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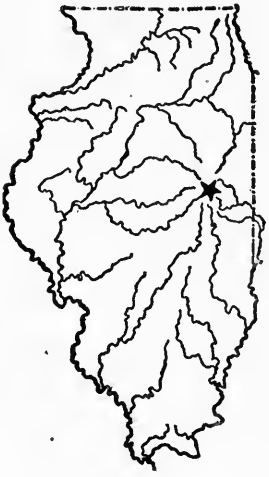
BULLETIN No. 210

FIELD INVESTIGATIONS OF FORAGE POISONING IN CATTLE AND HORSES

H. P. RUSK AND H. S. GRINDLEY



URBANA, ILLINOIS, JUNE, 1918

Summary of Bulletin No. 210

Feeding Tests with Corn Silage Suspected of Causing Forage Poisoning in Cattle.—Numerous outbreaks of forage poisoning in cattle, horses, and mules have been reported to the University, but attempts to reproduce the disease experimentally in cattle by feeding suspected or contaminated feeds have been unsuccessful.

The results of these investigations seem to indicate that most cattle are not so susceptible to forage poisoning as are horses and mules, and that contaminated corn silage, and possibly other animal feeds which are unsafe or fatal to horses, may be fed with less danger to cattle. Evidence from many outbreaks leads to the suggestion that some cattle may be more susceptible than others, and that damaged or otherwise contaminated corn silage, and possibly other feeds, may in some instances produce fatal results in cattle following ingestion. Pages 163-169.

Report of Forage Poisoning Investigations with Horses at Ottawa, Illinois.—Contaminated corn silage from the McLean silo near Ottawa, Illinois, induced a fatal type of forage poisoning in horses following ingestion. The most obvious and characteristic symptoms exhibited by the horses affected in this experiment were paralysis of the throat, profuse salivation, and lack of muscular coordination.

Prophylactic doses of Botulinus antitoxin and related immune sera, developed by Drs. Graham, Brueckner, and Pontius at the University of Kentucky, protected experimental horses against the effect of the daily ingestion of contaminated corn silage responsible for the McLean outbreak. The results of the two tests at the McLean farm apparently justify a trial of these sera in cases of similar outbreaks. Pages 169–176.

Note.—These investigations were completed before the Division of Animal Pathology was established. They were continued by Dr. Robert Graham, Chief in Animal Pathology. All communications relating to forage poisoning should be addressed to the above division.

FIELD INVESTIGATIONS OF FORAGE POISONING IN CATTLE AND HORSES

By H. P. RUSK, Assistant Chief in Cattle Husbandry, and H. S. GRINDLEY, Chief in Animal Nutrition

During recent years an increasing number of inquiries relative to forage poisoning have been received by the Department of Animal Husbandry at the University of Illinois. Many of these inquiries regarding outbreaks in herds of cattle mentioned corn silage as a suspected feed. While this department did not attempt to give any authoritative opinion on such cases, it was freely conceded that our experience would not lead us to suspect corn silage as the source of trouble in outbreaks of forage poisoning among cattle. Common molds found on silage are often suspected of having pathogenic properties, but specific evidence to warrant such suspicion is wanting. It is common knowledge that in most cattle-feeding plants where corn silage is used extensively, cattle often receive some more or less moldy silage, and in many cases are allowed to pick over with impunity the refuse from the tops of newly-opened silos. Certainly the number of outbreaks of this disease in cattle is irrelative to the primary occurrence of molds upon animal feeds.

FEEDING TESTS WITH CORN SILAGE SUSPECTED OF CAUSING FORAGE POISONING IN CATTLE

The series of investigations reported herein was started at the University after an outbreak of forage poisoning had occurred among twenty experimental calves during the winter of 1915-16. These calves consisted of steers and heifers, coming yearlings that were being fed in two lots of ten each in a test (known as Experimental Project 229) to determine the relative efficiency of feeding grain according to appetite and in feeding it in restricted amounts with silage as the sole roughage. The plan of this experiment was to feed each of the two lots the following rations. Lot 1: shelled corn 5 parts, and cottonseed meal 1 part, according to appetite; silage to be fed in such amounts as would not restrict the calves' appetite for concentrates. Lot 2 was to receive the same grain mixture as Lot 1, but the amount was to be restricted to that barely necessary to obtain satisfactory gains; corn silage to be fed *ad libitum* to this lot.

For some time prior to the first of January, 1916, it had been evident that a few calves in each lot were doing poorly. They were

unthrifty in appearance, ate very sparingly, and made unsatisfactory gains. On December 16, No. 35, a calf in Lot 1, was found dead about two hours after the lot received its morning feed. It was thought that she had slipped on the sleety pavement and broken her neck, as her head was doubled back under her body. Even in the light of subsequent developments, it appears unlikely, altho possible, that death may have occurred during convulsions accompanying an attack of forage poisoning. On January 26, No. 38, a Hereford heifer in Lot 2, died in a tonic spasm, which undoubtedly was due to forage poisoning. Unlike Calf No. 35, No. 38 had shown symptoms of unthriftiness for at least a month previous to death. During this time she had been more or less stiff and her appetite was poor. The stiffness gradually increased until the evening of the 25th. She was down on the morning of January 26, and convulsions preceded death about noon.

During the month of January, seven calves were observed to be very unthrifty, showing marked stiffness in moving, loss of appetite, and a falling off of gains. When these unthrifty animals were excited, as would happen on weigh days or when the men were cleaning the manure from the lots, the stiffness seemed to be aggravated, their eyes became starey, and they exhibited a terrified appearance. Several times on such occasions, individual calves were suddenly seized with tonic convulsions, followed by complete loss of locomotion. A calf thus affected would stand for a moment or two with fore feet wide apart as if trying to brace itself, mouth open, tongue slightly extended as if about to cough, and then gradually lean backward until it fell to the ground and lay broadside with feet extended, presenting an appearance resembling death rigor. This condition would last from a few seconds to a few minutes, when the calf would relax, slowly revive, and assume a normal attitude. These nervous manifestations, involving the voluntary muscles, were accompanied by profuse salivation, a lateral movement of the jaws, and difficulty in breathing. These unthrifty calves, when excited, would often show evidence of impaired vision by running or walking into fences, against the feed bunks, or against other calves in the lot, without falling or suffering from tonic spasms. While in this condition, they would show extreme stiffness, muscular tremors in the limbs, and general nervousness.

On March 11, it was so evident that the object of the experiment could never be realized because of the unthriftiness and nervous derangement of so many of the calves, that it was decided to abandon the project and use the calves in an attempt to determine whether any of the feeds were responsible for the abnormal condition described. This test (known as Project 229a) was conducted according to the following plan.

TEST AT ILLINOIS EXPERIMENT STATION TO DETERMINE FEEDS RESPONSIBLE FOR UNTHRIFTINESS OF CALVES

Plan.—Six normal and six abnormal calves were selected from the animals used in Project 229 and divided into six lots; each lot contained one thrifty and one unthrifty animal. The rations fed to the respective lots consisted of the feeds indicated by the following tabulation and in addition 5 parts of shelled corn:

Lot 1 Cottonseed meal 1 part, silage 6 parts
Lot 2 Cottonseed meal 1 part, alfalfa hay
Lot 3 Linseed oil meal 1 part, silage 6 parts
Lot 4 Linseed oil meal 1 part, moldy silage 6 parts
Lot 5 Cottonseed meal 2 parts, silage 7 parts
Lot 6 Cottonseed meal 2 parts, alfalfa hay

Method of Feeding.—All animals were fed individually in stalls. Those receiving silage had the grain and silage thoroly mixed together before feeding. Hay was fed in the same manger as the grain but not mixed with it. All refused feed was weighed back before the following feed was given. All cattle were fed according to appetite.

Equipment.—Two units of the old cattle-feeding plant were used. This plant consists of a long, low shed 12 feet deep and open on the south. Each unit is 36 feet long and opens on a 36x48-foot paved lot. One-half of each of these two units was divided into six stalls, in which the calves were fed individually. The calves were confined in the stalls at feeding time by means of a heavy chain hooked across the rear of each stall. Approximately two hours after feeding, the calves were turned out of the stalls and allowed to run together in the remaining half of the shed and pen. Lots 1, 2, and 3 were kept in the east unit and Lots 4, 5, and 6, in the unit next to the west.

Cattle:

	Calf No.	Weight	Previous treatment
		lbs.	
Lot 1	40	885	Light grain ration
	23	665	Heavy grain ration
		[redacted]	
Lot 2	6	725	Light grain ration
	36	465	Light grain ration
		[redacted]	
Lot 3	28	825	Heavy grain ration
	8	575	Heavy grain ration
Lot 4	11	795	Heavy grain ration
	27	645	Heavy grain ration
Lot 5	21	745	Light grain ration
	39	635	Heavy grain ration
Lot 6	13	790	Heavy grain ration
	34	595	Heavy grain ration

This experiment was started on March 11, 1916, and concluded July 8, 1916.

A study of the foregoing outline will show that an attempt was made to determine by a process of elimination the feed responsible for the condition described. Lot 1 received the same feed mixture that was fed in Project 229. In Lot 2, alfalfa was substituted for corn silage. In Lot 3, linseed oil meal was substituted for cottonseed meal, the roughage remaining unchanged. In Lot 4, the cottonseed meal was replaced by linseed oil meal and the roughage consisted exclusively of moldy silage. Lot 5 received a double allowance of cottonseed meal with silage as the roughage. Lot 6 received a double allowance of cottonseed meal with alfalfa as the roughage. It was felt that if the unthrifty condition was due to the accumulative effect of long-continued feeding of cottonseed meal, Lots 1, 2, 5, and 6 might provide some positive evidence on this point, and Lot 3, and possibly Lot 4, might be expected to give negative results. If the silage were primarily involved, then Lots 1, 3, 4, and 5 might give positive results, and the remaining lots negative results. If it were moldy silage, then Lot 4 might be expected to give positive results, and Lots 2 and 6 negative results. It may be significant that the calves were bedded with straw during the progress of Project 229, while shavings were used for bedding in the forage-poisoning test. A general summary of the results from March 11 to July 8 is contained in Table 1.

A study of this table shows that in no case did a calf that was unthrifty at the beginning of the test consume as much feed as any one of the calves that was thrifty when the test was started.

Considering the length of time that these cattle had been on feed when this test was started, and the season of the year during which it was conducted, the gains made by the calves that were thrifty at the start were entirely satisfactory, with the possible exception of the gains made by No. 11, a heifer that received spoiled silage as her sole roughage. However, this heifer could not have been considered unthrifty in spite of the fact that she gained only .76 pound per day. She carried a good finish and was in excellent thrift, as shown by her general appearance at the end of the test. In fact, there was a general improvement in every animal, with the possible exception of No. 27. This steer suffered from malnutrition during the test and his joints were badly swollen at times, but even he was not at his worst at the close of the experiment, and at no time during the test did he show symptoms suggestive or diagnostic of forage poisoning such as were exhibited by this and other calves before the trial was inaugurated.

The data collected in this test and the reaction of these calves to the rations used do not warrant any conclusion regarding the identity of the feed harboring the causative agent of disturbances observed in these calves during the progress of Project 229.

TABLE 1.—FEED CONSUMPTION AND GAINS IN TEST TO DETERMINE THE FEED RESPONSIBLE FOR UNTHRIFTINESS OF CALVES (PROJECT 229a)

March 11—July 8, 1916

	Calf No.	Feeds	Total feed consumed	Daily feed	Total gain	Daily gain
			lbs.	*lbs.*	*lbs.*	*lbs.*
Lot 1	40	Corn	1469.75	12.34	225	1.89
		C. S. M.	294.50	2.47		
		Silage	1767.35	14.85		
	33	Corn	920.16	7.73	140	1.18
		C. S. M.	181.89	1.53		
		Silage	1101.45	9.26		
Lot 2	6	Corn	1481.60	12.45	220	1.85
		C. S. M.	297.40	2.50		
		Alfalfa	349.90	2.94		
	36	Corn	846.83	7.12	105	0.88
		C. S. M.	170.27	1.43		
		Alfalfa	170.05	1.43		
Lot 3	28	Corn	1152.90	9.70	165	1.39
		Oil meal	231.50	1.95		
		Silage	1390.90	11.69		
	8	Corn	677.75	5.69	85	0.71
		Oil meal	135.75	1.14		
		Silage	755.95	6.38		
Lot 4	11	Corn	1085.80	9.12	90	0.76
		Oil meal	218.15	1.83		
		Bad silage	1237.30	10.40		
	27	Corn	792.20	6.65	40	0.34
		Oil meal	159.35	1.34		
		Bad silage	871.65	7.28		
Lot 5	21	Corn	1224.10	10.29	245	2.06
		C. S. M.	496.15	4.17		
		Silage	1712.38	14.39		
	39	Corn	859.72	7.22	165	1.39
		C. S. M.	342.43	2.88		
		Silage	1194.50	10.04		
Lot 6	13	Corn	1219.75	10.25	190	1.60
		C. S. M.	487.85	4.10		
		Alfalfa	399.45	3.36		
	34	Corn	803.36	6.75	125	1.05
		C. S. M.	319.14	2.68		
		Alfalfa	199.07	1.67		

A FEEDING TEST WITH SUSPECTED SILAGE AT HARRISTOWN, ILLINOIS

Shortly after the foregoing project was started, Charles Ash, of Harristown, Illinois, notified the University of the loss of several coming yearling pure-bred Herefords and a few older cattle from illness resembling forage poisoning. Here again, silage was the suspected feed. Upon the request of Mr. Ash, representatives from the University visited the farm and examined the silage and other feeds used. A preliminary examination of the feeds revealed nothing that might be suspected except a very little mold in small areas in the silo. The silage, as a whole, was judged to be good.

With the cooperation of Mr. Ash, it was decided to conduct a test upon his farm supplementary to the one under way at the University. This test was conducted according to the following outline:

Plan.—One lot of five choice yearling steers and one lot of plain bull calves were fed a ration of the suspected corn silage, linseed oil meal, and water.

Cattle.—Five choice Hereford yearling steers were purchased from Mr. Ash, and five pure-bred Holstein bull calves dropped the preceding fall were purchased from the Dairy Department, University of Illinois. The calves had been used on a milk-substitute experiment and did not show the thrift and bloom that the yearlings possessed. The average initial weight of the Herefords was 675 pounds, and the average initial weight of the calves was 242 pounds.

TABLE 2.—FEEDING TEST WITH SUSPECTED SILAGE AT HARRISTOWN, ILLINOIS

Initial date (1916)	Final date	Days	Total initial weight	Final weight	Gain	Ave. daily gain	Silage	Oil meal
Lot 1—Holstein Calves								
			lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
May 10	May 24	14	1210	1290	80	1.14	1060	26.50
May 24	June 28	35	1290	1490	200	1.14	3130	78.25
June 28	July 5	7	1490	1480	−10	(—)	660	16.50
July 5	July 19	14	1480	1525	45	.643	2010	50.25
Lot 2—Hereford Yearlings								
May 10	May 24	13½	3375	3520	145	2.14	1966.20	49.30
May 24	June 28	35	3520	3915	395	2.25	6694.63	167.37
June 28	July 5	7	2915	3900	−15	(—)	1400.00	35.00
July 5	July 19	14	3900	3970	70	1.0	2910.00	72.75

All of the cattle made satisfactory gains; in fact, the Herefords yielded a profit on the operation after all expenses were deducted. The Holstein calves were not as thrifty at the start and did not make as satisfactory gains as the Herefords.

During the late summer of 1916, a further test was made at Ottawa, Illinois. In this test three two-year-old steers, one cow, and

two sucking calves were fed corn silage which had been experimentally proved capable of inducing a fatal type of forage poisoning when consumed by horses. One calf died during the experiment, but death was attributed to causes other than forage poisoning. As in the other field tests with cattle, typical symptoms of forage poisoning were not produced by the experimental ration.

The results of these investigations seem to indicate that most cattle are not so susceptible to forage poisoning as are horses and mules, and that contaminated corn silage, and possibly other animal feeds which are unsafe or fatal to horses, may be fed with less danger to cattle. This deduction is in accord with the observations of Graham, Brueckner, and Pontius, in a remote outbreak of forage poisoning,[1] where the disease was produced in a horse and the cattle appeared to be non-affected. However, the evidence from many outbreaks leads the authors to suspect that some cattle are more susceptible than others and that damaged or otherwise contaminated corn silage, or possibly other feeds, may in some instances produce fatal results in cattle following ingestion.

REPORT OF FORAGE POISONING INVESTIGATIONS WITH HORSES AT OTTAWA, ILLINOIS

During the month of June, 1916, an outbreak of forage poisoning occurred among horses on the farm of Alexander McLean, near Ottawa, Illinois. This disease was reported to the University by Mr. I. S. Brooks, County Adviser for LaSalle county. Upon investigation, it was learned that Mr. McLean had fed silage to his horses during the late winter and spring months but had discontinued the use of silage during the early part of the summer while the pastures were good. Some time in June, after the pastures began to fail, the silo was reopened, and the feeding of silage to both horses and cattle was resumed. Some of the spoiled silage removed from the silo when it was reopened, was used as bedding for both horses and cattle. Within three or four days after the use of silage was resumed, symptoms of forage poisoning were observed in certain of the horses and two mules. Eight or nine head of horses in all were affected and six died. Dr. Fowlie, the local veterinarian who attended these cases, described the symptoms as typical of forage poisoning. An inspection of the feeds used and the history of the outbreak led the authors strongly to suspect silage as the contaminated feed, but the evidence was not conclusive, as cattle receiving feed from the same silo had shown no symptoms of the disease and some of the other feeds which had been fed to the horses were not entirely free from molds; hence it was

[1] Ky. Exp. Sta. Bul. 208.

decided to attempt to secure some positive evidence in regard to the role silage played in this outbreak.

Five horses were purchased in the vicinity of Ottawa and put on a ration of the suspected silage, wholesome corn, and water, at the McLean farm on June 28, 1916. One horse began to show symptoms of forage poisoning on the third day and died on the fourth. Another went down on July 2 and died on July 4. Another was killed on July 8, after showing pharyngeal paralysis for four days and consuming no feed or water for that length of time. The two remaining horses survived considerably longer, but all five were dead by the end of the third week. One of Mr. McLean's horses was used as a control and fed corn from the same source as that used in the test, with negative results.

The symptoms of forage poisoning, as exhibited by the horses affected in these tests, were uniform and pronounced. The most characteristic symptom was paralysis of the throat. One of the first manifestations of the disease was the inability of the affected horse to drink. Prolonged efforts were made to drink but to no avail. This condition is often overlooked where horses obtain their water from tanks so large that it is difficult or impossible to tell whether or not the water has actually been lowered. In fact, under such conditions, the observer may get the impression that the horse is drinking abnormally large amounts when in reality he is swallowing very little or none. However, when allowed access to water in a bucket, affected animals made prolonged efforts to drink without perceptibly lowering the water. Some were able to eat from one to three or four days after they were unable to drink. Our observations were that affected animals soon became unable to swallow feed as well as water. The appetites remained normal. Many of the horses continued to masticate feed as long as they could stand, but this masticated feed mixed with saliva dribbled from their mouths, due to their inability to swallow. The other characteristic symptoms were profuse salivation and lack of muscular coordination. In the opinion of those connected with this feeding test, the results clearly established the fact that the silage was the source of the poisoning. An autopsy was held on each horse and bacteriological cultures were made from various organs of all the horses as well as from the feed.

Three steers, a cow, and two calves, were fed experimentally for several weeks on a ration composed exclusively of this silage and water, without producing any noticeable symptoms of forage poisoning. These results correspond with the previous experience of the authors in trying to induce the disease in cattle, reported in the first part of this bulletin; and taken in conjunction with results of previous tests they indicate that cattle are much less susceptible to the disease than are horses. However, the history of several outbreaks

of an apparently similar disease among cattle leads to a strong belief that contaminated silage may sometimes cause forage poisoning in this class of animals.

At the University of Illinois, the bacteriological examination of the feed, as well as the cultures made from the organs of the dead horses, failed to reveal any organism that could be considered the causative agent of forage poisoning. However, Dr. Robert Graham, formerly of the University of Kentucky but now connected with the University of Illinois, whose services had been secured in an advisory capacity on this project, took samples of the silage to his laboratory at the Kentucky Experiment Station, where he was able to isolate an organism corresponding very closely to one he had isolated from an oat hay which had been proved to be the source of an outbreak of forage poisoning in Kentucky. Graham, Brueckner, and Pontius, working at the University of Kentucky independently of Rusk and Grindley, developed a serum that in laboratory tests protected against fatal doses of broth cultures of the organisms isolated from both of these sources, as well as from similar organisms isolated from other animal feeds.

In the meantime, the University of Illinois purchased the silage remaining in the McLean silo with the understanding that the silo would be refilled and as soon as it was fed down to the point where the contaminated silage commenced, the University would be given an opportunity to conduct further experiments. A circular oilcloth cover made to fit the silo marked the division between the new and the old silage. When this point in the silo was reached, arrangements were made to give the serum mentioned a field trial against the McLean silage. Accordingly, on June 13, 1917, eight horses that had been purchased on the Chicago market, were started on a ration of this silage, wholesome corn, and water. Five of these horses received intravenous injections of the Botulinus antitoxin and three were left as controls without serum. The summary of this test is shown in Table 3.

TABLE 3.—SECOND FEEDING TRIAL WITH HORSES AT THE MCLEAN FARM
June 13—July 12, 1917

Horse No.	Serum	Silage fed	Silage refused	Silage consumed	Silage consumed per day	Days without feed	Days without water	Date died
		lbs.	*lbs.*	*lbs.*	*lbs.*			
1	*None*	445.5	136.75	308.75	22.87	6.5	10.0	July 3
2	Serum	996.5	366.0	630.5	21.02	None	None	
3	Serum	523.5	294.5	229.0	16.96	8.5	1.0	July 5
4	Serum	835.5	406.5	409.0	13.63	None	None	
5	*None*	287.5	101.0	186.5	26.64	2.5	3.5	June 22
6	Serum	1188.0	477.5	710.5	23.68	None	None	
7	Serum	1308.5	336.0	972.5	32.41	None	None	
8	*None*	247.0	78.5	168.5	21.06	4.0	4.0	June 23

In this table no account is taken of the corn fed, as the horses received a uniform amount of 6 pounds of ear corn per head per day, and practically none was refused. The consumption of silage varied a great deal with individuals, ranging from 13.63 pounds per day in the case of No. 4 to 32.41 pounds per day for No. 7. It will be noticed from the foregoing tabulation that all of the control horses died in from 9½ to 20 days after the beginning of the experiment. All of the serum horses came thru in excellent condition except No. 3, a horse that was clearly off from the second day of the experiment. On that day, Dr. Fowlie, of Ottawa, who gave this test a great deal of his personal attention, stated that in his opinion this horse had been "drugged" before he left the Chicago yards, and that he was suffering from an overdose. At different times during the test, this horse showed symptoms of colic, a condition not observed in any of the horses suffering from forage poisoning. Dr. Fowlie, on two or three occasions, gave this horse purgatives with indifferent results. From June 26 until he died, this horse ate little or no feed. During this time, he received 141 pounds of silage and refused all but 9 pounds. This difference of 9 pounds was probably due as much to error in weighing and drying out of the silage as to actual consumption by the horse. He died on July 5, and upon post-mortem examination it was found that his caecum was ruptured, accompanied by diffuse peritonitis. His death was thought not to be due in any way to forage poisoning.

While the foregoing table makes no mention of the fact, the feed records taken contain a complete record of water drunk and of temperatures taken twice daily. A study of these temperature data did

FIG. 1.—HORSE NO. 9 JUST BEFORE DEATH. NOTE PENDULANT CONDITION OF THE TONGUE, DUE TO PARALYSIS

FIG. 2.—BOTTOM OF MANGER OF HORSE NO. 5, SHOWING PARTLY MASTICATED FEED MIXED WITH SALIVA, WHICH HAD DRIBBLED FROM HIS MOUTH

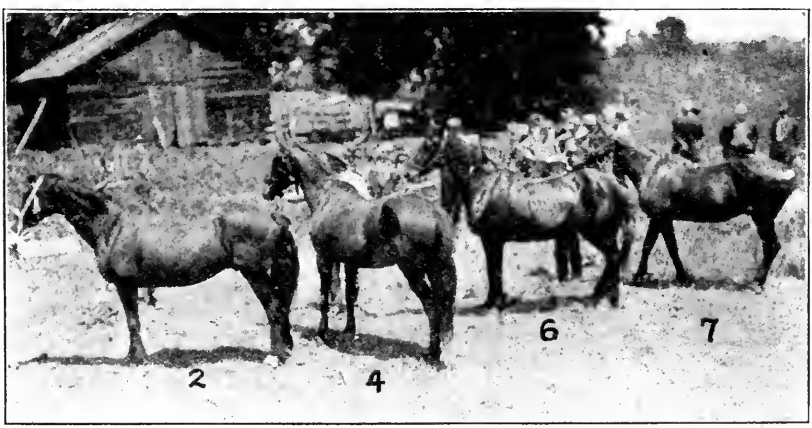


FIG. 3.—HORSES NOS. 2, 4, 6, AND 7, ON JULY 12, 1917

not reveal any characteristic or consistent fluctuation from the normal and the data therefore were not tabulated.

Horses Nos. 6 and 7 were worked regularly during the last few days of the test, in order to determine whether or not this ration was sufficient to maintain them at hard work. Each horse was hitched with one of Mr. McLean's and given a full day's work in cultivating corn. No. 6 gave an unplanned-for exhibition of her superabundant energy on the second day that she was worked by taking the leading part in a spirited runaway.

To make a further and more comprehensive study of the prophylactic properties of the immune sera, another test was started on June 24 with ten head of horses. These horses received nothing but contaminated corn silage and water, no corn being fed and no bedding used. The serum treatment of these horses is shown in Table 4 and a summary of the feeds eaten and the gains made are shown in Table 5.

TABLE 4.—SERUM TREATMENT OF HORSES IN THIRD FEEDING TRIAL AT McLEAN FARM

June 24—July 12, 1917

Horse No. and treatment	June 24, 2:30 p. m.	July 3	July 5	July 6	
9—*None*	....	....	....	....	*Died*
10—G. M.	40 cc. intra.	40 cc. sub.	40 cc. sub.	....	Lived
11—S. G.	40 cc. intra.	40 cc. sub.	....	....	Lived
12—S. G.	40 cc. intra.	....	....	....	Lived
13—G. M.	40 cc. intra.	40 cc. sub.	40 cc. sub.	....	Lived
14—G. M.	40 cc. intra.	....	....	....	Lived
15—H. O.	40 cc. intra.	....	....	40 cc. intra.	Lived
16—H. O.	40 cc. intra.	....	....	....	Lived
17—H-91	40 cc. intra.	....	....	40 cc. intra.	Lived
18—H-91	40 cc. intra.	....	....	....	Lived

G. M.=Goat serum immune to pathogenic bacillus isolated from McLean silage.
S. G.=Sheep serum immune to pathogenic bacillus isolated from Gaines silage.
H. O.=Horse serum immune to pathogenic bacillus isolated from Griffith oat water.
H-91=Horse serum immune to pathogenic bacillus isolated from cecum of Horse 91.

TABLE 5.—SUMMARY OF DATA FROM THIRD FEEDING TRIAL WITH HORSES AT THE McLEAN FARM
June 24—July 12, 1917

Horse No.	Serum	Silage fed	Silage refused	Silage cunsumed	Silage consumed per day	Initial weight	Final weight	Gain (+) or loss (—)
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
9	*None*	819.0	75.0	744.0	46.50	1125	...	*Died*[1]
10	Serum	578.0	119.5	458.5	25.47	875	830	—45
11	"	726.0	53.0	673.0	37.39	1150	1120	—30
12	"	651.5	123.5	528.0	29.33	1050	1010	—40
13	"	692.5	99.0	593.5	32.97	1025	975	—50
14	"	650.5	113.5	596.0	33.11	875	830	—45
15	"	697.0	75.0	602.0	33.44	825	815	—10
16	"	713.5	37.0	676.5	37.58	1080	1125	+45
17	"	731.0	54.5	676.5	37.58	1100	1090	—10
18	"	685.0	77.5	607.5	33.75	950	930	—20

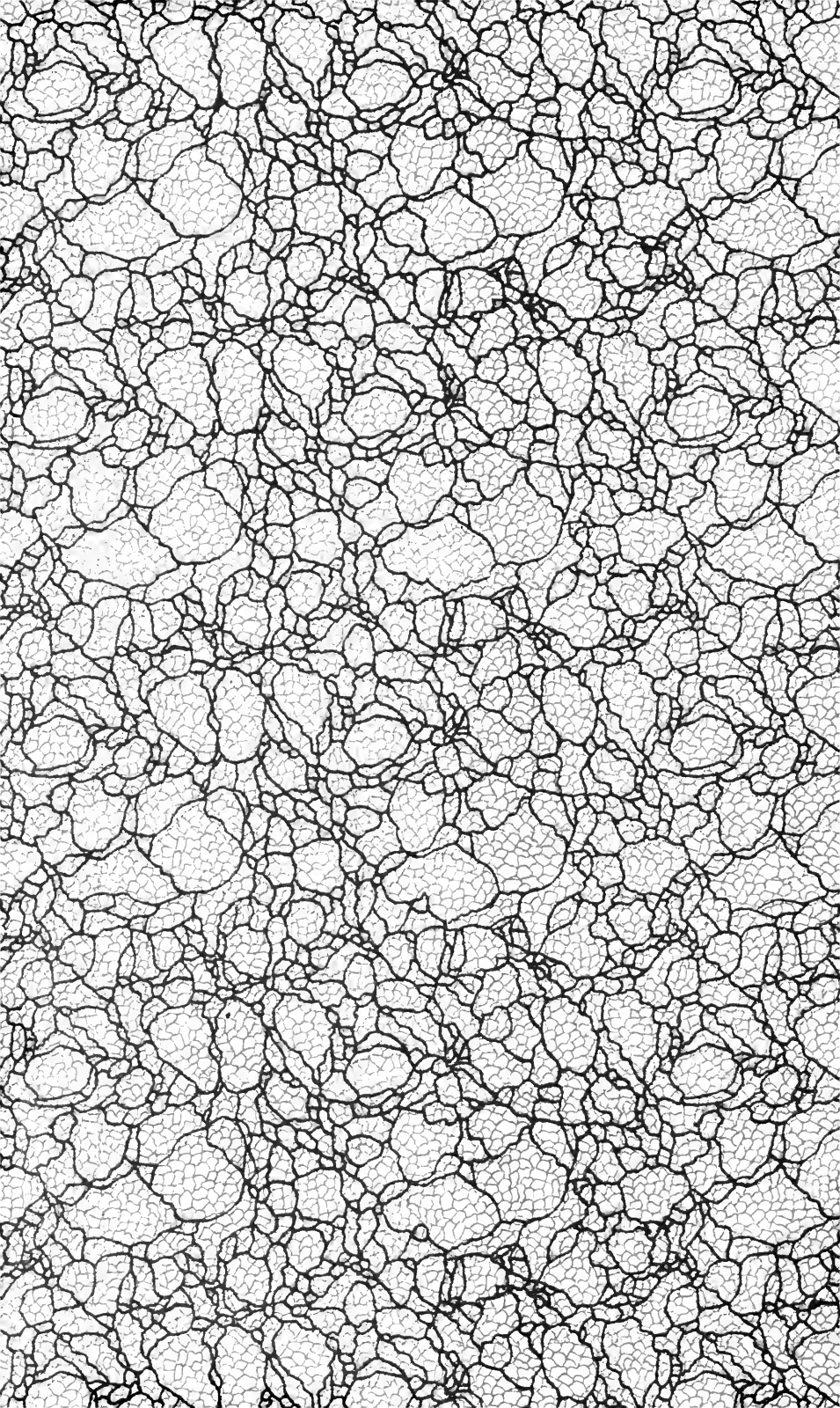
[1]No. 9 died July 12, having lived two days without water and feed.

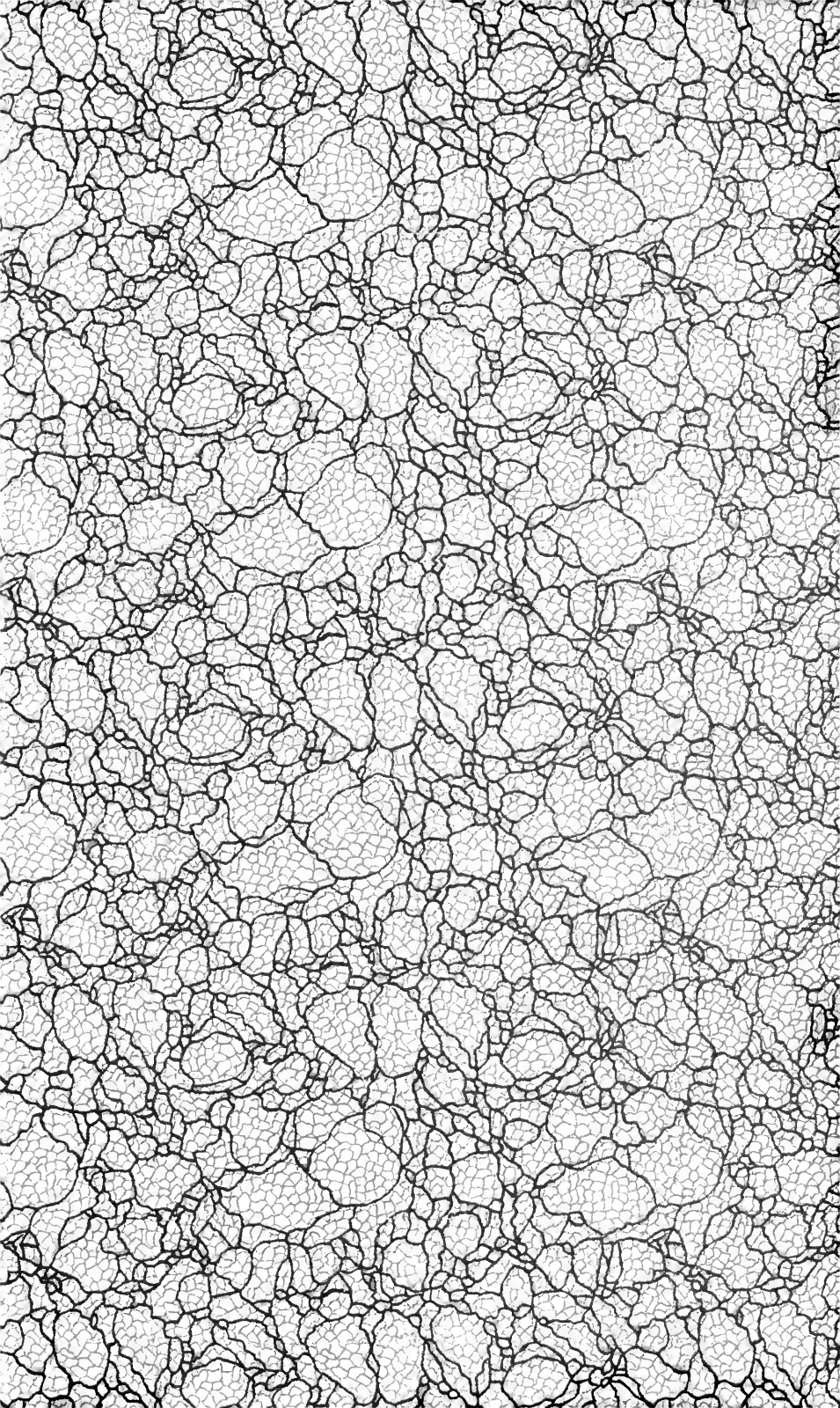
It will be noted that all but one of these horses received serum. This horse developed typical symptoms of forage poisoning and died on July 12. None of the other horses at any time exhibited symptoms of forage poisoning. They were continued on this ration until after the morning feed on Sunday, July 15, at which time the silage was practically gone and its use had to be abandoned. While only one of these horses maintained his weight on a ration of corn silage and water, the losses were not significant, and in all probability most of these horses would have regained their initial weight if the experiment could have been continued a month longer.

FIG. 4.—HORSES IN THIRD FEEDING TRIAL AT McLEAN FARM. NOS. 9 TO 18, FROM RIGHT TO LEFT

The results of these two tests at the McLean farm lead the authors to believe that these sera protected the horses against forage poisoning caused by the organism responsible for the McLean outbreak. Of course it is not contended that all outbreaks of forage poisoning among horses are caused by this or similar organisms, but the results of this experiment apparently justify a trial of this serum in cases of similar outbreaks.

The authors wish to acknowledge their indebtedness to Drs. Graham, Brueckner, and Pontius, of the Kentucky Agricultural Experiment Station, for the opportunity of using the various sera which they had developed, and also for valuable suggestions. The authors also wish to acknowledge their indebtedness to Mr. H. C. Eckstein, Assistant in Animal Nutrition, and Dr. J. A. Sperry, Associate in Bacteriology, who aided very much in the experimental work.





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