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Bulletin No. 189 - Three Poisonous Vetches

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UNIVERSITY OF WYOMING
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Three Poisonous Vetches

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THREE POISONOUS VETCHES
BY
O. A. BEATH, J. H. DRAIZE AND H. F. EPPSON

INTRODUCTION

The native vetches of the Rocky Mountain region are numerous and are widely distributed. In the "New Manual of Rocky Mountain Botany," by Coulter and Nelson, some 117 species are listed. These vary in appearance from miniature plants to those of bush-like types. The group belongs to the Legume family, botanically known as Astragali. The number of known poisonous species in Wyoming is confined to a comparatively small group. Livestock losses caused by poisonous vetches center about three kinds, one of which is widely distributed over the state. They are the two-grooved milk vetch (Astragalus bisulcatus (Hook.) Gray.) A. scobinatus, Sheld., and timber milk vetch (A. campes-tris Gray) (A. Hypophyllum (Rydg.) A. Nels.). The list of poisonous species could be considerably enlarged if one were to include those occurring in all the western states. Of the total number of vetches, it is clear that the majority of them are non-poisonous and that many species yield a high quality forage for grazing animals.

This bulletin deals with the general results of the chemical and physiological experiments with the three species of vetches positively known to be troublesome, viz., the two-grooved milk vetch, A. scobinatus and the timber milk vetch.

*In 1917' the senior author published a preliminary bulletin on the general poisonous properties of the two-grooved milk vetch. Since that time additional data have been secured both in the laboratory and field to fully confirm our original findings and to broaden our knowledge concerning the character of the poison and its action on animals.

The timber milk vetch was suspected in 1926 as being responsible for sheep and cattle losses in southwestern Wyoming. As

*The small numbers refer to items listed under "Literature Cited" at the end of this bulletin.
with several of the other poisonous vetches, two forms of the disease produced were noted, the acute and the chronic. In cattle the chronic manifestation was called "cracker-heel," a local name assigned by those who had observed cattle in their weakened condition-produce an audible note originating from the friction of the fetlocks. Cattle and sheep losses have been severe in Wyoming.
In 1927, Dr. E. A. Bruce of the Canadian Department of Agriculture reported on the poisonous properties of the timber vetch, gave its general habitat, and described the symptoms of poisoned animals.

To our knowledge, *A. scobinatulus* has not previously been reported on.

**TWO-GROOVED MILK VETCH**

*Distribution, Habitat and Other Characteristics.*—This plant occurs widely distributed over Wyoming. The situations for its most favorable development are found on open draws and bottom lands in soils having a fairly strong concentration of alkali. This vetch appears early in May, is in full bloom about July 1 and goes to seed usually late in July. It remains green until late in the fall and, even after heavy frosts have partially caused a withering of the main leaves, one can still find unaltered leaves and stems close to the ground. The plant varies between one and three feet in height, depending upon the soil and moisture conditions. Figure 1 shows a close-up view of a portion of a clump. The density of its distribution is shown in Figure 2, where a soil is particularly

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Fig. 2. A natural setting for the growth of the two-grooved vetch. Plants are in full bloom.
The plant has a central tap root that extends to a considerable depth. It is a perennial, as are all species of the vetch group. Grubbing out previous to the seeding stage is the only satisfactory method of eradicating it from troublesome areas.

Poisonous Period. Occasional livestock losses occur previous to the flowering period. Figure 3 shows a mature sheep poisoned by the vetch the last of May. Most trouble, however, may be expected during the late summer and fall. A severe frost appears to have a decided influence upon its subsequent activity. Sheep losses in Wyoming at this season have been alarmingly severe. The largest single loss observed by the senior author occurred in the vicinity of Elk Mountain, where approximately 340 mature sheep (Fig. 4) died from the vetch within twenty-four hours. The band was being trailed from the mountains about September 1. Severe sheep losses have occurred also in the vicinity of Rock
October 23, 1930, a sheep operator in this region lost 125 sheep from this plant. About 75 died on the bed ground (Fig. 5).

Inasmuch as no previous mention has been made of the past seeding stage of the two-grooved vetch in connection with the poisoning of livestock, a general review of three cases of cattle deaths from two-grooved milk vetch usually occur in a comparatively brief period of time. Out of 125 deaths, some 75 died during the night, as illustrated in part.
Fig. 6. Cattle may select the poisonous vetch even if suitable forage is available.

poisoning during 1931 may be of interest here. Late in August the Diamond Ranch, located near Chugwater, lost 10 healthy, mature cattle of mixed ages and sexes. The herd of several hundred head of mixed mature cattle had access to third growth, immature alfalfa. Adjoining the field of this alfalfa were scattered bunches of two-grooved vetch with only the stripped, coarse branches left, due to the heavy grazing.

The fact that the alfalfa stubble had been deserted by at least a few of the cattle in order to browse upon a coarse plant would indicate that this vetch had some preferred element or compound which these cattle craved. The correlation of symptoms and autopsies with the laboratory tests completed at a later time fully convinced us of the plant’s poisonous character. Further confirmation was obtained in October on a ranch near Gillette. Here, also, certain cattle had browsed upon two-grooved vetch when ideal forages in the immediate area had been passed by. The symptoms, autopsies and laboratory tests were conclusive in pointing to this vetch as the cause. The owner of the cattle had the vetch, which was still green, grubbed out. The herd of cattle was then returned to the same area and no further poisoning occurred.
A number of cattlemen in Campbell County reported that losses were of common occurrence in the late fall. In every instance where the senior author made a personal inspection the two-grooved vetch was located and quite often a skeleton or two near at hand aided materially in his conclusions.

The offensive odor of the two-grooved milk vetch appears to be subject, in a degree, to soil and climatic conditions. In some areas the offensiveness seems to be utterly lacking, while in others it is decidedly noticeable. Regardless of its offensive odor, this vetch appears at times to have some ingredient that livestock desire. This was illustrated by a case (Fig. 6) in which a number of healthy cattle were poisoned by it in August, 1931, in an area carrying an abundance of desirable forage. The vetch was in seed at this time. Dry weather had dried the leaves out to some extent. Possibly heat and the lack of moisture may have produced some change similar to that caused by freezing.

*Nature and Distribution of the Poison.* Attempts to obtain the active principle so as to classify it have not been successful. It appears to be present in all parts of the plant.

Particular emphasis has been placed in our chemical studies upon the composition of the ash and other compounds in order to determine, if possible, the element or combination of elements sought by grazing animals. It should not be understood that all vetch poisoning occurs on ranges carrying an ample supply of good forage. In many cases vetch poisoning is caused by trailing hungry and fatigued sheep where little else prevails except this plant. Evidence is quite complete, however, that at times both sheep and cattle are attracted to the two-grooved milk vetch for other reasons. Inasmuch as the two-grooved vetch and *A. scobinatulus* are closely related botanically, we chose the former for certain chemical studies. The data are presented and discussed under the heading of chemical experiments.
TIMBER MILK VETCH

Distribution, Habitat and Other Characteristics. The timber vetch is noted as being particularly abundant in the western part of the Hayden Forest and in the foothill region of the Uinta Range in southwestern Wyoming. Scattering patches have been observed to occur throughout the Wyoming National Forest. Dense areas have also been noted in the Sunlight Basin area northwest of Cody.

This vetch is much smaller in size than the other two under discussion in this bulletin. Figure 7 shows a few of the individual stalks with leaves and flowers attached. The plant in its native state grows in clusters. The height of an average bunch seldom exceeds six or seven inches. Unlike the two-grooved vetch, it has no offensive odor and is eaten readily by livestock. Figure 8 shows its natural aspen association and pictures a group of experimental sheep in an enclosure feeding upon the vetch.

The habitat of the timber vetch is such that it requires a good soil, shade and an average amount of moisture. Its occurrence in Wyoming is confined to elevations between 6,000 and 8,000 feet. The plant appears early in June, is in bloom by July 1 and, in most instances, goes to seed early in August. It dries up quite rapidly after September 1.
Poisonous Period. Most cases of timber vetch poisoning occur during the flowering and seeding stages. We have made no physiological tests on the pre-bloom plants because there appears to be no practical reason for so doing. In the national forests proper, grazing is usually not permitted until about July 1 so that the timber vetch problem is of little importance before the blooming period. We have found no essential difference between the flowering and seeding plants with respect to their poisonous properties.

Livestock Affected. The timber milk vetch may be fatal to livestock under range conditions in a comparatively short period if an excessive feeding is made at one time. That a large amount must be considered is indicated from the experiment undertaken in Uinta County during August, 1930. Ten sheep of varying ages were put in an enclosure on a timber vetch patch (seeding stage) that was estimated to represent 80 per cent of the total forage. The vetch was grazed eagerly. In fact, it was freely chosen even though the other 20 per cent of browse and grasses were of a palatable character. The enclosure, which was of woven wire, was moved onto an ungrazed vetch area the sixth day after the test was started. In addition, fresh material was daily hand-picked.

Fig. 8. The habitat of the timber milk vetch; also experimental pen where sheep were grazed for several days on the vetch.
Fig. 9. The timber milk vetch produces a chronic type of disease in several respects similar to the common “locoism” of the plains.

from near-by vetch patches and thrown into the enclosure. In this manner an abundance of material was offered the sheep during the eleven-day experimental period. At the conclusion of the test the sheep appeared normal, contented, and well fed. They were marked and put back with the range herd from which they came, but no delayed bad effects were reported by the owner.

The sheep were not trailed or unduly excited during the experiment. Water was offered them at all times. Daily rains occurred throughout the entire eleven days so that the plants were at no time free from adhering moisture. Whether this had anything to do in delaying action cannot be ascertained until more information is available concerning the physical and chemical properties of the toxic principle.

The chronic type of poisoning is noticeably evident, especially with cattle. Figure 9 illustrates two cases having the chronic type of the disease produced by the timber vetch. Diseased cattle show emaciation, salivation, incoordination and diarrhea.

*Nature of Poison.* The chemical phases of the toxic principle of the timber vetch is discussed under the heading of Chemical
Experiments. Like the other vetches referred to in this bulletin, the timber vetch appears to have the toxic ingredient disseminated throughout the entire plant. In true locoism an animal acquires the habit of feeding on loco weed to the exclusion of any other feed. With reference to the timber vetch, opinions differ as to whether an animal acquires a vetch habit or if it is eaten because of its predominating occurrence. So far as the writer knows, no definite experiments have been made to test this point.

ASTRAGALUS SCOBINATULUS, SHELD.

Distribution, Habitat, and Other Characteristics. This vetch occurs abundantly in the southern part of Wyoming. Like its near

Fig. 10. A few individual branches of *astragalus scobinatulus*, Sheld. Like its near relative *A. bisulcatus*, a plant unit is a clump from which many stalks emanate.
relative, *A. bisulcatus*, it is found growing on a heavily clay soil, impregnated with alkalies, along gulleys, and poorly drained depressions. *A. scobinatulus* is the dominant two-grooved vetch south of Rawlins and Rock Springs to the state line. It is in general, a smaller plant (Fig. 10) than *A. bisulcatus* and has whitish flowers with the keels tinged pinkish. The seeds have two grooves as noted in *A. bisulcatus* but they are cross ribbed, shorter and flatter. This species, undoubtedly, has been correctly described by botanists as an intermediate between *A. bisulcatus* and *A. Haydendianus*.

Further experimentation upon this species will be necessary before its poisonous status can be fully ascertained.

**CHEMICAL EXPERIMENTS**

Reference has been made in the preceding discussion to the possible attraction that a plant may have in order to account for the fact that livestock losses from plant poisoning are not to be wholly explained on the assumption that the poisonous plants are eaten because of starvation, or because they are green and hence inviting in appearance. Range inspectors, who are in a position to follow poisonous plant studies from the early spring to the late fall, have been confronted with the possibility that certain losses might well be traced to a chemical compound or mixture of compounds which are harmless in themselves but are desired nevertheless by a part of a herd of cattle or band of sheep. The common salt in arrow grass, the high crude protein content of the early stages of larkspurs, the mannitol in the larkspur flowers and the edible oil in lupine fruits are suggestive of a few constituents that may be considered important in discussing phases of plant poisoning.

With special reference to the poisonous vetches, we have made determinations of certain elements and compounds to find, if possible, an explanation of those cases in which it would appear that the plants were eaten because of directed choice rather than that of forced grazing or starvation. The results of the type forage analysis given below are arranged in tabular form for comparative study. Material for the analyses was a composite from the main collection. The stages of growth of the vetches were as follows:
Three Poisonous Vetches

Two-grooved milk vetch, (1) full bloom, (2) past seeding; timber milk vetch, full bloom.

*A. scobinatus* was first collected as it was approaching the flowering period.

<table>
<thead>
<tr>
<th></th>
<th><em>A. campestris</em></th>
<th><em>A. bisulcatus</em></th>
<th><em>A. bisulcatus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Air Dry)</td>
<td>(Air Dry)</td>
<td>(Air Dry)</td>
</tr>
<tr>
<td>Water</td>
<td>5.60%</td>
<td>8.30%</td>
<td>6.38%</td>
</tr>
<tr>
<td>Ash</td>
<td>6.08%</td>
<td>8.56%</td>
<td>7.70%</td>
</tr>
<tr>
<td>Ether Extract</td>
<td>2.93%</td>
<td>3.04%</td>
<td>1.33%</td>
</tr>
<tr>
<td>Crude Protein</td>
<td>21.00%</td>
<td>15.40%</td>
<td>16.56%</td>
</tr>
<tr>
<td>Crude Fiber</td>
<td>22.50%</td>
<td>21.51%</td>
<td>26.90%</td>
</tr>
<tr>
<td>Nitrogen-Free</td>
<td>41.89%</td>
<td>43.20%</td>
<td>41.10%</td>
</tr>
</tbody>
</table>

The ash or the mineral matter of the three vetch samples is in fair agreement. An average sample of alfalfa will yield between 9 and 10 per cent of ash. The crude protein content of the timber vetch is distinctly higher than the other two and also above that of alfalfa. Both the timber and past seeding two-grooved vetches yield a fairly high amount of fatty matter as indicated by the ether extract. All three show a comparatively strong carbohydrate balance (nitrogen-free.)

Further comparisons follow with particular reference to the timber and two-grooved vetches.

<table>
<thead>
<tr>
<th></th>
<th><em>A. campestris</em></th>
<th><em>A. bisulcatus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full bloom</td>
<td>Past seeding</td>
</tr>
<tr>
<td>Reducing sugars</td>
<td>1.19%</td>
<td>0.44%</td>
</tr>
<tr>
<td>(invert sugar)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sucrose</td>
<td>1.64%</td>
<td>4.61%</td>
</tr>
<tr>
<td>Starch</td>
<td>1.93%</td>
<td>2.62%</td>
</tr>
<tr>
<td>Pentosans</td>
<td>12.50%</td>
<td>13.50%</td>
</tr>
</tbody>
</table>

From a chemical point of view, it is becoming more and more evident that the palatability of forages in general depends in a measure upon the sugar content. In a combined chemical and feeding test at this station during 1931 it was found that out of nine native hays fed to cattle, experimentally, the one having the highest percentage of total sugars was first in palatability. The least palatable had the lowest sugar content. A few exceptions occurred, but on the whole the trend followed this relationship.
An inspection of the data shows the two-grooved vetch comparatively high in its total sugar content. It is possible that in this and other vetches where a grazing preference has been indicated, the attraction may be traceable to a characteristic aroma or flavor not suggested by ordinary chemical tests.

The pentosans include plant gums and mucilages. The two vetches yield approximately the same per cent.

**SELECTIVE SOLVENT ACTION**

<table>
<thead>
<tr>
<th>Solvent</th>
<th>A. campestris (Full bloom)</th>
<th>A. bisulcatus (Past seeding)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ligroin (gasoline 93-113° C.)</td>
<td>2.22%</td>
<td>2.66%</td>
</tr>
<tr>
<td>Ethyl Ether</td>
<td>0.81%</td>
<td>0.41%</td>
</tr>
<tr>
<td>Ethyl Acetate</td>
<td>1.66%</td>
<td>0.54%</td>
</tr>
<tr>
<td>Alcohol 95%</td>
<td>24.40%</td>
<td>15.70%</td>
</tr>
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The action of the several organic solvents shows clearly that strong alcohol extracts considerably more organic matter from the timber vetch than is given by the two-grooved vetch. In this connection we have found that it requires strong alcohol to remove the toxic principle from the timber vetch.

**INORGANIC CONSTITUENTS**

<table>
<thead>
<tr>
<th>Constituent</th>
<th>A. campestris (Full bloom)</th>
<th>A. bisulcatus (Past seeding)</th>
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<tbody>
<tr>
<td>Phosphorus (P₂O₅)</td>
<td>0.50%</td>
<td>0.33%</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>0.16%</td>
<td>1.35%</td>
</tr>
<tr>
<td>Chlorine</td>
<td>0.17%</td>
<td>0.22%</td>
</tr>
<tr>
<td>Sodium and Potassium (chlorides)</td>
<td>4.72%</td>
<td>2.69%</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>4.49%</td>
<td>2.30%</td>
</tr>
</tbody>
</table>

These percentages are based on the total weight of plant and not on ash alone. The phosphorus content of the two-grooved vetch is somewhat lower than that of average alfalfa hay. The difference in sulphur content is striking, but whether it has any bearing in itself upon the general problem of grazing preference can only be determined by further research.
The striking amount of magnesium in the two-grooved vetch is of interest. In an average sample of alfalfa the magnesium content as MgO would not exceed 4 per cent. The significance of the high percentage of magnesium found in this vetch would depend largely upon its combination in the plant itself either as an inorganic or organic compound. One would be inclined to look for an organic relationship since a magnesium salt would not be looked upon as particularly desirable by grazing animals, providing they were not under-salted. This and other related problems are in need of more experimental data in order to have a basic understanding of the functional relationships of chemical elements and compounds in poisonous plants. If such additional information was available, there is a possibility that supplementary feeding would be indicated during periods of danger as a means of supplying these food elements which cause animals to eat poisonous plants in preference to the non-injurious plants which are normally grazed.

**NATURE OF POISON**

No attempts have been made in our laboratories to systematically classify and identify the poisonous principles of the vetches. The preparation of extracts for the physiological tests has given us some general knowledge of their behavior. The most potent extract of the two-grooved vetch is obtained by the use of 80 per cent alcohol. Full strength alcohol is necessary for the preparation of a timber vetch extract. The chemical tests verify our physiological findings in indicating that each vetch species has an apparently distinctive active principle. Tests for alkaloids, saponins, glucosides and miscellaneous plant ingredients have been made on each of the three species, but with negative results.
PHYSIOLOGICAL CONSIDERATIONS

With the addition of *Astragalus scobinatus*, Sheld., to the family of known poisonous vetches, it becomes important to undertake a study of these members. *A. scobinatus* is so recent an addition that our notes on this species are chiefly toxicological observations. The physiological work has been confined to *A. campestris* and *A. bisulcatus*.

With the *A. bisulcatus* a profound difference in its physiological reactions are noted in its various stages of growth. Whether this also holds true for the *A. campestris* has not been ascertained. This work has been confined to laboratory animals: dogs, rabbits, and guinea pigs. The *A. bisulcatus* chosen for study are represented by two stages of growth, namely, the full bloom and past seeding. The observations with *A. campestris* are confined to the full bloom stage.

Symptoms of Poisoning. Doses which are just sub-lethal cause the animals to go in a coma. This coma is especially profound with *A. bisulcatus*, full bloom, in which case it may last several days, eventually leading to the death of the animal, due to secondary causes. In this respect animals receiving *A. bisulcatus* show the least tendency to remain in a comatose state. A mild period of excitement is noted with all three but especially marked with the *A. bisulcatus*, past seeding. Its actions are best described as "movements executed without the guide of the animal's intelligence."

The full bloom vetches act more nearly like true nerve poisons and are powerful depressants. On the other hand, the *A. bisulcatus*, past seeding, may be just as powerful a depressant, but it produces marked irritation to the whole gastro-intestinal tract so that this irritation may mask some of the depression and resulting coma. The animals treated with *A. campestris* show paralytic symptoms even when given small doses: The three specimens produce a paralysis which begins in the hind legs, gradually involving the whole body. Upon recovery, which is slow, paralytic effects will be last seen in the hind legs.
Acute deaths, that is from one massive dose, are always caused by failure of respiration. Any betterment of the respiration acts beneficially upon the heart and circulation. It has not been determined just what is the mechanism causing a failing respiration. It is believed, however, that the poison acts either by paralyzing the respiratory center directly or by gradually raising the threshold for carbon dioxide and thereby lessening the irritability of the center. Portions of a typical graph are seen in Figure 11.

The first effects on the respiration are usually an acceleration of the rate. Very shortly thereafter the rate becomes lessened, but with the amplitude practically unchanged. The rate gradually becomes slower to a point where periods of apnoea (no breathing) occur. These periods of apnoea become longer and longer.

Fig. 11. Two portions of a graph giving a record of the blood pressure and respiration before and after the administration of _A. bisulcatus_ as indicated.

The periods of apnoea (no breathing) which are separated by 5 or 6 respiratory acts are only slightly slower as to rate and a little greater in amplitude than the normal respiration. The circulation follows the respiration closely, any betterment in the latter being immediately reflected in the former. The periods of apnoea gradually become longer until death. Those shown in the graph are approximately 30 seconds long. The blood pressure varies but little until just previous to death.
Such periods of apnoea are separated by 5 or 6 respiratory acts which are nearly normal as to rate and amplitude. During the longer periods of apnoea the blood pressure may drop 10 or 12 mm. Hg, and the heart beat becomes feeble; but immediately upon resumption of respiration there is nearly a complete recovery. Death occurs during a long period of apnoea. The *A. bisulcatus*, past seeding, vetch is slightly different in that death may come during a convulsion which is asphyxial in origin, the final respiratory acts of these animals often being just a series of deep gasps. Another symptom commonly noted with *A. bisulcatus*, past seeding, vetch is a profuse salivation (frothing at the mouth). The aspiration of some of this saliva often causes stertorous breathing.

All these vetches cause a diuresis, the nature of which is not known. Histological examination only reveals a mild degeneration in the kidney tubules. Occasionally there may be evidence of a mild nephritis.

These vetches cause a drop in body temperature which assumes dangerous proportions in the case of the *A. bisulcatus*, past seeding, and *A. campestris*, not with the *A. bisulcatus*, full bloom, in which the greatest drop observed never exceeded 2° C. The body weights also decrease, even in the cases of animals receiving but a small daily dose and in spite of the fact that animals maintain good appetites and eat a normal amount of food. In this case again the *A. bisulcatus*, past seeding, causes the most injury, with *A. campestris* causing nearly an equivalent drop of body weight at the same comparable doses. It is only by employing much larger doses of *A. bisulcatus*, full bloom, that a drop of body weight is obtained.

*Relative Toxicities.* The following table shows the relative toxicities of the three specimens of vetches on the guinea pig. It will be noted that *A. bisulcatus*, past seeding, is slightly more poisonous than *A. campestris* and about 60 per cent more poisonous than *A. bisulcatus*, full bloom.
Three Poisonous Vetches

Minimum dose in gms. of moisture-free plant necessary to kill a 500-gm. guinea pig. Doses given intraperitoneally:

<table>
<thead>
<tr>
<th>Plant</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. bisulcatus, past seed</td>
<td>0.9—1.0</td>
</tr>
<tr>
<td>A. campestris, full bloom</td>
<td>1.0—1.1</td>
</tr>
<tr>
<td>A. bisulcatus, full bloom</td>
<td>1.5—1.6</td>
</tr>
</tbody>
</table>

Lesions or Types of Injury. The three vetch specimens produce characteristic lesions when chronically administered in sublethal doses of varying amounts to rabbits. All the visceral organs have been examined grossly and microscopically. Grossly, the organs of the animals receiving A. bisulcatus, past seeding, show the most severe injury. This is especially true of the whole gastrointestinal tract, which shows areas of inflammation, hemorrhage and even small areas denuded of its epithelium (inner lining). Areas of chronic inflammation are noted all through the small intestines and to a much lesser extent in the large intestines. Areas showing the greatest injury are just previous to valves; for example, the pylorus of the stomach and the lower ileum. The animals receiving A. bisulcatus, full bloom, also show some injury in the gastro-intestinal tract but of a much milder nature, the least injury being noted in the animal treated with A. campestris. All three specimens, however, produce the same characteristic lesions, the hearts are flabby with dilated chambers and the walls are thinner than normal. Such hearts undoubtedly are inefficient. The lesions in the other organs, particularly the lungs, liver, and spleen, show chronic, passive congestions, likely the result of a weak, sluggish and failing circulation. The dyspnoea (difficult breathing) so constantly observed in advanced cases of poisoning with either of the three vetches can well be attributed to the chronic, passive congestion in the lungs which in turn results from the failing circulation. None of the cases have shown any evidence of a pneumonia. The mode of death in chronic cases is very likely due to a failing circulation, whereas acute death from one massive dose is caused by failure of respiration.
Toxicities of Various Plant Parts. Little is known concerning the toxicities of the various plant parts. In the case of *A. bisulcatus* the stems were found 20 per cent more toxic than the leaves and small twigs. This material had been collected about the middle of October after a heavy frost, due to which the leaves had been badly shriveled.

**SUMMARY**

*General.* The poisonous vetches in Wyoming are responsible for livestock losses of considerable magnitude.

The timber milk vetch in certain areas in southern and south-western Wyoming has compelled livestock operators to abandon badly infested ranges.

A small band of mixed sheep was held on the timber vetch during ten days in August, 1930, without any ill effects. During the experiment they were not trailed or unduly excited.

The chronic form of the poisoning is more prevalent than the acute in Wyoming.

Special care for the poisoned stock is the only recommendation that can be made at this time.

The two-grooved milk vetch is particularly troublesome, some years, in the late summer and fall.

Fatalities are confined to sheep mainly.

Death occurs quickly where an appreciable amount is eaten at one time.

Chronic types of the disease occur only occasionally.

The extent of cattle losses caused by the two-grooved vetch is uncertain at this time. It is unquestionably poisonous to cattle in late summer and fall. Evidence points to the fact that under range conditions it is sought out for some unexplained peculiar property of the plant, such as palatability, aroma, mineral content, etc.

Supervised grazing and the grubbing out of the plant are the only suggestions offered for its control.

*Physiological.* The *A. bisulcatus* is nearly two times as toxic when past seeding as it is in its full bloom stage. The *A. campes-
tris in full bloom is nearly as toxic as *A. bisulcatus* in the stage past seeding.

Timber milk vetch acts more like a true nerve depressant than the two-grooved milk vetch.

The two-grooved milk vetch, past seeding, causes severe injury to the gastro-intestinal tract.

Acute deaths with all three vetch specimens are caused by failure of respiration. The severe congestion in the lungs, etc., together with the weak dilated hearts suggest that a failing circulation or secondary effects due to such a weak, sluggish circulation are mainly responsible for chronic deaths.

Large sub-lethal doses of *A. bisulcatus*, past seeding, and the timber vetch causes severe drops in body temperatures. These two vetch types also cause serious loss of body weight.

Doses sufficiently large to cause the animals to exhibit symptoms of poisoning have been administered daily for a period of two months. Histological examination of the tissues of these animals fails to reveal any evidence of a pneumonia produced by the administration of any of the vetches.

Our data on the toxicity of the various stages of growth of *A. scobinatulus* is too incomplete at present to make comparisons with the corresponding stages of *A. bisulcatus* and *A. campestris*.

LITERATURE CITED


