Compliments of the Author.

The State Agricultural College

THE AGRICULTURAL EXPERIMENT STATION

Colorado



BULLETIN No. 38

# SHEEP SCAB

## A Few Insect Enemies of the Orchard

APPROVED BY THE STATION COUNCIL

ALSTON ELLIS, President

FORT COLLINS, COLORADO

APRIL, 1897

THE SMITH-BROOKS PRINTING COMPANY
DENVER

THE

# Agricultural Experiment Station

FORT COLLINS, COLORADO

## THE STATE BOARD OF AGRICULTURE

| | | Term Expires |
|---|---|---|
| HON. JOHN J. RYAN | Fort Collins | 1897 |
| HON. E. H. SNYDER | Highlands | 1897 |
| HON. J. E. DuBOIS | Fort Collins | 1899 |
| HON. A. S. BENSON | Loveland | 1899 |
| HON. JAMES L. CHATFIELD | Gypsum | 1901 |
| HON. A. LINDSLEY KELLOGG | Rocky Ford | 1901 |
| HON. B. F. ROCKAFELLOW | Canon City | 1903 |
| MRS. ELIZA F. ROUTT | Denver | 1903 |
| GOVERNOR ALVA ADAMS, } *ex-officio* | | |
| PRESIDENT ALSTON ELLIS, } | | |

## EXECUTIVE COMMITTEE IN CHARGE

A. L. KELLOGG, Chairman. JOHN. J. RYAN. J. E. DuBOIS.
ALSTON ELLIS. A. S. BENSON.

## STATION COUNCIL

ALSTON ELLIS, A. M., Ph. D., LL. D. ..... President and Director
WELLS W. COOKE, B. S., A. M. ..... Agriculturist
C. S. CRANDALL, M. S. ..... Horticulturist and Botanist
WILLIAM P. HEADDEN, A. M., Ph. D. ..... Chemist
L. G. CARPENTER, M. S. ..... Meteorologist and Irrigation Engineer
C. P. GILLETTE, M. S. ..... Entomologist
DANIEL W. WORKING, B. S. ..... Secretary
LATHROP M. TAYLOR, B. S., Stenographer

## ASSISTANTS

FRANK L. WATROUS ..... Agriculturist
JACOB H. COWEN, B. S. ..... Horticulturist
CHARLES RYAN ..... Chemist
EMMA A. GILLETTE ..... Entomologist
ROBERT E. TRIMBLE, B. S. ..... Meteorologist and Irrigation Engineer

## SUB-STATIONS

PHILO K. BLINN, B. S. ..... Superintendent
Arkansas Valley Station, Rocky Ford, Colorado

J. E. PAYNE, M. S. ..... Superintendent
Rain-Belt Station, Cheyenne Wells, Colorado

# SHEEP SCAB.

Clarence P. Gillette, M. S.

The diseases known as "scab" in sheep, "itch" in man and "mange" in cattle, horses, dogs and other animals are caused by minute animal parasites that feed upon or just beneath the surface of the skin.

These parasites are spider-like in structure and belong to the true mites, which differ from spiders in being, for the greater part, minute in size, in having but six legs when young, and in having the three parts of the body, head, thorax and abdomen, all united in one. (See figure 1.)

Although the different species of mange mites look very much alike, it is seldom that a species that infests one kind of animal will live upon any other. The species (*Psoroptes communis*) that causes common scab of sheep is known to infest horses and cattle, though it seldom thrives well upon them.

Common scab has long been considered one of the worst maladies that sheep are subject to in this country, and it has also attracted a large amount of attention in Europe and Australia. As the parasites readily spread from sheep to sheep, the disease is properly considered a contagious one and rigid quarantine laws have been enacted nearly everywhere that the disease prevails to prevent, as much as possible, its spread into uninfested localities.

Sheep-feeding has become a very important industry in Colorado during the past few years. Hundreds of thousands of lambs are fattened for the eastern markets during the winter, and nearly all require to be dipped for scab. There is a wide diversity of opinion among feeders as to the best dips to use and as to the best methods of handling the flocks to prevent or cure scab, and it was with a view of settling, or, at least, throwing some light upon these questions, that the experiments and observations reported in the following pages were undertaken. The work has only been in progress during the past winter and spring and is necessarily incomplete. In fact, the present paper should be considered as a progress report rather than a report upon a finished work. I hope, next fall and win-

ter, to make extensive tests of the more promising dips by treating a thousand or more scabby sheep in each.*

## SYMPTOMS OF THE DISEASE.

The infection nearly always occurs along the back of the sheep between the base of the neck and the tail. Bad patches sometimes occur well down on the side of the sheep and even upon the tail. The presence of the mites causes uneasiness and, apparently, intense itching, which the animal endeavors to relieve by pulling the wool from the infested spot with its teeth ("digging"), or by rubbing. The first indication is usually a small loose lock of wool projecting from some place upon the side or back of the sheep. If not attended to, the scabby spot increases rapidly in size and the continual pulling entirely removes the wool so that there is soon a bare spot of greater or less extent. Fortunately the mites are gregarious in habit, i. e., living in colonies and not scattering themselves over the sheep generally, so that a thorough treatment of the infested spot will usually result in a permanent cure unless re-infection takes place from some other animal.

When a spot is just starting with, perhaps, a single mite upon it, it can be detected by one who has had a little experience, from the pale or yellowish color of the skin and its moist surface, due to an exudation of serum. The certain test is to actually find the mite or mites present, which is not a difficult matter if one has a fairly good hand lens.

A little later this patch will have increased in size, the central portion will be covered with a yellowish scaly or mealy material somewhat resembling dandruff, produced by the drying of the serum. Finally these spots become thickly covered with scales or "scabs," and the mites mostly migrate into the wool about the margin, where, with their eggs, they often almost cover the skin. I have seldom found mites or eggs under very heavy scab. Sometimes a heavy reddish scab, indicating the presence of blood and an open sore, are found, but such cases are not common in my experience.

## HOW THE DISEASE IS SPREAD.

As the disease is caused by a living creature that is able to crawl freely about and to live for several days, either in the egg or mature state, off the body of the sheep, it is easy to understand how the infection may spread from animal to ani-

*The manufacturers of Zenoleum and Skabcura have already offered their dips in any quantity desired for a test, free. This certainly shows the confidence these manufacturers have in their respective dips.

mal. The spreading of the disease is greatly helped by the rubbing and pulling of the wool, which often removes numbers of both mites and eggs.

These mites are never winged and their power of locomotion is not great, so that I do not think it likely that one of these parasites would be able to travel more than a very few rods in its lifetime.

## HOW LONG YARDS MAY RETAIN THE INFECTION.

It is important to know how long these mites or their eggs may remain alive in the yards or corrals after the sheep have been removed. My experiments have all been conducted since last November, so they are not as complete as could be desired. I feel very safe in concluding from them, however, that it would be impossible to carry the disease over in the corrals from one year to another, or from fall to spring or spring to fall, and it seems highly improbable that the eggs or mites can be kept alive more than a few weeks under ordinary conditions. In my experiments, a temperature of 0, or 4 or 5 degrees below, have killed both eggs and mites in every case. Eggs kept at a temperature near that of the body will hatch in from four to eight days, and mites kept at the same temperature will seldom live more than five days without food. If kept in a temperature below that at which the eggs will hatch or the mites be active, both will retain vitality for a much longer time, but just how long I have not yet fully determined. For farther information on these points, see tabulated statements and notes.

## DESCRIPTIONS OF THE MITES AND THEIR EGGS.

Figure 1 will show the structure of these mites to the average reader better than a technical description. In all stages they are nearly white in color; the females are a little larger than the males, and are about one-fortieth of an inch in length, or almost exactly the size of the dot of this letter (i) when fully grown. The mature insects have four pairs of legs, like the spiders, but the last pair is small, and in the young they are entirely wanting. A very noticeable peculiarity in these mites is the long gossamer threads attached to the third pair of feet, and which trail behind them as they travel along. In a newly-hatched mite I have seen these threads fully two and one-half times the length of the body, and so slender that it required a rather high power of the microscope to see them at their distal ends. The males can be distinguished from the females

by their more rounded form of body, the smaller fourth pair of legs, which do not have the gossamer threads, the two teat-like projections at the extremity of the abdomen, and the large,

Fig. 1

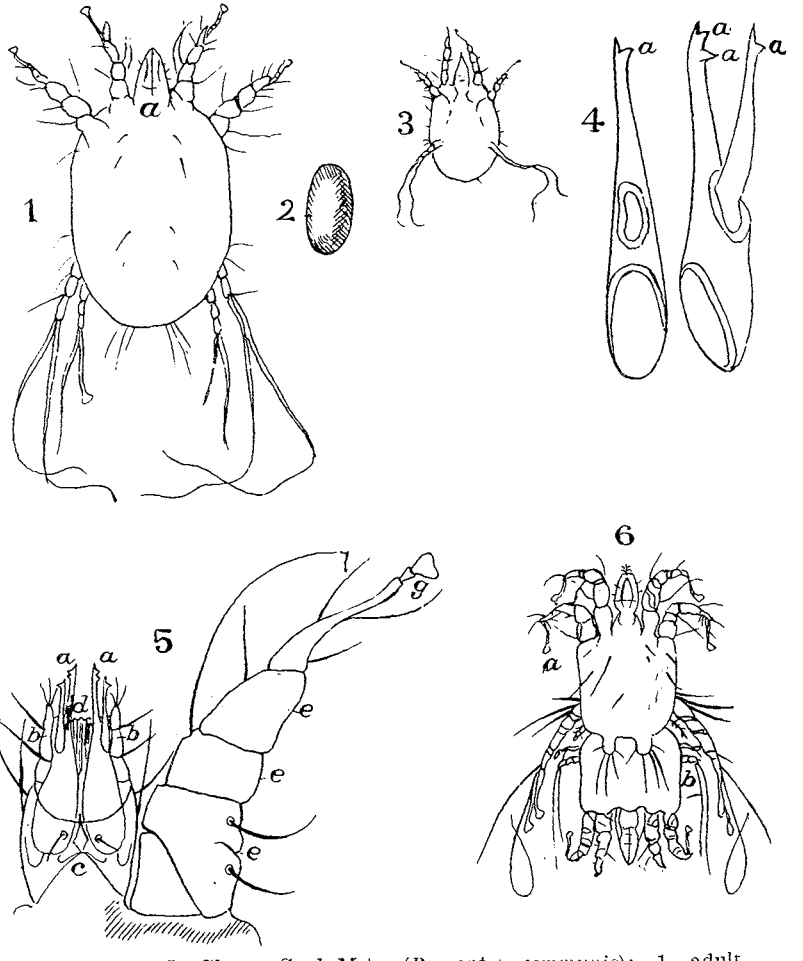


Figure I.—Sheep Scab-Mite (*Psoroptes communis*): 1, adult female, dorsal view; 2, egg; 3, newly hatched young; 4, jaws, which are also shown at 5aa; 5, head and one fore leg, showing mouth parts and sucker-like foot; 6, male above, female below, in copula. (Copied from *Animal Parasites of Sheep*, by Curtice.)

flesh-colored area on the posterior dorsal part of the body. Whenever any considerable number of specimens are taken together there will nearly always be a few pairs in copula, as

shown in Figure I., 6. The eggs are white or whitish-translucent in color, about twice as long as broad and very large as compared with the mites. They are about four-tenths the length of the mature female and eight of them would entirely cover her body. They are deposited upon the surface of the skin of the sheep and not upon the wool. They stick readily to anything that touches them, especially to wool, so they are not readily lost from the sheep if anything should dislodge them from the skin.

## EXPERIMENTS FOR THE DESTRUCTION OF THE MITES AND THEIR EGGS—NOTES ON SUBSTANCES USED.

The following substances were all used for the destruction of the mites or their eggs in the laboratory, but only the first ten were applied to sheep.

**The Fort Collins Lime and Sulphur Dip*—I have called this the Fort Collins dip because I know of no name previously given to lime and sulphur dip used in the same proportions. It contains lime, eleven pounds; sulphur, thirty-three pounds to 100 gallons of water. The lime and sulphur are first thoroughly mixed in a small amount of water and boiled for about two hours and then diluted to 100 gallons and used at about 110 degrees temperature. In my experiments the temperature was only about 90 degrees, and the sheep were kept in two minutes.

Dr. Headden, our station chemist, tells me that, if the lime is of good quality, it should take but one pound to cut four pounds of sulphur, and that it is the excess of lime used, or faulty preparation in the lime and sulphur dips that does the injury to the wool that is so often complained of. Mr. Drake tells me that there have been no complaints of injury to the sheep he has dipped in lime and sulphur.

*California Dip*—Sulphur, 100 pounds; lime, twenty-five pounds; water to make 100 gallons.

The lime and sulphur were first mixed in a small amount of water and boiled about two hours before using.

Also used at one-half the above strength.

*Potassium Sulphide Dip*—This substance was first suggested by Dr. Headden, who furnished me with a quantity of the crystals as purchased upon the market. These seemed less effectual

*Mr. W. A. Drake, an extensive purchaser and feeder of sheep near Fort Collins, tells me that he has put 38,000 sheep through a dip prepared in this manner the past fall and winter, and in only one instance has fresh scab appeared when the sheep were twice dipped, and he thinks that due to putting a scabby sheep in the bunch after dipping. The sheep were kept in the vat only one-half minute.

than what he afterwards prepared by boiling together sixty pounds of sulphur and nine pounds of washing soda in a small quantity of water, and then diluting this to 200 gallons of the dip. The crystals were used in the proportion of one pound to five gallons of water.

*Cooper Dip*—This is one of the arsenic-sulphur dips. It is manufactured in England and is one of the leading dips upon the markets. It is sold as a fine yellow powder in paper packages of about ten pounds weight. It mixes readily in either cold or warm water.

*Black Leaf Sheep Dip*—Manufactured by The Louisville Spirit Cured Tobacco Company, Louisville, Ky. The manufacturers claim this to be a pure and highly concentrated extract of tobacco. It mixes readily in cold or warm water, but the manufacturers recommend that it be used at 110 to 120 degrees. It is a pleasant dip to use in that it requires no stirring during the dipping and does not dry or chap the skin like the lime dips.

*Skabcura*—Put out by The Skabcura Dip Company, Chicago, Ill. This, like the preceding, is a tobacco dip. A bottle containing enough of the dip for 100 gallons of water is claimed to be the extract from 200 pounds of tobacco stems. It mixes with great readiness in water, cold or hot, and is a pleasant dip to use.

*Zenoleum*—Manufactured by The Zenner-Raymond Disinfectant Company, Detroit, Mich.

This dip, also the three succeeding ones, seem to be coal-tar dips. They are black, sirupy liquids, mixing without the slightest difficulty in cold or warm water and having a distinct tarry odor. When put in water they all form a white mixture (an emulsion) resembling milk. They are all recommended as disinfectants and washes for sores, and when put upon the skin leave the latter soft and oily with no disagreeable after effect, so that the men using these dips took pleasure in washing their hands in them to make them soft.

*Chloro-Naptholeum*—Put out by The U. S. Manufacturing Company, Minneapolis, Minn. Seems in all respects like the preceding except that when emulsified with water it does not form quite as white a mixture.

*Quibell's Liquid Dip*—Manufactured by Quibell Brothers, Newark, England. This dip seems in all respects like the preceding.

*Sulpho-Napthol*—Manufactured by Sulpho-Napthol Company, Boston, Mass. I have had but a small quantity of this dip to

experiment with, but it seems like the preceding three dips, except that it did not form so complete an emulsion with water, a small amount of black, oily fluid rising to the top.

*Australian Dip*—Sulphur, 150 pounds; lime, 100 pounds, to 100 gallons of water. The lime and sulphur were mixed with a small amount of water first and heated until all became a bright red liquid and then diluted to 100 gallons.

*Copperas Dip*—Copperas, thirty pounds; water, 100 gallons.

*Flour of Sulphur*—The dry powder used pure.

*Flour of Sulphur in Water*—Used in the proportion of ten pounds of sulphur to 100 gallons of water.

*Curtice Dip*—Tobacco leaves, fifty pounds; sulphur, ten pounds, to 100 gallons of water. The tobacco was first thoroughly steeped, after which the leaves were removed and the sulphur put in the decoction and boiled for a half hour.

*Milk of Lime*—Lump lime, 150 pounds; water, 100 gallons. Lime slaked in the water and used at once.

*Tobacco Decoction*—Tobacco dust, 200 pounds; water, 100 gallons. The tobacco was steeped in the water and then the leaves squeezed and the strong decoction used in full and one-half, one-fourth and one-eighth full strength.

*Quibell's Powder Dip*—Put out by the same company as Quibell's Liquid Dip. This dip seems almost identical with the Cooper Dip. Like that dip, it is sold in paper packages, and was use in the proportions recommended by the directions. The powder dissolves readily in hot or cold water.

*Arsenite of Soda Dip*—White arsenic, one ounce; carbonate of soda, one ounce; water, one gallon. The arsenic and carbonate of soda were first put in a small amount of water together, and boiled until the arsenic became entirely dissolved, and then the remainder of the water was added. Also used in weaker solutions.

*Carbolic Acid and Corrosive Sublimate*—Carbolic acid, eight parts; corrosive sublimate, one part; water, 1,600 parts. (Suggested and prepared by Dr. Headden.)

*Carbolic Acid*—Pure carbolic acid in water in proportions varying from one part in 100 to one part in 2,000.

*Kerosene Emulsion*—Soap, one pound; water, one gallon; kerosene, two gallons. After making the emulsion in these proportions in the usual manner the whole was diluted to sixteen gallons. Also used in one-half this strength.

*Pure Kerosene*—Used without dilution.

*Alcohol*—Used 95 per cent. pure.

*Whale-Oil Soap*—Used in the proportion of one pound to two gallons of water.

**Crude Aniline*—Dissolved in water in the proportion of one to 800 by weight.

**Phenyl Hydrazine*—Dissolved in water in the proportion of one to 500 by weight.

## MANNER OF APPLYING THE DIPS.

Unless otherwise stated in the notes upon the different dips, it will be understood that all were used at about 95 degrees temperature, and that the time of dipping was two minutes. In the laboratory experiments the mites were in each case procured on the day of the experiment by pulling wool from live scab. The mites were treated by dipping the wool that they were on into the various substances used, and, after two minutes, removing the wool and hanging it on pins to dry. This was thought to come as near the natural conditions as it was possible in the laboratory.

In most cases the dipping was done between five and six in the afternoon, and the first examination made between nine and ten the next morning. Examinations were made under a dissecting microscope, and all mites that could not be induced to move were accounted dead. When possible, a second or even a third examination was made, but the pressure of other work often made this impossible.

It must not be concluded that all dead mites found after treatment are necessarily dead because of the treatment, as an examination of the check lots will show that when removed from the sheep and kept in a warm atmosphere the mites died rapidly after the first few hours when untreated.

## LABORATORY EXPERIMENTS.

The final test of any dip must be upon sheep infested with scab. Laboratory tests are of much value to the experimenter in that they can be conducted in larger number under conditions that can be more completely controlled, and they give information that greatly aids in the selection of dips of promise and in the rejection of those that seem worthless. As very little experimental work has been done with sheep dips as yet in this country, and, as it is probable that the subject is to attract con-

*Suggested and prepared by Dr. W. P. Headden.

siderable attention in the future, I have thought it best to record the results of all my experiments with different materials for the destruction of either eggs or mites for the guidance of those who may take up the work hereafter.

## EXPERIMENTS WITH THE DIFFERENT DIPS.

*Fort Collins Lime and Sulphur Dip*—This dip was used upon sheep only; the laboratory tests of lime and sulphur dips were made in other proportions.

On November 18, thirty-five sheep were dipped, care being taken that all were put entirely under at least twice.

Mild cases of scab were known to exist in this bunch, but, unfortunately, the men who did the work misunderstood my directions and put in no sheep having heavy scab, as I intended that they should. December 1 the sheep were dipped again in the same preparation, no sign of scab having developed in the meantime. At this date, April 15, no fresh scab has appeared.

By purchasing the sulphur in a car-load lot, the feeders at this place were able to dip their sheep at less than one cent per head in November.

*California Dip*—

*Laboratory Experiments*—Applied October 27. Examined sixteen hours after, when several active, but no dead, mites could be found.

Experiment repeated November 5. Examined sixteen hours after, when four active and seven dead mites were found. Examined forty hours after, when only one living mite could be found.

Repeated again November 6. Sixteen hours after a single mite was found, which was very active. After using this dip the wool would dry into a hard lump, so that it was difficult to find the mites at all. The lump would crush rather easily into a mass of fine powder.

Experiment repeated in one-half the above strength, November 5. Sixteen hours after there were ten dead and five active mites found. Forty hours after there were still five active mites, but only one seemed in good condition.

*Experiment on Sheep*—One sheep with heavy live scab was treated with this dip November 14.

When examined, November 16, the wool was matted and heavily loaded with a fine powder. The wool was harsh and dry, and could be easily picked from the sheep with the thumb and finger. The wool did not pull from the skin, but would break near the body, where the fibres were nearly eaten off by the lime. No living mites could be found. No living scab has developed to the present time, April 15.

## POTASSIUM SULPHIDE DIP.

Table Showing Results of Laboratory Experiments.

| Date of Treatment | Condition After 16 Hours | | Condition After 48 Hours | | Strength Used |
|---|---|---|---|---|---|
| | Dead | Alive | Dead | Alive | |
| **November 1 | 13 | 0 | .... | .... | Full Strength |
| **November 1 | 3 | 7 | 10 | 0 | ½ Strength |
| November 3 | 3 | 7 | 7 | 3 | ½ Strength |
| November 4 | 8 | 2 | .... | .... | Full Strength |
| November 6 | 22 | 5 | 27 | 0 | Full Strength |
| November 6 | 0 | All | .... | .... | ½ Strength |
| November 11 | Few | 0 | .... | .... | Full Strength |
| November 15 | 5 | 5 | .... | .... | Full Strength |
| November 16 | 7 | 2 | 9 | 0 | Full Strength |
| November 27 | 9 | 16 | .... | .... | Full Strength |

The laboratory experiments with this dip were not at all encouraging. Experiments upon sheep did much better.

Only the crystals were used in the laboratory. The "full strength" mentioned in the table was in the proportion of one pound of crystals to five gallons of water.

*Experiments on Sheep*—The crystals were used in the proportion of one pound to five gallons of water, on November 10, to dip one sheep with a rather large patch of heavy scab on its back. The sheep was dipped but once. The weather being rather cold the sheep was kept in a barn for a few days.

A lock of wool was pulled twenty-four hours after the dipping, on which were found thirty-three mites, and all but one seemed dead. The wool at this time was quite wet.

Forty-eight hours after another lock of wool was examined, on which I found six apparently dead and six active mites. The wool was still moist on the sheep.

The sheep was repeatedly examined at intervals of a few days. The mites soon began to increase rapidly, and by the 1st of December the sheep had a bad case of scab again. On December 12 the sheep was dipped in Zenoleum, one part to 200 of water, and showed no signs of scab afterwards.

Experiment repeated November 18. At this time a bunch of forty sheep was dipped in a preparation made by Dr. Headden as follows:

Nine pounds of potash lye (caustic soda) were dissolved in four gallons of water, and then thirty-two pounds of flour of sulphur were added slowly, while the liquor was kept at boiling heat. After boiling one hour, the whole was put in the dipping vat and diluted to 200 gallons.

**In these two experiments the wool was put in a glass tube before it was perfectly dry and so kept moist the whole time, which probably accounts for the greater effectiveness of the dip in these than in later experiments.

Forty sheep were dipped in this mixture, several of which had heavy scab. After drying, the wool was full of a very fine yellow powder that kept the skin of the sheep completely covered. The sheep were dipped again December 1. No live scab has developed on any of these sheep since the dipping.

I have a letter from Leggett & Brother, New York, offering the lye, or caustic soda, in lots of 1,000 pounds or more at the rate of four cents a pound on board the cars. Calling the sulphur four cents and the lye five cents, after adding freight, and I think these are outside figures on large lots, it would make the dip cost only about eighty cents for 100 gallons. At these figures this dip would rival the lime and sulphur dips for cheapness, and the lye is more easily handled than the lime. It may be difficult to understand why the potassium sulphide crystals did not do as well as the same substance made by using the sulphur and lye, but the former left but little powder in the wool, while the latter left a large amount of it on drying, and I believe the mites are unable to endure, for a very long time, being covered with a dry powder of any sort. It will not do to rest the value of this dip upon a single experiment, but it seems to me to give promise of being a very cheap and practical dip. I hope to be able to test it farther at another time.

It will be noticed that all the lime and sulphur dips did better on the sheep than in the laboratory experiments. I believe it to be due to the continuous action, on the mites, of the fine dust that remains so long in the wool after dipping. There is some reason to think that the action of these dips is largely to drive the mites from the sheep and cause them thus to perish.

LABORATORY EXPERIMENTS WITH COOPER DIP.

| Date of Treatment | Condition after 16 Hours | | Condition after 40 hours | |
|---|---|---|---|---|
| | Dead | Alive | Dead | Alive |
| *October 31 | .... | .... | 10 | 12 |
| November 3 | .... | .... | 16 | 1 |
| November 4 | 13 | 1 | 14 | 0 |
| November 5 | 5 | 1 | 6 | 0 |
| November 9 | .... | .... | 10 | 3 |
| November 11 | 10 | 4 | .... | .... |
| November 27 | .... | .... | 10 | 3 |
| Totals | 28 | 6 | 56 | 16 |

One lock was dipped on November 5 at one-half the ordinary strength, and at the end of forty hours there were ten dead and five living mites.

*This lock of wool was dried on paper after dipping, which took the water out much more quickly than if dried like the others. This probably accounts for the lessened effect of the dip.

*Experiments on Sheep*—On November 10, one sheep, with moderately heavy live scab on the back, was treated with the Cooper Dip—one pound to ten gallons of water.

The sheep was kept in the barn for a few days. Twenty-four hours after dipping the wool was still very wet. A lock was pulled and examined that contained forty-seven dead and nine living mites.

At the end of forty-eight hours the wool was still moist. An examination showed a good number of dead and one living mite in the wool.

On November 13 the sheep was examined again, and an occasional living mite was found. By far the greater number were dead. The living mites were fully grown, and could not have come from eggs since dipping. The sheep was examined November 16, and again December 5, and a few living mites found on both occasions. On December 12 it was dipped again as before. The sheep has shown no scab since.

November 18, a bunch of forty sheep was treated with Cooper Dip, and the treatment was repeated December 1. In this bunch there were but three known cases of scab, and two of these were rather light. One sheep had a rather heavy, but not large, patch of scab on the rump. No farther signs of scab were noticed until January 7, when the sheep that had the somewhat heavy scab on the rump was seen "digging," and an examination showed a small spot of fresh scab near the old one. This sheep was "patched," and there have been no signs of scab in this bunch since.

This dip has been largely used in this vicinity for some years, and is considered by many feeders as a good dip, but most of the men who have used it tell me that unless there is very slight signs of scab among their sheep they have to dip twice, and if the sheep are very scabby they nearly always have to do some "patching" after twice dipping. The expense of the dip is about twice that of the lime and sulphur.

BLACK LEAF DIP.

Table Showing Results of Laboratory Experiments.

| Date of Treatment | Condition after 16 hours | | Condition after 48 hours | | Condition after 4 days | | Strength Used |
|---|---|---|---|---|---|---|---|
| | Dead | Alive | Dead | Alive | Dead | Alive | |
| November 2 | 6 | 1 | ---- | ---- | ---- | ---- | |
| November 3 | 10 | 3 | 13 | 0 | ---- | ---- | |
| November 6 | 3 | 6 | 6 | 3 | 6 | 3 | 1/40 |
| November 27 | 9 | 9 | ---- | ---- | ---- | ---- | |
| December 12 | 12 | 3 | ---- | ---- | ---- | ---- | |
| November 5 | 5 | 6 | 9 | 2 | ---- | ---- | 1/50 |
| November 6 | 0 | 18 | 4 | 14 | Few | Several | 1/80 |
| November 5 | 6 | 13 | 14 | 5 | ---- | ---- | 1/100 |

*Experiments on Sheep*—One sheep with a patch of moderately heavy scab, the size of a man's hand, was dipped with Black Leaf Dip, in the proportions of one to forty by measure, on November 10.

The sheep was examined twenty-four hours after, and several mites seen crawling about in the wool. The wool was still quite wet. Two days after the application a lock of wool was pulled, upon which ten living and about an equal number of dead mites were found. The living mites seemed rather sluggish.

November 13, the sheep was examined and only an occasional living mite could be found. Those found were too large to have hatched from eggs since dipping. On November 16, a careful search revealed but two mites, and on the 19th I looked in vain to find a living mite. The sheep was also carefully examined on December 5 and again on the 19th, without my finding mites or living scab.

On February 6 the sheep was noticed rubbing its tail against a feeding trough, and on examination it was found that there was a bad patch of scab covering most of the dorsal surface of that organ and two small spots were starting on the rump at the roots of the tail. The mites that survived the effect of the dip seem to have migrated to the tail and were there overlooked in previous examinations.

*Experiment Repeated on a Larger Scale*—On November 18, three bunches of sheep of forty each were treated with Black Leaf Dip in the proportion of one gallon to forty-two gallons of water. These bunches were treated again December 1. There

were a few cases, only, of rather mild scab among these sheep. On the second day after dipping, one sheep was found with a few living but apparently sick mites. Since that time no scab has developed in any of the pens containing these sheep.

Three sheep known to have some scab when first dipped were kept out at the second dipping, and one of these on January 8 was found to have a small spot of live scab near the old patch of moderately heavy scab. The other two cases, which were rather mild, were entirely cured by the one treatment.

All my experiments seem to indicate that this dip kills slowly but quite surely. Moderately bad cases were in some instances entirely cured by once dipping, while others broke out again. The dip is a pleasant one to use but is rather expensive. I hope to test it further.

### SKABCURA DIP.

*Laboratory Experiments*—November 3, mites were dipped in this preparation in twice the recommended strength.

Sixteen hours after, seven mites were active and about an equal number (not counted) seemed dead. At the end of forty-eight hours only four mites remained active.

Another lot was dipped on the same date in the recommended strength of this dip. Sixteen hours after, all seemed perfectly active. After fifty-six hours many were still active. No count was made.

This dip seemed much more effectual when applied to sheep.

*Experiment on Sheep*—On November 10, one sheep with moderately heavy scab was dipped with this preparation.

A lock pulled from the sheep twenty-four hours after, gave four dead and ten active mites.

Another lock, taken forty-eight hours after treatment, gave ten apparently dead and nineteen active mites. On November 13 only a very few living mites could be found on this sheep, and on the 16th of the same month I was unable to find any, and none have appeared since.

My early laboratory experiments with this dip were so unpromising that I dropped it to take up dips of more promise, but in following through the effects of the dip on the one sheep treated, it seems that the effect of Skabcura is much like that of Black Leaf, namely, having a cumulative effect, extending over a number of days. This dip seems to me to promise well.

## ZENOLEUM.

*Laboratory Experiments*—My first experiments with this dip were in the proportion of one part to twenty-five and one part to fifty of water. All were killed that were thus treated.

Table Showing Results of Laboratory Experiments.

| Date of Treatment | Condition after 16 Hours | | Strength Used |
|---|---|---|---|
| | Dead | Alive | |
| November 4 | 6 | 0 | |
| November 5 | 18 | 0 | 1/100 |
| November 6 | 12 | 0 | |
| November 6 | 13 | 0 | |
| November 9 | 10 | 0 | |
| November 11 | 8 | 0 | |
| December 2 | 13 | 0 | |
| December 5 | 14 | 0 | 1/200 |
| December 26 | 10 | 0 | |
| February 6 | 30 | 0 | |
| February 6 | 20 | 0 | |
| November 9 | 9 | 0 | |
| November 11 | 16 | 0 | |
| November 12 | 19 | 0 | |
| November 13 | 6 | 0 | 1/400 |
| December 12 | 14 | 1 | |
| February 6 | 43 | 1 | |
| February 6 | 27 | 1 | |
| November 11 | 20 | 0 | |
| November 12 | 36 | 11 | |
| November 13 | 12 | 10 | 1/800 |
| December 12 | 10 | 10 | |
| November 11 | 2 | 7 | |
| November 12 | 0 | 8 | 1/1600 |
| November 12 | 0 | Many | 1/3200 |

The experiments with this dip gave such promising results from the start that I was led to test it more thoroughly than any other, both in the laboratory and upon sheep.

*Experiments on Sheep*—One sheep with very heavy scab covering a space about six inches wide and twelve inches long on the shoulders and back was dipped with Zenoleum, diluted 100 times with water, on November 10.

The sheep was examined the next day and many times thereafter, but no live scab appeared again and no living mites have since been found. The scab healed quickly and the sheep has done well ever since.

On the same date another sheep with heavy live scab was dipped in Zenoleum diluted 200 times. Twenty-four hours after dipping, wool was pulled showing many dead mites but no living ones. The sheep has been frequently examined since, but no live scab has appeared during the six months.

On December 12, one sheep not cured by previous dipping with potassium sulphide, was dipped in Zenoleum diluted 200 times, and has shown no live scab since.

On the same date, two sheep, one with a small patch of light scab, and one with a small patch of rather heavy scab, were dipped in Zenoleum diluted 600 times. In both cases the scab seems to have been completely cured, no signs of live scab appearing since.

*A Bunch of Sheep Dipped Once*—On November 18 a bunch of forty sheep, many of them with heavy live scab, was dipped in Zenoleum diluted 200 times. No scab was afterwards found in this bunch until February 9, at which time six cases of live scab were found, all but one very light. It was found that the one sheep with heavy scab was put in the bunch on December 13 in order to make this bunch of sheep compare in numbers with other bunches that were to be used in a feeding experiment. The scab had gone unnoticed, as it had developed in a large patch of short wool that could not be pulled by the sheep. It seems to me that the presence of this one sheep would readily account for the five incipient cases. However this may be, there were several bad cases that never showed any scab after the dipping.

*A Bunch of Sheep Dipped Twice in Zenoleum, Diluted 200 Times*—Another bunch of forty sheep that was dipped in Zenoleum, one to 200, on November 18, was dipped again on December 1. This bunch, like the preceding, had a good number of cases of heavy scab.

No live scab was found in this pen until February 9, when the sheep were all examined and one was found with a small patch of fresh scab about one inch in diameter. On December 13, three sheep were put in this pen also, preparatory to a feeding experiment, and on the date that the scabby sheep above mentioned was found, these three sheep were also found to have some scab; one of them had a bad patch on its tail, which it was seen rubbing on a feeding trough. The three sheep were

"spotted" and no scab has since appeared. It seems probable that the sheep put into the pen were the cause of the one sheep that had been dipped with Zenoleum getting scab again.

*A Bunch of Sheep Dipped Twice in Zenoleum, Diluted 400 Times*—On November 18, and again December 1, a bunch of forty sheep was dipped in Zenoleum diluted 400 times. No live scab appeared again until March 2, when one sheep with a small patch, less that an inch in diameter, was found. It is the only case that has appeared. This bunch had a good number of very scabby sheep when dipped.

EXPERIMENTS WITH CHLORO-NAPTHOLEUM.

Table Showing Results of Laboratory Experiments.

| Date of Treatment. | Condition after 16 Hours | | Condition after 44 Hours | | Strength Used |
|---|---|---|---|---|---|
| | Dead | Alive | Dead | Alive | |
| November 14 | All | 0 | .... | .... | 1/100 |
| November 26 | 30 | 0 | .... | .... | |
| November 14 | Many | 2 | .... | .... | 1/200 |
| November 16 | 14 | 0 | .... | .... | |
| November 14 | 8 | 8 | .... | .... | 1/400 |
| November 16 | 15 | 3 | .... | .... | |
| November 14 | 0 | All | .... | .... | 1/800 |
| November 16 | .... | .... | 3 | 4 | |

*Applied to Sheep*—On November 18, this dip was applied to forty sheep in the proportion recommended on the cans, which is three quarts in 200 gallons of water. There were a few cases of mild scab in this bunch, but no heavy scab. The treatment was not repeated and no scab has appeared since dipping. Further experiments are necessary before drawing definite conclusions regarding this dip.

EXPERIMENTS WITH QUIBELL'S LIQUID DIP.

Table Showing Results of Laboratory Experiments.

| Date of Treatment | Condition after 16 Hours | | Strength Used |
|---|---|---|---|
| | Dead | Alive | |
| February 26 | 14 | 0 | 1/100 |
| January 5 | 10 | 0 | 1/200 |
| February 26 | 19 | 0 | 1/200 |
| February 27 | 16 | 0 | 1/200 |
| January 12 | 12 | 0 | 1/200 |
| January 5 | 14 | 0 | 1/400 |
| January 12 | 9 | 3 | 1/400 |
| February 26 | 27 | 0 | 1/400 |
| February 27 | 15 | 1 | 1/400 |
| January 12 | 8 | 0 | 1/800 |
| February 27 | 14 | 0 | 1/800 |

*Experiments on Sheep*—On December 12 six sheep were treated with this dip as follows: Two sheep in a mixture of one part of dip to 200 parts of water; two sheep in a mixture of one part of dip to 400 parts of water; two sheep in a mixture of one part of dip to 600 parts of water. One of the sheep, dipped in the strongest preparation, had a large patch of heavy scab along the back, while the other had only a very small patch of light scab. In each of the weaker mixtures one sheep was dipped having a small but moderately heavy live scab, and one having one or two patches of very light scab. The sheep with heavy scab, dipped in the strongest mixture, was not cured, the mites continuing both on and about the old scabby spot. The one having very light scab was cured.

The two sheep dipped in the one to 200 strength were both cured.

The sheep with the heavier scab, dipped in the one to 600 strength, was not cured, while the one with incipient scab has shown no signs of scab since dipping.

## LABORATORY EXPERIMENTS ONLY.

### SULPHO-NAPTHOLEUM.

This dip was not obtained in time to enable me to do much with it. A lock of wool containing thirty-seven mites was dipped in this substance, diluted 200 times, and at the end of sixteen hours all were dead. Another application in one-half the above strength, in which forty-two mites were used, resulted in the death of all within the sixteen hours.

### QUIBELL'S DRY DIP.

Three different lots of mites on wool were dipped in the proportions recommended on the packages. Sixty-six mites were included in the experiments, about one-third of which were alive at the end of sixteen hours. In one case the mites were examined after sixty-four hours and several found active. The indications are that this will not prove a very effectual dip.

### CARBOLIC ACID.

One part to 100 parts of water. One lot of six mites were all dead after sixteen hours. One lot of fourteen mites gave nine dead and five living after twelve hours.

One part to 200 of water. A lot of fifteen mites treated in this strength all seemed dead at the end of sixteen hours. Another lot of a good number, but not counted, were about half dead at the end of twelve hours.

One part to 400 parts of water. One lot treated, and about half were active at the end of sixteen hours. Also used in proportions of 1 to 500, 1 to 1,000 and 1 to 2,000, but in no case did the treatment seem to kill any mites inside of sixteen hours. As carbolic acid is a dangerous substance to put animals into, it seems as though it is very doubtful if it can be employed safely in sufficient strength to kill the mites.

## ARSENITE OF SODA.

Table Showing Results of Laboratory Experiments.

| Date of Treatment | Condition After 16 Hours | | Condition After 44 Hours | | Strength Used |
|---|---|---|---|---|---|
| | Dead | Alive | Dead | Alive | |
| November 5 | 12 | 0 | ---- | ---- | Full Strength |
| November 6 | 10 | 4 | 7 | 7 | ½ Full Strength |
| November 11 | 10 | 0 | ---- | ---- | ⅔ Full Strength |
| November 11 | 12 | 0 | ---- | ---- | ⅓ Full Strength |
| November 12 | 3 | 3 | 4 | 2 | ⅓ Full Strength |
| November 13 | 16 | 9 | ---- | Few | ⅓ Full Strength |
| December 6 | 10 | 6 | 10 | 6 | ¼ Full Strength |
| December 6 | 6 | 10 | 4 | 12 | ⅛ Full Strength |

Full strength, as given in the above table, would be one ounce of arsenic and the same of carbonate of soda to one gallon of water. The experiments would indicate that, if used much weaker than this, it would not be very effectual. I believe this dip too poisonous to be used with safety.

## AUSTRALIAN DIP.

Laboratory experiments with this dip were not satisfactory, as the solution on drying became a hard lump that inclosed the mites. On crushing this it became a mass of dry powder. Most of the mites that could be found after sixteen hours were dead, but in nearly every case a few living were found also.

There is no doubt but what this would be a very effectual lime and sulphur dip, but I believe it too strong to use on the sheep, and stronger than is necessary to kill scab.

## COPPERAS DIP (GREEN VITRIOL).

Two tests were made in the laboratory of copperas as a dip. In one, the proportions were three pounds of the crystals to ten gallons of water, and in the other three pounds of the crystals to twenty gallons of water. In the former strength, about one-third of the mites were quiet at the end of sixteen hours, and in the latter strength only one mite in eight seemed dead at the end of the same time. At the end of forty-four hours one-half of those treated with the weaker solution were still active.

## FLOUR OF SULPHUR (DRY).

Dry sulphur was thoroughly dusted into a lock of wool containing scab mites. At the end of sixteen hours four dead and five living mites were found, the latter having all left the wool. At the end of forty hours two mites were still crawling about covered with sulphur.

## FLOUR OF SULPHUR IN WATER.

Used in the proportion of one pound to eight gallons, and one pound to twelve gallons of water. In the former case there were four dead and five active ones at the end of sixteen hours. At the end of forty hours one mite covered with sulphur was still active. In the weaker strength all the mites were active at the end of twelve hours.

### CURTICE DIP.

Only one laboratory test was made with this dip. After sixteen hours there were many active and few, if any, dead mites. At the end of five days two active mites were found.

A very similar dip, prepared in the proportions of four pounds of strong tobacco and one pound of sulphur to ten gallons of water, was also used. At the end of sixteen hours the mites seemed uninjured. Only one test.

### MILK OF LIME.

Wool treated with this dip became a hard lump on drying. After crushing the lump, at the end of sixteen hours, three living mites were found. Probably there were dead ones present, but, being quiet, were not seen. It would seem that lime has but little effect on the mites.

### TOBACCO DECOCTION.

The first lot dipped was kept under for only one minute, and then the wool was dried by laying it on blotting paper. Nearly all the mites were lively at the end of four days. The decoction was also used in one-half, one-fourth and one-eighth the above strength in the same manner, and with the same result in each case.

Very strong tobacco leaves, from tobacco raised by the horticultural department, were also used in the same proportion (two pounds to a gallon of water), but the dipping was for two minutes, and the drying of the wool was in the usual manner. At the end of forty-four hours twelve dead and eight active mites were found.

These experiments seemed so unfavorable for tobacco that I concluded not to experiment with it farther. It is very possible that tobacco has a cumulative effect not shown in these experiments.

### CARBOLIC ACID AND CORROSIVE SUBLIMATE.

Only one lot treated. At the end of twenty-four hours there were twelve active mites and few, if any, that were dead.

### KEROSENE EMULSION.

Having found kerosene emulsion very effectual in destroying lice that infest cattle and hogs, I expected it would be an effectual remedy for scab in sheep. My laboratory experiments were so disappointing that I did not test the emulsion farther. It might have proven more effectual on sheep.

The mites were first dipped for one-half minute in full and one-half strengths. At the end of sixteen hours the mites were all lively, though wet with kerosene. The experiment was repeated in both of the above strengths, and at the end of forty-four hours all the mites were lively.

### KEROSENE.

Failing with kerosene emulsion, I made one test with pure kerosene to see if it would kill. A lock of wool containing mites was dipped for one minute. At the end of two hours all the mites were active. At the end of sixteen hours four semed dead and five were still active. All were wet with the oil. At the end of forty-eight hours all were dead. Kerosene, either pure or in the form of an emulsion, may be a sure destroyer of the mites, but it is certainly not rapid in its action.

### ALCOHOL.

Finding that kerosene had so little effect, I thought I would see what 95 per cent. alcohol would do. A quantity of mites was dipped for one minute in this substance. At the end of sixteen hours all were still active, and at the end of forty-eight hours only a few had died.

### WHALE-OIL SOAP.

Used in the proportions of one pound to two gallons of water, and in one-half and one-fourth of this strength, and with no apparent effect in any case. In the strongest preparation many mites were alive at the end of sixty-four hours.

### EXPERIMENTS WITH THE EGGS.

There is a prevailing opinion that the eggs are not killed by the applications that destroy the mites, and that, as a consequence, a second dipping is made necessary to destroy the young mites hatching from the eggs that survived the first treatment. It is commonly recommended to dip a second time from ten to fourteen days after the first treatment, but I can not find that anyone has actually determined the time required for the eggs to hatch. There is also the greatest difference of opinion as to the length of time the eggs may survive when off the sheep, some thinking they may live for years, and others that they can not survive more than a few weeks. These are all matters of very great importance, and the experiments tabulated below were conducted for the purpose of throwing light upon them. The eggs are difficult to obtain in sufficient numbers for experimental purposes, and it is not a very easy matter to keep them under a very close approach to natural conditions. The method that I adopted was to use small glass tubes supplied with corks. The cork, in each case, was removed, moistened with saliva on the inner end, the eggs for the particular experiment placed upon it, where they adhered without trouble after the cork was replaced. The tubes were then carried in an inside vest pocket during the day and kept in a warm place during the night. Any ordinary low temperature seemed to have no effect upon the eggs except to lengthen the period of incubation.

Tabulated Experiments with Eggs of Sheep Scab-Mite.

| Date of Application | Date of Notes | Number of Eggs | | Treated With | Strength of Dip |
|---|---|---|---|---|---|
| | | Hatched | Unhatched | | |
| Nov. 27 | Dec. 11 | 0 | 9 | Black Leaf | 1 to 40 |
| Nov. 7 | Nov. 12 | 10 | 0 | Black Leaf | 1 to 42 |
| Nov. 19 | Nov. 27 | 1 | 0 | Black Leaf | 1 to 50 |
| Nov. 17 | Nov. 26 | 2 | 7 | Phenyl Hydrazine | Full strength |
| Nov. 17 | Dec. 9 | 0 | 7 | Crude Aniline | Full strength |
| Nov. 17 | Dec. 9 | 0 | 2 | Crude Aniline | One-half strength |
| Nov. 7 | Dec. 9 | 0 | 2 | Zenoleum Dip | 1 to 100 |
| Nov. 27 | Dec. 11 | 0 | 5 | Zenoleum Dip | 1 to 200 |
| Dec. 13 | Dec. 24 | 0 | 1 | Zenoleum Dip | 1 to 200 |
| Feb. 7 | Feb. 24 | 0 | 4 | Zenoleum Dip | 1 to 200 |
| Feb. 7 | Feb. 27 | 0 | 12 | Zenoleum Dip | 1 to 200 |
| Nov. 13 | Nov. 26 | 0 | 6 | Zenoleum Dip | 1 to 400 |

| Date of Application | Date of Notes | Number of Eggs | | Treated With | Strength of Dip |
|---|---|---|---|---|---|
| | | Hatched | Unhatched | | |
| Nov. 20 | Nov. 26 | 0 | 13 | Zenoleum Dip | 1 to 400 |
| Nov. 20 | Dec. 9 | 0 | 13 | Zenoleum Dip | 1 to 400 |
| Dec. 13 | Dec. 24 | 2 | 4 | Zenoleum Dip | 1 to 400 |
| Feb. 7 | Feb. 27 | 0 | 12 | Zenoleum Dip | 1 to 400 |
| Feb. 7 | Feb. 24 | 0 | 7 | Zenoleum Dip | 1 to 400 |
| Nov. 13 | Nov. 14 | 1 | 0 | Zenoleum Dip | 1 to 800 |
| Nov. 13 | Nov. 17 | 3 | 0 | Zenoleum Dip | 1 to 800 |
| Feb. 7 | Feb. 27 | 0 | 10 | Sulpho-Naptholeum | 1 to 200 |
| Feb. 10 | Feb. 24 | 0 | 9 | Sulpho-Naptholeum | 1 to 200 |
| Nov. 20 | Dec. 10 | 0 | 1 | Cooper Dip | |
| Nov. 27 | Dec. 11 | 0 | 5 | Chloro-Naptholeum | 1 to 100 |
| Nov. 17 | Dec. 1 | 0 | 4 | Chloro-Naptholeum | 1 to 200 |
| Nov. 17 | Dec. 1 | 0 | 8 | Chloro-Naptholeum | 1 to 400 |
| Nov. 27 | Dec. 1 | 0 | 6 | Quibell's Liquid Dip | 1 to 100 |
| Nov. 27 | Dec. 14 | 2 | 5 | Quibell's Liquid Dip | 1 to 200 |
| Nov. 28 | Dec. 14 | 0 | 9 | Quibell's Liquid Dip | 1 to 200 |
| Dec. 13 | Dec. 24 | 0 | 13 | Quibell's Liquid Dip | 1 to 200 |
| Nov. 27 | Dec. 14 | 0 | 4 | Quibell's Liquid Dip | 1 to 400 |
| Nov. 28 | Dec. 14 | 0 | 14 | Quibell's Liquid Dip | 1 to 400 |
| Dec. 13 | Dec. 24 | 0 | 4 | Quibell's Liquid Dip | 1 to 400 |
| Nov. 27 | Dec. 11 | 1 | 10 | Quibell's Liquid Dip | 1 to 800 |
| Nov. 6 | Nov. 12 | 1 | 0 | Potassium Sulphide Dip | 1 pound to 5 gallons |
| Nov. 27 | Dec. 11 | 0 | 4 | Potassium Sulphide Dip | 1 pound to 5 gallons |
| Nov. 7 | Nov. 12 | 1 | 0 | Arsenite of Soda | 1 ounce to 1 gallon |
| Nov. 13 | Nov. 19 | 2 | 0 | Arsenite of Soda | 1 ounce to 4 gallons |
| Nov. 27 | Dec. 11 | 1 | 19 | Quibell's Dry Dip | According to direct'ns |
| Nov. 27 | Dec. 9 | 0 | 5 | Quibell's Dry Dip | According to direct'ns |
| | | | | | Minimum Temperatures |
| *Nov. 19 | Dec. 30 | 2 | 1 | Out of Doors | 8.3° |
| Nov. 27 | Dec. 14 | 0 | 6 | Out of Doors | —9.8° |
| Nov. 23 | Dec. 9 | 0 | 6 | Out of Doors | 5.1° |
| Nov. 19 | Dec. 24 | 0 | 5 | Out of Doors | 3.2° |
| Nov. 30 | Dec. 11 | 0 | 1 | Out of Doors | 1.5° |
| Feb. 6 | Mar. 13 | 0 | 2 | Out of Doors | —5.3° |
| Feb. 6 | Feb. 24 | 5 | 8 | Out of Doors | 11.8° |
| Feb. 9 | Mar. 13 | 0 | 7 | Out of Doors | —5.3° |
| Feb. 9 | Mar. 7 | 0 | 2 | Out of Doors | .1° |
| Feb. 11 | Feb. 24 | 0 | 4 | Out of Doors | 11.8° |
| Feb. 20 | Feb. 27 | 0 | 25 | Out of Doors | .1° |

An examination of the preceding table will show that the eggs are nearly, if not quite as easily killed, as the mites. It is possible that the eggs are more protected by the scabs than the mites, but in all the above experiments mites and eggs were treated alike on the wool and seem to have been killed about equally well.

It seems strange that in the use of Black Leaf all of the eggs should have hatched that were taken from a sheep twenty-four hours after dipping, and nearly all should have been killed that were treated in the laboratory.

* This lot was kept on an outer window sill.

The tar dips all did splendidly in destroying eggs. Zenoleum was most used. In dilutions of one to 100 and one to 200 it killed all. When diluted 400 times, only two hatched out of fifty-seven. In the proportion of one to 800, all hatched.

Out of a total of sixty-eight eggs treated with Quibell's Liquid Dip, only three hatched. Smaller numbers were dipped in Chloro-Naptholeum and Sulpho-Napthol and none hatched.

*Effects of Exposure on Hatching the Eggs*—The effects of exposure on the hatching of the eggs may be summarized as follows:

Four eggs were out five days with the minimum temperatures ranging between 11.8 degrees and 24.8 degrees. None hatched.

Thirteen eggs were out three days when the minimum temperatures ranged between 11.8 degrees and 24.5 degrees. Five hatched.

Twenty-five eggs were out fourteen days, when the minimum temperature ranged between .1 degree and 34 degrees. None hatched.

Six eggs were out twenty-one days when the minimum temperatures ranged between 12 degrees and 37 degrees. None hatched.

Two eggs were out thirty-two days when the minimum temperatures ranged between —5 degrees and 34 degrees. None hatched.

Seven eggs were out thirty-five days when the minimum temperatures ranged between —5 degrees and 34 degrees. None hatched.

Six eggs were out one night when the temperature went down to —9.8 degrees. None hatched.

One egg out one night when the temperature went down to 15 degrees. Did not hatch.

Five eggs were out eight nights when the temperature went to a minimum of —11.8 degrees. None hatched.

Three eggs were out a few nights (dates lost) when the temperature went to a minimum of 8.3 degrees. Two hatched.

Four eggs were out a few nights (dates lost) when the minimum temperature went down to —5.3 degrees. None hatched.

Do not understand that any of the eggs hatched while exposed to the cold. As soon as brought in the eggs were carried in a warm pocket, as before described.

These experiments show that the eggs may be subjected to a temperature of 8.3 degrees and still hatch. Those subjected

to a temperature of 5 degrees or lower did not hatch in any case. It seems probable that the eggs will not bear a temperature as low as 0 and live.

Whether or not exposure will kill one of these eggs probably depends upon, at least, three things, viz., the degree of cold, the duration of the exposure and the stage of incubation of the egg when exposed.

*Period of Incubation*—When carried in the pocket, the longest time that eggs have lived and hatched after being removed from a sheep has been nine days. One egg known to have been laid November 3, was kept in a warm pocket and the mite emerged on November 8. Time of incubation evidently depends much on temperature. In their natural position on the skin of the sheep and protected from the cold by a heavy coat of wool, it is probable that the eggs hatch in from three to five days.

*Where the Eggs are Placed*—The eggs of these mites are not glued to the fibers of the wool, neither are they inserted beneath the surface of the skin, but are placed directly upon the moist skin or upon light scab.

## EFFECT OF EXPOSURE ON THE MITES.

It is also a matter of much importance to know how long the mites can live off the sheep. How soon after scabby sheep have been turned out of a corral or field will it be safe to put healthy sheep in them without danger of their becoming diseased? The following experiments bear upon this point, but it must be remembered that I have been able to study the conditions during cold weather only.

### EXPERIMENTS IN WHICH THE MITES WERE KEPT WARM.

In these experiments the mites were placed on wool in small vials and carried in an inside pocket during the day and were kept at a temperature of about 60 degrees during the night.

*Lot 1*—Fourteen mites of different ages, taken November 3.

November 4, all seemed active; November 5, five were active and nine quiet; November 6, only two were active; November 7, there were no signs of life.

*Lot 2*—Thirty-six mites of all ages, taken October 31.

November 2, eighteen seemed dead and eighteen were active; not examined again.

*Lot 3*—Fifteen mites taken November 5.

November 6, seven appeared dead and eight alive; November 7, only two showed any signs of life.

*Lot 4*—Seventeen mites taken November 6.

November 7, two seemed dead and the remainder alive; November 9, a few were still active, no count made; November 11, all were dead.

*Lot 5*—Eighteen mites taken November 12.

November 13, only fourteen were active; November 14, only four were active; not examined again.

*Lot 6*—Thirteen females taken November 13.

November 19, all were dead and no eggs had been laid.

*Lot 7*—A large number (not counted) of mites taken November 19.

November 27, one very sluggish mite was all that showed any signs of life; November 28, all were dead.

*Lot 8*—A large number of mites taken November 27.

Not examined till December 2, when all were dead.

The longest time that a mite lived in any of the above experiments was eight days. As a rule, all were dead at the end of five days.

EXPERIMENTS IN WHICH MITES WERE KEPT OUT OF DOORS.

In these experiments, mites were exposed for a greater or less time on wool, in vials, out of doors, then they were brought in and warmed to see if they would become active. If the mites were still alive they always became active in a very few minutes when the vials were warmed in the hand or with the breath.

*Lot 1*—A quantity of mites taken and put out November 3.

November 5 and 6, all seemed lively on warming; on the 6th, 7th and 8th, a few of the mites failed to revive, but no counts were made; on the 9th, only four seemed alive; on the 10th, only three, and on the 12th, two; on the 14th, two, and on the 17th, none. So that two mites in this case lived at least eleven days. Minimum temperature during the time was 13 degrees.

*Lot 2*—A good number of mites put out along with the preceding.

Examined for first time November 23, when all the mites became active on being warmed. Minimum temperature during the time, 13 degrees.

*Lot 3*—A quantity of mites put out November 19.

Examined for the first time November 28, when all were found to be dead. Minimum temperature while out, —11.3 degrees.

*Lot 4*—A large number of mites put out November 27.

Examined November 28, when all were dead. Minimum temperature during the night, —9.8 degrees.

*Lot 5*—Like the preceding, except that they were kept on an outer window sill where, according to tests made later, the temperature was probably about 7 degrees higher than upon the ground, or —2.8 degrees.

November 28, all the mites were dead.

*Lot 6*—Ten mites put out January 29.

February 1, on warming the mites, six, none of which were adults, became active; four, all adults, did not revive. Those that did revive seemed very sluggish. The minimum temperatures for the three nights were 10.7 degrees, 7.8 degrees and 8 degrees respectively.

*Lot 7*—A number of mites put out November 23.

When first examined, January 3, all were dead. Minimum temperature during this time, 11.3 degrees.

*Lot 8*—Mites put out November 30.

Examined January 3, when all were dead. Minimum temperature for this time, 5 degrees.

*Lot 9*—Mites put out February 6.

Examined February 9, when all became active on warming. They were kept in but a few minutes and then put back. The minimum temperature to which these mites was subjected was 11.8 degrees.

Examined again March 9, when all were dead. Minimum temperature during this time, 5.3 degrees.

*Lots 10* and *11*—Put out February 6 and February 9, respectively.

Both lots were examined for the first time March 24, when all the mites were found dead. The minimum temperature during the exposure was 5.3 degrees.

*Lot 12*—Put out February 23.

Taken in and warmed February 24, when all became active. The lowest temperature during the night, 5 degrees.

*Lot 13*—Mites put out February 6.

First examined March 9, when all were found to be dead. Minimum temperature during this time, — 5.3 degrees.

The conclusions that may be drawn from the foregoing experiments are the following:

First—That the mites can not endure a temperature much below zero and survive, even for a single day.

Second—That the mites can endure a temperature of 5 degrees and live.

Third—That the immature mites can endure as low, if not a lower, temperature than the adults.

Fourth—That the mites may live very much longer in a temperature low enough to keep them dormant than in a warm

temperature that will keep them active, provided the temperature is not low enough to kill them and that they are not supplied with food.

Fifth—That they will live longer in a moderately low temperature if the temperature is kept steadily below that point which will make them active. In other words, a steady low temperature is not as destructive to them as alternating low and high temperatures.

The longest that mites were kept alive with above experiments was twenty days.

The results with the preceding experiments, both with eggs and mites exposed to out-door temperatures, make it almost certain that the infection can not be carried over winter off the sheep, and it also makes it highly improbable that the mites or their eggs will live for more than a very few weeks at any time of the year unless upon sheep or some other animal that can serve as food.

## DOES DIPPING GIVE THE SHEEP A "SET-BACK?"

Sheep feeders are quite unanimous in the opinion that dipping gives the sheep a set-back. Some think it will take one, others that it will take two or three weeks of feeding to get the sheep back to the weight at the time of dipping. The following weights were made for the purpose of determining the loss occasioned by dipping in these experiments:

Table Showing Loss of Weight Caused by Dipping.

| Lot | †Dates of Weighing | | | | | | | | | Dips Used |
|---|---|---|---|---|---|---|---|---|---|---|
| | Nov. 17 | Nov. 20 | Nov. 23 | Nov. 25 | Nov. 27 | Dec. 3 | Dec. 5 | Dec. 8 | Dec. 22 | |
| 1 | 51 | 50 | 50 | 52 | 50 | 55 | 53 | 56 | 59 | Zenoleum, Nov. 18th. |
| 2 | 52 | 50 | 51 | 53 | 51 | 55 | 55 | 55 | 58 | Zenoleum, Nov. 18th and Dec. 1st. |
| 3 | 52 | 49 | 50 | 53 | 50 | 52 | 48 | 56 | 58 | Zenoleum, Nov. 18th and Dec. 1st. |
| 4 | 53 | 51 | 51 | 53 | 51 | 54 | 56 | 57 | 59 | Potassium Sulphide, Nov. 18th and Dec. 1st. |
| 5 | 43 | 44 | 47 | 48 | 46 | 51 | 51 | 53 | 54 | Ft. Collins Lime and Su. Dip, Nov. 18th and Dec. 1st. |
| 6 | 43 | 43 | 47 | 47 | 47 | 48 | 49 | 50 | 53 | Chloro-Naptholeum, Nov. 18th only. |
| 7 | 42 | 43 | 46 | 45 | 43 | 46 | 47 | 48 | 50 | Cooper Dip, Nov. 18th and Dec. 1st. |
| 8 | 44 | 45 | 47 | 46 | 44 | 48 | 50 | 50 | 52 | Black Leaf, Nov. 18th and Dec. 1st. |
| 9 | 44 | 45 | 48 | 47 | 44 | 47 | 49 | 49 | 52 | Black Leaf, Nov 18th and Dec. 1st. |
| 10 | 43 | 44 | 47 | 46 | 44 | 46 | 49 | 49 | 51 | Black Leaf, Nov. 18th and Dec. 1st. |
| 11 | 47 | 47 | 49 | 49 | 47 | 51 | 51 | 52 | 53 | Not dipped. |

†These weights were made by F. L. Watrous, of the Agricultural Department.

In the above table, lots 1 and 6 were dipped once, lot 11 was not dipped at all, and all others were dipped twice.

Each lot contained about forty sheep, except lot 11, which had but twenty.

Lots 1, 2, 3, 4 and 11 were all treated alike in feed, and are suitable for comparison. Lot 5, unlike any of the others, was fed on ensilage. Lots 6 to 10 were all fed grain, but differently, so that they are not suitable for comparison to determine loss from dipping. Lots 5 to 10 are included in the table only for the purpose of showing whether or not the dips seemed to have any particular injurious or beneficial effects.

The mid-day temperature for November 18, the first date of dipping, was 33 degrees, and the minimum temperatures for the three nights following were 8.8 degrees, 8.3 degrees and 13.7 degrees respectively.

COMPARISON OF LOTS ONE TO FOUR WITH LOT ELEVEN.

On November 20 the dipped lots averaged just two pounds per sheep less than on the day before dipping, while the check lot in pen 11 just held their own.

On November 23 the dipped lots averaged one and one-half pounds per sheep less than before dipping, while the check lot had made a gain of two pounds per sheep.

On November 25 the dipped sheep had gained three-quarters of a pound each to a gain of two pounds each in lot 11.

On November 27, the last weighing before the second dipping, the dipped sheep averaged three-quarters of a pound less than on the day before dipping, while the undipped lot showed neither gain nor loss.*

This would indicate a loss of three-quarters of a pound per sheep as a result of dipping and as indicated by weighing nine days after.

COMPARISON OF LOTS TWO, THREE AND FOUR WITH LOT ONE.

These four lots were as near alike in every respect as they could be made, including numbers. Lots 2, 3 and 4 were dipped December 1. The mid-day temperature was 38.5 degrees in the shade, and the minimum temperatures for the three nights following were 13.6 degrees, 28.7 degrees and 28 degrees.

On December 3 the dipped lots showed an average gain per sheep, since the last weighing, of three pounds, while lot 1 showed a gain of five pounds per sheep. This would indicate a set-back of two pounds per head as the result of dipping.

*The sudden fluctuations in weights were due to sudden changes in temperature. On the night of November 25 the temperature went down to 20.3 degrees, and on the night of November 26 it went to 11.3 degrees.

I will omit the weighings of December 5, because of the unaccountable falling-off in lot 3, probably due to an error in weighing.

On December 8 the dipped lots had made an average gain of five and one-third pounds to an average gain of six pounds in the check lot.

On December 22 we find an average gain of seven and two-thirds pounds in the dipped lot against a gain of nine pounds by the checks, indicating a set-back of one and one-third pounds in consequence of the dipping.

It is a question concerning which there might be a difference of opinion as to whether the real set-back is better indicated within a very few days after the dipping, or after two or three weeks. It is my opinion that it is best indicated in a very few days. However we may think in regard to this, the weights given above show two-thirds of a pound as the least set-back and three and one-half pounds as the largest set-back. If the least loss indicated were the real loss, it would indicate a tax of about three cents per head for dipping at the temperatures above indicated. If the sheep are worth four cents, live weight, the heaviest loss, three and one-half pounds per sheep, would mean a loss of fourteen cents for each sheep dipped.

The amount of loss will, of course, depend largely upon the degree of cold, the distance the sheep are driven, and the manner in which they are handled, but I am fully convinced from the above experiments that when the temperature is approximately what it was in the above experiments, the loss of weight from dipping will cost the owner of the sheep fully five cents per head, and this must be added to the expense of dipping to get at the total cost. It is therefore very important that the most effectual dips be used, even though they may cost more, and the dipping should be done at such time and in such manner as to do the least possible injury to the sheep. This applies more particularly, of course, to sheep or lambs that are being fed for the market.

## DO DIFFERENT DIPS HAVE DIFFERENT EFFECTS?

Patent dips are often recommended as having some tonic or other beneficial effect upon the sheep, aside from killing scab, which will more than pay for its use, while such dips as lime and sulphur are sure to have some bad effect. A study of the above table does not indicate anything of that kind. It will be noticed that the bunch dipped with lime and sulphur made the largest gain of any. To be sure, this bunch was fed upon ensilage, while the others had dry food, but the rapid gain argues strongly against any specially bad effect of this dip.

The next best gain, ten pounds, was in lot 6, but these were only dipped once. The others that were fed grain, lots 7 to 10, were dipped twice and made a gain of eight pounds each.

## GENERAL DIRECTIONS FOR PREVENTING AND CURING SCAB.

A little prevention will often save many dollars of expense and much trouble in dealing with this disease.

If one has sheep that are free from scab, he should not allow sheep that may have the disease to be put with them. Suspicious sheep should be kept in a yard by themselves until it is quite certain that they are free from the infection.

Persons who are purchasing lambs or sheep from a locality where scab is known to be present should not put them at once into the yards where they are to be fed for the market. They should, if possible, be kept out of these yards until dipped, at least once, and it would be better if they could be dipped twice. The experiments to determine how long the mites may live off the sheep prove that they may live at least twenty days. There is no certainty then of eradicating the disease with the best dip, even in two dippings, fourteen days apart if the sheep are put back in the old yards. A single surviving female would be sufficient, if she could find her way back on the sheep, to start the disease afresh.

Where sheep are kept the year around it will be much cheaper to dip soon after shearing when the wool is short, as it will take less material.

If lime and sulphur, or potash and sulphur are used, boil thoroughly before using in order to get a more perfect combination of the ingredients. Also, do not use more than one pound of lime to three or four pounds of sulphur, as it is the excess of lime that does the injury to the wool.

Do not get the idea that the disease may be spontaneous under any possible conditions, for it is not. As well think of horses or jack rabbits coming into existence without parents. Every sheep that contracts scab does so by getting the mites or their eggs directly or indirectly from other animals.

I wish to acknowledge the assistance received from the farm department in carrying on these experiments.

Prof. Cooke has taken much interest in the work, has helped with good suggestions, and by putting at my disposal the dipping vat belonging to the farm department and such of the farm help as was needed in carrying on the work.

# A FEW INSECT ENEMIES OF THE ORCHARD.

Clarence P. Gillette, M. S.

## SCALE LICE.

Colorado fruit growers may well congratulate themselves that no serious outbreak of scale insects has ever occurred in the orchards of the state, and also, that the San Jose scale has not yet been found in Colorado. But, while congratulating ourselves thus, we must not fail to take care of the few species of scale lice that are known to be present in limited localities and to take every precaution against introducing others from abroad.

### HABITS AND APPEARANCE OF SCALE LICE IN GENERAL.

Scale lice are so called because they secrete over themselves, for protection, a thin, horny covering or scale. If one examines these scales in the fall or winter he usually finds them filled with minute eggs. These eggs hatch early in the spring, and the minute, wingless lice that come from them crawl about over the tree for a few days and then insert their beaks into the bark, fruit or leaves and begin to draw the sap and to grow. Once located, the lice of most species never move again. The scale soon begins to form for protection and increases in size with the growth of the louse underneath.

These scales usually imitate the bark of the tree very closely in color, so that they are often unnoticed until the tree is nearly or quite dead. A close observer will notice, however, that the bark of the tree appears rough and scaly, and that the tree lacks vigor.

### HOW THE LICE ARE SPREAD.

It may seem strange that so minute a creature without wings, and one that is able to run only for a few days, can distribute itself so rapidly and be so difficult to exterminate.

These insects are scattered for the most part by being carried upon nursery stock or grafts, or even upon fruit, from place to place. They are also carried by winds and are undoubtedly carried long distances in many cases upon the feet of birds.

## A FEW SCALE LICE FOUND OR REPORTED IN COLORADO.

### THE SAN JOSE SCALE (*Aspidiotus perniciosus*).

This, the most destructive of all the scale lice that infest deciduous fruit trees, has been reported on a few occasions in

*Fig. 2.*

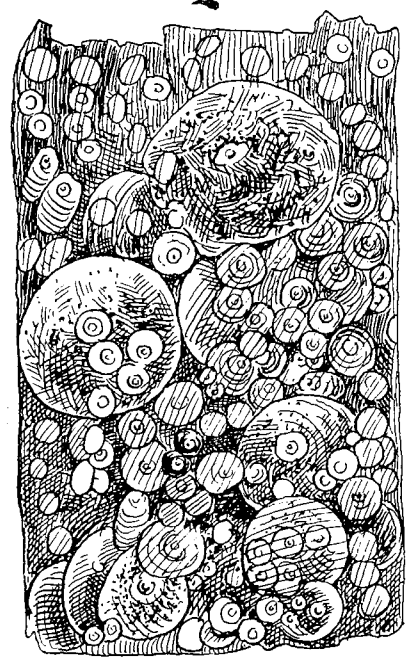

Figure II.—Piece of bark covered with San Jose scale, greatly magnified. (From United States Department of Agriculture, Division of Entomology, copied.)

Colorado, but I wish to assure the readers of this article that none of these reports have been corroborated. The recent reports of this scale in Mesa county were all a mistake, the scale in question being Putnam's scale, which is mentioned below.

After determining this to be Putnam's scale, I sent samples to Prof. Cockerell, of New Mexico, and to Dr. Howard, of the department of agriculture, at Washington, and both assured me that my determination was correct and that the species in question could not be San Jose scale.

This scale has been reported in no less than twenty states and territories, and is scattered from the Atlantic to the Pacific.

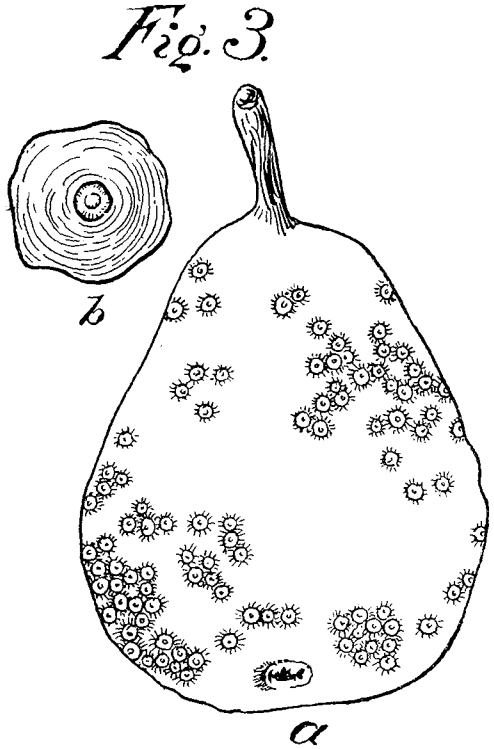


Figure III.—a. Pear infested with San Jose scales, natural size; b, a single scale greatly enlarged, showing the rust-colored spot at the center. (From the United States Department of Agriculture, Division of Entomology, copied.)

Our nearest neighbors reported as having it are New Mexico, Arizona, Idaho, Indiana and California.

The scales attack all parts of the tree above ground—bark, leaf and fruit. They are seldom over one-twenty-fifth of an inch in diameter, but may attain twice this size where there are only scattering individuals. Figure II. shows the appearance of

scales and young lice upon bark greatly magnified, and figure III. shows the scales on a pear, where they are represented of natural size.

PUTNAM'S SCALE (*Aspidiotus ancylus*).

This scale resembles the preceding very closely, but can usually be told from it by its darker color and the brighter or deeper rust-colored spots on the center of the scales. These two scales can only be distinguished with certainty by the use of

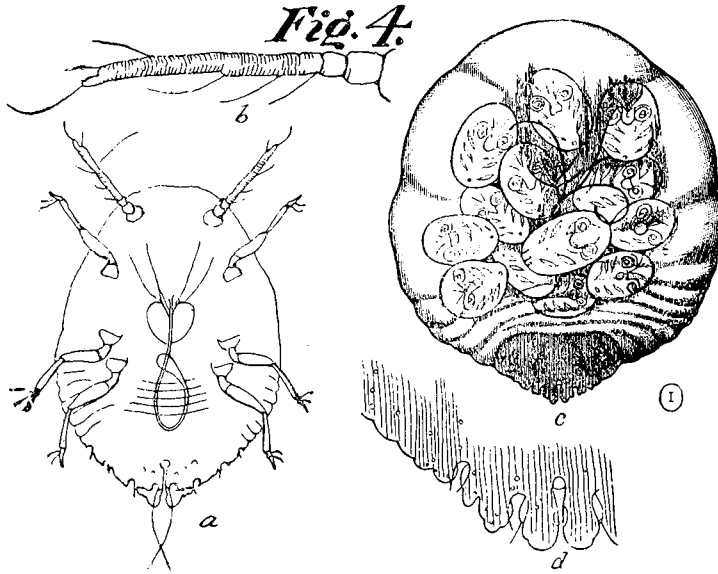


Figure IV.—a, Immature San Jose scale louse removed from the scale and greatly enlarged; b, its antenna, or feeler, still more enlarged; c, gravid female, showing young within her body; d, outline of the anal plate, greatly enlarged. (Copied from bulletin of United States Department of Agriculture, Division of Entomology.)

a compound microscope in the hands of a specialist. It is important, therefore, if either of these scales are suspected, that samples be forwarded at once to the experiment station for determination. So far as I can learn, Putnam's scale has never been a very serious pest in any part of the United States, but there is always a possibility that an insect that has formerly attracted little attention may suddenly become very abundant and injurious when introduced into a new locality. This has been known to be present in a few places in Colorado for several years. I know of one small plum orchard in Cañon City

where this scale is very abundant and is probably the cause of several trees dying. Mr. Oyler, of Grand Junction, has sent me twigs from pear and plum trees in Mesa county containing this scale in large numbers. He reports the scale to be scattered over a large territory and in many orchards, but seemingly doing but little harm, except to a single plum tree. Prof. Cockerell, of New Mexico, tells me that this scale is found in that state on oak, box-elder and cottonwood, as well as on various fruit trees. It probably occurs in many orchards in this state where it is not suspected at present.

HOWARD'S SCALE (*Aspidiotus howardi*).

This scale is a comparatively new species and was first discovered by the writer upon native plum trees at Cañon City, Colo. The scales infest both the tender bark of the twigs and the fruit. The scales are of about the same size as those of the two preceding species, but they are almost white in color and lack almost wholly the reddish center. This species seems to have decreased rather than increased since it was first discovered. If it occurs in any abundance it will probably be found conspicuous on the fruit of plum trees.

A SCALE UPON PEACH TREES (*Lecanium persicae*).

I have just recently received from Mr. A. F. Reeves, of Montrose, Colo., peach twigs from his locality infested with a large rust-colored scale about three-sixteenths of an inch long by about one-eighth of an inch broad. The scales are prominent and stand out like little galls on the bark. The scales were very abundant on the twigs sent, and, when received, March 28, the young lice had hatched and were thickly scattered over the twigs. From their size, it seems probable that they hatched last fall. Mr. Reeves reports the scales on about forty trees, so far as he can determine. As the young of this species appear all within a short time, it is probable that this scale can be easily kept in check by the use of a strong kerosene emulsion, or a strong solution of fish-oil soap soon after hatching. It will be comparatively easy to treat them while the foliage is off the trees.

Whale-oil or fish-oil soap, lime, sulphur and salt washes, resin washes and kerosene emulsion are the most common remedies used against the scale insects.

THE BROWN OR CLOVER MITE (*Bryobia pratensis*).

This is one of the worst pests on fruit trees, especially pear, apple, plum and cherry, in the mountainous districts of Colorado.

Its presence in the summer time is best noticed by the pale, sickly appearance of the foliage of the trees, by the whitish, scurvy appearance on the under side of the limbs and about the small crotches of the trees, and by the minute spider-like objects, of a dark color running about upon the bark. On examination, it will be seen that the scurvy appearance of the limbs is due to the cast skins and empty egg shells of the mites.

Although the injury to the trees is chiefly manifested in the bleached foliage, the mites will seldom be found on the leaves.

## REMEDIES.

The following are the results of experiments for the destruction of both eggs and mites that were conducted by myself one year ago. During the fall, the mites deposit enormous numbers of reddish eggs upon the limbs of the trees, chiefly about the crotches. The eggs are massed together, and are plainly seen as reddish or rusty patches upon the bark:

A number of small limbs of a pear tree that were almost covered with eggs were procured from Cañon City and set out in moist earth for the experiments. Some of these I took while in Cañon City, and others were sent me by Judge W. B. Felton:

*Whale-Oil Soap*, in the proportions of one pound to a gallon of water, and in one-half and one-fourth this strength, killed perfectly all the eggs that were treated with it, but in the proportion of one pound to eight gallons it did little good. The newly hatched mites were killed by whale-oil soap in all strengths down to one pound to eight gallons.

*Kerosene Emulsion*, used without diluting (in which the kerosene was two-thirds of the mixture) and diluted with water to one-half and one-fourth this strength, killed perfectly in every case. When diluted so that the kerosene was one-sixteenth of the mixture (or one-half of the last named strength) a very few of the mites hatched. This last strength did kill, perfectly, mites in all stages when thoroughly treated with it.

*Leggett's Potash Lye*, in the proportion of one pound to one gallon of water, did very little good in preventing the hatching of the eggs. As near as I could estimate, it killed one-third of the eggs.

*Tobacco Decoction*, made by steeping one pound of tobacco in three gallons of water, had no perceptible effect upon the eggs, all hatching perfectly.

*Sulphur Spray*, prepared by combining three pounds of sulphur and two pounds of caustic soda and diluting to 200 gallons in water, was also used against the eggs, but without effect.

The whale-oil soap and the kerosene emulsion, being entirely efficient, one or the other should be used against this pest. As it is much easier and cheaper to make the application during the winter season, while the foliage is off the trees, this is the season that should be chosen to destroy the brown mites.

### THE CODLING MOTH, OR APPLE WORM (*Carpocapsa pomonella*).

This pest causes heavier annual loss to the apple crop than any other insect. It is found in nearly every part of the world where apples are grown. In the orchards of Delta county, Colorado, it was for a number of years unknown. It is now present in all the orchard regions of the state, unless it be in some very limited and isolated places. It is not a pest that we can hope to exterminate, and orchardists can not afford to let it go unchecked.

*Life Habits of the Insect*—There are two, and perhaps a partial third, brood of this insect in Colorado each year. The moths of the first brood begin to appear early in the spring, and are ready to deposit their eggs in the blossom ends of the small apples as soon as the blossoms fall. The moths do not all appear at once, so that the eggs of the first brood are distributed through several weeks. If the weather is warm, the eggs will hatch in about four or five days, and the young larvæ will begin to eat in the blossom end of the apple and to burrow their way to the core, about which they feed until mature. When mature, the larvæ or worms eat a large hole to the outside, and escape to go in search of a suitable place to spin a silken cocoon and change to a chrysalis, and, a little later, to come forth as moths. This second brood of moths begins to appear about the first week in July, and in a few days, like the first brood, fly to apples or other suitable fruit to deposit their eggs. This time the eggs are often laid in the stem end of the apple or upon any rough spot where they will readily adhere. The habits of this brood are like those of the first. The later individuals do not leave the apples until they have been barreled or put in winter quarters. The winter is spent in the worm state in some protected spot, as between barrel staves, under barrel hoops, under scales of bark on apple trees, etc. Early in the spring these worms change to chrysalids, and a little later appear as moths.

#### REMEDIES.

On account of the habit of the larva in feeding for a little time in the blossom of the apple before burrowing to the core,

it has been found that a thorough spraying with London purple or Paris green at the correct time will destroy about 70 per cent. of them.

The proper time for spraying is immediately after the blossoms fall and *never before*. To spray before the blossoms fall is not only waste of time and material, but will also be liable to poison honey bees that visit the flowers for honey and pollen. If the spraying is much delayed, many of the worms will have already eaten their way into the fruit and be out of the reach of the poison. A second application should be made in a week or ten days after the first. If heavy rains fall, it is well to make the second application as soon as possible afterward. Should there be much rain-fall following the first or second treatment within a few days, it would pay to make a third treatment, but otherwise not. Care should be taken to throw the spray so that it will strike the blossom ends of the apples, and the treatment should be thorough. It is best to stop as soon as the leaves begin to drip.

In the eastern states, it is usually recommended to make the application in the proportion of one pound of poison to 200 gallons of water. In the dry atmosphere of Colorado I have found it very safe to apply in the proportion of one pound to 160 gallons the first time. The weaker mixture will do for the second or third applications.

A great many worms may be caught and destroyed by tying bandages of burlap or other cheap cloth about the trunks of the trees, and removing these once in a week or ten days to kill the worms that collect beneath them. This work should begin about the last week in June, and be continued until fall.

Where apples are kept in cellars, the windows and doors should have screens to prevent the escape of the moths that hatch in the cellars. Care should be taken not to take fruit barrels or boxes from storehouses or fruit dealers to the farm unless they have been thoroughly disinfected, as they often contain the larvæ of the codling moth in great numbers.