Loco Plant Poisoning in Sheep

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Highlight

This report includes data on utilization of loco plant by sheep on winter range, a comparison of the toxicity of loco plant to sheep of different ages, influence of supplementation on the incidence of locoism, and a detailed review of the literature on locoweed poisoning in sheep. Sheep grazed locoweed readily even though other good forage and supplements were available. The amount of locoweed they consumed increased throughout the experiment. At the end (12 weeks), sheep were eating primarily locoweed and shadscale and were severely "lococd." Signs of poisoning were observed first in aged ewes and lambs. Presently the prevention of loco poisoning on winter desert ranges lies in avoiding loco-infested areas almost entirely.

Review of Literature

Loco poisoning in livestock has long been a problem to the range livestock industry of the West. "Loco" is a Spanish word, meaning "crazy." The term has been applied to livestock affected by this kind of plant and also to the plants causing the disease. The disease is caused by the ingestion by livestock of certain species of *Astragalus* and *Oxytropis*.

There may be as many as 300 species of *Astragalus* in North America, which makes this genus one of the largest in the legume family (Kingsbury, 1964). Many species of *Astragalus* are difficult to identify. Cross fertilization is common in certain loco species so their taxonomy is complicated. Fortunately, the fruits of the species differ enough to permit identification. *Astragalus* species may be annuals, biennials, or perennials. Both *Astragalus* and *Oxytropis* have a taproot (Barnaby, 1964) and are herbaceous.

Ecology.—Astragalus grows primarily on the plains and desert regions of western United States. Important species also grow in the Rocky Mountains.

The *Oxytropis* species of North America are principally perennial herbaceous plants which occur circumboreal to northern New Mexico and from Minnesota to the Pacific coast (Harrington, 1964). They are adapted to a wide variety of soil types, although many species grow only around specific range sites. Barnaby (1964) has indicated that edemism is a feature of the *Astragalus* species. The growth of many species is restricted to particular sites because of optimal moisture conditions, essential minerals, or some other confining ecological factors.

Seeds of desert *Astragalus* species retain their vitality for 30 to 40 years and perhaps longer (Barnaby, 1964), germinating readily if they become well soaked. Apparently, factors other than moisture are involved in germination since some species become epidemic only if temperature as well as moisture is optimal. Marsh (1909) indicated that locoweed, including *Astragalus mollissimus* and *Astragalus lambertii*, was abundant in high rainfall years and nearly disappeared in dry years. Under Utah conditions, heavy infestations seem to follow wet, warm, autumn seasons. Few plants are seen during the summers that follow a dry fall and winter. Locoweed species grow in a wide range of precipitation.

Coarse soil fragments are consistently associated with occurrence and abundance of loco plants. Payne (1957) found that white point loco (*Oxytropis sericea* Nutt.) grew in a wide range of soil depths. In the desert regions of western and eastern Utah, speckled loco plant or freckled milk-

[1] Presently with Deseret Land and Livestock Co., Salt Lake City.

vetch (*Astragalus lentiginosus*) occurred extensively in the soils with a substantial component of coarse fragments but only infrequently in thin breaks.

Response to Grazing.—Payne (1957) concluded that *Oxytropis sericea* was a typical "increaser" on a range grazed by domestic livestock. It increased as range deteriorated from good or excellent condition and decreased under heavy grazing pressure on rangeland in fair condition. This species was practically eradicated by close grazing by sheep in small pastures, but the persistence of hard seeds insures that loco will be one of the first plants to become re-established when grazing pressure is released, Blankinship (1903). Thus, eradication by means other than grazing should be sought.

Toxicity.—Astragalus and *Oxytropis* plants, although suspected, were not proven toxic to livestock until 1905 (Marsh, 1909). Since then, much time and effort has been expended to isolate the toxic material. Among the more prominent of the suspected toxic agents are barium, (Crawford, 1908) selenium (Trelease and Beath, 1949) and locoine (Fraps et al., 1936), a compound suspected of being an alkaloid. The positive identity of the toxic agent is still unknown. Livestock may graze these plants for an extended time before signs of poisoning become apparent.

The toxic material has a cumulative effect. Locoweed causes a nonreversible change in the central nervous system of livestock.

Some species of the *Astragalus* and *Oxytropis* species are believed nontoxic. Kingsbury (1964) has divided the toxic species into 3 different categories: (1) Selenium accumulators. Trelease and Beath (1949) have listed obligate selenium species. Examples are *A. bisulcatus* (twogrooved milkvetch) and *A. pattersonii* (Patterson milkvetch); (2) Loco plant. These produce the typical signs of loco poisoning. Examples of these species are: *A. lentiginosus* (freckled milkvetch), *A. earlei* (Earls woolly loco), *A. wootonii* (Wooton milkvetch), *A. mollissimus* (woolly locoweed), and *O. sericea* (white point loco); (3) A third group of *Astragalus* is more acutely toxic. They do not produce signs of poisoning typical of group two. These plants are toxic in smaller quantities over a shorter time and respiratory involvement is usually present. An example is *A. miser* (timber milkvetch).

Palatability.—The loco plants have been considered by most investigators (Marsh, 1909) to be unpalatable to all classes of livestock and have been believed to be eaten only when range feed was scarce or other similar stress conditions. However, the palatability of plants to animals is relative and varies with plant composition, season, and stage of growth. Forage acceptability to animals may vary during the season. The palatability of the live loco plants among dried associated species is relatively high. The loco plants are readily eaten by animals that have previously grazed the plant and also during time of feed shortages. Dried loco plants are toxic (Mathews, 1932).

Once range livestock start to eat the loco plant, they acquire a taste for it (Marsh, 1929). Some have described this as a habituating, narcotic, or addicting effect. The affected cow, horse, or sheep will then graze the loco plant to the exclusion of other forage and will even search for it. Marsh (1929) suggests that some animals may acquire the habit by imitating other livestock that are eating loco.

Prevention of Poisoning.—Prevention is the most realistic goal in plant poisoning. Preventive measures suggested by Marsh (1916) are: (1) use the range when poisonous plants are least poisonous or least palatable (2) provide abundant feed to reduce consumption of poisonous plants, and (3) use care in the management of animals new to the range. To these admonitions should be added: (1) do not turn hungry animals into areas infested with poisonous plants and (2) use extreme care in grazing animals around watering places as poisonous plants often occur near isolated watering locations.

One can be sure that when animals start grazing toxic species of *Astragalus* and *Oxytropis,* loco poisoning will result if the animals are not summarily removed from such ranges.

At present, there is no known treatment for loco poisoning in any species of range livestock. Since locoed animals are easily disturbed and difficult to handle, attempts to treat them may be more harmful than beneficial.

Mathews (1932) found that less loco plant was required to produce a critical stage of locoism when concentrates (corn and wheat bran or cottonseed cake) were added to the ration than when the diet consisted of loco plant and hay.

Signs of Poisoning in Sheep.—The signs of poisoning vary somewhat among species of range livestock. The more prominent signs of loco poisoning listed by Marsh et al. (1936) and James et al. (1967) in sheep are: a peculiar erratic gait, head held high, nervousness, stiffness, loss of sense of direction and herding instinct, muscular incoordination, loss of weight, and progressive general body weakness. There may be periods of depression. Some locoed sheep may push against solid objects. Later they may show coordinated walking or running motions. These animals evidently die of exhaustion and starvation. Obviously unaware of the surroundings, some sheep walk off ledges, into rivers or other dangerous places. The signs of poisoning develop gradually over a period of time. Sheep that survive remain in a poor, emaciated condition.

Since the toxic material in the loco plant has a cumulative effect, the signs of poisoning are not usually manifested until the plant has done con-

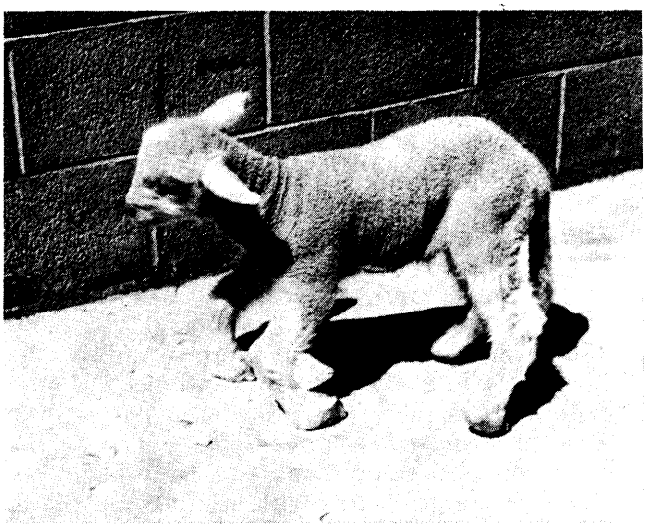

FIG. 1. A lamb born to a ewe that grazed *A. pubentissimus* during pregnancy; note skeletal malformation.

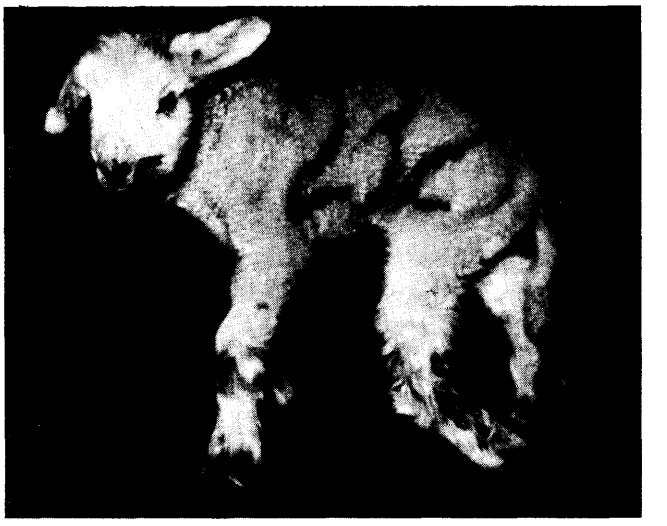

FIG. 2. A lamb born to a ewe that was experimentally fed *A. pubentissimus*; note hypermobility of hock and stifle joints.

siderable harm to the animal. Livestock that are severely poisoned are of questionable economic value. Horses never recover, while sheep and cattle may with time recover enough to be marketed. Those only mildly poisoned may show signs of poisoning whenever they become excited, even after a long period of time.

Horses are more susceptible to loco poisoning and show more central nervous disturbance than do other livestock. Cattle respond somewhat similarly to horses. Sheep do not readily show the marked nervous signs, but nevertheless do show signs characteristic of the condition. Marsh (1909) has suggested that Aberdeen Angus cattle are more susceptible to locoism than Herefords; sheep of the black-face breeds are more susceptible than Merinos; and imported livestock are more likely to be poisoned on loco than native livestock.

Teratogenic and Abortifacient Effects.—Sheep and cattle grazed on loco plant early in gestation may abort or give birth to congenitally deformed offspring (James et al., 1967). Sheep fed loco plant as early as the first 10 days or as late as the 55th day of gestation have aborted. Whether abortions occur when loco is fed beyond that date remains to be tested but it seems likely. Reportedly, 60% of a herd of 2,000 ewes aborted due to loco poisoning. Abortions can be caused by locoweed even though signs of poisoning are not visible.

Congenital deformities induced by the consumption of loco plant are characterized by any or all of the following anomalies: arthrogryposis (curvature and rigidity of the limbs, Fig. 1); aplasia (shortening) of the lower jaw, and hypermobility of the hock and stifle joints (Fig. 2); and a greatly increased incidence of contracted tendons, especially the ankles (James et al., 1967).

Trelease and Beath (1949) suggested that selenium may cause congenital malformations similar to those produced by loco plant. Binns and James were unable to produce congenital malformations by feeding selenium alone.[2]

Locoism and Reproduction.—Ewes that have been locoed and have given birth to a deformed lamb or have aborted can conceive and give birth to a normal lamb the following year. Ewes that have been poisoned on loco plant may be unthrifty in appearance but apparently can successfully raise a lamb (James et al., 1967).

Rams fed *O. sericea* for 62 days produced sperm equal in quality and volume to that of normal rams (Shupe et al., 1968). Libido was maintained even when the rams showed signs of poisoning. It would be expected however, that a point would be reached when all sexual activity would cease.

According to Mathews (1932), sexual activity of the bull and estrus in the cow are suppressed in animals poisoned on *A. wootoni* and *A. earlei*. These functions returned following cessation of locoweed ingestion and improvement of physical conditions. The cows in Mathews' experiment all aborted; all were later bred and conceived.

Mathews also presented evidence that the toxic principle is not excreted in the milk of cattle.

Blood Changes in Loco Poisoning.—Marsh (1909) reported that anemia is a constant finding in locoism. However, Mathews (1932) and James and Binns (1967) were unable to confirm this result. The sulfobromophthalein liver function test indicated some liver damage and increases in plasma urea nitrogen indicated there was at least

[2] Unpublished data by W. Binns and L. F. James, 1959.

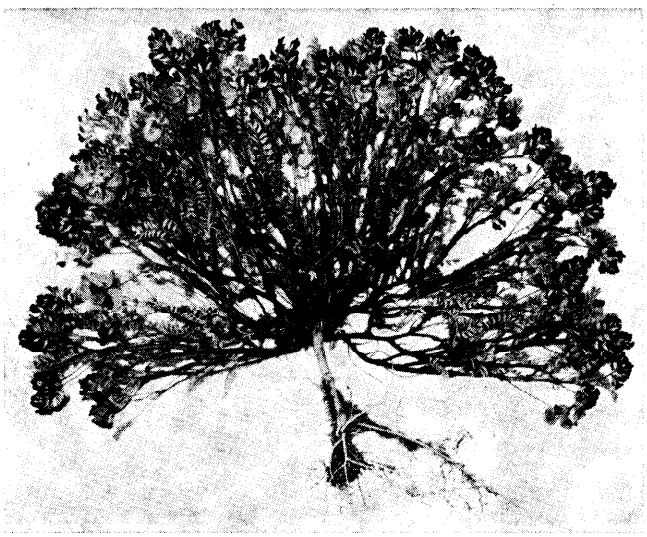

FIG. 3. *Astragalus pubentissimus*, a biennial locoweed growing in eastern Utah.

Table 1. Percentage of plant composition of study pastures.[1]

Species	Pasture Number			
	#1	#2	#3	#4
Astragalus pubentissimus	10	18	7	9
Artemisia tridentata	48	51	61	53
Atriplex confertifolia	15	20	13	20
Sarcobatus vermiculatus	2	Trace	1	1
Grayia spinosa	1	Trace	Trace	1
Chrysothamnus nauseosas	Trace			
Chrysothamnus viscidiflorus	4	2	6	4
Kochia americana	Trace	1		Trace
Tetradymia sp.	Trace			Trace
Miscellaneous herbs	20	8	9	10
Poa sp.		Trace	Trace	
Sitanian hystrix		Trace	Trace	
Hilaria jamesii		Trace	3	2
Oryzopsis hymenoides			Trace	Trace
Total	100	100	100	100

[1]Ground cover was 7% in all four pastures.

a mild nephritis. Serum glutamic oxalacetic transaminase (SGO-T) is elevated. Enhanced SGO-T values may reflect myocardial infarctions and chronic liver disease.

Ulcerations of the abomasal mucosa were reported by Marsh (1909). Ulceration has been observed in field cases investigated but not in experimentally fed animals (James, unpublished data).

Experimental Area and Procedure

During 1957–58 and again in 1965–66, there was an unusually heavy growth of *Astragalus pubentissimus* (Green River milkvetch) in eastern Utah and southwestern Wyoming. *A. lentiginosus* was abundant in western Utah and parts of Nevada in 1964–65. Heavy losses from deaths, abortions, and congenital malformations were reported among sheep grazing these areas. Some losses were reported in cattle and horses in Nevada.

Each year of abundant loco plant growth had a warm wet fall and a mild winter. The loco plants started growing in the early fall and growth continued until early winter, resuming in the spring. Since loco weed was the only green plant, sheep readily grazed it.

The research reported here was done to investigate the possibility of using supplements to help prevent loco poisoning, to compare the toxicity of loco plants to sheep of various ages, and to study the utilization of loco plants by sheep under winter desert range conditions in eastern Utah.

Forty acres of desert winter range, southeast of Vernal, Utah, typical of the area and supporting a substantial growth of *A. pubentissimus* (Fig. 3), was fenced into four pastures of equal size (approximately 10 acres). One aged ewe, three middle-aged ewes (3 to 5 years old) and a lamb were placed in each pasture November 22, 1965.

The plant composition was determined (Table 1). All pastures were considered similar. Water was available from snow, or was hauled to the sheep daily when no snow was available.

All diets consisted essentially of the same natural forage plants plus the following supplements: Pasture 1—cottonseed meal plus 2% dicalcium phosphate; Pasture 2—cottonseed meal only; Pasture 3—dicalcium phosphate only; and Pasture 4—no supplement. The sheep were observed weekly for signs of poisoning and the pastures were inspected so as to ascertain if the loco plant was being grazed. Sheep grazing the open range were also observed.

Results

During the first week the sheep in all pastures ate only small amounts of loco plant. Their diets consisted primarily of annual weeds and browse. Loco plant consumption increased during the second and third weeks.

Sheep ate only small amounts of the supplement during the first 2 weeks. During this period the only source of water was in watering troughs near the supplement. After a persistent snowfall of four inches sheep consumed none of the water or supplement.

The amount of loco plants eaten increased markedly during the last of the second week and the third week. All sheep appeared to improve in condition up to this time. At the end of the third week, the diets consisted primarily of loco plant and shadscale.

The first signs of loco poisoning, such as un-

Table 2. Percentage of loco in plant composition before and after grazing.

Pasture Number	Before	After
1	10	5
2	18	10
3	7	1
4	9	Trace

steady gait, were manifested in one aged ewe and a lamb during the fifth week. By the end of the sixth week, another aged ewe was showing marked signs (unsteady gait and head held high) of poisoning. The other sheep were beginning to show some equivocal signs of poisoning with the lambs and aged ewes appearing to be most affected.

All aged ewes and lambs showed marked signs of poisoning by the time the middle-aged ewes were showing mild, though unequivocal signs of poisoning. It was estimated at this time that 10% of the available forage had been utilized, with the major use being made of loco plant, shadscale, and annual weeds. Sagebrush and other forage plants were only slightly used.

By the end of the ninth week, 1 aged ewe had died, all of the other aged ewes and lambs were seriously locoed and the middle-aged ewes were showing increased signs of poisoning. At this time 3 aged ewes, 1 middle-aged ewe, and 2 lambs were taken from the pastures for blood sampling and necropsy.

During the tenth through the twelfth week, all sheep continued to decline. It was possible to walk up to several as they lay on the ground unable to get up. Perhaps the most interesting observation was vascillation of the signs of poisoning. One day a sheep would be down and unable to rise and a few days later be up and much improved. The more prominent signs of poisoning were head held high (acting as if "wool blind"), depression, stiffness, peculiar gait and recumbency.

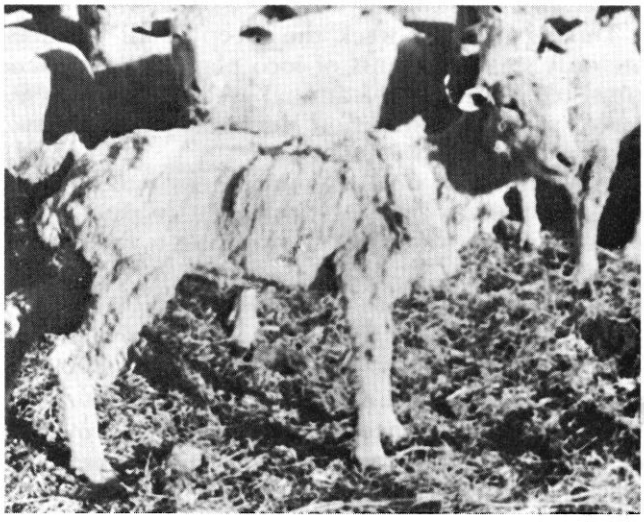

FIG. 4. A ewe that has been locoed; note emaciated condition 4 months after removal from loco plant.

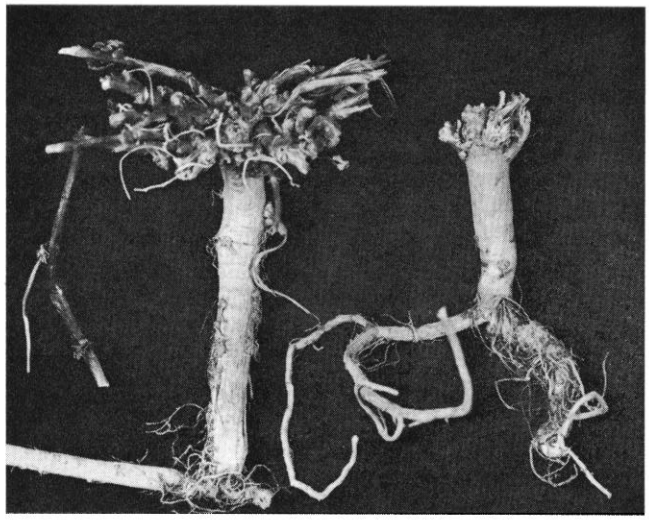

FIG. 5. *Astragalus pubentissimus* that was grazed by sheep on winter desert range.

At the end of 12 weeks, all but 3 middle-aged ewes and 1 lamb were taken for blood samples and necropsy. The remaining 4 were removed from the pastures at the same time.

A utilization study of loco plant was made after the experiment ended (Table 2).

Field Observations.—During 1965–66, approximately 55% of a herd of 1,900 head of sheep that grazed in the vicinity of the experimental pastures died from loco poisoning. Approximately 120 of the remaining ewes gave birth to normal, full-term lambs. These and the other surviving ewes were very emaciated (Fig. 4). Approximately 45% of another band of ewes that grazed the loco plant aborted their lambs. In both herds, some of the damage to the sheep from grazing the loco plant occurred before signs of loco poisoning became evident.

Fig. 5 shows an *A. pubentissimus* plant that was grazed by sheep. Many of these plants had been pulled out of the ground and part of the roots eaten. Sheep were also observed eating the dried, blackened, year-old stems of *A. lentiginosus*. These sheep had been locoed the previous year. Loco poisoning has been observed in sheep grazing dried year-old loco *A. pubentissimus*, and cattle grazing dried year-old *A. lentiginosus*.

Feeding studies have shown *A. lentiginosus* to be more toxic than either *O. sericea* or *A. pubentissimus*.[3]

[3] Unpublished data by L. F. James and W. Binns, 1964.

Hematology.—Blood samples were obtained from sheep in the pastures as well as those in herds of locoed sheep. No measurable differences were noted in the blood values from the two groups.

A total of 12 blood samples was obtained from sheep having slight to very severe signs (recumbency) of loco poisoning. The mean cell volume of these sheep was 38% with a range from 26% to 49%. All values were within normal limits. The mean hemoglobin was 12Gm Hb/100 ml of blood with extremes of 7.9 and 14.8, which were within normal limits. The mean value for total white blood cell counts for all ewes tested was 11.70×10^3/cmm. The minimal-maximal limit for white cell counts is 4 to 12×10^3/cmm of blood. The red blood cell count had a mean of 12×10^6/cmm, which was within normal limits of $8.0–16.0 \times 10^6$/cmm.

The mean SGO-T for 21 locoed ewes was 1910 units with the extremes being 390–2440 units (serum transaminase activity is expressed in units/milliliter with one unit equal to the formation of 1 microgram of pyruvate under conditions specified). Buck et al. (1961) list the normal for SGO-T as 85 units with minimal-maximal limits of 54 and 128.

Discussion

The sheep placed in the pastures started to graze loco plant rather quickly. The daily intake of loco foliage appeared to increase with time. The grazing of loco plant cannot be attributed entirely to a lack of forage in this trial, because all four pastures contained an abundance of winter forage of good variety. Protein and mineral supplements offered in three of the pastures were largely rejected by the sheep. Alfalfa hay was placed near the water and supplement troughs in an attempt to lure the sheep to eat the supplement, but they grazed the loco in preference. The aged ewes and lambs showed signs of poisoning earlier than the middle-aged ewes. One explanation might be the condition of the teeth of these sheep. The aged ewes varied from a total lack of teeth to a few long ones, while the lambs were just losing their milk teeth and obtaining permanent ones. In some instances loco plants were grazed below the soil surface. They may have been enticed to eat the loco plant, even the crown, because it was more succulent and easier to chew than other plants.

Snow cover over the plants did not prevent the sheep from eating loco. The sheep would paw through the snow to get it.

It was apparent that the sheep had acquired a taste (habit) for the plant before signs of poisoning became evident.

Competition from desirable nonpoisonous range plant species might offer some relief from the loco plant problem through suppression of loco plant populations.

Abortions can occur in sheep fed foliage from loco plant as early as the first 10 days of gestation, up to and probably beyond the 55th day.

Biological changes associated with loco poisoning are difficult to identify and evaluate. As signs of poisoning begin to appear, feed consumption declines and eventually ceases. Starvation then becomes a factor.

It is apparent that the prevention of loco poisoning on winter ranges still lies in avoiding loco-infested areas almost entirely.

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