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WHORLED MILKWEED

The Worst Stock-Poisoning Plant in Colorado

By W. L. MAY, Assistant Botanist

A bad patch of milkweed on a rocky hillside just below an irrigation ditch.

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WHORLED MILKWEED

The Worst Stock-Poisoning Plant in Colorado

By W. L. MAY, Assistant Botanist

The investigative work on the whorled milkweed in Colorado, carried on during the past two summers, has demonstrated that this plant is the most dangerous poisonous plant in the State, both because of its toxic properties and because of its extreme resistance to eradication measures. The importance of the problem justifies continued effort and expense on a larger scale than has so far been employed. The problem is not yet solved, but enough has been done to justify placing before the stockmen and farmers of the State the results of the work so far done.

LOSSES CAUSED BY WHORLED MILKWEED IN COLORADO

It has long been known to medical science that the various species of *Asclepias* possess toxic and medicinal properties, and the members of the genus have long been viewed with suspicion as being poisonous, but it is only recently that particular attention has been directed to the species under discussion as being a very dangerous stock-poisoning plant. At the present time it is definitely established that *Asclepias galioides* has been responsible for very heavy annual losses of sheep, cattle, and horses in Western and Southwestern Colorado, and it is suspected that the plant has been the cause of some unexplained losses in Huerfano and Las Animas Counties and in the irrigated sections along the Arkansas River from Canon City to the state line.

The earliest case on record at this station of the heavy loss probably due to "whorled" or "bedstraw milkweed" is that of the loss of 85 head of lambs by Mr. W. E. Ryman, a sheepman near Colona, Colorado, in 1909. These lambs were poisoned in an orchard containing much of the milkweed and Mr. Sam Phillips, a neighbor of Mr. Ryman, reported to the writer in 1918 that the state veterinarian at that time suspected the milkweed as being responsible.

The attention of the Colorado Experiment Station was first called to this plant in 1915 by Dr. A. P. Drew, of Grand Junction, who reported that he had strong evidence of the poisoning of stock from milkweed fed in the hay. Dr. Drew later reported that a large percentage of his winter practice is from stock poisoning due to this cause. About this time Dr. Walter Craig, a veterinarian at Paonia, also sent in samples of the plant and pronounced them as being suspicious.

Among the cases of large losses that have come to the notice of this station in the last few years are the following:

On Rogers Mesa, near Hotchkiss, Colo., in the fall of 1917, 44 head of steers belonging to the Bar K Cattle Company were lost over night in a pasture. These steers had been driven a distance of about 20 miles from the range and were turned into the pasture hungry. In the morning 44 head of the animals were found dead. Whorled milkweed was present in considerable quantities and Dr. Craig, of Paonia, reports that this plant was doubtless responsible for the poisoning.

Near this same place the Bennett brothers, in June, 1918, lost 350 head of sheep. The following is taken from Bulletin No. 246 of this station, page 4. "This case was between Hotchkiss and Paonia, Colorado. A herd of 1,700 sheep had been ranged in the cedars and sagebrush. On June 2 these were turned into an old, abandoned 10-acre orchard for one day for the purpose of shearing and dipping. The orchard was enclosed. They were left in the orchard about eight hours, and in the evening driven out of the orchard to their bedding grounds in the cedars about 100 yards away. Between that evening and the following noon 350 sheep died. Inspection of this old orchard was made on June 14. It was very thickly grown up to whorled milkweed; in fact, there was very little succulent vegetation of any kind in the enclosure except the milkweed. Inspection showed that practically every plant had been eaten down, and that that the growth present, was that made between the dates June 2 and June 14. The orchard stood in the midst of a cedar and sagebrush growth, and examination showed no milkweed in this native association. It is clear in this instance that the sheep were forced to eat milkweed, and they came there from their range hungry."

The following case came under the author's observation, five miles north of Cortez, Colorado:

Sheep which were lambing were kept in a dry pen for two weeks and were fed on nothing but bright, green alfalfa hay. About 9 o'clock on the morning of June 8, a number of these sheep with their lambs were taken from one pen and driven about 75 yards along a bare road to a corral previously unused. The sheep were not fed as usual at noon, and the owner did not go to the corral until about 4 p. m. At that time 15 of the sheep were

dead and others were sick. Only the old sheep that could eat were poisoned; none of the suckling lambs were affected. A thorough examination of the corral, which was about 2 acres in extent, showed that the only vegetation present was a few scrub pinon and cedars, one or two dried up sage bushes, and in one corner a patch of milkweed about 30'x50' in extent. This milkweed had been about half eaten off, and it could not have been more than two or three inches high, so that a comparatively small amount was eaten by the sheep which were killed.

Near Grand Junction, in August, 1918, horses which were being fed from a stack of hay cut from a new field were dying with typical poison symptoms. Other horses having the same care but which were fed from other hay were not affected. This particular stack of hay was found to contain large quantities of whorled milkweed, and an examination of the field from which it was cut showed that about one-third of the ground was infested with the milkweed. In all, six head of horses were poisoned from the stack of hay and when the milkweed was picked out of the alfalfa, or stock changed to other hay, the losses stopped.

On a main sheep driveway near Cortez, Colorado, there occurred a series of heavy losses which have become historical in the records of the investigations on milkweed in Colorado. The place where these losses occurred has been named Death Valley by the stockmen in that section of the country. It is on the driveway along which at least 50,000 sheep are moved annually between the winter and summer ranges. It is situated close to water and to Cortez, forming an ideal place to camp, so that bands were often held there over night. These losses were all of sheep, although there is strong evidence that seven head of cattle were poisoned while being driven through this area.

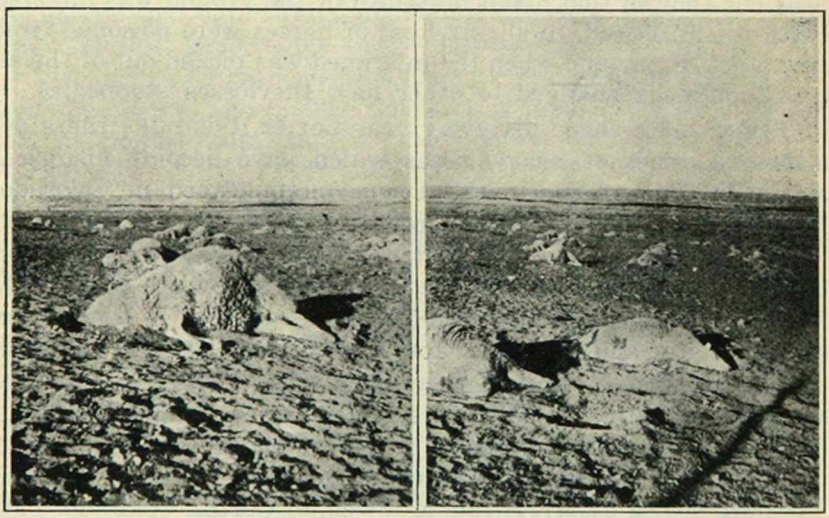
The first loss of any size at this place was that of 30 head of sheep owned by Mr. Hiram McEwen, of Cortez, Colorado. This was in 1915.

In the fall of 1916, James Gawith of Cortez, drove 1,100 head of sheep from the summer range down thru Montezuma Valley to the winter range. This band was stopped at Death Valley, and held for a time. Within a few hours after leaving the bed grounds 576 head died. The symptoms were so nearly like those from strychnine poisoning that many people at that time suspected that the sheep had been deliberately poisoned by alien enemies.

In early June, 1917, Mr. W. T. Fowler was driving a band of 1,100 sheep thru Montezuma Valley on their way to the

summer range. The sheep, according to Mr. Fowler's statement, had been on the driveway for four days, and had had only about one-fourth rations. When they reached Death Valley another owner ahead asked Mr. Fowler to hold his band an hour or two so as to prevent the two bands from mixing. The sheep grazed over the area since found to be badly infested with milkweed for about two hours, and at the end of that time they began to die. Two hundred and twelve head were dead before night.

In November, 1917, Mr. R. E. Walker pastured 900 head of ewes across the milkweed-infested field. Whorled milkweed constituted about all of the available forage at the time. The band was held on this patch for some time and 780 head died within twelve hours with the same typical poisoning symptoms shown by the sheep previously lost at this place. Figures 1 and 2



Figs. 1 and 2—780 head of sheep out of 900 were poisoned here in one day.

do not show the sheep after they were dragged together, but as they actually fell. Four hundred were pulled out of the main road to allow cars to pass.

This series of losses at one place and under practically the same conditions led to the sending of the writer into the field in the spring of 1918 to establish the identity of the plant causing the trouble and to work out its distribution and efficient methods of control and eradication.

This work has been carried on during the summers of 1918 and 1919 and the data so far obtained has shown that the milk-

weed problem is one of considerable importance both from the standpoint of stock-poisoning and from the difficulties of eradication which it presents. It deserves the continued attention of stock owners, farmers, and experimental workers.

HOW IT MAY BE IDENTIFIED

The plant under discussion belongs to the group of milkweeds having verticillate or whorled leaves which are linear in outline. There are three common members of this group, *Asclepias verticillata, A. galioides* and *A. pumila. A. pumila* is much smaller than the other two, seldom being over a foot high, and having very fine leaves. (Fig. 3). *A. galioides* and *A.*

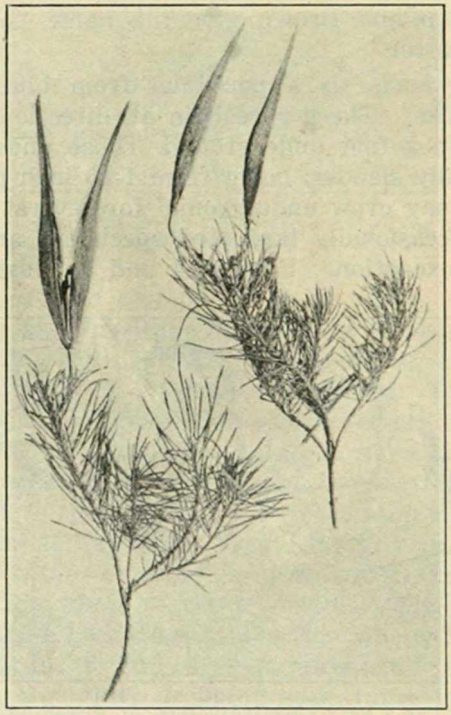


Fig. 3—Low milkweed (**Asclepias pumila**) not known to be poisonous.

verticillata are much more nearly alike. In Bulletin No. 246 of this Station, published in July, 1918, the plant which has been responsible for the losses of livestock in Colorado was called *A. verticillata.* This bulletin was issued as an information bulletin to call attention of stockmen to the poisonous nature of the

plant, and before very much investigative work from the botanical standpoint had been done. Further investigations have shown that *Asclepias galioides* is probably the species responsible for the heavy losses of livestock in Colorado. *A. verticillata* does not occur in large quantities in the State, tho it is present, nor is it known definitely at this Station whether or not the two species, *A. verticillata* and *A. pumila* are toxic. The determination of the toxicity of these two species is part of the work planned at this station.

Although the common name "whorled milkweed" more properly belongs to *Asclepias verticillata,* it has been considered advisable to retain the name whorled milkweed, inasmuch as it has become so widely used in this State in reference to *A. galioides*. Britton and Brown give the name "bedstraw milkweed" to the latter.

Asclepias galioides is a perennial from horizontal, underground rootstocks. These spread in all directions at distances from an inch to a foot underground. These underground rootstocks are usually slender, being from 1-16 inch to 1-2 inch in diameter, and may grow underground for several feet from the main plant. Occasionally taprooted specimens are found, but these are the exception. Figures 4 and 5, illustrate the type

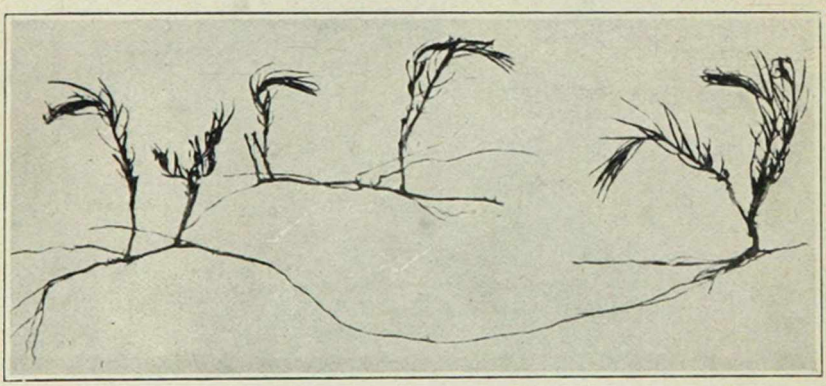


Fig. 4—The plant has a very effective method of spreading by creeping horizontally underground.

of underground growth. The nature of spreading results in characteristic, thick, circular patches. The roots and rootstocks may be so thick as to form practically a turf in the upper several inches of soil. This turf is very tough and exceedingly hard to plow. The seedlings have a single, slender taproot during the first season.

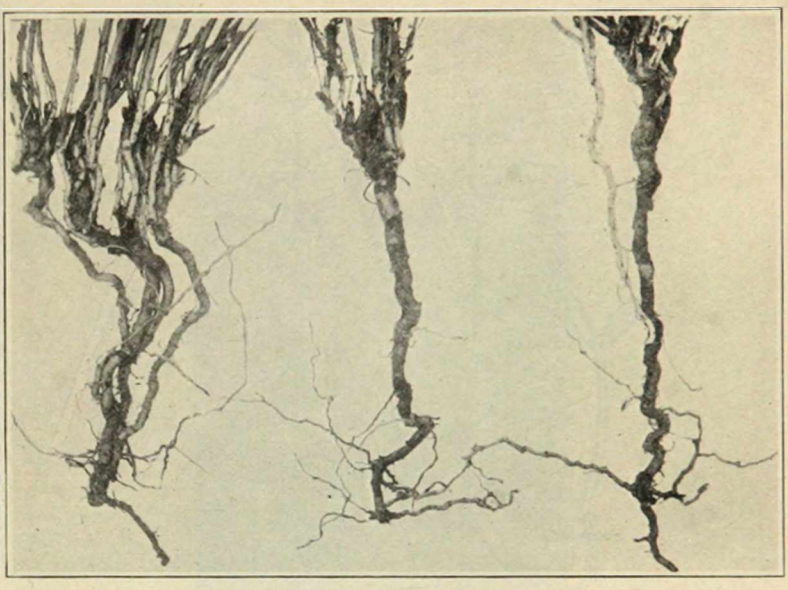


Fig. 5—The rootstocks of whorled milkweed may extend to considerable depth in the soil.

The stems grow in clumps from a crown and are unbranched. They are smooth, except for a minute pubescence, and light green in color. The bast fibre is strong and abundant. Their height varies from 14 inches to 4 feet. The leaves are in whorls, almost invariably three well-developed at each joint of the stem, tho four is not an uncommon number. Never has the author seen a stem of A. *galioides* in Colorado with more than four well-developed leaves at each joint, but the number is usually constant in any given stem. In the case of seedlings, (Fig. 6) the leaves are **opposite** for the first seven to fifteen nodes and then the whorl of three begins. The leaves are narrowly linear from 1¼ inches to 4 inches in length and usually not over about ⅜ inch wide. The margins are somewhat revolute. They have a slightly drooping appearance in contrast to the stiff, upright, position of leaves of *A. verticillata*. The color is a light, slightly bluish green. Figure 7 gives a very good idea of the general appearance of the plant.

The flowers are mostly borne in axillary umbels on pedicels from ½ inch to 1 inch in length and with from twelve to twenty flowers in a group. The individual flowers are greenish white. A group of blossoms at a distance resembles nothing closer than

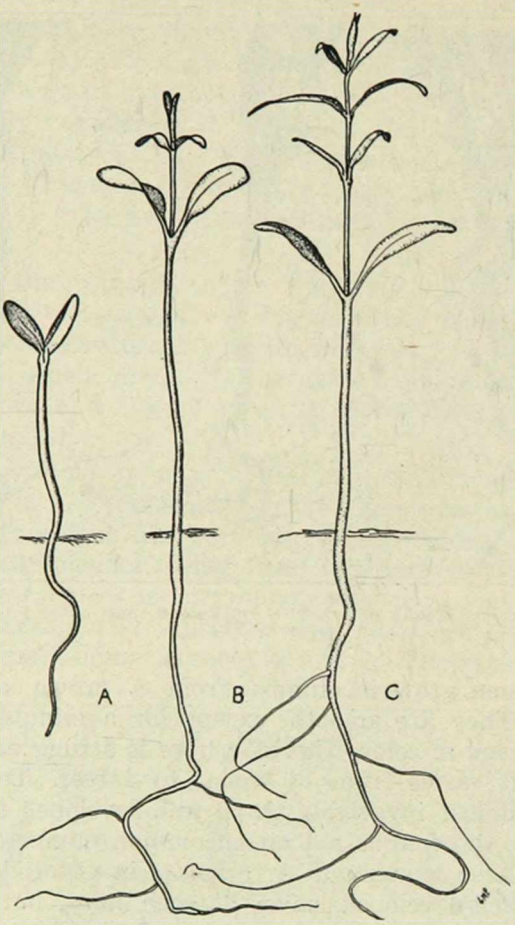


Fig. 6—Seedlings of whorled milkweed. A. Seven days after planting. B. Twenty-one days after planting. C. Twenty-eight days after planting. Note that the first foliage leaves are in pairs.

a small group of onion blossoms, tho in the case of the milkweed the clusters of blossoms are borne in axils of the leaves as well as terminally (Fig. 8).

The pods are erect, long-pointed above and short pointed below. They may be borne singly or in clusters, as shown in Figure 9. They are commonly from 2½ inches to 4 inches long. Each pod is filled with closely packed, flat, reddish-brown seeds to each of which is attached a number of white silky hairs which facilitate spreading to a marked degree (Fig. 10).

Fig. 7—A typical whorled milkweed plant in late blossoming stage.

Figure 11 is that of a plant very commonly supposed in this State of the poisonous milkweed. It is *Asclepias speciosa*, the showy milkweed, and is not the one responsible for losses of livestock. Note in this plant the large, broad leaves. The blossoms are lavender in color and much larger than in the whorled milkweed. The pods in the showy milkweed are also larger and covered with protuberances.

DISTRIBUTION IN COLORADO

The map on page 16 (Fig. 12) shows the present known distribution of whorled milkweed in Colorado. By far the worst

Fig. 8—Axillary clusters of blossoms of whorled milkweed.

infestation is on the Western Slope, particularly in Mesa County. On the Eastern Slope the present known distribution is confined to isolated spots in Las Animas and Huerfano Counties and thru the irrigated sections of the Arkansas Valley from Canon City to the state line. In all probability there are other infestations in the State not shown on the map. It is also very probable that there are other regions in addition to those shown on the map where losses have occurred. From the facts at present known about the plant there is no reason why it could not occur in any of the irrigated sections of the state.

The milkweed is known to be present in quantities sufficient to cause trouble in Utah and New Mexico, and recently a communication fom an official of the United States Reclamation Service states that the milkweed occurs in large quantities on the Truckee-Carson Project near Fallon, Nevada, and is suspected of causing losses of livestock in that region.

WHERE TO LOOK FOR IT

Thruout the State the milkweed is confined almost entirely to the irrigated sections. In the non-irrigated lands there have been found a few patches, but these nearly always occur where the soil has been broken, or where water from heavy rains collects for a considerable time during the year. The plant does not require much water after once being established, but is very slow in

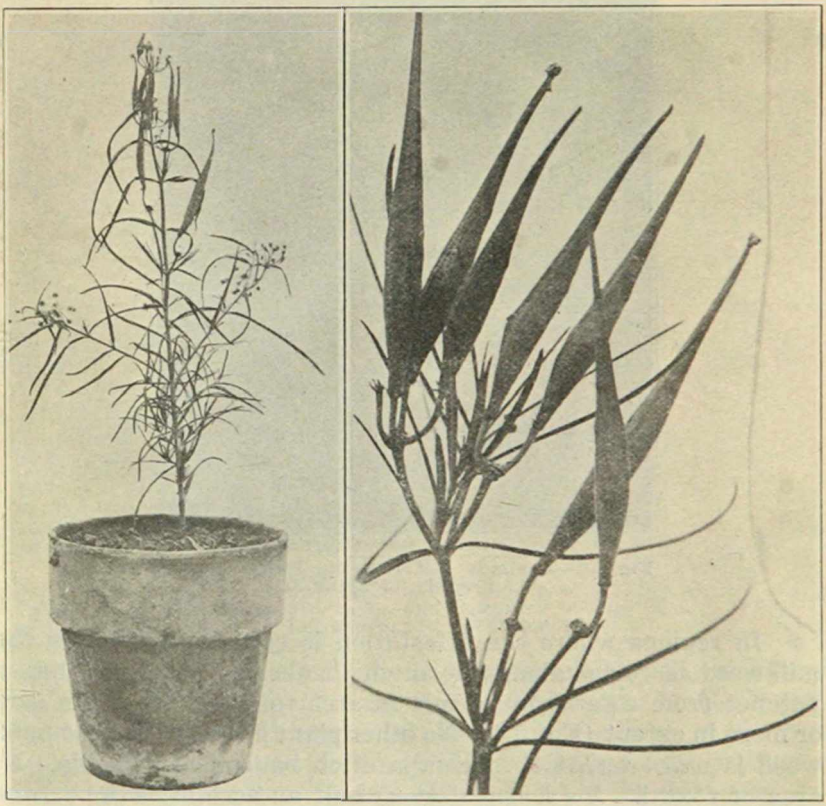


Fig. 9—The pods are erect and pointed and may be borne singly or in groups.

getting started and requires moist conditions during the first part of its life. The seedling is very easily killed, but after the plant is well rooted it will withstand extreme conditions of drought. The worst infestations from the eradication standpoint occur on hillsides below ditches where the seep keeps a water level within a foot of the surface, or where the seep may reach the top of the ground. In the latter case, the milkweed does not

grow directly in the seep, but around the moist edges and back to the extremely dry land.

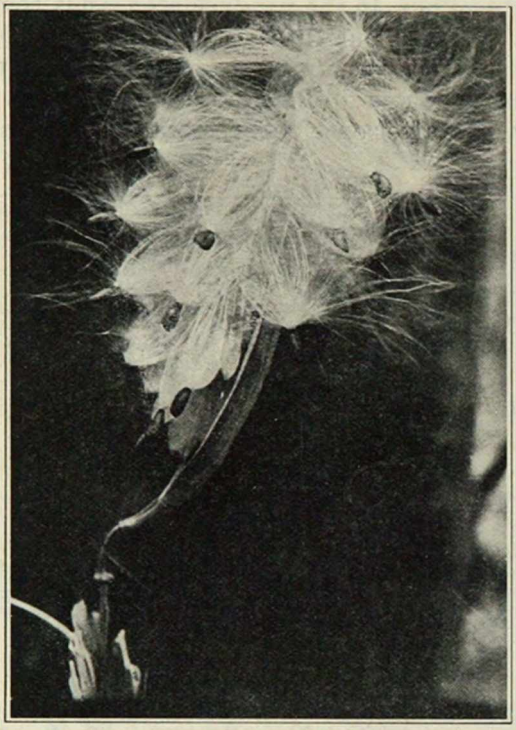


Fig. 10—A single pod showing large numbers of seeds escaping.

In regions where the infestation is comparatively new the milkweed is found along the ditch banks in isolated, heavy patches from a few square feet in area to a quarter of an acre or more in extent (Fig. 13). **No other plant** grows where the milkweed is *well established.* Below a ditch bank near Paonia, an area of foxtail (*Hordeum jubatum*) half an acre in extent was driven out by whorled milkweed in three years. In oat fields, where there were patches of milkweed and the field was plowed in the spring, no oats grew in the areas occupied by the stands of milkweed, despite the fact that the surrounding crop was very heavy.

This species has been found on several types of soil, from a very light sandy loam to a heavy clay adobe, and from fine soil to a soil composed largely of gravel and rocks. It does best, how-

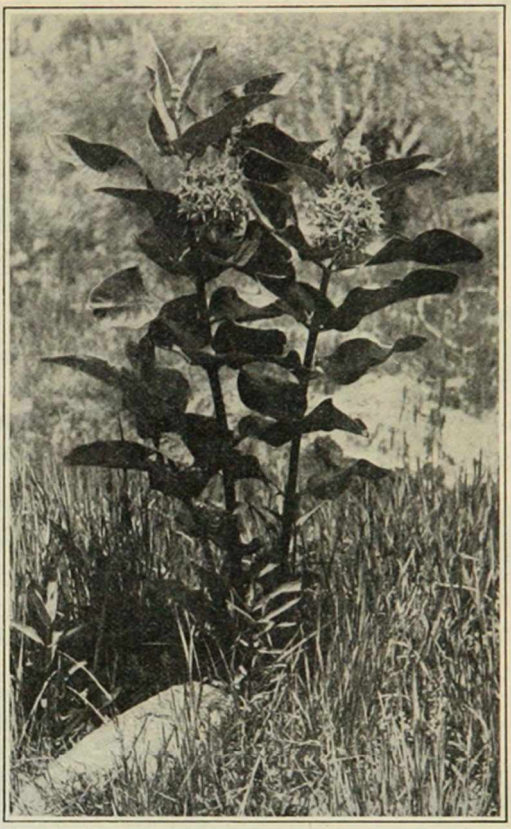


Fig. 11—Showy milkweed. This plant is often supposed to be the poisonous milkweed. It is not known to be poisonous.

ever, on the heavier clay type. It does especially well on the red clay loam of La Plata and Montezuma Counties and on the heavy, gray clay of the North Fork and Grand River valleys. It is not so well adapted to the lighter sandy soils. Alkaline soils produce a better growth than do acid soils, although from the salt spray experimental work at Cortez, it appears that the alkalinity can be raised with common salt at least to such a percentage as to kill the milkweed without inhibiting the growth of such plants as Russian thistle.

The altitudinal limit for Colorado seems to be somewhere in the neighborhood of 7,500 feet. Plants found at a little below this elevation did not appear to be as thrifty as plants at lower elevations, nor have any extensive infested areas been found above

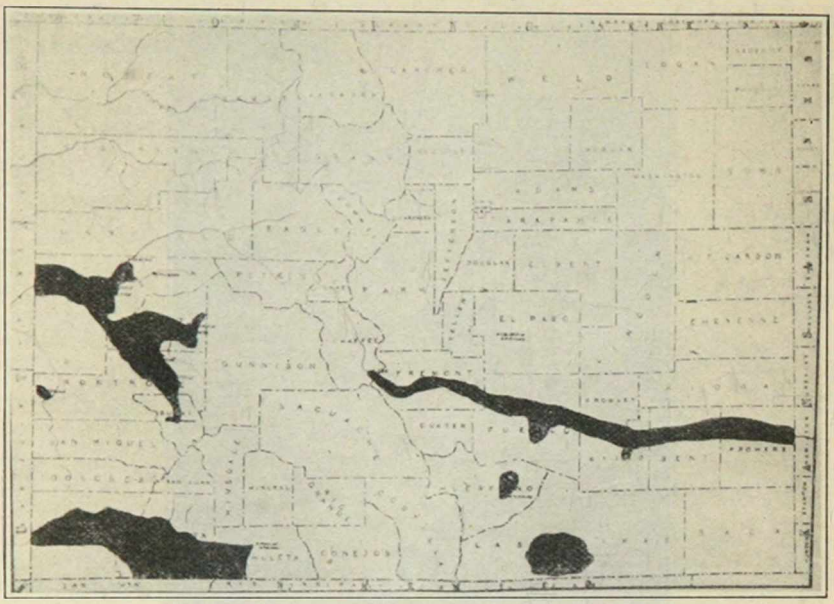


Fig. 12—Map of Colorado giving present known distribution of whorled milkweed.

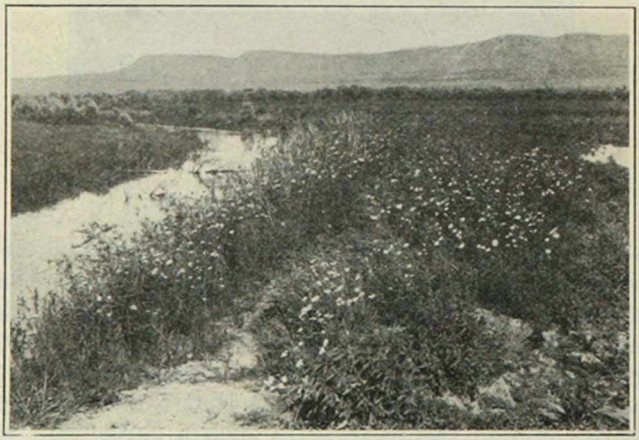


Fig. 13—In new regions the milkweed occurs in patches on the ditchbanks.

7,000 feet. The altitudinal range of best growth in this State is from about 5,000 feet to 6,500 feet.

The plant is commonly found along ditch banks, roadways, and railroad right-of-ways, in fence rows (Fig. 14), and

abandoned fields and in orchards only partially clean cultivated. (Fig. 15). Where the infestation becomes bad it will make its way by the underground rootstocks into solid stands of blue grass or into alfalfa fields.

HOW IT IS SPREAD

The seed of this species, like all of the milkweeds, is admirably fitted for wide and easy distribution.

The agencies, in the probable order of their importance, that are responsible for the spreading of the seed are: (1) Water, (2) wind, (3) railroads, (4) animals.

Water.—In every infested area so far observed it has been clearly shown that irrigation water plays an important role in carrying the milkweed seed. In territories newly infested, the patches are always found along the laterals. This was well demonstrated in the West Paradox Valley. Four years ago sheep were lost in the west and upper end of the valley and at the time whorled milkweed was suspected by Mr. John Rohwer. He has been watching this plant since then, and has noted the gradual spread of it over the ranches in the upper end of the valley. Last summer the infestation had spread several miles down the valley and the lower patches are largely along irrigation laterals or in

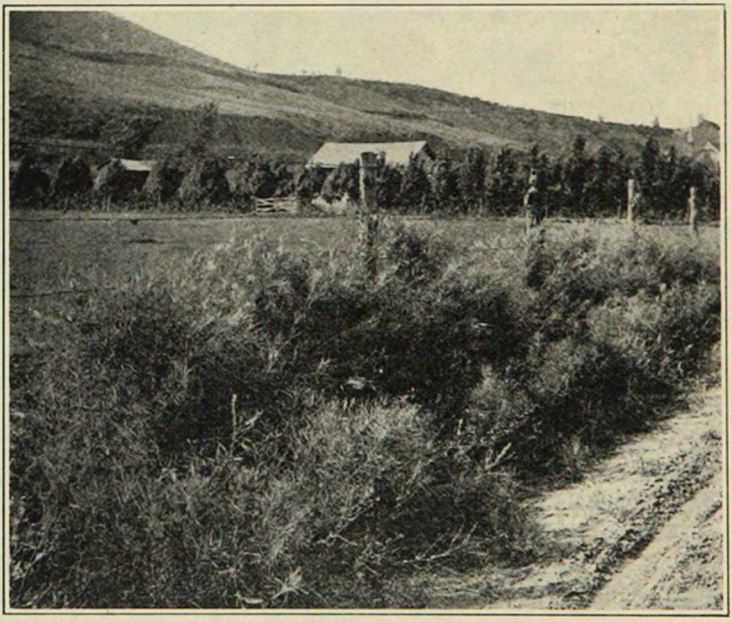


Fig. 14—The fence row is a common place for this plant to be found.

Fig. 15—An uncultivated orchard taken by milkweed.

irrigated fields or orchards. These same observations are duplicated in other sections of the State.

Wind.—The buoyancy of the seed, due to the lightness of the seed itself, and to the parachute of silky hairs, makes it very well adapted to dispersal by wind. Everyone is familiar with the ease with which milkweed seeds are carried on a light breeze. It is not probable that seeds are carried in this manner as far as they are carried in large irrigation laterals, but the wind undoubtedly serves to cause a great deal of dispersal. The dispersal by water is undoubtedly the most effective because it not only carries the seed long distances but always places them in a suitable place for germination.

Railroads.—This agency is important not so much from the standpoint of numbers carried as from the fact that it has probably been responsible for the establishment of the weed in entirely new territories. The railroad right-of-way is a very common habitat of the milkweed. This does not, of course, argue that the railroad is responsible for the carrying of all the seed that has been scattered along the right-of-way. Wind might just as easily be responsible for the carrying of much seed to the embankments or cuts along the railroad but there have been a number of cases of occurrence of the weed at railroad switches, especially at points where stock are unloaded, that are very con-

vincing circumstantial evidence that the weed has become established at these points from seed carried on the hoofs or in the tails or coats of animals that have been unloaded from the cars. A very noticeable case of this kind is the occurrence of a single isolated patch of the milkweed at Jay spur on the D. & R. G. narrow guage above Ridgway in Ouray County. So far as could be determined by a rather careful survey of the Dallas Valley, this is the only patch present. The closest known infestation is in the Uncompahgre Valley around Colona and Uncompahgre, about fifteen miles below Jay spur, and, therefore, the seed could not have been carried by water. Many cattle are loaded in the Colona and Uncompahgre section and shipped up the narrow gauge. Occasionally some of these are unloaded at Jay spur. The most obvious explanation of the spread of the milkweed in this case is the carrying of the seed by animals in the cars.

Other places where milkweed occurs under very similar conditions as stated above are at stockyards near Dolores, Colorado, and at Cucharas Junction in Huerfano County. There can be no doubt that the milkweed is being carried to new territories by this means.

Animals.—The probable carrying of seed by animals being shipped has been noted above in connection with dispersal by railroads. Since the seed is not fitted with clinging structures it is not likely that animals are a very important factor in carrying milkweed seed, but a very interesting case came under the writer's observation in Archuleta County the past summer. Milkweed occurs in this county along the main sheep driveway to the summer range. There is no other infestation in this section except in the driveway, where the animals have trampled the ground. It is known that the lower winter and spring ranges are in bad milkweed areas, and it is probable that in this case the seed has been carried in the wool or hoofs of the sheep and trampled into the soil.

Possibility of Dispersal In Crop Seeds.—While no definite cases of the establishment of new patches through impure seed have come to the attention of this station, the writer can see no reason why such has not been the case. There are many grain fields in which the milkweed produces seed before the grain is cut and the writer has seen bins of grain containing milkweed seed. One case has been reported of a man feeding oats containing a large quantity of milkweed seed with the death of a horse from typical poisoning symptoms as a result. Milkweed seed is undoubtedly present in some grain that is harvested in this State

and it is only necessary that this seed be sown for the plant to become established. There has been started a practice in some parts of the State of allowing alfalfa fields too badly infested with milkweed to be used for hay, to go to seed. This procedure cannot be too strongly condemned, because while the milkweed seed may be cleaned from the alfalfa, these fields will become breeding grounds for seed to be blown by the wind and carried by water. Furthermore, seed buyers will learn to discriminate against such sections, and their sale of seed will be injured.

GERMINATION OF MILKWEED SEEDS

The accompanying table shows the germination of whorled milkweed seed gathered in the Montezuma Valley in August, 1918. Part of this seed was gathered from pods which had matured on the plant, the rest from pods which were not matured at the time the plants were cut, but which burst open after the plants had lain on the ground for a week or ten days. There was no difference in germination between these lots of seeds. These were produced in an extremely dry and unfavorable season.

TABLE I

Germination of Seeds of **Asclepias galioides**

Date Begun	Per Cent Germination					
	3 days		5 days		14 days	
	A	B	A	B	A	B
Sept. 17, 1918	30	42	46	59	57	64
Sept. 17, 1918	28	31	67	63	71	65
Oct. 16, 1918	91	42				
May 6, 1919	93	92	93	92	93	92
May 20, 1919	93	93	94	94	94	94
June 3, 1919	95	97	96	97	96	97
June 16, 1919	94	95	94	95	94	95
June 30, 1919	95	98	95	98	95	98
July 14, 1919	92	96	92	96	93	96
July 28, 1919	95	97	95	97	95	97
Aug. 11, 1919	96	95	97	95	98	95
Aug. 25, 1919	95	93	97	94	97	94
Aug. 8, 1919	96	98	96	98	96	98
Aug. 22, 1919	98	98	98	98	98	98

NOTE—All lots tried in September and October, 1918, germinated over 90 per cent at the end of 20 days.

The germination tests were carried out to answer three questions: (1) What percentage of the milkweed seed is viable? (2) How soon after being shed from the plant are the seeds viable? (3) For how long a time do the milkweed seeds keep their viability?

An answer to the first question was desired in order that some gauge might be had by which to determine the importance of the seed in dissemination. Fitted as it is for dispersal, the milkweed requires only that an appreciable percentage of the seed will germinate in order for it to become easily established in a new territory. The results as shown in Table I prove that milkweed seed has a high percentage of germination. It is believed that this is generally true.

The second question as to the period of time which must elapse before the shedding of the seed and the time when germination will begin, arose from certain observations in the field. Altho a close watch for seedlings was maintained thruout the season of 1918, none were found in any appreciable quantities. The writer returned to the station at just about the time that seeds were being shed in 1918, and no observations were made as to the appearance of seedlings in the early fall, but the lack of seedlings early in the year indicated a possibility that the seeds germinate in the fall as soon as they are blown from the plant if they stop in locations favorable as to moisture. The germination tests in the fall of 1918 showed that this theory was entirely tenable. The germination, it will be noted, was rather low, but the lots started on September 17, 1918, and October 16, 1918, showed over 90 per cent. germination at the end of three weeks. The lots on September 17 were placed in the germinator about three weeks after being gathered from the field.

It was at first thought probable that the dry summer of 1918 prevented germination during the season but further observations in 1919 seem to bear out the fall germination theory. Near experimental plots at Paonia, this particular phase was closely observed. A hillside and basin below an irrigation ditch at this point are about 50 per cent. covered with milkweed. The soil surface at this place was moist enough to make a good seed bed during most of the summer season, but it was not until August 25th, **about two weeks after the ripening of the first seeds in 1919,** that any seedlings were found on unoccupied territory. On this date as many as eighteen seedlings per square foot of ground surface were counted, and they would average six to ten seedlings per square foot over a quarter of an acre. These seedlings showed in most cases only the two seed leaves, but before the summer was over, they were 3 or 4 inches high. It seems very probable that many of the seeds germinate in the fall immediately after ripening.

A search for an answer to the third question, however, seems to show that the seeds do not have to germinate in the fall. The table shows that both lots placed in the germinater on September 22, 1919, gave a germination within five days of 98 per cent. This establishes the fact that seeds kept in a dry condition will retain their viability, absolutely unimpaired, for at least a year. Seeds are not usually kept dry in the field, however, and it is possible that the wetting during the winter months may, and undoubtedly does, reduce the germination percentage. It is very possible

that this reduction in the number that live over combined with the number that germinate in the fall so reduce the number left the following spring that the seedlings which do come up are so few as to easily escape detection.

When it is taken into consideration that it has been estimated that a single exceptionally large plant of milkweed as shown in Fig. 16, is capable of producing 10,000 to 13,000 seeds and that 90 to 98 per cent. of these are viable, it is readily seen that rapid spreading of the plant depends only on the efficiency of the agents of dispersal as discussed in the foregoing pages.

CONDITIONS UNDER WHICH POISONING OCCURS

The general statement that stock do not like poisonous plants but will eat any other kind of forage in preference to them, is especially true of whorled milkweed. Numerous cases have been observed of cattle being grazed in pastures where milkweed occurs without there being any losses or any symptoms of poison-

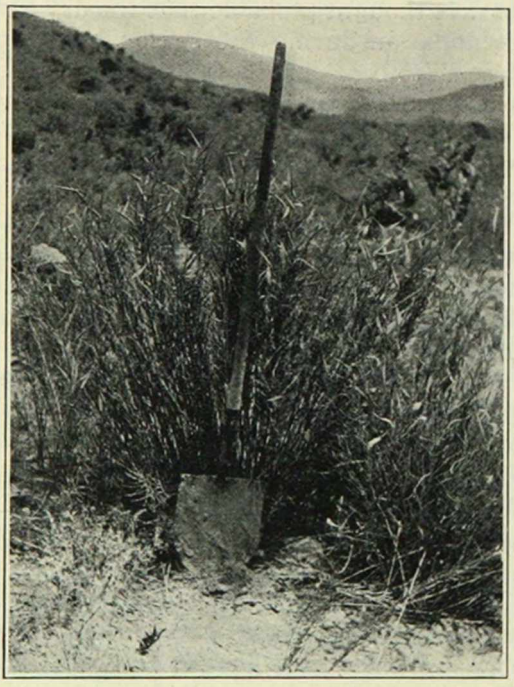


Fig. 16—An exceptionally large milkweed plant estimated to have 13,000 seeds.

ing, but in every case it has been found that the milkweed grows up and goes to seed, although all other forage may be eaten close

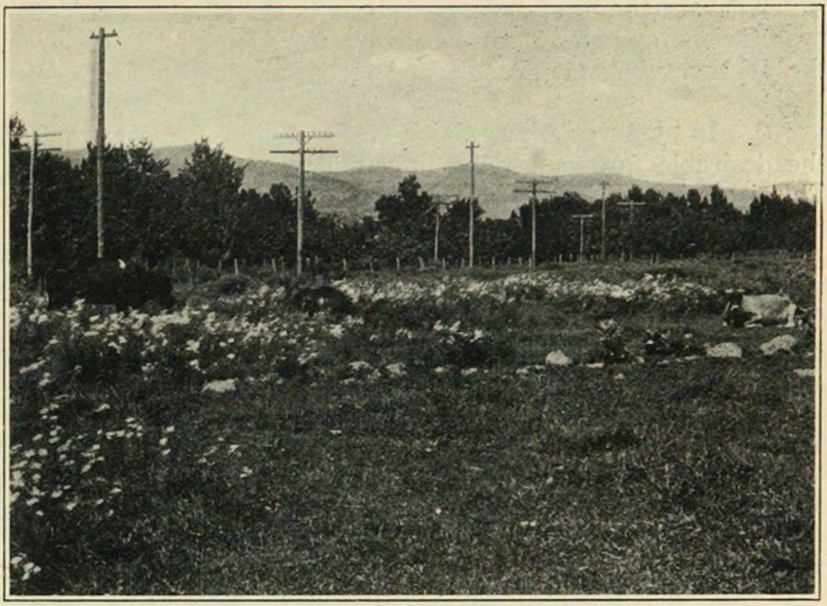


Fig. 17—Stock will eat down everything but milkweed.

to the ground. This is well shown in Figure 17. Note that the grass is eaten down while milkweed is shedding seed. The writer has seen an animal get a mouthful of this plant by mistake, and then drop it immediately. At other times cattle have been observed to go through a thick milkweed patch and pick out a few stray spears of grass without taking any of the milkweed. Roadways along which cattle and horses are being grazed daily will show patches of milkweed in blossom and pod while every other bit of forage is eaten off even with the ground surface. It is very obvious then, that the only conditions under which poisoning from this plant may occur are those where the stock are very hungry and there is an absolute lack of other feed. The one possible exception to this rule is when the milkweed occurs in alfalfa hay and the stock get it along with the alfalfa. Even then animals are likely to nose out the milkweed unless they are very hungry and are eating greedily.

The following conditions are common ones under which losses have occurred:

1. **Along driveways** where other forage has been eaten off and the stock have come onto a large milkweed patch after having been driven a considerable distance. This was the condition

which caused the heavy losses of sheep in the Montezuma Valley near Cortez, and was also responsible for some of the losses on the driveway between Paonia and Hotchkiss in the North Fork Valley.

2. **In pastures** where dairy or farm stock have grazed off the desirable forage, leaving only milkweed in any quantities. This is the condition that existed when the Bar K Cattle Company lost 44 head of steers in one night.

3. **In orchards** which are not being cultivated and which may be used as corrals in which to hold a number of stock either for a short time, or which may be used as pastures. In many of the orchard sections, particularly around Grand Junction and in the North Fork Valley, the owners have abandoned clean cultivation methods with the result that orchards are being taken by weeds. The weed which is most abundant in many cases is whorled milkweed. The use of these orchards for pasturing has resulted in some very heavy losses, the most conspicuous being that of the loss of 350 head of sheep by Bennett Bros. near Hotchkiss, details of which have been previously given.

4. When the milkweed is present in sufficient quantities **in the hay** so that an animal can get a toxic dose in one feed. This condition is very common in the section around Grand Junction, and both cattle and horses are being lost in that neighborhood from this source. In one instance six head of horses were poisoned from one stack of hay containing milkweed. Near Whitewater, Colorado, Mr. Fred Burford poisoned 350 head of sheep from one load of hay containing the weed and about 75 or 80 head of these died.

5. In the winter when snow may cover up desirable forage, and **milkweed stems are sticking above the snow.** During the summer stock will eat down everything but milkweed with the result the stalks of the latter will grow up and will not be covered except by a heavy snow. Under conditions where other forage is covered up, cattle will get hungry and eat the milkweed. Figure 18 shows a small bunch of milkweed under these conditions and shows that the cattle ate the tops. Figure 19 shows the result. Three dead steers are shown in the picture. Seven others died nearby. This was in the early winter of 1919-1920.

Any condition which brings a hungry animal in contact with whorled milkweed is almost sure to result in poisoning.

PREVENTION OF POISONING

From the preceding paragraph the methods of the prevention of poisoning are of course obvious:

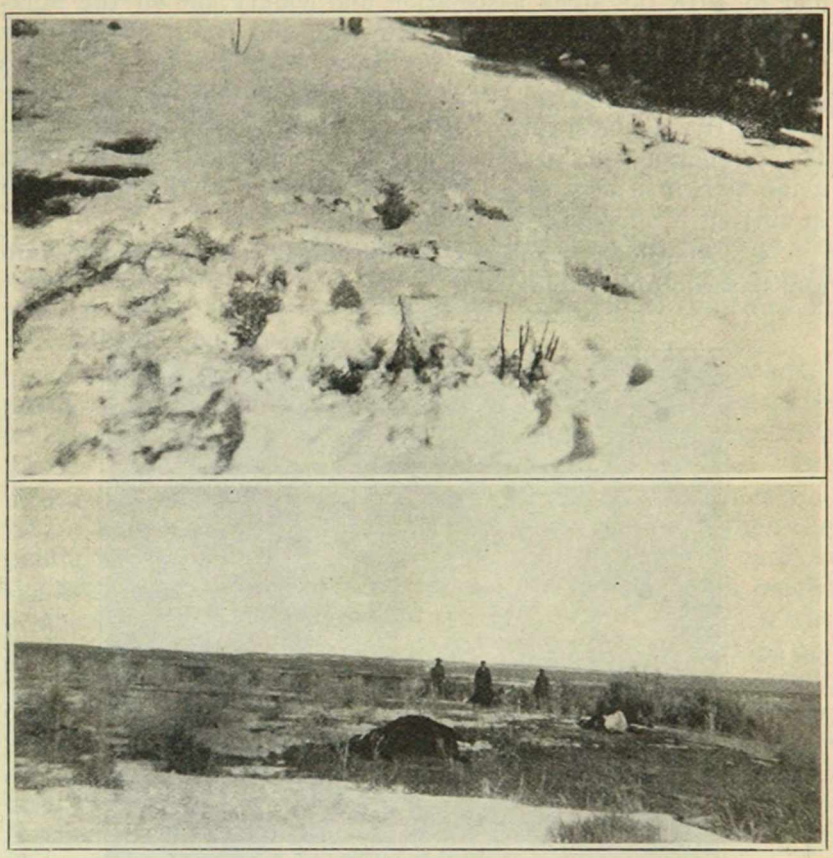


Fig. 18—Above: Milkweed plants sticking above snow eaten off by hungry cattle.
Fig. 19—Below: Three dead animals as a result of eating the milkweed.

1. The stockman should learn to know the plant and should determine if it is present where his stock graze, or in the hay he is feeding. Figure 20 shows a method of sign posting adopted by the State in its publicity and educational campaign on this plant.

2. Hungry animals should be kept away from milkweed.

3. If an infested area must be crossed, one of two things should be done. The milkweed may be cut off along the line of the drive and burned, or the stock may be well fed before crossing the area and the drive kept moving. The latter course does not insure against losses but it reduces the risk to a minimum. It is interesting to note that in the Montezuma Valley in the sum-

mer of 1918 the stock association and county cut off the milkweed along ditch banks and driveways, and that, whereas the the annual loss in the valley for three years previous to this work had been between $20,000 and $30,000, during the winter of 1918-19 and the spring of 1919, no losses occurred in this area. This reduction was as much due to the publicity work which made stockmen acquainted with the plant as to the work done in cutting it off along the driveways.

4. Another precaution is to absolutely refrain from feeding any hay containing milkweed.

Fig. 20—A sign posted by the State to acquaint stockman with whorled milkweed.

There is no doubt that as long as milkweed is present in any considerable quantities, poisoning is likely to occur, so that if losses are to be absolutely stopped, eradication is the only solution.

ERADICATION

Experimental Work in Montezuma Valley

Experiments were carried on with a view to determining such methods as would fit into general farming practice. Work was begun in the Death Valley area 1 1-2 miles east of Cortez in June, 1918. The soil here is a heavy red clay loam three to four

feet deep. There is good drainage. The milkweed occurs in a field which was formerly cultivated in ordinary farm crops, but has been abandoned for a number of years. As previously mentioned this area is on the main sheep driveway thru the Montezuma Valley and has been used as a camping ground by bands going thru. This field, which contains about eleven acres infested with milkweed, was responsible for the loss of 1,600 head of sheep in the years from 1916 to 1918, inclusive.

The County of Montezuma co-operated with the State in the experimental work done on this area during 1918. The 1919 work was carried on by the State Experiment Station in co-operation with the state entomologist.

Plot I. Spraying with Salt Solution.—For this plot a small patch of the milkweed about 10 feet in diameter was used. The application of the spray was made with a hand spray pump. Five gallons of salt solution were used for each application. The strength of the solution was 2 pounds of salt to a gallon of water. The first application was made on June 15, 1918, when the plants were about 3 inches high. The tops were killed back to the ground. On July 8, growth had again been made to a height of about 3 inches, from the roots, and the second application was given. The tops were again killed back. On July 23 the third application was made, when the growth had again reached a height of about 3 inches. On August 23 it was estimated that the growth made between July 23 and August 23 was about 4 per cent. as thick as the original stand, but the shoots seemed healthy, were growing well, and were about 4 inches high. No further applications of salt were made and the milkweed on the plot seemed uninjured except that it had been thinned out.

In the early summer of 1919 no shoots of milkweed made their appearance on this plot and an examination of the soil showed that a crust had been formed by the salt in the upper 2 inches of the soil. This crust was dark brown and hard. In this dark stratum of soil the milkweed stems were all blackened and dead, but in the soil below, the roots and rootstocks were alive. **At no time during the summer did a single shoot of the milkweed succeed in making its way thru the salt crust.** One hundred per cent. eradication was obtained on this plot. Figure 21 shows the condition of this plot at the beginning of spraying in 1918 and again in July, 1919. Russian thistle succeeded in becoming established on top of the crust. It must be noted that the season of 1918 was a very dry one, not a single good rain falling from June 1 to September 1. Under these conditions, the

salt could not be washed away. Also the plot is removed from an irrigation ditch and consequently is not kept moist. It is not known whether or not this method would prove so successful under humid conditions; but where the summer season is usually very dry it should prove rather efficient, tho somewhat expensive. Thirty pounds of salt were used on this area, containing a little over 75 square feet.

Plot II. Smothering with Tar Paper.—For this experiment a patch of milkweed almost identical with that used for Plot I was selected (Fig. 22). This plot, however, was somewhat larger, containing about 100 square feet. The tops were first cut off when about two or three inches high on June 15, 1918. Tar paper was applied on the same day. The strips of paper were laid flat on the ground and lapped about 1 1-2 inches to insure no entrance of air. The sun effectively sealed these laps. The outside edges of the tar paper were covered over with dirt.

On June 15, 1919, one-half of this tar paper was removed and during the season of 1919, no milkweed growth appeared above ground on this part of the plot. The remainder of this plot was left covered.

This method is recommended for use only on small patches of milkweed on smooth ground where stock do not run and where the ground is not in use. Its advantage is that it needs to be attended to at only one time and can then be forgotten. Care must be taken that the tar paper extends beyond the outer limits of the patch or underground growth will creep out from the main patch.

An interesting modification of this method of treatment was tried out by a farmer near Hotchkiss, Colorado. Wet, heavy manure was piled onto the patch and packed solidly to a depth of from 8 inches to 1 foot. In this way the air was excluded from the patch as effectively as with tar paper and as good results were obtained. **Success with this method as with any other method of eradication, depends entirely upon the thoroughness with which the job is done. Slipshod work is ineffective.** In this method, the object sought is to exclude air from the plants and consequently an airtight cover must be put on the patch.

Grubbing on Dry Land Away from Ditches.—This plot is about 15 feet in diameter and at the beginning of the experiment was covered solidly with the milkweed. The first grubbing was given on July 8, 1918, when the plants were just beginning to bloom. The tool used was a heavy, broad-bladed mattock. A trench was first dug at one side of the patch to a depth

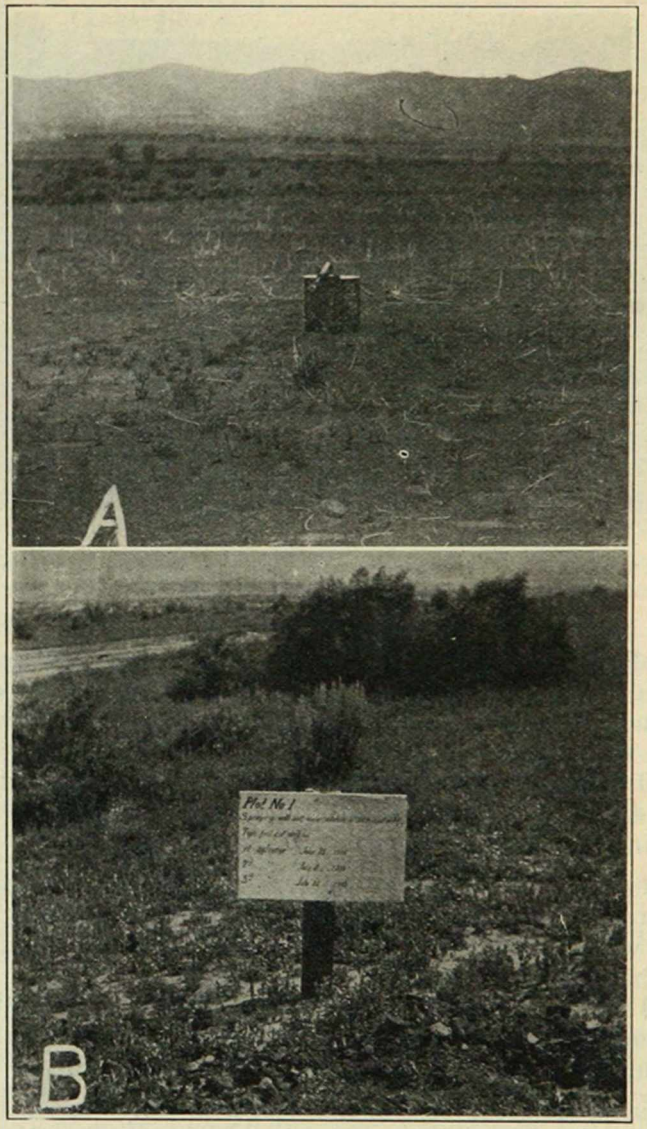


Fig. 21—Plot I. A. June 1918 at start of experiment. B. August 1919 after being sprayed with salt solution. No milkweed present.

of 8 to 10 inches. The trench was dug back a foot or sixteen inches from the outermost green shoot to insure getting beyond the rootstocks creeping underground. This method of procedure

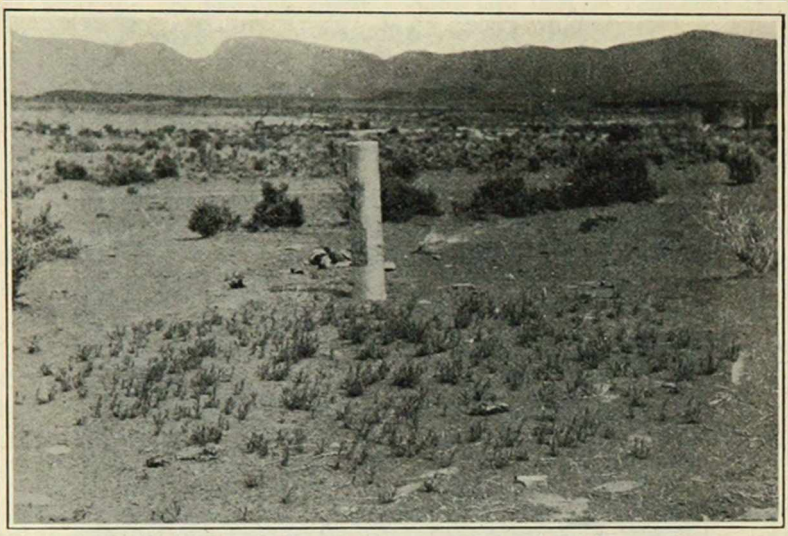


Fig. 22—Plot II. June 1918 before covering with tar paper. Note circular appearance of patch.

gave a bank to work to and by "moving the trench" across the patch all the soil was turned over and the roots and rootstocks removed. The time necessary to do this first grubbing was one hour and a quarter. The time required for grubbing will, of course, vary somewhat with the type and condition of the soil. The soil in this case was worked with comparative ease, although it was dry. The application of the worker will also cause a variation in time required for doing the work.

On July 23 a few plants had come up around the edges from underground parts outside of the grubbed area, and also a few shoots were found in the grubbed part. The entire patch was regrubbed, (time 1-2 hour) and 12 shoots were found on the ground actually grubbed the first time, **all coming from the solid ground below that which had been turned over at the first grubbing.**

During the 1919 season this plot was left untouched. A large stand of other weeds came up on the plot but not over 3 per cent. of the original milkweed stand appeared.

Plot IV. Summer Fallow 1918 Followed by a Cultivated Crop in 1919. —During 1918 this plot was given the following treatment:

Plowed June 15, with a double-disc plow to a depth of 3 or 4 inches.

Doubled disced June 26.
Double disced July 8.
Plowed with tractor 8 inches to 10 inches deep July 23.
Double disced August 26.
Double disced September 20.
Double disced October 15.

The principle followed in this treatment was to keep the plant from having any green leaves during the season; at no time was the milkweed allowed to form any green leaves. As soon as a very few showed through the surface the plot was double disced. The persistence with which the roots continued to send up stalks thru the soil was remarkable. It must be remembered that no rains fell during the period from June 1 to September 1, and that by the latter date the upper 8 inches of soil was as dry and as porous as an ash heap. Every bit of milkweed in this upper layer was dried up and dead but the roots below the furrow slice continued to send shoots to the top of the soil thru the dry dirt until fall. Figure 23 is a picture taken of some of these shoots. In most cases these roots were about the size of ordinary binding twine or smaller, and yet enough shoots were sent up to make the stand as thick as it was originally.

From May 16 to May 20, 1919, this plot was double disced and harrowed. On May 20 part of the plot was planted to potatoes and part to corn. These two crops were treated as follows during the season.

Hoed June 10.
Hoed June 26.
Cultivated three times over July 25.
Cultivated August 10.

The crop was given the treatment of an ordinary farm crop, with the exception that a little more care was given.

The rainfall during the 1919 season was considerably greater than in 1918, but the corn and potatoes were not irrigated. **Despite this treatment the milkweed was thicker in 1919 than it had been at the beginning of the experiment in 1918.** The potato and corn crop were not in any way held back by the milkweed. In fact, due to the summer fallow the previous year, the crops were very good, as shown in Figure 24. The experiment was a good demonstration, proving conclusively that thorough work, begun early and continued thruout the season, and followed the next year by a hoed crop, is inefficient as a means of eradicating milkweed.

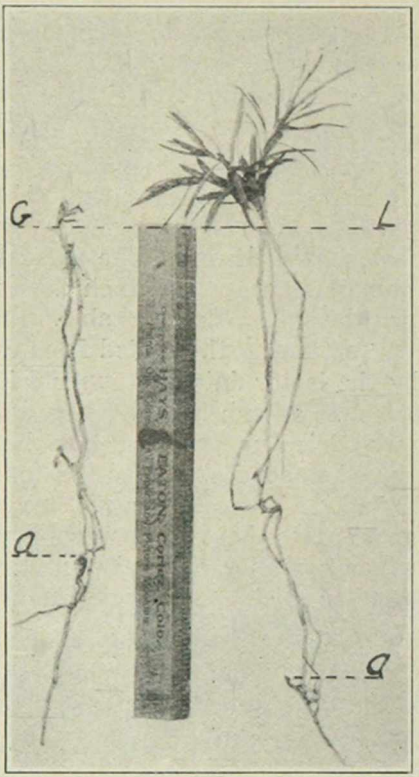


Fig. 23—Growth made on Plot IV from July 20th to August 20th, 1918. A and A are the points at which the old plants were cut off. G. D. is the ground line. The growth was made after the severe treatment outlined in text.

Plot V. Grubbing Along Ditch Banks.—This plot is located a quarter of a mile east of Cortez, on the Cortez lateral. The ground which was infested with milkweed extends along the ditch bank for 50 feet and averages 8 feet in width. The milkweed extended to the water's edge for the full distance. The soil is the heavy, red clay loam, characteristic of the Montezuma Valley, free from rocks and easily worked. The ground was solidly covered with the milkweed at the beginning of the experiment, no other weeds being present. Work was begun at the time the plants were just beginning to form pods, on July 15, 1918. The same method was followed as in Plot III; that is, a trench 8 or 10 in-

Fig. 24—Corn crop on Plot IV, August 1919. Note the small milkweed in foreground.

ches deep was dug along the full length of the patch on the side away from the ditch. This trench was then "moved across" the patch and all the roots thrown out, (Fig. 25).

On August 23, it was estimated that 3 per cent. of the milkweed was showing up, and the patch was thoroughly regrubbed. During the season of 1919, twelve spindling shoots of milkweed came up in the patch. The plot was covered with a heavy stand of horsemint which effectually shaded the ground and held the milkweed back. In this case over 99 per cent. of the milkweed was killed. **It is noticeable that in this case work was not begun unitl later in the season than on any previous plot, and that the ground was immediately taken by a plant that effectually shaded the soil.** It has been noticeable in all the eradication work for this plant that work begun early in the season is ineffective.

The closer it was to seeding time when work was begun the larger was the percentage of milkweed killed for the effort expended.

Plot VI. Late Summer and Fall Plowing.—This plot is located on the ranch of Mr. M. W. Milligan, 12 miles southwest of Cortez. Mr. Milligan did all the work under the direction of the Experiment Station. This plot was located in an abandoned field on red clay loam. On August 1 it was plowed thoroughly to a depth of 5 inches. On August 26, about 3 per cent. was showing through the surface, and a larger percentage was beginning to grow below the surface. The plants which were growing came either from stems that were not cut off or from solid ground below the furrow slice. The plot was again plowed September 2 to about 6 inches in depth and allowed to lie over winter. During the 1919 season about 10 per cent. of the milkweed came back. Practically all that came up was in the dead furrow where the roots were left exposed. The plot was thoroughly shaded with a stand of wild sunflowers, which seemed to hold the milkweed in check. Fig. 26 is a picture taken of the plot in late June, 1919. In 1918 this patch was solidly covered with milkweed. The shading of the sunflowers shown had much to do with keeping the milkweed in check.

Fig. 25—Method of grubbing in small patches. Note bank to be worked to.

RESULTS OF WORK DONE BY FARMERS

All over the State where the milkweed exists, farmers have experienced a great deal of difficulty in making any headway toward eradication of the plant. The most common method tried by farm owners has been to cut the plant off a number of times dur-

ing the summer season. In no case has any success been obtained by this method. One Japanese gardener near Delta, pulled or hoed the milkweed out of an onion patch ten times during the summer of 1918 and yet the stand seemed uninjured during 1919.

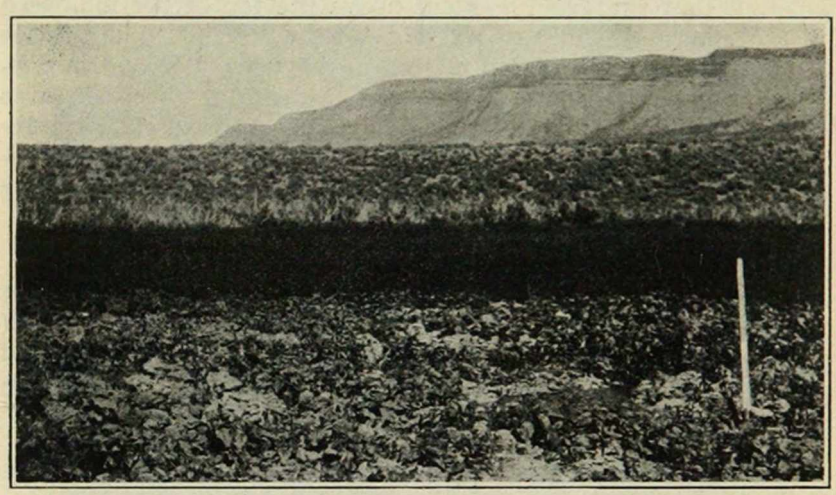


Fig. 26—Plot IV in June 1919. The heavy stand of sunflowers shaded and held in check the few milkweed plants that came back.

Some farmers are reporting good results from pulling the plant late in the summer when the ground is wet. Other reports are to the effect that this treatment does not kill any of the weed. In no case which has come under the writer's observation has this method given results that would warrant its recommendation as a means of eradication. In some cases the pulling has resulted in a thinning out of the stand and on wet, rocky hillsides, where the only object sought is to keep the plant from going to seed and to prevent poisoning while driving in the fall, this method is probably the best and cheapest to apply.

Under the direction of the Experiment Station, Mr. Robert Mead three miles east of Grand Junction, tried out a modification of the method followed in Plot VI, of the Montezuma Valley experimental plots, with very encouraging results. The field he worked on was the one previously mentioned, from which hay had been cut containing the milkweed that resulted in the poisoning of six head of horses. The field was plowed early in August to a depth of 4 to 5 inches, and allowed to lie until early in September, when it was plowed again and planted to winter wheat. The wheat got the start of the milkweed the following spring and

the only place that the latter showed up was in the irrigation furrows. An examination of this field early in July, 1919, showed only about 10 per cent. as much milkweed as had been present the previous year. The crop of wheat, which had just been removed was excellent and the milkweed had been so checked by shading that the grain was cut above the top of the milkweed plants, consequently there was none of the poisonous plant in the straw. The field was again plowed in August, 1919, and in September, and again planted to wheat. Probably the best course to follow in this case would be to fallow again in 1920 after the removal of the grain and in 1921 to sow heavily to alfalfa, the object being to get in a crop as soon as possible that will completely take the ground.

ERADICATION ON ROCKY HILLSIDES

The most difficult problem from the eradication standpoint is presented by the occurrence of the whorled milkweed on the rocky hillsides below irrigation ditches. This condition is represented in Figure 27. The hillside shown is between Paonia and Hotch-

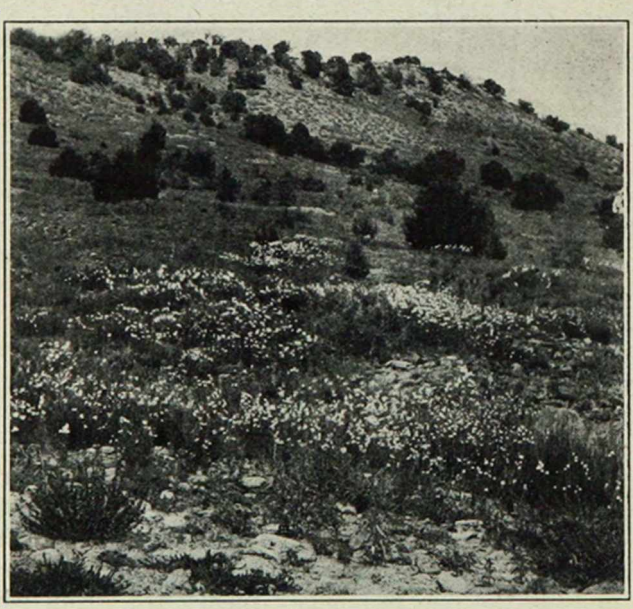


Fig. 27—Milkweed on hillside below ditch on driveway between Paonia and Hotchkiss.

kiss in Delta County on a main stock driveway. This condition is prevalent for twelve or fourteen miles in this particular locality. The formation is as shown in Fig. 28. The ditch here shown is at

the top of the hillside in Fig. 27. Water readily seeps out and keeps the hillside below rather moist beneath the surface.

A glance at the soil conditions here will show the impracticability of cultivation methods. The prevalence of this condition in certain sections of the Western Slope led to the beginning of a series of experiments using chemical sprays. So far these experiments have yielded only negative results, but it is contemplated that the work will be carried on another season.

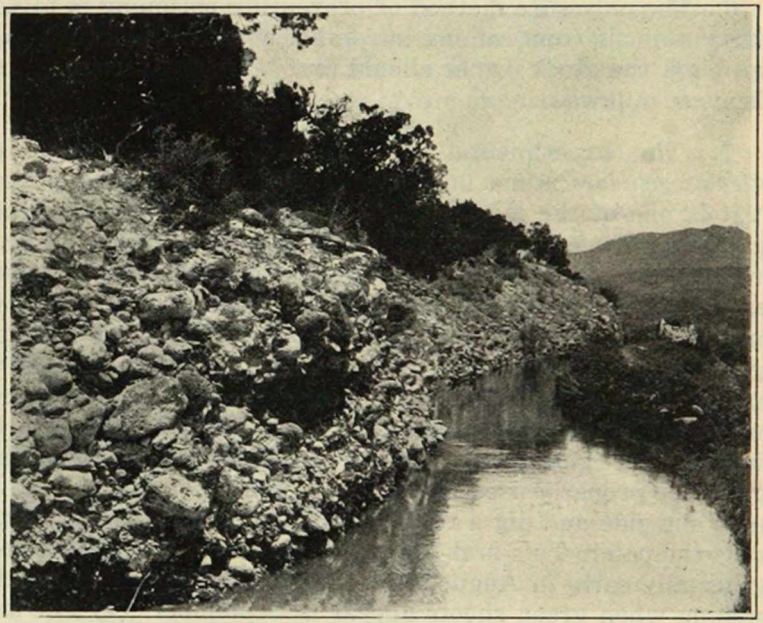


Fig. 28—The ditch above the hillside shown in Fig. 27. This gives an idea of the formation in which some of the milkweed occurs.

SUMMARY

1. Heavy losses of cattle, sheep, and horses on the Western Slope in Colorado have been due to *Asclepias galioides,* commonly called, in this State, the whorled milkweed.

2. This plant is pretty well distributed throughout the southern half of the State in irrigated sections from 5,000 to 7,000 feet in altitude.

3. Irrigation water, wind, railroads, and stock that are being moved are probably the most important factors in the spread of milkweed by seed.

4. Milkweed seeds are able to germinate as soon as they burst from the pod, and if kept under dry conditions, will retain their vitality unimpaired for at least a year.

5. Poisoning occurs under any condition in which hungry stock come in contact with the milkweed when there is a scarcity of other forage. This may occur (1) along driveways, (2) in overgrazed pastures, (3) in old orchards, (4) when milkweed occurs in the hay.

6. The only sure method of preventing poisoning is to keep hungry animals from coming in contact with the milkweed. As a beginning, the stock owner should first learn to recognize the poisonous milkweed.

7. The experimental work has demonstrated: (1) *Asclepias galioides* is not only a very dangerous poisonous plant, but it is one of the most persistent weeds that we have, ranking with bindweed and poverty weed in this respect. (2) Early summer work and surface work are equally ineffective. (3) Summer fallowing, followed by a hoed crop, was ineffective. (4) Three applications during a dry summer, of 10 pounds of salt in 5 gallons of water to a plot 10 feet in diameter did not kill the plant in 1918, but prevented its appearance in 1919. (5) The best time to begin eradication measures is as late as possible in the summer before the ripening of the seed. (6) For small patches, a grub hoe properly used is effective. The best method is to begin at one side and dig a trench and then "move the trench" across the patch. This first treatment should be just before seeding, usually early in August, and should be followed by another grubbing when green shoots appear in September. (7) For larger patches thorough plowing at the time given above for the grubbing has given good results. (8) In every case best results were obtained on plots where the grubbing or plowing was followed by a heavy smother crop. In Colorado, winter wheat is probably the best crop for this purpose.

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