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THE POISON PARSNIP OR WATER HEMLOCK
A PLANT DEADLY TO LIVESTOCK IN NEVADA

By C. E. Fleming and N. F. Peterson

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THE UNIVERSITY OF NEVADA
AGRICULTURAL EXPERIMENT STATION

Bulletin No. 100

RENO, NEVADA

December, 1920

To diminish suffering and loss among domestic animals

THE POISON PARSNIP OR WATER HEMLOCK

(*Cicuta occidentalis*)

A Plant Deadly to Live Stock in Nevada

By

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Poison Parsnip (*Cicuta occidentalis*). The Most Dangerous Stage of Growth.

THE PURPOSE OF THIS BULLETIN

While for more than half a century in Nevada the plant known here as poison parsnip has been recognized as a poisonous plant, there has been concerning it a good deal of confused opinion.

Even among trained scientists there is no agreement. One writer states that the tops are poisonous; another that 41 pounds of the roots were fed within two weeks to a sheep without causing serious illness. Some writers assert that the roots are much less poisonous at one time of year than at another; others, that cattle and horses are poisoned, but not sheep or goats. To clear away this confusion and to gain exact information which would be of service to Nevada stockmen, several series of feeding tests were undertaken at the University.

Evidently, the actual feeding of roots and tops to live stock is the best possible method of gaining exact information about the amount required to kill an animal, the part of the plant which is poisonous, and the time of year when it is dangerous. For example, we cannot reach a safe conclusion concerning the deadly dose for a sheep by feeding the plant to a rabbit or a guinea pig. Chemical analyses, however, throw much light upon the nature of the active poisonous principles in the plant.

The series of feeding tests summarized in this bulletin cleared away much of the previous confusion of opinion, and showed what part of the plant is deadly and also how poisoning may readily be prevented.

It is clear that in the long run studies of this character will diminish suffering and loss among our domestic animals.

S. B. DOTEN,

Director, Nevada Agricultural Experiment Station.

UNIVERSITY OF NEVADA, December 1, 1920.

Figure 1. Flowers of Poison Parsnip (Water Hemlock). The flowers, like those of the common parsnip, are borne in little clusters on slender stems, which radiate from the end of the flower stalk like the ribs of an umbrella.

SECTION I

Poison Parsnip (Water Hemlock) as a Plant Deadly to Live Stock in Nevada

SUMMARY

(1) The poison parsnip or water hemlock is a poisonous weed commonly found along ditch banks and in wet pasture lands throughout the larger part of Nevada.

(2) The leaves look somewhat like those of celery or the common parsnip. They are dark-green and glossy. The plant sends up long branching stems from two to even five or six feet high, bearing numerous flattened clusters of tiny white flowers.

(3) The rootstock is thick and fleshy with numerous branches sometimes as thick as a man's thumb. The main root, rootstock, has numerous empty spaces in the middle with cross-partitions. When it is cut little drops of a yellow poisonous sap ooze out.

(4) In late summer the seeds fall into the water and are carried away for long distances, finally being washed out upon wet pasture land or else lodging against the bank of the ditch, producing new plants.

(5) A long and complete series of experiments, 1918-1920, conducted by the Nevada Agricultural Experiment Station showed that (a) the leaves and stems are not poisonous in summer or autumn, and large quantities might then be eaten by either sheep or cattle without harm; (b) the roots are deadly throughout the year, the old rootstocks being more poisonous than the new; (c) the first green leaves and stems coming up from the ground in the spring are deadly, almost as much so as the roots themselves; (d) under ordinary conditions very few animals ever get the roots in summer and autumn. Frost and ice in winter frequently loosen and heave up the roots. They may then be pulled and eaten in the spring by animals attracted by the new green growth.

(6) The greatest danger comes from the tender green shoots in the spring. They are apt to show up strongly along ditches before the grass begins to grow, and may then be eaten greedily by animals hungry for green feed.

(7) Losses from poison parsnip (water hemlock) are readily prevented by keeping stock away from places where the plant grows in the spring, until other green feed is making a good showing.

(8) Along ditch banks the poison parsnip may easily be grubbed out. It appears to be unnecessary to dig the whole root, as apparently if the top of the rootstock is cut off, no new shoots will be sent up from the remainder. Roots which have been dug should be dried in a place where cattle cannot get at them and then burned; for even when dead and dry they are still extremely poisonous.

(9) This bulletin contains a detailed report of feeding experiments on which the above conclusions are based.

Figure 2. Flowers and Leaves of the Poison Parsnip. This is growing in the midst of a tangle of other vegetation in a swampy meadow.

From the days of the earliest settlements in Nevada the poison parsnip (water hemlock) has been known as a poisonous plant. Long before the white people came into the country its properties were known to the Indians, who used it as a means of suicide. The roots and the earliest green growth are violently poisonous to all kinds of live stock and every year cause losses of cattle, horses, and sheep. The greatest losses are of cattle, perhaps largely because they are more frequently pastured where the plant is abundant.

Common Names of Water Hemlock.

In Nevada, as in other Western States, this poisonous plant is usually called Poison Parsnip or Wild Parsnip. In some other States it is

Figure 3. The Leaf of the Poison Parsnip. The leaflets grow in little groups by twos and threes, and the edge of each leaflet is sharply saw-toothed.

often called Cow-bane. Perhaps the best common name is Water Hemlock. The scientific name of the kind found in Nevada is *Cicuta occidentalis*. Throughout the northern half of the world there are many other kinds of *Cicuta*, all of which contain deadly poisons.

Description of Plant.

The poison parsnip belongs to the parsley family. Mature plants are from two to six feet high. The largest leaves are at the bases of the

plants and are twice branched (see Figures 2 and 3). The stem is smooth, green, and hollow, except at the nodes or joints where the leaves are attached. This hollow is formed by the breaking down of the pith, and very young stems may still be solid. The flower clusters are broad and flat and resemble those of parsnips or carrots. The flowers are small and inconspicuous, greenish-white in color. Flowers and flower clusters are well shown in Figures 1 and 2.

The lower underground part of the stem is thickened and fleshy, with a series of cross-partitions, which divide the interior into small short chambers, as shown in Figure 4. The hollows between these partitions are formed like the hollow in the rest of the stem—that is, by the

Figure 4. Root and Rootstock of the Poison Parsnip. The full-grown rootstock is divided by thin partitions into a number of shallow chambers.

breaking down of the pith; and they may not be found in very young roots. Attached to this thickened tuberos central portion are a number of thick fleshy roots with some ordinary root-fibers.

When the tuber or the roots are cut, a reddish or yellowish sirupy liquid oozes out on the cut surface. This is cicutoxin, the poisonous principle of the plant.

How to Distinguish the Poison Parsnip from Other Plants.

Several other plants belonging to the parsley family resemble the poison parsnip so much that they may be mistaken for it if the tops

alone are examined. However, they may all be distinguished easily if the underground parts are dug. Only a few of the others have an underground stem with cross-partitions; and in these it is not thick and fleshy and has no fleshy roots like those of the poison parsnip, and no cicutoxin appears when the underground stem is cut.

The common field parsnip has a fleshy root; but it lacks the open spaces, the cross-partitions, and the yellow cicutoxin. Both the field parsnip and the poison parsnip have a peculiar odor which is lacking in other plants of much the same appearance.

The stems and leaves of the poison parsnip are coarse, the flower is white, and the whole plant has a strong unpleasant odor when crushed. On the whole, it is easy to tell the roots of the poison parsnip from any of the others by: (1) the cross-partitions of the rootstock; (2) the rank parsnip smell; (3) the oily yellow drops of deadly cicutoxin which ooze out when the rootstock is cut. If a root shows all three of these

Figure 5. Leaves of Water Parsnip (on left) and Water Hemlock, or Poison Parsnip. The principal difference appears to be in the fact that the leaflets of water parsnip, a harmless plant, grow singly, while those of water hemlock grow in little groups of two or three each.

characters, one may be sure that it is the root of the poison parsnip (water hemlock).

In Nevada many related plants belonging to the parsnip family grow in dry soil, but the poison parsnip is never found except in wet places. There is another plant called water parsnip (*Sium*) which grows in similar places and is often associated with the water hemlock. It can be distinguished by the less divided leaf, shown in Figure 5.

Where It Grows.

The poison parsnip or water hemlock grows in wet, marshy soil or in shallow water. It is common along streams and around ponds, and in or along ditches. In Nevada it is most commonly found along the edges of irrigation ditches and scattered over wet meadows and pastures. It does not usually occur throughout such pastures and meadows, but is limited to very wet areas and to the ditch banks.

Methods of Reproduction and Spread.

The plant produces a great amount of seed which is carried by the irrigation water to new fields and ditches. Small plants are sometimes washed out and carried to a distance by the water, but it is the seed falling on the water which is the important means of spread.

The seedlings do not bloom nor produce seeds the first year; and it may take the plant several seasons to develop a tuber large enough to send up a flowering stem. The young plants do not produce an erect stem, but only a bunch of leaves. Each year the old tuber dies in the fall; but before this happens it has given rise to one or more new tubers which live through the winter and begin growth again very early the next spring. When more than one new tuber is formed, this

Figure 6. Roots and Early Spring Growth of the Poison Parsnip (Water Hemlock). Both the rootstock and the fleshy roots contain the deadly cicutoxin.

results in a local increase in the number of plants. For this reason the poison parsnip plants often grow in clusters which all originated from a single seed.

When the new tuber is first formed it contains little or no cicutoxin, but as it grows older the amount increases until it becomes as poisonous as the old ones. This difference between the new tubers and the old is probably what has led some writers to conclude that the plant is less poisonous at certain times in the year. The old decaying tubers retain most of their cicutoxin, the poisonous principle, and are still poisonous when almost completely decayed.

Poisonous Principle.

The poisonous principle, as has been already stated, is called cicutoxin. This substance is found principally in the tuberous underground parts of the plant, *i. e.*, in the rootstock and in the tuberous roots. When the little green shoots first come up in the spring they contain considerable amounts and are almost as poisonous as the tubers. Later only very small amounts are present in the lower part of the stem and in the lower leaf stalks. The chemistry of cicutoxin is fully discussed by Dr. C. A. Jacobson in Bulletin No. 81 of this Station.

Time of Year When Most Dangerous.

The early spring while the leaves are still poisonous is the time when the plant is the most dangerous. At this time also the tubers may be trampled or pulled out of the ground and eaten; but later they develop fibrous roots and are so anchored by these and by the roots of other plants, that it is almost impossible for grazing animals to pull them. In the early spring in some soils the tubers are loosened and often stand partly above the surface of the ground, heaved up by winter frost and ice. The first leaves grow rapidly because they are nourished by food stored in the tuber; they make tempting feed before other plants have made much growth (see frontispiece and Figure 6).

Purpose of the Experimental Feedings.

At the time when our feeding tests were undertaken, although the plant had long been considered poisonous, only a few experiments had been made to determine exactly what parts of the plant are poisonous and how much of each part it will take to make an animal sick or to cause death. Moreover, different experimenters had obtained very different results.

Because of this lack of exact information the Nevada Station has made a long series of experimental feedings of various parts of the plant to sheep, cattle, and horses. The old tubers were fed at different times during the growing season; the new tubers, when they had formed in midsummer; the leaves, when they first appeared in the spring, while the older tops were fed at different times during the summer. As all of the Nevada material was collected near Reno, and because it seemed possible that differences of climate and soil might make a difference in the poisonous quality of the plant, a few other feedings were made with material which was collected in Nebraska. The results of all of these feedings follow.

TABLE No. I
POISON PARSNIP (WATER HEMLOCK). FRESHLY GATHERED OLD TUBERS
FED TO SHEEP

Animal No.	Weight lbs.	Date fed	Time fed	Amount fed, ozs.	Time symptoms appeared	Time of death or recovery	Final result
6.....	65	5-29-18	3:45 p. m.	$\frac{1}{2}$	-----	-----	Negative
29.....	65	5-30-18	3:00 p. m.	1	-----	-----	Negative
33.....	90	8-20-18	2:15 p. m.	1	-----	-----	Negative
8.....	72	8-30-18	3:08 p. m.	1	-----	-----	Negative
34.....	97	8-20-18	2:35 p. m.	$1\frac{1}{2}$	-----	-----	Negative
36.....	102	8-20-18	2:50 p. m.	2	-----	-----	Negative
6.....	65	5-30-18	3:05 p. m.	2	4:30 p. m.	6:00 p. m.	Recovery
16.....	70	5-30-18	3:00 p. m.	2	3:25 p. m.	4:07 p. m.	Death
28.....	78	8-20-18	3:50 p. m.	2	4:45 p. m.	5:10 p. m.	Death
11.....	73	5-30-18	2:55 p. m.	3	3:35 p. m.	4:21 p. m.	Death
7.....	71	5-30-18	3:14 p. m.	3	3:30 p. m.	4:02 p. m.	Death
32.....	80	8-20-18	4:10 p. m.	3	(?)	Before 7:15 p. m.	Death
13.....	69	5-30-18	2:58 p. m.	4	3:25 p. m.	4:36 p. m.	Death
23.....	78	5-28-18	4:15 p. m.	$5\frac{1}{16}$	4:35 p. m.	5:28 p. m.	Death

Feeding Freshly Dug Old Tubers to Sheep.

During the seasons of 1918 and 1919, fourteen feedings of fresh old tubers were made, the results of which are summarized in Table No. I.

Amounts from $\frac{1}{2}$ to $1\frac{1}{2}$ ounces gave negative results. Four two-ounce feedings were made; one caused no symptoms, one made a sheep sick, but it recovered, while both the other two caused death. The sheep that was not made sick was larger than the others. All feedings of three ounces and over caused death. Thus, any amount of the tubers above two ounces when eaten by ordinary range ewes will probably cause death. That is, if a ewe eats more than $\frac{1}{3}$ of a pound, death is likely to follow.

Feeding Dried Old Tubers to Sheep.

The old tubers were dug and allowed to dry in the air. The results of feeding air-dried tubers are shown in Table No. II.

TABLE No. II
POISON PARSNIP (WATER HEMLOCK). AIR-DRIED OLD TUBERS FED TO SHEEP

Animal No.	Weight lbs.	Date fed	Time fed	Amount fed, ozs.	Time symptoms appeared	Time of death or recovery	Final result
25-----	77	7-5-18	10:35 a. m.	$\frac{1}{2}$	11:55 a. m.	12:24 p. m.	----- Death

We made only one feeding of the dried tubers to sheep. The result showed conclusively that the air-dried tubers are deadly and made further tests unnecessary.

Eighteen pounds of old tubers were air dried to 2.9 pounds, or only $\frac{1}{6}$ of the original weight. A half ounce, $\frac{1}{32}$ of a pound, of this dry material was fed. This is equivalent to about three ounces of the fresh tubers. The result was death, the animal exhibiting typical water hemlock poisoning symptoms.

This one feeding indicated (1) that there is little if any immediate loss of the poisonous principle upon drying, and (2) that grubbed roots are extremely dangerous to live stock and should be so disposed of that there is no chance of animals eating them.

Feeding New (Young) Tubers to Sheep.

Table No. III summarizes the feeding of new tubers to sheep:

TABLE III
POISON PARSNIP (WATER HEMLOCK). FRESHLY GATHERED NEW TUBERS FED TO SHEEP

Animal No.	Weight lbs.	Date fed	Time fed	Amount fed, ozs.	Time symptoms appeared	Time of death or recovery	Final result
35-----	111	8-20-18	2:23 p. m.	2	-----	-----	Negative
29-----	65	8-20-18	3:40 p. m.	2	-----	-----	Negative
36-----	110	8-24-18	11:40 a. m.	4	-----	-----	Negative
47-----	60	8- 1-19	11:00 a. m.	5	(?)	Before 1:00 p. m.	Death
33-----	90	8-20-18	9:00 a. m.	6	-----	-----	Negative
36-----	110	8-27-18	9:00 a. m.	8	9:35 a. m.	10:32 a. m.	Death

Five feedings of freshly dug new tubers were made in 1918; and amounts from two to six ounces, $\frac{1}{8}$ to $\frac{1}{3}$ of a pound, produced no symptoms, while eight ounces, $\frac{1}{2}$ pound, caused death. A single feeding of five ounces made in August, 1919, caused death. It would appear from these feedings that it takes from two to four times as much of

the new tubers to kill as of the old. It seems probable that the very young tubers are only slightly poisonous, becoming more so later in the season, until, when fully matured, they are as poisonous as the old ones.

Feeding Tubers of Water Hemlock from Nebraska.

The material fed to sheep in Table No. IV was collected in Nebraska and fed in Nevada.

TABLE No. IV
POISON PARSNIP (WATER HEMLOCK). WILTED TUBERS FROM NEBRASKA
FED TO SHEEP

Animal No.	Weight lbs.	Date fed	Time fed	Amount fed, ozs.	Time symptoms appeared	Time of death or recovery	Final result
76-----	81	7-13-20	10:00 a. m.	1	-----	-----	----- Negative
77-----	88	7-13-20	10:00 a. m.	1	-----	-----	----- Negative
74-----	88	7-13-20	10:10 a. m.	1½	-----	-----	----- Negative
69-----	74	7-13-20	10:10 a. m.	1½	-----	-----	----- Negative
28-----	59	7-13-20	10:20 a. m.	2	-----	-----	----- Negative
120-----	102	7-14-20	8:15 a. m.	2½	-----	-----	----- Negative
77-----	83	7-14-20	8:25 a. m.	3	-----	-----	----- Negative
10-----	89	7-14-20	10:20 a. m.	4	1:00 p. m.	3:00 p. m.	----- Recovery
8-----	98	7-14-20	2:45 p. m.	4	-----	-----	----- Negative
28-----	58	7-15-20	8:45 a. m.	4	-----	-----	----- Negative

The Nebraska material was partly dry, and had lost about half its weight, so that in Table IV the amount fed is doubled.

From the results it would appear that the Nebraska rootstocks were less poisonous than those from Nevada. As seen by Table No. I, two ounces of the Nevada material, when fed fresh, usually caused serious poisoning or death, while it took four ounces of the Nebraska material to cause symptoms. These feedings seem to show that the water hemlock is less dangerous in some parts of the country than in others.

Feeding Young Leaves to Sheep.

More losses of stock from water hemlock poisoning occur in the early spring than at any other season, and it is by no means clear that such losses are always due to the eating of pulled tubers. For this reason it seemed probable that the green shoots of the plant are poisonous when they first appear in the spring. Table No. V summarizes the results of feeding young leaves to sheep:

TABLE No. V
POISON PARSNIP (WATER HEMLOCK). YOUNG TOPS FED TO SHEEP

Animal No.	Weight lbs.	Date fed	Time fed	Amount fed, ozs.	Time symptoms appeared	Time of death or recovery	Final result
48-----	91	2-3-20	10:15 a. m.	6	10:40 a. m.	11:10 a. m.	----- Death
37-----	87	2-5-20	9:50 a. m.	1	-----	-----	----- Negative
56-----	120	2-5-20	2:10 p. m.	2	-----	-----	----- Negative
37-----	90	2-6-20	8:35 a. m.	3	9:50 a. m.	11:15 a. m.	----- Death
64-----	85	4-2-20	1:30 p. m.	3	-----	-----	----- Negative
64-----	85	4-3-20	10:30 a. m.	4	-----	-----	----- Negative
64-----	85	4-9-20	11:08 a. m.	8	12:45 p. m.	2:00 p. m.	----- Death
68-----	101	5-5-20	11:50 a. m.	16	-----	-----	----- Negative
68-----	101	5-5-20	3:30 p. m.	40	-----	-----	----- Negative

Fed green parts of leaves only:

68-----	101	5-6-20	9:25 a. m.	7	10:00 a. m.	Slight trembling only symptom	----- Recovery
---------	-----	--------	------------	---	-------------	-------------------------------	----------------

Ten feedings were made. In the series of feedings made early in

February one and two ounces produced no symptoms, while three ounces caused death. The leaves were then about two to three inches tall and the leaflets were not yet unfolded. The results indicate that the leaves at this stage of development are almost as deadly as the tubers.

In April three feedings were made. Feedings of three and four ounces gave negative results, while eight ounces caused death. The

Figure 7. The Poison Parsnip Growing in a Wet Meadow. In such locations the plant is easily grubbed out, and the cost of a single poisoned animal would more than pay for the labor required to clear a large area.

leaflets were now beginning to unfold and the leaves were becoming less toxic.

Early in May two feedings were made of leaves from which all parts which had not turned green were removed. One feeding was of one pound, and the other of $2\frac{1}{2}$ pounds. No symptoms were produced from either feeding. The following day the white and yellow parts, amount-

ing to seven ounces, less than half a pound, which had been discarded from the material used in the above feedings, were fed to the same sheep. About half an hour after feeding, it had a slight nervous trembling, resembling the first symptoms exhibited when an animal becomes poisoned with this plant. No other symptoms developed. It appears therefore from this series of feedings that as the leaves expand and become green they cease to be poisonous.

The growth in February was due to abnormally warm weather; and ordinarily the first green shoots would not appear till some weeks later in the season.

Such early spring growth is very tempting, being about the only green feed available, and is highly dangerous to live stock.

Feeding Older Tops to Sheep.

Table No. VI gives results of feeding older tops to sheep.

TABLE No. VI
POISON PARSNIP (WATER HEMLOCK). THE OLD GREEN PLANT FED TO SHEEP

Animal No.	Weight lbs.	Date fed	Time fed	Amount fed, lbs.	Time symptoms appeared	Time of death or recovery	Final result
6-----	65	5-28-18	4:25 p. m.	$\frac{1}{2}$	-----	-----	Negative
29-----	65	5-29-18	3:40 p. m.	$\frac{1}{2}$	-----	-----	Negative
7-----	71	5-29-18	4:20 p. m.	1	-----	-----	Negative
28-----	65	6-15-18	10:00 a. m.	1	-----	-----	Negative
24-----	67	5-30-18	11:45 a. m.	2	-----	-----	Negative
4-----	87	6-18-18	3:00 p. m.	6	-----	-----	Negative
32-----	85	7-26-18	10:30 a. m.	10	-----	-----	Negative
		7-27-18	1:00 p. m.	7	-----	-----	Negative
		7-28-18	8:30 a. m.	10	-----	-----	Negative
		7-29-18	7:30-11:30 a. m.	6	-----	-----	Negative
			4:30 p. m.	2	-----	-----	Negative
75, 78--	80 ea.	6-21-20	-----	4	-----	-----	Negative
		6-22-20	-----	$3\frac{1}{2}$	-----	-----	Negative
		6-23-20	-----	$7\frac{1}{2}$	-----	-----	Negative
		6-28-20	-----	7	-----	-----	Negative

As will be seen from the above table single feedings up to six pounds were made without producing any symptoms. A sheep was fed amounts varying from 7 to 10 pounds daily for four days, making a total of 35 pounds, without showing any symptoms. Two sheep were fed 22 pounds in four days without showing any symptoms.

This shows that the older tops are practically, if not entirely, non-poisonous, and that there is no danger in feeding them, or allowing sheep to graze upon them, or in feeding hay containing water hemlock tops.

Feeding Old Water Hemlock Tubers to Cattle.

Table No. VII shows the results of feeding fully matured tubers to cattle.

TABLE No. VII
POISON PARSNIP (WATER HEMLOCK). OLD TUBERS FED TO CATTLE

Animal No.	Weight lbs.	Date fed	Time fed	Amount fed, ozs.	Time symptoms appeared	Time of death or recovery	Final result
739-----	985	6-15-18	10:00 a. m.	4	-----	-----	Negative
739-----	985	6-19-18	5:30 p. m.	8	-----	-----	Negative
739-----	985	6-21-18	9:45 a. m.	12	10:50 a. m.	11:00 a. m.	Death

A cow was fed four ounces without producing any symptoms, and four days later eight ounces were fed with no effect. Two days later

she was fed 12 ounces, which caused death. The poisonous dose for a cow of nearly 1,000 pounds weight would seem to be somewhere between $\frac{1}{2}$ and $\frac{3}{4}$ of a pound of the freshly gathered old tubers.

Feeding Old Water Hemlock Tops to Cattle.

Table No. VIII gives the results of feeding old water hemlock tops to cattle.

TABLE No. VIII

POISON PARSNIP (WATER HEMLOCK). THE OLD GREEN PLANT WITHOUT ROOTS
FED TO CATTLE

Animal No.	Weight lbs.	Date fed	Time fed	Amount fed, lbs.	Time symptoms appeared	Time of death or recovery	Final result
739-----	985	5-29-18	4:30 p. m.	2 $\frac{1}{2}$	-----	-----	----- Negative
			9:30 a. m.	3 $\frac{1}{2}$	-----	-----	----- Negative
		5-30-18	11:30 a. m.	5 $\frac{1}{2}$	-----	-----	----- Negative
			3:15 p. m.	1 $\frac{1}{2}$	-----	-----	----- Negative
			5:00 p. m.	6	-----	-----	----- Negative
			9:30 a. m.	8 $\frac{1}{2}$	-----	-----	----- Negative
		5-31-18	9:30 a. m.	10	-----	-----	----- Negative
		6- 1-18	9:30 a. m.	9	-----	-----	----- Negative
			9:45 a. m.	9	-----	-----	----- Negative
		6- 4-18	11:15 a. m.	22 $\frac{1}{2}$	-----	-----	----- Negative
			3:10 p. m.	18 $\frac{1}{2}$	-----	-----	----- Negative
			3:35 p. m.	12	-----	-----	----- Negative
15-----	235	6-20-20	-----	5	-----	-----	----- Negative
		6-21-20	-----	8	-----	-----	----- Negative
		6-22-20	-----	8 $\frac{1}{2}$	-----	-----	----- Negative
		6-23-20	-----	12	-----	-----	----- Negative

During four days a cow was fed 46 pounds, eating as much as 28 pounds in a single day. Later she ate 41 pounds in an afternoon without any symptoms.

A calf was fed 33 $\frac{1}{2}$ pounds in four days, eating as much as 12 pounds in one day, without showing any symptoms. This shows, as did the feeding of tops to sheep, that the old tops are not dangerous.

Feeding Old Water Hemlock Tubers to Horses.

Table No. IX gives results of feeding old tubers to horses.

TABLE No. IX

POISON PARSNIP (WATER HEMLOCK). FRESHLY GATHERED OLD TUBERS
FED TO HORSES

Animal No.	Weight lbs.	Date fed	Time fed	Amount fed, ozs.	Time symptoms appeared	Time of death or recovery
8-----	865	5-26-19	2:05 p. m.	15	2:50 p. m.	-----Shot at 3:22 p. m.
2-----	990	5-27-19	10:15 a. m.	8	10:45 a. m.	-----Shot at 10:54 a. m.

Only two horses were fed—one received eight ounces, $\frac{1}{2}$ of a pound; and the other 15 ounces, nearly a pound. Both were made sick and would have died. There was no hope for their recovery and they were in such agony that they were shot for humane reasons. The poisonous dose appears to be less for a horse than for a cow of about the same weight (see Figure 8).

Time Required for Symptoms to Appear.

With sheep it took from 16 to 75 minutes for symptoms to appear. In eight cases the average time was 39 minutes. The two cases in which the earliest symptoms were not observed would probably have increased the average a little. In the cow it took about an hour, and in

**Figure 8. A Horse Fatally Poisoned
by the Poison Parsnip.**

the two horses 30 and 45 minutes. Cicutoxin is evidently a poison which is rapidly taken up by the system and which acts quickly.

Symptoms.

Usually the first symptom noticed was a twitching of the muscles; and often a quivering of the lips and nose and a pronounced uneasiness. This was soon followed by a series of spasms, during which there was convulsive champing of the jaws and grating of the teeth and a bending backward of the head and neck. In the tests the cattle and sheep usually went down with the first severe spasm and never got up again; while the horses stayed on their feet during some of the spasms and would get up again after going down. While down, there would be a series of spasms at intervals of varying length. During these intervals the animal would sometimes appear to be recovering.

During the spasms there was always a very rapid kicking or running movement of the legs, often rolling of the eyes, groaning, grating of the teeth, and movements of the jaws. The head was often drawn back, the legs stiffened; and frothing at the mouth was often noticed. Sometimes the animal would groan from pain while lying still.

In the one sheep that recovered there was almost constant dribbling of the urine for about an hour after the spasms had ceased. Bloating occurred in about half the sheep, some of them being severely bloated. Before death there was a period of quiet, during which the animal showed few signs of life except breathing.

Treatment.

The only treatment that has proven of any value in human beings who have been poisoned by water hemlock is to produce vomiting before a fatal dose has been absorbed. There is no known specific antidote. To produce vomiting is usually impossible or impractical in either cattle, horses, or sheep. The poison acts so quickly that there is little time for any treatment, and after the symptoms appear the animal is so excitable that any treatment would be difficult to apply.

Method of Preventing or Reducing Losses.

The water hemlock has such a limited distribution that can easily be grubbed out from pastures where it is causing losses. The cost of a poisoned steer would pay for grubbing several acres. In grubbing it does not appear to be necessary to remove the entire root; as experiments seem to show that the plant dies if the rootstock, the heavy tuberous underground base of the stem, is removed. It seems that if the rootstock is even badly mutilated it will die and decay.

After the plants have been grubbed they should not be left in the field but should be removed to where stock cannot get at them, and where they can later be burned. On the range they may be put in a hole, a fire built over them and the hole afterwards refilled. Great care must be taken not to leave any roots on the surface of the ground, or the danger of poisoning will be increased.

CONCLUSIONS CONCERNING POISON PARSNIP (WATER HEMLOCK)

- (1) It is highly poisonous to cattle, sheep, and horses.
- (2) The tops are deadly in the early spring, but as they grow larger they cease to be poisonous.
- (3) The older tops are not poisonous.
- (4) Two ounces, $\frac{1}{8}$ of a pound, or more of the old tubers (roots) are sufficient to kill ordinary range ewes or to make them sick.
- (5) Ten to twelve ounces, about $\frac{3}{4}$ of a pound, of the old tubers will usually prove fatal to fully matured cows.
- (6) A dose of $\frac{1}{2}$ pound to one pound of the old tubers will kill a horse.
- (7) The young tubers are much less poisonous than the old ones, for it takes from two to four times as much of the new tubers to kill an animal.
- (8) Water hemlock tubers shipped to Reno from Nebraska were much less poisonous than the tubers found growing in Nevada.
- (9) For sheep it takes from 16 to 75 minutes for symptoms to appear. In the cow it takes about an hour and in horses about 45 minutes.
- (10) There is no known remedy.
- (11) Drying does not immediately destroy the poisonous principle in the plant. One-half ounce of dried tubers killed a mature ewe.
- (12) The poison parsnip is easily removed from fields by grubbing. Great care must be taken to dispose of all the tubers, so that live stock cannot get any chance to eat them.
- (13) Most of the year only the tubers (roots) are poisonous. In the early spring the young leaves are almost, if not quite, as poisonous as the tubers. This is the time when the danger is greatest.

SECTION II

Technical Information Concerning the Poison Parsnip (Water Hemlock)

This section is not intended for use by farmers and stockmen. The information included is intended primarily for chemists and veterinarians.

THE ACTIVE POISONOUS PRINCIPLE OF CICUTA

Chemical researches have been made, both in this country and abroad, on various members of the genus *Cicuta*, all species of which are probably poisonous. When the rootstocks of *Cicuta* are cut or broken open there is an exudation of a yellowish, aromatic oily material which in a few moments begins to darken to a reddish-brown color. (See Bulletin 81, Nevada Experiment Station.) This yellowish exudate is the poisonous principle of the root and it may be also seen in the lower portions of the stems to a lesser extent. This poisonous principle of *Cicuta* has been the subject of researches by a number of experimenters and a fair idea is to be had concerning its nature.

In order to obtain the poison in a state pure enough for most experimental work the fresh tubers may be reduced to a pulp and extracted with ether, in which the cicutoxin (the name given to the active principle) dissolves. Removal of the moisture and ether leaves the cicutoxin in the pure state. In addition to ether it will also dissolve in alcohol, methanol, acetone, and chloroform. It is only slightly soluble in benzene, carbon tetrachloride, and petroleum ether; and is insoluble in water, glycerine, and aniline.

A method for the purification of the poison has been devised which is based on its relative solubility in alcohol and petroleum ether, the resulting product differing but little in purity from that prepared by the method first mentioned. The chemical formula of the substance was found by Dr. C. A. Jacobson of the Nevada Station to be $C_{19}H_{26}O_3$. In extracting the green tubers with ether it was found that cicutoxin could be obtained in a quantity of from 0.3 to 0.4 per cent of the weight of the tubers used.

When prepared in the pure condition cicutoxin is a viscous yellowish liquid which changes spontaneously into a semisolid body of a ruby-red to reddish-brown color. It has the characteristic odor of the poison parsnip and a very persistent bitter taste. When it is prepared by dissolving in alcohol and precipitating by means of petroleum ether it is obtained in a noncrystalline solid which melts to a sirupy mass when heated to 20° . A greater increase in temperature causes a loss in toxicity and differences have apparently been observed in the substance obtained from plants in the warmer and cooler parts of the year.

Experiments with the rootstocks of the plant or the pure poison as obtained and administered by mouth show that it is a narcotic cramp poison, the symptoms of which in the lower animals are like those in man except for being less marked.

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