U. S. DEPARTMENT OF AGRICULTURE.
BOTANICAL DIVISION.
BULLETIN NO. 8.

A RECORD

OF

SOME OF THE WORK OF THE DIVISION,

INCLUDING

EXTRACTS FROM CORRESPONDENCE AND OTHER COMMUNICATIONS.

PREPARED BY

Dr. GEO. VASEY
AND
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UNDER THE DIRECTION OF THE COMMISSIONER OF AGRICULTURE.

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LETTER OF SUBMITTAL.

SIR: We have the honor of presenting a bulletin representing, in part, the work of this Division, which we trust will be received as a contribution of some value in advancing the mutual helpfulness and interdependence which should exist between the Department of Agriculture and the workers and thinkers in the line of agricultural and botanical science.

Respectfully,

GEO. VASEY.
B. T. GALLOWAY.

Hon. NORMAN J. COLMAN,
Commissioner of Agriculture.

INTRODUCTION.

In the progress of the work of the botanical division many facts and observations are brought to light which hardly seem appropriate to be incorporated in the annual reports, but which will be of interest to many readers, and which will surely be welcomed in some form by special investigators in botanical science.

In the great work which the Government has undertaken, of furnishing the means of an advanced practical education through the agricultural colleges and experiment stations, new appliances and new facilities for instruction are becoming a necessity. It has seemed to the officers of this division that much valuable material can be furnished in this direction by the occasional issuance of a bulletin especially adapted to help forward the line of botanical work for teachers and students.

In the hope that this may be the result, the present paper is dedicated to the agricultural colleges of the country.

PART I.

BOTANICAL DIVISION.

PREPARED BY DR. GEO. VASEY.

BOTANICAL DIVISION.

Prepared by Dr. GEORGE VASEY.

GRASS EXPERIMENT STATIONS.

For several years past the Department of Agriculture has been making special investigation of the grasses of the West, particularly those of the arid districts, with a view of ascertaining what are the prevailing or prominent species, what is their range of distribution as to locality and soil, what their value for grazing purposes, and what kinds offer a reasonable prospect of being valuable for cultivation. Great interest has been felt in this subject both by farmers and cattlemen, and Government aid has been invoked for the purpose of conducting suitable experiments, and such aid has been strongly recommended by the Commissioner of Agriculture.

In response to these requests, Congress, a few months ago, made a moderate appropriation for the purpose of establishing grass experiment stations. It was determined that one of these stations should be located west of the 100th meridian. Commissioner Colman immediately appointed Dr. Vasey, botanist of the Department, to proceed to the West to select a location. After a careful investigation he made a selection at Garden City, in southwestern Kansas, where a public spirited citizen made a free lease to the Government, for five years, of 160 acres of land on the high prairie two miles north of the city. This is so located that irrigation can be employed on such portion of the land as may be desirable. The chief object of the station is to experiment with grasses and forage plants, both native and foreign—with any kinds, in fact, which give promise of utility and adaptation to the climatic conditions of the arid plains, and furnish a substitute for the scanty pasturage now existing. This is a great necessity. In order to secure the permanent settlement of this portion of country, it should be ascertained what can be depended upon in the occupation and cultivation of the dry uplands where irrigation can not be applied. It is a vital question, affecting the interests of thousands of settlers over a great extent of country.

Upon the location of the station the Commissioner appointed Prof. J. A. Sewall, of Denver, as superintendent of the station; and he has up to the present time had 80 acres fenced, 40 acres plowed, a quan-

tity of grass sods transplanted into prepared ground; has put up a small seed-house, and made everything in readiness for more extensive work next spring. The results of these experiments will be watched with great interest; but definite results can not be expected without the allowance of a considerable period of time.

The need of some grasses suitable to the climate of the dry region lying mainly west of the 100th meridian has been long felt and acknowledged. It is estimated that there are in eastern Colorado, western Kansas, western Nebraska, and southern Wyoming 120,000 square miles, or over 76,000,000 acres, of this arid, elevated country. This region was known to be covered principally by short grasses called "buffalo" and "mesquit," in some places thickly covered, in others more and more sparsely, while in some portions the amount of grass was exceedingly small. During the greater part of the last twenty-five years this region has been occupied for cattle and sheep ranches, for which purpose alone it was thought to be adapted. But even for this purpose its ability to support the domestic grazing animals was very small compared with its vast extent. This arises partly from the fact that only such portions as were within reasonable distance from water could be utilized, and partly from the scanty supply of grass. The estimates as to the supporting capacity of these plains vary much according to localities, some statements being that 40 to 50 acres are required to support one animal, others that 20 or 30 acres are sufficient, and yet others that 10 to 15 acres are enough.

All these estimates are correct as to certain localities, and it may be considered probable that over the entire region the average amount required would be 15 acres to the head of stock. This, however, was under the wasteful ranch system. A limitation of the range and the size of the herds, so that they could be properly cared for as to water, shelter, and winter food, would greatly increase the grazing capacity of the country.

But during the past five or six years there has been such an overwhelming influx of settlers into that district that the ranchmen have been nearly all forced to abandon the country in favor of homesteaders, who are seeking to make farms of their quarter and half-sections. A series of favorable seasons had occurred, during which the few scattered settlers in the country had been successful in their agricultural efforts, and then began a rush of immigration which soon absorbed a great portion of the most desirable locations. The settlers were full of the most sanguine expectations, and an army of boomers invaded the country, located town sites and city sites, and a general inflation of values occurred. A few well located towns will perhaps retain their marvelous development, but many others have come to a stand-still, and many will retrograde, for the reason that numerous thriving towns can not exist in an agricultural country without the improvement and successful cultivation of the surrounding land, and to this end the residents of that region must now direct their efforts.

Sufficient time has not yet elapsed to determine what will be the ultimate success of general agriculture in this section, but there can be no doubt that the country is eminently adapted to pastoral uses, and the settlers would do well to bestow their attention largely on stock-raising and dairying. But it is evident that in order to make this business profitable for small farmers or men of limited acres, some means must be devised for securing an increased production of grass upon the land. This is the present most important problem for the arid districts. It is asserted that the commonly cultivated grasses will not be successful in these arid lands except where irrigation can be applied. The native grasses of the region, which are mostly "buffalo grass" and "grama grass," are acknowledged to be very nutritious, but the yield is so light as to require a large area for cattle to range over to obtain support. The inquiry naturally occurs, "Can not some grasses be obtained which will not only endure the aridity of the climate, but also make a more vigorous growth and a more abundant production?"

It may be safely laid down as a principle that no great improvement in this respect can be expected without a cultivation of the soil. With this even the buffalo and grama grasses may be expected to double their production.

Theinquiry is sometimes made, "Which of our native grasses might be reasonably expected to be adapted to cultivation in the said region?"

We have already stated that the "buffalo grass" (*Buchloe dactyloides*) and "grama grass" (*Bouteloua oligostachya*) were the prevailing native species on the prairie or upland districts. But there are others which deserve consideration, and some of them may be found to possess the qualities desired.

Andropogon provincialis, commonly called blue-joint, is a grass of wide range, being found from Massachusetts to Texas, and to the Rocky Mountain region. It is also, sometimes, but improperly, called "blue-stem" and "blue-grass." Even the name "blue-joint" is inappropriate, for the joints are rarely if ever blue, and the most conspicuous color about the grass is its purplish top, by which it may be distinguished at a great distance. It commonly grows from 4 to 6 feet high, rather sparsely on the ground, but with an abundance of long leaves, so that it produces a large crop of hay. It was formerly plentiful on the prairies of Illinois and Iowa, and still occurs largely in most of the states west of the Mississippi, and is universally esteemed and cut for hay in its wild state. It thrives best on rich bottom-land, not too moist nor too dry, but is capable of considerable variety in that respect. It is well known all over Kansas, being abundant in the eastern part of the state, and the general testimony is that it has been spreading westward since the settlement of the country, and its extension in the West is always regarded with pleasure. It starts growth late in the season, and is chiefly valuable for summer and fall grazing, and for hay-making. It is said that close pasturing for a few years kills it out.

2. *Andropogon Hallii.*—This species much resembles the preceding, but the culms are stouter, the leaves thicker and more succulent, the flower spikes are larger, and the flowers more hairy. It prevails in very sandy soil, and is most frequent in western Kansas and Colorado, also in Nebraska and northward along the Missouri River. The leaves and stem are commonly of a light bluish-green color. This will probably be well adapted to light sandy soils.

3. *Andropogon scoparius.*—This is very common on prairies, and is sometimes called short or small blue-joint, sometimes bunch-grass, and sometimes wire-grass. It grows in dense tufts or bunches, both on low land and in thin soils on bluffs and hills. It is in most places a constituent of prairie hay, and if cut early makes good feed.

4. *Stipa spartea*, called porcupine grass, arrow-grass, and devil's knitting-needles, from the long, stiff, twisted awns inclosing the seed. These awns are said to be injurious to stock, and particularly to sheep, as their sharp points penetrate the wool and sometimes the flesh. But the seeds ripen early (about the 1st of July, according to Professor Crozier), and during the rest of the season the grass is well marked by the tall culms bearing the bleached, empty, oat-like panicles. But the long root-leaves continue to grow and furnish valuable feed until late in the season. It should receive attention in any experiments for a pasture grass. It is the buffalo grass of the Saskatchawan region.

5. *Sporobolus heterolepis*, called bunch-grass, and wire-grass, from the abundant, long, wiry leaves and stems. I found it a considerable element in the prairies of southern Dakota, and it occurs southward to Texas. It was also common on the prairies of Illinois and Wisconsin before the incoming of settlements. West of the 100th meridian, however, especially in sandy soils, this species is replaced by two others of the same genus, viz: *Sporobolus cryptandrus* and *S. airoides*. All these species should receive attention.

6. *Deyeuxia Canadensis*, frequently called red-top, and sometimes also blue-joint. Professor Crozier, who spent some time in northwestern Iowa and adjacent parts of Minnesota and Dakota, in studying the native grasses, says: "This is considered by some to produce the best hay, for cattle, of all the native grasses. It is very leafy and stands remarkably thick upon the ground. The seed ripens early in July, but the leaves remain green until winter. It is probably hardly equal to some of the upland grasses in quality, but it gives a larger yield, and is undoubtedly worthy of cultivation. It is usually found upon the margins of ponds; it will thrive, however, on land that is only slightly moist, and often occurs along the banks of roadside ditches. On rather low land which has been broken and allowed to go back it frequently comes in, and after a few years occupies the land to the exclusion of all other vegetation."

This species, athough promising for moist land, would perhaps fail on arid soil, but there are other species of the genus prevailing in the

mountain region, which are accustomed to dry soil, and may be found serviceable for cultivation, particularly such as *D. confinis* and *D. sylvatica.*

7. *Ammophila longifolia*, a tall, coarse-stemmed grass occurring in very sandy districts, or on sandy river-banks, is in some localities a useful grass as a resort for cattle late in the autumn, and in winter it is said to save many range cattle from starvation. Its long, creeping root-stocks penetrate deeply into the soil and give it good staying qualities, for which reason it may be valuable in some localities.

8. *Oryzospis cuspidata.*—This is one of the so-called bunch-grasses, which occurs near the mountains, in sandy soil, and has been called Indian millet. It will grow in very dry, sandy soil, furnishes a considerable foliage, and large, spreading panicles of very nutritious seeds. It is said that cattle keep fat upon the grass in the mountain districts.

9. *Panicum virgatum*, sometimes called switch grass and sometimes wild red-top. It occurs mostly in low or moist ground, usually near streams, and varies in height from 2 to 4 feet, with long leaves and a wide, spreading panicle. Professor Crozier says it yields two to four tons per acre, and should be cut early to be of good quality. Its value has been recognized in some parts of Colorado, and around Greeley it has been considerably cultivated, with satisfactory result. It should receive a fair trial in the experiments.

10. Another perennial species, *Panicum obtusum*, occurs in some parts of Colorado and New Mexico which ought to receive attention. In New Mexico and Texas it is called vine mesquit and running mesquit, from its habit of throwing out long runners, sometimes 6 to 10 feet long, which at intervals form thickened, woolly joints, which sometimes take root. I found patches of it growing in southern Colorado, making an even, grassy surface, and appearing as if it would cut two tons per acre. I also saw it occurring in considerable quantity in hay brought into the Pueblo market. It deserves attention with reference to its agricultural value.

11. *Chrysopogon nutans* is related to the *Andropogons*, particularly to the tall *A. provincialis.* It often grows 6 feet high, and has a drooping panicle somewhat resembling oats, and hence, has been called wild oats. It is of frequent occurrence on the prairies and is a nutritious grass, but should be cut early, as at full maturity the stems are coarse and are rejected by cattle.

12. *Agropyrum glaucum.*—This is known by different names, as Colorado blue-stem, blue-grass, wheat-grass, wild quack-grass, and gumbo-grass. It is closely related to the quack-grass or couch-grass, so common and so much dreaded by some in the older-settled parts of the country. It has a stiff stem and leaves, which are usually of a bluish-green color. On hard, dry soil its growth is low and sparse, only here

and there a scattered stalk with a flower spike, somewhat like a starved, beardless head of wheat; but in low, moist ground it often grows with great vigor 2 or 3 feet high, and is considered valuable for hay. On the borders of ditches and on irrigated ground it yields a heavy cutting. It has great persistence in the ground on account of its strong, running root-stock. Whether it will, in cultivated ground become as difficult to eradicate as its Eastern namesake can not now be predicted, but when a persistent, nutritious grass is the great want of a country it is worth while to take some risks.

13. *Agropyrum tenerum.*—Another species of this family is found in Colorado, western Kansas, and Nebraska, which may prove valuable for some qualities. It has a narrow, slim spike of flowers and stiff culms. It does not have running root-stocks, but grows in clumps of variable size. It furnishes a large quantity of foliage and matures early, and for these qualities it may be desirable to cultivate it in a mixture of grasses for pasture. It is common on banks of ditches and on the waste grounds in the city of Denver.

14. Several species of Elymus, particularly *Elymus canadensis* and *E. virginicus*, are common and known by the name of rye-grass. They are considered nutritious grasses, and are commonly cut for hay. They are coarse and probably would not bear pasturage, but may be worth cultivating for forage.

The above are the principal native perennial grasses which have occurred to me as having promise of utility for the arid districts which are now under consideration. Other species will come in for attention, particularly some whose range is more restricted to the neighborhood of the mountains.

I have already stated that the grama-grass should be placed under cultivation, not only the most common species, *Bouteloua oligostachya*, but others, as the *B. racemosa*. There are also several strong-growing species in Mexico which should be tried. The tall-growing bunch-grasses of Arizona might also be experimented with. These include several species of *Sporobolus* and *Epicampes*.

Panicum bulbosum, a vigorous grass of Arizona and New Mexico, having thickened, bulbous root-stalks, should be tried, and if it would endure the winters would probably be a valuable pasture grass. There are also several species of *Poa* belonging to the mountain district which might prove valuable in cultivation, as *Poa tenuifolia*, *P. andina*, *P. nemoralis*, and others. There are also some native species of Festuca which merit attention, such as *Festuca scabrella*, and several large forms of *Festuca ovina*. Also several species of *Bromus*.

Some attention must also be given to annual grasses suitable for forage and hay. The necessary supply of hay for winter feeding of cattle may sometimes be more profitably procured from the annual grasses, as millet, Hungarian grass, and the various forms of sorghum. In this

class of annual grasses there is a wider field for selection than in the perennials, and they are obtainable from our own and other countries.

There are also many fodder plants, other than grasses, which need careful trial. The family of leguminous plants furnishes a large number of these valuable species, such as the clovers, alfalfa, medicago, melilotus, sainfoin or esparsett, vetch, peas, lotus, lupines, serradella, etc.

There are also some native forage plants which deserve experiment. We have several species of *Lupinus* in the Rocky Mountain region which are vigorous growers and of large size, apparently more productive than the usually cultivated foreign ones. Of *Vicia* and *Lathyrus* we have also promising native kinds. Some of the native species of *Atriplex* are well known to furnish valuable winter forage for cattle, and it may be well to ascertain what will be their value under cultivation, especially for unusually sterile or sandy soil.

Attention should be given to a combination of grasses for pastures, some of which should be of early growth and some of later, so as to secure a succession of feed during the entire season. The judicious blending of five or six species may be made to accomplish this result.

By using such a mixture the ground may be more uniformly covered and there will be a better succession of tender foliage. Some recent experiments at the Missouri Agricultural College fully bear out this conclusion. A 50-acre lot was sowed with five varieties of pasture grass and three of clovers. Upon this 50 acres fifty-two head of cattle grazed throughout the season, without making use of an adjacent pasture, a part of which contained excellent blue-grass, except at long periods, and then only cursorily passing over it.

In England great attention has been given to combining several kinds of grasses in meadows and pastures, and it is claimed that the practice is better for the land, and gives a larger yield than when only one variety is employed.

In any plan for experiments with grasses for the purpose above indicated the element of time must receive large consideration. It must be remembered that the seeds of wild species have first to be obtained in small quantities and to be collected by hand, and that two years will be consumed in getting fairly started.

Having once obtained preliminary beds from which a stock of seed may be easily obtained, the trials can be made on a larger scale. Several acres of each kind of grass or fodder plant should be secured, with careful note of their relative merits as to quality and yield.

These experiments can not be completely satisfactory without ascertaining the conduct of the grasses in actual use as pastures, for it is well known that some grasses will bear the tramping and grazing of cattle, while others will not.

The least attempt at a series of experiments, therefore, should cover a period of five years, and there is great reason to expect that they may be profitably continued for twice that time.

Experiments of this kind are difficult and expensive, and can not well be made by private individuals. The great extent of country interested in, and needing such work renders it highly expedient that the Government should undertake it.

It is expected that another station for the trial of new grasses will be located next spring, probably in one of the Southern States.

NOTES ON GRASSES.

On the south bank of the Arkansas River, at Garden City, in southwestern Kansas, there is a long range of sand hills or sand bluffs. The citizens of the place say that a few years ago these bluffs were destitute of vegetation, and the loose, white sand was blown about in clouds by the strong prevailing winds, but that recently they have become covered with grass. I crossed the river to ascertain what were the grasses that had secured a foothold in the shifting sand beds, and found that they are now sparsely covered principally with *Andropogon Hallii* and *Redfieldia flexuosa*. The first grass is a close relative of *A. provincialis*, but with stouter culms, shorter and more succulent leaves, larger flowers, and the whole plant of a glaucous-green color. Its roots are strong and penetrate deeply in the sand to reach moisture. On sandy ridges and prairies it often takes the place of *A. provincialis*, and is a promising grass for such situations. The other grass, *Redfieldia flexuosa*, formerly called *Graphephorum flexuosum*, has not been collected by botanists for many years, its known localities being very few. It was therefore a great pleasure to rediscover it here. Its roundish, cylindrical leaves, one and one half to two feet long, were sparsely scattered, and could with difficulty be pulled up from the long, deep, underground root-stocks, which evidently were very efficient in holding the sand in place.

Unfortunately there were few flowering culms visible, and they were immature and varied from the typical plant in having but one flower developed in the spikelets. Whether this variation is constant in this locality or is dependent upon the unusual dryness of the present season can not now be determined, but is deserving of future investigation.

Agropyrum glaucum and *A. tenerum* are both prevalent inthe dry districts of Kansas, Colorado, and Dakota, particularly where the native sod has been disturbed, as in old, abandoned wagon-roads and in the neighborhood of ditches. Both kinds are conspicuous on roadsides in the city of Denver, near the shallow irrigating ditches. *A. tenerum* grows in clumps and does not have running root-stocks. It is an early grass, maturing in July, and afterwards is conspicuous by its whitened culms and leaves.

In several places in Kansas, Colorado, and Dakota an erect, much-branched, bushy form of *Muhlenbergia glomerata* was observed. Its ap-

pearance of thrift and greenness has been noticed, and my attention was called to it by farmers and observant citizens. It would under cultivation produce a large amount of forage, and it will be given trial at the grass station.

What are the common grasses of the prairies?

Near Wichita, Kans., the examination of a piece of native upland prairie showed *Stipa spartea*, *Panicum virgatum*, *Kœleria cristata*, *Andropogon provincialis*, and *Andropogon scoparius* as the principal species. Here and there occurred a little of *Bouteloua racemosa* and *B. oligostachya*, with occasionally small patches of *Buchlœ dactyloides*. With these were mingled *Amorpha canescens*, *Psoralea floribunda*, *Petalostemon violaceum*, a *Helianthus*, *Aplopappus rubiginosus*, and *Euphorbia marginata*. On lower ground were *Panicum virgatum* of larger growth, *Agropyrum glaucum*, *Spartina cynosuroides*, with *Elymus virginicus* and *E. canadensis*.

A ride of 20 miles over the prairies of Butler County showed that the principal upland grasses are the five species first mentioned. A very intelligent farmer said they would yield a cutting of 1 to 2½ tons per acre. He had tried various tame grasses, but without much satisfaction, as they mostly winter-killed, and he doubted if he could obtain any grasses better than those of the virgin prairie. Old settlers say that buffalo grass used to be very abundant, but it has nearly disappeared from this section. Blue-grass (*Poa pratensis*) is coming in, and he thinks it will take the country.

In southwestern Minnesota and southern Dakota there yet remain extensive stretches of primitive prairie, and a careful examination showed that on the uplands the common grasses were mainly the ones mentioned as prevailing in eastern Kansas, viz: *Stipa spartea*, *Andropogon provincialis*, *A. scoparius*, *Kœleria cristata*, together with patches of *Sporobolus heterolepis* and *Bouteloua racemosa*. On moister ground was *Panicum virgatum*, *Elymus canadensis*, and in wet ground *Spartina cynosuroides*. Wherever the ground has been broken and not cultivated, as on railroad embankments and roadsides, *Agropyrum glaucum* and *A. tenerum* had taken possession. According to the observation of Professor Crozier the native prairies of northwestern Iowa are characterized by the same species as above mentioned. Having been familiar with the prairie vegetation in northern Illinois forty years ago, I was struck with the similarity, the same species being then prevailing ones in that region. The *Stipa spartea* is an early grass and ripens its seeds about the first of July. Later in the season it is recognized by the persistent bleached culms and empty glumes of the spreading panicle. But the radical tufts of leaves continue growing green and vigorous throughout the summer, frequently being 2 feet long. Although somewhat coarse they make very good hay.

There is great latitude in the popular use of the term "mesquit grass." On the plains of western Kansas, New Mexico, Colorado, and Nebraska it is generally applied to the prevailing grass of that region, viz, *Bouteloua oligostachya*, although the same grass is also called buffalo grass, particularly northward.

A correspondent in Texas sends three grasses under the name of mesquit, viz, *Bouteloua texana*, which he says is the common mesquit (this species seems to be mainly confined to Texas); (2) *Hilaria cenchroides* var. *texana*, which is running mesquit; and (3) *Buchlœ dactyloides*, which there is called curly mesquit. There are several other species of *Bouteloua*, common in New Mexico and Arizona, which are also generally recognized as mesquit grasses. Strangely, however, in the Southern States, according to Professor Phares, *Holcus lanatus* is sometimes called velvet mesquit grass, and he states that so far as has come to his knowledge nine tenths of all the so-called mesquit grass planted in the Southern States is this *Holcus*.

Mr. F. W. Anderson, of Great Falls, Mont., states that in that section *Lygodesmia juncea* is becoming a bad weed in cultivated ground. The somewhat related European *Chondrilla juncea* is a very troublesome weed in Maryland and Virginia, extremely difficult to eradicate. It was introduced at an early period in the settlement of the country.

P. S. Clark, Hempstead, Tex., writes that *Sesbania vesicaria* has covered the entire prairies this summer, and caused the destruction of the grass.

Considerable has been said recently in Florida agricultural papers about a grass called maiden cane, which there is considered a great nuisance. This grass is *Panicum curtisii*, or a variety of it. In swampy land it grows 3 or 4 feet high, with strong culms and coarse running root-stocks and is almost invariably sterile. In dry, sandy fields it is lower in stature, and has a branching panicle. It has been particularly brought to notice by Mr. Simpson, of Manatee, and Professor Curtiss, of Jacksonville (not the Curtis for whom the species was named, Rev. M. A. Curtis, of North Carolina), has called it Simpson grass.

Polish wheat, *Triticum polonicum*, is frequently sent from Montana and the Northwest, where it is partially naturalized under the name of wild-goose wheat and Montana rye. A notion prevails that the seed was dropped by wild geese. It has been sometimes cultivated, and is very hardy and productive, but not of very good quality.

Mr. F. A. Swinden, Brownwood, Tex., writes that alfalfa (*Medicago sativa*) seems in that locality to do well without irrigation. He will plant 100 acres of it in the spring. He has an orchard of 400 acres of pecan trees (*Carya olivæformis*).

R. Maitre, New Orleans, says that *Panicum crus-galli* delights in moist ditches or furrows, and has the appearance of thrifty oat-stalks, and it

is eagerly eaten by horses, mules, or cattle. Professor Phares states that in Louisiana, Mississippi, and some other States it is mowed annually, some farmers asserting that they harvest four or five tons per acre. In one county in Mississippi hundreds of acres are annually mowed on single farms.

The genuine *Ranunculus repens*, undoubtedly introduced from Europe, according to J. G. Fish, Whitney's Point, N. Y., is becoming a dangerous enemy to the farmer. When it once gets thoroughly rooted in the soil, and particularly in meadow lands, clover, timothy, red-top, and June grass are perfectly impotent to resist it.

W. H. Williams, Crook City, Dak., sends specimens of two grasses, (*Agropyrum tenerum* and *Elymus canadensis*) which he says are superior to any kinds he has seen. They are found mostly on land that has been broken and allowed to stand uncultivated. The growth is remarkably heavy and the hay is of superior quality.

W. A. Sanders, Sanders P. O., California, sends a bunch of grass (*Epicampes rigens*) cut from his pasture, and says it is closely grazed off wherever stock can get at it. He says it grows all summer without water, and under excessive dryness cures into hay and makes palatable, nutritious feed until spoiled (as all hay spoils) by autumn rains. It is our best native *dry land* grass.

Dr. M. McKenzie, Centreville, Mo., sends specimens of *Triodia sesslerioides*, a tall, showy grass, which he introduced into his pastures and finds that it is likely to become a pest.

Mr. E. W. Reasoner, of Manatee, Fla., sends specimens of a grass, a species of Pennisetum, the seed from Northwest India, which he has had in cultivation, and which he says is very luxuriant and grows to the height of 6 or 7 feet. One plot 10 feet wide and 100 feet long averages 6½ feet high. It was planted in June, and part of it was cut twice. He has not yet determined whether it is annual or not, but considers it a promising grass.

Paspalum distichum.—Several species of Paspalum have received attention in the South, as being useful pasture grasses and very durable from their creeping and rooting habit. *Paspalum distichum* is one of these species. It grows principally in low, moist ground. Its stems and culms are mostly prostrate and running, sending up here and there a few flower-bearing culms. It is found in the Southern States and Texas, thence to California. Farther south it is found in most tropical countries. Mr. W. A. Sanders, of Fresno County, Cal., writes recently as follows: "Are you aware of the value of Paspalum distichum for seeding pond-holes that dry up or nearly so in autumn? Such ponds are usually spots of bare, stinking mud, but when well set to this grass will yield all the way up to 80 tons (in the green state) of autumn feed for stock, especially valuable for cows first, then follow with sheep till every vestige is devoured. Surely it has an immense food value in such places."

This genus is one of great difficulty to the student, and the present monograph, it is hoped, will be of essential benefit in the prosecution of botanical investigation.

PANICUM, *Linn.*

Spikelets with one perfect terminal flower, and usually a second one which is male only or rudimentary. Outer empty glumes two, one of which is smaller than the other, often very small, or rarely wanting, membranaceous. The glume of the perfect flower with its palet are usually of a coriaceous texture, and obtuse or obtusish. The second flower, when present, is membranaceous. Inflorescence spicate or paniculate.

SECTION 1.—*Digitaria.*—Panicles of several spikes or spike-like branches, which are digitate or approximate at the top of the culm; spikelets usually small and in alternate pairs along one side of the flattened rhachis, one sessile and one short-pedicelled; empty glumes two, or sometimes three, the lower one then being minute.

1. P. glabrum, *Gaud.*
2. P. sanguinale, *Linn.*
3. P. filiforme, *Linn.*
4. P. serotinum, *Trin.*

SECTION II.—*Trichachne.*—Spikelets densely silky hairy, or fringed with long hairs, sessile or short-pedicelled, in pairs or clustered along the rhachis of the numerous simple, erect, spikes or branches of the panicle, acute; lower glume very minute.

5. P. leucophæum, *H. B. K.*
6. P. lachnanthum, *Torr.*

SECTION III.—*Subspicata.*—Panicle linear or narrow, the branches short, sessile, erect or appressed, or the apex spicate.

Branches densely flowered:

7. P. paspaloides, *Pers.*
8. P. Curtisii, *Chap.*
9. P. obtusum, *H. B. K.*
10. P. reticulatum, *Torr.*
11. P. Texanum, *Buckl.*

Branches lax flowered:

12. P. Chapmani, *Vasey.*
13. P. Reverchoni, *Vasey.*
14. P. subspicatum, *Vasey.*
15. P. stenodes, *Gris.*

SECTION IV.—*Platyphylla.*—Panicle of few (three to six), simple, mostly sessile, spreading branches, the spikelets sessile in two rows on

one side of a flattened rhachis, as in *Paspalum*, but with a small lower glume.

16. P. platyphyllum, *Munro.*
17. P. plantagineum, *Link.*

SECTION V.—*Brachiaria.* Branches erect, or somewhat spreading, not appressed, mostly approximate and sessile.

18. P. prostratum, *Lam.*
19. P. cæspitosum, *Swz.*
20. P. fasciculatum, *Swz.*
21. P. grossarium, *Linn.*

SECTION VI.—*Polystachya.*—Branches of the panicle numerous, spreading, single or subfasciculate, simple, or with some short branchlets, flowering to the base (except in *P. hians*), spikelets sessile or very short pedicelled.

22. P. barbinode, *Trin.*
23. P. gymnocarpon, *Ell.*
24. P. repens, *Linn.*
25. P. anceps, *Mich.* (some forms).
26. P. laxum, *Swz.*
27. P. hians, *Ell.*

SECTION VII.—*Eupanicum.*—Branches of the panicle subdivided, single or fascicled, spreading and usually naked below, with the spikelets pedicelled, sometimes long-pedicelled.

Panicle small, narrow; branches few, erect.

28. P. ciliatissimum, *Buckl.*
29. P. xanthophysum, *Gray.*
30. P. pedicellatum, *Vasey.*
31. P. depauperatum, *Muhl.*
32. P. angustifolium, *Ell.*, non Chapman.

Panicle small but diffuse, oval or oblong:

33. P. nitidum, *Lam.*
34. P. laxiflorum, *Lam.*
35. P. dichotomum, *Linn.*
36. P. neuranthum *Gris.*
37. P. Joorii, *Vasey.*
38. P. nudicaule, *Vasey.*
39. P. consanguineum, *Kth.*
40. P. scoparium, *Lam.*
41. P. Wilcoxianum, *Vasey.*

Panicle larger, oval, or oblong:

42. P. spærocarpon, *Ell.*
43. P. microcarpon, *Muhl.*
44. P. viscidum, *Ell.*
45. P. commutatum, *Schultz* (P. nervosum, *Ell.*).
46. P. clandestinum, *Linn.*

Panicle larger, oval, or oblong—Continued.

47. P. latifolium, *Linn.*

48. P. scabriusculum, *Ell.? Chap.*

Panicle effuse; branches capillary and much subdivided, except in P. sparsiflorum (P. angustifolium Chap., non Ell.):

49. P. capillare, *Linn.*

50. P. autumnale, *Bosc.*

51. P. Hallii, *V. & S.*

52. P. proliferum, *Lam.*

53. P. miliaceum, *Linn.*

54. P. verrucosum, *Muhl.*

55. P. sparsiflorum (P. angustifolium, *Chap.*, non *Ell.*).

Tall grasses, with ample and diffuse panicle:

56. P. anceps., *Michx.*

57. P. agrostoides, *Muhl.*

58. P. bulbosum *H. B. K.* and var. avenaceum.

59. P. maximum *Jacq.* (P. jumentorum, *Pers.*).

60. P. amarum, *Ell.*

61. P. virgatum, *Linn.*

62. P. Havardii, *Vasey.*

SECTION VIII.—*Frutescentes.*—Culms frutescent, spikelets large and turgid, empty glumes loose.

63. P. divaricatum, *Linn.*

SECTION IX.—*Villiflora.*—Panicle diffuse, spikelets very large, the glumes very silky-villose.

64. P. Urvilleanum, *Kth.*

Section I.—DIGITARIA.

1. P. glabrum, *Gaud.* (Digitaria humifusa *Pers*).—Culms spreading, prostrate or erect, 5 to 12 inches long; leaves 1 to 2 inches long, smooth or pubescent; spikes 2 to 6, spreading, 1 to 2 inches long, approximate; spikelets oblong, about 1 line long, obtusish; empty glumes, mostly two (the lower one generally wanting), pubescent, both equaling the flower.

In cultivated and waste grounds less common than the following.

Variety Mississippiensis, *Gattinger.*—Taller (6 to 20 inches high), spikes longer (1½ to 3½ inches), spikelets acutish.

Vicinity of Nashville, Tenn. (Dr. Gattinger).

2. P. sanguinale, *Linn.* (Crab-grass).—Culm erect or decumbent, usually rooting at the lower joints, leaves and sheaths smooth or hairy, variable in length and breadth; spikes 3 to 10 or 15, spreading, digitate or approximate, 3 to 6 inches long; spikelets oblong-lanceolate, about 1½ lines long, acute, smoothish, pubescent; first glume minute, second half to two-thirds as long as the spikelet, third equaling the spikelet.

Variety ciliare (P. ciliare *Retz*).

Naturalized everywhere.

3. P. filiforme, *Linn.*—(Digitaria filiformis *Muhl.*).—Culms very slender, 1 to 3 feet high, erect, simple, or sparingly branched; leaves narrowly linear, 3 to 10 inches long, erect, somewhat pubescent, and with sheaths hairy, spikes 2 to 8, erect or somewhat spreading, 2 to 6 inches long; spikelets 1 line long or less, oblong, acute; empty glumes two, the lower slightly shorter and the upper equaling the flower.

Sandy or gravelly ground; Maine to Florida and westward.

4. P. serotinum, *Trin.* (Digitaria serotina *Mx.*; D. villosa *Ell.*).—Perennial, extensively creeping, much branched, making a thick carpet; flowering culms 6 to 10 inches; leaves short, erect, hairy, 1 to 2½ inches long, sheaths villous; spikes 3 to 5, about 2 inches long, narrow; spikelets less than 1 line long, acute, two empty glumes, the first one-quarter to one third as long, and the second nearly as long, as the spikelet.

North Carolina to Florida and westward.

Section II.—Trichachne.

5. P. leucophæum, *H. B. K.*—Culms stout, 2 to 4 feet high, erect; leaves broadly linear, 1 foot long, scabrous above, ligule ciliate; panicle racemose, contracted, dense, 6 to 10 inches long, the simple branches numerous, erect, fasciculate, 2 to 4 inches long; spikelets linear-lanceolate, acuminate, about 2 lines long; lower glume minute, second nearly as long as, and the third equaling, the perfect flower, which is linear-lanceolate and mucronate-pointed. Low, rich ground, South Florida, (Chapman, Curtiss, etc.).

6. P. lachnanthum, *Torr.*—Culms rather slender, 2 to 3 feet high; leaves much narrower and shorter, panicle shorter, more slender, with fewer and shorter spikes; spikelets smaller, 1 to 1½ lines long, ovate-lanceolate, the perfect flower ovate-lanceolate, acute and mucronate-pointed.

Mostly on dry hills, Texas, Arizona, and New Mexico.

Section III.—Subspicata.

7. P. paspaloides, *Pers.*—Culms 2 to 3 feet high, decumbent and rooting below, smooth, stout, leafy; leaves narrow, 6 to 10 inches long, becoming somewhat involute, and with the sheaths smooth; panicle 5 to 10 inches long, strict, of 10 to 20 appressed, sessile, simple branches, the lower ones 1 to 1½ inches long, above gradually shorter; spikelets ovate-oblong, obtusish, smooth, 1 to 1¼ lines long, imbricate in two rows on the narrow axis, the lower glume truncate-obtuse, one-third as long, and second glume two-thirds as long as the spikelets (also thin and obtuse).

In ditches or water, Florida to Texas and Mexico.

8. P. Curtisii, *Chap.*—Culms 3 to 4 feet high, often rooting at the lower joints; leaves linear-lanceolate, plane, rigid, 6 to 9 inches long, 6 to 9 lines wide, smooth, sheaths smooth or hairy; panicle slender,

spike-like, 6 to 8 inches long, of numerous appressed slender, single, or fascicled branches, the lower ones remote; spikelets ovate-lanceolate, acutish, about 1 line long, lower glume acute, keeled, half as long as the spikelet, the second a little shorter than the third, which equals the acutish perfect flower; second and third glumes strongly three to five nerved, sterile flower triandrous. Closely resembles the preceding.

Ponds and swamps, Florida to Texas.

9. P. obtusum, *H. B. K.*—Culms 1½ to 2 feet high, firm, leafy; sending off long (sometimes 8 to 10 feet) runners from the base; leaves 4 to 6 inches long, 2 to 3 lines wide; panicle 3 or 4 inches long, narrow, composed of four to seven approximate, appressed, sessile branches, the lower ones about 1 inch long, the upper becoming very short, densely flowered; spikelets mostly in alternate pairs of which one is sessile, the other short-pedicelled, forming three to four rows, turgid, oblong, obtuse, and 1½ lines long, lower glume two-thirds as long as the spikelet, five-nerved, second glume seven-nerved, third five-nerved, a little longer than the fertile flower; sterile flower triandrous.

Mexico, Texas, New Mexico to Colorado.

10. P. reticulatum, *Torr.*—Culms 10 to 15 inches high, much branched below, leafy; leaves 1½ to 3 inches long, acute, scabrous or pubescent, as also are the sheaths; panicle 2 to 3 inches long, lateral ones shorter, close or dense; branches single or fasciculate, unequal, 1½ or 2 inches long, the longer with interrupted spikelets; about 1½ lines long, single or in pairs, one sessile and one pedicelled, obovate, acutish; first glume one-fourth to one-third as long as the spikelet, acutish, second and third strongly five to seven nerved, and conspicuously reticulately veined.

Texas to Arizona.

11. P. Texanum, *Buckley.*—Culms stout, 2 to 4 feet high, branching from a decumbent and sometimes rooting base, leafy, smooth; leaves lanceolate, 4 to 10 inches long, 6 to 12 lines wide, smoothish or scabrous above and on the margins, sheaths softly and sparsely pubescent, nodes pubescent; panicle (the base generally inclosed in the upper sheath) 4 to 8 inches long, one-half to 1 inch wide, of 5 to 10 erect, rather slender, simple, erect branches, 1 to 3 inches long, closely flowered; rhachis scabrous-pubescent; spikelets single or in pairs, alternate along the angular rhachis, oblong, lanceolate, acute, 2 to 2½ lines long, smooth, or finely pubescent; first glume broadly ovate, half to two-thirds as long as the spikelets, acute, five nerved, second and third glumes equaling the spikelet, strongly five to seven nerved, perfect flower ovate or oblong-ovate, acutish, transversely wrinkled with fine reticulated striæ.

Cultivated for a forage grass. Texas.

12. P. Chapmani, *Vasey.* (P. tenuiculmum, *Chap.* non *Meyer*).—Culms filiform, 1½ to 2½ feet high, erect, simple; leaves chiefly radical, linear, half as long as the culm, about 2 lines wide, upper ones shorter; panicle 6 to 12 inches long, of eight to twelve remote, slender, erect spikes, the

upper ones short and few (three to six) flowered, sessile, one-half inch long, the lower longer, sometimes subdivided, and with long, sheathed peduncles; rhachis flexuous, bristle-like at the apex, spikelets about one line long, ovate, lower glume one-half as long as the spikelet, obtuse, upper glume nine-nerved.

Florida (Chapman, Curtiss, Garber).

13. P. Reverchoni, *Vasey.* (distributed by Reverchon as Setaria uniseta).—Culms filiform from a thick, strong rootstock, erect, 10 to 18 inches high, simple; leaves chiefly radical, long and narrow, half as long as the culm; panicle 3 to 6 inches long, slender, an interrupted spike, at least above, below with short, three to five-flowered, remote, fasciculate branches; spikelets 1½ lines long, plano-convex, obtusish; lower, glume one-half as long as the spikelet, three-nerved, second and third seven-nerved; rhachis terminated by a short bristle, sometimes also a bristle below the spikelets.

Texas (Reverchon).

14. P. subspicatum, *Vasey.*—Culms 10 to 18 inches high, leafy; upper leaves longer than the lower (lowest 1 inch, highest 5 inches), 1 to 2 lines wide, rather rigid, light green, acute; panicle spicate at apex, below with five or six short, approximate, appressed, rather lax branches, one-half inch to 1 inch long; spikelets 1 line long, a little curved, lower glume one-half as long as the spikelet, second glume seven-nerved, third glume five-nerved; rhachis with a short bristle at apex and sometimes a bristle below the spikelets. Leaves shorter and more rigid, spike shorter and closer, and spikelets smaller than in the preceding.

Texas (Buckley, Nealley).

These three (12, 13, and 14) form a natural group.

15. P. stenodes, *Gris.* (P. anceps var. strictum *Chap.*).—Culms 2 to 3 feet high, wiry, smooth; leaves erect, rigid, narrow (1 to 2 lines), 3 to 4 inches long; panicle narrow, 2 to 3 inches long, of five to six slender, short, appressed branches, sessile or nearly so, mostly single, sometimes two or three together; spikelets about 1 line long, lanceolate, acute; first glume half as long as the spikelet; second and third five-nerved, acute. In ponds and water.

Florida to Alabama (Dr. Mohr) and Texas (Nealley).

Section IV.—Platyphylla.

16. P. platyphyllum, *Munro.*—Culms decumbent and rooting at the lower joints, 1 to 2 feet high, branching below, pale green in color; leaves lanceolate, 3 to 4 inches long, 4 to 6 lines wide, smooth, firm, the base clasping; margins scabrous, pale green; sheaths smooth, striate, the upper one inclosing the base of the panicle, which consists of three to five simple, sessile, alternate, slightly spreading, distant branches, each 1½ to 3 inches long; spikelets sessile, and alternate on a flattened rhachis; lower glume thin, obtuse, one-third as long as the sec-

ond and third, which are five-nerved, smooth, and one-third longer than the obtuse fertile flower; sterile flower of a glume only.

Texas (E. Hall, G. C. Nealley).

17. P. plantagineum, *Link.*—Much like the preceding, but stouter and larger, with larger and wider leaves (6 to 10 inches by 6 to 9 lines), the spikes more remote, longer (2 to 4 inches), and the lower peduncled in the sheaths; spikelets much like the preceding.

Introduced on ballast ground at Philadelphia.

Section V.—Brachiaria.

18. P. prostratum, *Lam.* (P. cæspitosum *Swz?*).—Culms creeping and rooting at the base, then ascending, 1 to 2 feet long, with rather distant leaves, which are 1½ to 2 inches long, lanceolate or ovate-lanceolate, acute, clasping at the ciliate base, sheaths shorter than the internodes; panicle exserted, short, about 2 inches long, of five to eight simple or subsimple branches, the lowest of which are 1 to 1½ inches long, closely flowered; rachis frequently with stiff hairs; spikelets three-quarters of a line long, smooth, first glume one-quarter as long as the spikelet, second and third equal; perfect flower striate-punctulate, mucronate-pointed. Our specimens agree with Trinius, Fig. 185 A.

Louisiana (Langlois), Texas (Nealley).

19. P. cæspitosum, *Swz.?*—Culms numerous, succulent, and thickish, rooting at the base, ascending to 1 or 2 feet long; leaves crowded below, erect, linear-lanceolate, 2 to 4 inches long, 3 to 4 lines wide, ciliate on the margins, striate, lower sheaths inflated, panicle about 2 inches long, of five to eight branches becoming long exserted, rhachis and branches hairy and angular, lower branches about 1 inch long; spikelets 1¼ to 1½ lines long, ovate-oblong, acute, lower glume one-third as long as the spikelet, perfect flower as in the preceding but larger. The whole plant pale green.

Probably in Texas and New Mexico, certainly in Chihuahua, Mexico. (Pringle, No. 375.)

20. P. fuscum, *Swz.* (P. fasciculatum *Sw.*).—Culms 1 to 3 feet high, decumbent and branching at base; leaves linear or lanceolate-linear, 3 to 10 inches long, glabrous or pubescent; panicle 3 to 6 inches long, spreading, the branches simple or more or less fasciculated below, the lower about 2 inches long; rhachis hairy; spikelets in pairs or in small clusters, 1¼ lines long, acutish, lower glume about one-third as long as the spikelet, deltoid, second and third glumes five to seven nerved, and cross-nerved.

Texas.

Variety major; culms stouter, 2 to 3 feet high, branched, sheaths and leaves scabrous-punctulate or smoothish, leaves broader, acuminate; panicle fuller, 3 to 6 inches long, branches more numerous (up to twenty or thirty), scattered and fasciculate, rhachis and branches scabrous, and with scattered hairs.

Mexico (Dr. E. Palmer).

Variety fasciculatum (P. fasciculatum, *Sw.*); leaves longer and wider (8 to 10 lines wide), panicle 4 to 5 inches long, the branches very numerous, spikelets becoming dark brown.

Southern Florida.

21. P. grossarium, *Linn.*

Specimens from ballast ground at Philadelphia have been referred to this species, but if correct it seems too near P. fuscum.

Section VI.—Polystachya.

[Small forms of P. anceps might come in this group.]

22. P. barbinode *Trin.* (Para-grass).—Culms 2 to 6 feet high, stout, ascending; nodes villous; leaves linear-acuminate, glabrescent; panicle lax, 6 to 8 inches long, branches mostly simple or a few, fascicled, spreading, about 2 inches long, somewhat distant, spikelets 1 to 1½ lines long, glabrous, one-sided, spreading, lowest glume deltoid, one-fourth as long as the spikelet, one-nerved, second and third equaling the spikelet, five-nerved; fertile flower ellipsoidal, bluntish. Introduced and cultivated in the South.

23. P. gymnocarpon, *Ell.*—Perennial. Culms 2 to 4 feet high, erect, rigid, smooth; leaves lanceolate, smooth, 1 foot long or more, 1 inch or more wide, cordate at base, sheaths shorter than the internodes, striate, nodes black; panicle large, 9 to 15 inches long, branches 4 to 6 inches long, erect-spreading, scattered or 2 to 3 together, racemose, spikelets in nearly sessile clusters of 3 to 6, appressed along the branches, somewhat one sided, 2½ to 3 lines long, lanceolate, outer glumes nearly alike, lanceolate-subulate, rough-keeled, two to three times longer than the perfect flower, first glume three-nerved, a little to one-third shorter than the second and third, which are about five-nerved, the third glume or neutral flower with a palet one-half as long.

Florida to Texas.

24. P. repens, *L.*—Culms 1½ to 2 feet high, from strong creeping rhizomas, leafy, covered below with loose sheaths with short or deficient blades, the blades becoming longer upward, conduplicate or involute, the uppermost 3 to 4 inches long, sometimes pubescent at the base; panicle erect, thin, 3 to 4 inches long, the branches alternate, naked at base, erect or slightly spreading, the lower ones each with two or three rather long, appressed branchlets; spikelets short-pedicelled and appressed, interrupted or racemose along the slender branches, 1 line long, oval, acute, smooth, the lower glume broad, obtuse, one-third as long as the spikelet, second and third about seven-nerved.

Sandy shores of the Gulf, Florida to Texas.

Variety confertum, *Vasey.*

Culms shorter, leaves very divergent and rigid, panicle more condensed, the branches shorter and spikelets more crowded, lower glume rather longer and less obtuse.

Mobile, Ala., to Vera Cruz, Mex. (2177 F. Muller.)

25. P. anceps, *Mich.*—See No. 56.

26. P. laxum *Sw.* of this group, common in the West Indies, is probably also in southern Florida, but I have seen no authentic specimens.

27. P. hians, *Ell.*—Perennial, culms slender, smooth, 6 to 18 inches high, simple, from slender, wiry, creeping root-stocks; leaves linear, 3 to 5 inches long, 1 to 2 lines wide, smooth, erect; panicle rather small, 3 to 5 inches long, the slender, racemose branches 1 to 2 inches long, erect-spreading, mostly single and distant, the lower third naked; spikelets about 1 line long, in small, nearly sessile, approximate clusters, outer glumes ovate, acute, generally three-nerved, the lower one-half as long as the spikelet, third glume longer than the second and having a thick, rigid, obovate palet rather longer than its glume, and spreading apart from it, hence probably the name *hians*, from *hio*, to gape.

North Carolina to Texas.

28. P. ciliatissimum, *Buckl.*—Culms procumbent and much branched, often rooting at the joints, at first short-jointed and much condensed, with leaves 1 to 1½ inches long, and the panicles short and invaginate, becoming elongated, with long-exserted panicles (lateral and terminal) which become 1½ to 2 inches long, narrow, with a few short, few-flowered, appressed branches, and linear-lanceolate, acuminate leaves, 2 to 4 inches long, ciliate on the margins below, with sparsely ciliate and hairy sheaths, the nodes white-woolly; spikelets ovate, acute, 2 lines long, pubescent or villous; the lower glume lanceolate, acute, three-nerved; smooth, except at the base, two-thirds as long as the spikelet; second, eleven to thirteen nerved; pubescent to densely villous, with a smooth, acute, hardened point; the third one, or flowering glume of the sterile flower a little shorter than the second, five-nerved, ciliate on the margins, its palet equally long, ovate, thin, the fertile flower one-fourth to one-third shorter than the largest glume, obtusish, minutely furrowed.

Texas.

Section VII.—Eupanicum.

29. P. Xanthophysum, *Gray.*—Culms erect, 1 to 2 feet high, simple or branched near the base; leaves lanceolate, acuminate, 4 to 6 inches long, 5 to 10 lines wide, smooth except the scabrous margins, strongly nine to eleven nerved, rather contracted at the ciliate, clasping base; panicle long-exserted, 2 to 4 inches long, of a few simple, erect or appressed, few-flowered branches; spikelets obovate, 1½ lines long, minutely downy; lower glume about half the length of the spikelet, second and third about nine-nerved.

Plant yellowish-green. Canada to Pennsylvania and Wisconsin.

30. P. pedicellatum, *Vasey.*—Culms 1 to 2 feet high, slender, branching below, smooth; culm leaves 2 to 3 inches long, 2 to 3 lines wide, gradually tapering to an acute point, erect, somewhat rigid; main panicle long exserted, the lateral ones less so, all small and few flowered, 1½ to 2

inches long, of four or five alternate short branches each only two to three flowered; spikelets long-pedicelled, oblong-obovate, obtuse, 1½ lines long, sparsely pubescent, the lowest glume at some distance from the others, ovate, one-nerved, nearly half as long as the spikelet, second and third glumes oblong, obtuse, seven-nerved.

Texas, J. Reverchon.

Resembles P. angustifolium, *Ell.*, but is smaller, with smaller, fewer-flowered panicle, and rather smaller spikelets.

31. P. depauperatum, *Muhl.*—Culms erect, simple, tufted, 6 to 16 inches high; leaves of the culm about three, erect, narrowly linear, 3 to 6 inches long, sheaths usually pubescent; panicle small, 1 to 2 inches long, contracted, sometimes overtopped by the upper leaves; spikelets 1 to 1½ lines long, obovate, lower glume one-third the length of the seven to nine nerved upper ones. Common east of the Mississippi.

Variety laxa.—Weaker stemmed, panicle with longer and more spreading branches (1½ to 2 inches) the lower ones single, or verticillate; spikelets smaller.

Virginia, Florida, Texas, Arkansas, Missouri.

32. P. angustifolium, *Ell.*, non *Chapman.*—Culms weak, slender, smooth, 1 to 2 feet long, diffusely branched from the base; leaves linear, 3 to 5 inches long, 1 to 2 lines wide; sheaths short, nodes thickened; panicles simple, terminal and lateral, 3 to 5 inches long; the few branches single, capillary, distant, 1 to 3 inches long, bearing each two to six spikelets which are mostly in pairs at the end of the branchlets; spikelets oblong-obovate, acute, 1½ lines long, the outer glumes papillose-hispid, the lower one minute, acutish.

South Carolina to Texas.

33. P. nitidum, *Lam.*—Culms 10 to 20 inches high, slender but firm, rarely branched, smooth; leaves mostly at the base of culm, lanceolate or lance-linear, 1 to 2 inches long, rather rigid, and with the sheaths smooth, the culm leaves few and smaller; panicle ovate or oblong, 1½ to 2½ inches long; branches verticillate below, the lower ones, 1 to 1½ inches long, spreading, capillary, numerously flowered; purplish spikelets on pedicels 2 to 4 times as long, oval, one-half to two-thirds line long, pubescent, the lowest glume one-fourth to one-third the length of the spikelet.

(*a*) Variety minor (P. ramulosum of Chapman's supplement, but I think cannot be the plant of Michx.).—Lower than the type (6 to 8 inches high); tufted; leaves narrower and smaller; panicle 1 to 1½ inches long; rhachis smooth; spikelets smooth or nearly so; second and third glumes five-nerved.

Florida.

(*b*) Variety ensifolium (P. ensifolium *Bald.*).—Radical leaves linear lanceolate, 1½ inches long, smooth, those of the slender (8 to 12 inches long) culm, distant, small (about one-half inch), and horizontally diver-

gent; panicle depauperate, less than an inch long, the rays single and few flowered. Described from Dr. Chapman's specimens.

Florida.

(*c*) var. major.—Here I could place several variable forms, mostly smooth, with stouter culms, a more open, less dense panicle, with fewer and stouter branches (sometimes reflexed), and fewer and larger spikelets.

34. P. laxiflorum, *Lam.*—Culms erect, weak, 6 to 18 inches high, rarely branched, smooth below the panicle; leaves linear or lanceolate-linear, 3 to 7 inches long, 3 to 4 lines wide, mostly radical, the 2 or 3 of the culm little shorter, acuminate, nearly smooth except on the ciliate margins, pale green or yellowish-green; sheaths mostly shorter than the leaves, sparsely and retrorsely villose; ligule a ring of soft, white hairs, panicle capillary, 2 or 3 inches long, branches sparingly divided from the base, mostly single, alternate and few flowered, spreading; the rhachis and branches sparsely long-hairy; spikelets long-pedicelled, 1 line long, oval, or elliptical, obtuse, strigosely pubescent, lower empty glume ovate, one nerved, one-quarter as long as the spikelet; second and third glumes seven to nine nerved; fertile flower as long as the spikelet, acutish. In sandy woods.

Var. pubescens.—Culm rather stouter, and pubescent, 12 to 15 inches high; leaves hairy, shorter, lanceolate, the lower 2 to 2½ inches long, 3 to 5 lines wide, the upper about 1 inch, upper sheath elongated; panicle 2 to 3½ inches long, the branches and spikelets more numerous, and spikelets smaller; lowest glume roundish ovate, one-third as long as the spikelets; second and third glumes five to seven nerved. Closely approaches P. nitidum, and is perhaps the P. nitidum, var. ciliatum, Torr.

35. P. dichotomum, *Linn.*—Culm 10 to 30 inches high; at first mostly simple, smooth, or pubescent, bearing a more or less exserted, spreading, compound panicle, 1 to 4 inches long, and lanceolate, flat leaves; those of the culm larger above, 3 to 4 inches long; those at the root tufted, usually ovate-lanceolate, short, and thick; the culms commonly branching later in the season, the branches often clustered, and bearing smaller, mostly included panicles; spikelets about 1 line long (two-thirds of a line to 1 line), oblong-obovate, pubescent or downy, lower glume one-third as long as the spikelet.

(*a*) Variety barbulatum.—With the nodes barbed, and with the sheaths smooth or pubescent.

(*b*) Variety viride.—Smooth all over, leaves light green and narrower.

(*c*) Var. divaricatum.—Erect, 6 to 9 inches high, slender, smooth, very much branched above the base, caespitose, the radical leaves very short and tufted, those of the culm and branches very narrowly linear or involute, acuminate, about 1 inch long, divaricate, the numerous panicles small, racemose, few flowered; the spikelets on alternate, filiform pedicels one-half inch to 1 inch long; spikelets three-fourths of a line long, oval-oblong, smooth, the lower glume one-third as long as the spikelet; second glume one-third shorter than the spikelet, five-nerved; third

glume equaling the spikelet, seven-nerved; fertile flower as long as the spikelet.

(*d*) Variety villosum (P. villosum *Ell.*?—Culms decumbent, branching from the first, leaves scabrous above, ciliate, sheaths and culms villose, panicle thinner and fewer-flowered.

(*e*) Var. elatum.—Culms tall (2 to 3 feet), erect, smooth; cauline leaves 4 to 5 inches long, 5 to 6 lines wide, smooth, very acute; panicle 4 inches long, smooth, the branches long, erect-spreading, rather sparsely flowered; spikelets a little more than 1 line long, smooth, oblong, acutish, the lower glume ovate, acute or acutish, nearly half as long as the spikelet, fertile flower shorter than the spikelet.

36. P. neuranthum *Gris.*—Erect or ascending, about 1 foot high, slender, smooth; leaves linear-acuminate, 2 to 4 inches long, firm, flat or subinvolute; terminal panicle long exserted, 1 to 2 inches long, with few-flowered, divergent branches, the lateral panicles numerous, narrow, short (less than 1 inch long), oval, pubescent, lower glume minute, deltoid, nearly nerveless, one-third to one-fourth as long as the spikelet, second and third seven-nerved, equaling the fertile flower, which is ovoid, obtuse, and smooth.

(a) Variety ramosum *Gris.*—Ascending, much branched, leaves flat or involute, very narrow; spikelets 1 line long, elliptical, obtuse.

South Carolina, Florida to Texas.

37. P. Joorii, *Vasey.*—Culms about 1 foot high, much branched above, very leafy; leaves 4 to 6 inches long, 6 to 10 lines wide, thinnish, smooth, those of the extreme branches smaller; panicles numerous, small, inclosed in the sheaths, few-flowered; spikelets oblong, over 1 line long, sparsely pubescent.

Louisana (Dr. J. F. Joor); Mississippi (Professor Tracy).

This is very unusual in its abundant, large leaves, and condensed form, growing in dense tufts.

38. P. nudicaule, *Vasey.*—Culms 1½ to 2 feet high, slender, with 2 or 3 long internodes; leaves mostly near the base, linear lanceolate 2 to 4 inches long, 2 to 3 lines wide, smooth, light green, the 2 to 3 culm-leaves distant, narrow, giving the culm a naked appearance; panicle long-exserted, small, smooth, 2 to 3 inches long, 1 inch wide, sparsely flowered, branches alternate; spikelets elliptical-oblong, acute, 1¼ lines long, smooth, the lower glume very small (one-fifth as long as the spikelet), second glume seven nerved, third, five nerved, fertile flower one-fourth shorter than the spikelet.

Swamps, Santa Rosa County, Fla. (A. H. Curtis).

39. P. consanguineum, *Kth.* (P. villosum *Ell.*).—Culms about 1½ feet high, erect, branching in age; leaves linear-lanceolate, mostly about 3 inches long, 2 to 5 lines wide, the later ones almost filiform, somewhat pubescent, sheaths villose; panicle 2 to 3 inches long, open, rather thin; spikelets 1 to 1¼ lines long, pubescent.

South Carolina to Florida.

40. P. scoparium *Lam.* (P. pauciflorum, *Ell.*).—Culms erect, becoming branched and reclining, 1 to 2 feet high, somewhat scabrous; leaves erect, about 3 inches long, 4 to 5 lines wide, faintly nerved, scabrous on the margins, hairy-fringed near the base, the sheaths bristly with stiff, spreading hairs, or smoothish; the panicle 2 to 3 inches long, spreading, open, branches smooth, mostly simple, alternate, rather few flowered; spikelets 1½ to 1¾ lines long, oval to obovate, hairy or smoothish, lower glume about one-third as long as spikelet.

New England to California and southward. A widespread species.

(*a*) Var. major (P. scoparium, *Ell.*).—This differs from the preceding in its stouter, rougher culm, larger leaves, 4 to 6 inches long, three-fourths of an inch wide (1 to 1½ inches wide, Elliott), which are soft-pubescent below, and its spikelets 2 lines long.

We have only seen this from South Carolina (Dr. Ravenel).

(*b*) Var. angustifolium.—Culms tall and erect, 2 to 3 feet high, branching; leaves longer and narrower than the type, 3 or 4 inches long, 3 to 4 lines wide, rather rigid, sheaths sparsely pubescent; panicle long-exserted, 3 to 4 inches long.

South Carolina (Dr. Ravenel); Illinois (Dr. Schenck); Fortress Monroe, Va. (Vasey).

(*c*) Var. Liebergii (P. Liebergii, *Scrib.*).—Culms tall and erect, unbranched, 2 feet high; leaves lanceolate, distant, 3 to 4 inches long, 6 to 9 lines wide, scabrous or papillose, hairy, about eleven-nerved, sheath shorter than the internodes, ciliate, or the margins somewhat scabrous and sparsely hairy, panicle about 3 inches long, 1 inch wide, the fewish branches erect-spreading and few-flowered; spikelets obovate, obtuse, 1¾ lines long, the outer glumes papillose, hairy, lower glume ovate or ovate-lanceolate, pointed, nearly half as long as spikelet, second glume seven-nerved, third glume nine-nerved, equaling the flower, having a hyaline palet of nearly its own length, and inclosing three stamens.

Plymouth County, Iowa (John Lieberg).

41. P. Wilcoxianum, *Vasey.*—Culms about 6 inches high, entire or sparingly branched and with the leaves more or less white-hairy; leaves linear-lanceolate, erect, acuminate, 2 to 3 inches long, hairy both sides, rather rigid, sheaths striate, hairy, mostly longer than the internodes, ligule obsolete; panicle oblong, rhachis zigzag, 1 inch long, lower branches subverticillate, short, spikelets about 1¼ lines long, pubescent, lower glume ovate, one-fourth as long as the spikelet, second and third glumes with five to seven broad nerves, the third hardly as long as the flowering glume.

Nebraska (Dr. T. E. Wilcox).

42. P. sphærocarpon, *Ell.*—Culms 15 to 24 inches long, 5 to 7 lines wide, lanceolate, acute, obscurely nerved, smooth except at the ciliate-cordate base, sheaths shorter than the joints, smooth; panicle 3 to 4 inches long, spreading, spikelets oval, five-eighths to three fourths of a line long,

smoothish, lower glume one-third as long as the spikelet. Differs from P. dichotomum in its more rigid, smooth, pale leaves, with cordate base.

Dry or moist ground, of same range as the next species.

Var. Floridanum.—Culms 1½ to 2½ feet high, rigidly erect, leaves rigid, erect, six to seven on the culm, lanceolate, smooth, about 3 inches long, 5 to 6 lines wide, the margins near the base, and sheaths ciliate; panicle oval to oblong, 3 to 5 inches long, and spikelets one-half line long, pubescent, the lower glume one-fourth or one-fifth as long as the spikelet.

Florida.

Described by Dr. Chapman as P. sphaerocarpon *Ell.*, but it hardly agrees with Elliott's description. It is intermediate between P. microcarpon and P. sphærocarpon.

43. P. microcarpon, *Muhl.* (P. multiflorum, *Ell.*).—Culms 2 to 3 feet high, stout, erect, smooth; leaves 4 to 7 inches long, 9 to 12 lines wide, lanceolate, gradually tapering to a slender point, with nine to eleven nerves, roughish above and on the margin, sometimes bristly-ciliate at the rounded, clasping base, smooth on the under side, sheaths mostly longer than the internodes, smooth except on the margins; ligule nearly obsolete, panicle becoming long-peduncled, 3 to 7 inches long, 1 to 2 inches broad, spreading, multiflorous, branches mostly verticillate, very numerous, flowering to the base, spikelets mostly long-pediceled, oval, five-eighths of a line long, nearly smooth, lower glume one-fourth as long as spikelet, second glume 7-nerved.

Low ground, Massachusetts to Texas.

44. P. viscidum, *Ell.*—Culms 2 to 4 feet high, stout, becoming much branched, leafy, velvety-downy all over, except a narrow ring below each node; sheaths soft-downy, the hairs spreading or reflexed and often viscid, leaves downy or smoothish, lanceolate, 4 to 8 inches long, diffuse, the branches numerous and much subdivided, spikelets fully 1 line long, oblong-obovate, pubescent, lower glume one-fourth to one-fifth as long as the 7 to 9 nerved upper one.

Common.

45. P. commutatum, *Schultz* (P. nervosum, Muhl.).—Culms 2 to 2½ feet long, erect, unbranched, rather slender, smooth; leaves at the base rigid, ovate-lanceolate, the three or four culm leaves firm but not rigid, mostly 3 to 4 inches long, 8 to 12 lines wide, acuminate, cordate at base, smooth except on the margins, sheaths smooth or somewhat pubescent, much shorter than the nodes; panicle peduncled, 3 to 5 inches long, 2 to 3 inches wide, open, rather thin, branches smooth, single or subverticillate; spikelets rather long-pedicelled, oblong, sparsely hairy, 1 to 1¼ lines long, lower glumes one-third as long as the spikelet, second about five, and third seven nerved. A fine species, in

appearance like P. clandestinum, but more slender, with shorter leaves, and smaller spikelets, which are early deciduous.

Pennsylvania to Texas.

(*a*) Var. minor, differs from the preceding in its rather smaller size (1½ to 2 feet) and smaller panicle, and the spikelets more persistent.

Southern States.

46. P. clandestinum, *Linn.*—Culms rigid, 2 to 3 feet high, leafy to the top, rarely branched, upper nodes smooth, the lower often hairy; sheaths smoothish, or the lower ones often rough with papillose, bristly hairs, shorter than the internodes, leaves large, lanceolate to oblong-lanceolate, 4 to 8 inches long, 9 to 15 lines wide, with a cordate, clasping base, very taper-pointed, smooth except the rough margins; panicle at first partially sheathed, becoming long-pedunculate, somewhat oblong in outline, 4 to 6 inches long, open and becoming spreading, branches verticillate; spikelets 1½ lines long, slightly pubescent or smooth, oblong-ovate to obovate, the lower glume acutish, nearly one-half as long as the spikelet, second and third equal, many nerved; perfect flower oblong, pointed.

New England to Virginia, North Carolina, and westward to Illinois.

47. P. latifolium, *Linn.*—Culms 1 to 2½ feet high, smooth, mostly simple, the nodes (generally) and the collar of the sheath soft woolly-hairy, sheaths smooth or more or less pubescent; leaves broadly lanceolate from a cordate, clasping base, 3 to 4 inches long, about three-fourths to 1½ inches wide, tapering to a point, roughish above, smooth, or sparsely hairy below, eleven to thirteen nerved; panicle more or less exserted, becoming long-peduncled, 2 to 4 inches long, the branches mostly alternate, spreading, rather few flowered; spikelets 1½ to 2 lines long, obovate, sparsely pubescent, the lower glume one-third, or less than one-half as long as the spikelet, upper one about nine nerved.

Maine to Texas.

(*a*) Variety molle; downy all over.

Virginia to Louisiana.

(*b*) Var. australis; leaves more contracted at base, and spikelets larger, 2 to 2½ lines.

Alabama to Texas.

48. P. scabriusculum, *Ell.? Chap.* (P. Nealleyi, *Vasey*).—Culms 3 to 4 feet high, firm, smooth, rarely branched; leaves linear-lanceolate, 4 to 8 inches long, one-half inch wide, long-pointed, firm, mostly smooth except near the base, sheaths shorter than the joints, mostly smooth, or sometimes sparsely pubescent; panicle larger, 5 to 8 inches long, diffuse, smooth, branches mostly alternate, much divided, the larger ones 3 inches long; spikelets ovate, acutish, sparingly pubescent when young, becoming smooth, lower glume small, second glume strongly seven to nine nerved.

North Carolina to Texas.

This is the P. scabriusculum described by Chapman, but does not ap-

pear to me to answer that of Elliott, who compares his with P. virgatum.

49. P. capillare, *Linn.*—Culms 10 to 20 inches high, mostly branched at the base, rather robust, erect or ascending, sheaths and usually the leaves copiously hairy or hirsute; panicles, lateral and terminal, half to two-thirds the length of the plant, vaginate below, much branched, the branches divaricate when old; spikelets ovoid to oblong or lanceolate, obtusish, acute or even acuminate, three-fourths to nearly 2 lines long, smooth, on long capillary pedicels, lower glume one-half to two-thirds as long as the spikelet, obtuse to acuminate, fertile flower obtusish, rather shorter than the spikelet.

All over the continent.

a. variety campestre, *Gattinger.*—Culms slender, 1½ to 2 feet high, much branched, leaves and sheaths sparsely hirsute, panicle, rather pyramidal, much shorter than in the type (4 to 6 inches long, more open and thinly flowered, spikelets three-fourths of a line long, smooth, oblong, rather acute, lower glume obtusish.

Tennessee, Dr. Gattinger.

b. variety flexile, *Gattinger.*—Culms slender, 1½ to 2½ feet high, branched below, leaves linear, 6 to 10 inches long, narrow, erect, smooth or smoothish, sparsely ciliate on the margins and sheaths, panicle longer and narrower than in the preceding, 5 to 9 inches long, 2 to 4 inches wide, branches slightly spreading, single or in twos, smooth; spikelets 1¼ lines long, lanceolate-acuminate, lower glume acute, perfect flower one-third shorter than the spikelet.

Tennessee, Dr. Gattinger.

50. P. autumnale, *Bosc.* (P. divergens, *Muhl.*).—Culms 12 to 18 inches high, erect or decumbent below; leaves comparatively small, 2 or 3 inches long, 2 to 3 lines wide, smooth except on the scabrous or undulate margins, sheaths smooth or the lower ones, sparsely hairy, ligule membranaceous, obtuse, conspicuous; panicle very effuse, one-third the length of the culm or more, the capillary branches long and sparingly divided, often reflexed at maturity, and somewhat scabrous, the axils sometimes sparsely hairy, the branchlets or pedicels long, naked, and terminated by a single spikelet, which is spindle-shaped or obovate, 1 to 1½ lines long, acute, the lower glume very minute (one-sixth to one eighth as long as the spikelet), second and third glumes acute, ciliate near the apex, or in southwestern specimens (variety pubiflorum), pubescent all over, but little longer than the acute flowering glume.

Illinois to Texas and the Southern States.

51. P. Hallii, *V. & S.*—Culms slender, 1 to 2 feet high, branching; leaves slender, 4 to 6 inches long; sheaths sparsely pubescent or smooth; panicle open, diffuse, 4 to 5 inches long, sparsely flowered; spikelets 1½ lines long, acute, smooth, lower glumes half as long as spikelets, perfect flower a little shorter. More slender than P. capil-

lare, with smoother culms, smaller panicles, stouter branches, and rather larger spikelets.

Texas.

This species has resemblance to P. capillare on one side and to P. proliferum on the other. From the first, it is distinguished by its more erect slender culms, never more than sparsely pubescent, smaller panicle, with erect spreading stouter branches, and usually larger or thicker spikelets; from the second, by its smaller size, more erect culms, and smaller panicles, with shorter branches.

52. P. proliferum, *Lam.*—Annual. Culms usually thickish, often succulent, branching, geniculate at the decumbent or procumbent base, 1½ to 3 feet long, glabrous; leaves linear, 6 to 12 inches long, sheaths flattened, glabrous, ligule ciliate; panicles terminal and lateral, 4 to 12 inches long, the long, slender, primary branches at length spreading and diffuse; spikelets 1 to 1½ lines long, pale green, sometimes purplish, appressed, short pedicelled, lower glume broad, obtusish, about one fourth as long as the spikelet, perfect flower a little shorter than the spikelet.

Damp places, Maine to Texas.

(*a*) Var. geniculatum (P. geniculatum, *Ell.*).—Culms 3 to 6 feet high, succulent, sometimes nearly an inch thick at the base, bent and branching at the joints, leaves sometimes 2 feet long and 6 to 10 lines wide; sheaths much inflated when young, sometimes a little hairy at the base; panicle sometimes 2 feet long, very diffuse. A valuable grass.

Southern States to Texas.

53. P. miliaceum, *Linn.*—Culms 2 to 4 feet high, erect, branched, pubescent; sheaths loose, striate, hirsutely pubescent; leaves flat, linear-lanceolate, 6 to 10 inches long, 4 to 8 lines wide, smoothish above, sparsely pubescent below; panicle oblong, nodding, 6 to 10 inches long, branches verticillate, erect-spreading (not diffuse), solitary or in pairs, angular, hispid, or scabrous; spikelets ovate, acuminate, glabrous, 2 lines long, lower glume broad, very acuminate, five-nerved, about one-half as long as the spikelet, the third glume seven to nine-nerved, a little longer than the oval, acute, biconvex, perfect flower.

Cultivated, and rarely escaped from cultivation. Valuable for forage.

54. P. verrucosum, *Muhl.*—Culms slender, 1 to 3 feet long, somewhat branching, smooth; leaves linear-lanceolate, 3 to 4 inches long, 2 to 3 lines wide, and with the sheaths glabrous; panicles mostly terminal, 6 to 10 inches long, diffusely-spreading, branches mostly single, capillary, rather few flowered; spikelets three-fourths to 1 line long, obovate or oval, obtuse or abruptly acute, the outer glumes roughened with fine warts, the lower one about one-fourth as long as the spikelet; perfect flower, acute, about equaling the spikelet.

New England to Florida and Mississippi.

55. P. sparsiflorum, *Vasey.* (P. angustifolium, *Chap.* non *Ell*).—Culms weak, slender, smooth, 1 to 2 feet long, diffusely branched from

the base; leaves linear, 3 to 5 inches long, 1 to 2 lines wide; sheaths short; nodes thickened; panicles simple, terminal and lateral, 3 to 5 inches long, the few branches single, capillary, distant, 1 to 3 inches long, bearing each 2 to 6 spikelets, which are mostly in pairs at the end of the branchlets; spikelets oblong-obovate, acute, 1½ lines long, the outer glumes papillose hispid, the lower one minute, acutish.

South Carolina to Texas.

56. P. anceps, *Michx.*—Culms flattened, erect, 2 to 3 feet high, less stout than in P. agrostoides, from strong creeping root-stocks; leaves rather broadly linear, a foot or more long, 4 to 5 lines wide, smooth or the lower ones with the sheaths pubescent; panicles contracted, lateral and terminal, 6 to 12 inches long, the branches from single to verticillate, rather distant, particularly below, generally very abundantly flowered; spikelets 1 to 1½ lines long, ovate to lanceolate, pointed, the apex a little curved, lower glume about one-half as long as the spikelet, upper glume five to seven-nerved.

✓ (*a*) Var. pubescens.—Leaves and sheaths more or less pubescent; panicle and branches slender; spikelets ovate-lanceolate, acute, little more than 1 line long.

Mobile, Ala. (Dr. Mohr).

✓ (*b*) Var. angusta.—Lower sheaths villose; leaves very long and narrow, erect, rigid; spikelets narrowly lanceolate, acuminate, 1½ lines long, the lower glume one-third as long as the spikelet.

Texas (G. C. Nealley).

✓ (*c*) Var. densiflorum.—Leaves broad; panicle glomerate and interrupted, the branches densely flowered; spikelets lanceolate, 1½ lines long.

Texas (J. F. Riggs).

57. P. agrostoides, *Spreng.*—Culms flattened, erect, stout, 2 to 4 feet high, usually in thick clumps, glabrous, much branched above, the branches erect; leaves linear, 1 to 2 feet long, 3 to 4 lines wide, smooth, as are the compressed sheaths; panicles terminal and lateral, 4 to 12 inches long, oblong, becoming pyramidal, very full, the lower branches 2 to 3 inches long, much subdivided to the base; spikelets racemose, very short pedicelled, crowded and mostly one-sided on the branches, ovate-oblong to lanceolate, three-fourths of a line to 1½ lines long, lower glumes acute or acutish, half as long as the spikelet, second and third glumes five-nerved, half longer than the perfect flower, which is a little bearded at the apex. In wet ground.

Varies in the size and form of the spikelets, which in the Western form seldom exceed a line long; there is an Eastern form in which the spikelets are lanceolate, about 1½ lines long, and the perfect flower small and conspicuously stalked.

58. P. bulbosum, *H. B. K.*—Rhizoma creeping, thick, bulbous; culms 4 to 5 feet high, smooth, stout, with long internodes; leaves long and narrow (1 to 2 feet by 2 to 4 lines), smooth, or the lower ciliate below; panicle about 1 foot long, spreading, copious, pale green, branches

scattered and verticillate, the lower 4 to 5 inches long, much subdivided nearly to the base, branchlets slender and numerously flowered; spikelets sometimes in pairs or racemose, 1½ lines long, smooth, obtuse or acutish, not acuminate, lower glume half or rather more than half as long as the spikelet, broad, three-nerved, acutish, second and third glumes equal, five-nerved, the third with a narrow palet, perfect flower as long as the spikelet, oblong, lanceolate, abruptly acute, the point sometimes a little roughened.

Texas, New Mexico, and Arizona.

Probably P. avenaceum *Kth.* is not different.

√ (*a*) Var. minor (P. maximum, var. bulbosum, *Munro*), a smaller form, about 2 feet high, with the panicle much reduced.

In same region.

59. P. maximum, *Jacq.* (P. jumentorum *Pers.*).—Culms erect, 3 to 5 feet high, glabrous; nodes softly pubescent; leaves linear, 1 to 1½ feet long, 9 to 12 lines wide, rather rigid, margin scabrous, sheaths smooth; panicle 1½ feet long, much branched, hispid or scabrous, the branches verticillate, long and contracted, racemose, scabrous; spikelets mostly short-pedicelled, 1½ lines long, ovate, smooth, acute; lower glumes about one-third as long as the spikelets; second glume shorter than the spikelet; perfect flower acute.

Introduced and cultivated in the South.

60. P. amarum, *Ell.*—Culms 2 to 3 feet high, from a stout running root-stock, thick, columnar, nearly one-half inch in diameter; leaves nearly flat, almost coriaceous, glaucous, 1 to 1½ feet long, 4 to 6 lines wide, tapering to a long, slender point; sheaths glabrous, striate; panicle 1 foot or more in length, appressed, or becoming somewhat spreading, the lower branches verticillate, 6 inches long, subdivided nearly to the base, narrowly paniculate; spikelets rather racemose, ovate, 2½ lines long, acute; glumes thick, the lower glume about two-thirds the length of spikelet, acute; second glume the longest, seven-nerved, acuminate; third glume rather shorter and obtusish; perfect flower linear-oblong, obtuse, one-fourth shorter than the spikelet.

Grows among the sand-hills on the sea shore. South Carolina to Florida.

√ (*a*) Var. minor, *T. & S.*—Leaves involute; panicle shorter, narrower, distantly branched, comparatively few-flowered, the branches rather glomerate and unequal; spikelets rather larger (2½ to 3 lines); the lower glumes longer, or nearly as long as the spikelet.

Fortress Monroe, Va., and northward, near the coast.

61. P. virgatum, *Linn.*—Stout, erect, unbranched, 3 to 5 feet high, from strong, creeping root-stocks; leaves flat, very long (1 foot or more), 3 to 4 lines wide, smooth; panicle compound, 6 to 18 inches long; branches single to verticillate, generally very numerous and becoming diffuse, spreading or drooping; spikelets on rough pedicels, 1½ to 2 lines long, ovate to ovate-lanceolate, pointed, smooth; lower glume more than half the length of the spikelet (sometimes two-thirds), five-nerved; sec-

ond, five-nerved; third, five to seven-nerved, acute to acuminate, larger than the perfect flower. Sterile flower with 3 stamens. Widely diffused and quite variable. The Atlantic form has spikelets about 1½ lines long. The Western form has spikelets about 2 lines long, the glumes acuminate. A form on the Atlantic coast has the panicle quite close and rather oblong, and may be called variety conferta; another form (var. elongata) has a very long and narrow panicle, with spikelets even 2½ lines long.

Maine to Florida, and throughout the interior of the country.

62. P. Havardii, *Vasey.* (P. virgatum var. macrospermum, V.).—With the habit of western forms of P. virgatum, but much stouter; culms 5 to 6 feet high, with rigid, involute, long-pointed, glaucous leaves, ligule a ring of short hairs; panicle 1½ feet long, diffuse, the branches less abundantly flowered; spikelets 3 lines long; lowest glume one half as long as the spikelet, prominently five to seven-nerved; second glume nine-nerved, ovate, acuminate; third glume five to seven-nerved, its thick palet nearly as long; fertile flower about one-fourth shorter than the spikelet.

Guadaloupe Mountains, Texas; Dr. Havard, G. C. Nealley.

Section VII.—Frutescentes.

63. P. divaricatum, *Linn.*—Shrubby, smooth; culms 6 to 8 feet high with short and spreading branches; leaves lanceolate, acuminate, 2 to 4 inches long, 2 to 6 lines wide, deciduous from the persistent sheaths; panicles terminating the branches, 1 to 3 inches long, nearly simple or branched, the branches rather distant and diverging, half to 1 inch long, rather sparsely subdivided; spikelets smooth, 2 lines long, tumid, obovate, nodding, on pedicels as long or longer; lower glume triangular-ovate, one-third as long as the spikelet; second and third glumes as long as the spikelet, very broad, nine to eleven nerved; apex of the fertile flower downy-tipped.

Southern Florida.

Section IX.—Villiflora.

64. P. Urvilleanum, *Kth.*—Culms 1½ to 2 feet high, from a strong running root-stock, the whole plant densely soft-hairy; near the base short-jointed and covered with weather-worn leaves or sheaths; leaves rigid, 12 to 18 inches long, 3 lines wide at the base, becoming convolute, and ending in a long, setaceous point, the upper ones exceeding the panicle, which is 6 to 10 inches long, open, but rather contracted, the branches semi-verticillate or scattered, the shorter ones flowering to the base; the longer ones (3 to 4 inches long) racemosely subdivided and flower bearing towards the ends or throughout; spikelets 2½ to 3 lines long, ovate, acute; the empty glumes silky-villous; lower glume seven-nerved, two-thirds as long as the fifteen-nerved second glume; third glume rather shorter, eleven to thirteen-nerved; perfect flower oblong, glabrous, except on the margins, which are long-ciliate.

In sand, southern California to Arizona.

PART II.

SECTION OF VEGETABLE PATHOLOGY.

PREPARED BY B. T. GALLOWAY.

CONTENTS.

SECTION OF VEGETABLE PATHOLOGY.

POTATO SCAB.

During the past year the Section has received frequent inquiries from different parts of the country relative to this disease, and while it is not our purpose in this paper to fully answer these, it is hoped that what is here stated may lead to a better understanding of the nature of the malady among those who are particularly interested.

Potato scab is not a new disease by any means, nor is it peculiar to America, for we find frequent mention of its occurrence in Europe; in fact, most of the important papers on the subject are to be found in German works on plant diseases.[1]

The cause of scab is a question that has long been discussed. Some of the older writers held that it was due to the attacks of fungi, while others attributed it to the depredations of animal parasites. At present, however, it is the general belief of those who have given the matter careful study that it is not, as a general thing, due to either of the foregoing causes, but is the result of certain physiological changes that take place in the tuber when the latter is grown under certain conditions.

The potato is in reality an underground stem, and, like similar parts of other plants, its outer covering consists of a thin, tough membrane, which serves as a protection to the more tender parts within. This enveloping coat is made up of minute cells, the walls of which consist of a substance known as suberine, or cork. The corky membrane is provided with numerous minute structures known as lenticels, by means of which an exchange of gases takes place between the interior and exterior of the tuber.[2] In the presence of an excess of moisture the lenticels greatly increase in size, and often appear as small, woolly tufts, scattered here and there over the surface. At the same time the cork layer becomes thickened at these points, and as a final result of this process small wart-like projections are formed. Where these occur the skin is weakened, and, if the conditions which favor this development continue, decay soon sets in. In its efforts to heal the wound thus produced the tuber gives rise to new layers of cork cells beneath the diseased parts, and, as a result of this continued dying of the outer cells and the formation of a new growth beneath, a scab is produced.

Wherever the corky membrane is wounded the tuber immediately makes an effort to repair the injury. It would seem reasonable, there-

[1] See Bibliography.

[2] Stahl, Bot., Zeit. 1873.

fore, to believe that in some cases at least the primary injury is due to the depredations of grubs, myriapods or other small animals,[1] or it may be brought about by the irritating or corroding action of some substance in the soil. In any event the final result is practically the same as where the original damage is caused by an enlargement of the lenticels.

All who have thoroughly investigated the disease agree in the opinion that extreme humidity favors its development, but what influence beyond this the character of the soil has upon the malady is not positively known. There have been many theories advanced having a bearing upon this question, but they are so conflicting that nothing of value can be derived from them. During the year 1887 a number of trials were made at the New York Agricultural Experiment Station with a view of testing (1) influence of the soil, (2) effects of excessive moisture, (3) use of scabby seed, (4) effects of color of skin, (5) effects of fungicides, and (6) effects of chemical fertilizers and stable manure upon the development of scab. It was shown by these experiments that an excess of moisture and the use of fresh stable manure materially increased the number of scabby potatoes. The data obtained are summed up as follows:

"(1) The scab is not primarily caused by a fungus.

"(2) It is not due to the work of insects.

"(3) In nearly every instance an increased yield was accompanied by an increased percentage of scabby potatoes.

"(4) Any marked change in the rapidity of growth, either an increase or a decrease, tends to an increased production of scab.

"(5) A continuous growth from the time of first vegetation until the tubers are fully matured appears to be the condition least favorable to the production of scabby potatoes."

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Plowright: Gardener's Chronicle, vol. 23, 1885, p. 60.

Report of the Connecticut Agricultural Experiment Station, 1877, p. 67; 1886, p. 79.

Sorauer: Handbuch der Pflanzen Krankheiten, 1st ed., 1884, p. 84; 2d ed., 1886, p. 227.

[1] Mr. Alfred Rose, writing to the Rural New Yorker under date of March 7, 1885, says that he has experimented largely for forty years on potato culture, and he thinks the wire worm (Iulus) causes scab; that these "worms" are more prevalent and the scab much worse on rather moist soils than on those light and sandy; that where scab prevails, the sooner the potatoes are dug the better, and that anything that forwards the crop aids in escaping the scab. He has found that the use of lime slaked with water which has been saturated with salt and into which 2 pounds of sulphur have been stirred for each bushel of lime has effectually driven out these "worms" and prevented scab. He thinks that land infested with these worms should be plowed in the fall and have 250 pounds of kainit and 5 bushels of lime, prepared as above described, sown broadcast per acre and well cultivated in.

POTATO SCAB.[1]

This disease, which is known to practical gardeners as scab or scurf, may be recognized by the brown, irregular concavities, with ragged, often upturned edges, that make their appearance in the tuber. These concave places spread gradually and become filled with brown, decayed remains of cells, excrements of mites, mycelium threads, etc.

The deeper these places eat into the flesh of the healthy tuber the greater is its loss of sound tissue, and consequently of food value; but even if the scabby portions are not very deep and the decrease in food value unimportant, the potatoes affected with scab spots lose considerably in market value on account of their diseased appearance.

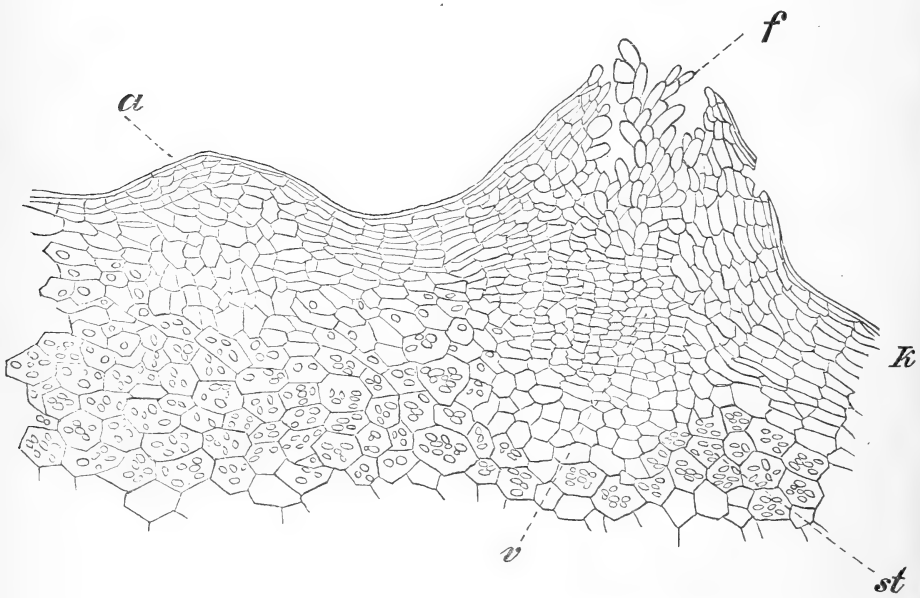
If the small projections on the edge of the scab are examined they will be found to consist of parenchyma cells, which once formed a part of the healthy tissue of the tuber, but are now dark colored, and mostly without starch grains, in place of which the other cell contents are massed together in a spherical shape. From these dead, suberified cells there is either a gradual transition into the healthy, starch-bearing tissue, or they are separated from the latter by a layer of true tabular cork cells which have arisen, at the expense of the starch, from the cell layers bordering on the scab spot.

The danger to the potato lies in the fact that as long as it remains in the ground the edges of the scab very often begin to degenerate again and the spot becomes deeper. If the potatoes are once dug, no further penetration of the scab spot can be discerned, even when buried for the winter. In case of early varieties that are gathered at different times, a section of the scab spots shows that they are no deeper in those potatoes dug at the end of the season than in the ones gathered some weeks earlier. I conclude from this circumstance that the extension of scab spots is not continuous, even while the potatoes remain in the ground, but is confined to different periods, and perhaps in many cases to one.

I consider the times when hard showers follow a long continued drought as such scab forming periods. This view is founded upon the changes which occur when a potato is brought into a very moist atmosphere or part of it into direct contact with dripping water. By this means the development of the lenticels becomes so increased from their normal condition that they are easily recognized by the naked eye as small, white, woolly warts. Nearly all parts of plants which are covered by a persistent cork layer possess interruptions on the surface in form of lenticels or bark-pores, in which there is a loose, corky tissue provided with air conducting intercellular spaces. This tissue usually arises beneath the stomata and shares in their physiological work, *i. e.*, the exchange of atmospheric air between the interior and exterior of the plant. In

[1] Translation of paper by P. Sorauer, Handbuch der Pflanzen-Krankheiten, 1886, p. 227.

the wild cherry,[1] privet, elder, ash, and willow, the lenticels arise under one stoma, and in the black walnut and poplar under several, by the separation of the parenchyma cells underneath and surrounding the breathing pores. In other plants—for example, barberry, broom-corn, currants, and other species of *Ribes*—the lenticels originate in the cork cambium (phellogen). In the potato the rind is composed of tabular cork cells (Fig. 1 *k*), and under this, as well as below the stomata[2] the first beginnings of the lenticel formation occur in the form of irregular cells containing but little protoplasm. (Fig. 1 *a*). The formation of these cells is continually penetrating farther in, while the cells first formed absorb water, swell up, and burst the cork rind, thus forming the scab-producing lenticel, from which the loose cells within (Fig. 1 *f*) emerge in a whitish, moist, flour-like mass. These cells soon degenerate, and the process of degeneration extends inward, so that the compact, united lenticel cells (Fig. 1 *v*) must always be looked for deeper and deeper in the flesh, and the starch (Fig. 1 *st*) disappears proportionally from the surrounding tissue.



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We have, therefore, two processes to consider in the formation of scab; the first is the growth of lenticel cells, which proceeds until the discharge of the flour-like cell mass; and the second consists of the de-

[1] E. Stahl, Entwicklungsgeschichte und Anatomie der Lenticellen, Bot. Zeit., 1873, Nr. 36–39.

[2] Caspari in Sitzungsberichte der niederrheinischen Gesellschaft für Natur- und Heilkunde, v. 8, Jan., 1857, cited in Bot. Zeit., 1857, p. 116.

generation of the cells in the interior of the lenticel, and the consequent extension of cork formation into the interior of the tuber.

That this hypertrophied formation of lenticels is dependent upon an unusual amount of moisture we conclude from the following facts: During a long continued season of wet weather the lenticels of alder trees stand out in the form of thick white protuberances; by immersing a piece of cherry stem in water a luxuriant growth of cork can be artificially produced; finally, in case of the potato, these cork warts may be actually produced by keeping the potato for a long time in moist air. Nobbe[1] found, by a water culture of the potato, that the tubers grown in water produced small warts while still very young. These warts were caused by a local increase in growth in the cork formation, and were not present in tubers produced in the air.

The view that superfluous moisture at an unseasonable time is the cause of the increased growth of cork that produces scab is indorsed by Caspari[2] and Schacht[3] as well by Frank.[4] A later work by Stahl establishes the fact that if transpiration is stopped lenticels develop beneath the stomata.[5] On the contrary, farmers assert that in the majority of cases the adding of lime and marl to the soil, and manuring[6] with dung and street-sweepings causes the disease. Kuhn agrees with Wallroth[7] in the opinion that the formation of scab is caused by a fungous growth (*Erysibe subterranea*, Wallr.).

On the other hand, iron, when present in a low state of oxidation, is considered injurious. In a field of potatoes at Newmarket three rows which had been marled with light colored earth mixed with iron oxide were found free from scab, while the rows that had received marl that was dark colored from the presence of ferrocyanate of peroxide of iron were very scabby.[8]

The assertion has frequently been made by practical farmers that fresh animal manure causes scab, especially in the thin-skinned varieties,[9] and that the disease makes its appearance after an application of soapsuds, while after a strong application of potash, which had proved very injurious at another time, the tubers were free from scab.[10]

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[1] Versuchsstationen, 1864, p. 58.

[2] Bot. Zeitung, 1857, p. 116.

[3] Bericht an d. Kgl. Landes-Oecomomie-Collegium über die Kartoffelpflanze und deren Krankheiten, Berlin, p. 15.

[4] Die Krankheiten der Pflanzen, 1880, p. 141.

[5] Biedermann's Centralbl., 1879, p. 714.

[6] Landwirthsch. Zeitschr. f. Westphalen und Lippe, 1864.

[7] Linnæa, 1812, p. 332. Der Knollenbrand der Kartoffel, von Hofrath Dr. Wallroth. He says: "The much discussed disease of the potato known in economic writings under the name of potato scab, potato wart, scab disease, brown stain, and potato rot, I have known for a long time as a kind of vegetable rust (*Uredo*, *Ustilago*, and *Cæoma* of authors, *Erysibe Theophr.*, Adans, Murr., Wallr., not DC.).

[8] Landwirth, 1875, p. 352.

[9] Landwirth, 1875, p. 319 and 352.

[10] Janovski, Kartofflenbauversuche. Prager Landw. Wochenbl., cited in Central bl. f. Agrik.-Chemie, 1876, I, p. 430.

I believe that Wallroth's opinion is erroneous. It is true we find fungous formations upon the dead parts, but none that attack healthy tissues. Many have objected to the view that scab is caused by adding lime, marl, or dung to the soil, but when it comes to final definite results the reports vary in regard to secondary circumstances. For example, one person says that scab made its appearance after the application of marl, but that the greatest development of the disease did not occur the first year,[1] during which the potatoes were perfectly healthy, but that the disease steadily increased during the ten following years. The same account claims that beets are similarly affected by marl. It is interesting to note that where the marl was not used the potatoes showed no scab. In Posnia, in the seventeenth century, marl was frequently added to the loose soil of large estates for the purpose of raising *Medicago media*. This was generally preceded by two crops of potatoes, which were always marled. In spite of this, scab never made its appearance if the marl was drawn before winter and thoroughly mixed with the soil.[2] The same experiment was recorded a year earlier in Saxony in the *Zeitschrift des landwirthsch. Centralvereins* (p. 219).

Heiden[3] reports a very thorough experiment at Pommritz in regard to the use of lime. A piece of new land was given heavy applications of lime (3,600 pounds per acre) six times between 1868 and 1878, and in 1878 the land bore potatoes after a fresh application. The potatoes when gathered were completely free from scab. It will be seen that in this ground there was lime of different ages, from the fresh to that ten years old, and no injury resulted.

Contradictory as these results appear, they may nevertheless be harmonized if the theory should be confirmed that the frequently-occurring secondary action of lime may be the dangerous agent that causes the death of the growing cork cells. Heiden directs attention to the fact that the ammonia already contained in humus is set free by the lime; when a great deal of lime is employed and the soil is not at the time able to absorb all the ammonia that is set free, a part of it will escape. This surplus ammonia will be very apt to destroy the loose cork cells within the lenticels and cause the cork formation to penetrate farther into the tissues. The ammonia will become harmless only when oxidized into nitric acid, and we have a positive statement in this direction. Kraus-Triesdorf[4] mentions the experiments of Dr. Schreiner, who found that scabby potatoes were very abundant in almost pure quartz sand which had been manured with ashes, pulverized turf, and nitrogen in the form of ammonia; but when in the form of nitric acid no such effect was produced. Quartz sand, without manuring, or with the ashes alone, did not produce scabby tubers, even when mingled with turf. Iron filings,

[1] Landw. Zeit. f. Westphalen und Lippe, 1864, p. 106.

[2] Fühling's Landwirthsch. Zeit., 1871, vol. 5, p. 391.

[3] Algemeine Hopfenzeitung, 1882, p. 295.

[4] C. Kraus., Mechanik der Knollenbildung. Flora, 1877, p. 125.

iron oxide (turf ashes rich in iron), may perhaps act indirectly by checking the formation of nitric acid.

From our present knowledge it seems advisable to keep soils which experience has shown to foster potato scab well aerated by means of repeated harrowing.

GUM DISEASE OR FOOT ROT OF THE ORANGE.

I. General Observations.

For a number of years past the orange trees in Florida have suffered from the attacks of this malady, and for the purpose of bringing together some of the facts in the case, as well as to awaken a deeper interest in the matter, the following paper has been prepared:

Gum disease, or "foot rot," as the disease is commonly called in Florida, is not peculiar to the United States; but has long been known in southern Europe, and the loss it has there occasioned to the lemon and orange groves is estimated at many millions of dollars. An Italian writer, referring to the injury it has occasioned in one district in his country, says:

> The damage already done may be estimated at not less than 10,000,000 lire ($2,000,000), in fact so extensive have its ravages become through the kingdom, that it is now looked upon as a national calamity.

The disease is supposed to have originated something over fifty years ago in one of the Azores Islands, where it reached its maximum in 1840, destroying in one year one-fourth of the orange trees on the island of St. Miguel. According to Fougue[1] it appeared in Portugal in 1845, and occasioned the greatest injury there from 1858 to 1861. Opinions differ as to the exact date it appeared in Florida. Judging from the reports of correspondents, however, we conclude that it has been known in the State for twelve or fifteen years. From statements made by Dr. A. H. Curtis[2] it appears that the "bad cases" are found at points on both the eastern and western coast, as well as in the interior, but whether it was introduced from Europe is not certainly known.

II. External Characters of the Disease.

The disease, as a rule, is first manifested by the appearance of a gummy effusion which appears, principally in the spring and autumn, on the trunk of the trees close to the ground, or directly upon the root. Even before there are any outward signs of diminished health, small drops of gum appear on the bark of the trunk; these increase in size and number, and the bark appears to melt away or become honeycombed; finally the gum liquefies, assumes a muddy brownish color and a disagree-

[1] Revue des deux Mondes.

[2] Bulletin No. 2, Florida Agricultural Experiment Station.

able odor. In summer or winter when the effusion of gum decreases or stops, the greater part of the bark around the point of infection dies and becomes detached from the wood. When dry it springs away from the wood and becomes hard and brittle. The surface of the wood underneath the bark is also affected to some little distance in all directions from the point of infection. The most vital part of the trunk, the cambium layer, which lies between the bark and the wood, is destroyed, and each year this destruction extends until it has made the round of the trunk girdling the tree completely, thus cutting off all communication of the vital fluids between the roots and the top, which is certain death to the tree.

When the disease attacks the roots the death of the tree follows more rapidly—sometimes in less than a year. The sudden changing of the leaves to a sickly yellow color is the first visible symptom of the disease when the roots are attacked. It must be kept in mind, however, that the leaf-yellowing may be due to other causes. Such is the diagnosis of the disease as it appears in Europe, and according to the reports of correspondents it is evidently the same as that which prevails in Florida. [1]

III. Conclusions as to the Cause of Gum Disease.

So far the cause of the disease is not certainly known, but this does not appear to be due to a lack of interest; for many scientists have investigated the matter and large rewards have been offered to stimulate these researches.[2] According to Sorauer[3] the gum when carried to healthy parts of the tree by the action of rain or other agents induces disease; but all attempts made here to convey the malady to healthy orange trees by inoculations have failed. A microscopic examination of the diseased tissues and gum reveals the presence of a vast number of bacteria and filamentous threads of some fungus or fungi, but what connection these may have with the disease has not yet been ascertained. It appears from Briosi's[4] researches, that the disease in Italy is always accompanied by a fungus to which has been given the name *Fusarium*

[1] Dr. Curtis, in the Bulletin already referred to, describes the disease as follows: The prominent symptoms are exudation of a gummy or sappy fluid from near the base of the trunk, and decay of the bark in that region and of the roots below.. The flow of gum and attendant decay extend upwards and in a lateral direction until the tree is girdled, also penetrating successive layers of wood. In some cases gum exudes from cracks in various parts of the trunk, or even on the branches, and in others the decay progresses without emission of gum. Attendant or premonitory symptoms are excessive and rather late blooming, the flowers being small and mostly unfruitful, and arrested and unnatural development of the foliage, which becomes yellow and drops. The disease manifests itself in the top on the same side as at the base, and makes like progress above and below.

[2] The Italian minister of agriculture has offered a reward of 25,000 lire ($5,000) for an effectual remedy.

[3] Pflanzenkrankheiten, 1886; page 879.

[4] Il male di gomma negli Agrumi.

limoni;[1] the body of this fungus consists of very slender, colorless threads which are divided by frequent transverse partitions or septa. The threads are found in all parts of the diseased tissues and in the process of growth they give rise to numerous compact tufts of erect branches upon the free ends of which are developed crescent shaped spores or reproductive bodies; the latter are produced in prodigious numbers and germinate readily in water or moist air. Referring to the *Fusarium*, Briosi says:

> It is not certainly known what connection this fungus has with the disease under consideration. Whether it should be placed among the causes or be considered a simple incident of the malady are questions that remain to be answered. * * * I do not think there is any doubt, however, that its presence generally accelerates the disorganization of the tissues.

In the Florida specimens which have been examined we have failed to find the fungus described by Briosi; but in the Department greenhouses there is a fungus on the diseased trees which resembles Briosi's figures, and is probably the same as the one found by him. Many theories have been advanced as to what extent the nature of the soil, method of culture, manner of setting the trees, kind of manure used, etc., influences the disease, but these are so conflicting that it is difficult to draw any practical conclusions from them. Those who have given the matter careful study agree in saying that heavy manuring, an excess of water in the soil, and frequent cultivation favors the development of the disease.[2]

IV. Treatment.

From all the evidence at hand it appears that the only safe means of preventing or checking the ravages of the malady are, (1) to bud at least 3 feet above the ground on resistant stocks,[3] (2) to plant on dry or porous soil, (3) to irrigate sparingly, (4) to use the knife freely whenever the malady appears, and burn or destroy all diseased wood.

V. Bibliography.[4]

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Briosi: Il male di gomma negli Agrumi, Botter, Giorn. d'Agricolt., Ser. N., anno III, vol. VI, n. 19, 20, 21.

[1] *Fusarium limoni*, Briosi. (Penzig Annali di Agricoltura; p. 422; 1887).—Acervuli gregarious, confluent, white; hyphæ spreading, septate; conidiophores erect or ascending, with alternate or opposite branchlets; conidia very variable, acrogenous, continuous or septate in the middle, or bi-triseptate, oblong or fusiform, slightly curved, attenuated, slightly constricted at the septa, hyaline, 26-27 μ long, 2,4–2,8 μ in diameter.

[2] Sorauer affirms that the disease is promoted by the cultivation of such crops as beans, pumpkins, tomatoes, etc., between the trees. He also states that analyses of healthy, dead, and diseased trees show the latter to contain less phosphoric acid and iron.

[3] In Florida it is claimed that sweet seedlings are especially liable to the attacks of foot-rot, while all other stocks are practically resistant.

[4] Only some of the more important papers are here noted.

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Zirilli: Una proposta a rimediare al male degli Agrumi (Botter, Giorn. d'Agric., Vol. 19, 1873, p. 158).

A PARTIAL LIST OF THE PARASITIC FUNGI OF MISSOURI, WITH REMARKS ON THE SPECIES OF ECONOMIC IMPORTANCE.

The present list was completed more than a year ago, but several unavoidable delays have prevented its earlier publication. As it now stands, the list includes about 400 strictly parasitic species, divided among the following genera: *Æcidium*, *Cæoma*, *Coleosporium*, *Gymnosporangium*, *Melampsora*, *Peridermium*, *Phragmidium*, *Puccinia*, *Ræstelia*, *Uredo*, *Uromyces*, *Doassansia*, *Entyloma*, *Tilletia*, *Urocystis*, *Ustilago*, *Cystopus*, *Peronospora*, *Phytopthora*, *Erysiphe*, *Microsphæra*, *Phyllactinia*, *Podosphæra*, *Sphærotheca*, *Uncinula*, *Asterina*, *Cercospora*, *Cladosporium*, *Coniothyrium*, *Cylindrosporium*, *Diplodia*, *Entomosporium*, *Glœosporium*, *Ramularia*, *Septoria*, *Epichlœ*, *Leptosphæria*, *Phyllachora*, *Sphærella*, *Taphrina*.

I am indebted to Prof. S. M. Tracy and Rev. C. H. Demetrio for valuable assistance in the preparation of the work, and to Mr. J. B. Ellis, who has kindly determined many of the doubtful species.

	Fungus (Latin name).	Host (Latin and common name).	Parts affected.	Date of appearance.	Remarks.
	Rusts.				
1	Æcidium abundans, Pk	Symphoricarpus vulgaris (Buck Bush).	Leaves	May, June	Common throughout northern Missouri and often quite destructive to this plant, which is a great pest in many sections.
2	Æcidium actææ (Opiz.) Wall	Actæa alba (Cohosh)	do	May	Not common.
3	Æcidium alliicolum, Winter	Allium stellatum (Wild Onion)	do	do	Collected by Demetrio, near Perryville, in May, 1883.
4	Æcidium apocyni, Schw	Amsonia latifolia (Amsonia)	do	May, June	Along the Mississippi River, northern Missouri; not common.
5	Æcidium asterum, Schw	Aster sagittifolius (Aster); Solidago, sp. (Golden Rod).	Leaves and young stems.	Early summer	Very common on the young root-leaves, doubtless frequently prevents the host from maturing seed, which is desirable, as it is a vile weed.
6	Æcidium cerastii, Winter	Cerastium nutans (Chick-weed)	Leaves	May	This was collected in Perry County in 1885 by Demetrio, and is described by Winter in the Journal of Mycology, Vol. I, page 126.
7	Æcidium cephalanthi, Seymour	Cephalanthus occidentalis (Button Bush).	do	May, June	Not common; appearing usually in May or June and forming rather large yellow spots on the leaves.
8	Æcidium clematidis, DC	Clematis Virginiana (Virgin's Bower).	Leaves, petioles, and young branches.		Frequently destroys plants growing in shady woods.
9	Æcidium cimicifugatum, Schw	Cimicifuga racemosa (Snakeroot)	Leaves	May, June	Not common.
10	Æcidium compositarum, Winter	Erigeron annuum; Erigeron strigosum; Erigeron bellidifolium (Flea-bane); Silphium terebinthinaceum (Prairie Dock); Silphium perfoliatum (Cup Plant); Helianthus, sp. (Sunflower).	Leaves and young stems.	do	One of the most common of all the Æcidiums, occurring on many noxious weeds, and may therefore be regarded as a beneficial species.
11	Æcidium convallariæ, Schum	Uvularia perfoliata (Bellwort)	Leaves	do	Northern Missouri; not common.
12	Æcidium crassum, Pers	Rhamnus lanceolatus (Narrow-leaved Buckthorn).	do	May	Near Concordia, Lafayette County, 1887; Winter places this with *Puccinia coronata*, Corda.
13	Æcidium euphorbiæ, Gmel	Euphorbia hypericifolia (Spurge)	do	Aug., Sept	The host is a common weed, and the fungus is usually abundant on all the leaves, causing them to appear sickly and yellow.
14	Æcidium fraxini, Schw	Fraxinus Americana (Ash)	do	May, June	During the year 1884 this fungus was very abundant on several species of ash; of late, however, it has been quite rare; western and southern Missouri, Lafayette County, 1887.
15	Æcidium grossulariæ, DC	Ribes rotundifolium (Gooseberry)	Leaves and fruit	do	Common throughout the State, but not injurious.
16	Æcidium hibisciatum, Schw	Hibiscus grandiflorus (Rose-mallow).	Leaves	July	Collected in Perry County in 1885.
17	Æcidium houstoniatum, Schw	Houstonia cærulea (Bluets)	do	May, June	Perry County, 1886; Concordia, 1887.
18	Æcidium hydnoideum, B. & C	Dirca palustris (Leather-wood)	do	do	Southern Missouri, Tracy; also Perry County, Demetrio.
19	Æcidium impatientis, Schw	Impatiens pallida (Touch-me-not).	Leaves and petioles.	June	Very common throughout the State, forming large yellow spots on the affected parts.

	Fungus (Latin name).	Host (Latin and common names).	Parts affected.	Date of appearance.	Remarks.
	Rusts—Continued.				
20	Æcidium Jamesianum, Peck	Asclepias tuberosa (Milkweed)	Leaves and petioles.	June, July	A rare species but quite destructive to this troublesome weed.
21	Æcidium lysimachiæ, (Schl.) Wallr	Lysmachia ciliata (Loose-strife)	Leaves	May, June	Perry County; not common.
22	Æcidium myosotidis, Burrill	Myosotis verna (Forget-me-not)	do	do	Northern Missouri, also Perry County.
23	Æcidium œnotheræ, Peck	Œnothera biennis (Evening Primrose).	do	June	Common in many of the northern counties, also reported from Perry County; forming large purple spots on the leaves.
24	Æcidium onobrychidis, Burrill	Psoralea Onobrychis (Psoralea)	do	Early summer	
25	Æcidium Pammelii, Trelease	Euphorbia corrollata (Spurge)	do		Perry County.
26	Æcidium pentstemonis, Schw	Pentstemon gracilis (Beard-tongue); Mimulus ringens (Monkey Flower).	do	Summer	Very common in the southern part of the State.
27	Æcidium orobi, Pers	Amphicarpæa monoica (Hog-pea-nut).	do	Early summer	Forming conspicuous yellow spots; not common.
28	Æcidium plantaginis, Ces	Plantago major (Common Plantain); Plantago Virginica (Narrow-leaved Plantain); Plantago lanceolata (Rib Grass).	do	May, June	This species was not observed within the borders of the State until 1887, when it was very abundant in several localities.
29	Æcidium polemonii, Pk	Phlox divaricata (Phlox); Phlox repens (Phlox).	do	June, July	Common.
30	Æcidium porosum, Pk	Vicia Americana (Vetch. Tare.)	do	Summer	Perry County.
31	Æcidium pteleæ, B. & C	Ptelea trifoliata (Shrubby Trefoil; Hop-tree).	do	June	A very common species, frequently greatly disfiguring the leaves. The host is occasionally cultivated as an ornamental shrub.
32	Æcidium punctatum, Pers	Anemone Caroliniana (Wind Flower).	do	Summer	Not common.
33	Æcidium ranunculi, Schw	Ranunculus Cymbalaria (Sea-side Crowfoot).	do	May, June	Perry County.
34	Æcidium sambuci, Schw	Sambucus Canadensis (Common Elder).	Leaves, stems	June	Often greatly distorting the young limbs and petioles; common throughout the State.
35	Æcidium splendens, Winter	Croton monanthogynus (Croton)	Leaves	Early summer	Perry County.
36	Æcidium tenue, Schw	Eupatorium altissimum (Thoroughwort).	do	June, July	
37	Æcidium thalictri-flava, (DC.) Winter.	Thalictrum anemonoides (Rue-Anemone).	do	July	Said to be the Æcidium of *Puccinia caricis*, Schum. Common in the northern part of the State.
38	Æcidium urticæ, Schw	Bœhmeria (False Nettle)	do	Early summer	Perry County.
39	Æcidium verbenicola, E. & K	Verbena angustifolia (Vervain)	do	May to July	Boone and Perry Counties.
40	Æcidium zanthoxyli, Pk	Zanthoxylum Americanum (Northern Prickly Ash).	do	May, June	A very common species, frequently greatly injuring the host.
41	Cæoma agrimoniæ, Schw	Agrimonia eupatoria (Agrimonia)	do	July to Sept	Boone County.
42	Cæoma nitens, Schw	Rubus villosus; Rubus occidentalis (Blackberry).	Green parts	June, July	The well-known "blackberry rust;" common everywhere on wild and cultivated plants.

43	Coleosporium ipomœæ, Schw., II, III.	Ipomœa Nil. (Morning glory)	Leaves, petioles	Sept., Oct	Common on young plants.
44	Coleosporium sonchi-arvensis, Lev., II, III.	Vernonia fasciculata (Iron-weed); Aster sagittifolius (Aster); Solidago latifolia; Solidago altissima (Golden Rod).	Leaves	Aug., Sept	One of the most widely distributed of all the rusts; no doubt checks the growth of the weeds upon which it occurs.
45	Gymnosporangium macropus, Lk.	Juniperus Virginiana (Red Cedar).	Young branches	Apr., May	Very common wherever the red cedar is found, forming large jelly-like masses. Has been shown to be one stage of apple-leaf rust, *Ræstelia pyrata* (Schw.).
46	Melampsora crotonis, Burrill	Crotonopsis linearis (Croton)	Leaves	October	*Trichobasis crotonis*, Cook.
47	Melampsora epilobii, (Pers.) Fckl	Epilobium coloratum (Willow Herb).	do	Sept	Rare.
48	Melampsora populina, Lev	Populus tremuloides; Populus monilifera (Aspen).	do	Sept., Oct	A very common species, covering the leaves with a reddish brown powder. Usually attacks young plants.
49	Melampsora salicina, Lev	Salix nigra (Black Willow)	do	Oct	Common throughout the State on young willows along streams, frequently disfigures the foliage.
50	Peridermium orientale, Cook	Pinus mitis (Pine)	do	May	Perry County, Cook, Grev. 7, page 45.
51	Phragmidium fragariæ, (DC.) Rossm., II, III.	Potentilla Canadensis (Five Finger).	do	May, Sept	Second stage, reddish brown; third stage forming black tufts of hair-like points on the leaves.
52	Phragmidium subcorticium, (Schrank), Wint., I, II, III.	Rosa sp. (Roses)	Green parts	Throughout the season.	Very destructive to roses, especially the hardy varieties. First stage distorts the petioles and young twigs.
53	Phragmidium speciosum, Fries., II, III.	Rosa lucida (Rose, Sweet Brier)	Stems	Aug., Sept	Forming large, blackish, swollen areas upon the stem, which it invariably kills.
54	Puccinia amorphæ, Curt	Amorpha fruticosa (Lead Plant)	Leaves	Summer	
55	Puccinia asteris, Duby	Krigia Virginica, Aster sagittifolius (Aster).	do	July, Aug	Common throughout the State on *Aster*. Reported from Perry County, on *Krigia*.
56	Puccinia andropogi, Schw., II, III.	Andropogon provincialis (Blue Stem Grass).	Leaves and culms	Aug., Sept	Very common.
57	Puccinia atropunctata, B. & C	Veratrum Woodii (Hellebore)	Leaves	July	Southern Missouri (Tracy).
58	Puccinia caricis, (Schum.), Rebent., II, III.	Carex sp. (Sedge)	Leaves and culms	Summer	
59	Puccinia circææ, Pers., III	Circæa lutetiana (Enchanter's Nightshade).	Leaves	Aug	Perry County.
60	Puccinia conoclinii, Seymour, III.	Conoclinium cœlestinum	do	do	Perry County, 1886.
61	Puccinia convolvuli, Cast., I, II, III.	Calystegia sepium (Hedge Bindweed).	do	Summer	Not common.
62	Puccinia emaculata, Schw., II, III.	Triodia sesleroides (Tall Red Top Grass).	Leaves and sheaths	Aug. to Oct	A very common species; the second stage brick red: third black.
63	Puccinia flosculosorum, Roehl., II, III.	Taraxacum officinale (Dandelion)	Leaves	Throughout the season.	Very common in autumn on young plants. We have observed that such plants rarely produce seed the following spring.
64	Puccinia galiorum, Lk., I, III	Galium triflorum (Bed Straw)	Leaves and stems		First stage occurs in May, while the third appears later.
65	Puccinia graminis, Pers., I, II, III,	Grasses, Sedges, and Cereals. Berberis vulgaris (Barberry).	Leaves and culms	Summer	The well-known rust of the wheat, oats, and other grasses.
66	Puccinia Kuhniæ, Schw	Kuhnia eupatorioides	Leaves	Aug	Perry County, 1885.
67	Puccinia lateripes, B. & R., II, III.	Ruellia ciliosa	do	Summer	Forming conspicuous spots on the foliage; common.
68	Puccinia lobeliæ, Gerard, III	Lobelia syphilitica (Great Lobelia).	do	June, July	Boone, Howell, and Perry Counties.
69	Puccinia maculosa, Schw., III	Cynthia Virginica (Cynthia)	do	Early summer	Perry County.
70	Puccinia malvastrii, Pk	Malvastrum coccineum (False Mallow).	do	Sept	Perry County. Believed to be a form of *P. malvacearum*, Mont., which causes the so called "hollyhock disease."

	Fungus (Latin name).	Host (Latin and common name).	Parts affected.	Date of appearance.	Remarks.
	Rusts—Continued.				
71	Puccinia maydis, Carradori, II, III.	Zea Mays (Indian Corn)	Leaves	Aug., Sept	Causes considerable injury to the foliage.
72	Puccinia menthæ, Pers., I, II, III.	Monarda fistulosa (Wild Bergamot); Mentha Canadensis, Blephilia hirsuta (Horse Mint).	....do	....do	Common throughout the State.
73	Puccinia Peckiana, Howe, II, III.	Rubus occidentalis (Blackberry)	....do	Autumn	Said to be one form of the well known orange rust, *Cæoma nitens*, which occurs on the same host earlier in the season.
74	Puccinia pimpinellæ, Lk., I, II, III	Osmorrhiza longistylis (Sweet Cicely).	....do	May, Sept	First, rare; second and third stages, common.
75	Puccinia podophylli, Schw., I, III.	Podophyllum peltatum (May Apple).	....do	Early summer	Very common everywhere, often greatly disfiguring the host.
76	Puccinia polygoni-amphibii, Pers., II, III.	Polygonum amphibium (Water Persicaria).	....do	Summer	Checks the growth of the weed.
77	Puccinia pruni-spinosæ, Pers., III.	Cultivated Plum	....do	Autumn	Frequently causing considerable injury to young trees in the nursery.
78	Puccinia seymeriæ, Burrill, III	Seymeria macrophylla (Mullein Fox Glove).	....do	July	Very common in the northern part of the State.
79	Puccinia silphii, Schw., III	Silphium integrifolium (Rosin Plant); Silphium perfoliatum (Cup Plant).	Leaves and stems	Aug	Forming prominent black spots on the affected parts.
80	Puccinia smilacis, Schw., III	Smilax rotundifolia (Common Greenbrier).	Leaves	....do	Jackson County (Tracy).
81	Puccinia tanaceti, DC., II, III	Helianthus decapetalus, Helianthus annuus, Helianthus angustifolius, Helianthus mollis (Sunflower).	....do	Summer	Widely distributed, frequently retarding the growth of the weeds upon which it occurs.
82	Var. Vernoniæ, II, III	Vernonia fasciculata (Iron-weed)	....do		Common.
83	Puccinia verrucosa, (Schultz), Wint., III.	Lophanthus nepetoides (Giant Hyssop).	....do	Aug	Perry County.
84	Puccinia violæ, DC., I, II, III	Viola striata (violet)	....do	May, Aug	Do.
85	Puccinia xanthii, Schw., III	Ambrosia trifida (Great Ragweed); Xanthium strumarium (Common Cocklebur).	....do	Aug	Very common; often destroys the leaves, which is certainly an advantage in this case.
86	Puccinia zygadeni, Trelease, III	Zygadenus elegans (Zygadene)	....do		Perry County.
87	Ræstelia lacerata, Fries	Gillenia stipulacea (American Ipecac); Crataegus tomentosa (Black or Pear Thorn).	....do	Early summer	Very common on the latter host throughout the State; reported from Perry County, on *Gillenia*.
88	Ræstelia pyrata, Schw	Pyrus coronaria (Crab Apple); Pyrus malus (Apple).	Leaves and fruit	July	Frequently destructive to apple trees, causing the so called "rust."
89	Uredo polopodii, Wint	Cystopteris fragilis (Fern)	Leaves	Aug	Perry County.
90	Uredo quercus, Duby	Quercus alba (White Oak)	do	....do	Northern Missouri.
91	Uromyces accuminatus, Arthur, II, III.	Spartina cynosuroides (Cord Grass).	Leaves and culms	Aug., Sept	Not common.

92	Uromyces affinis, Winter, I, III.	Hypoxys erecta (Star Grass)	Leaves	May	Perry County (Demetrio).
93	Uromyces appendiculata, Pers. Lev., II, III.	Phaseolus vulgaris, Phaseolus helvolus (Kidney Bean).	... do	Autumn	Common throughout the State.
94	Uromyces caladii (Schw.), Farlow, I, II, III.	Arisæma dracontium (Dragon Root); Arisæma triphyllum (Indian Turnip).	Leaves and stems.	May, Aug	Very common and very destructive to young plants.
95	Uromyces euphorbiæ, C. P., II, III.	Euphorbia maculata, Euphorbia dentata (Spurge).	Leaves	Autumn	Widely distributed.
96	Uromyces hedsayri-paniculati, Farlow, II, III.	Desmodium paniculatum, Desmodium rotundifolium (Tick-Trefoil).	....do	Sept	Very common everywhere.
97	Uromyces hyperici, Curt	Hypericum corymbosum (Saint John's Wort).	....do	Aug	Perry County.
98	Uromyces Howei, Pk., III	Asclepias Cornuti (Milk-weed)	....do	Sept	Do.
99	Uromyces lespedezæ (Schw.), Pk., II, III.	Lespedeza procumbens (Bush Clover).	Leaves	Summer	Abundant throughout the State.
100	Uromyces polygoni, Fckl., I	Polygonum aviculare (Knot Grass)	....do	July, Aug	Frequently checks the growth of the weed.
101	Uromyces rudbeckiæ, Arth. & Hol.	Rudbeckia laciniata (Cone-flower)	....do	Aug	Rare.
102	Uromyces terebinthi (DC.), Wint.	Rhus toxicodendron (Poison Ivy)	....do	Sept	Greatly disfiguring the host.
	Ustilagineæ.				
103	Doassansia alismatis, Fr	Sagittaria variabilis (Arrow-head)	....do	July	Southwest Missouri.
104	Entyloma linariæ, Schrot., var. Veronica, Farlow.	Veronica sp. (Speedwell)	....do	Sept	Perry County.
105	Entyloma lobeliæ, Farlow	Lobelia inflata (Indian Tobacco)	....do	Autumn	
106	Entyloma menispermi, Farlow	Menispermum Canadensis (Moonseed).	....do	Aug	Very common, forming whitish patches on the leaves.
	Smuts.				
107	Tilletia striæformis, (West.), Wint.	Agrostis vulgaris (Red Top)	....do	Early summer	Common in several sections; often causes considerable injury.
108	Tilletia tritici, (Bjerk.), Winter	Wheat	Ovaries	Summer	The well-known "smut" or "bunt" of wheat; quite destructive.
109	Urocystis anemones, (Pers.), Winter.	Hepatica triloba (Round-lobed Hepatica).	Leaves	July	Not common.
110	Ustilago anomala, Schrtr	Polygonum dumetorum (Climbing False Buck-wheat); Polygonum incarnatum (Smart Weed).	Flowers	Sept	The smut prevents the formation of seed.
111	Ustilago Austro-Americana, Speg.	Polygonum hydropiper (Water-pepper).	Ovaries	....do	Boone County (1884), Perry County (1885). Probably not a distinct species, doubtless the form referred to by Farlow in Bot. Gaz. VIII, p. 271, 1883.
112	Ustilago caricis, (Pers.), Wint	Carex sp. (Sedge)	....do	Autumn	Perry County.
113	Ustilago hydropiperis, (Schum.), Wint.	Polygonum Pennsylvanicum (Smart Weed).	....do	....do	Very common, greatly distorting the affected parts and preventing the formation of seed.
114	Ustilago panici-miliacei, (Pers.), Winter.	Panicum agrostoides	....do	Sept	Perry County.
115	Ustilago segetum, (Bull.), Winter.	Avena sativa (Oats, Wheat, and Barley).	....do	July	Widespread and destructive.
116	Ustilago utriculosa, Tul	Polygonum sp. (Smart Weed	....do	Autumn	Common.
117	Ustilago zeæ mays, Winter.	Zea Mays (Indian Corn)	Green parts	Summer	The well known corn smut.

EXTRACTS FROM CORRESPONDENCE.[1]

REMEDIES FOR APPLE SCAB.

I am preparing to spray 1,400 ten-year old apple trees with Paris green and want to add something for the scab. Has sulphate of copper been used for the latter disease?—(Charles Patterson, Kerksville, Adair County, Mo.)

Answer. I would suggest the use of liver of sulphur or sulphide of potassium, using the solution of the strength of one-half ounce to the gallon of water. This should be used as soon as prepared, or in other words, it should not be prepared until you are all ready to make the applications.

In regard to the use of sulphate of copper, the strength of the solution which may be used has not been determined. The following preparation may be tried experimentally: In 2 gallons of hot water dissolve 2 pounds of sulphate of copper (pure); in another vessel dissolve 2½ pounds of ordinary carbonate of soda; mix the two solutions and when all reaction has ceased add 1 pint of liquid ammonia; then dilute to 25 or 30 gallons. This is easily applied with a good spraying pump, and adheres strongly to the parts sprayed. Its preventive action lasts for a long time. The action of the liver of sulphur is soon dissipated.

APPLE RUST.

I inclose some apple leaves, affected, as I suppose, by a fungus. Please let me know what it is and how to prevent it. Only certain varieties are affected, but among those are some of the best for this climate.—(James S. Whitman, Dardanville, Ark.)

Answer. The leaves are affected with the apple-leaf rust—a species of *Rœstelia*—which is quite common throughout the Middle and Western States, affecting more or less seriously certain varieties over others. The fungus lives within the tissues of the leaves and fruit (when this is attacked), and becomes visible on the surface when ready to produce its spores or reproductive bodies. It is important to state that this fungus as it appears on the apple is but one stage in its life history, another form appearing earlier in the season on Cedar trees, causing the growth of what is familiarly termed "cedar apples." This stage on the Cedar is regarded as the first and essential condition of that appearing later on the apple, and it is also the stage by which the fungus hibernates, if we may so apply this term.

Perhaps by making applications of the salts of copper or other fungicidal preparations to the apple trees before the spores from the "cedar apples" come upon them the development of the *Rœstelia* form may be prevented; but so far as we are aware, no experiments have been made to determine this question. The destruction of the cedars, together with the application of preventive remedies is the only course of treatment which a knowledge of the facts in the case suggest.

[1] The correspondence of the section consumes a large part of the time of the office force, but it is believed that as an important means of disseminating useful information it should receive all the attention possible.—B. T. Galloway.

BITTER-ROT OF APPLES.

(*Glœosporium versicolor*, B. & C.)

I send you several apples affected with a disease similar to grape-rot. The varieties most subject to the malady are Willow Twig and Ben Davis. Any information as to the cause of the rot will be thankfully received.—(L. D. Grover, Cuba, Mo.)

Answer. The rot is due to the attacks of a minute parasitic fungus closely related to that which causes the disease of the grape now commonly known as Anthracnose. As stated by you, the apple disease, at least in its earlier stages, resembles that of the grape, caused by the black-rot fungus. The disease under consideration first manifests itself in the form of small, more or less circular, brownish or blackish spots, which rapidly enlarge and run together, thus affecting the entire apple in a very short time. As the disease progresses the interior of the fruit becomes brown and soft, and finally the whole shrivels and dries up.

The effects just described are due to the development of the vegetative part of the fungus—known as the mycelium—within the fruit. We have found the spores in abundance on old apples collected under the trees during the last of February. The rot frequently develops after the apples have been stored for the winter, and in such cases it spreads rapidly, and causes great injury.

The only course of treatment which a knowledge of the facts in the case suggests is to bury or burn all diseased fruit as soon as the rot begins to show itself. Great care should be taken not to store fruit that shows the slightest indication of the disease, and during the winter it should be carefully looked over every few weeks, and all the apples showing rot specks removed, for the disease will spread in the bin from the diseased to the healthy apples. If this is thoroughly done serious loss during the winter may be avoided.

As far as we are aware no attempts have been made to apply preventive remedies to the trees. As an experiment in this direction we would suggest that next spring the trees be sprayed with a solution of sulphuret of potassium, one-half ounce of potassium to 1 gallon of water. Make the first application when the fruit is about half grown, and if possible use a force pump with a nozzle of fine aperture for applying the liquid. Repeat the applications every two or three weeks throughout the summer and note the effect, if any. The disease here described is widely distributed. During the past year specimens have been received from Mississippi, Texas, New Jersey, Arkansas, Missouri, and other States. From our own experience with the malady, together with the testimony of others, we feel warranted in saying that it is an enemy to be dreaded, and fought against with every available means.

PEAR BLIGHT.

I send you by to-day's mail some diseased pear cuttings of the Le Conte variety. The trees from which the cuttings were taken I set four years ago, being one year old at the time of setting. The trees are on well-drained sandy lands, which has been well fertilized with stable manure, cotton-seed meal, and phosphates mixed with a

large amount (1 bushel to the tree) of well-rotted swamp muck or peat. They have been vigorous up to this year, but within the past month about every twelfth tree on a tract of four acres has manifested the "die back," beginning in the bud, generally of the highest and most vigorous shoot, and gradually extending downward until in a few instances it has reached the root, thus killing the entire tree.—(C. H. Franklin, Union Springs, Ala.)

Answer. Your samples show unmistakable signs of the disease which has come to be generally known as "Pear Blight." This malady is caused by one of the most minute of living organisms—a species of bacterium, named by Professor Burrill, the discoverer, *Micrococcus amylovorus*. They are frequently spoken of collectively as disease-producing germs, and the malady they occasion belongs to the same category of germ diseases now definitely proven to occur among animals and plants. These germs are of extreme tenuity; they are borne from place to place and from tree to tree by the atmosphere, which is never so quiet but that its movements are sufficient to keep such impalpable bodies afloat. At present we know of no certain means for rendering the trees insusceptible to the disease. Fumigation, spraying, or washing the trees with various known fungicides, notably sulphur and lime, have given no positive results. As the disease is local and spreads through the tissue slowly, it is possible, as has long been known, to effectually check its progress by amputation. The smaller limbs should be cut off a foot or two below the lowest manifestation of the disease, and the spots on the trunk and larger limbs should be shaved out, cutting deep enough to remove all discoloration. The instrument for cutting should be kept disinfected with carbolic acid or otherwise, to guard against conveying the disease to freshly cut surfaces. The exposed and newly cut surfaces ought to be at once painted over in order to exclude the germs that might reach them through the atmosphere.

REMEDY FOR BLACK-ROT OF THE GRAPE.

Will you kindly inform me if you have any reason to expect good results from the employment of the sulphate of copper remedies in the treatment of black-rot of grapes?

Answer. The treatments made this season at Vineland, N. J., by Col. A. W. Pearson, under the direction of the Commissioner of Agriculture, render it no longer doubtful that by the proper application of the sulphate of copper remedies we can subdue or entirely prevent black-rot. In the experiments above referred to the Bordeaux mixture, made as follows, has given the most decided results:

Dissolve 6 pounds of sulphate of copper in 16 gallons of water; in another vessel slake 4 pounds of lime in 6 gallons of water. When the latter mixture has cooled, it is *slowly poured into the copper solution*, care being taken to mix the fluids thoroughly by constant stirring. It is well to have this compound prepared some days before it is required for use. (The sulphate of copper ought to be purchased in a powdered state, as it dissolves with difficulty in the ordinary crystalline form.)

The remedies were applied with the "Eureka Sprayer" and the applications were made on May 29, June 4, June 22, July 2, and July 11. On the treated vines the loss did not exceed 5 per cent., while vines in adjoining rows not treated lost from 90 to 95 per cent. of their crop.

BLACK-KNOT OF THE GRAPE.

I send with this several specimens of grape vine affected with a peculiar disease. Any information in regard to the matter will be thankfully received.—(C. Gere, East Springfield, Erie County, Pa.)

Answer. This is a disease which the French have named *Broussins*, the Germans *Krebs* or *Schorf*, and the Italians *Malattia dei tubercoli*. The first name, "Broussins," meaning excrescences, is descriptive of the disease, and is the one we will adopt. Professor Viala, in his work on the Maladies de la Vigne, pp. 441, 442, has clearly described the disease in question, and illustrated it with two excellent figures. His description is very complete, and the cause to which he attributes the malady appears most reasonable, and we can not do better than to translate in full what he has written:

Under the action of the frosts of autumn and winter, and especially those of spring, peculiar malformations are developed upon the roots, the root crown, the side branches, and the shoots left after pruning. Upon the roots they appear as little nodules the size of a pea, more rarely as large as an egg, which are soft and spongy when moist, but become firm and hard when dry. They have a warty surface, being formed of smaller nodules, which run together where they unite with the root. Upon the crown of the root there is sometimes produced a proliferation of tissues, comparable to the *Broussins* of the root, but which may arise from other causes than early frosts. These spongy masses, harder and less warty than those on the roots, some times grow to a great size; specimens have been seen which had a radius of 3½ inches.

Upon grafts the adjacent layers of generative tissues some times multiply to an unusual extent, giving rise to a spongy swelling, having the form of *Broussins*. But it is especially upon the young branches and side shoots that these formations are most frequent. *Broussins* usually appear at the insertion of the shoots upon the side branches, but it also occurs over the whole length of the internode, or even several successive nodes, entirely changing their normal appearance. There are formed several masses of irregular excrescences, composed of a large number of shapeless nodules. The wood thus covered is often enlarged to four or five times its proper diameter. The bark is torn and often stretched in narrow strips over the irregular groups of nodules. The latter are soft and spongy, but become very hard when dry.

The anatomical structure of these nodules has only been imperfectly studied. It appears, however, that frosts have destroyed the generative cell-layers at certain points and that about these points the unaltered bark and cambium cells multiply in an abnormal manner, producing the tuberculous malformations which constitute *Broussins*.

By some it is believed that the latent buds, which are very numerous at the insertion of the shoots upon the old wood or of the roots upon the crown, can, when influenced by the same phenomenon, make similar excrescences by all growing out at the same time. Others contend that the excrescences on the vine are not composed solely of cellular tissues. Von Thumen has tried to show in this disease the action of a parasitic fungus which he has assigned to the genus *Fusisporium*, the development of which he has not been able to follow. He is the only author who has given expression to this opinion, which now seems to be erroneous.

The branches and main stem should be cut off down to the healthy part; this is the only means of arresting the unhealthy change of tissues.

MELON RUST.

(*Glœosporium lindemuthianum*, Sacc. & Magnus.)

I send inclosed a number of melon leaves affected with a disease commonly known in this region as rust. The disease is very destructive, especially if the weather is hot and moist. Any information as to the cause of the disease and the existence of a remedy will be thankfully received.—(Edward Tillett, Harbinger, N. C.)

Answer. The disease of the melon known as "rust" is caused by a parasitic fungus which grows in the tissues of the leaves and rind. This fungus is a plant like the vine upon which it lives; unlike the latter, however, it has not the power of obtaining its food from the soil and air, but depends entirely upon the juices of the vine for sustenance. In order to build up its own body the fungus robs the melon plant of its nourishment, and as a result of this action the tissues turn brown or "rust."

With the aid of a microscope it is an easy matter to see little tufts of the fungus seated upon the brown spots, and further manipulation shows that these are made up of an immense number of spores or reproductive bodies. The reproductive bodies being very minute are easily wafted from place to place by the wind, and when they fall upon healthy vines, and the proper conditions of moisture and heat are present, they germinate just as seed will germinate when placed in a warm, moist soil. In germinating, the spores send out slender tubes which penetrate the tissues and ultimately give rise to the "rust" spots again.

Heavy dews, fogs, or an excess of moisture in any form favors the development of the fungus, and this fact explains why the rust usually appears during the prevalence of wet weather. It is possible that the disease may be prevented by the application of some substance to the plants which will prevent the spores of the fungus from germinating, but so far as we are aware no experiments having a bearing on this question have been undertaken. By way of trial I would suggest that you spray the vines with a solution made as follows, taking care to thoroughly wet the leaves, but not to drench them:

Dissolve 1 pound of sulphate of copper in a gallon of hot water; to this solution add 1 pint of liquid ammonia, a little at a time, until all the copper is precipitated; the liquid is then turbid and blue in color. Add 2 or 3 gallons of water and let stand to settle. Pour off the clear liquid, which contains sulphate of ammonia—the compound which causes the burning of the leaves. Then pour upon the precipitate left in the vessel just enough liquid ammonia to dissolve it. The result is a clear liquid of a beautiful deep blue color. When required for use, dilute to 22 gallons.

It would be well to make one application of this solution about the middle of July, as the disease rarely appears earlier than this date. It must be borne in mind that the copper acts merely as a preventive, therefore it should be applied before the disease makes its appearance.

ANTHRACNOSE OF THE BEAN.

(*Glœosporium lindemuthianum*, Sacc. & Magnus.)

For the past eight or ten years the gardeners of this city have lost most of their bean crops from the attacks of a peculiar disease. The malady appears suddenly, frequently destroying the entire crop in one night. I have tried many ways of planting, different fertilizers, etc., but so far I have failed to discover a remedy. The only definite information that I am able to give you in regard to the matter is that the disease is always more abundant during warm, "muggy" weather.—(V. Anseman, New Orleans, La.)

Answer. The beans are affected with a parasitic fungus which grows in the tissue of the pods, producing the large brown spots with which you are familiar. The little pinkish, mealy tufts seen in the center of the spots are the spores or reproductive bodies of the fungus. These are easily blown about by the wind, and when they fall upon healthy bean-pods they germinate, providing there is sufficient moisture present, and ultimately produce similar discolorations to those referred to above.

The disease is usually more abundant where the plants are too thick, or where there is an excess of moisture in the soil. In some cases, however, even the most vigorous plants are attacked by it, and on this account it has come to be regarded by many gardeners as a most dangerous foe. There is considerable doubt as to how the fungus lives over winter, and it seems probable that this may be more easily determined from beans grown in the South, since the winter form will develop earlier than with us.

The probability is that the spores which you see on the spots, or other spores of a similar nature, fall to the ground and retain their vitality until spring, when they get upon the young beans. The pods are probably infected early, but the fungus needs moisture in order to develop, and a long shower furnishes this. Hence, you find the pods spotted immediately after. So far little is known concerning a remedy for this disease. I would suggest, however, the following treatment in the hope of discovering a remedy for the pest:

1. Soon after the beans begin forming, spray the plants with a solution made by dissolving 1 ounce of hyposulphite of soda in 1 gallon of water. Apply this mixture thoroughly to the young pods; it is perfectly harmless, and no injury to the plants or the person will result from its use. Repeat the operation when the pods are one-half or two thirds grown, and again eight or ten days later.

2. Apply as described above, but to different plants, a solution made by dissolving one-fourth ounce of sulphide of potassium in 1 gallon of water. The chemicals here mentioned are for sale by all druggists, and they ought not to cost more than 10 cents per ounce. Besides this, it will be well to carefully burn all the vines and diseased pods, and, if possible, to select another site for your bean plot which will be as dry and airy as possible.

"MALARIAL GERM."

A friend handed me on yesterday a report of the Section of Vegetable Pathology for 1886. In Plate II, Fig. 4, of this report, I find an illustration of what I suppose is the cause of most of the diseases incident to this climate. The following extract from the Texas Medical Journal contains an account of the discovery of what I suppose to be the true "malarial germ." It was in Navarro County, Tex., during the summer of 1861, that I noticed a deposit similar to dust upon the leaves of the oak. Finding this upon leaves remote from ways of travel, where there could be no suspicion of dust, I was prompted to make an examination; but having nothing to aid me except a small pocket microscope, I came to the conclusion that it was simply mold. But if mold, why was it invariably found upon the upper side of the leaf? Why had it not formed during the previous wet spell, when the earth was saturated with water and vegetation filled with sap? These and similar reflections caused me to believe that this deposit was nothing but undeveloped spores with which the atmosphere was filled during that season of the year; and that those spores required, for their full development, heat and moisture, both of which would be furnished by the sun and dew in which they were deposited. * * * If this hypothesis be correct, then I thought that an atmosphere so vitiated would have a deleterious effect upon the human economy, and that each appearance of this deposit would be followed by disease, the type of which would depend upon the quantity of these spores in the atmosphere, as evidenced by the quantity of this deposit. Observation then fully convinced me of the truth of that hypothesis. And now, after an observation and experience of more than a quarter of a century in Texas, I am fully persuaded that the cause of malaria is a spore, which rises from a dry, though previously wet soil, and is suspended in the atmosphere until washed out by a general rain-fall. That the sample sent you by Dr. Osburn was deposited with the dew, upon the leaf, and developed into a visible germ by the action of the sun, there can I think be no possible doubt.—(John L. Felder, Cleybourne, Tex.)

Answer. In reply to your inquiries concerning the so-called "malarial germ," I would say that the substance that you describe as occurring upon oak leaves is probably one of the common powdery mildews which is abundant throughout the entire country. This mildew is a true plant, just as much so in fact as the oak upon which it occurs; it of course differs greatly in habit from the latter and it is placed much lower in the plan of nature. There is fully as much difference, however, between the germs which are believed to be the cause of many diseases of the human family and the mildew upon the oak as exists between the former and the oak itself.

To botanists the mildew occurring upon oak leaves is known as *Microsphæria quercina*, and like all true plants it lives, grows, produces bodies analogous to seed, and finally dies. The black capsules mentioned as being found upon the leaves are the sacs or receptacles which contain the spores or reproductive bodies of the fungus. The spores are produced late in the summer and they fall to the ground with the leaves, remain dormant during the winter, and the following spring are set free, and, being very light, are easily wafted from place to place by the wind. When they fall upon the oak leaves and the proper conditions of moisture and heat are present they germinate and give rise to the same kind of whitish threads from which they were derived. As

to this fungus being the cause of fever or any similar disease there is not the slightest grounds for such a belief. There may be some connection, however, between the parasite and certain fevers, as the same climatic conditions that favor one may also influence the other. There are in the United States about seventy-five species of the so called powdery mildews, which occur on widely different host plants. I send with this a few specimens.