THE STATE AGRICULTURAL COLLEGE.

The Agricultural Experiment Station.

BULLETIN NO. 25.

PROGRESS BULLETIN

ON THE

LOCO AND LARKSPUR.

Approved by the Station Council,

ALSTON ELLIS, President.

FORT COLLINS, COLORADO,

OCTOBER, 1893.

The Agricultural Experiment Station.

FORT COLLINS, COLORADO.

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PROGRESS BULLETIN

ON THE

LOCO AND LARKSPUR.

By DAVID O'BRINE, Chemist.

The literature of the so-called "loco" weed is quite extensive. In the Agricultural Report of 1874, page 159, we find the following, and as it describes the symptoms of the so-called "loco" poisoning, it is inserted here: "I think very few, if any, animals eat the loco at first from choice; but, as it resists the drought until other feed is scarce, they are at first starved to it, and after eating it a short time appear to prefer it to anything else. Cows are poisoned by it as well as horses, but it takes more of it to affect them. It is also said to poison sheep. As I have seen its action on the horse, the first symptom of the poison, apparently, is hallucination. When led or ridden up to some little obstruction, such as a bar or rail lying in the road, he stops short, and if urged, leaps as though it were four feet high. Next, he is seized with fits of mania, in which he is quite uncontrollable, and sometimes dangerous. He rears, sometimes even falling backward, runs or gives several successive leaps forward, and generally falls. His eyes are rolled upward until only the white can be seen, which is strongly injected, and, as he sees nothing, is as apt to leap against a wall or man as in any direction. Anything which excites him appears to induce the fits, which, I think, are more apt to occur in crossing water than elsewhere, and the animal sometimes falls so exhausted as to drown in water not over two feet deep. He loses flesh from the first, and sometimes presents the appearance of a walking skeleton. In the next and last stage, he only goes from the loco to water and back again; his gait is feeble and uncertain; his eyes are sunken, and have a flat, glassy look; and his coat is rough and lustreless. In general, the animal appears to perish from starvation, with constant excitement of the nervous system,

but sometimes appears to suffer acute pain, causing him to expend his strength in running wildly from place to place, pawing and rolling, until he falls, and dies in a few minutes."

The plants that were said to cause these symptoms are the *Astragalus Hornii* and *Astragalus lentiginosus*. Dr. Vasey in speaking of the plant says: "The plant submitted to us as the one in question was the *Oxytropis Lamberti*, a plant of the pea family, nearly related to the Astragalus, and also to the Lupin. It grows in considerable abundance upon the elevated plains near the mountains, and extends up into the mountains to the elevation of 7,000 to 8,000 feet. It is perennial, and grows in small clumps, the leaves all at the base, and sending up a few erect flower-stalks, seldom over a foot, which have a spike-like raceme of rather showy flowers, varying in color from cream to purple. These are succeeded by short, stiff, pointed pods, which contain a number of small clover-like seeds. If the statements above given respecting these two or three leguminous plants are substantiated by further experiment and observation, it will be interesting to determine by chemical analysis what is the peculiar poisonous principle which they contain. Plants belonging to this natural order (*Leguminosæ*) have generally been considered as not possessing poisonous properties." The Agricultural Report of 1878, page 134, again speaks of the loco and says: "A further examination will be made of the plant, and any facts concerning it are desired by the department. An examination of this weed by Miss Catherine M. Watson, of Ann Arbor, Mich., is reported in the *American Journal of Pharmacy*, December, 1878. The plant was obtained from Rosita, Colorado, and she reports the presence in small quantity of an alkaloid and a resin. The dried root was taken by way of experiment in four forty-grain doses within one and a half hours, with no other perceptible effect than a slight smarting of the eyelids and slight colic pains. One and one-half ounces of the fluid extract was given to a kitten two months old with no perceptible effect."

In the Report of 1884, page 123, the symptoms are in substance again described, and Dr. Vasey says: "After becoming affected, the animal may linger many months, or a year or two, but usually dies at last from the effects of the complaint. This diseased condition has been attributed to various plants, but mainly to a few which belong to the order *Leguminosæ*. Of these, two species of *Astragalus* have been ascertained in California, and in Colorado and New Mexico another species of *Astragalus* (*A. Mollissimus.*) and a closely related species of *Oxytropis* are generally charged with the

Oxytropis Lamberti.

trouble in question." Omitting the account from Wheeler's report, he says: "Several analyses have been made of the plants which are said to be the cause of this affection, without satisfactorily ascertaining what is the peculiar poisonous principle. No antidote has been discovered. If the plants can be ascertained and exterminated, the trouble should come to an end; but, even if the plants are recognized, their extermination over large tracts of country will be difficult and expensive." From the same source we give the botanical description and cuts of the plants, *Astragalus Mollissimus*—loco weed: "A perennial herbaceous plant of the region of the great plains from Colorado to New Mexico, Texas and Arkansas. It belongs to the order *Leguminosæ*, or pea family. There are usually a great many stalks proceeding from a large root stock. They are reclining towards the base and erect above. These stalks are so short that the leaves and flower stalks seem to proceed directly from the root. They are branching at the base and give rise to numerous leaves and long stems bearing the flowers and pods. The leaves are usually from 6 to 10 inches long, composed of 9 to 15 leaflets (in pairs except the upper one). These leaflets are of oval form, ½ to ¾ of an inch long, of a shining, silvery hue, from being clothed with soft, silky hairs. The flower stalks are about as long or sometimes longer than the leaves, naked below, and at the upper part (¼ to ½) bearing a rather thick spike of flowers, which are nearly 1 inch long, narrow, and somewhat cylindrical, the corolla of a velvety or purple color, the calyx half as long as the corolla and softly pubescent. The flower has the general structure of the pea family and is succeeded by short, oblong, thickish pods, ½ to ¾ inch long, very smooth and with about two seeds in each. *Oxytropis Lamberti*—loco weed: A plant belonging to the same family as the *Astragalus Mollissimus*. It is about the same height, and like it grows in strongly-rooted clumps; but it differs in having an erect habit, with shorter leaves and longer and stiffly erect flower stalks. The leaflets are longer and narrower, about 1 inch long by ¼ to ⅓ inch wide, and hairy, especially on the upper surface. The flower stalks proceed from the root stock, are usually 9 to 12 inches long, and naked except near the top, which has a rather close and thick cluster of flowers, much like those of the *Astragalus* in general appearance, but differing in some minute characters which separate it into another genus, and are succeeded by erect, lance, oblong, pointed pods, of about 1 inch long. This plant is very abundant on the high plains and in the mountains ranging from British America to Mexico. The flowers are subject to much varia-

tion in color, some varieties being purple, some yellow, and others white."

From the Agricultural Report of 1886, page 75, the same description of symptoms are given, and Dr. Vasey again says: "We invite further information from those acquainted with the plant and its poisonous qualities. The plants sent were those of *Astragalus lentiginosus*, locally called 'rattle weed' and 'loco.' It belongs to the order *Leguminosæ*, and is somewhat similar to lucern in appearance, and produces bladdery pods, in which the seeds rattle when ripe. Hence the name 'rattle weed.' In Colorado and New Mexico the same disease among horses and cattle is produced by *Astragalus Mollissimus* and other allied plants. The loss of stock from the eating of these plants has been very great." The other accounts of the loco are mostly found in the *Journals of Chemistry and Pharmacy*. In *The Druggists' Circular and Chemical Gazette* of October, 1888, there is an article by James Kennedy, read at the Austin meeting of the Texas Pharmaceutical Association on the loco weed—*Astragalus Mollissimus*. The chemical analysis used in the method is described in detail. We have room but for his conclusion: "Our experiments were conducted upon the dog, because horses and cattle were not to us available subjects; and we believe they have demonstrated conclusively the non-toxic or innocuous character of the drug. If death is produced by the plant at all, it is not dependent on any poisonous principle contained therein, but is perhaps due to the tough, fibrous and indigestible character of the plant acting as a foreign body, producing irritation and symptoms consequent thereupon, or else its action is identical with an overload of green food of any kind. As the observations heretofore reported were all upon animals feeding in pastures, there seems to be no positive evidence that 'loco' has ever caused the death of any animal, and the immense destruction of stock with which it is charged may have been caused by some poisonous plant heretofore unsuspected. Our conclusions, therefore, are that the 'loco' (*Astragalus Mollissimus*) is non-poisonous and does not possess any of the properties ascribed to it by popular superstition."

In the *Druggists' Bulletin*, May, 1889, page 145, in an article headed "Loco Weed," by Prof. L. E. Sayre, Department of Pharmacy, Kansas State University, he states his attention has been called to the loco weed since 1885. Cuts of the *Oxytropis Lamberti*, *Astragalus Mollissimus*, and *Astragalus tridactylicus* are given. The chemical examination is described, and also his visits to Indian Territory, No-Man's Land, the western part of Kansas, Colorado, and New Mexico during the

Astragalus mollissimus.

summers of '87 and '88. When speaking of his journeys through the country, he says: "I was unable to find a single animal with symptoms answering to those ascribed to this weed. Among the few I found suspected of this distemper was one of a herd from Indian Territory, just south of Arkansas City, brought from Texas for pasture. When informed of the case, I was very eager to avail myself of the opportunity, and at once went to the ranch. But on inspecting the animal was very much disappointed to find no symptoms corresponding with my expectations of an ideal locoed animal. On the contrary, the creature was affected with some loathsome disease combined with very old age.

"In the summer of '87, I had a good opportunity to kill and make post-mortem examination of a cow said to have been eating the weed for two years, and which was given to me as an example of an animal possessed of the loco habit. She was four years old, though no larger than at two years. The loco had not only stopped her growth, but made her quite poor, and gave her a wasted appearance. She seemed stupid, debilitated, unsteady in her movements, the breathing short and rapid, with muscular force very much impaired. Whether walking or standing, it was seemingly beyond her power to so control the muscles as to keep her head perfectly still. Her eyes had exhibited a wild stare, so said, but this had recently disappeared.

POST-MORTEM.

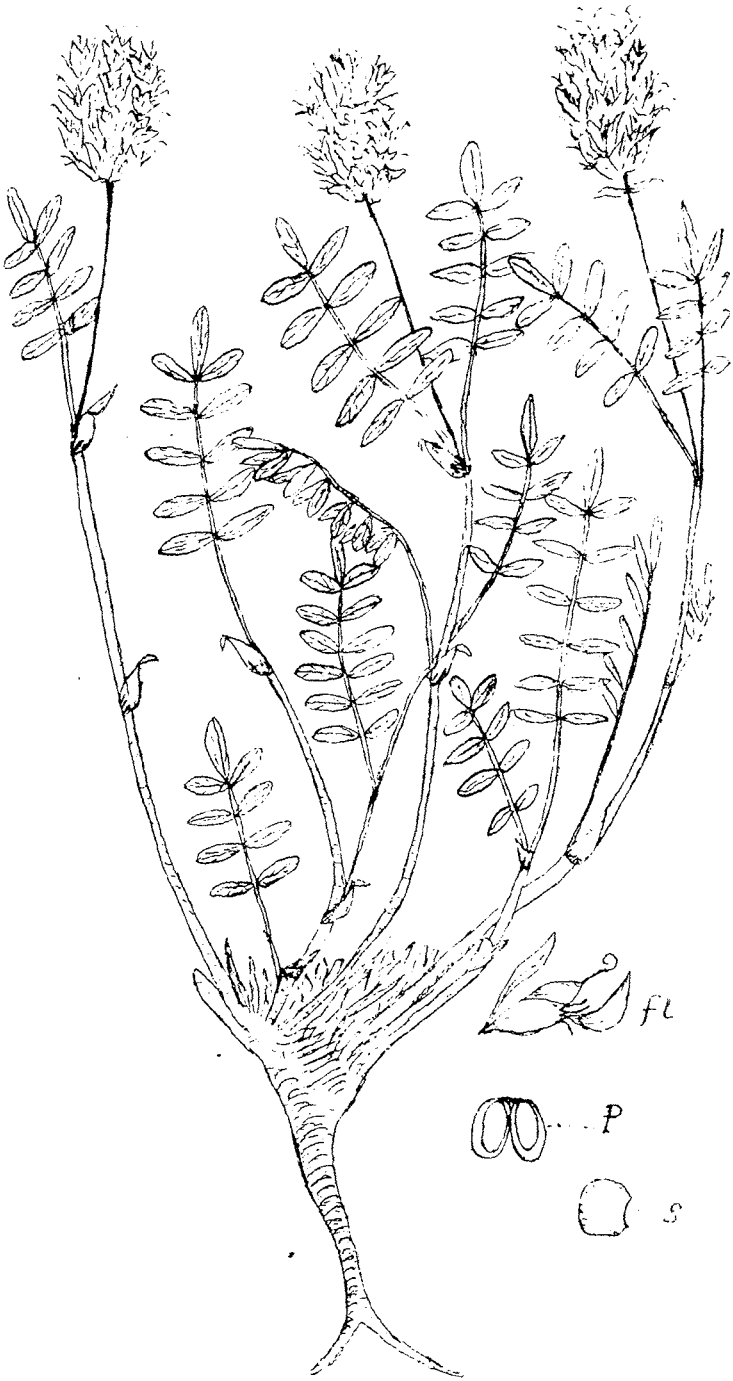
"The blood was light but not normal; having no instrument at hand it was not microscopically examined. The paunch was in a normal condition; the reticulum and psalterium softened, and apparently diseased. Throughout the entire length of the intestines there seemed to be degeneration of tissue, being on the inside peculiarly soft. Two or three perforations were observed in the small intestine. Both the large and small intestines were delicate, devoid of elasticity, and even with most careful handling would be torn or broken apart in places; they appeared to be as one expressed it, rotten in spots. The peritoneum and omentum were inflamed, and presented numerous tumors about the size of a pea, fleshy in appearance and of fibrous nature, The pleura appeared normal, as also did the diaphragm. The pericardium was streaked with red on the inner side, the sac containing about a pint of liquid of a pale color. The heart seemed to be about one third larger than the normal. The mitral and tricuspid valves were inflamed around the edges. The valves of the aorta appeared normal, and just above them the serous coat

was streaked with red; in other respects, nothing abnormal. The bile was thin and watery, even after standing twenty-four hours. The pancreas and spleen appeared natural; kidneys normal; inner coat of bladder softened. Membranes of the brain congested and adherent; the congestion may have been caused by a blow on the head previous to killing the animal. She was, however, only stunned by a light blow, and then immediately bled to death. The brain itself appeared pale, but the bleeding may have caused this. The membranes of the spinal cord were inflamed and adherent, the cord itself normal.

"Evidently the disease was one of mucous and serous membranes, which would account for the nervous and debilitated condition of the animal. The general diseased condition of the alimentary canal, by interfering with digestion and proper nutrition, would account for stunted growth and weakness in traveling." Here follows a quotation from *New Remedies*, August, 1882, page 226, where the physiological experiments of Dr. Isaac Ott, of Easton, are described. He goes on to state his own physiological experiments, and says they have given negative results:

"So fully have I been impressed with the non-poisonous properties of the drug, that I have tried the effect of concentrated solutions of it upon myself. Commencing at first cautiously with a dose of 15 minims every three hours, I have increased it from a tablespoonful to two tablespoonfuls (corresponding to one ounce of the drug). This dose, although repeated at short intervals, produced not even the slightest effect upon the nerves, upon the pupil of the eye, and not much other than a stimulating effect upon the stomach and circulation. Similar experiments with the solution of the supposed crude alkaloid as prepared by Dr. Ott, were made. A tablespoonful of this solution gave not the least evidence of narcotism, although several times repeated.

"I do not put forward these results as showing conclusively that this weed is not poisonous to horses and cattle. The subject needs further study and close inspection, and is one the State of Kansas can well afford to spend money upon to secure the same. The State Board of Agriculture has done already a very creditable work in this direction, and it is to be hoped they will continue unceasingly until the question is finally settled. I may state incidentally, that I am now making preparations to continue the work, in connection with Dr. Burleigh, during the summer of 1889, experiments upon herbiverous animals now being proposed.



Astragalus adsurgens.

"It might seem an easy matter to reach a conclusion upon this subject which is of such vital interest to the farmer and ranchman of the West; but to do this, and satisfy the exactions of science, requires not only careful chemical investigation, but physiological work of a peculiar kind, and close and long-continued observation. To uproot a prejudice of many years' standing, and confront long-established hearsay evidence, even if possessed of no basis of truth, scientific men must push their investigation to the farthest limit."

The *Botanical Gazette*, July, 1889, contains an article by F. W. Anderson, Great Falls, Montana, in which he calls the attention of botanists and others to the fact that something should be done to help the ranchmen with their stock. Much valuable work has been done in Kansas by Prof. Sayre. In the report of the Kansas State Board of Agriculture, December 31, 1887, a prescription is offered for the diseased mucous and serous membranes and for the nervous and debilitated condition of the animal. Dr. Harding thinks that

Pulverized extract belladona..... 10 grains.
Corrosive sublimate..... 1 to 1½ grains.
Licorice..... 1 oz.
Glycerine.....q. s.

Mix. Make a thin paste, and give a tablespoonful. The belladonna and mercury may be increased according to the severity of the symptoms. In the *Rocky Mountain Druggist*, July, 1889, page 81, notes on the so-called loco weeds by Prof. Dr. Frederick B. Power, taken from *Hoffmann's Pharm. Rundschau*, the work of Prof. Sayre is reviewed and the experiments of Dr. Mary Gage Day are cited as to the toxicity of the loco weed. Prof. Power seems to think that it is clearly established that the loco weed contains some alkaloid that affects cattle and horses. In the *Rocky Mountain Druggist*, January, 1891, pages 5 to 9, and in the *Pharmaceutische Rundschau*, January, 1891, page 8, the same article appears: Chemcal examination of some loco weeds, *Astragalus Mollissimus*, Torrey and *Crotalaria Sagittalis*, Lin. by Prof. Dr. F. B. Power and J. Gambier, in which the literature of the subject is first noticed and then the chemical examination of *Astragalus Mollissimus* is taken up, giving in detail the method and tests used. We have room only for the conclusion: "In concluding this investigation the authors are sensible of the fact that the chemistry of the plants under notice has not been pursued to its furthest limits, but being unable at present to devote more time to the subject we have thought it proper to record the results thus far obtained. These results

have, however, afforded us the conviction that both the *Astragalus* and the *Crotalaria* contain very small amounts of toxic alkaloids, to which we believe the symptons of poisoning produced by these plants may reasonably be attributed. It is only to be regretted that these alkaloids, as well as most of the other constituents of the plants, are of such a character as not to render their further chemical study specially alluring."

In the report of the Veterinary Department of the State Agricultural College, by Dr. Faville, issued in January, 1885, page 13, he says: "With a view of determining the symptons and *post mortem* appearances of the disease, (during the month of August,) President Ingersoll, of the college, visited the ranch of Hon. J. M. Givens, of El Paso county, who set aside for his experiments, a number of sheep that were "locoed." I append the report of the President, made to me upon his return from the investigation. He found the animals showing a very great degree of emaciation, and also showing to its greatest degree, the loco habit. They would wander about in an aimless way, refusing all other food except the loco. President Ingersoll made several *post mortem* examinations, and found the same condition of things that I shall describe further on. As an experiment he tried the effect of feeding the loco. A young lamb about two months old, that was being raised on a bottle, was selected. Twenty pounds of loco were cut just below the crown, and that contained no seed; in other words, just the portion that the sheep were getting to eat. This was placed in a wash boiler, in seven or eight gallons of water, covered tightly, and boiled for twelve hours. The juice was then expressed and evaporated to the volume of one quart, when it was a thick syrup, with a smell and taste much like glucose. This was then given to the lamb instead of milk, being fed from the bottle, just as the milk had been. It was given as follows: Seven tablespoonfuls at 4:30 p. m.; four tablespoonfuls at 5:30 p. m.; four tablespoonfuls at 7 p. m. The next morning the bowels were slightly loosened, but nothing more could be seen. The next day two tablespoonfuls were given at 6 a. m.; four tablespoonfuls at 7 a. m.; six tablespoonfuls at 12 m.; two tablespoonfuls at 1:30 p. m.; four tablespoonfuls at 6 p. m. The next morning two tablespoonfuls at 6 a. m.; four tablespoonfuls at 12 m., making thirty-nine tablespoonfuls that were given, in the place of the regular allowance of milk, and which constituted all the food it got for forty-three and one-half hours. There were no deleterious effects, that could be noticed, and I saw and very carefully examined the lamb, about two weeks after-

Astragalus Drummondii.

ward. The results of chemical examination of a syrup made in the same way, I will speak of further on.

"During the first week in September, I spent a few days at Mr. Givens' repeating the experiments of President Ingersoll. The animals that I had to examine were not so badly locoed as many of the flock had been, and most of them had begun to recover. I noticed a condition of things almost identical with those that are described in the President's report. Upon making *post mortem* examinations, I found the following conditions: Organs of thorax were normal. In the abdominal cavity, I found the stomach filled with a mass of semi-digested loco leaves. The liver was normal in appearance; gall bladder filled with a greenish color bile. In the duct, running from the gall bladder to the small intestines, I found a mass of tape worms (*tænia expansa*). The small intestine I found filled with a mass of these worms, varying in length from six inches to five or six feet. The kidneys were normal in size and color, but, upon section I found the pelvis filled with a gelatinous material (*amyloid degeneration*). The muscular system was exceedingly flabby and pale in color. The body seemed to be absolutely destitute of fat. The urine was normal. The brain showed a slight, serous effusion about the base, and to a slightly greater extent in the region of the medulla oblongata. There also was a slight effusion into the abdominal cavity. The only other change that could be found in the brain of these sheep was a slight congestion of the arachnoid membrane. About the middle of October, I received a letter stating that, if I so desired, I could obtain some fine specimens of locoed horses, on the ranch of Mr. J. T. Cheatham, at Lake station, on the Kansas Pacific railroad, about one hundred miles southeast of Denver. I arrived at Lake, Oct. 19th, and at once began my investigation. I found several affected horses. Two of these I killed by bleeding, and made careful *post mortem* examinations upon them. I found the two cases exactly similar, a description of one answering perfectly for the other.

"The first case examined was a sorrel gelding that had been brought through from Texas. He presented the following conditions: Great emaciation; the horse was found standing apart from the rest, and could not be observed to be eating, to any appreciable degree; bowels extremely constipated. The animal apparently had lost all muscular control. Whenever he moved it was in an irregular manner, as if he were intoxicated, and frequently he knuckled over at the fetlocks, as if from complete exhaustion. When a motion was made at him, he would throw his head upward, and stagger

to one side. The power to back was completely lost. If the animal were left to himself he would wander about in a listless, aimless manner, or stand for a long time, with head drooped, in a sort of stupor. The mucous membranes were exceedingly pale. When it was desirous to lead him, we found it to be impossible. When the rope was thrown on to him, he reared backward, and it was impossible to get him to move forward. In the attempt to lead him, he fell. I killed him by opening the jugular vein.

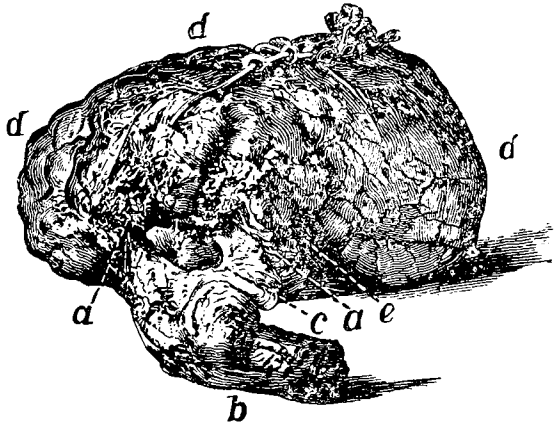
POST MORTEM CONDITIONS.

"The organs in the abdomial cavity were in the following conditions: The stomach was empty, except a small quantity of partially chewed grass and weeds, and a small amount of sand and dirt. The small intestines and cæcum were in a normal condition, except that the coats appeared thinner than they should, and the muscular coat was flabby and relaxed. The colon was enormously distended with food, that was undigested and presented a partially chewed appearance. The spleen was somewhat shrunken and much more dense than normal; kidneys were normal; the liver was considerably shrunken and hardened, and extremely adherent to the capsule. The capsule of the liver showed numerous spots of more or less perfectly organized lymph. The liver pulp, granular and friable.

NERVOUS SYSTEM.

"The *spinal cord* was softened considerably throughout the greater portion of its extent.

"The cerebral hemispheres of the brain appeared normal, except a slight congestion and fibrous hardening of the arachnoid membrane. The middle ventricles were almost filled with serum of a yellowish color. The fourth or cerebellar ventricle was filled with a hemorrhagic effusion, the whole base of the cerebellum being covered with a blood-clot, more or less organized, and a large quantity (three fluid ounces) of serum bathing the base of the brain, and the medulla oblongata. The hemorrhagic effusion, or blood-clot, completely covered the base of the brain, floating in this serum, as well as the fourth ventricle, and was held to the brain substance by well organized tough fibers and also to the meninges of the brain. The blood was deficient in fibrine, only, imperfectly coagulating. All of the serous cavities had an abnormal quantity of serum in them. The second case was a brown three-year-old gelding. The colt showed all the symptoms of the other case, except that he was stronger, and, if possible,



EXPLANATION OF CUT.

a-a—Blood clot in fourth ventricle.
b—Medulla oblongata.
c—Fourth ventricle.
d-d-d—Cerebrum.
e—Fissure between cerebrum and cerebellum.

The cerebellum was lifted away from the medulla oblongata by means of the chain hooks, and as the brain is viewed from the posterior aspect, it shows the fourth ventricle.

showed a greater craziness. The whole system was so run down that, in running and throwing himself, he bled profusely at the nose. The unsteadiness and emaciation were the same as in the first case. The *post mortem* symptoms were the same, a description of one answering for the other. I had the brain from this case photographed and a cut made of it, which is appended."

Dr. Faville's conclusion was that the loco contained some poisonous principle "that caused a hemorrhagic effusion into the base of the brain, causing symptoms of craziness and loss of muscular control." During the fall of 1889, Dr. McEckran, then of the college, instituted the experiment of feeding the loco to an animal, the property of Hon. B. S. LaGrange, a member of the State Board of Agriculture. I have not been able to obtain the record of the experiment, and can only state the general plan and the conclusion of the experiment. The animal was placed in a stable and the loco (*Astragalus Mollissimus* and *Oxytropis Lamberti*) was cut up fine, and mixed with other food so the animal would eat it. This feeding was continued about two months with no symptoms of the so-called loco disease.

Enough has been given of the history of the loco and also of the symptoms by which the animals are affected. I have made many inquiries of those that stated they had any experience with the loco or locoed animals.

BINFORD & SPENCER,
COAL DEALERS,

DENVER, Colo., September 27, 1890.

D. O'Brine, Professor Chemistry, Agricultural College, Fort Collins, Colo.:

DEAR SIR.—You will please excuse my apparent neglect in not complying with your request sooner, in giving you my experience with the loco weed in New Mexico. The summer of '81 was the most disastrous to stockmen that to my knowledge has ever occured in that Territory, and probably the cattle in Ute Creek Valley suffered more than those on other streams. The loco weed was that bearing purple and white flowers; the conditions were, dry weather and short grass. The stock ate freely of the weed, and at any time one could see horses and cattle in all stages of the disease, caused by eating thereof. The rough examination that we were able to give the stock which died, showed the stomach and sometimes portions of what is commonly called the manifold, to be lined and perforated by a small parasite.

A certain druggist in Springer, whose name I cannot recall, had a fair microscope. This we used in examining the plant. We found that almost every plant had one or more leaves that were rolled, indicating that some worm or bug had been at work on it. These leaves, on being unrolled, contained a very small, white parasite. I cannot say that the two, that is the parasite in the stomach and the one in the leaf, had much resemblance to each other, in fact, rather the contrary. But this, if our theory is true, might be due to the growth of the insect. It was the common opinion of those of us who were investigating this matter, that

the loco plant of itself was harmless, and that the effect on animals was the effect of the parasite in their system. The common symptoms, such as near-sightedness, trembling of the limbs, are greatly aggravated by running or any continued quick movement. It is commonly known to be a fact that the loco weed is harmless after severe freezing, and this point will appear to show that there is some other cause than any poison that may be in the plant itself.

From conversation with horsemen in Wyoming, I have heard the same opinion expressed regarding the effect of freezing on the plant. I fear this is not as full a statement as you had hoped for, but at the present day it is about the best I can do.

I should be pleased, at your convenience, to have a summary of the experiments that you are conducting. Hoping that you will be able to get at the bottom of the matter, I am, Respectfully yours,

BINFORD & SPENCER.

UNITED STATES DEPARTMENT OF AGRICULTURE,
Division of Chemistry.

WASHINGTON, D. C., March 11, 1890.

David O'Brine, Fort Collins, Colo.:

DEAR SIR.—In regard to the analysis of the "loco weed," I will say that we have made several examinations of this weed for an alkaloid or poisonous matter, and have separated a substance which exists only in small quantities and which has some of the characteristics of an alkaloid, but which we have not yet obtained in large enough quantities for further examination. We use various methods for extracting the alkaloid, among the best of which we find the saturation of the finely-ground material with sulphuric acid, the addition in excess of sodium hydrate or ammonium hydrate, and shaking the alkaloid out with ether. Among other methods, those used for the separation of Calycanthine, described by me in the *American Chemical Journal*, Vol. II., No. 8. may also be used.

I should expect the largest yield of the alkaloidal principle from the plants after they had reached maturity. Respectfully,

H. W. WILEY,
Chemist.

JOURNAL OF ANALYTICAL CHEMISTRY,
EDWARD HART, Editor.

EASTON, Pa, March 14, 1890.

Mr. David O'Brine:

DEAR SIR.—I worked some time, myself, several years ago with loco weed (*Astragalus Mollissimus*), but could not get any alkaloid. I was forced to lay it aside by press of other work, and have not been able to take it up again. If you succeed with it, I wish you would let me know. In the limited time I worked with the weed, I could only get a gummy residue, which refused to crystallize.

Very truly yours,

EDWARD HART.

The people of Colorado had great faith that it was the loco weed that caused so much disease and death among horses, sheep and cattle, for the Legislature passed an act, as follows :

"Any person who shall dig up, not less than three inches below the surface of the ground, any loco or poison weed during the months of May, June or July, shall receive a premium of 1½ cents per pound for each pound of such weed dug up, to be paid out of the state treasury as hereinafter provided; *provided*, that such weed shall not be weighed in a green state, but shall be thoroughly dried and weighed."

On writing to Hon. W. H. Brisbane, State Treasurer, I received the following reply:

OFFICE OF
STATE TREASURER,
W. H. BRISBANE, Treas.

DENVER, Colo., May 30, 1890.

Prof. David O'Brine, Fort Collins, Colo.:

DEAR SIR.—The State has paid out in bounties on loco weed nearly $200,000. The law was repealed April, 1885. I should like to know your conclusions when finished.

Yours truly,

W. H. BRISBANE,
State Treasurer.

On examining the statute, we find the law was passed March 14, 1881, and repealed February 18, 1885. It cost the State $50,000 a year for bounty.

The plants that we examined on this occasion were identified by Professor Cassidy and later by Professor Crandall. They were dried, ground and sifted, and treated first by the Dragendorff method. The method is described in his work on plant analysis, 1884, published by J. H. Vail & Co., New York, or in Wharton and Stille's Medical Jurisprudence, Vol. II. on poisons, page 356, § 348. It has been thought too technical to be inserted here. In every instance I failed to get anything that would crystallize, only a gummy extract, that gave reactions with Wagner's reagent (iodine in potassium iodide solution), with Mayer's (potassium mercuric iodide), with Sonnenschein's (phosphomolybdate), with Marme's (potassium cadmium iodide), with Dragendorff's (potassium bismuth iodide), with Hager's (picric acid), with Schibler's (Metatungstic acid), with Berzelius' (tannic acid) and also with the chlorides of platinum and gold. Their general action was reducing; when ammonium molybdate was dissolved in strong sulphuric acid it acted like morphine, reduced it to a sapphire blue (Frœhde's reagent); with iodic anhydride and bisulphide of carbon free iodine was liberated. These reactions were tried from the chloroform, ether and absolute alcohol extracts, and it seemed to make but little difference which was used, or whether the extract came from an acid or an alkaline solution. After I had thoroughly tried the reaction, I tried alfalfa, treated identi-

cally like the loco and got the same reactions with the reagents above described. I tried treating with sulphuric acid first, and afterwards I tried hydrochloric, then tartaric, then acetic acids. When the sulphuric acid extract was evaporated down, it gave a blacker residue than the other acids. Nearly all the samples when treated with alcohol, there separated out crystals of lime, that were insoluble in the alcohol. At Dr. Wiley's suggestion I obtained a copy of the *American Chemical Journal*, Vol. II., No. 8, and carefully followed out the method recommended there, with the same results as before. Prof. Sayre visited me in 1890 and called my attention to what Prof. Power had done, and almost at the same time I saw the article of Profs. Power and Gambier in the *Pharmaceutische Rundschau* and in the *Rocky Mountain Druggist*. This year I secured other specimens and carefully followed the method there laid down. The results were the same as in former years. Also tests were made with rabbits by feeding a teaspoonful of the aqueous extract every hour, from 8 to 5 p. m., on Friday, Sept. 2, 1892 to Monday, Sept. 5, 1892, with no bad effects. During the summers of 1891 and 1892, considerable time was spent on the analyses of the loco plant. I visited Livermore or vicinity five times, and made three post mortems. A brief outline of the post mortems is here appended. The first post mortem was made on a 3-year-old colt, the property of Mr. C. The colt was brought in from the range, and was in very poor condition. When driven around the yard he had the peculiar high step so often described as being a characteristic symptom of loco. He was roped, thrown, and his throat cut. The post mortem appearance was as follows: The heart, lungs and liver were normal in appearance. The stomach was completely covered with bots, and contained, besides, a large number of thread worms. The intestine connected with the stomach (duodenum) was filled with sand. I estimated that about two gallons were in the intestines. (When it is known that the post mortems are held from twenty to thirty miles from the College, and in such conditions as we can obtain the animals, only estimates can be made of some things). The brain had a clot of blood at the base of it. I advised the owner (because he had twenty horses suffering from like symptoms) to put the animals on good, green feed, so it might act as a physic, and carry the sand out of the system. I recommended a tonic of nux vomica. He told me the affected animals improved so they were all finally sold. The sand, as I think, comes from the animals not being properly salted, and from eating the alkali soil.

Sophora sericea.

The second animal was 2 years old, and in fair condition He had been taken up, fed and treated for a month in the stable, but he was injured so by throwing himself in the stable that he had to be turned out in the pasture to live or die. I found the liver, heart, kidneys and spleen normal The lungs were congested, and covered with dark, livid spots about the size of a twenty-five cent piece. The stomach and intestines did not have a normal appearance, but were pale and apparently bloodless. The small intestines were cut with a scissors, and were found filled with spindle-shaped worms about 6 to 8 inches long. About one quart of them, (*Ascaris Megalocephala*) was obtained. In cutting the intestines, before we came to the worms, I would find a green mucus discharge; as many as six of them would be found in one place, completely closing up the intestines. Bots were found in large quantities. The reason why so many parasites were found, as I think, is because the animals have to get water wherever they can find it, and in many cases drink stagnant, filthy stuff that is loaded with many forms of animal life. The brain was examined, and the usual clot of blood was found at the base. The colt was owned by Mr. J.

Post mortem No. 3 took place about thirty miles from Fort Collins. The owner, Mr. S., had about 100 head of horses. The colt was 3 years old and had been affected the year before. He had been put up in good pasture about one month before I saw him. The liver, lungs and kidneys were more or less diseased. The liver was tuberculous, the lungs congested, the kidneys were filled with ulcers so the pus could be scraped off when cut into. The clot of blood was found at the base of the brain. As the animal had been on green feed for one month, but few parasites were found. Samples were brought to the laboratory for microscopic examination.

The Bureau of Animal Industry at Washington has kindly consented to assist me in identifying the parasites, and in the miscroscopic examination of the affected parts. "Franks" were sent me to send the specimens to Washington for identification.

In all the examinations thus far made, I have found cause enough to account for the symptoms. The more I examine the loco question, the more I am persuaded that we must look for some other cause besides the loco weed. The loco weed is so common in and about Fort Collins that if it was the cause of the trouble, animals in *this* vicinity must be affected with the so-called loco disease; but I have not been able to find a single specimen in the neighborhood, while the loco is as abundant here as in the localities where the animals

are affected. I have had a great deal of trouble in obtaining subjects for post mortem, as the ranchmen do not want it known that they have any animals affected with loco. They say it would interfere with the sale of their stock. I have been unable to form any reliable estimate of the number of animals that yearly die from the so-called loco disease.

METHOD OF ANALYSIS.

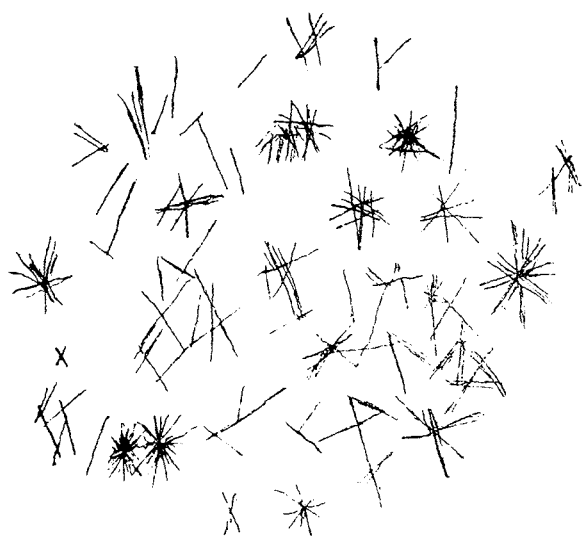
There are quite a number of methods of analyses for the detection and estimation of poisons and ptomaines:

The Otto-Stass method; Granteir and Etard's method; Brieger's method; Luff's method; Graham's method; Fischer's method; Sonnenschein's method; Dragendorff's method. Almost everyone who has had any great experience with this kind of work modifies the method he uses, or adapts the method to his own case. Last year Prof. Sayre called my attention to a method described in *Pharmaceutische Rundschau* for January, 1891, p. 8, by Profs. Power and Gambier, as they claim to have found alkaloids or something that gives alkaloidal reactions. I have followed their method in detail and in every particular, as follows: One kilogram (2.2 lbs.) of the dried and finely ground powder was extracted with strong alcohol for 5 days. The alcohol was pressed out with a filter press. The alcoholic extract was distilled in a Remington still to recover the alcohol; the concentrated residue was treated with water and a little acetic acid to precipitate the resin. This resin was given to a rabbit and produced no effect. I took it in 10 grain doses and could feel no effects. The taste was very disagreeable. The aqueous liquid was treated with lead acetate and the precipitate washed with water, and treated with sulphuretted hydrogen, filtered, boiled down to a small bulk and given to rabbits; it produced no effects. The filtrate, after the lead acetate had been added, was filtered and evaporated to a small bulk and the following tests applied:

Mayer's (potassio mercuric iodide) gave a..... yellowish white precipitate
Dragendorff's (potassio bismuthic iodide) gave a. reddish yellow precipitate
Wagner's (iodine in potassium iodide) gave a.... reddish brown precipitate
Sonnenschein's (phospho-molybdate) gave a..... yellowish precipitate
Hager's test (picric acid in alcohol) gave a..... light yellowish precipitate
Berzelius (tannic acid in alcohol) gave a..... light brown precipitate

The unused portion of this liquid was divided into two parts; one half was made acid by a few drops of sulphuric acid, and the other half made alkaline with a few drops of ammonia. These solutions were evaporated to a small bulk on the water bath, and each treated with Prollius' fluid that was made as follows: 70 c. c. of 94 per cent. alcohol, 30 c. c. of 28 per

Astragalus sericoleucus.



Crystals of Sulphate of Lime.

cent. ammonia, 300 c. c. of absolute ether, and 300 c. c. of chloroform were mixed in a bottle, and the mixture well shaken before being used. The substance obtained by treating with Prollius' fluid was, in each case, evaporated to dryness on the water bath, redissolved in water and again evaporated to see if any crystalline precipitate could be seen by the microscope; but none could be found. These residues were fed to rabbits and I could not see that they were in the least affected. I tasted the residues and found a bad, pungent taste that would be difficult to describe. Thinking that the quantity used was too small, I tried the method over again, using 3 kilos. (6.6 lbs.) with the same result as to crystalline products and as to effects upon rabbits. 4 kilos. (8.8 lbs.) of the dry and finely-ground powder were treated with distilled water containing ½ per cent of sulphuric acid for 6 hours on the water bath. The liquid was strained through a new linen filter and this filtrate evaporated to a small bulk on the water bath. During the evaporation a white cyrstalline salt separated out and was filtered off. This, on examination, I found to be calcium sulphate (see cut). Microscopic drawings were made of these three years ago. The crystals were in the plant as calcium acetate, as I afterwards found.

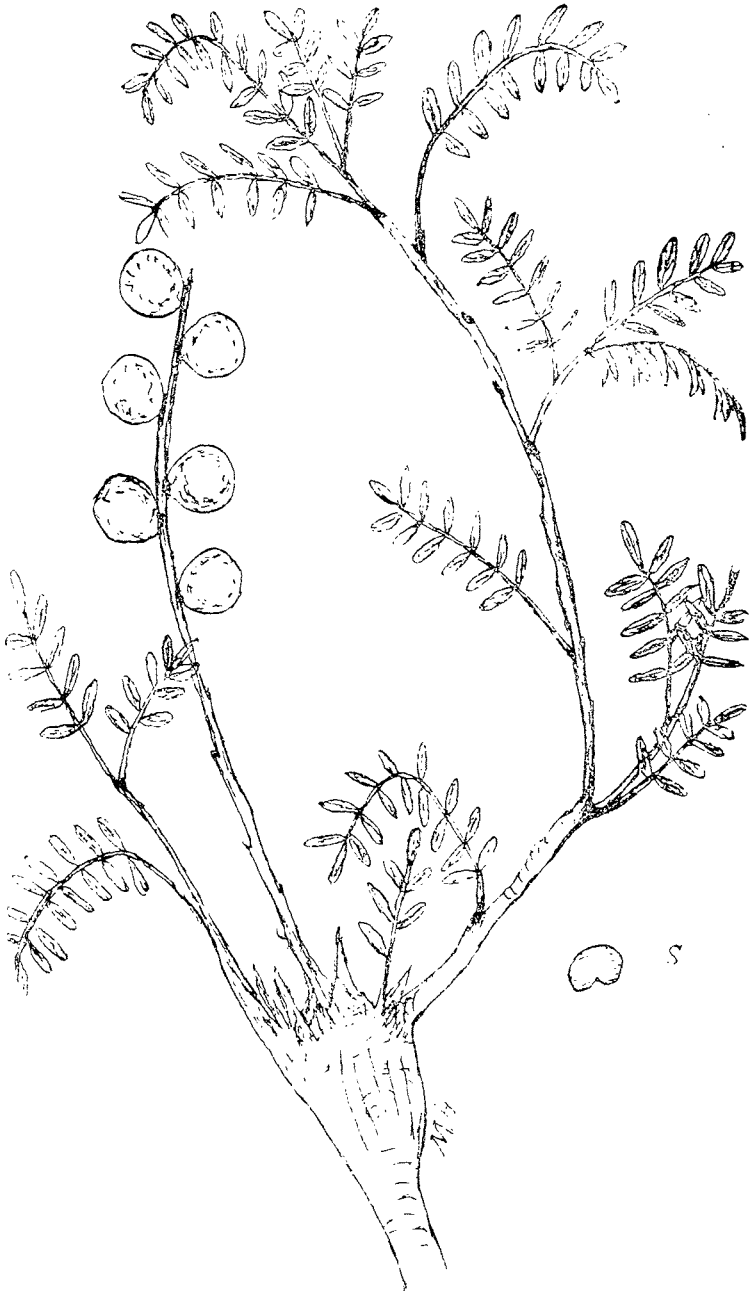
The liquid above described was evaporated to a soft extract and the extract divided into two parts. One part was made acid with sulphuric acid, and the other part made alkaline with ammonia, and these treated with alcohol, ether and chloroform successively and evaporated to dryness on the water bath. The undissolved residue, as well as the amount dissolved by the ether, alcohol and chloroform, was tested for alkaloids by dissolving in water, and gave reactions with Mayer's and the other reagents before described. The residue was diluted with water to the consistency of molasses and given to rabbits every hour for two days, with no bad results. Last year and this year I tried alfalfa in the same way: 1 kilo. (2.2 lbs.) was cut fine and pounded in an iron mortar until it became soft and pulpy, and then treated with dilute (½ per cent.) sulphuric acid for three days, then filtered, the filtrate concentrated on the water bath to a syrup; this syrup was divided into two parts. One half was treated with 95 per cent. alcohol, and the alcohol extract filtered and allowed to evaporate, the residue dissolved in water and tested for alkaloids, as follows:

Wagner's test gave a.....dirty red precipitate
Hager's test gave a.....yellow precipitate
Marme's test gave a.....light yellow precipitate
Berzelius' test gave a.....light yellow precipitate
Mayer's test gave a.....yellowish white precipitate

The residue that was not treated with alcohol, when diluted with water, also gave reactions with the above reagents. To be sure that the alcohol was not the cause of the trouble, I tried the dilute alcohol with the reagents, but could get no reaction. The results of this year with alfalfa were confirmatory with those of two years ago.

One hundred grams (1-5 lb.) of the finely-ground plant were digested with water strongly acidulated with sulphuric acid. This was filtered and distilled; the distillate had an acid reaction; barium carbonate was added to form a barium salt. This barium salt was heated with alcohol and sulphuric acid. when acetic ether was given off, showing the presence of acetic acid.

In all my work on the loco, I have never failed to obtain tests for the alkaloids, and I have never succeeded in obtaining any physiological effects upon myself or rabbits. Last year I tried the Dragendorff method as described in his Plant Analysis, 1884, and also the method of Dr. Wiley, as published in the *American Chemical Journal*, Vol. II., No. 8, page 557. In either case I did not succeed in eliminating any residue that gave physiological reactions. My attention was called to a paper on the recovery of alkaloids by J. U. Lloyd, of Cincinnati, read at the meeting of the American Pharmaceutical Association, at New Orleans. He kindly sent me two copies. His method consists in treating the fluid extracted with a mixture of equal amounts of dry hydroxide of iron and bicarbonate of soda. The stiff magma is treated with chloroform a number of times. He says: "By this method I now find alkaloids in many drugs that failed to yield them heretofore. Indeed, comparatively few drugs are destitute of organic bases." I tried his plan, as follows: Two kilos. (4.4 lbs.) of the dried and finely-ground plants were packed in a percolator. Percolate it with dilute alcohol (1 alcohol to 3 of water); evaporate the alcoholic extract to the consistency of thick honey; thicken this with a mixture of equal amounts of hydroxide of iron and sodium bicarbonate to a thick paste; exhaust with chloroform and evaporate the chloroform. The chloroform residue is treated with a little dilute sulphuric acid and examined for alkaloids. This residue gave me alkaloidal reactions but no crystalline substance, nor physiological test with rabbits. Prof. Lloyd's letter contained a statement that may be of use to others who may investigate the subject. "It seems to me from a review of the papers that I have seen concerning the action of this plant, that it is evident that the result of its use is that of an increasing toxic agent, that is, the effect is not such as I would suppose would follow the action



Astragalus caryocarpus.

of a known amount of poisonous ingredient, but is rather that of a substance that becomes increasingly virulent after it has been eaten. It seems to me that the chemical assay of the plant, as far as I have determined, does not at present account for the physiological action of the drug, and I will say that I would not be at all surprised if it would be shown that the plant does not contain a fixed constituent that will produce the craziness that follows after its use as a food. I am rather of the opinion, therefore, that we will have to look for a fermentative poison that results after the plant is eaten, rather than a poison contained in the plant. I would not be at all surprised if, in the study of this plant, it will be shown that under the influence of the digestive agents, a substance is produced which accounts for the subsequent action of the plant. In other words, it is my surmise that the poisonous action of the loco weed is due, perhaps, to a *product* instead of an *educt*. It remains to be seen whether this product is of a nature of the microbe or of the ptomaine, whether it is an alkaloid or an organism. I will add that in this surmise I am not carrying myself beyond what has been demonstrated to be true of other substances outside of foods, and will call your attention that in modern medicine we now use a preparation of jequirity, which depends altogether on its action from the swarms of microbes that form in the infusion of the beans, and I will add that it is then a violent poison, while the bean itself does not contain a constituent of that nature. It may be that I am off in my surmise, but at least I think that loco will bear investigation in this direction, and I would suggest that a careful examination be made microscopically, locally, of the parts of the animal affected after the plant has been eaten. You will perceive from the foregoing that while the plant undoubtedly contains an alkaloid, or alkaloids, I do not believe this alkaloid is of the importance some think it will prove to be."

The statement of Prof. Lloyd is worthy of very careful consideration. I have been long persuaded that the best way to study the loco question is to spend the summer where the animals are said to be locoed, to see what the animals eat, how they act, what they drink, and to carefully observe their symptoms and post mortem appearances. The reason why I make these comments is that there are so many contradictory statements made to one, that you can believe but little of what you hear about locoed animals. Many of the ranchmen call the larkspur, or poison weed, the loco. A chemical analysis was also made of the larkspur. It was treated the same as the loco weed by the Dragendorff method. The solution

from Prollius' fluid was in appearance like the loco extract, a thick, molasses-looking mass, soluble in water, and giving it a coffee-colored appearance when diluted. Millon's, Berzelius', Marme's, Hager's, Mayer's, and Wagner's tests, before described, gave precipitates with the solution. Bulletin No. 3, Oregon Station, October, 1889, page 25, contains the following statement in regard to the

LARKSPUR.

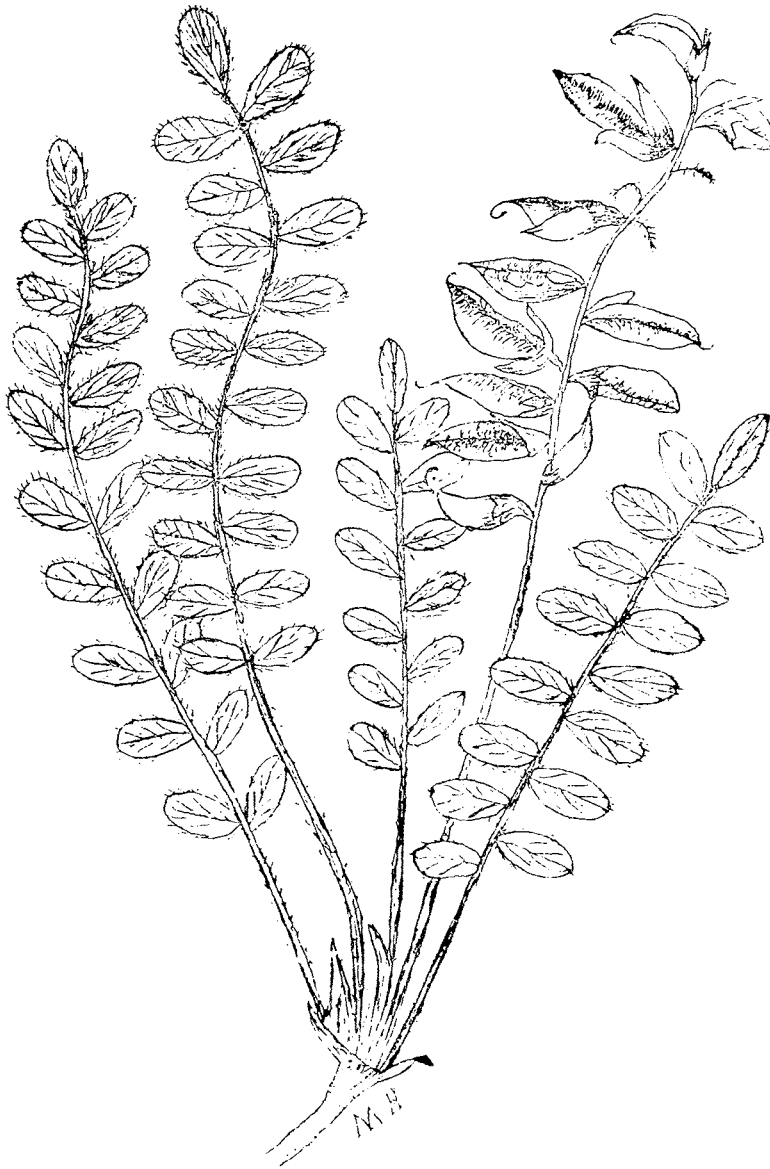
"The matter was taken up on account of the numerous letters received at the station during the spring and summer, asking information with regard to plants which were thought to be poisonous to stock. The method of investigation was the following: Two well-developed, healthy, yearling steers were bought for the experiments, which were primarily to discover whether the plants under examination were injurious, and if so, to note the symptoms developed and try various antidotes for the effects produced. That all parts of the plants might be tested, the tops, *i. e.*, the leaves and stem were fed to one animal, the roots to the other. As great a quantity of the plant was fed to each as cattle under ordinary circumstances would be liable to obtain in the pasture. That the plants might be readily eaten they were, in most cases, mixed with some chopped grass and a small amount of oats added. The experiments commenced May 7. and the first plant tried was the common blue larkspur (*delphinium exaltatum*).

"Twenty-four specimens were taken. The tops chopped and mixed with about an equal amount of clover grass, were fed to one, the roots prepared in a similar way, were fed to the other animal, in both cases without any apparent ill effect. The larkspur used was mostly in full bloom and the individuals were chiefly good-sized plants."

"White larkspur was next tried. Thirty plants, well developed, in full flower, were fed in a manner similar to that noted with the blue larkspur. No effects noted."

In Bulletin No. 35, December, 1892, of the Kansas station, page 115, a cut of the *Astragalus Mollissimus* is shown. The article is headed, 'Some Observations upon the Loco.' The article contains the usual symptoms and post mortem appearances. The conclusion is especially interesting:

"A careful survey of the experiments performed and observations noted leads me to the opinion that the disease known as 'loco' is the result of mal-nutrition, or a gradual starvation, caused by the animal eating the plants known as 'loco weeds,' either *Astragalus Mollissimus* or *Oxytropis*



Astragalus mollissimus—large species.

Lamberti. If there is a narcotic principle in the plant chemists have failed to find it, and a fluid extract does not possess it, and a ton of the plant eaten by an animal ought to contain enough of the poisonous properties to destroy an animal.

"It is extremely doubtful, even though there might be a narcotic agent in the plant, that an animal can reason sufficiently to know that eating this plant would produce narcosis. Why they do eat the plant is probably because the plant remains more green and fresh after other plants have dried up, and also because of its peculiar taste, perhaps disagreeable at first, but soon accustomed to and attractive.

"Whether the disease is the result of mal-nutrition or mal-assimilation, I am unable to say. It is reasonable to suppose that, as the loco plants remain green throughout the year, they would not contain as much nutritious material as other leguminous plants. If they do contain the nutritious material it is not in a form in which it can be assimilated by the animal. The reason why horses have fits of delirium or insensibility may be due to the formation of clots or thrombi in the blood-vessels of the brain, as there is a well-known tendency to their formation during wasting and debilitating diseases.

"The general emaciation of the body, the flaccid atonic condition of the digestive system, the large amount of serum surrounding the brain and in the abdominal cavity, the swollen and dropsical condition of dependent parts (from an enfeebled circulation), and the low temperature of the body, all point to the same cause, *mal-nutrition.*

"The diseased condition of the brain gives rise to the peculiar 'crazy' symptoms associated with the disease. It is well-known that if an animal suffers from degeneration of brain tissue, even though the animal may recover from the disease which caused it, it does not recover its normal mental faculties. This may account for the fact that a locoed animal never makes a complete recovery.

TREATMENT.

"Prevention, by not allowing animals access to the plant or by furnishing suitable food after the pastures have dried up, is much better than treatment. If an animal has acquired a taste for the plant, it should be placed where it cannot get the weed, and fed upon nourishing food. Some good 'condition powders' may be given, as the following :

Sulphate of iron, pulverized..... 1 ounce,
Gentian root, pulverized.....4 "
Ammonia muriate, pulverized.....1 "
Potassium nitrate, pulverized.....1 "

"Mix thoroughly, and give from a heaping teaspoonful to a tablespoonful, according to the size of the animal, in the food three times daily. It will, probably, require considerable time for the animal to recover somewhat of its former vigor, and good nutritious food is to be depended on more than medicine."

The following letters from Dr. Riley explain the parasites that infests the loco.

UNITED STATES DEPARTMENT OF AGRICULTURE,
Division of Entomology.

WASHINGTON, D. C., July 24, 1890.

Professor David O'Brine, Agricultural Experiment Station, Fort Collins, Colorado.

DEAR SIR :—I have your letter of July 14, and the fruit of the "loco weed," with the contained larvæ.

This insect seems to be a weevil of the genus *Bruchus*, allied to the common Bean and Pea Weevil; but it will be impossible to determine the species without rearing the adult. It is very interesting matter, and I trust that you will send me on more of these fruit from time to time.

Hoping to hear from you again, I remain

Yours truly,
C. V. RILEY,
Entomologist.

U. S. DEPARTMENT OF AGRICULTURE,
Division of Entomology.

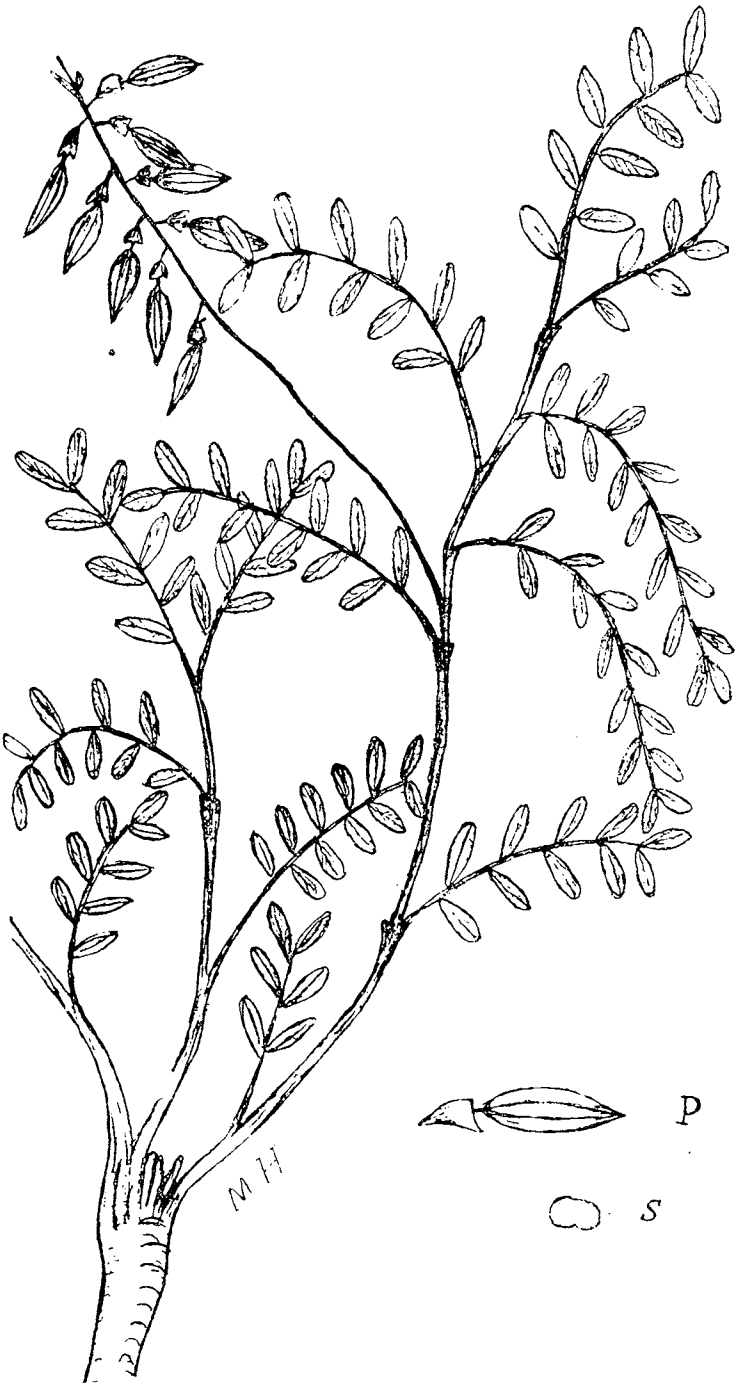
WASHINGTON, D. C., December 6th. 1890.

Dr. David O'Brine, Agricultural Experiment Station, Fort Collins, Colorado.

DEAR SIR :—Yours of the 4th inst. has just come to hand. I am thoroughly convinced that the insects which infest the loco weed have nothing whatever to do with the effect of this plant upon live stock. The loco weed has a number of insect enemies in which I have been for some years quite interested. It is a common thing for persons to suppose that the insects might cause the trouble rather than the plant. I shall always be glad to hear from you further and should especially like to get some more specimens of the Bruchus which you sent last year.

Yours truly,
C. V. RILEY,
Entomologist.

The following table gives the ash analyses of the loco and larkspur: It explains itself.



Astragalus bisulcatus.

ASH ANALYSES OF THE LOCO AND LARKSPUR.

	Total Ash.	Carbon C.	Silica. SiO_2.	Iron and Alumina. Fe_2O_3, Al_2O_3	Calcium CaO.	Magnesia. MgO.	Potash. K_2O.	Soda. Na_2O.	Sulphuric Acid. SO_3.	Carbonic Anhydride. CO_2.	Chlorine. Cl.	Phosphoric Acid. P_2O_5.	Total.
Leaves and Stems No. 1	10.75	2.25	4.13	7.46	7.86	6.43	20.95	10.04	14.98	13.52	6.60	5.49	99.71
Roots No. 1	8.54	3.89	42.80	16.97	7.13	1.43	8.03	6.87	1.73	6.72	1.96	2.53	100.06
Whole Plant No. 2	12.15	4.13	32.77	16.26	6.05	3.11	13.30	3.21	3.90	10.55	.47	6.12	99.87
Fruit of No. 3	10.44	1.52	33.46	11.32	3.00	2.34	20.14	4.31	4.18	7.79	3.73	7.47	99.66
Plants and Fruit of No. 3	12.36	4.00	7.82	5.97	12.10	3.55	23.35	3.38	5.56	20.62	9.00	4.67	100.02
Whole Plant No. 4	13.52	2.22	17.08	12.21	14.27	2.62	17.26	5.75	3.22	17.87	3.87	3.30	99.66
Whole Plant No. 5	14.61	1.44	56.81	16.90	5.70	1.89	5.55	3.30	1.06	4.61	.60	1.98	98.84
Whole Plant No. 6	8.68	2.50	5.20	5.03	12.50	5.64	26.33	3.94	6.00	20.53	7.07	5.11	99.85
Larkspur	13.23	3.40	9.00	8.87	16.72	3.14	20.05	4.15	2.25	27.57	7.82	4.00	99.97

Last year the following specimens were analyzed: No. 1, *Astragalus Mexicanus*; No. 2, *Astragalus Mollissimus*; No. 3, *Astragalus Caryocarpus*; No. 4, *Oxytropis Lamberti*; No. 5, *Oxytropis Monticola*; No. 6, *Astragalus Drummondii*; No. 7, *Larkspur*.

	Moisture.	Ether Extract.	Absolute Alcohol Extract.	Chloroform Extract.	Albuminoid Nitrogen.	Ash.	Nitrogen free extract.	Crude Fiber	When Collected 1890.	Part Examined.	Stage of Ripening
No. 1	8.90	5.12	8.30	.93	11.43	10.75	40.60	22.87	May 24	Leaves and Stems	Bloom.
No. 1	8.10	1.74	5.46	1.69	6.60	8.54	33.57	42.40	" 24	Roots No. 1	"
No. 2	8.97	4.77	14.38	.96	12.86	12.15	35.56	19.32	" 27	Whole Plant No. 2	"
No. 3	13.52	4.36	15.16	.71	10.91	10.44	40.62	17.80	June 10	Fruit of No. 3	Fruit
No. 3	7.36	4.74	12.12	.75	12.68	12.36	39.50	17.85	" 10	Plants and fruit No. 3	"
No. 4	7.27	3.43	5.85	1.32	7.02	13.52	33.26	35.60	" 14	Whole of No. 4	"
No. 5	6.74	3.32	6.65	1.30	6.50	14.61	37.14	30.48	" 18	Whole of No. 5	Bloom
No. 6	8.55	3.88	10.38	.43	9.95	8.68	36.02	30.66	" 23	Whole of No. 6	Fruit
No. 7	10.26	5.12	3.41	1.12	6.75	13.23	47.59	22.78	" 24	Larkspur.	Bloom

It is quite common to find the loco, that was abundant in a certain locality one year, the next year to be nearly all gone. This is no doubt due to the ravages of insect parasites. We examined the root and found a larvæ or grub of *Tincidæ*. Prof. Riley's letter shows the leaves may contain a weevil, *Bruchus*, and we have seen a great many snout-beetles, curculionid, on the plants. Coulter's manual of The Rocky Mountain Region gives under *Astragalus* 64 kinds, and under *Oxytropis* 11 kinds, making 75 kinds of the so called loco weeds. The figures of the loco weeds were drawn from nature by Miss Minnie Harrington, a student of the College. During the past year my assissant, Mr. Ryan, helped me in the chemical examination of the plants, and in confirming the tests of former years.

CONCLUSION.

In conclusion we would say we have been unable to find any alkaloid in the plants examined, though we get alkaloidal reactions from the loco and the alfalfa.

We have not been able to produce any physiological action upon rabbits with the extract from the loco in any of its forms. In the case of the sheep in the southern part of the state, said to have been locoed, it has long been known that the disease was caused by parasites in the liver.

The post mortems made showed such a variety of diseased conditions that in our judgment they could hardly be due to one or the same cause.

It has always been noticed that when the feed on the range is good, locoed animals are scarce. The range about Fort Collins contains the loco in large quantities, but I have never seen a locoed animal except upon the mountain range or foothills.

In our experience the animals affected, and the subjects for post mortems, were in every case young animals, mostly under four years old, the great majority yearlings and two year olds,

I have long been persuaded that the person who investigates the subject of loco should spend considerable of his time on the range and notice very carefully the habits of the animals, the food they eat, and the water they drink. The subject has not been investigated to the extent that its importance demands.

It is never wise to draw hasty conclusions from imperfect data, or from a few post mortems. Judgment had better be withheld until the subject is more thoroughly investigated.