TEXAS AGRICULTURAL EXPERIMENT STATIONS.

BULLETIN No. 53.

Veterinary Section—OCTOBER, 1899—*Live Stock.*

TEXAS FEVER.

POSTOFFICE:

COLLEGE STATION, BRAZOS CO., TEXAS.

J. J. PASTORIZA PRINTING & LITHO. CO.
HOUSTON, 1899.

TEXAS AGRICULTURAL EXPERIMENT STATIONS.

OFFICERS.

GOVERNING BOARD.

(BOARD OF DIRECTORS A. & M. COLLEGE.)

M. SANSOM, President.....Alvarado.
F. A. REICHARDT.....Houston.
F. P. HOLLAND.....Dallas.
D. A. PAULUS.....Hallettsville.
P. H. TOBIN.....Denison.
A. P. SMYTH.....Mart.
JOHN W. KOKERNOT.....San Antonio.
JEFFERSON JOHNSON.....Austin.

STATION STAFF.

THE PRESIDENT AND TREASURER OF THE COLLEGE.

J. H. CONNELL, M. SC.....Director.
H. H. HARRINGTON, M. SC.....Chemist.
M. FRANCIS, D. V. M.....Veterinarian.
R. H. PRICE, B. S.....Horticulturist.
B. C. PITTUCK, B. S. A.....Agriculturist.
P. S. TILSON, M. S.....Associate Chemist.
W. C. MARTIN, B. S.....Assistant Chemist.
H. C. KYLE, B. S.....Foreman of Farm.
J. G. HARRISON.....Bookkeeper.
A. M. FERGUSON, M. SC.....Assistant Horticulturist

SUPERINTENDENT OF BEEVILLE STATION:

S. A. MCHENRY.....Beeville, Bee County.

NOTE.—*The main station is located on the grounds of the Agricultural and Mechanical College in Brazos County. The postoffice address is COLLEGE STATION, TEXAS. Reports are sent free of cost to farmers of the State upon application to the Director.*

TEXAS FEVER.

Experiments made by the Texas Experiment Station, in co-operation with the Missouri Experiment Station and the Missouri State Board of Agriculture, in immunizing Northern breeding cattle against Texas Fever.

BY

M. FRANCIS, Veterinarian, Texas Experiment Station,

AND

J. W. CONNAWAY, Veterinarian, Missouri Experiment Station.

For many years Texas Fever has been a serious obstacle to the growth of trade in blooded breeding cattle between the Northern breeders and the Southern cattle raisers. The losses from this malady, in cattle shipped from the North, are rarely less than 40 per cent., and frequently 70 per cent. or more. The pressing need for some practical method of preventing these losses has led the Experiment Stations of Missouri and Texas and the Missouri State Board of Agriculture to undertake the experiments reported herein.

This co-operative work was begun in 1896, and is still in progress. The interests of the cattle industry demand that the results attained up to the present time be presented in official form. There is probably much work yet to be done before the methods that can now in careful hands be employed with a degree of success, reach the perfection that is desirable.

The work reported herein includes:

I. Experiments to determine whether sterile blood serum of immune Southern cattle contains any chemical substance of the nature of an antitoxin, or toxin that could be utilized practically in stimulating at least a passive immunity in susceptible cattle.

II. Experiments on immunizing cattle by infection with the microparasite of the disease by means of tick infestation.

III. Experiments on immunizing cattle by infection with the microparasite of the disease through blood inoculation.

These different lines of experiments will be discussed in the order named. Only a brief discussion of the first two lines of work will be given in this bulletin.

The final results of the experiments on inoculation with sterile serum show that such material possesses no protective properties.

Immunizing by tick infestation can be employed with success,

but on account of maintaining a quarantined pasture, and the necessity of hand-feeding in the case of calves of non-immune cows; this method is not as desirable as that of blood inoculation.

In the blood inoculation experiments over 400 *pure bred cattle have been used. The losses from inoculation and from subsequent exposure to infected pastures in Texas, have been less than* 8 *per cent.*

I. EXPERIMENTS ON INOCULATION OF NORTHERN CATTLE WITH STERILE SERUM FROM IMMUNE SOUTHERN CATTLE.

These experiments were made to determine whether the serum of the blood of immune Southern cattle contains any chemical substance, apart from the living organism of the disease, that might be used in a practical way in bringing about immunity in susceptible cattle. The value of such material would be that the danger of the development of an acute fever that attaches to other methods, as "tick infestation" and "blood inoculation," would be avoided. Moreover, the material could be transported and used at any distance without the dangers from septicæmia that are liable to arise from the shipment to a distance of blood containing the living parasites.

The discovery of the protective properties of the serum of animals made immune to a certain disease, as diphtheria and tetanus, led to the somewhat broad statement by Behring, one of the chief investigators of serum therapy, *"that if an animal has acquired immunity against a disease-producing micro-organism, or its toxins, the serum from the blood of the immunized animal will prevent the disease in another susceptible animal."*

While Texas fever is due to protozoon micro-parasites, instead of bacteria, as is the case of diphtheria, the immunity attained on recovery from an attack of the disease appears to be as great as in the latter malady. And it was not unreasonable to suppose that, in the physiological processes by means of which immunity is established against Texas fever, some new product should be formed which might stimulate in the cells of a susceptible animal a condition or metabolism like that of the cells of the immune animal, and thus establish at least a passive immunity that would tide the animal over the danger-period, following tick infestation.

The first experiment with sterile serum inoculation was made in the fall of 1896 on an 8-year-old cow. 200 cc. of serum were inoculated subcutaneously during a couple of weeks previous to infesting her with ticks. This cow was inoculated with 80 cc. more of serum after the infestation. This inoculation began September 2d; the infection was made September 16th, and the

animal was kept under observation until November 2d; morning and afternoon temperatures were taken. During this time there was no elevation of temperature, except on the afternoon of the 17th and 18th days following tick infestation; 103.8 F. and 106. F. Outwardly the animal appeared to be in perfect health throughout the experiment.

The following spring, in conjunction with the Mississippi Experiment Station, a lot of young cattle and one cow were inoculated at Enterprise, Miss. These had all sickened from accidental tick infestation. Twelve other cattle had died, all but two of them being adult animals. All the inoculated animals lived. A full report appears in bulletin No. 37 of the Missouri Experiment Station, where the method of preparing the serum is described.

These experiments were not regarded as conclusive, since the season of the year at which the work was done and youthfulness of most of the animals inoculated, might account for the result. In order to give the matter a more decisive test, a larger experiment was planned for the following summer, and carried out in conjunction with the Mississippi Experiment Station in June and July, 1897. A full report of the results upon the cattle shipped to the Mississippi Station appears in bulletin No. 42 of that Station. Only a summary is here given.

Eleven head were inoculated, eight of these at the Missouri Station before shipping, and three after their arrival in Mississippi. These cattle varied in age from 1 1-2 years to 11 years. They were inoculated daily with serum in doses of 40 to 60 cc., according to size of animal. The minimum quantity injected into any one animal was 146 cc.; the maximum quantity was 772 cc. After tick infestation, all of them suffered from acute attacks of the fever, and all except two of the younger animals (2-year-old) died.

During the same summer five more head were inoculated at the Missouri Station, two mature cows and three yearling steers. The material used in this experiment came from different sources than that used in the Mississippi experiment—one lot was obtained from the Texas Station, and another from a Texas animal in Kansas City. One cow received subcutaneously a total of 230 cc.; the other one 420 cc., in doses of 20 to 40 cc. over a period of two weeks or more immediately preceding tick infestation. Both died from acute attacks of the fever following tick infestation. Not the least mitigation in severity of the attack appears to have resulted from the use of serum.

The three yearling Jersey steers were inoculated with doses of 10 cc., to 40 cc., over a period of two weeks; one steer received 144 cc., another 320 cc., and the third 180 cc. All of these suf-

fered from attacks of the fever after tick infestation, but recovered. A check animal, not inoculated, appeared to suffer more severely; this animal, however, was somewhat younger and less vigorous.

While the desired economic end of this experiment was not attained, the data supplied in regard to the effects of tick infestation are valuable in the experiments that follow.

It appears that so far as experiments have yet shown, the only way of producing immunity is through an actual attack of the disease, induced either by tick infestation or by inoculation of infected blood.

II. EXPERIMENTS ON IMMUNIZING BY TICK INFESTATION OF YOUNG CATTLE.

The fact has long been known to stockmen that calves are more resistant to Texas fever than mature cattle. The same effect has been observed in all scientific investigations of this disease where young and mature cattle were used. In the investigations of Smith and Kilbourne into the nature and means of transmitting Texas fever, a large per cent. of adult susceptible cattle used in their experiments died when exposed to infection, while only a small per cent of the young animals succumbed. The case of the dairy herd at Enterprise, Miss. (mentioned under "serum inoculation"), illustrates, in a marked manner, the greater resistance of the young animals as compared with those more mature. In this lot were eleven head of grown cattle, four yearlings and twelve calves. Out of this number, all of the grown cattle, except one, died; while two of the yearlings and all of the calves lived. Those that survived had been grossly infested with ticks and suffered more or less from fever. In the serum experiments of the following summer, the same difference was noted between young and old cattle in resisting the disease.

These observations led to the experiment to test the practicability of immunizing cattle on Northern stock farms by tick infestation. This work was begun in 1897, and has been continued to the present time.

The following animals were used in the experiments in 1897:

No. 1. "Jerry," a yearling Jersey steer.
No. 2. "Spot," a yearling Jersey steer.
No. 3. "Red," a yearling Jersey steer.
No. 4. "Fawn," Jersey steer 10 months old.
No. 5. "Durham," Shorthorn steer 14 months old.
No. 6. "Estes," grade Shorthorn bull 2 months old.
No. 7. Jersey bull calf, 6 weeks old; dam "Alpha Elf."
No. 8. Jersey bull calf, 5 weeks old; dam "College Nina."

No. 9. Jersey bull calf; 3 weeks old; dam "May Bates."
No. 10. Jersey bull calf, 3 weeks old; dam "Mattituck."
No. 11. Jersey bull calf, 3 weeks old; dam "Daisy Bates 3d."
No. 12. Jersey bull calf, 2 weeks old; dam "Daisy Bates."

In 1898 all the above, except Nos. 4, 6, 11 and 12, were reinfested, and the following animals were added to the experiment:

No. 13. Holstein heifer "Bessie," 10 months old.
No. 14. Holstein heifer "Beauty," 10 months old.
No. 15. Jersey bull calf, 4 weeks old; dam "May Bates."
No. 16. Jersey bull calf, 2 weeks old; dam "Mattituck 2nd.
No. 17. Jersey bull calf, 3 1-2 weeks old; dam "Daisy Bates 3rd."
No. 18. Jersey bull calf, 5 weeks old; dam "Mary Herbert."
No. 19. Jersey bull calf, 3 weeks old; dam "Alpha Elf."
No. 20. Jersey bull calf, 5 weeks old; dam "Mattituck."
No. 21. Jersey bull calf, 3 1-2 weeks old; dam "Bachelor Girl."

In 1899 six animals of the first group (Nos. 1, 2, 3, 5, 7 and 8) were reinfested for a third season. In the second group Nos. 13, 15, 16, 19 and 21 were reinfested a second season.

Certain individuals and groups in the above lot of animals were treated differently; some were grossly and continuously infested; while others were but slightly or intermittently infested. It will be of interest to notice briefly these individual cases and groups.

No. 1, "Jerry," was infested July 27th, 1897, with several hundred fever ticks. These had nearly all matured and fallen off by September 1st. The steer remained free from ticks about a month, and was on October 5th reinfested artificially with several hundred. In addition, the steer became infested with many more from the pasture. An acute attack of the fever resulted from the first infestation; the morning temperature on the twelfth day after infestation was 105 F., and continued high for four days, when it fell to normal. The afternoon temperature during this period ranged from 105 to 107 F. The steer fell off some in flesh, became somewhat gaunt, but continued to graze. He made a good recovery, and at the time of the second infestation was lively and apparently in perfect health. The second more gross infestation produced no fever. Temperature observations were continued until November 1st. The animal went into winter quarters in excellent condition. He was grossly reinfested the following summer and fall (1898), but showed no evidence of fever. Through the spring, summer and fall of 1899 he was exposed to a presumably more severe infection in the quarantine territory, at College Station, Texas. The animal remained in perfect health.

The following group of Jersey steers, No. 2, "Spot;" No. 3,

"Red," and No. 4, "Fawn," ages given above, were infested August 28th, 1897, with about 200 ticks each. They had also been placed a week before upon a pasture that proved to be grossly infested with ticks (from "single dipped" Texas cattle). Morning and evening temperatures were recorded from date of infestation until November 1st. A few mature ticks were found September 13th, twenty days after infestation. In a few days mature ticks were numerous, and continued so for a week. On September 28th, these steers were almost free from the ticks coming from the artificial infestation. This artificial infestation produced scarcely any elevation of temperature in No. 2 and No. 3. In No. 4 several high afternoon temperatures had been observed, but nothing indicating a continuous fever period. On October 29th, it was observed that the animals were well infested with small ticks picked up from the pasture.

From October 4th to 9th, No. 2, "Spot," had a fever period, morning temperature ranging from 102.7 to 105.7 F., and evening temperatures for two weeks from 103.7 to 107.7 F. The animal became gaunt, laid down much of the time, and had little appetite. On October 11th, the morning temperature was normal, and continued so until November 1st, when regular observations ceased. These animals were not free from ticks until well into the winter. A few immature ticks were found as late as January 3d.

No. 3, "Red," showed no outward signs of fever until October 20th, but from October 7th to 16th the evening temperature had ranged from 103.5 to 106.4, and the morning temperature from 101 to 103. The calf had fallen off some in flesh. The morning temperature, October 20th, as 103.3; evening temperature 106.4, calf stupid. October 21st, morning 104, evening 106.2, calf sick. October 22d, morning 104, evening 105.9, calf dull and gaunt. October 23d, morning 101.5, evening 105.4. October 24th, temperature normal. Calf has been grossly and continuously infested with ticks.

No. 4, "Fawn." This calf showed but little signs of fever from the first infestation. From August 1st to September 25th, the morning temperature remained normal, and only an occasional high evening temperature occurred. On September 26th, the evening temperature arose to 104, and from that date until October 30th, the evening temperatures remained high, ranging from 103.7 to 106.3 F., only an occasional normal temperature being observed. From the 23rd to the 29th the temperature ranged from 103 to 103.6, but through the greater part of the experiment the morning temperature remained normal.

The continuous and severe infestation to which these calves were subjected from running on grossly infested pasture caused

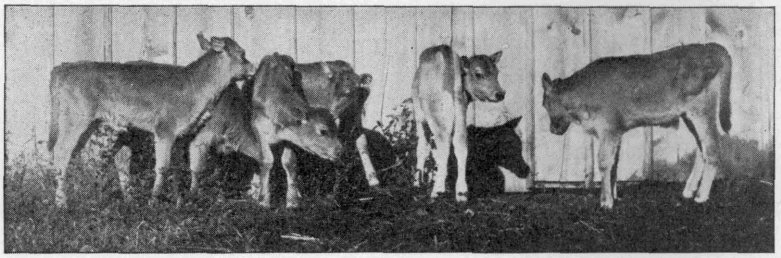
them to fall off greatly in flesh. They went into winter quarters in bad condition, with skin harsh and scurfy. This condition was, however, in part due to lack of nutrition; the pasture became dry and short. On December 31st, calf No. 4 died from accident, having been horned into the manger, probably by a Texas cow that was kept in the same pen. No. 2 and No. 3 improved during the winter, and were put on the grass in the spring in fair condition.

In July, 1898, both were reinfested with Texas ticks. These matured, and the steers became grossly reinfested from the pastures. Neither of these animals showed any signs of sickness during the season. They were never off food and were in good condition at the end of the season. They had evidently become immune from the severe infestation of the previous year. These two steers were shipped with others to the Texas Experiment Station on December 28th, 1898, and have been on infested grounds since January 1st. No signs of fever have appeared. The temperature records and tests of the blood by means of haematokrit show that these steers were fully immuned by the tick infestation at the North.

No. 5, "Durham," shorthorn steer, 14 months old. This steer was used as a check on seven head of double dipped Texas cattle. He was exposed on the same grounds, a small pasture, from July 19th to October 27th, and during this time was observed almost daily for ticks. The dipping proved so nearly perfect that during the summer and fall only five ticks were found on this animal, and but ten ticks on the seven head of Texas steers, as a result of infection of the pasture. No doubt many ticks escaped observation, but it is safe to say that during the entire season not more than twenty-five or fifty ticks infested this steer. This very mild natural infestation gave rise to no serious symptoms, and the animal remained in good condition. This steer was infested the following year to determine whether so mild an infestation would prove protective against a somewhat severe infestation. On July 21st, 1898, several hundred Texas ticks were applied to this animal, and later in the season he became grossly infested from the pasture. Ripe ticks were found on the steer 23 days after infestation. The animal showed some high temperature and some depression on hot afternoons in July and August, but no serious illness occurred. The steer did well through September. In October he fell off some on account of short pasturage and gross tick infestation. At the close if the season the steer was fed for awhile, and was shipped in fair condition, on December 28th to the Texas Experiment Station, where he has been exposed since January 1, 1899, without showing any signs of fever.

TICK INFESTATION OF YOUNG CALVES.

In the fall of 1897 six young Jersey bull calves two to six weeks old (Nos. 7, 8, 9, 10, 11, 12) were put in a quarantine pen and infested artificially with from twenty-five to fifty ticks. After these had matured and dropped off, the calves were infested again with from seventy-five to two hundred ticks. These also matured Some of the calves for a time were off feed and a little dull and gaunt, but at no time during the infestation period were any of them seriously sick. The thermometer showed some fever in each calf. This, however, was of short duration and of mild character. From fear of carrying the infection into the barns, these calves were kept in the quarantine pens somewhat late in the season, and were exposed to a few sharp winter storms, from which they all suffered severly, and two (Nos. 11 and 12) died. The post mortem showed no indication of Texas fever. The four remaining



Group of Young Calves, Two to Six Weeks Old. Infested Artificially with Ticks.

calves were put in the barns December 12th, and in a few weeks were in excellent condition.

These calves were infested again the following summer. July 28th, 1898, bull No. 7 was infested with about 400 ticks. July 7th, bull No. 8 was infested with 300 ticks, and again September 10th with 500. Bull No. 10 was infested July 28th with 200 ticks, and again on September 10th with 500. Up to the time of maturing the first crop of ticks, none of these bulls had shown any period of fever, only an occasional high temperature was noted on very warm days. On the 28th of August, No. 10, after becoming quite free from ticks, appeared somewhat gaunt and had diarrhoea, but appeared quite well in a few days.

In addition to the artificial infestation, these bulls were quite grossly infested with ticks hatched on the pastures. As the result of excessive tick infestation, and lack of proper nourishment from dry condition of pasture, these young bulls fell off considerably in flesh, and in September one of them, No. 10, developed

an acute attack of fever. The bull was found sick on September 30th, and died during the day. The post-mortem showed typical lesions of Texas fever.

On June 21st, 1899, bull No. 7 was artificially infested for the third season with several hundred ticks, and later became grossly infested from the pastures and was not free from ticks until October 1st. To test the immunity of this animal more severely, he was also inoculated with large doses of infected blood from a Texas cow. A dose of 7.5 cc. was given June 15th, and a second dose of 10 cc. August 4th. Daily temperature records were kept, and during this time no rise of temperature indicating a fever period was shown. The blood was tested from time to time by means of the hæmatokrit to determine variation in the percentage of corpuscles; but little variation from normal was observed. The bull appeared to be in perfect health during the entire season. The picture of this animal as he appeared at the close of the experiment is shown on page 64.

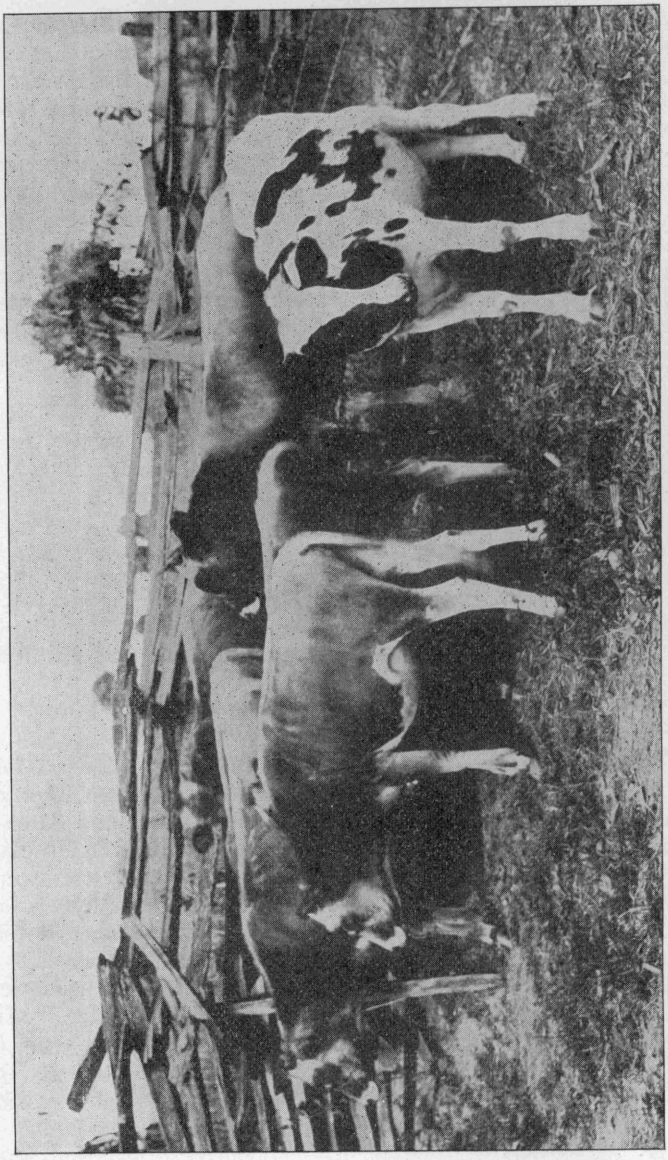
Bull No. 8 was shipped to Texas December 28th, 1898, and has been exposed to the natural infection on a pasture at College Station since January 1st, 1899. The bull has remained in perfect health throughout the season. Temperature records and blood examinations were made twice a week.

Bull No. 9 was killed March 20th for a class demonstration, as the calf was infected with "Hoose." The post-mortem showed the parasitic worms of the disease almost plugging many of the small bronchi.

INFESTATIONS OF 1898 AND 1899.

The group of animals from Nos. 13 to 21 was infested for the first time in 1898. The two Holstein heifers, Nos. 13 and 14, were infested August 13th, with 300 ticks each, and later they became grossly infested from the pasture. The first infestation was made during the warmest part of the summer. The heifers showed high evening temperatures through the hot weather. Heifer No. 14 suffered more severely, and in October developed an acute case of the fever, dying October 8th, fifty-six days after the first infestation. The post-mortem showed the usual lesions of Texas fever, such as bloody urine in the bladder, softened spleen, yellow liver, and bloodless condition of the flesh. This heifer was also found to be affected with "Hoose." The small bronchi were badly infested with the parasitic worms of this disease, and pneumonic areas were found in the lungs.

The long time that elapsed after the first infestation and before the death of this animal, makes it probable that she would have lived if she had not been subjected too soon to the gross



Group of Young Cattle at End of Second Year's Infestation with Ticks.

tick infestation that occurred on the pasture, and had not been suffering from another disease.

The Holstein that survived (No. 13) did poorly through the winter, but improved when put on pasture in the spring, and was in fine condition June 21st, 1899, when she was reinfested with several hundred ticks. In addition to the tick infestation this heifer was inoculated June 15th with 6.5 cc. infected blood from a Texas cow, and on August 4th with 8 cc. The heifer has been in the best of health throughout the season, and is no doubt well immunized.

(HISTORY OF THE SEVEN JERSEY BULLS, NOS. 15 TO 21, INCLUSIVE.)

The seven Jersey bulls, Nos. 15, 16, 17, 18, 19, 20 and 21, were infested with Texas fever ticks September 23d, 1898. From 50 to 100 ticks were applied to each, and they matured on all the bulls. Four of them showed scarcely any rise in temperature, while three showed more or less fever. All these had diarrhœa, no doubt in part due to change of food, from early weaning. One, No. 18, died from scours January 16, 1899, 115 days after the infestation; the post-mortem showed no evidences of Texas fever. All the other calves passed the winter safely, and, with the exception of No. 20, were well infested the following season, August 1st to November 1st, 1899. No. 20 died from unknown cause in the spring of 1899, after being put on pasture. As this death occurred before any of the calves had been reinfested and the pasture was shown to be free from ticks, the death could not have been due to Texas fever.

In addition to the tick infestation, all the calves were inoculated with infected blood. June 15th, previous to the second period of infestation, 3 cc. of blood from a Texas cow was injected subcutaneously into bulls Nos. 15, 16, 17 and 21. They were again inoculated on August 4th with 5 cc. each from the same animal.

No. 19 was inoculated June 13th with 4 cc. from a native recovered cow, and six days later infested with several hundred ticks. June 29th, sixteen days after the inoculation, the calf appeared to be in good health, the temperature was normal, and the percentage of blood corpuscles from hæmatokrit readings was 36 per cent. (about normal). On July 6, twenty-third day after inoculation and fifteen days after tick infestation, the percentage of corpuscles had fallen to 20 per cent., the morning temperature was 104.9, and evening temperature 106.5 F.; ticks in second moult, animal off feed, sluggish and gaunt. This condition appears to have arisen from the tick infestation rather than from the blood inoculation. No rise of fever was noted at the usual period after inoculation. This calf was a little dumpish all summer, but has fed well.

All the other calves showed no outward symptoms of illness apparent to the average observer; but all showed through the season some elevation of temperature and destruction of blood corpuscles, as determined by means of the hæmatokrit. Bull No. 15 showed a dimunition of corpuscles from 37 to 18 per cent; No. 16, from 44 to 20 per cent.; No. 17 fell to 24 per cent.; No. 21 showed but little destruction of corpuscles. The greatest destruction occurred not immediately following the inoculation and tick infestation, but in the fall after the pastures had become dry and grass scanty.

Acute Case of Texas Fever Induced by Artificial Tick Infestation.

SUMMARY AND CONCLUSIONS—TICK INFESTATION.

It will be seen from the history of the above twenty-one head of young cattle that but one died from acute attack of the fever within the usual period of thirteen to twenty days following tick infestation, and that this one, No. 6, a 2-month-old calf, was purposely infested with an excessively large number of ticks. The first crop of ticks matured on all the other cattle, and but few of the animals showed any distressing symptoms of the fever from the first infestation. The yearlings that were mildly or intermittently infested the first season did not suffer profound nutritive disturbances noted in others that were grossly and continuously infested. (Contrast steers Nos. 1 and 5 with steers Nos. 2, 3 and 4, all infested in 1897.) Young calves, from 2 to 6 weeks

old, infested mildly in the fall, suffered but little from the infestation, but were not fully immunized against the effects of gross infestation the following year, after being free from ticks for seven months. Bull No. 10 died from relapse in the fall of the second season (1899), and others in the 1899 group, while apparently in good health, showed considerable destruction of blood corpuscles. An acute fatal relapse occurred in two animals (Nos. 10 and 14) following second gross infestation; both had matured ticks earlier in the same season and one (No. 10, mentioned above) had carried ripe ticks the previous fall. Lack of proper nourishment and a concurrent disease are to be regarded as contributing largely to these relapses.

Animals that had been well infested with the fever ticks at the North, proved immune when exposed to the more prolonged infestation occuring in the South.

Five head of the experiment animals died from other causes than Texas fever. Jersey bull calves from the dairy herd were mainly used in the experiments. They were taken from the mother quite young and fed by hand. Their care through the winter was such as given ordinary stock cattle, and not that which is given to breeding animals intended for sale. These losses, largely preventable, would probably not have been so great in calves of the beef breeds intended for sale, instead of experiment.

A quarantine pasture has been maintained at the Missouri Station through four summers, and during this time no deaths have occurred in the farm cattle grazing in an adjacent pasture, separated by a space of fifteen feet.

From the above we may conclude that complete immunity is not acquired by the young animal through a single mild infestation with fever ticks, but that the immunizing process is a gradual one requiring several months for its completion.

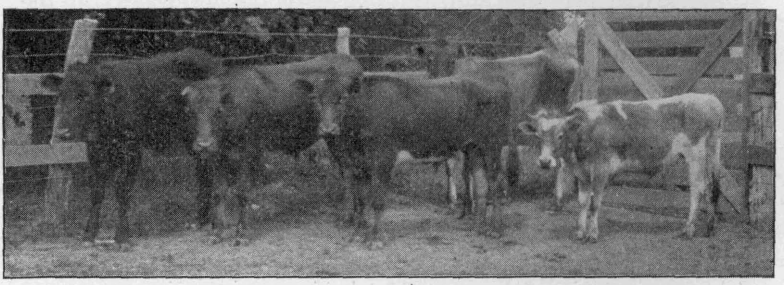
The preferable way of effecting immunity by this method would be to give a mild infestation as early in the season as possible, and reinfest at intervals with a gradually increased number of ticks; permitting the animal to be free from ticks for a short time before reinfesting and seeing that all fever from previous infestation had passed. Gross reinfestation from the pasture, before the animal is ready to bear it, may be prevented by one change to a clean pasture during the season.

One of the most important requisites in immunizing is that the calf be well nourished throughout the immunizing period. Otherwise stunting of the animal will occur, and occasionally a fatal relapse.

From the fact that exclusive hand-feeding is not desirable in raising calves of the beef breeds, the tick infestation method cannot

come into large use in immunizing these animals, unless the breeder finds it profitable to maintain a herd of immune cows. There are no very serious difficulties in the way of maintaining infected pastures on Northern stock farms, and the animal that has stood the test of tick infestation at the North carries with him his own certificate of immunity, namely, the ticks themselves or their ineffaceable scars.

The blood inoculation method to be described may, however, meet all requirements.



"DURHAM" "SPOT" "RED" "JERRY" BULL No. 8

Group of Five Steers After Eight Months Exposure to Infected Pasture in Texas. They have carried great numbers of Ticks, but have shown no signs of Texas Fever.

In order to make a practical test of the degree of immunity brought about by infestation with ticks, the following animals were shipped to the Texas Experiment Station in December, 1898, viz:

Bull No. 8, "Jerry," "Spot," "Red" and "Durham."

They arrived at the station in good order on January 1st, 1899.

On January 3rd they were sent to the cattle pasture. This pasture lies directly west of the depot and contains about 600 acres. It is thickly wooded with trees and undergrowth. In the north and west portions of it small prairies occur. The water supply is from a branch which passes through it and from a large tank in the north corner. There are cattle in this pasture the whole year. At this time there were fifty or more wintering there.

There were some considerable number of ticks on the native cattle at the time, so that these grounds seemed the most suitable on which to make the test.

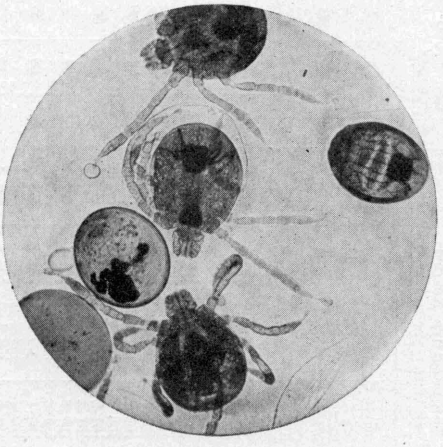
January 21st.—The cattle are losing flesh, evidently from lack of food. Arranged to have them fed cotton seed meal twice a week.

January 28th.—Ticks found on all the steers except No. 8. No fever or blood destruction present.

February 3rd.—Cold, wet weather set in today, which increased in severity until February 11th, by which time the temperature had fallen to zero. About twenty-five mature ticks found on the cattle during this cold spell.

From January 28th until August 31st these cattle were fed twice a week and their temperature, the condition of their blood and the number of ticks (Boophilus bovis) ascertained and recorded. The gap in the blood record was due to an accident to the apparatus. The percentage of red blood corpuscles was determined by the haematokrit. The numbers of the ticks must be regarded as estimates. When there were but a few, say twenty-five or less, they were counted, but in those cases where there were hundreds present, the numbers given are to be regarded as guesses.

No fever, blood destruction or other evidence of Texas fever occurred among these cattle at any time during the season, though they were subjected to the most severe test possible.



Tick Eggs and Young Ticks.

TABLE 1.—Tick Infestation Experiments.

Table Showing the Temperature Record, Blood Record and Degree of Tick Infestation of Animals Exposed to Virulent Pastures in Texas, after having been Rendered Immune to Texas Fever at the Missouri Experiment Station.

1899	Temperature Record					Red Blood-Corpuscles					TICKS									
											No. 8		"Spot"		"Jerry"		"Durham"		"Red"	
	No. 8	"Spot"	"Jerry"	"Durham"	"Red"	No. 8	"Spot"	"Jerry"	"Durham"	"Red"	Adult	Young	Adult	Young	Adult	Young	Adult	Young	Adult	Young
Jan. 28....	102.2	102.2	102.6	102.5	103	30	42	47	39	38	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Feb. 4....	.....	101.4	101.6	101.2	102	.....	.....	.....	.....	.....	.....	.....	8	50	3	25	8	50	6	25
" 7.....	103.2	102.8	102.4	103.5	103.8	.....	.....	.....	.....	.....	.....	10	...	100	5	45	10	35	....	20
" 11....	100.6	99.4	99.2	100.2	100.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
" 15....	102.4	102	102.2	102.2	102.2	.....	.....	.....	.....	.....	.....	8	10	75	1	50	8	25	6	12
" 18....	101.9	102.4	101.8	101.7	102.4	29	38	38	27	36	....	25	9	60	5	50	11	25	8	15
" 22....	101.8	101	100.4	101.2	101.2	29	38	38	30	40	2	100	5	50	10	50	5	25	4	30
" 25....	102.2	102.2	101.6	102.7	101.6	26	41	39	32	39	4	40	2	10	15	20	6	15	5	25
March 1....	103.8	103	101 4	103.3	102.5	.....	.....	.....	.....	.....	5	50	3	25	9	40	3	10	2	10
" 4...	101.2	101.2	100.8	101.2	101.4	27	40	36	31	34	7	35	4	6	15	35	5	10	3	25
" 8 ..	102.6	101.4	101.8	102	101.6	.....	.....	.....	.....	.....	7	20	5	15	2	....	4	15	4	10
" 11 ..	100.7	100.6	98.3	101.1	101	25	34	37	33	32	3	5	.....	5	1	3	5	6	2	10
" 15....	103.2	101.6	102.6	102	102	.....	.....	.....	.....	.....	1	5	.....	.....	1	5	1	3	.....	.....
" 18 ...	102.1	100.4	100.6	101	101	26	39	39	33	38	.....	35	.....	15	1	10	3	6	....	5
" 22 ...	102.8	102.7	102.2	103	103.1	.....	.....	.....	.....	.....	2	10	.....	20	2	25	5	15	.....	12
" 25 ..	102.3	101 6	100 4	102 4	101.8	.....	.....	.....	.....	.....	2	15	3	10	3	8	2	5	.....	10
" 29 ...	101	102.8	100 9	102.4	100 3	.....	.....	.....	.....	.....	4	15	1	20	.....	10	.....	15	.....	12
April 2....	100.8	100.6	100 2	101.2	101.6	.....	....	.....	.....	.....	2	50	.....	40	3	25	.....	50	1	
" 5....	101.4	100.4	100 2	101.4	102.8	....	.. ..	....	.....	.....	4	50	3	25	5	25	8	75	7	40
" 8 ...	102 2	101.7	100 6	101.6	102	.....	.....	.....	.....	.....	10	40	.....	30	2	25	4	50	1	35
" 11 pm	104 6	103	102 8	103.6	103.4	.....	.....	.....	.....	.....	6	50	1	20	2	25	13	50	2	25
" 15 ..	101.6	101	101	101.5	104.8	....	.....	.....	.....	.....	12	35	7	20	8	25	60	30	4	35
" 19....	101.3	101.4	100	101.4	101.2	27	33	33	34	30	1	35	7	40	1	20	6	25	1	20
" 22....	103	102.5	102.2	102 8	101.8	25	27	38	30	41	4	30	.....	10	1	25	2	15	1	50
" 25 ..	101.6	102	102.2	102	101.8	.....	.....	.....	.....	.....	10	80	6	20	16	30	8	15	5	20
" 29 ...	101.9	101.7	101.2	102.5	101.6	30	33	36	32	37	1	25	1	20	4	25	18	20	1	15

May 3.....	101 6	101.6	101	104	102	.....	.....	.....	.....	.....	1	10	3	18	5	20	8	15	4	40
" 6.....	101.5	101.4	100.9	104.1	101.7	28	25	36	37	32	3	20	2	10	.....	6	3	5	2	10
" 10.....	102.1	101.6	101.2	101.8	101.5	.....	.....	.....	.....	.....	1	15	.....	10	.....	15	...	5	2	10
" 13.....	103.2	102	102.1	102.8	102.3	30	33	40	35	34	1	.....	2	4	.....	5	1	5	1	5
" 17.....	101.8	101.6	101.3	101.5	101 6	.....	.....	.....	.....	.....	.....	3	.....	5	.....	4	.....	2	.....	6
" 20.....	101.7	101.5	101 6	101.6	101.8	25	32	36	27	32	.....	5	1	4	...	4	.....	6	2	5
" 24.....	101 4	101.2	101	101.3	101 5	.....	.....	.....	.....	.....	.....	.....	1	15	1	10	2	6	2	8
" 27.....	102.2	101.5	101.9	102.8	102.2	29	36	38	30	32	.....	8	2	20	4	15	3	35	.....	40
" 31.....	101.6	101 6	101 8	101.2	101.2	.....	.....	.....	.....	.....	20	80	50	125	100	250	5	100	40	200
June 3.....	101.5	101.8	100.8	101 8	101.4	30	30	40	28	29	2	225	22	100	3	275	37	250	7	150
" 7.....	101.8	102	101.5	101.2	101.4	.....	.....	.....	.....	.....	6	100	2	50	30	150	13	250	7	275
" 10.....	102	103.2	101.4	101.2	102	29	34	33	32	30	13	150	3	100	20	175	50	150	35	200
" 14.....	102.4	101 6	102	103	102.2	.....	.....	.....	.....	.....	25	150	10	100	100	750	150	1000	25	400
" 17.....	102 1	101	101.3	101.4	102	23	28	29	25	34	25	250	30	325	100	1000	275	1250	156	840
" 21.....	101.6	100.9	100 8	101	101.1	.....	.....	.....	.....	.....	180	555	25	135	75	880	315	1345	225	755
" 24.....	102	101	100.8	102 5	101	25	29	34	30	32	77	365	105	450	250	750	350	1300	305	860
" 28.....	100 2	101	101.3	101.8	101 6	.....	.....	.....	.....	.....	55	300	75	375	125	575	275	850	225	550
July 1.....	102.1	101.2	101.3	102 2	101.8	25	31	27	25	35	35	99	75	140	150	205	45	150	25	75
" 5.....	101 4	100.7	101	101.2	101.8	.....	.....	.....	.....	.....	15	150	20	250	30	225	18	125	5	75
" 8.....	102.2	101 9	102 5	102 8	102.6	30	33	26	29	29	7	175	10	125	20	150	15	50	5	15
" 12.....	101 8	101 2	101.7	101.6	101.3	.....	.....	.....	.....	.....	5	80	8	100	10	75	7	25	3	20
" 15.....	102 7	102.6	103.4	103.8	103.7	27	36	34	31	35	12	18	6	15	10	35	5	25	7	20
" 19.....	103.2	101.2	103 8	102.4	101.7	.....	.....	.....	.....	.....	20	75	5	20	15	50	10	60	7	30
" 22.....	102.2	101.3	104	101.8	101.5	26	33	18	36	36	8	28	3	7	5	15	10	20	2	25
" 25.....	102 3	102.1	102 8	102.5	101.7	.....	.....	.....	.....	.....	6	12	5	10	8	17	15	25	10	15
" 29.....	101 4	101.1	102	101.7	101.7	25	40	30	36	39	4	7	10	15	3	5	6	10	.....	5
August 2.....	101.5	101 6	102	102.1	102.2	.....	.....	.....	.....	.....	5	15	4	10	3	8	8	20	5	12
" 5.....	102.2	101.4	101.6	102.3	101.8	28	35	29	29	31	12	30	25	75	10	20	15	45	8	35
" 9.....	101.6	100.8	100.4	101	101	.....	.....	.....	.....	.....	35	150	20	75	15	25	10	15	20	20
" 12.....	101.2	101 1	102	102.1	101.3	25	36	32	30	37	15	25	20	30	18	35	25	40	20	35
" 16.....	101.1	102	101 4	101.6	101.7	.....	.....	.....	.....	.....	8	25	10	90	15	70	8	25	5	20
" 19.....	102.4	101.4	101.2	101.5	101.6	27	38	33	32	35	15	50	25	75	10	35	8	25	18	20
" 23.....	101.1	101 7	100.6	101.6	100.9	.....	.....	.....	.....	.....	100	150	200	325	25	100	150	250	20	50
" 26.....	101.4	101.1	100.6	101	101 3	28	37	31	27	33	250	450	800	2000	200	750	300	500	20	75
" 31.....	101 8	101 7	101.5	101.3	102	28	38	34	30	36	200	400	700	1500	175	700	200	500	25	100

Experiment closed, August 31st. Animals in perfect health.

III. EXPERIMENTS TO DETERMINE THE PRACTICABILITY OF IMMUNIZING SUSCEPTIBLE CATTLE AGAINST TEXAS FEVER BY INOCULATION WITH INFECTED BLOOD.

The investigations made by Smith and Kilbourne into the pathology of Texas fever have shown, among other things, that the disease may be produced by inoculation with infected blood; and that the mortality from such attacks is, as a rule, much lower than in those cases which have been induced by natural tick infestation. It is well known that a considerable percentage of animals recover from the disease, and that they subsequently resist the infection when exposed to it in its most virulent form. This shows that a considerable degree of immunity is brought about in some way by the first attack. Moreover, certain officers of the Queensland (Australia) government, notably, C. J. Pound, director of the

Group of Aberdeen Angus Bulls After One *Season's* Exposure in South Texas. Inoculated with Immune Blood.

Stock Institute, and J. Sidney Hunt, government pathologist, have shown that the disease known as "Red Water," in Australia, is identical in its nature with what we call "Texas Fever;" and that if the inoculations be made with the blood of animals which have *recently recovered* from the disease, the degree of immunity resulting from it is sufficient to enable the animal to withstand the disease in its most virulent form. With these facts before us, we have made the following experiments:

EXPERIMENT No. 1.

BULLOCK.—TEN HEAD OF ABERDEEN ANGUS BULLS.

This experiment was made to ascertain the practical value of inoculation with the blood of an immune Southern animal, to pre-

vent the fatal type of Texas fever. The cattle used consisted of ten Aberdeen-Angus bulls, 6 to 10 months of age, that were raised near Wichita, Kansas.

The blood was drawn from the jugular vein of an immune cow in Brazos county, Texas, into a clean sterile vessel. To it was added 10 per cent. of a saturated watery solution of tri-Kresol, to lessen the danger of putrefaction. The blood was immediately forwarded to Wichita. The inoculations were made by Dr. Ward on November 19th, 1897, who gave each bull 8 cc. of the blood subcutaneously. After inoculation, the bulls were kept as quietly as possible in a lot during the day and in a warm barn at night. They were fed prairie hay and a mixture of equal parts of corn chops, oats and bran. During the fever following the inoculation they showed a marked loss of flesh, but none refused food entirely. They were held in this lot for thirty days, and then shipped to the Brightside ranch in Brazoria county, Texas, where they arrived December 24th, 1897. They were put with Southern cattle, no attempt being made to isolate them. They were grazed on oats and fed cotton seed and sorghum hay. On January 14th, 1898, one of them died suddenly. A post-mortem examination was made by the manager, who attributes the death to "dry murrain."

One or two others were sick but recovered. No other sickness occurred among them during the following summer (1898), and they have grown fairly well. As to the present condition of these cattle, the manager writes:

"In the spring of 1899 they were turned in with the range cattle in the big pasture, being at that time 2 years old. They have taken their chances like Southern grown cattle, and have done good service and look well."

EXPERIMENT No. 2.

RHEA.—TEN HEAD OF REGISTERED SHORTHORNS.

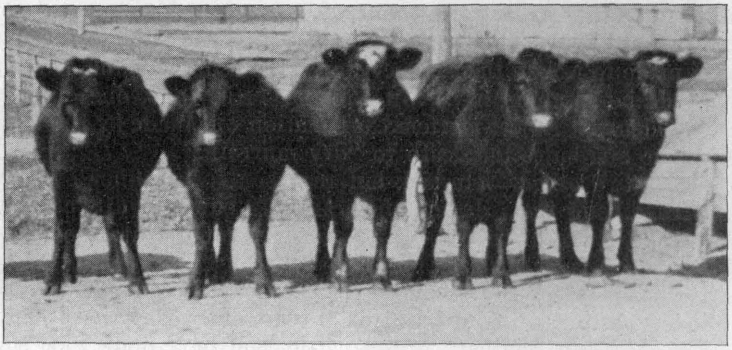
This experiment differs from the preceding in that the inoculations were made with immune blood after the cattle had been taken south.

Lot I consisted of four animals, two bulls about 8 months old, and two heifers about 12 months old. These cattle were pure bred Shorthorns, raised near Council Grove, Kansas. They were shipped south and arrived in Collin county, Texas, in February, 1898. They received subcutaneous injections of defibrinated immune blood, prepared as in the preceding experiment, from a cow in Brazos county, Texas, as follows: The bulls received 4 cc. and the heifers 8 cc. In eight days one of the bulls and one of the heifers refused their food, became gaunt, showed reeling gait, which con-

tinued for some days. They were eating again reasonably well by the expiration of two weeks. The other bull and other heifer which received the same dose at the same time were not apparently affected.

After twenty days the four were inoculated as in the first instance. The two that were sickened by the first dose were not apparently affected by the second. The other two, on the ninth day refused to eat, and were stupid for several days. On April 25th, each animal received a third inoculation, of 8 cc. of defibrinated blood; but no effects were apparent from it.

Lot II consisted of six registered Shorthorns, raised in Cooper county, Missouri. They were shipped to Collin county, Texas, where they arrived April 21st, 1898. The lot consisted of one bull 7



Registered Short-Horn Heifers at Close of First Season's Exposure in North Texas. Inoculated with Immune Blood.

months old and five heifers from 8 to 12 months old. On April 25th each one received 4 cc. of defibrinated blood subcutaneously. This blood, as in the former experiment, had been prepared at the Texas Experiment Station, from an immune cow. Eight days later four of the calves left their food untouched, but no other symptoms of an alarming character developed.

May 25th, 1898, each calf received a second inoculation of defibrinated blood of 4 cc. subcutaneously. Eight days later they all showed a lack of relish for their food, which continued three or four days. Nothing further was noticed until September 10th, 1898, when one of the heifers of lot 1 died. All of the remaining heifers produced good, healthy calves in the spring of 1899, and have all passed the summer of 1899 successfully, though they have been very ticky and have perhaps suffered from them.

EXPERIMENT No. 3.

GREEN.—ONE HUNDRED AND THIRTY-SIX HEAD OF REGISTERED SHORTHORNS.

Lot I consisted of ninety-four pure bred Shorthorns, whose ages ranged from 6 to 12 months. They were raised in New York, Ohio, Indiana, Illinois and Iowa, and had been bunched on the owner's farm in Coles county, Ill.

October 15th, 1898, each received 2.5 cc. of defibrinated blood subcutaneously. The blood used was from a 6-year-old ox which had been raised in Southern Texas and had been brought to Illinois in September, 1898.

October 29th (fourteenth day).—The smallest calves seem to be sick. Five or six have been stupid two or three days, and half of the bunch show symptoms of fever. The largest ones are not affected apparently.

November 2nd (seventeenth day).—One of the calves died yesterday (sixteenth day). Two are very sick; others are in various stages. Nearly all are discharging mucous from the nose and mouth. They show staring coat, drawn and pinched appearance, drooping ears, panting, stiffness of the limbs, glassy eyes. In many the catarrhal symptoms, labored breathing and weakness are severe.

November 4th (nineteenth day).—No local trace of inoculation on any of the calves. Two of the smallest are sick. Some are getting better and some are just taking sick. The heifers seem to be less severely affected than the bulls. The most pronounced symptoms are drooping ears, nasal discharge which is bloody in some cases, rapid breathing, staggering gait; loss of appetite and flesh, pinched, drawn appearance of the whole body.

Lot II.—November 9th.—Inoculated forty-three more calves from Iowa, that have arrived since October 15th, giving each 2.5 cc. of blood taken from the mate to the ox whose blood was used on October 15th. Also reinoculated six of the first lot which showed no marked symptoms, using 2.5 cc. of the same blood as lot No. II.

The majority of the cattle are doing well, about twenty appear gaunt, but the most of them are eating well. One young bull refuses food and appears very sick.

November 10th.—The young bull that has been so sick, died last night.

November 19th.—One calf of lot II is very sick (tenth day.)

November 28th (forty-third day).—The sick calf of lot I, which had a relapse (second reaction) is about well.

December 3rd (forty-ninth day).—The calves are doing very well. Feeding them corn, oats, bran and hay, and turn them into

the pasture on pleasant days. The second lot have not been so sick as at first. Some of the first have had relapse (second reaction). Three of the six which were reinoculated have shown the effects of it. All are in thriving condition except two or three of lot I. The probable cause of the cattle of the first lot not doing so well as the second is that they were exposed to a cold rain storm about the time of the primary fever period.

December 18th.—Cattle shipped south.

December 20th.—Cattle fed at Parsons, Kansas.

December 23rd.—Train wrecked at Marques, Texas, at midnight. One car turned over. Ten calves killed outright and many crippled.

December 24th.—Cattle arrive at San Antonio, Texas, and are put in yard. They appear badly fatigued and gaunt from long journey and shake up of wreck. Many of them have pink-eye.

January 17th, 1899.—Cattle have been moved to the ranch in Dimmit county. Four or five have died of black-leg. Otherwise they are doing nicely.

August 23rd.—No losses from fever among inoculated cattle up to July 10th. Not many ticks on them until then. Since that date have lost ten which were inoculated, and ten others have been sick but have recovered. They had been fed grain and hay or cane until June 1st, when grass was so abundant that they preferred it. They were doing as well as one could wish until July 10th. One red poll bull, which has carried ticks all spring and summer has shown no signs of fever to date.

September 20th.—Cattle all doing well. Have lost about 40 per cent. of those that were not inoculated.

EXPERIMENT No. 4.

TOD.—THIRTY HEAD OF REGISTERED HEREFORD BULLS.

This lot of bulls, consisting of thirty head of registered Herefords, bred in Missouri and Illinois, was supplied by Captain John Tod, manager of the Laureles ranch, Corpus Christi, Texas. On their arrival at the Missouri Station, November 1st, 1898, they varied in weight from about 275 pounds to 850 pounds. The weights of each at the beginning and end of the experiment, with gain or loss, are given at the head of the temperature tables. Before inoculating the bulls, they were given a weeks' rest, to allow them to overcome the soreness and fatigue incident to shipment, changes of food and surroundings.

On November 7th, fourteen head of the small and medium sized bulls were inoculated, each receiving subcutaneously 2.5 cc. defi-

brinated blood from an immune Texas steer.* This lot of bulls is designated in the temperature tables as "Group I," and consisted of animals numbered as follows: Nos. 1,3, 2, 13,7, 14, 17, 12, 19, 15, 26, 4, 21 and 18. Bulls Nos. 4, 21 and 18 were reinoculated December 8th with 2.5 cc. of defibrinated blood from a "recovered" native.

On November 15th ten more head were inoculated from the Texas steer, 2.5 cc. blood being given. In this lot was included one of the larger bulls (No.23) weighing 680 pounds. In the temperature table this lot appears as Group II. The lot comprises bulls Nos. 8, 22, 20, 23, 24, 16, 10, 28, 25 and 5. All these except the first four were reinoculated December 8th, dose 2.5 cc., from the recovered native.

Registered Hereford Bulls on the Laureles Ranch, in South Texas. Inoculated with Immune Blood.

The remaining six bulls, Nos. 58, 11, 29, 9, 30 and 6, the largest ones of the shipment, were inoculated November 29th, an initial dose of 1 cc. being given from the Texas steer, and nine days later (December 8th) a second inoculation, of 2 cc. from the recovered native was given. No reaction had appeared in this lot up to the time of the reinoculation.

Most of the bulls that were *reinoculated* in groups I and II had shown no marked fever from the first inoculation, but a few animals that had shown fever were also reinoculated to determine the effect.

Clinical notes in addition to the temperature tables, are given

*This supply animal was received from College Station, Texas, in June, 1898; was one left over from "dipping experiments." The animal was kept on an infected pasture during the summer and was bearing a few mature ticks at the time the blood was used.

upon each animal. These notes show date of rise of fever, its duration and type, whether severe or mild, the condition of the animal when shipped, and the history of the bulls after shipment south.

A study of the temperature notes and records shows that, as a rule, the inoculation fever begins about the eighth or ninth day after the injection, but sometimes a little earlier and sometimes a little later, and that it usually continues from seven to eight days. In some cases it may not exceed more than four days, and in others it may be prolonged to fifteen days. The daily average of the temperature during the primary fever period, counting all that reacted distinctly, was about 104.5.

A remarkable feature observed in quite a number of the animals in this experiment was the occurrence of a distinct secondary fever period, beginning at about the twenty-fifth to thirtieth day after inoculation, and continuing from seven to eight days (in a few cases four or five days, and in a few from twelve to sixteen days). This secondary fever appeared to be not so severe as the primary. The graphic records, page 84, illustrate this matter of the primary and secondary fever periods. In some animals that received but one inoculation, no appreciable reaction appeared at the usual period of primary fever, but came up strongly at the secondary period. These bulls were not kept under observation a sufficient length of time to determine whether a regular "periodicity" occurs in this fever, as in malaria (the micro-organism of which appears to be nearly related to that of Texas fever). The suggestion arises that tertiary and succeeding recurrences of fever take place, each milder than the preceding, until finally immunity is attained.

The matter of the occurrence of the marked secondary fever period has been confirmed in experiment No. 8, carried on during the succeeding summer at the Texas Experiment Station. In this latter experiment five animals were used; the temperature records were taken twice daily and in a more systematic manner than in the larger group of the above experiment. In addition, regular determinations of the decrease and increase of blood corpuscles during the experiment were made. The temperature records and clinical notes are given of each animal of this lot. These data give a more accurate knowledge of the effects of inoculation upon cattle of different ages than are supplied by the preceding experiments, of which we had no opportunity to make a close study.

CLINICAL NOTES ON THE TOD BULLS.

Group I.—Inoculated November 7, 1898; dose 2.5 cc. each. Shipped to Corpus Christi, Texas, January 1, 1899. Arrived at destination January 6th, 1899.

Bull No. 1.—Weight when received 272 pounds; gain in sixty days, 38 pounds. High fever on eighth day, continued from 105 to 106 F. for five days, with slighter fever for a few days longer. The maximum temperature during this period was 106.4 F. On the thirty-third day began a secondary fever period which continued four days. The temperature was about 104 during this period. Calf ate but little during the acute stage of the primary fever, was very sick, urine highly colored from urates; found no hæmaglobin in the urine. Fell off in flesh considerably, but ate well and improved in condition after the acute stage of the fever had passed. In fair conditiion when shipped. January 9th, third day after arrival, temperature 103.2. Died from snake bite May 28th; had carried ticks since February.

Bull No. 3.—Weight when received 285 pounds; gain in sixty days, 25 pounds. Had fever on ninth day; continued four days, temperature ranging from 104 to 106 F. Secondary fever arose on the thirty-fourth day, continued four days, 104 to 105.9 F. Fell off some in flesh, but ate well and improved in condition. Shipped in fair condition. June 24th, temperature 102, carrying ticks. August 14th, having carried ticks through spring and summer, has shown no serious illness, is alive and in good health.

Bull No. 2.—Weight 300 pounds when received; loss during experiments, 10 pounds. Primary fever began on eighth day, continued eleven days, 104 to 105.7 F. Was free from fever about thirteen days. Secondary fever period began on the thirty-third day and continued a week, at 104 to 105.8 F., was off feed at height of fever; got thin and suffered from cold, although well protected in a barn. Was in poor condition when shipped. Calf appeared to be affected with "Hoose," had husky cough when brought to Missouri Experiment Station. January 9th, temperature 104. June 24th, temperature 104; has some ticks. This bull died in the summer. From the description given the death was probably due to "Hoose," or lung worms..

NOTE—The above three calves had just been weaned before being sent to the Station, and were not in proper condition for inoculation.

Bull No. 13.—Weight 382 pounds when inoculated; gained 18 pounds. Fever appeared on ninth day and continued ten days. 103.9 to 108.4 F. A slight secondary fever the thirty-third day, continued four days; 103 to 104 F. During height of primary fever was off feed and dull, head drooped. After fever had passed he ate while at the Station. Was shipped in fair condition. January 9th, third day after arrival in Texas, temperature 104. January 11th, appeared well; was found infested with ticks early in February; no fever. April 24th, no sickness since recovery from the shipping fever. June 24th, temperature 104; has a few ticks, urine clear. July 22nd, doing well. August 14th, doing well.

Bull No. 7.—Weight when inoculated 390 pounds; no gain. Fever on eighth day; continued four days, 104 to 105.8 F. An occasional high temperature from twelfth to thirtieth day. Secondary fever twenty-ninth to thirty-fifth day, 103.4 to 105.2 F. Did not thrive, fell off in flesh; somewhat thin when shipped. Temperature was not taken at Corpus Christi; condition not mentioned. Became infested with ticks in February; no sickness apparent. April 24th, has done well. June 24th, temperature 102.4, and is extremely "ticky;" no depression apparent. August 15th, in good health.

Bull No. 14.—Weight when inoculated 390 pounds; gained 10 pounds. Fever on tenth day, continued six days, 103.8 to 104.4. Slight recurrence on twenty-fifth to twenty-seventh days. Animal ate well and showed outwardly but little signs of fever. Shipped in fair condition. January 9th, temperature on third day after unloading in Texas was normal, 102 F. Was infested with ticks in February, and has carried more or less through the summer. On June 24th was very ticky, but showed no signs of illness. Temperature 102.4. In May and June was put for a while with heifers. August 15th, is in good health.

Bull No. 17.—Weight 410 pounds when inoculated; gain 75 pounds. Fever on eighth day, continued eight days, 104 to 105.5 F. On the fortieth to forty-second, day temperature 104 to 104.7. Bull was off feed and dumpish during primary fever period. Made a good recovery and was shipped in excellent condition. The temperature was normal, 102.1, on the third day after reaching Texas. This animal carried ticks through the summer, but had no fever. June 24th, temperature 101.8; was carrying ticks. Was for a time with heifers in May and June. August 15th, in good health.

Bull No. 12.—Weight 412 pounds when received; gain 18 pounds. Had not recovered from shipping fever when inoculated; temperature 104. Had a well marked primary reaction, maximum temperature of 107.4 F. on the tenth day, and fever ten days longer, ranging from 103 to 105 F. Secondary rise, 103.2 to 105.6 from thirty-fourth to thirty-eighth days. This bull was off feed occasionally, but ate well the greater part of the time. Was looking well when shipped. Temperature after reaching destination, 103. Has carried ticks since early in February. June 24th, was carrying ticks; temperature 101.4. August 15th, in good health. Did some service in May and June with heifers.

Bull No. 19.—Weight 428 pounds. Fever on the fourth day. Continued about two weeks. 103.4 to 106 F. Slight secondary fever on twenty-ninth and thirtieth days. Made good recovery and was shipped South in fair condition. Ate well most of the time; lost some flesh during fever period, but regained his condition. Temperature normal. 102 F., on arrival in Texas. Ticks found on him on February 10th. April 24th, no fever to date. June 24th, temperature 103, very ticky. August 15th, in good health. Did some service in May and June.

Bull No. 15.—Weight 455 pounds when received; gain, 20 pounds. From fourth to fourteenth day somewhat feverish, 103.5 to 106.4 F. (evening temperatures), but was not off feed. From twenty-third to twenty-seventh day calf appeared dumpish, laid down considerably, ate some, but appetite not good. Morning temperature 104.7 to 106.2; one evening temperature 106.5 F., on a cold stormy day, December 3rd, for twelve days succeeding this fever period, animal did well. A *third* period of fever began about the thirty-ninth day and continued eight days, 103.6 to 105 F. This calf had some fever when shipped. January 9th, three days after arrival in Texas, temperature 102.6. February 10th, had ticks. April 24th, no sickness to date. June 24th, temperature 103.7; very ticky. August 15th, good health; was with cows and heifers in May and June.

Bull No. 26.—Weight 480 pounds when received; gain 20 pounds. Through the usual primary fever the daily temperature was somewhat irregular, 103 to 104.5 F. Afternoon temperature on tenth day was 106.2. On the nineteenth day had a catarrhal discharge from nose. Was not off feed, and did not show outwardly any serious symptoms up to the fortieth day, when he appeared dumpish. Had a regular fever period from thirty-ninth to forty-third day. Temperature 103.8 to 106.8 F., the latter on the morning of the forty-second day, at 11 a. m.

Except for a slight running at the nose was in good condition when shipped; was eating well. Temperature on arrival in Texas was about normal. Infested with ticks in February. April 24th, no sickness yet appeared. June 24th, animal ticky, but appeared well. August 15th, bull in good health; has done some service.

Bull No. 4.—Weight 380 pounds when inoculated; gain 45 pounds. Fever on eighth day, continued ten days, 103.4 to 105.8 F. Secondary fever began on the twenty-ninth day and continued eight days, 103.8 to 105.8 F. This bull ate well and except for some falling off in flesh following the fever period, no outward signs of the fever were noticeable. At the time if the shipment the animal was in fair condition. This bull was reinoculated by mistake on December 8th, the third day of the secondary fever period. Temperature on arrival in Texas (102) normal. Has carried ticks during the summer. August 15th, is in good health.

Bull No. 21.—Weight 415 pounds when inoculated; gain 30 pounds. Fever on fourth day, continued ten days; ranged from 103.6 to 104.4. Ate well and showed no marked outward signs of illness. Secondary rise on thirty-third day, continued five days, 104 to 104.6 F. Shipped in good condition. This animal was reinoculated December 8th with 2 cc. Temperature on arrival in Texas 103.6, slight fever. Became tick infested in February. April 24th, reported in good health. June 24th, temperature 102.5, and carrying ticks. August 15th, bull is in good health; has done some service.

Bull No. 18.—Weight 445 pounds when received; gain 85 pounds. No distinct fever period occurred at the usual time following inoculation, only a few isolated high temperatures. On the thirty-first day and for a few days following the temperature was up to 104. The bull at this time was somewhat dumpish and off feed. The animal was reinoculated at the beginning of this fever period. Was sent South in good condition. Had fever on arrival at Corpus Christi, Texas. Temperature January 9th, 104.2. Was off feed a few days—probably a secondary reaction from the inoculation of December 8th. Animal carried ticks through the summer. June 24th, temperature 103.4, bearing ticks. Was put with cows and heifers for a while in May and June. August 15th, is in good health.

Group II.—Inoculated November 15th, 1898, with 2.5 cc. defibrinated blood from Texas steer. Shipped to Corpus Christi, Texas, January 1st, 1899, arrived at destination January 6th.

Bull No. 8.—Weight 370 pounds when received; gained 10 pounds. Had fever off and on during the sixty days at the Station. From twenty-fifth to thirty-fourth days a somewhat continuous fever, 104 to 105.6 F. Animal looked thin when shipped, although he had made a slight gain in weight. Temperature on arrival in Texas, 103. Carried ticks through the summer; showed no serious illness. August 15th, in good health.

Bull No. 22.—Weight 435 pounds when received; gain 90 pounds. Had some fever when inoculated, probably from shipping. On tenth day was dull and off feed, afternoon temperature 106.3. From thirtieth to thirty-third days temperature 104 to 105 F., animal dumpish. The animal did well the greater part of the time, and was shipped in good condition. January 9th, three days after arrival in Texas, temperature 103 F. August 15th, in good health; has been well infested with ticks.

Bull No. 20.—Weight when received 550 pounds; gained 60 pounds. Scarcely any elevation of temperature until the twenty-ninth day after inoculation. From the twenty-ninth to thirty-seventh days, 103.8 to 104.6 F. Was a little off, but did not refuse food. Did well and was

shipped to Texas January 1st, in good condition. January 9th, temperature 103. Reported well April 24th, June 24th and July 22nd. August 15th, is in good health. Has done service.

Bull No. 23.—Weight 680 pounds; gained 30 pounds. Fever on the eleventh day, continuing eight days. Temperature ranging from 104 to 107.6 F. Animal was off feed, dumpish, lay down much of the time, and appeared to be extremely sensitive to cold. Had no secondary reaction. Made a good recovery, and was shipped in fair condition. Temperature January 9th, 103.2. August 15th, has carried ticks since early in February, and has shown no serious illness. Has done some service.

Bull No. 24.—Weight 365 pounds; gained 50 pounds. Had no distinct reaction at the primary fever period, but a few isolated high temperatures—105.6 F. on the tenth day, 103.8 on the twelfth day. On the thirty-fifth day and following, a more continuous fever occurred, the temperature ranging from 103.7 to 107.1 F. This bull received a second dose of 2.5 cc. defibrinated blood from a recovered native on the twenty-third day after the first inoculation. January 9th, temperature 102.6. Was found to be infested with ticks in February. No illness resulted. Was in good health April 24th. June 24th, very ticky, temperature 103. No depression; in fair flesh. August 15th, is in good health.

Bull No. 16.—Weight when inoculated 402 pounds; gained 88 pounds. This bull was inoculated twice, but during the entire sixty days that he remained at the Station only a few high temperatures were observed—on the eighth day, 103.8; seventeenth day, 103.9; twenty-first afternoon, 106; thirty-fourth day, 103.9; fortieth day, 103.6 F. No continuous fever period occurred. This bull ate well and kept in excellent condition. Had some fever on arrival in Texas, 104 F. January 9th. A delayed reaction may have occurred. This animal became very ticky and on June 24th had some fever, 104 F., but outwardly showed no marked signs of illness, and no depression. August 15th, no illness, was with cows and heifers a part of May and June.

Bull No. 10.—Weight, 480 pounds; gained 105 pounds. Showed but little rise of temperature from the first inoculation. Was reinoculated twenty-three days later (December 8th) with 2.5 cc. blood from a native made immune by artificial tick infestation. A marked fever period followed this second inoculation, beginning on the fifth day and continuing six days or longer. This fever period corresponds to the secondary reaction of the usual type, and it is possible that this may be a delayed response to the first inoculation. January 9th, temperature 101.1; February 10th, had ticks. April 24th, no illness to date. June 24th, July 22nd and August 15th, in good health. Has done some service.

Bull No. 28.—Weight when received, 498 pounds; gained 47 pounds. Had an occasional high temperature following the first inoculation, but no sustained fever period. A well marked period of fever followed the second inoculation, averaging 104.2 for nine days. In good condition when shipped. January 9th, temperature 102.6 F. Reported in good health February 10th, though carrying ticks. Also on April 24th, June 24th, July 22nd and August 15th, in good health; has borne ticks. Has done service.

Bull No. 25.—Weight, 507 pounds when received; gained 38 pounds. No fever period occurred at the usual time following the first inoculation, but eleven days after the second inoculation the temperature rose to 105 and continued at about this point for five days. January 9th, temperature 102 F. August 15th, has carried ticks through the summer, and has shown no illness. Has done some service.

Bull No. 5.—Weight when received, 600 pounds; gained 80 pounds. Temperature normal for twenty-seven days following the first inoculation, except on twelfth day, 104.8 F. Reinoculated on the twenty-third day; five days later a well marked fever period began and continued five days. Temperature 104 to 106.5 F. Was somewhat dumpish, but continued to eat; was shipped in good condition. January 9th, temperature 102.2. June 24th, 102.2. August 15th, in good health after carrying ticks through the summer, and doing some service.

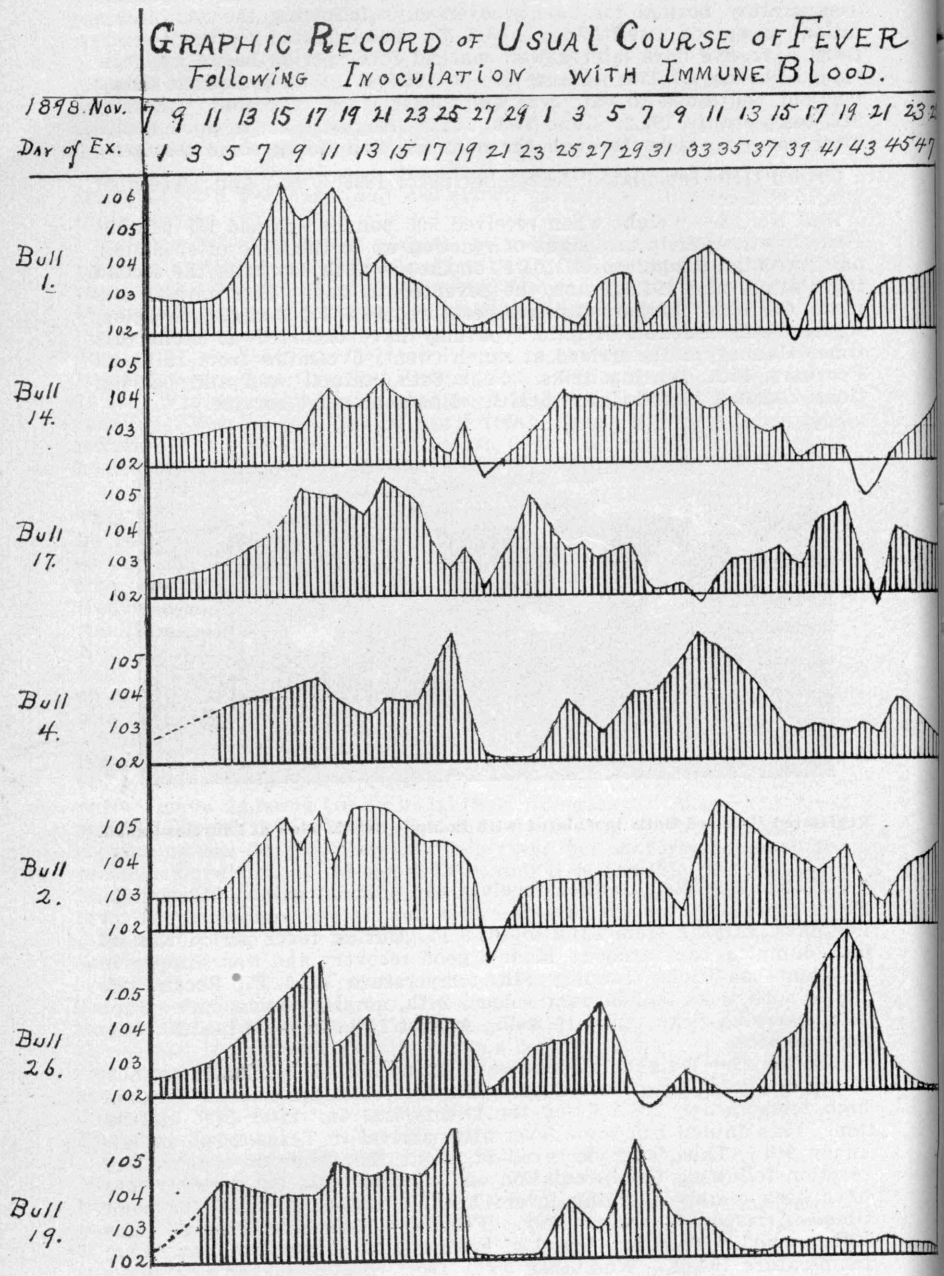
Group III.—Inoculated November 29th, 1898, 1 cc.; and December 8th, 1898, 2 cc.

Bull No. 58.—Weight when received 505 pounds; gained 135 pounds. Had shown scarcely any signs of reaction up to the time of shipment, only two high temperatures, 104 F. on the eleventh day after the second inoculation, and 103.8 F. on the seventeenth day. This animal was never off feed. January 9th, temperature 103.6 F., a slight elevation. A secondary reaction of mild type may have occurred at about this time. January 20th, arrived at ranch twenty-five miles from railroad. February 10th, bearing ticks. June 24th, animal well and bearing ticks. August 15th, in good health. Has done some service.

Registered Hereford Bulls Inoculated with Immune Blood. Now at Laureles Ranch.

Bull No. 11.—Weight when received 620 pounds; gained 110 pounds. Fever arose on the sixth day after first inoculation, and continued for five days, varying from 104.2 to 106.3 F. During fever period was off feed, dumpish, back arched. Made a good recovery and was shipped in excellent condition. January 9th, temperature 103.1 F. Became infested with ticks in February. April 24th, no sickness to date. June 24th, carrying ticks; appears well. August 15th, in good health. Has done service.

Bull No. 29.—Weight, 715 pounds when inoculated; gained 15 pounds. No fever period had occurred up to the date of shipment, and only one high temperature, 104.1 F. on the twenty-first day after first inoculation. This animal had some fever after arrival in Texas, 104.6 on Januanary 9th. This fever occurred at about the time for a secondary reaction following the inoculation on December 8th, but possibly may have been simply shipping fever; but did not thrive well for some time. Arrived at ranch safely. February 10th, found ticks. May 13th, turned with cows; found sick June 7th, twenty-five days later; temperature 104. F. Was taken away from cows and kept quiet for a


GRAPHIC RECORD OF USUAL COURSE OF FEVER
Following Inoculation with Immune Blood.
1898. Nov. 7 9 11 13 15 17 19 21 23 25 27 29 1 3 5 7 9 11 13 15 17 19 21 23
Day of Ex. 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47
Bull 1.
Bull 14.
Bull 17.
Bull 4.
Bull 2.
Bull 26.
Bull 19.
106
105
104
103
102

couple of weeks and was then turned out to service again, and has kept well ever since.

Bull No 9.—Weight, 795 pouds when received; gained 95 pounds. Fever on thirteenth, fourteenth and fifteenth days following first inoculation, 103.8 to 105.6 F. Animal kept in good condition, no prolonged fever period. Shipped to Texas in good condition. Temperature January 9th, 105.8; January 11th 105; appears to be a secondary reaction from the inoculation. February 25th, had ticks; shows no sickness. April 24th, no sickness to date. August 15th, has carried ticks through the summer and has had considerable service.

Bull No. 30.—Weight, 815 pounds; gained 135 pounds. Inoculated November 29th with 1 cc. blood from an immune Texas steer, and reinoculated December 8th with 2 cc. from a recovered native. No rise of temperature up to time of shipment. January 9th, three days after reaching Corpus Christi, had temperature of 103.4. Appeared sick on January 11th, temperature 104. This may be a delayed reaction from the inoculation brought out by shipping, or simply shipping fever.

Registered Hereford Bulls, Inoculated with Immune Blood.

January 20th, arrived at Laureles ranch, driven out twenty-five miles from Corpus Christi. February 10th, found ticks. February 15th, appears sick. February 25th, ticks on this bull, appears well. April 24th, has done well. May 16th, turned into pasture with cows. June 3rd, sick; temperature 108 F. 7:30 a. m. June 5th, died of Texas fever, passed red water before death. Post-mortem showed enlarged spleen and red water in bladder.

Bull No. 6.—Weight when inoculated, 823 pounds; gained 117 pounds before shipping. Had a slight reaction on seventh to tenth days following second inoculation; had chill at beginning of attack. Was off food and dumpish. Recovered appetite in a few days, was shipped in good condition. This animal had fever on arrival in Corpus Christi; January 9th, temperature 104.6, either from shipping fever or secondary reaction from inoculation. January 20th, arrived at ranch twenty-five

miles from Corpus Christi. February 10th, found ticks. February 15th, this bull was sick. February 25th, has recovered and is carrying ticks; temperature at 4 p. m., 103. April 24th, appears to be free from ticks; no illness observable. May 13th, was put in pasture with cows, was in strong, vigorous condition; had been well infested with ticks. June 4th, died from acute attack of Texas fever.

TABLE 2.

Temperature Record of Group I.

		Bull 1	Bull 3	Bull 2	Bull 13	Bull 7	Bull 14	Bull 17	Bull 12	Bull 19	Bull 15	Bull 26	Bull 4	Bull 21	Bull 18
Weight Nov. 1		272	285	300	382	390	390	410	412	428	455	480	380	415	445
Weight Jan. 1.		310	310	290	400	390	400	485	430	475	475	500	425	445	530
Gain or Loss		38	25	—10	18	.....	10	75	18	47	20	20	45	30	85
Nov.	7....	..	102	103	103	102.5	.....	102.8	102.5	104	102 5	103	102.5	103.5	.....	... .
"	11....	4	102.9	103.2	103.1	102.8	104 8	103	102.9	104	104.5	104 5	103.2	103.6	104.4	101.5
"	15 ...	8	106 4	103.4	105 4	103.2	104.8	103 2	104.2	105.4	104	106 4	103.3	104 2	104.1	103
"	16 ...	9	105.4	104	104.4	104	104	103	105.2	107.2	103.8	103 6	103 5	104.1	.....	104.2
"	17....	10	105.6	104	105 6	103.9	105.8	103.8	104	107.4	104.1	103.5	106.2	104.5	.....	103
"	18 ...	11	106.2	106	103.9	106 5	104 4	104 2	105	105 8	105	103.8	103 4	104	104	104.1
"	19....	12	105 3	106	105.6	108 4	.	103.7	104	107 3	. . .	104	103.5	....	...	103.2
"	20....	13	103 5	102.4	105.7	107.2	103 6	104	104 5	103	104.5	103.4	104 4	103.4	103.6	103.2
"	21 ...	14	104.2	103.5	105.7	104	103.3	104 4	105.5	104 5	104.8	104.4	102 7	103.9	104.2	104.3
"	23 ...	16	103 4	103 3	104.6	102	104 1	103 8	104.8	104.9	103 4	102	104.4	103 8	102 8	102.6
"	24 ...	17	103.1	.....	105 1	104 5	...	....	102.8	104	....	....	....	....	...	... .
"	25....	18	104	102 8	104.6	104 8	105.8	102 2	102.8	103	106	103	104.2	105 8	102.1	101.6
"	26....	19	102	103	104	104 1	103.4	103.2	103 4	104 5	102.3	102.8	103.5	103.8	102.3	103.6
"	27....	20	102.2	105	101	101.2	103.4	101.6	102 2	104 8	102	102	102	102.2	104	102.4
"	30....	23	103	103 5	103.4	104.2	103 5	102 8	105	105	102	105	103 4	102	103.2	103 2
Dec.	2...	25	....	.....	....	...	104 5	104.1	103.3	103.5	103.8	104.7	103 6	103 9	103.5	104
"	3....	26	102 1	101.8	103.4	105.5	.....	103.9	103.5	102.2	....	105 8	..	103	.....	103 3
"	4 ...	27	103 2	102.3	103 6	102.5	103.2	103.9	103.1	103.7	102.9	106 2	104.8	102.8	102	101.9
"	6...	29	103.6	103 3	104*5	103	105.2	103.6	103.5	103 6	105 6	102.5	102	104	103.3	103.6
"	7....	30	102	103.6	103.6	100 6	104 2	104	102.1	98 4	104 2	103	101 6	104	102.1	103.2
"	9....	32	103	103	102.4	102.2	103.4	104 4	102 3	102 6	103.1	103	102 6	105	103.1	104.1
"	10 ...	33	104.2	101.6	104.2	104	105	103.6	101 8	103 4	103 2	102 6	102.4	105 8	104	104
"	11....	34	104 3	105 9	105.8	102.5	104 7	103 5	.....	105.4	102 8	.....	102	105 4	104 2	103
"	12....	35	104.2	104 6	105.4	103.6	104.2	103 8	103	105.6	102.4	102	101.8	105	104	104.2
"	13....	36	103.8	105	105 2	103	103	103.5	.....	105 4	102	. .	.....	104	104 6	103.6
"	14....	37	103	104.2	104 4	103 8	102	102.8	103.2	103.2	102	103	102.2	103.8	.....	.....
"	15....	38	102.6	103	104.2	102.6	102.6	103	103.4	104.2	102 5	103.4	103.5	103	104.2	103.8
"	16....	39	101.6	103.8	104	102	102.5	102	102 6	101.8	102.4	103 6	103 8	102.8	103.4	102 8
"	17....	40	103	103	103.6	102 6	103	102.4	104.1	102 6	102.5	104.2	105 4	103	104.2	103
"	19....	42	103.4	102 4	104.4	105.4	103 4	102 4	104.7	103.7	102.4	104.8	106.8	102 8	103.1	104
"	20....	43	102	101 2	103	101.2	102 6	101	103	101.6	102 4	104	105	103	104	101.4
"	21 ...	44	101	102.8	102 6	103.2	103.8	101.2	101.8	102.6	102 6	104 1	103.2	102 7	101.6	102
"	22....	45	103	104	103.6	101 6	104.2	102 4	104	102	102 4	105	102 6	103.8	102 6	102.2
"	25....	48	103.6	102.5	104.5	103.8	102	103.7	103.4	103.8	102.2	104	101.8	102 4	102 3	104

*p m

Temperature Record of Group II.

		Bull 8	Bull 22	Bull 20	Bull 23	Bull 24	Bull 16	Bull 10	Bull 28	Bull 25	Bull 5
Wt. before Inoculation ..		370	435	550	680	365	402	480	498	507	600
Wt. after Inoculation....		380	525	610	710	415	490	585	545	545	680
Gain or loss.....		10	90	60	30	50	88	105	47	38	80
Nov. 11		.....	106	103.4	.....		102.2	.....	....	103.4	103.3
" 15.....	1	103	104	103.6	102	104.6	103.2	104	104	104	104
" 17.....	2	103.8	103.2	102	....	103 5	102	.....	103.8	103.3	.....
" 18	3	104	103	102.7	102	102.8	101.1	102	103.4	103	103
" 20.....	5	103.5	102.6	102.3	100.9	103 4	102 4	101.9	101.8	102.8	101 9
" 21	6	104.4	104.7	102.8	.....	102.3	103.4	103 8	104.3	101.1	.....
" 23	8	103	102 8	103	101	103.5	103 8	102.8	105	101 8	102.3
" 25	10	103.1	106 3	103.4	104.7	105.6	102 6	103	103	102.2	102 5
" 26.....	11	104	103 5	101 7	104	102.4	102.2	104	102.5	102.3	102.4
" 27.....	12	103.8	104	102.4	105	103.8	101.2	103	104 2	101.8	104 8
" 30	15	103 4	103.5	102.8	105 4	103.6	103.5	102	103	101 8	102.6
Dec. 2	17	104.4	103.6	104.2	104.6	103.5	103.9	103.2	104.5	102.9	103
" 4.....	19	104.8	104.2	101 6	106.8	102	102.8	101.4	101.4	101 6	102.1
" 6.....	21	103 3	103 4	102 8	107.2	102.3	106	101.6	102.8	102.1	102.5
" 7.....	22	103 1	102.2	102.8	101 8	103	103 6	101 8	102.8	100.6	102.8
" 9	24	103	103	103	101 5	102 5	102.2	100.2	100.9	101.4	102
" 10	25	105.6	103	103	102	102.8	102.6	103.2	104	100	103
" 11.....	26	104	103	102.4	103.1	104.3	103 2	102.1	101	101 5	102
" 12	27	104 8	102 4	103	102.8	103	103.2	103 7	103	102	103.4
" 14	29	104 6	103.4	104	100	103	103	105 6	105	103.6	104
" 15.....	30	104	104.9	104 6	101.8	104.4	101.9	106	103.9	104.4	106.5
" 16	31	103.6	104	103.8	101	103	102	105 8	103	103	105.8
" 17.....	32	104	105	104.6	102.6	104.6	103.3	...	105.1	102.6	104.2
" 18....	33	.....		.....		.....	.....	105	.....	.....	104.2
" 19	34	104	103.5	104 4	102.4	103.2	103 9	103.2	104	105	103
" 20	35	103 2	103	104.2	103 8	104 2	101.6	104.6	104 4	104.8	103.8
" 21.....	36	101.8	102.6	104	102.8	103.9	102.2	103 7	104	105 8	102.2
" 22	37	104	104.2	104	103 4	107.1	101.8	104	105	105	104.3
" 25	40	102 8	102.2	103	103 8	103.7	103 6	103.3	103.6	104.9	102 8
" 26	41	103.5	.....	103.3	103	104.2	.....	.....	103.8	103.2	103 5

Temperature Record of Group III.

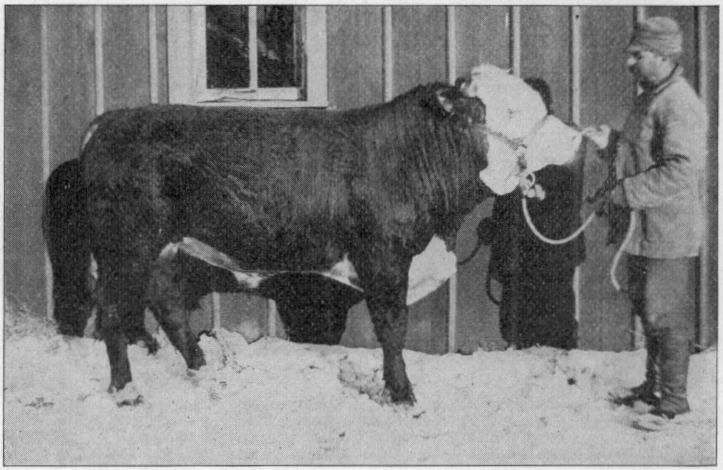
	Bull 58	Bull 11	Bull 29	Bull 9	Bull 30	Bull 6
Weight before Inoculation.....	505	620	715	795	815	823
Weight after Inoculation	640	730	730	890	950	940
Gain or Loss.....	135	110	15	95	135	117
November 11.....	.....	102.8	102 5	102.8	102.9	103 3
" 15.....	102.2	104	102.3	102 3	105.5	103
" 17	102.5	...	.....	...	104	.....
" 18	102.4	101.8	100.5	102.2	100.4	102.9
" 20.....	102 2	101.3	101	102 2	101.2	100.8
" 23.....	103.9	101.9	102 2	102.5	102	103 5
" 25	103	102.2	100.5	102.3	101.8	102.3
" 27.....	102.8	102.1	103.6	105	103	101 9
" 29	103.6	102 4	103	103	102.8	103.4
December 2.....	102.9	103	102.2	102.2	102 5	102.6
" 5	102	101.8	99.5	101	100.4	102
" 7	101	100.9	101.6	101.2	101	102.4
" 8	102 8	102	101.7	103.2	102	101.8
" 9.....	99 8	101.8	101.2	99.6	100 5	101.4
" 10	102.4	106.3	103	102.6	103	101.3
" 11.....	.....	106.1	.....	.....	102.2	.....
" 12.....	102.4	106.2	102 4	105.6	102.2	103
" 13.....	103	105	102.8	105	102	103
" 14	102.6	104 2	103.4	103.8	101.8	102.3
" 15	101.4	103	103.5	102 6	101	105.4
" 16	102 3	103	103 4	101	102.2	105 8
" 17.....	103	102.4	101.8	102 3	102.6	102.8
" 18	.....	102 2	102.4	.....	...	103.8
" 19	104	102.1	102.4	102 2	102 4	101.5
" 20	100.8	100	101.7	101	101.2	101.4
" 21	102.2	101	104.1	101.8	102.4	101.6
" 25.....	102.6	101.8	103	101	101.2	103.8
" 26.....	103.8	102.8	101.9	102	101.8 Died	102.2 Died

EXPERIMENT NO. 5.

WASKOM—THREE HEAD OF REGISTERED HEREFORD BULLS.

This lot consisted of three pure bred Hereford bulls that were raised in Missouri. No. 534 was 2-year-old and weighed 1252 pounds. No. 540 weighed 1100 pounds. No. 3 weighed 550 pounds. They arrived at the Missouri Experiment Station December 3, 1898, and were held until the effects of the inoculation had passed off, before sending them south. The experiment is of interest on account of the age of two of the individuals.

The first inoculation was made December 8th. Each bull re-



Registered Hereford Bull No. 534; Weight 1252. Inoculated with Immune Blood. Now in Harrison County, Texas.

ceived 2 1-2 cc. of recovered blood from a steer that had been rendered immune to Texas fever by artificial tick infestations.

Bull 534 took sick on the twelfth day following. On the thirteenth day the fever was 105.2. The fever continued, though not so high, until the eighteenth day, after which the temperature fell to the normal. During the fever the bull was off feed, gaunt and laid down the most of the time.

Bull 540—Fever appeared on the thirteenth day, with a maximum of 104.8. It was of short duration; he continued eating and appeared to be not seriously sick.

Bull No. 3—Fever appeared on the sixth day, and reached 104.3,

and continued six days, after which it fell and the animal's appetite returned.

The second inoculation was made January 2d, 1899. Each bull received 2 1-2 cc. of blood from a steer which had been raised in Texas.

Bull 534 showed only a mild reaction from this inoculation. It is likely that it was really the secondary reaction from the first inoculation.

Bull 540 showed fever on the fourth day. January 6th, fever 105.4; bull lies down much. January 7th, 106; bull off feed. January 8th, 103.7; won't eat. January 9th, 101.5; eat hay only. January 12th, temperature 100, eats quite well. From this time the bull remained in good health.

Bull No. 3—Severe fever followed in this bull. January 7th, bull appears to have a chill. January 12th, fever 103.8. January 13th, fever 105.6; bull off feed and has diarrhoea. January 14th, fever 104.6. January 15th, fever 104.5; urine clear. January 16th, fever 105.8. January 17th, 104.5 at 3 p. m. January 18th, fever 104.6; bull eating. January 19th, 104.8. January 21, 103.5; fever falling. From this time on this bull appeared quite well. During his stay at the Station he gained 65 pounds in weight.

A *third inoculation* was given to these bulls. Each received 3 cc. of immune blood from a Texas steer on February 22d. The bulls were shipped south February 25th. They arrived in good condition at the ranch in Harrison county, Texas, March 2d.

CLINICAL NOTES AFTER SHIPMENT.

March 28th.—The bulls are in a fine condition. Found one tick on Nos. 534 and 540. None on No. 3. Feed them bran and oats twice a day, and allow them to run on a good pasture.

April 3rd.—The bulls run daily with our native cattle. They are apparently well.

April 10th.—The bulls appear healthy. Found six ticks on Nos. 534 and 540. No ticks on No. 3. The bulls run freely with native cattle, but are housed and fed at night.

April 24th.—The bulls are doing well. But few ticks have been on them.

May 30th.—The bulls appear in good health.

June 14th.—Bulls well infested with ticks. No. 534 has fever, temperature 104.5; gave salts. No. 540 has fever, temperature 106.5; gave salts. No. 3 has no fever, well infested with ticks.

June 16th.—Bulls recovering. No. 534, fever falling, temperature 102.5, desires food. No. 540, fever falling, temperature 104.5, appears better. No. 3, no fever, appears normal.

June 18th.—Bulls all doing well. No. 3 has no signs of fever.

June 19th.—Bulls appear well. July, no report on the bulls.

August 18th.—Bulls running with native cows. They all appear well. No. 3 has never shown any signs of fever.

EXPERIMENT NO. 6.

OVERALL—EIGHTY-FOUR HEAD OF REGISTERED HEREFORD BULLS.

This lot consisted of eighty-four head of Registered Hereford bulls, all of which were natives of Missouri. Their ages ranged from 7 to 12 months. They had been shipped in the cars during very rough weather. So, when they arrived at the ranch in Coleman county, Texas, they were very tired and drawn. They were fed cotton seed, which caused a considerable number of them to have scours. On December 22d, 1898, they were inoculated with defibrinated blood drawn from the jugular vein of a 2-year-old steer, bred and raised on the ranch. Sixty-four were given 1 cc. of the blood and the remaining twenty were given 2 cc. of the blood. These calves began getting sick in the usual time after inoculation (about ten days), and about one-half of them were severely affected. Three of the number died. At this time the manager noticed that many of them had ticks on them. By April 24th, six of them had died, and the whole lot showed sickness. About June 1st they were turned into a large pasture of 30,000 acres, among the range cattle, and have remained there the whole summer. The owner says they are doing very nicely (August 15th, 1899), and up to this time seven have died of fever. Six have died of black leg, and one from accident. He says that in his opinion they should have been kept up in a dry lot until the inoculation fever was over before exposing them to the ticks.

EXPERIMENT NO 7.

BURGESS—SIXTY-EIGHT HEAD OF REGISTERED SHORTHORNS.

This lot consisted of sixty-eight pure bred Shorthorns, whose ages ranged from 8 to 12 months. They had been raised in Kentucky, and had arrived at the Blue Mound Ranch in Wise county, Texas, November 24th, 1898. On January 4th, 1899, each one received subcutaneously 1 cc. of defibrinated blood from the jugular vein of a 2-year-old steer that had been raised on the ranch. The owner of these cattle reports (in substance), under date of March 4th, 1899, that four of the calves have died and that the remainder have become reduced in flesh, but appear healthy otherwise. About June fever appeared among them and about one-half of them showed severe symptoms; by July 24th twelve have died in all.

EXPERIMENT NO. 8.

SUBER—SIX HEAD.

This lot consisted of one pure bred Shorthorn bull and five graded Shorthorn heifers. They were about ten months of age, and were raised in Cooper and Boone counties, Missouri. They were shipped south by rail and arrived on the grounds of the Texas Experiment Station in good condition on January 1st, 1899.

On January 7th, each received subcutaneously 1 cc. of defibrinated immune blood, from the jugular vein of a grade Shorthorn cow on which were a considerable number of ticks (B. bovis) in various stages of development. The calves were kept in a dry lot, in which there were no ticks, and were not allowed to come in contact with Texas cattle, or tick infested grounds until April 11th.

Grade Shorthorn-Hereford Heifers. Inoculated three times with Immune Blood; Described in Experiment No. 8. Now in Brazos County, Texas.

They were examined regularly and carefully for ticks. In doing this each one was turned on its back to allow a thorough examination. All the heifers had white skin along the belly, so that it was exceedingly improbable that any ticks were attached to them and escaped notice, until they were sent to the pasture in April. Their diet had consisted of hay, ground corn, oats and bran. This was gradually changed to cotton seed meal, bran and oats and cotton hulls. They were fed regularly all they would eat. From the first day, January 7th, until August 31st, their temperature was taken daily, and the record appears in this report. The changes in the blood were determined by the "hæmatokrit." The blood was ex-

amined two times per week. A gap occurs in the record, from March 22d to April 17th, on account of an accident to the apparatus. All of the samples of blood for examination were taken from ear, and, as soon as possible, they were subjected to a very rapid centrifugal action. By comparison with other cattle's blood, we may regard the normal percentage of red blood corpuscles to be from 35 per cent. to 40 per cent. No effects of the inoculation, either local or systemic, were noticed until January 14th, eight days after inoculation, when the hæmatokrit readings indicated a destruction of the blood corpuscles. At the beginning of the experiment the average per cent of red corpuscles in the blood was 38.3 per cent. On the eighth day of the experiment it had fallen to an average of 31.3 per cent. The increase in temperature was very abrupt, rapid and almost simultaneous. It appeared on the ninth and tenth days after inoculation. We call this the *primary fever period.*

The fever ranged from 103.6 the lowest, to 105.6 the highest; in the mornings. This continued from seven to nine days and then returned to normal. The destruction of the blood corpuscles continued until the thirteenth day of the experiment, the average was 27.3 per cent.; on the fifteenth day it was 23.3 per cent. By the nineteenth day (January 25th), the fever had ceased, and the blood gained a little, reading an average of 24.5 per cent.

The symptoms of digestive disorder are worthy of mention. During the fever we noticed a lack of relish, though they continued eating. The well ones crowded the sick ones aside. If the sick ones be fed separately, they will consume a reasonable amount. We noticed among some calves bloating, and a disposition to eat a quantity of dirt. In some cases there was diarrhœa, and discharge of mucus from the nostrils, muscular weakness, trembling, and a desire to lie down for a considerable period. In no case was bloody or red urine noticed. By the eighteenth day, the fever of the primary reaction had entirely ceased. We sometimes noticed even sub-normal temperatures. One individual had a temperature of 100.8 on the twenty-second day (January 28th). The lowest average per cent of blood corpuscles resulting from the primary reaction was 23.1 per cent., which occurred on the fifteenth day. From the eighteenth to the twenty-ninth day the calves appeared normal. Their appetite improved, their blood corpuscles increased in numbers. By the twenty-fifth day the average per cent had risen to 31.

The *secondary fever period* began on the twenty-eighth or twenty-ninth day. It greatly resembled the primary one in its severity, but differed from it in continuing longer, and in appearing in some animals on the twenty-eighth or twenty-ninth day, while in

others it appeared on the thirty-fourth or thirty-fifth day. The hæmatokrit readings also show a second fall in the blood corpuscles. This reached its lowest average (21 per cent.) on the twenty-ninth day. The lowest inidivdual on that day was 14 per cent., the highest 26 per cent. The secondary reaction must be regarded as due to the activity of the micro-organism in the blood, and not to a reinfection from without. Every calf was examined with great care for ticks until the ninetieth day, but none were found. The secondary fever period did not terminate so abruptly as the primary, but showed a tendency to an occasional high temperature. For instance, we found No. 3 with a temperature of 105 on the morning of the forty-seventh day, and No. 1 with 103.5 on the fifty-fourth day, and No. 4 with 103.8 on the fifty-ninth day. While these subsequent temperatures are interesting and very suggestive, we may say they were not of any practical importance. The calves gained in weight and growth, and their blood showed some improvement, which was slow but steady.

Second Inoculation—Two cc. of defibrinated blood was given on the seventy-seventh day (March 23d) subcutaneously to all except No. 4. This produced a mild reaction in about eleven days; the highest morning temperature was 104 1. Calf No. 4 was not given the second dose of 2 cc. with the others and showed a morning temperature of 104.2 on the ninety-fourth day, which was near the same time the other calves were reacting from second inoculation. No record of blood changes was possible because the hæmatokrit was out of order at that time. The first re-examination of the blood occurred on the 106th day (April 20th), at which time the average was 33.5. The lowest average reading found since that time was 30.5 per cent., which occurred on the 113th and 120th days.

A *third inoculation* was made on May 18th, the 132d day. This consisted of 2 cc. of immune defibrinated blood given subcutaneously to Nos. 1, 2, 3 and 5. No. 4 received 1 cc. of the same material. (No. 6 had died of blackleg on April 10th.) The reaction from this was very feeble. The highest morning temperatures noticed were: No. 1, May 28th, 102; No. 2, May 20th and 23d, 103.3; No. 3, May 25th, 103.4; No. 4, May 25th, 105.2; No. 5, May 28th, 103 degrees.

It appears from this that No. 4 showed some reaction, but it was of short duration. The others may be regarded as a very feeble reaction, if any. The hæmatokrit readings do not indicate any appreciable blood destruction, so that we may regard the third injection as producing no effect, and assume that immunity has been attained. These cattle were placed in the pasture April 11th. It remains to be shown that they were exposed to infection. They were frequently examined for ticks and at once be-

came infested with the lone star variety (Amblyomma unipuntata), which do not concern us in this report.

The cattle were infested with young ticks (B. bovis), on May 5th, May 6th and May 27th. During June and July they carried and matured a few ticks of this species. It was not until August that any considerable number of ticks were carried. There did not seem to be any constitutional disturbance due to their presence, as shown either by the thermometer or by hæmatokrit examinations of the blood. The experiment closed August 31, 1899. There was no fever among the cattle, nor had there been any. The average per cent of red corpuscles was 33.4 at that time.

TABLE 3.

Hæmatokrit Record of Blood Changes. Experiment No. 8.

Date	Day of Exp.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	Ave.
January 7	1	First Inoculation—1 cc. Blood.						
" 10	4	40	40	35	40	35	40	38.3
" 14	8	33	33	30	29	33	30	31.3
" 19	13	31	27	33	25	28	20	27.3
" 21	15	27	27	19	28	20	18	23.1
" 25	19	24	29	21	23	26	24	24.5
" 28	22	32	27	29	28	29	28	28.8
" 31	25	38	29	28	31	33	27	31
February 4	29	30	28	27	26	29	27	27.8
" 6	31	36	29	18	28	32	27	28.3
" 9	34	26	34	18	16	24	28	24.3
" 14	39	21	24	19	22	26	14	21
" 18	43	23	19	26	23	21	19	21.8
" 21	46	25	20	23	19	23	24	22.3
" 25	50	23	28	24	21	30	28	25.6
" 28	53	18	22	24	21	25	26	22.6
March 4	57	19	28	29	26	26	24	25.3
" 7	60	20	24	28	20	24	21	22.8
" 11	64	30	23	34	24	26	22	26.1
" 14	67	22	26	22	29	27	27	25.5
" 18	71	22	27	32	20	32	25	26.3
" 21	74	30	22	33	24	27	22	26.3
" 23	77	Second Inoculation—2 cc. Blood.						
April 22	106	32	33	35	35	35	.....	33.5
" 29	113	32	30	31	29	31	.....	30.5
May 6	120	35	29	34	25	29	.....	30.5
" 13	127	37	27	36	27	32	.....	31.8
" 18	132	Third Inoculation—2 cc. Blood.						
" 20	134	36	30	43	26	30	.....	33
" 27	141	33	32	34	35	29	.....	32.6
June 3	148	34	31	40	27	34	.....	33.2
" 10	155	30	30	40	28	37	.....	33
" 17	162	37	32	38	31	30	.....	33.6
" 24	169	42	36	38	32	31	.....	35.8
July 1	176	43	32	40	31	30	.....	35.2
" 8	183	40	33	36	30	29	.....	33.6
" 15	190	40	31	30	30	32	.....	34.2
" 22	197	36	32	36	29	32	.....	33
" 29	204	39	32	38	28	30	.....	33.2
August 5	212	38	32	34	30	31	.....	33
" 12	218	37	37	38	27	36	.....	35
" 19	225	36	33	39	26	34	.....	33.5
" 26	232	30	34	26	32	33	.....	33
" 31	237	35	32	37	30	33	.....	33.4

Experiment closed.

Temperature Record of Animals in Experiment No. 8.

Date	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
1899	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
Jan. 7	101 4	.....	102.8	.....	101.8	.....	103	.....	103	.....	103	.....
" 8	101 6	.....	102.2	.....	102.4	.....	102.6	.....	102.2	.....	102.6	.....
" 9	102.2	.....	102.6	.....	102.4	.....	102.4	.....	102.6	.....	102.2	.....
" 10	101.8	.....	101.9	.....	102.2	.....	101.6	.....	102	.....	102.3	.....
" 11	101.6	.....	102.1	.....	102	.....	102.4	.....	102.2	.....	102.6	.....
" 12	102.2	.....	101.2	.....	101.5	.....	102.6	.....	102	.....	102.2	.....
" 13	101.6	.....	102.4	.....	102.2	.....	101.4	.....	101.9	.....	102.1	.....
" 14	101.8	.....	102.2	.....	102.4	.....	101.9	.....	102 4	.....	102.1	.....
" 15	101.8	.....	101.5	.....	102.6	.....	102 1	.....	102.6	.....	102.2	.....
" 16	101.7	.....	102	.....	101.6	.....	103 4	.....	104	.....	104	.....
" 17	103	.....	103.8	.....	104.1	.....	104.8	...	104 6	.....	104.4	.....
" 18	103 8	.....	103	.....	103.5	.....	102.8	.....	103.2	.....	104.1	.....
" 19	102.8	104.6	103.2	104.3	103.2	104 5	104.4	105.7	102.8	104.5	105.6	105.7
" 20	104.6	104.2	101.8	102.6	102	104 1	103.6	103 4	104.8	103.4	103.3	104
" 21	101.4	102.1	102.4	102.8	105.2	104.1	102 8	103.6	101.8	102.2	102.4	102.4
" 22	102	.....	101.8	.....	101.8	.....	102 3	...	101.4	.....	102.2	.....
" 23	101.4	.....	101.4	.....	102	.....	102.4	.....	101.7	.....	104.2	.....
" 24	101.7	.....	102.2	.....	102.4	.....	102.4	...	102	.....	103.4	.....
" 25	101.6	102.5	101	103.2	101.6	102.4	101.5	103.4	101.4	103	103.2	104
" 26	101.7	.....	101.4	.....	101.8	.....	101.8	.....	102.2	.....	102.2	.....
" 27	101.3	.....	101.4	.....	101	.....	101.3	.....	101.5	.....	101.5	.....
" 28	101.8	.....	102.6	.....	100.8	.....	102.1	.....	102.4	.....	102.8	.....
" 29	101.4	.....	101.8	.....	102.2	.....	101.6	.....	102.4	.....	101.8	.....
" 30	101.5	.....	101.8	.....	101.6	.....	101.6	....	101.4	.....	102.4	.....
" 31	101.6	.....	101	.....	102	.....	101.5	.....	101.7	.....	102	.....
Feb. 1	102.6	.....	101.4	.....	101.6	...	102.2	.....	102	.....	101.8	.....
" 2	102.6	.....	102	.....	102.8	.....	102.5	.....	102.4	.....	103	.....
" 3	102.2	.....	102	.....	103	.....	102.3	.....	102.5	.....	102.4	.....
" 4	102.3	.....	102.4	.....	102.6	.....	102.8	.....	101.6	.....	102.2	.....
" 5	102	103.2	102.8	103	103.4	104.4	105.6	106.8	105.2	104.8	101.5	103
" 6	102.8	103.6	101.8	102.2	104	104.6	102	103.1	102.6	102.1	103	103
" 7	102.8	.....	102.2	.....	103.4	.....	103.2	.....	102.6	.....	102.6	.....
" 8	102.4	104.2	103	103	103.4	105.2	103.4	105.2	102.4	102.1	103.1	104
" 9	103.4	104	102	103.4	103.1	104.1	105	105.4	102.4	105.3	103.7	105.8
" 10	103	105	101.8	102.6	104	104.4	104.9	105.1	102.4	103.6	105.6	105.2
" 11	103.6	104	102	102	103.6	103.6	105	105.2	104.6	104.2	104	102
" 12	103.8	103.8	104.2	103	102.6	102.4	104.8	104	104	104.9	103	103.4
" 13	104	104.6	103.2	105	102.8	103	104.3	104	104.1	104.8	104.8	104.2
" 14	103.4	103.4	104.5	103	102.2	102.4	102.4	103	103.4	104.8	104.6	105.3
" 15	103.4	102.8	103.3	103.6	102.2	102.6	104	102.8	103.5	105	104	104.3
" 16	103	104.8	103.2	104	102.2	103.2	102.4	103.4	103.2	103.4	103.5	104
" 17	104.1	105.7	103.2	104.2	101.6	103.3	101.5	104	103.5	104.2	102.6	105
" 18	103.4	104.4	102.4	104.4	102	103	101.8	103.4	102.4	104	102.1	103.5
" 19	102.9	104.8	102.3	104.3	101.7	103.8	102.5	104	102.4	104.4	101.8	103
" 20	103.1	104.8	101.7	103.8	101.7	103.8	102.6	104	100.8	104	101.4	102.5
" 21	103.8	105	102	102.8	102.4	102.4	101.7	103.2	102.1	103.2	101.8	102.2
" 22	102	103.2	102.1	103.9	105	105.2	102.1	103.2	102.4	103.8	101.5	103.4
" 23	101.7	102.2	101.8	103.6	103	104	101.1	103.1	101	102.2	101.7	102.8
" 24	102	102.8	102.2	102.2	103	102.8	101.7	102.2	101.4	101.8	101.5	102
" 25	102.3	103.5	102.8	102.2	102.8	103	102.4	103	102.5	103	103.2	104.2
" 26	102.5	104.1	101.5	103	101.4	102.1	103	103.4	101.7	102	102.1	102.2
" 27	102.7	102.5	101.7	103.3	101.3	102.1	102	103.8	101.8	102.9	101.4	101.9
" 28	103.1	103.3	101.1	103.8	101.3	102.7	102.1	103.8	101.7	103.9	101	102.8
Mar. 1	103.5	104.4	101.7	103.2	101	102.2	102.6	103.4	101.9	103	101.2	103.2
" 2	103.4	104.7	102.1	103.3	102	102.5	102.4	104	101.8	103	102.3	103.7
" 3	102.4	104	102	103.2	102	102.8	102.5	103.2	101.4	102.7	102.1	103.8
" 4	102.9	103.5	103	103.9	102.9	103	101.7	103.2	101.2	102.1	101.4	102.6
" 5	102	103.4	102.6	103.8	102.2	102.9	101.5	104.2	101.3	102.8	102.4	103.3
" 6	101.8	104.9	101.8	103.5	101.2	102	103.8	104.3	101.6	102	102.2	103
" 7	102.4	104.8	102.2	103.4	101.2	102	102.8	104.2	102	102.7	102.2	102.8
" 8	102.1	103.8	101.8	102.2	101.2	102	101.7	103.2	101.6	102.3	101.9	102.9
" 9	101.6	103.8	103.1	104	102	102.6	102.2	104.7	103.2	103.2	102.1	103.6
" 10	101.2	102.6	102.4	104.6	102.3	102.5	101.6	103	102.4	102.9	102.3	102.8
" 11	101	103	103	104.9	101.7	102.4	101.9	103	101.9	102.9	102	102.4
" 12	101.3	103	101	103.1	101.9	102.6	102.2	102.8	102.1	103.1	102.2	103.3
" 13	102.4	102.8	101.3	102.7	102.5	103.1	102.7	103.2	102.2	102	101.2	102.6
" 14	102.6	103.3	101.9	102	101.5	102	102.4	102.8	102	102.5	102	102
" 15	101.5	101	101.4	102.2	101.3	102	102	102.6	101 8	102.5	101.7	102.4
" 16	102.2	102.7	101.3	102.3	101.4	102.3	101.8	102.8	101.4	102	101.9	102.4
" 17	102.7	102.7	101.5	103.5	101	102.2	101.9	103.5	101.7	101.8	101.8	102.6
" 18	101.3	103.2	102.2	103.4	101.4	103	102.2	103	102	102.7	102 1	103
" 19	102	103.7	102	103	100.3	101.2	102.2	103.5	102.4	102.5	103	102.7

Temperature Record of Animals in Experiment No. 8.—Con.

Date	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
1899	A.M.	P.M.	A.M.	P.M	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
Mar 20	101.9	103 1	100.8	103 2	100.7	102.1	101.9	104	101.4	102.2	101.2	102.8
" 21	102.2	104.1	102	103.7	102.3	101 9	102.5	103	101.9	101.9	102	103.2
" 22	102 5	103.7	100.8	103.8	101.7	103 1	103 4	103.2	101	102 6	102.1	103.3
" 23	101.4	103 2	101	102.8	101 7	102.5	101.6	103	101.2	103	101.6	102 9
" 24	101.4	102	101.8	103.3	102	102.2	101.8	102.2	101.8	102.2	101.3	102 1
" 25	101.5	102.8	101.6	102 8	101.8	103	103 2	103.1	102.7	103	101.6	102.3
" 26	101	102 2	101.6	103.4	102 5	103.4	102	103.8	101.6	103.7	101	102.5
" 27	101 4	101 2	101	101 5	101.7	102.3	100.5	101.4	101.3	101.7	101.8	101.8
" 28	101.4	103 3	102.6	103	101.2	102.6	102.4	102 3	102.5	102.8	101.8	102
" 29	101.4	102	102	103.1	101 8	102.4	104 4	103 6	101 3	103	102	103.1
" 30	101.5	103 5	102.4	103 8	103.4	104.1	103.5	103.6	103	104	103.2	104.2
" 31	101.1	102	101.4	102.4	101 2	102	102	102 6	101.7	102.9	102	103.4
Apr. 1	101.6	103.2	101.6	102.9	102 1	102.8	100 6	103.1	101 4	102 6	103.3	102.3
" 2	101 2	103	101	103	101 3	103 2	100 6	102.3	101 5	102.4	101	103 3
" 3	101.5	102.2	102.4	102.5	102 6	102.1	102.1	102.8	101.6	102.3	101	102 4
" 4	101.3	102 4	101 3	103.5	100.3	102 2	100.4	103	100 2	102	101.2	102.7
" 5	101.8	103	103	103.6	102.8	102.2	102 1	102.8	101.9	103	102	102.1
" 6	102.5	102.6	103	103.3	101.8	102.3	102 4	102.8	102 2	102.2	102 6	102.9
" 7	102.1	103.5	103.8	105 2	102.4	103.3	102 3	104.1	102 6	103.3	101.8	104
" 8	102	103.6	103	103 3	103.2	104 1	101.6	103 5	102 2	103.7	102 6	105.1
" 9	102.1	103.4	103 8	104.3	103 6	104 8	104.2	105 6	102.6	102 6	102 8	103
" 10	102.1	105 2	102.8	103 6	104.1	104 2	104 7	106 4	101 5	103 4	101.5	Died
" 11	103.2	103 5	102 7	104 7	102.4	103.6	103	104.9	101 6	103.4	.....	.....
" 12	102	103	104 1	104 2	102.1	102.4	102.2	103	102	103 2	.....	.....
" 13	101.9	103	104	104 6	102	102.7	102 2	103.2	102.2	103 7	.....	.....
" 14	102	102 7	102 8	103.9	101 8	102.5	102.2	103	103	103.8	.....	.....
" 15	101.8	102 7	102 8	103.1	102 1	103	102.6	102.6	104 2	104.1	.....	.....
" 16	101.5	102 2	102.3	102.6	102 4	103.1	103.8	102 6	103.6	104.1	.....	.....
" 17	102 2	102.7	102.2	103	102	102 7	102 1	103	102 6	102 8	.....	.....
" 18	101.8	102.7	102 6	103 7	102 8	103 2	103	103.7	102	103 3	.....	.....
" 19	101.8	103.5	103	103	102.4	102.8	102 2	103 6	102	102.7	.....	.....
" 20	102	103.2	102.8	103 2	102	103.1	102	103.9	102 8	102.8	.....	.....
" 21	102.4	103.4	102.8	102 8	101.7	102.5	102.4	103.4	101.8	102 2	.....	.....
" 22	102.4	104	102	103.7	102 3	103 8	102.1	103.6	102 2	102.9	.....	.....
" 23	102.6	103.3	102.5	103 6	101.8	103 2	102.1	103.6	102	103	.....	.....
" 24	102	103 6	102.2	102.7	102.5	103	102	103.8	102 4	102.8	.....	.....
" 25	103 2	103.1	102 2	103.5	103	103.4	102 4	103 4	102 6	103.5	.....	.....
" 26	102.1	103 8	102	103	102 3	103.2	102	103 3	102	103	.....	.....
" 27	101.7	103	102.2	103	101 8	103	102 6	103.6	102 1	102.8	.....	.....
" 28	101.8	103 3	102.4	103.4	102.7	102.5	102.6	103	101 9	103.3	.....	.....
" 29	102.1	102.6	102.6	104	102.9	103	102.5	103.5	102.4	102.8	.....	.....
" 30	102	103 9	101 7	102.6	102.3	102.2	102	103.2	102 4	102.8	.....	.....
May 1	101.8	102 5	102.5	102 7	102.3	102.8	102.4	103.2	102.8	102 4	.....	.....
" 2	102	102.4	102.6	103 2	102 2	103 1	102.4	103.8	101.8	103	.....	.....
" 3	102.1	102.8	102.3	103 2	102 2	103.1	102.4	104	102 4	103.2	.....	.....
" 4	102.1	103.2	102.6	103.5	102.4	103	102 8	103 8	102 8	103	.....	.....
" 5	101.6	103.1	101 5	103.1	101.8	103.2	102.1	103.7	101.9	103 6	.....	.....
" 6	101.6	103.3	102 3	102 8	103	103.4	102.9	104	103 1	102 8	.....	.....
" 7	101.6	102.8	102.3	102.6	102 6	102.4	102.7	103.3	102.6	102	.....	.....
" 8	101.8	102.7	102	103 2	102.2	102.9	102 4	103	102 1	102.5	.....	.....
" 9	101.8	102.8	102 8	103.2	102.2	103.2	103	103 6	102.8	102.9	.....	.....
" 10	102	103	102.5	103.5	102.2	102.8	102.4	103 4	102.2	102.7	.....	.....
" 11	101 8	102.5	102 8	103	102.2	103.2	103	103.1	102.8	102.9	.....	.....
" 12	101 5	103.1	102.6	103.4	103	103.2	102.4	104	102 8	103.2	.....	.....
" 13	101.6	103 7	103.2	104	102 8	103.8	102.8	104 2	102.4	103.4	.....	.....
" 14	102	102	101.8	104	102.2	103.5	102	104 2	102.4	104.1	.....	.....
" 15	101 7	102.5	101 8	103.8	102 4	103.5	102.1	104	102	103.3	.....	.....
" 16	101.9	102.7	102 2	103	102.2	103.2	102 6	103	102.2	102.2	.....	.....
" 17	101.8	102.8	102	103 4	102.1	103 1	102.1	103	101 8	102.4	.....	.....
" 18	102	103.1	102.4	102.8	102.4	103	103	103 4	102.4	102 4	.....	.....
" 19	101.6	102 6	101.5	103.2	102.4	103	102	103 6	101.8	102.7	.....	.....
" 20	101.6	103.8	103.3	102.5	102.3	102.8	103.4	103	102.4	102.4	.....	.....
" 21	101.6	102 7	102 3	103.2	102 4	102.6	102 3	103 3	102	102 7	.....	.....
" 22	101.4	102.6	102	103 6	101.8	103	102.5	103.8	101.8	102 5	.....	.....
" 23	101.6	102.8	103.3	103.7	102.8	103 2	103	104 3	102.8	102.8	.....	.....
" 24	101.7	103 4	101.4	104 4	101.5	1 3.8	102	104.8	101.2	103.9	.....	.....
" 25	101.6	102 8	102 8	103.3	103.4	103	105.2	103 8	102.2	103.5	.....	.....
" 26	102.2	103	102.1	103.2	102.3	103.1	102	103.4	102 2	103	.....	.....
" 27	101.5	102.2	102.1	102.8	102.8	103	102.4	103	102.8	102.8	.....	.....
" 28	102	102.4	102.6	103.4	102.6	103	102.4	103.8	103	103 6	.....	.....
" 29	101.8	103	102.2	103	102.2	102.8	102.6	102.8	102.4	103.4	.....	.....
" 30	102	103.6	102.8	103.4	102.4	102.9	102.8	103.6	102.4	103.3	.....	.....

Temperature Record of Animals in Experiment No. 8.—Con.

Date	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
1899	A.M.	P.M	A.M	P.M.	A M.	P.M.	A M.	P.M.	A M.	P.M.	A.M.	P.M.
May 31	101 8	102 4	102.6	103.1	102.4	102.6	103	103.2	102	102.5	.....	.....
June 1	101.8	102.8	102.2	104.1	102	103.6	102 6	103 6	102 4	103	.....	.....
" 2	101.8	102.3	102.6	103 3	102.1	102 3	102 1	102.8	103 1	104.7	.....	.....
" 3	102.3	102 9	103.2	102.8	102 3	102.6	102 8	104.8	102.7	102 4	.....	.....
" 4	102.6	103.5	102	102.7	102.4	102.2	102.6	104 2	102.6	102.3	.....	.....
" 5	103.5	102.5	102 7	103	102 2	102.4	104.2	103.6	102.3	102 6	.....	.....
" 6	101.7	103	101.6	102	101.2	102.2	101 9	103	102	102	.....	.....
" 7	102	103.4	102.1	102.6	103	102.2	103 6	103 2	102	103	.....	.....
" 8	102.6	104	102 8	102.3	102.4	102.7	102 8	103.6	102.2	102.4	.....	.....
" 9	102.8	104	102.5	102.8	102.2	104	102 6	103	101.6	102.4	.....	.....
" 10	102.9	102	103	102.6	103.4	103.1	102.8	103	102.4	102	.....	.....
" 11	102.6	104	102.8	103.7	102	103.1	102.8	105	102	102.6	.....	.....
" 12	102	103.8	101.8	103.2	101.8	103.3	101.8	104.2	101.6	103.4	.....	.....
" 13	101.8	102.4	101.8	102	101.8	102.4	101.8	103	102	102	.....	.....
" 14	102.6	102.7	102.5	102.3	102.2	102.2	103	103.1	101.5	102.4	.....	.....
" 15	102.7	102.6	102.8	103.1	102.1	102.6	102.7	104.3	102.2	102.7	.....	.....
" 16	102.5	103.5	102.7	103.1	102.4	103.3	102.6	102.4	102.2	103	.....	.....
" 17	102.4	102.7	101 4	102	101 7	102 2	102.2	102 8	101 6	102 1	.....	.....
" 18	102	103.6	101.4	103	101 2	102.8	101.3	103	101.7	102.8	.....	.....
" 19	102	104.1	101 3	102.2	101 7	102 3	102 6	102.7	101 6	102.4	.....	.....
" 20	102.6	103.2	102.2	102.4	101.4	102.1	101.7	102.8	101.8	102 4	.....	.....
" 21	102 1	103.6	101 4	102.7	101.6	102.1	102	103	101.8	102 5	.....	.....
" 22	102.8	102 5	101.5	102.2	101.8	102 2	102 2	102.8	102.2	102.1	.....	.....
" 23	102 2	103.7	101	103.5	102	102 5	101.7	103.3	101 1	102.7	.....	.....
" 24	102.6	103 1	102	103	102.1	102.6	103	102 1	102	102.2	.....	.....
" 25	101.7	102.8	101 4	102	101.2	102.4	101.2	104.5	101.6	102.1	.....	.....
" 26	102 3	102.6	102.4	102	102	101.8	102 5	103	102.2	102.1	.....	.....
" 27	102	101 8	101.2	101 6	101.3	102.4	101.4	102	102 2	102.8	.....	.....
" 28	100.6	101.6	101.1	102	101	101.4	101	101.8	101.2	101.3	.....	.....
" 29	101.1	101.5	101.5	102	101.2	101.3	101	101.8	101.4	101.6	.....	.....
" 30	102 1	102 5	102	101.6	102.5	101 8	102.4	102.4	102.2	102	.....	.....
July 1	101.7	102.6	102	102.4	102.7	101 6	102	101.8	101.3	102.1	.....	.....
" 2	101 6	102	101.4	101.8	101.7	101.9	101 9	102.1	101.4	101.7	.....	.....
" 3	101 2	102.6	101	102 2	101	103	102	102.6	101.5	102.1	.....	.....
" 4	101.3	102.8	101.4	102.1	101.7	102	101.6	103 7	101	102 2	.....	.....
" 5	100.6	103 3	100 8	102.1	101.4	102	102.5	104	101.6	102 2	.....	.....
" 6	101.3	102.8	101.1	102 5	101.1	102	102.4	103.4	101.2	102.1	.....	.....
" 7	100.8	103 2	101.2	102.4	101.8	102 1	101.8	103 3	101.2	102.8	.....	.....
" 8	102 2	103.1	101.8	103	101.8	102.3	103	104 2	102	103.4	.....	.....
" 9	101 8	104.5	101 2	103.2	101.3	102 2	102	105 2	101.7	103.2	.....	.....
" 10	102 2	103.4	102.1	102.2	101 6	102.4	102	102.3	101.6	102.5	.....	.....
" 11	102 4	103.5	101.2	103.1	101.7	102.3	102	103.4	101.6	102.8	.....	.....
" 12	101.1	103.3	101.3	103.1	101 5	102.5	101.8	103.3	102.3	102.4	.....	.....
" 13	102.8	103.6	102	103 4	101.4	102.5	102.6	103.1	101.6	102.6	.....	.....
" 14	102.4	103.3	103.6	102.8	101.7	102.2	102.1	103	101.8	102.1	.....	.....
" 15	103.2	103.5	103.3	103	102.4	102.8	103.1	103 2	103.2	102 7	.....	.....
" 16	102	102.3	102.1	102.3	102	102.4	102.2	102.2	102.4	102 5	.....	.....
" 17	102.1	104 6	101.7	103.5	101 9	103	102.3	104.7	102.2	102.3	.....	.....
" 18	102 4	103.8	102.2	103.2	102.2	103.4	102.7	103.6	102 5	103.6	.....	.....
" 19	102.7	104.6	102.3	104.5	102	103.8	102.3	104.5	101.8	103 4	.....	.....
" 20	102.8	103.6	102.8	103.7	101.9	103 5	102.4	103.4	101.8	103.3	.....	.....
" 21	103.2	103 2	102 3	103.4	102 5	102.8	103.6	103.6	102.1	103.5	.....	.....
" 22	102 3	103.5	101 8	102.8	102.3	103	102.7	104.1	101.3	102.8	.....	.....
" 23	102	103.5	101.7	102.8	101.5	102 6	102 3	102 9	101.8	103	.....	.....
" 24	103.2	105.2	102.6	104.8	102	104.4	103	105.6	102 2	105 5	.....	.....
" 25	103 2	104.3	102.8	101.8	102.4	102.2	102.3	103.2	103 1	101.5	.....	.....
" 26	101.6	103.4	101 5	104	101.3	102.7	102.1	103.1	101 2	102 5	.....	.....
" 27	101 6	102 8	101.8	103.5	102	103	101.7	103 2	101.5	102.8	.....	.....
" 28	101 8	103.6	102	102.3	101 5	102.6	101.8	103	102.1	102.2	.....	.....
" 29	102.8	103.4	102.1	103	104.3	103 2	102.2	102.5	102	102.8	.....	.....
" 30	101.6	102.8	101.3	103	101.5	102.4	102.2	103.3	101.2	103.1	.....	.....
" 31	101.4	103.1	101.1	103	101.2	102.3	102.4	103.2	101.1	102.7	.....	.....
Aug. 1	102	104 4	101 3	103.2	101.1	103 3	102.1	103.6	101.4	103.4	.....	.....
" 2	101.5	104.7	101.4	103 5	101 2	103.2	102 6	105	101.6	102.3	.....	.....
" 3	102.1	104.4	101.8	104.1	101.7	103.4	102.2	103.7	102	103	.....	.....
" 4	102	104.3	101.5	103	101.1	102.7	102.8	104.2	101.5	102.1	.....	.....
" 5	102 8	103.4	101.8	103	102.1	102.8	102.2	103.3	101.7	102.4	.....	.....
" 6	101.6	103.2	101.1	103.5	101	103.1	102	104.1	101.2	103.6	.....	.....
" 7	103.2	104.1	102.2	103.2	101.8	103.3	102.4	104.2	102	102.7	.....	.....
" 8	102.5	104	101.4	103.4	101.3	102.6	102	103.6	101.6	103	.....	.....
" 9	101.8	103.6	101.3	103	100.6	103.1	102.7	103 4	101.1	102.4	.....	.....
" 10	102	103.6	101	102.8	101.3	102.4	102 5	104	101	102.2	.....	.....

Temperature Record of Animals in Experiment No. 8.—Con.

Date	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
1899	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M
Aug 11	102.4	103.4	101.6	103.1	102	102.8	102.6	102.8	101.8	102.6	.....	.....
" 12	101.8	103 4	102	103	101.6	103 1	102.8	103	101.6	102.8	.....	.....
" 13	102	103.8	101.8	103.8	101.6	102.6	102.4	104.4	102.2	102.6	.....	.....
" 14	101.3	103.8	102.1	103.4	101.4	103.5	102 2	104 6	102.1	103.8	.....	.....
" 15	101.7	104.1	101.6	104.2	102	103.3	103.2	104.4	102.2	103.8	.....	.....
" 16	101.8	103	101.4	103.2	101	103	101.6	102.4	103.2	105.2	.....	.....
" 17	102.3	103	102.2	103.2	101.8	102.8	102	103.4	103	103.1	.....	.....
" 18	101.4	103	101	103.2	101.1	103.8	101.8	104.8	102.6	104.1	.....	.....
" 19	101.4	103.6	101.6	103.2	101.4	103	102.7	103 6	103.2	105.2	.....	.....
" 20	102	102.6	101.8	103 8	101.2	103.2	102.1	104	102.4	105.2	.....	.....
" 21	102.4	103	102.2	102.8	101.4	102.6	102 4	103.2	103	104.2	.....	.....
" 22	102.4	103.2	102.7	102.7	101.5	102.6	102.5	102.3	102.4	103.4	.....	.....
" 23	102.6	103.7	102	103.5	101.3	103.4	101.9	103.1	102.5	104	.....	.....
" 24	102.2	103.2	102.1	103.1	101.6	102.6	101.6	102.4	102.4	103 4	.....	.....
" 25	102.2	103.7	102.4	102.8	102.3	102.7	102.1	103.6	102.4	103.3	.....	.....
" 26	102.2	103.3	101.8	102.5	101.4	102.6	102	102.6	101.8	103.8	.....	.....
" 27	101 3	103.6	101.4	103.8	100.7	102.4	102.4	104	101.5	103.2	.....	.....
" 28	102	103	102 1	102.7	101.7	102.7	102.2	103.6	102.3	102.5	.....	.....
" 29	102.4	103.3	102	103	101.8	103.4	103 3	103.2	101.7	103	.....	.....
" 30	102.1	103	102	103.2	102 2	103.1	102.2	103.1	101.7	103.4	.....	.....
" 31	102	103.2	101.8	103 1	101.6	102.8	102.4	103.4	102.1	103.6	.....	.....

EXPERIMENT NO. 9.

KRUEGER—SIX HEAD OF REGISTERED HEREFORDS.

This lot consisted or six pure bred Herefords, two bulls and four heifers, whose ages ranged from 6 to 12 months. They were raised near Emporia, Kansas, and had been shipped south, where they arrived December 7th, 1898, at the Carter Ranch in Bee county, Texas.

On December 17th, 1898, each received 1 cc. of defibrinted blood from the jugular vein of a 3-year-old cow on the ranch. This cow had a considerable number of ticks on her at this time. The calves were kept in a dry lot and fed bran and cactus, and watered from a cistern.

January 23rd, 1899—Saw these calves. All have lost flesh, and there is marked looseness of the bowels. They are evidently in the secondary reaction fever period today. Their evening temperature is: Bull No. 1, 106 degrees; bull No. 2, 105 degrees; heifer No. 366, 105.8 degrees; heifer No. 51, 107 degrees; heifer No. 52, 106.5 degrees; heifer No. 57, 104.2 degrees.

February 6th, 1899—Temperature has fallen to the following: Bull No. 1, 104 degrees; bull No. 2, 104 degrees; heifer No. 366, 103.5 degrees; heifer No. 51, 103 degrees; heifer No. 52, 102.5 degrees; heifer No. 57, 104 degrees.

June 27th, 1899.—Saw these cattle today. Heifer No. 366 is evidently pregnant. The cattle appear in good shape.

September 15th, 1899—Bull No. 1 in good thriving condition. Bull No. 2, inoculation has caused arrest in development in this

calf. He has been thin, but is doing well now. The heifers have done well; the oldest one dropped a calf recently. No deaths.

EXPERIMENT NO. 10.

NUTT—NINE HEAD OF REGISTERED HEREFORDS

This lot consisted of nine pure bred Herefords, raised in Hartley county, Texas. There was one bull and eight heifers. They had been shipped by rail, and arrived at the Nutt Ranch in Bee county, Texas, on January 17th, 1899.

On January 23d, 1899, each received 1 cc. of defibrinated blood from the jugular vein of a 2-year-old heifer which had been raised on this ranch, and which had ticks on her at the time. They were fed bran and cactus daily. The inoculation did not cause much disturbance or loss of flesh. Saw these cattle June 27th, 1899. All have considerable number of ticks on them and appear in good flesh. No deaths.

EXPERIMENT NO. 11.

COOK—FIFTY-FIVE HEAD OF HEREFORDS.

This lot consisted of fifty-five pure bred Herefords, forty-one heifers and fourteen bulls. Their ages ranged from one month to 22 months. Eight of them were raised in Illinois, and the remainder in Hartley county, Texas. They were shipped south by rail and reached Bee county, Texas, February 2d, 1899. On February 14th each individual received 1 cc. of defibrinated blood from a 2-year-old heifer. These inoculations were made by Dr. Stephens. This lot has done very well. One death occurred from inoculation and one from blackleg. June 27th, 1899: Saw these cattle. All have a considerable number of ticks on them, yet they are all in good condition.

EXPERIMENT NO. 12.

RHEA—FIFTEEN HEAD OF REGISTERED SHORTHORNS.

This lot consisted of thirteen pure bred Shorthorn heifers, 8 to 15 months old, and two bulls 12 months old. All had been raised in Missouri. They were shipped south by rail and arrived in Collin county, Texas, April 9th, 1899. April 15th, each received subcutaneously 1 cc. of defibrinated blood from a 6-year-old cow. No serious symptoms developed. June 24th, each received a second inoculation of 1 cc. of blood from the same cow as the first dose. A letter from the owner of these cattle, dated August 29th, 1899, says that all of the above cattle have done well, and he thinks all the heifers are safe in calf. No deaths.

DISCUSSION OF EXPERIMENTS.

From the experiments reported in the preceding pages, it will be seen that immunity against Texas fever may be brought about in two ways. It is our purpose at this time to review only those experiments in which the infection was introduced by inoculation with infected blood. The practical application of this method requires some explanation as to the details of management and attention to the animals, that are necessary to insure satisfactory results. The matter may be accomplished by either of two methods of proceedure.

I. The first may be called the Northern plan. In this instance the cattle are confined in suitable quarters until the dangerous effects of the innoculation have passed, before sending them south. The most suitable time for this work is in the early fall. This allows sufficient time for the animals to recover from the more severe features of the disease before the rough weather of winter sets in; which is very trying on young animals infected with Texas fever. The best attention to diet and comfort of the cattle is necessary. We have been feeding a hay of mixed timothy and clover and a grain ration composed of equal parts of crushed corn, oats and bran.

These details are mentioned because the success of innoculation is, in a great measure, dependent upon the skill displayed in keeping the animals properly nourished. At this season of the year some grass is available, which is greatly appreciated by fevered cattle, as they often refuse all other food.

The time required for recovery from the effects of innoculation varies in different animals. As a general rule, fifty to sixty days are sufficient; but in the practical handling of a lot of cattle there will be some individuals that will not have recovered their strength by the expiration of the time mentioned; and there will probably be others that have failed to react sufficiently to the first innoculation, and thus require a second dose; thereby causing some delay in shipping the whole lot at one time. It would be inadvisable for such cattle to arrive in the infected district in Texas before December 1st, because of the danger of gross tick infestation before winter.

II. THE SECOND PLAN of management may be called the Southern plan. In this instance the cattle are taken south before innoculation. This should be done in winter, after there have been several severe frosts. In Texas this would be about January 1st, as a rule. A suitable place should be prepared, some months previously, to receive and hold the cattle. To do this, the best plan seems to be to enclose a small pasture, about the previous July, and allow no Texas cattle in it after that time. About December 1st burn the grass off and erect suitable sheds for shelter. Very few ticks will survive such measures.

The cattle should be put in the above described enclosure immediately on their arrival, and allowed some time to recover from the effects of their journey; say ten to fifteen days, before being inoculated They will require some time to adjust themselves to a new diet. It will be seen from examination of experiment No. 8 that this may be done gradually without any marked digestive disturbance. We have noticed some calves contract a very troublesome diarrhoea from having access to cotton seed in large quantities. As a rule, however, they may in a few weeks be taught to eat cotton seed hulls and a mixture of bran, oats and cotton meal without marked digestive disorder. In many parts of the state the cactus is abundant. This is a very suitable food for cattle during the inoculation fever, as it contains a mucilaginous substance which has a laxative effect. If this be not available, a few acres planted in oats furnishes an excellent winter pasture. The cattle should be kept from tick infested grounds until the inoculation fever has entirely passed away. Putting this period at sixty days, it would be March 1st before it would be reasonably safe to expose them to ticks.

AGE OF ANIMALS.

The most suitable subjects for inoculation are young cattle from 8 to 12 months of age, and in good condition as to flesh. They should weigh from 500 to 800 pounds. Younger animals bear the inoculation quite well, but they are usually somewhat hard to manage on account of not having learned to thrive on a grain and hay ration. In some experiments yet under way, we find that young calves, yet nursing their mothers, recover from inoculation promptly; but as their mothers cannot be inoculated with safety, or be taken to the infected district without great danger, the use of calves so young is not desirable from the business point of view of a Southern buyer.

SOURCE OF BLOOD FOR INOCULATION.

In all the experiments reported in this bulletin, except No. 5, the blood was taken from immune Southern cattle. In experiment No. 5 the first dose was taken from a Missouri steer that had been rendered immune by tick infestations. Our knowledge of the quality of immune blood is yet very meagre. The most we can say is that the safe course to pursue is to test the quality of the blood from each individual supply animal.

SIZE OF DOSE.

The initial dose of infected blood should be small. A study of the experiments shows that it varied from 1 to 2 1-2 cc. of fresh

blood. In experiments 1 and 2 larger quantities were used because the blood could not be used for one or more days after being drawn, and in these instances certain antiseptics were added which probably destroyed the vitality of some of the Texas fever germs. Since the initial dose of 1 cc. of fresh blood is capable of producing a high fever and marked destruction of the blood corpuscles, it must be unsafe to give a much larger quantity (see experiment No. 8). At the present state of our knowledge, we must regard a first dose of 1 to 2 cc. within the limits of safety, for calves 8 to 12 months of age.

INOCULATION FEVER.

The fever resulting from inoculation appears about the tenth day. In some instances it was a day or two earlier, and in others a few days later. This is the *primary reaction.* It usually appears suddenly, with a morning temperature of 104 or more, and rises to about 106. In experiment No. 4, bull No. 12 had a temperature of 107.4 on the tenth day; and bull No. 13, 108.4 on the twelfth day. These high temperatures are unusual. The fever of the primary reaction continues several days; then falls rapidly, and has ceased about the twentieth day. A glance at the graphic record of a part of the animals in experiment No. 4, will make this feature of Texas fever readily understood. The sudden fall in the temperature is a critical time with the animal. Some sub-normal temperatures are recorded, and the deaths that occur are usually at this time, from collapse. If the temperature soon rises to normal, the chances for recovery are favorable. Bloody urine was not noticed in any of the experiments under consideration. The destruction of the red blood corpuscles during the primary reaction is rapid. In experiment No. 8 we found that the average per cent had fallen to 23.1 by the close of the primary fever period. This destruction of the blood corpuscles causes the blood to become thin and watery, and to contain the broken down material of which the corpuscles were composed. This implies that new corpuscles must be rapidly formed to perform the functions of those destroyed, and that the broken down material must be eliminated in some way from the system. There seems to be considerable evidence that the new corpuscles are formed in the red marrow of the bones, in certain types of connective tissue, and possibly in such circumstances, in some of the so-called "blood glands."

Therefore, whatever immunity be acquired by animals which have had the disease in question, it seems, for the best we know, to be brought about by the ability of the cells and tissues of the calf's body to supply the demands made upon it for new corpuscles, and to eliminate the waste products. The latter duty falls to the

liver and kidneys. It is apparent then, that in the practical management of inoculation fever, the animal's strength should be maintained by proper nourishment, and that the eliminative organs be kept active. The bowels and kidneys must be kept active. This can best be managed by suitable feeding. If these measures fail, salts may be given in doses of twelve ounces. A small pasture of winter oats will provide suitable grazing. In the north, a mixture of equal parts of corn meal, bran, ground oats with a small quantity of old process linseed meal added, and clover hay. If possible, let the animal have some green grass. In the South, use a mixture of equal parts of cotton seed meal, bran and oats, with hulls for roughness. When the cactus is available, it may be used to advantage when cut to suitable size and sprinkled with bran.

SECONDARY REACTION.

The secondary fever period begins about the thirtieth day after inoculation. In experiment No. 8 it appeared on the twenty-ninth day. It resembles the primary one in a general way, but differs from it in being somewhat irregular in its course. An examination of the graphic record accompanying experiment No. 4 will show the variations met with. In bulls 1, 3, 15, 12 and 13 the secondary fever was lower than the primary. In bull 26 it was higher. In bulls 14, 18, 21, 2, 7 and 19 the difference was not so great. The remarks in regard to attention and care during the primary reaction apply to the secondary as well, and need not be repeated.

In experiment No. 8 it will be noticed that a second fall in the percentage of blood corpuscles occurred during the secondary reaction. The lowest average for the six animals, reading 21 per cent., occurred on the thirty-ninth day. The lowest individual at this time was 14 per cent. The secondary reaction, in Experiment No. 8, terminated on the forty-third day. In Experiment No. 4, bull 19 had passed through it by the thirty-sixth day; bull No. 14 on the fortieth day; bull 26 on the forty-sixth day. Bull 2 was evidently fevered when the experiment closed. These cases are cited to show the variations encountered.

From the data before us at this time, we find that the time required for cattle to recover from inoculation fever is about fifty days. They should not, therefore, be exposed to ticks before the expiration of the time mentioned.

SECOND AND THIRD INOCULATIONS.

A study of Experiment No. 3 shows that the cattle were inoculated in October, and that they did not become infested with any considerable number of ticks until the following July, when some twenty or more of them became sick and ten of the number died.

It seems from this that whatever immunity may have been brought about by the inoculation in October, was either lost, or was too feeble to prevent deaths during the following July. It would seem that these cattle should have received a second dose, perhaps in February or March. There is no satisfactory way of ascertaining in such cases, the condition of the animal except by centrifugal analysis of the blood. If this should show a low percentage of the red blood corpuscles, say 25 per cent. or less, and especially should an inspection of the individual show chronic blood destruction, then a second inoculation would probably not be necessary.

On the contrary, as a second inoculation causes little or no disturbance in those which possess immunity, and as it causes fever in those which do not possess it; the practical thing to do in such cases is to make a second inoculation. Moreover, if the primary reaction has been mild, say below 105, and there is no marked evidence of blood destruction, it would seem reasonable to give the second dose, say sixty days after the first one.

A THIRD INOCULATION was given in experiments 2, 5 and 8. While but one death occurred among these animals, a study of the clinical notes in Experiment 5 shows that two of the animals (bulls 534 and 540) contracted Texas fever, though they recovered. Evidently three inoculations failed to produce a perfect immunity in these bulls. This matter, then, must await further study.

EFFECTS OF INOCULATION.

The fever and changes that result from inoculation with infected blood are the same in nature as those that occur when the disease has been contracted in the natural way. Among these, we find:

1st. *Recovery with immunity;* this is the result desired, and requires no further notice at this time.

2nd. Partial recovery with chronic blood destruction; this type occurs in a small percentage of cases. They require prolonged care and the very best of food and attention to prevent an arrest in development. This occurs especially in pampered animals of high breeding, and often results in a failure of the animals to develop into the individual that it was reasonable to expect from his breeding.

3rd. Death from inoculation fever; two deaths occurred from inoculation in Experiment No. 3. No data are available as to the details. Several deaths occurred in Experiment 6 soon after inoculation. It is possible that the latter were, in some considerable measure, due to the infestation with ticks which occurred at the time.

EFFECTS ON REPRODUCTION.

No evil effects of inoculation on the powers of reproduction have been observed in these experiments.

In Experiment No. 1, "The bulls have done good service."

In Experiment No. 2, "All the heifers produced good healthy calves the following spring."

In Experiment No. 4, "The bulls have sired 200 calves."

In Experiment No. 8, "All heifers appear to be pregnant."

In Experiment No. 9, "The oldest heifer produced a good calf 9 1-2 months after inoculation."

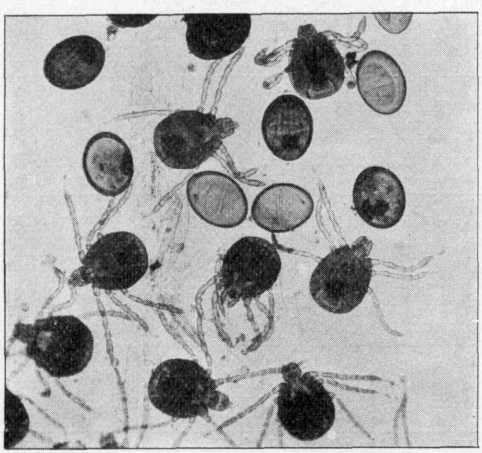
In Experiment No. 12, "All the heifers appear to be pregnant, five months after inoculation."

We have no data as to the dangers of abortion following inoculation. On this point J. S. Hunt (Pathologist to the Department of Agriculture, Queensland, in annual report for 1897-98, page 87) says: "The risk is also greater in cows that are in calf; abortion frequently follows inoculation when considerable fever occurs."

Immunity to Texas fever then, is not absolute. It depends upon the ability of the cells of the animal to resist the germs of the disease. Whatever operates to reduce this power of resistance, whether it be the fatigue of a long journey on the cars; the exposure of inoculated cattle to the rough weather of a Northern winter; the lack of sufficient food during the droughts of summer; the enervating influences of a warm climate; excessive tick infestation; these things, singly or in combination have a tendency to bring on a relapse. It is therefore important that inoculated animals be not subjected to extreme conditions, for a year or more.

From the experiments before us, we conclude that in careful hands and with proper management, preventive inoculation is a reasonably safe and practical measure against the fatal type of Texas fever.

October, 1899.



Young Fever Ticks—"Boophitus Bovis"—and Eggs—Highly Magnified.

TABLE 4. Summary of Inoculation Experiments.

Number of Animals Inoculated, 432. *Deaths from Fever 8%.*

	Owner	Number	Breed	Bulls	Heifers	Age and Weight	Native State	Arrived in Infected Ter.	County (Tex)	First Inoculation	Quantity	Second Inoculation	Quantity	Third Inoculation	Quantity	Deaths			REMARKS
																Fever	Blk-Leg	Other	
1	Bullock.	10	Aberdeen Angus	10	..	8 to 12 mos	Kansas..	Dec. 24, '97	Brazoria	Nov. 19, '97	8 cc.....	.....	.....	.....	....	..	..	1	1 death, Jan. 14, 1898.
2 *i*	Rhae....	4	Shorthorn	2	2	8 to 12 mos.	Kansas..	Feb. '98	Collin....	Feb. '98	8 cc heif'rs 4 cc bulls	20 day later	8 cc heif'rs 4 cc bulls	April 25	8 cc	..	..	..	No deaths.
ii	Rhae....	6	Shorthorn	1	5	7 to 12 mos.	Missouri	April 21, '98	Collin....	April 25, '98	4 cc.....	May 25	4 cc.....	.....	....	..	..	1	1 death, Sept. 10, 1898.
3 *i*	Green...	93	Shorthorn	..	..	6 to 14 mos.	Ills., O., Ind., N.Y	Dec. 24, '98	Dimmit..	Oct. 15, '98	2.5 cc.....	9 he'd Nov 9	2.5 cc.....	.....	....	12	..	..	2 died from Inocul'n.
ii	Green...	43	Shorthorn	..	..	6 to 14 mos	Iowa	Dec. 24, '98	Dimmit..	Nov. 9, '98	2.5 cc.....	.....	.....	.....	....	..	..	..	10 died, July, 1899. 10 others sick, recovered
4 *i*	Tod	11	Hereford	11	..	272 to 480 lbs.	Mo , Ills.	Jan. 5, '99	Nueces..	Nov. 7, '98	2.5 cc.....	.....	.....	.....	....	..	..	..	
ii	Tod	3	Hereford	3	..	330 to 445 lbs.	Mo , Ills.	Jan 5, '99	Nueces..	Nov. 7, '98	2.5 cc.....	Dec 8	2 cc.....	.....	....	..	..	1	1 died from snake bite
iii	Tod	4	Hereford	4	..	370 to 550 lbs.	Mo , Ills	Jan. 5, '99	Nueces..	Nov. 15, '98	2.5 cc.....	.....	.....	.....	....	..	..	..	
iv	Tod	6	Hereford	6	..	365 to 600 lbs.	Mo., Ills.	Jan. 5, '99	Nueces..	Nov. 15, '98	2.5 cc.....	Dec 8	2.5 cc.....	.....	....	..	..	..	
v	Tod	6	Hereford	6	..	505 to 823 lbs.	Mo , Ills.	Jan. 5, '99	Nueces..	Nov. 29, '98	1 cc.....	Dec 8	2 cc.....	.....	....	2	..	..	2 died in April, 1899.
5	Waskom	3	Hereford	3	..	550 to 1250 lbs	Missouri	Feb. 25, '99	Harris'n	Dec. 8, '98	2.5 cc.....	Jan 2 1899	2.5 cc.....	Feb. 22, '99	3 cc	..	..	..	No deaths.
6	Overall .	84	Hereford	84	..	6 to 10 mos	Missouri	Dec. 20, '98	Coleman	Dec. 23, '98	64—1 cc.... 20—2 cc....	.....	.....	.....	....	7	6	1	Deaths due to too early exposure to ticks.
7	Burgess.	68	Shorthorn	..	..	8 to 14 mos.	Kent'ky.	Nov. 24, '98	Wise	Jan. 14, '99	1 cc.....	.....	.....	.....	....	12	..	..	Deaths in June, 1899.
8	Suber ..	6	Shorthorn	1	5	10 to 12 mos.	Missouri	Jan. 1, '99	Brazos ..	Jan. 7, '99	1 cc.....	Mar 24, '99	2 cc.....	May 18, '99	2 cc	..	1	..	1 death from Black-Leg, April 10, 1899.
9	Kruger .	6	Hereford	2	4	8 to 14 mos.	Kansas..	Dec. 7, '98	Bee.....	Dec. 17, '98	1 cc.....	.....	.....	.....	....	..	..	..	No deaths.
10	Nutt	9	Hereford	1	8	10 to 16 mos.	Hartley Co., Tex.	Jan. 17, '99	Bee.....	Jan. 23, '99	1 cc.....	.....	.....	.....	....	..	..	..	No deaths.
11	Cook	55	Hereford	14	41	4 to 22 mos.	47 Hartley Co Tex., 8 Ills.	Feb. 2, '99	Bee.....	Feb 14, '99	1 cc.....	.....	.....	.....	....	1	1	..	Two deaths.
12	Rhea	15	Shorthorn	2	13	8 to 18 mos	Missouri	April 9, '99	Collin ...	April 15, '99	1 cc.....	June 24, '99	1.25 cc.....	.....	....	..	..	..	No deaths.