New York Agricultural Experiment Station

Geneva, N. Y.

In Co-operation with
New York State Veterinary College,
Ithaca, N. Y.

The Bang Method of Controlling Tuberculosis, with An Illustration of Its Application.

H. A. Harding and Geo. A. Smith,
Of the New York Agricultural Experiment Station

And

V. A. Moore,
Of the New York State Veterinary College.

Published by the Station.
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THE BANG METHOD OF CONTROLLING TUBERCULOSIS, WITH AN ILLUSTRATION OF ITS APPLICATION.

H. A. HARDING AND GEO. A. SMITH, of the New York Agricultural Experiment Station, AND V. A. MOORE, of the New York State Veterinary College.

SUMMARY.

1. Tuberculosis is one of the most important diseases of cattle.
2. The Bang method of handling herds affected with this disease has been tried with success in various countries. This method is especially adapted to herds of valuable animals.
3. The method consists in isolating the reacting animals in order to stop the spread of the disease and holding them for breeding purposes.
4. Calves of tuberculous cows are rarely if ever tuberculous at birth. They should be immediately separated from the dam and fed on the milk of healthy cows or on milk which has been properly pasteurized.
5. The milk of tuberculous cows is safe after it has been pasteurized at 185° F. (85° C.).
6. More than one-half of the herd of the New York Agricultural Experiment Station was found to be tuberculous in December, 1900.
7. Quarters were prepared and the application of the Bang method begun in October, 1901, with a total of thirty animals, thirteen of which were healthy and seventeen tuberculous.
8. During four years this herd produced twenty-three desirable heifer calves, approximately one-half coming from the tuberculous animals, and in November, 1905, it contained thirty healthy animals.
INTRODUCTION.

During the last decade the progress which the cattle owners of this State have made in the control of tuberculosis in their herds has been slight and this progress has been in comparatively few herds. While exact data are lacking it is probable that there is more tuberculosis in the herds of the State today than there was ten years ago.

As long as tuberculosis was considered purely as a public health problem and was handled with little regard for the interests of the cattle owner, there was often a disinclination on his part to face the facts. With a better knowledge of the nature of the disease the more progressive breeders and dairymen are coming to feel that tuberculosis, like any other destructive disease of cattle, is an unprofitable adjunct to the business. Accordingly they are beginning to inquire into the various methods of freeing their herds from this pest.

The herd of the New York Agricultural Experiment Station was accidentally infected through the purchase of apparently sound cows and before the disease was detected more than one-half of the herd had become tuberculous. From this undesirable condition the herd has been transformed into a sound one within four years and it is believed that a statement of the conditions encountered and means employed to eradicate the disease will be especially helpful to the dairymen at this time.

In this work we can lay little claim to originality since we have followed the method recommended by Dr. Bang of Copenhagen. Considering the uniform success which this method has met with in the various countries in which it has been employed it seems strange that it has not been more widely used in America. It is

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1 In the report of a Special Committee of the Assembly on Tuberculosis presented February 1, 1900, the tuberculosis among cows in New York State was estimated at not to exceed 6 to 7 per ct.


hoped that this presentation of the method and of the way in which it was successfully employed in the Station herd may stimulate its introduction into the herds of the State.

ACKNOWLEDGMENT.

The official heads of the two cooperating institutions, Dr. W. H. Jordan of this Station and Dr. James Law of the New York State Veterinary College, have taken a keen and inspiring interest in the work here reported and we desire to record our appreciation of the value of their suggestions and advice in connection with the same.

THE NATURE OF TUBERCULOSIS.

Tuberculosis is a specific infectious disease. It is specific because it is produced by a single cause, the tubercle bacillus; it is infectious because this organism gets into the animal body and multiplies there. It affects the animal by growing into the tissues and actually destroying the organs of the body that are necessary to the life of the individual, such as the liver, lungs and other vital parts. Although the course of the disease is often very chronic, it possesses all of the characters that determine an infectious malady. Because of its insidious nature and slow development, cattle owners are very liable to ignore the essential conditions in its dissemination and thereby often expose their herds to this most destructive of cattle diseases.

The two most important facts to know about an infectious disease are, (1) how the micro-organisms that cause it escape from the diseased animal and (2) how the sound animals become infected. The answers to these questions relative to bovine tuberculosis are for the greater part not difficult.

The tubercle bacteria escape from a tuberculous animal when the tissues they have destroyed are being discharged from the body. If the lungs are affected the dead particles of tissue, laden with tubercle bacilli, escape into the bronchial tubes and after being coughed up into the mouth they leave the body with the saliva. In these cases the tubercle bacteria can be found in the saliva that is left on the surface of the water in watering troughs
or on the bottom of the mangers.\textsuperscript{3} If the tissues attacked happen to be glands in the walls of the intestine the dead particles of tissue escape with the intestinal contents. If the disease becomes localized in the udder then the bacteria pass out with the milk. In cases where the lesions are restricted to subcutaneous glands or tissues, abscesses may be formed and the dead tissues laden with tubercle bacteria may escape through an opening in the skin. If the disease is localized the tubercle bacteria are liable occasionally to grow or eat their way into a blood vessel when they may be carried in the blood to any or all parts of the body and temporarily escape into the milk, intestinal contents or sputa.

When the bacteria have escaped from infected individuals into mangers, watering troughs, or onto the grass in pastures, they are readily taken up by healthy cattle that drink, feed or graze after diseased animals. In case the bacteria are escaping with the milk, calves and swine fed with it are very liable to become infected.

The period of incubation, that is the time between the entrance of the bacteria into the body and the appearance of the fresh tissue changes (tubercles) is variable. There is good evidence to show that it may be very short in some cases and very long in others. It is safe to assert that it may vary from a few days or weeks to as many months. Tuberculin does not give a reaction during the period of incubation. This condition requires for safety that animals that do not react to tuberculin in herds where the disease exists and where they may have become infected must be tested several months later to be sure that they were not infected at the time the first test was made.

The duration of the disease varies quite as much as the period of incubation. Tuberculosis may run a rapidly fatal course, the affected animal dying in a few months.\textsuperscript{4} As a rule, however, the duration of the disease is much longer. The tuberculous tissue may become encapsulated and the disease remain stationary for a

\textsuperscript{3} Ravenel, M. P. The dissemination of tubercle bacilli by cows in coughing a possible source of contagion. University (Penn.) Medical Magazine, November, 1900.

\textsuperscript{4} The cow Jane is an illustration of this point. She became diseased during 1901 and first reacted in October, 1901. She failed rapidly and was killed in June, 1902. The autopsy showed that her liver was badly diseased.
long time\(^5\) and in some cases recovery may take place. In an experiment by Moore,\(^6\) twelve of seventeen cows that reacted in April failed to react in October. These were all destroyed. They all contained tubercular lesions of a chronic type. They all contained living tubercle bacteria as proven by guinea pig inoculations. It is known that the lesions may remain in a chronic encapsulated condition for three years and the tubercle bacteria still be alive.\(^7\) In the cases of arrested tuberculosis the disease does not spread in the body, but so long as the tubercle bacilli remain alive it is possible that the disease may start up at any time for there is very little, if any, immunity established against a subsequent attack by the development and encapsulation of the primary lesion. One of us (Moore) has the records of over fifty cows that have reacted but failed on subsequent tests, from six to eighteen months thereafter, to react but still later did react. Whether the late reaction was caused by a reinfection or by renewed activity of an encapsulated, arrested lesion is not determined, but the fact that, to all appearance and methods of diagnosis in a living animal, the lesions in these animals were healing or healed and that later they responded to the test suggests that the first attack did not impart immunity.

As a rule the tubercular changes occur in one or more of the following organs: (1) In the lungs or lymphatic glands draining them, (2) in the lymphatic glands about the head, (3) in the intestines and mesenteric glands, (4) in the glands of the liver or the liver itself and (5) in the generative organs and udder. It frequently happens that the pleura or the peritoneum is thickly sprinkled with tubercular nodules. The extent of the disease that

\(^5\) This is well illustrated by Chloe and Kate. They were tuberculous when tested as two year-olds in 1900 but when killed and examined in 1905 both were so slightly diseased that their carcasses would both pass a Federal meat inspection examination. During these five years Chloe gave a positive reaction to tuberculin at eight different tests while Kate gave a positive reaction five times and failed to do so at three tests.


\(^7\) Millie D. gave a reaction in October, 1901, and in June, 1902. She failed to react at six subsequent tests beginning with December, 1902. She contained living germs of tuberculosis in 1905, page 109.
may exist and have the animals appear to be in perfect health depends upon the location of the lesions. Frequently large masses of tubercular deposits are found in apparently healthy animals. As a rule these are not in vital organs. Again, cattle run down rapidly and may die of the disease before the lesions attain great size because they are in and destroying an organ that is very essential to the life of the individual.

The possible long period of incubation and duration of the disease, the frequent encapsulated condition of the lesions and the absence of immunity from a natural infection are important factors to be considered in the application of any method for its elimination or control.

THE BANG METHOD.

The Bang method for handling tuberculosis is simply the procedure recommended and carried into effect in Denmark by Prof. B. Bang of the Copenhagen Veterinary College. The object of this method is to replenish a tuberculous herd with as little loss as possible. It requires that all animals that show physical symptoms of the disease shall be destroyed. Those which give a tuberculin reaction but which exhibit no evidence on physical examination of being tuberculous are isolated. They are kept for breeding purposes. The reacting animals are carefully watched and if any of them develop obvious symptoms of the disease they are slaughtered.

The method as originally proposed has been modified from time to time in accord with increased knowledge of the disease and the conditions under which it exists. The success of the method rests in the fact that it conforms to the chronic nature of the disease and its tendency to become arrested. The large percentage (35 4%) of dairy cows in Denmark that reacted to tuberculin suggested the importance of replenishing the herds

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8 Bang B. The struggle with tuberculosis in Denmark. The Veterinarian, 68: 688. 1895.
9 Loc. cit.
with healthy cows before the total destruction of the reacting ones. The method is summarized in the following statements.

1. A herd is tested with tuberculin. The animals that are in a bad condition are slaughtered. The reacting animals that show no physical evidence of the disease are isolated. They are kept for breeding purposes.

2. The offspring from the reacting cows are promptly removed from their dams and fed milk from non-reacting cows, or the pasteurized (heated to a temperature of 85°C (185°F.) milk from the reacting ones. The milk of the isolated cows after pasteurization is also used for human food.

3. If any of the isolated cattle give evidence of the disease advancing, such as enlarged glands or emaciation, they are slaughtered.

4. The non-reacting animals are tested from time to time and if any individuals react they are placed with the isolated ones.

5. The calves that are raised from the reacting cows and which fail to react to tuberculin are placed in the sound herd.

As the sound herd is replenished the isolated cattle may be fattened and killed, under proper inspection, for beef. The laws of nearly, if not all, countries permit the use of meat of tuberculous animals for food when the disease is localized. In this way

10 It is important to test, with tuberculin, calves that have been born of tuberculous dams and raised on pasteurized milk of tuberculous cows for the reason that it is possible through inadvertent accidents that some of them have become infected. In our observations in various herds from one to four per ct. of the calves brought up under these conditions have reacted to tuberculin at six months of age. No such cases appeared among the calves of the Experiment Station herd during the progress of this work.

11 In the disposition of tuberculous cattle, practice has established the feasibility and safety of using the flesh for food when the disease is localized. The United States Meat Inspection Regulations permit the carcasses of tuberculous animals to pass and to be sold as sound when the lesions are restricted in their distribution as follows:

"(1) The carcasses may be passed when the lesions are limited to one group of lymphatic glands or one other gland.

"(2) The carcasses may be passed when the lesions are limited to two groups of visceral lymphatic glands in either the thoracic or abdominal cavity.

"(3) The carcass may be passed when the lesions are limited to two visceral
the people of Denmark have been able to greatly reduce the very high percentage of tuberculous cattle and at the same time minimize the loss they formerly sustained by the frequent death of diseased animals.

Among the first, if not the first, to put the Bang method to a test in this country was the Wisconsin Agricultural Experiment Station.\(^\text{11}\) They began in January, 1896, with 16 reacting animals and 18 healthy ones. In February, 1899, they had 27 healthy animals, all the progeny of the group of tuberculous cattle. Russell pointed out at that time that the method afforded a practical and often a most desirable way to replace a tuberculous herd.

The Bang method has been applied with great success in Hungary where the reports show that many highly infected herds have been freed of the disease in from four to six years. In Norway and Sweden the results have been equally good. Prof. Regner \(^\text{12}\) states that the percentage of reacting animals among 36,149 cattle was, at the beginning of the application of this method, 33.6 per ct. After a period of from two to nine years it has been reduced to 4.7 per ct. It is not the purpose of the method to return to the sound herd animals that have reacted but which after a period of one or more years fail to react. Experience has shown that a variable number of reacting animals will stop reacting in from six

organs (other than lymphatic glands) in the thoracic or the abdominal cavity, provided the lesions are slight, calcified, and encapsulated.

\(^1\text{(4) The carcass may be passed when the lesions are limited to one group of visceral lymphatic glands and one other organ in the thoracic or abdominal cavity, provided the lesions in the affected organs are slight.}\)

\(^2\text{(5) The carcass may be passed when the lesions are confined to two groups of visceral lymphatic glands and one other organ in the thoracic or abdominal cavity, provided the lesions are slight, calcified, and encapsulated.}\)

\(^3\text{(6) The carcass may be passed when the lesions are confined to the lungs, the cervical lymphatic glands, and one group of the visceral lymphatic glands of the thoracic cavity, provided the affection is slight and the lesions are calcified and encapsulated.}\)

\(^\text{11}\) U. S. Dept. Agric.: B. A. I. Order 125.

\(^\text{12}\) Regner, Gustav.—The suppression of tuberculosis among domesticated animals. Eighth International Veterinary Congress, Budapest. Sept., 1905.
to eighteen months and remain apparently in a sound condition. The present interpretation of this phenomenon is that the disease has been arrested, but because the time limits of the life of tubercle bacteria residing in encapsulated lesions is not known, it can not be considered safe to return these animals to the healthy herd.

This method has the redeeming feature that it requires the elimination of cattle that have no real value because of the advanced stage of the disease but enables the owner to obtain the actual worth of the others. It has been possible, because of the great value of tuberculin in detecting the infected animals that still appeared to be in perfect health.

TUBERCULIN.

Tuberculin is the concentrated liquid, usually glycerinated bouillon, on which the tubercle bacteria have grown until the products resulting from their multiplication have become imparted to the medium in sufficient quantity to inhibit their further development. It is not definitely determined just what these products are or just how they are elaborated.

In the preparation of tuberculin the saturated cultures are heated to destroy the tubercle bacteria, filtered through the Pasteur or Berkefeld filter to remove all the bacteria, and the filtrate condensed over a water bath. To the properly concentrated fluid a little carbolic acid is added to preserve it. It is evident, therefore, that tuberculin cannot produce tuberculosis, as the tubercle bacteria have been first killed by heat and then removed by filtration. It has never been known to produce any bad effect upon either tubercular cattle or healthy ones. It is the most accurate test for the detection of disease that is known to medical science.
APPLICATION OF TUBERCULIN.

In applying the tuberculin it is important to observe the following:

1. The normal temperature of the animal to be tested must be determined. It is recommended that it be taken hourly or every two hours for the day preceding the test. In practice veterinarians usually take the temperature but once or twice before injecting the tuberculin.

2. The tuberculin is injected subcutaneously in the side of the neck. Care should be taken that the syringe is sterile and the site of injection should be disinfected. The size of the dose depends upon the preparation of the tuberculin, that is, the degree of its concentration.

3. Beginning 6 or 8 hours after injection the temperature should be taken hourly, or at least every two hours for fully three-fourths of a day.

4. During the time of testing the cattle should be kept quiet and free from all exposure and fed normally.

5. In case of reaction there should be a rise of at least $1.5^\circ$ F. above the normal individual temperature as determined on the preceding day. In order to avoid error several initial temperatures should be taken. In practice, veterinarians usually take only a single temperature to determine if the cow is not suffering from a fever, due perhaps to other causes. The reaction in such cases is determined by the temperature curve. This procedure is liable to give erroneous results. The elevation of temperature should come on gradually, remaining practically at its maximum for a few hours and gradually subside. Erratic elevations of short duration are to be excluded. In cases of doubt the animal should be retested.

6. Animals advanced in pregnancy and those known to be suffering from any disease should be excluded. All methods of treatment, including exposure to cold or kind of food or drink which would tend to modify the temperature should be avoided. Animals in which tuberculosis is far advanced are said sometimes to fail to react.\(^{13}\)

\(^{13}\)Such a case has not come under our immediate observation. Aurora gave a decided reaction when her body was literally filled with tuberculous tissue. See page 101.
7. The dose of tuberculin should vary to correspond to the weight of the animal. The dose for an adult cow of average weight is 0.25 cc. of the concentrated Koch tuberculin. This should be diluted to 2 cc. with a weak (1 per cent.) solution of carbolic acid before injecting. The tuberculin prepared at the New York State Veterinary College is ready to inject when it is sent out. In cases where a second test is made within a few days the quantity of tuberculin injected should be larger than for the first test.

The interpretation of the temperature record requires care. If, however, all conditions pertaining to the protection of the animal have been fulfilled, the temperature curve mentioned is a very sure indication that the animal is suffering from an active, although it may be a very small, tubercular growth. If there is no reaction the correct interpretation is more difficult. In this case there are three conditions which must be taken into account, namely: (1) If the animal is extensively diseased it may not react. In this case the physical condition would show that the animal was at least not healthy. (2) If the test was made during the period of incubation there would be no reaction although the disease may soon develop. To overcome this danger a subsequent test should be made in from three to six months. (3) It is known that cows that have reacted, may, because of the arrest of the disease, fail to react subsequently but later the disease may start up again, when the animal would react. We have records of several cases of this kind. Great care must be exercised, therefore, in the interpretation of negative results, especially in tests made in herds where tuberculosis exists, and where it is possible that the animals failing to react have been infected.

COMPOSITION OF THE STATION HERD.

In December, 1900, the Station herd contained seventeen mature cows and eleven heifers ranging in age from eight months to two years. Eight of the cows were full-blooded Jerseys and the remainder, with a single exception, were Jersey grades. Two of the cows had been raised on the farm, while the remaining fifteen had been purchased in 1898-1899. The purchased animals represented nine herds in the central part of the State.
Care had been exercised in purchasing to procure desirable animals from all points of view. They were not bought, however, subject to the tuberculin test. 14

The young stock had all been raised on the farm and represented the most promising heifers of the two preceding seasons.

FINDING TUBERCULOSIS IN THE HERD.

In the fall of 1900, Cow No. 8, which had been purchased by the Station in 1898, steadily lost flesh. She was given a physical examination on Nov. 27 by a local veterinarian who pronounced her tuberculous. She was promptly killed and found to be suffering from the disease in its advanced stage. 15 As in many other

14 Soon after the arrival of the new animals abortion became troublesome and continued for some years. This trouble seriously interfered with our later attempts at renewing the cows through their offspring as not only did many of the old cows lose a calf but for some years practically every heifer lost one calf and in one case two in succession.

15 The autopsy notes show the following distribution of lesions:

"Right sub-maxillary lymph gland contained pus. Caudal mediastinal lymph gland enlarged to eight inches in length and tuberculous. Lungs normal except for a tubercular area in each caudal lobe, the larger being on the left side. Heart and pleurae were normal. Many tubercles ½ to ½ inch in diameter scattered over the peritoneum. Capsule of the liver was dotted over with tubercles but the liver itself appeared to be normal. Uterus was infiltrated with tubercular tissue. The ovaries contained caseated masses, probably tubercular, in the center of each. The udder, which was considerably enlarged at the date of killing, was removed to the laboratory. Here it was cut into thin slices and carefully observed but no tubercles were found."

November 30, three rabbits were injected with material from Cow No. 8. One received a portion of the milk from the udder, a second received pus from an ovary while the third was injected with water in which two small tubercles from the uterus had been crushed.

February 12 one of the rabbits died and the other two were killed. The autopsies in all cases showed well marked tuberculosis. The lungs and diaphragm of all three were effected, in one case to such an extent as to make breathing difficult. In two cases the peritoneum was covered with nodules while in the third case where the injecting needle had not reached the abdominal cavity there was a large fibrous mass with pus at its center. One or both kidneys in each of the rabbits contained tubercles. These results made it plain that not only was cow No. 8 suffering from tubercu-
herds, the breaking down of a tuberculous animal was the first intimation that the disease had gained a foothold.

Naturally the first question that arose was as to the state of health of the remaining animals. But two methods of determining their condition were available; the physical examination and the tuberculin test. Physical examination is a general method which is commonly applied to the diagnosis of many animal diseases. For the reason that dairymen are familiar with it and constantly using it in handling their cattle many of them are inclined to place more confidence in its results than in a method with which they have had practically no experience. In detecting the early stages of tuberculosis in cattle, physical examination is of little assistance because at this stage the disease is ordinarily located in the deep-lying glands entirely out of the range of observation. It is only when the disease has progressed to the point where considerable lung tissue is involved or some of the superficial glands are considerably enlarged that the tubercular condition may be readily detected.

The tuberculin test, on the other hand, responds to the presence of a single active tubercular nodule as readily as to a number, but it unfortunately does not give any measure of the extent of the disease. From these facts it would seem plain that when dealing with the early stages of this disease the tuberculin is the more efficient guide. In our own case only one animal was considered suspicious on physical examination while a tuberculin test of the herd, on Dec. 5-6, 1900, gave a positive reaction with eight mature cows and seven of the young cattle out of a total of twenty-eight. As will be seen the subsequent results proved the reliability of the test.

Ilosis in an advanced stage but what was more alarming her milk contained virulent tubercle bacilli. This latter fact was especially interesting in view of the failure to find any tubercular lesions in the tissue of the udder even when it was cut into thin strips and carefully examined both by sight and touch.

The stable in which these animals were kept was a large basement with two rows of stanchions facing each other but with a wide driveway extending down the center. While the cattle were let out daily, in suitable weather, into the paddock or pasture they were returned each night regularly to their own stanchions. Accordingly the location of the diseased animals in the barn is of interest. Cow No. 8 had stood midway in a row of fifteen mature
CONSIDERING THE SITUATION.

A sound herd was a necessity in order that the experimental work of the Station might be properly conducted. With more than one-half of our cattle diseased, the question was as to the best way to obtain a sound herd. The only way in which we could do this was either by disposing of the diseased animals and buying sound ones or by following the Bang method which has already been described.

The common method of disposing of reacting animals was by slaughter and burial. Where this wasteful method is not followed but the cattle in the earlier stages of the disease are fattened and sold for beef, subject to Federal inspection, only the beef value of a part of the animals could be obtained. In this herd all of the animals represented good breeding and a part of them were registered stock. By following the slaughter method all of the advantages of this breeding would be lost. Again it would be necessary to buy cows to replace the diseased ones, and even if bought subject to the tuberculin test there was a strong probability that they would not all be sound animals. 17

It was accordingly decided to apply the Bang method as soon as suitable quarters could be provided for the two herds. A substantial addition to our stable was then being built and was ready for use in March, 1901.

animals. The first four cows standing immediately to her right all reacted and the first three and the fifth cow standing to her left also reacted. These eight were the only mature cows which responded to this tuberculin test. The two oldest heifers were at the extreme right of the line of cows and did not react. The remainder of the young cattle were at the opposite side of the barn and arranged according to age. The two oldest at the end of the line did not react but the seven younger heifers ranging in age from eight to seventeen months all reacted.

17 These failures to detect the disease are largely due to the period of incubation. (See page 84). This is well illustrated by a cow purchased in 1904 from a herd containing tuberculosis. A few days after her purchase she did not react to the tuberculin test. She remained in our sound herd for six months and at that time gave a good reaction. An autopsy made six months later showed two small tubercles in the glands of the neck and one small one in the lung.
PARTIAL SEPARATION OF THE HERD.

Ten cows and six calves were transferred to this new stable in March, 1901. Because of the time which had elapsed since the test, cows were selected from those which had not reacted at the previous test and included only the two oldest non-reacting heifers. Five of the calves had been dropped since the previous test and had been raised on pasteurized milk.\(^8\)

The remaining heifer, Nellie, was so young at the time of the first test that she was not tested at that time.

While this division of the herd was made as the result of the test it should not be forgotten that this test had been made some three months previous to the date of separation. During this interval the cattle had all been kept in the same stable or had occupied the same paddock.

CHANGES IN THE HERD.

During the interval between the discovery of tuberculosis in November, 1900, and the separation of the sound and reacting animals into two herds in March, 1901, five cows passed out of the herd. Two of the reacting cows died with milk fever and a third became so lame with a tuberculous joint that she was killed. One reacting and one sound cow were sold for beef. March 25th, 1901, we received a heifer calf Carey in exchange for bull calves. She was added to the sound herd. As this calf became a part of our herd before the real beginning of our work of breeding tuberculosis it has been thought best to include her in the enumeration\(^9\) throughout.

During the years in which this work was in progress nine cows and three bull calves have been purchased. As these animals have not been in the herd for the full time and as they were all purchased

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\(^8\) The milk was heated to 85°C. (185°F.) in a continuous pasteurizer such as is commonly used in connection with butter making.

\(^9\) She later produced one heifer and two bull calves and her heifer dropped a bull calf. If any one should take exceptions to this manner of treating the matter they have only to deduct one from the list of sound animals at the beginning and two from the list at the close to obtain the corrected number.
as sound animals (although as has been noted, some became tubercular) it has seemed best that neither these cows nor their offspring should be considered in giving the history of our original herd.

BANG METHOD APPLIED.

Test of October, 1901.—After an interval of eleven months the entire herd was again tested, October 11-12, 1901. At this test, all the animals remaining in the old stable reacted, with the exception of Kittie, one of the heifers which had given a reaction at the previous test. Kate and Tess, two heifers which had not reacted in 1900, now gave an undoubted reaction.

In the new stable the calf, Nellie, which had not been tested the previous year, as well as the cow, Jane, which stood beside it reacted. Two other cows in this stable, Millie D. and Lady of Loch, also gave a reaction.

During the year five cows had developed the disease beside the calf, Nellie, which had not been previously tested. This observation is of interest as it gives an idea of the rate at which the disease was spreading through the herd.

Separation of the herd on the basis of the test.—The calf and the three cows in the new stable which had given a reaction with the tuberculin were now placed with the unsound herd. This left seven cows and six calves, or a total of 13, which had not given a reaction to the tuberculin test out of a total of thirty.

This was the condition of our herd when in October, 1901, we started to replace the diseased animals with sound ones by means of healthy heifer calves raised from the two herds.

In accomplishing this end we did not hesitate to reject any healthy cow or calf when for any reason it did not give promise of being a profitable and desirable dairy animal. Belle of Spring Brook was sold for beef before the end of the year because of sterility. Pet was also sold for beef because she was not a sufficiently profitable animal to be desirable for breeding purposes. For the same reason five of the reacting animals were disposed of at the same time.
DISINFECTION OF THE STABLES.

If the herd was to be kept healthy it was necessary that any germs of tuberculosis which may have been scattered in the new stable by the tuberculous animals be destroyed. Accordingly the new stable was first cleaned and swept and the floor allowed to dry. This latter precaution was taken in order to insure good penetration of the disinfecting solutions.

When in proper condition the entire interior of the stable, with all the utensils in use there, was sprayed with a solution of corrosive sublimate, one part to one thousand parts of water.  

The disinfecting solution was applied in a fine spray with the hope of hitting every part of the surface but the application was continued until the surface was soaked so that there might be enough material at hand to penetrate to considerable depth in porous places.

When the application of corrosive sublimate was dry the walls and stanchions were treated to a coat of oil or paint depending upon the way in which they were originally finished.

In order to reduce the danger of reinfection and consequent aggravation of the disease as well as to decrease the danger of the infected material being carried into the new stable, the old stable was also disinfected.

After a thorough sweeping down and cleaning out, this stable was also carefully sprayed with corrosive sublimate. In this stable the disinfection was followed by a coat of whitewash. We attempted to apply this with a hand spray pump thinking that in this way we could more effectually fill the small crevices. It did not seem practical in this way to handle a whitewash of sufficient body to give satisfaction. With a power sprayer it is quite possible that the result might be better. The caustic effect of the freshly prepared whitewash is such as to destroy the germs with which it comes in contact. While it is a good disinfectant as far as it reaches, its mechanical form is such that it does not penetrate into all of the crevices where it is desirable that a disinfectant should go. For this reason we had made the previous application of corrosive sublimate.

This strength is most conveniently obtained by the use of compressed tablets which may be obtained at any drug store; or 2 ¼ ounces of the powdered corrosive sublimate to fifteen gallons of water will give a solution of the desired strength.
PLAN FOR HANDLING THE HERDS.

The stables having thus been rendered as free from tubercle bacilli as it was practical to get them and all animals which had given evidence of tuberculosis having been taken out of the new stable the task of producing a sound herd of equal size was begun.

As has been explained the plan was to prevent the disease from attacking any more of the sound animals if possible and to rely upon the healthy calves to rebuild the herd. In order to accomplish this, certain precautions seemed necessary.

In the healthy herd.—The animals were kept from all contact with the diseased ones both in the stable and in the pasture. The food and water supply was carefully guarded from infection by the germs of tuberculosis. A satisfactory water supply at the barn is difficult to arrange. A single diseased animal using the common source of supply is liable to contaminate it. For a year we used individual pails but found it a troublesome method.

No barn utensils of any kind were taken from the stable of the infected cows into that of the healthy herd without first being so treated as to remove the danger of carrying disease.

So far as was practical the two herds were looked after by different men. When it became necessary for a single attendant to work with both herds the use of a separate pair of shoes and outer garments in the two barns was required.

The ventilation of the barn was adjusted with the aim of supplying an abundance of fresh air and the exercise and food of the animals was arranged with the idea of keeping them in vigorous condition rather than of forcing a large production.

The cattle were tested with tuberculin twice each year in order that any cases of disease which might develop might be detected before it had spread to other animals. May and November were preferred for making the test but the exact time was determined partly by convenience and partly by a desire to avoid testing cows in an advanced state of pregnancy. Cows were usually omitted from the test when within six weeks of the date when they were due to calve. Strictly speaking, no purchased animal should have been admitted to the sound herd until it had been
tested with tuberculin and failed to react. For lack of a convenient place for holding such animals in quarantine they were usually placed in the sound herd and tested within a few weeks. In a number of cases they were found to be tuberculous and accordingly for a time had exposed the herd to serious danger.

Animals reacting to tuberculin were at once removed to the other herd and were considered as tuberculous after that time no matter what reaction they gave later. There may be exceptions to the rule that an animal once tuberculous always remains so but in the present state of our knowledge the only safe course lies in observing it.

In the diseased herd.—The cattle were given the same care as to their feed and general condition that was bestowed upon the sound herd. It was often a matter of comment by persons who inspected both herds at different times during the progress of the work that the diseased herd, so far as physical appearance went, was fully the equal of the sound one.

The cattle were tested with tuberculin at least once a year and in most cases twice. This was done for the purpose of scientific study rather than with any idea of returning them to the sound herd.

Whenever any of the animals were found to be unsatisfactory for breeding purposes and were in good condition they were sold for beef.

When any of the animals began to show signs of breaking down due to the disease they were killed and buried. This was done because their usefulness was about at an end and to have kept them longer would have needlessly exposed their companions and have increased the danger to the sound herd. For this reason Cows No. 4 and No. 10 were killed in November, 1901.

A few of the tuberculous cows were killed in order to clear up certain questions which arose in connection with the work.

The milk from the tuberculous herd was handled in entirely separate utensils and was passed through a continuous pasteurizer at 85°C. (185°F.). It was then considered harmless\(^2\) and the skim milk was fed to the calves and the cream made into butter.

\(^2\) The fact that all of the 25 calves fed with this milk remained free from tuberculosis is good evidence that it was really harmless.
During a considerable period the milk was used, after being thus pasteurized, for the local milk trade with entire satisfaction.

The calves from the tuberculous cows were at once removed to the sound herd and were fed on the full milk of the sound cows and later upon the mixed, pasteurized, skim milk from both herds.

**Changes Induced by the Burning of the Barns.**

In May, 1902, the Station barns were destroyed by fire. This fire started in the upper portion of the new stable and spread so rapidly that three calves and one two-year old heifer from the sound herd were destroyed. In the confusion attending the removal of the cattle from the stables both herds were allowed to mingle and remain together for a few hours. They were, however, promptly separated and placed in temporary quarters.

Up to this time we had accurate records of the food consumed and milk produced by each animal. From this data we hoped to obtain some information concerning the relative profit of keeping tuberculous and sound cows. All of these data were lost through the burning of the barns and until some months later it was not practicable to continue these observations. It then seemed necessary to dispose of all of the least promising cows on account of the lack of stable facilities. A comparison of the relative profit after such a process of selection would be of little value and has not been attempted.

**Progress of the Experiment.**

*Test of June, 1902.*—At this test we had thirteen sound animals, twelve from the last test and a calf from the tuberculous Millie D.

The fourteen diseased animals all reacted, including Kittie who had failed to do so at the test in 1901.

Jane was killed just prior to the test as she was failing fast. The disease had vigorously attacked her liver which probably accounted for her breaking down in about a year after she had contracted tuberculosis.

*Test of December, 1902.*—In the sound herd, Belle of Spring Brook and Pet had been sold for beef. The eleven animals remaining from the previous test failed to react as did the calf of
the tuberculous Aurora, giving us a total of 12 sound animals.

In the diseased herd five animals had been sold for beef and Cassy, who was breaking under the disease, was killed. The autopsy showed fairly generalized tuberculosis. Of the eight remaining cows, Cow No. 9 was not tested because she was about due to calve. The other seven were tested and all reacted except Millie D.

Test of April, 1903.—The twelve healthy animals and the three calves, all from healthy cows, failed to react making a total of 15 sound animals. The tuberculous herd was not tested. Cow No. 9 died with milk fever just after the date of the previous test, leaving but seven diseased animals.

Test of December, 1903.—The sound herd, consisting of the fifteen head at the last test, now numbered twenty, three of the five calves coming from the diseased herd. All passed the test.

In the diseased herd Aurora was not tested because she was about due to calve and of the remaining six only Chloe and Nettie gave a reaction. No satisfactory reason can be given for the failure of the other four to react.

Test of May, 1904.—The sound herd contained twenty-four animals at the date of testing, two of the four calves dropped since the last test coming from the diseased herd. A single animal, Daisy of Lock, gave a typical reaction with the tuberculin, leaving us 23 sound animals. Almost immediately following the test this cow became so lame as to be practically helpless. Treatment failed to relieve the trouble and she was killed. An autopsy showed the presence of a few tubercular lesions in the mediastinal glands. This was evidently a case of recent infection and as we obtained a reaction at the same test from a cow which had been added to the herd by purchase an explanation of the avenue of infection seems simple. This was the first case of infection in our sound herd after the separation in 1901.

The lameness was apparently not connected with tuberculosis but was probably due to accident. At least no evidence of tubercular lesions could be found in the affected joint.

With the exception of Millie D. the seven diseased cows all gave a reaction with the tuberculin. The reaction was a surprise in the case of Aurora who had been failing very rapidly and was now plainly in the last stages of the disease. It is often
stated that animals in such a condition fail to react. She was killed and examined shortly after the test and was as full of diseased tissue as a cow could well be conceived of being. Her lungs were so solid that they did not collapse after death and both body cavities were so covered with tubercles as fairly to obscure the membrane upon which they rested.

Test of November, 1904.—All of the members of the sound herd failed to react. This herd now contained the twenty-three animals which were sound at the last test and two calves, both coming from diseased cows, making a total of 25.

Millie D. and Lady of Loch of the six diseased animals failed to react.

Test of May, 1905.—The sound herd now contained twenty-nine animals, of the increase 3 being due to calves from the sound herd and 1 from the diseased. All of this herd passed the test except Aurora's Fancy, leaving 28 sound animals. This was the second and the latest case of a member of our sound herd becoming diseased. This animal was the last calf dropped by Aurora at a time when the dam was in the advanced stages of the disease. The calf was always of doubtful vigor and its destruction on this account had been discussed. However, on account of the desirable breeding involved it was thought best to hold her until she had shown her ability as a milker. She was evidently not diseased from birth as she had failed to react as a yearling. Two avenues of infection may be suggested but neither of them seems satisfactory. The bull pen is in the same stable in which the young cattle are kept and our bull had given a typical reaction the year previous. Also the man who had charge of the tuberculous herd assisted in caring for the young cattle. The main difficulty with both explanations is the fact that the calf was sound at the previous test and had been placed in pasture immediately after and had remained there until a few days preceding the test at which she had reacted. Again if the stable conditions were responsible for her infection it was strange that no similar cases have developed before or since.

With the exceptions of Kate and Millie D. all of the 6 cows in the diseased herd responded to the test. As this was the last test given to these animals, with the exception of Millie D., the record of this test is given in Table I.
<table>
<thead>
<tr>
<th>NAME</th>
<th>BREED.</th>
<th>Before Use of Tuberculin</th>
<th>After Use of Tuberculin</th>
<th>Before Use of Tuberculin</th>
<th>After Use of Tuberculin</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<td>P. M.</td>
<td>A. M.</td>
<td>P. M.</td>
</tr>
<tr>
<td></td>
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<td>7:00</td>
<td>9:15</td>
<td>9:45</td>
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<tr>
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<td>101.8</td>
<td>102.2</td>
<td>103.4</td>
</tr>
<tr>
<td>Lady</td>
<td>Jersey</td>
<td>11</td>
<td>960</td>
<td>101.4</td>
<td>102.3</td>
</tr>
<tr>
<td>Kate</td>
<td>Grade Jersey</td>
<td>6</td>
<td>900</td>
<td>101.4</td>
<td>102.0</td>
</tr>
<tr>
<td>Lily</td>
<td>Jersey</td>
<td>6</td>
<td>880</td>
<td>100.9</td>
<td>102.4</td>
</tr>
<tr>
<td>Nettie</td>
<td>Jersey</td>
<td>13</td>
<td>950</td>
<td>101.2</td>
<td>101.6</td>
</tr>
<tr>
<td>Millie D.</td>
<td>Jersey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Test of November, 1905.—The sound herd now contained the twenty-eight animals which did not react in May and two calves, one descended from each herd. None of these animals gave any reaction to the tuberculin.

Millie D. was the only member of the diseased animals which was tested at this time. She again failed to react.

This test practically closes this experiment as we had now thirty sound animals which was the total number in our herd at the time we undertook to stop the further spread of the disease and replace the diseased animals by healthy calves.

SUMMARY OF CONDITION OF STATION HERD.

Table II shows the progress of the work during the four years, giving the standing of the herds at each test as well as the changes occurring during the preceding six months. From the table it will be seen that it took four years to replace the seventeen animals which were diseased at the beginning, the two which later contracted the disease, the four which were burned with the barn, and the two which were sold, making a total of twenty-five. Of this number of calves eleven have descended from the thirteen sound animals and fourteen from the seventeen diseased animals. The contribution from the diseased herd was affected by the removal of nine of the cows during the first year of the experiment without their producing offspring and by two of the remainder producing only bull calves.

This work was carried out in the face of as many natural difficulties as can ordinarily be expected in an average dairy. It is accordingly believed that with good care the rebuilding of a similar herd can be regularly accomplished in from three to five years.
**TABLE II.—Summary of Condition of Station Herd.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Healthy</th>
<th>Diseased</th>
<th>Total</th>
<th>Heifer calves dropped</th>
<th>Died</th>
<th>Sold</th>
<th>Rejected, infected</th>
<th>Heifer calves dropped</th>
<th>Died</th>
<th>Sold</th>
<th>Killed</th>
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<tbody>
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<td>1901</td>
<td>Oct...</td>
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<td>17</td>
<td>30</td>
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<td>12</td>
<td>8</td>
<td>20</td>
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<td>2</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
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<td>April</td>
<td>15</td>
<td>7</td>
<td>22</td>
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<tr>
<td>1903</td>
<td>Dec....</td>
<td>20</td>
<td>7</td>
<td>27</td>
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<td>1</td>
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<tr>
<td>1904</td>
<td>May....</td>
<td>23</td>
<td>7</td>
<td>30</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
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<td>Nov....</td>
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<td>6</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1905</td>
<td>May....</td>
<td>28</td>
<td>6</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1905</td>
<td>Nov....</td>
<td>30</td>
<td>6*</td>
<td>36</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*The six diseased animals were killed after the November test. For their autopsy record see page 108.

**THE SALE OF TUBERCULOUS COWS FOR BEEF.**

The most exacting rules which are employed in this country in judging of the quality of meat for human food are those of the Bureau of Animal Industry. Similar regulations are in force in many of the more highly civilized countries. These rules are applied in all of the slaughter houses which are engaged in

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22 The regulations applying to tuberculous cattle are given on page 87.

23 The Royal Commission of England reports that "as a result of the inspection in 29 towns in Saxony during the year 1895 tuberculosis was found to exist in 22,758 carcasses—being 27.48 per cent. of the whole number slaughtered. Of the total number, 22,758 carcasses, showing tuberculous lesions, 21,062 or 92 ½ per cent. were passed as fit for food; 1,256 or about 5½ per cent. were disposed of in the Freibank as inferior meat, at a fixed cheap rate; and the remainder 440 carcasses or 2 per cent. of the whole number pronounced tuberculous in a greater or less degree were condemned as unfit for food and destroyed. (From Report of N. Y. Assembly Committee, 1901.)
inter-state or export trade and they specifically provide that carcasses of cattle affected with tuberculosis in which the lesions do not exceed a stated limit shall be stamped the same as those from absolutely sound animals. As a result of the inspection under these rules, a considerable amount of beef\(^{24}\) from tuberculous animals is annually included in that class which is justly considered the best beef on the American and European markets.

The animals disposed of by us were sold with the understanding that they should be sent to slaughter-houses where the carcasses would receive an official inspection.

If one studies the nature of tuberculosis, it is evident, as experiments and practice have shown, that localized lesions enclose the tubercle bacteria and that the danger from consuming the flesh of such animals is very slight. If the disease is generalized, i. e. the lesions are distributed in the organs of both the large body cavities or, according to Ostertag, if there is an old tubercular lesion and many small miliary tubercles in organs in the same body cavity, the carcass should be condemned.

Experience has shown that when reacting animals of a herd are killed, after the tuberculin test, a very large percentage of them are so slightly diseased that the lesions would have escaped notice had the animal been killed in the ordinary way for beef, or, if the changes are in evidence they would not, because of their localization, condemn the carcass. In view of the practice of various national meat inspections which have proven to be safe, it seems perfectly proper and just that animals that have reacted to tuberculin but which, from the flesh point of view, are in a fit condition for beef should be retained for food providing they pass inspection under the rules of the Federal Meat Inspection Service.

It is most unfortunate that the butchers of our small towns and cities, and often those slaughtering for home consumption in our larger cities, are permitted to sell meat from animals that are

\(^{24}\) According to the report of the Bureau of Animal Industry its representatives, during the fiscal year 1903-04, made post mortem inspection of 6,383,080 cattle and 24,170,230 hogs. Of these 10,173 carcasses and 703 parts of carcasses of cattle and 34,656 carcasses and 181,820 parts of carcasses of hogs were condemned for tuberculosis.
not so inspected at the time of slaughter. In the absence of such a general system, the published rules of the Federal Meat Inspection Service (see page 87) make it possible for a competent veterinarian to decide for the owner whether or not a carcass can be used with safety for food. It is hoped that in the near future the laws of this State will provide for the inspection of such animals, thereby giving the small owner an equal chance with the large packing houses for the equitable disposition of slightly infected animals.

The situation would be highly satisfactory if as consumers we could avoid eating the meat or drinking the milk of tuberculous animals, but under existing conditions we can hardly expect to do this. We shall approach perfect conditions in this respect only as we reduce the number of infected animals. There can be no hesitancy, however, in the acceptance of the statement that the inspected carcasses are much to be preferred to great quantities of home-killed beef that is sold without inspection of any kind and where the only protection the consumer has against the consumption of the meat of animals suffering from generalized tuberculosis is the opinion and conscience of a man unskilled in the nature of this disease. If the meat and milk of animals suffering from generalized tuberculosis can be excluded, a long step in advance of present conditions will have been taken.

AUTOPSY ON TUBERCULOUS COWS AT CLOSE OF EXPERIMENT.

At the close of the experiment we still had six of the diseased cows. Of these Chloe was in good condition for beef, while Millie D., who was now fourteen years old, was in poor condition. The others were in average flesh for dairy cows.

As three of these cows had been diseased for five years, or since they were calves, and the other three had been tuberculous for at least four years it seemed best to hold an autopsy on these animals in order to note the progress which the disease had made during this time.

In order to conserve the beef value which was in the cows an
arrangement was made with a local butcher to buy such of the
 carcasses as should pass a proper inspection and were otherwise
 in condition for beef. The Bureau of Animal Industry kindly
 consented to send an inspector from Buffalo to pass upon the
 quality of the carcasses under the same rules in use at the
 slaughter houses in Buffalo and elsewhere.

The local health officer, when consulted, raised objection on
 the basis of local regulations to the sale of such Government
 Inspected meat which if passed would have been of the same
 quality as that which is being shipped to this city in car load lots
 and would have been immeasurably better from the standpoint of
 public health than much of the locally killed meat which is sub-
 jected to no inspection whatever.

Desiring to avoid any conflict with the local authorities the
 idea of selling the meat was abandoned, but in order to deter-
 mine what value still remained in the animals the carcasses were
 carefully inspected. For this work we availed ourselves of the
 services of Dr. W. B. Mack, Assistant in the Department of Com-
 parative Pathology and Bacteriology at the N. Y. State Veterinary
 College. While no longer officially connected with the Bureau of
 Animal Industry, Dr. Mack had just returned from Kansas City
 where for some months he had served as a Federal Inspector in
 one of the large slaughter houses. The results of the examina-
 tion made by Dr. Mack of the carcasses of five of the tuberculous
 cows are, in reference to that disease, as follows:

POST MORTEM NOTES BY W. B. MACK, D.V.M.
Geneva, N. Y., Nov. 17 and 18, 1905.

The following tubercular lesions were found:—

Nettie.— Mediastinal lymphatic glands enlarged and caseated with a few
 slight calcareous foci in one of them. Right lung, principal lobe, contained
 a caseous area about 1.5 cm in diameter. In the liver substance were
 seven or eight tubercles from 0.5 to 1.5 cm in diameter.

Lily.— Mediastinal lymphatic glands enlarged and caseous. Extensive
 caseous lesions in both lungs. A large number of tubercles from 0.3 to 1
 cm in diameter attached to the left costal pleura and that covering the
 mediastinum. Liver contained four tubercular areas from 1 to 2 cm in
 diameter.
Chloe.—One mediastinal lymphatic gland showed slight tubercular foci. Both prescapular lymphatic glands contained slight foci of the disease, apparently quite old.

Lady.—Mediastinal lymphatic glands enlarged and caseous with extensive caseous lesions in both lungs.

Kate.—Mediastinal lymphatic glands somewhat enlarged and contained slight tubercular foci in a calcareous condition. Left prescapular gland has two foci of the disease about 0.4 cm in diameter.

"In my opinion the cows Chloe and Kate would pass the Federal meat inspection. The lesions in the others were either too extensive, too largely distributed or in such condition as to warrant their condemnation for food."

In considering the slight progress which had been made by the disease in the case of some of these cows it should be remembered that they were what had been left by a process of selection from the entire herd of nineteen animals.

Millie D. was in such poor condition as to have little beef value. She was killed and carefully examined December 12. Her poor physical condition was evidently due to causes incident to old age as a very complete examination showed only small tubercles (about the size of a small pea), evidently well encapsulated, in three of the tracheal and mediastinal lymphatic glands. It should be remembered that this cow had not reacted for three years so that the age of the lesions can be very closely determined. Although these hard and sharply circumscribed lesions gave every appearance of dead tissue, a Guinea pig was inoculated subcutaneously with three of these little tubercles. It died in six weeks with generalized tuberculosis. This observation is important in that it shows how long these bacteria may remain alive in the encapsulated tubercles.