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VETERINARY DEPARTMENT.

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Bovine Tuberculosis.

INTRODUCTION.

The recent public post-mortem examination of the fifteen head of tuberculous cattle belonging to the college herd seems to have awakened an unusual interest in the question of tuberculosis among animals, especially dairy herds, and its relation to human health.

There has sprung up a sudden demand among farmers and stockowners for more minute information regarding the cause, nature and treatment of tuberculosis in dairy herds, as well as the all important question of "disinfection."

The object of this bulletin is to meet this demand; but since the Veterinary Department has recently issued a short report on this same subject, a few wholesome repetitions will have to be indulged in. It has been thought well to append, with comments, a copy of the temperatures taken while testing the fifty-nine animals of the college herd for tuberculosis; and also the results of the test on the recently acquired dairy herd, which consisted of twenty grade cows of different breeds, bought up in one of our western counties and selected for their milk producing qualities and general appearance of perfect health. The fact that ten per cent of this little herd was tuberculous, as shown by the tuberculin reaction and the following post-mortem examination, furnishes material for reflection to those who think there is no such disease as tuberculosis in Kansas cattle.

BOVINE TUBERCULOSIS.

Definition. Tuberculosis is an infectious disease that is caused by the tubercle bacillus, a minute micro-organism belonging to the lowest order of plants, the bacteria. This micro-organism was discovered by Dr. Robert Koch in 1882. Through its discovery Koch was enabled to prove conclusively that tuberculosis in animals, and tuberculosis or consumption in man, are identically the same disease. Through its discovery the dispute as to whether or not tuberculosis is an infectious disease, is also ended. Wherever we find a case of tuberculosis the presence of the tubercle bacillus can be demonstrated. Wherever we find the tubercle bacillus in an animal organ, we have tuberculosis.

No disease can be rationally studied nor successfully treated without a knowledge of its cause. Prevention is today considered the greatest factor in the treatment of all infectious diseases. A thorough knowledge of the cause of a disease can throw the greatest light on methods of prevention.

It will therefore be proper to begin with a study of the tubercle bacillus.

THE TUBERCLE BACILLUS.

As above mentioned, this micro-organism is a bacterium be longing to an order of fungi. Fungi are plants that are destitut of chlorophyll (the green coloring matter of ordinary leaves) and hence connot live on inorganic matter as can ordinary plants, but depend for their sustenance on matter already organized by other living things, plants or animals. Another characteristic of these low organisms is that they grow in the absence of sunlight; indeed, sunlight in most cases is absolutely injurious to them, so much so that a very short exposure will often result in their total destruction. This circumstance accounts for an underlying principle of disinfection and hygiene, as we shall see later on.

The tubercle bacillus is an inconceivably small, one-celled organism, that has the shape of a slender, slightly bent rod. It is from two to five micro-millimeters in length, or about 2/3 the length of the diameter of a human red blood corpuscle. When viewed under a microscope with a magnifying power of one thousand diameters the tubercle bacillus looks like a delicate rod, about 1/8 of an inch in length. Eight thousand of these bacilli placed end to end would make a line about an inch in length. A single layer of them over a surface one inch square would contain more than four hundred millions.

When placed in a suitable medium, the tubercle bacillus grows and multiplies by a process of simple division. A single cell increases in length, divides at the middle and two new cells, or bacilli, are the result. This process goes on rapidly and indefinitely as long as suitable food material is present. The tissues of the animal body are the most favorable medium for the growth of this germ. A great many disease germs, indeed most of them, have the power of living and propagating either in an animal body or outside of it; in dead organic matter of any kind, vegetable or animal. Some germs prefer one kind, others prefer another kind. They can remain indefinitely under such conditions when they are not disturbed by the presence of sunshine. Continued sunshine checks the growth, just as continued absence of sunlight cheeks or retards the growth of higher plants and finally destroys them. In the absence of sunlight the disease germs just referred to can adapt themselves to either a parasitic life in the body of an animal or they can exist outside of the animal body with equal facility. Parasites of this kind are called facultative parasites. The tubercle bacillus does not belong to this class. This germ is a true parasite; it can grow and multiply, (so far as we know, under natural conditions) in a living animal body only. Outside of the animal body it can exist or retain its vitality for a certain time, and when again introduced into an animal body it will again grow and multiply; but otherwise it would finally perish. A parasite of this kind, one that depends entirely on an animal body for its growth and development, is known as a true or obligate parasite. Such a one we have in the tubercle bacillus. The knowledge of this fact is of the greatest importance; it means that diseases that are produced by obligate parasites can be wiped out of existence, if the sacrifices necessary to bring about the proper conditions are made.

A great many bacteria, when placed under certain conditions, usually conditions unfavorable for their growth, develop within themselves a minute oval or roundish body called a *spore.* This spore corresponds to the seed in higher plants. Like a seed it has the power of remaining dormant or inactive for a very long time; and when suitable opportunity is afforded it germinates, develops into a bacterium, and this latter multiplies by division, as before explained. From a pathological point of view the most important characteristic of spores is their great power to resist the destructive action of various agents called disinfectants.

To illustrate:

The bacillus of Anthrax is killed by continued exposure to a temperature of 131 degrees Fahr. A one three-hundredth per cent solution of corrosive sublimate also destroys it.

The spores, on the other hand, resist the boiling water temperature for over an hour. Artificial cold of 166 degrees Fahr. below zero has no effect on their vitality. And it requires ten minutes for a one-tenth per cent solution of corrosive sublimate to kill them.

This is enough to show the importance of so-called spores of disease germs.

Although less is known about their properties, it is believed that tubercle bacilli also develop spores under certain conditions.

THE TUBERCLE BACILLUS AND ITS RELATION TO ANTISEPTICS.

Since the tubercle bacilli form spores, their power of resisting the destructive action of disinfectants is very considerable. Outside of the animal body, however, they soon die; the continued action, for a few hours, of strong sunlight is capable of destroying them. For this reason the development of these germs outside of an animal body after the manner of a miasma is impossible, and hence tuberculosis is a distinctly contagious disease.

On the whole, however, and compared with other disease germs, tubercle bacilli are quite resistant to the action of external agencies; e.g., in common water they remain virulent (disease producing) 120 days. Tuberculous sputum of man has been known to remain virulent 226 days. When diluted with four hundred thousand times their bulk of water, and introduced into the abdominal cavity, they are still capable of producing tuberculosis.

The action of steam at 212 degrees Fahr., must be continued for fifteen minutes before the germs are killed in dried sputum. Dry heat of the same temperature requires an hour to produce the same effect.

Tubercle bacilli in milk are killed by heating it to 185 degrees Fahr.

One-tenth per cent solutions of corrosive sublimate will destroy the bacilli in one-twelfth their bulk of sputum in 24 hours.

Five per cent solutions of carbolic acid or creolin have the same effect.

On the other hand—concentrated solutions of common salt, drying, freezing, alcohol and putrefaction processes, have no effect upon the vitality of the tubercle bacillus.

In the production of all contagious and infectious diseases two causes may be considered as acting, viz., the *exciting cause* which we have just considered somewhat at length (as the tubercle bacillus) and the predisposing cause, or causes, a discussion of which may now properly follow.

THE PREDISPOSING CAUSES OF TUBERCULOSIS.

It has long been observed that tuberculosis or consumption occurs most frequently in certain families; among human beings this is just as noticeable, as, or perhaps more so than, among the lower animals. The first and perhaps natural inference was that the disease was transmitted by inheritance. For a great many years this was the generally accepted theory, and not until. the infectious nature of the disease began to be suspected, did doubts arise as to the correctness of this view.

Since Koch's discovery that tuberculosis was invariably caused by the tubercle bacillus and by nothing else, and that the tubercle bacillus produced tuberculosis and no other disease, the peculiar fact that tuberculosis *runs* in certain families had to be re-explained.

It is explained in this way. When infectious diseases like smallpox, yellow fever, etc., occur in the form of an epidemic it is noticed that certain individuals are always attacked first, others later, and still others not at all. Some experience a light attack and recover; others have a severe attack and die. We explain this by saying that the latter class of persons is *predisposed* to take the disease. Some animals and some men are more predisposed, that is, they have less power to ward off an attack of disease, than others. The greater an animal's predisposition, the easier will be the attack, and the greater will be its suffering as a consequence.

Just as certain physical characteristics, such as size, form and color, are transmitted from parent to offspring, certain biological characteristics, of which predisposition to disease is one, are also transmitted.

The predisposition to attack by tuberculosis; in other words, the inability to resist an attack by this disease, is inherited.*

*This points to the doubtful advisability of breeding from affected animals.It is well known that animals free from tuberculosis can be bred and reared from slightly affected dams; but this offspring must be considered more liable to contract the disease than offspring from originally healthy animals.There is little if anymore reason in favor of trying breed healthy animal from diseased ones than there is for trying to breed a milk cow from a beef cow.When we try to raise milk cows we begin with the best milk cow we have. When we breed for health. why not make it a rule to start with the healthiest animal at our disposal?Health is just as likely to be inherited as a predisposition to tuberculosis.

In exceedingly rare cases the disease itself is inherited. But how rarely this actually takes place in human beings may be inferred from definite statistics gathered among animals.

Of one million calves slaughtered for veal in Munich from 1878-1882 only five were found with congenital tuberculosis. In Berlin, 1885-1886, of 80,000 calves only seven, in 1886-1887 of 90-000 only six were found tuberculous. In Augsburg (1873-1886) of 230,000 slaughtered calves only nine were found tuberculous. In 1889, in Prussia, of 370,000 calves 73 were tuberculous, or 0.02: per cent. These figures are somewhat lower than they should be because many cases of abortion are due to congenital tuberculosis, and these of course are not found on slaughter house records. But taking even that into account we see that congenital tuberculosis is much more rare than is commonly supposed.

To go back to the question of why tuberculosis runs in families, one other factor besides the inheritance of predisposition must not be forgotten. An animal or child born of tuberculous parents inherits one thing more, it inherits the chance (if the expression may be used) to become infected. It constantly associates with a tuberculous mother, and is exposed to every danger that such a tuberculous mother creates by her presence. Stables that contain tuberculous animals, or dwellings with consumptive persons, are a source of danger to any one, but infinitely more so to a young being that is constantly exposed.

Now the question arises, if the tubercle bacillus, together with the various predisposing causes, produces the disease by entering the system and developing there, how does the tubercle bacillus gain entrance into the animal body?

Briefly stated, this germ, like many others, may enter the body in one or all of three or four ways.

1. It may be inhaled directly into the lungs, in the form of dust; to the particles of which the germ clings.

The germ itself has no power of moving, nor of flying in the air; but when matter containing it (sputum and other material coughed up from the lungs, feces from animals with intestinal tuberculosis, etc.) dries, it may be reduced to dust; and this dust when carried into the air by the wind takes the germs with it. A single particle of dust may contain innumerable germs.

When thus inhaled the germs lodge in the lungs or air passages, and if conditions are favorable they remain there and develop, and produce pulmonary tuberculosis. This method of infection is common in cattle and in man.

2. This germ may be taken directly into the stomach and digestive tract by means of food containing it, most commonly meat or milk from tuberculous animals, or meat from healthy animals contaminated with tuberculous offal. This would produce an intestinal form of tuberculosis, and is common in pigs and poultry.

3. The germ may enter the tissues directly through a wound in the skin and produce either local or general tuberculosis. This method of infection is not common and is most frequently produced experimentally in the lower animals.

4. Infection through the genital organs is also possible.

HOW THE TUBERCLE BACILLUS IS DISSEMINATED.

The source of the tubercle bacillus is always, directly or indirectly, animal tissue containing it.

Animals affected with lung tuberculosis cough up dead pieces of lung tissue, sometimes pus and mucus, that contain the bacilli. The feces of animals with intestinal tuberculosis often contain them. These ejecta are scattered about more or less promiscuously. They are reduced to dust, carried into the air by a gust of wind, and inhaled. Tuberculous meat and milk are another fertile vehicle for the dissemination of this germ. Among human beings the bed clothes, handkerchiefs, wearing apparel, carpets in rooms of tuberculous patients, the dust on the floors of public buildings, street cars, railroad coaches, etc., are good places to look for the bacillus tuberculosis

The mangers from which tuberculous animals feed, and into which their nasal secretions drop, can readily act as carriers of the contagion. Contact of the animals themselves, by licking, smelling, etc., is another means of contagion. Finally, hay, straw or feed of any kind kept in a barn harboring infected animals; beams, floors, posts, etc., with which such animals have been in contact, can each and all act as carriers of the infectious material.

After dissemination in this manner it can readily be seen how an animal or person may take the germs into its (or his) system.

EXTENT OF TUBERCULOSIS.

Tuberculosis is one of the most widely distributed diseases. It occurs in all countries and in all races of men, and few of the domesticated animals are exempt from its attacks.

Among human beings, one-seventh of all recorded deaths are due to tuberculosis. This does not include the great number of cases of this disease that are cut short by death from other causes.

Among cattle it is the most common and widely spread disease, and there is no doubt that this is the most frequent source of infection for human beings, except, of course, infected human beings themselves.

The disease occurs in cattle more frequently than in other animals; it will therefore occupy our chief attention. Among hogs tuberculosis is much more common than is supposed, even by men that ought to be informed on the subject. In Berlin in 1883-5 0.4—0.9 per cent of all slaughtered hogs were found tuberculous. In Copenhagen 3.0 per cent were found affected. In chickens tuberculosis is also very frequently met with.

Sheep and goats, horses, asses and mules, dogs and cats, are affected, but not so commonly as the above named animals.

Animals kept in confinement, under unnatural conditions, as in zoological gardens, often fall victims to tuberculosis. In monkeys it is common, and it is observed in lions, tigers, bears, dromedaries, jackals, panthers and rodents of many kinds. But to return to the ox, the subject of this bulletin:

No breed of the bovine species is exempt from possible infection with tuberculosis. It is true however that certain breeds are attacked more frequently than others. Breeds that originate or inhabit wet lowlands always show a higher percentage of cases of tuberculosis than do those of dry highlands. Stabled cattle and pampered pure breds show a higher percentage than scrubs roaming wild over the plains. The reason for this is evident enough. The former classes are subjected to more unsanitary conditions, and greater exposures to infection. Overfeeding with poorly selected rations and unscientific attempts to develop animals for special purposes, inbreeding, etc., reduce the vitality of an animal or breed and thus lessen its power to resist an attack of disease. This applies not only to tuberculosis but to all diseases.

Below are given a few statistics to show the prevalence of tuberculosis among cattle.

The figures given, as will be seen, are mainly from German reports. These seem to be more reliable than those of other countries because there the system of meat inspection is most perfectly organized; and through the records of the slaughter houses alone can extensive observations of this kind be gathered, most animals, at slaughter age, showing no external symptoms of the disease whatever.

In the whole German Empire, during the year 1888-1889, from *two* to *eight* per cent of *all cattle* have been estimated as being tuberculous, and this is supposed to be an under estimate.

The different German states furnish the following figures

Prussia, 5 per cent (6-7 per cent of all cows.)
Saxony, 8 per cent
Bavaria, 3 per cent
Baden and Hesse, 2 per cent.
Province of Pommerania, 16 per cent.
W. and E. Prussia, 3 per cent.
Magdeburg, 12 per cent.

The actual slaughter house records show the following percentages:

Munich, 2-11 per cent.
Berlin, 2-5 per cent.
Chemnitz, 3-5 per cent.
Goldberg, 20 per cent.
Leipzig, 4 per cent.
Bremen, 2 per cent.
Copenhagen, 16 per cent.
Paris, 6 per cent.
Belgium, 4 per cent.
Saxony, 1889—1-16 per cent. 1888—½ to 22 ½ per cent.

Reliable statistics showing the prevalence of tuberculosis throughout the United States cannot be obtained for the simple reason that enough ground has not as yet been worked over. Estimates by the Bureau of Animal Industry place the figure for some of the eastern states at 2 ½ to 3 ½ per cent of all cattle, but this is undoubtedly too low. This figure is much lower than the figures given for Germany, for two reasons perhaps: tuberculosis is undoubtedly of less frequent occurrence in this country, owing to the less crowded and consequently more sanitary conditions under which the cattle are kept, and secondly, our statistics upon which estimates are based are not nearly so complete as they are for Germany. Our machinery for obtaining them is more recently introduced and consequently less thorough in its results. However much too low these figures may be they are high enough as they are to demand our serious attention.

There exists in this state a wide spread and well rooted belief that the climate of Kansas is such that tuberculosis cannot develop. While it is true that a dry climate like that of Kansas is much less conducive to the development of this disease than the humid climate of some of the more eastern states there can hardly be a doubt but that the time has arrived when something should be done in Kansas to at least determine the extent to which the disease exists.

The less we have of this disease in our state the more do our stock interests demand that attention be given to this subject.

Tuberculosis could now be exterminated at a less cost than will ever again be possible.

The dairy interests in this state are growing wonderfully. Every dairyman knows that this means more artificial conditions for our cattle. Our cows will be housed more in the future, they will be fed more and richer food and their systems will be taxed more. This means development of certain organs at the expense of others, and at the expense of disease resisting power. Farmers contemplating the introduction of a dairy as part of their farm work cannot study this question too closely. Science has discovered means to select cattle free from tuberculosis and to keep them free from it. Farmers should take advantage of these facts. But more of this later on.

Of the 59 head of pure bred cattle at the college farm 15 were found tuberculous at the November *post-mortem* examinations.

On the strength of the prevailing belief that Kansas cattle are free from tuberculosis the remainder of this herd was disposed of and a small herd of twenty Kansas cows was bought in one of our western counties for the purpose of establishing a small dairy, (for instruction purposes) at the college. These animals were fair representatives of the grade cattle found throughout the state. They were selected at random, and each and every one as far as physical examination and general appearance could indicate, was in perfect health. As soon as these animals had been stabled for a sufficient length of time to become accustomed to their new environments, they were tested with tuberculin; 10 per cent of this herd proved to be tuberculous. The record of their temperatures together with those of the 59 head constituting the college herd will be found appended.

The fact that 10 per cent of this little herd proved to be tuberculous of course proves nothing but the existence of tuberculosis in some of our herds. To what extent this disease actually exists must be determined by extensive tuberculin tests throughout the state. This work has been planned to go into effect in the near future.

The extent to which tuberculosis is sometimes found to exist is shown in bulletin 51 of the Veterinary Department of the University of Minnesota. Of 3,430 animals tested with tuberculin,

7.8 per cent of the natives were found tuberculous,
10.8 per cent of the high grades,
16.6 per cent of the pure breds,
14.2 per cent of farm herds, or 7.8 per cent if 55 animals from two herds are omitted.
10.4 per cent of city dairy herds,
10.1 per cent of herds kept under "good" general condition of stables.
7.28 " " " " " under "fair" condition of stables.
19.1 " " " " " under "poor" " " " " "
9.8 " " " " . " in stables with good ventilation.
6.16 " " " " " " " " " fair " "
16.6 " " " " " " " " " poor " "

"The data submitted (in this table) was collected in the most impartial way that could be devised and was not collected with a view to establishing any theory or to promote any argument; but is merely a showing of cold facts and is offered for what it is worth, not as proving anything but merely as so much circumstantial evidence"*

SYMPTOMS OF TUBERCULOSIS.

Tuberculosis is characterized by its slow and chronic course. The earliest stages of the disease produce no observable symptoms whatever; even in very advanced stages the affected animals may be in good flesh and in apparently perfect health. As a rule, however, after the disease has existed for some time and has made some progress in its development various groups of symptoms, that differ according to the seat of the attack, will appear.

The very first symptom that may follow infection is a slight fever, but as this soon passes away it is rarely noticed; the animals accustom themselves to their morbid condition and live on as before, with general health, appetite and spirits little affected.

The symptoms of the advanced stages, when noticeable, may be grouped under the following heads, depending on the seat of disease.

1. PULMONARY TUBERCULOSIS.

When the lungs are affected there may develop a short, dry,

*Minnesota Bulletin, No. 51.

dull cough which gradually becomes more and more distressing to the animal. Later on the cough may be attended with more or less copious discharges, through the nostrils, of purulent mucus containing particles of broken down lung tissue swarming with tubercle bacilli (which of course can be detected with a powerful microscope only). These symptoms are usually most prominent early in the morning after the animals rise, or after drinking water, or taking exercise.

If the lungs are examined by placing the ear on the ribs opposite them, various kinds of abnormal sounds can be heard; rubbing, grating, gurgling, etc., depending on the condition and character of the lesions present. Sometimes no sounds whatever can be heard in certain areas, indicating that the process of breathing is entirely interrupted. Abnormal sounds can best be recognized as such by comparing them with the sounds heard in a healthy animal.

Later on the animal begins to "run down in condition." The mucous membranes of the mouth and eyes become pale, the eyes are sunken, the skin is hard and dry and the coat of hair rough; the animals get thin and thinner, lose appetite and spirits, breathe in a distressed manner, get weaker and weaker and finally die of sheer exhaustion. The time when the animal begins to run down and show plain, external symptoms depends to a great extent on the general care it has been receiving in the form of food, shelter and general sanitary surroundings.

TUBERCULOSIS OF THE INTESTINES AND ABDOMINAL ORGANS.

The symptoms of this form of disease are usually much less pronounced than those of the previous form. Sometimes severe diarrhoeas that often become chronic set in; sometimes periods of diarrhoea and constipation alternate. In advanced stages the same general symptoms noted under pulmonary tuberculosis will appear. When the ovaries and uterus are affected an abnormally frequent desire for the male (nymphomania) may be manifested. Cows come into heat with abnormal frequency and remain in that condition an unusual time. They often fail to breed, or when they do breed, abortion is a common result. Discharges from the genital organs may also occur. Abortion is often the first indication of tuberculosis in a herd of cattle, although, as a rule, abortion is produced by other causes.

TUBERCULOSIS OF THE BRAIN AND SPINAL CORD.

This produces symptoms similar to or identical with many other nervous affections—great excitability, raving madness, cramps and spasms; or the reverse, great dullness, paralysis, peculiar gait, etc.

This form cannot be diagnosed as such and can only be suspected when other marked symptoms of other forms of tuberculosis are present.

TUBERCULOSIS OF THE UDDER.

The symptoms of this may attend those of the previously described forms, or they may occur independently. Usually there is a diffuse (scattered) painless, but firm swelling noticeable in one, rarely two, and usually the *hind* quarters of the udder.

The affected quarters may also take on a knotty appearance; they grow harder and harder as the disease progresses; becoming sometimes almost stonelike.

The character and appearance of the milk is usually unchanged (contrast with milk in acute inflammations and other diseases of the udder); and not until the disease is quite advanced are noticeable changes present, the milk then becoming flaky, thin and watery. The milk often contains tubercle bacilli in enormous numbers, and when fed to man or other animals, especially pigs (which are popularly supposed to be proof against tuberculosis) it will produce tuberculosis. This is not theory, but fact demonstrated by numerous experiments.

The lymphatic glands situated above and behind the udder are often enormously enlarged.

GENERAL TUBERCULOSIS.

The symptoms of this form are various combinations of all those already mentioned, more prominent or less so according to the importance of the organ or organs most seriously affected.

When bones and joints are attacked the affected parts may become enlarged, and stiffness or lameness may result.

HOW TO DIAGNOSE TUBERCULOSIS.

None of the symptoms above outlined will serve to diagnose a case of tuberculosis within a reasonable degree of certainty, at least no one but an expert could presume to assume such responsibility.

The fact that an animal coughs, or is out of condition, or has a discharge from its genitals, or aborts, or has a hard and knotty udder, or a swollen joint or gland, does not necessarily indicate that it is affected with tuberculosis. Many other affections of a much less serious nature show these same symptoms. Only when these conditions are considered in connection with other things, especially their history, the manner of their occurrence, the condition of other animals kept in the same stables, the known previous occurrence of tuberculosis in one or another herd, etc.,—then only can tolerably safe conclusions be drawn. A layman can not draw reliable conclusions in this case. He can at most suspect this disease to be present. In most cases even the skilled veterinarian can not begin to detect the disease by ordinary means-

Fortunately, science, through the medium of Dr. Robert Koch, that eminent investigator, has provided a method by which even the slightest cases of tuberculosis can be detected; cases so slight that it often requires no ordinary amount of skill and knowledge to discover the lesions in a slaughtered animal, lesions that might not become recognizable in the living animal after months or even years; and still such an animal, apparently in perfect health, might constitute the medium through which other animals became affected. This invaluable diagnosticum is tuberculin.

TUBERCULIN.

Tuberculin is a product (an excretion, so to speak) of the tubercle bacillus (the cause of tuberculosis); it is present in the bodies of all tuberculous patients.

It was prepared artificially by Dr. Robert Koch by growing the tubercle bacillus in a nutrient medium, and then separating the tuberculin resulting from this process of growth by means of heat to kill the germs and filtering processes to remove the dead organisms.

The first object in preparing this toxin (tuberculin) was to use it as a curative agent in human beings. For this as well as for diagnostic purposes in man it proved a failure. In cattle, however, it has proved to be a diagnosticum, not infallible to be sure, but nevertheless of the greatest value and importance. It has opened the way for the possible extermination of this disease from our herds of cattle.

The use of tuberculin as a diagnostic agent is based on the circumstance that when a certain quantity of this substance is injected into the tissue of an animal affected with tuberculosis, no matter in what stage of development the disease may be, a distinct temporary fever is the result. That is, the animal's body which has a normal temperature of 102 degrees Fahr., (varying somewhat with age, sex, individual, time of day and other conditions, pregnancy, etc.) will in the lapse of six to eighteen hours, (average fifteen hours,) after the injection, indicate a temperature of two or more degrees Fahr., above the normal or usual temperature. This increase of temperature is spoken of as the *reaction,* and must, in order to be of serious significance, continue for several hours; as a rule it should last six, eight or ten hours, or longer, but sometimes a shorter duration is observed as shown in cow number seventy-two of the grade dairy herd. When such cases are observed we can usually find a cause for the sudden drop in temperature. In this case the fact that the animal drank a large quantity of cold water furnished the explanation. Sometimes animals reacting in that way prove to be free from the disease.

Under ordinary conditions all animals that react will be found to be tuberculous. Single exceptions are found only among large numbers of cases of disease. As a rule, the animals that do not react have the disease in such an advanced stage that it can be detected by physical means.

Sometimes perfectly healthy animals e.g., cows heavily in calf;* animals affected with actinomycosis or lumpy jaw, lung abscesses, liver abscesses, mastitis or garget, caseated and calcified echinococci, etc., may react, but many of these cases can often be diagnosed as such, and serious mistakes need not result if the examination be made by a competent and experienced man.

Because affected animals sometimes fail to react it is customary to repeat the "tuberculin test" after the lapse of a month or six weeks on all doubtful animals, and in that way discover the remaining cases. If the test is repeated before the lapse of four to six weeks the results are not trustworthy.

POST-MORTEM APPEARANCES.

The anatomical changes brought about by this disease are most frequently found in the lungs and on the *lining membrances* (serous membranes) of the lungs and chest cavity, and of the abdominal cavity. When these organs are attacked the lymphatic glands which are in connection with these places are always attacked also. In generalized tuberculosis every organ in the body may show some morbid changes, and on the other hand, the morbid changes may be limited to a part of a single organ.

The characteristic change resulting from the presence of tuberculosis is the so-called tubercle. The tubercle is the result

*See record of Genteel II, No. 40 and 80 CollegeHerd: also illustration Fig. 10

of the colonization and development of the tubercle bacillus in the animal tissue. At first these tubercles are microscopic in size, they gradually increase in size until they become as large as a millet seed or larger. Through processes of further growth and union with each other, and finally through death and disintegration, these original tubercles give rise to the various sized but always conspicuous nodules, variously outlined, and containing within their centers masses of a cheesy, yellow pus. At first this is comparatively soft, but as it gets older it becomes firmer, and finally gritty or even stonelike in texture. There is always a distinct, tough tissue capsule surrounding each focus of pus. When such an abscess is located near a bronchus (large air tube in lung) it may occur that it breaks, discharges its contents into a bronchus, is coughed up by the animal, and with the germs it contains is scattered around to the risk of other victims.

The advanced tubercles are of various sizes and shapes. On the serous membranes of the thoracic and abdominal cavities they range from smooth millet seed and pea-like nodules to enormous conglomerations resembling huge bunches of various sized grapes, hence the name "pearly disesse" and "grapes" that was sometimes applied.

The mass of tubercles present on the serous membranes alone, in a case recorded by Spinola, had a weight of fifty-two pounds, while another weighed seventy pounds. Sometimes, however, only a very few are found, and occasionally the morbid change is limited to a slight adhesion of a portion of the lung to the thoracic wall.

When in a certain stage of advancement these nodules contain cheesy or partly calcifled (gritty) centers.

Other places where these cheesy abscesses are commonly found are the *lymph glands* situated between the two lungs, before and behind the heart (anterior and posterior mediastinal glands), which sometimes enlarge to tuberculous tumors eighteen inches long! The glands behind the upper end of the windpipe (retropharyngeal glands), the glands between the kidneys (renal glands), and those under the liver (portal glands) are also commonly affected. The lungs, liver, spleen and kidneys themselves may be literally packed with tuberculous abscesses, or, one of these organs may contain only a few.

As before stated, any tissue or organ of the body may be more or less affected, but the process is always most marked and

Fig. 1

Fig. 2

Fig. 3

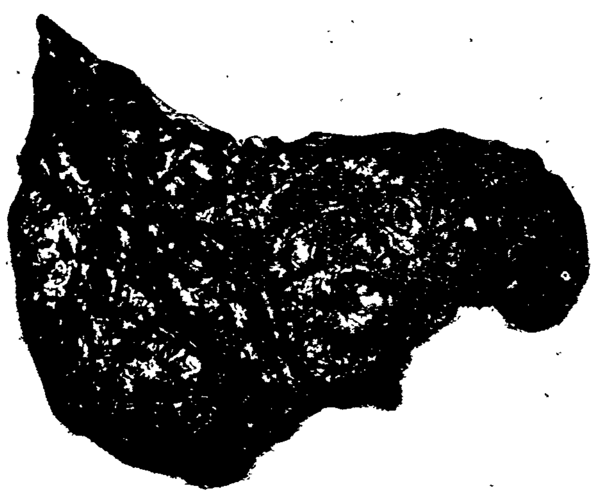


Fig. 4

FIG. 5

EXPLANATION OF PLATES

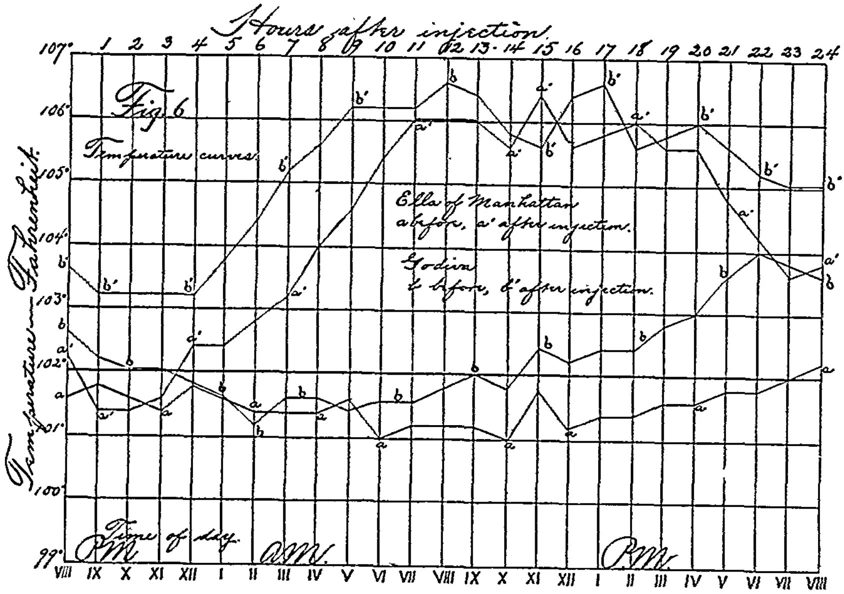
FIG. 1. Liver of Short Horn Cow No. 10, Carry, showing large tuberculous ulcers in the liver.

FIG. 2. An enormously large tubercle about 14 inches long, laid open to show numerous, small, caseated centers scattered through it. From region anterior to right shoulder--Polled Angus Cow No. 2, Ella of Manhattan.

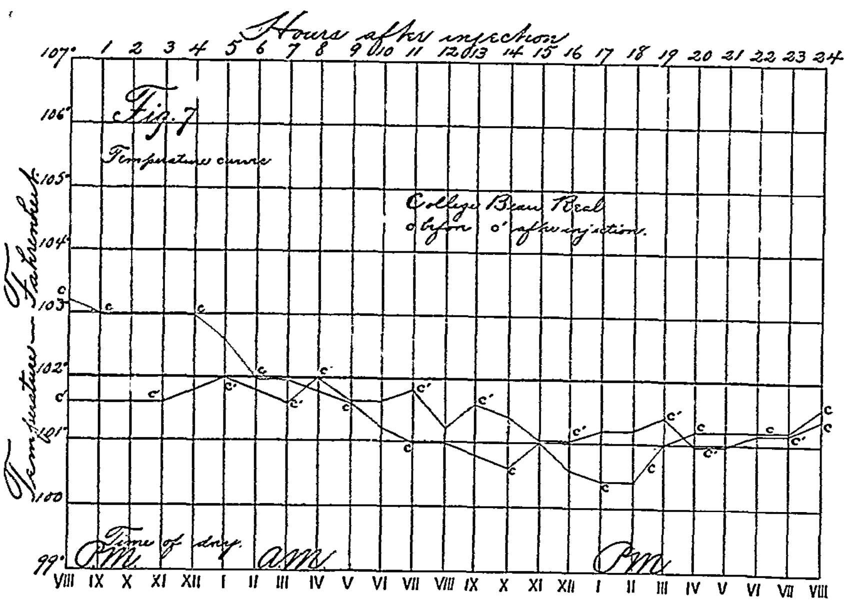
FIG. 3. External nodular surface of an extensively affected lung, From Short Horn Cow No. 4, Godiva.

FIG. 4, Section through tuberculous lung, showing the lighter colored, round or oval, caseated tubercles. From Short Horn Cow, No. 4, Godiva.

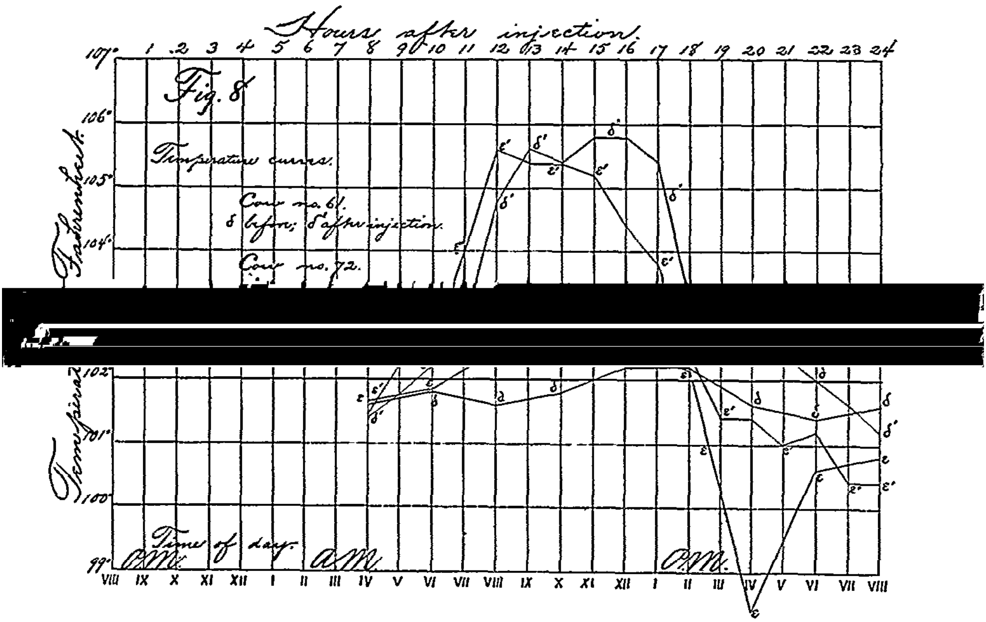
FIG. 5 Bronchial gland with caseated foci. From Short Horn Cow No. 8, Gleeful II.

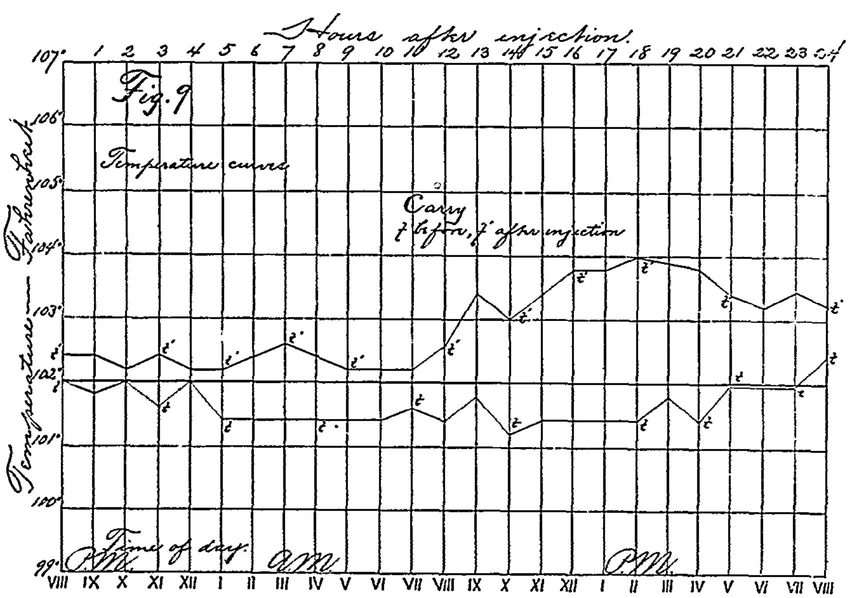


ELLA OF MANHATTAN—Number 2 in temperature table.
GODIVA—Number 4 in temperature table.

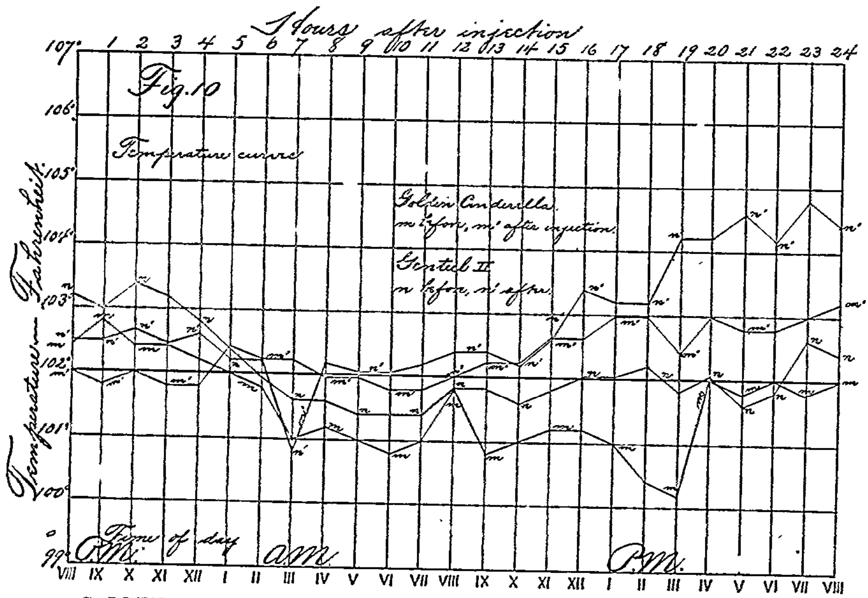


COLLEGE BEAU REAL—Number 57 in temperature table.

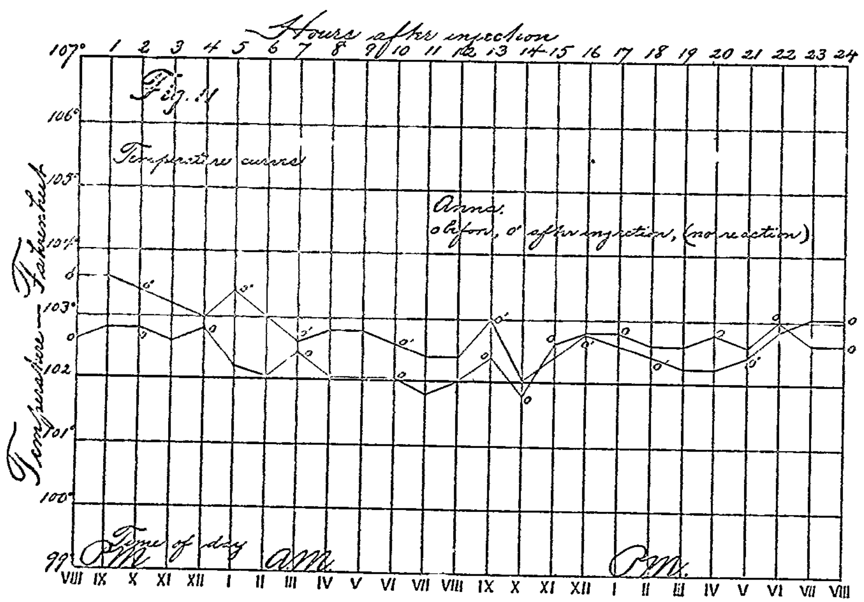




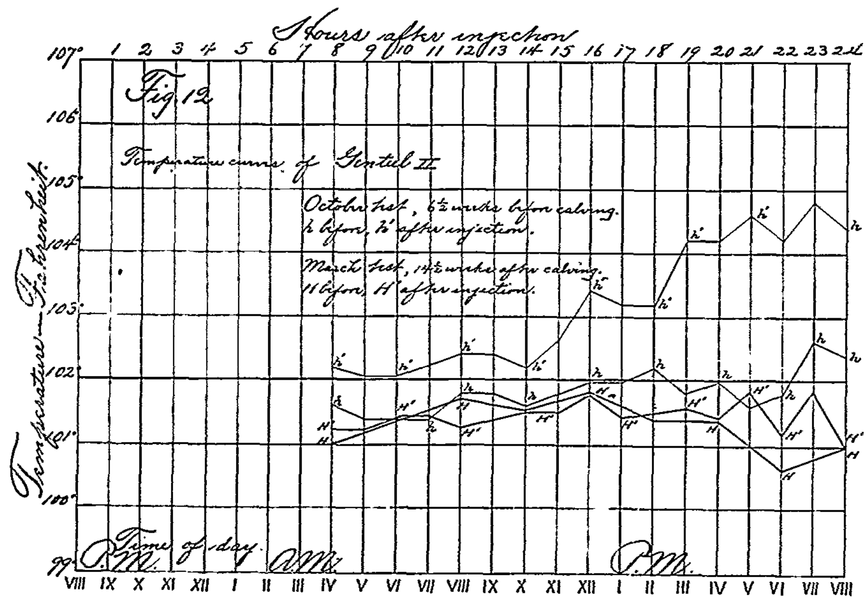
CARRY—Number 10 in temperature table.



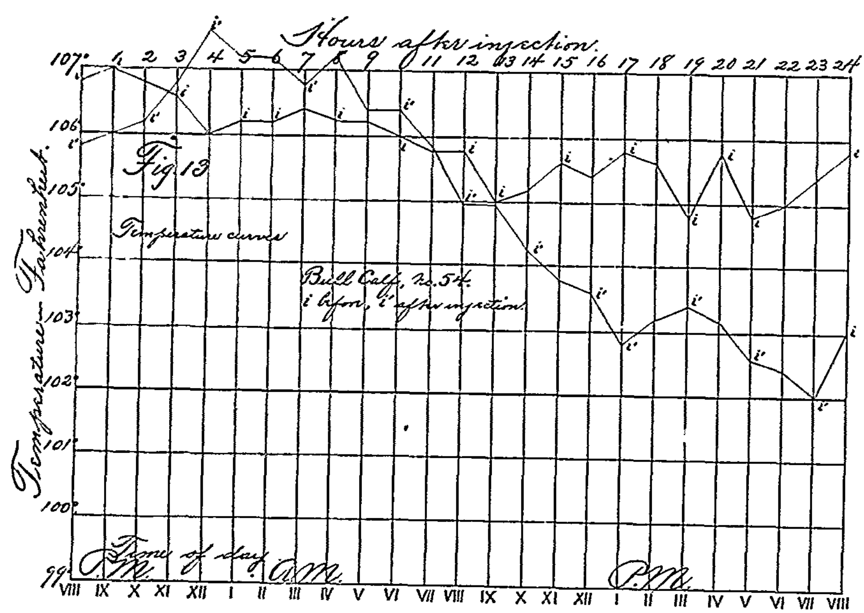
GOLDEN CINDERELLA—Number 37 in temperature table.
GENTEEL II—Number 40 in temperature table.



ANNA—Number 31 in temperature table.



GENTEEL II—Numbers 40 and 80 in temperature tables.



characteristic in those organs or clusters and chains of organs known as lymphatic glands. A chain of these organs, situated above the intestines in their supporting fold, is the chief seat of changes in intestinal tuberculosis.

Sometimes the lining membranes of the stomach and intestines contain tuberculous ulcers. All of these abscesses, but especially their enveloping tissue capsules, contain tubercle bacilli.

(*See plates for illustrations of morbid changes in various organs.*)

DISPOSITION OF TUBERCULOUS CATTLE.

The question now arises, what is to be done with the affected animals after they have been discovered in an infected herd? This is the most important question in the whole subject of tuberculosis. As soon as the disease is discovered and the affected animals have been singled out they should be separated from the rest of the herd and kept under quarantine until the method of their final disposition is determined. The treatment of the remaining healthy animals is discussed later on.

As to the diseased animals; those visibly affected should be immediately killed and their carcasses destroyed by fire or deep burial. Either method should be carried out as near as possible to the spot where the killing is done and the post-mortem examination is made, because moving affected carcasses after they have been opened simply increases the opportunities for spreading the infectious material.

Cattle that have reacted but are apparently in good health could be disposed of in the same way as the above, but it would entail a loss that could not or at least would not willingly be borne by many owners, and hence such a suggestion would stand in the way of successfully combating this disease. There is another way out of the difficulty; a method involving so small a loss that if every cattle owner in the state would avail himself of it we could soon rid our herds of the disease at the smallest possible cost. Before discussing this question further, a few general statements are necessary.

The meat and milk, butter and cheese, from tuberculous animals may, and in a great many cases do, prove to be the source of infection of human beings.

This has been demonstrated by experiments with the lower animals.

On the other hand it has also been demonstrated that these same products from animals with undoubted tuberculosis can often be fed with impunity to susceptible animals without producing any serious consequences.

These two apparently conflicting statements rest on the fact that certain forms of tuberculosis have an entirely different nature as far as danger of infection from feeding affected carcasses is concerned. When the disease is strictly localized, the affected parts and certain organs in intimate relation with them are alone dangerous. When the disease is generalized or in any degree extensive, the whole carcass, including of course the milk, is dangerous.

A competent meat inspector can determine when the carcass from an affected animal is fit for human consumption and when it is dangerous and consequently unfit to be put on the market.

If, therefore, proper provision were made for their thorough inspection before being placed on the market, the cattle which are in apparent health, but have reacted under the tuberculin test, could be fattened and sold for beef. We would then have placed on our markets carcasses of animals slightly affected with tuberculosis; but from which all parts that could in any possible way be dangerous had been removed under the supervision of men trained for that business.

As matters now stand, tuberculous cattle in all stages and in all forms of the disease are sold indiscriminately by unscrupulous or ignorant or at the least uninformed butchers, and there is no possible way for the public to protect itself.

By following the plan here suggested, i.e., by the establishment of meat inspection within the state, the placing of such a system into operation under skilled men, and by using quarantine precautions against imported cattle to prevent renewed importation of the disease, the state of Kansas would soon solve the tuberculosis question.

Similar plans have been adopted by Massachusetts; but in that state the disease is so much more common and all affected animals being wholly condemned the expense to that state is enormous compared with what it need be in Kansas.

The sooner this question is taken up by the state of Kansas the more will be accomplished at the less cost.

The introduction of a compulsory general meat inspecting system in the state of Kansas would affect not only the existence of tuberculosis, but it would control the spread and thus prevent the occurrence of a great many parasitic diseases in man, of which tapeworm disease, trichinosis and botulism are only a very few. The effect that such a system would have in preventing these diseases is not a matter of speculation, it is a matter of figures and statistics that are decided enough to convince anyone inclined to entertain doubts. The hospital records of parasitic diseases in most meat inspection countries present astounding contrasts when periods before and periods after meat-inspection has been practiced are compared. Such diseases diminish rapidly in number under those conditions, and meat inspection alone is responsible for this.

AFTER TREATMENT OR DISINFECTION.

The after treatment of a tuberculosis infection applies of course only to the remaining healthy animals and the quarters occupied by them.

As before intimated, rearing healthy calves from slightly affected tuberculous dams is a practice that should not be encouraged; there are enough healthy animals for this purpose.

The treatment for the remaining healthy animals consists in keeping them in non-infected quarters, giving them pure food and water, judicious exercise and an abundance of fresh air and sunshine; all of this is necessary for the permanent maintenance of health. Unscientiftc inbreeding and injudicious breeding for special purposes should be avoided.

When new purchases are made into a herd a clear bill of health should be obtained for every newly acquired animal. The tuberculin test will decide this.

Bulls used for breeding purposes should be known to be free from tuberculosis, and from every tendency toward acquiring it. In this manner and in this manner alone can we keep a herd free from a disease so insidious and wide-spread as tuberculosis.

One more important thing must not be neglected if all expense in the past and all care and management in the future are not to be in vain. The barns, sheds, or stables that were used as shelter for the affected cattle are infected and constitute a source of danger to other cattle that are kept in them for any considerable length of time, and no less so to the attendants of these animals.

To make these places safe they must be *disinfected!* In order to disinfect properly the work must be done thoroughly; disinfection is one of those things that cannot be done halfway. Halfway disinfection is no disinfection at all.

The direct object of disinfection is to destroy disease germs. We have seen how inconceivably small these things are, and in how many different ways and through what various channels they can be spread and become lodged in secret hiding places. In the minutest particles of dirt, the smallest holes and finest cracks, these germs may be hiding in untold numbers.

All these places must be reached with the disinfecting fluid. This may seem a simple and trivial thing, but nothing in the whole question of tuberculosis is of greater importance.

The disinfecting fluid may be one thing or another, many solutions of chemicals in water will answer the purpose. The cheapest and most effective, perhaps, is corrosive sublimate or bichloride of mercury in two per mil solutions (one-fifth of one per cent) or approximately one pound of corrosive sublimate dissolved in sixty (60) gallons of water; (accurately, 62 1/2 gal.) It is very important that the chemical is thoroughly dissolved in the water; in order to accomplish this it is best first to dissolve all in a small quantity of hot water and then to mix this solution with sufficient additional cold water to make the proper bulk. This solution should be made in wooden vessels as it corrodes metal, and being highly poisonous it should be kept out of reach of children and animals.

A good spray pump is the best instrument for applying a disinfecting solution in a barn or stable: by its use all corners, holes and cracks can be penetrated. In old buildings containing partially rotted floors, sills, walls, partitions etc., it may often be best to do some tearing down and rebuilding, but this question is one to be settled for each individual case. Loose boards must always be removed before spraying.

The one object of disinfection is to reach every speck or spot of surface that has had any possible chance to have the contagion adhere to it. Contact with this solution is sure death to the tubercle bacillus.

It may be needless to state that before the floor of a stable is disinfected all litter should be removed from it and firmly adhering solids scraped off with a sharp hoe, and removed to a safe place.

Although cases of poisoning are no doubt rare it might be well, after the mangers have received their spray, to wash them an hour later with hot water, thus removing all corrosive sublimate which by that time will have done its work, and avoiding all risk of possible poisoning of the animals.

If the procedure above outlined is thoroughly carried out the building may be considered perfectly safe as far as any danger of contracting an infectious disease is concerned.

The healthy animals may now be put back into their old quarters; and the more fresh air and sunlight that is permitted to enter such a building the longer will it be likely to remain pure and free from disease germs.

After this the tuberculin test should be repeated every year for several years and every reacting animal properly disposed of. With such treatment disinfection need be repeated in and for those stalls only in which an affected animal has stood and for the one on each side.

DISPOSITION OF MANURE.

Manure is a dangerous source of infection in cases where intestinal tuberculosis was present. It is a valuable article and its destruction by burning would be a considerable as well as an unnecessary loss. All animals, especially pigs, should be kept away from a suspicious manure pile. At the first opportunity such manure should be hauled out on a level field where no washing or surface drainage occurs, and spread out in a thin, even layer and exposed to the disinfecting action of the sun's rays. A Kansas summer's sun will here easily outdo a two per mil solution of corrosive sublimate.

THE TUBERCULIN TEST.

This subject has already been touched upon, and the principle upon which the results are interpreted, explained. The best practical method to pursue in testing a herd of cattle is first to house or stable them for a sufficient length of time until all unnatural excitement incident to this unaccustomed change has passed away.

We next begin at sx a. m., and take the temperature* of every

*Tho temperatures of animals are taken by inserting the thermometer into the rectum and allowing it to remain there at least three minutes. A self registering thermometer is the only reliable kind. The same person should take all the temperatures of the same animal and with the same thermometer. Insertion of the thermometer is facilitated by moistening it with saliva, or oil if preferable.

animal every two hours untilten p. m., of the, same day. At ten p.m., immediately after taking the last temperature, the animals should be injected† with the tuberculin. The amount to be injected varies with the brand of the article and the size or weight of the animal. The tuberculin manufactured by the Bureau of Animal Industry** of the United States Department of Agriculture is injected at the rate of two cubic centimeters for an adult animal of average size. The amount injected in the test shown by the appended tables was at the rate of two cubic centimeters for every 1200 lb. wt. of the animal, for about half the cases. For the other half the rate was 2cc., for every 1000 lb. wt. Equally good results seem to have been obtained.

At six a.m., on the following morning temperatures should be again taken, this time every hour, and continued for twenty-four hours or until definite results are obtained.

The temperatures of the second day are then compared with those of the first, and if an increase of two degrees Fahr., or for six or eight hours or longer, above the corresponding temperature of the preceding day is shown, the animal may be set down as being tuberculous; unless, as already stated, other reasons can be assigned for the abnormal temperature.

Some animals have abnormally high temperatures to begin with; a temporary fever, pregnancy or other causes may account for this. Such animals should be reserved for a second or later test.

The best way to interpret the results of a tuberculin test is to construct a fever or temperature chart as is shown in figures six to thirteen.

A number of vertical lines are drawn at equal distances from each other to represent the time between hours. Twelve or fifteen of these are usually sufficient to answer the purpose. These are then crossed by another set of similar but horizontal lines, eight in number, representing the degree of temperature, say from 100 degrees Fahr., to 107 degrees Fahr. The spaces between the horizontal lines are divided into fifths or tenths by points or dots placed on the vertical lines. At these points the temperature each hour for two days may be indicated, and the points connected with lines. This forms two broken lines known as temperature curves that represent the variation of temperature during a day, and the

†The injection is made with a hypodermic syringe, into the loose tissue under the skin. and preferably in the region of the neck.

**This brand was used in testing the College animals.

difference before and after injection, in a very graphic manner. The higher and longer the second day curve as compared with the first day curve is found to be, the nearer will it approach a typical tuberculosis reaction curve.

Fig. 6 shows several typical reactions.

Fig. 10 shows doubtful reactions.

Fig. 11 shows no reaction.

Following is the temperature record of the fifty-nine animals constituting the College herd. Some of these animals had been tested once or even more times before. The details of these tests can be found by referring to bulletin 69, pp. 118-121.

Animals Nos. 46, 47 and 48, whose temperatures do not appear in the record, were young calves affected with diarrhoea at the time of the test and hence could not be tested.

Animals No. 53 and 54 were unthrifty bull calves; both had abnormally high temperatures, No. 54 excessively so, both before and after injection; but neither showed any reaction. Both were killed and post-mortem examinations made of their carcasses. As the post-mortem notes show, no unequivocal evidence of tuberculosis was found.

Fig. 13 illustrates the temperature of No. 54.

TEMPERATURE RECORDS

Running Number	Date	Breed	Sex	Age of Animal. Yrs.	Wt. of Animal. Lbs.	Amount Injected	BEFORE			
							A M 6:00	A M 8:00	A M 10:00	A M 12:00
*1	Oct. 13,'97	Holstein Friesian	Female	5.17	1271	2.1 c c	102.2	101.8	101.8	101.4
*2	" "	Polled Angus.....	"	8.11	1448	2.4 c c	101.4	101.0	101.2	101.0
*3	" "	Polled Angus.....	"	9.26	1175	2.0 c c	101.2	101.0	101.2	100.8
*4	" "	Short Horn.......	"	4.24	1370	2.3 c c	101.6	101.6	101.8	101.8
*5	" "	Short Horn.......	"	4.75	1463	2.4 c c	101.4	101.8	102.0	101.2
*6	" "	Short Horn.......	"	6.73	1406	2.3 c c	101.8	101.2	101.4	101.2
*7	" "	Short Horn.......	"	4.70	1430	2.4 c c	101.0	101.6	101.6	101.8
*8	" "	Short Horn.......	"	5.06	1347	2.2 c c	101.0	101.2	101.2	101.0
*9	" "	Short Hopn.......	"	5.08	1257	2.1 c c	101.4	101.4	101.2	100.8
*10	" "	Short Horn.......	"	5.06	1266	2.1 c c	101.4	101.4	011.4	101.2
*11	" "	Short Horn.......	"	10.06	1582	2.6 c c	102.4	102.4	102.2	103.0
*12	" "	Jersey	"	3.57	990	1.7 c c	102.4	102.4	102.2	102.0
*13	" "	Polled Angus.....	Male	8.47	1800	3.0 c c	100.8	101.2	100.8	100.8
*14	" "	Holstein Friesian	"	4.20	1925	3.2 c c	102.0	102.2	102.2	102.0
15	" "	Jersey	"	.76	455	0.8 c c	103.0	103.0	102.8	102.0
16	" "	Hereford	"	.68	411	0.8 c c	103.0	103.2	103.6	101.2
17	" "	Short Horn.......	"	1.12	722	1.2 c c	102.2	102.2	102.2	102.0
18	" "	Short Horn.......	"	1.31	899	1.5 c c	101.4	102.2	102.2	102.0
19	" "	Shor6 Horn.......	"	1.40	1035	1.4 c c	101.4	102.0	101.6	101.4
20	" "	Short Horn.......	"	2.05	1189	2.0 c c	101.6	101.4	101.6	101.6
21	" "	Holstein Friesian	"	1.70	1340	2.2 c c	101.6	101.0	101.0	101.4
22	" "	Holstein Friesian	"	1.94	1513	2.5 c c	101.6	100.4	101.4	101.8
23	" "	Short Horn.......	"	.68	437	0.7 c c	102.8	102.6	102.4	101.6
24	" "	Jersey	Female	2.62	958	1.6 c c	102.2	102.0	102.4	102.8
25	" "	Jersey	"	3.62	862	1.4 c c	101.8	101.6	102.0	102.0
26	" "	Holstein Friesian	"	3.06	1345	2.2 c c	101.4	101.4	101.8	101.8
27	" "	Holstein Friesian	"	3.92	1283	2.1 c c	102.0	101.0	101.6	102.0
28	" "	Holstein Friesian	"	4.91	1420	2.4 c c	101.2	101.0	101.6	102.2
29	" "	Holstein Friesian	"	11.61	1550	2.6 c c	101.0	101.2	101.6	101.8
30	" "	Jersey	"	1.84	850	1.4 c c	102.4	102.2	102.6	102.6
31	" "	Jersey	"	1.91	735	1.2 c c	102.0	102.0	102.0	101.6
32	" "	Jersey	"	1.81	800	1.3 c c	102.4	102.0	102.4	102.4
33	Oct. 16,'97	Short Horn.......	"	.75	393	0.7 c c	102.2	102.0	102.4	101.2
34	" "	Short Horn.......	"	3.18	1129	2.2 c c	101.0	101.2	101.6	100.6
35	" "	Short Horn.......	"	1.11	695	1.3 c c	101.8	102.0	101.4	101.2
36	" "	Short Horn.......	"	1.98	927	0.7 c c	101.2	101.0	101.2	101.0
37	" "	Short Horn.......	"	2.00	1039	2.0 c c	101.2	100.8	101.8	101.0
38	" "	Short Horn.......	"	2.51	1259	2.5 c c	101.0	101.0	101.4	101.2
39	" "	Hereford	"	2.69	1228	2.5 c c	102.2	101.6	101.4	102.2
**40	" "	Short Horn.......	"	3.88	1375	2.7 c c	101.6	101.4	101.8	101.6
41	" "	Short Horn.......	"	1.26	690	1.4 c c	102.0	101.8	101.6	101.2
42	" "	Short Horn.......	"	1.28	715	1.5 c c	101.4	101.2	101.2	101.0
43	" "	Hereford	"	1.69	925	1.8 c c	101.4	101.4	101.6	101.2
44	" "	Hereford	"	7.10	1510	3.0 c c	100.6	100.8	101.2	101.4
45	" "	Short Horn.......	"	7.04	1405	2.8 c c	101.2	101.0	101.4	101.6
49	" "	Short Horn.......	Male	.50	279	0.6 c c	102.6	102.4	102.6	101.0
50	" "	Short Horn.......	"	.62	296	0.6 c c	104.0	103.6	103.6	102.4
51	" "	Short Horn.......	Female	.31	206	0.4 c c	104.2	103.6	103.6	102.8
52	" "	Aberdeen Angus.	Male	.30	236	0.5 c c	102.2	102.4	102.0	101.8
†53	" "	Aberdeen Angus.	"	.18	151	0.3 c c	103.6	103.4	103.6	102.8
†54	" "	Holstein..........	"	.48	335	0.7 c c	106.2	106.0	105.8	105.2
55	" "	Holstein..........	"	.74	452	0.9 c c	102.2	102.0	101.0	102.0
56	" "	Holstein..........	"	.78	330	0.7 c c	101.8	101.6	101.8	101.6
††57	" "	Hereford	"	3.86	1638	3.2 c c	101.8	101.2	101.0	100.6
58	" "	Short Horn.......	"	5.42	2180	4.3 c c	101.0	100.1	100.4	101.0
59	" "	Jersey	"	2.60	1450	2.9 c c	102.4	102.8	101.6	101.8

*These animals reacted.
**See figure 12.
†See page 103 and figure 13.
††See note on page 107.

OF THE COLLEGE HERD.

	TEMPERATURE													
	INJECTION					AFTER INJECTION								
	P M 2:00	P M 4:00	P M 6:00	P M 8:00	P M 10:00	A M 6:00	A M 8:00	A M 10:00	A M 12:00	P M 2:00	P M 4:00	P M 6:00	P M 8:00	P M 10:00
1	102.2	102.6	102.8	102.8	102.8	106.8	106.0	106.2	104.2	104.8	105.2	105.4	104.4	104.8
2	101.2	101.4	101.6	101.8	102.2	104.0	105.4	106.0	105.6	105.6	106.0	105.6	104.2	103.8
3	101.2	101.0	101.8	101.6	102.0	105.8	105.6	105.8	105.2	105.2	105.4	104.8	104.8	105.0
4	102.2	102.4	103.0	104.0	103.6	105.6	106.2	106.6	105.8	106.4	105.6	106.0	105.2	105.0
5	101.4	101.2	101.6	102.2	102.2	105.6	106.2	105.6	105.0	105.0	105.8	106.2	105.8	105.4
6	101.2	101.2	101.8	102.0	102.4	102.8	102.0	102.6	104.6	105.2	104.4	104.8	104.2	104.0
7	101.8	101.8	101.6	102.0	102.0	102.2	103.0	105.0	106.0	105.2	105.6	105.8	106.0	104.4
8	101.4	101.4	101.4	102.2	102.2	104.4	105.0	105.8	105.6	105.2	105.6	105.8	106.0	106.6
9	101.0	101.2	101.6	102.2	102.0	102.2	102.2	104.2	104.0	103.4	103.8	102.8	102.4	102.0
10	101.4	101.4	101.4	102.0	102.4	102.4	102.2	102.6	103.0	103.8	104.0	103.8	103.2	103.2
11	103.4	104.0	102.8	103.2	103.0	106.6	107.2	107.0	105.6	105.2	104.6	104.6	103.8	703.4
12	102.4	102.6	103.2	103.0	103.0	107.0	106.8	105.8	105.8	106.6	106.6	107.2	105.6	105.4
13	101.0	101.0	101.2	102.2	101.8	101.2	101.6	101.4	102.4	104.4	105.2	105.4	105.4	105.0
14	102.6	102.6	103.0	103.0	102.8	103.0	103.8	105.2	105.2	105.8	105.4	104.6	103.8	103.6
15	102.4	102.0	102.6	103.4	103.2	103.0	102.8	102.8	101.8	102.6	102.6	102.8	103.0	103.0
16	102.0	102.2	103.4	103.8	103.6	103.6	104.0	104.0	102.0	102.8	102.8	103.0	103.4	103.4
17	102.2	102.8	102.8	103.4	103.4	103.2	103.0	103.0	102.2	103.2	103·0	103.4	104.0	103.2
18	102.4	102.2	102.2	102.4	102.8	102.8	102.6	102.2	102.4	102.6	102.8	103.2	103.0	103.2
19	101.6	101.8	102.0	103.0	102.4	101.8	102.8	101.8	101.8	102.0	102.2	102.8	103.0	102.8
20	102.0	102.0	102.0	102.6	102.4	102.4	102.0	102.2	101.8	102.0	102.0	102.8	102.6	102.4
21	100.6	100.2	101.6	101.6	101.8	102.0	102.4	101.6	101.4	101.4	101.4	101.8	102.2	102.0
22	101.6	101.8	102.0	102.0	101.8	100.6	100.8	102.0	102.2	101.6	101.8	102.0	101.8	102.2
23	101.6	102.0	102.0	102.0	102.0	102.2	101.2	101.8	101.4	102.0	102.4	102.8	101.8	102.2
24	102.6	103.2	103.0	103.2	102.6	102.6	102.2	102.8	102.2	102.6	103.4	103.4	103.4	103.2
25	101.6	102.2	102.4	103.0	103.0	102.0	101.6	102.2	102.0	102.0	103.0	102.8	102.4	102.0
26	101.8	102.0	102.0	102.0	101.8	101.8	101.4	101.6	101.2	102.0	101.8	102.0	101.8	102.0
27	101.6	102.0	102.0	102.6	102.2	102.2	101.8	101.8	101.6	102.2	102.2	102.4	102.4	102.6
28	101.8	101.8	101.8	102.0	101.8	101.4	101.4	102.0	101.8	101.8	102.0	102.0	102.2	102.4
29	101.6	101.8	102.0	102.2	102.2	101.4	101.8	102.2	101.8	101.6	102.2	102.8	103.0	102.4
30	103.0	103.4	103.4	104.2	103.8	103.0	102.8	102.8	102.6	103.4	103.6	104.2	103.8	103.6
31	102.8	102.6	102.8	103.0	102.6	102.8	102.6	102.4	102.0	102.8	102.4	102.2	102.8	103.0
32	103.0	103.4	103.6	103.8	103.2	103.0	102.6	102.6	102.8	103.2	103.2	103.4	103.8	103.6
33	102.0	102.3	103.2	103.6	102.6	103.0	103.2	103.8	101.4	102.2	102.6	103.4	103.8	103.0
34	100.4	101.2	101·6	101.6	102.6	101.2	101.4	102.0	102.2	102.2	102.2	102.0	102.0	101.6
35	101.4	101.6	102.0	101.6	103.8	102.8	102.4	102.4	101.8	102.2	102.2	102.2	102.0	102.6
36	101.0	101.0	101.0	101.6	103.6	102.0	102.0	101.6	101.6	101.6	101.6	101.6	101.8	101.8
37	101.2	100.4	102.0	102.0	102.0	102.0	101.8	102.0	102.2	102.6	103.0	103.0	102.8	103.2
38	101.0	101.4	101.6	102.0	102.2	102.8	102.0	101.8	102.0	101.8	102.0	102.4	102.8	102.6
39	101.8	102.4	102.2	102.2	102.6	102.8	101.8	102.4	102.8	103.4	103.2	103.0	101.8	102.8
40	102.0	102.2	102.0	101.8	102.4	102.2	102.0	102.4	102.2	103.4	103.2	104.2	104.2	104.4
41	101.4	101.4	101.8	101.6	105.0	101.8	101.8	102.0	101.6	101.6	102.2	101.8	102.0	102.0
42	101.0	100.6	101.6	101.2	103.4	102.4	102.0	102.2	101.6	101.8	101.8	102.0	102.6	102.4
43	101.2	101.6	101.6	102.0	102.8	102.0	101.8	101.8	101.8	101.8	102.4	103.0	103.0	102.8
44	101.4	100.8	101.6	101.2	102.2	100.8	101.0	101.4	101.8	101.4	101.8	101.8	101.0	101.4
45	101.6	101.0	102.0	101.6	102.0	101.2	100.8	101.2	101.2	100.8	101.0	101.0	101.2	101.2
49	101.4	101.8	102.2	102.6	103.8	103.6	103.4	103.4	101.4	101.6	101.8	102.0	101.8	102.2
50	102.2	101.6	101.4	102.0	105.8	102.8	103.0	103.0	101.4	102.2	101.4	102.0	102.2	102.4
51	103.2	103.0	103.0	103.4	104.6	104.0	102.8	102.8	102.8	102.6	102.8	103.0	103.4	103.2
52	101.8	101.6	102.4	102.8	103.4	103.0	103.0	103.0	102.4	102.6	103.2	103.2	103.0	103.4
53	103.0	102.4	102.6	102.8	104.0	103.6	103.4	103.6	103.0	102.4	102.4	102.8	102.8	102.8
54	105.4	105.6	105.8	105.0	105.8	107.2	106.4	105.0	104.2	103.6	103.2	103.2	102.4	103.0
55	101.0	101.0	102.0	101.6	103.6	102.2	101.8	101.8	102.2	101.6	101.6	102.2	102.0	101.8
56	101.8	101.8	102.2	102.2	103.0	102.4	101.8	102.4	102.2	102.0	102.4	102.4	102.2	101.6
57	100.6	100.4	101.2	101.2	101.6	102.0	101.6	101.2	101.4	101.0	101.2	101.0	101.2	101.4
58	100.2	101.4	101.4	101.0	101.6	101.2	101.2	100.6	101.0	101.2	101.0	101.0	101.2	102.2
59	101.8	101.8	101.8	101.4	101.6	102.4	101.8	101.6	101.8	101.8	101.8	101.8	101.6	101.4

POST MORTEM NOTES ON SLAUGHTERED ANIMALS.

No. 1. Hereford cow, Miss Beau Real of Manhattan II; age, 5.17 years. Cluster of black nodules on right side of pharyngeal glands; black nodules scattered through the liver; mesenteric glands necrotic, with commencing caseation; mediastinal glands greatly enlarged, with caseated and calcified foci.

No. 2. Aberdeen Angus Cow, Ella of Manhattan; age, 8.11 years, in good condition, fat; udder with numerous caseated tubercles; portion of mammary lymph glands enlarged and containing caseated foci; numerous mesenteric glands caseated and with black nodules the size of pin heads; omentum with fibroid tubercles; bronchial glands extensively caseated; an enormously large tubercle with many centers of softening in front of left shoulder blade and three other similar tubercles on the abdominal wall.

No. 3. Aberdeen Angus, Ethel of Manhattan; age, 9.36 years. Lungs containing many caseated centers of various size scattered throughout the tissue; mediastinal glands containing necrotic foci and caseated centers.

No. 3. Shorthorn Cow, Godiva; age 4.24 years. Numerous congested tracheal glands; bronchial glands 3.5 by 2.5 inches, caseated and slightly calcified; mediastinal glands 3.5 by 3.5 and 6.5 by 4 inches; small caseated tubercles abundantly scattered through both lungs and over pleura.

No. 5. Shorthorn Cow, Diana; age 4.75 years. Bronchial gland enlarged and caseated; small caseated tubercles in lung; mesenteric glands slightly congested.

No. 6. Shorthorn Cow, Cinderella; age, 6.73 years. Pharyngeal glands congested; bronchial glands caseated; portal glands caseated and calcified; mesenteric glands congested.

No. 7. Shorthorn Cow, Fanny; age, 4.7 years. Bronchial glands caseated; mediastinal glands highly congested; deep surface of spleen containing tuberculous neoplasms; congested glands of third and fourth stomachs; numerous mesenteric glands with several small caseated centers.

No. 8. Shorthorn Cow, Gleeful II; age, 5.06 years. Bronchial glands enlarged, badly caseated and calcified; right lung with extensive tubercles; mesenteric glands indurated; udder with tuberculous abscess with many small lymph nodules.

No. 9. Shorthorn Cow, Dimples II; age, 5.08 years. Retropharyngeal glands congested, false membranes on inside of pericardium and on surface of spleen; mesenteric glands with numerous necrotic centers and numerous black lymph nodules in the mesentery.

No. 10. Shorthorn Cow, Carry ; age, 5.06 years. Pharyngeal glands containing a tuberculous abscess four inches long; bronchial gland caseated; mediastinal glands with caseated centers as large as marbles; liver containing three large abscesses with caseated portions.

No. 11. Shorthorn Cow, Genteel; age, 10.06 years. Bronchial glands extensively caseated and actively inflamed; left lung congested and containing caseated foci.

No. 12. Jersey Cow, Lukanga II; age, 3.57 years. Retropharyngeal glands caseated and calcified; inferior maxillary gland caseated, mesenteric glands congested.

No. 13. Aberdeen Angus Bull, Rosebud's Boy; age, 8.47 years.

Inferior pharyngeal gland degenerated into a fibroid tubercle with caseated centers, two bronchial glands congested; right submaxillary lymphatic gland in a state of fibroid degeneration mesenteric glands congested and caseated.

No. 14 . . Holstein-Friesian Bull, Princess Pel's Me cht Sir Henry; age, 4.2 years.

Submaxillary lymphatic glands deeply congested and firmly fibroid, greatly enlarged; sublumbar glands congested, immense mass of tubercles in sublumbar region, twelve inches in length, with softened caseated centers; mediastinal glands calcified, fringes on pericardium; number of caseated centers in liver; mesenteric glands calcified.

No. 53. Aberdeen Angus bull calf; age, 1.8 year. A few slightly congested sublumbar and mesenteric glands. A few containing many minute hemorrhagic foci; a few black lymph nodules, here and there.

No. 54. Holstein-Fresian bull calf; age, .48 year. Retropharyngeal glands congested and containing haemorrhagic points.

*No. 57. Hereford Bull, College Beau Real; age, 3.86 years. Retropharyngeal glands greatly enlarged with many caseous and purulent centers; a fibrous nodule projecting one-half inch above the surface of the mucous membrane; black nodule in center of bronchial gland; mesenteric glands with marked congestion.

*This animal, College Beau Real, (Hereford Bull) did not react. He had been rested before, on several occasions, never responding to the tuberculin test. His temperature curve which was below the average normal a great deal of the time both before and after injection is shown in Fig. 7 This animal suffered for some months from a severe wheezing caused by a swelling in his throat. He was killed on the circumstantial evidence of this and the fact that he associated with a tuberculous herd for some years. Post-mortem examination showed him to be in an evidently tuberculous condition, as the notes indicate.

TEMPERATURE RECORDS

Running Number	Date	Breed	Age of Animal. Yrs.	Sex	Wt. of Animal. Lbs.	Amount Injected	BEFORE A M 6:00	BEFORE A M 8:00	BEFORE A M 10:00	BEFORE A M 12:00
60	Mch,10,'98	Grade		Female	996	2.0 c c	100.4	101.2	101.4	101.4
*61	" "	"		"	939	1.9 c c	101.6	101.8	101.6	101.8
62	" "	"		"	1124	2.2 c c	100.8	101.4	101.4	102.0
63	" "	"		"	1236	2.5 c c	101.4	101.0	101.6	101.6
64	" "	"		"	740	1.5 c c	101.4	102.2	101.6	101.4
65	" "	"		"	777	1.6 c c	101.4	101.8	101.2	102.0
66	" "	"		"	864	1.7 c c	101.2	102.0	101.4	101.8
67	" "	"		"	831	1.7 c c	101.4	101.8	101.4	101.6
68	" "	"		"	977	2.0 c c	101.6	101.6	101.8	101.8
69	" "	"		"	863	1.7 c c	101.0	101.6	102.0	101.8
70	" "	"		"	987	2.0 c c	101.0	101.2	101.0	101.0
71	" "	"		"	910	1.8 c c	101.4	100.8	101.8	102.0
*72	" "	"		"	890	1.8 c c	101.6	101.8	102.4	102.4
73	" "	"		"	1114	2.2 c c	101.4	102.0	102.2	102.0
74	" "	"		"	983	2.0 c c	101.4	101.4	101.4	102.2
75	" "	"		"	1061	2.1 c c	100.6	101.2	101.4	101.8
76	" "	"		"	1033	2.1 c c	101.0	101.4	102.2	101.8
77	" "	"		"	1019	2.0 c c	101.2	101.6	101.2	101.0
78	" "	"		"	965	1.9 c c	101.8	102.2	100.8	101.6
79	" "	"		"	870	1.8 c c	101.6	101.6	103.0	103.2
†80	" "	Shorthorn		"	1275	2.5 c c	101.0	101.4	101.8	101.6

*See figure 8.
†Second test of number 40, Genteel II, see figure 12.

POST MORTEM NOTES.

No. 61. Right and left inferior maxillary lymphatic glands containing a large number of small, softened abscesses; posterior mediastinal glands, with prominent fibroid tubercles, portal glands with numerous haemorrhagic foci. One mesenteric gland distinctly caseated; several with haemorrhagic foci; inguinal glands with distinct tubercular nodules; glomerules of left kidney distinctly haemorrhagic. Tubercle bacillus upon microscopic examination.

OF THE GRADE DAIRY HERD.

TEMPERATURE

	INJECTION					AFTER INJECTION								
	P M 2:00	P M 4:00	P M 6:00	P M 8:00	P M 10:00	A M 6:00	A M 8:00	A M 10:00	A M 12:00	P M 2:00	P M 4:00	P M 6:00	P M 8:00	P M 10:00
60	101.6	101.2	101.2	100.4	101.2	101.2	101.6	101.8	101.8	101.2	101.0	100.8	101.4	101.2
*61	102.2	102.2	101.6	101.4	101.6	101.4	102.2	104.8	105.4	105.8	103.2	102.6	102.0	101.2
62	102.0	101.8	98.4	100.4	100.8	101.2	101.4	101.8	102.0	102.2	101.6	102.0	101.6	102.0
63	101.4	102.0	99.6	101.2	101.2	100.8	100.4	101.6	101.6	101.8	101.6	101.4	101.6	101.4
64	101.6	101.6	101.6	102.0	102.0	101.6	102.0	102.6	102.4	102.2	100.8	101.4	101.8	101.8
65	102.2	102.0	101.0	101.4	101.4	101.6	101.8	102.4	102.4	102.2	99.6	101.4	101.2	101.4
66	102.0	101.4	101.6	101.8	101.4	101.4	101.8	102.2	102.2	101.8	98.8	100.4	100.8	101.0
67	102.2	101.4	99.8	100.6	101.2	101.8	102.0	102.2	102.4	102.6	100.6	101.4	101.2	101.2
68	101.8	102.4	97.2	99.8	100.8	101.2	101.8	102.0	102.2	102.2	100.4	101.2	101.8	101.4
69	102.4	102.2	98.6	100.0	100.0	100.6	101.2	101.8	101.8	101.4	101.2	101.0	100.8	100.8
70	101.6	101.2	100.0	100.4	100.8	100.8	101.2	101.2	101.2	101.8	101.4	101.8	101.4	101.2
71	102.4	101.8	100.4	101.2	101.2	101.0	101.4	102.0	102.2	102.2	100.6	101.8	151.8	101.4
*72	102.6	102.2	98.4	100.6	100.8	101.4	102.6	105.6	105.4	104.4	102.4	101.4	101.2	100.8
73	102.0	101.8	101.0	101.0	101.4	101.2	102.2	102.4	102.2	102.4	101.8	101.6	100.8	101.4
74	102.0	101.4	98.6	100.6	100.6	101.0	101.6	102.4	102.2	102.2	101.0	101.0	101.0	101.2
75	102.0	102.0	99.6	101.0	101.2	101.2	101.2	101.4	102.2	102.0	101.0	101.4	101.6	101.8
76	101.8	102.2	100.6	100.8	101.2	101.2	101.4	102.4	101.4	102.0	101.8	101.8	101.2	101.0
77	101.8	102.2	101.4	101.6	101.8	101.2	101.6	101.2	101.6	101.6	101.0	101.4	100.8	101.6
78	102.0	101.8	101.0	101.0	102.0	101.8	102.6	102.2	102.4	102.2	101.0	101.2	101.6	101.6
79	102.4	102.6	98.4	101.0	101.4	101.2	101.8	102.4	102.4	104.2	102.2	102.2	101.6	101.6
†80	101.8	101.4	101.4	100.6	101.0	101.2	101.4	101.2	101.6	101.8	101.4	101.4	101.2	101.0

No. 72. Small haemorrhagic lymph nodules near and in both inferior maxillary glands; retropharyngeal glands haemorrhagic; chain of a large number of haemorrhagic nodules on posterior surface of liver; left renal gland with haemorrhagic centers; left lumbar glands with large, distinctly defined haemorragic centers; a number of mesenteric glands with caseated centers.

Nos. 62, 68, 69, 74, 75 and 79 show apparent reactions for a short time. It will be noticed that the great differences in temperature occur at six p. m., and are due to drinking cold water the evening before the injection None of these animals indicate temperatures *above* the normal after the tuberculin was injected.