
University of the State of Missouri.

COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

Agricultural Experiment Station

AND THE

MISSOURI STATE BOARD OF AGRICULTURE
IN COOPERATION WITH THE TEXAS AG-
RICULTURAL EXPERIMENT STATION.

BULLETIN NO. 48.

Texas Fever.

Immunizing Northern Breeding Cattle for the Southern
Trade.

- (I) By Serum Inoculation.
- (II) By Tick Infestation.
- (III) By Blood Inoculation.

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Texas Fever.

Experiments Made by the Missouri Experiment Station
and the Missouri State Board of Agriculture, in
Cooperation with the Texas Experiment
Station, in Immunizing Northern
Breeding Cattle Against Texas
Fever for the Southern
Trade.

By J. W. CONNAWAY, Veterinarian Missouri Experiment Station.
By M. FRANCIS, Veterinarian Texas Experiment Station.

GENERAL OUTLINE OF THE WORK.

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 forty per cent and frequently seventy 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 cooperative work was begun in 1896, and is still in progress. The interests of the cattle industry demand that the results obtained up to the present time be presented in official form. There is probably much work yet to be done before the methods, which can now in careful hands be employed with a great 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 might be utilized

practically in stimulating at least a passive immunity in susceptible cattle.

II. Experiments on immunizing cattle by infection with the micro-parasites of the disease by means of *tick-infestation*.

III. Experiments on immunizing cattle by infection with the micro-parasites of the disease through *blood inoculation*.

These 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 the necessity 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 practicable as that of blood inoculation.

In the blood inoculation experiments, over four hundred head of thoroughbred cattle have been used. The losses from inoculation and from subsequent exposure to infected pastures in Texas, have been less than eight per cent.

The cause of "Texas fever," and the means by which it is transmitted, have been so fully presented in Experiment Station Bulletins, and in the agricultural press, that any extended treatment of these matters will be unnecessary for the purposes of this bulletin.

It will be sufficient to state that the cause of the fever is a minute parasite occurring in the blood of southern-raised cattle, but causing in these under ordinary circumstances no illness, these cattle being immune; but when transferred in any considerable numbers to the blood of northern-raised cattle give rise in the latter to a serious fever.

The natural way in which these micro-parasites are transmitted is by means of the southern-cattle-tick, (*Boophilus bovis*). The disease can also be induced artificially in susceptible cattle by hypodermic injection of infected blood from southern cattle.

*The full details, temperature records, etc., of the first two lines of work will be given in the next Annual Report, for the benefit of those who are interested in these matters from the purely scientific point of view. These records would unnecessarily burden this bulletin which is mainly intended to present results of practical interest.

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 organisms of the disease, that might be used in a practical way in bringing about immunity in susceptible cattle.

The value of such a 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 septicaemia 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 certain diseases, 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 a protozoon micro-parasite, instead of bacteria as in 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 eight year old cow. 200 cc. of serum were inoculated subcutaneously during a couple of weeks previous to infesting her with ticks. After the infestation,

this cow was inoculated with 80 cc. more of serum. This inoculation began September 2nd; the infestation was made September 16th, and the animal was kept under observation until November 2nd, morning and evening temperatures being taken. During this time there was no elevation of temperature, except on the afternoon of 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, Mississippi. 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 the 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 given here.

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 one and one-half years to eleven years. They were inoculated daily with serum in doses of 40 to 60 cc., according to the size of the 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 years old) died.

During the same summer five head more 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 Texan animal at the North. 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 suffered 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 less vigorous.

In addition to the serum experiments one cow was inoculated with 50 cc of blood from an animal recently dead from an acute case of Texas fever. A small quantity of formalin was added to destroy the microparasites. But little physiological disturbance was noted; indicating that no toxic substance was present. Bile from the same animal was used on another cow with like results. Both cows died from acute cases of the fever after tick-infestation.

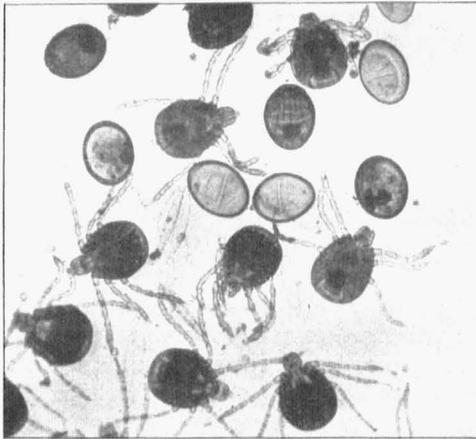
While the desired economic end of this experiment was not attained, the data supplied in regard to the effects of tick infestation are valuable in the experiments that follow.

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 with living infected blood."

II. EXPERIMENTS ON IMMUNIZING AGAINST TEXAS FEVER 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 fact 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 the infection, while only a small per cent of the young animals succumbed. The case of the dairy herd at Enterprise, Mississippi (mentioned under "serum inoculation"), illustrates in a marked manner the greater resistance of 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 the grown cattle except one died; while two of the yearlings and all the calves lived. Those that survived had been grossly infested with ticks and suffered more or less from the fever. In the serum experiments of the following summer, the same difference was noted between young and old cattle in resisting the disease.



*Fig. 1.—Young fever ticks—"Boophilus bovis,"
—and eggs—Highly magnified.*

These observations led to the experiments 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.

The following animals were used in the experiments: In 1897,

No. 1.—"Jersey," a yearling Jersey steer.*

*Nos. 1, 2 and 3 were also used in the "Serum Experiments."

- 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.
 No. 8.—Jersey bull calf, 5 weeks old.
 No. 9.—Jersey bull calf, 3 weeks old.
 No. 10.—Jersey bull calf, 3 weeks old.
 No. 11.—Jersey bull calf, 3 weeks old.
 No. 12.—Jersey bull calf, 2 weeks old.

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, four weeks old.
 No. 16.—Jersey bull calf, 2 weeks old.
 No. 17.—Jersey bull calf, 3 1-2 weeks old.
 No. 18.—Jersey bull calf.—5 weeks old.
 No. 19.—Jersey bull calf, 3 weeks old.
 No. 20.—Jersey bull calf, 5 weeks old.
 No. 21.—Jersey bull calf, 3 1-2 weeks old.

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, and all have lived.

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.

TICK INFESTATION OF YEARLINGS.

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 for about a month, and was again reinfested with several hundred

*All of these except No. 7, were shipped to the Texas Experiment Station, where they have been on infested grounds since January 1st, without showing any signs of fever. Temperature records and blood examinations were made twice a week. No. 7 was kept at the Missouri Experiment Station and given a severe test without showing any fever. See cut p. 15.

more ticks. In addition the steer became grossly reinfested 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. This steer was infested in a different pasture from Nos. 2, 3, and 4. He was grossly reinfested the following summer and fall (1898) but showed no evidences of fever. Through the spring, summer and fall of 1899 he was again exposed to a presumably more severe infection in the quarantine territory, at College Station, Texas, and remained in perfect health.

The following group of yearling Jersey steers: No. 2, "Spot;" No. 3, "Red," and No. 4, "Fawn," 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 infesting. In a few days mature ticks were numerous, and continued so for a week. On September 26th, these steers were almost free from the ticks coming from the artificial infestation. This infestation produced scarcely any elevation of temperature in Nos. 2 and 3. In No. 4, several high afternoon temperatures had been observed, but nothing indicating a continuous fever period. October 29th, it was observed that the animals were well infested with small ticks picked up from the pasture. This infestation proved to be more severe. From October 4th to 9th, No. 2, "Spot," had a fever period, morning temperatures ranging from 102.7 to 105.7 F., and evening temperature for two weeks from 103.7 to 107.7 F. The animal became gaunt, lay down much of the time, and had little appetite. October 11th, the morning tem-

perature was normal and continued so until November 1st, when regular observation ceased. A few immature ticks were found on this steer as late as January 3rd. No. 3, "Red," showed no outward signs of fever until October 20th, but from October 7th to 16th the evening temperatures had ranged from 103.5 F., to 106.4 F., and the morning temperature from 101 to 103 F. The calf had fallen off some in flesh. The morning temperature October 20th was 103.3; evening temperature, 106.4, calf stupid. October 21st, morning, 104; evening, 106.2, calf sick. October 22nd, morning, 104; evening 105.9; calf dull and gaunt. October 23rd, morning, 101.5; evening, 105.4. October 24th, temperature normal. Calf has been grossly and continuously infested with ticks.

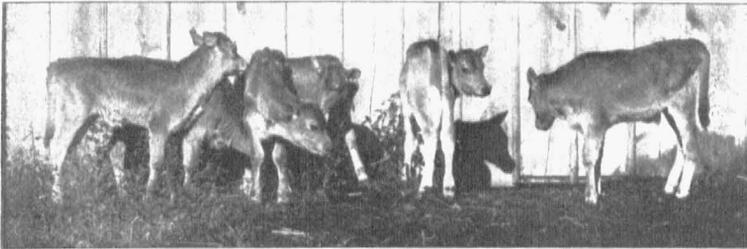


Fig. 2.—Group of Jersey Calves at time of first tick-infestation.

No. 4, "Fawn." This calf showed but little signs of fever from the first infestation. From August 1, to September 25, the morning temperature remained normal, and only an occasional high evening temperature occurred. On September 26th, the evening temperature arose to 104 F., 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 temperatures were 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 condi-

tion was, however, in part due to lack of nutrition; the pastures became dry and short. On December 31st, calf No. 4 died from accident, having been horned into the manger, probably by a Texan cow that was kept in the same pen. No. 2 and No. 3 improved during the winter, and were put on 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 feed" and were in good condition at the beginning of winter. These two steers were shipped with others to the Texas Experiment Station on December 28, 1898, and have been on infected grounds since January 1st, 1899. No signs of fever have appeared. The temperature records and tests of the blood by means of the haematokrit show that these steers were fully immunized 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 Texan cattle. He was exposed from July 19th to October 27th, 1897, and during this time was observed almost daily for ticks. The dipping proved to be 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 Texan steers, from infection of the pasture. No doubt many ticks escaped observation, but it is safe to say that during the entire season not more than 25 or 50 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 reinfested the following year to determine whether so mild an infestation had made the steer immune. 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 23 days after infestation. The animal showed a few high temperatures 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 of the season the steer was fed a while, and was shipped in fair condition, on Decem-

ber 28th, to the Texas Experiment Station, where he has been exposed since January 1, 1899, without showing any signs of fever.

The two Holstein heifers, Nos. 13 and 14, about 10 months old, were infested August 13th, 1898, 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, 56 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 between the first infestation and the death of this animal, makes it probable that she would have lived if she had not been subjected too soon to the gross tick infestation that occurred on the pasture, and had not been suffering from another disease.

The Holstein that survived (No. 13) was also affected with lung worms, and did poorly through the winter, but improved when put on pasture in the spring. She was in fine condition June 21, 1899, when she was reinfested with several hundred ticks. Later she became well infested from the pasture. In addition to the tick infestation, this heifer was inoculated June 15th with 6.5 cc. infected blood from a Texan cow, and again on August 4th with 8 cc. This severe test caused no fever. The heifer has been in the best of health and condition throughout the season.

TICK INFESTATION OF YOUNG CALVES.

Calf No. 6, 2 months old, was purposely infested (July 28, 1897) *with a very large number of ticks*, to test the effect of sudden gross infestation on a young animal. The number of ticks applied was doubtless far greater than would under natural conditions, infest an animal at one time. On the morning of August 6th, nine days after infesting, the calf had a temperature

of 106.2 F. On the following day, 107.2 F., and death resulted August 10th, thirteen days after the ticks were applied. A "post-mortem" showed lesions of Texas fever. This experiment shows that sucking calves, which ordinarily are quite resistant to the disease, may succumb if excessive infestation occurs.

In the fall of 1897, six young Jersey bull calves, 2 to 6 weeks old (Nos. 7, 8, 9, 10, 11, 12), were put in a quarantine pen and infested artificially with from 25 to 50 Texas fever ticks. After these had matured and dropped off, the calves were infested again with from 75 to 200 ticks. These also matured. Some of the calves for a short time were off feed and a little dull and gaunt, but at no time during the infestation period was any 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 severely, and two (Nos. 11 and 12) died. The "post-mortem" showed no indication of Texas fever. The four remaining calves were put in the barn December 12th, and in a few weeks were in excellent condition.

These calves were infested again the following summer, after they had been free from ticks seven months. Bull No. 7, was infested July 28, 1898, with about 400 ticks. July 7th, bull No. 8, was infested with 300 ticks, and again on July 7, with 100 more. Bull No. 9, was infested July 7, with 100 ticks, and again September 10th, with 500. Bull No. 10, with 200 ticks on July 28th, and again on September 10, with 500. The first crop of ticks matured without any of the bulls showing a fever period, only an occasional high temperature was noted on very warm days. On the 28th of August, No. 10, after becoming quite free from ticks, was somewhat gaunt and had diarrhoea, but appeared quite well in a few days.

In addition to the artificial infestation, these bulls became grossly infested with ticks hatched on the pastures.

As the result of excessive tick infestation, and lack of proper nourishment from dry condition of the pasture, these young bulls fell off considerably in flesh, and in September, one of them, No. 10, developed an acute attack of the fever. The

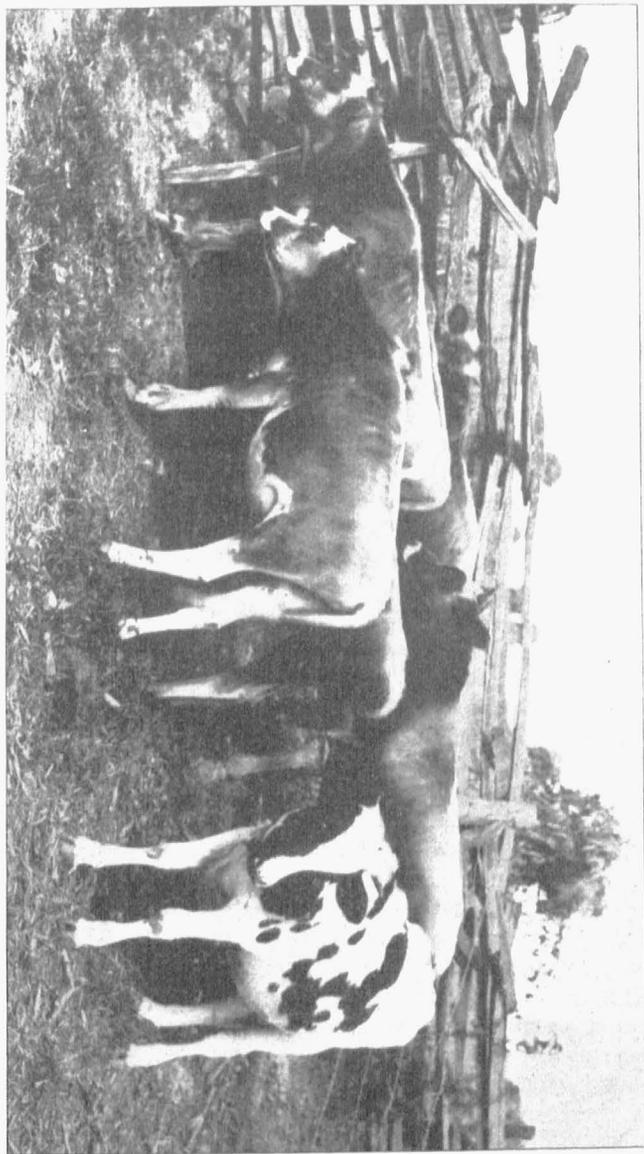


Fig. 3.—Group of calves at close of second year's infestation.

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 haematokrit to determine variation in the percentage of corpuscles; but little variation from the normal was observed. The bull appeared to be in perfect health during the entire season. A picture of this bull as he appeared at the close of the experiment is shown on page 15.

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

Bull No. 9, was not reinfested the third season, but was killed March 20th, for a class demonstration, as the calf was affected with "Hoose," "verminous bronchitis." The post-mortem showed the parasitic worms of the disease almost plugging many of the small bronchi.

Another group of Jersey bulls (Nos. 15, 16, 17, 18, 19, 20 and 21) were infested with Texas fever ticks September 23, 1898. From 50 to 100 ticks were applied to each, and they matured on all the bulls. Four of the bulls showed scarcely any rise of temperature, while three showed more or less fever. All the latter had diarrhoea, no doubt in part due to change of food, from early weaning. No 19 was quite sick, had bloody diarrhoea, but recovered. 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, Aug. 1st to Oct. 15, 1899. No. 20 died from some 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 in-

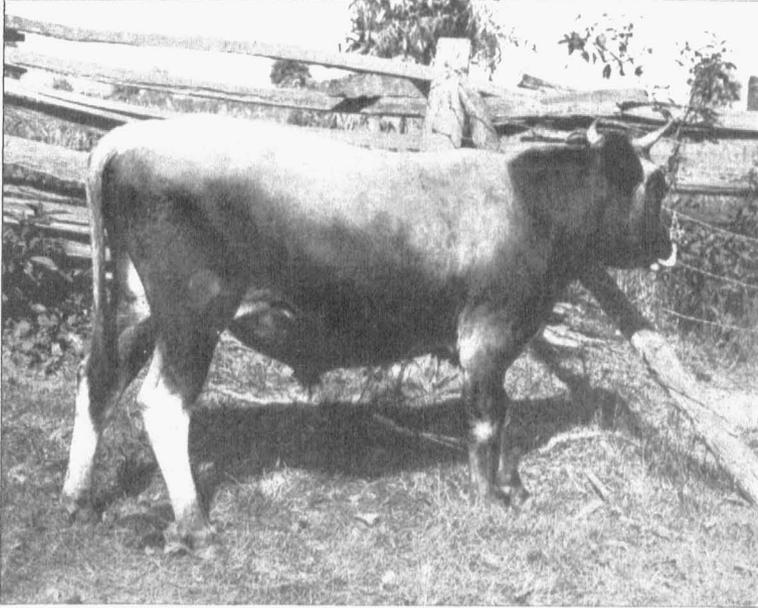


Fig. 4.—Jersey bull No. 7. Calved August, 1897. From a group infested three seasons.

jected 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, 16 days after the inoculation and 8 days after tick infestation, the calf appeared to be in good health, the

temperature was normal, and the percentage of blood corpuscles from haematokrit readings was 36 per cent (about normal). On July 6th, 23rd day after inoculation and 15 days after tick infestation, the percentage of corpuscles had fallen to 20 per cent. On July 8th, the haematokrit reading was 13 per cent, the morning temperature 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.

None of the other calves showed any outward symptoms of illness apparent to the average observer; they were never off feed; the thermometer, however, showed that all of them had some elevation of temperature during the season and there was considerable destruction of blood corpuscles, as determined by means of the haematokrit. Bull No. 15 showed a diminution 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 diminution in percentage of corpuscles. The greatest fall in percentage appeared to result not from the inoculation and earlier tick infestation, as it occurred later in the fall after the pastures had become dry and grass scanty, and ticks more numerous on the pasture. All these calves had about regained the normal percentage of corpuscles at close of the experiment.

SUMMARY AND CONCLUSIONS. (TICK INFESTATION.)

It will be seen from the history of the above 21 head of young cattle that but one died from an acute attack of the fever within the usual period of 12 to 20 days following tick infestation, and that this one, No. 6, a two months 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. The yearlings that were mildly or intermittently infested the first season did not suffer the profound nutritive disturbances noted in others that were grossly and continuously infested. (Contrast steers No. 1 and 5 with steers No. 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 2nd season (1898), and No. 19 was quite ill his second season (1899), and others of 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 gross secondary 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 occurring at 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 is 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 the 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 can not 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.

III. EXPERIMENTS ON IMMUNIZING NORTHERN CATTLE AGAINST TEXAS FEVER BY INOCULATION WITH INFECTED BLOOD.

In the following section a report is given of the inoculation of over four hundred registered breeding cattle raised north of Texas fever quarantine line, and shipped into infected territory in the State of Texas.

As stated in the introductory section Texas fever can be induced artificially in northern raised cattle by hypodermic injection of blood from immune southern cattle. This discovery was made by Drs. Smith and Kilbourne, in their classical investigations into the pathology of Texas fever.* In the course of these investigations it was observed that the attack induced in this artificial way "was not so fatal as the natural disease;" and the suggestion was made that by further experimentation a practical method of preventive inoculation might be perfected.

Recent experiments in Australia, where the "fever tick" is gradually spreading over the country on account of the mildness of the climate, show that preventive inoculation by means of infected blood has met with great success as a defensive measure

*Bulletin No. 1 Bureau of Animal Industry and Reports of C. J. Pound, director of Queensland Stock Institute, and Dr. J. Sidney Hunt, Government Pathologist, Queensland.

on the cattle ranges of that country. Moreover that the method is being employed in immunizing stud and range bulls intended for infected territory.

The work reported herein shows that the employment of this method as a purely commercial measure, has given fair success notwithstanding the unavoidable fatiguing effects of a long railroad journey, and the widely different climatic conditions that must be encountered by cattle shipped from northern to southern sections of this country.

In regard to the mechanical details of this work, it will be sufficient to say that the blood is taken from the jugular vein of a proper supply animal by means of a sterile canula. The vessel for collecting the blood, and all instruments that come in contact with it being sterilized, and kept sterile throughout the operation. The fibrin is removed by means of a wire whipper to keep the blood in a fluid condition. The inoculation is made by means of a properly graduated hypodermic syringe. Minute details as to sterilizing the instruments, drawing and preparing the blood, and making the injections are unnecessary; as those who are competent to carry on this work have been trained in these surgical details. Everyone who undertakes inoculation should be familiar with the pathology of this disease, for medical treatment will be necessary in some cases, and can not be carried out intelligently without a practical knowledge of the pathological processes.

The impression prevails that inoculation against "Texas fever," is as simple and harmless as inoculation against "black-leg." On the contrary, the effects are more severe; some signs of illness are expected in all that become properly immunized and attention is necessary through the inoculation fever. Moreover, some attention must be given throughout the first season of tick infestation to prevent fatal relapses especially in the older bulls.

The history of the several lots of cattle that have been inoculated is given below.

BULLOCK.—10 HEAD OF REGISTERED ABERDEEN ANGUS BULLS.

The cattle used consisted of ten Aberdeen-Angus bulls, six to ten months of age, raised near Wichita, Kansas.

The blood used was drawn from an immune cow in Brazos county, Texas. To it was added ten per cent of 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 quiet 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 chop, 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 30 days, 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. 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, being at that time two years old. They have taken their chances like southern grown cattle, and have done good service and look well."

RHEA.—10 HEAD OF REGISTERED SHORTHORN BULLS
AND HEIFERS.

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

Lot I, consisted of four animals, two bulls about eight 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 blood, from a cow raised in Brazos county, Texas. The bulls received 4 cc., and the heifers 8 cc. Tri-kresol was added as in the above experiment. In eight days one of the bulls and one of the heifers refused their food,

became gaunt, showed reeling gait, which continued 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 re-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, bred by W. P. Harned. They were



Fig. 5.—Group of inoculated Shorthorn heifers, raised in Cooper county, Missouri. Have passed two seasons in Texas.

shipped to Collin county, Texas, where they arrived April 21st, 1898. The lot consisted of one bull seven 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 feed untouched, but no symptoms of an alarming character developed.

May 26th, 1898, each calf received a second inoculation of 4 cc. defibrinated blood, subcutaneously. Eight days later they all showed a lack of relish for their food, which continued 3 or 4 days. Nothing further was noticed until September 10th,

1898, when one of the heifers of lot I 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 some from them.

GREEN.—136 HEAD OF REGISTERED SHORTHORN BULLS
AND HEIFERS.

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

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

As neither of us could remain to make observations, most of the clinical notes have been supplied by Mrs. Dr. Green.

"October 29th (14th day). The smallest calves seem to be sick. Five or six have been stupid 2 or 3 days, and half of the bunch show symptoms of fever. The largest ones are not affected apparently."

"Nov. 2nd (17th day). One of the calves died yesterday (16th day). Two are very sick; others are in various stages. Nearly all are discharging mucous from 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."

"Nov. 4th (19th day). No local trace of the 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."

Nov. 9th. Went to Oakland again to see cattle and inoculate others. The majority of the cattle are doing well, about twenty look somewhat gaunt but most of them are eating well,—one young bull refuses food and appears very sick. Inoculated 43 more calves from Iowa, that had arrived since

Oct. 15th, giving each 2.5 cc. of blood taken from the mate to the ox whose blood was used Oct. 15th. Also reinoculated six of the first lot which showed no marked symptoms, using 2.5 cc. of the same blood as Lot II.

"Nov. 10th. The young bull that has been so sick died last night."

"Nov. 19th. One calf of lot II. is very sick (10th day)." recovered.

"Nov. 28th (43rd day). The sick calf of lot I, which had a relapse (2nd reaction) is about well."

"Dec. 3rd (49th day). The calves are doing very well. Feeding them on corn, oats, bran and hay, and turn them into the pasture on pleasant days. The second lot have not been so sick as the 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 now in thriving condition except two or three of lot I." The probable cause of the cattle of the first lot not doing as well as the second is that they were exposed to a cold rain storm about the time of the primary fever period.

Dec. 18th. Cattle shipped south.

Dec. 20th. Cattle fed at Parsons, Kansas.

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

Dec. 24th Cattle arrived at San Antonio, Texas, and put in yards. They appear badly fatigued and gaunt from long journey and the shake-up of the wreck. Many of them have pink-eye.

Jan. 17th, 1899. Cattle have been moved to the ranch in Dimmit county. Four or five have died of blackleg. Otherwise they are doing nicely.

Aug. 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 have 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 Polled bull which has carried ticks all spring and summer has shown no signs of fever to date.

Sep. 20th. Cattle all doing well.

Has lost about 40 per cent of those that were not inoculated.

TOD.—LAURELES RANCH, 30 HEAD OF REGISTERED HEREFORDS.

This lot of bulls, consisting of thirty head of registered Herefords bred in Missouri and Illinois, was supplied by Capt. John Tod, manager of the Laureles Ranch, Corpus Christi, Texas. On their arrival at the Missouri Station, Nov. 1st, 1898, they varied in weight from about 275 lbs. to 850 lbs. The weight of each at the beginning and end of experiment, with

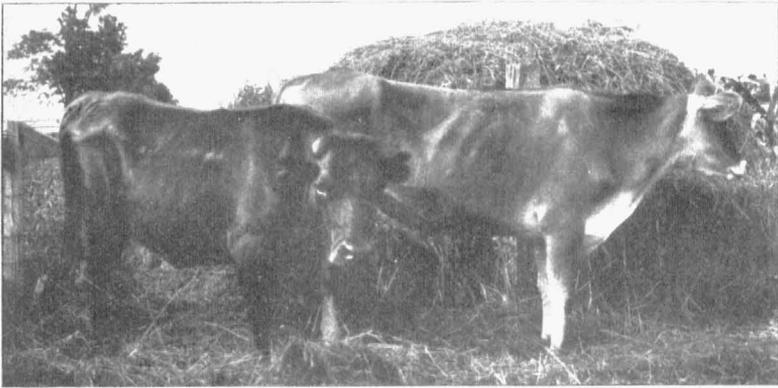


Fig. 6.—A native Texan and a "recovered" Northern animal that have supplied blood for inoculation at the Missouri Experiment Station.

gain or loss, are given at the head of the temperature tables, see pages 37 to 40, also in the clinical notes, pages 27 to 36. Before inoculating the bulls, they were given a week's rest, to allow them to overcome the soreness and fatigue incident to shipment, and to adjust themselves to changes of food and surroundings.

On November 7th, fourteen head of the small and medium size bulls were inoculated, each receiving subcutaneously 2.5 cc. defibrinated blood from an immune Texas steer.* This lot of

*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.

bulls, is designated in the temperature tables and clinical notes 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 Dec. 8th with 2.5 cc. of defibrinated blood from a "recovered" native.

On Nov. 15th ten head more were inoculated from the Texan steer, 2.5 cc. blood being given. In this lot was included one of the larger bulls (No. 23) weighing 680 lbs. In the temperature table and clinical notes 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 Dec. 8th, dose 2.5 cc., from the recovered native.

The remaining six bulls, Nos. 58, 11, 29, 9, 30 and 6, the largest ones of the shipment, designated as Group III., were inoculated Nov. 29th, an initial dose of 1 cc. being given from the Texan steer, and nine days later (Dec. 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, although a few animals that had shown fever were reinoculated to determine the effect of a second inoculation.

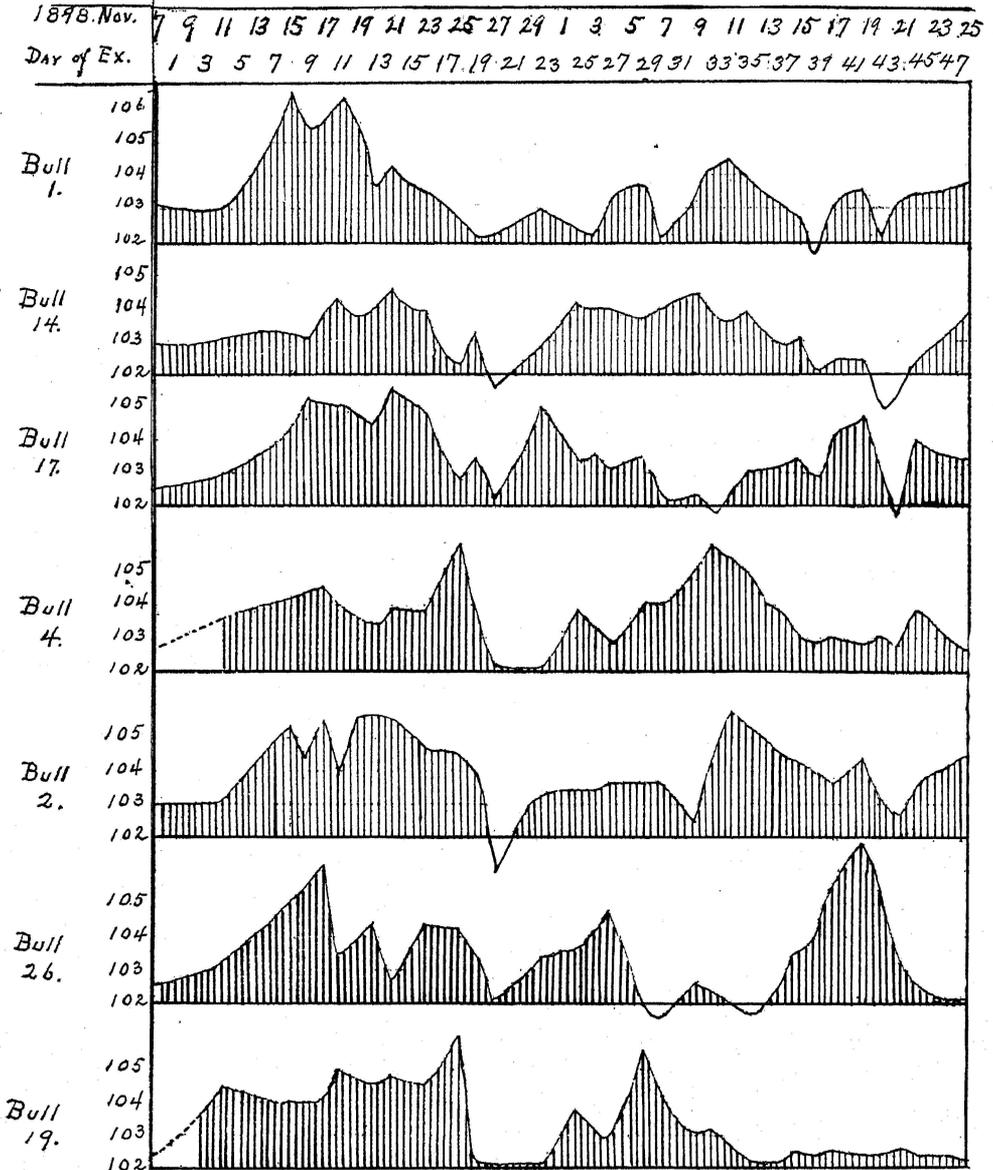
Temperature records and clinical notes are given upon each animal of this lot, to supply fuller knowledge of the effects of inoculation upon cattle of different sizes, than is available in the preceding experiments. These notes give the date of rise of fever, its duration and type, whether severe or mild, the condition of the animal when shipped and the history of the bulls after arrival in the south.

A study of the temperature records and notes shows that, as a rule, the inoculation fever begins about the 8th or 9th day after the inoculation, sometimes a little earlier and sometimes later; and that it usually continues from 7 to 8 days. In some cases it may not exceed 4 days, and in others it may be prolonged to 15 days. The daily average of the temperature during the primary fever period, counting all that reacted distinctly, was about 104.5 F.

A remarkable feature observed in this experiment was the occurrence in quite a number of animals of a distinct secondary

Fig. 7.

GRAPHIC RECORD OF USUAL COURSE OF FEVER Following INOCULATION WITH IMMUNE BLOOD.



fever period, beginning at about the 25th to 30th day after inoculation and continuing from 7 to 8 days (in a few cases 4 or 5 days and in a few from 12 to 16 days.) This secondary fever as a rule was not so severe as the primary. The graphic records, page 26, 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 "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 a 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 spring and 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 was possible 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. See graphic record, page 65.

CLINICAL NOTES ON THE TOD BULLS.

Group I. Inoculated Nov. 7, 1898; dose 2.5 cc. each. Shipped to Corpus Christi, Texas, Jan. 1, 1899. Arrived at destination Jan. 6, 1899.

Bull No. 1. Weight when received 272 lbs.; gained 60 days, 38 lbs. On eighth day had high fever which 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 33rd day began a secondary fever which continued four days. The temperature was about 104 during this period. Calf ate but little during acute stage of the primary fever, was very sick, urine highly colored from urates; found no haemoglobin in the urine. Fell off in flesh considerably, but ate well and improved in condition after acute stage of fever had

passed. In fair condition when shipped. Jan. 9th, 3rd day after arrival in Texas, temperature 103.2. Reported dead from snake bite May 28th; had carried ticks since February, without showing fever.

Bull No. 3. Weight when received 285 lbs; gained in 60 days 25 lbs. Had fever on 9th day; continued 4 days, temperature ranging from 104 to 106 F. Secondary fever period arose on 34th day, continued 4 days 104 to 105.9 F. Fell off some in flesh, but ate well and recovered condition. Shipped Jan. 1 in fair condition. Jan. 9th, temperature 102 F. June 24th, temperature 102 F. carrying ticks. Aug. 14th, has carried ticks through spring and summer, and has shown no serious illness, in good health Oct. 1st.

Bull No. 2. Weight 300 lbs. when received; lost during experiment 10 lbs. Primary fever began on eighth day, continued 11 days, 104 to 105.7 F. Was free from fever about 13 days. Secondary period began on 33rd 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 appears to be affected with "Hoose;" had husky cough when brought to Missouri Experiment Station. Jan. 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.*

Bull No. 13. Weight 382 lbs. when inoculated; gained 18 lbs. Fever appeared on 9th day and continued 10 days, 103.9 to 108.4 F. A slight secondary fever 33rd day, continued 4 days, 103 to 104 F. During height of fever was off feed and dull, head drooped. After fever had passed, ate well throughout the remainder of his stay. Was shipped in fair condition. Jan. 9th, third day after arrival in Texas, temperature 104. Jan. 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 22, doing well. Aug. 14th, doing well. Oct. 1st, in good health.

Bull No. 7. Weight when inoculated 390 lbs; no gain. Fever on 8th day; continued 4 days, 104 to 105.8 F.; an

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

occasional high temperature from 12th to 30th day. Secondary fever 29th to 35th 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; and 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. Aug. 15th; in good health; Oct. 1st; doing well.

Bull No. 14. Weight when inoculated 390 lbs.; gained 10 lbs. Fever on 10th day, continued 6 days, 103.8 to 104.4. Slight recurrence on 25th to 27th days. Animal ate well and showed outwardly but little signs of fever. Shipped in fair condition. Jan. 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 very ticky but showed no signs of illness. Temperature 102.4. In May and June was put for a while with heifers. Aug. 15, in good health; Oct. 1, doing well.

Bull No. 17. Weight 410 lbs. when inoculated; gain 75 lbs. Fever on 8th day, continued 8 days, 104 to 105.5 F. On the 40th to 42nd 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. Aug. 15th, in good health. Reported well Oct. 1st.

Bull No. 12. Weight 412 lbs. when received; gain 18 lbs. Had not recovered from shipping fever when inoculated, temperature 104. Had a well marked primary reaction, maximum temperature of 107.4 F. on the 10th day, and fever ten days longer, ranging from 103 to 105 F. Secondary rise, 103.2 to 105.6 34th to 38th 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. Aug. 15th, was in good health. Did some service in May and June. Was reported Oct. 1st as looking well.

Bull No. 19. Weight 428 lbs. when received; gain 49 lbs. Fever on the 4th day. Continued about two weeks, 103.4 to 106 F. Slight secondary fever on 29th and 30th days, lost some weight during fever period, but regained flesh. Ate well most of the time; made good recovery and was shipped south in fair condition. Temperature normal, 102 F., on arrival in Texas. Ticks were found on him Feb. 10th. April 24th, no fever to date. June 24th, temperature 103, very ticky. Did some service in May and June. Aug. 15th, reported in good health. Oct. 1st, looking well.

Bull No. 15. Weight 455 lbs. when received; gain 20 lbs. From 4th to 14th day, somewhat feverish (103.5 to 106.4 F. evening temperatures), but was not off feed. From 23rd to 27th day, calf appeared dumpish, lay down considerably, ate some, but appetite not good. Morning temperatures 104.7 to 106.2; one evening temperature 106.5 F., on a cold stormy day, Dec. 3rd. For twelve days succeeding this fever period, animal did well. A third period of fever began about the 39th day and continued eight days, 103.6 to 105 F. This calf had some fever when shipped. Jan. 9th, three days after arrival in Texas, temperature 102.6. Feb. 10th, had ticks. April 24th, no sickness to date. June 24th, temperature 103.7, very ticky. Aug. 15th, is in good health; was with cows and heifers in May and June. Oct. 1st, looking well.

Bull No. 26. Weight 480 lbs. when received; gain 20 lbs. Through the usual primary fever period the daily temperature was somewhat irregular, 103 to 104.5 F. Afternoon temperature on 10th day was 106.2. On the 19th day had a catarrhal discharge from nose. Was not off feed, and did not show outwardly any serious symptoms up to the 40th day, when he appeared dumpish. Had a regular fever period from 39th day to 43rd. Temperature 103.8 to 106.8 F., the latter on the 42nd 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 had yet appeared. June 24th, animal ticky, but appeared well. Aug. 15th; bull in good health, has done some service. Reported well Oct. 1st.

Bull No. 4. Weight 380 lbs. when inoculated; gain 45 lbs. Fever on 8th day continued 10 days, 103.4 to 105.8 F. Secondary fever began on 29th day and continued 8 days, 103.8 to 105.8 F. This bull ate well through the fever and except for some falling off in flesh following the fever period, no outward signs of the fever were noticeable. At time of 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, normal. Has carried ticks during the summer. Reported in good health Aug. 15th and Oct. 1st.

Bull No. 21. Weight 415 lbs. when inoculated; gain 30 lbs. Fever on 4th day, continued 10 days; ranging from 103.6 to 104.4. Ate well and showed no marked outward signs of illness. Secondary rise on 33rd day, and continued 5 days, 104 to 104.6 F. Shipped in good condition. This animal was reinoculated Dec. 8th with 2 cc. from a recovered native. Temperature on arrival in Texas 103.6, slight fever. Became infested with ticks in February. April 24th reported in good health. June 24th, temperature 102.5, and carrying ticks. Aug. 15th, bull is still in good health; has done some service. Oct. 1st, reported well.

Bull No. 18. Weight 445 lbs. when received; gain 85 lbs. No distinct fever period occurred at the usual time following inoculation, only a few isolated high temperatures. On the 31st 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 Dec. 8th at the beginning of this fever period, with 2.5 cc. from a recovered native. Was sent south in good condition. Had fever on arrival at Corpus Christi, Texas. Temperature Jan. 9th, 104.2. Was off a few days—probably a secondary reaction from the inoculation of Dec. 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. Was reported in good health Aug. 15th and Oct. 1st.

Tod's Bulls, Group II. Inoculated Nov. 15th, 1898, with 2.5 cc. defibrinated blood from Texan steer. They were shipped to Corpus Christi, Texas, Jan. 1, 1899, arrived at destination Jan. 6.

Bull No. 8. Weight 370 lbs. when received; gained 10 lbs. Had fever during the 60 days at the Station. From 25th to 34th 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, and Aug. 15th was in good health. Oct. 1st, reported well.

Bull No. 22. Weight 435 lbs. when received; gained 90 lbs. Had some fever when inoculated, probably from shipping. On 10th day was dull and off feed, afternoon temperature 106.3. From 30th to 33d days temperature 104 to 105 F., dumpish. The animal did well the greater part of the time, and was shipped in good condition. Jan. 9th, temperature, three days after arrival in Texas, 103 F. August 15th, in good health, has been well infested with ticks. Oct. 1st, looks well.

Bull No. 20. Weight when received 550 lbs; gained 60 lbs. Scarcely any elevation of temperature until the 29th day after inoculation. From 29th to 37th days, 103.8 to 104.6 F. Was a little off, but did not refuse food. Did well and was shipped in good condition. Jan. 9th; temperature 103. Reported well April 24th, June 24th, and July 22nd. Aug. 15th was still in good health. Has done service. Oct. 1st, reported in good health.

Bull No. 23. Weight 680 lbs; gained 30 lbs. Fever on the 11th day, continued 8 days. Temperature ranging from 104 to 107.6 F. Animal was off feed, dumpish, laid 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 Jan. 9th; 103.2. August 15th, has carried ticks since early in February, and has shown no serious illness; has done some service. Was reported well Oct. 1st.

Bull No. 24. Weight 365 lbs.; gained 50 lbs. Had no distinct reaction at the primary fever period, but a few isolated high temperatures—105.6 F. on the 10th day, 103.8 F. on the 12th day. On the 35th day and following, a more continuous fever occurred, the temperature ranging from 103.7 to 107.1 F. This bull was reinoculated with 2.5 cc. defibrinated blood from a recovered native on the 23rd day after the first inoculation. Twelve days after this the fever period began. He made a good recovery and was shipped in good condition. Jan. 9th, temper-

ature 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. Aug. 15th, and Oct. 1st, in good health.

Bull No. 16. Weight when inoculated 402 lbs.; gained 88 lbs. This bull was inoculated twice, but during the entire 60 days that he remained at the Station only a few high temperatures were observed—on the 8th day 103.8; 17th day 103.9; 21st afternoon, 106; 34th day, 103.9; 40th 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., Jan. 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. Aug. 15th, no illness. Was with cows and heifers a part of May and June. Oct. 1st, was in good health.

Bull No. 10. Weight 480 lbs.; gained 105 lbs. Showed but little rise of temperature from the first inoculation. Was reinoculated twenty-three days later (Dec. 8th) with 2 1-2 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 in time to the secondary reaction of the usual type, and it is possible that this may be a delayed response to the first inoculation. Jan. 9th, temperature 101.1; Feb. 10th, had ticks. April 24th, no illness to date. June 24th, July 22nd and Aug. 15th, in good health. Has done some service. Oct. 1st, was looking well.

Bull No. 28. Weight when received, 498 lbs.; gained 47 lbs. Had an occasional high temperature following the first inoculation, but no sustained fever period. A well marked fever period followed the second inoculation, averaging 104.2 for nine days. In good condition when shipped. Jan. 9th, temperature 102.6 F. Reported in good health Feb. 10th, though carrying ticks. Also reported in good health April 24th, June 24th, July 22nd and Aug. 15th, and Oct. 1st. Has borne ticks. Has done service with cows and heifers.

Bull No. 25. Weight 507 lbs. when received; gained 38 lbs. No fever period occurred at the usual time following the first inoculation, but 11 days after the second inoculation the

temperature rose to 105 and continued at about this point for 5 days. Jan. 9th, temperature 102 F. Aug. 15th, has carried ticks through the summer, and has shown no illness. Has done some service. Oct. 1st, was reported doing well.

Bull No. 5. Weight when received 600 lbs.; gained 80 lbs. Temperature normal for 27 days following first inoculation, except on 12th day, 104.8 F. Reinoculated on the 23rd day; five days latter 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. Jan. 9th, temperature 102.2. June 24th, 102.2. Aug. 15th, is in good health after carrying fever ticks through the summer. He has done some service. Reported in good health Oct. 1st.

Group III. Inoculated Nov. 29th, 1898, 1 cc.; and Dec. 8th, 1898, 2 cc. Shipped to Corpus Christi, Texas, Jan. 1, 1899. Arrived at destination Jan. 6.

Bull No. 58. Weight when received 505 lbs.; gained 135 lbs. Had shown scarcely any signs of reaction up to the time of shipment, only two high temperatures, 104 F. on the 11th day after the second inoculation, and 103.8 F. on the 17th day. This animal was never off feed. Jan. 9th, temperature 103.6 F., a slight elevation. A secondary reaction of mild type may have occurred at about this time. Jan. 20th, arrived at ranch 25 miles from railroad. Feb. 10th, bearing ticks. April 24th, no sickness observed to date. June 24th, animal well and bearing ticks. Aug. 15th, is now in good health; has done some service. Oct. 1st, looking well.

Bull No. 11. Weight when received 620 lbs.; gained 110 lbs. Fever arose on the 6th 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. Jan. 9th, temperature 103.1 F. Became infested with ticks in February. April 24th, no sickness to date. June 24th, is carrying ticks, appears well. Aug. 15th, in good health; has done service. Oct. 1st, reported well.

Bull No. 29. Weight 715 lbs. when inoculated; gained 30 lbs. No fever period had occurred up to the date of shipment, and only one high temperature, 104.1 F., on the 21st day after

the first inoculation. This animal had some fever after arrival in Texas, 104.6 on Jan. 9th. This fever occurred at about the time for a secondary reaction following the inoculation on Dec. 8th, but possibly may have been simply shipping fever; did not thrive well for some time. Arrived at ranch safely. Feb. 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 couple of weeks and was then turned out to service again, and has been well since. Reported well Aug. 15th and Oct. 1st.

Bull 9. Weight 795 lbs. when received; gained 95 lbs. Fever on 13th, 14th and 15th 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 Jan. 9th, 105.8. Jan. 11th, 105; which appears to be a secondary reaction from the inoculation. Feb. 25th, had ticks; shows no sickness. April 24th, no sickness to date. Aug. 15th, has carried ticks through the summer and has done considerable service. Is now in good health. Reported well Oct. 1st.

Bull No. 30. Weight 815 lbs.; gained 135 lbs. Inoculated Nov. 29th with 1 cc. blood from an immune Texan steer, and reinoculated Dec. 8th with 2 cc. from a recovered native. No rise of temperature up to time of shipment. Jan. 9th, three days after reaching Corpus Christi, had temperature of 103.4. Appeared sick on Jan. 11th, temperature 104. This may be a delayed reaction from the inoculation, brought out by shipping, or simply shipping fever. Jan. 20th, arrived at Laureles ranch, driven out 25 miles from Corpus Christi. Feb. 10th, found ticks. Feb. 15th, appears sick. Feb. 25th, carrying ticks and 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 lbs.; gained 117 lbs. before shipping. Had a slight reaction on 7th to 10th days following second inoculation; had chill at beginning of attack, was off feed and dumpish. Recovered appetite in a few days, was shipped in good condition. This animal had fever on

arrival in Corpus Christi; Jan. 9th, temperature 104.6, either from shipping fever or a secondary reaction from inoculation. Jan. 20th, arrived at ranch 25 miles from Corpus Christi. Feb. 10th, found ticks. Feb. 15th, this bull was sick. Feb. 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 4. Died from an acute attack of Texas fever.

A discussion of these relapses appears in the concluding section.



Fig. 8.—Group of inoculated Hereford bulls, six months after exposure to infection at the Laureles Ranch, Corpus Christi, Texas.

TOD BULLS: TABLE SHOWING GAIN OR LOSS IN LIVE WEIGHT, AND DAILY TEMPERATURE RECORDS.

The greater number of the temperatures recorded in the following tables were taken between 10 and 11 o'clock a. m., and are therefore somewhat higher than early morning temperatures. The normal in these records may be taken to range from 101 to 103° F. In the discussion of this experiment, 103.8° F. is about the lowest temperature included in a "fever period."

Group I.			Bull.													
			1	3	2	13	7	14	17	12	19	15	26	4	21	18
Wt. when recd., lbs...			272	285	300	382	390	390	410	412	428	455	480	380	415	445
Wt. when shipped, lbs.			310	310	290	400	390	400	485	430	475	775	500	425	445	530
Gain or loss			+38	+25	-10	+18	0	+10	+75	+18	+49	+20	+20	+45	+30	+85

		Days After Inoculation.														
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

TOD BULLS: TABLE SHOWING GAIN OR LOSS IN LIVE WEIGHT, AND DAILY TEMPERATURE RECORDS—Continued.

Group I.			Bull.														
			1	3	2	13	7	14	17	12	19	15	26	4	21	18	
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	
	5	28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	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	
	8	31	104.
	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	102.6	102.4	104.	

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Tod Bulls.		Bull.									
Group II.		8	22	20	23	24	16	10	28	25	5
Wt. when recd., lbs...		370	435	550	680	365	402	480	498	507	600
Wt. when shipped, lbs.		380	525	610	710	415	490	585	545	545	680
Gain or loss		+10	+90	+60	+30	+50	+88	+105	+47	+38	+80
	Days After Inoculation.										
Nov.	11	.....	106.	103.4	.....	.....	102.2	.....	.....	103.4	103.3
	15	103.	104.	103.6	102.	104.6	103.2	104.	104.	104.	104.
	17	103.8	103.2	102.	.....	103.5	102.	.....	103.8	103.3	.....
	18	104.	103.	102.7	102.	102.8	101.1	102.	103.4	103.	103.
	20	103.5	102.6	102.3	100.9	103.4	102.4	101.9	101.8	102.8	101.9
	21	104.4	104.7	102.8	.....	102.3	103.4	103.8	104.3	101.1	.....
	23	103.	102.8	103.	101.	103.5	103.8	102.8	105.	101.8	102.3
	25	103.1	106.3	103.4	104.7	105.6	102.6	103.	103.	102.2	102.5
	26	104.	103.5	101.7	104.	102.4	102.2	104.	102.5	102.3	102.4
	27	103.8	104.	102.4	105.	103.8	101.2	103.	104.2	101.8	104.8
	30	103.4	103.5	102.8	105.4	103.6	103.5	102.	103.	101.8	102.6
Dec.	2	104.4	103.6	104.2	104.6	103.5	103.9	103.2	104.5	102.9	103.
	4	104.8	104.2	101.6	106.8	102.	102.8	101.4	101.4	101.6	102.1
	6	103.3	103.4	102.8	107.2	102.3	106.	101.6	102.8	102.1	102.5
	7	103.1	102.2	102.8	101.8	103.	103.6	101.8	102.8	100.6	102.8
	9	103.	103.	103.	101.5	102.5	102.2	100.2	100.9	101.4	102.4
	10	105.6	103.	103.	102.	102.8	102.6	103.2	104.	100.	103.
	11	104.	103.	102.4	103.1	104.3	103.2	102.1	101.	101.5	102.
	12	104.8	102.4	103.	102.8	103.	103.2	103.7	103.	102.	103.4
	14	104.6	103.4	104.	100.	103.	103.	105.8	105.	103.6	104.
	15	104.	104.9	104.6	101.8	104.4	101.9	106.	103.9	104.4	106.5
	16	103.6	104.	103.8	101.	103.	102.	105.8	103.	103.	105.8
	17	104.	105.	104.6	102.6	104.6	103.3	.....	105.1	102.6	104.2
	18	.....	.....	.....	.....	.....	.....	105.	.....	.....	104.2
	19	104.	103.5	104.4	102.4	103.2	103.9	103.2	104.	105.	103.
	20	103.2	103.	104.2	103.8	104.2	101.6	104.6	104.4	104.8	103.8
	21	101.8	102.6	104.	102.8	103.9	102.2	103.7	104.	105.8	102.2
	22	104.	104.2	104.	103.4	107.1	101.8	104.	105.	105.	104.3
	25	102.8	102.2	103.	103.8	103.7	103.6	103.3	103.6	104.9	102.8
	26	103.5	.....	103.3	103.	104.2	.....	.....	103.8	103.2	103.5

Tod Bulls. Group III.		Bull. 58	Bull. 11	Bull. 29	Bull. 9	Bull. 30	Bull. 6
Wt. when recd., lbs...		505	620	715	795	815	823
Wt. when shipped.....		640	730	730	890	950	940
Gain or loss.....		+135	+100	+15	+95	+135	+117
	Days After Inoculation						
Nov.	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
	Dec.	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	102.	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	102.2	

1cc. Texas Steer Blood.

2cc. "Recovered" Native
"Spot .

WASKOM.—2 LARGE AND 1 SMALL HEREFORD BULLS.

This experiment is of interest on account of the age of two of the individuals. This lot consisted of three pure bred Hereford bulls, raised in Missouri. Two of these, No. 534 and No. 540, were about 2 years old and weighed respectively 1252 lbs. and 1100 lbs. No. 3 weighed 550 lbs. They arrived at the Missouri Experiment Station Dec. 3, 1898, and were held until the effects of the inoculation had passed off, before sending them south.

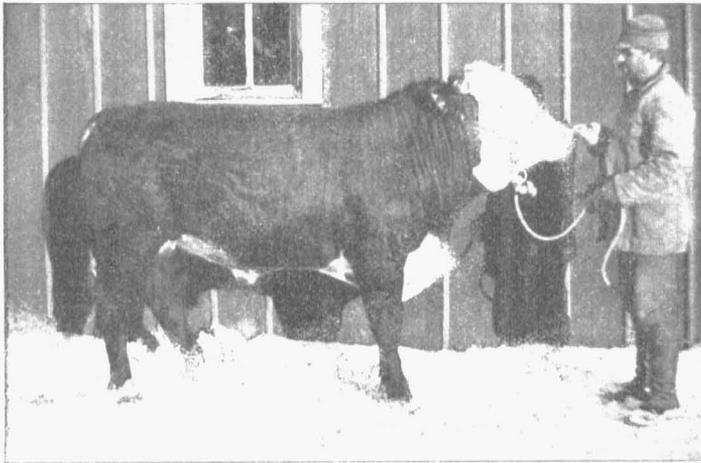


Fig. 9.—A two-year-old bull, weight 1250 lbs., inoculated during the winter of 1898, at Missouri Experiment Station.

The first inoculation was made Dec. 8th. Each bull received 2 1-2 cc. of blood from a northern steer that had been rendered immune to Texas fever by artificial tick infestations.

Bull 534, took sick on the 12th day following. On the 13th day the fever was 105.2. The fever continued, though not so high, until the 18th day, after which it fell to the normal. During the fever the bull was off feed, gaunt and laid down much of the time.

Bull 540. Fever appeared on the 13th day, with a maximum of 104.8. It was of short duration, he continued eating, and did not appear to be seriously sick.

Bull No. 3. Fever appeared on the 6th day, temperature 104.3 F. Had fever and did not eat well for six days. After this the temperature fell and the bull's appetite returned.

The second inoculation was made Jan. 2nd, 1899. Each bull received 2 1-2 c.c. of blood from an immune Texan steer.

Bull 534, showed only a mild reaction from this inoculation. This possibly was a secondary reaction from the first inoculation.

Bull 540, showed fever on the fourth day. Jan. 6th, fever 105.4; bull lies down much of the time. Jan. 7th, 106; bull off feed. Jan. 8th, 103.7; refuses food. Jan. 9th, 101.5, eats hay only. 12th, temperature 100 F., eats quite well. From this time the bull remained in good health.

Bull No. 3. Fever followed second inoculation. Jan 12th, fever 103.8. Jan. 13th, fever 105.6; bull off feed and has diarrhoea. Jan. 14th, fever 104.6 F.; Jan. 15th, fever 104.5 F., urine clear. Jan. 16th, fever 105.8 F. Jan. 17th, 104.5 at 3 p. m. Jan. 18th, fever 104.6, bull eating. Jan. 19th, 104.8. Jan. 21, 103.5, fever falling. From this time on this bull appeared quite well. During his stay at the Station he gained 65 lbs. in weight.

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

Clinical notes after shipment March 28th. The bulls are in fine condition. Found one tick on Nos. 534 and 540. None on No. 3. They are fed on bran and oats twice a day, and allowed to run on a good pasture.

April 3rd. The bulls run daily with the 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 were infested with ticks. No. 534 has fever, temperature 104.5 F.; gave salts. No. 540 has fever, temperature 106.5 F.; 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 shown no signs of fever.

June 19th, bulls appear well. July, no report.

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

OVERALL.—84 HEAD OF REGISTERED HEREFORD BULLS.

This lot consisted of 84 head of Hereford bulls, all bred in Missouri. Their ages ranged from 7 to 12 months. They were shipped in very rough weather, and on arrival 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 22nd, 1898, they were inoculated with defibrinated blood from a two-year-old immune steer, bred on the ranch. Sixty-four were given 1 cc. each of the blood and the remaining twenty were given 2 cc. each. These calves became sick at the usual time after inoculation (about 10 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 some ticks on them. By April 24th, six had died, and the entire lot showed sickness. About June 1st they were turned into a large pasture of thirty thousand acres, among the range cattle, and have remained there the whole summer. The owner says they are doing very nicely (Aug. 15th, 1899), and up to this time seven had 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.

BURGESS.—68 HEAD OF REGISTERED SHORTHORNS.

This lot consisted of 68 head pure bred Shorthorns, whose ages ranged from 8 to 12 months. They were raised in Kentucky, and arrived at the Blue Mound Ranch in Wise county,

Texas, Nov. 24th, 1898. On January 4th, 1899, each one received subcutaneously 1 cc. of defibrinated blood from a two-year-old steer that had been raised on the ranch. The owner of these cattle reports under date of March 4th, 1899, that four of the calves have died and that the remainder have been 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 had died in all.

“COLLEGE STATION.”—6 HEAD SPECIAL EXPERIMENT CATTLE.

This lot consisted of one pure bred Shorthorn bull and five high grade Shorthorn heifers. They were about ten months of age, and were raised in Cooper and Boone counties, Missouri. They arrived at the Texas Experiment Station in good condition January 1st, 1899.

On Jan. 7th each received subcutaneously 1 c.c. of defibrinated immune blood, from 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. 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 at the north 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. Daily temperature records were made from Jan. 7th, until August 31st, these appear on page 50. The changes in the blood were determined by the “haematokrit” see table page 49. The blood was examined twice a week. A gap occurs in the record, from March 22 to April 17th, on account of an accident to the apparatus. All of the samples of blood for examination were taken from the ears, and at once 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 Jan. 14th, eight days after inoculation, when the haematokrit 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. On the 8th day of the experiment it had fallen to an average of 31.3 per cent. The rise in temperature in the several animals was very abrupt, rapid and almost simultaneous. It appeared on the 9th and 10th days after inoculation. We call this the primary fever period. The morning temperatures ranged from 103.6 the lowest to 105.6 the highest. This continued from 7 to 9 days and then returned to normal. The destruction of the blood corpuscles continued until on the 13th day of the experiment the average was 27.3 per cent; on the 15th day it was 23.3 per cent. By the 19th day (Jan. 25th) the fever had ceased, and the blood gained a little, reading an average of 24.5 per cent. See graphic record Fig. 12.

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 crowd the sick aside. If the sick ones were fed separately, they consumed a reasonable amount. We noticed among some calves bloating, and a disposition to eat quantities of dirt. In some cases there was diarrhoea, and discharging of mucous from the nostrils, muscular weakness, trembling, and a desire to lie down for considerable periods. In no case was bloody or red urine noticed. By the 18th day, the fever of the primary reaction had entirely ceased. The lowest average per cent of blood corpuscles resulting from the primary reaction was 23.1 per cent, which occurred on the 15th day. From the 18th to the 29th day the calves appeared normal. Their appetite improved, and their blood corpuscles increased in numbers. By the 25th day the average per cent had risen to 31.

The secondary fever period began on the 28th or 29th 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 28th and 29th day, while in others it appeared on the 34th or 35th day. The haematokrit readings also show a second fall in the blood corpuscles. This reached its lowest average (21 per cent) on the 39th day. The lowest individual 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 90th day, but none were found. Moreover in the case of the Tod bulls inoculated the previous fall at the Missouri Station there was no possibility of the *secondary reaction* being due to a secondary invasion of the microparasites from tick-infestation, as these bulls were in noninfected territory. 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 47th day, and No. 1 with 103.5 on the 54th day, and No. 4 with 103.8 on the 59th day. The calves gained in weight and growth, and their blood showed some improvement, which was slow but steady.

Second inoculation. 2 cc. of defibrinated immune blood was given on the 77th day (March 23rd) subcutaneously to all except No. 4. A mild reaction followed in about eleven days; the highest morning temperature found 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 94th day, which was at the same time the other calves were reacting from the second inoculation. No record of blood changes was possible because the haematokrit 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 per cent was 33.5. The lowest average reading found since that time was 30.5 per cent, which occurred on the 113th and 120th days.

Third inoculation. On May 18, the 132nd day, a third inoculation was made. 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 23rd, 103.3; No. 3, May 25th, 103.4; No. 4, May 25th, 105.2; No. 5, May 28th, 103.

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 haematokrit 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

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 fever ticks. It was not until August that any considerable numbers 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 haematokrit examinations of the blood. The experiment closed August 31st, 1899. There was no fever among the cattle, nor had there been any. The average per cent of red blood corpuscles was 33.4 at that time.



Fig. 10.—Grade Heifers from Boone County, Missouri, used in inoculation experiments at the Texas Experiment Station.

TABLE SHOWING PERCENTAGE OF RED BLOOD CORPUSCLES AS SHOWN BY
HAEMATOKRIT READINGS.

Date.	Day of Ex.	Calf.	Calf.	Calf.	Calf.	Calf.	Calf.	Average.	Remarks.	
		No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.			
Jan...	7	1								
"	10	4	40	40	35	40	35	38.3	1cc blood. 1st Inoculation.	
"	14	8	33	33	30	29	33	31.3	.....
"	19	13	31	27	33	25	28	27.3	.....
"	21	15	27	27	19	28	20	18	23.1	Primary fall.
"	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	31.0	.....
Feb..	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	21.0	*Secondary fall.
"	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								2cc blood. 2nd Inoculation.
April.	22	106	32	33	35	33	35	†	33.5	†No. 6 died April 10 of
"	29	113	32	30	31	29	31	.....	30.5	blackleg.
May..	6	120	35	29	34	25	29	.....	30.5	.....
"	13	127	37	27	36	27	32	.....	31.8	.....
"	18	132								2cc blood. 3d Inoculation.
"	20	134	36	30	43	26	30	.....	33.0	.....
"	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	.....	33.0	.....
"	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	.....	33.0	.....
"	29	204	39	32	38	28	30	.....	33.2	.....
Aug..	5	212	38	32	34	30	31	.....	33.0	.....
"	12	218	37	37	38	27	36	.....	35.0	.....
"	19	225	36	33	39	26	34	.....	33.5	.....
"	26	232	30	34	36	32	33	.....	33.0	.....
"	31	237	35	32	37	30	33	.....	33.4	Experiment closed.

TABLE SHOWING DAILY TEMPERATURE RECORDS.

Jan. 1899	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6.	
	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
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.	101.2	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.	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	103.2	103.4
17	104.1	105.7	103.2	104.2	101.6	103.3	101.5	104.	103.5	104.2	102.6	105.
18	103.8	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

TABLE SHOWING DAILY TEMPERATURE RECORDS.

Feb. 1899	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6.	
	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
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
May.												
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	103.3	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
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
Aprl												
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	103.2	102.8	103.6	104.1	104.2	104.7	106.4	101.5	103.4	101.5	*
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	.....	.....

Calf No. 6 died of Blackleg on April 10th.

TABLE SHOWING DAILY TEMPERATURE RECORDS.

Apl. 1899	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6.	
	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
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	.....	.....
y												
1	101.8	102.5	102.5	102.7	102.3	102.8	102.4	103.2	102.8	102.4	.....	.....
2	102.0	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	103.3	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	103.8	102.	104.8	101.6	103.9	.....	.....
25	101.6	102.8	102.8	103.3	103.4	103.	105.†	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	.....	.....
31	101.8	102.4	102.6	103.1	102.4	102.6	103.	103.2	102.	102.5	.....	.....

* Third Inoculation. †Bad Thermometer.

TABLE SHOWING DAILY TEMPERATURE RECORDS.

June 1899	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6.	
	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
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	103.3	.....	.....
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	.....	.....

TABLE SHOWING DAILY TEMPERATURE RECORDS.

July 1899	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.			
	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
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	.....	.....
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	.....	.....

KRUGER.—6 HEAD OF REGISTERED HEREFORDS.

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

On December 17th, 1898, each received 1 cc. of defibrinated blood from the jugular vein of a three-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 were evidently in the secondary fever period. The temperatures were: Bull No. 1, 106 degrees; Bull No. 2, 105 degrees; Heifer No. 366, 105.8 degrees; Heifer No. 51, 107 degrees; Heifer No. 525, 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. Heifer 366 is evidently pregnant. The cattle appear in good condition.

September 15th. 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.

NUTT.—9 HEAD REGISTERED HEREFORDS.

This lot consisted of nine thoroughbred Herefords, raised in Hartley county, Texas, one bull and eight heifers. They arrived by rail at the Nutt ranch in Bee county, Texas, on January 17th, 1899.

On January 23rd, 1899, each received 1 cc. of defibrinated blood from the jugular vein of a two-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 a considerable number of ticks on them and appear in good flesh. No deaths.

COOK.—55 HEAD OF HEREFORD BULLS AND HEIFERS.

This lot consisted of fifty-five pure bred Herefords, forty-one heifers and fourteen bulls. Their ages ranged from one month to twenty-two 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 2nd, 1899. On February 14th, each received 1 cc. of defibrinated blood from a two year old heifer. These inoculations were made by Dr. Stephens. This lot has done very well. One death occurred from inoculation and one from black-leg. June 27th, 1899, saw these cattle. All have a considerable number of ticks on them, yet they are all in good condition.

RHEA.—15 HEAD REGISTERED SHORTHORN BULLS AND HEIFERS.

This lot consisted of 13 pure bred Shorthorn heifers, 8 to 15 months old, and two bulls 10 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 six 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.

TABULATED SUMMARY OF INOCULATION EXPERIMENTS.

Expt. No.	Owner.	No. Cattle.	Breed.	Sex.		Age and Weight.	Native State.	Arrival in Infected Territory.	County in Texas.	Date of First Inoculation	Quantity Blood Used.
				Bulls.	Heifers.						
1.	Bullock	10	Angus..	10	0	8 to 12 mos ..	Kan.	Dec. 24,'97.	Brazoria.	Nov. 19,'97.	8 c.c.
2. I.	Rhea. .	4	Shorthorn.	2	2	8 to 12 mos ..	Kan.	Feb.—,'98.	Collin....	Feb.—,'98.	8 c.c.hf's 4 c.c.b'ls
II.	Rhea. .	6	Shorthorn.	1	5	7 to 12 mos ..	Mo.	Apr. 21,'98.	Collin....	Apr. 20,'98.	4 c.c.
3. I.	Green .	93	Shorthorn.	....	....	6 to 14 mos ..	Ill., Ohio, N. Y., Ind..	Dec. 24,'98.	Dimmit..	Oct. 15,'98.	2.5 c.c.
II.	Green .	43	Shorthorn.	....	....	6 to 14 mos ..	Iowa.	Dec. 24,'98.	Dimmit..	Nov. 9,'98..	2.5 c.c.
4. I.	Tod... .	11	Hereford..	11	0	272 to 480 lbs	Mo., Ill.	Jan. 5,'99..	Neuces. .	Nov. 7,'98..	2.5 c.c.
II.	Tod... .	3	Hereford..	3	0	330 to 445 lbs	Mo., Ill.	Jan. 5,'99..	Neuces. .	Nov. 7,'98..	2.5 c.c.
III.	Tod... .	4	Hereford..	4	0	370 to 550 lbs	Mo., Ill.	Jan. 5,'99..	Neuces. .	Nov. 15,'98.	2.5 c.c.
IV.	Tod... .	6	Hereford..	6	0	365 to 600 lbs	Mo., Ill.	Jan. 5,'99..	Neuces. .	Nov. 15,'98.	2.5 c.c.
V.	Tod... .	6	Hereford..	6	0	505 to 823 lbs	Mo., Ill.	Jan. 5,'99..	Neuces. .	Nov. 29,'98.	1 c.c.
5.	Waskom	3	Hereford..	3	0	550 to 1250 lbs	Mo....	Feb. 25,'99.	Harrison.	Dec. 8,'98..	2.5 c.c.
6.	Overall	84	Hereford..	84	0	6 to 10 mos..	Mo....	Dec. 20,'98.	Coleman .	Dec. 23,'98.	64-1 c.c. 20-2 c.c.
7.	Burgess	68	Shorthorn.	....	....	8 to 14 mos ..	Ky.	Nov. 24,'98.	Wise ...	Jan. 4,'99..	1 c.c.
8.	Suber .	6	Shorthorn.	1	5	10 to 12 mos .	Mo.	Jan. 1,'99..	Brazos ...	Jan. 7,'99.	1 c.c.
9.	Kruger	6	Hereford..	2	4	8 to 14 mos ..	Kan.	Dec. 7,'98..	Bee. ...	Dec. 17,'98.	1 c.c.
10.	Nutt... .	9	Hereford..	1	8	10 to 16 mos .	†.	Jan. 17,'99.	Bee....	Jan. 23,'99.	1 c.c.
11.	Cook .	55	Hereford..	14	41	4 to 22 mos ..	*.	Feb. 2,'99..	Bee....	Feb. 14,'99.	1 c.c.
12.	Rhea... .	15	Shorthorn.	2	13	8 to 18 mos ..	Mo.....	Apr. 9,'99..	Collin....	Apr. 15,'99.	1 c.c.

†Hartley County, Texas, above Quarantine line.

*8 Illinois and 47 Hartley County, Texas.

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TABULATED SUMMARY OF INOCULATION EXPERIMENTS.—CONTINUED.

Expt. No.	Owner.	No. Cattle.	Breed.	Date of Second Inoculation.	Quantity Blood Used.	Date of Third Inoculation.	Quantity Blood Used.	Deaths.			
								Fever...	Blackleg	Other Causes...	
1.	Bullock	10	Angus....	.....	.....	.....	.....	0	0	1	1 death Jan. 14, 1898.
2. I.	Rhea..	4	Shorthorn.	20 das. later	8 c.c. hf's 4 c.c. b'ls	Apr. 25,'98.	8 c.c.	0	0	0	
II.	Rhea..	6	Shorthorn.	May 25....	4 c.c. ....	.....	.....	0	0	1	Death Sept. 10, 1898,
3. I.	Green..	93	Shorthorn.	9 head Nov. 9.....	2.5 c.c. ....	.....	.....	12	...	...	} 2 died from inoculation; 10 died in July, 1899; 10 others sick but recovered.
II.	Green..	43	Shorthorn.	.....	.....	.....	.....	0	.....	.....
4. I.	Tod....	11	Hereford..	.....	.....	.....	.....	0	.....	.....
II.	Tod....	3	Hereford..	Dec. 8,'98..	2 c.c. ....	.....	.....	0	.....	.....
III.	Tod....	4	Hereford..	.....	.....	.....	.....	0	.....	.....
IV.	Tod....	6	Hereford..	Dec. 8,'98..	2.5 c.c. ....	.....	.....	0	.....	.....
V.	Tod....	6	Hereford..	Dec. 8,'98..	2 c.c. ....	.....	.....	2	.....	.....	2 died in April, 1899.
5.	Waskom	3	Hereford..	Jan. 2,'99..	3 c.c.	Feb. 21,'99.	3 c.c.	0	0	0	
6.	Overall	84	Hereford..	.....	.....	.....	.....	7	6	1	} Deaths due to too early exposure to ticks. Died in June, 1899.
7.	Burgess	68	Shorthorn.	.....	.....	.....	.....	12	.....	.....
8.	Suber..	6	Shorthorn.	Mar. 24....	2 c.c.	May 18....	2 c.c.	0	1	0	} 1 died of blackleg April 10, 1899.
9.	Kruger	6	Hereford..	.....	.....	.....	.....	0	0	0	
10.	Nutt ..	9	Hereford..	.....	.....	.....	.....	0	0	0	
11.	Cook ..	55	Hereford..	.....	.....	.....	.....	1	1	0	
12.	Rhea..	15	Shorthorn.	June 24....	1.25 c.c. ....	.....	.....	0	0	0	

SUMMARY AND CONCLUSIONS.

THE INOCULATION FEVER AND IMMUNITY—The reports on the Tod cattle, page 24, and the "College Station" lot, page 43, present the important features of the inoculation fever, such as incubation period, duration and severity of the primary and secondary fevers. Attention is called in the graphic record to the sudden fall of the primary fever; this occurs in many cases, and appears to be the critical period. At this time collapse and death may occur in severe cases.

The variation in the percentage of corpuscles during the fever, in comparison with the variation of temperature, is shown in College Station experiment, see chart, page 65. It will be noted that the diminution in corpuscles corresponds closely to the rise of temperature, but continues for a time after the temperature has fallen; and that during the interval between the primary and secondary fever periods, the percentage rises, but falls again on the occurrence of the secondary fever. The table, page 47, gives the haematokrit readings for each animal, and the average for the group.

It must always be kept in mind that the inoculation fever is genuine Texas fever, and that in some cases it will take an acute course and cause death in the inoculated animal. A few words in regard to the pathology of Texas fever and how immunity against it is acquired and maintained, will aid in the more intelligent handling of inoculated cattle, both during the course of the inoculation fever and during exposure to the infection at the South.

When a susceptible animal is infested with ticks or is inoculated with infected blood, the micro-parasites thus introduced attack the blood-corpuscles and destroy them in large numbers. This is the essential pathological change in this disease. As a result, the oxygen-carrying function of the blood is greatly impaired, and a large amount of debris that requires to be eliminated is added to the blood stream.

The recovery from the fever and the maintenance of an immune condition depends upon the ability of the animal, *1st to keep in check the growth of the micro-parasites; 2nd, to supply new corpuscles as rapidly as they are destroyed; and 3rd, to remove the waste products promptly.*

In regard to the micro-parasites, it is found that in this disease, unlike most others, they probably never entirely disappear from the blood of an animal that has once been well infected. In animals, however, that gain a high degree of immunity, the blood contains comparatively few of the micro-parasites. This indicates that by some means their multiplication is inhibited. It is probable that the constant presence of the micro-organisms in the blood has stimulated an increased production of white corpuscles ("phagocytes"), and that by these "soldiers and scavengers" of the blood many of the micro-parasites are destroyed.

As to the regeneration of the red blood corpuscles, this is a function that is carried on normally; for in perfect health the corpuscles are constantly wearing out and must be replaced by new ones. The increased destruction of corpuscles due to the micro-organisms of Texas fever simply stimulates those tissues normally concerned in the production of red corpuscles to greater activity. And it is probable that in all immune Southern cattle and in Northern cattle that become immune, a greater activity of these tissues is maintained throughout life.

In regard to the elaboration and removal of the waste products, resulting from the destruction of the corpuscles — the organs mainly concerned are the spleen, liver, kidneys and bowels. The importance of these organs in removing waste products is readily understood by any one who has seen at the post-mortem of an animal that has succumbed to an acute case of the fever, the enlarged and softened spleen, the intensely yellow liver clogged with bile, and the claret colored urine. In immune Southern cattle the spleen is somewhat larger than in Northern cattle, which indicates that a more active condition of this organ and probably of the other organs mentioned is maintained throughout life.

The above facts in regard to the pathology of the disease and the way in which immunity is maintained, shows the importance of keeping an animal well nourished and seeing that the eliminative organs are active.

AGE OF ANIMAL —The most suitable subjects for inoculation are young cattle from 8 to 12 months old, weighing from 500 lbs. to 800 lbs. They are more easily cared for than younger or older cattle. Calves recently taken from the cow and not well accustomed to a grain and hay diet do not do well; they fall off in flesh and do not regain condition as rapidly as older, well-weaned calves. These younger calves may, however, be safely inoculated if kept with the cow. In August of the present year (1899), thirteen sucking calves, from three to seven months old, were inoculated on a farm near the Missouri Station, and all except one of the smallest calves did well through the inoculation fever. This lot has not yet been exposed to tick infestation. Our experience with animals above 12 months of age is limited. But the fact that in the natural disease older animals are more liable to die, leads to the conclusion that aged bulls and cows can not be immunized as successfully as those of the ages mentioned. The two year old Waskom bulls gave good reaction from inoculation, and were sent south in excellent condition. Both, however, had a relapse in the South, and were very sick for a few days, but recovered and have done good service.

SOURCE OF BLOOD FOR INOCULATION —Blood from two sources has been used; namely, from naturally immune southern cattle, and from northern cattle made immune by artificial tick infestation, and blood inoculation. It is probable that the method by which an animal has been made immune can make no difference in the quality of the blood, since the same end is attained—a permanent infection. Recent observations, however, have shown that the blood of different supply animals may differ in virulence; and that it may vary in the same animal from time to time. In work now in progress on cattle that have not yet been sent south, two supply animals have been used, one a Texan cow that has been north since the summer of 1896, but has been kept on infected grounds the past two summers; the other a northern cow that was inoculated during the past winter and suffered from an acute attack of the fever, but recovered and has carried ticks during the summer and fall without apparent illness. An equal number of cattle have been inoculated from these two supply animals. More severe

symptoms have been caused by the blood of the recovered native. This was probably due to the fact that this animal was more grossly infested with ticks during the latter part of the summer and fall than the Texan, and was well infested at the time the blood was used. Blood from the same supply animal was used in midsummer, in doses of 2 to 6 cc. on a few cheap experiment animals without showing as severe symptoms as appeared in others inoculated in the fall with doses of 1 to 3 cc., after the supply animal had become grossly infested with ticks. It is probable that the safest supply animal is one that is thoroughly immune, and in which great variations in virulence of the blood is avoided by keeping free from ticks. The supply animal should be at the place where the inoculations are made and the blood should be used when perfectly fresh.

SIZE OF DOSE.—The size of the dose will depend largely upon the degree of virulence of the blood used. If the blood of a tick-infested animal is used, doses of from 1 to 2.5 cc. appear to be sufficiently large. Severe attacks of fever have been produced by the use of 1 cc. of blood from an animal grossly infested with ticks. As the susceptibility of animals varies greatly, it is prudent to give a small initial dose and repeat if necessary. In the Bullock and Rhea inoculations, pages 19, 21, large quantities were given, because the blood could not be used for a day or so after being drawn; and in these cases an antiseptic was added to prevent decomposition; and no doubt many of the Texas fever germs were destroyed.

DIET—It is important that the inoculated animal should be well nourished, during the inoculation fever and subsequently, since there is a great lowering of the vitality of the animal, due to destruction of the red blood corpuscles. In the experiments at the North, the food has consisted of oats, bran, crushed corn, linseed meal, timothy and clover hay; corn being withheld during the acute stage of the fever. The effort is made to feed in a manner that will maintain a lax condition of the bowels, since the elimination of waste products from the liver is mainly through the bowels. Under the heading of "Inoculation in the South" is given suggestions as to appropriate feeding in that section.

SEASON OF THE YEAR.—Inoculations have been made successfully at all seasons of the year. In the north in midsummer,

fall and winter. In the south, in winter and early spring. The most suitable time is at seasons when the animal does not suffer either from extreme heat or cold. If inoculated in the winter the cattle must be well sheltered, as the thinning of the blood resulting from the inoculation fever makes them less resistant to cold. Cattle inoculated in the north should be sent south in December or January, to prevent sudden gross infestation with ticks, as this may bring on a relapse.

INOCULATION IN THE SOUTH.—Cattle may be safely inoculated in the south, if they are kept free from the fever ticks until well recovered from the inoculation fever, say about 60 days. This is best done in the winter after 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 such cattle. To do this, the best plan seems to be to enclose a small pasture the previous June or July and allow no Texas cattle on it after that time. About December 1st, burn off the grass. Very few ticks will survive such measures. Suitable sheds for shelter against storms should be provided. 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 or fifteen days, before being inoculated. They will require some time to adjust themselves to a new diet. It will be seen from the "College Station" experiment, page 44, that this may be done gradually without any marked digestive disturbance. With proper care they become accustomed in a few weeks to eating cotton seed hulls and a mixture of bran, oats and cotton seed meal. They should not have free access to cotton seed in large quantities, as this causes a very troublesome diarrhoea in some calves. 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.

RELAPSES.—A few deaths occurred four or five months after the cattle were exposed to infected grounds. In the Green herd ten head died. Among the Tod bulls, two of the oldest animals died, and another of the large ones was sick. A few

of the smaller ones were a little off. Both of the Waskom two-year-old bulls were sick, but recovered.

All of the bulls had ripened a few ticks without showing any fever. The Tod bulls had been well infested, but at the time of death were carrying only a few ticks. It appears that in the Green herd a number of the calves did not pick up many ticks until well along in the summer, when they became grossly infested. In this case, the long interval between inoculation and gross infestation may account for the result. An additional inoculation or several mild tick infestations earlier in the season might have given the necessary stimulation to effect immunity. In this case it is not known whether the bulls that died had reacted well from the inoculation as individual records of this lot were not made.

In the case of the Tod and Waskom bulls, the owners think that the relapses were preventable. Capt. Tod says: "I have now no doubt but over excitement, over service, and over heating aggravated by fighting a good deal, was the cause of their succumbing," and that this result could have been avoided by putting these bulls with a restricted number of cows, each in a small pasture where they would not have had the trying conditions of worrying with other bulls. "Three others that showed signs of relapse were taken away from the cows for ten days or more and nursed up, then turned back to service. They have been well ever since." These relapses show that it probably requires a full season at the south before northern bulls acquire that degree of immunity possessed by southern raised animals. Care should therefore be taken during the first season to avoid all conditions that tend to lessen the vitality of the animal. With proper care but few bulls that have reacted from the inoculation will die, and they will usually give good service.

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

Bullock.—"The bulls have done good service."

Rhea.—"All the heifers," first inoculated, "produced good healthy calves the following spring and another lot appear to be pregnant five months after inoculation."

Tod.—"The bulls have done good service, I estimate that they have sired 200 calves."

Waskom.—The bulls run daily with the cows and are doing service.

College Station.—All the heifers appear to be pregnant.

Kruger.—The oldest heifer produced a good calf 9 months after inoculation.

We have but little data as to the dangers of abortion following inoculation. Only one case has occurred in our experiments. This one in a Hereford heifer recently inoculated at the Missouri Experiment Station. On this point Dr. J. S. Hunt (Pathologist to the Department of Agriculture, Queensland, in Annual Report for 1897-'98, page 87), says: "The risk is greater in cows that are in calf; abortion frequently follows inoculation when considerable fever occurs.



Fig. 11.—Hereford bulls from 8 to 12 months old, inoculated at the Missouri Experiment Station and exposed to the fever in Texas one year. No losses.

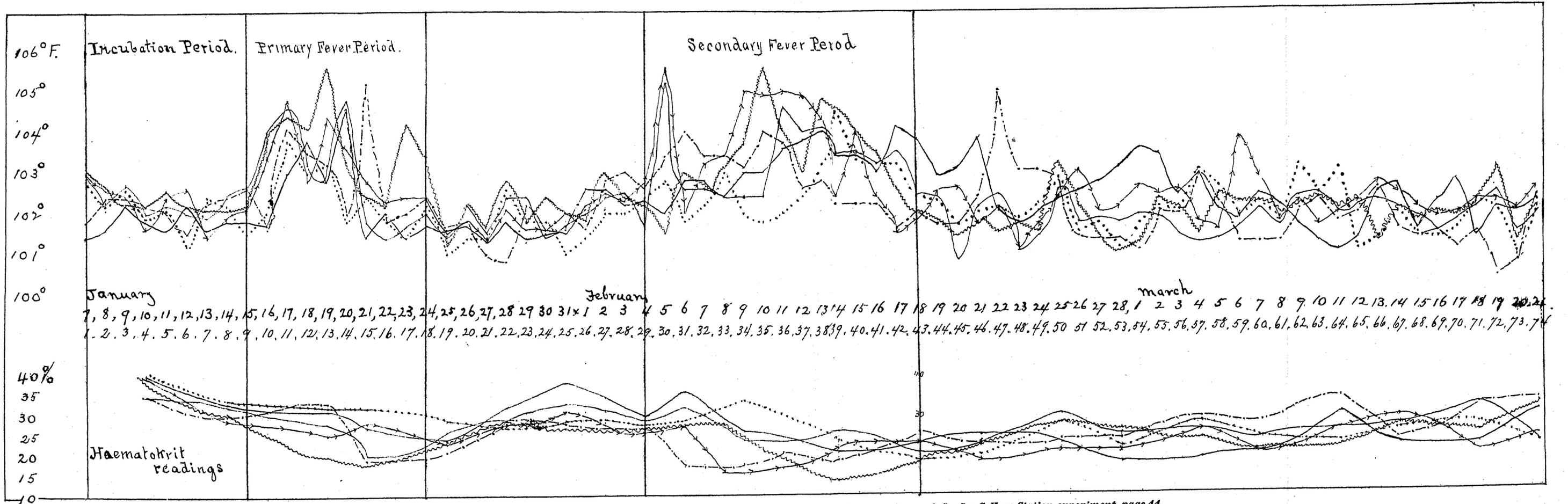


Fig. 12. Graphic record of temperature and blood changes in six head of calves, during immunizing period. See College Station experiment, page 44.