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A SUMMARY OF STUDIES OF LOCO-WEED DISEASE OF SHEEP.[1]

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Eleven years ago, during the summer of 1903, I was engaged [234] by the United States Department of Agriculture to investigate loco-weed disease in Montana, and I continued this study during the summer of 1904. The data thus obtained were worked up into two reports to the Department of Agriculture submitted in 1904 and in the spring of 1906. A more complete technical report was also submitted to the Department. The reports have not been published by the Department, and recently Secretary Houston has given me permisson to publish elsewhere. The full details of my studies will soon be published in the Bulletin of the Philosophical Society of the University of Virginia, Vol. I. In this article I shall give a brief review of my detailed report.

Widely spread over the western ranges from Canada to Mexico and from Kansas to California are many plants called loco-weeds. The plants properly called loco-weeds conform to two or three main types, all of which are members of the family Leguminosæ. These plants are hardy; bloom luxuriantly in the early summer and maintain themselves even where the soil is very poor, being most abundant, probably, in the higher plains and foothills east of the Rockies though not limited to this locality.

According to popular opinion, animals which feed upon these plants are attacked in the most remarkable way. They become crazy, hence the name "loco" or "crazy" disease; they are affected by the most peculiar mental and nervous symptoms; they become drug fiends, in that they want little else than the loco-weed to eat; they sooner or later emaciate and die from exhaustion or intercurrent disease. The length of the disease is not clearly described and many of the symp-

[1] Published by permission of the Secretary of Agriculture.

[234] toms are extremely vague. Animals are supposed to teach one another the habit of eating loco-weed and often the disease will go through an entire herd or flock. The disease entered the United States from Mexico in the early stock-raising days of the west and gradually swept north and now it is found as far north as Montana. The losses resulting from it are supposed to be perfectly enormous, partly directly by death, but to a greater extent from the depreciation of the animals which are supposed rarely to recover.

Experimental studies upon the loco-weed and feeding experiments have given the most contradictory results, but it is safe to say that no one has succeeded in definitely identifying any poisonous principle, inherent in the loco-weed, and capable of producing the symptoms popularly associated with loco disease.

My studies were confined to the locoed sheep of Montana. Other locoed animals could not be obtained for study even after extended search for them. Most exhaustive inquiries were made of stock raisers concerning various aspects of the symptoms, the etiology and course of the disease. These inquiries alone served to show that stock raisers had not a single clear cut disease in mind in describing loco disease; the description of one stockman not tallying with that of another. It appeared probable from studying as a composite picture the information thus obtained that loco disease was something in the nature of an infectious process or at least that it was communicable, and that it attacked especially the younger and weaker animals and prevailed more particularly over ranges and feedings grounds which had been in use for ten or more years.

An important part of my work consisted in inspecting flocks of sheep suffering from loco disease and in examining in detail the most typical cases of severe loco selected from these flocks. Detailed autopsies were performed upon the selected animals after the symptoms had been studied as carefully as possible. The autopsy tissues were studied microscopically. It was hoped that these studies would establish postively the symptoms of loco-weed poisoning, and would reveal any anatomic changes resulting in animals which were victims of the locoweed.

It soon become evident that the "locoed" sheep from different flocks were not affected by the same disease. One flock, for example, presented emaciation and weakness as the chief symptoms, and at autopsy these sheep were found to be heavily infected with a tapework of the liver, "*Thysanosoma actinioides.*"[2] A second group of sheep which were supposed to be typical locoes were overcome with bronchitis and respiratory distress. In these cases lung worms and pneumonias were very common. A third group of sheep whose behavior was regarded as most typical of locoed animals were found to be suffering from nasal and respiratory difficulties which were definitely proved to be associated with severe sheep fly infection (*Oestrus ovis*). A few other forms of parasite were encountered but the above mentioned were the most significant. In addition to these infections it became clear from inspection and from careful inquiry of the stock raisers themselves that the sheep in Montana, generally speaking, were insufficiently nourished. The ranges are grazed over so frequently that the grass does not have a chance to attain a good growth in the intervals between grazings; the flocks are too large for the available grazing grounds, while the grazing grounds are becoming curtailed as more and more open range is fenced in. Moreover in a large flock the delicate sheep have little chance to obtain good nourishment as they are crowded into the background by the stronger sheep. [234] [235]

A most careful study of the sheep failed to reveal anything in the least distinctive of the hypothetical loco poisoning either clinically or anatomically. The locoed sheep presented not a uniform picture as of a single disease, but varied appearances as from different diseases, any of which may be called loco disease by the ranchmen. The abnormalities observed in the selected specimens which I studied could be completely and satisfactorily accounted for by the evidence presented of underfeeding and parasitic infection. Moreover, a few very ill

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[2] **The diseases produced in sheep by *Thysanosoma actinioides* formed the subject of a paper presented by me before the Association of American Pathologists and Bacteriologists in April, 1912, in which I described a new form of biliary hepatitis due to infection with this tapeworm.**

[235] sheep, which were regarded by the ranchmen as typical examples of severe loco-weed disease, were kept under observation, and exhibited a distinct distaste for the loco-weed. At autopsy they were found to be emaciated, and to be infested with parasites. I therefore concluded that the animals which I had observed, although called locoed sheep by expert western ranchers, did not owe their condition to loco-weed poisoning, but were, in fact, examples of poorly nourished sheep, usually suffering from parasitic infection.

During 1904, in addition to continuing the examination of locoed sheep, an experiment was carried out of rather an elaborate nature in an attempt to produce pure loco disease in sheep by feeding them upon loco-weed. A tract of public land upon which the loco-weed, *Aragallus spicatus* (Hook.) Rydberg, was very abundant, and where no other poisonous plant could be found, was fenced in and divided into several lots. Eighty sheep—lambs, ewes and yearlings—were selected from a healthy looking flock and were dosed thoroughly with thymol and creosote in order to rid them of parasites. They were then divided into several groups and placed in a series of corrals. The sheep in some corrals were not allowed to eat loco-weed, but were fed abundantly with alfalfa hay. A second group were given only one-half rations of alfalfa hay, but no loco-weed. A third group were given no alfalfa hay, but plenty of loco-weed. A fourth group were given one-half rations of alfalfa hay and plenty of loco-weed. Another group were given plentiful rations of alfalfa hay and were also allowed to feed freely on loco-weed. The experiment was continued from July 15 to September 6, 1904, 54 days. The details of this experiment are recorded elsewhere. It will suffice to summarize the results here.

It appeared that the healthy sheep did not eat the loco-weed if they could easily obtain a plentiful supply of green forage, but it was easy to force them to adopt a loco-weed diet by reducing their food, or by reducing available green forage, even when the animals were given a plentiful supply of cut alfalfa hay. When once the animal had started to eat the loco-weed, in no instance did they appear to eat it to the exclusion of other food, although they may eat rather more of loco-

weed than of any other single plant and may show rather a [235]
preference for it. In no instance did an animal eating the loco-weed exhibit any characteristic symptoms.

The animals which were not given alfalfa but were forced to feed on the loco-weed and the small amount of other forage in the corral suffered markedly from starvation. It was clear that this was no specific effect of the loco-weed because the animals receiving abundant alfalfa and also eating abundantly of loco-weed kept in much better condition and gained more in weight than those animals receiving only alfalfa and not eating loco-weed. In other words it appeared from this experiment that alfalfa and loco-weed is a better food for sheep than alfalfa alone and moreover it appeared that loco-weed alone does not keep the animal in a good state of nutrition.

Several other interesting points were indicated by this experiment. The sheep were divided into sets, some of which received salt regularly and others did not receive any salt during the course of the experiment. Strangely enough the animals which received salt gained less in weight than those which were unsalted, and among the animals which lost weight the unsalted lost less weight than the salted animals. The young animals were more severely affected by the insufficient diet than the adult sheep.

During the course of the experiment sheep fly disease (Myiosis), attacked all the corrals and was exceedingly severe in its effects upon the starved animals while the better nourished ones escaped with little damage, the sheep receiving alfalfa and loco-weed suffering less than any others.

The outcome of this experiment was to convince me that none of the abnormalities encountered in the sheep which I had studied could be attributed to the poisonous action of the loco-weed. None of my sheep gave the slightest evidence of having suffered any ill results from eating the weed. On the other hand the experiment seemed to confirm the view advanced in 1903 that the animals were suffering chiefly from starvation combined with one type or more of parasitic infection.

My conclusions are at variance with the opinion held by [236]
members of the United States Department of Agriculture and

[236] further experiments have subsequently been conducted on the most elaborate scale by Crawford and Marsh. Crawford's work which led to the conclusion that the symptoms of loco disease are due to barium poisoning was soon upset by a publication by Alsberg and Black from the Department of Agriculture. Marsh's work is hitherto the last word from the Department on the subject of loco disease. I have gone most carefully and painstakingly over the available reports from Marsh and his colleagues and find that the several reports contain perplexing contradictions, and are lacking in important scientific details which it is necessary for Marsh to supply before his conclusions can be accepted. So far as I can make out from a careful study, Marsh claims that he has been able to produce with regularity, definite and fatal forms of poisoning in sheep, horses, and cattle by feeding them for a long time on loco-weed. Very few of his animals developed symptoms of locoism until they had been feeding on loco-weed longer than had my experimental sheep. He claims that there are definite and diagnostic symptoms which can be easily recognized when once they have been seen, and moreover—which is even more important, he claims that there are diagnostic anatomic changes in the animals which have died of loco poisoning. These anatomic changes consist essentially in ulceration and congestion of the stomach of horses or of the fourth stomach of sheep and cattle; of pronounced anemia; and of what are spoken of as serous collections around the heart and around the spinal canal outside of the dura mater. In the latter situation the so-called serous collections are frequently found in a state of organization. In addition there are frequently hemorrhages into the ventricles of the brain. In my more elaborate report I have analyzed carefully the writings of Marsh and have come to the conclusion that Marsh has by no means established the fact that the conditions he describes are due to loco-weed, and that up to the present time his work must be taken as a further substantiation of my claim that "loco disease" is not a clinical entity, because he has added one more to the list of diseases which go by the name of "loco-weed disease." Until Marsh gives definite and conclusive reports upon the nature of these remarkable spinal

coagula and definitely excludes the possibilities of spinal meningitis and meningo-encephalitis, and until he fulfils other necessary requirements it cannot fairly be claimed that he has established loco-weed disease either as a clinical or as a pathologic entity. [236]

The situation as it now stands is about this: The western ranchmen have for years been suffering heavy losses which have been attributed to the poisonous action of the loco-weed.

The Department of Agriculture, through Marsh's publications, has adopted the view that the ranchmen are correct in imputing their heavy losses to the loco-weed. Marsh urges the launching of a very expensive campaign against the loco-weed, with the object of eradicating it, a campaign for which I can find no reasonable justification.

My investigations have convinced me that there are several diseases of western livestock masquerading under the general name "loco disease." One hundred per cent of the severely "locoed" sheep which I studied were not suffering from locoism, but from underfeeding combined with parasitic infection. I therefore think there is reason to be doubtful as to the existence of pure, bona fide loco-weed poisoning, and I hold that it is perfectly certain that the heavy losses attributed to loco-weed disease, are at least in large measure due to other causes, which can usually be ascertained by careful study.

My investigations have brought to light several dangerous parasitic diseases of western live stock, and I have emphasized the fact that it is common for the animals to be distinctly underfed. My conclusions have received support during the last ten years through several publications from the Bureau of Animal Industry, dealing with various parasitic diseases of western live stock. A study of the literature upon the subject, and of the works of Marsh and Crawford, and a review of my own work leads me to believe that the very serious losses which occur among western live stock raisers demand attention, and that their interests can best be served, not by a blind assault upon the loco-weed, but by a vigorous campaign directed first at combatting the overstocking of ranches and the underfeeding of stock, and second at combatting the parasitic diseases prevalent over the western ranges.