CATTLE DIPPING, EXPERIMENTAL AND PRACTICAL.

By VICTOR A. NÖRGAARD, V. S. (Copenhagen),
Chief of Pathological Division, Bureau of Animal Industry.

INTRODUCTION.

By the term cattle dipping is meant the immersion of cattle in solutions of various chemical preparations for the purpose of destroying parasites which infest their skin. The purpose of this paper is to consider the practice of cattle dipping, with particular reference to freeing the cattle of the parasites known as ticks, especially the *Boophilus bovis*, the tick which causes Texas, or Southern, fever.

Southern, or splenetic, fever (usually called Texas fever) is an infectious disease caused by a microparasite. This parasite, when it enters the system of susceptible animals (those animals which have been reared in sections of the country where the tick is not indigenous), destroys the red corpuscles of the blood to such an extent that the blood becomes thin and watery. The disease is always accompanied by high fever, and the course is, as a rule, acute, reaching the climax on the fifteenth or sixteenth day after infection, when death generally results.

Considered as a parasite, the Texas fever tick, so long as it is confined to cattle which are reared in sections of the country where the tick is native, is less injurious than those which are the cause of itch, mange, and other cutaneous diseases. But when by any means, natural or artificial, the ticks come in contact with cattle from other parts of the country, they produce the fatal disease commonly known as Texas fever. Therefore, when cattle from a territory infected with these ticks are to be taken into a noninfected territory, it is of the greatest importance that they first be freed of all ticks. So far as known at this time, the only remedy is to dip the cattle in a strong disinfecting solution. This is the process which will be discussed in this paper.

ESTABLISHMENT OF QUARANTINE LINE.

As early as 1889 Dr. D. E. Salmon demonstrated that the district from which cattle carried the contagion of Texas fever was identical with the territory in which the cattle tick was found, and although it was not until a few years later that the true relationship between the tick and Texas fever was finally established, a precautionary measure against the spread of the disease was taken in the form of a rigid quarantine, which excluded all cattle of the Southern tick-infected
country from the uninfected district, where cattle were known to contract the fever and die when they came in contact with Southern cattle. As experience had proven that during cold weather the danger of infection was greatly diminished, if not entirely eliminated, the quarantine regulations were suspended during the coldest part of the season, that is, from December 1 to February 15. This period, the so-called open season, was later changed to November 1 to December 31, during which time all cattle from the infected territory were allowed to pass into the uninfected territory without any restrictions whatever. During the remaining ten months, however, cattle from below the quarantine line could only be shipped north of it when intended for immediate slaughter, and rigid precautions were taken to prevent the spread of the disease from such animals.

That these measures worked great hardships to the cattle raiser south of the quarantine line is evident. The Southwest is and always will be the breeding ground of the whole country, from which the great majority of stock cattle and feeders are furnished to the central grain-producing States, as well as to the vast maturing ranges of the Northwest. Cutting these cattle off from the market for ten months in each year naturally results in a glut during the open season, with correspondingly lower prices. Furthermore, the cattle must be shipped North from the mild Southern climate at a season of the year when they are frequently exposed to extreme cold weather, for which they are entirely unprepared and which often causes heavy loss among them. On the other hand, the Northern buyer is compelled to purchase the feeders which are to consume his surplus of grain at a season when it is difficult to acclimate them, and which is always far behind the time when he is ready to receive them.

In the immense pastures of the Northwest cattle develop to a greater size on the nutritious grass than anywhere else, but owing to the long and severe winters a sufficient number of calves can not be raised to keep these pastures stocked. Calves that are born late in the summer and fail are difficult to winter, and the precautions necessary to bring them through are more costly than to purchase stock cattle from the South and mature them on the rich grass.

In view of these important facts, all efforts were concentrated to devise some means whereby the Southern feeders and stock cattle might at all times of the year be brought to the large stock centers and fed lbs in the grain-growing States or the maturing ranges of the Northwest. Experience soon showed that this object might be attained if a satisfactory dipping solution could be found.

THE CATTLE TICK THE TRANSMITTER OF TEXAS FEVER.

In a bulletin issued by the Bureau of Animal Industry in 1893 it was shown that the cattle tick is the sole transmitter of Texas fever, and that when Southern cattle had been completely freed from ticks they
might be brought into the noninfected territory without danger of communicating the disease to the Northern cattle. The same bulletin suggested a means to free the cattle from ticks, namely, to pass them through a disinfecting bath, or, as it is now termed, to dip them.

THE FIRST DIPPING VAT.

The first dipping vat to be built in this country was constructed by Mr. R. J. Kleberg, manager of the Santa Gertrude's ranch, in Nueces County, Tex., who used it for treating his stock for mange and itch. For this purpose the cattle were dipped in a strong solution of carbolic acid, and it was soon noticed that a large number of the ticks which infested the cattle became severely affected by the dip. Mr. Kleberg then placed his dipping vat and also his ticky cattle at the disposal of the Bureau of Animal Industry, and during the following five years, with the object of testing the tick-destroying properties of various disinfecting preparations, there were dipped at this ranch more than 25,000 cattle. The important fact was learned during these experiments that the ticks were better able to resist the effects of these preparations than the cattle. When the solution was strong enough to destroy all the ticks it injured the cattle, and when sufficiently diluted not to irritate the skin and eyes of the cattle the ticks would survive. As an instance showing the resistance of the tick to strong disinfectants, it may be mentioned that a solution of corrosive sublimate in water (1 to 250) does not in the least affect the tick when left in it for several minutes. The same is true of carbolic acid, arsenic, lime-and-sulphur, and a great number of proprietary sheep dips.

THE OIL BATH.

Dr. M. Francis, of the Texas Agricultural Experiment Station, was the first to suggest the use of an oil dip. It is common experience that any kind of grease or oil will destroy the ticks when applied to cattle infested with these parasites. Dr. Francis suggested the use of crude cotton-seed oil. A layer of 2 or 3 inches was floated on water, which filled the dipping vat to a depth of about 5 feet. When cattle were immersed in such a bath they would, as a rule, come out well covered with oil; but it was soon found that many ticks survived the dipping, even when 10 to 15 per cent of crude carbolic acid was added to the oil. Besides this drawback, the oil had a very heating effect on the cattle, especially during the hot summer months. Nevertheless, the oil dip was a step in the right direction, and various kinds of oil and oil emulsions with soap and carbolic acid were tested at Santa Gertrude's ranch; but none of them proved satisfactory. It was evident, also, that a lighter oil must be found in order to avoid the heating effect on the cattle, and one which at the same time would have a more decided effect on the ticks. Dr. Francis then
suggested crude black mineral oil, which also proved too severe on
the animals, and, besides, a double dipping, with an interval of several
days, did not destroy all the ticks.

EXPERIMENTS AT FORT WORTH.

About the middle of 1897 great interest was being taken in the dip-
ping question in various States, and stockmen everywhere began to
realize that it would be of immense economic importance if a satis-
factory dip could be discovered. In August, 1897, the Fort Worth
Stock Yards Company built a large dipping plant and placed it at
the disposal of the Bureau of Animal Industry.

The results previously obtained indicated that a light mineral oil
would be most likely to have the desired effect on the ticks, and
hence experiments were inaugurated at Fort Worth in order to test
some of the so-called paraffin lubricating oils. These oils, which are
derived from crude petroleum after the more volatile substances, as
benzine, gasoline, and kerosene, have been distilled over, were used
in a layer varying in depth from a few inches to 1 foot on water in
the dipping vat, and it was found that their effect was superior to
anything which had hitherto been tried. It was observed that while
the vegetable oils, as well as the crude mineral oil, had merely a
mechanical effect, in that it closed up the pores of the skin of the
parasites, the paraffin oil had in addition a decided chemical action.

After the cattle had passed through a paraffin-oil dip many of the
ticks would immediately drop off and die. Within a few hours those
that remained on the cattle showed violent contractions, changed in
color, and shriveled up. These effects were produced in some cases in
a few hours, but the majority of the ticks did not die until from
twenty-four to forty-eight hours after dipping, and some after even
a longer period. The effect on the cattle was less severe than was
observed in the experiments with other oils. On warm days, when
shelter from the sun was provided, the cattle did not pant as when
dipped in black mineral oil or cotton-seed oil. It was only by use of
a thermometer that a rise in temperature (from 2° to 5° F.) could be
discovered. Some of the animals showed a stiffness and swelling of
the legs and reddening of the skin, while the eyelids of some became
slightly swollen. These effects, however, passed off in the course of
a few days.

These very encouraging results, which were given wide publicity
through the press, caused a greater interest to be taken in the dip-
ping question, especially by those States which were desirous of
obtaining stock from Texas at all times of the year. The manage-
ment of the Fort Worth Stock Yards, in reply to numerous inquiries,
agreed to furnish the necessary cattle and oil to demonstrate to rep-
resentatives of State live-stock sanitary boards the feasibility of em-
ploying the dipping process for commercial purposes. A convention
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was called in September, 1897, at Fort Worth, which was attended by delegates from Illinois, Missouri, Nebraska, Kansas, Colorado, Oklahoma, and Indian Territory, as well as from many parts of Texas. A number of cattle were dipped, 1 foot of paraffin oil being used on the water. A small amount of animal oil was added to the paraffin oil, as it was supposed that this would tend to allay the irritating effect on the eyes and skin, but no noticeable improvement was observed. The delegates were pleased with the manner in which the cattle were put through the vat, and the effect of the oil on the ticks was equally gratifying. However, a small number of ticks survived, and, the weather being extremely warm, the oil had a more severe effect on the cattle than had hitherto been experienced. For these reasons the experiments could not be considered an unqualified success.

This convention commended the Bureau of Animal Industry for the work it had done, expressing the belief that the experiments carried out rendered "the transmission of Southern fever no longer a matter of dread," and requested that the Bureau carry on the work another year, in the hope that the question might be brought to a successful conclusion as early as possible. It was of importance that the method should be perfected early enough the following spring to permit the dipped cattle to be exposed in the various States north of the quarantine line for a period of two months during the hottest part of the summer, in order to demonstrate that the dipping had deprived them of their ability to transmit the fever. The representatives from the various States signified their willingness to cooperate with the Bureau of Animal Industry in this exposure test, and the dipping vats at Santa Gertrude's ranch and Fort Worth were placed at the disposal of the Bureau.

EXPERIMENTS AT SANTA GERTRUDE'S RANCH.

On the first of April, 1898, the experiments were therefore resumed at Santa Gertrude's ranch, where it was less difficult to obtain ticky cattle. A paraffin oil lighter than the one which was used at Fort Worth the previous season was procured. This was a clear lubricating oil of a slightly less specific gravity than the one used at Fort Worth. This lighter oil was considerably thinner than the kind used at Fort Worth, and it was believed that it would drain off the cattle more quickly than the latter, and perhaps also lessen the heating effect. Experiments were made with this oil in a layer of 6 inches on the water in the vat. As was expected, a number of cattle dipped in this bath emerged with a thinner coating of oil; otherwise there was not much difference in the effect on either the ticks or the cattle. Some of the animals became slightly stiff and others had swollen eyelids, and though the greater number of full-grown ticks were destroyed, a number of medium size survived. The ticks which were not killed were located principally on the lower parts of the body—the brisket, abdomen,
legs, etc. This fact gave rise to the suggestion that the ticks which became steeped in the water while the animal was swimming through the vat passed through oil only as the animal made the plunge and at the moment of leaving the vat, when oil and water as a rule are very much agitated, and consequently left these ticks covered with less oil than those on the upper parts of the animal. (See figs. 121 and 122.) It was therefore decided to make a test of dipping in a vat of oil alone. For this purpose a small vat was constructed, with a capacity of 250 gallons, being large enough for the complete submersion of a good-sized yearling. A number of animals were then dipped in this solid-oil bath, and it soon became evident that it had a more severe effect on the animals than when used with water. A limited number of ticks (two or three on a dozen cattle) remained alive. The effect on the cattle was too severe to admit of double dipping. It therefore became necessary to discard this oil and to find some means whereby either the tick-destroying properties of the oil might be increased or the irritating effect on the animal sufficiently lessened to allow of a double dipping.

An old-time remedy for ticks and other skin parasites in the South is sulphur; and while this had been tested in various forms, both externally and internally, it had never been found to be reliable
where the result desired was to free cattle completely of ticks. However, it was thought that by the addition of sulphur the effectiveness of oil might be increased. In carrying out this suggestion it was soon discovered that part of the sulphur was dissolved in the oil, and if the oil and sulphur were heated to about 200° F. the oil would take up from 2 to 3 per cent of the sulphur, part of which, however, was precipitated when cooled off to ordinary temperature, leaving about 1½ per cent of sulphur in the solution. As no facilities could be obtained for heating a large quantity of oil at the ranch, the sulphur was simply added to the cold oil and stirred repeatedly for two days, at the end of which time the oil had dissolved about 1 per cent of the sulphur. This preparation was poured into a small vat and a number of yearlings dipped in it. After three days not a single living tick could be found, but most of the animals had swollen eyelids and suffered considerably from heat. It is doubtful whether the addition of sulphur increased the irritating effect of the oil, but it was apparent that the animals dipped in it were not in a condition to be driven or transported. Those left in a good pasture, close to the dipping vat, soon recovered from the effects of the oil, but attempts to remove them to other parts of the ranch had to be abandoned, as they quickly became overheated.

Fig. 122.—Steer emerging from dipping vat.
As no means could be found whereby the irritating effect on the cattle might be lessened, it having been shown in previous experiments that an addition of animal oil did not have the desired effect, it became necessary to suspend any further experiments with this oil; and as no other oil could be obtained in sufficient quantities within a reasonable length of time the field of operations was removed to Fort Worth. The experiments at Santa Gertrude's ranch had demonstrated that the tick-destroying properties of an oil might be increased through the addition of sulphur, and that a solid oil bath was more reliable, so far as the ticks on the lower part of the body were concerned, than a dip consisting of a layer of oil floating on water.

The problem remained to find an oil with a less irritating and heating effect than those heretofore employed, and, it having been observed that these effects decreased in direct proportion to the thickness of the oil, it was decided to obtain an oil as thin as possible. For this purpose a number of samples of various lubricating oils were examined and one of very light specific gravity, called extra dynamo oil, was selected. This oil was said to be perfectly free from acid, and to contain less paraffin than those hitherto used, while it contained a higher percentage of volatile substances than any of the others. A number of barrels of this oil was procured. In order to test the effect of the oil alone, two yearlings were dipped in a small vat completely filled with oil. The effect on the ticks was surprising. Two to three hours after the dipping all the large ticks were dead, most of them having turned into a black, brittle substance, resembling grains of scorched corn that might be ground into powder between the fingers. All the smaller ticks and molting ticks were also badly affected, while the medium-sized ones showed more resistance. In the course of forty-eight hours only two medium-sized live ticks could be found, those being on one animal, and as the oil had evaporated to a great extent there did not seem to be much probability of their dying. Neither of the animals showed any swelling of eyelids or any noticeable stiffening of the legs. One of them, however, an emaciated Jersey-cross "dogy," gradually lost its appetite and became weaker and weaker until after two weeks it died. A post-mortem examination showed thin, watery blood and a slightly enlarged spleen. At the time, however, this was not recognized as a case of Texas fever. As the other, a stronger animal, recuperated quickly, it was thought that the smaller one was sick at the time of dipping, and therefore did not possess sufficient strength to withstand the shock received during the process. As two ticks survived, the oil could not be considered reliable as a tick destroyer after a single dipping, wherefore it was decided to add sulphur to it. Six ticky yearlings were dipped in this preparation, and in the course of two days all the ticks, both large and small, had died with the
exception of half a dozen of the medium-sized ones, which did not die until the fourth or fifth day after the dipping. By that time all of the oil had practically disappeared from the skin and the protracted effect upon the remaining six medium-sized ticks was ascribed to the sulphur left after the evaporation of the oil. Not one of these animals appeared to suffer any inconvenience from the dipping, and after one week none of them showed unusual symptoms of any kind except the loosening up of the old epithelium on the sides of the neck and the shoulders, and on the inside of the hind legs. The skin remained soft and flexible, however, and no blisters or cracks were formed.

In view of these highly gratifying results the Bureau of Animal Industry issued instructions to repeat the experiment with a larger number of animals. Thirteen ticky yearlings were immediately dipped, and the result was equally gratifying, with the exception that one weak Jersey cross died in a manner similar to the one referred to previously. The middle of July arriving, the sanitary boards of the various States which were to cooperate with the Bureau in the tests of exposing dipped cattle with susceptible cattle in pastures north of the quarantine line became impatient, as pastures had been reserved since early in the season to receive the dipped cattle. In fact, all of the States except Illinois withdrew. Therefore no time was to be lost if a final conclusion was to be reached during the summer, and it was decided to use the extra dynamo oil with sulphur for the experiments. A tank car of this oil was immediately procured, the company selling the oil agreeing to heat it and dissolve the sulphur in it before shipping.

**FIRST ILLINOIS EXPERIMENT.**

On July 17 three members of the Illinois Live Stock Sanitary Board, including the secretary and State veterinarian, arrived at Fort Worth, accompanied by Dr. B. B. Page, of Rockford, Ill., who had arranged to buy a train load of cattle to be used in the experiment. He purchased at Jacksboro, Tex., a point about 65 miles northwest of Fort Worth, and more than 100 miles south of the quarantine line, 311 head of two and three year old steers, and had them shipped to Fort Worth. These 311 head of cattle were dipped in the large vat in the stock yards at Fort Worth on July 22. The weather, which had been remarkably cool up to this time, suddenly changed to intense heat, and, it being desirable not to expose the cattle to the sun immediately after the dipping, they were not passed through the vat until after sunset. By 11 o'clock at night all had gone through without a single accident, and the 311 head of cattle were at once loaded on 11 clean, disinfected cars, well bedded with hay. Hay was preferred to sand as a bedding, as the latter absorbed the oil too quickly when it came in contact with the skin when the cattle were lying down; but in the later experiments sand was used in the bottom of the cars.
with a thick layer of hay on top, as with hay alone the floor became too slippery for the cattle to ride well. The train was placed in charge of Dr. Rice P. Steddom, an inspector in the Bureau of Animal Industry, and at 4.15 a.m. July 23 the train left Fort Worth for Rockford, Ill., arriving at the latter place on July 26 at 9 p.m. Dr. Steddom's report on the condition of the animals and their surroundings while en route is given, as follows:

Leaving Fort Worth at 4.50 a.m., July 23, the train arrived at Denison, Tex., at 8.30 a.m., at which time a small number of the dipped cattle began to show a slight irritation of the eyelids; in cars loosely loaded some were lying down ruminating. Many of the matured ticks had dropped off. As the day advanced the heat became intense, with no perceptible movement of the air, and the effect on the oil-covered cattle was very depressing, especially when the train stopped at stations.

Toward noon the inflamed condition of the eyelids became more general, and a 2-year-old steer fell down and was unable to remain standing when helped up. By 4 o'clock 4 more animals were down, and by 6 o'clock 3 cattle were dead and 6 were unable to stand. The car floors had become slippery from the oil, and the cattle stood with difficulty during the irregular jerking of the train. All ticks had turned dark, and none were alive so far as could be ascertained.

During the early part of the night the cattle cooled gradually and were fairly comfortable, although a number of them, exhausted from the heat of the day, could not be induced to remain standing, and were consequently severely bruised by being trampled upon.

At 3 a.m. the following morning (July 24) the cattle were unloaded at Parsons, Kans., for rest, feed, and water; 5 were dead and there were 6 "downers." Owing to the lack of shade at the Parsons stockyards, the cattle were loaded again at 10 a.m. the same morning after each car had been rebedded with 200 pounds of straw. The cattle were tired and sore, and all ticks were dark, hard, and shriveled. The temperature was a little more moderate than the day before and many cattle remained lying down during the entire day. The irritation of the eyes did not increase, but some of the more thin-skinned animals showed wrinkling and reddening of the skin on the neck and the inside of the thighs. At 6 p.m. the cattle were unloaded at Sedalia, Mo., when there were 3 more dead and 1 "downer."

At 7 a.m. the following morning the cattle were reloaded, and, the weather being cool, they rode fairly well to Galesburg, Ill., where they were unloaded at 10 p.m.

On the morning of the 26th the weather was decidedly cool, and the cattle were loaded at Galesburg at 11.30 a.m. in the best condition since they left Fort Worth; 3 "downers" were left at Galesburg. The trip from Galesburg to Rockford, Ill., was without unusual occurrence. The train arrived at its destination at 9 p.m., and the cattle finished unloading at the Northwestern stock yards at 12.30 a.m., July 27, there being 4 "downers" on the last run.

SUMMARY OF THE REPORT.

Of the 311 cattle loaded at Fort Worth, Tex., 295 arrived at Rockford, Ill., 4 of which were unable to stand and all rather tired and sore. Eight cattle died en route and 8 "downers" were left behind. The casualties were principally caused by the extreme heat during the first day's travel and the confinement and discomfort incident to shipment.

Dr. Steddom's notes, added to the facts given above, show that the first practical test with dipping and shipping Southern cattle was
made under very unfavorable circumstances. First, the heat became intense, registering more than 100° F. in the shade at several places through which the train passed during the first day on its way north; second, a number of the cars were overloaded, not leaving sufficient room for the animals to lie down and rest; third, the distance shipped was exceedingly long, consuming more than ninety-six hours. That loss during transit was not entirely due to the effect of the dipping is shown by the fact that a train load of undipped cattle, which were shipped at the same time over the same road, but for a shorter distance, suffered a proportionately greater loss from the heat alone.

CONDITION OF CATTLE AFTER ARRIVAL AT ROCKFORD.

Two hundred and eighty-seven head were placed in five different pastures in the vicinity of Rockford, Ill., where the animals soon began to fill out on the rich blue grass, and when seen again, in the middle of August, most of them had recovered and looked even better than before they were dipped.

A careful examination, made in company with the State veterinarian and the live-stock commissioners of Illinois, showed that not a single tick had survived, and only a small number of shriveled ticks were found, all of which were loosely attached to the skin and dropped off when merely touched. Some of the cattle were covered on neck and shoulders with peeled-off epithelium, but most of them showed absolutely no indications of having been dipped. The swelling of the eyelids had entirely disappeared, and the skin was soft and flexible in all cases, though the dry flakes and scales gave it a bad appearance.

A number of native cattle had been placed with each lot of dipped cattle (altogether about thirty-eight head) and, as the pastures were not very large, there was every probability that if any of the ticks should mature and produce young ones they would have a chance at all times to get on the native cattle. In order to demonstrate that the dipped cattle actually harbored the Texas fever microorganism in their systems, a number of ticks were obtained from the pastures in Jack County, Tex., where the cattle shipped to Rockford had been raised. These ticks were forwarded to Rockford, where their eggs were permitted to hatch. The young ticks were placed on two native cows in the stock yards at Rockford, and in the course of twelve to fifteen days both cows developed Texas fever and died.

Two months later, on September 24, Dr. Steddom again visited Rockford, and under date of September 30 he reported that his inspection of the dipped cattle revealed the fact that all, both dipped and native, were in good health. The Southern cattle appeared to be thriving, as shown by glossy coat and marked general improvement over their condition prior to dipping. There were no ticks on any of the cattle, and parties in charge of the several herds reported that no living ticks had been found, and that there was no ailment or disease among the cattle.
CONCLUSIONS FROM FIRST ILLINOIS EXPERIMENT.

The conclusions to be drawn from the Fort Worth experiment are (1) that dipping cattle in a saturated solution of sulphur in extra dynamo oil will destroy all ticks on them in a single dipping, no matter what stage of development the ticks may have reached; and, (2) that Southern infested cattle may, after all ticks on them have been destroyed, be brought into uninfected territory during the warmest season of the year and placed in close contact with susceptible cattle without danger of transmitting Texas fever to the latter.

While these results were highly gratifying, there were, nevertheless, several undesirable features which must necessarily be eliminated before the dipping process can be considered an unqualified success. The first and most important of these features is the extreme heat, which evidently must be avoided at time of dipping, and, so far as possible, while the cattle are in transit.

TEST OF SHORTER DISTANCE OF TRAVEL.

In order to test the effect of shipment to a shorter distance, the Fort Worth Stock Yards Company arranged to dip two car loads of ticky cattle and ship them from Fort Worth to Midland, Tex., a run of about twenty-seven hours. Unfortunately, the cattle secured for this experiment were a lot of ordinary range stock in very poor condition. It was a foregone conclusion that losses would occur, as at least half a dozen of the 110 head were cripples, and many others were so weak that they could walk only with difficulty. It was concluded, however, that if this class of cattle were able to stand dipping and shipping for a short distance, all classes of cattle would be able to undergo the test. On September 3 the 110 yearlings were driven through the vat without any accidents, and were immediately loaded into two cars well bedded with both sand and hay. Dr. Kiernan, an inspector of the Bureau of Animal Industry, was placed in charge, and about 11 o'clock in the forenoon the train started. The cattle had been dipped in the morning, and it was noticed that before the train left every tick which could be seen on the cattle after they were loaded in the cars had shriveled and turned black. The dipped yearlings arrived at Midland the next afternoon between 2 and 3 o'clock, and all of them were unloaded in fairly good condition. Dr. Kiernan's report of this trip follows:

After the dipping the cattle were loaded into two clean, disinfected cars, well bedded with sand and straw. The train left Fort Worth at 11 a. m. on September 3, and arrived at Midland at 2 p. m. on the following day. It was noticed during the entire trip that the ticks were dying fast and falling off the cattle. The animals shipped well, and when they were unloaded at Midland showed no ill effects from either the dipping or the trip. The cattle were taken to a pasture about 2 miles from town, where they were watered, and all drank freely. The temperature was then 100° F. in the shade, and there was no shelter of any kind to protect the animals from the burning rays of the sun. An examination
of the cattle on the following morning (September 15) showed that nearly 50 per cent of the animals were free from live ticks, but the cattle seemed to suffer considerably from the intense heat. On September 17 two yearlings were found dead in the pasture, the death of one being due to an accident. An examination of the remaining 108 head showed 90 per cent of them to be free from live ticks, while 17 head still had a few discolored and shriveled but live ticks on them. On September 20 four more yearlings had died, and no live ticks could be found on any of the remaining animals. A large number, however, were stiff and considerably lame, and some of them seemed to be very weak in the loins. A number of post-mortem examinations showed inflammation of both the large and small intestines, and a general anemic condition, but in no case was there found evidence that death was due to the effect of the dipping. In the course of the following two weeks 14 more head died, but it was a noticeable fact that the skin of many of these was not by far so severely affected as was the case with some of those which survived, which fact makes it difficult to attribute the deaths directly to the dipping.

The cattle, however, continued to die after their arrival, and when cold weather set in a large number of them succumbed. According to a recent statement by the owner, which was published in a local stock paper, there were at the time he wrote only 32 head alive, and some of them were not expected to survive the winter. From later reports sent in by inspectors of the Bureau and of local cattle inspectors, there can be little doubt that the greater number of these animals died from Texas fever. The appearance of this disease among native Texas cattle will be discussed later.

The conclusions to be drawn, therefore, are that weak and emaciated yearlings should not be dipped and shipped even for a short distance, unless precautions are taken to protect them against extreme climatic conditions. The death rate in this Midland experiment by far exceeds that of the Illinois experiment, although the distance the cattle were shipped in the latter case was nearly five times greater than in the Midland experiment. This proves conclusively that strong, vigorous cattle, such as those in the Illinois experiment, are better able to stand the dipping and subsequent shipment than weak, emaciated cattle.

**SECOND ILLINOIS EXPERIMENT.**

Notwithstanding these rather unfortunate results, the Illinois Board of Live Stock Commissioners decided to attempt another shipment of dipped cattle from Texas, and Dr. Page, of Rockford, again volunteered to purchase the cattle for the experiment. The cattle which had been dipped in July and shipped to Illinois had improved so rapidly in the northern pastures that Dr. Page was of the opinion that, with cooler weather in his favor, a second shipment might reimburse him for the loss which he sustained in the first shipment. Consequently he purchased at Jacksboro, Tex., 184 head of strong, well-bred yearlings and 2-year olds, all more or less infested with ticks, which were taken to Fort Worth. On September 24 they were dipped and immediately loaded in cars, well bedded with both sand and hay,
and shipped to Rockford, Ill. Upon arrival at Rockford 9 head were down and soon died; others were not expected to live. In the course of the following week some of these died, and, according to a statement made by the State veterinarian of Illinois, who made post-mortem examinations of them, all showed symptoms of acute Texas fever.

On October 10 the writer visited Rockford, when 24 head, mostly yearlings, had died. A number of the remaining cattle were found to be considerably stiff, with the epithelium peeling off the neck and shoulders, and two or three were so severely affected that they were expected to die. Owing to his heavy loss, Dr. Page decided not to destroy any of the animals for post-mortem examination, but promised in case any more should die to forward specimens of the organs to the laboratory of the Bureau of Animal Industry in Washington for examination. This promise he complied with a short time afterwards, when two more yearlings had died, making a total loss of 26 head. A microscopic examination of the organs proved the diagnosis of Texas fever to be correct, as all of the tissues contained an abundance of the microparasite of that disease.

As these cattle were all raised and bred in Texas, hundreds of miles below the quarantine line, and all were infested with Texas-fever ticks at the time of the dipping, there can be little doubt that they were what is ordinarily considered cattle immune to Texas fever. Experience teaches, however, that such immune cattle may develop the disease within their systems when their vitality has been reduced by unusual exposure and hardships; and when to this is added the mechanical and chemical irritation of the skin which follows dipping, it is not surprising that a number of the dipped animals developed Texas fever.

TEXAS FEVER EASILY DEVELOPED IN TICKY CATTLE.

As an instance of this disease developing among Southern tick-infested cattle, may be mentioned a shipment of several thousand head of Texas cattle to Colorado in the winter of 1897-98. The cattle, all of which came from below the quarantine line, arrived near Denver in the beginning of January, 1898, and were immediately exposed to a severe blizzard, which was followed by intensely cold weather. As a result of this, 40 per cent of them (more than 1,000 head) developed typical Texas fever and died. A microscopical examination proved the microparasite of Texas fever to be present in nearly 50 per cent of the red blood corpuscles. In this case the cattle had not been dipped, but simply exposed to an extreme change of climate.

In the same manner Southern tick-infested cattle may develop Texas fever in warm weather when their vitality is reduced by driving either too fast or too long. A bunch of nearly 300 head of tick-infested cattle from a ranch in Hidalgo County, Tex., on the border
of Mexico, was driven to Nueces County, Tex., a distance of about 120 miles, during very hot weather. The pasture from which these cattle were driven and the one to which they were taken belonged to the same man, who every year took cattle from the one to the other without ill effect. In this case, however (the summer of 1896), the cattle developed Texas fever, probably due to the excessive heat during the drive. More than 60 per cent became affected, and nearly 70 head died. These cattle had not been dipped either, and were generally considered immune to Texas fever, as the records of the ranch where they were raised show that cattle have been shipped from there to all parts of Texas below the quarantine line without any ill effect resulting.

These circumstances tend to prove that the great loss of cattle in the three dipping experiments above mentioned are more due to other causes than to the direct effect of the dipping, although the slightly irritating effect of the oil no doubt tends to increase the mortality. It is a noticeable fact that in a bunch of dipped cattle which have been exposed alike in every respect there may be a number which do not show the slightest effect of the dipping, except the loosening up of the old epithelium. Though this may give a bad appearance to the animal, it certainly is not injurious, except perhaps in cold weather, as the skin remains soft and flexible. On the other hand, a number of animals of the same breed, age, and condition may show a staring coat, arched back, and the skin closely attached to the underlying tissues. The inexperienced mind naturally forms the opinion that the hides of the animals are scorched to a crisp by the oil and sulphur, when the fact is that the animals are simply hidebound, a very common symptom of Texas fever.

DEGREES OF IMMUNITY.

These great variations in power of resistance to the effects of dipping with cattle of exactly the same breed, age, and condition can not well be ascribed to a constitution more or less strong, or to individual peculiarities, except when viewed from one standpoint, namely, the degree of immunity to Texas fever which each individual has acquired. The manner in which the Southern cattle become immune to Texas fever, that is, by being exposed to the infection in pastures infested with ticks, warrants the inference that, according to the degree of infection, the cattle, even in the same pasture, are immunized to a greater or less extent. At times the cattle in the infected territory may grow to be several years old without ever being greatly infested with ticks; in fact, in one pasture there will often be numerous animals without a single tick on them, while others will be covered. Experiments show that a single exposure to ticks does not make an animal completely immune to Texas fever, even if a severe attack of the disease is produced thereby, and experience teaches that the infection proper, that
is, the microparasite of Texas fever, is of highly varying virulence in different parts of the country. Take, for instance, the various shipments of Louisiana and Mississippi cattle into Texas during the spring and summer of 1897 and 1898, which caused outbreaks of Texas fever among the supposedly immune tick-infested cattle in Texas.

An explanation of this fact is only possible from the point of view that the microparasites harbored in the blood of the Mississippi and Louisiana cattle were possessed of a higher degree of virulence than the microparasites to which the Texas cattle had been exposed and to which their systems had adapted themselves, and when transferred to the latter by means of ticks the result was outbreaks of Texas fever among the native cattle in the heart of Texas. For this reason Texas quarantined against cattle from Mississippi and Louisiana.

We are consequently justified in believing that not all cattle in the same region are equally immune or resistant to the effect of the Texas fever microparasite; and as the dipping of nearly 20,000 cattle during the past fall and winter has demonstrated that a number of these supposedly immune cattle succumb to Texas fever, it is obvious that those which died were the least resistant to the disease. This theory explains how a large number of the dipped cattle remained perfectly healthy while many animals in the same bunch became stiff and hide-bound after receiving exactly the same treatment. Those which had acquired perfect immunity, and whose systems were in condition to suppress the ever-alert microparasite in their blood, remained well, while apparently equally healthy and thrifty cattle which, either for want of sufficient exposure or from a constitutional deficiency in antitoxin-producing properties, were unable to restrain the development of the germ, became affected with Texas fever.

Similar conclusions have been reached in other countries. Dr. J. Sidney Hunt, pathologist to the Department of Agriculture in Queensland, Australia, in discussing the preventive inoculation for tick fever (Texas fever), writes as follows:

This increased resistance is often, for convenience, spoken of as immunity. It should be at once indicated, however, that by "immunity," in this connection, is meant only such a degree of increased resistance as to amount to practical immunity under ordinary conditions. It is perhaps open to question if absolute immunity is ever acquired by cattle against tick fever, for it is a common observation in Queensland that herds through which the disease has passed may, though still tick infested, be perfectly healthy on their own runs. Yet, when such cattle are subjected to the hardships of droving, especially in bad seasons, a certain percentage will sometimes succumb to the disease. Unfortunately, we do not in fact know whether such mortality occurs in consequence of fresh tick infection picked up on the stock routes, and affects only such animals as have for some reason previously escaped the disease, or whether it is in reality due to a second attack of fever brought out by fresh tick infection in animals that have, indeed, already had the disease, but have not thereby acquired the necessary degree of resistance to withstand a fresh infection under the trying conditions frequently encountered on the stock routes. Or, again, for all we know to the
contrary, the mortality may be due, not to any fresh tick infection at all, but to the direct effect of such adverse influences as exertion, privation, and exposure in rekindling, as it were, the fires of the fever which have been lying dormant in their blood, or, as drovers say, “in bringing out the disease.” And if it can be definitely shown that droving in connection with, or apart from, fresh tick infection brings out the disease in animals that are immune on their own runs, then we shall have to recognize two grades or degrees of immunity—station immunity and road immunity.

That the dipping and shipping experiments of this summer have definitely proven that Dr. Hunt’s supposition is correct can not be doubted, as all possibility of a fresh tick infection of the dipped animals which were shipped to Illinois is excluded.

ANIMALS TO BE DIPPED SHOULD BE IN GOOD CONDITION.

Experiments with thousands of cattle during the last five years have shown that animals may be dipped in highly irritating solutions which all but remove the hair and epithelium without fatally injuring the animals if they are properly cared for afterwards; and recent experiments have shown that hundreds of cattle may be dipped in oil and sulphur without a single loss when care is taken not to reduce their vitality by excessively long shipment or driving immediately after the dipping.

At Mammoth Spring, Ark., near the southern border of Missouri, a dipping vat was built during the latter part of September, and subsequently more than 600 head of cattle were dipped without a single loss. Only in the case of one lot of 24 calves which were greatly emaciated and badly infested with ticks, and where the owner insisted on having the animals dipped, although he was told that they were not in a condition to stand it, did some loss occur.

REMOVAL OF RESTRICTIONS FOR DIPPED CATTLE.

In order to make it possible to transport dipped cattle across the quarantine line, an order was issued by the Bureau of Animal Industry under date of October 12, 1898, as follows:

It is hereby ordered that cattle originating in the district described in the order of December 15, 1897, and amendments thereto, which district is known as the quarantine district, may, after having been properly dipped, under the supervision of an inspector of this Department, in a solution of 86 pounds of flowers of sulphur to each 1,000 gallons of extra dynamo oil, be shipped without further restriction: Provided, That application be first made to this Department and permission granted to establish the dipping stations, and that after being dipped the cattle are certified by an inspector of the United States Bureau of Animal Industry, and that the cattle, when dipped within the quarantined district, be shipped in clean cars, without unloading within that district.

During the following weeks a large number of applications were received for the establishment of official dipping vats in the various States and Territories interested in this matter.

About the middle of October the Interstate Association of Live
Stock Sanitary Boards held a meeting at Omaha, Nebr., at which fourteen States and Territories were represented. At this meeting the writer of this paper gave a detailed account of the various experiments with the dipping of cattle which had been under his direct supervision. The dipping question was discussed in full and the objectionable features of it were explained at length. Owing, however, to the very favorable reports received from the dipping station at Mammoth Spring, Ark., where by that time nearly 1,000 head of cattle had been dipped without any casualties resulting, the meeting passed a resolution as follows:

Whereas the experiments recently conducted have demonstrated that Southern cattle dipped in dynamo oil saturated with sulphur will effectually destroy the Southern cattle tick, and that such cattle may be mixed with Northern native cattle without danger of communication of Texas, or Southern, fever; therefore,

Resolved, That the quarantine regulations may be amended with safety so as to admit dipped Southern cattle, on the certificate of a designated inspector of the State or of the United States Department of Agriculture, to the Northern States during any portion of the year.

OPERATIONS FOR THE SEASON OF 1898.

Several dipping plants were built and put in operation without awaiting the sanction of the Government; but a number of casualties which occurred among several lots of dipped cattle, greatly exaggerated by press reports, very soon cooled the ardor of those who wished to establish dipping plants for speculative purposes. Since the middle of December very few cattle have been dipped.

In Oklahoma and Indian Territory several dipping vats were built, and during October, November, and December, 1898, about 10,000 head of cattle were dipped in oil and sulphur, the estimated loss being a little more than 1 per cent, confined entirely to cattle in a poor condition. At the dipping station of the Fort Worth Stock Yards Company there were dipped between October 29 and November 26 nearly 3,000 head of cattle, and only in instances where the dipped cattle were exposed to severe cold and blizzards immediately upon their arrival at their destination did the owners suffer losses of any consequence.

In all there have been dipped more than 20,000 head of cattle, and so far as the Bureau of Animal Industry has been informed the total losses are less than 250 head, or about 1.4 per cent. These losses were in every instance due to the poor condition of the cattle, unusual exposure to extreme climatic conditions, or unnecessarily long drives or shipments. The only place where the dipping of cattle has been carried on regularly as an enforced measure against the introduction of ticky cattle is in Oklahoma Territory. Mr. R. J. Edwards, secretary of the Live Stock Sanitary Board for Oklahoma, in the First Biennial Report of the Oklahoma Live Stock Commission, says:

Approximately, about 8,000 head were dipped under supervision and in compliance with the regulations of this commission within the last four months. The
results were entirely satisfactory, from an experimental as well as practical and commercial standpoint. In some few cases where cattle were young and weak the dipping was attended with disaster, but where cattle were in good condition the results have been most satisfactory. Considerable complaint came from the owners of herds that were dipped, who, wherever any loss occurred subsequent to dipping, attributed the cause of death invariably to the dipping, with no allowance whatever for the injury the cattle might have sustained while in transit on railway cars or from the effects of sudden climatic changes. Investigation of all these complaints by our Territorial veterinarian as well as the agents and veterinarians of the Bureau of Animal Industry proved beyond question that in most cases the death of the stock could be attributed more to other causes than to the dipping. The heaviest losses occurred in herds of cattle that were in very poor condition, that had suffered greatly in shipment before being dipped, and that had come from a climate which was much warmer than Oklahoma. The loss among the local herds of cattle in good condition at the time of dipping was proven by actual computation to be less than one-half of 1 per cent.

CONDITIONS FOR SUCCESS OF THE DIPPING PROCESS.

It is hardly to be expected that a remedy may be found which in a single dipping will destroy all the ticks on an animal without having any injurious effect whatever. The tenacity of life of the ticks and their power to resist the effect of chemical preparations which may be applied to cattle in the form of a dip have been too well demonstrated to give much encouragement along this line. The ultimate success of the dipping process is probably to be looked for in the exclusion of weak and emaciated cattle from the dipping vats and in protecting the animals against extreme climatic conditions and all circumstances which may tend to reduce their vitality during the first week after dipping. In the meantime experiments will be continued in order to determine if the dipping fluid can be modified so as to reduce the injury to the stock without vitiating its tick-destroying properties. Until this is accomplished all dipping under official supervision has been suspended.

SUMMARY OF THE PAST YEAR'S EXPERIENCE IN DIPPING CATTLE.

(1) Tick-infested Southern cattle, if they have been entirely freed from ticks, may be shipped into the uninfected district and pastured for an indefinite length of time with susceptible Northern cattle without communicating Texas fever to them.

(2) Dipping tick-infested cattle into a saturated solution of sulphur in extra dynamo oil will destroy all the ticks on the animals in a single dipping, no matter what state of development the ticks may have reached.

(3) The loss of cattle resulting from dipping is insignificant when proper precautions are taken not to reduce the vitality of the animals through exposure, extreme heat, or otherwise.

(4) Weak or emaciated cattle are unfit for either dipping or shipping, and young animals suffer more than older ones.
(5) Pregnant cows should never be dipped, as the shock itself is sufficient to produce abortion.

(6) The dipping of cattle in oil and sulphur has a tendency to produce a recrudescence of Texas fever in animals which are only partially immune to the disease.

(7) The effects of dipping and hardships incident thereto are more or less severe on Southern cattle in direct proportion to their susceptibility to Texas fever.

(8) Dipping in oil and sulphur has but a slight irritating effect on the skin of Southern animals which are perfectly immune to Texas fever, and only causes desquamation of the dead epithelium, which during cold weather may make the animals more susceptible to the surrounding temperature.