been moderate the grasses are much more evenly developed and the yield decidedly better than upon the unfertilized prairie. The lesson is plain. A too plenteous application of fertilizer will thin out the grasses and reduce the yield of forage at least for the first season or two, since many species will not stand such treatment. On the other hand, a proper amount of fertilizer will increase the yield. It is quite possible to use too much fertilizer for any crop, and the native grasses seem to be more sensitive in this respect than the ordinary cultivated species.

Any pasture which has been grazed closely for some time will be benefited by an application of a thin top-dressing of well rotted stable manure, followed by a thorough harrowing. It is doubtful if much is gained by putting coarse unrotted manure on the pasture; it can be used to better advantage on cultivated land. Ashes usually have a beneficial effect upon grasses on soils not too plentifully supplied with alkali.

FIG. 3.—Big bluestem (*Andropogon provincialis*).

SOWING TAME GRASSES ON NATIVE PASTURE LANDS.

While it is hardly possible, and not always desirable, to make a native pasture over into a tame one, yet, as stated before, the pasturage may be materially increased by the addition of some of the cultivated species. A pasture which has had the thin places seeded to hardy tame grasses is certainly more valuable than it would be were these same places grown up to weeds.

In dry upland pastures such grasses as Kentucky blue-grass, sheep's fescue, red fescue, and Canadian blue-grass may be used to advantage. The fescues are especially valuable if the soil is very sandy.

Lowland pastures, particularly those in which the grass has been killed out by overflowing, may be reseeded with timothy, fowl meadow grass, red top, meadow fescue, and alsike. Kentucky blue-grass will do well if the soil is not too wet. It is likely that smooth brome-grass will prove useful on pastures that are to be kept for long periods of time.

The practice of collecting the seeds of such native species as western wheat grass, slender wheat-grass, wild rye, prairie June-grass, and the blue-stems and sowing them on the pasture is to be recommended. The writer recalls an instance where a farmer in South Dakota obtained an excellent pasture by collecting western wheat-grass and filling in the bare places with it.

FIG. 4.—Bushy blue-stem (*Andropogon nutans*).

Though timothy as a general thing is a poor pasture grass for upland soils, it may sometimes be profitably employed in old or worn pastures. The farmer very often has a greater or less quantity of seed which has shattered out in the hay mow. It has cost practically nothing and would probably hardly pay for the cleaning if he were to sell it. If this be scattered about over the pasture, either in the fall or spring, it will pay very well indeed. The timothy may not live in the pasture more than two or three years, but it will yield considerable forage in the mean time and help the native grasses keep down the weeds. In eastern Nebraska, Kentucky blue-grass is one of the best grasses that can be used for reseeding the native pastures. The seed may be sown just as the last snow is melting in the early spring. The grass when once started keeps slowly spreading, and after a time forms an excellent sod. It begins its growth early in the spring and, though often dry and short during midsummer, makes good grazing after the fall rains, and hence gives a longer season, during which the stock can be kept on the pasture.

SUMMARY.

1. Keep from overstocking.
2. When the soil begins to get baked and packed, stir it up with a harrow.
3. Give occasional light top-dressings of well rotted stable manure.
4. Fill in thin spots with hardy tame or wild grasses before the weeds get a start.
5. Keep the weeds mowed off so that the grasses may get the benefit of *all* the plant food there is in the soil.

THOMAS A. WILLIAMS,
Assistant Agrostologist.

Approved:
CHAS. W. DABNEY, Jr.,
Assistant Secretary.

WASHINGTON, D. C., *November 2, 1896.*

CIRCULAR No. 1.—(Revised.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

THE RENEWING OF WORN-OUT NATIVE PRAIRIE PASTURES.

Throughout the prairie regions of the West one frequently sees native pastures nearly devoid of grass and often grown up to weeds of various kinds. Plainly such pastures are of little value to the owners, so far as the forage obtained from them is concerned, and the weeds are a constant eyesore, often rendering the land even worse than worthless.

Such a condition of things is usually due to two causes, drought and overstocking. While the farmer may have no control over the drought itself, he can, by a little care and foresight, put the pasture in condition to withstand it in a great measure, and he certainly can prevent the pasture from being overstocked. Not infrequently the use of the pasture is almost entirely lost for one or two seasons, when a little rest by removing the stock for a time or by feeding green corn, sorghum, or other soiling crops would have kept it in good condition.

The native grasses are hardy and are adapted to the natural conditions which prevail on the prairies. Some species stand grazing much better than others, and after a pasture has been used for several years it will be found that the weaker grasses are giving way to the stronger ones.

As a rule, the forage obtained from the average prairie pasture is furnished by a comparatively small number of species. In the more thickly settled portions of the great prairie States big blue-stem, bushy blue-stem, the wheat-grasses, switch grass, prairie June-grass, wild-rye, blue-joint, and the various species of *Stipa*, *Poa*, and *Bouteloua* furnish most of the native pasturage.

FIG. 1.—Western wheat-grass (*Agropyron spicatum*).

WEEDS OF THE NATIVE PASTURES.

The most troublesome weeds are either annuals or perennials. The former, because of their vigorous and rapid growth spring up and take possession of a pasture in a very short time. The latter spread more slowly, but are more difficult to eradicate. Left to themselves, the native grasses will hold their own against the weeds, but when they are pastured off and trampled upon by the stock they are less able to cope with the more aggressive species, and soon begin to die out. This is the time when the farmer should give the grasses some extra care. With very little trouble the pasture can be kept in condition for profitable grazing, while neglect or carelessness may result in the practical loss of the use of the pasture for one or more seasons.

Perennial weeds, such as golden-rod, iron-weed, and some of the sunflowers, can usually be kept in check by mowing when in early bloom. The mower should be run high so as to miss as much of the grass as possible. Occasionally it is necessary to grub out such plants as the rosinweeds.

Annual weeds, like mare's-tail or fireweed, sunflower, and ragweed may be destroyed in the same manner. The mowing should always be done before the seeds ripen. This not only gets rid of the weeds, but gives the grass a chance to take advantage of the fall rains. A thorough harrowing in the spring while the weeds are very young will destroy many of them and will also give new life to the grass. Very often weeds of both classes may be very effectually checked by burning over the pasture after they are well started in the spring.

EFFECT OF CULTIVATION ON NATIVE GRASSES.

The various native grasses are very differently affected by cultivation. Some do not do well at all and soon die out, others are but little affected either way, while still others respond very quickly and improve almost at once. This last class includes the most valuable of the native species, such as big blue-stem, western wheat-grass, wild-rye, and prairie June-grass.

FIG. 2.—Slender wheat-grass (*Agropyron tenerum*).

The effect of loosening up the soil is very apparent in a field which has "gone back" and seeded itself to wheat-grass or blue-stem. In many parts of Nebraska and the Dakotas three or more tons of hay are often cut from such fields. The fine growth which most grasses make along the edges of cultivated fields is a sight familiar to all who have traveled over the western prairies, and ought to be an object lesson to those to whom these same grasses are of so much importance.

The fact that cultivation improves the more desirable native grasses has been demonstrated by nearly every experiment station in the West and by a great many private parties as well.

An experiment made at the Kansas Station in 1892 shows what a thorough stirring up of the soil will do for an upland prairie pasture. The experiment was made on a pasture in which the grasses had been dying out for some time and the weeds were beginning to appear in abundance. It had been reduced to this condition by drought and overpasturing. The surface was thoroughly loosened up by driving a weighted disk harrow over the field in several directions. The pasture was sown to a mixture of orchard grass, meadow fescue, blue grass, timothy, red top, clover, and alfalfa, which was harrowed in and a roller was driven over the field to level the surface and firm the ground. The seed germinated quickly and the tame grasses made an excellent start, but by September the wild grasses had crowded them out and held complete possession of the field.

In this case the stirring of the soil and the season's rest not only enabled the prairie grasses to recover and to overcome the weeds, but to crowd out a good stand of tame grasses as well.

This has been the experience in Nebraska and South Dakota where like attempts have been made to renew worn-out pastures. The tame grasses are undoubtedly valuable aids, since the hardier of them will retain at least partial possession of portions of the pasture and add considerably to the forage obtained. Many of them, though they do not as a rule stand drought so well as the native species, start earlier in the spring or make a better growth in the fall, and thus lengthen the season during which the pasture may be used.

The continual trampling of the stock can not help but pack the soil more or less, and consequently prevent its proper aeration. This packed condition also keeps the water from gaining ready entrance, and it runs off and is lost. This, too, when lack of moisture is perhaps the principal reason for the failure of the pasturage. The old grass roots become crowded and die out or are weakened through lack of available food and suitable soil in which to develop.

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Fig. 3.—Big blue-stem (*Andropogon provincialis*).

Any pasture which has been grazed closely for some time will be benefited by an application of a thin top-dressing of well rotted stable manure, followed by a thorough harrowing. It is doubtful if much is gained by putting coarse unrotted manure on the pasture; it can be used to better advantage on the cultivated land. Ashes usually have a beneficial effect upon grasses on soils not too plentifully supplied with alkali.

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In dry upland pastures such grasses as Kentucky blue grass, sheep's fescue, red fescue, and Canadian blue-grass may be used to advantage. The fescues are especially valuable if the soil is very sandy. It is likely that smooth brome-grass will prove useful on pastures that are to be kept for long periods of time.

Lowland pastures, particularly those in which the grass has been killed out by overflowing, may be reseeded with timothy, fowl meadow grass, red top, meadow fescue, and alsike. Kentucky blue-grass will do well if the soil is not too wet.

The practice of collecting the seeds of such native species as western wheat-grass, slender wheat-grass, wild-rye, prairie June-grass, and the blue-stems and sowing them on the pasture is to be recommended. The writer recalls an instance where a farmer in South Dakota obtained an excellent pasture by collecting western wheat-grass and filling in the bare places with it. Where the wheat grasses are naturally abundant excellent results have been obtained by plowing up the pasture and keeping the stock off of it until these grasses take possession, which occurs in a very short time.

Fig. 4.—Bushy blue-stem (*Andropogon nutans*).

Though timothy as a general thing is a poor pasture grass for upland soils, it may sometimes be profitably employed in old or worn pastures. The farmer very often has a greater or less quantity of seed which has shattered out in the hay mow. It has cost practically nothing and would probably hardly pay for the cleaning if he were to sell it. If this be scattered about over the pasture, either in the fall or spring, it will pay very well indeed. The timothy may not live in the pasture more than two or three years, but it will yield considerable forage in the meantime and help the native grasses keep down the weeds. In eastern Nebraska, Kentucky blue-grass is one of the best grasses that can be used for reseeding the native pastures. The seed may be sown just as the last snow is melting in the early spring. The grass when once started keeps slowly spreading, and after a time forms an excellent sod. It begins its growth early in the spring and, though often dry and short during midsummer, makes good grazing after the fall rains, and hence gives a longer season, during which the stock can be kept on the pasture. Another plant which can be profitably used for this purpose is white clover; it persists in the soil for a long time and, though small, adds considerably, both in quantity and quality, to the pasturage and exerts a beneficial influence upon the soil.

SUMMARY.

1. Keep from overstocking.
2. When the soil begins to get baked and packed, stir it up with a harrow.
3. Give occasional light top-dressings of well rotted stable manure.
4. Fill in thin spots with hardy tame or wild grasses before the weeds get a start.
5. Keep the weeds mowed off so that the grasses may get the benefit of *all* the plant food there is in the soil.

Thomas A. Williams,
Assistant Agrostologist.

Approved:
James Wilson,
Secretary.

Washington, D. C., *November 15, 1897.*

CIRCULAR No. 5.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

COWPEAS.

(*Vigna catjang.*)

(Reprinted from the Yearbook of the U. S. Department of Agriculture for 1896.)

ORIGIN AND GENERAL CONSIDERATIONS.

The cowpea is to the South what alfalfa is to the West and red clover to the North—a forage plant perfectly adapted to the needs of the region where it grows. The cultivation of this crop in America dates back to the early part of the eighteenth century. A South Carolina planter received a quantity of seed from a foreign source, which, according to certain authorities, was an English acclimatization society or the captain of a trading vessel from far-off India or China. From this small and obscure beginning cowpeas spread throughout the South, and their cultivation has been essayed as far north as Connecticut, New York, and South Dakota, and westward to California.

Cowpeas grow wild in far eastern tropical lands, including India, China, Siam, the Malay Archipelago, and portions of Central Africa, and have become an escape from cultivation in the southern United States and tropical America. From the South the plant has been carried in recent years to South Africa and Australia, so that it is now grown as a forage plant or for human food throughout all the warmer quarters of the globe. Cowpeas are in their relationship and habit of growth really beans, and not, as the name would indicate, peas. They belong to the genus Vigna, the members of which are largely represented in South Africa, and are closely related to the lablab, lima, and haricot beans of our gardens, as well as to numerous cultivated or half-wild garden sorts common in tropical Asia and America, but little known to us.

There are a very large number of named forms or varieties of this forage plant. New forms are constantly arising, due to variations in habit of growth, color of leaf, stem, and pod, and the shape and color of the seed. Variations from any chosen type are constantly appearing, and as one or another of these sports or forms gains sufficient local reputation a new name is applied and sooner or later the supposed new variety is placed upon the market. In this way one variety of cowpea may be cultivated in a dozen different localities under as many names, or a dozen different peas may bear the same name. The whole subject of the nomenclature of varieties is in a chaotic state and can be straightened out only after years of careful study have been given to it by botanists and the experimental agriculturists. No valid conclusions can be drawn from the brief study of a subject so complex. Cowpeas pass through every gradation of form, from a short, stocky, upright bush having single stems a foot high with very short lateral branches to those with trailing runners growing as flat upon the ground as sweet-potato and melon vines, the prostrate stems 15 or 20 feet in length. The pods vary from 4 to 16 inches in length, and the peas are of every imaginable shade through white, yellow, green, pink, gray, brown, red, purple, and black, of solid colors or variously mottled and speckled, and of varying sizes and forms from large kidney-shaped to little round ones smaller than the garden pea. There is a like variation in the length of time the different forms require to ripen seed, some requiring eight or nine months, a few ripening in sixty days from the time of planting.

There seems to be a somewhat constant relation between the time required for attaining maturity and the habit of growth. The bush varieties ripen in a shorter season than the trailers, but a bush variety taken from the North will, in the course of a few seasons, assume the trailing habit and lengthen out its period of growth in any of the Southern States. Also, a runner or creeper requiring six to eight months for reaching maturity in Louisiana will, if planted each year a hundred miles farther north, gradually accommodate itself to the shorter season and at the same time shorten its runners, approaching more and more to the upright or "bush" habit of growth. There can be no hard and fast line of separation between bush peas, trailers, and runners. The best varietal character is probably the color of the seed. It is quite probable that more than one species is in cultivation. The "red" and "black" varieties are closely allied; the round "lady" peas form a separate group; the large "black-eyed" and "purple-eyed" are typical of another, and the variously mottled and speckled "whip-poor-wills" are only a degree removed from the solid-colored yellow, pink, and light-brown ones, and together would naturally be taken to constitute one species or variety. The black peas pass through various shades of red before maturity. The red varieties sometimes carry their change of color in ripening so far that they can not be distinguished from the black. The "black-eyed" and "purple-eyed" are of the same ground color, differing only in the color of the ring surrounding the eye. The various "crowders," yellow and white, the whip-poor-will, clay, and "yellow-eyed" forms have numerous crosses and so-called hybrids in which the fundamental yellows and browns form varying mixtures.

COWPEAS AND SOIL RENOVATION.

A field of cowpeas has been very happily designated "the poor man's bank," for in common with all its leguminous congeners, the field pea, clovers, alfalfa, and a score of others, this crop has the power of increasing the fertility of the soil upon which it grows. This fact has long been accepted by farmers and students of agriculture, but until recent discoveries in Germany and America it was believed that the chief function of these plants was to pump up nitrogen from the subsoil reservoir to the surface by means of their long roots for the use and benefit of succeeding crops.

But experiments in the field and laboratory for the purpose of determining the causes of natural phenomena have taken the place of class-room philosophy and speculative reasoning. Within the last twenty years scientific workers have discovered that minute micro-organisms, or bacteria, which live within the tissues of the roots of leguminous plants take up free nitrogen from the gases in the soil, just as the higher plants and animals utilize the oxygen of the air. This nitrogen enters into combination to form nitric acid, which unites with the mineral elements of the soil to form nitrates, a kind of plant food exceedingly valuable to the growing crop. Nitrogen, when in combination with other elements, is an indispensable form of plant and animal food, but the free element can not be utilized, uncombined, by any of the higher organisms. Small amounts of nitrous acid are formed as a result of lightning discharges and are washed out of the air by the rains, to be in part absorbed by the soil, and in part carried by rivers and drainage waters into the sea. Free nitrogen exists only in the air and in the gases of the soil, but as ammonia, nitrous and nitric acid, nitrites and nitrates, it is present in varying quantities in the soil, the unbroken rocks, and the waters of continents and oceans.

The most available purchasable nitrogen is obtained either as saltpeter or nitrate of soda from the extensive deposits in the Peruvian deserts, or from some form of animal wastes, such as freshly ground bone, dried blood, guano, tankage, and fish scrap, and from cotton-seed meal and other like by-products of the oil mills. These fertilizers are all expensive, so much so that they can be profitably employed by the farmer only in intensive farming with specialized crops. The gain in yield with low-priced crops, such as corn, cotton, tobacco, cowpeas, and the grasses, using high-grade and costly fertilizers, is not commensurate with the additional expense. But every farmer, rich and poor, has over three thousand tons of atmospheric nitrogen resting on every acre of his farm, a certain quantity of which can be transformed into available plant food every time that he grows a crop of cowpeas, red clover, or alfalfa.

There are a great many acres of farming land in the South in need of renovation. The red uplands and yellow-clay soils were undoubtedly less fertile originally than the alluvial and black prairie soils, and the methods of cultivation which formerly prevailed have still further diminished their productiveness. In the days when every plantation numbered its acres by the thousand and labor was cheap, the planter could afford to clear off the native forest growth and bring fresh fields into cultivation whenever the yields of cotton and tobacco fell below what was considered a profitable figure. The old field, stripped in a few years of its accumulated store of humus, was abandoned and allowed to grow up to weeds and underbrush. The forest again spread across it, and gradually, in the slow course of half a lifetime, the natural enrichment of its surface soil by the growth of the woodland grasses made it ready for another robbery.

But with the breaking up of the large estates and the abrupt change in the labor conditions this method of farming became no longer profitable or even possible. A planter with fewer acres could no longer afford to await nature's slow process of rejuvenating the soil. A new system of farming was necessary. The land must not be allowed to "go back." It must be kept up to the highest state of productiveness by a rotation of crops, a judicious use of commercial fertilizers, the growth of nitrogen-fixing leguminous crops, and good and thorough cultivation. To maintain the fertility of any soil the amount of humus or decaying organic matter in it must be kept up. Take two soils of as nearly as possible the same physical and geological formation, but the one rich in humus and the other lacking it, and fertilize them with equal quantities of commercial manures; the one which has the most organic matter in its composition will yield the largest crop. The soil on that field will stand drought better, will wash less under torrential rains, and be more friable and of better tilth. The average soils of the South need more humus. It can be best supplied by sowing more grass, more permanent pasture lands, more leguminous crops. In a word, plant cowpeas.

COWPEAS FOR FORAGE.

There is no forage plant better adapted to the needs and conditions of Southern agriculture than this rank, free-growing annual. It will thrive luxuriantly upon the rich, swampy, cane lands of Louisiana. On the driest and most sterile worn-out uplands it serves the admirable purpose of supplying a larger quantity and better quality of forage than any other bean or clover. And whenever a crop of cowpeas has been taken off a field the surface soil is left richer by a good many pounds of that most costly of all plant foods, nitrogen. The roots of the cowpea enter deeply into the soil, opening and loosening it far down for the benefit of the roots of the succeeding crops of corn, cotton, and tobacco. It has been found by experiment that the fertilizing value of the roots and stubble of the cowpea are very considerable, but not as great as that of the hay removed from the field. The best and most economical use of this forage crop is, then, to cut for hay, feed to stock, and return the stable manure to the soil. Plowing the whole crop under is less remunerative because there is much needless waste of the muscle-making and fat-forming constituents of the plant which would bring more profit if turned into beef, pork, wool, cheese, or butter.

As regards the disposal of the crop, there is a wide variation in practice. The feeding value of vines and peas much exceeds their fertilizing value. But as between the practice of turning the vines under green in autumn and that of allowing them to lie on the ground during the winter, the latter is undoubtedly sometimes to be preferred, though theoretically wrong. Theoretically, to plow the vines under in autumn will be to save all the available nitrogen and convert the whole plant into humus. Practically, the turning under of so large an amount of watery green herbage is highly injurious, causing a too rapid decay and consequent "burning" or souring of the soil. The upper soil layers, freshly stirred and mellowed in autumn, lose more by leaching and washing than they do in an unplowed field covered by its winter mulch of decaying herbage, though in both cases there is a decided loss of fertility over what would result by following the peas with a crop of rye, winter wheat, the turf-forming winter oats, winter vetch, or crimson clover. The yields of forage are better on rich soils than on poor ones, but the beneficial effects upon the succeeding crop due to the growth of this one are not so marked in the former case as in the latter.

METHODS OF CULTIVATION AND HARVESTING.

Cowpeas are planted broadcast or in drills, very commonly between the corn rows after the crop is laid by. The amount of seed used varies from 4 quarts to 2 bushels per acre, the average amount being, perhaps, about 3 pecks. If sown in drills, 18 to 30 inches apart, less seed is required than when sown broadcast. The seed will stand being covered to the depth of 2 or 3 inches, but care must be taken to plant when the ground is neither too wet nor too cold, as the peas rot very rapidly under such circumstances. In regard to excess of moisture cowpeas behave like beans, and in the early stages delight in a warm, mellow seed bed. Much of the failure that has attended the attempted introduction of cowpeas into the Northern States is due to planting before the ground is warm enough. It must be remembered that this plant originated in the Tropics and that when transplanted to higher altitudes it makes its best growth in the hottest weather. It is even more susceptible to cold and wet than is Indian corn. Hence, proper delay in planting will permit economy in the use of seed. Where the vines are grown for hay, the yield will be larger if the seed is planted in drills and cultivated a time or two. The yield of peas is also larger when only a moderate amount of seed is sown and the vines have more space and light and air between them. It is also heavier from late-planted vines than from the very early ones. In tests to determine the relative value of different named varieties it has been found that, as a rule, those which make the heaviest yields of vines also bear large crops of peas.

The vines should be mowed for hay when the peas are well formed and the leaves are first beginning to turn yellow. After wilting on the ground or in windrows from twenty-four to forty-eight hours, the hay is placed in small, thin piles, or cocks, and allowed to cure for several days, when it may be carted to the barn or stacked under sheds. The haymaking process is a difficult one, requiring more care and attention than in the case of red clover, because the broad leaves and thick stems contain a larger amount of water. The hay must be placed in cocks before the leaves become brittle, and the piles must be small enough to allow free circulation of air to the center of each. Bright cowpea hay, clean and well cured, is worth as much as the best red-clover hay, and there is no good reason why the Southern farmers and planters should buy the Northern-grown article for their working stock or for fattening their cattle. Every ton of hay used on the estate should be grown there. Another method of curing hay is to stack the vines in a pen or rack of rails or poles so arranged as to allow the air to enter every part of the pile. This stacking over poles is the best where the vines are pulled, or where the trailing and creeping sorts are used. The bush varieties are the best for hay, because of the greater ease with which they may be mowed and handled. They also hold their leaves better than the ranker trailing sorts. The yield of hay varies according to the fertility of the soil upon which it is raised, whether it is grown on rich lowlands or on the drier and more sterile uplands. In the Gulf States cowpeas will probably give an average yield of 2 to 3 tons per acre, while 4 to 6 tons are not uncommon. Farther north the average will range from $1\frac{1}{2}$ tons in Ohio to $2\frac{1}{2}$ tons in Arkansas, Missouri, and Tennessee. As with other crops, the time of planting, the character of the soil and of the cultivation, and the amount of rainfall have much to do with the yield. Along the Gulf it is one of the best hay crops. North of the latitude of the Ohio River it is chiefly valuable as an addition to the list of drought-resistant, summer-soiling crops and as a crop that will yield a considerable amount of forage on soil too sterile to grow red clover. The commercial value runs from \$6 to \$20 per ton, being governed by the relative abundance of other grades of hay and fodder. Its feeding value is equal to that of the best red clover, and the hay ranks high in palatability and digestibility.

COWPEAS FOR SWINE AND CATTLE.

When cowpeas are planted for green manure, it is an excellent practice to turn hogs into the field about the time that the first peas are ripening. Young pigs thrive amazingly on the succulent foliage and well-filled pods, and the quality of the pork raised on such a healthful and nutritious diet is very fine. This is a very profitable method of fattening hogs or of preparing them for topping off with corn or sorghum for market. An acre of ripening cowpeas will pasture from fifteen to twenty hogs for several weeks, and the gain in fertility from the droppings of the animals during that period will more than counterbalance the fertilizing value of the forage eaten. The rapid increase in weight will thus represent so much clear profit, and the farmer is richer by half a ton or more of prime pork for every acre planted. Chickens and turkeys also eat the ripe peas and do well upon them. Cattle and horses are sometimes pastured on them, but the safer and more economical way of feeding cowpea vines to such stock is to cut or pull and feed partially wilted. There will be less waste and destruction from trampling, and if each animal is given only so much as it can eat clean, the greatest economy as well as greatest profit will result. Furthermore, cattle and sheep are liable to bloat if allowed to eat too ravenously of cowpea vines or any other rich and succulent forage, and by using it as a soiling crop the danger may be more readily controlled and the loss prevented. The report has been sent out from some of the Northern experiment stations, where this forage plant is not ordinarily cultivated, that cattle will not eat the green vines except after having been starved to it, and then only sparingly. We have seen Western horses and ponies that would not touch red clover or a grain ration of oats, and have heard of Eastern stock that would not eat alfalfa hay. But these few adverse cases do not prove that red clover, alfalfa, and oats are not good forage. With the cowpea the case is similar. It is very rarely that any Southern planter reports that this forage is refused by any kind of stock

COWPEAS FOR ENSILAGE.

Reports are very conflicting in regard to the value of this crop for ensilage. There is much positive testimony both for and against, some authorities stating that the quality is excellent and others that the vines contain too much water, the product of the fermentation being a slimy, foul-smelling mass, unfit for food for any kind of animals. From reports on the subject it is to be believed that the attempt to convert cowpea vines into good ensilage can not be made with such uniform success as in the case of red clover. The percentage of water in the tissues is too high, and the mechanical difficulties in the way of running a mass of tangled herbage through the feed cutter are too great. Special machinery would have to be constructed for the purpose. Indian corn will probably remain for many years the best all-round forage plant for this purpose. The consensus of opinion among agricultural workers seems to be that ensilage made from any legume, whether it be cowpeas, vetches, soja beans, alfalfa, or the clovers, does not equal in feeding value good hay made from the same. Under certain conditions that arise in the silo the crude protein is converted into indigestible or insoluble nitrogenous compounds. The cowpea or clover ensilage is then valuable only for the carbohydrates that it contains, and either corn or sorghum is far superior to it.

HARVESTING THE SEED.

The majority of farmers harvest only enough seed of cowpeas to plant again the next season. The ripe pods are picked by hand and are stored in barrels until needed or are thrashed out by machine or with flails on the barn floor during the winter. Sometimes, if the crop is heavy enough to render it profitable, the vines are run through an ordinary thrashing machine from which the concaves and alternate teeth of the cylinder have been removed. But a machine breaks and bruises more of the seed than when the pods are first picked off by hand. Fully 95 per cent of the seed placed upon the market is hand picked. The yield per acre varies according to the varieties and the method of cultivation. Eight to twelve bushels is a fair average of the amount that can be obtained when the peas are planted in the corn rows. Sown alone, broadcast or in drills, yields of from twenty to thirty-five and even, in rare cases, fifty bushels are obtained. The Black, Unknown, Red Ripper, Clay, and Calico varieties are all heavy seed bearers. Lady and White Crowder are good for table use and also yield well. The Black-eyed, Red Crowder, and Whip-poor-will or Speckled are very widely cultivated and find ready sale. Those which make the largest growth of vines for green manure, as a winter soil mulch, for hay or soiling are the Unknown, Red Ripper, Southdown, and Clay. Whip-poor-will, Black-eyed, White, and Red Crowder ripen in from twelve to fourteen weeks, and hence are adapted to cultivation farther north than the very late, but ranker growing, Unknown, Wonderful, Red Ripper, Black, and Gourd varieties. The New Era and Lee ripen seed in from six to seven weeks, and hence are the ones to recommend for summer-soiling crops in the upper prairie region of the Mississippi Valley or anywhere else that an early maturing cowpea is required. This is one of the species of cultivated plants which is very readily modified by change of habitat. Early and late maturing forms may be found of every strain that has been in cultivation for any considerable time.

THE FEEDING VALUE OF COWPEAS.

The feeding value of cowpea vines is very high, as shown by both feeding tests and chemical analyses. As hay the vines are more valuable than fed green for soiling purposes. A comparison with red clover and alfalfa is made in the table on the next page, a compilation[1] of the averages of a number of analyses from various sources.

[1] Handbook of Experiment Station Work, Appendix, 1893.

Feeding value of cowpeas compared with red clover and alfalfa.

Article.	Number of analyses	Fresh or air-dry material. Water.	Ash.	Protein.	Fiber.	Nitrogen free extract	Fat.
Cowpeas:							
Green	10	83.6	1.7	2.4	4.8	7.1	0.04
Hay	8	10.7	7.5	16.6	20.1	42.2	2.9
Red clover:							
Green	43	70.8	2.1	4.4	8.1	13.5	1.1
Hay	38	15.3	6.2	12.3	24.5	33.6	3.9
Alfalfa:							
Green	23	71.8	2.7	4.8	7.4	12.3	1.0
Hay	21	8.4	7.4	14.3	25.0	42.7	2.2

Article.	Calculated to water-free substance. Ash.	Protein.	Fiber.	Nitrogen free extract	Fat.
Cowpeas:					
Green	10.5	14.3	29.0	43.6	2.6
Hay	8.5	18.6	22.5	47.2	3.2
Red clover:					
Green	7.2	15.3	27.8	45.8	3.9
Hay	7.3	13.5	31.3	43.0	4.9
Alfalfa:					
Green	9.4	17.1	26.2	43.9	3.4
Hay	8.1	15.6	27.3	46.6	2.4

A study of the percentages here given will show that the green vines contain more water, less protein or nitrogenous, muscle-making food, and less of the fat-forming crude fibers, fats, and nitrogen-free extracts than either the green alfalfa or red clover. The air-dry hay, however, contains more protein than either of the others, less fiber, more nitrogen-free extracts than the red clover, and more fat than the alfalfa. As is the case with leguminous forage plants in general, a ration of cowpeas, to be well balanced, requires the addition of some coarse fodder, such as corn stover, sorghum, timothy, Bermuda, or prairie hay, otherwise a portion of the protein will be wasted.

FERTILIZERS.

It has been found that, as a rule, it does not pay to use high-grade commercial fertilizers on cowpeas; this, however, depends a good deal on the soil and on what crop is to follow this green manurial one. It is usually unprofitable to fertilize with expensive nitrogen, in the form either of nitrate of soda or of guano, and even the organic nitrogen of cotton-seed meal does not act upon this crop as rapidly as upon cotton and the cereals. The nitrogen of the fertilizers seems not to influence the percentage of protein in the crop, and the general opinion of agriculturists in the South is that it does not cause a sufficient increase in yield of vines to pay the cost. At the Delaware Station 160 pounds of muriate of potash per acre doubled the yield of vines, and superphosphate produced no effect. At the Georgia Station combinations of superphosphate and potash gave the best results, but later experiments there indicated that large amounts of potash are unprofitable, and that superphosphate at the rate of from 200 to 400 pounds per acre gave better results. Superphosphates are very much preferable to untreated rock phosphate. The latter can be sold at much lower rates, and it remains to be seen whether it would not be a profitable method to apply the soft phosphate to the cowpeas for the benefit of the succeeding crop in the rotation, for it has been found that the insoluble phosphoric acid of the untreated rock becomes changed to forms available as plant food in the presence of large amounts of decaying vegetable matter in the soil. If it is found that this process can be relied upon, then the cowpea will have another valuable quality added to it, namely, that of being able to change into high-grade and more costly superphosphate the low-grade and cheap but unavailable phosphoric acid of the untreated rock.

The chief functions of this crop, then, are to furnish large amounts of nitrogen abstracted from the air and fixed in the roots and stubble in a conveniently available form for the use of succeeding crops; second, to produce a large yield of vines and peas rich in digestible protein, which, either as hay or for soiling purposes, will take the place of concentrated nitrogenous foods; and, third, to supply humus, which acts directly and indirectly to produce fertility by breaking down and rendering available the basic minerals of the soil. The fertilizing value of the nitrogen in the vines is entirely dissipated or greatly diminished by weathering when they are left on the surface of the field during the winter. Hence, to secure the full value, the cowpeas should be fed and the stable manure returned to the field. If the vines are plowed under in autumn, a winter forage crop, such as winter oats, crimson clover, rye, or vetches, should be planted to prevent the leaching and washing action of the winter rains.

JARED G. SMITH,
Assistant Agrostologist.

Approved:
JAMES WILSON, *Secretary.*
WASHINGTON, D. C., *November 26, 1897.*

CIRCULAR No. 5.—(Revised edition.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

COWPEAS.

(*Vigna catjang.*)

(Reprinted from the Yearbook of the U. S. Department of Agriculture for 1896.)

ORIGIN AND GENERAL CONSIDERATIONS.

The cowpea is to the South what alfalfa is to the West and red clover to the North—a forage plant perfectly adapted to the needs of the region where it grows. The cultivation of this crop in America dates back to the early part of the eighteenth century. A South Carolina planter received a quantity of seed from a foreign source, which, according to certain authorities, was an English acclimatization society or the captain of a trading vessel from far off India or China. From this small and obscure beginning cowpeas spread throughout the South, and their cultivation has been essayed as far north as Connecticut, New York, and South Dakota, and westward to California.

Cowpeas grow wild in far eastern tropical lands, including India, China, Siam, the Malay Archipelago, and portions of Central Africa, and have become an escape from cultivation in the southern United States and tropical America. From the South the plant has been carried in recent years to South Africa and Australia, so that it is now grown as a forage plant or for human food throughout all the warmer quarters of the globe. Cowpeas are in their relationship and habit of growth really beans, and not, as the name would indicate, peas. They belong to the genus Vigna, the members of which are largely represented in South Africa, and are closely related to the lablab, lima, and haricot beans of our gardens, as well as to numerous cultivated or half-wild garden sorts common in tropical Asia and America, but little known to us.

VARIETIES.

There are a very large number of named forms or varieties of this forage plant. New forms are constantly arising, due to variations in habit of growth, color of leaf, stem, and pod, and the shape and color of the seed. Variations from any chosen type are constantly appearing, and as one or another of these sports or forms gains sufficient local reputation a new name is applied and sooner or later the supposed new variety is placed upon the market. In this way one variety of cowpea may be cultivated in a dozen different localities under as many names, or a dozen different peas may bear the same name. The whole subject of the nomenclature of varieties is in a chaotic state and can be straightened out only after years of careful study have been given to it by botanists and the experimental agriculturists. No valid conclusions can be drawn from the brief study of a subject so complex. Cowpeas pass through every gradation of form, from a short, stocky, upright bush having single stems a foot high with very short lateral branches to those with trailing runners growing as flat upon the ground as sweet-potato and melon vines, the prostrate stems 15 or 20 feet in length. The pods vary from 4 to 16 inches in length, and the peas are of every imaginable shade through white, yellow, green, pink, gray, brown, red, purple, and black, of solid colors or variously mottled and speckled, and of varying sizes and forms from large kidney-shaped to little round ones smaller than the garden pea. There is a like variation in the length of time the different forms require to ripen seed, some requiring eight or nine months, a few ripening in sixty days from the time of planting.

There seems to be a somewhat constant relation between the time required for attaining maturity and the habit of growth. The bush varieties ripen in a shorter season than the trailers, but a bush variety taken from the North will, in the course of a few seasons, assume the trailing habit and lengthen out its period of growth in any of the Southern States. Also, a runner or creeper requiring six to eight months for reaching maturity in Louisiana will, if planted each year a hundred miles farther north, gradually accommodate itself to the shorter season and at the same time shorten its runners, approaching more and more to the upright or "bush" habit of growth. There can be no hard and fast line of separation between bush peas, trailers, and runners. The best varietal character is probably the color of the seed. It is quite probable that more than one species is in cultivation. The "red" and "black" varieties are closely allied; the round "lady" peas form a separate group; the large "black-eyed" and "purple-eyed" are typical of another, and the variously mottled and speckled "whip-poor-wills" are only a degree removed from the solid-colored yellow, pink, and light-brown ones, and together would naturally be taken to constitute one species or variety. The black peas pass through various shades of red before maturity. The red varieties sometimes carry their change of color in ripening so far that they can not be distinguished from the black. The "black-eyed" and "purple-eyed" are of the same ground color, differing only in the color of the ring surrounding the eye. The various "crowders," yellow and white, the whip-poor-will, clay, and "yellow-eyed" forms have numerous crosses and so-called hybrids in which the fundamental yellows and browns form varying mixtures.

METHODS OF CULTIVATION.

Cowpeas are planted broadcast or in drills, very commonly between the corn rows after the crop is laid by. The amount of seed used varies from 4 quarts to 2 bushels per acre, the average amount being, perhaps, about 3 pecks. If sown in drills, 18 to 30 inches apart, less seed is required than when sown broadcast. The seed will stand being covered to the depth of 2 or 3 inches, but care must be taken to plant when the ground is neither too wet nor too cold, as the peas rot very rapidly under such circumstances. In regard to excess of moisture cowpeas behave like beans, and in the early stages delight in a warm, mellow seed bed. Much of the failure that has attended the attempted introduction of cowpeas into the Northern States is due to planting before the ground is warm enough. It must be remembered that this plant originated in the Tropics and that when transplanted to higher latitudes it makes its best growth in the hottest weather. It is even more susceptible to cold and wet than is Indian corn. Hence, proper delay in planting will permit economy in the use of seed. Where the vines are grown for hay, the yield will be larger if the seed is planted in drills and cultivated a time or two. The yield of peas is also larger when only a moderate amount of seed is sown and the vines have more space and light and air between them. It is also heavier from late-planted vines than from the very early ones. In tests to determine the relative value of different named varieties it has been found that, as a rule, those which make the heaviest yields of vines also bear large crops of peas.

HARVESTING.

The vines should be mowed for hay when the peas are well formed and the leaves are first beginning to turn yellow. After wilting on the ground or in the windrows from twenty-four to forty-eight hours, the hay is placed in small thin piles, or cocks, and allowed to cure for several days, when it may be carted to the barn or stacked under sheds. The haymaking process is a difficult one, requiring more care and attention than in the case of red clover, because the broad leaves and thick stems contain a larger amount of water. The hay must be placed in cocks before the leaves become brittle, and the piles must be small enough to allow free circulation of air to the center of each. Bright cowpea hay, clean and well cured, is worth as much as the best red-clover hay, and there is no good reason why the Southern farmers and planters should buy the Northern-grown article for their working stock or for fattening their cattle. Every ton of hay used on the estate should be grown there. Another method of curing hay is to stack the vines in a pen or rack of rails or poles so arranged as to allow the air to enter every part of the pile. This stacking over poles is the best where the vines are pulled, or where the trailing and creeping sorts are used. The bush varieties are the best for hay, because of the greater ease with which they may be mowed and handled. They also hold their leaves better than the ranker trailing sorts.

The majority of farmers harvest only enough seed of cowpeas to plant again the next season. The ripe pods are picked by hand and are stored in barrels until needed or are thrashed out by machine or with flails on the barn floor during the winter. Sometimes, if the crop is heavy enough to render it profitable, the vines are run through an ordinary thrashing machine from which the concave and alternate teeth of the cylinder have been removed. But a machine breaks and bruises more of the seed than when the pods are first picked off by hand. Fully 95 per cent of the seed placed upon the market is hand picked. The yield per acre varies according to the varieties and the method of cultivation. Eight to twelve bushels is a fair average of the amount that can be obtained when the peas are planted in the corn rows. Sown alone, broadcast or in drills, yields of from twenty to thirty-five and even, in rare cases, fifty bushels are obtained. The Black, Unknown, Red Ripper, Clay, and Calico varieties are all heavy seed bearers. Lady and White Crowder are good for table use and also yield well. The Black-eyed, Red Crowder, and Whip-poor-will or Speckled are very widely cultivated and find ready sale. Those which make the largest growth of vines for green manure, as a winter soil mulch, for hay or soiling are the Unknown, Red Ripper, Southdown, and Clay. Whip-poor-will, Black-eyed, White, and Red Crowder ripen in from twelve to fourteen weeks, and hence are adapted to cultivation farther north than the very late, but ranker growing, Unknown, Wonderful, Red Ripper, Black, and Gourd varieties. The New England and Lee ripen seed in from six to seven weeks, and hence are the ones to recommend for summer-soiling crops in the upper prairie region of the Mississippi Valley or anywhere else that an early maturing cowpea is required. This is one of the species of cultivated plants which is very readily modified by change of habitat. Early and late maturing forms may be found of every strain that has been in cultivation for any considerable time.

YIELD AND VALUE.

The yield of hay varies according to the fertility of the soil upon which it is raised, whether it is grown on rich lowlands or on the drier and more sterile uplands. In the Gulf States cowpeas will probably give an average yield of 2 to 3 tons per acre, while 4 to 6 tons are not uncommon. Farther north the average will range from $1\frac{1}{2}$ tons in Ohio to $2\frac{1}{2}$ tons in Arkansas, Missouri, and Tennessee. As with other crops, the time of planting, the character of the soil and of the cultivation, and the amount of rainfall have much to do with the yield. Along the Gulf it is one of the best hay crops. North of the latitude of the Ohio River it is chiefly valuable as an addition to the list of drought-resistant, summer-soiling crops and as a crop that will yield a considerable amount of forage on soil too sterile to grow red clover. The commercial value runs from \$6 to \$20 per ton, being governed by the relative abundance of other grades of hay and fodder. Its feeding value is equal to that of the best red clover, and the hay ranks high in palatability and digestibility.

FERTILIZERS.

It has been found that, as a rule, it does not pay to use high-grade commercial fertilizers on cowpeas; this, however, depends largely on the soil and on what crop is to follow this green manurial one. It is usually unprofitable to fertilize with expensive nitrogen, in the form either of nitrate of soda or of guano, and even the organic nitrogen of cotton-seed meal does not act upon this crop as rapidly as upon cotton and the cereals. The nitrogen of the fertilizers seems not to influence the percentage of protein in the crop, and the general opinion of agriculturists in the South is that it does not cause a sufficient increase in yield of vines to pay the cost. At the Delaware Station 160 pounds of muriate of potash per acre doubled the yield of vines, and superphosphate produced no effect. At the Georgia Station combinations of superphosphate and potash gave the best results, but later experiments there indicated that large amounts of potash are unprofitable, and that superphosphate at the rate of from 200 to 400 pounds per acre gave better results. Superphosphates are very much preferable to untreated rock phosphate. The latter can be sold at very much lower rates, and it remains to be seen whether it would not be a profitable method to apply the soft phosphate to the cowpeas for the benefit of the succeeding crop in the rotation, for it has been found that the insoluble phosphoric acid of the untreated rock becomes changed to forms available as plant food in the presence of large amounts of decaying vegetable matter in the soil. If it is found that this process can be relied upon, then the cowpea will have another valuable quality added to it, namely, that of being able to change into high-grade and more costly superphosphate the low-grade and cheap but unavailable phosphoric acid of the untreated rock.

THE FEEDING VALUE OF COWPEAS.

The feeding value of cowpea vines is very high, as shown by both feeding tests and chemical analyses. As hay the vines are more valuable than fed green for soiling purposes. A comparison with red clover and alfalfa is made in the following table, a compilation[1] of the averages of a number of analyses from various sources.

Feeding value of cowpeas compared with red clover and alfalfa.

Article.	Fresh or air-dry material.							Calculated to water-free substance.				
	Number of analyses.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Cowpeas:												
Green	10	83.6	1.7	2.4	4.8	7.1	0.04	10.5	14.3	29.0	43.6	2.6
Hay	8	10.7	7.5	16.6	20.1	42.2	2.9	8.5	18.6	22.5	47.2	3.2
Red clover:												
Green	43	70.8	2.1	4.4	8.1	13.5	1.1	7.2	15.3	27.8	45.8	3.9
Hay	38	15.3	6.2	12.3	24.5	33.6	3.9	7.3	13.5	31.3	43.0	4.9
Alfalfa:												
Green	23	71.8	2.7	4.8	7.4	12.3	1.0	9.4	17.1	26.2	43.9	3.4
Hay	21	8.4	7.4	14.3	25.0	42.7	2.2	8.1	15.6	27.3	46.6	2.4

A study of the percentages here given will show that the green vines contain more water, less protein or nitrogenous, muscle-making food and less of the fat-forming crude fibers, fats, and nitrogen-free extracts than either the green alfalfa or red clover. The air-dry hay, however, contains more protein than either of the others, less fiber, more nitrogen-free extracts than the red clover, and more fat than the alfalfa. As is the case with leguminous forage plants in general, a ration of cowpeas, to be well balanced, requires the addition of some other fodders, such as corn stover, sorghum, timothy, Bermuda, or prairie hay, otherwise a portion of the protein will be wasted.

COWPEAS FOR FORAGE.

There is no forage plant better adapted to the needs and conditions of Southern agriculture than this rank, free-growing annual. It will thrive luxuriantly upon the rich, swampy cane lands of Louisiana. On the driest and most sterile worn-out uplands it serves the admirable purpose of supplying a larger quantity and better quality of forage than any other bean or clover. And whenever a crop of cowpeas has been taken off a field the surface soil is left richer by a good

[1] Handbook of Experiment Station Work, Appendix, 1893.

many pounds of that most costly of all plant foods, nitrogen. The roots of the cowpea enter deeply into the soil, opening and loosening it far down for the benefit of the roots of the succeeding crops of corn, cotton, and tobacco. It has been found by experiment that the fertilizing value of the roots and stubble of the cowpea are very considerable, but not as great as that of the hay removed from the field. The best and most economical use of this forage crop is, then, to cut for hay, feed to stock, and return the stable manure to the soil. Plowing the whole crop under is less remunerative because there is much needless waste of the muscle-making and fat-forming constituents of the plant which would bring more profit if turned into beef, pork, wool, cheese, or butter.

As regards the disposal of the crop, there is a wide variation in practice. The feeding value of vines and peas much exceeds their fertilizing value. But as between the practice of turning the vines under green in autumn and that of allowing them to lie on the ground during the winter, the latter is undoubtedly sometimes to be preferred, though theoretically wrong. Theoretically, to plow the vines under in autumn will be to save all the available nitrogen and convert the whole plant into humus. Practically, the turning under of so large an amount of watery green herbage is highly injurious, causing a too rapid decay and consequent "burning" or souring of the soil. The upper soil layers, freshly stirred and mellowed in autumn, lose more by leaching and washing than they do in an unplowed field covered by its winter mulch of decaying herbage, though in both cases there is a decided loss of fertility over what would result by following the peas with a crop of rye, winter wheat, the turf-forming winter oats, winter vetch, or crimson clover. The yields of forage are better on rich soils than on poor ones, but the beneficial effects upon the succeeding crop due to the growth of cowpeas are not so marked in the former case as in the latter.

COWPEAS FOR SWINE AND CATTLE.

When cowpeas are planted for green manure, it is an excellent practice to turn hogs into the field about the time that the first peas are ripening. Young pigs thrive amazingly on the succulent foliage and well-filled pods, and the quality of the pork raised on such a healthful and nutritious diet is very fine. This is a very profitable method of fattening hogs or of preparing them for topping off with corn or sorghum for market. An acre of ripening cowpeas will pasture from fifteen to twenty hogs for several weeks, and the gain in fertility from the droppings of the animals during that period will more than counterbalance the fertilizing value of the forage eaten. The rapid increase in weight will thus represent so much clear profit, and the farmer is richer by half a ton or more of prime pork for every acre planted. Chickens and turkeys also eat the ripe peas and do well upon them. Cattle and horses are sometimes pastured on them, but the safer and more economical way of feeding cowpea vines to such stock is to cut or pull and feed partially wilted. There will be less waste and destruction from trampling, and if each animal is given only so much as it can eat clean the greatest economy as well as greatest profit will result. Furthermore, cattle and sheep are liable to bloat if allowed to eat too ravenously of cowpea vines or any other rich and succulent forage, and by using it as a soiling crop the danger may be more readily controlled and the loss prevented. The report has been sent out from some of the Northern experiment stations, where this forage plant is not ordinarily cultivated, that cattle will not eat the green vines except after having been starved to it, and then only sparingly. We have seen Western horses and ponies that would not touch red clover or a grain ration of oats, and have heard of Eastern stock that would not eat alfalfa hay. But these few adverse cases do not prove that red clover, alfalfa, and oats are not good forage. With the cowpea the case is similar. It is very rarely that any Southern planter reports that this forage is refused by any kind of stock.

COWPEAS FOR ENSILAGE.

Reports are very conflicting in regard to the value of this crop for ensilage. There is much positive testimony both for and against, some authorities stating that the quality is excellent and others that the vines contain too much water, the product of the fermentation being a slimy, foul-smelling mass, unfit for food for any kind of animals. From reports on the subject it is to be believed that the attempt to convert cowpea vines into good ensilage can not be made with such uniform success as in the case of red clover. The percentage of water in the tissues is too high, and the mechanical difficulties in the way of running a mass of tangled herbage through the feed cutter are too great. Special machinery would have to be constructed for the purpose. Indian corn will probably remain for many years the best all-around forage plant for this purpose. The consensus of opinion among agricultural workers seems to be that ensilage made from any legume, whether it be cowpeas, vetches, soy beans, alfalfa, or the clovers, does not equal in feeding value good hay made from the same. Under certain conditions that arise in the silo the crude protein is converted into indigestible or insoluble nitrogenous compounds. The cowpea or clover ensilage is then valuable only for the carbohydrates that it contains, and either corn or sorghum is far superior to it.

COWPEAS AND SOIL RENOVATION.

A field of cowpeas has been very happily designated "the poor man's bank," for in common with all its leguminous congeners, the field pea, clovers, alfalfa, and a score of others, this crop has the power of increasing the fertility of the soil upon which it grows. This fact has long been accepted by farmers and students of agriculture, but until recent discoveries in Germany and America it was believed that the chief function of these plants was to pump up nitrogen from the subsoil reservoir to the surface by means of their long roots for the use and benefit of succeeding crops.

But experiments in the field and laboratory for the purpose of determining the causes of natural phenomena have taken the place of class-room philosophy and speculative reasoning. Within the last twenty years scientific workers have discovered that minute micro-organisms, or bacteria, which live within the tissues of the roots of leguminous plants take up free nitrogen from the gases in the soil, just as the higher plants and animals utilize the oxygen of the air. This nitrogen enters into combination to form nitric acid, which unites with the mineral elements of the soil to form nitrates, a kind of plant food exceedingly valuable to the growing crop. Nitrogen, when in combination with other elements, is an indispensable form of plant and animal food, but the free element can not be utilized by any of the higher organisms. Small amounts of nitrous acid are formed as a result of lightning discharges and are washed out of the air by the rains, to be in part absorbed by the soil, and in part carried by rivers and drainage waters into the sea. Free nitrogen exists only in the air and in the gases of the soil, but as ammonia, nitrous and nitric acid, nitrites and nitrates, it is present in varying quantities in the soil, the unbroken rocks, and the waters of continents and oceans.

The most available purchasable nitrogen is obtained either as saltpeter or nitrate of soda from the extensive deposits in the Peruvian deserts, or from some form of animal wastes, such as freshly ground bone, dried blood, guano, tankage, and fish scrap, and from cottonseed meal and other like by-products of the oil mills. These fertilizers are all expensive, so much so that they can be profitably employed by the farmer only in extensive farming with specialized crops. The gain in yield with low-priced crops, such as corn, cotton, tobacco, cowpeas, and the grasses, using high-grade and costly fertilizers, is not commensurate with the additional expense. But every farmer, rich and poor, has over three thousand tons of atmospheric nitrogen resting on every acre of his farm, a certain quantity of which can be transformed into available plant food every time he grows a crop of cowpeas, red clover, or alfalfa.

There are a great many acres of farming land in the South in need of renovation. The red upland and yellow-clay soils were undoubtedly less fertile originally than the alluvial and black prairie soils, and the methods of cultivation which formerly prevailed have still further diminished their productiveness. In the days when every plantation numbered its acres by the thousand and labor was cheap, the planter could afford to clear off the native forest growth and bring fresh fields into cultivation whenever the yields of cotton and tobacco fell below what was considered a profitable figure. The old field, stripped in a few years of its accumulated store of humus, was abandoned and allowed to grow up to weeds and underbrush. The forest again spread across it, and gradually, in the slow course of half a lifetime, the natural enrichment of its surface soil by the growth of the woodland grasses made it ready for another robbery.

But with the breaking up of the large estates and the abrupt change in the labor conditions this method of farming became no longer profitable or even possible. A planter with fewer acres could no longer afford to await nature's slow process of rejuvenating the soil. A new system of farming was necessary. The land must not be allowed to "go back." It must be kept up to the highest state of productiveness by a rotation of crops, a judicious use of commercial fertilizers, the growth of nitrogen-fixing leguminous crops, and good and thorough cultivation. To maintain the fertility of any soil the amount of humus or decaying organic matter in it must be kept up. Take two soils of as nearly as possible the same physical and geological formation, but the one rich in humus and the other lacking it, and fertilize them with equal quantities of commercial manures; the one which has the most organic matter in its composition will yield the largest crop. The soil on that field will stand drought better, will wash less under torrential rains, and be more friable and of better tilth. The average soils of the South need more humus. It can be best supplied by sowing more grass, more permanent pasture lands, more leguminous crops. In a word, plant cowpeas.

SUMMARY.

The chief functions of this crop, then, are to furnish large amounts of nitrogen abstracted from the air and fixed in the roots and stubble in a conveniently available form for the use of succeeding crops; second, to produce a large yield of vines and peas rich in digestible protein, which, either as hay or for soiling purposes, will take the place of concentrated nitrogenous foods; and, third, to supply humus, which acts directly and indirectly to produce fertility by breaking down and rendering available the basic minerals of the soil. The fertilizing value of the nitrogen in the vines is entirely dissipated or greatly diminished by weathering when they are left on the surface of the field during the winter. Hence, to secure the full value, the cowpeas should be fed and the stable manure returned to the field. If the vines are plowed under in autumn, a winter forage crop, such as winter oats, crimson clover, rye, or vetches, should be planted to prevent the leaching and washing action of the winter rains.

JARED G. SMITH,
Assistant Agrostologist.

Approved:
JAMES WILSON,
Secretary.

WASHINGTON, D. C., *March 25, 1898.*

CIRCULAR No. 6.—(Agros. 25.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

THE CULTIVATED VETCHES.

The demand for early spring forage plants is increasing in almost every section of the United States. This demand arises from a variety of causes, chief among which is the rapid increase of the dairying industry. Soiling crops and pastures supply the desired succulent forage from early summer until the first hard autumn freeze, and ensilage and root crops tide over the early winter. With good management such substitutes for green forage may be made to last until the grass starts, but on too many American farms there is a period of shortage of succulent feed in late winter and spring. To bridge over this critical period, annual leguminous crops, such as crimson clover and the vetches, are each year coming deservedly into greater prominence. The vetches are nitrogen gatherers. Like the clovers they have the property of absorbing through their roots the free gaseous nitrogen of the air, which is present in all well cultivated soils, and fixing a portion of it in a form which may become either a fertilizer if left in the soil or a muscle-making element in the forage. Nearly all leguminous forage crops have this property and hence their great importance as green manure and soiling crops.

The vetches are also useful because they form a living mulch in spring and early winter, shading the ground and preventing the growth of weeds, thus retarding the constant loss of soluble plant foods that is going on wherever a soil is left bare and unprotected from the direct action of the elements. A mulch of weeds would serve the same purpose, but all can see why it would be better to have the winter cover consist of vetches or clovers rather than of a tangle of noxious weeds.

In the Southern States vetches should be sown in the late summer or early fall, so that they may be out of the way in time to plant the next season's field crops. In the North or wherever the winters are severe they may be sown in early spring at the same time as the spring wheat or other small grain. They are all crops which delight in cool growing weather like that of the northern spring or fall and the southern winter.

HAIRY VETCH, OR SAND VETCH.

(*Vicia villosa.*)

This annual leguminous plant is a native of western Asia. It has been cultivated for about fifty years in some parts of Europe, especially southern Russia, Germany, and France, and was introduced into this country for the first time about 1847, under the name of Siberian vetch. Its cultivation was then neglected until its reintroduction about twelve years ago by this Department. It has since been tried in various parts of the United States. Excellent reports as to its drought-resisting qualities and its adaptability to our climate have been received from Washington, Nebraska, Georgia, New Mexico, South Dakota, Minnesota, Montana, and Pennsylvania. It has been grown on the experimental grounds of the Department of Agriculture at Washington, D. C., and has proved to be thoroughly adapted

FIG. 1.—Hairy vetch or sand vetch (*Vicia villosa*): *a*, cross-section of stem; *b*, flower; *c*, stamens; *d*, pod.

to and valuable for this locality. The seed was sown about the 25th of April, and the plants commenced to bloom the middle of July, continuing in flower until the end of November. Sown in August it grew well until the first hard frost and continued an intermittent growth all winter during periods of open weather. By the middle of March it had formed a thick mat of vines over the soil. It blossomed by the first of May and was then ready to be cut. Hairy vetch withstands winter cold and summer drought, but it does not do well where there is an excess of water in the soil. It is one of the most promising fodder crops which has been brought into the United States in recent years and by some is considered especially valuable for light sandy soils.

CULTIVATION.

Hairy vetch (fig. 1) may be sown in autumn, from about the middle of August to the middle of September; or in spring, from the latter part of April to the middle of May. It should be sown broadcast or with a grain drill at the rate of 1 to 1½ bushels of seed per acre. The latter method will require a less amount of seed. When the seed is put in broadcast, a bushel of rye, oats or wheat should be sown at the same time, so as to furnish a support to keep the vines up off the ground. If it is sown in drills in the latter part of August the crop should be cultivated several times. It will furnish some forage in autumn, and where the winter is not too severe will start to grow again in the spring, thus producing forage in late autumn and early spring, at the two periods when it is most needed.

While it gives a fair crop on poor soil it is most profitable as a forage plant on rich and well-tilled land. It needs considerable moisture during the first six weeks of its growth, but when once fairly established withstands drought and extremes of temperature. The seeds germinate poorly when they are more than two years old. Most of the seed used in this country is imported from Europe, so that particular care ought to be taken by importers and dealers to handle none but such as can be sold under guarantee as good, fresh seed.

At the Mississippi Agricultural Experiment Station seed of this vetch was sown in October, 1888, and since that time has given heavy annual crops on the same ground, although receiving no attention. Its seeds germinated with the first autumn rains, and covered the ground by the first of January, furnishing good grazing until April or May. If the stock is taken off the field in March the plants will mature and reseed the ground freely for the next year.

FORAGE VALUE.

Hairy vetch is eaten with relish by all kinds of stock. If properly cured it makes good hay, though on account of its habit of growth the process is difficult. It has been tested in the silo in alternate layers with green corn and also alone. The former method is the one to be used if the best ensilage is desired. It is a most excellent forage plant for soiling purposes. On account of the difficulty of cutting it properly, it will give the most satisfactory results fed in this way.

The seed is as yet very expensive, being about $4 per bushel of 70 pounds. As soon as its cultivation has increased to such an extent that the seed may be obtained at prices less prohibitive, this vetch will undoubtedly occupy a permanent place in American agriculture.

SPRING VETCH, OR TARES.

(*Vicia sativa.*)

Spring vetch is a leafy, annual, trailing herb, 1 to 2 feet high, with 4- to 5-angled stems, simple or branched from the base. The leaves are compound and are terminated with 3 or 4 tendrils. The 5 to 7 pairs of leaflets are broadest above the middle, blunt or notched at the end, and tipped with an abrupt point (fig. 2). The flowers are rather large, deep purple, one or two together in the axil of the leaf on a very short stalk. The plant is soft and hairy all over.

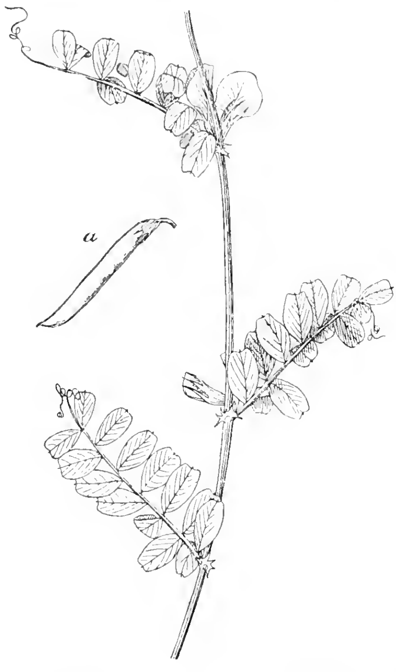

FIG. 2.—Spring vetch or tares (*Vicia sativa*): *a*, pod.

HISTORY.

This old-world forage plant has been cultivated in Europe for nearly twenty centuries. It is a native of western Asia and of all Europe except Lapland. It was cultivated by the Romans, and was esteemed by them a valuable fodder crop. In Italy it has been grown continuously up to the present day. It is one of the many soiling crops in use in northern Europe and the British Isles. Spring vetches were introduced into the United States in a casual way nearly a hundred years ago. They have been tried in nearly all the States and have proved very unsatisfactory, except for certain districts in New England, New York, northern Michigan, Wisconsin, and lower Canada. They were very largely grown throughout the New England and Northern States during the period from 1865 to 1885, but their cultivation there has now almost ceased, it having been found that the yield of hay or of green fodder is not a profitable one compared with that of the red and crimson clovers and field peas. The principal drawback to their more extensive cultivation is the high price of the seed ($2.50 to $3 per bushel of 70 pounds) and the fact that they can not withstand even temporary drought or hot weather. In England, where they are extensively used, the growing season is much cooler, with more rain and an equable temperature.

CULTIVATION.

Spring vetches seem to be adapted more particularly to northern countries, where the season is short and the rainfall abundant. The seed should be sown at the rate of 5 to 8 pecks per acre, with one bushel of rye or oats as a nurse crop. As high a seeding as 3 to 3½ bushels per acre is sometimes recommended, but the product per acre will not warrant the use of so much seed at the present high prices. Vetches should be sown in April or May. They will be ready to cut by the middle of June or the first of July, from full bloom until the pods are half formed. When sown alone the vines lodge and make a dense mat, and the object of the nurse crop is to furnish a support to lift the vines up off the leaves. The vines are very difficult to harvest when sown alone, on account of the tangled mass of stems, but may be easily cut with a pea harvester. An acre of vetch and oats yields ordinarily from 6 to 8 tons of green forage. Where it can be grown, its chief value arises from the fact that it is ready to cut between the first and second crops of red clover, thus filling a gap in the series of early summer soiling crops. Spring vetches are also used for hay. To make hay, more care is required than with red clover. Two crops are sometimes cut in one season, and where this is possible the second is the one to be saved for seed. The first crop ripens very irregularly, and some of the pods will be shelled before the rest are ripe. Where they can be grown they are a very good summer feed for horses, but must not be fed earlier than full bloom, on account of their diuretic action. They are good for soiling sheep and milch cows, and are said to very materially increase the flow of milk.

FEEDING VALUE.

The percentage of digestibility of spring vetch forage has not been determined in this country, but analyses show a high food content comparable with alfalfa rather than the clovers. The average sample of vetch hay contains 11.3 per cent water, 7.9 per cent ash, 17 per cent crude protein, 25.4 per cent fiber, 36.1 per cent nitrogen-free extract, and 2.3 per cent fat. The flat pea and the soy bean are the only leguminous fodders which exceed this in the crude protein content.

FERTILIZING VALUE.

At the time when ready to cut for hay the vetch contains about 20 per cent of dry matter,[1] and in this 20 per cent there are contained 3.16 per cent nitrogen, 0.72 per cent phosphoric acid, and 3.36 per cent potash. Calculating on this basis the fertilizing ingredients contained in a crop of twelve tons of green forage produced from one acre there would be 153 pounds of nitrogen, 37 pounds of phosphoric acid, and 163 pounds of potash. In addition to this the stubble and roots to the depth of 22 inches would contain 27.2 pounds of nitrogen, 7.2 pounds of phosphoric acid, and 21.8 pounds of potash, making a total of 180.2 pounds of nitrogen produced in a single season by one crop of spring vetches, or as much as is contained in 18 tons of barnyard manure.

Spring vetches are not recommended as a forage crop for general cultivation. They have value for some few northern localities, but have proved a signal failure elsewhere in this country. The plants come into flower very unevenly, so that sometimes the seed does not ripen in sufficient quanties at one time to pay for harvesting. The crop is liable to injury by drought and excessive heat.

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[1] Third Ann. Rept. Conn. (Storrs) Agr. Expt. Sta. (1890).

WINTER VETCH.

(*Lathyrus hirsutus.*)

Winter vetches (fig. 3) were introduced into the United States from Italy, where they are grown quite extensively as a winter soiling crop. They are of value only in the Southern States and have not been found hardy anywhere north of the latitude of Washington, D. C.

Winter vetches are very similar in habit and manner of growth to the spring vetches or tares. They are trailing, vine-like plants that grow in dense masses. The stems are narrowly wing-margined; the narrow leaflets are in pairs with a tendril arising between them; the inch-long pods are quite hairy; and the rounded, dark-brownish seeds appear warty under a lens.

FIG. 3.—Winter vetch (*Lathyrus hirsutus*).

WINTER VETCHES FOR THE SOUTH.

Winter vetches should be sown broadcast in August or September at the rate of two bushels of vetch and one bushel of winter rye or winter oats per acre. If sown in the latter part of August they furnish a bite of green forage in November and December, at a time when it is particularly desirable, and can be cut for hay in the early spring. Winter vetches sown in February in the Gulf States provide a supply of green forage in April or May. The plant deserves to be more widely cultivated as it is valuable both as a soiling and a hay crop. It makes its best growth in the spring and autumn, when the weather is cool. Winter vetches thrive on any soil which will grow cowpeas, provided that it is not too wet. Its cultivation has been very successful in all portions of the South where it has been tried, and particularly so in central Georgia and Alabama. The winter vetch is desirable as an addition to our list of forage plants, because it lengthens out the soiling season, and furnishes green foliage late in autumn and very early in spring, during two periods of scanty vegetation. Winter vetch should be cut for hay when in full bloom. Considerable care is required to get it into the stack or barn without its heating. Anyone who can make good cowpea or alfalfa hay can successfully handle winter vetch.

KIDNEY VETCH.

(*Anthyllis vulneraria.*)

The kidney vetch (fig. 4) is a perennial leguminous plant which is found wild over a large part of Europe. It grows naturally along roadsides, wherever the soil is dry and thin and the subsoil calcareous.

It was first introduced into cultivation by a German peasant about 40 years ago. This farmer noticed that the vetch grew on the dry calcareous soils of hillsides, in places too poor to support even white clover. He gathered a few seeds, sowed them the next year, and kept on saving and sowing the seed until he had enough to plant quite a large field. From this small beginning the cultivation of the kidney vetch has spread throughout northern Germany and many foreign countries, and to the United States.

FIG. 4.—Kidney vetch (*Anthyllis vulneraria*): *a*, flower.

CULTIVATION.

In Germany the custom is to sow the seed in autumn at the rate of 18 to 22 pounds per acre, with oats, barley, or other small grain as a nurse crop. Sometimes it is sown alone in the spring. The product of the first year is very small, so that it is only a profitable crop when it is sown with grain, in order that some income may be derived from the land during that time. The second year the vetch throws up large stems that often make a growth 3 or 4 feet high.

The yield of hay is quite small, generally not more than one cutting per season, and perhaps a ton or a ton and a half of hay per cutting. It is cut in full bloom, and cured in about the same way as red clover. Two crops may be secured in one season by cutting the first before the plant blossoms, but usually the aftermath, consisting entirely of root leaves, is depastured and no attempt is made to get more than one crop of hay.

Kidney vetch is not recommended for sowing in the United States, except on poor, thin, calcareous or very sandy soils, which are too sterile to support the red or crimson clovers, or any of the better forage crops. It has been tried at a number of the experiment stations throughout the United States, but has been reported as of small value.

JARED G. SMITH,
Assistant Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *April 5, 1898.*

CIRCULAR No. 6.—Revised. (Agros. 25.)

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DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

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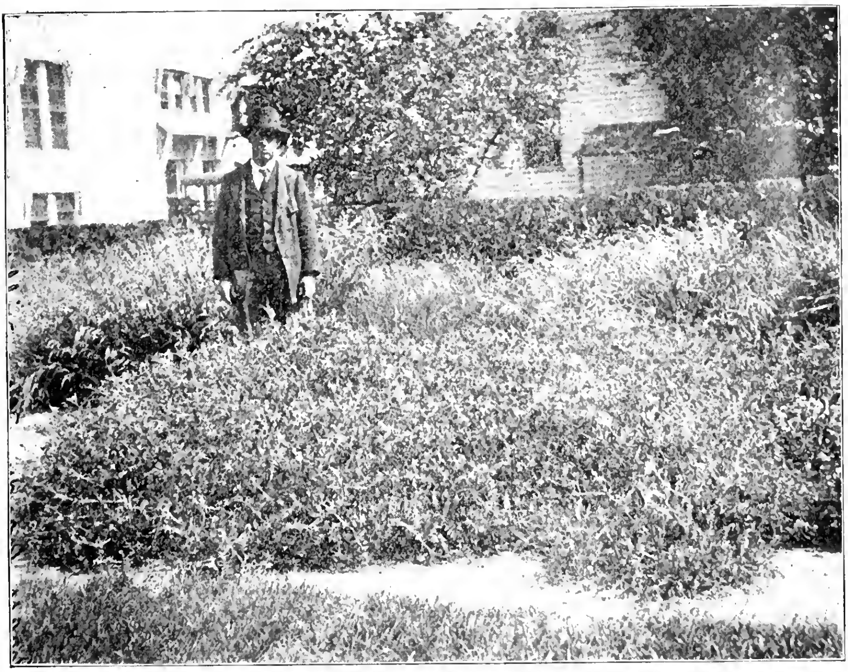

FIG. 1.—Hairy vetch: Plot in Grass Garden, U. S. Department of Agriculture.

freeze, and ensilage and root crops tide over the early winter. With good management such substitutes for green forage may be made to last until the grass starts, but on too many American farms there is a period of shortage of succulent feed in late winter and spring. To bridge over this critical period, annual leguminous crops, such as crimson clover and the vetches, are each year coming deservedly into greater prominence. The vetches are nitrogen gatherers. Like the clovers they have the property of absorbing through their roots the free gaseous nitrogen of the air, which is present in all well cultivated soils, and fixing a portion of it in a form which may become either a fertilizer if left in the soil or a muscle-making element in the forage. Nearly all leguminous forage crops have this property and hence their great importance as green manure and soiling crops.

The vetches are also useful because they form a living mulch in spring and early winter, shading the ground and preventing the growth of weeds, thus retarding the constant loss of soluble plant foods that is going on wherever a soil is left bare and unprotected

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CULTIVATION.

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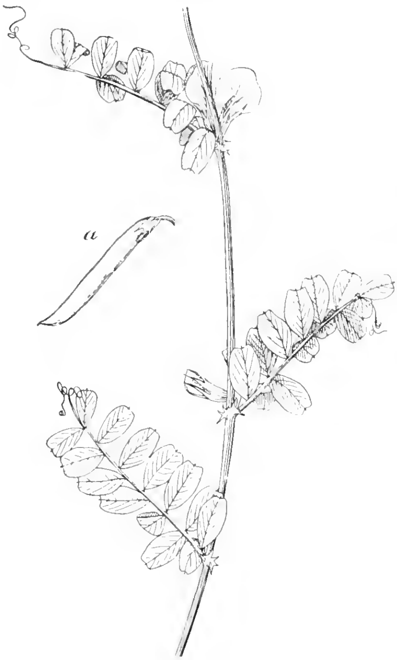

FIG. 3. Spring vetch or tares (*Vicia sativa*): *a*, pod.

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HISTORY.

This old-world forage plant has been cultivated in Europe for nearly twenty centuries. It is a native of western Asia and of all Europe except Lapland. It was cultivated by the Romans, and was esteemed by them a valuable fodder crop. In Italy it has been grown continuously up to the present day. It is one of the many soiling crops in use in northern Europe and the British Isles. Spring vetches were introduced into the United States in a casual way nearly a hundred years ago. They have been tried in nearly all the States and have proved very unsatisfactory, except for certain districts in

New England, New York, northern Michigan, Wisconsin, and lower Canada. They were very largely grown throughout the New England and Northern States during the period from 1865 to 1885, but their cultivation there has now almost ceased, it having been found that the yield of hay or of green fodder is not a profitable one compared with that of the red and crimson clovers and field peas. The principal drawback to their more extensive cultivation is the high price of the seed ($2.50 to $3 per bushel of 70 pounds) and the fact that they can not withstand even temporary drought or hot weather. In England, where they are extensively used, the growing season is much cooler, with more rain and an equable temperature.

CULTIVATION.

Spring vetches seem to be adapted more particularly to northern countries, where the season is short and the rainfall abundant. The seed should be sown at the rate of 5 to 8 pecks per acre, with one bushel of rye or oats as a nurse crop. As high a seeding as 3 to 3½ bushels per acre is sometimes recommended, but the product per acre will not warrant the use of so much seed at the present high prices. Vetches should be sown in April or May. They will be ready to cut by the middle of June or the first of July, from full bloom until the pods are half formed. When sown alone the vines lodge and make a dense mat, and the object of the nurse crop is to furnish a support to lift the vines up off the leaves. The vines are very difficult to harvest when sown alone, on account of the tangled mass of stems, but may be easily cut with a pea harvester. An acre of vetch and oats yields ordinarily from 6 to 8 tons of green forage. Where it can be grown, its chief value arises from the fact that it is ready to cut between the first and second crops of red clover, thus filling a gap in the series of early summer soiling crops. Spring vetches are also used for hay. To make hay, more care is required than with red clover. Two crops are sometimes cut in one season, and where this is possible the second is the one to be saved for seed. The first crop ripens very irregularly, and some of the pods will be shelled before the rest are ripe. Where they can be grown they are a very good summer feed for horses, but must not be fed earlier than full bloom, on account of their diuretic action. They are good for soiling sheep and milch cows, and are said to very materially increase the flow of milk.

FEEDING VALUE.

The percentage of digestibility of spring vetch forage has not been determined in this country, but analyses show a high food content comparable with alfalfa rather than the clovers. The average sample of vetch hay contains 11.3 per cent water, 7.9 per cent ash, 17 per cent crude protein, 25.4 per cent fiber, 36.1 per cent nitrogen-free extract, and 2.3 per cent fat. The flat pea and the soy bean are the only leguminous fodders which exceed this in the crude protein content.

FERTILIZING VALUE.

At the time when ready to cut for hay the vetch contains about 20 per cent of dry matter,[1] and in this 20 per cent there are contained

[1] Third Ann. Rept. Conn. (Storrs) Agr. Expt. Sta. (1890).

3.16 per cent nitrogen, 0.72 per cent phosphoric acid, and 3.36 per cent potash. Calculating on this basis the fertilizing ingredients contained in a crop of twelve tons of green forage produced from one acre there would be 153 pounds of nitrogen, 37 pounds of phosphoric acid, and 163 pounds of potash. In addition to this the stubble and roots to the depth of 22 inches would contain 27.2 pounds of nitrogen, 7.2 pounds of phosphoric acid, and 21.8 pounds of potash, making a total of 180.2 pounds of nitrogen produced in a single season by one crop of spring vetches, or as much as is contained in 18 tons of barnyard manure.

Spring vetches are not recommended as a forage crop for general cultivation. They have value for some few northern localities, but have proved a signal failure elsewhere in this country. The plants come into flower very unevenly, so that sometimes the seed does not ripen in sufficient quanties at one time to pay for harvesting. The crop is liable to injury by drought and excessive heat.

FIG. 4.—Winter vetch (*Lathyrus hirsutus*).

WINTER VETCH.

(*Lathyrus hirsutus.*)

Winter vetches (fig. 4) were introduced into the United States from Italy, where they are grown quite extensively as a winter soiling crop. They are of value only in the Southern States and have not been found hardy anywhere north of the latitude of Washington, D. C.

Winter vetches are very similar in habit and manner of growth to the spring vetches or tares. They are trailing, vine-like plants that grow in dense masses. The stems are narrowly wing-margined; the narrow leaflets are in pairs with a tendril arising between them; the inch-long pods are quite hairy; and the rounded, dark-brownish seeds appear warty under a lens.

WINTER VETCHES FOR THE SOUTH.

Winter vetches should be sown broadcast in August or September at the rate of two bushels of vetch and one bushel of winter rye or winter oats per acre. If sown in the latter part of August they furnish a bite of green forage in November and December, at a time when it is particularly desirable, and can be cut for hay in the early spring. Winter vetches sown in February in the Gulf States provide a supply of green forage in April or May. The plant deserves to be more widely cultivated as it is valuable both as a soiling and a hay crop. It makes its best growth in the spring and autumn, when the weather is cool. Winter vetches thrive on any soil which will grow cowpeas, provided that it is not too wet. Its cultivation has been very successful in all portions of the South where it has been tried, and particularly so in central Georgia and Alabama. The winter vetch is desirable as an addition to our list of forage plants, because it lengthens out the soiling season, and furnishes green foliage late in autumn and very early in spring, during two periods of scanty vegetation. Winter vetch should be cut for hay when in full bloom. Considerable care is required to get it into the stack or barn without its heating. Anyone who can make good cowpea or alfalfa hay can successfully handle winter vetch.

KIDNEY VETCH.

(*Anthyllis vulneraria.*)

The kidney vetch (fig. 5) is a perennial leguminous plant which is found wild over a large part of Europe. It grows naturally along roadsides, wherever the soil is dry and thin and the subsoil calcareous. It was first introduced into cultivation by a German peasant about 40 years ago. This farmer noticed that the vetch grew on the dry calcareous soils of hillsides, in places too poor to support even white clover. He gathered a few seeds, sowed them the next year, and kept on saving and sowing the seed until he had enough to plant quite a large field. From this small beginning the cultivation of the kidney vetch has spread throughout northern Germany and many foreign countries, and to the United States.

FIG. 5. Kidney vetch (*Anthyllis vulneraria*): *a*, flower.

CULTIVATION.

In Germany the custom is to sow the seed in autumn at the rate of 18 to 22 pounds per acre, with oats, barley, or other small grain as a nurse crop. Sometimes it is sown alone in the spring. The product of the first year is very small, so that it is only a profitable crop when it is sown with grain, in order that some income may be derived from the land during that time. The second year the vetch throws up large stems that often make a growth 3 or 4 feet high.

The yield of hay is quite small, generally not more than one cutting per season, and perhaps a ton or a ton and a half of hay per cutting. It is cut in full bloom, and cured in about the same way as red clover. Two crops may be secured in one season by cutting the first before the plant blossoms, but usually the aftermath, consisting entirely of root leaves, is depastured and no attempt is made to get more than one crop of hay.

Kidney vetch is not recommended for sowing in the United States, except on poor, thin, calcareous or very sandy soils, which are too sterile to support the red or crimson clovers, or any of the better forage crops. It has been tried at a number of the experiment stations throughout the United States, but has been reported as of small value.

DAKOTA VETCH.

(*Lotus americanus.*)

One of the most valuable leguminous plants of the vetch family is Dakota vetch (*Lotus americanus*). It is a bushy annual found throughout the Rocky Mountain region of the Northwest, being most abundant upon the sandy river bottoms. Stock of all kinds are fond of it and it is used either as pasturage or hay. In the upper Missouri region it is one of the most highly prized native forage plants. Being an annual it must be permitted to mature at least a portion of its seed and consequently should not be grazed too closely or cut too early. The blooming season covers a considerable period, so that buds, flowers and both mature and green pods are often found upon a plant at the same time. As a rule many of the seeds are ripened before the haying season arrives and it is a common practice among ranchers to use hay racks with tight bottoms in order to save the shattered seed, which later is scattered or sown over the meadows. The plant reseeds itself freely and when once established voluntary crops are assured from year to year.

FIG. 6. Dakota vetch (*Lotus americanus*).

BIRD VETCH.

(*Vicia cracca*).

Bird vetch is a perennial species from Europe, where it is cultivated, and is used both for soiling and for hay. It is recommended for cultivation in low meadows and especially in open woodlands. In Germany it is often found in barren sheep pastures and is there deemed especially valuable on account of its nutritive value, the fodder being especially rich in protein.

JARED G. SMITH,
Assistant Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *April 15, 1898.*

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CIRCULAR No. 7.—(Agros. 36.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

GRAM, CHICK-PEA, OR IDAHO PEA.*

HISTORY.

Gram, Idaho Pea, or Chick-Pea (*Cicer arietinum*), has been in cultivation in eastern countries longer than any other leguminous crop. Its native country is unknown, but it is supposed to have originated in Asia Minor. It was one of the plants of the Greeks at the time of Homer, and occupied a prominent place among the food plants of the lower classes during the time of the Roman Empire.

From Europe it was introduced in comparatively recent times into India, where it is estimated that there are now over 5,000,000 acres devoted to its cultivation either alone or as a by-crop with wheat. Next to the cereals, gram forms the largest part of the food used in India and in portions of northern Africa, Spain, and other countries bordering on the Mediterranean.

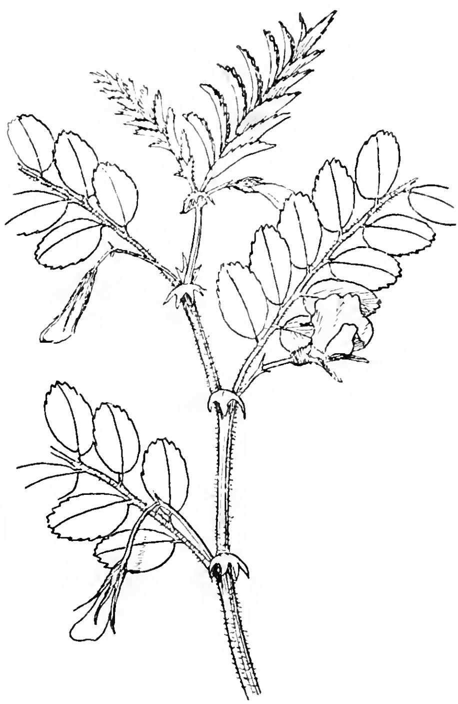

FIG. 1.—Gram (*Cicer arietinum*).

DESCRIPTION.

This plant is a branching annual, with many upright stems from the same root. The leaves resemble those of the vetch, having seven pairs of small leaflets. These are oblong, soft-hairy all over, one-half inch long or less, and sharply toothed on the margins. The flowers are borne singly in the axils of the leaves, on short stalks about one-half inch long.

*An article has been going the rounds of some of the agricultural papers and the newspapers concerning a new forage plant, the Idaho pea, which is said to have been a native of the northern Rocky Mountains, first introduced into cultivation less than twenty-five years ago. Its cultivation has been highly recommended in the West, on account of the value of its seeds both as horse feed and as a coffee substitute.

The pods are bladdery, inflated, from one-half to three-fourths of an inch long, and finely pubescent with glandular hairs. Each pod contains one, or very rarely two, large seeds, which are wrinkled and bear a fanciful resemblance to a ram's horn, whence the Latin name *arietinum*. The seeds are a little larger than those of the common garden pea, to which they are quite similar.

USE AS AN ADULTERANT.

This crop is cultivated in Mexico, where it is known by the Spanish name "Garabanza." It is there used to some extent as food, but is considered inferior to corn. Gram has been introduced into this country at various times since 1864 as a substitute for coffee, but it should be remembered that there is no such thing as a coffee *substitute*. Various peas and beans, chickory, or even rye flour or bread crumbs, may be roasted and prepared in the same manner as coffee, but the beverage has none of the stimulating qualities of that drink and only resembles it in color and to some extent in taste. It can be used as an adulterant of coffee. The Idaho pea was cultivated at the Colorado Experiment Station in 1895 and 1896. Professor Cooke states that it "has demonstrated its ability to make a large growth with plenty of water and a fair growth with a very limited supply. It belongs to the pea family and is grown in rows, 30 inches apart, and the plants 6 to 12 inches apart in the rows. Its growth indicates that it can be raised for about 1 cent per pound."

SEED PER ACRE—GENERAL CLIMATIC CONDITIONS NECESSARY.

About 30 to 50 pounds of seed are used per acre, depending upon whether it is sown in drills or broadcast. In India the largest acreage is in the Northwest Provinces, where the soils are similar to those west of the one hundredth meridian, and the climate is much like that of New Mexico and Arizona. All authorities agree that it is better suited to arid and semiarid regions than to humid ones, the crop apparently requiring a great many sunny days during its season of growth. Better results are secured in growing it with irrigation than without, although it makes a fair yield on comparatively dry soils. If continued experiments with this plant in the West prove that its average yield is as high as has been claimed, it will undoubtedly prove a valuable addition to the list of forage plants suitable to semiarid regions.

TIME TO SOW SEED.

There are a number of varieties, which differ from one another in the color of the seed and length of season required for maturity. The forms which have been cultivated in Spain, Mexico and the Northwest Provinces of India are liable to prove more adaptable to American conditions than those from subtropical India. The gram plant is very sensitive to cold. The seed should be sown not earlier than May 15, or at the higher altitudes about the 1st of June, and, if some of the short-season varieties are procured, there will be less danger of their being caught by early frosts. Gram is grown in India as a winter crop. The seed is sown there in October or November and the crop ripens in February, March, or April, according to the portion of the country in which it is grown. It is said to be adapted to almost any soil, from light sandy to heavy clays or loams, apparently preferring the latter. It might prove of some value in parts of the Southern States as a winter crop and soil cover, on lands which are unsuited to the vetches and the crimson clover. It requires only moderate amounts of moisture and is said to be injured by prolonged cloudy weather or abundant rains, which cause it to flower prematurely and thus materially affect the yield of seed.

AS A SOIL RENOVATOR.

Gram is one of the leguminous forage crops which has the power of absorbing gaseous nitrogen from the air, thus adding to the stores of nitrogen in the soil, and though the fact of nitrogen-absorption by leguminous plants has not been well understood until recent years, this has long been considered one of the best Indian crops for soil renovation and improvement. Watt states that over a large portion of India gram is grown either to check weeds or as green manure, and where this is the main object, only enough seed is saved to sow again the coming season.

FOR FEEDING PURPOSES.

Gram is a staple article of horse feed in India. The seed is also highly valued for fattening sheep and cattle. There is a considerable trade with England and other foreign countries where the peas are used for the same purposes. The total exports amounted in 1887 to over 15,000 tons. The average analyses of the seeds show that they contain about 20.5 per cent crude protein, 3.9 per cent fat, and 59.4 carbohydrates, having approximately the composition of the seeds of the field pea commonly grown in the Northern States. Digestion experiments have not been made with them but their fattening qualities in use show them to be fully as valuable as the seeds of many of the other legumes.

Besides serving as a fattening ration for cattle and sheep the seeds and different parts of the plant find many uses among the natives of India. The green peas are eaten as a vegetable. The meal is used for porridge; and the parched peas are used either in the preparation of a beverage or in various confections and candies. The young plants are eaten as a salad and sometimes cooked like spinach.

OTHER USES—POISONOUS QUALITIES.

The leaves of the gram are viscid with a secretion which contains oxalic, acetic, and malic acids, the first of these predominating. In

India the secretion is collected by means of cloths spread over the plant at night and wrung out in the morning when wet with dew. The solution thus obtained is used in the preparation of cooling drinks and also finds sale as a vinegar. The forage is said to be actually poisonous to horses on account of the excess of oxalic acid in the leaves. Cattle eat it, but it often proves injurious to them, although to a less extent than to horses. However, this crop is not ordinarily grown as a forage crop, but for the seeds, and the seeds alone are used in India for feeding purposes.

PRODUCTION PER ACRE.

Gram has been grown experimentally at the grass garden in Washington, D. C., and seed has also been distributed to a limited number of farmers in various parts of the country. The reports concerning it were not very favorable except from some parts of Colorado, Wyoming, Utah, Idaho, and Montana. In the grass garden of the Department of Agriculture it did not grow higher than from 8 to 10 inches and the seed production was very moderate. The newspaper reports of this pea grown in the Rocky Mountain regions mention yields estimated at the rate of 90 bushels to the acre, but this is very unusual. The average crop in India is about 10 bushels to the acre and the highest yields do not exceed 25 bushels, the latter only when grown on the best soils under the most favorable conditions.

In common with other leguminous crops gram is dependent on the presence of certain organisms in the soil for its ability to absorb nitrogen from the air and it is possible that the lack of success with this crop in the Eastern States has been due to the absence of the particular tubercle-forming bacteria which are parasitic upon this plant. To determine finally upon this point importations could be made of soil upon which this crop has been grown, or pure cultures could be secured of the organism itself and the soil or seed inoculated before planting, as has been so successfully done in the case of the hairy vetch at the Alabama Experiment Station. If this crop will yield even 25 bushels per acre during average seasons, it will prove a valuable addition to Western forage crops on account of the high feeding value of its seeds, but until fuller and more extended trials have been made we would advise Western farmers to be cautious of investing too much money or devoting too much land to the cultivation of the Idaho pea, chick-pea, or gram.

JARED G. SMITH,
Assistant Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *November 18, 1898.*

CIRCULAR No. 8. (Agros. 37.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

EXPERIMENTS IN RANGE IMPROVEMENT.

The chief problem in the cattle regions of the Southwest is, How shall we restore or bring back the grasses on lands where they have been destroyed by overstocking? An estimate based on such statistics as we have been able to obtain from correspondents indicates that the carrying capacity of the southwestern ranges was 40 per cent less at the beginning of 1897 than it had been in 1880. The money value of this loss has been variously estimated at from ten million to forty million dollars in the State of Texas alone, and on the other ranges in the Western States and Territories the aggregate loss from this cause (overstocking) is not less than a hundred million dollars. In other words, if the natural pastures in the country west of the ninety-eighth meridian were now covered with as luxuriant a growth of grass as they were twenty years ago, the additional number of live stock which could be carried would be worth probably upwards of a hundred million dollars.

The regrassing of overstocked lands is to the interest both of the individual stockowner and the commonwealth. The smaller losses sustained by each owner become in their aggregate a sum which materially affects the welfare of the State. It is the common testimony of stockmen that there are vast areas where the abundance and quality of the natural herbage has been decreased. The better grasses have been run out by overstocking during years of drought. Weedy annuals of less value, because less palatable to stock and less nutritious, have taken their places. If these fail the ground becomes entirely bare of vegetation. In other sections the amount of natural pasturage has been decreased by the encroachment of perennial weeds and thorny shrubs and by the cactus thickets, or the grasses have been destroyed by rabbits and prairie dogs. Overstocked lands are not only unproductive, but they rapidly deteriorate in productive capacity. They require rest and treatment to again restore them. The soil soon becomes hard and compacted by the trampling of cattle. Less of the annual rainfall is absorbed by the soil, and more each year is lost in the flood waters. Moreover the finer and hence richer portions of the surface soils are washed into the streams, because there is no protecting mat of grass roots to retain them.

EXPERIMENTS BY STOCKMEN.

Many experiments have been undertaken by individual farmers and stockmen to determine methods of again bringing up the value of the prairie pastures and to increase the grazing capacity. Such work, undertaken as it often is by men who have a wide influence among stockmen and stock-owners, is of great value. But the results of such experiments, however valuable, do not obtain that extensive and rapid circulation which they merit. There is probably no class of American producers who are more ready to undertake work which will tend toward the betterment of the marketable product than the cattlemen and sheepmen of the West. All who are familiar with the history of the cattle industry will admit that there is room for improvement in methods all along the line, from the breeding sections to the feeding pens, but nowhere is it more important than in the pasture—to provide more and better grasses. An abundant supply of nutritious forage in the pastures means more continuous and rapid growth of the animal, and in the end a finer quality of beef and mutton, a better yield and grade of wool. There is immediate need of work along this most important line—range improvement.

EXPERIMENTS BY THE DIVISION OF AGROSTOLOGY.

Experiments have been undertaken by this Division at two points in Texas. An effort is being made to determine the most practicable and at the same time the most economical way of treating the natural pastures in order to again cover them with the native grasses, or with other better species from similar regions in other countries. One experiment is being made at Channing, in Hartley County, which will in a large measure represent the conditions that prevail on the high plains of the Panhandle of Texas, western Kansas, and Oklahoma, and parts of Colorado and New Mexico; and one at Abilene, to serve for the central and western prairies of Texas, up to the border of the Staked Plains.

The work was commenced at both of these places in March, 1898. An idea of its scope may be obtained from the accompanying plan (fig. 1) of the range station, near Abilene, Tex. The use of an irregular body of land, containing about 640 acres, was donated by Mr. C. W. Merchant, for a period of three years. The fences and two tanks to supply water were provided by the citizens of Ablilene. The work was inaugurated by Prof. C. C. Georgeson, formerly of Kansas, at that time in the employ of this Division. Since its establishment it has been in charge of a special field agent, Mr. H. L. Bentley.

The section was divided into six pastures of 80 acres each, two of 40 acres, and one of 70 acres, and the remaining 10 acres is being devoted to the cultivation of grasses. The work as planned is as follows:

Pasture No. 1.—No treatment except to keep stock off until June 1, pasturing the balance of the season.

Pasture No. 2.—Cut with a disk harrow and kept stock off until June 1, pasturing the balance of the season.

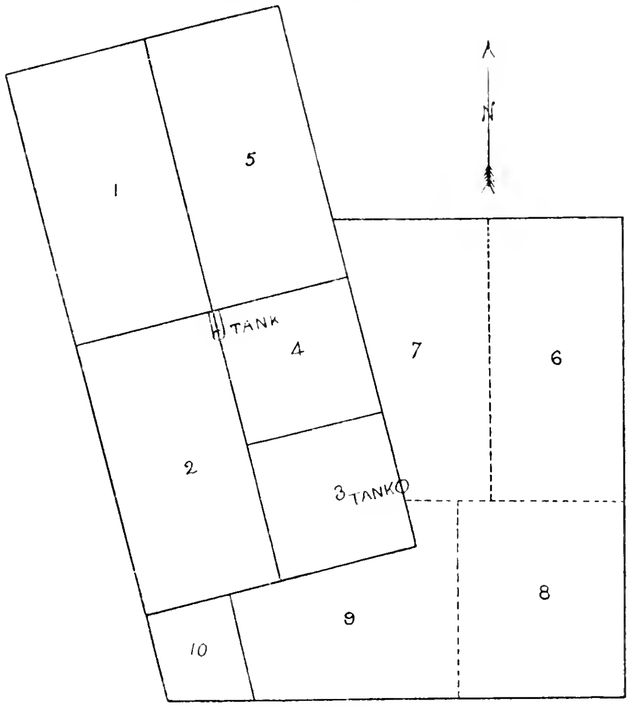

FIG. 1.—Plan of 640-acre tract used for the range experiments at Abilene, Tex. (Scale 3 inches to the mile.)

Pastures Nos. 3 and 4 (of 40 acres each).—Grazed alternately, the stock being changed from one pasture to another every two weeks, thus allowing the grasses a short period for recovery after each grazing.

Pasture No. 5.—No treatment except pasturing until June 1 and keeping stock off the balance of the season.

Pasture No. 6.—Left as a check, without any treatment whatever except to keep stock off during the first season.

Pasture No. 7.—Dragged with an ordinary straight-toothed harrow and stock kept off during the first season.

Pasture No. 8.—Disked and stock kept off during the first season.

The 70-acre pasture, No. 9, was not grazed. Seeds of a number of wild and cultivated varieties were sown directly upon the sod.

An effort has been made to get a stand of Texas Blue Grass and Curly Mesquite by transplanting fragments of sod to the bare spots. East and west furrows were also broken in order to arrest the grass seeds which are blown over the ground by the prevailing north and south winds, the idea being to form seed beds, from which the most valuable sorts should spread in every direction.

To insure uniformity the section of land was inspected before the commencement of work by a committee of stockmen, who made an estimate of the carrying capacity of the land at that time (April 1, 1898). The committee decided that the land would carry 40 head of stock cattle to the square mile, in the proportion of ten cows with calves, 15 yearlings, and 15 two-year-olds, which proportion will be maintained as closely as possible until the end of the experiment. The land will be judged again at intervals during the experiment, in order to determine as exactly as possible the percentage and rate of improvement in the different portions under the various methods of treatment.

Mr. H. L. Bentley, the special agent in charge, estimates that there has already been a gain of 25 per cent in the amount of grass on the land, in the case of those pastures which have been disked and harrowed. His report, dated November 24, 1898, concerning the experiments, is herewith appended:

REPORT OF MR. BENTLEY.

The drought that has been on here for several months has not yet been broken. Since April 1 the rainfall in the immediate section embracing the Station has been distressingly small. There are two large tanks on the property, but there is water in only one of them, and at present only a small amount. There are also 15 or 20 shallow water-holes that in ordinary years catch and hold water most of the season, but they have been only partially full twice in seven months and now all are dry. As a result there has been no end of difficulty in keeping cattle in the pastures on account of the water scarcity. Just now I have no cattle in pasture at all, not having sufficient water for even the 13 head called for by the experiment. I hope, however, that we will soon have another good season here. If once the tanks are filled there will be sufficient water to carry the cattle through the winter in accordance with the plan. Notwithstanding the protracted drought the grass is good—astonishingly good. In the pastures which were harrowed I believe that there is fully twice as much grass as at this time last year. Had we had normal seasons since April 1 it is plain to me that the harrowing experiments would have shown splendid results.

The 10 acres of garden land are in first class condition to catch and hold all the rain that shall fall during the winter. The woven wire fence around the 10-acre tract was placed in position by experienced fence builders, and I feel confident now that the grasses and legumes will not be troubled seriously in the spring by the prairie dogs and rabbits. The prairie dogs moved *en masse* on the garden as soon as the crops appeared. Before the fence (woven wire) was placed in position they had nearly destroyed the roots of the alfalfa and cowpeas, but I anticipate no further trouble from them.

Enough seed of the cowpeas was saved for the next year's trials. The velvet bean vines bloomed too late to mature the beans before frost. An abundant crop of pods formed, but no matured seed was secured. The teosinte grew to be from 18 to 32 inches tall, then the drought set in and it never recovered sufficient to do much good. The roots lived and it made some growth, but did not mature any seed.

I am certain that with normal amount of rain next year we will be able to demonstrate:

(1) *That the culture of the native sod with disk and tooth harrows will pay well in this section.*

(2) That alfalfa of all kinds can be grown successfully without irrigation.

(3) That the teosinte is a splendid forage plant for this section, superior to any of the sorghums so far tested.

(4) That the velvet bean will do astonishingly well and prove a crop of much value.

(5) That all of the many varieties of cowpeas which were experimented with this year are available crops for forage purposes.

There have been practically no results from any of the grass seeds that were sown. A number of varieties germinated, but they did not develop satisfactorily because the rains did not come in time.

The data thus far secured at the close of eight months' work give sufficient promise that definite, tangible results will accrue from these experiments for the benefit of stockmen. It is too soon to draw conclusions, but the outlook for rapid increase in the quantity of grass on these overstocked pastures is encouraging. Moreover, the methods in use are such as are well within the reach of any stock owner, should he wish to avail himself of the results.

FUTURE WORK.

During the succeeding seasons experiments will be made as to the practicability of sowing alfilaree, bur clover, Bokhara clover, alfalfa, sorghum, and other wild and cultivated grasses and forage plants directly on the sod without further treatment than to keep stock off during at least the first year. On an examination of the plans it will be seen that a number of methods are being undertaken which may be adopted at but little expense by stock owners, should they prove to result profitably.

These experiments ought to be carried on for at least three years. At the end of that time sufficiently tangible results will undoubtedly be secured to enable stockmen to decide what is the best method of bringing back the grasses.

JARED G. SMITH,
Assistant Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *December 27, 1898.*

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ISSUED FEB. 21. 1899.

CIRCULAR No. 9.—(Agros. 39.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigation.]

NEW SPECIES OF NORTH AMERICAN GRASSES.

In the present circular are brought together the descriptions of a number of new species of grasses, mostly belonging to the genus *Poa*, from the western part of the United States. This form of issuing descriptions is adopted to expedite publication and to allow the citation of names in non-technical publications where new descriptions can not well be given.

1. **POA CAPILLARIFOLIA** Scribn. & Williams, sp. nov.

A smooth, cæspitose perennial, 2–4.5 dm. high, with long, thread-like leaves, marcescent basal sheaths and narrow greenish panicle, about 4 or 5 cm. long. Culm with the short, basal internodes usually much exceeded by the sheaths. Leaves soft, 1–2 dm. in length, abundantly produced from numerous intravaginal innovations. Sheaths smooth, striate, the basal ones swollen, membranous, and persistent. Panicle narrowly ovate, or oblong in outline, closely flowered, lower branches solitary or in twos, or more rarely in threes, the lower ones from 1½–3 cm. in length; spikelets 3–4-flowered, 5–6 mm. long; empty glumes unequal, scabrous on the back, 3-nerved, scarious-margined, the lower one broadly lanceolate, acute, 2½ mm. long, the upper obtuse, 3 mm. long, both often erose-dentate above; flowering glumes thin, 5-nerved, broadly ovate, obtuse or acutish, minutely hispid on the back above and on the keel and nerves, with broad hyaline margins and usually erose-dentate apex, about 3½ mm. in length. The palet nearly or quite equaling the flowering glume, hyaline, with distinct greenish ciliate-hispid keels and erose-dentate apex.

Type specimen No. 2614, Geo. Hansen, California.

Allied to *Poa cusickii* Vasey, but with smaller flowers, longer and more filiform leaves and smaller, closer panicle. In some ways this species is intermediate between *P. cusickii* Vasey and *P. idahoënsis* Beal.

POA VASEYOCHLOA Scribn., new name. *P. pulchella* Vasey (1882), not Salisb. nor Parl.

POA NUDATA Scribn., new name. *Poa capillaris* Scribn. (1898), not Linn.

2. **POA SAXATILIS** Scribn. & Williams, sp. nov.

A slender, closely cæspitose perennial, 2½–3½ dm., tall, with soft, smooth leaves and stems and lax, variegated panicles from 5–7 cm. long. Culms erect or somewhat geniculate below, very smooth, with conspicuous purplish nodes. Leaves flat, rather obtusely pointed, those of the stem from 1½–2 cm. or more in length; those of the sterile shoots about twice as long. Sheaths smooth, or basal ones sparsely pubescent, striate, shorter than the internodes, the lower ones swollen and often split open by the growth of the intravaginal shoots. Ligule 2–3 mm. long, acute. Panicle branches ascending, filiform and somewhat flexuous, usually in twos, the lower ones about 4 cm. long, flower-bearing above the middle. Spikelets compressed, lanceolate, 3–5-flowered, 6–9 mm. long. Empty glumes somewhat unequal, obtuse, or subacute, 3-nerved, smooth, about 4 mm. long. Flowering glume obscurely

5-nerved, oblong, obtuse or subacute, minutely scabrous on the back, sparsely pubescent at the base, more densely pubescent on the keel and marginal nerves, green below, purplish above with rather broad, scarious, erose-dentate margins, 4–4½ mm. long. Palet nearly equaling the flowering glume, ciliate on the keels, apex bidentate.

Type specimen No. 1964, C. V. Piper, dry rocky places, Mt. Rainier, Washington, August 1895. Altitude 2100 meters.

This species has been most frequently referred to *Poa gracillima* Vasey, but differs in its more densely cæspitose habit, shorter, flatter leaves, more closely-flowered panicle, larger spikelets and flowers, and in the firmer texture of the flowering glumes.

3. **POA LECKENBYI** Scribner, sp. nov.

A pale green, tufted perennial, about 7½ dm. high, with long, slender leaves, somewhat inflated, persistent basal sheaths and pale rather narrow panicle about 1½ dm. long. Culms smooth, frequently rooted at the basal nodes. Leaves glaucous green, smooth below, rough above and on the margins, acute; sheaths smooth, all except the uppermost exceeding the internodes, the lower ones membranous; ligule about 6 mm. long, acute, or often fimbriately divided, decurrent. Panicle branches erect, flower-bearing nearly or quite to the base, the longer ones about 5 cm. in length. Spikelets compressed, oblong-lanceolate, 5–6-flowered, 9–11 mm. long. Empty glumes subequal, 3-nerved, rough-hispid on the nerves, rather narrowly lanceolate, acute or acuminate, 7 mm long, slightly exceeding the lower flowering glumes. Flowering glumes ovate-oblong, 5-nerved, 5–6 mm. long, scarious-margined and often erose-dentate above, hispidulous on the upper and pubescent on the lower half, pubescence most abundant on the keel and marginal nerves. Palet shorter than the flowering glume, 2-keeled, conspicuously ciliate-pubescent on the keels and minutely pubescent below between the keels, narrowed above to an erose-ciliate apex.

Type specimen from Scott, Klickitat County, Washington, June 5, 1898, collected by A. B. Leckenby for whom the species is named. The grass grows in very sandy soil and is an excellent sand binder. It has something the appearance of *Poa nevadensis* Vasey, but may be easily distinguished by its inflated membranous sheaths, larger flowers, and pubescent flowering glumes, which are much less firm in texture.

4. **POA BREVIPANICULATA** Scribn. & Williams, sp. nov.

An erect, rather rigid, cæspitose grass, 1½–3 dm. high, from short, stout rhizomes, with a short, broad, closely-flowered, greenish or purplish panicle. Culms smoothish or somewhat roughened below the panicle; lower internodes short, exceeded by the sheaths. Leaves flat or more often conduplicate, smooth below, rough above and on the margins; cauline leaves 2–3, short, the upper usually reduced to a mucro, the ligule short-truncate, often reduced to a narrow band; leaves of the sterile shoots longer, 1 dm. or more in length, acute with rigid points, ligule obsolete; basal sheaths persistent. Spikelets compressed, 4–6-flowered, 4–6 mm. long, ovate-lanceolate, rather acute. Empty glumes unequal, hispid on the keel and more or less scabrous on the back; the lower narrowly lanceolate, acuminate, 1-nerved; the upper broader, acute, 3-nerved, 3½ mm. long. Flowering glumes broadly ovate, obtuse or acutish, strongly pubescent on the lower half of the keel and marginal nerves, minutely scabrous above on the back or sometimes hispidulous, intermediate nerves obsolete, 3½–4 mm. long; palet hyaline with green, hispid-pubescent keels, apex bidentate.

Type specimen No. 554, G. F. Breninger, Table Rock, Colorado, May 25, 1891. Meadows. Altitude 2200 meters.

Tall forms of this species approach *Poa longepedunculata* Scribn., but may be distinguished by the smaller size, stout rootstocks, very short lower internodes, broader panicle, denser pubescence on the flowering glumes and more rigid appearance. It also approaches forms of *Poa eatoni* S. Wats., but differs in its shorter, broader panicle, shorter basal internodes and fewer-flowered spikelets. Like the following species it has usually been referred to *Poa fendleriana*. Its range extends from Colorado to New Mexico and Arizona.

5. **POA LONGILIGULA** Scribn. & Williams, sp. nov.

A cæspitose glaucous perennial, 4 or 5 dm. high, with rather harsh culms and leaves abundantly produced from short rhizomes, persistent basal sheaths and rather crowded panicles of large, shining, green or purplish spikelets. Leaves of the sterile shoots erect or spreading, usually 1½ to 2½ dm. long, flat or conduplicate, with a conspicuous, decurrent ligule; cauline leaves shorter, with longer ligules (5–7 mm.), the upper one sometimes reduced to a mere mucro; leaves all rather rigid and mucronate-pointed. Panicle ovate in outline, erect or rarely somewhat nodding, ¾ to 1¼ dm. long, lower branches seldom exceeding 3½ cm. Spikelets compressed, ovate-lanceolate, rather acute, 4–6-flowered, 6–10 mm. long. Empty glumes unequal, more or less rough-hispid on the back; the lower lanceolate, acute or acuminate, 1-nerved, 4½ mm. long, the upper much broader, 3-nerved, 5 mm. long. Flowering glumes ovate-oblong, rather obtuse, 5-nerved, the intermediate nerves inconspicuous, more or less scabrous above on the back, woolly pubescent on the lower half of the keel and marginal nerves, with broad hyaline margins, usually erose-dentate above, 4–5½ mm. long; palet much shorter than the flowering glume, hyaline, with green, hispid-pubescent keels.

Type specimen No. 5149, Marcus E. Jones, Silver Reef, Utah, May 3, 1894. Altitude, 1,200 meters.

This species has been referred to *Poa fendleriana* (Steud.) Vasey, from which it is easily distinguished by its coarser growth, harsh stems and leaves, much longer decurrent ligule, conspicuous on the leaves of both sterile shoots and culms, larger spikelets and flowers, and denser pubescence of the flowering glumes.

Sclerochloa californica Munro, in Bentham's Pl. Hartweg. (without description), to which specimens of both this and the preceding species have been referred, is a very different plant and is also distinct from *Poa fendleriana*. It is represented in the National Herbarium by Hartweg's No. 2035 and Brewer's No. 1122, both from California, which agree exactly with the type of *Poa secunda* Presl. in the herbarium of the Missouri Botanical Garden.

Poa longiligula ranges from southwestern South Dakota to Southern Colorado, Arizona, and Oregon.

6. **POA PLANIFOLIA** Scribn. & Williams, sp. nov. (P. glaucifolia Sc. & W.

An erect, loosely spreading, glaucous perennial, about 6 dm. high, from short rhizomes, with rather long, flat, abruptly pointed leaves and an open, subpyramidal panicle 1–2 dm. long. Culm smooth, except just below the nodes, where it is minutely roughened. Sheaths striate, somewhat keeled, more or less rough on the keel, otherwise smooth; leaves flat, glaucous, smooth below, roughened above, especially on the margins, 1½ to 2 dm. long; ligule obtuse or truncate, about 2 mm. long. Panicle branches in 3's or 5's, scabrous, spreading, the lower 5–10 cm. long, flower-bearing along the upper half.

Spikelets compressed, ovate-lanceolate, acute, 3–4-flowered. Empty glumes ovate, obtuse or acutish, 3-nerved, scabrous on the back, subequal, about 4 mm. long; flowering glumes oblong-ovate, obtuse, 5-nerved, puberulent on the back, conspicuously pubescent on the lower half of the keel and marginal nerves, and more or less pubescent on the intermediate nerves, scarious-margined above, 3–4 mm. long; palet nearly or quite equaling the flowering glume, rather narrow, tapering above to a narrow truncate, more or less irregularly fringed apex, the prominent green keels hispid-pubescent. Grain pointed below, narrowed above, and bearing three minute, whitish tubercles on the summit.

Type specimen No. 2814, Thos. A. Williams, moist banks, Spring Creek, in the Big Horn Basin, Wyoming, August 4, 1897. Altitude, 1,500 meters.

This species has been confused with *Poa lucida* Vasey, from which it differs more particularly in habit of growth and in the longer, flat, glaucous leaves, stems rough below the nodes, and conspicuously pubescent nerves of the flowering glumes, which are glabrous between the nerves.

Its range as indicated by specimens in the U. S. National Herbarium extends from southwestern South Dakota to central Wyoming and north to central Montana.

7. POA ACUTIGLUMIS Scribner, sp. nov.

A loosely tufted perennial about 6 dm. high, with rather short radical leaves and pale green or purplish panicle about 1 dm. in length. Culm smooth or somewhat roughened at the nodes and just below the panicle. Cauline leaves 2–3, minutely roughened on both the upper and lower surfaces. Sheaths smooth or somewhat roughened above, striate, shorter than the internodes. Ligule about 5 mm. long, acute, often more or less fimbriately divided, rough-hispid on the back. Panicle ovate in outline, acute at both ends, branches in twos or threes, rough-hispid, ascending, the lower longer ones about 5 cm. in length. Spikelets lanceolate, acute, remotely 4–6-flowered, 8–11 mm. long; empty glumes unequal, rough-hispid on the back, the lower long-acuminate, 3-nerved, the upper lanceolate, acute or acuminate, more or less distinctly 5 nerved, 5–6 mm. long; flowering glumes rather conspicuously 5-nerved, narrowly oblong-lanceolate, acute, rough-hispid, on the back, with a short, crisp pubescence at the base and on the lower half of the nerves, about 5 mm. long. Palet a little shorter than the flowering glume, oblong-linear, acute, conspicuously ciliate on the keels and sparsely pubescent near the base between them.

Type specimen collected by Thos. Howell at Grave Creek, Oregon, May 21, 1884. A very distinct species, apparently without any very near relatives.

8. POA TENERRIMA Scribn., sp. nov.

A very slender, cæspitose perennial, 3–5 dm. high with short, filiform leaves and spreading capillary panicles, 7–9 cm. long. Leaves of the intravaginal innovations 4–8 cm. long, thread-like; those of the culm 3–5 cm. long, the uppermost usually about 4 mm., involute, filiform, at least when dry, smooth. Panicle branches in twos and threes, or solitary above, minutely scabrous, flower-bearing only near the tips; spikelets 3–4-flowered, about 7 mm. long, florets rather remote on a slender rachilla; empty glumes lanceolate, acute, the first about 2.5 mm. long, the second a little longer and broader than the first. Flowering glumes about 4 mm. long, oblong, obtuse, 5-nerved, perfectly smooth excepting for a short, crisp pubescence near the base. Palet nearly as long as the glume, 2-keeled, 2-toothed at the apex, keels ciliate, excepting near the base.

Type specimen from California without special locality or collectors named. A striking species, remarkable for the short, filiform leaves and rather few-flowered capillary panicles. The spikelets in the specimen in hand are purplish, as is the culm, and the plants appear to be staminate.

9. **POA LIMOSA** Scribn. & Williams, sp. nov.

An erect, robust, glaucous perennial, 7 or 8 dm. high, from a rhizomatous base, with broad, flat leaves and narrow, closely flowered panicle 1–1½ dm. long. Culm smooth. Culm-leaves 2 or 3, 4–10 cm. long, those of the sterile shoots 10 to 20 cm. or more long, all flat (rarely conduplicate), smooth except on the margins, and abruptly pointed; sheaths smooth, conspicuously striate, all except the lowermost much shorter than the internodes; ligule about 5 mm. long, acute or acuminate, often fimbriate, rough-hispid on the back. Panicle-branches scabrous, erect (or sometimes spreading during anthesis), the lower ones about 4 or 5 cm. in length. Spikelets compressed, lanceolate, 4–5-flowered, about 6 mm. long; empty glumes unequal, smooth or slightly rough on the back, the lower lanceolate, acute, indistinctly 3-nerved, a little less than 3 mm. long, the upper ovate-lanceolate, rather obtuse or subacute, strongly 3-nerved, slightly exceeding 3 mm. in length; flowering glume conspicuously 5-nerved, oblong-ovate, obtuse, minutely scabrous on the back and rough-hispid on the nerves, 3½ mm. long; palet about equaling the flowering glume, sometimes slightly exceeding it, ciliate on the keels, bidentate at the apex.

Type specimen collected by H. N. Bolander, at Mono Lake, California, evidently growning in wet boggy soil, but no notes as to habitat accompany the specimen. Specimens collected by Bolander, No. 6114, and with no locality other than "California," belong to this species.

The species is related to *Poa nevadensis* Vasey and is apparently confined to the Pacific Slope.

10. **POA EPILIS** Scribn., sp. nov.

A rather slender, erect, closely cæspitose perennial, 4–6 dm. high, with numerous basal leaves from intravaginal shoots, and contracted, closely flowered, green, bronze-brown or purplish, usually somewhat nodding panicles about 5 cm. long. Culm smooth, composed of about three internodes, the lowest short, the other two long and much exceeding their sheaths. Leaves smooth, slender, acute, flat, or convolute when dry, those of the sterile shoots much the longest, often 2 dm. or more in length. Sheaths smooth, striate. Ligules of the cauline leaves acute, about 3 mm. long, those of the sterile shoots obtuse, often reduced to a narrow band. Panicle branches erect or ascending, smooth, the longer ones more or less flexuous, simple and flower-bearing near the top or sometimes branched and flower-bearing nearly to the base, seldom over 3 cm. long. Spikelets somewhat compressed, ovate-lanceolate, 3–4-flowered, about 5 mm. long. Empty glumes smooth, unequal, the lower lanceolate or ovate-lanceolate, acute or acuminate, 1-nerved, 2½ mm. long, the upper broadly ovate, acute, 3-nerved, about 3 mm. long; flowering glumes 5-nerved, rough-hispid on the back, the roughness most conspicuous on the keel and marginal nerves, oblong-elliptical, obtuse, about 4 mm. long; palet a little shorter than the flowering glume, cilate on the keels, apex bidendate. Grain pale, ellipsoid, rather acute at both ends, with a conspicuous white tubercle at the apex.

Type specimen No, 1457, Shear and Bessey, open places, thin, moist timberland, Buffalo Pass, Colorado, August 13, 1898. Altitude, 3,000 to 3,500 meters.

Plants belonging to this species have usually been referred to *Poa cuspidata* Vasey, but the type of that species belongs to *Poa wheeleri* Vasey, from which *Poa epilis* differ in its smooth sheaths, contracted panicles and abundantly produced intravaginal shoots.

Poa epilis ranges from central Colorado to northeast Wyoming and central Montana, and occurs in the mountains at rather high altitudes.

11. **POA INCURVA** Scribn. & Williams, sp. nov.

A slender, closely cæspitose perennial about 2 dm. high, from strong fibrous roots, with purplish flexuous stems, rather rigid flexuously recurved leaves and small, purplish panicles 2–4 cm. long. Culm smooth. Culm-leaves about 2, smooth below, minutely hispidulous above and at the acute apex, convolute, 1–3 cm. long; sheaths smooth, striate, shorter than the internodes; ligule acute, often irregularly fimbriate, 1–2 mm. long. Leaves of the sterile shoots much longer than those of the culm, recurved-flexuous, otherwise similar; basal sheaths persistent. Panicle few-flowered, flexuous, the branches mostly solitary, minutely scabrous, flower-bearing at the outer extremities. Spikelets compressed, purplish, loosely 2–3-flowered, about 5 mm. long: empty glumes unequal, the lower oblong-lanceolate, subacute, indistinctly 3-nerved, slightly more than 2 mm. long, the upper broadly ovate, obtuse or subacute, distinctly 3-nerved, usually a little more than 3 mm. long; flowering glume rounded on the back, indistinctly 5-nerved, ovate, obtuse or subacute, smoothish above, densely pubescent below, the pubescence strongest on the middle and marginal nerves, purple on the back, rather broadly scarious-margined above, about 4 mm. long; palet nearly or quite equaling the flowering glumes, strongly 2-keeled, ciliate on the keels, apex bidentate.

Type specimen No. 1989, C. V. Piper, Morain of Duckaloose Glacier, Olympic Mountains, Washington, August, 1895. Altitude, 2,100 meters.

Allied to *Poa sandbergii* Vasey but distinguished by its flexuous stems, smaller spikelets, and smoother, convolute, recurved-flexuous leaves.

12 **POA INVAGINATA** Scribn. & Williams, sp. nov.

A smooth, cæspitose erect or somewhat decumbent perennial, about 4 dm. high, with numerous intravaginal shoots, marcescent sheaths and pale, open panicles 10–12 cm. long. Leaves mostly flat, rather narrow, acute, smooth or the margins minutely hispidulous near the base; sheaths smooth, striate; ligule acute, decurrent, 4–5 mm. long, alike on leaves of both culms and sterile shoots. Panicle subpyramidal to oblong, the branches usually in threes or fives, filiform, flexuous, scabrous, flower-bearing along the upper half, the longer ones seldom exceeding 5 cm. in length; spikelets compressed, lanceolate, rather loosely 2–4-flowered, 6–7 mm. long; empty glumes 3-nerved, narrowly oblong to oblong-ovate, obtuse or subacute, the lower 3–4 mm., the upper 4–5 mm. long; flowering glumes keeled, oblong ovate, obtuse or subacute, 5-nerved, minutely scabrous above, pubescent below on the nerves and sometimes sparsely pubescent between them, 4–5 mm. long; palet shorter than the flowering glume, ciliate on the keels, apex erose-dentate.

Type specimen in Herb. Scribner, No. 20, Calif. Acad. Sciences, collected at "Summit Camp, Sierra Nevada," July 10, 1870.

It has been collected by C. F. Sonne at Dormer Lake, Calif., July 4, 1892 (No. 17) and at Mt. Stanford, Calif., August, 1888 (No. 24), and also by W. N. Suksdorf at Mitchells Point, Wasco Co., Oregon, May, 1884 (No. 107a).

This species has been confused with *Poa gracillima* Vasey and *Poa cusickii* Vasey but may be easily distinguished from the former by its coarser habit, flat leaves, larger and more abundantly flowered panicle, larger spikelets and longer, more conspicuously nerved flowering glumes, and from the latter by its broader, flat leaves and pubescent flowering glumes.

13. **ERAGROSTIS LUTESCENS** Scribn., sp. nov.

A low, much branched and densely cæspitose annual, 1–2 dm. high, with rather short, flat leaves, and narrow, pale green or straw-colored panicles, 4–7 cm. long. Culms glabrous. Sheaths loose or somewhat inflated, striate and glabrous, or with a few short hairs at the throat; ligule very short, ciliate; leaf-blade 2–5 cm. long, 2–3 mm wide, minutely scabrous above, very acute. Panicle branches ascending or appressed, naked below. Spikelets narrowly oblong, 2–3 mm. long, about 1.5 mm. broad, 3 to many- (usually 10–12) flowered. The empty glumes unequal, the first about 1 mm. long, the second one-third longer and larger; flowering glumes obtuse, about 2 mm. long, distinctly 3-nerved.

This species is allied to *Eragrostis purshii*, but is more densely cæspitose and is at once distinguished by its narrow, yellowish-green panicles.

Type specimens from sandy banks of Snake River, Almota, Washington, collected by C. V. Piper, July 7, 1897, No. 2624. Number 4729 Prof. L. F. Henderson found growing in sandy, moderately dry ground along the Platte River, Platte, Southern Idaho, August 1, 1897, belongs to this species.

14. **ELYMUS ARENICOLUS** Scribn. & Smith, sp. nov.

A stout, erect, glaucous perennial, about 1 m. high, with numerous, tough, creeping rootstocks. Culms terete, glabrous, 8–15 dm. high; nodes glabrous. Sheaths striate, smooth, or the upper ones minutely strigose-pubescent, nearly as long as the nodes and closely enveloping them; ligule coarsely fimbriate, about 1 mm. long. Blades rigid, deeply furrowed on both sides, smooth or very minutely strigose-pubescent on the back, strongly scabrous-pubescent on the nerves, scabrous along the margins, 2–4 mm. wide, 2–3 dm. long, strongly involute and pungently pointed. Spike rather slender, subflexuous, 1.5–2.5 dm. long, interrupted below; rachis compressed, sparsely hirsute along the margins and densely hirsute at the nodes. Spikelets single or in pairs, lanceolate, compressed, about 6-flowered; empty glumes subulate, or narrowly lanceolate, rigid, scabrous or sparsely hispid above, slightly unequal, 7–10 mm. long, about half or less than half the length of the spikelet. Flowering glumes rounded on the back, obliquely lanceolate, acute, sparsely hirsute, especially toward the base, 5-nerved, mucronate- or sometimes awn-pointed, the lowest about 10 mm. long. Palea a little shorter than its glume, scarious along the margins, hispid scabrous on the keels, obtuse or emarginate at the apex.

Type collected by A. B. Leckenby, at Suferts, Oregon, November 26, 1898. Growing in the sand dunes along the Columbia River.

Other specimens examined are Nos. 466 and 468 Sandberg and Leiberg, Washington, 1893; No. 1176 Suksdorf, Rockland, Klickitat Co., Washington, June 3, 1890.

It differs from *Elymus flavescens*, with which it has been previously confounded, in the narrowly lanceolate flowering glumes, which are less densely pubescent. Like *Elymus flavescens* it grows on the dryest sand dunes and is an excellent sand binder. The bases of the culms are clothed with dead leaf sheaths.

F. Lamson-Scribner,
Agrostologist.

Approved:
James Wilson,
Secretary of Agriculture.

Washington, D. C., *February 15, 1899.*

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CIRCULAR No. 10.—(Agros. 42.) Issued April 15, 1899.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigation.]

POA FENDLERIANA AND ITS ALLIES.

Poa fendleriana and its allies form an interesting and difficult group of species and are found chiefly in the southwestern part of the United States. The species are much confused in herbaria and have been very differently understood by the various botanists who have studied them. The first name published for any of the species was *Eragrostis fendleriana* Steudel, based on Fendler's No. 932 from New Mexico. Munro confused this as well as allied species with Hartweg's No. 2035, to which he gave the manuscript name *Sclerochloa californica* and much of the difficulty that later botanists have experienced has arisen from the fact that in his determinations of material he gave this name to such a great variety of plants, many of them differing widely in botanical characters. Thurber followed Munro in making the *Atropis californica* of Watson's Botany of California include very diverse forms. The *Poa californica* of Coulter's Manual of Rocky Mountain Botany and of which Munro is cited as the authority, is, according to both synonymy and range, even more puzzling than Thurber's *Atropis californica*. As stated in a recent publication of this Division (Circ. 9, Div. Agros., p. 3) Hartweg's No. 2035, to which Munro first gave his manuscript name *Sclerochloa californica*, is a very different

FIG. 1.—Poa fendleriana.

plant from the type of Steudel's *Eragrostis fendleriana.* It is a member of the "*tenuifolia*" group and agrees with the type of *Poa secunda* Presl, at least so far as the specimens in the National and Gray Herbaria are concerned. Dr. Vasey in "Illustrations of North American Grasses," Vol. 2, took up Steudel's specific name but still confused that species with Munro's *Sclerochloa californica* and figured a plant which seemingly does not belong to either and which is certainly not typical of *Poa fendleriana.*

Fendler's No. 932 seems to have been a mixture. There are two sheets under this name in the Gray Herbarium. The larger specimen on one of the sheets and a smaller plant in an envelope agree well with the specimen in the National Herbarium and with Steudel's description. A smaller undeveloped plant on this sheet is apparently the same as the larger specimen on the other sheet, which differs from what is here taken to be the type of *Poa fendleriana*, in having longer, narrower flowering glumes, which are rough-hispid on the back between the nerves, and relatively broader flat leaves. The panicle is also different. The smaller plant on this second sheet has a panicle much like that of *Poa brevipaniculata* S. & W., but the leaves and glumes are those of typical *Poa fendleriana.* A specimen in the Herbarium of Academy of Natural Sciences, Philadelphia, to which one of Fendler's labels is attached, is still different, belonging to an entirely different section of the genus.

The grasses of the *fendleriana* group are all conspicuous for their tufted habit of growth and are more or less completely diœcious. This latter character can not be satisfactorily studied in herbarium material, and careful field studies are necessary before all the members of the group can be properly understood.

SYNOPSIS OF THE SPECIES.

1. Ligules usually 5–7 mm. long, acute or acuminate, decurrent, those of the leaves of the sterile shoots conspicuous. *P. longiligula.*
1. Ligules much shorter, rounded or truncate at the apex; those of the leaves of the sterile shoots reduced to a narrow band or fringe, or obsolete. 2.
2. Panicle narrow and contracted. *P. longipedunculata.*
2. Panicle open. 3.
3. Panicle short, subpyramidal; lower internodes very short, exceeded by the sheaths; plants seldom reaching 3 dm. in height. 4.
3. Panicle longer, usually 8 cm. or more in length; internodes longer, seldom exceeded by the sheaths; plants usually 4–6 dm. in height. 5.
4. Flowering glumes oblong, leaves slender, rough. *P. scabriuscula.*
4. Flowering glumes broadly ovate, leaves smoother, broader and more rigid. *P. brevipaniculata.*
5. Spikelets rather acute, ovate, 4–7-flowered; leaf-blades hispid-~~pubescent on~~ the upper surface. *P. fendleriana.*
5. Spikelets more obtuse, oblong to somewhat ovate, 5–9-flowered; leaf-blades rough-hispid above, but not pubescent. *P. eatoni.*

POA LONGILIGULA Scribner & Williams, Circ. 9, Div. Agros., p. 3 (Feb. 24, 1899).

This is one of the most clearly defined species of the *fendleriana* group, at once distinguished by its larger proportions, rough leaves, and long, decurrent ligules, well developed on leaves of both culm and sterile shoots.

Specimens have been examined as follows:

South Dakota: Black Hills (Rydberg 1144).

Wyoming: Evanston (Nelson 2991); Slough Creek, Yellowstone Park (Tweedy, 631).

Colorado: Navajo Canyon (Eastwood 10½); "Colorado Ter." (Thomas).

Utah: Silver Reef (Jones 5176, 5149, type); Echo (Jones); Springdale (Jones 5249); Santa Clara Valley (Jones 5139); Copper Mine, 18 miles west of St. George (Jones 5006); "S. Utah" (A. L. Siler 85).

New Mexico: Fort Wingate (Dr. W. Matthews 61).

Arizona: Pagumpa (Jones 5089); Congress (Orcutt 2534); Red Creek (Palmer 474½); Peach Spring (Lemmon 3172); Kingman (Orcutt 2474); Oak Creek (Lemmon 3155); Fort Mohave (Lemmon 3170).

California: Lemmon 18, without locality; San Francisco (Bolander 2286); Sierra County (Lemmon).

Nevada: West Humboldt Mountains (Watson 1312); Mica Spring (Jones 5057); Virginia City (Bloomer 2266); "Nevada" (Wheeler 1872).

Oregon: Steins Mountains, opposite Devine Ranch (Leiberg 2480).

POA LONGILIGULA WYOMINGENSIS var. nov.

Leaves more slender than in the species, usually strongly convolute, and the ligules less conspicuous; culm less leafy; panicle more contracted.

Type specimen No. 4799*a*, Aven Nelson, "In draws, Tipton, Sweetwater County, Wyoming, June 17, 1898."

Specimens have been received from the following localities, all in the southwestern part of Wyoming:

Leroy (Nelson 4589); Point of Rocks (Nelson 4758); Evanston (Nelson 4526 4527, 4562a and b); Tipton (Nelson 4799, 4799a, type).

Occurs in dry soil of broken prairies and on hillsides at an altitude of about 2250 meters. It approaches *P. longipedunculata* in habit of growth, but is readily distinguished by the character of the leaves, ligules, and glumes.

POA LONGIPEDUNCULATA Scribn., Bull. 11, Div. Agros. 54 (July 20, 1898), *Poa andina* var. *spicata* Vasey, Bot., Wheeler Exped. 290 (1878), not *P. spicata* Linn.

The original description of *P. longipedunculata* was drawn from a specimen with short leaves, much contracted panicle, and glumes nearly or quite smooth between the nerves, but does not seem specifically distinct from Vasey's plant, which has longer leaves, somewhat looser panicle, and glumes minutely hispid on the back. However, Vasey's name is preoccupied and the species must bear the name above given. The species is abundantly distinct from *Poa fendleriana* in its more densely cæspitose habit of growth, generally smoother leaves and culms, narrow, contracted panicle, and smaller spikelets and flowers.

Specimens of this species have been examined from the following localities:

Wyoming: Sheep Mountain (Nelson 3292, type of *Poa longipedunculata*; Williams 2296); Quarry Canyon (Nelson 3180); Pole Creek (Elias Nelson 3194).

Colorado: Silver Plume (Shear 666; Rydberg 2418); Grays Peak (Shear 685; Letterman 49; Patterson 5); Graymont (Rydberg 2444; Letterman 64, 65); Stove Prairie (Osterhout 16); Lake Ranch (French); Bear

Creek Divide (Tracy, Earle and Baker 4263); Beaver Creek (Pammel); Marshall Pass (Shear 931); Manitou (Shear 765); "Colorado" (Wolfe 1135, 1136, 1137).

New Mexico: Santa Fe Canyon (Heller 3685).

POA LONGIPEDUNCULATA VIRIDESCENS var. nov.

Differs from the species in its greener color, generally longer, softer leaves, less contracted, often interrupted panicle, the more delicate texture of the glumes and the usually more conspicuous intermediate nerves of the flowering glumes.

Type specimen No. 2302, Thomas A. Williams; open places, dry mountain sides, Sheep Mountain, Wyoming, July 2, 1897. Altitude 2,400 meters.

Specimens have been examined as follows:

Wyoming: Sheep Mountain (Williams 2302, 2302a, 2276; Nelson 3304).

New Mexico: Barranca (Heller 3588); Santa Fe (Heller 3611); Santa Magdalena Mountains (Vasey).

The general aspect of this variety is quite different from the species and a study of a more extended series of specimens will possibly prove it to be deserving of specific rank.

POA SCABRIUSCULA sp. nov.

A pale green, closely cæspitose perennial, 2½–3 dm. high, with slender, lax leaves, abundantly produced from intravaginal shoots and rather closely flowered subpyramidal panicles 5–7 cm. long by 2–3½ cm. broad. Culm erect, striate, smooth except for a short distance immediately below the panicle; lower internodes short, usually exceeded by the sheaths, upper one much exserted. Leaf-blades flat or convolute, those of the sterile shoots 8–12 cm. long by 1–1½ mm. wide, those of the culm short, the upper one seldom over 1 cm. long, often reduced to a mucro; leaf-blades all striate, more or less roughened throughout; ligule obtuse, about 1½ mm. long; sheaths striate, rough, the lower ones persistent. Panicle erect, the branches scabrous, seldom exceeding 3 cm. in length. Spikelets compressed, usually 4-flowered, 5–7 mm. long, rachilla pubescent; empty glumes somewhat unequal, lanceolate, acute or subacuminate, smooth or very sparsely rough-hispid on the keels, shining, hyaline with green keel and nerves, lower 1-, upper 3-nerved, about 3 mm. long. Flowering glumes oblong, obtuse, keeled, smooth with keel and marginal nerves pubescent below and sparsely hispid above, intermediate nerves subobsolete, pale green or purplish with hyaline margins, about 3½ mm. long; palet much shorter then the flowering glume, hyaline with green ciliate-hispid keels, apex bidentate.

Type specimen No. 136, L. F. Ward, mountains south of Glenwood, Utah, May 29, 1895. Altitude 2,550 meters. The species was also collected by J. Wolf (No. 184) in 1875 in South Park, Colorado.

The species is in some respects intermediate between *Poa fendleriana* (Steud.) Vasey and *P. brevipaniculata* Scribn. & Williams, but it is easily distinguished from the former by its shorter panicle, smaller spikelets and flowers, oblong flowering glume and rougher leaves, and from the latter by the character of the spikelets, texture and shape of the flowering glumes, slender, lax, rough leaves and lack of rhizomes.

POA BREVIPANICULATA Scribn. & Williams, Circular 9, Div. Agros., p. 2 (Feb. 24, 1899).

Specimens referable to this species have been examined from the following localities:

Colorado: Table Rock (G. F. Breninger 554, type); Mt. Hesperus (Tracy, Earle and Baker 262); West Mancos Creek (Tracy, Earle and Baker 160); Bob Creek (Tracy, Earle and Baker 205); Cripple Creek (Tweedy 279).

The grass occurs in dry soil of meadows and on mountain sides at an altitude of from 2,300 to 3,500 m.

POA BREVIPANICULATA SUBPALLIDA var. nov. Differs from the species in its paler green color, slender, soft leaves, which are less often conduplicate, and usually more contracted panicles.

Type specimen Hall & Harbour (674 in part), Rocky Mountains, Colorado, 1862. A specimen belonging to this variety and possibly of the same collection as the preceding is in the National Herbarium ticketed as *Poa alpina* var., Rocky Mountains, 1862, E. Hall.

POA FENDLERIANA (Steud.) Vasey, Ill., N. Am. Grasses **2**. No. 74 (1893), in part. *Eragrostis fendleriana* Steud., Gram., 278 (1855). *Atropis californica* Thurber, Wats. Bot. Calif. **2**; 309, in part. *Poa andina* Vasey, Bot. Wheeler Exped. 289, not of Nuttall nor of Linn. *Poa californica*, in part, Coulter, Man. Rocky Mountain, Bot., 420 (1885). (Fig. 1.)

An erect, cæspitose perennial, 3½–6 dm. high, with rather pale upright leaves, abundantly produced from intravaginal shoots and open, erect or somewhat flexuous, usually purplish panicle 5–10 cm. long. Culm striate, scabrous immediately below the panicle and nodes; internodes usually equaling or exceeding the sheaths. Leaf-blades flat or more often convolute, scabrous below, hispid-pubescent above, mucronate-pointed, those of the sterile shoots 1–2 dm. long, by about 1½ mm. broad, those of the cauline leaves much shorter, the upper one often reduced to a mucro; ligule short, rounded or truncate, reduced to a narrow band or fringe on the leaves of the sterile shoots; sheaths striate, scabrous, the lower ones membranous and persistent. Panicle branches spreading in anthesis, ascending in fruit, scabrous, the longer lower ones seldom more than 3 cm. long, flower-bearing above the middle. Spikelet compressed, ovate to ovate-lanceolate, rather acute, 4–7 (rarely more) flowered, 7–8 mm. long, 3–3½ mm. broad; empty glumes unequal, smooth, the lower 1-nerved, lanceolate, acute or subacuminate, the upper 3-nerved, ovate to ovate-lanceolate, acute, about 4 mm long; flowering glumes keeled, oblong-elliptical to oblong-ovate, obtuse, pubescent below on keel and marginal nerves, smooth between the nerves, intermediate nerves obsolete, about 5 mm. long; palet much shorter than the flowering glumes, sharply bidentate, sparsely hispid-ciliate on the keels; rachilla more or less hispid-pubescent.

Colorado: Trinidad (Crandall 15); Upper La Plata (Tracy, Earle and Baker 4257); Maniton (Heller 3502).

New Mexico: Mangus Springs (Rusby 452); Silver City (Greene 438); Santa Magdalena Mountains (Vasey); Santa Fe (Heller 3530, 3561). "New Mexico" (Fendler 932, at least for the most part, type).

Arizona: Dos Cabezos (MacDougal 787; Emersley); Flagstaff (MacDougal 2); Ash Fork (Rusby); San Rita Mountains (Pringle); San Francisco Peak (Jones).

California: "Sta. Crus Sonora" (Parry).

Grows on dry hills and mesas at an altitude of from 1,350 to 2,750 m.

POA FENDLERIANA ARIZONICA var. nov.

Differs from the species in being strongly glaucous throughout, in having longer, rougher leaves, more unequal empty glumes, and in the firmer texture of the flowering glumes.

Type specimen collected at Yavapai Creek, June 1883, by Dr. H. H. Rusby. It was also collected by Dr. Rusby at Prescott, Arizona. A less glaucous plant, with smoother, flat leaves, collected by Dr. Rusby (No. 452) in the San Francisco Mountains, Arizona, may be the staminate form of the variety.

POA EATONI S. Watson, Bot. 40th Parallel, p. 386, 1871.

An erect, cæspitose perennial 4–6 dm. high, from short rhizomes, with rough, more or less glaucous leaves and rather open, oblong, or somewhat ovate panicle, 7 or 8 cm. long. Culm smooth, more or less roughened immediately below the panicle, composed of two or three internodes, all but the lowest exceeding the sheath, the upper one long and much exserted. Leaf-blades flat or becoming conduplicate, scabrous below, and rough-hispid above; those of the basal leaves spreading, 1–2 dm. long, those of the cauline leaves seldom over 2 cm. long, the upper one often reduced to a mucro. Ligule short, with a rounded or truncate apex, that of the leaves of the sterile shoots reduced to a narrow band or fringe. Sheaths striate, the basal ones persistent. Panicle branches scabrous, erect or ascending, seldom more than 3 cm. long, flower-bearing along the upper half; spikelets compressed, oblong, rather obtuse, 5–9-flowered, 7–10 mm. long, about 3 mm. broad. Empty glumes subequal, acute, or subacuminate, the lower 1-, the upper imperfectly 3-nerved, hispid on the keels $\frac{1}{2}$–$\frac{2}{3}$ the length of the adjacent flowering glume. Flowering glumes strongly keeled, the keels and lateral nerves thickly pubescent below, hispid above, smooth between the nerves, 4–5 mm. long, the intermediate nerves obsolete.

Very closely allied to *Poa fendleriana* but possibly distinct through its oblong, usually more numerously-flowered spikelets and shorter, broader, spreading leaves which, though rough, are not pubescent on the upper surface. It is possibly more strongly rhizomatous but this can only be determined by studies in the field. No specimens have been seen that can be referred to this species except those from the original collection by D. C. Eaton at Cottonwood Canyon, Wahsatch Mountains, Utah, where the plants grew in dry rocky soil at an altitude of 2,000 meters. Most of the material that has been placed by botanists under this species is true *Poa fendleriana*. Prof. J. Macoun has collected a plant in British Columbia (No. 58, Spencers Bridge, 1889; and 91, and 93, Valley of Fraser River, 1875), which has much the habit of *P. eatoni* to which it has been referred but it has the longer leaves (more or less hispid-pubescent above) and ovate to ovate-lanceolate spikelets of *P. fendleriana* and seems to be an intermediate form. It is not improbable that further study will result in the suppression of Watson's species.

NOTE.—In Circular 9, Div. Agrost., p. 3, the name *Poa planifolia* was applied to a species of the Rocky Mountain region, but since this combination has already been used by Dr. O. Kuntze (Revis. **3**:, pt. 3, sec. 2, p. 366, 1898) for a South American plant, a new name is necessary for our species. It may be called *Poa glaucifolia* Scribn. and Williams.

THOMAS A. WILLIAMS,
Assistant Agrostologist.

Approved:

JAMES WILSON,
Secretary of Agriculture.

CIRCULAR No. 11. (Agros. 13.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

THE FLAT PEA.

DESCRIPTION.

The flat pea is a variety of the woodland pea (*Lathyrus sylvestris*), which is not very different in appearance from the common sweet, or everlasting, pea. It is a perennial, enduring sometimes for

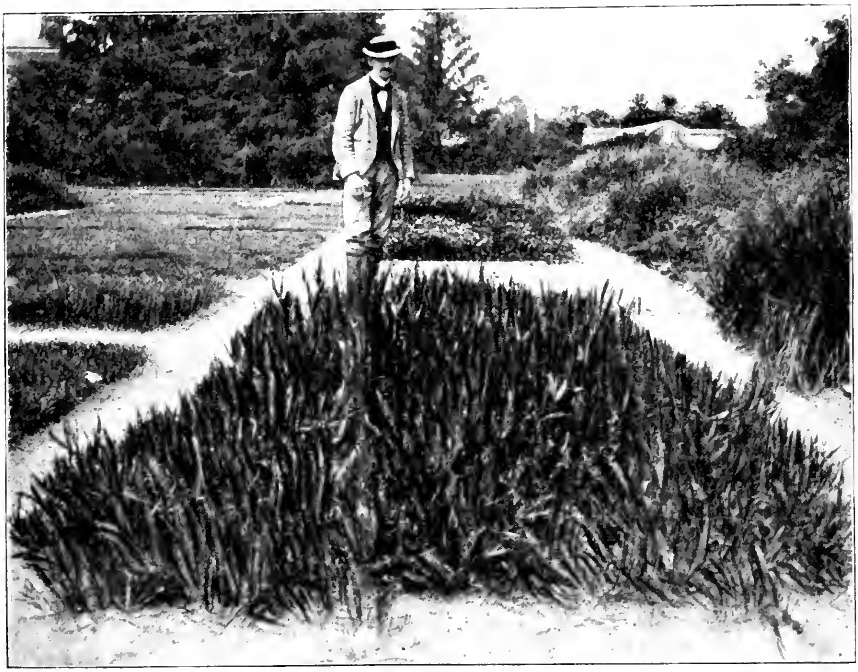

FIG. 1. Plot of flat pea in the Grass Garden on the grounds of the Agricultural Department.

twenty-five years or more, has strong, deep, much-branched roots, and produces many trailing or climbing stems, which interlace in great tangled masses. The rather handsome rose-colored flowers are borne in loose clusters and are followed by pods not unlike those of the common pea.

This pea is a native of Europe, and is most abundant in the central and southern parts, extending into northern Africa. It is found in thickets and hedgerows, and on rocky hillsides, blossoming throughout the summer. A variety has long been cultivated for ornament in English gardens under the name of everlasting pea.

HISTORY OF ITS INTRODUCTION.

In 1862, Herr Wagner, an agriculturist of Kircheim-Teck in Wurtemberg, Germany, had occasion to visit the Little Carpathian Mountains, where he observed that, while all other herbage had been burned up by the intense summer drought, the masses of stems and foliage of *Lathyrus sylvestris* remained green and tender. It occurred to him that here was a good fodder plant for dry soils, the more so as this luxuriant growth was upon pure chalk rubble. But when Wagner put the *Lathyrus* to practical test he found it wanting in two particulars: first, it contained certain alkaloids which rendered it disagreeable and injurious to cattle; and second, the seed is protected by an exceedingly hard coat, so that it may lie in the ground for years without germinating.

FIG. 2. Flat Pea (*Lathyrus sylvestris wagneri*).

Thinking that possibly these defects might be eliminated by cultivation, Wagner undertook the systematic improvement of the *Lathyrus*. As a result the bitter alkaloids were gotten rid of, and the hard, vitreous seed coat was rendered comparatively soft and pervious to moisture, so that germination took place in two or three weeks, instead of as many years, after sowing. This alteration was accomplished by yearly transplanting, each time to a better soil.

The improved variety of *Lathyrus sylvestris* thus brought into notice was named *Lathyrus sylvestris wagneri*, in honor of the cultivator. English agriculturists have named it "Flat Pea." It has received much attention in Germany, but has not yet been cultivated on an extensive scale. A great deal has been published about it, chiefly in newspapers and agricultural journals. In England it has excited some interest, and in the arid regions of Cape Colony its cultivation has been attended with seeming success. In the United States practical agriculturists have not yet taken it up to any great extent. Several of the State experiment stations, notably those of Louisiana, Michigan, California, and Massachusetts, have grown the flat pea in a small way and have made chemical analyses of it. In Louisiana the success of the experiment has so far not been marked, although the experimenter admits that there has not been time for a fair trial of it. At the Michigan Station quite favorable results have been obtained, the yield being good and cattle relishing the fodder.

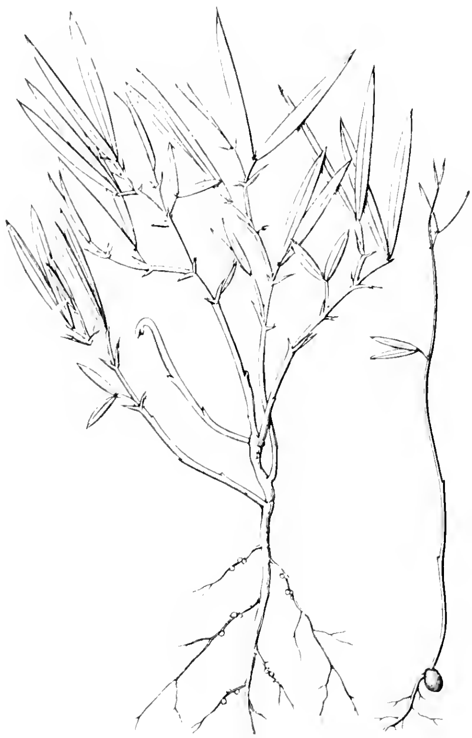

FIG. 3. Young plants of flat pea. The one to the left shows the root tubercles.

USES.

Owing to its power of taking nitrogen from the air, and therefore of growing without the aid of nitrogenous manures when once well established, the flat pea is thought to be especially adapted to comparatively poor, sandy, shaly, or "chalky" soils. Hence its greatest value should be as a soil renovator to restore nitrogen to ground which has been exhausted by cereals and like crops, or is otherwise lacking in sources of protein. This is a function largely delegated in the United States to the clovers and cowpeas. The *Lathyrus* is said to be a good binder for drifting, sandy soils, the strong, deeply penetrating roots forming a mesh which holds the particles of soil together. The roots are sometimes 20 to 30 feet long.

It is claimed that the hay of the Wagner flat pea makes an excellent fodder, much relished by cattle, sheep, and hogs, and contains more nutriment than most standard fodders. Owing to the high rate of nutritive matter in *Lathyrus* hay, it is recommended that it be mixed with one-third or one-half of straw. At the Michigan Experiment Station it was found that cattle relished the green fodder, but no report is made of its effect upon them. A writer in

Der Landbote, a German agricultural publication, states that a plantation of flat pea affords excellent "standing mast" for pigs, and the flowers of the *Lathyrus* are much frequented by bees, the honey from this source being exceptionally fine.

CULTIVATION.

German authorities recommend that the flat pea should be first planted in the seed bed, from which the young vines are transplanted to the locations where it is desired they finally should grow. It is estimated about 30,000 plants are needed for an acre. In a country so rich in forage plants as the United States, and especially where the methods practiced are so different from what they are in European countries, this manner of procedure is not likely to be followed. More economical and expeditious methods must be sought. One method recommended is that of planting the seeds in drills 15–20 inches apart, burying the seed to the deepth of 3 inches, deeper if the soil is very sandy and the region dry, or less deep in heavy soils. The land should be prepared for receiving this crop the same as for wheat or corn, although it is claimed that the flat pea will grow in regions or in soils where these crops will not succeed. The young plants usually come to the surface within three weeks from planting and during the first season make a small growth, 10 or 12 inches perhaps. The land during this season should be kept free from weeds and the vines cultivated. The second year the growth is more vigorous and during the third year the plants attain their full size. In the Gulf States the vegetation is perennial, but in the latitude of Washington the plants die down in the winter, although they are quite resistant to frost and are slow in starting in spring. Their heaviest growth appears to be during the months of July and August, and at this season the vines make a dense mat, completely covering the ground, often to the depth of 3 or 4 feet. This tangled mass of vines is cut with difficulty and must be mown with a scythe or cut with a sickle. The vines, when cut, dry out readily and the making of the hay is a simple matter.

CHEMICAL ANALYSIS.

The analysis of the air-dried hay at the Michigan Agricultural Experiment Station is as follows:

	Per cent.
Water	7.99
Crude ash	8.32
Ether extract, fat, etc	2.08
Crude fiber, wooded matter	26.70
Nitrogen, free extract, starch, sugar, etc	27.74
Crude protein	27.17
	100.00

The following is an analysis made at the California Experiment Station with comparative analyses of the flat pea made in England, and of alfalfa. It is the general conclusion that although the amount of crude protein in flat-pea hay is very high, the plant does not commend itself for forage:

	Flat Pea.		
	California Station (cut before bloom).	England (cut after bloom).	Alfalfa
Moisture	63.48	58.63	67.46
Crude protein	8.18	7.41	5.91
Crude fat	1.63	2.05	1.15
Carbohydrates	13.77	16.58	12.02
Crude fiber	9.76	12.21	10.51
Ash	3.18	3.09	2.95
Total	100.00	100.00	100.00

NOTES FROM EXPERIMENT STATIONS.

The California Experiment Station reports that the flat pea maintains a heavy growth with very little moisture, keeping green all summer without irrigation. Cattle and horses will eat the hay, but avoid the green vines. Sheep and pigs eat it readily green. Flat peas grow best on upland, sandy soils.

The North Carolina Station reports that the flat pea requires three or more years to secure a stand and then it is of no practical value for North Carolina. "The flat pea we place next to sachaline as the most loudly trumpeted swindle perpetrated upon the long-suffering public in recent years."

The Alabama Station reports that flat pea grows 8 to 10 inches high the first year, withstands light frost, continuing to grow throughout the winter. Cows and horses crop the vines, especially before other plants have started. It is regarded as good a soil renovator as cowpeas.

At the Hatch Experiment Station, Massachusetts, the flat pea was cultivated for two years at considerable expense without securing any fodder.

The Nebraska Station reports that this fodder plant appears to be too tender to stand ordinary treatment and does not recommend it.

The Utah Station reports that *Lathyrus sylvestris* dried up during the summer of 1893, although it remained green several weeks after the alfalfa plants growing with it were dead.

The Kansas Station reports that young seedling plants of the flat pea withstood the drought satisfactorily.

In the Michigan Experiment Station report for 1895 it is stated that the flat pea had grown with fair success for several years, but the feeding tests showed that sheep and cows had a decided distaste for the forage. Sheep confined on flat-pea pasture lost weight, and cows fed in stable lost weight and diminished in production of milk and butter-fat when either green or ensiled flat-pea fodder was fed as a part of the ration.

CONCLUSION.

In localities where it will pay to go to considerable trouble in order to establish a growth of some forage plant, as in some of the sandy and arid regions of the West, especially in limestone and chalky regions of the Southwest, flat pea may be considered as having some possible value; but where other crops can be grown, such as Indian corn, the sorghums, wheat, rye, barley, clovers, or the ordinary tame grasses, it will not pay to cultivate this fodder plant. The deeply penetrating, tenacious roots and perennial habit exclude this plant from ordinary use in rotation.

Finally, it must be borne in mind that this plant, naturally growing upon sterile ground, was improved by continual transplanting to better soil. If sown upon poor soil, is there no danger that it will revert to its original state, regaining the injurious qualities lost in the course of improvement? The method of improvement—by continual transplanting to better soil—makes the probability of reversion great. Indeed, those who advertise the plant most extensively admit that many who raise seed for sale have, on account of careless cultivation, placed on the market seed of inferior or unimproved forms. Unless this can be stopped it is to be feared that the result will be the entire reversion of the improved variety.

F. LAMSON-SCRIBNER,
Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *April 28, 1899.*

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigation.]

RAPE AS A FORAGE PLANT.

Throughout a large portion of the United States farmers and stock-raisers could advantageously grow more of the succulent forage crops for feeding stock during the summer and autumn months, when the supply of grasses and clovers is often limited. Such crops may usually be grown on land that has already produced an early matur-

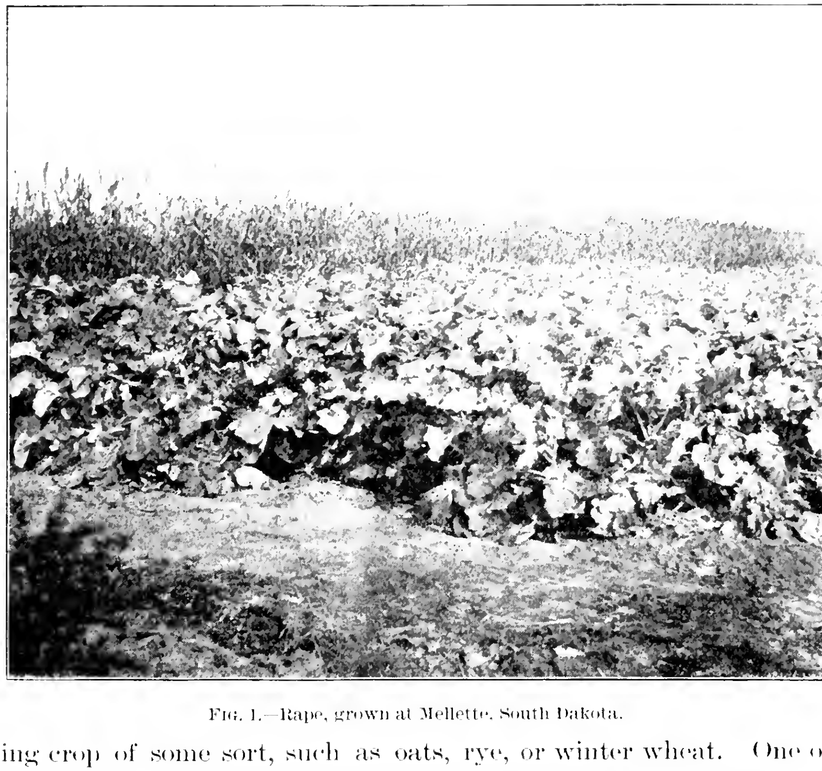

FIG. 1.—Rape, grown at Mellette, South Dakota.

ing crop of some sort, such as oats, rye, or winter wheat. One of the best of these succulent crops is rape (*Brassica napus* Linn.), a plant closely related to cabbage, turnips, and several other garden and field crops.

DESCRIPTION.

Rape is much like the Swedish turnip or rutabaga in appearance, but the root is more like that of cabbage. The leaves are large, glaucous, smooth, spreading, and variously notched and divided; the flowers are bright yellow, nearly one-half inch in diameter; the seeds are produced in pods usually 2 inches or more long.

Under ordinary field conditions the plant reaches a height of from $1\frac{1}{2}$ to 4 feet, and the strong-growing roots penetrate the soil to a considerable depth.

Rape is either annual or biennial. The annual varieties (summer rape) are grown chiefly for the seed, and have not been much cultivated in this country. The biennial varieties (winter rape) are used largely for forage.

NATIVITY, USES, AND EXTENT OF CULTIVATION.

Rape, like the turnip, is a native of northern Europe, ranging eastward into Siberia. Although it has long been cultivated in the Old World, it has received but little attention in America until within comparatively recent years, and is now much more widely grown in Canada than in the United States. Practically, all the rape grown in this country is the winter or biennial sort, but in Europe, especially in England, summer rape is widely cultivated. The seed yields about 33 per cent of expressed oil, which is of value for lubricating, and is also used for lighting. The compressed rape-seed cake is used as a food for stock and as a fertilizer. It is regarded as particularly valuable as a fertilizer for flax and turnips. The seed is much used as a bird food. In this country rape is grown almost exclusively for forage, being used chiefly for soiling and summer and autumn pasturage.

Rape is best adapted to rather cool, moist climates, such as prevail in portions of Canada and the northern United States. It can, however, be successfully grown as a forage crop in many of the warmer and dryer sections. Thus in favorable seasons or with a small amount of irrigation excellent crops of rape are grown in Wyoming, Montana, the Dakotas, and other States in the so-called semiarid region, and many instances are on record where good crops have been produced without irrigation, under conditions of drought so severe as to cause the failure of corn and other farm crops. In parts of the South rape may be grown for late fall or winter forage.

SOIL REQUIREMENTS.

For its best development rape requires a rich, moist, loamy soil, and will usually do well on any but light sandy soils and stiff clays, such soils being usually deficient in vegetable matter. In general a soil that will produce good crops of turnip, cabbage, wheat, and corn will be suitable for rape.

Rape is a gross feeder and draws quite heavily on the nitrogen as well as the mineral constituents of the soil, and hence should be used in rotation with crops that feed largely on other elements of plant food. For example, rape and fodder corn take about the same proportions of nitrogen, potash, and phosphoric acid from the soil, and experience has shown that corn does not do well after rape, unless the land is naturally rich in these substances. Results obtained at the North Dakota Experiment Station indicate that the growing of a crop of rape on land that has been sown to wheat for a number of years produces a decided increase in the yield of wheat from the succeeding crop. This is a point of much value in regions where wheat is extensively grown.

VARIETIES.

All the varieties of rape that have come into prominence in American agriculture are winter or biennial sorts. Dwarf Essex or English rape has been most widely cultivated. Recently a variety has been placed on the market under the name of Dwarf Victoria rape, or simply Victoria rape, which has given excellent results in New England and also in the Northwest, yielding, as a rule, rather better than the Dwarf Essex. At the New Hampshire Experiment Station this variety is reported as yielding nearly 50 tons of green fodder per acre, and yields of 25 to 30 tons per acre are reported from South Dakota and elsewhere in the Northwest. Under average conditions a yield of from 10 to 20 tons or more may be expected from either of these varieties.

CULTURE.

Owing to the great variety of ways for utilizing rape and the many places it may occupy in the rotation of crops on the farm, there are numerous methods of culture that may be followed in growing it. When it is grown as the primary crop of the season the land should be prepared by deep and thorough plowing, preferably early in the preceding autumn. In some soils a second plowing should be given in the spring before the seed is sown, but in soils that are naturally loose and mellow, such as are found in portions of the Northwest, a simple stirring of the surface with a cultivator or disk-harrow will often be sufficient. The land should be well pulverized by harrowing before the seed is sown. When the land needs fertilizing barnyard manure may be applied before plowing in the autumn, or if the land is plowed twice the manure may be spread on during the winter or early spring before the last plowing. Commercial fertilizers may be applied by harrowing in at the time that the land is being pulverized previous to seeding. Whatever treatment the land is given in preparation for this crop it should be such as to afford a deep, mellow seed bed, as free as possible from noxious weeds.

SEEDING.

Throughout the Northern States generally, seeding may take place from the first of June or possibly earlier, to the middle or last of July, according to the season and locality. In the South the seed may be sown in September or early in October. Under favorable conditions 2 to 3 pounds of seed per acre will be sufficient and it will never be necessary to use more than 5 pounds per acre. The seed should be planted in drills far enough apart to allow cultivation. In practice the distance varies, but it is seldom less than 20 inches nor more than 32; 24 to 28 being perhaps the most satisfactory, all things considered. For planting small fields any of the common garden drills will be found quite satisfactory, but for large fields a grain drill with some of the feed hoppers closed may be used. When the ground is clean and in proper condition otherwise, good results may be obtained by using the grain drill with all feed hoppers open, and giving no after cultivation. As a rule, however, it will be best to plant in wide drills and give sufficient shallow cultivation to keep the soil in good physical condition and destroy weeds. With favorable soil and climatic conditions, good crops of rape may be obtained from broadcast seeding, but whenever there is any danger of the surface soil becoming very dry during the time the seed is germinating or when land is at all foul, drilling will give much better results.

AS A CATCH CROP.

When rape is grown as a secondary or catch crop it will not often be possible to pay so much attention to the preparation of the soil and the time and method of seeding, and quantity of seed used may be varied to suit the circumstances. Often fine rape may be grown on land that has already produced a crop of some of the early maturing cereals, such as rye, oats, or barley. As soon as the crop of grain is removed, the land is plowed or "disked" and at once seeded to rape. Field peas and other early maturing forage crops, or rye or winter oats that have been pastured off in spring may also be followed by rape with profitable results.

Another practice which is coming into favor in some sections of the country is to sow rape in the spring with some grain crop, such as wheat, allowing the former to take possession of the field when the latter has been removed. This method is especially satisfactory when succulent forage is desired for fall feeding. Rape may also be sown in the cornfield just before the last plowing, as is often done with rye and winter wheat.

AS A WEED DESTROYER.

Aside from its value as a forage, rape is an excellent crop to grow on fields that are foul with weeds. The late date at which the seed may be sown allows the weeds to get well started before the final preparation of the soil begins, they are further kept in check by the cultivation required for the crop during its early growth and later the rape plants shade the ground so completely as to keep the weeds down. An excellent treatment for a foul field is to plow thoroughly in late summer or early autumn and seed to rye or some other forage crop to be pastured off during the fall, winter, or early spring. When the crop has been pastured sufficiently and before the weeds have produced seed, plow again, plant rape in drills and give thorough cultivation. There are few weeds that will survive such treatment and the land will have given profitable returns in forage in the meantime.

HARVESTING AND UTILIZING THE CROP.

The rape is usually ready for use in about 8 or 10 weeks from the date of seeding. The general practice is to use it as a soiling crop or as pasturage. Sheep and swine may be turned into the field and allowed to remain until the rape is pastured off. Cattle may also be allowed to run in the field, but as they waste much of the forage by pulling up the plants and trampling them down it is a better plan to cut the rape with a scythe or mower and feed it to the animals.

With sheep and cattle care should be taken at first not to allow the animals to eat too much, as there is danger of injury from bloating. Hungry animals should not be allowed to eat their fill, and it is not best to turn them into the rape when the leaves are wet. There is no danger of bloating with swine. It is an excellent plan to have the fields so arranged that the sheep and cattle have access to an open pasture as well as to the rape. Animals should have free access to salt at all times when being pastured on this crop.

FEEDING VALUE.

Rape has a high feeding value. It makes an excellent feed for fattening sheep and swine and for producing an abundant flow of milk in milch cows. On account of danger of tainting the milk many people do not feed it to the cows until after milking. Rape can be used to good advantage as a part of the ration for animals that are being fed in pens for market or for the show ring. It is also a valuable food for young lambs at weaning time. By beginning as early as practicable in the spring and seeding at intervals of two or three weeks, a continuous succession of rape can be produced throughout the period when the permanent pastures are most likely to be short. Rape will endure quite severe cold weather and thus will last a long time after the ordinary pasture grasses succumb to the frost. By the use of this crop stock can be gotten into good condition for the holiday markets or for winter and there need be no check in growth, fat, and milk production through insufficient succulent food during the late summer and autumn months, as is too frequently the case.

Under favorable conditions two or three cuttings may be made in a single season from a field of rape grown as a primary crop. Mr. W. H. Heidman, of Kalispell, Mont., reports three cuttings the first season with a heavy yield of forage. He allowed the plants to stand the second season and obtained a fine yield of first-class seed. Not much attention has been paid to growing rape for seed in this country, possibly because of the fact that in most localities where this crop has been extensively grown the winters are so severe as to destroy the plants. It seems however that there are localities where rape can be profitably grown for seed and farmers might well devote more attention to this feature of rape growing since most of that now used is imported.

THOMAS A. WILLIAMS,
Assistant Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *May 1, 1899.*

CIRCULAR No. 13. (Agros. 15.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigation.]

FLORIDA BEGGAR WEED.

(Also Known as Beggar Weed, Florida Clover, Giant Beggar Weed.)

(*Desmodium tortuosum.*)

DESCRIPTION.

Florida beggar weed is an erect annual, a native of the West Indies, and perhaps also of southern Florida. It is a leguminous plant with rather woody stalks from 3 to 8 or 10 feet high, bearing an abundant leafage above and when in flower tipped with much-branched erect panicles, the ascending lateral branches often 8 to 12 inches long. The seeds are borne in many-jointed prickly pods, which break apart at maturity and are carried about by sticking to the bodies of animals or the clothing of persons. The plant is hairy throughout, and has trifoliate leaves, the obliquely rhomboid leaflets being from 2 to 4 inches long. Florida beggar weed is closely related to the beggar weeds or beggar lice of northern woodlands and prairies. Being a subtropical species, it is adapted to cultivation either as forage or for soil renovation in subtropical regions. It now ranks in the estimation of the planter with velvet bean, though perhaps its sphere of usefulness is not so extended as the latter.

FIG. 1.—Beggar weed (*Desmodium tortuosum*).

BEGGAR WEED AS A FERTILIZER.

In common with all other leguminous plants, the beggar weed has the power of taking nitrogen from the air by means of tubercle-forming bacteria in its roots. Beggar weed may be used as a nitrogen gatherer by the farmer, who is thus enabled to procure at small expense large quantities of this most valuable fertilizer or plant food.

It has been reported by farmers who have grown beggar weed in their orchards and corn fields that the texture and color of the soil have been changed within two years as a result of plowing under the annual crops of beggar weed. It grows best on light, sandy soils and makes its rankest growth when fertilized liberally with superphosphate and muriate or sulphate of potash. Sandy soils do not retain an excess of phosphoric acid and potash in the same manner as clayey soils unless there is a good deal of humus or decaying organic matter present, and it is of the highest importance, if the fertility of such light soils is to be increased, that large quantities of some form of green manure be given them. This can best be done by growing leguminous crops, such as beggar weed or velvet bean, which not only supply a rank bulk of vegetation, but contain larger amounts of nitrogen than the non-leguminous crops. Humus added to the soil makes it more retentive of moisture and improves its physical condition; and the humus acts as a reservoir of surplus inorganic plant foods, preventing or retarding their leaching into the drainage waters. A crop of beggar weed turned under, will, when decomposed, retain near the surface in ready reach of the roots of succeeding crops more of whatever fertilizers are subsequently applied. Besides adding a large amount of nitrogen to the soil, the beggar weed takes up large quantities of lime and potash, about one-half of the total amount of ash consisting of these two elements. Analyses show that one ton of beggar-weed ash contains 508 pounds of lime, 230 pounds of phosphoric acid, and 482 pounds of potash, valued, when purchased in the form of commercial fertilizers, at about twenty dollars. One ton of beggar-weed hay contains about 38 pounds of nitrogen. It requires from 20 to 25 tons of hay to yield one ton of ash. At a four-ton yield per acre, which is not an unusual one, the fertilizing value of the crop would be about as follows: 150 pounds of nitrogen, at 15 cents per pound, $22.50; phosphoric acid and potash worth $5.25, making a total of $27.75. A four-ton crop of beggar weed would therefore, if turned under as green manure, supply an equivalent of half a ton of the best commercial fertilizer for the use of the succeeding crop in the rotation.

HOW TO SOW THE SEED.

For a crop of seed, beggar weed should be sown at the rate of 5 or 6 pounds of clean seed per acre. If grown for hay, from 8 to 10 pounds should be used. It should not be sown until the ground is warm and moist, and the clean seed is preferable to the pods because of the more uniform germination and better stand which may be obtained. The seed is about the size, shape, and color of red clover and weighs about as much to the bushel. It is now on the market at a price low enough to place it within the reach of any farmer.

If sown at the beginning of the summer rains the seed need not be covered. It must not be buried too deeply else the young plants will not be able to reach the surface. By sowing at the beginning of summer two crops may be secured. If cut for hay at the time the first flowers appear the roots will send up a second crop, which may be saved for seed, and enough seed will scatter to insure a crop the next season. The seed may also be scattered in the corn rows at the time of the last cultivation or at the beginning of the rains in June. Then, after the corn has been stripped or cut for fodder, the beggar weed may be mown for hay or harvested for seed. The crop should be cut for hay when it is about 3 or 4 feet high, or at the beginning of the blooming period. If cut after full bloom many of the lower leaves will have fallen and much of the best part of the crop will be lost.

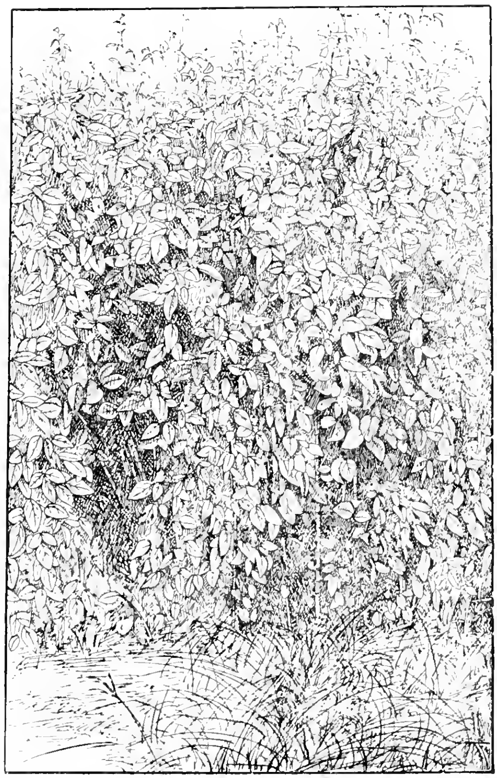

FIG. 2.—Florida beggar weed, grown at the Mississippi Agricultural Experiment Station—plants 7 to 8 feet high.

ITS VALUE AS A HAY CROP.

Beggar weed makes a very fine quality of hay, which is relished by all classes of farm stock.

According to analyses made at the Florida Experiment Station of the upper parts of plants not yet in seed, 100 pounds of hay contained 19.4 pounds of crude protein. When cut after the seed had ripened the crude protein had decreased to 15.75 pounds, the fat and non-nitrogenous extracts from 45.4 pounds to 42.7 pounds, and the crude fiber or indigestible portion had increased from 19.6 to 26.5 pounds. An average of two analyses of the entire plant, including the woody stems, the one made from plants in green seed, the other from those not yet seeding, indicated 11.85 pounds of crude protein in 100 pounds of hay. This may be taken as representing more nearly the crude protein value of average beggar-weed hay than the larger quantity shown to be present in the upper, more leafy, and more tender portion of the plant.

If in cutting this crop only the upper leafy parts were saved then the higher percentage of protein might be taken as representing the value.

COMPARED WITH OTHER FORAGE PLANTS.

Digestion experiments with beggar-weed forage have not been made, but judging from the comparison of the analyses with those of red clover, the nutritive ratio would be about the same. There are 12.3 pounds of crude protein in 100 pounds of red clover hay, 15.2 pounds in crimson clover, 15.4 in soy bean, 16.6 in cowpea, and 14.3 in alfalfa. In the beggar weed the percentage of crude protein is less than in red clover, because there is a much larger amount of crude fiber due to the larger and more woody stems. The percentage of loss in feeding beggar-weed hay is accordingly greater. On the other hand, the yield per acre is higher than that of red clover, ranging from 3 to 5 or even 6 tons per acre, especially when two crops are cut.

BEGGAR WEED AS A FEED.

Beggar weed hay may be fed to best advantage by adding to the ration some coarse forage which contains a smaller amount of crude protein and more carbohydrates. In this way all of the digestible portion of the crude protein in the beggar weed may be utilized. If more is fed than can be utilized, that is to say, if the nutritive ratio of the ration is too narrow, the surplus of crude protein will be wasted. The crude protein is the nitrogenous muscle-making element in the food, while the digestible carbohydrates, including a portion of the fiber, and the fat, starch, gums, and sugars are used up in producing heat and energy. Crude protein enters into the formation of lean meat and it is necessary for a forage to contain enough nitrogenous food to enable the animal to make new blood, tendon, and bone, and a substantial increase in weight. Nitrogen enters into the fibrin of blood, the albumen of muscle, the gelatine of bone and tendon, and the casein of milk, and to a certain extent into the surplus fat. For the production of new and the repair of worn out tissues the presence of crude protein in the forage is essential. The animal can not make satisfactory growth if fed a forage deficient in crude protein. Hence the great value of leguminous forage crops.

After the seed crop has been harvested, the beggar weed comes up again, the rowen supplying fine pasturage until killed by frosts. It never becomes a bad weed. The seeds do not sprout until the ground is warm, and it may be used as a rotation crop, following early spring vegetables or corn, the seeds remaining in the ground and making their appearance after these crops are out of the way. As a hay plant it is superior to velvet bean on account of the ease with which it may be cut with an ordinary mower. It is also a better crop to sow in orchards for green manure because it is not, like the velvet bean, a climber, and does not have to be kept out of the trees.

This plant is one of the hosts of the root knot (*Heterodora radicola*). Professor Rolfs states that the "cowpea is frequently attacked, the velvet bean occasionally, and the beggar weed rarely." The nodules formed by this worm resemble the tubercles formed by the nitrogen-gathering bacteria but may be distinguished by microscopical examination.

ADAPTABILITY TO LIGHT SOILS.

Grazing and the production of hay for home consumption or sale are each year becoming more important industries in the Southern States as a natural result of the diversification of crops. Great quantities of hay were formerly shipped South, it being rather a common opinion among Southern farmers and planters that good hay could not be grown. This opinion is, however, no longer held and there are many progressive farmers in the South who have abandoned the cultivation of low-priced cotton in favor of a more remunerative hay crop. There is no good reason why the South should not grow every pound of hay that is needed for feeding work stock, nor is there any reason why butter, cheese, and meats should not be produced. Many of the farms in the South are not suited to the growth of timothy and red clover, but there are plenty of good leguminous hay crops and pasture grasses which equal or surpass them in yield or feeding value. Some leguminous forage crop should be grown on every farm. With beggar weed, alfalfa, velvet bean, soy bean, and cowpea, there is a good list to choose from. Beggar weed is, perhaps, the best of these for the lighter, sterile sandy soils, including the hammock and pine lands of Florida and the sandy pine lands along the Gulf Coast.

JARED G. SMITH,
Assistant Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *May 6, 1899.*

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CIRCULAR No. 14—(Agros. 48.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

THE VELVET BEAN.

(*Mucuna utilis.*)

The velvet bean has within the past three or four years attracted a good deal of attention in the Southern States. It is probable that very few forage or other farm plants have spread so rapidly during so short a time. The uniformly favorable reports regarding its value in the South may be taken as an indication of the remarkable interest shown by farmers throughout the land in the more extended cultivation of leguminous crops. Every one now knows that the legumes, including such plants as the clovers, alfalfa, beggar weed, cowpeas, and velvet bean, are capable of enriching the land on which they are grown because they are fitted by the tubercles on their roots to absorb nitrogen from the air, while other crops, such as the cereals, grasses, sorghum, and sugar cane, must have nitrogen provided for them. Because of this ability to manufacture fertilizers, leguminous crops are of great importance in the renovation and building up of worn or sterile soils.

ORIGIN OF THE VELVET BEAN.

The velvet bean is apparently a native of India and has been in cultivation as an ornamental garden plant for a good many years. It is believed to have been first introduced into this country by the Department of Agriculture for this purpose about twenty-five or thirty years ago. In favorable localities it often forms vines 30 to 50 feet in length. It is an excellent plant for quickly covering unsightly objects or arbors. The purple flowers are borne in clusters at intervals of 2 or 3 feet at the joints of the stem. These are followed by clusters of short, cylindrical pods, covered with a black, velvety down which has given the name to the plant. Each pod contains 3 to 6 large, rounded, brown and white mottled seeds. The pods are constricted laterally between the seeds and are often more or less curved.

The value of the velvet bean as a forage plant was accidentally discovered about six or eight years ago. Being a native of the tropics it only matures seed in Florida and the lower half of the States immediately along the Gulf coast. It will probably not ripen seed north of a line drawn from Columbia, S. C., 150 or 200 miles back from the coast to San Antonio, Tex. Wherever it ripens seed it is considered to be equal or superior to cowpeas, but where seed must each year be purchased it does not equal that crop.

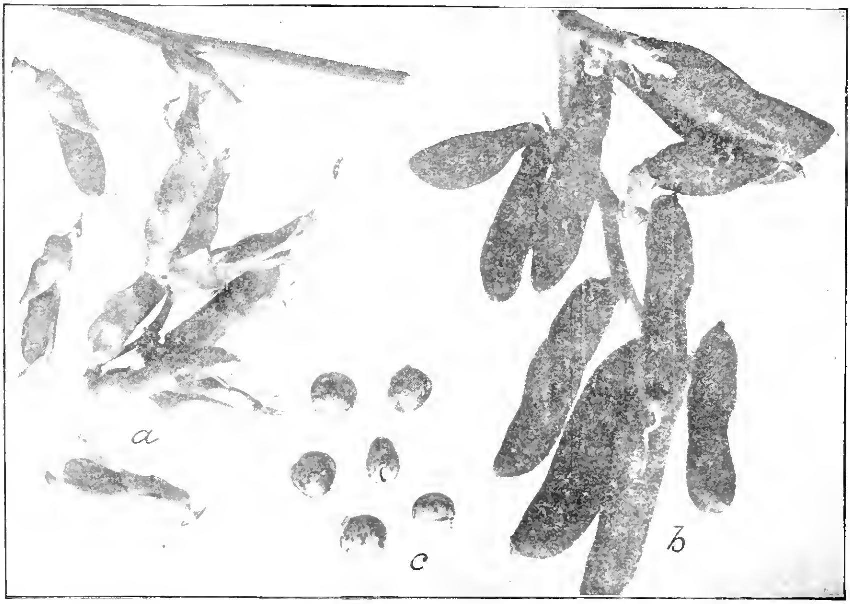

FIG. 1.—Velvet bean: *a* flowers, *b* pods, and *c* beans.

SEEDING.

In Florida the seed is sown in drills 4 feet apart, dropping from two to four seeds in hills 2 feet apart in the row. The seed may be dropped in furrows when the ground is plowed, and covered 2 or 3 inches deep. The crop should be cultivated several times. In orange groves and orchards the beans may be sown in drills 4 or 5 feet apart and not less than 5 feet away from the trees in order to keep the vines out of them. They make a better mulch crop in the orchard than the cowpea because when the vines are cut down by frost they form a tangled mass which retains the leaves and protects the soil from rain and sun. The leaves stay on the vines longer than on cowpeas. Farther north the seeds should be sown thicker in drills 2 or 3 feet apart, or broadcast at the rate of 1 or 2 bushels per acre. Its range of profitable cultivation does not extend beyond that of cotton and will not until its period of cultivation has been extended long enough to result in the origination of new varieties suited to a wider range of soils and climates.

FERTILIZERS.

Velvet bean makes its best growth on the lighter, sandy soils. While capable of increasing the amount of nitrogen it requires a liberal dressing of phosphoric acid and potash in the form of superphosphates and muriate or sulphate of potash. It pays to feed the crop well because on rich ground the gain of nitrogen through the increased crop of vines is more than proportionate to the added cost of the potash and phosphoric acid.

YIELD.

The yields of hay are about the same as for the best varieties of cowpeas on similar soils. The plant grows looser and bulkier and looks as though it would yield twice as much hay as the cowpea, but experi-

FIG. 2.—Velvet bean, showing leaves, flowers, and young pods. Grown in grass garden, Department of Agriculture, Washington, D. C.

ments conducted at the Alabama Experiment Station prove that the superiority in this regard is only apparent. The reported yields range from 2 to 4 tons of hay per acre, or more in Florida, where two or three cuttings are made during one season. Farther north the crop has not the same recuperative ability and can only be cut once. The yield of seed amounts to from 20 to 25 or 28 bushels per acre, about the same as for the most prolific varieties of cowpeas.

FEEDING VALUE.

The beans have a high feeding value, as shown by analyses made by the Florida Experiment Station. The air-dried shelled beans contain 6.29 per cent fat, 18.81 per cent crude protein, and 53.5 per cent non-nitrogenous extract. Cowpeas contain 51.4 per cent fat, 55.7 per cent non-nitrogenous extract, and 20.8 per cent crude protein; the peanut 39.6 per cent fat, 15.6 per cent non-nitrogenous extract, and 27.9 per cent crude protein: while soy beans contains 16.9 per cent fat, 28.8 per cent non-nitrogenous extract, and 34 per cent crude protein. Digestion experiments have not been made either with the hay or seeds. Judging from the chemical analyses, they are about equal in feeding value to cowpeas, but are of less value than either peanuts or soy beans. An analysis of velvet bean hay made at the North Dakota Experiment Station

FIG. 3.—Velvet bean in an orange grove near Earleton, Fla. Seed sown in drills 5 feet apart. Photographed August, 1898.

showed 5.3 per cent crude fat, 16 per cent crude protein, 20.7 per cent crude fiber, and 41.8 per cent nonnitrogenous extract. The plants were just commencing to flower at the time the analysis was made.

VALUE OF FERTILIZER.

Comparative analyses of the vines, fallen leaves, and roots of the velvet bean, Spanish peanut, and "unknown" cowpea were made at the North Louisiana Experiment Station to determine the amount of fertilizers contained in each crop. For the velvet bean 4,113 pounds of vines and leaves contained 93.4 pounds of nitrogen, worth $14; 3,382 pounds of fallen leaves contained 58.2 pounds, worth $8.73, and 173 pounds of roots without any stubble contained 2.7 pounds, worth 40 cents, making a total of 154.2 pounds of nitrogen in the velvet beans produced on 1 acre of ground, worth $23.13. An acre of peanuts contained 193 pounds of nitrogen, worth $28.95, while the 108.5 pounds of nitrogen in an acre of cowpeas was worth $16.26. Similar analyses have been made at the Alabama Experiment Station. Here a yield of 8,240 pounds of cured vines and fallen leaves and 1,258 pounds of roots, including about 3 inches of stubble, contained 201 pounds of nitrogen, worth, at 15 cents per pound, $30.15. There was 2.29 per cent nitrogen in the cured vines and 1 per cent in the air-dried roots.

Experiments were also made at the Alabama Station to determine the value of the velvet bean as a fertilizer, judging from the yield of succeeding crops of oats and sorghum. The increased yield of sorghum fodder was 3,272 pounds per acre over the yield on the plat which had not been cropped the previous year—something over 1½ tons, valued at $12. The yield of oats grown on land where velvet bean stubble had been plowed under was 38.7 bushels, and where velvet bean vines were used 28.6 bushels, while land on which a crop of crab grass and weeds had been plowed under only yielded 7.1 bushels, an average gain of 26.5 bushels of grain as a result of growing velvet beans on the land the previous year. The average gain was about the same when cowpeas were grown.

It is harder to plow under a crop of velvet beans than one of cowpeas, on account of the tangled mass of vines. It is necessary to use a rolling cutter, unless the farmer has a disk plow. At the Alabama Experiment Station it was found that as good results were obtained from plowing under the stubble as from plowing under a full crop of vines. As a general rule, it may be considered a wasteful practice to turn under the entire crop, because the feeding value of any leguminous crop is always greater than its fertilizing value. A greater profit can be secured in the form of marketable meat products without materially lessening the influence of the leguminous crop on the succeeding one in rotation.

USE OF THE BEANS FOR FOOD.

Velvet beans have been used to some extent as human food. The general opinion, as expressed by correspondents of the Southern agricultural papers, is that they are richer and less palatable than cowpeas.

The seeds are large, difficult to thrash, and the pod does not break up readily. Special machines have been constructed for the purpose of cleaning them. For feeding purposes it is a good idea to grind them up, pods and all, thus saving the expense of thrashing. The meal may be used as a concentrated feeding stuff in the same manner as cottonseed meal. It is said that cattle, sheep, hogs, and poultry are all very fond of them, but horses apparently do not relish them.

JARED G. SMITH,
Assistant Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.
WASHINGTON, D. C., *May 13, 1899.*

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CIRCULAR No. 15.—(Agros. 19). Issued July 11, 1899.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigation.]

RECENT ADDITIONS TO SYSTEMATIC AGROSTOLOGY.

In 1890 there was published under the title of "The True Grasses" a translation of Edward Hackel's contribution to the great work of Engler and Prantl, "Pflanzenfamilien," by F. Lamson-Scribner and Effie A. Southworth. Since the date of this publication a number of important works on grasses have appeared and several new genera have been described. Last year, 1898, Hackel published, in a supplement to the German work above cited, the important recent additions to literature and descriptions of the new genera which have appeared since the publication of his first work. A few of these additions appeared in "The True Grasses," but the recently-described genera and important changes in nomenclature, not published in that work, warrant their presentation at this time for the use of American students of grasses. Naturally the contents of this circular are based largely upon the "supplement" here referred to.

NEW LITERATURE.

A. et Cas. de Candolle, Monographiæ Phanerogamarum, Vol. VI. Andropogoneæ, auct. E. Hackel, Paris, 1889.—H. Baillon, Histoire des Plantes; Monographie des Graminées, Paris, 1893.—O. Kuntze, Revisio Generum Plantarum, pars II (1891).—Bruns, der Grasembryo (Flora 1892).—Celakovsky, Ueber den Aehrchenbau der brasilianischen Grasgattung *Streptochaeta*, in Sitzungsbericht der Boehmischer Gesellschaft der Wissenschaften, 1889.—Derselbe, Das Reductionsgesetz der Blatter das. 1894. Derselbe, Nejnovejsi badani a názory o embryn trav. (Die neuesten Forschungen und Ansichten über den Grasembryo (boehmischen), in Věstnika České Akademie Fr. Josefa V, 1896).—A. Schlickum, Morphologie und anatomish Vergleich der Kotyledonen und ersten Keimblatter der Keimpflanzen der Monokotylen, Bibl. bot. Heft. 35 (1896).

ADDITIONS AND CHANGES.

After *Zea* L. add as a synonym *Thalysia* L. 1735.

After *Tripsacum* L. add as a synonym *Dactylodes* Zanoni Nonti. 1742.

After *Coix* L. add as a synonym *Sphaerium* L. 1735.

After *Pollinia* Trin. add:

Ischnochloa Hook. f.—Spikelets very small in solitary clusters in the leaf-axils, on a continuous rachis, arranged in pairs, one sessile, the other long pedicellate, both hermaphrodite, lanceolate, long awned. First empty glume subcoriaceous, compressed dorsally, 5–6-nerved; the second similar, 3 nerved, both awnless. Third empty glume wanting; flowering glume awned from the cleft in the apex; awn slender, geniculate. Stamens 3.

Species one (*I. Falconeri* Hook. f.) in the northwestern Himalayas; a delicate grass, growing among moss, similar in habit to *Arthraxon microphyllus*, but without close relationship to that species. At first this would seem to belong to section 2 of *Pollinia*, in which, forms occur without the third empty glume; but in *Pollinia* the racemes are never solitary and the rachis is articulate.

The genus *Manisuris* Sw. has been renamed *Hackelochloa* by O. Kuntze because *Manisuris* is used for *Rottboellia* L. f. Hackel had already stated this fact in DC. Monogr. Phanerog. Vol. VI, p. 314, without drawing the same conclusion as O. Kuntze.

After *Rhytachne* Desv. add *Lepturopsis* Steud., as a synonym.

After *Andropogon* L. add *Sorghum* L. 1735, as a synonym.

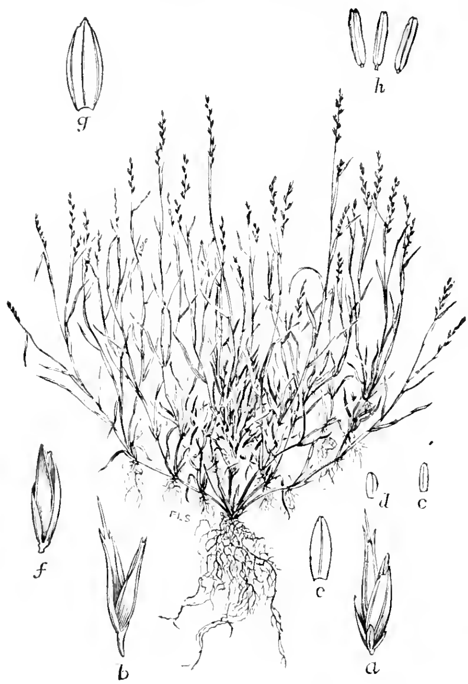

Fig. 1. *Fourniera mexicana*, male plant: *a*, spikelet; *b*, second floret; *c*, *d*, *e*, the three outer glumes (*e*, corresponds to *e* in fig. 2); *g*, the floral glume of the same; *h*, stamens. The details are all drawn upon the same scale.

Under the subgenus *Schizachyrium* add *Heterochloa* (Desv. as a genus) as a synonym.

The subgenus *Hypogynium* is divided into two sections in DC. Monogr. Phan. VI.: *Euhypogynium* and *Pseudanthistiria*; the latter has been raised to a genus under this name by Hook. f. in Flora Indica.

Under the subgenus *Arthrolophis* insert *Arthrostachys* Desv. as a synonym.

Under the subgenus *Amphilophis* insert *Bothriochloa* O. Kuntze, with one species (*B. anamitica*) from Anam. The difference may only lie in the different interpretation of the inflorescence.

Under the subgenus *Dichanthium* add *Diplasanthum* Desv. as a synonym.

After *Tragus* add:

Monelytrum Hack. Spikelets 4–5, in closely approximate fascicles, simulating a 4–5-flowered spike, the fascicles crowded into long, thick, awned, and woolly spikes somewhat resembling *Alopecurus*. First empty glume wanting, the second large, rough-nerved, but without bristles, terminating in a long, spreading awn. Flowering glumes almost of equal length, thin and bristle-pointed. Palea obtuse. Lodicules none. Only the lowest spikelet of each fascicle hermaphrodite, the second staminate, the bristle-form, uppermost one sterile.

Species one, *M. luderitzianum* Hack., in German Southwest Africa.

Nazia Adans. 1764, is a synonym of *Tragus* Hall, 1768.

After *Schaffnera* add:

Fourniera Scribn. (figs. 1, 2). Distinctly diœcious. Spikelets solitary and sessile along a continuous rachis, falling off at maturity, the two sexes unlike; staminate spikelets two-flowered, the lower flower sessile, the upper raised on a short pedicel, which is not prolonged beyond the flower; empty glumes three, in a whorl, the two anterior ones shorter and narrower; flowering glumes 3-nerved, those of the upper flowers 3-toothed, teeth awnlike. Stamens three. Pistillate spikelets one flowered, with a three awned prolongation of the rachilla beyond the flower; empty glumes 3, equal, cuneate, whorled, flowering glumes on short pedicels, 3 nerved, 3-toothed, the middle tooth longest; styles 2; stigmas plumose. A delicate, much branched, creeping grass with erect spikes.

Species one (*F. mexicana* Scribn.) in Mexico.

This grass is quite distinct from other members of the tribe. The significance of the three empty glumes standing in a whorl is not clear; in the pistillate plant they are attenuated below into a short, bearded pedicel and appear almost like an involucre of three rudimentary spikelets (compare *Themeda*).

Under *Paspalum*, Sect. I, *Eupaspalum*, insert *Paspalanthium* Desv. as a synonym.

Under *Panicum* insert, after *Trichachne*, *Gramerium* Desv.? as a synonym.

After *Oplismenus* Beauv. add *Hippagrostis* Rumph., 1749, as a synonym.

Under *Setaria* add:

"The generic name *Setaria* has been much discussed in recent times from the fact that it was originally used by Beauvois for a species of *Pennisetum* and moreover had been used before by Acharius for a genus of lichens. O. Kuntze combines *Setaria* with *Chamaeraphis* R. Br. and uses for *Setaria* the latter, older name; Scribner, on the contrary, rightly does not approve of this combination, and proposes for *Setaria* the new name "*Chaetochloa*" now adopted by American authors.

FIG. 2.—*Fourniera mexicana*, female plant: *a*, terminal portion of rachis with two spikelets; *b*, a spikelet; *c*, *d*, *e*, outer glumes (*e* may represent a glume-like continuation of the secondary axis supporting the spikelet, or it may represent a second spikelet of a cluster or two); *f*, flowing glume raised upon a short joint of the rachilla (stipe); *g*, palea. At the left of *a* is a 3-awned prolongation of the rachilla. The pistil is shown in the upper left-hand corner.

After *Chaetochloa* add:

Setariopsis Scribn. Rept. Field Columb. Mus. (bot. ser.) **1**: 288, 1896. Plate XI. Panicles narrow, interrupted, and spike-like, the short branches bristle-pointed; second glume broadly ovate or orbicular, auriculate or cordate at the base, 11–13-nerved; third glume narrow, 11-nerved, lyre-shaped, the margins below becoming somewhat coriaceous at maturity; the fourth or flowering glume much shorter than the second and third, apiculate or mucronate-pointed.

Species two, in Mexico and Central America.

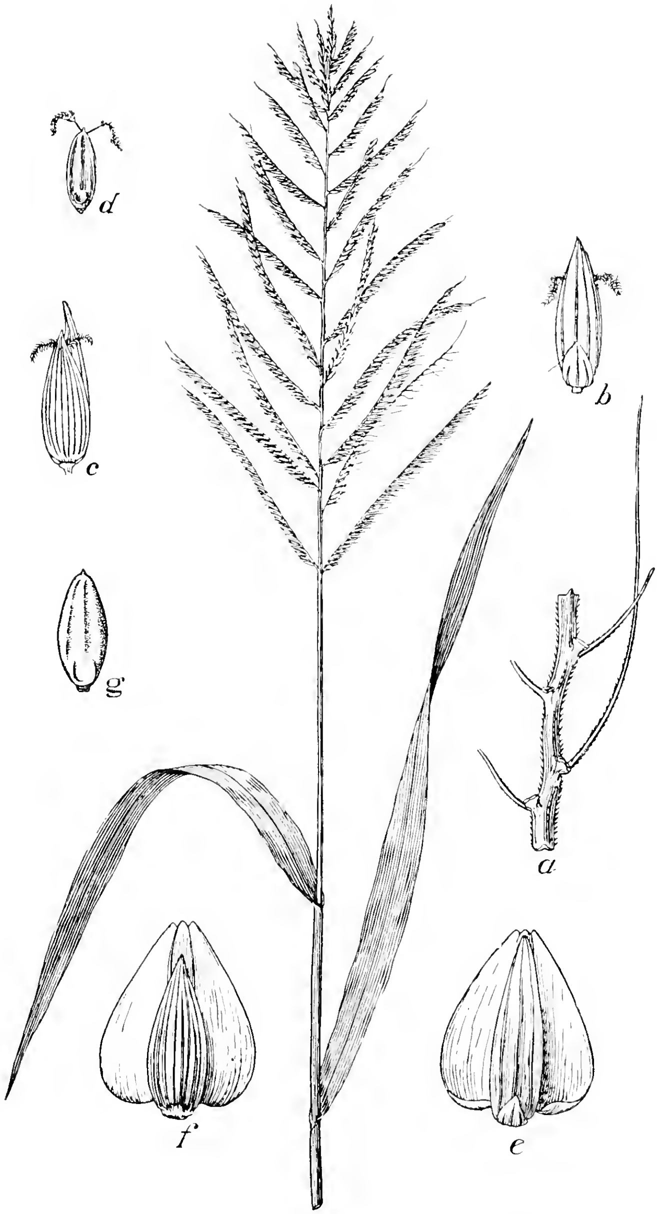

FIG. 3.—*Ixophorus unisetus*: *a*, a portion of the rachis of one of the racemes; *b*, a spikelet showing back of the first and third glumes; *c*, a spikelet showing the many-nerved second glume; *d*, fourth or flowering glume seen from the back with the projecting styles and stigmas; *e*, spikelet in fruit, showing the first and third glumes and the broad wing-like margins of the palea of the third glume; *f*, the same as *e*, seen from the other side; *g*, dorsal view of the fourth glume in fruit.

Reduced by Hackel to a section of *Setaria*.

After *Setariopsis* add:

Ixophorus Schlecht. (fig. 3), which Bentham and Hackel formerly placed with *Setaria*, is a well-defined genus. Characters: Spikelets 2 flowered, the upper flower hermaphrodite, the lower staminate, arranged in two rows along the branches of a simple panicle, their pedicels provided with a smooth, sticky, awn-like bristle (*chætocladium*). First empty glume very short; second somewhat shorter than the third; the latter 5-nerved, much longer than the flowering glume of the hermaphrodite flower, which is awn-pointed. The palea of the staminate flower (in the axis of the third glume) has at maturity two broad, parchment-like wings, determining the form of the spikelet. Very different from *Chætochloa* in inflorescence, approaching in this respect the section *Ptychophyllum* of *Panicum*. The viscid secretions on the bristles are worthy of notice.

Species two, in Mexico.

After *Ixophorus* add: **Dissochondrus** (Hillebr. as subgenus) O. Kuntze. Like *Chætochloa*, but both flowers hermaphrodite with coriaceous, persistent flowering glumes and palea; the leaf-blades attenuate below, the mouth or throat of the sheath with two long, narrowly-lanceolate lobes.

Species one (*D. biflorus* O. Kuntze) in the Sandwich Islands.

The synonym *Oxyanthe* Steud., under *Pennisetum*, probably belongs to *Arundo*.

Under *Oryza* add: *Rhynchoryza* Baill., founded on *Oryza subulata* Nees (from Brazil), differs from *Oryza* only in the flowering glumes being lengthened into a hollow beak, articulated by separation-membranes (instead of a deciduous awn) and in the united lodicules. It might better be regarded as a subgenus of *Oryza*.

After *Piptochætium* Presl, add as a synonym *Caryochloa* Spreng.

The genus *Brachyelytrum*, through recent discoveries, has undergone an extension and is now be divided into three subgenera, as follows:

Sect. 1. *Aphanelytrum* Hack. Empty glumes diminutive, scarcely 0.5 mm. long, often wanting. Flowering glumes subhyaline with short, subulate awn.

Species one (*B. procumbens* Hack.) Ecuador.

Sect. 2. *Eubrachyelytrum* Hack. Empty glumes short, firm in texture, the upper about one-eighth the length of the flowering, which is long awned.

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

Sect. 3. *Pseudobromus* K. Schum. as a genus. Empty glumes from one-half to two-thirds the length of the flowering glume, which is long-awned, firm, herbaceous.

Species two, in Africa: *B. Africanum* Hack., in Transvaal and *B. silvaticum* (K. Schum.) Hack., in Kilimandscharo.

After *Crypsis* Ait. add as a synonym *Pallasia* Scop.

Chaboissæa Fourn., Mex. Pl. Enum., Gram. 112. 1886. Spikelets in narrow panicles, 2-flowered, the lower flower hermaphrodite, the upper imperfect; empty glumes unequal; flowering glumes mucronate-pointed and ciliate on the margins; stamens 3; styles long; stigmas plumose.

Species one in Mexico. Allied to *Muhlenbergia*.

Before *Mibora* Adans. insert **Brousmichea** Bal. False spike cylindrical; empty glumes solitary and united below at the margins for one-third to two-thirds their length. Flowering glume awnless, 1-nerved; palea nerveless. Lodicules none. With the aspect of *Sesleria*.

Species one (*B. seslerioides* Bal.) in Tonkin.

After *Garnotia* insert the three following genera:

Woodrovia Stapf. (Hook. Icon, Pl. 5: *Pl. 2447*. 1896). Spikelets in slender racemes which are subdigitately panicled; empty glumes compressed, 1-nerved with a rounded, thickened keel, the first much exceeding the 2-lobed flowering glume which bears a slender, geniculate awn between the lobes; stamens 2. Annual.

Species one (*W. diandra* Stapf.) from India.

Garnotiella Stapf. Spikelets solitary along the short branches of an elongated panicle, articulate with the pedicels. Empty glumes delicate, nerveless, not keeled, the second mucronate-pointed. Flowering glumes very small, with a long, geniculate and twisted awn from the cleft of the apex. Palea very small. Lodicules wanting. Stamens 2. Habit like *Garnotia*.

Species one (*G. philippinensis* Stapf.) in the Philippine Islands.

Cyathopus Stapf. Spikelets solitary along the branches of an open panicle, articulate on short pedicels, which are thickened and cup-shaped above. Empty glumes 3-nerved, mucronate; flowering glume somewhat shorter, more delicate, 5-nerved (the nerves disappearing below the apex), awnless. Palea hyaline. Lodicules 2; stamens 3.

Species one (*C. sikkimensis* Stapf.) in Sikkim-Himalaya.

Before *Zenkera* Trin. insert:

Massia Bal. (*Megalachne* Thw. non Steud.). Panicle open; empty glumes lanceolate, subulate-pointed, many nerved; flowering glumes with a stout, terminal awn, finally becoming indurated together with the long, two-awned palea.

Species one (*M. triseta* Bal.) from Ceylon to Tonkin.

After *Spartina* Schreb. add *Chauvinia* Steud. as a synonym.

After *Chloris* Sw. insert *Biatherium* Desv. as a synonym.

After *Monochaete* Doell. insert *Doellochloa* O. K. as a synonym.

Before *Craspedorachis* Benth. insert:

Willkommia Hack. Spikes densely flowered; empty glumes flat, not keeled, one-nerved. Flowering glume with pointed, short-haired callus at the base, hyaline, short-awned. Palea somewhat shorter than the flowering glume, obtuse. Lodicules wanting.

Species three, in southwestern Africa.

Before *Tripogon* Roth. place:

Pentarraphis Kunth. (*Polyschistis* Presl.) Spikes or rather groups of spikelets fascicle-like, consisting of 1–2 spikelets, and 1–2 awn-like, often two-cleft, rudiments of a second or third, loosely arranged on the main axis of the inflorescence. Spikelets 2-flowered, the upper flower generally staminate, the lower hermaphrodite, the first empty glume of the spikelet very narrow (in the dried condition), awn-like; in case but one fertile spikelet is present in each group the first empty glume of the same forms, with the 4–5 awn-like rudimentary glumes, an apparently lateral fascicle of awns (resembling a deeply 5-cleft glume), when there are two fertile spikelets there is between them a fascicle of 3–4 awn-like glumes. The flowering glume is always 3-awned. Low, turf-forming grasses.

Species two, in Mexico. (See Scribner in Bull. Torr. Bot. Club, **17**: 121, plates 107 and 108.)

Lepidopironia Rich. is reduced to a synonym of *Tetrapogon*.

Opizia Presl, Hackel amplifies and recharacterizes as follows:

Staminate spikelets in 2–5 spikes, like those of section 1 of *Bouteloua*; pistillate spikelets in two rows, on short spikes, which are half hidden in the sheaths of the lower leaves, one-flowered; the first empty glume short, the second as large as the flowering glume, the latter 3-cleft, 3-awned; palea shortly 2-toothed or 2-lobed. Above the fertile flower 1–2 sterile glumes, either 3 or many-awned. Low, creeping grasses. (See Scribner in U. S. Dept. Agr. Div. Agros. Bull. 4: 9, f. 4.)

Sect. 1. *Euopizia*. First empty glume of the spikelet very small. Flowering glume of the pistillate flower as well as sterile glumes with 3 long awns. *O. stolonifera* Presl. (Fig. 4.) Mexico.

Sect. II. *Pringleochloa* Scribn.* (as a genus). First empty glume of the pistillate spikelet linear, little shorter than the second; flowering glume of the fertile flower shortly 3-cleft; the 2–3 sterile ones many awned above. *O. Pringlei* (Scribn.) Hack. (Fig. 5.) Mexico.

The characters of *Orcuttia* Vasey, should be modified as follows: Cæspitose, spreading annuals with large, many-flowered spikelets in terminal spikes; flowering glumes broad, many-nerved, and toothed or lobed at the broad apex.

Species two, in Southern California.

After Diplachne insert:

Pogochloa Moore. Spikelets laterally compressed, 5-flowered, two-ranked on long panicle branches (the rows approximate below), sessile. Empty glumes unequal, the lower 3–5-nerved, the upper with 9 strong nerves. Flowering glumes boat-shaped, keeled, 3-nerved, shortly two-toothed or almost entire, with a long, erect awn between the teeth.

Species one (*P. brasiliensis* Moore). In the state of Matto Grosso, Brazil.

Under Eragrostis there is to be added under

Sect. I. *Cataclastos. Cladoraphis* French, (as a genus), is a one-flowered depauperate form of *E. spinosa* Nees.

Ipnum Phil. is reduced to *Diplachne*.

After *Eragrostis* add:

Halopyrum Stapf. Spikelets many-flowered, in narrow panicles with a hairy axis breaking up at maturity. Empty glumes shorter than the flowering glumes, the lower 3- the upper 5-nerved. Flowering glumes firm in texture, keeled, 3-nerved, mucronate-pointed. Caryopsis broadly furrowed in front. In other respects like *Eragrostis*, with the section *Platystachya* of which it is closely related. Bentham placed the species belonging here in Eragrostis, Sect. *Sclerostachya*, a conglomeration of species not closely related, which ought to be completely broken up.

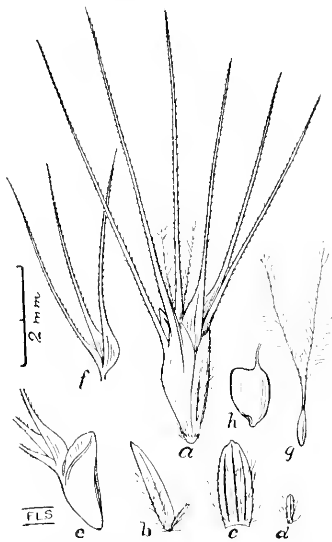

FIG. 4.—*Opizia stolonifera*: *a*, female spikelet; *b*, empty glumes; *c*, second empty glume; *d*, first empty glume; *e*, palea and adnate sterile rudimentary floret (*f*); *g*, pistil; *h*, caryopsis.

Species one (*H. mucronatum* Stapf., *Brizopyrum mucronatum* Nees, according to Stapf. = *Uniola mucronata* L. ?) distributed along the coast of the Indian Ocean from Ceylon to the mouth of the Zambezi; a grass with rigid, convolute leaves.

Anthochloa Nees (in Pl. Meyen, 164). (*Stapfia*, and *Neostapfia* Davy, and *Davyella* Hack.) Panicles densely flowered, ovoid or cylindrical and spikelike; spikelets 2–5-flowered; flowering glumes thin-membranaceous, broad, flabelliform, finely toothed and minutely ciliate-fringed, awnless; lower glumes narrow, sometimes wanting.

Species three, two South American; one, *A. colusana* (Davy) Scribn., from California.

After *Lasiochloa* Kunth, add as a synonym *Tribolium* Desv.

*(Bot. Gaz. 21: 137, plate 13.) Monœcious, staminate and pistillate spikelets unlike. Staminate spikelets one-flowered, in racemose, unilateral spikes on erect branches; pistillate spikelets on short, basal branches; flowering glumes 3-awned, with rudimentary, many-awned empty glumes above. Low, stoloniferous perennial.

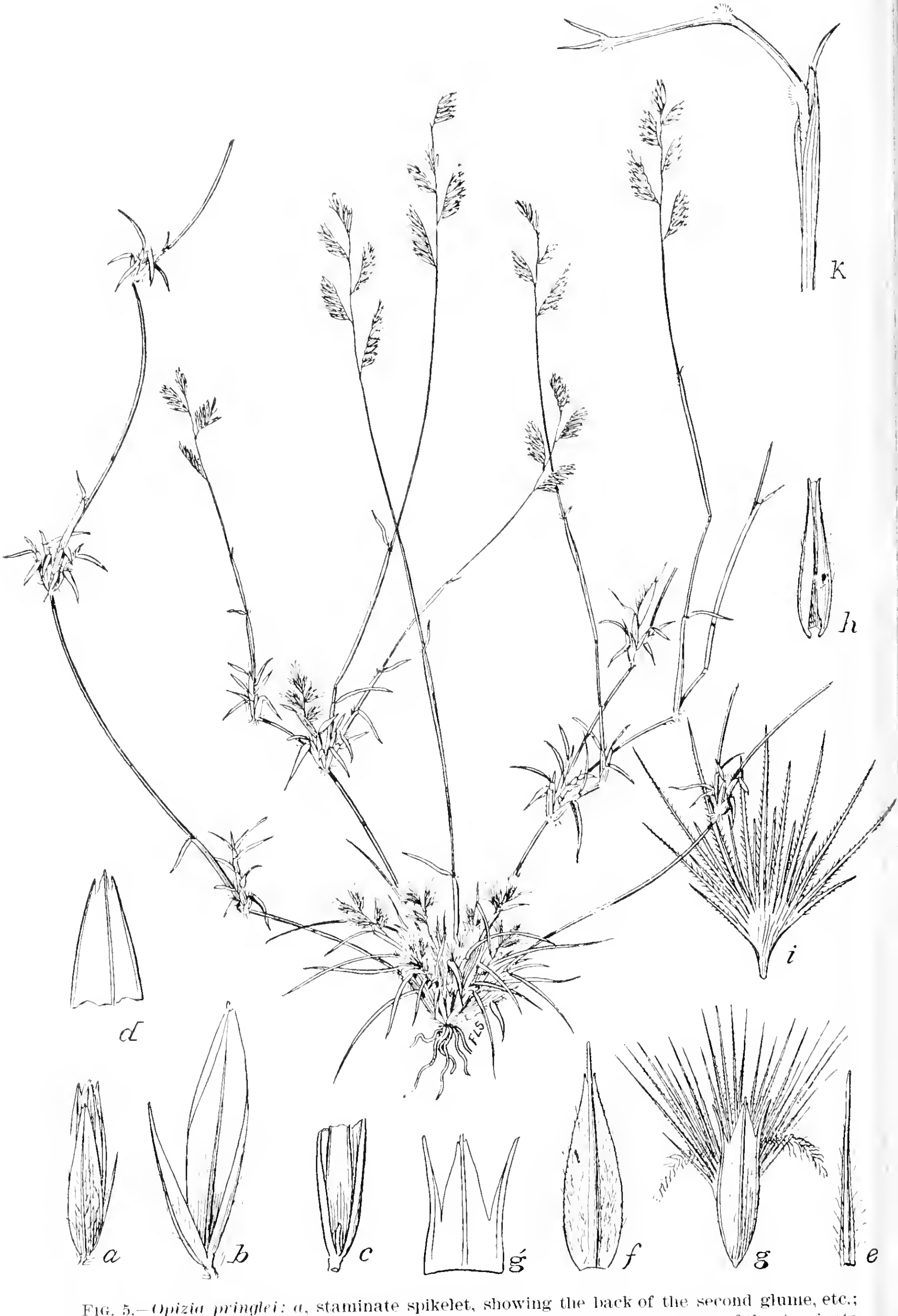

FIG. 5.—*Opizia pringlei*: *a*, staminate spikelet, showing the back of the second glume, etc.; *b*, empty glumes of the staminate spikelet, more highly magnified; *c*, lower part of the staminate floret, showing the short continuation of the rachilla behind the palea; *d*, apex of the flowering glume of the staminate spikelet; *e*, first glume of the pistillate spikelet; *f*, second glume of the same; *g*, pistillate spikelet, dorsal view, empty glumes removed; *h*, palea of the female floret; *i*, fourth glume of the pistillate spikelet, the glumes above these have successively fewer awns; *k*, rachis, to which were attached three female spikes.

After *Cynosurus* insert:

To section *Phalona* belongs *Plerium* Desv. (as a genus). For *Lamarckia* Moench., O. Kuntze has brought forward the older synonym *Achyrodes* Boehmer. 1760.

After *Festuca* insert:

Littledalia Hemsley, probably belongs to *Festuca* (as a section?); from the description and illustration there appears to be no other difference than the 7-nerved (in Festuca 5 nerved) flowering glume. Of these 7 nerves 3 extend almost to the obtuse, unawned apex. *Littledalia tibetica* Hemsley is a noteworthy grass 2.5 cm. high, with large spikelets.

After *Bromus* add:

Duthiea Hack. Spikelets 3–5 flowered, in simple, compact, almost capitate racemes, short pediceled, the pedicels of the lowest often with subtending bracts; empty glumes 5–7-nerved, nearly as long as the first flowering glumes or longer. Flowering glumes rounded on the back, many-nerved, two lobed, with a somewhat geniculated awn between the lobes, which is slightly twisted below. Lodicules wanting. Ovary long and densely hairly, with a style which is cleft above into very long, threadlike, projecting stigmas that are covered with short hairs.

Species two: *D. bromoides* Hack. in Cashmere and D. *oligostachya* (Munro) Stapf, in Afghanistan.

Euraphis Trin. (as a section) is a synonym of *Boissiera* Hochst.

Instead of *Kralikia* Coss. Dur., O. Kuntze has introduced the name *Arcangelina*. On account of the homonymous older genus of *Compositæ* of Shultz, Cosson and Durieu had already changed the name to *Kralikella* on the printed labels of the Dauphinese Society. Since, however, in Hofmann's work on the *Compositæ* the genus of Schultz is suppressed, the name may remain in use for the genus of *Gramineæ*.

Under *Jouvea* Fourn. may be included a grass from Lower California described by Vasey and by him made the type of a new genus, *Rhachidospermum*. (See Scribner, in U. S. Dept. Agr., Div. Agros. Bull. 4: 11.)

Under *Monerma* Beauv. add as a synonym *Ophiurinella* Desv.

Under *Haynaldia* add the following note:

Instead of *Haynaldia* Schur., Durand has introduced the name *Dasypyrum*, used by Cosson and Durieu as the name of a section, on account of the homonymous fungus genus of Schulzer-Mueggen. However, the latter originated the same year (1866) as that of Schur. and it is not evident which name was published first; moreover, *Haynaldia* Schulzer is ignored by modern mycologists, as for example, Saccardo and Schroeter.

Under *Arundinaria* add as a section, *Glaziophyton* (Franch. as a genus), which is connected with the section *Thamnocalamus* on account of the subtending leaves of the spikelets and panicle branches, but which bears the panicles on leafless, nodeless culms, breaking up by means of separation membranes, while the leafy culms (and not rarely also the leafless) remain sterile, similar to *A. falcata* and *A. khasiana*, species found in the Himalayas.

Species one (*A. mirabilis* (Franch.) Hack.) in Brazil.

After *Arundinaria* add:

Microcalamus Franch. Spikelets only 2-flowered, the upper flower hermaphrodite, the lower staminate or reduced to the two glumes, without a sterile flower above the hermaphrodite. Empty glumes 2, short; flowering glumes of the lower flower similar to the empty glume, that of the hermaphrodite flower longer, narrower, keeled, bow shaped. Palea naked on the keels. Styles 2, long and slender, free, their stigmas short, broad plumose. Herbaceous, not more than 0.5 m. high, with rootstock, slender culms, and lanceolate leaves, the short stalks of which are articulate with the sheath. Panicle few-flowered, terminal.

Species one (*M. barbinodis* Franch.). In the Congo region.

After *Phyllostachys* add:

Fargesia Franch. This genus differs from *Phyllostachys*, of which it will be much better classed as a section, principally on account of the sessile (in *Phyllostachys* pedicellate) fruit-nodes, and 3 styles separated to the base (in *Phyllostachys* being grown together for quite a distance).

Species one (*F. spathacea* Franch.), in China.

Under *Bambusa* Schreb. insert *Arundarbor* Rumph. as a synonym.

To Bambusa probably belongs a form first described by Gamble as a new genus *Microcalamus* (non Franch., whose name is older), then referred to Arundinaria (as *A. prainii*). Habit of *Arundinaria*, but with 6 anthers. Seems to be closely related to *Bambusa senanensis* Franch.

Sect. III. *Guaduella* Franch. (As a genus) according to Franchet's more recent and complete statements must be restored to generic rank.

Before *Atractocarpa* Franchet insert:

Thyrostachys Gamble. Spikelets two-flowered, arranged in twos or threes along the panicle-branches, subtended by large bracts. Empty glumes 2; flowering glumes broad, many-nerved. Palea of the lower flower 2-keeled, 2-cleft almost to the middle, with subulate divisions, those of the upper flowers rounded on the back, slightly or not at all cleft. Lodicules 2; stamens 6, free. Ovary on short pedicel, depressed turbinate. Style long, with 3 plumose stigmas.

Species two, in Burmah.

Oreobambos K. Schum. Spikelets two-flowered, arranged in many-flowered whorls, subtended by 2 broad bracts; empty glumes 1–2; flowering glumes broad, many-nerved. Palea generally two-keeled, rarely rounded on the back. Lodicules wanting. Stamens 6, free. Ovary on a short, naked gynophore, 3-cornered-ovate, smooth, produced or attenuated into a long, hairy, undivided style with simple (?) stigma.

Species one (*O. Buchwaldii* K. Schum.) in Usambara.

Before Subtribe *C. Dendrocalameæ* add: **Bonia** Balansa, a doubtful genus of the *Eubambuseæ*, is characterized as follows: Spikelets 3–4, sessile on the panicle-branches, 3–4-flowered; the empty glumes separated from the nearest flowering glumes by a naked internode 1 cm. long, which they surround like a sheath; lowest flower articulate with this internode. Flowering glumes 7-nerved. Palea 2-keeled. Lodicules 3. Stamens 3. Styles 3, grown together to the middle. Stigmas plumose, elongated. Caryopsis cylindrical.

Species one (*B. tonkinensis* Bal.) in Tonkin. The genus is very closely related to *Bambusa*; the significance of the two lowest bracts (called empty glumes by Balansa) is doubtful.

CIRCULAR No. 16. (Agros. 50.) Issued July 1, 1899.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigation.]

NEW SPECIES OF NORTH AMERICAN GRASSES.

In Circular No. 9 of this Division there was published 13 new species of North American grasses belonging chiefly to the genus *Poa*. Circular No. 10 was also technical in its character, being devoted to *Poa fendleriana* and its allies. In the present circular nine new or little known species of grasses are described.

1. **ANDROPOGON TENNESSEENSIS** Scribner. n. comb. (*A. provincialis* var. *tennesseensis* Scribn. Bul. Tenn. Agr. Expr. Sta. 7 : 23. 1894.)

Pedicellate spikelet usually hermaphrodite, 8–10 mm. long, the 1st glume lanceolate, acuminate, rounded on the back, 11–13-nerved, apex acute, subaristate or minutely bimucronate, scabrous all over the back and especially on the nerves and margins. Second glume 7–9-nerved, lanceolate, acute or subaristate, scabrous all over the back and ciliate along the hyaline, infolded margins above. Third glume about as long as the outer ones, lanceolate, acute, scabrous on the back above and fimbriate-ciliate along the margins. Fourth glume shorter than the third, apex bifid, ciliate on the margins above, awned. Awn slender, a little twisted, 2–4 mm. long. Palea $\frac{1}{4}$–$\frac{1}{3}$ as long as its glume. Stamens and pistil as in the sessile spikelet. Sessile spikelet about 8–10 mm. long, more than twice as long as the pedicels. First glume rigid and very rough-scabrous all over the back, ciliate-scabrous along the keels above. Second glume compressed and strongly keeled, long-acuminate pointed, scabrous on the sides and very rough on the keels, ciliate on the narrowly inflexed margins above. Third glume a little scabrous on the back above. Racemes as in *A. provincialis*. Hairs on pedicels and joints yellow. Pedicels and outer glumes very rough scabrous.

Open fields, Knoxville, Tenn. Rare.

2. **PUCCINELLIA SIMPLEX** Scribn., sp. nov. (Fig. 1.)

A slender, densely cæspitose, erect or spreading, glabrous annual, 0.5–2 dm. high, usually branching near the base, with soft, narrow leaves and simple, racemose panicles 2–8 cm. long. Sheaths loose or somewhat inflated, mostly longer than the internodes; ligule 2.5–3.5 mm. long, acute, hyaline; leaf-blade 2–3.5 cm. long, flaccid, 1–2 mm. wide, minutely scabrous toward the apex, otherwise glabrous. Spikelets solitary, or 2–3 on short, appressed branches, 2–3 flowered, about 5 mm. long, with unequal, acute, glabrous empty glumes, the second one 3-nerved, and acuminate flowing glumes which are 5-nerved, pubescent on the back and 3–3.5 mm. long.

Woodland, California, collected by J. W. Blankinship, May 6, 1893. This species is entirely distinct from any other with which I am acquainted. Its slender, somewhat wiry culms, rigid, strict panicles and pubescent, acute flowering glumes are its most striking characters.

3. **DISTICHLIS TEXANA** Scribn., n. comb. (*Poa texana* Vasey, Contrib. Nat'l. Herb. 1: 60, 1890; *Sieglingia wrightii* Vasey l. c., 269, 1893).

A rather stout, rigid, glabrous, creeping perennial, the upright branches 3–6 dm. high, with flat leaves and densely flowered, narrow panicles 10–20 cm. long. Staminate spikelets compressed, 5–7-flowered: pistillate spikelets, subterete.

FIG. 1.—*Puccinellia simplex* Scribn. *a*, A portion of the axis with the empty glumes; *b*, Spikelet, empty glumes removed: *c*, Floret, showing a portion of the rachilla; *d*, Palea; *e*, Grain.

fusiform, 12-25 mm. long. Western Texas, New Mexico (1038, C. Wright). [Mexico, No. 507, E. Palmer, 1898.]

The dioecious habit, the character of the inflorescence, the rigid subcoriaceous glumes, long-exserted styles protruding from the apex of the floret, and grain inclosed in the coriaceous base of the palea, clearly connect this grass with *Distichlis*.

4. **POA CURTIFOLIA** Scribn., sp. nov.

A slender, densely cæspitose, upright perennial 1–3 dm. high, with short, but strong, creeping root-stocks, flat leaves and narrow panicles 4–8 cm. long. Sheaths rather loose, glabrous; ligule 3–5 mm. long, lanceolate, hyaline, acute; leaf blades 1–4 cm. long, those of the culm usually 1–2 cm. long, 2–3 mm. wide, scabrous on both sides and along the margins, especially near the involute and somewhat hooded apex, uppermost leaf often very short or nearly wanting. Spikelets about 8 mm. long, 3–5-flowered, usually 3-flowered; empty glumes broadly lanceolate, acute, 3-nerved nearly equal, the first 5–6 mm. long; florets rather remote on a slender, naked rachilla; first flowering glume, about 6 mm. long, broadly lanceolate or oblong, acute, 5-nerved, glabrous. Palea a little shorter than its glume, ciliate-scabrous along the keels excepting near the base. Mount Stuart, Kittitas County, Washington, August, 1898, Nos. 1148 and 1150 A. D. E. Elmer.

This species is remarkable for its short, blunt leaves resembling those of the *Poa alpina*, from which, however, it is at once distinguished by the characters presented by its spikelets.

5. **DACTYLOCTENIUM AUSTRALIENSE** Scribn., sp. nov. (Fig. 2.)

A cæspitose, diffusely spreading, more or less branching annual, 1.5–2 dm. high, with short, loose sheaths, flat leaves, and short spikes at the apex of the culm or its branches. Culm and sheaths glabrous. Ligule short, ciliate-fringed; leaf-blade 5–10 cm. long, flat, acute, ciliate on the margins near the base, with a few scattering hairs on both surfaces springing from white papillæ. Spikes 3–6, 0.5–1 cm. long, densely crowded so that the inflorescence appears capitate. Axis of the spikelets projecting a little beyond them, strongly ciliate-scabrous on the keel and margins, which are white—the intermediate space on either side being green. Spikelets 2–3-flowered, about 4 mm. long. Second empty glume oblong, broadly obtuse, with a scabrous awn about 1 mm. long. First flowering glume about 3 mm. long, 3-nerved, strongly keeled scabrous toward the apex, which is shortly acuminate-pointed.

Cultivated from seed collected in Ooduodatta, South Australia, received from A. Molineaux.

Chiefly distinguished from *Dactyloctenium ægyptiacum* by its more cæspitose and more depressed habit of growth, and especially by its much shorter spikes, which are crowded into nearly globular heads at the apex of the culms. The whole plant is also more slender and the axes of the spikes are distinctly winged-margined.

6. **PANICUM OVINUM** Scribn. and Smith, sp. nov.

A slender, erect or ascending, cæspitose perennial, 3–4 dm. high. Nodes 4 or 5, glabrous, sheaths closely enveloping and shorter than the internodes, ciliate on the overlapping margins above, otherwise smooth. Ligule a line of white hairs about 1 mm. long. Culm leaves rather rigid, linear-acuminate, 7–9 cm. long, 2–4 mm. wide, ascending, glabrous beneath, scabrous on the margins toward the apex, closely striate, but without prominent lateral nerves or midrib except at the base below, basal leaves lanceolate, acute, 4–5 cm. long, 6–8 mm. wide. Panicles terminal, 5–8 cm. long, shortly exserted, few-flowered; branches flexuous, single or in pairs, ascending; pedicels widely varying in length. Spikelets about 2 mm. long, elliptical-obovate, obtuse; first empty glume less than one fourth the length of the spikelet, broadly ovate, obtuse, glabrous; second and third glumes obovate, obtuse, prominently 7-nerved and minutely pubescent between the nerves. Flowering glumes nearly 2 mm. long, elliptical, ovate, obtuse, with a conspicuous depression near the base.

Fig. 2.—*Dactyloctenium australiense* Scribn.—*a*, Empty glumes; *b*, Spikelet with empty glumes removed; *c*, Palea; *d*, Spikelet of *D. ægyptiacum*; *e*, Axis of spike; *f*, Axis of spike of *D. ægyptiacum*.

Type collected by F. W. Thurow, Waller County, Texas, May 25, 1898. Closely related to *Panicum angustifolium* Ell., from which it is distinguished by its much smaller and minutely pubescent spikelets and the smooth sheaths and leaves.

7. **PANICUM INFLATUM** Scribn. & Smith, sp. nov.

An erect or ascending, much-branched perennial, 2.5–4 dm. high, often rooting at the lower nodes, with glabrous culms, pubescent nodes, loose or inflated sheaths, lanceolate, spreading, obtuse leaves 5–7 cm. long, and ovate-pyramidal, exserted, rather densely flowered panicles 6–7 cm. long. Sheaths longer than the internodes, ciliate-pubescent along the margins and tuberculate-dotted between the striæ; leaf-blades 8–10 mm. wide, abruptly rounded at the base, very smooth on the back, scabrous on the margins and along the nerves above. Axis of the panicle slender and the flexuous branches sparingly glandular viscid. Spikelets 1.3 mm. long, broadly obovate, or nearly spherical. First empty glume ovate, obtuse, less than one-fourth the length of the spikelet; second and third empty glumes orbicular, obovate, obscurely 5–7-nerved, the second a little shorter than the broadly ovate, obtuse, flowering glume, which is equaled by the third; the culms, sheaths, and empty glumes are purple.

Type No. 4622, S. M. Tracy, collected at Biloxi, Miss., October, 1898. Closely related to *Panicum lindheimeri* Nash and resembling it in both the form of the panicle and the spikelets, but readily distinguished by its tuberculate, inflated sheaths, glandular panicle-branches, and obtuse leaves.

8. **PANICUM THUROWII** Scribn. & Smith, sp. nov.

A rather stout, erect or ascending, pubescent or villous, simple or sparingly branched perennial, 3–4 dm. high, with 5–6 densely white-bearded nodes, sparingly villous sheaths, lanceolate-linear leaves 7–10 cm. long, and ovate-pyramidal, shortly exserted panicles, 7–8 cm. long. Sheaths shorter than the villous internodes, striate and tuberculate above between the striæ; ligule a ring of stiff, white hairs 3–4 mm. long; leaf-blades flat, 7–10 mm. wide, softly pubescent on the lower surface, glabrous above, unusually ciliate on the scabrous margins toward the base. There is a very densely villous line on the back where the blade joins the sheath. Axis of the panicle sparingly pilose; the branches subflexuous, villous at the base. Spikelets narrowly elliptical, obtuse, 1.5–2 mm. long. First glume one-fifth the length of the 7-nerved, pubescent and obtuse second and third glumes which are slightly shorter than the lanceolate-elliptical, acute floral glume.

This species is named for Mr. F. W. Thurow, by whom it was collected in Waller County, Texas, June 5, 1898, No. 9. No. 11 collected May 10 is the same species.

Very closely related to *Panicum pubescens* Lam., differing in its more densely flowered, narrower panicles, smoother spikelets and simple culms. The leaves and spikelets are purplish.

Also collected by H. W. Ravenel, Houston, Texas, 1869.

9. **PANICUM OCTONODUM** Scribn. & Smith, sp. nov.

A slender, ascending, unbranched, glabrous perennial 4–6 dm. high, with 8 or 9 brownish, smooth nodes, rigid, linear, acuminate, ascending or spreading, flat leaves, 5–10 cm. long, and exserted, rather densely flowered, narrowly pyramidal panicles 5–12 cm. long. Sheaths shorter than the internodes, sparingly ciliate on the overlapping margin above; ligule a dense fringe of white hairs, about 1 mm. long; leaf-blades 4–7 mm. wide, obscurely 9-nerved below, scabrous on the margins, acute. Axis of the panicle smooth, branches subflexuous, solitary, often fasciculately branched just above the base. Spikelets 1.5 mm. long, elliptical ovate, obtuse, first empty glume minute, the faintly 5–7-nerved, obtuse second and third glumes slightly exceeded by the obtuse, perfect floret.

Waller County, Texas. Collected by F. W. Thurow, May 5, 1898.

Closely related to *Panicum nitidum* Lam., from which it may be separated by the greater number of nodes of the culm, the smooth leaves and sheaths, and the glabrous spikelets. No. 565 Lindheimer (1846) approaches this in habit and leaf characters, but has the ovate, obtuse panicles abruptly rounded at the base, the branches horizontal and more flexuous, and the minutely puberulent second and third empty glumes exceeded by the flowering glume.

F. Lamson-Scribner,
Agrostologist.

Approved:
James Wilson,
Secretary of Agriculture.

Washington, D. C., *June 16*, 1899.

Circular No. 17.—(Agros. 53).

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

CRIMSON CLOVER.

DESCRIPTION.

Crimson clover (*Trifolium incarnatum* L.), also known as scarlet clover, German clover, Italian clover, and carnation clover, is an annual plant native to southern Europe and has long been cultivated as a forage crop in the warmer portions of that country. It is an erect, tufted plant, 1 to 2 feet high, with soft-hairy stems and leaves, and usually bright scarlet flowers in elongated heads. The root system is well developed and penetrates deeply into the soil and the plant is a vigorous grower. The seed is larger than that of red clover, oval in shape, bright reddish-yellow when fresh (paler in the white-flowered variety) and has a highly polished surface. The plants stool freely, many stems arising from a single root.

Fig. 1.—Crimson Clover.

Several varieties are recognized in Europe, distinguished chiefly by the color of the flowers and the time required by the plants to reach maturity. Very little attention has been paid to these different varieties in this country. A white-flowered variety is sometimes seen on the market, but as a general rule only one sort is recognized by seedsmen and this is usually sold under the name of crimson clover.

CONDITIONS OF GROWTH.

Crimson clover will not stand severe freezing although it is one of the so-called "winter annuals" and under favorable conditions makes much of its growth during the cool, moist weather of fall, winter, and early spring. Its strong-growing roots enable it to secure nourishment in many soils so poor and thin that red clover would fail entirely. While requiring a warm climate, it will not endure severe drought. It thrives best on rich, rather sandy loams; but, when the conditions of moisture and temperature are favorable, it gives good results on light sandy soils as well as on clays if they are not too stiff and cold.

Crimson clover has come into prominence in this country within comparatively recent years. It can hardly be regarded as a successful crop outside of the region from New Jersey west to the Allegheny Mountains and south to eastern Tennessee and Texas. True, good yields are often obtained in other sections, but can not be depended upon year after year. In the middle and south Atlantic States this clover is one of the best crops that can be grown for forage and soil renovation. It has given good results in many portions of the Gulf States but many failures are also reported. In the colder sections of the country this clover is sometimes successfully grown as a summer crop but it usually winterkills badly when sown in the autumn. At the experiment stations in Rhode Island, New York, Ohio, Michigan, Illinois, South Dakota, Nebraska, and other States in the North and West, the general results of tests show that it is too tender for the climate and is less valuable than red clover. From results recently obtained at the Alabama Experiment station it seems very likely that in many cases, especially in the South, failures with this crop are to be attributed to the absence from the soil of the tubercle-forming organisms which are necessary for the proper appropriation of nitrogen by the plant. These organisms being supplied to the soil, excellent crops were obtained where without them the result was a failure.

CULTURE.

Preparation of soil.—There are many ways of preparing the soil for this crop, depending largely upon the purpose for which it is intended. Little if any fertilizer is needed, except what may be used in connection with the clover to prepare the land for the next crop in the rotation. On very poor, worn-out soils it is usually a good plan to give a moderate application of phosphate and potash. When crimson clover follows a cultivated crop like corn no preparation is necessary other than that of the cultivation of the corn or other crop. When the clover follows a crop of small grain it is usually necessary to plow the land and this should be done just before the time for sowing the seed. Cloddy land should be well pulverized before seeding. A fine seed bed is essential to uniform germination.

Seeding.—It is extremely important that a farmer should sow none but *fresh* seed. It is an easy matter to test the germinating power of the seed; it requires but a very short time and is well worth the while of every farmer intending to sow in any quantity*. Good fresh seed should germinate 90 to 95 per cent and under proper conditions the sprouting should take place within three days. American seed has given much better results than the imported, on account of its greater vitality. The amount of seed sown per acre varies from 10 to 20 pounds, depending largely upon the character of the soil and the use to which the crop is to be put. Rarely a smaller quantity may be used. The common practice is to use about 12 or 15 pounds.

The seed may be sown broadcast or with a drill. The former is the most common in practice, perhaps largely from the fact that the clover is so often sown on land already occupied by corn, potatoes, or some other crop. The seed is often sown by hand, sometimes from horseback, but better results will usually be secured by the use of some machine like the Cahoon broadcast seeder.

Throughout the middle Atlantic States and the South generally crimson clover may be sown any time from July 15 to September 15, and if the moisture conditions are favorable it may be sown still later in the Gulf States. As a rule the best results are obtained from seed sown in July and August. The seed may also be sown in the spring, but, except in the colder northern States or for some special purpose, the results are much less satisfactory. In the North, spring sowing is necessary if this crop is grown at all. It may sometimes be grown to advantage in this section as a temporary crop in place of red clover.

Some farmers do not cover the seed at all; but many failures have resulted from following this method, attributed by some to heavy rains immediately after the seed is sown but more likely due to the exposure of the tender, unprotected plants to the hot summer sun.

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* A full discussion of the selection and testing of crimson clover seed will be found in Circular No. 18, Div. Bot., U. S. Dept. Agric., August, 1899.

When its use is practicable, the roller is an excellent implement for covering the seed. It presses the seed into the soil and insures uniform germination. A light harrow or a brush drag may also be used.

Harvesting.—Crimson clover may be harvested in the same way as common red clover. It is sometimes difficult to cure properly, as it is ready to cut at a time when wet weather is likely to interfere. It may be cut for hay as soon as it comes into bloom and should never be cut for this purpose later than when it is in full bloom. The hairs upon the calyx of the flowers become hard and stiff as the plant matures and are likely to prove troublesome to animals eating the hay, forming "hair balls" in the stomachs of the animals, which sometimes cause death. When harvested for the seed, cutting should take place as soon as ripeness has been reached to avoid loss through shattering. It is also well to thrash the crop or put it under cover as soon as it is dry, as heavy rains may injure the seed by causing it to sprout in the head.

Under average conditions from 8 to 15 tons of green, or 1½ to 3 tons of cured forage may be obtained from an acre of crimson clover. Very poor soil or drought may result in a lighter yield, while as high as 20 tons are reported under favorable conditions. The yield of seed per acre usually ranges from 8 to 12 or 15 bushels.

USES.

For hay.—When cut in proper season and well cured, the hay is, if anything, superior to that of red clover, having much the same chemical composition and a somewhat higher percentage of digestibility. It is relished by all kinds of stock and is very highly prized for feeding to animals that are required to do heavy work. Its nutritive ratio varies from 1:3.5 to 1:4.

For soiling.—Crimson clover is an excellent crop for this purpose. It is ready for use some time before red clover and at a time when there are few other forage crops at hand. It is particularly valuable for this purpose on dairy farms. In experiments made at the New Jersey station, nearly one and one-half tons per acre of digestible food, valued at $25.00, were secured. A ton of crimson clover in proper condition for soiling contains about 325 pounds of dry matter, of which about 5½ pounds of crude fat, 50 of crude protein, and 150 of carbohydrates are digestible. Rape is sometimes sown with the clover when a soiling crop is desired and the resulting forage is excellent.

For pasturage.—This crop readily lends itself to use for pasturage, especially in the early spring. It may be used alone or in connection with winter rye or rape. At the New Jersey experiment station it was estimated that an acre of crimson clover six inches high contained "sufficient food to properly nourish twelve cows for one week."

For silage.—This is one of the best of the clovers for use in the silo. The yield of forage is large, is easily handled, and it makes a better quality of ensilage than most other legumes commonly grown for this purpose. The silage is especially valuable for feeding dairy stock.

For green manure.—This is one of the most important uses to which this crop can be put. Its season of growth is such that it can be used without in any way interfering with the production of the primary crop of grain or vegetables and it affords a large amount of fertilizing material. The herbage is heavy, the roots are abundantly produced and penetrate deeply into the soil, and together these form a large amount of vegetable mould, exerting a beneficial effect on the physical condition of the soil as well as adding much nitrogen and other valuable elements of plant food to the surface soil where it will be available to corn, wheat, and other crops. It is estimated that the average crop of crimson clover is worth from $15 to $30 per acre for the fertilizing value of the nitrogen alone. An important advantage which crimson clover has over cowpeas as a fertilizer lies in the fact that it decays more readily and is less likely to "burn" the soil when a heavy crop is turned under. Another advantage arises from the possibility of producing the crop of clover between the time of harvesting the regular crop of one season and the planting of the next. It may often be used along with cowpeas to good advantage, the cowpeas being used as a summer crop and followed by the clover for the winter.

As a soil cover.—In many sections of the country, especially where the soil "leaches out" or washes badly, it is imperative to have the land covered with vegetation during the time it is not occupied with the primary crop, particularly during periods of heavy rains. Crimson clover is peculiarly well adapted to use as a cover crop. It may be sown in corn, tobacco, potatoes, cowpeas, sorghum, and many other crops after the last cultivation and, when these are removed, will come on and occupy the land during the fall, winter, and early spring and may be pastured off or plowed under in time for the planting of the next crop. It is an excellent cover crop for use in orchards, where it is also one of the best of sources of nitrogen for the trees. Crimson clover in the orchard reduces the amount of cultivation necessary to keep the weeds in check, and if the crop is not needed for fertilizing the soil, it can be cut for hay, soiling, or silage. The roots and stubble left on the ground from a crop of clover cut when in full bloom at the New Jersey station contained nearly 40 pounds of nitrogen, over 10 of phosphoric acid and over 14 of potash per acre. When the crop is allowed to mature the potash in the roots and stubble is increased but the nitrogen and phosphoric acid is reduced. This crop can be used in connection with small fruits as well as with peaches, pears, and apples.

SUMMARY.

1. Crimson clover is an annual, not adapted to use in permanent meadows and pastures and too tender for successful general cultivation outside of the Middle and South Atlantic and Gulf States. It thrives best in warm, moist loams of at least moderate fertility and makes most of its growth in the fall and early spring.

2. The seed should be sown in late summer or early autumn (July 15 to September 15) at the rate of from 10 to 20 pounds per acre on a well prepared seed bed. It may be sown alone or with other crops, a frequent practice being to sow with corn, potatoes, and like crops at or after the last cultivation. The seed may also be sown in the spring, but the results are not as satisfactory as when sown as above stated.

3. Crimson clover has a high feeding and fertilizing value and is one of the best crops that can be grown in short rotations for forage and soil renovation, lending itself readily to use for hay, pasturage, soiling, silage, green manure, and as a soil cover to prevent leaching and washing.

4. The crop should be cut for hay at or before full bloom, and for seed as soon as ripe; in the latter case it should be thrashed or put under cover as soon as dry.

Thomas A. Williams,
Assistant Agrostologist.

Approved:
James Wilson,
Secretary of Agriculture.

Washington, D. C., *August 19, 1899.*

CIRCULAR NO. 18. (Agros. 54.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[GRASS AND FORAGE PLANT INVESTIGATIONS.]

F. Lamson-Scribner, Agrostologist.

SMOOTH BROME-GRASS.

(*Bromus inermis.*)

Smooth brome has been known in Europe for over one hundred and thirty years. The early agriculturists did not consider it of any value because of its creeping rootstocks, thus resembling the dreaded couch grass. In 1884, however, Stebler and Shroeter demonstrated by experiments conducted for thirty years at Magocs, Hungary, that it had the power to withstand long periods of drought when all other grasses succumbed.

These experiments resulted in introducing the grass into cultivation in Hungary where it still retains the name of Hungarian brome-grass. Its introduction to the United States must have taken place about the same time for we find the seed is offered for distribution in Bulletin 22 of the California Experiment Station, issued November 5, 1884, and the statement made that "our experience indicates that it will do well here either with or without irrigation." Since then the experiment stations of Colorado, Minnesota, Manitoba, North Dakota, South Dakota, and the different grass stations of the Agricultural Department, Washington, D. C., have conducted extensive experiments and all speak of it in the highest terms.

FIG. 1.—Smooth brome-grass showing rootstocks, seed-head, spikelet, and parts of flower.

GENERAL CHARACTERS.

Smooth brome-grass is a native of Europe and Asia, ranging from France eastward into Siberia, growing along roadsides, river banks, borders of fields and woods, and upon sterile hillsides and pastures. It is a vigorous, hardy perennial with strong, creeping rootstocks, smooth, upright, leafy stems, one to four feet high, and loose, open panicles, or "seed heads" four to eight inches long. In a few years it forms a very tough sod, soon crowding out other grasses, clovers, and weeds. Its remarkable drought-resisting qualities have proved it to be the most valuable grass for dry regions where other grasses could hardly exist.

As it is thoroughly permanent and grows with wonderful rapidity, producing heavy crops and luxuriant pasture, its value to the farmers of dry regions can not be over estimated. All kinds of stock eat it with relish and the chemical analyses made show that it is rich in flesh-forming ingredients, much more so than timothy. It is very hardy and not injured by severe spring and fall frosts when once established. As it starts to grow very early in the spring before any of the grasses upon the native prairies show any signs of life, and remains green and succulent far into November, it will supply the long-felt want of early spring and late fall pastures.

DISTRIBUTION OF SEED.

Since 1896 six hundred and three experimenters have received seed of smooth brome-grass from the Department of Agriculture, Washington, D. C. This distribution does not include the State experiment stations to some of which large quantities were sent. The packages sent out varied in amount from one quart to thirty-five pounds. The larger part of this seed was purchased from Russia by the Secretary of Agriculture and distributed directly by this Division, or through the Section of Seed and Plant Introduction. Almost every State in the Union is represented in this distribution as shown by the following table:

TABLE I.—*Number of experimenters and distribution of smooth brome grass seed.*

Fiscal Year.	Alabama.	Arizona.	Arkansas.	California.	Colorado.	Florida.	Georgia.	Idaho.	Illinois.	Indiana.	Indian Territory.	[illegible]wa.	[illegible]sas.	[illegible]cky.	[illegible]isiana	Mai[illegible]	[illegible]d.	[illegible]sachusetts.	Michigan.	Minnesota.	Mississippi.	Missouri.
1896–97	0	0	0	0	13	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	[illegible]	0	0	0
1897–98	2	7	4	10	27	0	4	2	6	5	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	0	[illegible]	4	1	4
1898–99	0	0	0	8	1	0	2	2	0	1	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	1	2	[illegible]	1	2
Totals	2	7	4	18	42	0	6	4	6	6	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	7	5	2	6

TABLE I.—*Number of experimenters and distribution of smooth brome-grass seed*—Continued.

FISCAL YEAR.	Montana.	Nebraska.	New Jersey.	New Mexico.	New York.	North Carolina.	North Dakota.	Ohio.	Oklahoma Ter.	Oregon.	Pennsylvania.	South Carolina.	South Dakota.	Tennessee.	Texas.	Utah.	Virginia.	Vermont.	Washington.	Wisconsin.	Wyoming.
1896-97	6	1	1	0	1	1	0	1	1	1	0	0	1	0	4	0	2	0	0	1	0
1897-98	37	28	0	11	8	3	34	9	6	28	5	0	22	9	27	6	4	0	33	11	12
1898-99	2	9	0	2	1	1	4	0	2	4	0	2	1	3	10	0	5	1	4	1	5
Totals	45	38	1	13	10	5	38	10	9	33	5	2	24	12	41	6	11	1	37	13	17

The States receiving the largest amounts of seed as shown by the table, were Kansas, Montana, Texas, Colorada, Nebraska, North Dakota, Washington, and Oregon, in the order named. The North and South Dakota experiment stations have also systematically distributed large quantities of their home-grown seed throughout their State. In the former State it has been so distributed that it is now in the hands of farmers in all but two counties in the State.

METHOD OF SEEDING.

Smooth brome-grass will grow on almost any soil, but its productiveness depends upon the degree of fertility. It seems to germinate well on rich, moist land, but is also able to produce a crop where the soil is poor and the conditions unfavorable for the growth of other grasses. The land should be fall plowed and put in good condition by disking and spring-tooth or peg-tooth harrowing as the land may require. The seed may be sown as early as wheat is seeded, or it may be sown as late as the first of August or September if the land is kept from drying out and from growing weeds, by an occasional surface cultivation. In some parts of California, Washington, and Oregon it has been found better to sow in the fall during the months of October and November.

Some farmers have reported that they had succeeded in sowing the seed with a drill but the large majority abandoned it after a trial and sowed broadcast. The seed is very light and chaffy, weighing only fourteen pounds to the bushel, which makes it difficult to feed satisfactorily through an ordinary seed-drill. The most common plan is [illegible] broadcast by hand at the rate of from eighteen to twenty pounds per acre and harrow it in thoroughly with a peg-tooth harrow.

If proper seed-drills could be secured, there is a saving of seed, a better chance for germination, and a less likelihood for the grass to be[illegible] "bind[illegible]ad," owing to its spreading rootstoocks, than when sown broadcast. The seed may be procured from any of the large [illegible] l firms at [illegible]te of about \$2.25 per bushel of 14 pounds. When [illegible]e is desir[illegible] ving a pasture or meadow and is limited in means, the following method is recommended by the South Dakota Experiment Station:

"Purchase enough seed to sow a small parcel of land, say an acre. Use good clean land and keep out all weeds. Save the seed sown on this piece of land and sow it the next spring. In a few years a field of the desired size can be obtained at a comparatively small expense. By mixing red clover, alsike, alfalfa, millet, or other short-lived or more tender forage plants with the smooth brome a larger piece of land can be sown, and as these die out the brome-grass will spread and finally fill the field."

VALUE FOR HAY.

The yield of hay from smooth brome-grass varies from one to four and a half tons per acre according to climatic conditions, method of seeding, and fertility of soil. The quality of the hay is excellent, fully equaling that of timothy in palatability and nutritive qualities. In order to obtain the best product, the hay should be cut at time of full bloom. One important feature which distinguishes smooth brome-grass from other hay grasses is that it does not deteriorate rapidly after the flowering period and even if cut when the seeds are ripe the hay will have lost but little of its nutritive qualities, owing to the fact that after the seed-bearing stem has grown up a large number of leafy shoots spring up from the base. After furnishing three or four crops of hay the sod thickens up too much for a good growth of stems. This thickening occurs sooner if the grass is allowed to ripen seed, than it does when it is cut for hay, or if it has been seeded heavily at first.

VALUE OF PASTURE.

Smooth brome-grass is essentially an early spring and late fall pasture grass. After the hay crop has been taken off a heavy growth of aftermath or second growth springs up. It seems to be especially adapted for permanent pastures. After it has produced several crops of hay it thickens up, forming a very compact sod and a heavy growth of leaves. If one desires to use it for pasture at once it will be better to seed it thickly at the rate of about twenty-five pounds per acre.

As shown by the numerous testimonials received from all parts of the United States it is relished by all kinds of stock. Cows are very fond of it and are said to prefer it to timothy and even clover.

Mr. Gluyas, of Hofflund, Williams County, N. Dak., has tested the palatability of this grass for horses. Some seed was accidentally scattered over the native prairie sod. As a result, about two square rods of smooth brome-grass appeared in bunches. Horses which had access to the pasture cropped the smooth brome-grass close and left the prairie grass around it although the latter was still green and in good condition.

FIG. 2.—Smooth brome-grass.

KILLING THE SOD.

On lands where frequent rotation is desired smooth brome-grass should not be sown. Its creeping rootstocks resemble to some extent those of the common couch, or quitch-grass, and for this reason it is not so easily killed by turning under as the more common grasses used in rotations. Up to the present time the seed has been so scarce and expensive that few farmers who have secured a good field of the smooth brome have felt inclined to destroy the sod, so that our knowledge on this subject is limited.

The results of investigations carried on along this line at the Minnesota Experiment Station and the Manitoba Experiment Station at Brandon, prove that the sod could be thoroughly and successfully killed. It was found by these stations that a crop of hay can be harvested and taken from the land, and if the sod was plowed over immediately afterwards and backset in September, that at the latter date the grass would be all dead. When the grass was allowed to ripen seed, however, it was found that the new shoots at the base had gained such a foothold that when the sod was plowed under at this stage it was not killed at the time of backsetting in the fall.

HARDINESS.

Smooth brome-grass will withstand extreme changes in the temperature without injury. Its ability to produce good pasture during long periods of drought far exceeds that of any other cultivated variety. In Canada where it had been exposed to a temperature of several degrees below zero and not covered by snow it was entirely uninjured. Out of seven or eight hundred varieties tried at the Kansas Experiment Station this proved to be the best. Without doubt it is the grass for the semiarid regions of the West. From the reports received it is evident that it is very little influenced by the changes of climate. It does well in California, Kansas, Montana, North and South Dakota, Tennessee, Utah, Wyoming, and all parts of Canada.

RESULTS OF TRIALS IN FORTY STATES.

Out of six hundred and three experimenters receiving seed of smooth brome-grass two hundred and sixty have complied with a request from the Department for reports as to its success or failure.

During the seasons of 1898 and 1899 report blanks have been sent out to all those receiving seed of smooth brome-grass for trial, containing the following questions:

Kind, conditions, and preparation of soil?

Date and method of planting?

Cultivation, if any?

Date of harvesting and stage of maturity reached when harvested?
Date of full bloom?
Date of ripening?
Yield per acre (if practicable)?
Quality of product?
Notes on growth, probable value, etc.

The following table will indicate the number of reports received from farmers in the different States during the years 1898 and 1899:

TABLE II.—*Number of reports received from experimenters in the different States.*

FISCAL YEAR.	Alabama.	Arizona.	Arkansas.	California.	Colorado.	Florida.	Georgia.	Idaho.	Illinois.	Indiana.	Indian Territory.	Iowa.	Kansas.	Kentucky.	Louisiana.	Maine.	Maryland.	Massachusetts.	Michigan.	Minnesota.	Mississippi.	Missouri.	Montana.
1898	0	0	0	6	6	0	1	0	1	1	1	4	18	0	0	0	1	0	2	2	0	0	20
1899	0	1	0	3	3	0	0	0	2	2	0	1	23	2	0	1	1	0	3	2	1	0	10
Totals	0	1	0	9	9	0	1	0	3	3	1	5	41	2	0	1	2	0	5	4	1	0	30

FISCAL YEAR.	Nebraska.	New Jersey.	New Mexico.	New York.	North Carolina.	North Dakota.	Ohio.	Oklahoma Ter.	Oregon.	Pennsylvania.	South Carolina.	South Dakota.	Tennessee.	Texas.	Utah.	Virginia.	Vermont.	Washington.	Wisconsin.	Wyoming.	Grand total.
1898	6	0	1	0	2	9	1	2	6	0	0	7	5	1	3	1	0	8	2	6	123
1899	12	0	6	1	1	13	0	2	5	1	0	15	2	8	1	1	0	6	3	4	137
Totals	18	0	7	1	3	22	1	4	11	1	0	22	7	9	4	2	0	14	5	10	260

By comparing Tables I and II it will be seen that in most cases the number of reports received correspond to the number of experimenters receiving seed, the most coming from Kansas with 41, Montana 30, North Dakota 22, South Dakota 22, and Nebraska 18. In California, Washington, and Oregon smooth brome will succeed with or without irrigation. In Colorado it retains its fresh green appearance until December, affording excellent pasture. During the severe droughts in Kansas, Montana, and Nebraska it dies down and appears dead but as soon as rain falls it becomes green again. It is now well established in the Dakotas and is grown extensively both for hay and pasture. In Indiana and Ohio it is said to make about the same growth as orchard grass but withstands dry weather much better.

Sufficient experiments have not been carried on in the South to enable us to state its value for that part of the country, but it is probable that it will be found of considerable value for winter grazing.

The following are a few of the reports which will show the great value that this grass has become to many of the States:

T. E. Pearce, Edgerton, Johnson County, Kans.: The land used was high prairie soil on the bluff of a creek, part of which is underlaid closely with rock. The soil was deeply plowed, disked, and harrowed down fine. The seed was sown broadcast on April 19, 1898, and then harrowed in lightly as the ground was in a very moist condition. I thought it had died out in the fall and so reported to you, because wild grasses had completely covered it up. In the spring of 1899, however, it woke up like a sleeping giant and covered the ground with dense foliage 1 foot high. It did not produce much seed but proved to be an excellent pasture grass. As the grass does not get tough like most grasses do, it is very tender to eat. The green growth starts very early in the spring and I think from what I have seen of it so far, that it will be a fine pasture and hay grass.

W. W. Heideman, Kalispell, Flathead County, Mont.: The land used was a rather light sandy soil plowed this spring. The seed was sown April 13, 1898, without a nurse crop, harrowed three times and then rolled. It bloomed August 5 and ripened September 15; while other grasses were drying up it retained a healthy green color all through the summer.

W. S. Delano, Custer County, Nebr.: The seed was sown broadcast May 14, 1898, and covered by light harrowing. One-third of it was sown with barley as a nurse crop. It made a very good stand but that sown with barley was almost a total failure. On account of the drought the growth was light. In the spring of 1899 it was pastured and then later a crop of hay was mowed July 10. After this cutting its tops dried and died down. In October, however, it started again from the crown and at this date, October 31, it is 3 inches high. It is an excellent grass, starting earlier in spring than alfalfa and thickens into a solid turf. As all stock like it, it promises to be an excellent grass for this section.

Messrs. Guill Bros., Chico, Butte County, Cal.: The seed was drilled in by hand on March 4 and covered two inches deep. The soil is a sandy loam and had been put into excellent condition by fall plowing and harrowing with a spring tooth harrow. The crop was cultivated three times. The vitality of this seed is remarkable. We had no rain to wet the ground for six months, from May to November, yet there was none of the grass that died from drought. The grass made a growth of about 8 inches during the season. During the autumn and early winter it had continued its development and is now in excellent condition. A plot of this grass was sown on October 21, broadcast and harrowed in, and is looking very well at the present time. It has withstood some of our severest winter weather without any ill effects.

W. R. Gluyas, Hofflund, Williams County, N. Dak.: The seed was sown broadcast at intervals from April 15 to November 10, 1898, on well prepared sandy loam and harrowed sufficiently to cover seed. On August 27, 1899, it was harvested for seed. When it had attained its full growth it was five feet 6 inches high and the yield per acre of hay would have estimated 4½ tons. It is an excellent hay and pasture grass, withstanding all the severe climatic conditions and is relished by all stock. When first sown it grows very slowly for a long time and does not make any crop that can be harvested the first year. It stands without any equal for both hay and pasture in the dry belt.

SUMMARY.

Smooth brome-grass is a vigorous hardy perennial with strong, creeping rootstocks, valuable alike for hay and pasturage.

The land should be fall plowed, disked and harrowed thoroughly, and the seed sown in the spring except in California, Oregon, and Washington, and probably in the Southern States, where it is preferable to sow in October or November. Sow broadcast at the rate of 18 to 20 pounds per acre and harrow in thoroughly.

The yield of hay varies from 1 to 4½ tons per acre according to climatic conditions, amount of seed sown, and fertility of the soil. In quality it is equal to timothy, both in regard to palatability and nutritive value.

It is essentially an early spring and late fall pasture grass, producing a very compact sod and a heavy growth of leaves. All kinds of stock eat it with relish.

It has remarkable drought-resisting qualities and is the most suitable grass yet introduced for the dry regions of the West and Northwest. When once established it will withstand a temperature of many degrees below zero without being injured.

Where frequent rotation is desired smooth brome-grass should not be sown as it is not so easily killed as the more common grasses used in rotations.

P. BEVERIDGE KENNEDY, Ph. D.,
Assistant in Division of Agrostology.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *December 1, 1899.*

CIRCULAR No. 19.—(Agros. 56.) Issued January 2, 1900.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

NEW OR LITTLE KNOWN MEXICAN GRASSES.

Nearly all the grasses enumerated in this circular were collected by Mr. C. G. Pringle in 1899. While the collection is a small one, it is remarkable for containing several species of *Panicum* of the *heterophyllæ*, or so-called dichotomous, group which have not before been represented in Mr. Pringle's *Plantæ Mexicanæ.*

ISCHÆMUM LATIFOLIUM Kunth. Rev. Gram. **1**: 168. 1835.

Under the spray of the Cascade in the Barranca of Texola near Jalapa, altitude 1,100 m. (3,500 feet), April 30. C. G. Pringle, No. 8106. 1899.

PASPALUM CANDIDUM Kunth. Mem. Mus. Par. **2**: 68. 1803. (See Kew Index.)

Barranca of Texola near Jalapa, state of Vera Cruz, altitude 1,100 m. (3,500 feet), April 30. C. G. Pringle, No. 7884. 1899.

PANICUM PILOSUM Sw. var. **MACRANTHUM** var. nov.

Secondary axes or branches of the panicle (longer lower ones) 3.5 cm. long, pilose, with papillate hairs about 2 mm. long. Spikelets 2.2 mm. long, the outer glumes strongly scabrous on the keel near the apex, as is the fruiting glume and palea.

Swamps near Jalapa, State of Vera Cruz, altitude 1,230 m., May 21. C. G. Pringle, No. 8195. 1899.

PANICUM LAXIFLORUM Lam. Encycl. 4: 748. 1797. (*P. jalapense* Kth. ?)

Low, densely cespitose perennial, 1.5–3 dm. high, with crowded, lanceolate, acute, pilose leaves and spreading, ovate panicles 4–5 cm. long. Culms much branched near the base, glabrous. Nodes bearded with spreading hairs. Sheaths pilose with soft, spreading or reflexed hairs. Ligule a dense fringe of hairs about 1 mm. long. Leaves lanceolate, acute, 3–6 cm. long, 6–10 mm. wide, pilose on both surfaces with soft hairs, ciliate on the margins with long, spreading, papillate hairs. Axis of the panicle glabrous or pubescent. Spikelets oblong, obtuse, 2 mm. long, first glume broadly obtuse, about one-third the length of the spikelet, 3-nerved, the second and third glumes prominently 7-nerved, pubescent with short spreading hairs between the nerves.

Gravelly banks near Jalapa, State of Vera Cruz, altitude 1,250 m. (4,000 feet), March 29. C. G. Pringle, No. 8083. 1899.

Nearly identical with the grass from the Southern States which has been referred to *P. laxiflorum* Lam.

PANICUM INFLATUM Scribn. & Smith. Circular 16, Div. Agros. 5, July, 1899.

Gravelly banks near Jalapa, State of Vera Cruz, altitude 1,250 m. (4,000 feet). Date not given. C. G. Pringle, No. 7883. 1899.

PANICUM VISCIDELLUM Scribn., sp. n.

A slender, ascending or erect, finally branching perennial, 6–10 dm. high, with numerous, bearded nodes, pubescent internodes, pubescent sheaths, lanceolate, acute, pubescent leaves, and ovate, exserted panicles 5–7 cm. long. Leaves 5–8 cm. long, 1–2 cm. broad, cordate-clasping at the base; ligule pilose. Panicle branches somewhat viscid, the lower ones 2.5–3 cm. long. Spikelets 1.8 mm. long, obovate, obtuse, or subacute, the 7-nerved second and third glumes glabrous or with a few scattering hairs.

Gravelly banks near Jalapa, State of Vera Cruz, altitude 1,250 m. (4,000 feet). C. G. Pringle, No. 8089. 1899. In thickets near Mirador, October. Liebmann, No. 323. 1841.

Related to *P. viscidum*, but stems much more slender, leaves shorter and less rigid, panicles smaller, as are also the spikelets, which are nearly smooth. Fournier in his enumeration of the grasses of Mexico refers this grass to *P. commelinæfolium* Rudge, and cites *P. multiflorum* Ell. and *P. microcarpon* "Michx." as synonyms. I have not Rudge's work, "Plantæ Guianæ," in which *P. commelinæfolium* is illustrated, and upon which illustration Fournier based his determination of Liebmann's plant, but our grass is certainly not *P. multiflorum* Ell. (*P. polyanthes* Schultes), nor does it agree with available descriptions of *P. commelinæfolium*. *P. microcarpon* Ell., Sk. Bot. S. C. & Ga., p. 127, not Muhl., is the grass now usually referred to *P. barbulatum* Mx.

PANICUM MULTIRAMEUM Scribn., sp. n.

A rather slender, tufted perennial, 20–30 cm. long, with the glabrous culms densely fasciculate-branched above, bearded nodes and glabrous or thinly pilose sheaths which are bearded at the throat; lower culm leaves 5–8 cm. long, those on the branches much shorter and narrower, sparingly ciliate near the base, pubescent beneath, minutely scabrous along the margins which are very narrowly cartilaginous. Panicles loosely flowered, 2–4 cm. long; spikelets about 2 mm. long, obtuse, and 7-nerved, the second and third glumes thinly pubescent, the fourth glume subacute; the broadly obtuse; first glume one-third to nearly one-half as long as the spikelet.

Gravelly hills near Jalapa, State of Vera Cruz, altitude 1,250 m. (4,000 feet). C. G. Pringle 7882, 1899. Orizaba, State of Vera Cruz, February 17. Jared G. Smith, No. 593. 1892.

Allied to *Panicum ciliosum* Nash but smaller, nodes more distinctly bearded and leaves less ciliate.

PANICUM ALBOMACULATUM Scribn., sp. n.

A rather slender, erect, sparingly branched perennial, 6–8 dm. high, with striate sheaths, short, ciliate ligules and spreading panicles 12–16 cm. long. Nodes glabrous, the overlapping margins of the sheaths very densely ciliate or sub-villous. Leaf-blade 7–12 cm. long, 5–10 mm. wide (when dry), very acute, rounded at the somewhat clasping base, scabrous on the nerves below, glabrous above, sharply serrulate scabrous on the narrowly cartilaginous margins which are ciliate near the base. Axis and branches of the panicle glabrous, the lower longer branches 8–10 cm. long. Spikelets ovate, obtuse, 2.5 mm. long; first glume obtuse, 1-nerved, sub-remote, clasping the pedicel, the second and third glumes 7-nerved, thinly pubescent with short hairs, about equaling the smooth and shining fourth glume; the third glume has a thin, short palea. The exposed portion of the culm and sheaths purplish, the latter (in the type) white-spotted with small, oblong spots or blotches.

Dry rocky hills, Patzcuaro, State of Michoacan, October 10. C. G. Pringle, No. 5203. 1892.

Allied to *Panicum scabriusculum* Ell. but readily distinguished by its larger spikelets, less densely flowered panicles, and distinctly cartilaginous, serrulate leaf margins. The plant throughout is more slender.

PANICUM POLYCAULON Nash. Torr. Bul. **24**; 200, April, 1897. Low places, borders of swamps, Minatitlan, State of Vera Cruz, June 30. Jared G. Smith, No. 555. 1892.

MUHLENBERGIA SETARIOIDES Fourn., Mex. Pl. Enum. Gram. 84. Under the spray of the Cascade in Barranca of Texola near Jalapa, State of Vera Cruz, altitude 1,100 m. (3,500 feet), April 30. C. G. Pringle, No. 8096. 1899.

MUHLENBERGIA ALAMOSANA Vasey. Coult., Bot. Gaz. **16**: 146, 1891. Mossy cliffs, Sierra de Tepixtlan near Cuernavaca, altitude 2,300 m. (7,500 feet), February 8 and March 14. C. G. Pringle, No. 6994. 1899.

SPOROBOLUS PILIFERUS (Trin.) Kunth. Enum. Plant. **1**: 211, 1833. Fields near Jalapa, State of Vera Cruz, altitude 1,250 m. (4,000 feet). C. G. Pringle, No. 7881. 1899.

AVENA MICRANTHA sp. nov. (Fig. 1.)

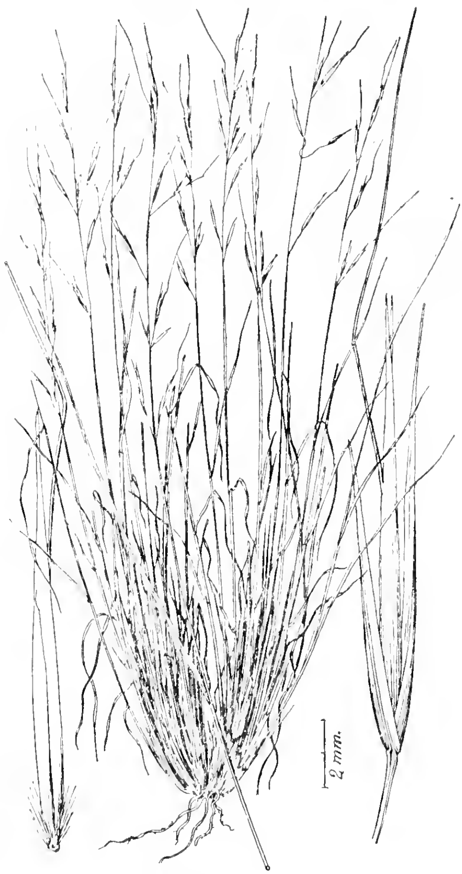


FIG. 1.—Avena micrantha. Scribn.

A very slender, densely cespitose, upright perennial, 2.5–3.5 dm. high, with soft leaves 6—15 cm. long, 1–2 mm. wide, ligules 5–6 mm. long, and loosely flowered simple panicles 5–7 cm. long. Sheaths glabrous; leaves pubescent above, smooth beneath, becoming involute when dry; branches of the panicle capillary, spreading or ascending, 1–3-flowered, the longer lower branches 1–3 cm. long; empty glumes unequal, lanceolate, the first about 8 mm. long, 1-nerved, the second about as long as the flowering glume, 3-nerved near the base, thin membranous and abruptedly pointed; flowering glume glabrous, 5-nerved, rounded on the back, 2-toothed at the apex, the teeth awn-like; callus rather densely bearded, hairs stiff, the longer ones 3–4 mm. long; awn arising below the apex of the flowering glume, slender, geniculate, twisted below the geniculation, about 17 mm. long; palea as long as the flowering glume, rather rigid, margins rounded, inflexed, apex subhyaline, the two nerves extending into subulate awn-like teeth.

Cool, mossy cliffs, Sierra de Tepixtlan near Cuernavaca, State of Morelos, altitude 2,300 m. (7,500 feet), February 5. C. F. Pringle, No. 8018. 1899.

AVENA STIPOIDES Scribn., sp. n.

A very slender, erect, somewhat wiry perennial 5-6 dm. high, with linear, erect leaves, and loosely few-flowered, simple panicles 5–10 cm. long. Sheaths shorter than the internodes, very minutely strigose-pubescent; ligule 5–8 mm. long, hyaline; leaves involute-setaceous, at least when dry, 1–2.5 mm. wide, 1–2 dm. long, scabrous. Spikelets about 12 mm. long exclusive of the awn; empty glumes unequal, thin, scarious, 1-nerved, acute, the first about 4 mm. long, the second 5.5 mm. long, flowering glume 11 mm. long, 5-nerved, slightly roughened on the nerves above, 2-toothed at the apex, teeth awnlike, awned on the back below the 2-toothed apex. Awn geniculate, twisted below, attached about two-thirds above the base, 12–14 mm. long. Palea equaling the glume, the two nerves extending into subulate, awnlike teeth. Callus hairs 1–2 mm. long.

Sierra de San Felipe, State of Oaxaca, altitude 3,130 m. (10,300 feet), September 19. C. G. Pringle, No. 4905. 1894. Distributed as *Muhlenbergia stipoides* Trin.

This grass is closely allied to *Avena micrantha*, No. 8018, but is at once distinguished by its shorter empty glumes.

The strictly one-flowered spikelets of this and the last species is a character which would lead one to place these grasses in the tribe *Agrostideæ*; but the densely hairy callus and rather rigid 5-nerved flowering glume which is deeply 2-toothed at the apex, and the dorsal, geniculate, and twisted awn formed by the union of three of the nerves suggest relationship with *Avena* as does the character of the empty glumes, and I have tentatively placed these species in that genus.

POA PRATENSIS L. Sp. Pl. 67. 1753.

Mountains near Jalapa, State of Vera Cruz, altitude 1,750 m. (5,700 feet), April–May. C. G. Pringle, No. 7880. 1899.

SITANION BREVIFOLIUM J. G. S. Bul. 18, Div. Agros. 17, June 24, 1899. Cerro Ventoso, above Pachuca, State of Hidalgo, altitude 2,600 m. (8,500 feet), August 18. C. G. Pringle, No. 6944, 1899.

F. Lamson-Scribner,
Agrostologist.

Approved:
James Wilson,
Secretary of Agriculture.

Washington, D. C., *December 19, 1899.*

CIRCULAR No. 20. (Agros. 57.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

F. Lamson-Scribner, Agrostologist.

EXPERIMENTS WITH FORAGE PLANTS IN ONTARIO.

The following brief report by Dr. P. Beveridge Kennedy, an assistant in the Division, on a portion of the proceedings of a meeting of the Ontario Agricultural and Experimental Union, held at Guelph, Ont., December 6–8, 1899, and which Dr. Kennedy attended officially, will be of value to many farmers in our northern States.—*F. L. S.*

The large majority of the experiments were carried on with the cereals, root crops, and horticultural plants, while grasses and forage plants were only investigated and experimented with to a small extent.

The following table indicates the gradual development of the Ontario Agricultural and Experimental Union since its foundation. While in 1886 only one experiment was undertaken by 12 experimenters there have been carried on in 1899 twenty-three different experiments by 3,485 experimenters:

The difficulty met with in the proper receipt of reports from the free distribution of seeds is met with by the Ontario Experimental Union to a larger degree than in our Division here.

Cooperative experiments in agriculture for the Province of Ontario.

Years.	No. of different experiments.	No. of experimenters.	Satisfactory reports.
1886	1	12	8
1888	1	90	40
1891	12	203	126
1892	12	754	295
1893	13	1,204	416
1894	14	1,440	504
1895	15	1,699	513
1896	16	2,260	501
1897	18	2,835	610
1898	19	3,028	667
1899	23	3,485	739

It will be seen that out of 3,485 experimenters only 739 sent in satisfactory reports during the season of 1899.

This in a large measure is due to many farmers feeling too keenly their lack of educational ability to write up a report or to fill out the blanks forwarded to them. Sometimes, however, it is due to neglect, or owing to the experiments having resulted in a failure they have not cared to inform anyone of it.

There are 2,505,422 acres of land in Ontario devoted to the growth of hay and clovers.

Within the last thirteen years 72 different varieties of hay and clovers have been experimented with by the Ontario Agricultural College, while 8 varieties have been tested throughout Ontario.

The following grasses have been tested during the season of 1899:

Grasses.

Variety.	Height. first season.	QUANTITY OF HAY PER ACRE. Second season.	Third season.
	Inches.	*Tons.*	*Tons.*
Tall Oat Grass	11.8	3.0	2.3
Timothy	6.3	2.7	2.1
Orchard Grass	10.8	2.0	1.6
Meadow Fescue	10.2	2.1	1.3

It is of interest to note that a much larger crop is obtained during the second season than the third. Tall Oat Grass producing 3 tons to the acre during the second season and only 2.3 tons during the third season. The same may be said of Timothy, Orchard Grass, and Meadow Fescue.

An interesting experiment on the diffierent clovers was carried on during the present year. The following table indicates the average height of the clovers for three years during the first season and the tons of green and dry hay per acre produced during the second season:

Clovers.

Variety.	Height, first season (Average for three years).	QUANTITY PER ACRE, SECOND SEASON. Green hay.	Dry hay.
	Inches.	*Tons.*	*Tons.*
Mammoth Red	9.2	7.3	3.6
Common Red	7.3	6.0	2.4
Alsike	6.8	5.6	2.4
Lucern	7.8	5.3	2.0

Mammoth clover it will be seen produces a much larger amount of fodder both in the green and dry state than the common Red, Alsike, or Lucern clovers in Ontario.

In regard to special crops for green fodder the following results have been obtained for Hairy Vetch, Common Vetch, and Grass Peas:

Vetches.

Variety.	Length of plant (inches).	Tons per acre (5 tests).
Hairy Vetch	41	9.0
Common Vetch	29	6.9
Grass Peas	25	5.1

It will be seen that Hairy Vetch in amount of forage and tons per acre far exceeds the common Vetch or the Grass Pea. The latter, however, is said to be weevil proof, which is a great advantage in the production of seed.

Three varieties of the early soy beans have been tested and may prove of considerable value in some parts of Ontario.

Soy beans.

Variety.	Estimated value.	YIELD PER ACRE. Straw (tons).	Grain (bushels).
Medium Green	72	2.6	22.4
American Coffee Berry	100	1.4	21.3
Extra Early Dwarf	86	1.1	12.7

While in the District of Columbia, and in the South generally, it is possible to grow three or even four crops of soy beans in a season; in Ontario only one crop can be grown from May to September. From the table it may be gathered that the Medium Green soy bean produces the largest yield of straw as well as the largest amount of grain.

Three varieties of Millets were tested with the following results:

Millets.

Variety.	Estimated value.	Tons per acre of green hay.	
	Two years.	*Five tests.*	*Thirty tests.*
Japanese Panicle	100	4.4	6.4
Japanese Barnyard	72	3.7	5.9
Hungarian Grass	62	4.0	4.8

Japanese panicle heads the list with 6.4 tons per acre of green hay.

CRIMSON CLOVER.

The immense value of the use of Crimson Clover as a cover crop was exemplified by Mr. Ghent of New York State.

By delay in tilling the soil in early spring a loss of about 200 tons of water per acre takes place in a single week, while it has been estimated that an acre of meadow grass eliminates from the soil 106 tons of water per acre in twenty-four hours in the month of June.

The soil may be greatly aided in the conservation of moisture by the aid of a cover crop. There are many leguminous crops which may be used for this purpose but Crimson Clover has been found especially valuable in the North. Till very early in the season and continue doing so until the crops are mature, then save the moisture by the use of a cover crop. Crimson Clover is an annual, grows rapidly, and being a legume the growing of it enriches instead of impoverishes the soil. The following table indicates the value of tillage with the use of Crimson Clover:

Tillage with and without crimson clover.

	With three crops of clover.	Without clover.
	Per cent.	*Per cent.*
Water	15.00	8.75
Nitrogen	.21	.12
Humus	2.94	1.91
Available phosphoric acid	.015	.008

The above shows the great difference in composition of a soil which has had three crops of clover grown upon it and one which has had the same amount of tillage but where no clover has been used. When such results can be obtained the necessity of artificial fertilizers may well be questioned.

P. BEVERIDGE KENNEDY, Ph. D.,
Assistant in Division of Agrostology.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *December 15, 1899.*

CIRCULAR No. 21.—(Agros. 58.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

COOPERATIVE RANGE GRASS AND FORAGE PLANT EXPERIMENTS AT HIGHMORE, S. DAK.

INTRODUCTORY.

In the early part of the present year the Secretary of Agriculture received a communication from Director Shepard of the South Dakota Experiment Station, asking the cooperation of the Department with that station in a series of experiments with drought-resisting grasses and forage crops with a view to finding varieties suitable for use in the range regions. Through Professor Shepard the South Dakota authorities made a proposition to furnish land for the experiments and properly equip the Station, asking the assistance of the Department of Agriculture in planning, instituting, and carrying on the experiments.

The proposition meeting the approval of the Secretary of Agriculture, Mr. Thomas A. Williams of the Division force was sent to South Dakota with instructions to complete the arrangements for cooperation and to assist the authorities of the South Dakota Station in planning and instituting experiments for testing such drought-resisting grass and forage crops as seem likely to be of value on the northwestern ranges.

The results of the work for the first season are most satisfactory both as to the plan of cooperation and the tests undertaken. The authorities of the South Dakota Experiment Station and also of the State Agricultural College are doing all in their power to make the work a success. The same can be said of the people of that section who are interested in the question of forage supply. The cordiality with which all parties have entered into this work, the representative character of the site selected for the Station as to both soil and climatic conditions, and the practical nature of the experiments, give every promise that the results accomplished will be of great value to the people of the northwestern range region.

Mr. Louis W. Carter, a graduate of the South Dakota Agricultural College, was appointed special agent on the rolls of the Division and placed in charge of these cooperative experiments and the results of the work of the present season are appended.

The grounds of the Highmore Cooperative Grass and Forage Plant Experiment Station consist of one hundred and seventeen acres, being that part of section eleven, town one hundred and twelve north, range seventy-two east, lying north of the Chicago and Northwestern Railroad. This land was deeded to the South Dakota Experiment Station by the people of the county in which Highmore is situated for the purpose of testing dry-land grasses and forage plants and experiments in range renovation. The soil of the land selected and the climatic conditions are fairly representative of the great range region of western Nebraska, South Dakota, North Dakota, Wyoming, and Montana. It is on the high rolling prairie which separates the valleys of the Missouri and James rivers and about equidistant from each. The soil is a rich, sandy loam containing little or no alkali and, with sufficient moisture, would produce good yields of the ordinary farm crops. The subsoil is the yellow bowlder clay characteristic of the drift soils in the Northwest. The Station is equipped with a seed house 14 by 22 feet, 1½ stories high, with a lean-to 14 by 22 feet for a tool shed, a cistern and the necessary tools for planting and cultivating the crops.

Between 40 and 50 acres lying close to the railroad were broken up in 1884 and 1885 and cultivated for a number of years. This land was then left idle and grew up to weeds and native grasses or "went back," as the common saying is. It had not been plowed for six or seven years. Beginning on the south side, series of plats were laid off, each series being eight rods wide. These were again divided into quarter-acre plats, each plat being 5 by 8 rods, and numbered consecutively, beginning at the east. There are 30 plats in each series. The series are lettered A, B, C, etc. Series A and B and about one-half of series C were plowed 6 inches in depth with a common stirring plow. About thirty permanent plats were sown. Most of these made a good growth but those sown broadcast are mixed with the native grasses, western wheat grass (*Agropyron spicatum*) being most prevalent. Quite a number of annuals were planted and the rest of the ground plowed was sown to millet or planted to corn to keep the weeds down.

Rain and snowfall at Highmore, S. Dak., for the years 1897, 1898, 1899, as observed by Mr. J. C. Stoner.

1897.

Month.	Rain or snow.	Inches.
February	Snow	8.
March	do	11.
	Rain	1.6
April	Snow	13.
	Rain	2.32
May	Rain	.51
June	do	2.79
July	do	3.75
August	do	1.45
September	do	.41
October	Snow	2.
	Rain	1.05
November	Snow	4.
	Rain	.08
December	Snow	3.5
Total	Snow	41.5
	Rain	13.88

1898.

Month.	Rain or snow.	Inches.
February	Snow	2.
March	Rain	1.40
April	do	1.51
May	do	4.17
June	do	1.67
July	do	2.33
August	do	.62

Rest of year missing.

Total, Feb. to Sept. 1:

Snow, 2. inches.
Rain, 11.70 inches.

1899.

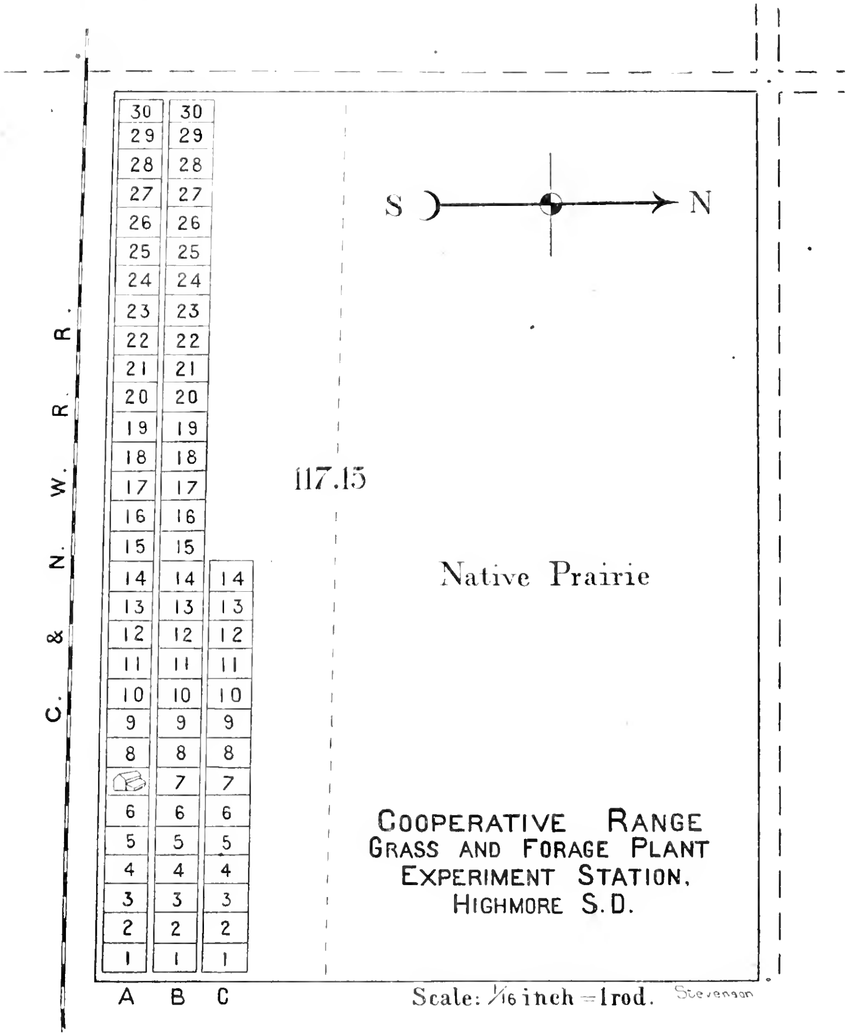
Month.	Rain or snow.	Inches.
January	Snow	2.6
	Rain	.11
February	Snow	.50
March	Snow	14.50
April	do	6.
	Rain	1.4
May	Snow	.5
	Rain	3.75
June	do	4.2
July	do	1.81
August	do	2.19
September	do	.48
October	do	.84

Total to October 22:

Snow, 23.6 inches.
Rain, 14.67 inches.

NOTES ON THE PLATS.

PLAT A (1).—Thirty-four rows on the east side of this plat were sown to smooth bunch grass (*Poa lævigata*). Seed collected by Shear and Bessey in Colorado in 1898. Part of the seed was sown broadcast and part of it was drilled. Very little of the seed germinated on the ground sown broadcast, and this was pulverized June 30 to destroy weeds. The seed drilled did not make a very good stand, but made a healthy growth. Seed sown May 10; sprouted and up May 23; October 23, the plants were two to three inches high and still green.



Scale: 1/16 inch = 1 rod.

Ten rows on the west side of this plat were drilled to bunch redtop (*Poa buckleyana*). Seed sown May 10; sprouted and up May 26. All the young plants were destroyed by drought, and the ground was cleaned of weeds June 30.

PLAT A (2).—The east half of this plat was planted to bunch grass (*Poa* sp. ?), the seed of which was collected in Wyoming by Mr. Griffiths in July, 1898. Sown broadcast May 10; sprouted and up May 31. The stand is very thin.

The west half of this plat was sown in a like manner to a robust form of Canadian blue grass (*Poa compressa*), collected by Mr. Griffiths at Norfolk, Nebraska, in 1898. Sown May 10; up May 31. Stand thin.

PLAT A (3).—Nevada blue grass (*Poa nevadensis*). One-half of this plat was drilled and the other half sown broadcast. Seed collected by Williams and Griffiths in Wyoming in 1898. Sown May 10; sprouted and up May 31. The stand on part of the drilled portion was so thin it was sown to millet to keep weeds down. The part left made a good, healthy growth. The stand on the part of plat sown broadcast was also very thin. Mown July 29 to kill weeds. October 23, the plants were two to three inches high and still green.

PLAT A (4).—Oregon brome (*Bromus unioloides*). This plat was sown broadcast May 10. Seed from Oregon. Sprouted and up May 22. This seed germinated well, but the plat was very weedy. August 5, it was twelve to eighteen inches high; August 21, seed was ripe and one-half bushel gathered by hand; October 23, six to eight inches high and still green.

PLAT A (5).—The last row on the west side of the plat was sown to Buffalo bunch grass (*Festuca scabrella*). Seed collected by Shear and Bessey in Colorado in 1898. Seed sprouted, but the young plants died as a result of the drought.

The second row from the west was sown to Langsdorff's reed-bent grass (*Calamagrostis langsdorffii*). Seed failed to germinate.

Six rows near the west side of this plat were drilled to Safflower (*Carthamus tinctorius*). Seed drilled May 10; sprouted and up May 21. Seed came from Professor Hansen, of the South Dakota Agricultural College. Grew to be two or three feet high. Seed ripened in September. This plant is grown in Russia for the oil extracted from the seed.

Rows 9 and 10 from the west were sown to "Pajsa" No. 493. Seed failed to germinate.

The east four-fifths of this plat were sown broadcast to short-awned brome grass (*Bromus breviaristatus*). Seed collected by Mr. Griffiths in Wyoming in 1898. Sown May 10; sprouted and up May 24. The plat was mowed July 29 to kill weeds. This grass made a good stand, and on October 23 it was two to three inches high and still green.

PLAT A (6).—This plat was drilled to King's fescue (*Festuca kingii*). Seed collected by Williams and Griffiths in Wyoming in 1898. Sown May 12; sprouted and up May 24. This grass made a good stand. The dry weather did not seem to affect it. October 23, the plants were three to four inches high and still bright green.

PLAT A (7).—This plat was selected as a site for the seed house and only part of it sown to three kinds of imported millets. Two of these failed to germinate. The millet that grew was a black broom-corn millet (South Dakota Experiment Station No. H–9). This millet made a good growth, 24 to 30 inches in height, and was not badly affected by the dry weather; ripened, and was cut August 12. It yielded a quantity of seed but no reliable estimate of the yield per acre could be made on such a small piece of ground. This is evidently the same as the millet grown on plat C–12.

PLAT A (8).—The first four rows on the east side of this plat were sown to the woodland rye-grass (*Elymus glaucus*). Seed collected by Williams and Griffiths in 1898. Drilled May 11; sprouted and up May 28. August 5 it was eight to ten inches high and of a bright green color. October 24 still bright green. The fifth and sixth rows in this plat were drilled to bearded wheat grass (*Agropyron caninum*). Seed collected by Shear and Bessey in Colorado in 1898. Seed drilled May 11, but failed to germinate.

The seventh, eighth, and ninth rows were drilled to bearded wheat grass. Seed from U. S. Grass Garden in 1896. Failed to germinate. The next nine and one-half yards east of drilled portion were sown broadcast May 13 to feather bunch grass (*Stipa viridula*). Seed collected by Griffiths in South Dakota 1898. Sprouted and up May 30. Stand thin, mown July 29 to kill weeds.

The east half of this plat was sown broadcast to bearded wheat grass (*Agropyron caninum*). Seed collected by Williams and Griffiths in 1898 in Wyoming. Seed sown May 11; sprouted and up May 25. Fair stand. Mown July 29 to kill weeds. October 23, curing on the ground but still green at the bottom.

Plat A (9).—This plat was drilled May 11 to giant rye-grass (*Elymus condensatus*). Seed collected by Williams and Griffiths in Wyoming in 1898. Sprouted and up May 24. July 26, ten inches high. August 5, twelve inches high and very badly rusted. October 24, leaves all dead, killed by frosts.

Plat A (10).—This plat was sown broadcast to six lots of slender wheat grass (*Agropyron tenerum*). Five of these were collected by Williams and Griffiths in Wyoming and Montana and one lot by Shear and Bessey in Colorado. They all made a fine stand. No difference could be detected this year. Seed sown May 13; sprouted and up May 22. Mown July 29 to kill weeds. October 24, not very high but still green.

Plat A (11).—This plat was drilled to slender wheat grass (*Agropyron tenerum*). Seed collected by Shear and Bessey in Colorado in 1898. Drilled May 12; sprouted and up May 28. There was a great difference in parts of this plat. July 26, six inches high; some heading out. August 5, first five rows headed out, twelve to fourteen inches high. In the next twenty rows the plants are darker green, smaller, and later, just beginning to head out. Rest of plat same as first five rows. October 24, rusted badly but still partly green.

Plat A (12).—This plat was sown broadcast to wild timothy (*Muhlenbergia racemosa*). Sown May 11; sprouted and up June 6. August 5, three to four inches high; very thin stand and very weedy. Mown July 31 to kill weeds. October 24, all dead, killed by frosts.

Plat A (13).—Eight yards on the east side of this plat were sown to curly mesquite (*Hilaria cenchroides*). Sown broadcast May 11; sprouted and up June 1. Very thin stand. Mown July 31 to kill weeds.

The next eight yards of this plat were sown broadcast to blue grama (*Bouteloua oligostachya*). Seed collected by Williams and Griffiths at Billings, Montana, 1898. Seed sown May 11; sprouted and up May 27. Stand thin and plat weedy.

The next five yards in this plat were sown broadcast to blue grama (*Bouteloua oligostachya*). Seed collected by Williams and Griffiths, Montana, 1898. Seed sown May 11; sprouted and up June 4. Mown July 31 to kill weeds. Thin stand.

The rest of this plat, four paces, was sown to King's fescue (*Festuca kingii*). Seed collected by Williams and Griffiths in Wyoming, 1898. Sown broadcast May 13; sprouted and up May 26. Plat was mown July 31 to kill weeds.

Plat A (14).—Blue grama (*Bouteloua oligostachya*). Seed on the west half of plat came from Walla Walla, Wash. Sown broadcast May 11. Thin stand. Mown July 31 to kill weeds.

Plat A (15).—Mixed grama. Seed from Texas. Sown broadcast May 11; sprouted and up June 8. Thin stand. Mown July 31 to kill weeds.

Plat A (16).—First twenty-two rows on east side drilled to false couch grass (*Agropyron pseudorepens*). Seed from Texas. Drilled May 12; seed failed to germinate. The next eleven rows were sown to annual saltbush (*Atriplex holocarpa*). Seed grown in U. S. Grass Garden, at Washington, in 1898. Drilled May 12; seed failed to germinate.

The next twenty-four rows in this plat were sown to silvery saltbush (*Atriplex argentea*). Seed collected by Williams and Griffiths in Montana, 1898. Drilled May 12; seed failed to germinate.

The last six yards on west side of plat were sown broadcast to wire bunch grass (*Agropyron divergens*). Seed collected by Williams and Griffiths in Wyoming in 1898. Sown May 13. Thin stand. Mown July 31 to kill weeds. October 24, three to four inches high and still green.

PLAT A (17 and 18).—Hairy or sand vetch (*Vicia villosa*). Seed imported from Russia by the U. S. Department of Agriculture. Drilled May 12; sprouted and up May 26. Sown too thick; nearly every seed germinated. July 26, two to four feet long. Almost all killed by hot winds July 15 to 20. Very weedy. Around the edges next to paths it made a good growth and blossomed in August and September, but failed to mature seeds. October 24, still green and would make good pasture.

PLAT A (19 and 20).—Sown broadcast May 23 to Turkestan alfalfa (*Medicago sativa* var. *turkestanica*). Seed from Section of Seed and Plant Introduction, No. 991. Sprouted and up May 29. The alfalfa grew nicely until the first of July, when it was six to eight inches tall. The dry weather in July and August stopped the growth and damaged it badly.

PLAT A (22 and 23).—Western wheat grass (*Agropyron spicatum*). Seed collected by Williams and Griffiths in Wyoming in 1898. Sown broadcast May 11; sprouted and up June 4. Mown July 31 to kill weeds. Good stand. October 24, three to four inches high and still green.

PLAT A (21 and 24 to 29, inclusive).—Were sown broadcast May 10 to smooth brome grass (*Bromus inermis*). Seed grown at the South Dakota Experiment Station, at Brookings, S. Dak. Sprouted and up May 21. July 26, good stand from four to six inches tall. Mown July 31 to kill weeds. October 24, still green, five to six inches high and very thrifty. This grass has made the best showing of any of the grasses sown broadcast.

PLAT B (1).—Original prairie. Broken in June. Not planted.

PLAT B (2).—North half of this plat was drilled to Hagi (*Lespedeza bicolor*), introduced from Japan by the Section of Seed and Plant Introduction. Very thin stand. Grew to be twenty-four to thirty inches high but did not come into bloom. Had a single stalk and was very woody.

PLAT B (3).—Earliest ripe fodder corn. Seed from J. A. Salzer Seed Co. Planted in rows 22 inches apart, May 24. Sprouted and up June 1. Part of this plat was drilled, part planted in hills 14, 28, and 42 inches apart in the rows. The drilled portion suffered from drought in July and only grew to be from two to three feet high. The thinnest planting made the coarsest fodder and the yield seemed to be heavier. The wind blew the corn together so that the different sections of plat could not be weighed separately. Tasseled July 27. Cut September 11. Weighed October 20.

Yield on one-quarter acre 400 pounds, or at the rate of 1,600 pounds per acre. This plat is on some of the lowest ground under cultivation. The tallest corn was from three and one-half to four feet high.

Four rows on the west side of this plat were sown to yellow milo maize. Seed furnished by Mr. J. C. Stoner, of Highmore. It was old and failed to germinate.

PLAT B (4).—Salzer's Superior fodder corn. Seed furnished by J. A. Salzer Seed Co. Planted May 24 in rows 22 inches apart, hills 14, 28, and 42 inches apart in the row. As in the preceding plat the corn planted farthest apart made the largest growth. Sprouted and up June 1. July 27, three to four feet high. Very rank growth. Most of it tasseled out before September 1. Cut September 11. Four to seven feet high. Weighed October 20; weight for one-quarter acre 810 pounds, or at the rate of 3,240 pounds per acre.

PLAT B (5, 6, 7, and 8).—Sown broadcast to Turkestan alfalfa (*Medicago sativa* var. *turkestanica*) at the rate of 25 pounds per acre. Seed from Section of Seed and Plant Introduction, No. 991. Sown May 21. Sprouted and up May 27. Made a fine growth up to July 4. Badly damaged by hot winds July 15 to 20. Six to ten inches high July 1. Did not grow any taller. Still alive and fresh October 24.

PLAT B (9).—Earliest ripe fodder corn. Seed from J. A. Salzer Seed Co. Planted May 24, in hills 42 inches apart. Sprouted and up June 2. July 27, three to four feet high. Thin stand. Cut September 11. Had quite a number of small ears. Weighed October 20; weight, dry fodder, 310 pounds, or at the rate of 1,240 pounds per acre. This fodder was badly blown about by the winds.

PLAT B (10).—Jerusalem corn. Seed from J. A. Salzer Seed Co. Half of this plat was drilled and half sown broadcast. Stand was thin, seed did not germinate well. Three rows on east side of plat were left to ripen seed and yielded one peck. Ripened in September. The corn on part of plat sown broadcast grew to be two or three feet high; that drilled, three to four feet. Cut September 11. Weight estimated 300 pounds or at the rate of 1,200 pounds per acre.

PLAT B (11).—Salzer's Superior fodder corn. Seed from J. A. Salzer Seed Co. Planted in hills 42 inches apart May 24. Sprouted and up May 31. Made a good growth. July 27 was four feet high. Cut September 12; five to six feet high at time of cutting. Weight October 20, 500 pounds, or at the rate of 2,000 pounds per acre. The land being higher than plat B (4), this corn did not make as thrifty a growth as on that plat.

PLAT B (12).—East half of plat planted to Wisconsin amber cane. Seed from J. A. Salzer Seed Co. Drilled May 25; sprouted and up June 14. About 75 per cent of a stand. July 27, two and one-half to three feet tall; badly damaged by hot winds. Cut September 13. Three rows left to ripen seed. About one-half was badly affected by smut.

PLAT B (12).—West half of plat planted to hairy vetch (*Vicia villosa*) and Jerusalem corn. Sown broadcast May 25. Vetch sprouted and up June 2; corn sprouted and up June 8. Badly damaged by drought in July; very weedy. September 1, corn and vetch dead except a little near the edges of the plat.

PLAT B (13).—East half of plat. Dwarf Victoria rape. Drilled in rows one foot apart May 25; sprouted and up May 30. Seed sown too thick. July 27, one to one and one-half feet high. Did not grow any after July. Yield, four to five tons of green fodder per acre.

PLAT B (13).—West half of plat. Dwarf Victoria rape and Wisconsin amber cane. Sown broadcast May 25; rape sprouted and up June 2; cane sprouted and up June 13. Plat was sown too thick; cane all died. Rape six inches high. Rape did not grow any after July.

PLAT B (14).—Salzer's Superior sand vetch (*Vicia villosa*). East half of plat sown in drills two feet apart; west half of plat sown broadcast. Sown May 25; sprouted and up May 31. July 27, drilled portion, one to one and one-half feet long; did not grow any more. That sown broadcast died from hot winds in July.

PLAT B (15).—Salzer's Superior fodder corn. Seed from J. A. Salzer Seed Co. Planted in hills 42 inches apart May 25; sprouted and up June 4. July 27, 75 per cent of a stand; four feet high. Cut September 13; five to six feet high. Weight, October 10, 500 pounds, or at the rate of 2,000 pounds per acre.

PLAT B (16).—Earliest ripe fodder corn. Seed from J. A. Salzer Seed Co. Drilled May 25, in rows 42 inches apart; sprouted and up June 3. Tasseled out July 27; three to three and one-half feet high. Cut September 11. A few ears of corn on stalks. Weight, October 20, 300 pounds, or at the rate of 1,200 pounds per acre.

PLAT B (17).—Hairy vetch (*Vicia villosa*). East half of plat drilled; west half sown broadcast. Sown May 26; sprouted and up May 30. July 27, in blossom; one to two feet long on drilled portion. Part of plat sown broadcast, dried out and destroyed by dry weather. A few plants next to paths made a good growth and blossomed, but did not mature seeds.

PLAT B (18).—Kafir corn. Seed from J. A. Salzer Seed Co. Half of plat drilled and half sown broadcast. Sown May 26; sprouted and up June 12. Germination poor. Portion sown broadcast killed by weeds and dry weather. Drilled corn two to two and one-half feet high; part of it left for seed, part cut September 13. None of that left for seed filled. Weighed October 20; yield at the rate of 1,500 pounds per acre.

PLAT B (19).—Combination plat—sand vetch, alfalfa, and Kafir corn. Sown broadcast and drilled May 26; sprouted and up June 1. Portion sown broadcast dried out and died. July 27, drilled portion—corn, two feet high; vetch, one to two feet long; alfalfa, eight to ten inches. Did not grow any after July. October 20, alfalfa and sand vetch still green but not growing.

The rest of Series B was planted to fodder corn and cultivated to keep the ground clean.

PLAT C (1 and 2).—New breaking, not planted.

PLAT C (3 to 6).—Common millet (*Chætochloa italica*). Sown for feed at the rate of twelve quarts per acre. Sown June 7. Sprouted and up June 16. These plats were on low ground and the millet made a good growth one to two feet high. Cut for hay August 8. Yield 2,961 pounds.

PLAT C (7 to 10, inclusive).—One acre. Common millet (*Chætochloa italica*). Sown at the rate of sixteen quarts per acre. Sown June 7. Sprouted and up June 16. Cut for hay August 8. This millet was on high ground and suffered badly from drought in July. Yield 1,740 pounds.

PLAT C (12).—Red Orenburg broom-corn millet (*Panicum miliaceum*). Seed from Section of Seed and Plant Introduction, No. 2960. Sixteen rows on east side of plat drilled June 16. Sprouted and up June 23. Very poor germination. July 27, one and one-half feet high; low and spreading; seed red; heads compact and heavily seeded. About two quarts of seed were saved of this variety.

PLAT C (12).—Black Russian broom-corn millet (*Panicum miliaceum*). Seed from Section of Seed and Plant Introduction, No. 2795. Eighteen rows drilled June 16 July 27, one and one-half feet high; very rank grower. September 1, two to two and one-half feet high. Seed ripe. This is a black-seeded millet and the best of the Russian millets tried. One and one-half quarts of seed were raised.

PLAT C (12).—Red Veronezh broom-corn millet (*Panicum miliaceum*). Seed from the Section of Seed and Plant Introduction, No. 2796. Twenty-five rows drilled June 16. Poor germination. July 27 one and one-half feet high. Plants low and spreading; heads long; seed red. Three quarts of seed were raised.

PLAT C (13).—Tambov broom-corn millet (*Panicum milaceum*). Seed from Section of Seed and Plant Introduction, No. 2794. Fifteen rows drilled June 16. Sprouted and up June 23. Very poor germination of seeds. July 27, headed out, one foot high. Plants low and spreading. Two quarts of seed raised from this number.

PLAT C (13).—Red Russian broom-corn millet (*Panicum miliaceum*). Seed from the Section of Seed and Plant Introduction, No. 2797. Fourteen rows drilled June 16. Sprouted and up June 23. Poor germination. July 27, headed out, one and one-half feet high. Heads long and spreading; seed red. Two quarts of seed of this millet were saved.

Plat C (14).—Kursk millet (*Chætochloa italica*). Seed from the Section of Seed and Plant Introduction, No. 2798. Thirty-one rows drilled June 16. Sprouted and up June 24. July 27, very thick; one foot high. August 1, headed out sixteen to eighteen inches high. Damaged somewhat by hot winds. Heads one to three inches long. Eight quarts of seed were saved.

SUMMARY.

The preceding notes record the results of the season's work at Highmore, S. Dak. There are a few conditions which must be kept in mind in studying the results. The land slopes from west toward the east, the west side of the Station being a dry ridge. The land had "gone back" and had not been plowed for six or seven years and had become full of foul seeds. Russian thistles, pigeon grass, and western wheat grass had complete possession of the ground. The plats sown broadcast could not be weeded and the young plants had to contend against the weeds without aid. The annuals (corn, rape, vetches, etc.) did not yield as well as they undoubtedly would have, had the ground been cultivated for the past four or five years. The land was packed from the trampling of stock and when plowed was lumpy and could not be made into a satisfactory seed bed in so short a time. The season also was peculiar. A study of the moisture records will show that while there was the usual amount of rainfall it came early and late in the season and July was both dry and windy.

The pressing need of this section of the country is winter feed, either hay, fodder, or pasture. Some of the bunch grasses from the higher altitudes in Wyoming and Montana, such as bunch redtop (*Poa buckleyana*) and smooth bunch grass (*Poa lævigata*) give much promise for winter pasture, while Nevada blue grass (*Poa nevadensis*) and King's fescue (*Festuca kingii*) give promise of both hay and pasture. The frost does not affect them until very late in the season. The favorable growth and behavior of smooth brome grass (*Bromus inermis*) this year as well as previous experience here and elsewhere in the Northwest with this grass shows it to be a good hay and pasture grass. On the highest, driest ground of the Station it made a good stand and kept green and thrifty during the driest weather. Oregon brome has made a fine showing and deserves a thorough trial on account of its excellent yield of seed and forage, and drought-resistant qualities. The native wheat grasses furnish the larger percentage of the hay in this section and under cultivation and favorable conditions will undoubtedly increase in productiveness.

One of the results of the investigation of the forage problem of the northwestern ranges is a demonstration of the need of united and continued effort along the line of experimentation designed to test the adaptability of the various native and introduced grass and forage crops to the conditions which prevail on the ranges, to learn more as to the best methods of growing these crops and of improving and maintaining the general productiveness of the ranges themselves. Much can be accomplished by the individual efforts of the ranchmen and others concerned; but all will agree that the best results can be secured only through the united, systematically planned investigations of the representatives of the General Government and the State experiment stations in close cooperation with the farmers and ranchmen. The grass and forage plant investigations at Highmore, South Dakota, are being conducted along these lines, and the results are highly gratifying.

Some of the millets introduced from the plains of Russia, and some of the varieties of sorghum and fodder corn, indicate the possibility of obtaining profitable returns in forage for winter use. With varieties sufficiently hardy to withstand the drought, or early enough to produce a crop of forage before the drought begins, the question of winter feed will be settled and the production of milk and butter through the winter months assured. By the cultivation of a relatively small area of land to these crops, the ranchman can produce enough forage to bring his stock safely through the winter, and the native pastures and meadows will be left in much better condition because of the lighter drain on their resources.

One point can not be too much emphasized, and that is the careful handling of the range so as to keep it up to the highest limit of productiveness. Experiments in range renovation have begun by properly fencing the Station grounds. The difference already seen where there has been a summer's rest, should be an object lesson to every stockman. Experiments along different lines will be carried on next season, such as scarifying and sowing grass seeds on the native sod and scarifying alone.

F. Lamson-Scribner,
Agrostologist.

Approved:
James Wilson,
Secretary of Agriculture.

Washington, D. C., *December 20, 1899.*

CIRCULAR No. 22.—(Agros. 59.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

GRASS AND FORAGE PLANT INVESTIGATIONS ON THE PACIFIC COAST.*

INTRODUCTION.

The Department of Agriculture has from time to time carried on investigations of the grasses on the Pacific coast, but the first really systematic work of this kind dates from a personal visit made to that section during the season of 1898. On this trip a number of the more important localities were visited, especial attention being devoted to the investigation of the present conditions and needs of the range region of central and eastern Washington and Oregon and the areas subjected to the shifting sands along the coast region and at various points along the Columbia River.

Throughout the drier sections east of the Cascades, the carrying capacity of the ranges has been very much reduced through drought and overstocking, and one of the questions of greatest importance in this region has to do with the improvement of the range and bringing it back, if possible, to its original productiveness. The present worn-out condition has undoubtedly resulted from a combination of circumstances. During the years when the ranges were at their period of greatest productiveness, they were grazed to their utmost capacity, and upon the advent of the series of dry seasons, which naturally resulted in light yields of forage, it was necessary to overgraze in order to keep the stock alive. Then, again, the open winters made it possible to keep the stock on the range a much greater portion of the year than previously, and close grazing followed at a season when the grasses could least endure it—namely, in early spring. The grass was given no opportunity to recuperate, and the present worn-out condition of the ranges resulted.

The large number of horses which have ranged over some sections of the country have had much to do with the present depleted condition, while in other sections much injury has been caused by sheep. To any one visiting these grazing regions it is at once apparent that

*This report is based upon personal observations and upon communications received from time to time from Mr. A. B. Leckenby, a special agent of this Division in charge of investigations on the Pacific coast. A report in detail upon the varieties grown by Mr. Leckenby is in preparation.—*F. L. S.*

drought-resisting grass and forage crops were of the utmost importance as well as improved methods of range management. In many sections the native grasses have been driven out and their places taken by weeds to such an extent that reseeding is about the only way that the lands can be restored to anything like their original productiveness. To do this, grasses and forage crops capable of enduring severe drought and other hardships are necessary. It seemed desirable to select some point or points where experiments could be conducted, having for their object the testing of drought-resisting grass and forage crops and of the range conditions. With this end in view, a number of localities were visited. At Yakima and Walla Walla, both in the State of Washington, it was found that some work had already been undertaken; that at the former place under the auspices of the Northern Pacific Railway Company, and that at Walla Walla by the Oregon Railroad and Navigation Company. The officials of each of these companies expressed a readiness to cooperate with the Department in continuing in this work of testing grasses and forage crops and range improvements, and went so far as to offer to turn over for the use of the Department the lands occupied by their respective experiment stations and any others that might be deemed suitable or necessary for making such tests. For the station at North Yakima this offer included tools, team, and other appliances used at the station. These offers seeming to afford a desirable opportunity to carry on these much needed investigations, their acceptance was recommended. This recommendation meeting with the approval of the Secretary, the Division took charge of the experimental work at these places, and special efforts were made to collect in quantity the seed of native grasses and forage crops that seemed so desirable to be tested in connection with the work of range improvement.

The investigations on the Pacific slope were continued during the season of 1899, both in the field and at North Yakima, Walla Walla, Rowena, and other points. The Agrostologist and two other members of the office force of the Division staff spent a considerable portion of the summer in the field studying the native grasses of the region and other questions connected with the forage problem.

At various points along the immediate coast and on the Columbia River, the question of fixing the drifting sands is an important one, and much time has been spent in studying the conditions which exist there and in endeavoring to secure practical means of holding the shifting sands in place. At some points along the river the sand occurs in such abundance and drifts so badly that it is a decided menace to orchards and farm crops in the immediate vicinity, and seriously impedes traffic by forming drifts over railroads and other avenues of commerce. In the course of our investigations a number of native plants have been discovered which promise to be of great value as sand-binders, and some of them also as sources of forage.

Among the more important of these native sand-binders are seaside, or Astoria, blue grass (*Poa macrantha*); sand blue grass (*Poa leckenbyi*); sea lyme grass (*Elymus arenarius*); yellow lyme grass (*Elymus flavescens*); small sand lyme (*Elymus arenicolus*), similar to the preceding; and a sand-binding sedge (*Carex macrocephala*). Other grasses that are being tested as to their value as sand-binders in this region are big sand grass (*Calamovilfa longifolia*), Marram grass (*Ammophila arenaria*), Bermuda grass (*Cynodon dactylon*), and Johnson grass (*Sorghum halapense*).

EXPERIMENTS AT NORTH YAKIMA AND WALLA WALLA.

In the experiments undertaken at North Yakima and at Walla Walla, a large number of grasses and forage plants have been tested as to their ability to withstand drought, and, in many cases, also have been grown under irrigation. As far as possible these stations have been used in the production of seed to be distributed to the different points in the region where their value under existing conditions can be tested. At North Yakima the land used in these experiments, although rich, is quite rocky, and hence difficult to cultivate, and the general conditions are much less favorable than those which prevail at Walla Walla. At the latter place, the soil is a rich, volcanic ash, and in fine condition for the various operations connected with cultivation, and is so graded that irrigation may be resorted to when necessary. During the present year a considerable amount of seed has been produced, particularly at the Walla Walla station, and this will be used in our investigations for the coming year.

VARIETIES.

In the experiments made at Walla Walla during the past year about 150 varieties of grasses and forage crops have been tested. These include most of the commonly cultivated sorts, varieties recently introduced by the Department of Agriculture through its special agents in foreign countries, and many native species, particularly those of the Rocky Mountains and the region east of the Cascades. Most of the seeding was done during the first half of April.

Of the varieties tested some 25 or more have shown themselves to be adapted to the conditions which prevail in the Northwest and have in most cases given excellent results without artificial watering of any sort. These include varieties adapted to all the various uses in feeding stock; varieties suitable for the ordinary meadows and pastures and also those adapted for use on the drier uplands. They also include annual varieties suitable for use in short rotations and varieties adapted to soils strongly impregnated with alkali. The common clovers, particularly alsike and mammoth red clover, have given very satisfactory results and the same may be said regarding timothy, meadow fescue, and tall meadow oat-grass. Smooth brome grass has produced the same excellent results here that it has given elsewhere in the Northwest and gives promise of being to the drier sections of this region what the blue grass is to Kentucky and timothy is to the northern States. Of the more recent introductions the Japanese wheat grass promises to be of great value, particularly for winter pasturage, while the varieties of alfalfa from Turkestan and northern Africa seem to possess great powers of adaptability to the conditions which prevail in the semiarid regions.

Some of the best results have been secured from our native grasses. A species of brome, closely related to the rescue grass, has given good yields of seed and forage and seems likely to prove as valuable for the Pacific coast as rescue grass is for the South. Several of the native wheat grasses show wonderful adaptability to cultivation and are destined to assume an important place on our list of forage-producing plants. Four of these deserve especial mention, namely, western wheat grass (*Agropyron spicatum*), meadow wheat grass (*A. pseudorepens*), slender wheat grass (*A. tenerum*), and bunch wheat grass (*A. divergens*). The first three species are suitable for meadows and may be grown either with or without irrigation. The bunch wheat grass is a native of the dry uplands and is likely to prove one of the best grasses for reclaiming the worn-out ranges. The plants thrive under conditions of extreme drought and afford excellent pasturage for all kinds of stock. This is *the* bunch grass of the great grazing regions west of the Rocky Mountains, and formerly occupied extensive areas affording much pasturage. Another native grass which does well under cultivation and which will undoubtedly prove valuable in reseeding the ranges is blue grama, known in Montana as buffalo grass. It is perfectly hardy, responds quickly to cultivation, resists trampling of stock, and affords first-class grazing. Under favorable conditions of soil and moisture it may also be cut for hay. This grass, however, has one drawback in that the seeds are difficult to handle in the various harvesting and seeding operations.

Of the annual grasses Japanese barnyard millet and black Russian broom-corn millet are most deserving of special mention. Both of these made excellent yields of forage and seed and are of undoubted value to this section.

In addition to the above-mentioned grasses and forage plants which may be regarded as of undoubted value to the Pacific coast region, about twenty sorts were successfully grown at Walla Walla the present season, but further experimentation is necessary to decide as to their real value. Most of these, while they made a good growth of foliage, either failed to produce seeds or showed other characters which may possibly exclude them from the list of varieties of practical utility for general cultivation. Johnson grass made a good yield of forage, but is objectionable to some because of its habit of growth, which, in the South, renders it at times a serious pest in cultivated fields. Both big blue-stem and bushy blue-stem thrive under cultivation, but it is quite difficult to secure seeds that will germinate. The Metcalfe bean made an excellent growth, covering the ground thickly with its leaves and stems, and produced flowers, but did not mature seed. It showed great sensitiveness to frost and stock did not seem to relish the forage obtained from it. Gram, or chick pea, and lentil produced good crops of seed and may prove valuable for use in connection with grain and other feed stuffs in fattening stock.

Quite a number of other grasses, some twenty in all, gave results of sufficient promise to deserve further study and experimentation. These include a number of the indigenous species of *Poa*, *Elymus*, *Paspalum*, and *Muhlenbergia*, which in their native condition are valuable for hay and pasturage. The more important of these are mutton grass (*Poa fendleriana*), smooth bunch grass (*Poa lævigata*), Wyoming blue grass (*Poa wheelerii*), Canadian lyme grass (*Elymus canadensis*), smooth paspalum (*Paspalum læve*), and wild timothy (*Muhlenbergia racemosa*).

Of the sand-binding grasses which were tested during the season, Marram grass has made a fine growth and will, no doubt, prove as valuable here as it is on the Atlantic coast. Bitter panic grass (*Panicum amarum*) made a good growth, but failed to mature seed, and for this reason may prove to be of less value here than it is along the coast of the Southern States. Reed canary grass (*Phalaris arundinacea*) has made an excellent showing, particularly in situations that are liable to be submerged for some time; for example, along the Columbia River. Even where submerged six weeks during the summer, excellent growth was made early in the spring and late in fall, affording a large amount of forage. In addition to serving as a sand and soil binder, this grass has also made a good showing on the drier land of the experimental plots at Walla Walla, and also at Pullman on the grounds of the State Experiment Station. Small sand lyme grass (*Elymus arenicolus*) has made an excellent growth at Walla Walla from roots transplanted from Grants, Oregon, indicating that it will grow on ordinary soil as well as dry, sandy ground, where it occurs naturally. It will undoubtedly be of great value as a sand-binder. Big sand grass (*Calamovilfa longifolia*) has not given very good results and may prove unsuitable to the conditions which prevail on the Pacific coast. Seaside blue grass (*Poa macrantha*) has given excellent results wherever tried and, especially at the Walla Walla station, seemed to endure the hot, dry weather perfectly. In addition to being one of the best native sand-binders of the coast region, this grass gives promise of being of great value for forage. Seed sown on the sand dunes of the Great Lake region the past season made a good showing, indicating the possibility of introducing this grass into the sandy regions of the interior. Indian millet (*Eriocoma cuspidata*), although not coming very well from the seed, shows indications of being valuable as a sand-binder, especially on relatively high and dry situations. Although the forage is rather harsh, it is often eaten by stock which are especially fond of the rather abundantly produced seeds.

Mr. A. B. Leckenby writes to the Agrostologist, under date of December 11, 1899:

I am delighted to tell you that the *Elymus arenarius* is a grand success, where the water does not remain on it too long, as is also *Elymus arenicolus* and *Elymus flavescens*. You would be delighted to see the grasses growing through seven feet of drifting sand. The *Elymus arenarius* is particularly pleasing because of its luxuriant growth. I planted about one acre with *Elymus flavescens*, Thursday and Friday, with roots procured from the Dalles. I am sending you by same mail some roots of this same grass.

Of the various saltbushes tested, Australian saltbush (*Atriplex semibaccata*) has given the best results of any of the introduced sorts, and white or sweet sage (*Eurotia lanata*) is most promising of the native series. The latter grows naturally on the dry, sterile soils of the ranges and adapts itself readily to cultivated conditions producing an abundance of seed. It will undoubtedly prove of great value for use in reclaiming the worn-out ranges.

In November some very interesting observations were made at the Walla Walla station regarding the behavior of different grasses and forage crops toward the early frosts. A variety of brome grass secured at Portland, Oregon, was not at all injured by the early frosts and remained fresh and green, while nearly related varieties from the Rocky Mountains suffered quite severely. Seaside blue grass and other of the *Poas*, or blue grasses, showed little, if any, effects of the frosts, while the grama grasses and the blue-stems early became dry and brown. Bearded wheat grass (*Agropyron caninum*) remained fresher and greener than either slender wheat grass or western wheat grass. Giant rye-grass (*Elymus condensatus*) was injured while other rye-grasses, such as Canadian rye-grass and Terrell grass, were very slightly affected. Turkestan alfalfa was not injured at all, while Oasis alfalfa from Africa suffered considerably and the commonly-grown variety of alfalfa was slightly injured. Such annuals as bur clover, lentil, and gram were not injured, indicating their possible value for fall and early winter grazing. Smooth brome and Oregon brome were not at all injured and were growing finely.

GRASS AND CLOVERS AVAILABLE FOR USE IN THE UPPER PACIFIC COAST REGION.

Judging from the results of the experiments conducted at North Yakima and Walla Walla and the information acquired through personal observation of our own field agents and correspondents who are cooperating with the Division, the following grasses may be suggested as available for use in the upper Pacific coast region:

Grasses and clovers for permanent meadows and pastures where the average conditions of soil and climate prevail.—Alsike, mammoth clover, meadow fescue (*Festuca pratensis*), red fescue (*Festuca rubra*), reed fescue (*Festuca arundinacea*), tall meadow oat-grass (*Arrhenatherum elatius*), western wheat grass (*Agropyron spicatum*), meadow wheat grass (*Agropyron pseudorepens*), slender wheat grass (*Agropyron tenerum*), smooth brome (*Bromus inermis*), Kentucky blue grass (*Poa pratensis*), perennial rye-grass (*Lolium perenne*), Turkestan alfalfa (*Medicago sativa* var. *turkestanica*).

As deserving of trial: Wild timothy (*Muhlenbergia racemosa*), bearded wheat grass (*Agropyron caninum*), smooth bunch grass (*Poa lævigata*), mutton grass (*Poa fendleriana*), Terrell grass (*Elymus virginicus*), Wyoming blue grass (*Poa wheelerii*), pale bunch grass (*Poa lucida*), and Oasis alfalfa.

Hardy annuals.—Rescue grass (*Bromus unioloides*), Japanese barnyard millet (*Panicum crusgalli*), Japanese wheat grass (*Brachypodium japonicum*), black Russian broom-corn millet (*Panicum miliaceum*), bur clover (*Medicago denticulata*), spring vetch (*Vicia sativa*), hairy vetch (*Vicia villosa*).

The following are suggested for further trial:

Crowfoot or goose grass (*Eleusine indica*) African millet (*Eleusine coracana*), gram (*Cicer arietinum*), lentil (*Ervum lens*).

Grasses for the dry uplands.—Blue grama (*Bouteloua oligostachya*), side oats grama (*Bouteloua curtipendula*), bunch wheat grass (*Agropyron divergens*), Nevada blue grass (*Poa nevadensis*), sheep fescue (*Festuca ovina*), King's fescue (*Festuca kingii*), white or sweet sage (*Eurotia lanata*), sainfoin (*Onobrychis sativa*), smooth brome.

Sand Binders.—Sea lyme grass (*Elymus arenarius*), slender sand lyme grass (*Elymus arenicolus*), yellow lyme grass (*Elymus flavescens*), Astoria blue grass (*Poa macrantha*), Leckenby's blue grass (*Poa leckenbyi*).

F. LAMSON-SCRIBNER,
Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *December 22, 1899.*

CIRCULAR No. 23—(Agros. 63).

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

(Grass and Forage Plant Investigations.)

F. LAMSON-SCRIBNER, Agrostologist.

PROGRESS OF EXPERIMENTS IN FORAGE CROPS AND RANGE IMPROVEMENT AT ABILENE, TEX.

[In a great many sections of the Southwest the natural ranges and pastures have been nearly or entirely destroyed by overstocking. The native grasses have died out through excessively close grazing, and their places have been taken by useless weeds and shrubs. Owners of what have heretofore been fine grazing properties have thus suffered great loss in being deprived of their pastures, and are now engaged in an effort to somewhat restore the former conditions, if possible.

The Division of Agrostology in 1898 commenced a three-years' experiment with a view to helping in this matter. A body of land 640 acres in extent, near Abilene, Tex., was kindly loaned by its owner, and the citizens of that town cheerfully assisted in the movement by having the property placed under fence, building water tanks, etc. Mr. H. L. Bentley, special field agent of the Division of Agrostology, was placed in charge, and has been carrying out the plan of experimentation devised by the Agrostologist of the Department.

This is Mr. Bentley's second report of progress of experiments in range improvement, the first one having been submitted and printed in December, 1898, as Circular No. 8, and entitled "Experiments in Range Improvements."—F. L. S.]

There have been many serious difficulties to contend with during the past season. In the first place the months of January and February, especially the latter, were very unfavorable for experimental work. In order to explain the conditions that prevailed here, a statement showing the protracted and extreme cold during the month of February is presented.

Table showing the dates during February, 1899, when the temperature was below the freezing point.

Date.	Degrees.	Date.	Degrees.
Feb. 1	21	Feb. 11	1
2	18	12	—6
3	25	13	9
4	14	14	26
5	14	15	22
6	12	18	30
7	10	22	28
8	14	23	17
9	13	24	20
10	13	26	20

There were only eight days during the month when the temperature was above 32 degrees.

A large number of seeds were sown during the month of October, 1898, and others during the January following, but as a result of the extreme cold weather during February, everything that had come up was killed by March 1.

The month of January was very dry. The following table shows the precipitation during that month:

Date.	Inch.	Date.	Inch.
Jan. 4	0.06	Jan. 11	0.02
5	.10	23	.08
9	.24	27	.01

Total for the month, 0.51 inch.

During February there was only 0.01 inch of rain, which fell on the 4th, and during March there was only 0.04 inch, which fell on the 11th. The ground in the pastures was not in condition to be harrowed, and the grass garden could not be plowed and made ready to receive seeds until April. During that month the rainfall was about normal for the season. The following table shows the precipitation during this month:

Date.	Inch.	Date	Inch.
Apr. 5	0.30	Apr. 20	0.38
6	.56	21	.30
15	.78	22	.40
16	.24		

Total for the month, 2.96 inches.

The rain on April 5 and 6 put the pasture ground in fair condition for harrowing, and on April 10 that work was begun and continued, with some interruptions, until completed.

During the autumn of 1898 the 10 acres in the grass garden had been plowed deep with a turning plow. March 15 following, notwithstanding the dry weather, the ground was in fair condition; as a result of the freezing during February it was easily pulverized, but was very cold and contained but little moisture. However, in anticipation of rain, the work of seed planting was begun March 15 and continued through April until May 4. Many of the seeds planted in March did not germinate at all, which was most probably due to the fact that the ground was very cold and the vitality of the seed thereby destroyed. The seeds that did germinate made a very vigorous growth. The same conditions, however, that induced such growth also induced a corresponding growth of weeds. The grass garden was laid off in plots 20 feet wide, separated into subdivisions according to the quantities of seeds in hand. The plots and subdivisions were marked by rows of sorghum, as a rule, and the grass seeds were sown broadcast. It was impossible to use plows in fighting weeds, and the work of getting rid of them had to be done by hand. It was necessary for the weeders to be in the plots, and as the ground was very wet a portion of the grasses in the plots was also destroyed in the effort to get rid of the weeds, either by trampling or by being pulled up with the weeds. The rainfall during May aggregated 4.02 inches, much above normal. During June it aggregated 5.45 inches. During July there was a sudden falling off in precipitation, as shown by the following table.

Date.	Inch.	Date.	Inch.
July 1	0.52	July 17	0.20
2	.10	24	.56

Total for the month, 1.38 inches.

By the 1st of August everything in the station garden had begun to show the inevitable effect of the drought. Hot winds were blowing during all of July, and the succulent garden plants presented the appearance of having been scalded with hot water, and in some instances were killed. During August the rainfall was only normal, being 0.10 of an inch on the 16th. In September there was a fraction more, viz, 0.44 of an inch on the 7th. During the first twenty-five days of October there was a precipitation of only 0.01 inch, falling on the 16th.

In view of the hot winds and the protracted dry weather it is remarkable that anything in the garden survived. October 26 the first rainfall of any consequence since June 30 (when the precipitation was 2.09 inches) occurred: the precipitation was 2.89 inches. During November there were several rains, viz:

Date.	Inch.	Date	Inch.
Nov. 1	0.18	Nov. 21	0.12
18	.06	29	.90
20	1.10		

Total for the month, 2.36 inches.

Of the plants in the garden, the several varieties of alfalfa, sulla, sainfoin, and hairy vetch greened out wonderfully, and have since then made vigorous growths, in spite of the frosts during the months of November and December. Following the slight rainfall of November 1, there was a killing frost (the first of the season) on the night of the 2d, and there was much freezing weather during the months of

November and December, as will appear by the following table, showing the dates when the temperature was as low as 32 degrees:

Date.	Degrees.	Date.	Degrees.
Nov. 3	28	Dec. 15	26
4	30	19	27
Dec. 4	32	20	28
5	29	21	32
14	26	22	32

In view of the extremes of heat and cold and dry and wet weather, it will be seen that there were serious difficulties to contend with during the season of 1899.

RANGE IMPROVEMENT.

METHODS EMPLOYED.

The section of 640 acres was divided into six pastures of 80 acres each, two of 40 acres each, one of 70 acres, and the remaining 10 acres were set apart for testing such grasses or forage plants as fairly promised to be of practical value in the semiarid regions of Texas.

The work as planned by the agrostologist in 1898 was as follows:

Pasture No. 1.—No treatment except to keep stock off until June 1, pasturing the balance of the season.

Pasture No. 2.—Cut with a disk harrow and kept stock off until June 1, pasturing the balance of the season.

Pastures Nos. 3 and 4 (of 40 acres each).—Grazed alternately, the stock being changed from one pasture to another every two weeks, thus allowing the grasses a short period for recovery after each grazing.

Pasture No. 5.—No treatment except pasturing until June 1 and keeping stock off the balance of the season.

Pasture No. 6.—Left as a check, without any treatment whatever except to keep stock off during the first season.

Pasture No. 7.—Dragged with an ordinary straight-toothed harrow and stock kept off during the first season.

Pasture No. 8.—Disked and stock kept off during the first season.

The 70-acre pasture, No. 9, was not grazed. Seeds of a number of wild and cultivated varieties were sown directly upon the sod.

Three of the most experienced stockmen of Texas personally inspected every acre of the section March 23, 1898, and unanimously reported that its utmost capacity for supporting cattle at that time was 1 head of mixed stock to every 16 acres, or 40 head to the section. The rainfall during 1898 was exceptionally light, and practically nothing was accomplished that year on the station except the cultivation of the native sod—that is to say, a disk harrow was used in two of the 80-acre pastures to cut up the sod as thoroughly as practicable. An ordinary iron-tooth harrow was used on one 80-acre pasture, and the surface of the land was scarified as thoroughly as was possible under the circumstances. There is a rather heavy growth of mesquite trees growing in each of the pastures, and on account of them it was not possible to scarify the surface of every acre.

The theory was, that by cutting the surface as deep as was practicable with the harrows (disk and tooth) the roots in the ground would be given better chance for development, the runners from the grasses would find soft ground in which to take root readily, the rain would sink into it instead of running off, and the seeds that fell would find a suitable place in which to germinate. In spite of the drought of

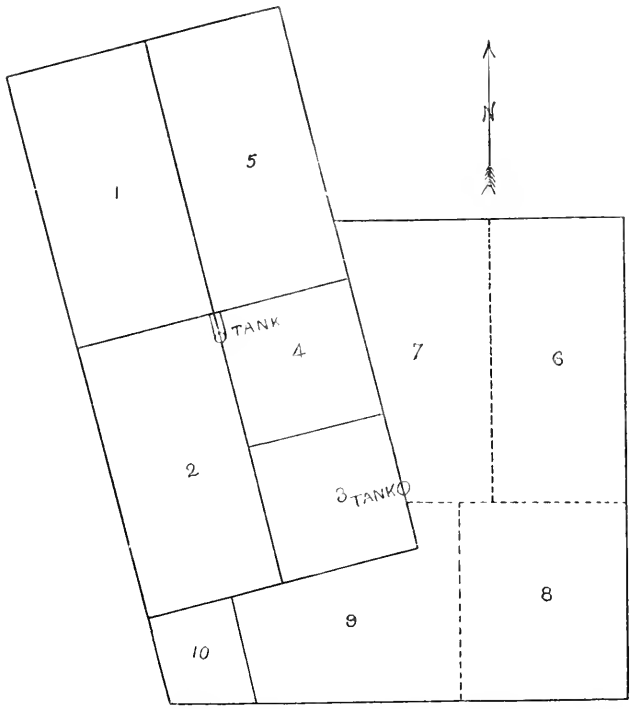


FIG. 1.—Plan of 640-acre tract used for the range experiments at Abilene, Tex. (Scale 3 inches to the mile.)

1898, during which there was less rainfall even than during the memorable dry year of 1887, there was a marked improvement in the range, treated as above mentioned. The harrowing was done during March and April, 1898, and, fortunately, the rainfall was reasonably good just after the work was completed and the autumn rains were nearly up to the normal, although the sum of precipitation for the season was very much below normal. A year from the first inspection, the same three stockmen made a second visit to the station and unanimously reported a very marked improvement over the conditions as they had found them in March, 1898. They reported in March, 1899, that the capacity of the section to support stock was then 1 head of mixed cattle to 10 acres, or 64 head to the section. Later, in April, 1899, two of the men (Messrs. Middleton and Bryan) made another inspection of the pastures after the long spring rains had commenced falling, and reported that 1 head of mixed cattle to every 8 acres (80 head to the section) was the then capacity of the section. It is on this basis that cattle are now being held and will be held during the next year in the station pastures. This gain of 100 per cent in capacity to support stock is phenomenal, considering the drought of 1898, and had the pastures been stocked to their full capacity, as recommended by the inspectors, I would have taken the result as finally demonstrating the great value of cultivating the sod as explained above. But on account of the scarcity of water for stock in the pastures it was not possible to keep in them the proportion of animals contemplated, hence the pastures were rested for several months, and precisely at the season when the grass seeds were maturing and dropping. In determining, therefore, what factors entered into the experiment resulting in so marked an improvement in the range conditions, the fact of the resting of the pasture must not be overlooked. Indeed, I am satisfied that the improvement in the said range conditions has been due largely to this period of rest. My conclusions are: (1) That it will pay farmers and stockmen of Texas, especially in the semiarid districts of the State, to cultivate their pastures by use of disk and iron-tooth harrows; (2) that it will pay them to rest their pastures periodically during the seasons when the grass seeds are maturing and falling to the ground.

COST.

A farmer or stockman having his own teams and hands can do the work incident to these experiments when practically nothing else can be done on the farm or ranch, and at a nominal cost. The best time for such work is believed to be in the early spring, just before or just after rains. But it is quite probable that it will pay also to have similar work done in the autumn. The difficulty that is likely to be met with in making these experiments in the fall is that the rains at that season are not very regular in this section, and are generally followed by frosts; hence, it is quite possible that the damage caused by exposure of the grass roots, especially where the disk harrow is used, may more than offset the advantage that may be secured. The matter is worth testing and will be tried as soon as practicable.

CATCHING WIND-BLOWN SEEDS.

Another experiment has been instituted on one of the station pastures that promises to result favorably, namely, catching the grass seeds that are blown about by the winds.

The prevailing winds during the summer months in central Texas are from the south. Many of the grass seeds, as they fall to the ground, except where the surface has been scarified or plowed, are blown by the winds onto other lands. In this way such seeds are often lost to the grounds on which they are grown and matured. In order to save these seeds to the pastures producing them, a part of one of the station pastures was selected, and about every 12 feet furrows have been plowed from east to west, the idea being, (1) that the seeds falling to the ground, if blown at all by the winds, will be caught in these furrows and in that way saved to the pastures, (2) that the storm waters falling on such pastures, instead of being allowed to waste by running off into creeks and bottoms, will also be caught in the furrows.

This work was done in May, 1899. By June 30 the furrows had caught a great many seeds, and, as the result of the surface irrigation incident to the rain having been collected in them, the grass immediately proximate to such furrows was much greener and more vigorous than that farther away. Indeed, in approaching the pasture so treated the furrows could easily be traced by the eye a half mile or more away by their fresh, green appearance.

TRANSPLANTING GRASS ROOTS.

Another experiment in the improvement of range conditions has been the transplanting of grass roots. There were considerable areas in the pastures of the station that were bare of all vegetation a year ago, the result of overstocking, drought, insects, and prairie dogs. Several native turf grasses were selected the past spring and the sods were taken up and planted in a few of these naked spots, just before rains. In every instance they have grown well and promise to cover the naked spots in a short time. The following grasses were used in this experiment: Curly mesquite (*Hilaria cenchroides*), needle grass (*Aristida fasciculata*), cotton-top (*Panicum lachnanthum*), wild timothy (*Muhlenbergia racemosa*), Galleta or black grama (*Hilaria mutica*), blue grama (*Bouteloua oligostachya*), side-oats grama (*Bouteloua curtipendula*), Canada rye grass (*Elymus canadensis*), and everlasting grass (*Eriochloa punctata*). All of these are natives of central Texas and occur in nearly every county. There are many other native grasses and forage plants here that may be used to good advantage in the same way.

GARDEN WORK.

In the 10 acres set apart for experiments with seed of grasses and forage plants the tests made this year have not been altogether satisfactory, chiefly owing to the dryness of the season, but results of practical value have been secured.

The soil is thin and dry, as a rule, and part of the ground is too rocky for cultivation. The bed of a small stream extends through the east side of the garden and drains the moisture from the lower lands; next to it is the dry soil, characteristic of the upland. The stream has water in it only immediately after rains; it is a "dry branch" as understood in Texas. About 100 different varieties of seeds were received from the Division of Agrostology and they have been carefully tested, in many cases with satisfactory results.

SALTBUSHES.

Seeds of several varieties of saltbushes were planted, but only a few of them germinated. The plantings were made March 16 and April 18. The seed of Nelson's saltbush (*Atriplex pabularis*) came up, but only a few plants were saved. Of Nuttall's saltbush (*Atriplex nuttallii*) only a few vigorous plants were secured. About a dozen weak plants of the shad scale (*Atriplex canescens*) came up, but they soon died. Of all the varieties of saltbushes that were tested the annual saltbush from Australia (*Atriplex holocarpa*) gave the best result. The seeds were planted March 16 and April 18. A number of vigorous plants were secured, but most of them were destroyed in one night by a prairie dog that made its way into the grass garden through a woven wire fence. The two plots of saltbush planted were on thin land. The growth was not very vigorous, being only from 12 to 18 inches, but the seed development was surprisingly great. As a drought-resisting plant too much can not be said in its favor. Seed formed and matured in the long, hot, dry summer. Up to December 1 the bushes continued green, but by December 15 the plants were nearly dead. On each of the varieties except the shad scale there were many thousand seeds, and although twice in July and August they were carefully stripped of seed, the ground under each bush is now covered with hundreds of the seeds that have ripened and fallen off. It is said that the saltbush will mature several crops of seeds in a season, and this is not hard to believe considering the results of the tests in the station garden this year. It withstood the utmost extremes of drought. November 1, after four months of dry weather, with the hot winds which at that season prevail in this section and in all the western counties of Texas, when nearly everything else in the grass garden was showing the effects of the heat and the dry weather, the saltbush appeared nearly as vigorous as it did during the wet weather. The saltbushes are recommended especially for the sections of Texas in which the soils are impregnated with alkali. The annual saltbush is valuable; it is an excellent forage plant for soiling sheep and cattle, and horses will eat both the bush and the seed.

LEGUMES.

ALFALFA OR LUCERN.

Seeds of alfalfa (*Medicago sativa*) were sown in March, 1898, on the freshly broken sod. A rather thin stand was secured and when it had grown to about 6 or 10 inches in height, the long dry spell began and checked all further growth; indeed, it gradually dried up on its roots until scarcely a stem of it was to be seen. The following fall and winter the prairie dogs and rabbits destroyed pretty nearly all the roots left by the drought. In the early spring of this year (1899) a few of the stems were noticed after the ground had been plowed, and they were carefully protected. Without other water than the natural rainfall the plants developed remarkably. By June 1 they had grown to be from 18 to 27 inches tall, at which time the crop was cut. On July 2 it was cut again, many of the stems measuring from 24 to 28 inches. July 22 a third crop was ready for cutting, some of the stems measuring from 18 to 20 inches in length. It is true the rainfall here from April 1 to July 1 had been above normal, but I am strongly inclined to believe that alfalfa will thrive in this section without irrigation. April 25, 1899, one pint of seed was procured and sown in a rather low but not at all wet plot of ground, affording an excellent stand. The growth continued to be vigorous up to about July 20, by which time the severe drought had set in. The foliage was dried and parched by August 1, and even the roots appeared to be dying. October 26 the drought was broken by a good rain, and by the 30th green leaves began to start from the roots. By the last of November the new foliage was from 8 to 10 inches in height. There were several white frosts and one or two freezes in November, but December 1 this plot was as green as in spring time, and the new growth was from 12 to 18 inches tall, and is even yet (December 30) green and vigorous looking.

TURKESTAN ALFALFA.

(*Medicago sativa turkestanica.*)

The seed of the Turkestan alfalfa was sown in April on rather thin dry land and only a partial stand was secured. It grew well until the drought set in, but soon began to show indications of injury. By August 1 the plants began to drop their leaves, and by September 1 the roots also appeared to be dead or dying. After the rains (October 26) the roots were slow to revive, but by November 15 they had put out a new growth. By December 1 this growth was from 11 to 12 inches tall, but less strong than the common alfalfa. At this date the plants are green and vigorous.

OASIS ALFALFA.

A small package of oasis alfalfa from Tunis was received through the Division of Agrostology. Three plantings were made, one in February, 1899, which, on account of the severe frosts that followed a day or two later, failed to germinate. In April one half of the balance of the seed was sown in a low but not damp plot, and what was left was planted on higher land. Excellent stands were secured from each of these last two plantings. The growth was vigorous from the start, but by July 30 the plants were looking wilted and by August 1 the foliage had withered badly and the roots were apparently dead. I reported about that time that I feared the roots were all dead. The rain that fell October 26 quickly revived them; by November 5 fresh leaves were putting out, and by November 15 the new growth was from 8 to 12 inches tall. On December 1 the growth was from 12 to 20 inches high and at this date (December 30) the plants are still green and vigorous. In approaching the station garden the vigorous growth of these plots can be distinctly noticed at a distance of half a mile. The results of the experiments with this particular variety of alfalfa are very gratifying and it seems likely to do well in this section without other moisture than a normal rainfall. To date, the oasis alfalfa is more satisfactory than the other varieties.

RED CLOVER.

Seeds of this variety were sown in two plats and good stands secured in each, one in low the other in higher land, both dry. The plantings were both made in April. In each case the growth was vigorous at the start, but on account of the early spring rains a very heavy growth of weeds resulted, that choked out many of the clover roots. In spite of this difficulty, by May 5 there was a vigorous growth from 8 to 16 inches high, that continued green through June and as late as July 20. By August 5 the hot, dry winds had very much injured the plants; by September 1 the foliage was withered, and soon even the roots were mostly dead.

WHITE CLOVER.

This variety failed to yield a good stand, and at no time during the year did it do as well as the red clover. The weeds got the start of it in the early spring, and when the drought set in the foliage soon withered, and by September 1 most of the roots were dead.

CRIMSON CLOVER.

The seed of this variety was sown in a low flat plot near a dry "branch." The early spring rains filled the branch and kept it full of water several weeks. A fair stand was secured, but the weeds soon injured it materially. Soon after the drought set in the plants began to languish, and by September 1 the roots were dead. The foliage turned yellow during the early spring rains, evidently the result of too much moisture.

MAMMOTH CLOVER.

This variety was also tried without obtaining a first-class stand and the weeds soon thinned that which was secured. The growth was never very vigorous and gave way entirely soon after the drought began.

BUR CLOVER.

(*Medicago denticulata.*)

Only a few seeds of this variety were sown, therefore only a few bunches of clover were secured. These grew up nicely and continued green until about August 1, when they were checked by hot, dry winds

A month later most of the roots were apparently dead. Quite recently (December) some of the roots have taken on new life and are coming out nicely. They are at this date not only alive, but have developed new foliage in spite of the freezing weather since the October rains. I desire to make another test of this variety of clover during 1900, and am inclined to think that it will do well here under normal conditions.

VETCHES.

Few of the farmers of Texas are familiar with the vetches. Two varieties were successfully tested during 1899, viz. spring vetch (*Vicia sativa*) and hairy vetch (*Vicia villosa*). Seeds of Stolley vetch (*Vicia leavenworthii*) were sown in February, but the freeze that followed a few days later and continued through the month destroyed them. In the same month seeds of the other two varieties named were sown, but few of them germinated and none of the plants (not vigorous at any time) survived. The later plantings (March 17 and April 10) did well. The spring vetch (*Vicia sativa*) is an annual trailing herb and grew from 18 to 20 inches tall. The hairy vetch has been successfully grown without irrigation in the moist coastal regions of Washington, on the dry prairies of South Dakota, and the rich loamy soils of the Gulf country. Both of these varieties, the spring vetch and the hairy vetch, if sown in Texas in April or May, will be ready for harvest by the middle of August or first of September. Texas farmers are strongly recommended to try both of them. This year seed sown broadcast, in drills, and in hills all gave satisfactory results.

SULLA.

(*Hedysarum coronarium*).

This is a perennial legume, native to southern Italy, that should be known to and cultivated by our Texas farmers. The main plot was planted May 4 and is on the side of a dry, gravelly hill. From the start the growth was vigorous and by the time the hot, dry winds began in July the foliage was from 6 to 12 inches long. The roots penetrated the ground to a considerable depth and up to about August 1 it seemed that this crop was going to stand the drought well. By the 15th of that month, however, it began to show the effects of drought and by September all the foliage was withered and dead. From that time until late in October there was no evidence of vitality in the plants. Following the rain of October 26 the roots revived very quickly and by November 10 the new growth was from 3 to 6 inches tall; since then the roots have been growing down into the earth and the foliage has been pushing up, and the plot is still green. Roots were sent to the Department of Agriculture recently that measured 10 to 14 inches in length with foliage from 5 to 8 inches long. The recent freezes, none of them very severe, however, do not appear to have made any impression either on the roots or foliage. The good showing made by this forage plant on this upland soil, with the severest drought ever known here, certainly indicates that it may prove of much value in this section. There can be no doubt of its great value in portions of Texas less subject to long, hot, dry spells than this immediate section.

SAINFOIN.

(Onobrychis sativa).

This plant, known also as esparcette, is a deep-rooting, perennial legume that thrives on dry calcareous soils which are not favorable for either clover or alfalfa. Seeds were sown May 4, and the plants which were from 12 to 18 inches high stood the dry and hot weather better than the vetches, clover, or alfalfa, and quite as well as the sulla. There is no better forage plant for barren hillsides.

COWPEAS.

About sixteen varieties of cowpeas were tested this year, all of them giving satisfactory results. The seed was planted in drills 3 feet apart, and cultivated as long as the season permitted by stirring the surface of the ground between the drills and about the roots. All the plantings were made on the same date, April 11, as there was but little seed of each variety. The plants grew nicely and all matured seed, none of them doing as well as they would have done had the season been more favorable. Seed of each variety was harvested, and will be tried again in 1900. The vines failing on account of the hot, dry winds, were cut and stacked in July, and several bales of excellent hay much relished by cattle and horses were secured.

CANADA FIELD PEA.

Seeds of the Canada field pea were planted April 10, resulting in only a very indifferent stand. The vines grew well, luxuriantly in fact, bloomed well and matured seed abundantly. Both for the vines, which make an excellent forage, and for the seeds, which are quite as rich as the well-known garden pea, which it much resembles in appearance, this variety will doubtless prove of much value to farmers and stockmen in central Texas.

MUMMY PEA.

A few seeds of this variety were planted April 11 in a heavy soil. Only a few germinated. A vigorous growth of vines was secured, but only a few seeds matured.

BLUE PEAS.

A small planting of this variety was made April 11 on the bank of the "dry creek" elsewhere referred to. During the next ten days the rainfall was excessive, the creek overflowed, and most of the vines were destroyed. The few that were left grew luxuriantly but bloomed sparingly, and only a few pods of peas matured.

VELVET BEAN.

The plot of velvet bean in the garden withstood the hot, dry spell of weather better than anything else except the soy bean, up to about August 15, but by September 5 the leaves were drying up and dropping, and by October 1 the plants were mostly dead. The seed was planted in hills about 4 feet apart each way. The vines covered the ground completely and some of them grew to be 10 or 12 feet long. No seed was matured.

SOY BEAN.

The soy bean promises to be one of the best forage plants for this section. Three varieties, early, medium, and late, were tested in the station garden. The early variety grew to be from 8 to 12 inches high and the plants were well filled with pods and seed. The medium variety grew to be from 8 to 12 inches tall and produced a very heavy yield of seed. The late variety proved a vigorous grower. The plants were from 24 to 30 inches high, but they matured only a few beans. This variety did not stand the dry, hot weather quite as well as the velvet bean.

METCALFE BEAN.

(*Phaseolus retusus.*)

A few seeds of the Metcalfe bean were received from the Division of Agrostology and a few from Mr. J. K. Metcalfe, of Silver City, N. Mex. Three plantings were made, March 21, April 11, and April 18, respectively. It was given the best possible chance, in the hope that it would do well in this section. Good stands were secured, and the vines grew nicely, some of them reaching 8 or 10 feet in length. Up to July 1 there was every indication of good results, but very soon after the drought began the vines showed evidence of injury, and by August 1 most of them were either dead or very much dried up.

NATIVE HORSE BEAN.

(*Phaseolus angustissimus.*)

Seed was also received from Mr. Metcalfe of a bean which stockmen here recognized as that known in New Mexico and Arizona as the horse bean. The seeds were planted April 11 and produced only a few plants that grew vigorously and promised good results, but they were injured by drought and produced no blooms, although the vines continued green until early in August. By October 15 they were all dead and the roots did not revive after the rain appeared in the fall.

LENTIL.

From seeds planted April 11 a good stand was secured. The growth was not vigorous, only from 6 to 8 inches tall. Seed formed, but the plot was on the bank of the "dry creek" mentioned, and in an overflow all the plants were destroyed.

SORGHUM.

Several varieties of sorghum were tested in the garden, the non-saccharine as well as the sweeter varieties. All the saccharine varieties did well. The Dhoura corns, Milo maize, Jerusalem corn, "Gyp" corn, Kafir corn, and other varieties of the non-saccharine sorghums all did as well as any reasonable farmer could desire. Satisfactory crops were secured from each of the following varieties: Big Amber, Red Amber, Early Black Amber, and Orange cane; Milo maize, "Gyp" corn, Jerusalem corn, Red Kafir corn, White Kafir corn, White Branching Dhoura corn, and Brown Branching Dhoura corn, all planted April 25. All of the varieties of sorghum tested in central Texas have proved fairly well adapted to the conditions of climate ordinarily prevailing here. They do better during dry years than anything else in the line of grains or forage crops that are cultivated. They, as a rule, yield large crops, and there is no difficulty in curing and preserving them. The idea of baling the hay, noted elsewhere, was to determine if they could be handled successfully in that way. If baling can be practiced they can be grown here to great advantage, and ought to possess considerable commercial value. No richer stock food can be grown in central Texas, and if the hay can be shipped to advantage it will command good prices farther west.

TEOSINTE.

Teosinte was successfully cultivated in the station garden this season. A long season of hot weather and a rich, rather moist, soil are necessary for its full development. One plot of it was in soil that was neither very moist nor very rich, and it made a vigorous growth in spite of the dry weather. It somewhat resembles sorghum in appearance, but has a more branching habit, usually making from 20 to 60 shoots from a single seed and growing from 5 to 10 feet tall. It will prove a valuable forage plant in all parts of this State, to be fed green, as silage or as fodder.

One planting was made April 10, in hills 4 feet apart each way. By July 1 it had met in the rows: but by July 15 the drought had set in, and by August 1 the teosinte had begun to suffer seriously. After that date no seed heads were formed, and those that had previously formed did not develop further. By August 15 the fodder had become yellow and dry, though the roots were still alive. Had a good rain fallen on them even as late as September 1, I am confident they would have revived and put forth a further growth of foliage. However, by October 26, when the drought was broken, even the roots were dead. Early in July some of the stalks were cut, cured, stacked, and later baled. The bales have kept sweet, and those still on hand are all that could reasonably be desired for forage purposes. The stalks are small, the leaves abundant, and the hay is soft. Cattle and horses relish it very much. A yield of 10 to 15 tons per acre can probably be secured here under normal conditions. As the hay is softer and more easily baled and handled than the sorghums, it will pay farmers and stockmen in central Texas, and in all parts of Texas east and south of this section, to try to grow teosinte for forage.

MILLETS.

Several varieties of millet have been tested in the station garden this year with satisfactory results in each case.

JAPANESE BARNYARD MILLET.

(*Panicum crus-galli.*)

On March 15 seed was sown in rather thin land on a hillside, which had been broken deeply in October, 1898, and not plowed since. A good stand was secured, and by April 18 the millet covered the ground with vigorous growth. On May 11 weeds were abundant and threatened to choke out the millet. June 3 the millet was cut, affording a splendid yield. The new growth started up immediately, and July 1 a second cutting was made—yield rather light. The millet began a third growth, but the drought of July was too severe, and it did not make another crop. The first crop grew to be 3 feet tall and seeded abundantly. Seed sown in another plot April 10 gave quite as satisfactory results. Under normal conditions this variety of millet will probably yield three crops a year.

SHAMA MILLET.

(*Panicum frumentaceum*).

Seed was planted October 4, 1898, and germinated well, but the winter freezes destroyed all the roots. Other plantings were made March 17 and April 10, 1899. Splendid stands were secured, the growth was vigorous, 18 to 24 inches tall, and the seed development was very good. Several bales of hay were made from the plat, which is equal to the best hay grown or imported into this section. Stock are very fond of it and the yield is good. One cutting only was secured before the drought set in. The second growth gradually dried up during July and August, and by September 1 was to all appearances dead.

PEARL MILLET.

A good stand was secured from seed sown April 18. Some of the stalks grew 7 feet tall with seed heads 8 to 10 inches long. There was an abundance of fodder, which was cut, cured, and baled, making rich soft hay that was relished by stock. It was a success here notwithstanding the drought.

BROOM-CORN MILLET.

Planted in April. The yield was large and the seeds matured before July.

GERMAN MILLET.

This variety has been fully tested here during past years and is justly regarded as of great value.

DWARF ESSEX RAPE.

Seed of this plant was sown April 18. A splendid stand was secured The growth was vigorous and promised well, but before the conclusion of the experiment the plants were destroyed by prairie dogs.

EXPERIMENTS WITH GRASSES.

Seeds of a large number of varieties of grass were received from the Division during the year. Some were planted October 18, 1898, some in January, 1899, and others early in February, 1899, but on account of the very severe freezing weather that continued through the latter month many of them either failed to germinate or were killed.

SMOOTH BROME.

(*Bromus inermis.*)

This grass has been tested in several of the Southern States and has given good results. Three plantings, all of Russian seed, were made October 4, 1898, November 15, 1899, and April 10, 1899, respectively. The seeds first planted germinated, but the grass was killed down the following February. The results from the other plantings were only partially satisfactory. Fair stands were secured. The growth was rather strong and stood the dry hot weather in July and August reasonably well, but by September 15 it showed the effects of the drought badly. The roots, though still alive, did not revive after the autumn rains began.

SIDE-OATS GRAMA.

(*Bouteloua curtipendula.*)

This is a native grass and the few seeds saved in 1898 were planted April 18, 1899. A good stand was secured, the grass did well, stood the drought well, and the roots revived after the autumn rains began, although the grass is now not green, having cured on the ground as is its habit when growing on the open range. This is one of the most valuable of all the native grasses of central Texas.

BUFFALO GRASS.

(*Bulbilis dactyloides.*)

This grass is frequently mistaken by stockmen for grama grass. It is a native of all this section and furnishes more rich stock feed than any other variety of so-called grama known here. It can be grown successfully from the seed. Land well seeded down to it, along with curly mesquite and needle grass, makes an ideal pasture. Plantings were made October 4, 1898, January, 1899, and April 18, 1899. Those of October 4 and January gave no results. Some seeds germinated, but the young roots were killed by the following February freeze. The planting of April 18 gave very satisfactory results. A fair stand was secured and the grass stood the drought well. By October 15 the grass had dried up and promised to make good winter pasturage.

OREGON RESCUE GRASS.

(*Bromus unioloides.*)

The few seeds of this variety received were planted May 4 and an excellent stand was secured, although the growth was at no time vigorous. The seed heads began to form when the stalks were 6 to 8 inches tall. By September 1 the grass showed in a marked degree the effect of the hot, dry winds of July and August, and by October 1 the foliage was all dead. The roots did not revive after the autumn rains began, although many of them are still alive.

BERMUDA GRASS.

(*Cynodon dactylon.*)

Sowings were made October 4, 1898, January 8, 1899, March 16, 1899, and April 18, 1899. There were no results from the first two. A few seeds of the March sowing germinated, but the plants soon disappeared entirely. A rather thin stand was secured from the April sowing and the grass grew nicely, continuing green until August, when it showed evidence of suffering on account of the hot, dry winds. By October 1 it had disappeared. The roots did not revive after the autumn rains began, although a few are still alive. This plot is on a rather high point; soil thin and gravelly.

GIANT RYE-GRASS.

(*Elymus condensatus.*)

Seeds of this variety were sown March 15 and April 11. Only a few germinated, and the grass was choked out by weeds.

CANADA RYE-GRASS.

(*Elymus canadensis.*)

This grass was not grown at the station, but an experiment made with it the past season is of interest and demonstrates its value in this section. A small plot of ground outside of the grass station contained this grass, which in the early part of January, 1899, was green and from 4 to 5 inches tall, while nearly all the other varieties of grass in the same neighborhood were dried up and gave no indication of growth. It was arranged with the farmer, who had a lease on the field, to turn over that small spot for experimentation; it was cleared of brush and the past year's growth of weeds, the surface broken with an iron-tooth harrow, and the soil about the roots loosened. By March 1 there was a splendid growth of grass that kept at least two weeks ahead of any other variety. During June a heavy crop, well headed out and ripe, was cut. A month later a second growth of this wild rye was ready to be cut, and bundles that measured from 20 to 30 inches in length were secured. Later a third crop was cut from the same plot, measuring 15 inches in length, that, when cut, was as green as in springtime, notwithstanding the fact that since October 26 there have been several freezes. During the long, hot, dry spell from early in July to late in October the wild rye-grass gave little evidence of injury from the drought and was about the only grass in this section that continued green. There is no better native hay grass in this section. Stockmen and farmers in all parts of Texas are recommended to secure seeds of wild rye and cultivate the grass for both hay and pasturage. A pasture of 100 acres of it as it is now growing near the station would furnish abundant, rich pasturage for from 30 to 40 head of cows, after having produced two crops of hay during the year.

MEADOW FESCUE.

(*Festuca pratensis.*)

Only one planting was made (November 15), affording a fair stand, and the grass lived through the summer, but by September 1 was to all appearances dead. The roots are still alive, but have made little or no autumn growth.

GRAPEVINE MESQUITE.

(*Panicum obtusum.*)

The sowings of this grass were made March 17 and April 10. Every seed must have germinated, as splendid stands were secured. The seeds were saved by me in 1898. The grass is native to this section of Texas and grows in most of the counties of central Texas. It seems to prefer low, moist ground, but frequently grows luxuriantly on high ground. Both of the plots in the station garden this year were on high land. It has long, creeping, jointed stems that root wherever they touch the ground. The leafage is rather scanty and harsh. The seed is produced abundantly and clings to the stems far into the autumn. The native growth in this section is from 18 to 24 inches in height. Two bales of the cured hay were secured. Stock seem to relish it. None of the grasses grown this year in the station garden resisted the drought more successfully. One plot planted to it was not cut this year and is now covered with the grass, dried up of course, but the roots are alive. It is well worth cultivation for pasture as well as hay.

BALING LEGUMES AND SORGHUMS.

One experiment in baling legumes and sorghums, made this year, is well worth particular mention. The seasons in this section are very favorable as a rule to the devolopment of a vigorous growth of pea and bean vines, although they do not always mature seeds. These vines well cured make rich forage, but as the leaves fall off badly, they have little commercial value. To determine if these crops would bear baling several varieties were secured and planted in the grass garden. They made vigorous growths, and bore heavy crops of peas and beans. When the fruits were nearly full grown, and before they began to turn yellow, the vines were cut and carefully cured as hay. Later a few bales were made of each. Recent examination showed that the hay was as sweet as when first baled. Since very large yields of these legumes can be grown in all parts of Texas nearly every year, the crops can be given a decided commercial value if carefully cured and baled.

A similar experiment was tried with the sorghums and other coarse forage crops, such as teosinte and pearl millet. When the stalks were from 3 to 5 feet tall, and while the seeds were "in the dough," several bundles of each variety were cut, cured, and stacked, and later baled, to determine if they could be handled in that shape to advantage. The bales have kept as sweet as those of the well recognized hay grasses of this section, and, as in the case of the legumes, the experiment was a decided success.

FAIR EXHIBITS.

In September last an exhibit was made of native and other grasses and forage plants grown during the year. Several boxes of baled hay were prepared for the exhibit at the Paris Exposition in 1900, and 53 bales of excellent hay, each representing a different variety, were made up and turned over to the managers of the district fair held here in October. The exhibit attracted a great deal of favorable attention from farmers and stockmen of this section, who became much interested in the station work. Heretofore many of them have either known nothing of such work or have paid but little attention to it. In the future they will watch the experiments more closely. They are manifesting especial interest in the work intended to improve the range conditions by cultivation of the native pasture grasses.

SUMMARY.

In spite of the adverse conditions under which they have been conducted, the experiments here have yielded results of great value. They have demonstrated the availability of alfalfa (especially oasis alfalfa), sulla, sainfoin, smooth brome, Canada rye grass, Terrell grass, and others for use in permanent pastures and meadows; of the vetches, cowpeas, velvet bean, soy bean, teosinte, and a larger number of varieties of the sorghums and millets for annual or temporary pastures, and as sources of coarse forage, either fresh or cured; of saltbush for alkali soils; of the gramas, Canada rye grass, grapevine mesquite, curly mesquite, galleta, and needle grass for reseeding the worn-out ranges. They have shown the feasibility of range improvement by resting and scarifying the land and by sowing hardy native and introduced grasses. The farmers and ranchmen are beginning to understand that they can, at comparatively small expense, greatly improve their ranges, and by cultivation of the many excellent grasses and forage plants tested this year in the station grounds can add very much to the productive capacity of their ranches and farm pastures. They are beginning to recognize the fact that there are very many native grasses and forage plants that are well worth careful attention and that others of almost, if not quite, equal value are being imported from the semiarid regions of the Old World and can be successfully cultivated here. Many of them propose, during 1900, to test on their own places the different varieties of alfalfa, vetches, sulla, sainfoin, teosinte, saltbush, the saccharine and nonsaccharine sorghums, and the best native and foreign grasses.

Respectfully,

H. L. Bentley,

Special Agent, in Charge of Experiments at Abilene, Tex.

Approved:

James Wilson,

Secretary of Agriculture.

Washington, D. C., *December 30, 1899.*

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CIRCULAR No. 24.—(Agros. 64.)

UNITED STATES DEPARTMENT OF AGRICULTURE,

DIVISION OF AGROSTOLOGY.

[Grass and forage plant investigations.]

F. LAMSON-SCRIBNER, *Agrostologist.*

[Corn is everywhere the king of fodder crops, and cowpeas are to the South what the clovers are to the North. One supplements the other, and combined as they may be in the silo, they constitute a ration of high feeding value. The practical possibility of growing and harvesting the two crops together is set forth in the present circular prepared at the request of the Secretary of Agriculture by Mr. W. Gettys, a prominent and successful farmer and dairyman of Tennessee. His methods of handling cowpeas and corn for silage and fodder will be of interest to every farmer in the South who is seeking improved systems of farming and stock feeding.—F. L.-S.]

COWPEAS AND CORN FOR SILAGE AND FODDER.

OBSERVATIONS ON CORN AND PEA STOVER.

In the South, at least in Tennessee and some of the other border States, the silo has become a necessity to the dairyman and live-stock breeder. It is the compensating hand of nature reaching out to us and making good some of the natural deficiencies found in our Southern agriculture, and enabling us to compete successfully with the West in making beef and butter. Nothing can fill up the gap made by a short summer crop, bridge over a fall drought, or draw reluctant spring into the lap of winter so well as good silage. When the spring floods have drowned out the regular crops on the lowlands or so delayed their growth that they will not mature in due season, then the silo comes to the planter's relief and enables him to utilize his crops, as he can in no other way, before they are caught and ruined by the early frost. Or should the drought cut short his hay crop, he still has the chance at some of the numerous catch crops, such as sorghum, millet, cowpeas, and corn. Any of these forage plants, if the season is at all favorable, will advance far enough to make a fair crop of silage. Low, wet, bottom lands that remain useless for anything else till midsummer can profitably be used in this way. Even large mill ponds, that are in the winter and early spring seasons applied to grist and saw-mill power, may be dried off in the late spring and their beds cultivated in time for a crop of corn silage. The soil of such lands is especially rich in all the elements requisite for large yields of such crops. To convert these catch crops that I have named into hay is, in our uncertain climate, a very unsatisfactory, and often a very unprofitable, part of the farmer's work. It requires a succession of hot, dry days to cure for safe-keeping such coarse provender, and even when hay caps are resorted to, the crop is badly damaged if the weather takes an unfavorable turn before it is put under shelter. But all these ills may be cured, regardless of the weather, by the use of the silo.

Many silage growers secure fairly successful yields by turning early wheat stubble land and sowing cowpeas, and succeed in getting the crop into the silo before frost. This is an uncertain dependence, for its success hangs on having a good growing season all through. Yet it rarely fails to pay the expenses of the effort, because if the season is such as will not make mature silage or hay, the planter will have valuable late pastures for his stock and the land will be benefited by the peas and be ready for another crop of small grain without further plowing. No other kind of stock food, green or dry, grain or stover, will make milch cows respond at the pail and churn so readily as a late growth of peas pastured off in the fall at a time when everything else seems to fail to arrest the natural tendency of the cow to decrease her flow of milk. The dairy product, however, will be somewhat unfavorably affected in its flavor by too much of this feed.

During the fifteen years that the writer has been using the silo he has endeavored to ascertain the best kind of crop for silage, and in doing so has grown nearly all the forage plants that were thought to be adapted to this climate and soil, taking into consideration always the quality as well as the quantity of the product, and the purposes for which that product was to be used· viz. making winter food for a breeding herd of dairy cows.

SORGHUM UNDESIRABLE FOR SILAGE.

The several kinds of sorghums have been tried under the different methods of planting and cultivation, and while the production was large, the quality of the silage was not good.

COWPEAS ALONE NOT SATISFACTORY.

Most of the varieties of cowpeas have also been tried and found, when grown alone on rich soil, expensive to handle and injurious to the flavor of a first-class dairy product, although among the best for a large production of milk and butter and for feeding beef and stock cattle. Probably no other kind of silage will carry dry cattle and young stock through the winter in such fine appearance as will that made from cowpeas.

CORN ALONE TOO EXHAUSTING TO THE LAND.

Corn alone, as we grow it for the silage in the South, is, perhaps, as nearly a perfect, all round silage crop as is possible to be had, but it is exhausting to the soil. To remedy this objection the effort was made to find some forage plant that would grow well with the corn and, while adding quality and quantity to the yield, would add nitrogen to the soil. For this purpose tests were made with various legumes and a suitable crop found in the cowpea which adds quantity to the crop, and being a renovater of the soil and a conserver of its fertility, counteracts or counterbalances the exhausting effects of the corn on the land. Especially is the question of soil renovation important to the South now, since of late years it has become next to impossible to secure a stand or a good crop of red clover, even on land that once grew enormous yields of that most valuable forage plant. In this agricultural emergency the cowpea has become a boon to a large section of the South for both hay and silage, and the area in cultivation has widened in Tennessee wonderfully within the last few years.

Some writers have doubted the advisability of growing cowpeas for ensilage on account of its alleged inferior quality as food. But the writer's experience leads him to believe that if the crop is grown properly, harvested at the right stage of maturity, evenly mixed in the silo with an equal portion of corn, and fed in connection with good hay or other provender, the quality of the combined crop will produce milk and butter of first-class quality, which is well known to be the most severe test that can be applied to any cattle food. The question of the quality of the silage is of much importance, since the last five years have witnessed a great increase in the number of silos built and used in the South, especially in east Tennessee, and perhaps the greater part of their contents is fed to dairy cattle, a class of stock that demands the best of health-giving food, and whose dairy product must be of unexceptional quality.

WHIP-POOR-WILL PEA THE BEST.

Of all the varieties of cowpeas the whip-poor-will has been found the best for silage purposes, because, when planted with corn, it grows rank enough; does not entangle the corn so much as the others, and hence damages it less; is the most easily harvested, and in this climate and soil yields more grain and ripens its vine more uniformly than the ranker growers, such as the "Clay," "Unknown," "Wonderful," and other runners. The "Whip" pea, strictly speaking, is a bunch pea and not a climber or runner, but with us, in favorable soils and seasons, it does climb in many instances as high as 10 feet, and bears fully matured pods in profusion to the top.

Fig. 1.—Three stalks of corn covered with a growth of whip-poor-will cowpeas.

AN IDEAL TENNESSEE CROP FOR SILAGE DESCRIBED.

My own silage crop of "Whip" peas and corn grown together the past season was, to all appearances, an ideal one. A 20-acre field of chocolate land, lying in, and on the slopes of the valley, was well broken and prepared, and the corn planted the middle of May without fertilizer. The corn, a large Southern variety, was put in with a one-horse drill, in rows 4½ feet apart and from 9 to 16 inches apart in the row. This width of row was given to admit plenty of sunshine and air. After the first cultivation and during the first days of June, when the corn was about 6 inches high, the peas were planted between the corn and in the same row with the corn, with a hand planter, commonly used for replanting purposes. The delay in planting the peas is deemed necessary to give the corn a good start ahead of the peas, the latter being of more rapid growth. If the corn rows are straight the peas may be put in more expeditiously with the one-horse drill, if care is taken to keep the same close up to the corn row; the object being to have both crops grow so as to be harvested together with the corn harvester, and bound into bundles, without waste, ready for the wagons. The season was favorable for both corn and peas, the stand was good, and after three cultivations the crop was all that could be desired. I have seen larger crops of both, when grown separately, but never such a yield of grain and provender of both plants combined and in such perfect condition for harvesting quickly and economically. The corn stood up well, and the peas, confining themselves to the row, grew over much of the field to the base of the corn tassel, fully grown and matured pods being found on the vines 10 feet from the ground.

The accompanying cut (Fig. 1), showing a man of ordinary height standing by the stalks, gives a fair idea of the growth of the crop. The harvesting began September 8, when the grain of the corn was beginning to glaze and when three-fourths of the pea pods were ripe, using a corn harvester (with four mules attached) that cut and bound the crop in bundles ready for the silage cutter. Few noxious weeds or grasses could stand under such a growth, so that after a satisfactory harvest and a few days of gleaning by the herd of cows the field was ready, without further preparation, for the disk harrow and wheat drill, and is now covered by what promises to be a very good and very cheaply grown crop of wheat. This land is ordinarily good for a yield of from 40 to 50 bushels of corn and from 18 to 25 bushels of wheat per acre. From this year's crop a considerable portion of the riper grain was pulled from the corn before cutting, for fattening hogs, hence no estimates were made by which the weight of the crop could be indicated, a fact I now regret. Doubtless comparative failures of this silage crop will now and then occur, as with all crops, but I am sure, from my own experience of several years, that all good corn-growing seasons will bring paying yields of this combination, grown as above described, and it will meet more fully than anything else of the kind the wants of the Southern silage grower.

SILOING AND FEEDING THE CROP.

The crop was put into the silos in the usual way. The field being half a mile away, four two-horse wagons, with one hand to each wagon and two, sometimes three hands, loading, were required to keep the cutter going. The knives were set to cut half inch in length, the cutter being preferred to the shredder, because it did its work more cheaply and quickly. The silos being side by side, the work of filling was all done at one setting of the cutter by simply shifting, when required, the table chute at the top of the carrier over the pits, and were both filled as nearly at the same time, as possible, on alternate days, so as to allow the contents to heat and settle. In this way a greater quantity can be put in the same space. Two men were kept in the pits all the time, tramping the sides well. When full the contents were covered with some of the chaffy, less valuable part of the same material, without putting on any weights. They were well tramped once a day for a week, after which they were let alone till time for using.

The feeding should begin at the top, using the windows in the sides for removing the silage as the pits are emptied. This crop of silage, as that of former years, has kept well, comes out of the pits with fine color and flavor, and is much relished by the cows, about 40 pounds a day, in two feeds, being allotted to each cow. As silage of any kind, of itself, is not considered a perfectly balanced ration, the cows receive in addition, during the winter, 4 quarts of wheat bran, 2 quarts of corn meal, and 1 pound of cotton-seed meal, night and morning, together with one feed of corn-and-pea stover. Good clover hay would be preferred to the roughage named, if it could be had. In feeding a breeding or dairy herd during the winter, silage, however good or plentiful, should always be supplemented by some kind of mill feed and well-cured hay or other stover. When the increase of the herd is the greatest consideration, the cows forward in calf and the breeding bulls should be given silage sparingly.

THE QUALITY OF THE SILAGE ON TRIAL.

The quality of this kind of silage and its influence on the character of the dairy product are now receiving a fair trial. The cows are apparently in perfect health, and the cream from the herd averages $33\frac{1}{3}$ per cent of butter fat. A portion of this goes to a near-by city, where it is scientifically manufactured into various kinds of food for the table. The balance is made into butter and sent to customers in a Southern city, some of whom have been using my product for eighteen years. Thus far no complaint from either source has been heard and none is anticipated.

THE GROWING CROP DIVERTED TO OTHER USES.

Should there be, as there was in the writer's case, more of the standing crop of corn and peas grown together than is needed for silage, as already described, it can be very profitably used as a dry provender. Allow the crop to stand till the proper stage of maturity is reached, which is shown by the brown husk of the corn and the yellow leaves and ripe pods of the pea vines. Then cut with a corn harvester and shock as with ordinary corn, putting about sixteen hills to the shock. To guard against molding at the center, go through the field two or three days ahead of the harvester and make small shocks, which will give a dry nucleus or center to the main shock and prevent all danger of damage. See that all shocks stand up well, and that they are well tied together at the top with binder twine. Select dry, cool weather in November or December, the sooner the better, provided the cornstalks are dried out enough to keep in the mow, then haul to the barn and run the crop through the "corn shredder and husker." In one operation the peas will be knocked from the pods and carried, with the small proportion of corn that is shelled in the process, into sacks to be taken to the mill and ground for stock food; the ears of corn husked and dumped into the wagons, to be carried to the crib; and the corn fodder and pea vines torn to pieces and conveyed up through the blowpipe into the hayloft, to be used as winter stover. Such stover is now being fed, in connection with silage, with as good results, and with as little waste as would be with the ordinary hay, such as is made and sold in this part of the country. The work mules and dry cattle get no other roughage and do well.

ALWAYS PLANT PEAS WITH THE CORN.

Considering this necessity of growing corn in some manner for livestock food and as a rotation crop, the planter should aim to secure as large yields of provender to the acre as possible with a minimum amount of exhaustion to the soil. Therefore none of our uplands in the South, and particularly within the bounds of what is known as the "Piedmont region," where the cowpea seems to have its home, should be put into corn without peas being planted with it. This advice will hold good, whether the crop be intended for silage or dry provender. Peas add to the quality, as well as to the quantity, of the yield and restore to the soil its fertility. To harvest and put away this combined growth quickly and economically requires improved agricultural implements that are especially adapted to the purpose, such as the corn harvester, silage cutter, and corn shredder and harvester. These every well-to-do stock grower and farmer should own or be able to hire.

COWPEA HAY FROM STUBBLE LAND.

It may be of interest and some benefit to Southern stockmen and planters to recount here the experience of the writer in growing a catch crop of pea hay from stubble land. The wheat was taken off as early as possible after harvest, and in June the land was turned and well harrowed and rolled, the season being favorable for such work. Whip-poor-will peas, a bushel to the acre, were sown with an ordinary wheat drill. The seed being defective, the stand was not good, but the growth was rapid and promised a rich crop of grain. As harvest time approached the thought occurred to the writer that, while there might be a medium-sized crop of good hay secured from the land, cut and put away in the usual manner, there should be more of the grain saved and utilized than is possible when the crop is handled as ordinary hay, knowing from past observation that much, if not most, of the grain is scattered and lost by the time the hay reaches the feed manger. If peas are to be our dependence in the future, in the absence of clover, we must discover the best method of reaping the greatest benefit from their production. The crop was permitted to stand before cutting a few days longer than it would have been for making hay, so as to give a greater proportion of the pods time to ripen. It was then cut with a mower and let lie in the hot sun thirty-six hours, when it was thrown into light windrows with a hayrake, the raking being done after sunset, sometimes by moonlight, when the plant was tough, to avoid shattering the leaves and grain. After remaining in the windrows twenty-four hours, it was thrown into small cocks and left exposed to the sun and air for thirty-six hours longer, when it was loaded on wagons and taken to the barn. No thrasher suitable for the work being available, the crop was run through the silage cutter. The cutter had a shredder attachment, but this, requiring too much speed, was removed and the cutter knives used as with silage. To save the thrashed peas separately from the stover was the next problem encountered. For this purpose a section 8 feet long was cut out of the bottom of the carrier and a suitable wire screen tacked in place of the solid bottom, which allowed the peas to drop through into a wagon bed on the ground underneath, while the pea stover was carried on up 36 feet into the barn loft, where it was well scattered and mixed with other dry feed.

The peas were damaged but little in the process, and after being run through a hand pea cleaner were spread out on a granary floor to dry a few days before sacking. The hay was not so good as it would have been if cut earlier, but this was more than counterbalanced by the money value of the peas secured, which was greater than the value of the wheat crop just removed. The land was much benefited by the growth of the peas, and required only the doubling of the disk harrow to prepare an excellent seed bed for the wheat that was to immediately follow. Inasmuch as wheat was to follow wheat, the greater part of the labor and expense of this catch crop of peas was but the preparation of the land for the succeeding crop of wheat, leaving a very small expense account chargeable to the crop of peas. Of course, the harvesting and housing of the crop in this manner required favorable weather, but not more so than would have been required to put away successfully the crop in the ordinary way. In such work as this the planter is more or less dependent on the weather for his success, this being one of the incidents of his calling.

If it were possible again to grow such fine crops of clover on the lands in Tennessee, and elsewhere in the South, as we secured years ago,

FIG. 2.—A field of corn and whip-poor-will cowpeas.

the questions discussed and experiences given in this paper would be of less importance than they are now. But as this can not be done, and as the cowpea has come to be regarded as the substitute for clover, for the purpose of fertilizing and renovating the soil, and for furnishing food for live stock, the planters and stock growers in these States are compelled, by self-interest, to study the question in all of its bearings, in order to ascertain the best manner of cultivating and saving this crop. And the question is made more important by the fact that this substitute is so varied in its useful purposes and capable of serving the planter in so many different kinds of combinations with his other farm crops. The writer's advocacy of the cowpea for the needs of the South and his reasons for growing and using it in so many ways are not based on a study of any scientific analysis giving its comparative feeding value for stock. He has been content in consulting only the good effect the plant has produced for him, as shown in the marked improvement of the soil, the continued good health of his cattle, and their increase, and the quality and quantity of their product at the pail and churn. All of which observations and experiences lead to the belief that no single grain of the plant was ever cast intelligently into Southern soil without profit to the sower.

Respectfully,

W. GETTY

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *February 26, 1900.*

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CIRCULAR No. 25.—(Agros. 68.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
WASHINGTON, D. C., *April 9, 1900.*

SIR: I have the honor to transmit herewith and recommend for publication as a circular of this Division the information now in hand relative to the Turkestan alfalfa, imported and distributed by you in 1898 and 1899.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

TURKESTAN ALFALFA.

(*Medicago sativa* var. *Turkestanica.*)

This variety of alfalfa was secured from Russian Turkestan by Prof. N. E. Hansen while engaged as special agent of this Department in 1898. The localities from which the seed was collected represent a wide range of climatic conditions, as follows: Inventory No. 469, from the Turkestan Agricultural Society, Turkestan; 679, from Bokhara; 991 and 1101, from Tashkend; 999, from Uralsk Agricultural School; 1150 and 1151, from Djarkent; 1169, from Merke; 1295, from Samarkand—all in Turkestan, and 1159, from Kopal, Siberia.

THE CLIMATE OF TURKESTAN.[1]

Russian Turkestan is about two-fifths as large as the United States, with a population of 3,000,000, and yet for the most part it is a vast tract of country consisting of either steppes or marshlands. A considerable portion of the country is not adapted to settled agriculture; so that the inhabitants are mainly employed in cattle raising. The climate of Turkestan, far removed as it is from the ocean and closed in on nearly every side by wide stretches of dry land, is not unlike that of many of our interior States. The summers are very hot, cloudless, dry and long, lasting from five to five and one-half months; the autumns and springs are mild and rainy, and the winters usually

[1] The Industries of Russia, 3; 444, 1893.

open, with but little snow. Severe frosts occur sometimes, but these very rarely last long. In many places the evaporation exceeds by many times the quantity of moisture that has fallen in the course of the year. From May to September very little rain falls, often only 1.1 inches, and in many parts of the steppe regions, which are removed from the mountainous districts, there is absolutely no rain during the entire summer season. Dry winds from the north and northeast prevail during the summer, with a temperature of about 130 F. (40 degrees Celsius), which generally dry up the whole Turkestan basin until vegetation can not exist without irrigation. The extent of watered lands in Turkestan is, in comparison with its whole area, by no means great, not more than two and one-half per cent, which is altogether insufficient for the subsistence of its population. This deficiency is partially redeemed by the growing of wheat, barley, and millet, which depend on the winter moisture in the soil and a sufficient fall of rain during the spring.

MERITS OF TURKESTAN ALFALFA OVER THE EUROPEAN VARIETIES.

The following extracts from an article by Prince V. I. Massalski, of the Russian Department of Agriculture, show its great value to the arid regions of Russia over the European varieties:[1]

Lucern clover (*Medicago sativa* var. *Turkestanica*) is the chief forage in use throughout Central Asia, and to the settled population of Turkestan is of the highest importance, since during the summer it forms the chief, and in winter, prepared in the shape of hay, the only fodder for cattle. It is of all the greater importance because, within the regions populated by settled inhabitants, there are no meadows. Soft herbs and other grasses that grow up in the early spring in certain parts of the steppes are quickly dried up by the hot rays of the sun and give place to coarse, prickly stubble, or, in any case, to less nutritive grasses that are in general unfitted for sheep, camels, or steppe cattle, and still less fitted for horses or the cattle of those who are settled in the oases, and are thus closely confined to the foreland or rivers, in most cases far removed from the steppes.

Massalski describes the native methods of cultivation and irrigation, and continues—

The native lucern would seem to be a cattle fodder that can not be replaced in countries as dry and hot as Turkestan and the Transcaspian Province. Parallel experiments that have been made in the Merv oases, in the Transcaspian Province, in growing native and French lucern, under widely different conditions of water supply have shown that the native lucern, particularly where there is a lack of water, is vastly superior to the French in the crop it yields, and that it is able to grow satisfactorily with a minimum supply of water, a supply so small that the European lucern would perish with drought. It possesses a very large root system, and its leaves are covered with thick down. This, in conjunction with a deeply channeled leaf, enables the plant on the one hand to imbibe the moisture from the deeper layers of the soil; and on the other hand, to exhale it in very small quantity.

[1] The Industries of Russia, 3; 459, 1893.

DISTRIBUTION OF THE SEED.

(See Table I.)

In 1898 and 1899, 1,111 packages of the seed of Turkestan alfalfa, of from 2½ to 20 pounds each, were distributed by the Secretary of Agriculture through the Section of Seed and Plant Introduction of the Division of Botany and through this Division. This distribution included experimenters in forty-seven States and Territories. Unfortunately, owing to the primitive conditions prevailing in the region in which the seed was collected, it was not clean when purchased, and had to be carefully inspected and freed from all weed seeds before being distributed. This occasioned such a delay in sending the seed out that for most localities it was too late for spring sowing. Many experimenters planted the seed immediately upon receiving it, and thus subjected the young and tender plants to the dry, hot summer weather, which in many cases killed the alfalfa, as the roots had not a sufficiently strong hold on the ground to enable them to withstand the drought. Some have been holding the seed for a favorable season in which to sow, and have not yet planted it, but expect to do so the present season.

As this variety of alfalfa was introduced especially for the semiarid regions, the largest consignments of seed were sent to the following States: California, 48 packages; Colorado, 77; Idaho, 21; Kansas, 97; Montana, 38; Nebraska, 49; New Mexico, 30; North Dakota, 26; Oklahoma, 37; Oregon, 27; South Dakota, 20; Texas, 318; Washington, 28; and Wyoming, 21. The number of experimenters to whom seed was sent in each of the States and Territories and the number and character of the reports received are given in Table I.

REPORTS RECEIVED FROM VOLUNTEER EXPERIMENTERS.

A total of 466 reports have been received, and of this number 237 are satisfactory and 229 unsatisfactory. (See Table I.) A report in this experiment has been termed "unsatisfactory" unless the Turkestan alfalfa has proved in some quality to be superior to the common alfalfa. Included in the 229 unsatisfactory reports are 76 which state that owing to the seed being received too late in the season, or because of the unfavorable weather or conditions, it has not yet been planted.

TABLE I.—*Distribution of seed of Turkestan alfalfa and number and character of reports received from experimenters.*

States.	Number of experimenters.	Number of reports satisfactory.	Number of reports unsatisfactory.	Total.
Alabama	11	1		1
Arizona	13	1	2	3
Arkansas	11	2	4	6
California	48	8	11	19
Colorado	77	11	18	29
Connecticut	1			
District of Columbia	10		3	3
Florida	5		2	2
Georgia	6		1	1
Idaho	21	3	4	7
Illinois	9	1	3	4
Indiana	12	5	2	7
Indian Territory	4			
Iowa	17	3	3	6
Kansas	97	39	22	61
Kentucky	9	1	2	3
Louisiana	7	2	4	6
Maine	1	1		1
Maryland	2	1	2	3
Massachusetts	5			
Michigan	3			
Minnesota	10	4	2	6
Mississippi	11	2	3	5
Missouri	16	3	5	8
Montana	30	22	7	29
Nebraska	49	14	12	26
Nevada	10	4	1	5
New Jersey	1			
New Mexico	30	3	5	8
New York	10	2	1	3
North Carolina	4	1	4	5
North Dakota	26	8	4	12
Oklahoma	37	8	8	16
Ohio	15	1	3	4
Oregon	27	6	5	11
Pennsylvania	8	4	1	5
Rhode Island	1	1		1
South Carolina	4		1	1
South Dakota	20	9	3	12
Tennessee	7	3	2	5
Texas	318	43	60	103
Utah	18	4	4	8
Virginia	16	1		1
Washington	28	5	6	11
West Virginia	6	1	1	2
Wisconsin	9	1	2	3
Wyoming	21	8	6	14
Total	1,101	237	229	466

The following testimonials from the experimenters will in some degree indicate the value of Turkestan alfalfa in the different States.

ARKANSAS.

Mr. C. T. Burns, Lynn, Lawrence County:

Alfalfa is practically unknown here. The seed received was sown under favorable conditions and came up well, but about the time it began to show green over the field, we had a long drought which killed out many of the plants. I think if I can get a stand it will be of great value, and on rich land the productiveness will exceed any of the grasses. I should have sown earlier.

Mr. H. N. Jameson, Calhoun, Columbia County:

Alfalfa has never been sown before in my immediate neighborhood. I selected a thoroughly drained, rich, loamy, well-prepared soil, which received no fertilizers. The seed came up well, but the young plants were washed over by a waterspout on the 12th of May and ruined. I believe alfalfa will grow here.

CALIFORNIA.

Mr. J. J. Dean, Moneta, Los Angeles County:

I prefer the Turkestan alfalfa to our common alfalfa, as it was up eighteen days earlier; is not so woody; has more and larger leaves and grows more rapidly. It is hardy, keeps green, and is not as easily injured by frosts as the other varieties. For dairies it is the best. My cows prefer it. The Turkestan alfalfa that I sowed June 5, 1898, I have cut nine times this year (1899), the growth being about 18 inches each time. The crop was irrigated with deep-well, sulphur water.

Mr. M. Hartley, Dehesa, San Diego County:

I received the seed too late to sow in 1898, which was a dry year with us, and so also was 1899. The creek did not run through my place, so the bottom land was wet only on the surface. However, I sowed the seed in March after a good rain. It came up beautifully and grew very well for about two months, when the vegetation dried up on the highlands and caused the quail and rabbits to flock in from all sides, and they destroyed almost every growing thing, including the Turkestan alfalfa.

Mr. W. H. Old, Chualar, Monterey County:

There is no particular variety of alfalfa grown in this part of the country, and very little attention is given to any kind. I secured a beautiful stand of the Turkestan alfalfa, 90 per cent or more of the seed germinating. It seems to have the power of withstanding drought well, as last year was unusually dry. It is hardy and extra early.

Mr. J. R. Robinson, Lancaster, Los Angeles County:

The Turkestan alfalfa is doing well for the first year. It was cut three times. I shall save the seed for further use, as it is difficult to determine its value from a single year's experiment. It was not affected by a temperature of from 100 to 110 degrees.

COLORADO.

Mr. F. E. Ewing, Hugo, Lincoln County:

I have experimented with Turkestan alfalfa for two seasons. The past season was unusually dry, yet this variety of alfalfa withstood the drought well. The growth was only about 12 inches high, but the plants were strong and vigorous. The crop was not irrigated at any time, and we had but one good rain during the season.

Mr. Adolph Froelich, Aroya, Cheyenne County:

A sandy loam, broken last season, was plowed about 6 inches deep this year. The seed was sown broadcast, May 9, 1899, when the ground was very dry, and harrowed in. We had less than the usual amount of rain; in fact, the driest season in eighteen years. The Turkestan alfalfa began to bloom on August 1, and I cut it with a scythe and left it on the ground. It soon grew up again 18 inches high. Part of it was irrigated when sown, and again on the 8th of August. That irrigated has a fine stand, but that not irrigated was a total failure, only twenty-five plants coming in a plot 150 by 100 feet. This variety held its own better after it came up than our common alfalfa would have done; that is, where a good stand was first obtained by irrigation.

Mr. D. Y. Hamill, Seguro, Huerfano County:

The first year, 1898, the Turkestan alfalfa proved to be a quick, strong grower. I cut it when it was 2 feet 2 inches high. It afterwards made a growth of 2 feet before the winter set in. The second season, 1899, was so cold and dry that the Turkestan alfalfa made only one-half a crop. After cutting, it leafed out and remained green till winter. Native grasses—oats, barley, and wheat—did not make one-half stand. Most of the common alfalfa sown in 1898 died in July or earlier, but the Turkestan alfalfa, which was sown on the level ground, grew well. One-sixth of that grown on the slopes died.

Mr. William Raymann, Deertrail, Arapahoe County:

I am in a very poor position this year to give you information, as we had such a very bad season—no rains until too late to be of any use. I plowed the Turkestan alfalfa, never thinking it would grow; but must confess I was surprised, as some of it came up. The crop suffered from an unusually long drought.

Mr. M. J. Weyand, Sedgwick, Sedgwick County:

The Turkestan alfalfa is of a darker-green color, has larger leaves, and grows taller. It will be a famous plant in two more years. It is early, grows rapidly, and would bring a good crop of hay even in a short season. The plant is perfect, but our water is scarce at times.

GEORGIA.

Mr. E. J. Hartman, Orr, Gilmer County:

The soil was well prepared and the seed sown broadcast about the end of May and the field lightly harrowed. It gave two good cuttings of excellent quality. This alfalfa has done wonderfully well on our soil. I have a fine stand now and hope to get excellent crops next year.

INDIANA.

Miss Kate A. Drake, Elkhart, Elkhart County:

A poor, sandy soil was plowed and harrowed. The seed was sown in the fall of 1898, after a rain. It came up nicely and grew well. We had a very severe winter, and some of it froze out, but a large part of it came on again in the spring. This grew well, some of it reaching 18 inches in height. The severe drought caused it to dry up, but did not kill it, as a part of it has come up this fall (1899) and looks very promising. I hope it will be a success. I would like to send you a report next summer after I see if it dries up again. I believe it will be adapted to our soil and prove a valuable acquisition to the drought-stricken parts of the country.

Mr. M. F. Eastman, North Vernon, Jennings County:

A clay loam was well prepared and the seed sown broadcast in March, 1899. The plat, 10 by 200 feet, has been cut three times this season, which has been very dry. The yields were very heavy at each cutting, estimated at 2 tons per acre. I believe it to be a paying crop if a catch can be secured, but, owing to its slow growth, it is difficult to get a stand.

KANSAS.

Mr. A. Y. Bentley, Wallace, Wallace County:

A good sandy loam that had been in cultivation for several years was used. The seed was sown May 12, 1898, and we had rain on the 13th and 14th. I mowed it when about 7 inches high and left it on the ground. The grasshoppers kept it eaten down to the crown, but it came up again and is a good stand now. I sowed several patches of common alfalfa in the spring and the grasshoppers took them all just as they did the Turkestan, which is the only patch that survived.

Mr. Ben. Brown, Natoma, Osborne County:

A rich, light, prairie soil was plowed and harrowed twice. The seed was sown about May 27, 1898. A good stand was up by June 3. It grew well until checked by drought in July and August, but this did not seriously injure it. Since the heavy rains of September 8 to 14, it has grown from 8 to 10 inches high, and is now green. The field looks promising for future crops. I have 80 acres of common alfalfa, which I cut four times each season, getting from 4 to 6 tons to the acre. It does not give a full crop until the third or fourth year. If the Turkestan beats this it will do well.

Mrs. Sarah J. Gilmore, Norcatur, Decatur County:

The Turkestan alfalfa was sown on high upland and received no irrigation. In the summer of 1898 we were sixty-five days without rain, and the alfalfa lived through it, although the plants were small. I think it much better than the common alfalfa to withstand the drought.

Mr. J. G. Gray, Ottawa, Franklin County:

The Turkestan alfalfa is earlier, hardier, more productive, and grows more rapidly than the common alfalfa.

Mr. H. C. Hollowell, Barnes, Washington County:

A dry, black loam was plowed early and harrowed. The seed was sown broadcast about May 20, 1898, and harrowed in. The growth was short, but it stood the dry weather well. I think it better than our common alfalfa.

Mr. C. H. Jackson, Kidderville, Hodgeman County:

The seed was sown May 12, 1898. The alfalfa grew about 6 inches high by the first frost. The dry weather tested it severely, but it would green up now if we had a little rain. This is the only variety that seems to offer a chance for a crop in this part of the State.

Mr. Don. F. Lyman, St. Francis, Cheyenne County:

The Turkestan alfalfa differs from the common variety in having smaller stems and larger roots. It is very hardy, early, quite productive, and grows until very late in the season. The growth of this alfalfa last summer was surprising, as the season was very dry and hot. I believe it is going to be a success here.

Mr. Mads. Olson, Mullinville, Kiowa County:

The soil was second sod in good condition. The seed was drilled in the last day of May, 1898. It came up well and was nicely in bloom when the grasshoppers came and destroyed it.

Messrs. Wm. B. Sutton and Son, Russell, Russell County:

A piece of new black loam was broken and finely cut with a disk. The seed was sown broadcast about May 1. The season was very dry, but I obtained a fine stand, 8 inches high. It withstood the drought well, and is now growing quite nicely. This has been a poor season to test it. A four-year old field of common alfalfa made only one small cutting in June. There was no rain in June, July, or August.

Mr. Theo. Swartz, Salina, Salina County:

The Turkestan alfalfa seems to have finer stems and smaller leaves, which are considerably darker green in color than the common alfalfa. The seed came up evenly, made a good start, and looks fine at present, comparing very favorably with the common alfalfa sown at the same time. As I only sowed in May, 1899, it is too soon for me to judge of its special qualities.

MASSACHUSETTS.

Messrs. Jas. H. Gregory & Son, Marblehead, Essex County:

We planted a small sample of Turkestan alfalfa from your Department, and noted that it made quite 50 per cent more plant and stood the winter better than the common alfalfa planted by its side.

MINNESOTA.

Mr. C. F. Miller, Faribault, Rice County:

I have experimented two seasons with the Turkestan alfalfa and find it very productive. I think from its behavior that it will succeed in the Northwest. The common alfalfa is uncertain here.

MONTANA.

Messrs. W. W. Gamble & Son, Burton, Choteau County:

A gravelly land on bench land was well plowed and harrowed. The seed was sown broadcast, May 19, 1898, with a hand-seeder. No cultivation except irrigation was given the crop. It was in full bloom in July and ripened in August. The quality of the product was good. This seems to be a better plant in its growth than the ordinary alfalfa. The winter of 1898–99 seemed quite trying to alfalfa, with a tendency to winter-kill. In the spring of 1899 our ordinary alfalfa came up bunchy in appearance, and although it recovered itself later in the season, the growth was irregular. The Turkestan alfalfa, however, grew even and uniform throughout the season under precisely the same conditions. It is probably a better variety than the ordinary sort sold here.

Mr. W. H. Heideman, Kalispell, Flathead County:

The soil was very light, sandy, and open, varying to a black, sandy loam. The land was plowed thoroughly, harrowed, then rolled and harrowed again. The seed was sown broadcast and the land then smoothed with a harrow and rolled. It came up May 18, and was in full bloom by July 28. The crop was cut with a mower along with the weeds. So far as the experiment has gone it is very promising. I think the alfalfa has done remarkably well for the first year. The season was very hot and dry, with no rain after June, but the drought did not seem to affect it. It was about fourteen inches high on July 28, 1898. The winter of 1898–99 was very severe, but none of it was winter-killed. The fore part of the season of 1899 was very dry, but a great deal of rain has fallen since August 1st. The plat of Turkestan still continues to do well. It was pastured by hogs till May 28 and then let go for seed. It made a great growth, but did not fill well, the cold weather probably preventing the production of seed. After cutting, the alfalfa grew up again rapidly. I think it is going to be more valuable than the common variety. It seems to do well on alkali spots. I would advise all to sow it as soon as they can secure seed.

Mr. Len. Lewis, Lewis, Meagher County:

Dry, limestone, bench land was used. A good, strong growth was secured. It seems to be hardier than the ordinary alfalfa. I think it is highly satisfactory.

Mr. Emory Vine, Miles City, Custer County:

The Turkestan alfalfa wintered well and is coming on this spring as if it meant business. At the present time it has a decided advantage over our common French alfalfa. It shows green several rods away, while the common variety sown last season has not started to green yet.

NEBRASKA.

Mr. J. A. Anderson, Harrison, Sioux County:

A sandy soil in good condition was thoroughly prepared and irrigated. The seed was sown with oats, May 15, 1898. The quality of the product was good, and I think it will make a valuable forage plant in this section. It did better than the ordinary alfalfa.

Mr. W. Benjamin, Banksville, Red Willow County:

From the short experience I have had with the Turkestan alfalfa, I believe it will succeed in our dry climate when it once gets acclimated. My experiment was handicapped by jack-rabbits, cotton-tails, and grasshoppers destroying the plants.

Mr. T. R. Butler, Beaver City, Furnas County:

The outlook is encouraging. I can hardly tell yet whether it has any special qualities over the common alfalfa, but I think it has. It came up well, producing a good stand when the common alfalfa was killed out by drought.

Mr. J. W. Williams, Weeping Water, Cass County:

A thin, black loam was plowed and harrowed. The seed was sown broadcast, May 25, 1898. The alfalfa made a very heavy growth; withstood our short drought very well and is still in excellent condition. It did much better than our common alfalfa for the first year.

NEVADA.

Mr. H. C. Campbell, Skelton, Elko County:

The Turkestan alfalfa does not seem to require as much water as the common alfalfa.

NEW MEXICO.

Mr. J. A. Gishwiller, Roswell, Chaves County:

A good, clay loam was plowed three times and harrowed fine. The seed was sown broadcast, July 13, 1898, and covered with a harrow. I secured a good stand. The growth was strong and vigorous, somewhat stronger than that made by our common alfalfa sown on adjoining land. Another season will be necessary to compare it well with the common alfalfa.

NORTH DAKOTA.

Mr. Joe Horsky, Anamoose, McHenry County:

No other varieties of alfalfa are grown in this vicinity. The Turkestan alfalfa seems to be hardy both as to drought and cold so far.

Mr. W. Loughland, Nesson, Williams County:

I am pleased to report very favorably on the Turkestan alfalfa received from your Department. I had seven acres sown to the common alfalfa, which was all killed off in the winter of 1898–99, while the Turkestan variety, which was sown May, 1898, was not affected in the least. This winter, 1899–1900, we are having no snow, and I am looking forward to its withstanding the frosts. If it does that, it is just the plant that is wanted here.

Mr. C. M. Lovett, Pingree, Stutsman County:

The seed of the Turkestan alfalfa gave a poor stand at first, but thickened up remarkably well after the fall rains. It seems to be easier to get a catch with his variety than with the common alfalfa. I think it is promising.

Mr. C. F. Miller, Harmon, Morton County:

Alfalfa has never been tried in this neighborhood to my knowledge. The Turkestan alfalfa was sown May 2, 1899. The plants came up within ten days and grew vigorously till injured by frost on June 1. During two weeks of warm weather they started again from the roots and grew until December, when growth was checked by frost.

OKLAHOMA.

Mr. C. L. Boyd, Redmoon, Roger Mills County:

A black, sandy, bottom soil was broken early in February, rebroken at the time of seeding, and harrowed down fine. The seed was sown broadcast, May 5, 1898, and the land was then harrowed and rolled. The quality of the Turkestan alfalfa was the finest I have ever seen. I sowed along side of it a plot of the common alfalfa, and there was a marked difference between them, the Turkestan variety growing much ranker. I think the Turkestan alfalfa the more valuable variety.

Mr. W. A. Rowan, Gallienas, Beaver County:

A sandy soil was plowed, well pulverized, and put in fine condition. The seed was sown broadcast, May 9, 1898, and harrowed in. The field was irrigated about May 25, and again on June 20. I secured a good stand, but the alfalfa does not mature sufficiently the first year to make a good crop. It was sown by the side of common alfalfa and given the same care. The Turkestan variety seems to be stronger and hardier. The value of a good stand would be about $30 per acre.

OREGON.

Mr. F. T. Byrd, Pilot Rock, Umatilla County:

I found the Turkestan alfalfa a superior drought-resisting plant. My experiment was seriously interrupted by the continued freezing and thawing last winter. The plants grew splendidly through the longest and hottest summer ever known in Oregon.

Mr. A. Wintermier, Silvies, Harney County:

A decayed lava and clay soil was used. The Turkestan alfalfa came up very nicely with an even stand. When about three inches high a severe frost cut it down. It grew up again, however, but was a second time cut down by frost, and still it grew to be one foot high. Apparently it will not stand frost as well as the French alfalfa, but seems to be better adapted to dry soils. Another year will determine what it will do in this part of the country.

PENNSYLVANIA.

Mr. J. O. Brown, Pittsburg, Allegheny County:

Alfalfa of any kind is a new plant here. I have tried Wisconsin, Nebraska, and Turkestan seed, and I think the last-mentioned germinates best and is the most hardy. The few plants that were not destroyed by grasshoppers in the summer of 1898 started to grow earlier in the spring of 1899 than the American alfalfa, and, I think, stood the extremely cold winter better. The hot, dry summer seemed to have about the same effect on both kinds, but I think the Turkestan variety recovered quicker in the fall. I have gathered sufficient seed from the sowing of 1899 to double the amount of ground.

SOUTH DAKOTA.

Mr. H. C. Clifford, Casey, Ziebach County:

In May, 1898, you placed in my charge Turkestan alfalfa seed. I planted it May 16 on four different plats.

Plat No. 1.—A black, sandy loam was used. I gave it plenty of water, and the alfalfa came up in four days and grew well. On July 12, when 1½ feet high, it was cut, a plat 40 by 100 feet, yielding 1,200 pounds. I cut it again September 20, when about the same height as before, and it yielded 1,500 pounds. I think it away ahead of the American alfalfa, as a two-year old field of alfalfa, such as we commonly grow in South Dakota, did not yield any better, if as well.

Plat No. 2.—A gravelly and sandy loam was used. The alfalfa came up nicely, although I did not water it; growing to a height of from 4 to 6 inches, where it remained and kept green, although the season was very dry and hot.

Plat No 3.—A rich, black loam was used. The plants grew 2 or 3 inches tall and then died out.

Plat No. 4.—A white, gumbo land was used. The plants came up but did not amount to anything.

Plats Nos. 3 and 4 were sown with oats. The oats grew well, and my opinion is that alfalfa will do better alone, as the oats seem to smother it. Nos. 2, 3, and 4 got only the moisture from the natural rainfall, which was merely sufficient to start it. As to whether it will endure the winter or not, I can not say as yet.

Mr. W. H. H. Phillips, Brookings, Brookings County:

A black loam, with a clay subsoil, was well harrowed and made fine. The seed was sown broadcast about May 20, 1898. In March, 1899, it was covered with barnyard manure. On May 17, 1899, it froze somewhat, which gave the weeds a start. I mowed it early in July. Since then it has made a good growth. The first year it made but little growth, but now (October, 1899) it is very promising.

Hon. H. C. Warner, Forestburg, Sanborn County:

A black, sandy loam was plowed deep in the spring and well prepared. The seed was sown broadcast April 24, 1898, and harrowed in. The stand was perfect, and notwithstanding the drought of summer, and the cold, open winter, without snow, the plants came through in perfect condition. The Turkestan alfalfa was not cut this season, judging that it is better to let it become well established first. Every root of common alfalfa growing by the side of it was killed.

TEXAS.

Mr. Severin Ball, Lytle, Atascosa County:

A black, sandy land was used. I planted the seed the latter part of October, and would have sown earlier, but the ground was too dry. The alfalfa seemed to grow very slowly during the winter; apparently the weather was too cold for it to grow rapidly. As it is only a few months since it was sown, I can not say much about it yet. It seems, however, to be vigorous and long rooted at the present time.

Mr. J. W. Cartwright, Amarillo, Potter County:

The seed was sown the latter part of September, 1899. The alfalfa came up nicely, and now looks well, with four inches of snow on the ground. I am quite proud of this, and will report later on.

Mr. T. A. Coleman, San Antonio, Bexar County:

The Turkestan alfalfa grows luxuriantly here and makes fine hay.

Mr. Wm. Fancher, Taopi, Fisher County:

A dark, sandy loam, with clay subsoil and containing some alkali, was used. The seed was sown October 15, 1899, in very dry weather, but it came up well and produced a good stand by November 1. Thus far the Turkestan alfalfa has done well in this section. I think it will stand the drought well.

Mr. B. H. A. Groth, Selma, Bexar County:

A loam with plenty of lime in the soil was used. The soil in this section does not need drainage, from the fact that for the most part there is nothing to drain, and when there is, the subsoil, a sandy loam, will take it up. The seed was sown April 8, 1899. Last season we suffered from a severe drought. From the 1st of July to the 1st of November there was no rain, and from the middle of July to the last of August the weather was extremely hot. I can as yet answer only to the hardinesss of the Turkestan alfalfa. It is green now (January 2, 1900), and we have had some ice on water in vessels. I believe the Turkestan alfalfa will withstand our dry climate and furnish us a good forage plant.

Mr. J. Q. Hanna, Olga, Nolan County:

The 1898 sowing on what we call black land was a complete failure. The 1899 sowing is showing well on the sandy land. That it is now standing leads me to be very hopeful. I do not know whether the seed will mature here without irrigation; the common alfalfa will not. I have faith that the Turkestan alfalfa will prove a success here. If so, its value can not be overestimated. It will be worth millions to the stockmen of Western Texas.

Mr. George Hoeffert, Schulenburg, Fayette County:

A heavy, black soil was used. The seed was planted about the middle of March, at the same time as some California alfalfa. The Turkestan variety came up sooner and produced a better stand on the same soil. It seems to be earlier, hardier, more drought-resisting, and more valuable than the California alfalfa.

Mr. S. R. Jeffery, Graham, Young County:

A sandy loam was used. I planted the Turkestan alfalfa in drills in the fall of 1898. It came up perfectly, but a very severe winter followed and killed out the greater part of it. In the spring it came rather late and very thin. I did not cut the plants nor allow them to be grazed. They grew to be two and one-half feet high and seeded. We had the driest and hottest summer for years, but the stems of the Turkestan alfalfa kept green through it all, and when our fall rains came numerous shoots came up all around the old plant. It is now, December 28, from eight to twelve inches high, looking very green and fresh. I think it will be a great plant for this section of the State.

Mr. Geo. Loeloff, Hellemans, Bexar County:

A dry, black soil mixed with clay was used. The seed was sown, October 1, 1899, so that the plants could be compared with Colorado seed. The leaves are similar but somewhat broader in the Turkestan variety. On examination of the seedlings of both varieties thirty days after sowing, when three inches high, the Turkestan alfalfa appeared more robust, more leafy, stronger and deeper rooted than the Colorado alfalfa. Further comparison at a later date, December 23, showed these differences to be even more pronounced.

TEXAS.

Mr. W. S. Marshall, Channing, Hartley County:

I believe that the alfalfa from Turkestan is a more valuable plant for this section than the common variety. It withstands the drought much better, seems to be hardier, starts very early in the spring, and is very productive.

Mr. P. P. McDermatt, St. Joe, Montague County:

A black, waxy, somewhat sandy land was used. The seed was planted in the spring of 1899. I have not grown this variety long enough to give a full report on it. I secured a good stand and it withstood the extreme drought of last summer. I expect to get seed from it the coming season.

Mr. H. B. McCurry, Fate, Rockwall County:

The Turkestan alfalfa seems to be a splendid drought-resister.

Mr. R. T. Shelton, Anna, Collin County:

A well-drained, black, waxy soil was used. The seed was sown April 15, 1899. The drought began this summer in July and lasted until the middle of October. The native variety was dried up, while the Turkestan remained green.

Mrs. H. P. Thomas, Ector, Fannin County:

The seed was sown by the side of the native variety. The Turkestan alfalfa made the stronger growth, being almost twice as large. It stood the summer drought very well.

Mr. J. W. Tillerson, Roseland, Collin County:

A black, waxy soil was used. The Turkestan alfalfa is the only variety we have tried. It seems to be early, hardy, and productive, and will be valuable for hay and pasture.

Mr. Arnott West, Brownwood, Brown County:

A rich, deep, black, slightly ashy soil was used. The quality of the product was good, and altogether throughout the season would produce from eight to ten tons per acre. This variety stands the dry weather splendidly in this part of the country if it has a deep, well-drained soil. Alfalfa should be grown here exclusively. I am feeding two hundred steers on it and they are getting fat.

UTAH.

Mr. James Lofthouse, Paradise, Cache County:

The seed was sown broadcast, May 28, 1898, on a clay loam. The alfalfa bloomed July 25, but was destroyed by stock before ripening seed. It stands drought better than the kind of alfalfa commonly grown here. It grew eighteen inches high, and outgrew the common alfalfa under similar conditions.

Mr. Samuel Roskelly, Logan, Cache County:

A dry, sage-bush upland that had been cultivated in wheat for three years, was well plowed and harrowed. The seed was sown broadcast May 9, 1898, and harrowed in lightly. I consider this one of the best and most valuable fodders for dry farms, which are not irrigated, in this western country. I have raised common lucern for twenty years, but for drought resistance I think this is better. My experience is that seed should not be raised from first year's growth, as cutting before maturity causes it to send the roots down to find moisture.

WASHINGTON.

Mr. N. S. Dickinson, Clover, Okanogan County:

The soil was black loam with a clay subsoil. The seed was sown May 15, 1898, and irrigated the first season. The summer of 1899 I let it go to seed, but lost it all on account of heavy rains. I think it is a good variety for this climate. It seems to be earlier than the kind commonly sown here and makes a finer quality of hay.

Mrs. M. A. Kuehn, Valley, Stevens County:

A sandy soil was fertilized and irrigated, and the seed planted in drills about June 10, so as to avoid frosts while the plants were young and tender. The field was irrigated about every eight days. I have a very good stand of alfalfa, and am satisfied this is a good section for growing it. There is no alfalfa grown in this vicinity that I know of, and few people seem to know of its forage value. My Turkestan alfalfa was not affected by drought or cold. I have great faith in it as a food for all kinds of stock.

WEST VIRGINIA.

Mr. Ira C. Snider, Avon, Doddridge County:

The land is a loose, well-drained, sandy loam. The seed was sown April 3, 1899. I believe the Turkestan alfalfa will prove quite successful in this country for its hardiness, and its deep-rooting qualities will enable it to withstand the drought well.

WYOMING.

Mr. Edwin M. Howard, Sarver, Bighorn County:

I am growing the common variety and the Turkestan alfalfa, and am satisfied the latter is the more successful. I can see a difference in the bloom, and the hay is of a finer quality. It starts two weeks sooner than the common alfalfa, grows taller, and will produce more to the acre.

Mr. J. M. Rowsier, Farrall, Crook County:

The Turkestan alfalfa looks very much like the common variety, except that the stems are more slender and taller and grow finer. The experiment has proven that it is especially able to resist drought.

THE RESULTS OF EXPERIMENTS WITH TURKESTAN ALFALFA BY THE STATE EXPERIMENT STATIONS.

Seed of Turkestan alfalfa was sent to Experiment Stations in the following States:

Alabama, Arizona, California, Colorado, Connecticut (Storrs Station), Florida, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York (Cornell and Geneva Stations), Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Texas, Utah, Washington, and Wyoming.

Reports have been received from the Experiment Stations as follows:

ALABAMA.

Canebrake Experiment Station, Uniontown.

The Turkestan alfalfa was planted in March, 1899, and cut for hay three times during the season. It stood the dry fall and winter freezes fairly well, but not so well as our common Medicago sativa. The plat is now (March 28, 1900) in a flourishing condition with plants about 8 inches high, which will be ready to cut for hay in about fifteen days.—H. BENTON, *Director.*

CALIFORNIA.

State Experiment Station, Berkeley.

Seed of Turkestan alfalfa sent to the California Experiment Station by the Section of Seed and Plant Introduction, Department of Agriculture, was forwarded by me to the substations and also planted at the Central Station. This was in March, 1898. The season was dry, to very dry, throughout California, and even in favorable seasons alfalfa should be planted in the autumn, with the first rains, or not later than January.

At the Central Station the seed was sown on good soil and had more rainfall than at other places. The Turkestan variety showed no especial peculiarity in the season's growth, excepting that it was more compact than other alfalfa.

The seed sent to the Amador County substation (elevation 2,000 feet) in the Sierra foothills grew excellently without irrigation, but was badly eaten down by rabbits.

At Pomona in the Chino Valley, Los Angeles County, the Turkestan alfalfa was tested on alkali soil and on arid, sandy soil. In both of these localities it proved superior in drought resistance to the common variety.

The best test of this alfalfa was at Paso Robles substation, San Luis Obispo County. The total rainfall of season was about 5 inches, distance to water nearly 200 feet, and the soil shallow and very poor, on deep hardpan. The only two species of forage plants which endured these conditions and remained green during the summer without irrigation were Turkestan alfalfa and Australian saltbush (*Atriplex semibaccata*). The latter made growth and furnished more fodder, but the former promises well and deserves much more extended trial under similar conditions.—C. H. SHINN, *Inspector of Stations.*

COLORADO.

State Experiment Station, Fort Collins.

Of the Turkestan alfalfa furnished by the Department of Agriculture last season most was distributed by Professor Cooke of the Agricultural section. Some was tried at the substation at Rocky Ford and at Cheyenne Wells. A good part of the seed was sown on the elevated ridge between the Arkansas and Platte rivers known as the Divide. The results have been rather negative, that is, the plant has not been especially better than our alfalfa, which is the common plant grown in Colorado under irrigation. It was a poor stand at Cheyenne Wells which is not irrigated and did not do so well on the Divide, which is also without irrigation.—L. G. CARPENTER, *Director and Irrigation Engineer.*

CONNECTICUT.

Storrs Experiment Station, Storrs.

The Turkestan alfalfa received from the Section of Seed and Plant Introduction was sown April 21, 1898. The soil is a medium heavy loam, with good natural drainage. The land was plowed, harrowed, and raked before seeding. For several years previously the plat of ground had been fertilized, mainly with mineral fertilizers. *Method of Seeding*: Oats were first sown at the rate of about 2½ bushels per acre (designed as a protective crop), the alfalfa seed was sown on a fine seed beed, immediately after sowing the oats, at the rate of about 50 pounds per acre. The oats and alfalfa both germinated well and made a good growth for two or three weeks. We had a severe drought, lasting from the early part of May till after the middle of June, and during this period the alfalfa made a very slow growth. The oats were cut off rather high June 15, and again July 18. The weeds by this time had become quite thick, and owing to the weak condition of the alfalfa plants, most of them died out during the latter part of the summer.—C. S. PHELPS, *Vice-Director.*

MASSACHUSETTS.

Hatch Experiment Station, Amherst.

The Turkestan alfalfa was sown side by side with alfalfa seed from a number of different sources, as follows: Arizona, Colorado, California, Utah, and Kansas. The seed from all sources was sown in rows in well-drained, medium loam. The plants were hand cultivated and hand weeded to give them a good start. The Turkestan variety proved among the least hardy. The plants were seriously affected by a parasitic growth upon the leaves, which appeared to be a rust which seriously weakened them, and at the end of the first winter nearly all were dead. The seed which came from Kansas and Utah gave the best results.—WM. F. BROOKS, *Agriculturist.*

FLORIDA.

State Experiment Station, Lake City.

A portion of the Turkestan alfalfa seed was sown upon new ground, prepared fur the purpose, but, either through unadaptation to our climate or the exceedingly dry weather, it failed to germinate, so we did not succeed in securing anything like a satisfactory stand. My impression from so slight a trial is that it is not adapted to the dry soils of Florida, except where irrigation is possible.—H. E. STOCKBRIDGE, *Agriculturist.*

ILLINOIS.

State Experiment Station, Urbana.

The Turkestan alfalfa did not prove upon our grounds more hardy than other varieties, and seemed unable to withstand the conditions.—A. D. SHAMEL, *Assistant in Agronomy.*

INDIANA.

State Experiment Station, Lafayette.

A small area, perhaps one-fortieth of an acre, was seeded to Turkestan alfalfa, with seed obtained from the Department of Agriculture, Washington, D. C., in 1898. I recall that my former assistant thought this made a better growth than the home-grown alfalfa seed. By some oversight, however, he left no written record concerning it. My present assistant tells me that it did not stand the winter of 1898–99 as well as the home-grown seed, and that it did not consequently make as large a growth in 1899. It also seemed to be more affected with some leaf disease. This, however, is common to all alfalfa that we have grown here, the second season. I think it due rather to the dry conditions and the hardpan layer from one and one-half to three feet below the surface of the soil.—W. C. LATTA, *Agriculturist.*

IOWA.

State Experiment Station, Ames.

In the spring of 1898 one-quarter of an acre was seeded with Turkestan alfalfa, received from the Department of Agriculture. A similar area was seeded with the common alfalfa, 20 pounds of seed per acre being used in each case. Both crops flourished during the first season, and by fall the ground was completely occupied with plants. In January and February of 1899 the weather was unusually severe, so much so that clover throughout the State was killed. Not a solitary plant of the common alfalfa lived through the winter, and only about one dozen survived on the Turkestan plot, a stand which we did not consider sufficient to justify us in allowing it to remain.

This experience would lead us to believe that the Turkestan is slightly more hardy than the common variety, but not sufficiently so to withstand the severe conditions which sometime prevail in this State.—JAMES ATKINSON, *Assistant in Agriculture.*

KENTUCKY.

State Experiment Station, Lexington.

The Samarkand alfalfa seed was planted (three-eighths of a pound to one-eightieth of an acre) May 21, 1898. It produced only a fair stand, which, August 21, was six inches high—an even growth, but rather spindling. All through this season it looked weak and unpromising. In 1899 it appeared much stronger. Under date of May 23, 1899, I find the following among my notes: "This plot, started from seed furnished by the Department of Agriculture, is now in excellent condition, averaging about 16 inches high and densely covering the ground with a fine green growth, among which some purple heads can be seen. I can see no difference between it and other alfalfa." August 23, 1899, the plat was again noted as in excellent condition and the growth about 18 inches high, with some bloom. It was cut, and material was secured for chemical analysis. We have had in the experiment farm for many years a plat of alfalfa started from seed obtained from an eastern seedsman. It looks and behaves much like Samarkand alfalfa. Both withstand drought well; both hold their own against weeds very well. The older plat has furnished two cuttings during some specially favorable seasons, but at other times would produce but a scant cutting. It has held its own, however, better than the red clover planted near it. It must be added that the soil is rather sterile for this region, and otherwise is not well adapted to the plant. We are starting new plats in better land this spring and may have a more favorable report to make later.—H. GARMAN, *Botanist*.

LOUISIANA.

State Experiment Station, Audubon Park.

The Turkestan alfalfa received by us and distributed by the Section of Seed and Plant Introduction was duly received and planted. It was rather late in the season to plant alfalfa, which is usually done here in early October, and from this cause and, perhaps, from defect in the seed, we did not obtain as good a stand as we usually do. However, we have still growing over an acre of this crop from the seed sent us. There are growing near it several acres of alfalfa from our home-grown seed, and the difference in growth is very noticeable. Our home-grown gives us from six to eight cuttings per year; the Turkestan has given only three to four. During the winter just passed we have not cut the Turkestan at all; in fact, it remained almost stationary from last October up to the present time. It has now the appearance of putting on a new growth. In the meanwhile, we have cut the home-grown alfalfa twice during the winter. The plants seem to be identical, but I fear the Turkestan variety is not yet acclimated to our environments. We intend this year to let it go to seed in order that we may experiment afresh with the seed grown from that sent us.—W. C. STUBBS, *Director*.

MARYLAND.

State Experiment Station, College Park.

We made every effort to get a stand of the Turkestan alfalfa, but failed to do so, partially on account of the failure of the seed to germinate and partially on account of the very dry weather which prevailed throughout the growing season of 1898, so that, on the whole, our test with the seed was a failure.—H. J. PATTERSON, *Director*.

MISSOURI.

State Experiment Station, Columbia.

The alfalfa seed from Turkestan, furnished by the Department of Agriculture, was sown April 26, 1898, on carefully prepared seed bed and lightly covered with a hand rake and rolled. Only a small proportion of the seed germinated, and many of the plants died apparently from the excessive heat of July and August. The stand was further reduced by the alternate freezing and thawing of the following spring, leaving so small a number of the plants that the plats were abandoned. This alfalfa does not seem to be quite so hardy as the common alfalfa.—H. J. WATERS, *Director*.

NEBRASKA.

State Experiment Station, Lincoln.

On May 24, 1898, a one-tenth acre plat of ground was seeded to Turkestan alfalfa by drilling with a press drill in rows 6 inches apart. The seed began to come up on May 30, giving a good stand. It was cut three or four times during the summer to keep down the weeds, but no crop of alfalfa. In 1899 it was cut on June 15, yielding at the rate of one and seven-hundredths (1.07) tons of hay per acre. This was considerably less than the yields obtained from ordinary alfalfa in nearby fields cut at the same time. The other fields were older, but one sown in 1897 gave in 1898 a yield of two and one-half tons of hay to the acre and in 1899 two and one-quarter tons. Our experience with the Turkestan alfalfa would indicate that it does not produce as heavy yields as does the ordinary variety.

It seems, however, to have a somewhat smaller leaf and thinner stem, which would indicate a somewhat higher feeding value. During the winter of 1898–99, which was a very severe one in this region, the Turkestan alfalfa suffered absolutely no loss from winter-killing, while the ordinary alfalfa killed out to some extent.—T. L. LYONS, *Acting Director.*

NEW JERSEY.

State Experiment Station, New Brunswick.

The Turkestan alfalfa sent to us by the Department of Agriculture was given a trial on a plat of ground containing one-fifth of an acre. The soil was a medium clay loam, well drained. The seed was sown May 14, 1898, at the rate of thirty pounds per acre, and a good stand was secured. The yield the first season (1898) was at the rate of 7.5 tons per acre from two cuttings. The second season (1899) four cuttings yielded at the rate of 9.42 tons per acre. Four-fifths of an acre of the variety which is commonly grown was sown at the same time as the Turkestan and yielded the first season (1898) at the rate of 8 tons per acre from two cuttings, and the second season at the rate of 20.2 tons per acre from four cuttings, and was much more vigorous than the Turkestan variety. The results indicate that the common variety is superior to the Turkestan for this locality.—C. B. LANE, *Assistant in Dairy Husbandry.*

NEW MEXICO.

State Experiment Station, Mesilla Park.

On the 13th of April, 1898, six pounds of Turkestan alfalfa seed were sown broadcast on one-fourth of an acre. The seed was covered with an ordinary tooth-harrow, and on the same day it was irrigated to produce germination. By the 4th of May the alfalfa was growing quite well, but the ground had baked and cracked considerably; and in order to help the weaker plants break through the crust, another irrigation was given on this date. Nothwithstanding the fact that the seed had been sown late in the season, the germination was good and uniform. The first crop was cut June 13, when the alfalfa was about a foot high but was not yet in bloom. On the 17th, four days after cutting, it was irrigated to start the new growth. On July 21 the second crop was cut, but owing to the lack of water to irrigate with and the drought, the alfalfa made a short crop. During the rest of the season the alfalfa made a very short growth, as the drought continued and there was no water for irrigation. The Turkestan alfalfa, under similar conditions, will grow as well and yield as much as our common alfalfa (*Medicago sativa*) in this region. There seems to be no material difference between the two varieties in their drought-resisting qualities.—FABIAN GARCIA, *Assistant Agriculturist.*

NEW YORK.

Cornell Experiment Station, Ithaca.

The Turkestan alfalfa seed, which was received by the Cornell University Experiment Station, was planted on a gravelly loam soil in May, 1898. The soil was one especially subject to effect of droughts, and no fertilizer has been applied for the past five years. The alfalfa seed germinated quickly, and the plants made good growth. Three cuttings were made in 1898. During the winter of 1898–99 a portion of the alfalfa was killed by the ice which formed over it. Seed was sown upon the patches killed out, and a good growth was secured during the season of 1899. We cut the alfalfa four or five times during the season. From what I have seen of it, I should say that for our soil it is not as valuable as our common alfalfa or lucern.—L. A. CLINTON, *Assistant Agriculturist..*

OHIO.

State Experiment Station, Wooster.

We sowed the Turkestan alfalfa seed April 29 on a piece of land previously well prepared. The soil would be designated as clay loam, with a subsoil definitely clay. This alfalfa made a fair stand, but by the first of July had nearly all died out or disappeared. This has been the common experience with alfalfa here. It does not seem to be adapted to the soil, I think, for the reason that it is rather too tenacious in its make up. It has been our greatest difficulty to secure a stand of alfalfa, but when we get it started it does well and holds well in the ground.—J. FREMONT HICKMAN, *Agriculturist.*

OKLAHOMA.

State Experiment Station, Stillwater.

The Turkestan alfalfa seed received from the Department of Agriculture was sown alongside of some Kansas-grown seed. Last season was a poor one for the alfalfa yields, though the stand was not seriously affected. No comparative yields were obtained, and at this time no appreciable difference exists between the stand and vigor of the plants on the two plats, both starting off vigorously and giving promise of good yields this season.—JOHN FIELDS, *Director.*

RHODE ISLAND.

State Experiment Station, Kingston.

The Turkestan alfalfa, of which the seed was sent here in 1898, was tested on the station grounds. It germinated well and came through the winter of 1898 and 1899 in excellent condition, showing itself as hardy as the other five lots of alfalfa, the seed of which came from different States and was also being tested. In yield it was a fair average with the others. A part was sown on ridged and a part on level land, to see under which method of cultivation it would winter best. So little difference was noticeable as to make no practical difference in favor of either method.—J. A. TILLINGHAST, *Assistant, Field Experiments.*

SOUTH CAROLINA.

State Experiment Station, Clemson.

I received the Turkestan alfalfa too late for spring planting in 1898. Planted plants on alluvial river bottom in July, August, and September following. The July and September plantings vegetated well, the August planting poorly. All plants disappeared during the late fall and winter, probably on account of the very wet season, as alfalfa sown near by failed in the same way. No experiment was made on upland.—J. S. NEWMAN, *Agriculturist.*

SOUTH DAKOTA.

State Experiment Station, Brookings.

I have just made a careful examination of the Turkestan alfalfa sown in the spring of 1898, and find that it has stood the winter well. All the plants seem to be alive and are begining to make a strong, vigorous growth.

The winter of 1898–99 was a very severe one on all kinds of meadows, and nearly all clover in this locality was completely killed out. The Turkestan alfalfa, however, was not injured. The past winter was very mild and open and not so trying upon meadows, but there was no snow to protect the alfalfa; it has come through this, its second winter, in fine shape and is now well established, and is certainly the most promising variety of alfalfa yet tried in this locality.—E. C. CHILCOTT, *Vice Director and Agriculturist.*

WYOMING.

State Experiment Station, Laramie.

Following is a brief report of our results with Turkestan alfalfa from seed furnished by the Department:

Sown in spring of 1895.—Not cut that season.

In 1896 the plat was cut only once (September 21), and the yield was small.

In 1897 it was allowed to go to seed, but was planted so thickly that the seed failed to ripen here, as the seasons are very short.

In 1898, cut August 3; yield, 6,446 pounds per acre. Cut a second time, September 15; yield, 943 pounds per acre. Total yield, 7,389 pounds per acre, cured hay.

In 1899, cut July 20; yield, 4,717 pounds per acre. Cut a second time September 18; yield, 3,145 pounds per acre. Total yield, 7,862 pounds per acre, cured hay.

Average yield last 2 years, Turkestan alfalfa: First cutting, 5,581 pounds; second cutting, 2,044 pounds; total for season, 7,625 pounds cured hay.

Average yield last 2 years, common variety: First cutting, 4,620 pounds; second cutting, 1,710 pounds; total for season, 6,330 pounds cured hay.

The winter of 1898–99 was unusually severe. The plat of Turkestan alfalfa was not affected, while the common variety suffered winter killing to a considerable extent.—B. C. BUFFUM, *Vice Director and Agriculturist.*

SUMMARY.

The results thus far reported are at first glance apparently quite contradictory, particularly with respect to the tests made at the State Experiment Stations. If these reports are analyzed closely, however, it will be seen that the results are what might be expected from our knowledge of the Turkestan alfalfa and the natural conditions under which the variety has been developed. The reports from the region west of the Mississippi River and north of Kansas and California indicate that this variety is hardier and more productive than that commonly grown in this region. It seems to endure drought better, is not so easily affected by freezing, and gives better results on strongly alkaline soils. In the East, however, where there is a heavy rainfall and where heavy soils predominate, this variety seems to be little, if any, superior to the French or Chilean varieties; in fact, it seems certain that, in some localities at least, it is less valuable. In the South so few tests have been made that no definite conclusions can be drawn, the reports from some sections being favorable to the Turkestan alfalfa, while those from others indicate that the commonly grown varieties are the most valuable. In the extreme Southwest the results are as yet quite contradictory, and further experimentation is needed.

The seed of Turkestan alfalfa will germinate much quicker and the plants start into growth earlier under the same conditions than common alfalfa. The plants are more leafy, grow more rapidly, and have a stronger, more vigorous root system. Another advantage which the Turkestan variety has is that the stems are more slender and less woody, the plants making a more nutritious hay of finer quality. That it will withstand drought under the same conditions better than ordinary alfalfa seems certain from the reports of the experimenters. In the West and Northwest, at least, it seems to be more productive, both with and without irrigation.

There is every indication that the introduction of this variety will result in a very marked extension of the area devoted to the cultivation of alfalfa, and this, too, in sections where the forage problem is one of paramount importance, and where heretofore climatic conditions have largely prohibited the growing of leguminous forage crops.

P. Beveridge Kennedy, Ph. D.,
Expert and Agent in Charge of Experimental Work.

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CIRCULAR No. 26.—(Agros. 71.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

F. LAMSON-SCRIBNER, Agrostologist.

RESCUE GRASS.

Bromus unioloides (Willd.) HBK.

DESCRIPTION.

An annual, or sometimes perennial grass, growing three to four feet high under favorable conditions and sending up several stems from the same base. The panicle is usually large and spreading, bearing much flattened spikelets about one inch long and one-quarter of an inch wide, composed of seven to ten florets overlapping each other. The flowering glumes are rather coarse in texture, strongly nerved, and usually bearing a short point or awn rarely exceeding an eighth of an inch in length. The "seed," in the commercial sense of the term, represented in fig. 1, *b*, consists of the flowering glume with the inclosed palet and grain.

FIG. 1.—*Bromus unioloides* (Willd.) HBK. RESCUE-GRASS: *a*, outer or empty glumes; *b*, side view of one of the florets; *c*, palea

There are several forms in cultivation, varying somewhat in the size of the panicle and the length of its branches, also in the length of the awn on the flowering glume. The form illustrated in the figure is the one to which the name *Bromus schraderi* has been especially applied. It differs from the typical form only in having the branches somewhat longer and more drooping.

HISTORY.

Rescue grass was known to botanists in Europe in the latter part of the eighteenth century. In 1806 it was described and figured by Willdenow from specimens grown in the botanical garden at Berlin from seed sent from Carolina, where it had apparently been introduced. The grass is a native of South America, where it is quite widely distributed. It also appears to be native in Central America and Mexico and possibly southern Texas, but apparently became distributed in our Southern States through the agency of the European settlers. The first attempt to introduce it into cultivation to any extent, so far as we can learn from published records, was made by B. V. Iverson, of Columbia, S. C., in 1853 and 1854. He wrote some glowing accounts of it and was quite successful in introducing it in various parts of the South at the rate of $5 per peck. He also gave it the name, "rescue grass." It was also called in his honor "Iverson's grass."

About this time it was also introduced into Australia, where it was very popular for some time under the name of California prairie grass, this name having arisen apparently from the erroneous idea that it was a native of California. It is still used quite extensively in Australia under various names, as Australian oats, Australian brome, and prairie grass, and is highly regarded by writers on Australian grasses.

It was also introduced into France with very extravagant statements, made mostly by people hoping to derive profit from its sale. It was called Schrader's brome-grass, a translation of one of its botanical names, *Bromus schraderi*. This name is also more or less prevalent in this country. It has also been called arctic grass.

CULTIVATION AND USE.

This grass is adapted to cultivation in the Gulf States and has been tried with success as far north as North Carolina. Its value is in its use for winter pasture and hay. It has been tried at several of the experiment stations in the South and spoken of very favorably. In eastern Texas it is rather common as a volunteer crop and is spoken of very highly by some of the farmers. It grows best on a rich, loamy soil, and will do well in somewhat shady locations. On light, poor soil it produces but a scanty growth, and for pasture in such soil it is inferior to rye. To secure the most satisfactory results, the land should be well plowed and harrowed, and the seed drilled or sown broadcast and harrowed in, using 30 to 40 pounds of seed per acre.

The seed is rather expensive at present. It is sold by most of the larger dealers and is quoted at from 25 to 30 cents per pound, or 10 to 25 dollars per hundred-weight. The seed weighs about 16 pounds per bushel. After having seeded a small area, the grower may find it profitable to grow his own seed rather than pay 25 or 30 cents per pound for it.

The seed should be sown in late August or early September, so as to be ready to germinate as soon as the first fall rains come. In case of a dry autumn the crop will be late, but under favorable conditions a heavy stand will be produced, furnishing excellent pasture from December to April or May; or if it is desired for hay, one or sometimes two crops may be secured.

The grass is naturally an annual, producing its seed and then dying, but if prevented from seeding by continuous cutting or pasturing, it will survive several years and produce well; but as the grass dries up during the summer, the use of the land during that period is practically lost. Results giving the most general satisfaction in growing this grass may be secured by pasturing it until spring and then letting it reseed itself. After it has matured its seed, the land may be plowed and sown, preferably to cowpeas or Japan clover, which should be harvested in time to allow the rescue grass to start again with the first autumnal rains. Excellent volunteer crops may be secured in this way for several years.

FEEDING VALUE.

Oats, rye, barley, and hairy vetch are the other principal annual plants grown with more or less success for winter forage in the region to which rescue grass is adapted; so that it must be compared with these in determining its relative value. Professor Tracy, writing of this grass in Bulletin No. 20, of the Mississippi Station, says: "Sown with equal care it will give a better winter pasture than will either oats or rye, and in the spring can be plowed in with equal advantage as a fertilizer." For hay, Professor Phares says it is equal to a good stand of oats.

Professor Brunk, of the Texas Agricultural College, in writing of it, says: "It makes more forage in February and March than any other grass tried. When cut for hay in April it produced about two tons per acre." He places it second in a list of grasses for winter pasture in Texas, placing reed canary grass, which is a perennial, first.

Professor McCarthy, in reporting on this grass in Bulletin No. 73, of the North Carolina Experiment Station, says: "It requires rich, moist, light soil. On poorer soils it is much inferior to common rye for winter grazing."

Its nutritive value is high. Comparing the chemical analyses of the grass with those of rye and oat fodder, it is found that it contains a larger percentage of protein and fat than either. Its nutritive ratio is 1.6, showing it to be a well-balanced ration for stock.

Experience has shown that though rescue grass can not be offered as a panacea for all the troubles of the Southern farmer as was first claimed, it can be safely recommended as a valuable addition to the winter forage plants of the South, either for hay or pasture.

CORNELIUS L. SHEAR,
Assistant Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *May 21, 1900.*

CIRCULAR No. 27.—(Agros. 74.) (Issued Dec. 4, 1900.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage-Plant Investigations.]

F. LAMSON-SCRIBNER, *Agrostologist.*

AGROSTOLOGICAL NOTES.

INTRODUCTION.

In the present circular, to which the general title "Agrostological Notes" is given, are considered:

1. Grasses in the Herbarium of Dr. H. Muhlenberg.
2. Two New Species of *Eatonia.*
3. A New Variety of *Panicum nashianum.*
4. Nomenclature Notes.
5. Notes on *Melica* and *Stipa.*

The circular is scientific in its character and is of interest to the student of systematic Agrostology. The examination of Muhlenberg's grasses by Mr. Merrill and myself has helped to clear up some doubtful points in synonymy. The several papers here presented are too short to be issued in bulletin form, but it has been thought that the matter was of sufficient importance to warrant its publication as a circular, thus avoiding needless delay.—F. L.-S.

1. THE GRASSES IN THE HERBARIUM OF DR. H. MUHLENBERG.

By F. LAMSON-SCRIBNER and ELMER D. MERRILL.

In 1817 Dr. H. Muhlenberg published his "Descriptio Uberior Graminum et Plantarum Calamarium Americæ Septentrionalis." The collections upon which this work was based are now the property of the American Philosophical Society, and at present are deposited in the Academy of Natural Sciences of Philadelphia. Through the courtesy of the Conservator of the Botanical Section of the Academy opportunity was given to make a careful examination of this collection. The specimens are preserved in folios 10½ by 15 inches, which are inclosed in wooden book-like cases, opening by a slide upon one side. They are well preserved, and although often fragmentary, at least in the case of North American material, they are sufficiently ample for identification. The *Gramineæ*, *Cyperaceæ*, and *Juncaceæ* occupy three boxes and are consecutively numbered from 1 to 414. The classification is according to the Linnæan system. No data accompany the specimens in most cases excepting the numbers, which are the same as those of the list of the species contained in the folio, written upon the outside sheet. These names are not always the same as those under which the species are published, but the arrangement of the specimens follows that of his work and there is seldom any doubt as to the plant intended. It not infrequently happens, however, that more than one species is included in a fold. When this occurs, it is usually possible to determine the plant referred to, by careful examination of the description. Unfortunately many of Muhlenberg's species are not represented in his herbarium. There has long been a doubt as to the identity of a number of Muhlenberg's species through a lack of knowledge of his types, and it has not infrequently happened that they have been wrongly referred or the names cited as synonyms under species with which they are in no wise related. On this account the matter here presented will be of interest from the fact that it serves to clear up many points of synonymy.

"151 **Panicum pungens** M. 97 Elliott, 358." This was published as *Panicum setaceum* Muhl. Descr. 99. *Panicum neuranthum* Griseb., is the same. A specimen in this sheet bears the label "*P. uniflorum* n. s. ?"

"152 **Panicum glaucum** M. 98 a" = *Chætochloa glauca* (L.) Scribn.

"153 **Panicum glauco** *aff. aristis purpur.* Mon. 99 a. b." This was published by Muhlenberg, Descr. 101, without name, Schrader giving it the name *Setaria affinis* in Roemer & Schultes Mantissa **2**: 276. 1824. One specimen on this sheet, labelled *Panicum polystachion*, is *Chætochloa corrugata parviflora* (Poir.) Scribn. & Merrill. Another specimen is *Chætochloa imberbis* (Poir.) Scribn.

"154 **Panicum lævigatum** Elliott 352 M. 99 c"=*Chætochloa imberbis* (Poir.) Scribn. A very young form with undeveloped spikelets, exactly matched by a specimen in Herb. U. S. Department of Agriculture, collected in the Dismal Swamp, Virginia, by G. McCarthy, 1883.

"155 **Panicum viride** Mon. 100"=*Chætochloa viridis* (L.) Scribn.

"156 **Panicum verticillatum** Mon. 98, b"=*Chætochloa verticillata* (L.) Scribn.

"157 **Panicum italicum** M. 101 a"=*Chætochloa italica* (L.) Scribn.

"158 **Panicum germanicum** M. 101, 6, Elliott 33"=*Chætochloa italica germanica* (Mill.) Scribn.

"159 **Panicum hirtellum** Elliott 85, Mon. 100 b"=*Oplismenus hirtellus* R. & S.

"160 **Panicum crus-galli** M. 102 a." There are two forms in this cover—one the common long-awned, long-branched form of *Panicum crus-galli* L.; the other, *Panicum crus-galli muticum* Vasey.

"161 **Panicum crus-galli** var. **humifusa** M. 102, 6." There is nothing in this cover.

"162 **Panicum hispidum** M. 103 b, Elliott 35"=*Panicum walteri* Pursh.

"163 **Panicum colonum** v. **serotinum** M. 103 a"=*Panicum colonum* L.

"164 **Panicum dimidiatum** Walter, Ell. 478." This was published by Muhlenberg, Descr. 108, as *Panicum walteri*, and is *P. digitaroides* Carpenter.

"165 **Panicum molle ?** Mon. 77 c"= **Eriochloa mollis** (Michx.) Kunth.

"166 **Panicum latifolium** Mon. 104 a." This cover contains both forms of *Panicum latifolium* L. (*P. porterianum* Nash and *P. pubifolium* Nash)and also a form of *Panicum commutatum* Schultes.

"167 **Panicum scoparium** M. 104 b, **macrocarpon** Ell. 481." In this cover is one specimen of true *Panicum scoparium* Lam. (*P. viscidum* Ell.) and one specimen of *Panicum pauciflorum* Ell.

"168 **Panicum clandestinum** M. 105 b" = *Panicum clandestinum* L., as understood by modern botanists.

"169 **Panicum nitidum (microcarpon)** M. 105 b" = *Panicum polyanthes* Schultes.

"170 **Panicum depauperatum** M. 106." This cover contains the form now recognized as *Panicum depauperatum*, and also specimens of *Panicum linearifolium* Scribn.

"171 **Panicum verrucosum** M. 107, 6" = The form so considered to-day.

"172 **Panicum dichotomum** M. 107 a, b." In this cover are several specimens of *Panicum dichotomum viride* Vasey, the form now considered as true *Panicum dichotomum* Linn. by common consent. The tall form of *Panicum lucidum* Ashe is also represented, and also several unrecognizable scraps.

"173 **Panicum laxiflorum** Lamarck, M. 108 a" = *Panicum barbulatum* Michx. This was published by Muhlenberg, Descr. 114. 1817, as *Panicum discolor* Sprengel. In this cover are also a few scraps of the form generally referred to *Panicum pubescens* Lam. by recent authors.

"174 **Panicum flexuosum** ? M. 108 b." This form was published by Muhlenberg in his Descriptio 115, as *Panicum discolor* co-species *vel varietas major*, and is exactly identical with *Panicum mattamusketense* Ashe, Journ. E. Mitch. Sci. Soc. **15:** 45. 1898. Ashe's name must, however, be retained as *major* is preoccupied by *Panicum nitidum* var. *majus* Pursh, Fl. Am. Sept. **1:** 67. 1814.

"175 **Panicum pubescens** M. 109." This cover contains true *Panicum scoparium* Lam. (*P. viscidum* Ell.), and also several plants erroneously referred by botanists to *Panicum pubescens* Lam.

"176 **Panicum melicarium** M. 112." This species has previously been referred to *Panicum hians* Elliott, but is *Sporobolus junceus* (Michx.) Kunth.

"177 **Panicum agrostoides** M. 111." This cover contains the form generally referred to *Panicum agrostoides* Muhl., and also specimens of *Panicum elongatum* Pursh, not Salisb.

"178 **Panicum divergens** Elliot 358, M. 112, 6" = *Panicum cognatum* Schultes.

"179 **Panicum virgatum** M. 112." This cover contains several specimens of the form considered to-day as true *Panicum virgatum* L. and also a specimen of *Panicum amarum* Ell.

"180 **Panicum rostratum** M. 113, **anceps** Mx." = *Panicum anceps* Michx. There is also a specimen of *Panicum agrostoides* Muhl. in this cover.

"181 **Panicum geniculatum (dichotomiflorum)** M. 114" = A small branched form of *P. proliferum* L.

"182 **Panicum capillare** L. M. 115 a" = The common large panicled form of this species.

"183 **Panicum capillare minor**" = *Panicum flexile* (Gatt.) Scribn. Mr. Nash[1] referred the wrong plant to *Panicum minus* (Muhl.) Nash. The synonymy of this form should be as follows:

Panicum philadelphicum Bernh.; Trin. Gram. Pan. 216. 1826, as synonym; Nees, Agrost. Bras. 198. 1829. (*Panicum diffusum* Pursh, Fl. Am. Sept. **1**: 68. 1814, not Swartz, 1788; *P. capillare minus* Muhl. Descr. 124. 1817, not *P. pubescens minor* Poir. in Lam. Encycl. **4**: 272. 1816, nor *P. minus* Nash, Bul. Torr. Bot. Club, **22**: 421. 1895. *P. capillare flexile* Gatt. Tenn. Fl. 94. 1887; *P. flexile* (Gatt.) Scribn. Bul. Torr. Bot. Club, **20**: 416. 1893.) We believe

[1] Bul. Torr. Bot. Club, **1**: 421. 1895.

Panicum philadelphicum to be the earliest tenable name for this species, as the description applies to the form here referred to that species, and, moreover, the statement is made by Nees that he had seen specimens in Schreber's Herbarium (which were doubtless from Muhlenberg), and at the same time he cites *Panicum capillare minus* Muhl., as a synonym. For the form referred by Mr. Nash to *Panicum minus* we propose the following: PANICUM MINIMUM (Engel.) n. comb. (*Panicum capillare minimum* Engel.; Scribn. Tenn. Agr. Exp. Sta. Bul. **7**: 44, *fig. 40*, 1894; *P. minus* Nash, Bul. Torr. Bot. Club, **22**: 421. 1895, not *P. capillare minor* Muhl. Descr: 124. 1817.)

"184 **Panicum** ——— M. 116 a, N. Angl." This is described on page 37 of the "Descriptio" without name. Roemer & Schultes gave it the name of *Panicum spretum*, Mantissa, **2**: 248. 1824. This is exactly *Panicum eatoni* Nash, Bul. Torr. Bot. Club, **25**: 84. 1898, and should be referred to *Panicum nitidum* Lam. (See Bul. **24**, Division of Agrostology.)

"185 **Panicum aquaticum** M. 116 b, Elliott 38" = *Panicum gibbum* Ell.

"186 **Panicum ciliatum** M. 117, Elliott 480" = *Panicum ciliatum* Ell.

"187 **Panicum strigosum** M. 117, Elliott 497." This species is in the same relative position in Muhlenberg's Herbarium as is the description of *Panicum cartilagineum* in his "Descriptio." There is in this cover of *Panicum strigosum* one specimen of *Panicum nashianum* Scribn., one specimen of *Panicum scabriusculum* Ell., and several specimens labeled "*Panicum aureum*," which are now referred to *Panicum laxiflorum* Lam. *Panicum nashianum* Scribn. = ? *P. cartilagineum* Muhl.

"188 **Panicum,** guinea-grass polyg." = *Panicum maximum* Jacq.

"189" = 188.

"190 **Panicum** near **enslini.**" This cover contains both *Panicum baldwinii* Nutt. and *P. wrightianum* Scribn.

"191 ———" This cover contains several forms of *Panicum commutatum* Schultes.

"192 **Panicum parvulum** M. 110, 6." In this cover are several unrecognizable scraps, and also three plants with a label attached, bearing the name *Panicum deustum*. We consider this to be the type of *Panicum tenue* Muhl. Descr. 118, and it is exactly identical with *Panicum trifolium* Nash. The synonymy of this species is as follows:

PANICUM TENUE Muhl. Descr. 118. 1817. (*Panicum deustum* Brickell et Enslin, l. c. 119, as synonym; *Panicum lilon* R. & S. Mant. **2**: 250. 1824; *Panicum macrum* Kunth, Rev. Gram. **1**: 40. 1835; *Panicum trifolium* Nash, Bul. Torr. Bot. Club, **26**: 580. 1899.) *Panicum tenue* Muhl., was changed by Roemer & Schultes and by Kunth because of an earlier use of the name by Roxburgh, Catalog. 1813, but we believe this earlier publication is a *nomen nudum*, the description not being published until the issue of his Flora Indica **1**: 306. 1820, in which case Muhlenberg's name *Panicum tenue* should be retained. It is possible that this species is true *Panicum ensifolium* Baldw. ex Ell. Sk. Bot. S. C. and Ga. **1**: 126. 1817. A careful search in the herbarium of the Academy of Natural Sciences of Philadelphia, revealed no *Panicum ensifolium* from Baldwin.

"193 **Panicum simplici** *affini* Baldw. 866 *Milium*" = ?

"194 **Panicum dubia** Baldw." This cover contains unrecognizable scraps of several species.

The following species of *Panicum*, considered by Muhlenberg, are not represented in his herbarium:

11 **Panicum** ——— Muhl. Descr. 106. 1817 (sine nomine). Evidently a form of *Panicum crus-galli* L.

12 **Panicum** ——— Muhl. Descr. 106. 1817 (sine nomine). Evidently a form of *Panicum crus-galli* L.

25 **Panicum nervosum** Muhl. Descr. 116. 1817, not Lam. (*P. commutatum* Schultes.)

27 **Panicum** ——— Muhl. Descr. 118. 1817 (sine nomine) (*Panicum Muhlenbergianum* Roemer & Schultes Mant. **2**: 230. 1824.)

33 **Panicum densum** Muhl. Descr. 122. 1817.

36 **Panicum acuminatum** Swartz, in Muhl. Descr. 125. 1817. (*Panicum Muhlenbergii* Sprengel, Syst. Veg. **1**: 143. 1825; *P. sprengelii* Kunth, Rev. Gram. **1**: 39. 1835.)

39 **Panicum** ——— Muhl. Descr. 127. 1817 (sine nomine). (*Panicum tremulum* Spreng. ex Roemer & Schultes, Mantissa **2**: 237. 1824.)

41 **Panicum cartilagineum** Muhl. Descr. 128. 1817. ?

"201 **Eleusine filiformis**" published as *Eleusine sparsa* Muhl. Descr. 135. 1817.= *Leptochloa mucronata* (Michx.) Kunth, a depauperate form.

"206 **Poa viridis**" Muhl. Descr. 138. 1817.= *Poa pratensis* Linn.

"207 **Poa stolonifera**" Haller in Muhl. Descr. 139. 1817.= *Poa trivialis* Linn.

"214 **Poa capillaris** var." *Poa capillaris* co-species, Muhl. Descr. 145. 1817.= *Eragrostis frankii* Steud.

"215 **Poa hirsuta**" Muhl. Descr. 145. 1817.= *Eragrostis pectinacea* (Michx.) Steud. A specimen of *Eragrostis trichodes* (Nutt.) Nash, is also in the sheet.

"216 **Poa reflexa** Ell. 361." Published as *Poa refracta* Muhl. Descr. 146. 1817.=*Eragrostis refracta* (Muhl.) Scribn.

"223 **Poa stricta uniflora.**" This was published as *Poa ? uniflora* Muhl. Descr. 151. 1817, and is the same as the species now called *Sporobolus serotinus* (Torr.) A. Gray. The synonomy should be as follows:

SPOROBLUS UNIFLORUS Muhl. new comb. (*Poa ? uniflora* Muhl. Descr. 151. 1817; *Agrostis serotina* Torr. Fl. U. S. **1**:88. 1824; *Sporobolus serotinus* A. Gray. Man. Bot. 577. 1848).

"235 **Festuca prostrata.**" This was published as *Festuca procumbens* Muhl. Descr. 163. 1817, and is the same as *Leptochloa fascicularis* (Lam.) A. Gray.

"238 **Festuca clandestina**" Muhl. Descr. 162. 1817.= A depauperate form of *Leptochloa fascicularis* (Lam.) A. Gray.

"**Festuca brevifolia**" Muhl. Descr. 167. 1817.= *Triplasis purpurea* (Walt.) Chapm. In this sheet are also specimens of *Panicularia acutiflora* (Torr.) Kuntze.

"248 **Bromus ciliatus**" Muhl. Descr. 169.=*Bromus kalmii* A. Gray. There are fragments of several other species in this sheet.

"252 **Aristida oligantha.**" This is the form published by Muhlenberg as *Aristida racemosa* Descr. 172. 1817, and is *Aristida purpurascens* Poir. *Aristida oligantha* Muhl. Descr. 173, is not represented in the herbarium.

"256 **Elymus villosus**" Muhl. Descr. 175. 1817—Muhl. in Willd. Enum. 131. 1809.= *Elymus striatus* Willd., at least in part. Specimens of *Elymus hirsutiglumis* Scribn. are also in the sheet, but Muhlenberg's description does not apply to this species.

"258 **Elymus glaucifolius**" Muhl. Descr. 177. 1817—Muhl. in Willd. Enum. 131. 1809.=*Elymus canadensis glaucifolius* A. Gray.

"261 **Elymus ciliatus**" Muhl. Descr. 179. 1817. In this sheet there is only the spike of the plant, which is evidently a form of *Elymus striatus* Willd., with unusually narrow outer glumes.

"267 **Avena glumosa**" Muhl. Descr. 184. 1817.=*Danthonia sericea* Nutt., not *Danthonia glumosa* Beauv.

"278 **Erianthus brevibarbis**" Muhl. Descr. 193. 1817.=*Erianthus strictus* Baldw. ex Elliott, Sk. Bot. S. C. and Ga. **1**:39. 1816. There are a few short hairs at the base of the pedicellate spikelets.

"387 **Holcus odoratus**" Muhl. Descr. 273. 1817.=*Savastana odorata* (L.) Scribn.

"389 **Holcus saccharatus**" Muhl. Descr. 275. 1817, is a form of cultivated *Sorghum*, called broom corn.

"390 **Holcus cernuus**" Muhl. Descr. 276. 1817, is also a form of cultivated *Sorghum*.

"391 **Chloris monostachya**" Muhl. Descr. 286. 1817.=*Campulosus aromaticus* (Walt.) Trin.

"394 **Atheropogon apludoides**" Muhl. Descr. 287. 1817.=*Bouteloua curtipendula* (Michx.) Torr.

"402 **Andropogon,** Elliott, **glaucus** M. 264 b." *A. glaucus* Muhl. Descr. 278. 1817.=A slender form of *Andropogon glomeratus* (Walt.) B. S. P.

"407 **Andropogon purpurea.**" Published as *Andropogon purpurascens* Muhl. Descr. 282. 1817.=*Andropogon scoparius* Michx.

2. TWO NEW SPECIES OF EATONIA.

EATONIA PUBESCENS Scribn. & Merrill sp. nov.

An erect or ascending, tufted, pubescent perennial 4 to 8 dm. high, with linear leaves and exserted contracted panicles. Culms densely pubescent below, with short, spreading or reflexed matted hairs, sometimes nearly smooth above; nodes smooth; sheathes shorter than the internodes, strongly striate, densely pubescent, with hairs similar to those of the culm; ligule prominent, generally hyaline, obtuse, somewhat lacerate, 3 mm. long, rather densely pubescent on the back; leaf-blades linear, 10 to 18 cm. long, 4 to 6 mm. wide, slightly auriculate at the base, very strongly scabrous on both surfaces and margins, often somewhat pubescent beneath, with short spreading hairs. Panicle lanceolate in outline, 10 to 18 cm. long, rather densely flowered; common axis sparingly pubescent; branches erect or ascending, the lower ones 5 to 6 cm. long. Spikelets 3 to 3.5 mm. long, 2-flowered; empty glumes very unequal, the first linear, scabrous on the keel, nearly 2 mm. long, the second 2 to 2.2 mm. long, broadly obovate, obtuse or truncate, scabrous on the keel and on the two faint lateral nerves; flowering glumes lanceolate, acute, sparingly scabrous at the apex, slightly punctate, sessile one about 2.5 mm. long, the pedicellate one slightly shorter.

Type specimen collected by S. M. Tracy at Starkeville, Miss., April 30, 1891, distributed as *Eatonia pennsylvanica* (DC.) A. Gray. Other specimens referable to this species, Hinson Springs, Tex., L. C. Johnson, 1886; Palestine, Tex., 45 E. N. Plank, April, 1895.

This species is related to *Eatonia obtusata* (Michx.) A. Gray, but is readily distinguished by its densely pubescent culms, sheaths, and ligule.

EATONIA ARISTATA Scribn. & Merrill sp. nov.

An erect nearly glabrous, perennial, with very long, narrow leaves, elongated, contracted panicles, and rather small spikelets, the second flowering glume bearing a short awn. Culms and nodes smooth; sheaths shorter than the internodes, striate, often sparingly pubescent between the striae; ligule hyaline, obtuse, 1.5 mm. long; leaf blades linear, glabrous, 10 to 18 cm. long, about 2 mm. wide. Panicles 15 to 25 cm. long, interrupted, the branches erect or ascending, the lower ones 5 to 7 cm. long, somewhat flexuous. Spikelets 3 to 3.5 mm. long, 2 to 3 flowered; first glume very narrow, linear, slightly scabrous on the keel, about 2 mm. long; second glume 2.5 mm. long, broadly ovate, acute, slightly scabrous on the keel; sessile floret about 2.5 mm. long, acute, very slightly scabrous and punctate, its palea nearly equaling the glume; pedicellate spikelet shorter, scabrous, bearing a scabrous awn just below the apex 1 to 2 mm. in length, which is sharply geniculate, forming nearly a right angle with the glume.

Type specimen collected in South Carolina by A. H. Curtiss in 1875.

This species closely resembles *Eatonia filiformis* in its very long, narrow leaves and panicles, but is distinguished from that species by its larger spikelets and awned second floret. It is most closely related to *Eatonia pallens*, but is at once distinguished by its elongated and very narrow leaves, smaller spikelets, and geniculate awn of the second flowering glume.

This plant was considered by Vasey[1] as being identical with the species discussed as a hybrid between *Eatonia pennsylvanica* and *Trisetum palustre*, but it is very distinct from that species. This form, like *Eatonia pallens*, shows the close relationship of *Eatonia* to *Trisetum*.

EATONIA PALLENS (Spreng.) Scribn. & Merrill, new comb. (*Aira pallens* Spreng. Mant. Fl. Hal. 33. 1807; *A. pallens* Muhl. Descr. 84. 1817, at least in part; *Trisetum palustre* Torr. × *Eatonia pennsylvanica* (DC.) A. Gray; Vasey, Bot. Gaz. **9**:165. 1884; and Scribn. l. c. 167. *fig. 1.*)

An erect perennial 6 to 10 dm. high, with linear leaves, long contracted panicles and pale spikelets, the second flowering glume bearing a slender awn at the apex. Culms and nodes glabrous; sheaths shorter than the internodes, striate, glabrous; ligule about 2 mm. long, hyaline, obtuse, lacerate; leaf blades thin, 7 to 16 cm. long, 3 to 5 mm. wide, scarcely narrowed at the auriculate base, striate, slightly scabrous on the margins and nerves above, otherwise glabrous. Panicle pale, exserted, lanceolate in outline, 12 to 18 cm. long, the branches fasciculate, erect or ascending, slender and somewhat flexuous, the lowers ones 5 to 6 cm. long, naked below, rather densely flowered above. Spikelets 4 mm. long, 2-flowered; empty glumes very unequal, the first 2.5 mm. long strongly-compressed, scabrous on the keel, hyaline on the margins, lanceolate, acute and about 0.6 mm. broad when spread out, the second glume 3 mm. long, much broader than the first, scabrous on the keel, broadly obovate, about 1.7 mm. broad when spread out; first floret sessile, its flowering glume 3.3 mm. long, lanceolate, acute, scabrous on the keel, peculiarly and finely punctate. Palea hyaline 2.5 mm. long, cleft at the apex. Second floret pedicellate, its rachilla somewhat hispid, similar to the sessile floret except in being slightly shorter and bearing a slender scabrous somewhat flexuous awn about 2 mm. long, immediately below the apex.

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[1] Bot. Gaz. **9**:166. 1884.

Type locality: "Pensylvania." General distribution: in wet meadows, Pennsylvania and Virginia, June–July.

The original description of this species and also Muhlenburg's description are given below.

"*Aira pallens* aristata, panicula contracta, valvulis calycinis inæqualibus, flosculo altero aristato, altero mutico. Folia linearia, glabra, rigida, subinvoluta, vaginis pubescentibus.

E. Pensylvania *Muhlenb.*" Sprengel, Mantissa Flora Halensis 33. 1807.

"*Aira pallens.* Culmo tripedali erecto nodoso. Foliis lineari-lanceolatis glabris, nodis glabris. Ligula retusa ciliata. Vagina substriata. Panicula contracta nutante. Ramis paniculæ 5, ternis geminisque scabris, ramulis alternis. Cal. gluma 2-valvis corolla minor, nervosa, scabra, valvula una latiori; altera lineari utraque acuminata mutica, bi- et triflora, flosculo uno pedicellato, omnibus hermaphroditis. Cor. gluma 2-valvis puncticulata, flosculi sessilis mutica, pedicellati aristata, arista paulo infra apicem sive dorsali contorta, pedicello flosculi lævi nec pubescente. Stam. 3. Pist. 2. Semen glabrum. Radix perennis. Habitat in pratis humidis et varietas omnino mutica in sylvis, floret Junio et iterum Sept. *Aira Pennsylvanica*, Sprengel. Habitus *Avenæ sesquitertiæ*, cf. *Avena palustris*, Michaux." Muhlenberg Descriptio 84. 1817.

In Muhlenberg's herbarium there are two sheets, one labeled "128 *Aira pallens*" and the other "129 *Aira pallens* var. *aristata.*" In the first sheet are several fragments of *Deschampsia flexuosa* Trin., *Poa debilis*, Torr. and an *Eatonia*, probably *Eatonia nitida* (Spreng.) Nash., while in the second sheet there are specimens of *Trisetum palustre* Torr., and the grass described by Vasey as a hybrid between *Eatonia pennsylvanica* and *Trisetum palustre*, the form here taken up as *Eatonia pallens.* It is at once evident from an examination of Muhlenberg's description above, that this last form is the plant described by Muhlenberg as *Aira pallens.* Muhlenberg erred in citing *Aira pennsylvanica* Spreng., as a synonym, as this species is awnless and is *Eatonia nitida* (Spreng.) Nash.

Sprengel's description of *Aira pallens* does not exactly apply to our plant, as he speaks of its subinvolute leaves and pubescent sheaths. It is very probable that he had other species under the same name, possibly *Eatonia nitida* or some species of *Trisetum*, as is the case in Muhlenberg's Herbarium. This is more probable, because Sprengel received the material on which the species was based, from Muhlenberg.

This form was discussed by Vasey and also by Scribner[1] as a hybrid between *Trisetum palustre* and *Eatonia pennsylvanica*, and in this discussion the close relationships of *Eatonia* and *Trisetum* are pointed out with the conclusion that the genus *Eatonia* should properly be placed in the *Aveneæ* next to *Trisetum* and not in the *Festuceæ*, where it now is. In considering this form as a species in the genus *Eatonia*, it is necessary to modify the character of the genus so as to include this awned form. See Scribner, U. S. Dept. Agr., Div. Agros., Bul. **20** : 135, *fig. 104*, 1900. This species is at once distinguished from *Eatonia pennsylvanica* (DC.) A. Gray, to which it is most closely allied, by its awned second-flowering glume.

The only specimens we have seen referable to this species is the one in Muhlenberg's Herbarium and a specimen collected at Hunting Creek, Alexandria, Va., by Dr. Vasey, June 6, 1884.

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[1] Bot. Gaz. **9**. 165–169. 1894.

3. A NEW VARIETY OF PANICUM NASHIANUM.

PANICUM NASHIANUM PATULUM Scribn. & Merrill var. nov.

Culms much branched, slender, often purplish, puberulent or short pubescent throughout; sheaths much shorter than the internodes, rather densely pubescent, with short, spreading hairs, ciliate on the margin; leaf blades densely short-pubescent on both sides, papillate ciliate, with few long hairs on the rather strongly cartilaginous margins. Rachis and branches densely puberulent. Spikelets 2 to 2.5 mm. long; first glume thin, obtuse, about one-third as long as the spikelet; second and third glumes densely pubescent, with short, spreading hairs.

Type specimen: 1296 Robert Combs, Braidentown, Manatee County, Fla., September 3, 1898.

General distribution: In fertile hammock and pine woods, Florida and Mississippi, March to September. Other specimens referred to this species: *Florida:* Old Town, 858, 859 Combs, 1898; Grasmere, 1169 Combs, 1898; Lake City, 132 (in part) Combs and Rolfs, 1898; Lake Alfred, T. Holm, 1893; Jacksonville, 140 T. H. Kearney, 1895. *Mississippi:* Biloxi, 4586, 4587 S. M. Tracy, 1898.

This variety is closely related to the species, intermediate forms occurring, and approaches *Panicum demissum* Trin. nearer than any other North American plant we have seen. From the former it is at once distinguished by its pubescent culms, sheaths, and leaves, and larger densely pubescent spikelets. From the latter it is distinguished by its much smaller one-nerved first glume and densely pubescent first and second glumes. The spikelets of *Panicum demissum* are glabrous.

4. NOMENCLATURE NOTES.

PANICUM RAMISETUM Scribn. nom. nov. *Panicum subspicatum* Vasey, U. S. Dept. Agr. Div. Bot. Bul. **8**:25, 1889, not Desvaux, Opuscules 84, 1831.

AGROPYRON OCCIDENTALE Scribn. new comb. (*Agropyron glaucum occidentale* Scribn. Trans. Kans. Acad. Sci. **9**:119. 1885; *A. spicatum* Scribn. & Smith, U. S. Dept. Agr. Div., Agros. Bul. **17**:298, *fig. 594*, 1899, not *Festuca spicata* Pursh, Fl. Am. Sept. **1**:83. 1814; *Agropyron smithii* Ryd. Mem. N. Y. Bot. Gard. **1**:60. 1900.) Rydberg states that he examined the type of *Festuca spicata* Pursh, in the herbarium of the Academy of Natural Sciences of Philadelphia, and found that this form had been wrongly interpreted in Bulletin No. 4 of this Division. He, therefore, applied the name *Agropyron smithii* to this species, under the impression that *Agropyron glaucum occidentale* Scribn. was a *nomen nudum.* A description of this variety was published, however, in the Trans. Kan. Acad. Sci. **9**: 119. 1885, and according to the Rochester rules, the name *occidentale* will have to be retained for this species.

AGROPYRON OCCIDENTALE PALMERI Scribn. new comb. *Agropyron spicatum palmeri* Scribn. & Smith, U. S. Dept. Agr., Div. Agros., Bul. **4**:33. 1897; *A smithii palmeri* Heller, Cat. N. Am. Pl. ed. 2, **3**. 1900.

AGROPYRON OCCIDENTALE MOLLE Scribn. new comb. *Agropyron spicatum molle* Scribn. & Smith, l. c.; *Agropyron molle* Ryd., Mem. N. Y. Bot. Gard. **1** : 64. 1900.

ELYMUS BOREALIS Scribn. nom. nov. *Elymus ciliatus* Scribn., U. S. Dept. Agr., Div. Agros., Bul. **11** : 57, *pl. 16*, 1898, not Muhl. Descr. 179. 1817. *Elymus ciliatus* Muhl. is not listed in Index Kewensis.

5. NOTES ON MELICA AND STIPA.

NOTE.—The following notes were made by Prof. C. V. Piper while studying the types of certain Western grasses in the Gray Herbarium, Cambridge, Massachusetts, and later at the herbarium of the Division of Agrostology.—F. L.-S.

MELICA BELLA Piper, nom. nov. (*M. bulbosa* Geyer in Hook. Journ. Bot. and Kew Gard. Misc. **8** : 19. 1856, *nomen nudum*; *M. bulbosa* Geyer in Gray, Proc. Am. Acad. **8** : 409. 1872, *nomen nudum*; *M. bulbosa* Geyer in U. S. Dept. Agr., Div. Bot., Bul. **13** : 63, *pl. 63*, 1893, not *Melica bulbosa* Geyer in Thurber in S. Wats. Bot. Cal. **2** : 304. 1880.)

The fact seems to have been overlooked hitherto that both the first and second publications of the name *Melica bulbosa* Geyer are *nomina nuda*. The first publication of the name, with a description appended, is that of Thurber in the botany of California, and while the species there described is not the original plant of Geyer at all, nevertheless the name must stand for the plant there described.

The first description of *Melica bella*, the original species of Geyer, is in U. S. Dept. Agr., Div. Bot., Bul. **13**, Vasey's "Grasses of the Pacific Slope." It is somewhat variable, but its cæspitose habit distinguishes it from its immediate allies. Geyer's plant, which may be designated the type of *Melica bella*, and which is in the Gray Herbarium, was collected in a "rocky ravine, Upper Platte." It is matched by Cusick's No. 900*a*, from Union County, Oregon.

STIPA THURBERIANA Piper, nom. nov. (S. *occidentalis* Thurb. in Wilkes U. S. Explor. Exped. **17**:483. 1874, not U. S. Geol. Explor. 40th Par. **5**:380. 1871.)

Much confusion has arisen in the names of the above two Stipas. Thurber first described as *Stipa occidentalis* a plant collected by Pickering and Breckenridge in Washington on the "N. branch of the Columbia," which was not published, however, until 1874. In the mean time he had identified and named Californian plants of Bolander's collection as *Stipa occidentalis*, one of which, No. 5038, from "Yosemite Trail," was taken by Watson as the type of *Stipa occidentalis* published in the Botany of the King Expedition in 1871.

Dr. Vasey in 1882 detected the fact that the form described as *Stipa occidentalis* in the U. S. Geol. Explor. 40th Par., 1871 was different from that described in Wilkes U. S. Explor. Exped. 1874, but in segregating them, unfortunately renamed the one which had first been published, namely, the plant described in the U. S. Geol. Explor. 40th Par. 1871.

It is clear, therefore, that the name "*Stipa occidentalis*" must pertain to the plant published in the U. S. Geol. Explor. 40th Par. 1871, and consequently the plant of the Wilkes' U. S. Explor. Exped. 1874, is here renamed.

Stipa occidentalis Thurber, in Watson U. S. Geol. Explor 40th Par. **5**: 380. 1871. (*S. stricta* Vasey, Bul. Torr. Bot. Club, **10**:42. 1883, not Lamarck, Tabl. Encycl. **1**:158. 1791. *S. stricta sparsiflora* Vasey, Contr. U. S. Nat. Herb. **3**:51. 1892. *S. oregonensis* Scribn., U. S. Dept. Agr. Div. Agros. Bul. **17**: 130, *fig. 426*, 1899.)

CIRCULAR No. 28—(Agros. 77.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage-Plant Investigations.]

F. LAMSON-SCRIBNER, *Agrostologist*.

GRASSES AND FODDER PLANTS ON THE POTOMAC FLATS.

During the past summer the Division of Agrostology has grown a large variety of native and imported grasses and fodder plants upon the island in the Potomac River, which is just south of the city of Washington and locally known as the "Potomac Flats." The soil consists of dredgings from the river bed and is very rich. It is an ideal place for growing the coarser annual fodder plants and has afforded an interesting field for studying the new perennial grasses and clovers, both of native varieties and those imported from foreign countries through the Section of Seed and Plant Introduction of this Department and grown here for the first time. The behavior of a number of grasses from our Southwestern States and Territories is especially worthy of note.

Curly mesquite, from the plains of Texas and Arizona, made a wonderful growth and produced a large crop of seed; turnip grass, from New Mexico, made a surprisingly rich growth and seeded heavily; water grass exhibited a growth which maintains for it all the claims which have been made respecting its forage value; and sprangle, a native of Texas and regions west of that State, promises to be one of the most productive and finest hay grasses grown on our trial grounds. A number of species from Australia have manifested a ready adaptability to our climatic conditions and on the soil of the Flats grew finely. Button grass from the interior plains of South Australia grew with remarkable vigor and seeded most abundantly. It is not unlikely that this grass may have high value for portions of the warmer and drier regions of the Southwest. Mitchell grass, another Australian species, regarded by stockmen in the interior of New South Wales as one of the best of all native grasses both for its drought-enduring qualities and its fattening properties, made a vigorous growth and appeared to be perfectly at home in its new surroundings. Bermuda grass, the king of pasture grasses for the South, grew readily from seed sown early in the season and made a most luxuriant growth, the mass of leaves and stems covering the ground knee-deep with a rich bed of pasturage. A number of the Australian saltbushes grew finely and showed great possibilities for forage production of their class. The growth of the clovers and alfalfa was inferior compared with that of the grasses, but the vetches and different varieties of peas and beans succeeded well, while such plants as Kafir corn, several varieties of pearl millet and teosinte grew with great vigor and yielded an astonishing amount of forage, especially the last named. A detailed report by Mr. C. R. Ball, assistant in the Division, who had charge of the work of the Division on the Flats, is here presented and its publication recommended, not only for the interest attached to the several species cultivated, but to place the work on record.—F. LAMSON-SCRIBNER.

INTRODUCTION.

The experiments noted herein are exclusive of those made in the grass garden on the grounds of the Department, and relate wholly to the work done on about 4 acres of land on the Potomac Flats. These 4 acres constitute a part of an area of some 22 acres, which has been used during the past season by several divisions in the Department for conducting experiments with plants and vegetables, and which was primarily set apart for the use of the Division of Botany. The land in question is on an island just south of Washington, D. C., near Long Bridge, and was originally a tidal marsh. Its present condition is the result of dredging out the channel between it and the main land, now forming the city water front, and pumping the mud over upon the marsh. The surface was thus raised from two to ten feet above high tide. This work was done by the War Department, and the use of the land by the Agricultural Department was through permission of the Secretary of War. The land is exceedingly rich, being the city drainage and harbor deposit of many years' accumulation.

On the higher, well-drained areas the soil is loose and porous, washing badly with heavy rains, but on the lower portions it forms a hard surface crust as it dries after having been packed by floods. As might be expected from the origin of the island, the subsoil is very porous, so much so that the surface water frequently breaks suddenly through the firmer upper crust into subterranean cavities, new openings of this character being apparent after every heavy rain. It will be readily seen that the soil is peculiar to the island, and can in no way be considered typical of this or any other region. This fact does not especially injure its value for comparative experiments.

The ground was cleared and plowed in the spring of 1899 and fallowed during that season. In the late fall it was plowed three times, at intervals of about three weeks, and left rough over winter. In the spring of the present year an Acme harrow was used frequently, being run over the field in both directions to keep down the weeds. Ever since the formation of the land some ten years ago, weeds have been growing and seeding unrestrained, and they covered the surface with a dense and luxuriant growth. On the higher part the most abundant were sweet elder (*Sambucus Canadensis* L.), velvet leaf (*Abutilon Avicennae* Gaertn.), lamb's quarter (*Chenopodium album* L.), purslane (*Portulaca oleracea* L.), and morning glory (*Convolvulus sepium* L.) On the low ground, wormseed (*Chenopodium anthelminticum* L.), and a species of heartsease or smartweed (*Polygonum*) were so abundant and so vigorous as to call forth the most strenuous efforts to prevent their choking the young forage plants entirely. A constant warfare was waged on the pests during the entire season, and it is to be hoped that they will prove less troublesome another year.

For several reasons the conditions under which the experiments of this year were carried out were far from satisfactory, a fact which gives greater value to the good results obtained and no doubt explains some of the failures, partial or entire. Work was not begun until the end of April, and was then greatly retarded by a lack of assistance and equipment, due to the insufficiency of the appropriation which could be used for that purpose. The months of May and June were very wet, as will be seen from the following rainfall tables:

Daily precipitation at Washington, D. C., from April to November, 1900.

(Data furnished by the U. S. Weather Bureau.)

Date.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1			.08				.30	.06
2			3.48				T[1]	T
3		.21					.01	.75
4	.04			.04		T	.01	
5				T	.35		T	
6				T				
7	T			.03			T	
8			2.84				.44	.34
9		.41				.02	T	.25
10								
11	.03	T				.03		
12	.53	T	.17	T	.08			
13	T		.78	.01	.03		.19	
14			.56			.19	.23	
15			.03			1.27		
16			1.00		.07	1.68		
17	.02		1.68		.04			
18	.68	.01						T
19	.12	3.15	T	.14				
20		T		.40	.13			T
21	.22		T		.38	T		.01
22	.01			.19	T			T
23	.09			T	.11	.07	.06	
24		.14	T		.87		.20	.31
25		.04	.08	.08	.07			.12
26			.24	.32				.31
27			T			T		
28		T			.15	1.06		
29		.06						
30			T	.04		.29		
31		T						
Total	1.74	4.02	10.94	1.25	2.28	4.61	1.44	2.15

[1] "T" as used throughout this table denotes a trace of rainfall.

The extremely heavy rains of May 19, June 2, and June 8 did much damage. The first one, coming after the planting of a large part of the higher ground, fell with such rapidity and violence as to wash away both seed and soil from some plats and mix the seed on several others so thoroughly as to entirely vitiate their integrity and necessitate replanting. Each of these rains covered the lower field with standing water several inches deep, which drained away but slowly from the level land or sloping in from the river. This seriously delayed the planting on that area.

During July and August the weather was very hot and dry, affording excellent opportunity to observe the drought-resisting properties of the various crops. Some very interesting results were obtained in this connection. Many of the plats, however, had been sown so late that the young plants had not become firmly established before they were overcome by the arid conditions which followed. A large number managed to just about hold their own during those months and afterward made a good growth.

The land allotted to this Division was divided by a roadway into two nearly equal fields, numbered 9 and 10. Each field was then laid out into plats a rod square, with paths 2 feet wide running in both directions. There were about 480 of these plats. Each row of plats running lengthwise of the field was given a series letter, A, B, C, etc., and the plats in each series were numbered consecutively. The first of the series in field 9 would thus be 9—A—1, the second 9—A—2, and so on for row A. The plats in the next row would be 9—B—1, 9—B—2, etc. The same scheme was used for field 10.

PERENNIAL MEADOW AND PASTURE GRASSES.

About 150 plats were devoted to experiments with grasses other than the millets and sorghums. Quite a large number of those sown earliest were rendered valueless for test purposes by a heavy rain falling just after seeding, washing away a large amount of seed and mixing some of the remainder. This was most unfortunately the case in a series containing 25 brome grasses, from which much in the way of comparative results had been hoped. No report is made here on several of our common cultivated grasses, such as red tops, orchard grass, etc., which were included in the experiment. These are well known perennials, and may better be reported on in another season.

Bermuda grass (*Cynodon Dactylon* (L.) Pers.).—This plat was intended to demonstrate that Bermuda could be profitably started from seed, and it was a complete success. The seed was from the Division supply, purchased in 1899, and was planted June 6 at the rate of 20 pounds per acre. By the middle of July there was an abundance of the creeping stems 3 to 6 inches long. Two weeks later the plat presented a luxuriant mass of foliage about 4 inches high. On the 20th of August the creeping branches covered the ground completely for a distance of 2 or 3 feet on all sides of the plat, which was a dense mass of grass 12 to 18 inches high, and was ready for cutting. The sides of the plat were now cut back to their original position. Two months later, on October 20, the foliage was still soft, luxuriant, and perfectly healthy, while the creeping stems had again reached a length of 4 feet. Had the plat been cut for hay at the time the stems were cut back it would have been ready for a second cutting before this date. Pieces of the stem trimmed off in August had covered the entire surface of an adjacent vacant plat with wiry stems which have as yet produced few leaves. Several severe frosts during the first two weeks of November killed most of the foliage.

As stated, this plat was seeded at the rate of 20 pounds per acre, which is 2 or 2½ times as thick as is generally recommended. The resulting growth was very thick, much thicker than was necessary to secure a good stand and an abundant hay crop. At the rate of 8 pounds per acre, with seed costing 75 cents per pound, the expense per acre is only $6. This ought, with well prepared soil and careful seeding, to result in a good hay crop, free from weeds, the same season. The ordinary method of planting the roots, while primarily less expensive, usually results in a weedy field, with little or no crop the first year. Where seed is used, the difference in amount of hay or pasturage obtained the first year should more than pay for the seed.

Turnip grass (*Panicum bulbosum* H. B. K.).—Two square rods were planted on June 6 with seed raised in the grass garden in 1899. In five weeks the plants reached a height of about 6 inches, of vigorous growth and a beautiful glaucous color. By the end of July they were nearly 1½ feet in height, and this rapid, sturdy growth was maintained throughout August. Early in September the grass flowered at a height of about 5 feet, the seeds in the large open panicles ripening by October 1, and 9 pounds were gathered on the 5th. By the 20th of October the plants, still green and vigorous, began putting out small lateral panicles to replace the large ones cut for seed.

An adjacent plat, planted with seed from what was called *Panicum avenaceum*, proved identical with the above in every respect.

This grass makes a very rapid, vigorous growth, and, if planted thickly and cut before maturing, it should yield an abundance of excellent hay. It promises to be of great value in the Southwest and possibly also for other sections. Its luxuriant growth on the "Flats" was hardly more striking than that in the poorer soil in the grass garden on the Department grounds.

Sprangle (*Leptochloa dubia* Nees.).—One square rod was planted June 7 from seed raised in the grass garden in 1899. It sprouted quickly, and the plants made a fine growth, reaching a height of 8 inches by the middle of July and of 2 feet by the 1st of August. A month later the grass stood 4 feet high, strong and healthy, and it was in full flower early in September. Owing to its isolated position, it was badly lodged by heavy winds. Seed was gathered October 5 and the plat mowed. Two weeks later a good aftermath was observed.

For softness and abundance of foliage and fineness of stem, this grass is unrivaled by any other which grows to the same size—5 feet or over. This I regard one of the most important grasses from the Southwest yet experimented with and have no hesitation in recommending its extended cultivation.

Large water grass (*Paspalum dilatatum* Poir.).—This valuable grass was sown May 23 on five fractional plats equivalent to 2 square rods. The seed, which was obtained from an eastern seed firm, germinated slowly, and not until the end of June were the plants above ground. During the remainder of the season growth was vigorous, and by the middle of October the plants were 3 feet high and strongly tufted. The basal and culm leaves made a dense growth of foliage 18 inches to 2 feet high, above which rose the naked flowering culms, on which the seed was nearly ripe. On November 17, after several heavy frosts, the foliage was injured but little and later seed was still ripening.

Another square rod planted on June 6 from seed gathered by the writer on the Red River in Louisiana in 1898 came up at the same time and grew a little more vigorously, ripening its seed at the same time.

This is one of the largest of the water grasses and has long been recognized as valuable for wet meadows and pastures in the South. It can be highly recommended and should be more generally used.

Jaragua (*Andropogon rufus* Kth.).—One square rod was sown June 6 with seed received from Brazil by the Section of Seed and Plant Introduction (No.

3891). It germinated fairly well and grew slowly during the hot, dry months of July and August. On the 20th of October the grass had reached a height of 4 to 5 feet, a luxuriant mass of long, soft, and flexible basal leaves, but with no sign of flowering culms. The foliage was killed by the early November frosts, but it is hoped that the roots will survive the winter and establish a permanent plat.

Dr. J. F. de Assis-Brasil in his work, "Cultura dos Campos," speaks of it as follows:

It reproduces itself readily both by seeds and creeping rhizomes. The stem grows to the height of 12 feet at the time of flowering. As the stems are at that time rather hard, it is best to pasture the meadows occasionally in order to keep down the flowering stalks. An analysis made by Dr. Trovassos indicates a higher percentage of protein and carbohydrates than in the best leguminous plants, but for the purposes of this note it is sufficient to say that this indigenous grass produces an extremely rich forage.

This grass may prove of great value in the South and Southwest.

Louisiana grass, carpet grass (*Paspalum compressum* Nees.).—One plat was sown May 23 with seed purchased by the Division in 1899 and presumably of the crop of that year. At the end of seven weeks, or by the middle of July, it had just begun to germinate. A second plat was sown on the 2d of June with seed secured in 1898. By the middle of July this presented a close, even growth about 2 inches in height, and this lead over the first plat was maintained throughout the season. In the middle of October the grass on both plats was about a foot high and both were in flower. A firm turf had been formed by the creeping stems, and the foliage on the erect culms was healthy and abundant.

Both plats were situated on rather low ground where the water stood longest after rains. In the South where this grass is native it grows abundantly on open hillsides in the pine barrens as well as in the lower and more shaded lands along the creeks and branches. It is valuable for lawns, and especially so for pastures.

Grapevine mesquite (*Panicum obtusum* H. B. K.).—Two plats were planted June 7. The seed did not germinate until late in July, when a thin stand appeared. During the rest of the season the growth was vigorous, the erect shoots reaching a height of 18 inches and producing considerable foliage. The stolons, or runners, were very abundant and extended from 5 to 6 feet in every direction, binding the soil very closely. The foliage was killed by frosts early in November.

It is native of the Southwest, extending into Mexico, and is worthy of experiment in those regions. A plat of this grass in the garden on the Department grounds has persisted for five years resisting the cold winters and making a good growth each summer.

Mitchell grass (*Astrebla pectinata* F. v. Muell.).—One plat was planted May 26 with seed received from Prof. J. H. Maiden, Queensland, Australia. It germinated readily and a fair stand was obtained. By the middle of July the strong, leafy plants were 12 to 15 inches high and the first heads were appearing. Two weeks later found the height increased to 2 to 2½ feet, and some of the seed was ripe. Production of seed continued throughout the season, the last being gathered October 20, at which time the plants were about 3 feet high and the foliage very abundant. Frosts in early November killed the foliage.

This grass is very highly regarded as a hay and forage plant on the interior plains of Australia. It is very productive, and the strong root system enables it to withstand long periods of dry weather; so that it should be of value in our Southwestern States. It should be noticed that most of the growth was made during July and August, which were exceedingly dry and hot months.

Button grass (*Dactyloctenium australiense* Scribn.).—Two plats were planted with seed received from Australia under the name of "Munyeroo," or "Petachartes" grass. The grass on these two plats was identical in habit and appearance with the plants grown in the grass garden in 1896 from Australian seed and reproduced each year by volunteer seeding. Some of the grass garden seed of 1899 was planted on two near-by plats, but it was either washed away or most of it failed to germinate, as only a few weak plants appeared. The button grass was sown May 26, and by July 14 the circular prostrate tufts were a foot in diameter and loaded with flower heads. On July 30 the first gathering of seed was made. From that time until the plants were killed by frosts in November, seed was produced in great abundance and gathered at intervals of about two weeks. The diameter of the individual plants increased to about 18 inches.

Two adjacent plats, planted also on May 26, with a mixture of Australian grass seeds were found to contain a small *Panicum*, considerable *Eragrostis brownii*, and about half button grass. The rate of development during the season was very much the same as that of the plats just described. The single plants were, however, much larger, the branches being about 2 feet long and rooting strongly near the base, the whole plant being some 4 feet in diameter. The color was light green, and relatively much more foliage and less seed was produced than in the other plats. This should make it of more value as a forage plant and soil holder.

Button grass is a native of the hot and dry interior regions of Southern Australia, and it may be of great use in similar regions in this country.

Curly mesquite (*Hilaria cenchroides* H. B. K.).—Three plats were planted June 7 with seed gathered in 1897; germination was good and the growth was unchecked by dry weather. By the middle of July the grass was 2 inches high and the runners were abundant. Two weeks later the runners had reached a length of 2 feet or more, striking root every four or five inches and sending up sturdy new plants which filled all the vacant space between the original seedling plants and made a strong, close growth, excellent for pasturage purposes. The erect culms were about 6 inches high and in full flower. One plat was taken up in September and transplanted to the Division's exhibit on the Pan-American Exposition grounds at Buffalo, N. Y. The plants on the other two ripened seed about October 1, at which time the fruiting culms were nearly dead, but the basal portions and the young plants were still vigorous. This is one of the most valuable grasses of the cattle ranges of the Southwest, and its successful propagation by seed is of great economic significance.

Black heads (*Pappophorum nigricans* R. Br.).—This well-known Australian forage grass proved to be the chief ingredient of a package of seed of mixed sand grasses received from that continent through Prof. J. H. Maiden. It was planted May 23 on one of the driest plats on the grounds. Germination was prompt, and the growth continued without check during the dry months of July and August, when the plants reached their maximum size of a foot to 15 inches and were fruiting abundantly. The production of fresh growths of leafy branches and seeds was continued until stopped by the November frosts.

This grass is very highly esteemed for pasturage in the drier parts of Australia. It probably would never be valuable as a hay grass on account of its low, tufted habit, but it should prove a desirable addition to the pasture grasses of our drier regions.

A grass very closely resembling "Black Heads" both in appearance and habit of growth occurs on the cattle ranges of Arizona, where it is highly valued by cattlemen.

Grama grasses (*Bouteloua*).—One plat of Side-oats grama (*B. curtipendula* (Mx.) Torr.), one plat of Blue grama (*B. oligostachya* (Nutt.) Torr.), and two plats of Bristly grama (*B. hirsuta* Lag.) were planted on May 21 on the highest ground of the field.

All three of these valuable gramas germinated rather poorly and the Bristly grama quite slowly also, but all were uninjured by the drought, and all made a vigorous growth and produced an abundance of both foliage and seed. Their value as native pasture grasses in the Southwest is well known.

Blue grasses (*Poa*).—Twenty plats were sown to different species of Poas, mostly from western seed. Some failed entirely, owing to poor seed, dry weather, and unsuitable soil. Others made a very satisfactory progress, considering the conditions.

The soil of the Flats can scarcely be considered suitable for testing the mountain grasses. Several plats planted with forms of Kentucky blue grass from Oregon and Washington gave very promising results. Six plats of Canada blue grass, of two different lots, made a good growth and are well established for another season.

Fescues (*Festuca*).—Nineteen different lots of fescues, comprising fourteen species, were planted June 7 and 8 on the lowest part of the field. Two lots of King's fescue (*F. Kingii* Scribn.) failed to germinate. Most of the smaller ones, such as forms of red fescue, sheep's fescue, and slender fescue, did not do very well. From a few scattering tufts to a meager half stand was secured, the growth ranging from 1 to 3 inches. Two plats of tall meadow fescue from Russia (S. P. I. Nos. 1180 and 1337) both came up well and grew slowly during the entire season, reaching a height of 1 foot. A plat of reed fescue (*F. arundinacea*), from grass-garden seed of 1899, made the best stand and greatest growth, about 2 feet. Two plats of rough fescue (*F. scabrella*) from seed grown at our grass station at Walla Walla, Wash., presented a fine stand and a vigorous growth of long, soft leaves, 12 to 18 inches in height. With a variety of hard fescue from the same source a fine stand was secured with a sturdy growth of 1 foot.

Palm-leafed panic (*Panicum plicatum* Lam.).—This ornamental grass was planted on June 2, from seed raised the previous year in the grass garden. The two plats were on very low ground and were wet for some time after planting. On one plat and part of the second the seed came up quickly, while on the remainder of the second it did not germinate for several weeks. Growth on the first was fairly constant during the season, and the plats presented a very pleasing appearance. By the middle of October the grass was 3 to 4 feet high and the long, slender panicles appeared. The folded or plicate leaves were 12 to 18 inches long, about 2 inches wide, and very handsome. The foliage was entirely killed by the first hard frosts.

Some roots have been potted with the intention of trying its value as a house plant. By proper trimming it may probably be made to resemble quite closely the common *Pandanus*. It is valuable as an ornamental grass.

SUMMER AND SOILING CROPS.

MILLETS.

More than 50 plats were devoted to the different kinds of millets, exclusive of pearl millet, which will be found in another place (p. 10). The millets are divided into three groups, the foxtail millets, the broom-corn millets, and the barnyard millets, each representing a different species with its varieties.

Foxtail millets (*Chaetochloa italica* (L.) Scribn.).—Thirty-one plats were seeded on May 17 and 18 to the different forms, Common millet, German millet, Golden Wonder millet, and Hungarian millet. Except for a few which washed out and were later reseeded, very satisfactory results were obtained. The plants varied in height from 2 to 2½ feet for some of the common millets to 6 feet for some of the German and Golden Wonder millets. Fully one-third of them matured seed in from 75 to 78 days. These were chiefly Common millets. Most of the remainder matured in from 80 to 90 days. Three German millets took 103 days and one required 110 for ripening its seeds.

One plat of Common millet was badly affected by a leaf-spot disease, while a second one contained a number of smutted heads.

Broom-corn millets (*Panicum miliaceum* L.).—Eighteen plats of these millets were sown May 17 and 18. Most of the seed was secured through the Section of Seed and Plant Introduction from China, Russia, and Asia Minor. There were many decided differences observable in varieties grown in the different plats. The plants varied greatly in regard to the thickness, height, and amount of branching of the culms, hairiness, the size and habit of the panicle, and the time of maturing. Two of the largest, 3½ to 4½ feet tall, with large, slender, drooping panicles 10 to 14 inches long, were very slow in growth, the seed ripening August 7, eighty-one days from planting. One was from Asia Minor (S. P. I. No. 3665), the other from China (S. P. I. No. 3867). Another, similar in habit but smaller, from Russia (S. P. I. No. 1387), was equally slow. All of the remainder, including three from American-grown seed, matured between July 21 and July 25, or in from sixty five to sixty-nine days from the time of seeding. On one plat only was any smut observed.

Barnyard millets (*Panicum crus-galli* L.).—The barnyard millets are cultivated forms of our common barnyard grass. Four plats were seeded on May 17 and 18. One (9–E–11) with 1899 seed from the Washington Experiment Station ripened on August 14, and one (9–E–2) with Russian seed (S. P. I. No. 2798) on August 10. Both grew to a height of three feet, but the Russian plant was much more slender in habit. Another (9–F–8*b*), sown with seed from the Division supply, was 4½ to 5 feet high by the 1st of August, but had produced no heads. It made a very luxuriant, leafy growth, but died about the end of September without having flowered.

SORGHUMS (*Sorghum vulgare* L.).

Two plats of brown dhoura (9–G–3 and 4), the second of which was mixed with yellow milo maize, gave good results. The plants grew 6 to 7 feet in height, producing an abundance of stocky, much-branched stems full of leaves. The short, stout panicles are both lateral and terminal. A plat (9–G–7) of white African millet sown with Texas-grown seed made a splendid growth of about 7 feet, with abundant foliage, the lower leaves 3 to 4 inches wide and 2 feet long. Several plats of sorghum grew from 8 to 9 feet tall and produced a most succulent forage.

TEOSINTE (*Euchlæna luxurians*).

Teosinte stands unrivaled for quantity of forage produced. Two plats (9–H–9–10) were sown May 21 with seed from France (S. P. I. No. 3024). By the middle of July it was 3 feet high, and on August 1 it had reached 6 feet in height and so luxuriant in growth that the rows, planted 3 feet apart, could no longer be distinguished. By October 15 it was 10 feet high and an almost solid mass of culms and foliage. The leaves were about 3 inches wide and 3 feet long and crowded on the stems, which were 1 inch in diameter. About November 1 the male flowers began to appear, but soon afterward frost killed the plants. Two adjoining plats, of which the label was unfortunately lost, made an equally satisfactory growth.

PEARL MILLET (*Pennisetum spicatum*).

One plat was planted May 18 with seed obtained from a Richmond, Va., firm. On July 14 a fine stand of plants 3 to 4 feet high was noted. By August 1 it stood 6 to 7 feet tall, very full of leaves, but with no heads. Two weeks later heads began to appear. On October 18 it was 10 to 12 feet high. The culms were much branched but rather slender in habit, and the slender, spreading branches gave the plants a bushy appearance.

Another plat (9–G–13) sown with seed received from College Station, Tex., presented a striking contrast. The plants were 8 to 10 feet high and much more strict in habit than the preceding. The culms were much branched at the top, but the branches were appressed and bore no spikes. The spikes on the central stems were erect and 10 to 16 inches long.

MISCELLANEOUS FORAGE PLANTS.

SALTBUSHES.

Seed of several native species were planted May 12, but after the heavy torrential rain of the 19th, none of the seed could be found; certainly none of it ever grew. Some of the Australian species and several Kochias, closely related plants from Australia, were also lost in the same way.

Australian saltbush (*A. semibaccata* R. Br.).—One plat (9–A–1) planted May 12 with seed from California (S. P. I. 3922) germinated quickly and well, and made excellent growth. On July 3 it was 8 inches high, and July 31, after a month of very hot weather, the branches had grown to be 12 to 16 inches in length. Growth continued throughout the season, the vines on October 17 being 3 to 4 feet long and making a dense mat about 6 inches in depth on the ground. This was the slowest to produce fruit of any species grown this year. On the date last mentioned hardly enough had been formed to pay for picking.

Three more plats were planted June 9—two with seed from the Division supply and one with the same seed as the plat just described. All were up by the 1st of July, and during that hot month each made a growth of about 1 foot, a rate maintained until the middle of October, when they had caught up with the plat sown a month earlier—at least in size and vigor, but had just begun to fruit.

Gray saltbush (*A. halimoides* Lindl.).—One plat (9–A–11) was planted on May 12 with seed from California (S. P. I. 3925). On June 9 the plants were 1 inch high; on July 3 they were 6 inches high, and on July 31 they were fine and vigorous, 12 inches in height. Two plats sown July 9 with seed from the same lot produced plants which were about 5 inches shorter than the preceding through the summer, but had reached an equal size by October 17, when all were robust, spreading bushes fully 2 feet high and loaded with the spongy fruits which had been ripening and falling to the ground in such quantities that a bushel was taken up from each plat at this time. The plants continued to fruit until nearly the end of November, when they were pulled.

Annual saltbush (*A. holocarpa* F. v. Muell.).—One-half a plat (9-C–10*a*) was sown May 16 with seed from the United States grass station at Abilene, Texas, 1899. Germination was prompt and growth was rapid. On July 3 the stout bushes were 6 to 8 inches high, and fruit on some was nearly full grown. August 1 they were 12 to 15 inches high, widely branching and full of fruit, some of which was ripe and falling off. The plants grew to be 16 to 18 inches high and fruited abundantly until they were pulled, November 28. On October 17, 1½ bushels of fruit were taken up from the ground under the plants, and on November 28 about 1 bushel more was secured, the total yield being at the rate of 800 bushels per acre.

Slender saltbush (*A. leptocarpa* F. v. Muell.).—One plat (9-A-10) was planted May 12 with California seed (S. P. I. 3926). On June 9 the plants were 1 inch high, and on July 3 they were 6 to 8 inches high and beginning to spread out on the ground like the Australian saltbush, which this plant closely resembles. Two more plats (9-A-8 and 9) were sown June 9 with seed of the same number and made a similar growth, equaling those from the first seeding by the middle of October, when all presented a dense mat of prostrate vines 3 feet or more in length and fruiting abundantly. They remained unharmed by frosts until the end of November, when they were taken up for seed.

BURNET (*Poterium sanguisorba* L.).

A plat (9-C-11) was seeded on May 18, and on June 6 the first plants appeared. On July 3 they were 3 to 5 inches high, but their growth was checked by the heat and increased only 2 or 3 inches during the month. With the coming of the September rains they began a vigorous growth, and soon the plants had a diameter of about 2 feet and continued green and fresh until December 1.

RAPE (*Brassica napus* L.).

One plat (9-C-7) was sown May 16 with French seed (S. P. I. No. 1449), which germinated very quickly and by June 6 gave a good stand of healthy plants 3 inches high. On July 3 they were 1 to 2 feet high, strong and vigorous, the largest in flower. A second plat (9-A-14) started June 9, came up well, and grew rapidly at first, but was badly burned by the hot weather of July, standing only 6 to 10 inches high at the end of that month and making almost no growth later.

LEGUMES.

More than 200 plats were devoted to the experiments with leguminous plants, for the most part with seed obtained from abroad through the Section of Seed and Plant Introduction. The remainder were from the Division stock.

ALFALFA (*Medicago sativa* L.).

Fifteen different lots of alfalfa were sown. The seeds were grown in different parts of the United States, in the Argentine Republic, in Italy, France, and Bavaria, in Turkestan, Siberia, and China, and in Egypt. Some of them were planted on May 14, some on May 24, and some as late as June 22. The ground selected was on the highest and best-drained portion of field 9. All the seed germinated well, and the young plants made a vigorous start, but in the last days of June and during July they were badly burned by the intense heat. Growth was completely checked for over a month, and the uppermost leaves became yellowish and finally died. The comparative vitality of the plants in the different plats could best be judged by the way in which they recovered from their injury.

Two plats (9-B-3 and 6) sown May 24 with Arizona seed seemed less vigorous after the burning than did most of the others and were quite badly affected with spot disease. Plat 9-C-14 was sown June 22 with Argentine seed (S. P. I. No. 3507), and plats 9-C-17 and 18 were seeded the same day with No. 3508. On

July 3, when most of the early planted plats were burned badly, these were just germinating in excellent condition. By August 1 they were about 6 inches high and slightly burned. On October 18 they stood 12 to 15 inches tall, healthy and vigorous, some in flower, and with little or no spot disease to be found.

Four plats were sown May 23 with seed from Southern Europe. Plat 9-B-13 was planted with Italian seed, plat 9-B-14 with Bavarian seed, plat 9-B-15 with seed from the south of France, and plat 9-C-15 with seed from Provence, France. All were badly tip-burned early in July, and did not grow any more until the end of that month. On October 17 the Bavarian stood nearly 18 inches high, while the others were only 1 foot high, but all except the Italian were weak and dying. None were affected with spot disease except the Provençal, and that but slightly.

Plat 9-B-17 was sown May 14 with seed from Bokhara, Turkestan (S. P. I. 679). This suffered severely from burning and made only 1 foot of growth during the season. In October much spot disease had developed and the lower leaves were dying. Plat 9-B-5 was sown on May 24 with Samarkand seed (S. P. I. No. 1295). This made the same growth during the season as the last, but remained quite green until the last of November. Very little spot disease was observed. Plats 9-B-1 and 2, planted from the same seed on June 21, were just coming up on July 3 when most of the plats were badly burned. By the middle of October they were 14 to 18 inches high and quite healthy in appearance. Plat 9-C-4 was sown with seed of Turkestan alfalfa (*M. sativa Turkestanica*) (S. P. I. No. 1169). It was injured by heat as badly as any and recovered as slowly. The growth amounted to 12 inches by October 17, when the lower leaves were dying, but none was affected by spot disease.

Plats 9-C-5*b* and 6 were planted May 16 with seed from China (S. P. I. 1152). The results were the same as with Turkestan alfalfa. Plat 9-B-4, sown May 24 with Egyptian seed, was badly burned, but made good recovery, and reached a height of 12 to 18 inches by October 18, when it appeared vigorous and healthy. No spot disease was found upon it.

CLOVERS.

Only five species were grown this year. They were all planted on the lower part of the land, where they made a very satisfactory growth.

Alsike clover (*T. hybridum* L.).—Plats 10-F-5 to 7 were seeded May 29 with American seed. On June 11 the plants were just up and the stand was excellent. By the 1st of July it was about 6 inches high. During July the growth was considerably checked but the foliage remained healthy and bright. Increase in size commenced with the September rains. By October 16 it stood 12 to 15 inches high, flowering and seeding abundantly. November 17 it was still fresh and green, notwithstanding several frosts.

Crimson clover (*T. incarnatum* L.).—Five plats, 10-I-14 to 18, were sown on June 1 with seed from the Division supply. It was well up on June 11 and, except for a slight burning in July, maintained a steady healthy growth throughout the season, reaching a foot in height in October. On November 17 the plants showed no effects of the severe frosts.

Hungarian clover (*T. pannonicum* Jacq.).—Plat 10-F-2 was seeded to this May 29. Only a few plants appeared and made but a slow growth. By October 16 each plant was a sturdy tuft of crowded stems about 6 inches high. It seems perfectly hardy here for it was not injured by November frosts. It is a native to Southern Europe, where it is said to be much earlier than red clover but less relished by stock.

Mammoth clover (*T. medium* L.).—Two plats, 10-F-8 and 9, were planted May 29. This germinated quickly and grew well, showing but little effect of the drought. By October 16 the plants were 2 feet high and seeding well, but were beginning to die. November 17 the most of the foliage was dead but no injury had been done by frost.

Strawberry clover (*T. fragiferum* L.).—Plat 10-F-1 was sown May 29 with Russian seed (S. P. I. No. 1018). On June 19 the first plants appeared. These grew slowly during the summer, showing no injury by heat. On October 16 the plants were in vigorous healthy condition, 5 to 6 inches high, making a thick, close growth. No flowers were produced. November 17 a few of the younger, tenderer leaves were killed by frost but the mass of the foliage was not injured.

Bush clover (*Lespedeza* sp.).—Plats 10-F-14 and 15 were planted May 29 with Japanese seed of *L. sericea* Benth. (S. P. I. No. 3121). The plants came up thinly and grew steadily through the hot spell, reaching a height of 2 feet in October. The plant is perennial, erect, with slender ascending branches, short, sessile leaves and white flowers borne sessile on the main stem and branches, nearly hidden by the numerous small leaves. The stems are tough and woody, but aside from this the plant should make good forage if palatable.

Another species (*L. bicolor* Turcz.) called "Hagi" in Japan (S. P. I. No. 2923) was planted May 29 on plats 10-F-16 to 18. It grew very much as the preceding but attained to the larger size of 3 feet. This species is very much branched with longer silky leaves, and flowers in an open terminal panicle. It has much more foliage in proportion to the stems and branches and would make more and better forage. It is also a perennial. The leaves were mostly killed by frost in November, by which time most of the seed was ripe.

Bird's-foot clover (*Lotus corniculatus* L.).—A half plat, 10-G-3a, was sown with Russian seed (S. P. I. No. 1065) on May 31. Only a few plants came up, but by their prostrate habit they soon covered the surface of the ground. By August 3 the plants were about 18 inches across and buds were appearing. September 20 the plants measured 2½ feet in diameter and were covered with bunches of bright yellow flowers. A month later these had disappeared and the seed was nearly ripe. The younger leaves were killed by November frosts, but the plat still looked green and fresh.

This little plant is highly esteemed in Europe for use on light, sterile soils and in dry places. It has become naturalized in the Southern States. The foliage is relished by both cattle and sheep.

Swamp lotus (*Lotus uliginosus* Schkuhr.).—A two-thirds plat, 10-G-2b, of this was started with French seed (S. P. I. No. 1468) on May 31. A fair stand resulted and the plants grew slowly until the heat of July checked them for a time, burning the tender foliage somewhat. On September 20 they were 6 inches high, healthy, and beginning to flower. Growth continued but no seed set. Frost killed only the more delicate young leaves.

The swamp lotus is a native of northern Europe, where it is valuable for wet or swampy land. It has been used successfully in similar places in the northern United States.

Sulla (*Hedysarum coronarium* L.).—Plat 10-G-4 was planted May 31 with Division seed and plats 10-G-5 to 7 on the same date with French seed (S. P. I. No. 1518). A good stand of each was secured by June 11. July 6 the plants were about 3 inches high and noticeably affected by the dry weather, from which they recovered only slowly. In August rapid, vigorous growth commenced, and by October 16 they were over 1 foot high and quite healthy in appearance. November 18 found them 18 inches in height and but little injured by frosts.

PEAS AND BEANS.

Field pea (*Pisum arvense* L.).—Four lots of field peas were sown May 29. All were imported seed (S. P. I. No. 1173 and Nos. 1485, 1486, and 1487) from France and Russia. Only a thin stand was obtained, and while they did not appear affected by the drought, their growth was always slow. The vines finally attained a length of 18 inches to 2 feet and most of them flowered, but none ripened any seed. All died in the latter part of September. Many of them were affected by downy mildew.

Bitter flat pea (*Lathyrus sativus* L.).—Three plats (10–D–10 to 12) were planted on May 28 and two plats (10–E–13 and 14) on May 29 with Russian seed (S. P. I. 1175). The plants came up promptly and grew vigorously during the summer. The plants were 16 to 20 inches high by the end of July, with an abundance of flowers and some full-grown pods. By October 1 they were nearly all dead and the seed ripe.

This species has not been cultivated in this country to any extent, because the seeds contain an alkaloid which is said to be poisonous. It would probably be of some value in the Southwest.

Chicharaca (*Lathyrus tingitanus* L.).— Plat 9–D–13 was seeded on May 28 with seed from Algeria (S. P. I. No. 3289). Only a thin stand was secured, but the growth was very rapid. The plants were unaffected by the heat and drought and reached a length of 3 to 4 feet by the end of the season. They produced numerous flowers during July, but no seeds set and the pods did not develop. On November 15 the vines were still green and healthy in spite of several severe frosts. This species closely resembles the bitter flat pea, but grew much larger. It has not heretofore been cultivated in this country. It was introduced from Algeria, where it is used as a winter forage, and is said to be free from the poisonous properties found in so many of the flat peas. It is cultivated in the Canary Islands and Morocco also, and is said to be hardy in Southern France where exposed to a temperature of 26° F.

Winter flat pea (*Lathyrus cicer* L.).—Two plats (10–D–14 and 15) were planted on May 28 with seed from France (S. P. I. No. 1459). On June 5 a good stand appeared. By the middle of July the plants were 5 to 6 inches high and somewhat burned. Toward the end of the month they revived a little and made some new growth, but produced no flowers, and later died. It is used in Germany and France as an early spring forage.

Everlasting flat pea (*Lathyrus sylvestris* L.).—Two plats (10-D–3 and 4) were planted on May 28 with Russian seed (S. P. I. No. 2802), and a half plat (10–D–6*a*) with French seed (S. P. I. No. 1460). Both lots came up thinly and grew slowly but steadily, reaching a height of about 16 inches by October 15. On November 16 they were still fresh and green after several heavy frosts.

Improved everlasting flat pea (L. *sylvestris wagneri*).—Seed from France (S. P. I. No. 1461) was used in planting a half plat (10–D–6*b*). In growth and appearence it did not differ from the above, This plant has been widely praised as a valuable forage during recent years; but, it must be said, that experiments in various parts of this country do not establish its claim.

Gray milk-pea (*Galactia canescens* Benth.).—A half plat (10–G–2*a*) was planted May 31. The seed did not germinate until June 19, and then the growth was quite slow. On July 15 the seedlings were 3 inches high and bush-like in habit. By August 3 the twining branches were 6 to 8 inches long; September 20 their length had increased to 1 or 1½ feet, and a few flowers were out. On the 16th of October the fruit was well set and the plants still fresh. By the middle of November the plants had succumbed to the frosts without ripening more than a small part of the seed. It is native to the dry region from Texas westward, and for that part of the country should be valuable.

Chick pea, garbanzo (*Cicer arietinum* L.).—Four plats were sown May 28 with French seed 10-C-12 and 13 with S. P. I. No. 2137, and 10-C-14 and 15 with No. 2376. Plats 10-C-16 and 17 were planted with Morocco seed (S. P. I. No. 2977), which failed to germinate. Both lots of French seed germinated well and made rapid, healthy growth. By the end of July the vines were 1½ feet in height, nearly done flowering, and bearing an abundance of nearly full-grown pods. September 20 the vines were almost all dead, and the pods were then picked and thrashed, only to find that but few of them contained good seed. Some were empty, and many contained moldy, immature seed.

Green gram (*Phaseolus mungo* L.).—Plats 10-C-18 to 20 were planted May 28 with Russian seed (S. P. I. 1385). It germinated quickly and gave a fair stand by June 5. On July 12 the plants were 12 to 15 inches high. The leaves were considerably eaten by insects. July 27 the vines were very vigorous in appearance, 2 feet or more in length, and making a tangled mass of very leafy forage. Flower buds were appearing. On the 22d of September nearly half the seeds were ripe and were then gathered. The older leaves were beginning to wither. On October 15 the seed was all ripe, but the vines were still green. Twenty-five pounds of seed were produced.

Two-thirds of a plat (10-H-3a) was planted on June 1 with seed of what was called Chinese soy bean (S. P. I. No. 2873). Germination was very irregular, but a fair stand was finally secured. Its habit and appearance soon showed it to be the green gram. It made about the same growth as the one just described, but the vines died a little earlier.

Slender bean (*Phaseolus angustissimus* Gray).—Plat 10-D-1 was planted May 28 with seed grown in the grass garden in 1899. Only a few of the seeds germinated, but the plants grew rapidly, reaching a length of 3 feet by September 20 and twining on each other in the absence of other support. It was then in full flower. On October 15 the seeds were nearly ripe, and the vines were dying. This bean is a native of the Southwest and may be worthy of cultivation in that region. The slender, twining vines grow vigorously, are much branched, and produce an abundance of foliage and fruit, which should make good forage.

Lablab (*Dolichos lablab* L.).—Several varieties of this bean from Italy and Algeria were planted June 1 on low ground. They came up well and made a most luxuriant growth of vines during the season. None of them seemed injured or even checked by the drought. The long, running shoots reached a length of 8 to 10 feet and produced an abundance of flowers in September. Fruit was matured only on one or two of the dark-leaved, purple-flowered varieties. All were killed by the November frosts.

Lentils (*Ervum lens* L.).—Plats 10-F-19 and 20 were planted May 29 with seed from Smyrna (S. P. I. No. 3658). A fair stand appeared. On June 11 the plants were 2 to 3 inches high, and on July 16 the height was 6 to 8 inches. By July 27 they were badly twisted about by winds and were beginning to die. On September 20 they were entirely dead.

Seed (S. P. I. No. 1467) planted May 31 on plats 10-G-18 to 20 gave a good stand, but the plants grew very slowly, took on a dried and sickly appearance, and finally died after reaching a height of 4 inches. No flowers were produced. Plats 10-G-16 and 17, planted on the same date with No. 1466, gave scarcely better results. The plants grew a little taller and lived a little longer, but also produced no flowers.

On May 31 plats 10-G-13 to 15 were sown with seed (S. P. I. No. 1183) from India. On June 11 the plants were 2 inches high and the stand excellent. By July 16 the plants were flowering at a height of 6 inches. August 3 they were still flowering, though badly beaten down and covered by dirt. On August 27 they were entirely dead and the seeds ripe.

Velvet bean (*Mucuna utilis* Wall.).—Plats 10-F-10 and 11 were planted May 29 with seed from Florida (S. P. I. No. 4333) and plats 10-F-12 and 13 with seed from the Division supply. Germination was fairly prompt, the young plants appearing by June 11, but the stand was poor. By the middle of July the vines were 3 feet long and growing vigorously. On September 20 the plats presented a tangled mass of vines about 3 feet deep and running out for 8 to 10 feet on all sides—a most luxuriant growth. October 16 they were still growing with no sign of flowers. October 25 showed the more tender and exposed foliage killed by the light frosts and early in November all were dead.

Soy bean (*Glycine hispida* Maxim.).—Several lots of soy beans were planted June 2. The series of plats on which they were sown was intersected by a wet depression in which the plants were noticeably smaller and less healthy in color. As no lot was situated entirely in the depression, the comparative value of the tests was not impaired. There were some striking differences in the time of maturing and in size and habit also.

Seed of a variety from China (S. P. I. No. 2869) wiih light green leaves and blue flowers made a growth of nearly 3 feet and matured about September 12. The variety "Kaiyuski daiszu" from grass garden seed had also light green leaves, very much wrinkled, and white flowers. It matured at the same time.

A variety from Paris (S. P. I. No. 5039) produced rather slender plants with dark foliage. Fruit ripened September 20. This was called "Early Black."

Two Japanese forms (S. P. I. Nos. 4912 and 4913) were sturdy bush-like plants about 2½ feet high and ripened their seeds about October 10.

Another Japanese variety, called "Best Green" (S. P. I. No. 4914) produced stout, heavy plants which grew to be 3 feet high and matured very slowly. On October 16 the vines were yet fresh and green and the seed was not ripe. Most of it matured from November 7 to 13.

Two Chinese varieties, "Chin Pi Do" (S. P. I. No. 2871) and "Hêh Pi Do" (S. P. I. No. 2872) were planted May 31. The first grew to a height of 4 to 6 feet. The plants were at first erect but finally bent over from their own weight. On October 16 the fruit was well formed but not ripening, and the plants were still vigorous. On November 17 the frost had destroyed most of the foliage. Only a few of the seeds were fully ripe. The second variety reached a height of over 4 feet and matured a little earlier than the preceding.

LUPINES AND VETCHES.

Eight different lots of lupines were planted on May 29. The seeds of one were collected in Wyoming in 1898. The others were all secured in France and Russia by the Section of Seed and Plant Introduction. All were failures from the start, as not more than a dozen germinated on any plat, and most of these succumbed to the heat and insect attacks. Not more than a dozen plants on all the plats lived to produce seeds, of which the greater part were eaten by insects.

Thirty-six different lots of vetches, comprising fifteen different species, five native and ten foreign, were planted May 22, 26, and 28. The different lots of Giant Vetch (*Vicia gigantea* Hook.) and Stolley Vetch (*V. leavenworthii* T. & G.), both native species, failed to germinate, as did also one lot of *Vicia dumetorum* from France. Five different lots of horse bean (*V. faba* L.) resulted in a very poor stand of weak plants, which were badly injured by heat. The few plants which survived made a growth of 1½ feet and some produced flowers. Three lots of Narbonne Vetch (*V. narbonensis* L.) gave similar results. Two lots of the one-flowered vetch (*V. monantha*) gave fair stands, but the plants were dried up at the height of 5 inches. They recovered somewhat later, but made little growth, spending the remainder of the season in dying slowly. Two lots of the Big-seeded vetch (*V. macrocarpa* Bert.) from France resulted about the same, but grew 10 inches high and persisted longer. It closely resembles Spring Vetch. Two lots of Narrow-leafed vetch (*V. angustifolia*) gave only a few small plants, which soon died. A half plat of the American vetch (*V. americana* Muhl.), planted with Wyoming seed of 1898, gave but a few plants, which made little growth, were badly eaten by insects, and finally died early in October.

Vicia Bironea Rafin.—Plat 10–A–2 was planted May 22 with seed from Australia, 1897 (No. 23740 of Professor Maiden). A thin stand resulted, but the young plants grew finely, reaching 6 to 8 inches in height by July 12. They showed no sign of injury by the heat. By September 1 they were a foot high, forming a dense, tangled mass, but died soon after without producing flowers.

Black bitter vetch (*V. ervilia*).—One plat (10–A–20) planted May 29 gave a thin stand, as did plats 10–D–19 and 20 planted with seed from France (S. P. I. No. 1452). The plants grew slowly but did not seem affected by the heat. By October 15 the plants were a foot high and still green but had produced no flowers. This species is adapted to hot dry climates. It is cultivated in the Barbary States, where it produces large crops.

Scarlet vetch (*V. fulgens* Batt.).—Plats 10–B–11 and 12 were planted on May 28 with seed from France (S. P. I. No. 1514) and plats 10–B–13 and 14 with another lot (S. P. I. No. 4336) from the same source. In each case a thin stand was obtained. On July 12 each was 6 to 8 inches high, the first entirely healthy, the second somewhat burned at the tender tips. By the end of the month no difference could be observed between the two. On September 17 they were 1½ to 2 feet high, a healthy vigorous growth of slender, tangled vines. October 15 they stood about 3 feet high and showed no signs of flowering. On November 17, the vines, while matted down somewhat, showed no injury from the frosts. This annual comes from Algeria, where it is known as a rapid grower and is considered one of the most valuable forage plants.

Spring vetch (*V. sativa* L.).—Nine different lots of this vetch were sown, and the results in all cases were nearly the same. The stand was not more than one-half in any case. The young plants were healthy, but were soon checked by the hot weather and quite badly burned. They recovered slowly from this and made new growth, but were always feeble, reaching a final height of about 10 inches and none of them producing flowers. By the end of September most of the plants were dead.

Mogollon vetch (*V. exigua* Nutt.).—Plat 10–C–1 was sown May 28 with seed of the crop of 1897 and plat 10–C–2 with seed of 1898. About half the seed grew, and the young plants, like those of the wild vetch, grew slowly throughout the hot months and showed no actual injury. The plants lived until the middle of October, at which time they had reached a length of from 18 inches to 3 feet, but had produced no flowers. This plant is native to the Southwest from New Mexico to California.

Vicia hirsuta Koch.—Plat 10–A–3 was planted May 22 with seed of this vetch raised at Ophir, Wash., in 1899. A thin stand appeared, and on June 19 the plants were 1 to 2 inches high. July 12 found them 4 to 5 inches high, green and healthy, and with no sign of injury from the heat. On July 27 the plants, though no larger, were still uninjured, but subsequent growth was slow. September 17 showed a height of 7 inches, but no sign of flowers. On October 15 the plants were beginning to take on autumn colors. November 27, after several severe frosts, they were still alive.

This vetch is a native of Asia and has been sparingly introduced into this country from Europe

Milk vetches.—The seeds of several native species of milk vetches from the Rocky Mountains and of two imported species were planted June 1. Of the natives only one germinated at all, and that produced but a half dozen plants.

Morton's milk vetch (*Astragalus Mortoni* Nutt?).—Plat 10–I–1 was sown with seed from the Division supply. Only a few came up, and these made but a slow growth, although they did not appear to be affected by the heat—at least the foliage was not injured. The plants are prostrate, forming round mats about three feet across. On November 17 they were still growing, after severe frosts, but had not flowered. This species is native to the Rocky Mountains and westward to the coast. It produces an abundance of foliage and may prove of some value in that region.

Astragalus falcatus Lam.—Two lots of French seed were sown June 1. Plat 10–I–4 was planted with S. P. I. No. 1448, and 10–I–6 and 7 with No. 5034. A thin stand was secured and a slow growth resulted. October 16 the plants were one foot high, fresh and healthy in appearance, but without flowers. November 17 they were unharmed by the heavy frosts. This species is native to the Caucasus, and may prove of value in the Rocky Mountain region.

Genge, rengeso (*Astragalus sinicus* L.).—Plat 10–I–5 was planted with seed from Japan (S. P. I. No. 3725). On June 11 a good stand had appeared. About July 1, when the plants were only two inches high, they were checked and burned by the heat, and recovered only slowly. October 16 the plat presented a very healthy appearance. The plants were then six inches high and a few clusters of blue flowers were out. November 17 flowers were still appearing, but the upper leaves had been killed by frosts. The rest of the plant was uninjured.

C. R. Ball,
Assistant in charge of Grass Gardens and Experiments within the District of Columbia.

Approved:

James Wilson, *Secretary.*

Washington, D. C., *December 13, 1900.*

CIRCULAR No. 29. (Agros. 78.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage-Plant Investigations.]

F. LAMSON-SCRIBNER, *Agrostologist.*

THE GRASSES IN ELLIOTT'S "SKETCH OF THE BOTANY OF SOUTH CAROLINA AND GEORGIA."

One of America's most distinguished botanists was Stephen Elliot, born at Beaufort, S. C., in 1771. He was a man of marked ability, and began his career as a legislator, in which capacity he served his State for many years, taking a leading part in many of the important measures of his day. Although constantly engaged in public and engrossing financial business, he did not neglect literary and scientific pursuits. He found time during his busy life to prepare what he modestly termed a "Sketch of the Botany of South Carolina and Georgia," a work of 1,344 pages, written in Latin and English, and containing a dozen finely executed plates, illustrating nearly 50 species of grasses and sedges. The work is an enduring monument to Elliott's scientific skill and acumen. Not until one has prepared a book where almost every line contains a statement of fact learned from original observation, can he fully appreciate the amount of patience and labor involved in the preparation of such a work as the "Sketch of the Botany of South Carolina and Georgia." For many years Elliot's "Sketch" was the only botanical authority for the plants of the region it embraced, and to-day it remains indispensable to the working systematic botanists of our country.

Elliott began the publication of his work in parts. The first part, including pp. 1–96, was published in October, 1816; the second, which carried the work to pp. 222, was issued in February, 1817. This second part contained descriptions of the grasses, and is, therefore, the one most immediately interesting to agrostologists.[1] The entire work was finally issued in two volumes, the first volume, containing parts 1–5, was published in 1821, as indicated by the title page, the second in 1824.

The following notes presented here for publication are based upon a careful examination of the collection several years ago by myself, the notes then taken having been recently verified by Mr. Elmer D. Merrill, who was by my direction sent to Charleston for that purpose. I wish to thank the authorities of the College of Charleston for kindly extending to the Department the privileges accorded to it, enabling us to accomplish our object.

NOTES ON THE SPECIES.

Many species noted below were described by Elliott as new, but some had been published by foreign botanists who had received specimens from American collectors, and a few of the earlier published species taken up by Elliott were misunderstood by him. There is much existing doubt respecting the identity of some of Elliott's

[1] *Anthoxanthum* and the species of *Erianthus* were published in the first part.

species of grasses, and as the only means of clearing up this confusion and preventing further error it was necessary to examine the specimens upon which they were based. Fortunately Elliott's herbarium has been preserved and is now the property of the College of Charleston. The herbarium consists of 28 volumes of folios, 12 by 23 inches in size, and the specimens are for the most part attached to the sheets and labeled both on the outside of the fold and on the inside. Often several species are in one sheet, but in such cases each specimen is separately labeled. A part of the herbarium, especially that containing the grasses, is in very good state of preservation, while in several of the volumes of other plants nearly all the specimens have been destroyed by insects. The *Gramineae* occupy exclusively one volume and portions of three others.

Anthoxanthum odoratum Linn.; Ell. Sk. 1:37.

Erianthus alopecurioides Ell. Sk. 1:38.=*Erianthus saccharoides* Michx.

Erianthus brevibarbis Michx.; Ell. Sk. 1:39. On this cover is also the name "*Erianthus contortus,*" which is scratched out. The specimen in the Herbarium of Elliott is matched by No. 1426 A. P. Anderson, South Carolina, October 1, 1897, in the U. S. National Herbarium.

Erianthus strictus Baldwin; Ell. Sk. 1:39. This is the same as a specimen in the Herb. Acad. Nat. Sci., Phila., so labeled by Baldwin.

Erianthus contortus Ell. Sk. 1:40. This name appears in the Herbarium of Elliott only on the cover with *Erianthus brevibarbis* noted above.

Cenchrus echinatus L.; Ell. Sk. 1:93.

Cenchrus tribuloides L.; Ell. Sk. 1:93. In this cover is true *Cenchrus tribuloides* L., and a specimen of *Cenchrus macrocephalus* (Doell.) Scribn.

Spartina juncea Ell. Sk. 1:94.=*Spartina patens* (Ait.) Muhl.

Spartina polystachya Michx.; Ell. Sk. 1:95.

Spartina glabra Muhl.; Ell. Sk. 1:96.=*Spartina stricta maritima* (Walt.) Scribn.

Arundinaria macrosperma Michx.; Ell. Sk. 1:96.

Muhlenbergia diffusa Ell. Sk. 1:98.

Muhlenbergia erecta Muhl.; Ell. Sk. 1:98.=*Brachyelytrum erectum* (Schreb.) Beauv.

Trichodium laxiflorum Michx.; Ell. Sk. 1:99.=*Agrostis hyemalis* (Walt.) B. S. P.

Trichodium perennans Walt.; Ell. Sk. 1:99=A form of the grass now referred to *Agrostis altissima* (Walt.) Tuckerm.

Leersia virginica Willd.; Ell. Sk. 1:100=*Homalocenchrus virginicus* (Willd.) Britton.

Leersia lenticularis Michx.; Ell. Sk. 1:100.=*Homalocenchrus lenticularis* (Michx.) Kuntze.

Leersia oryzoides Linn.; Ell. Sk. 1:101.=*Homalocenchrus oryzoides* (Linn.) Poll.

Phalaris americana Ell. Sk. 1:102.=*Phalaris caroliniana* Walt.

Aulaxanthus ciliatus Ell. Sk. 1:102.=*Anthaenantia villosa* (Michx.) Benth.

Aulaxanthus rufus Ell. Sk. 1:103.=*Anthaenantia rufa* (Ell.) Schultes. Specimen not seen.

Milium paspaloides Ell. Sk. 1:104.=*Paspalum paspaloides* (Michx.) Scribn. This species is in Elliott's Herbarium under the name "*Milium corrugatum*." With it is a note by Ravenel saying "This is *M. paspaloides* Ell. Sk."

Paspalum setaceum Michx.; Ell. Sk. 1:104. Not seen.

Paspalum deblie Michx.; Ell. Sk. 1:105. Not seen.

Paspalum ciliatifolium Michx.; Ell. Sk. 1:105. A form with long narrow leaves, which are regularly ciliate along the margins, otherwise smooth. Sheaths hairy at the throat. Racemes solitary. Spikelets very smooth, 2 mm. long.

Paspalum dasyphyllum Ell. Sk. 1:105. Leaves 15 cm. long, 5 to 7 mm. wide, pubescent on both sides with stiff, rather long, spreading, papillate hairs. Rachis of the racemes about 1 mm. broad, undulate. Spikelets slightly pubescent, about 1.5 mm. long, crowded.

Paspalum praecox Walt.; Ell. Sk. 1:106. This resembles *Paspalum purpuracens*. Spikelets about 2 mm. long, in four rows. Rachis flat, as broad as the rows of spikelets. Racemes 3, ascending.

Paspalum laeve Michx.; Ell. Sk. 1:106.

Paspalum floridanum Michx.; Ell. Sk. 1:107. In Elliott's Herbarium the plant under this name is identical with the specimen under *Paspalum laeve* except in having the sheaths somewhat pubescent.

Paspalum plicatulum Michx.; Ell. Sk. 1:107. Specimen not seen.

Paspalum purpurascens Ell. Sk. 1:108. = *Paspalum boscianum* Flügge.

Paspalum distichum Linn.; Ell. Sk. 1:108. Specimen not seen.

Paspalum vaginatum Ell. Sk. 1:109. = *Paspalum membranaceum* Walt.

Ceresia fluitans Ell. Sk. 1:109 = *Paspalum mucronatum* Muhl.

Phleum pratense L.; Ell. Sk. 1:110. The only specimen under this name in Elliott's herbarium is from Sullivan's Island, and is *Polypogon monspeliensis* (L.) Desf.

Alopecurus geniculatus L.; Ell. Sk. 1:111.

Panicum cenchroides Ell. Sk. 1:111 = *Cenchrus myosuroides* H. B. K.

Panicum laevigatum Muhl.; Ell. Sk. 1:112 = *Chaetochloa imberbis* (Poir.) Scribn. This species is in Elliott's herbarium under the name "*Panicum glaberimum*," and is exactly matched by a specimen in the herbarium of the U. S. Dept. Agriculture, collected in North Carolina by G. McCarthy in 1889, distributed as *Setaria glauca* var. *laevigata* Chapm.

Panicum glaucum L.; Ell. Sk. 1:112 = *Chaetochloa glauca* (L.) Scribn.

Panicum glaucum var. **glaucum**? Ell. Sk. 1:113 = *Chaetochloa corrugata parviflora* (Poir.) Scribn. & Merrill.

Panicum glaucum var. **flavescens** Ell. Sk. 1:113 = A yellow-awned form of *Chaetochloa glauca* (L.) Scribn.

Panicum glaucum var. **purpurascens** Ell. Sk. 1:113 = A short-awned form of *Chaetochloa imberbis* (Poir.) Scribn.

Panicum corrugatum Ell. Sk. 1:113 = *Chaetochloa corrugata* (Ell.) Scribn., the form so considered in Bul. **21**:22, *fig. 11*, of this Division, and matched by No. 108 T. H. Kearney, Apalachicola, Fla, July 15, 1895, in the U. S. Nat. Herb.

Panicum italicum Walt.; Ell. Sk. 1:115 = *Chaetochloa magna* (Griseb.) Scribn.

Panicum crus-galli L.; Ell. Sk. 1:114 = The form so considered to-day. Var. **muticum** is the awnless form. Var. **aristatum** is not represented in the herbarium. Var. **hispidum** is *Panicum walteri* Pursh.

Panicum walteri Ell. Sk. 1:115 = *Panicum digitarioides* Carpenter. In this sheet is a label bearing the name "*P. dimididiatum.*" Muhlenberg considered this species under the same name (*Panicum walteri*). See Scribner & Merrill, Circular **27**:2, of this Division.

Panicum hirtellum Michx.; Ell. Sk. 1:115 = *Oplismenus hirtellus* R. & S.

Panicum gibbum Ell. Sk. 1:116.

Panicum molle Michx.; Ell. Sk. 1:116 = *Eriochloa mollis* Kunth.

Panicum gymnocarpum Ell. Sk. 1:117.

Panicum geniculatum Muhl.; Ell. Sk. 1:117 = *Panicum proliferum* Lam.

Panicum anceps Michx.; Ell. Sk. 1:118. Not seen.

Panicum hians Ell. Sk. 1:118 = *Panicum melicarium* Michx.

Panicum latifolium Walt.; Ell. Sk. 1:119=*Panicum latifolium* Linn. (excluding reference to Sloane). A specimen of *Panicum currani* Ashe, is also in the cover.

Panicum scoparium Lamarck; Ell. Sk. 1:119. Recent investigations have shown that *Panicum scoparium* Lam., has been entirely misunderstood by American botanists and that it is the form described by Elliott as *Panicum viscidum*. See Scribner & Merrill Bul. **24**:34 of this Division. A description of Elliott's plant is given below.

Panicum ravenelii Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **24**:34. January 9, 1901. *Panicum scoparium* of Ell. Sk. Bot. S. C. and Ga. 1:119. 1817, not Lam. Encycl. 4:144. 1797.—An erect or ascending, caespitose perennial 3 to 6 dm. high, with broad, ascending leaves, large spikelets and generally few flowered panicles. Culms at first simple, later becoming branched, rather densely papillate-pubescent with ascending or nearly appressed hairs; nodes bearded with a dense ring of short spreading hairs, and with a smooth ring immediately below; sheaths shorter than the internodes, or the upper ones crowded and overlapping, striate, distinctly papillate-pubescent, densely bearded on the back at the apex; ligule a fringe of rather stiff hairs 3 to 5 mm. long; leaf-blades lanceolate, acute, slightly narrowed at the rounded and somewhat clasping base 8 to 13 cm. long, 1.5 to 2 cm. wide, ciliate on the cartilaginous margins, rather densely pubescent beneath with soft hairs, glabrous above or rarely with few scattered papillate hairs, nerves faint above, very prominent on the lower surface. Panicles about 10 cm. long, the branches spreading or the lower ones often erect; rachis and branches densely pubescent with short hairs. Spikelets 4 mm. long, ovate, obtuse, slightly pubescent with short spreading hairs; first glume acuminate, about one-third as long as the spikelet; second and third glumes 9 to 11 nerved; flowering glume very smooth.

Type specimen in the Herbarium of Elliott, College of Charleston, Charleston, S. C., type locality, South Carolina.

General distribution: in shaded fertile soil, District of Columbia south to Florida and Texas, May to September, not common.

Specimens examined: *District of Columbia:* near Eastern Branch, L. F. Ward, June 16, 1881; near Chain Bridge, E. S. Steele, 1899. *Tennessee:* no locality. S. M. Bain, 1893. *South Carolina:* no locality, Stephen Elliott, type in Herbarium of Elliott; Aiken, W. H. Ravenel—F. L. Scribner, 1894; *Florida:* Apalachicola, A. W. Chapman, 2994a Biltmore Herbarium; Monticello, 305 R. Combs, August 4, 1898. *Arkansas:* "Northwest Arkansas" 31 F. L. Harvey; Benton County, E. N. Plank. *Texas:* Harvester, No. 7 F. W. Thurow, June, 1898; Waller, 7a F. W. Thurow, 1898.

This species is readily distinguished from *Panicum pauciflorum* Ell., and *P. scribnerianum* Nash, to which it is most closely related, by its much broader pubescent leaves and larger spikelets. Of the specimens cited above, S. M. Bain, 1893; Steele, 1899; 2994a Biltmore Herbarium, and the specimens from Ravenel have been carefully compared with Elliott's type.

Panicum pauciflorum Ell. Sk. 1:120. A distinct species, related to *Panicum scribnerianum* Nash. The same as the specimen in the Herbarium of Columbia University, so labeled by Elliott = *Panicum oligosanthes* Schultes.

Panicum virgatum Linn.; Ell. Sk. 1:120.

Panicum amarum Ell. Sk 1:121. The specimen in the Herbarium of Elliott under this name is a robust form of *Panicum virgatum* Linn. From Elliott's description, however, it is very evident what plant he had in mind. The true *Panicum amarum* Ell., is represented by the following specimens in the U. S. National Herbarium. *Virginia:* Ocean View, Geo. Vasey, August 5, 1890; Virginia Beach 2063, 2064 T. H. Kearney, jr., October 6, 1898; 3090, T. A. Williams, September 24, 1900. *Florida:* Key Largo, A. H. Curtiss, November 7, 1894; Lake Worth Inlet, 5527, A. H. Curtiss, September 2, 1895; Indian River, 3578 Curtiss; Cape Malabar, Curtiss, September, 1879. The small form which was called *Panicum amarum minor* Vasey & Scribn. U. S. Dept. Agr. Div. Bot. Bul. 8:38. 1889, is here proposed as the following species.

FIG. 1.—*Panicum amaroides* Scribn. & Merrill. *a*, shows habit of the plant; *c*, a spikelet somewhat enlarged; *d*, the perfect floret showing the flowering-glume, palea, stamens, and stigmas; *e*, anterior view of the same with the palea closed; *b*, a portion of panicle of *P. amarum* Ell.

PANICUM AMAROIDES Scribn. & Merrill sp. nov. (*Panicum amarum minor* Vasey & Scribn. U. S. Dept. Agr. Div. Bot. Bul. 8:38. 1889, not *P. capillare minor* Muhl. 1817.) (Fig. 1.) A glabrous, glaucous, non-caespitose perennial, 3 to 8 dm. high from horizontal root-stocks, with thick, often involute leaves and narrow, contracted panicles. Culms erect, or ascending, often somewhat branched below, stout, the lower internodes very short; nodes smooth; sheaths loose, glabrous, crowded, and overlapping; ligule a dense fringe of soft white hairs 2 to 3 mm. long; leaf-blades very thick, smooth, lanceolate, acuminate, not nar_ rowed at the rounded base, 1 to 3 dm. long, 5 to 10 mm. wide, strongly involute at least above. Panicles 1 to 2.5 dm. long, few flowered, narrow, the branches appressed 1 to 7 cm. long. Spikelets glabrous ovate acuminate 5 to 6 mm. long; first glume clasping the base of the spikelet, strongly nerved

PANICUM AMAROIDES Scribn. & Merrill sp. nov.—Continued.

three-fourths or sometimes as long as the spikelet, usually scabrous on the keel near the apex; second glume slightly exceeding the third, 7-nerved similar to the first; third glume thin, faintly 7-nerved, inclosing the flowering glume and palea, subtending a thin palea of equal length which bears a staminate flower; flowering glume elliptical-ovate, smooth, 3 to 3.5 mm. long. Palea as long as the glume and of similar texture, plane or nearly so.

Type specimen collected at Fortress Monroe, Va., by Dr. George Vasey, in 1879.

Fig. 2.—*Panicum ovale* Ell. *a*, *b*, *c*, spikelets; *d*, anterior view of the third glume, showing small palea; *e*, dorsal view of the fourth or fruiting glume; *f*, anterior view of same showing back of palea.

General distribution: In sands along the coast, Connecticut to Florida and Mississippi, August to October.

Specimens examined: *Connecticut:* New Haven, J. A. Allen, September 30, 1876; A. L. Winton, jr., 1887; D. C. Eaton, no date. *New York:* Staten Island, A. A. Tyler, September 17, 1895; Northville, L. I., H. W. Young, Nov. 5, 1872. *Delaware:* Sand dune, no locality, W. M. Canby, September. *Maryland:* Bay Ridge, F. L. Scribner, September 3, 1897. *Virginia:* Fortress Monroe, Geo. Vasey, 1879 (type); G. McCarthy, 1883; Ocean View, Geo. Vasey, Aug. 5, 1890; Virginia Beach, 3089 T. A. Williams, September 24, 1900. *North Carolina:* Ocracoke Island, 2317 T. H. Kearney, jr., October 17, 1898; Brunswick County, 211 G. McCarthy, August 11, 1885. *Mississippi:* Horn Island, 2854 S. M. Tracy, August 20, 1894–September 6, 1897.

This species is readily distinguished from *Panicum amarum* Ell. by its much smaller size, smaller panicles, larger spikelets, and longer first glume. In its habit of growth it is strikingly different from *Panicum amarum*. The following notes are from the field observations of Mr. T. A. Williams: *Panicum amarum* grows in densely caespitose bunches from 9 to 18 dm. high, from vertical root-stocks. *Panicum amaroides* is not at all caespitose, sending up solitary culms from long horizontal root-stocks, and rarely attains a height of 8 dm. At Virginia Beach, where both species were observed, *Panicum amaroides* was in full bloom and at the same time *Panicum amarum* was in fruit or late bloom. The former species was closely grazed wherever it was accessible, while the latter was avoided by stock.

PANICUM AMAROIDES Scribn. & Merrill sp. nov.—Continued.

Panicum amaroides is an excellent sand binder, and although not caespitose, it covers considerable areas, holding the sands by means of its strong horizontal rootstocks.

Panicum scabriusculum Ell. Sk. 1:121.

Panicum nervosum Muhl.; Ell. Sk 1:122=*Panicum commutatum* Schultes, and is exactly matched by the following specimens in the National Herbarium: *South Carolina*, Aiken, H. W. Ravenel, June 1, 1867; *Florida*, A. W. Chapman, no locality or date; 366 (in part) Chapman, no locality or date: Jacksonville, A. H. Curtiss, September.

Panicum multiflorum Ell. Sk. 1:122=*Panicum polyanthes* Schultes (*P. microcarpon* Muhl. Descr. 111. 1817.)

Panicum ovale Ell. Sk. 1:123. (*Panicum erythrocarpon* Ashe, Journ. E. Mitch. Sci. Soc. **16**: 90, 1900 is the same.) (Fig. 2.) The specimen in the herbarium of Elliott to which this label is attached is matched by the following specimens: *North Carolina:* near Wilmington, W. W. Ashe, June, 1899 (cotype *Panicum erythrocarpon* Ashe). *South Carolina:* Aiken, H. W. Ravenel, May. *Florida:* A. H. Curtiss, 3583 N. Am. Plants (in part).

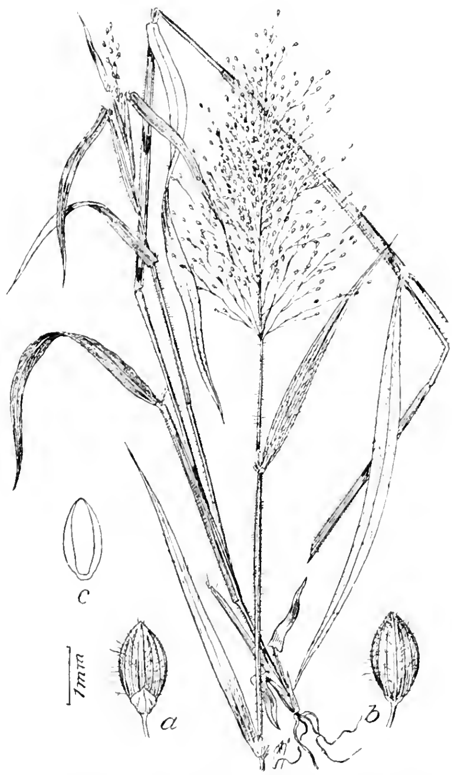

FIG. 3.—*Panicum lanuginosum* Ell. *a*, *b*, spikelets, in *a* the short first glume is seen; *c*, outline of anterior view of the fruiting glume showing back of palea.

Panicum lanuginosum Ell. Sk. Bot. S. C. and Ga. 1:123. 1817. (*Panicum tennesseense* Ashe, Journ. E. Mitch. Sci. Soc. **15**: 52. 1898). (Fig. 3.) An erect or ascending, finally much-branched pubescent perennial 1.5 to 8 dm. high, with weak culms, thin leaves and slightly exserted, usually many-flowered panicles. Culms geniculate below, papillate-pilose with few weak, spreading hairs; nodes yellow, sparingly bearded with few reflexed hairs, and generally with a smooth ring immediately below; sheaths shorter than the internodes, rather loose, striate, papillate-pilose with scattered spreading hairs; leaf-blades spreading or ascending, thin, soft, lanceolate, 3 to 8 cm. long, 4 to 10 mm. wide, acute, slightly narrowed to the rounded base, scabrous on the margins, appressed-pubescent beneath with scattered, short, papillate hairs, and often also on the upper surface, giving the leaves a peculiar lustre or sheen. Panicles 4 to 8 cm. long, broadly ovate or subpyramidal, pale green; rachis pilose; branches capillary, spreading, the lower ones often densely flowered and interlaced, giving the panicle a characteristic matted

Panicum lanuginosum Ell. Sk. Bot. S. C. and Ga. 1:123—Continued.
appearance; secondary panicles included, few flowered. Spikelets ovate, obtuse, 1.5 mm. long, first glume hyaline, acute, one-fourth as long as the spikelet; second and third glumes, rather strongly striate, pilose with rather long, weak, spreading hairs.

Type specimen in the herbarium of Elliott; type locality, Georgia.

GENERAL DISTRIBUTION: Low thickets, woods and swamps, Maine to Illinois, south to Kansas and Mississippi, May to August.

SPECIMENS EXAMINED: *Maine:* Orono, M. L. Fernald, 1892; Hiram, 48, 49 H. W. Merrill, 1897; East Auburn, 9 E. D. Merrill, 1898. *Vermont:* Brandon, F. H. Knowlton, 1882. *Massachusetts:* Framington, 741, 743 E. C. Smith, 1899; Salem, J. H. Sears, 1883. *Rhode Island:* Providence, T. J. Battey, 1886. *Connecticut:* New London, C. B. Graves, 1898; Portland, 134 F. Wilson, 1897. *New York:* Dresden Station, 4a C. H. Peck, 1898; Gansevoort, 7a Peck, 1897; Albany County, 7 Peck, 1897; Niagara County, 2, 3 E. C. Townsend. *Pennsylvania:* Easton, T. C. Porter, 1898. *District of Columbia:* F. L.-Scribner, June 7, 1894; 33 T. H. Kearney, 1897. *Virginia:* no locality, 9 T. Holm, 1888. *Michigan:* Belle Isle, 597d, O. A. Farwell, 1892. *Tennessee:* Knoxville, F. L.-Scribner 1891; La. Vergne County, 7087 Biltmore Herbarium (co-type of *Panicum tennesseense* Ashe); Knox County, T. H. Kearney, 1892; Franklin County, 30 H. Eggert, 1897; *Georgia:* no locality, Dr. Baldwin (type). *Mississippi:* Fairport, 3208 S. M. Tracy, 1897 Macon, 3223 Tracy, 1897. *Illinois:* Peoria, F. Brendel. *Iowa:* Lebanon, 35 Ball & Sample, 1898; Ames, 45 C. R. Ball, 1896. *Missouri:* Shannon County, 746, 760 B. F. Bush, 1894. *Kansas:* Cherokee County, 682, A. S. Hitchcock, 1896.

This species is characterized by its lax habit of growth, thin leaves which generally have a peculiar lustre or sheen, pale green generally somewhat implicate panicles, at least in herbarium specimens, and long-pubescent spikelets. It is most closely allied to *Panicum unciphyllum* Trin. (*P. pubescens* of authors not Lam.) and is distinguished by the characters noted above. The type specimen is exactly matched by specimens collected at Knoxville, Tenn., and Brookland, D. C., by F. Lamson-Scribner, cited above. The specimen from Elliott in the herbarium of Columbia University, noted in Bul. Torr. Bot. Club **27**:595, 1900, as being identical with *Panicum orangensis* Ashe, is very different from the specimen in Elliott's herbarium which must be considered as the type of the species. Ashe's name (*Panicum orangensis*) should be retained for that species. *Panicum tennesseense* Ashe is only the branched state of *P. lanuginosum* Ell.

Panicum viscidum Ell. Sk. 1:123 = *Panicum scoparium* Lam., see Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **24**:34. 1901.

Panicum dichotomum L.; Ell. Sk. 1:124. In this cover are several unrecognizable scraps and a specimen of *Panicum barbulatum* Michx.

Panicum villosum Ell. Sk. 1:124. This is exactly identical with the form so considered by Nash, Bul. Torr. Bot. Club, **23**:147. 1896. The synonymy of this species is as follows:

PANICUM CONSANGUINEUM Kunth, Enum. 1:106. 1833. (*Panicum villosum* Ell. Sk. Bot. S. C. and Ga. 1:124. 1817, not Lamarck, 1791; *Panicum georgianum* Ashe, Journ. E. Mitch. Sci. Soc. **15**:36. 1898; *Panicum cahoonianum* Ashe, ibid., 113. 1898.)

Panicum sphaerocarpon Ell. Sk. 1:125.

Panicum pubescens Lam.: Ell. Sk. 1:125 = *Panicum pseudopubescens* Nash.

Panicum strigosum Muhl.; Ell. Sk. 1:126. The type is well matched by No. 3597 A. H. Curtiss. A specimen from Elliott in the Herbarium of Columbia University is the same. (*Panicum longipedunculatum* Scribn.)

Panicum ciliatum Ell. Sk. 1:126.

Panicum ensifolium Baldw.; Ell. Sk. 1:126. (Fig. 4.) This is exactly the form described by Ashe as *Panicum cuthbertii*, Journ. E. Mitch. Sci. Soc. 15:48. 1898. The grass described by Ashe, Journ. E. Mitch. Sci. Soc. l. c., 46. as *Panicum ensifolium* Baldw., is *Panicum tenue* Muhl.

Panicum barbulatum Michx.; Ell. Sk. 1:127. This is very distinct from the form considered as *Panicum barbulatum* Michx. to-day, and is proposed below as a new species.

PANICUM SUBBARBULATUM Scribn. & Merrill sp. nov. (*Panicum barbulatum* of Ell. Sk. Bot. S. C. and Ga. 1:127. 1817, not Michx. Fl. Bor. Am. 1:49. 1803.

An erect or ascending, glabrous, caespitose perennial, 4–9 dm. high, with small panicles, bearded nodes, and pubescent spikelets. Culms wiry, simple, or becoming branched above; nodes bearded with reflexed hairs; sheaths much shorter than the internodes, ciliate on the margins; ligule a short ciliate ring; leaf-blades lanceolate, primary ones 5–6 cm. long, 5–8 mm. wide, spreading, the secondary ones 3–4 cm. long, 3–5 mm. wide, narrowed at the base, acute, scabrous on the margins, the nerves rather prominent. Panicles exserted, ovate, 4–7 cm. long, the branches ascending. Spikelets ovate, obtuse, 2 mm. long, pubescent: first glume about one-fourth as long as the spikelet.

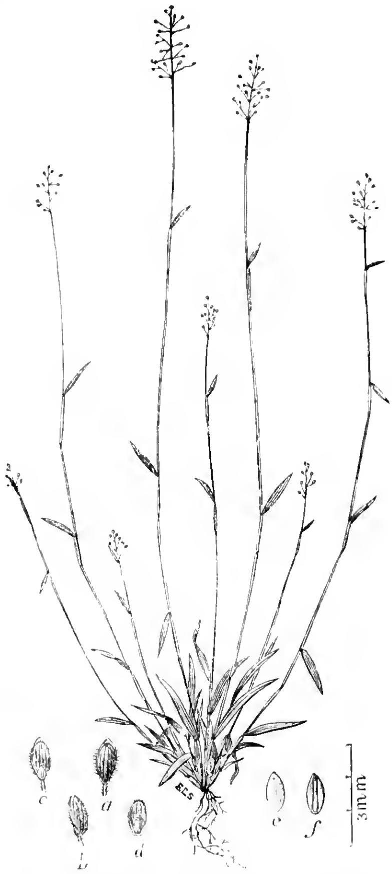

Fig. 4.–*Panicum ensifolium* Baldw. *a*, *b*, *c*, spikelets; *d*, anterior view of the third glume, showing small palea; *e*, *f*, fruiting glume.

The type of the species in the herbarium of Elliott is well matched by the following specimens: 3600a A. H. Curtiss, Sumpter County, Fla., margins of pine-barren ponds; 3388 S. M. Tracy, June 13, 1897, Morrisonville, Miss.

This species is readily distinguished from *Panicum barbulatum* Michx., by its smaller size, smaller leaves, and panicles and larger pubescent spikelets.

Panicum microcarpon Muhl.; Ell. Sk. 1:127 = *Panicum barbulatum* Michx.

Panicum nitidum? Lam.; Ell. Sk. 1:128. = *Panicum erectifolium* Nash.

Panicum melicarium Michx.; Ell. Sk. 1:128. Not in the herbarium. There is, however, a specimen of *Sporobolus junceus* in the collection, evidently from Muhlenberg, so labeled, but corrected to *Agrostis junceus* by Elliott.

Panicum debile Ell. Sk. 1:129. = *Panicum verrucosum* Muhl.

Panicum angustifolium Ell. Sk. 1:129. This is well matched by 4615 S. M. Tracy, Biloxi, Mississippi, June 14, 1898. Culm leaves 15–20 cm. long, 4–6 mm. wide, very long acuminate and hairy at the base. Panicle few-flowered. Spikelets 3 mm. long, acute.

Panicum divergens Muhl.; Ell. Sk. 1:130 = *Panicum cognatum* Schultes.

Digitaria sanguinalis Ell. Sk. 1:131 = *Panicum sanguinale* Linn.

Digitaria villosa Walt. ? Ell. Sk. 1:132 = *Panicum serotinum* Trin.

Digitaria filiformis Ell. Sk. 1:132 = *Panicum filiforme* Linn.

Digitaria dactylon Ell. Sk. 1:133 = *Cynodon dactylon* Pers.

Agrostis arachnoides Ell. Sk. 1:134 = *Agrostis elliottiana* Schultes.

Agrostis tenuiflora Ell. Sk. 1:134 = *Muhlenbergia diffusa* Schreb.

Agrostis sericea Ell. Sk. 1:135 = *Agrostis hyemalis* (Walt.) B. S. P. Specimen from Schweinitz.

Agrostis trichopodes Ell. Sk. 1:135. = *Muhlenbergia trichopodes* (Ell.) Chapm.

Agrostis decumbens Muhl.; Ell. Sk. 1:136 = *Agrostis verticillata* Vill.

Agrostis dispar Michx.; Ell. Sk. 1:136. Not in the herbarium. *Agrostis dispar* Michx. in the herbarium of the Paris Museum of Natural History, is a form of *Agrostis alba* Linn., identical with *Agrostis stolonifera* of European botanists.

Agrostis alba L.; Ell. Sk. 1:137.

Agrostis juncea ? Michx.; Ell. Sk. 1:137 = *Sporobolus junceus* Kunth.

Agrostis clandestina Muhl.; Ell. Sk. 1:138. This species is not represented in the herbarium.

Agrostis indica Ell. Sk. 1:138 = *Sporobolus indicus* R. Br.

Agrostis virginica Ell. Sk. 1:139 = *Sporobolus virginicus* Kunth.

Stipa avenacea Ell. Sk. 1:139.

Stipa stricta Lam.; Ell. Sk. 1:140. This species is not represented in the herbarium.

Stipa capillaris Lam.; Ell. Sk. 1:140. This species is represented in Elliott's herbarium under the name *Stipa sericea* and is *Muhlenbergia capillaris* Trin.

Aristida spiciformis Ell. Sk. 1:141.

Aristida dichotoma Michx.; Ell. Sk. 1:141.

Aristida gracilis Ell. Sk. 1:142. A specimen in the herbarium with the following label "*Aristida geniculata* Rafin. n. sp. ? Rafinisque, Long Island," is the same. *Aristida geniculata* was published by Rafinesque in American Monthly Magazine, **2**:119. Dec., 1817.

Aristida stricta Michx.; Ell. Sk. 1:142.

Aristida lanosa Muhl.; Ell. Sk. 1:143.

Andropogon ciliatus Ell. Sk. 1:144 = *Andropogon nutans avenaceus* Hack.

Andrpogon nutans Ell. Sk. 1:144 = *Andropogon nutans linneanus* Hack.

Andropogon ambiguus Michx.; Ell. Sk. 1:145 = *Gymnopogon ambiguus* (Michx.) B. S. P.

Andropogon melanocarpus Ell. Sk. 1:146.

Andropogon scoparius Michx.; Ell. Sk. 1:146. This is in Elliott's herbarium under the name "*Andropogon purpurascens.*"

Andropogon ternarius Michx.; Ell. Sk. 1:147 = *Andropogon argyræus* Schultes.

Andropogon argenteus Ell. Sk. 1:148 = *Andrpogon argyræus* Schultes.

Andropogan vaginatus Ell. Sk. 1:148 = *Andropogon virginicus* L., and is under this name in the herbarium.

Andropogon dissitiflorus Michx.; Ell. Sk. 1:149 = A form of *Andropogon glomeratus* (Walt.) B. S. P.

Andropogon macrourus Michx.; Ell. Sk. 1:149 = *Andropogon glomeratus* (Walt.) B. S. P.

Andropogon tetrastachys Ell. Sk. 1:150 = *Andropogon virginicus tetrastachys* (Ell.) Hack.

Andropogon furcatus Muhl.: Ell. Sk. 1:150.

Aira pallens var. **aristata** Muhl.; Ell. Sk. 1:151 = *Trisetum pennsylvanicum* (Linn.) Beauv.

Aira flexuosa Ell. Sk. 1:151 = *Deschampsia flexuosa* (L.) Trin.

Aira purpurea Walt.; Ell. Sk. 1:152 = *Triplasis purpurea* (Walt.) Chapm.

Aira capillacea Lam.; Ell. Sk. 1:152. This species is not represented in the herbarium.

Aira triflora Ell. Sk. 1:153 = *Poa*, sp. indet.

Aira obtusata Michx.; Ell. Sk. 1:153 = *Eatonia obtusata* A. Gray.

Aira mollis Muhl.; Ell. Sk. 1:154 = *Eatonia nitida* (Spreng.) Nash.

Melica glabra Michx.; Ell. Sk. 1:154 = *Melica mutica* Walt.

Dactylis glomerata L.; Ell. Sk. 1:155.

Poa capillaris L.; Ell. Sk. 1:156 = *Eragrostis capillaris* Nees.

Poa tenuis Ell. Sk. 1:156 = A very small-flowered form of *Eragrostis capillaris* Nees.

Poa hirsuta Michx.; Ell. Sk. 1:157. Not in the herbarium.

Poa parviflora Pursh.; Ell. Sk. 1:157 = *Panicularia nervata* (Willd.) Kuntze.

Poa conferta Ell. Sk. 1:157 = *Eragrostis glomerata* (Walt.) L. H. Dewey. It is in the herbarium under the name "*Poa glomerata*."

Poa annua Linn.: Ell. Sk. 1:158.

Poa autumnalis Muhl.; Ell. Sk. 1:159.

Poa viridis Muhl; Ell. Sk. 1:159 = *Poa pratensis* L.

Poa angustifolia Ell. Sk. 1:160 = *Poa pratensis* Linn.

Poa tenella Linn.; Ell. Sk. 1:160 = *Eragrostis pilosa* Beauv.

Poa eragrostis Ell. Sk. 1:161 = *Eragrostis purshii* Schrad.

Poa nitida Ell. Sk. 1:162 = *Eragrostis nitida* (Ell.) Chapm.

Poa refracta Muhl.; Ell. Sk. 1:162 = *Eragrostis refracta* (Muhl.) Scribn.

Poa fluitans Ell. Sk. 1:163 = *Panicularia fluitans* (Linn.) Kuntze.

Poa reptans Michx.; Ell. Sk. 1:163 = *Eragrostis hypnoides* (Lam.) B. S. P.

Poa rigida Ell. Sk. 1:164 = *Scleropoa rigida* (Kunth) Griseb.

Poa quinquifida Pursh; Ell. Sk. 1:164 = *Triodia seslerioides* (Michx.) Benth. On the sheet are also the following names: "*Poa flava* Linn.;" "*Poa seslerioides* Mx."

Poa ambigua Ell. Sk. 1:165 = *Triodia ambigua* (Ell.) Benth.

Briza eragrostis Ell. Sk. 1:165 = *Eragrostis major* Host.

Uniola paniculata Ell. Sk. 1:166.

Uniola spicata L.; Ell. Sk. 1:166 = *Distichlis spicata* (L.) Greene.

Uniola latifolia Michx.; Ell. Sk. 1:167.

Uniola nitida Baldwin; Ell. Sk. 1:167.

Uniola gracilis Michx.; Ell. Sk. 1:168 = *Uniola laxa* (L.) B. S. P.

Festuca tenella Pursh; Ell. Sk. 1:168. This species is not represented in the herbarium.

Festuca polystachya Michx.; Ell. Sk. 1:169. This species is not represented in the herbarium = *Leptochloa fascicularis* (Lam.) A. Gray.

Festuca myurus L.; Ell. Sk. 1:169.

Festuca parviflora Ell. Sk. 1:170. This is apparently a young, undeveloped form of *Festuca octoflora* Walt., although it may prove to be distinct. Empty glumes nearly equal; flowering glumes nearly smooth, about 3 mm. long; awns about equaling the glumes in length.

Festuca duriuscula L.; Ell. Sk. 1:171 = *Festuca pratensis* Linn.

Festuca grandiflora Lam.; Ell. Sk. 1:171. Not in the herbarium.

Festuca unioloides Willd.; Ell. Sk. 1:171. Not in the herbarium.

Festuca nutans Ell. Sk. 1:172. In the same cover is a specimen of *Festuca obtusa* Spreng.

Bromus secalinus L.; Ell. Sk. 1:172.

Bromus ciliatus L.; Ell. Sk. 1:173.

Bromus purgans L.; Ell. Sk. 1:173. Not in the herbarium.

Avena spicata Ell. Sk. 1:174 = *Danthonia spicata* (L.) Beauv.

Avena pennsylvanica Ell. Sk. 1:174 = *Arrhenatherum elatius* (Linn.) Beauv.

Eleusine mucronata? Michx.; Ell. Sk. 1:175 = *Leptochloa mucronata* Kunth.

Eleusine indica Ell. Sk. 1:175.

Eleusine cruciata Ell. Sk. 1:176 = *Dactyloctenium aegyptium* Willd. It is in the herbarium under the name *Chloris mucronata*.

Monocera aromatica Ell. Sk. 1:177 = *Campulosus aromaticus* (Walt.) Trin.

Chloris petræa Michx.; Ell. Sk. 1:178.

Rottboellia dimidiata? Ell. Sk. 1:179 = *Stenotaphrum secundatum* (Walt.) Kuntze.

Elymus virginicus L.; Ell. Sk. 1:180.

Elymus striatus Ell. Sk. 1:180 = *Elymus canadensis* Linn.

Elymus europæus Ell. Sk. 1:181. Not in the herbarium.

Elymus hystrix Ell. Sk. 1:481 = *Asperella hystrix* (L.) Humb.

Panicum verticillatum L.; Ell. Sk. 1:Adv. 1. Not in the herbarium.

Panicum walteri Pursh.; Ell. Sk. 1:Adv. 1. This is the same as *Panicum crus-galli hispidum* Ell., page 114.

Panicum fusco-rubens Lam.; Ell. Sk. 1:Adv. 4. Not in the herbarium.

Panicum striatum Lam.; Ell. Sk. 1:Adv. 4. Not in the herbarium.

Panicum diffusum Swartz.; Ell. Sk. 1:Adv. 4. Not in the herbarium.

Panicum nodiflorum Lam.; Ell. Sk. 1:Adv. 5. Not in the herbarium.

Agrostis pauciflora Pursh.; Ell. Sk. 1:Adv. 5. Not in the herbarium.

Agrostis cinna Ell. Sk. 1: Adv. 5 = *Cinna latifolia* Griseb.

Agrostis lateriflora Michx.; Ell. Sk. 1 :Adv. 6. The specimen in this sheet is *Calamagrostis canadensis* (Michx.) Beauv.

F. LAMSON-SCRIBNER,
Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

CIRCULAR NO. 30. (Agros. 79.) Issued March 8, 1901.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY,

[Grass and Forage Plant Investigations.]

NEW OR LITTLE KNOWN GRASSES.

The following descriptions are of new or little known species of grasses which have appeared in recent collections from several sources and their publication as a circular of this Division is recommended. The notes on *Danthonia intermedia* are by the late Prof. Thomas A. Williams, and were made just before his death.

Setariopsis latiglumis (Vasey) Scribn. Field Columb. Mus. Bot. Ser. **1**:289. Pl. XI. December, 1896 (*Setaria latiglumis* Vasey, Bul. Torr. Bot. Club, **13**:229. 1896).

Culms 1 m. high; nodes bearded with erect, appressed hairs; sheaths, at least the lower ones, papillate-pilose, long-hairy at the throat; leaves thinly hairy or pilose on the upper surface, the lower ones pilose on the back, at least towards the base which is long dentate; the broader leaves 1.5 to nearly 2 cm. wide, long-acuminate-pointed and gradually tapering to a very narrow base. Panicle about 30 cm. long, rather densely flowered; branches erect, appressed, the lower ones 4–5 cm. long.

This description is drawn from No. 8412. C. G. Pringle, 1900, collected in Iguala, Guerrero, Mexico. Pringle's specimens are much more robust and coarser than the type, No. 117*a*, E. Palmer, 1885. In Palmer's plants the leaves are 5–10 mm. wide, and the comparatively few flowered panicles 6–10 cm. long. The spikelets, however, in Palmer's plant are somewhat larger than those in the specimens above described. There is such a close resemblance, however, in the character of the essential parts that I must regard them as representing a single species.

ICHNANTHUS APICULATUS Scribn. sp. nov.

A slender, wiry, ascending perennial, more or less extensively creeping and rooting at the lower joints, with flat, lanceolate, acute leaves 3–8 cm. long, and loosely flowered, spreading panicle 14–20 cm. long, the base partially included or barely exserted from the uppermost leaf sheath. Culms striate, glabrous or with a pubescent line along one side; nodes finely and shortly pubescent; sheaths striate, ciliate along the margin, papillate-pilose towards the apex and pubescent at the summit on the back, where it is somewhat contracted; ligule very short, the margin shortly and finely ciliate; leaf blade 4–8 mm. wide, rounded at the base and gradually tapering from near the middle to the very sharply acute apex, sparingly papillate-pilose on both surfaces or nearly glabrous, margins minutely and sharply scabrous and with a few long hairs near the base; lower panicle brănches ascending, 8–12 cm. long, the upper branches more spreading, gradually becoming shorter. Spikelets on rather slender pedicels, often in pairs—one short pedicellate, the other supported on a longer pedicel—oblong-ovate in outline, 3–3.5 mm. long, about 0.5 mm. broad, obtuse. Outer glumes prominently nerved, glabrous—the first, 3-nerved, obtuse, two-thirds to three-fourths as long as the spikelet;

second and third glumes 5-nerved, broadly ovate, oblong, obtuse, minutely pubescent at the apex, slightly exceeding the fourth or flowering glume, which is about 2.5 mm. long, contracted at the base and depressed on the back, the obtuse and somewhat hooded apex shortly apiculate. Palea glabrous, about as long as the glume which it resembles in color and texture.

Type specimen from near Jalapa, State of Vera Cruz. C. G. Pringle, No. 9208, May 13, 1900. Allied to *Ichnanthus lanceolatus* Scribn., from which it is at once distinguished by its narrower, sessile leaf blades, more obtuse and somewhat shorter spikelets, and distinctly apiculate fourth glume.

Agrostis nana (Presl) Kunth, Enum. **1**: 266. 1833. (*Tricodium nanum* J. S. Presl in C. B. Presl Reliq. Haenk. **1**: 243. 1830.) On cliffs near Fort Bragg, Mendocino County, Cal., No. 6159, Jos. Burtt Davy and Walter C. Blasdale.

The type locality of this species is doubtfully given by Presl as Peru. The original specimens might, however, have come from the California coast, where Haenke also made collections. *Agrostis nana* Kunth, as represented by specimens in the herbarium of the Missouri Botanical Garden and illustrated by figure 2, plate 34, in the Tenth Annual Report of Missouri Botanical Garden, is a much smaller plant than that collected by Davy and Blasdale; but the habit of growth, and size and character of the spikelets are identical, and the very full description given by Presl applies so closely to our plant that there can be little doubt of its identity. The characters of the Mendocino plant are as follows:

A densely cæspitose, wiry, glabrous perennial 1–2 dm. high, with involute filiform leaves and strict, few-flowered panicles 2–4 cm. long. Ligule 1.5 mm. long, cleft in three divisions, the lateral divisions auriculate. Leaf-blades of the culm about 2 mm. wide. The axis of the panicle and the closely appressed branches are 1 cm. long or less, strongly scabrous. Spikelets on short, rigid, appressed, scabrous pedicels; outer glumes nearly equal or the first a little longer than the second, about 3 mm. long, scabrous on the back, especially along the keel, broadly lanceolate and acute; flowering glumes about 1.8 mm. long, oblong truncate, and erose dentate at the apex, awnless or very short-awned just above the middle. Palea minute or wanting, callus short, obtuse.

The only manifest difference between our plant and that of Presl is in the vegetative characters which are most likely to vary.

Agrostis pringlei Scribn., U. S. Dept. Agr. Div. Agros. Bul. **7**: 156, *fig. 138.* 1897. Along cliffs at Point Arena, Mendocino County, Cal., No. 6030, Davy and Blasdale. 1899.

These specimens represent a multi-branched form of the species, with panicles more densely flowered than in the type, but the essential characters of the spikelets, root habits, and foliage are those of *Agrostis pringlei.* This species is remarkable for the long hairs at the base of the floret. These hairs are 1–2 mm. long.

AGROSTIS VIRESCENS MICROPHYLLA (Steud.) Scribn. n. comb. (*Agrostis microphylla* Steud. Syn. Pl. Gram. 164. 1854). Dry places in meadows near Sherwood Valley, Mendocino County, Cal., No. 5142, Davy and Blasdale, 1899.

Culms very slender, 1–1.5 dm. high, apparently annual. Leaves 1-2 cm. long; ligule about 2 mm. long. Panicle densely flowered, 1–3 cm. long, purplish. Empty glumes lanceolate, scabrous, long acuminate, subulate pointed; the first 3.5–4 mm. long, little exceeding the second; flowering glumes 1.5 mm. long, scarcely one-half the length of the outer glumes, awned on the back near the middle. Apex bifid, each division minutely two-toothed by prolongation of the lateral nerves. Awn ascending from near the middle of the glumes on the back, 4–4.5 mm. long, rather stout below, geniculate and projecting beyond the glumes.

While these plants are very much smaller than *Agrostis virescens* H. B. K., the differences are in the vegetative rather than in the essential characters. *A. virescens* in the typical form is 20–54 cm. high, with a more open panicle, longer and broader leaves, but the spikelet characters of the variety here noted, are so closely identical with those of the species that the plant can not be regarded as representing anything more than a variety. Specimens here described have the appearance of being annuals or seedlings, and this may account for their diminutive size.

AGROSTIS DAVYI Scribn. sp. nov.

A rather slender, erect, or ascending perennial, 6–9 dm. high, with narrow, scabrous leaves and loosely flowered, narrow panicles 1–2 dm. long. Culms and sheaths scabrous, ligule about 10 mm. long, hyaline, scabrous on the back, at least below, decurrent. Leaf-blades 8–18 cm. long, 3–6 mm. wide, scabrous on both sides. Spikelets 3.5–4 mm. long, outer glumes lanceolate, acuminate, very acute, scabrous on the back, especially along the keel, nearly equal; flowering glumes about 3 mm. long, oblong, truncate, 5-nerved, lateral nerves projecting as very short teeth or setæ, the mid-nerve usually excurrent at or above the middle as a short, slender, inconspicuous bristle. Callus hairy on the sides, the hairs 1–1.5 mm. long.

In brush on hillsides near Point Arena, Mendocino County, Cal., No. 6062 Davy and Blasdale. May–August, 1899.

The spikelets of this species closely resemble those of *Agrostis pringlei* Scribn., and this resemblance is carried to the remarkably long callus hairs, but in other respects the species are very distinct. The culms in *Agrostis davyi* are simple, and much taller, and the panicles longer and more loosely flowered.

STIPA LEMMONI (Vasey) Scribn. n. comb. (*Stipa pringlei* var. *lemmoni* Vasey, Contr. U. S. Nat. Herb. **3**:55. 1892). Near Harris, Humboldt County, Cal., No. 5348, Davy and Blasdale; dry rocky slopes, Long Valley, No. 5287, Davy and Blasdale.

A rather slender, rigid perennial 4–6 dm. high, with narrow, involute leaves and strict, few-flowered panicles 10–12 cm. long. Culms glabrous; sheaths striate, glabrous, shorter than the internodes. Ligule 1.5 mm. long, rounded-obtuse, entire, decurrent. Leaves 2–3 mm. wide, 5–10 cm. long (those of the innovations longer and narrower), glabrous beneath, pubescent and strongly striate above, closely involute when dry, divergent at the apex. Panicle branches erect, the longer lower ones in twos and threes, 2–3 cm. long, few-flowered. Spikelets rather large and pale green or straw-colored; empty glumes nearly equal, about 12 mm. long, broadly lanceolate, long acuminate-pointed, 3–5-nerved, scarious excepting the nerves; flowering glume oblong, about 7 mm. long, obtuse, 2-toothed at the oblong apex, thinly pilose all over with appressed hairs. Callus broadly obtuse, shortly bearded. Palea broad, nearly as long as the glume, and similarly hairy. Anthers naked.

This grass has been referred to *Stipa viridula*, but it is very distinct from that species in its larger spikelets, longer palea, fewer-flowered panicles, fewer, shorter, and narrower leaves. In addition to the above-cited specimens, this species is represented in the National Herbarium by specimens from West Klickitat County, Columbia River, Washington, No. 146, W. N. Suksdorf, May 16, 1885, and the type No. 5456, J. G. Lemmon, Mohawk Valley, Plumas County, Cal., May, 1889.

STIPA LEMMONI JONESII var. nov. A small form of the species with rather more slender culms and panicles, and spikelets, with the outer glumes 7–8 mm. long and flowering glumes about 6 mm. long. This variety is represented in the National Herbarium by Nos. 3563, L. Schoenfeldt, collected at Laguna, Cal., June 4, 1894; 49, J. W. Blankinship, collected at Mount San Hedrim, Mendocino County, Cal.; 3298, Marcus E. Jones, collected at Emigrant Gap, Cal., June 28, 1882 (type). There is also a specimen from Mariposa County, Cal., collected by J. W. Congdon, June 4, 1897.

BOUTELOUA PRINGLEI sp. nov.

A rather slender, apparently cæspitose and erect perennial 10–14 dm. high, with flat, pilose leaves, and many, usually spreading or reflexed spikes scattered along the common axis forming a somewhat one-sided raceme 10–30 cm. long. Culms and nodes glabrous, sheaths papillate-villous, at least above, with long, lanate hairs; lower portion of the sheaths usually glabrous; ligule very short. Upper surface of the leaves strongly papillate-pilose along the nerves, less strongly so on the under surface. Spikes 30 to 50 or more, approximate along the common axis, the lower ones somewhat remote, axis of spikes 0.5–3 cm. long, bearing 6–20 spikelets, apex more or less deeply cleft, the divisions subulate; these axes sometimes branched again, the secondary axes bearing 2–3 spikelets. Spikelets 4–5 mm. long; outer glumes very unequal, the first nearly subulate, 3–4 mm. long, the second lanceolate-oblong, 4–5 mm. long, short-awned at the apex, silky hairy on the back, strongly 1-nerved, hairs 1 mm. long or more; flowering glumes nearly 4 mm. long, 3-nerved, 3-toothed at the apex, the teeth about equal in length, the lateral ones awn-like, rather densely pilose hairy on the back. especially along the margins. Palea as long as its glume, 2-toothed, finely pubescent on the back. Rudiment very small, usually reduced to a mere pedicel. Mountains of Iguala, Mexico, No. 8374, C. G. Pringle, 1900.

This species is very closely allied to *Bouteloua curtipendula*, from which it is at once distinguished by its densely villous-hairy sheaths, and pilose outer and floral glumes.

BOUTELOUA HIRTICULMIS Scribn. sp. nov.

An erect or ascending, cæspitose perennial, 4–6 dm. high, with long leaves, hirsute culms, and 2 to 4 spreading, often reflexed, densely flowered purple spikes 3–5 cm. long. Culms simple, striate, very densely hirsute below with spreading hairs, about 2 mm. long, the upper portion of the culm glabrous or nearly so; nodes bearded with few short appressed hairs, or nearly glabrous; sheaths usually shorter than the internodes, striate glabrous, or the lower ones, which are crowded, with few scattered hairs; ligule a very short ciliate ring; leaf-blades linear, firm, 1–2.5 dm. long, 3–4 mm. wide, glabrous beneath, usually with few scattered papillate hairs on the upper surface, scabrous on the margins. Panicle exserted, axis sparingly pilose; spikes with the short strongly-bearded pedicels, the rachis continued beyond the spikelets, the continuation 1.5–2 cm. long, awn-like. Spikelets numerous, crowded; empty glumes lanceolate, acuminate, the first thin, smooth, about 3 mm. long, the second about 5 mm. long, with a row of dark or black glands on each side of the mid-nerve, each emitting a long hair; flowering glume pilose with appressed scattered hairs, about 5 mm. long, 3-lobed, the lobes awn-pointed, the middle one 3 mm. long, the lateral ones about 2 mm. in length; sterile rudiment on a short pedicel, naked, consisting of three imperfect glumes and three scabrous awns.

Type specimen collected in the Sierra de San Francisquito Mountains, Lower California, No. 11 T. S. Brandegee, September 29, 1899; same locality, No. 30 T. S. Brandegee, October 18, 1890.

The following specimens are also referable to this species, although they differ in several minor respects from the type: Chipias, Mexico, No. 3121 (in part) E. W. Nelson, September, 14, 1895; Oaxaca, No. 1259 E. W. Nelson, September 28, 1894; Mexico, No. 201, E. Palmer, 1896.

This species is closely related to *Bouteloua hirsuta* (H. B. K.) Lag., but is at once distinguished by its usually greater size, more numerous spikes, longer leaves, and especially by its densely hirsute culms.

DANTHONIA AMERICANA Scribn. nom. nov. (*Danthonia grandiflora* Philippi, Anal. Univ. Chil. 568 (1873). Not Hochst. ex. A. Rich. Tent. Fl. Abyss. 2:418. 1851.

A slender, densely caespitose perennial 2–4 dm. high, with short, slightly inflated sheaths, narrow mostly involute leaves and simple panicles of 1–4 large spikelets. Culms and nodes very smooth; sheaths much shorter than the internodes, pilose-pubescent, at least the lower ones, long bearded at the throat; culm leaves 3–7 cm. long, 1–2 mm. wide, mostly involute, the lower ones sparingly pilose; leaves of the innovations involute-filiform, 8–10 cm. long, pilose with long spreading hairs. Axis of the panicle and pedicels puberulent. Spikelets 12–18 mm. long; empty glumes as long as or slightly exceeding the florets, lanceolate-acuminate, the narrowed apex obtuse, 7–9 nerved; flowering glume exclusive of the awn and teeth 6–8 mm. long, rounded and glabrous on the back, densely silky villous along the margins from just above the base to a little above the middle, the hairs crowded in little tufts, broadest above the middle, abruptly 2-toothed, teeth very slender, bristle-form 4–6 mm. long; callus narrow, about 1 mm. long, barbate, the hairs from 0.5 to nearly 2.5 mm. long; awn very slender, twisted below, 7–9 mm. long. Palea rather broad, about 6 mm. long, shortly ciliate on the keels.

This species is distinguished from *D. unispicata* with which it has been confounded, by its shorter and narrower leaves, the presence of 2–3 or more spikelets in each culm, comparatively shorter and less acuminate outer glumes, broader and more abruptly acuminate flowering glumes, the teeth of which are much longer and more slender, and in the more abundant hairiness of the flowering glumes.

SPECIMENS EXAMINED: *California:* Walkers Valley, Mendocino County, May 25, 1899, "very abundant," No. 5038 J. Burtt Davy; Kawah meadows, Tulare County, altitude 9,300 feet. No. 5247 C. A. Purpus. In this specimen the spikelets are only 10 mm. long; Silver Lake, Amador County, Hansen, June 30, 1899. *Oregon:* Cougar Peak, August 8, 1896, No. 189 Coville and Leiberg. *Washington:* Falcon Valley, in low grounds, July 2, 1885, No. 150 W. N. Suksdorf. In these specimens the outer glumes are 18 mm. long, a little longer than in the type and the callus hairs are a little longer but the plants are otherwise the same. Near Montesano, Chehalis County, June 8, 1898, No. 3908 A. A. and E. Gertrude Heller. There is also a specimen in the National Herbarium from Washington, collected by Suksdorf in 1880. *Canada:* Crevices of rocks, Nanaimo, Vancouver Island. No. 39 J. Macoun, June 13, 1887. *Chile:* Province of Nuble, No. 256 Herb. Philippi.

DANTHONIA THERMALE Scribn. sp. nov.

A rather slender, erect, densely caespitose perennial with narrow, more or less pilose leaves and densely few-flowered panicles 3–5 cm. long. Sheaths, at least the lower ones, papillate pilose; ligule a dense fringe of short hairs, those near the margin 2–3 mm. long. The lower leaves, especially those of the innovations conspicuously pilose, the upper surface rather densely hairy. Branches of the panicle 1–2-flowered, erect, pedicels scabro-pubescent. Outer glumes nearly equal, 12–13 mm. long, 3 mm. wide, 5–7-nerved, apex acute;

flowering glumes, including the very sharp-pointed or subulate teeth, 5 mm. long, thinly pilose, hairy on the back, more densely so on the margin. Callus with a few short hairs. Awn about 7 mm. long. Teeth at the apex of the flowering glume subulate, 1.5–2 mm. long.

Type specimen No. 6140, Aven Nelson and Elias Nelson, collected on the dry slopes about the geyser formations in Norris basin, Yellowstone Park, July 25, 1899. Same locality, No. 169 E. D. Merrill, August, 29, 1900. Other specimens examined, apparently belonging to this species, are No. 307, Williams and Griffiths, collected near the edge of Lolo Hot Springs, Montana, September 17, 1898. This is a small form, 12–24 cm. high. No. 449, David Griffiths, collected in abundance in ravines near Sundance, Bear Lodge Mountains, Wyoming, August 9, 1897; No. 896, David Griffiths, Sundance, Bear Lodge Mountains, Wyoming, 1898; No. 982, David Griffiths, collected in clearings in parks, Bear Lodge Lountains, Sundance, Wyoming, July 21, 1898

This species is most closely related to *Danthonia spicata* of the East, from which it may be distinguished by its more rigid and erect habit, larger spikelets, broader and more conspicuously nerved empty glumes, and larger flowering glumes, the teeth of which are much prolonged and subulate pointed. The flowering glumes are also much more conspicuously hairy above on the back and margins.

In the latter part of August, 1900, I found this grass growing on geyser formations in the Norris basin, doubtless in the same locality as that from which the type was collected. It grew in scattered tufts in the white shelly deposits close to the geyser, where one would scarcely expect to find any vegetation at all, and, in fact, where there was little else than this grass to be found. The specimens from Montana, above cited, were collected within two feet of Lolo Hot Springs. The differences in the spikelets between this plant and *Danthonia spicata* of the East, together with the geographical range and peculiar habitat, are our reasons for distinguishing it as a species.

Danthonia intermedia Vasey.

This species was described by Dr. Vasey[1] from specimens collected at Mount Albert, Lower Canada, July 26, 1881, by O. D. Allen, and the original description reads in part as follows:

"Radical leaves, 6 to 10 inches long, narrow; cauline leaves, 2 to 6 inches, pubescent, especially on the sheaths."

The material in the National Herbarium shows wide variation in the character of the pubescence. In the type specimen the long white hairs are but sparsely scattered on the sheaths and under surface and margins of the leaves. In other specimens (Griffiths, 486, and Henderson, 3064*b*) the pubescence is dense and shaggy, while on the other hand specimens not otherwise distinguishable (Henderson, 1315, 3064*a*; Williams, 2770) are quite destitute of hairs, except at the throat of the sheaths and on the leaves of the sterile shoots, and in the latter instance they are very scattering and easily overlooked. The species also varies considerably in the width of the leaves and size of the spikelets.

Specimens examined: *Canada:* Mt. Albert, O. D. Allen, July 26, 1881; (type) No. 16 and 31, J. Macoun, August 26 and 27, 1882; mountains north of Griffin Lake, British Columbia, 46*a*, J. Macoun, August 5, 1899; Milk River Ridge, Alberta, No. 13070, J. Macoun, July 19, 1895; head of Qu'Appelle, Great Plains, No. 120, J. Macoun, July 11, 1879.

Washington: Stevens Pass, Cascade Mountains, No. 760, Sandberg & Leiberg, August 16, 1893; Loomiston, No. 553, A. D. E. Elmer, August, 1897.

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[1] Bul. Torr. Bot. Club. **10**: 52. 1883.

Oregon: Mt. Hood, No. 1315, L. F. Henderson, August 24, 1884.
California: No. 6104, H. N. Bolander: No. 1866, J. G. Lemmon, Tuolomne River, Yosemite National Park, August, 1897.
Idaho: Beaver Canyon, No. 302, C. L. Shear, June 27, 1895, and No. 2057, P. A. Rydberg, June 27, 1895; De Smet Mission, Coeur d'Alene Mountains, No. 1008, J. B. Leiberg, June 21, 1895; Salmon River near Petit Lake, No. 3568, L. F. Henderson, July 30, 1895; without locality, Nos. 3064*a* and *b*, L. F. Henderson, 1895, representing both the smooth (No. 3064*a*) and the hairy (3064*b*) forms of the species.
Montana: Lower basin, Gallatin River, J. W. Blankinship, July 8, 1898.
Wyoming: Crazy Woman Creek, Big Horn Mountains, No. 2770, T. A. Williams, August, 1897; Bear Lodge Mountains, near Sundance, No. 486, D. Gr.ffiths, August 10, 1897.
Colorado: No. 404, J. Wolf, 1873; Silverton, No. 1241, C. L. Shear, August 6, 1897; Red Dirt Divide, Steamboat Spring Road, Routt County, No. 1354, Shear & Bessey, July 31, 1898.

The grass is usually found in rather dry meadows and on mountain sides, reaching an elevation of over 3,000 m. towards the southern limits of its range and descending to 700 m. toward the northern limits.

DANTHONIA INTERMEDIA CUSICKII T. A. Williams, var. nov.

Distinguished from the type of the species by its larger size, longer, flatter, softer, less scabrous leaves quite destitute of pubescence, except occasionally on the younger leaves of the sterile shoots, loose, glabrous, shining sheaths, rather larger spikelets and usually more open panicle.

Type specimen No. 2427, Wm. C. Cusick, Oregon, 1899, growing in partial shade at an altitude of about 1200 m. Other specimens referable to this variety are No. 2047, Cusick, head of Dirt Creek, Southern Blue Mountains, Oregon, July 19, 1898; No. 2244, P. A. Rydberg, Mystic Lake, Montana, July 25, 1895; No. 586, C. L. Shear, and No. 2338, P. A Rydberg, Beaver Canyon, Idaho, August 7, 1895.

This form apparently grows in moister situations than the species.

DANTHONIA SPICATA LONGIPILA Scribn. & Merrill, var. nov.

A slender form, 3 to 4 dm. high, with small, few-flowered panicles and smaller spikelets than in the species. Leaf blades very narrow, involute, pilose throughout with scattered ascending hairs about 2 mm. in length. Basal leaves 1 to 2 dm. long, those of the culm shorter. Empty glumes slightly unequal, the first 8 to 9 mm. long, the second about 1 mm. shorter. Flowering glumes 2 to 2.5 mm. long, pilose.

Type specimen collected in Benton County, Arkansas. No. 38, E. N. Plank. Nos. 40, 62, and 97, Plank, from the same locality, are the same. This variety is distinguished from the species by its smaller spikelets and pilose leaves.

DANTHONIA EPILIS Scribn. nom. nov. *Danthonia glabra* Nash, Bul. Torr. Bot. Club, **24**: 43. 1897. Not *Danthonia glabra* Philippi Anal. Univ. Chile, Pl. Neuv. Chilenas, **94**: 30. 1896.

DESCHAMPSIA CURTIFOLIA Scribn. nom. nov. *Deschampsia brachyphylla* Nash, Mem. N. Y. Bot. Gard. **1**: 37. 1900. Not *Deschampsia brachyphylla* Philippi Anal. Univ. Chile, Pl. Neuv. Chilenas, **94**: 23. 1896; *Deschampsia brevifolia* R. Br. App. Parry's Voy. 291. 1821. Not *Aira brevifolia* Bieb. Fl. Taur. Cauc. **3**: 63. 1819.

CALAMAGROSTIS PERPLEXA Scribn. nom. nov. *Calamagrostis nemoralis* Kearney U. S. Dept. Agr. Div. Agros. Bul. **11**: 26. 1898. Not *Calamagrostis nemoralis* Philippi Anal. Univ. Chile, Pl. Neuv. Chilenas **94**: 18. 1896; *C. Porteri* of Vasey, Dudley Cayuga Fl. 125. 1886. Not A. Gray.

CALAMAGROSTIS LUCIDA Scribn. nom. nov. *Calamagrostis laxiflora* Kearney U. S. Dept. Agr. Div. Agros. Bul. **11**: 34. 1898. Not *Deyeuxia laxiflora* Philippi Anal. Mus. Nac. Chile Bot. 84. 1891; *Calamagrostis laxiflora* Philippi Anal. Univ. Chile Pl. Neuv. Chilenas **94**: 18. 1896.

Agrostis pseudointermedia Farwell, Ann. Rept. Com. Parks and Boulevards, Detroit, Mich., **11**:46. 1900. *Agrostis intermedia* Scribn. Tenn. Agr. Exp. Sta. Bul. **7**^{2}:76. 1894. Not *Agrostis intermedia* Balb. Elenco, 85. 1802.

TRISETUM SHEARII Scribn. nom. nov. *Trisetum argenteum* Scribn. U. S. Dept. Agr. Div. Agros. Bul. **11**:49. *fig. 8*, July 20, 1898. Not *Trisetum argenteum* R. & S., 1817, nor Schur 1860. Named for C. L. Shear, who collected the grass in Las Animas Canyon near Silverton, Colorado in 1897 (No. 1214).

MELICA IMPERFECTA PUBENS Scribn. var. nov. A slender form 9–12 dm. high with the sheaths and lower surface of the leaves below strongly pubescent with spreading or sometimes matted hairs.

Type specimen collected by T. S. Brandegee, No. 64, Santa Cruz Island, California, 1888.

MELICA CEPACEA (Phil.) new comb. (*Festuca cepacea* Phil. Linnæa **33**: 297. 1864–65; *Melica acuminata* Bolander Proc. Calif. Acad. **4**:104 1870. Calif. and Chili.

PANICULARIA NERVATA PARVIGLUMIS Scribn. & Merrill, var. nov. A lax, glaucous grass 8–9 dm. high, with long thin leaves, open pale green panicles and very small spikelets. Leaf-blades 1–3 dm. long, about 5 mm. wide, thin, glaucous, scabrous above and on margins. Panicle 1–2 dm. long, the lower branches often 1 dm. long spreading or ascending. Spikelets 2–2.5 mm. long, generally about 1 mm. wide, 3–5 flowered; empty glumes thin, triangular, the first 0.5 mm. long, the second nearly 1 mm. long; flowering glumes about 1.3 mm. long, 0.5 mm. wide, obovate, obtuse, or truncate, strongly nerved.

Type specimen collected in rich low woods, Racine, Wisconsin, No. 36 S. C. Wadmond, June 26, 1900. The same form has also been collected on the county line, Racine County, by Mr. Wadmond, July 14, 1900. This variety is distinguished from the species by its smaller and more lax flowered and narrower spikelets, shorter and narrower flowering glumes.

F. Lamson-Scribner,
Agrostologist.

Approved:
James Wilson,
Secretary.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY,

[Grass and Forage Plant Investigations.]

F. LAMSON-SCRIBNER, Agrostologist.

BERMUDA GRASS.

Bermuda grass (*Cynodon dactylon*) is well known throughout the Southern States. It is a native of tropical regions of the East, and was introduced into the United States at an early period. It has since spread over the region from Maryland to Missouri and Texas, and is locally abundant from New Mexico to southern California. Although its name would indicate that it came from the Bermudas, it is well known in Europe, and is thought to have originally come from Southern Asia. Bermuda grass is said to have been first noticed in this country about 1825 by General Bethune, of Georgia, who planted it in many places throughout the South.

FIG. 1.—Bermuda grass (*Cynodon dactylon*).

There are many local names for Bermuda, among which are reed grass, scutch grass, Bahama grass, and, in the region of Washington, wire grass. In Australia it is called couch grass. It is a standard grass in the South, but can not be grown successfully north of Virginia and Oklahoma.

DESCRIPTION.

Bermuda grass is a low perennial grass, spreading extensively by creeping stems. These stems may be on the surface of the soil, or commonly more or less buried, sometimes to the depth of several inches. Under favorable circumstances they may extend 5 or 6 feet with lateral branches of a foot or more. At intervals of an inch or two, roots are produced, and usually a leafy stem is thrown up to the height of a few inches. The flowering stems are upright, naked above, and have the flowers in slender, one-sided spikes at the summit. (See fig. 1.) These spikes are from 1 to 2 inches in length, and are in clusters of four or five, although there may be more or fewer, according to conditions under which the grass grows.

Where it obtains a foothold, Bermuda grass spreads with rapidity, and in exposed situations tends to drive out other vegetation. It does not thrive in the shade, but will endure great extremes of heat and drought. It adapts itself to a great variety of soil conditions, growing on sand, clay, black loam, or even on strongly alkaline soils, and will endure a large amount of moisture or even inundation. It does not usually produce fertile seed in the United States, except in the extreme South. The seed upon the market is mostly imported from the West Indies or other tropical regions. Professor Toumey reports that it seeds abundantly in Arizona, and occasional plants with apparently mature seeds have been found as far north as Philadelphia.

ST. LUCIE GRASS.

This is a variety of Bermuda grass which is much used in Florida and somewhat elsewhere as a lawn grass. It differs from Bermuda in having the propagating stems more upon the surface of the soil and in the lighter green color of its foliage. It is said to be more resistant to frost and to keep green in winter longer than Bermuda. It is reported to have withstood a temperature of 10° below zero in Tennessee and to remain green through heavy frosts. This variety has been grown successfully upon the grounds of the Department of Agriculture, surviving the severe winter of 1898–1899.

BERMUDA AS A PASTURE GRASS.

Bermuda is the most valuable of all the grasses for pasture in the South. It will stand trampling of stock, is very nutritious, and thrives on soils too poor for the successful cultivation of other crops. It is preeminently a summer grass, the length of its season depending upon the latitude. In Mississippi it furnishes grazing from the middle of May to the middle of November. In the Gulf States, where grazing is desired through the entire season, it is recommended to combine Bermuda with bur clover (*Medicago maculata*). In this case the Bermuda sod is scarified about September 1 with a cutaway or disc harrow, and 15 to 20 pounds of bur clover sown per acre. The clover grows during the winter and disappears in the spring when the Bermuda appears.

In California Bermuda grass has obtained a foothold in the southern part of the State and thrives on all kinds of soil. Mr. Leckenby reports that it furnishes feed during nine months of the year, and recommends it for land not suited for other purposes. When other grasses are mixed with Bermuda, these are likely to be replaced by the latter when subjected to continued grazing, especially on poor soils. Professor Tracy, of Mississippi, states that Bermuda and Japan clover should be the foundation of pastures, especially upland, through the Gulf States. On the black soils of Mississippi and Alabama he recommends that sweet clover be added. In the course of a few years a Bermuda pasture becomes somewhat sod-bound. To renovate such a pasture and keep it in good condition, it should be plowed and harrowed in the spring every three to five years.

BERMUDA GRASS FOR HAY.

On fertile soil the growth becomes very luxuriant, and may reach a height of 2 feet or more. It can be cut two or three times during a season, and yields a nutritious hay of high feeding value. The yield under favorable conditions may be as much as two to four tons per acre, and even as high as ten tons during the season is reported.

The following treatment is recommended by Professor Tracy:

> "After the last cutting in the fall, plow the land and sow with oats or vetch, or a mixture of the two. The soil should be thoroughly harrowed both before and after the sowing, and if possible smoothed off with a heavy roller, in order to give a level surface for mowing. The oats and vetches give a crop of hay in May, and by October the Bermuda may be cut."

Red clover is often sown when Bermuda is first planted, in order to increase the yield of hay. Like other grasses, it responds readily to the application of stable manure or other fertilizers.

FORMATION OF PASTURE OR MEADOW.

The grass may be started from seed or cuttings of the creeping stems. To start a pasture from seed the ground should be carefully prepared and sown in early spring with good seed at the rate of 6 to 8 pounds per acre, and pressed in with a roller. If sown just before a rain the rolling is unnecessary. The seeds are small (about 118,000 to the ounce), and should not be covered too deeply. Trials on the Potomac Flats at Washington, D. C., using 20 pounds of seed per acre, gave excellent results. Less quantity of seed may be used, but the stand is not so likely to be complete. On account of the high price of seed, and the necessity of a thorough preparation of the soil, pastures and meadows are more often started from cuttings. To prepare cuttings the sod is gathered and cut into small pieces with a feed cutter or other similar machine, or a wooden block and hatchet can be used if only a small quantity is needed. Since most of the propagating stems are near the surface, it is necessary to shave off a layer of sod only an inch or two thick. If cuttings are wanted in large quantities, the sod can be plowed and the roots harrowed into windrows or piles. In all cases care should be taken not to allow the roots to get dry. The cuttings may be planted at any time of the year in the South except the coldest winter months, but the work is usually done in March. If a meadow is desired, more care should be taken in the planting of the cuttings to insure a level surface for the mowing machine. The cuttings are planted by dropping them at intervals of a foot or two in shallow furrows and covering with the next round of the plow. This can be done when the field is plowed, the cuttings being dropped every other round or every third round. Or the field can be prepared first and the cuttings dropped upon the surface and pressed in with the foot as they are planted. For meadows it is best to go over the land with a roller after planting. For pastures, when a smooth surface is not necessary, it is sufficient to plow shallow furrows every 2 to 4 feet and drop the cuttings therein, covering them with the foot or by turning the soil back over them with the plow.

Professor Tracy remarks: "So easily may Bermuda grass be propagated that good stands can be secured by scattering a dozen or more sods to the acre and cultivating the land in corn or cotton two or three years, when the grass becomes distributed in the field."

AS A SOIL BINDER.

On account of its creeping habit of growth, Bermuda grass is an excellent plant to prevent the washing of soils along ditches, ravines, embankments, or other similar places, and also to prevent the drifting of sand upon sand dunes. It has been used for the latter purpose with excellent results upon sand dunes of the coast of Southern California. It is not stout and vigorous enough to hold large shifting dunes, but it will cover sandy soil and prevent its blowing.

FOR LAWNS.

Bermuda is the best known lawn grass of the South. It has all the desirable qualities of a lawn grass except that of holding its color during the winter. It turns brown upon the approach of cold weather, and is rather late in becoming green in the spring. It is, however, a good turf former, has a good color and a fine texture (fig. 2), and under the usual lawn treatment forms an ideal lawn, except during the winter months.

St. Lucie grass, as mentioned above, has, for the purposes of lawn making, certain advantages over the common variety, one of which is its remaining green later in winter. On account of its habit of of growing more upon the surface it can be more easily eradicated, and is not so likely to become a pest.

The quickest method for the production of a lawn, if the extent of surface is not too great, is to transplant sod if that can be obtained. A lawn can, however, be formed by the methods given under meadows. To insure a perfect stand and uniform appearance, it may be necessary to sprinkle or to hand-weed. It should be kept closely mowed and rolled.

METHODS OF ERADICATION.

The very qualities which render Bermuda so valuable as a pasture grass serve to make it an aggressive and pestiferous weed. On account of its tendency to spread and insinuate itself into land where it is not wanted, and to persist in fields which are to be used for other purposes, it has, in many cases, not been utilized to the extent that its good qualities would indicate. However, it can be eradicated from a field with comparative ease by proper cultivation. Since it will not thrive in the shade, it is only necessary to smother it out by some quick-growing crop. A method recommended by Southern agriculturists, and which may be modified to suit conditions, is to plow the land after the last crop of hay is cut, if the field is a meadow, or about this season if it is a pasture. Sow the field to oats, wheat, or other thick-growing crops. When this crop is harvested, plow the land immediately and plant to cowpeas. It is probably best to plant

FIG. 2. A closely cut turf of Bermuda Grass (as seen from above, designed to show texture).

these in drills and cultivate them until the vines meet, after which they will shade the ground and prevent the growth of Bermuda. Usually this treatment is sufficient to completely destroy the Bermuda; but if not, the process can be repeated.

FEEDING VALUE.

Bermuda grass is much relished by all kinds of stock, both when fresh and in the form of hay. Experience has shown that its milk-producing qualities, ton for ton, are fully equal to timothy. The feeding tables show that it contains more protein than most of the grasses commonly cultivated for forage.

SUMMARY.

(1) Bermuda grass is a native of the tropics, but widely introduced throughout the Southern States. It can not be successfully grown much north of Virginia.

(2) It is a creeping perennial, which will grow upon a great variety of soils and will endure extreme conditions of temperature and moisture.

(3) It is the best pasture grass for most parts of the South, especially upon poor land.

(4) On rich soil it produces an abundance of nutritious hay, two to four cuttings of which can be made each season.

(5) It can be started by thoroughly preparing the land and sowing in the spring about 6 to 8 pounds of seed per acre, pressing it in with a roller. It is usually more satisfactory to plant root-cuttings, or bits of sod 2 inches square, about 2 feet apart each way.

(6) It is a valuable soil binder, and is used to hold steep slopes and to prevent washing of soil or blowing of sand.

(7) It is the best-known lawn grass in the South, and is to be recommended for this purpose, especially the variety known as "St. Lucie grass."

(8) It can be eradicated from fields by proper cultivation of shading crops, especially cowpeas.

(9) Ton for ton the feeding value of its hay is equal to that of timothy. It is rich in protein, and is one of the most nutritious of the cultivated grasses.

A. S. HITCHCOCK,
Assistant Agrostologist.

Approved:
JAMES WILSON,
Secretary.

WASHINGTON, D. C., *March 21, 1901.*

CIRCULAR No. 32.—(Agros. 83.) Issued April 22, 1901.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

SOME ARIZONA GRASSES.

The material on which the following list of Arizona grasses is based was collected by Prof. David Griffiths and Director R. H. Forbes while pursuing their investigations of the forage conditions in Arizona, in cooperation between the Division of Agrostology and the Arizona Agricultural Experiment Station. Unless otherwise stated, the specimens cited below were collected by Professor Griffiths during the months of September and October, 1900.—F. LAMSON-SCRIBNER.

TRACHYPOGON SECUNDUS (Presl) Scribn. n. comb. (*Heteropogon secundus* Presl, Rel. Haenk. 335. 1830; *Trachypogon montufari* Nees Agrost. Bras. 342. 1829, not H. B. K. 1815; *Trachypogon polymorphus secundus* Hack. in DC. Monog. Phan. **6**: 326. 1889.)

Dragoon Mountains, No. 1839; near Pearce, No. 1934.

Elionurus barbiculmis Hack. in DC. Monog. Phan. **6**: 339. 1889.

Near Pearce, No. 1956.

ELIONURUS BARBICULMIS PARVIFLORUS Scribn. var. nov. Sessile spikelets about 5 mm. long, broader in proportion to its length and less acuminate-pointed than in the species, in which the sessile spikelet is 8–9 mm. long.

Dragoon Mountains, No. 1849.

Andropogon contortus L. Sp. Pl. 1045. 1753. (*Heteropogon contortus* R. & S. Syst. **2**: 836. 1817; *H. hirtus* Pers.)

Dragoon Mountains, No. 1844; Vales, No. 1678; near Pearce, No. 1947.

The first glume of the pedicellate spikelet glabrous or sparingly tuberculate-pilose near the apex.

Andropogon hirtiflorus feensis (Fourn.) Hack. in DC. Monog. Phan. **6**: 372. 1889. (*A. feensis* Fourn. Mex. Pl. **2**: 62. 1881.)

Dragoon Mountains, No. 1851.

Andropogon torreyanus Steud. Nom. ed. 2, **1**: 98. 1840. (*A. glaucus* Torr., not Muhl.; *A. saccharoides torreyanus* Hack. in DC. Monog. Phan. **6**: 495. 1889.)

Papayo Reservation, without number.

Sessile spikelet 3–4 mm. long.

Andropogon leucopogon Nees, Linnaea, **19**: 694. 1845. (*A. saccharoides leucopogon* Hack. in DC. Monog. Phan. **6**: 496. 1889.)

Tombstone, No. 1982; Dragoon Mountains, No. 1854; Sulphur Spring Valley, No. 1639; Rincon Mountains, No. 1784.

Andropogon halepensis (L.) Brot. Fl. Lusit. **1**: 89. 1804.

University grounds, Tucson, No. 1533.

Nazia aliena (Spreng.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **17**: 28, *fig. 324*. 1899. (*Lappago aliena* Spreng. Neue Entd. **3**: 15. 1822.) Western prickle-grass.

Near Pearce, No. 1952; Benson, No. 1832.

Nazia racemosa (L.) Kuntze, Rev. Gen. Pl. **3**²: 357. 1898. (*Cenchrus racemosus* L. Sp. Pl. 1049. 1753; *Lappago racemosa* Honck. Syn. **1**: 440.) Prickle-grass.

University grounds, Tucson.

Hilaria jamesii (Torr.) Benth. Journ. Linn. Soc. **19**: 62. 1881. (*Pleuraphis jamesii* Torr. Ann. Lyc. N. Y. **1**: 148. *t. 10*. 1824.) Black bunch-grass.

Sulphur Spring Valley, No. 1647. R. H. Forbes.

Hilaria mutica (Buckl.) Benth. Journ. Linn. Soc. **19**: 62. 1881. (*Pleuraphis mutica* Buckl. Proc. Acad. Nat. Sci. Phil. **1862**: 95. 1862.) Black grama.

Benson, No. 1998; Vales, No. 1679. The margins of the outer glumes densely fringed with short silky hairs, prominent nerves of the broad outer glumes three, diverging above as in the type, which, however, has 5–7 nerves in the outer glumes.

Sulphur Spring Valley, No. 1647. In this specimen the outer glumes of the staminate spikelets are about 6 mm. long, oblong, obtuse or subacute; nerves 3–5, running nearly parallel. The shape of the glumes approaches those of *H. jamesii*, but the size of the spikelets and character of the pubescence at the base of the group are those of *H. mutica*.

Hilaria cenchroides H. B. K. Nov. Gen. et Sp. Pl. **1**: 117, *t. 37*. 1815. Curly mesquite.

Tucson, No. 1534; Rincon Mountains, No. 1583; Cochise, No. 1883.

Paspalum distichum Linn. Amœn. Acad. **5**: 391. 1759. Knot-grass.

Tucson, No. 610.

Eriochloa aristata Vasey, Bul. Torr. Bot. Club, **13**: 229. 1886.

University grounds, Tucson, Nos. 1612, 1546. Not previously reported from the United States. Introduced from Mexico.

Eriochloa annulata (Flügge) Kunth, Rev. Gram. **1**: 30. 1835. (*Paspalus annulatus* Flügge, Monog. 135. 1810; *Helopus annulatus* Nees, Agrost. Bras. 17. 1829—Doell in Mart. Fl. Bras. **2**²: 124, *t. 19*. 1871–1877.)

University grounds, Tucson, September 5, 1900, No. 1516.

This distinct and widely distributed species has not previously been reported from the United States, probably introduced. It is represented in the U. S. National Herbarium by specimens from Cuba, Australia, and India.

Eriochloa punctata (L.) W. Hamilt. Prodr. Pl. Ind. Occ. 5. 1825.

University grounds, Tucson, No. 1537; Benson, No. 2002.

Eriochloa punctata minor Vasey, Contr. U. S. Nat. Herb. **3**: 21. 1892.

Sulphur Spring Valley, R. H. Forbes, October, 1900, No. 1641.

PANICUM ARIZONICUM Scribn. & Merrill sp. nov. (*Panicum* (sine nomine) Scribn. Bul. Torr. Bot. Club, **9**: 76. 1882; *P. fasciculatum dissitiflorum* Vasey, in herb. Not *P. dissitiflorum* Steud. 1841.)

A tufted, nearly glabrous perennial (?) 3 to 6 dm. high, with narrowly lanceolate leaves, open panicles, and pubescent spikelets. Culms prostrate below and rooting at the lower nodes, glabrous except just below the panicle, as are the numerous branches; nodes glabrous. Sheaths shorter than the internodes, smooth, rather loose; ligule about 1 mm. long, ciliate; leaf-blades 8 to 15 cm. long, 5 to 8 mm. wide, cordate and clasping at the base, gradually tapering to the acuminate apex, thin, but firm, minutely serrulate-scabrous on the prominent, cartilaginous margins and with few scattered, stiff, papillate hairs on the margins and often on the midnerve beneath. Panicle at length exserted, 18 to 20 cm. long, the axis and the erect or ascending simple branches pilose with rather stiff, spreading hairs, the lower ones 5 to 8 cm. long, bearing the approximate but not crowded racemose spikelets in pairs (the upper ones solitary), one nearly sessile and often imperfectly developed, the other on a pedicel nearly its own length; pedicels pilose. Spikelets oblong or obovate, somewhat pointed, 3–3.5 mm. long, the three outer glumes pubescent with short, spreading hairs; first glume deltoid, obtuse, enclosing the base of, and about one-third as long as the spikelet, 5-nerved; second and third glumes prominently nerved, subequal, as long as the flowering glume, the second 7-nerved, the third 5-nerved, slightly reticulate-veined above; flowering glume about 3 mm. long, pointed and finely transversely rugose.

Type specimen collected on mesas near Camp Lowell, Santa Cruz Valley, Arizona, 465 C. G. Pringle, 1881.

Other specimens examined: *Arizona:* Tucson, 1596 D. Griffiths, September, 1900; Bowie, 29 J. W. Toumey, October 1, 1896; no locality, 353 J. G. Lemmon, 1882; sandy plains near the Mexican boundary, C. G. Pringle, August 29, 1884; along streams, Santa Catalina Mountain, 3062 J. G. Lemmon and wife, August, 1883. *New Mexico:* Mangos, O. Metcalfe, September 14, 1897. *Texas:* near Madeira Creek, Presidio Co., G. C. Nealley, September, 1892. *Mexico:* Guaymas, 159, 208 E. Palmer, 1887; no locality, 250 E. Palmer, 1897. *Lower California:* San Jose del Cabo, 18 T. S. Brandegee, September 4, 1890.

This species was described by Scribner,[1] without name, as "*Panicum* (*Virgaria*) allied to *P. fuscum* Sw.," but is certainly distinct from that, and from related species. In some respects it resembles *Panicum velutinosum* of Trin. Icon. 2: *t. 180*, but is distinct from the plant there described and also very distinct from *P. velutinosum* Nees. Agrost. Bras. 121. 1829, which is certainly different from the plant so considered by Trinius.

Panicum arizonicum is at once distinguished from related species by its panicle characters and especially by its pointed pubescent spikelets.

PANICUM ARIZONICUM TENUE Scribn. & Merrill var. nov.

A small, caespitose form 1.5 dm. high or less, with smaller leaves and panicles than in the species, the panicle branches 1 to 3 cm. long. Spikelets as in the species.

Type specimen collected at Fort Huachuca, Arizona, by T. E. Wilcox in 1894. Other specimens examined: Mexican boundary line, south of Bisbee, Arizona, 1072 E. A. Mearns, October 9, 1892. *Texas:* El Paso, M. E. Jones, September 10, 1884.

PANICUM ARIZONICUM LÆVIGLUME Scribn. & Merrill var. nov.

A low, caespitose, much branched form, which differs from *Panicum arizonicum tenue* only in having glabrous spikelets, but which is clearly related to *Panicum arizonicum* rather than to *P. fuscum*.

Type specimen collected at Mescal, Arizona, 1810 David Griffiths, October, 1900. Other specimens examined: Cochise, 1810 Griffiths, October, 1900; Fort Huachuca, T. E. Wilcox, 1894; Johnson's Ranch, 11 miles east of San Pedro River, Mexican boundary, 1694 E. C. Merton, August 7, 1893.

PANICUM ARIZONICUM MAJOR (Vasey) Scribn. & Merrill n. comb. (*Panicum fuscum major* Vasey, U. S. Dept. Agr. Div. Bot. Bul. 8: 26. 1889). A stout, erect form 6–9 dm. high, with larger leaves, which are scabrous-punctulate or nearly smooth, scabrous-punctulate sheaths, and larger, more branched panicles. Southwestern Chihuahua, Mexico, Dr. E. Palmer, August to November, 1885.

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[1] Bul. Torr. Bot. Club, 9: 76. 1882.

The species in this group are much confused and no two botanists have interpreted them alike. The following notes on the several species may be of interest. *Panicum fuscum* Swartz is apparently the most common and widely distributed species in the group and is represented in the U. S. National Herbarium by specimens from Florida, Texas, New Mexico, Mexico, St. Croix, Porto Rico, Martinique, Honduras, and Costa Rica. It is distinguished by its ascending panicle branches, dark-brown, somewhat obtuse, glabrous spikelets, the outer glumes of which are prominently reticulate-veined. See Trin. Icon. **2**: *t. 206*. 1829. The plant figured by Trinius is doubtless *P. fasciculatum* Sw. which evidently is only a large form of *P. fuscum*.

PANICUM FUSCUM RETICULATUM (Torr.) Scribn. & Merrill n. comb. (*P. reticulatum* Torr. in Marcy's Explor. Red R. La. 299. 1853; *P. fasciculatum reticulatum* Beal, Grasses N. A. **2**: 117. 1896.)

Tucson, Nos. 1545, 1616; Papayo Reservation, No. 1754.

This variety is distinguished from the species only by its contracted panicles and should perhaps be considered only as a form of *Panicum fuscum* Sw. It is represented in the U. S. National Herbarium by specimens from Texas, Arizona, and Mexico.

Panicum grossarium Linn. Amoen. Acad. **5**: 392. 1759. (*Panicum adspersum* Trin. Gram. Panic. 146. 1826; Icon. **2**: *t. 169*, 1829.) This species is very distinct from *Panicum fuscum* Swartz, and is at once recognized by its larger, lanceolate leaves, 15–20 cm. long, 1.5–2 cm. wide, ciliate sheath margins, scabrous, not papillate rachis, and larger spikelets, which are 4 mm. long, prominently pointed, the outer glumes sparingly tuberculate-hispid, not reticulate-veined. It is well represented by the following specimens from Florida: St. Augustine, 176 T. H. Kearney, jr., July 24, 1895; 6705 A. H. Curtiss, August 3, 1900; Sanibel Island, 292 J. H. Simpson, March, 1891; Key West, 5431 Curtiss, June 22, 1895; Sand Key, Cape Sable, 3606 Curtiss, July 1880; no locality, A. W. Chapman. A small form of this species was also collected on ballast at Philadelphia, Pennsylvania, by F. Lamson-Scribner, September, 1881.

This is apparently a distinct species and is so considered by Grisebach, Fl. Brit. W. Ind. 546, although some of the Florida specimens referred to here are much larger than the plant he described.

Panicum carthaginense Swartz, Prodr. Veg. Ind. Occ. 22. 1788, is apparently represented by a specimen collected on ballast at Mobile, Alabama, by Dr. C. Mohr, September 16, 1891. This species is of doubtful value and should perhaps be considered as a synonym of *Panicum fuscum* Swartz or as a variety of that species.

Panicum capillare Linn. Sp. Pl. 86. 1753.

University grounds, Tucson, No. 1520; near Pearce, No. 1938; Cochise, No. 1918, a small form related to *Panicum barbipulvinatum* Nash.

Panicum cognatum Schultes, Mant. **2**: 235. 1824. (*P. divergens* Muhl. 1817, not H. B. K. 1815; *P. autumnale* Bosc. 1825.)

Benson, No. 1833; Dragoon Mountains, No. 1862.

Panicum colonum Linn. Syst. Nat. ed. 10, 870. 1759.

Papayo Reservation, No. 1655; University grounds, Tucson, Nos. 1518 and 1534, forms approaching *Panicum crus-galli* Linn.

Panicum crus-galli Linn. Sp. Pl. 56. 1753.

Benson, No. 1993; Papayo Reservation, No. 1671; Fairbank, No. 1970; Tucson, No. 1616. All these numbers represent the awnless form, which has been called var. *muticum* by various authors, although all are somewhat different from the European specimens and those of the eastern United States so referred.

Panicum hallii Vasey & Scribn. Bul. Torr. Bot. Club, **11**: 61. 1884.

Mescal, No. 1813.

Panicum obtusum H. B. K. Nov. Gen. et Sp. Pl. **1**: 98. 1815.
Tucson, Nos. 1514, 1546; Benson, No. 2006; near Pearce, No. 1935; Sulphur Spring Valley, No. 1645 R. H. Forbes, October, 1900.

Panicum sanguinale Linn. Sp. Pl. 57. 1753. (*Syntherisma sanguinalis* Nash.)
University grounds, Tucson, No. 1517.

Panicum saccharatum Buckl. Prel. Rept. Geol. and Agrl. Surv. Tex. App. 2. 1866. (*P. lachnanthum* Torr. 1857, not Hochst. 1855.)
Near Pearce, No. 1942; Benson, No. 1997; Fort Lowell, No. 1572; Dragoon Mountains, No. 1871; Rincon Mountains, No. 1782.

Chætochloa composita (H. B. K.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **4**: 39. 1897—Scribn. & Merrill, ibid. Bul. **21**: 27. 1900. (*Setaria composita* H. B. K.)
Benson, No. 2003; Tucson, No. 1511, small form.

Chætochloa grisebachii (Fourn.) Scribn. l. c.—Scribn. & Merrill, l. c. 35. (*Setaria grisebachii* Fourn.)
Common in sandy soil, Sulphur Spring Valley, Wilcox to Cochise, No. 1901.

Chætochloa macrostachya (H. B. K.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 29. 1900. (*Setaria macrostachya* H. B. K.)
Near Pearce, No. 1944.

Chætochloa viridis (Linn.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **4**: 39. 1897. (*Panicum viride* Linn.; *Setaria viridis* Beauv.)
University grounds, Tucson, No. 1526.

Cenchrus montanus Nees in Royle, Ill. Bot. Himal. 416. 1839.
University grounds, Tucson, No. 1530. Introduced from Asia.

Cenchrus tribuloides Linn. Sp. Pl. 1050. 1753.
Fort Lowell, No. 1560.

Aristida æquiramea Scheele, Linnæa, **22** : 343. 1849.
Cochise, No. 1880.
Aristida æquiramea Scheele has been variously referred to *A. purpurea* Nutt., *A. fendleriana* Steud., *A. longiseta* Steud., and *A. fasciculata* Torr., but is a very distinct species. It is most closely related to *Aristida purpurea* Nutt., but is readily distinguished by its usually larger size, larger spikelets, shorter empty glumes, and especially by its very strongly tuberculate-hispid flowering glumes. No. 1880 Griffiths, cited above, differs from typical *A. æquiramea* in having nearly awnless empty glumes.

Aristida americana Linn. Amœn. Acad. **5** : 393. 1760. (*Aristida fasciculata* Torr. Ann. Lyc. N. Y. **1** : 154. 1824; *Aristida dispersa* Trin. & Rupr. Agrost. **3** : 129. 1842.)
University grounds, Tucson, No. 1528.
From a careful study of the synonymy of this species, it is evident that *Aristida americana* Linn. is the correct name for this species.

ARISTIDA AMERICANA BROMOIDES (H. B. K.) Scribn. & Merrill, n. comb. (*Aristida bromoides* H. B. K. Nov. Gen. et Sp. Pl. **1** : 122. 1815.)
Benson, No. 1835; Rincon Mountains, No. 1808; Pearce, No. 1926; Sulphur Spring Valley, 1632 R. H. Forbes, October, 1900.
This is the common, low, caespitose form of the species, and scarcely worthy of specific rank.

Aristida divaricata Humb. & Bonpl. in Willd. Enum. 99. 1809.
Mescal, No. 1816.

Aristida divergens Vasey, Contr. U. S. Nat. Herb. **3** : 48. 1892. (*A. schiedeana minor* Vasey.)
Dragoon Mountains, No. 1872; near Pearce, No. 1838.

Aristida havardii Vasey, Bul. Torr. Bot. Club, **13** 27. 1886.
Cochise, No. 1885.

Aristida schiediana Trin. & Rupr. Agrost. **3** : 120. 1842.
Dragoon Mountains, No. 1866.

Muhlenbergia gracillima Torr. Pac. R. R. Rept. **4**^{5} : 155. 1857.
Rincon Mountains, No. 1805; Mescal, No. 1811; Dragoon Mountains, No. 1857.

Muhlenbergia porteri Scribn. in Beal, Grasses N. A. **2** : 259. 1896. (*M. texana* Thurb. in Coult. Man. Bot. Rocky Mt. Reg. 410. 1885. Not Buckley. 1862.)
Vales, No. 1872; Tucson, No. 1602. A form with unusually large panicles.

Muhlenbergia vaseyana Scribn. Rept. Mo. Bot. Gard. **10** : 52. 1899. (*M. distichophylla* of American authors. Not Kunth.)
Dragoon Mountains, No. 1876; near Pearce, No. 1857 (small form).

Lycurus phleoides H. B. K. Nov. Gen. et Sp. Pl. **1** : 142. 1815.
Pearce, No. 1959; Dragoon Mountains, No. 1838.

Sporobolus airoides Torr. Pac. R. R. Rept. **7**^{3} : 21. 1856.
Sulphur Spring Valley, No. 1638 R. H. Forbes, October, 1900; Benson, No. 2005; Tucson, No. 1502; Wilcox, No. 1904, abundant about an alkali lake bottom, a valuable grass, called "fine saccaton."

Sporobolus argutus (Nees) Kunth, Enum. **1** : 215. 1833. (*Vilfa arguta* Nees Agrost. Bras. 395. 1829.)
Benson, No. 1490; Wilcox, sandy ground, No. 1896.

Sporobolus auriculatus Vasey, Contr. U. S. Nat. Herb. **3** : 64. 1892. (*S. asperifolius brevifolius* Vasey, ibid. **1** : 56. 1890. Not *S. brevifolius* Nees.)
Dragoon Mountains, No. 1864. A peculiar form with nearly all the spikelets 2-flowered.

Sporobolus confusus (Fourn.) Vasey, Bul. Torr. Bot. Club, **15** : 293. 1888. (*Vilfa confusa* Fourn. Mex. Pl. **2** : 101. 1881.)
Dragoon Mountains, No. 1846.

Sporobolus cryptandrus (Torr.) A. Gray, Man. Bot. 576. 1848. (*Agrostis cryptandra* Torr. Ann. Lyc. N. Y. **1** : 151. 1824.)
Fairbank, No. 1981; Fort Lowell, No. 1581; Sulphur Spring Valley, No. 1636 R. H. Forbes, September, 1900.

SPOROBOLUS STRICTUS (Scribn.) n. comb. (*Sporobolus cryptandrus stricta* Scribn. Bul. Torr. Bot. Club, **9** : 103. 1882.)
Benson, No. 2004; University grounds, Tucson, No. 1532; Rincon Mountains, No. 1796; Wilcox, No. 1893.
This form is readily distinguished from *Sporobolus cryptandrus* A. Gray, by its strict, erect, densely flowered, wand-like panicles, the lower portion of which is enclosed in the inflated leaf-sheath.

Sporobolus wrightii Munro in Scribn. Bul. Torr. Bot. Club, **9** : 103. 1882.
Sulphur Spring Valley, No. 1637 R. H. Forbes, October, 1900.

Sporobolus utilis Torr. Pac. R. R. Rept. **5**^{2} : 365. 1857. (*Vilfa saccatilla* Fourn. Mex. Pl. **2** : 101. 1881; *Sporobolus saccatilla* Griseb. l. c.)
Sulphur Spring Valley, R. H. Forbes, No. 1635.

Epicampes rigens Benth. Journ. Linn. Soc. **19** : 88. 1881. (*Cinna macroura* Thurb. 1880. Not Kunth. 1835.)
Dragoon Mountains, No. 1848. Forms large tussocks and is invariably closely cropped by stock.

Polypogon monspeliensis (Linn.) Desf. Fl. Atl. **1**:67. 1798. (*Alopecurus monspeliensis* Linn. Sp. Pl. 89. 1753.)
Tucson, No. 1619.

Cynodon dactylon (L.) Pers. Syn. **1** : 85. 1805. (*Panicum dactylon* Linn. Sp. Pl. 85. 1753; *Capriola dactylon* O. Kuntze, Rev. Gen. Pl. **2** : 764. 1891.)
University grounds, Tucson, No. 1520.

Chloris elegans H. B. K. Nov. Gen. et Sp. Pl. **1** : 166, *t. 49.* 1815. (*Chloris alba* Presl, Rel. Haenk. **1**: 289. 1830.)
Cochise, No. 1923; near Pearce, No. 1929; University grounds, Tucson, No. 1521; Mescal, No. 1826; Dragoon Mountains, No. 1852; Sulphur Spring Valley, No. 1643 R. H. Forbes, October, 1900.

Chloropsis mendozina (Phil.) Kuntze, Rev. Gen. Pl. **3**^{2} : 348. 1898. (*Chloris? mendozina* Phil. Anal. Univ. Chile, **36** : 208. 1870; *Chloropsis blanchardiana* J. Gay in herb. Paris; *Trichloris blanchardiana* Scribn. Bul. Torr. Bot. Club, **9** : 146. 1882; *Trichloris fasciculata* Fourn. Mex. Pl. **2** : 142. 1881; *Trichloris verticillata* Vasey, U. S. Dept. Agr. Div. Bot. Bul. **12**^{2} : 25, *pl. 25.* 1891; *Chloropsis fasciculata* O. Kuntze, Rev. Gen. Pl. **2** : 771. 1891; *Chloropsis blanchardiana* O. Kuntze, l. c.; *Trichloris mendocina* Kurtz, Mem. Facult. Ci. Univ. Cordoba. **1896**: 37. 1897; *Leptochloris greggii* Munro in herb.)
Benson, No. 1969.
Note—Kuntze[1] has the following note regarding this genus: "*Trichlora* und *-is* sind nicht nebeneinander zülassig, sodass das synonym von Hackel giltig wird. Hackel schrieb: bei den "Gärtnern" als *Chloropsis* oder *Chloridopsis* (ein unpublicirten name) bekannt. Durand ind. schreibt, *Chloridopsis* "Gaertn." sodass man den botaniker namens Gaertner damit verstehen müsste."

Chloropsis Hack. 1887. "Hort." in Engler & Prantl, Nat. Pfl. **2**^{2} : 59. 1887, as synonym; *Chloridopsis* Hack. l. c., as synonym; *Trichloris* Fourn. Mex. Pl. **2**: 142. 1881. Not *Trichlora* Baker. 1877.
Kuntze is, however, evidently wrong in his conception of species in this genus, as he recognizes six, holding *Chloropsis fasciculata*, *C. blanchardiana*, and *C. mendozina* as distinct species, although they are identical. There are apparently two well-marked species in this genus, *Chloropsis mendozina* (Phil.) O. Kuntze and *C. pluriflora* (Fourn.) O. Kuntze (*Trichloris pluriflora* Fourn.), both of which grow in North and South America. For an admirable discussion of the species in this genus see F. Kurtz, Col. Fl. Arg. 46–50. 1900 (reprint from Bol. Acad. Nac. Cordoba **16.** 1900).

Bouteloua aristidoides (H. B. K.) Griseb. Fl. Brit. W. Ind. 537. 1864. (*Dinebra aristidoides* H. B. K. Nov. Gen. et Sp. Pl. **1** : 171. 1815.)
Mescal, No. 1818; University grounds, Tucson, No. 1527; near Pearce, No. 1928; Cochise, No. 1922.

Bouteloua bromoides (H. B. K.) Lag. Gen. et Sp. Nov. 5. 1816. (*Dinebra bromoides* H. B. K. Nov. Gen. et Sp. Pl. **1** : 172, *t. 51.* 1815.)
Rincon Mountains, No. 1670; near Pearce, No. 1949.

Bouteloua curtipendula (Michx.) Torr. in Emory, Notes Mil. Recon. 153. 1848. (*Chloris curtipendula* Michx. 1803; *Bouteloua racemosa* Lag. 1805.)
Benson, No. 1834; Dragoon Mountains, No. 1837; Cochise, No. 1907.

Bouteloua eriopoda Torr. Pac. R. R. Rept. **4**^{5} : 155. 1857.
Mescal, No. 1825; Rincon Mountains, No. 1669.

Bouteloua havardi Vasey, Proc. Am. Acad. **18** : 179. 1883.
Mescal, No. 1829.

Bouteloua hirsuta Lag. Varied. Cienc. Lit. Art. **2** : 141. 1805.
Dragoon Mountains, No. 1865; near Pearce, No. 1948; Rincon Mountains, No. 1809.

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[1] Rev. Gen. Pl. **2**: 771. 1891.

BOUTELOUA MICRANTHA Scribn. & Merrill sp. nov.

A very slender, erect, cæspitose, glabrous perennial 7–9 dm. high, with sparingly branched culms, which are geniculate below, 6–10 very slender, erect or ascending, densely flowered spikes 2–2.5 cm. long, and very small spikelets. Sheaths shorter than the internodes, glabrous; ligule a ciliate fringe about 2 mm. long; leaf-blades 5–8 cm. long, about 3 mm. wide, with few long papillate hairs on the margins and often on the upper surface. Panicle 1.5–2 dm. long, the spikes about equaling or the upper ones exceeding the internodes, common rachis smooth. Pedicel of the spikes about 2 mm. long, minutely short-pubescent; the rachis flattened, scabrous on the margins. Spikelets crowded in two rows, secund, purplish, 2–2.5 mm. long; empty glumes unequal, the first hyaline, lacerate at the apex, about 1 mm. long, the second firm, purplish, ovate, pubescent, with few short, stiff hairs, cleft at the apex, the midnerve prominent, excurrent as a stout awn 0.5 mm. in length; flowering glume about 2 mm. long, pilose with rather long, ascending hairs below and on the margins, smooth above, three-cleft, three-awned, the awns from the cleft less than 1 mm. long, scarcely exceeding the lobes of the glume, the two middle lobes broad, obtuse, the lateral ones very narrow, acute. Palea equaling the glume, 4-toothed, the teeth ciliate. Awns 2, very short. Sterile rudiment on a pedicel about 0.5 mm. long, with a tuft of few short hairs at the apex, consisting of three glumes and three awns which are somewhat longer than those of the flowering glume.

Type specimen collected at Fort Lowell, Arizona. David Griffiths, September 1900, No. 1556. No. 244 of E. Palmer's Mexican collection for 1897 is the same.

This species has been confused with *Bouteloua polystachya* and *B. microstachya*, but is strikingly different from those species in habit of growth. It is perhaps most closely related to *Bouteloua rothrockii*, but is distinguished by its very slender habit, smaller, narrower spikes, much smaller spikelets, and shorter awns.

Bouteloua oligostachya (Nutt.) Torr. in A. Gray, Man. Bot. ed. 2, 553. 1856. (*Atheropogon oligostachyus* Nutt. Gen. **1** : 78. 1818.)

Wilcox, No. 1905; near Pearce, No. 1980; University grounds, Tucson, No. 1552; Dragoon Mountains, No. 1863; Sulphur Spring Valley, R. H. Forbes, No. 1640.

Bouteloua polystachya (Benth.) Torr. Pac. R. R. Rept. **4**^{5} : 366, *t. 10.* 1847. (*Chondrosium polystachyum* Benth. Bot. Voy. Sulph. 56. 1841.)

Wilcox, No. 1897, abundant on sandy ground; Benson, No. 2009; University grounds, Tucson, No. 1524; Sulphur Spring Valley, R. H. Forbes, No. 1646; Rincon Mountains, No. 1785.

Bouteloua vestita (S. Wats.) Scribn. Contr. U. S. Nat. Herb. **2** : 531. 1894. (*B. polystachya vestita* S. Wats. Proc. Am. Acad. **18** : 177. 1883.)

Mescal, No. 1819; Pearce, No. 1927.

Dactyloctenium ægyptium (Linn.) Willd. Enum. 1029. 1809.

University grounds, Tucson, No. 1515.

Leptochloa dubia (H. B. K.) Nees, Syllog. Ratisb. **1** : 4. 1824. (*Chloris dubia* H. B. K. Nov. Gen. et Sp. Pl. **1** : 169. 1815; *Diplachne dubia* Scribn. Bul. Torr. Bot. Club, **10** : 30. 1883.)

Cochise, No. 181; near Pearce, No. 1943; University grounds, Tucson, No. 1539, a young plant.

Leptochloa fascicularis (Lam.) A. Gray, Man. Bot. 588. 1848. (*Festuca fascicularis* Lam. Tabl. Encycl. **1** : 189. 1791; *Diplachne fascicularis* Beauv. Agrost. 160. 1812.)

Fairbank, No. 1971.

Leptochloa mucronata (Michx.) Kunth, Rev. Gram. **1** : 91. 1835. (*Eleusine mucronata* Michx. Fl. Bor. Am. **1** : 65. 1803.)

University grounds, Tucson, No. 1513.

Leptochloa mucronata pulchella Scribn. Bul. Torr. Bot. Club, **9** : 147. 1882.

Benson, No. 1989. This variety is the small tufted form and extends from Mississippi to Arizona and Mexico. From the specimens in the U. S. National Herbarium it is evident that its small size is due to habitat.

LEPTOCHLOA PILOSA Scribn. sp. nov.

A caespitose, rigid, somewhat purplish perennial about 3.5 dm. high, with papillate-hispid sheaths and terminal panicles of many slender, spreading spikes 3–6 cm. long. Culms glabrous, somewhat branched below; sheaths usually exceeding the internodes, rather loose, pilose with long, weak, spreading hairs, each from a dark-colored glandular papilla; ligule a lacerate fringe about 2 mm. long; leaf-blades 5–12 cm. long, 4–6 mm. wide, rigid, ascending, acute, subauriculate at the base, often somewhat involute, and with few scattered papillate hairs on the upper surface, glabrous beneath. Spikelets about 2 mm. long, 2- to 3-flowered; empty glumes subequal, acute; flowering glumes obscurely emarginate, not mucronate, about 1.5 mm. long.

Type specimen collected in sandy soil, Dappan, Travis Co., Texas, 294 J. E. Bodin, September, 1891.

No. 1603 Griffiths, Tucson, Arizona, September, 1900, is apparently the same, differing only in its shorter leaves and panicle branches.

This species is closely related to *Leptochloa mucronata*, but is at once distinguished by its rigid leaves and papillate-pilose sheaths.

Leptochloa pringlei Beal, Grasses N. A. **2** : 426. 1896. (*Diplachne pringlei* Vasey, l. c.) Dragoon Mountains, No. 1850; Rincon Mountains, No. 1801.

Leptochloa viscida (Scribn.) Beal, Grasses N. A. **2** : 434. 1896. (*Diplachne viscida* Scribn. Bul. Torr. Bot. Club, **10** : 30. 1883.)

Benson, No. 1988; No. 1968, from the same locality, is a lax form of this species.

Pappophorum wrightii S. Wats. Proc. Am. Acad. **18** : 128. 1883. (*P. boreale* Torr. Pac. R. R. Rept. **4**⁵ : 155. 1857. Not Griseb. 1853.)

Mescal, No. 1827; Rincon Mountains, No. 1673; Vales, No. 1668; University grounds, Tucson, No. 1525; Cochise; No. 1908; Pearce, No. 1925.

Pappophorum vaginatum Buckl. Prel. Rept. Geol. and Agrl. Surv. Texas, App. 1. 1866. (*P. apertum* Munro in Scribn. Bul. Torr. Bot. Club, **9** : 148. 1882.)

Fairbank, No. 1969; University grounds, Tucson, No. 1538.

As Buckley's name is the earliest one published for this species it is here taken up, as both Buckley's and Munro's species were based on the same plant, No. 803 C. Wright, Texas, 1849.[1] At the time the description of *P. apertum* was published it was supposed that *P. vaginatum* was only an herbarium name, although it had been published many years before. On account of its very obscure publication it was not listed in Index Kewensis.

Cottea pappophoroides Kunth, Rev. Gram. **1** : 281, *t. 52*. 1835.

Near Pearce, No. 1939.

Arundo donax Linn. Sp. Pl. 81. 1753.

No label; probably University grounds, Tucson.

Triodia mutica (Torr.) Scribn. Bul. Torr. Bot. Club, **10** : 30. 1883. (*Tricuspis mutica* Torr. Pac. R. R. Rept. **4** : 156. 1857.)

Tombstone, No. 1976; Mescal, No. 1812, frequent on gravelly banks.

TRIODIA PILOSA (Buckl.) n. comb. (*Uralepis* (*Tricuspis*) *pilosa* Buckl. Proc. Acad. Nat. Sci. Phil. **1862** : 94. 1862; *Tricuspis acuminata* Munro in A. Gray, l. c., 335; *Sieglingia acuminata* O. Kuntze, Rev. Gen. Pl. **2** : 789. 1891; *Sieglingia pilosa* Nash in Britt. & Br. Illus. Fl. **3** : 504. 1898.)

Tombstone, No. 1975.

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[1] Scribn. Bul. Torr. Bot. Club, **9** : 148. 1882.

Triodia pulchella H. B. K. Nov. Gen. et Sp. Pl. **1** : 155. *t. 47.* 1815. (*Sieglingia pulchella* Kuntze, Rev. Gen. Pl. **2** : 789. 1891.)
Tombstone, No. 1978; Rincon Mountains, No. 1665; Tucson, Nos. 1503, 1807.

Scleropogon brevifolius Philippi, Anal. Univ. Chile, **34** : 205. 1870—Sert. Mendoc. **2** : 48. 1871. (*Tricuspis monstrosa* Munro in Hemsl. Diagn. Pl. Nov. Mex. 56. 1880; *Lesourdia multiflora* Fourn. Bul. Soc. Bot. Fr. **27** : 102. 1880; *L. Karwinskyana* Fourn. l. c.; *Scleropogon karwinskyanus* Benth. in S. Wats. Proc. Am. Acad. **18** : 181. 1883.)
Dragoon Mountains, Nos. 1855, 1856; Cochise, No. 1912; Sulphur Spring Valley, R. H. Forbes, No. 1630.

Eragrostis abyssinica Schrad. Linnaea, **12** : 450. 1838.
University grounds, Tucson, Nos. 1422, 1542. Introduced.

Eragrostis lugens Nees, Agrost. Bras. 505. 1829.
Dragoon Mountains, Nos. 1843, 1853.

Eragrostis major Host. Gram. **4** : 14, *pl. 14.* 1809.
Mescal, No. 1814; Papayo Reservation, No. 1653; University grounds, Tucson, No. 1523.

Eragrostis purshii Schrad. Linnaea, **12** : 451. 1838.
Benson, No. 2010.

Distichlis spicata (L.) Greene, Bul. Calif. Acad. Sci. **2** : 415. 1887. (*Uniola spicata* L. Sp. Pl. 71. 1753; *D. maritima* Raf. Journ. Phys. **89** : 104. 1819.)
Tucson, Nos. 1504, 1505; Wilcox, No. 1899. Abundant and was the means of carrying many cattle through the dry spell, although not eaten ordinarily.

Poa pratensis Linn Sp. Pl. 67. 1753.
University grounds, Tucson, No. 1512, a depauperate form.

Festuca octoflora Walt. Fl. Carol. 81. 1788. (*Festuca tenella* Willd. Enum. **1** : 113. 1809.)
On high peaks near Pearce, No. 1958.

Bromus unioloides (Willd.) H. B. K. Nov. Gen. et Sp. Pl. **1** : 151. 1815. (*Festuca unioloides* Willd. Hort. Berol. **1** : 3, *pl. 3.* 1806.)
University grounds, Tucson, No. 1531.

Elymus canadensis Linn. Sp. Pl. 83. 1753.
Papayo Reservation, No. 1660.

ELMER D. MERRILL,
Assistant in Charge of Collections.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *April 8, 1901.*

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CIRCULAR No. 33.—(Agros. 84.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

RANGE GRASS AND FORAGE PLANT EXPERIMENTS AT HIGHMORE, S. DAK.—REPORT OF PROGRESS.*

The cooperative range grass and forage plant experiments at Highmore, S. Dak., begun in the spring of 1899 and conducted in cooperation with the South Dakota Experiment Station, were continued during the season of 1900, and the present circular is based upon the report of Mr. Louis W. Carter, who has had immediate charge of the work. In 1899 there were cultivated 74 plats, including 42 varieties of grasses and forage plants, all but 12 of which were perennials. In 1900 57 varieties were grown, of which 27 were not grown in 1899. These were as follows: Meadow fescue, red fescue, *Bromus erectus*, *B. kalmii*, *B. tectorum*, orchard grass, Washington blue-grass, Japanese barnyard millet, white Russian broom-corn millet, Samarkand alfalfa, French alfalfa, Australian saltbush, bitter vetch (*Lathyrus sativus*), white milo maize, Egyptian corn, March rape, Canadian lyme grass, blue Canadian lyme, goose wheat, oats, barley, speltz, emmer, Russian buckwheat, *Vicia faba*, white soy beans, sweet clover.

The season of 1900 was peculiar in that, although the rainfall was larger than usual, the season as a whole was very unfavorable. The preceding winter was dry and without snow until the latter part of March, when there was a fall of 8 inches. This, together with a fall of 3.2 inches of rain at the end of April, furnished favorable conditions for the germination of seeds, but was followed by a protracted drought of about seven weeks. During that period hot winds blew a part of the time, the prairie turned yellow, ponds dried up, and wells began to fail. The drought was general over South Dakota and all grasses and grains suffered, but cultivated crops, like corn and potatoes, when well tended, resisted the drought and

*The report for 1899 is embodied in Circular No. 21 of this Division, entitled Cooperative Range Grass and Forage Plant Experiments at Highmore, S. Dak.

suffered little. Rains in the first half of July were followed by a period of hot, dry weather, accompanied by hot winds, which produced serious injury and was fatal to corn which was drilled or planted thickly. Corn in hills and well cultivated resisted the drought, which fact shows that methods of culture tending to conserve the soil moisture are of great importance. There was a rainfall of 7.2 inches in August and 4.39 in September.

The report includes a record by plats, following the system presented in the first report.

PLAT A (1).—Smooth bunch grass (*Poa lævigata*). After the June rains the grass resumed its growth, interrupted by the spring drought, and formed quite a sod, but did not get over 6 inches high and did not form heads.

A part of the plat was plowed up and sown to the seed of this grass, but the young plants were all killed by the drought.

PLAT A (2).—East half. Bunch grass (a form of *Poa lævigata*). Good growth in May, but did not head out. Formed a good sod latter part of summer.

The west half, in Canadian blue grass (*Poa compressa*), made a good growth early in the season and headed out June 1, but formed no seeds.

PLAT A (3).—Nevada blue grass (*Poa nevadensis*). Condition similar to the preceding.

PLAT A (4).—Oregon blue grass (*Bromus unioloides*). Resown. Seems to be a winter annual. Self-sown seeds germinated in the fall, survived the winter, and headed out in June.

PLAT A (5).—Short-awned brome grass (*Bromus breviaristatus*). Poor stand.

PLAT A (6).—King's fescue (*Festuca kingii*). Fair growth, but did not head out.

PLAT A (8).—East half. Bearded wheat grass (*Agropyron caninum*). Did not head out, but grew fairly well.

Most of the west half in feather bunch grass (*Stipa viridula*), but growth poor.

PLAT A (9).—Giant rye grass (*Elymus condensatus*). Growth poor.

PLAT A (10).—Six lots of slender wheat grass (*Agropyron tenerum*). Made a growth of about 6 inches.

PLAT A (11).—Slender wheat grass (*Agropyron tenerum*). This plat, which was drilled, stood the drought better than the preceding, which was sown broadcast.

PLAT A (12).—Wild timothy (*Muhlenbergia racemosa*). Growth poor, but headed out in September. Killed by frost September 20.

PLAT A (13).—A mixture of curly mesquite (*Hilaria cenchroides*), blue grama (*Bouteloua oligostachya*), and King's fescue (*Festuca kingii*). Growth poor.

PLAT A (14).—Blue grama (*Bouteloua oligostachya*). Growth poor.

PLAT A (15).—Mixed grama grasses. Growth poor.

PLAT A (16, 17, 18).—Sown to *Bromus inermis*, *B. erectus*, *B. kalmii*, *B. tectorum*, *Agropyron pseudorepens*, *Dactylis glomerata*, *Muhlenbergia racemosa*, and *Poa nevadensis*, but all failed to germinate.

PLAT A (19, 20).—Turkestan alfalfa (*Medicago sativa turkestanica*). Grew well except during the midsummer drought.

PLAT A (22, 23, 24).—Western wheat grass (*Agropyron spicatum*). Growth fair, but did not form heads.

PLAT A (21, 25 to 29).—Smooth brome grass (*Bromus inermis*). Growth good except during summer drought.

PLAT B (1).—Planted to potatoes in preparation for next year.

PLAT B (2).—Planted in sugar corn.

PLAT B (3).—Planted to millets; west side to Japanese barnyard millet. Growth good, finally reaching a height of 4 to 5 feet. One of the best forage plants tested this year. Another portion of plat planted to white Russian broom-corn millet (S. P. I., No. 1387). Growth poor. The remainder of the plat planted to red veronezh broom-corn millet (S. P. I., No. 2796). Growth very poor.

PLAT B (4).—Samarkand and French alfalfa. Drilled in rows 1 foot apart. Growth good in both cases.

PLAT B (5, 6, 7, 8).—Turkestan alfalfa (*Medicago sativa turkestanica*). Wintered well. Growth fair.

PLAT B (9).—Turkestan alfalfa (S. P. I., No. 991). Sown broadcast at the rate of 28 pounds per acre. Suffered from the midsummer drought. Killed by frost September 20.

PLAT B (10).—Australian saltbush ((*Atriplex semibaccata*). Drilled May 10 on the following plan: 11 rows on the west side, seed pressed in; 11 rows in the center, seed covered one-half inch; 11 rows on the east side, seed 1 inch deep. Seed did not sprout till June 20. Only a few plants came in at west side. In the center the stand was about 50 per cent, while on the east side the stand was about 25 per cent. Made a growth during the latter part of the season, but was all dead by the 1st of November.

PLAT B (11).—Bitter vetch (*Lathyrus sativus*). Made a fair growth and stood the drought well.

PLAT B (12).—Milo maize (*Andropogon sorghum*). Yellow variety cut September 10. Weighed, November 3, at the rate of 6,336 pounds per acre. White variety cut September 15. Weighed, November 3, at the rate of 12,693 pounds per acre.

The yellow milo maize formed heads, but the white did not.

PLAT B (13).—Egyptian corn (*Andropogon sorghum*). Stand poor and growth fair. Formed heads August 18. Cut September 11, when about 5 feet high. Weighed, November 3, at the rate of 3,120 pounds per acre.

PLAT B (14).—Wisconsin amber cane (*Andropogon sorghum*). Stand, about 50 per cent. Yielded at the rate of 2,960 pounds per acre.

PLAT B (16).—Hairy vetch (*Vicia villosa*). Failed to germinate.

PLAT B (17).—Rape (*Brassica napus*). West half, March rape, drilled May 10; not successful. East half, dwarf Victoria rape, drilled May 10, made a rank growth and yielded, September 1, green fodder at the rate of 26,880 pounds per acre. A single plant weighed 23 pounds.

PLAT B (18 to 24).—Sown to the following grasses, but all were killed by drought: Hard fescue (*Festuca scabrella*), red fescue (*Festuca rubra*), wild timothy (*Muhlenbergia racemosa*), Washington blue grass, rye grass (*Elymus canadensis glaucifolius*), smooth brome grass (*Bromus inermis*), and Western wheat grass (*Agropyron spicatum*).

PLAT B (25 to 30).—Smooth brome grass (*Bromus inermis*). A very poor stand.

PLAT C (1).—Planted to potatoes in preparation for next year.

PLAT C (2, 3).—Goose wheat. Severely injured by drought and Russian thistles.

PLAT C (4, 5).—Oats. Killed by drought.

PLAT C (6 to 11).—Russian speltz. Growth poor. Yielded at rate of 4 to 5 bushels per acre.

PLAT C (12).—Emmer (*Triticum dicoccum*). S. P. I., No. 2789, on part of plat, remainder sown to Russian buckwheat (*Fagopyrum fagopyrum*), S. P. I., No. 2801, but in both cases the young plants were killed by the drought.

PLAT C (13).—Planted to various varieties of imported wheats, oats, barley, and speltz, bitter vetch (S. P. I., No. 1175), horse beans (*Vicia faba*), and white soy beans, but all were killed by drought.

PLAT C (14).—Red Orenburg broom-corn millet, S. P. I., No. 2960 (*Panicum miliaceum*). Growth poor, but stood the drought better than any of the broom-corn millets except the black (Plat C, 19).

PLAT C (15).—Tamboy broom-corn millet, S. P. I., No. 2794. A red variety. Badly damaged by the hot winds.

PLAT C (16).—Red Russian broom-corn millet, S. P. I., No. 2797. Similar to preceding.

Plat C (17).—A white variety of foxtail millet (*Chætochloa italica*). Made a fair growth. Cut September 6.

Plat C (18).—A red variety of the preceding. Made a good growth.

Plat C (19).—A black variety of Russian broom-corn millet, S. P. I., No. 2795. Made a fair growth and withstood the drought well.

Plat C (20 to 30).—Sown to common millet to keep down the weeds.

An additional series (D) was broken up and planted this season, with the intention of carrying on experiments in green manuring, but owing to the dry weather they were not successful. Series E was broken up and sown broadcast to common millet to keep the ground clean.

Series F.—A portion of this had not been plowed for eight years and was very weedy in places. This portion was pulverized last May and sown broadcast with *Bromus inermis* and then dragged. The seed germinated about September 1, and the results will be noted the following season. The remainder of this plat is broken in preparation for the next year.

Series H.—Numbers 4 and 5 were treated with 40 loads of manure, which was harrowed in. These plats showed an increase of grass of about 30 per cent.

Plat H (6).—Scarified and sown to *Bromus inermis*.

Plat H (7).—Scarified and sown to Nevada blue grass (*Poa nevadensis*).

Plat H (8).—Scarified and sown to King's fescue (*Festuca kingii*).

Plats H (9, 10, 11, 12).—Scarified and left to be sown the following spring.

From the preceding it will be seen that the grasses mentioned in the report of 1899 as giving promise have in most cases confirmed the estimates placed upon their value. Among these may be mentioned smooth bunch grass (*Poa lævigata*), Nevada blue grass (*Poa nevadensis*), King's fescue (*Festuca kingii*), and Oregon brome grass (*Bromus unioloides*). On account of the extremely dry weather many of these did not form seed, but they nevertheless made a fair growth and thickened into more or less of a sod. A few other perennial grasses grew well in spite of the unfavorable conditions, such as bearded wheat grass (*Agropyron caninum*), slender wheat grass (*A. tenerum*), and western wheat grass (*A. spicatum*). Canadian blue grass (*Poa compressa*) made considerable growth early in the season and headed out by June 1, though it formed no seed. This grass, however, is not so valuable from an agricultural standpoint as some of the others. Smooth brome grass (*Bromus inermis*) made a favorable growth, though, like most of the other perennial grasses, it suffered from the summer drought, but it renewed its growth upon the return of more favorable conditions. This is undoubtedly one of the best grasses for the dry regions of the Northwest for both hay and pasture.

Turkestan alfalfa has grown fairly well, but so far it has not justified the claim of great superiority over the ordinary sort.

The Australian saltbush (*Atriplex semibaccata*) germinated poorly, but withstood the drought quite well. As it does not survive the winter it must be treated as an annual and sown each spring. Except on alkali soil, it probably is not to be recommended in this latitude, as there are other more promising annual plants for ordinary soil.

Among the annual grasses that furnish coarse forage there are several that proved able to produce a crop in spite of the extreme conditions. Japanese barnyard millet is especially to be recommended. Common or foxtail millet also did well. The broom-corn millets made a fair growth, but the varieties tested thus far are inferior to the common millet.

The sorghums, including amber cane, Egyptian corn, and milo maize, in several cases produced a large amount of fodder, a white variety of milo maize yielding at the rate of 6 tons per acre (Plat B, 12).

Dwarf Victoria rape made a rank growth and yielded green fodder at the rate of 13 tons per acre.

Many varieties of grasses which were tried failed to get sufficient start before the summer drought and succumbed to the dry weather. These will be given further trial and doubtless some will prove of value.

It is evident that certain of the perennial grasses tried can be used for permanent pasture. But in case of prolonged periods of drought it is necessary to supplement the pastures by soiling crops. For this purpose Japanese barnyard millet, common millet, the sorghums, and rape can be used to advantage. Smooth brome grass and some of the other perennial grasses can usually be depended upon for hay. In addition to these hay can be obtained from the millets and cane.

F. Lamson-Scribner,
Agrostologist.

Approved.
James Wilson,
Secretary of Agriculture.

Washington, D. C., *April 2, 1901.*

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CIRCULAR No. 34.—(Agros. 85.) ISSUED MAY 24, 1901.

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

[GRASS AND FORAGE PLANT INVESTIGATIONS.]

F. LAMSON-SCRIBNER, Agrostologist.

ARISTIDA PURPUREA NUTT., AND ITS ALLIES.

The species of *Aristida* belonging to the section with very unequal empty glumes, occurring in the United States, never have been clearly understood, and an attempt is here made to show the relationships of the many species, or supposed species, which have been described by various authors. While in some instances the conclusions are not wholly satisfactory, and some species are interpreted to include many different forms, it has been thought that the only proper way to treat this group is on broad lines. Under the present tendency to multiply species, some authors would doubtless add many new species in this group; but we are of the opinion that such a multiplication of species would add to rather than lessen the difficulty in determining the limits of the several species. There appears to have been a tendency to overlook old published species which, by reason of their very short or imperfect descriptions, are doubtfully known, and in the present paper an attempt is made to correlate the old species and varieties, with the belief that, even if these are wrongly interpreted, such work is often of more value than promiscuous publications of many new species with no attempt to determine the limitations of those already published. Among the old species and varieties in this group are *Aristida americana* L., *A. fasciculata* Torr., *A. purpurea* Nutt., *A. dispersa* T. & R., *A. purpurea berlandieri* T. & R., *A. purpurea hookeri* T. & R., *A. fendleriana* Steud., *A. longiseta* Steud., *A. romeriana* Scheele, *A. æquiramea* Scheele, *A. filipendula* Buckley, and *A. curtiseta* Buckley. —F. LAMSON-SCRIBNER.

There are in the U. S. National Herbarium the types of the several species and varieties described by Dr. Vasey, and also cotypes of the following species: *Aristida longiseta* Steud. (978 Fendler), *A. fendleriana* Steud. (973 Fendler), *A. purpurea berlandieri* T. & R. (1777 Berlandier), *A. purpurea hookeri* T. & R. (293 Drummond), and, apparently, *A. æquiramea* Scheele (562 Lindheimer). Through the courtesy of Mr. Stewardson Brown, curator of the botanical section of the Philadelphia Academy of Natural Sciences, we were able to examine the types of *A. purpurea* Nutt., *A. filipendula* Buckley, and *A. curtiseta* Buckley. Mr. George V. Nash kindly matched specimens with the type of *Aristida fasciculata* Torr., in the herbarium of Columbia University.

Of the above-mentioned species, *Aristida americana* L., was first taken up for the plant which long passed under the name of *Aristida dispersa* T. & R., by Scribner.[1] *A. fasciculata* Torr., is a synonym of this species. *A. fasciculata* and *A. purpurea* have previously been confused, although they are not even closely related. The confusion of these two species doubtless occurred from the fact that *fasciculata* was interpreted to apply to habit of growth rather than to the inflorescence. Nearly all of the other species here considered have at one time or another been referred to *A. purpurea* or *A. fasciculata*, either as synonyms or as varieties. *A. æquiramea* Scheele, treated here as a variety of *Aristida purpurea*, is perhaps worthy of specific rank.

In studying this group, one of the chief difficulties has been the large amount of young or imperfectly developed material in the herbarium, which, in many cases, we found impossible to determine satisfactorily; and, in addition to this, the great variability in habit, doubtless due to environment, added to the difficulty in determining the limits of the several species. It is hoped that the present paper will at least lead to some uniformity in determining the species here considered, as heretofore the names *Aristida purpurea*, *A. fasciculata*, *A. fendleriana*, and *A. longiseta*, etc., have been variously applied, first to one form, then to another.

A. *Culms branched, awns not exceeding 2 cm. in length.*

Aristida americana Linn. Amoen. Acad. **5**:393. 1759. (Pugill. Jam. Pl.) (*Aristida fasciculata* Torr. Ann. Lyc. N. Y. 1:154. 1824; *Chætaria fasciculata* Schult. Mant. **3**:578. 1826; *Aristida dispersa* Trin. & Rupr. Agrost. **3**:129. 1842.)

The original description of this species in Amoenitates Academicæ is as follows: "*Aristida americana. Gramen* Festucam referens. Culmus ramosus. Differt ab *Aristida ascensionis* quod radii *paniculæ* sint indivisi. *Spiculis* alternis e flosculis sessilibus, quorum valvula calycina purpurascens est."

Munro[2] says regarding the specimen in the Linnean Herbarium: "*Aristida americana* L. Am. Acad. **5**:393. From Jamaica, Browne. This is called *A. dispersa* Trin.; but Linnæus's name ought to take precedence. Kunth has misplaced the Linnean synonym in *Eutriana juncifolia*." Linnæus compares *Aristida americana* with his *A. adscensionis*, to which the form here considered, is closely related, not only in habit but also in spikelet characters. The description of *Aristida americana* in later editions of Linnæus's works is very different from the original one given above, and this may explain why Kunth referred this species to *Eutriana* (*Bouteloua*).

The type of *Aristida fasciculata* Torr., in the Herbarium of Columbia University, bears the label, "*Aristida fasciculata* Torr., Forests of the Canadian, Long's Expedition, Dr. James," and has been variously interpreted by different authorities. This specimen is well matched by No. 66 E. Palmer, Guaymas, Mexico, 1887, distributed as *Aristida dispersa* Trin. & Rupr.

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[1] Bul. Torr. Bot. Club **9**:87. 1888.

[2] On the identification of the Grasses of Linnæus's Herbarium, Journ. Linn. Soc. Bot. **6**:149. 1862.

Aristida americana Linn., is an extremely variable species and extends from Kansas to Arizona, Lower California, Mexico, and the West Indies. It is a cæspitose, much branched perennial 3 to 6 dm high, with rather short involute leaves and many-flowered panicles 5 to 15 cm. long. Spikelets 8 to 10 mm. long, fasciculate; empty glumes usually purplish, unequal, the first one-half to two-thirds as long as the second, which about equals the flowering glume. Awns subequal, 1 to 1.5 cm. long.

SPECIMENS EXAMINED.—*Kansas:* sandy soil, Comanche County, 888 A. S. Hitchcock, 1896. *Texas:* "Western Texas," 741 C. Wright, October, 1849, also 30 V. Havard, September, 1883, Limpia Canyon, 163 G. C. Nealley, September, 1892; Abilene, H. L. Bentley, 1899. *New Mexico:* Mangos Valley, J. G. Smith, September 22, 1896; Organ Mountains, G. R. Vasey, 1881. *Arizona:* Fort Huachuca, Dr. T. E. Wilcox. 1894; Santa Catalina Mountains, 13 J. W. Toumey, April 3, 1894. *Mexico:* Guaymas, 66 E. Palmer, 1887; Mexican Boundary, near White Water, 2264 E. A. Mearns, September 11, 1893; Saltillo, State of Coahuila, 388 E. Palmer, September, 1898; also 1352, E. Palmer, 1880; Durango, State of Durango, 535 E. Palmer, August, 1896; Chihuahua, 390 C. G. Pringle, August, 1885. *Lower California:* 504 E. Palmer, 1887. *Dutch West Indies:* St. Croix, 64 A. E. Ricksecker, November 11, 1895. *Porto Rico:* Guanica, 3438, 3766 P. Sintenis, 1886.

Aristida americana bromoides (H. B. K.) Scribn & Merrill, U. S. Dept. Agr., Div. Agros., Cir. 32:5. 1901. (*Aristida bromoides* H. B. K. Nov. Gen. et Sp. Pl. 1:122. 1815; *Aristida dispersa bromoides* Trin. &. Rupr. Agrost. 3:130. 1842; *Chætaria bromoides* R. & S. Syst. 2:396. 1817).

A low tufted form 1 to 3 dm. high, with slender, simple or branched culms, short involute leaves and densely-flowered purplish or pale panicles 2 to 5 cm. long. Spikelets as in *Aristida americana.*

In dry soil, Texas to California (Mexico).

SPECIMENS EXAMINED: *Texas:* Guadaloupe Mountains, 67 V. Havard, 1881. *New Mexico:* between Santa Fe and Canoncito, 3754 A. A. & E. G. Heller, June 23, 1897; Santa Fe, 1325 A. L. Mulford, September 16, 1895, Socorro, G. R. Vasey, 1881. *Arizona:* Santa Catalina Mountains, 14 J. W. Toumey, April 20, 1894; near Bisbee, 1027 E. A. Mearns, October 5, 1892, also 861 Mearns, September 14, 1892; Quitovaquito, 2759 E. A. Mearns, January 30, 1894; Congress, C. R. Orcutt, April, 1896; Ehrenberg, W. M. Canby, September, 1874; Valley of the Colorado, 542 E. Palmer, 1876. *Nevada:* Rioville, 5034 M. E. Jones, April 12, 1894. *California:* near Saratoga Springs, 259 Coville & Funston, February 2, 1891, The Needles, 3788 M. E. Jones, May 3, 1884; Santa Catalina Islands, T. S. Brandegee, May 16, 1890. *Lower California:* near Indian Wells, 2033 C. R. Orcutt, February 5, 1890; San Julio, 12 T. S. Brandegee, 1889; Guadalupe Island, 669, 675 E. Palmer, 1889; Cedros Island, 665 Palmer, 1889; Santa Rosalia, 270 E. Palmer, 1890; no locality, 503 E. Palmer, 1887. *Mexico:* Sonora, Guadalupe Canyon, 2033 E. C. Merton, August 27, 1893; Guaymas, 270 E. Palmer, 1890; Valley of Mexico, Federal District, 6227 C. G. Pringle, November 4, 1895.

This variety is distinguished from *Aristida americana* by its smaller size, smaller panicles, usually less branched culms and more caespitose habit of growth. We have assumed this form to be *Aristida bromoides* H. B. K., but may be wrong in so interpreting it. The form here considered is doubtless *Aristida nana* Steud. Nom. ed. 2. 1:131. 1840.

B. *Culms simple, awns 2 to 8 cm. in length.*

Aristida longiseta Steud. Syn. Pl. Gram. 420. 1855. (*Aristida fasciculata nuttallii* Thurb. in Beal, Grasses N. A. 2:208. 1896.)

A densely tufted glaucous, glabrous perennial 1 to 4 dm. high, with numerous involute, basal leaves, erect simple culms and long, usually purplish setæ. Sheaths shorter than the internodes, striate; ligule a ciliate fringe; leaf-blades strongly involute, wiry, 2 to 11 cm. long, the basal ones numerous, often recurved, culm leaves one or two, similar to the basal ones. Panicles few-flowered, exserted, the branches solitary or 2 or 3 at the lower nodes, ascending, at least in herbarium specimens, each bearing 1 to 3 or 4 flowers. Spikelets rather large, purplish; empty glumes unequal, the first shorter than the flowering glume, slightly scabrous on the keel, acute or with a very short mucronate tip, 11 mm. long; second glume much exceeding the flowering glume, about 20 mm. long, otherwise like the first; flowering glume about 14 mm. long, including the densely pubescent callus, which is about 1 mm. long, smooth below, scabrous above. Setæ nearly equal, scabrous, about 7 cm. long.

Type locality, New Mexico, No. 978 A. Fendler, 1847.

General distribution.—In dry soil, South Dakota to Montana, south to Texas, New Mexico, and Arizona (Mexico). May to September.

Specimens examined.—*South Dakota:* Stearns, 33 E. J. Wallace, August 2, 1896. *Montana:* Upper Big Horn River, 184 J. W. Blankinship, July, 1890. *Wyoming:* Devil's Tower, 544 David Griffiths, August 13, 1897. *Colorado:* Grand Junction, 5476 M. E. Jones, June 21, 1894; Denver, 11 J. M. Holzinger, 1896, also 31 Alice Eastwood, July, 1891; Walsenburg 790 C. L. Shear, July 10, 1896; Fort Collins, E. D. Ball, June 26, 1898, also 518 C. S. Crandall, July 1, 1892; Arboles, 14 C. F. Baker, June 29, 1899; Julesburg, 24 E. N. Plank, June, 1896; McElmo Canyon, 17*b* Alice Eastwood, June, 1892. *Utah:* Springdale, 5249 M. E. Jones, May 16, 1894; Silver Reef, 5163 M. E. Jones, May 4, 1894; Antelope Island, 1297 S. Watson, June, 1869. *Nebraska:* North Platte, 2025 P. A. Rydberg, June 22, 1895, also 279 C. L. Shear, same date; near Thedford, 1300 P. A. Rydberg, September 8, 1893; Lavaca, 817 J. M. Bates, July 14, 1898; Longpine, 1121 J. M. Bates, July 23, 1898. *Kansas:* Rockport, E. Bartholomew, June 12, 1889; Osborne City, 158 C. L. Shear, July 9, 1894; Ellsworth County, 589*a* A. S. Hitchcock, July 12, 1895; Riley County, 263 Hitchcock, July 15, 1895; Ulysses, 63 C. H. Thompson, June 27, 1893. *Texas:* San Diego, J. G. Smith, June 11, 1897; Kerrville, J. G. Smith, June 22, 1897; Palestine, 49 E. N. Plank, April, 1895. *Arizona:* Tucson, J. W. Toumey, 1892; "North Arizona," J. G. Lemmon, 1884; Port Apache, 575 E. Palmer, June, 1890; Ash Fork, 16, 17 J. W. Toumey, June, 1892. *New Mexico:* No locality, 978 A. Fendler, 1847 (cotype); Rosa, 152 C. F. Baker, June, 1899; Mangos, J. K. Metcalfe, May, 1897; White Sands, 404 E. O. Wooton, August 28, 1897; Santa Fe, 3535 A. A. & E. G. Heller, May 15, 1897; Socorro, 74 E. N. Plank, August, 1895. *Mexico:* Chihuahua, 473 C. G. Pringle, October 8, 1885.

This widely distributed species has been variously referred to *Aristida purpurea*, *A. fendleriana*, *A. fasciculata*, etc., but is readily distinguished by its simple, erect, slender culms, few, large spikelets, acute or but slightly mucronate empty glumes and long, purplish setæ.

Steudel describes *Aristida longiseta* as being but 3 or 4 inches high, but in all other particulars his rather full description applies to the form here considered. It is evident that Steudel based his description on a very small form. Fendler's No. 978 in the U. S. National Herbarium is 3 dm. high, while the same number in the herbarium of the Philadelphia Academy of Natural Sciences is but 1.5 dm. high.

ARISTIDA LONGISETA ROBUSTA var. nov.

A stout, densely tufted form, 3 to 4 dm. high, with robust culms, more rigid inflorescence and usually longer leaves than in the species. Empty glumes as in the species except that both are prominently cleft at the apex, bearing in the cleft a scabrous awn about 2 mm. long; flowering glume nearly smooth or only slightly scabrous.

General distribution.—In dry soil, South Dakota to Kansas, west to Washington and British Columbia. June to August.

Specimens examined.—*South Dakota:* Aurora County, 35 E. N. Wilcox, August 18, 1896; Redfield, 68 David Griffiths, August 29, 1896; Belle Fourche, 404 Griffiths, August 4, 1897; Canning, 43 Griffiths, August 27, 1896; Lebanon, 252 Griffiths, July 23, 1896; Custer, 1118 P. A. Rydberg, August 16, 1892; Rosebud, 34 E. J. Wallace, July 26, 1896. *Iowa:* Rock Rapids, 410 C. R. Ball, July 6, 1897. *Nebraska:* St. Helena, 2629, F. Clements, June 27, 1893; Longpine, 1123 J. M. Bates, August 18, 1898; Osborne City, 156 C. L. Shear, July 9, 1894. *Wyoming:* Clear Creek, 116 Williams & Griffiths, August 5, 1898; Devil's Tower, 517 Griffiths, August 12, 1897; Whalen Canyon, 540 A. Nelson, July 19, 1894. *Montana:* Billings, 222 Williams & Griffiths, August 30, 1898; Glendive, L. F. Ward, July 21, 1883; Missoula, 250 Williams & Griffiths, September. 1898; Indian Creek, 336 F. L. Scribner, July 5, 1883 (type); Prickly Pear Canyon, 559 R. S. Williams, July 23, 1897. *Idaho:* T. E. Wilcox, 1881. *Colorado:* Colorado Springs, 496 S. M. Tracy, 1887. *Washington:* Alma, 536 A. D. E. Elmer, July, 1897; Rock Island, 439 Sandberg & Leiberg, July, 1893; Spokane, 906 Sandberg, Heller & McDougal, August 16, 1892, also 2597 C. V. Piper, June 25, 1897. *British Columbia:* Spencer's Bridge, J. Macoun, May 28, 1889.

This variety can be readily distinguished from the species by its more robust culms, and especially by its rather prominently awned empty glumes.

ARISTIDA LONGISETA HOOKERI (Trin. & Rupr.). (*Aristida purpurea hookeri* Trin & Rupr. Agrost. **3**: 107. 1842).

A robust form 4.5 to 7 dm. high, with longer leaves and stouter culms than in the species. Leaf-blades rigid, involute, 10 to 20 cm. long. Spikelets somewhat larger than in the species, the empty glumes entire or only slightly toothed at the apex; flowering glume glabrous, or nearly so.

General distribution.—In dry soil, Texas, New Mexico, and Arizona. May to August.

Specimens examined.—*Texas:* No locality, 293 Drummond (cotype); Llano, J. G. Smith, June, 1897, also 6 E. N. Plank, August, 1892; San Antonio, 45 Plank, May, 1893, also V. Havard, 1882; no locality, 11 J. Reverchon, 1881. *New Mexico:* Mesilla Park, 42 E. O. Wooton, June 19, 1897. *Arizona:* no locality, J. G. Lemmon, 1884.

This variety is evidently related to *Aristida longiseta* rather than to *A. purpurea*, and is distinguished by its larger size, longer leaves, and glabrous flowering glumes.

ARISTIDA LONGISETA FENDLERIANA (Steud.). (*Aristida fendleriana* Steud. Syn. Pl. Gram. 420. 1855: *A. purpurea fendleriana* Vasey Contr. U. S. Nat. Herb. **3**: 46. 1892; *A. fasciculata fendleriana* Vasey in Beal, Grasses N. A. **2**: 207. 1896.)

A densely tufted form 2 to 4 dm. high, with simple, erect culms, numerous involute basal leaves and much shorter setæ than in the species. Panicles strict, few-flowered. Empty glumes unequal, acute, generally cleft at the apex and bearing a short awn; second glume equaling or slightly exceeding the somewhat scabrous flowering glume. Setæ subequal, 2 to 3 cm. long.

General distribution.—In dry soil, Montana and Wyoming, south to Texas, Arizona, and California.

Specimens examined.—*Montana:* Billings, 223 Williams & Griffiths, August 30, 1898. *Wyoming:* Pine Bluff, 3617 A. Nelson, July 6, 1897. *Colorado:* Grand Junction, 5469 M. E. Jones, June 21, 1894; Buena Vista, 605 C. L. Sheldon, July 6, 1892; Durango, 12 Alice Eastwood July, 1891; La Porte, L. H. Pammel, June 25, 1896; Salida, 953 C. L. Shear, August 2, 1896; Colorado Springs, 2113 T. A. Williams, July 20, 1896; Trinidad, 15 S. M. Tracy, 1887. *Utah:* Glenwood, 70 L. F. Ward, May 22, 1875; "South Utah," M. E. Jones, 1880. *Texas:* Dallas, 769 E. Hall, 1872; El Paso, M. E. Jones, April 21, 1884; no locality, G. C. Nealley, 1887; J. Reverchon, 1880. *New Mexico:* 2015 C. Wright, 1851–52; 973 A. Fendler, 1847 (cotype). *Arizona:* Cosnino, 4046 M. E. Jones, August 9, 1884; Tucson, J. W. Toumey, 1892; Mormon Lake, 91 D. T. MacDougal, June 11, 1898; Mt. Elden, 355 MacDougal, July 11, 1891; Moki Reservation, 9 W Hough, 1896; no locality, E. Palmer, 1869. *California:* The Needles, 133 M. E. Jones, May 6, 1884.

This variety is fairly constant in its characters and is distinguished by its short setæ and short second glume, which about equals the flowering glume in length. In *Aristida longiseta* the second glume much exceeds the flowering glume.

Aristida purpurea Nutt. Trans. Am. Phil. Soc. **5**: 145. 1837. (*A. purpurea berlandieri* Trin. & Rupr. Agrost. **3**: 107. 1842; *A. romeriana* Scheele, Linnæa **22**: 344. 1849.)

A tufted, glabrous perennial 3 to 6 dm. high, with slender culms, involute leaves and lax pale or purplish panicles. Culms simple, leafy, glabrous, sheaths shorter than the internodes; ligule a short ciliate fringe; leaf-blades 5 to 10 cm. long, involute, rigid, slightly scabrous. Panicles 5 to 15 cm. long, the branches at first erect or ascending, often becoming somewhat spreading and flexuous, short, solitary or two or three at each node, few-flowered. Spikelets pale or purplish; empty glumes unequal, the first lanceolate, 6 mm. long, cleft at the apex; the teeth acute, about 1 mm. long, bearing between them a scabrous awn about 1.5 mm. long. Second glume 12 mm. long, exceeding the flowering glume, cleft at the apex; the teeth 1.5 mm. long, the awn 2 mm. long. Flowering glume 10 mm. long, smooth below, tuberculate roughened above; callus bearded, about 0.5 mm. long. Awns equal, purplish, 2 to 4 cm. long (description of spikelet characters drawn entirely from the type specimen).

Through the courtesy of Mr. Stewardson Brown, curator of the botanical section of the Philadelphia Academy of Natural Sciences, we have been able to examine the specimen on which Nuttall based his *Aristida purpurea*.

Specimens examined.—*Indian Territory:* 387 E. Palmer, 1868. *Texas:* Presidio, 66 V. Havard, 1881; San Angelo, J. G. Smith, July 12, 1897; San Angelo to Stirling City, 382½ W. L. Bray, May 20, 1899; Austin, 767, 768 E. Hall, May 12, 1872; Bracket, 267 W. M. Canby, March 21, 1900; Turtle Creek, Kerr County, 166 W. L. Bray, May 1. 1899; El Paso, 17*a* M. E. Jones, April 18, 1884; Llano, J. G. Smith, June 29, 1897; Laredo, 104 G. C. Nealley, August, 1892; Bastrop, 43 E. N. Plank, July, 1892; Gregory, 1579 A. A. Heller, April 14, 1894; Beeville, J. G. Smith, May 22, 1897; no locality, 3 S. B. Buckley, 1883; 949 Berlandier; 1777 Berlandier (cotype of *Aristida purpurea berlandieri* Trin. & Rupr.). *New Mexico:* Eddy, J. G. Smith, August 4, 1897. *Arizona:* Ash Fork, 47 H. H. Rusby, May 20, 1883 (exactly matches the type); no locality, Wheeler's expedition, 1872.

Aristida purpurea Nutt., has been variously interpreted by different authorities and many very different forms have been referred to it. It apparently presents constant characters and, so far as our herbarium material shows, is confined to Indian Territory, Texas, New Mexico, and Arizona. It is readily distinguished from *Aristida longiseta* Steud., by its lax habit of growth, slender culms, smaller spikelets, shorter awns, tuberculate-roughened flowering glume and awned empty glumes.

Aristida purpurea micrantha Vasey, Contr. U. S. Nat. Herb. **3**: 47. 1892. (*Aristida fasciculata micrantha* Beal, Grasses N. A. **2**: 207. 1896).

A very slender form with pale, lax panicles, the flexuous branches capillary, spreading or reflexed; spikelets smaller than in the species, the flowering glume, 6 to 8 mm. long, very slightly scabrous or nearly smooth.

GENERAL DISTRIBUTION.—Texas to New Mexico (Mexico).

SPECIMENS EXAMINED.—*Texas:* Corpus Christi, 85 W. H. Ravenel, April 30, 1869; Western Texas, 743 C. Wright, October, 1849; San Diego, J. G. Smith, June 12, 1897; Del Rio, 82 E. N. Plank, December, 1891; no locality, S. B. Buckley, 1883; G. C. Nealley, 1888, 1889 (type); 563 F. Lindheimer, 1846; 2094 C. Wright, 1851–52.

This variety is distinguished from the species by its smaller spikelets, more lax panicles, the branches often somewhat spreading and flexuous, and usually nearly glabrous flowering glumes.

ARISTIDA PURPUREA ÆQUIRAMEA (Scheele). (*Aristida æquiramea* Scheele, Linnaea **22**:343. 1849. (*Aristida filipendula* Buckley, Proc. Acad. Nat. Sci. Phila. **1862**:93. 1862; *Aristida purpurea californica* Vasey, Contr. U. S. Nat. Herb. **3**:47. 1892; *Aristida fasciculata californica* Vasey in Beal, Grasses N. A. **2**:207. 1896.)

A rather stout, tufted, glabrous form 4 to 8 dm, high with simple culms, involute rigid leaves, erect or ascending panicle branches and very tuberculate-scabrous flowering glumes. Ligule a short ciliate ring; leaf-blades 8 to 15 cm. long, 1 to 2 mm. wide, involute. Panicles purplish, the branches capillary, generally erect or ascending, sometimes somewhat flexuose, usually many flowered, 3–5 at each node. Spikelets pale or purplish; second empty glume twice as long as the first, equaling the flowering glume, both cleft at the apex, the midnerve excurrent as a scabrous awn 1 to 2 mm. long; flowering glume about 10 mm. long, strongly tuberculate-scabrous. Awns subequal, 5 to 7 cm. long.

GENERAL DISTRIBUTION.—In dry soil, Texas to California.

SPECIMENS EXAMINED.—*Texas:* no locality, 1409 bis, J. Reverchon; 562 F. Lindheimer, 1846; G. C. Nealley, 1887; Abilene, H. L. Bentley, 1899. *Arizona:* J. G. Lemmon, 1882. *California:* San Jacinto, 1549 S. B. & W. F. Parish, June, 1882; near San Bernardino, 2123 S. B. Parish, May 15, 1891, also 3668 S. B. Parish, May 20, 1895; Capon Valley, 5474 J. G. Lemmon, May, 1891.

This variety was based on a specimen collected in Texas by Lindheimer, no number cited, but doubtless the form distributed under 562 as *Aristida æquiramea* Scheele, as this specimen agrees perfectly with Scheele's description. The plant in the Herbarium of the Philadelphia Academy of Natural Sciences under this number is identical with the same number in the U. S. National Herbarium and is labeled by Buckley "*Aristida filipendula,*" and is the form to which Buckley's description applies. Another specimen in the herbarium so labeled by Buckley is a form of *Aristida americana* Linn. *Aristida purpurea californica* Vasey, was based on number 1549 S. B. and W. F. Parish, cited above.

This variety is distinguished from the species by its larger size, usually more densely flowered panicles, longer awns, more prominently awned empty glumes and more strongly tuberculate-scabrous flowering glume.

ARISTIDA PURPUREA LAXIFLORA var. nov.

A lax, tufted form 3 to 6 dm. high, with open, few-flowered panicles. Panicle branches mostly solitary, flexuous, capillary, 1 to 3 flowered. Spikelets as in the species.

Type specimen collected in Texas, no locality, No. 12 J. Reverchon, May, 1881; No. 13 Reverchon, same date, is identical with No. 12. A specimen from Texas, no locality, collected by G. C. Nealley, in 1887, is referred here and also a specimen collected at Tucson, Arizona, by J. W. Toumey, in 1893.

This variety is very closely related to var. *æquiramea*, and is only distinguished by its very lax, open, few flowered panicles.

ARISTIDA PURPUREA CAPILLARIFOLIA var. nov.

A pale glaucous form about 4 dm. high, with lax, few-flowered panicles and numerous involute basal and culm leaves 2 to 3 dm. long. First glume 6 mm. long, the second about 14 mm. long, mucronate and slightly exceeding the scabrous flowering glume. Awns 3 to 4 cm. long.

Type specimen collected in Texas by G. C. Nealley. No locality given.

Aristida reverchoni Vasey, Bul. Torr. Bot. Club, **13**:52. 1886.

A densely tufted glabrous perennial, 3 to 5 dm. high, with numerous wiry, radical leaves 7 to 15 cm. long, and narrow spike-like panicles 10 to 15 cm. long. Sheaths short; ligule a short ciliate ring; leaf-blades involute, curved. Panicles purplish, the branches in pairs, unequal, the lower ones 2 cm. long, all appressed. First glume about 8 mm. long, the second 12 mm. long, about equaling the glabrous flowering glume. Awns about 2 cm. long, nearly equal.

General distribution.—Texas to Arizona.

Specimens examined.—*Texas:* Rocky hills, Crockett County, 1237 J. Reverchon, May; Comanche Peak, 154 Reverchon, 1882; no locality, G. C. Nealley, 1887, 18 Reverchon, 1885; Limpia Canyon, 146 G. C. Nealley, September, 1892; El Paso, G. R. Vasey, 1881; Kerrville, J. G. Smith, June 21, 1897. *New Mexico:* Mangos, O. Metcalfe, September 2, 1897. *Arizona:* Fort Huachuca, T. E. Wilcox, September, 1894.

This species, although closely related to other species in this group, and especially to *Aristida longiseta fendleriana*, is readily distinguished by its narrow spike-like panicle and relatively longer first glume.

Aristida reverchoni angusta Vasey, Contr. U. S. Nat. Herb. **3**:46. 1892.

A form distinguished from the species by its much narrower panicles, a character doubtless due entirely to habitat.

Specimens examined.—*Texas:* Comanche Peak, 10 J. Reverchon, September, 1881 (type); San Angelo, J. G. Smith, July 12, 1897; no locality, G. C. Nealley, 1889.

Aristida curtiseta Buckl. Proc. Acad. Nat. Sci. Phila. **1862**:92. 1862.

It is impossible to identify this species, as the specimen on which Buckley based his description is a form in which the spikelets are aborted by a species of *Ustilago*. It is probably *Aristida purpurea* Nutt., or some closely related form. Buckley's type is in the herbarium of the Philadelphia Academy of Natural Sciences.

Elmer D. Merrill,
Assistant in Charge of Collections.

Approved:
James Wilson,
Secretary of Agriculture.

Washington, D. C., *May 3, 1901.*

CIRCULAR No. 35. (Agros. 86.) (Issued June 18, 1901.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

(GRASS AND FORAGE PLANT INVESTIGATIONS.)

F. LAMSON-SCRIBNER, *Agrostologist*.

AGROSTOLOGICAL NOTES.

INTRODUCTION.

Agrostological Notes was the general title of Circular No. 27 which contained several short papers of purely technical nature and the same title is here adopted for a series of papers of similar character as follows:

1. Some Species of Grasses published by by S. B. Buckley.
2. Notes on *Calamovilfa*.
3. Three New Species of *Panicum*.
4. A new Species of *Poa*.
5. Some Changes in Nomenclature.

1. SOME SPECIES OF GRASSES PUBLISHED BY S. B. BUCKLEY.

By ELMER D. MERRILL.

In 1866 Mr. S. B. Buckley published a small octavo volume of 81 pages, with an appendix of 4 pages, that was issued from the office of the "State Gazette" at Austin, Texas, under the title "A Preliminary Report of the Geological and Agricultural Survey of Texas." The appendix, which is paged separately, is the part of the report of interest to agrostologists. In it one genus and nine species of Texan grasses, supposed by the author to be new, are described. These species, which for some reason were not included in Index Kewensis, are as follows:

Schleropelta Buckley, Prel. Rept. Geol. and Agrl. Surv. Texas, App. 1. 1866. =*Hilaria* H. B. K. Nov. Gen. et Sp. Pl. **1**: 116. 1815.

Schleropelta stolonifera Buckley, l. c.=*Hilaria cenchroides* H. B. K. l. c. 117.

Pappophorum (Polyrhaphis) vaginatum Buckley l. c. This is the earliest publication of this species and Buckley's name should be retained. *Pappophorum apertum* Munro in Scribn. Bul. Torr. Bot. Club, **9**: 148. 1882, is a synonym. See Merrill, U. S. Dept. Agr. Div. Agros. Cir. **32**: 9. 1901.

Cenchrus setoides Buckley, l. c., 2=*Cenchrus myosuroides* H. B. K. Nov. Gen. et. Sp. Pl. **1**: 115. *t. 35*. 1815.

Calamagrostis (Deyeuxia) longirostris Buckley, l. c. "Culm erect, a little scabrous, half a foot high, sheaths a little scabrous, and about equal to the internodes; ligula elongate, membranaceous and subentire; leaves plain or convolute, scabrous, shortly pubescent above, 4 to 6 inches long, and 2 to 3 lines broad; panicle terminal, somewhat open and interrupted, 3 to 5 inches long and 8 to 12 lines broad; rachis terete, pubescent; glumes subequal, lanceolate, acute, longer than the florets, scabrous on the back, margins and apex hyaline; upper 1 to 3 nerved, lower palea 3 to 5 nerved, shortly pilose at the base, hyaline upon the margin, apex bifid, below the middle long aristate; awns twisted, jointed and double the length of the florets; lower internodes of the rachis about 8 lines in length; upper intervals 2 to 3 lines long; long estrays naked near their bases and densely spiked near their summits; spikelets about 3 lines long."

The identity of this species is in doubt.

Panicum (Tridachne) saccharatum Buckley, l. c., 2. This name should be retained. *Panicum lachnanthum* Torr. 1857, not Hochst. 1855, is a synonym.

Panicum glomeratum Buckley, l. c., 3.=*Panicum platyphyllum* Munro. Buckley's description antedates that of Munro, but the name *Panicum glomeratum* is preoccupied by *Panicum glomeratum* Moench, 1794, et al.

Panicum texanum Buckley, l. c., 3. This is a distinct species and, so far as known, has no synonyms.

Panicum repente Buckley, l. c., 3.=*Panicum obtusum* H. B. K. Nov. Gen. et Sp. Pl. **1**: 98. 1815.

Panicum ciliatissimum Buckley, l. c., 4. A very distinct and well-marked species.

2. NOTES ON CALAMOVILFA.

By F. Lamson-Scribner and Elmer D. Merrill.

CALAMOVILFA GIGANTEA (Nutt.) n. comb. *Calamagrostis gigantea* Nutt. Trans. Am. Phil. Soc. II, **5** : 143. 1837.

A stout, erect glabrous perennial, 10 to 20 dm. high, from a stout creeping rootstock, with rigid involute leaves and large, open panicles. Sheaths exceeding the internodes, glabrous; ligule a dense ciliate fringe of hairs about 1 mm. long; leaf-blades about 3 dm. long, glabrous. Panicles 3 to 7 dm. long, the branches spreading or ascending, the lower ones often 3 dm. in length, naked below, flower-bearing toward their extremities. Spikelets 8 to 10 mm. long; empty glumes unequal, glabrous, acute, the first shorter than the second. Flowering glume about 8 mm. long, glabrous above and on the margins, pilose below on both sides of the keel with rather long, appressed white hairs, basal hairs copious, about one-half as long as the glume. Palea about equaling the flowering glume, pilose along the margins, otherwise glabrous.

The type specimen in the herbarium of the Philadelphia Academy of Natural Sciences is ticketed by Nuttall: "*Toxeumia gigantea, Calamagrostis* Nutt., Arkansas, Salt River." This specimen, although covering the entire sheet, represents but little more than the panicle of the plant. The entire plant must have been very large. The panicle is over 2 feet long, and the wide-spreading branches more than 1 foot in length, which are flower-bearing toward their extremities, naked below. In many of the spikelets on this specimen the empty glumes are about equal; in others, the second is often slightly longer than the first—10 mm. long, or somewhat less. The flowering glume and palea are equal, the former being pilose-pubescent on the back for two-thirds its length, the latter pilose-pubescent on the margins.

General distribution in sandy soil, Kansas to Arizona, July to October.

Specimens examined.—*Kansas:* Moonlight, 183 C. H. Thompson, August 15, 1893; Riley County, 904 J. B. Norton, 1896; Stevens County, 344 M. A. Carleton, July, 1891. *Oklahoma Territory:* Kay County, Mark White, July 23, 1898. *New Mexico:* No locality or collector given. 1882. *Arizona:* Holbrook, H. H. Rusby, August, 1883; San Francisco Mountains, Loew, 1873; Chalcedony Park, Myrtle Tuck, October 15, 1897; Moki Reservation, 41 Walter Hough, 1896.

This species was recognized by Torrey in Marcy's Explor. Red Riv., La. 300. 1853, and also in Pac. R. R. Rept. $\mathbf{4}^5$: 154. 1857, but was later reduced to *Calamagrostis longifolia* by Gray. It is closely related to *Calamovilfa longifolia* (Hook.) Hack., and all the specimens cited above have been so referred in herbaria. It is distinguished by its larger size, large, open panicles, elongated branches, larger spikelets, and in the pilose flowering glume and palea.

Calamovilfa longifolia (Hook.) Hack. True Grasses, 113. 1890; *Calamagrostis longifolia* Hook. Fl. Bor. Am. 241. 1840; *Vilfa rigida* Buckl. Proc. Acad. Nat. Sci. Phila. **1862**: 89. 1862; *Ammophila longifolia* Benth. in Vasey, U. S. Dept. Agr. Spec. Rept. **63**: 29. 1883.

This species extends from Western Ontario and Indiana westward to Wyoming, Montana, Idaho, and southward to Iowa, Nebraska, and Colorado. It is distinguished by its usually contracted panicles and glabrous flowering glume and palea.

CALAMOVILFA LONGIFOLIA MAGNA var. nov. This variety is distinguished from the species mainly by its large size, 12 to 18 dm. high; in this respect approaching *Calamovilfa gigantea*, but distinguished from that species by its glabrous spikelets. It is represented in the National Herbarium by specimens collected on the lake shore at the mouth of the Kalamazoo River, Mich., by W. A. Taylor in 1894. It is very abundant and valuable as a sand binder in the dunes about South Haven and Grand Haven, Mich.

3. THREE NEW SPECIES OF PANICUM.

By F. Lamson-Scribner and Elmer D. Merrill.

PANICUM (VIRGARIA) BARTOWENSE sp. nov.

Panicum proliferum pilosum Griseb. Pl. Cub. 232. 1866. ? Not *Panicum pilosum* Swartz, 1788, et al.

A stout, erect annual 12 to 16 dm. high, with very long leaves, tuberculate-hispid sheaths and diffuse panicles 3 to 6 dm. long. Culms simple, glabrous, 5 to 7 mm. in diameter below. Sheaths about equaling or somewhat exceeding the internodes; ligule a ciliate fringe about 2 mm. long; leaf-blades 4 to 6 dm. long, about 10 mm. wide, tapering to the acute apex, scarcely narrowed at the rounded and somewhat clasping base, scabrous on the margins and on the nerves above, glabrous beneath, or often with few scattered papillate hairs on both surfaces. Panicles pale or purplish, the branches at first erect, finally spreading, the lower ones 3 to 4 dm. long; the primary axis and branches scabrous. Spikelets nearly 2.5 mm. long, narrowly ovate, acute, glabrous; first glume truncate, enclosing the base of the spikelet, less than 0.5 mm. long; second and third glumes subequal, acute, slightly exceeding the flowering glume, both 7-nerved, the nerves rather prominent, the third glume subtending a hyaline palea about 1 mm. long; flowering glume less than 2 mm. long, ovate, acute, smooth and shining.

Type specimen collected in wet, reclaimed swamps at Bartow, Polk County, Fla. No. 1220, Robert Combs, September 29, 1898; No. 971, Combs, collected in a water ditch at Homosassa, Citrus County, Fla., September 13, 1898, is the same; No. 483, A. S. Hitchcock, collected in inundated fields, Myers, Lee County, Fla., July–August, 1900, represents a later stage of the species with a very diffuse, open panicle; No. 5386, A. H. Curtiss, low grounds, Palmbeach, Fla., May 13, 1895, belongs here.

This species is closely related to *Panicum proliferum* Lam., the most striking difference being its tuberculate-hispid sheaths and very small first glume.

PANICUM SHASTENSE sp. nov.

A tufted, pubescent perennial about 3 dm. high, with erect or ascending leaves and open, ovate, rather few-flowered panicles. Culms geniculate below, pilose with scattered long white hairs; nodes bearded with spreading or reflexed hairs and with a smooth ring immediately below. Sheaths close, striate, shorter than the internodes, pilose with long spreading hairs; ligule a ciliate fringe about 2 mm. long; leaf-blades narrowly lanceolate, acute, slightly clasping at the base, 5 to 7 cm. long, 6 to 8 mm. wide, pilose beneath with weak spreading hairs, nearly glabrous above, scabrous on the margins.

Panicles about 8 cm. long, rachis and branches sparingly pilose, branches fasciculate at the nodes, ascending, few-flowered. Spikelets ovate, obtuse, 2.5 mm. long, pale, or purplish at the base, first glume triangular, pubescent, less than 1 mm. long; second and third glumes about equal, densely pubescent with short spreading hairs, the third glume enclosing a hyaline palea a little over one-half as long as the glume; flowering glume ovate, 2 mm. long.

Type specimens collected in a moist meadow at the edge of pine forests at Castle Crag, near Mt. Shasta, California, by Louis A. Greata, June, 1899.

Related to the common and widely distributed *Panicum unciphyllum* Trin. (*P. pubescens* of authors, not Lamarck), but is at once distinguished by its larger spikelets. In some respects it resembles *Panicum scribnerianum* Nash, but it is not closely related to that species.

PANICUM FUNSTONI sp. nov.

A slender tufted, nearly glabrous perennial 4 to 7 dm. high, with numerous, ascending leaves, slender erect culms, exserted ovate panicles and small spikelets. Culms at first simple, becoming much branched, sparingly appressed-pubescent or glabrous. Sheaths shorter than the internodes, striate, glabrous except on the ciliate margins; ligule a prominent fringe of hairs 3 mm. long, leaf-blades narrowly lanceolate, those of the primary culm 5 to 7 cm. long, 6 to 8 mm. wide, acute, slightly clasping at the base, glabrous except on the scabrous margin which is often papillate ciliate at the base, those of the branches much smaller, crowded, the upper ones often minutely puberulent beneath. Panicles 4 to 5 cm. long, ovate, the rachis and branches glabrous; secondary panicles small, few-flowered, mostly enclosed in the upper sheaths. Spikelets ovate, 1.5 mm. long or slightly less; first glume very small, less than 0.5 mm. long; second and third glumes rather densely pubescent with short spreading hairs, the second slightly shorter than the flowering glume.

Type specimen collected on the bank of Kaweah River at Three Rivers, Tulare County, Cal., No. 1286, Coville & Funston, July 26, 1891. No. 142 Dr. Ezra Michener, Sacramento, Cal., August 31, 1894, is also referred here, although it differs from the type in its more lax habit of growth, thinner leaves and glabrous culms.

This species is very distinct from any other from the Pacific slope, and is apparently not closely related to any of those of the Eastern States. It is distinguished by its tall, slender culms, numerous crowded leaves on the branches, and small pubescent spikelets, the second glume being shorter than the flowering glume. We take pleasure in naming it for General Funston who first collected it.

It is the *Panicum dichotomum* of the Botany of the Death Valley Expedition, Contr. U. S. Nat. Herb. **4**: 216. 1893.

4. A NEW SPECIES OF POA.

POA APERTA Scribn. & Merrill sp. nov.

A lax, loosely tufted, glabrous, glaucous, perennial, 4 to 5 dm. high, from creeping rootstocks, with wiry spreading culms, linear leaves and open, few-flowered panicles 4 to 8 cm. long. Culms terete, branching below, geniculate and rooting at the lower nodes. Sheaths striate, the lower ones marcescent, crowded; ligule membranceous, acute, 2 to 3 mm. long, decurrent as a rather prominent white sheath margin; leaf-blades rather firm, striate, minutely scabrous, glaucous, acute, those of the innovations 10 to 16 cm. long, about 2 mm. wide, those of the culm shorter. Panicle exserted, ovate in outline, rigid, branches spreading or reflexed, scabrous, the lower ones 2 to 2.5 cm. long, bearing about 3 spikelets, the upper ones solitary, shorter.

Spikelets purplish, lanceolate-ovate, acute, 5 to 6 mm. long, 3 to 4-flowered; empty glumes, lanceolate, acute, glabrous except for the slightly scabrous keel, slightly unequal, the first 3.5 mm. long, the second somewhat broader, 4 mm. long; flowering glumes lanceolate, minutely pubescent throughout and prominently webby-hairy on the keel and lateral nerves below.

Type specimen collected at Telluride, Colo., No. 98, C. L. and Wm. Shear, September 1, 1900, occasional in small loose tufts, on moist open mountain sides. Altitude 2940 m.

This species bears a striking resemblance to *Poa compressa* L., in habit of growth, but otherwise is not closely related to that species. It is readily distinguished by its terete culms, rigid, spreading or reflexed panicle branches, and spikelet characters.

5. SOME CHANGES IN NOMENCLATURE.

By Elmer D. Merrill.

Panicum striatum (Linn.) Lam. Tabl. Encycl. **1**: 172. 1791; Encycl. **4**: 738. (err. typ., 748. 1797.); *Holcus striatus* Linn. Sp. Pl. 1048. 1753; Gronov. Fl. Virg. 135. 1739; *Panicum gibbum* Ell. Sk. Bot. S. C. and Ga. **1**: 116. 1817; *Panicum aquaticum* Muhl. Gram. 126. 1817; *Panicum* Muhl. l. c. 127. No. 39 (sine nomine); *Panicum tremulum* Schultes, Neue Ent. **2**: 103. 1821; Mant. **2**: 237. 1824; Syst. **1**: 319. 1825; *Panicum elliottianum* Schultes Mant. **2**: 256. 1824; *Panicum hydrophilum* Schultes l. c., 237.

While Lamarck does not mention *Holcus striatus* Linn., in connection with his *Panicum striatum*, his description is so ample as to leave no doubt as to the identity of the plant he had in mind. Munro[1] says, "*Holcus striatus* Gronov. Virg. 135, is *Panicum gibbum* Ell." The descriptions of both Gronovius and Linnaeus apply to this species. *Panicum elliottianum* was applied to this species by Schultes, as he believed Elliott's name to be preoccupied by *Panicum gibbosum* R. Br. *Panicum hydrophilum* Schultes, was based on *P. aquaticum* Muhl., which is the same as Elliott's *Panicum gibbum*.[2] *Panicum tremulum* Schultes, was based on *Panicum* No. 39 Muhl. Gram. 127 (sine nomine), and although this species is not represented in Muhlenberg's herbarium we do not hesitate in referring it to *Panicum striatum*. Muhlenberg queries "An varietas *P. aquatici?* sed folia multum angustioria."

Panicum hemitomum Schultes, Mant. **2**: 227. 1824. (*Panicum dimidiatum* Walt. Fl. Carol. 72. 1788, not Linn. 1753; *Panicum walteri* Muhl. Gram. 108. 1817; Ell. Sk. Bot. S. C. and Ga. **1**: 115. 1817, not Pursh, 1814; *Panicum carolinianum* Spreng. Syst. Veg. **1**: 310. 1825; *Panicum carinatum* Torr. Boston Journ. Nat. Hist. **1**: 137. 1835. *Panicum digitarioides* Carpenter, Steud. Syn. Pl. Gram. 75. 1854; *Panicum curtissii* Chapm. Fl. So. U. S. 573. 1860.

From examination of the herbaria of Muhlenberg and Elliott, it was found that *Panicum walteri* of both these authors is the grass now known as *Panicum digitarioides*.[3] *Panicum hemitomum* Schultes, was based on *P. walteri* Muhl., and is the earliest available name. *Panicum carolinianum* Spreng., published one year later was based on *Panicum walteri* Ell. which is the same as Muhlenberg's *Panicum walteri*. Both of these names antedate *Panicum digitarioides* Carpenter, which in any case is untenable as it is antedated by *P. digitarioides* Raspail, Kunth. Enum. 1:53. 1833.

[1] On the identification of the Grasses of Linnaeus's Herbarium, Journ. Linn. Soc. Bot. **6**: 53. 1862.

[2] Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Cir. **27**: 4. 1900.

[3] U. S. Dept. Agr. Div. Agros. Cir. **27**: 2. 1900. Ibid. Cir. **29**: 4. 1901.

SPOROBOLUS COMPOSITUS (Poir.) n. comb. *Agrostis compositis* Poir. in Lam. Encycl. Suppl. 1: 254. 1810; *Agrostis involuta* Muhl. Gram. 72. 1817; *Agrostis longifolius* Torr. Fl. U. S. 1: 90. 1824; *Sporobolus longifolius* Wood, Class-book, 775. 1861: *Sporobolus asper* Vasey, Contr. U. S. Nat. Herb. 3: 59. 1892, not Kunth. 1833.

Agrostis composita Poir., based on a specimen collected by Bosc in "Caroline," is evidently the earliest available name for this species, and is here taken up. *Agrostis involuta* Muhl. has been previously referred to *Sporobolus asper*, but according to the specimens in Muhlenberg's herbarium and to his description, it is identical with the form described by Torrey as *Agrostis longifolia*, which it antedates.

Bromus pubescens Muhl. in Willd. Enum. 120. 1809; Gram. 169. 1817.

This species, according to the specimen so labeled in Muhlenberg's herbarium, now deposited in the Philadelphia Academy of Natural Sciences, is identical with *B. purgans* Linn., and should be cited as a synonym of that species.

Bromus scabratus Scribn., U. S. Dept. Agr., Div. Agros., Bul. 13: 46. 1898, is a synonym of *Bromus porteri* (Coult.) Nash. It is based on No. 3800 A. Nelson, Vermillion Creek, Wyo., July 20, 1897.

The above names were not cited in Bulletin No. 23, in which the North American species of *Bromus* are monographed.

Chætochloa hispida Scribn. & Merrill, U. S. Dept. Agr., Div. Agros., Bul. 21: 25, *fig. 13.* 1900.

This species was based on a single specimen collected in Cuba by C. Wright, January, 1865, but has recently been collected in Florida by A. S. Hitchcock, No. 915, shell mounds, Marco, Lee County, July–August, 1900. This specimen is somewhat larger than the type, about 9 dm. high, with slightly larger spikes, but otherwise the same.

Phalaris paradoxa Linn. Amoen. Acad. 4: 264. 1759; Sp. Pl. ed. 2. 1665. 1763.

This species has been introduced into California and is represented by specimens collected near Princeton, Colusa County, by J. Burtt Davy, May, 1898, and at San Diego by T. S. Brandegee, January, 1901. It is considered by Jepson, in his "Flora of Middle Western California," and is apparently quite widely distributed in that State. It is a native of Mediterranean region of Europe, Africa, and Asia.

Approved:

James Wilson,

Secretary of Agriculture.

Washington, D. C., *June 4, 1901.*

CIRCULAR No. 36.—(Agros. 87.)

United States Department of Agriculture,

DIVISION OF AGROSTOLOGY.

(GRASS AND FORAGE-PLANT INVESTIGATIONS.)

LIST OF THE PUBLICATIONS OF THE DIVISION OF AGROSTOLOGY.

ANNUAL REPORTS.

(The annual reports of the Chief of the Division of Agrostology are bound with those of the Secretary of Agriculture, and since 1896 have also been published separately.)

Report of the Agrostologist for 1895. By F. Lamson-Scribner. From the Report of the Secretary of Agriculture for 1895. Pp. 165–168.

Report of the Agrostologist for 1896. By F. Lamson-Scribner. From Report of the Secretary of Agriculture for 1896. Pp. 103–108.

Report of the Agrostologist for 1897. By F. Lamson-Scribner. From Annual Reports, Department of Agriculture for 1897. Pp. 161–166.

Report of the Agrostologist for 1898. By F. Lamson-Scribner. From Annual Reports, Department of Agriculture for 1898. Pp. 145–152.

Report of the Agrostologist for 1899. By F. Lamson-Scribner. From Report of the Secretary of Agriculture for 1899. Pp. 113–117.

Report of the Agrostologist for 1900. By F. Lamson-Scribner. From the Annual Reports of the Department of Agriculture for 1900. Pp. 83–90.

YEARBOOK ARTICLES.

Grasses as Sand and Soil Binders. By F. Lamson-Scribner. Reprint from the Yearbook of the U. S. Department of Agriculture for 1894. Pp 421–436, figs. 100–110.

Grasses of the Salt Marshes. By F. Lamson-Scribner. Reprint from the Yearbook of the U. S. Department of Agriculture for 1895. Pp. 325–332, figs. 75–79.

Canadian Field Peas. By Thos. Shaw. Reprint from the Yearbook of the U. S. Department of Agriculture for 1895. Pp. 223–232, figs. 46–48.

Grass Gardens. By F. Lamson-Scribner. Reprint from the Yearbook of the U. S. Department of Agriculture for 1895. Pp. 301–308, figs. 68–69.

Forage Conditions of the Prairie Region. By Jared G. Smith. Reprint from the Yearbook of the U. S. Department of Agriculture for 1895. Pp. 309–324, figs. 70–74.

Timothy in the Prairie Region. By Thomas A. Williams. Reprint from the Yearbook of the U. S. Department of Agriculture for 1896. Pp. 147–154, figs. 29–30.

Division of Agrostology. By F. Lamson-Scribner. Reprint from the Yearbook of the U. S. Department of Agriculture for 1897. Pp. 160–175, pl. 1.

Lawns and Lawn Making. By F. Lamson-Scribner. Reprint from the Yearbook of the U. S. Department of Agriculture for 1897. Pp. 355–372, pls. 8–14.

Leguminous Forage Crops. By Jared G. Smith. Reprint from the Yearbook of the U. S. Department of Agriculture for 1897. Pp. 487–508, pl. 31, figs. 17–24.

Sand-Binding Grasses. By F. Lamson-Scribner. Reprint from the Yearbook of the U. S. Department of Agriculture for 1898. Pp. 405–420, pls. 28–30, figs. 110–120.

Forage Plants for Cultivation on Alkali Soils. By Jared G. Smith. Reprint from the Yearbook of the U. S. Department of Agriculture for 1898. Pp. 535–550, figs. 125–128.

Succulent Forage for the Farm and Dairy. By Thos. A. Williams. Reprint from the Yearbook of the U. S. Department of Agriculture for 1899. Pp. 613–626, pls. 59–60.

Progress of Economic and Scientific Agrostology. By F. Lamson-Scribner. Reprint from the Yearbook of the U. S. Department of Agriculture for 1899. Pp. 347–366, figs. 5–9.

Our Native Pasture Plants. By F. Lamson-Scribner. Reprint from the Yearbook of the U. S. Department of Agriculture for 1900. Pp. 581–598, pls. 76–79, figs. 75–85.

BULLETINS.

No. 1.—Notes on the Grasses and Forage Plants of the Southeastern States. By T. H. Kearney, jr., Assistant Agrostologist. Pp. 28, figs. 7. 1895.

This bulletin is divided into two parts, the first of which gives an alphabetical list of the grasses and other plants of importance as forage found in the sections visited, with brief economic notes on each. The second part contains a classified list of the species found with remarks upon their distribution and variations in forms.

No. 2.—Fodder and Forage Plants Exclusive of the Grasses. By Jared G. Smith, Assistant Agrostologist. Pp. 58, figs. 56. 1896.

A revise of this bulletin was published in 1900, containing 86 pages, 46 figures, and 2 plates. The work contains brief descriptions of about 200 species of native and introduced forage plants. The descriptions are brief and remarks under each species afford such information as farmers and those interested would be most likely to wish to know.

No. 3.—Useful and Economic Grasses. By F. Lamson-Scribner. Pp. 119, figs. 89. 1896.

This bulletin contains an enumeration of the more important grasses of this and other countries with brief descriptions and economic notes.

No. 4.—Studies on American Grasses. Pp. 43, pls. 5, figs. 15. February 6, 1897.

This is a technical bulletin and contains the following papers: I. The Genus Ixophorus, by F. Lamson-Scribner; II. A List of the Grasses collected by Dr.

E. Palmer in the vicinity of Acapulco, Mexico, 1894–95, by F. Lamson-Scribner; III. Some Mexican Grasses collected by E W. Nelson in Mexico, 1894–95, by F. Lamson-Scribner and Jared G. Smith; IV. Some American Panicums in the Herbarium Berolinense and in the Herbarium of Willdenow, by Theo. Holm; V. Native and Introduced Species of the Genera Hordeum and Agropyron, by F. Lamson-Scribner and Jared G. Smith; VI. Miscellaneous Notes and Descriptions of New Species. The new species of *Fourniera* is here described and illustrated as well as a number of new species from various sources.

No. 5.—A Report upon the Grasses and Forage Plants of the Rocky Mountain region. By P. A. Rydberg and C. L. Shear. Pp. 48, figs. 29. 1897.

This bulletin is based upon the field notes and general observations made by the authors in Nebraska, Idaho, Montana, Utah, and Colorado during the summer of 1895. The first part contains descriptions of the more important economic species observed and a classified list of all the species collected with notes upon their distribution, etc., closes the bulletin.

No. 6.—Grasses and Forage Plants of the Dakotas. By Thos. A. Williams. Pp. 47, figs 10. 1897.

This bulletin contains general notes of the forage conditions in the Dakotas, a general review of the species which are or may be important for forage and a classified list of all the grasses and forage plants collected or observed in the Dakotas in 1896 by the author, who was assisted by Messrs. M. A. Brannon, E. N. Wilcox, and David Griffiths.

No. 7.—American Grasses, I. Pp. 319, illustrations 302. 1897.

A second revised edition of this bulletin was published in 1898, and a third revise in which the descriptions were entirely rewritten and enlarged, was published in 1900.

No. 8.—Studies on American Grasses. Pp. 20, pls. 9, fig. 1. May 1, 1897.

This is a technical bulletin and contains the following papers: "New or Little-Known Grasses," by F. Lamson-Scribner; and "The Leaf Structure of Jouvea and of Eragrostis obtusiflora," by Miss E. L. Ogden.

No. 9.—Notes on the Grasses and Forage Plants of Iowa, Nebraska, and Colorado. By L. H. Pammel. Pp. 47, figs. 12. 1897.

This report contains, first, general observations upon the physical conditions and important questions relative to forage production in the States named. The second part is devoted to an enumeration of the more important grasses and forage plants of these States with economic notes. In the third part the author presents a classified list of the grasses of Iowa, Nebraska, and Colorado, collected by him during the seasons of 1895 and 1896.

No. 10.—A Report upon the Grasses and Forage Plants of Central Texas. By H. L. Bentley. Pp. 38, figs. 14. 1898.

This report contains brief accounts of the physical condition of central Texas, the early condition of the cattle ranges and popular descriptions and general observations upon the economic importance of a large number of the grasses and forage plants native to the region.

No. 11.—Studies on American Grasses. Pp. 62, pls. 17, figs. 12. July 20, 1898.

This bulletin contains; "A Revision of the Native American Species of Calamagrostis," by Thos. H. Kearney, jr.; and "Descriptions of New or Little-Known Grasses," by F. Lamson-Scribner.

No. 12.—A Report upon the Grasses and Forage Plants and Forage Conditions of the Eastern Rocky Mountain Region. By Thos. A. Williams. Pp. 78, figs. 30. 1898.

This bulletin is based upon the field observations of Mr. Williams and agents of the Division in 1896 and 1897. The general topographical features of the region in question are discussed; also the present aspect of the forage problem, and the forage conditions on the ranges of South Dakota and northwestern Wyoming. The cultivated grasses and forage plants are treated somewhat in detail, as are also the native plants of the same class.

No. 13.—The Red Desert of Wyoming and Its Forage Resources. By Aven Nelson. Pp. 72. pls. 5, figs. 24. 1898.

This bulletin treats of the topography of the soils and climate of the Red Desert of Wyoming, the characteristic desert plants and forage plants of the summer range, and closes with a list of the plants of the Red Desert based upon specimens secured by the author during the summer of 1897.

No. 14.—Economic Grasses. By F. Lamson-Scribner. Pp. 85, pls. 3, figs. 91. 1898.

This is practically a revision of Bulletin No. 3, with the addition of some new figures and plates. The work closes with a list of grasses for special soils or uses.

No. 15.—A Report upon the Forage Plants and Forage Resources of the Gulf States. By S. M. Tracy. Pp. 55, figs. 20. 1898.

This work treats of the soils and natural pastures of the Gulf States, formation of pastures, the leading forage plants and the more important hay and pasture grasses and miscellaneous forage crops.

No. 16.—Grazing Problems in the Southwest and How to Meet Them. By Jared G. Smith. Pp. 47, figs. 9. 1899.

This bulletin treats of the former condition of the ranges, their present condition, and the causes which have led to their deterioration, the renewing of the cattle ranges, the relation of land laws to range improvement, etc.

No. 17.—American Grasses, II. By F. Lamson-Scribner. Pp. 349, figs. 325. 1899.

A revised edition of this work was published in 1901. This work is a continuation of Bulletin No. 7, and is uniform with the third edition of that bulletin in type and illustrations.

No. 18.—Studies on American Grasses: A synopsis of the Genus Sitanion. By Jared G. Smith. Pp. 21, pls. 4. June 24, 1899.

Twenty-two species of the genus *Sitanion* are here described.

No. 19.—Structure of the Caryopsis of Grasses with Relation to Their Morphological Classification. By P. B. Kennedy. Pp. 44, pls. 8. 1899.

No. 20.—American Grasses, III. By F. Lamson-Scribner. Pp. 197, figs. 136. 1900.

This bulletin includes descriptions of the tribes and genera and a bibliography of the works cited in American Grasses, I, II, and III.

No. 21.—Studies on American Grasses. The native American species of Chaetochloa. By F. Lamson-Scribner and Elmer D. Merrill. Pp. 44, figs. 24. March 8, 1900.

In this paper twenty-eight native American species are described, twenty-three of which are natives of this continent. Six of these species are here published for the first time.

No. 22.—Cooperative Experiments with Grasses and Forage Plants. By P. B. Kennedy. Pp. 86, pls. 13, fig. 1. 1900.

In this bulletin the reports received from farmers and others to whom seeds were sent for experimental purposes from the Division are presented.

No. 23.—Studies on American Grasses. A revision of the North American species of Bromus occurring north of Mexico. By Cornelius L. Shear. Pp. 66, figs. 40. July 3, 1900.

This bulletin contains descriptions of thirty-six species and twenty-eight varieties of the genus *Bromus*. Three species and fifteen varieties are described as new.

No. 24.—Studies on American Grasses. Pp. 55, figs. 23. January 9, 1901.

This bulletin contains the following papers: (1) "Some Recent Collections of Mexican Grasses," by F. Lamson-Scribner and Elmer D. Merrill; (2) "Notes on Panicum nitidum Lam., Panicum scoparium Lam., and Panicum pubescens Lam.," by F. Lamson Scribner and Elmer D. Merrill; (3) "Miscellaneous Notes and Descriptions of New Species," by F. Lamson-Scribner and Carleton R. Ball.

CIRCULARS.

No. 1.—A Note on Experimental Grass Gardens. By J. G. Smith. Pp. 4. 1895.

No. 2.—Hairy Vetch, Sand Vetch, or Russian Vetch. By F. Lamson-Scribner. Pp. 4, fig. 1. 1895.

No. 3.—Saltbushes. By Jared G. Smith. Pp. 4, figs. 3. 1896.

No. 4.—Renewing of Worn-out Native Prairie Pastures. By Thos. A. Williams. Pp. 4, figs. 4. 1896.

No. 5.—Cowpeas. By Jared G. Smith. Reprint from the Yearbook of the U. S. Department of Agriculture for 1896. Pp. 11. 1898.

No. 6.—Cultivated Vetches. By Jared G. Smith. Winter vetch, hairy vetch, guinea vetch, and Dakota vetch, are described and illustrated. Pp. 8, figs. 6. 1898. Revised.

No. 7.—Gram, Chick Pea, or Idaho Pea. By J. G. Smith. Pp. 4, fig. 1. 1898.

No. 8.—Experiments in Range Improvement. By J. G. Smith. Pp. 5, fig. 1. 1898.

Relates to the experiments conducted at Abilene, Texas, by Mr. H. L. Bentley, Special Agent of this Division.

No. 9.—New Species of North American Grasses. By F. Lamson-Scribner. Pp. 7, figs. 24. February 24, 1899.

Fourteen new species are described.

No. 10.—Poa fendleriana and its Allies. By Thos. A. Williams. Pp. 6, fig. 1. April 15, 1899.

No. 11.—The Flat Pea. By F. Lamson-Scribner. Pp. 6, figs. 3. 1899.

Describes the Flat Pea (*Lathyrus sylvestris*), its method of cultivation and uses.

No. 12.—Rape as a Forage Plant. By Thos. A. Williams. Pp. 6, fig. 1. 1899.

No. 13.—Florida Beggarweed. By Jared G. Smith. Pp. 5, figs. 2. 1899.

No. 14.—Velvet Bean. By Jared G. Smith. Pp. 5, figs. 3. 1899.

No. 15.—Recent Additions to Systematic Agrostology. By F. Lamson-Scribner. Pp. 10, figs. 5. July 14, 1899.

Gives description of genera and cites synonyms not published in Hackel's "True Grasses." The contents of the circular are based largely upon a supplement to Engler & Prantl's "Pflanzenfamilien." *Fourniera mexicana*, *Ixophorus unisetus*, *Opizia stolonifera*, and *Pringleochloa mexicana*, are illustrated.

No. 16.—New Species of North American Grasses. By F. Lamson-Scribner. Pp. 6, figs. 2. July 1, 1899.

Nine new species are described. *Puccinellia simplex* Scribn. and *Dactyloctenium australiense* Scribn. are illustrated.

No. 17.—Crimson Clover. By Thos. A. Williams. Pp. 6, figs. 3. 1899.

No. 18.—Smooth Brome-grass. By P. Beveridge Kennedy. Pp. 9, figs. 2. 1899.

No. 19.—New and Little-Known Mexican Grasses. By. F. Lamson-Scribner. Pp. 4, fig. 1. January 2, 1900.

Five new species are described.

No. 20.—Experiments with Forage Plants in Ontario. By P. Beveridge Kennedy. Pp. 3. 1899.

No. 21.—Cooperative Range Grass and Forage Plant Experiments at Highmore, South Dakota. By F. Lamson-Scribner. Pp. 10, fig. 1. 1900.

Describes the experiments being made at Highmore, South Dakota, in cooperation with the South Dakota Experiment Station.

No. 22.—Grass and Forage Plant Investigations on the Pacific Coast. By F. Lamson-Scribner. Pp. 7. 1900.

Describes experiments made in 1899 with grasses and forage plants at Walla Walla and at North Yakima, Washington, in cooperation with the Northern Pacific Railroad and the Oregon Railroad and Navigation Companies.

No. 23.—Progress of Experiments in Forage Crops and Range Improvement at Abilene, Texas. By H. L. Bentley. Pp. 20. 1900.

Descriptions of the experiments with grasses and forage plants made at Abilene, Texas, under the immediate charge of H. L. Bentley, Special Agent.

No. 24.—Cowpeas and Corn for Silage and Fodder. By W. Gettys, Athens, Tennessee. Pp. 10, figs. 2. 1900.

No. 25.—Turkestan Alfalfa. By P. Beveridge Kennedy. Pp. 20. 1900.

This circular includes reports on trials with Turkestan alfalfa from those to whom seed was sent by the Department of Agriculture.

No. 26.—Rescue Grass. By C. L. Shear. Pp. 4, fig. 1. 1900.

Brief description of rescue grass (*Bromus unioloides*), and an account of its cultivation and value.

No. 27.—Agrostological Notes. Pp. 10. December 4, 1900.

This circular contains the following short papers: (1) "Grasses in the Herbarium of Dr. H. Muhlenberg;" (2) "New Species of Eatonia;" (3) "A New Variety of Panicum nashianum;" (4) "Nomenclature Notes;" (5) "Notes on Melica and Stipa."

No. 28.—Grasses and Fodder Plants on the Potomac Flats. By Carleton R. Ball. Pp. 18. 1900.

This circular gives a brief account of the grasses and fodder plants grown by this Division on the Potomac Flats during the season of 1900.

No. 29.—Grasses in Elliott's Sketch of the Botany of South Carolina and Georgia. By F. Lamson-Scribner. Pp. 12, figs. 4. 1901.

The circular is based upon an examination of the grasses in Elliott's herbarium by F. Lamson-Scribner and Elmer D. Merrill. Two new species are described.

No. 30.—New or Little-Known Grasses. By F. Lamson-Scribner. Pp. 8. March 8, 1901.

Seven new species are described.

No. 31.—Bermuda Grass. By A. S. Hitchcock. Pp. 6, fig. 1. 1901.

No. 32.—Some Arizona Grasses. By Elmer D. Merrill. Pp. 10. April 22, 1901.

This circular is based upon specimens collected during the summer of 1900 by Profs. R. H. Forbes and David Griffiths, of the Arizona Experiment Station. Three new species and five new varieties are described.

No. 33.—Range Grass and Forage-Plant Experiments at Highmore, South Dakota. Report of progress by F. Lamson-Scribner. Pp. 5. 1901.

This circular is a report of the progress of the range experiments carried on by this Division in cooperation with the South Dakota Experiment Station at Highmore, South Dakota.

No. 34.—Aristida purpurea Nutt. and Its Allies. By Elmer D. Merrill. Pp. 8. May 24, 1901.

Aristida fasciculata Torr. and *Aristida dispersa* Trin. are referred to *Aristida americana* Linn. *Aristida longiseta* Steud. is recognized with three varieties, and *Aristida purpurea* Nutt. is also recognized with three varieties, two of which are new.

No. 35.—Agrostological Notes. By F. Lamson-Scribner and Elmer D. Merrill. Pp. 6. June 18, 1901.

This circular contains the following short articles: (1) "Some Species of Grasses," published by S. B. Buckley; (2) "Notes on Calamovilfa;" (3) "Three New Species of Panicum;" (4) "A New Species of Poa;" (5) "Some Changes in Nomenclature."

No. 36.—List of the Publications of the Division of Agrostology. By F. Lamson-Scribner. Pp. 8. June 29, 1901.

FARMERS' BULLETINS.

No. 31.—Alfalfa, or Lucern. By Jared G. Smith. Pp 24, figs. 3. 1895.

Several editions of this bulletin have been published. It contains a full account of the history, habits of growth, methods of cultivation, harvesting, etc., of alfalfa.

No. 50.—Sorghum as a Forage Crop. By Thos. Williams. Pp. 20, fig. 1. 1897.

Treats of the extent of cultivation in the United States, varieties, conditions of growth, methods of harvesting, etc.

No. 58.—Soy Bean as a Forage Crop. By Thos. A. Williams. Pp. 24. 1898. Revised 1899.

This bulletin treats of the varieties, methods of culture, harvesting, value as a soiling crop, as a hay crop, as a soil renovator, etc. There is an appendix on the "Soy Bean as Food for Man," by C. F. Langworthy, of the Office of Experiment Stations.

No. 66.—Meadows and Pastures. By Jared G. Smith. Formation in the Middle Eastern States. Pp. 28, figs. 9. 1898. Revised 1899.

This bulletin treats of grasses as soil builders, fertilizers for grass lands, methods of preparing the soil, manner of sowing the seed, varieties of hay grasses, clovers for meadows and pastures, and some grass mixtures.

No. 72.—Cattle Ranges of the Southwest. A history of the exhaustion of the pasturage and suggestions for its restoration. By H. L. Bentley. Pp. 32, figs. 9. 1898.

This bulletin treats of the early and present condition of the Texas pastures, especially those of central Texas, the obstacles to the renewal or improvement of the ranges, how the ranges may be renewed. There is also a discussion of the remaining grasses and forage plants native to the Southwest.

No. 89.—Cowpeas. By Jared G. Smith. Pp. 16. 1899.

No. 101.—Millets. By Thos. A. Williams. Pp. 28, figs. 6. 1899.

This bulletin treats of the place of millets among the farm crops, of the cultivated varieties of foxtail millet, barnyard millet, broom corn millet, the culture of millet, and their uses and value.

No. 102.—Southern Forage Plants. By F. Lamson-Scribner. Pp. 48, figs. 14. 1899.

This bulletin treats of the formation and care of pastures, soiling and fodder crops, the more important grasses for hay and pasture lands, leguminous forage crops, and miscellaneous forage plants.

No. 108.—Saltbushes. By P. Beveridge Kennedy. Pp. 20, figs. 9. 1900.

This bulletin treats of the general characteristics of the introduced and American saltbushes, chemical composition of saltbushes and their feeding value, and miscellaneous plants for alkali soils.

F. Lamson-Scribner,
Agrostologist.

Approved:

James Wilson,
Secretary of Agriculture.

Washington, D. C., *June 12, 1901.*

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