E118-8M-L180

TEXAS AGRICULTURAL EXPERIMENT STATION

A. B. CONNER, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

BULLETIN NO. 504 JANUARY, 1935

DIVISION OF VETERINARY SCIENCE

Immunization of Sheep and Goats Against Soremouth [Contagious Ecthyma]

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
T. O. WALTON, President

STATION STAFF†

Administration:
A. B. Conner, M. S., Director
R. E. Karper, M. S., Vice Director
Clarice Mixson, B. A., Secretary
M. P. Holleman, Chief Clerk
J. K. Francklow, Asst. Chief Clerk
Chester Higgs, Executive Assistant
Howard Berry, B. S., Technical Asst.

Chemistry:
G. S. Fraps, Ph. D., Chief; State Chemist
S. E. Asbury, M. S., Chemist
J. F. Fudge, Ph. D., Chemist
E. C. Carlyle, M. S., Asst. Chemist
T. L. Ogier, B. S., Asst. Chemist
A. J. Sterges, M. S., Asst. Chemist
Ray Treichler, M. S., Asst. Chemist
W. H. Walker, Asst. Chemist
Velma Graham, Asst. Chemist
Jeanne F. DeMottier, Asst. Chemist
W. E. Merrill, M. S., Asst. Chemist
W. H. Garman, M. S., Asst Chemist
A. R. Kemmerer, Ph. D., Asst. Chemist
A. W. Walde, Ph. D., Asst. Chemist

Horticulture:
S. H. Yarnell, Sc. D., Chief

Range Animal Husbandry:
J. M. Jones, A. M. Chief
B. L. Warwick, Ph. D., Breeding Investiga.
S. P Davis, Wool and Mohair
J. H. Jones, B. S., Animal Husbandman

Entomology:
F. L. Thomas, Ph. D., Chief; State Entomologist
H. J. Reinhard, B. S., Entomologist
R. K. Fletcher, Ph. D., Entomologist
W. L. Owen, Jr., M. S., Entomologist
J. N. Roney, M. S., Entomologist
J. C. Gaines, Jr., M. S., Entomologist
S. E. Jones, M. S., Entomologist
F. F. Bibby, B. S., Entomologist
**R. W. Moreland, B. S., Asst. Entomologist
C. E. Heard, B. S., Chief Inspector
C. J. Burgin, B. S., Foulbrood Inspector

Agronomy:
E. B. Reynolds, Ph. D., Chief
R. E. Karper, M. S., Agronomist
P. C. Mangelsdorf, Sc. D., Agronomist
D. T. Killough, M. S., Agronomist
J. T. Vantine, Jr., M. S., Asst. Agronomist
J. O. Beasley, M. S., Asst. Agronomist

Publications:
A. D. Jackson, Chief

Veterinary Science:
*M. Francis, D. V. M., Chief
H. Schmidt, D. V. M., Veterinarian
**F. P. Mathews, D. V. M., M. S., Veterinarian
J. B. Mims, D. V. M., Asst. Veterinarian

Plant Pathology and Physiology:
J. J. Taubenhaus, Ph. D., Chief
W. N. Ezekiel, Ph. D., Plant Pathologist
L. B. Loring, M. S., Asst. Plant Pathologist
G. E. Altstatt, M. S., Asst. Plant Pathologist
"Glenn Boyd, B. S., Asst. Plant Pathologist

Farm and Ranch Economics:
L. P. Gabbard, M. S., Chief
W. E. Paulson, Ph. D., Marketing
C. A. Bonnen, M. S., Farm Management
‡**W. R. Nisbet, B. S., Ranch Management
**A. C. Magee, M. S., Ranch Management

Rural Home Research:
Jessie Whitacre, Ph. D., Chief
Mary Anna Grimes, M. S., Textiles
Sylvia Cover, Ph. D., Foods

Soil Survey:
**W. T. Carter, B. S., Chief
E. H. Templin, B. S., Soil Surveyor
J. W. Huckabee, B. S., Soil Surveyor
I. C. Mowery, B. S., Soil Surveyor

Botany:
V. L. Cory, M. S., Acting Chief

Swine Husbandry:
Fred Hale, M. S., Chief

Dairy Husbandry:
O. C. Copeland, M. S., Dairy Husbandman

Poultry Husbandry:
R. M Sherwood, M. S., Chief
J. R. Couch, M. S., Assoc. Poultry Husb.
Paul D. Sturkie, B. S., Asst. Poultry Husb.

Agricultural Engineering:
H. P. Smith, M. S., Chief

Main Station Farm:
G .T. McNess, Superintendent

Apiculture (San Antonio):
H. B. Parks, B. S., Chief
A. H. Alex, B. S., Queen Breeder

Feed Control Service:
F. D. Fuller, M. S., Chief
James Sullivan, Asst. Chief.
S. D. Pearce, Secretary
J. H. Rogers, Feed Inspector
K. L. Kirkland, B. S., Feed Inspector
S. D. Reynolds, Jr., Feed Inspector
P. A. Moore, Feed Inspector
E. J. Wilson, B. S., Feed Inspector
H. G. Wickes, D. V. M., Feed Inspector

SUBSTATIONS

No. 1, Beeville, Bee County:
R. A. Hall, B. S., Superintendent

No. 2, Tyler, Smith County:
P. R. Johnson, M. S., Superintendent
**B. H. Hendrickson, B. S., Sci. in Soil Erosion
**R. W. Baird, M. S., Assoc. Agr. Engineer

No. 3, Angleton, Brazoria County:
R. H. Stansel, M. S., Superintendent
H. M. Reed, B. S., Horticulturist

No. 4, Jefferson County:
R. H. Wyche, B. S., Superintendent
**H. M. Beachell, B. S., Junior Agronomist

No. 5, Temple, Bell County:
Henry Dunlavy, M. S., Superintendent
C. H. Rogers, Ph. D., Plant Pathologist
H. E. Rea, B. S., Agronomist
**E. B. Deeter, B. S., Soil Erosion
**P. L. Hopkins, B. S., Junior Civil Engineer

No. 6 Denton, Denton County:
P. B. Dunkle, M. S., Superintendent
**I. M. Atkins, B. S., Junior Agronomist

No. 7, Spur, Dickens County:
R. E. Dickson, B. S., Superintendent
B. C. Langley, M. S., Agronomist

No. 8, Lubbock, Lubbock County:
D. L. Jones, Superintendent
Frank Gaines. Irrig. and Forest Nurs.

No. 9, Balmorhea, Reeves County:
J. J. Bayles, B. S., Superintendent

No. 10, College Station, Brazos County:
R. M. Sherwood, M. S., In Charge
L. J. McCall, Farm Superintendent

No. 11, Nacogdoches, Nacogdoches County:
H. F. Morris, M. S. Superintendent

No. 12, Chillicothe, Hardeman County:
**J. R. Quinby, M. S. Superintendent
**J. C. Stephens, M. A., Asst. Agronomist

No. 14, Sonora, Sutton-Edwards Counties:
W. H. Dameron, B. S., Superintendent
I. B. Boughton, D. V. M., Veterinarian
W. T. Hardy, D. V. M., Veterinarian
O. L. Carpenter, Shepherd
**O. G. Babcock, B. S., Asst. Entomologist

No. 15, Weslaco, Hidalgo County:
W. H. Friend, B. S., Superintendent
S. W. Clark, B. S., Entomologist
W. J. Bach, M. S., Plant Pathologist
J. F. Wood, B. S., Horticulturist

No. 16, Iowa Park, Wichita County:
C. H. McDowell, B. S., Superintendent
L. E. Brooks, B. S., Horticulturist

No. 19, Winterhaven, Dimmit County:
E. Mortensen, B. S., Superintendent
**L. R. Hawthorn, M. S., Horticulturist

Members of Teaching Staff Carrying Cooperative Projects on the Station:

G. W. Adriance, Ph. D., Horticulture
S. W. Bilsing, Ph. D., Entomology
D. Scoates, A. E., Agricultural Engineering
A. K. Mackey, M. S., Animal Husbandry
R. G. Reeves, Ph. D., Biology
J. S. Mogford, M. S., Agronomy
F. R. Brison, M. S., Horticulture
W. R. Horlacher, Ph. D., Genetics
J. H. Knox, M. S., Animal Husbandry
A. L. Darnell, M. A., Dairy Husbandry
R. O. Berry, B. S., Biology
R. T. Stewart, Ph. D., Agronomy
V. A. Little, M. S., Entomology

*Dean, School of Veterinary Medicine.
**In cooperation with U. S. Department of Agriculture.
‡In cooperation with Texas Extension Service.

†As of January 1, 1935

Contagious ecthyma (soremouth) is an infectious disease of sheep and goats caused by a filterable virus and characterized by the formation of vesicles, pustules, and scab on the lips, accompanied by intense inflammation and severe swelling. Although lambs and kids are most susceptible to the infection and suffer from it most severely, older animals contract the disease, usually in a mild form.

Soremouth which is prevalent throughout the sheep country of the Edwards Plateau and Trans-Pecos regions of West Texas occurs annually during the spring and summer months. The uncomplicated disease runs a course of about thirty days and heals spontaneously, leaving the lips smooth and without scars; the mortality from soremouth itself is negligible but the rapid loss of weight and condition in the infected animal is serious, occurring as it does at a critical period of its life.

The occurrence of soremouth parallels the period of greatest activity of the screw-worm fly, *Cochliomyia americana*, which is common to all parts of the sheep-raising regions in this State. The infestation of the lesions of soremouth by the flesh-eating larvae of this fly constitutes a very serious problem and causes enormous annual losses among lambs and kids in West Texas.

The virus of soremouth is contained in the characteristic hard scab which drops on the range. The virus is very resistant to soil and weather conditions retaining its infectivity for an indefinite time. Soremouth may disappear from a pasture or ranch only to reappear after a lapse of one or more years. Obviously this indicates that a ranch once infected may so remain for a variable period of time, the length of which has not been determined.

Medical treatment of soremouth is unsatisfactory to say the least and is of no practical value in arresting the disease.

Field experiments in which suckling lambs were vaccinated with a soremouth scab emulsion were successful in preventing soremouth. More than two and one-half million lambs and kids have been vaccinated by Texas sheepmen during the past two years with excellent results.

Vaccination establishes an immunity which endures for at least twenty-eight months and protects the lamb on the range and in the feed lot. The vaccination of lambs and kids infected with soremouth is of value in shortening the course and reducing the severity of the disease. Vaccination of lambs and kids should be carried out only on ranges where soremouth infection already exists.

CONTENTS

BULLETIN NO. 504 JANUARY, 1935

IMMUNIZATION OF SHEEP AND GOATS AGAINST SOREMOUTH (Contagious Ecthyma)

I. B. Boughton and W. T. Hardy

Contagious ecthyma is an infectious disease of sheep and goats caused by a filterable virus and characterized by the formation of papules, vesicles, pustules, and scabs on the skin of the lips which cause intense inflammation and painful swelling. The infection occurs principally in lambs and kids, usually in a severe form but older animals are susceptible and ordinarily develop a type of the disease which is benign in character and of short duration. The infected lamb or kid with its thickened, stiff, sensitive lips, can neither suckle nor graze, rapid loss of weight and condition at the critical period of its life resulting (Fig. 1).

In the Edwards Plateau and Trans-Pecos regions of West Texas, uncomplicated cases of contagious ecthyma run a course of 25 to 30 days and heal spontaneously, leaving the lips smooth and without scars. Direct losses from the disease itself are confined to shrinkage and the more or

Fig. 1. Typical soremouth (contagious ecthyma). This photograph was taken on the 14th day after infection.

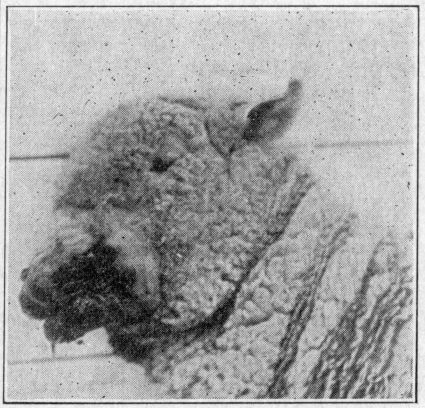

Fig. 2. Screw-worm damage following soremouth infection.

less permanent stunting of the animal. The largest part of the severe annual losses in lambs and kids is due to the damage done by the larvae of the screw-worm fly, *Cochliomyia americana*, (Cushing and Patton (2)) which infest the inflamed, swollen lips of the animal suffering from the infection and cause its death in many cases (Fig. 2). Such annual losses, in past years, have amounted to hundreds of thousands of dollars. The disease has been prevalent in these regions for the past quarter century and longer, becoming more and more prevalent with the fencing of the range. Obviously the infection in these pastures has been intensified from year to year by the repeated dropping of the infectious scab, which is very resistant to weather and soil conditions, on the range.

Schmidt and Hardy (7) in their review of the literature of soremouth showed that the disease is widely distributed, occurring in all the sheep-raising countries of the world. Since the publication of their work some additional information on various aspects of the disease have been reported by other investigators.

Seddon and McGrath (8) found that English and Australian strains of the virus confer a solid immunity against each other as well as against homologous strains, when inoculated into susceptible lambs. Newsom and Cross (5) succeeded in filtering the virus from scab emulsions made from natural cases of soremouth occurring in feed-lot lambs in Colorado, through Berkefeld V filters. They state that *Actinomyces necrophorous* in natural cases may sometimes produce serious complications, but that this organism must be considered a secondary invader. In a later report Newsom and Cross (6) record the transmission of soremouth to man through the handling of infected sheep.

Boughton and Hardy (1) filtered the virus through Mandler filters, described the disease thoroughly, and presented charts illustrating the excellent results of field tests of vaccination of young suckling lambs with a scab emulsion. These writers record the transmission of the disease to man through the handling of infectious material.

Glover (3) reporting his work with seventeen strains of sheep virus, states that all gave a typical reaction when inoculated into susceptible lambs and that all conform to a single type. Further he found that goat strains inoculated into susceptible lambs, always induce a mild type of lesion and that the same results are obtained when the process is reversed. By complement fixation tests the author was able to demonstrate the presence of specific antibodies in the blood of hyperimmunized lambs.

Hudson (4) in 1930 reported from Africa that sheep immune to sheep-pox are still susceptible to infestation with soremouth virus.

Cause—A Filterable Virus

The writers, like all other investigators working with soremouth, have experienced difficulty in obtaining potent filtrates from scab emulsions from either experimental or natural cases of the disease but have succeeded in several instances. The filtration of such emulsions, through Mandler filter candles, was carried out in the usual manner, the absence of contaminating organisms in the filtrate being demonstrated by lack of growth in the aerobic and anaerobic cultures of the filtrate.

The potency of one such filtrate is shown in Table 1. It will be noted that both test animals, Nos. 428 and 429, developed soremouth subsequently to inoculation with the filtrate while the control lamb, No. 427, also developed the disease following inoculation with the residue left in the filter candle tube.

Resistance of the Virus

In experiments to determine the thermal death point it was found that heating at 58-60° C. in a water bath for 30 minutes kills the virus. This is illustrated in Table 2, where the test lambs, Nos. 428, 429, and 430

showed no indication of a "take" following inoculation with the heated virus, while the controls, Nos. 397 and 398, developed typical lesions follow-

Table 1. Transmission test with filterate of sheep soremouth scab emulsion

Lamb number	Treatment	Results
428 429	Inoculated in scarified skin of lips with filtrate	Soremouth
427 Control	Inoculated in scarified skin of flank with residue in candle tube after filtration of scab emulsion	Soremouth

ing inoculation with the unheated virus. Other experiments in which the virus was heated at 50° and 55° C. respectively for a like period of time failed to kill the virus.

Several experiments to test the longevity of the virus in the scab under experimental conditions showed that sometimes the virus is killed after relatively short periods of time, while it remains potent for months or

Table 2. Potency test of filtrate of sheep soremouth scab emulsion heated in a water-bath at 58-60° C. for 30 minutes

Lamb number	Treatment	Results
428 429 430	Inoculated in scarified skin of flank with heated filtrate	Negative
397 398 Controls	Inoculated in scarified skin of flank with unheated filtrate	Soremouth

years in other instances. Virulent scab exposed on the range during the summer lost its potency sometime between 30 and 60 days. In this experiment the scab was thrown on the ground in a small wire enclosure within which some tall grass and one small live-oak tree were located. This grass shaded the ground during the early morning and late afternoon hours, while the live-oak tree afforded shade during the middle of the day. Consequently the scab was exposed to the direct rays of the sun only during a small part of the day. Another lot of virulent scab was thrown into a similar enclosure in September and was still potent when tested on susceptible lambs the following April. Scab dried over sulphuric acid, powdered, and stored in well-stoppered or sealed glass tubes in the ice-box retained its potency for at least 32 months. Of three batches of potent dried powdered scab, stored in stoppered glass tubes in the dark at an average mean temperature of 83 degrees Fahrenheit, one had lost its potency within 54 days, another within 64 days, and the third within 120 days. None of these batches of scab were tested at a shorter interval.

That the virus in the scab is resistant to weather and soil conditions is proved by the persistence of the infection from year to year on ranges all over the sheep country. The fact that the disease reappears on a given range after lapses of several years shows that the virus survives despite adverse weather and soil conditions and indicates that once the range

becomes infected it may remain so for an undetermined period of time. Experience shows this to be true even though all sheep and goats are removed for a year or longer.

Field Vaccination

Inasmuch as the medicinal treatment of the disease had been proved by years of experience to be of little avail the prevention of the disease through vaccination with scab emulsions was studied. Schmidt and Hardy in their preliminary report on soremouth in Texas Agricultural Experiment Station Bulletin No. 457, found that an immunity was established in their experimental lambs and kids that recovered from the disease. They took advantage of this finding and immunized the lambs and kids on the range in a small flock of sheep and goats with very encouraging results. Following up this work the authors undertook to extend these experiments and vaccinated lambs on the range on a large scale in the spring of 1932 to test the efficiency of such procedure under field conditions.

These experiments were designed to demonstrate whether or not the vaccination of the young suckling lamb offered a practical, dependable means of protecting the animal against soremouth infection and the consequent screw-worm damage. In other words, we wanted to know whether the immunity conferred by such procedure would immunize the lambs against the disease for the six months that constitute approximately the annual soremouth season in this region.

For this experiment five ranches were selected. Each ranch was 14 to more than 100 miles distant from any other ranch and soremouth had appeared annually in a rather severe form for the past several years on each one.

In a series of transmission experiments it was found that scab emulsion consisting of one part scab to 100 parts of an equal mixture of sterile normal salt solution and sterile glycerine consistently produced good "takes" when inoculated into the scarified skin of susceptible animals. In all the experimental work reported in this paper a scab emulsion of this strength was used unless otherwise stated.

The procedure on the individual ranches was the same. Approximately one-half of the young lambs on each property were vaccinated and the other half were left as controls. The vaccinated animals were run in pastures where they had no opportunity to come into contact with the control animals and where the drainage from such pastures was away from the pastures occupied by the non-vaccinated animals; any possibility that the controls would contract the disease from the vaccinated animals was thereby eliminated.

After vaccination the lambs in each group were turned into the permanent pastures with their mothers. About two weeks after the vaccination had been completed on each ranch several vaccinated lambs (approximately 50 head) were gathered in each pasture and inspected for "takes". In each instance every animal examined showed well-developed lesions at the site of inoculation. After this preliminary examination, monthly inspections of the vaccinated and non-vaccinated lambs on each ranch were made until

the end of the soremouth season. All lambs, vaccinated and controls, were subject to ordinary range conditions during this period. These experiments are summarized in Table 3.

A total of 7884 lambs were vaccinated and 10,173 animals were left untreated as controls. The final results show that only 30 (.38%) of the vaccinated animals developed soremouth subsequent to vaccination, while

Table 3. Results of vaccinating on the range with sheep soremouth virus young lambs from 2 days to 8 weeks old

Ranch	Number of lambs	No. of lambs developing soremouth within 4½ months after vaccination
A	Vaccinated - - 2511 Controls - - - 5204	7 mild 2852 severe
B	Vaccinated - - 782 Controls - - - 847	15 mild 847 severe
C	Vaccinated - - 2021 Controls - - - 2012	5 mild 1684 severe
D	Vaccinated - - 2338 Controls - - - 1855	1 mild 1157 severe
E	Vaccinated - - 232 Controls - - - 255	2 mild 127 severe

6667 (65.3%) of the untreated control animals developed the disease during the soremouth season. It will be noted that the 30 vaccinated animals which showed soremouth lesions developed a very mild form, while all of the controls showed typical severe cases of the infection. Despite the active presence of screw-worm flies on the various ranches during these experiments the "takes" of only two lambs became infested with screw worms.

Duration of Immunity Following Vaccination

The experimental and field use of the vaccine has demonstrated beyond question that the vaccination of the young suckling lamb will protect it against soremouth and practically eliminate screw-worm damage on the range. But the duration of the immunity conferred by such vaccination has not been definitely determined. The report of a few investigators are not always in agreement; some state that such immunity endures for at least eight months, while others contend that the immunity might lapse after five months. One investigator reported that immunity following a natural attack lasts for 2½ years but that vaccinated animals are susceptible to infection one year later.

Observations during the spring and summer of 1934 of the two-year-old ewes which were vaccinated as suckling lambs in the spring of 1932, in the field experiments described above, showed that none of these animals had developed soremouth since vaccination despite the fact that they had been running in infected pastures during this time and that many of them suckled vaccinated lambs this past spring. This is excellent field evidence that the immunity following vaccination protected for at least two years against field infection.

Several pen experiments to determine the duration of immunity following vaccination were carried out with relatively small numbers of lambs.

In these experiments the animals in the various groups were vaccinated and then re-inoculated with a potent scab emulsion at 8, 13, 19, and 24-28 month periods respectively (Table 4).

It will be observed in this table that one of the vaccinated lambs in Group A showed no reaction to artificial reinfection—an indication of complete immunity; while the rest of these lambs, twenty-one in number,

Table 4. Test of duration of immunity in vaccinated sheep by inoculation with potent sheep soremouth virus 8, 13, 19, and 24-28 months after vaccination

Group	No. of Sheep	Inoculated with potent sheep soremouth virus	Tested for immunity* after	Results
		1932	months	
A	22	May 18	8	1 negative 21 mild** soremouth
B	7	June 23	13	5 negative 2 mild soremouth
C	26	December 22	19	7 negative 19 mild soremouth
D	9	March 15-July 14	24-28	9 negative

*In each group an adequate number of controls was included, all of which developed severe soremouth.
**Mild soremouth="takes" developed to pustular stage only and healed in 10 days or less.

showed only a very mild "take," which progressed to the pustular stage and then dried up into a thin flaky scab which had dropped by the tenth day following inoculation. The ten control lambs in this group developed typical "takes," which were healed the 24th day after vaccination.

Five vaccinated lambs in Group B showed no reaction to reinoculation, while the remaining two animals manifested a "take" which progressed to the pustular stage, dried up, and healed by the tenth day. The three susceptible control lambs in this group showed typical severe "takes," which healed in 28 days.

Of the twenty-six vaccinated lambs in Group C seven were negative to reinoculation, the remaining nineteen test lambs developed mild "takes," which healed by the tenth day, and the four control animals all showed typically severe reactions, which were healed in 27 to 30 days, respectively, following inoculation.

The nine vaccinated lambs in Group D were immune to reinfection, since no reaction developed at the point of inoculation; the two susceptible control lambs developed typical "takes," which healed in 26 days after vaccination.

Feed Lot Examinations

After the original field tests of vaccination had been made, it was found desirable to follow the vaccinated lambs through the feed lot, since the development of the disease in lambs in the feed lot usually means the absence of any profit for the feeder. As stated in previous pages, the virus of the disease exists in the feed lots and many of the lambs originating in various parts of the sheep-raising States develop the disease shortly after they are placed in these lots.

During October and November of 1933, we examined many vaccinated and non-vaccinated lambs, originating on ranches in Texas and other states, in feed lots located near Wichita and Morris, Kansas; Lamar, Colorado; and Plainview, Texas. Previous to the examination we had secured information from the buyers as to the origin of the Texas lambs and had ascertained from the ranchmen concerned whether the lambs had or had not been vaccinated. The examinations were made about three weeks after the lambs were put in the infected feed lots. The result of these examinations are shown in Table 5.

A total of 31,872 vaccinated lambs were examined, among which only two mild cases (.006%) of soremouth were found; a total of 19,980 non-vaccinated lambs running in the same lots showed 1,616 animals (8.08%)

Table 5. Soremouth among vaccinated and non-vaccinated Texas lambs in Kansas, Colorado, and Texas feed lots

Location	Vaccinated	Non-vaccinated	Number of lambs showing soremouth
Kansas	13,656	—	2
	—	8,331	453
Colorado	14,816	—	0
	—	6,749	1078
Texas	3,400	—	0
	—	4,900	85
Total	31,872	19,980	

suffering with the disease. The great majority of the cases in these non-vaccinated lambs were so severe that the animals were unable to eat to any extent.

The negligible percentage of infection found in the vaccinated lambs in these feed lots coupled with the high percentage of infection found in non-vaccinated lambs running in the same lots, demonstrates beyond question that the vaccination of young lambs on the range will protect these animals against soremouth when they are placed in feed lots some six or eight months later.

Vaccination of Soremouth-infected Lambs

Not long after the experiments looking toward the prevention of soremouth in lambs by means of vaccination were undertaken the question arose as to whether vaccination of the lamb already manifesting lesions of the disease would lessen the severity and duration of the disease. Since soremouth is a disease of the skin and the immunity from vaccination is a skin immunity, it seemed reasonable to suppose that vaccination of infected animals might stimulate the production of such immunity and thereby hasten recovery.

With this idea in mind nineteen susceptible lambs were inoculated in the scarified skin of the right flank. Nine days later, when all of these animals were showing good "takes" at the point of inoculation they were again inoculated in the scarified skin of the left flank together with four susceptible lambs to serve as controls for this inoculation (Table 6).

The "takes" resulting from the first inoculation continued typical and severe until the second inoculation in the other flank. A few days subsequent to this second inoculation the original "takes" were observed to be

Table 6. Inoculation of soremouth-infected lambs with sheep soremouth virus

No. of lambs	Inoculated in skin of right flank	Observation on 9th day	Inoculated in skin of left flank	Observation on 9th day	Results
19	April 29	Pustules, inflammation, swelling	May 8 (Second inoculation)	Right flank, normal Left flank, normal	Healed in 18 days Healed in 9 days
4	——	——	May 8 Controls	Moist scab, inflammation, swelling	Healed in 23 days

noticeably milder in character; the swelling and inflammation subsided rapidly thereafter and the scab dropped on the 17th day. The "takes" resulting from the second inoculation envolved to the pustular stage only, were accompanied by very slight swelling and inflammation, and were completely healed within nine days. It is interesting to note that the scab from the first and from the second inoculations dropped on the same day. The control animals, Nos. 340, 341, 342, and 343, which were inoculated in the scarified skin of the right flank, developed only typical "takes," which ran the usual course and healed after 24 days.

Susceptibility of Newly-born Lambs Dropped by Soremouth-immune Ewes

Severe soremouth in very young lambs is often observed on the range. An experiment in which twenty-five newly-born lambs dropped by soremouth-immune ewes which had been vaccinated with a potent scab emulsion during the second month of pregnancy were inoculated in the scarified skin of the lips with scab emulsion after they had suckled their mothers from two to four days, showed that all these animals contracted typical severe cases of soremouth. Apparently the newly-born lamb, dropped by a soremouth-immune mother, inherits no immunity from her nor is there any indication that immune bodies or substances are contained in the milk secreted by her.

Technique of Vaccination

The method of vaccinating is simple, being similar to smallpox vaccination in man. As a rule one man ("the catcher") grasps the right fore leg and the right hind leg of the lamb in his right hand and the left legs in his left hand, holding the animal at about his waist level and presenting the belly surface of the lamb to the operator.

The operator grasps the right hind leg of the animal, tightens the skin of the flank by drawing on it with his thumb, makes one or several small superficial scratches about 1/4 inch long with the scarifying instrument, places a drop of the vaccine on the scarified area with a small, stiff-bristled brush, and rubs it thoroughly into the skin.

Any sharp-pointed instrument, such as a knife blade held sidewise or a hypodermic needle, can be used to make the scratch. Many types of

"scratchers" and combination "scratchers and vaccine applicators" have been made by ranchmen and are being used successfully.

The main things to remember in vaccinating are:

(1) Scarify the skin lightly, merely breaking through the superficial layer. It is neither necessary nor desirable to draw blood; the idea is to break through the superficial layer of the skin (epidermis) into the deeper layer (dermis). Care should be exercised in making the scarification to be sure that it is so placed in the flank that the lesion produced

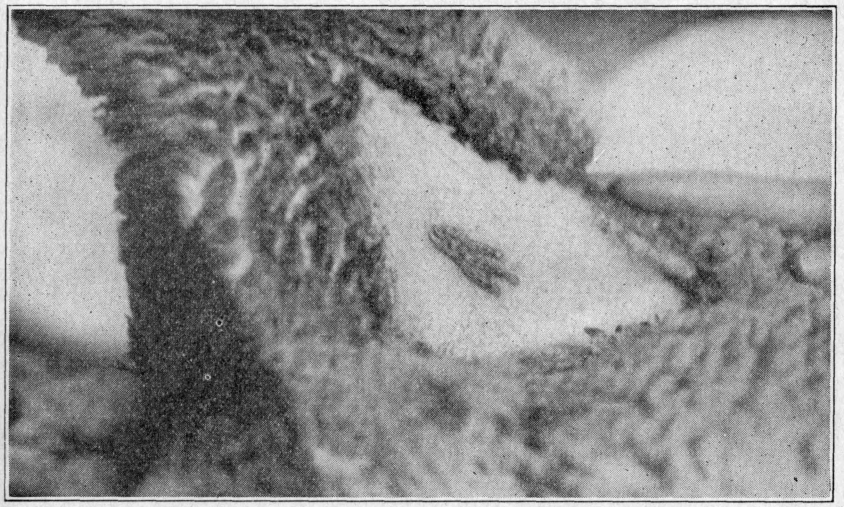

Fig. 3. A "take" following vaccination in flank. (Photographed on the 6th day after inoculation.)

will not rub on the skin of the belly. If the scarifications are too large or too numerous the resultant "takes" will be very severe and may possibly attract the screw-worm flies.

(2) Apply a small quantity of vaccine (one drop is ample) on the scarified area. It should be borne in mind that the vaccine is capable of inducing "takes" when dropped on the unbroken skin and, for this reason, one should exercise care in vaccination, being sure that no vaccine is dropped on the skin except where intended and that the proper quantity of vaccine is used.

(3) Rub this vaccine in thoroughly with a stiff-bristled brush or similar instrument.

Experience during the last three years has demonstrated that a "take" varying from the size of a dime (15 mm.) up to that of a quarter (30 mm.) produces a satisfactory immunity (Fig 3).

DISCUSSION

The field experiment described in this paper leaves no room for doubt that a practical dependable means of preventing soremouth on the range has been developed. As a result of these experiments more than two

and one-half million lambs and kids have been vaccinated by ranchmen during the past two years. This extensive vaccination of lambs and kids was extremely successful. Many ranchmen were interviewed and others volunteered information regarding the results and several inspections of vaccinated lambs on ranches were made. In all cases no soremouth occurred except in lambs which had been "missed" during the roundup previous to "marking" and consequently had not been vaccinated.

During the field vaccination experiments conducted in 1932, we observed that a small number, approximately 8%, of the vaccinated lambs manifested very mild lip lesions of soremouth some 8 to 10 days after the vaccination was set in the skin of the flank; in no case were these lesions severe enough to damage the lamb or to attract the ever-present screwworm flies. During the past two years when so many lambs were vaccinated, many ranchmen made the same observation, stating that the number manifesting these lesions is always small, usually about ten per cent. Inasmuch as there is no indication that the disease ever becomes generalized, as attested by the failure of subcutaneous or intravenous inoculations of the virus into susceptible lambs to produce external lesions, the writers believe that the development of these mild lesions following vaccination results from autoinoculation by the lamb. We have many times observed the vaccinated lamb lick the site of vaccination and thereby transfer some of the virus to the skin of the lips. The experiment in which it was demonstrated that vaccination of already infected lambs shortens the course and reduces the severity of the disease probably explains why the lesions resulting from this autovaccination are always mild and of short duration.

While tests on the duration of immunity in vaccinated animals show that the majority of them may still possess slight susceptibility to experimental reinoculation with the virus subsequent to vaccination there can be no question that the immunity established by vaccination is sufficiently solid to protect them against the field exposure to the virus. It is worthy of note that in all the immunity experiments detailed in the foregoing pages none of the vaccinated animals, following reinoculation, developed more than very mild infection, which progressed to the pustular stage only.

It is probable that the mild "takes" observed in these immunized animals following reinoculation are due partially to the presence of *Staphylococcus* aureus in the scab emulsion. We have observed, as has Glover (2), that vaccine which contains relatively large numbers of this organism usually produces a more severe "take" than does a vaccine which contains only a relatively small number of them.

The resistance of more than two million range sheep, vaccinated as lambs during the past two years, to range soremouth infection offers practical, concrete evidence of the immunity established by such procedure.

In connection with the experimental vaccination of soremouth-infected lambs shown in Table 6 it is worthy of note that several ranchmen have applied this procedure in infected range lambs with very good success. They all report that the lip lesions of the natural infection dried up, the

inflammation and the swelling subsided, and the lamb returned to normal in a remarkably short time.

Experience has shown that there is little danger that the larvae of the screw-worm fly will infest the vaccination lesion even though the animals are vaccinated when the flies are abundant and active. There is some danger of infestation if the "takes" are very large and not properly located in the flank. During the past spring when the flies were particularly abundant a few ranchmen reported that the vaccination lesion of a number of their lambs became infested with screw worms. Investigation in these cases showed that the "takes" were both too large and were located where they were rubbed by skin folds when the animal walked. Practical field experience shows that careful vaccination will obviate the danger of subsequent screw-worm infestation of the vaccination lesion.

In connection with vaccination it should be borne in mind that soremouth is transmissible to man in a mild form; hence all precautions to avoid infection should be taken by the operator. The wearing of thin rubber gloves is recommended as being the best way for the operator to avoid infection. Frequent washing of the hands in a reliable disinfectant solution during the vaccinating operations will avoid any danger of infection. Naturally, spilling the vaccine on the hands and rubbing the face with possibly contaminated hands should be avoided. Immediately after the vaccination is completed, the operator should wash and disinfect his hands thoroughly.

The empty vaccine bottle should be promptly burned, since the vaccine is a living virus. This procedure obviates the possibility of adding to the soremouth infection already present in the soil.

There certainly is no danger that the vaccinated suckling lamb will carry the infection with it to the feed lots several months later. The scab ordinarily drops within 25 to 30 days following vaccination and there is no evidence that recovered animals act as carriers of the infection. There is, of course, the possibility that sheep act as mechanical carriers of the virus through particles of virulent scab that have become attached to the wool, but the danger from this is more imaginary than real.

The fact that the infectious scab drops on the range following vaccination obviously limits the use of the vaccine to ranches where the infection already exists. There is nothing to be gained by placing the infection on ranges which are free from the disease. Inasmuch as the routine vaccination of lambs is carried out almost altogether during the spring months, which means that the scab is exposed to the weather during the summer months, it is a debatable question as to how much such vaccination adds to the infection already on the range. Especially is this so in view of the long, hot, dry summers which prevail in West Texas; while it has been demonstrated that the virus is extremely resistant to dessication, experiments have also shown that the summer climate here is capable of killing the virus in the scabs within 30 to 60 days.

SUMMARY

Soremouth (contagious ecthyma) is caused by a filterable virus to which only sheep and goats among the domestic animals and man are susceptible.

Field experiments demonstrate clearly that vaccination of the suckling lamb on the range with a properly-prepared emulsion will prevent the occurrence of the disease. In an experiment out of 7,884 lambs thus vaccinated, only 30 (.38%) subsequently developed the disease, while 6,677 (65.3%) of 10,173 non-vaccinated control lambs manifested severe cases of soremouth. During the past two years, 1933 and 1934, more than two and a half million lambs have been vaccinated with excellent results.

The immunity conferred by such vaccination endures for at least twenty-eight months.

Suckling lambs vaccinated on the range are immune to soremouth infection in the feed lots some six to eight months later. Only two (.006%) out of a total of 21,872 vaccinated lambs developed the disease in the feed lots, while 1,616 (8.08%) lambs out of a total of 19,980 non-vaccinated, manifested lesions of soremouth while running with these vaccinated animals in the same feed lots.

Vaccination of soremouth-infected animals is of definite value in shortening the course and reducing the severity of the disease as judged by the results obtained in one experiment with twenty-five soremouth susceptible lambs. Field reports corroborate the results of this experiment.

Apparently lambs inherit no immunity from immune mothers nor are there any immune bodies or substances secreted in the mother's milk, as judged by one experiment with twenty-five susceptible, newly-born lambs.

LITERATURE CITED

1. Boughton, I. B., and Hardy, W. T. 1934. Contagious Ecthyma (Soremouth in Sheep and Goats. Jour. A. V. M. A., LXXXIV, N. S. 38 (2), pp. 150-178.
2. Cushing, E. C., and Patton, W. S. 1933. Studies on the Higher Diptera of Medical and Veterinary Importance: *Cochliomyia americana*, sp. nov., the screw-worm fly of the New World. Ann. Trop. Med. and Parasit. 27 (4), p. 539.
3. Glover, R. E. 1933. Contagious Pustular Dermatitis: Cross-immunity experiments with various strains and serological tests. Third Rept. of the Director. Animal Path. Institute. U. of Cambridge, pp. 1-12.
4. Hudson, J. R. 1930. Ann. Rept. Dept. Agri. Kenya. 132. Cited from Glover (3).
5. Newsom, I. E., and Cross, F. 1934. Soremouth in Feeder Lambs due to a Filterable Virus. Jour. A. V. M. A., LXXXIV, N. S. 37 (2), pp. 233-247.
6. Newsom, I. E., and Cross, F. 1934. Soremouth in Sheep Transmissible to Man. Jour. A. V. M. A., LXXXIV, N. S. 37 (5), pp. 799-901.
7. Schmidt, H., and Hardy, W. T. 1932. Soremouth (Contagious Ecthyma) in Sheep and Goats. Texas Agri. Expt. Sta., Bull. 457.
8. Seddon, H., and McGrath, T. 1931. Cross-immunity tests with virus of infectious labial dermatitis of sheep. Vet. Res. Report, Dept. of Agr., New South Wales, Australia. 6 (III), pp. 109-110.