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DIVISION OF VETERINARY SCIENCE

MESCALBEAN (SOPHORA SECUNDIFLORA) POISONOUS FOR LIVESTOCK

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
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A poisoning among range sheep resulting from eating green leaves of *Sophora secundiflora* (commonly known as mescalbean, mountain laurel, or coralbean) sometimes occurs during the late fall and winter months on ranches in parts of the Edwards Plateau region of West Texas. Experimentally, goats, like sheep, suffer from a benign type of the poisoning but cattle are extremely susceptible and die within a few hours after eating relatively small amounts of the leaves.

The characteristic symptoms in sheep and goats are muscular trembling, a shortened, stiff gait in the hind legs, and falling, following brief forced exercise. The animal remains recumbent and sleepy for a few minutes then rises naturally and walks away, apparently recovered. Repeated exercise will bring on another characteristic seizure, but we have been unable to cause death in the affected animals even though they were forcd to undergo repeated seizures for relatively long periods of time.

The seeds, which are bright red in color and provided with a hard outer coat, are poisonous, containing the narcotic alkaloid sophorine. Feeding tests with these seeds demonstrated that sheep can consume relatively large amounts of the crushed seed (approximately ¼ of 1% of their body weight) without danger of poisoning. The hard outer coat of these seeds evidently keeps them from being digested and thus prevents poisoning, inasmuch as the presence of many seeds in sheep and goat manure in the pens during the fall and winter indicates that these animals eat the seeds during this time.

The experimental feeding tests showed that the poison in the leaves varies to a large extent with the season of the year, the mature fall and winter leaves being much more toxic than the young leaves during the spring months.

The poisoning evidently results from the ingestion of a large amount of leaves at one time rather than from the continued nibbling of the leaves over a period of days. Feeding tests showed definitely that the poison in the leaves is not cumulative, animals receiving as much as ½ of 1% of their body weight daily for several days with no manifestation of poisoning. The same animals when later given known toxic amounts of the leaves in a single feeding developed typical symptoms of poisoning.

The condition evidently is not of common occurrence even during periods of extremely dry, short range when the animals probably eat the leaves because of the scarcity of weeds and grass. There is reason to believe that the supplemental feeding of range animals during periods of short range will prevent any occurrence of this poisoning.

In pastures in which the tree is not too abundant, eradication by chopping the tree and grubbing the roots is practical at a relatively low cost.

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A disease among range sheep in parts of the Edwards Plateau, characterized clinically by violent muscular trembling, a shortened, stiff gait, and falling, following forced exercise of brief duration, was found to be due to the ingestion of the leaves of the evergreen shrub *Sophora secundiflora*, variously known to the ranchmen as mescalbean, mountain laurel, coralbean, frijolito, or frijolillo. After being driven for a relatively short distance affected animals show the characteristic stiff-legged gait and muscular trembling. Within a few seconds the animal pitches down, struggles to rise for a moment, and then lies quietly in a somnolent condition. About five minutes later it "perks up," rises, and walks away. Additional exercise induces a repetition of the syndrome. Experimentally goats and cattle have also been shown to be susceptible to the poisoning. The affected goats, like sheep, recover from the poisoning, but cattle are extremely susceptible and may die in from two hours to two or three days after being fed a relatively small amount of the leaves.

The seeds of this shrub, enclosed in the tough pods, are brilliant red beans with an extremely hard coat and contain the highly poisonous narcotic alkaloid sophorine. The presence of the whole ripe seeds in the droppings in sheep pens and corrals attests to the fact that they are commonly eaten by sheep and goats without apparent injury. Evidently the extremely hard coat prevents digestion of the bean.

Range observations of affected sheep coupled with experimental feeding tests show that a poisonous substance is also present in the leaves. Inasmuch as the symptoms shown by animals poisoned by ingestion of the leaves are identical with those manifested by animals fed the seeds it is probable that the leaves also contain the alkaloid, sophorine. Obviously ingestion of the leaves constitutes a menace to grazing animals, particularly during the winter months when the range vegetation is short and dry and the animals, hungry for green feed, are apt to be attracted by these succulent-appearing leaves. At least twice the amount of young green leaves, harvested in May, was required to induce poisoning in experimental feeding tests with sheep as was necessary to produce typical cases when mature leaves, harvested in December, were fed. Obviously these results indicate a decided variation in the toxicity of the leaves and probably explain why outbreaks of the poisoning usually occur only during the late fall and winter months.

LITERATURE

Dayton (2) lists this tree under the name of mescalbean and states that the seeds are extremely poisonous. Chestnut (1) states that the

mescalbean is poisonous to livestock. Havard (3), referring to the work of Bellanger*, says that the Indians near San Antonio formerly used the seed as an intoxicant, half of a seed producing a delirious exhilaration followed by a deep sleep lasting two or three days. He states further that consumption of one whole seed is fatal to an adult. Standley (4) reports that fatalities have occurred among Mexican children after eating the seeds.

All available literature states that the seeds are highly poisonous, but the writers have been unable to find any reference to poisoning in livestock resulting from ingestion of the leaves.

BOTANICAL DESCRIPTION†

Sophora secundiflora (Ortega) Lag. is a leguminous shrub or small tree. As a tree it grows from 25 to 35 feet high, with a straight trunk 6-8 inches in diameter separating at some distance above the ground into a number of upright branches forming a narrow head. On the limestone hills and mountain canyons of the Edwards Plateau and the Trans-Pecos area of Texas it rarely grows other than as a shrub, commonly less than 10 feet in height.

The foliage is evergreen, and the leaves are odd-pinnate, consisting of 7-14 (average 9) large, thick, leathery, oblong leaflets, shiny and dark yellow-green above, paler, conspicuously netted-veined, and free from hair or nearly so, below. The leaflets are more than an inch long, broadest at the middle; entire, rounded, slightly notched, or with a small, short point at the apex; and gradually narrowed to a short stalk at the base. The leaf-stalk is stout, usually covered with short hairs, and slightly enlarged at the base. The plant is without spines.

The flowers are showy violet-blue, very fragant (the powerful fragrance being pleasant or agreeable to many but repugnant to others). They are an inch or so long and are borne on stout stalks up to an inch in length in a terminal one-sided, hairy, dense cluster as much as four inches long. The calyx is bell-shaped, slightly enlarged on the upper side, and 5-toothed, with the 3 lower teeth triangular and nearly equal, the 2 upper lobes larger than the others and united.

The fruit is a woody legume or pod, cylindrical, 1-7 inches long, .5 inch broad, 1-8 seeded, constricted between the seeds (bead-like), stalked, beaked with the thickened remnants of the style, coated with a thick, hairy covering. It does not open at maturity to release the seeds.

The seeds (beans) are large, (.5 inch long), oblong, rounded, and bright red or scarlet, and they have a bony seed-coat.

The wood is very heavy and close-grained, in color orange streaked with red, with thick bright-yellow sapwood.

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*Bellanger's report not available to the writers.

†Botanical description and distribution furnished by V. L. Cory, Range Botanist, Texas Agricultural Experiment Station.

DISTRIBUTION

Locally, in Texas *Sophora secundiflora* is commonly referred to as "mountain laurel," but it is not the Mountain Laurel *(Kalmia latifolia)* which was described as a stock-poisoning plant in Technical Bulletin No. 219, December, 1930, U. S. Dept. of Agriculture. In fact, *S. secundiflora* is not a true laurel but belongs to the bean family. Because its seeds are red or scarlet, it frequently is called "Coralbean," but this name is properly applied to two other legumes in Texas, both species of the genus Erythrina, which have similarly colored seeds. Locally, the shrub is called either "Frijolillo" or "Frijolito" by the Spanish-speaking population. The term mescalbean is more truly descriptive, however, and is the accepted name used in Standardized Plant Names.*

This tree is of common occurrence in the limestone hills and canyons of the southern part of the Edwards Plateau, and much less abundant in the limestone soils west of the Pecos River.

The plants grow exclusively in limestone soils, being absent from acid soils. They occur abundantly in the southern part of the Edwards Plateau and are common both in that part of the Rio Grande plain and along the river valleys to the coast where the soils are calcareous. It does not occur on the Gulf prairies except on the shell beds along the coast as far east as the head of Matagorda peninsula. In the rather moist limestone soil on the shores of Matagorda Bay, this tree attains its largest size, forming groves. It extends westward across southwestern Texas to the mountain canyons of southeastern New Mexico and on south into the mountain canyons of Nuevo Leon and San Luis Potosi in Mexico.

FIELD INVESTIGATION

In November 1934 the senior author, accompanied by V. L. Cory, Range Botanist, investigated a peculiar condition in a band of 220 bred range ewes and eight rams, on a ranch some 40 miles southwest of this station.

The history showed that the condition had first appeared among these sheep about three weeks previous to the time of this investigation. The owner reported that at least 10% of the animals in this pasture had been affected during this period, all of them recovering within 48 hours or so after first showing the characteristic symptoms of stiffness in the hind legs and falling after being forced to walk a short distance. These sheep, running in a section pasture, were being rounded up and fed cottonseed cake every morning.

At the time of our visit, after the animals had been driven a short distance, several of them were noticed to slow up; their hind legs became stiff and the stride remarkably shortened, decided muscular trembling developed, and then, after walking a few feet, the animals fell to the ground. Immediately after falling they made strenuous but unsuccessful

*Edition 1924, p. 472.

efforts to rise. This was succeeded by a period of quiet lasting about five minutes during which the animals were somnolent, resting quietly on the brisket or prone on the side. At the end of this time they became alert, pricked up their ears, got up, and walked away. If they were again forced to walk for a short distance the same performance was repeated. Several animals which showed the stiffness and trembling were observed to stop and lie down voluntarily; later they rose and started grazing.

Examination of several affected animals during the period of recumbency showed slightly increased respirations, a fast, bounding pulse, but normal temperatures. No other clinical symptoms were manifested.

Approximately 10% of the animals in this pasture exhibited the same symptoms by the time they had been driven to the pen, a distance of approximately one-half mile. Despite repeated seizures none of the animals died.

The vegetation in this pasture was exceedingly short and very dry, there being practically no grass or weeds available for grazing animals. Investigation indicated that the animals had been browsing, apparently almost exclusively, on the leaves of shin oak (Quercus sp.) and the mescalbean *(Sophora secundiflora)*, both of which were abundant in the pasture. We collected a large sackful of the green leaves of the latter tree for experimental feeding.

An affected ewe was brought to the laboratory and placed overnight in an outside pen. The next day red and white blood cell counts and a differential white count were all within normal range. Calcium (Clark's method) was 10 mgs. per 100 cc. of blood serum, which is within normal limits as judged by previous determinations of the amount of this mineral present in the blood serum of healthy range sheep. Inorganic phosphorus (Benedict-Theiss' method) was 10 mgs. per 100 cc. blood serum, more than twice the amount found in normal range sheep.

Despite continued forced exercise at this time the animal failed to manifest any of the symptoms exhibited 24 hours previously. She was alert and active, and had a very good appetite. This ewe had apparently recovered, at least so far as clinical manifestations were concerned. She was held under observation for seven days and then released as healthy. During this time it was noted that more than 200 whole ripe mescalbean seeds were passed with the feces. On the day of release the calcium was 10 mgs. per 100 cc. of blood serum, while the inorganic phosphorus had decreased to 4.1 mgs., a normal figure.

EXPERIMENTAL FEEDING TESTS

Within a week after the investigation mentioned above, experimental feeding tests, in which healthy sheep were fed the green leaves of the mescalbean tree *(S. secundiflora)* collected on this ranch, demonstrated that these leaves, if eaten in sufficient quantity, are capable of producing a condition indistinguishable from that observed among range sheep.

In these tests it was found that the experimental animals would not eat the leaves voluntarily. Consequently the leaves were ground up and

administered to the animal with an ordinary colt-size balling-gun. Given in this way, a relatively large amount of the ground leaves could be fed in a period of 30 to 45 minutes.

The results of the various experimental tests, in which mature leaves, harvested in December, were fed, are shown in Table 1.

Sheep 415 developed typical symptoms approximately 24 hours after being fed 1.21% of body weight of leaves. Pulse was 76; respiration, 18; temperature, 101.4° F. This animal became recumbent shortly after the symptoms appeared. For the first few days there was a complete paralysis of the legs, no response to external stimuli (with a needle) being secured. About the fifth day the animal was able to raise itself on the hind legs but apparently was unable to move the anterior limbs. At this time the appetite returned. Within the next 48 hours the animal moved about the stall, using its hind feet for propulsion and standing on the knees. On the twelfth day the animal had recovered, moving briskly about and showing nothing in the way of symptoms even after prolonged exercise.

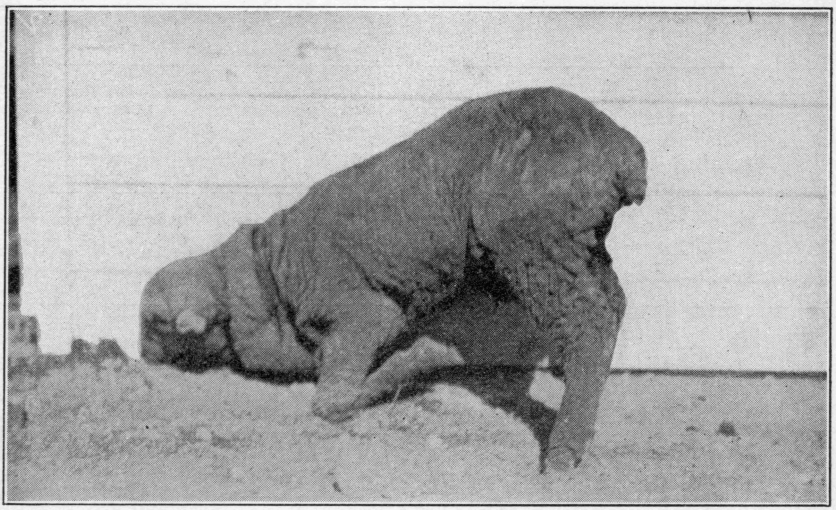

Fig. 1. Poisoning from leaves of *Sophora secundiflora*. The beginning of a fall immediately after brisk exercise. (Sheep 415.)

On the second day after feeding, the inorganic phosphorus in the blood serum amounted to 7.68 mg. per 100 cc.; on the fifth day it was 4.5 mgs., and when the animal was released on the 12th day, it was 3.32 mgs. Serum calcium determinations made on the same days remained constant at 11.5 mgs. per 100 cc.

Sheep 414 was recumbent and semi-conscious 24 hours after being fed .76% of body weight of fresh leaves. Pulse was 60; respiration, 20; temperature, 102.0° F. Six hours later the animal was fairly alert; it was able to stand for a few minutes when placed on its feet, but trembled

Table 1. Experimental Feeding of Mature, Fresh Leaves and Ripe Seeds of *Sophora Secundiflora* (Leaves and seed harvested in December)

Animal	Age Yrs.	Weight Lbs.	Part of Plant Fed	Amount Fed Grams	Per Cent of body weight	Feeding Period	First Symptoms after Hour:	Result
Sheep 415	3	82	Leaves	453	1.21	One feeding	24	Gradually recovered in 12 days
Sheep 414	6	131	do	453	.76	One feeding	18	Recovered in 3 days
Sheep 421	3	119	do	404 539 809	.75 1.0 1.5	One feeding 24 hrs. later 24 hrs. later	7–after final feeding	Recovered in 36 hours
Sheep 420	3	111	do	252 252 252 252 252 252	.5 .5 .5 .5 .5 .5	One feeding 24 hrs. later 24 hrs. later 24 hrs. later 24 hrs. later 24 hrs. later	None	Remained normal
Sheep 424	3	83	do	376	1.0	One feeding	8	Recovered in 2 days; nursing lamb remained normal
Sheep 416	6	95	Ripe seeds (finely ground)	105 105 105 105 210	.243+ .243+ .243+ .243+ .487+	One feeding 24 hrs. later 24 hrs. later 24 hrs. later 48 hrs. later	18-after final feeding	Recovered in 4 days
Sheep 419	2	78	do	353	1.0	One feeding	12	Died in 18 hours
Goat 423	5	62	Leaves	281 422	1.0 1.5	One feeding 32 hrs. later	16-after final feeding	Recovered in 6 days
Calf 426	6 mo.	200	do	906	1.0	One feeding	½	Died in 1¾ hours
Calf 427	6 mo.	294	do	999	.75	One feeding	1½	Died in 3¼ hours
Calf 430	9 mo.	340	do	386	.25	One feeding	18	Died in 45 hours
Calf 434	9 mo.	360	do	408 612	.25 .375	One feeding 48 hrs. later	8-after final feeding	Recovered 16 days

violently all over and pitched down. Two hours later this sheep could rise and walk a few feet before falling. The appetite was suspended. The next morning the animal could rise but manifested symptoms and fell after being forced to walk about 100 yards. It was alert and eating. The next

day (3d) the sheep was clinically normal, alert, and hungry; it showed no symptoms after prolonged exercise. The animal remained normal and was released on the 6th day.

On the 3d day the inorganic phosphorus was 5.25 mgs. per 100 cc. blood serum, and on the 6th day it had decreased to 4.0 mgs. Serum calcium remained constant at 11.6 mgs. per 100 cc., the determinations being made on the same days.

Sheep 421 was force-fed .75% of body weight of green leaves and was normal 24 hours later. At this time 1% body weight of leaves was fed; the animal remained normal after 24 hours despite prolonged exercise. It was then given 1.5% body weight of green leaves. Seven hours later this animal manifested symptoms after brief exercise, went down, and had to be carried back to the stall. The next day, 24 hours after final feeding, this sheep was standing but trembling, and went down after walking about 20 feet. Pulse was 120; respiration, 45; temperature, 102.0° F. Nine hours later decided improvement was noted and the animal was nibbling at its hay. The morning of the 2nd day after the final feeding the animal was alert and eating, and remained normal after prolonged exercise.

Blood serum showed amounts of inorganic phosphorus as follows:
Before first feeding—4.25 mgs. per 100 cc.
Before final feeding—4.50 mgs. per 100 cc.
24 hours after final feeding—7.12 mgs. per 100 cc.
48 hours after final feeding—4.12 mgs. per 100 cc.

The serum calcium, determined on the same days, remained constantly within the normal range.

Sheep 420 received .5% body weight of green leaves daily for six consecutive days and remained normal, never showing any signs of poisoning during this period.

Sheep 424 was a healthy ewe nursing a two weeks old lamb. She received 1% body weight of leaves at 8 a. m. Eight hours later typical symptoms developed. Pulse was 90; respiration, 28; temperature, 101.6° F. The next morning this ewe was recumbent, trembling, and semi-conscious. The appetite was gone and the milk flow reduced but not stopped. Pulse, 90; respiration, 27; temperature, normal. Twenty-four hours later she was able to rise, but manifested symptoms and went down when exercised. She was eating and allowed her lamb to nurse. Pulse, 80; respiration, 18; temperature, normal. By the next morning this animal had apparently recovered completely. The lamb nursed throughout the test and remained healthy.

Inorganic phosphorus in 100 cc. blood serum:
Before feeding—3.82 mgs.
24 hours after feeding—5.0 mgs.
72 hours after feeding—4.2 mgs.
Serum calcium remained normal during the test.

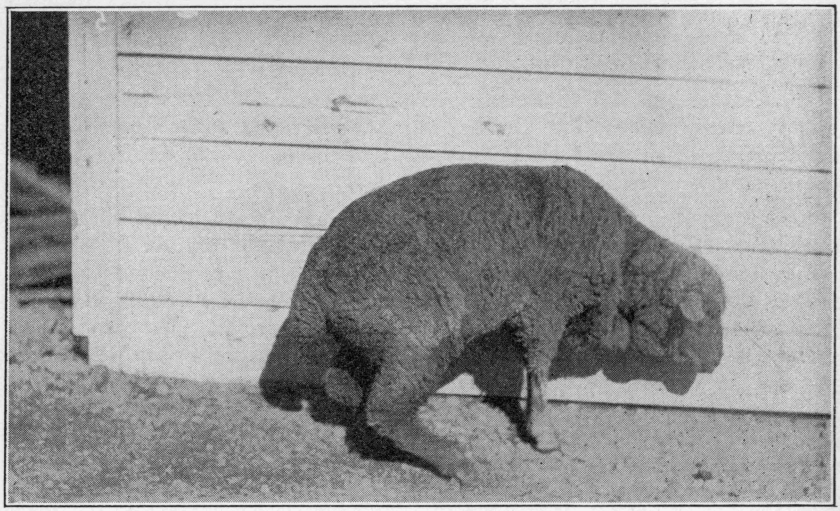

Fig. 2. Poisoning from leaves of *Sophora secundiflora*. The animal is falling while being forced to exercise. (Sheep 424.).

Sheep 416 was fed .243% body weight of the ripe seeds (finely ground) daily for 4 consecutive days and remained normal during this period. Forty-eight hours later .487% body weight of these seeds was fed. The next morning the animal was recumbent, groaning, trembling, and semi-conscious; late that afternoon this ewe was alert and nibbling her hay but unable to rise. The following day she was still recumbent and would remain on her feet, when lifted up, for only a few minutes before trembling violently and falling. Gradual improvement was observed during the next two days and, by the morning of the 4th day after the final feeding, the animal had entirely recovered.

Inorganic phosphorus in 100 cc. blood serum:
24 hours after final feeding—9.08 mgs.
96 hours after final feeding—5.55 mgs.

Calcium remained constant at 10 mgs. per 100 cc. blood serum throughout the test.

Sheep 419 received 1% body weight of the finely ground, ripe seeds at one time. This animal died 18 hours later of acute poisoning. Autopsy revealed slight congestion in the kidneys and the liver; no other gross lesions were found.

Goat 423 was given 1% body weight of green leaves and remained normal. Thirty-two hours later this animal received 1.5% body weight of green leaves. The next morning this animal could rise voluntarily but would fall almost immediately. The appetite was completely suspended. By afternoon this nanny could not rise and was semi-conscious, remaining in this condition for the next 35 hours. Three hours after this she was

alert, eating, and able to stand voluntarily on the hind legs but to rise only to her knees in front. The next day (4th after final feeding) she was weak but could walk a few feet before manifesting typical symptoms and falling. She recovered entirely, except for a slight slowness in the action of the front legs during the next 48 hours, and was released.

Inorganic phosphorus in 100 cc. blood serum:

Before feeding—4.25 mgs.
24 hours after final feeding—5.0 mgs.
96 hours after final feeding—5.55 mgs.
Serum calcium determinations were not made.

As noted in Table I three calves, 426, 427, (both 6 months old), and 430, (9 months old), received respectively 1%, .75% and .25% of their body weights of green leaves at one feeding. They died of acute poisoning in 1¾ hours, 3¼ hours, and 45 hours in the order given.

Calf 434 was fed .25% of body weight of green leaves, remaining normal at the end of forty-eight hours. It then received .375% of body weight of the leaves. Six hours later this animal showed muscular tremors after five minutes of exercise. Six and one-half hours after this, following brief exercise, the calf manifested trembling, weakness, and incoordination of hind legs with shortening of stride. It staggered, went down, and was unable to rise. It remained prone on its side, semi-conscious, without appetite for the next 47 hours. The next morning it was found resting on the brisket with legs drawn under the body, alert, and eating, but unable to rise. When tailed up it was unable to remain on the hind feet for more than a minute. For the next ten days this animal remained recumbent despite repeated attempts to rise. Twenty-four hours later it was able to walk, showing only a slight shortening in the stride of the hind legs. The next day it was released as healthy.

In Table II are shown the feeding tests using the young leaves of *S. secundiflora*, harvested in April and May. These results illustrate very well the lesser toxicity of such leaves.

Goat 173 was force-fed 1% of its body weight of the fresh leaves daily for sixteen consecutive days. Further feeding was suspended because the animal developed severe symptoms of pharyngeal inflammation. This nanny kidded normally on the 22nd day after the feeding started. At no time did she show any signs of poisoning from the feedings. Calcium and inorganic phosphorus determinations of the blood serum at various times during the feeding period showed no significant variation from the normal amounts.

Sheep 305 was a range ewe nursing a healthy lamb, some 2 months of age. She was given .75% of body weight of leaves and remained normal one day later. She then received 1% of body weight of leaves; twenty-four hours later, no signs of poisoning being manifested, this animal received 1.5% of body weight of the leaves, again with negative results. Forty-eight hours after this time she was fed 2% of her body weight of the fresh leaves. The next morning this animal manifested the characteristic symptoms of the poisoning; she was subjected to violent exercise for

Table 2. Experimental Feeding of Fresh, Young, Green Leaves of *Sophora Secundiflora* (Leaves harvested in April and May)

Animal	Age Yrs.	Weight Lbs.	Condition	Fresh Leaves Fed Grams	Per Cent of body weight	Feeding Period	First Symptoms after: Hours	Result
Goat 173	4	73	Pregnant	331	1	Daily for 16 consecutive days	.....	Remained normal—kidded on 22d day
Sheep 305	4	64	Lactating	218 290 434 580	.75 1 1.5 2	At one time 24 hrs. later 24 hrs. later 24 hrs. later	18-after final feeding	Recovered in 1 day. Udder active during test
Sheep 306	2 mo.	18	Nursing Sheep 305	.....	.....	.....	.....	Remained healthy; nursed throughout test
Sheep 307	3	79	Healthy Mutton	716	2	At one time	24	Recovered in 6 hrs.
Sheep 308	3	78	Healthy Mutton	706 1414	2 4	At one time 24 hrs. later	12-after final feeding	Recovered in 36 hrs.

about thirty minutes and made to tumble repeatedly, during which time the pulse was too fast to count and the respirations were shallow and counted at 68. Eight hours later (32 hours after the final feeding) this animal was apparently normal, since 15 minutes of brisk exercise would not induce the typical seizure. Throughout the test the milk flow remained practically normal, the lamb being allowed to suck at any time.

Lamb 306 nursed its mother throughout the test and remained normal in all respects.

Sheep 307, a range mutton, was fed 2% of the body weight of the fresh leaves. Twenty-four hours later, after about 5 minutes of brisk exercise, this animal trembled slightly and pitched down but was able to rise immediately and walk away. A few minutes after this the animal remained normal despite forced exercise. The inorganic phosphorus in 100 cc. of blood was as follows:

Before feeding—4.16 mgs.
30 hours after feeding—7.14 mgs.
The serum calcium remained within normal range.

Sheep 308, also a range mutton, received 2% of body weight of leaves at one time and remained healthy. Three days later this animal was given 4% of its body weight of leaves. Sixteen hours later it was recumbent, unable to rise, somnolent, and semi-conscious. Pulse, 90; respiration, 31; temperature, 101.3° F. The next day (24 hours later) the animal was alert, nibbling at its feed, but still recumbent. It could

rise but trembled and fell after taking a few steps. Twelve hours later it had recovered completely so far as could be determined. The inorganic phosphorus in 100 cc. of blood serum was recorded as follows:

Before the final feeding—4.16 mgs.
48 hours after feeding—5.55 mgs.
72 hours after feeding—6.25 mgs.
96 hours after feeding—4.86 mgs.

The serum calcium determinations made at the same periods showed no abnormal variation.

SYMPTOMS OF THE EXPERIMENTAL DISEASE

As may be seen from the foregoing discussion the animal may manifest symptoms within a few hours after eating the leaves; this was especially evident in the three calves which died of acute poisoning.

Muscular trembling, especially noticeable over the shoulders and rump, are manifested very soon after the animal is forced to walk a short distance. Then the hind legs become stiff with the stride markedly shortened, the back is "humped up," and the animal is able to walk only a few feet before falling. Flirting of the tail is usually noted as the stiffness of the hind legs becomes pronounced. In most of our cases the animals pitched down on the brisket, the front legs buckling under them, but a few of the affected animals went down behind first.

Immediately after falling the animal makes one or two unsuccessful efforts to rise and then remains quietly on the brisket or prone on its side with the ears drooped and the nose frequently resting on the ground. It is conscious but very sleepy during this period, and the pupils of its eyes show slight dilatation. After resting thus for about five minutes, alertness returns, the ears are brought erect, and the animal gets up without visible effort and walks away.

When the first symptoms are noted and immediately after the animal goes down, the pulse is increased, up to 120 per minute, full and bounding. As a rule the respirations are increased but we have found this to vary greatly in different animals. No temperatures higher than normal have been found in either experimental or range cases.

The appetite is completely suspended during the manifestation of the characteristic symptoms but as soon as the animal is able to rise we have noted in every case that it starts nibbling at its feed almost immediately. On the range the affected animal invariably starts grazing a few minutes after it arises from one of the typical seizures.

Brief exercise will cause a repetition of the syndrome at any time from a few hours to a day or so after the ingestion of the leaves. But it is remarkable how quickly the animal completely recovers from the poisoning.

No gross pathological lesions worthy of note were found at the autopsies of either the one sheep which died from acute poisoning following indigestion of the ground ripe seeds or at those of the three calves which died shortly after being fed the green leaves.

CONTROL

No treatment was attempted in either the range or experimental cases in view of the fact that most of the affected animals recovered.

Inasmuch as the condition apparently never appears except during the period when range vegetation is exceedingly short and dry, the problem of prevention should not offer any insurmountable difficulty. When they are receiving adequate rations, there is little likelihood that range animals will eat enough of the leaves to cause symptoms of poisoning, even though this evergreen shrub be abundant in the pastures. From a practical standpoint poisoning can be prevented by feeding range animals during the periods of short dry range.

Eradication of the trees in pastures where there are only a few is practical and not at all costly. The trees can be chopped down and the roots grubbed. Several ranchmen who have done this say that this tree can be eliminated, even from pastures where there is a rather abundant growth, at a relatively small cost.

DISCUSSION

The results of both field observations and feeding tests show that the leaves of the *S. secundiflora* are poisonous when eaten by sheep, goats, and cattle. But that this poisoning is not fatal except in cattle is evident from the experimental tests.

With the experimental sheep and one goat, efforts to kill them by forcing them to exercise while they were very sick were unsuccssful. Naturally it is probable that fatal poisoning would result from the ingestion of exceptionally large quantities of the leaves, but this possiblity is exceedingly remote since the amounts required would be more than a grazing sheep or goat ever eats.

The fact that three out of four 6 to 9 months old calves died after the ingestion of relatively small quantities of the fresh leaves shows that this species is particularly susceptible to the poison, presumably the alkaloid sophorine. In all probability range cattle very seldom eat a sufficient quantity of the leaves to induce poisoning, for the writers have observed anything suggestive of it in only two range yearlings, and have been able to find only one or two ranchmen who said that they had lost cattle showing symptoms comparable to those described in this bulletin.

The negative results of daily feeding of small doses of the leaves to sheep (probably more than the animal would consume in grazing) indicates that the poison does not have a cumulative effect. From this the logical deduction is that poisoning in range animals results from eating a relatively large quantity of the leaves at one time rather than from the continued daily consumption of small quantities.

The amounts fed in the feeding tests show a decided variation in the susceptibility of individual animals. Sheep 414 showed symptoms after being fed .76% of the body weight while Sheep 421 became poisoned only after consuming 1.5% of its body weight of leaves. Likewise, Sheep

307 showed signs of poisoning after consuming 2% of its body weight, while Sheep 308 manifested symptoms only after the ingestion of 4% of its weight.

That there is decidedly less poison in the young green leaves (during the spring months) than in the mature leaves (during the winter) is well illustrated in the dosages fed experimental animals. Such animals all required much larger amounts of the young leaves before symptoms appeared than did the animals fed the mature leaves. This increased toxicity in the mature leaves, coupled with the fact that the winter range is more likely to be short and dry, probably explains why the condition is seldom seen except during the late fall and winter months.

It is interesting to note that one sheep, No. 416, consumed .243% of its body weight of the ripe seeds (ground into a meal) daily for five consecutive days without manifesting symptoms of poisoning. Apparently grown sheep can safely consume a much larger amount than heretofore supposed despite the common belief that two or three seeds are sufficient to kill a healthy grown animal.

There is no danger of poisoning in livestock from the consumption of the unbroken ripe seeds since the hard outer coat is not dissolved in the digestive tract, the whole seed passing with the feces. Of course a few of the seeds which are infested by weevils and consequently are partially broken before ingestion by the animal may be digested, but there is no possibility of poisoning therefrom. As a matter of fact the unbroken ripe seeds are very commonly found in the manure of sheep and goats in corrals but no cases of poisoning from their ingestion on the range have been observed by the writers nor reported by any ranchman. The presence of these seeds in the feces suggests the possibility that the animals graze the leaves to some extent. But the rare occurrence of symptoms among such animals indicates that they seldom eat a sufficient quantity of the leaves at one time to cause trouble.

In the one affected range sheep and in the experimental sheep there was found to be a decided increase in the inorganic phosphorus in the blood serum during manifestation of symptoms. Analyses of the leaves of *S. secundiflora* made in September and in December, by the Division of Chemistry, Tex. Agr. Expt. Station, showed their phosphoric acid content to be .31% and .29%, respectively. These figures show conclusively that the phosphoric acid content of the leaves even in large doses is not sufficient to cause the increase of inorganic phosphorus in animals suffering from *S. secundiflora* leaf poisoning. It is interesting to note that the writers have also found a decided increase in the inorganic phosphorus in the blood serum of sheep suffering from bitterweed, *Actinea odorata*, poisoning. The serum calcium in all cases was within normal limits. These findings would indicate that the determination of the amount of inorganic phosphorus in the blood serum of affected sheep might be a reliable means of distinguishing between poisoning from the leaves of *S. secundiflora* and clinically-similar sheep diseases of unknown origin.

It should be borne in mind that a diagnosis of *S. secundiflora* poisoning cannot be based safely on the fact that the trees show evidence of having been browsed, particularly when we realize that sheep may nibble small amounts of the leaves without becoming poisoned.

CONCLUSIONS

1. Experimental feeding tests have demonstrated conclusively that the leaves of *Sophora secundiflora* cause a characteristic, non-lethal poisoning in sheep indistinguishable from the condition investigated in a band of range sheep where the trees were abundant and showed evidence of being heavily browsed. Experimentally, goats and cattle are also susceptible to the poison, presumably sophorine, in the leaves; the goats recovered but only one calf, out of four 6 to 9 months' old animals fed, recovered, the other three succumbing to acute poisoning.

2. Judging from experimental feeding tests, the mature fresh leaves during the late fall and winter months are much more toxic than are the young fresh leaves during the spring months.

3. There is decided variation in the susceptibility of individual animals to the poisoning from eating the leaves. Feeding tests show that amounts of leaves greater than range sheep or goats ever eat are insufficient to cause death. While cattle are very susceptible it is seldom that they will eat enough leaves on the range to produce fatal results.

4. Contrary to general opinion, ingestion of a relatively large amount of the ripe ground-up seeds is required to cause fatal poisoning in sheep. In unbroken seeds the hard covering prevents digestion of the seed and, for all practical purposes, obviates the danger of poisoning resulting from their ingestion by range animals.

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