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Cattle tick & Texas fever: results of experiments at State Experiment Station, Baton Rouge, La.

William Haddock Dalrymple

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—OF THE—

AGRICULTURAL EXPERIMENT STATION,

—OF—

LOUISIANA STATE UNIVERSITY AND A. AND M. COLLEGE,

WM. C. STUBBS, PH. D., Director and State Chemist.

CATTLE TICK & TEXAS FEVER.

RESULTS OF EXPERIMENTS AT

STATE EXPERIMENT STATION, BATON ROUGE, LA.,

—BY—

DR. W. H. DALRYMPLE, M. R. C. V. S.,
H. A. MORGAN, B. S. A.,
W. R. DODSON, A. B., S. B.

ISSUED BY THE BUREAU OF AGRICULTURE AND IMMIGRATION,
J. G. LEE, COMMISSIONER.

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ERRATA.

1—On page 240 should appear (*Boophilus bovis*, Riley) instead of the style in which it appears.

2—On page 241, first line, "amblyomnia" should read "amblyomma."

3—On page 243, twelfth line, "six" should be "three."

4—On page 243, eighteenth line, the sentence is incomplete, the word "distinguishable" being omitted.

5—On page 243, eighteenth line, "V" should appear after the word "plate."

6—On page 243, the main heading "A Study of the Condition of Development," should read "A Study of the Conditions of Development."

7—On page 247, fourth line, a "comma" should appear after the word "eggs."

8—On page 260, seventh line of second paragraph, "ammunization" should read "immunization."

9—On page 262, fifth line of first paragraph, "baeterial" should read "bacterial."

10—On page 272, the heading "Disinfected Pastures" should appear as a main heading.

11—On page 272, in sixth line of last paragraph, the word "non-immune" should be substituted for "infected."

LOUISIANA STATE UNIVERSITY AND A. AND M. COLLEGE,
OFFICE OF EXPERIMENT STATIONS, Baton Rouge, La.

Hon. J. G Lee, Commissioner of Agriculture and Immigration, Baton Rouge, La.:

DEAR SIR—I hand you herewith results of investigations made during the past year with "Cattle Tick" and "Texas Fever," by Drs. W. H. Dalrymple and S. B. Staples, Profs. H. A. Morgan and W. R. Dodson, and ask that they be published as Bulletin No. 51.

Respectfully submitted,

WM. C. STUBBS,

Director.

PREFACE BY THE DIRECTOR.

This bulletin has been the outgrowth of necessity. The embargo placed upon Southern cattle by a national quarantine, effective ten months in the year, and the danger attending the importation of Northern cattle into the South have had a decided tendency to check the development of the cattle industry throughout this and other Southern States. Such a condition of affairs called loudly for relief.

In response, this Station has made two efforts looking to a solution of the vexed problem. In 1894 four head of cattle were carefully selected in Memphis, said to have been raised in Northwestern Tennessee and brought to the Station for experiments looking to the securement of a successful method of treatment by which imported animals could be protected from Texas fever.

After six months of careful treatment, administered daily throughout the summer, our disappointment was great on finding that neither the treated nor the untreated cattle had had the slightest symptoms of Texas fever.

The inference was at once made that these cattle had come from an infected district and were immune. On investigation it was found that they were raised in the extreme northwestern portion of Tennessee, and that this section was within the infected district. Undaunted by this failure, in the spring of 1897, nine head of cattle of all ages and sizes, were procured from the Union Stock Yards of St. Louis, by Dr. W. S. Cass, Veterinarian of the United States Department of Agriculture, and shipped by boat to the Station at Baton Rouge. After resting and recuperating from the fatigue of the long and tedious trip, the experiments described in the bulletin were made with them.

Drs. W. H. Dalrymple and S. B. Staples studied the disease as it developed in each animal, making frequent observations of temperature, respiration, etc. Prof. W. R. Dodson, bacteriologist, prepared and administered the serum,

made frequent microscopical investigations of the blood, counted the blood corpuscles at stated periods and otherwise superintended the progress of the experiments. Prof. H. A. Morgan, entomologist, assisted in the work and simultaneously studied, both in the laboratory and on the cattle, the life history of the Cattle Tick and remedies for its suppression or eradication.

This bulletin gives the results of all of these experiments. Dr. Dalrymple furnished the chapter upon the nature and characteristics of Texas fever; Prof. Morgan the chapter on the Cattle Tick; and Prof. Dodson the details of the experiments, with microscopical results.

While no very practical results have been obtained from these experiments, a large amount of valuable information has been obtained, which is herewith given to the public, and which will be useful to the station workers in the continuation of experiments along the same line in the immediate future.

This bulletin is cordially commended to all farmers, planters and stock raisers of this State as worthy of perusal and study; throwing much light upon a subject hitherto but imperfectly understood by our farming classes.

TEXAS, OR SOUTHERN CATTLE FEVER.

There is perhaps no ailment to which the bovine tribe is susceptible that has such an important bearing upon the cattle interests of the Southern States as Texas or Southern Cattle Fever.

It may be said that this disease militates in two ways against the success of the cattle business in the South. In the first place it prohibits, very largely, the importation into our Southern country of pure bred animals from localities north of the Federal quarantine line (see fig. 1) of which we may be desirous for the building up of our dairy herds and the grading and improvement of our beef cattle.

In the second place, it has resulted in a barrier being placed by the United States authorities, for the protection of Northern cattle against the exportation of our Southern stock to Northern markets, except by rail or boat for immediate slaughter during a period of about ten months out of the twelve; *i. e.* from the 15th of January to the 15th of November. In other words, our Northern export store cattle trade, for the greater part of the year, is simply crippled on account of this bovine malady.

The enormous monetary loss to the country, occasioned by this disease, has been the means of causing many investigations and experiments to be undertaken, both by the Bureau of Animal Industry at Washington and several of our State Experiment Stations, our own among the number, with the hope of discovering means by which the fatal results of Texas fever might be stayed.

Whether it is a fact that our Southern cattle tick be solely responsible for the disease, or merely the carrier of the organism is, I believe, up to the present time, not fully determined. But there can be no doubt, having been proved by experiment, that when ticks, which have been living on the blood of our Southern cattle, are transported to latitudes north of the Texas fever line, and become attached to cattle in those sec-

tions, or when Northern cattle from above the quarantine line are brought South and subjected to infestion by ticks from off

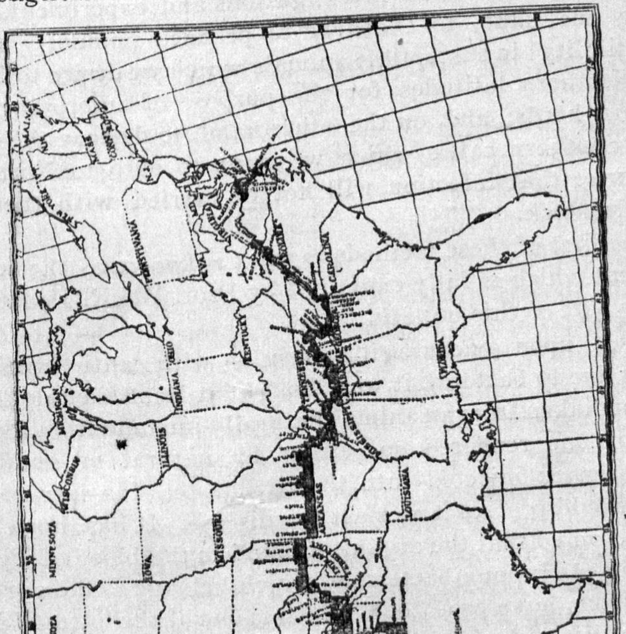


FIG 1.

our native stock, in either case, the animals will contract the disease. Proving, as has just been said, that the tick is at all

events the vehicle through which the contagion is conveyed.

The methods which have been occupying the attention of those engaged in recent investigations and experiments are, on the one hand, to endeavor to produce immunity (non-susceptibility) in susceptible animals which we desire to bring from Northern latitudes for the purpose of improving our Southern herds; and, on the other hand, to destroy the ticks on our Southern cattle which we want to ship to Northern markets so that infection will not be carried with them to Northern stock.

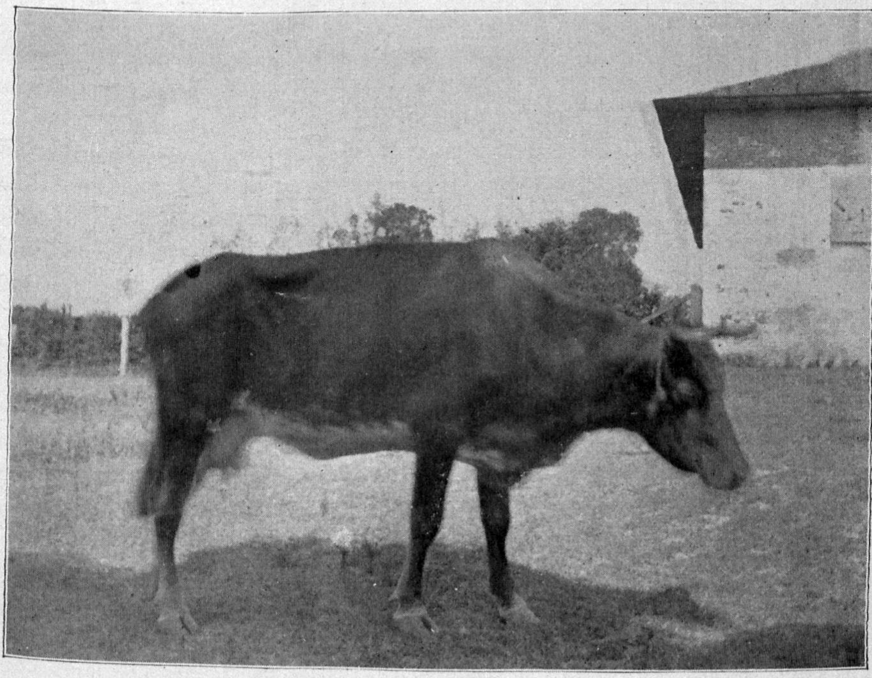
The first of these methods is what is known as the serum treatment which is fully explained by Prof. W. R. Dodson in another part of this bulletin.

Based upon encouraging results with anti-toxins in diseases due to bacteria, it was thought at least feasible, that the serum taken from an animal naturally immune from Texas fever, or one rendered so, either by natural or artificial methods, when injected into the circulation of a susceptible animal would protect it against the disease. It has, however, been discovered that the organism found in the blood of Texas fever subjects is not a bacterium, which belongs to the vegetable kingdom, but a protozoon, which is one of the lowest forms of animal life. And, although, some experiments have given hope and encouragement, it yet remains for future experimental work to prove that the serum treatment will confer absolute immunity in all cases against Southern Cattle Fever.

The second method of endeavoring to control the disease, is the destruction of the cattle tick, and this has been receiving a great deal of attention, both in this country and Australia. This will be found fully dealt with, elsewhere in this bulletin, by Prof. H. A. Morgan.

It might be well to state, that uniformity in the nomenclature of a disease is very much to be desired, for the reason that a very great deal of complication often arises from a number of names being given to one disease; and, perhaps, there is no malady of cattle that is honored with so many titles as the one under consideration. Murrain, bloody murrain, red water, black water, yellow water, acclimating fever, acclimatization fever, etc., although it may not be generally

PLATE I.



General Appearance of a Cow Suffering from a Typical Case of Texas Fever. Photo taken shortly before death.

understood, are, each and all, nothing more nor less than Texas or Southern Cattle Fever.

Texas or Southern Cattle Fever, or as it has been somewhat recently denominated, Bovine Tick Fever, is a specific fever, communicated, not in a direct manner from one animal to another, but indirectly, through the medium of cattle from infected pastures, roads and other places, and in an indirect manner conveying the disease to susceptible animals which are exposed to those infected surroundings. From an article by Drs. Smith and Kilborne, of the National Bureau of Animal Industry, we find that the earliest records of the disease date as far back as 1814, when before the Philadelphia Society For Promoting Agriculture, Dr. James Mease stated that cattle from a certain district in South Carolina so certainly disease all others with which they mix in their progress to the North, that they are prohibited by the people of Virginia from passing through the State. That these cattle infect others while they themselves were in perfect health. A similar condition of affairs has been observed in the majority of the Southern States. The name Texas Fever being given to the malady was due to the frequent and severe losses which followed in the wake of cattle which were driven from the infected district of Texas, into and across the Western States and Territories. It is now known, however, that Texas is not solely responsible for the infection, as it extends northward almost to the southern boundary of Maryland.

Although the cattle tick is in great measure responsible for the conveyance of this disease to the bodies of susceptible animals, the organism which is found in the blood of affected cattle, and which seems to be the true infective agent, is a micro-organismal parasite belonging to the protozoa, and known as the "*pyrosoma bigeminum.*"

SYMPTOMS.

The acute form of Texas fever is that seen chiefly in the hot months of summer. It appears suddenly, and where it attacks a herd of susceptible animals, they all become affected almost simultaneously. If the temperature be taken by the clinical thermometer, it will be found that the fever precedes

the outward symptoms by several days, and animals apparently in good health, will register a temperature varying from 105 to 108 F. If the temperature of exposed animals be taken daily, say in the morning, it will be found that at the beginning of the disease, it will rise, within twenty-four hours, from the normal (100.5 to 102.5) to 104 F., or even higher. In the following twenty-four hours it may rise to 105 to 107 F., or even higher. The continued daily record will then show a high temperature until the disease terminates in death or recovery. In the cases, which prove fatal, the temperature may fall from 2 to 4 degrees F. below the normal just before death. When recovery sets in, it may fall as quickly to, or even below the normal, as it rose in the beginning of the attack. Should the temperature be taken twice daily (morning and evening) a different set of phenomena appear. The temperature at the outset rises during the day, is highest in the evening, and may be low again in the morning. The oscillation in the temperature (which is a normal occurrence) may be noticed for three or four days in some cases, the morning temperature gradually rising until it is as high as the evening temperature. The high temperature then remains continuous until the end of the fever. For these and other observations with regard to symptoms (*ante and post-mortem*) which closely correspond to our own cases, we are indebted to the investigations of the veterinary officers of the Bureau of Animal Industry at Washington. Elevation of temperature may be detected by an experienced hand, even without a thermometer. The whole surface of the body feels hot to the touch, and if the hand be brought in contact with those parts of the skin which are devoid of hair, as underneath the tail, the heat is especially noticeable.

The number of pulsations and respirations increase in frequency with the fever. In the acute stage, the respirations may reach from 60 to 100 per minute, and the pulse to between 90 and 110. As the fever subsides and recovery begins, the great weakness of the animal still keeps the pulse very high for a time, especially if the animal be moved about or excited in any way. When death apprcaches, the heart-beats increase in number as they grow feebler, and the respirations

fall with the body temperature below the normal. The urine voided is often of a dark-red color, which has led to the impression that the animal was passing blood by the kidneys. This color is not due to blood, however, but to hæmoglobin, or the coloring matter of the broken down red corpuscles or cells of the blood.

Hæmoglobinuria, or hæmoglobin in the urine, may be said to be present in most acute fatal cases of Texas fever. As the presence of hæmoglobin in this fluid-excrement seems to depend upon the rapidity with which the red blood corpuscles are infected or destroyed, it is difficult to assert positively that hæmoglobinuria is *always* present in acute cases of the disease, but that which contains this coloring matter of the blood, varies in depth of shade, according to the concentration of the hæmoglobin.

Torpidity of the bowels is, as a rule, present during the fever. As the fever subsides, the fœces again become softer, and are then found more or less deeply tinged with bile. There is loss of appetite, and general cessation of rumination accompanying the fever after the third or fifth day.

The *brain* symptoms, when present, are manifested by partial loss of vision, delirium, staggering gait, etc. Trembling of the muscles may be observed, especially of the hind quarters, when the animal is standing.

Thinness of the blood is another characteristic of the disease. If a small incision be made in the skin, the blood which exudes will be found to be thin, watery and pale in color, in contrast to the rich red blood from an animal in health. If examined under the microscope, and the red corpuscles counted by a special instrument called the "hæmocytometer," they will be found to number only from about 1,500,000 to 2,000,000 to the cubic millimeter, whereas in normal blood they run up to 6,000,000 and 7,000,000. This reduction is of course due to the breaking down and destruction of the red globules, and is the most constant characteristic of Texas fever.

The duration of the disease varies, more or less, but the continuous high fever rarely lasts longer than eight to ten days. In those animals which recover, the falling of the tem-

perature marks the end of the destruction of red corpuscles, and the disappearance of the micro-organism from the blood.

The mild or chronic form of this disease, especially in northern latitudes, is seen usually in the fall, when the extreme heat of the summer months has passed over. The principal difference between this and the acute type rests in the fact, that a stage of the organism prevades the blood of the mild cases, which is different from that observed in the acute form.

The symptoms differ only in degree, the temperature being low and fluctuating; the destruction of the blood corpuscles, by the micro-parasite, going on much more slowly, hence the duration of the disease is more prolonged. Hæmoglobinuria may probably not be present.

In alluding to the *post mortem appearances*, we will mention those organs, or tissues, only, which exhibit the more important and characteristic changes.

The *adipose tissue*, or fat, in some cases, has a decidedly yellowish tinge.

In the *heart*, the right ventricle is distended with blood, which may be in a fluid condition, or clotted, depending upon the time which has elapsed between death and the examination. The left ventricle is usually firmly contracted, and may contain a small quantity of blood. A very constant appearance is that of extravasated blood underneath both the pericardium and the endocardium.

The *spleen* or milt is much larger than in health, varying considerably according to the stage of the disease in which the animal succumbs. In a steer weighing 1000, the normal weight of the spleen is about 1.72 pounds. In acute cases this organ is generally found to be from two to four times its weight in health. When an incision is made into the substance of the spleen, the pulp appears as a dark brownish red mass, resembling, as some one has remarked, very much the appearance of "blackberry jam." This enlargement and peculiar color is shown by the microscope, to be due to engorgement with the red blood corpuscles.

The *liver* is the organ most seriously involved, showing enlargement, congestion, biliary injection and fatty degenera-

tion; the weight being from three to five pounds heavier than the healthy organ, paler in color, and of a peculiar mottled appearance, the mottling being due to a paler-yellowish discoloration of the zone bordering the intralobular veins. Besides occlusion of the biliary ducts, there is observed fatty degeneration of the hepatic or liver cells. There are various other pathological changes to be seen in the liver, but of too technical a character to be of interest, except to those conversant with pathological histology, so we may pass them by.

The *bile in the gall-bladder* is found in considerable quantity after death, and is very much changed, having been likened unto the appearance of chewed grass, and it can be drawn out in long flat bands. When allowed to settle in a vessel a layer of flakes forms at the bottom.

The *kidneys* vary more or less in color, according to the severity and stage of the disease. In those cases which become early victims to the fever, and in which the bladder is filled with port-wine—colored urine, the kidneys are enlarged and of a uniform dark brownish-red color throughout.

The bladder is found to contain from one to four quarts of urine, holding more or less hæmoglobin in solution.

It may be stated, that all the various pathological processes which occur in Texas fever take their origin in the destruction of the red corpuscles of the blood.

The foregoing, although incomplete, will give some idea of the cause, symptoms, both *ante* and *post-mortem*, of Southern Cattle Fever; also the lines of investigation and experiment which are being pursued in endeavoring to discover satisfactory preventive measures upon the absolute success of which depends our hope. Investigation is being faithfully carried on by workers in various States, our own included, and we sincerely trust the day is not far distant when this menacing disease will be perfectly under control. That much-wished-for day means the breaking down of quarantine barriers against our Southern cattle for Northern markets, as also, perfect safety in importing pure-bred stock for the improvement and up-building of our herds, both of dairy and beef cattle.

A summary of the more diagnostic characters to be looked for when Texas fever is suspected, would include:

(1.) Cattle ticks.

(2.) Hæmoglobinuria, enlarged spleen, enlarged yellowish liver, thick flaky bile, extravasations on the outer and inner surface of the heart.

(3.) Reduction in the number of red-corpuscles, thinness of the blood and the tardiness with which it exudes from an incision.

THE SOUTHERN CATTLE TICK.

(*Boophilus bovis.*)

RILEY.

According to Dr. Curtice, (bulletin 24, Texas Experiment Station), the cattle tick is probably a native of North Africa, whence it was introduced into Spain, and from there into South America, Mexico and the Southern States of North America.

To the stock breeder of Louisiana the cattle tick occasions difficulties of a three fold nature: Directly, it is a parasite of *no uncommon order*, frequently occurring in such numbers upon stock as to cause death; indirectly, acting as the primary host of the Texas fever germ, it (1) brings fatality to nearly all cattle brought into Louisiana from the Northern States and from those sections in which the tick does not exist; and (2) has caused an embargo to be placed upon all cattle shipped to northern markets from tick infested areas, during certain seasons of the year. (The most recent map of the tick infested portion of the United States is given in Fig. 1.)

The increasing interest in stock raising, which is so manifest in all parts of Louisiana is creating a general inquiry as to the cause of the very high death rate occurring among all northern cattle brought into the State. Our farmers, as a rule, are not familiar with the fact that the cattle tick so common upon stock pasturing upon the bluff and sandy regions of the State is the chief, if not the only, vehicle of the Texas fever germ. It is true that other species of tick—the

lone star tick (*Amblyomnia unipuncta*, Pack) and the wood or dog tick (*Dermacentor americanus*, Linn)—are found upon cattle, yet they are few in numbers as compared with the cattle tick, and the remedies prescribed for the cattle tick, will generally apply with equal effectiveness to these other species.

Dr. Cooper Curtice, for a long time connected with the Bureau of Animal Industry, of the Department of Agriculture at Washington, D. C., began the study of the cattle tick in the fall of 1889, and was the first to tell us anything of the development of this pest. The results of his investigations were read before the Biological Society of Washington on February 3rd, 1890, and afterwards published by the Journal of Comparative Medicine and Veterinary Archives in July, 1891 and January, 1892, reprints of which have also been circulated. The Texas Experiment Station in bulletin 24 on the "Biology of the Cattle Tick" has also for its author, Dr. Curtice. A reprint of this bulletin appeared in the Agricultural Gazette, of New South Wales, Vol. VII, Part 7, published July, 1896. In bulletin No. 20, of the Arkansas Experiment Station, published 1892, Dr. Dinwiddie gives an account of a number of Texas fever experiments, and of original observations made upon the development of the cattle tick. In 1893 Drs. Kilborne and Smith of the Bureau of Animal Industry, published in Bulletin No. 1, a very comprehensive treatise on the relation of the cattle tick to Texas fever. The New South Wales Agricultural Gazette, Vol. VII, Part 2, contains an article by Mr. Claude Fuller on "Bovine Tick Fever" (a name Mr. Fuller suggests as more applicable than the local one of "Texas Fever"). This article is "a summary of what information there is obtainable relating to the disease known as 'Texas Fever.'" In 1896 the Division of Entomology of the Department of Agriculture, Washington, D. C., issued a bulletin (No. 5, New Series) on "Insects Affecting Domestic Animals," in which ticks in general are discussed. The last of the more important articles upon the tick and Texas fever was issued on January, 1897, by the Missouri Experiment Station as Bulletin 37, and by the Mississippi Experiment Station in Bulletin 42.

In our studies of the cattle tick, pursued during last year (1897), the above articles were freely consulted and have been of great value in suggesting additional lines of investigation.

The development of the cattle tick is of great scientific interest, but the object of investigation has been to produce some means of eradicating it, and thus the Texas fever, and to suggest remedies of relieving native animals of intense tick parasitism. Previous remedial measures have been directed to the destruction of the tick during its parasitic life and to the production of immunity in imported animals. The work of this station last year corroborated the investigations of other workers, as to the relation of ticks to Texas fever, as well as extended the study of the life history of the tick, determining more exactly the conditions under which it develops. As a result of this life history study, remedies will be suggested which bear upon the non-parasitic period of the ticks' existence, as well as upon the parasitic.

STATEMENT OF THE GENERAL LIFE HISTORY OF THE TICK.

The fully engorged female, that stage of tick most easily observed upon cattle, drops to the ground and in some secluded place deposits between 1500 and 3000 eggs. The greatest number of eggs deposited, by a single specimen, out of many females under observation was 3198, the average being 2320. Mr. C. J. Pond, Director of the Stock Institute of Brisbane, is quoted in New South Wales Gazette, Vol. VII, Part 11, Page 770, as stating the number of eggs deposited to be from 1600 to 2000. Bureau of Animal Industry, United States Department of Agriculture, in Bulletin No. 1, gives the average as 2100 eggs. Dr. Dinwiddie in Bulletin 20, of the Arkansas Experiment Station, gives on page 8 the number of eggs deposited as from 2000 to 4000. This statement is made in a general way and an actual count may not have been made. During the summer months these eggs hatch in from fifteen to twenty days, giving rise to a six-legged form, which, because of its resemblance to the seeds of various kinds, is called the "seed tick." Another explanation given for the denomination of "seed tick," is, that the eggs are the seeds of the tick, and the young on hatching are

called "seed ticks." In this condition it is gregarious, bunching in great numbers upon grass, weeds, and, in fact, any elevated object near the place of hatching. See figures illustrating the bunched condition, upon the side of the breeding cage, and upon the most terminal portion of a leaf, the pedicle of which has been sunk in the soil of the breeding cage. The passing animal coming in contact with a bunch of ticks becomes thoroughly infested, the young ticks soon becoming fixed by their mouth-parts to the skin of the host. In the course of from twelve to fifteen days the young hexapodous form molts, after which it possesses four pairs of legs in place of six. Another shedding of the skin takes place in from four to six days after the first, up to which time no sexual characters are apparent, except that the extreme size of the adult female, seems now to be foreshadowed. After the second molt the larger size, and the dorsal shield of the female, the ventral bands and the pointed shoulders of the male become characters easily. See plate —, figs. 5 and 6. At this period mating takes place and in a few days the "round of life" is complete, the females filled with blood, drop to the ground, lay their eggs, and another generation begins. From the time the "seed ticks" (the hexapodous forms) attach themselves to the animal, until maturity is reached, there is very little disposition on their part to change the point of location. None, in fact, except at the very beginning of their parasitic life, or perhaps immediately after each molt, or in the case of males, to some extent, during their adult existence. Practically it means the death of the cattle tick, if removed from its host when once well located.

A Study of the Condition of Development.

EGGS.

See plate II, figures 1, 2, 3, 4, 5.

Tick eggs are covered with a cement-like substance which gives superior protection, even under adverse conditions, as will be shown by the following experiments:

EFFECT OF WATER UPON INCUBATION.

Eggs deposited August 10th were placed upon potted earth and were sprinkled daily until the earth even puddled and the eggs were in part submerged. Even the wettest season would not produce the extremes of moisture as existed in this experiment. Hatching began on September 1st. As all the eggs hatched and the time consumed was the same as a check experiment under which the eggs received only the moisture of the soil upon which they were placed, the conclusion is that rainfall, even as great as occurs in Louisiana (62 inches annually), has no influence upon the incubation period. The cement covering agglutinates the eggs in masses, and should the flooding of the egg-infested lands take place they may be washed into ditches, and off into larger water areas where the young on hatching are lost.

THE EFFECT OF LIGHT UPON INCUBATION.

Nearly all of the eggs under experiment were kept in reflected light and hatched readily. It was thought of interest to test the influence of direct sunlight, and of absolute darkness upon incubation. On August 9th eggs were placed upon dry potted soil and exposed to direct sunlight in a window of the laboratory the greater part of the day. On August 20th another batch was given the same exposure, but was moistened daily. Not a single egg hatched in either case, nor in any of the subsequent tests could eggs be induced to hatch that had been exposed to direct sun rays. (Dr. Dinwiddie in Bulletin 20 of Arkansas Experiment Station calls attention to this fact). Eggs placed in small boxes, giving absolute darkness, hatched in the usual time (twenty to twenty-one days). From the above, it may be inferred, that direct sunlight is destructive to egg life, and may thus, in a measure, account for the predominance of ticks in woods over open pastures.

THE EFFECT OF REFRIGERATION UPON INCUBATION.

It is remarkable the early date in the fall, even in Louisiana, that incubation is checked by cold. Eggs deposited on the 25th of October have gone through the winter unhatched.

Their fertility was tested by hatching a few of the same batch in an incubator. Some of the eggs under the hibernating experiment did hatch during protracted warm spells, yet this was rather the exception.

Eggs layed on December 7th, placed in an ice freezer at temperature of 15° F. for twenty-four hours, then removed to an incubator at a temperature of 95° F., hatched on January 14th. As it is seldom that a Louisiana winter reaches at any time the temperature of 15° F., it can not be expected that even our extreme cold weather will destroy egg fertility.

In Bulletin No. 1, of the Bureau of Animal Industry, page 90, it is stated that eggs survived in 1890-'91 the winter in Washington, D. C.

The only relief we can expect to derive from our winter seasons in the consideration of the egg condition, is the extension of the incubation period and a corresponding reduction in the number of broods.

EFFECT OF HEAT UPON INCUBATION.

The presence of ticks in much warmer portions of the globe than Louisiana is evidence that any results gotten from high temperature experiments could not be carried into practical effect. Eggs were placed in incubator at a temperature of 110° F. without effecting fertility. Eggs that are hibernating seem less sensitive to incubator heat than eggs deposited during the warmer months of the year are to the sun's heat; these experiments were irregular, however, and the certainty of this is not yet determined.

The average incubation period under a temperature of from 86° to 92° F. was twenty-one days. Mr. Pound in the Agricultural Gazette, of New South Wales, for 1896, page 770, is quoted as giving the incubation period under a temperature ranging from 90° to 114° F., as from fourteen to twenty-six days. The Bureau of Animal Industry, Bulletin 1, 1893, pages 88–89, gives the incubation period during the months of August, September, October and November as ranging all the way from twenty to forty-five days while the temperatures are not given; yet during the early part of the fall hatching took place much more rapidly than in the latter

part of October and in November. Dr. Dinwiddie in Bulletin No. 20, of Arkansas Experiment Station, gives incubation period as twenty-five days in summer, twenty-nine in September and six weeks in the latter half of September and October.

SEED TICKS.

See plate II, fig. 6; plate III, figs. 1 and 2.

There is perhaps no more interesting stage in the development of the tick than the seed tick stage. The congregating of the individuals into bunches sometimes of an inch or more in diameter, upon elevated objects, such as stems and blades of grass, and twigs of pine undergrowth, affords a very ready means of attaching themselves to cattle. It is interesting to note the eagerness with which they await their host. The two hind pairs of legs are used to hold to the stem of grass, etc., while the front pair are kept constantly waving in the air. As a result of this difference in function the size of the fore pair is very much greater than those of the hind pairs. (See plate IV, Figs. 2 and 3, illustrating relative sizes of the distal portion of fore and hind legs.)

A knowledge of the extended period which the seed ticks are capable of enduring without food may afford a favorable opportunity of effecting remedies; at least it will give a better understanding of the time required to disinfect pastures after all animals have been removed.

EFFECT OF WATER UPON SEED TICKS.

Experiments were conducted to determine as far as possible the influence of heavy rainfall upon this condition of tick life. Lightly spraying bunches of ticks located upon blades of grass, or even upon the ground, made no material change in their behavior or location. Seed ticks placed directly into vessels containing water, floated upon the surface as long as the individuals remained together; when separated, drowning immediately took place. In one instance two individuals remaining attached floated about on the surface of the water for three days.

The result of these experiments show that ordinary rain

fall will not reduce the numbers of seed ticks, but that in cases of very heavy showers, sufficient to flood flat or level land, great numbers of seed ticks are drowned, or like masses of eggs are washed off into ditches which carry them out into larger water areas, to finally perish. These results have thrown some light upon the conditions, which naturally disinfect pastures in the alluvial and level districts of the State, and account in part for the greater prevalence of ticks upon the uplands of the State.

EFFECT OF REFRIGERATION UPON SEED TICKS.

The fact that ticks are more abundant some years than others, has usually been accounted for by the character of the winter preceding. Just that degree of cold capable of being endured by the seed tick was determined by the use of ice freezers. In the first trial the temperature was reduced to 16° F. for twenty-four hours. On examination, the specimens, at the end of this period, appeared dead, having released all hold upon the box in which they were enclosed and were lying upon the bottom, on their backs. Upon being removed to a temperature of 70° F. signs of life soon reappeared and in an hour they were all as active as under normal conditions. In the second trial the thermometer registered a shade below 15° F. for twenty-four hours, in which case only one specimen out of many hundred survived. It would seem from this that the limit of refrigeration capable of being endured had been reached, and that some support is given to the theory of winter influencing the number of ticks the succeeding summer.

It was observed in the absence of a certain degree of warmth that seed ticks remained close to the ground, bunching around the egg shells, getting as much protection as possible. In fact specimens bunched upon the breeding cage would frequently fall to the ground on the approach of cold of 45° F. It is a common observation among hunters and others that there are few, if any, seed ticks from October until May. Certain stages of other species of ticks which are sometimes called "seed ticks," are found during this period, for instance those of the lone star tick and the dog or wood tick; the

stages of either of these species usually collected are, those after the first, and the second molts (before engorgement). While our laboratory experiments seem to prove that there are seed ticks all the year round, only a few occurring during the winter months, they would also corroborate the above observation by hunters, in that they are more liable to remain upon the ground during cold weather, getting the protection of grass, pine straw, etc.

Bunches of seed ticks are less affected by cold than individuals, as in the above experiment, on the influence of refrigeration, individuals were the first to let go their place of attachment and succumb to the cold. Thus the bunching of the seed tick serves two purposes in its economy: the first and most important, that of affording an easy means of securing the host, and second, that of protection during cold weather.

STAGES FROM SEED TICK TO ADULT.

See plate V, figs. 2, 3, 4, 5 and 6.

The almost stationary position of the tick upon its host, from the seed tick stage on to maturity, permits of little deviation from the general line of development. It has been observed, however, that growth during this parasitic period, is much more rapid in summer than in winter, which explains the prevalence of ticks upon cattle during winter, even when no seed ticks can be found in the pastures. This statement is modified by the occasional prolonged warm spells of winter which may cause seed ticks to crawl up on the grass, as well as hasten the development of the parasitic stages.

ADULT TICK.

Plate VI, figures 1, 2, 3 and 4.

There is a great deal of interest in the biological study of the adult tick, as is true of the other stages, that has little or no bearing upon the prosecution of remedial measures, and therefore is purposely omitted in this bulletin.

The male is mature immediately after the second molt, and from this time on is found beneath the female. From the diminutive size of the male as compared with a fully engorged

female he usually escapes notice, but if a close examination be made a comparison of the sizes of the sexes is easily accomplished.

EFFECT OF RAINFALL UPON ADULT FEMALE.

In the discussion of the seed tick stage it was shown that heavy rainfall upon flat pastures materially reduced the number of seed ticks. In testing this question in connection with the adult female we found her more susceptible to injury by water (heavy rainfall) than the seed tick, drowning at once when in water of sufficient depth to cover the body. Applications of water upon female ticks, placed upon soil easily drained, did not materially affect them, but excessive applications to level land soon flooded the specimens and drowning resulted. There is no doubt but this condition is a potent one in accounting for the natural disinfection of the alluvial and flat lands of the State, as it is not an uncommon thing during very heavy rainfall for such lands to be temporarily flooded.

EFFECT OF REFRIGERATION UPON ADULT FEMALE.

Under any circumstances the adult female possesses much less vitality than the seed ticks; this is especially true under the influences of cold. All the specimens died that were exposed to a temperature of 20° F. for twenty-four hours. It is not an unusual occurrence for the tick-infested regions of the State to experience 12° of frost during the winter, and unless adult females are buried beneath pine straw, dried tufts of grass, or otherwise protected, there is bound to be a great decrease in their number.

EGG LAYING OF FEMALES.

Any environment retarding development, reduces in proportion to its effect, the number of ticks by lessening the number of broods per season. This is well exemplified in the delay in hatching due to the influence of cold weather. Low temperature (from 70° down to that which causes death in the adult) greatly lengthens the period occurring between the time the adult drops from the animal to that when egg laying begins. In summer, oviposition commences from

twelve to forty-eight hours after the female drops to the ground, but as the cold weather approaches the time lengthens as the thermometer lowers until as long a period as three weeks may elapse before egg laying begins (November 23d to December 14th).

In summer, too, oviposition takes place in a few days, while the period in winter is protracted into weeks (January 7th to February 14th). These data are not only important in accounting for the variations occurring in the development of the tick, but may also be used in the intelligent prosecution of remedies.

MEANS OF HIBERNATION.

In the foregoing discussion of the conditions developing the tick the means of hibernation have been mentioned and are now brought forward under a separate heading only to emphasize the wintering phases of tick existence.

According to the order of development of the tick the means of hibernation are as follows:

(1). The delay in beginning oviposition, nearly three weeks in winter as compared with twenty-four to forty-eight hours in summer.

(2). The protracted oviposition period (from time egg-laying begins until completed), under summer temperature, the time consumed is only a few days, while in winter it may extend over a period of five weeks.

(3). In winter incubation is almost suspended and months may elapse before hatching takes place. In summer the normal incubation period is about twenty days.

(4) Seed ticks are capable of existing without food four and one-half months in winter (September 14th, 1897, to January 26th, 1898); in summer the time survived was about two months (July 20th to September 15th). In either instance this power of living for a considerable period of time would aid greatly hibernation; the period of four and a half months is almost sufficient in itself to tide over the winter.

Dr. Curtice is quoted in Agricultural Gazette, N. S. Wales, Vol. VII, page 770, as having kept seed ticks during the winter four and one-half months without food. Mr. Pound is

quoted in the same journal as having kept them seventeen weeks without food.

(5) The parasitic period of the tick's life (from seed tick to adult) is, during the summer months, completed in from twenty-four to thirty days, while in winter the parasitic period extends over two to three months.

From the above, it will be observed, that a number of agencies combine to tide the tick through the winter, the extent to which they operate depending upon the severity of the winter and the stage in which the tick is in when cold weather first appears.

Remedies.

To successfully affect the extermination of the cattle tick, the disinfecting of pastures to eliminate the non-parasitic stages and the direct application to cattle of oils and other substances, to destroy the parasitic stages must go hand in hand. At any season of the year ticks are to be found simultaneously upon cattle and pastures.

THE EXTERMINATION OF THE TICK FROM PASTURE LANDS.

Ticks may be effectively starved to death by removing all cattle from pasture lands for at least one season. Pastures upon this station that were intensely effected during 1894 were entirely free from ticks in 1897. No cattle grazed upon these lands during the seasons of 1895 and 1896, but horses and mules were kept more or less constantly upon them. It is more than likely that there were no ticks on this pasture during 1896, but not having any non-immune cattle we were unable to give the matter a test.

From the life history standpoint it is possible to estimate the time required to free lands from ticks provided no cattle are permitted to roam over or graze upon them. Eggs passing through the winter hatch from April until July 1st. Taking four and one-half months as the greatest period which the seed ticks are capable of enduring without food (we do not think they can exist this long in summer), would carry them until November 15th. In case adult females hibernate and the eggs not deposited until spring, hatching might occur after

July 1st and thus disinfection would not be absolutely complete until after November 15th.

In the matter of starving ticks from any given section, the warmer portions of the great tick infested area of the United States, are more fortunate than those nearer the tick line, as a longer warm season hastens incubation and renders much shorter the life cycle of the tick, as well as the period of time required to eradicate it from any given area by starvation.

Pasture disinfection may be hastened by cultivating the land one season, or should it not be convenient to cultivate, but desirable to retain the land in pasture, sheep, (upon which the tick cannot live on account of the extremely oily condition of the wool) if allowed to graze upon the land, will greatly aid tick extermination. The seed tick is unable to select its host (this being purely accidental). Thus pastures upon which sheep and cattle graze conjointly, are never so intensely infested as those over which only cattle roam.

Before placing native cattle upon uninfected, or disinfected pastures they should be thoroughly dipped or washed with an oil or other tick destroyer, to remove any ticks which might again infect the land.

In intensely infested portions of the State, where cattle roam extensively at large, it may be impossible to completely eradicate the tick because of the lack of co-operative action on the part of stock owners, and thus Texas fever will remain a menace to the stock raising interests. Where such conditions prevail it is not impracticable to disinfect small pasture lots, in which may be kept an imported blooded sire (even the constant stabling of this stock bull will shield him from infection and from Texas fever). This sire bred to natives, and the offspring either inheriting immunity from the dams, or acquiring it when young, are in turn bred to another blooded bull, the first to be exchanged for the second, or sold. In this way herds may be built up to a superior grade without danger of heavy loss.

PASTURE METHODS OF RELIEVING ANIMALS OF INTENSE TICK PARASITISM.

From the study of the conditions of development of the tick, we found that direct sunlight was very destructive to egg fertility; that clean level lands were freed during heavy rainfall from eggs, seed ticks and adults; that the attachment of seed ticks to their host was accomplished by the habit of bunching upon blades of grass, young undergrowth pine, weeds, etc., and that seed ticks and adults are destroyed by cold. From these facts pastures should be freed from all unnecessary coarse growth of grass and weeds which become loaded with seed ticks and aid in infesting animals; from all after math, pine straw or rubbish that will give protection to any of the stages of the tick (in winter from frost, in summer from the direct sun rays); or that will hinder direct flooding and drainage of the pastures when such is possible. Clean pastures will greatly reduce the tick infestion of cattle.

TREATMENT OF ANIMALS INFESTED WITH TICKS.

In our experiments last year it was found difficult to rear ticks upon cattle in "high flesh." The oil of the skin is nature's great barrier to tick infestion.

In many sections of the State the lands are devoted almost entirely to the growing of cotton, rice or sugar cane, and the cattle kept are oxen, or perhaps a few milch cows. It is an easy matter to eliminate the ticks from these sections by sponging the animals a couple of times during the season with mineral, fish, or cotton seed oil (either pure or as an emulsion). This treatment should be supplemented by the system of rotating pastures.

If at any time in the future these sparsely infected areas should become stock raising centers they could be exempt by law from the embargo placed upon all cattle shipped to Northern markets, provided they are now freed from the cattle tick.

DIPPING.

A few years ago Dr. M. Francis, of the Texas Experiment Station, introduced the plan of dipping cattle in large vats in a manner similar to that used for the dipping of sheep.

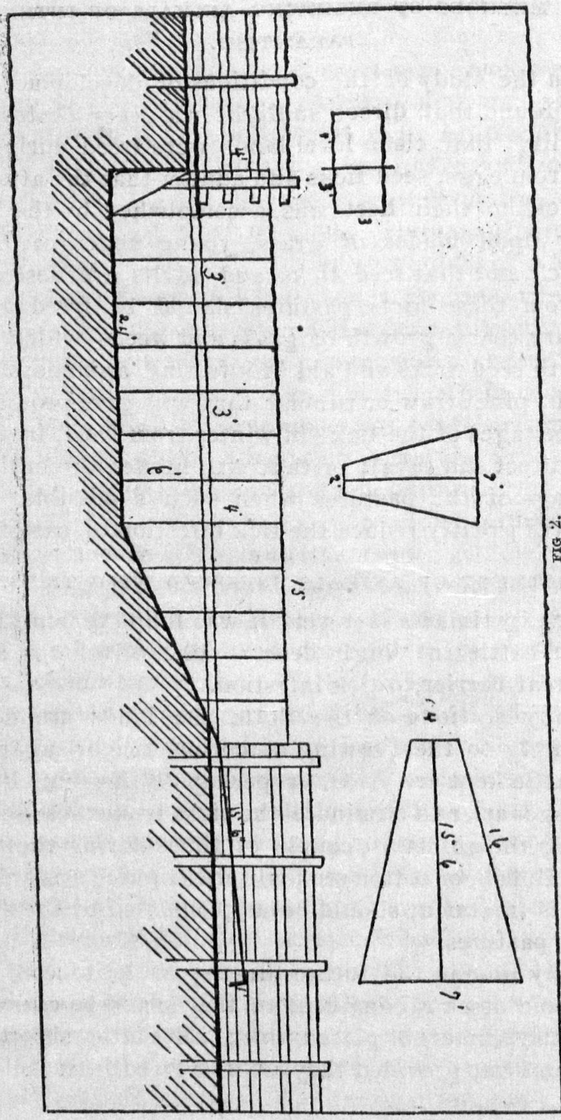


FIG. 2.

The vat used at the Texas Experiment Station consists of a V-shaped vat, twenty-four feet long and 6 feet deep, and has a capacity of 5000 gallons. It is nearly filled with water and upon the surface is floated a layer of oil (cotton seed oil,

or a mineral oil, such as the West Virgina black) three-quarters to one inch in thickness. The latter has been found more effective and may be purchased in fifty to one-hundred gallon lots at 14 cents per gallon. Cost of vat, $100. The cattle are driven through a narrow chute and on a trap door which is balanced on the edge of the vat in such a manner that when the animal comes on it, it tilts, thus compelling the animal to slide into the vat. See fig. 2, page 254.

Dr. Francis states: "We dip our cattle two or three times during the tick season, which extends from the 1st of July to the 1st of November. In 'oil dipping' the cattle must come through the vat in single file—crowding produces imperfect work. Our vat, so arranged, will dip about 1000 head per day. The wilder cattle are the better. In our experience we have never injured any animals—no broken legs, no abortion, none drowned."

Dr. Connaway, of the Missouri Experiment Station, says ("Texas Stock Farm Journal," for February 23rd, 1898): "I have come to the conclusion that the adopting of a process of 'dipping' to free cattle from ticks will soon be a complete success. Three dippings will be necessary to make Southern cattle perfectly safe to Northern ones." Referring to the shipment of Southern beef animals to Northern markets, Dr. Connaway continues: "To save time and yardage in removing the cattle from the Southern ranch to the Northern market, I suggest that the first dipping be done on the ranch, the second, a week later, at some shipping point in the South, and the third, at the Northern terminal yards before the cattle are sent out to interior points. By this plan little time will be lost in importation."

If the "dipping" process can be made to completely destroy all ticks upon our cattle sent to Northern markets, it can on the other hand, be used in connection with the rotation of pastures to exterminate the tick from the State. If a single circumscribed pasture area can be eradicated of ticks there is no reason why the plan of clearing such area might not be applied with equal results to large ones, and have the ticks not only enterminated from the State, but from all the States in which they exist.

EXPLANATION OF PLATES.

Stages in Development of the Cattle Tick.

PLATE II.

FIG. 1. Adult female ovipositing; natural size to the right.
FIG. 2. Eggs slightly enlarged.
FIG. 3. Egg five days previous to hatching (greatly enlarged).
FIG. 4. Egg immediately before hatching (greatly enlarged).
FIG. 5. Mussel like egg shell (greatly enlarged).
FIG. 6. Seed tick (greatly enlarged).

PLATE III.

FIG. 1. Bunches of seed ticks upon the glass cylinder of the breeding cage.

FIG. 2. Bunch of seed ticks upon the distal portion of a leaf.

PLATE IV.

FIG. 1. Side view of distal portion of leg of seed tick (greatly enlarged).

FIG. 2. Distal portion of fore leg of seed tick (greatly enlarged).

FIG. 3. Distal portion of one of hind legs (greatly enlarged).

FIGS. 2 and 3. Illustrate size of the front pair of legs of seed tick as compared with two hind pairs.

PLATE V.

FIG. 1. Mouthparts of seed tick (the clear bean-shaped spots at base should be omitted) much enlarged.

FIG. 2. First stage of tick just previous to second molt (greatly enlarged).

FIG. 3. Second stage of tick just after first molt (greatly enlarged).

FIG. 4. Second stage of tick just previous to second molt (greatly enlarged).

FIG. 5. Male just after second molt (greatly enlarged).

FIG. 6. Female just after second molt (greatly enlarged).

PLATE VI.

FIG. 1. Dorsal view of fully engorged female (adult); natural size to the right.

FIG. 2. Ventral view of fully engorged female (adult), natural size, to the right.

FIG. 3. Ventral view of male, full grown (greatly enlarged).

FIG. 4. Dorsal view of male, full grown (greatly enlarged).

FIG. 5. Tick molting second time (greatly enlarged).

PLATE II.

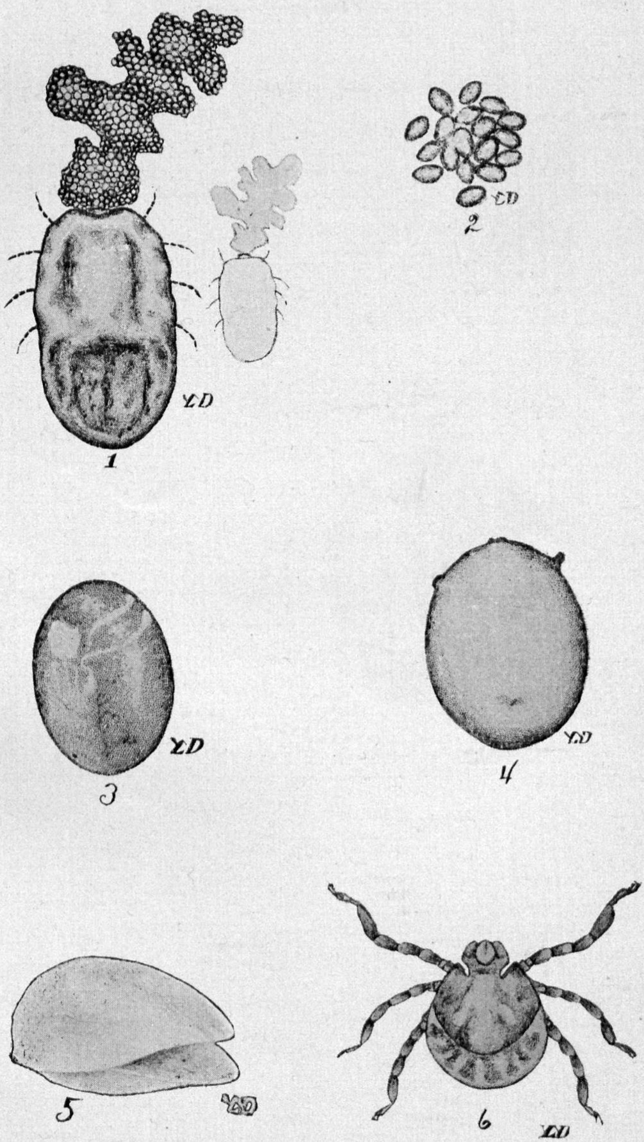


PLATE III.

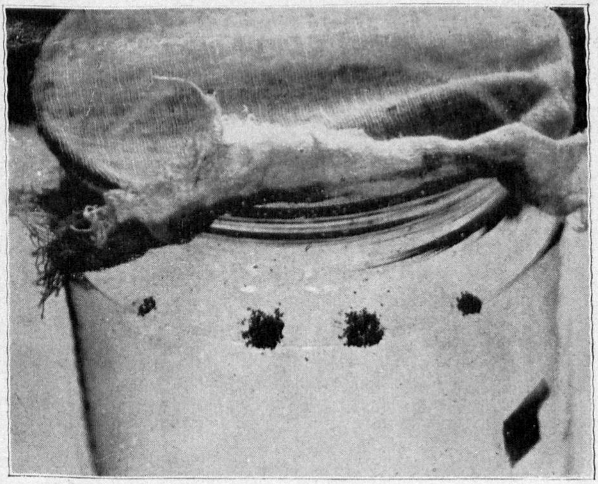
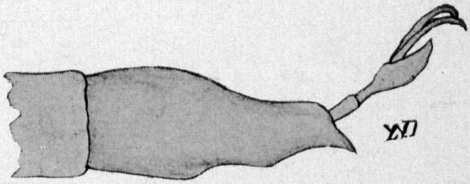


Fig. 1.

Fig. 2.

PLATE IV.



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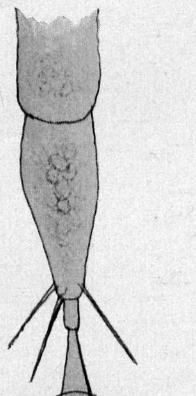

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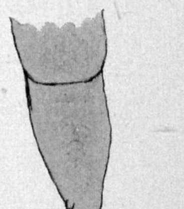

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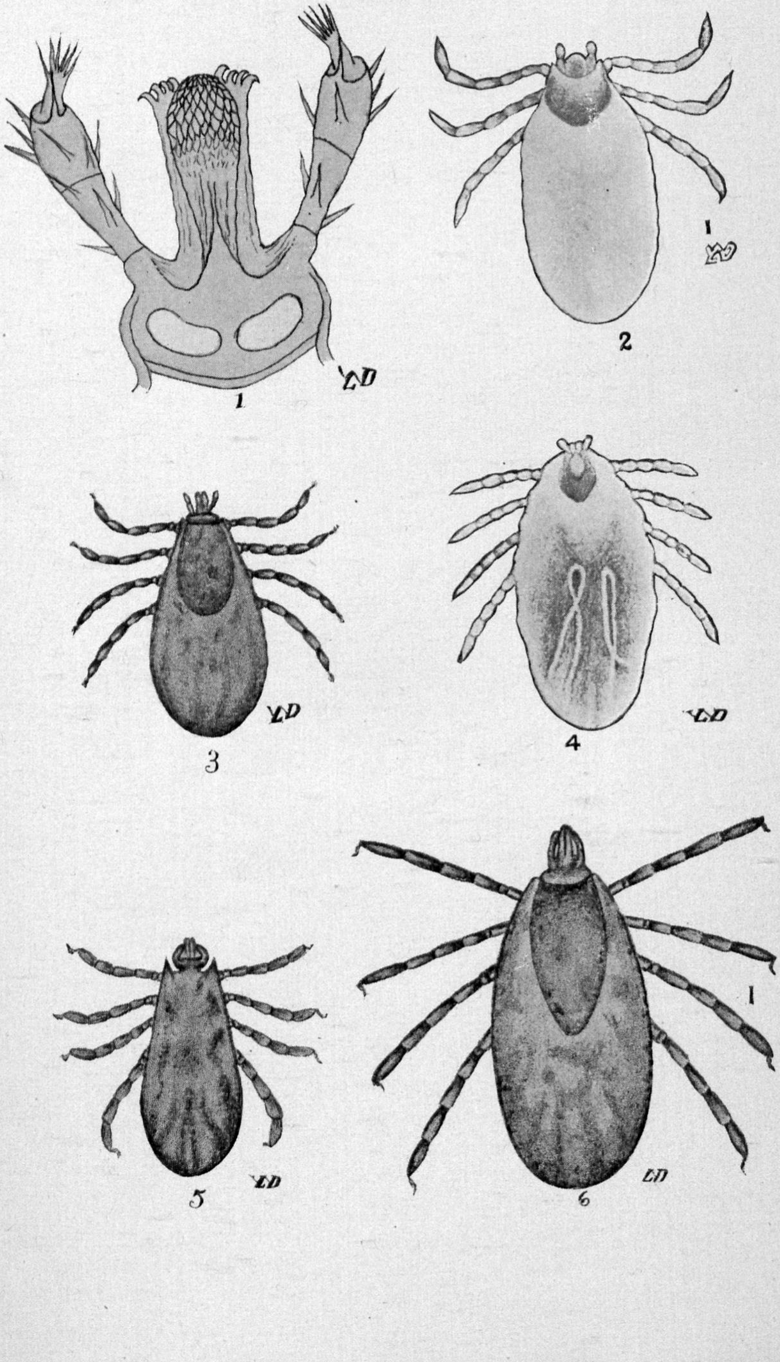

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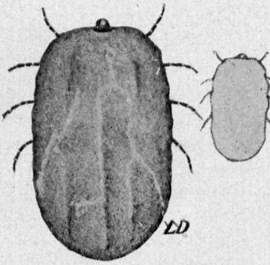

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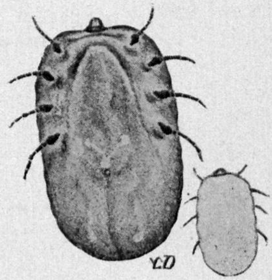

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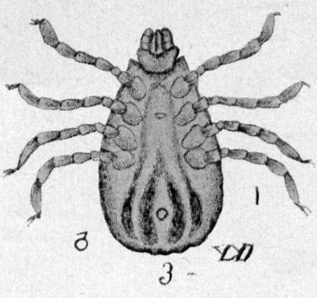

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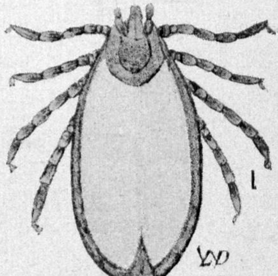

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Experiments With Cattle.

On June 20th, 1897, the Experiment Station received from St. Louis stock yards, by steamboat, nine head of cattle to be used in studying the Texas fever, and for the further purpose of testing the efficacy of the serum treatment as outlined by Dr. Connaway, in Bulletin 37, of the Missouri Experiment Station. The cattle were first placed in a small field which had previously been thoroughly disinfected. The boat trip was somewhat taxing, and they all showed signs of fatigue, their temperature registering above normal for a few days after arrival.

CONTROL ANIMALS.

In the selections of animals to act as checks or controls on those which were to undergo the serum and pasture experiments, animals of extreme ages were chosen.

**Control No. 1* was a red muley cow about 8 years old, and was less affected by the boat trip than any of the others. She was placed among native cattle on June 26th, and in a few days became thoroughly infested with ticks, the first of which matured July 21st, or less than a month from the time of infection. Artificial applications of seed ticks were made to the cow, by which means great numbers of ticks were constantly kept upon her during the entire experiment. As will be shown later, this is the only one out of the nine head imported that possessed immunity. Her temperature remained normal throughout the entire period of the experiment, and every count of blood corpuscles gave more than six millions per cubic millimeter. Unfortunately it is not known where the cow was raised. It is barely possible, but hardly probable, that she was born below the tick line and afterwards transported to some point in the North, from which she was shipped to St. Louis; on the other hand it is probable that she is one of the very few cases in which a Northern bred cow has an immunity from the disease.

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*The temperature of this animal was taken daily, but as it remained normal throughout the entire period of the experiment the table is not published.

all cases, susceptible to Texas fever, and generally die from it when contracted. Sometimes they recover and afterwards have an immunity from the disease, the animal having *acquired* a power of resistance.

Up to the present time we have been able to do very little to aid imported cattle in withstanding the mortal malady.

Every year Northern cattle are shipped to the South without any assurance that they will live through the summer. Sometimes this is done in ignorance of the dangers incurred, sometimes with the knowledge of the experience of those who have in previous years made the same experiment with heavy loss. If a reliable cure or a preventive measure could be discovered, it would be of inestimable value to the South. Anything that gives a reasonable promise of lessening the danger to importation for the improvement of our herds, and to unrestricted exportations to a Northern market is eagerly sought for.

In the summer of 1896, Dr. J. W. Connaway, of the Missouri Experiment Station, seemingly produced an immunity against Texas fever in a Northern animal. His method of treatment was to inject serum from the blood of a native Southern into the circulation of a Northern bred animal. Upon the strength of this experiment the possibility of artificial ammunization was set forth in a report and has been considerably discussed through the stock journals and agricultural papers.

To test the efficiency of this method of treatment was one of the objects of the work carried on at the Louisiana Experiment Station during the summer and fall of 1897.

Although the experiments were negative in result, we have no reason, as yet, to unconditionally reject the principles involved in the method of treatment. To show that some method of a successful serum treatment, yet to be perfected, may be a possibility, we would call to notice the following facts, taken from the investigations in the field of bacteriology.

It has been established that in a number of cases the blood of an immune animal contains a principle which neutralizes or counteracts the power of pathogenic bacteria. If the blood

or blood serum of such an immune animal be mixed with a virulent culture of the bacteria, the culture loses in part, or altogether, its previous virulence. Also, in some cases, if a small quantity of blood from an animal, immune from a certain disease, be injected into the circulation of a susceptible animal, its power to resist the invasion of this disease is increased. For instance: The frog is naturally immune from anthrax and the mouse is susceptible. It has been shown by Ogata and Jasuhara, of Tokio, Japan, that a drop of blood from the frog is sufficient when injected under the skin, to protect a mouse from a fatal infection of anthrax. "The protective inoculation was effective when made seventy-two hours before infection, or six hours after infection." When the animal was thus aided in recovering from anthrax it was afterwards immune from an inoculation of a virulent culture of the bacillus. Furthermore, it is well known that in a number of cases the blood of an animal that has *acquired* an immunity from a particular disease exerts a protective power against that disease when introduced into the circulation of another animal.

The serum treatment of diphtheria is a familiar and frequent application of this principle. The diphtheria serum is obtained from the blood of an animal that has acquired an immunity from the disease, and when this serum is introduced into the circulation of a susceptible animal, it protects that animal from an invasion of this particular disease producing organism.

At present we do not know whether the calf is born with an immunity from Texas fever, or acquires an immunity after birth. When the mother is immune the offspring would probably inherit that immunity to some extent, and it would be further strengthened by assimilation of the milk of the mother. It is possible that the young animal may have the fever in a mild form from the first infection of ticks, and afterwards becomes immune. If the blood of the naturally immune frog injected into the circulation of the mouse will protect the mouse from a fatal attack of anthrax, or if the blood serum from an animal that has *acquired* an immunity from diphtheria will protect a susceptible animal from a fatal attack of

diphtheria, may it not be possible to protect a Northern cow from Texas fever by introducing into her circulation, blood or blood serum, of an immune Southern cow? It seems at least that the experiment is worthy of trial.

While it is believed that Texas fever is not due to a bacterial (vegetable) form of life, but to a protozoan, (one of the lower forms of animal life) we do not know that immunity is not to be accounted for in the same way as we account for immunity in baeterial diseases. Taking it for granted that the Texas fever is due to the development of the protozoan, *Pyrosoma bigeminum*, (Smith and Kilbourne) in the blood of the animal, certain characters of the disease may be comparable to those of diseases produced by bacteria. For instance: We know that some pathogenic (disease producing) bacteria develop in their growth a poisonous substance, which introduced into the body of a suscepible animal, develops symptoms similiar in character to those produced by the inoculation of the bacillus itself, indicating that it is not the organism didirectly but some chemical product of its growth that produces these symptoms of disease.

Smith and Kilbourne discovered the fact that when an animal was afflicted with Texas fever it suffered a very rapid loss in the number of the red corpuscles of the blood, losing in a few days, in most cases, two-thirds or more of the total number found in normal healthy blood, The normal number of red corpuscles in the blood of a healthy cow is about six million per cube millimeter. In Texas fever the number is often reduced to less than two million per cube millimeter. As the protozoan, above referred to, was found inside a large number of corpuscles, it was inferred that the destruction of the red corpuscles, was directly attributable to the organism. The loss of blood corpuscles might account largely for the weakness in the animal, but the partial paralysis of the muscles, the severe suffering in the advanced stage of the disease, and the spasms just preceding death, strongly indicate that some toxic body is produced in the tissues that is incompatible with the vital requirements of the tissues.

If the protozoan be the cause of Texas fever, and if it may develop or causes to be developed such a toxic body, we might

expect an immune animal, or one that has survived the disease, to have the power to produce a chemical substance, an antitoxine, that would counteract the effects of that toxic substance.

Whatever may be the explanations of an animal having an immunity from a disease due to a bacterial form of life, and whatever may be the cause of Texas fever, we do not know at present that the same laws may not be in operation in both cases to produce immunity. In the light of the facts referred to above, we were not incredulous when it was announced that the serum treatment for the prevention of Texas fever had been successfully applied.

It may be well to give here, briefly, a summary of Dr. Connaways work on the serum treatment. A native Texas steer in the Kansas City stock yards was selected to furnish the serum. The blood was drawn under proper aseptic conditions into glass jars, the jars placed on ice and allowed to remain till the clear serum had separated from the coagulated blood and come to the top. The serum was then drawn off and preserved by the addition of 0.5 per cent. trikesol, a compound with properties similar to carbolic acid. It was then taken to the Experiment Station at Columbia, Mo., and injected into a native Missouri cow, in doses of about five and one-half drachms daily for ten days, making about seven ounces of serum introduced into the circulation of the cow. The animal was then placed in a pasture that was infected with ticks. In addition to what the animal gathered from the pasture, other ticks were placed directly on the cow. During the three weeks following about three ounces additional serum was injected into the animal. The seventeenth and eighteenth days after the ticks were placed on the cow the temperature rose abnormally high, but it soon subsided and remained normal during the rest of the experiment. The blood was examined during the fever, but it is not stated whether any parasites were seen. The corpuscles were not counted, but Dr. Connaway does not think the animal had any symptoms of Texas fever. Inasmuch as other animals died in the same lot from the same broods of ticks, it looked very

much as if the serum treatment had protected the animal from the disease.

In January, 1897, Messrs. Keemper, Miller & Co., of Enterprise, Miss , imported from Topeka, Kansas, twenty-seven head of high grade cattle. In February they began to die with Texas fever. Ten had died when Dr. Connaway and Dr. Roberts, of the Mississippi Station, began to treat twelve of the remaining ones with the serum treatment. All were given tonics. All that received serum treatment recovered.

It was thought that the serum treatment was largely responsible for the recovery of the animals. Favorable results were also reported from the serum treatment in Texas in a few cases. With these testimonials in favor of the serum treatment we undertook to verify some of the results.

ANIMALS USED IN THE SERUM TREATMENT.

An account has already been given of the bunch of cattle secured from the St. Louis stock yards and transported to Baton Rouge, in June 1897. From this number two were selected to receive the serum treatment as soon as they had recovered from the ill effects of a long hot trip on the boat. One animal selected was a small heifer, between two and three years old, the other was an old cow. Two controls were selected, one a yearling heifer and the other a medium sized cow, about six or seven years old. Both animals were scrubs. The serum treatment was also tried on two other cows after they had served the purpose of a previous experiment. An account of each case treated is given in tabular form.

THE SERUM.

The serum used was obtained from native Southern cattle that were heavily infested with ticks. It has been suggested that a Northern animal that has recently recovered from the Texas fever would probably render a serum more potent than that from a Southern cow. But we were not inclined to follow this suggestion in securing the serum. This might be of interest from a scientific standpoint but not from a practical one. The number of cows that recover from Texas fever is so limited that the serum would be a very expensive article unless

the virulence of the disease could be reduced, and if that could be done there would not be such an urgent need for the serum treatment. It was thought that if the serum treatment is to become a success at all the serum must be obtained at a reasonable cost.

The method of securing the serum may be briefly given as follows: The blood of slaughtered animals was collected in tall glass jars, allowed to coagulate, the coagulated mass cut from the sides of the jars, the jars put on ice and allowed to remain for fifteen or twenty hours. At the end of this time a good quantity of serum had separated from the red blood. By the use of a large pipete the serum was drawn off and placed in bottles and the bottles stopped with cotton plugs. The serum for the first treatment was preserved by adding one-half of one per cent. of trikresol, the trikresol being added without dilution. This caused a precipitation or coagulation in the serum and for the second and third injection chloroform was used as a preservative. This gave a clear amber serum. The chloroform was driven off by heating to about sixty degrees before using the serum. The serum for injections after the third, with one or two exceptions, was preserved with trikresol to which had been added enough water to prevent the appearance of the white coagulation. Fresh serum was obtained every other day, as it was thought the fresh article would be better than that preserved for several days.

It might be added that trikresol is a mixture of ortho-meta and para-cresol, and is said to be three times as powerful as carbolic acid, as a preservative, but only one-third as poisonous. It has the same ordor as carbolic acid.

Serum Experiment No. 1.

"*White Heifer*"—Treatment was begun on this animal July 1st. Previous to this date the body temperature had remained fairly constant for several days, though a little higher than normal. After the injection of serum the animal was placed in a separate lot and ticks placed on her. At later dates additional ticks were taken from the incubating jars and placed

on different parts of the body, as the udder, flank, neck and hips. The serum was injected under the skin behind the shoulder. The hair was cut very close and the skin washed with dilute carbolic acid, a thin keen knife blade inserted through the skin to make an opening for the needle, the needle inserted and the serum slowly injected. Wounds inflicted cured rapidly, and no serious soreness was experienced.

The heifer was between two and three years old, scrub stock, medium flesh, apparently in good health, except irregular temperature, as will be seen from the table given. She weighed about 600 pounds.

RECORD OF CASE 1.—WHITE HEIFER.

Date.	Temperature.		Pulse.		Respiration.		Max Tem., Weather.	Min. Tem., Weather.	Number of blood corpuscles per cubic millimeter.
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.			
July 1	101.4	100.8	.....	60	.....	60	96	75	10cc serum.
2	102.4	103.4	.....	78	.....	144	96	76	10cc serum.
3	101.4	104.8	66	84	72	138	91	74	15cc serum.
4	101.0	103.0	60	72	66	84	90	74	15cc serum.
5	101.6	102.1	54	66	66	90	89	74	15cc serum.
6	100.8	101.0	66	60	72	66	95	73	15cc serum.
7	100.8	102.6	48	60	54	90	95	74	15cc serum.
8	100.4	102.4	48	66	66	96	95	74	15cc serum.
9	100.2	102.6	66	66	48	108	93	72	20cc serum.
10	100.8	101.2	56	60	72	72	94	74	20cc serum.
11	102.4	102.5	60	Slow	90	Slow	87	74	
12	100.0	102.4	60	66	42	120	88	71	First ticks added.
13	100.8	102.8	54	70	48	84	91	69	
14	100.2	104.4	60	78	60	150	94	62	
15	101.8	105.2	66	78	60	144	93	70	15cc serum.
16	100.6	104.0	60	60	72	76	93	70	Blood corpuscles, 6,100,000.
17	101.4	103.4	.....	48	.....	132	92	71	15cc serum.
18	100.6	101.3	.....	78	.....	54	93	73	
19	100.0	103.0	.....	70	.....	96	92	71	
20	102.0	103.3	.....	78	.....	120	93	73	
21	102.0	104.4	.....	88	.....	126	93	72	
22	102.[illegible]	100.4	.....	48	.....	108	93	73	
23	101.4	103.4	.....	54	.....	60	94	73	
24	101.8	104.9	.....	.....	.....	.....	95	73	15cc serum.
25	101.2	104.2	60	72	84	120	95	75	
26	101.0	104.0	60	.....	72	.....	86	74	
27	100.6	102.4	.....	.....	.....	.....	94	76	
28	102.2	104.4	.....	.....	.....	.....	93	74	
29	102.2	104.6	.....	.....	.....	.....	93	69	
30	103.0	104.5	.....	.....	.....	.....	93	67	15cc serum.
31	102.6	105.8	66	78	54	72	96	68	15cc serum.
August 1	105.2	105.4	72	66	90	90	97	69	Blood corpuscles, 3,040,000.
2	106.0	105.9	66	78	90	120	98	74	
3	105.0	105.5	....	78	.....	120	98	76	Blood corpuscles, 2,520,000.
4	104.4	103.3	84	84	60	54	94	76	Blood corpuscles, 2,080,000.
5	104.4	104.0	114	90	66	84	94	73	Blood corpuscles, 2,000,000.
6	103.8	105.1	90	90	78	120	96	74	
7	103.8	105.4	84	.....	90	.....	96	75	Blood corpuscles, 1,940,000.
8	103.8	103.9	90	.....	66	.....	96	77	
9	103.7	105.0	90	72	78	96	96	76	Blood corpuscles, 2,184,000.
10	100.8	.....	.....	.....	.....	.....	.....	.....	

Total amount of serum injected before the development of the fever, 150cc; after development of fever, 75cc; total amount of serum, 225cc, or nearly one pint.

The animal died August 10, 4 p.m. Post mortem examination was made by S. B. Staples, D. V. S, who pronounced the case typical Texas fever, every characteristic of the disease being pronounced.

Serum Experiment No. 2.

This animal was rather an old cow, a shorthorn, rather poor in flesh, weighed about 900 pounds. Method of treatment, same as in previous case. Was treated five days with injections of serum before ticks were placed on her.

RECORD OF CASE 2—SHORT HORN.

Date.	Temperature. A M	Temperature. P. M.	Pulse A. M.	Pulse P. M.	Respiration. A. M.	Respiration. P. M.	Max. Tem., Weather.	Min. Tem., Weather.	Number of blood corpuscles per cubic millimeter.
July 1	100.6	102.2	.....	.....	.....	.....	96	75	10cc serum.
2	100.8	101.8	.....	54	.....	78	96	76	15cc serum.
3	100.4	102.6	.....	60	.....	84	91	74	15cc serum.
4	100.2	101.0	....	54	.....	48	90	74	20cc serum.
5	100.8	100.7	60	54	36	42	89	74	Large ticks added.
6	100.8	101.5	78	60	60	60	95	73	20cc serum.
7	101.0	102.8	60	60	60	72	95	74	25cc serum.
8	100.5	102.6	54	66	60	66	95	74	25cc serum.
9	100.0	101.0	54	60	54	60	93	72	25cc serum.
10	100.2	101.7	54	54	60	60	94	74	Ticks placed on udder and neck.
11	101.0	100.1	60	.....	54	.....	87	74	
12	99.8	101.2	48	66	24	66	88	71	
13	100.8	101.2	50	60	30	42	91	69	
14	100.4	102.6	54	60	60	84	94	62	More ticks added.
15	100.6	101.0	48	72	36	72	93	70	20cc serum.
16	100.0	102.4	54	72	36	72	93	70	
17	100.4	102.4	.....	60	.....	84	92	71	20cc serum.
18	99.8	100.2	.....	48	.....	30	93	73	
19	99.6	101.8	.....	60	.....	50	92	71	
20	100.7	101.6	.....	60	.....	60	93	73	
21	100.9	102.1	.....	54	.....	54	93	72	20cc serum.
22	100.8	99.5	.....	54	.....	54	93	73	
23	100.1	101.2	.....	36	.....	36	94	71	
24	100.2	102.4	.....	.....	.....	.....	95	73	20cc serum.
25	100.9	102.3	.....	.....	.....	.....	95	75	Ticks added.
26	100.8	101.9	60	.....	48	.....	86	74	
27	100.8	101.8	.....	.....	.....	.....	94	76	Blood corpuscles about 6,000,000.
28	102.0	104.2	.....	.....	.....	.....	93	74	
29	103.0	105.0	.....	.....	.....	.....	93	69	Blood corpuscles about 4,500,000.
30	105.0	106.2	.....	66	.....	88	93	67	20cc serum a. m. 20cc serum p. m.
31	104.0	106.2	60	72	23	72	96	68	20cc serum.
August 1	102.0	.....	.....	.....	.....	.....	97	69	Died August 1st.

SUMMARY OF SERUM EXPERIMENT NO. 2.

Total amount of serum injected before the fever developed 285cc., or over one pint. Amount of serum injected after the fever developed, 60cc. Total amount of serum injected into the animal, 345cc. Duration of the fever five days.

The number of blood corpuscles given is only approximate, as the determination was made with the centrifuge, an instrument not well suited for accurate work in blood determinations. A number of attempts were made to determine the per cent. of red corpuscles with this instrument but the results are not given as the were clearly unreliable. A few days after the death of this animal, a haemacytometer was received, an instrument that is reliable for accurately counting the number of blood corpuscles. All further determinations were made with this instrument.

In making the examinations af the blood there was found what was taken to be Smith and Kilbourne's *Pyrosoma bigeminum* in the corpuscles, but all the stages figured by them in their report could not be made out. The animal died.

The *post mortem* examination was made by Dr. W. H. Dalrymple, M. R. C. V. S., who pronounced it an unmistakable case of Texas fever.

Conclusion.—No encouragement for serum treatment.

Serum Experiment No. 3.

"*Blackey*"—An animal about six years old, scrub stock, 900 pounds weight. After serving the purpose of a previous experiment in testing the danger of infecting a pasture in close proximity to infected territory, was driven to the experiment farm September 22d, 1897. Up to this time the animal had been in good health save for a period of two or three days, when she ate an excessive quantity of fresh hay. On October 6th, the first high temperature occurred from Texas fever, fourteen days after becoming infested with ticks.

It was decided that a large quantity of serum should be tried on this animal to thoroughly test its efficiency as a cura-

tive. Accordingly, 515 c. c., or about a quart, was injected in six days, in doses given in the table. On the seventh day the temperature remained very high, and as there was no evidence that the serum was doing any good treatment was discontinued.

However the animal recovered. November 23d, the blood corpuscles were counted and found to be 3,728,000 per c. m.

TABLE OF SERUM EXPERIMENT No. 3.

DATE.	Temperature		Weather Record.		c.c. Serum Injected.	Blood Corpuscles per c. m.	
	P. M.	P. M.	Max	Min			
October 6....	106	106.5	90	66	60cc A.M.	6,500,000	
7....	106.6	106.2	..	....	70cc P.M.	5,980,000	Stands, eyes closed
8....	106.6	106.6	87	56	90cc	4,168,000	Very sick.
9....	106.8	106.6	88	65	90cc	3,528,000	Beginning to get weak.
10....	106.5	106.1	82	63	105cc	....	
11....	105.3	105.6	83	65	100cc	2,176,000	Difficult to obtain blood from ear.
12....	......	106.4	85	62	....	....	
13....	105.2	......	...	....	....	1,904,000	
14....	......	105.7	...	....	....	....	
15....	103.6	......	....	....	....	....	
16....	103.8	105.8	85	64	....	1,900,000	
17....	102.5	102.5	....	....	....	....	
18....	102	......	....	....	....	1,952,000	
20....	......	103.1	....	....	....	....	

October 21—Animal apparently free from suffering. Observations discontinued. The cold weather coming on probably saved the animal. It is not probable that the serum had anything to do with her recovery as the temperature was not lowered by the treatment.

Serum Experiment No. 4.

"*Holstein Spot*"—A grade Holstein, about six or seven years old, weighed about 800 pounds. This animal had been kept on a disinfected lot, as described in another experiment. She was in good health when driven to the pasture of the experiment farm September 22d, 1897. The first high temperature was noted on October 6th, or fourteen days after being infested with ticks. On October 7th, she received serum treatment. The record of the course of the disease follows:

TABLE OF SERUM EXPERIMENT No. 4.

Date.	Temperature.		Weather Record.		Serum Received.	Number of blood corpuscles per c. m.
	A. M.	P. M.	Max	Min.		
October 6	......	105.9	90	66	......	6,144,000
7	103.2	104.4	......	......	100cc	......
8	101.1	105.8	87	56	75cc	6,048,000
9	104.8	104.1	88	65	100cc	5,200,000
10	103.8	103.6	82	63	......	......
11	100.7	101.1	83	65	......	3,872,000
12	101	104.2	85	62	......	......
13	100.6	......	......	......	......	4,608,000
14	......	104.4	......	......	......	......
15	102.5	......	......	......	......	4,744,000
16	......	104.6	85	64	......	......
17	......	103.8	......	......	......	......
18	102	......	......	......	......	4,136,000
20	......	102.2	......	......	......	......

Observations discontinued. Animal recovered.

This animal *did not* present any outward symptoms of disease or suffering during the fever. It will be noted that her temperature was not very high, having reached 105 only twice. Had it not been for the high temperature indicated by the thermometer and the reduction of the number of blood corpuscles, she would not have been suspected of having the fever. She continued to lose flesh, however, and became very poor during the winter.

SUMMARY.

The first animal treated with the serum was a young animal, believed to be not as susceptible as older ones to the disease. Treatment began just before the first exposure to the

ticks. She contracted the fever and died after a period of twenty-six days sickness.

The second animal, an old cow, was treated before infested; she contracted the fever and died after five days sickness.

The third animal was treated after the fever developed, receiving a very large amount of serum and recovered. Her temperature ran very high and may be called a very severe case.

The fourth animal was treated after the fever developed receiving only a small quantity of serum and recovered. After the first day the temperature did not go very high, the blood corpuscles did not diminish as much as in other cases, and the animal seemingly suffered very little. This would be called a very mild case of the fever. We have no special reason to believe that the serum treatment was responsible for the recovery of either animal. In one case it did not reduce the temperature at all, and the other case was so mild that the animal would probably have recovered anyway.

WORK AT OTHER STATIONS.

The Mississippi Station has been testing the serum treatment. They treated cows with serum before they left the North, and all had the fever when they were brought South. Cattle that were treated before they left the North and also after they reached Mississippi were not immune. Those that were treated only after they reached Mississippi also had the fever.

Dr. Connaway, of the Missouri Station, has also further tested the matter and pronounced it unsatisfactory.

DISINFECTED PASTURES.

Experiment No. 1 was on an old brindle cow, not in good condition. She remained under the general disinfected pasture experiment (under which all the animals were placed until removed for individual experiment) until July 22d, when she was placed in a disinfected pasture with a native cow free from cattle ticks. If infected cattle take fever when ranging with natives infested with ticks, or when pasturing upon tick-infested

lands, and are not subject to fever when ranging upon disinfected pastures within infected latitudes, or with natives from which all ticks have been removed, the natural conclusion is that the ticks are directly or indirectly the cause of the fever. This animal remained perfectly free from any signs of fever throughout the experiment. On September 22d, she was placed with native cattle infested with ticks, and on October 8th, began showing symptoms of fever, which terminated in death from typical Texas fever on October 15th. In the experiments with this cow two results seem assured. (1) That imported animals remain free of fever upon disinfected or uninfected pastures; (2) there is no danger in permitting native cattle to roam with imported ones upon disinfected pastures provided the natives have been entirely freed from ticks.

TABLE OF PASTURE EXPERIMENT No. 1.

Date.	Temperature.		Weather Record.		Number of Blood Corpuscles per c. m.
	A. M.	P. M.	Max	Min	
October 6	......	103	90	66	....
7	102	......	89	59	....
8	......	105.6	87	56	....
9	......	102.5	88	65	6,384,000
10	......	105	82	63	....
11	......	106.2	83	65	5,344,000
12	......	107.2	85	62	....
13	107.6	......	86	63	3,880,000
14	......	105.5	87	68	....
15	100	......	85	68	1,576,000

Died October 15 at 11 A. M.

Experiment No. 2 was a black cow of medium size and in good condition, but somewhat affected by the trip. On July 5th, she was placed in disinfected pasture separated from a badly infested pasture by a picket fence. The object of the experiment was to determine the length of time it would take the ticks to pass a fence of this kind as a barrier. The cow gained in flesh and remained free from ticks until removed to an infested pasture on September 22d, where she became infested at once. Symptoms of fever became apparent on October 6th, and for a few days following the cow was

very sick. She recovered slowly. (See table under serum treatment of No. 3, page 270.)

Experiment No. 3 was a graded Holstein cow, about the same age as the last described, but not in as good condition. She was placed in a disinfected pasture separated from an infected one by two fences four feet apart. The space between was well cultivated at the beginning of the experiment, but was not afterward disturbed. The experiment, as may be seen, was similar to the one described under No. 2, except that the barrier separating the infected and disinfected areas was greater. As in No. 2, the animal remained in good health and free of ticks until September 22d, when she was placed with native cattle in infected pastures. Ticks appeared upon her at once and on October 6th she was taken down with Texas fever. Recovery took place, but the animal was much emaciated. Nos. 2 and 3 of the pasture experiments were given large injection of serum during the early stages of the fever. (See table of temperature, etc., under serum experiment No. 4, page 271.)

Experiment No. 4 was on a spotted cow of a type similar to No. 2. She was inclosed in a small uninfected lot separated from No. 2 by a wire fence, and was not thirty feet away from the infected area which was separated from No. 2 by the picket fence. Since No. 2 remained free from ticks it became evident that No. 4 might be used for some other experiment. The question of an animal gradually acquiring immunity was suggested. In order to accomplish this, it was thought wise to limit the first tick infection to two specimens of seed ticks which were applied on August 15th. It was a difficult matter to confine the active seed tick to a definite area upon the cow, and the specimens were soon lost sight of. These did not develop, nor did four other specimens which were afterwards applied. The length of time required for the tick to develop and to determine the result of each application made it dfficult to make more than two applications. On September 22d, this cow was placed in an infected pasture. Fever symptoms appeared October 12th, and she died on October 20th. The very high infection of one-half dozen seed ticks seemed in no way to modify the attack.

TABLE OF PASTURE EXPERIMENT No. 4.

Date.	Temperature.		Weather Record.		Number of blood corpuscles per c. m.
	A. M.	P. M.	Max.	Min.	
October 10	......	101.8	82	63	
11	......	102.0	83	65	
12	......	103.5	85	62	
13	104.0	......	86	63	6,344,000.
14	......	104.0	87	68	
15	......	......	85	68	6,152,000.
16	......	107.0	85	64	
17	......	107.2	85	62	
18	106.7	.....	81	66	5,520,000.

Died October 20th, 1897.

Experiment No. 5 was an old cow, very thin, and was kept under the same experiment as No. 3 until August 26th, when she was transferred to a tick infested pasture which had been purposely burnt, plowed and fenced. Every effort was made to eradicate all weeds and vegetation within the enclosure. It was hoped to gather from this experiment precise information as to the effect of cultivation upon seed ticks. We found it difficult to keep down the grass and weeds and hence infection, as was expected, resulted. On September 29th, she began to show marked symptoms of Texas fever, and on October 5th died. On the latter date the ticks upon her were just molting the second time. She became infested, approximately, eighteen or twenty days previously to death, or about September 14th. This experiment suggests that cultivation delayed infection but did not prevent it.

TABLE OF PASTURE EXPERIMENT No. 5.

Date.	Temperature.		Weather Record.		Number of Blood corpuscles per c. m.
	A. M.	P. M.	Max.	Min	
September 29	....	106.2	87	63	
30	106.1	106	85	63	2,854,000
October 1	106	104.8	86	67	3,224,000
2	....	103.4	89	62	2,840,000
3	103.2	106.2	90	58	
4	....	101.2	86	50	

Died October 5, 1897.

It will be seen that control No. 1 possessed natural immunity, or at sometime previous to her importation had had Texas fever. From the results of pasture experiments 1, 2, 3 and 4, it may be assumed that a disinfected pasture well fenced is sufficient protection to non-immune cattle.

While the evidence suggested in the above experiments corroborates the statement "that the tick is the vehicle of the Texas fever germ," it is not any more convincing than the fact that throughout much of the alluvial districts of this State no ticks are to be found, and while Northern animals are constantly being imported for family and dairy purposes, Texas fever is unknown. Two examples will suffice as instances of this condition. Upon a plantation about five miles blow the city of Baton Rouge, a gentleman imported about six years ago from one of the Northern States a couple of cows, one a Shorthorn and the other a Holstein. These cows, although in a high condition of flesh, have not suffered any inconvenience from the change of location. An examination of the conditions surrounding these animals, made last year, showed that they had been kept upon small pasture lots on the plantation and had never been permitted to roam with other animals. There have not been any ticks upon the place since the animals were imported, although badly infested areas exist upon the bluff lands but a mile or so distant.

In the city of New Orleans there are hundreds of imported cows in the large dairies and in family use, which have never had Texas fever, although imported several years ago, in fact the inporting of blooded dairy animals has gone on for years without any Texas fever results, except when a native was brought into the herd, or a family cow taken "over the lake" (a summer resort in the infected area) during the sojourn of the family through the summer months.

Last year inquiries were sent out to many parts of the alluvial districts of the State soliciting information relative to the distribution of the cattle tick over these sections. A summary of the replies received would indicate that no ticks are present unless animals are imported from the highlands of the State which infect temporarily the pastures occupied by them. So certain are the people living upon these lands that

the tick, which is constantly being introduced, brings Texas fever to animals native to these districts, that their past complaints have changed into earnest efforts to prevent any further importation of highland cattle.

From present information it is highly probable that the large areas of alluvial lands of this State (and perhaps also the prairies of Southwest Louisiana) are free from the cattle tick and thus exempt from Texas fever, for the reasons assigned elsewhere in this bulletin. (See pages 243-251, on "a study of the conditions of development)."

The importation of native stock may temporarily infect these lands, but the natural conditions prevailing will ultimately destroy the ticks and thus render them innocuous, and only by repeated introduction of hill cattle can these lands be kept infected.

Remedies suggested by the above pasture experiments have been considered under "remedies" for the cattle tick. See pages 251-255.

Regulations Concerning Cattle Transportation.

In accordance with laws passed by Congress, Hon. Jas. Wilson, National Secretary of Agriculture, Washington, D. C., issued for 1898 regulations concerning cattle transportation from which we make the following extracts:

"All that country lying south, or below, a line beginning at the northwest corner of the State of California; thence east, south, and southeasterly along the boundary line of said State of California to the southeastern corner of said State; thence southerly along the western boundary line of Arizona to the southwest corner of Arizona; thence along the southern boundary lines of Arizona and New Mexico to the southeastern corner of New Mexico; thence northerly along the eastern boundary of New Mexico to the southern line of the State of Colorado; thence along the southern boundary lines of Colorado and Kansas to the southeastern corner of Kansas; thence southerly along the western boundary line of Missouri to the southwestern corner of Missouri; thence easterly along the southern boundary line of Missouri to the western boundary line of

Dunklin county; thence southerly along the said western boundary to the southwestern corner of Dunklin county; thence easterly along the southern boundary line of Missouri to the Mississippi river; thence northerly along the Mississippi river to the northern boundary line of Tennessee at the northwest corner of Lake county; thence easterly along said boundary line to the northeast corner of Henry county; thence in a northerly direction along the boundary of Tennessee to the northwest corner of Stewart county; thence in an easterly direction along the northern boundary of Tennessee to the southwestern corner of Virginia; thence northeasterly along the western boundary line of Virginia to the northernmost point of Virginia; thence southerly along the eastern boundary line of Virginia to the northeast corner of Virginia, where it joins the southeastern corner of Maryland at the Atlantic ocean.

"From the 15th day of January to the 15th day of November, inclusive, during each year, no cattle are to be transported from said area south or below said Federal quarantine line above described to any portion of the United States above, north, east or west of the above-described line, except by rail or boat, for immediate slaughter, and when so transported the following regulations must be observed:

"1. When any cattle in course of transportation from said area are unloaded above north, east, or west of this line to be fed or watered, the places where said cattle are to be fed or watered shall be set apart, and no other cattle shall be admitted thereto.

"2. On unloading said cattle at their points of destination, pens, sufficiently isolated, shall be set apart to receive them, and no other cattle shall be admitted to said pens; and the regulations relating to the movement of cattle from said area, prescribed by the cattle sanitary officers of the State where unloaded, shall be carefully observed. The cars or boats that have carried said stock shall be cleansed and disinfected as soon as possible after unloading and before they are again used to transport, store or shelter animals or mechandise.

"3. All cars carrying cattle from said area shall bear placards, to be affixed by the railroad company hauling the

same, stating that said cars contain Southern cattle, and each of the waybills or bills of lading of said shipments by cars or boats shall have a note upon its face with a similar statement. Whenever any cattle have come from said area and shall be reshipped from any point at which they have been unloaded to other points of destination, the cars carrying said animals shall bear similar placards with like statements, and the waybills or bills of lading be so stamped. At whatever point these cattle are unloaded they must be placed in separate pens, to which no other cattle shall be admitted.

"4. (*a*) No boat having on board cattle from said district shall receive on board cattle from outside of said district.

"(*b*) Cattle from said district shall not be received on board when destined to points outside of said district where proper facilities have not been provided for transferring the said cattle from the landing to the stock-yards and slaughter-houses without passing over public highways, unless permission for such passing is first obtained from local authorities.

"5. The cars and boats used to transport such animals, the chutes, alleyways, and pens used during transportation, and at points of destination, shall be disinfected in the following manner:

"(*a*) Remove all litter and manure. This litter and manure may be disinfected by mixing it with lime or saturating it with a 5 per cent. solution of 100 per cent. carbolic acid; or, if not disinfected, it may be stored where no cattle can come in contact with it until after November 15.

"(*b*) Wash the cars and the feeding and watering troughs with water until clean.

"(*c*) Saturate the entire interior surface of the cars and the fencing, troughs, and chutes of the pens with a mixture made of 1½ pounds of lime and one quarter pound 100 per cent. straw-colored carbolic acid to each gallon of water; or disinfect the

cars with a jet of steam under a pressure of not less than 50 pounds to the square inch.

"Notice is hereby given that cattle infested with the *Boophilus bovis*, or Southern cattle tick, disseminate the contagion of splenetic or Southern fever (Texas fever); therefore cattle originating outside of the district described by this order, or amendments thereof, and which are infested with the *Boophilus bovis* ticks, shall be considered as infectious cattle and shall be subject to the rules and regulations governing the movement of Southern cattle.

"Stockyard companies receiving cattle infested with said ticks shall place such cattle in the pens set aside for the use of Southern cattle, and transportation companies are required to clean and disinfect all cars and boats which have contained the same, according to the requirements of this Department.

GENERAL SUMMARY.

1. The development of the cattle tick is less rapid in winter than summer.

2. The period of incubation is influenced by cold, and egg fertility is destroyed by direct sunlight.

3. Seed ticks are capable of living a considerable length of time without food; this period is less in summer than in winter.

4. Seed ticks may endure cold down to 16° F., below which death takes place.

5. The parasitic period of development of the tick is very much longer in winter than in summer.

6. The cattle tick remains attached to animals from the seed tick stage to adult condition; if removed from its host during this parasitic period it soon perishes.

7. The adult female tick is more easily destroyed by rainfall and cold than any of the other stages.

8. The conditions lessening the number of broods per season, also aid hibernation.

9. Clean pastures materially aid disinfection.

10. Ticks will not exist upon alluvial pastures unless they (the pastures) are constantly being re-infected by the importation of highland cattle.

11. Pastures may be disinfected by removing all cattle from them for at least one year, as would be the case in a system of rotation of crops.

12. Ticks may be removed from animals by the use of mineral oil, applied either with a sponge or rag, or by plunging animals into a vat containing water upon the surface of which floats a thin layer of oil.

13. Herds may be improved by keeping an imported stock bull in a small disinfected pasture or in a stable. The offspring of this animal will either possess immunity from birth, or acquire it very young.

14. The injection of two cubic centimeters of serum for

each hundred pounds of the animal's weight, given daily for ten days before ticks are allowed to get on the cow, will not prevent the animal from taking Texas fever.

15. The injection of a moderate amount of serum, for ten days, beginning the treatment about the time the animal becomes infested with ticks, does not prevent the development of Texas fever.

16. The injection of a large quantity of serum after the fever has developed does not influence the temperature of the animal.

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